VGOES HDR User Manual

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Revision History

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Original Issue

Table of Contents

Warranty

Safety

This product has been designed and tested according to International Safety Requirements. To ensure safe operation and to keep the product safe, the information, cautions, and warnings in this manual, must be heeded.

Warranty

This Valcom product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Valcom will, at its option, either repair or replace products which prove to be defective. For warranty service or repair, this product must be returned to a service facility designated by Valcom. However, warranty service for products installed by Valcom and certain other products designated by Valcom could be performed at the Buyer's facility at no charge within the Valcom service travel area.

Limitation Of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by the Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenace.

Customer Inquiries

Inquiries regarding the VGOES HDR transmitter may be made to Valcom Manufacturing Group Inc.

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Chapter 1. Specifications

General

The Valcom VGOES HDR is a transmitter Certified by the National Oceanic and Atmospheric Administration (NOAA) and the National Environmental Satellite Data Information Service (NESDIS) for access to the Geostationary Operational Environmental Satellite (GOES) system.

Satellite telemetry provides an efficient method of collecting environmental data from remote locations. The GOES system relays messages from the data collection platforms to ground receiving stations.

VGOES meets or exceeds the NOAA/NESDIS specification for self timed and random reporting data collection platform radio sets (DCPRS), and may be used in any data collection system without requiring system certification.

Configuration is done through the serial interface by the user for any of the standard, high data rate and international GOES channels. See Appendix A for DCPRS Transmit Frequencies. Data and programming information are input to the transmitter over the bi-directional serial port. Time of day, time to next transmission and diagnostic information can be read from the transmitter.

Electrical Characteristics

Serial Interface

- RS232 (+/- 12V)
- 9600bps
- 8bit data
- no parity
- 1 stop bit
- no flow control

Operating Voltage

- 10.5 to 15VDC

Important: Transmission are inhibited if the supply voltage is not within this specification. If the voltage goes out of range while transmitting the output power is shut down and the transmission is aborted.

Transmit Power

- 10 Watts (MAX) @ 100bps and 300bps
- 20 Watts (MAX) @ 1200bps

Current Consumptions

- 3mA Quiescent
- 100mA during GPS fix
- 2.5A during 100bps or 300bps transmission
- 3.2A during 1200bps transmission

Recommended Antenna

- Valcom Cross Yagi (10 dBi gain)[1]

Output Frequency Range

- 401.7Mhz to 402.1Mhz

Machanical

Module Size

- 22.9cm X 13.5cm X 5.1cm

Module Weight

- 1.0Kg

Operating Temperature

- -40°C to 50°C

Front Panel Connectors

RF Output

- TNC type socket, 50Ω

Serial Communication and Power

- 15 pin D-Sub (See Appendix C for the pin description)

Power Supply

- 2 pin terminal block (ground,power)

  The power supply input has reverse voltage protection and is current limited to 7A by a non resettable fuse.

SDI-12

- 3 pin terminal block (data,ground,power)

  SDI-12 power supply output is from 10.5 to 15VDC. Current is limited to 1.5A by a time delay resetting fuse.

GPS Receiver Antenna

- Trimble GPS Antenna, part number 39265-50
- 5m cable length
- 3.1mm connector

Notes

1. http://www.valcom.ca/Guelph/products/vhighfreq/crossed_yagi_photo.html

Chapter 2. Configuration Profiles

Approval to Transmit

Before transmitting with the Valcom VGOES, permission must be obtained from NESDIS.

U.S. federal, state, or local government agencies, or users sponsored by one of those agencies are eligible.

When permission has been obtained, NESDIS will assign the following parameters:

- platform ID
- channel number
- bit rate
- time slot

These parameters must be entered into the transmitter during configuration.

Self Timed and Random Transmissions

Self Timed

Typically, in this mode a DCP will be configured to send a 30 second message every few hours. The specific timing of these transmissions are coordinated by NESDIS. Each DCP is allocated specific time slots throughout the day.

Alarm Random

The host computer or data logger typically analyzes acquired data. When an alarm condition arises (eg. water level too high or changing too quickly), the host computer commands the transmitter to set the alarm. The transmitter will then begin random transmissions at the programmed alarm rate.

Special random channels are reserved in which DCP are not assigned specific time slots. They transmit when required and introduce randomness in the time between transmissions. Messages are usually kept short and Pseudo Binary encoded to minimize the probability of collisions with other random transmissions.

For more information please refer to the "User's Guide for Random Reporting" document prepared for NESDIS, NOAA and the U.S. Department of Commerce.

Regular Random

This mode sends short messages at random times throughout the day. It is commonly used in conjunction with Alarm Random if no Self Timed slot has been allocated to confirm the system and sensors are functioning properly.

Chapter 3. System Operation

Scheduling

Transmission timing is always accurate to within 0.5 seconds. If both self timed and random transmissions are enabled the random transmission will avoid the self timed ones by scheduling around them.

Note: Transmissions only take place if there is data in the buffer to be transmitted.

GPS Time Source

GPS (Global Positioning System) is a navigational system involving satellites and computers that can determine the latitude and longitude of a receiver on Earth by computing the time difference for signals from different satellites to reach the receiver.

VGOES uses the pulse-per-second signal from an integrated GPS receiver to automatically set the exact time of day and fine tune its crystal oscillator. This ensures the RF output is centered properly and minimizes time drift.

VGOES starts its attempt to synchronize with GPS two minutes before each transmission. The process is canceled if it does not complete before the scheduled transmit time. The transmission will only be skipped if there has not been a full GPS sync within 4 days.

There are many reasons for a GPS sync to fail but it should be extremely rare for a transmitter to fail enough GPS syncs to skip a transmission. The main reason for a fail is bad reception from the GPS satellites. They criss cross the sky throughout the day so a clear wide view of the sky will improve reception. Also, the sync takes longer if the almanac is out of date. The software detects this situation and re-enables the GPS after the transmission. The almanac is a set of information that is continuously re-broadcast by the GPS satellites.

Failsafe Protection

In the event of a critical software malfunction, failsafe logic will disable the transmitter. It will detect transmissions that are too long and time intervals between successive transmissions that are too short. The LED on the front panel will flash red if the failsafe protection has been tripped. Holding the push button for 10 seconds will return the transmitter to normal operation.

SDI-12

A future software release will allow the transmitter to operate as a stand alone unit with SDI-12 compatible sensors connected to the SDI-12 port. Please contact Valcom if you are interested in this feature.

