OPERATION & MAINTENANCE

OF THE

MRC-565-15 GNSS PACKET DATA RADIO

Rev. G
December 23, 2021

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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.

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 ensure safe operation the antenna must be mounted such that the separation between the antenna and any human occupants of the vehicle exceeds 0.90 meters (36"). 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 2.2 meters from any humans occupants. Lower gain antennas, such as side mount dipoles, exhibit lower gain (5.2 dBi) allow closer separations (1.3 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

Revision #	Date	Revision
Redline	04/20/2014	Redline Release
Initial	05/10/2014	Initial Release
A	05/25/2014	Release A TD
B	12/23/21	Update format, references, TOCs (JW)
C	6/21/2014	Update format, references, TOCs (JW)
D	6/22/2014	Updated Theory of Ops TD
E	7/17/2014	Update format, TOC (JW)
F	10/25/2021	Added GNSS module to CMU board
G	10/25/2021	Added FET PA board
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
- The MRC-565 has a wideband (40-46 MHZ) FET-PA with adjustable power levels (10,25,50,100 watts) controlled by CMU commands.
- No battery backed up RAM. No PWR FAIL RESTORE message
- New LPM modes
- Ethernet Port with TCP/IP
- M8 Ethernet Port – connection to GNSS Daughter Board hosted on main processor board
- 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 can operate with one modulation format:

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).

The radio is FCC type accepted for operation with either modulation in Low Band VHF 40-46 MHZ band with an authorized bandwidth of 20 KHZ.

The MRC-565 is frequency synthesized. One MRC-565 model covers the range of frequencies from 40 to 46 MHZ. This model has a unique FCC Type acceptance number as noted below:

MRC-565-40-46 Frequency Range 40-46 MHZ FCC ID 2ABUV-MRC565-40-46

"This device complies with part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference."

"Changes or modifications not expressly approved by Maiden Rock Communications could void the user's authority to operate the equipment."

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 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.

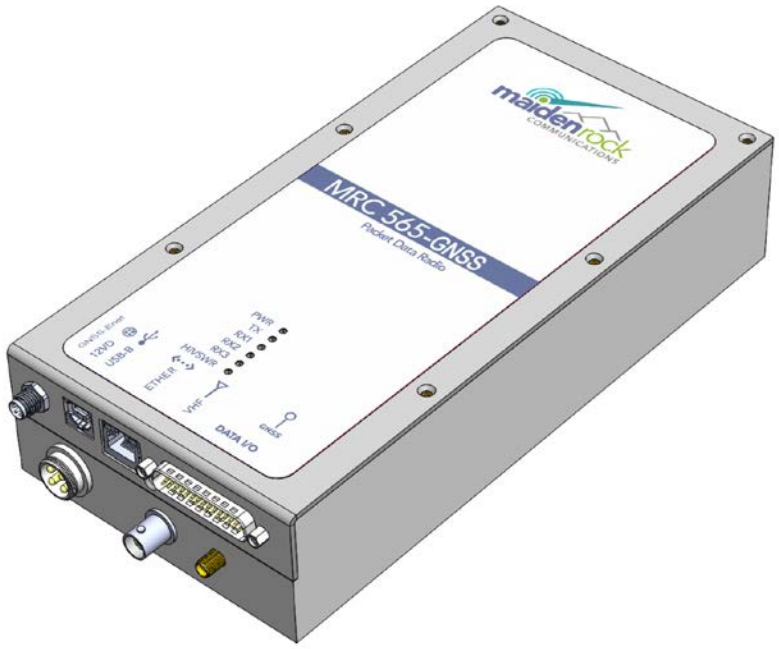


Figure 1. MRC-565 Packet Data Radio

The MRC-565 has two Printed Circuit Assemblies and one optional GNSS Daughter board:

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), 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 variable power level (10,25,50,100 watt) Power Amplifier (PA)

   The power amplifier is used to boost the RF TX level of the CMU from 0 DBM to 40-50DBM (10,25,50,100 watts) using a 3-stage power amp. This amplifier contains an AGC that maintains a fixed power level under varying DC voltage levels over a temperature range of -30 to +60 C.

3. Optional GNSS Daughter board can be added to the MRC565 allowing for Sub 10cm accurate positioning, given that RTK broadcasts are setup at the Base Station radio.

2 NETWORKS

2.1 Extended Line of Site Systems

The MRC-565 can operates 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 3 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 of Repeater in carrier sense multiple access mode.

The remainder of this manual is organized in the following 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

2.2 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. Application Note: CR10X Data Acquisition, January 25, 2014
2. Application Note: CR1000 Data Acquisition, February 23, 2014.
3. 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.

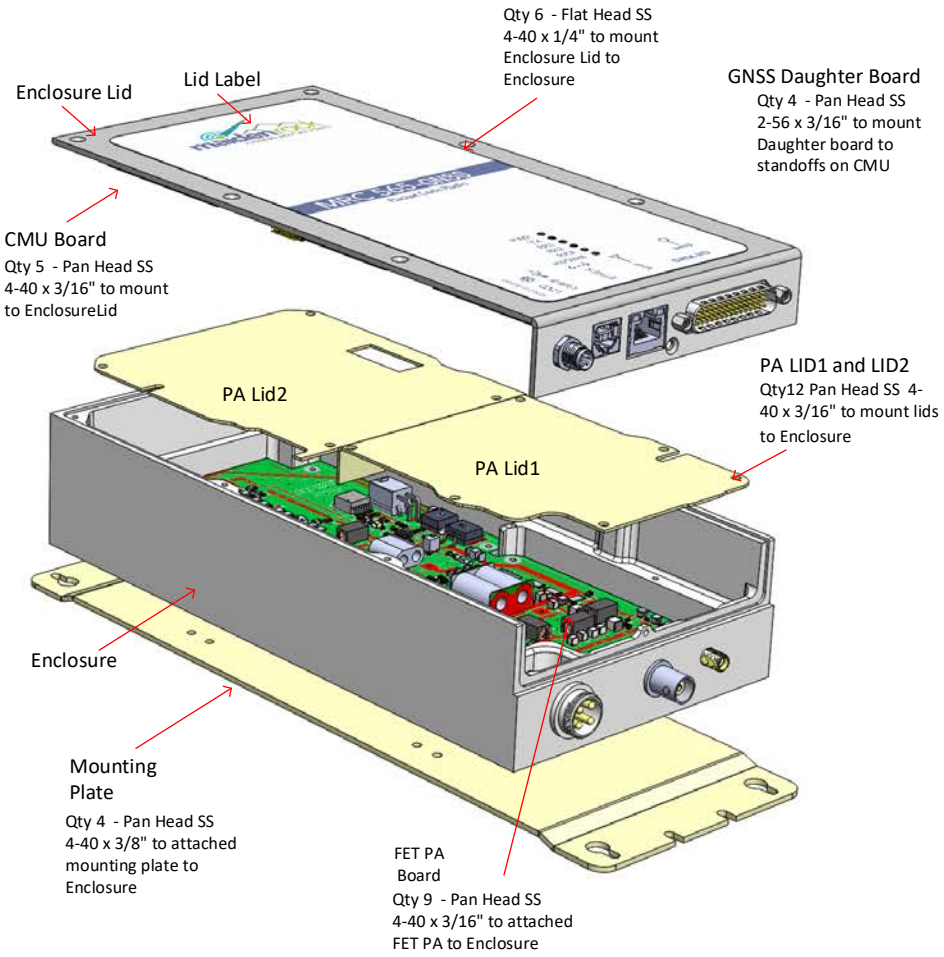


Figure 2. Exploded view of MRC-565

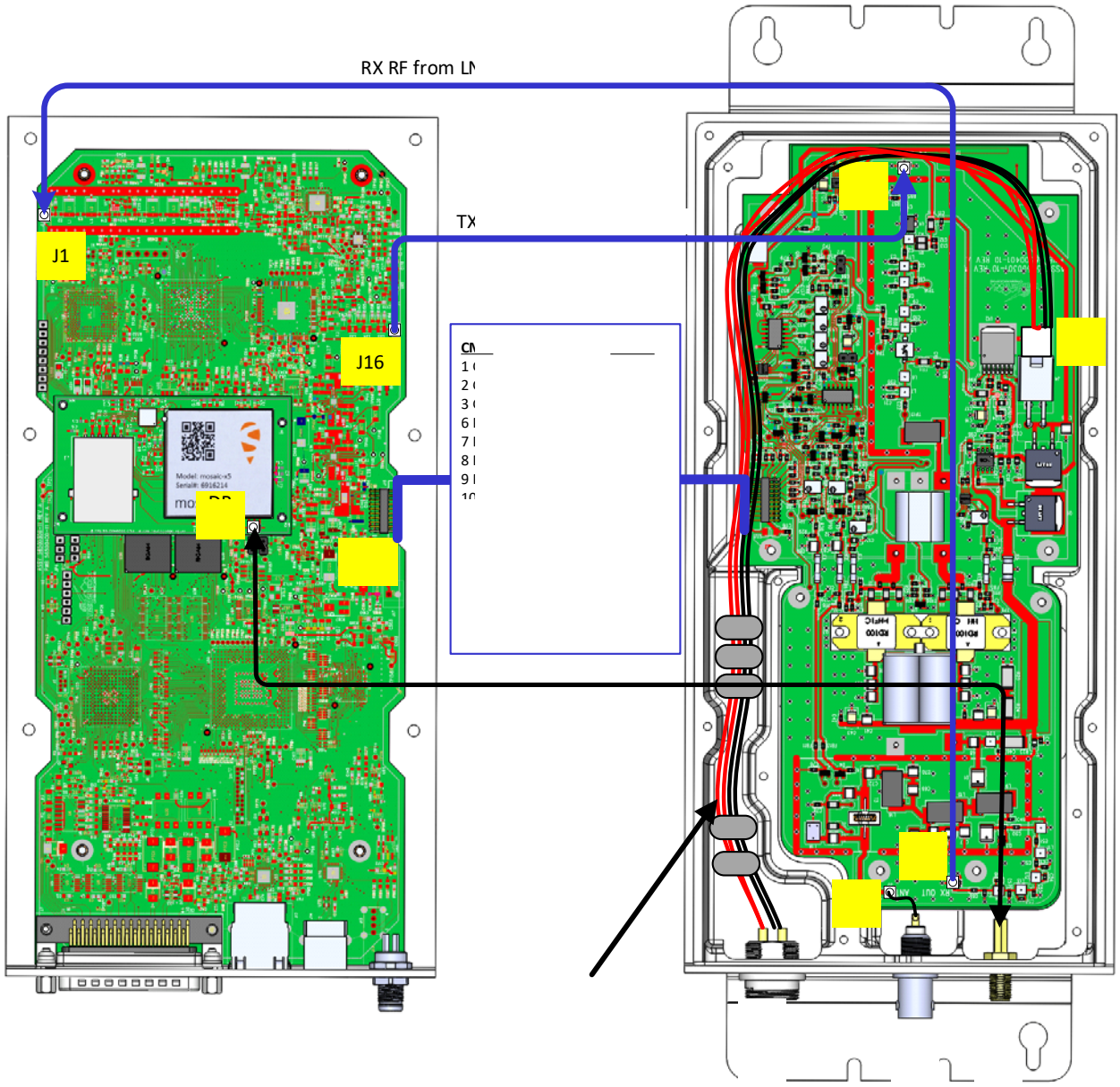


Figure 3. MRC-565 Wire Diagram

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-56500300-04
2. Power Amplifier (PA) MRC-5650030-10

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:

- 8M x 16 of non-volatile flash memory for program storage
- 8M 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-B Device Port for connecting MNT port Laptop
- Internal TTL GNSS Daughter board mounted onto CMU .
- Transmitter 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.

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 up-conversion 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 10,25,50,100 watt configurable power 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 10,25,50,100 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 braclet)	9.8"L X 4.8"W X 2.1"H
Weight	3.8 lbs.
Temperature Range	-30° to 60° C (-22° to 140° F)
Power Requirements 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	12 V_{DC} Nominal (11-15 V_{DC}) 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) 40-46 MHZ	+/-.0005% Synthesized 10KHz steps
Modulation: Type Rate Format	GMSK 9.6 kbps NRZ
Noise Figure	< 7 dB minimum
Sensitivity: Bit Error Rate < 10^{-3} 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
3rd 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) 40-46 MHZ	 +/- .0005% Synthesized 5KHz steps
RF Power Output	> 10,25,50 or 100 Watts at 12-16 V_{DC} Input
Load VSWR	< 2:1 Rated Power (shut down if >2:1)

Harmonic Levels	70 dB below Unmodulated Carrier
Modulation: Type Rate	GMSK 9.6 kbps
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 (shuts down if VSWR > 2:1)

Table 4. MRC-565 Microprocessor Specifications

CHARACTERISTIC		SPECIFICATION
Main Processor		Motorola MC68332FC 32-bit Embedded Controller
Memory:	Program Storage Data Storage Parameter Storage	8M x 16 non-volatile Flash memory 32M x 16 static Dynamic RAM 8M 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 (8M 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 (8M 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 recopy 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 > 2:1 is detected (means bad antenna, RF power turned off)

Figure 4. MRC-565 Front Panel

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.

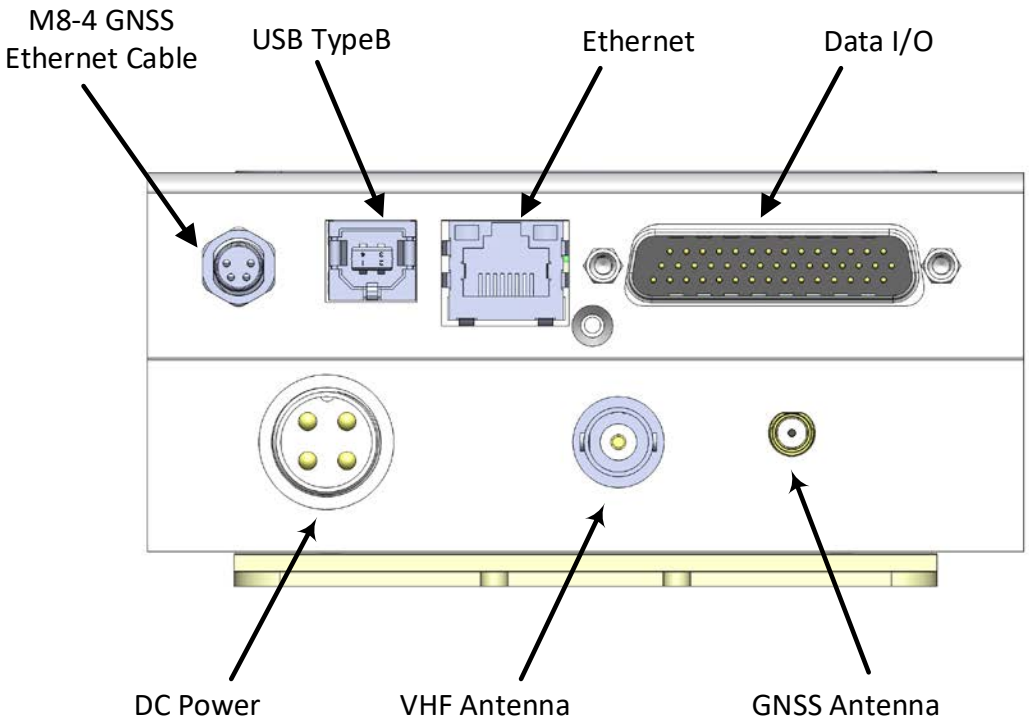


Figure 5. MRC-565 Connector Panel

4.1.1 DC Power

The MRC-565 requires a power source that can deliver up to 20 amps of pulsed power (100 msec) from a +12 V_{DC} to +16V_{DC} 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:

