TGT1 GOES TRANSMITTER
OPERATOR'S MANUAL

REVISION: 3/03

Warnings for TGT-1 Users

1. The datalogger operating system must be compatible for use with the TGT-1. CR10X dataloggers must have version 1.6 or later. CR500 dataloggers need version 1.4 or later. CR23X dataloggers should have version 1.4 or later. CR10 and 21X dataloggers require a special PROM. CR10 PROM is item number 8131-00, 21X PROM is item number 8132-04. Check *B mode for operating system version. If you did not purchase the TGT-1 and datalogger together, make sure you have the latest operating system. Contact a Campbell Scientific Applications Engineer if you have any questions.

2. The datalogger clock must be set to Coordinated Universal Time. All references to time are based on Coordinated Universal Time.

3. The timing of the P120 instruction should not coincide with the assigned transmission time. Leave at least a two-minute buffer.

4. If you are using the keypad (CR10KD) when the datalogger initiates a P99, P120 or P123 instruction, the instruction will fail without reporting a failure.

5. Due to atmospheric interference and other sources of error, it is possible for a data transmission to be missed by the ground station. If this happens, your missed data is still in the datalogger until overwritten by new data.

6. To prevent communication collisions when connecting storage modules (SM192/716, SM4M, SM16M) and a TGT-1 to the CR10(X) or CR23X, connect the storage module and then enter the command string "*91A9A*0" to put the storage module into the SDC mode. This is done automatically if the storage module is connected to the logger when the logger is powered up. The same command should be executed when a new storage module replaces the previous one.

7. Array IDs smaller than 255 are stripped off when data are sent to the transmitter. Array IDs between 255 and 511 (highest possible) are not stripped off.

Warranty and Assistance

The **TGT1 GOES TRANSMITTER** is warranted by CAMPBELL SCIENTIFIC, INC. to be free from defects in materials and workmanship under normal use and service for twelve (12) months from date of shipment unless specified otherwise. Batteries have no warranty. CAMPBELL SCIENTIFIC, INC.'s obligation under this warranty is limited to repairing or replacing (at CAMPBELL SCIENTIFIC, INC.'s option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CAMPBELL SCIENTIFIC, INC. CAMPBELL SCIENTIFIC, INC. will return such products by surface carrier prepaid. This warranty shall not apply to any CAMPBELL SCIENTIFIC, INC. products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CAMPBELL SCIENTIFIC, INC. is not liable for special, indirect, incidental, or consequential damages.

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RMA#_____
815 West 1800 North
Logan, Utah 84321-1784

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CAMPBELL SCIENTIFIC, INC.

815 W. 1800 N.
Logan, UT 84321-1784
USA
Phone (435) 753-2342
FAX (435) 750-9540
www.campbellsci.com

Campbell Scientific Canada Corp.
11564 -149th Street
Edmonton, Alberta T5M 1W7
CANADA
Phone (780) 454-2505
FAX (780) 454-2655

Campbell Scientific Ltd.
Campbell Park
80 Hathern Road
Shepshed, Loughborough
LE12 9GX, U.K.
Phone +44 (0) 1509 601141
FAX +44 (0) 1509 601091

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TGT1 GOES Transmitter

1. Introduction

The TGT1 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. This transmitter features a crystal oscillator that is digitally temperature-compensated to prevent the frequency from drifting into adjacent channels. The TGT1 is manufactured for CSI by Telonics Inc. and inter-faces directly to the datalogger's 9-pin I/O port.

2. GOES System

2.1 Orbit

The TGT1 transmitter sends data via Geosta-tionary 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 addresses, uplink channels, and self-timed/random transmit time windows. Self-timed windows allow data transmission only during a predetermined time frame (typically 1 minute every 3 or 4 hours). The self-timed data is erased from the transmitter's buffer after each transmission. 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 windows can be executed by the TGT-1.

2.3 Data Retrieval

Data retrieval via the TGT1 and the GOES system is illustrated in Figure 2-1. The 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 the DOMSAT satellite downlink. DOMSAT is only practical for organizations with many GOES users; contact NESDIS for more information (see Appendix A).

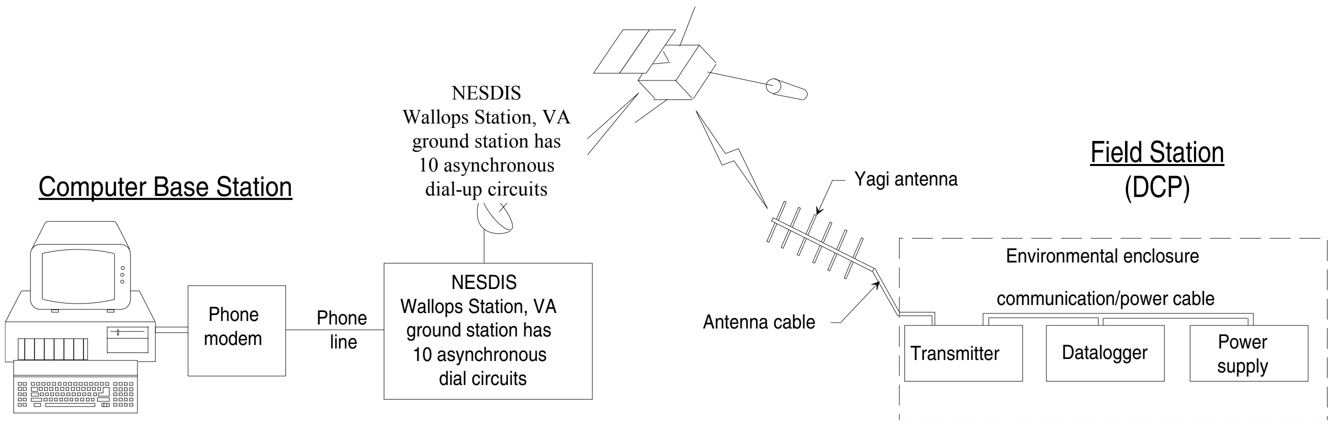

FIGURE 2-1. Data Retrieval Diagram

3. Specifications

Output level: +40 dBm (10 watts), ±1.0 dBm at 12 VDC with automatic leveling control

Typical current drain: 9 mA quiescent, 2200 mA active

Operating temperature range: –40° to +60°C

Supply voltage range: 10.5 to 14.0 VDC

Dimensions: 3.5" x 7.2" x 4.4" (8.9 x 18.3 x 11.2 cm)

Weight: 2.1 lbs (1.0 kg)

Self-timed buffer: 2000 bytes

Random buffer: 2000 bytes

Transmission rate: 100 bits per second

Typical number of data points transmitted: 118 for a 1 minute transmit-window (with 15 second guard bands)

Maximum EIRP allowed by NESDIS: +50 dB

Antenna's maximum gain: +9 dB with right-hand circular polarization, +12 dB with linear polarization.

Clock accuracy: Capable of running 420 days without adjustment.

4. Required Equipment

4.1 Computer Base Station

The equipment required at the computer base station is listed below.

- Phone modem with MNP level 4 error correction. (Most commercially available Hayes-compatible modems contain this error-checking protocol. Check the operator's manual for your modem).

- Computer with user-supplied commu-nication software (e.g., Procomm Plus, Crosstalk).

4.2 Field Station

The field stations equipment is illustrated in Figures 4-1 and 4-2. The required equipment is listed below.

- TGT1 satellite transmitter (includes the SC925G communication/power cable). If required, the datalogger's PROM is ordered with the transmitter.

- Datalogger (CR23X, CR10X, CR500, CR10, or 21X). A CR10KD keyboard/display is required when using a CR10X, CR10, or CR500. The CR10 and 21X require a special PROM. When using a 21X with both a TGT1 and a storage module (SM192, SM716, or CSM1), hardware and datalogger programming modifications are required. Contact a Campbell Scientific applications engineer for more information.

- RHCP Yagi antenna, mounting bracket (CSI model 12261), and COAX NM-L cable.

- Campbell's ENC SAT enclosure. The ENC SAT includes a water-tight compression fitting for the antenna, 6 water-tight compression fittings for the sensors and the solar panel, a 12 AHr or 24 AHr (optional) sealed rechargeable battery, a Campbell's CH12R regulator, and an MSX10 solar panel.

- A 6832 filter is also required when measuring sensor(s) requiring equalization with the atmosphere (e.g., vented pressure transducers, barometers). This filter fits into one of the ENC SAT compression fittings to allow pressure equalization between the inside and outside of the enclosure. The filter retards the entry of water vapor into the enclosure protecting the transmitter and measurement electronics.

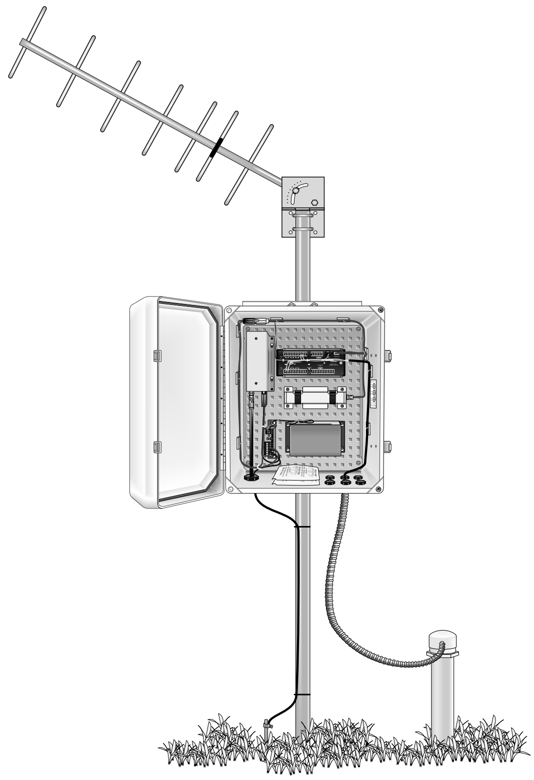

FIGURE 4-1. A Field Station Monitoring a Well's Depth (Solar Panel Not Shown)

