Product Manual

Communications
Device

TX326

Satellite Transmitter for METEOSAT

Revision: 10/2021

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC

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1. Introduction

The TX326 is a satellite transmitter that uses the Meteosat/EuroSat satellite system to provide one-way communications from a data collection platform (DCP) to a receiving station.

Meteosat/EuroSat is a system of geostationary meteorological satellites operated by EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites). Geostationary satellites have orbits that coincide with the Earth's rotation, allowing each satellite to remain above a specific region. EUMETSAT is an intergovernmental organization created through an international convention of European countries.

2. Precautions

- READ AND UNDERSTAND the Safety section at the back of this manual.
- Although the TX326 is rugged, it should be handled as a precision scientific instrument.
- A proper antenna connection is required before transmission occurs. Failure to use a properly matched antenna cable and antenna may cause permanent damage to the radio frequency (RF) amplifiers.
- The TX326 requires an active GPS antenna with a maximum gain of 25 dB. The TX326 will supply 3.3 V to the active GPS antenna.

3. Initial inspection

- Upon receipt of the TX326, inspect the packaging and contents for damage. File damage claims with the shipping company.
- Check the ships with list to ensure all components are received.

4. QuickStart

Use our Device Configuration Utility to enter the required European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) information that is unique to each data collection platform (DCP). This QuickStart is for the CR6 (≥OS 10), CR300-series (≥OS 10), CR1000X (≥OS 4), and GRANITE-series (≥OS1) data loggers.

1. Connect the data logger **RS-232** to the TX326 **RS-232** connector and connect the data logger to a power supply. Also ensure the TX326 has power.
2. Connect to the data logger using Device Configuration Utility.
    a. Do the following to directly connect your data logger to the Device Configuration Utility:
        i. Use the USB cable to connect the data logger to the computer.
        ii. Click your data logger model for the **Device Type** in the Device Configuration Utility.
        iii. Click **Direct** for the **Connection Type**.
        iv. Select the **COM port** on the computer to which the data logger is connected.
        v. Click **Connect**.
    b. For data loggers on an IP connection, do the following to remotely connect with the Device Configuration Utility:
        i. Click your data logger model for the **Device Type** in the Device Configuration Utility.
        ii. Click **IP** for the **Connection Type**.
        iii. Type the **Server Address**.
        iv. Type the **PakBus/TCP Password**.
        v. Click **Connect**.
3. Click the **Settings Editor** tab.

4. Click the **GOES Radio** sub tab (FIGURE 4-1 (p. 3)).

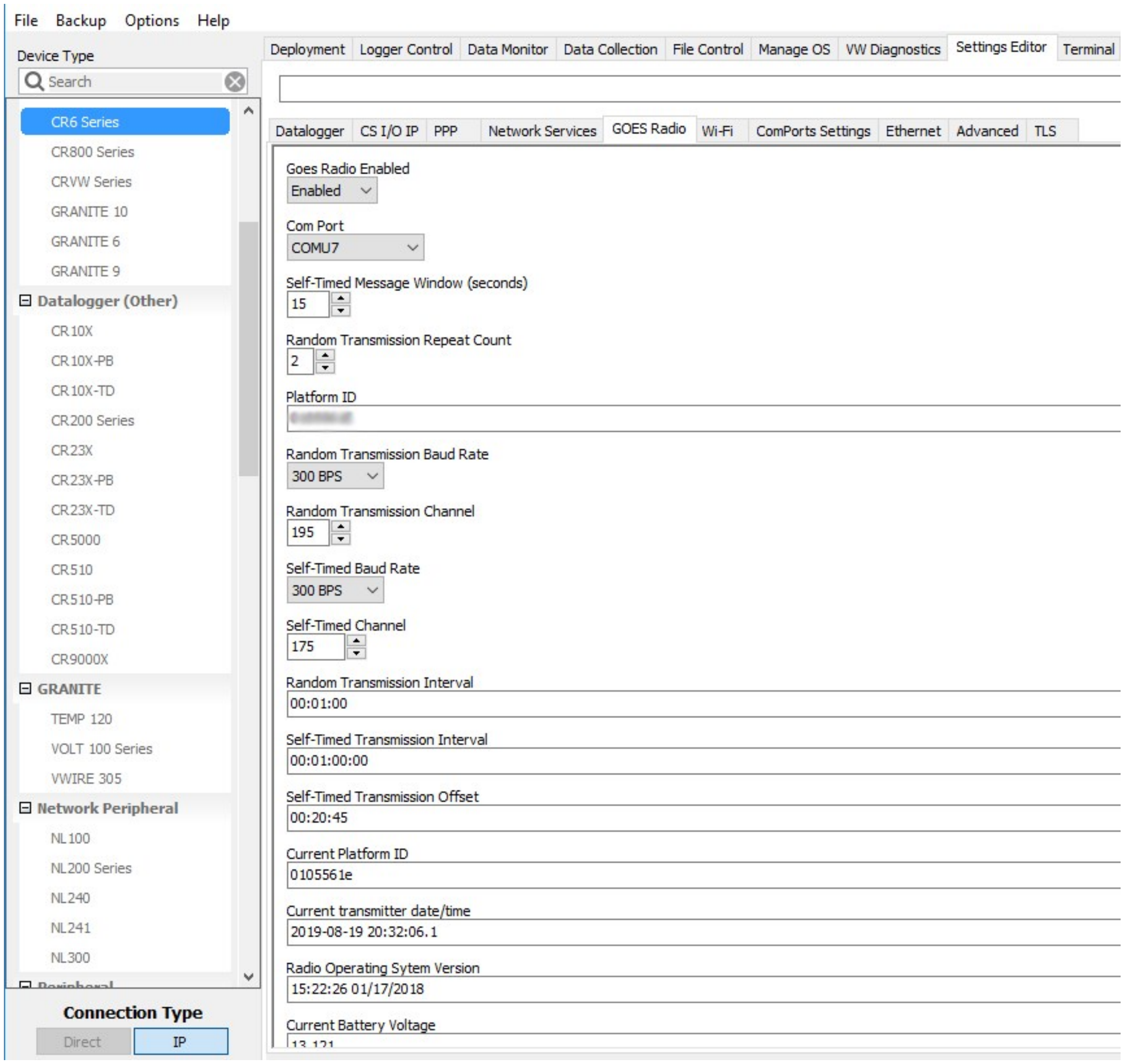
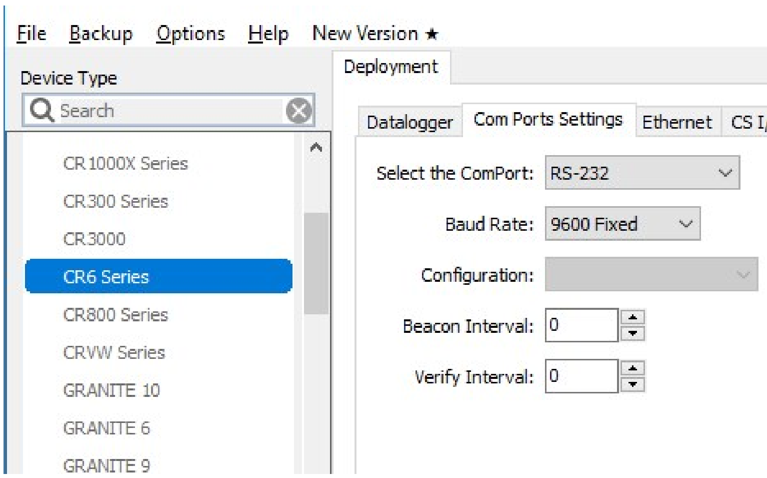


FIGURE 4-1. Device Configuration Utility GOES Radio screen

5. Select **Enabled** from the **Goes Radio Enabled** field.
6. Select the **Com Port** to which the GOES radio is connected.
7. Type the **Self-timed Message Windows (in seconds)** as assigned by EUMETSAT.
8. Type the **Platform ID** (in HEX) as assigned by EUMETSAT.
9. Select the **Random Transmission Baud Rate** as assigned by EUMETSAT.
10. Type the **Random Transmission Channel** as assigned by EUMETSAT.
11. Select the **Self-Time Baud Rate** as assigned by EUMETSAT.