LED Status Information

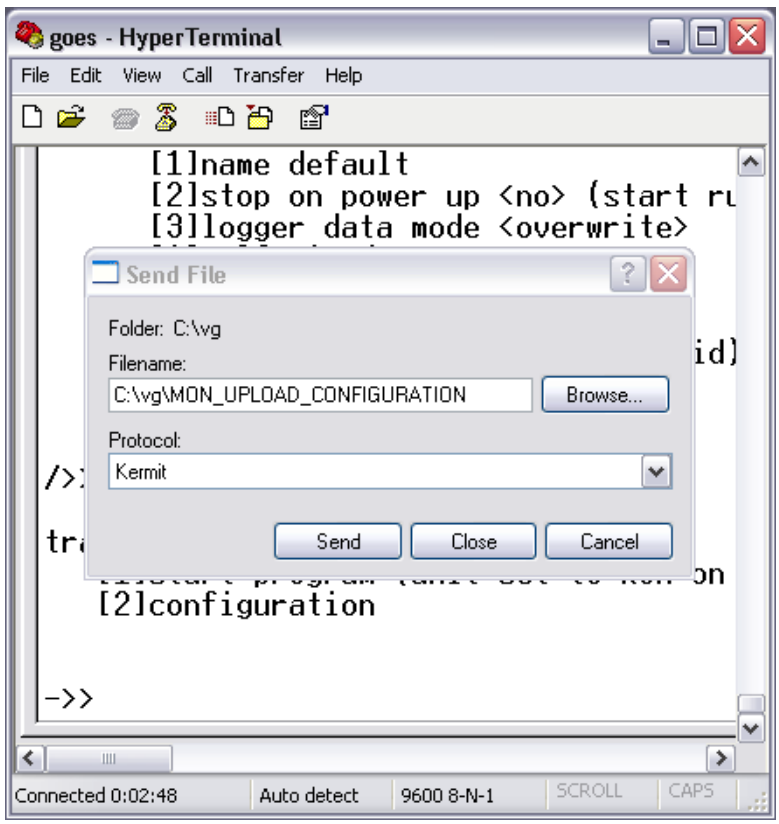
LED	description
solid red	`STOP` mode
flashing red	failsafe tripped
solid green	transmitting
flashing green	synchronizing with GPS
flashing yellow	time not synchronized with GPS
off	`RUN` mode

Chapter 4. Programming

The VGOES serial port provides an interface to Campbell CSI compatible loggers, a VGOES binary protocol and also a console menu system.

VGOES Binary Interface

The VGOES binary interface is a simple protocol implemented on top of the Kermit File Transfer Protocol[1].



The interface works by sending and receiving files with key names. For example, a new configuration can be uploaded by using Kermit to send a file named "MON_UPLOAD_CONFIGURATION"; the contents of the file being a valid configuration. Downloading is done in two steps. Send an empty file with the key name you want to download, then use the Kermit receive function.

The advantage of this format is that no proprietary host PC software is required. Any computer that has a serial port and an implementation of Kermit will work fine. Also, binary data can be uploaded to the transmit buffers.

An overview of Kermit can be found online with the Windows Hyperterminal[2] documentation. See the book by Frank da Cruz titled “Kermit: A File Transfer Protocol” (ISBN 0-932376-88-6) for a complete reference.

File Name Keys

MON_RUN_MODE

Sending this file key will switch the transmitter into `RUN` mode.

MON_STOP_MODE

Sending this file key will switch the transmitter into `STOP` mode.

MON_DOWNLOAD_LOG

Receive this file key to download the event log.

MON_DOWNLOAD_CONFIGURATION

Receive this file key to download the configuration. See the Section called *Configuration File Format* for the format.

MON_SELF_TIMED_BUFFER

Send this file key to write data to the self timed transmit buffer. The contents of the file will overwrite whatever is currently in the buffer.

MON_SELF_TIMED_BUFFER_PRE_APPEND

Send this file key to write data to the self timed transmit buffer. The contents of the file will be pre-appended to whatever is currently in the buffer.

MON_SELF_TIMED_BUFFER_POST_APPEND

Send this file key to write data to the self timed transmit buffer. The contents of the file will be post-appended to whatever is currently in the buffer.

MON_RANDOM_BUFFER

Send this file key to write data to the random transmit buffer. The contents of the file will overwrite whatever is currently in the buffer.

MON_RANDOM_BUFFER_PRE_APPEND

Send this file key to write data to the random transmit buffer. The contents of the file will be pre-appended to whatever is currently in the buffer.

MON_RANDOM_BUFFER_POST_APPEND

Send this file key to write data to the self timed transmit buffer. The contents of the file will be post-appended to whatever is currently in the buffer.

MON_TRIGGER_ALARM

Send this file key to put the transmitter in alarm mode. The transmitter will schedule random transmissions if the profile is enable

MON_CANCEL_ALARM

Send this file key to stop `random alarm` transmissions from being scheduled.

MON_UPLOAD_FIRMWARE

Send this file key to upgrade the firmware. The content for file will be supplied by Valcom when upgrades are issued.

MON_UPLOAD_CONFIGURATION

Send this file key to upload a configuration file. See the Section called *Configuration File Format* for a description of the format.

Configuration File Format

The configuration file is an image of the following C structure.

```
typedef struct configuration_struct {
 char config_format_version;
 char config_name[20];
 char config_version[20];
 unsigned long long config_date;
 unsigned char checksum;
 unsigned short max_random_file_size;
 unsigned short max_self_timed_file_size;
 unsigned int logger_data_mode:3;
 unsigned int stop_on_power_up:1;
 unsigned char extra_pad[4];

 unsigned int random_regular_enabled:1;
 unsigned int random_regular_platform_id:32;
 unsigned int random_regular_interval:17;
 unsigned int random_regular_window_size:17;
 unsigned int random_regular_repeat_count:4;
 unsigned int random_regular_channel:9;
 unsigned int random_regular_bit_rate:2;
 unsigned int random_regular_interleaver:2;
 unsigned int random_regular_format:2;
 unsigned int random_regular_append_count:1;
 unsigned int random_regular_append_v:1;
 unsigned int random_regular_append_forward_power:1;
 unsigned int random_regular_append_reverse_power:1;
 unsigned int random_regular_append_file_age:1;
 unsigned int random_regular_append_file_size:1;
 unsigned int random_regular_append_message_log:1;

 unsigned int random_alarm_enabled:1;
 unsigned int random_alarm_platform_id:32;
 unsigned int random_alarm_interval:17;
 unsigned int random_alarm_window_size:17;
 unsigned int random_alarm_repeat_count:4;
 unsigned int random_alarm_channel:9;
 unsigned int random_alarm_bit_rate:2;
 unsigned int random_alarm_interleaver:2;
 unsigned int random_alarm_format:2;
 unsigned int random_alarm_append_count:1;
 unsigned int random_alarm_append_v:1;
 unsigned int random_alarm_append_forward_power:1;
 unsigned int random_alarm_append_reverse_power:1;
 unsigned int random_alarm_append_file_age:1;
 unsigned int random_alarm_append_file_size:1;
 unsigned int random_alarm_append_message_log:1;

 unsigned int self_timed_enabled:1;
 unsigned int self_timed_platform_id:32;
 unsigned int self_timed_interval:17;
 unsigned int self_timed_interval_offset:17;
 unsigned int self_timed_window_size:17;
 unsigned int self_timed_repeat_count:4;
 unsigned int self_timed_channel:9;
 unsigned int self_timed_bit_rate:2;
 unsigned int self_timed_interleaver:2;
 unsigned int self_timed_format:2;
 unsigned int self_timed_append_count:1;
 unsigned int self_timed_append_v:1;
 unsigned int self_timed_append_forward_power:1;
 unsigned int self_timed_append_reverse_power:1;
 unsigned int self_timed_append_file_age:1;
 unsigned int self_timed_append_file_size:1;
```

```
 unsigned int self_timed_append_message_log:1;
} __attribute__((packed)) configuration_t;
```

Terminal Menu

The menu system can be used to configure the transmitter, switch operating modes and monitor the status.

Menu items are selected by entering the menu item number. The ESC key is used to back out of a menu and the ENTER key can be used to redisplay the current menu. There is a menu item to enter RUN mode but to get back into STOP mode the user has to press ESC five times in a row. This is to avoid accidentally entering STOP mode.

The following is a description of the STOP and RUN mode menus.

