INSTRUCTION MANUAL

TX320 Transmitter

Revision: 8/11

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About this manual

Please note that this manual was originally produced by Campbell Scientific Inc. (CSI) primarily for the US market. Some spellings, weights and measures may reflect this origin.

Some useful conversion factors:

Area:	1 in^2 (square inch) = 645 mm^2
Length:	1 in. (inch) = 25.4 mm 1 ft (foot) = 304.8 mm 1 yard = 0.914 m 1 mile = 1.609 km
Mass:	1 oz. (ounce) = 28.35 g 1 lb (pound weight) = 0.454 kg
Pressure:	1 psi (lb/in2) = 68.95 mb
Volume:	1 US gallon = 3.785 litres

In addition, part ordering numbers may vary. For example, the CABLE5CBL is a CSI part number and known as a FIN5COND at Campbell Scientific Canada (CSC). CSC Technical Support will be pleased to assist with any questions.

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TX320 Transmitter

1. Introduction

The TX320 transmitter supports one-way communication, via satellite, from a Campbell Scientific datalogger to a ground receiving station. Satellite telemetry offers a convenient telecommunication alternative for field stations where phone lines or RF systems are impractical.

The TX320 uses non-volatile memory to store configuration information, such as platform ID, transmission baud rate, channel number, scheduled transmission time, offset time and message window length. The TX320 also has a 15.7 K byte RAM buffer for scheduled transmissions and a buffer for random transmissions. The clock is maintained with a GPS receiver.

TX320 supports the following certification standards:

- GOES Data Collection Platform Radio Set (DCPRS) Certification Standards at 300 bps and 1200 bps, version 2, effective date: June 2009
- 300/1200 BPS DCPRS Certification Standard version 1.0b - March 2000
- 100 BPS Self-timed DCPRS Certification Standard - November 1981
- 100 BPS Random DCPRS Certification Standard - November 1981

The TX320 supports High Data Rate specifications. The TX320 includes the following communication ports:

- CS I/O port for Campbell dataloggers
- RS-232 port for dataloggers and PC communication
- USB port for PC communications

The CS I/O port is a Campbell Scientific Synchronous Device for Communication (SDC) port, address 4.

NOTE The 21X and CR7 dataloggers do not support SDC or the TX320.

Specifications:

On-board Memory:	Non-volatile flash for setup parameters. 16 kbytes for data
Transmission Data Rates:	100, 300 and 1200 bps
Power Requirements:	10.8 to 16 VDC, 5 mA quiescent, 90 mA during GPS fix, and 2.6 Amps during transmission
25316 Transmit Antenna:	11 dBi Gain, Right Hand Circular polarization, Type N female connector, wind load of ~100 knots
Transmit Power:	5.6 watts for 100 and 300 bps, 11.2 watts for 1200 bps

Frequency Range:	401.701 MHz to 402.09850 MHz
Frequency Stability:	Initial Accuracy: ±20 Hz disciplined to GPS; Short term drift: ±0.04 Hz/sec, Ageing: ±0.1 ppm/Year, Vcc + Temperature: ±0.1 PPM
Channel Bandwidth:	100/300 bps 1.5 kHz; 1200 bps 3 kHz
Time Keeping:	Initial setting accuracy: ± 100 microseconds synchronized to GPS; Drift ± 10 milliseconds/day over operating temperature range; GPS scheduled updates are 1 at power up and once per day there after. Once every 28 days required for continual operation.
GPS Antenna:	3.3 volt active; SMA female connector
RS-232 Serial Port:	Signal Levels: RS-232C; Connector: DB9F; DCE Command protocols: ASCII, binary, field diagnostics, dataloggers with RS-232 port
USB Port:	Connector: Type B Command protocols: ASCII, binary, field diagnostics
CS I/O Port:	Signal Levels: TTL, Connector DB9M; Command Protocol: Campbell Scientific Synchronous Device Communication, address 4, Binary Command, Campbell Scientific Dataloggers.
Environmental:	Operating: -40° to 60°C; Storage -50º to 70ºC; 0 to 99% RH, non-condensing
Dimensions (with connectors):	6.7” H x 10.6” L x 2.1” W (17.0 x 24.9 x 5.3 cm)
Dimensions (without connectors):	6.2” H x 9.8” L x 2.1” W (15.8 x 24.9 x 5.3 cm)
Weight:	2.25 lbs (1.02 kg)
Emission Designators	
@ 300 bps:	300HG1D
@ 1200 bps:	1K20G1D
Power Usage	
Sleep:	0.5 mA
Transmission:	2.6 mA
GPS:	80 mA – 15 mA/day

2. GOES System

Appendix A provides information about getting onto the GOES system and eligibility.

2.1 Orbit

The TX320 transmitter sends data via Geostationary Operational Environmental Satellites (GOES). GOES satellites have orbits that coincide with the Earth's rotation, allowing each satellite to remain above a specific region. This allows a user to point the GOES antenna at a fixed position in the sky.

There are two satellites, GOES East and GOES West. GOES East is located at 75° West longitude and GOES West is located 135° West longitude. Both satellites are located over the equator. Within the United States, odd numbered channels are assigned to GOES East. Only even numbered channels are assigned to GOES West. Channels used outside the United States are assigned to either spacecraft.

2.2 NESDIS and Transmit–Windows

GOES is managed by the National Environmental Satellite Data Information Service (NESDIS). NESDIS assigns the platform ID, uplink channel number, and self-timed or random transmit windows. Self-timed windows allow data transmission only during a predetermined time frame (typically 10 seconds every hour). The self-timed data is erased from the transmitter's buffer after each transmission, random data is not. Random windows are for critical applications (e.g., flood reporting) and allow transmission immediately after a threshold has been exceeded. The transmission is then randomly repeated to ensure it is received. A combination of self-timed and random transmission can be executed by the TX320.

2.3 Data Retrieval

Data retrieval via the TX320 and the GOES system is illustrated in Figure 2-1. The DAPS User Interface Manual, provided by NOAA/ NESDIS, describes the process of retrieving the data from the NESDIS ground station. The data are in the form of 3-byte ASCII (see Appendix B for a computer program that converts the data to decimal). You can also retrieve data directly from the NESDIS ground station via DOMSAT, LRGS, or LRIT. DOMSAT is only practical for organizations with many GOES users. Contact NESDIS for more information (http://www.noaasis.noaa.gov/DCS/).

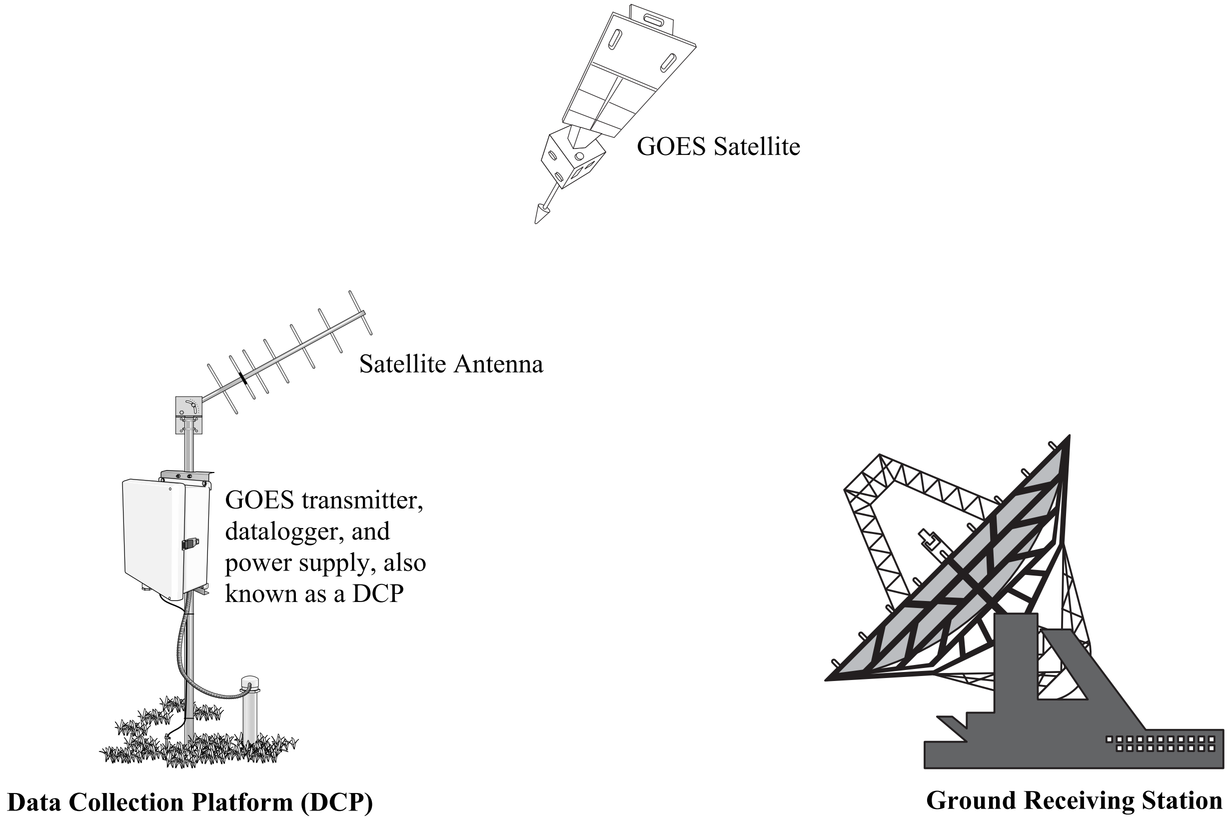

FIGURE 2-1. Major Components of the GOES/DCP System (GPS antenna not shown)

3. TX320 Functions

3.1 LED Function

The TX320 has four LEDs used to indicate the state of the TX320 transmitter.

When power is first applied to the TX320, the four LEDs will cycle through quickly, then the Synchronizing Clock to GPS LED will light for 15 minutes.

If there are data in a buffer waiting for transmission time, the Data In Buffer LED will light.

During transmission, the Transmitting LED will light.

The Status LED will only light after the Diagnostics button has been depressed. Press and hold the Diagnostics button for about 2 seconds. The Status LED will flash once to indicate the Failsafe has not been tripped. If the LED flashes twice, the Failsafe has tripped. To clear the Failsafe, press and hold the diagnostic button for about 10 seconds.

3.2 Diagnostics Switch

The Diagnostics switch has two purposes. Press and hold the Diagnostics button for about 2 seconds. The Status LED will flash once to indicate the Failsafe has not been tripped. If the LED flashes twice, the Failsafe has tripped. To clear the Failsafe, press and hold the diagnostic button for about 10 seconds.

The Failsafe circuit is designed to shut down a malfunctioning transmitter that is transmitting too long or too often. The Failsafe circuit helps prevent malfunctioning transmitters from interfering with other transmissions.

3.3 Communication Ports

NOTE The CS I/O port and RS-232 port share the same hardware and therefore cannot be connected simultaneously.

3.3.1 CS I/O Port

The CS I/O port is a Campbell Scientific Synchronous Device for Communication (SDC) port. The CS I/O port is specifically designed to work with Campbell Scientific SDC capable dataloggers. The CS I/O port is used by Campbell Scientific dataloggers to transfer data from the datalogger to the TX320 transmitter. The CS I/O SDC port allows other SDC devices and one modem enabled device to be connected to the same port at the same time. This SDC port will allow the TX320 transmitter, the RF95A RF modem and a phone modem to be connected to the CSI datalogger serial port all at the same time. The CS I/O port is a DB9 male, voltage levels are TTL, SDC address 4, pin out is:

1, 3, 5, 8 are not used
2 = Ground
4 = RXD (output)
6 = SDE (input)
7 = CLK (input)
9 = TXD (input)

3.3.2 RS-232 Port

The RS-232 port is a DB9 female connector configured as DCE. Only three pins are used, transmit on pin two, receive on pin three, and ground on pin five. Transmit is an output and receive is an input to the TX320.

The RS-232 port allows the transmitter to be connected to a PC's 9-pin serial port or to a datalogger's RS-232 port. Connection to a PC is required to configure the transmitter via the 32 bit windows compatible software, SatCommand. SatCommand software reads, writes, saves, and transmits the configuration information from the computer to the TX320 transmitter. SatCommand is also used to read status information from the transmitter.

3.3.3 USB Port

The transmitter also has a type B USB port for connecting to a PC. Many newer computers only have USB ports. Configuration of the transmitter via Sat Command requires that the transmitter is connected to a PC.

3.3.3.1 Installing USB Drivers

The following procedures install required drivers to the PC. Install drivers BEFORE connecting the TX320 to the PC.

1. Obtain software drivers from one of the following sources.

   Source 1: Insert the CD supplied with a new TX320. The CD should auto run and present a menu (if not, open AutoRun.exe). Click on [Install Drivers] button.

   Source 2: Drivers can be accessed through the TX320 service of DevConfig.

   Source 3: Obtain the TX320_Drivers.exe file at www.campbellsci.com, and copy it to a PC drive. Open the file and follow the prompts.

2. Follow the on-screen prompts to copy driver files to the PC.

3. Install drivers for TX320 as outlined in Table 3.3-1. Procedures differ for different Windows® operating systems and assume driver files have been copied to the PC.