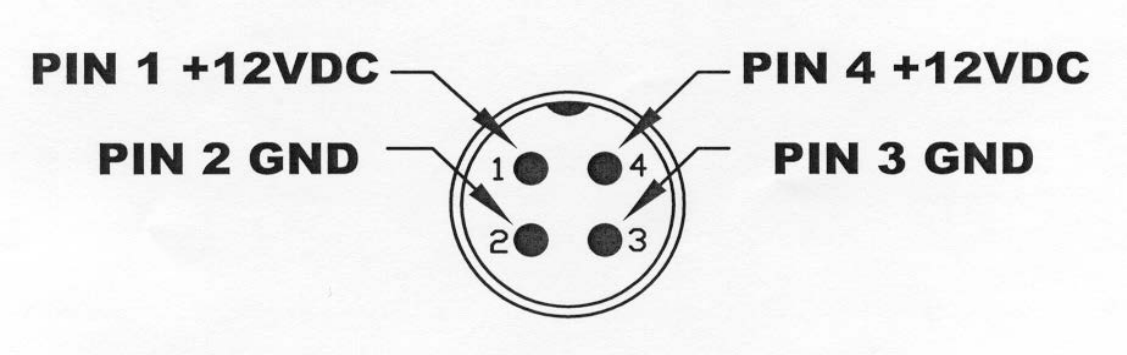


Figure 6. DC Power Connector

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

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 5 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:

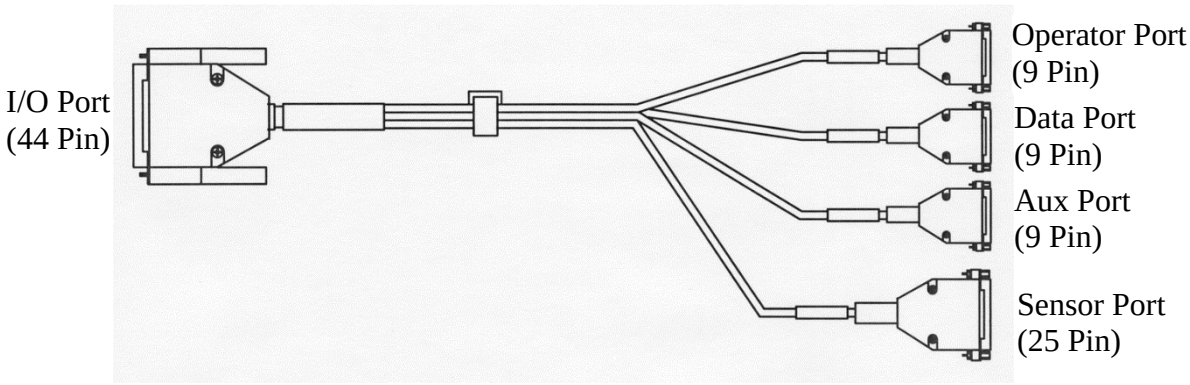


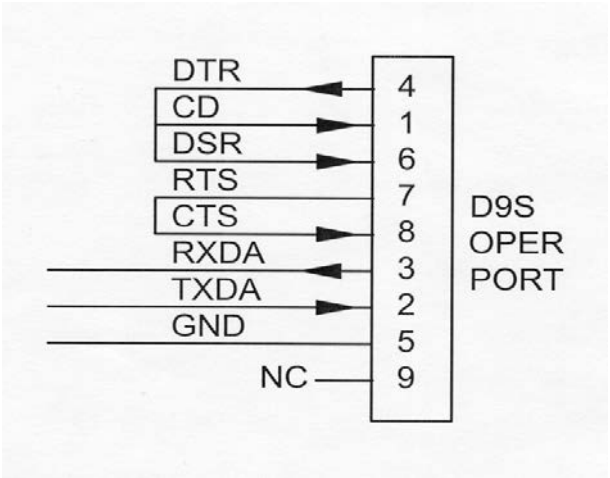
Figure 7. MRC-565 44 Pin I/O Cable

A 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

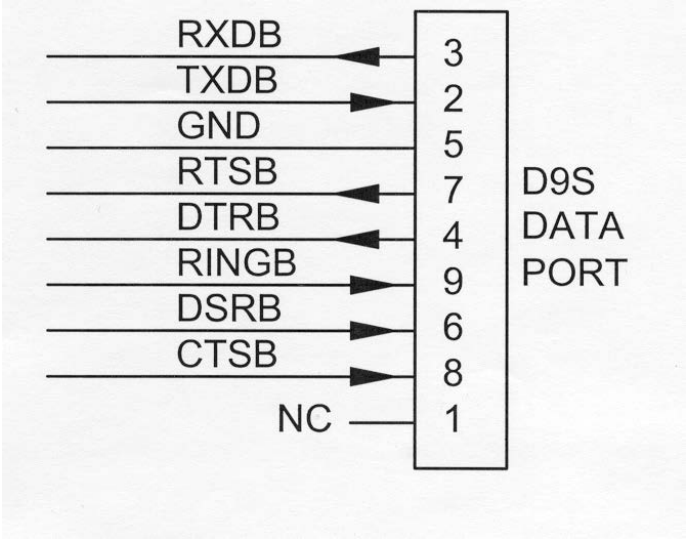


The Operator Port will display all warnings, messages, data report, and alerts.

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.

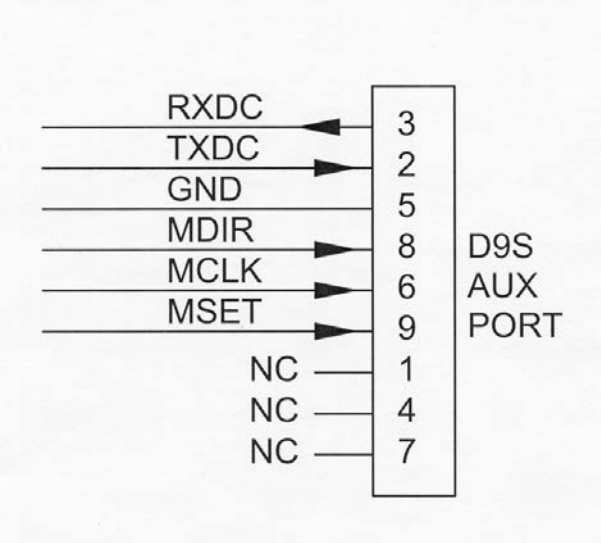
DATA PORT – 9S	
Pin	**Signal**
1	Not Used
2	Tx Data
3	Rx Data
4	DTR
5	Ground
6	DSR
7	RTS
8	CTS
9	Ring



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.

SENSOR PORT	
Pin	**Signal**
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) ±1%
20	Analog Input #4 (0 to 5 V) ±1%
21	Analog Input #5 (0 to 5 V) ±1%
22	Analog Input #6 (0 to 5 V) ±1%
23	+12V Switched (.5A Max)
24	+12V (0.5A Max)
25	Det RF for Chan #1

4.1.5 GNSS Ethernet

GNSS Ethernet Port on the front panel of the MRC565 Radio is used to configure and monitor the internal GNSS daughter board attached to the Main CMU board. To access, a web browser the default IP address 192.168.10.2 port 80 can be used.

4.1.6 Radio Ethernet Port

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 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 protocl

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 5.3.1.2 .

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

                    /
                  /  /  /
                 /  /  /
           ***  O  /  O    Maiden Rock Comm, LLC
         *******  O    /\
      /\ *********   /\/  \/\
   /\/  ***********\/  \  /  \
 ^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
     MRC-565 Packet Data Radio
Copyright (C) 2014 Maiden Rock Comm, LLC
        All Rights Reserved
CMU  Version 1.01.0121 10/15/21 07:30 AM
DSP  Version 02.10 140221a_fc
FPGA Version 01.20 140216_ab
CPLD Version 56 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. The CPLD version must be 56 or the PA power level control commands will not function properly

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 LOS 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 or BASE. 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.

If you want to operate as a Base enter

DEVICE,BASE [ENTER]

SAVE [ENTER]

4.3.2 Role

ROLE is used to set the Operating Mode and the RF Protocol for the device.

LOS Used LOS networks

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

ROLE [ENTER}

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.

MODE	DESCRIPTION
PREF	Unit connects to the **mmmm** 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. **In this mode the unit can communicate with only one Master at a time.**
AUTO	Unit connects to the **mmmm** 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. **In this mode the unit can communicate with only one Master at a time. This is the preferred mode for LOS networks**
FIXED	Connectivity will be fixed to the **mmmm** Master. **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.**

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         3       9.6K       gmsk9.6
 Channel Table:
  Channel   TX mhz     RX mhz   Mod-Val   Bit rate   Modulation
    00      40.0000    40.0000      3        9.6K       gmsk9.6
    01      46.000     46.0000      3        9.6k       gmsk9.6
```

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 0 above enter:

ASSIGN,RX1,0

CHANNEL, 0

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	LOS
ID	00500,00001,MULTI	DEFAULT DEST.	0
MODULATION	GMSK9.6	TRANSMIT KEY	STARTED
BIT RATE	9.6K	MESSAGE HOLD	OFF
DUPLEX MODE	HALF DUPLEX	SCHEDULE	ACTIVE or EMPTY
SERIAL	1	TX LIMIT	200
CHECK IN	90	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_{DC}.
- 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 2:1. Check the antenna and coaxial cabling for proper installation.

If the DET RF is greater than –110 dBm (for example, -100 dBm), the unit will still perform properly but the latency time of the link will be increased. Refer to Appendix D 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

5 OPERATIONS

This chapter covers the basic operating procedures for the MRC-565 as it's used in a LOS 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]

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, Base
- Device Role — LOS
- 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

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.

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 a LOS network:

