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GOES.hopper

Operating Manual

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Chapter 1 Introduction

1.1 About the Manual

This manual is pertinent for units equipped with either the G5 or the G6 transmitter. The few differences between the two will be indicated in the pertinent portions of the text.

1.2 General Description

GOES.hopper is a system based around a GOES transmitter and provides GOES telemetry for any SDI-12 capable sensor. The transmitter assembly (Figure 1) is housed in an enclosure and attaches onto an FTS keyway plate. For ease of use, the transmitter communicates via the Eon GOES antenna which eliminates the need to aim the antenna within 53° latitude.

Figure 1-1: GOES.hopper transmitter assembly

Chapter 2 GOES Transmitter

The GOES transmitter is the main component in the system. The GOES transmitter responsible for initiating communications to the attached SDI-12 sensor(s) as well as performing the GOES transmissions.

2.1 Command Port

The Command Port on the GOES transmitter is an RS-232 protocol, command line, text based interface used to configure the transmitter. The Command Port can also be used to check communications with the attached SDI-12 sensor(s) and to provide operational details on the GOES transmitter.
The RS-232 port settings required are:

- 9600 baud
- 8 data bits
- no parity
- 1 stop bit
- no flow control

Typically, Tera Term or another terminal emulation-style program running on a PC is used to communicate with the transmitter. Communication with the GOES.hopper is normally achieved through a USB serial port adaptor. Through the PC's Control Panel, select Device Manager, and then Ports. The USB serial port adaptor will use the COM port. Note the COM port number. When setting up the Tera Term (or similar program), select Serial and the appropriate Communications Port.

2.2 Status Panel

The Status Panel on the GOES transmitter consists of four indicators and a pushbutton. The indicators provide visual feedback on the operation of the transmitter, and the pushbutton enables the user to query the state of the transmitter failsafe circuit. Also, when power is first applied to the GOES transmitter, the transmitter will go through a sequence of self-tests indicated by cycling four times through the FAULT, TX, DATA, and SYNC GPS indicators.

2.2.1 Synchronize Clock to GPS Indicator

After power is first applied to the GOES transmitter and the self-test cycle is completed, the transmitter will attempt to acquire a GPS fix.

If the GPs antenna is not connected the synchronization light will illuminate for two seconds and then turn off for a minute and a half. Check your antenna connections. It will continue this cycle until it detects a GPS antenna.

If all connections are correct, the SYNC GPS indicator will illuminate indicating that the transmitter is acquiring a GPS fix and is trying to synchronize its clock to UTC time. The indicator will turn off when time synchronization is complete. Once the transmitter time is synchronized, it will be able to transmit on the specified time schedule.

IMPORTANT! Ensure you take at least two minutes to observe the Synchronize Clock to GPS indicator once it turns off, to verify that it has synchronized. If the light remains off, synchronization has been achieved. If it blinks and then turns off again, it does not detect an antenna and you must check your connections and equipment.

Note that the first GPS fix after power up will normally be acquired within five minutes; however, UTC time synchronization can take as long as 20 minutes. If the transmitter cannot synchronize to UTC time during the first 20 minutes, the transmitter will switch off the GPS module for one minute and then will restart the synchronization cycle. This process continues until the transmitter successfully synchronizes to UTC time.

After initial time synchronization, the transmitter will attempt a single resynchronization to UTC time every 24 hours to correct its time drift. The transmitter is capable of operating for 28 days without a time resynchronization. After 28 days, if a time resynchronization is not achieved, the transmitter will disable transmissions. However, it will continue to attempt time resynchronization and, if successful, will re-enable transmissions.

The most common reason for time resynchronization failure is because the GPS antenna is being blocked by snow. If transmissions do not recommence with expected snow melt, or snow blockage is an unlikely reason, contact FTS Support.

2.2.2 DATA indicator

The DATA indicator shows that the transmitter has acquired data from the sensor and has stored that data in the transmitter's data buffer. The DATA indicator should be illuminated from approximately 2 minutes past the sensor interval (when the sensor is read) until one minute prior to transmission time (when the transmitter empties and formats the buffer contents in preparation for transmission). The light will remain illuminated if there is a sensor read within the time frame prior to transmission. Any data received within 1 minute of data transmission or during a timed transmission, will not be included in the current transmission but will be buffered for the next interval.

2.2.3 TRANSMIT (TX) Indicator

The TX indicator will illuminate at transmission time for the duration of the data transmission (about three seconds in total); however, if there is a failsafe error the FAULT indicator will blink twice to show that failsafe has been tripped and the transmitter has been switched off.

2.2.4 FAULT Indicator

The FAULT indicator is used in conjunction with the DIAGNOSTIC button to examine the state of the transmitter's failsafe circuit. If there is a failsafe error the FAULT indicator will blink twice when the DIAGNOSTIC button is pressed. Typically a failsafe error could occur if a transmission is attempted when the supply battery voltage falls below 10.5 volts.

2.2.5 DIAGNOSTIC button

The Diagnostic button allows the user to query the state of the transmitter failsafe circuit and also allows the user to clear the transmitter failsafe circuit if the failsafe has been tripped. To query the state of the failsafe, push and hold the Diagnostic button for about 2 seconds and monitor the state of the Fault indicator. The Fault indicator will flash once if the failsafe is OK (not tripped) or twice to indicate the failsafe has been tripped. A tripped failsafe indicates that there is a problem with the GOES transmitter. The failsafe is designed to disable a malfunctioning transmitter in order to protect other users of the satellite system from a transmitter that is transmitting for too long or too frequently. If the failsafe has tripped it can be cleared by depressing the Diagnostic button for at least 10 seconds. If the failsafe continues to trip, the unit should be returned to FTS for repair or replacement.

Chapter 3 Setting Up GOES Satellite Communications

3.1 General

Once the GOES.hopper is installed, and power is supplied to the GOES transmitter, it will go through a booting up cycle and GPS synchronization (see section 2.2.1). While the GPS synchronization is taking place, the G6 transmitter can be configured to communicate with the GOES satellite system.

3.2 Communicating with the GOES Transmitter

Communication with the GOES transmitter is enabled by connecting a PC which has a terminal program such as Windows Hyper Terminal or Tera Term installed to the Command Port.

The G6 implements an ASCII command line interface protocol. ASCII commands are not case sensitive but commas and some other characters are mandatory so care must be used when inputting the commands to ensure the syntax is correct.

Communication with the transmitter is initiated by the carriage return (CR) command which is generated by striking the Enter (or Return) key. The transmitter responds with a **>** prompt to indicate that it is ready to receive a command. Commands can then be input and terminated by the Enter key (CR).

If no characters are entered for 60 seconds, the transmitter will enter low power mode. Any partially entered commands will be deleted and the communication port will go to sleep. Communication must be re-established by striking the Enter key (CR) until the **>** prompt is returned.

Commands must be terminated with the Enter key (CR). Any character received following an Enter will be ignored. If you have message data with a CR in the line feeds (ie: so data will be printed out in columns rather than a line), then the CR must be preceded with a tilde (~). Backspace (BS) deletes the last character entered. ESC will delete the entire command.

Once all parameters or changes have been input, there are three commands which must be entered prior to exiting

1) >SAVE – this will save the changes to the non-volatile memory

2) >RCFG – read configuration to confirm the input changes are accurate

3)>ETX – enable transmissions to check parameters for validity

If the >ETX command returns BAD PARAMETER instead of OK, an error was made inputting the transmit parameters. Review the configuration and then re-enter the erroneous command with the correct parameter.

3.3 Setting up NOAA/EUMETSAT Transmit Parameters

The first step in configuring the G6 is to enter the assigned transmit parameters. Transmit parameters for the G6 are provided by the United States National Oceanic and Atmospheric Administration (NOAA) or the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), depending on your area of operations. These parameters allow users to retrieve data from their remote site using the GOES Data Collection System (DCS). The transmit parameters consist of the following:

NESID[1] : The ADDRESS (an eight character identifier) for your assignment.
Channel : Your assigned PRIME CHANNEL (TCH)
Bit Rate : Your assigned platform baud rate (TBR)
Interval : Your assigned REPORT RATE (TIN)
First Tx : Your assigned FIRST TRANSMISSION time (FTT)
Window : Your assigned XMT (transmit) WINDOW (TWL)

Refer to Table 3-1 for guidance on the individual transmit parameters.

NOAA/EUMETSAT Assigned Item	Command and Response Example	Comments/Explanation
Unique NES Identifier	**>NESID=**12345678 **>OK**	This is the unique hexadecimal alpha-numeric identifier for this GOES Station (for this place, not for the transmitter). Must end in an even number.
NESID Channel	**>TCH=**195 **>OK**	Channel number specified by NESID. Even channels are on the west satellite and odd on the east.
NESID Bit Rate	**>TBR=**300 **>OK**	Baud rate varies between platforms. NOAA will assign you a Baud rate based on the information it was provided on your NESID request.
Transmission Interval	**>TIN=**00:01:00:00 **>OK**	The transmission interval is how often transmissions are made and is specified in dd:hh:mm:ss format. Valid range is 00:00:05:00 to 30:23:59:59.
First Transmission Time	**>FTT=**00:43:00 **>OK**	First time of transmission in hh:mm:ss format and in 24 hour clock. Valid range is 00:00:00 to 23:59:59.
Transmission Window Length	**>TWL=**10 **>OK**	Window sizes can vary. The most common are 10 or 15 second windows.