12. Type the **Self-Time Channel** as assigned by EUMETSAT.
13. Type the **Random Transmission Interval** as assigned by EUMETSAT. Format is hh:mm:ss.
14. Type the **Self-timed Transmission Interval** as assigned by EUMETSAT. Format is dd:mm:hh:ss.
15. Type the **Self-timed Transmission Offset** as assigned by EUMETSAT. Format is hh:mm:ss.
16. Click the **Deployment** tab.
17. Click the **Com Port Settings** sub tab.
18. Select 9600 for the **Baud Rate**.



19. Click **Apply** to save the changes.

Now the settings are stored in the data logger. CRBasic programming is required to push data over the network. The `GOESTable()` and `GOESField()` CRBasic instructions used in conjunction with `DataTable()` facilitate the transmission of data across the GOES satellite network.

4.1 Data collection platform (DCP) installation

1. Yagi antenna installation procedure:
   a. Mount the Yagi antenna to a pole or mast by using the U-bolts included with the antenna mount.

b. Attach elements to boom.

> **NOTE:**
> When attaching elements to the boom, make sure to place them such that the number of grooves on the element equals the number of dimples on the boom. For example, the element with four grooves should be placed at the spot on the boom with four dimples, and so forth.

c. Aim the Yagi antenna at the spacecraft; azimuth and elevation angle positions are included on the bracket label.

2. GPS antenna installation procedure:

   a. Connect the GPS cable to the GPS antenna.

   b. Route the cable through the 0.75-inch IPS threaded pipe and insert the pipe into the GPS antenna.

c. Mount the 0.75-inch IPS threaded pipe to a crossarm by using the Nu-Rail® fitting, or CM220 mounting bracket.

> **CAUTION:**
> The GPS antenna will not receive a GPS signal through steel roofs or steel walls. Concrete might also be a problem. Heavy foliage, snow, and ice will attenuate the GPS signal.

3. Mount the TX326, the power supply, and the data logger to the backplate of an enclosure.
4. Mount the enclosure and solar panel to the pole or tripod.

5. Connect the COAXNTN cable to the Yagi antenna. Route the COAXNTN cable through the enclosure conduit and connect it to the **RF Out** connector on the TX326 (FIGURE 4-2 (p. 7)).

FIGURE 4-2. TX326 connectors

6. Route the GPS antenna cable through the enclosure conduit and connect it to the **GPS** connector on the TX326 (FIGURE 4-2 (p. 7)).
7. Plug the green connector from the power supply to the green receptacle on the TX326.
8. Connect the data logger to the TX326 **RS-232** terminal.
9. Route the solar panel cable through the enclosure conduit and connect the red and black wires to the CHG terminals on the CH150, CH200, or CH201.

5. Overview

The TX326 can transmit either self-timed or random messages to the Meteosat/EuroSat satellites. In a typical configuration, the TX326 is connected to a data logger via an RS-232 serial connection. The data logger makes measurements, then formats those values to create a data packet, which is transferred to the transmitter at time of transmission. The data logger buffers the message until its transmission window (or random transmission time), then transmits the data. Supported transmission rates are 100 (SRDCP) and 1200 (HRDCP) bps.

GPS is required for the radio to work in the Meteosat/EuroSat network. All the radios in the network must have exact timing of their transmissions so they don't step on each other during transmissions. Extremely accurate timing is obtained from the integrated GPS receiver (±100 µs), and the internal clock is capable of maintaining accurate time for a minimum of six days without a GPS fix. If the TX326 finds itself without an accurate time, it suspends data transmissions until an accurate time is obtained. The GPS time is synched every 11 hours. The data logger clock is synched with the GPS time of the TX326.

Features:

- EUMETSAT SDR and HDR certified
- Based on Signal Engineering OmniSat3 design
- Compatible with Meteosat/EuroSat satellite data collection system
- Easy integration with Campbell Scientific data loggers
- Field tested and proven track record of reliability
- Embedded GPS receiver for stabilized internal time keeping and transmit frequency for long service intervals
- Low standby current consumption for battery-powered systems at remote DCP installation sites
- Quick assessment of radio health via monitoring of diagnostic data from the radio
- Compatible CRBasic data loggers: GRANITE series, CR6, CR1000X, and CR300 series

5.1 Meteosat/EuroSat system

Meteosat/EuroSat is a system of geostationary meteorological satellites operated by European Organization for the Exploitation of Meteorological Satellites (EUMETSAT). Geostationary satellites have orbits that coincide with the Earth's rotation, allowing each satellite to remain above a specific region. FIGURE 5-1 (p. 9) shows the coverage of each satellite. EUMETSAT is an intergovernmental organization created through an international convention of European countries. For Meteosat DCP registration information, refer to: www.eumetsat.int/website/home/Data/MeteosatDataCollectionServices/index.html.

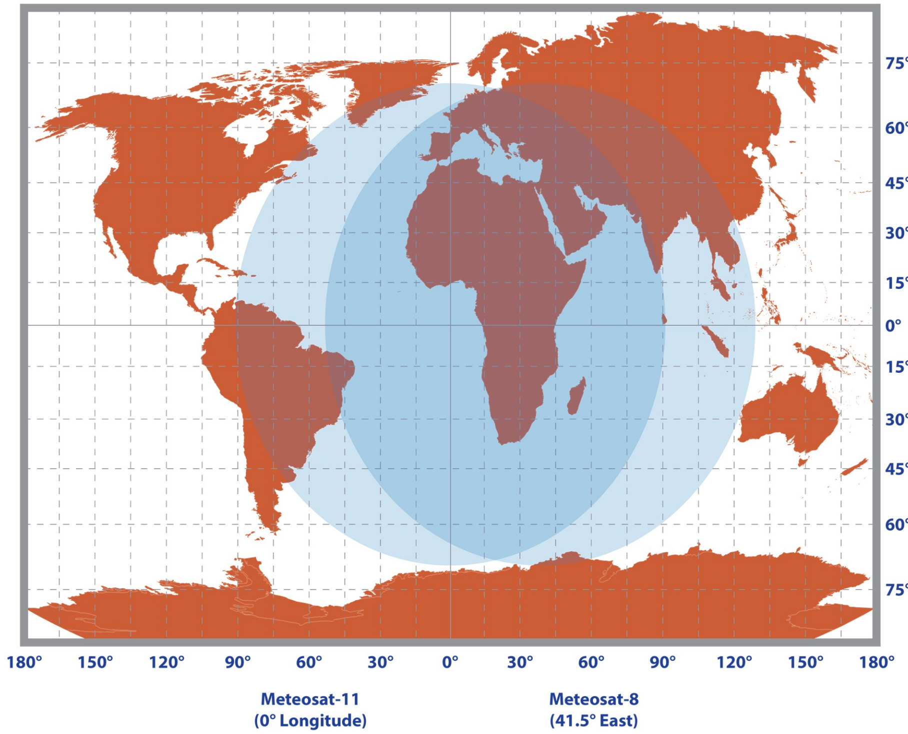


FIGURE 5-1. Coverage of the Meteosat-11 and Meteosat-8 satellites

6. Specifications

Compliance documents:	View at www.campbellsci.com/tx326
EUMETSAT DCP Radio Certification (2013-003):	EUMETSAT 2013-003-DCP-SDR (17 July 2013) for standard rate (100 bps) EUMETSAT 2015-001-DCP-HDR (12 March 2015) for high rate (1200 bps)
Transmissions supported:	Timed (Scheduled), Random
Data formats:	ASCII data with restrictions, ASCII data, binary data, pseudo binary (1200 baud only), Meteosat alert message
Radio module:	OmniSat-3