TABLE 3.3-1. USB Driver Installation		
Windows® XP	**Windows® Vista**	**Windows® 7**
1. Use the USB cable to connect the TX320 to the PC. 2. The *Found New Hardware Wizard* window will open. Select "No, not this time," when asked to connect to Windows® Update, then click *Next*. 3. Select "Install the software automatically," then click *Next*. 4. If the *Windows® Security* window appears, select "Install this driver software anyway" to continue. 5. Click *Finish* to close the *found New Hardware Wizard* window.	1. Use the USB cable to connect the TX320 to the PC. 2. The *Found New Hardware* window will open. Click on "Locate and install driver software." 3. If the *Windows® Security* window appears, select "Install this driver software anyway."	1. Use the USB cable to connect the TX320 to the PC. 2. Windows® 7 configures the driver automatically.

3.4 RF Connectors

3.4.1 RF Transmission Connector

The TX320 utilizes the type N female connector for RF power out. This connector must have a proper antenna connection before transmission occurs. Failure to use a properly matched antenna cable and antenna may cause permanent damage to the RF amplifiers. The nominal impedance is 50 ohms, the frequency range is approximately 400 to 403 MHz. At 100 and 300 BPS transmission rates, the nominal EIRP is 48 dBm with an 11 dBic gain antenna. At 1200 BPS, the nominal EIRP is 52 dBm. CS-2 standards use lower transmit power.

3.4.2 GPS Connector

The GPS connector is an input to the TX320. Operation without an antenna connected will not cause damage, but the transmitter will not transmit without a valid GPS fix. The GPS connector is an SMA female. The GPS receiver uses an active 3.3 V antenna.

The TX320 transmitter uses the GPS receiver for two functions. The precise GPS time is used to ensure scheduled transmissions occur at the proper time. The one-second GPS synchronization pulse is used to ensure a precise, drift-free carrier frequency. See Section 6.3 for more information regarding GPS and GPS antenna placement.

3.5 Power Connector

The TX320 power connector has two pins: ground and 12 V. The input power requirement is 10.8 to 16 VDC at 3 amps. Because the TX320 can use up to 3 amps, the power should be connected directly to the battery. An in-line 7 amp fast blow fuse can be used to help protect the transmitter. The TX320 is shipped with a power cable that includes the fuse and a connector arrangement that allows the transmitter to pull power directly from the battery when using the CH100, PS100, PS12LA or CH12R power supply.

With the potential for a 3000 mA current drain, the voltage drop along the battery power leads must be considered. The battery power leads are both wires that run from the battery to the power input connectors of the TX320. To calculate the voltage drop along the power leads, we must know the resistance of the wire and the length of the wire. Usually the resistance of the wire is listed as ohms per 1000 feet. As an example, a 24 AWG wire used by CSI has a resistance of 23 ohms per 1000 feet. The length of the wire is the distance the wire travels from the battery to the transmitter multiplied by two. You must consider the current travels from the battery, to the transmitter and back to the battery.

The TX320 will operate with a battery voltage range from 10.8 V to 16 V. A fully charged lead acid battery will have a voltage of about 12.5 V. If the battery is fully charged, a 1.7 V drop along the battery leads will stop the transmitter from transmitting. At 3 amps, 1.7 V will be dropped with 0.566 ohms of resistance. Using the 24 AWG wire with 23 ohms resistance per 1000 ft, 24 feet of wire (battery power leads 12 ft long) will prevent transmission. A reliable system that will transmit without a perfect battery voltage will minimize voltage drop along the battery power leads. To minimize voltage drop, keep the battery power leads short. A five-foot power lead is a long power lead. If you must have a longer lead, use heavy wire. For power leads less than ten feet but more than five feet, use no smaller than 18 AWG.

FIGURE 3-1. TX320 Label

FIGURE 3-2. TX320 Connectors

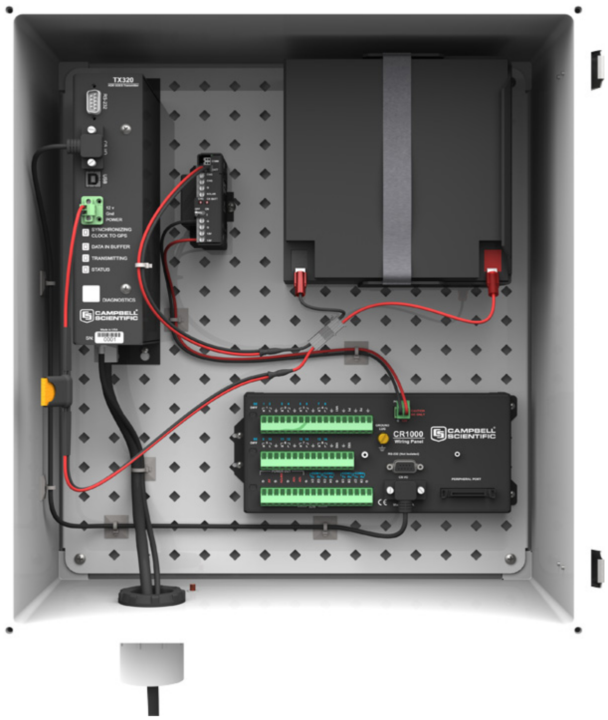

FIGURE 3-3. DCP Enclosure

4. SatCommand Software

Certain information required by NESDIS is unique to each DCP. This setup information includes: platform ID, transmission baud rate, channel number, scheduled transmission time, offset time, and message window length. The TX320 has non-volatile memory to store the setup information. The setup information is entered in the SatCommand software, then transferred to the TX320. SatCommand software is a 32-bit windows application. The TX320 can be setup using terminal emulation software, but the process requires knowledge of the ASCII commands. See the appendix section for a list of appropriate commands.

4.1 Install SatCommand

Follow instructions on the disk.

4.2 SatCommand General Description

SatCommand has a status window, a terminal window, several control buttons, a main menu, and an edit window used to make setup changes.

The Terminal window is used to manually enter commands to the transmitter. The Status window is used to display information regarding the current state of the transmitter. The control buttons are used to initiate some communications between the computer and the TX320 transmitter. The main menu is across the top of the screen and includes some file control functions, a list of commands that can be sent to the transmitter, and a couple of tools. The edit window is where changes to the transmitter setups are to be entered and saved for later use.

4.3 Making Edits

Edits are made in the configuration window. The configuration window has two columns; use the right column for all edits. When SatCommand is first started, a default setup template is loaded. If the Retrieve Settings button is selected, the current configuration of the TX320 will be loaded to the fields of the edit window.

4.3.1 NESDIS ID

Edit the NESDIS ID number (also called Platform ID). Type in your NESDIS assigned ID number. This is an 8-digit hex number. Valid characters are 0-9, A, B, C, D, E and F. Example: 4F3E2D1E

4.3.2 Timed Channel

The Timed Channel is the NESDIS assigned self-timed transmission channel. When using 100 and 300 baud, valid channel numbers are between 0 and 267. When using 1200 baud, valid channel numbers are 0 to 133. For 1200-baud channels, the formal channel designation is the channel number followed by the letter A, for example: 99A. For clarification, see Appendix D. If your assigned channel number does not include the letter A, either you don’t have a 1200-baud channel assignment or you’ve been given a 100/300 channel number. In SatCommad, don't enter the letter A. When 0 is entered, self-timed transmissions are disabled.

4.3.3 Timed Bit Rate

Enter the assigned channel bit rate (baud rate). Valid entries are 100, 300, or 1200. The bit rate is assigned by NESDIS and is tied to the channel number. Using the wrong bit rate will prevent NESDIS from receiving your data.

4.3.4 Timed Interval

The Timed Interval is how often data is transmitted. The options include days, hour, minutes, and seconds. Generally the interval will be zero days, one hour, zero minutes, and zero seconds.

4.3.5 First Timed Transmission

The First Timed Transmission is also referred to as the Offset. The first timed transmission will always be between zero and the timed interval. The TX320 will transmit on the next Timed Interval after the clock has been set.

4.3.6 Timed Tx Window

The Timed Transmit Window is the length of the assigned self-timed transmit window in seconds. Valid entries are 5 to 120 seconds in 1 second increments.

4.3.7 Timed Msg Format

The Timed Message Format determines how the flag word is written and which characters are legal. Select A if the data format is ASCII, select P for Pseudo Binary, option B has not yet been defined by NESDIS. Please note: The Timed Msg Format does not change the format of the data; instead, the flag word is changed. The datalogger program determines the data format and must match the format selected in the Timed Msg Format option.

4.3.8 Random Channel

If NESDIS has not assigned a Random Channel, Sections 4.3.8 through 4.3.14 do not apply.

The Random Channel is the NESDIS assigned random transmission channel. When using 100 and 300 baud, valid channel numbers are between 0 and 267. When using 1200 baud, valid channel numbers are 0 to 133. For 1200-baud channels, the formal channel designation is the channel number followed by the letter A, for example: 99A. For clarification, see Appendix D. If your assigned channel number does not include the letter A, either you don't have a 1200-baud channel assignment or you've been given a 100/300 channel number. In SatCommad, don't enter the letter A. When 0 is entered, self-timed transmissions are disabled.

4.3.9 Random Bit Rate

Enter the assigned channel bit rate (baud rate). Valid entries are 100, 300, or 1200. The bit rate is assigned by NESDIS and is tied to the channel number. Using the wrong bit rate will prevent NESDIS from receiving your data.

4.3.10 Random Randomizing Interval

The Randomizing Interval is the average time between random transmissions. When the TX320 receives data in the random data buffer, a random transmission is scheduled. After the first transmission, the transmitter will select a pseudo random time somewhere within the randomizing interval. This process is repeated until the Random Repeat Count has been met, or the datalogger removes the data from the random buffer.

4.3.11 Random Randomizing Percentage

Enter the percent of the randomizing interval that should be used in the randomizing of random transmissions. Valid entries are 10 to 50, representing 10 to 50 percent of the randomizing interval.

4.3.12 Random Repeat Count

Enter the total number of random transmissions you want repeated after data has been loaded to the random data buffer. Typically, 3 works well.

4.3.13 Random Data Format

The Random Message Format determines how the flag word is written and which characters are legal. Select A if the data format is ASCII, Select P for Pseudo Binary, option B has not yet been defined by NESDIS. Please note: The Random Msg Format does not change the format of the data; instead, the flag word is changed. The datalogger program determines the data format and must match the format selected in the Random Msg Format option.

4.3.14 Random Msg Counter

The Random Msg Counter will insert a counter at the beginning of the data stream. The counter indicates the number of random messages sent so far.

4.4 Save and Transfer the Settings to the TX320

Using the drop list, select the appropriate RS-232 or USB communication port for your computer.

Connect the computer’s RS-232 serial port to the TX320 RS-232 serial port via a standard RS-232 serial cable. Or connect the computer’s USB port to the transmitter’s USB port via a standard USB cable. Apply 12 volts DC to the Power terminal.

NOTE The CS I/O port and RS-232 port share the same hardware and therefore cannot be connected simultaneously.

Test the communications link by typing the enter key with the cursor in the Terminal window. The TX320 will respond with the > character whenever the Carriage Return character is received on the TX320 port.

After the information from Section 4.3 has been entered, select the Save/Send Settings button. Provide a file name to save the settings to disk, then select the Yes button on the Send to Transmitter dialog box. The settings will be transferred to the TX320.

Once the transfer is complete, select the Status button to verify the transmitter is setup and enabled. Specifically, look for the line that says Transmitter: Enabled. If Transmitter: Disabled is shown, then the configuration settings have an illegal parameter, or the transfer didn't succeed.

4.5 Using SatCommand for TX320 Testing

4.5.1 Terminal Window

The Terminal is always open and ready for use. The Open Port button will open the serial port. If the port is closed, typing in the terminal window will open the port. To use the terminal window, use a standard serial or USB cable to connect the serial or USB port of the computer to the RS-232 or USB port of the TX320. SatCommand can be used to send data to the transmitter, read the Audit Log, GPS Status, etc. The Terminal window supports manually-entered commands (see the appendix for individual command). The Terminal Window also supports automated commands found under Main Menu/Commands.

4.5.2 Commands

From the main menu select Commands. Within the Commands menu there are several useful commands that can be issued to the TX320. Both the command and the TX320 response are shown in the Terminal Window.

4.5.2.1 Recall Configuration Settings

Recall Configuration Settings is best for experienced TX320 users. All the settings are displayed in the terminal window, but each setting is not labeled. Instead, the command used to read or set the setting is displayed before the actual setting is displayed.

4.5.2.2 Position

Position will retrieve the time of the last GPS fix, Latitude, Longitude, and Altitude in meters.

4.5.2.3 Version

Version will display information about the TX320 hardware and software. The unit serial number, hardware version number, firmware version number, and GPS version are displayed.

4.5.2.4 GPS Status

GPS Status will display if the GPS power is on or off. If the GPS is powered, the GPS system reports the satellites currently tracked and the signal strength from each spacecraft. If the GPS is off, use the Position or Read Audit Log option to verify if the GPS system has obtained a GPS fix.

4.5.2.5 Read Audit Log

The Read Audit Log will display a history of the transmitter operation. The latest entry in the audit log is shown at the top of the screen. The audit log will record any error condition that has occurred in the past, plus other events.