STOP Mode

The top line of the menu display shows the current mode and firmware version.

```
transmitter mode:[STOP]-v1.0.1
   [1]start program (unit set to RUN on power up) (1)
   [2]sdi-12 port                                 (2)
   [3]configuration                               (3)
   [4]check bytes                                 (4)
```

(1) The **start program** menu item will switch the unit into RUN mode. This menu item also shows whether the unit will start up in RUN mode or STOP mode.

(2) The **sdi-12 port** menu item starts the transparent SDI-12 communication. This interface can be used to configure sdi-12 devices attached to the sdi-12 port.

(3) The **configuration** menu option opens the **configuration** menu.

(4) The **check bytes** menu option shows the memory check bytes.

Check bytes are used to ensure memory has not been corrupted. The value of the check byte in each memory area is set so the 8 bit checksum will equal zero. The transmitter performs an integrety check before entering RUN mode and reverts to STOP it fails.

```
transmitter mode:[STOP]-v1.0.1
   configuration
      [1]name default                                                  (1)
      [2]stop on power up <no> (start running program on power up)     (2)
      [3]logger data mode <overwrite>                                  (3)
      [4]self timed                                                    (4)
      [5]regular random                                                (5)
      [6]alarm random                                                  (6)
      [7]reload (configuration is valid)                               (7)
      [8]save changes (184/80)                                         (8)
```

(1) The **name** menu item allows a name to be given to the configuration.

(2) The **stop on power up** menu option configures the unit to either stop or run when power is applied. Normally units are set to start running on power up.

(3) The **logger data mode** option controls whether CSI insert commands `append` or `overwrite` data. This option was added for extra flexibility. Normally this option should be set to `overwrite`.

(4) Enter the **self timed** menu to configure the unit's self timed transmissions.

(5) Enter the **regular random** menu to configure the unit's regular random transmissions.

(6) Enter the **regular random** menu to configure the unit's alarm random transmissions.

(7) The **reload** menu item can be used to revert to the configuration saved in non volatile memory. This menu also shows whether the modified (not saved) configuration is valid.

(8) The **save changes** menu item is used to save the changes to non volatile memory. This menu will show `modified` if changes have been made since the last save. Once changes have been saved the menu item will show the maximum bytes per transmission given the current configuration. This example shows 184 bytes per self timed transmission and 80 bytes per random transmission.

```
transmitter mode:[STOP] v1.0.1
   configuration
      self timed
         [1] <enabled>            (1)
         [2]platform id C0101034  (2)
         [3]interval 00:15:00     (3)
         [4]offset 00:01:02       (4)
         [5]window size 00:00:10  (5)
         [6]data repeat 0         (6)
         [7]channel 195           (7)
         [8]bit rate <300bps>     (8)
         [9]interleaver <long>    (9)
         [:]format<ascii>         (10)
         [;]automatic data        (11)
```

(1) The **enabled/disabled** menu item controls whether or not this type of transmission will be scheduled.

(2) The **platform id** menu item is used to set the platform id for this type of transmission. This id is sent along with each transmission so the receiving station can identify the sender.

(3) The **interval** menu item is used to set the interval between start of transmissions. In this example the unit is set to transmit every 15 minutes.

(4) The **offset** menu item is used to set the offset of the window within the interval. In this example the unit will transmit at XX:01:02, XX:16:02, XX:31:02 and XX:46:02 every hour.

(5) The **window size** menu item limits the duration of each transmission. The transmitter will truncate message data if necessary.

(6) The **data repeat** menu item can be used to send redundant data. Data will be kept in the output buffer until it has been transmitted the specified number of times. Most recent data is sent first and repeated data is automatically appended. Normally **data repeat** is set to zero.

(7) The **channel** menu item selects the channel. See Appendix A for a list of the available channel and bit rate combinations.

Note: International DCP channels start at 100bps/channel 202

(8) The **bit rate** menu item selects the bit rate.

(9) The **interleaver** menu item is used to selection an interleaver. The interleaver is an optional feature of HDR GOES that enhances the system's ability to correct transmission bit errors. Using this feature may help if messages are being corrupted by adjacent channel interference or other sources of burst RF interference.

(10) The **format** menu item selects the message data character set. The available formats are `ascii`, `pseudo binary` and `binary`. See Appendix B for more information on each character set.

(11) The **automatic data** menu item is used to add extra information to the output message.

```
transmitter mode:[STOP]-v1.0.1
   configuration
      regular random
         [1] <disabled>                        (1)
         [2]platform id C0101034               (2)
         [3]interval 00:10:00                  (3)
         [4]window size <fixed at 3 seconds>   (4)
         [5]data repeat 0                      (5)
         [6]channel 195                        (6)
         [7]bit rate <300bps>                  (7)
         [8]interleaver <none>                 (8)
         [9]format <ascii>                     (9)
         [:]automatic data                     (10)
```

(1) The **enabled/disabled** menu item controls whether or not this type of transmission will be scheduled.

(2) The **platform id** menu item is used to set the platform id for this type of transmission. This id is sent along with each transmission so the receiving station can identify the sender.

(3) The **interval** menu item is used to set the average interval between transmissions. In this example the unit is set to transmit, on average, every 10 minutes.

(4) The **window size** menu item limits the duration of each transmission. The transmitter will truncate message data if necessary. Random HDR transmission have fixed window sizes. When the bit rate is set to 300bps or 1200bps the window window size is fixed at 3.0s or 1.5s.

(5) The **data repeat** menu item can be used to send redundant data. Data will be kept in the output buffer until it has been transmitted the specified number of times. Most recent data is sent first and repeated data is automatically appended. Normally **data repeat** is set to zero.

(6) The **channel** menu item selects the channel. See Appendix A for a list of the available channel and bit rate combinations.

Note: International DCP channels start at 100bps/channel 202

(7) The **bit rate** menu item selects the bit rate.

(8) The **interleaver** menu item allows the selection and use of an interleaver. The interleaver is an optional feature of HDR GOES that enhances the system's ability to correct transmission bit errors. Using the interleaver may help if messages are being corrupted by adjacent channel interference or other sources of burst RF interferences.

(9) The **format** menu item selects the message data character set. The available formats are `ascii`, `pseudo binary` and `binary`. See Appendix B for more information on each character set.

(10) The **automatic data** menu item is used to add extra information to each message.

```
transmitter mode:[STOP]-v1.0.1
   configuration
      alarm random
         automatic data
            [1]message count <no>   (1)
            [2]supply voltage <no>  (2)
            [3]forward power <no>   (3)
            [4]reverse power <no>   (4)
            [5]file age <no>        (5)
            [6]file length <no>     (6)
```

(1) This option adds a count to the transmitted message. A separate count it maintained for both self timed and random transmissions. If the message format is ASCII then the count will be shown using two characters representing an 8 bit (00 to ff) hexadecimal number. If the format is pseudo binary then the count will be shown as one 6 bit pseudo binary digit. If the format is binary one 8 bit byte will be used.

(2) This option adds the supply voltage to the output message. It is measured while transmitting carrier, right before the message is transmitted. Power consumption is greatest when transmitting carrier so this can be regarded as a worst case battery voltage. The value is in 1/4 Volt increments.

(3) This option adds the forward power reading to the output message. It is measured while transmitting carrier right before the message is transmitted. The measurement is not very accurate but it should be fairly constant. The value is expressed in 1/4 Watt increments.

(4) This option adds the reverse power reading to the output message. It is measured while transmitting carrier right before the message is transmitted. The measurement is not very accurate but it should be fairly constant. The value is expressed in 1/4 Watt increments.