Table 3-1

The steps required for setting the transmit parameters follow:

1) Connect the PC to the G6 Command Port and then start the HyperTerminal program.
2) Start a text file capture so that you have a record of the Command Port session.
3) Ensure the transmitter is powered.
4) Press enter, then wait 2 seconds and then press enter again to wake the transmitter. The transmitter should respond with a > prompt.

NOTE: Examples of the commands are provided. ASCII commands are indicated in bold, example parameters or values are in red. Ensure you input your assigned parameters/desired values and do not copy the red examples.

5) Set the assigned NESID address

[1] The NOAA uses the term NESID (National Environmental Satellite Identification). The equivalent EUMETSAT term is DCPID (Data Collection Platform Identification) or DCP Address. This document uses NESID.

>NESID=01234568 : for example set the NESID to 01234568
OK : the transmitter responds with the OK message

6) Set the Channel

>TCH=195 : for example set the channel to 195
OK : the transmitter responds with the OK message

7) Set the assigned Bit Rate

>TBR=300 : for example set the bit rate to 300 baud
OK : the transmitter responds with the OK message

8) Set the assigned Interval

>TIN=00:01:00:00 : for example set the interval to hourly
OK : the transmitter responds with the OK message

9) Set the assigned First Transmit Time

>FTT=00:17:40 : for example set the first transmit time to 17 minutes, 40
OK : the transmitter responds with the OK message

10) Set the Window

>TWL=10 : for example set the window length to 10 seconds
OK : the transmitter responds with the OK message

11) Issue a Save command to store the parameters in the transmitter's non-volatile memory.

>SAVE : save current parameters to non-volatile memory
OK : the transmitter responds with the OK message

12) Read the transmitter's configuration to confirm the parameters. The following list will be returned. Note that after the transmit parameters, the additional parameters are at factory default settings and will be explained in the following section.

>RCFG : enter the read the current configuration command
NESID=01234568 : the transmitter responds with the configuration – note
TCH=195 the displayed configuration is in accordance with the
TBR=300 example parameters (in red). Yours will return the figures/values
TIN=00:01:00:00 you input
FTT=00:17:40
TWL=10
CMSG=N : Note the default setting is N (no) however, Y (yes) is
EBM=N recommended. See Section 3.2 for details.
TPR=S
TIL=N
TDF=A
RCH=0
RBR=0
RIN=0
RPC=0
RRC=0
RDF=A
RMC=N

IRC=?
GIN=00:00:00
SDIMODE=SDI
SDF=1
ESBV=Y :Note: this command is SBV=Y for a G5 transmitter
SIN=01:00:00
SOF=00:02:00
SDI 0 empty
SDI 1 empty
SDI 2 empty
SDI 3 empty
SDI 4 empty
SDI 5 empty
SDI 6 empty.
SDI 7 empty
SDI 8 empty
SDI 9 empty

SDI Command Table for configuring sensors. See Section 5.2 for details.

13) If there are no additional changes to be made, issue an Enable Transmission command

>ETX : enable transmissions
OK : the transmitter responds with the OK message

NOTE: If it returns BAD PARAMETER instead of OK, an error was made inputting the transmit parameters. Review the configuration and then re-enter the erroneous command with the correct parameter.

3.4 Setting up Additional Parameters

The rest of the parameters are optional: some are user defined and some need to remain in the factory default. Table 3-2 briefly explains each item.

Enter the command for the additional parameters with which you wish to configure the G6 following the format in the table.

NOTE: Greyed table entries are the default settings which SHOULD NOT be changed.

Default Setting	Item	Command and Response Examples	Comments
CMSG=N	Center Message in Window	>CMSG=Y >OK	Y=Yes (Recommended). N=No. See Section 3.3.1 for details.
EBM=N	Empty Buffer Message	>EBM=Y >OK	Y=Yes. Transmitter will always transmit even if there is no data in the transmit buffer. N=No. There will be no transmission if there is no data in the buffer. See Section 3.3.2.
TPR=S	Transmit Preamble Length	N/A	Default Setting. Do not change.

TDF=A	Transmit Data Format	Default	Default setting is A (ASCII). Other options are pseudo binary (P) and binary (B).
RCH=0	Random Channel	Default	N/A as the GOES.hopper is not capable of random transmissions (a data logger is needed to perform that function). Keep the default settings.
RBR=0	Random Baud Rate	Default	
RIN=0	Random Interval	Default	
RPC=0	Random Tx Random Percentage	Default	
RRC=0	Random Tx Repeat Count	Default	
RDF=A	Random Tx Data Format	Default	
RMC=N	Random Tx Message Counter	Default	
IRC=?	ASCII Replacement Character	Default	Prohibited ASCII characters detected in the transmission data will be replaced with a question mark (?) when operating in ASCII or Pseudo-Binary mode.
GIN=00:00:00	GPS Fix Interval	Default	The GPS will fix at power up and every 24 hours. See Section 3.3.3 for details if not using the default setting.
SDIMODE=SDI	Transmitter Mode	>SDIMODE=SDI >OK	SDI is the only mode available. Do not change the default setting.
SDF=1	SDI Data Format	>SDF=1 >OK	There are 2 modes to choose from (SDF=1 and SDF=4) to display the Transmitted Data Format (section 3.3.4).
ESBV (Note: if using a G5 transmitter this command is SBV)	Enable SDI Battery Voltage	>ESBV=Y (>SBV=Y for a G5 transmitter)	To receive a reading of the battery voltage levels in the transmitted data. Choose Y (Yes) or N (No). Yes is recommended.
SIN=00:00:00	Sensor Sample Interval	>SIN=01:00:00 >OK	Any interval that's required but all sensors would be sampled at the same interval. In hh:mm:ss format. See Section 3.4.5
SOF=00:00:00	Sensor Sample Offset	>SOF=00:05:00 >OK	The period of time after midnight samples are taken. (hh:mm:ss). See Section 3.4.5.

Table 3-2

3.4.1 Message Centering

If selected, **Message Centering** causes the G6 to transmit its data centered in the middle of its transmission window instead of transmitting right at the start of its transmission time.

The default setting is N (no) but NOAA's recommendation is to select message centering. Message centering takes into account the full length of the message and then places it in the middle of the window. This helps avoid message collisions due to a neighboring or rogue message going over its 10 second window. If the data to be transmitted fills the entire transmit window some of it may be lost as some of the transmit window time is allotted for the time it takes the message to leave the site, reach the satellite, and be decoded by the ground station.

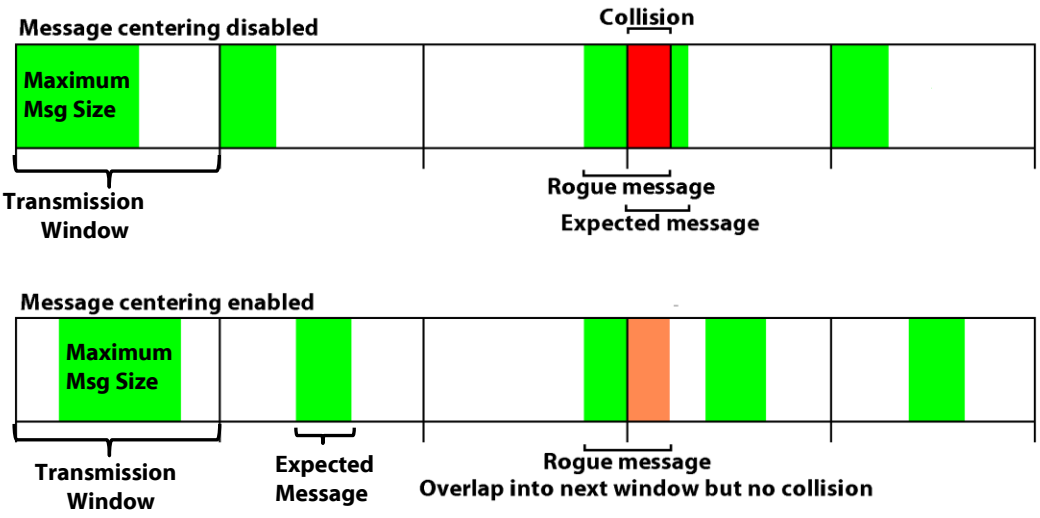


Figure 3-1: Message Centering

3.4.2 Empty Buffer Message (EBM)

If the GOES transmission intervals (TIN) are more frequent than the sampling intervals, you will receive transmissions which consist of the GOES DCS header, SDI address and a series of ///.

EG: 44A0C67414097210915G30+0HN116WXW00018 21:00:00,1,///

This is because there is no data in the buffer to send. If you only want to receive transmissions which contain data, set the EBM to No (>EBM=N).

3.4.3 Setting the GPS Interval

If you require periodic GPS fixes more often than the default setting permits, use the GIN=hh:mm:ss command. A valid interval range is 00:05:00 to 24:00:00. The GPS fix interval MUST NOT coincide with the transmit interval (TIN). It should be at least two minutes either side of the transmit interval. The parameter is non-volatile when saved using the SAVE or ETX commands.

3.4.4 Transmitted SDI Data Format

There are two format choices in which to transmit data: SDF=1 and SDF=4.

