METEORCOMM LLC

545C Operations Manual

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Revision History

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1.0	02/10/2012	Legacy document formatted in 2012 template

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Table of Contents

Table of Figures

Table of Tables

Acronyms

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	Gausian 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
MCC	Meteor Communications Corporation
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

1. Introduction

This manual outlines the operation of the MCC-545C Packet Data Radio through software revision 6.87.

The MCC-545C Packet Data Radio is used in MCC's FleetTrak™ network. This chapter briefly describes this network application; refer also to Appendix F for a complete discussion of MCC Network Interoperability.

In addition to information and instructions for line of sight applications, this manual also contains information regarding meteor burst master and remote station installation and refers to antennas used in those installations that apply to use of the MCC-545B or other MCC models.

Please refer to the tables in the MCC-545C RF Energy Exposure Guide for lists of antenna types suitable for use in vertically-polarized line of sight applications of the MCC-545C.

Each MCC-545C features rugged construction and is packaged in a stainless steel, weather-resistant enclosure that measures 10.6"L x 4.0"W x 2.42"H and weighs 3.5 pounds, as shown in Figure 1.1.

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Figure 1: MCC 545C Packet Data Radio

The MCC-545C radio is frequency synthesized and uses a GMSK modulation scheme with selectable data rates, as shown below.

Model No.	Modulation	Data rate
MCC-545C	GMSK	9.6 kbps

The MCC-545C has 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. In addition, it has a built-in test capability that automatically monitors the operating integrity of the unit at all times. This feature also eliminates the need for any special test equipment during the installation phase. A laptop, palmtop, or equivalent is required to initialize and operate the MCC-545C packet radio.

1.1 FleetTrak™ Network

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. The FleetTrak□ network is shown in Figure 1.2.

Figure 2: FleetTrak™ network diagram
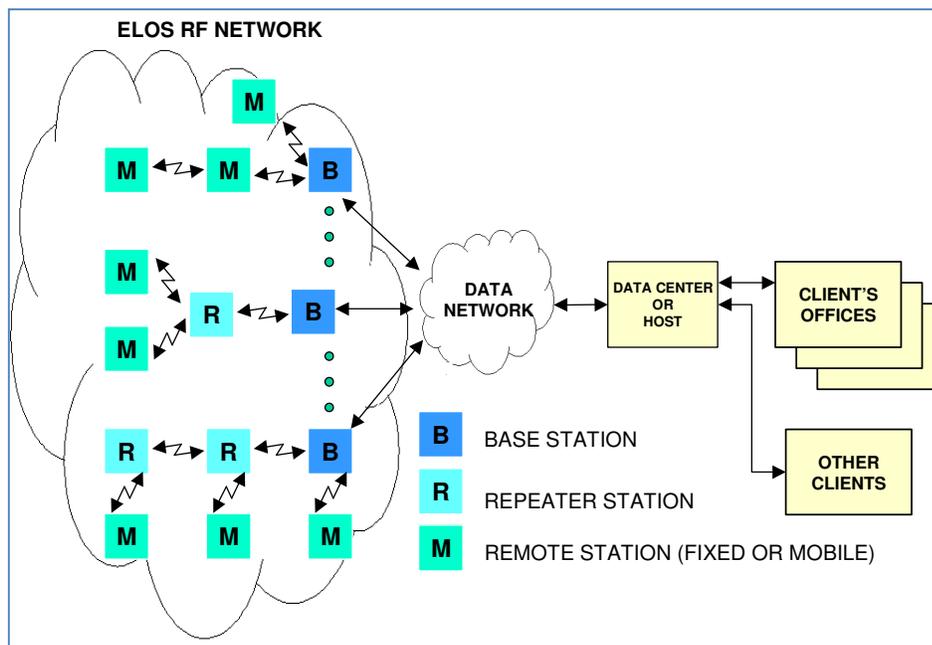
The FleetTrak™ network is comprised of Base Stations, Repeaters, and Remote Stations. The MCC-545C can be programmed to operate as any of these three distinct station types. The FleetTrak™ network is used for position reporting in mobile applications (AVL), fixed site data collection (SCADA), and messaging.

The FleetTrak™ network operates line-of-sight using groundwave and uses an LOS protocol for channel access. In an LOS network, there is always an RF connection path between adjacent stations, and stations transmit data whenever they have something to send. These transmissions use CSMA (carrier sense multiple access) to gain channel access and to prevent RF signal collisions.

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 MCC from 50-100 miles through the use of robust protocols, sensitive receivers, and short packetized messages.

1.2 Manual Organization

There are 5 major sections in this manual, plus a number of appendices:

Section 2.0   RF Safety and Regulatory Information

This section provides important information regarding antenna installations and means to safely limit exposure to RF radiation.

Section 3.0   Description

This section provides both a physical description and a functional description of each module in an MCC-545C. The detailed technical specifications are provided for each printed circuit board assembly (PCA), as well as the organization of the unit's computer memory.

Section 4.0   Installation

This section covers site selection and general installation guidelines, 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 MCC-545C on-line within the network.

Section 5.0   Operation

This section describes all the operating procedures for the MCC-545C. All commands and operational parameters are described for data collection, supervisory control, messaging, and interpreting system operational statistics. It also contains a list of all MCC-545C commands.

Appendices include:

   Appendix A Command Printouts

   Appendix B Factory Default Parameters

   Appendix C Loading a Script File

   Appendix D Programming an Event

   Appendix E MCC Hardware and Sample Part Numbers

Appendix F   Interoperability With Other MCC Products

1.3 Related Documents

Additional documents and application notes that may be helpful in the operation of a MCC-545C Packet Data Radio are given below. These documents (and more recent updates, if available), can be obtained from MCC or downloaded from MCC's web site, www.meteorcomm.com.

1. XTermW – Operation of the XTermW Terminal Emulation Program for Windows, October 22, 1999

2. DMC – Data Monitor and Control, DMC 6.313, Users Manual, January 14, 2002

3. MBNET 200 – a complete list of all commands and printouts

4. MCC-520B/C Master Station – Operations of the MCC-520B/C Meteor Burst Communications Terminal, Rev. K, December 2002

5. CR10X Data Acquisition – Application Note: CR10X Data Acquisition, January 25, 2000

6. Wireless Data – MCC Wireless Data Services, EDT 11039, January 2000

2.   RF Safety and Regulatory Information

2.1   Limiting RF Exposure

> ⚠️ **Please refer to the MCC-545C RF Energy Exposure Guide for specific information regarding safe distances that must be maintained between personnel and energized transmitting antennas.**

The information in the MCC-5454C RF Energy Exposure Guide "RF Exposure Guide" is determined from FCC and Industry Canada rules that when followed, limit human exposure to radio frequency energy to acceptable levels. Obeying these limits will provide reasonable protection to both employees and the general public.

This radio is intended for installation and use by employees who have full knowledge of their exposure and can exercise control over their exposure to meet FCC and IC limits. This radio device is not intended for use by consumers or the general population.

- Table 1 in the RF Exposure Guide lists the calculated lateral distances to be maintained between the general public and an operational transmitter antenna for two antenna types for mobile applications.

- Table 2 in the RF Exposure Guide lists the calculated lateral distances to be maintained between employees and an operational transmitter antenna for two antenna types for fixed applications.

Once the authorized ERP, antenna gain and the losses from feed line, connectors and any inline RF filters are known, the transmitter power must be evaluated and if necessary, attenuated to a value that will ensure that the authorized ERP and RF exposure requirements are met. Example ERP calculations are provided further below.

⚠️	**Caution: Be aware that a transmitter may operate automatically at any time when functioning as a data radio. Always disable the transmitter prior to beginning any service or maintenance. Remove the antenna and connect a dummy load during testing.**

2.2   RF Interference to Residential Receivers

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

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment

generates and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

2.3   Equipment Modifications

Caution: Any changes or modifications to this equipment not expressly approved by the party responsible for compliance (in the respective country of use) could void the user's authority to operate the equipment.

3.   Description

3.1 General

The MCC-545C Packet Data Radio provides packet switched communications from fixed or mobile sites to a central Host. It can be used for data collection, position reporting, 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.

The MCC-545C also has a built-in data collection capability so that an external data logger is not required for those installations that have less

than 10 sensors. A special break-out cable is supplied by MCC to access the following I/O capability:

Inputs	**Outputs**

6 analogs
    0-5V
    4-20 mA (with external 250 ohm resistor)
    10 bit accuracy/resolution
	2 Form C
	SPDT Relays

4 ON/OFF, optically isolated

1 GPS, NMEA compatible

3 RS-232 Ports

An outline drawing and an exploded view of the chassis are shown in Figures 2.1 and 2.2.

Figure 3: MCC-545C outline drawing

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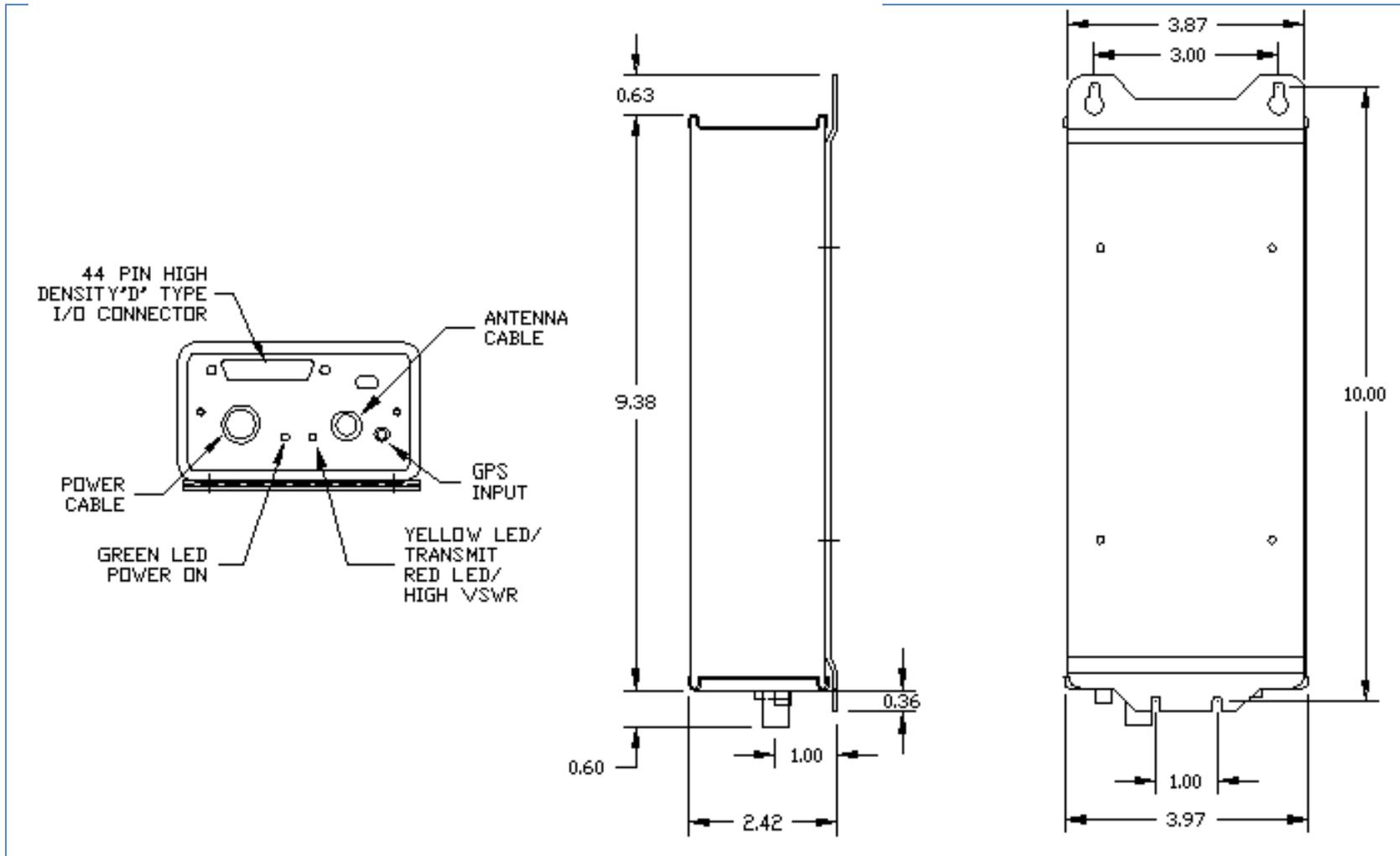
Figure 4:Exploded view of the MCC-545C
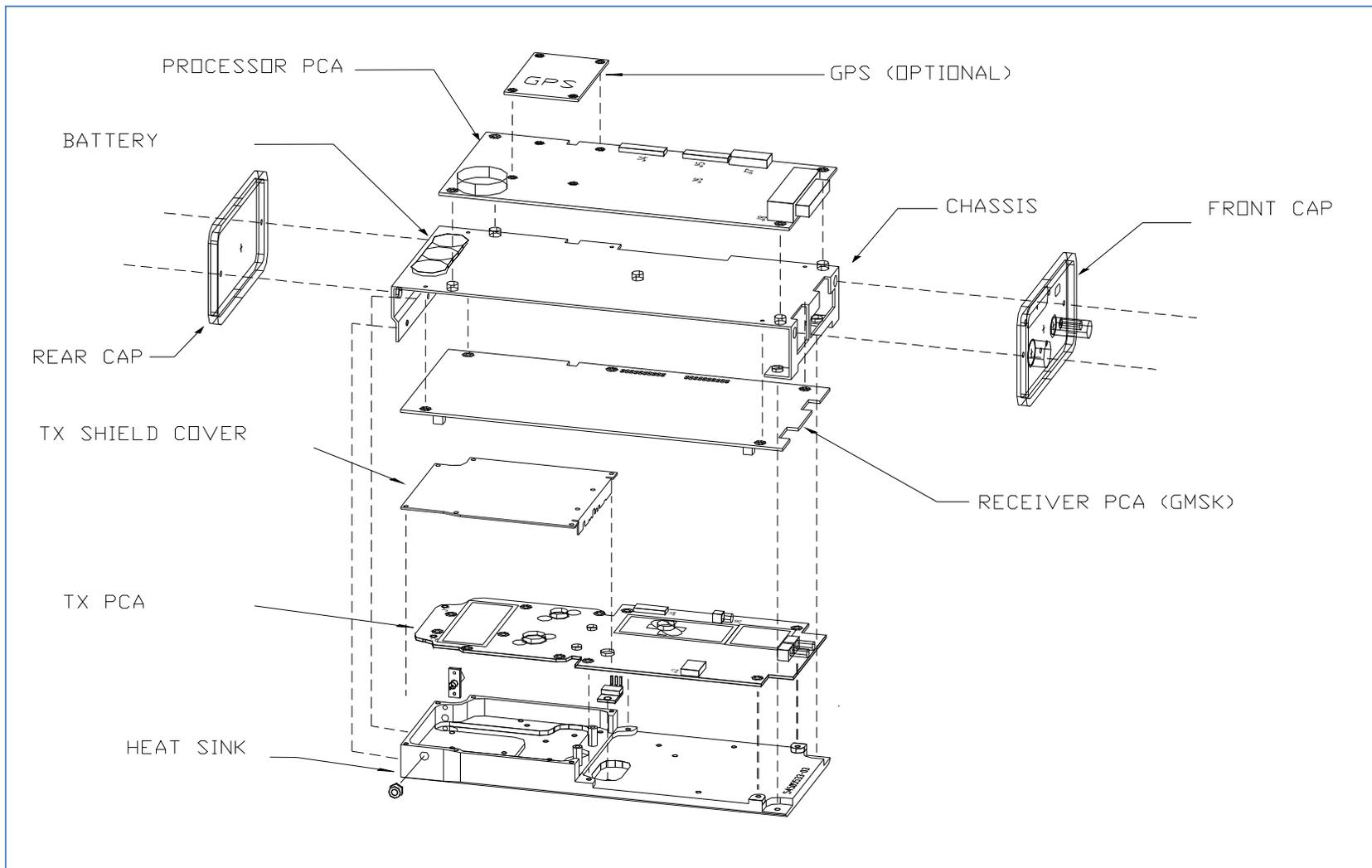
3.2 Printed Circuit Board Assemblies

The MCC-545C contains three printed circuit board assemblies as shown in Figure 2.2.

3.2.1 Microprocessor

The low-power 32-bit microprocessor controller performs the radio control, link, and network protocol functions. This assembly also contains a digital signal processor (DSP) and digital-to-analog converter (DAC) for generating the in-phase (I) and quadrature-phase (Q) base band signals for generating the GMSK RF signal.

3.2.2 Transceiver

The selectable-rate transceiver uses a vector phase modulator (+13DBm output) and frequency synthesizers to produce 9.6 kbps.

3.2.3 Power Amplifier

Note: The nominal RF power amplifier rating of the MCC-545C is 100W or 50 dBm. The output power is calibrated at the factory at the expected operating frequency. Measured power values may vary up to 1 dB from rated power, up to 51 dBm or 125W over the frequency range of the radio.

The multi-stage power amplifier includes a 2 watt, 2-stage preamplifier; a 100 watt, solid-state, 2-stage power amplifier; and a power switch.

A 12-channel GPS receiver may be mounted on the processor board as an optional subassembly.

All components are soldered in place using surface mount technology. As an option, the boards can be conformal coated with an acrylic encapsulate that contains a tropicalizing, anti-fungal agent to provide additional protection against moisture and contamination.

3.3 Microprocessor

The microprocessor is a Motorola-based, embedded processor located on a single PCB that contains:

- 512K x 16 of non-volatile flash memory for program storage
- 512K x 16 of non-volatile flash memory for parameter storage
- 1024K x 8 of static RAM for data storage (optionally 2048K x 8)
- 3 External RS-232 I/O ports
- Internal TTL GPS port
- Transmitter communication port
- Receiver communication port
- 10-bit 11 channel A/D converter (6 channels are available for external sensors)
- Real-time clock
- Power fail detection circuitry
- Digital Signal Processor with D/A converters
- 6 Optically isolated digital inputs
- 2 Form C Relay Outputs with a current rating of 2 amps

All I/O ports are RS-232 compatible and can be programmed to adapt to various customer protocols. The DATA port contains full flow control hardware lines.

Figure 5:MCC-545C block diagram
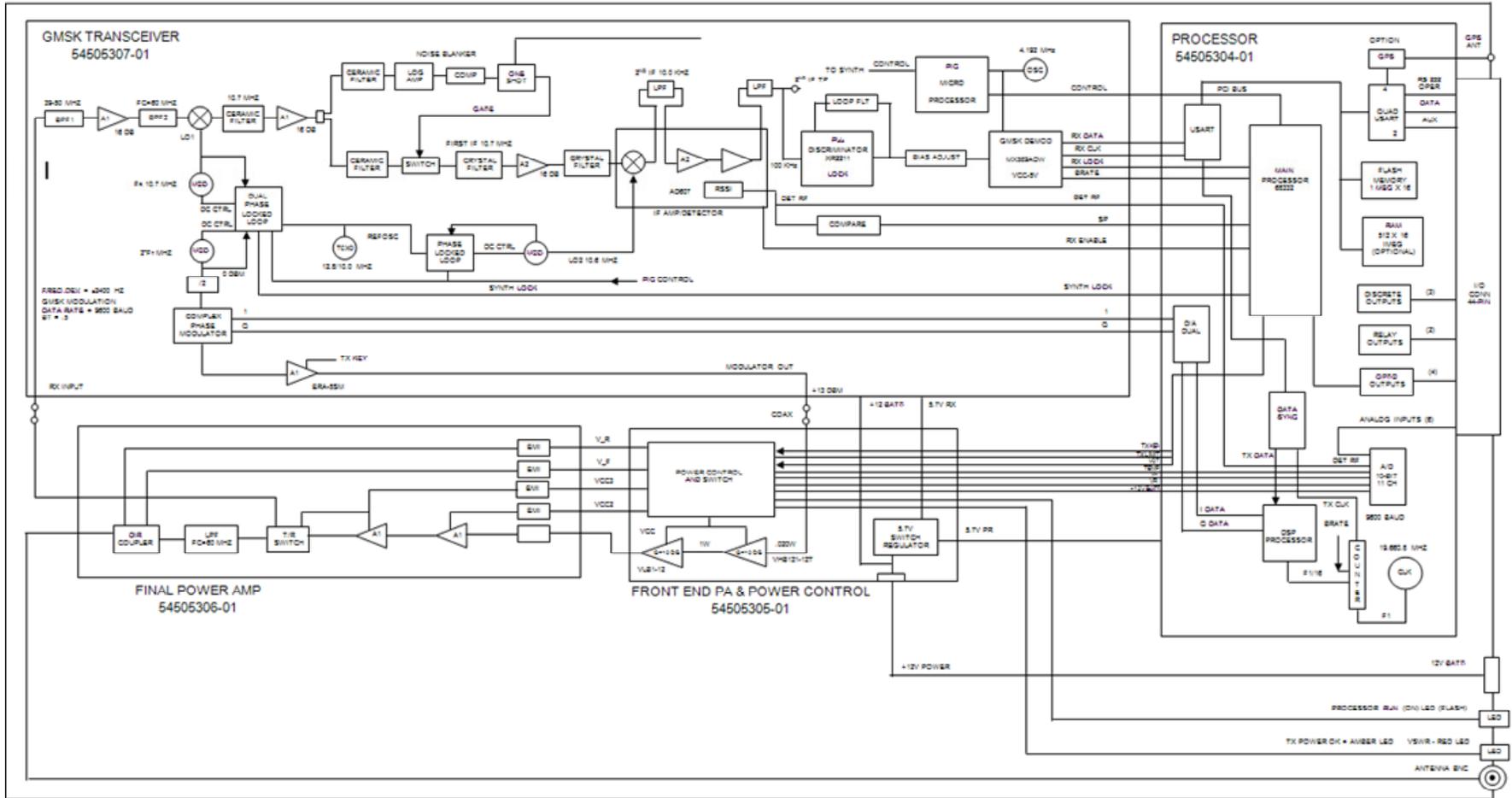
The A/D converter measures TX forward and reverse power, battery voltage, antenna noise voltage, transmitter board temperature, and 6 channels of 0-5V external sensor inputs. In –03 or later versions the internal nickel metal hydride battery (3.6V) can also be read.