(5) This option pre appends the age in seconds to each file transmitted.

(6) This option pre appends the file size to each file transmitted.

RUN Mode

In `RUN` mode the first line shows the firmware version and the current GMT time. The time since reset will be shown until the real time is acquired from GPS.

```
transmitter mode:[RUN]-v1.0.1 00:00:03
   [1]event log                    (1)
   [2]system status                (2)
   [3]process slots                (3)
```

(1) The **event log** menu item displays a log of the most recent events.

(2) The **system status** menu item will show information useful for assessing the overall health of the transmitter.

(3) The **process slots** menu item will display information about the running processes.

```
<17/03/2006 18:46:12> speed down  (1)
[17/03/2006 18:46:09] battery:12.1V reverse power:0.7W forward power:6.5W
[17/03/2006 18:46:09] tx done, next tx: 19:01:02
[17/03/2006 18:45:14] drift correction: 0.047ms -- drift rate correction: -3ms/day (-14
[17/03/2006 18:45:04] vedas inserted 240 bytes into self timed buffer
[17/03/2006 18:45:03] select buffer done
[17/03/2006 18:44:21] speed up
[17/03/2006 18:31:08] speed down
```

```
[17/03/2006 18:31:06] battery:12.0V reverse power:0.7W forward power:6.5W
[17/03/2006 18:31:06] tx done, next tx: 18:46:02
[17/03/2006 18:30:03] vedas inserted 119 bytes into self timed buffer
[17/03/2006 18:30:03] select buffer done
[17/03/2006 18:17:26] drift correction: 0.000ms -- drift rate correction: 3ms/day (14hz
[17/03/2006 18:16:33] speed up
[17/03/2006 18:16:13] speed down
[17/03/2006 18:16:10] battery:11.9V reverse power:0.7W forward power:6.5W
[17/03/2006 18:16:10] tx done, next tx: 18:31:02
[17/03/2006 18:16:01] terminating pre-tx GPS sync
[17/03/2006 18:15:04] vedas inserted 282 bytes into self timed buffer
[17/03/2006 18:15:03] select buffer done
[17/03/2006 18:08:35] drift correction: 0.000ms -- drift rate correction: -3ms/day (-14
[17/03/2006 18:07:38] first sync done, next tx: 18:16:02
[ no time   00:02:29] drift correction: 0.000ms -- drift rate correction: -27ms/day (-1
[ no time   00:00:12] read status done
[ no time   00:00:12] select buffer done
[ no time   00:00:12] read config done
[ no time   --:--:--] reset (2)
[17/03/2006 18:01:06] battery:12.1V reverse power:0.7W forward power:6.5W
[17/03/2006 18:01:06] tx done, next tx: 18:16:02
[17/03/2006 18:00:14] drift correction: -0.043ms -- drift rate correction: -6ms/day (-2
[17/03/2006 18:00:03] vedas inserted 119 bytes into self timed buffer
```

(1) Time stamps that have "<" and ">" are messages that are still in volatile memory. They will be written to non volatile memory after the next transmission.

(2) Date stamps marked as `no time` indicates that the transmitter time was not synchronized using GPS yet. The time stamp will be the time since reset.

```
GPS is currently powered off (1)
 Antenna Feedline is OK
 Almanac is valid
time valid 3 days + 23:56:39 without GPS (2)
GPS UTC offset is 14 seconds (14) (3)
time required for last GPS synchronization: 1 minutes and 14 seconds (4)
oscillator offset is 75 (5)
oscillator table offset is -10 (6)
last drift rate correction: -3ms/day (-14hz @ 401Mhz) (7)
last drift correction: -0.038ms (8)
uptime: 0 days + 00:43:50 (9)
 maximum drift correction: 0.047ms
 3 GPS sync(s) and 0 timout(s)
 transmissions:3
 speed switches:3
 total drift correction: 0.009ms
 total drift rate correction: -3ms/day (-14hz @ 401Mhz)
next tx @ 19:01:02, <self timed> (alarm is not set) (10)
```

(1) Information from the GPS unit is displayed first. Reception status will be shown while the transmitter is performing a frequency calibration or time synchronization. Reception improves once the Almanac is received from the GPS satellite system so the GPS unit is kept powered until it has been received.

(2) This line shows information on the time accuracy. The VGOES will transmit only if the time is accurate to within 0.5 seconds. To meet this requirement it needs to sycnronize with the time from the GPS unit at least every four days.

(3) This line shows the difference between UTC time and GPS time. This difference accumulates because UTC time is adjusted once in a while with leap seconds and GPS time is not. VGOES obtains the offset from the GPS almanac so it's able to automatically adjust the time when leap seconds accur.

(4) This line shows how long it took for the last GPS synchronization. GPS syncs start two minutes before every transmission. They are aborted if they don't complete before the transmission. If the GPS Almanac is not valid, another sync is started after the transmission. The extra sync will timeout after 17 minutes.

(5) This line shows the offset applied to fine tune the main crystal oscillator frequency. The number is an 8bit hexadecimal number.

(6) This line shows the difference between the transmitter's built-in temperature vs. offset table and the actuall offset calculated using the GPS. This number should stay fairly constant over temperature changes and drift slowly as the oscillator ages.

(7) This line shows how much frequency change there was by the last GPS sync.

(8) This line shows how much the time was moved forward or backward by the last GPS sync.

(9) These lines show the running statistics of the transmitter.

(10) This line shows information about the next scheduled transmission.

The **process slots** menu item displays information about the processes that are currently running. A process slot is a set of resources used by a running process. The firmware reserves enough resources for a maximum of 12 processes.

```
#slot 0 stage 2# ALMANAC STARTED (1)
#slot 1 stage 1# GPS handling 82 (1 bytes) 12
slots free: 10 of 12 (2)
```

(1) Each line shows the status of a running process. It shows its stage and a short description of the task.

(2) The last line shows the number of slots available.

CSI Compatible Loggers

The CSI format specification is by Campbell Scientific Inc.[3] This is the format used by Valcom's VEDAS II logger.

Commands that change the configuration are only accepted when in stop mode and most of the diagnostic or buffer commands only work properly while in `RUN` mode. A reset is performed when the unit changes mode.

The VGOES automatically enters CSI compatibility mode when it receives a BREAK on the serial line, handles the incoming CSI command and switches back. If it doesn't receive a command within two or three seconds it will switch back out of CSI mode automatically.

As soon as the VGOES enters CSI mode it will send an STX (0x02). If for some reason the command is rejected VGOES will return NAK (0x15). If the command is accepted VGOES will return ACK (0x06) followed by the appropriate response for the given command.

