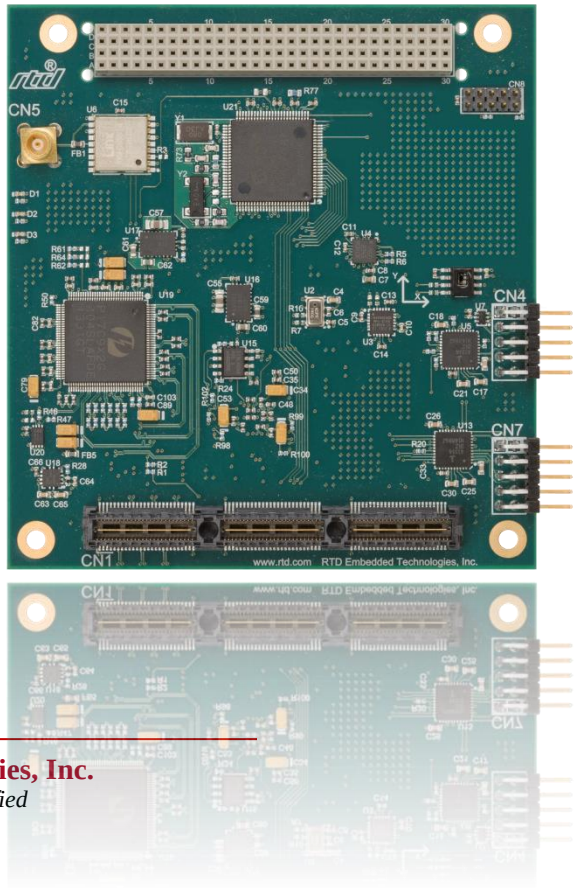
GPS25165HR/GPS35165HR

PCIe/104 GPS Receiver and 9DoF Sensor

User's Manual

BDM-610020124 Rev. B



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Revision History

Rev A	Initial Release
Rev B	Added Magnetometer 12 position calibration procedure picture. Added new calibration commands Added notes which commands require the latest firmware. Added IDAN connector information Added COCOM Limits Section

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1 Introduction

1.1 Product Overview

The GPS35165 is designed to provide a PCIe UART interface to a GPS Receiver. This GPS module utilizes the Linx RXM-GNSS-TM GPS Receiver. This provides a low-power solution that supports NMEA-0183 protocol. This module also supports +3.3V and +5V active antennas.

This module also provides a serial interface to 9 Degree of Freedom (9DoF) inertial sensor and altimeter/barometer sensor. These sensors will provide the user additional position information that a GPS alone cannot provide.

1.2 Board Features

- PC/104 form factor
- Bus Structure Options:
  - **PCIe/104 (GPS35165HR)**
    - PCIe universal expansion bus (Type 1 or Type 2)
  - **PCI/104-Express (GPS25165HR)**
    - PCIe universal expansion bus (Type 1 or Type 2)
    - PCI pass-through expansion bus
- PCIe x1 interface (Gen 2, 5 GT/s)
- PCIe link repopulation allowing increased PCI Express stack capacity
- Linx RXM-GNSS-TM GPS engine
  - L1 1575.42MHz, C/A code
  - 33-channel satellite tracking
  - Position accuracy: 2.5m
  - Time accuracy of ±11ns
  - 1Hz update rate (configurable up to 10Hz)
  - Tracking sensitivity down to -164 dBm
  - Protocol: NMEA-0183 ver 4.10
  - Constellation System Support:
    - GPS
    - GLONASS
    - GALILEO
    - QZSS
  - DGPS support:
    - (SBAS) Satellite-Based Augmentation System
    - (RTCM) Radio Technical Commission for Maritime Services
    - (WAAS) Wide-Area Augmentation System
    - (EGNOS) European Geo-Stationary Navigation System
    - (MSAS) MTSAT Satellite-Based Augmentation System
    - (GAGAN) GPS-Aided Geo-Augmented Navigation
- Supports active (+3.3V or +5V) and passive antennas
- I2C Sensor Interface via COM port
  - Inertial Sensor Module
    - 3-axis digital compass
    - 3-axis accelerometer
    - 3-axis gyroscope
  - Altimeter/Barometer Module
- Requires only +5 VDC for operation

1.3 Ordering Information

The GPS35165 is available with the following options:

Table 1: Ordering Options

Part Number	Description
GPS35165HR	PCIe/104 GPS Receiver with Linx RXM-GNSS-TM GPS Engine
SK-GPS35165HR	Starter Kit including GPS35165HR, adapter cable, and antenna (XK-CM57)
GPS25165HR	PCI/104 Express GPS Receiver with Linx RXM-GNSS-TM GPS Engine
SK-GPS25165HR	Starter Kit including GPS25165HR, adapter cable, and antenna (XK-CM57)
IDAN-GPS35165HRS	PCIe/104 GPS module in modular IDAN frame
IDAN-SK-GPS35165HRS	PCIe/104 GPS module in modular IDAN frame; with cables and antennae kit (IDAN-XKCM34)
IDAN-GPS25165HRS	PCI/104 Express GPS module in modular IDAN frame
IDAN-SK-GPS25165HRS	PCI/104 Express GPS module in modular IDAN frame; with cables and antennae kit (IDAN-XKCM34)

The Intelligent Data Acquisition Node (IDAN™) building block can be used in just about any combination with other IDAN building blocks to create a simple but rugged 104™ stack. This module can also be incorporated in a custom-built RTD HiDAN™ or HiDANplus® High Reliability Intelligent Data Acquisition Node. Contact RTD sales for more information on our high reliability systems.

1.3.1 Cable Kits

XK-CM57

The XK-CM57 is a GPS antenna for use with the stand-alone GPS25165HR/GPS35165HR.

- 50-Ohm MCX Plug connector
  - 1.575 GHz Magnetic
  - +5 VDC Active Antenna
  - Magnetic Base Mount
- Dimensions
  - Cable length: 16 feet
  - Height: 0.5 inches
  - Base: 1.8 inches square
- Weight: < 1 lbs.
- Operating temperature, 90% humidity non-condensing: -40 to +85C
- Storage temperature, -40 to +85C

IDAN-XKCM34

The IDAN-XKCM34 is a GPS antenna for use with the IDAN-GPS25165HRS and IDAN-GPS35165HRS.

- 50-Ohm SMA connector
  - 1.575 GHz Magnetic
  - +5 VDC Active Antenna
  - Magnetic Base Mount
- Dimensions
  - Cable length: 16 feet
  - Height: 0.5 inches
  - Base: 1.8 inches square
- Weight: < 1 lbs.
- Operating temperature, 90% humidity non-condensing: -40 to +85C
- Storage temperature, -40 to +85C

1.4 Contact Information

1.4.1 Sales Support

For sales inquiries, you can contact RTD Embedded Technologies sales via the following methods:

Phone: 1-814-234-8087 Monday through Friday, 8:00am to 5:00pm (EST).
E-Mail: sales@rtd.com

1.4.2 Technical Support

If you are having problems with you system, please try the steps in the Troubleshooting section of this manual.

