Vanguard 3000™
Multicarrier 3G Cellular Router

I/O Agent Application Note
PN 009-0000-237 Rev 0
October 2012

REVISION HISTORY

REV	DATE	REVISION DETAILS
0	Oct 2012	Initial Version of P/N 009-0000-237

IMPORTANT NOTICE

Because of the nature of wireless communication, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e., have errors), or be totally lost. Significant delays or losses of data are rare when wireless devices such as the Vanguard 3000 are used in a normal manner with a well-constructed network. Vanguard 3000 should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury, death, or loss of property. CalAmp accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using Vanguard 3000, or for the failure of Vanguard 3000 to transmit or receive such data.

DOCUMENT STATEMENT

Every effort is taken to provide accurate, timely product information in this user document. Product updates may result in differences between the information provided herein and the product shipped. The information in this document is subject to change without notice.

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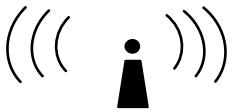
RF EXPOSURE COMPLIANCE REQUIREMENTS



RF Exposure **Please read and understand the important regulatory and safety information contained in the Vanguard 3000 user manual (P/N 001-7300-100) before commissioning Vanguard 3000.**

The manual will state if CalAmp recommends / requires that Vanguard 3000 be professionally installed and that a minimum separation distance between the radiating structure and any person be respected.

TABLE OF CONTENTS

1 DOCUMENT OVERVIEW

For specific details on how to configure the Vanguard 3000, please refer to the Vanguard 3000 user manual (P/N 001-7300-100).

2 Audience

This document can be used as a technical reference for developers using, and system administrators installing, Vanguard 3000.

2.1 ABBREVIATIONS AND ACRONYMS

Acronym	Description
NMEA	National Marine Electronics Association
PDU	Protocol Data Unit

2.2 TERMS AND DEFINITIONS

Acronym	Description
Protocol Data Unit (PDU)	Information that is delivered as a unit among peer entities of a network and that contains information that can be processed by that peer.

2.3 REFERENCED DOCUMENTS

ID	Description
1	NMEA 0183 Standard For Interfacing Marine Electronic Devices / Version 2.30 / March 1, 1998
2	Sample code: nmea_sender.c
3	CalAmp P/N 001-7300-100, “VANGUARD SC & 3000 USER MANUAL”

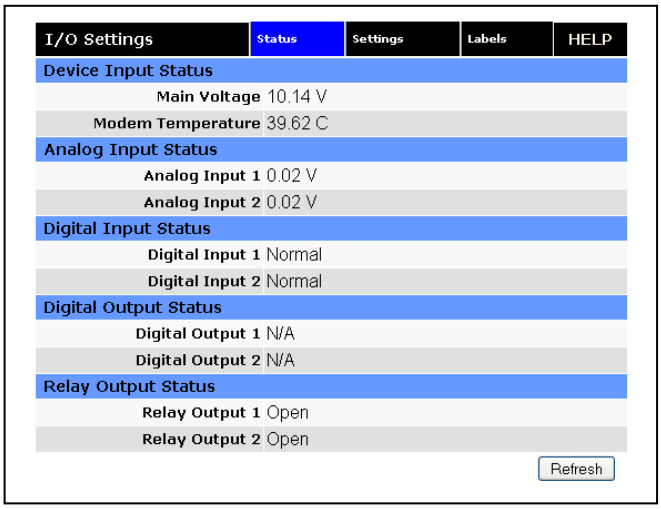
3 Introduction

As described in [3], the Vanguard 3000 modem supports the following I/Os:

- Vanguard 3000 Input Status: Ignition Sense, Main Voltage indication and Modem Temperature
- Two general-purpose external analog input lines
- Two general-purpose external digital input lines
- Two general-purpose external digital outputs (relay-driven contact closures)

The Vanguard 3000 I/O agent subsystem is configured via the Vanguard 3000 Web pages. Status Monitoring is provided via an NMEA-based protocol. The Vanguard 3000 I/O subsystem operates according to a manager/agent model. The manager sends requests to the Vanguard 3000 I/O agent, which performs the required actions. The Vanguard 3000 agent reports alarms and indications to the manager.