Configuration Commands

Set Data Collection Platform ID

command format

1. command code, `0x01`
2. platform ID byte 3
3. platform ID byte 2
4. platform ID byte 1
5. platform ID byte 0
6. checksum byte 1
7. checksum byte 0

response format

1. result code, ACK(`0x06`) or NAK(`0x15`)

Set Self Timed Messaging

command format

1. command code, `0x02`
2. bit rate (100bps:`0x01`, 300bps:`0x02`, 1200bps:`0x03`)
3. channel byte 1
4. channel byte 0
5. interval days, *not supported by VGOES*
6. interval hours
7. interval minutes
8. interval seconds
9. offset hours
10. offset minutes
11. offset seconds
12. message window size in seconds
13. preamble (long:`0x00`, short:`0x01`) *not supported by VGOES, the long preamble is used when transmitting on an international channel otherwise the short preamble is used*
14. interleaver (none:`0x00`, long:`0x01`, short:`0x02`)
15. checksum byte 1
16. checksum byte 0

response format

1. result code, ACK(`0x06`) or NAK(`0x15`)

Set Random Messaging

command format

1. command code, `0x03`
2. bit rate (100bps:`0x01`, 300bps:`0x02`, 1200bps:`0x03`)
3. channel byte 1
4. channel byte 0
5. interval days, *not supported by VGOES*
6. interval hours
7. interval minutes
8. interval seconds
9. interleaver (none:`0x00`, long:`0x01`, short:`0x02`)
10. checksum byte 1
11. checksum byte 0

response format

1. result code, ACK(`0x06`) or NAK(`0x15`)

Set Operational Mode

command format

1. command code, `0x04`
2. mode (stop:`0x01`, run:`0x03`)
3. checksum byte 1
4. checksum byte 0

response format

1. result code, ACK(`0x06`) or NAK(`0x15`)

Transmit Random Message

command format

1. command code, `0x0B`, *not supported by VGOES*
2. checksum byte 1
3. checksum byte 0

response format

1. result code, ACK(`0x06`) or NAK(`0x15`)

Diagnostic Commands

Read Time

command format

1. command code, `0x11`

response format

1. result code, ACK(`0x06`) or NAK(`0x15`)
2. hours, 0x99 will be returned if the time has not been synchronized with GPS
3. minutes, 0x99 will be returned if the time has not been synchronized with GPS
4. seconds, 0x99 will be returned if the time has not been synchronized with GPS

Read Status

command format

1. command code, `0x09`
2. checksum byte 1
3. checksum byte 0

response format

1. result code, ACK(`0x06`) or NAK(`0x15`)
2. command code, `0x09`
3. number of bytes in self timed buffer, byte 1
4. number of bytes in self timed buffer, byte 0

5. time to next timed transmission, days
6. time to next timed transmission, hours
7. time to next timed transmission, minutes
8. time to next timed transmission, seconds
9. number of bytes in random buffer, byte 1
10. number of bytes in random buffer, byte 0
11. time until start of random interval, hours
12. time until start of random interval, minutes
13. time until start of random interval, seconds

    The logger will usually be set up to write its data at the start of random interval. The data is transmit at some time within the interval.
14. failsafe (clear:0x00, tripped:0x01)
15. volts, supply voltage measured while transmitting the last message (tenths of Volts)
16. GPS acquisition time, time required to synchronize with GPS (tens of seconds)
17. checksum byte 1
18. checksum byte 0

Read Last Message Status

command format

1. command code, `0x0A`
2. checksum byte 1
3. checksum byte 0

response format

1. result code, ACK(`0x06`) or NAK(`0x15`)
2. command code, `0x0A`
3. message type (self timed:`0x00`, random:`0x01`)
4. number of bytes transmitted byte 1
5. number of bytes transmitted byte 0
6. foward power
7. reverse power
8. supply voltage (tenths of Volts)
9. GPS fix time (`0x00` if time was not synchronized to GPS)
10. oscillator drift (signed hundreds of Hertz)
11. latitude degrees
12. latitude minutes
13. latitude seconds

14. longitude degrees
15. longitude minutes
16. longitude seconds
17. checksum byte 1
18. checksum byte 0

Read Configuration

command format

1. command code, `0x0C`
2. checksum byte 1
3. checksum byte 0

response format

1. result code, ACK(`0x06`) or NAK(`0x15`)
2. command code, `0x0C`
3. platform ID byte 3
4. platform ID byte 2
5. platform ID byte 1
6. platform ID byte 0
7. self timed bit rate
8. self timed channel byte 1
9. self timed channel byte 0
10. self timed interval days
11. self timed interval hours
12. self timed interval minutes
13. self timed interval seconds
14. self timed offset hours
15. self timed offset minutes
16. self timed offset seconds
17. self timed window size
18. self timed interleaver (none:`0x00`, long:`0x01`, short:`0x02`)
19. random bit rate (100bps:`0x01`, 300bps:`0x02`, 1200bps:`0x03`)
20. random channel byte 1
21. random channel byte 0
22. random interval hours
23. random interval minutes
24. random interval seconds

25. random preamble (long:`0x00`, short:`0x01`)
26. random interleaver (none:`0x00`, long:`0x01`, short:`0x02`)
27. checksum byte 1
28. checksum byte 0

Read Error Register

command format

1. command code, `0x0D`
2. checksum byte 1
3. checksum byte 0

response format

1. result code, ACK(`0x06`) or NAK(`0x15`)
2. command code, `0x0D`
3. error count
4. entry 1 command
5. entry 1 error
6. entry 2 command
7. entry 2 error
8. entry 3 command
9. entry 3 error
10. entry 4 command
11. entry 4 error
12. checksum byte 1
13. checksum byte 0

Reset Error Counter

command format

1. command code, `0x0E`
2. checksum byte 1
3. checksum byte 0

response format

1. result code, ACK(`0x06`) or NAK(`0x15`)

Read GPS data

command format

1. command code, `0x0F`
2. checksum byte 1
3. checksum byte 0

response format

1. result code, ACK(`0x06`) or NAK(`0x15`)
2. time byte 3 (seconds since Jan 1, 2000)
3. time byte 2 (seconds since Jan 1, 2000)
4. time byte 1 (seconds since Jan 1, 2000)
5. time byte 0 (seconds since Jan 1, 2000)
6. latitude byte 3
7. latitude byte 2
8. latitude byte 1
9. latitude byte 0
10. longitude byte 3
11. longitude byte 2
12. longitude byte 1
13. longitude byte 0
14. elevation byte 3
15. elevation byte 2
16. elevation byte 1
17. elevation byte 0
18. magnetic variation byte 3
19. magnetic variation byte 2
20. magnetic variation byte 1
21. magnetic variation byte 0
22. checksum byte 1
23. checksum byte 0

Data Transfer Commands

Select Data Buffer

command format

1. command code, `0x32`
2. buffer selection (self timed:`0x00`, random:`0x01`

response format

1. result code, ACK(`0x06`) or NAK(`0x15`)

Insert to Buffer

command format

1. command code, `0x20`
2. null terminated string, 7bit characters, 8th bit is odd parity
3. checksum byte 1
4. checksum byte 0

response format

1. result code, ACK(`0x06`) or NAK(`0x15`)

Append to Buffer

command format

1. command code, `0x21`
2. null terminated string, 7bit characters, 8th bit is odd parity
3. checksum byte 1
4. checksum byte 0

response format

1. result code, ACK(`0x06`) or NAK(`0x15`)

Notes

1. http://www.columbia.edu/kermit/kermit.html
2. http://msdn.microsoft.com/library/default.asp?url=/library/en-us/randz/protocol/hyperterminal_kermit_file_transfer.asp
3. http://www.campbellsci.com

Chapter 5. Message Retrieval

DCS Automated Processing System (DAPS)

The DAPS CDA (Command and Data Acquisition) ground station in Wallops, VA provides many support services for the GOES system. Users can log on to their servers using dial up modems or via the Internet using the telnet protocol. See the DAPS[1] web site for more information.

Local Readout Ground Station (LRGS)

The DAPS station broadcasts all Data Collection Platform messages over a domestic communications satellite (DOMSAT). The LRGS is a ground system that receives this data stream and provides a mechanism that allows client programs running on other machines to connect and retrieve DCP messages.

