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G6 GOES $PM_{2.5}$

Operating Manual

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CHAPTER 1 CONTENTS

CHAPTER 1 INTRODUCTION

1.1 ABOUT THE MANUAL

This manual is pertinent for units equipped with the G6 GOES transmitter manufactured by FTS.

1.2 GENERAL DESCRIPTION

Forest Technology Systems' GOES:$PM_{2.5}$ is an add-on GOES transmitter for Met One E-Sampler or E-Bam particulate monitors. The transmitter assembly (Figure 1) is housed in a sealed case and attaches onto the same tripod used to hold the Met One particulate monitor. For ease of use, the transmitter assembly includes an omni directional Eon GOES antenna to eliminate the need to aim the antenna at the satellite and electrical connections to the particulate monitor are limited to power and communications.

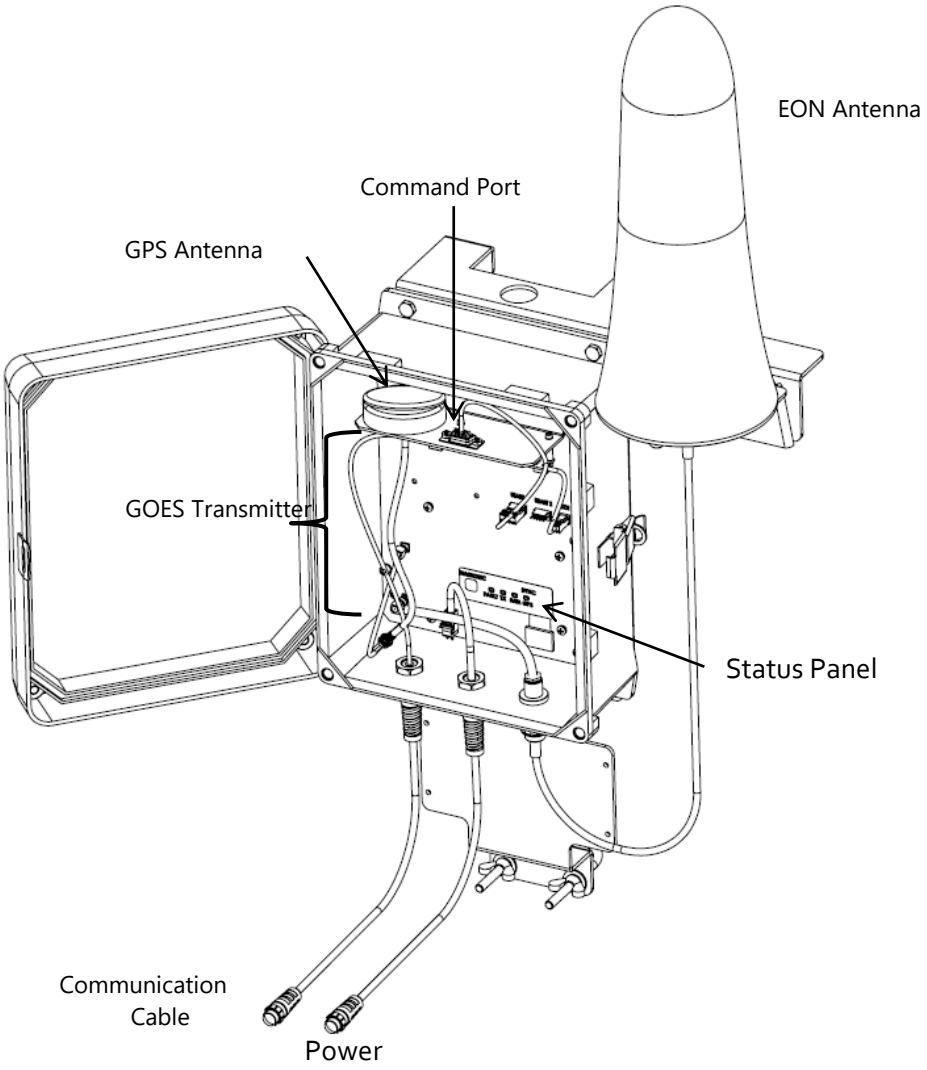


Figure 1-1: GOES $PM_{2.5}$ transmitter assembly

1.3 DEPLOYMENT AND GENERAL OPERATING INFORMATION

1.3.1 Deployment

To deploy the particulate monitor and GOES:$PM_{2.5}$ transmitter assembly, set-up the particulate monitor as per Met One instructions and then connect the GOES:$PM_{2.5}$ transmitter assembly. Assembly instructions are in Chapter 2. The transmitter assembly automatically starts operating when power is applied. Ensure the particulate monitor is synchronized to UTC time.