An internal lithium ion battery is used to maintain the internal real time clock and battery backed RAM. This battery operates the clock in a power down state for a period of approximately 6 months. This battery should be removed if the unit is stored for extended periods of time.

In -03 or later versions of the units, the lithium ion battery has been replaced with a rechargeable nickel metal hydride battery. This battery is located at the rear of the unit with Velcro. (You have to open the rear lid to get access to it.) A short jumper is used to connect the battery to the processor board. This jumper should be removed if the unit is stored for long periods of time (longer than 2 months). The battery must be connected before the unit will start operating.

3.4 Transceiver

The transceiver assembly contains a receiver, transmit and receive frequency synthesizers, and a modulator. The MCC-545C receiver and modulator support 9.6 kbps Gaussian Minimum Shift Keying (GMSK).

 GMSK Receiver

- Input bandpass filter (37-50 MHz)
- RF amplifier (17 dB)
- Low pass image filter (Fc=50 MHz)
- Mixer
- IF amplifiers and filters (10.7 MHz)
- Noise blanker
- Mixer, 2nd IF filter and amplifier (100 kHz), and RSSI circuit
- Phase lock loop frequency discriminator
- GMSK bit detector and clock generator

Synthesizer (1st and 2nd local oscillator and transmit oscillator)

- Reference Oscillator (12.8 MHz +/- 2.5 PPM)
- Tx phase lock loop (74-100 MHz output, 20 kHz steps)
  (86-92 MHz, 20 kHz steps in FCC ID: BIB54505003-01)
- A divide by 2 circuit (37-50 MHz output, 10 kHz steps)
  (43-46 MHz, 10 kHz steps in FCC ID: BIB54505003-01)

- Rx 1st local oscillator phase lock loop (47.7-60.7 MHz output, 10 kHz steps limited to 53.7 – 56.7 MHz in FCC ID: BIB54505003-01)
- Rx 2nd local oscillator phase lock loop (10.6 MHz)
- PIC Microcontroller

GMSK Modulator

- DSP digital baseband GMSK generator
- I and Q DACs
- I/Q Vector Phase Modulator (GMSK)
- Pre amplifier (+13 dBm output)

All components are mounted on an 8.5" by 3.5" two-sided printed circuit board. All components are surface mounted.

3.5 Pre-Amp, Final Power Amp, and Power Control

This board contains two low-level amplifiers that amplify the +13 dBm (10 mW) signal from the modulator to the 2 watts required by the final power amplifier. A special 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 16%. A temperature sensor is also located on this board for monitoring the internal temperature of the MCC-545C. This temperature reading may be transmitted to the Host for maintenance purposes.

The 100 watt power amplifier is mounted inside an aluminum enclosure to provide RF shielding between the low level phase lock loop synthesizers 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 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.

A switching regulator power supply provides 5.7 volts for the processor and transceiver boards.

3.6 Detailed Specifications

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

Table 1:MCC-545C general specifications

Characteristic	Specification
Dimensions	10.6"L x 4.0"W x 2.42"H
Weight	3.5 lbs.
Temperature Range	-30° to 60° C (-22° to 140° F)
Power Requirements	12 V_{DC} Nominal (10-14 V_{DC}) Standby: 80 ma (Continuous) Transmit: 25 Amps Nominal (100 msec)

Table 2:MCC-545C receiver specifications

Characteristic	Specification
Frequency	37-50 MHz or 43-46 MHz Synthesized 10 kHz steps Frequency accuracy, calibrated: ±1ppm Frequency stability: ±5ppm -30˚to +60˚C
Modulation: Type Rate Format	GMSK 9.6 kbps NRZ
Noise Figure	≤7 dB
Sensitivity: Bit Error Rate < 10^{-3} at 9.6 kbps	≤-114 dBm
IF Bandwidth (3/80 dB)	13/40 kHz typical
RF Bandwidth (3 dB)	13 MHz typical
Signal Acquisition Time	< 5 ms
3rd Order Intercept Point	>- 4 dBm
Image Response Attenuation	> 70 dB minimum
Spurious Response Attenuation	> 70 dB minimum
SP Threshold	Adjustable from –115 to –106 dBm Triggered by DET RF and Demodulator Lock
Noise Blanker	> 20 dB Reduction in Impulse Noise

I/O	MCC Standard (Refer to Section 3.2.3)

Table 3: MCC-545C transmitter specifications

Characteristic	Specification
Frequency	37-50 MHz (FCC ID: BIB54505001-01) 43-46 MHz (FCC ID: BIB54505003-01) Synthesized 10 kHz steps Frequency accuracy, calibrated: ±1 ppm Frequency stability: ±5 ppm -30 to +60C
RF Power Output, Nominal	100 Watts into 50 ohms at 12 V_{DC} Input
Load VSWR	< 2:1 Rated Power
Harmonic and Spurious Levels	-70 dB TIA-603C
Modulation: Type Rate Format	GMSK 9.6 kbps NRZ
Spurious	> 70 dB TIA-603C
Transmit Modulation Spectrum	TIA-603C (FCC Mask C – 20 kHz channels)
Tx Duty Cycle Firmware limit: Hardware limit:	10% max averaged over 5 minutes RF PA self-limits at > 16% in one minute
T/R Switch	Solid-State Switching Time < 100 microseconds
I/O	MCC Standard (Refer to Section 3.2.3)
High VSWR Protection	Withstands Infinite VSWR

Table 4:MCC-545C microprocessor specifications

Characteristic	Specification
Main Processor	Motorola MC68332FC 32-bit Embedded Controller
Memory: Program Storage Parameter Storage Data Storage	512K x 16 non-volatile Flash memory 512K x 16 non-volatile Flash memory 1024K x 8 static RAM (optional 2048K x 8)

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Switches: SW1	System Reset, Momentary

3.7 Memory Organization

The MCC-545C has three types of memory:

3.7.1 Program Memory (PM)

The Program memory is non-volatile Flash (512K x 16). It contains the MBNET200 image software, bootstrap, configuration, and application software. These programs are installed at the MCC facilities at the time of shipment. The information stored in the Program memory is referred to as "factory defaults".

3.7.2 Parameter Memory (CPM)

The Parameter memory is non-volatile Flash (512K x 16). It contains the configuration data for the unit such as the customer number, the serial number and ID of the MCC-545C, 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 MCC facilities or on site.

3.7.3 Data Memory (RAM)

The Data memory is volatile RAM (1024K x 8) and has battery backup. Date, time, executable programs, command parameters, and program dynamic data (messages, data, position, etc.) are all stored in RAM during normal operations. As an option, the Data memory may be expanded to 2048K x 8.

During normal operation, the MCC-545C 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:

- The Boot command is issued.
- The Reset button (SW1) is depressed. (Remove the rear panel to locate SW 1.)
- The internal backup battery fails or is disconnected. (In -02 units, remove jumper JP1 while the external power is turned off to the unit. In -03 or later units, remove connector J1.)
- 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.

3.8 Front Panel LEDs

The two LEDs on the front panel provide the operator with a quick assessment of the unit's operational status.

Figure 6: MCC-545C front panel LEDs
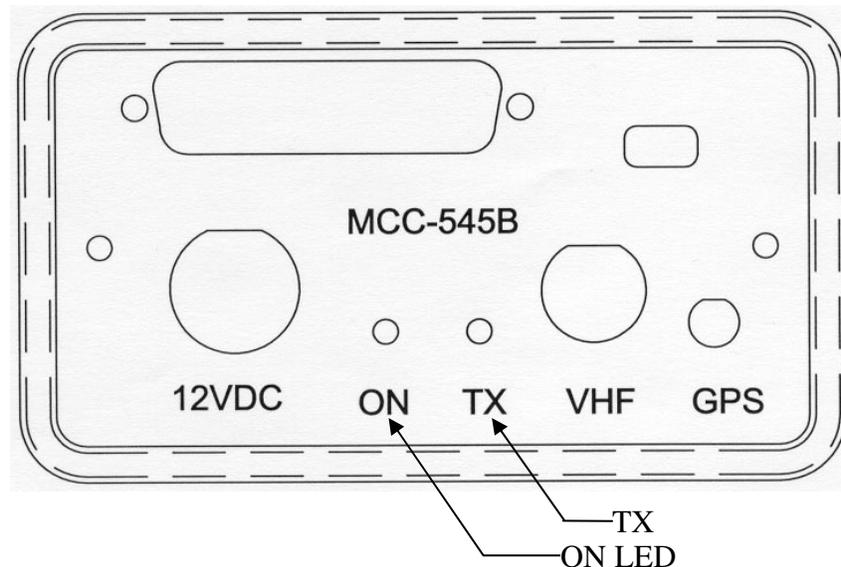
LED	COLOR	STATUS
ON	Green; flashes every 5 seconds	Power is on and the processor is running

TX	Yellow; flashes during transmission	Transmit power is normal and VSWR is below 3.0:1
	Red; flashes during transmission	Transmit power is normal but VSWR is greater than 3.0:1
	Off	Transmit power is off or below normal

4.   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 MCC-545C on-line within the network.

4.1 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

4.1.1   External Noise/Interference

Noise and signal interference can reduce the performance of the MCC-545C. The most common sources of noise and interference are as follows:

- Cosmic Noise
- Power Line Noise
- Automobile 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 man-made noise is 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 msec (1/60 Hz) or every 10 msec (1/50 Hz). The level of the spikes is 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 msec to several dozen every 8-10 msec. The impulse noise blanker in the MCC-545C removes a large amount of this type of noise. However, as the number of spikes increase, the effectiveness of the blanker is reduced. When setting up a site always, check 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 regular 8-10 msec period 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 can result if any of these signals couple into the antenna at the MCC-545C receive frequency. To minimize this type of interference, try to keep the antenna away from computers by at least 100 feet. The MCC-545C's noise blanker does not suppress computer-generated interference.

External Signal Interference

This type of interference occurs whenever another transmitter produces harmonics at the receiver center frequency of the MCC-545C. 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.

4.1.2 DC Power Source

The MCC-545C requires a 12 VDC power source. The average standby current is about 80 mA. When the unit transmits it requires about 25 amps for 100 msec. For normal operation, including transmission time, the average current requirement will be approximately 125 mA (80 mA without GPS option) when operating at a normal duty cycle of 10%. An automobile battery provides an excellent power source.

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 30 watt solar panel will suffice. At higher elevations, where winter temperatures are below freezing, a larger panel will have to be used. Consult MCC or contact the solar panel manufacturer to perform this calculation for you and make a recommendation.

The power cable between the battery and the MCC-545C should be kept shorter than 10 feet and rated at #14 AWG or lower. (See Section 3.2.3.1 for more details.)

> ⚠️ **Caution:** The MCC-545C does not have an internal fuse and consideration should be given to installing an external fuse between the battery and MCC-545C.

4.1.3 Horizon Angle

To obtain maximum performance, the Remote Station must be installed on level, flat ground to provide a good ground plane. Lack of a good ground plane can reduce link performance by a factor of two. Furthermore, the terrain in front of the antenna must be free of buildings, bridges, and other obstructions for a distance at least 30 times the height of the antenna. Trees and other shrubbery do not present a problem if they are kept at least 20 feet (6 meters) from any of the antenna elements.

The antenna generally does not require a tilt angle and can be mounted parallel to the ground. In the case of very short ranges (200-300 miles), and obstructions exceeding 5° from horizontal, a tilt angle may be advantageous. Please consult MCC's engineering department for specific recommendations.

4.1.4 Antenna Selection

Antenna selection depends on the type of network in which the MCC-545C is operating.

Vertical polarization is used in the FleetTrak™ network to provide omnidirectional coverage to all adjacent nodes in the network. A good choice for a base station antenna is dual-stacked dipoles mounted on two sides of a triangular tower. A 10' whip is a good antenna choice for a data collection site.

Horizontal polarization is normally used in a Meteor Burst network. The simplest antenna to use is a dipole, as shown in Figure 3.1; however, a Yagi antenna (Figure 3.2) can provide an improvement in performance by a factor from 2 to 4, depending on the number of elements used.

Figure 7: Single dipole antenna
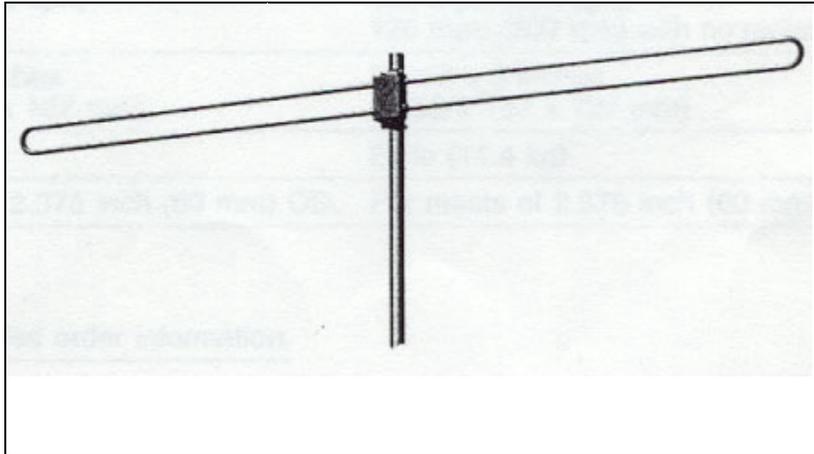
Figure 8: 3-Element YAGI antenna

The information bandwidth of the system is less than 25 kHz, therefore, a very narrow bandwidth antenna may be used when operating on a single frequency. In a two-frequency network the bandwidth of the antenna must be wide enough to accommodate both frequencies. The antenna must provide a 50 ohm load. In the U.S. CONUS Network, two frequencies are used: TX = 45.90 MHz and RX = 44.20 MHz. The Bandwidth of the antenna used is 1.7 MHz.

Always consult with MCC'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.

4.1.5   Antenna Height

The height of the antenna should be optimized as a function of the distance between the Remote Station and the Master Station. A plot of optimum antenna height versus range is shown in Figure 3.3.

Figure 9: Remote station antenna height for meteor burst
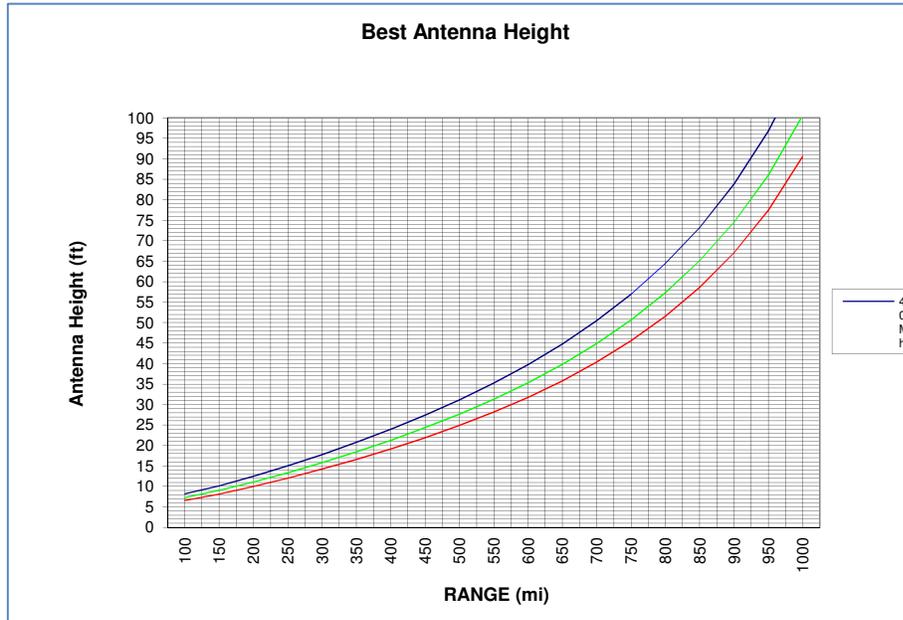
The antenna cable length must be kept as short as possible to minimize line losses. Try to maintain a line loss between the antenna and the MCC-545C to less than 2 dB.

A table of cable loss (at 50 MHz) for various types of co-ax cables is given in Table 3.1 for reference.

Table 5: CO-AX cable loss (50 MHz)

Cable Type	Loss/100 feet (dB)	Diameter (Inches)	Weight/100 feet (lbs.)
RG 223, RG 58	3.0	.211	3.4
RG 214, RG 8	1.8	.425	12.6
RG 17	1.2	.870	20.1
LDF4A-50 1/2 inch heliax	.48	.500	15.0
LDF5A-50 7/8 inch heliax	.26	.875	33.0

4.1.6   Human Exposure To Radio Frequency Electromagnetic Fields

For fixed applications, antenna gains and mounting techniques can vary depending on the application. Antennas suitable for use with the MCC-545C are listed in the MCC-545C RF Energy Exposure Guide. It includes details on the human to antenna separation requirements for specific fixed and mobile antennas with various gains.

Always disable the transmitter when working on the antenna and/or co-ax cable.

4.2 Equipment Installation

The MCC-545C operates over a temperature range from -30°C to +60°C and is housed in a stainless steel enclosure that can be used in a wide range of applications.

4.2.1   Mobile Applications

Mobile applications can include vehicles, aircraft, vessels, and locomotives. Each application may require a different type of antenna. For example, a 3' base-loaded ¼-wave whip is generally a good solution for vehicles. Low profile antennas, vertically polarized, are required for locomotives. 10' ¼-wave whips are generally used for vessels; these antennas should be designed for operation in maritime environments. Refer to the MCC-545C RF Energy Exposure Guide for more antenna information and means to limit RF exposure. MCC's engineering services department can be contacted for specific recommendations.

For vehicle installations, the MCC-545C may be mounted in any convenient location (e.g., in the trunk, under the seat, or in the engine compartment).

Refer to Appendix E for a list of example equipment components required for an MCC-545C used in a typical mobile application.

4.2.2   Data Collection Applications

The case of the MCC-545C itself is not waterproof, and a NEMA waterproof enclosure is recommended for outdoor installations. To ensure proper operation, shielded cable is recommended for all connectors. Also, use adequate strain relief on all cables and a weatherproof seal at the entry point of the enclosure.

A typical Remote Station data collection installation is shown in Figure 3.4.

Refer to Appendix E for a list of example equipment components required for an MCC-545C used in a typical data collection application.

Figure 10: Typical remote station with 3-element YAGI antenna
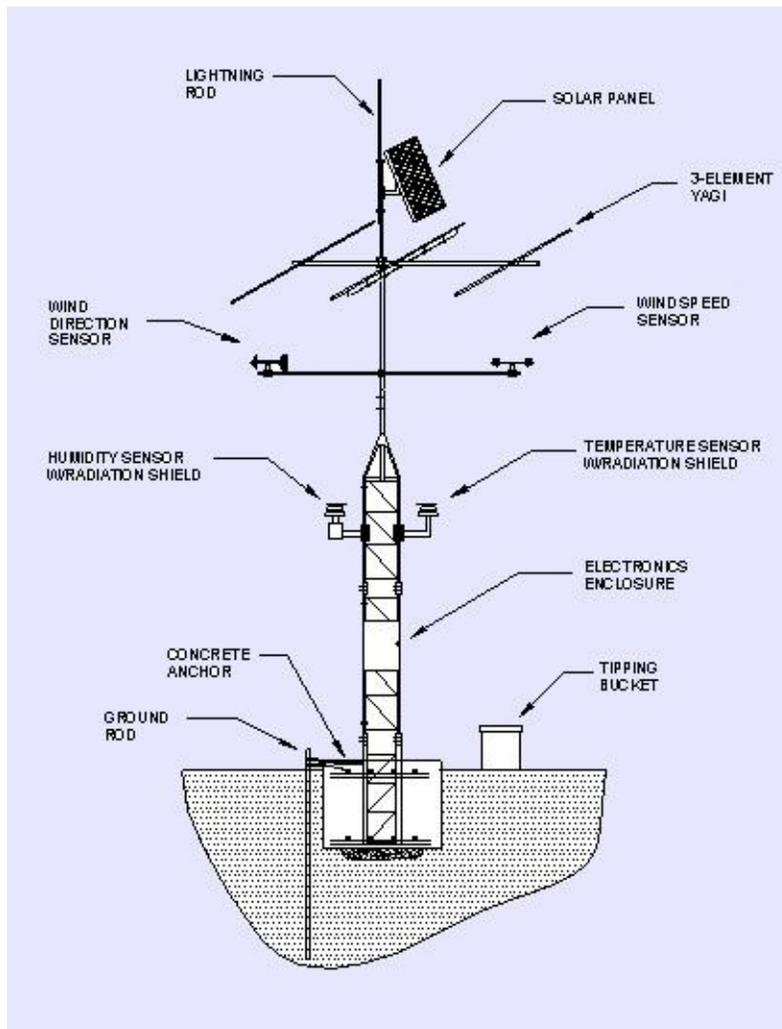
4.2.3   Cable Connections

There are a maximum of four cable connections to be made to the MCC-545C, as shown in Figure 3.5. These connections are used for both mobile and fixed site applications.