Temperature range	
Operating:	–40 to 60 °C
Storage:	–55 to 75 °C
Case dimensions	
Without connectors:	15.88 x 12.7 x 4.57 cm (6.25 x 5 x 1.8 in)
With connectors:	15.88 x 14.99 x 4.57 cm (6.25 x 5.9 x 1.8 in) additional clearance required for cables, wires, and antennas
Weight:	0.77 kg (1.7 lb)
Supply voltage range:	10.5 to 16 VDC
Current drain at 12 VDC	
While transmitting:	<2.75 A (1.8 typical)
Standby:	< 5 mA (2.8 typical)
During GPS acquisition:	<40 mA (25 mA typical)
Baud rates:	100 (tolerance ±0.005 bps) and 1200 bps (tolerance ±0.06 bps)
Transmit power	
Maximum:	42 dBm (100 bps), 50 dBm (1200 bps)
Maximum EIRP:	52 dBm (100 dBm), 50 dBm (1200 bps); based on a 11 dbm gain antenna with 1 dbm line loss
Typical EIRP:	47 to 50 dBm (100 bps), 40 to 50 dBm (1200 bps)
Frequency range	
Meteosat:	402.0355 MHz (channel #1) to 402.4345 MHz (channel #267) (267 channels with a 1.5 KHz channel bandwidth each.)
International:	402.0025 MHz (channel #268) to 402.034 MHz (channel #289) (21 channels reassigned from international bandwidth 1.5 KHz)
Initial frequency stability:	±20 Hz disciplined to GPS (GPS fix occurs after power up and once per day thereafter)
Channel bandwidth:	1500 Hz (100/1200 bps)

GPS receiver

> NOTE:
> The TX326 can source up to 19 mA at 2.7 V for an external GPS antenna. Campbell Scientific recommends a maximum antenna Low-Noise Amplifier (LNA) of 1.5 dB.

Maximum RF input gain:	3.3 V active
Receiver type:	25 dB

Timekeeping

Initial accuracy:	±100 µs (synchronized to GPS)
Drift:	±40 ms/day (without GPS)
GPS schedule:	1 fix at power up (updated at ~11-hour rate)
Transmission continuation without GPS fix:	6 days

Interface connectors

RS-232:	DB9 F, DCE, 3-wire RS-232
Satellite RF transmit out:	Type N jack
GPS:	SMA jack
Power:	2-pin screw terminal, 0.2 in. pitch

7. Installation

7.1 Field site requirements

The GPS antenna must have a clear view of most of the sky and the transmission antenna must have a clear view of the spacecraft. The TX326 must be installed in a well desiccated, environmentally sealed enclosure. Its mounting plate has keyholes for securing the TX326 to the backplate of a Campbell Scientific enclosure. Most Meteosat/EuroSat systems are powered by a battery charged by a solar panel. The solar panel must have a clear view of the southern sky. Pay special attention to winter sun angles.

7.2 LED function

A green **Status** LED and a red **Failsafe** LED indicate the state of the TX326 transmitter by using various blink patterns. Table 7-1 (p. 12) and Table 7-2 (p. 13) provide the blink patterns for the green **Status** and red **Failsafe** LEDs, respectively.

Table 7-1: Green LED Status indicator blink patterns

Blink pattern	Indicates
At power up, blinks on and off two times.	Normal software is running. RS-232 control interfaces enabled. Power-up initialization complete and ready to receive commands.
At power up, blinks on and off three times.	Bootloader software is running. Ready to load new operating system.
On continuously.	Transmitter failed to start up normally after power up. Turn the transmitter off and on to reboot.

Table 7-2: Red LED Failsafe indicator blink patterns	
Blink pattern	**Indicates**
Blinks on and off four times per second.	A transmission is in progress.
Blinks on and off two times per second for 30 s.	The post-transmit interval is in progress. The transmitter enters this state after its RF output is turned off either by a **Reset** command or by the normal completion of a data message transmission. The radio needs to wait 30 seconds before making another transmission to keep it from going into **Failsafe** mode.
On continuously.	TX326 is in the **Failsafe** mode. To clear a **Failsafe** mode, push the **Reset** button (FIGURE 8-1 (p. 20)). A power cycle will NOT clear the **Failsafe** mode.

7.3 Ports and connectors

The RS-232 port is a DB9 male connector configured as DTE. 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 TX326. The RS-232 port allows the transmitter to be connected to a data logger. Refer to the following table for the cable options and data logger connection.

Table 7-3: Cable options, data logger compatibility, and data logger connections		
Cable description	**Compatible data loggers**	**Data logger connection**
RJ45 to DB9 female cable (-R option when ordered with the TX326)	Granite-series, CR6, CR1000X	**RS-232/CPI** RJ45 port
SC110 TX/RX cable (-C option when ordered with the TX326)	Granite-series, CR6, CR1000X	White: Odd **C** or **U** terminal Brown: Even **C** or **U** terminal Yellow: **G** Clear: **G** or ⏚
RS-232 DB9 female to DB9 male serial cable (-S option when ordered with the TX326)	CR300-series	**RS-232** 9-pin port

The **RF Out** connector is for attaching the transmission antenna. A properly matched antenna cable and antenna must be connected to the TX326 before transmission occurs.

WARNING:
Failure to use a properly matched antenna cable and antenna may cause permanent damage to the radio frequency (RF) amplifiers.

The **GPS** port on the TX326 is an SMA female connector for attaching an active 3.3 V GPS antenna. Operation without a GPS antenna connected will not cause damage, but the transmitter will not transmit without a valid GPS fix. The 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.

The TX326 power connector has two pins: ground and 12 V for connection of the power supply. The input power requirement is 10.5 to 16 VDC can use up to 2.5 A. A power supply consisting of a CH150, CH200, or CH201 regulator, BP12 or BP24 battery, and a solar panel typically can support these requirements. For this power supply, the regulator connects to the TX326 power connector.

7.4 Transmission antenna

The TX326 transmission antenna is a right-hand circular polarized Yagi with 11 dBi gain. A bracket is included with the antenna for mounting to a mast or pole. 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. 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 quickly.

NOTE:
When attaching elements to the boom, make sure to place them such that the number of grooves on the element equals the number of dimples on the boom. For example, the element with four grooves should be placed at the spot on the boom with four dimples, and so forth.

7.5 GPS antenna

The GPS antenna mounts to the end of a crossarm by using a 0.75-inch IPS threaded pipe and a 0.75-inch-by-1-inch Nu-Rail® fitting or CM220 mounting bracket. Mount the GPS antenna above obstructions, but with the shortest cable possible. The GPS antenna will not receive GPS signals through steel roofs, steel walls, or possibly concrete. Heavy foliage, snow, and ice will attenuate the GPS signal. An unobstructed view provides better GPS performance resulting in fewer (or no) missed transmissions. Poor GPS antenna placement increases the number of missed transmissions, and possibly stops all GPS transmissions.

7.6 Data logger programming

The CRBasic program can read and enter TX326 settings. Settings can also be entered using the Device Configuration Utility (see QuickStart (p. 2)). Table 7-5 (p. 18) provides the TX326 settings that can be read and entered. Table 7-4 (p. 16) provides the read-only settings.

The CRBasic program should include the `GOESTable()` and `GOESField()` instructions used in conjunction with the `DataTable()` instruction to facilitate the transmission of data across the GOES satellite network. The `GOESTable()` instruction has the following syntax:

```
GOESTable (Result, ComPort, Model, BufferControl, Fields_Scan_Order,Newest_
First,Format)
```

The `Result` is a string variable that holds either the data to be output in its specified format or a message indicating there are no data to output to the transmitter. For the `Model`, enter 3 to use the TX326. For the `BufferControl`, a value of 0 writes to the self-timed buffer and a value of 1 writes to the random buffer. Data formats and transmission durations (p. 21) discusses the `Format` options.

The `GOESField()` instruction has the following syntax:

```
GOESField(NumVals, Decimation, Precision, Width, SHEF)
```

The `NumVals` is the number of historical values of the field to output. For `Decimation`, enter 1 to output every value, enter 2 to output every other value, etc. `Width` specifies the number of characters in the field. Use empty quotes ("") for `SHEF`if no SHEF code is specified.