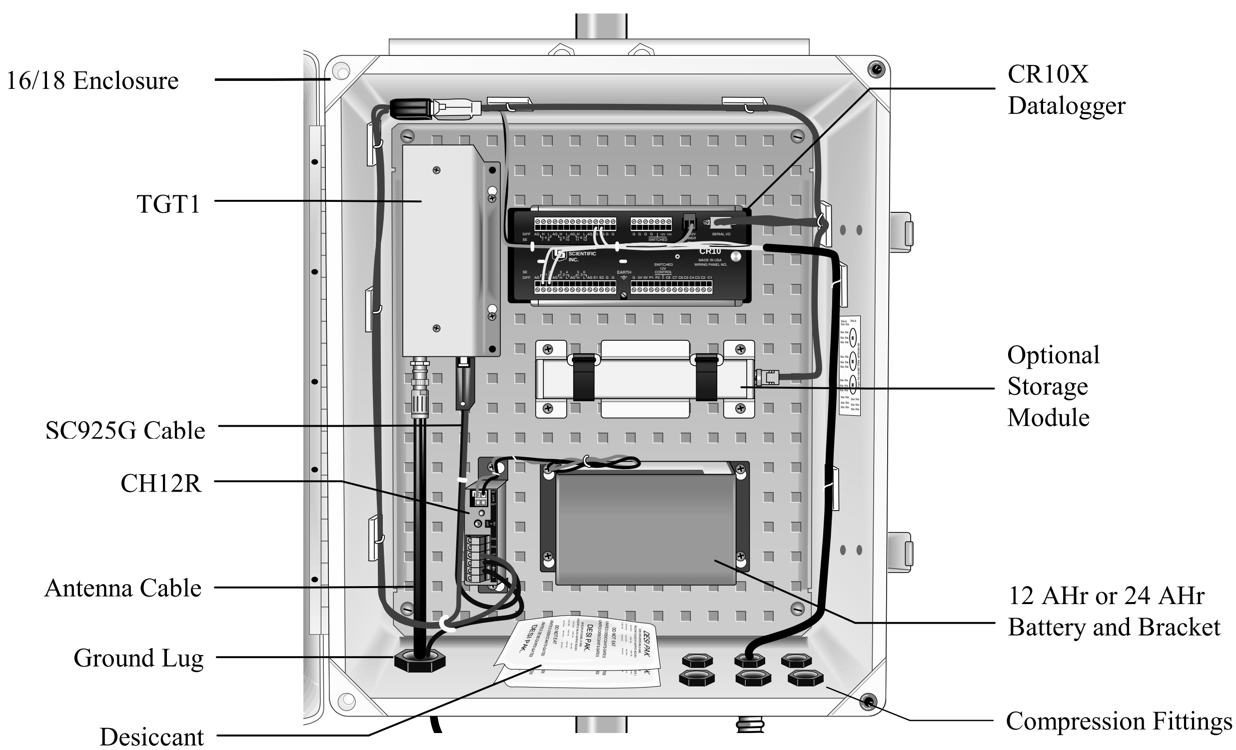

FIGURE 4-2. Inside the ENC SAT Enclosure of a Typical Field Station

5. Power Supplies

5.1 12 and 24 AHr Sealed Rechargeable Batteries

Typically, the system is powered with a 12 AHr sealed rechargeable battery that connects to a CH12R regulator and an MSX10 solar panel. The 12 AHr battery lasts 15 to 20 days per charge. A 24 AHr sealed rechargeable battery which lasts 30 to 40 days is available.

NOTE This assumes the data are trans-mitted for 30 seconds at 3 hour intervals, the datalogger's scan rate is 1 second, and the sensors have negligible power consumption.

A discharged 12 AHr battery is recharged by a 10 watt solar panel in 2 to 3 days when there are a 1000 watts per square meter of illumination and the solar panel temperature is 25°C. A 20 watt solar panel is available. The battery voltage should be monitored with datalogger program Instruction 10, sampled, and output as a part of the user’s data stream.

5.2 AC Power and Deep-Cycle Rechargeable Batteries

Although either the 12 or 24 AHr battery is sufficient for most systems, applications with high current drain sensors or peripherals (e.g., SDM devices) might require AC power or a user-supplied deep-cycle rechargeable battery that is trickle-charged with an MSX20R solar panel. Campbell Scientific's power supply brochure and application note provide information about determining your system's power requirements.

5.3 Datalogger's Batteries

The transmitter's power consumption is too high for alkaline batteries. The 21XL's rechargeable batteries do not source sufficient current for the transmitter. Although the PS12LA 7 AHr battery can power the transmitter, the battery only lasts 3 to 7 days per charge. One option is to have the datalogger's batteries power the datalogger and sensors, while the transmitter uses a 12 AHr battery, a 24 AHr battery, or a deep-cycle battery.

NOTE The datalogger's batteries should be removed when not in use. Rechargeable batteries should be trickle charged by a PS12LA or CH12R charger.

6. Installation

6.1 Wiring

Typically, ENC SAT hardware (excluding the battery and solar panel) and the datalogger are premounted and prewired. The enclosure's ground lug must be connected to an appropriate earth ground (see Table 6.1-1).

6.2 Battery

Before installing the battery, the CH12R's power switch must be turned OFF. To install the battery, remove the battery bracket from the ENC SAT and insert the battery facing outward into the bracket. When inserting the 24 AHr battery into its bracket, the battery's power connections (posts) go on the top side where a section of the bracket has been cut away. Reattach the bracket to the ENC SAT, and connect the battery cable (see Table 6.1-1). The antenna must be connected to the transmitter before turning on the CH12R's power switch.

6.3 Antenna

You mount the antenna to a tripod, tower, or vertical 1.5" OD pipe (see Figures 6.3-1 through 6.3-3). The antenna is then oriented towards the satellite by using a computer program (see Appendix C). This program prompts you for the satellite's longitude (provided by NESDIS) and the antenna's longitude, latitude, and height. It then calculates the antenna's elevation and azimuth (see Figure 6.3-4). You must also account for local magnetic declination (see Appendix G).

After the antenna is properly oriented, insert the antenna cable into the enclosure's largest compression fitting and connect the cable to the transmitter.

CAUTION The antenna must be connected before transmission or the transmitter will be damaged.

TABLE 6.1-1 Wiring Diagram

<u>SC925G Cable</u>
25-Pin connector connects to TGT1 I/O port
Black connects to CH12R ⏚ (Ground)
Red connects to CH12R +12 Terminal
9-Pin connector connects to datalogger I/O port

<u>Antenna Cable</u>
BNC male connector connects to TGT1 BNC female port

<u>Red Cable</u>
Connects to CH12R +12 and datalogger 12 V

<u>Black Cable</u>
Connects to CH12R ⏚ and datalogger G (Ground)

<u>Green Cable</u>
Connects to datalogger G (Ground) and is routed through the enclosures ground lug and connected to earth ground

