Product Manual

Communications Device

TX325

Satellite Transmitter for GOES V2

Revision: 11/2021

CSL I.D - 1314

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC

Guarantee

This equipment is guaranteed against defects in materials and workmanship. We will repair or replace products which prove to be defective during the guarantee period as detailed on your invoice, provided they are returned to us prepaid. The guarantee will not apply to:

- Equipment which has been modified or altered in any way without the written permission of Campbell Scientific
- Batteries
- Any product which has been subjected to misuse, neglect, acts of God or damage in transit.

Campbell Scientific will return guaranteed equipment by surface carrier prepaid. Campbell Scientific will not reimburse the claimant for costs incurred in removing and/or reinstalling equipment. This guarantee and the Company's obligation thereunder is in lieu of all other guarantees, expressed or implied, including those of suitability and fitness for a particular purpose. Campbell Scientific is not liable for consequential damage.

Please inform us before returning equipment and obtain a Repair Reference Number whether the repair is under guarantee or not. Please state the faults as clearly as possible, and if the product is out of the guarantee period it should be accompanied by a purchase order. Quotations for repairs can be given on request. It is the policy of Campbell Scientific to protect the health of its employees and provide a safe working environment, in support of this policy a "Declaration of Hazardous Material and Decontamination" form will be issued for completion.

When returning equipment, the Repair Reference Number must be clearly marked on the outside of the package. Complete the "Declaration of Hazardous Material and Decontamination" form and ensure a completed copy is returned with your goods. Please note your Repair may not be processed if you do not include a copy of this form and Campbell Scientific Ltd reserves the right to return goods at the customers' expense.

Note that goods sent air freight are subject to Customs clearance fees which Campbell Scientific will charge to customers. In many cases, these charges are greater than the cost of the repair.

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WHEN MEASUREMENTS MATTER

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About this manual

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

Some useful conversion factors:

Area:	1 in^2 (square inch) = 645 mm^2	**Mass:**	1 oz. (ounce) = 28.35 g
			1 lb (pound weight) = 0.454 kg
Length:	1 in. (inch) = 25.4 mm		
	1 ft (foot) = 304.8 mm	**Pressure:**	1 psi (lb/in^2) = 68.95 mb
	1 yard = 0.914 m		
	1 mile = 1.609 km	**Volume:**	1 UK pint = 568.3 ml
			1 UK gallon = 4.546 litres
			1 US gallon = 3.785 litres

In addition, while most of the information in the manual is correct for all countries, certain information is specific to the North American market and so may not be applicable to European users.

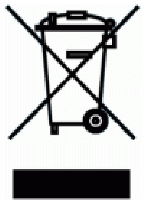
Differences include the U.S standard external power supply details where some information (for example the AC transformer input voltage) will not be applicable for British/European use. *Please note, however, that when a power supply adapter is ordered it will be suitable for use in your country.*

Reference to some radio transmitters, digital cell phones and aerials may also not be applicable according to your locality.

Some brackets, shields and enclosure options, including wiring, are not sold as standard items in the European market; in some cases alternatives are offered. Details of the alternatives will be covered in separate manuals.

Part numbers prefixed with a "#" symbol are special order parts for use with non-EU variants or for special installations. Please quote the full part number with the # when ordering.

Recycling information



At the end of this product's life it should not be put in commercial or domestic refuse but sent for recycling. Any batteries contained within the product or used during the products life should be removed from the product and also be sent to an appropriate recycling facility.

Campbell Scientific Ltd can advise on the recycling of the equipment and in some cases arrange collection and the correct disposal of it, although charges may apply for some items or territories.

For further advice or support, please contact Campbell Scientific Ltd, or your local agent.

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Safety

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND **TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC**. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

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.eu or by telephoning +44(0) 1509 828 888 (UK). 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

- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- 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, or 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.

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.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

Table of contents

1. Introduction

The TX325 transmitter sends data via Geostationary Operational Environmental Satellites (GOES), and is the successor to the TX321. In the Western Hemisphere, the TX325 is compatible for use with NOAA GOES DCS with a coverage range including Canada, the United States of America, and Mexico—as well as most countries in Central America and many South American countries.

The TX325 is the telemetry backbone for many data collection platforms (DCP) that use GOES. The satellite transmitter can be integrated with a number of Campbell Scientific data loggers and is an available communications option for many systems, serving a wide range of applications.

2. Precautions

- READ AND UNDERSTAND the Safety section at the front of this manual.
- Although the TX325 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 TX325 requires an active GPS antenna with a maximum gain of 25 dB. The TX325 will supply 3.3 V to the active GPS antenna.

3. Initial inspection

- Upon receipt of the TX325, 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 National Environmental Satellite Data and Information Service (NESDIS) 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 TX325 **RS-232** connector and connect the data logger to a power supply. Also ensure the TX325 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)).