```
+CHANNEL 01/01/00 01:08:29
 Primary Channel   TX mhz     RX mhz   Mod-Val   Bit rate   Modulation
                00   40.0000   40.0000     3         9.6K       gmsk9.6
 Channel Table:
  Channel      TX mhz        RX mhz   Mod-Val   Bit rate   Modulation
   > 00        40.0000       40.0000   3         9.6K       gmsk9.6
     01        46.0000       46.0000   3         9.6K       gmsk9.6
+
```

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

5.2.2 Device Type

The MRC-565 can operate as either a Remote Station, 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 connect to a Base Station using base station selection algorithm.

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**)**

5.2.3 Setting the Operating Role

To see what ROLE the device is set to enter:

ROLE

The **Role** must be set to LOS for LOS networks.

5.2.4 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.

5.2.4.1 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

5.2.4.2 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

5.2.4.3 LPM,ALARM

This mode is the same at 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.

5.2.4.4 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 power 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 the is mode you must also set an power time out interval which turn 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

5.2.5 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

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,	(RS-232 Port Functions)
		E1F1, E1F2, E1F3, E1F4,	(Ethernet1 Functions)
		RX1, RX2, RX3	(RF Receiver Functions)
	Port =	0, 1, 2	(RS-232 ports)
		3	(I2C)
		4, 5, 6, 7	(Ethernet1 Ports)
		0, 1, 2	(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
STT,secs	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 Uses a lookup table to relate the printed power levels to the VF voltage
Power Amplifier Uses a lookup table to relate the printed power levels to the VR voltage
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 converters 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:

Scale Factor = (5.0/4095) *1/INPUT DIVIDER = .0012207 * 1/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.

COMMAND	DESCRIPTION
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 resister 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 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 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.

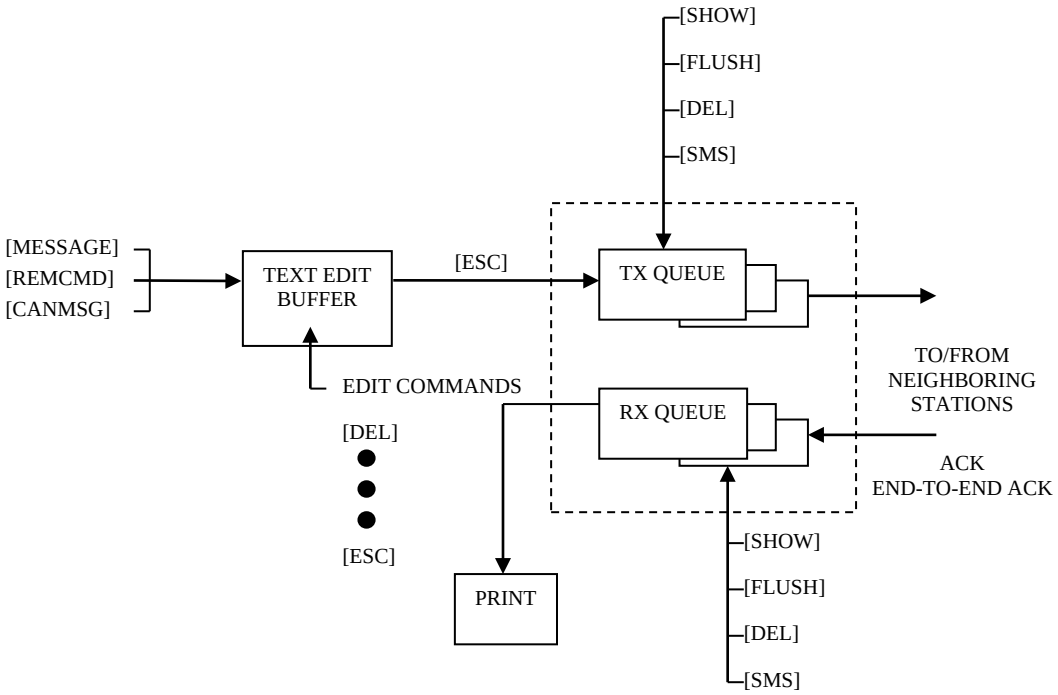


Figure 7. Message Flow and Associated Commands

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

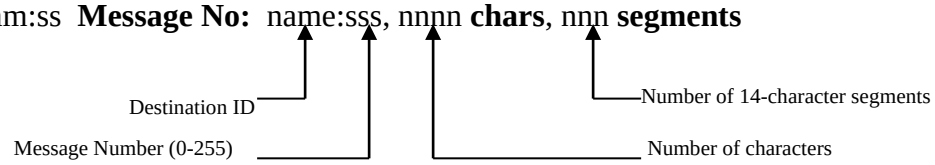
Commands may be sent to any station within the network. The entry of a command is similar to the MESSAGE command described in Section 4.3.1.

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, $+12V_{DC}$ 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 +/-.1% and an accuracy over temperature of ±1%.

SIGNAL PORT	
Pin	**Signal**
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**.

CR10X	Display CR10X configuration parameters
,ACQMODE,ALL	Get all reports since previous scan
,CURRENT	Get only the current (last) data group
,LAST,N	Get only the last 'N' data groups (backsup 'N' data groups from the last one)
,SETPTR,DATE,TIME	Manual set up of last data pointer in the MRC-565
,INTERVAL,N	Scan interval in seconds
,OFF	Scan only when UPDT command is entered
,ORDER,FIFO	Get final storage data in FIFO order
,LIFO (not avail)	Get final storage data in LIFO order
,GROUP,MRC-565A	Let MRC-565 assign group numbers
,CR10X	Get Group Number from 1st stored sensor
,TIME,MRC-565A	Use MRC-565 internal Time
,CR10X	Get time from 2nd and 3rd sensor
,MAXQ,NNN	Set maximum number of reports to queue for each scan of the CR10X
,SCALE,CR10X	Scale sensors in cr10X Hex units
,INT (or MRC-565A)	Scale sensors in integer Hex units
,REGISTER,N	Read internal storage register 'N'
N,DDD	Set internal storage register 'N' to 'DDD'
,STAT	Read and display CR10X internal pointers and error statistics.
,RESET	Reset CR10X internal error statistics.
,SECURITY,1111,2222,3333	Enter CR10X Internal Security Codes
,SIGNATURE	Read and Display Current CR10X programs Signature.
,MODEM ENABLE	Enable/Disable use of ME/Ring control

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 is 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**”x 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

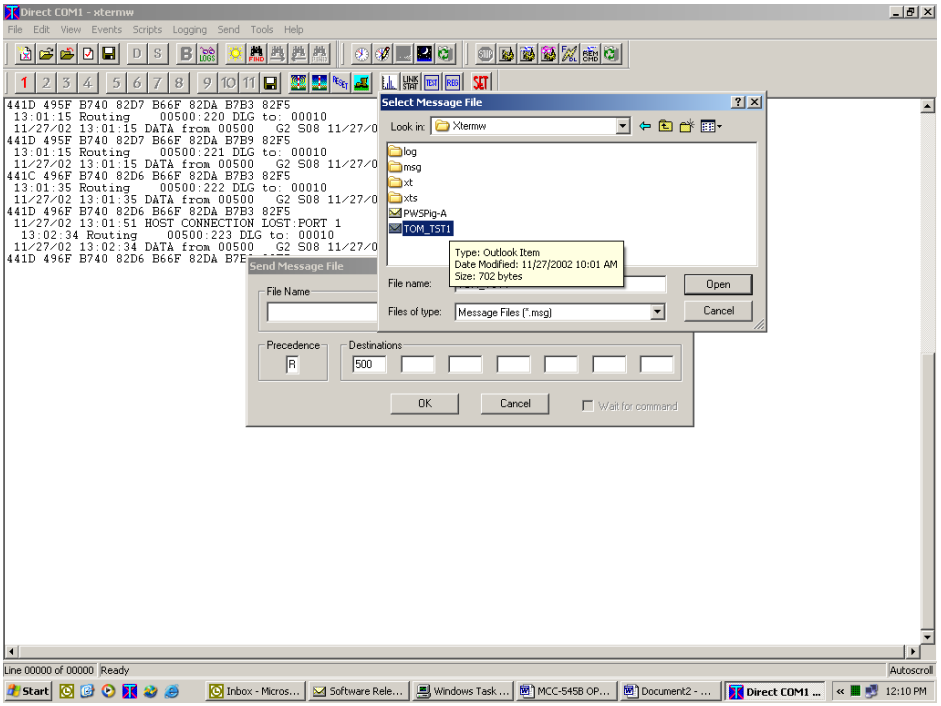
The CR10X uses security codes that are set up within the source code of the stored program. When these are included in the source code, and their values are non-zero, then access will be inhibited as described in section 1.7 of the CR10X Operators Manual. Of the 3 codes used, the MRC-565 needs code 1 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.

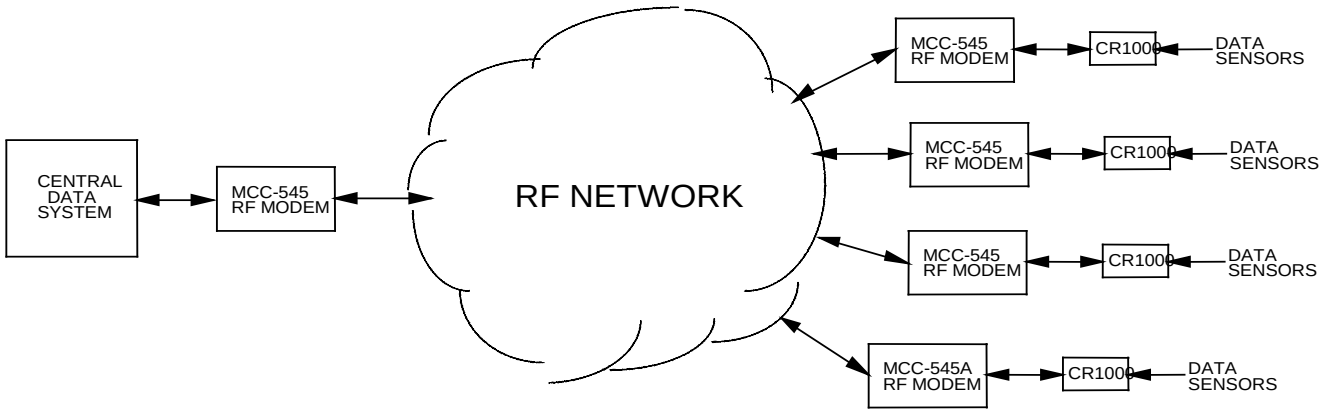


Figure 8. Typical Data Acquisition System

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 CR1000,ACQMODE,CURRENT CR1000,ACQMODE,LAST,N	Get all reports since previous scan Get only the current (last) data group 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 CR1000,INT,OFF	Scan interval in seconds Scan only when UPDT command is entered
CR1000,ORDER,FIFO CR1000,ORDER,LIFO	Get final storage data in FIFO order (not avail)Get final storage data in LIFO order
CR1000,GROUP,545 CR1000,GROUP,CR1000	Not implemented. Group numbers come from CR1000 only.
CR1000,TIME,545 CR1000,TIME,CR1000	Use radios internal Time 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 CR1000,SCALE,INT	Not available. Scale sensors in CR1000 HEX only.
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 (Not Currently implemented)
CR1000,MODEM ENABLE	Enable/Disable use of RI/ME control
CR1000,TSWATH,BEGIN,END,{TX} I	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.
CR1000,TABLEDEF	Show current tables and fields that are programmed into the CR1000.
CR1000,GETTIME	Display current CR1000 date and time.

CR1000,STATUS,ALL	Displays all Status fields in list form.
CR1000,STATUS,FIELD NAME	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	Displays all Public fields in list form.
CR1000,PUBLIC,FIELD NAME,{xxx}	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      EDCD
 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
```

```
ProgErrors              0
VarOutOfBound           0
SkippedScan             0
SkippedSystemScan       0
ErrorCalib              0
MemorySize              4194304
MemoryFree              8284
CPUDriveFree            479744
USRDriveFree            0
CommsMemFree            9251505
FullMemReset            0
DataTableName           Tbl1
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

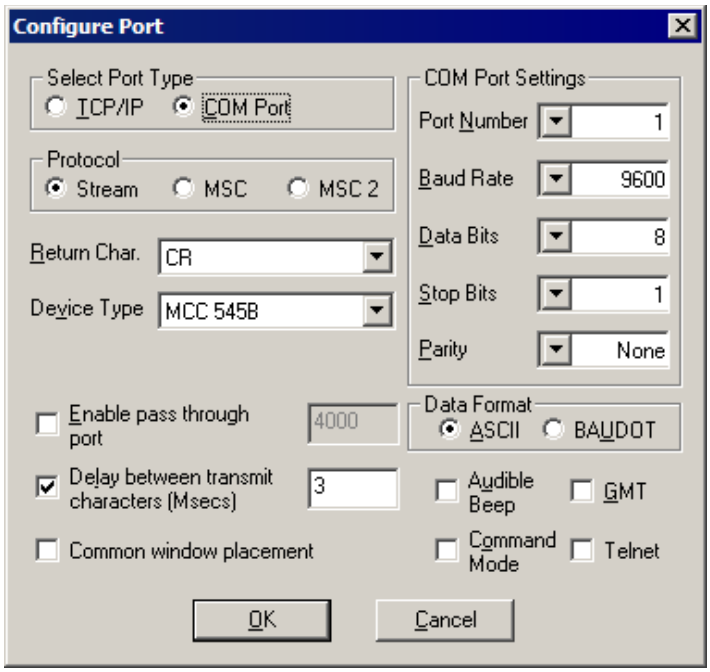
A new or revised CR1000 internal program can be transmitted to a radio which will then download it to the CR1000 and tell the CR1000 to compile and run it. The program source, in ".CR1" format must be copied into a message (or multiple messages if longer than 3500 bytes) that starts with **"$CR10X,DL,xx,yy,"** as the first 18 characters followed by the source text. "**xx**" is the message fragment sequence number with a leading zero and "**yy**" is the total number of fragments with a leading zero. Note: the last character must be a comma following the message fragment identifiers. The “$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.

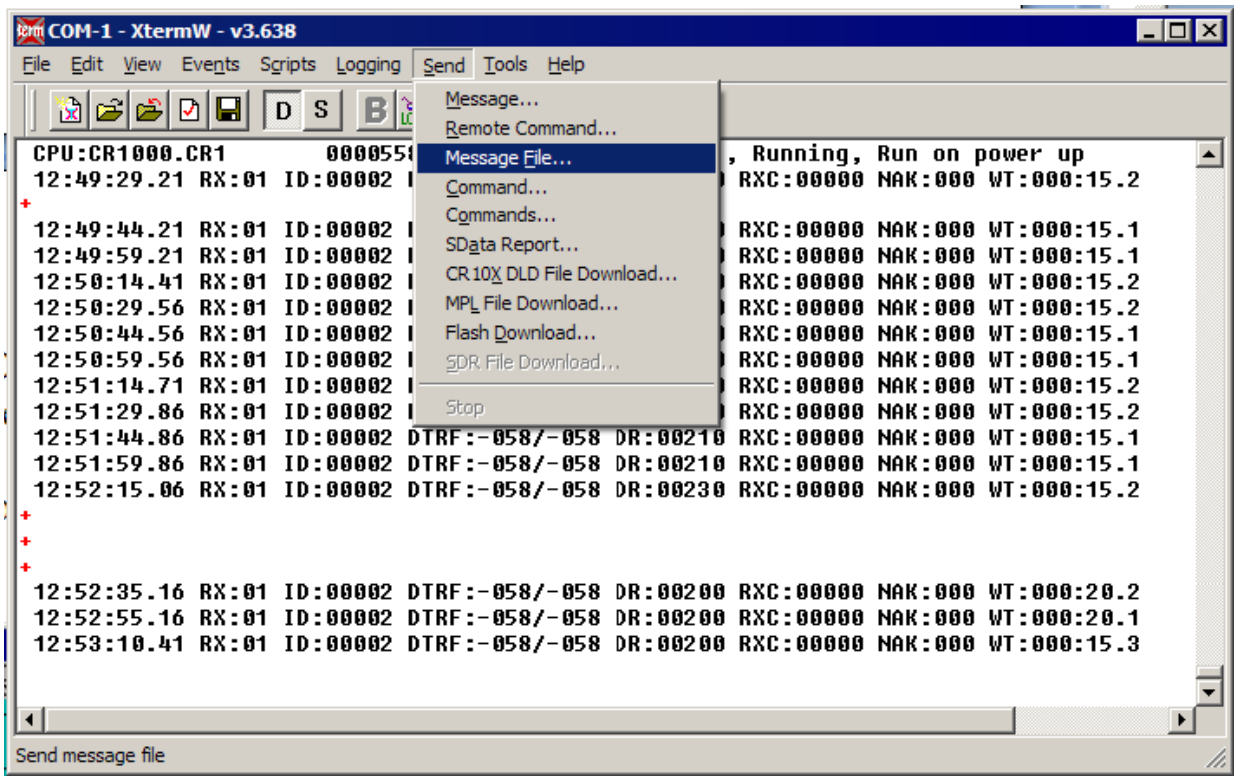
WARNING:
The 565 radio software does not have a way to get the filename from Xtermw at the time of the download so there can only be one program in the data logger memory at a time. Its name will be “CPU:CR1000.CR1” by default. When the program is downloaded all of the previous final storage data records 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.

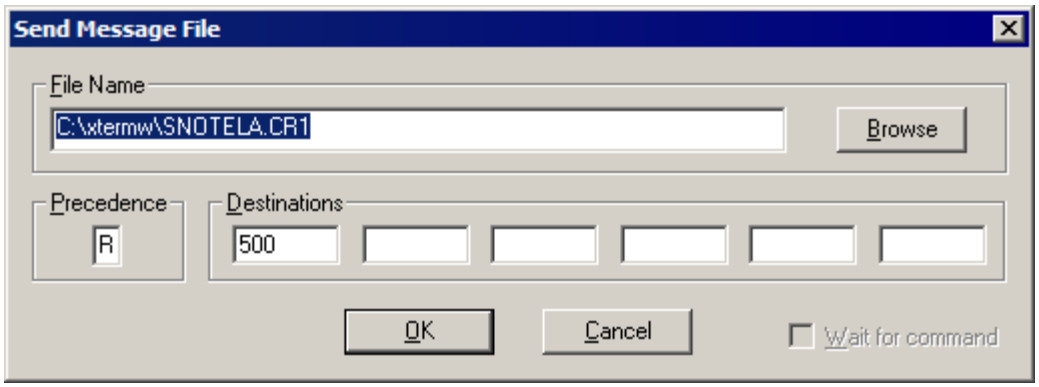
Before starting a download be sure to set some delay between characters in the connection configuration settings dialog box. In the box below this is checked and set to “3”. Failure to do this can cause corruption in the file or script to be downloaded.



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.

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.

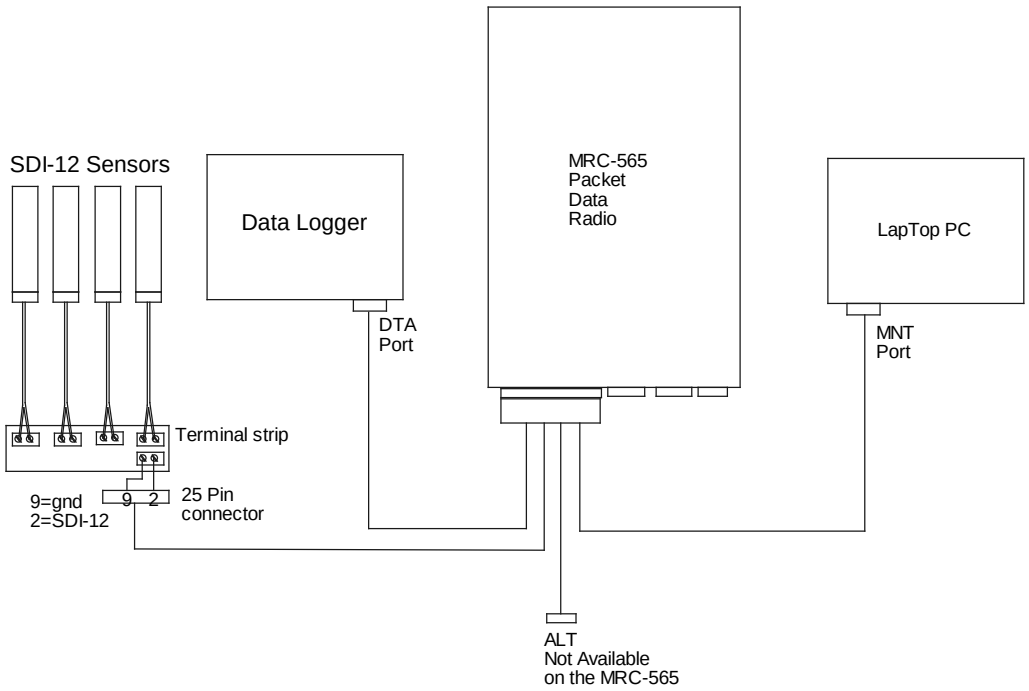


Figure 10. Test Bench Connection Diagram

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 <0M!>
 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)]
```

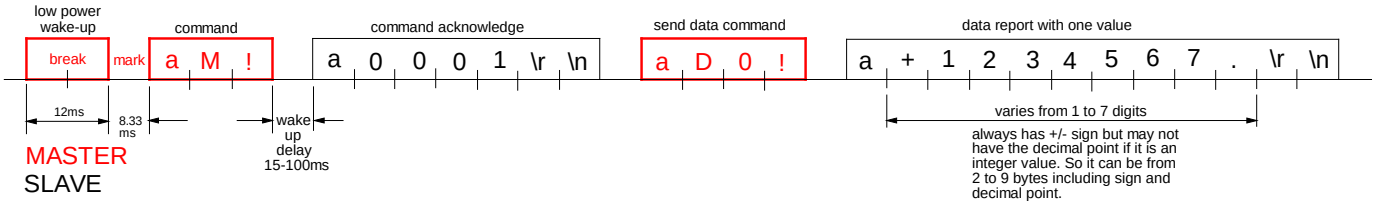
5.9.9 SDI-12 Command/Response List

Name	**Command**	**Response**
Break Continuous	spacing for 12 ms	None
Acknowledge Active	a!	a<CR><LF>
Send Identification	aI!	allccccccccmmmmmmmvvvxxx...xx<CR><LF>
Change Address	aAb!	b<CR><LF> (support for this command is required only if 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	aD0! … aD9!	a<values><CR><LF> or a<values><CRC><CR><LF>
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>

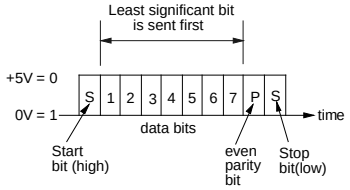
Continuous Measurements	aR0! ... aR9!	a<values><CR><LF> (formatted like the D commands)
Continuous Measurements + CRC	aRC0! ... aRC9!	a<values><CRC><CR><LF> (formatted like the D commands)

*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
```
123.4<cr><lf>
09:15:00<cr><lf>
19.8<cr><lf>
33<cr><lf>
99<cr><lf>
1089.45<cr><lf>
```

With time tag
```
10/14/02  09:15:00<cr><lf>

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

With Sensor Labels
```
Date/Time: 10/14/02

AC Voltage     +123.4<cr><lf>
DC Voltage      +19.8<cr><lf>
Pulse Count     +33.0<cr><lf>
Error Code      +99.0<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 1st sensor is located either on line 2 as in the 1st 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 2nd 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 1st line of the report. If the line number is given, data can start on other than the 1st line. In addition, if the start parameter is given, data can begin in a column other than the 1st 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.

