OPERATIONS MANUAL
PCM-GPS

NOTE: *This manual has been designed and created for use as part of the WinSystems Technical Manuals CD and/or the WinSystems website. If this manual or any portion of the manual is downloaded, copied or emailed, the links to additional information (i.e. software, cable drawings) may be inoperable.*

REVISION HISTORY

P/N 403-0321-000

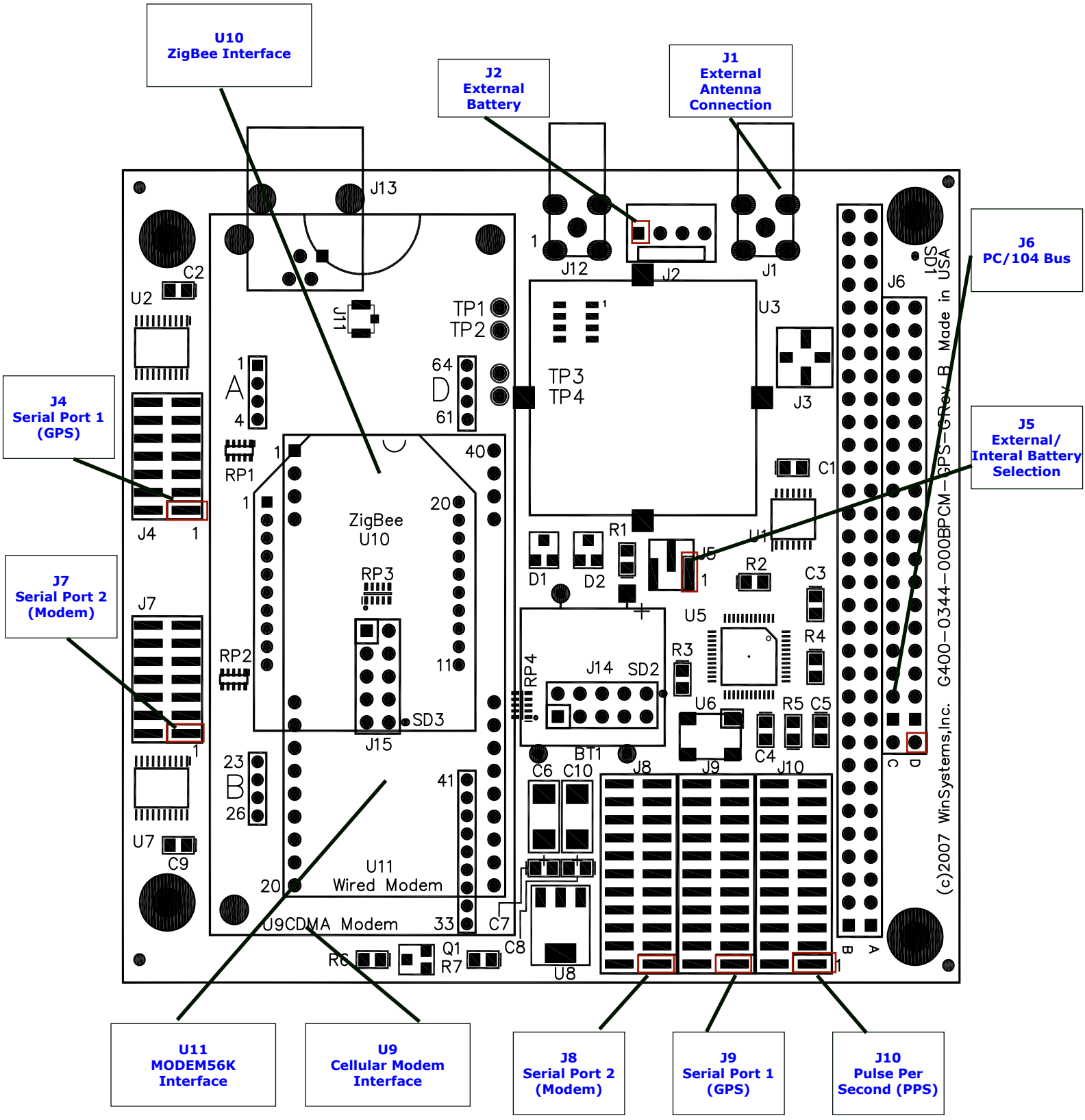
ECO Number	Date Code	Rev Level
ORIGINATED	050408	B
07-150	080306	B.1
08-145	080924	B.2
09-45	091110	B.3

Table of Contents

Visual Index – Quick Reference

Top View - Connectors

For the convenience of the user, a copy of the Visual Index has been provided with direct links to connector and jumper configuration data.



Introduction

This manual is intended to provide the necessary information regarding configuration and usage of the PCM-GPS board. WinSystems maintains a Technical Support Group to help answer questions regarding usage or programming of the board. For answers to questions not adequately addressed in this manual, contact Technical Support at (817) 274-7553, Monday through Friday, between 8 AM and 5 PM Central Standard Time (CST).