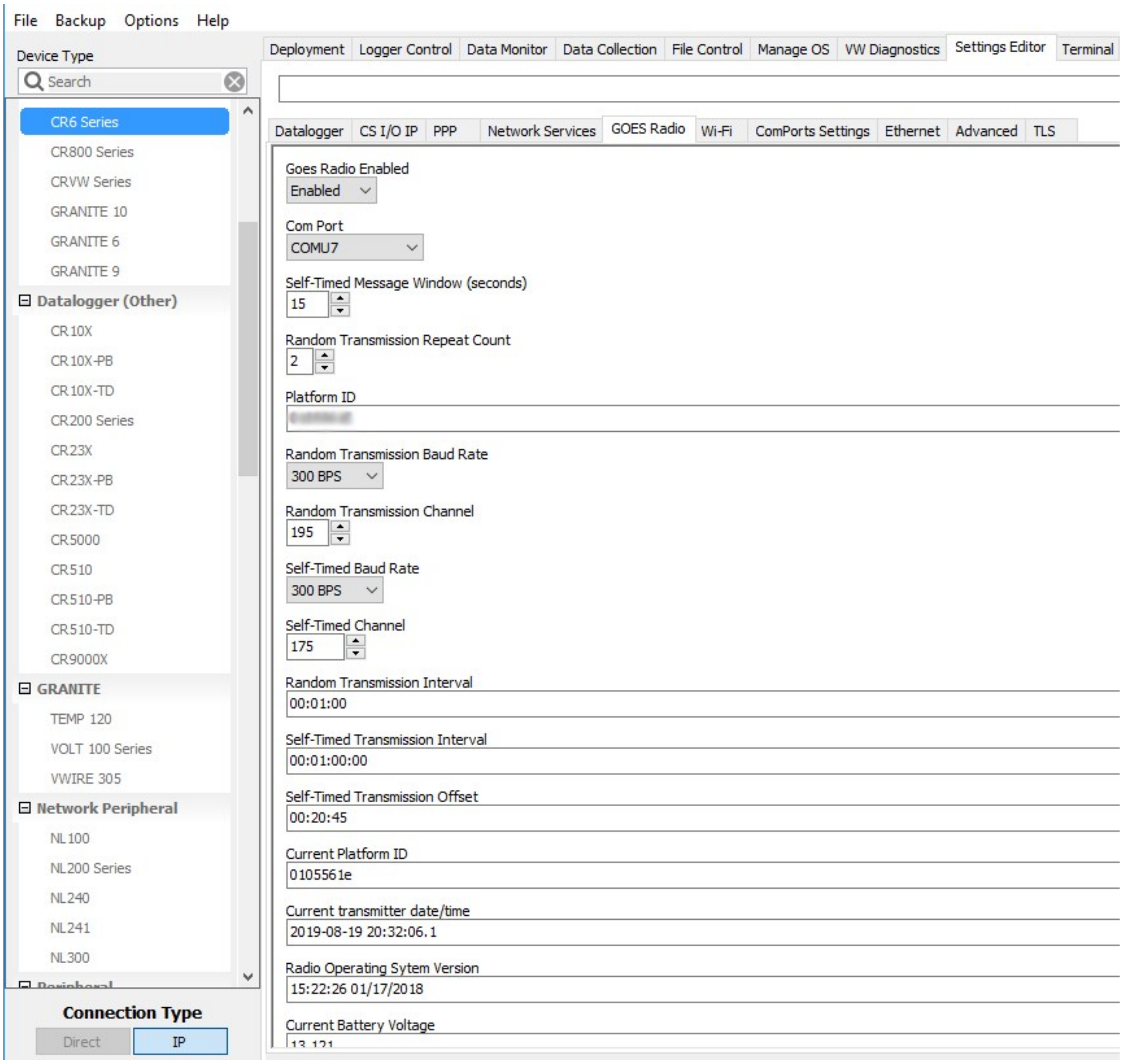
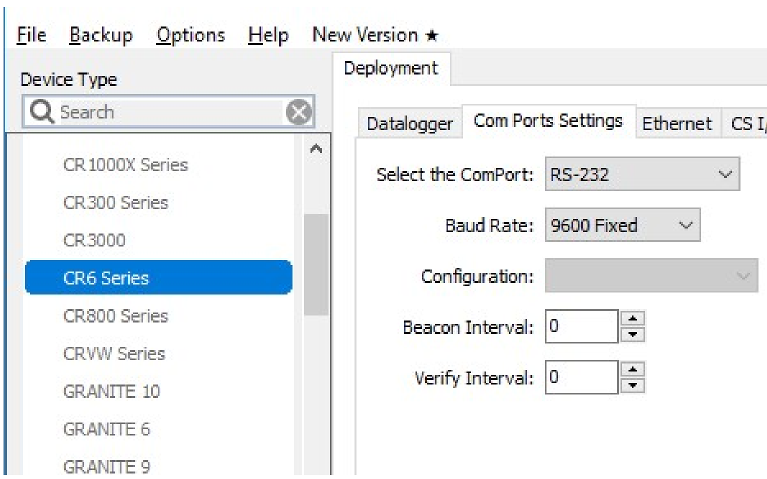


FIGURE 4-1. Device Configuration Utility GOES Radio screen

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 the GOES DCS Program.
8. Type the **Platform ID** (in HEX) as assigned by the GOES DCS Program.
9. Select the **Random Transmission Baud Rate** as assigned by the GOES DCS Program.
10. Type the **Random Transmission Channel** as assigned by the GOES DCS Program.

11. Select the **Self-Time Baud Rate** as assigned by the GOES DCS Program.
12. Type the **Self-Time Channel** as assigned by the GOES DCS Program.
13. Type the **Random Transmission Interval** as assigned by the GOES DCS Program. Format is hh:mm:ss.
14. Type the **Self-timed Transmission Interval** as assigned by the GOES DCS Program. Format is dd:mm:hh:ss.
15. Type the **Self-timed Transmission Offset** as assigned by the GOES DCS Program. 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 TX325, 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 TX325 (FIGURE 4-2 (p. 7)).

