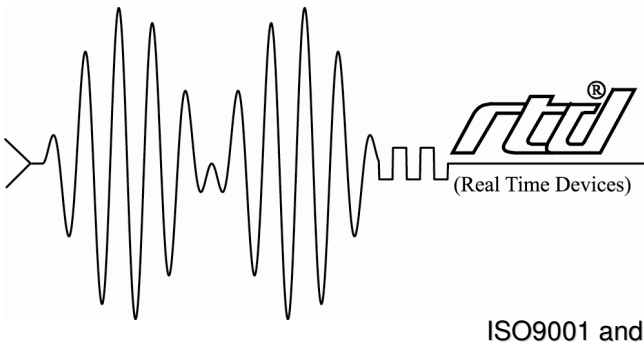
GPS6160HR Board Manual

Global Satellite Positioning PC/104 Module



RTD Embedded Technologies, Inc.
"Accessing the Analog World"®

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Rev. A

ISO9001 and AS9100 Certified

GPS6160HR Board Manual

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- Updated information to reflect the new iTrax03-02 GPS engine.
- Added note about previous versions which used iTrax02 engine.
- Added information about Windows serial mouse detection issues.

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Introduction

Product Overview

The GPS6160HR is designed to provide a global positioning system (GPS) for PC/104-based systems. Its main features are:

- Fastrax iTrax03-02 GPS engine
  - L1 frequency, C/A code (SPS)
  - 12-channel satellite tracking
  - Position accuracy of 3m (CEP), 8m (95%)
  - Velocity accuracy of 0.2m/s RMS
  - 1Hz update rate (configurable up to 5Hz)
  - Tracking sensitivity down to -153 dBm
  - Choice of GPS message formats
    - ASCII: NMEA-0183
    - Binary: Fastrax iTalk
- Supports active (+3.3V or +5V) and passive antennas
- OSX/MCX antenna jack
- Standard 16C550 UART Interface
  - Compatible with all modern operating systems.
  - Jumper-selectable Base Address and IRQ
  - TX and RX only, no flow control or handshaking required
- Digital I/O
  - 8 TTL compatible inputs
  - 8 TTL compatible outputs
- Two Status LEDs
- PC/104 compliant
- +5V Only Operation, no additional voltages required

Available Options

The GPS6160 is available as a starter kit, bundled with an active antenna. It may also be purchased as an IDAN module for integration into an RTD IDAN system.

The following is a summary of the different GPS6160 configurations:

Part Number	Description
GPS6160HR	GPS6160HR
SK-GPS6160HR	GPS6160HR with an active antenna
IDAN-GPS6160HRS	GPS6160HR mounted in an IDAN frame
IDAN-SK-GPS6160HRS	GPS6160HR mounted in an IDAN frame with an active antenna

For antenna specifications, please refer to the “GPS6160HR Specifications” chapter of this manual.

Getting Technical Support

If you are having problems with your system, please try the following troubleshooting 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.
- **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, obtain the base address and IRQ settings of the GPS6160HR and other modules in the system. After you have this information, contact RTD Embedded Technologies via the following methods:

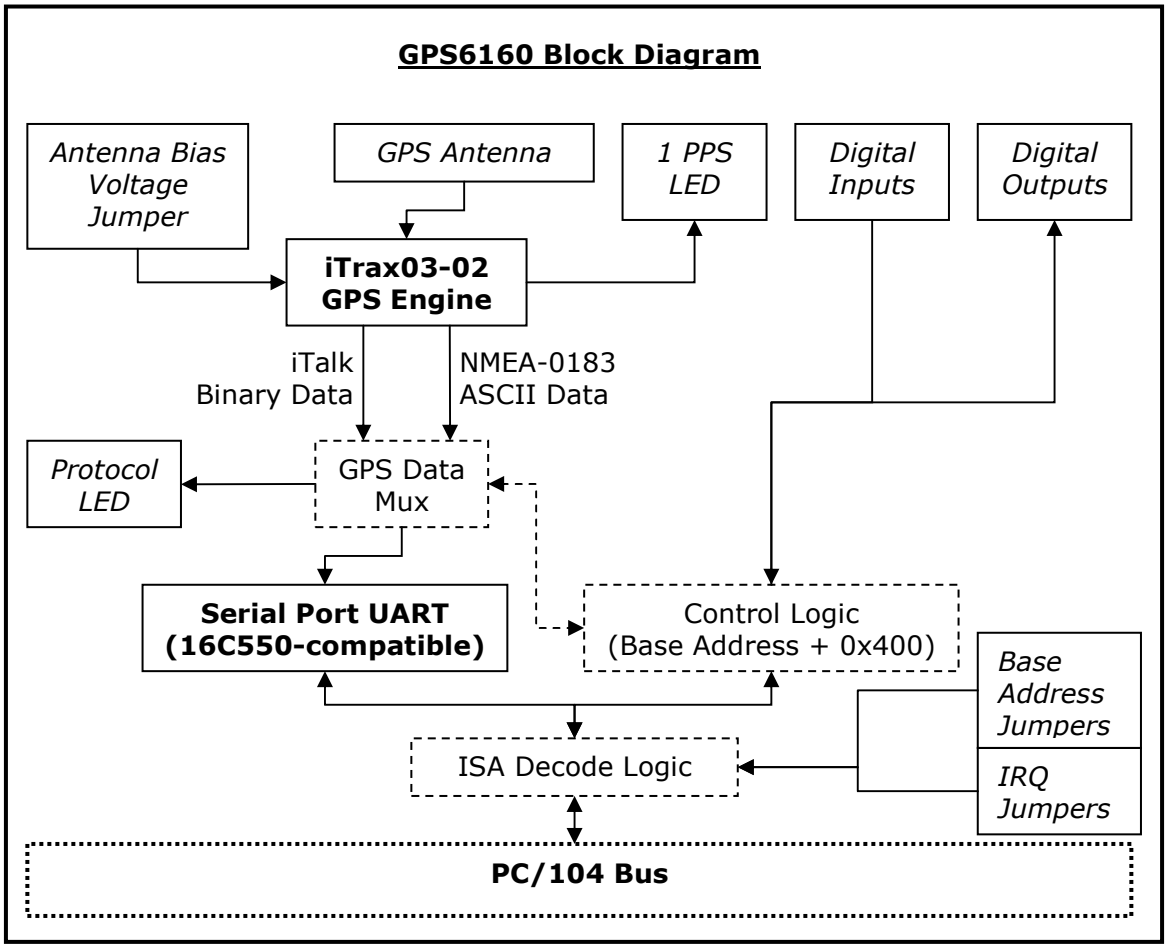
Phone: +1-814-234-8087

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.

Hardware Description

Block Diagram



GPS Receiver

The GPS6160 is based on the iTrax03-02 GPS engine from Fastrax. It is a standard L1 frequency C/A code GPS. For more detailed specifications on the iTrax03-02 GPS, refer to the chapter "GPS6160HR Specifications" later in this manual.

The GPS receiver has two available protocols. You may select to either the NMEA protocol or alternatively the iTalk binary protocol. The GPS receiver has two internal serial ports that operate in parallel. These outputs are multiplexed into the 16C550 UART channel on the GPS6160HR board. You may change between protocols by writing to a control bit in the internal registers of the board. This will be described in the later chapters of this manual.

GPS Antenna Considerations

Most recently-made GPS antennas are active. The GPS6160HR accepts either +5V or +3.3V active GPS antennas. Jumper J27 is used to select the operating voltage of the antenna.

A 90 degree 50 Ohm OSX/MCX plug should be selected to directly connect antenna jack on the board. High quality low loss antenna cable should be used. Try to reduce the number of connectors on the cable to minimize signal reflections. Signal reflections on the antenna line may cause incorrect readings for altitude information.