Normally the GOES:$PM_{2.5}$ transmitter assembly is supplied completely preconfigured and ready for deployment with the exception of the GOES transmit parameters (unless these had been supplied to FTS prior to shipping). If GOES transmit parameters had been supplied, then a GOES Transmit Parameter tag will be attached to the transmitter (inside the enclosure). If you must configure the GOES parameters follow the procedure outlined in Sections 4.2 and 4.3.

1.3.2 Transmission Cycle

Once the equipment is powered and operating, the data transmission cycle is as follows:

1) At the top of the hour, the particulate monitor calculates the concentration average.
2) At two minutes past the top of the hour, the transmitter reads data from the particulate monitor and illuminates the DATA indicator
3) The DATA indicator remains illuminated until one minute prior to data transmission.
4) At transmission time, the transmitter sends the GOES message and illuminates the TX indicator for the duration of the transmission.
5) The cycle repeats, go back to (1).

Note that once a day, the GPS SYNC indicator will illuminate while the transmitter is updating its GPS fix. GPS updates are done on power-up and then every 24 hours afterwards.

1.3.3 Time synchronization Requirement

Time synchronization between the particulate monitor and GOES:$PM_{2.5}$ transmitter is necessary for timely data transmission. The transmitter is always time synchronized to UTC time and will always request the latest data from the particulate monitor at two minutes past the top of the hour. If the particulate monitor's clock was set incorrectly or has drifted so that the particulate monitor's time is more than two minutes ahead of the transmitter time, then the transmitter will end up transmitting the previous hour's particulate data. It is important for the user to ensure the particulate monitor's time is accurately set to UTC time.

1.3.4 First Transmission Requirements

Two events need to take place after the particulate monitor / transmitter assembly is first powered in order for particulate data to be transmitted. First, the particulate monitor must obtain an hourly sample so that there is data to transmit, and second, the transmitter must acquire GPS synchronization so that it is able to transmit.

Depending on when the equipment is powered, the first expected transmission may not occur if GPS synchronization has not been obtained, or if the particulate monitor does not have valid data then the first transmission may occur but the transmission will not contain particulate data.

1.3.5 GOES Transmission Message Format

The format of the GOES transmission is the same for E-Sampler and E-Bam particulate monitors. Transmissions occur hourly with 16 fields following the GOES header. The fields are:

Field 1.	Latitude	6 decimals	
Field 2.	Longitude	6 decimals	
Field 3.	Particulate Monitor Type 0 = E-Bam $PM_{2.5}$ 1 = E-Bam PM_{10} 9 = E-Sampler	integer	
Field 4.	Particulate Monitor Serial Number	integer	
Field 5.	Concentration RT in mg/m3	3 decimals	
Field 6.	Concentration HR in mg /m3	3 decimals	: E-Bam only
Field 7.	Flow rate in liters per minute	1 decimal	
Field 8.	Ambient Temperature in Celsius	1 decimal	
Field 9.	Ambient Humidity in %	integer	: optional sensor
Field 10.	Barometric Pressure in Pascals	integer	: E-Sampler only
Field 11.	Filter Temperature in Celsius	1 decimal	: E-Bam only
Field 12.	Internal Humidity in %	integer	
Field 13.	Wind Speed in meters/second	1 decimal	: optional sensor
Field 14.	Wind Direction in degrees	integer	: optional sensor
Field 15.	Battery voltage in Volts	1 decimal	
Field 16.	Alarm status	integer	

Note that data fields not supported by the particulate monitor will be filled with -999 and that all fields will be filled with -999 if the particulate monitor fails to respond to the transmitter. The Alarm status value is as reported by the particulate monitor.

1.3.6 Sample GOES Transmission

001057E210151161941G42+1NN195EXE00111	: GOES Header
48.444214	: latitude
-123.520828	: longitude
+9	: type
+5530	: serial number
+0.001	: concentration, real-time
-999	: concentration, hourly
+2.0	: flow
+24.5	: ambient temperature
+0	: ambient humidity
+100037	: barometric pressure
-999	: filter temperature
+32	: internal humidity
+0.3	: wind speed
+1	: wind direction
+14.1	: battery voltage
+0	: alarm

CHAPTER 2 GOES $PM_{2.5}$ TRANSMITTER ASSEMBLY

The GOES:$PM_{2.5}$ transmitter assembly has several components. The function of each component follows.

2.1 GOES $PM_{2.5}$ TRANSMITTER

The GOES transmitter is the main component in the assembly. The GOES transmitter is responsible for initiating communications to the attached particulate monitor as well as performing the GOES transmissions. The GOES transmitter is manufactured by FTS and is field proven and highly reliable

2.2 GPS ANTENNA

The GPS Antenna signal is used by the GOES transmitter as a timing calibration standard in order to meet the time and frequency tolerance requirements of the GOES system. The GPS antenna is housed inside the enclosure to protect the antenna from the elements.