FIGURE 4-2. TX325 connectors

6. Route the GPS antenna cable through the enclosure conduit and connect it to the **GPS** connector on the TX325 (FIGURE 4-2 (p. 7)).
7. Plug the green connector from the power supply to the green receptacle on the TX325.
8. Connect the data logger to the TX325 **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 TX325 can transmit either self-timed or random GOES messages to the GOES West and GOES East satellites. In a typical configuration, the TX325 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 at either 300 or 1200 bps.

GPS is required for the radio to work in the GOES network. The GOES network is a TDMA network that requires all the radios in the network to 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 TX325 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 TX325 when using a GRANITE-series, CR6, CR1000X-series, and CR300-series data logger.

Features:

- NESDIS HDR V2 certified
- Based on Signal Engineering OmniSat3 design
- Compatible with GOES DCS 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 are fully compatible. The CR3000, CR800 series, and CR1000 have limited compatibility.

5.1 GOES, NESDIS, and transmit windows

GOES coverage area is latitude 68° North to 68° South and longitude 150° East to 2° West (see FIGURE 5-1 (p. 9)). GOES satellites have orbits that coincide with the Earth rotation, allowing each satellite to remain above a specific region (geosynchronous). GOES has two satellites: GOES East located at 75° West longitude and GOES West located at 135° West longitude. Both satellites are located over the equator. Within the United States, odd-numbered channels are assigned to GOES East, and even-numbered channels are assigned to GOES West. Channels used outside of the United States are assigned to either spacecraft.

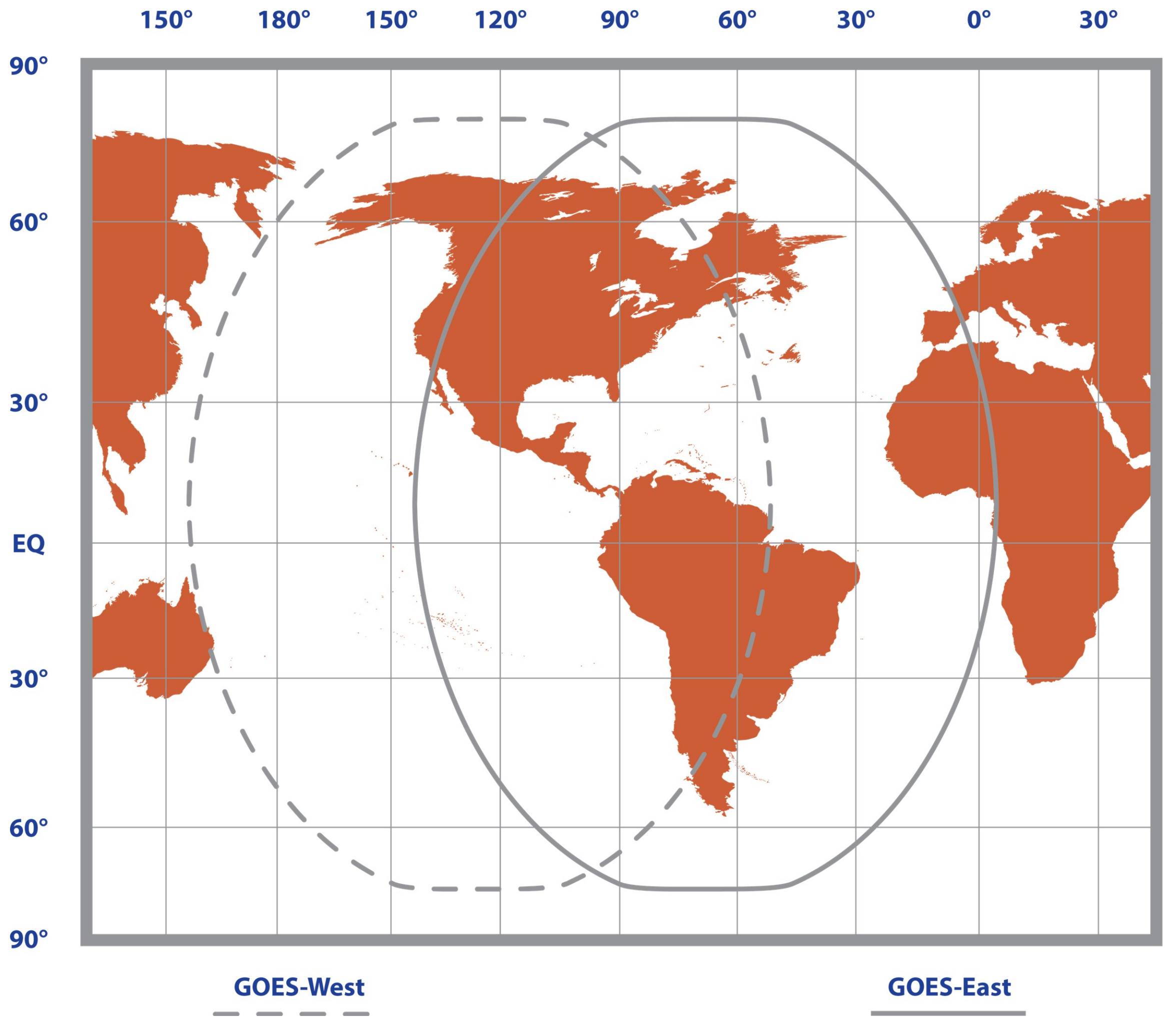


FIGURE 5-1. Coverage of GOES East and GOES West satellites

The GOES system is administered by the National Environmental Satellite Data Information Service (NESDIS), which assigns addresses, uplink channels, and self-timed/random transmit time windows. Self-timed windows allow data transmission only during a predetermined time frame (typically 10 seconds every hour). Random windows are for applications of a critical nature, such as flood reporting, and allow transmission immediately after a threshold has been exceeded. The transmission is randomly repeated to ensure it is received. A combination of self-timed and random transmission can be executed by the TX325.