The main differences between the two formats are outlined in the following table:

SDF=1	**SDF=4**
The battery voltage measurement is taken from the SDI Address "z". Both the SDI address and the battery voltage follow the follow the transmission timestamp. See SDF=1 FORMAT in section 3.4.4.1.	The battery voltage measurement is taken from the Command Table Entry "50" which precedes the timestamp. The battery voltage measurement follows the transmission time stamp. See SDF=4 FORMAT in section 3.4.4.1
Identifies data by SDI-12 Sensor address	Identifies data by Command Table Entry number
Separates all data line elements with commas	Only separates data values in data lines with commas

3.4.4.1 Transmitted SDI Data Format Examples

In the following examples, the returned data is from the Command Table which has been formatted as follows (this is an excerpt from the >rcfg command):

SDI 0,1M! (Command table entry 0, SDI-12 sensor at address 1 sends the M command)
SDI 1,2M! (Command table entry 1, SDI-12 sensor at address 2 sends the M command)
SDI 2,2M2! (Command table entry 2, SDI-12 sensor at address 2 sends the M2 command)

SDF=1 FORMAT:

The default setting, SDF=1, will transmit data as a series of records on individual lines (separated by [CR][LF]) each of which is preceded by a 24 hour time stamp in hh:mm:ss format . The records are buffered until transmission time and then transmitted in reverse chronological order.
In each SDF=1 transmitted record, the first line will return the GOES DCS Header[2] followed by the 24-hour timestamp of the time of transmission in HH:mm:ss, format. If ESBV =Y (SBV=Y for a G5 transmitter) is input, the last value will be the battery voltage. The elements of the subsequent lines are separated by commas and consist of: the time the measurements were taken (in HH:mm:ss format), the SDI sensor address, followed by the data values.

0105E59016305194504G43+1NN196WXW00085 19:44:00,z[3],+12.65
19:00:00,2,+22.79,+0

19:00:00,2,+999.4

19:00:00,1,+211,+51.8

SDF=4 FORMAT:

SDF=4 is the recommended transmission format as it separates data from the GOES header, simplifying data extraction. Note that the first value in the data lines is the Command Table Entry of the SDI sensor rather than the SDI address (as in SDF=1), which is then followed by the time stamp.

In each SDF=4 transmitted record, the first line will return the GOES DCS Header[2] , 24-hour timestamp of the time of transmission in HH:mm:ss format. If ESBV =Y (SBV=Y for a G5 transmitter) is input, the last value will be the battery voltage. The subsequent lines indicate the Command Table Entry Number, the time the measurements were taken in HH:mm:ss format, and comma separated data for each sensor.

0105E59016306194502G45+0HN196WXW00087 50[4] 19:44:00 +11.79
2 19:00:00 +23.28, +0
1 19:00:00 +1005.3
0 19:00:00 +211, +51.9

[2] For details on decoding the GOES DCS Header, refer to the FTS 700-Axiom-Telemetry Reference
[3] The "z" is the SDI address assigned to the battery voltage measurement from code.
[4] The "50" is the Command Table Entry assigned to the battery voltage measurement from code.

3.4.5 Sensor Sample Interval (SIN) and Sensor Sample Offset (SOF)

It is important to understand the difference between SIN and SOF. The SIN is how often samples will be taken, and the SOF is the time at which the samples will be taken expressed in time after midnight. After the initial sample is taken in accordance with its offset time (SOF) relative to midnight, subsequent samples will be taken in accordance with the SIN interval. Both time inputs are in hh:mm:ss format
If the SOF remains at the default 00:00:00 time, samples will be taken at the interval input at the SIN based on midnight as the starting time.

> NOTE: Whereas you must have an SIN, the SOF is optional and not commonly used.

EXAMPLE 1: Samples every 15 minutes starting on the hour:

>SIN=00:15:00 >SOF=00:00:00	SIN indicates that samples will be taken every 15 minutes. SOF indicates the first samples will be taken at midnight (there is no offset). Subsequent samples will be taken at 00:15:00, 00:30:00, 00:45:00, 01:00:00, etc.

*EXAMPLE 2***:** Samples every fifteen minutes offset 5 minutes from the hourly time:

>SIN=00:15:00 >SOF=00:05:00	SIN indicates that samples will be taken every 15 minutes. SOF indicates the first samples will be taken at the offset time of 00:05:00 (five minutes after midnight). Subsequent samples will be taken at 00:20:00, 00:35:00, 00:50:00, 01:05:00, etc.

*EXAMPLE 3***:** Samples every 6 hours commencing at 1 a.m.

>SIN=06:00:00 >SOF=01:00:00	SIN indicates that samples will be taken every 6 hours. SOF indicates the first samples will be taken at the offset time of one hour after midnight (1 a.m.). Subsequent samples will be taken at 07:00:00, 13:00:00, 19:00:00 (7 a.m., 1 p.m. and 7 p.m.), etc.

3.5 Setting Antenna Power Levels

1) Switch the transmitter to technician mode (case sensitive).

   >techmode alpha
   OK

> WARNING! When operating in the TECHNICIAN mode, care must be used as changes made can permanently change or damage the transmitter. The technician mode should only be used as directed in this manual. For any further operations, contact FTS support for guidance.
>
> As long as **>SAVE** or **>SAVECAL** is not entered after changes are made in the TECHNICIAN mode, then the previously saved configuration can be recalled using the **>RSTR** command or by power cycling the GOES transmitter.

2) Check and/or set transmitter power levels. Power levels will differ dependent on the GOES antenna that is used and should be in accordance with DCPRS Effective Isotropic Radiated Power (EIRP)[5]. Refer to your antenna's specifications and operating manual. DO NOT USE the example values which appear in red font. If the returned power levels are not within the specifications, you will have to change them.

>PWRLVL	: Check power levels
PWRLVL=37.5,37.5,38	**:** Transmitter returns current output power level settings for 100, 300 and 1200 bps respectively

a) Use the PWRLVL command to set the desired calibration parameters:

>PWRLVL=38,38,38	: Example values shown are the recommended values for the G6 transmitter when using the FTS Eon antenna. Set power levels to desired values.
OK	

IMPORTANT! Guidance for determining appropriate power level setting for the FTS Eon antenna can be found in Appendix B.

b)	**>SAVECAL** **OK**	:save the calibration parameters to non-volatile memory
c)	**>USERMODE**	: Return to User mode

IMPORTANT! Returning to User mode is critical to ensure any inadvertent changes to the operating features of the transmitter are not made.

[5] NOAA: GOES Data Collection Platform Radio Set (DCPRS) CERTIFICATION STANDARDS, NOAA/NESDIS, June 2009; http://www.noaasis.noaa.gov/DCS/docs/DCPR_CS2_final_June09.pdf; Section 4.1.1.
EUMETSAT: TD-16 – Meteosat Data Collection and Distribution Service v2, 19 November 2013; Section 5.1.4

Chapter 4 Configuring Sensors

4.1 General

> IMPORTANT: A sensor should be connected to the terminal strip and assigned an address before the next sensor is attached.

In order for the G6 to receive data from the attached SDI sensor(s), the sensors must be configured. Until this happens, when the read configuration (RCFG) command is entered, the SDI information will be returned as empty (eg: SDI 0 empty) as seen in Section 3.3. paragraph12.

Sensors can be configured concurrently while GPS synchronization is taking place.

4.2 Connecting Sensors

When initially setting up a GOES.hopper station, only one sensor at a time should be connected to the terminal strip. This sensor should be assigned an address, a measurement command and then tested. Once satisfied that the sensor is operating as desired, it should be disconnected from the terminal strip (disconnecting a single wire is sufficient), and the next sensor attached.

> WARNING! Ensure bare wires do not come in contact with each other or to other connections on the terminal strip as this can cause contention.

4.3 Communicating with the Sensors

The SDI-12 sensors connected to the G6 use ASCII characters to communicate using standard SDI-12 communications protocol[6]. SDI-12 commands are used to configure the sensor(s) and are entered in the same manner as described in Section 3.6 using a PC with the installed terminal program.

Every command must commence with the sensor address and terminate with an exclamation mark (!). Every response will also commence with the sensor address.

If you have not already done so (ie: conducting a site visit rather than initial installation of the station)

1) Connect the PC to the Command Port and then start the terminal program.
2) Start a text file capture so that you have a record of the Command Port session.
3) Ensure the transmitter is powered.
4) Press enter, then wait 2 seconds and then press enter again to wake the transmitter. The transmitter should respond with a > prompt.

In order to communicate with the sensors using SDI-12 commands, you must first enter the transparent mode.

5) Issue the enter transparent mode command (ETM) and wait for the * prompt.

```
>ETM
*
```

[6] For a detailed explanation of SDI-12 protocols and commands refer to SDI-12 Specification, Version 1.3 at http://www.sdi-12.org

4.4 Step 1 - Assigning Sensor Addresses

Each sensor attached to the terminal strip must have its own unique address. Standard addresses range from 0–9. The factory default address for SDI sensors is zero (0) and if the sensor is one which has already been in use, it may have a different address assigned.

> IMPORTANT! A sensor should be connected to the terminal strip, assigned an address and disconnected before the next sensor is attached.

Once a sensor is attached, the first step is to determine which address the sensor has, ensure it is not in conflict with another sensor's address, and assign it a unique address if necessary.

	Syntax	In which:	Meaning
Command	***a***!	***a*** = sensor address ! = command terminator	Sensor at address ***a*** acknowledge active
Response	***a***	***a***=sensor address	Sensor at address ***a*** is active

Example:

Command: 0! :sensor at address 0, acknowledge active
Response: 0 :the sensor at address 0 is active

If the sensor responds, that indicates it is at address zero. Proceed to Step 2.
If there is no response, the SDI sensor has a different address which you must determine.

> NOTE: If the response is a series of dots (.....), that indicates there is no sensor at the requested address or there is a problem with the setup or sensor.

4.4.1 Address Query

When given the address query command, the sensor will respond with its address.