4.5.2.6 Enable Transmitter

The Enable transmitter will enable the transmissions if the transmitter setup parameters are all valid; otherwise, the transmitter cannot be enabled.

4.5.2.7 Disable Transmitter

The Disable Transmitter option is used to prevent the transmitter from transmitting until it has been enabled.

4.5.2.8 Max Timed Message Length

The Maximum Timed Message Length command will calculate the maximum number of bytes that can be sent given the current configuration of the transmitter. To calculate the maximum number of bytes that can be sent, the transmitter looks at the data rate (bits per second), and the message window length. To convert the number of bytes that can be sent to the number of data points that can be sent, divide the number of bytes by 3 if using Pseudo Binary or by 7 if using an ASCII format.

4.5.2.9 Max Random Message Length

See Section 4.5.3.8 for details. The random message does not have a fixed limit on message window size, but random messages should be kept as short as possible to increase the likelihood of successful reception.

4.5.2.10 Clear Timed Buffer

The Clear Timed Buffer command will erase all data from the timed buffer.

4.5.2.11 Clear Random Buffer

The Clear Random Buffer command will erase all data from the random buffer.

4.5.2.12 Send to Timed Buffer

The Send to Timed Buffer command is used to send data to the timed buffer. Data will then be scheduled for transmission on the next available time slot.

4.5.2.13 Send to Random Buffer

The Send to Random Buffer command is used to send data to the random buffer. Data will then be scheduled for transmission very soon.

4.5.2.14 Show Defaults

The Show Defaults will populate the edit window with default values, which are not valid for transmission. Selecting show defaults, then sending the defaults to the transmitter will return the transmitter to factory default settings and prevent transmission of data. Once the defaults are loaded to the edit window, the defaults can be edited. Sometimes it is useful to start from a known condition.

5. Programming the Datalogger

5.1 CRBasic Programming

This section covers CRBasic programming concepts for the CR295(X), CR800, CR850, CR1000, CR3000, and CR5000 dataloggers. Not all options are available for the CR5000 and CR295(X) dataloggers. There are four program instructions directly related to the TX320 GOES transmitter: GoesData, GoesStatus, GoesGPS and GoesSetup.

5.1.1 GoesData

The GoesData instruction is used to send data from the datalogger to the TX320 transmitter. Each time GoesData is executed, data is ordered with the newest data to be transmitted first, which is opposite of how Edlog dataloggers arrange data.

There are five parameters to the GoesData instruction: Result Code, Data Table, Table Option, Buffer Control, and Data format.

In GoesData(), Table Option, Buffer Control, and Data Format can be variables declared as type long. Error checking is done at run time instead of compile time. See Table 5.1-7 for runtime error codes.

Using CRBasic dataloggers, time of Max, Min, etc. are stored as number of seconds since 1990, which does not work for GOES transmission.

5.1.1.1 Result Code

The result code is used to determine if the GoesData instruction executed successfully. When successful, GoesData will return a zero to the Result Code variable. When GoesData executes successfully, but there is no new data in the specified table, the result code is set to 100. See Table 5.1-6 for details regarding result codes.

5.1.1.2 Data Table

The Data Table argument is used to specify which data table the GoesData instruction is to copy data from.

5.1.1.3 Table Option

The Table Option is used to specify what data is copied from the data table. There are three options. Use zero to specify all new data. Use one to specify only the most current record. Use any other positive number to specify the number of records to be copied each time GoesData is executed. When copying data, the entire record, except the timestamp and record number, is copied from the datalogger to the TX320 transmitter.

5.1.1.4 Buffer Control

Buffer Control is used to determine which buffer data is copied to, and if the buffer is erased before data is copied to the buffer. Use Zero to append to the self-timed buffer, use 1 to overwrite the self-timed buffer. Use 2 to append to the random buffer, and 3 to overwrite the random buffer.

5.1.1.5 Data Format

Data Format is used to determine what format the data is transmitted in. This is the format of the data sent over the satellite. The TX320 does not determine the actual data format used, but can be set to match for data format selected with the GoesData instruction. Use zero for CSI floating point pseudo binary. Use 1 for floating point ASCII. Use 2 for 18 bit signed integer pseudo binary. Options 3 through 8 are used for RAWS7 or Fire Weather applications. Option 9 is used to clear the random buffer.

In dataloggers that support strings as a data type, all data format options except 3 (RAWS7) will support strings. Strings are transmitted from the first character until the null terminator. If strings contain illegal characters, the TX320 will replace the character with another character. By default the replacement character is an asterisk. The replacement character can be changed.

NOTE Both the random and timed buffers of the TX320 can be set to accept ASCII or Pseudo Binary data. If the TX320 is set to Pseudo Binary, all ASCII data is transmitted as the replacement character, which is an Asterisk by default. When the TX320 is set to ASCII data, both Pseudo Binary and ASCII data are transmitted normally. Data format options zero and 2 are Pseudo Binary, all others are ASCII.

NOTE When transmitting random messages in pseudo binary format the message counter must be turned off (RMC=N). The message count is a simple 3 digit count of how many times the transmission has been repeated. Digits (0 - 9) are not legal characters in pseudo binary mode and are replaced at transmission time with the replacement character specified by the IRC command. The default IRC character is *. If the random message counter is on when the random data format is set to pseudo binary, the first 3 characters sent are 0x20,0x20,0x2a (space,space,*) instead of the intended 0x20,0x20,0x31 (space,space,1).

NOTE The order data appears in each transmission can be controlled. Only whole records are copied from the datalogger to the TX320. Each record is copied in the same order it appears in the datalogger memory. The order of data records, oldest to newest or newest to oldest, can be controlled. To arrange data records oldest to newest, execute the GoesData instruction when data is written to the data table. To arrange data newest to oldest, execute the GoesData instruction once per timed transmission. Either method works best when the table option is set to zero.

5.1.1.6 GOESData() Example

```
' GOESData() Example

' Sample program makes a few simple measurements and
' stores the result in the table named Tempdata.
' All new data from TempData is copied to the
' transmitter hourly.

' An hourly record containing stats regarding
' the Last GOES message are stored in another table

'declarations
Public TCTemp
Public PanelT
Public battery1
Public RC_Data
Public LastStatus(14)

Alias LastStatus(1)=RC_Last
Alias LastStatus(2)=Lst_Type
Alias LastStatus(3)=Lst_Bytes
Alias LastStatus(4)=Lst_Forward
Alias LastStatus(5)=Lst_Reflected
Alias LastStatus(6)=Lst_BattVolt
Alias LastStatus(7)=Lst_GPS
Alias LastStatus(8)=Lst_OscDrift
Alias LastStatus(9)=Lat_Deg
Alias LastStatus(10)=Lat_Min
Alias LastStatus(11)=Lat_Secd
Alias LastStatus(12)=Long_Deg
Alias LastStatus(13)=Long_Min
Alias LastStatus(14)=Long_Secd

'program table
DataTable (Tempdata,1,1000)
    DataInterval (0,15,min,10)
    Sample (1,TCTemp,FP2)
    Sample (1,PanelT,FP2)
    Sample (1,battery1,FP2)
EndTable
```

```
DataTable(GoesStats,true,300)
DataInterval(0,1,hr,0)
    Sample(14,LastStatus(),fp2)
EndTable

BeginProg
    Scan (10,Sec,3,0)
        Battery (battery1)
        PanelTemp (PanelT,250)
        TCDiff (TCTemp,1,mV25C ,2,TypeT,PanelT,True ,0,250,1.8,32)
        CallTable TempData
        If IfTime (0,1,Hr)
            GOESData (RC_Data,TempData,0,0,1)
        EndIf
        If IfTime (0,10,min)
            GOESStatus (LastStatus(),2)
        EndIf
        CallTable GoesStats
    NextScan
EndProg
```

5.1.2 GoesStatus

The GoesStatus instruction is used to read information from the TX320. Information that can be read and stored in the datalogger includes information relating to the next transmission, the last transmission, GPS time and position, and all logged errors. The status information can be used to set the datalogger clock and troubleshoot any problems that might arise. The GoesStatus instruction also includes options to initiate a random transmission on command.

The GoesStatus instruction includes seven different functions: Read Time, Read Status, Read Last Message Status, Transmit Random Message, Read Error Register, Clear Error Register, Return transmitter to on-line mode.

GoesStatus expects two parameters. The first is the array used to store the data returned by GoesStatus, the second is the command to be issued. The first element of each array returned by the GoesStatus command is the result code. The result code is used to test if the GoesStatus instruction executed successfully. When the result code is zero, GoesStatus executed successfully. See Table 5.1-2 for details.

5.1.2.1 GoesStatus Read Time

Example:

Public gps(4)

GoesStatus (gps(), 0)

Command zero (Read Time) will read the TX320 clock. Under normal operating conditions the time is GMT. There are delays in reading the time from the TX320. The array needs to be four elements or more. Data is returned as: Result Code, Hour, Minute, Second.

TABLE 5.1-1. GoesStatus Command 0: Read Time

Index	Contents
1	Command Result Code
2	Hours (GMT)
3	Minutes
4	Seconds

5.1.2.2 GoesStatus Read Status

Example:

```
Public Stats(13)

GoesStatus(Stats(), 1)
```

Command 1, (Read Status) is used to read information regarding the current status of the transmitter. Information returned includes the number of bytes in each data buffer, time until transmission and a loaded battery voltage.

TABLE 5.1-2. GoesStatus Command 1: Read Status

Index	Contents
1	Command Result Code
2	Bytes of data in self-timed buffer
3	Time until next self-timed transmission: Days
4	Time until next self-timed transmission: Hours
5	Time until next self-timed transmission: Minutes
6	Time until next self-timed transmission: Seconds
7	Bytes of data in random buffer
8	Time until next random transmission interval start: Hours
9	Time until next random transmission interval start: Minutes
10	Time until next random transmission interval: Seconds
11	Failsafe, 1 indicates transmitter disabled due to failsafe.
12	Loaded power supply voltage, 1 amp load. (tenths of volts)
13	Average GPS acquisition time (tens of seconds)

5.1.2.3 GoesStatus Read Last Message Status

Example:

```
Public LastStats(14)

GoesStatus(LastStats(), 2)
```

Command 2 (Read Last Message Status) is used to read information regarding the last transmission. Information includes the type of transmission, size, forward power, reflected power, etc. Also returned is the GPS derived Latitude and Longitude, which is updated once a day. The GPS update interval can be changed.

TABLE 5.1-3. GoesStatus Command 2: Read Last Message Status

Index	Contents
1	Command Result Code
2	Message type: Self-timed or Random
3	Size of message in bytes
4	Forward power in tenths of watts
5	Reflected power in tenths of watts
6	Power supply voltage under full load, in tenths of volts
7	GPS acquisition time in tens of seconds
8	Oscillator drift (signed, hundreds of Hz)
9	Latitude degrees
10	Latitude minutes
11	Latitude seconds
12	Longitude degrees
13	Longitude minutes
14	Longitude seconds.

5.1.2.4 GoesStatus Read Error Register

Example:

Public Errors(10)

GoesStatus(Errors(), 4)

Command 4 (Read Error Register) is used to return the total number of errors that have occurred, and codes describing the last four errors. When the command that caused the error is listed as 31, the error is an internal fault. Otherwise the error is just a communication error.

TABLE 5.1-4. GoesStatus Command 4: Read TX320 Error Registers

Index	Contents
1	Result Code
2	Number of Errors
3	Command that Caused the Error
4	Error Code
5	Command that Caused the Error
6	Error Code
7	Command that Caused the Error
8	Error Code
9	Command that Caused the Error
10	Error Code

TABLE 5.1-5. Error Codes

Error Codes:

Decimal	
00	No error
01	Illegal command
02	Command rejected
03	Illegal checksum or too much data
04	Time out or too little data
05	Illegal parameter
06	Transmit buffer overflow
16	PLL lock fault
17	GPS fix fault
18	Input power supply fault
19	Software fault
20	Failsafe fault
21	GPS time synchronization fault
22	SWR fault – RF Load
23	Time Synch edge 1 detect fault
24	Time Synch edge 2 detect fault
25	Internal RF power supply failure

The TX320 has registers used to store information about errors that have occurred. The total number of errors is stored, up to 255. Also stored is the command that was issued when the error occurred and a code specific to the type or error.

Internal fault codes are stored. When the command that failed is listed as 31 (0x1F), the error condition is an internal error with the TX320. The datalogger receives the error code as a hex value and converts to decimal. Decimal values are placed in input locations.

The error codes are very important information if the DCP experiences trouble during operation. Generally a GPS time synchronize fault should not cause concern, but a GPS fault may cause a scheduled transmission to be missed. The data will be sent on the next transmission if the instruction appends data to the self-timed buffer.

The internal TX320 errors provide critical information for diagnostics. Error codes are return in hex format when using SatCommand software. Error codes are returned in decimal format when using the datalogger.

Error code 16 (0x10), message abort due to PLL, is a hardware failure of the phase locked loop circuit. Repeated PLL failures can not be rectified in the field.

Error code 17 (0x11), message abort due to GPS, indicates the transmitter aborted a transmission because the required GPS information was not available at transmit time. Usually the transmitter will transmit on the next transmit time. Check GPS antenna placement and GPS antenna type. See Section 6.3 for more information regarding the GPS antenna.