Refer to Eligibility and getting onto the GOES system (p. 23) for more information.

6. Specifications

Compliance:	Refer to Compliance documents and certificates (p. 45) and www.campbellsci.eu/tx325
Transmissions supported:	Timed (Scheduled), Random
Data formats:	ASCII (SHEF), pseudo binary
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:	< 2.5 A (1.8 typical)
Standby:	< 5 mA (2.8 typical)
During GPS acquisition:	< 50 mA (25 mA typical)
Baud rates:	300 and 1200 bps
Transmit power	
Maximum:	31 dBm (300 bps), 37 dBm (1200 bps)
Maximum EIRP:	41 dBm (300 bps), 47 dBm (1200 bps); based on a 11 dbm gain antenna with 1 dbm line loss
Typical EIRP:	37 to 41 dBm (300 bps), 43 to 47 dBm (1200 bps)
Frequency range:	401.701 to 402.09925 MHz

Initial frequency stability: ±20 Hz disciplined to GPS (GPS fix occurs after power up and once per day thereafter)

Channel bandwidth: 1500 Hz (300 bps), 2250 Hz (1200 bps)

GPS receiver

> NOTE:
> The TX325 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 TX325 must be installed in a well desiccated, environmentally sealed enclosure. Its mounting plate has keyholes for securing the TX325 to the backplate of a Campbell Scientific enclosure. Most GOES 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 TX325 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.	TX325 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 TX325. 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 TX325)	Granite-series, CR6, CR1000X	**RS-232/CPI** RJ45 port
SC110 TX/RX cable (-C option when ordered with the TX325)	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 TX325)	CR300-series, CR3000, CR800-series, CR1000	**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 TX325 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 nominal impedance is 50 ohms; the frequency range is approximately 400 to 403 MHz. At 300 bps transmission rates, the maximum transmit power is 31 dBm. At 1200 bps, the transmit power is 37 dBm.

The **GPS** port on the TX325 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 TX325 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 TX325 power connector.

7.4 Transmission antenna

The TX325 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

> **NOTE:**
> This section provides programming information for the GRANITE-series (≥OS 1), CR6 (≥OS 10), CR1000X (≥OS 4), and CR300-series (≥OS 10), data loggers. For information on programming the CR3000, CR800-series, and CR1000 data loggers, refer to the example program at www.campbellsci.eu/downloads/tx325-example-program-cr3000-cr1000-cr800 or contact Campbell Scientific.

The CRBasic program can read and enter TX325 settings. Settings can also be entered using the Device Configuration Utility (see QuickStart (p. 2)). Table 7-4 (p. 16) provides the TX325 settings that can be read and entered. Table 7-5 (p. 18) 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 TX325. 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. 24) 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 TX325 to the RS-232 port:

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

The CRBasic program reads the TX325 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 TX325 settings are typically read in a SlowSequence section of the program. Table 7-4 (p. 16) provides the TX325 settings that can be set and read. Table 7-5 (p. 18) provides the read-only settings.

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

7.6.1 Read and write settings

Table 7-4: Read and write TX325 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 TX325 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 NESDIS. Valid entries are 1 to 110 s.
GOESPlatformID	8-digit hexadecimal identification number assigned by NESDIS. Value is a string.

Table 7-4: Read and write TX325 settings	
Field Name	Description
`GOESRTBaudRate`	Baud rate for the random transmissions. Valid settings are 100, 300, or 1200. The baud rate must match the user's NESDIS-channel assignment.
`GOESRTChannel`	Channel used for the random transmission assigned by NESDIS. Valid channel numbers are 0 through 566. 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.
`GOESSTBaudRate`	Baud rate for self-timed transmissions. Valid settings are 300 or 1200. The baud rate must match the user's NESDIS-channel assignment.
`GOESSTChannel`	Channel used for the self-timed transmission assigned by NESDIS. Valid channel numbers are 0 through 566. 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 NESDIS. 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 TX325 will transmit the message data. Valid entries are 1 to 3.

7.6.2 Read-only settings

Table 7-5: Read-only TX325 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 TX325 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 metres.
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.
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

Table 7-5: Read-only TX325 settings	
FieldName	Description
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.
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

8. Troubleshooting

Issue: TX325 is not transmitting

First, check the power supply and make sure that the TX325 power supply voltage is at least 10.5 VDC (see Specifications (p. 10)). Next, check the red **Failsafe** LED. If the LED is on continuously, the TX325 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.

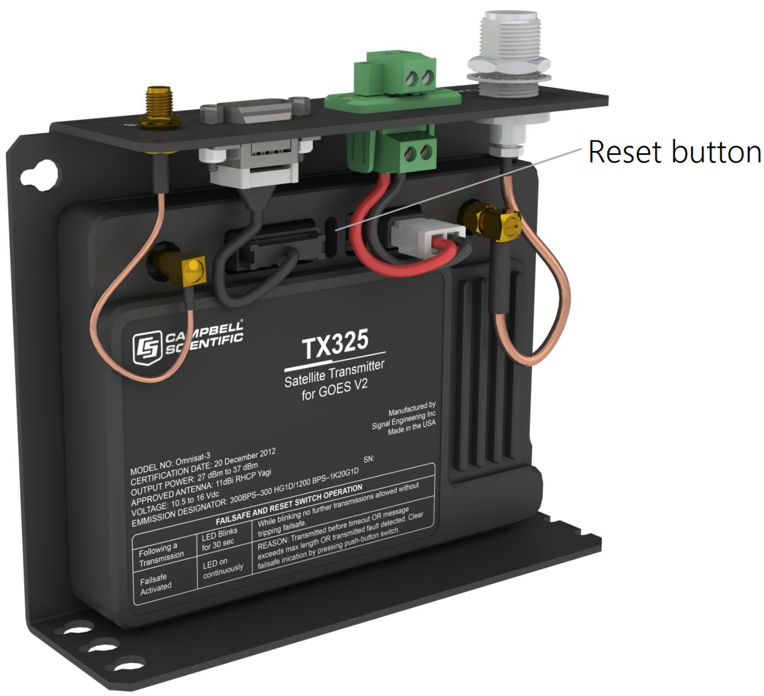


FIGURE 8-1. Reset button location

The TX325 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.