<u>Battery</u>
Connects to CH12R INT white connector

<u>Solar Panel</u>
Connects to CH12R CHG Ports

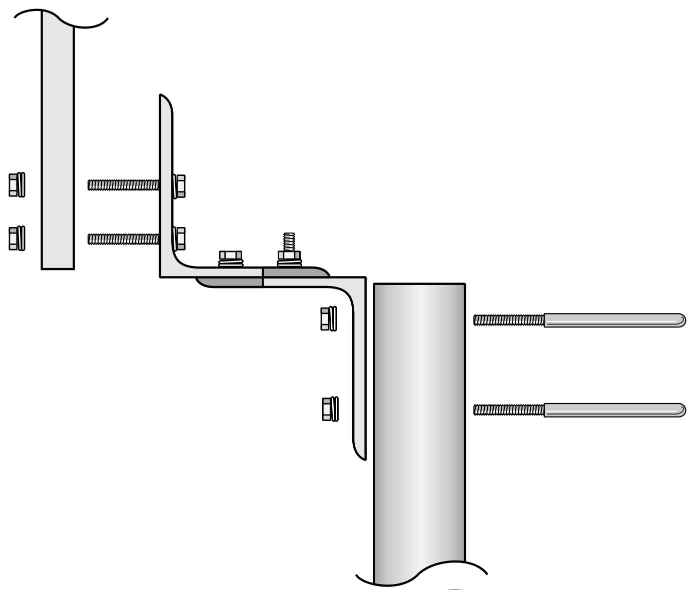

FIGURE 6.3-1. Antenna Mounting Hardware, Exploded View

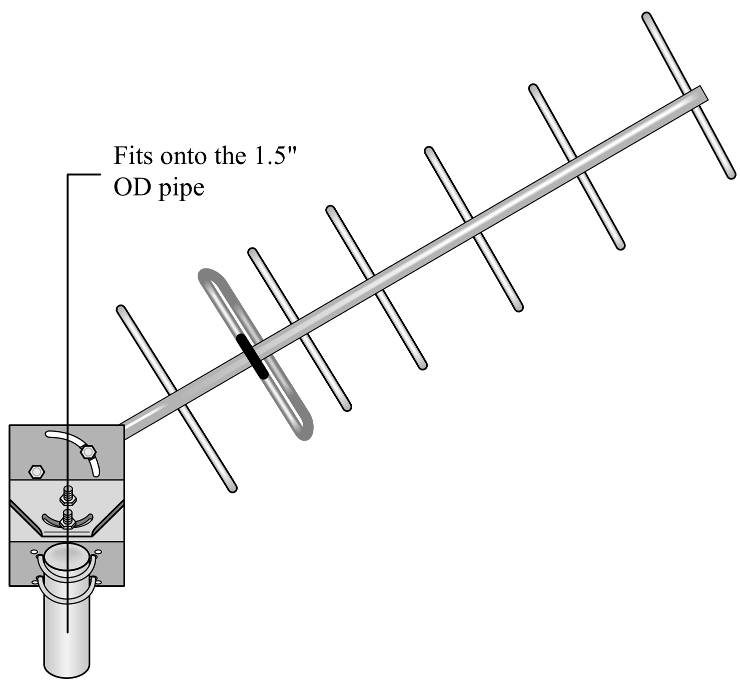

FIGURE 6.3-2. Antenna Mounting Hardware, Assembled View 1

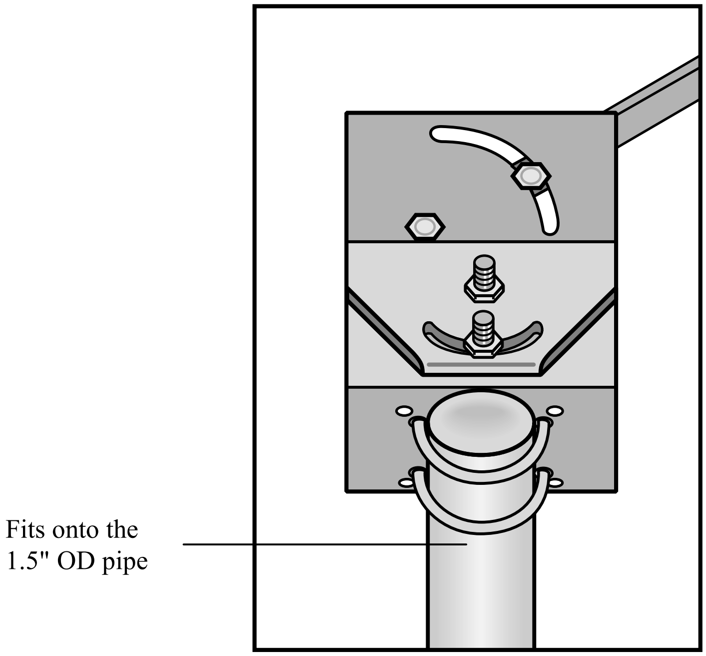

FIGURE 6.3-3. Antenna Mounting Hardware, Assembled View 2

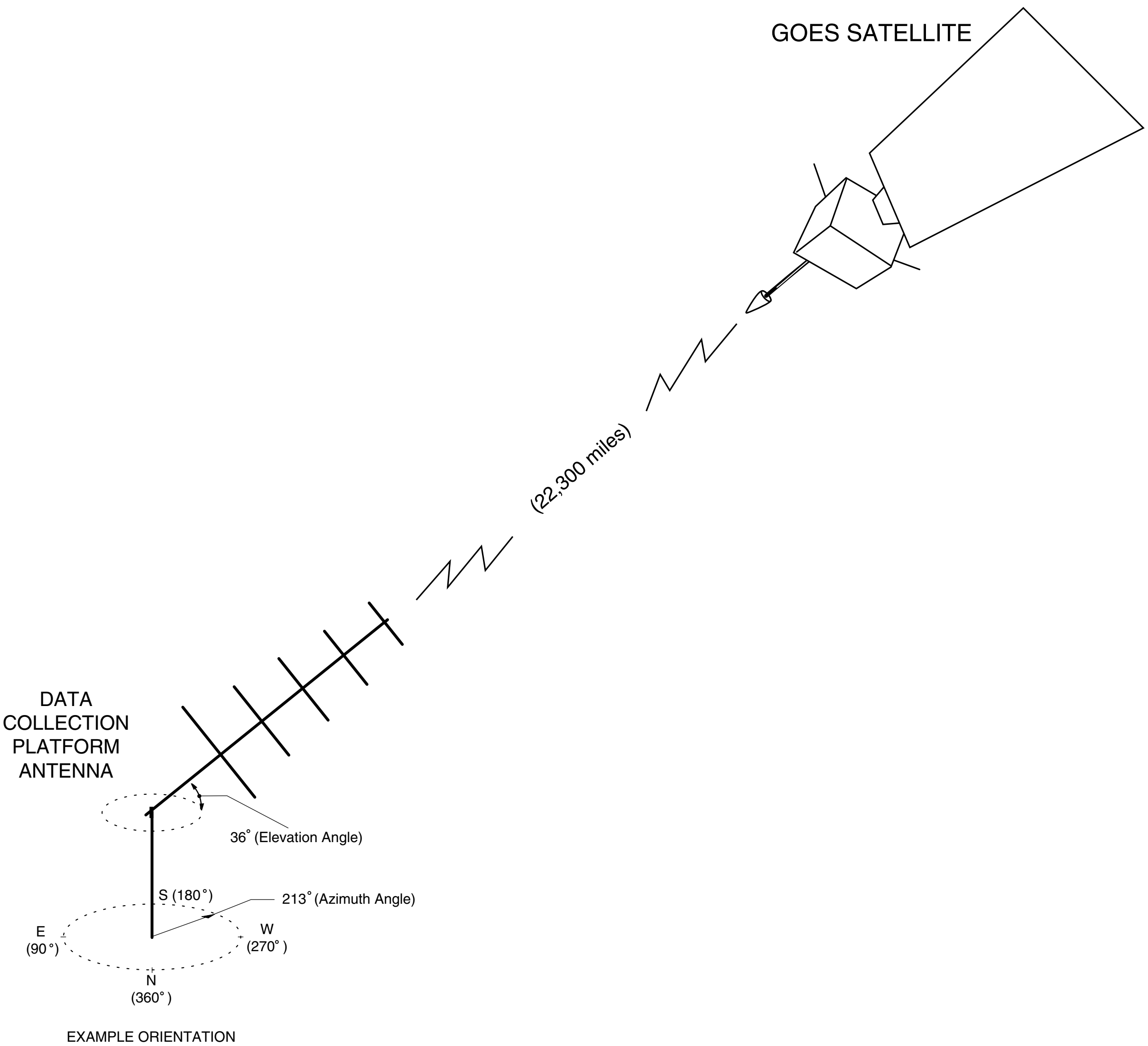

FIGURE 6.3-4. Example Antenna Orientation Diagram

7. Forward and Reflected Power

Forward and reflected power are measured (in decimal units) and updated during each transmission (see Sections 8 and 9). The forward power must be within 165 to 215 for the transmitter's output level to be within specifications. The antenna/cable assembly is operating properly when the percentage of power reflected is less than 5. A reflected power reading of 27 is 5% of 165 and 2.7% of 215.

This percentage can be estimated with the following equation (see the datalogger program in Appendix D.3).

$$\% \text{ power reflected} = [((\text{ref} + 17.4)/(\text{fwd} + 17.4))^2 \times 100] - 1$$

When the percentage of power reflected is greater or equal to 5, one or more of the following situations exist and must be corrected:

- The antenna is not connected.
- The antenna is too close to metal.
- You are transmitting inside a building.
- The antenna is covered with snow or ice.
- The frequency that the antenna is tuned to does not match the transmitter's frequency.
- There is a problem with the coaxial cable connector or connection.
- There is a problem with the antenna cable.

8. Programming the Transmitter

8.1 Star Pound Mode

The star/pound (*#) mode is for programming the transmitter. It establishes and edits parameters, displays status information, and performs test transmissions. The *# mode is accessed via a keyboard/display (**not** with a computer).

NOTE If storage modules are used along with the TGT-1, enter the command “*91A9A*0” after connecting the storage module.

NOTE *# mode cannot be accessed without a P120 instruction in the program table.

8.2 Establishing and Editing Parameters

The parameters set the transmitter's clock and define the address, transmission intervals, and uplink channels (see Table 8.2-1). The parameters are temporarily stored in the datalogger. The clock parameters are transferred to the TGT-1 after parameter 3 is entered with the “A” key. The remaining parameters are transferred to the TGT-1 after parameter 26 is entered with the “A” key. If the keyboard/display sits idle for 2 minutes, the datalogger will discard all changes that have not been transferred to the TGT-1.

Before establishing the parameters, type in *0. The display should show only LOG, not LOG1, LOG2, or LOG12.

NOTE The *# mode will not run when *1 and *2 are active, therefore their scan rates must be set to zero.

Enter the *# mode by typing in *#. The colon disappears during the upload process and reappears when the process is complete. 12:00 is displayed when you are in *# mode. Press A to edit parameters. 01: is then displayed indicating the datalogger is ready for parameter 1. You type an A to store each parameter and to advance to the next one. Individual parameters can also be edited by typing in *# and the parameter number. Remember, the TGT-1 clock is not changed until the “A” key is pressed after the 3rd parameter. No other changes are saved until the “A” key is pressed after the 26th parameter.

TABLE 8.2-1 *# Parameter's Descriptions

Parameter	**Description**
1 - 3	Set the transmitter's clock. All scheduled operations are referenced to this clock. Because timing is critical, it must be set to Coordinated Universal Time (CUT). CUT can be obtained by calling the WWV or WWVH time services (call (303) 499-7111 for WWV time and (808) 335-4363 for WWVH). The clock must be reset <u>at least</u> once a year. Parameter 1 is hours; 2 is minutes and 3 is seconds. The TGT-1 clock is set and starts to run when the “A” key is pressed after the 3rd parameter. Note: This is a 24-hour format.
4 - 11	The NESDIS-assigned address. Convert the letters in the address to their decimal equivalent (Table 8.2-2). For example when the address is 0104C186, parameters 4 through 11 are the following: <u>Parameter Number</u> — <u>User Types</u> 04: 0 A 05: 1 A 06: 0 A 07: 4 A 08: 12 A 09: 1 A 10: 8 A 11: 6 A
12	NESDIS-assigned self-timed uplink channel (see Appendix E channel/ frequency correlation). If not assigned a self-timed channel, type in zeros.
13	NESDIS-assigned random uplink channel (see Appendix E for channel/ frequency correlation). If not assigned a random channel, type in zeros.
14 - 17	Self-timed transmission interval is NESDIS-assigned and usually 3 or 4 hours (minimum interval is 15 minutes). Parameter 14 is days; 15 is hours; 16 is minutes and 17 is seconds. Note: This is a 24-hour format.
18 - 20	Random transmission interval (the NESDIS-assigned time period that the transmission is randomly re-peated, minimum interval is 5 minutes). Parameter 18 is hours; 19 is minutes and 20 is seconds.
21 - 23	Set the time of the initial self-timed transmission (NESDIS-assigned). The “initial” time is not the first time but an offset. Self-timed transmissions occur on multiples of the self-timed transmission interval plus the offset. Parameter 21 is hours; 22 is minutes and 23 is seconds. Note: This is a 24-hour format.

24	Transmit window length is NESDIS-assigned and usually 1 minute. Type 0 for a 1 minute window or 1 for a 2 minute window. The transmission is automatically centered around the middle of the transmit window.
25	Sets the preamble length. In general, type 0 to use a short preamble (0.98 seconds) for stationary land based stations. Random mode requires the short preamble. Type 4 for a long preamble (7.3 seconds). A long preamble increases the time the satellite can lock onto the signal but reduces the time for transmitting data.
26	Selects the buffer or buffers used. Type 1 to select only the self-timed buffer, a 2 to select only the random, and a 3 to select both buffers. These buffers must match Instruction 120's parameters (see Section 9).

TABLE 8.2-2 Decimal Equivalent

Number or letter	Decimal equivalent
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
A	10
B	11
C	12
D	13
E	14
F	15

8.3 Status Information and Test Transmissions

The *#60 mode is for displaying status infor-mation and performing test transmissions. *#60 mode is entered by typing *#60A. The execution interval must be set to zero in table 1 and 2. You perform each command by typing the command number (see Table 8.3-1) and an A. Multiple parameter commands require typing an A to advance to the next parameter.

8.4 Error Messages

There are two error messages. The E101 message appears after the user types *# and indicates the transmitter is not communicating with the datalogger (i.e., TGT1 is not powered, SC925G cable is not connected or the storage module is blocking communication. See warnings on first page.). E102 appears after a parameter is entered incorrectly.

