VX1004

DATA ACQUISITION AND TELEMETRY UNIT
USERS MANUAL

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(ENGLISH MENUS)

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VX1004 OPERATOR'S MANUAL

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UNPACKING

Included with each VX1004 is a packing list itemizing all pieces shipped with the VX1004. All items should be checked against the packing list. The VX1004 may be shipped in one of two configurations. The VX1004L is strictly a data-logger and comes standard with the following:

Item	Qty	Description
1	1	VX1004L Data Logger.
2	1	3 pin detachable terminal block for counters 1 & 2 inputs.
3	1	5 pin detachable terminal block for open collector outputs.
4	1	13 pin detachable terminal block for anolog inputs.
5	2	2 pin detachable terminal block for power connection. (power in & switched 12v out)
6	1	6 pin detachable terminal block for serial I/O & Counter 3 connections
7	1	Users Manual (one per 6 VX1004s).

The VX1004DCP has the same data collection and storage capabilities as the VX1004L data logger. Additionally, the VX1004DCP has satellite transmission capability. The VX1004DCP comes standard with the following components:

Item	Qty	Description
1	1	VX1004G Data Logger with GOES Synthesizer & Power Amp
2	1	3 pin detachable terminal block for counters 1 & 2 inputs.
3	1	5 pin detachable terminal block for open collector outputs.
4	1	13 pin detachable terminal block for anolog inputs.
5	2	2 pin detachable terminal block for power connection. (power in & switched 12v out)
6	1	6 pin detachable terminal block for serial I/O & Counter 3 connections
7	1	Users Manual (one per 6 VX1004s).

Additional items required by the VX1004DCP for satellite transmission capability are a Vitel V2TH antenna and antenna cable. These must be ordered separately. When ordering the antenna cable, the length must be specified. The ordering number for an RG-8 antenna cable is:

181-1022-XX
XX = cable length in feet

Any standard serial communications package may be used to communicate with the VX1004. Some common software packages are: Procomm, Bitcom, Smartcom, the Windows Terminal, etc.

GETTING STARTED

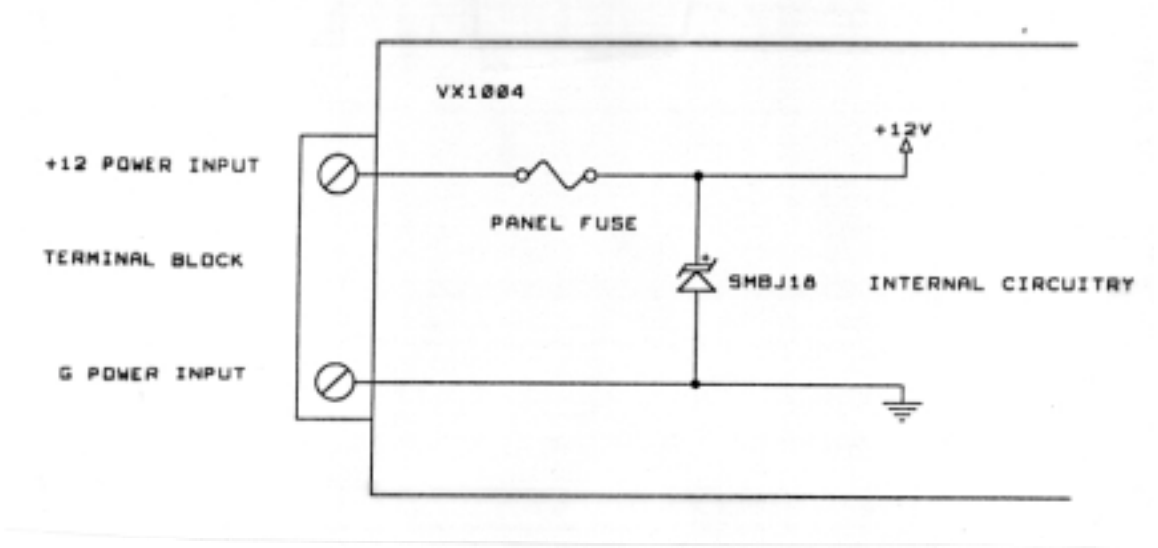
Figure 1.
VX1004 DCP

POWER CONNECTION

Power is applied to the VX1004 through the two terminals labeled PWR. The "-" pin should be connected to power ground and the "+" terminal should be connected to the +12 volt supply. These correspond to "-" and "+" of a 12-volt battery. The VX1004 is protected against reverse voltage being applied to the two power terminals. If reverse voltage is applied a resettable fuse will trip, but can be reset by disconnecting the power and correctly reapplying it.

The maximum input voltage of 16.5 volts must not be exceeded as this will permanently damage the circuitry of the VX1004. Voltage transient conditions of very short duration may be tolerated. The power input is protected by a high power transzorb. Longer duration transient voltage condition above the maximum input voltage may blow the power fuse. Replacing the fuse may restore the unit to operation; however, if replacing the fuse does not restore the unit to operation, the VX1004 should be returned to the factory for repair.

Figure 2.
Power Input Circuitry Diagram



RS-232 TERMINAL CONNECTION

The male end of the serial communications cable should be connected to the female DB9 jack of the VX1004 labeled RS-232 DTE. The female end of the serial communications cable should be connected to the COMM port of the lap-top computer or other computer. The user may now run the desired communications package. Be sure to set the computer software for 8 data bits, no parity, 1 stop bit. The baud rate may be set to either 1200, 2400, 4800, or 9600; it must match the baud rate setting in the VX1004. This communications package on the computer may be referred to as the "terminal" in the following sections.

If the ON/OFF button on the front panel has been pushed and the display is active, the VX1004 will have no communication through the RS-232 port. In order to turn off the display, either wait for the DCP to time out or press SCROLL till Activate is displayed in the display window and press SELECT.

At this point the computer is ready to communicate with the VX1004. With +12 volts supplied to the VX1004, the VX1004 should respond to commands typed on the keyboard of the computer. If the VX1004 is in its low power standby mode, the unit may be activated by depressing any key on the keyboard and then the unit will print out a User Menu on the computer's screen.

In the VX1004s standby mode, the unit is in its low power state and no communications are taking place. To awaken the unit from its standby state, connect the terminal to the VX1004s RS-232 port and strike a key on the keyboard. The VX1004 will wake up upon receiving a keystroke through its RS-232 port. At this time the VX1004 sends the main menu through the RS-232 port to the terminal screen. The unit is now ready to respond to input from the user. At any point the user may abandon an entry by pressing the <ESC> key on the keyboard. The VX1004 will also time out and enter its standby mode if there is no activity on the serial port for two minutes.

The baud rate of the VX1004 must match the baud rate of the communications software (9600 baud default). If nothing appears on the computer screen, the baud rates may not match. The VX1004 baud rate may be set to 9600 baud through the front panel buttons and display. See "Front Panel Operation" for more details. An explanation of the serial port menus follows this section. For step by step guide to installing the VX1004, see the "Installation and Setup" section.

VX1004 MAIN MENU

The VX1004 Version G2.20-E Main Menu is shown below:

T Time
D Date
L Location Name
S Sensor
N Self-Timed Satellite
R Random Satellite
Gn Group (1-4) Setup
E Retrieve Data
O Ops Tests
A Activate
B BCD Relays
X SDI-12 Slave Ops

Selection:

Each function is executed by pressing the proper letter and then pressing <ENTER>. When selecting one of the Group setup menus, press G1, G2, G3, or G4, and then <ENTER>. The menu selections are reviewed in detail in the following sections.

SERIAL PORT MENU TREE

VX1004 VERSION G2.20-E MAIN MENU

T Time
D Date
L Location Name
S Sensor -- Select Sensor Type, one of the following:

B	Battery
C1 C2 C3	Counters
S0-S9	SDI-12
E1-E16	Expanded Analog

Sensor Setup, M1-M6
- G Group: 1
- P Dec Pt: 0
- H SHEF
- A Averaging: 10 Sec or 1 Min, or OFF
- R Selected Data (if averaging is on) any combination of the following is allowable: None,average,minimum,maximum
- E Special Sensor: None
- M Multiplier: 1
- D Divisor: 1
- B Base : 0
- V Verify Sensor

Sensor Setup, C1-C3
- G Group: 1
- P Dec Pt: 2
- H SHEF
- R Averaging: OFF
- E Special Sensor: None
- M Multiplier: 1
- D Divisor: 1
- B Base : 0
- T Ctr Type : FREQUENCY
- N Ctr Threshold: TTL/Switch Closure
- I Init Counter
- V Verify Sensor

Sensor Setup, S0-S9
- G Group: 1
- P Dec Pt: 0
- H SHEF
- A Averaging OFF
- R Selected Data (Same as above)
- B SDI-12 Address: 0
- M M-Command: 0
- D D-Command: 3
- K Keep Values All
- N Num Vals to Log
- X SDI-12 Extended Mode
- V Verify Sensor

Sensor Setup, E1-E16
- G Group: Inactive
- P Dec Pt: 0

H SHEF
A Averaging OFF
E Special Sensor: None
M Multiplier: 1
D Divisor: 1
B Base : 0
S Single/Diff: Single
V Verify Sensor

N Self-Timed Satellite
S Satellite
A Transmissions: ON
I ST ID: 0101F3DC
C ST Channel: 151
H First Tx: 01:25:15
T Tx Interval: 0240 min
P Preamble: SHORT
G GTM Max Bytes: 0
V VGTM Header: ON
R RTS Action: Always ON
F Format ST Sat TX
Tx Duration (sec): XX:XX

R Random Satellite
A Transmissions: ON/OFF
C Random Tx Channel: 151
I Random Tx ID: 0101F3DC

Gn Group (G1-G4) Setup
U Update Interval: 15 minutes
D ST Data Sets: 12
W Warmup Time: 5 seconds
Sensors: M1 M2 C1 S0 etc.
P Driving Parameter: M1
Z Rn Data Sets: 3
B Base Interval: 1440
A Alarm Interval: 20
H High Limit: 10000
L Low Limit: 2000
C Change: 500
Tx Duration: 3.60 seconds

E Retrieve Data
F Format: XMODEM/ASCII
S Start: 11/10/95 09:41
E End: 11/10/95 09:48
A All Sensors
1 1 Sensor
P Setup From PC
T Setup To PC
I Initialize RAM
V View Event Log
G Init Event Log

O Ops Tests
E Echo: On

R Random Tx (Group 1)
P Power Check
F FS Reset

A Activate

B BCD Relays

X SDI-12 Slave Ops

A listing of all the menus the user has access to through the RS-232 port of the VX1004 follows.

TIME SELECTION

Current time: 09:48:12

Enter new time: HH:MM:SS <ESC> to exit

The user may enter a new time in the 24 hour format shown above. Seconds are optional. The time is written into the real time clock of the VX1004 when the user presses <ENTER>. At any point the user may press the <ESC> and abandon the new time entry; the old time is retained.

For units transmitting through a satellite, the time is usually referrenced to Coordinated Universal Time (CUT), oftentimes referred to as Greewich Mean Time(GMT) or GPS Time.

DATE SELECTION

Current Date: 11-10-95

Enter new date: MM-DD-YY <ESC> to exit

The user may enter one or two digit numbers for the day, month and year, with each field separated by a hyphen(-) or a slash (/), followed by <ENTER>. At any point hitting the <ESC> key will abandon the new date entry and the old date will be retained.

LOCATION SELECTION

This allows the user to enter any string of characters. This information is included when logged data is retreived via the RS-232 port and may be used to identify the site location or name. It is not used for any other purpose.

Current Location Name:
VX1004DCP

Enter new location now. No quotes. Up to 38 characters. <ESC> to exit.

SENSOR SELECTION

The VX1004 contains several different types of sensor inputs. There are six 0 to 5 volt analog inputs on the main terminal block, referred to as M1 through M6. There are three counter inputs; these are referred to as C1 C2, and C3. The VX1004 allows up to ten SDI-12 sensors to be used; these are referred to as S0 through S9 (more about SDI-12 later). If the VX1070 Analog Expansion V-BUS module is present, up to 16 more single ended or 8 differential analog sensors may be used; these are referred to as E1 through E16. When you select the SENSOR option from the main menu, the following prompt appears:

Select sensor. Press B, M1..M6 C1..C3, S0..S9, or E1..E16, and <ENTER>
<ESC> to exit . .

To configure one of the sensors, type the reference name of the desired sensor, followed by <ENTER>. If 'B' is pressed, the battery voltage is returned once per second until the user presses <ESC>. To configure one of the standard analog inputs, press M1 throgh M6. For example, if M2 is selected, the following menu appears.

MUX INPUT (ANALOG) SETUP MENU

```
Sensor Setup, M2
 G  Group:          1
 P  Dec Pt:         0
 H  SHEF
 A  Averaging:      OFF
 E  Special Sensor:  None
 M  Multiplier:     1
 D  Divisor:        1
 B  Base   :        0
 V  Verify Sensor
<ESC> Return to previous menu

 Selection:
```

Group Entry (G)

The VX1004 allows sensors inputs to be assigned into any one of four sensor groups, each of which may be assigned its own set of measurement and logging parameters. A sensor must be assigned into an enabled group before it may be read during the VX1004 normal operating loop. This option allows the user to enter the group number for the sensor, or to enter zero to disable the sensor.

Decimal Point (P)

The Decimal Point entry allows the user to specify the number of digits
to the right of the decimal point. The number with decimal point is the value that gets downloaded during a data retrieval process. The decimal point is also displayed during a sensor check. The data transmitted does not have the decimal point.

SHEF (H)

The Standard Hydrometeorological Exchange Format (SHEF) is a documented set of rules for coding of data in a form for both visual and computer recognition. It is designed specifically for real-time use and is not designed for historical or archival data transfer. All the critical elements for identification of data are covered. Station identifiers,

parameter descriptors, time encoding conventions, unit and scale conventions, and comment fields are all part of the code.

SHEF was designed for interagency sharing of data, visual and machine readability, and compatibility with anticipated receiving databases. The widespread implementation of SHEF allows the same decoding software to
process data from various agencies. New data sources can easily be added as they become available. The visual nature of SHEF allows users quickly to become familiar with it. SHEF fully qualifies the data so that receiving databases have all the necessary information to describe the data.

For a full overview of SHEF Code, please visit the web site for the National Weather Service at http://www.nws.noaa.gov

Averaging Setup (A)

It is often desired to record the average, minimum, and maximum values for a parameter over a given period of time. For instance, the user may want to know the average temperature over a 30 minute period, and also record the maximum and minimum values for this period. The VX1004 provides flexible averaging options. The user may opt for no averaging, in which case the sensor is measured at the group update interval and no maximum or minimum values are available. The user may also select to take samples every 10 seconds or once per minute. Pressing 'A' <ENTER> repeatedly cycles through these options: OFF, 10 SEC, 1 MINUTE. For example, if 1 minute averaging were enabled and the group update interval for this sensor was 30 minutes, the VX1004 takes one reading per minute for thirty minutes and then calculates the average, minimum and maximum.

Data Selection (R)

If averaging is enabled for a sensor, the user may then choose which data to keep; the average, minimum, and maximum are not always desired. Selecting this option runs the user through a simple menu that allows them to include or abandon the average, minimum, and maximum. The selected values then appear in the menu. If averaging is not enabled this menu selection does not appear.

Special Sensors(E)

This option allows the selected input to operate in a special non-standard fashion. This option causes the Special Sensor sub-menu to be displayed.

Special Sensors Menu

C Clear Setting
1 SE 8500 Bin
2 SE 8500 BCD
3 Wind Speed
4 Wind Dir
<ESC> Return to previous menu

Selection:

Selection 'C' erases the previous special selection.

Selections 1&2 are for interfacing to the Sutron 8500 shaft encoders either with the BCD version or using the Vitel SCU8500 interface and choosing option 1 above.

Wind Processing -- Many applications require vectored averaging of the sampled wind. If wind processing is desired, a special sensor must be defined for both wind speed and wind direction. If both are not defined then wind processing will not be performed. The scaling factors for the wind direction must be set up to cause the wind direction value to vary from 0 to 360, where 0 or 360 is north, 90 is east, 180 is south, and 270 is west. Each sensor must have the appropriate averaging enabled (usually 10 second); the appropriate data must be selected. Most users set up one sensor for wind speed and select the average and maximum value (gust); another sensor is set up as the wind direction and only the average value is saved. The user may elect to save all the data if it is of interest. In that case the average, maximum and minimum values of wind speed are logged. The maximum wind direction corresponds to the direction of the maximum sampled speed. The minimum wind direction is the direction taken with the minimum wind speed sample.