	Syntax	In which:	Meaning
Command	?!	? = address query ! = command terminator	Address Query
Response	***a***	***a***=sensor address	Sensor at address ***a*** is active

Example:

Command: ?! : request address
Response: 0 : sensor is at address 0 – the expected response for new sensors

If the sensor returns an address other than 0 which does not conflict with another sensor's address and you are happy to leave it, continue to configure the sensor. Go to Step 2.

4.4.2 Change Address

If the sensor returns an address of 0 or an address which is in conflict with another sensor' address, you must ass assign a new address to the sensor. Use the change address command.

> IMPORTANT! Do not leave a sensor's address at 0 as this address will be in conflict with any sensor which is set to the factory default when it is first connected to the terminal strip.

	Syntax	In which:	Meaning
Command	***a***Ab!	***a*** = the sensor's current address A = change address command b = the new address ! = command terminator	Sensor at address ***a ,*** change address to the number input as b.
Response	b	b = new sensor address	Address changed

NOTE: If the sensor replies with the original address, it does not support software changeable addresses and is unable to change the address.

Example:

Command: 0A1! : sensor at address zero change address to 1
Response: 1 : sensor is at address 1

4.5 Step 2 – Confirming Sensor Operation

4.5.1 Send Identification

Use this command to get information about the sensor. The sensor will return its SDI-12 compatibility level, model number and firmware version number.

	Syntax	In which:	Meaning
Command	***a***I!	***a*** = the sensor 'saddress I = send identification ! = command terminator	Send Identification
Response	***a***Icmvx	***a***= the sensor's address I = SDI-12 version compatability c= 8 character vendor identification m = 6 characters specifying the sensor model number v = 3 characters specifying the sensor version x = an optional field, up to 13 characters, used for serial number or other sensor information	Identification

NOTE: If not all character spaces for c, m and v are used, the unused spaces will be filled with dashes.

Example:

Command: 3I! : sensor at address 3, send identification
Response: 013FTS-----CM11B-1--1234
(the sensor at address zero is compatible with SDI-12 ver 1.3 and is manufactured by FTS. The sensor model is CM11B operating on firmware version 1 and with serial number 1234).

Note that if you are using an SDI interface cable, the identification and serial number will be for the cable not the SDI sensor.

4.5.2 Start Measurement

This command tells the sensor to take a measurement. The sensor will return how long it takes to take a measurement and how many measurements it will take. Note that the sensor will not return the actual data taken. The send data command must be issued to get the measurement(s).

IMPORTANT! Certain logging sensors, especially those used in groundwater applications, are equipped with an internal battery and the sensor must be turned on otherwise data logging within the sensor will not occur.

	Syntax	In which:	Meaning
Command	***a****M*!	***a*** = the sensor's address M = start measurement ! = command terminator	Sensor at address ***a,*** start a measurement.
Response	***a***tttn	***a*** = the sensor's address ttt = the time in seconds before the sensor will have the measurement(s) ready n = the number of measurement values the sensor will make and return. The valid range is from 1-9.	Address changed

Example:

Command: 1M! : sensor at address 1, start a measurement
Response: 10052 : sensor at address 1 will take 5 seconds to have data ready and will return 2 measurement values

4.5.3 Send Data

This command is used to get data from the sensor. It must be issued after the Start Measurement command.

	Syntax	In which:	Meaning
Command	***a****D0*!	***a*** = the sensor's address D0 = send data ! = command terminator	Sensor at address ***a,*** send a measurement.
Response	***a***<values>	***a*** = the sensor's address <values> = pd.d in which p = polarity sign (+/-) d = numeric digits (the decimal point is optional) NOTE: the maximum number of digits for a data value is 7. The minimum is 1. The maximum number of characters in a data value is 9 (the polarity sign plus 7 digits plus a decimal).	Sensor returns the values measured

Example:

Command: 2D0! : sensor at address 2, send data
Response: 2+34.2,109.5 : sensor at address 2 returns two measurement values (+34.2 and 109.5)

REPEAT: Once satisfied the attached sensor is operating as desired, disconnect it and repeat the process (Section 4.4 through 4.5) for each sensor.

4.6 Completing Sensor Connections

Once all sensors have been assigned a unique address and configured, you can re-attach all of them to the terminal strip.

Conduct a final test to ensure all attached sensors are operating as desired by issuing a Start Measurement and a Send Data command to each sensor attached. Refer to Sections 4.5.2 and 4.5.3.

IMPORTANT! When the final test is completed, exit the transparent mode by striking the escape (Esc) key.

Once all sensors have been connected to the terminal strip and duly tested, the connections should be completed by using a crimp-type connector or soldering. Bare wire connections can degrade equipment performance and data transfer.

Chapter 5 Configuring the GOES Transmitter with Sensor Measurement Commands

5.1 General

Once the sensors have all been assigned an address and are confirmed to be operating, the G6 must be configured so that it can trigger measurements and store the data in its buffer before transmission.

> NOTE: You must refer to the SDI sensor's manual to determine its measurement command.

If not already, done:

1) Connect the PC to the G6 Command Port and then start the terminal program.
2) Start a text file capture so that you have a record of the Command Port session.
3) Ensure the transmitter is powered.
4) Press enter, then wait 2 seconds and then press enter again to wake the transmitter. The transmitter should respond with a > prompt.

> IMPORTANT! If continuing from Chapter 4, after connecting sensors ensure you have exited the transparent mode before proceeding. Ensure the prompt is indicated by > and not an asterisk * which indicates you are still in transparent mode.

5.2 Configuring the Command Table Index

The GOES transmitter has a Command Table which holds up to ten SDI-12 Measurement Command entries. These entries are assigned a command table index location from 0-9. The SDI-12 Measurement Commands are used by the G6 to direct the SDI-12 sensor to take measurements and send the data values to the GOES transmitter's buffer. The measurement commands are executed consecutively in the order they appear in the Command Table index.

Data Format

In addition to taking measurements and sending the data values to the buffer, the format of the data to be transmitted can be configured. One way is by using the optional **#values** parameter in the **Add SDI-12 Measurement Command** (section 5.2.1). This will return the raw data but only in the order of the measured fields. You cannot specify to return data from only field 2, 4 and 5 (for example). The other way is to use the **SDIFMT Command** (section 5.2.2) in which you can specify data values to be returned from specific fields and specify the precision of the decimal places.

5.2.1 Add SDI-12 Measurement Command to the Command Table

The syntax of the command is (note comma placement): >**SDI i,aXCn!,#values**

In which:

Mandatory Elements

- **i,** = a command table index location from 0-9
- **a** = the SDI address of the sensor
- **X** = the command type and is one of M, C or R (as specified in the sensor's manual)
- **C** = an optional character indicating the CRC[7] is to be used in the SDI-12 bus transaction
- **n** = an optional parameter indicating the measurement variant being used (0-9) (ie: M1, M2, M3, etc.)
- **!** = the command termination character

,#values = an optional parameter. The number of data values to add to the transmit buffer from those returned by the sensor. If #values is not specified, all returned data values are added to the transmit buffer.

NOTE! If the number of values returned by the sensor is less than the **#values** parameter, the missing fields will be filled with "///". If there are more values returned than specified by the **#values** parameter, the values will be added in the order they are measured and those exceeding the parameter will be truncated.

The response to the SDI-12 measurement command will be "OK" if the SDI command was successfully added to the command table or "Unknown Format" if the command format is not recognized. This is usually due to missing a mandatory component of the command, or a typographical error.

Examples:

i) **SDI 1,1R!** SDI measurement command at command table index 1. SDI-12 sensor at address 1 uses the R command followed by the command termination character. All data returned from the sensor will be added to the transmit buffer.

NOTE: Example i) shows the mandatory elements, the minimum information required to make up the SDI-12 Measurement Command.

ii) **SDI 2,1M6!,3** SDI measurement command at command table index 2. SDI sensor at address 1 uses the M command, measurement variant of 6 (optional), command termination character, add the first 3 returned values to the transmit buffer

iii) **SDI 7,3CC4!,2** SDI measurement command at command table index 7. SDI sensor at address 3 uses the C command, cyclic redundancy check is being used (optional), measurement variant of 4, command termination character, add the first 2 returned values to the transmit buffer

NOTE! If the number of values returned by the sensor is less than the **#values** parameter, the missing fields will be filled with "///". If there are more values returned than specified by the **#values** parameter, the extra values will not be included in the transmit buffer.

[7] Cyclic Redundancy Check – an error detecting code used to detect accidental changes to raw data that has been transmitted on a communications link.

5.2.2 Configuring the SDI Sensor Data Format (Optional)

The sensor's data can also be configured to return specific measurement fields and decimal places using the SDIFMT command followed by >SAVE.

The syntax of the command is: >**SDIFMT i,n,n,n:b**

In which:

i is the command table index location from 0-9

n is the measurement fields to be output from the SDI-12 sensor being used. There is a maximum of 20 fields numbered 0-19.

:b is the number of decimal places in the data. If it is not used the data will be returned with the default number of decimal places in accordance with the sensors settings

IMPORTANT: Because **n** is populated with a numeral string commencing with zero (0), care must be taken to ensure the corresponding measurement fields from the measurement command are correctly assigned. The first measurement field must be denoted by zero (0), the second field by one (1), etc.

Examples:

i) **>SDIFMT 3,1:2**: the sensor at command table index 3 will return data from the second field measured to two decimal places

ii) **>SDIFMT 1,0:2,2:3** the sensor at command table index 1 will return data from the first field to 2 decimal places and from the third field to three decimal places

iii) **>SDIFMT 2,0,2,4:2** the sensor at command table index 2 will return data from fields one and three to the default number of decimal places and field five to two decimal places

The response to the SDI command will be "OK" if the SDI sensor data format command was successfully added to the command table or "Unknown Format" if the command format is not recognized.