TABLE 8.3-1 *#60 Commands

Command Number	Description
1	Displays the current TGT-1 time; hours, minutes, and seconds are the parameters. The TGT-1 time is retrieved when the “A” key is pressed.
2	The amount of time until the next transmission of the active buffer; parameters are days, hours, minutes, and seconds. If [31:31:63:63] is displayed, the active buffer contains no data. The time is retrieved when the “A” key is pressed. The active buffer is set using command 6 and 7.
3	Forward power is the first parameter and reflected power is the second (see Section 7).
4	The first parameter displays the number of errors. Parameters 2-9 list the history of errors, where parameter 2 is the most recent. Call CSI to decode errors.
5	Number of bytes in self-timed or random buffer (**used after command 6 or 7**).
6	Selects self-timed buffer (**used before command 5**).
7	Selects random buffer (**used before command 5**).
8	Initiates test transmission of data in the random buffer. You must be assigned a random channel (see *# parameter 13) or obtain from NESDIS a channel for testing. The random buffer must contain data. The TGT-1 will not perform a test transmission more often then once each minute. Clear the random buffer before final TGT-1 setup. Appendix F contains a datalogger program that dumps data into the random buffer.

9. Programming the Datalogger

9.1 CR10X and CR10

9.1.1 Instruction 120 and Instruction 124 (Fire Weather)

CR10X program Instruction 120 transfers the final storage data to the transmitter's buffer and designates locations for the forward/reflected power. The CR10s use Instruction 99 instead of Instruction 120. The CR10 Instruction 99 and CR10X Instruction 120 are identical except for the instruction number. This instruction also automatically compares the datalogger to the transmitter clock. If the clocks differ more than 3 seconds, the datalogger's clock is set to the transmitter's. However, only the seconds are compared. Therefore, the datalogger's clock is **NOT** reset when the minutes or hours differ. The complete time (HH:MM:SS) will be updated if the clocks differ by more than 3 seconds. Table 9.1-1 lists and describes Instruction 120's parameters.

TABLE 9.1-1 CR10X's Instruction 120 Parameters and CR10's Instruction 99 Parameters

01:	ABC	Where:	A = 0	binary mode (3-bytes per data point)
			A = 1	ASCII mode (7-bytes per data point)
			A = 2	18 bit integer (see Appendix K)
			B = 0	self-timed buffer
			B = 1	random buffer
			C = 0	appends the new data to the old data
			C = 1	writes over the old data
02:	z	Where:	z > 0	Starting input location for the forward power reading (see Section 7). The next input location automatically contains the reflected power reading (e.g., when the forward power's input location is 10, the reflected power's input location is 11). By placing these readings into input locations, you can sample and output the forward and reflected power as part of the data stream (Instruction 70).
			z = 0	The forward and reflected power readings are NOT placed into input locations.

NOTE

The ASCII option (1xx) requires approximately 7 bytes per data point which is double the number of bytes required for the binary option (0xx). This is a convenient method of sending data since no post-processing conversion is required. However, the required transmission time for ASCII is doubled. With a typical transmission window of one-minute, you can send up to 59 data points in ASCII or 118 data points in binary (this allows 15 second guard bands before and after transmission to allow for normal clock drift).

Array IDs smaller than 255 are stripped off when data are sent to the transmitter. Array IDs between 255 and 511 (highest possible) are not stripped off.

9.1.2 Datalogger Programming Theory

The CR10X and CR10 are programmed via a CR10KD keyboard/display or an IBM-PC compatible computer running PC208 software. The datalogger's program must have this structure:

Set Output Flag 0 high (10) based on condition 1
Output Processing Instructions
P120 Data transfer to TGT1 or P124 Fire weather data transfer to TGT1
.
.
.
Set Output Flag 0 high (10) based on condition n (n = 1,2, . . .)
Output Processing Instructions
P120 Data Transfer to TGT1

With the following structure, ONLY the last output is sent to the TGT1:

Set Output Flag 0 high (10)
Output Processing Instructions
Set Output Flag 0 high (10)
Output Processing Instructions
P120 Data Transfer to TGT1
P120 Data Transfer to TGT1

Table 9.1-2 illustrates the correct programming structure.

TABLE 9.1-2 CR10X Example Program

This example makes a thermocouple and battery voltage measurement and sends data to the TGT1's buffer only when the CR10X generates an output.

NOTE Use a conditional statement (i.e., Instruction 92) to transfer data only when there is an output to final storage.

```
;
*Table 1 Program
  01:  10.0             Execution Interval (seconds)

;Measure reference temperature.
01:  Internal Temperature (P17)
  1:    1               Loc [ RefTemp   ]

;Measure thermocouple temperature.
02:  Thermocouple Temp (DIFF) (P14)
  1:    1               Reps
  2:    1               ± 2.5 mV Slow Range
  3:    5               DIFF Channel
  4:    1               Type T (Copper-Constantan)
  5:    1               Ref Temp Loc [ RefTemp   ]
  6:    2               Loc [ TCDeg_C   ]
  7:    1               Mult
  8:    0               Offset

;Measure battery voltage every 10 seconds.
03:  Batt Voltage (P10)
  1:    3               Loc [ Battery   ]

;Set Output Flag High (10) for hourly data (user defined).
04:  If time is (P92)
  1:    0               Minutes (Seconds --) into a
  2:    60              Interval (same units as above)
  3:    10              Set Output Flag High

;Timestamp data
05:  Real Time (P77)
  1:    220             Day,Hour/Minute (prev day at midnight, 2400 at midnight)
```

```
;Output hourly the average reference Temp, TC Temp, and battery voltage.
06:  Average (P71)
   1:   3              Reps
   2:   1              Loc [ RefTemp   ]

;Sample the forward and reflected power.
07:  Sample (P70)
   1:   2              Reps
   2:   4              Loc [ FwdPwr    ]

;Transfer data to TGT1 every hour.
08:  If time is (P92)
   1:   0              Minutes (Seconds --) into a
   2:   60             Interval (same units as above)
   3:   30             Then Do

;Transfer datalogger's final storage data to the TGT1, read the transmitter's latest forward and
reflected power readings, and place the results in two sequential input locations.
09:  Data Transfer to GOES (P120)
   1:   00             Buffer Selection
   2:   4              FWD/Ref Power Loc [ FwdPwr    ]

10:  End (P95)

;Set Output Flag High (10) for daily output.
11:  If time is (P92)
   1:   0              Minutes (Seconds --) into a
   2:   1440           Interval (same units as above)
   3:   10             Set Output Flag High

;Timestamp data
12:  Real Time (P77)
   1:   220            Day,Hour/Minute (prev day at midnight, 2400 at midnight)

;Average, maximize, and minimize the reference and thermocouple temperatures, the battery voltage,
and the forward and reflected power readings.
13:  Average (P71)
   1:   5              Reps
   2:   1              Loc [ RefTemp   ]

14:  Maximize (P73)
   1:   5              Reps
   2:   0              Value Only
   3:   1              Loc [ RefTemp   ]

15:  Minimize (P74)
   1:   5              Reps
   2:   0              Value Only
   3:   1              Loc [ RefTemp   ]
```

```
;Sends data to TGT1 every day.
16:  If time is (P92)
   1:    5              Minutes (Seconds --) into a
   2:    1440           Interval (same units as above)
   3:    30             Then Do

17:  Data Transfer to GOES (P120)
   1:    00             Buffer Selection
   2:    4              FWD/Ref Power Loc [ FwdPwr    ]

18:  End (P95)
```

Fire Weather-Data Transfer to the TGT1

Use instruction 124 in the place of instruction 120 to send data to the TGT1 using the RAWS Fire Weather format. Data in the RAWS Fire Weather format can be directly loaded into WIMMS. P124 is better at clearing the random buffer to turn off random transmission.

```
1: Fire Weather-Data Transfer to TGT1 (P124)
   1:    00             Fire Weather Format
   2:    00             Buffer Control
   3:    0000           FWD/Ref Power Loc [ __________ ]
```

Fire Weather Format

0 RAWS 7 output
1 xxx.x ASCII output
2 xx.xx ASCII output
3 x.xxx ASCII output
4 xxx ASCII output
5 xxxxx ASCII output

Options 1 through 5
The ASCII output is formatted as a fixed number of digits, with a fixed decimal place. For options 1 through 4, the data must be in low resolution. Option 5 can be either high or low resolution.

Option 0
The RAWS 7 (Remote Automated Weather Station, seven data values) format expects data to be stored in one, two, or three arrays, with seven data points in each array. Other output will cause this instruction to behave unpredictably. The data must be in low resolution.

The data is formatted as follows:

Data Point	Description	Units	Format
1	Hourly total rainfall	inches	xx.xx
2	Hourly average wind speed	MPH	xxx
3	Hourly vector average wind direction	degrees	xxx
4	Sample air temperature	Deg. F	xxx
5	Hourly average RH	percent	xxx
6	Hourly average fuel stick temp.	Deg. F	xxx
7	Hourly average battery voltage	VDC	xx.x

Buffer Control

Code	Description
0	self-timed buffer, appends the new data to the old
1	self-timed buffer, writes over the old data
2	random buffer, appends the new data to the old
3	random buffer, writes over the old data
9	erases random buffer without writing any data

Self-timed and Random Buffers

The GOES transmitters have two buffers. One buffer stores the self-timed data; the other stores the random.

Self-timed data are transmitted only during a predetermined time frame. All self timed data that has been transmitted are erased from the transmitter's buffer after each transmission.

Random data are transmitted immediately after a threshold has been exceeded. The transmission is then randomly repeated until the random buffer is cleared to assure it is received. Use instruction 124 with the buffer control code set to 9 to clear the random buffer.

FWD/REF Power Location

Enter the starting input location that will store the forward power reading. The next consecutive location will automatically store the reflected power reading. If you enter a 0 for this parameter, the values for forward and reflected power will not be saved in an input location.

For more information about forward and reflected power, see Section 7 and Appendix D.

Example: When the location number of this entry is 10, the forward power will be stored in input location 10 and the reflected power will be stored in input location number 11.

9.2 Program Instruction 123 - TGT-1 Auto Setup

9.2.1 Functional Description

The program instruction P123 is used for automatic setup of the TGT-1. This instruction is used in place of the Star Pound Mode (*#). P123 will transfer all the information needed to properly transmit data via the TGT-1 satellite transmitter. The information is assigned by NESDIS. See table 9.2-1 for a complete description of each parameter of P123.

P123 is only available on CR10X dataloggers with version 1.6 operating system or later, CR500 dataloggers with version 1.4 or later, and all CR23X dataloggers.

P123 should only be run once. See program example. The programming theory is as follows. Using a P91 statement determines if flag x is low, if true set flag x is high, and execute P123. When the datalogger is powered up all flags are low. The datalogger will detect flag 1 low, set flag 1 high, and execute P123. If power is lost, P123 will automatically be executed when power is restored. This is not the only way to run P123.