Sensor Scaling: Multiplier, Divisor, Base

These options allow the user to scale the analog to digital (A/D) data samples in order to log, transmit, and display data in proper engineering units. The raw A/D readings will vary from 0 to 4095 counts as the input voltage varies from 0 to 5 volts. Pressing M, D, or B followed by <ENTER> allows the user to enter the desired scaling values. The values operate on the raw readings as follows:

$$\text{Scaled Value} = \frac{(\text{Raw Reading} \times \text{Mult})}{\text{Divisor}} + \text{Base}$$

All of the scaling parameters are integers. The data values that are logged and transmitted are integers. A decimal point may be inserted into each integer value when it is displayed or downloaded to a computer in ASCII format. Selection 'P' (DEC_PT) allows the user to specify how many digits of the scaled value will appear to the right of the decimal point.

Scaling Example

The following example is the setup for a Vitel VS100-15 Pressure Transducer for a zero to 10 meter water level:

Mult: 2442
Div: 1000
Base: 0
Dec_pt: 3

Example A/D Reading: 819 counts (1 volt)

$$\text{Scaled value} = \frac{(819 \times 2442)}{1000} + 0 = 1999$$

With Dec_pt set to 3, 1999 prints as 1.999 meters.

An offset may be added to account for local stage setting. The final scaled value, prior to the Dec-Pt, must be within the range of +/-32767. To calculate these scaling factors, the user must calculate the multiplier and divisor in terms of desired units per count.

Verify Sensor (V)

This option causes the VX1004 to read the selected sensor and display the sensor value (scaled) about once per second until the user presses <ESC>.

COUNTER SETUP MENU

If C1, C2, or C3 is selected from the select sensor prompt, then the following menu is displayed:

```
Sensor Setup, C1
 G  Group:          1
 P  Dec Pt:         2
 H  SHEF
 A  Averaging:      OFF
 E  Special Sensor:  None
 M  Multiplier:     1
 D  Divisor:        1
 B  Base   :        0
 T  Ctr Type :      FREQUENCY
 N  Ctr Threshold:   TTL/Switch Closure
 I  Init Counter
 V  Verify Sensor
<ESC> Return to previous menu

 Selection:
```

The options for the counter setup are identical to those for the mux input setup explained above, with additional options provided specifically for counter inputs.

Type of Sensor Input Freq/Count (T)

This selection determines whether the counter will function as a frequency measurement or as a count accumulator. The frequency measurement may be used for sensors such as wind speed sensors. The accumulator may be used for sensors such as tipping buckets. Press 'T' <ENTER> repeatedly to cycle through the options.

Threshold (N)

This selection determines the detecting threshold for the input. The user may select either TTL Level/Switch Closure, or Small Signal AC. The small signal threshold is approximately 50 millivolts and is used for sensors such as some wind speed sensors with an AC sine wave output. The TTL threshold is a maximum of 3.2 volts on the rising input and a minimum of 0.3 volts on the falling input. (There is also an internal 470K pullup resistor which is energized when the TTL input threshold is selected, allowing operation without an external pull-up resistor). Press 'N' <ENTER> repeatedly to cycle through the options.

Note: Counter 3 Threshold is limited to TTL/Switch Closure only.

Initialize Counter (I)

If any setup parameters have been changed, the Initialize Counter (I) selection must be chosen, otherwise the changes will not take effect until the unit is powered down, then up again. Initialize Counter (I) will also zero the counter contents. This is important only if the counter is in accumulator mode.

SDI-12 SETUP MENU

If S0 through S9 is selected from the select sensor prompt, the following menu is displayed:

```
Sensor Setup, S0
 G  Group:          1
 P  Dec Pt:         0
 S  SHEF
 A  Averaging:      OFF
 B  SDI-12 Address:  0
 M  M-Command:       0
 D  D-Command:       3
 K  Keep Values:              All
 N  Num Vals to Log: 1
 X  SDI-12 Extended Mode
 V  Verify Sensor
<ESC> Return to previous menu

 Selection:
```

The VX1004 is equipped with an SDI-12 interface. This is capable of issuing ten different measure and data commands. Because the SDI-12 specification allows sensors a great deal of variety in the response format, there is not necessarily a one-to-one correlation between the number of sensor devices and the number of VX1004 SDI-12 inputs. If the attached sensor has multiple measurement commands, multiple data buffers, or both, several SDI-12 inputs will have to be configured to fully read that sensor's data. Each input can be configured to issue a single measurement/data command pair and receive a single data value per sensor response buffer. For example, given an SDI-12 sensor at address "a" with the following command set:

Measure	Data		
aM!	aD0!		(measurement returns one data buffer)
aM1!	aD0!	aD1!	(measurement returns two data buffers)

a total of 3 sensor inputs would need to be reserved in order to
fully query this sensor.

The Verify Sensor, Group, SHEF, Averaging, and Dec-PT selections operate as previously described for the mux and counter inputs. Additional options specific to the SDI-12 sensor inputs have been added as follows.

SDI-12 Bus Address (B)

Measurement and data commands sent by the data logger to the SDI-12 bus must be prefixed with a valid sensor address between 0 and 9, inclusive. This selection prompts the user for the bus address prefix which will be appended to the command suffixes specified in the Measure and Data Command selections.

SDI-12 Bus Address = 0
Enter new value . . . <ESC> to exit

Measure Command (M)

The VX1004 issues measurement commands to the SDI-12 sensors to initiate one of up to ten measurement operations. The default measurement command has the format "aM!", where a is the sensor bus address. If the sensor provides more than one type of measurement, subsequent measure commands have the format "aMx!", where a is the sensor bus address, and x specifies the desired measurement and may be any digit between 1 and 9, inclusive. Each SDI-12 input on the VX1004 may issue a single measure command to the target sensor, specified by a command number between 0 and 9, where "0" specifies the default measurement command, and "1" through "9" specify subsequent commands. For example, entering "0" on the prompt line for SDI-12 0 would cause an "aM!" command to be issued to the sensor connected to SDI-12 0.

Measure Command = 0
Enter new value . . . <ESC> to exit

Recover Data Command (D)

The VX1004 issues data commands to the SDI-12 sensors to retrieve measurement information stored in one of up to ten sensor data buffers. SDI-12 data commands have the format "aDx!", where a is the sensor bus address, and x is the required data buffer. Each SDI-12 input on the VX1004 may issue a single data retrieval command to the target sensor, specified by a buffer number of any value between 0 and 9, inclusive. For example, entering "1" on the prompt line for SDI-12 0 would cause a "aD1!" command to be issued to the sensor connected to SDI-12 0.

Data Command = 1
Enter new value . . . <ESC> to exit

A decimal point may be inserted into each integer value when it is displayed or downloaded to a computer in ASCII format. Selection 'P' (DEC_PT) allows the user to specify how many digits of the value will appear to the right of the decimal point.

Keep Values Command (K)

Some SDI-12 devices include multiple values and scaling factors in the returned data string. The keep value allows the user to choose which of the values they wish to keep for the **'D'** request above. The choises may include any combination of the values.

Number of Values to Log Command (N)

It is sometimes desirable to access the sensor more frequently than is necessary for logging purposes, especially if a display is connected to the DCP and frequent updates are desired. This command gives the user the freedom to choose how many values they wish to log in the DCP per data collection cycle. For instance; suppose you were doing one minute averaging to keep the display updated, but only wished to collect and log data every fifteen minutes, the user would set the **'N'** command to 1 and the update interval **(U)** in the Group Setup to 15. With Averaging turned on to update the display, the user also has the option of including the min/max/average data in the logged data. If this selection is set to none, then only the instantaneous reading will be logged as if averaging were not turned on. Normally for a situation like this, Update Interval=15 min, N=1, Averaging=1 min, Selected Data = None.

SDI-12 Extended Mode (X)

The SDI-12 specification requires data loggers to provide an Extended Mode of operation, where commands can be sent to the sensor from a terminal connected to the data logger. Most SDI-12 sensors come equipped with an Extended Command Set, requiring a transparent communications mode to permit the user to calibrate the sensor, change its bus address, or perform other setup functions necessary for operation with the data logger. The serial interface of the VX1004 can be used to provide an Extended Mode SDI-12 interface, allowing individual commands to be sent to the SDI-12 bus from the user terminal. Any ASCII sequence can be sent to the SDI-12 bus in this mode; the user is responsible for verifying that only valid commands are entered. Any responses from bus sensors are echoed to the terminal screen. If no response to the entered command sequence is detected, the VX1004 will perform up to 10 retries of the entire command string. If there is still no response from any sensor on the bus, the message "No response from sensor" will be displayed.

Verify Sensor Command (V)

Pressing V will force the VX1004 to take one reading from the SDI-12 sensor and display the results on the terminal or display. This reading is not entered into the log.

EXPANDED ANALOG SETUP MENU

If the VX1070 Analog Expansion Module is present, the user may define up to 16 more analog inputs, known as E1 through E16. These may be configured as 16 single-ended inputs or as 8 differential inputs, or any combination. The menu for the expanded analog sensors is shown below:

```
Sensor Setup, E1
 G  Group:          inactive
 P  Dec Pt:         0
 H  SHEF
 A  Averaging:      OFF
 E  Special Sensor:  None
 M  Multiplier:     1
 D  Divisor:        1
 B  Base   :        0
 S  Single/Diff:    Single
 V  Verify Sensor
<ESC> Return to previous menu

 Selection:
```

These options are identical to the M1 through M6 analog inputs, except for the single-ended/differential selection. Press 'S' <ENTER> repeatedly to cycle through the option. The differential selection allows a pair of inputs to function as a differential pair. Defining E1 to be differential causes E1-E2 to act as a differential pair. This option is only available on the odd numbered inputs.

SELF-TIMED SATELLITE SELECTION

From the main menu, select 'N' <ENTER> to get to the self-timed GOES setup menu. The following menu will appear:

```
Self-Timed Satellite
 S  Satellite        GOES
 A  Transmissions: ON
 I  ST ID:        0101F3DC
 C  ST Channel:    151
 H  First Tx:      01:25:15
 T  Tx Interval:   0240 min
 P  Preamble:      SHORT
 G  GTM Max bytes: 0
 V  VGTM Header:   ON
 F  Format ST Sat Tx
    Tx Duration (sec):     20.56
<ESC> Return to previous menu

 Selection:
```

The duration of the transmission is calculated and displayed in this menu. The duration is affected by preamble type, number of sensors enabled, average/min/max data selected, and the number of data sets.

Satellite (S)

Sets the DCP for proper communication with the various satellite types used throughout the world. Repeatedly pressing ‘s’ <Enter> steps through the choises GOES, GMS, and METEOSAT.

Enable/Disable Self-Timed Transmissions (A)

Enables or disables self-timed GOES transmissions. Press 'A' <ENTER> to toggle the setting. If transmissions are disabled, the VX1004 will function either in a random only mode or as a data logger.

ID (I)

This selection prompts the user for the 31-bit BCH-encoded platform ID assigned by the administrator to the DCP. The ID string must be entered as an even 8-digit hex number.

Channel (C)

This selection prompts the user for the GOES transmit channel to be used by the VX1004.

First Transmit Time (H)

The user must specify the time of the first GOES transmission of the 24-hour day. This time is usually between midnight and 04:00 AM. All subsequent transmissions will occur at the intervals specified by the Transmit Interval selection. It is good practice to include a "guard" time in the seconds field of this time (5 to 15 seconds). This prevents your DCP from drifting out of the proper time slot; it also prevents your transmissions from being interfered with by another DCP with a drifting clock.

Transmit Interval (T)

Specifies the interval in minutes between self-timed GOES transmissions. Valid entries can be between 3 and 1440 minutes, although intervals are usually 180 or 240 minutes.

Preamble Type (P)

Both the SHORT (1 second) and the LONG (7.5 seconds) preamble types may be selected. Random transmissions automatically revert to the SHORT preamble. If any channel greater than 200 (international channels) is selected then the LONG preamble is sent regardless of the setting of this parameter. Older demodulators require the LONG preamble; the SHORT preamble can almost always be used. Press 'P' <ENTER> to toggle the setting of this parameter.

GTM Max Bytes (G)

This is the maximum number of bytes from another attached logger allowed in the VX1004 satellite transmission**.**

VGTM Header (V)

The 'VGTM' header is attached to GTM transmissions if chosen

RTS ACTION (R)

Provides wakeup command for external loggers such as the Stevens AXSYS which may be using the VX1004 as a GTM.

Format ST Sat Transmission (F)

This option causes the VX1004 to format a self-timed GOES transission and to print it to the serial port. This is useful to verify that the transmission format is correct and to help program the decoding software. The format is exactly as is transmitted except the battery voltage character (the last character in the transmission) is always defaulted to a 'B'.

RANDOM GOES SELECTION

```
Random GOES
 A  Transmissions: OFF
 C  Random Tx Channel: 151
 I  Random Tx ID:      0101F3DC
<ESC> Return to previous menu

 Selection:
```

Random GOES transmissions are usually sent on a separate channel from the self-timed transmissions. The preamble type is fixed at SHORT (0.5 seconds). All other applicable options are the same as explained above in the Self-Timed Transmissions section.

GROUP VARIABLES SETUP

Four sensor groups (1 through 4) are available. Each group may have an independent data acquisition interval, warmup time, and each group may drive random (emergency) transmissions. Select G1<ENTER> from the main menu to access the group 1 setup. (G2, G3, or G4 may also be selected.) The following Group Setup menu is displayed:

```
Setup, Group 1
 U  Update Interval: 15 minutes
 D  ST Data Sets:       12
 W  Warmup Time:        5 seconds
    Sensors:   M1 M2 C1 S0
 P  Driving Parameter:  M1
 Z  Rn Data Sets:       3
 B  Base Interval:   1440
 A  Alarm Interval:  20
 H  High Limit:     7000
 L  Low Limit:     -32767
 C  Change:         300
    Tx Duration:       3.60 seconds
<ESC> Return to previous menu

 Selection:
```

If a sensor is assigned to the current group, it will appear in the "Sensors" list.

Update Interval (U)

This option specifies the interval (in minutes) at which the sensors in the group will be processed. The data for each sensor is processed and logged at this interval. Valid interval entries can be between 1 and 1440 minutes. Enter zero to disable the group.

Data Sets (Self-Timed) (D)

A Data Set is the data processed and logged from each sensor at the update interval. This option allows the user to specify how many data sets are to be inclued in the satellite transmission. For example, if the update interval for the group is 15 minutes (4 data sets per hour) and the DCP is transmitting every 3 hours, the user may enter 12 (4 x 3) as the number of data sets to be included. The more data sets included, the longer the transmission. Check the transmission time under the Self-Timed GOES option to make sure that the transmission will not exceed the assigned time window. Valid entries for data sets are from 0 to 255.

Warmup Time (W)

For sensors requiring a warmup time before the output is read, the VX1004 has a programmable warmup period from 0 to 30 seconds. The warmup time is counted from the second that the switched 12 volt power and the 5 volt excitation are turned on.

Random Transmissions

The other main purpose of placing sensors in groups is to allow different sensors to drive random (emergency) transmissions. Many users place a precipitation sensor in a different group from a water level sensor (even if the update interval is the same) so that both sensors can drive alarm transmissions for flood warning and at independent intervals. A random transmission contains the most recent data from each sensor in the group. A random transmission is usually used for

emergency data, but may be used in a non emergency basis to verify the random channel communications.

For each group, one sensor may be specified as the critical driving parameter for a random transmission. The Group Menu allows the user to fully quantify the conditions under which a random transmission from each group may occur.

When an alarm occurs, the first random transmission is sent within 3 minutes, unless this conflicts with an upcoming self-timed transmission. At least three random transmissions are sent when an alarm is recognized.

Driving Parameter (P)

This selection specifies the sensor whose measurement will initiate a random GOES transmission. Only one sensor per group may be selected. This option presents a sensor selection prompt as shown below:

Select sensor. Press B, M1..M6 C1..C2, S0..S9, or E1..E16, and <ENTER>
<ESC> to exit . .