Users can set up their own LRGS or use the LRGS servers maintained by NESDIS. They have the DROT machine that receives its data through a DOMSAT link, just as any LRGS at a user site would and the CDADATA machine that receives data through a direct wire connection from DAPS. See the Wallops CDA[2] site for more information.

Message Format

Here is an example of a message downloaded from the DAPS ground station.

```
C01010340603615330OG45-0NN195EFF00195" :HG 3 #5 0.0220 0.0260 0.0260 <...>
```

The following is a break down of the information fields.

```
C0101034 (1)
        06 (2)
          036 (3)
             153300 (4)
                   G (5)
                    45 (6)
                      -0 (7)
                        N (8)
                         N (9)
                          195 (10)
                             E (11)
                              FF (12)
                                00195 (13)
                                      " (14)
                                        :HG 3 #5 0.0220 0.0260 0.0260 (15)
```

(1) DCP address.

(2) Year

(3) Julian day of year. In this example the date is February 5th 2006.

(4) Hours, minutes and seconds in the form HHMMSS. This is a time stamp applied when the message is received. Note, the system rounds up.

(5) Failure code,
G - good message
? - message received with parity errors
W - message received on wrong channel
D - message received on multiple channels (duplicate)
A - message received with address error(s) (correctable)

(6) Signal strength in dB, 32 to 57

(7) Offset from center frequency. +/- 0 to 9 in increments of 50Hz or A for 500Hz

(8) Modulation index
N = normal, 60 degrees
L = low, < 50 degrees
H = low, > 70 degrees

These codes are not defined for High Data Rate messages. Note, it is normal to see H or L for short HDR messages.

(9) Data quality
N = normal, 85% or more of the bits were good
F = fair, 70% to 85% of the bits were good
P = poor, < 70% of the bits were good

(10) Channel

Note, 1200bps transmissions show the closest lower 100bps/300bps channel number. See Appendix A. For example, 1200bps channel 99 will be shown as channel 197.

(11) GOES spacecraft
E = GOES East
W = GOES West

(12) This field no longer has a meaning.

(13) The number of message bytes to follow.

(14) This field is not included for 100bps (Low Data Rate) transmissions.
bit 0 - unused, always clear
bit 1 - clock updated, set if time has been synchronized with GPS
bit 2 - unused, always clear
bit 3 - unused, always clear
bit 4 - unused, always clear
bit 5 - ASCII format, (pseudo binary if both ASCII and binary are set)
bit 6 - binary format
bit 7 - odd parity bit, this is not a flag

The following table shows the different character representations for the flag byte.

format	no GPS reception	clock updated
ASCII	SPACE	"
Pseudo Binary	’	b
Binary	@	B

(15) Message data, this is the data received from the logger

Notes

1. http://dcs.noaa.gov
2. http://cdadata.wcda.noaa.gov

Appendix A. DCPRS Transmit Frequencies

Frequency (Mhz)	100bps,300bps	1200bps	international
401.701000	1		
401.701750		1	
401.702500	2		
401.704000	3		
401.704750		2	
401.705500	4		
401.707000	5		
401.707750		3	
401.708500	6		
401.710000	7		
401.710750		4	
401.711500	8		
401.713000	9		
401.713750		5	
401.714500	10		
401.716000	11		
401.716750		6	
401.717500	12		
401.719000	13		
401.719750		7	
401.720500	14		
401.722000	15		
401.722750		8	
401.723500	16		
401.725000	17		
401.725750		9	
401.726500	18		
401.728000	19		
401.728750		10	
401.729500	20		
401.731000	21		
401.731750		11	
401.732500	22		
401.734000	23		
401.734750		12	
401.735500	24		
401.737000	25		
401.737750		13	

Frequency (Mhz)	100bps,300bps	1200bps	international
401.738500	26		
401.740000	27		
401.740750		14	
401.741500	28		
401.743000	29		
401.743750		15	
401.744500	30		
401.746000	31		
401.746750		16	
401.747500	32		
401.749000	33		
401.749750		17	
401.750500	34		
401.752000	35		
401.752750		18	
401.753500	36		
401.755000	37		
401.755750		19	
401.756500	38		
401.758000	39		
401.758750		20	
401.759500	40		
401.761000	41		
401.761750		21	
401.762500	42		
401.764000	43		
401.764750		22	
401.765500	44		
401.767000	45		
401.767750		23	
401.768500	46		
401.770000	47		
401.770750		24	
401.771500	48		
401.773000	49		
401.773750		25	
401.774500	50		
401.776000	51		
401.776750		26	
401.777500	52		

Frequency (Mhz)	100bps,300bps	1200bps	international
401.779000	53		
401.779750		27	
401.780500	54		
401.782000	55		
401.782750		28	
401.783500	56		
401.785000	57		
401.785750		29	
401.786500	58		
401.788000	59		
401.788750		30	
401.789500	60		
401.791000	61		
401.791750		31	
401.792500	62		
401.794000	63		
401.794750		32	
401.795500	64		
401.797000	65		
401.797750		33	
401.798500	66		
401.800000	67		
401.800750		34	
401.801500	68		
401.803000	69		
401.803750		35	
401.804500	70		
401.806000	71		
401.806750		36	
401.807500	72		
401.809000	73		
401.809750		37	
401.810500	74		
401.812000	75		
401.812750		38	
401.813500	76		
401.815000	77		
401.815750		39	
401.816500	78		
401.818000	79		

Frequency (Mhz)	100bps,300bps	1200bps	international
401.818750		40	
401.819500	80		
401.821000	81		
401.821750		41	
401.822500	82		
401.824000	83		
401.824750		42	
401.825500	84		
401.827000	85		
401.827750		43	
401.828500	86		
401.830000	87		
401.830750		44	
401.831500	88		
401.833000	89		
401.833750		45	
401.834500	90		
401.836000	91		
401.836750		46	
401.837500	92		
401.839000	93		
401.839750		47	
401.840500	94		
401.842000	95		
401.842750		48	
401.843500	96		
401.845000	97		
401.845750		49	
401.846500	98		
401.848000	99		
401.848750		50	
401.849500	100		
401.851000	101		
401.851750		51	
401.852500	102		
401.854000	103		
401.854750		52	
401.855500	104		
401.857000	105		
401.857750		53	

Frequency (Mhz)	100bps,300bps	1200bps	international
401.858500	106		
401.860000	107		
401.860750		54	
401.861500	108		
401.863000	109		
401.863750		55	
401.864500	110		
401.866000	111		
401.866750		56	
401.867500	112		
401.869000	113		
401.869750		57	
401.870500	114		
401.872000	115		
401.872750		58	
401.873500	116		
401.875000	117		
401.875750		59	
401.876500	118		
401.878000	119		
401.878750		60	
401.879500	120		
401.881000	121		
401.881750		61	
401.882500	122		
401.884000	123		
401.884750		62	
401.885500	124		
401.887000	125		
401.887750		63	
401.888500	126		
401.890000	127		
401.890750		64	
401.891500	128		
401.893000	129		
401.893750		65	
401.894500	130		
401.896000	131		
401.896750		66	
401.897500	132		