Some guidelines for using P123:

1. Before the datalogger is connected to the TGT-1, the datalogger clock must be set to “Coordinated Universal Time”.

2. P123 should only be run once, usually the first time through program table 1.

3. P123 will not execute properly if the keypad is in communications with the datalogger. If the keypad is connected to the logger, the keypad display must show “LOG 1” or “LOG12”.

4. P123 will not execute properly if the datalogger is connected to a PC.

5. P123 requires about 8 seconds to execute. To avoid table overrun errors, program table execution rate should not be less then 10 seconds.

6. After the initiation of P123 the datalogger and TGT-1 should not be interrupted for 1 minute or 2 times the execution rate, whichever is longer.

7. The hardware must be completely setup before power is applied to the system.

TABLE 9.2-1. P123 Parameter Descriptions

Parameter Number	Description
1 - 8	The NESDIS-assigned address. Convert the letters in the address to their decimal equivalent (Table 8.2-2). Each digit of the address is placed in one parameter.
09	NESDIS-assigned self-timed uplink channel (see Appendix E channel/ frequency correlation). If not assigned a self-timed channel, type in zeros.
10	NESDIS-assigned random uplink channel (see Appendix E for channel/ frequency correlation). If not assigned a random channel, type in zeros.
11 - 14	Self-timed transmission interval is NESDIS-assigned and usually 3 or 4 hours. Parameter 11 is days, 12 is hours, 13 is minutes, and 14 is seconds. Note: This is a 24-hour format.
15 - 17	Random transmission interval (the NESDIS-assigned time period that the transmission is randomly repeated). Parameter 15 is hours, 16 is minutes, and 17 is seconds.
18 - 20	Set the time of the initial self-timed transmission (NESDIS-assigned). Parameter 18 is hours, 19 is minutes, and 20 is seconds. Note: This is a 24-hour format.
21	Transmit window length is NESDIS-assigned and usually 1 minute. Type 0 for a 1 minute window or 1 for a 2 minute window.
22	Sets the preamble length. A long preamble increases the time the satellite can lock onto the signal but reduces the time for transmitting data. The random mode requires the short preamble. For a long preamble (7.3 seconds), type 4. For a short preamble (0.98 seconds), type 0.
23	Selects the buffer or buffers used. Type 1 to select only the self-timed buffer, a 2 to select only the random, and a 3 to select both buffers. These buffers must match Instruction P120 parameters (see Section 9).

Program example using P123 instruction

This example program will execute P123 only after the program has been compiled or when power is turned on. In this example the datalogger will configure the TGT-1 transmitter to use the NESDIS assigned address of “0104C186”, interval or self-timed channel number 151, with a 1 minute window every 4 hours. Preamble will be set to short. The random channel is not used.

```
1:  If Flag/Port (P91)
   1:   21            Do if Flag 1 is Low
   2:   30            Then Do

2:  Do (P86)
   1:   11            Set Flag 1 High

3:  Automatic Setup of TGT1 (P123)
   1:   0             Address
   2:   1             Address
   3:   0             Address
   4:   4             Address
   5:   12            Address
   6:   1             Address
   7:   8             Address
   8:   6             Address
   9:   151           Assigned Uplink Channel
   10:  0             Random Uplink Channel
   11:  0             Self-timed Interval Days
   12:  4             Self-timed Interval Hours
   13:  0             Self-timed Interval Minutes
   14:  0             Self-timed Interval Seconds
   15:  0             Random Interval Hours
   16:  0             Random Interval Minutes
   17:  0             Random Interval Seconds
   18:  1             Initial Self-timed Hours
   19:  33            Initial Self-timed Minutes
   20:  0             Initial Self-timed Seconds
   21:  0             One Minute Window
   22:  0             Short Preamble
   23:  1             Self-Timed Buffer

4:  End (P95)
```

9.3 21X

9.3.1 Instruction 99

The 21X's Instruction 99 is the same as the CR10's Instruction 99, except there is an extra parameter that specifies the array of data that is transferred to the TGT1 buffer. Instruction 99 also automatically compares the datalogger and transmitter's clocks. If the clocks differ more than 3 seconds, the datalogger's clock is set to the transmitter's. However, only the seconds are compared therefore the datalogger's clock is not reset when the minutes or hours differ. The complete time (HH:MM:SS) will be uploaded to the 21X if the clocks differ by more than 3 seconds. Table 9.3-1 lists and describes Instruction 99's parameters.

TABLE 9.3-1 21X's Instruction 99 Parameters

01:	xy	Where:	x = 0	self-timed buffer
			x = 1	random buffer
			y = 0	appends the new data to the old data
			y = 1	writes over the old data
02:	z	Where:	z>0	Starting input location for the forward power reading (see Section 7). The next input location automatically contains the reflected power reading (e.g., when the forward power's input location is 10, the reflected power's input location is 11). By placing these readings into input locations, you can sample and output the forward and reflected power as part of the data stream (21X Instruction 70).
			z = 0	The forward and reflected power readings are **NOT** placed into input locations.
03:	ID	Where:	ID>0	The array ID for the data that is transferred to the TGT1's buffer.

9.3.2 Datalogger Programming Theory

The 21X is programmed via the keyboard/ display or an IBM-PC compatible computer running PC208 software.

The datalogger's program must have this structure:

Set Output Flag 0 high (10) based on condition 1
Output Processing Instructions
P99 Data transfer to TGT1
.
.
.
Set Output Flag 0 high (10) based on condition n (n = 1,2, . . .)
Output Processing Instructions
P99 Data Transfer to TGT1

With the following structure, ONLY the last output is sent to the TGT1:

Set output Flag 0 high (10)
Output Processing Instructions
Set Output Flag 0 high (10)
Output Processing Instructions
P99 Data Transfer to TGT1
P99 Data Transfer to TGT1

Also, when a storage module is connected, special datalogger programming and a serial cable for the storage module are required; contact a Campbell Scientific applications engineer for more information.

Table 9.3-2 illustrates the correct programming structure.

TABLE 9.3-2 21X Example Program

This 21X program measures the battery voltage, performs a thermocouple measurement, and transfers an array of data to the TGT1's self-timed buffer.

NOTE Use a conditional statement (i.e., Instruction 92) to transfer data only when there is an output to final storage.

```
;{21X}
;
*Table 1 Program
  01: 10.0          Execution Interval (seconds)

;Measure reference temperature.
01: Internal Temperature (P17)
  1: 1              Loc [ RefTemp   ]

;Measure thermocouple temperature.
02: Thermocouple Temp (DIFF) (P14)
  1: 1              Reps
  2: 1              ± 5 mV Slow Range
  3: 5              DIFF Channel
  4: 1              Type T (Copper-Constantan)
  5: 1              Ref Temp Loc [ RefTemp   ]
  6: 2              Loc [ TCDef_F   ]
  7: 1.8            Mult
  8: 32             Offset

;Measure battery voltage every 10 seconds.
03: Batt Voltage (P10)
  1: 3              Loc [ Battery   ]

04: If time is (P92)
  1: 0              Minutes into a
  2: 60             Minute Interval
  3: 10             Set Output Flag High

;Designate 111 as ID for hourly data
05: Set Active Storage Area (P80)
  1: 1              Final Storage
  2: 111            Array ID or Loc [ _________ ]

;Timestamp data
06: Real Time (P77)
  1: 220            Day,Hour/Minute (prev day at midnight, 2400 at midnight)

;Output hourly the average reference Temp, TC Temp, and battery voltage.
07: Average (P71)
  1: 3              Reps
  2: 1              Loc [ RefTemp   ]
```

```
;Sample the forward and reflected power.
08:  Sample (P70)
   1:  2            Reps
   2:  1            Loc [ RefTemp   ]

;Transfer data to TGT1 every hour.
09:  If time is (P92)
   1:  0            Minutes into a
   2:  60           Minute Interval
   3:  30           Then Do

;Transfer data array ID 111 to the TGT1's self-timed buffer and places the transmitter's latest
forward and reflected power readings into Input Locations 4 and 5.
10:  Data Transfer to GOES (P99)
   1:  00           Buffer Selection
   2:  4            FWD/Ref Power Loc [ FwdPwr    ]
   3:  111          Array ID (ID>0) Transferred to TGT1'S Buffer

11:  End (P95)

;Set Output Flag High (10) for daily output
12:  If time is (P92)
   1:  0            Minutes into a
   2:  1440         Minute Interval
   3:  10           Set Output Flag High

;Timestamp data
13:  Real Time (P77)
   1:  220          Day,Hour/Minute (prev day at midnight, 2400 at midnight)

;Designate 222 as the array ID.
14:  Set Active Storage Area (P80)
   1:  1            Final Storage
   2:  222          Array ID or Loc [ _________ ]

;Average, maximize, and minimize the reference and TC temperatures, battery voltage, and the
forward and reflected power readings.
15:  Average (P71)
   1:  5            Reps
   2:  1            Loc [ RefTemp   ]

16:  Maximize (P73)
   1:  5            Reps
   2:  0            Value Only
   3:  1            Loc [ RefTemp   ]

17:  Minimize (P74)
   1:  5            Reps
   2:  0            Value Only
   3:  1            Loc [ RefTemp   ]
```

```
;Sends data to the TGT1 every day
18:  If time is (P92)
   1:    5              Minutes into a
   2:    1440           Minute Interval
   3:    30             Then Do

19:  Data Transfer to GOES (P99)
   1:    00             Buffer Selection
   2:    4              FWD/Ref Power Loc [ FwdPwr    ]
   3:    222            Array ID (ID>0) Transferred to TGT1'S Buffer

20:  End (P95)
```

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

The TGT1 transmits at 100 baud. No new 100 baud channel assignments are being given out by NESDIS so the TGT1 can only be used to fill or replace existing 100 baud channel assignments. For further information link to the following:

http://noaasis.noaa.gov/DCS/index.html

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. Detailed Forward/Reflected Power Information

D.1 Impedance Matching

The reflected power to forward power ratio shows the degree of impedance match between the transmitter and the cable/antenna assembly. The percent of power reflected approximates the impedance match with the following equation:

% power reflected = $[((\text{ref} + 17.4)/(\text{fwd} + 17.4))^2 \times 100] - 1$

This equation is an approximation because some of the power reflected to the transmitter can be reflected back to the antenna and then reflected back to the transmitter. These multiple reflections can cause incorrect readings, especially when the reflected power is large.

Impedance matching is also measured as reflection coefficient (Γ), Voltage Standing Wave Ratio (VSWR), and Return Loss (RL). Table D.1-1 correlates values between the different measurements.