Figure 11: MCC-545C cable connections
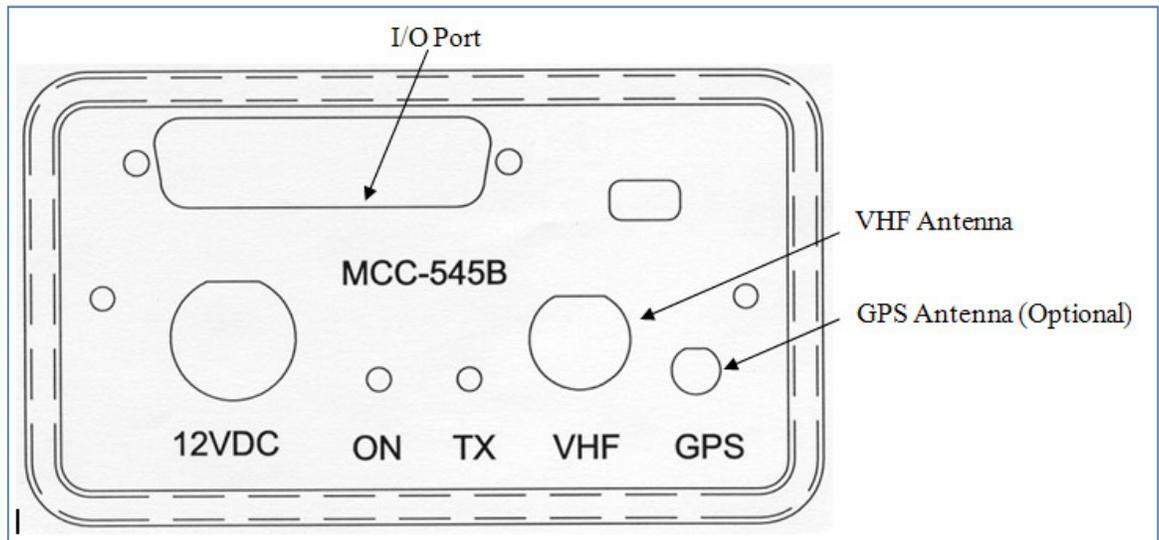
DC Power

The MCC-545C requires a power source that can deliver up to 25 amps of pulsed power (100 msec) out of a +12 VDC to +14VDC power source. The 25 amp power demand 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. MCC recommends using two #16 AWG wires for both the power and ground, with a cable length that does not exceed 10 feet. If a longer cable is required use #14 AWG. MCC provides a standard 6-foot power cable with lugs for connecting to a 3/8" battery post.

The power connector pins are shown in Figure 3.6:

Figure 12: MCC-545C power connector pins

PIN 1 +12VDC PIN 4 +12VDC
PIN 2 GND PIN 3 GND
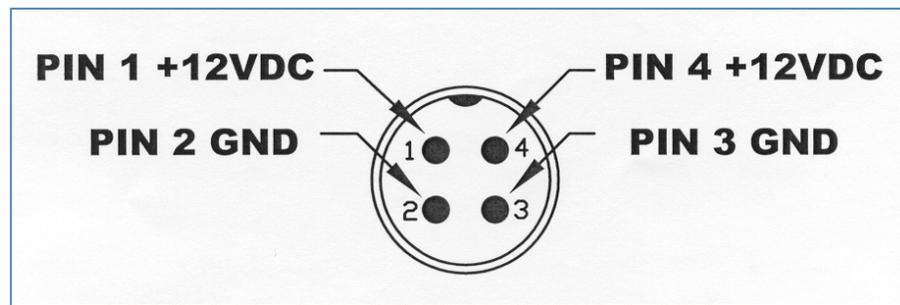
The voltage at pins 1 and 4 should not drop by more than 2VDC during transmission.

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 Section 3.1.5 for proper cable length.

GPS Antenna (Optional)

An external GPS antenna is required when the internal GPS receiver is used. Connect the GPS antenna cable to the SMA connector on the front panel.

I/O Port

The 44 pin I/O connector on the front panel includes three RS-232 ports and one Sensor port. MCC provides a standard cable harness that breaks out these four ports as shown in Figure 13:

29

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Figure 13: MCC-545C I/O port cable
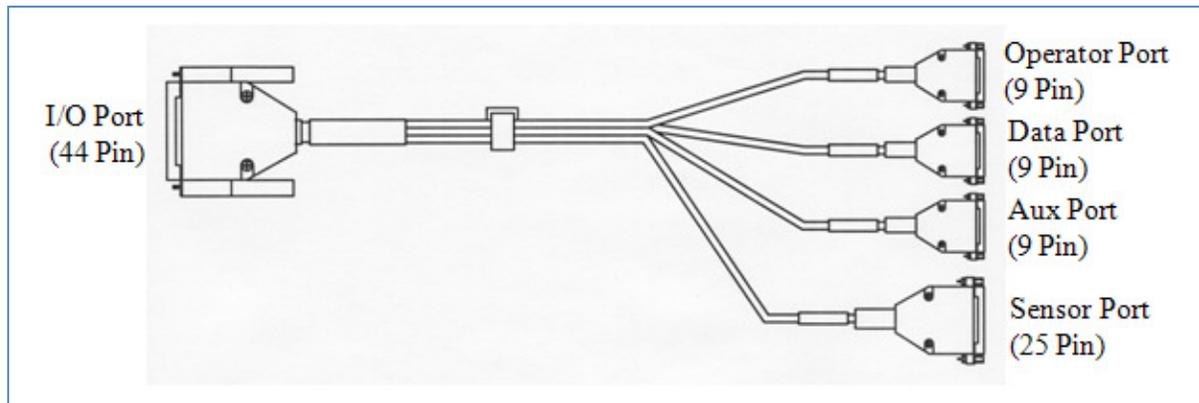
Operator Port

The Operator Port is normally connected to a local operator terminal. Use a standard RS-232 cable with a 9-pin male 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.

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
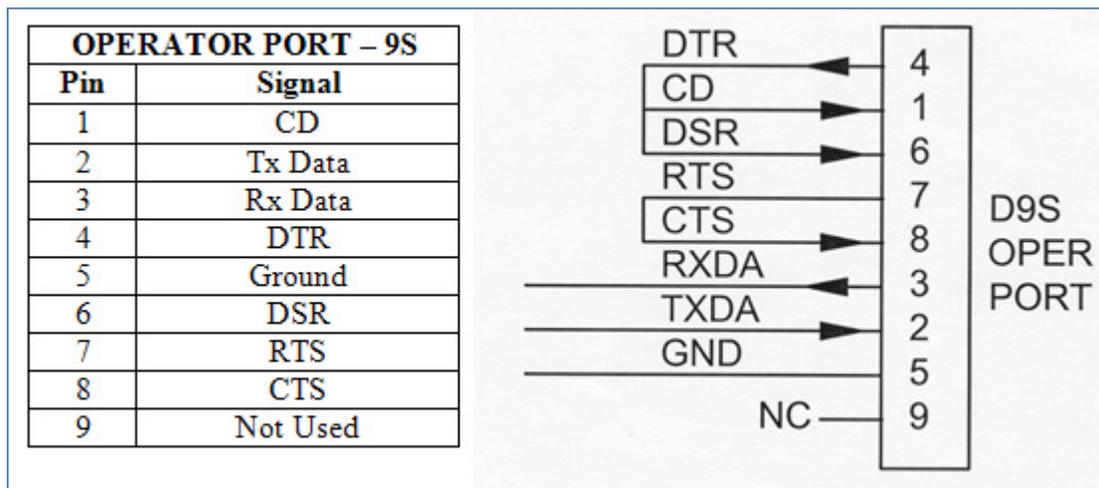
Data Port

The Data Port may be used for connecting to a data logger, GPS receiver or other serial input device. Use a standard RS-232 cable with a 9-pin male D connector. Refer to Section 4.5 for more information on interfacing to data loggers or other serial input devices.

Auxiliary Port (AUX)

The Auxiliary Port may be connected to any serial input device. Use a standard RS-232 cable with a 9-pin male D connector. This port is also used for interfacing to MCC test equipment (pins 6, 8, and 9).

AUX PORT – 9S	
Pin	**Signal**
1	Not Used
2	Tx Data
3	Rx Data
4	Not Used
5	Ground
6	MCLK (TTL)
7	Not Used
8	MDIR (TTL)
9	MSET (TTL)

RXDC — 3
TXDC — 2
GND — 5
MDIR — 8   D9S
MCLK — 6   AUX
MSET — 9   PORT
NC — 1
NC — 4
NC — 7
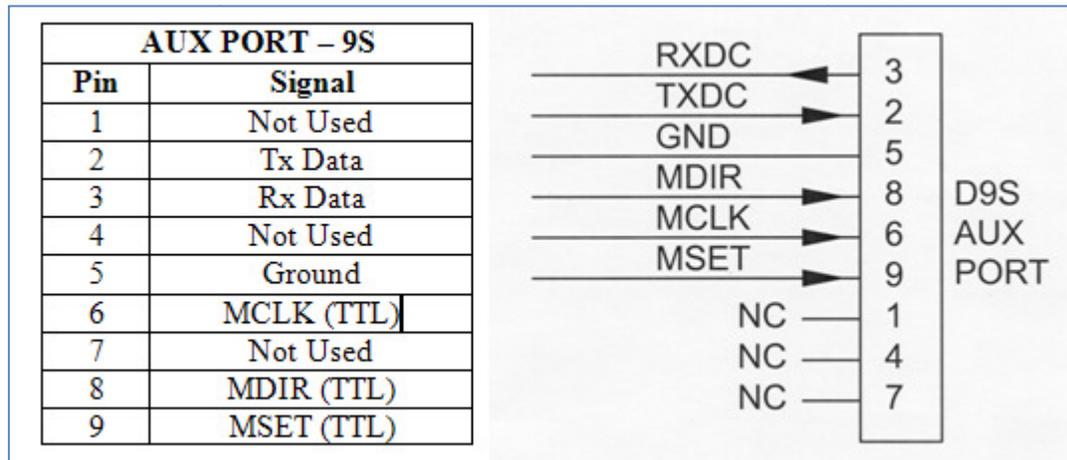
⚠ **Important:** The AUX port connector has three extra pins (pins 6, 8, and 9) whose signals do not conform to the RS-232 standard. These are for MCC test purposes. These pins will NOT interfere with a normal 3-wire RS-232 connector (pins 2, 3, and 5).

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.

SENSOR PORT	
Pin	**Signal**
1	Optocoupled input #1 positive (500 ohm resistor)
2	Optocoupled input #1 return
3	Optocoupled input #2 positive (500 ohm resistor)
4	Optocoupled input #2 return
5	Optocoupled input #3 positive (500 ohm resistor)
6	Optocoupled input #3 return
7	Optocoupled input #4 positive (500 ohm resistor)
8	Optocoupled input #4 return
9	Ground
10	Relay Output #1 Normally Open (2 Amp rating)
11	Relay Output #1 Common
12	Relay Output #1 Normally Closed (2 Amp rating)
13	Relay Output #2 Normally Open (2 Amp rating)
14	Relay Output #2 Common
15	Relay Output #2 Normally Closed (2 Amp rating)
16	Switched +12V (battery)
17	Analog Input #1 (0 to 5 V) ±0.5%
18	Analog Input #2 (0 to 5 V) ±0.5%
19	Analog Input #3 (0 to 5 V) ±0.5%
20	Analog Input #4 (0 to 5 V) ±0.5%
21	Analog Input #5 (0 to 5 V) ±0.5%
22	Analog Input #6 (0 to 5 V) ±0.5%
23	+5V Ref (10mA for sensor excitation)
24	+12V (0.5A maximum)
25	Detected RF Test Point

```
IN1+ ── 1
IN1– ── 2
IN2+ ── 3
IN2– ── 4
IN3+ ── 5      D25S
IN3– ── 6      SENSOR
IN4+ ── 7      PORT
IN4– ── 8
GND  ── 9
NO1  ── 10
COM1 ── 11
NC1  ── 12
NO2  ── 13
COM2 ── 14
NC2  ── 15
+12Vsw ─ 16
ADC1 ── 17
ADC2 ── 18
ADC3 ── 19
ADC4 ── 20
ADC5 ── 21
ADC6 ── 22
+5VREF ─ 23
+12V ── 24
DETRF ── 25
```
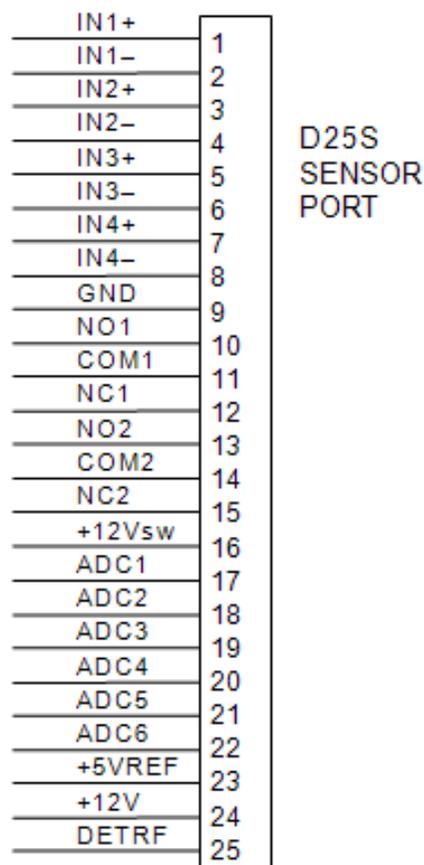
Note: In -03 series or later radios, the sensor connector pin #16 has been changed from ground to a switched +12 volt (battery). This switched +12 volt can be used to drive sensors. The total current load on the +12 volt and switched +12 volt must not exceed 500mA. Use EVENT programming (Section 4.6) to control the +12 volt switched output.

For reference, the pin-outs of the 44 pin I/O connector are shown below:

I/O PORT (44 PIN)
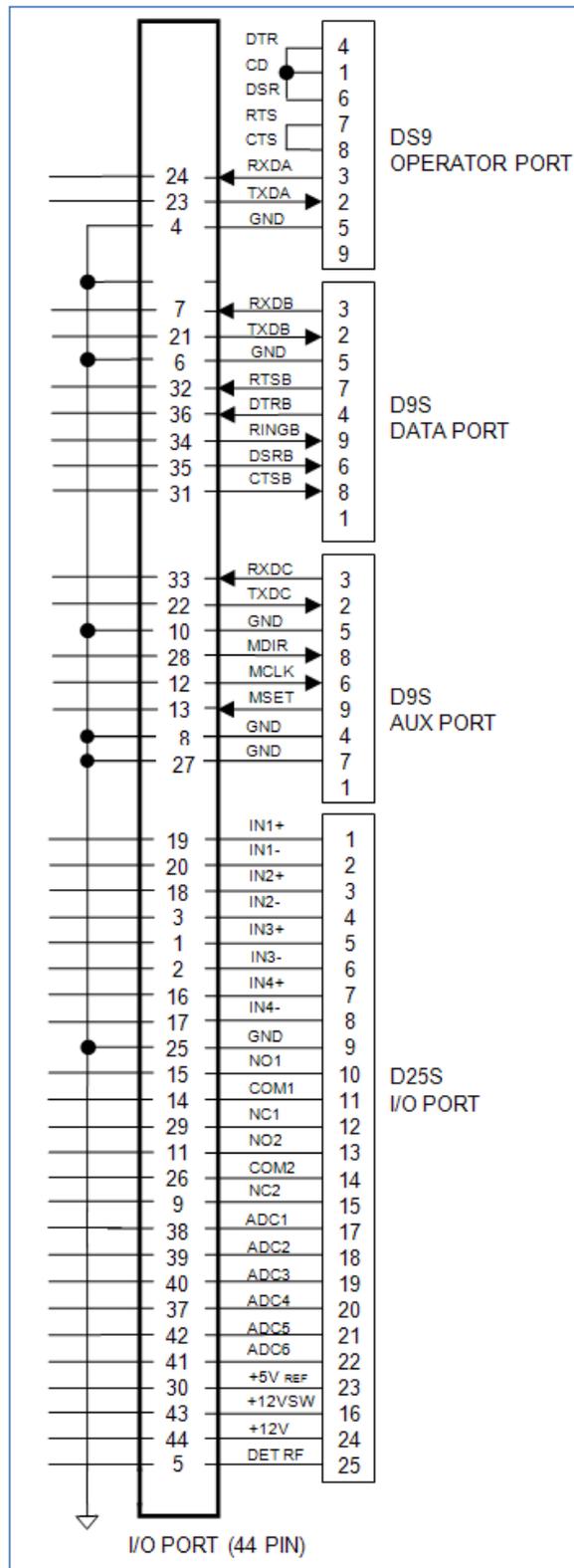
4.3 Power-Up Sequence

Important: Before applying power to the MCC-545C, check all connections between the MCC-545C and the external equipment (power, antenna, operator terminal, and data logger). Refer to Section 3.2.3 for cabling instructions.

Caution: Disconnect the antenna cable until all steps in Section 3.3 have been completed.

4.3.1 Operator Terminal

Connect a laptop or an operator terminal, with XTermW installed, to the Operator Port. XTermW is an MCC windows-based terminal emulation program designed for interfacing with MCC products. The operator terminal must be programmed with the same configuration parameters as the Operator Port.

The Operator Port of the MCC-545C is programmed with the following factory default configuration at the time of shipment:

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

4.3.2 Power Connection

Power up the MCC-545C by applying +12VDC to the power connector.

Note: When the unit transmits, it will draw up to 20 amps; therefore, review Section 3.2.3.1 for proper cabling to the power source. The voltage drop at the input connector during transmission should be less than 2 VDC for proper operation of the unit. Verify this during the Operational Test Procedure in Section 3.4.

When power applied is initially applied to the MCC-545C, or after a software boot or hardware reset, the following message will be displayed:

```
              545C PACKET DATA RADIO

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                 All Rights Reserved

  S/W Part Number* P1079-00-00 Version* 6.87 09/29/05
```

* Part Number, Version Number, and date vary according to a particular radio's firmware.

At this time all configuration data is loaded from Program Memory into RAM. This data will remain in RAM and on all subsequent power-cycle sequences the following message will be displayed:

```
01/23/04 16:54:10  POWER SHUTDOWN/FAIL OCCURRED.

02/02/04 12:54:44  POWER HAS BEEN RESTORED... RESUMING OPERATION.

+
```

This is the type of message that should be displayed when you first apply power to the unit during a field installation, and for each subsequent power cycle of the radio.

If the greeting message is not displayed, then the RAM contents may have been lost under one of the conditions described in Section 2.4 and the proper script file must be re-entered into the MCC-545C using XTermW. (Refer to Sections 3.3.3.5 and 4.2.7 and Appendix C for more information on using script files.)

4.3.3 Initialization Procedures

The following initialization procedures should now be performed in the order they are given below.

Verify Device Type

The MCC-545C must be programmed to operate as a particular device type, such as Remote Station, Repeater, or Base, depending on your network configuration. The device type is normally set at the factory prior to shipment to ensure proper integration with your network.

Use the following command to display what device type the unit is configured as:

```
DEVICE [ENTER]
```

Always check with your System Administrator to determine which device type your unit should be configured as.

For example, if the device should be a Remote Station and it is not currently configured properly, you can change the device type, as follows:

```
DEVICE,REMOTE [ENTER]

SAVE [ENTER]
```

Caution: Do not change the device type unless told to do so by your System Administrator. Changing the device type can make your unit cease operating and can impact communications throughout the entire network.

Verify ID Number

Every MCC unit is programmed at the factory with a 16-bit unit ID. To display the unit ID number on the operator terminal, enter:

```
ID [ENTER]
```

Contact your System Administrator to make sure this ID is registered in the network configuration database. Under some circumstances the ID may have to be changed on-site. This can only be done if the ID is not locked.

Caution: ID changes must be coordinated with both MCC and your System Administrator. Failure to do so may result in data or messages being misrouted or lost. Refer to Section 4.1.4.1 for more information on unit ID settings.

Verify Frequency

The MCC-545C is programmed at the factory 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:

```
FREQUENCIES [ENTER]
```

or

```
FREQ [ENTER]
```
for short cut

This shows you the active or "primary" TX and RX frequency pair, plus up to 9 additional frequency pairs for channels that may be programmed at the factory.

For example, the following table could be displayed:

```
+freq 05/18/04 08:53:50 Primary TX 044.58 MHz RX 044.58 MHz
Frequency Table
Channel         TX                      RX
>00*            044.58 MHz              044.58 MHz
01              045.90 MHz              044.20 MHz
02              000.00 MHz              000.00 MHz
03              000.00 MHz              000.00 MHz
04              000.00 MHz              000.00 MHz
05              000.00 MHz              000.00 MHz
06              000.00 MHz              000.00 MHz
07              000.00 MHz              000.00 MHz
08              000.00 MHz              000.00 MHz
09              000.00 MHz              000.00 MHz
```

Caution: Do not change the frequency pair unless told to do so by your System Administrator. Changing the frequency pair can make your unit stop communicating with the network.

Once the frequencies are verified, confirm that the synthesizer is "ON" and locked by entering the following command:

```
 SYNTHESIZER [ENTER]
```

 or

```
SYNTH [ENTER]
```
for short cut

The unit responds with:

```
SYNTH,ON,LOCKED (or UNLOCKED)
```

If the synthesizer returns an unlocked response, ensure that the proper frequency pair is selected.