Select the desired sensor to drive the transmissions, or <ESC> to exit without changing the previous selection. Enter 'D' to disable random transmissions for this group.

Data Sets (Random) (Z)

This is similar to the self-timed data sets described earlier, except that no more than three data sets may be programmed.

Base Interval (B)

Random GOES transmissions may be scheduled at approximate time intervals to verify VX1004 operation on the random channel. Note that the specification of a base interval only guarantees one random transmission at some point within that interval, rather than specifying a rigid time slot. Valid intervals can be between 3 and 1440 minutes. Enter zero to disable regular random transmissions; random transmissions will then only occur if an alarm condition exists.

Alarm Interval (A)

Once an alarm condition has been detected, more frequent transmissions are usually required. Again, the interval between transmissions is approximate. When a new alarm is recognized, the first alarm transmission usually is sent within 3-4 minutes. Subsequent alarm transmissions will be at the specified alarm interval. Values between 3 and 1440 minutes may be specified.

Alarm Thresholds (H,L,C)

Alarm conditions may be triggered when the parameter goes above or below specified thresholds, or when the parameter value is changing very quickly. The High Limit, Low Limit, and Change thresholds are specified with the 'H', 'L', and 'C' options. The high and low limits are checked with each measurement, even if readings are taken every 10 seconds.

The change threshold applies over the update interval. If a sensor change is greater than the change threshold from one update interval to the next, then that sensor is in an alarm condition. The change is an absolute value; it does not matter whether the change is positive or negative.

Scaled values are used to check the thresholds, but no decimal point is included. In the menu shown above, suppose that the parameter represents a water level from 0 to 10.000 meters (0 to

10000 integer value). The sensor will be in alarm condition if the water rises above 7.000 meters, or if the level changes by 0.300 meters from one update interval to the next.

RETRIEVE DATA (E)

From the main menu, press 'E' <ENTER> to get to the Retrieve Data menu. This menu is used to retrieve logged data from the VX1004, to transfer setup information to the VX1004, to retrieve setup information from the VX1004 and to view or initialize the event log. The VX1004 can log approximately 57,000 integer data samples. Retrieving data from a fully loaded VX1004 can take about 10 minutes for an XMODEM transfer, or much longer for an ASCII transfer. The VX1004 continues to acquire and transmit data during any data download.

Download Menu

F Format: XMODEM
S Start: 11/10/95 09:41
E End: 11/10/95 09:48
A All Sensors
1 1 Sensor
P Setup From PC
T Setup To PC
I Initialize RAM
V View Event Log
G Initialize Event Log

Format (F)

This selection allows the user to toggle between ASCII and XMODEM file transfer protocols. ASCII transfers are slow but simple to see and understand. They are good for spot checks of data over a limited time frame. XMODEM transfers are much faster; the resulting file is a binary data file which must be translated into readable numbers by software running on a PC.

Start Data Time (I)

This allows the user to specify the starting boundary date and time for which to retrieve data.

End Data Time (E)

This allows the user to specify the end boundary date and time for which to retrieve data.

All Sensors (A)

This option allows the user to retrieve data from all active sensors into one file. See Downloading Logged Data, below.

1 Sensor (1)

This option allows the user to retrieve data from one sensor into one file. The VX1004 prompts the user for the desired sensor as follows:

Select sensor -- Type M1..M6 C1..C2, S0..S9, E1..E16, and <ENTER>
<ESC> to exit . .

Configuration from PC to VX1004 (P)

This option allows the user to load configuration settings from a computer serial port to the VX1004 serial port. The setup data is stored in an ASCII file in the computer; see the appendix for the exact format. The VX1004 serial communications are somewhat limited; delays must be inserted in the transfer to insure that the VX1004 does not miss any characters. Delays of about 10 mS after each character, and 100 mS after each line are required.

NOTE -- The VX1004 will NOT acquire data or send GOES transmissions during this procedure.

Press 'P' <ENTER> to prepare the VX1004 to receive the file. The VX1004 prints a message saying that it is waiting for the file. Then use the communications software of your computer to initiate the ASCII file transfer. After the transfer is complete, the VX1004 prints a summary of lines received and a count of any errors. The user should verify the settings through the usual serial menus.

Configuration from VX1004 to PC (T)

This procedure transfers the VX1004 configuration from the VX1004 to the serial port of the computer. The format is exactly as required to be loaded back into the VX1004, or into another VX1004.

Download Logged Data - General Procedure

Select the proper transfer format (ASCII/XMODEM), start and end times. Select either the "All sensors" or "1 sensor" option.

For ASCII transfers, the VX1004 prints a message to prepare the computer to receive the file and then press <ENTER>. At this point, prepare your PC to receive the file (procedure varies with your communications software). When your PC is ready, press <ENTER>; the VX1004 will start sending data immediately.

For XMODEM transfers, the VX1004 also prints a message to prepare the computer to receive the file. At this point prepare your PC to receive the XMODEM/Checksum file (procedure varies with communications software). As soon as the PC is ready, it will initiate the transfer from the VX1004.

Initialize Logging RAM (I)

IMPORTANT -- The Initialize logging RAM procedure must be performed with any new installation or any time the backup battery is disabled and then re-enabled. This will clear data memory of any existing data and initialize internal pointers and tables. To prevent inadvertent clearing of data memory, the user must confirm that memory should be cleared. Hitting the <ESC> key at any time will abort the initialization. This procedure also initializes the diagnostic counters that are included at the beginning of each self-timed GOES transmission.

View Event Log (V)

The VX1004 logs events into a special location for diagnostic purposes. These events include the number of times the DCP has been reset, the number of resets caused by low battery voltage, the number of random transmissions and the date and time of the self-timed transmissions. This log is viewable by pressing ‘V’ <Enter>.

Initialize Event Log (G)

The event log is initialized (cleared) by pressing ‘G’ <Enter>.

OPS TEST SELECTION

This menu contains a few miscellaneous menu options and operational tests. Press 'O' <ENTER> from the main menu; the following menu appears:

Operations Test Menu

E Echo On/Off
R Random Tx (Group 1)
P Power Check
F FS Reset
<ESC> Return to previous menu

Selection:

Echo On/Off (E)

This option allows the user to enable or disable measurement echo. If the echo is enabled, the VX1004 prints measurements as they are taken. This is a good way to observe the operation of the VX1004. If the measurement echo is OFF, the VX1004 does not print out anything as it operates. (The VX1004 does not print out measurements whenever the serial port menus are active.)

Random Transmission (R)

This option forces a random transmission from Group 1. It is useful as a final check when installing a station. This should only be used when the DCP is connected either to an antenna or a load!

Power Check (P)

This option is designed to be used in the laboratory to set the output power of the VX1004 power amplifier. Unmodulated carrier is sent on channel 151 until <ESC> is pressed. This should only be used when the DCP is connected to a load!

Failsafe Reset (F)

This command is used to reset the transmitter failsafe in the event it should ever trip.

ACTIVATE SELECTION (A)

This option causes the VX1004 to compute its next wake-up time and enter the low power standby mode. If satellite transmissions are enabled and the clock has not been properly set a warning message is printed. It will also print its next wake-up time for a satellite transmission if enabled. If the VX1004 is left in the serial menus without any activity for about two minutes, the VX1004 will activate itself.

BCD RELAYS SELECTION

This option enables control of the BCD Relay Outputs VBUS Module. See the section at the end of the manual for a detailed discussion of this option. If the option is not present, all these selections should be inactive.

SDI-12 Slave Ops

The VX1004 can appear as an SDI-12 sensor to another data logger, beit another VX1004 or something else. When interrogated by the other logger, it will send an SDI-12 data string to it consisting of data from up to ten sensors it is reading. This menu lets the user configure the VX1004 as they would other SDI-12 sensors, setting the Address and choosing the sensors and their order to be included in the data string

VX1004 FRONT PANEL OPERATION MENUS

The front panel menus and sub-menus correspond for the most part to the RS-232 port menus in function. See the previous section "Serial Port Menus" for a detailed explanation of the various options.

The front panel display and buttons may be used any time the VX1004 is not currently performing a measurement or transmission. To activate the front panel interface, depress the ON/OFF button momentarily. Once the front panel interface is active, the ON/OFF key functions as an <ESC> key, allowing the user to go back to a previous menu or abort a parameter selection.

The OPTION buttons, SCROLL and SELECT move the user through the front panel menu selections. The SCROLL button will selectively display all menu options. The SELECT button will select the option currently displayed on the LCD. This option may lead to another sub-menu or it may display a current value. If there is another sub-menu, the SCROLL and SELECT keys will operate just as they did in the previous menu.

The VALUE buttons, CHANGE and ENTER allow individual parameters to be changed. Once the parameter to be changed is displayed, the CHANGE button should be depressed. Depressing the CHANGE button will cause a blinking cursor to be displayed for numerical entries. For entries not requiring an individual numbers to be entered (such as baud rate) the possible selections are displayed by depressing the CHANGE button until the desired entry is displayed.

Once the desired number or entry is displayed on the LCD, the number may be entered by depressing the ENTER button. For multiple digit numbers (such as time or date), depressing the ENTER button will move the blinking cursor to the next digit. At any time during the entry process the entry may be aborted and the old value retained by depressing the ON/OFF button (<ESC>).

The LCD is backlit for low light conditions. To turn on the backlight, depress and hold the ON/OFF button until the backlight comes on, typically four seconds. The backlight will then go off by either activating the logging mode or depressing the ON/OFF button for another four seconds. This may be done anywhere in the front panel menus, however note that the ON/OFF button will also back the user out of the current operation.

The logging RAM may be initialized from the front panel. To confirm the initialization procedure, press the SELECT and CHANGE buttons simultaneously for about 1 second.

VX1004 FRONT PANEL MENU TREE

- TIME — Display, change current time
- DATE — Display, change current date
- BAUD — 1200, 2400, 4800, 9600
- SENSOR
  - Batt — Read Only
  - Mux 1
    - Read
    - Group Num
    - SHEF
    - Mult
    - Divisor
    - Base
    - Dec Pt
    - Ave Num
    - Special
  - Mux 2
  - Mux 3
  - Mux 4
  - Mux 5
  - Mux 6
  - Counter 1
  - Counter 2
  - Counter 3
  - SDI-0 through SDI-9, measure only
  - Exp 1 through Exp 16
- GROUP
  - G1, G2, G3, G4
  - Update Interval
  - Data Sets
  - Warmup
- SATELLITE
  - SelfTime
  - On/Off
  - Channel
  - ID
  - Tx Interval
  - First Tx
  - Preamble Type
  - Satellite Type
  - Satellite Max Bytes
  - Satellite VGTM Header
  - Random
    - On/Off
    - Channel
    - ID
- TEST OP
  - Ops TestPwr Chk
  - Ops TestRan TX
  - Ops TestMeasEcho
  - Ops TestFS Reset
  - Ops TestGTM Test
- MEMORY
  - Initialize Internal RAM
  - Initialize EEPROM
- ACTIVATE

INSTALLATION AND SENSOR WIRING

MOUNTING

The VX1004 comes with the basic items necessary to start the unit operating. The VX1004 has a sealed case, but this is not a weathertight seal. The VX1004 will withstand condensing humidity and a wide temperature range, but not direct exposure to the environment.

EQUIPMENT GROUNDING

Both circuit ground and chassis ground are common inside the VX1004, however all signal lines are bypassed directly to the grounding lug (4-40 lug labeled GND on front panel). Therefore, upon installation this lug should have a low resistance grounding cable to a good ground.

SENSOR WIRING

The VX1004 has the following provisions for sensor connections:

6	0-5 volt single ended voltage inputs (labeled MUX I/O).
3	Frequency/Counter inputs with programmable thresholds.
1	SDI-12 sensor bus.
1	V-BUS interface for expansion modules.
1	Switched Power output (switched battery voltage)
2	+5 volt excitation outputs
3	Analog ground connections

The analog ground pins should not be used for high current ground return lines. The following describes the connection of general sensor types.

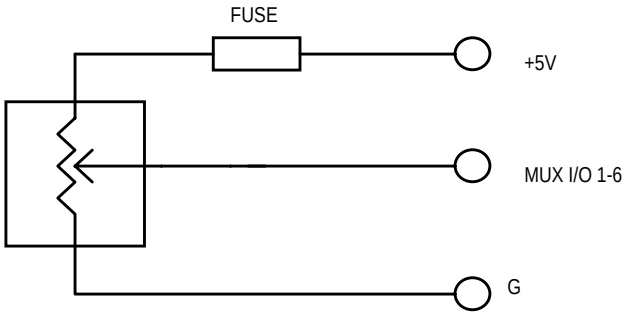
To allow checkout of sensors and connections, the VX1004 has provision for directly reading of sensor inputs without having to go through a measurement cycle. See the "Sensor" selections of both the "Serial Port Menus" section and the "Front Panel Operation Menus".

The number that is displayed on the screen is the reading after the scaling and offset factors have been applied to the direct reading.

Ratiometric Potentiometer Sensors

An example of a ratiometric sensor is a wind direction indicator. The sensor excitation for the potentiometer comes from the +5V excitation output and the ground should be connected to the analog ground pin. The sensor output then gets connected to the desired MUX I/O input terminal

Figure 3.
Ratiometric Sensor Wiring

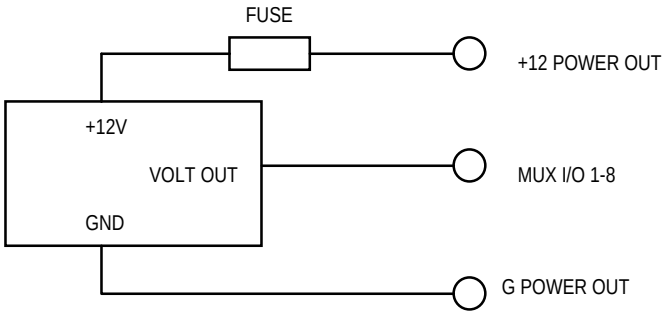


The zero output of the sensor will be read as zero counts and the full scale output will be read as 4095 counts. A slope and offset may be applied to these numbers. See "Sensor Scaling Factors" page 15 for more detail.

Battery Powered Voltage Output Sensors

Some sensors may be powered off the battery voltage and give a voltage output which is proportional to the parameter the sensor is measuring. The power and ground leads from the sensor should be connected to the POWER OUT terminals of the VX1004. The POWER OUT is switched on at the programmed measurement time and is switched off at the end of the measurement. For sensors requiring a warmup time before the output is read, the VX1004 has a programmable warmup period from 0 to 255 seconds. The sensor output signal should then be connected to a MUX I/O input terminal.

Figure 4
Battery Powered Sensor Connections With Voltage Output



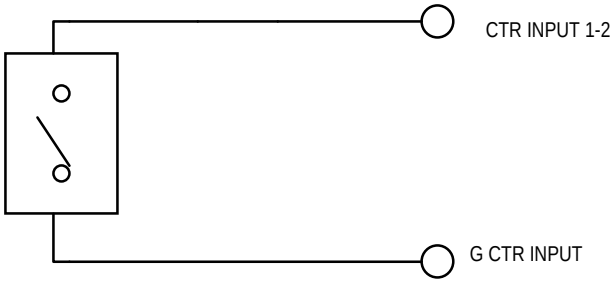
The POWER OUT terminal will supply up to 800 milliamps. The POWER OUT current does not go through the VX1004 resettable fuse so any sensor using this should be separately fused. To prevent damage to the VX1004, the POWER OUT terminal is protected by an internal automatically resetting current limiter.

A zero voltage input signal corresponds to zero counts and a 5 volt input signal corresponds to 4095 counts. Thus each count is equal to 1.221 millivolts. A slope and offset may be applied to these numbers. See "Sensor Calibration" page 15 for more detail.

Switch Closure Sensors

A common example of a switch closure sensor is a tipping bucket precipitation gauge. The switch closure completes a circuit between the two sensor leads. The counter inputs can be used to measure this type of sensor output in one of two modes. The frequency of the tipping over a one second measurement period may be measured or the total number of switch closures that have occurred may be counted. The desired mode is selected from the Sensor Counter setup menu. Connection to the VX1004 is to a ground pin and the desired counter input terminal.