Table D.1-1. Impedance Matching Correlation

% power ref	Γ	VSWR	RL
1	0.1	1.2	20
2	0.14	1.3	17
5	0.22	1.6	13
10	0.32	1.9	10
20	0.44	2.6	7
50	0.71	5.8	3
80	0.89	17.9	1

D.2 Calculating Power-Out

The amount of power going out of the transmitter at the BNC connector is approximated by the following equation:

Approx $P_{out} = (10 \log[((\text{fwd} + 17.4) \times 0.0100077)^2 \times 1000/50]) + 20.8$

This equation assumes the dBm is 50 ohms and the impedance match between the trans-mitter and the cable/antenna assembly is good (% power reflected less than 5). Table D.2-1 lists P_{out} for various values of forward power.

Table D.2-1. P_{out} Values

FWD	P_{out} (dBm)
110	+35.9
130	+37.2
150	+38.3
165	+39.0
175	+39.5
185	+39.9
195	+40.4
205	+40.8
215	+41.1
230	+41.7
250	+42.4

D.3 Impedance Match Datalogger Program

D.3.1 CR10X and CR10

This example calculates the percent of power reflected and the amount of power going out to the transmitter if the percent of power reflected is less than 5.

```
;
*Table 1 Program
  01:  10.0          Execution Interval (seconds)
;USER DEFINED PROGRAM

;Calculate the percent of power reflected with this equation: % power reflected = [((ref +17.4)/(fwd
+ 17.4))^2 x 100] -1
01:  Z=X+F (P34)
  1:   5             X Loc [ RefPwr    ]
  2:   17.4          F
  3:   8             Z Loc [ RefPlus   ]

02:  Z=X+F (P34)
  1:   4             X Loc [ FwdPwr    ]
  2:   17.4          F
  3:   9             Z Loc [ FwdPlus   ]

03:  Z=X/Y (P38)
  1:   8             X Loc [ RefPlus   ]
  2:   9             Y Loc [ FwdPlus   ]
  3:   10            Z Loc [ Scratch1  ]

04:  Z=X*Y (P36)
  1:   10            X Loc [ Scratch1  ]
  2:   10            Y Loc [ Scratch1  ]
  3:   10            Z Loc [ Scratch1  ]
```

```
05:  Z=X*F (P37)
   1:    10            X Loc [ Scratch1  ]
   2:    100           F
   3:    10            Z Loc [ Scratch1  ]

06:  Z=X+F (P34)
   1:    10            X Loc [ Scratch1  ]
   2:    -1            F
   3:    7             Z Loc [ PerRef    ]

;Calculate the amount of forward power going out to the transmitter if the % reflected is less than 5.
07:  IF (X<=>F) (P89)
   1:    7             X Loc [ PerRef    ]
   2:    4             <
   3:    5             F
   4:    30            Then Do

08:  Z=F (P30)
   1:    99.923        F
   2:    0             Exponent of 10
   3:    11            Z Loc [ Scratch2  ]

09:  Z=1/X (P42)
   1:    11            X Loc [ Scratch2  ]
   2:    11            Z Loc [ Scratch2  ]

10:  Z=X*Y (P36)
   1:    4             X Loc [ FwdPlus   ]
   2:    11            Y Loc [ Scratch2  ]
   3:    11            Z Loc [ Scratch2  ]

11:  Z=X*Y (P36)
   1:    11            X Loc [ Scratch2  ]
   2:    11            Y Loc [ Scratch2  ]
   3:    11            Z Loc [ Scratch2  ]

12:  Z=X*F (P37)
   1:    11            X Loc [ Scratch2  ]
   2:    20            F
   3:    11            Z Loc [ Scratch2  ]

13:  Z=LN(X) (P40)
   1:    11            X Loc [ Scratch2  ]
   2:    11            Z Loc [ Scratch2  ]

14:  Z=X*F (P37)
   1:    11            X Loc [ Scratch2  ]
   2:    4.3429        F
   3:    11            Z Loc [ Scratch2  ]
```

```
15:  Z=X+F (P34)
  1:   11            X Loc [ Scratch2  ]
  2:   20.8          F
  3:   6             Z Loc [ Fwd_dBm   ]

16:  Else (P94)

17:  Z=F (P30)
  1:   0             F
  2:   0             Exponent of 10
  3:   6             Z Loc [ Fwd_dBm   ]

18:  End (P95)

;Set the Output Flag High (10) every hour

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

;Timestamp hourly data
20:  Real Time (P77)
  1:   220           Day,Hour/Minute (prev day at midnight, 2400 at midnight)

;Sample the percent of power reflected and the forward power in dBm.
21:  Sample (P70)
  1:   2             Reps
  2:   6             Loc [ dBmFwd    ]

;Transfer data to the TGT1 when Output Flag is set High (10).
22:  Data Transfer to GOES (P120)
  1:   00            self-timed buffer/append new data to old data
  2:   4             FWD/Ref Power Loc [ FwdPwr    ]
```

D.3.2 21X

The 21X's program is the same as the CR10X and CR10's, except Instruction 99 has an extra parameter. With this parameter, you specify the array of data that is transferred to the buffer (see Section 9.2).

Appendix E. Channel/Frequency Correlation

Channel	Frequency (MHz)	Channel	Frequency
1	401.7010	50	401.7745
2	401.7025	51	401.7760
3	401.7040	52	401.7775
4	401.7055	53	401.7790
5	401.7070	54	401.7805
6	401.7085	55	401.7820
7	401.7100	56	401.7835
8	401.7115	57	401.7850
9	401.7130	58	401.7865
10	401.7145	59	401.7880
11	401.7160	60	401.7895
12	401.7175	61	401.7910
13	401.7190	62	401.7925
14	401.7205	63	401.7940
15	401.7220	64	401.7955
16	401.7235	65	401.7970
17	401.7250	66	401.7985
18	401.7265	67	401.8000
19	401.7280	68	401.8015
20	401.7295	69	401.8030
21	401.7310	70	401.8045
22	401.7325	71	401.8060
23	401.7340	72	401.8075
24	401.7355	73	401.8090
25	401.7370	74	401.8105
26	401.7385	75	401.8120
27	401.7400	76	401.8135
28	401.7415	77	401.8150
29	401.7430	78	401.8165
30	401.7445	79	401.8180
31	401.7460	80	401.8195
32	401.7475	81	401.8210
33	401.7490	82	401.8225
34	401.7505	83	401.8240
35	401.7520	84	401.8255
36	401.7535	85	401.8270
37	401.7550	86	401.8285
38	401.7565	87	401.8300
39	401.7580	88	401.8315
40	401.7595	89	401.8330
41	401.7610	90	401.8345
42	401.7625	91	401.8360
43	401.7640	92	401.8375
44	401.7655	93	401.8390
45	401.7670	94	401.8405
46	401.7685	95	401.8420
47	401.7700	96	401.8435
48	401.7715	97	401.8450
49	401.7730	98	401.8465
		99	401.8480

100	401.8495	150	401.9245
101	401.8510	151	401.9260
102	401.8525	152	401.9275
103	401.8540	153	401.9290
104	401.8555	154	401.9305
105	401.8570	155	401.9320
106	401.8585	156	401.9335
107	401.8600	157	401.9350
108	401.8615	158	401.9365
109	401.8630	159	401.9380
110	401.8645	160	401.9395
111	401.8660	161	401.9410
112	401.8675	162	401.9425
113	401.8690	163	401.9440
114	401.8705	164	401.9455
115	401.8720	165	401.9470
116	401.8735	166	401.9485
117	401.8750	167	401.9500
118	401.8765	168	401.9515
119	401.8780	169	401.9530
120	401.8795	170	401.9545
121	401.8810	171	401.9560
122	401.8825	172	401.9575
123	401.8840	173	401.9590
124	401.8855	174	401.9605
125	401.8870	175	401.9620
126	401.8885	176	401.9635
127	401.8900	177	401.9650
128	401.8915	178	401.9665
129	401.8930	179	401.9680
130	401.8945	180	401.9695
131	401.8960	181	401.9710
132	401.8975	182	401.9725
133	401.8990	183	401.9740
134	401.9005	184	401.9755
135	401.9020	185	401.9770
136	401.9035	186	401.9785
137	401.9050	187	401.9800
138	401.9065	188	401.9815
139	401.9080	189	401.9830
140	401.9095	190	401.9845
141	401.9110	191	401.9860
142	401.9125	192	401.9875
143	401.9140	193	401.9890
144	401.9155	194	401.9905
145	401.9170	195	401.9920
146	401.9185	196	401.9935
147	401.9200	197	401.9950
148	401.9215	198	401.9965
149	401.9230	199	401.9980

Appendix F. Data Dump Datalogger Program

F.1 Introduction

The data dump program inserts 20 data points (60 bytes) into the transmitter's random buffer when user FLAG 1 is manually toggled HIGH. The buffer is cleared when the user FLAG 2 is set HIGH.

F.2 Toggling User FLAG 1 HIGH

You start by typing in *6AD to enter the FLAG Status Mode. [00:00:00:00] is displayed, indicating user FLAGS 1 through 8 are set low. To toggle user FLAG 1 HIGH, type 1. After the display shows [10:00:00:00], type *0. When the data points are in the buffer, [00:00:00:00] is displayed.

If the display shows [00:00:00:00] before *0 is typed, the data dump failed. To try again, type a 1 and a *0. Twenty seconds after the display shows LOG1, type *6AD. When [00:00:00:00] is displayed, the data points are in the buffer. The FLAG Status Mode is exited by setting the scan rate to 0 (*1A0A) then typing in *0.

F.3 Checking the Buffer

Check the buffer for the 20 data points (60 bytes) with *#60 commands 7 and 5 (see Section 8.3). If the display shows a number other than 60, the data dump failed. You must then reset the scan rate to 10 and return to the Flag status mode to set user FLAG 1 HIGH (see Section F.2).

F.4 Test Transmission

CAUTION The antenna must be connected before the test or the transmitter will be damaged.

To cause the TGT1 to transmit, use *#60 command 8. The transmission will last less than 5 seconds. To verify transmission occurred, check forward and reflected power (*#60 command 3). The TGT-1 will not perform a test transmission more often than once each minute.

F.5 Toggling User FLAG 2 HIGH

After the test transmission, the random buffer **MUST BE** cleared or the data will be randomly transmitted throughout the transmission interval. The buffer is cleared by setting the scan rate to 10 and typing *6AD2 which sets user FLAG 2 HIGH. After the display shows [01:00:00:00], type in *0. If [00:00:00:00] is shown before *0 is typed, you must type in a 2 and a *0.

After waiting twenty seconds, set the scan rate to 0 and check the buffer with *#60 commands 7 and 5. If a number other than 0000 is displayed, the steps for setting user FLAG 2 HIGH must be repeated.