Error code 18 (0x12), message abort due to power supply, indicates the transmitter power supply did not provide enough voltage. Check system battery. If the system battery is low, the RF power supply will not be able to operate properly. The loaded battery voltage must not drop below 10.8 volts.

Error code 19 (0x13), Software error, indicates the transmitter was not able to run its internal software.

Error code 20 (0x14) is the Failsafe error. The failsafe is an internal hardware circuit that will shut down the TX320 if it transmits too frequently or for too long. The failsafe error code is not logged until the transmitter tries to transmit after the failsafe has been tripped. The transmitter only trips the failsafe when a serious hardware failure has occurred. Failsafe limits are different for different baud rates. At 1200 baud, transmission cannot exceed 105 seconds or repeat more often than every 30 seconds. At 100 baud, transmission cannot exceed 270 seconds or repeat more often than 60 seconds. At 300 baud, same transmission on time as 100 baud, but cannot repeat more often then every 30 seconds. The Failsafe can be reset by pressing and holding the reset switch for 10 seconds.

Error code 21 (0x15) indicates the transmitter missed a GPS fix, but does not guarantee a missed a transmission. See Section 6.3 for GPS antenna information.

Error code 22 (0x16) indicates a Standing Wave Ratio (SWR) Fault. The SWR fault can be triggered by several different conditions. High reflected power will trigger the SWR fault. Reflected power is caused by poor transmission antenna and/or antenna cable condition or wrong type of antenna or antenna cable. See Section 6 for transmission antenna information. Ice buildup on an antenna can change the antenna properties, which can cause excessive reflected power. Corrosion in connectors, water in antenna cables, metal in close proximity to the antenna, and a damaged antenna can also cause excessive reflected power.

The SWR fault can also be triggered by a low battery. If the transmitter cannot generate enough transmission power, the SWR fault will trip. Always check the system battery if there has been an SWR fault. This condition is indicated by low reflected power.

To determine if the reflected power is too high or low, read the last message status information. When the reflected power number is divided by the forward power number, the result should be 0.5, with limits of 0.4 to 0.6. See Section 5.1.2.3 for details on the Last Message Status command.

5.1.3 GoesGPS

Example:

Public GPSdata(6), GPStime(7)

GoesGPS(GPSdata(), GPStime())

The instruction GoesGPS() returns two arrays of information. The first array is six elements long. The second array is seven elements long. The first array includes the result code (see Table 5.1-6), time in seconds since January 1, 2000, Latitude in fractional degrees with 100 nanodegree resolution, Longitude in fractional degrees with 100 nanodegree resolution, Elevation as a signed 32-bit number in centimeters, and Magnetic Variation in fractional degrees with a one millidegree resolution.

The second array, which must be dimensioned to seven, holds year, month, day, hour (GMT), minute, seconds, microseconds. The second array can be used to set the datalogger's clock. See the ClockSet() instruction in the CRBasic help for details.

5.1.4 GoesSetup

In GoesSetup(), All parameters can be variables of type Long except for the Timed Interval, Timed Offset and Random interval which are all of type String.

The GoesSetup() and GoesData() only return error messages at run time.

Using GoesSetup, the datalogger can configure the transmitter under program control. Because the parameters in the GoesSetup instruction can be variables, error checking is done at run time, not compile time. Using GoesSetup(), the custom display menu options and the datalogger keypad/display, programs can be written that allow TX320 configuration via simple menus on the keypad/display. See CRBasic help and Display Menu for details. GoesSetup can also be used with constant values allowing fixed goes configuration parameters to be stored in the datalogger, and executed when needed.

After GoesSetup executes, several TX320 settings are set to default values.

1) Messages are not centered in the transmission window.

2) Self-Timed message format is set to ASCII, which ONLY changes the flag word. Pseudo binary formats will still work.

3) Random message format is set to ASCII, which ONLY changes the flag word. Pseudo binary formats will still work.

4) Empty buffer message is turned off.

5) Randomizing percentage is set to 50%.

6) Data in the random buffer is repeated until cleared by the datalogger.

7) Random message counter is turned off.

Instruction details:

GoesSetup(Result Code, Platform ID, Window, Timed Channel, Time Baud, Random Channel, Random Baud, Timed Interval, Timed Offset, Random Interval)

5.1.4.1 Result Code

Result Code is used to indicate success or failure. Zero indicates Success. Positive result codes indicate communication problems; negative result codes indicate an illegal value in one of the parameters. See Table 5.1-6 for positive result codes and Table 5.1-7 for negative result codes.

TABLE 5.1-6. Result Codes Indicating Communication Problems

0	Command executed successfully
2	Time out waiting for STX character after SDC addressing
3	Wrong character (not STX) received after SDC Addressing
4	Something other than ACK returned when select data buffer command executed
5	Timed out waiting for an ACK when data buffer command was sent
6	CS I/O port not available, port busy
7	ACK not returned following data append or insert command

TABLE 5.1-7. GoesSetup and GoesData Runtime Result Codes

Code	Error Condition
-11	Illegal Buffer Control
-12	Illegal Message Window
-13	Illegal Channel Number
-14	Illegal Baud Rate
-15	R count Error
-16	Illegal Data Format
-17	Illegal Data Format FP2_ASCII
-18	Self-Timed Interval Error
-19	Self-Timed Offset Error
-20	Random Interval Error
-21	Platform ID Error

5.1.4.2 Platform ID

Platform ID is an eight-character hexadecimal number assigned by NESDIS. The Platform ID is always divisible by 2. Valid characters are 0-9 and A-F.

5.1.4.3 Window

Window is the message window length in seconds. Valid range is 5-120.

5.1.4.4 Timed Channel

Timed Channel is the assigned self-timed transmission channel. Valid range for 300 bps is 0-266 and 0-133 for 1200 bps. Often1200 bps channels are referred to using the 300 channel number scheme. Divide by 2 to get the real 1200 baud channel number.

5.1.4.5 Timed Baud Rate

Timed Baud rate is assigned and channel dependent. Valid options are 100, 300, and 1200.

5.1.4.6 Random Channel

Random channel is the assigned random channel number. See Timed Channel description for valid entries.

5.1.4.7 Random Baud Rate

Random Baud rate is assigned and channel dependent. Valid options are 100, 300, and 1200.

5.1.4.8 Timed Interval

Timed Interval is assigned by NESDIS and is a string variable in the format of "dd_hh_mm_ss", where dd is days and usually 00, hh is hours and usually 01, mm is minutes and usually 00, and ss is seconds and usually 00.

5.1.4.9 Timed Offset

Timed Offset is assigned by NESDIS and is a string variable in the format of "hh_mm_ss", where hh is hours and usually 00, mm is minutes, and ss is seconds.

5.1.4.10 Random Offset

Random Offset is a string variable in the format of "hh_mm_ss" where hh and ss are usually zero and mm is 30 or 45.

5.1.4.11 GOESSetup Example

```
Public setup_RC, setup

Sub Gsetup
    GOESSetup (setup_RC,&H12345677,10,195,300,0,100,"0_01_00_0" ,"0_16_20" ,"1_0_0" )
    If setup_RC  = 0 Then setup = false
EndSub

BeginProg
    setup = true
    Scan (10,Sec,0,0)
        If setup Then Call Gsetup
    NextScan
EndProg
```

5.2 Edlog Programming

This section only applies to the CR10(X), CR23X, and CR510 dataloggers.

The datalogger is used to measure and record data values. The TX320 is used to transmit data over a GOES satellite to a ground receiving station. Program instruction 126 is used to send data from the datalogger to the TX320 satellite transmitter. The TX320 has two data buffers. The data buffers will hold data until it is time to transmit the data. Data in the self-timed buffer is erased after transmission. Data in the random buffer will be erased after the preset number of repetitions has been met. When properly configured, the TX320 will ensure the data is transmitted on the correct channel, at the correct baud rate and at the correct time without overrunning the transmit window.

The datalogger will interface with the TX320 under program control. Two program instructions are used, P126 and P127. P126 is used to send data to a buffer. New data is either added to existing data (append) or overwrites existing data. In overwrite mode, all data in the buffer is erased before new data is written. P127 is used to retrieve information from the TX320. Information regarding GPS time, latitude and longitude can be retrieved and stored in the datalogger. Information regarding the status and past errors can also be retrieved.

Data that is sent to the self-timed buffer 60 seconds or more before transmit time will be transmitted on the next scheduled transmission; otherwise, the data will be scheduled for a later transmission.

5.2.1 Deciding How Much Data will be Transmitted and When

The amount of data that can be transmitted depends on several factors: the transmit window length, the transmit baud rate, and the data format. The transmit window limits the time available for data to be sent. The baud rate determines how fast data is sent. The data format determines how many bytes are required per data point.

The maximum number of data points that can be sent is estimated with this formula:

$$b(a-2)/8c = \text{total number of data points per transmission}$$

Where:

a = window length in seconds
b = baud rate or bits/second; i.e., 100, 300, or 1200
c = bytes per data point

Binary data uses 3 bytes per data point.

ASCII data uses 7 bytes per data point.

The Sat Commander Software includes a Command to read the Max Timed Message Length, which will use the TX320 to calculate the maximum number of bytes to be sent, not the maximum number of data points. To use the software to calculate the maximum number of data points that can be sent, first setup the transmitter, then use the max timed message length command. Take the result and divide by 3 if the data format is pseudo binary or divide by 7 if using an ASCII format.

5.2.2 Deciding What Data Format to Use

The choice of data format effects two areas. First, the data format effects how much data can be sent in a single transmission. Binary data formats require 3 bytes per data point. ASCII data formats require 7 bytes per data point. Second, binary data must be decoded after transmission, ASCII does not. The datalogger formats the data before the data is sent to the TX320. The data format is chosen with the P126 program instruction.

5.2.3 Managing Data, Writing More Data than Will Be Transmitted

The datalogger has two data storage areas: Final Storage area 1 (FS1) and Final Storage area 2 (FS2). When data is written to final storage, data is written to the active final storage area. The active final storage area defaults to FS1 when the datalogger starts the program table. Program instruction 80 (P80) is used to set the active final storage area. When P126 executes, all new data in the active final storage area is sent to the transmitter. New data is all data that has been written to the active final storage area since P126 last executed.

Two separate data files can be maintained by managing which final storage area is active when data is written. The amount of data copied to the transmitter and the order of data copied to the transmitter can be controlled by utilizing both final storage areas. If using FS2, datalogger memory must be allocated to FS2. Final storage area 2 memory can be allocated using Edlog or the keypad.

5.2.4 Sending Data to the Transmitter (P126)

Edlog instruction 126 is used to transfer data to the TX320.

```
1:  Data Transfer to TX320 (P126)
  1:    0000          Buffer Control
  2:    0000          Data Format
  3:    0000          Result Code Loc [ ______ ]
```

Parameter1: Buffer Control

0	Append to Self-Timed Buffer
1	Overwrite Self-Timed Buffer
2	Append to Random Buffer
3	Overwrite Random Buffer
9	Clear Random Buffer

Parameter 2: Data Format

0	CSI Floating Point Binary
1	Floating Point ASCII
2	Binary Integer, 18 Bit
3	RAWS 7, Fire Weather
4	Fixed Decimal, ASCII, xxx.x
5	Fixed Decimal, ASCII, xx.xx
6	Fixed Decimal, ASCII, x.xxx
7	Fixed Decimal, ASCII, xxx
8	Fixed Decimal, ASCII, xxxxx

Parameter 3: Input Location for Result Code

1	Input Loc [________]

5.2.4.1 Buffer Control

The first parameter of Edlog instruction 126 (P126) is called buffer control. Buffer control has two purposes: 1) to determine which buffer data is written to, and 2) if the buffer is erased before data is written. The TX320 has two independent buffers, one for self-timed transmissions and one for random transmissions. The self-timed buffer is treated differently than the random buffer. After a self-timed transmission, the data is erased from the self-timed buffer. After a random transmission, the data in the random buffer is scheduled to be transmitted again. Random transmissions are repeated at random intervals until P126 is used to "Clear Random Buffer" or the maximum number of random transmissions have been met. The maximum number of random transmissions can be set in SatCommander, default is off.

5.2.4.2 Data Format

The second parameter of P126 is used to format the data. The data is formatted as P126 copies data from the datalogger to the transmitter.

CSI floating point binary data requires 3 bytes per data point. Data must be low resolution. Sign and decimal location are maintained. This is an efficient data format.

Floating point ASCII requires 7 bytes per data point. Data must be low resolution. Sign and decimal location are maintained. Data does not need to be converted after transmission. Data points are separated by a comma. This is not an efficient data format, but it is convenient.

Binary, 18 bit, integer data format requires 3 bytes per data point. All data stored in the datalogger must be in high resolution. All information right of the decimal place is truncated. Data is transmitted as a signed, two's compliment, 18-bit integer. Precision can be maintained by pre and post processing. This is an efficient data format that requires conversion and post processing. See Appendix D for details.

5.2.4.3 P126 Result Codes

The third parameter of P126 requires an input location. In the input location, the result of the P126 execution is stored as a result code. The result code can be used to determine if P126 executed successfully. Under most conditions, if P126 was not successful, a second execution of P126 will work.