UART Interface

GPS data is sent and received through a standard 16C550 compatible UART. Most modern operating systems will recognize and support this serial communication device. The GPS6160HR uses its own onboard serial port and will not reserve serial port resources from the system.

Digital I/O Interfaces

For general-purpose digital I/O interfacing a 16-bit digital I/O port is provided. This port includes 8 TTL-level digital outputs and 8 digital inputs with 10K Ohm pull-down resistors. These I/O's are ideal to be used to interface to LCD displays, LED's push buttons or other low power controls.

Status LEDs

Two status LEDs are provided for easy system status detection. One LED shows the selected protocol. The other LED indicates the GPS tracking status.

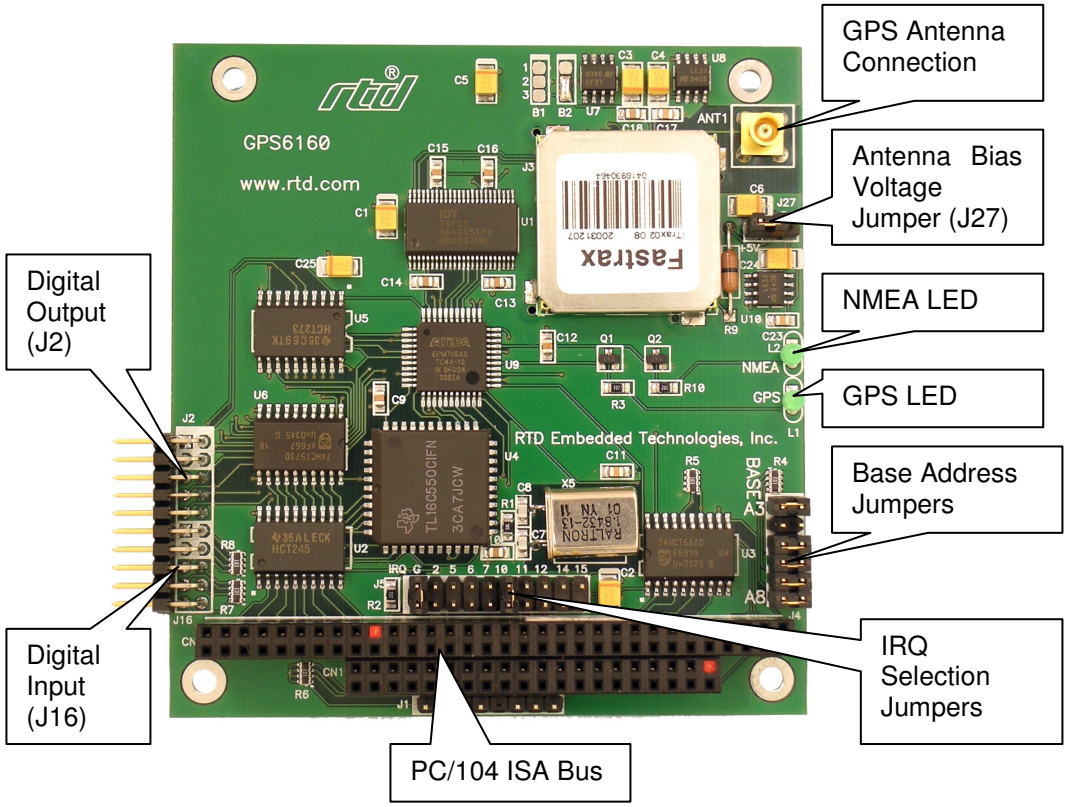
NMEA LED	On	NMEA protocol currently selected
	Off	iTalk protocol currently selected
GPS LED	Blinking	GPS receives signal and is tracking satellites
	Off	GPS fix, tacking and all coordinates are valid.

Board Connections

Connector and Jumper Locations

The following diagram shows the location of all connectors and jumpers on the GPS6160HR. Different hardware revisions of the board may have cosmetic differences. For a description of each jumper and connector, refer to the following sections.