An example of using the the `GOESTable()` and `GOESField()` instructions follows:

```
DataTable (ST_DATA, TRUE, -1)
  DataInterval(0, 15, Min, 4)
  GOESTable (st_table_results, COMRS232, 3, 0, TRUE, TRUE, 3)
  GOESField (4, 1, 3, 6, "")
  Sample (1, battery_voltage, IEEE4)
  GOESField (4, 1, 3, 6, "")
  Sample (1, panel_temperature, IEEE4)
EndTable
```

In the main portion of the program, settings are written using `SetSetting()` instruction with the following the syntax:

```
SetSetting ( "FieldName", Value )
```

The `FieldName` must be enclosed in quotes as shown. The following example instruction sets the port used to communicate with the TX326 to the RS-232 port:

```
SetSetting("GOESComPort", COMRS232)
```

The CRBasic program reads the TX326 settings using the following format:

```
Variable = Settings.FieldName
```

For example, `goes_comport = Settings.GOESComPort` reads the Com port setting and stores it in the `GOESComPort` variable. The TX326 settings are typically read in a `SlowSequence` section of the program. Table 7-5 (p. 18) provides the TX326 settings that can be set and read. Table 7-4 (p. 16) provides the read-only settings.

A downloadable example program is available at: www.campbellsci.com/downloads/tx325-example-program-granite-cr6-cr1000x-cr300.

7.6.1 Read-only settings

Table 7-4: Read-only TX326 settings

FieldName	Description
`GOESid`	Current ID programmed into the radio. The ID isn't programmed into the radio until right before a radio transmission starts.
`GOESdateTime`	Current date and time (UTC) of the TX326 radio. Value is a string.
`GOESversion`	Current radio firmware version. Value is a string.
`GOESCurrentbattery`	Battery voltage in VDC.
`GOESCurrenttemperature`	Current radio temperature in degrees Celsius.
`GOESbatteryBeforeTx`	Battery voltage of the radio just prior to its last transmission.
`GOEStemperatureBeforeTx`	Radio temperature before the last transmission.
`GOESbatteryDuringTx`	Radio-battery voltage during the last transmission.
`GOESLatitude`	Latitude in decimal format of the GOES radio.
`GOESLongitude`	Longitude in decimal format of the GOES radio.
`GOESAltitude`	Altitude of the GOES radio in meters.
`GOESTimeLastGPSPosition`	Date and time (UTC) of the last GPS position fix. Value is a string.
`GOESNumberOfMissedGPS`	Number of times the radio has failed to get a GPS fix.
`GOESTimeLastMissedGPSFix`	Last date and time (UTC) that the radio failed to get a GPS fix. Value is a string.

Table 7-4: Read-only TX326 settings

FieldName	Description
GOESGPSAcquisitionStatus	Acquisition status of the radio GPS. 0 = valid GPS fix 1 = no GPS position fix, no GPS satellites in view 8 = no GPS position fix, no usable GPS satellites in view 9 = no GPS position fix, one usable GPS satellite in view 10 = no GPS position fix, two usable GPS satellites in view 11 = no GPS position fix, three usable GPS satellites in view
GOESGPSAntennaStatus	Status of the GPS antenna. 0 = GPS antenna is working 16 = GPS antenna is not connected 48 = GPS antenna is shorted
GOESFailSafeIndicator	Radio failsafe status. 1 = Failsafe has been tripped 0 = Radio is OK and Failsafe has not been tripped
GOESDurationOfTransmit	Duration of the last transmission of the GOES radio in milliseconds.
GOESForwardTxPower	Forward RF power of the transmitter in watts.
GOESReflectedRfPower	Reflected RF power of the transmitter in watts.
GOESVSWR	Voltage standing wave ratio (SWR) of the radio.
GOESLastTxControlFlags	Control flags used in the last transmission.
GOESLastTxStartTime	Start time (UTC) of the last radio transmission. Value is a string.
GOESLastTxChannel	Channel number used during the last radio transmission.
GOESLastTypeCode	Type of transmission used during the last radio transmission.
GOESLastDatelength	Number of bytes in the last radio transmission.
GOESLastHDRFlagWord	HDR flag word used in the last radio transmission.

Table 7-4: Read-only TX326 settings	
FieldName	**Description**
`GOESTxResultCode`	Status of the last radio transmission. 0 = Last transmission was OK 1 = Transmission aborted, radio battery voltage is too low 2 = Transmission aborted, radio PLL lock failure 3 = Transmission aborted, radio flash is corrupt
`GOESCurrentTxState`	Current state of the radio. 0 = Idle 1 = Transmission is in progress 2 = Post transmission failsafe wait is in progress

7.6.2 Read and write settings

Table 7-5: Read and write TX326 settings	
Field Name	**Description**
`GOESComPort`	Port used to communicate with the GOES transmitter.
`GOESEnabled`	Controls whether the data loggers polls the `GOESComPort` to see if a TX326 radio is attached to it. With the default setting of 0 (not enabled), the data logger ignores all other GOES settings. A value of 1 enables the setting.
`GOESMsgWindow`	Length, in seconds, of the assigned self-timed transmission window assigned by EUMETSAT. Valid entries are 1 to 110 s.
`GOESPlatformID`	8-digit hexadecimal identification number assigned by EUMETSAT. Value is a string.
`GOESRTBaudRate`	Baud rate for the random transmissions. Valid settings are 100 or 1200. The baud rate must match the user's EUMETSAT-channel assignment.
`GOESRTChannel`	Channel used for the random transmission assigned by EUMETSAT. Valid channel numbers are 0 through 289. The default value of 0 disables random transmissions.
`GOESRTInterval`	Average time between random transmissions. The value is a string entered in the format of “Hours:Minutes:Seconds”. Typically, the assigned interval is in hours, so the minutes and seconds parameters are left at 0. For example, “01:00:00” setups up an hourly interval. Maximum interval is 24 hours; minimum interval is 1 minute.

Table 7-5: Read and write TX326 settings	
Field Name	**Description**
`GOESSTBaudRate`	Baud rate for self-timed transmissions. Valid setting is 1200.
`GOESSTChannel`	Channel used for the self-timed transmission assigned by EUMETSAT. Valid channel numbers are 0 through 289. The default value of 0 disables the self-timed transmissions.
`GOESSTInterval`	Time between self-timed transmissions. The value is a string entered in the format of "Days:Hours:Minutes:Seconds". Typically, the assigned interval is in hours, so the days, minutes and seconds parameters are left at 0. For example, "00:01:00:00" sets up an hourly interval. Maximum interval is 14 days; minimum interval is 1 minute.
`GOESSTOffset`	Time after midnight for the first self-timed transmission as assigned by EUMETSAT. The value is a string entered in the format of "Hours:Minutes:Seconds". Typically, only hours and minutes are used, and seconds are 0, unless the transmission window is less than 60 seconds. Maximum offset is 23:59:59. A value 0 results in no offset.
`GOESRepeatCount`	Number of times within the random transmit interval that the TX326 will transmit the message data. Valid entries are 1 to 3.

8. Troubleshooting

Issue: TX326 is not transmitting

First, check the power supply and make sure that the TX326 power supply voltage is at least 10.5 VDC (see Specifications (p. 9)). Next, check the red **Failsafe** LED. If the LED is on continuously, the TX326 is in its fail safe mode, which is cleared by pressing the **Reset** button. The **Reset** button is located near the LEDs and is accessed through a hole in the side of the transmitter housing (FIGURE 8-1 (p. 20)).

> **CAUTION:**
> A power cycle will not clear the fail safe mode.

FIGURE 8-1. Reset button location

The TX326 transmitter will go into the fail safe mode if one of two events occurs:

1. The transmitter RF output is turned on and left on for more than 110 seconds.
2. The transmitter is given a command to transmit less than 30 seconds after a transmission has taken place.

If a fail safe condition occurs, the red **Failsafe** LED is on continuously; its RF output is disabled; and its microprocessor is reset (causing the transmitter to reboot). While in the fail safe mode, the transmitter can communicate normally with the data logger, but is unable to transmit again until the fail safe mode has been cleared.

Appendix A. Data formats and transmission durations

Data transmissions are generally described as having an ASCII or pseudobinary format. The particular nature of how the data is formatted prior to sending the data over-the-air. The data order in those transmissions is determined by the content and organization of the `DataTables()` and execution of `GOESTable()` and `GOESField()`. Scan-order (interleaved) and channel-order data can be sent by using an ASCII or pseudobinary format with one of the native data logger data format options. The flexibility of CRBasic allows virtually any message type to match the decode system requirements.