To better understand the result codes, it is necessary to understand the sequence of communication with the transmitter. Here are the steps:

1) The Datalogger CS I/O port is checked to see if the serial port is available. If not, return code 6.

2) The transmitter is addressed and should return the STX character within 200 msec. If there is no response from the transmitter, result code 2 is returned. If something other than the STX character is received, result code is 3.

3) The command to select a data buffer is sent (random or self-timed). The transmitter should respond with the ACK (06) character. If something

besides the ACK is received, result code is 4. If nothing is received within 500 msec, result code is 5.

4) If the first three steps are successful, the datalogger sends the command to append or overwrite the data buffer, followed by the data. If the transmitter does not respond with the ACK character within 500 msec after the data has been transferred, the result code is 7. Result code 7 indicates the data was not received by the transmitter. The datalogger cannot resend the data.

P126 result codes are the same as the positive result codes for our CRBasic instructions and are shown in Table 5.1-6.

The result codes can be used to increase the success rate of data transmissions. When the result code is 0, all went well. When the result code is 2-6, P126 did not execute properly, but can still send the data. A result code of 7 indicates P126 did not execute properly and the data probably cannot be sent again.

5.2.5 Read Status and Diagnostic Information from the TX320

Edlog instruction 127 (P127) is used to read status and diagnostic information from the TX320.

```
1:  TX320 Status (P127)
  1:    0000          Status Command
  2:    0000          Result Code Loc [ _____ ]
```

Parameter 1: Status Command

0	Read Time, Uses four Input Locations
1	Read Status, Uses 13 Input Locations
2	Read Last Message Status, Uses 14 Input Locations
3	Transmit Random Message, must be followed by command 6. One Input Location
4	Read Error Register, Uses Ten Input Locations
5	Reset Error Register, One Input Location
6	Return transmitter to online mode, used after command 3, One Input Location

Edlog instruction 127 (P127) has four basic functions:

1) Datalogger will retrieve information from the TX320 transmitter.

2) Datalogger will initiate a test transmission on a random channel.

3) Datalogger will reset the error register of the TX320.

4) Return TX320 to on-line mode following a forced random transmission.

Parameter 1 allows you to determine what command will be issued to the TX320.

Parameter 2 is the starting input location for the string of information the TX320 will return.

Each P127 command returns a string of information. Each command requires a different number of input locations. The first piece of information returned is always the result code of the command. Table 5.2-1 lists the result codes and explains them.

TABLE 5.2-1. P127 Result Codes

0	Execution successful
1	Checksum error in response
2	Time out waiting for STX character after addressing
3	Something besides STX received after addressing
4	Received a NAK
5	Timed out while waiting for an ACK
6	CS I/O not available
7	Transmit random message failure, could be no data in random buffer
9	Invalid command code

5.2.5.1 P127, Command 0: Read Time

Retrieve the GPS time from the HDR GOES transmitter. The time is Greenwich Mean Time (GMT). A time of 153 hours, 153 minutes, 153 seconds indicates GPS time is not available.

TABLE 5.2-2. P127 Command 0: Read Time

In Loc	Contents
1	Command Result Code
2	Hours (GMT)
3	Minutes
4	Seconds

5.2.5.2 P127, Command 1: Read Status

Read Status Command provides information specific to the next scheduled or random transmission, including the amount of data in the buffers and power supply voltage.

TABLE 5.2-3. P127 Command 1: Read Status

In Loc	Contents
1	Command Result Code
2	Bytes of data in self-timed buffer
3	Time until next self-timed transmission: Days
4	Time until next self-timed transmission: Hours
5	Time until next self-timed transmission: Minutes
6	Time until next self-timed transmission: Seconds
7	Bytes of data in random buffer
8	Time until next random transmission interval start: Hours
9	Time until next random transmission interval start: Minutes
10	Time until next random transmission interval: Seconds
11	Failsafe, 1 indicates transmitter disabled due to failsafe.
12	Loaded power supply voltage, 1 amp load. (tenths of volts)
13	Average GPS acquisition time (tens of seconds)

5.2.5.3 P127, Command 2: Read Last Message Status

Returns information specific to the last message transmitted plus the GPS derived Latitude and Longitude.

TABLE 5.2-4. P127 Command 2: Read Last Message Status

In Loc	Contents
1	Command Result Code
2	Message type: Self-timed or Random
3	Size of message in bytes
4	Forward power in tenths of watts
5	Reflected power in tenths of watts
6	Power supply voltage under full load, in tenths of volts
7	GPS acquisition time in tens of seconds
8	Oscillator drift (signed, hundreds of Hz)
9	Latitude degrees
10	Latitude minutes
11	Latitude seconds
12	Longitude degrees
13	Longitude minutes
14	Longitude seconds.

5.2.5.4 P127, Command 3: Transmit Random Message

Overwrite random buffer with 1 2 3 4 (ASCII)

During GPS acquisition the LED lights green.

During transmission the LED lights red.

TABLE 5.2-5. P127 Command 3: Initiate Random Transmission

In Loc	Contents
1	Result Code

Random message channel and repeat interval must be enabled in the TX320 configuration. If random messages have not been enabled, command 3 will fail. If the GPS acquisition fails, the random transmission will fail. Command 3 will pull the TX320 off line. After the random transmission attempt, the TX320 must be put back on line with command 6. When command 6 is used, all data in the TX320 is erased. Random transmission may require up to five minutes (GPS timeout) for setup and transmission. If command 6 is executed before transmission, random transmission will be canceled.

During GPS acquisition, the LED will light solid green. During transmission, the LED will light solid red. Command 3 will return 1 value, the command result code. Zero indicates a successful execution of command 3, but does not indicate the random transmission has happened or was successful.

5.2.5.5 P127, Command 4: Read TX320 Error Registers

Read error registers of TX320. Requires 10 input locations.

TABLE 5.2-6. P127 Command 4: Read TX320 Error Registers

In Loc	Contents
1	Result Code
2	Number of Errors
3	Command that Caused the Error
4	Error Code
5	Command that Caused the Error
6	Error Code
7	Command that Caused the Error
8	Error Code
9	Command that Caused the Error
10	Error Code

TABLE 5.2-7. Error Codes

Error Codes:

Hex	Decimal	
0x00	00	No error
0x01	01	Illegal command
0x02	02	Command rejected
0x03	03	Illegal checksum or too much data
0x04	04	Time out or too little data
0x05	05	Illegal parameter
0x06	06	Transmit buffer overflow
0x10	16	Message abort due to PLL
0x11	17	Message abort due to GPS
0x12	18	Message abort due to power supply – internal 16 volt – RF
0x13	19	Software fault
0x14	20	Failsafe fault
0x15	21	GPS time sync fault
0x16	22	SWR fault – transmission antenna connection
0x19	25	Internal RF power supply failure

See Section 5.1.2.4 for more information.

5.2.5.6 P127, Command 5: Clear TX320 Error Registers

Clear error registers of TX320. Requires one input location.

TABLE 5.2-8. P127 Command 5: Clear Error Registers

In Loc	Contents
1	Result Code

Result code of 0 indicates success. Command 5 is used to erase all errors from the error registers of the TX320.

5.2.5.7 P127, Command 6: Return TX320 to on-line mode.

Command 6 is used to return the TX320 to online mode. Typically used after a forced random transmission. The TX320 has an off-line time-out of one hour.

TABLE 5.2-9. P127 Command 6: Force On-line Mode

In Loc	Contents
1	Result code

Result code of 0 indicates success.

5.2.6 Edlog Programming Examples

Edlog instruction 126 is used to copy data from the datalogger final storage area to the TX320 data buffer.

Edlog program example 1 writes data to final storage once an hour and transfers data to the TX320 once every 4 hours.

```
; Edlog Program Example 1

; Set output flag high hourly

1:  If time is (P92)
   1:   0            Minutes (Seconds --) into a
   2:   60           Interval (same units as above)
   3:   10           Set Output Flag High (Flag 0)

; Write a time stamp to final storage

2:  Real Time (P77)
   1:   1221         Year,Day,Hour/Minute,Seconds (midnight = 2400)

; Write 41 input locations to final storage

3:  Sample (P70)
   1:   41           Reps
   2:   1            Loc [ Status_RC ]

; Check if top of 4 hour interval, if true execute P126

4:  If time is (P92)
   1:   0            Minutes (Seconds --) into a
   2:   240          Interval (same units as above)
    3:  30           Then Do

; Transfer data to TX320

5:  Data Transfer to HDR GOES (P126)
   1:   0            Self-Timed/Append
   2:   0            Binary Format
   3:   41           Result Code Loc [ P126_RC   ]

6:  End (P95)
```

6. Field Installation

6.1 Field Site Requirements

The TX320 has two siting requirements for proper operation. The GPS antenna must have a clear view of most of the sky. The transmission antenna must have a clear view of the spacecraft. Other requirements are not specific to the TX320, but are mentioned here anyway. The TX320 must be mounted in an enclosure that will protect it from the environment, including condensation. Most GOES systems are powered by a battery that is charged by a solar panel. The solar panel must have a clear view of the southern sky. Pay special attention to winter sun angles.

6.2 Transmission Antenna

The TX320 transmission antenna is a right-hand circular polarized Yagi with 11 dBic gain. A bracket is included with the antenna for mounting to a mast or pole (see Figure 6-1). The antenna is directional and should be aimed at the spacecraft. Both elevation and azimuth are unique to the location on the planet, and must be set. A poorly aimed antenna will cause a drop in signal strength or possibly prevent successful transmission.

The accuracy of the antenna aiming is not critical, but should be reasonably good. As a guide, if the antenna is aimed 20 degrees off the spacecraft, the received power will be half of a properly aimed antenna. Beyond 20 degrees, the received power drops off very quickly.

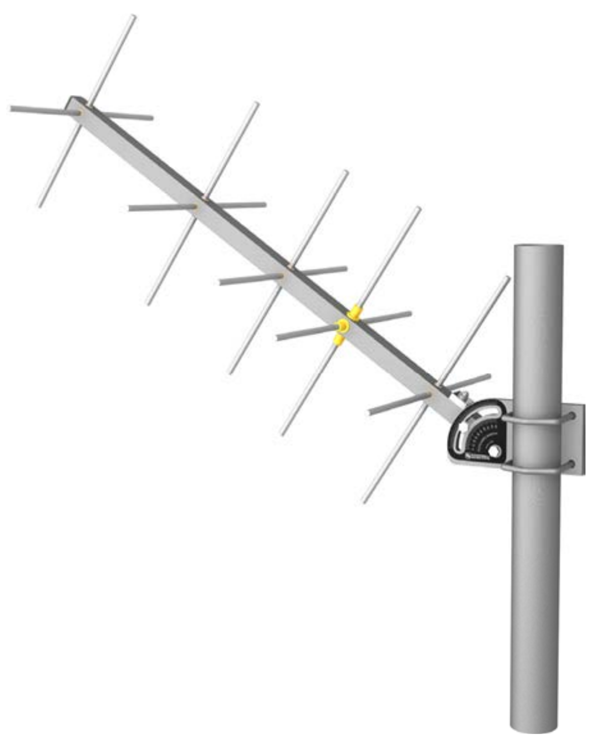

FIGURE 6-1. Yagi Antenna

6.3 GPS Antenna

6.3.1 How the GPS Signal is Acquired and Used

The GPS receiver will acquire a complete GPS fix at power up and once a day. The TX320 transmitter will continue to operate normally for 28 days without a GPS fix.

The GPS signal is used for two functions. To keep track of time, four satellites are required. The second use of the GPS signal is to correct the oscillator frequency. The GPS receiver will output a very accurate 1-second pulse. The 1-second pulse is used to correct oscillator drift caused by changes in temperature and crystal aging.

The GPS is required for proper operation. After the transmitter is reset, or first powered up, it can't schedule a transmission until a GPS fix has been established or the internal clock has been manually set. After the first fix, the TX320 will acquire a GPS fix once a day. Each time the GPS system acquires a fix, the entire GPS almanac is downloaded, which requires about 15 minutes.

6.3.2 GPS Antenna Location

The GPS antenna mounts to the end of a crossarm via the 7623 3/4-in. IPS threaded pipe and a 1049 NU-RAIL fitting or CM220 mounting bracket (see Figures 6-2 and 6-3). The ideal location for the GPS antenna is above everything, with the shortest cable possible. The GPS antenna will not receive the GPS signal through a steel roof or steel walls. Concrete will probably act like steel. Heavy foliage, snow, and ice will attenuate the GPS signal. The more of the sky the antenna has a clear unobstructed view of, the better the GPS performance. Better GPS performance will show up as less or no missed transmissions. Poor GPS antenna placement will increase the number of missed transmissions, or possibly stop all transmission

FIGURE 6-2. Exploded view of the GPS antenna mounted to a crossarm via the CM220.

FIGURE 6-3. GPS Antenna

Appendix A. Information on Eligibility and Getting Onto the GOES System

A.1 Eligibility

U.S. federal, state, or local government agencies, or users sponsored by one of those agencies, may use GOES. Potential GOES users must receive formal permission from NESDIS.

A.2 Acquiring Permission

1. The user contacts NESDIS at the following address and submits a formal request to transmit data via GOES. Non-U.S. or private users must also submit a written statement indicating that their sponsor requires all or part of the transmitted data. NESDIS will fax or mail the user a question form to complete and submit for approval.