5.2.3 Reading the Existing SDI Sensor Data Format

This command is used to read and confirm the existing data format or to confirm the configuration input using the SDIFMT command outlined previously

The syntax of the command is: >**PSDIFMT i**

Where:

i is the command table index location of the sensor

The response will follow the same format as noted in 5.2.2: **i,n,n,n:b**

Undefined fields in the format will be indicated by the number 255.

1) 255:255 indicates an unused field;

2) A number before the colon with 255 after the colon means the data for the specified field will include all possible decimal places (:b was not defined for that field when the SDI Sensor Data format was configured)

   Examples:

   >PSDIFMT 3 :Command - sensor at command table index 3 get the SDI-12 sensor data format

   >SDIFMT 3,1:2 : Response – sensor at command table index 3, data from the second field measured to two decimal places

   >PSDIFMT 1 :Command - sensor at command table index 1 get the SDI sensor data format

   >SDIFMT 1,0:255,3:255,7:255,8:2,255:255,255:255,255:255…..255:255

   : Response – sensor at command table index 0, data from the first, fourth and eighth fields measured to maximum decimal places, data from the ninth field measured to two decimal places followed by a series of unused fields.

5.3 Save SDI Configuration

Once all desired parameters have been entered.

1) Issue a Save command to store the parameters in the transmitter's non-volatile memory.

   >SAVE : save current parameters to non-volatile memory
   OK : the transmitter responds with the OK message

5.4 Confirm the Configuration

2) Read the transmitter's configuration to confirm the changes.

   >RCFG : read the current configuration
   NESID=01234568
   TCH=195
   TBR=300
   TIN=00:01:00:00
   FTT=00:27:00
   TWL=10
   CMSG=Y
   EBM=Y
   TPR=S
   TDF=A
   RCH=195
   RBR=300
   RIN=10
   RPC=50
   RRC=1

RDF=A
RMC=N
IRC=?
GIN=00:05:00
SDIMODE=SDI
ESBV=Y
SDF=4
SIN=01:00:00
SOF=00:00:00
SDI 0 empty
SDI 1, 1R!
SDI 2,1M6!,3
SDI 3 empty
SDI 4 empty
SDI 5 empty
SDI 6 empty
SDI 7, 3CC4!,2
SDI 8 empty
SDI 9 empty

Note that the command table entries which have configured SDI sensors (using the examples in section 5.2) now show the SDI measurement command.
To view the SDI sensor data format information for a G6 transmitter, you must use the **PSDIFMT** command

SDIFMT 1
SDIFMT 2
SDIFMT 7
SDIFMT 1,0:1,6:2,255:255,255:255,255:255
SDIFMT 2,0:3,1:0,2:1,255:255,255:255,255:255,255:255,255:
SDIFMT 7,0:2,1:2,2:255,3:255,4:255,5:255,6:255,7:255,8:255,9:255,10:255,11:255,12:255,

SDIFMT (SDI sensor data format) information is returned for a RCFG command with a G5 transmitter. 255 is a default returned for empty fields.

Issue an ***Enable Transmission*** command to check configuration parameters for validity.

>ETX : enable transmissions
OK : the transmitter responds with the OK message

NOTE: If it returns BAD PARAMETER instead of OK, an error was made inputting the transmit parameters. Review the configuration (use the RCFG command) and then re-enter the erroneous command with the correct parameter(s).

Chapter 6 Verifying Communications

6.1 Confirming Transmission Status

In order to get the status of the transmission and confirm transmission details, enter a ***Get Transmission Status*** command

>RST	:Get transmission status
Transmitter: Enabled	:the transmitter responds with the following information
GPS: On	Note that this is an example and times and values will be
RTC: Valid	different for individual systems
Time To Next Tx: 00:00:46:39	
Timed Message Length: 119 bytes	: if there is no data in the buffer it will be 0 bytes
Next Timed Tx: 2015/03/19 18:00:20	
Random Message Length: 0 bytes	
Random Message Tx Count: 0	
Next Random Tx: N/A	
Failsafe: OK	
Supply voltage: 15.7 V	

This message indicates that all is ready to transmit

6.2 Verifying Sensor Communications

Following is a series of steps required for verifying communications with the sensor(s) and ensuring the sensor(s) are transmitting data as expected:

1) Issue the Transparent mode command (ETM) and wait for the * prompt.

   >ETM
   *****

2) At the asterisk prompt, enter the following command:

   aI! : sensor identification request in which '**a'** is the SDI address of the sensor

   The response format will be:

   aVM-----m-f--s in which:

   - a : sensor SDI address
   - V : SDI-12 version with which it is compatible (normally 13 for ver 1.3)
   - M : manufacturer's identifier
   - m : sensor model
   - f : version of sensor firmware
   - s : sensor serial number

   Example:

*1I!	: send information on sensor at address one (1)
113FTS-----CM11B-1--1234	: the sensor at address one is compatible with SDI-12 ver 1.3 and is manufactured by FTS. The sensor model is CM11B operating on firmware version 1 and with serial number 1234.

NOTE: If the response is a series of dots (.....), that indicates there is no sensor at the requested address or there is a problem with the setup or sensor.

3) Repeat for all sensors.
4) Press the escape key <Esc> to exit from transparent mode and return to the > prompt.
5) A scan of all the sensors can be forced at any time(for G6 units) with the following command. G5 units must have had the time set by the GPS clock synchronization before this command can be used. Scanned measurement results are displayed on the screen and will not be buffered for transmission. :

   >STT
   >22:06:46,0,+10.359,+2.339
   22:06:46,1,+1.643,+102.763

   If the data returned has fields populated with back slashes (ie: \\, \\), there is a problem with the equipment set up. Refer to the troubleshooting guide for assistance.

6.3 G6 Test Transmission

In order to ensure the transmitter is fully functional and the antenna is correctly aligned a test transmission should be conducted prior to leaving the site. This transmission can be conducted on your assigned test channel (if you have one) or on the manufacturer's test channel: 195 for east satellites or 196 for west satellites. A secondary option would be to use your random channel if your NESID assignment includes one. When conducting a test transmission be aware that there is the possibility that the transmission could be blocked by another transmission on the same channel.

Following is a series of steps required for verifying communications of the G6 transmitter with a satellite system. If the PC is not already connected:

1) Connect the PC to the Command Port and then start the terminal program.
2) Start a text file capture so that you have a record of the session.
3) Ensure the transmitter is powered.
4) Press enter, then wait 2 seconds and then press enter again to wake the transmitter. The transmitter should respond with a > prompt.
5) Switch the transmitter to technician mode (case sensitive).

   >techmode alpha
   OK

WARNING! When operating in the TECHNICIAN mode, care must be used as changes made can permanently change or damage the transmitter. The transparent mode should only be used as directed in this manual. For any further operations, contact FTS support for guidance.

As long as **>SAVE** or **>SAVECAL** is not entered after changes are made in the TECHNICIAN mode, then the previously saved configuration can be recalled using the **>RSTR** command or by power cycling the G6.

6) Disable regular transmissions:

>DTX : disable regular transmissions
OK

7) Disable GPS synchronization:

>DAS
OK

8) Turn on the oven controlled oscillator (ocxo):

>OCXOON
OK

9) Wait 90 seconds for the oven controlled oscillator to stabilize.

10) Issue the test transmission (the TX indicator will illuminate for approximately 7 seconds).

IMPORTANT! For test transmissions that are operating with the GOES Satellite system it is important that only the type 4 parameter be used (ie: the **FTX 4**,XXX,XXX command).

This command will send a transmission that self terminates thereby limiting the exposure of other users to erroneous traffic on their time slots if the channel were not correct.

>FTX 4[a],Channel[b], bit rate[c] :see the following notes for details.

a) **FTX** - **Must** use FTX 4

b) **Channel** - Use your assigned test channel. If you do not have an assigned test channel, use195 if your assignment is on the GOES East satellite, or 196 if your assignment is on the GOES West satellite.

c) **Bit Rate** - Input your assigned bit rate

Example: **>FTX 4,195,300**

11) Check the transmission using the EDDN field message retrieval webpage.[8] The transmitted test message will be:

012345681513414356G42-1NN195EXE00392 : GOES header
Operator Initiated Test Transmission: : Test Message will repeat
Operator Initiated Test Transmission:
Operator Initiated Test Transmission:
Operator Initiated Test Transmission:
Operator Initiated Test Transmission:
Operator Initiated Test Transmission:
Operator Initiated Test Transmission:
Operator Initiated Test Transmission:
Operator Initiated Test Transmission:
Operator Initiated Test Transmission:
Operator Initiated Test Transmission:

[8] http://eddn.usgs.gov/fieldtest.html.

12) Get the last transmission status.

>LTXS
Tx Status: OK
Tx Type: Test Message
Last Tx Length: 62 bytes : if there is no data in the buffer it will be 0 bytes
Last Tx Start Time: 2000/01/01 00:06:16
Last Tx Stop Time: 2000/01/01 00:06:27 : Tx time is 11 seconds
Forward Power: 40.4 dBm
Reflected Power: 9.0 dBm
SWR: 1.05
Power Supply: 11.9 V

The following steps are CRITICAL. If you fail to return the transmitter back to this state, no transmissions will be made, necessitating another site visit.

13) Turn the oven controlled oscillator (ocxo) off.

>OCXOOFF
OK

14) Enable automatic GPS synchronization.