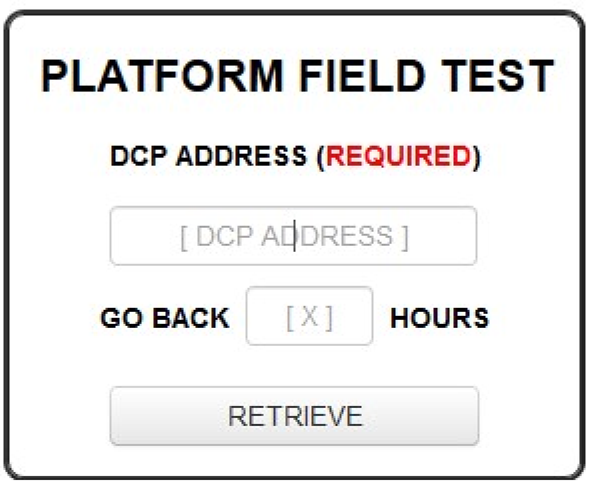
8.1 Troubleshooting over-air transmissions

TX325 users within the GOES system can troubleshoot their over-the-air data transmissions by using one of the following websites:

- https://dcs1.noaa.gov/Account/FieldTest
- https://dcs2.noaa.gov/Account/FieldTest
- https://dcs3.noaa.gov/Account/FieldTest
- https://dcs4.noaa.gov/Account/FieldTest

These websites provide the raw data sent through the GOES satellite system but do not require a login, user name, nor password.

1. Type your eight-character **DCP ADDRESS**.
2. Type the number of hours you want the field test system to go back to.
3. Click **RETRIEVE**.



The **PDT INFORMATION** provides your assigned DCP address, channels, transmission times, and window length. Make sure your setting in your DCP match this information. Failure to do so will result in loss of data and transmitting over the top of other DCP scheduled slots and also will result in the loss of other user's data.

PDT INFORMATION

ADDRESS	[illegible]
GROUP	CAMSCI
P-CHAN	3
S-CHAN	121
FIRST	00:16:50
PERIOD	01:00:00
WINDOW	00:00:10

The bottom table shows information that can help you determine the health of the DCP transmissions. This information includes signal quality (**QUAL**), transmission start time (**CARRIER**), and stop time(**END**).

SIGNAL	PHASE	QUAL	FREQ	CARRIER	END
33.8	6.15	83.3	-0.9	3/19/2020 20:16:50	3/19/2020 20:16:59

The **DATA** field provides the data transmitted through the GOES system. An extra character could be in front of the transmitted data message, indicating whether or not the GPS time synched (Table 8-1 (p. 22)). This character is added to the number of bytes (shown as LEN) that were in the data transmission.

Table 8-1: Characters indicating time sync

Character	Data type	Time synched since last transmission
Space	ASCII	No
Double quote (")	ASCII	Yes
Apostrophe (')	Binary	No
Lower case b	Binary	Yes

Appendix A. Eligibility and getting onto the GOES system

U.S. federal, state, or local government agencies, or users sponsored by one of those agencies, may use GOES. Potential GOES users must apply for and be granted a System Use Agreement (SUA) by NESDIS, which is typically renewable every 5 years. Use the following procedure to acquire permission for getting onto the GOES system:

1. Follow the steps provided at: https://dcs2.noaa.gov to submit an application for GOES DCS SUA. Once submitted, the approving authorities will review the application and notify you within two weeks. If you are approved NESDIS will send you a Memorandum of Agreement (MOA).
2. Sign and submit the MOA. After the MOA is approved, NESDIS will issue a channel assignment and an ID address code.
3. **IMPORTANT:** Contact NESDIS to coordinate a start-up date.

See https://dcs2.noaa.gov for more information.

Appendix B. 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.

B.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.

B.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 B-1 (p. 25)).
- Variable precision of 0.001 to 1, depending on placement of decimal point (see Table B-1 (p. 25)).
- Precision (placement of decimal point) is automatically determined based on the magnitude of the value (Table B-1 (p. 25)).
- 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 B-1 (p. 25)).