GPS6160HR Connector and Jumper Locations



Digital I/O Connections

The following sections describe the digital I/O connections of the GPS6160HR.

Digital Output J2

Connector J2 provides 8 TTL digital output lines, along with a +5V pin and a ground pin.

The pins of J2 are arranged in the following pattern:

Pin 9	Pin 7	Pin 5	Pin 3	Pin 1
Pin 10	Pin 8	Pin 6	Pin 4	Pin 2

Note: Pin 1 can be identified by a square solder pad. Pins 2 – 10 have round solder pads.

The pins of J2 have the following functions:

Pin 1	Ground
Pin 2	Digital Output 1
Pin 3	Digital Output 2
Pin 4	Digital Output 3
Pin 5	Digital Output 4
Pin 6	Digital Output 5
Pin 7	Digital Output 6
Pin 8	Digital Output 7
Pin 9	Digital Output 8
Pin 10	+5V

Digital Input J16

Connector J16 provides 8 TTL input lines, along with a +5V pin and a ground pin.

The pins of J16 are arranged in the following pattern:

Pin 9	Pin 7	Pin 5	Pin 3	Pin 1
Pin 10	Pin 8	Pin 6	Pin 4	Pin 2

Note: Pin 1 can be identified by a square solder pad. Pins 2 – 10 have round solder pads.

The pins of J16 have the following functions:

Pin 1	Ground
Pin 2	Digital Input 1
Pin 3	Digital Input 2
Pin 4	Digital Input 3
Pin 5	Digital Input 4
Pin 6	Digital Input 5
Pin 7	Digital Input 6
Pin 8	Digital Input 7
Pin 9	Digital Input 8
Pin 10	+5V

Jumpers

The following sections describe the jumper configuration options available on the GPS6160HR. For a reference that shows the location of each set of jumpers, refer to the diagram of the GPS6160HR at the beginning of this chapter.

Base Address Jumpers (Default: 2E8)

The base address selection jumpers (A3 through A8) allow you to set the base address of the serial port UART of the GPS6160HR. Any software that accesses the board will do so through reads and writes to the I/O address set by the jumpers. To function properly, the I/O address the software is expecting must match the base address set by the jumpers.

The tables below show the possible base address settings for the GPS6160HR. All base addresses are in hexadecimal. An 'X' indicates a closed jumper, while an empty cell indicates an open jumper.

Base Address (Hexadecimal)	Jumpers					
	A8	A7	A6	A5	A4	A3
200						
208						X
210					X	
218					X	X
220				X		
228				X		X
230				X	X	
238				X	X	X
240			X			
248			X			X
250			X		X	
258			X		X	X
260			X	X		
268			X	X		X
270			X	X	X	
278			X	X	X	X
280		X				
288		X				X
290		X			X	
298		X			X	X
2A0		X		X		
2A8		X		X		X
2B0		X		X	X	
2B8		X		X	X	X
2C0		X	X			
2C8		X	X			X
2D0		X	X		X	
2D8		X	X		X	X
2E0		X	X	X		
2E8		**X**	**X**	**X**		**X**
2F0		X	X	X	X	
2F8		X	X	X	X	X

Base Address (Hexadecimal)	Jumpers					
	A8	A7	A6	A5	A4	A3
300	X					
308	X					X
310	X				X	
318	X				X	X
320	X			X		
328	X			X		X
330	X			X	X	
338	X			X	X	X
340	X		X			
348	X		X			X
350	X		X		X	
358	X		X		X	X
360	X		X	X		
368	X		X	X		X
370	X		X	X	X	
378	X		X	X	X	X
380	X	X				
388	X	X				X
390	X	X			X	
398	X	X			X	X
3A0	X	X		X		
3A8	X	X		X		X
3B0	X	X		X	X	
3B8	X	X		X	X	X
3C0	X	X	X			
3C8	X	X	X			X
3D0	X	X	X		X	
3D8	X	X	X		X	X
3E0	X	X	X	X		
3E8	X	X	X	X		X
3F0	X	X	X	X	X	
3F8	X	X	X	X	X	X

By default, the GPS6160HR comes configured with a base address of 0x2E8.