Figure 5.
Switch Closure Sensor Connections

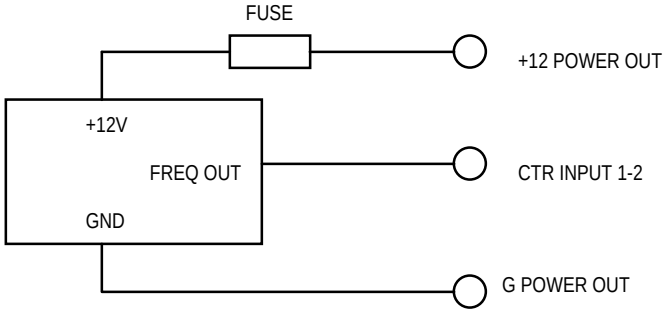


For a switch closure sensor, the input must be configured for TTL levels. An external pull-up resistor is not required. When the TTL input level is selected, an internal 470K pullup resistor is energized. If a smaller pullup resistor is required by the particular sensor, one may be wired from the counter input terminal to battery voltage, switched power, or +5V excitation output. The one used is dependent upon whether it must be on all the time or not.

Battery Powered 0-5 Volt Frequency Output Sensors

Some sensors may be powered off the battery voltage and give a frequency output which is proportional to the parameter the sensor is measuring. The power and ground leads from the sensor should be connected to the POWER OUT terminals of the VX1004. The POWER OUT is switched on at the programmed measurement time and is switched off at the end of the measurement. For sensors requiring a warmup time before the output is read, the VX1004 has a programmable warmup period from 0 to 255 seconds. The sensor output signal should then be connected to a CTR INPUT terminal.

Figure 6.
Battery Powered Sensor Connections With Frequency Output



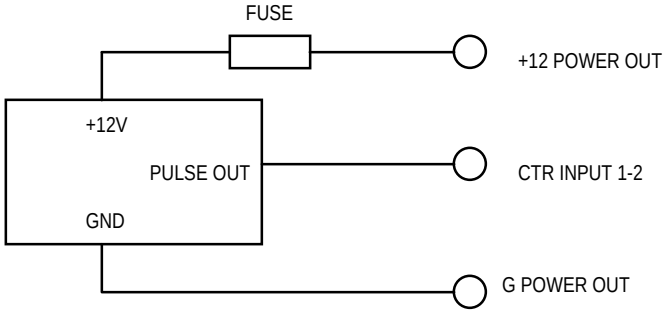
The POWER OUT terminal will supply up to 800 milliamps. The POWER OUT current does not go through the VX1004 resettable fuse so any sensor using this should be separately fused. To prevent damage to the VX1004, the POWER OUT terminal is protected by an internal automatically resetting current limiter.

The frequency is measured over a one second period. A zero frequency input signal corresponds to zero counts. Even though the counter input will accept a signal up to 500 KHz, the counter will only count up to a maximum of 65,536 counts before it wraps back to zero and starts counting up again. If the expected frequency is known, this can be compensated for. If not, the maximum frequency at the input is 32,767 hertz. A slope and offset may be applied to these numbers. See "Sensor Scaling Factors" page 15 for more detail.

Battery Powered 0-5 Volt Event Output Sensors

Some sensors may be powered off the battery voltage and give a digital output signal whenever a particular event occurs. the counter inputs may be used to count the number of events that have occurred during a given time frame. The power and ground leads from the sensor should be connected to POWER INPUT plus and minus terminals of the VX1004 or other convenient battery connection.

Figure 7.
Battery Powered Sensor Connections With A Digital Event Output

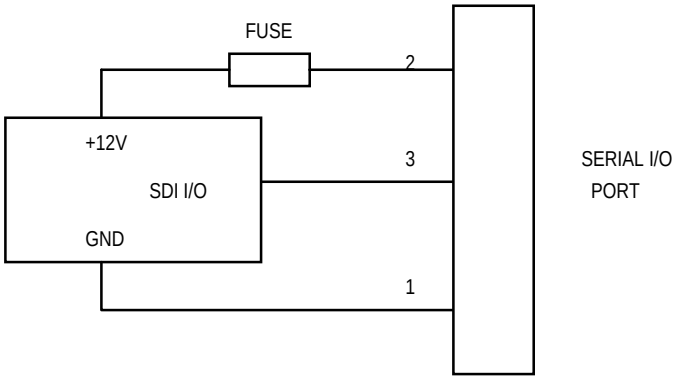


The internal counters will continue to count events at the input and are only reset by the user through the proper menu. At each log time, the current counter contents are logged. Thus the number of event from one log time to the next is the difference between the two readings. A slope and offset may be applied to these numbers. See "Sensor Scaling Factors" page 15 for more detail.

SDI-12 Sensor Bus

Sensors equipped with SDI-12 compatibility require power and ground leads from the data logger, as well as a serial data line which is available at the Serial Output connector on the VX1004 Front Panel. The power and ground leads of the sensor should be connected to the POWER OUT terminals of the VX1004, and the SDI-12 serial data line to pin 9 of the DB-9 SERIAL I/O connector or pin 2 of the Pheonix style Serial I/O connector.

Figure 8
Battery Powered Sensor Connections with SDI-12 Output



Up to ten SDI-12 sensors may be chained in parallel to this bus, provided that dthe combined current draw of the sensors does not surpass 800 milliamps. All sensors should be separately fused.

BCD Driver

The VX1004 can control up to four BCD Relay Drivers. Please refer to the Appendix for a complete detail of wiring and operation.

The VX1020 BCD Relay Module provides a 5 digit BCD output that can be driven by sensors connected to the VX1004 Data Acquisition System. The module can display BCD numbers in the +/-32767 range. The module is connected to the VX1004 via the VBUS port. The module contains relays that are either connected or not connected to an isolated common signal. The common can be connected to the VX1004 battery or ground, or to an unrelated signal of the user's choice.

GPS MODULE

Time keeping can be vastly improved and automated with the use of the GR3230 Global Positioning System (GPS) module interface. It is used to read the time from the GPS satellites and update the time and date in the VX1004 automatically. It is connected through the Serial Port.

A copy of the GR3230 manual can be found in the Addendum 5.

PROGRAMMING THE VX1004 FOR OPERATION

The various parameters required by the VX1004 may be set either through the RS-232 port or by using the front panel LCD and buttons. The procedure is the same in either case. For correct operation, the following must be set:

- Sensor setup, scaling, group assignment.
- Group measurement interval.
- Time and date.
- Random or self-timed Satellite ID.
- Self-timed Satellite transmit time.
- Self-timed Satellite transmit interval.
- Random or self-timed Satellite enable.

If the unit is being used in data logging mode only, the Satellite parameters do not need to be set. Both Self-timed and Random Satellite transmissions should be disabled.

All of these parameters except the time are retained in non-volatile EEPROM memory and thus will not be lost even if the unit is powered down and the backup battery turned off. Because of the precise time required for self-timed GOES transmissions, every time the unit is powered down and up again, the user should reset the clock.

Most of the programming is self-explanatory through the menus. Appendix A contains a checklist for verifying that all parameters have been programmed correctly. All of the setup information may be programmed in the VX1004 ahead of installation time. At installation, only the time and the Satellite transmit enable then need be set. For simplicity of verifying all setup parameters, the programming of the VX1004 may be downloaded to a file and printed out. See "VX1004 Serial Port Menus" for a more detailed description of setup information download.

Any time the VX1004 is started for the first or restarted as a new unit, the RAM INITIALIZE option should be executed from the RETRIEVE DATA menu. If the unit has already been operating this is not necessary.

SENSOR SCALING FACTORS

Each sensor setup includes unique scaling factors allowing the raw data readings to be transformed to other engineering units. The raw data from an analog voltage measurement (one of the MUX inputs) is 0 to 4095 counts which is equivalent to 0 to 5 volts. The raw data from a frequency measurement (one of the CTR inputs) is from 0 to 32767 counts per second. The Multiplier, Divisor, and Offset parameters are applied to the raw data according to the following equation:

Logged Measurement = [(Multiplier x Raw Data) / Divisor] + Offset

The (Multiplier / Divisor) is considered as the slope of the reading.

The Decimal Point entry allows the user to specify the number of digits
to the right of the decimal point. The number with decimal point is the value that gets downloaded during a data retrieval process. The decimal point is also displayed during a sensor check. The data transmitted does not have the decimal point.

These steps may be used to determine the scaling factors for any sensor.

Step 1. Determine Multiplier and Divisor (slope)

The slope relating the reading to counts is determined by dividing the sensor output by the corresponding VX1004 input range. The slope is then:

$$\frac{\text{Sensor output range}}{\text{VX1004 input range}} = \text{Slope}$$

Example: A barometer having a 600 to 1100 millibar range with a corresponding output range of 1 to 5 volts has a slope of 125 mB/volt,(1100-600)/(5-1). This must be translated into millibars per count. Since the VX1004 analog input has 1.221 millivolts per count, millibars per count would be:

(125 mB/volt) x (0.001221 volts/count) = 0.1526 mB/count

The Slope is 0.1526.

This must be translated into a fraction with a Multiplier and Divisor, neither of which may be a decimal value or exceed 4095, thus:

$$0.1526 = \frac{0.1526}{1} = \frac{153}{1000} = \frac{\text{Multiplier}}{\text{Divisor}}$$

For the example, the Multiplier = 153 and the Divisor = 1000.

Step 2. Determine the Offset

If the sensor output is zero for a zero measurement, then the offset is zero. Otherwise the offset factor must be computed. To compute the offset, the output relative to a given input must be known. Then:

Reading = slope (VX1004 reading) + Offset

or:

Offset = Reading - (Slope x (VX1004 reading))

In the example, slope = 0.1526, the reading of 1100 millibars = 4095 (full scale input). Therefore:

Offset = 1100mB - (0.1526 x 4095) = 475

SYSTEM STARTUP

Once the VX1004 is installed and properly programmed for operation, the following should be checked:

1) Verify that the satellite transmitter fail-safe is not tripped. This may be done by resetting the fail-safe either through the FS Reset option under the OPS Test Menu or by momentarily grounding the fail safe test point located behind the red access cover on the front panel. On the older two piece units, switch number 2

behind the red access cover is the failsafe reset switch. Temporarily move this swith up to reset the failsafe and then back down for operation.

2) Verify that GOES transmissions are enabled.

SATELLITE TRANSMITTER FAIL-SAFE

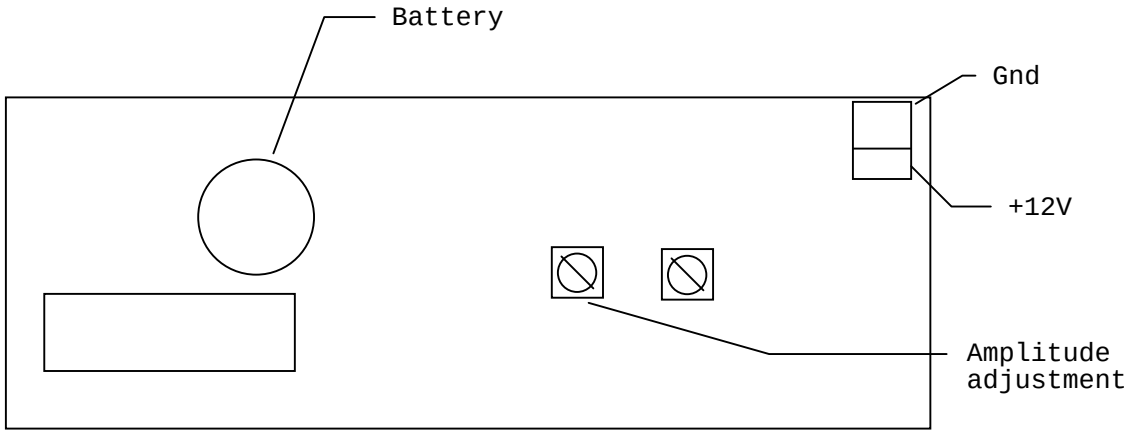
The Satellite Transmitter fail-safe will disable Satellite transmissions until the fail-safe circuit is manually reset. The fail-safe circuit is tripped when the transmission exceeds 110 seconds or the time between two successive transmissions is less than 80 seconds. In the Satellite setup menu, the rough transmission time is calculated and displayed to the user.

The fail-safe does not inhibit operation of the VX1004, but prevents any power to the transmit antenna. Thus, from monitoring operation of the VX1004 it is not evident that the Satellite transmissions are being inhibited. The fail-safe status may be checked by forcing a transmission into a dummy load through a watt-meter. If there is no power output, but the VX1004 went through a transmission cycle, then the fail-safe may be tripped and must be reset.

On the two piece DCPs, the fail-safe state is maintained (even in the event of removing power to the VX1004PA RF amplifier) by a lithium battery located in the power amplifier module. In the all-in-one-piece DCP, the failsafe will be reset when the power is interrupted. Note that if the power is interrupted, the time will need to be reset and you must still wait approximately two minutes prior to the next transmission.

NOTE: Since the lithium battery in the power amp of the two piece VX1004 holds the failsafe in a static state even when the main battery voltage is disconnected from the DCP, it is important to ensure the failsafe is not tripped when the DCP is put into storage lest this lithium battery will run down fairly quickly and the DCP will not transmit again prior to replacing this battery.

Figure 9
Location of Power Amplifier Battery,
Enable Jumper, and Power Adjustment



If the power amplifier backup battery is low or the battery enable jumper is not installed, the power output of the power amplifier will be inhibited.

GOES TRANSMIT POWER ADJUSTMENT

The transmit power of the VX1004PA power amplifier may be adjusted by using a small non-metallic flathead screwdriver to adjust the power adjustment potentiometer. For the two piece DCP, the location of this potentiometer may be seen from Figure 8. For the one piece DCPs, the power adjustment is located behind the red access cover on the front panel. To adjust the power output, the RF output of the power amplifier should be connected to a wattmeter. The wattmeter should have a 25 watt element in the 402 MHz range with a 25 watt dummy load. Adjust the power output during a transmission until the desired power is attained.

The maximum received EIRP must not be exceeded. Nominally, the power output with a Vitel V2TH antenna should be set to 12.5 watts. Factors such as antenna cable length, antenna cable type, and antenna orientation will affect the power received by the satellite.

TROUBLESHOOTING

The following is a list of possible problems which may be encountered with a VX1004 installation. The following possible causes should be investigated before the unit is assumed to be malfunctioning.

Problem	Possible Cause
No menu sent to terminal upon power up.	Improper power connection. Blown fuse. Bad or improper serial cable to computer. Communications software not running. Baud rates not compatible.
Incorrect sensor readings.	Improper sensor wiring. Terminal block not plugged in all the way. Warm-up time for switched power not long enough. Wrong scaling factors applied. Too many decimal places specified. Sensor malfunction.
No Satellite transmissions.	Time and Satellite enable not set. Power to system was lost and restored. RF cable from VX1004 to RF amplifier bad or not connected. RF cable from RF amplifier to antenna bad or not connected. Antenna not properly oriented. Low battery. Low coin-cell battery voltage in the power amplifier. Power amplifier output not correctly adjusted. Wrong GOES channel. Wrong GOES ID. Fail-safe tripped.
No sensor data with GOES transmissions.	Sensor order in group not specified. Group not enabled for GOES transmissions.
Data lost upon power down.	Backup battery switch not turned on. Backup battery needs to be replaced.