A.1 ASCII data format

ASCII data formats are used to transmit data in plain readable text. This format is widely used for random or alert transmissions. They can be used for self-timed messages. Several standard formats are selectable within CRBasic. Formats not included can be easily formed using string-formatted data fields, allowing the content to be tailored to your application needs. String-formatted data fields are limited to 13 characters for each field.

A.1.1 7-byte floating-point ASCII (GOESTable() format option 1)

The 7-byte floating-point ASCII data type is a fixed-width format with variable precision.

- Operating range of ±7999, depending on placement of decimal point (see Table A-1 (p. 22)).
- Variable precision of 0.001 to 1, depending on placement of decimal point (see Table A-1 (p. 22)).
- Precision (placement of decimal point) is automatically determined based on the magnitude of the value (Table A-1 (p. 22)).
- Number are rounded to selected precision during conversion. For example, +12.345, will be rounded to +12.35.
- Value is always 7 characters including a trailing comma.
- Value is always signed (+/-).

- Leading zeros and trailing zeros are added to maintain the width (7 characters) of the value transmitted.
- Value always has a trailing comma. This includes the last value sent.
- Valid data outside of operating range are set to –7999 or +7999, unless it is a NAN, +INF, or -INF (see Table A-1 (p. 22)).

Table A-1: 7-byte floating-point ASCII data

Range	Maximum precision	Example ASCII output
±7.999	0.001	+1.200,
±79.99	0.01	+12.00,
±799.9	0.1	+120.0,
±7999	1	+1200.,
NAN[1] = –8190.,		
+INF[2] = +8191.,		
-INF[2] = -8191.,		

[1]Not A Number

[2]Infinity

Example output (with 10 fields):

```
GoesTable() Fields_Scan_Order = FALSE, Newest_First=FALSE, Format = 1
GoesField() Decimation = 1
    <CR><LF>-7994.,-7994.,+8191.,-8191.,-8190.,+8191.,-8191.,-8190.,+13.10,+27.32,


GoesTable() Fields_Scan_Order = FALSE, Newest_First=FALSE, Format = 1
GoesField() Decimation = 4
    <CR><LF>-7997.,-7997.,+8191.,-8191.,-8190.,+8191.,-8191.,-8190.,+13.15,+26.08,
    <CR><LF>-7996.,-7996.,+8191.,-8191.,-8190.,+8191.,-8191.,-8190.,+13.16,+26.04,
    <CR><LF>-7995.,-7995.,+8191.,-8191.,-8190.,+8191.,-8191.,-8190.,+13.17,+26.03,
    <CR><LF>-7994.,-7994.,+8191.,-8191.,-8190.,+8191.,-8191.,-8190.,+13.19,+26.18,
```

```
GoesTable() Fields_Scan_Order = True, Newest_First=FALSE, Format = 1
GoesField() Decimation = 1
   <CR><LF> -7994.,
   <CR><LF> -7994.,
   <CR><LF> +8191.,
   <CR><LF> -8191.,
   <CR><LF> -8190.,
   <CR><LF> +8191.,
   <CR><LF> -8191.,
   <CR><LF> -8190.,
   <CR><LF> +13.13,
   <CR><LF> +27.72,
```

```
GoesTable() Fields_Scan_Order = True, Newest_First=FALSE, Format = 1
GoesField() Decimation = 4
   <CR><LF>-7997.,-7996.,-7995.,-7994.,
   <CR><LF>-7997.,-7996.,-7995.,-7994.,
   <CR><LF>+8191.,+8191.,+8191.,+8191.,
   <CR><LF>-8191.,-8191.,-8191.,-8191.,
   <CR><LF>-8190.,-8190.,-8190.,-8190.
   <CR><LF>,+8191.,+8191.,+8191.,+8191.,
   <CR><LF>-8191.,-8191.,-8191.,-8191.,
   <CR><LF>-8190.,-8190.,-8190.,-8190.,
   <CR><LF>+13.12,+13.12,+13.12,+13.11,
   <CR><LF>+27.59,+27.59,+27.59,+27.60,
```

A.1.2 ASCII table space (GOESTable() format option 2)

This option provides a tabular format. Columns are fixed width, according to the field format, and are space delimited. Lines are <CR><LF> delimited. You can send either the newest or oldest data first. A <CR><LF> is added at the end of the final line sent.

- NANs, +INFs, -INFs, and missing values show as forward slashes (/) in the output.
- Each line contains all the values listed in `GOESTable()` that have been set with `GOESField()` and are sent in the order they are listed in the data table if `Scan_Order` is set to **False**.
- Each line has all data from a single sensor if `Scan_Order` is set to **True**.
- SHEF Codes can be added as headers or at the beginning of lines using `GOESField()` option SHEF.
- Value has a fixed width (Table A-2 (p. 24)).
- Value has a fixed precision (Table A-2 (p. 24)).
- Value only has a leading sign when negative (–).

- Data outside of operating range will be set to the minimum or maximum of the range.
- Value always has a trailing space character.

Table A-2: ASCII format, width, precision, and range

Format	Width	Precision	Range	Example ASCII output containing two values
xxx	3	1	–99 to 999	012 -34
xxxxx	5	1	–9999 to 99999	00012 -0034
xxx.x	5	0.1	–99.9 to 999.9	001.2 -03.4
xx.xx	5	0.01	–9.99 to 99.99	00.12 -0.34
x.xxx	5	0.001	–.999 to 9.999	0.012 -.034

Example outputs (with 10 fields):

```
GoesTable() Fields_Scan_Order = FALSE, Newest_First=FALSE, Format = 2
GoesField() Decimation = 1, Precision = 3, Width = 4
   <CR><LF>-7.982 -7.982 //// //// //// //// //// //// 13.1 25.8<CR><LF>


GoesTable() Fields_Scan_Order = FALSE, Newest_First=FALSE, Format = 2
GoesField() Decimation = 4, Precision = 3, Width = 5
   <CR><LF>-9.81 -9.81 ///// ///// ///// ///// ///// ///// 13.15 26.08
   <CR><LF>-9.80 -9.80 ///// ///// ///// ///// ///// ///// 13.13 26.08
   <CR><LF>-9.79 -9.79 ///// ///// ///// ///// ///// ///// 13.14 26.08
   <CR><LF>-9.78 -9.78 ///// ///// ///// ///// ///// ///// 13.14 26.08<CR><LF>


GoesTable() Fields_Scan_Order = TRUE, Newest_First=FALSE, Format = 2
GoesField() Decimation = 1, Precision = 3, Width = 5
   <CR><LF>-9.68
   <CR><LF>-9.68
   <CR><LF>/////
   <CR><LF>/////
   <CR><LF>/////
   <CR><LF>/////
   <CR><LF>/////
   <CR><LF>/////
   <CR><LF>13.12
   <CR><LF>26.43<CR><LF>
```

```
GoesTable() Fields_Scan_Order = TRUE, Newest_First=FALSE, Format = 2
GoesField() Decimation = 4, Precision = 3, Width = 5
   <CR><LF>-9.45 -9.44 -9.43 -9.42
   <CR><LF>-9.45 -9.44 -9.43 -9.42
   <CR><LF>///// ///// ///// /////
   <CR><LF>///// ///// ///// /////
   <CR><LF>///// ///// ///// /////
   <CR><LF>///// ///// ///// /////
   <CR><LF>///// ///// ///// /////
   <CR><LF>///// ///// ///// /////
   <CR><LF>13.13 13.14 13.13 13.13
   <CR><LF>26.24 26.24 26.24 26.24<CR><LF>
```

```
GoesTable() Fields_Scan_Order = FALSE, Newest_First=FALSE, Format = 2
GoesField() Decimation = 1, Precision = 3, Width = 5, SHEF set to HG, TA, VB
   <CR><LF>HG TA VB
   <CR><LF>-7.94 13.13 26.72<CR><LF>
```

```
GoesTable() Fields_Scan_Order = FALSE, Newest_First=FALSE, Format = 2
GoesField() Decimation = 4, Precision = 3, Width = 5, SHEF set to HG, TA, VB
   <CR><LF>HG TA VB
   <CR><LF>-8.32 13.14 26.74
   <CR><LF>-8.31 13.14 26.74
   <CR><LF>-8.30 13.14 26.74
   <CR><LF>-8.29 13.14 26.74<CR><LF>
```

```
GoesTable() Fields_Scan_Order = TRUE, Newest_First=FALSE, Format = 2
GoesField() Decimation = 1, Precision = 3, Width = 5, SHEF set to HG, TA, VB
   <CR><LF>HG -6.79
   <CR><LF>TA 13.12
   <CR><LF>VB 26.68<CR><LF>
```

```
GoesTable() Fields_Scan_Order = TRUE, Newest_First=FALSE, Format = 2
GoesField() Decimation = 4, Precision = 3, Width = 5, SHEF set to HG, TA, VB
   <CR><LF>HG -8.26 -8.25 -8.24 -8.23
   <CR><LF>TA 13.14 13.14 13.13 13.14
   <CR><LF>VB 26.76 26.76 26.76 26.76<CR><LF>
```

```
GoesTable() Fields_Scan_Order = TRUE, Newest_First=FALSE, Format = 2
GoesField() Decimation = 4, Precision = 3, Width = 5, SHEF set to HG, TA, VB
```