F.6 CR10X Data Dump Program

```
;
*Table 1 Program
  01:  10.0          Execution Interval (seconds)

01:  If Flag/Port (P91)
  1:   11            Do if Flag 1 is High
  2:   30            Then Do

02:  Do (P86)
  1:   10            Set Output Flag High

03:  Sample (P70)
  1:   20            Reps
  2:   1             Loc [ Data      ]

;Transfer "test" data of 20 zeros (60 bytes) to Random buffer for test transmission
04:  Data Transfer to GOES (P120)
  1:   11            random buffer/overwrite the old data
  2:   1             FWD/Ref Power Loc [ Data      ]

05:  Do (P86)
  1:   21            Set Flag 1 Low

06:  End (P95)

07:  If Flag/Port (P91)
  1:   12            Do if Flag 2 is High
  2:   30            Then Do

;Clear Random buffer to prevent random transmissions.
08:  Data Transfer to GOES (P120)
  1:   11            random buffer/overwrite the old data
  2:   1             FWD/Ref Power Loc [ Data      ]

09:  Do (P86)
  1:   22            Set Flag 2 Low

10:  End (P95)
```

F.7 21X Data Dump Program

The 21X's program is the same as the CR10X and CR10's, except Instruction 99 has an extra parameter. With this parameter, you specify the array of data that is transferred to the buffer (see Section 9.2).

Appendix G. Local Magnetic Declination

G.1 Determining True North

Orientation of the antenna is done after the location of True North has been found.

1. Establish a reference point on the horizon for True North (or other direction relative to True North). True North is usually found by reading a magnetic compass and applying the correction for magnetic declination as discussed below. Other methods employ observations using the North Star or the sun, and are discussed in the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV - Meteorological Measurements[4].

A general map showing magnetic declination for the contiguous United States is shown in Figure G-1. Magnetic declination for a specific site can be obtained from a USGS map, local airport, or through a computer service offered by the USGS called GEOMAG (recommended). Section G.2 has a listing of the prompts and the declination determined by GEOMAG for a site near Logan, Utah.

Declination angles east of True North are considered negative, and are subtracted from 0 degrees to get True North as shown in Figure G-2. Declination angles west of True North are considered positive, and are added to 0 degrees to get True North as shown in Figure G-3.

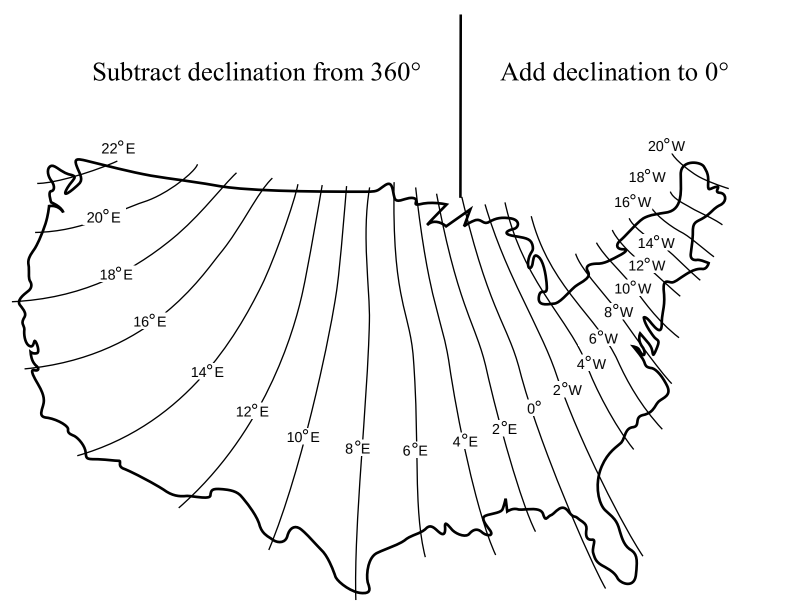

FIGURE G-1. Magnetic Declination for the Contiguous United States

G.2 Prompts from GEOMAG

GEOMAG is accessed by calling 1-800-358-2663 with a computer and telephone modem, and communications program such as TERM or GraphTerm (PC208 Software). GEOMAG prompts the caller for site latitude, longitude, and elevation, which it uses to determine the magnetic declination and annual change. The following Menu and prompts are from GEOMAG:

MAIN MENU

Type
- Q for Quick Epicenter Determinations (QED)
- L for Earthquake Lists (EQLIST)
- M for Geomagnetic Field Values (GEOMAG)
- X to log out

Enter program option: M

Would you like information on how to run GEOMAG (Y/N)? N

Options:

1 = Field Values (D, I, H, X, Z, F)
2 = Magnetic Pole Positions
3 = Dipole Axis and Magnitude
4 = Magnetic Center [1] : 1

Display values twice	[N]: press return
Name of field model	[USCON90]: press return
Date	[current date]: press return
Latitude	: 42/2 N
Longitude	: 111/51/2 W
Elevation	: 4454
Units (m/km/ft)	: ft

Example of report generated by GEOMAG:

Model: USCON90	Latitude: 42/2 N
Date : 7/27/93	Longitude: 111/51/2 W
	Elevation: 4454.0 ft

D
deg min

15 59.6

Annual change:

0 -6.1

The declination in the example above is listed as 15 degrees and 59.6 minutes. Expressed in degrees, this would be 15.99 degrees. As shown in Figure G-1, the declination for Utah is east, so True North for this site is 360 - 15.99, or 344 degrees. The annual change is -6.1 minutes.

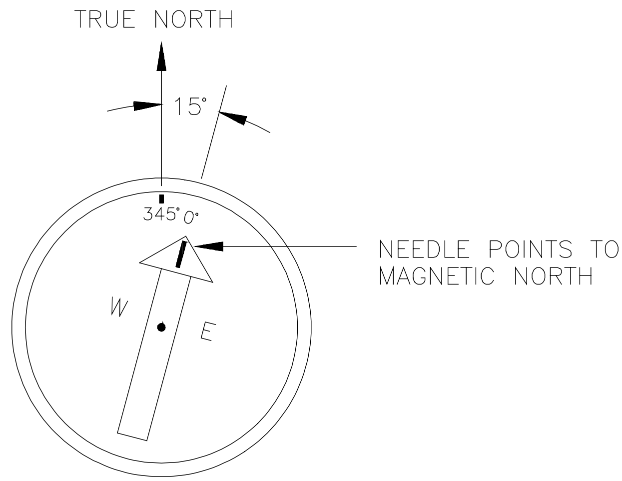

FIGURE G-2. Declination Angles East of True North

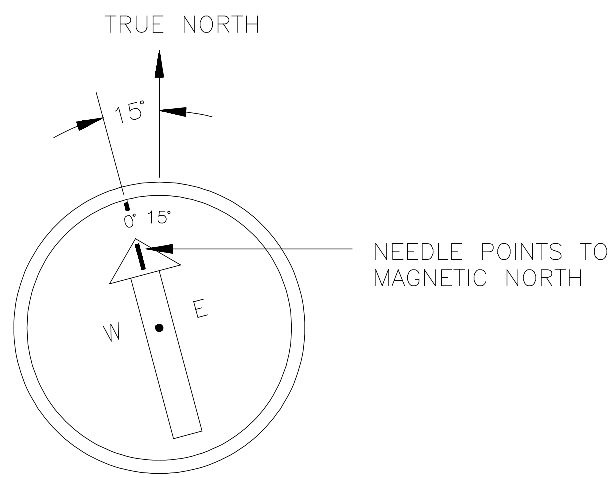

FIGURE G-3. Declination Angles West of True North

Appendix H. Changing the CR10's RAM or PROM Chips

This section describes changing the CR10's PROM, not the CR10X's; the CR10X already contains Instruction 99. The CR10 has two sockets for Random Access Memory (RAM) and one socket for Programmable Read Only Memory (PROM). The standard CR10 has 64K of RAM, (a 32K RAM chip in each socket). Earlier CR10s had 16K of RAM (an 8K RAM chip in each socket).

H.1 Disassembling the CR10

The sockets provided for RAM and PROM are located on the CR10 CPU circuit card inside the CR10 can. To expose the RAM and PROM sockets, remove the two phillips head screws from the end opposite the connectors. Remove the end cap. The ends of two circuit cards and the RF shield will be visible (see Figure H-1). Now lay the CR10 on a flat surface, (i.e., a table), and push on the RF shield with your thumbs while grasping the can with your hands. Remove the circuit cards from the can. Orient the cards with the connector on the left and with the card that matches Figure H-2. The Central Processing Unit (CPU) is found at location H-9 and the three slots for RAM and PROM will be directly beneath it.

H.2 Installing New RAM Chips in CR10s with 16K RAM

The two 8K RAM chips are found at locations C-11 and C-14. With a small flat screw driver gently pry out the two 8K RAM chips at these locations and replace them with the 32K RAM chips provided in the memory upgrade. The new chips should be installed so the notched end is towards the nearest card edge. Before pushing the chips into the socket make certain that all the pins are correctly seated. After installing the 32K chips check for pins that may be bent or not firmly seated in the socket. If you notice a bent pin, remove the chip, carefully straighten it and repeat the installation procedure.

H.2.1 Changing Jumpers

There are six jumpers used to configure hardware for different RAM sizes. Figure H-2 shows the jumper settings for different memory configurations. A pin or small screw driver tip will work best for pulling these jumpers and relocating them as shown in Figure H-2.

H.2.2 RAM Test

Attach the CR10KD Keyboard/Display and apply power to the CR10. After the CR10 executes the RAM/PROM self test, the number 96 should be displayed in the window. The number is the sum of Kbytes in RAM (64) plus the number of Kbytes in ROM (32).

H.3 Installing New PROM

The PROM chip is found at location C8 on the CR10 CPU board, (see Figure H-2). With a small flat screw driver, gently pry out the PROM chip and replace it with the new one. The new chip should be installed so that the notched end is towards the nearest card edge. Before pushing the chip into the socket make certain that all the pins are seating correctly. After installing the chip check for pins that may be bent or not making contact. If you notice a bent pin, remove the chip, carefully straighten it and repeat the installation procedure.

To make certain that the new chip is installed correctly enter the CR10 *B mode, and advance to the second window. This window displays the PROM signature. The five digit number in the window should match the PROM signature given with the new PROM documentation. If the numbers are different disassemble the CR10 and look for pins that are bent or not firmly seated.