   DCS Coordinator
   Federal Office Building 4
   Suitland, MD
   (301) 457-5681
   http://dcs.noaa.gov/contact.htm

2. Following approval, NESDIS sends a Memorandum of Agreement (MOA). The MOA must be signed and returned to NESDIS.

3. After the MOA is approved, NESDIS will issue a channel assignment and an ID address code.

4. NESDIS MUST BE contacted to coordinate a "start-up" date.

See http://noaasis.noaa.gov/DCS/ for more information.

Appendix B. Data Conversion Computer Program (written in BASIC)

```
1 REM THIS PROGRAM CONVERTS 3-BYTE ASCII DATA INTO
  DECIMAL
5 INPUT "RECEIVE FILE?", RF$
6 OPEN RF$ FOR OUTPUT AS #2
10 INPUT "NAME OF FILE CONTAINING GOES DATA"; NFL$
20 DIM DV$(200)
25 WIDTH "LPT1:", 120
30 OPEN NFL$ FOR INPUT AS #1
40 WHILE NOT EOF(1)
50 LINE INPUT #1, A$
55 A$ = MID$(A$, 38)
56 PRINT A$
100 J = INT(LEN(A$) / 3)
105 PRINT J
110 FOR I = 1 TO J
120 DV$(I) = MID$(A$, 3 * I - 2, 3)
130 NEXT I
140 B$ = RIGHT$(A$, LEN(A$) - 3 * J)
160 A$ = B$ + A$
170 K = INT(LEN(A$) / 3)
180 L = J
190 FOR I = J + 1 TO L
200 DV$(I) = MID$(A$, 3 * (I - J) - 2, 3)
210 NEXT I
270 FOR I = 1 TO L
280 A = ASC(LEFT$(DV$(I), 1)) AND 15
290 B = ASC(MID$(DV$(I), 2, 1)) AND 63
300 C = ASC(RIGHT$(DV$(I), 1)) AND 63
310 IF (A * 64) + B >= 1008 THEN DV = (B - 48) * 64 + C + 9000:
    GOTO 400
320 IF A AND 8 THEN SF = -1 ELSE SF = 1
330 IF A AND 4 THEN SF = SF * .01
340 IF A AND 2 THEN SF = SF * .1
350 IF A AND 1 THEN DV = 4096
360 DV = (DV + ((B AND 63) * 64) + (C AND 63)) * SF
400 PRINT #2, USING "####.### "; DV;
405 IF I MOD 17 = 0 THEN PRINT #2, CHR$(13)
406 DV = 0
410 NEXT I
1000 WEND
```

Appendix C. Antenna Orientation Computer Program (written in BASIC)

```
5 REM THIS PROGRAM CALCULATES THE AZIMUTH AND ELEVATION FOR AN
6 REM ANTENNA USED WITH A DCP FOR GOES SATELLITE COMMUNICATIONS
10 CLS : CLEAR 1000
20 INPUT "SATELLITE LONGITUDE (DDD.DD)"; SO
30 INPUT "ANTENNA LONGITUDE (DDD.DD)"; SA
40 PRINT "ANTENNA LATITUDE (DDD.DD)--(SOUTH LATITUDE ENTERED"
45 INPUT "AS NEGATIVE NUMBER)"; AA: A = 90 - AA
50 INPUT "ANTENNA HEIGHT ABOVE SEA LEVEL IN FEET"; AH
60 T = SO - SA: TR = T * .01745329#: BR = 90 *  .01745329#: AR = A * .01745329#
70 X = COS(AR) * COS(BR) + SIN(AR) * SIN(BR) * COS(TR)
80 CR = -ATN(X / SQR(-X * X + 1)) + 1.5708
90 C = CR * (1 / .01745329#)
100 X1 = (SIN(BR) * SIN(TR)) / SIN(CR)
110 BR = ATN(X1 /SQR(-X1 * X1 + 1)): B = BR * (1 / .01745329#)
115 GOSUB 300
120 A1 = 90 - C: R1 = A1 * .01745329#
130 S1 = (6378 + (AH * .0003048)) / SIN(R1)
140 S2 = 35785! + 6378 - S1
150 A2 = 180 - A1: R2 = A2 * .01745329#
155 S4 = SQR(S1 ^ 2 - (6378 + AH * .0003048) ^ 2)
160 S3 = SQR(S4 ^ 2 + S2 ^ 2 - 2 * S4 * S2 * COS(R2))
170 X2 = (SIN(R2) / S3) * S2
180 ER = ATN(X2 / SQR(-X2 * X2 + 1)): E = ER * (1 / .01745329#)
190 PRINT "ANTENNA ELEVATION ANGLE="; E; " DEGREES"
200 PRINT "ANTENNA AZIMUTH ANGLE="; B; " DEGREES"
210 PRINT : PRINT : PRINT "HIT ANY KEY TO CONTINUE"
220 I$ = INKEY$: IF I$ = "" THEN 220 ELSE CLS : GOTO 20
300 IF T < 0 AND AA > 0 THEN B = B + 180: GOTO 380
310 IF T < 0 AND AA < 0 THEN B = B * -1: GOTO 380
320 IF T > 0 AND AA < 0 THEN B = 360 - B: GOTO 380
330 IF T > 0 AND AA > 0 THEN B = B + 180: GOTO 380
340 IF T = 0 AND AA > 0 THEN B = 180: GOTO 380
350 IF T = 0 AND AA < 0 THEN B = 360: GOTO 380
360 IF AA = 0 AND T > 0 THEN B = 270: GOTO 380
370 IF AA = 0 AND T < 0 THEN B = 90
380 RETURN
400 RETURN
460 RETURN
```

Appendix D. GOES DCS Transmit Frequencies

300 & 100 BPS Channels		1200 BPS	Channels
Channel	Frequency	Channel	Frequency
Number	MHz	Number+ A	MHz
1	401.701000	1	401.701750
2	401.702500		
3	401.704000	2	401.704750
4	401.705500		
5	401.707000	3	401.707750
6	401.708500		
7	401.710000	4	401.710750
8	401.711500		
9	401.713000	5	401.713750
10	401.714500		
11	401.716000	6	401.716750
12	401.717500		
13	401.719000	7	401.719750
14	401.720500		
15	401.722000	8	401.722750
16	401.723500		
17	401.725000	9	401.725750
18	401.726500		
19	401.728000	10	401.728750
20	401.729500		
21	401.731000	11	401.731750
22	401.732500		
23	401.734000	12	401.734750
24	401.735500		
25	401.737000	13	401.737750
26	401.738500		
27	401.740000	14	401.740750
28	401.741500		
29	401.743000	15	401.743750
30	401.744500		
31	401.746000	16	401.746750
32	401.747500		
33	401.749000	17	401.749750
34	401.750500		
35	401.752000	18	401.752750
36	401.753500		
37	401.755000	19	401.755750
38	401.756500		
39	401.758000	20	401.758750
40	401.759500		
41	401.761000	21	401.761750
42	401.762500		
43	401.764000	22	401.764750
44	401.765500		
45	401.767000	23	401.767750
46	401.768500		
47	401.770000	24	401.770750

300 & 100 BPS Channels		1200 BPS	Channels
Channel	Frequency	Channel	Frequency
Number	MHz	Number+ A	MHz
48	401.771500		
49	401.773000	25	401.773750
50	401.774500		
51	401.776000	26	401.776750
52	401.777500		
53	401.779000	27	401.779750
54	401.780500		
55	401.782000	28	401.782750
56	401.783500		
57	401.785000	29	401.785750
58	401.786500		
59	401.788000	30	401.788750
60	401.789500		
61	401.791000	31	401.791750
62	401.792500		
63	401.794000	32	401.794750
64	401.795500		
65	401.797000	33	401.797750
66	401.798500		
67	401.800000	34	401.800750
68	401.801500		
69	401.803000	35	401.803750
70	401.804500		
71	401.806000	36	401.806750
72	401.807500		
73	401.809000	37	401.809750
74	401.810500		
75	401.812000	38	401.812750
76	401.813500		
77	401.815000	39	401.815750
78	401.816500		
79	401.818000	40	401.818750
80	401.819500		
81	401.821000	41	401.821750
82	401.822500		
83	401.824000	42	401.824750
84	401.825500		
85	401.827000	43	401.827750
86	401.828500		
87	401.830000	44	401.830750
88	401.831500		
89	401.833000	45	401.833750
90	401.834500		
91	401.836000	46	401.836750
92	401.837500		
93	401.839000	47	401.839750
94	401.840500		

300 & 100 BPS Channels		1200 BPS	Channels
Channel	Frequency	Channel	Frequency
Number	MHz	Number+ A	MHz
95	401.842000	48	401.842750
96	401.843500		
97	401.845000	49	401.845750
98	401.846500		
99	401.848000	50	401.848750
100	401.849500		
101	401.851000	51	401.851750
102	401.852500		
103	401.854000	52	401.854750
104	401.855500		
105	401.857000	53	401.857750
106	401.858500		
107	401.860000	54	401.860750
108	401.861500		
109	401.863000	55	401.863750
110	401.864500		
111	401.866000	56	401.866750
112	401.867500		
113	401.869000	57	401.869750
114	401.870500		
115	401.872000	58	401.872750
116	401.873500		
117	401.875000	59	401.875750
118	401.876500		
119	401.878000	60	401.878750
120	401.879500		
121	401.881000	61	401.881750
122	401.882500		
123	401.884000	62	401.884750
124	401.885500		
125	401.887000	63	401.887750
126	401.888500		
127	401.890000	64	401.890750
128	401.891500		
129	401.893000	65	401.893750
130	401.894500		
131	401.896000	66	401.896750
132	401.897500		
133	401.899000	67	401.899750
134	401.900500		
135	401.902000	68	401.902750
136	401.903500		
137	401.905000	69	401.905750
138	401.906500		
139	401.908000	70	401.908750
140	401.909500		
141	401.911000	71	401.911750
142	401.912500		
143	401.914000	72	401.914750
144	401.915500		

300 & 100 BPS Channels		1200 BPS	Channels
Channel	Frequency	Channel	Frequency
Number	MHz	Number+ A	MHz
145	401.917000	73	401.917750
146	401.918500		
147	401.920000	74	401.920750
148	401.921500		
149	401.923000	75	401.923750
150	401.924500		
151	401.926000	76	401.926750
152	401.927500		
153	401.929000	77	401.929750
154	401.930500		
155	401.932000	78	401.932750
156	401.933500		
157	401.935000	79	401.935750
158	401.936500		
159	401.938000	80	401.938750
160	401.939500		
161	401.941000	81	401.941750
162	401.942500		
163	401.944000	82	401.944750
164	401.945500		
165	401.947000	83	401.947750
166	401.948500		
167	401.950000	84	401.950750
168	401.951500		
169	401.953000	85	401.953750
170	401.954500		
171	401.956000	86	401.956750
172	401.957500		
173	401.959000	87	401.959750
174	401.960500		
175	401.962000	88	401.962750
176	401.963500		
177	401.965000	89	401.965750
178	401.966500		
179	401.968000	90	401.968750
180	401.969500		
181	401.971000	91	401.971750
182	401.972500		
183	401.974000	92	401.974750
184	401.975500		
185	401.977000	93	401.977750
186	401.978500		
187	401.980000	94	401.980750
188	401.981500		
189	401.983000	95	401.983750
190	401.984500		
191	401.986000	96	401.986750
192	401.987500		
193	401.989000	97	401.989750
194	401.990500		

300 & 100 BPS Channels		1200 BPS	Channels
Channel	Frequency	Channel	Frequency
Number	MHz	Number+ A	MHz
195	401.992000	98	401.992750
196	401.993500		
197	401.995000	99	401.995750
198	401.996500		
199	401.998000	100	401.998750
200	401.999500		
201	402.001000	101	402.001750
202	402.002500		
203	402.004000	102	402.004750
204	402.005500		
205	402.007000	103	402.007750
206	402.008500		
207	402.010000	104	402.010750
208	402.011500		
209	402.013000	105	402.013750
210	402.014500		
211	402.016000	106	402.016750
212	402.017500		
213	402.019000	107	402.019750
214	402.020500		
215	402.022000	108	402.022750
216	402.023500		
217	402.025000	109	402.025750
218	402.026500		
219	402.028000	110	402.028750
220	402.029500		
221	402.031000	111	402.031750
222	402.032500		
223	402.034000	112	402.034750
224	402.035500		
225	402.037000	113	402.037750
226	402.038500		
227	402.040000	114	402.040750
228	402.041500		
229	402.043000	115	402.043750
230	402.044500		
231	402.046000	116	402.046750
232	402.047500		
233	402.049000	117	402.049750
234	402.050500		
235	402.052000	118	402.052750
236	402.053500		
237	402.055000	119	402.055750
238	402.056500		
239	402.058000	120	402.058750
240	402.059500		
241	402.061000	121	402.061750
242	402.062500		
243	402.064000	122	402.064750
244	402.065500		

300 & 100 BPS Channels		1200 BPS	Channels
Channel	Frequency	Channel	Frequency
Number	MHz	Number+ A	MHz
245	402.067000	123	402.067750
246	402.068500		
247	402.070000	124	402.070750
248	402.071500		
249	402.073000	125	402.073750
250	402.074500		
251	402.076000	126	402.076750
252	402.077500		
253	402.079000	127	402.079750
254	402.080500		
255	402.082000	128	402.082750
256	402.083500		
257	402.085000	129	402.085750
258	402.086500		
259	402.088000	130	402.088750
260	402.089500		
261	402.091000	131	402.091750
262	402.092500		
263	402.094000	132	402.094750
264	402.095500		
265	402.097000	133	402.097750
266	402.098500		

Appendix E. High Resolution 18-Bit Binary Format

When using the binary 18 bit signed 2's complement integer format, all data values in the datalogger final storage area must be in high resolution format. In most cases the datalogger program should set the data resolution to high at the beginning of the program. Use the P78 instruction with parameter 1 set to 1. Note: P77 Real Time can not write the time or date in high resolution. To send a time stamp, first write the time back to input locations, then sample the input locations as high resolution. As an alternative to using P77 for a time stamp, the GPS time can be retrieved from the transmitter and written to final storage in high resolution format. See instruction P127 for details.