>EAS
OK

15) Enable transmissions.

>ETX
OK

16) Return to User mode

>USERMODE
OK

17) Confirm sensor communications:

Issue the SDI-12 Command Table test

>STT

The measurement results will be displayed on the computer screen. Confirm all desired sensors and fields are correct.

18) Close the HyperTerminal text file capture and disconnect from the Command Port.

6.3.1 Failed Transmission

If the transmission failed, there are two ways to troubleshoot the issue.

1) Read the audit log. This will return a list of recent events. See Section 8.3 for details of possible audit log messages.

   >RAL
   2015/03/19 17:34:22 TX Aborted: Timed Tx Buffer Empty : example message

2) Get the status of the last failed transmission.

   Example 1:

   >LTXL
   Tx Status: TX Aborted: Timed Tx Buffer Empty : example message
   Tx Type: Self Timed
   Last TX Length: 0 bytes
   Last Tx Start Time: 2015/03/19 17:34:22
   Last Tx Stop Time: N/A
   Forward Power: N/A
   Reflected Power: N/A
   SWR: N/A
   Power Supply: N/A

   Note that some fields will be marked as N/A depending on the context of the failure which is described by 'Tx Status'.

   Example 2:

   >LTXL
   Tx Status: Msg Truncated
   Tx Type: Self Timed
   Last Tx Length: 2214 bytes
   Last Tx Start Time: 2012/06/13 21:36:59
   Last Tx Stop Time: 2012/06/13 21:37:58
   Forward Power: 32.0 dBm
   Reflected Power: 16.3 dBm
   SWR: 1.39
   Power Supply: 10.9 V

   Msg Truncated (message truncated) indicates that there was more data than could have been transmitted within the transmission window.

6.4 Field Message Retrieval

It is possible to confirm that the GOES transmitter assembly has transmitted correctly and the actual power of the transmission using your computer or smartphone. Visit http://eddn.usgs.gov/fieldtest.html and enter the DCP address or NESID for the station that you wish to check and the number of hours of data that you want to inspect.

Chapter 7 Quick Set Up Guide

This Chapter is meant as a basic step by step reference to perform a basic field setup of the GOES.hopper sensors. For detailed instructions and explanations of the steps refer to the earlier portions of this manual. Relevant sections are referenced after each heading.

1) Connect the PC to the G6 Command Port and then start the TeraTerm (or similar) program.
2) Start a text file capture so that you have a record of the Command Port session.
3) Ensure the transmitter is powered.
4) Press enter, then wait 2 seconds and then press enter again to wake the transmitter. The transmitter should respond with a > prompt.

7.1 Step 1: Setting up NOAA/EUMETSAT Transmit Parameters (Sections 3.3-3.4)

Type the commands in after the > prompt and then strike the Enter key. The transmitter will respond to every valid command with >OK. The x's indicate where you must input your desired characters and the hh:mm:ss indicate that a time must be input (hours:minute:seconds), otherwise enter the command as shown.

	Command	**Example**	**Comments**
1	>NESID= xxxxxxxx	>NESID= 12A09E18	Enter the eight character identifier provided by NOAA or EUMETSAT
2	>TCH=xxx	>TCH=196	Enter your *assigned* Prime Channel
3	>TBR=xxx	>TBR=300	Enter your *assigned* Baud rate (100, 300 or 1200)
4	>TIN=dd:hh:mm:ss	>TIN=01:01:00:00	Input your *assigned* report rate dd:hh:mm:ss format. The example shows daily, hourly transmissions.
5	>FTT=hh:mm:ss	>FTT=00:43:00	Your *assigned* first transmission time (from NOAA/EUMETSAT)
6	>CMSG=Y		Message Centering on
7	>ESBV=Y >SBV=Y (for G5 units)		To receive a reading of the battery voltage levels in the transmitted data. The default is No but Yes (Y) is recommended.
8	>SIN=hh:mm:ss	>SIN=00:05:00	How often the sensors are sampled. Any interval that's required but all sensors would be sampled at the same interval. The example shows sensors being sampled every 5 minutes.

7.2 Step 2: Setting Antenna Power Levels (Section 3.5)

	Command	Comments
1	>techmode alpha	WARNING! When operating at the TECHNICIAN level, care must be used as changes made can permanently change or damage the transmitter.
2	>PWRLVL=38,38,38	These power settings are the standard settings for G6 use with an Eon antenna and are proven to work in most locations. Note that if operating at a bit rate of 1200, the Eon antenna MUST be aimed and a power level of 38 entered
3	>SAVECAL	This saves the power level settings.
4	>USERMODE	Return to User mode

7.3 Step 3: Connecting Sensors

When initially setting up a GOES.hopper station, only one sensor at a time should be connected to the terminal strip. This sensor should be assigned a unique address, a measurement command and then tested. Once satisfied that the sensor is operating as desired, it should be disconnected from the terminal strip (disconnecting a single wire is sufficient), and the next sensor attached.

> WARNING! Ensure bare wires do not come in contact with each other or to other connections on the terminal strip as this can cause contention.

7.4 Step 4: Setting Up Sensors (Section 4.4 – 4.5)

> IMPORTANT! Do not leave a sensor's address at 0 as this address will be in conflict with any sensor which is set to the factory default when it is first connected to the terminal strip.

This process assumes all the sensors area at the factory default setting of zero (0) and are subsequently assigned a new address in numerical order. You can assign any address from 1-9 as long as any address is only used once.

	Command	Response	Comments
1	>ETM	*	This enters the transparent mode. Note that the prompt will turn to an asterisk * rather than the >. WARNING! When in the transparent mode, any changes made to the configuration may be irreversible and could render the G6 GOES transmitter inoperable. The trans-parent mode should only be used as directed in this manual.
2	*0!	*OK	The default address of all SDI sensors is zero (0). If the sensor has been assigned a different address you must find out what it is set to. See Section 4.4.1.
3	*0A1!	1	Changes the sensor address from zero (0) to one (1). The response should be the newly assigned address (1)
4	*1I!	113FTS----CM11B-1--1234 (example response)	Send identification command The sensor will return its address (1), SDI version (1.3), manufacturer, model number, sensor version number, serial number
5	*1M!		Sensor at address one, start a measurement. IMPORTANT! Some sensors used for groundwater purposes are equipped with an internal battery and the sensor must be turned on before data logging can occur.
6	*1D0!	*1+34.2,109.5 (example response)	Sensor at address 1 send data Response is the sensor address followed by the measured values
7	Once satisfied the attached sensor is operating as desired, disconnect it (detaching one wire is sufficient but ensure it does not touch any other wires or connectors). Attach the next sensor and assign it a unique address.		
8	*0!	*OK	
9	*0A2!	2	Changes the sensor address from zero (0) to two (2). One (1) is already in use. The response should be the newly assigned address (2).
10	*2I!	213FTS-----BR007-2-A56B (example response)	Send identification command.
11	*2M!		Sensor at address two, start a measurement
12	*2D0!	2,45,-6.3,265 (example response)	Sensor at address 2 send data.
13	Once satisfied the attached sensor is operating as desired, disconnect it (detaching one wire is sufficient but ensure it does not touch any other wires or connectors). Attach the next sensor and assign it a unique address.		
14	*0!	*OK	

	Command	Response	Comments
15	*0A3!	3	Changes the sensor address from zero (0) to three (3). One (1) and two (2) are already in use. The response should be the newly assigned address (2).
16	*3I!	313FTS-----BR007-2-A56B (example response)	Send identification command.
17	*3M!		Sensor at address two, start a measurement
18	*3D0!	3,45,-6.3,265 (example response)	Sensor at address 3 send data.

Continue in this fashion until all sensors have been assigned an address and confirmed to be operating by taking and sending a measurement. Ensure you follow the pattern of assigning different addresses.

Once all sensors have been assigned an address and tested, all sensors can be secured to the terminal strip.

Conduct a final test to ensure all attached sensors are operating as desired by issuing a Start Measurement and a Send Data command to each sensor attached.

> IMPORTANT! When the final test is completed, exit the transparent mode by typing *ESC. The transmitter will respond with a > prompt to indicate that transparent mode is exited.

7.5 Step 5: Configuring G6 to Trigger Sensors to Start Measurements (Section 5.2)

Each attached sensor must be directed by the G6 to take measurements. Before starting this section you must know which sensor is at each address and what command type it uses. It will be one of M, C, or R and will be specified in the sensor's manual.
For simplicity, numerical order should be retained and each command will assign a command table index value from 0-9 (different than the SDI address), followed by the SDI address. However, you can assign any command table index desired. This step will only show the mandatory elements of the command, which are normally sufficient for most applications. If advanced properties are required, see Section 5.2 for a detailed explanation of the command

	Command	Example	Response	Comments
1	>SDI 0,1x!	SDI 0,1M!	>OK	Command table index 0, holds SDI sensor at address 1which uses the M command (Replace the x with M, C or R as specified in the sensor's manual).
2	>SDI 1,2x!	SDI 1,2C!	>OK	Command table index 1, holds SDI sensor at address 2 which uses the C command.
3	>SDI 2,3x!	SDI 2, 3R!	>OK	Command table index 2, holds SDI sensor at address 3 which uses the R command.

7.6 Step 6: Configuring SDI Data Format (Section 5.2.1)

Specify the measurement fields and precision of the data values returned. You must know which the index table number of the sensor, which measurements fields you want reported, and the desired precision of the returned data before using this command.