Frequency (Mhz)	100bps,300bps	1200bps	international
401.899000	133		
401.899750		67	
401.900500	134		
401.902000	135		
401.902750		68	
401.903500	136		
401.905000	137		
401.905750		69	
401.906500	138		
401.908000	139		
401.908750		70	
401.909500	140		
401.911000	141		
401.911750		71	
401.912500	142		
401.914000	143		
401.914750		72	
401.915500	144		
401.917000	145		
401.917750		73	
401.918500	146		
401.920000	147		
401.920750		74	
401.921500	148		
401.923000	149		
401.923750		75	
401.924500	150		
401.926000	151		
401.926750		76	
401.927500	152		
401.929000	153		
401.929750		77	
401.930500	154		
401.932000	155		
401.932750		78	
401.933500	156		
401.935000	157		
401.935750		79	
401.936500	158		
401.938000	159		

Frequency (Mhz)	100bps,300bps	1200bps	international
401.938750		80	
401.939500	160		
401.941000	161		
401.941750		81	
401.942500	162		
401.944000	163		
401.944750		82	
401.945500	164		
401.947000	165		
401.947750		83	
401.948500	166		
401.950000	167		
401.950750		84	
401.951500	168		
401.953000	169		
401.953750		85	
401.954500	170		
401.956000	171		
401.956750		86	
401.957500	172		
401.959000	173		
401.959750		87	
401.960500	174		
401.962000	175		
401.962750		88	
401.963500	176		
401.965000	177		
401.965750		89	
401.966500	178		
401.968000	179		
401.968750		90	
401.969500	180		
401.971000	181		
401.971750		91	
401.972500	182		
401.974000	183		
401.974750		92	
401.975500	184		
401.977000	185		
401.977750		93	

Frequency (Mhz)	100bps,300bps	1200bps	international
401.978500	186		
401.980000	187		
401.980750		94	
401.981500	188		
401.983000	189		
401.983750		95	
401.984500	190		
401.986000	191		
401.986750		96	
401.987500	192		
401.989000	193		
401.989750		97	
401.990500	194		
401.992000	195		
401.992750		98	
401.993500	196		
401.995000	197		
401.995750		99	
401.996500	198		
401.998000	199		
401.998750		100	
401.999500	200		
402.001000			
402.002500			202 (1)
402.004000			
402.005500			204 (2)
402.007000			
402.008500			206 (3)
402.010000			
402.011500			208 (4)
402.013000			
402.014500			210 (5)
402.016000			
402.017500			212 (6)
402.019000			
402.020500			214 (7)
402.022000			
402.023500			216 (8)
402.025000			
402.026500			218 (9)

Frequency (Mhz)	100bps,300bps	1200bps	international
402.028000			
402.029500			220 (10)
402.031000			
402.032500			222 (11)
402.034000			
402.035500			224 (12)
402.037000			
402.038500			226 (13)
402.040000			
402.041500			228 (14)
402.043000			
402.044500			230 (15)
402.046000			
402.047500			232 (16)
402.049000			
402.050500			234 (17)
402.052000			
402.053500			236 (18)
402.055000			
402.056500			238 (19)
402.058000			
402.059500			240 (20)
402.061000			
402.062500			242 (21)
402.064000			
402.065500			244 (22)
402.067000			
402.068500			246 (23)
402.070000			
402.071500			248 (24)
402.073000			
402.074500			250 (25)
402.076000			
402.077500			252 (26)
402.079000			
402.080500			254 (27)
402.082000			
402.083500			256 (28)
402.085000			
402.086500			258 (29)

Frequency (Mhz)	100bps,300bps	1200bps	international
402.088000			
402.089500			260 (30)
402.091000			
402.092500			262 (31)
402.094000			
402.095500			264 (32)
402.097000			
402.098500			266 (33)

Appendix B. Character Sets

Table B-1. ASCII Character Set

lsb↓	0x00+	0x10+	0x20+	0x30+	0x40+	0x50+	0x60+	0x70+
0x0	NUL	✗*DLE*	SPACE	0	@	P	’	p
0x1	✗*SOH*	DC1	!	1	A	Q	a	q
0x2	✗*STX*	DC2	"	2	B	R	b	r
0x3	✗*ETX*	DC3	#	3	C	S	c	s
0x4	✗*EOT*	DC4	$	4	D	T	d	t
0x5	✗*ENQ*	✗*NAK*	%	5	E	U	e	u
0x6	✗*ACK*	✗*SYN*	&	6	F	V	f	v
0x7	BEL	✗*ETB*	’	7	G	W	g	w
0x8	BS	✗*CAN*	(	8	H	X	h	x
0x9	HT	EM	)	9	I	Y	i	y
0xA	LF	SUB	*	:	J	Z	j	z
0xB	VT	ESC	+	;	K	[	k	{
0xC	FF	FS	,	<	L	\	l	|
0xD	CR	✗*GS*	-	=	M	]	m	}
0xE	SO	✗*RS*	.	>	N	^	n	~
0xF	SI	✗*US*	/	?	O	_	o	DEL

Table B-2. Illegal Characters

lsb↓	0x00+	0x10+	0x20+	0x30+	0x40+	0x50+	0x60+	0x70+
0x0		DLE						
0x1	SOH							
0x2	STX							
0x3	ETX							
0x4	EOT							
0x5	ENQ	NAK						
0x6	ACK	SYN						
0x7		ETB						
0x8		CAN						
0x9								
0xA								
0xB								
0xC								
0xD		GS						
0xE		RS						
0xF		US						

Table B-3. Domestic Character Set

lsb↓	0x00+	0x10+	0x20+	0x30+	0x40+	0x50+	0x60+	0x70+
0x0	NUL		SPACE	0	@	P	’	p
0x1		DC1	!	1	A	Q	a	q
0x2		DC2	"	2	B	R	b	r
0x3		DC3	#	3	C	S	c	s
0x4		DC4	$	4	D	T	d	t
0x5			%	5	E	U	e	u
0x6			&	6	F	V	f	v
0x7	BEL		’	7	G	W	g	w
0x8	BS		(	8	H	X	h	x
0x9	HT	EM	)	9	I	Y	i	y
0xA	LF	SUB	*	:	J	Z	j	z
0xB	VT	ESC	+	;	K	[	k	{
0xC	FF	FS	,	<	L	\	l	|
0xD	CR		-	=	M	]	m	}
0xE	SO		.	>	N	^	n	~
0xF	SI		/	?	O	_	o	DEL