Figure 1 - I/O Setting – Status



4 Specifications

4.1 COMMUNICATION MODEL

The Vanguard 3000 I/O subsystem operates according to a manager/agent model

The manager sends requests to the Vanguard 3000 I/O agent, which performs the required actions. The Vanguard 3000 agent also reports asynchronous events (alarms and indications) to the manager.

4.2 PDU TRANSPORT

Exchanges between the manager applications and the Vanguard 3000 support TCP/IP

Exchanges between the manager applications and the Vanguard 3000 support UDP/IP

The Vanguard 3000 I/O agent uses an arbitrary IP port (default: 6263), configured via the Vanguard 3000 Web pages.

The manager is able to send I/O requests & ACKs to the Vanguard 3000 via:

(a) TCP (connection is initiated by the Vanguard 3000)

(b) UDP (carrier-assigned WAN-side IP address, or LAN address)

The Vanguard 3000 is able to send I/O responses, alarms and indications to a manager IP address via:

(a) TCP (connection initiated by the Vanguard 3000)

(b) UDP

A single operator-configurable transport service (UDP or TCP) is available at any moment and is used for both directions (manager --> Vanguard 3000, manager <-- Vanguard 3000)

4.3 CONGESTION CONTROL

Messages are not queued up; if the Vanguard 3000 cannot deliver them (ex: configured for TCP but no socket opened), they are silently dropped.

Congestion control for established TCP-based connections follow and are limited to the built-in Vanguard 3000 TCP/IP stack congestion control mechanisms.

4.4 PDU FORMAT

Vanguard 3000 I/O requests & responses, alarms/indications & ACKs use existing NMEA 0183 (V2.30) sentences.

Frame format are as described in Section 5

The "II" (Integrated Instrumentation) NMEA talker mnemonic is used

4.5 PROTOCOL EXCHANGES

4.5.1 Read Vanguard 3000 I/O value

```
(1) manager requests value (NMEA msg: ACK)
(2) Vanguard 3000 responds with requested data (NMEA msg: XDR)

[manager application] ---(1)--- request ----------> [Vanguard 3000]
[manager application] <-------- response ---(2)---- [Vanguard 3000]
```

4.5.2 Set the state of an output line

```
(1) manager requests operation (NMEA msg: ACK)
(2) Vanguard 3000 acknowledges that command has been executed by returning
    the updated output line state (NMEA msg: XDR)

[manager application] ---(1)--- request ---------> [Vanguard 3000]
[manager application] <-------- ack ---(2)-------- [Vanguard 3000]
```

4.5.3 Receive and acknowledge an alarm sent by the Vanguard 3000

```
(1) Vanguard 3000 sends alarm (NMEA msg: ALR)
(2) manager acknowledges alarm (NMEA msg: ACK)

[manager application] <--------- alarm ----(1)---- [Vanguard 3000]
[manager application] ---(2)--- ack -------------> [Vanguard 3000]
```

4.5.4 Receive an indication generated by the Vanguard 3000

```
(1) Vanguard 3000 sends indication (NMEA msg: ALR)

[manager application] <--------- alarm ----(1)---- [Vanguard 3000]
```

4.6 ALARMS AND INDICATIONS

4.6.1 Alarms

Alarms are abnormal conditions / faults declared by the Vanguard 3000

The manager is able to acknowledge alarms to stop their repeated generation

4.6.1.1 Reporting

Alarms are reported continually at GPS AVL reporting rate until acknowledged by the manager or until the alarm root cause disappears.