The syntax of the command is: >**SDIFMT i,n,n,n:b**

In which:
i is the command table index number of the sensor
n is indicates the measurement fields to be output from the SDI sensor being used (0-8)
b is the number of decimal places in the data

NOTE: Because the numbering for the measurement fields (**n**) start at zero rather than one, care must be taken to ensure the value of **n** accurately reflects the desired field (ie: **n** will be one digit less than the place number of the field order).

Measurement Field Order	1	2	3	4	5	6	7	8	9
n Value	0	1	2	3	4	5	6	7	8

	Command	**Example**	**Response**	**Comments**
1	>SDIFMT 1,n:b	SDI 1,2:2	>OK	The sensor at command table index 1 will return the third measurement field to two decimal places.
2	>SDIFMT 2,n,n:b	SDI 2,1,3:2	>OK	The sensor at command table index 2 will return the second and fourth measurement fields to two decimal places.
3	>SDIFMT 3, n:b,n:b,n:b	SDI 3,1:3,2:1,3:2	>OK	The sensor at command table index 3 will return the second, measurement field to three decimal places, field 3 to one decimal place, and field 4 to two decimal places.

Once all the sensors have all been configured:

	Command	**Response**	**Comments**
1	>SAVE	OK	Saves the input parameters to the non-volatile Memory
2	>RCFG	OK	Read the current configuration to confirm your changes.
3	>ETX	OK	Enables transmissions. Note if the response is BAD PARAMETER an error was made inputting the transmit parameters. Review and correct.
4	>STT	>22:06:46,1,+10,2.39 22:06:46,2,16,+102.75 22:06:46,3,1.643,12.7, 7.05	Requests a scan of all the sensors. Following a time stamp, each sensor should return its address and measured data in accordance with the assigned formats. Examples are shown in the response.

7.7 Step 7: Send a Test Transmission

	Command	Response	Comments
1	>RST	Transmitter: Enabled GPS: On RTC: Valid Time To Next Tx: 00:00:46:39 Timed Message Length: 119 bytes Next Timed Tx: 2015/03/19 18:00:20 Random Message Length: 0 bytes Random Message Tx Count: 0 Next Random Tx: N/A Failsafe: OK Supply voltage: 15.7 V	Get Transmission Status. Response should indicate ready to transmit (transmitter enabled). The response shown is an example and times and values will be different for your status message.
2	>techmode alpha	OK	WARNING! When operating at the TECHNICIAN level, care must be used as changes made can permanently change or damage the transmitter.
3	>DTX	OK	Disables regular transmissions.
4	>DAS	OK	Disable GPS synchronization.
5	>OCXOON	OK	Turn on the oven controlled oscillator (ocxo).
6	Wait 90 seconds		For the OCXO to stabalize
7	>FTX 4, *Channel, Bit Rate*	Example: **>FTX 4,195,300**	a) **Must** use FTX 4 b) Use your assigned Channel (195 if your assignment is on the GOES East satellite,196 if your assignment is on the GOES West satellite). c) Input your assigned bit rate
8	Check the transmission using the EDDN field message retrieval webpage (http://eddn.usgs.gov/fieldtest.html). The transmitted test message will be: 01234568151341435556G42-1NN195EXE00392 : GOES header (example – yours will be unique) Operator Initiated Test Transmission: : Test Message will repeat Operator Initiated Test Transmission: Operator Initiated Test Transmission: Operator Initiated Test Transmission: Operator Initiated Test Transmission: Operator Initiated Test Transmission: Operator Initiated Test Transmission: Operator Initiated Test Transmission: Operator Initiated Test Transmission: Operator Initiated Test Transmission: Operator Initiated Test Transmission:		

9	>LTXS	Tx Status: OK Tx Type: Test Message Last Tx Length: 0 bytes Last Tx Start Time: 2015/01/01 00:06:16 Last Tx Stop Time: 2015/01/01 00:06:27 Forward Power: 40.4 dBm Reflected Power: 9.0 dBm SWR: 1.05 Power Supply: 11.9 V	Get the last transmission status. Response is an example. Your values will be different.
10	>OCXOOFF	OK	Turn the OCXCO off
11	>EAS	OK	Enable automatic GPS synchronization
12	>ETX	OK	Enable transmissions
13	>usermode	OK	Return to User mode

7.8 Step 8: Confirm Sensor Communications

	Command	**Response**	**Comments**
1	>STT		
2	*1I!	1	Sensor identification request. The response should be the sensor address to indicate that sensor is active.
3	*2I!	2	
4	*3I!	3	
5	Escape Key		Strike the Escape key to exit the transparent mode.
6	Close the text file capture and disconnect from the Command Port.		

Chapter 8 Maintenance and Trouble Shooting Guide

8.1 Maintenance

GOES.hopper should not require recalibration. Field maintenance required is limited to a periodic check of the battery, cables and connectors for deterioration. If further maintenance or calibration is required, contact FTS. Contact information is supplied on page ii of this manual.

8.2 Trouble Shooting Command Errors

These error messages can appear when setting or retrieving configuration/calibration parameters.

"Message"\Problem	Meaning	Solution
"Bad Parameter"	Command parameter invalid	Check typing Refer to equipment manual for parameter formats
"Unknown Format"	There are too many or too few parameters	Check typing Refer to equipment manual for parameter formats
"Access Denied"	Command requires a higher access level	Contact FTS support
"Unknown command"	Command is unknown	Check typing
"Execution error"	Command fails during execution	Re-type the command If error message continues, contact FTS support
"Transmitter must be disabled"	Transmitter must be disabled prior to using this command	>DTX This command disables transmissions. Normal scheduling of transmissions is suspended. ***Remember to enable transmissions once you are finished***
"Transmitter must be enabled"	Transmitter must be enabled prior to using this command	>ETX This command enables transmissions. It will transmit at previously configured parameters.
"Configuration Not Recognized"	Configuration is invalid	Check typing or relevant manual for correct configuration
>stt command returns: hh:mm:ss,sensor address,///,/// eg: 19:00:00,4,///,///	1) Disconnected direct read cable or equipment 2) Incompatible equipment 3) Wrong SDI-12 address or there may be more than one sensor given the same address	1) Check all cable connections 2) Replace equipment with compatible models[1] 3) Confirm sensor address (see section 5.2.1)

1. Note that if using Solinst Levelogger models, only models 3001 "Levelogger Edge" (black) and older gold models are compatible with the GOES.hopper. Models 3001 LTC Levelogger Junior and Levelogger Junior Edge (both silver) are incompatible.

8.2.1 Confirm Sensor Address

If more than one sensor is attached to the terminal strip, there is a possibility that more than one is assigned the same address. If that is the case, you must determine which sensors are in conflict. Disconnect all but one of the sensors from the terminal strip. When disconnecting the sensors, it is not necessary to disconnect all the wires; removing one will be sufficient (data wire recommended).

Note that examples are provided which may not coincide with your sensor's output. Refer to your sensor's manual for details particular to your fit.

A) You must enter the transparent mode to troubleshoot.

> WARNING! When in the transparent mode, any changes made to the configuration may be irreversible and could render the G6 GOES transmitter inoperable. The transparent mode should only be used as directed in this manual. For any further operations, contact FTS support for guidance.

>ETM	: enter the transparent mode. When in transparent mode the prompt becomes * vice >
OK	
*?!	: address query
3	: response indicates the sensor at address 3 is responding

B) Determine if the sensor is functioning correctly

*3M!	: command for sensor at address 3 to provide a measurement
30022	: this response (for example) indicates address 3 takes 002 seconds to reply, and will provide 2 fields of data

Type in the command to read the data. A functioning sensor will reply as follows:

*3D0!	: read the data returned by the previous M command
3+6.586+674.4	: this response (ie: data is returned) indicates that the sensor responds as expected, so it is likely another sensor has the same address. Proceed to steps C and D.

A malfunctioning sensor will reply as follows:

*3D0!	: read the data returned by the previous M command
30000	: The series of zeroes after the sensor address (3 in our example) indicates that the SDI cable is connected. The malfunction is caused by the direct read cable or the sensor itself.
	Check the direct read and other cable connections. Ensure the associated sensor is compatible with GOES.hopper

C) Determine if another sensor has the same address

If you have determined that the first sensor is functioning correctly, detach the first sensor and connect another sensor to the terminal strip. Conduct an address query as in A). If the response returns the same address number as the first sensor, you must assign a new address.

*aAb! : changes sensor address from “a” to “b” in which “a” and “b” are the numerical values of SDI addresses
: for example *3A2! Change this sensor’s address from 3 to 2

2I! : read sensor information from the newly assigned sensor at address 2

Determine if the sensor is functioning correctly by following steps at B.

Repeat with third sensor (if installed) to ensure all three instruments have different addresses.

8.3 Trouble Shooting Using the Audit Log

If you are not receiving data or the data returned is not as expected, you can use the audit log to help determine the source of the problem. Any time there is a significant event or a fault detected, the G6 will create an event message which can be reviewed via the audit log.

To review the audit log, enter the Read Audit Log command:

>RAL

yy/mm/dd hh:mm:ss event message eg: 14/06/17 20:34:16 Failsafe Tripped

Most of the event messages are self-explanatory (ie: “GPS antenna disconnected”, “TX aborted: Supply Voltage too low”, “Invalid bitrate”) and can be solved at the user level. FTS Support should be sought for messages that are not self-evident or which are not covered in the following table.