When selecting a base address for the GPS6160HR, please observe the following guidelines:

- Every device in your PC/104 system must have a unique base address! When selecting a base address for the GPS6160HR, make certain that it does not conflict with any other devices.
- Base addresses 0x3F8 and 0x2F8 are typically used by serial ports COM1 and COM2, respectively. If you wish to use one of those base addresses, you will need to disable the conflicting serial port.
- Some operating systems expect UART devices to be located at the standard serial port base addresses (0x3F8, 0x2F8, 0x3E8, and 0x2E8). Setting your GPS6160HR to one of these addresses can make system setup and configuration easier.

IRQ Jumpers (Default: IRQ 5, G Jumper closed)

The IRQ selection jumpers allow you to set the IRQ used by the serial port UART of the GPS6160HR. The GPS6160HR can be configured for any one of the following IRQs: 2, 5, 6, 7, 10, 11, 12, 14, or 15. The IRQ can be set by closing the appropriately labeled jumper on the board.

Note: Typically IRQs can not be shared; although there are some special cases (see "The G Jumper" later in this document). In general, the IRQ you select should not be used by any other devices in your system.

Selecting an IRQ

Some of the IRQ choices on the GPS6160HR may already be used by your CPU's onboard peripherals. Some commonly-used IRQs are:

- IRQ 5 or 7 may be used by the CPU's parallel port. Check your CPU's configuration to avoid a conflict.
- IRQ 6 is used by the floppy controller. To use this IRQ, you must disable any floppy drives *and* their controllers.
- IRQ 12 is used by the PS/2 mouse. To use this IRQ, you will need to remove the PS/2 mouse from the system. Some CPUs also require a BIOS setting to disable the PS/2 mouse controller.
- IRQ 14 is used by the primary IDE controller. To use this IRQ, you will need to disable the primary IDE controller.
- IRQ 15 is used by the secondary IDE controller. To use this IRQ, you will need to disable the secondary IDE controller.

The G Jumper

The GPS6160HR supports shared interrupts as defined by the PC/104 specification. This sharing is accomplished via the G jumper, which is located adjacent to the IRQ jumpers. The G jumper installs a 1K-ohm resistor to pull the signal to the low state, allowing an interrupt to drive the signal high. To share interrupts, configure the devices for the same IRQ, and close the G jumper on one (and only one) of the devices.

When using interrupt sharing, consider the following guidelines:

- An interrupt can only be shared if all devices on the IRQ support it. If you have two sharing and one non-sharing device on the same IRQ, it will not work.
- To share interrupts, the system's drivers and operating system must support it. The Interrupt Service routines must be written to check all devices on an IRQ when the interrupt is detected. Many popular operating systems do not support interrupt sharing for ISA devices.

Note: If you are not sharing interrupts, make sure you leave the GPS6160HR's G jumper closed!

Antenna Bias Voltage J27 (Default: +5V)

Active GPS antennas require a supply to drive the antenna. If using a passive antenna, this jumper should be removed. Typical supply voltages for active antennas are +3.3V and +5V. Set this jumper to according to the requirements of your active antenna.

Closing pins 1-2 sets the antenna voltage to +3.3V. Closing pins 3-4 sets it to +5V.

Note: The supply selection jumper must be removed if using a passive antenna. Driving a passive antenna may cause permanent damage to the antenna.

Board Installation

Installing the Hardware

The GPS6160HR can be installed into a PC/104 or PC/104-*Plus* stack. It can be located almost anywhere in the stack, above or below the CPU.

Note: If the GPS6160HR is installed in a PC/104-*Plus* system, be sure to not break the chain of PCI devices (such as stacking the GPS6160HR between two PC/104-*Plus* boards).

Static Precautions

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.