For help with this product, or any other product made by RTD, you can contact RTD Embedded Technologies technical support via the following methods:

Phone: 1-814-234-8087 Monday through Friday, 8:00am to 5:00pm (EST).
E-Mail: techsupport@rtd.com

2 Specifications

2.1 Operating Conditions

Table 2: Operating Conditions

Symbol	Parameter	Test Condition	Min	Max	Unit
V_{cc5}	5V Supply Voltage		4.75	5.25	V
V_{cc3}	3.3V Supply Voltage		n/a	n/a	V
V_{cc12}	12V Supply Voltage		n/a	n/a	V
T_a	Operating Temperature		-40	+85	C
T_s	Storage Temperature		-55	+125	C
RH	Relative Humidity	Non-Condensing	0	90%	%
MTBF	Mean Time Before Failure	Telcordia Issue 2 30°C, Ground benign, controlled		TBD	Hours

2.2 Electrical Characteristics

Table 3: Electrical Characteristics

Symbol	Parameter	Test Condition	Min	Typical	Max	Unit
P	Power Consumption	V_{cc5} = 5.0V		TBD		W
I_{cc5}	5V Input Supply Current	Active		TBD		A
PCIe/104 Bus						
	Differential Output Voltage		0.8		1.2	V
	DC Differential TX Impedance		80		120	Ω
	Differential Input Voltage		0.175		1.2	V
	DC Differential RX Impedance		80		120	Ω
	Electrical Idle Detect Threshold		65		175	mV

3 Board Connection

3.1 Board Handling Precautions

To prevent damage due to Electrostatic Discharge (ESD), keep your board in its antistatic bag until you are ready to install it into your system. When removing it from the bag, hold the board at the edges, and do not touch the components or connectors. Handle the board in an antistatic environment, and use a grounded workbench for testing and handling of your hardware.

3.2 Physical Characteristics

STEP model is available upon request; contact RTD Tech Support for more information.

- Weight: Approximately 80 g (0.18 lbs.)
- Dimensions: 90.17 mm L x 95.89 mm W (4.570 in L x 3.775 in W)

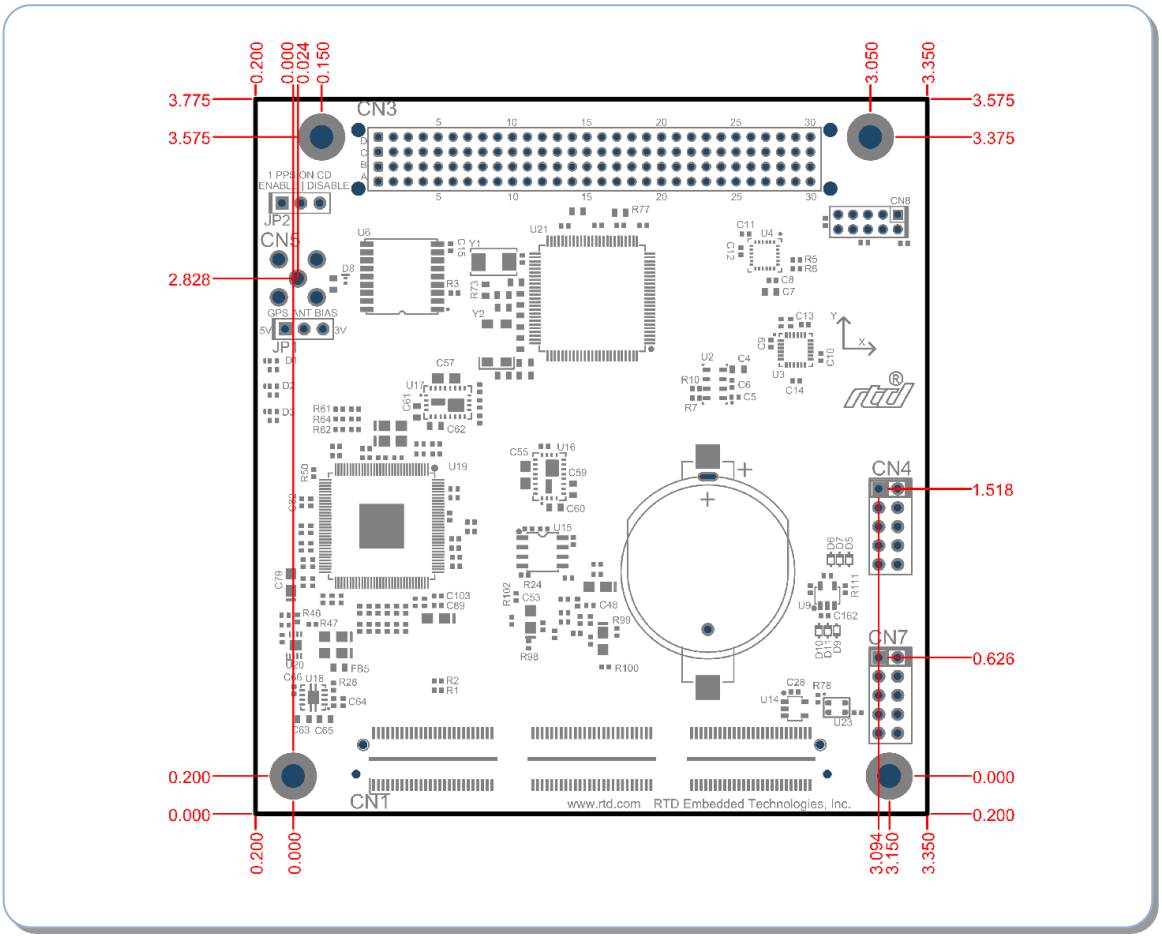


Figure 1: Board Dimensions

3.3 Connectors and Jumpers

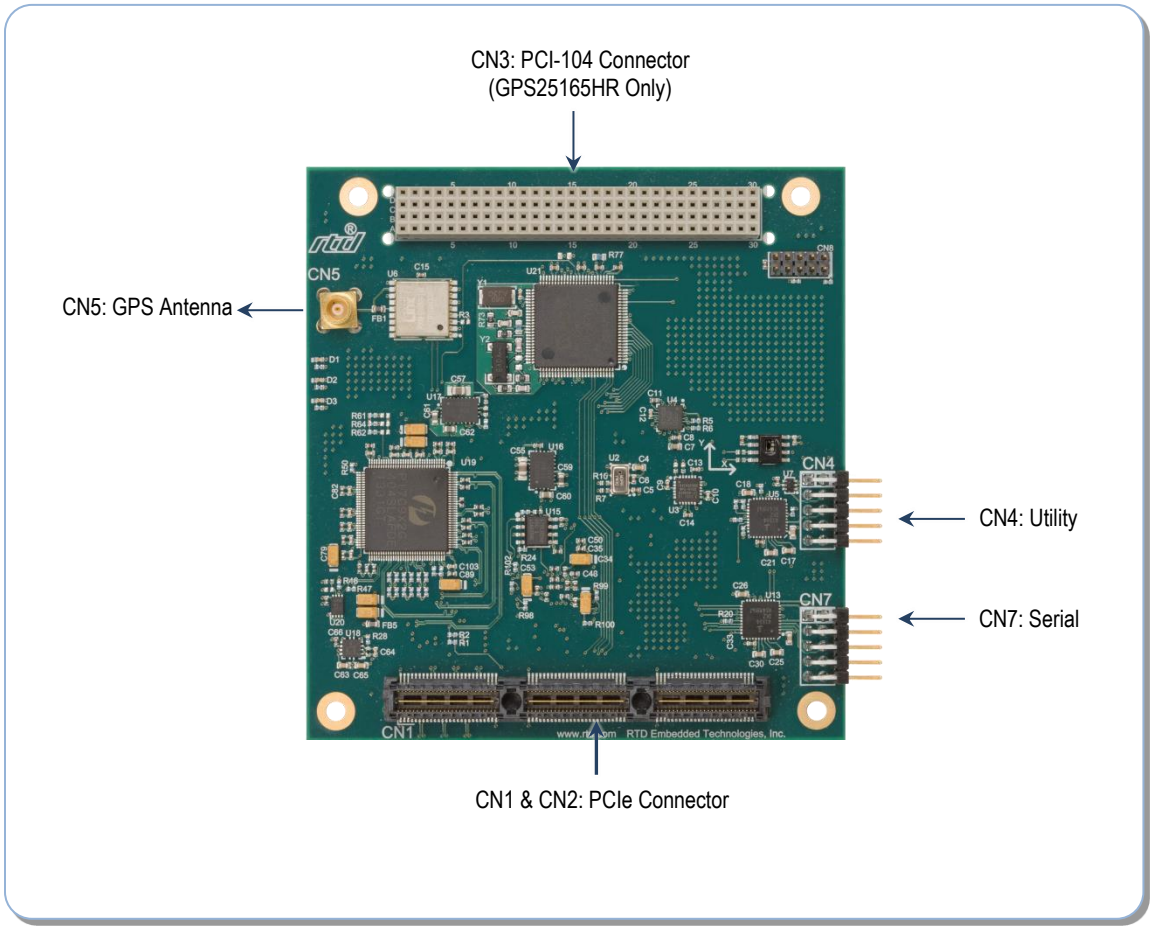


Figure 2: Board Connections

3.3.1 Bus Connectors

CN1(Top) & CN2(Bottom): PCIe Connector

The PCIe connector is the connection to the system CPU. The position and pin assignments are compliant with the *PCI/104-Express Specification*. (See PC/104 Specifications on page 28)

The GPS35165 is a "Universal" board, and can connect to either a Type 1 or Type 2 PCIe/104 connector.