Upon original assertion, alarms force the immediate generation of an alarm report message even if a GPS AVL report was not intended to go out at this moment

Subsequent reports for the same event (until acknowledged by the manager) are sent at the next normally scheduled GPS AVL report transmission

4.6.1.2 Indications

Indication messages are unacknowledged

4.6.1.2.1 Alarm return-to-normal

The Vanguard 3000 generates an indication message when the root cause of a previously declared alarm has disappeared.

4.6.1.2.2 Informational messages

The Vanguard 3000 generates an indication message when a non-alarm, informational event is detected (example: power-up boot sequence completed)

A single informational message is currently supportedVanguard 3000: Vehicle power-up (corresponds to initial detection of ignition sense)

4.6.2 Position Fix

Immediately following an alarm or indication message, the Vanguard 3000 sends a $GPRMC message followed by a $GPVTG message to help track the vehicle.

The $GPRMC and $GPVTG messages are sent in the same UDP datagram (when UDP is used) or in the same TCP socket (when TCP is used) as the alarm / indication message.

4.6.3 Multiple Alarms / Indications Reports

The Vanguard 3000 is able to send up to twelve (12) alarm and/or indication messages in a single transmission

Each alarm / indication is sent using its own ALR message

The GPS position fix is appended only after the last ALR message

```
Example: $IIALR … $IIALR … $IIALR … $GPRMC … $GPVTG
```

5 PDU Types

Note: In all the examples provided below, for clarity the checksum is replaced by the value "FF".

5.1 ACK MESSAGE

- - I/O value read request (manager --> Vanguard 3000)
- - Output line state setting request (manager --> Vanguard 3000)
- - Alarm acknowledgement (manager --> Vanguard 3000)

```
$IIACK,xxx,*hh<CR><LF>

xxx: ASCII-encoded hex target descriptor,
     composed of three fields <F1><F2><F3>
     <F1> Operation being performed
        0    Acknowledge an alarm or opening a digital output
        1    Close a digital output
        2    Read an analog or digital input
        3-F  Reserved for future use

     <F2> Class of I/O being operated on
        0    Digital input
        1    Analog input
        2    Relay output (contact closure)
        3-F  Reserved for future use

     <F3> I/O Channel number
        Digital Inputs (when <F2> is 0)
           0    Ignition sense
           1    DIN1
           2    DIN2
           3-F  Reserved for Future use

        Analog Input (when <F2> is 1)
           0    Vanguard 3000 input voltage sense
           1    Board/Cell module temperature sense
           2    AIN1
           3    AIN2
           4-F  Reserved for Future use

        Relay Output (when <F2> is 2)
           0    RLY1 (COM1/NO1)
           1    RLY2 (COM2/NO2)
           3-F  Reserved for Future use

hh: NMEA-compliant checksum
```

Example: Acknowledge a "Cell module temperature out of range" alarm

```
$IIACK,011,*FF<CR><LF>
```

Example: Close Relay1

```
$IIACK,121,*FF<CR><LF>
```

5.2 XDR MESSAGE

- - Response to I/O read request (manager <-- Vanguard 3000)
- - Response to output line state setting request (manager <-- Vanguard 3000)

```
$IIXDR,t,x.x,u,ioid;ip*hh<CR><LF>
```

```
t:  NMEA-compliant I/O type
     C  temperature     (Cell, PCI module temperature sense)
     U  voltage         (AIN1..4, Vanguard 3000 input voltage sense)
     S  switch or valve (digital or relay I/O, ignition sense)
     --- other NMEA types are not used at this time ---

x.x: NMEA-compliant free-form integer or floating point value.
     As per NMEA 0183, digital I/O values are:
      0 = OFF/OPEN
      1 = ON/CLOSED

u:  NMEA-compliant unit of measurement
     C = degrees Celsius
     V = Volts

ioid: I/O Identifier composed of <F2><F3>
     <F2> Class of I/O being operated on
        0    Digital input
        1    Analog input
        2    Relay output (contact closure)
        3-F  Reserved for future use

     <F3> I/O Channel number
        Digital Inputs (when <F2> is 0)
           0    Ignition sense
           1    DIN1
           2    DIN2
           4-F  Reserved for Future use

        Analog Input (when <F2> is 1)
           0    Vanguard 3000 input voltage sense
           1    Board/Cell module temperature sense
           2    AIN1
           3    AIN2
           4-F  Reserved for Future use

        Relay Output (when <F2> is 2)
           0    RLY1 (COM1/NO1)
           1    RLY2 (COM1/NO1)
           2-F  Reserved for Future use

ip: Operator-specified IP address

hh: NMEA-compliant checksum
```