2.3 EON GOES ANTENNA

The Eon GOES Antenna is an omni-directional antenna used to transmit the signal from the transmitter to the GOES satellite. The omni-directional characteristic of the antenna eliminates the need for the user to orient the station in a specific direction or to aim the antenna at the satellite at latitudes less than 53•.

2.4 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 particulate monitor 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

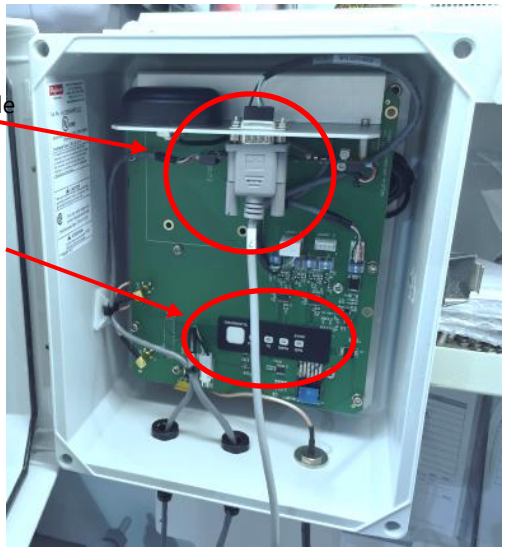


Figure 2-1: GOES G6 PM2.5 Transmitter

Typically, Tera Term or another terminal emulation-style program running on a PC is used to communicate with the transmitter. Communication with the GOES transmitter is normally achieved through a USB serial port adaptor connected to the transmitter assembly's Command Port. 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.

2.5 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.

2.5.1 Synchronize Clock to GPS Indicator (SYNC GPS)

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 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.

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.

> 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.

2.5.2 DATA indicator

The DATA indicator shows that the transmitter has acquired data from the particulate monitor 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 particulate monitor 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 the sensor is 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.

2.5.3 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.

2.5.4 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.

2.5.5 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 outside its assigned transmission window. 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.

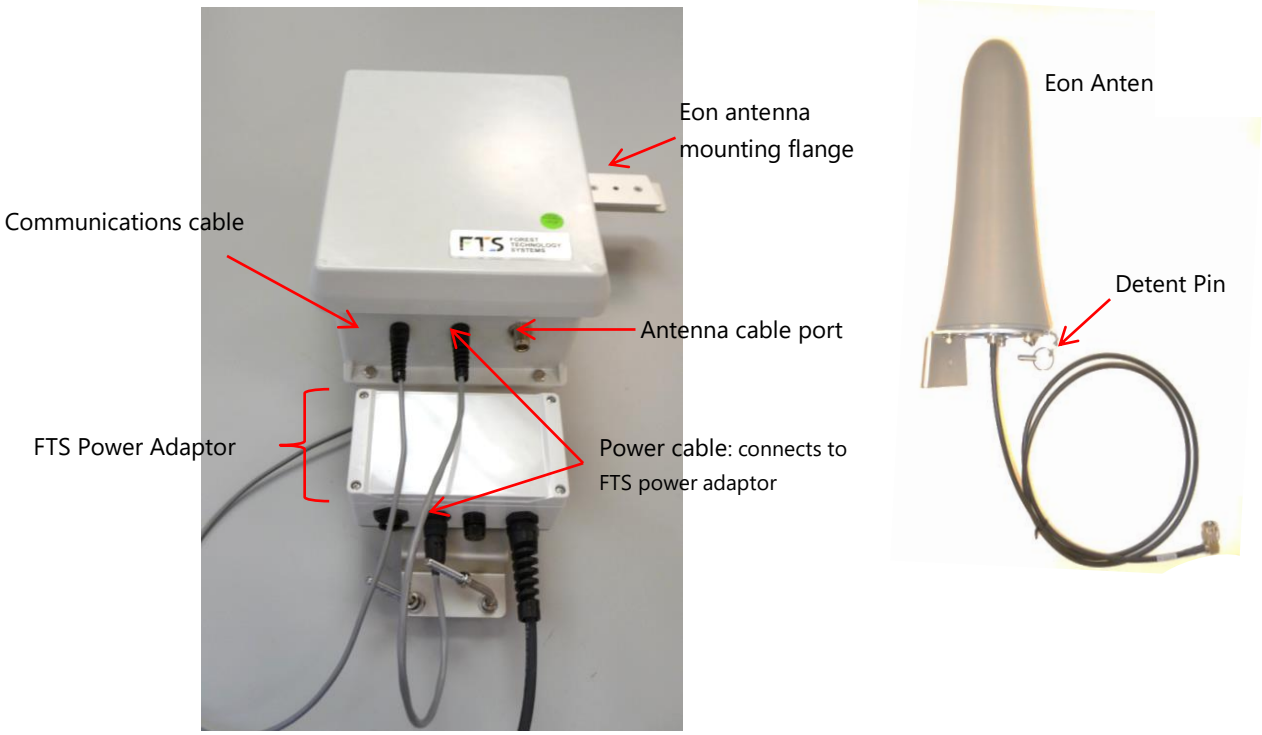
2.6 SAMPLER COMMUNICATION INTERFACE BOARD

The Sampler Communication Interface Board is an interface between the transmitter and the particulate monitor. When requested by the transmitter, the interface retrieves and formats data from the attached particulate monitor. The interface board automatically parses data from an E-Sampler or an E-Bam and returns a common data string to the transmitter.