CN3: PCI Connector (GPS25165HR Only)

The PCI connector is the connection to PCI peripheral modules. This connector is used only as a pass through connector on this board.

3.3.2 External I/O Connectors

CN7: Serial I/O Connector

CN7 is an RS-232 interface that is connected to the third port of the UART. Table 4 has the pin-out.

Table 4: CN7 in UART RS-232 Mode

Pin Name	Pin #	Pin #	Pin Name
DSR	2	1	DCD
RTS	4	3	RxD
CTS	6	5	TxD
RI	8	7	DTR
GND	10	9	GND

CN4: Utility Connector

CN4 is the Utility connector. It contains a buffered 1 pulse-per-second with a 6 ns maximum delay, RS-232 level GPS output data and an external battery connector for GPS module.

Table 5: CN4 Utility

Pin Name	Pin #	Pin #	Pin Name
GND	2	1	RSVD
1PPS	4	3	RSVD
GPS TX	6	5	GND
GND	8	7	External Battery
GND	10	9	RSVD

CN5: GPS Antenna Connector

The GPS35165 provides an MCX connector for the GPS antenna.

Connector Part #: SPC Technology 8589-0853 **Example Mating Connector:** Amp 901-9877-RFX

Note: CN8 is for Factory Use only

3.3.3 JUMPERS

JP1: GPS Antenna Bias

JP1 is used to select the antenna bias level. The available bias levels are shown in Table 6.

Table 6: JP3 Settings

Setting	Description	Notes
1 – 2	5V Bias Antenna	
2 – 3	3.3V Bias Antenna	Factory default
Open	Passive Antenna	

JP2: 1 PPS on Carrier Detect

JP2 is used to connect/disconnect the 1 PPS signal from UART 1 carrier detect. The options are shown in Table 7.

Table 7: JP4 Settings

Setting	Description	Notes
1 – 2	1PPS is connected to the UART 1 CD	Factory default
2 – 3	1PPS is disconnected from UART 1 CD	

3.3.4 LEDS

D1: GPS Fix LED

D1 shows if the GPS has a 3D fix. The LED will be on if the GPS has a fix.

D2: 1PPS LED

D2 shows the status of the GPS's 1PPS signal.

3.4 Steps for Installing

1. Always work at an ESD protected workstation, and wear a grounded wrist-strap.
2. Turn off power to the PC/104 system or stack.
3. Select and install stand-offs to properly position the module on the stack.
4. Remove the module from its anti-static bag.
5. Check that pins of the bus connector are properly positioned.
6. Check the stacking order; make sure all of the busses used by the peripheral cards are connected to the cpuModule.
7. Hold the module by its edges and orient it so the bus connector pins line up with the matching connector on the stack.
8. Gently and evenly press the module onto the PC/104 stack.
9. If any boards are to be stacked above this module, install them.
10. Attach any necessary cables to the PC/104 stack.
11. Re-connect the power cord and apply power to the stack.
12. Boot the system and verify that all of the hardware is working properly.

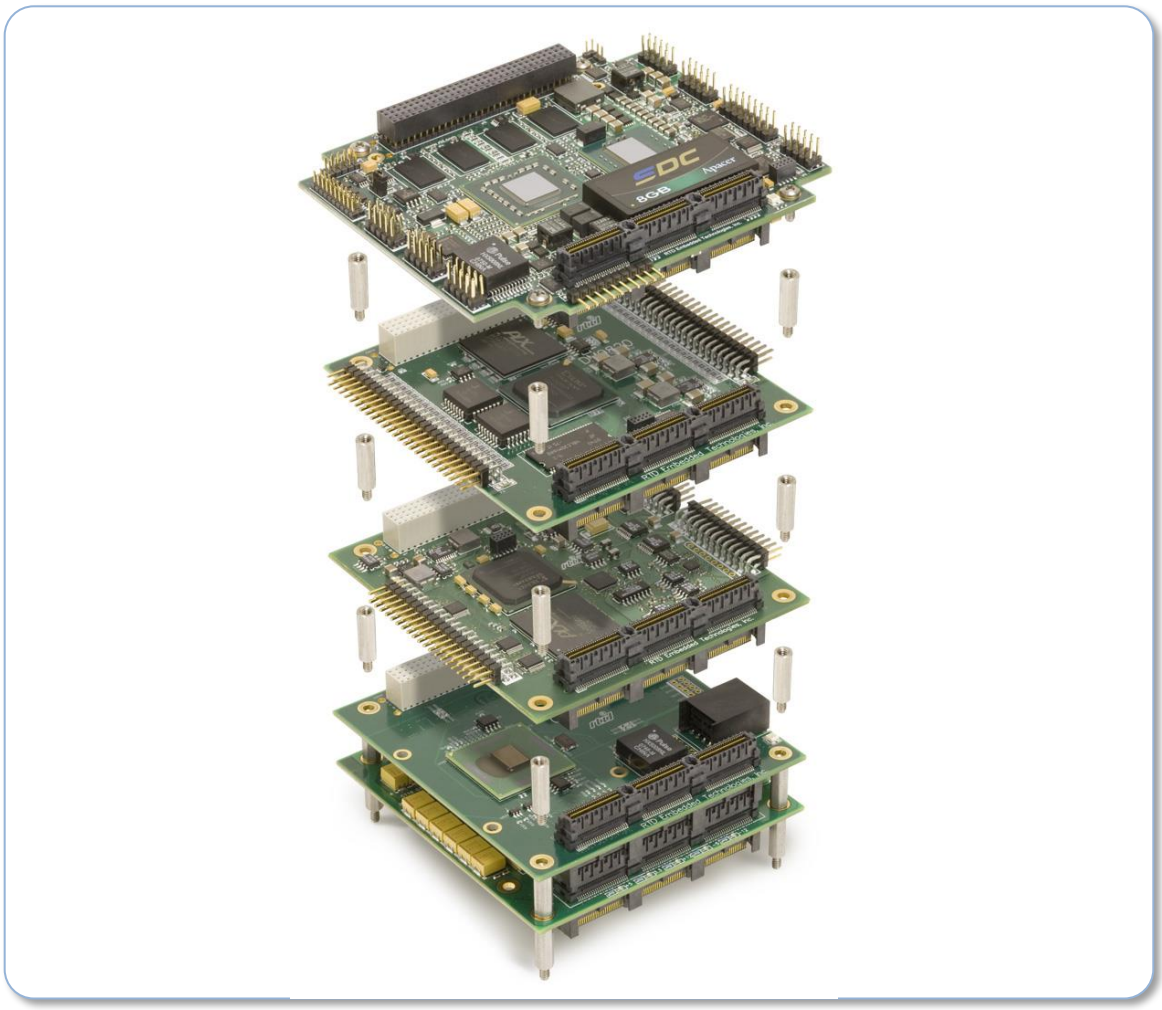


Figure 3: Example 104™ Stack

4 IDAN Connections

4.1 Module Handling Precautions

To prevent damage due to Electrostatic Discharge (ESD), keep your module in its antistatic bag until you are ready to install it into your system. When removing it from the bag, hold the module by the aluminum enclosure, and do not touch the components or connectors. Handle the module in an antistatic environment, and use a grounded workbench for testing and handling of your hardware.