> **Note:** The MCC-545C will not transmit if the synthesizer is not locked.

Select Site Name

A descriptive name may be given to the site where the MCC-545C 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, nnnnnn [ENTER]
```

where: nnnnnn = maximum of 32 alpha-characters

> **Caution:** Please double-check the site name entry for correct spelling and spacing. Data from a site with an incorrect site name will be mishandled or misrouted by the Host. An incorrect site name can result in significant effort to recover misrouted data.

Enter Script Files

The appropriate Script File is usually programmed into the MCC-545C at the factory prior to shipment. If the appropriate Script File has already not been entered, a new file can be loaded from your operator terminal using XTermW software. There is one Script File that uniquely programs the MCC-545C to operate as either a Base, Repeater, or Remote Station. Other Script Files define any 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 MCC-545C Meteorcomm CD (or diskette), with the Script File on it into your operator terminal, and load the Script File into your XTermW 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 MCC-545C.

4. From the `Scripts` pull-down menu in XTermW, choose Execute Script.

5. Select the appropriate Script File in the XTermW subdirectory. Double-click the file name to start execution.

The commands in the Script File are 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 a similar message, the Script File may have an error in it. If so, the script file needs to be corrected. Contact MCC or your System Administrator for a replacement.

You may verify that the correct configuration file has been loaded by entering the three commands: `ASSIGN`, `SNP`, and `CONFIG`.

THIS COMPLETES THE INTIALIZATION PROCEDURE

4.4 Operational Test Procedure

Note: Be sure to connect the antenna if it was disconnected per the CAUTION note of Section 3.3.

4.4.1 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 MCC-545C.

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 3:1. Check the antenna and coaxial cabling for proper installation.

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

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

This completes the initialization and power-up sequence of the MCC-545C.

The unit is now ready for operation.

Refer to Chapter 4 for detailed operating instructions.

5. OPERATIONS

This chapter covers the basic operating procedures for the MCC-545C as it is used in the FleetTrak™ network. The MCC-545C is programmed through the use of Script Files that contain the specific system parameters for operating in various modes. A script file is loaded into the MCC-545C at the MCC facilities prior to shipment. Script files may also be loaded and/or modified at the customer's site. (Refer to Section 4.2.7 and Appendix C for more information on Script Files.)

The last section of this chapter provides a summary of all MCC-545C commands; printouts from frequently-used commands are included in Appendix A.

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 3.3, 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 position reporting and data collection.

5.1 Getting Started

5.1.1 XTermW Terminal Emulator

XTermW is a windows-based terminal emulation program supplied by MCC. It is designed for interfacing with a wide variety of MCC products. All commands, script files, etc., can be entered into the MCC-545C using XTermW. The last section in this chapter contains a list of all valid MCC-545C commands.

XTermW can also be used to create log files of MCC-545C operations. Refer to the XTermW documentation supplied with the program.

Whether using XTermW, another terminal emulator, or a hardware terminal, you must program the operator terminal to use the same

configuration parameters as the MCC-545C Operator Port. The Operator Port of the MCC-545C has the following factory default configuration:

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

5.1.2   HELP Command

Entering HELP [ENTER] displays all of the commands used in the operation and maintenance of the MCC-545C. To obtain descriptive information about a particular command and how it is used by the MCC-545C, enter the command type. For example: HELP, ASSIGN [ENTER].

Refer to the last section of this chapter for a complete list of MCC-545C commands.

5.1.3   Role-Based Operations

The role that the MCC-545C plays in a communications network determines how it should be configured. There are three basic roles that an MCC-545C can be used in, depending on the network type:

- LOS Network consisting of Base and Repeater Stations, and Remote/Mobile units; Base Stations do not communicate with each other in this type of network. This is a typical FleetTrak™ network.
- LOS Network consisting of one or more Master Stations and Remote Stations (either fixed position or mobile units); Master Stations can communicate with each other in this type of network. This is a typical DataNet network.
- Meteor Burst network consisting of a single Master Station communicating with Remote Stations in fixed positions; Remote Stations do not communicate with each other in this type of network. This is a typical Meteor Burst network.

Table 4.1 shows the roles for which an MCC-545C can be configured; this is just an overview of the general commands needed for each role. The MCC-545C is not normally used in a Meteor Burst-only type of network.

Appendix F contains a description of the interoperability of all three types of MCC networks.

Table 6: Role-based operations

LOS Network **Base and Repeater Stations** **Remote/Mobile units**	LOS Network **Multiple Master Stations** **Remote Stations (fixed or mobile)**	Meteor Burst Network **Single Master Station** **Remote Stations (fixed)**
`ROLE,LOS`	`ROLE,LOS`	`ROLE,TRANSPOND`

`DEVICE,BASE`
`DEVICE,REPEATER,id` (which Base or Repeater to report to)
`DEVICE,REMOTE`
	`DEVICE,MASTER`
	`DEVICE,REMOTE`
		`DEVICE,REMOTE`

For Base/Repeaters:
`ID,master id`
For Remotes:
`ID,remote id, master id,AUTO`
	For Masters:
	`ID,master id`
	For Remotes:
	`ID,remote id, master id`
		For Masters:
		`ID,master id`
		For Remotes (single Master):
		`ID,remote id, master id`
		For Remotes (multiple Masters):
		`ID,remote id,1,MULTI,INIT`

`P,t` (idle probe rate – typically `t=20` seconds for Base and Repeaters; set `t=OFF` for Remotes in an LOS network)	`P,t` (idle probe rate – typically `t=20` seconds for Base and Repeaters; set `t=OFF` for Remotes in an LOS network)	`P,OFF` (for Remotes)
`BASE,low id,hi id` (typically 2-230 – used as a switch that turns the Base/Repeater mode on)	`BASE,OFF`	(BASE command not used in a Meteor Burst network)
`CONNECT, master id1, master id2` (limits which Master(s) a Remote Station can communicate with)	`CONNECT, master id1, master id2` (limits which Master(s) a Remote Station or Master Station can communicate with)	(CONNECT command not used in a Meteor Burst network)
`SNP,NDOWN,2,10` (Remotes switch to	`SNP,NDOWN,120,10` (Remotes switch to	(Single Master Station networks use

LOS Network	LOS Network	Meteor Burst Network
Base and Repeater Stations	**Multiple Master Stations**	**Single Master Station**
Remote/Mobile units	**Remote Stations (fixed or mobile)**	**Remote Stations (fixed)**
another Base Station or Repeater after 2 minutes without communications or after 10 failed tries; if only one Base Station, Remote goes into position (POS) broadcast mode)	another Master Station after 120 minutes without communications or after 10 failed tries; if only one Base Station, Remote goes into position (POS) broadcast mode)	default SNP parameters)
POS,15 (sets up GPS; typically 15 seconds, or 120 seconds depending on requirements)	CR10X (displays data logger configuration parameters; can be changed as needed)	CR10X (displays data logger configuration parameters; can be changed as needed)
ASSIGN,POS,2,GPS (sets up RS-232 port)	ASSIGN,DTA,1,type (select data logger type for DTA port)	ASSIGN,DTA,1,type (select data logger type for DTA port)

5.1.4   Unit Identification and Factory Settings

Unit ID

Every MCC unit is programmed at the factory with a 16-bit unit ID. This allows up to 65,536 unique ID numbers per network. Type the command ID and press [ENTER] to display the unit ID number on the operator terminal. 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 MCC and your System Administrator. Failure to do so may result in data or messages being misrouted or lost. In addition, the network topography and statistics will receive incorrect data that will impair network performance.

To change the ID, enter the following command:

```
ID,nnnnn,mmmm{,aaaaa},INIT
```

`where:nnnnnn` = unit ID

`mmmm`   = Master Station assignment

`aaaaa`   = Master select mode: `PREF, AUTO, MULTI, or FIXED`

Obtain the proper Master Station assignment and select mode from your System Administrator. The MCC-545C 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 Station for the **NDOWN** period (set with **SNP** command). After **NDOWN** period unit connects to the Master Station 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 Station, if it is not successful it switches to another Master Station. It will stay with that Master Station 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 standard mode for FleetTrak™ networks.*

Mode	Description
FIXED	Connectivity will be fixed to the mmmm Master Station. *In this mode the unit can communicate with only one Master Station at a time. This is the standard mode for networks with a single Master Station.*
MULTI	In this mode the unit can connect to multiple Master Stations. *This is the standard mode for Meteor Burst networks with more than one Master Station.* The format for this mode is: `ID,nnnnn,1,MULTI,INIT`

You can also change just the mode for the ID by typing:

```
ID,aaaaa
```

Customer ID

The MCC-545C may also be assigned a unique customer ID number that can correspond to a customer-specific network or system ID, an asset tracking number, or other identifier as needed.

Factory Default Parameters

When you type FACTORY,DEFAULT,INIT, the unit restores the factory default parameters. Refer to Appendix B for more details regarding the factory default parameters.

Note: If the ID and the CONFIG are not LOCKED before typing FACTORY,DEFAULT,INIT, the unit's ID will remain the same, but the ID mode will be set to be the fixed mode . The frequency synthesizer will get unlocked (Both TX and RX frequencies will be set to 99.99 MHz.). In this case, you need to set your frequencies again, in addition to other parameters, using the script file (refer to Section 4.2.7).

5.1.5   System Time and Date

The MCC-545C has its own internal clock – periodically it can synchronize its clock to the nearest second either with its assigned Master Station or its own internal GPS receiver (if available). Enter the following command:

```
TIMESYNC,source
```

where: source = **ON**   (sync with Master Station)
                = **GPS**   (sync using internal GPS)
                = **OFF**   (uses internal clock only)

If required, the MCC-545C's internal date and time can be initialized by entering the following commands:

```
DATE, mm/dd/yy

TIME, hh:mm{:ss}
```

The Master Station receives the correct date and time from either its Host or an RTCM broadcast. The Master Station then periodically broadcasts this date and time information to all Remotes for synchronizing their internal clocks.

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

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

The time zone offset is defined with the following command:

```
TIME ZONE, UTC offset, local time offset
```

Always set "UTC offset" to 0; the "local time offset" should be set to the Remote Station's time zone offset (+/- TZ) from the Master Station time zone.

5.1.6   System Memory

The MCC-545C 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 design, the MCC-545C has three types of memory:

1. Program Memory (PM)

2. Random Access Memory (RAM)

3. Configuration Parameter (CPM)

The PM is non-volatile flash memory that has been programmed with the MCC-545C's operational software. 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 MCC-545C 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 MCC-545C. All data logger data, positional data, and messages entered into the MCC-545C 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. To prevent this, a small internal NiCad or Ni Metal Hydride battery (internal to the unit) is used to maintain power to the RAM when external power is off.

During normal operation, the MCC-545C 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 MCC-545C retains a copy of all the programmed configuration parameters in CPM. The MCC-545C will write configuration parameters, that 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 MCC-545C will automatically SAVE the configuration. A validation checksum

is used by the MCC-545C to verify the data in CPM is correct. If the checksum is invalid, the unit will revert to factory defaults.

The only configuration parameter that is not stored in CPM is the CR10X pointer. This parameter, together with the date and time, is stored in the clock chip battery backed up RAM. These will be lost if the internal battery is discharged or removed from the unit. It will not be lost if the FACTORY,DEFAULT,INIT command is used to change the configuration back to the factory defaults.

When the MCC-545C 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 crash or failure of the battery backup RAM, all changes will be lost unless they were previously saved in CPM.

5.2 Station Configuration

The station configuration parameters are usually entered by loading a configuration script file as described in Section 3.3.3.5. 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 the last section of this chapter for a complete list of commands.

In order for the MCC-545C 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.

5.2.1 Configuring the MCC-545C

Configuration parameters include the unit ID, the Master Station assignment, I/O port functions and baud rates, transmit and receive parameters and network parameters. Parameters or operational states set by these commands are retained and will determine the way in which the MCC-545C 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 Configuration Parameter Memory (CPM) for non-volatile storage.

The software normally executes using the data and parameters stored in RAM. When the unit is turned off, or power is disconnected, the RAM information will be maintained by battery backup. When main power is restored the unit continues operation from RAM. When this happens, you will see the following message on the Operator Port. (See Section 3.3 for details.)

```
POWER SHUTDOWN/FAIL OCCURRED

POWER HAS BEEN RESTORED... RESUMING OPERATION
```

The RAM contents will be lost under the following conditions:

- The boot command is issued.
- The Reset button (SW1) is pressed.
- The internal battery backup is disconnected.
- The internal battery fails or is discharged.
- The software crashes and restarts.

The software will detect these events and will then recopy the configuration values from CPM back into RAM when operation is resumed.

The software will revert to the factory settings contained in the PM if the contents of the CPM become invalid.

The user should beware that it is possible to "get in trouble" using the configuration process. For example, assume you accidentally set the protocol for the operator port to MSC. If you do not have the ability to interface using MSC protocol you will immediately lose contact with the MCC-545C. You will no longer be able to issue commands. Power cycling will not help either because your change will be retained in RAM, even through power cycling. However, you can always recover by removing the lid on the MCC-545C and pressing the Reset button (SW1). This will reboot and restore the CPM settings.

Alternatively, assume you want to change the operator port to MSC. You connect in ASCII protocol, command the change to MSC protocol, then switch your PC to also use MSC protocol. Operation resumes and all is well. But do not forget to do a SAVE. If the software ever reboots, it will revert back to ASCII. And remember, once you do the SAVE you are committed to MSC protocol. The Reset button now reboots to MSC and there is no easy way back to the factory default settings. You will need an MSC capability to command a change back to ASCII.

5.2.2   Setting frequencies

The MCC-545C is programmed at the factory with the authorized frequencies to be used in your network. These frequencies are stored in Parameter memory and cannot be changed.

You can display TX and RX frequencies by entering the following command:

```
FREQUENCIES
```

This shows you the active or "primary" TX and RX frequency pair, plus up to 9 additional frequency pairs for channels that may be programmed at the factory.

```
+freq 05/18/04 08:53:50 Primary TX 044.58 MHz RX 044.58 MHz
Frequency Table
   Channel       TX          RX
    >00*     044.58 MHz 044.58 MHz
     01      045.90 MHz 044.20 MHz
     02      000.00 MHz 000.00 MHz
     03      000.00 MHz 000.00 MHz
     04      000.00 MHz 000.00 MHz
     05      000.00 MHz 000.00 MHz
     06      000.00 MHz 000.00 MHz
     07      000.00 MHz 000.00 MHz
     08      000.00 MHz 000.00 MHz
     09      000.00 MHz 000.00 MHz
```

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

`FREQUENCIES, n`

where: `n` = desired channel number

To set the frequencies manually, enter the following command:

`FREQUENCIES,aaaa,bbbb,xx`

where: `aaaa` = Tx Frequency (e.g., 4053 for 40.53 MHz)

`bbbb` = Rx Frequency (e.g., 4153 for 41.53 MHz)

`xx`   = Frequency Channel Number in the Frequency Table (0 thru 10)

This enters the above frequencies into "xx" channel number in the frequency table. Now select the desired channel number to make that pair of frequencies active or the "primary" frequency pair.

Important: If the synthesizer is unable to establish phase-lock when the command is entered, the MCC-545C will respond **ON, UNLOCKED** to the request and turn off the TX key. It will try once a minute thereafter to establish phase-lock. If it fails, the message **SYNTHESIZER UNLOCKED** will be displayed; if it succeeds, the MCC-545C will respond **LOCKED** and turn on the TX key.

5.2.3 Remote holdoff settings

The HOLDOFF command allows a Remote Station to hold off selecting a Master Station for a given period of time (in seconds) whenever it does a neighbor-down. (Neighbor-down is when a Remote Station doesn't hear from its assigned Master within a set period of time – the default setting is 2 minutes.) This lets the Remote pick a Remote Relay Station for the set holdoff time in conditions where a Remote can hear a Base Station, but the Base cannot hear the Remote.

5.2.4 Power turn on options

⚠️ **Note:** This option is only available on MCC-545C-03 or later units.

MCC-545C-03 or later radios have Jumper JP4 installed on shipment. This jumper ensures that the radio will power up when the battery voltage is applied to the power connector.

There is also the ability for the radio to be powered up from an external control signal (e.g., car ignition, data logger, etc.), connected to the I/O port. This can be used to turn the radio off under electronic control for purposes of reducing standby operating current. JP4 must be removed to allow this feature

This external signal (+4 to 12VDC voltage) is applied to the optical isolated port 2, available on the 25 pin connector (I/O Port). There is an internal 500 ohm resistor to limit the current. To connect the control signal to IN2, apply +V to IN2+ (Pin 3 on DB-25 connector) and –V (ground) to IN2- (Pin 4 on DB-25 connector).

This external control signal allows for the radio to be turned on/off within a predefined time interval. To enable this feature:

1. Remove Jumper JP4

2. Connect control signal to IN2 .

3. Set Power Time Out (PTO) in seconds to turn the radio off after the IN2 is removed.

To set the Power Time Out (in seconds), enter the following command:

```
PTO,xxx
```

> ⚠ **Note:** The PTO command must not be used (i.e., set to PTO,0) if JP4 is installed.

5.2.5 MCC-545C command schedule list

The SCHED command allows you to schedule the automated execution of commands. A schedule list simply consists of giving one or more commands a trigger time. When the MCC-545C's real-time clock reaches the trigger time, the scheduler invokes the command as though you had entered it from the MCC-545C's operator terminal.

> ⚠ **Note:** The command schedule list created by the SCHED command is different than programming MCC-545C "events" – see Section 4.6 and Appendix D for more information on programming events.

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 time 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,hh:mm:ss},command
```

where: `type`   = **INTERVAL** or **TIME**

          `time`   = `hours:minutes:seconds`

OFFSET,`hh:mm:ss`   = time offset from specified timeframe (optional)

          `command`   = any MCC-545C command (with parameters)

> **Note:** The scheduler ignores certain commands due to their interactive nature. The MESSAGE command is currently the only one ignored.

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

```
SCHED,DEL,xxx
```

where: xxx   = **ALL** (erases entire schedule)

or

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

> **Important:** The MCC-545C currently supports up to 50 scheduled commands. The schedule list will be erased if the system software re-boots (not to be confused with power failure recovery, which will preserve the schedule list).

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

5.2.6   Setting Timeout Duration

There is one programmable time limit for the I/O port input on the MCC-545C. Use the Set Teleprinter Timeout (**STT**) command to set the time limit for characters at the maintenance terminal, as follows:

```
STT,secs
```

where: secs   = **0** to **32767** seconds (default is 60 seconds)

MCC recommends using the pre-programmed default timeout parameter. You can choose to change the timeout limit by entering the number of seconds, or you can enter a 0 to turn off the time limit.

5.2.7 Script Files

The MCC-545C must be programmed with the parameters that "fit" the network that it is being used in, whether as a Base Station, Repeater, or Remote Station. This programming is accomplished by loading a Script File from the operator terminal into the MCC-545C via the Operator (MNT) port. A Script File can also be downloaded into a Remote Station via RF from the Master Station.

The appropriate Script File is usually programmed into the MCC-545C at the factory prior to shipment. If the appropriate Script File has already not been entered, a new file can be loaded from your operator terminal using XTermW software. There is one Script File that uniquely programs the MCC-545C 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.

New Script Files may be entered into MCC-545C using the procedures outlined in Section 3.3.3.5 and Appendix C. Changes to a Script File that is already loaded in the unit's Parameter Memory (also called CPM), may be made using the Station Configuration commands listed previously.

5.2.8 CPU Power Mode

The CPU of the MCC-545C also runs in either high-power or low-power mode. Use the _LPSTP command to select the CPU power mode. While in low-power mode, the CPU uses a "hibernate" mode to conserve battery power. The _LPSTP command is displayed as a Factory Default Parameter.

To select low-power mode, enter:

```
_LPSTP,ON
```

To select low-power mode, enter:

```
_LPSTP,OFF
```

> ⚠️ **Important:** Using the CPU in high-power mode causes that particular MCC-545C Remote Station to use higher power consumption. Check with your System Administrator to make certain whether the network configuration

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requires the Remote to use low-power mode or not.

5.2.9 Network Configuration

Selecting MCC-545C Remote/Master Operation

The MCC-545C can operate as either a Remote Station or as a Master Station. Use the DEVICE command to select the mode you require.

For normal MCC-545C Remote Station operation, enter:

```
DEVICE,REMOTE
```

For MCC-545C operation as a Master Station, enter:

```
DEVICE,MASTER
```

Note: Additional MCC-545C commands are available when **DEVICE,MASTER** is selected. If you attempt to enter a Master Station command during Remote Station operation, you will see the error "CMD not used for this device type."

Selecting Network Parameters

The Selecting Network Parameters (**SNP**) command is used in both FleetTrak™ and Meteor Burst networks; however, the timing parameters need to have a much higher range (longer periods of time) for meteor burst communication systems than in line-of-sight operations.

MCC recommends using the given default network parameters (values that are set on power-up or after reset). Before you choose to change these parameters, first review the discussion in this section, 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 boun¬da¬ry. 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,xx,yy – Neighbor-down threshold in "xx" minutes (default is 120 minutes), and "yy" is the number of times a Station attempts to communicate with a neighbor before attempting to talk to another Station; 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 Station 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 Station operation only) – Text message packet size in segments (default is 32 segments).

`FLOODP` (Master Station 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 Station operation only) – Infinity hop count (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 Station operation only) – Relay function specification (default is ON). Specifies whether the MCC-545C should act like a Remote Station in terms of relay functionality (i.e., does not share connectivity table with other Master Stations).