Because the binary 18 bit integer is an integer, all information to the right of the decimal point is dropped. This occurs while the datalogger is copying data to the transmitter. The original data is left intact in final storage of the datalogger. If transmitted data requires precision to the right of the decimal place, multiply the number by the required factor of 10 before storing the data to final storage. After data is received by the ground station, division by the appropriate factor of 10 will replace the decimal point.

In high resolution format, data stored in final storage has a maximum magnitude of 99999 and a minimum magnitude of 0.00001.

NESDIS has placed restrictions on the format of data sent over the GOES satellite network. The first restriction is the use of 7 data bits and one parity bit per byte. The second restriction is the most significant data bit of each byte, bit 6, is always set. Without data, each byte transmitted over the satellite has the format of "p1xxxxxx". The x's will hold the 6 bits per byte allocated to data information. The "p" is the parity bit and the "1" is bit 6 which is always set. Resolution of each data point would be severely limited if the data point consisted of only 6 bits. We use 3 consecutive bytes to form a data point word. The first byte sent is byte 3, the most significant byte. A complete word is created by using 3 consecutive bytes, stripping the 2 most significant bits from each byte, then combining the 3 bytes into a word. See the examples below.

Each data point is formatted as an 18 bit integer. The format uses the most significant bit (bit 17) to designate sign. The format of each 3 byte data point is as follows, note the top row shows the bits used and there significance.

		17	16	15	14	13	12			11	10	9	8	7	6			5	4	3	2	1	0
p	1	x	x	x	x	x	x	p	1	x	x	x	x	x	x	p	1	x	x	x	x	x	x

Where each "p" is the parity bit for that byte.
Where each "1" is bit 6 for that byte and always set to 1
Where the 6 "x"s represent bits 0 through 5, these make up the information for each byte.
Where the 18 bit data point is made by combining the three bytes after bit 7 and bit 6 of each byte have been dropped.
Where 0 represents bit 0 - the least significant bit

Where 17 represents bit 17 - the most significant bit and is used to determine the sign.

Converting the 18 bit data point to an integer can be done manually. Don't forget the 18 bits are numbered 0 through 17. Bit 17 is the sign bit, when bit 17 is set, the number is negative. If bit 17 is set, subtract 1 from the number then take the complement of the number. If bit 17 is not set, simply convert the number to its decimal equivalent.

Example positive data point conversion:

Byte Label	byte 3	byte 2	byte 1
Actual data point	01000101	11110010	11010010
Drop first 2 bits of each byte	000101	110010	010010
Combine the 3 bytes into one word	000101 110010 010010		
Convert from Binary to Decimal	23698		

Example of a negative data point conversion:

Byte Label	byte 3	byte 2	byte 1
Actual data point	01111010	11001101	11101101
Drop first 2 bits of each byte	111010	001101	101101

Notice bit 17 is set,

Combine the 3 bytes into one word	111010 001101 101101
Subtract 1 from the number	111010 001101 101100
Take the complement of each bit	000101 110010 010011
Convert the binary value into a decimal value, don't forget the negative sign	-23699

Appendix F. Extended ASCII Command Set

Appendix F describes the ASCII command interface for the TX320 transmitter. These commands can be entered using the terminal window of SatCommander software, or suitable terminal emulation software.

F.1 Command Interface

F.1.1 Port Interfaces

All Data Entry and Diagnostic functions are accessed using either the RS-232 Interface or USB interface.

F.1.1.1 RS-232 Details

The default settings for the RS-232 port are 9600 baud, 8 data bits, no parity and 1 stop bit.

Three RS-232 connections (TXD, RXD and GND) are used, no handshaking is needed and should be set to none in the terminal emulator.

F.1.1.2 Command Protocol

A [CR] (0x0d) must be entered to get the transmitter's attention and is used to terminate a command line. The transmitter responds with a '>' (0x3e) to indicate that it is ready to receive a command. If no characters are entered for 60 seconds, any partially entered commands are deleted and the transmitter's attention is lost. To get the transmitters attention a character must be entered followed by a [CR] until the '>' prompt is returned.

Commands can optionally be terminated with [CR][LF]; in other words, a [LF] character received following a [CR] will be ignored.

Each character entered is echoed to the host to allow for simple error checking and to support the terminal nature of the implementation. A backspace character (BS, 0x08) deletes the last character entered. The ESC character (0x1b) will delete the entire command.

The command protocol is not case sensitive. Many commands are used to set or retrieve various configuration parameters. When setting parameters, the command is followed by an equals sign ('=') and a comma separated list of parameters. When retrieving parameters, the command is entered without the '=' or followed by a question mark ('?').

Some commands are used to direct the transmitter to execute a specific function (e.g. clear a buffer); in such cases, neither a '=' or a '?' is required. If the command has parameters associated with it they will appear as a comma separated list following the command itself.

Unless otherwise noted, the transmitter will respond to all commands with one of the following:

“OK[CR][LF]>" if command was accepted,
"Bad parameter[CR][LF]>" if a command parameter was invalid,
"Unknown Format[CR][LF]>" if there are too many or too few parameters,
"Access Denied![CR][LF]>" if the command requires a higher access level,
"Unknown Command[CR][LF]>" if the command is unknown,
"Execution Error[CR][LF]>" if the command fails during execution,
"Transmitter Must Be Disabled[CR][LF]>" if the transmitter must be disabled prior to using this command.,
"Transmitter Must Be Enabled[CR][LF]>" if command must first be enabled,
"Configuration Not Recognized[CR][LF]>" if configuration is invalid,

If the command was a request for a configuration parameter the transmitter will respond with:

<cmd>=<data>**[CR][LF]**> When returning data parameters.

F.1.1.3 Command Access Level

All commands are subject to an access right to restrict access to calibration and test commands. Two access levels are defined: USER and TECHNICIAN. An error will be returned if a TECHNICIAN level command is entered while at the USER command access level. USER level commands are always available including when at the TECHNICIAN command access level. The Technician level commands are not described here.

The command access level is changed by using the password protected TECHMODE command. After power up the access level is always USER. The access level of each command is noted in each command description.

Some commands are only available when transmissions are disabled. This is also noted along with each command description.

F.2 General Configuration Commands

F.2.1 Clock Read/Set

Syntax:
TIME= yyyy/mm/dd hh:mm:ss

Access level: USER
TX320 State: Enabled/Disabled

This command sets the date and time in the transmitter. The date and time will be overwritten when a GPS time synchronization occurs. Self timed transmissions will not occur until the time has been set either using this command or from the GPS. Random transmissions will occur with or without time being set.

The real time clock starts at 01/01/2000 00:00:00 at power up.

F.2.2 Replacement Character Read/Set

Syntax:
IRC=c

Access level: USER
TX320 State: Enabled/Disabled

This command defines the ASCII character that will be substituted for any Prohibited ASCII character detected in the transmission data when operating in ASCII or Pseudo-Binary mode. The default character is '*'. Only printable ASCII characters, excluding space, are permitted. In Pseudo-Binary mode, numeric characters are considered illegal.

F.2.3 Save Configuration

Syntax:
SAVE

Access level: USER
TX320 State: Enabled/Disabled

This command directs the transmitter to commit the entered configuration parameters to non-volatile memory. Until this command is entered, the previously saved configuration can be recalled using the RSTR command.

F.2.4 Restore Configuration

Syntax:
RSTR

Access level: USER
TX320 State: Enabled/Disabled

This command directs the transmitter to restore the configuration parameters from non-volatile memory. Changes made to the configuration are not automatically saved to non-volatile memory as they are entered. This allows changes to be made and verified before committing them to permanent storage, but provides the ability to recall the last saved settings, if necessary.

F.2.5 Restore Default Configuration

Syntax:
DEFAULT

Access level: USER
TX320 State: Enabled/Disabled

This command directs the transmitter to set the configuration parameters to their factory default (mostly invalid) values; this essentially clears the operation of the transmitter. This command does not automatically save the cleared parameters to non-volatile memory; the SAVE command must be issued to complete the sequence.

This command does not set the calibration data or serial number to factory defaults.

F.2.6 Enable Transmissions

Syntax:
ETX

Access level: USER
TX320 State: Disabled

This command enables transmissions. The configuration parameters will be checked for validity. If valid, they are saved to non-volatile memory and the transmitter is enabled. The enabled/disabled state of the transmitter is also stored in non-volatile memory so that it will resume operation after a power cycle if it was previously enabled.

Note that the factory default configuration is not valid. The factory default parameters must be explicitly overwritten with valid values before transmissions can be enabled.

F.2.7 Disable Transmissions

Syntax:
DTX

Access level: USER
TX320 State: Enabled

This command disables transmissions. Normal scheduling of transmissions is suspended.

Note that the transmitter is automatically disabled if configuration parameters are modified and must be re-enabled with the ETX command to resume transmitting.

F.2.8 Read Configuration

Syntax:
RCFG

Access level: USER
TX320 State: Enabled/Disabled

This command lists all of the configuration parameters. Each parameter is in the same format as if its individual command had been executed.

For Example:
RCFG
NESID=326d31d4
TCH=92
.
.
.

The output from the RCFG command can be captured by the host (in a text file) and used to duplicate the configuration in another unit.

F.2.9 Enable Technician Command Mode

Syntax:
TECHMODE password

Access level: USER
TX320 State: Enabled/Disabled

This command changes the command access level to TECHNICIAN. The access level will not change unless the password is correct.

F.2.10 Enable User Command Mode

Syntax:
USERMODE

Access level: USER
TX320 State: Enabled/Disabled

This command changes the command access level back to USER. No password is required. A power cycle of the transmitter will also return the command access level to USER.

F.2.11 Set GPS Fix Interval

Syntax:
GIN=hh:mm:ss

Access level: USER
TX320 State: Disabled
Default value: 00:00:00

This command sets the GPS position fix interval to the hours, minutes, seconds specified in hh:mm:ss. It can also be used without the '=' sign to report the current value. Valid range of hh:mm:ss is 00:05:00 to 24:00:00. A value of 00:00:00 will disable periodic GPS position fixes although they will still occur at power up and every 24 hours as a side effect of the daily automatic OCXO calibration. The current value of the GPS fix interval is also reported by the RCFG command. The parameter is non-volatile when saved using the SAVE or ETX commands.

F.3 GOES Transmission Configuration commands

The following commands are used to set the configuration parameters for GOES transmissions. Unless otherwise specified, these parameters have invalid default values and must be set explicitly before transmissions can be enabled using the **ETX** command. These parameters are stored in non-volatile memory by issuing the **SAVE** command or will be automatically saved when the transmitter is enabled.

The transmitter is disabled automatically if any of these parameters are modified. Parameters can be read by entering the command without the '=' while transmissions are enabled or disabled. All parameters can be read at the same time using the **RCFG** command.

F.3.1 Set GOES DCP Platform ID

Syntax:
NESID=xxxxxxxx

Access level: USER
TX320 State: Disabled

Sets the transmitter's GOES DCP Platform ID to the hex value xxxxxxxx. Valid range is even hex numbers from 2 to 0xfffffffe.

F.3.2 Set Self-Timed Transmission Channel Number

Syntax:
TCH=ccc

Access level: USER
TX320 State: Disabled

This command sets the channel number (**ccc**) for timed transmissions. **ccc** is the channel number and has a valid range of 0 – 266 for bit rates of 100 and 300 BPS and a range of 0 – 133 for a bit rate of 1200 BPS.

For 100 BPS operation on channels 201-266, the transmitter will be configured for International operation. Specifically, the 31-bit International EOT will be used (0x63CADD04) in place of the ASCII EOT, and the preamble will be forced to Long.

Setting the channel number to 0 will disable timed transmissions.

F.3.3 Set Self-Timed Transmission Bit Rate

Syntax:
TBR=bbbb

Access level: USER
TX320 State: Disabled

This command sets the timed transmission bit rate where **bbbb** is the bit rate parameter and has valid values of 100, 300 and 1200 BPS.

F.3.4 Set Self-Timed Transmission Interval

Syntax:
TIN=dd:hh:mm:ss

Access level: USER
TX320 State: Disabled

Set interval between timed transmissions to days, hours, minutes, seconds specified in dd:hh:mm:ss. Valid range is 00:00:05:00 to 30:23:59:59.