4.2 Physical Characteristics

- Weight: Approximately 0.21 Kg (0.46 lbs.)
- Dimensions: 151.8 mm L x 129.8 mm W x 17.0 mm H (5.98 in L x 5.12 in W x 0.67 in H)

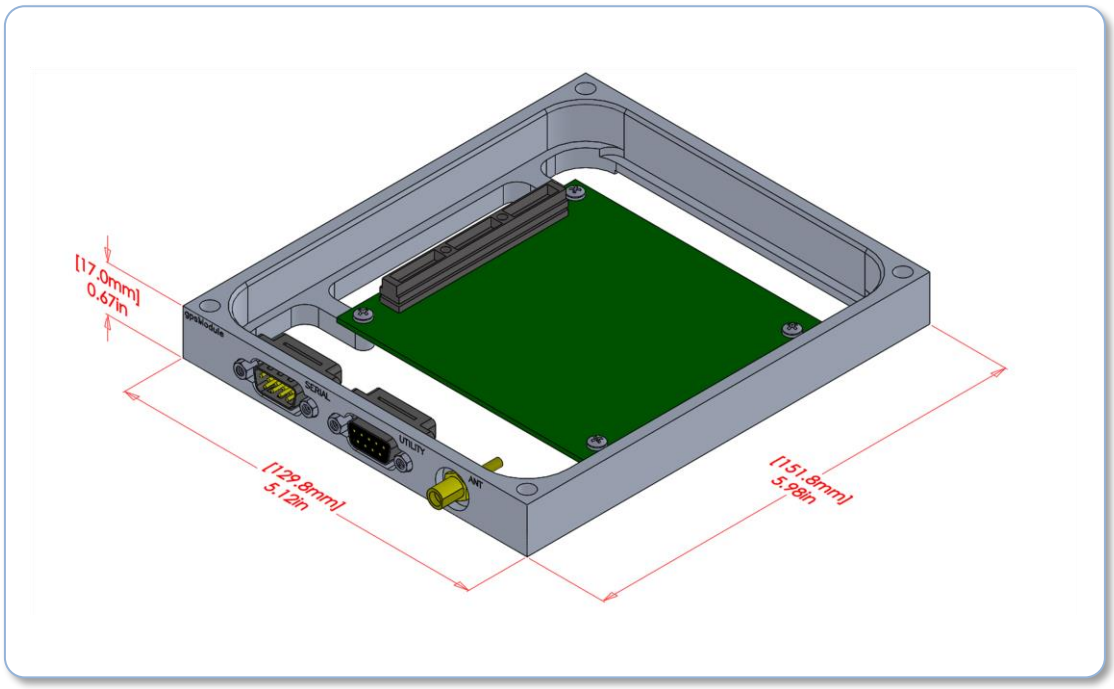


Figure 4: IDAN Dimensions

4.3 Connectors

4.3.1 Bus Connectors

CN1(Top) & CN2(Bottom): PCIe Connector

The PCIe connector is the connection to the system CPU. The position and pin assignments are compliant with the *PCI/104-Express Specification*. (See PC/104 Specifications on page 28)

The GPS35165 is a "Universal" board, and can connect to either a Type 1 or Type 2 PCIe/104 connector.

4.3.2 EXTERNAL I/O CONNECTORS

The figure below shows the pin orientation of the connectors on the IDAN-GPS35165HRS.

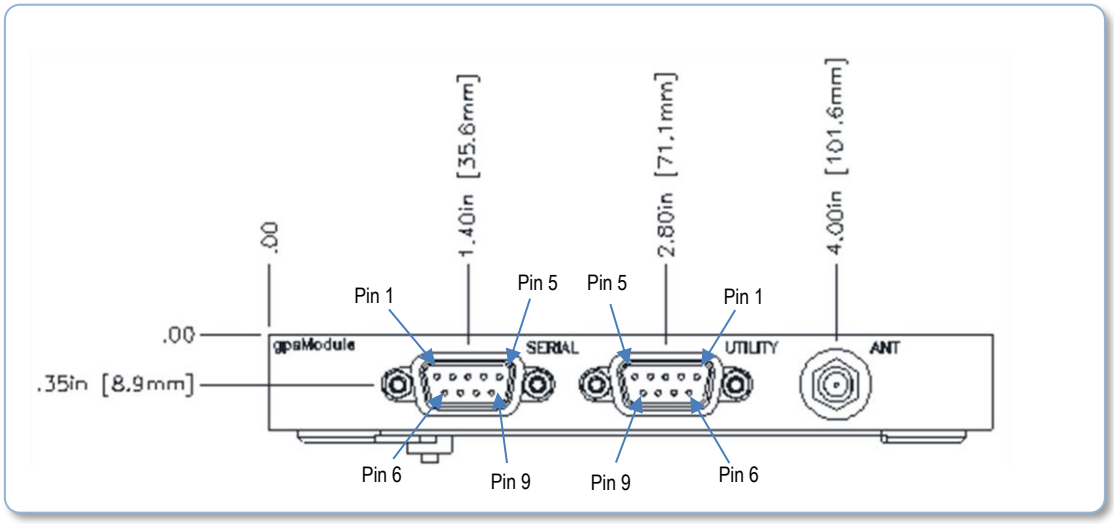


Figure 5: IDAN Front Panel

Utility Connector - 9-pin "D" Female Connector

Connector Part #: Amp 1658610-4 **Example Mating Connector:** Amp 1658608-4

Table 8: IDAN-GPS35165 Utility Connector

IDAN Pin#	Signal	GPS35165 Pin #	
1	RSVD	CN4	1
2	RSVD	CN4	3
3	GND	CN4	5
4	External Battery	CN4	7
5	RSVD	CN4	9
6	GND	CN4	2
7	1PPS	CN4	4
8	GPS TX	CN4	6
9	GND	CN4	8

Serial Connector - 9-pin "D" Male Connector

Connector Part #: VALCON DF-9P-CN **Example Mating Connector:** Amp 1658610-4

Table 9: IDAN-GPS35165 Serial Connector

IDAN Pin#	Signal(RS-232)	(RS-232)	GPS35165 Pin #	
1	DCD	-	CN7	1
2	RxD	RxD-	CN7	3
3	TxD	TxD-	CN7	5
4	DTR	-	CN7	7
5	GND	GND	CN7	9
6	DSR	-	CN7	2
7	RTS	TxD+	CN7	4
8	CTS	RxD+	CN7	6
9	RI	-	CN7	8

GPS Antenna - SMA Female Connector

Connector Part #: SPC Technology 8589-0853 **Example Mating Connector:** Amp 901-9877-RFX

4.4 Steps for Installing

1. Always work at an ESD protected workstation, and wear a grounded wrist-strap.
2. Turn off power to the IDAN system.
3. Remove the module from its anti-static bag.
4. Check that pins of the bus connector are properly positioned.
5. Check the stacking order; make sure all of the busses used by the peripheral cards are connected to the cpuModule.
6. Hold the module by its edges and orient it so the bus connector pins line up with the matching connector on the stack.
7. Gently and evenly press the module onto the IDAN system.
8. If any boards are to be stacked above this module, install them.
9. Finish assembling the IDAN stack by installing screws of an appropriate length.
10. Attach any necessary cables to the IDAN system.
11. Re-connect the power cord and apply power to the stack.
12. Boot the system and verify that all of the hardware is working properly.