“Message”	Explanation/Reason	Solution
“Failsafe Tripped”	The G6 transmitter is transmitting longer or more frequently than its maximum allowance	Clear the failsafe by depressing the Diagnostic button for at least 10 seconds. If the failsafe continues to trip, the unit should be returned to FTS for repair or replacement. Call FTS for support.
“GPS 28 days stale”	After 28 days, if a time resynchronization is not achieved, the transmitter will disable transmissions. However, it will continue to attempt time resynchronization and, if successful, will re-enable transmissions	1) GPS antenna blocked (usually by snow) 2) GPS antenna damaged 3) Other equipment damage or failure
“Msg Truncated”	More data loaded into the buffer than could be transmitted at the assigned bitrate. Message is cut off when maximum size is reached.	Reduce the amount of data to be transmitted 1) Increase the sensor sample time interval so there is less data per transmission; 2) If option 1 is not feasible, you can contact the United States National Oceanic and Atmospheric Administration (NOAA) and request to increase your bit rate from 300 bps to 1200 bps or increase your Tx window. *If you increase your bit rate, you will have to adjust your power levels

"TX Aborted: Timed Tx buffer Empty"	1) Transmission intervals are more frequent than the sensor reading intervals 2) Sensor not writing to the G6 transmitter	1) Adjust sensor and transmission time intervals so that there will be data written to the buffer prior to transmission 2) Faulty sensor or faulty G6 transmitter. Contact FTS support.
"Tx Aborted: VSWR Too High"	1) If the SWR is greater than 1.5 this indicates a line of sight issue. Either the signal is being reflected or absorbed by neighbouring structures or features.	1) Determine what may be responsible for the interference and remove it, or move the antenna/assembly to a clear area.

If you are unable to resolve your issue or have any questions, contact FTS support.

Appendix A G6 Specifications

NESDIS Certification Number: 1014-000114 Transmitter Model G6

Operating Voltage Range 10.8 – 16.0 VDC

Current Consumption

- Standby < 3 mA
- Transmit < 2.6 A
- GPS On < 50 mA

Communication Protocol ASCII, Binary (serial port1 only)

Serial Interface (Two Serial Ports) 3V3 volt levels suitable for RS-232 transceivers

Dimensions 4.0″ x 5.0″ x 0.9″

Weight 0.332kg (0.732 lbs)

Operating Temperature Range -40 to +60 °C

Transmission Data Rates 100, 300 and 1200 BPS

Transmit Frequency Range 401.701 MHz – 402.09850 MHz

Channel Bandwidth

- 100 BPS 3kHz
- 300 BPS 750 Hx
- 1200 BPS 1.5kHz

Nominal Transmit Power

GOES

- 300 BPS 14 W max
- 1200 BPS 14 W max

Meteosat

- 100 BPS 14 W max

Antenna Requirements

- Satellite Transmit Right hand circular polarization
- GPS 3.3V active patch

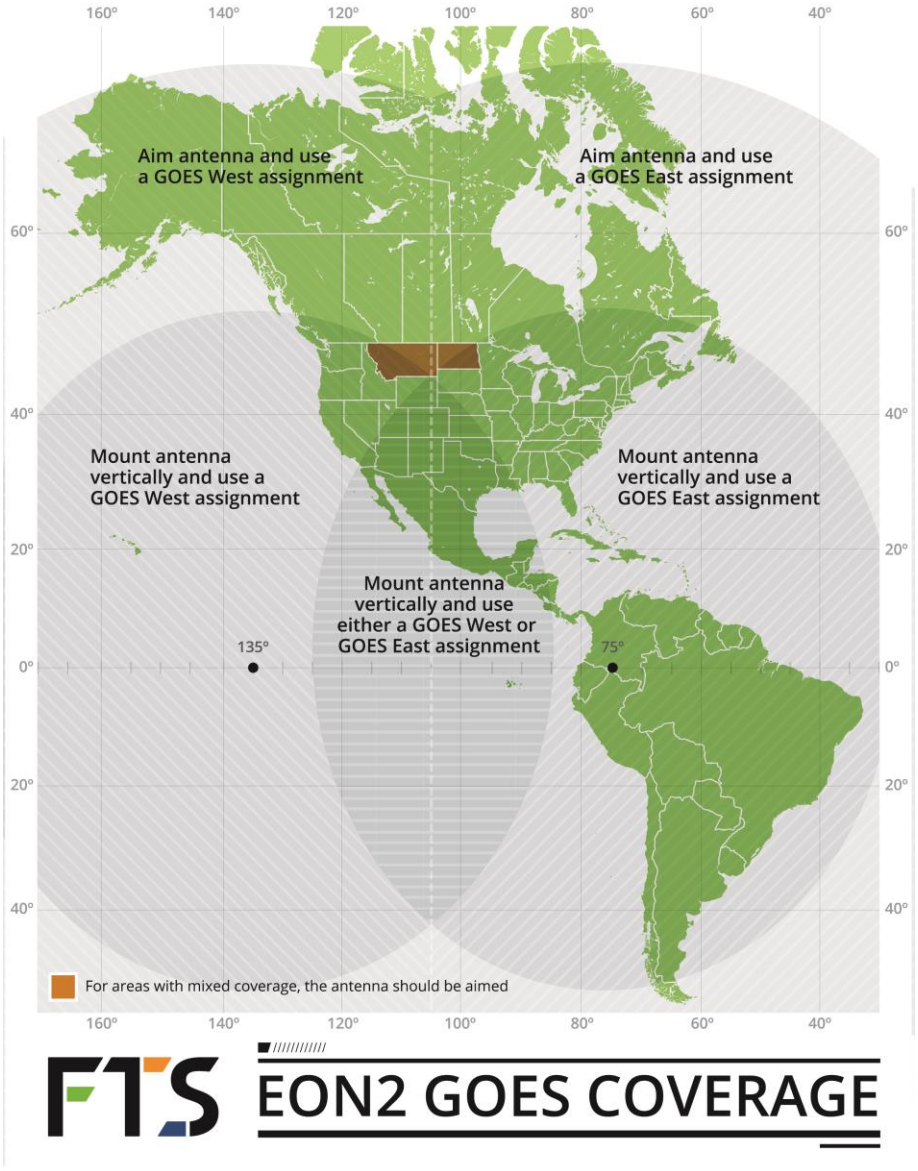
Appendix B EON Antenna Mounting and Power Settings

Full details of mounting the EON Antenna including the drilling template are available from Technical Bulletin 700-AN-128 found on the FTS Support Website, https://s3.amazonaws.com/Product_Technical_Bulletin/700-AN-128.pdf.

AIMING THE ANTENNA

The procedure to position your EON22 antenna will vary depending on your geographical location. If the antenna should be aimed, aim it an angle towards the GOES satellite's position. Ensure the transmission path is free from obstruction, including potential tree canopy.

Refer to the following image to determine the recommended action for your location.



POWER SETTINGS

The EON GOES antenna has a gain of 5.7 dB on axis and the output power of the GOES transmitter must be set as shown in the table below to achieve the recommended EIRP. The values in the table allow for a typical 0.5 dB loss due to the antenna cable and connectors. If the cable loss for a particular installation is higher than this the output power should be adjusted accordingly.

Bit Rate	Antenna Orientation	Output Power (dBm)	Expected EIRP (dBm)	NOAA Required EIRP (dBm)
300	Aimed	34	39	37 - 41
1200		38	43	43 - 47
300	Vertical	37	39	37 - 41
1200		41	43	43 - 47

The output power numbers in the table for the vertical antenna orientation are appropriate for locations south of 53 degrees latitude. For higher latitudes the output power should be increased or the antenna should be aimed at the satellite. Note that not all GOES transmitters can achieve an output power of 41 dBm. If this is the case the antenna may need to be aimed at the satellite if a bit rate of 1200 bps is used.

The table provides a guideline for setting transmitter output power for use with the EON antenna. The output power of a specific station may need to be adjusted from these values, either up or down, to achieve the recommended EIRP as measured by the GOES system and reported in the received message.

MOUNTING THE ANTENNA

Vertical surfaces too close to the antenna act as reflectors and can degrade or interfere with signal strength. These effects are reduced as separation between the reflector and the antenna is increased but they are still detectable out to 15m (49.2 ft).

There should be a separation of 75 cm (29.5") or greater between the antenna and the metal surface parallel to the axis of the antenna. If necessary, the EON2 Antenna Tower Mounting Arm is available as an optional accessory.

Should it not be possible to mount the antenna at the recommended distance from the metal post or other reflector, the following guidelines should be followed:

D= distance between EON2 antenna and metal post (or other reflector)

1) D < 18 cm (7"): Not recommended.
2) D = 18 cm (7"): Acceptable if the reflector is not between the antenna and the satellite.
3) D = 37.5 cm (14.5"): Not recommended, as it causes a large null in front of the antenna.
4) D = 56 cm (22"): Acceptable if the reflector is directly behind the antenna relative to the satellite. Not recommended if the reflector is 45 degrees to either side behind the antenna relative to the satellite.

Document Revision History

DATE	VERSION	COMMENTS
18 August 2014	1.0	Original. FW 8.02
11May 2015	2.0	Corrected NESID p.5
15 June 2015	3	Updated for G6
21 Aug 2015	4	Corrected Example for SDIFMT and added NOTE. (JIRA item GH-10). Corrected Table 3-2 (replaced G6 with GOES.hopper in the RCH comments). New manual format.
05 Oct 2015	5	Corrected SDIFMT in section 7.6
18 Nov 2015	6	Added Appendix B
02 Oct 2017	7	Corrected SDIFMT information. Clarified Chapter 5. Miscellaneous corrections/clarifications throughout. Updated Appendix B.
21 Mar 2018	8	Corrected TIN typographical error on p. 7