Table B-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,
```

B.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 B-2 (p. 27)).
- Value has a fixed precision (Table B-2 (p. 27)).
- 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 B-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>
```

B.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 B-2 (p. 27)).
- Value has a fixed precision (Table B-2 (p. 27)).
- 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>
```

B.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 B-2 (p. 27)).
- Value has a fixed precision (Table B-2 (p. 27)).
- 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 B-3 (p. 32))
  <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 B-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

B.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 B-4 (p. 33)).

Table B-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

B.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 B-5 (p. 34)) shows the numeric ranges and precision; Table B-6 (p. 34) describes the bits, and Table B-7 (p. 34) provides bit usage in calculating a finished value.

Table B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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 B-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

B.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 B-21 (p. 38).

Table B-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

B.2.3 Additional pseudobinary representations

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

B.3 Transmission durations

Table B-22 (p. 39) provides the transmission durations, calculated from the number of bytes in a message. Table B-23 (p. 39) 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 B-22: Calculating transmission duration for GOES 300/1200 bps messages

Transmit type	Transmission duration (seconds) (where N = number of data bytes in a message)
Self-timed, 300 bps	(137 + (N × 4))/150
Random, 300 bps	(137 + (N × 4))/150
Self-timed, 1200 bps	(223 + (N × 4))/600
Random, 1200 bps	(223 + (N × 4))/600

Table B-23: GOES self-timed-message maximum data bytes and assigned time-slot duration

Assigned time-slot duration (seconds)	GOES 300 bps maximum data per message (bytes)	GOES 1200 bps maximum data per message (bytes)
5	153	694
10	340	1444
15	528	2194
20	715	2944
25	903	3694
30	1090	4444
35	1278	5194
40	1465	5944
45	1653	6694
50	1840	7444
55	2028	8194
60	2215	8944

Appendix C. GOES Version 2 DCS channel frequencies

The following tables provide the frequencies for each channel.

Table C-1: GOES V 2.0 DCS frequencies for channels 1 through 46 and 301 through 346[1]

Channel number	Frequency (MHz)	Channel number	Frequency (MHz)	Channel number	Frequency (MHz)	Channel number	Frequency (MHz)
1	401.701000	312	401.718250	**24**	**401.735500**	335	401.752750
301	**401.701750**	13	401.719000	324	401.736250	**36**	**401.753500**
2	401.702500	**313**	**401.719750**	25	401.737000	336	401.754250
302	401.703250	14	401.720500	**325**	**401.737750**	37	401.755000
3	**401.704000**	314	401.721250	26	401.738500	**337**	**401.755750**
303	401.704750	**15**	**401.722000**	326	401.739250	38	401.756500
4	401.705500	315	401.722750	**27**	**401.740000**	338	401.757250
304	**401.706250**	16	401.723500	327	401.740750	**39**	**401.758000**
5	401.707000	**316**	**401.724250**	28	401.741500	339	401.758750
305	401.707750	17	401.725000	**328**	**401.742250**	40	401.759500
6	**401.708500**	317	401.725750	29	401.743000	**340**	**401.760250**
306	401.709250	**18**	**401.726500**	329	401.743750	41	401.761000
7	401.710000	318	401.727250	**30**	**401.744500**	341	401.761750
307	**401.710750**	19	401.728000	330	401.745250	**42**	**401.762500**
8	401.711500	**319**	**401.728750**	31	401.746000	342	401.763250
308	401.712250	20	401.729500	**331**	**401.746750**	43	401.764000
9	**401.713000**	320	401.730250	32	401.747500	**343**	**401.764750**
309	401.713750	**21**	**401.731000**	332	401.748250	44	401.765500
10	401.714500	321	401.731750	**33**	**401.749000**	344	401.766250
310	**401.715250**	22	401.732500	333	401.749750	**45**	**401.767000**
11	401.716000	**322**	**401.733250**	34	401.750500	345	401.767750
311	401.716750	23	401.734000	**334**	**401.751250**	46	401.768500
12	**401.717500**	323	401.734750	35	401.752000	**346**	**401.769250**

[1] Bold text indicates possible 1200 bps channel assignments.

Table C-2: GOES V 2.0 DCS frequencies for channels 47 through 108 and 347 through 408[1]							
Channel number	Frequency (MHz)	Channel number	Frequency (MHz)	Channel number	Frequency (MHz)	Channel number	Frequency (MHz)
47	401.770000	362	401.793250	**78**	**401.816500**	393	401.839750
347	401.770750	**63**	**401.794000**	378	401.817250	94	401.840500
48	**401.771500**	363	401.794750	79	401.818000	**394**	**401.841250**
348	401.772250	64	401.795500	**379**	**401.818750**	95	401.842000
49	401.773000	**364**	**401.796250**	80	401.819500	395	401.842750
349	**401.773750**	65	401.797000	380	401.820250	**96**	**401.843500**
50	401.774500	365	401.797750	**81**	**401.821000**	396	401.844250
350	401.775250	**66**	**401.798500**	381	401.821750	97	401.845000
51	**401.776000**	366	401.799250	82	401.822500	**397**	**401.845750**
351	401.776750	67	401.800000	**382**	**401.823250**	98	401.846500
52	401.777500	**367**	**401.800750**	83	401.824000	398	401.847250