`DATAP` – Priority of data reports initiated at the MCC-545C (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.

Message Accountability

`SNP,TTL`	**Message time-to-live**
`SNP,TTR`	**Message time-to-retry**
`SNP,TEXTL`	**Message packet size**

Message accountability guarantees that text messages get delivered to their proper destinations within an allotted time. Data reports, position reports, and remote commands/responses donot get this guarantee. They get only one chance to get through the network.

Networks can have units go offline for various reasons; local noise can interfere with RF links, congestion can slow throughput to a crawl, RF link bit errors can cause segments of a message to get lost, etc. The more complex a network is, the more chances there are to be problems.

Messages entered at each source unit specify a time-to-live (TTL); this time is the maximum time to attempt to deliver it. If it is not delivered in this time, the operator at the source unit is informed so something can be done about it. The time-to-retry (TTR) is the number of minutes between attempts to deliver the message. Once a message is sent, it goes through the network one hop at a time and can get blocked at some point if the connectivity changes suddenly. The retry attempts are separated to allow network changes to settle out and establish alternate routes. When a message is received by a destination, an end-to-end-acknowledgement (ETE) is sent from the destination back to the source to stop any more retries and let the operator know the message was received.

The maximum message size is determined by the text length (TEXTL) setting. A message packet can consist of up to 3570 characters and is further subdivided into segments. Each message is uniquely identified so it can be tracked through the network and the ETE can be sent for each individual message. The message ID consists of the originator ID (16 bits) and message serial number (8 bits). Serial numbers range from 1 to 255 and are assigned in round-robin order. Each message is then split into 14-byte segments which are in sequence from 0 to 255. The segments allow the message to be transmitted a little at a time over short meteor bursts. The segment sequence numbers are used by the RF link software to identify which ones are acknowledged and to indicate where to resume on each burst.

The first segment (sequence number 0) is the message header and contains all the network overhead (originator ID, message serial number, priority, I/O port entered on, message type, number of destinations, number of segments, time to live, retry count, multi-packet message serial number,

packet sequence number, total number of packets and first destination ID code). If the message has only one destination, segment 1 is the start of the actual text. If there are multiple destinations, segment(s) 1, . . . n contain the remaining destination codes, 7 destination codes per segment. The text starts on the next segment after the last destination code.

Network Connectivity Tables

`SNP,NUP`	**Number of receptions for neighbor-up**
`SNP,NDOWN`	**Number of minutes for Master neighbor down**
`SNP,RDOWN`	**Number of minutes for Remote neighbor down**

Network connectivity tables are automatically created and updated each time a Master detects a new neighbor unit or times out an existing unit. The NUP parameter gives the number of transmissions that must be received in one minute to declare a new neighbor. The **NDOWN** parameter gives the number of minutes with no receptions to time out a Master neighbor. The **RDOWN** parameter gives the number of minutes to time out a Remote neighbor. Setting **NDOWN** or **RDOWN** to "0" disables the feature (i.e., never declare neighbors down). The **NDOWN** parameter can also be set for the number of times a Station attempts to communicate with a neighbor before attempting to talk to another Station.

Congestion Control

| `SNP,OTL` | **Outstanding text limit** |

The OTL parameter specifies the maximum number of messages that will be transmitted while waiting for ETEs. Limiting messages, as cars are limited to entering the freeway at rush hour, tends to reduce congestion and memory buffer usage in the network and reduce the number of retries that happen as a result. Sending messages one at a time does not take advantage of the overlap caused by the ETE needing to come back through the network and does not take advantage of an occasional large burst that can significantly improve throughput.

Network Control Messages

`SNP,CONNP`	**Priority for connectivity messages**
`SNP,ETEAP`	**Priority for end-to-end-ack messages**
`SNP,FLOODP`	**Priority level to initiate "flood-routing"**
`SNP,DATAP`	**Priority for data reports**

The priority of network control messages should be set higher than the data traffic. This setting makes sense if you realize that messages can not get delivered as fast if the network connectivity is incorrect. Certain applications may have reasons for altering these values but any revision to the default priority scheme should be implemented carefully.

History Timeout

`SNP,HTO` **History timeout for duplicate filtering**

As each message is received by a unit, the originator ID and message serial number are retained in a history table. The HTO parameter specifies how long to retain each entry. Each received message ID is compared to this table and if the message was previously received and has not timed out, it is considered a duplicate message. The ETE is sent to the originator if it is a text message type but the duplicates are not output to the I/O ports. Duplicates happen due to network connectivity changes and retries.

Hop Count

`SNP,INF` **Infinity hop count**

The INF parameter specifies the maximum width of a network in hops + 1. If this parameter is set lower that the actual network width, units will be declared offline when they are not. If the number is set too high, extra connectivity packets are exchanged when a unit goes offline and the system looks for alternate routes.

`SNP,MBHOP` **Meteor burst link hop weight**

The MBHOP parameter 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. This parameter should be set high enough to prevent a meteor burst Master Station link to be picked over a line-of-sight Remote to Remote link in a generally line-of-sight network.

Message Relay

`SNP,RELAY` **Enable/disable Master's ability to relay messages for other destinations**

The MCC-545C, when configured as a Master Station, reports all of its neighbor connectivity to its neighbors when SNP,RELAY is set to ON. If it is set to OFF, it does not report any neighbor connectivity. The OFF setting keeps neighbor units from finding alternate network paths through that node. This option should be left ON unless there is a very good reason to have it OFF for some specific customer requirement.

Selecting the Burst Monitor

The MCC-545C 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.

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 Sending and Receiving Messages

The MCC-545C is a packet data radio and therefore enables an operator to send and receive messages to all units within the FleetTrak™ network.

The messages may be entered from an operator terminal that is connected to the OPERATOR PORT of the MCC-545C. There are three basic message types:

1. Free-form text messages

2. Canned messages

3. Commands

The general format for all messages is shown below:

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

where: `p` = any priority level from A (highest) to Z (lowest).

`dest n` = numerical ID of the station(s) to which the message will be routed.

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.

Figure 14 depicts the general flow of messages within the MCC-545C software and the various commands associated with each step in the process.

Figure 14: Message flow and associated commands
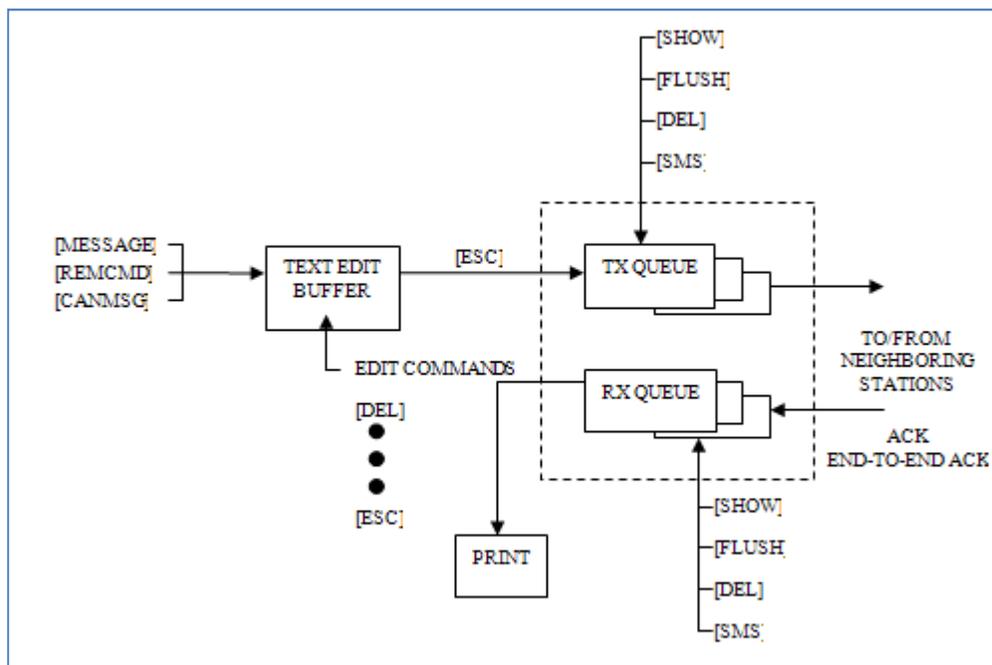
The following operations are explained in this section:

Section	Operations
4.3.1	Entering and Deleting Messages
4.3.2	Editing Messages
4.3.3	Sending Messages
4.3.4	Sending Commands
4.3.5	Sending Canned Messages
4.3.6	Receiving Messages
4.3.7	Examining Message Status
4.3.8	Examining and Revising Message Queues

5.3.1 Entering and Deleting Messages

All messages are composed and edited in the Text Edit Buffer. Messages may be up to 3,570 characters in length. When composing the message you must press [ENTER] at the end of each 80 character line.

There is a default destination programmed into the MCC-545C 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 responds with **ENTER TEXT**. The MCC-545C will now be in Compose-and-Edit mode (as opposed to normal Command-Line Entry 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 is transferred to a Transmit queue and will be automatically transmitted to the default destination at a priority level R.

The following message is displayed 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,`p,dest1,dest2,...dest n`

where: `p` = any priority level from A (highest) to Z (lowest).

`dest n` = numerical ID of the stations to which the message is 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.

There are three other special editing functions that may be used:

1. To Retransmit the Previously Entered Message

To retransmit a previously entered message, simply press the [ESC] key after the operator terminal prints **ENTER TEXT** and before any other key is pressed. The previous message entered into the Text Edit Buffer is then 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 is 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` = numerical station ID
`sss` = message serial number

The operator terminal displays the date and time, followed by **MESSAGE DELETED**.

5.3.2 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.

5.3.3 Sending Messages

Messages are automatically stored for transmission with the [ESC] key. Each message is placed in the Tx Queue according to 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 appears on the operator terminal as the MCC-545C 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 receives 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, the operator terminal displays an end-to-end acknowledgement:

```
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 MCC-545C purges the message from the Tx Queue and displays the following message:

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

You must then re-enter 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).

5.3.4   Sending 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:
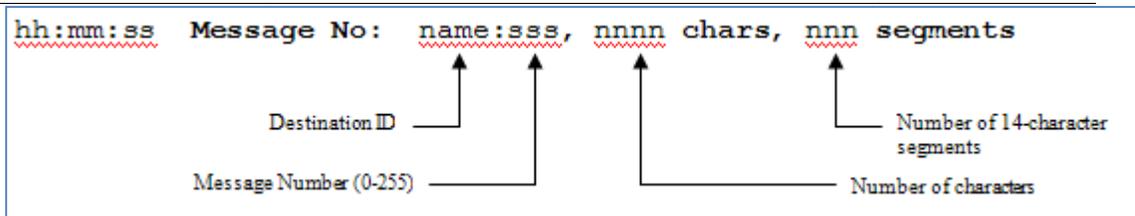
A response is received from the destination station(s) if the command was successfully received.

5.3.5 Sending Canned Messages

> **Important:**
> *Do not use Canned Message mode except for laboratory testing!*
>
> The number of canned messages generated can quickly bring network throughput to a stand-still in an operational FleetTrak™ or Meteor Burst network. Canned messages displace data capacity, and may prevent network users and stations from sending anything out. Use the **CANMSGOFF** command to clear canned message queue(s).

The MCC-545C 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,mmmm{,qq}{,nnnn}`

where: id = neighboring station ID
mmmm = message length from 1 to 3000 characters
qq = minimum queue depth from 1 to 25
nnnn = total number of canned messages to generate (maximum of 10,000)

The default queue depth is 5. Additional canned messages are automatically injected if the number of canned messages in the queue falls below the minimum queue depth.

If the Total parameter was entered, the canned message mode stops when the desired number of messages has been transmitted.

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 MCC-545C automatically routes up to 25 copies of the canned message to the destination station.

Each canned message is acknowledged by the selected neighboring station. No end-to-end acknowledgements are received for canned messages.

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`**

5.3.6   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 MCC-545C then generates an acknowledgement 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 MCC-545C 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.

5.3.7 Examining Message Status

The status of all messages may be examined while they are still in the Tx Queue. To examine the status messages destined for a particular station, enter:

```
SMS{,id}
```

where: `id`   = station ID

> ⚠ **Note:** Once an end-to-end acknowledgement is received for a message, it is deleted from the queue.

5.3.8 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** displays 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 displays:

`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 displays:

queue flushed

To delete a specific message, enter:

DEL MSG,`id:sss`

The terminal displays:

Message deleted

To delete all messages from all queues, enter:

FLUSH MSG

For each message deleted, the terminal displays:

`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.

5.4 GPS Position Reporting

The MCC-545C automatically transmits position reports derived from either an external GPS receiver or from its own internal GPS receiver. The appropriate script file must be loaded into the MCC-545C that allows it to interface to the protocol used by a particular GPS. The NMEA 0183 Version 2.0 protocol is used in this section for descriptive purposes only. Please consult MCC regarding script files for other protocols.

The MCC-545C will accept either a TTL or an RS-232 input from a GPS receiver. The internal GPS uses the TTL interface and its output is internally routed to the processor board assembly. If an external GPS is used it may be connected to either the AUX port or the Data port using the RS-232 interface.

5.4.1   Position Reporting Commands

The following commands are normally in a script file and are used for configuring the MCC-545C for position reporting.

Command	Description

`ASSIGN,POS,p,GPS`	Port selection for transmission of GPS data.
	  `p` = Selects the desired port:
	      2 = External AUX, RS-232
	      3 = Internal TTL

`SETBAUD,POS,4800,N,8,1`	Set up parameters for the selected port. For example:
	  `4800` = Baud rate
	  `N` = Parity
	  `8` = Data Bits
	  `1` = Stop Bit

`POS,``nn`**`,TEXT,NMEA`**	`nn` = Transmit interval in seconds of a position report to the system host. `TEXT` = Binary Text `NEMA` = Protocol type **Note:** Each time a report is transmitted to the Host it may also be sent to one of the local ports.
`POS,LOCAL,``nn`	`nn` = The time interval in seconds between reports sent to a local port. **Note:** This feature is used when more frequent position reports are desired on a local operator terminal than are being sent to the Host.
`POSRPT,ON`	**`ON`** = Used to display position reports from other remotes on a local operator terminal. **`OFF`** = Disable

5.4.2 Differential GPS

MBNET200 (ELOS protocol) may be used to broadcast differential correction data to all Remote Stations in the network. This eliminates the need for having a differential GPS receiver at each MCC-545C mobile unit.

Differential beacon receivers are installed at base or repeater stations only. The base stations then transmit the RTCM correction data at periodic intervals to all repeaters and mobiles.

The ASSIGN and SETBAUD commands are used to configure the base stations to use a beacon receiver.

Command	Description
`ASSIGN,POS,p,RTCM,nn`	Port selection for transmission of RTCM data. P = Port number, normally AUX port (2) is used. Nn = The interval, in seconds, that the RTCM error correction data is transmitted. A value of 20 seconds provides reasonable accuracy.
`SETBAUD,POS,4800,N,8,1`	Set up parameters for the selected port. For example: `4800` = Baud rate `N` = Parity `8` = Data Bits `1` = Stop Bit

A remote station will automatically receive and process the RTCM correction data. No other configuration commands are required.

5.4.3 GPS Report Formats

There are two position report formats used. The POS format is the basic report and has latitude, longitude, speed, heading and altitude. The POSS format includes all the information above but also has a 16-bit status word and an 8-bit code for appending canned messages. An example of each type of format is shown in Figure 4.2.

Figure 15: Position report formats
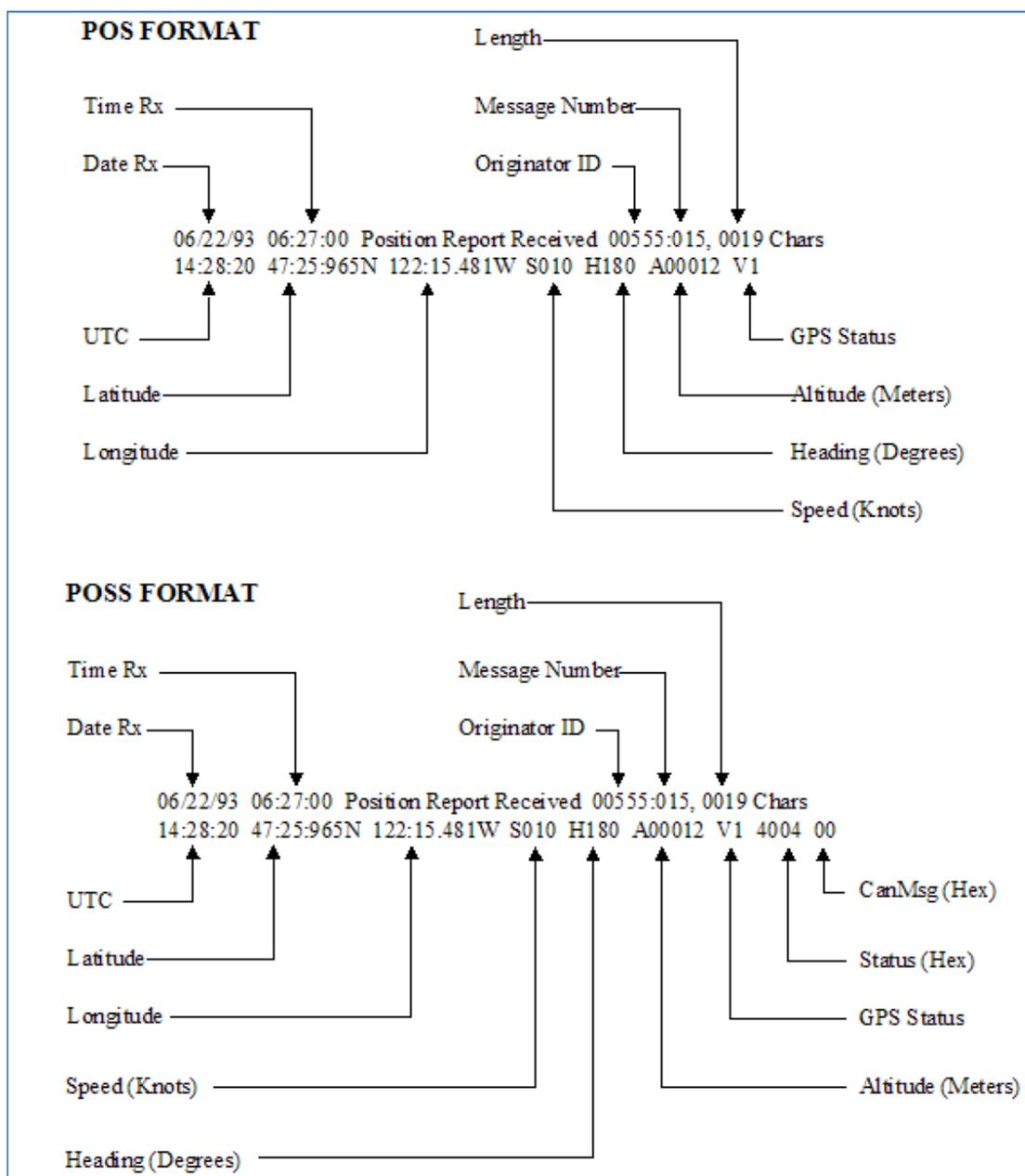
The Status bit field is application dependent and is normally defined by the user. For non-maritime applications speed is converted from knots to MPH on the operator's display.

The GPS status bits define if the GPS receiver is locked and the accuracy of the data.

| V0 | GPS not locked; position data is not valid. |

V1	GPS locked without differential correction.
V2	GPS locked with differential correction.

Standard V1 accuracy will be about ±10 meters. V2 accuracy will normally be ±2 meters and is dependent on the RTCM broadcast rate and the distance between the mobile and the nearest base station.

5.4.4 GPS Receiver Setup

The setup procedure for a GPS receiver is generally different for each manufacturer's type. Connect a laptop or PC to the GPS receiver for entering the desired sentences and update interval. A NMEA type GPS must be configured as follows:

Type of sentence	Update interval	Status
GPRMC	1 second	Required
GPGGA	1 second	Required
GPVTG	1 second	Optional

The TRACE command may be used to verify correct GPS operation:

```
TRACE,ON,GPS
```

All characters received will be displayed on the Operator Port, including sentence types. Verification that the position report is being transmitted at the desired POS,nn interval may also be observed.

To disable the display output, enter:

```
TRACE,OFF
```

5.4.5 Position Reporting in Subnets

The SUBNET command assigns a subnet code number from 1-255. The code number is maintained in the locked configuration parameter list along with the serial number, customer number and frequency table. The command formats are:

```
SUBNET            Display current subnet setting
SUBNET,OFF        Turn off the subnet number (must be unlocked)
SUBNET,nnn        Define a subnet number (must be unlocked)
```

After entering a subnet number and all the other configuration items, enter **LOCK,CONFIG** to lock the current setting.

The **SUBNET** command is used in conjunction with the **$PENTM,ON** command to limit the position reports that can be received to only those transmitted by other units with the same subnet code or any Base or Repeater. If **SUBNET** is **OFF**, then the unit can receive all position reports. The default setting is **OFF**.

Messages and remote commands are *not* limited to the subnet and can be sent to or received from any other unit.

> **Important:** The **$PENTM,ON** command must be entered to enable the POSS format reports, which will include the 16-bit status and 8-bit **SUBNET ID**. (The **SUBNET ID** replaces the MCC-545C's "normal" canned message.) Using **SUBNET** and **$PENTM,ON** precludes the use of canned message mode.

5.5 Supervisory Control and Data Acquisition

The MCC-545C is designed to perform a supervisory control and data acquisition (SCADA) function using one of three modes:

Sensor I/O Port

External Data Loggers

Direct Mode Protocol

This section covers these three modes, plus more advanced SCADA operations, including defining Data Relays, the **PASSTHRU** command, how to read the MCC-545C's internal sensor values, and details on the **GENERIC** data logger device drivers.

5.5.1   Sensor Port

A limited SCADA capability is built in 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 SPDT Form C relay outputs

In addition,±12VDC 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 pinouts and their respective functions are shown below.

The analog voltages are routed to a 10-bit analog-to-digital converter (ADC) which provides a resolution of +/-.1% and an accuracy over temperature of ±0.5%.

SENSOR PORT	
Pin	**Signal**
1	Optocoupled input #1 positive (500 ohm resistor)
2	Optocoupled input #1 return
3	Optocoupled input #2 positive (500 ohm resistor)
4	Optocoupled input #2 return
5	Optocoupled input #3 positive (500 ohm resistor)
6	Optocoupled input #3 return
7	Optocoupled input #4 positive (500 ohm resistor)
8	Optocoupled input #4 return
9	Ground
10	Relay Output #1 Normally Open (2 Amp rating)
11	Relay Output #1 Common
12	Relay Output #1 Normally Closed (2 Amp rating)
13	Relay Output #2 Normally Open (2 Amp rating)
14	Relay Output #2 Common
15	Relay Output #2 Normally Closed (2 Amp rating)
16	Switched +12V (battery)
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	+5V Reference (10mA for sensor excitation)
24	+12V (0.5A maximum)
25	Detected RF Test Point

Diagram (D25S I/O PORT):
IN1+ — 1
IN1− — 2
IN2+ — 3
IN2− — 4
IN3+ — 5
IN3− — 6
IN4+ — 7
IN4− — 8
GND — 9
NO1 — 10
COM1 — 11
NC1 — 12
NO2 — 13
COM2 — 14
NC2 — 15
+12Vsw — 16
ADC1 — 17
ADC2 — 18
ADC3 — 19
ADC4 — 20
ADC5 — 21
ADC6 — 22
+5VREF — 23
+12V — 24
DETRF — 25

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

Note: In -03 series or later radios, the Sensor I/O connector pin #16 has been changed from ground to a switched +12 volt (battery). This switched +12 volt can be used to drive sensors. The total current load on the +12 volt and switched +12 volt must not exceed 500mA. Use **EVENT** programming to control the +12 volt switched output (see Section 4.6)

5.5.2   External Data Loggers

Any data logger that MCC supports and has an RS-232 interface may be connected to any one of the 3 ports on the MCC-545C. 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`

    `ASSIGN,DTA,1,``type`

    `SETBAUD,DTA,9600`

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 third command sets the baud rate for the DTA Port. The specific type of data loggers that MCC supports may be obtained from MCC or your System Administrator.

5.5.3   Direct Mode Protocol

The **DIRECT MODE** protocol is used for the transmission of binary data from a peripheral device connected to one of the MCC-545C's serial ports to anywhere within the FleetTrak network. The serial data stream passes directly through the MCC-545C in a "transparent" mode, delivering the data to its destination in the same format as it was entered at the source.

The serial data stream may originate from a data logger, message device, or any peripheral that has an RS-232 interface.

> ⚠️ **Note:** The **DIRECT MODE** protocol can also be used in Meteor Burst networks, especially with external data loggers.

DIRECT MODE operation is similar to a "terminal server" on PC Ethernet Networks. The MCC-545C will accept any stream of unformatted characters on one of its ports (Operator, Data, or AUX), packetizes the data into message segments and transmits it to one or more destination addresses in the CSMA mode. The throughput rate will be dependent on channel availability at the time of transmission.

The **DIRECT** protocol is general in nature and allows the connecting equipment at the source and destination to manage all error control. The FleetTrak□ message acknowledgement protocol can also be used as an option to ensure reliability of message delivery. The **DIRECT** protocol is selected using the **ASSIGN** command, as shown in this example:

```
ASSIGN,DTA,1,DIRECT,30
```

This command would set up DATA port 1 to use the **DIRECT** protocol mode with a 30 second time out connection. Any, or all, ports can be set up independently and operate simultaneously.

Connection Management

A connection between the external equipment and the MCC-545C is made using a "connect string." The transfer then begins and continues until the connection is terminated. The proper connections at the destination are assumed to exist and the data is then automatically routed through the network to the destination equipment. There are two ways to establish a connection: a permanent connection or an ad hoc connection.

Permanent Connection

The permanent connection is made by setting the connect string **OFF**. This keeps the port open at all times and all characters received will automatically be transmitted. A connect string is not required to open the port and the connection does not terminate. Likewise, all characters received from the destination will be routed to the local port for printing.

Ad Hoc Connection

A connect string from 1 to 19 characters is used to open a connection on an ad hoc basis. The connection will remain open for as long as characters are being received or the connection times-out, whichever occurs first. Once the connection times-out it must be reestablished.

If the connect string is unknown, the command **ANY** will open the connection for any string of characters.

Connect Response

A connect response string may be enabled so that the peripheral device initiating the message will receive confirmation that the connection has been made. If the connect response string is turned **OFF** then no response will be sent when the connection is made.

Message Management

A message may be as long as 3,500 characters. Each message is assigned a sequence number and is broken up into a number of packets. A message header is inserted into each message ahead of the first data character.

$DIR,p,m,s,n

where: p =   the assigned port to which the message is directed.

m =   the message sequence number from 1-2554

s =   the packet sequence number in a multi-packet message

n =   total number of packets in a message

A message will be appended with either a terminator character or a maximum character count. The message will be terminated by either one of these characters or the "time-out" whichever occurs first.

Shorter messages are normally contained in a single packet with the s,n parameters set for 1,1. Longer messages will have several packets contained within the same message number "m". The "s" parameter for each packet will be incremented but the "n" parameter will be set to 0. The true "n" value is only transmitted with the last packet in the message.

For example, for a 3 packet message the s,n and m parameters will be as follows:

```
$DIR, p, m, s, n
```

		$DIR, p, m, s, n		
Packet 1		1	1	0
Packet 2		1	2	0
Packet 3		1	3	3

Messages may be transmitted from one to four destinations. When a **DIRECT** message is received at the destination MCC-545C, it will be routed to the assigned port(s) (Operator, Data or AUX). There are two types of connections that may be used: point-to-point and multi-point-to-single-point.

Point-to-Point

In the point-to-point mode the destination MCC-545C must also be pre-programmed in the **DIRECT** mode. When the message is received at the destinations, the **$DIR**,p,m,s,n header will be removed from the message and the message will be routed to the same port that was used at the source. That is, messages that were originated on Port 1 must also be routed to Port 1 at the destination.

The destination unit can respond with its own character stream back to the source. This provides a direct point-to-point, bi-directional channel between the two stations. The embedded ETE acknowledgement in the ELOS protocol may be used for ensuring message delivery.

Multi-Point-to-Single-Point

Many remotes can be set up to operate in the **DIRECT** mode, all routing their data to a common destination (base station or Host). The destination station does not have to be pre-programmed in the **DIRECT** mode as in the point-to-point case. The destination station will treat the message as it would for any other text message, using one of the many available port protocols. The message header, **$DIR**,p,m,s,n, is retained with the message so that the destination station will know how to format a return message to the source station. In this manner, the Host can send response packets to all sources by appropriately formatting the message header.
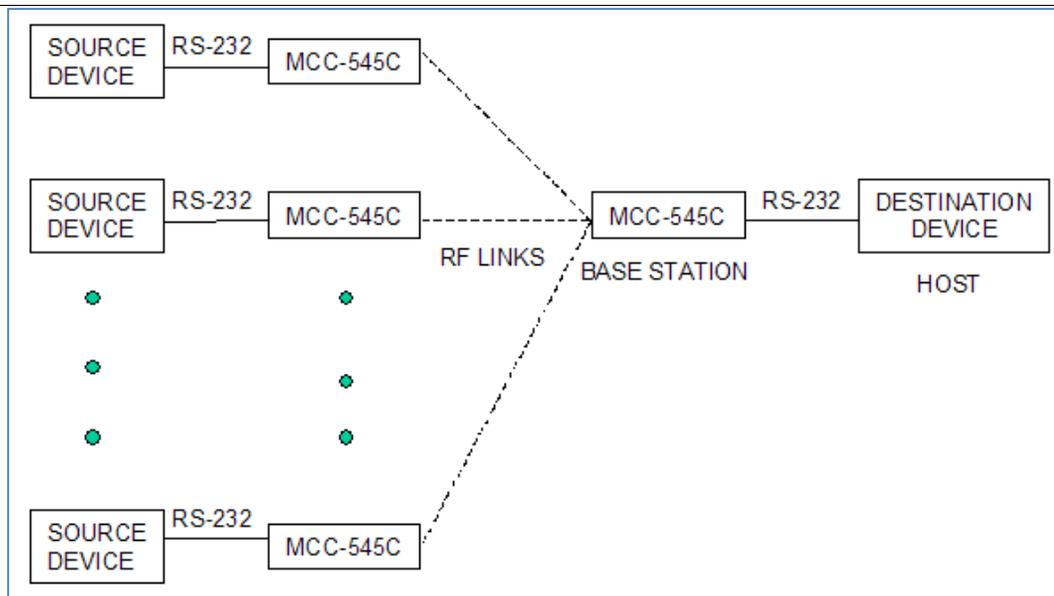
Messaging Options and Commands

Various options may be set up in the MCC-545C using the command DIRECT with the parameters shown in the following list. Each command is briefly described below:

Command List:

```
DIRECT
DIRECT, p, CONNECT STRING, OFF
DIRECT, p, CONNECT STRING, ANY
DIRECT, p, CONNECT STRING, connect-text-string
DIRECT, p, CONNECT RESPONSE, OFF
DIRECT, p, CONNECT RESPONSE, response-text-string
DIRECT, p, PACKET TIMEOUT, decimal-timeout-ticks
DIRECT, p, PACKET TERMINATOR, OFF
DIRECT, p, PACKET TERMINATOR, decimal-char-code
DIRECT, p, MAX PACKET, length
DIRECT, p, ETE, ON
DIRECT, p, ETE, OFF
```

Command Detailed Descriptions:

DIRECT

When used without any parameters the current port settings will be displayed

`DIRECT, p, CONNECT STRING, OFF`

Disables the connect string option. The MCC-545C will not expect a connect string and will stay connected all the time.

`DIRECT, p, CONNECT STRING, connect-text-string`

Defines a text string of up to 19 characters that is output by the external equipment to establish a connection with the MCC-545C **DIRECT** port task. The MCC-545C will receive the connect string and output the connect response string if one is defined.

`DIRECT, p, CONNECT STRING, ANY`

Defines that any unspecified text string will be acceptable to establish a connection.

`DIRECT, p, CONNECT RESPONSE, OFF`

Disables the response string option.

`DIRECT, p, CONNECT RESPONSE, response-text-string`

Defines a text string to be output by the MCC-545C to the external equipment to confirm a connection has been established.

`DIRECT, p, PACKET TIMEOUT, decimal-timeout-ticks`

Defines the timeout period in 1/16 second clock increments that marks the end of a packet. After each character of the packet is received the timer is reset. After the last character has been received and the timeout passed, the characters received will be placed in a message and queued for transmission.

`DIRECT, p, PACKET TERMINATOR, OFF`

Disables packet termination using a specified character code.

`DIRECT, p, PACKET TERMINATOR, decimal-char-code`

Enables packet termination when the given character code is received. For example, using a carriage return to terminate each packet will transmit each line of input as a separate message. The decimal code for carriage return is 13. The decimal code for linefeed is 10.

`DIRECT, p, MAX PACKET, length`

Defines the maximum length of a message. As characters are received they are filled into a buffer and when the maximum size is reached a new message is transmitted. The longest message that can be used by the MCC-545C is 3,500 characters.

DIRECT, p, ETE, ON

Defines the "reliable" type of message delivery. The source unit will retain each transmitted message and periodically retry them until the destination unit receives them and sends an end-to-end-acknowledgement for each message. It is possible for messages to be delivered out of sequence when a retry has occurred causing duplicate messages. These duplicate messages will be filtered out.

DIRECT, p, ETE, OFF

Disables the "reliable" type of message delivery. The source unit will not retain each transmitted message for retries. Each message will be deleted as soon as transmitted. It will be the responsibility of any receiving equipment to manage the message reliability. If any message gets lost in the RF network, then all characters in that message will be lost.

5.5.4   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 MCC-545C may be placed in a nearby quiet location and used as relay station between the MCC-545C at the noisy site and its master station. When used as a relay, the MCC-545C will concentrate the data reports it receives from one or more neighboring remote sites and forwards the data to the Master Station.

When used in the relay mode, the MCC-545C must be defined as a Master Station. The relay will then receive MCC-550C sensor data GROUP reports (see MCC-550C Operations Manual), repackage them and forward them to the Master Station. A relay can handle a total of 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 also 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 a MCC-520B Master Station using the MCC-550C RF format rather than the standard MCC-545C message format. When the relayed data is received at the MCC-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`   =   relay unit's ID

            `relay_group`   =   data group report number at the relay

            `remote_id`   =   originating Remote unit's ID

            `remote_group`   =   data group report number at the originating Remote unit

5.5.5   I/O Port PASSTHRU

The **PASSTHRU** command allows a bi-directional connection to be made between the different I/O ports of the MCC-545C. This will allow the operator to configure one port to be connected to another port in a direct ASCII mode where any characters coming in on one port will go out on the other port, and vise-versa. For example: the command **PASSTHRU,1,2** allows characters entered on port 1 to go out port 2, and characters received on port 2 will go out port 1. There can be from 0 to 2 different pass-through connections defined at any time. All ports given in a pass-through connection must be assigned to some protocol and baud rate before entering the **PASSTHRU** command. An error will be displayed if they are not.

Data coming in from a passed-through port will not be passed to the assigned protocol driver and will be sent out the "other" port of the connection.

The connection can be turned off by entering **PASSTHRU,OFF**,n where "n" is either port in the connection. In addition either port in a pass-through connection can output the string **PASSTHRU,OFF** to close its own connection. The first method can be used from the operator port to close a connection of other ports. The second method is used by the operator port if it is one of the ports in the pass-through connection.

If port 1 is assigned to a CR10X driver, and port 0 is the operator port, then the command **PASSTHRU,0,1** allows the operator port to be connected directly to the CR10X. One can then use XTermW or PC208 to talk to the CR10X via the operator port without re-connecting cables.

5.5.6   Internal Sensor Values

The new MCC-545C -03 and later radios have the capability to read a number of internal sensor values. These include:

- • Internal temperature of the MCC-545C unit
- • Internal rechargeable battery level
- • External battery levels (loaded and unloaded)

These sensor values can be read using the **EVENT** command – refer to Section 4.6.8 for details on how to program the MCC-545C to read these values.

5.5.7   Generic Data Logger

The MCC-545 family of RF Modems includes a set of device drivers for its serial ports. These have been customized for various external devices, depending on the device requirements. The **SDATA** command allows a simple text-based interface to send data groups to the MCC-545C for transmission to the master. Any customer who can configure their data report to meet this format can interface their data logger with no change in the MCC-545C 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 MCC-545C to create **SDATA** type messages from the ASCII text reports.

The following sections describe what can be done to adapt the MCC-545C to a variety of report formats.

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

Multiple line report examples:

No Time Tag	With Time Tag	With Sensor Labels	
123.4<cr><lf>	10/14/02 09:15:00<cr><lf>	Date/Time: 10/14/02 09:15:00<cr><lf>	
19.8<cr><lf>	+123.4<cr><lf>	AC Voltage	+123.4<cr><lf>

33<cr><lf>	+19.8<cr><lf>	DC Voltage	+19.8<cr><lf>
99<cr><lf>	+33<cr><lf>	Pulse Count	+33.0<cr><lf>
1089.45<cr><lf>	+99<cr><lf>	Error Code	+99.0<cr><lf>
	-1089.45<cr><lf>	Pressure	-1089.45<cr><lf>

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

Setup and Configuration

The MCC-545C 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 a operator terminal, and port 3 is an internal GPS port. That means ports 1 and 2 are open for external devices.

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   Scale  Type L# S  E   Type L# S  E   Type L# S  E

= ==== ===== == == == ==  ===== ==== == == ==  ==== == == ==  ==== == == ==

2 LINE FIXED 02 00 00 00  0.058  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, and Scale factor. 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 sensor values can be scaled by the multiplying factor shown in the Scale column. (The default scale is "1".)

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 MCC-545C.

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.

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, consider 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 MCC-545C. 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
```

02/10/2012   Prerelease   DCN 00001789-A
93

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 t he 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.

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 second 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 MCC-545C 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 MCC-545C 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 MCC-545C 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 first line of the report. If the line number is given, data can start on other than the first line. In addition, if the "start" parameter is given, data can begin in a column other than the first 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 MCC-545C 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 MCC-545C, 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
```

5.6 Event Programming

The MCC-545C 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 MCC and that MCC-545C behavior can be readily modified in the field. It also means that operators now have limited power to make the MCC-545C react to various field-programmable conditions.

The operator sets up the event program when installing the MCC-545C 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 MCC-545C 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.

Refer to Figure 16 for a block diagram of event programming inputs and outputs. Programming is usually done by creating a "script file" of the required event commands, and loading these into the MCC-545C using XTermW or any other terminal emulator software.

Several input/output lines are available directly from the processor card of the MCC-545C modems. These differ between the A, B, and C variations of the MCC-545. In addition, an optional I/O expander card (XIO) uses 3 lines to implement a high-speed serial link for accessing the signals of the expander card.

Figure 16: Event programming block diagram
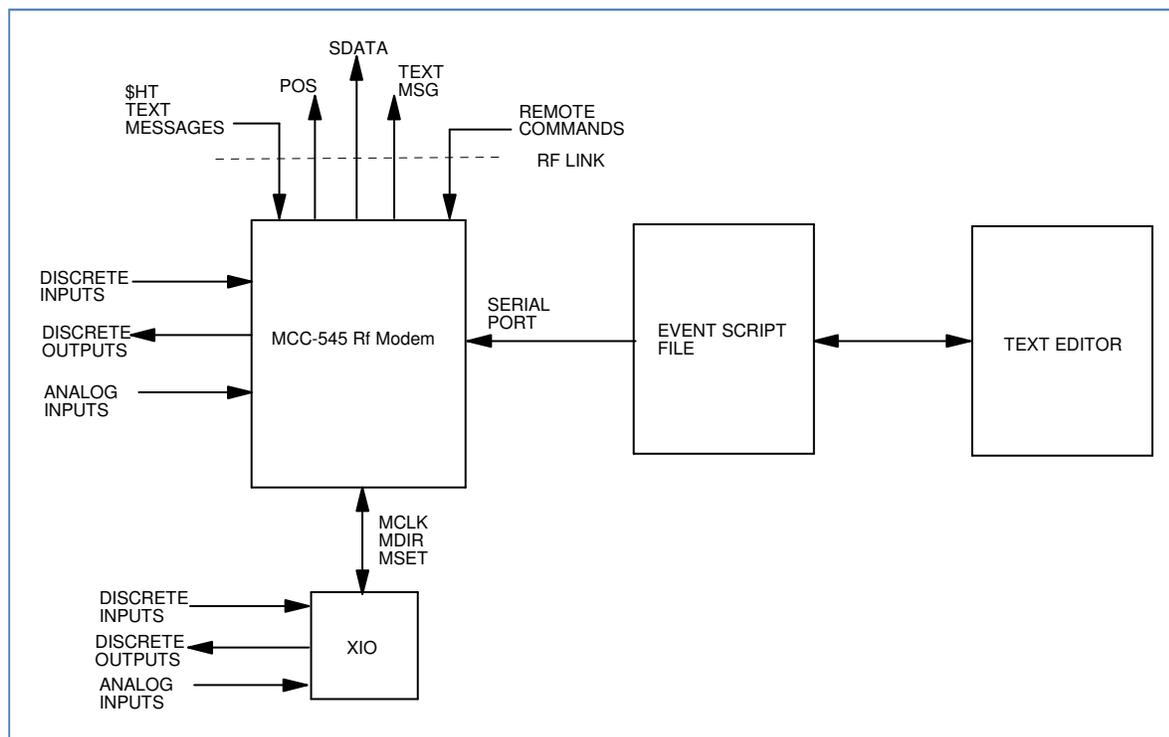
5.6.1   Event Programming Overview

Event programs are composed of signal test and action commands stored in a non-volatile event table. The MCC-545A stores the event table in battery-backed-up-RAM. The MCC-545B and MCC-545C store the event table in FLASH memory.

The operator enters these event commands into the MCC-545C. The MCC-545C 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 MCC-545C 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 MCC-545C 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.

5.6.2   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 MCC-545C 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 MCC-545C unable to respond to anything. An action taken on a reset event command will remain as defined in the command until the MCC-545C 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 MCC-545C 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 MCC-545C 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.

5.6.3   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 MCC-545C 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 MCC-545C 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.

5.6.4 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 ;l,m 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 MCC-545C 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
  ┌──────────────────────┐  ─────────────►  ⌐  Gravity
  │   MCC-545 RF Modem    │                     Switch
  │                       │     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
```
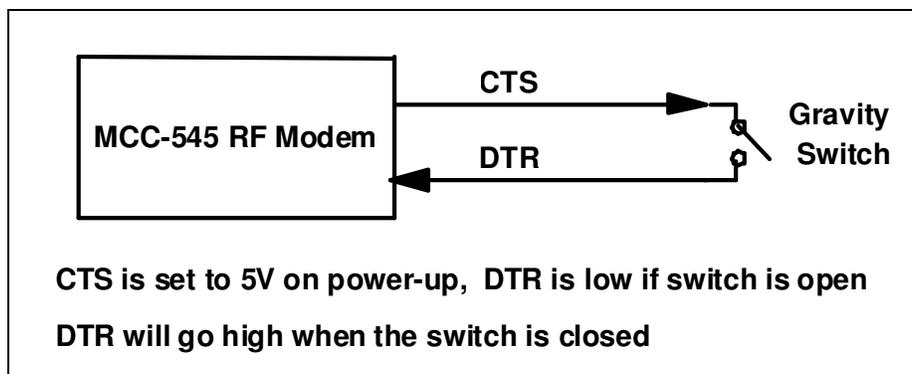
To make the tip-over detection mechanism function, the CTS signal must be enabled so that it can be detected at DTR should the switch close. A good time to enable CTS – set CTS to high – may be when the MCC-545C is powered up. The command EVENT,RESET,SET,CTS will do this. The event is RESET. The action 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 MCC-545C 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 **Marker-Drop**