Steps for Installing

1. Shut down the PC/104 system and unplug the power cord.
2. Ground yourself with an anti-static strap.
3. Set the Base Address and IRQ jumpers as described in the previous chapter.
4. Line up the pins of the GPS6160HR's PC/104 connector with the PC/104 bus of the stack and gently press the board onto the stack. The board should slide into the matching PC/104 connector easily. Do not attempt to force the board, as this can lead to bent/broken pins.
5. Connect the GPS antenna to the OSX/MCX jack. If the antenna is an active antenna, set the antenna bias voltage to +5V or +3.3V via J27. Remove the jumper if using a passive antenna.
6. If any boards are to be stacked above the GPS6160HR, install them.
7. Attach any necessary cables to the PC/104 stack.
8. Re-connect the power cord and apply power to the stack.
9. If the system has a PCI bus, enter the BIOS setup and reserve the GPS6160HR's IRQ as a Legacy ISA resource.
10. Apply power to the system, and verify that all of the hardware is working properly. Once power is applied, the GPS receiver will automatically initialize. A blinking LED will indicate activity on the GPS receiver.

Software Configuration

After physically installing the GPS6160, your operating system must be configured to recognize the new board.

Serial Port Setup

The GPS6160HR uses a standard serial port UART for host communication. Therefore, you must "install" a serial port under your host operating system for the GPS6160HR to be recognized.

If the GPS6160HR was installed using a standard serial port base address (0x3F8, 0x2F8, 0x3E8, or 0x2E8), your operating system may detect the GPS6160HR's UART automatically. If the GPS6160HR was not auto-detected, or if it was configured with a non-standard base address, the serial port will need to be configured manually.

The procedure for installing and configuring the serial port will vary depending on the operating system. Consult the operating system's documentation for instructions on how to do this.

Note: Under Windows 2000/XP, the GPS may be incorrectly detected as a Serial Mouse, causing erratic mouse cursor behavior. This issue has been documented by Microsoft, and can be resolved by a Registry change. For more information, refer to Microsoft Knowledge Base Article 283063.

The baud rate of the serial port is determined by the protocol used.

Serial port settings for NMEA protocol: 4800 baud, 8 data bits, no parity, 1 stop bit

Serial port settings for iTalk protocol: 115200 baud, 8 data bits, no parity, 1 stop bit

Since only the TX and RX lines of the iTrax03-02 are connected to the UART, there is no need for serial port flow control or handshaking.

Installing Drivers

The GPS data stream is accessed via the serial port UART, and therefore needs no special drivers. However, the digital I/O and certain control functions are accessed via their own registers (located at Base Address + 0x400).

To use the digital I/O, or to switch GPS protocols (from NMEA to iTalk), you will need to access these registers. This is typically done through a "driver". RTD provides drivers for supported operating systems. If you are using an operating system not supported by RTD, you will need to develop your own driver. You may also be able to access the registers directly.

Note: If you are only using ASCII/NMEA GPS functions, without digital I/O or the iTalk protocol, there is no need to install any special drivers.

GPS Software Interface

Reading the GPS Data

At power-up, the GPS6160 starts transmitting GPS data. Since the board is UART-based, it appears as a standard COM port to the CPU. The user can open a terminal program (e.g. Windows HyperTerminal) and observe the incoming GPS data.

Any software application that interfaces with the GPS6160 must "open" the COM port of the GPS and read the incoming data. This is typically done via the serial port drivers of the operating system. Consult your operating system's documentation for information.

Selecting the GPS Protocol

The iTrax03-02 outputs GPS data in two protocols: NMEA-0183 or iTalk. At power-up, the board defaults to NMEA-0183.

NMEA-0183 is an ASCII-based GPS message format. It is a standard format, used by many popular GPS engines. Many commercial third-party GPS programs are written for this protocol.

iTalk is a proprietary binary protocol supported by Fastrax GPS engines. It is primarily used by the Fastrax iSuite SDK.