THEORY OF OPERATION

6 THEORY OF OPERATION

The MRC-565 Packet Data Radio contains the Communications Management Unit (CMU) and The Power Amplifier (PA) printed circuit board assemblies. An optional GPS receiver can also be provided. This GPS solders onto the CMU and is done at the factory. These assemblies are discussed in the following paragraphs. The text references parts that can be located on the block diagrams and printed circuit board assembly drawings given below.

6.1 CMU (MRC-56500300-04)

The CMU is located on a single 8.5" x 3.5" printed circuit board

Discussion of the CMU includes:

- Receiver Analog Front End
  - Digital Receiver Components
  - ADC LTC2256
  - 19.2 MHZ TCXO
  - RX Clock Generator ADF4360
  - FPGA
  - DSP
  - DAC
- Digital Transmitter Components
  - Quadrature Digital Up Converter QDUC AD 9957
- Voltage Regulators
- I/O Circuitry
- Coldfire Microprocessor
-

6.1.1 Receiver Analog Front End

The received RF signal is coupled through the transmit/receive switch (on the power amplifier PCA) to the receiver input (first) Band pass filter (BPF) at connector J1. The BPF is a 2-section top-coupled design, with a 40 to 45 MHz pass band. The filter is fixed tuned by using and uses close tolerance L's and C's.

The first BPF output is amplified 21 dB by RF amplifier SGL0363 MMIC U13. The noise figure at J1 is about 5 dB and the 3rd order intercept point is approximately -20 dBm.

A 3-section LC BPF follows U13 to increase out of band selectivity to reduce receiver intermodulation products and for anti-alias (image) rejection. A second SGL0363 MMIC RF amplifier U44 provides additional 21 dB of gain.

The net analog receiver gain between the BNC antenna input jack and the LTC2256 analog to digital converter (ADC) U71 is ~36 dB. This means ADC input saturation occurs at levels above

-24 dBm. Note that the radio continues to receive strong *desired* signals on up to +10 dBm or more but any off-channel signals in the RF pass band stronger than -24 dBm will block desired signals.

6.1.2 Digital Receiver Components

6.1.2.1 Analog to Digital Converter

The LTC2256 high speed ADC (U71) marks the input point of the digital signal processing elements that function as the digital receiver and digital demodulator. It directly affects several of the receiver performance parameters such as noise figure, dynamic range and sensitivity. The ADC quantizes the analog input into discrete samples at a 34.08 MHz sample rate for receiver frequencies between 40 and 43 MHz. Each quantized sample is converted to a 14-bit signed digital word. Signal processing power consumption is directly proportional to sample rate. ADC and subsequent receiver processing elements' power consumption is directly proportional to the sampling rate. There is an obvious incentive to keep it as low as possible but this must be traded off with the required receiver front end bandwidth and the complexity of the analog filters that are required to eliminate unwanted signals related to the sampling frequency. The sampling frequency must also exceed the Nyquist rate, i.e., it must be a factor several times the approximately 5 MHz band pass filter bandwidth. The maximum differential voltage input to the ADC is 2 volts p-p. This level is the equivalent of a 10 dBm signal in a 50 ohm system. Signals greater than this level will saturate the DSP, meaning they will be clipped at the DSP input. (The ADC internal design avoids arithmetic overflow.) Saturation is allowed for a strong desired signal because only the signal phase must be preserved for demodulation of BPSK and GMSK. If the saturating signal is off-channel, the receiver will be blocked. The digital output of the ADC is 2's complement format but it is pseudo-randomized to avoid large supply current spikes when signals are near zero level. Such spikes can feed back to the ADC analog input and reduce its sensitivity. The ADC sampling clock is also passed to the FPGA to allow proper registration. The FPGA removes the pseudo randomness.

6.1.2.2 Temperature Compensated Crystal Oscillator (TCXO)

The master frequency and clock reference for the transmitter and receiver is the 19.2 MHz TCXO. It is designed to maintain frequency stable to ±2.5 ppm over the -40° to +85° C temperature range. It's actual frequency stability over the rated temperature range of the radio is typically ±1 ppm. The TCXO has a voltage input that allows calibrating its room temperature frequency to within a few Hertz of 19.2 MHz. The DSP receives the factory calibration factor from the CF via the host port interface and applies it to channel 0 of the octal utility DAC. This DAC voltage fine tunes the TCXO to the desired frequency. The TCXO output is buffered by U52, U59 and U87 to drive the precision reference clock to the receiver clock synthesizer, the transmitter clock synthesizer, the FPGA and the DSP.

6.1.2.3 Receiver Clock Synthesizer

The RX clock synthesizer is an ADF4360-9, U85. It is programmed to lock its VCO to 17.75 times its 19.2 MHz TCXO input, then divides it by 10 to 34.08 MHz. The internal VCO of the ADF4360-9 has a single sideband phase noise characteristic that is low enough to meet the receiver adjacent channel protection ratio (RX ACPR) specification. The RX clock can also be set to three higher frequencies 36.00, 37.92 and 39.84 MHz for higher receiver tuning ranges up

to 50 MHz. The U85 internal VCO operates at ten times the output frequency. The sampling clock applied to the ADC can be viewed at TP86. The main processor monitors the U85 lock condition via bit 13 of CPLD input register A. If unlock is detected, the synthesizer will be reloaded.

6.1.2.4 Field Programmable Gate Array – Receiving Logic

The 14-bit ADC output samples representing the analog signals in the 40 to 43 MHz tuning range are input to the field programmable gate array (FPGA) EP3C10 U37. The FPGA contains programmable logic hardware used in the receiver (as well as other logic used in the transmitter). It is well suited to very high speed dedicated repetitive tasks needed for digital reception and transmission. The FPGA logic functions are booted by loading compiled hardware description language (HDL) code into it at time of radio initialization.

The FPGA contains digital mixer, digital tunable oscillator, baseband digital channel width band pass I and Q filters that also decimate the sample rate to lower values. Digital RMS signal power detectors and automatic gain control (AGC) are also included. AGC is necessary to compress the full dynamic range of the receiver into convenient16-bit wide output samples. The first digital intermediate frequency is from approximately 6 (= 40-34) to 9 (= 43-34) MHz. The digital mixer output is baseband (or zero intermediate frequency) I and Q channels.

The other input to the digital mixer is from a direct digital synthesizer (DDS) numerically controlled oscillator (NCO). The NCO operates at the ADC sample rate and synthesizes the tuning frequency using an accumulator followed by sine and cosine lookup tables. For example, if the desired receiver frequency is 40.000 MHz, the first IF is 5.920 MHz and the NCO is tuned to 5.920 MHz to translate the desired signal channel carrier frequency to exactly 0 Hz baseband.

The signal in the desired 10 kHz bandwidth RF channel is represented by two 5 kHz low pass signals in quadrature phase relationship with each other, known as I (in-phase) and Q (quadrature-phase) digital channels. The sample rate is ultimately reduced to 48 ksps in each channel by the low pass decimator filters following the digital mixer. This rate still greatly exceeds the Nyquist rate for 5 kHz I and Q signal bandwidth at the FPGA output. The filtering and sample rate decimation provide a crucial signal to noise ratio (SNR) enhancement (also known as signal processing gain) that increases the SNR by more than 30 dB to overcome the high 38 dB effective noise figure of the ADC input.

6.1.2.5 DSP demodulator

The 48 ksps I and Q samples are transferred from the FPGA into the DSP working memory by its direct memory access (DMA) controller. The TMS320VC5510A DSP is 16-bit fixed point numeric implementation with internal program and data memory RAM. The DSP program is written in compiled C language that is loaded into the DSP by the CF at time of radio initialization.

The receiving samples are bundled in blocks of one hundred; one block is transferred every 2.08 ms. The FPGA notifies the DSP through an external interrupt when a block of samples is ready.

The DSP processes each sample block while the next block is being collected. A separate section discusses the multi-simultaneous channel capability of the receiver.

The sample block transfer and demodulation process is normally gated by the presence of a signal present (SP) average power detector that is implemented in the FPGA. User settable parameters determine the power level required in the receive channel to cross the SP threshold and this activates the FPGA to DSP sample block transfers. A later section discusses how features such as this are part of the low power modes (LPM) contribute to reducing the average receiving DC power dissipation while the receiver idles.

The DSP BPSK demodulator uses a squaring loop digital PLL to recover the estimated receiver carrier. This facilitates coherent detection of the BPSK samples. The symbol timing is also recovered. Data bits are recovered by hard decision sampling at the symbol (bit) rate. Note that for BPSK the symbol, baud and bit rates are all the same value. The bits are initially applied to a digital correlator that searches for the 24 bit synchronization (sync) word. When sync is detected, the DSP SP signal going to the CPLD is set high. This signal is needed to wake up the CF when it is sleeping in low power mode. DSP SP can be viewed at TP9.

The balance of the bits in the received packet are funneled into message bytes and entered into a receiver buffer in the DSP. It also notifies the CF via the HP_/HINT (TP33) that data packet bytes are available for collection via the host port interface (HPI) between the DSP and CF.

The DSP can alternately demodulate 9.6 kbps GMSK packets. GMSK is a variation of FSK. The I and Q sample blocks are applied to a digital limiter and frequency discriminator. The discriminator is implemented by a delay-conjugate-multiply plus arctan algorithm. Its output is applied to a sync correlator that detects the sync bytes as well as determining the optimum hard decision sampling instant for the following packet bits. Operation past that point is the same as BPSK.

6.1.2.6 Detected RF signal power (DETRF)

As mentioned earlier, the FPGA measures the noise and signal power in the signal channel, converts it to decibel values and passes the value to the DSP every 2.08 ms. The DSP applies a factory gain calibration factor called ADCGAIN to determine the absolute power level in dBm. This is reported as DETRF value via HPI to the CF (and is also known as received signal strength indicator RSSI) value that can be viewed by various commands such as MM or STAT. The value is also converted to a scale that drives one channel of the octal utility DAC U83 over a range of zero to five volts. The DAC output is routed to J7, the 40-pin front panel connector for viewing with a scope or voltmeter.

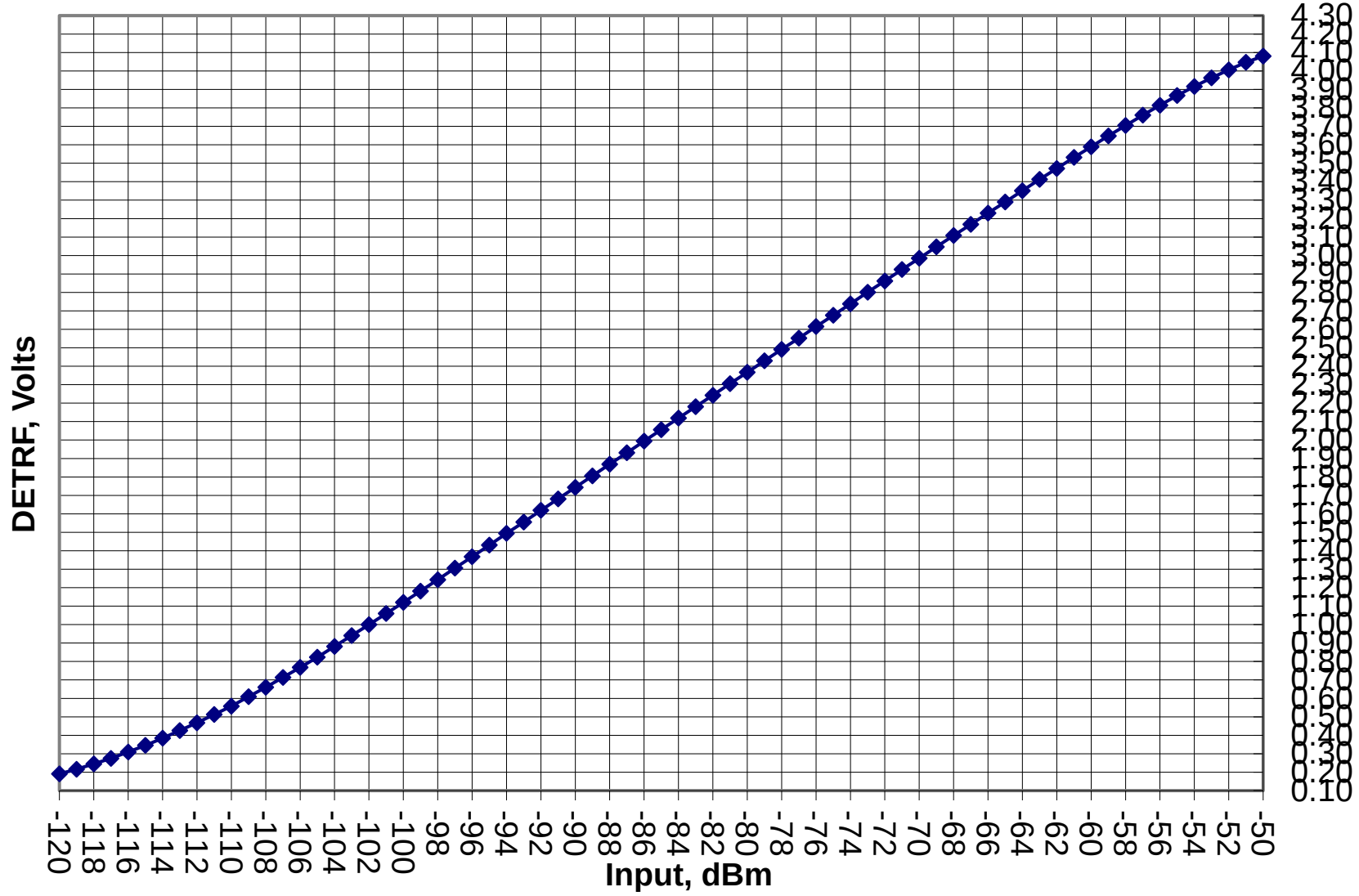


Figure 12. Detected RF Plot

6.1.3 Digital Transmitter Components

The transmit modulation path (TX exciter) starts with the CF, proceeds to the DSP, the FPGA and finally the Quadrature Digital Up Converter (QDUC). The QDUC outputs low level RF directly on the assigned carrier frequency. That signal is passed to the RF power amplifier PCA. Refer to the transmitter signal processing block diagram Figure 16 for the ensuing discussion.