CHAPTER 3 SETTING UP THE GOES $PM_{2.5}$

When planning your site visit, factor in time to assemble and confirm message transmission. After the unit has been assembled, powered up, and configured, you must wait until after the first transmission to confirm transmission, so base your site visit estimate on your scheduled transmission times.

The GOES:PM2.5 is an add-on GOES transmitter which easily connects to either a Met One E-sampler or E-Bam particulate monitor. The transmitter assembly is self-contained: both the transmitter assembly and the Eon antenna are pre-mounted on their mounting brackets. The transmitter assembly also easily attaches to either the E-Sampler or the E-Bam model particulate monitor.



3.1 STEPS TO SETTING UP THE GOES $PM_{2.5}$

In order to set up and verify operation of the GOES $PM_{2.5}$ transmitter, the following steps must be followed:

1) Mount the transmitter assembly (Section 3.2)
2) Make communication and power connections (Sections 3.3 and 3.4)
3) Set up GOES satellite communications and confirm configuration (Section 4.3)
4) Confirm communications between the transmitter assembly and particulate monitor (Section
5) Conduct a test transmission.

3.2 MOUNTING THE TRANSMITTER ASSEMBLY

The GOES:PM2.5 transmitter assembly mounts to the tripod which holds the particulate monitor. First, set-up the particulate monitor as per its instructions with the exception of mounting the cross-arm for external sensors (this is mounted later). Then connect the GOES:$PM_{2.5}$ transmitter assembly and cross-arm (if using) as described in the following steps.

To mount the transmitter assembly:

1) Remove the U-bolt on the bottom of the transmitter assembly
2) If installed on the tripod, remove the cross-arm used to mount the external sensors.
3) Align the cutout in the GOES PM mounting bracket with the cross-arm post and slide assembly down until it comes to a rest on top of the tripod
4) Place the U-bolt around the tripod, through the assembly flange and tighten
5) Reconnect the sensor cross-arm (if originally installed)
6) Slide the EON antenna onto its mounting flange and secure the antenna with the detent pin
7) connect the EON antenna cable to the antenna cable port on the transmitter assembly

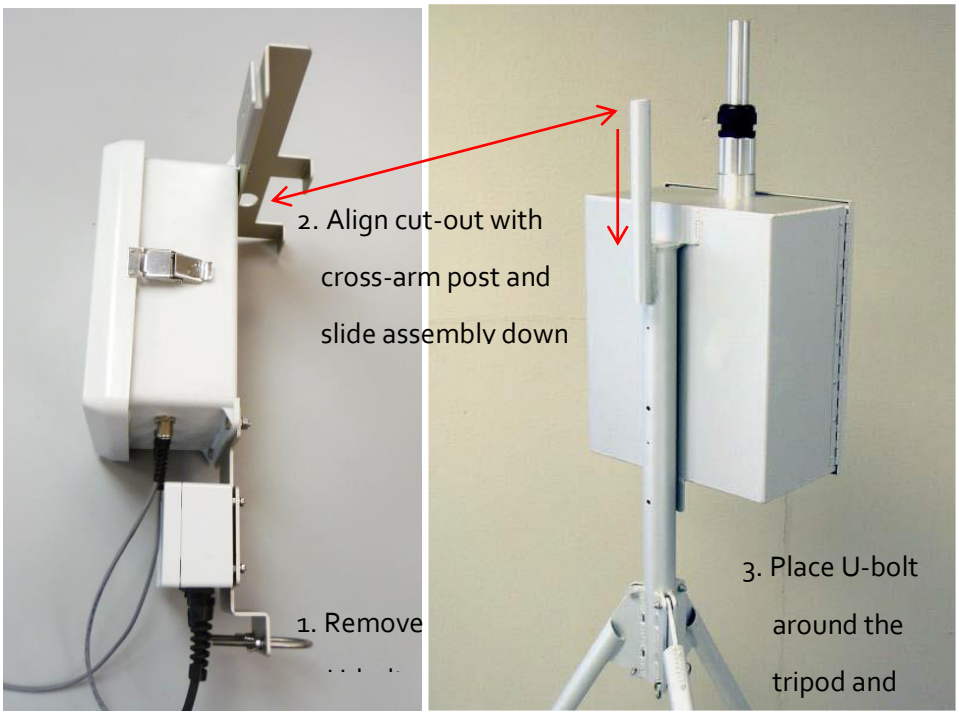


Figure 3-1: GOES $PM_{2.5}$ Transmitter Assembly Connection

3.3 COMMUNICATION CONNECTIONS

The transmitter assembly's communication cable should be connected to the particulate monitor's Comm port. The particulate monitor's Comm port is a 7-pin connection on the bottom of the monitor and is the same on both the E-Sampler and E-Ban monitors.