APPENDIX A
VITEL VX1004 SPECIFICATIONS

SENSOR INTERFACE		
Voltage Inputs	Number	6 single-ended
	Range	0 to 5 volts
	Accuracy	±0.1 % of full scale
	Resolution	12 bits (1 part in 4096)
Counter Inputs	Number	2 counter or frequency 1 counter only
	Maximum Input Range	±15 volts
	Programmable Thresholds	1.0 and 3.2 volts w/hysteresis 0 and 50 millivolts w/hysteresis
	Resolution	16 bits (1 part in 65,536)
Serial Inputs	SDI-12	Industry-Standard Smart Sensor Interface
Sensor Excitation	+5.000 volts DC +12 volts switched battery	±0.1% over temperature
System Monitoring	Battery	±0.1 volts
	Internal Temperature	±0.5 degrees Celsius
	Satellite TX Forward Power	Watts
	Satellite TX Fail-safe Status	OK / Tripped
	Satellite TX Lock Status	OK / Bad
Control Outputs	Number	4
	Type	Open collector to ground
USER INTERFACE		
Serial I/O	RS-232	Fully menu driven ASCII Data Download and System Setup
Integral I/O	Keypad LCD Display	
MEMORY		
Data Logging	Battery-backed SRAM	58,000 data points
System Program	EPROM Firmware	
Setup Parameters	Non-volatile EEPROM	
POWER SUPPLY		
Supply Voltage	Standard Applications	8 volts to 16 volts
	Satellite Certification Range	10.5 to 14.5 volts
Supply Current	Standby	0.5 milliamps
	Data Acquisition	25 milliamps
	Serial I/O	40 milliamps
	Satellite Standby	6 milliamps
TIMEKEEPING		
Real-Time Clock	Standard VX1004	±1 minute per month
	Satellite Applications	1ppm
PHYSICAL		
Dimensions	12.3” x 3.2” x 3.0” (w x h x d)	312mm x 80mm x 76mm
Weight (logger only)	2.5 lbs	1.13 kg
Weight	3.0 lbs	1.4 kg
ENVIRONMENTAL		
Temperature	-40C to +60C	
Humidity	0 to 99 percent, non-condensing	

APPENDIX B
CHANNEL FREQUENCY ASSIGNMENTS

GOES CHANNELS AND FREQUENCIES

Chan	Freq (MHz)	Chan	Freq (MHz)	Chan	Freq (MHz)
1	401.7010	51	401.7760	101	401.8510
2	401.7025	52	401.7775	102	401.8525
3	401.7040	53	401.7790	103	401.8540
4	401.7055	54	401.7805	104	401.8555
5	401.7070	55	401.7820	105	401.8570
6	401.7085	56	401.7835	106	401.8585
7	401.7100	57	401.7850	107	401.8600
8	401.7115	58	401.7865	108	401.8615
9	401.7130	59	401.7880	109	401.8630
10	401.7145	60	401.7895	110	401.8645
11	401.7160	61	401.7910	111	401.8660
12	401.7175	62	401.7925	112	401.8675
13	401.7190	63	401.7940	113	401.8690
14	401.7205	64	401.7955	114	401.8705
15	401.7220	65	401.7970	115	401.8720
16	401.7235	66	401.7985	116	401.8735
17	401.7250	67	401.8000	117	401.8750
18	401.7265	68	401.8015	118	401.8765
19	401.7280	69	401.8030	119	401.8780
20	401.7295	70	401.8045	120	401.8795
21	401.7310	71	401.8060	121	401.8810
22	401.7325	72	401.8075	122	401.8825
23	401.7340	73	401.8090	123	401.8840
24	401.7355	74	401.8105	124	401.8855
25	401.7370	75	401.8120	125	401.8870
26	401.7385	76	401.8135	126	401.8885
27	401.7400	77	401.8150	127	401.8900
28	401.7415	78	401.8165	128	401.8915
29	401.7430	79	401.8180	129	401.8930
30	401.7445	80	401.8195	130	401.8945
31	401.7460	81	401.8210	131	401.8960
32	401.7475	82	401.8225	132	401.8975
33	401.7490	83	401.8240	133	401.8990
34	401.7505	84	401.8255	134	401.9005
35	401.7520	85	401.8270	135	401.9020
36	401.7535	86	401.8285	136	401.9035
37	401.7550	87	401.8300	137	401.9050
38	401.7565	88	401.8315	138	401.9065
39	401.7580	89	401.8330	139	401.9080
40	401.7595	90	401.8345	140	401.9095
41	401.7610	91	401.8360	141	401.9110
42	401.7625	92	401.8375	142	401.9125
43	401.7640	93	401.8390	143	401.9140
44	401.7655	94	401.8405	144	401.9155
45	401.7670	95	401.8420	145	401.9170
46	401.7685	96	401.8435	146	401.9185
47	401.7700	97	401.8450	147	401.9200
48	401.7715	98	401.8465	148	401.9215
49	401.7730	99	401.8480	149	401.9230
50	401.7745	100	401.8495	150	401.9245

GOES Channel and Frequencies (Continued)

Chan	Freq (MHz)	Chan	Freq (MHz)	Chan	Freq (MHz)
151	401.9260	201	402.0010	251	402.0760
152	401.9275	202	402.0025	252	402.0775
153	401.9290	203	402.0040	253	402.0790
154	401.9305	204	402.0055	254	402.0805
155	401.9320	205	402.0070	255	402.0820
156	401.9335	206	402.0085	256	402.0835
157	401.9350	207	402.0100	257	402.0850
158	401.9365	208	402.0115	258	402.0865
159	401.9380	209	402.0130	259	402.0880
160	401.9395	210	402.0145	260	402.0895
161	401.9410	211	402.0160	261	402.0910
162	401.9425	212	402.0175	262	402.0925
163	401.9440	213	402.0190	263	402.0940
164	401.9455	214	402.0205	264	402.0955
165	401.9470	215	402.0220	265	402.0970
166	401.9485	216	402.0235	266	402.0985
167	401.9500	217	402.0250		
168	401.9515	218	402.0265		
169	401.9530	219	402.0280		
170	401.9545	220	402.0295		
171	401.9560	221	402.0310		
172	401.9575	222	402.0325		
173	401.9590	223	402.0340		
174	401.9605	224	402.0355		
175	401.9620	225	402.0370		
176	401.9635	226	402.0385		
177	401.9650	227	402.0400		
178	401.9665	228	402.0415		
179	401.9680	229	402.0430		
180	401.9695	230	402.0445		
181	401.9710	231	402.0460		
182	401.9725	232	402.0475		
183	401.9740	233	402.0490		
184	401.9755	234	402.0505		
185	401.9770	235	402.0520		
186	401.9785	236	402.0535		
187	401.9800	237	402.0550		
188	401.9815	238	402.0565		
189	401.9830	239	402.0580		
190	401.9845	240	402.0595		
191	401.9860	241	402.0610		
192	401.9875	242	402.0625		
193	401.9890	243	402.0640		
194	401.9905	244	402.0655		
195	401.9920	245	402.0670		
196	401.9935	246	402.0685		
197	401.9950	247	402.0700		
198	401.9965	248	402.0715		
199	401.9980	249	402.0730		
200	401.9995	250	402.0745		

GMS CHANNELS AND FREQUENCIES

Chan	Freq(MHz)	Chan	Freq(MHz)	Chan	Freq(MHz)
1	402.0025	51	402.1525	101	402.3025
2	402.0055	52	402.1555	102	402.3055
3	402.0085	53	402.1585	103	402.3085
4	402.0115	54	402.1615	104	402.3115
5	402.0145	55	402.1645	105	402.3145
6	402.0175	56	402.1675	106	402.3175
7	402.0205	57	402.1705	107	402.3205
8	402.0235	58	402.1735	108	402.3235
9	402.0265	59	402.1765	109	402.3265
10	402.0295	60	402.1795	110	402.3295
11	402.0325	61	402.1825	111	402.3325
12	402.0355	62	402.1855	112	402.3355
13	402.0385	63	402.1885	113	402.3385
14	402.0415	64	402.1915	114	402.3415
15	402.0445	65	402.1945	115	402.3445
16	402.0475	66	402.1975	116	402.3475
17	402.0505	67	402.2005	117	402.3505
18	402.0535	68	402.2035	118	402.3535
19	402.0565	69	402.2065	119	402.3565
20	402.0595	70	402.2095	120	402.3595
21	402.0625	71	402.2125	121	402.3625
22	402.0655	72	402.2155	122	402.3655
23	402.0685	73	402.2185	123	402.3685
24	402.0715	74	402.2215	124	402.3715
25	402.0745	75	402.2245	125	402.3745
26	402.0775	76	402.2275	126	402.3775
27	402.0805	77	402.2305	127	402.3805
28	402.0835	78	402.2335	128	402.3835
29	402.0865	79	402.2365	129	402.3865
30	402.0895	80	402.2395	130	402.3895
31	402.0925	81	402.2425	131	402.3925
32	402.0955	82	402.2455	132	402.3955
33	402.0985	83	402.2485	133	402.3985
34	402.1015	84	402.2515		
35	402.1045	85	402.2545		
36	402.1075	86	402.2575		
37	402.1105	87	402.2605		
38	402.1135	88	402.2635		
39	402.1165	89	402.2665		
40	402.1195	90	402.2695		
41	402.1225	91	402.2725		
42	402.1255	92	402.2755		
43	402.1285	93	402.2785		
44	402.1315	94	402.2815		
45	402.1345	95	402.2845		
46	402.1375	96	402.2875		
47	402.1405	97	402.2905		
48	402.1435	98	402.2935		
49	402.1465	99	402.2965		
50	402.1495	100	402.2995		

METEOSAT CHANNELS AND FREQUENCIES

VX1004/2 Channel	International Channel	Frequency (MHz)	VX1004/2 Channel	Regional Channel	Frequency (MHz)
1	1	402.0025	34	1	402.1015
2	2	402.0055	35	2	402.1045
3	3	402.0085	36	3	402.1075
4	4	402.0115	37	4	402.1105
5	5	402.0145	38	5	402.1135
6	6	402.0175	39	6	402.1165
7	7	402.0205	40	7	402.1195
8	8	402.0235	41	8	402.1225
9	9	402.0265	42	9	402.1255
10	10	402.0295	43	10	402.1285
11	11	402.0325	44	11	402.1315
12	12	402.0355	45	12	402.1345
13	13	402.0385	46	13	402.1375
14	14	402.0415	47	14	402.1405
15	15	402.0445	48	15	402.1435
16	16	402.0475	49	16	402.1465
17	17	402.0505	50	17	402.1495
18	18	402.0535	51	18	402.1525
19	19	402.0565	52	19	402.1555
20	20	402.0595	53	20	402.1585
21	21	402.0625	54	21	402.1615
22	22	402.0655	55	22	402.1645
23	23	402.0685	56	23	402.1675
24	24	402.0715	57	24	402.1705
25	25	402.0745	58	25	402.1735
26	26	402.0775	59	26	402.1765
27	27	402.0805	60	27	402.1795
28	28	402.0835	61	28	402.1825
29	29	402.0865	62	29	402.1855
30	30	402.0895	63	30	402.1885
31	31	402.0925	64	31	402.1915
32	32	402.0955	65	32	402.1945
33	33	402.0985	66	33	402.1975

SATELLITE FREQUENCY PLAN CROSS REFERENCE

Frequency (MHz)	GMS – Japan 3 KHz Channels	GOES -- USA 1.5 KHz Channels	METEOSAT – Europe 3 KHz Channels
401.7010		1 Domestic	
401.7025		2 Domestic	
401.9995		200 Domestic	
402.0010		201 International	
402.0025	1 International	202 International	1 International
402.0040		203 International	
402.0055	2 International	204 International	2 International
402.0685	23 International	246 International	23 International
402.0700		247 International	
402.0715	24 International	248 International	24 International
402.0970		265 International	
402.0985	33 International	266 International	33 International
402.1015	34 Regional		1 Regional
402.1045	35 Regional		2 Regional
402.1945	65 Regional		32 Regional
402.1975	66 Regional		33 Regional
402.2005	67 Regional		
402.3985	133 Regional		

PILOT FREQUENCIES

GOES 401.8500 MHz
GMS 402.1000 MHz

VX1004 SETUP CHECKLIST

Site Description: _____

Time: **Date:** **Location:**

(N) Self-Timed Satellite

(S) Satellite Selection GOES/GMS/METEOSAT
(A) Transmissions Enabled ON/OFF Location LAT: _____
(I) Satellite ID _____ LON: _____
(C) Self Timed Channel _____
(H) First Tx Time ___:___:_____ Antenna AZ: _____
(T) Transmission Interval _____ ELEV: _____
(P) Preamble Type Short / Long
(G) GTM Max Bytes _____
(V) VGTM Header ON/OF
(R) RTS Action Always ON/Handshake

(R) RANDOM SATELLITE

(A) Transmissions Enabled ON / OFF
(C) Random Reporting Channel _____
(I) Satellite ID _____

GROUP SETUP (G1-G4)

Group Setup	Update Interval	Data Sets	Warmup Time	Sensor Order	Driving Parameter	Rn Data Sets	Base Interval	Alarm Interval	High Limit	Low Limit	Change
Group 1											
Group 2											
Group 3											
Group 4											

SENSOR SETUP (S)

MUX Inputs	Device	Group	Digits Rt of Dec Pt	SHEF	Averaging	Selected Data	Special Sensor	Multiplier	Divisor	Base
MUX 1										
MUX 2										
MUX 3										
MUX 4										
MUX 5										
MUX 6										

Counter Inputs	Device	Group	Digits Rt of Dec Pt	SHEF	Averaging	Selected Data	Special Sensor	Multi-plier	Divisor	Base	Ctr Type	Ctr Threshold
C 1												
C 2												
C 2												

SDI-12 Setup	Device	Group	Digits Rt of Dec Pt	SHEF	Averaging	Selected Data	SDI-12 Address	Meas Command	Retr Data Command	Keep Values	Num Vals to Log
SDI- 0											
SDI- 1											
SDI- 2											
SDI- 3											
SDI- 4											
SDI- 5											
SDI- 6											
SDI- 7											
SDI- 8											
SDI- 9											

EXPANDED ANALOG MODULE INPUTS

Expand Inputs	Device	Group	Dec Pt	SHEF	Averaging	Select Data	Special Sensor	Multiplier	Divisor	Base	Single/Diff-erential
E- 1											
E -2											
E- 3											
E- 4											
E- 5											
E- 6											
E- 7											
E- 8											
E- 9											
E-10											
E-11											
E-12											
E-13											
E-14											
E-15											
E-16											

BCD DRIVER STATUS

DRIVER NUMBER	STATUS

DI-12 SLAVE OPS

Address	Sensor	Status
0		
1		
2		
3		
4		
5		
6		
7		
8		
9		

APPENDIX D
VX1004 GOES MESSAGE FORMAT

Stevens Water Monitoring Systems, Inc. 19 December 1996 FTB

I. DATA HANDLING IN THE VX1100 AND VX1004

The analog to digital (A/D) converter in the VX1100 provides a measurement between -32767 and +32767 counts. The counters inside the VX1100 provide a count between 0 and 65,535 for frequencies or running count measurements (such as a tipping bucket). Frequencies are measured over a 1 second period. The analog to digital (A/D) converter in the VX1004 provides a measurement between 0 and 4095 counts.

The output from these circuits may be converted to engineering units using the Multiplier, Divisor, and Offset in the sensor setup table. Different multipliers, divisors, and offsets may be applied to each sensor input. After applying these scaling factors to the raw measurement, you are left with an integer between -32,767 and +32,767. This integer value is what is transmitted over the satellite and stored in the data logging RAM.

When the data is printed out to the display or downloaded to a computer, a decimal point may be added to each value to make it more readable. The user specifies the number of digits that he would like to see to the right of the decimal point in the sensor scaling table. If a value of 2 were entered in the sensor setup table, it would cause the value 2162 to be printed as 21.62. This decimal point selection has no effect on the data that is transmitted over the satellite; any decimal points must be added by the receive site computer. For the example given above, the integer value 2162 is transmitted to the satellite.

II. SATELLITE TRANSMISSIONS AND DATA FORMAT

The VX1100 and VX1004 transmit all data in the pseudo ASCII format recommended by NESDIS; this allows the maximum amount of data to be transmitted within the assigned time slot. All messages conform to the specified format of Carrier, Clock, 15-Bit Frame Sync Word, 31-bit User Address, the user data field, followed by an EOT character. The platforms may be programmed to transmit either the long preamble (5 seconds carrier, 2.5 seconds clock) or the short preamble (0.5 seconds carrier, 0.48 seconds clock).

SELF-TIMED MESSAGES

The basic format of the user data field for self-timed transmissions is shown below. Please note that transmissions do not contain any carriage return or linefeed characters; they are added here to make the format readable.

<Message Header> <Sensor Data> <Battery Voltage> <EOT>

Message Header

For self-timed messages, the header consists of 7 bytes as defined below:

```
                    Xtvrbse, where
                    |||||||
                    ||||||-- e is error status byte,
                    |||||--- s is session counter
                    ||||---- b is low battery event counter
                    |||----- r is number of resets
                    ||------ v is software version
                    |------- t is msg type, * for self-timed
                    -------- X is Ascii 'X'
```

Error Status -- Not yet defined
Session Counter -- 0 to 63, Gets incremented each time session where setup is changed (Future).
Low Battery Count -- 0 to 63, circular, gets incremented each time a transmission is aborted due to low battery voltage.
Reset Counter -- 0 to 63, circular. Increments each time unit is reset. Goes to zero when logging ram is initialized.
Software Version -- This is the EPROM software version.
Message Type -- Always * for self-timed messages.
Header Byte -- Always X for the VX1100 and VX1004.