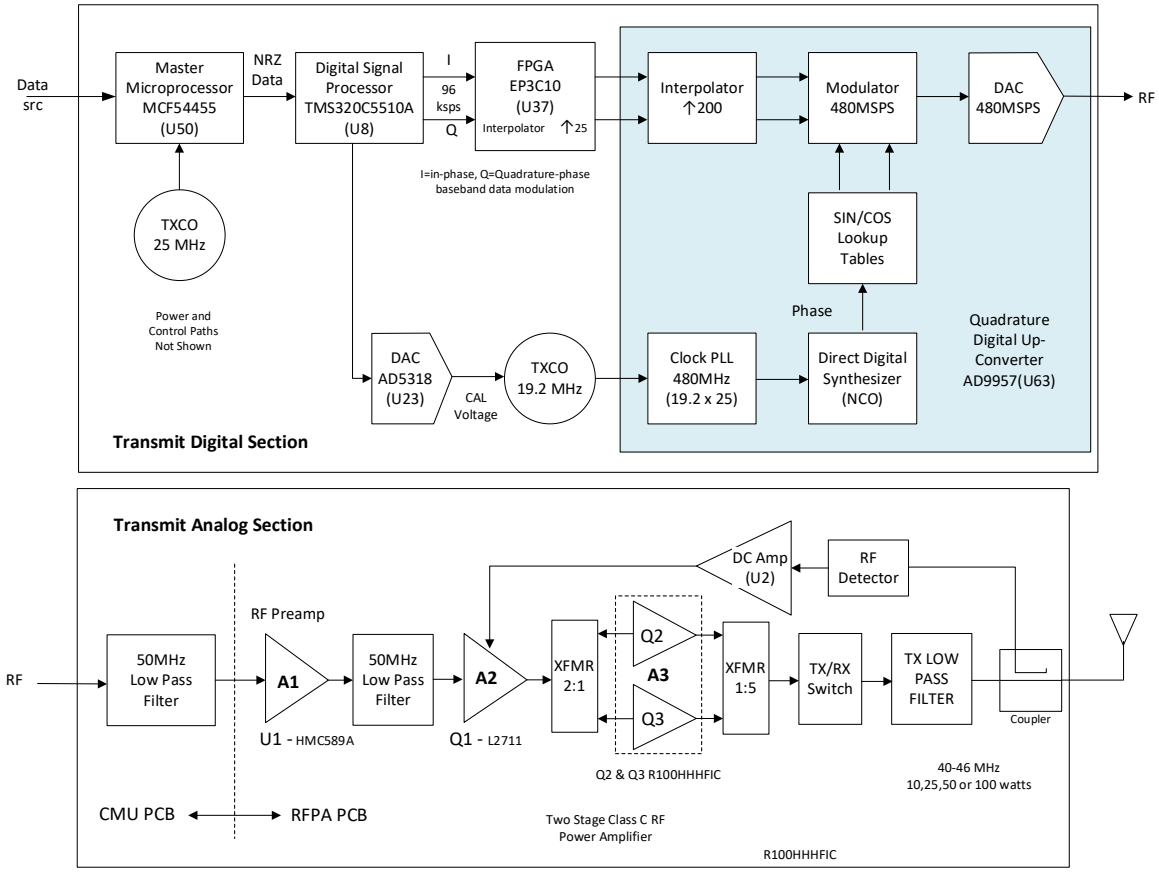


Figure 13. Transmitter Block Diagram

6.1.3.1 TX LO and Exciter

The transmitter carrier is generated and then modulated by the Quadrature Digital Up-Converter (QDUC) IC (U63). A control path (not shown) from the master processor operating system (OS) passes carrier frequency selection commands to the QDUC direct digital synthesizer (DDS). The QDUC is multifunctional. First, it uses a phase locked loop (PLL) to multiply the TCXO frequency to (19.2 * 25) = 480 MHz. This serves as the precision sample clock for a direct digital synthesizer (DDS) inside the QDUC. The carrier frequency is generated by the accumulator in the DDS numerically controlled oscillator (NCO). The available resolution is 100 Hz and the output frequency range is 40 to 47 MHz Because of the PLL tracking loop, the frequency accuracy and stability of the carrier is proportionally the same as the TCXO. The

QDUC PLL lock condition is monitored by the OS. The OS will abort or inhibit transmission if the QDUC PLL is unlocked.

The NCO output samples are applied to sine and cosine digital lookup tables. The sine and cosine signals are applied to a complex digital modulator operating at 480 Msps, also inside the QDUC. The modulator output is applied to a high speed DAC and then exits the QDUC as an approximate 1 mW modulated RF carrier. A 7-pole LC low pass filter then removes the 400+ MHz alias frequency output and other minor QDUC intermodulation products before the signal is routed to the RFPA.

Details of the carrier modulation process are provided below.

6.1.3.2 RF Power Amplifiers

The low level modulated carrier is passed to the RFPA circuit board where it is amplified to 10W, 25W, 50W or 100W by three RF amplifiers in a chain depending on operator selection. One inter-stage low pass filter and final output low pass filter as well as frequency selective components not shown remove harmonics created by the nonlinearity of the RF amplifiers. Automatic output power level control (ALC) is provided by a feedback loop as shown on the RFPA diagram. This keeps output power stable over a range of power supply voltages and operating temperatures.

6.1.3.3 Modulation Process

NRZ user data enters the MRC-565 via a serial, USB or Ethernet port. The OS packetizes it and adds preamble, synch, protocol headers and checksums. Packets will vary in length from approximately 20 ms to 200 ms. The transmitter can emit either constant envelope (CE) BPSK or CE GMSK.

6.1.3.3.1 CF and DSP TX Character processing

The CF assembles all of the header, payload and CRCC bytes of the message packet. The CF (including the CPLD glue logic) also orchestrates the TX start up and shut off control and sequencing. There is one message packet per transmission in half duplex mode. The CF uses the DSP HPI to transfer the TX character bytes to the DSP TX message FIFO buffer.

The DSP is responsible for modulation pre-coding, band limiting and part of the sample rate interpolation process. Packet Characters are block processed, one byte, i.e., 8 bits at a time. The packet bits are sent serially, one bit per symbol so the bytes are first disassembled into individual bits.

The DSP converts the message data bytes first to bipolar bits and then concatenates bits from consecutive bytes into a continuous stream. Each modulation type is further described below.

6.1.3.3.2 Constant Envelope Differentially Encoded BPSK Modulation

Differentially encoded BPSK is confined to a circular phase trajectory so it has fixed amplitude, i.e., no amplitude modulation (AM). Each new bit is converted to a bipolar value dependent on the previous bit. If the result is positive (negative), the phase of the carrier will be advanced (retarded) 180 degrees during the bit period. If the result is 0, the carrier phase is not affected. A

Gaussian low pass pulse filter is used to spectrally limit the pulse train so that it fits inside FCC spectral emission mask C. The sum of the filter coefficients is scaled to equal exactly 180 degrees of phase shift. The sine and cosine of the phase are determined from LUTs. The resulting I and Q samples are then transferred to the FPGA TX FIFO.

6.1.3.3.3 Constant Envelope GMSK Modulation

Minimum shift keying (MSK) is a form of FSK where the peak-to-peak frequency deviation is exactly one half of the bit rate and the peak deviation is therefore one fourth the bit rate. The carrier phase of unfiltered MSK snaps forward or back 90 degrees each bit period. There is no AM. A Gaussian LPF is added to smooth the step response to bit polarity changes and reduce the spectral bandwidth. The MRC565 GLPF uses BT = 1 meaning that the 3dB BW equals the bit rate. This mild filtering is suitable for meeting FCC spectral emission mask C at 9600 bps or less. A LUT is used to provide the filter response for the samples in one bit period based on the values of the current bit and the previous bit. The filter output represents a phase increment. This is accumulated to produce phase rotation (relative to unmodulated carrier phase) for each sample. A sin LUT is used to obtain the sin and cos of the phase. These values are entered into the I/Q sample buffers for transmission to the FPGA TX FIFO.

6.1.3.3.4 Downstream Transmit Sample Processing

The DSP output I and Q baseband modulation sample rate is 96 ksps. These samples must be further interpolated to the digital modulator sample rate to avoid modulation aliases. The FPGA is used to provide sample rate interpolation by a factor of 25 to 2.4 Msps. The 2.4 MHz I and Q samples are interleaved for transfer to the QDUC. The QDUC provides the final interpolation by 200 to 480 Msps.

6.1.3.4 Modulation Limiting

In either modulation type, the DSP calculations are precise and well-behaved. This is one way that transmitter spectral control is achieved. Digital signal processing and accurate clock sources produce baseband modulation signal waveforms that have precisely controlled amplitude and spectral characteristics described above. These levels and spectral characteristics are fixed by firmware and require no further calibration or adjustment prior to the modulator.

6.1.3.5 Power Limiting

The Transmitter Block Diagram, Figure 16, shows that the RF power amplifier (RF PA) has an average power output detector and DC feedback system to control the gain of one of the RF amplifier stages. This provides automatic level control to stabilize transmitter power output over rated temperature and power supply voltage ranges. The feedback is adjusted to set the RF output power to 100W at the programmed operating frequency at time of order processing. The power detector variation over the programmable transmitter frequency range is less than 1 dB.
A hardware duty cycle limiter in the PA relies on a fixed RC time constant to cut off power to the RF amplifiers to protect them against overheating as well as functioning as a backup to the OS duty cycle limiting algorithm.

6.1.4 Discrete Digital Output, Relay Junction and Analog Input

Four optically isolated inputs, two form “C” 2 amp relays and six 10-bit Analog to Digital converter channels are routed through a high density D-44 pin connector. A 4 lead adapter cable

is used to break out the discrete digital output, relay junction and analog input ports into one D-25 pin connector. The user can program these inputs and outputs to execute timed events or to monitor external asynchronous events.

6.1.5 Power Amp Interface

The CMU interfaces to the RFPA assembly via 4 cables. CMU J15 connects to the RFPA with a 20-pin ribbon cable. RX RF coaxial cable from the RFPA enters the CMU at J1. The TX exciter output to the RFPA is at J16. The optional GPS receiver input to the CMU is at J4.

Nominal 12V DC power for the CMU is obtained from the RFPA assembly via J15.

6.2 Microprocessor

This section outlines the general computer architecture for the MRC-565 microprocessor board. Detailed sections are supplied describing the power, processor, memory, and I/O subsystems.

Discussion of the microprocessor includes:

- Overview
- CPU
- Memory
- Data Input/Output
- Discrete Digital Output, Relay junctions and Analog to Digital Input
- Transmitter/Receiver Interface
- Peripherals
- Power Fail Detection/Protection
- DSP BPSK I & Q Generator

6.2.1 Overview

The MRC-565 microprocessor board contains a small, low power, industrial grade microcontroller (the Motorola MC68332 processor) surrounded with memory, I/O, and peripherals to meet the requirements for the MRC-565.

The basic unit contains:

- Motorola MCF 54455 Coldfire microprocessor
- External RS 232 I/O ports (+/- 5V), quantity 3
- Internal serial port1(jp3 selectable) , serial port 2 (jp4 selectable), or port 3 I2C for GPS (0 to 5V), quantity 1
- Power Amplifier Interface Port
- Real-time clock

- 12-bit 16 channel A/D converter
- Power fail detection circuitry
- Solid State Relay outputs, quantity 2
- Optically isolated digital inputs, quantity 4
- Digital outputs, quantity 5 (0 to +5V)
- Onboard temperature sensor (from PA board)

6.2.2 Cold Fire Processor

The MRC-565 microprocessor design is centered around the Motorola MC54455 Coldfire embedded controller. The MCF54455 is an advanced 32 bit processor based on the Version 4 Coldfire architecture. It contains a 32 Kbyte internal RAM, a USB On-the-Go Controller, DDR SDRAM Controller, a 16-channel DMA Controller, a DSPI controller, three UARTS, I2C Controller, Ethernet Controller and Flex Bus Controller for interfacing to external GPIO devices, Flash Memory Devices, and to the DSP Processor.

For detailed information on the CPU operation, refer to the MCF54455 User's Manual.

6.2.2.1 Memory

The MRC-565 microprocessor contains 128 Mbits of FLASH program memory (organized as 8 Meg of 16 bit words, 128Mbits of FLASH data configuration memory (organized as 8 Meg of 16 bit words), and 256 Mbits of low power dynamic RAM memory (organized as 16 Meg of 16 bit words).

New releases of operating code can be can be down loaded through the RS-232 ports (user on site) or remote down loading can be achieved via the Transmit and Receive hardware and another modem (user off site).

6.2.3 Data Input/Output

Three DCE RS-232 ports, one SDI-12 Port, 6 Analog to Digital converter channels, 2 Solid State 1/2 amp relays and 4 optically isolated inputs are available through one high density D-44 pin connector. A 4 lead adapter cable is used to break out the RS-232 ports and additional I/O into three DB-9 pin connectors and one DB-25 connectors. The three DCE RS-232 ports are labeled OPER, AUX, and DATA. The OPER port is intended for control terminals and carries only the necessary 3-wire RS-232 signals. The AUX port carries the 3-wire RS-232 signals. The DATA port contains the 3-wire RS-232 communications and basic handshake and modem lines (RTS,CTS,DTR,DSR,RING) defined in the RS-232 standard. Internal Jumpers (J3 & J4) are available allow one to select Port 1 or Port 2 to connect GNSS Daughter board to Codefire processor. When this is done, Port1 or Port 2 won’t be available externally.

6.2.4 Coldfire Microprocessor Peripherals and Serial Configuration

The MCF54455 Coldfire (CF) DMA-Supported Serial Peripheral Interface (DSPI) and its I2C serial interface supply serial communications to external peripherals. The CF DSPI select outputs are routed to the CPLD. The CPLD provides digital logic to produce serial chip selects.

When the radio is booted, the CF loads the FPGA hardware program and DSP firmware programs via the CF DSPI. Utility ADC U12 is read via the DSPI. The RX Synth Clock U85, the QDUC U63, and the high speed ADC U71 are configured by DSPI. Radio parameter serial storage memory nonvolatile EEPROM U62 is read and written via DSPI. I2C is used to configure clock ICs U51 and U60.

The CF Several peripherals are available on the MRC-565 microprocessor: 10-bit A/D converter, a temperature sensor and a real time clock. Four channels of the A/D converter are utilized in the transmitter/receiver hardware. The temperature sensor is connected to one channel of the A/D converter and can be accessed directly by the user. The remaining 6 A/D converter channels are accessible to the user . The third peripheral, a real time clock, is available for keeping system time and time stamping critical events.

6.2.5 Power Fail Detection/Protection

The MRC-565 microprocessor utilizes a high precision analog threshold detector to determine when power fails are occurring. A high priority interrupt is activated on the MCF 54455 processor when a pending power fail is detected after which the processor is guaranteed approximately 1 msec to prepare for power failure. If no power failure actually occurs, the internal watchdog wakes the MCF54455 in 45 seconds for normal operation. During an actual power fail, the microprocessor restarts once system power returns.