352	**401.778250**	68	401.801500	383	401.824750	**99**	**401.848000**
53	401.779000	368	401.802250	**84**	**401.825500**	399	401.848750
353	401.779750	**69**	**401.803000**	384	401.826250	100	401.849500
54	**401.780500**	369	401.803750	85	401.827000	**400**	**401.850250**
354	401.781250	70	401.804500	**385**	**401.827750**	101	401.851000
55	401.782000	**370**	**401.805250**	86	401.828500	401	401.851750
355	**401.782750**	71	401.806000	386	401.829250	**102**	**401.852500**
56	401.783500	371	401.806750	**87**	**401.830000**	402	401.853250
356	401.784250	**72**	**401.807500**	387	401.830750	103	401.854000
57	**401.785000**	372	401.808250	88	401.831500	**403**	**401.854750**
357	401.785750	73	401.809000	**388**	**401.832250**	104	401.855500
58	401.786500	**373**	**401.809750**	89	401.833000	404	401.856250
358	**401.787250**	74	401.810500	389	401.833750	**105**	**401.857000**
59	401.788000	374	401.811250	**90**	**401.834500**	405	401.857750
359	401.788750	**75**	**401.812000**	390	401.835250	106	401.858500
60	**401.789500**	375	401.812750	91	401.836000	**406**	**401.859250**
360	401.790250	76	401.813500	**391**	**401.836750**	107	401.860000
61	401.791000	**376**	**401.814250**	92	401.837500	407	401.860750
361	**401.791750**	77	401.815000	392	401.838250	**108**	**401.861500**
62	401.792500	377	401.815750	**93**	**401.839000**	408	401.862250

[1] Bold text indicates possible 1200 bps channel assignments.

Table C-3: GOES V 2.0 DCS frequencies for channels 109 through 170 and 409 through 470[1]							
Channel number	Frequency (MHz)	Channel number	Frequency (MHz)	Channel number	Frequency (MHz)	Channel number	Frequency (MHz)
109	401.863000	**424**	**401.886250**	140	401.909500	455	401.932750
409	**401.863750**	125	401.887000	440	401.910250	**156**	**401.933500**
110	401.864500	425	401.887750	**141**	**401.911000**	456	401.934250
410	401.865250	**126**	**401.888500**	441	401.911750	157	401.935000
111	**401.866000**	426	401.889250	142	401.912500	**457**	**401.935750**
411	401.866750	127	401.890000	**442**	**401.913250**	158	401.936500
112	401.867500	**427**	**401.890750**	143	401.914000	458	401.937250
412	**401.868250**	128	401.891500	443	401.914750	**159**	**401.938000**
113	401.869000	428	401.892250	**144**	**401.915500**	459	401.938750
413	401.869750	**129**	**401.893000**	444	401.916250	160	401.939500
114	**401.870500**	429	401.893750	145	401.917000	**460**	**401.940250**
414	401.871250	130	401.894500	**445**	**401.917750**	161	401.941000
115	401.872000	**430**	**401.895250**	146	401.918500	461	401.941750
415	**401.872750**	131	401.896000	446	401.919250	**162**	**401.942500**
116	401.873500	431	401.896750	**147**	**401.920000**	462	401.943250
416	401.874250	**132**	**401.897500**	447	401.920750	163	401.944000
117	**401.875000**	432	401.898250	148	401.921500	**463**	**401.944750**
417	401.875750	133	401.899000	**448**	**401.922250**	164	401.945500
118	401.876500	**433**	**401.899750**	149	401.923000	464	401.946250
418	**401.877250**	134	401.900500	449	401.923750	**165**	**401.947000**
119	401.878000	434	401.901250	**150**	**401.924500**	465	401.947750
419	401.878750	**135**	**401.902000**	450	401.925250	166	401.948500
120	**401.879500**	435	401.902750	151	401.926000	**466**	**401.949250**
420	401.880250	136	401.903500	**451**	**401.926750**	167	401.950000
121	401.881000	**436**	**401.904250**	152	401.927500	467	401.950750
421	**401.881750**	137	401.905000	452	401.928250	**168**	**401.951500**
122	401.882500	437	401.905750	**153**	**401.929000**	468	401.952250
422	401.883250	**138**	**401.906500**	453	401.929750	169	401.953000
123	**401.884000**	438	401.907250	154	401.930500	**469**	**401.953750**
423	401.884750	139	401.908000	**454**	**401.931250**	170	401.954500
124	401.885500	**439**	**401.908750**	155	401.932000	470	401.955250

[1] Bold text indicates possible 1200 bps channel assignments.

Table C-4: GOES V 2.0 DCS frequencies for channels 171 through 230 and 471 through 530[1]

Channel number	Frequency (MHz)	Channel number	Frequency (MHz)	Channel number	Frequency (MHz)	Channel number	Frequency (MHz)
171	**401.956000**	**186**	**401.978500**	**201**	**402.001000**	**216**	**402.023500**
471	401.956750	486	401.979250	501	402.001750	516	402.024250
172	401.957500	187	401.980000	202	402.002500	217	402.025000
472	**401.958250**	**487**	**401.980750**	**502**	**402.003250**	**517**	**402.025750**
173	401.959000	188	401.981500	203	402.004000	218	402.026500
473	401.959750	488	401.982250	503	402.004750	518	402.027250
174	**401.960500**	**189**	**401.983000**	**204**	**402.005500**	**219**	**402.028000**
474	401.961250	489	401.983750	504	402.006250	519	402.028750
175	401.962000	190	401.984500	205	402.007000	220	402.029500
475	**401.962750**	**490**	**401.985250**	**505**	**402.007750**	**520**	**402.030250**
176	401.963500	191	401.986000	206	402.008500	221	402.031000
476	401.964250	491	401.986750	506	402.009250	521	402.031750
177	**401.965000**	**192**	**401.987500**	**207**	**402.010000**	**222**	**402.032500**
477	401.965750	492	401.988250	507	402.010750	522	402.033250
178	401.966500	193	401.989000	208	402.011500	223	402.034000
478	**401.967250**	**493**	**401.989750**	**508**	**402.012250**	**523**	**402.034750**
179	401.968000	194	401.990500	209	402.013000	224	402.035500
479	401.968750	494	401.991250	509	402.013750	524	402.036250