Sensor Data

The message may contain from zero to many sensor data fields, depending on how many sensors are enabled for GOES transmissions. The sensor data field is defined below:

<Space><Sensor Number><Time Byte><data><data>...<data>

All sensor data fields are preceeded by an ASCII space character. The sensor number is transmitted as an ASCII character. The number is calculated by subtracting 40 hex (64 decimal) from the transmitted character. For example, sensor number 1 is transmitted as the ASCII character A, which is 41 Hex. 41 hex - 40 hex = 1.

The time byte is a one byte ASCII character which represents a number between 0 and 63. This number represents the number of minutes from when the data was logged to when it was transmitted. The time byte is followed immediately by sensor data.

The data is transmitted with the most recent data first. Each data value, which may vary from +/-32767, is transmitted as a 3-byte psuedo-ASCII value. Each integer data value is encoded to three pseudo-ASCII bytes, with six data bits in each byte, in the following manner:

	Bit Numbers							
Data Value:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

	Bit Numbers							
Encoded Value:	7	6	5	4	3	2	1	0
First Byte:		P	1	x	x	15	14	13	12
Second Byte:	P	1	11	10	9	8	7	6	
Third Byte:		P	1	5	4	3	2	1	0

As before, the P is the parity bit and bit 6 is always a '1'. The xx shown in the first byte are "don't care" bits and are set to 00 for zero or positive values, and to 11 for negative (two's complement) values. An example of how to encode the integer value 21429 follows:

Integer Value: 21429
Hex Value: 53B5
Binary Value: 0101 0011 1011 0101

Encoded Bytes:
First byte: P1 00 0101
Second byte: P1 0011 10
Third byte: P1 11 0101

Some values may be encoded to bytes that result in P111 1111 (Hex 7F), which is the non-printable ASCII DELETE character. In this specific case, that byte will be changed to P011 1111 (Hex 3F), the ASCII question mark (a printable character).

Battery Voltage

The battery voltage, measured during the Carrier portion of the transmission, is included as the last sensor data field. The battery voltage field consists of an ASCII space character, the ASCII zero character '0', and a one byte pseudo-ASCII character which represents the battery voltage. The one byte provides six bits for data, which accommodates the values from 0 to 63. The battery voltage is then calculated from the following equation:

Battery Voltage = 9.5 + (value)(0.10) Volts,

where "value" is a number from 0 to 63.

RANDOM TRANSMISSIONS

The basic format of the user data field for random transmissions is shown below.

<Message Header> <Sensor Data> <Battery Voltage> <EOT>

For Random messages, the header consists of 3 bytes as defined below:

```
Xtc, where
|||
|||-----  Random counter, increments 0 to 63,
||                circular.  Can help determine how well
||                random transmissions are received.
||------  Type:  # for regular random messages,
||                    ! for alarm random messages.
|-------  Header byte, always 'X'
```

Sensor Data Fields

Random transmissions may contain from zero to many sensors. The format of one sensor data field is shown below. It differs from the self-timed messages in two ways. There is no leading space before each sensor, and less data values from each sensor are included.

If averaging is enabled for a sensor, then the most recent data (acquired within the last minute) is included, along with up to three of the most recent logged values. The user may program the VX1004 to include the last 1, 2, or 3 logged values in the transmission.

No averaging enabled:
<Sensor Number><Time Byte><log data><log data><log data>

Averaging Enabled:
<Sensor Number><Time Byte><recent data><log data><log data><log data>

The data encoding and the trailing battery voltage field are identical to the self-timed transmissions.

III. Example GOES Transmissions

The transmissions shown below were downloaded from Wallops DAPS. The actual transmissions contain no linefeed or carriage returns. They are added here for clarity.

Self-timed Message
Raw Message:

0101F3DC 95 191 034812 G 47-0NN 151E FF 00183 X*3@@@@
AH@C{@Cu@Cw@Cw@C~@C}@C{@C~@CI@CJ@CI@CI@CI@CH@CH@CH@CH@CH
BC@sO@sM@sO@sO
@sM@sO@sO@sM@sO@sO@sM@sO@sN@sM@sO@vp@vp@vp@vp@vp@vp@vp@vp@vp@vp@vp@vp
@vp@vm@vp@vp@vp@vp@vp@vm@vp 0a

Decoded:
Wallops Added Header: 0101F3DC 95 191 034812 G 47-0NN 151E FF 00183
User Data:
X*3@@@@ - Message Header, Self timed message,
Software Version 3,
No resets, low battery events, etc.

AH - Sensor 1, 8 minutes since most recent data logged.
18 1 value data sets follow
@C{ @Cu @Cw @Cw @C~ @C} @C{ @C~ @CI @CJ @CI @CI @CI @CH @CH @CH @CH @CH

BC - Sensor 2, 3 minutes since most recent data logged.
@sO @sM @sO 12 Data sets, each contains Ave, Min, and Max values.
@sO @sM @sO
@sO @sM @sO
@sO @sM @sO
@sN @sM @sO
@vp @vp @vp
@vp @vp @vp
@vp @vp @vp
@vp @vp @vp
@vp @vm @vp
@vp @vp @vp
@vp @vm @vp

0a - Battery Voltage: 12.8 volts

Random Message
Raw Data:

0101F3DC 95 190 214016 G 46-0NN 151E FF 00016 X#AA@@@A@@@@@A@@B 0c

Decoded Data:
Wallops Added Header: 0101F3DC 95 190 214016 G 46-0NN 151E FF 00016
User Data: X#AA@@@@B@@Dm 0c
X#A - Header, Normal Random Message, Random Counter = 1

A@ - Sensor 1, Zero minutes since data acquired
@@A @@@ @@A @@B - Most recent data and last three logged values,
decodes to 1, 0, 1, 2
0c - Battery voltage, 13.0 volts

ADDENDUM 1
GOES MESSAGE FORMATS

Stevens Water Monitoring Systems, Inc. Modified: 23 Sept 1998 FTB

GOES Message Formats
for the
VX1004 and the VX1100 DCPs

I. DATA HANDLING IN THE VX1100 AND VX1004

The analog to digital (A/D) converter in the VX1100 provides a measurement between -32767 and +32767 counts. The counters inside the VX1100 provide a count between 0 and 65,535 for frequencies or running count measurements (such as a tipping bucket). Frequencies are measured over a 1 second period. The analog to digital (A/D) converter in the VX1004 provides a measurement between 0 and 4095 counts.

The output from these circuits may be converted to engineering units using the Multiplier, Divisor, and Offset in the sensor setup table. Different multipliers, divisors, and offsets may be applied to each sensor input. After applying these scaling factors to the raw measurement, you are left with an integer between -32,767 and +32,767. This integer value is what is transmitted over the satellite and stored in the data logging RAM.

When the data is printed out to the display or downloaded to a computer, a decimal point may be added to each value to make it more readable. The user specifies the number of digits that he would like to see to the right of the decimal point in the sensor scaling table. If a value of 2 were entered in the sensor setup table, it would cause the value 2162 to be printed as 21.62. This decimal point selection has no effect on the data that is transmitted over the satellite; any decimal points must be added by the receive site computer. For the example given above, the integer value 2162 is transmitted to the satellite.

II. GOES TRANSMISSIONS AND DATA FORMAT

The VX1100 and VX1004 transmit all data in the pseudo ASCII format recommended by NESDIS; this allows the maximum amount of data to be transmitted within the assigned time slot. All messages conform to the specified format of Carrier, Clock, 15-Bit Frame Sync Word, 31-bit User Address, the user data field, followed by an EOT character. The platforms may be programmed to transmit either the long preamble (5 seconds carrier, 2.5 seconds clock) or the short preamble (0.5 seconds carrier, 0.48 seconds clock).

SELF-TIMED MESSAGES

The basic format of the user data field for self-timed transmissions is shown below. Please note that transmissions do not contain any carriage return or linefeed characters; they are added here to make the format readable.

<GTM-Content><Message Header> <Sensor Data> <Battery Voltage> <EOT>

GTM-Content

If the GTM (GOES Transmitter Module) option of the VX1004 is used, any data from the attached external data logger is included at the beginning of the message, as follows:

<SPACE>VGTM<SPACE><Data from logger><SPACE>

The <Data from logger> field includes all bytes received from the attached external data logger. This could vary from zero bytes to hundreds of bytes. If the GTM option is not enabled, the GTM-Content field is not included in the message.

Message Header

For self-timed messages, the header consists of 7 bytes (Xtvrbse) as defined below:

Num	byte	Title	Comments
1	X	Ascii 'X'	Always X for self-timed messages.
2	t	Message Type	Always asterisk * for self-timed.
3	v	Firmware Version	Ascii character indicating firmware version installed in DCP.
4	r	Number of resets	0 to 63 circular. Gets incremented with each reset. Cleared when logging RAM initialized.
5	b	Low Battery Event Counter	0 to 63 circular. Gets incremented each time a transmission is aborted due to low battery.
6	s	Session Counter	Future. Gets incremented each time setup is changed. 0 to 63 circular.
7	e	Error Status	Future. Not Defined.

Sensor Data

The message may contain from zero to many sensor data fields, depending on how many sensors are enabled for GOES transmissions. The sensor data field is defined below:

<Space><Sensor Identifier><Time Byte><data><data>...<data>

All sensor fields are preceded by an ASCII space character.
The sensor indentifier may be transmitted in two ways. In the standard implementation, the sensor number is transmitted as single ASCII character. The number is calculated by subtracting 40 hex (64 decimal) from the transmitted character. For example, sensor number 1 is transmitted as the ASCII character A, which is 41 Hex.
41 hex - 40 hex = 1.

If the SHEF code option in the VX1004 is enabled, the sensor identifier is a 4 byte user programmable ASCII code followed by the ASCII ':' (colon) character.
The time byte is a one byte ASCII character which represents a number between 0 and 63. This number represents the number of minutes from when the data was logged to when it was transmitted. The time byte is followed immediately by sensor data.
The data is transmitted with the most recent data first. Each data value, which may vary from +/- 32767, is transmitted as a 3-byte psuedo-ASCII value. Each integer data value is encoded to three pseudo-ASCII bytes, with six data bits in each byte, in the following manner:

	Bit Numbers							
Data Value:	15	14	13	12	11	10	9	8

	Bit Numbers							
Encoded Value:	7	6	5	4	3	2	1	0
First Byte:	P	1	x	x	15	14	13	12
Second Byte:	P	1	11	10	9	8	7	6
Third Byte:	P	1	5	4	3	2	1	0

As before, the P is the parity bit and bit 6 is always a '1'. The xx shown in the first byte are "don't care" bits and are set to 00 for zero or positive values, and to 11 for negative (two's complement) values. An example of how to encode the integer value 21429 follows:

Integer Value: 21429
Hex Value: 53B5
Binary Value: 0101 0011 1011 0101
Encoded Bytes:
First byte: P1 00 0101
Second byte: P1 0011 10
Third byte: P1 11 0101

Some values may be encoded to bytes that result in P111 1111 (Hex 7F), which is the non-printable ASCII DELETE character. In this specific case, that byte will be changed to P011 1111 (Hex 3F), the ASCII question mark (a printable character).

Battery Voltage

The battery voltage, measured during the Carrier portion of the transmission, is included as the last sensor data field. The battery voltage field consists of an ASCII space character, the ASCII zero character '0', and a one byte pseudo-ASCII character which represents the battery voltage. The one byte provides six bits for data, which accommodates the values from 0 to 63. The battery voltage is then calculated from the following equation:

Battery Voltage = 9.5 + (value)(0.10) Volts,

where "value" is a number from 0 to 63.

RANDOM TRANSMISSIONS

The basic format of the user data field for random transmissions is shown below.

<Message Header> <Sensor Data> <Battery Voltage> <EOT>

For Random messages, the header consists of 3 bytes as defined below:

Num	Byte	Title	Comments
1	X	Ascii X	Header Byte, always X
2	t	Message Type	Type: ascii ! for alarm transmissions, ascii # for normal random transmissions.
3	c	Random Counter	0 to 63 circular. Incremented with each transmission. Can be used to calculate percentage of random transmissions received.

Sensor Data Fields

Random transmissions may contain from zero to many sensors. The format of one sensor data field is shown below. It differs from the self-timed messages in two ways. There is no leading space before each sensor, and fewer data values from each sensor are included.

If averaging is enabled for a sensor, then the most recent data (acquired within the last minute) is included, along with up to three of the most recent logged values. The user may program the VX1004 to include the last 1, 2, or 3 logged values in the transmission.

No averaging enabled:
<$><Sensor Number><Time Byte><log data><log data><log data>

Averaging Enabled:
<$><Sensor Number><Time Byte><recent data>
<log data><log data><log data>

The data encoding and the trailing battery voltage field are identical to the self-timed transmissions.

III. Example GOES Transmissions

The transmissions shown below were downloaded from Wallops DAPS. The actual transmissions contain no linefeed or carriage returns. They are added here for clarity.

SELF-TIMED - RAW MESSAGE:

0101F3DC 95 191 034812 G 47-0NN 151E FF 00183 X*3@@@@
AH@C{@Cu@Cw@Cw@C~@C}@C{@C~@CI@CJ@CI@CI@CI@CH@CH@CH@CH@CH
BC@sO@sM@sO@sO
@sM@sO@sO@sM@sO@sO@sM@sO@sN@sM@sO@vp@vp@vp@vp@vp@vp@vp@
vp@vp@vp@vp@vp@vm@vp@vp@vp@vp@vp@vm@vp 0a

SELF-TIMED MESSAGE - DECODED MESSAGE:

Wallops Added Header: 0101F3DC 95 191 034812 G 47-0NN 151E FF 00183
User Data:
X*3@@@@ - Message Header, Self timed message,
Software Version 3,
No resets, low battery events, etc.

AH - Sensor 1, 8 minutes since most recent data logged.
18 1 value data sets follow
@C{ @Cu @Cw @Cw @C~ @C} @C{ @C~ @CI @CJ @CI @CI @CI @CH @CH @CH @CH
@CH

BC - Sensor 2, 3 minutes since most recent data logged.
@sO @sM @sO 12 Data sets, each contains Ave, Min, and Max values.
@sO @sM @sO
@sO @sM @sO
@sO @sM @sO
@sN @sM @sO

@vp @vp @vp
@vp @vp @vp
@vp @vp @vp
@vp @vp @vp
@vp @vm @vp
@vp @vp @vp
@vp @vm @vp
0a - Battery Voltage: 12.8 volts

RANDOM - RAW MESSAGE:

0101F3DC 95 190 214016 G 46-0NN 151E FF 00016 X#A$A@@@A@@@@@A@@B 0c

RANDOM - DECODED MESSAGE:
Wallops Added Header: 0101F3DC 95 190 214016 G 46-0NN 151E FF 00016
User Data: X#AA@@@@B@@Dm 0c
X#A - Header, Normal Random Message, Random Counter = 1

$A@ - Sensor 1, Zero minutes since data acquired
@@A @@@ @@A @@B - Most recent data and last three logged values,
decodes to 1, 0, 1, 2
0c - Battery voltage, 13.0 volts

ADDENDUM 2
VX1004 GOES FLAGS

The following table relates the sensor names, internal sensor numbers, and the GOES flags that mark each sensor field in the GOES transmissions.

Sensor Name	Sensor Number	GOES Flag ASCII
M1	1	A
M2	2	B
M3	3	C
M4	4	D
M5	5	E
M6	6	F
M7	7	G
M8	8	H
C1	9	I
C2	10	J
C3	11	K
S0	12	L
S1	13	M
S2	14	N
S3	15	O
S4	16	P
S5	17	Q
S6	18	R
S7	19	S
S8	20	T
S9	21	U
E1	22	V
E2	23	W
E3	24	X
E4	25	Y
E5	26	Z
E6	27	[
E7	28	\
E8	29	]
E9	30	^
E10	31	_
E11	32	`
E12	33	a
E13	34	b
E14	35	c
E15	36	d
E16	37	e

ADDENDUM 3
GOES TRANSMITTER MODULE FUNCTION

Stevens Water Monitoring Systems, Inc. 03 November 1998 FTB

VX1004 Manual Addendum
GOES Transmitter Module Function

INTRODUCTION

The Vitel VX1004DCP GOES Transmitter Module (GTM) function is designed to accept serial data from a data logger, and transmit that data over the GOES (or other satellite) System. The VX1004 handles the precise time keeping required in order to use the GOES system. The VX1004 provides a NOAA/NESDIS certified GOES transmitter that is easily interfaced to most data loggers. The data is transferred from the data logger to the VX1004 over a standard RS-232 asynchronous serial port in ASCII format. See the block diagram, below, for a system overview.