Note: Current revisions of the GPS6160 use the iTrax03-02 GPS engine, which uses the iTalk version 3 protocol. Earlier revisions of the GPS6160 used the iTrax02 GPS engine, which supported iTalk version 2. The two protocols are significantly different. Before using the iTalk protocol on your GPS6160, verify which GPS engine is installed so that you use the appropriate communication protocol.

The Control Register (BASE+0x401) is used to select which protocol is used. A user application can select the GPS protocol at runtime by manipulating this register. Refer to the Registers and Interrupts chapter for a detailed description of the register.

Parsing the GPS Data

To actually get the longitude, latitude, etc, the application running on the host PC must parse the incoming GPS data. The algorithm for parsing the GPS data will depend on the protocol (NMEA or iTalk).

A complete explanation of GPS protocols and how to parse them is beyond the scope of this manual. See the Additional Information section for the protocol specifications.

RTD provides sample applications which demonstrate how to parse the GPS protocols. Source code is also provided. These samples can be used as a starting point to develop your own GPS application.

Fastrax iSuite SDK

Fastrax provides the iSuite Software Development Kit, which can be used to create GPS applications. See the Additional Information section of this manual for more information. Note that iSuite relies on the iTalk protocol, so you must switch the board into iTalk mode before using iSuite.

Registers and Interrupts

The registers of the GPS6160 are mapped into the I/O space of the host CPU. They are located at an offset from the Base Address (set by the Base Address jumpers).

Serial Port UART Registers

The registers in this area follow the standard layout for a 16C550 Serial Port UART. They are arranged as follows:

Offset from Base Address (Hex)	Access Type	Register Function
0	Read	Transmit Buffer
	Write	Receive Buffer
1	Read/Write	Interrupt Enable
2	Read	Interrupt Status
	Write	FIFO Control
3	Read/Write	Line Control Register
4	Read/Write	Modem Control Register
5	Read	Line Status Register
6	Read	Modem Status Register
7	Read/Write	Scratch Register

A detailed explanation of serial port programming is beyond the scope of this manual. There are several web sites and books dedicated to serial port programming. Refer to one of these resources for more information about these registers and their functions.

Digital I/O and Control Registers

The registers in the second I/O area exist at an offset of 0x400 from the base address. The registers are arranged as follows:

Offset from Base Address (Hex)	Access Type	Register Function
400	Read	Digital Input
	Write	Digital Output
401	Read/Write	Control Functions

Digital I/O (Offset 0x400)

This register serves two different functions, depending on whether read or write access is used. When the register is read, it will contain the binary value from connector J16. The register bits for read access are arranged as follows:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
J16 Pin 9	J16 Pin 8	J16 Pin 7	J16 Pin 6	J16 Pin 5	J16 Pin 4	J16 Pin 3	J16 Pin 2

A value of ‘1’ at a particular bit location indicates a logic high on the corresponding pin. A value of ‘0’ indicates a logic low on the corresponding pin.

When a value is written to the register, the pins of connector J2 will be updated. The register bits for write access are arranged as follows:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
J2 Pin 9	J2 Pin 8	J2 Pin 7	J2 Pin 6	J2 Pin 5	J2 Pin 4	J2 Pin 3	J2 Pin 2

Writing a value of ‘1’ to a particular bit location will set the corresponding pin to a logic high. Writing a value of ‘0’ sets the corresponding pin to a logic low.

Note: When the GPS6160 is reset (at power on or by rebooting), all output pins of J2 will be set to a logic low.

Control Functions (Offset 0x401)

This register is used to perform some control operations on the iTrax GPS module.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
(reserved)				UART Interrupt	(reserved)	GPS Reset	GPS Protocol

Bit 0 controls the format of the GPS data being sent from the UART. Setting the GPS Protocol bit to ‘1’ selects the iTalk protocol. Writing a value of ‘0’ selects NMEA/ASCII protocol (the default).