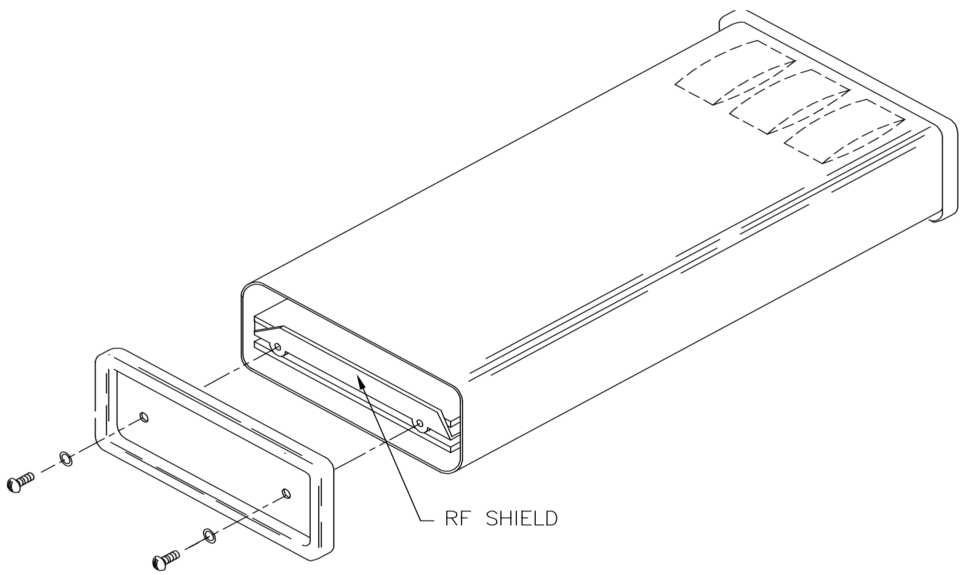

FIGURE H-1. Disassembling CR10

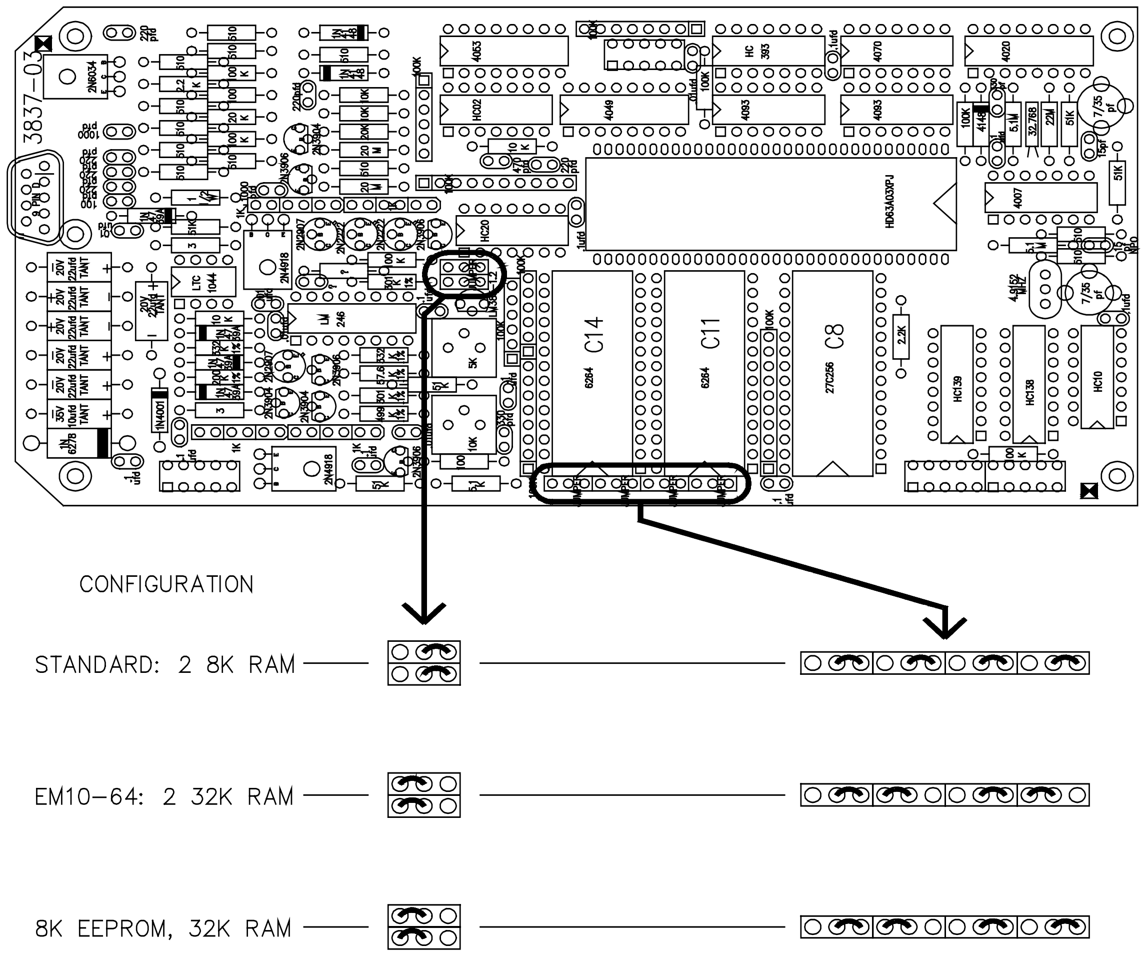

FIGURE H-2. Jumper Settings for Different RAM Configurations

Appendix I. Changing the 21X's RAM or PROM Chips

The 21X has 8 sockets for memory chips. Five sockets hold 8K Random Access Memory (RAM) chips and three hold Programmable Read Only Memory (PROM) chips. Older 21Xs may have two PROM chips and as few as two RAM chips.

I.1 Disassembly of 21X

1. Turn power off, remove the two Phillips head screws located near the edges of the front panel of the micrologger. Carefully lift the micrologger up and away from the battery pack and disconnect the plastic power connector.

2. Lay the micrologger face down on a padded surface. Remove the four Phillips head screws from the corners of the aluminum back plate. Lift the back plate up and away to expose the 21X CPU board. Figure I-1 shows the CPU card; the memory chips are in the lower right hand corner. The locations numbered 1-5 hold RAM chips. Locations 8, 7, and 6 hold PROM chips.

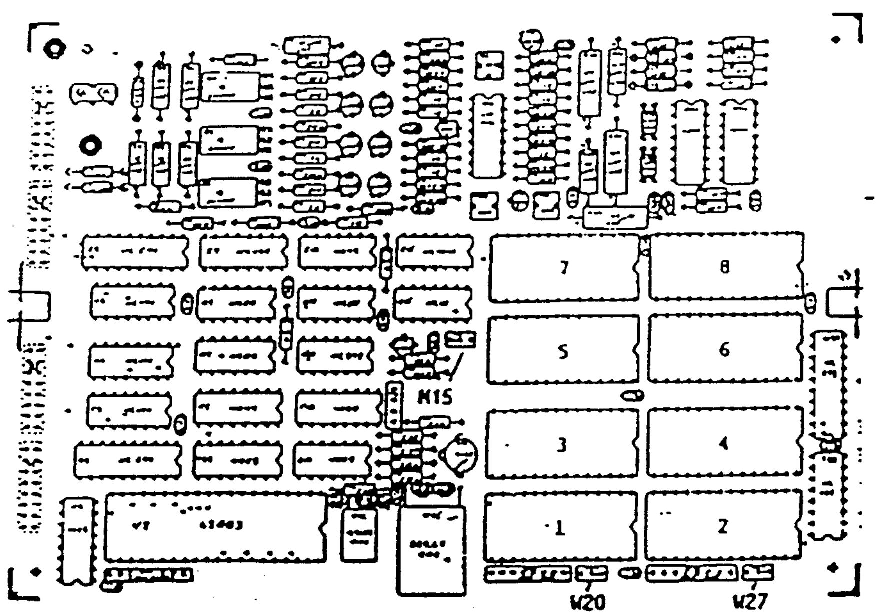

FIGURE I-1. Memory Sockets on CPU Card

I.2 Installing New RAM Chips

The standard 21X has the maximum memory allowable. In the unlikely event that a RAM chip fails, the 21X can detect the bad chip during its power-up memory check. As a result of this check the 21X displays the status of the memory chips as a sequence of 1s and 0s, each representing a chip with the status of chip 1 on the left and 8 on the right; 0 indicates a bad chip. For example, 11011111 indicates that chip 3 (Figure I-1) is bad.

To replace a RAM chip carefully pry the old chip with a small flat blade screwdriver, start at one end and then loosen the other, alternating until the chip is free. The new chip should be installed with the notched end in the same direction as the other chips, to the right side of the card in Figure I-1. Before pushing the chips into the socket, make certain that all pins are correctly seated. After installing the chip, check for pins that may be bent or not firmly seated in the socket. If there is a bent pin, remove the chip, carefully straighten the pin and reinstall the chip.

The earliest 21Xs were shipped with only two 4K RAM chips. Current software does not check for this condition; if an old 21X is being upgraded to new software PROMS, five 8K RAM chips (CSI Model number EMX8) should also be installed.

The older 21X has jumpers at locations M15, W20, and W27 (Figure I-1). With 8K RAM chips installed, M15 should be jumpered on the right set of pins and W20 and W27 should be jumpered on the left set of pins.

After changing RAM chips reassemble the 21X, turn on the power and confirm that the power-up check shows all good RAM.

I.3 Changing PROM Chips

PROMs are installed at locations 6, 7, and 8 in Figure I-1. The procedure for changing a PROM is the same as for a RAM chip, carefully pry out the old chip and insert the new one, being certain that the notch on the chip is toward the close edge of the card and that all pins are correctly seated in the sockets.

In general, the PROM chip with the lowest number is inserted in socket 8 and the PROM with the highest number in socket 6, but check the documentation received with the PROM update to be sure.

After changing PROMS, reassemble the 21X and turn on the power. Confirm that the power-up check indicates that all PROMS and RAM are good. Then check the signature in the *B Mode to be certain that they match those sent with the documentation for the PROMS.

Appendix J. Telonics Model TGT1 Certification by NOAA/NESDIS

CERTIFICATE NUMBER

39

NATIONAL ENVIRONMENTAL SATELLITE SERVICE

CERTIFIES THAT TELONICS, INC

MODEL MODEL NOS. TGT-1 and TGT-2

HAS BEEN TYPE TESTED AND MEETS THE REQUIREMENTS FOR USE IN THE GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE DATA COLLECTION SYSTEM.

CONDITION

If design changes or modifications are made that affect its technical performance as specified in the certification standards for this type of equipment, recertification of this model shall be required before placing in operation.

*In accordance with NESDIS Specifications §23.012 and §23.010 dated November 16, 1981, for random reporting and self-timed operation and in accordance with Annex 4 of the International Data Collection System's Users' Guide.

Director, Office of Systems Development (Signature)

W. John Hussey

DATE

3/2/93

NOAA FORM 83-1
(6-80)

GOES/RADIO SET CERTIFICATION

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Appendix K. 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		