> IMPORTANT! The particulate monitor must be set to 9600 baud in order to communicate with the GOES:$PM_{2.5}$ transmitter assembly.

3.4 POWER CONNECTIONS

Power for the GOES:PM2.5 transmitter assembly is supplied from the particulate monitor either through the E-Sampler External Sensor port or the FTS Power Adaptor[1] when connecting to the E-BAM. The transmitter assembly automatically starts operating when power is applied.

3.4.1 E-Sampler Power Connection Details

To mitigate potential AC power interruptions, the E-Sampler's internal battery option is used to provide power for both the E-Sampler and the GOES:$PM_{2.5}$ transmitter assembly. Follow the instructions in the E-Sampler Operation Manual when installing an internal battery into the E-Sampler. Connect the GOES:$PM_{2.5}$ transmitter assembly's power cable to the E-Sampler's External Sensor port.

> NOTE: The internal battery should be removed from the E-Sampler during transportation.

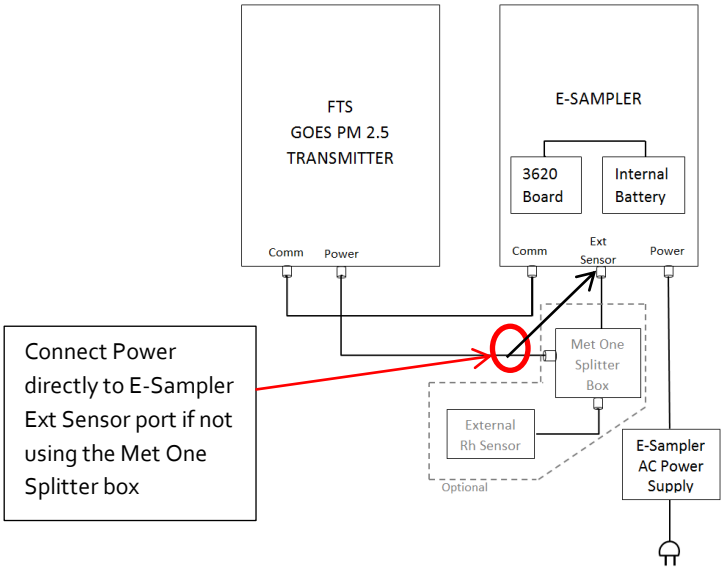


Figure 3-2: GOES $PM_{2.5}$ Transmitter to E-Sampler Connection

[1] Part # G5-Met1-PM-PWR

3.4.2 Connecting an External RH Sensor

If using the E-sampler's external RH sensor (Met One option EX-593) then Met One's splitter junction box (Met One part number 9427) must be used to connect the transmitter assembly and the external RH sensor to the E-Sampler's External Sensor port.

3.4.3 E-Bam Connection Details

Communication and Power connections between the GOES:$PM_{2.5}$ transmitter assembly and Met One E-Bam are shown in Figure 3-3. The FTS Power Adaptor is used in-line with the E-Bam power supply to provide power to the GOES:$PM_{2.5}$ transmitter assembly