> NOTE:
> To get a single battery voltage (or other additional data), set `GoesField()` Decimation = 1 for just the `battery_voltage` (or other) value in the `GOESTable()`.

```
<CR><LF>HG -9.70 -9.69 -9.68 -9.67
<CR><LF>TA 13.11 13.13 13.10 13.13
<CR><LF>VB 26.82 26.82 26.82 26.82
<CR><LF>BATTERY 13.13
<CR><LF>DATE 200336
<CR><LF>TIME 101500<CR><LF>
```

A.1.3 ASCII table space, comma separated (GOESTable() format option 3)

This option provides a tabular format. Columns are fixed width, according to the field format, and are comma (,) delimited. Lines are <CR><LF> delimited. You can send either the newest or oldest data first. A <CR><LF> is added at the end of the final line sent.

- NANs, +INFs, -INFs, and missing values show as forward slashes (/) in the output.
- Each line contains all the values listed in `GOESTable()` that have been set with `GOESField()` and are sent in the order they are listed in the data table if `Scan_Order` is set to **False**.
- Each line has all data from a single sensor if `Scan_Order` is set to **True**.
- SHEF Codes can be added as headers or at the beginning of lines using `GOESField()` option SHEF.
- Value has a fixed width (Table A-2 (p. 24)).
- Value has a fixed precision (Table A-2 (p. 24)).
- Value only has a leading sign when negative (–).
- Data outside of operating range will be set to the minimum or maximum of the range.
- Value always has a trailing comma (,).

Example outputs (with 10 fields):

```
GoesTable() Fields_Scan_Order = FALSE, Newest_First=FALSE, Format = 3
GoesField() Decimation = 1, Precision = 3, Width = 4
   <CR><LF>-7.982,-7.982,////,////,////,////,////,////,13.1,25.8<CR><LF>
```

```
GoesTable() Fields_Scan_Order = FALSE, Newest_First=FALSE, Format = 3
GoesField() Decimation = 4, Precision = 3, Width = 5
   <CR><LF>-9.81,-9.81,/////,/////,/////,/////,/////,/////,13.15,26.08
   <CR><LF>-9.80,-9.80,/////,/////,/////,/////,/////,/////,13.13,26.08
   <CR><LF>-9.79,-9.79,/////,/////,/////,/////,/////,/////,13.14,26.08
   <CR><LF>-9.78,-9.78,/////,/////,/////,/////,/////,/////,13.14,26.08<CR><LF>
```

```
GoesTable() Fields_Scan_Order = TRUE, Newest_First=FALSE, Format = 3
GoesField() Decimation = 1, Precision = 3, Width = 5
   <CR><LF>-9.68
   <CR><LF>-9.68
   <CR><LF>/////
   <CR><LF>/////
   <CR><LF>/////
   <CR><LF>/////
   <CR><LF>/////
   <CR><LF>/////
   <CR><LF>13.12
   <CR><LF>26.43<CR><LF>
```

```
GoesTable() Fields_Scan_Order = TRUE, Newest_First=FALSE, Format = 3
GoesField() Decimation = 4, Precision = 3, Width = 5
   <CR><LF>-9.45,-9.44,-9.43,-9.42
   <CR><LF>-9.45,-9.44,-9.43,-9.42
   <CR><LF>/////,/////,/////,/////
   <CR><LF>/////,/////,/////,/////
   <CR><LF>/////,/////,/////,/////
   <CR><LF>/////,/////,/////,/////
   <CR><LF>/////,/////,/////,/////
   <CR><LF>/////,/////,/////,/////
   <CR><LF>13.13,13.14,13.13,13.13
   <CR><LF>26.24,26.24,26.24,26.24<CR><LF>
```

```
GoesTable() Fields_Scan_Order = FALSE, Newest_First=FALSE, Format = 3
GoesField() Decimation = 1, Precision = 3, Width = 5, SHEF set to HG, TA, VB
   <CR><LF>HG,TA,VB
   <CR><LF>-7.94,13.13,26.72<CR><LF>
```

```
GoesTable() Fields_Scan_Order = FALSE, Newest_First=FALSE, Format = 3
GoesField() Decimation = 4, Precision = 3, Width = 5, SHEF set to HG, TA, VB
   <CR><LF>HG,TA,VB
   <CR><LF>-8.32,13.14,26.74
   <CR><LF>-8.31,13.14,26.74
   <CR><LF>-8.30,13.14,26.74
   <CR><LF>-8.29,13.14,26.74<CR><LF>
```

```
GoesTable() Fields_Scan_Order = TRUE, Newest_First=FALSE, Format = 3
GoesField() Decimation = 1, Precision = 3, Width = 5, SHEF set to HG, TA, VB
   <CR><LF>HG,-6.79
   <CR><LF>TA,13.12
   <CR><LF>VB,26.68<CR><LF>
```

```
GoesTable() Fields_Scan_Order = TRUE, Newest_First=FALSE, Format = 3
GoesField() Decimation = 4, Precision = 3, Width = 5, SHEF set to HG, TA, VB
   <CR><LF>HG,-8.26,-8.25,-8.24,-8.23
   <CR><LF>TA,13.14,13.14,13.13,13.14
   <CR><LF>VB,26.76,26.76,26.76,26.76<CR><LF>
```

```
GoesTable() Fields_Scan_Order = TRUE, Newest_First=FALSE, Format = 3
GoesField() Decimation = 4, Precision = 3, Width = 5, SHEF set to HG, TA, VB
```

> **NOTE:**
> To get a single battery voltage (or other additional data), set `GoesField()` Decimation = 1 for just the `battery_voltage` (or other) value in the `GOESTable()`.

```
   <CR><LF>HG,-9.70,-9.69,-9.68,-9.67
   <CR><LF>TA,13.11,13.13,13.10,13.13
   <CR><LF>VB,26.82,26.82,26.82,26.82
   <CR><LF>BATTERY,13.13
   <CR><LF>DATE,200336
   <CR><LF>TIME,101500<CR><LF>
```

A.1.4 Line SHEF (Standard Hydrological Exchange Format) (GOESTable() format option 6)

ASCII output using standardized SHEF codes in a format that is human readable.

- NANs, +INFs, -INFs, and missing values show as forward slashes (/) in the output.
- LABEL is the SHEF code (two character) parameter. Refer to https://dcs1.noaa.gov/documents/SHEF%20Codes.pdf for details on SHEF codes.
- OFFSET is how long ago the sensor reading was made and stored in the `GOESTable()` data table and is reported in number of minutes.
- INTERVAL is how often the measurement is made. This corresponds to `DataInterval()` of the GOES data table or the scan interval if `DataInterval()` is not used.
- DATA is the data that is stored in the GOES table.
- APPENDED OPTIONS refers to data that can be appended to the transmission.
- SHEF Codes can be added as headers or at the beginning of lines using `GOESField()` option SHEF.
- Value has a fixed width (Table A-2 (p. 24)).
- Value has a fixed precision (Table A-2 (p. 24)).
- Value only has a leading sign when negative (–).
- Data outside of operating range will be set to the minimum or maximum of the range.