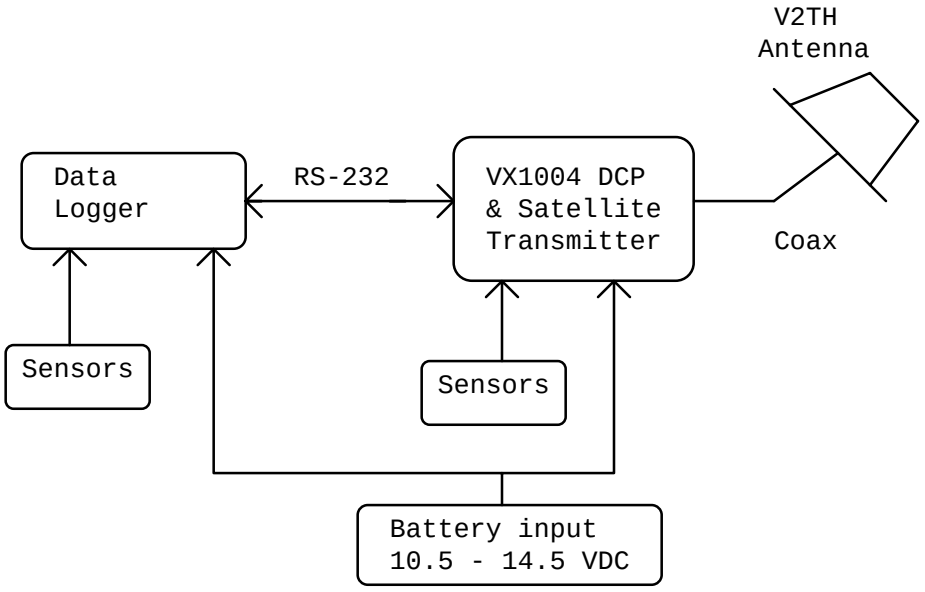


Figure 1. VX1004 GTM System Block Diagram

RS-232 DTE CONNECTION

The data logger communicates with the VX1004 through the 9-pin D connector marked RS-232 DTE. The wiring diagram for connecting a laptop computer 9-pin D connector to the VX1004 is shown in Figure 2.

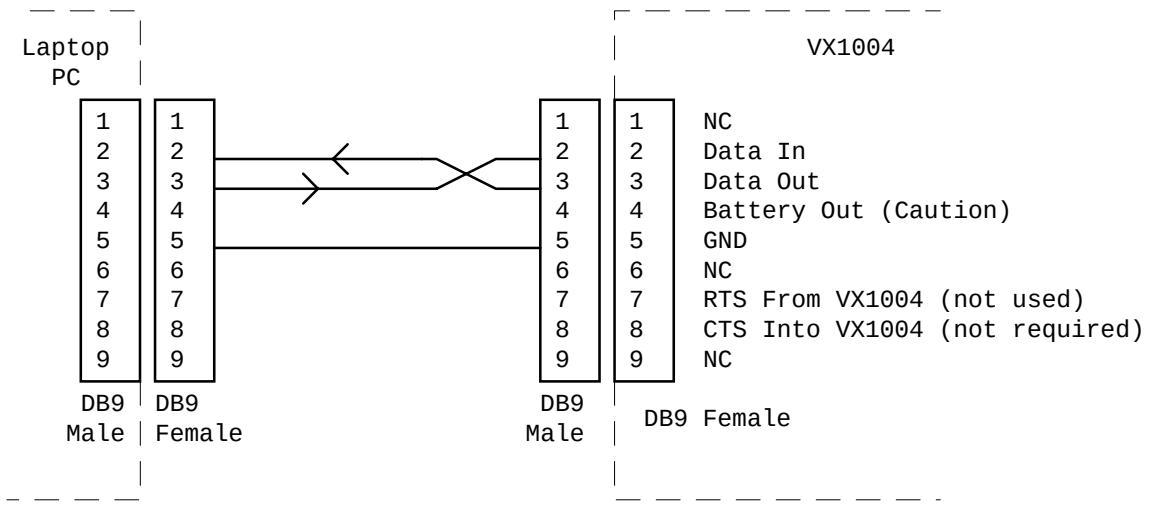


Figure 2. RS-232 DTE Connections

MAXBYTES

This is the only setup parameter required for using the VX1004 GTM function. This selection allows the user to specify the maximum number of bytes that the VX1004 will accept for transmission. Setting this number to the proper value insures that the VX1004 will not transmit outside its assigned time window in the event of a malfunctioning data logger. For example, if the data logger was supposed to transfer 500 bytes of data to the VX1004, but instead transferred 1500 bytes, it is likely that the transmission would take too long and overrun into the next time window. Setting the maximum number of bytes to 500 or 550 would prevent this error. Each byte takes 80mS to transmit over the satellite system. The transmission time is determined by the number of data bytes and the preamble type. A rough estimate of the transmission time can be calculated as follows:

Tx Time = Preamble + (number of bytes x 80mS)

Examples:
Long Format, Max bytes set to 500;
Tx Time = 7.5 seconds + (500 x .08) = 47.5 seconds.

Short Format, Max bytes set to 600;
Tx Time = 0.75 seconds + (600 x .08) = 48.75 seconds.

Long Format, Max bytes set to 1000;

Tx Time = 7.5 seconds + (1000 x .08) = 87.5 seconds,
too long for most time slot assignments.

The VX1004 will calculate the exact time value for you. See the last part of the Serial Port section.

Max Bytes is a maximum value. The VX1004 only transmits the number of data bytes transferred from the data logger. If the Max Bytes is set to 500, and only 100 bytes are transferred from the data logger, then the VX1004 transmits only the 100 data bytes. The VX1004 can buffer up to 2000 bytes.

If this option is selected, "MaxBytes" is displayed in the left half of the display. The current number of bytes is displayed in the right half. Press <CHANGE> to select a new value, <ON/OFF> to return to the setup menu. If <CHANGE> is pressed to select a new value, then a blinking cursor appears on the first digit of the number. Press <CHANGE> until the digit reads the desired value, the <ENTER> to move to the next digit.

<CHANGE>	Changes value of highlighted digit.
<ENTER>	Moves one digit to the right.
<ON/OFF>	Cancels the change, returns to the setup menu.

DCP-VX1004 DATA TRANSFER

This section defines the serial interface between the VX1004 GTM and the external data logger.

Physical

Electrical Interface:	RS-232
Baud Rate:	1200, 2400, 4800, 9600
Data:	8 bits/char, No parity, 1 stop bit

Operation

All the parameters that affect satellite operation are entered using the front panel display and pushbuttons. These include: the current Greenwich Mean Time (GMT), the next transmit time, the transmit interval, the satellite type, satellite channel, and satellite ID number. When all parameters are correctly entered, the VX1004 may be activated.

The VX1004 is usually in a low power idle state. About one minute before the next scheduled transmission, the VX1004 sends a 100mS break to the data logger, followed by a prompt to send data. The data logger sends the data to the VX1004. After the data is received, the VX1004 checks the data for forbidden characters and sets each byte to correct parity. At the proper time the VX1004 sends the transmission. After the transmission is sent the VX1004 sends a "transmission complete" message to the data logger. The VX1004 then returns to the low power idle state.

Data Header -- The VX1004 inserts the following data header at the beginning of every transmission: < Space >VGTM< Space >.

No Data -- The VX1004 sends a prompt to the data logger requesting data. If no data is received within 50 seconds, the VX1004 assumes that the data logger is not functioning and transmits a "No Data" message.

Data Characters -- All characters transmitted over the GOES (or other satellite) system must be valid ASCII characters. The data transferred from the data logger to the VX1004 must be 8-bit

characters between 0 and 127 decimal. The most significant bit of every byte will be zero. The VX1004 will set the most significant bit to the proper parity for transmission.

Forbidden Data Characters -- The following ASCII characters are not allowed to appear in the transmitted data: SOH, STX, ETX, ENQ, ACK, DLE, EOT, NAK, SYN, ETB, CAN, GS, and RS. If any of these characters appear in the received data, they will be changed to the ASCII "/" character (2F Hex).

Special Characters -- Three ASCII characters are used for signaling from the data logger to the VX1004. The ASCII EOT character is sent from the data logger to the VX1004 to mark the end of the data field. When the VX1004 detects the EOT, it responds by sending an "OK" response to the data logger. The ASCII CAN and DLE characters are used in error checking (see below).

Error Checking and Correction -- The VX1004 echoes each character back to the data logger as it is received. If the data logger receives an echo byte that is not correct, or does not receive the echo byte within a reasonable time, the data logger sends the ASCII DLE character to the VX1004. The VX1004 echoes the DLE character, and moves back one byte in its receive buffer. The DLE is used, in effect, to erase a one byte error. The DLE erase procedure may be used any number of times within a data transfer session.

If for some reason, the data logger is unsure that the VX1004 has received and buffered the data correctly, the data logger may send the ASCII CAN ("cancel") character to the VX1004. When the VX1004 detects the CAN character, it abandons all data received so far and restarts the procedure with the "send data" prompt.

The following page shows the details of a sample data transfer session. Some timing diagrams are included in figure 3 after the sample session.

SAMPLE DATA TRANSFER SESSION -- The following sequence illustrates the transfer of the ASCII data "HELLO" from the DCP to the VX1004.

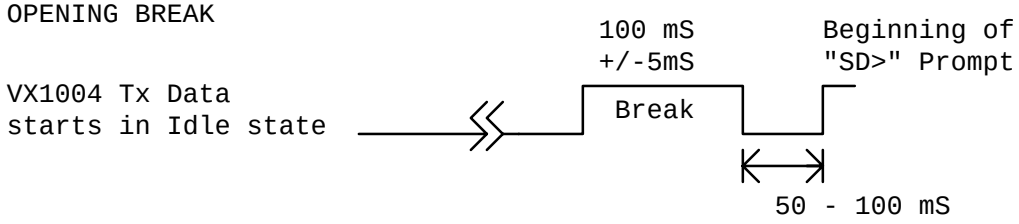
Data Logger		VX1004	Explanation
	<---	<BREAK>	Send 100mS Break to logger.
	<---	<CR><LF>	Send Carriage Return, Line Feed to logger.
	<---	SD>	Send prompt to logger.
H --->			Logger sends data to VX1004,
	<---	H	VX1004 echoes data.
E --->			
	<---	U	Incorrect echo, error !
<DLE> --->			Logger sends DLE to VX1004,
	<---	<DLE>	VX1004 moves back one byte in its buffer, and echoes the DLE character.
E --->			Logger re-sends the byte.
	<---	E	VX1004 echoes byte.
Logger decides to cancel present transfer, for some (any) reason.			
<CAN> --->			Logger sends CAN byte. VX1004 detects CAN, and restarts the sequence.
	<---	<CR><LF>	Send Carriage Return, Line Feed to Logger.
	<---	SD>	Send prompt to Logger.

```
      H      --->
                    <---   H
      E      --->     <---   E
      L      --->  <---      L
      L      --->  <---      L
      O      --->  <---      O
  <EOT> --->                          Logger sends End of Message
                                                character to VX1004.
                    <---   OK         VX1004 sends OK to Logger.
                    <---   <CR><LF>   Send Carriage Return,
                                                Line Feed to Logger.
```

There is now a delay until the transmission is complete. This time could be anywhere from several seconds to a few minutes. After the transmission is complete, the VX1004 sends a "transmission complete" message, and the current time (in HH:MM:SS format) to the logger.

```
                    <---   TX-OK      Send Transmission OK
                                                message to Logger.
                    <---   <CR><LF>   Send Carriage Return,
                                                Line Feed to Logger.
                    <---   12:42:51   Send Current time to Logger.
                    <---   <CR><LF>   Send Carriage Return,
                                                Line Feed to Logger.
```

The VX1004 now returns to the low power sleep mode until one minute before the next scheduled transmission.



The opening break can be used to wake up the data logger attached to the VX1004.

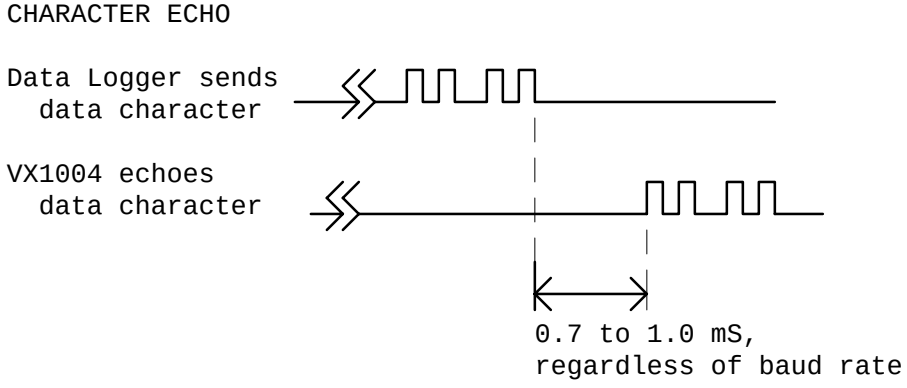


Figure 3. Data Transfer Timing Information

SATELLITE TRANSMISSION FORMAT

Any data transferred to the VX1004 is inserted into the transmission ahead of any data collected directly by the VX1004's own sensors. At the end of the GTM data, the standard VX1004 message header is inserted, followed by any enabled VX1004 sensor data. The battery voltage measured during the early part of the transmission (carrier) is always included at the end of the message. No GTM data is included in any standard VX1004 random transmissions.

ADDENDUM 4
VX1004-1 MODEL ONE PIECE UNIT

Stevens Water Monitoring Systems, Inc. 03 November 1998 FTB

VX1004 Manual Addendum

POWER AMPLIFIER

The power amplifier circuits are now contained within the single VX1004 DCP enclosure. No external power amplifier is required. The high power RF (10 to 20 Watts) comes out the SMA jack at the upper right corner of the VX1004 front panel.

The power adjustment potentiometer is accessible through the ACCESS cap at the lower right corner of the VX1004 front panel. Use a wattmeter and this potentiometer to adjust the transmitted RF power to the desired level. The pot is adjusted at the factory to 12.5 watts. More power may be required for long antenna cables or for low gain (omnidirectional) antennas.

The power connection to the VX1004 must carry about 4 amps during transmissions, and should be AWG 18 or larger wire. The connection between the battery and the VX1004 should be kept short and as low resistance as possible. A 0.25 ohm resistance in the battery wire will cause a 1 volt drop between the battery and the VX1004 during transmissions. Some fuses are relatively high resistance and should not be used between the battery and the VX1004.

INTERNAL FUSES

The VX1004 no longer contains any conventional fuses. All internal fuses are solid state resettable PTC fuses. If you suspect that an overcurrent condition has occurred, remove the battery power from the VX1004 front panel. Clear the condition that caused the fault (sensor wiring short, for example) and re-connect the battery to the VX1004.

Inside the VX1004 the power from the battery is split into several paths. The path to the power amplifier is fused at 8 amps. The path that supplies current to the rest of the VX1004 is fused at 1 amp. The path that supplies switched battery to external sensors is fused at 1 amp.

FAIL-SAFE

The fail-safe circuit acts to prevent a DCP in a fault condition from transmitting continuously and preventing other DCPs from being received on that channel. If a DCP transmits for more than 120 seconds, or there is less than 60 seconds between transmissions, then the fail-safe circuit trips. If the fail-safe circuit trips then the VX1004 will not transmit again until the fail-safe circuit is reset.