MCC-545 RF Modem

DTR **Switch**

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
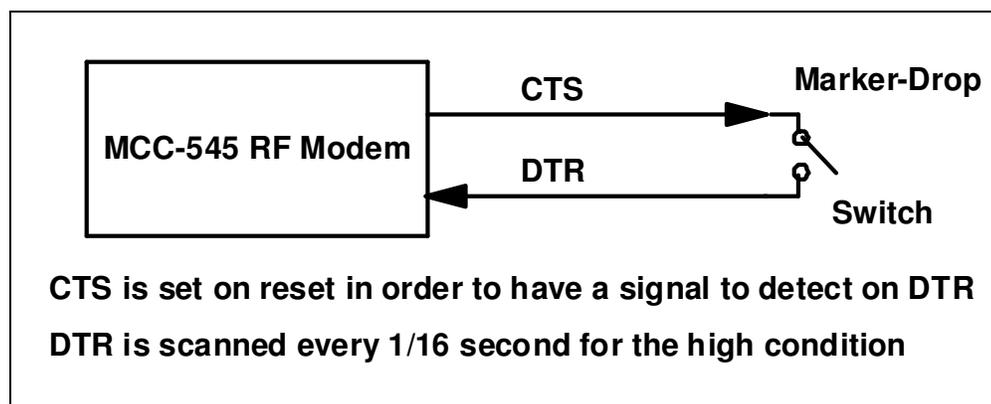
To make the marker-drop mechanism function, the CTS signal must be enabled so that it can be detected at DTR should the switch close. A good time to enable CTS – set CTS to high – may be when the MCC-545C is powered up. The command **EVENT,RESET,SET,CTS** will do this. The event is **RESET**. The action 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,BIT2
EVENT,DIOHI,DTR,16,160,MARK
EVENT,START
SAVE
```

5.6.5   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 is an array of 16 groups by 16 sensors. Each entry in the group table consists of a sensor type – discrete or analog – and a discrete bit identification or analog channel number. Commands tagged "Yes" in the "Group" column each

consume one entry in the group table. Some of the commands with "Yes" are used to free up group table entries. The text table is used to store up to 40 text messages or operator commands of up to 40 characters each.

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

Command	Table Entry?	
	Event	Group
EVENT	No	No
EVENT, DEL, *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

Command	Table Entry?	
	Event	Group
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

5.6.6   Event Programming Command Details

Command: **EVENT**

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

Command: **EVENT, DEL, ALL**

Delete all events in the event table. Event table commands should be edited in script files and output to the MCC-545C using XTermW in order to reload the event table. This command does not delete the text messages or group definitions.

Command: **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 MCC-545C using XTermW in order to reload the event table.

Command: **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 MCC-545C reset, the event scanner is started.

Command: **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 MCC-545C reset, the event scanner is started again if the **SAVE** command was not issued while in the **EVENT,STOP** state.

Command: **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 MCC-545C schedule list for periodic event application.

Command: **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>.

Command: **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 MCC-545C 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.

Command: **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	MCC-545C 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.

109

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

Command: **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	MCC-545C action to be taken when event is declared. See actions below.

Command: **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	MCC-545C action to be taken when event is declared. See actions below.

Command: **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	MCC-545C action to be taken when event is declared. See actions below.

Command: `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	MCC-545C action to be taken when event is declared. See actions below.

Command: `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
```

Command: `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**

Command: `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	MCC-545C action to be taken when event is declared. See actions below.

Command: `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	MCC-545C action to be taken when event is declared. See actions below.

Command: `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.

Command: **EVENT, TEXT**

Displays the current text table.

Command: **EVENT, TEXT, DEL, ALL**

Deletes all previously defined text items.

Command: **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.

Command: **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

Command: **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 bit-name or chan-name	Group number to be set by this command. Valid range: 1 through 16. 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)**

Command: **EVENT, GROUP, DEL, ALL**

Delete all group definitions. Clears the group table.

Command: **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.

Command: **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 MCC-545C 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.

Command: **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 MCC-545C 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.

Parameter	Description
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.

5.6.7 Action Details

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. "nn" can range from 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

Action Value	Action Parameters	Description
		status bits. The bit remains cleared.
CLR/N,ccc	ccc = status bit name	Clears the status bit and does <u>not</u> transmit POSS.
PULSE,bit–name, ddd, iii, nnn	bit-name = any discrete output signal ddd = pulse duration iii = interval between pulses nnn = number of pulses	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. "ccc" must be a valid counter (C1-C8)
DEC, ccc	-1	Decrement a counter by 1. "ccc" must be a valid counter (C1-C8)
ADD, ccc, ddd		Add the decimal value of "ddd" to "ccc". "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". "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". "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". "ccc" must be a valid accumulator (A1-A24).
MOV, ddd, sss		Move the source "sss" into "ddd". "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". "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". "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". "aaa" and "ccc" must be a valid accumulator (A1-A24).

Action Value	Action Parameters	Description
`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 MCC-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 MCC-545Cs as Base and/or Repeater Stations, then a single ID of "1" is used for routing to the Host via any Base or Repeater.

5.6.8 Reading Internal Sensor Values

The MCC-545C -03 and later radios have the capability to read certain sensor values, including the internal rechargeable battery, internal temperature of the unit, etc.

Following are the most commonly used commands to read these sensor values:

Command	Description
`EVENT,STATUS,TEMP`	Reads the internal 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,IBAT`	Reads internal NiMetal Hydride rechargeable battery
`EVENT,STATUS,ADC1` (through ADC6)	

5.6.9 Common Command Parameters

a. 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.

b. 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.

c. 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 MCC-545C (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 MCC-545C (dataset) on Tx Data.
CTS	Output; TTL 0V to 5V	Clear to Send	RS-232 serial port signal indicating the MCC-545C (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 MCC-545C (dataset) is wants the attention of the data terminal connected to the serial port.
MCLK	Output; TTL 0V to 5V	Clock	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.
MDIR	Output; TTL 0V to 5V	Data In	
MSET	Input; TTL 0V to 5V	Data Out	
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.

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Bit Name	I/O; Voltage Range	Definition	Description
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.

5.6.10   ADC Channel Names

Channel Name	Definition	Description
FPWR	Forward RF power	RF power going out of the MCC-545C transmitter.
RPWR	Reverse RF power	RF power being reflected back to the MCC-545C transmitter.
LBAT	Battery level	Voltage level of the MCC-545C battery.
DETRF	Detected RF	Current MCC-545C receiver detected RF level.
TEMP	Internal temperature	Internal temperature of the MCC-545C enclosure.
TXC	Transmit Count	Total number of transmissions
ACK	Acknowledge Count	Total number of acknowledgements

Channel Name	Definition	Description
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 MCC-545C 10-bit A-to-D channel.
ADC2	Analog Input	Available MCC-545C 10-bit A-to-D channel.
ADC3	Analog Input	Available MCC-545C 10-bit A-to-D channel.
ADC4	Analog Input	Available MCC-545C 10-bit A-to-D channel.
ADC5	Analog Input	Available MCC-545C 10-bit A-to-D channel.
ADC6	Analog Input	Available MCC-545C 10-bit A-to-D channel.

5.7 Command Summary

Table 7: MCC-545C commands

All implemented 545C commands are listed in Table 4.2 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. Command responses and unsolicited printouts are shown in Appendix A.

STATION CONFIGURATION COMMANDS		STATUS COMMANDS	MESSAGE COMMANDS
†*ASSIGN	†RCT	BINS	CANMSG
*BRATE	†REMOTE TYPE	CLS	CANMSG MODE
*CHECKIN	†RXTYPE	CONFIG	CANMSG OFF
†CLOSE PORT	SAVE	*HOURLIES	†COMPRESSION
†CONNECT	†SCALE	MEM	DEL MSG
DATE	†SCHED	MODE	DQE RXQ
*DESTINATION	SERIAL	†MON	DQE TXQ
*DEVICE	*SET BAUD	†MONOFF	FLUSH MSG
*DUTY CYCLE	†*SNP	†NETMON	FLUSH RXQ
*FREQUENCIES	*SOURCE RELAY	STAT	FLUSH TXQ
†HOST MODE	†START	*STAT TIME	*HOLD
†*ID	†STOP	T	MESSAGE

†LOGOFF	†STT	TEST	*MSG
†LOGON	†SUBST		*PRINT
*LOS CHECKIN	*SYNTH		REMCMD
*MODULATION	TIME		
†NEW PASSWORD	†TIME ZONE	**POSITION LOCATION COMMANDS**	
†OPEN PORT	*TXLIMIT	†*POS	†RED
†PASSWORDMODE		†POSRPT	†RTCM

MODE CONTROL COMMANDS

†CORPAT	†*HALF DUPLEX
*FULL DUPLEX	†*ROLE

MASTER SIMULATOR COMMANDS

*P

MAINTENANCE COMMANDS

BOOT	SHOW TXQ
RESET	SMS
REV	UPDT
SHOW RXQ	

DUAL MASTER STATION COMMANDS

†SWCTL	SWMON

UTILITY COMMANDS

FLASH	HELP

WARNING/WEATHER SYSTEM COMMANDS

†FLOOD TIMEOUT	†SENSOR
†GLOF	†STATION TYPE
†GLOF MONITOR	†WARNING
†HORN	†WARNING TIMEOUT
†PRIORITY	†WEATHER

DATA LOGGER COMMANDS

P77	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	NET STAT	SHOW MAINTENANCE MONITOR
CLEAR MAINTENANCE MONITOR CONFIGURATION	NET STAT PERIOD	SHOW REMOTES
	†POLL	SHOW RXQ
LISTM	PRG	SHOW TXQ
LISTT	REMOTE STAT	SML
MM	*REPEATER	SMS
NET	RX STAT	TYPE

* 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.

† Parameters/settings specified by these commands are stored in battery backed-up Data Memory (RAM). 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 RAM; in addition, the connector J1 must be in place to enable RAM back-up.

If both symbols are present on a command, certain aspects are stored in one way and other aspects are stored in the other. See command table below for clarifications.

Table 7: MCC-545C commands (continued)

COMMAND	DESCRIPTION	PARAMETERS	RANGE

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†*ASSIGN {,function,port,protocol {,timeout}} **NOTE** function, port and protocol information for ports 0, 1, 2 are stored in CPM; this information for port 3 and all timeout information is stored in BBU 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: Front Panel Port Connector 0 OPERATOR PORT DATA PORT 2 AUXILIARY PORT 3 DIAGNOSTICS PORT (Internal) **NOTE** It is possible to "lose control" of the 545C 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 545C. You must open the 545C and press the Reset button on the microprocessor board to re-enable the Operator Port.	function = user interface function port = physical device channel protocol = link level protocol timeout in seconds	MNT, DTA, ALT, POS 0-2, OFF ASCII,FWS,GPS,IHS,MSC,PHAROS,IDA,PKT,DATALITE, AEI RTCM,APCL5,CR10X,ENAV,TRAN,GYRO,H350,DIRECT, UAIS, PAKBUS,SERPT,CR10XTD,DG1100,GENERIC, SOUNDER 0 – 32767

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COMMAND	DESCRIPTION	PARAMETERS	RANGE
AIS	Display AIS Data		
AIS, INT, n	Set static data Tx interval (Minutes)		
AIS, DSINT, n	Set depth sounder Tx interval (Seconds)		
AIS, DEL, ALL	Delete previous pre-set static data		
AIS, ADD,ID,TYPE,NAME,MMSI,C ALL,IMO,DRAUGHT,A,B,C,D, DESTINATION			
AIS, MMSI, nnnnnnnnn	9-digit MSSI number		
AIS, IMO, nnnnnnnnn	9-digit IMO number		
AIS, NAME, cccccccccccccccccccc	20-char Name		
AIS, CALL, ccccccc	7-char call sign		
AIS, TYPE, nn	2-digit vessel type (see ITU)		
AIS, ANT,A,B,C,D	Ship/Antenna Dimensions in meters		**0-25.5**
AIS, DRAUGHT, nn.n	Ships draught in meters		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
AIS, PERSONS, nnnn	Number of persons on board		**0-8191**
AIS, TIME, HH:MM:SS	ETA time		
AIS, DATE, MM/DD/YY	ETA date		
AIS, DEST, dddddddddddddddddddd	20-char Destination		
AIS, NAV STAT, n	Navigation status code 0-9 (see ITU)		
*BASE{,nnn,nnn}	Set/display range of Master Station IDs reserved for use as Base Stations.	nnn = Master Station ID **OFF** = no Bases	**2 – 253**
BINS	Print link distribution statistics		
BOOT	Cold start of Station software. All volatile memory is lost.		
*BRATE,rate	Reports transmit bit rate in kilobits per second. This is fixed at 9.6 kbps	rate = **9.6K**	

COMMAND	DESCRIPTION	PARAMETERS	RANGE

CANMSG,nnnn (,msg length {,min queue depth},{total})	Automatically generate a 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 message in queue falls below minimum queue depth, additional canned messages will be injected.	nnnn = Station ID
		
		  Master = **1 – 4095**
		
		  Remote = **256 – 4095**
		
		msg length = number of characters in message
		
		min queue depth = min. # of canned messages in queue
		
		total = total number of canned messages to generate
			1 – 4095
			
			1 – 3000
			
			0 – 25
			
			0 – 9999

CANMSG MODE {,mode)	Set reception of canned message to two of the following states:
	
	     PRINT – print all messages
	
	     NO PRINT – does not print messages
		mode = **PRINT**
		
		       NO PRINT	

COMMAND	DESCRIPTION	PARAMETERS	RANGE

CANMSG OFF,nnnn	Turn canned message mode off	nnnn = Station ID
		
		  Master = **1 – 245**
		
		  Remote = **256 - 4095**
			1 – 4095

*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 545C 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 545C network activity and message flow. Do NOT use these commands unless directed to do so.	function = user interface function	**MNT, POS, MSG, ALT, DTA, C&S**
CLS	Print current values, then clear link statistics (see **LINKSTAT**).		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†**COMPRESSION**{,action}	Enable/disable data compression on outbound messages/data reports. Intermediate nodes pass on the information in compressed form. The destination decompresses the information.	action = **ON** – enable **OFF** – disable	
CONFIG	Show current configuration parameters report. **NOTE** Configuration in CPM may differ unless the **SAVE** command is used after configuration changes are made.		
CONFIGURATION	List major Master Station configuration settings.		
†**CONNECT,**{nnn…}	Limits Master-to-Master connectivity for lab and field network configuration. The radio will only communicate with the other radios in it's connect list.	nnn = Master Station **OFF** = no limitation	**1 – 253**
CORPAT	Without parameters, display report of available correlation patterns and indicate usage.		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†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 pattern	**1-- 8**
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	

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†CR10X,GROUP,**source**	Specify source of data report group assignment.	source = **545C** – 545C assigns group numbers; CR10X internal group number matches data array **CR10X** – CR10X assigns group numbers; 545C 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,ORDER,**order**	Specify order of final storage data (currently only **FIFO** is available).	order = **FIFO** – first in, first out **LIFO** – last in, last out	

COMMAND	DESCRIPTION	PARAMETERS	RANGE
CR10X,REGISTER,n{,ddd}	Read/Set internal storage register.	n = register number ddd = value	**1 – 28** Signed floating point number (see CR10X manual)
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**

COMMAND	DESCRIPTION	PARAMETERS	RANGE
CR10X,SETPTR,date,time	Manual set up of last data pointer in the MCC-545C	date = mmddyy time = hhmm	mm = **1 - 12** dd = **1 - 31** yy = **0 - 99** hh = **0 - 23** mm = **0 - 59**
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 = **545C** – 545C assigns timestamp **CR10X** – CR10X assigns timestamp; 545C gets timestamp from second and third sensors	
CUSTID,**nnnnn**	Display/Set customer id for this radio.	nnnnn= customer ID	**1-99999**

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COMMAND	DESCRIPTION	PARAMETERS	RANGE
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). Enter **0** to use source routing at the Master Station. If you turn off the 545C's default destination, no data will be queued, and the message editor will ask you to enter a destination before sending a message. Up to four destinations may be specified.	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 545C acts as a Remote or a limited Master Station).	type = **REMOTE** **MASTER**	
DG1100 ,COMMAND,{TX}	Typical command with Optional transmit to Host		
DG1100,DATE	Read Current date		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
DG1100,TIME	Read current time		
DG1100,LP,LAST	Most recent interval load profile		
DG1100,LP,DAYS	Most recent interval load profile		
DG1100,LPA	number of days of load profile		
DG1100,ID	Load Profile Accumulators		
DG1100,RB	Meter ID		
DG1100,RB	Rate Bins		
DG1100,DEMAND	Instantaneous Demand Info		
DG1100,METRIC	Third metric values		
DG1100,ERR	Error codes		
DG1100,DIAG	GYRBOX Diagnostic information		
DG1100,PHASE	GYRBOX Phase information		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
DIRECT	When entered without parameters, the command will display a table of all the current settings for all the ports. For a detailed description of DIRECT commands, please refer to Section 4.5.3.3.		
DIRECT, p, CONNECT STRING, OFF	Disables the connect string option. The 545C will not expect a connect string, and will stay connected all the time.		
DIRECT, p, CONNECT STRING, connect-text-string	Defines a text string of up to 19 characters that is output by the external equipment to establish a connection with the MCC-545C DIRECT port task. The 545C will receive the connect string and output the connect response string if one is defined.		
DIRECT, p, CONNECT STRING, ANY	Defines that any unspecified text string will be accepted to establish a connection.		
DIRECT, p, CONNECT RESPONSE, OFF	Disables the response string option.		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
DIRECT, p, CONNECT RESPONSE, response-text-string	Defines a text string to be output by the MCC-545C to the external equipment to confirm a connection has been established.		
DIRECT, p, PACKET TIMEOUT, decimal-imeout-ticks	Defines the timeout period in 1/16 second clock ticks that marks the end of a packet. After each character of the packet is received the timer is reset. After the last character has been received and the timeout passed, the characters received will be placed in a message and queued for transmission.		
DIRECT, p, PACKET TERMINATOR, OFF	Disable packet termination using a specified character code.		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
DIRECT, p, PACKET TERMINATOR, decimal-char-code	Enable packet termination when the given character code is received. For example using a carriage return to terminate each packet would transmit each line of input as a separate message. The decimal code for carriage return is 13. The decimal code for linefeed is 10.		
DIRECT, p, MAX PACKET, length	Defines the maximum length of a message. As characters are received on the port, they are filled into a buffer, and when the max size is reached, a new message is transmitted. One might want to transmit a message for each 256 characters, or for each 100, etc. The largest value that can be used by the MCC-545C is 3500 characters per message		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
DIRECT, p, ETE, ON	Defines the "reliable" type of message delivery. The source unit will retain each transmitted message and periodically retry them until the destination unit receives them and sends an end-to-end-acknowledgement for each message. It is possible for messages to be delivered out the destination units I/O port out of sequence when a retry has occurred. Duplicate messages will be filtered out. This method may be slower than when ETE's are turned off because there are more messages being sent through the network.		
DIRECT, p, ETE, OFF	Disables the "reliable" type of message delivery. The source unit will not retain each transmitted message for retries. Each message will be deleted as soon as transmitted. It will be the responsibility of any receiving equipment to manage the message reliability. If any message gets lost in the RF network, then all characters in that message will be lost.		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
DLOG	The DLOG command allows you to use unique freeform commands supported by the TM8/T data logger plus several special macro commands. Macro commands consist of 2 or more commands that may be dependent on the previous command response.		
DLOG,ID,nnnn	Defines the id of TM8/T data logger into the MCC-545C.	nnnn= data logger id number	
DLOG,ID	Displays the id of the TM8/T data logger.		
DLOG,DUMP	Dumps all the TM8/T data into MCC-545C and clears the TM8/T's data logger memory so it can continue to collect new data.		
DLOG,CHECK	Returns the TM8/T "HEADER" programming parameters.		
DLOG,TIMESET	Synchronizes the TM8/T's date/time clock to that of the 545's.		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
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** Remote = **256 − 4095** sss = msg serial number	**1 − 4095** **1 − 245**
*DUTY CYCLE {,percent}	Set/display transmitter duty cycle (default is 10%). Duty cycle increases in increments of 5%.	percent = **1 − 100**	**1 − 100**
EVENT	Show Event Table. For details, please refer to Section 4.6 and Appendix D.		
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.		