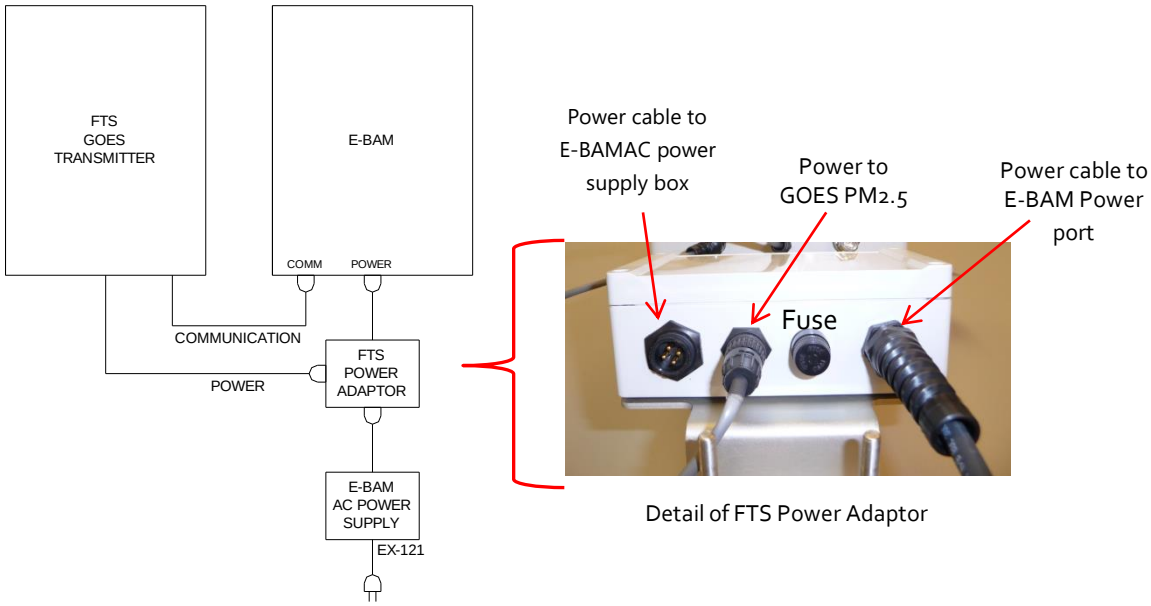


Figure 3-3: GOES $PM_{2.5}$ Transmitter to E-Bam Connection

3.5 PARTICULATE MONITOR (PM) CONFIGURATION

In order for consistent data collection and proper system operation with the GOES:$PM_{2.5}$ transmitter, the settings as indicated in Table 3-1 must be input into the particulate monitor. Refer to the particulate monitor's manual for details.

Table 3-1

ITEM	SETTING	PM MODEL	EXPLANATION
Time	UTC	E-Sampler E-Bam	Time must be synchronized with the GOES transmitter[1].
Average Period	60 minutes	E-Sampler	This is the National Wildfire Coordinating Group (NWCG) standard.
Real Time Average		E-Bam	
Baud Rate	9600	E-Sampler E-Bam	For communication between the transmitter and the PM.
Engineering Units	Metric	E-Sampler	This is the NWCG standard.
Concentration Units	mg/m^3	E-Sampler	

1) It is important that the time is accurately set as the transmitter will request the top-of-the-hour data from the PM at two minutes past the hour. If the time on the particulate monitor is not synchronized, the transmitter may be supplied with the previous hour's data

3.6 CONFIRM SETTINGS AND GOES COMMUNICATION

Before leaving the site, confirm the settings and ensure the GOES PM2.5 assembly is communicating with the satellite. To do so, you must follow the steps outlined in Chapter 4 to set up communications. If your unit has already been configured with the GOES settings, you can skip Steps 5-11 in Section 4.3.

CHAPTER 4 SETTING UP GOES SATELLITE COMMUNICATIONS

4.1 GENERAL

Normally the GOES:$PM_{2.5}$ transmitter assembly is supplied completely preconfigured and ready for deployment with the exception of the GOES transmit parameters (unless these had been supplied to FTS prior to shipping). If GOES transmit parameters had been supplied, then a GOES Transmit Parameter tag will be attached to the transmitter (inside the enclosure). If you must configure the GOES parameters or change some of the default settings follow the procedure outlined in Chapter 4.

When deployed, the transmitter assembly will automatically sense which style particulate monitor is connected. However, if you are configuring (or reconfiguring) a transmitter, transmit parameters need to be entered through the Command Port in order to make the station unique and fully functional.

4.2 COMMUNICATING WITH THE GOES TRANSMITTER

Once power is supplied to the GOES transmitter, it will go through a booting up cycle and GPS synchronization (see section 2.5.1). While the GPS synchronization is taking place, the transmitter can be configured to communicate with the GOES satellite system.

Communication with the GOES transmitter is enabled by connecting a PC which has a terminal emulation program installed (eg: Windows Hyper Terminal or Tera Term) to the transmitter assembly's Command Port (Figure 2-1).

The GOES transmitter 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.

IMPORTANT! 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 and correct the configuration.

4.3 SETTING UP NOAA/EUMETSAT TRANSMIT PARAMETERS

The first step in configuring the GOES is to enter the assigned transmit parameters. Transmit parameters are provided to your agency 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[2] : 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)

NOAA/EUMETSAT Assigned Item	Comments/Explanation
NESID	This is the unique ADDRESS (eight character identifier) specific for the GOES Station (for the position, not for the transmitter). Must end in an even number.
NESID Channel	Channel number specified by NESID. Even channels are on the west satellite and odd on the east.
NESID Bit Rate	Baud rate varies between platforms. NOAA will assign you a Baud rate based on the information provided on your NESID request.
Transmission Interval	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	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	Window sizes can vary. The most common are 10 or 15 second windows.

Table 4-1: Transmit Parameters explanations

[2] 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.

IMPORTANT! If your first transmit time is within the first 4 minutes and 30 seconds of the top of the hour, notify FTS support as the setup will need to be optimized to work with that transmission time.