Bit 1 is used to reset the GPS module. Writing a value of ‘1’ will assert the reset line on the GPS module. Writing a value of ‘0’ to will de-assert the reset line.

Bit 3 provides the ability to disable UART interrupts. Writing a value of ‘0’ enables interrupts. Writing a value of ‘1’ enables them.

Note: The reserved bits may be used in a future board revision. To maintain forward compatibility in your software, be sure to not manipulate these bits. Preserve their state via bitwise AND/OR operations.

Interrupts

Interrupts are used to notify the host CPU that an event happened on a particular device. In general, interrupts are more efficient than a polling technique, where the CPU must query the device status at regular intervals. Devices that use interrupts have a special connection to the CPU, called an *interrupt request line* (IRQ). When the device needs the CPUs attention, it asserts the IRQ line. Once the interrupt has been processed, the IRQ line is de-asserted.

The GPS6160’s UART will use the jumper-selected IRQ line. Since it is a 16C550-compatible UART, it supports all of the standard serial port interrupt events (data received, transmit buffer empty, etc).

A detailed explanation of serial port interrupts is beyond the scope of this manual. For more information, consult a serial port programming reference. The chapter titled “Additional Information” lists some resources to help the user.

GPS6160HR Specifications

Host Interface

16-bit PC/104 bus, XT-bus used for data

GPS Receiver

Source of Specifications:	Fastrax iTrax03-02 Data Sheet, rev 1.0 2005-09-01 (Based on 3.11 firmware)	
General:	L1 frequency, C/A code (SPS) 12 independent tracking channels Separate search and acquisition engines	
Update rate	1fix/s or configurable up to 5Hz	
Accuracy	Position: Velocity: Time:	3m (CEP), 8m (95%) 0.2m/s RMS TBD
Time to First Fix	Cold Start (out of the box): Warm Start: Hot Start:	40s typical 33s typical 4s typical
Sensitivity	Acquisition (cold): Acquisition (hot, warm): Tracking: Navigation:	-139dBm -149dBm -153dBm -152dBm

GPS Antenna

External	Passive or active +3.3V or +5.0V BIAS
Connector	OSX/MCX Jack, PCB mount
Starter Kit Antenna:	Manufacturer: Matsushita Electric Part number: GPS024OSX01C02

UART and Digital I/O

UART chip	Texas Instruments 16C550CI
UART compatibility	16C550
UART FIFOs	16-byte transmit and receive
Oscillator frequency	1.8432MHz
Connection to GPS Receiver	TX and RX only (no handshaking)
I/O Base Address	Jumper-selectable, 32 possible choices (0x200 – 0x3F8)

Interrupt	Jumper-selectable (2, 5, 6, 7, 10, 11, 12, 14, or 15)
Digital I/O	8 TTL outputs, 8 TTL inputs w. 10K pull-down

Electromechanical

Operating temperature range	-40 to +85C
Humidity	RH up to 95% non-condensing
Power consumption	100mW min @ +5.0VDC

Additional Information

iTrax03-02 GPS Engine

Detailed specifications of the iTrax03-02 GPS receiver and iTalk protocol may be downloaded from Fastrax:

http://www.fastrax.fi/

iSuite SDK

Information about the Fastrax iSuite SDK may be found online at:

http://isuite.fastrax.fi/

iTalk Protocol

A description of the iTalk protocol is provided in the iSuite SDK documentation, which may be found on the iSuite web site listed above.

NMEA-0183 Standard

For a complete description on the National Marine Electronics Association (NMEA-0183) protocol, visit the NMEA website:

http://www.nmea.org/

Information about specific NMEA messages supported by the iTrax03-02 is provided in the iSuite SDK documentation.

Serial Port Programming

For more information about programming serial port UARTs, consult the following book:

Serial Communications Developer's Guide
By Mark Nielson
ISBN: 0764545701

Interrupt Programming

For more information about interrupts and writing interrupt service routines, refer to the following book:

Interrupt-Driven PC System Design
By Joseph McGivern
ISBN: 0929392507

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