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COMMAND	DESCRIPTION	PARAMETERS	RANGE
EVENT,{DIOHIDIOLOW},BIT,SETTLE,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) **Settle**= Number of clock ticks for the input signal to settle at the high level before clearing 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**= MCC-545C action to be taken when the event is declared. See actions below.	

COMMAND	DESCRIPTION	PARAMETERS	RANGE
EVENT,{ADCHI,ADCLOW},CHAN,LEVEL,SETTLE,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.	

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-545C action to be taken when event is declared. See actions below.	
EVENT,CONT,ACTION EVENT,DO,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.		

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COMMAND	DESCRIPTION	PARAMETERS	RANGE
EVENT,TEXT	Show Event Text Message Table		
EVENT,TEXT,{TEXT ITEM NUMBER, MESSAGE 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.		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
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,DISPLAY,ITEM NUMBER	Display a specific item from the text table.		
EVENT,GROUP	Show Group Table		
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.		
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**

COMMAND	DESCRIPTION	PARAMETERS	RANGE
EVENT,STATUS,{bit-name, or chan-name}	Display an immediate value for any discrete input bit or any ADC channel. For more information on EVENT Programming, see Section 4.6 and Appendix D.		

 Prerelease DCN 00001789-A

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COMMAND	DESCRIPTION	PARAMETERS	RANGE
EVENT,ACTION	Immediate command Where ACTION = TXT,40 CHAR TEXT Msg CAN,NNN 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},An,Value MOV,{Tn,Cn,An},{Tn,Cn,An} ADCIN,CHAN,An,Fmul - Read ADC Channel into Accumulator Where CHAN = FPWR,RPWR,LBAT,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...XIN8 (outputs)DSR CTS RING MCLK MDIR MSET RO1 RO2 (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		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
FACTORY,DEFAULT,INIT	Restores the factory default parameters. Please refer to the Factory Default Parameters defined in Appendix B.		
FEC	Show current Forward Error Correction Settings		
FEC,mode	The system operator can enable the FEC operation using the FEC,FIXED or the FEC,AUTO command. The FEC,ON option will default to the FEC,AUTO mode.The FEC,OFF command will disable the software from transmitting FEC frames, but it can still receive FEC frames from other units.	Mode= **ON, OFF, FIXED, AUTO**	
FEC,{ERRORS,n**}**	max number errors to correct		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
FEC,{TEST,n,{FIXED,RANDOM}}	The FEC, TEST,n specifies a byte interval to inject errors in the transmitted RF frames. The minimum interval is every 5 bytes, the maximum is every 40 bytes. The FIXED option of this command will create equally-spaced errors, and each frame will have the same error spacing. The RANDOM option will use a different random interval for each RF frame transmitted. The minimum interval will be 5 bytes, and the maximum interval will be "n" bytes. The spacing between errors in any frame is still equally spaced, however.		**5-40**

COMMAND	DESCRIPTION	PARAMETERS	RANGE
FEC,{HISTORY,n}	The FEC,HISTORY,n command defined the number of transmissions that will be used by the algorithm to compute the number of errors correction parity bytes for each subsequent transmission. "n" can be set from 1-19. The size of the history queue determines how many points are averaged, and can effect the responsiveness to changes in the RF environment much like a low-pass filter. The longer the queue, the slower the response, and the shorter the queue, the quicker the response. The default value is 5.		
FREQUENCIES	Shows the Active Transmitter and Receiver frequency and the frequency table where up to 10 frequency channels can be defined. To change/set the frequency of the radio is a two step process: Select the TX and RX Frequency, along with the channel number to be assigned to that frequency in the frequency table. Assign that channel to the frequency synthesizer from the frequency table.		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
FREQUENCIES,xxxx,yyyy,z	Select Frequencies from the Transmitter and the Receiver	**xxxx**= Transmitter Frequency **yyyy**= Receiver frequency **z** = Frequency Table Channel Number	**xxxx**= 40 - 50 or 43-46 MHz **yyyy**= 40 – 50 or 43-46 MHz **z=** 0 – 10
FREQUENCIES,z	Load up Channel z from the list frequency channels under frequency table.	**z** = Frequency Table Channel Number	**z=** 0 – 10
*FULL DUPLEX	Set 545C in full-duplex mode. **IMPORTANT** When set to full-duplex mode, the MCC-545C's receiver is disabled by the built-in Tx/Rx switch. Do not use full-duplex mode without first consulting with your System Administrator.	NOT APPLICABLE	
GATEWAY	UAIS MSC port Gateway mode on,off		
GENERIC	show settings		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
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,AUTO	The AUTO group numbering will start at group 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".)		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
GENERIC,Port,DATE,AUTO	The AUTO date option will use the MCC-545C internal Date.		
GENERIC,Port,DATE,LINE,Line No,START,END{FORMAT}	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-545C internal time.		
GENERIC,Port,TIME,LINE,Line No,START,END,{FORMAT}	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.	

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COMMAND	DESCRIPTION	PARAMETERS	RANGE
GENERIC,Port,SENSOR,AUTO	In AUTO mode, sensor values are delimited by blanks or commas and there may be several per line.		
GENERIC GENERIC, P, SENSOR, AUTO, Line Number, Start	If the line number is given, data can start on other than the 1st line.		
GENERIC , P, SENSOR, LINE, Line Number, Start, End	if the start parameter is given, data can begin in a column other than the 1st column.		
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			

COMMAND	DESCRIPTION	PARAMETERS	RANGE
GENERIC,Port,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.		
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-545C, 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.		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†GLOF{,nnnn,nnnn}	Define the IDs for use as GLOF sensor Stations/display total GLOF setup.	nnnn = Station ID Master = **1 – 245** Remote = **256 – 4095** **OFF** disables GLOF sensor Stations	**1 – 4095**
†GLOF MONITOR,t,action	Setup timeout (in seconds) and action for the GLOF MONITOR Station	t = timeout in seconds action = **ALERT**, **FLOOD**	**10 – 3600**
GYRO	Display GYRO Heading		
†*HALF DUPLEX	Set 545C in full-duplex mode.		
HELP{,command}	Display help information on specified command. If no parameter entered, all commands are sequentially displayed in alphabetical order.	command = valid 545C command	
***HOLD**	Select message hold mode.		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†HORN,function{,open, close,on,off,duration}	Defines horn timing setup	function = **TEST, FLOOD, STAGE 2, STAGE3, ALL CLEAR** open = valve opening time close = valve closing time on = on time off = off time duration = overall duration for on/off cycle	All times in seconds **1 – 15** **1 – 15** **1 – 3600** **1 – 3600** **1 - 3600**

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†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 probe **OFF** = ignore host connection state; keep transmitting and do not set bit flagging loss in probe	
*HOURLIES{,action}	Turn on/off hourly statistics.	action = **ON** – enable **OFF** – disable	

COMMAND	DESCRIPTION	PARAMETERS	RANGE
If device – Remote: Normal operation †*ID{,nnn,mmm{,mode}{,INIT}} **NOTE** Remote and Master IDs are kept in CPM and mode is kept in BBU RAM.	Set 545C'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. **PREF** means Remote considers connectivity established. **AUTO** means no connectivity established. **MULTI** means Remote can connect to multiple Master Stations. **FIXED** (Default) means connect only with specified Master. **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 = **PREF**, **AUTO,** **MULTI,** or **FIXED**	**256 – 4095** **1 – 245**
†**ID**,mode	Change "mode" as discussed above without affecting ID; no reboot performed.	mode = **PREF**, **AUTO,** **MULTI,** or **FIXED**	

COMMAND	DESCRIPTION	PARAMETERS	RANGE
If device = Master: ***ID**{,nnn{,**INIT**}}	Set 545C'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	**1 – 245**
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			

COMMAND	DESCRIPTION	PARAMETERS	RANGE
LINKSTAT,{U}p,{B}rief			
LINKSTAT,{D}own,{B}rief			

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

LISTT{,nnnnn}	Display Remotes with "Type" flag set (all Remotes or given IDs up to 12)	nnnnn = Station ID
		    Master = **1 – 245**
		    Remote = **256 - 4095**
			1 – 4095

LOCATION{,latitude,longitude} format	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 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.	Format example>47:14.1234N,122:16.7812W	
LOCK,{ID,CONFIG}	Lock the ID or CONFIG settings When ID and CONFIG both locked, one cannot change the following settings of the radio: ID, FREQUENCIES, CUSTOMER ID and the SERIAL NUMBER.		

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COMMAND	DESCRIPTION	PARAMETERS	RANGE
†**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-545C	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**
MEM	Show usage of dynamic pool memory.		

COMMAND	DESCRIPTION	PARAMETERS	RANGE

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-545C automatically sends your message to its default destination (set with the **DESTINATION** command). If you want to use source routing, enter **0** for the destination.	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

MM	Print current value of RF signal on Receiver in dBm.		
MODE	Print operating mode information.		

***MODULATION**,degree,
 	
encoding
	Set the transmit modulation and data encoding.
	
	          IMPORTANT
	
	MCC-545C modulation must be the same as other units in the network.
		degree = **90** or **30**
		
		encoding =
		  MAN(Manchester),
		  DIFF(Dfferential)	

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†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		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
NOISEBLANK{,ON,OFF}	Turns Noise blanking **ON** or **OFF**		

NET	Display network routing table for all selected neighbors.
	
	    NET – no neighbors
	
	    NET1,2 – 1,2, etc., neighbors
	
	    NET,all – all neighbors		

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 the old password. The password will automatically be saved.	password = 3-20 character password	A-Z, 0-9, -
†OPEN 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 545C network activity and message flow. Do NOT use these commands.	function = user interface function	**MNT, POS, MSG, ALT, DTA, C&S**

COMMAND	DESCRIPTION	PARAMETERS	RANGE
*P{,?}{,xxx}{,OFF}	Configures 545C 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 periodic pulse mode (you can still transmit single pulses with **P**).	? = current settings xxx = periodic pulse period (in seconds) OFF = turn off periodic pulse mode	
P77	The **P77** command must be used to place the Julian date into position one, and Hour/Minute into position two. With this setup, the MCC 545C will strip off the first two sensor values and place the date and time derived from these values into the standard MCC 550B report.		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†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, -
PICREV	Shows PIC Software Revision number		
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	
PTO {1-65,000}	Power down delay in seconds. The radio shuts itself OFF after the PTO timeout.		1-65,000

COMMAND	DESCRIPTION	PARAMETERS	RANGE
$PENTM	Without parameter string, display report of current Entek MDP configuration.		
†$PENTM, ALERTEVENTS{,mask}	Set bit mask indicating Entek MDP status bits regarding as alarms. Status bits are checked against this mask on intercepted position reports and an alert message is sent to the local MNT and DTA ports for each match.	mask = hexadecimal bit mask	**0 – FFFF**
†$PENTM,ALERTMSGS {,nnn...}	Define canned messages constituting an alert. Any number may be defined (up to 10 per line). Intercepted messages matching one of these numbers cause an alert message to be sent to the local MNT and DTA ports.	nnn = canned message number	**1 – 120**
$PENTM,command string	Send command string to local Entek MDP.	command string = any valid Entek MDP command string	
†$PENTM,action	Enable/disable Entek MDP interface. When enabled, allows communication with mobile data processor in vehicle tracking applications and causes received status bits from the MDP to be included with the position data in the Remote's data reports.	action = **ON** – enable **OFF** – disable	

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†POLL{interval,offset, duration,retry}{,**ALWAYS**}	Define/display polling schedule for Base/Repeater Station. If **ALWAYS** parameter specified, do not timeout on-line units (i.e., ignore retry count in this case).	interval = polling interval in seconds offset = offset from top of minute duration = length of poll retry = retry count for failed polls	**1 – 86400** **1 – 59** **1 – 10** **1 – 99**
*POS{,interval,format, protocol}	Display/initialize internal 545C 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**

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†POSRPT{,action}	Enable/disable echoing of intercepted position reports to local MNT and DTA ports. Also used to enable/disable duplicate filtering and control format of these reports.	action = **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	
PRG,nnn	Undefine 545C Station from network.	nnn = Master Station ID	**1 - 245**
*PRINT	Enable messages to print as they are received.		
†PRIORITY,message type,p	Define priority characters for each message type.	message type = **FLOOD, ALERT, ROUTINE** p = priority	$A - Z, 0 - 9$

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†RCT{,action}	Display/set remote control terminal functionality. This functionality is applicable to Packet protocol systems only and controls whether the unit ignores intercepted data reports. If enabled, intercepted reports are ignored.	action = **ON** – enable **OFF** – disable	
RED	Without parameters, generates report of current RED setup.		
†RED,ID,nn-nnn	Enables reception of remote emergency indications from an MCC Remote Emergency Device (RED). The entered ID code is used with RED messages generated by the 545C using **RED,TEST** or **RED,TX**.	nn = call sign prefix nnn = call sign suffix	**0 – 99** **0 – 999**
†RED,NUM,n	Set dead-band interval in which repeated RED activations do not generate another alert message.	n = dead-band interval in seconds	**1 – 120**
†RED,OFF	Disable reception of remote emergency indications from an MCC Remote Emergency Device (RED).		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
RED,TEST	Simulate a RED test message. Unlike a true RED test button depression, this message is also echoed to the local MNT and DTA ports.		
RED,TX	Simulate a RED alert message. Unlike a true RED alert button depression, this message is also echoed to the local MNT and DTA ports.		

REMCMD
 	
,p,dest1{,...destn}
	With the text editor, enter a command to be sent to a Remote. After entering command, press [ESC] to send the command.	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

REG	Show Registration data		
REMDOWN,ID	Force Remote Neighbor down	n= radio ID	
REMOTES{,n}	Maximum number of remotes		
REMUP,ID	Force Remote Neighbor up		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
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**	**1 – 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**	
*****REPEATER**{,nnn}	Define/display Base Station to which the Repeater site repeats.	nnn = Base Station ID **OFF** clears a previously established definition	**1 – 245**
RESET	Perform hardware reset to clear and reinitialize I/O channels and RF controller. This command retains previous network configurations and message traffic.		
REV	Display part and revision numbers of current Link Controller and Tx/Rx Controller software.		

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COMMAND	DESCRIPTION	PARAMETERS	RANGE
†*ROLE{,role{,low,high} {,mode}} **NOTE** Role is kept in CPM and low, high and mode are kept in BBU RAM.	Define role played in network, either **SILENT** (never transmits), **TRANSPOND** (responds to probes), **PROBE** (actively probes), or **LOS** (line of sight) 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.	role = **SILENT, LOS, TRANSPOND** or **PROBE** 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,mode	Remote Relay Mode. Specifies if the radio can relay its data using another remote talking to the base station.	**Mode** = ON or OFF	

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†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**
RX STAT{,**CLEAR**}	Display statistics for the 545C Receiver	**CLEAR** = clear all statistics after display	
RXTYPE{,527,543,545b,545c}	Select Receiver Type		
SAVE	Save **CONFIG** parameters in CPM. Reboot of 545C (or restart due to software failure) returns unit to configuration saved in CPM.		
†SCALE{,parameter,value}	Display set A/D scaling factors for the unit. Factors depend on type of receiver and power supply used in the 545C.	parameter = **BAT** – battery voltage **DETRF** – detected RF **TXPWR** – transmit power value = scale factor	

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†SCHED{,basis,hh:mm:ss {,**OFFSET**,hh:mm:ss}, command string} **IMPORTANT** **SCHED** ignores the **MESSAGE** command. Up to 50 events can be scheduled.	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**
†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.	g = group number c = sensor count time stamp = mmdddhhmn value = ASCII hex sensor value	**1 – 4** **1 – 16** mm **1 – 12** ddd **1 –365** hh **0 – 23** mn **0 – 59** **0 – FFFF**

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†SENSOR{function} {weight}{low,high}}}	Defines the GLOF sensor data limit for fail/dry/wet determination. Gives the "weight" (i.e., how significant) of each case for the flood calculation.	Function: **DRY** **WET** **FLOOD** **FAIL**	 LOW **1 - 99** HIGH **1 – 9999** WEIGHT **1 - 99**
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,rate,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 rate = baud rate flow = flow control	**MNT, POS, MSG, ALT, DTA, CANDS,** **110, 150, 300, 600, 1200, 2400, 4800, 9600** **Y** or **N**
SHOW REMOTES	Display ID and assigned 520B of each Remote in system.		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
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**
SITENAME{,name}	Show/Set Site name		
SLEEP{,ON,OFF}	Show/Set low power sleep mode		
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**

COMMAND	DESCRIPTION	PARAMETERS	RANGE
SMS{,nnnn}	Display status of message packet in specified message list.	nnnn = Station ID Master = **1 – 245** Remote = **256 – 4095**	**1 – 4095**

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COMMAND	DESCRIPTION	PARAMETERS	RANGE
†*SNP{pname,value} **NOTE** Some network parameters are only for use in Master Operation mode (**RDOWN, CONNP, TEXTL, FLOODP, INF, RELAY**). **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 BBU RAM.	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 **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 level **INF** infinity hop quantity **DATAP** priority of data reports created by 545C **MBHOP** meteor burst link hop weight for meteor burst links **RELAY** relay function control	**0 – 2550** min. default = **120** **0 – 255** min. default = **20** **1 – 255** acq. 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**

A – Z

COMMAND	DESCRIPTION	PARAMETERS	RANGE
*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 545C automatically transmits statistics to Master Station.	xx = interval	**1 – 24** hours

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†STATION TYPE{,aaaaa}	Display/set special Station functionality. Determines how each Station responds to the messages it receives and limits the type of messages that can be created. Meaningful only in Flood Warning and Maritime Weather Systems.	aaaaa = **OFF** **FLOOD BASE** **FLOOD WARNING** **GLOF SENSOR** **GLOF MONITOR** **GLOF WARNING** **RELAY** **STREAM GAUGE** **SYSTEM MONITOR** **WEATHER**	
†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**

COMMAND	DESCRIPTION	PARAMETERS	RANGE
†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**
†SWCTL,OFF	Disables the monitoring and switching function.		
†SWCTL,ON,timeout,start delay	When the software boots up from a reset state, it will test the two RS-232 ports to determine which one is currently active, assuming the switch may have been manually controlled while it was off. From then on, it monitors the two Masters assuming the primary Master (1) is connected to the DTA port, and the Secondary Master (2) is connected to the ALT port.	timeout = inactivity time in seconds resulting in switchover. start delay = interval in seconds after starting before monitoring Master Stations.	**1 – 32767** **1 - 32767**
SWCTL,SW,n	Switch to designated Master Station switch position.	n = switch position	**1 - 2**

COMMAND	DESCRIPTION	PARAMETERS	RANGE
SWMON	Monitors both the RS-232 port and RF link. This **SWMON** command should be placed in the schedule of the 545C at an interval that detects a Master Station failure within the required system design. There are no parameters. A typical example is: **SCHED,I,5:0,SWMON**		
*SYNTH{,action}	Display/set status of frequency synthesizer. This command is applicable only to the MCC-545C.	action = **ON** – enable **OFF**– disable	
T	Show current date/time.		
TEST	Send test transmission and return updated statistics (uses same format as **STAT** command).		
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**
TIMEPROBE	Show current setting		
TIMEPROBE,OFF	Do NOT transmit time probes		

COMMAND	DESCRIPTION	PARAMETERS	RANGE
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**
TRACE,action,data stream	Diagnostic command used to enable/disable detailed analysis of the specified data stream.	action = **ON** – enable **OFF** – disable date stream = **RF, GPS, MSC, RTCM**	

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COMMAND	DESCRIPTION	PARAMETERS	RANGE
*TX LIMIT{,count}	Set limit on number of transmissions allowed in a 15-minute period (in minutes).	count = # of transmissions period = minute	

TYPE{,action{,nnn{nnn,…
 	
,nnnn}}}
	Control auditing of messages entered at specified units and routed through the 545C.	action =
		  ON - enable
		
		  OFF - disable
		
		nnn = units to be audited.
		
		  ALL – default
		
		  Master = **1 − 245**
		
		  Remote = **256 − 4095**
			1 - 4095

COMMAND	DESCRIPTION	PARAMETERS	RANGE
UPDT{,function,parameters}	Send update message to data logger type device.	**NOTE**: Read sensors but do not transmit data read **TX**: Read sensors and transmit data read **TIME:** Set time of 545C in logger **TEST:** Operate compo-nent in 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** **POS: Schedule position** report at same time data report sent	**RM**: Routine message format **RMP**: RMP Message format value appropriate to the register: **0 − 255**

COMMAND	DESCRIPTION	PARAMETERS	RANGE
VERBOSE{,ON,OFF}	Show/set full/partial command mnemonic		
VDUREV	Show VDU Software Revision number		

†**WARNING**,{nnnn,nnnn}	Define the IDs for use as the Standard Flood Warning Stations. Without parameters, displays total **WARNING** setup.	**OFF** = disables
		
		nnnn = Station ID
		
		  Master = **1 – 245**
		
		  Remote = **256 – 4095**
			1 – 4095

†**WARNING TIMEOUT** {,t}	Define/display timeout period in seconds for a Flood Base Station to determine a communications failure	t = timeout in seconds	**10 – 3600**

†**WEATHER**{,action}	Enable/disable Maritime Weather system functionality. Without parameters, displays total **WEATHER** setup.	action =
		
		  ON – enable
		
		  OFF – disable	

†**WEATHER,REPORT**,t	Defines data reporting interval in minutes for a Maritime Weather Station.	t = report interval in minutes	**0 – 32767**

Appendices

The information in the appendices is supplementary and unnecessary for basic operation of the MCC-545C. It is deleted to reduce file size. The information is available upon request.