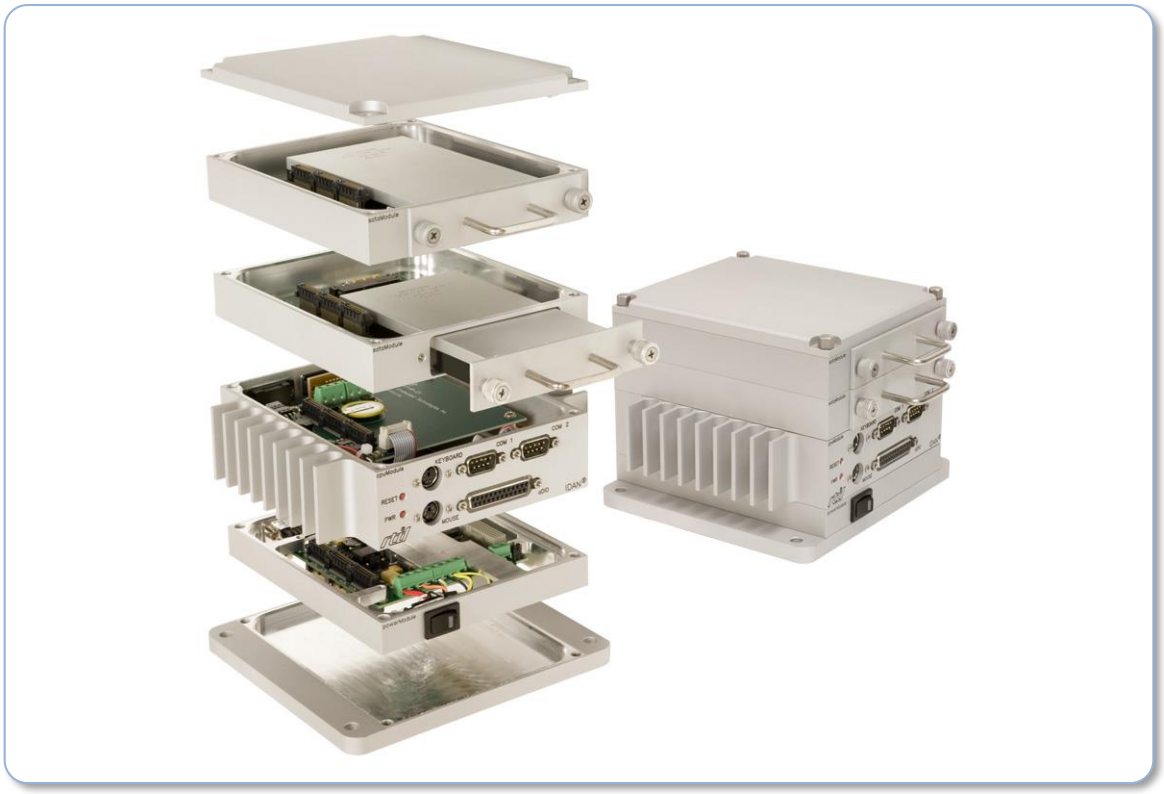


Figure 6: Example IDAN System

5 Functional Description

5.1 Block Diagram

The Figure below shows the functional block diagram of the GPS35165. The various parts of the block diagram are discussed in the following sections.

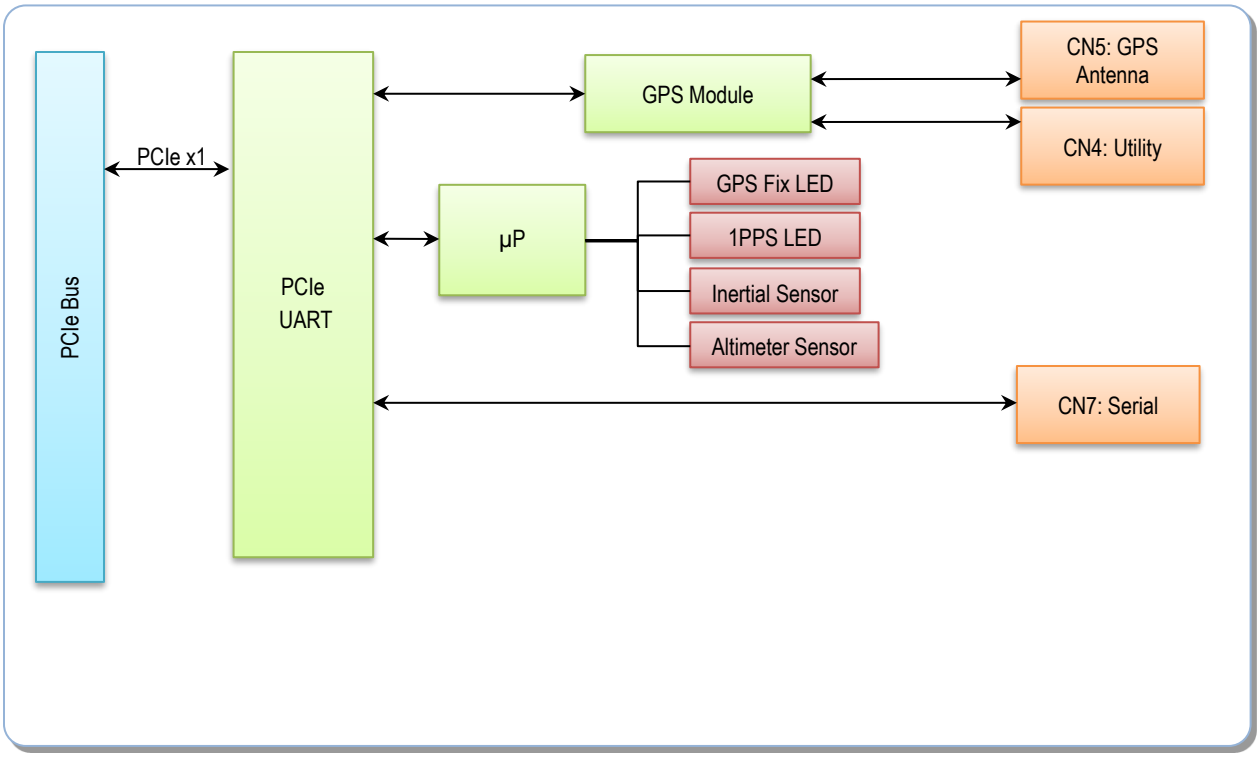


Figure 7: GPS35165 Block Diagram

5.2 PCIe UART

The GPS35165 provides a UART interface to the PCIe bus that connects to a GPS, a sensor interface and a serial connector CN7. There are four independent UARTs that are connected as follows:

- UART 1 to GPS
- UART 2 to Sensor Interface
- UART 3 to CN7
- UART 4 is unused.

5.2.1 GPS Interface

Integrated on the GPS35165 is a Linx RXM-GNSS-TX, a low power fast-fix 33-channel GPS receiver. This GPS receiver is especially designed for portable and mobile applications. The Linx RXM-GNSS-TM provides NMEA-0183 version 4.10 data and a 1 PPS signal.

A complete list of NMEA Messages and command messages is available from the manufacturer's website at www.linxtechnologies.com.

GPS module interface

The RXM-GNSS-TM GPS is connected to the host computer through a dedicated serial port. The default configuration for the serial port is:

- 9600 Baud
- 8 Data bits
- No parity
- 1 Stop bit
- No Flow Control

GPS Antenna

Most GPS antennas are "active" which means they have a low noise amplifier (LNA) built into the antenna that requires a power source for the GPS module. While the GPS35165 will work with a passive antenna, better performance will be achieved with an active antenna. The GPS35165 provides +3.3V/+5V for active GPS antennas.