Reports a temperature of 42.1 (in degrees Celsius) for the Cell module

```
$IIXDR,C,42.1,C,11;172.30.41.9*FF<CR><LF>
```

Confirms that contact closure #1 has been closed

```
$IIXDR,S,1,,20;172.30.41.9*FF<CR><LF>
```

As per NMEA 0183, the <u> field is left empty for digital I/O's, including ignition sense (switches and valves, <t> field value: S)

5.3 ALR MESSAGE

Vanguard 3000-generated alarms and indications (manager <-- Vanguard 3000)

```
$IIALR,hhmmss.ss,xxx,c,s,ip;uid;txt*hh<CR><LF>
```

```
hhmmss.ss: NMEA-compliant time (UTC) of initial condition change

xxx: ASCII-encoded hex target descriptor,
     composed of three fields <F1><F2><F3>
     <F1> Type of alarm message
        0    Original message for a given alarm
        1    Repetition of an event already reported
        2-F  Reserved for future use

     <F2> Class of I/O being operated on
        0    Digital input
        1    Analog input
        2    Digital output (contact closure)
        3-F  Reserved for future use

     <F3> I/O Channel number
        Digital Inputs (when <F2> is 0)
           0    Ignition sense
           1    DIN1
           2    DIN2
           3-F  Reserved for Future use

        Analog Input (when <F2> is 1)
           0    Vanguard 3000 input voltage sense
           1    Board/Cell module temperature sense
           2    AIN1
           3    AIN2
           4-F  Reserved for Future use

        Relay Output
           0    RLY1 (COM1/NO1)
           1    RLY2 (COM1/NO1)
           3-F  Reserved for Future use
c:  NMEA-compliant alarm condition
    A = Threshold exceeded (alarm is active)
    V = Threshold not exceeded (indication of return to normal state)

s:  NMEA-compliant alarm's acknowledge state
    V = unacknowledged

ip:  User-speficied IP address (as configured via the Vanguard 3000 WEB pages)

uid: Free-form text unit identifier (8 characters max)

txt: Free-form alarm/indication text (20 characters max)

hh:  NMEA-compliant checksum
```

Example: Reports a temperature-back-in-range indication for the Cell module

```
$IIALR,135912.01,011,V,V,172.30.41.9;ADAM12;PCI TEMP NORMAL*FF<CR><LF>
```

Example: Reports a "repeat: digital input #1" alarm

```
$IIALR,211545.22,101,A,V,172.30.41.9;ADAM12;MAN DOWN*FF<CR><LF>
```

Notes:

- < hhmmss.ss>: If the alarm message is being sent as a repetition of an event already declared, this field will bear the timestamp of the original report.
- <s> The Vanguard 3000 does not confirm alarm acknowledgement, therefore the NMEA 0183 "alarm has been acknowledged" state is not used.

- Both the IP address and the unit identifier are included, to make sure an association can be made between the two by the user application
- <txt>: Freeform text is hard-coded for dedicated usage I/O's and user-configurable for generic I/O's. NMEA 0183 character restrictions apply ([1] 6.1 Table 1, Table 2)

About CalAmp

CalAmp develops and markets wireless communications solutions that deliver data, voice and video for critical networked communications and other applications. CalAmp's two business segments are Wireless DataCom, which serves utility, governmental and enterprise customers, and Satellite, which focuses on the North American Direct Broadcast Satellite (DBS) market. For additional information, please visit the Company's website at www.CalAmp.com.