The fail-safe test point is reached through the ACCESS cap at the lower right corner of the VX1004 front panel. The test point is black and is sized for a standard 0.080" diameter voltmeter probe. If the fail-safe circuit is OK this test point measures about 0 volts DC. If the fail-safe circuit has been tripped this test point measures 5.0 volts DC. To clear the fail-safe, ground the test point for 2 seconds. After this action, the test point should measure 0 volts DC. To prevent an accidental fail-safe condition, do not attempt to transmit in the first 2 minutes after power has been applied to the VX1004.

Serial I/O

On earlier versions, the VX1004 front panel Serial I/O used a 9 pin D connector. This has been replaced with a 6 pin terminal block. The pinout for this connector is as follows:

1 Ground (the left-most pin)
2 SDI-12 Data Line
3 Battery (raw voltage, fused at 1 amp)
4 Switched Battery
5 TTL Rx Data
6 TTL Tx Data

COUNTER 3

A third counter has been added to the VX1004. The input for this counter is at the right end of the main terminal block at the pin labelled "PHONE T". It is best used in the COUNTER mode, as it is less accurate than counters 1 and 2 for frequency measurements. There is an internal 100 K-ohm pullup resistor to an internal 5 volt supply. This input is suitable for any up counter application, such as a tipping bucket rain gauge.

SATELLITE OPTIONS

The VX1004 allows the user to select one of three commonly used meteorological satellites: GOES, METEOSAT, OR GMS. GOES is a US satellite system used in the western hemisphere. METEOSAT is European satellite that is used in Europe and Africa. GMS is a Japanese satellite that is available in eastern Asia, Australia and much of the Pacific Ocean. The satellite selection is the first one in the self timed satellite menu. The satellite selection should be made prior to selecting the channel. If either METEOSAT or GMS is selected the preamble type (long or short) is meaningless; the VX1004 must use the long preamble for those satellites.

GOES TRANSMITTER MODULE FUNCTIONS

GOES Transmitter Module (GTM) functions, which previously were only available in a VX1004 with special firmware, have been added to the standard VX1004 DCP. This allows another smart sensor or data logger to transfer data to the VX1004 for transmission over satellite. The transfer occurs over the RS-232 serial port just prior to a satellite transmission.

To enable the GTM function the parameter GTM Max Bytes must be set to a non-zero value. If the value is zero, no GTM functions are performed. If the value is non-zero, the following differences in VX1004 operation occur:

The time of the next wake for transmission is always shown in the display. If the transmissions are not properly set up then the message "Sat TX Disabled" appears in the display.

The user must type the character 'M' or 'm' (for menu) to wake up the VX1004 via the serial port and use the serial menus. Simply hitting any key to use the menus will not work as it usually does.

No real time operational data is sent to the serial port. If the GTM function is disabled then the VX1004 prints sensor values, etc. to the serial port as it operates; this will not occur in the GTM mode.

The VX1004 wakes up about 50 seconds prior to the scheduled transmission and prompts the attached logger for data. Any data characters collected here appear in the satellite transmission prior to any data collected from other sensors attached to the VX1004. If the GTM mode is disabled, the VX1004 wakes up about 10 seconds prior to the transmission.

ADDENDUM 5

GR3230 GPS TIME RECEIVER

USER'S MANUAL

Version 1.00

January 29, 2003

Table of Contents

1 INTRODUCTION

The Steven-Vitel GR3230, Global Positioning System (GPS) module interface, is used to read the time from the GPS module and send the time and date to a target device that uses a menu to set time and date through an RS232 serial connection.

Since the GPS module cannot determine the time in a deterministic way, the GR3230 also has an internal clock. This internal clock is used to program the target after it has been set using the GPS derived time. The user can specify the exact time and period for the target time transfer. The user can also specify how many satellites to track, how long to power the receiver and how often to update the GR3230 internal clock. With these parameters the user has significant control of the GR3230's operation.

The GR3230 will normally be connected to the target via a DB9F to DB9F modem cable. The user can then perform all target and GR3230 configuration using a DB9F to DB9F null-modem cable and a PC running some RS232 communication software like Procomm® as though the GR3230 were not present.

The following sections describe the necessary hardware to connect the GR3230, and the software instructions to perform specific function.

2 HARDWARE

The GR3230 relies on several things in order to perform correctly. An external antenna with a clear view of the sky is used to obtain GPS information. A DB9F to DB9F modem cable is used to allow the GR3230 to communicate the time and date with a target device, usually a Steven-Vitel VX1100 or VX1004. A DB9F to DB9F null-modem cable and PC running serial communication software are used to program the GR3230 and to communicate with the target device when the GR3230 is operating in "Pass Through" mode.

2.1 HARDWARE DESCRIPTION

The following parts are used to connect the GR3230 to a target device that requires accurate time and date information.

2.1.1 GR3230 Module

The relevant user connections and indicators lights are presented in Figure 1.

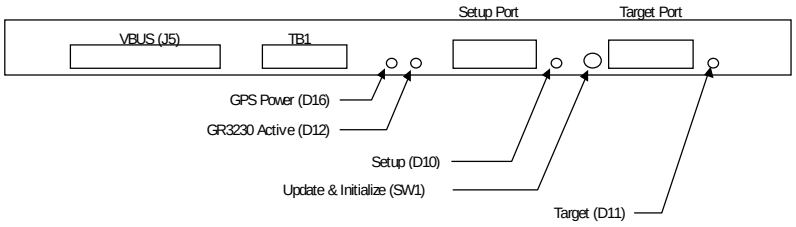


Figure 1

2.1.2 TARGET SERIAL CABLE

This is a fully populated modem cable connected between the target device (VX1100 or VX1004) and the Target Port of the GR3230. When connected to a VX1100, DTR (pin 4) is used to supply power to the GR3230 and J4 should be installed.

2.1.3 SETUP SERIAL CABLE

This is a fully populated null-modem cable connected between a PC running terminal software and the Setup Port of the GR3230.

2.1.4 ANTENA CABLE ASSEMBLY

The provided antenna is an omni-directional antenna that should be mounted where it has an unobstructed view of the sky to reduce the power on time of the GPS module.

2.2 HARDWARE SETUP

2.2.1 POWER REQUIREMENTS

When the GR3230 is getting power from the target device through the modem cable, jumper J4 must be installed. It can also receive power from TB1 (pin1 = GND, pin 2 = +12V) or the VBUS connector. The average current draw depends on prevailing conditions and user specified update intervals. While active, the GPS module requires 185mA. The GR3230 uses 1.4mA when sleeping.

2.2.2 BACKUP BATTERY

The GR3230 uses a CR2020 lithium battery to store user parameters and to provide power for the GR3230 internal clock. Replace the battery when it measures less than 2.9V. If the main power is removed at the same time as the backup battery, the unit should be re-initialized using the steps in section 0.

3 SOFTWARE

The GR3230 uses a command line interface to set and view all user configuration data. All of these commands take place while the GR3230 is operating in Command Mode as described in section 0.

3.1 SOFTWARE FUNCTION

3.1.1 RESET INPUT BUFFER

Any time the GR3230 receives the escape <ESC> character, 0x1B, the command input buffer is cleared. The input buffer in unaffected by GR3230 output. This means that although the terminal software may separate the user's command by update messages, the input is still continuous and uninterrupted.

3.1.2 GPS COMMAND MODE

Normally the GR3230 will operate in "Pass Through" mode. This allows the user to send and receive characters from the target without any interference. When the user enters the command sequence <CR> or <ESC> followed by +++<CR>, the GR3230 will enter "Command Mode". In this state, the GR3230 will take commands and execute them. To show that the unit has entered "Command" mode the welcome message is sent to the setup port. The GR3230 should respond with an identification, version number and copyright date message.

3.1.3 GR3230 PASS THROUGH MODE

To leave "Command" mode, send "q<CR>". If the user does not send the command within 3 minutes, the unit will automatically re-enter "Pass Through" mode and print "GR3230 Pass Mode".

3.1.4 HELP

To have the GR3230 print a terse list of user commands, send the command: '?<CR>'; where <CR> represents the enter key.

3.1.5 GR3230 COMMANDS

It is possible to read any user settable parameter by replacing the set value with a single question mark. To show the current GPS Power Timeout, send the command "gp?".

3.1.5.1 CLOCK READ

To read the GR3230 internal clock, send "ci<CR>". The GR3230 will respond with the time of the internal clock in the format: "Time= hh:mm:ss MM/DD/YYYY". To obtain time readouts for one minute send the command "cr<CR>". Thereafter, sending "<SPACE><ESC>" will abort time update as will any other valid command.

3.1.5.2 CLOCK WRITE

It is possible, but not necessary, to manually set the GR3230 clock. Use the command, "cwhh:mm:ss MM/DD/YYYY<CR>"; where hh = hours, mm = minutes, ss = seconds, MM = the month, DD = the date, and YYYY = the year. Use two or four digit appropriately. For example 9:35 a.m. January 13, 2001 would be: "cw09:35:00 01/13/2001<CR>".

3.1.5.3 CLOCK UPDATE

The user can force the GR3230 to turn on the GPS module at any time and retrieve the satellite derived time. Just send the command "cun" that stands for clock update now. Normally the user programs the GR3230 to periodically get the time by specifying an update interval. This interval is between 0 and 1440 minutes. If the user sets the interval to 0, the GR3230 will NEVER get the time from the GPS module. The exact time when the GR3230 will get the time is not specified. This is because of the indeterminate time required to track the satellites and calculate time. Therefore, only a period is specified as in: "cummmm" where mmmm is the number of minutes between updates. Type "cu?" to find the next time the unit will perform the next GR3230 update and the current user specified interval.

Factory Default: 0720 minutes (12 hours)

3.1.5.4 FACTORY TEST, INITIALIZE NON-VOLATILE RAM

It may be desirable to restore factory settings at some point. This can be accomplished by sending the command "fi<CR>". Alternatively, this can also be accomplished by holding the "Update" push button SW1 on the front panel while resetting the GR3230. This process can be verified by watching the power on sequence stop with just the "Active" LED on. The sequence will continue as soon as SW1 is released. The factory defaults are listed in each section of this manual where user parameters are set.

3.1.6.1 TARGET COMMANDS

3.1.6.1 TARGET TIME STRING

The GR3230 uses this command string to log into the target device and program the time. The command string is used to get the target to the point where the next 8 characters are the time in the format "hh:mm:ss<CR><LF>". The time sent is two seconds in advance of the current time. At the exact time, <CR><LF> are then sent. This minimizes error for serial transmissions. To show the current Target Time string type "td?".

Factory Default:
VX1100“/N/e/N/e/P31111/r/P37/r/P3”
VX1004“/N/e/N/e/N/e/P1T/r/P1"

The GR3230 uses a simple script language to implement a few features.

Symbol	Effect
/N	Do not wait for the target to echo the following character. Normally the GR3230 will send a character and wait for it to be echoed. If the echo does not take place in a finite time, it will re-send the character up to N times before aborting the process.
/Pn	Wait n x 100mS. For example, /P3 will cause a 300mS pause before acting on the next character in the command string. Valid characters are ‘0’ through ‘9’.
/e	Send an <ESC>, ASCII code 0x1B.
/n	Send a <LF>, ASCII code 0x0A.
/r	Send a <CR>, ASCII code 0x0D.
//	Send a single “/”, ASCII code 0x2F.

Table 1

3.1.6.2 TARGET DATE STRING

The date string is sent after the time update succeeds unless this string is empty. The string is used to move from the target’s “set time” menu to the target’s “set date” menu option. After the GR3230 acts on the target date setup string, it will send the date in the format “MM-DD-YY”. Refer to
Table **1** for a list of appropriate commands. To see the current Target Date string, type “td?<CR>”

Factory Default
VX1100“/N/e/P26/r/P1”
VX1004“D/P3”

3.1.6.3 TARGET LOGOUT STRING

To put the target device back into low power mode, this string is sent after the date string and date are sent. It uses the same commands found in
Table **1**. To see the current Target Logout String, type “tl?<CR>”.

Factory Default:
VX1100“/N/e/P31/N/r”
VX1004“A/r”

3.1.6.4 TARGET UPDATE PARAMETERS

The user is able to specify the exact time and interval that the GR3230 updates the target’s date and time using the command “tuhh:mm:ss xxxx<CR>”; where hh = 24 hour time, mm = minutes after the hour, ss = seconds after the minute, and xxxx = the number of minutes between the start of each time transfer. For example, “tu00:15:30 0060” would cause the GR3230 to transfer time to the target device every hour (sixty minutes) starting fifteen minutes and thirty seconds after midnight. Note that irregular intervals will cause the device to “slide” into times that are not easy to predict. For instance an interval of 59 minutes would cause transfers at 00:15:30, 01:14:30, 02:13:30, 03:12:30, etc… After a few hours, the next transfer time becomes “unpredictable without knowing exactly what date the unit started. If an interval of 0000 is used, NO updates will ever take place. To see the next Target update time and the interval, type “tu?<CR>”.

Factor Default: “00:15:00 0720”

3.1.7 GPS MODULE COMMANDS

3.1.7.1 GPS INITIALIZE

At the factory, the GPS module is initialized. This resets the GPS module to use UTC time instead of GPS time. The Target is assumed to be using GPS time and therefore the GPS module must be set back to GPS time mode. Initializing the GPS module also clears the GPS modules internal, battery backed clock and the internally saved almanac. Reading the clock after initialization will result in unpredictable clock times if the GPS module has not acquired at least one satellite. The GR3230 avoids this problem by always reading the number of satellites being tracked. The GPS response should be “GPS set to defaults”

3.1.7.2 GPS TIME MODE

The target should be set to GPS time and not UTC time. When the GPS module is reset, it defaults to UTC time. This command will tell the GPS module to use GPS time. The response should be “GPS time mode”.

3.1.7.3 GPS SATELLITE TRACKING NUMBER

The time is validated by the GR3230 by reading the number of satellites that are currently being tracked. Until the number tracked meets a user specified minimum, the GPS module will remain powered. To obtain an accurate time, the recommended number is three (3). Setting this number to high may result in the GR3230 reaching a GPS Power Timeout situation. If the number tracked never reaches the minimum specified and the power on timer exceeds the timeout, the unit will stop trying to synchronize the GR3230 clock with the satellite derived time. This does not effect the target update time since the two functions are independent. The current GPS module can track up to 8 satellites.

Factory Default: 3

3.1.7.4 GPS POWER TIMEOUT

There may be temporary conditions that prevent the GPS module from acquiring the correct time in a reasonable amount of time. Consider that the antenna is blocked by a large truck, for a few hours. In order to save power, the user can specify a timeout period from 000 to 360minutes. If 000 is used, the GPS module will stay on until the tracking number of section XXXX is met. The command is “gpmmm<CR>”. The first time the GR3230 is powered, this timeout is set to 60 minutes which gives the GPS module time to download the almanac which is used to track the satellites more quickly. Thereafter, the user specified timeout is used.

Factory Default: 012 minutes

3.1.7.5 GPS SELF-TEST

To insure that the antenna is connected and that the module is working correctly, it is possible to send the module a command to perform a self-test. The returned error code is a 16bit-mapped field:

Bit 15(msb)	Antenna undercurrent
Bit 14	Antenna over current
Bit 13	RTC comm & time
Bit 12	Temperature sensor
Bit 11	spare
Bit 10	RAM
Bit 9	ROM

Bit 8 1 KHz presence
Bit 7 – Bit 6 Channel 8 through Channel 1 correlation test.

The GR3230 reports the test result as a 4-digit hexadecimal error code. For example, the error code 0x8000 would represent Antenna undercurrent (a missing antenna). This command sets all of the GPS receiver parameters to their default values. The GPS module will then need to be set to GPS time mode, not UTC that is the default.

3.2 SOFTWARE SETUP

The unit is prepared for delivery by performing the following steps:

Install the backup battery as per section 0.

Connect the GR3230 to an external GPS antenna.

Connect the GR3230 to the target device using a modem cable as per section 0 and verify that jumper J4 on the GR3230 main board is installed.

Connect the GR3230 to a computer running terminal software using the null-modem cable of section 0. The software should be set to 9600, 8, N, 1.

Press and hold the Initialize button on the GR3230 while turning on the VX1100 power switch. Release the Initialize button when the GR3230 Active LED comes on.

Enter GR3230 command mode as per section 0.

Initialize the GPS module as per section 0.
Set the GPS module to use GPS time mode as per section 0.

Change the GR3230 to “Pass Through” as per section 0.

This leaves the GR3230 ready to receive data from the Global Positioning System at the specified intervals and able to update the target when able.