6.2.6 Voltage Regulators

The CMU contains several voltage regulators, as described below. In addition to these regulators there is a 3.3V Primary regulator that runs directly from the +10-16V input. This regulator provides power for the Real Time Clock (RTC) chip U60 and the power ON control chips. This voltage is powered on whenever the 10-16VDC is applied to the MRC 565. Its current drain when all other regulators are power off is less than 2 ma. If power is disconnected from the unit the RTC will loses its TOD and Alarm Clock settings and must be re set by the operator.

6.2.6.1 Input Switching Regulator

A Switching regulator chip is used to provide a stable 5.3 volt supply to all of the CMU circuits. The input to this regulator is obtained from the +10-16V input from the PA Interface Connector. The regulator is capable of supplying a minimum of 500 ma of current to the CMU. The regulator operates at an efficiency exceeding 85%.

The Regulator can be powered down by a PWR-ON control signal, generated by the CPLD..

The regulator feeds a linear 5V regulator and two additional switching regulators each with three outputs.

6.2.6.2 CF Switching Regulator

A three output switching regulator is used to generate the three voltages that power the Cold Fire Processor and its peripheral devices. The three voltage are:

- 3.3V Powers CF54455 I/O, CPLD, RS232 interfaces, Flash Memory, Ethernet Controller
- 1.8V Powers Dynamic RAM
- 1.5V Powers MCF 54455 Core

6.2.6.3 DSP Switching Regulator

A three output switching regulator is used to generate the three voltages that power all circuitry associated with the Receiver and Exciter circuitry. The three voltages are:

- 3.6V Powers FPGA and DSP I/O, Rx Clock synthesizer, RF Pre Amps, TCXO, and QDUC circuit.
- 2.0V Powers the ADC circuit, the FPGA Core (1.2V), and the DSP Core (1.6V)
- 1.8V Powers QDUC RF Output

There are several additional linear regulators that are used to filter the switching noise on the DSP Switching Regulator.

The total current in the receive mode is typically 120- 140 ma. This current can drop to 70 ma by using the low power modes controlled by the CF Processor.

6.2.6.4 5 V Regulator

A linear Voltage Regular is used to regulate the 5.3 voltage to 5.0 volts for powering the CF ADC, The DSP DAC, and the USB On-the-Go circuit.

6.3 Power Amplifier (MRC-56500301-10)

The amplification of the +0 DBM output of the CMU to the final RF output of 10, 25, 50 or100 watts is accomplished with 3 RF stages, A1, A2 and A3. The PCB mounts to the aluminum chassis that forms the bottom half of the MRC-565 enclosure. The chassis also provides a heat sink for all the high power RF transistors.

The RF output of the CMU (0dBm) is amplified to 50 milli-watts (17dBm)by the first stage of the amplifier, A1. The second stage of the amplifier, A2, amplifies the signal to 2 watts (33dBm). The final stage of the amplifier, A3, which includes two MOSFET Transistors and two center tap transformers, amplifies the signal to 10, 25, 50 or 100 watts depending on level set by operator. Frequency range for this amplifier is 40-46 Mhz.

A unique power switch circuit is used to control the application of DC Power (+12VDC) to the various amplifier stages. The purpose of this control is to insure that the RF power output is switched on with a controlled rise and fall time (approximately 1 msec) when the TXKEY signal from the processor is turned on and off.

The TXKEY signal from the processor triggers a duty cycle limit. When the key is held on in excess of one second or when the duty cycle exceeds 10%, the TXKEY will be gated off.

A temperature sensor is located on this PA to allow the processor to read the internal temperature of the unit. This temperature can be displayed on the operator port, or it can be transmitted to a distant MRC MRC-565

The final section of the power amplifier assemble contains a pin diode T/R switch, a 5^{th} order elliptic low pass filter, a directional coupler, and a BPF on the Receiver port of the T/R switch. The T/R switch, low pass filter, and directional coupler are enclosed in a metal shield.

An ALC loop is used to maintain a fixed RF output over temperature and voltage variations.

The output of the power amplifier is coupled through the T/R switch to the harmonic low pass filter. The switch is implemented with PIN diodes.

A fifth order elliptic low pass filter reduces the harmonics of the output signal. This enables the amplifier to meet FCC requirements for harmonic emissions. The filter attenuates second and high order harmonics by 60 dB. Its insertion loss is less than .3 dB.

The Power Amplifier board incorporates a dual port directional coupler. The coupler measures the forward and reverse transmitter power. The coupler is used to measure the voltage standing wave ratios (VSWR) of the antenna. If the VSWR exceeds a 2.0:1 ratio, the transmitter shuts down, preventing the unit from transmitting into an improper load or open circuit. This protects the output transistor from a catastrophic failure.

6.4 Internal GNSS daughter board (optional)

The X5 Daughter Board mounts directly inside the MRC565 radio on a modified MRC565 CMU board. Modifications to the CMU board include removing the Ublox GPS module, adding a 12-pin header connector and adding a 3.3V power regulator. The 12-pin header connector has a 3.3VDC, 5VDC, two RS232 ports, SPI port and PPS. The X5 Daughter board includes a Septentrio Mosaic X5 chip, mating 12 pin connector, Ethernet control chip and an Ethernet jack. Two jumpers (JP3, JP4) have been added to the CMU board allowing operator to select which serial port will be sacrificed for X5 Daughter board operation and which will remain connected to the 44-pin connector. For an MRC565 configured as a remote without the X5 Daughter board, both jumpers are set to connect Aux and DTA to 44 pin connectors.
For an MRC565 configured as a remote with the X5 Daughter board, the AUX jumper will be set connecting Aux serial to X5 Daughter board internally and leaving the DTA connected to the 44pin connector.
When configured as a base there are two options.

1. connect both AUX and DTA serial ports to X5 Daughter board, keeping both the NMEA and RTCMv3 streams connected to CMU board internally.
2. use IP sockets to connect X5 Daughter board to the CMU board. For this option will need an external ethernet switch.

The X5 Daughter board Ethernet jack also allows operator to access Mosaic X5 daughter boards internal Configuration Web Page via a new M8 Ethernet connector added to the front panel of the MRC565.

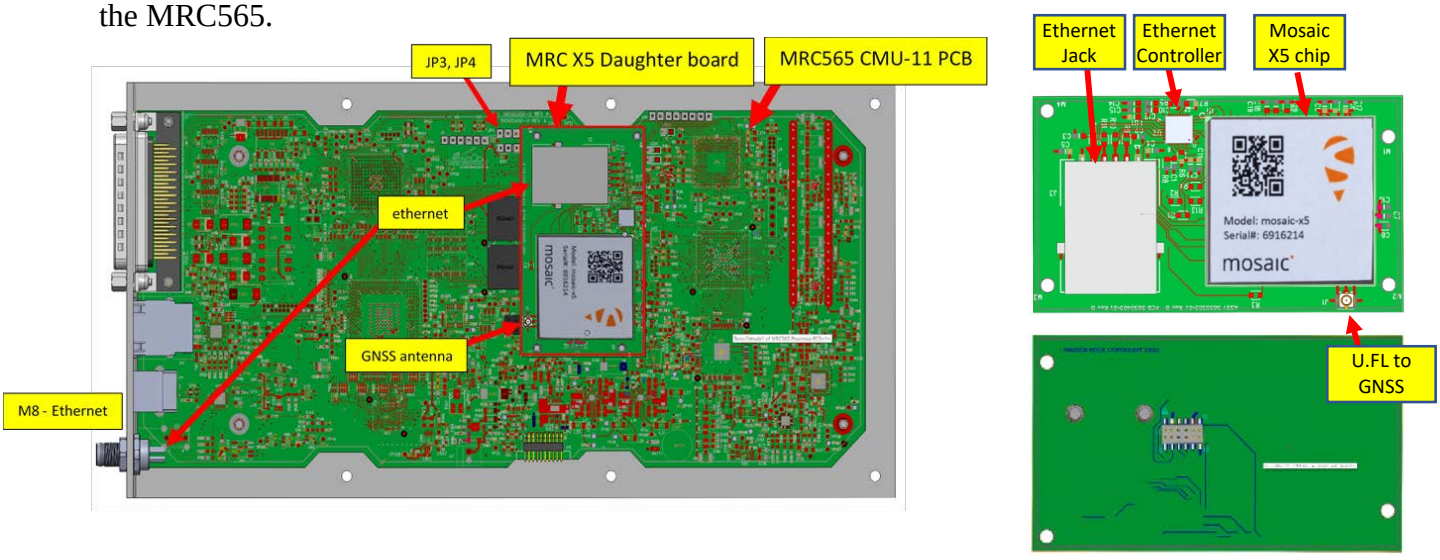


Figure 14 MRC565 Updated CMU board & Mosaic X5 Daughter Board

MAINTENANCE

7 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.

7.1 Script Files

It is critical that the proper script files are loaded before operation begins. These script files configure the MRC 565 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.

7.2 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

NO	TP	DESCRIPTION
1	89	5.000V
2	91	5.000V
3	120	3.300V
4	108	3.300V
5	115	1.800V
6	116	1.800V
7	100	1.500V
8	98	1.500V
9	110	3.600V
10	75	3.600V
11	105	1.800V_TX
12	99	1.800V_TX
13	32	3.300V_DSP_FPGA
14	69	3.300V_DSP_FPGA
15	3	3.300V_DSP_DSP
16	2	3.300V_DSP_DSP
17	113	2.500V_FPGA_PLL
18	117	2.500V_FPGA-PLL
19	47	1.200V_FPGA_CORE
20	48	1.200V_FPGA_CORE
21	37	1.600V_DSP_CORE
22	38	1.600V_DSP_CORE
23	88	3.300V_ETHERNET
24	96	3.300V_ETHERNET
25	103	1.800V_ADC1
26	50	1.800V_ADC2
27	137	3.300V_4360

1	46	25 MHZ CLOCK ETHERNET
2	66	25 MHZ CF
3	74	25 MHX CPL2
4	65	25 MHZ FLEX BUS
5	80	60MHZ CLOCK
6	87	19.200000MHZ CLOCK

7.3 Setting Up and Calibrating the MRC-565 Radio Parameters

7.3.1 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.

7.3.2 Power Amp Adjustments

The MRC-56500301-10 Power Amplifier is factory tuned to the customer specific frequencies at the factory. These parameters should not be changed in the field. With the 56500301-10 FET PA Amplifier 4 different power levels can be selected using the RFP command. RFP,10 → 10 Watts, RFP,25 → 25 watt, RFP,50 → 50 watts and RFP,100 → 100 watts.

APPENDIX A: COMMANDS

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

NEW PASSWORD IPC POSRPT RTCM

OPEN PORT S”n”
PASSWORDMODE

MODE CONTROL COMMANDS
*CORPAT *HALF DUPLEX
*FULL DUPLEX *ROLE

MAINTENANCE COMMANDS
BOOT SHOW TXQ
RESET SMS
REV UPDT
SHOW RXQ

MASTER SIMULATOR COMMANDS
*P

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	*REPEATER	SMS
NET	SHOW REMOTES	

* 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

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
***ASSIGN** {,function,port,protocol {,timeout}} **NOTE** {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.	Control allocation of user interface functions among physical device channels. When no parameters are entered, displays I/O configurations. Port definitions are as follows: 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 4000) **NOTE** 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 (**ASSIGN,MNT,OFF**), 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.	function = user interface function port = physical device channel protocol = link level protocol	**MNT, DTA, ALT, POS,E1F1,E1F2,E1F3,E1F4,CR10X,CR1000** **0=OPERATOR,1=DATA,2=AUX,** **4-7= Ethernet** **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**

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
		timeout in seconds	**0 – 32767**
ASSIGN,RXn,Channel,Protocol	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	
***BASE**{,nnn,nnn}	Set/display range of Master Station IDs reserved for use as Base Stations. **In MB networks set BASE to OFF.**	nnn = lowid,highid **OFF** = no Bases	**2 – 253**
BINS	Print link distribution statistics		
BOOT	Cold start of Station software. All volatile memory is lost.		
CANMSG,name,len{,Qsize}{,count}	Automatically generate a test message of specified length that repeats until turned off with **CANMSG OFF** 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. **CANMSG** 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 = **1 – 4095** Remote = **256 – 4095** len = number of characters in message Qsize = min. # of canned messages in queue count = total number of canned messages to generate	**1 – 4095** **1 – 3000** **0 – 25** **0 – 9999**
CANMSG MODE {,mode)	Set reception of canned test messages to two of the following states: **PRINT** – print all test messages **NO PRINT** – does not print test messages	mode = **PRINT** **NO PRINT**	
CANMSG OFF,nnnn	Turn canned test message mode off	nnnn = Station ID Master = **1 – 245** Remote = **256 - 4095**	**1 – 4095**

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
CHANNEL	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.		
CHANNEL,xxx.xxxx,yyy.yyyy,aa,bb	Select Frequencies, Modulation Value, and Channel for the Transmitter and the Receiver.	**xxx.xxxx**= Transmitter Frequency **yyy.yyyy**= Receiver frequency **aa** = mod_val **bb** = Channel Table Channel Number	**xxx.xxxx**= 40.000 – 50.000 MHz **yyy.yyyy**=40.000 – 50.000 MHz **aa=** 1 - 6 **aa= 1-6** **bb=** 0 - 20
CHANNEL,zz	Sets operating Channel from the list frequency channels under frequency table.	**zz** = Channel Table Channel Number	**zz=** 0 - 20
***CHECKIN**{,ii}	Select check-in interval in seconds	ii = interval	**1 – 65535**
CLEARBINS	Clear hourly bins		
CLEARLINKSTAT	Clear link stats		
CLOSE PORT,function {,function,…}	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. **CAUTION** The **OPEN/CLOSE PORT** commands directly affect MRC-565 network activity and message flow. Do NOT use these commands unless directed to do so by your System Administrator.	function = user interface function	RS-232 functions **MNT, POS, ALT, DTA** Ethernet1 func. **E1F1, E1F2, E1F3, E1F4** USB functions **U1F1, U1F2, U1F3, U1F4**
CLS	Print current values, then clear link statistics (see		

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
	LINKSTAT).		
CONFIG,{ }	Show current configuration parameters report. **NOTE** Configuration in CPM may differ unless the SAVE command is used after configuration changes are made.	NONE ALL SCRIPT	L:ists Summary Table of parameters Lists all parameters in list format Lists all parameters in a SCRIPT format
CONFIGURATION	List major Master Station configuration settings.		
CONNECT,{id1…id10}	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 **OFF** = no limitation	**1 – 65,500**
CORPAT	Without parameters, display report of available correlation patterns and indicate usage.		
CORPAT,RX,action {,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 = **ON** – define patterns or **OFF** – use only default pattern pppp = pattern number; **ALL** means recognize all patterns	**1 – 8**
CORPAT,TX,pppp {,**ALWAYS**}	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 **ALWAYS** means use specified pattern instead of received	**1-- 8**

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

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
CR10X,RESET	Reset CR10X internal error counters to zero		
CR10X,SCALE,type	Define sensor scaling type.	type = **545C** – data scaled in integer hexadecimal units **CR10X** – data scaled in Campbell Scientific floating point format	
CR10X,SECURITY,nnnn, nnnn,nnnn	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	**0 - 9999**
CR10X,SETPTR,date,time	Manual set up of last data pointer in the MCC-6100	date = mmddyy time = hhmm	mm = **1 - 12** dd = **1 - 31** yy = **0 - 99** hh = **0 - 23** mm = **0 - 59**

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

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
CR1000,PUBLIC			
CR10XTD,STAT			
CR10XTD,RESET			
CR10XTD,SECURITY,xxxx,yyyy,zzzz			
CUSTID,nnnnn	Display/Set customer id for this radio.	nnnnn= customer ID	**1-99999**
DATE{,mm/dd/yy}	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	**1 – 12** **1 – 31** **0 – 99**
DEL MSG,nnnn:sss	Delete specified message.	nnnn = Station ID sss = message serial #	 **1 – 255**
***DESTINATION**{,nnnn....}	Set default message/data destination(s). For MB operation enter **0** to use source routing at the Master Station.	nnnn = **OFF, 0** or Station ID: Master = **1 – 245** Remote = **256 – 4095**	**0 – 4095**
***DEVICE**{,type}	Select device type mode of operation (i.e., the MRC-565 acts as a Remote, Base, Repeater, etc.). MAK ETE	type = **MASTER** **REPEATER,**{ID} **BASE,**ETE,{on,off} **REMOTE**, {MAK,{ON,OFF}}, {ETE,{ON,OFF}}	
DQERXQ,nnnn:sss	Delete specified message from the receive queue	nnnn=Station ID Master = **1 – 245** Remote = **256 – 4095** sss = msg serial number	**1 – 4095** **1 – 245**
DQETXQ,nnnn:sss	Delete specified message from the transmit queue	nnnn=Station ID Master = **1 – 245**	**1 – 4095**

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

MRC-565 COMMANDS TABLE			
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. **Action**= MCC-6100 action to be taken when the event is declared. See actions below.	
EVENT,{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, **or** to go at or below a low level	**ADCHI**= Scan A-to-D converter channel(analog input signal)for high condition **ADCLOW**= Scan A-to-D converter channel(analog input signal)for low condition **Level**= Signal level for the event to trigger at or above (for hi-level), **or** 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.	