Table B-4. International Character Set

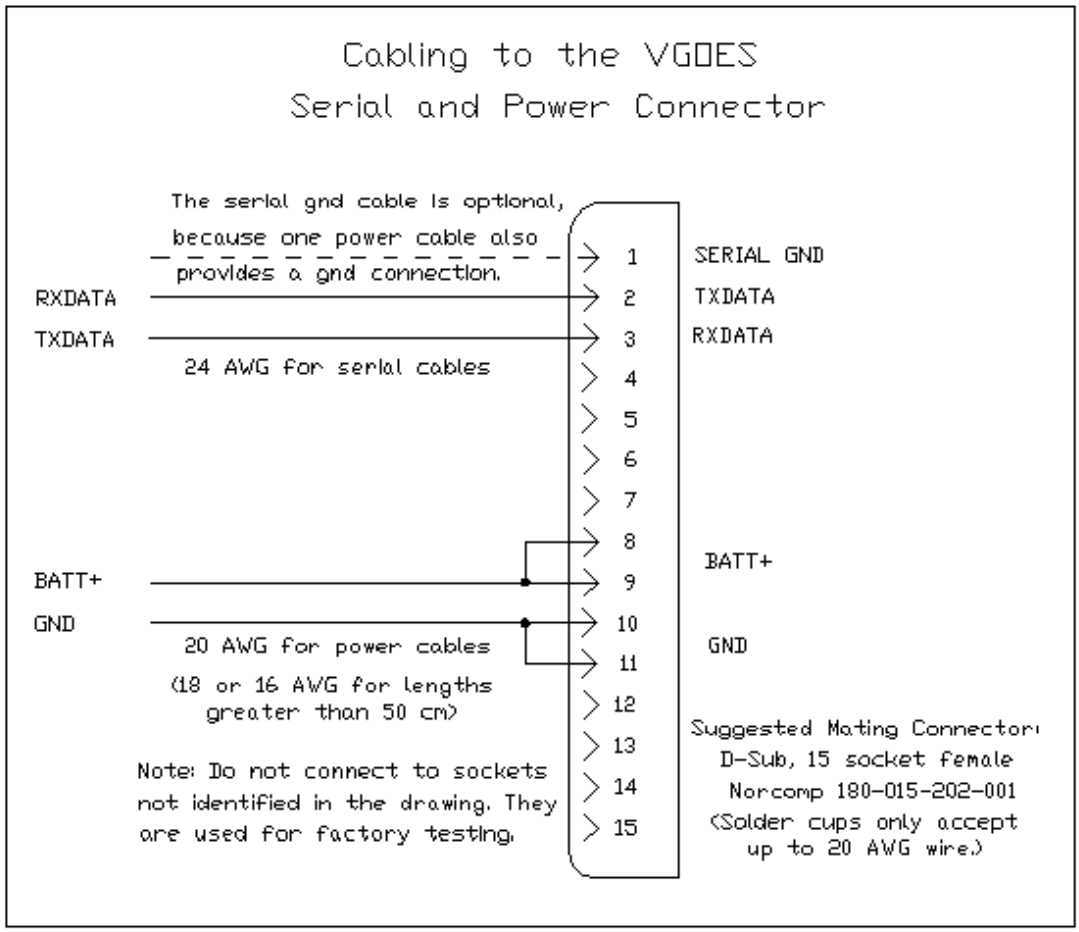
lsb↓	0x00+	0x10+	0x20+	0x30+	0x40+	0x50+	0x60+	0x70+
0x0			SPACE	0		P		
0x1				1	A	Q		
0x2				2	B	R		
0x3				3	C	S		
0x4				4	D	T		
0x5				5	E	U		
0x6				6	F	V		
0x7				7	G	W		
0x8			(	8	H	X		
0x9			)	9	I	Y		
0xA	LF			:	J	Z		
0xB			+		K			
0xC			,		L	\		
0xD	CR		-	=	M			
0xE			.		N			
0xF				?	O			

Table B-5. Pseudo Binary Character Set

lsb↓	0x00+	0x10+	0x20+	0x30+	0x40+	0x50+	0x60+	0x70+

lsb↓	0x00+	0x10+	0x20+	0x30+	0x40+	0x50+	0x60+	0x70+
0x0					@	P	′	p
0x1					A	Q	a	q
0x2					B	R	b	r
0x3					C	S	c	s
0x4					D	T	d	t
0x5					E	U	e	u
0x6					F	V	f	v
0x7					G	W	g	w
0x8					H	X	h	x
0x9					I	Y	i	y
0xA					J	Z	j	z
0xB					K	[	k	{
0xC					L	\	l	|
0xD					M	]	m	}
0xE					N	^	n	~
0xF				?	O	_	o	DEL

Appendix C. Serial Communcation and Power Cable



Appendix D. Antenna Orientation

This computer program calculates the direction of the GOES satellite relative to an antenna's longitude and latitude. The maximum gain for the GOES antenna is straight ahead with a perfect ground plane but in typical installations the radiation pattern will give the highest gain at about 6 degrees higher. So you'll find the best reception is achieved by pointing the antenna 6 degrees below the satellite.

```
(define earth-radius 6378) ; km
(define goes-altitude 35785) ; km
(define goes-latitude 0) ; over the equator
(define goes-east-longitude -75) ; western hemisphere
(define goes-west-longitude -135) ; western hemisphere
(define pi 3.14159265358979323846)
(define (deg->rad theta) (* theta (/ pi 180)))
(define (rad->deg theta) (* theta (/ 180 pi)))
;    rho = earth-radius + altitude
;    phi = 90 - latitude
;    theta = longitude
;    x=0,y=0,z=0 is center of the Earth
(define (cartesian->spherical x y z)
  (let* ((rho (sqrt (+ (expt x 2) (expt y 2) (expt z 2))))
         (S (sqrt (+ (expt x 2) (expt y 2))))
         (phi (rad->deg (acos (/ z rho))))
         (theta (rad->deg (if (< x 0)
                              (- pi (asin (/ y S)))
                              (asin (/ y S))))))
    (list rho phi theta)))
(define (spherical->cartesian rho phi theta)
  (let* ((x (* rho (sin (deg->rad phi)) (cos (deg->rad theta))))
         (y (* rho (sin (deg->rad phi)) (sin (deg->rad theta))))
         (z (* rho (cos (deg->rad phi)))))
    (list x y z)))
(define (elevation start-lon start-lat start-alt finish-lon finish-lat finish-alt)
  (let* ((start-position
           (spherical->cartesian
             (+ earth-radius start-alt) (- 90 start-lat) start-lon))
         (finish-position
           (spherical->cartesian
             (+ earth-radius finish-alt) (- 90 finish-lat) finish-lon))
         (diff (map - finish-position start-position))
         (vect (cartesian->spherical (car diff) (cadr diff) (caddr diff)))
         (elev (- (cadr vect) (- 90 start-lat))))
      (if (> elev 0)
         (- 90 elev)
         (+ 90 elev))))
(define (azimuth start-lon start-lat start-alt finish-lon finish-lat finish-alt)
  (let* ((start-position
           (spherical->cartesian
             (+ earth-radius start-alt) (- 90 start-lat) start-lon))
         (finish-position
           (spherical->cartesian
             (+ earth-radius finish-alt) (- 90 finish-lat) finish-lon))
         (diff (map - finish-position start-position))
         (vect (cartesian->spherical (car diff) (cadr diff) (caddr diff)))
         (dir (- (caddr vect) start-lon)))
    (if (> start-lat finish-lat)
      (- 180 dir)
      dir)))
```

here is an example calculation

```
(define my-longitude -80.078831)
(define my-latitude 43.418079)
(define my-altitude 0.100) ; 100m
```

```
(newline)
(display "elevation: ")
(display
  (elevation
    my-longitude my-latitude my-altitude
    goes-east-longitude goes-latitude goes-altitude))
(newline)
(display "azimuth: ")
(display
  (azimuth
    my-longitude my-latitude my-altitude
    goes-east-longitude goes-latitude goes-altitude))
```

the output

```
elevation: 39.92318138579852
azimuth: 174.29537983098888
```

Appendix E. NESDIS/NOAA Certification

National Environmental Satellite,Data, and Information Service

Certificate Number
0206020

Certifies that **Valcom Transmitter**
Model **VGOES-HDR**

Has been type tested and meets the requirements for use in the Geo-stationary Operational Environmental Satellite Data Collection System.

Condition

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

*In accordance with Version 1.0B Goes Domestic Random operations for 100bps and 300bps and 1200bps data rates. GOES Domestic Self-Timed Operations for 100bps and 300 bps and 1200bps data rates. International DCS Self-Timed operations for 100bps.

Director, Office of Systems Development

Signature

2/6/06

Date

NOAA Form 83-1
(6-80)

GOES/RADIO SET CERTIFICATION

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