Format of data transmitted:

```
: <LABEL1> <OFFSET> #<INTERVAL> <DATA1> <DATA1> ... <DATA1)>
: <LABEL2> <OFFSET> #<INTERVAL> <DATA2> <DATA2> ... <DATA2> ...
: <LABEL(N)> <OFFSET> #<INTERVAL> <DATA(N)> <DATA(N)> ... <DATA(N)>
```

Example output with explanation:

```
GoesTable() Fields_Scan_Order = TRUE, Newest_First=FALSE, Format = 6
GoesField() Decimation = 4, Precision = 3, Width = 5, SHEF set to VB and TA
(see Table A-3 (p. 29))
  <CR><LF><SPC>:VB<SPC>8<SPC>#15<SPC>13.15<SPC>13.13<SPC>13.18<SPC>13.19
  <CR><LF><SPC>:TA<SPC>8<SPC>#15<SPC>26.76<SPC>26.76<SPC>26.85<SPC>26.98<CR><LF>
```

Table A-3: Example SHEF output with descriptions

Output	Description
:VB	SHEF Code VB (Voltage – Battery)
8	Reading is 8 minutes old (happened 8 minutes prior to transmission)
#15	15-minutes measurement interval
13.15	Most recent sensor or measurement reading
13.13	Sensor or measurement reading taken 15 minutes prior to transmission
13.18	Sensor or measurement reading taken 30 minutes prior to transmission
13.19	Sensor or measurement reading taken 45 minutes prior to transmission
:TA	SHEF Code TA (Temperature, air, dry bulb)
8	Reading is 8 minutes old (happened 8 minutes prior to transmission)
#15	15-minutes measurement interval
26.76	Most recent sensor or measurement reading
26.76	Sensor or measurement reading taken 15 minutes prior to transmission
26.85	Sensor or measurement reading taken 30 minutes prior to transmission
26.98	Sensor or measurement reading taken 45 minutes prior to transmission

A.2 Pseudobinary data formats

The pseudobinary data format is a modified-ASCII format that uses the lower 6 bits of each 8-bit data character to represent part of a binary message. To encode a number, its binary form is broken into groups of 6 bits. Each group is placed into the lower 6 bits of a respective byte. The number 64 is added to each byte to set the seventh bit. Binary numbers are transmitted MSB (most significant bit) first.

Pseudobinary formats are preferred for GOES and Meteosat/EUMETSAT self-timed transmissions because users can include more data in the GOES message. This allows more data to be transmitted in a specific window of transmission time.

> **NOTE:**
> These messages are not human readable and need to be decoded by computer software or by using custom decoding tables.

Because only 6 bits are used in each byte, the range that a byte or series of bytes can represent is diminished (Table A-4 (p. 30)).

Table A-4: Pseudobinary ranges

Pseudobinary type	Range
1-byte encoded unsigned integer	0 to +63
1-byte encoded signed integer	–32 to +31
2-byte encoded unsigned integer	0 to +4094
2-byte encoded signed integer	–2048 to +2047
3-byte encoded unsigned integer	0 to +262143
3-byte encoded signed integer	–131072 to +131071
4-byte encoded unsigned integer	0 to +16777215
4-byte encoded signed integer	–8388608 to +8388607

A.2.1 Campbell Scientific FP2 data

The FP2 data format uses 16 bits to represent a variable-precision floating point number. FP2 has a total range of -7999 to 7999 and variable precision of 0.001 to 1. It also has the ability to signal +/– INF and NAN, most commonly used to indicate a computational or measurement error. Table A-5 (p. 31)) shows the numeric ranges and precision; Table A-6 (p. 31) describes the bits, and Table A-7 (p. 31) provides bit usage in calculating a finished value.

Table A-5: FP2 range and maximum precision		
Range	Maximum precision	b15 and b14 bit pattern
–7.999 to 7.999	0.001	11
–79.99 to 79.99	0.01	10
–799.9 to 799.9	0.1	01
–7,999 to 7,999	1	00

Table A-6: Bit description		
Name	Bit	Description
Sign (S)	16 (MSB)	Specifies the sign of the value. 0 = positive, 1 = negative.
Exponent (E)	15 and 14	Specifies the magnitude of the negative decimal exponent.
Mantissa (M)	13 to 0 (LSB)	Specifies the magnitude of the 13-bit mantissa, 0 to 8191

Table A-7: Calculation of finished value			
Sign (S)	Exponent (E)	Mantissa (M)	FP2 value equals
0	00	8191	+ INF
1	00	8191	– INF
1	00	8190	NAN
0 or 1	00 or 01 or 10	0 to 7999	(–1 ^ S) × (10 ^ –E) × M

When transmitted in a pseudobinary format, the 16 bits are encoded as follows. Bits 16 through 13 are the least significant four bits of the first byte, bits 12 through 7 are the least significant six bits of the second byte, and the last six bits are the least significant bits of the last byte. The following tables are examples of encoding values.

Table A-8: Encoding of 1234

Character 1 = @								Character 2 = S								Character 3 = R							
				Sign	Exponent		Mantissa			Mantissa								Mantissa					
p	1	0	0	b16	b15	b14	b13	p	1	b12	b11	b10	b9	b8	b7	p	1	b6	b5	b4	b3	b2	b1
0	1	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	1	0	1	0	0	1	0

Table A-9: Encoding of 1.234

Character 1 = F								Character 2 = S								Character 3 = R							
				Sign	Exponent		Mantissa			Mantissa								Mantissa					
p	1	0	0	b16	b15	b14	b13	p	1	b12	b11	b10	b9	b8	b7	p	1	b6	b5	b4	b3	b2	b1
0	1	0	0	0	1	1	0	0	1	0	1	0	0	1	1	0	1	0	1	0	0	1	0

Table A-10: Encoding of 12.34

Character 1 = D								Character 2 = S								Character 3 = R							
				Sign	Exponent		Mantissa			Mantissa								Mantissa					
p	1	0	0	b16	b15	b14	b13	p	1	b12	b11	b10	b9	b8	b7	p	1	b6	b5	b4	b3	b2	b1
0	1	0	0	0	1	0	0	0	1	0	1	0	0	1	1	0	1	0	1	0	0	1	0

Table A-11: Encoding of 123.4

Character 1 = B								Character 2 = S								Character 3 = R							
				Sign	Exponent		Mantissa			Mantissa								Mantissa					
p	1	0	0	b16	b15	b14	b13	p	1	b12	b11	b10	b9	b8	b7	p	1	b6	b5	b4	b3	b2	b1
0	1	0	0	0	0	1	0	0	1	0	1	0	0	1	1	0	1	0	1	0	0	1	0

Table A-12: Encoding of 0.123

Character 1 = F								Character 2 = A								Character 3 = {							
				Sign	Exponent		Mantissa			Mantissa								Mantissa					
p	1	0	0	b16	b15	b14	b13	p	1	b12	b11	b10	b9	b8	b7	p	1	b6	b5	b4	b3	b2	b1
0	1	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0	1	1	1	1	0	1	1

Table A-13: Encoding of -1234

Character 1 = H								Character 2 = S								Character 3 = R							
				Sign	Exponent		Mantissa			Mantissa								Mantissa					
p	1	0	0	b16	b15	b14	b13	p	1	b12	b11	b10	b9	b8	b7	p	1	b6	b5	b4	b3	b2	b1
0	1	0	0	1	0	0	0	0	1	0	1	0	0	1	1	0	1	0	1	0	0	1	0

Table A-14: Encoding of -1.234

Character 1 = N								Character 2 = S								Character 3 = R							
				Sign	Exponent		Mantissa			Mantissa								Mantissa					
p	1	0	0	b16	b15	b14	b13	p	1	b12	b11	b10	b9	b8	b7	p	1	b6	b5	b4	b3	b2	b1
0	1	0	0	1	1	1	0	0	1	0	1	0	0	1	1	0	1	0	1	0	0	1	0