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
EVENT,{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.	**IFGT**= If this parameter is greater than second parameter. **IFLT**= If this parameter is less than second parameter. **IFEQ**= If this parameter is equal to second parameter. **Bit1**= Name of a timer, counter or accumulator to test. **Bit2**= Name of a timer, counter or accumulator to test Bit1 against. **Action**= MCC-6100 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.		
EVENT,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.		
EVENT,TEXT	Show Event Text Message Table		

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
EVENT,TEXT,{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.	**TEXT**= Define a Text string command. **Item-number** = Item number to be created or replaced by this command. **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.	TEXT**= 1-40** MESSAGE TEXT = upto 40 Chars.
EVENT,TEXT,DEL,ALL	Deletes all previously defined text items.		
EVENT,TEXT,DEL,TEXT 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,DISPLAY,TEXT ITEM NUMBER	Display a specific item from the text table.		
EVENT,XDISPLAY,Acc#			
EVENT,GROUP	Show Group Table		
EVENT,GROUP,DEL,ALL	Delete all Group definitions. Clears the group table.		
EVENT,GROUP,DEL,GROUP-NUMBER,bit/chan list	Delete a specific group definition from the group table. This does not cause the other defined groups		

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
	to be renumbered. Note: use channel/F(x.xx) for CSI Flt Point Example: EVENT,GROUP,1,FPWR/F A0/F(0.1)		
EVENT,INVERT,DEL,{ALL, ITEM NUMBER}			
EVENT,INVERT,INPUT BIT LIST			
EVENT,TESTBITS,DEL,{ALL,ITEM NUMBER}			
EVENT,TESTBITS,INPUT BIT LIST			
EVENT,SELFTEST,N,action			
EVENT,UPDT,GROUP NUMBER	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 **= 1-16**
EVENT,STATUS,{CHANNEL,BIT}	Display an immediate value for any discrete input bit or any ADC channel.		
EVENT,STATUS,GROUP,TIMERS,COUNTERS,ACCUMULATORS}	Show current values		
EVENT,ACTION	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		

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
	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,ACK,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		
FACTORY,DEFAULT,INIT	Restores the factory default parameters.		
FILES	Show current working drive and directory.		
FILES,x	Change current working drive.		
FILES,{CD,CHDIR}{,dir}	Change or report current working drive and directory.		

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
FILES,{MD,MKDIR},dir	Make new directory.		
FILES,DIR{,dir}	Lists files in current or specified directory.		
FILES,{RD,RMDIR},dir	Deletes (removes) a directory.		
FILES,COPY,src,dst	Copies a file.		
FILES,MOVE,src,dst	Moves a file.		
FILES,{DEL,ERASE},file	Deletes a file or directory.		
FILES,REN,src,dst	Rename a file or directory.		
FILES,TEST,file,len	Create a test text file of specified length.		
FILES,TYPE,file	Displays the contents of a file.		
FLOODTIMEOUT{,tt}	Displays or sets flood timeout in minutes.		
FLUSHMSG	Delete all messages from all queues.		
FLUSHRXQ{,name}	Delete all messages from "name" from RX queue.		
FLUSHTXQ{,name}	Delete all messages from "name" from TX queue.		
***FULL DUPLEX**	Set MCC-6100 in full-duplex mode. **IMPORTANT** 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.		
GATEWAY	UAIS MSC port Gateway mode on,off		
GENERIC	Show settings		
GENERIC,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.		
GENERIC,Port,GROUP,AUT	The AUTO group numbering will start at group		

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
O	number 1 and increment by 1 for each 16 sensor values.		
GENERIC,Port,GROUP,LINE,1stGrpNo,START,END	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.		
GENERIC,Port,GROUP,FIXED,GrpNo	The FIXED option will use the Line Number parameter as the first group number then increment by 1 for each 16 sensor values.		
GENERIC,Port,GROUP,SCALE,{FLOAT,INT}	The SCALE option will scale sensor values by the factor given. (Default scale is "1".)		
GENERIC,Port,DATE,AUTO	The AUTO date option will use the MCC-6100 internal Date.		
GENERIC,Port,DATE,LINE,LineNo,START,END{,MM/DD/YY}	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.	
GENERIC,Port,TIME,AUTO	The AUTO time option will use the MCC-6100 internal time.		
GENERIC,Port,TIME,LINE,LineNo,START,END,{,HH:MM:SS}	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	

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
		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.	
GENERIC,Port,SENSOR,AUTO	In AUTO mode, sensor values are delimited by blanks or commas and there may be several per line.		
GENERIC, P, SENSOR, AUTO, 1stSenLineNo, START	If the line number is given, data can start on other than the 1st line.		
GENERIC, P, SENSOR, LINE,1stSenLineNo,START,END	if the start parameter is given, data can begin in a column other than the 1st column.		
GENERIC,Port,POLL,OFF			
GENERIC,Port,POLL,POLLSTRING,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.		
GENERIC,Port,REPORT,OFF			
GENERIC,Port,REPORT,Report String	The report string allows the definition a fixed string of printable ASCII characters that is at the beginning		

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
	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.		
GENERIC,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 ***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.		
HALFDUPLEX	Set MCC-6100 in half-duplex mode. (default setting)		
HELP{,command}	Display help information on specified command. If no parameter entered, all commands are sequentially displayed in alphabetical order.	command = valid MCC-6100 command	
***HOLD**	Select message hold mode.		
HOLDOFF{,n}	Time to hold off selecting a Master Station in minutes.		
HOST MODE{,mode}	Define host mode functionality in composite networks when host link is not available.	**STOP** = stop transmitting if host connection lost **CONTINUE** = keep transmitting if host connection lost, but set bit flagging loss in	

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
		probe **OFF** = ignore host connection state; keep transmitting and do not set bit flagging loss in probe	
HOSTSEGFWD{,on,off}	Enable/Disable multi-Master segment mode.		
***HOURLIES**{,action}	Turn on/off hourly statistics.	action = **ON** – enable **OFF** – disable	
HTTL{,n}	Set Host port timeout in minutes.		
If device = Remote: Normal operation ***ID**{,nnn,mmm{,mode}{,**INIT**}} **NOTE** Remote and Master IDs are kept in CPM, and mode is kept in RAM.	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 **INIT** parameter to change ID. **INIT** 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. **AUTO** means no connectivity established. **PREF** means Remote considers connectivity established. **FIXED** (Default) means connect only with specified Master. **MULTI** means Remote can connect to multiple Master Stations. **NOTE** If command does not change the ID or Master Station, the **SAVE** and reboot are not performed.	nnn = Remote ID mmm = Master ID mode mode = **AUTO, PREF, FIXED**, or **MULTI** **INIT** = initializes ID change	**256 – 4095** **1 – 245**

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

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
	until the INISTOP command is entered.		
IP	Show Port IP address.		
IPC or IPCONFIG	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}		
LINKSTAT	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.		
LINKSTAT,{M}asters, {B}rief			
LINKSTAT,{R}emotes, {B}rief			
LINKSTAT,{U}p,{B}rief			
LINKSTAT,{D}own,{B}rief			
LINKSTAT,id1,id2, , , id1-2. . . {B}rief			
LIST	Show all Nodes with Monitor on.		
LISTM{,nnnnn…}	Display Remotes with burst monitor bit set (all Remotes or given IDs up to 12).	nnnnn = Station ID Master = **1 – 245** Remote = **256 - 4095**	**1 – 4095**
LOCATION{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	

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
	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		
LOCK,{ID,CHANNEL,CONFIG}	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.		
LOGOFF	Used to disallow operator commands with automatic 10 minute timeout for LOS role and 60 minute timeout for **TRANSPOND** role. Logs you off, disables ALL following operator commands except **LOGON**, **$PENTM**, or **SDATA**.		
LOGON,password	**LOGON** used to allow operator commands. To log onto a unit, enter the **LOGON** 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	**A-Z, 0-9, -**
***LOS CHECKIN**{,ii,rr}	Select check-in interval (in seconds) and retry count for LOS operation.	ii = interval rr = retry	**1 – 65535** **1 – 65535**
LPM{,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	

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
	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. LPM,ALARM 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 LPM,PWR 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.	LPM,SP2 LPM,PWR	
MAINTMON,id	Define Maintenance monitor node ID.		
MEM	Show usage of dynamic pool memory.		
MESSAGE {,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 **DESTINATION** command). If you want to use source rounting, enter	p = priority dest1...destn = destination(s) name = node name nnnn = Station ID Master = **1 – 245** Remote = **256 – 4095**	**A – Z, 0 – 9** **A – Z, 0 – 9** **1 – 4095**

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

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
	the old password. The password will automatically be saved.		
NHL,starthour,duration	24 hour noise history - 5min averages - hourly averages - date stamp		
NHHA,starthour,duration	Noise history hourly averages - hourly averages - date stamp		
NHCLR	Clear noise history buffer.		
OPEN PORT,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. **CAUTION** The **OPEN/CLOSE PORT** commands directly affect MRC-565 6100 network activity and message flow. Do NOT use these commands unless directed to do so by your System Administrator.	function = user interface function	RS-232 functions **MNT, POS, ALT, DTA** Ethernet1 func. **E1F1, E1F2, E1F3, E1F4** Ethernet2 func. **E2F1, E2F2, E2F3, E2F4** USB functions **U1F1, U1F2, U1F3, U1F4**
***P**{,**?**/sec/**OFF**}	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 **P,?** to display current pulse probe mode settings. Enter **P**,xxx to send a single periodic probe once every "xxx" seconds. Enter **P,OFF** to turn off	**?** = current settings sec = periodic pulse period (in seconds) **OFF** = turn off periodic pulse mode	

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
	periodic pulse mode (you can still transmit single pulses with **P**).		
PAKBUS	Show PAKBUS Protocol Settings. Use with CR1000		
PAKBUS,ID,n	Sets PAKBUS ID	n	N = 1 to 4095
PAKBUS,INT,mm	Route Broadcast Interval	mm	MM= 1 to 3600
PAKBUS,INF, iii	Max # of hops in network	iii	Iii= 1 to 100
PASSTHRU	Show settings PASSTHRU,P1#,P2# PASSTHRU,OFF,P# PASSTHRU,OFF		
PASSWORDMODE,action, password	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, **$PENTM** commands, and **SDATA** commands will respond with "ACCESS DENIED!". You will not be able to turn off the mode without first logging on.	action = **ON** – enable **OFF** – disable password = 3-20 character password	**A-Z, 0-9, -**
POLL,{OFF,{interval,offset,duration,retry}}	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	**1 – 86400** **1 – 59** **1 – 10** **1 – 99**

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
		failed polls	
PORTROUTING{,ON,OFF}			
***POS**{,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	**0 – 65535** **BINARY, TEXT** **NMEA, ARNAV, TAIP, TRANSAS**
POS,LOCAL{,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; **OFF** disables local output	**1 – 86400**
POS{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}		
POSRPT{,action}	Enable/disable echoing of intercepted position	action =	

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

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

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
NOTE Role is kept in CPM, and low,high and mode are kept in RAM.	mode. If role is set to **TRANSPOND**, 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). Thresholds are specified in idle probes per minute. To prevent **LOS** operation altogether, set the low threshold to **1000** if the unit's Master is half duplex or **5500** if it is full duplex.	low = threshold for switching from **LOS** to **MB** mode in idle probes per minute high = threshold for switching from **MB** to **LOS** mode in idle probes per minute mode = **MB** or **LOS**	**0 – 32767** **0 – 32767**
RR,{on,off}	Remote Relay On or Off		
RTCM{,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	**0 – 59**
RXSTAT	Shows stats for each receiver that is defines	Up to 3	
RXTYPE	Display Receiver Type MRC-565		
RXTH	Display Receiver Threshold		
SAVE	Save **CONFIG** parameters in CPM. Reboot of MCC-6100 (or restart due to software failure) returns unit to configuration saved in CPM.		
SCALE	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 1.5VCFC 0.0012207 0.0000 1132.0000 1.3818324 3.3DSP 0.0012207 0.0000 2671.0000 3.2604897 1.6DSPC 0.0012207 0.0000 1218.0000 1.4868126 1.2VFPGAC 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		

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
	ADC6 1.0000000 0.0000 0.0000000 0.0000000 +		
SCALE,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 = **VBAT** – battery voltage **PA_VF** – PA Fwd Pwr **PA_VR**– PA Rev Pwr **PA_TEMP-** PA Temp **3.3V** **1.8V** **1.5VCFC** **3.3VDSP** **1.6VDSPC** **1.2VFPGAC** **ADC1, . . . ADC6** value = scale factor	
SCHED	Display all scheduled commands		
SCHED{,basis,hh:mm:ss {,**OFFSET**,hh:mm:ss}, command string} **IMPORTANT** Up to 50 commands can be scheduled. Do not schedule commands that require user interaction (such **MESSAGE**	Schedule execution of the specified command string. If timeframe basis = **INTERVAL**, the command string will be executed whenever the specified time interval elapses during the day. If timeframe basis = **TIME**, the command string will be executed at the specified time. The **OFFSET** option allows specification of an offset from the timeframe basis.	basis = **TIME** or **INTERVAL** hh - hours mm - minutes ss - seconds	 **0 – 23** **0 – 59** **0 – 59**

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
and **REMCMD)**, or any commands that change port configurations.			
SCHED,DEL,nn	Delete specified schedule item number. If nn = **ALL**, the entire schedule will be cleared.	nn = schedule item number	**1 – 50**
SDATA,g,c,time stamp, value...	Enter an MCC-550C data report directly from the serial I/O port. Up to 16 values may be entered. Use the **LINK** 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	**1 – 4** **1 – 16** mm **1 – 12** dd **1 – 31** hh **0 – 23** mn **0 – 59** **0 – FFFF**
SERIAL{,sss}	Set next packet serial number. Parameter "sss" is serial number of last packet transmitted.	sss = message serial number	**1 – 255**
SERIALNUMBER{,sn}	Display/Set serial number of this modem		
***SET BAUD** {,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	**ALT,C&S,DTA,MNT,MSG, POS** **50-115200** **O/E/N** **5/6/7/8** **1/2** **Y** or **N**

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
SHOW REMOTES	Display ID and assigned 520/525 of each Remote in system.		
SHOW RXQ,nnnn	Display contents of receive queue for the originating Station.	nnnn = originating Station ID Master = **1 – 245** Remote = **256 – 4095**	**1 – 4095**
SHOW TXQ,nnnn	Display contents of transmit queue for the destination Station.	nnnn = destination Station ID Master = **1 – 245** Remote = **256 – 4095**	**1 – 4095**
SIGNALPRESENT{,dBm}	Display/Set Signal Present threshold in dBm.	dBm = **-0 to -130**	
SIG,Block,-dbm	Enter the threshold in dbm for each block. MANUAL AUTO	Block = DSP FPGAHI FPGALO	
SITENAME{,name}	Display/Set Site name		**30 characters**
SML{,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 = **1 – 245** Remote = **256 – 4095**	**1 – 4095**
SMS{,nnnn}	Display status of message packet in specified message list.	nnnn = Station ID Master = **1 – 245** Remote = **256 – 4095**	**1 – 4095**
***SNP**{pname,value} **NOTE** Some network parameters are only for use in Master Operation mode (**RDOWN, CONNP, TEXTL, FLOODP, INF, RELAY**).	Set network parameters. See range column for values entered for each parameter.	pname = **TTL** time-to-live (truncated to nearest 10 minute boundary) **TTR** time-to-retransmit	**0 – 2550** min. default = **120** **0 – 255** min. default = **20** **1 – 255** acq.