COCOM Limits

The GPS module disable tracking when both altitude (18,000m) and speed (515 m/s) limits are exceeded. However, the module has an acquisition altitude limit of 10,000m. So, it cannot be powered on and acquire a position above 10,000m, but it will continue tracking if a position is acquired below 10,000m and then the module goes higher.

5.2.2 SENSOR INTERFACE

The GPS35165 communicates to the inertial and altimeter sensor over serial using the 2nd UART port. This board features LSM9DS0 9DoF inertial sensor, that has 3D accelerometer, 3D gyroscope and 3D magnetometer, and an MPL3115A2 altimeter/barometer sensor. This data is reported back to the user in XML format to allow ease of parsing the serial stream.

Sensor Interface UART Settings

The default configuration for the serial port is:

- 115200 Baud
- 8 Data bits
- No parity
- 1 Stop bit
- No Flow Control

Inertial Sensor

The inertial sensor has a linear acceleration full scale of ±2/±4/±6/±8/±16 g, a magnetic field full scale of ±2/±4/±8/±12 Gauss and an angular rate of ±245/±500/±2000 dps. It also has an adjustable rate for each sensor. The accelerator has rates of 3.125/6.25/12.5/25/50/100/200 Hz, magnetometer has rates of 3.125/6.25/12.5/25/50 Hz and the gyro has rates of 95/190 Hz.

Each sensor provides a 16-bit 2's complement value for each axis. This data is represented in hexadecimal in the serial stream. Below is the conversion formula for sensors.

$$Value = \frac{Data \times Scale}{32768}$$

Sensor Axis Orientation

The accelerometer's axis orientation is indicated on the silkscreen of the GPS35165 board. The positive x-axis is facing the east side of the PCB, the side with serial and utility connectors. The positive y-axis is facing the north side of the board, the side opposite of the PCIe connector. The positive z-axis is going out of the top side of the board.

The gyroscope's axis orientation is the same as the accelerometer. The positive rotation of the gyroscope is counterclockwise around the direction's positive axis, when facing out towards you.

The magnetometer axis orientation is the same as the accelerometer; however, the positive z-axis is going into the top side of PCB board.

See figures below.

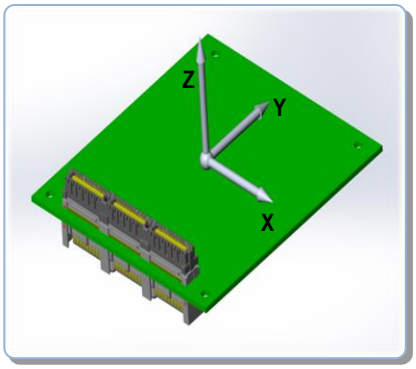


Figure 8: Accelerometer Orientation

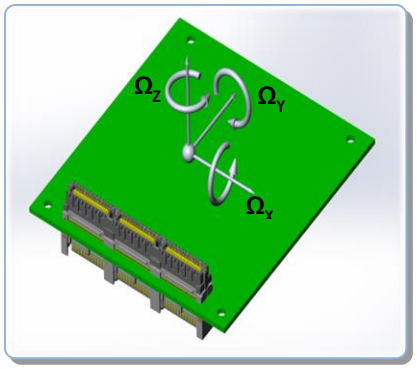


Figure 9:Gyroscope Orientation

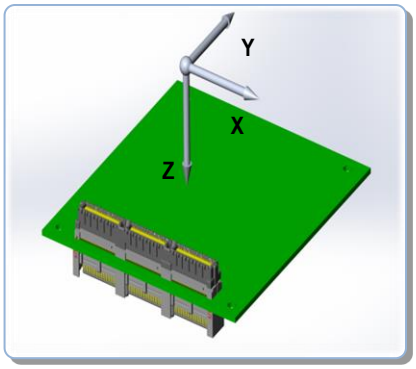


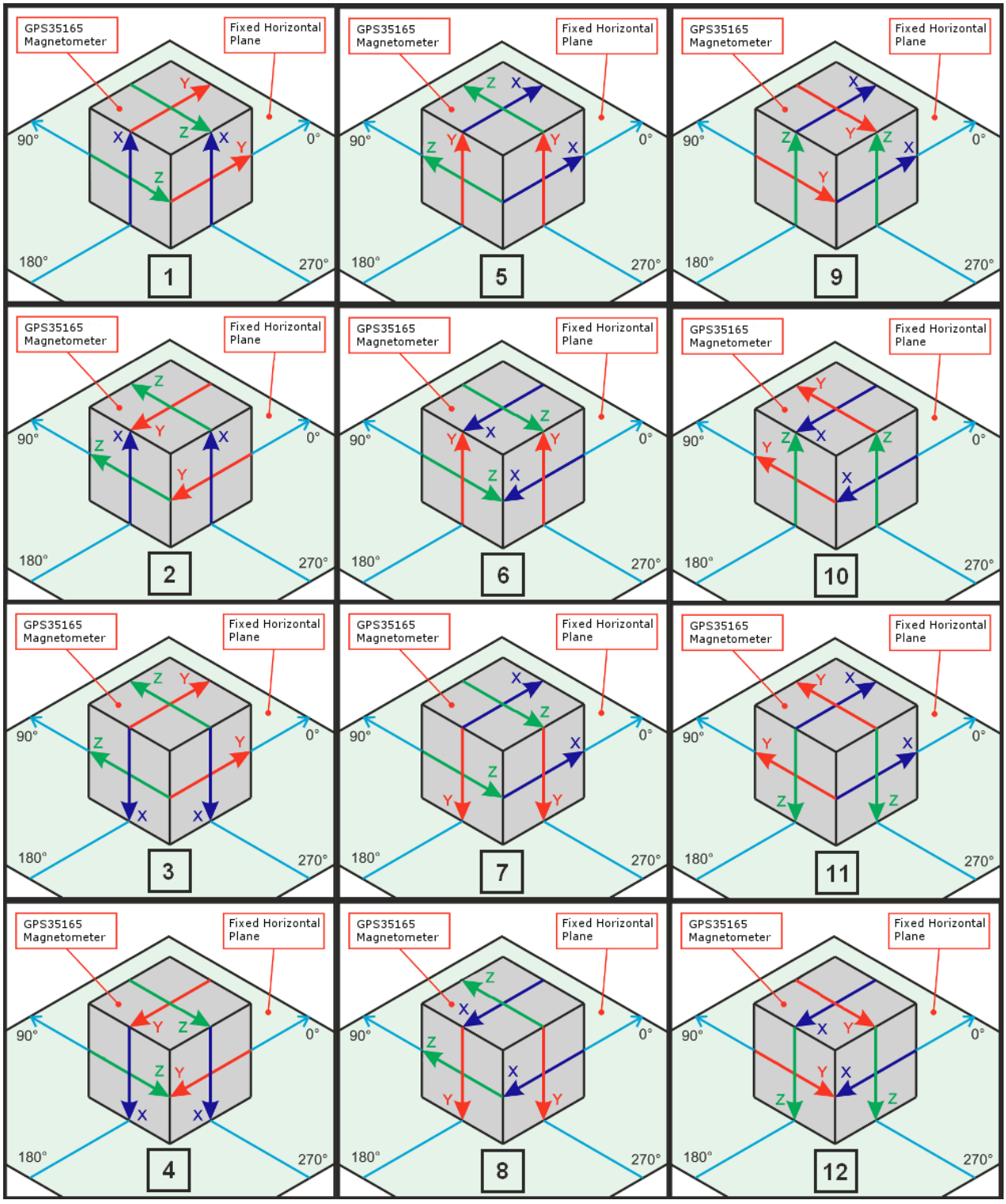
Figure 10: Magnetometer Orientation

Sensor Calibration

The GPS35165 loads offset calibration on the gyroscope and accelerometer on power on. The accelerometer is calibrated so it measures 1 g towards the Earth. The accelerometer calibration needs to be performed on a flat surface with the positive z-axis facing up. The gyroscope calibration zero's all axes; this is performed at the same time as the accelerometer. Both sensors will be factory calibrated, however they may need to be recalibrated based on the system.