The steps required for setting the transmit parameters follow:

1) Connect the PC to the Command Port and then start the terminal emulation 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. After a command is entered, the transmitter will reply with OK followed by the >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 and do not copy the red examples.

5) Set the assigned NESID address

>NESID=01234568 : for example, set the NESID to 01234568

6) Set the Channel

>TCH=187 : for example, set the channel to 187

7) Set the assigned Bit Rate

>TBR=300 : for example, set the bit rate to 300 baud

8) Set the assigned Interval

>TIN=00:01:00:00 : for example, set the interval to 1 hour

9) Set the assigned First Transmit Time

>FTT=00:17:40 : for example, set the first transmit time to 17 minutes, 40 seconds past midnight

10) Set the Window

>TWL=10 : for example, set the window length to 10 seconds

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

>SAVE : save current parameters to non-volatile memory

12) Read the transmitter's configuration to confirm the parameters. The following list will be returned.

>RCFG : enter the "read the current configuration" command
NESID=01234568 : the transmitter responds with the configuration –
TCH=187 NOTE: the displayed configuration is in accordance with the

TBR=300
TIN=00:01:00:00
FTT=00:17:40
TWL=10
CMSG=N
EBM=N
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=3
ESBV=N
SIN=01:00:00
SOF=00:15:10
SDI 0,0C1
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

example parameters (in red). Yours will return the figures/values you input in the previous steps

CMSG (Message Centering)[1] and EBM (Empty Buffer Message)[2] default settings are N (no) however, Y (yes) is recommended. See Sections 4.3.1 and 4.3.2 for details.

: Sensor Sample Interval
: Sensor Sample Offset

SDI Command Table for configuring sensors.
N/A for use with particulate monitors. Should indicate "empty"

If any of the returned parameters are different than the expected default or recommended settings, you must enter the correct configuration. Refer to Appendix A for parameter details.

1) When CMSG=Y the GOES transmits its data centered in the middle of its transmission window to avoid message collisions due to a neighboring or rogue message going over its 10 second window. NOAA recommends CMSG=Y.
2) When EBM=Y, transmissions will be made even if there is no data in the buffer to send. EBM=Y is good tool for trouble shooting as it is an indicator that if no data is received, it is not a transmitter problem.

13) If you desire to turn message centering on type >CMSG=Y

To receive messages even if there is no data type >EBM=Y

13) Issue an Enable Transmission command

>ETX : enable transmissions

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.

14) In order to get the status of the transmission and confirm transmission details, enter a ***Get Transmission Status*** command. The transmitter responds with the following information (Note that this is an example and times and values will be in accordance with your system)

>RST :Get transmission status
Transmitter: Enabled
GPS: On
RTC: Valid
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: 2020/03/19 18:00:20
Random Message Length: 0 bytes
Random Message Tx Count: 0
Next Random Tx: N/A
Failsafe: OK
Supply voltage: 11.7 V

This message indicates that all is ready to transmit

15) Wait until the next scheduled transmission then confirm the transmission.

>LTXL (Get Last Transmission Log)
Tx Status: TX Successful
Tx Type: Self Timed
Last Tx Length: 34 bytes
Last Tx Start Time: 2020/04/01 16:50:00
Last Tx Stop Time: 2020/04/01 16:50:00
Forward Power: 39.5 dBm
Reflected Power: 16.4 dBm
SWR: 1.15
Power Supply: 11.5 V

16) Close the terminal emulation program and disconnect from the command port.

17) Observe the transmission on the EDDN website.

CHAPTER 5 MAINTENANCE AND TROUBLE SHOOTING GUIDE

5.1 MAINTENANCE

The GOES PM2.5 transmitter assembly should not require recalibration. Field maintenance consists of a periodic check of the battery, cables and connectors for deterioration. If further maintenance or calibration is required, contact FTS. PM Maintenance should be in accordance with the relevant operating manual.

5.2 TROUBLESHOOTING

Troubleshooting is done using a PC and a terminal emulation program:

1) Connect the PC to the Command Port and then start the terminal emulation 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.

5.2.1 Trouble Shooting Transmitter 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

5.2.2 Confirm External Sensor Functioning Properly

1) 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

2) 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

5.2.3 Verify Sampler Interface Board Communication

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

>ETM

*****

6) At the asterisk prompt, enter the following command **0I!** (that is: the number zero, followed by a capital letter i, followed by an exclamation mark). The sampler interface board should reply with the string "013FTS-----232-PM-v1<serial#>" where <serial#> is the serial number of the transmitter assembly.

```
* 0I!  013FTS-----232-PM-v1<serial#>
*
```

7) Press the escape key <Esc> to exit from transparent mode and return to the > prompt.

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

5.2.4 Verify Particulate Monitor Communication

Following is a series of steps required for verifying communications to the particulate monitor:

1) Connect the PC to the Command Port and then start the terminal emulation 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.