180	**401.969500**	**195**	**401.992000**	**210**	**402.014500**	**225**	**402.037000**
480	401.970250	495	401.992750	510	402.015250	525	402.037750
181	401.971000	196	401.993500	211	402.016000	226	402.038500
481	**401.971750**	**496**	**401.994250**	**511**	**402.016750**	**526**	**402.039250**
182	401.972500	197	401.995000	212	402.017500	227	402.040000
482	401.973250	497	401.995750	512	402.018250	527	402.040750
183	**401.974000**	**198**	**401.996500**	**213**	**402.019000**	**228**	**402.041500**
483	401.974750	498	401.997250	513	402.019750	528	402.042250
184	401.975500	199	401.998000	214	402.020500	229	402.043000
484	**401.976250**	**499**	**401.998750**	**514**	**402.021250**	**529**	**402.043750**
185	401.977000	200	401.999500	215	402.022000	230	402.044500
485	401.977750	500	402.000250	515	402.022750	530	402.045250

[1] Bold text indicates possible 1200 bps channel assignments.

Table C-5: GOES V 2.0 DCS frequencies for channels 231 through 266 and 531 through 566[1]

Channel number	Frequency (MHz)	Channel number	Frequency (MHz)	Channel number	Frequency (MHz)	Channel number	Frequency (MHz)
231	**402.046000**	**240**	**402.059500**	**249**	**402.073000**	**258**	**402.086500**
531	402.046750	540	402.060250	549	402.073750	558	402.087250
232	402.047500	241	402.061000	250	402.074500	259	402.088000
532	**402.048250**	**541**	**402.061750**	**550**	**402.075250**	**559**	**402.088750**
233	402.049000	242	402.062500	251	402.076000	260	402.089500
533	402.049750	542	402.063250	551	402.076750	560	402.090250
234	**402.050500**	**243**	**402.064000**	**252**	**402.077500**	**261**	**402.091000**
534	402.051250	543	402.064750	552	402.078250	561	402.091750
235	402.052000	244	402.065500	253	402.079000	262	402.092500
535	**402.052750**	**544**	**402.066250**	**553**	**402.079750**	**562**	**402.093250**
236	402.053500	245	402.067000	254	402.080500	263	402.094000
536	402.054250	545	402.067750	554	402.081250	563	402.094750
237	**402.055000**	**246**	**402.068500**	**255**	**402.082000**	**264**	**402.095500**
537	402.055750	546	402.069250	555	402.082750	564	402.096250
238	402.056500	247	402.070000	256	402.083500	265	402.097000
538	**402.057250**	**547**	**402.070750**	**556**	**402.084250**	**565**	**402.097750**
239	402.058000	248	402.071500	257	402.085000	266	402.098500
539	402.058750	548	402.072250	557	402.085750	566	402.099250

[1] Bold text indicates possible 1200 bps channel assignments.

Appendix D. Compliance documents and certificates

Compliance documents include the ISO certificate (FIGURE D-1 (p. 45)) and the GOES V2 certificate (FIGURE D-2 (p. 46)). The TX325 EU Declaration of Conformity is available at: www.campbellsci.eu/tx325.

Certificate of Registration

This certifies that the Quality Management System of

Signal Engineering, Inc.

6370 Lusk Blvd., Suite F206
San Diego,, California, 92121, United States

has been assessed by NSF-ISR and found to be in conformance to the following standard(s):

ISO 9001:2015

Scope of Registration:
Engineering Design and Light Manufacturing of Electronic/Radio Communications Systems.

Certificate Number:	C0195647-IS3
Certificate Issue Date:	24-APR-2018
Registration Date:	14-MAY-2017
Expiration Date *:	12-MAY-2020

Carl Blazik,
Director, Technical
Operations & Business Units,
NSF-ISR, Ltd.

NSF International Strategic Registrations
789 North Dixboro Road, Ann Arbor, Michigan 48105 | (888) NSF-9000 | www.nsf-isr.org

Authorized Registration and /or Accreditation Marks. This certificate is property of NSF-ISR and must be returned upon request.
*Company is audited for conformance at regular intervals. To verify registrations call (888) NSF-9000 or visit our web site at www.nsf-isr.org

FIGURE D-1. ISO certificate

National Environmental Satellite, Data, and Information Service

Certificate Number
12142012

Certifies that Signal Engineering, Inc.

Model OmniSat-3

Has been type tested and meets the requirements for use in the Geo-stationary 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 Version 2.0 GOES DCPR Certification Standards 300bps and 1200bps data rates.

Director, Office of System Development

Signature

Date 12/20/12

NOAA Form 83-1
(6-HO)

GOES RADIO SET CERTIFICATION

U.S. Department of Commerce
National Oceanic and Atmospheric Administration

FIGURE D-2. GOES V2 certificate

INFO

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

Global Sales & Support Network

A worldwide network to help meet your needs

Campbell Scientific Regional Offices

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Phone: 61.7.4401.7700
Email: info@campbellsci.com.au
Website: www.campbellsci.com.au

Brazil

Location: São Paulo, SP Brazil
Phone: 11.3732.3399
Email: vendas@campbellsci.com.br
Website: www.campbellsci.com.br

Canada

Location: Edmonton, AB Canada
Phone: 780.454.2505
Email: dataloggers@campbellsci.ca
Website: www.campbellsci.ca

China

Location: Beijing, P. R. China
Phone: 86.10.6561.0080
Email: info@campbellsci.com.cn
Website: www.campbellsci.com.cn

Costa Rica

Location: San Pedro, Costa Rica
Phone: 506.2280.1564
Email: info@campbellsci.cc
Website: www.campbellsci.cc

France

Location: Vincennes, France
Phone: 0033.0.1.56.45.15.20
Email: info@campbellsci.fr
Website: www.campbellsci.fr

Germany

Location: Bremen, Germany
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