The GPS35165 also loads offset calibration for magnetometer on power on. The magnetometer is effect by surround magnetic fields, thus the sensor needs calibrated. This sensor is factory calibrated, however they may need to be recalibrated based on the system. Since firmware version 400040066B, the magnetometer uses a 12 position calibration procedure; below is a table used to orientate the module during the process. Move the system away from any magnetic materials, when perform calibration process. Position 1 through 12 in the table below corresponded to the position requested by the GPS35165 calibration process.

Note:	Firmware 400040066A, used a 3 axis rotation calibration which is no longer available.



Altimeter/Barometer sensor

The Altimeter/Barometer sensor employs a MEMS pressure sensor that provides accurate pressure/altitude and temperature data. This sensor reads the absolute pressure and then is processed to provide a scaled pressure or an altitude, depending on the mode selected. When in Barometer mode, all data is reported as 20-bit unsigned data in Pascal. When in Altimeter mode, all data is converted to equivalent altitude based on the US standard atmosphere and then stored as 20-bit 2's complement value in meters. Currently, altitude is calculated using 101,326 Pa as the local barometric pressure correction.

Pressure Conversion	Altitude Conversion
$Value = \frac{Pressure\ Data}{4}$	$Value = \frac{Altitude\ Data}{16}$

The temperature sensor provides a 12-bit 2's complement value in Celsius.

Temperature Conversion
$Value = \frac{Temperature\ Data}{16}$

6 Sensor Commands/Interface

The GPS35165 communicates to the inertial and altimeter sensor over serial using the 2nd UART port. This board features LSM9DS0 9DoF inertial sensor, that has 3D accelerometer, 3D gyroscope and 3D magnetometer, and also MPL3115A2 altimeter/barometer sensor. This data is reported back to the user in XML format to allow ease of parsing the serial stream. Default sensor interface serial settings can be found in section Sensor Interface UART Settings (page 19).

6.1 Data Format

The GPS35165 provides all sensor output data in XML format. Formatting example of all printable data is below.

```
<GPS35165_DATA>
<LSM ts = '%10d'> or <LSM ts = '%10u' gps_ts = '%02u:%02u:%02.3f'>
<M><X>%04x</X><Y>%04x</Y><Z>%04x</Z></M>
<G><X>%04x</X><Y>%04x</Y><Z>%04x</Z></G>
<A><X>%04x</X><Y>%04x</Y><Z>%04x</Z></A>
</LSM>
<MPL ts = '%10d'> or <MPL ts = '%10u' gps_ts = '%02u:%02u:%02.3f'>
<AL>%05x</AL>   or  <P>%05x</P>
<T>%03x</T>
</MPL>
</GPS35165_DATA>
```

ts = time since start of microcontroller in milliseconds. This will increment for approximately 50 days before resetting to zero.
<GPS35165_DATA> is generated when a command has been issued.
</GPS35165_DATA> is generated when all sensors are disabled.
<LSM ts = '%10d'> is generated when the inertial sensor is enabled and data is available on any of its three sensors, and not using GPS timestamp
<LSM ts = '%10u' gps_ts = '%02u:%02u:%02.3f'> is generated when GPS timestamp is enabled
<M> </M> are generated when magnetometer data is available and sent.
<G></G> are generated when gyroscope data is available and sent.
<A></A> are generated when accelerometer data is available and sent.
<X> </X> <Y> </Y> <Z> </Z> tags are generated when sensor data is available; all axes are sent each time the sensor data is available.
</LSM> is the close tag for the LSM block.
<MPL ts = '%10d'> is generated when the altimeter/barometric sensor is enabled and data is available, and not using GPS timestamp
<MPL ts = '%10u' gps_ts = '%02u:%02u:%02.3f'> is generated when GPS timestamp is enabled
<AL></AL> is generated if in altimeter mode and data is available and sent.
<P></P> is generated if in barometric mode and data is available and sent.
<T></T> this is the temperature tag. This is generated every time barometric or altimeter data is available and sent.
</MPL> is the close tag for the MPL block.
<ID BUILD='%s' PDP='%s' /> this is the tag generated when using the ID command. It provides a build number and PDP number.
<CMD_RESPONSE CMD='command'> this tag is generated when a command is issued. The data of tag describes if the command was processed or not.
</CMD_RESPONSE>is the close tag for the CMD_RESPONSE block

NOTE: Not all tags are guaranteed to be present at each ts interval based on user settings.

6.2 Command List

Below is a list of valid serial commands that are used to communicate to the microcontroller and sensors. All commands must end with return character '\r' to be processed. Syntax is not case sensitive. By default, all sensors are disabled at power-on. Once a command has been entered please wait for the system responses with the command tag before processing additional commands. The command tag will have a data value of 'INVALID' when invalid commands or an 'OK' when the command is valid.

Table 10:Sensor Interface Command List

Command	Syntax and Example Input(s)	Descriptions
/?		Display Onscreen Help This disables all sensors. This does not produce

Table 10:Sensor Interface Command List

Command	Syntax and Example Input(s)	Descriptions
		a <GPS35165_DATA> when command is issued.
/GPS_TS		Toggles timestamp from GPS data, if available. When not available it will return with all 0's
/ID		Displays firmware information about the devices
/MPL	/MPL [n=val] [m=val] [r=val] /MPL n=1	Configures the MPL3115A2 sensor See MPL Commands for all command options
/LSM	/LSM [n=val] [m=val] [g=val] [a=val] [r=val] [t=val] [e=val] /LSM n=1 m=2 g=245 a=2 r=50 t=4 e=100	Configures the LSM9DS0 sensor See LSM Commands for all command options
/CAL	/CAL [option=val] /CAL l=0	Sensor Calibration Options See CAL Options for all command options
/Reset		Resets the microcontroller It takes ~25ms for a power cycle.

6.2.1 MPL COMMAND OPTIONS

MPL command options are listed below. More than one command option can be entered at a time.

Table 11: MPL Command Options

Command Option	Input Value	Descriptions
N	0 – Off 1 – On	Turns the MPL3115A2 Sensor On/Off.
M	0 – Barometer 1 – Altimeter	Configures the MPL3115A2 for either Barometer or Altimeter Mode. Default: Altimeter
R	1,2,4,8,16,32,64,128	Configures the MPL3115A2 oversample rate. The sample rate at 1 is ~100Hz. Default: 128

6.2.2 LSM COMMAND OPTIONS

LSM command options are listed below. More than one command option can be entered at a time.

Table 12: LSM Command Options

Command Option	Input Value	Descriptions
N	0 – Off 1 – On	Turns the LSM9DS0 Sensor On/Off.
M	2,4,8,16	Configures the magnetometer magnetic field full scale Default: 2
G	245,500,2000	Configures the gyroscope angular rate full scale Default: 245
A	2,4,6,8,16	Configures the accelerometer linear acceleration full scale Default: 2
R	0,3,6,12,25,50	Configures the magnetometer update rate Default: 12
T	0 – Disabled 1 – 95Hz(12.5Hz BW) 2 – 95Hz(25Hz BW) 3 – 190Hz(12.5Hz BW) 4 – 190Hz(25Hz BW) 5 – 190Hz(50Hz BW) 6 – 190Hz(70Hz BW)	Configures the gyroscopes update rate BW is the anti-alias filter bandwidth Default: 190Hz(12.5Hz BW)
E	0,3,6,12,25,50,100,200	Configures the accelerometer update rate Default: 200

6.2.3 CAL COMMAND OPTIONS

CAL command options are listed below. Only one command option can be entered at a time.