5) Issue the SDI Test (STT) and wait 3 seconds.

```
>STT
                    : the transmitter queries the particulate monitor and displays the results.
>
-1111.109985        : latitude as supplied by the transmitter
-1111.109985        : longitude as supplied by the transmitter
+9                  : Particulate Monitor Data
+5530
+0.000
-999
+1.9
+24.2
+0
+100291
-999
+36
+0.3
+1
+12.8
+0
```

NOTES

a) Latitude and longitude values will not be correct until a GPS fix is obtained.

b) Communication to the particulate monitor is not correct if -999 is displayed in the particulate monitor data fields. Check the particulate monitor's baud rate setting to ensure it is set to 9600. Also, check the cable connection between the transmitter assembly and the particulate monitor.

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

5.2.5 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. The signal is being reflected or absorbed by neighbouring features.	1) Determine what may be responsible for the interference and remove it, or move the antenna/assembly to a clear area.

5.2.6 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 6.2.5 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.

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

Appendix A ADDITIONAL GOES INFORMATION

A.1 Details of GOES Configuration Parameters

The following table provides a brief explanation of the configuration parameters. Once the transmission parameters are input, there should be no need to change any of the other parameters.

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

Default Setting	Item	Command/ Response Examples	Comments
CMSG=N	Center Message in Window	>CMSG=Y >OK	Y=Yes (Recommended). N=No. See Section 4.4.1 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 4.4.2.
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 $PM_{2.5}$ 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. .
SDIMODE=SDI	Transmitter Mode	Default	SDI is the only mode available
SDF=3	SDI Data Format	Default	This format is specific for use with particulate monitors. Do not change.
ESBV=Y	Enable SDI Battery Voltage	>ESBV=Y	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 (see section A.1)	>SIN=01:00:00 >OK	How often samples will be taken. In hh:mm:ss format Example: Samples taken hourly.
SOF=00:00:00	Sensor Sample Offset (see section A.1)	>SOF=00:02:00 >OK	The offset time at which the sample will be taken in accordance with the sample interval. Example: Samples taken at 00:02:00, 01:02:00, etc.)

A.2 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. Because there is no offset, samples are 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 after the hour). 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.

A.3 Message Centering

If selected, **Message Centering** causes the GOES 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.

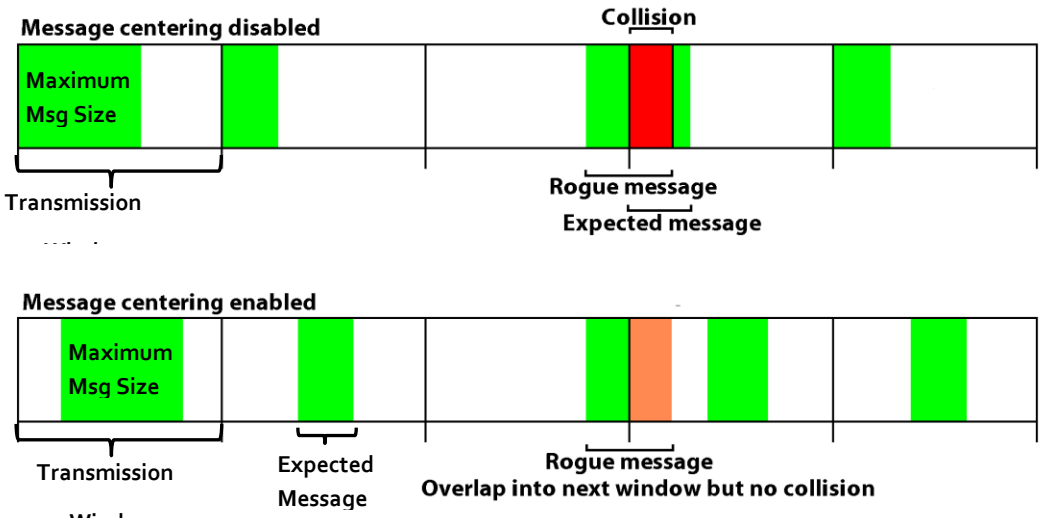


Figure 5-1: Message Centering

A.4 Empty Buffer Message (EBM)

When EBM=Y, transmissions will be made even if there is no data in the buffer to send. This can happen for a variety of reasons including equipment failure or having a GOES transmission interval (TIN) which is more frequent than the sampling intervals. A transmission with no data in the buffer will consist of the GOES DCS header, SDI address and a series of ///.

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

EBM=Y is good tool for trouble shooting as it is an indicator that if no data is received, it is not a transmitter problem.

If you only want to receive transmissions which contain data, set the EBM to No (>EBM=N).

Appendix B 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 C Eon Antenna 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.

DOCUMENT REVISION HISTORY

REV #	DATE	COMMENTS
1	21 April 2020	Original release.