Table A-15: Encoding of -12.34

Character 1 = L								Character 2 = S								Character 3 = R							
				Sign	Exponent		Mantissa			Mantissa								Mantissa					
p	1	0	0	b16	b15	b14	b13	p	1	b12	b11	b10	b9	b8	b7	p	1	b6	b5	b4	b3	b2	b1
0	1	0	0	1	1	0	0	0	1	0	1	0	0	1	1	0	1	0	1	0	0	1	0

Table A-16: Encoding of -123.4

Character 1 = J								Character 2 = S								Character 3 = R							
				Sign	Exponent		Mantissa			Mantissa								Mantissa					
p	1	0	0	b16	b15	b14	b13	p	1	b12	b11	b10	b9	b8	b7	p	1	b6	b5	b4	b3	b2	b1
0	1	0	0	1	0	1	0	0	1	0	1	0	0	1	1	0	1	0	1	0	0	1	0

Table A-17: Encoding of -0.123

Character 1 = N								Character 2 = A								Character 3 = {							
				Sign	Exponent		Mantissa			Mantissa								Mantissa					
p	1	0	0	b16	b15	b14	b13	p	1	b12	b11	b10	b9	b8	b7	p	1	b6	b5	b4	b3	b2	b1
0	1	0	0	1	1	1	0	0	1	0	0	0	0	0	1	0	1	1	1	1	0	1	1

Table A-18: Encoding of INF

Character 1 = A								Character 2 = ?								Character 3 = ?							
				Sign	Exponent		Mantissa			Mantissa								Mantissa					
p	1	0	0	b16	b15	b14	b13	p	1	b12	b11	b10	b9	b8	b7	p	1	b6	b5	b4	b3	b2	b1
0	1	0	0	0	0	0	1	0	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1

Table A-19: Encoding of -INF

Character 1 = I								Character 2 = ?								Character 3 = ?							
				Sign	Exponent		Mantissa			Mantissa								Mantissa					
p	1	0	0	b16	b15	b14	b13	p	1	b12	b11	b10	b9	b8	b7	p	1	b6	b5	b4	b3	b2	b1
0	1	0	0	1	0	0	1	0	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1

Table A-20: Encoding of NAN																							
Character 1 = I								Character 2 = ?								Character 3 = ~							
				Sign	Exponent		Mantissa			Mantissa								Mantissa					
p	1	0	0	b16	b15	b14	b13	p	1	b12	b11	b10	b9	b8	b7	p	1	b6	b5	b4	b3	b2	b1
0	1	0	0	1	0	0	1	0	0	1	1	1	1	1	1	0	0	1	1	1	1	1	0

A.2.2 Pseudobinary

Pseudobinary or 18-bit integer data format is used to transmit a signed or unsigned integer. The 18 bits are encoded across 3 bytes. When signed, the value is encoded using a two-complement representation. As an integer cannot directly represent a fractional number, measurements are often scaled before storing to the GOES data table. For example, a water-level surface elevation of 123.45 ft can be multiplied by 100 to get an integer of 12345. This integer is stored for transmission with the encoding shown in Table A-21 (p. 35).

Table A-21: Example encoding of water level surface elevation value of 12345																							
Character 1 = C								Character 2 = @								Character 3 = y							
p	1	b18	b17	b16	b15	b14	b13	p	1	b12	b11	b10	b9	b8	b7	p	1	b6	b5	b4	b3	b2	b1
0	1	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1	0	0	1

A.2.3 Additional pseudobinary representations

Other pseudobinary representations, such as 6, 12, and 24 bit integers, can be formed and transmitted using CRBasic.

A.2.4 Transmission durations

Table A-22 (p. 36) provides the transmit time slot and message lengths. Table A-23 (p. 36) provides the maximum data bytes for an assigned time slot duration. Users need to convert the data points they want to send to number of bytes.

Table A-22: METOESAT HRDCP transmit time slots and message lengths[1]					
Message type	Carrier duration (seconds)	Preamble length (bits)	ASM field length (bits	Maximum data in message (bytes)	Failsafe maximum transmit time (seconds)
Self-timed	0.5	128	64	7343	60
Alert	0.5	128	64	653	60

[1]Absolute maximum transmission time is 60 seconds. Minimum time allowed between end of transmission and start of next transmission is 2 seconds.

Table A-23: HRDCP message maximum data bytes versus assigned time slot duration	
Assigned time slot duration (seconds)	Maximum data per message (bytes)[1]
10	653
15	1322
20	1991
25	2660
30	3329
35	3998
40	4667
45	5336
50	6005
55	6674
60	7343

[1]If using the 1200 baud rate, add 18 bytes to each message to account for the METEOSAT HRDCP message header.

Appendix B. METEOSAT HRDCP message header

The following tables provide the HRDCP message header format and field descriptions.

Table B-1: METEOSAT HRDCP message header format

Field	DCP address	Res	Platform data length	Sequence counter	Engineering information				Spare
					Version	Type	Compr	Health	
Bits	31	1	16	16	3	1	2	10	16
Bytes	4		2	2	2				2

Table B-2: METEOSAT HRDCP message header field descriptions

Field	Length (bits)	Function
DCP address	31	DCP Address is a 31-bit Bose Chaudhuri Hocquenghem (BCH) coded word. This address uniquely identifies the DCP. The first (most significant) 21 bits are the address itself. The last 10 bits are derived from the first 21 bits and serve as an error check.
Reserved	1	Always set to 1.
Platform data length	16	The length in bytes of the platform data contained in the message.
Sequence counter	16	This field contains a 16-bit count that is incremented after each message is transmitted. It is set to 0 following power up or hardware reset, and then on reaching 65535, cycles back to 1. This provides a means of detecting missing messages and power cycles and hardware resets.

Table B-2: METEOSAT HRDCP message header field descriptions		
Field	**Length (bits)**	**Function**
Engineering information	16	Information about the unit's status and settings at the time of transmission: • Version (3 bits): The version of the HRDCP standard supported by the DCP. • Type (1 bit): Self timed or Alert message. • Compression (2 bits) indicates the type of data compression used. • Health (10 bits) contains vendor-specific data about the current health of the DCP.
Spare	16	Reserved for future use. Always set to 0.

Table B-3: TX326 HRDCP message header engineering information			
Sub-field name	**Length (bits)**	**Bit number**	**Usage**
Version	3	15..13	Contains the version of the HRDCP standard supported by the DCP. Used only for changes that are not reverse compatible. Current version = 0.
Type	1	12	HRDCP Message Type: 0 = Self timed 1 = Alert
Compression	2	11..10	Compression used on platform data in message: 0 = None 1 = Gzip compression 2 = Reserved 3 = Reserved

Table B-3: TX326 HRDCP message header engineering information

Sub-field name	Length (bits)	Bit number	Usage
Battery health	2	9..8	Indicates battery voltage under load during previous transmission: 0 = Battery voltage ≥ 11.5 1 = 10.5 ≤ Battery voltage < 11.5 2 = Battery voltage < 10.5 3 = Previous transmission aborted due to low battery voltage.
GPS health	2	7..6	Indicates number of consecutive missed GPS fixes since last successful GPS fix: 0 = 0 to 3 consecutive missed fixes. 1 = 4 to 8 consecutive missed fixes. 2 = 9 to 12 consecutive missed fixes. 3 = Previous transmission aborted due to too many consecutive missed fixes.
Antenna health	1	5	Indicates VSWR on previous transmission: 0 = VSWR < 3.75 (Healthy) 1 = VSWR ≥ 3.75 (Possible problem)
TOD clock updated	1	4	Indicates if TOD clock was updated from GPS since previous transmission: 0 = TOD clock was not updated. 1 = TOD clock was updated.
Reserved	4	3..0	Always set to 0.

Non-zero values in the Battery Health, GPS Health, or Antenna Health sub-fields may indicate a problem with those parts of the DCP system.

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Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com. You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Protect from over-voltage.
- Protect electrical equipment from water.
- Protect from electrostatic discharge (ESD).
- Protect from lightning.
- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, 6 meters (20 feet), or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.
- Only use power sources approved for use in the country of installation to power Campbell Scientific devices.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

Internal Battery

- Be aware of fire, explosion, and severe-burn hazards.
- Misuse or improper installation of the internal lithium battery can cause severe injury.
- Do not recharge, disassemble, heat above 100 °C (212 °F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent batteries properly.

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