Table 13: CAL Command Options

Command Option	Input Value	Descriptions
L	0 – Magnetometer 1 – Accelerometer & Gyroscope 2 – All	Loads calibration settings stored in flash.

Table 13: CAL Command Options

Command Option	Input Value	Descriptions
S	0 – Magnetometer 1 – Accelerometer & Gyroscope 2 – All	Saves calibration settings in flash Warning this overwrites previous stored calibration settings
C	0 – Magnetometer 1 – Accelerometer & Gyroscope 2 – 6-point Accelerometer	Runs calibration test. 12 position Magnetometer calibration. Accelerometer & Gyroscope static calibration require the system to be place on a flat surface with the positive z-axis pointing up. The 6-point Accelerometer calibration gave is more accurate calibration process. When this calibration is done, it will override the static calibration values.
E	0 – Local 1 – Local and Flash 2 – Clear 6-point calibration	Clears calibration values Local – Clears the local values, this doesn't erase the values stored In flash memory. Local and Flash – Clears both local and flash memory calibration values. Clear 6-point calibration – Clear local and flash memory calibration values. This will revert to using the static calibration value for the accelerometer if available.
D		Displays calibration values

Note: The follow commands require Firmware 400040066B or newer.

Table 14:Sensor Interface Command List

Command	Syntax and Example Input(s)	Descriptions
/GPS_TS		Toggles timestamp from GPS data, if available. When not available it will return with all 0's

Table 15: CAL Command Options

Command Option	Input Value	Descriptions
C	0 – Magnetometer 2 – 6-point Accelerometer	Runs calibration test. 12 position Magnetometer calibration. The 6-point Accelerometer calibration gave is more accurate calibration process. When this calibration is done, it will override the static calibration values.
E	0 – Local 1 – Local and Flash 2 – Clear 6-point calibration	Clears calibration values Local – Clears the local values, this doesn't erase the values stored In flash memory. Local and Flash – Clears both local and flash memory calibration values. Clear 6-point calibration – Clear local and flash memory calibration values. This will revert to using the static calibration value for the accelerometer if available.
D		Displays calibration values

7 Software

7.1 Installing the Software

The GPS35165 uses a PCIe UART which will require software and drivers for proper operation. Drivers are provided for Windows XP/7, DOS, and Linux with pre-3.8 kernels. The UART is supported in 3.8+ kernels.

The drivers are provided on the companion CD and are also available on the RTD web site (http://www.rtd.com) for download.

7.2 Software Programming

7.2.1 API Interface

Once the drivers for the GPS35165 have been properly loaded, all ports should be available as standard serial ports. All ports can then be controlled using the standard serial port interfaces built into the operating system.

A description of serial port programming for operating systems is beyond the scope of this manual. Consult the operating system documentation for information on how to interface with serial ports via software.

7.2.2 COM Port Numbering

Serial ports (aka COM ports) are typically assigned numbers by the operating system (e.g. COM1). These numbers are typically dynamically assigned by the operating system. However, different applications may enumerate the COM ports differently, assigning different port numbers (e.g. COM3-10 vs COM5-12). When developing your own serial port application, consult your operating system's documentation for the proper method of enumerating COM ports.

Note: Some applications are written to assume that no more than four COM ports are present in a system. These applications may have compatibility issues with the Exar PCIe UART.

7.2.3 Base Address and Register Mapping

The GPS35165 exposes all of the registers available on the Exar XR17V358. The register set of the XR17V358 mimics the standard 16C550 UART register map. However, the XR17V358 contains some additional registers not found in a typical ISA-based UART.

Additionally, the base address of the GPS35165's serial ports will be different than the standard PC serial port locations (0x3F8, 0x2F8, etc.). The GPS35165 is a memory mapped device. Since it is PCI-based, it may be mapped to any location within the address space of the CPU. The base address of PCI devices is determined by the CPU's BIOS and operating system at boot time.

The register-level differences between the GPS35165 and a standard 16C550 UART should be abstracted via the software drivers. Most users will not need to concern themselves with the actual registers of the board. If one is interested in directly accessing the registers of the board, consult the XR17V358 data sheet available from Exar.

7.3 Windows

When using the GPS35165 a terminal emulator can be used to communicate with the GPS and sensor interface. Since HyperTerminal is no longer provided with Windows we recommend the using Real Term or Tera Term. Default GPS serial settings can be found in the GPS module interface section (page 19). Default sensor interface serial settings can be found in the Sensor Interface UART Settings section (page 19).

NOTE: When using under Windows, the GPS may be incorrectly detected as a Serial Mouse, causing erratic mouse cursor behavior. This issue has been documented by Microsoft. For more information, refer to Microsoft Knowledge Base Article 283063.

8 Troubleshooting

If you are having problems with your system, please try the following initial steps:

- **Simplify the System** – Remove modules one at a time from your system to see if there is a specific module that is causing a problem. Perform you troubleshooting with the least number of modules in the system possible.

- **Swap Components** – Try replacing parts in the system one at a time with similar parts to determine if a part is faulty or if a type of part is configured incorrectly.

If problems persist, or you have questions about configuring this product, contact RTD Embedded Technologies via the following methods:

Phone: +1-814-234-8087
E-Mail: techsupport@rtd.com

Be sure to check the RTD web site (http://www.rtd.com) frequently for product updates, including newer versions of the board manual and application software.

9 Additional Information

9.1 PC/104 Specifications

A copy of the latest PC/104 specifications can be found on the webpage for the PC/104 Embedded Consortium:

www.pc104.org

9.2 PCI and PCI Express Specification

A copy of the latest PCI and PCI Express specifications can be found on the webpage for the PCI Special Interest Group:

www.pcisig.com

10 Limited Warranty

RTD Embedded Technologies, Inc. warrants the hardware and software products it manufactures and produces to be free from defects in materials and workmanship for one year following the date of shipment from RTD Embedded Technologies, Inc. This warranty is limited to the original purchaser of product and is not transferable.

During the one year warranty period, RTD Embedded Technologies will repair or replace, at its option, any defective products or parts at no additional charge, provided that the product is returned, shipping prepaid, to RTD Embedded Technologies. All replaced parts and products become the property of RTD Embedded Technologies. Before returning any product for repair, customers are required to contact the factory for a Return Material Authorization (RMA) number.

This limited warranty does not extend to any products which have been damaged as a result of accident, misuse, abuse (such as: use of incorrect input voltages, improper or insufficient ventilation, failure to follow the operating instructions that are provided by RTD Embedded Technologies, “acts of God” or other contingencies beyond the control of RTD Embedded Technologies), or as a result of service or modification by anyone other than RTD Embedded Technologies. Except as expressly set forth above, no other warranties are expressed or implied, including, but not limited to, any implied warranties of merchantability and fitness for a particular purpose, and RTD Embedded Technologies expressly disclaims all warranties not stated herein. All implied warranties, including implied warranties for merchantability and fitness for a particular purpose, are limited to the duration of this warranty. In the event the product is not free from defects as warranted above, the purchaser's sole remedy shall be repair or replacement as provided above. Under no circumstances will RTD Embedded Technologies be liable to the purchaser or any user for any damages, including any incidental or consequential damages, expenses, lost profits, lost savings, or other damages arising out of the use or inability to use the product.

Some states do not allow the exclusion or limitation of incidental or consequential damages for consumer products, and some states do not allow limitations on how long an implied warranty lasts, so the above limitations or exclusions may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

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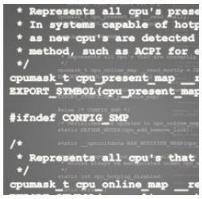

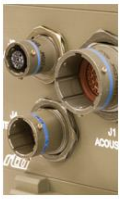
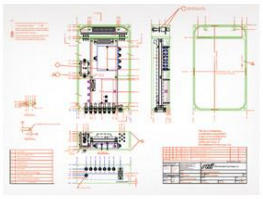

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