F.3.5 Set Self-Timed transmission First Transmission Time

Syntax:
FTT=hh:mm:ss

Access level: USER
TX320 State: Disabled

Set the time for the first timed transmission of the day. Valid range is 00:00:00 to 23:59:59. The First Transmission Time is also referred to as the Offset, and is between 00:00:00 and the Self-Timed Transmission Interval.

F.3.6 Set Self-Timed Transmission Transmit Window Length

Syntax:
TWL=xxx

Access level: USER
TX320 State: Disabled

Set the length of the timed transmit window. Length is specified in seconds. Valid range is 5 to 240 seconds.

F.3.7 Enable or Disable Self-Timed Transmission Message Centering

Syntax:
CMSG=Y/N

Access level: USER
TX320 State: Disabled

Center the timed transmission in the assigned window if Y otherwise transmit at beginning of assigned window.

F.3.8 Enable or Disable Self-Timed Buffer Empty Message

Syntax:
EBM=Y/N

Access level: USER
TX320 State: Disabled

If EBM is Y, send "BUFFER EMPTY" message if the buffer is empty at time of transmission. If EBM is N do not transmit if the buffer is empty.

THIS IS NOT FULLY IMPLEMENTED! CURRENTLY IF BUFFER IS EMPTY AT TRANSMIT TIME A MESSAGE IS WRITTEN TO THE AUDIT LOG IF EBM=Y

F.3.9 Set Self-timed Transmission Preamble Length

Syntax:
TPR=S/L

Access level: USER
TX320 State: Disabled

Set the preamble type for timed transmissions. Valid values are S or L (Short or Long). This setting only applies for 100 BPS timed transmissions on channels 1-200. All 300 and 1200 BPS transmissions us short preamble. All 100 BPS transmissions on channels above 200 use long preamble.

F.3.10 Set Self-Timed Transmission Interleaver Mode

Syntax:
TIL =S/L/N

Access level: USER
TX320 State: Disabled

Set the timed transmission interleaver type. Valid values are S,L,N (Short, Long or None). This setting only applies for HDR timed transmissions, i.e. 300 or 1200 BPS.

F.3.11 Set Self-Timed Transmission Data Format

Syntax:
TDF =A/P/B

Access level: USER
TX320 State: Disabled

This command sets the timed transmission format to ASCII, Pseudo-Binary or Binary. Valid values are A, P or B. This parameter is used to determine the flag word in 300 and 1200 BPS transmissions.

Note: It is the responsibility of the host to ensure the data provided for transmission is in the proper format. ASCII data can not be transmitted when Pseudo Binary format is selected. Pseudo Binary can be transmitted with ASCII format has been selected.

F.3.12 Set Random Transmission Channel Number

Syntax:
RCH=ccc

Access level: USER
TX320 State: Disabled

This command sets the channel number for random transmissions. **ccc** is the channel number and has a valid range of 0 – 266 for bit rates of 100 and 300 BPS and a range of 0 – 133 for a bit rate of 1200 BPS.

For 100 BPS operation on channels 201-266, the transmitter will be configured for International operation. Specifically, the 31-bit International EOT will be used (0x63CADD04) in place of the ASCII EOT.

Setting the channel number to 0 will disable random transmissions.

F.3.13 Set Random Transmission Bit rate

Syntax:
RBR=bbbb

Access level: USER
TX320 State: Disabled

This command sets the random transmission bit rate where **bbbb** is the bit rate parameter and has valid values of 100, 300 and 1200.

F.3.14 Set Random Transmission Interval

Syntax:
RIN =mm

Access level: USER
TX320 State: Disabled

Set the random transmission randomizing interval to mm minutes. The randomizing interval is the interval in which a random transmission will occur if there is data in the random transmission buffer. The actual transmission time will be random, but on average will occur at this rate. Valid range is 5 to 99 minutes.

F.3.15 Set Random Transmission Randomizing Percentage

Syntax:
RPC =mm

Access level: USER
TX320 State: Disabled

This value determines the range of randomization as a percentage of the randomizing interval. Random transmissions will occur at a uniformly distributed random time within this range and on average occur at the randomizing interval rate. Valid range is 10 to 50%.

For example, for a randomizing interval =15 (minutes) and a randomizing percentage =20 (%), then the time between any two random transmissions will be 12 to 18 minutes (15 ± 3 minutes).

F.3.16 Set Random Transmission Repeat Count

Syntax:
RRC =xx

Access level: USER
TX320 State: Disabled

The random transmission repeat count is the number of times a random transmission will be repeated. The random transmissions will occur once every random transmission interval as specified by the randomizing interval. The valid range of this parameter is 0 – 99. For example, a value of 3 will direct the transmitter to send the data in the Random buffer 3 times before clearing it. A value of 0 indicates that random transmissions will occur every random transmission interval until the random buffer is cleared by the host.

F.3.17 Enable or Disable Random Transmission Message Counter

Syntax:
RMC=Y/N

Access level: USER
TX320 State: Disabled

If RMC is Y a random message counter will be included at the beginning of the message, ahead of the user data. If it is N the random message count will not be included.

F.4 Data Buffer Loading Commands

The following commands are used to manage and store data in the GOES Transmission buffers.

F.4.1 Load Self-Timed Transmission Buffer

Syntax:
TDT =xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Access level: USER
TX320 State: Enabled

This command overwrites the GOES Timed Buffer with the data provided. The TX320 transmitter will insert the 31 bit GOES ID, any header information (e.g. HDR Flag byte), and append the EOT so these should not be included in the TDT data. If the timed data format is ASCII or Pseudo-Binary the transmitter will also insert the correct parity bit for each message character and replace illegal characters with the character specified by the **IRC=c** command before transmission.

Characters that have meaning for the command interface (CR, LF, BS, ESC,'~') must be preceded by a '~' character if they appear in the message data.

The maximum length of the formatted data can be up to 126000 bits, or 15750 bytes.

If there is more data loaded into the buffer than can be transmitted in the assigned transmit window the message will be truncated.

One minute prior to transmission data is removed from the transmit buffer and encoded for transmissiion (The Data In Buffer LED will go out). If this command is received within 1 minute of the transmission time or during a timed transmission, the data will not be included in the current transmission but will be buffered for the next interval.

F.4.2 Read Number of Bytes in the Self-Timed Transmission Buffer

Syntax:
TML

Access level: USER
TX320 State: Enabled/Disabled

Returns the number of bytes stored in the timed transmission buffer.

F.4.3 Read the Maximum Self-Timed Message Length

Syntax:
MTML

Access level: USER
TX320 State: Enabled

Returns the maximum number of bytes that can be transmitted with the current timed transmission bit rate, window length and preamble type.

F.4.4 Clear Self-Timed Transmission Buffer

Syntax:
CTB

Access level: USER
TX320 State: Enabled/Disabled

Clears the timed transmission buffer.

F.4.5 Load Random Transmission Buffer

Syntax:
RDT =xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

Access level: USER
TX320 State: Enabled

This command overwrites the GOES Random Buffer with the data provided. The G5 transmitter will insert the 31 bit GOES ID, any header information (e.g. HDR Flag byte), and append the EOT so these should not be included in the RDT data. If the random data format is Pseudo-Binary the transmitter will also insert the correct parity bit for each message character and replace illegal characters with the character specified by the IRC=c command before transmission.

Characters that have meaning for the command interface (CR, LF, BS, ESC,'~') must be preceded by a '~' character if they appear in the message data.

Loading data into the Random transmission buffer, triggers the random reporting sequence. Once triggered, the random reporting mechanism will send the data loaded in the buffer for the number of transmissions as specified by the random repeat count. The buffer will be cleared automatically when the number of transmissions specified have occurred.

If the command is received within 1 minute or during a random transmission the data will not be included in the current transmission but will be buffered for the next one.

If there is more data loaded into the buffer than can be transmitted at the assigned bitrate the message will be truncated.

F.4.6 Read Length of the Message in the Random Transmission Buffer

Syntax:
RML

Access level: USER
TX320 State: Enabled/Disabled

Returns the number of bytes stored in the random transmission buffer.

F.4.7 Read the Maximum Random Message Length

Syntax:
MRML

Access level: USER
TX320 State: Enabled

Returns the maximum number of bytes that can be transmitted at the current random transmission bitrate.

F.4.8 Clear Random Transmission Buffer

Syntax:
CRB

Access level: USER
TX320 State: Enabled/Disabled

Clear the random transmission buffer.

F.5 Status and Other Commands

The following commands are used by the host to determine the status of the transmitter for display and diagnostics purposes. These commands can be entered with transmissions enabled or disabled.

F.5.1 Read Version Information

Syntax:
VER

Access level: USER
TX320 State: Enabled/Disabled

This command returns the transmitter serial number, hardware version number, firmware version number and GPS module version numbers.

F.5.2 Read Transmission Status

Syntax:
RST

Access level: USER
TX320 State: Enabled/Disabled

This command returns the transmitter state, GPS state, time to next transmission, number of bytes in timed transmit buffer, number of bytes in random transmit buffer, number of times random data has been transmitted, failsafe status and supply voltage.

The transmitter responds with:

```
Transmitter: Enabled/Disabled[CR][LF]
GPS: On/Off[CR][LF]
RTC: Valid/Invalid[CR][LF]
Time To Next Tx: dd:hh:mm:ss[CR][LF]
Timed Message Length: nnnn[CR][LF]
Next Timed Tx: N/A or mm/dd/yyyy hh:mm:ss
Random Message Length: nnnn[CR][LF]
Random Message Tx Count: nnn[CR][LF]
Next Random Tx: N/A or mm/dd/yyyy hh:mm:ss
Fail-Safe: OK/Tripped[CR][LF]
Supply Voltage: xx.x V
```

F.5.3 Read Last Transmission Status

Syntax:
LTXS

Access level: USER
TX320 State: Enabled/Disabled

This command returns the status of the last transmission. The last transmission could have been a regularly scheduled timed transmission, a random transmission, or a test transmission triggered by a test command.

If a transmission has occurred since the unit was last powered up, the transmitter responds to the command with:

Tx Status: Failsafe Tripped/OK
Tx Type: Timed/Random/Test
Last Tx Length: 30 bytes
Last Tx Start Time: 2004/12/16 23:29:48
Last Tx Stop Time: 2004/12/16 23:29:49
Forward Power: -23.1 dBm
Power Supply: 12.0 V

If a transmission has not occurred since power up, the transmitter will respond with:

No Tx Has Occurred

F.5.4 Read GPS Status

Syntax:
GPS

Access level: USER
TX320 State: Enabled/Disabled

This command returns the current GPS status including satellite numbers and signal strengths in the following format if the GPS is on:

Fix Status: Full Accuracy
Almanac Available: N
PPS Output Stable: N
UTC Offset = 0.000000

Satellite #	Signal Strength
30	10.80
23	no lock
10	4.00
25	1.80
5	6.60
21	no lock
17	6.40
2	6.80

If the GPS is off the command returns:

GPS is off

F.5.5 Read GPS Position

Syntax:
POS

Access level: USER
TX320 State: Enabled/Disabled

This command returns position obtained during the last GPS fix in the following format:

```
Time of fix: dd/mm/yyyy hh:mm:ss[CR][LF]
Lat: sxx.xxxxx[CR][LF]
Long: sxxx.xxxxx[CR][LF]
Alt: xxxxx[CR][LF]>
```

Where latitude is in degrees, + for N and - for S, longitude is in degrees, + for E and – for W and altitude is in meters.

If a GPS fix has not yet occurred the transmitter will respond with: **No GPS Fix[CR][LF]>**

F.5.6 Read Audit Log

Syntax:
RAL

Access level: USER
TX320 State: Enabled/Disabled

The RAL command is used to retrieve the audit log information in the following format:

yy/mm/dd hh:mm:ss event message 1[CR][LF]
yy/mm/dd hh:mm:ss event message 2 [CR][LF]
.
.
.
yy/mm/dd hh:mm:ss event message N[CR][LF]>

Where: **yy/mm/dd hh:mm:ss** are the date and time that the message was created.
event message x is a short text string describing the event detected.

F.5.8 Read Forward Power

Syntax:
RFWD

Access level: USER
TX320 State: Enabled/Disabled

Returns the current forward power in dBm. This value is updated at the bit rate when transmitting and every 30 seconds when not transmitting.

F.5.9 Read Reflected Power

Syntax:
RRFL

Access level: USER
TX320 State: Enabled/Disabled

Returns the reflected power in dBm. This value is updated at the bit rate when transmitting and every 30 seconds when not transmitting.

F.5.10 Read Power Supply

Syntax:
RPS

Access level: USER
TX320 State: Enabled/Disabled

Returns the power supply voltage in Volts. This value is updated at the bit rate when transmitting and every 30 seconds when not transmitting.

F.5.11 Read TCXO Temperature

Syntax:
RTEMP

Access level: USER
TX320 State: Enabled/Disabled

Returns the TCXO temperature (PCB temperature) in degrees C. This value is updated at the bit rate when transmitting and every 30 seconds when not transmitting.

F.5.12 Read Measured Frequency

Syntax:
RMF

Access level: TECHNICIAN
TX320 State: Enabled/Disabled

This command returns the last measured OCXO and TCXO frequencies in the following format:

F-OCXO: 10000005.9000
F-TCXO: 43199.9166

Units are Hz.

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