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

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

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
SUBNET{,code}	Display/Set subnet code.		
SUBST,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#	**1 – 245** **0 – 15** **256 – 4095** **1 – 4**
SUBST,DEL,ALL	Delete entire substitution table		
SUBST,DEL,rrr,g1	Delete entry in substitution table	rrr = relay ID g1 = relay grp#	**1 – 245** **0 – 15**
SWCORR			
SWCTL			
SWMON			
T	Show current date/time.		
TOD	Display Time of Day and Date		
TEST	Displays RF Statistics with TX Keyed		
TEST{,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
TESTMODE{,ON,OFF}	Show/set test mode		
TIME{,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	**0 – 23** **0 – 59** **0 – 59**

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

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

MRC-565 COMMANDS TABLE			
COMMAND	**DESCRIPTION**	PARAMETERS	**RANGE**
VDUREV	Show SW Rev of VDU		

APPENDIX B: FACTORY DEFAULTS

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,TXRXLEVEL,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
RFP,{10, 25, 50, or 100} – CPLD firmware
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

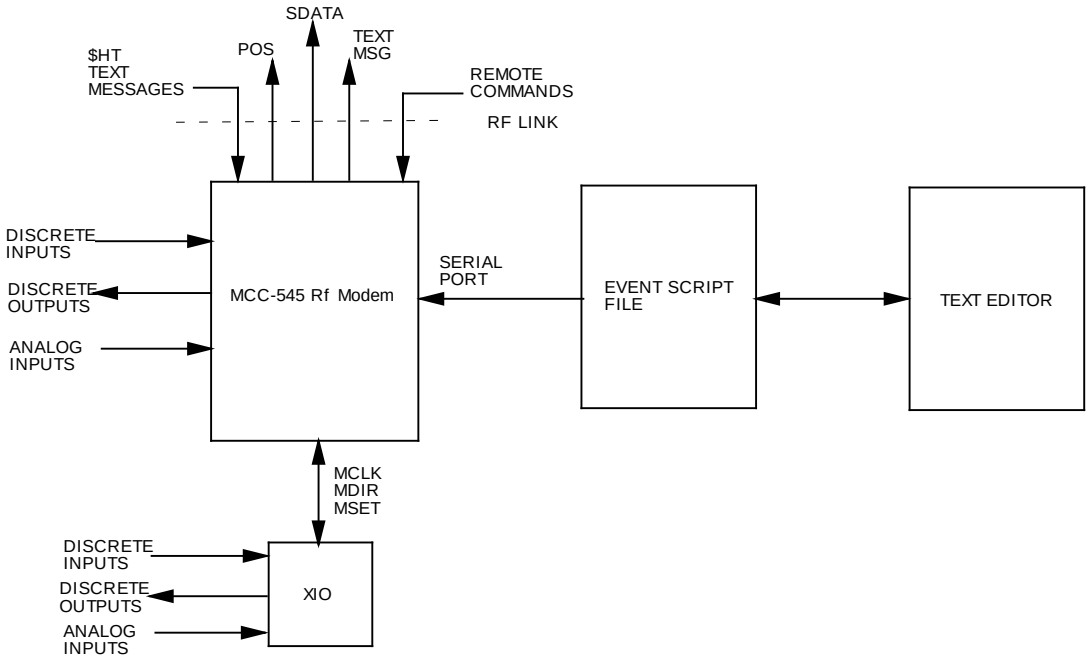
APPENDIX C: EVENT PROGRAMMING

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" in -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.

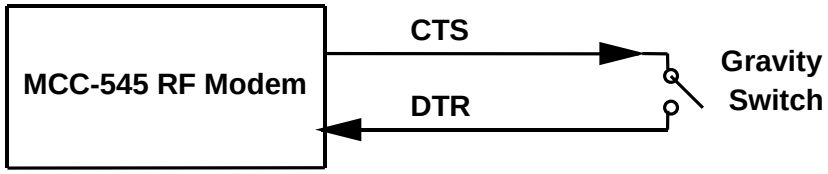
Programming in Real-Time

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

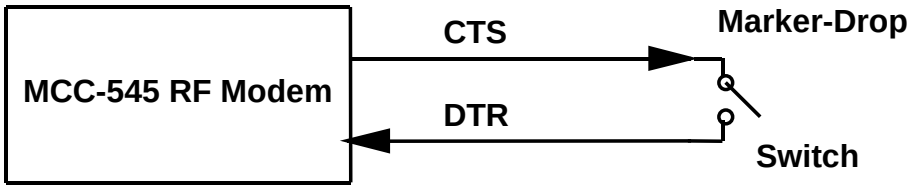
To make the tip-over detection mechanism function, the CTS signal must be enabled so that it can be detected at DTR should the switch close. A good time to enable CTS – set CTS to high – may be when the MRC-565 is powered up. The command `EVENT,RESET,SET,CTS` will do this. The event is `RESET`. The action 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.

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

EVENT, DISPLAY, *item-number*	Yes	No
EVENT, TEXT	No	No
EVENT, TEXT, *item-number, message text*	Yes	Yes
EVENT, TEXT, DEL, ALL	No	No
EVENT, TEXT, DEL, *item-number*	No	No
EVENT, GROUP	No	No
EVENT, GROUP, *group-number*, *bit-name* or *chan-name*, …	No	Yes
EVENT, GROUP, DEL, ALL	No	Yes
EVENT, GROUP, CLEAR, *group-number*	No	Yes
EVENT, UPDT, *group-number*	No	No
EVENT, STATUS, {*bit-name, chan-name*}	No	No
EVENT, *action*	No	No
SCALE, *chan-name, slope, offset*	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:

scaled value = (analog channel raw count * slope) + 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.

Action Value	Action Parameters	Description
TXT, *nn*	text table item number	Transmit a text message to the default destinations. NN can range from 1 to 40.
CMD, *nn*	text table item number	Execute a local command. NN can range from 1 to 40.
CAN, *nn*	Canned message number	The canned message number is transmitted to 1 to 4 default destination IDs. Valid range: 0 to 255.
POS		A position report with current GPS coordinates is transmitted to 1 to 4 default destination IDs.
MARK		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.
COLLISION		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.
SET, *ccc, ddd*	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.
SET/N, ccc	ccc = status bit name	Sets the status bit and does NOT transmit POSS
SET/T, ccc	ccc = status bit name	"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.
CLR, *ccc*	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.
CLR/N,ccc	ccc = status bit name	Clears the status bit and does NOT transmit POSS
PULSE,bit-name, ddd, iii, nnn	bit-name is any discrete output signal	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.
ADCIN, *ccc, aaa, mult*	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.
UPDT, *group-number*	SDATA report group number	The SDATA report specified by the group number is transmitted to 1 to 4 default destination ids.
NC, ccc	+1	Increment a counter by 1. Where ccc must be a valid counter (C1-C8)
DEC, ccc	-1	Decrement a counter by 1. Where ccc must be a valid counter (C1-C8)

ADD, 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.
SUB, 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.
MUL, 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).
DIV, ccc, ddd		Divide ccc by the decimal value of ddd and place the result in ccc. Where ccc accumulator (A1-A24).
MOV, ddd, sss		Move the source sss into ddd where sss and ddd are valid Timers (T1-T8) , Counters (C1-C8) or Accumulators (A1-A24)
ADDA, 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.
SUBA, 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.
MULA, 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).
DIVA, 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

Bit Name	I/O; Voltage Range	Definition	Description
BIT0-BIT15	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.
DTR	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.
RTS	Input; RS 232 ±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.
CTS	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.
RING	Output; RS 232 ±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.
MCLK **MDIR** **MSET**	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.
IN1,IN2 **IN3,IN4**	Optically Isolated Inputs 0-5 Volts	0 or 1	Typically requires an input greater than 1 volt to trigger an input transition from 0 to 1.
RO1,RO2	Relay Contacts	NO,NC	Provides NO,COM,NC contacts
GPS	GPS status	0 or 1	Current GPS receiver status and RS-232 port condition. 0=V0 or RS-232 disconnected. 1=V1 or V2 and RS-232 connected.
NET	Network Status	0 or 1	Network online/offline status. 0=offline , 1=online
T1 – T8	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 n	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.
C1 – C8	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.
A1-A24	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
FPWR	Forward RF power	RF power going out of the MRC-565 transmitter.
RPWR	Reverse RF power	RF power being reflected back to the MRC-565 transmitter.
LBAT	Battery level	Voltage level of the MRC-565 battery.
DETRF	Detected RF	Current MRC-565 receiver detected RF level.
TEMP	Internal temperature	Internal temperature of the MRC-565 enclosure.
TXC	Transmit Count	Total number of transmissions
ACK	Acknowledge Count	Total number of acknowledgements
RXC	Received Segments	Total number of received text message segments, position reports and data reports
PROBE	Idle Probe Count	Total number of Idle probes and poll frames received
REMOTE	Number of Remotes	Number of remotes connected to this unit.
ADC1	Analog Input	Available MRC-565/C 10-bit A-to-D channel.
ADC2	Analog Input	Available MRC-565/C 10-bit A-to-D channel.
ADC3	Analog Input	Available MRC-565/C 10-bit A-to-D channel.
ADC4	Analog Input	Available MRC-565C/ 10-bit A-to-D channel.
ADC5	Analog Input	Available MRC-565/C 10-bit A-to-D channel.
ADC6	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 100.6, multiplied by 10 to

```
;EVENT                ACTION                COMMENTS

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.

External Signal Name	Direction or Function	Internal Signal Name
XIN1	Discrete Input	Port C, bit 2
XIN2	Discrete Input	Port C, bit 1
XIN3	Discrete Input	Port B, bit 7
XIN4	Discrete Input	Port B, bit 6
XIN5	Discrete Input	Port B, bit 5
XIN6	Discrete Input	Port B, bit 4
XIN7	Discrete Input	Port B, bit 3
XIN8	Discrete Input	Port A, bit 4
XIC1	High Speed Input Counter	---
XIC2	High Speed Input Counter	---
XOUT1	Discrete Output	Port D, bit 7
XOUT2	Discrete Output	Port D, bit 6
XOUT3	Discrete Output	Port D, bit 5
XOUT4	Discrete Output	Port D, bit 4
XOUT5	Discrete Output	Port D, bit 3
XOUT6	Discrete Output	Port D, bit 2
XOUT7	Discrete Output	Port D, bit 1
XOUT8	Discrete Output	Port D, bit 0
XOUT9	Discrete Output	Port C, bit 7
XOUT10	Discrete Output	Port C, bit 8
XADC1	10-Bit Analog Input	Port A, bit 0
XADC2	10-Bit Analog Input	Port A, bit 1
XADC3	10-Bit Analog Input	Port A, bit 5
XADC4	10-Bit Analog Input	Port E, bit 0
XADC5	10-Bit Analog Input	Port E, bit 1
XADC6	10-Bit Analog Input	Port E, bit 2

APPENDIX D: INSTALLATION DETAILS

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 on 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 (11.0-15.0) 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.

Vertical Polarized Antenna

For LOS networks two antennas will be used. For base stations a Half wavelength Dipole 2.2dBi. For the Remote Vehicle antenna a ¼ wavelength vehicle mounted antenna 0dBi is used.

Antenna Selection

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.

Equipment Installation

Base station antennas are typically mounted on a tower 20-100 feet above ground level. Equipment needs to be installed in a climate controlled encloser.

Remote radios are mounted in vehicles – protected from the elements.

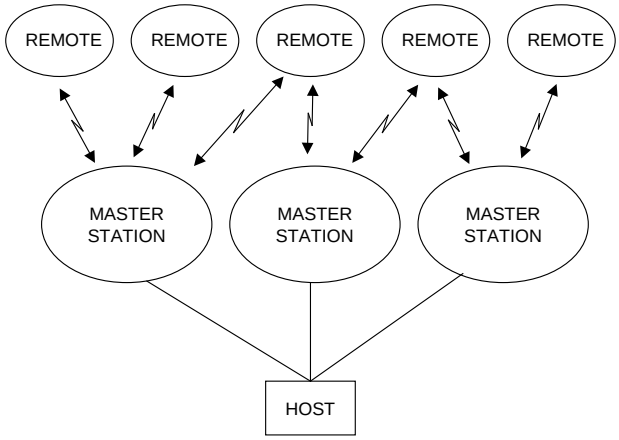
APPENDIX E: INTEROPERABILITY

MODE	NETWORK	PROTOCOL	FUNCTION
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.

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.

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



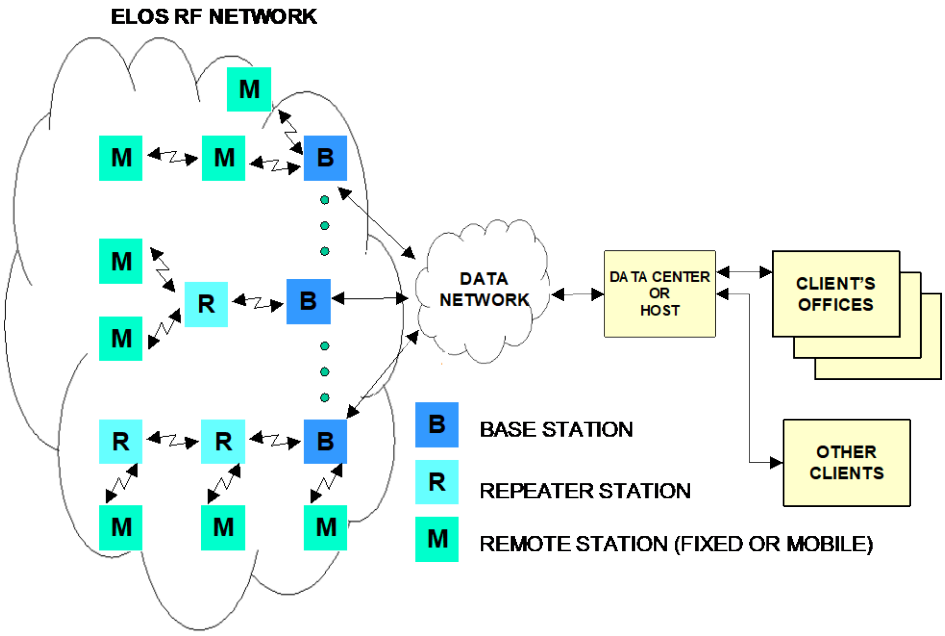
The remote stations transmit their data to whichever master station probe is received. Multiple master stations will significantly improve the performance of the network because of the additional RF links available to each remote station.

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.