General Information

Features

- Dual function PC/104-compatible board with GPS and optional Cell Modem support

GPS Features

- Trimble Lassen® receiver module
- TSIP, TAIP and NEMA 0183 protocols supported
- Pulse output support for accurate time standard
- External power antenna connection via a Standard SMA
- On-board battery retains GPS Almanac

Cell Modem (optional)

- GSM/GPRS and CDMA standard support
- Socket support for MultiTech® wireless module
- Recognizes standard AT commands
- Alarm management, phone book management and Short Message Service (SMS) support

ZigBee Support (optional)

- IEEE 802.15.4 ZigBee™ Wireless Interface
- Up to 1 mile line of sight range
- 2.4 GHz ISM frequency band
- 60 mW, 100 mW EIRP power output

Modem Support (optional)

- 56 kbps PC/104 Modem
- V.42, MNP Class2-4 error correction
- V.42bis, MNP 5 compression
- Integrated DAA provides compliance to global telephone standards
- Built-in fuse and SiDactor
- Caller ID Detection
- Parallel phone detection
- DTMF dialing

Industrial Operating Temperature Range

- -40°C to 85°C

Form Factor

- PC/104-compliant
- 3.60 in x 3.80 in (90 mm x 96 mm)

Additional Specifications

- Programmable address and interrupt setting support

General Description

The PCM-GPS from WinSystems is a PC/104 module incorporating the Lassen IQ 12-channel parallel tracking GPS receiver from Trimble®. The GPS receiver is interfaced to an on-board 16550 compatible DUART which receives the serial data sent by the GPS module. The data output as supplied by the factory is in TSIP format making it compatible with all off-the-shelf mapping, navigation, and geocaching application software. Supplied **C** source code assists the integrator in creating custom applications utilizing the PCM-GPS. The PCM-GPS also supports the Trimble receiver's high precision Pulse Per Second (PPS) output for use in critical time keeping or synchronizing applications. The PCM-GPS also supports the CDMA and GPRS/GSM cellular SocketModems® from Multi-Tech Systems®. These modems, when combined with the GPS positioning data, can provide a "phone home" function to report its current location.

Functional Capability

I/O Address Selection

Visual Index

The PCM-GPS requires eight consecutive I/O addresses beginning on an 8-byte boundary for each of the two on-board serial channels. The jumper blocks at **J4** and **J7** allow selection of the primary (GPS) and secondary serial (SocketModem®) port I/O addresses respectively. Address selection is made by placing a jumper on the jumper pair for the address bit, if a **0** is desired or leaving the jumper pair open if a **1** is required for the desired address. The illustration below shows the relationship between the address bits and the jumper position and a sample jumpering for an address of 300H.

I/O Base Address Select jumper
J4/J7 shown jumpered for 300H

J4/J7

1 o–o 2	A3
3 o–o 4	A4
5 o–o 6	A5
7 o–o 8	A6
9 o–o 10	A7
11 o o 12	A8
13 o o 14	A9

To disable a port, place a jumper on all 7 positions 9Address = 000H.

Interrupt Routing

Visual Index

The PCM-GPS can source up to three unique on-board interrupts. Two are available for each of the serial interfaces and a third for the Pulse Per Second (PPS) interrupt from the GPS. The jumper blocks at **J8**, **J9**, and **J10** allow for routing of the interrupts for the SocketModem®, the GPS serial output, and the PPS source respectively.

To route an interrupt to a source, place a jumper at the desired IRQ position. Unused sources should be left unjumpered. Each source must have its own unique interrupt.

J8 - SocketModem®
J9 - GPS
J10 - PPS Interrupt

J8/J9/J10

1 o o 2	IRQ3
3 o o 4	IRQ4
5 o o 6	IRQ5
7 o o 8	IRQ6
9 o o 10	IRQ7
11 o o 12	IRQ9
13 o o 14	IRQ10
15 o o 16	IRQ11
17 o o 18	IRQ12
19 o o 20	IRQ14
21 o o 22	IRQ15

On-board PPS Usage

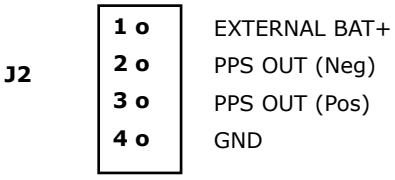
The GPS receiver generates a 4 µs wide positive pulse every second with the leading edge synchronized to UTC time within ±95 nanoseconds when valid position fixes are being reported. WinSystems' on-board implementation degrades this accuracy by buffering the PPS output using a 74HCT14 Schmitt trigger device which also inverts the signal. Since PC interrupts are edge-triggered on the rising edge, the actual interrupt will occur 4 µs plus the inverter propagation time later (typical 17 ns). This added delay is actually insignificant to any software synchronizing routines as the entire hardware interrupt acknowledgment process will consume many additional microseconds in a best-case scenario. The PPS signal begins immediately at power-up and continues even if the receiver loses GPS lock. The drift of the signal without GPS lock is unspecified.

External PPS Usage

Visual Index

The PPS signal, in addition to being available on-board for interrupt generation, is also terminated at two polarities on the **J2** connector. The negative pulsed output at pin 2 of **J2** is driven by a 74HCT14 inverter with a typical propagation delay of 17 ns.

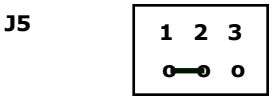
The positive signal is available on pin 3 of **J2** and is double-buffered by the same type device for a typical delay of 34 ns. Either of these signals can be used by external hardware for time synchronization purposes.



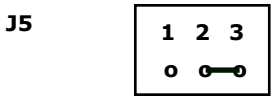
GPS Almanac Battery

Visual Index

The PCM-GPS is shipped with a 350 mAH 3.5V Lithium battery. This battery is used to retain GPS Almanac and Ephemeris data which provides for a greatly improved time to position fix from power-up. With the battery available, and valid Almanac data, the time for a valid fix is reduced from under 2 minutes to under 20 seconds. The Trimble® published current draw on the battery backup line is 19 µA typical at 25ºC. Alternately, an external battery may be connected between Pin 1 (+) and Pin 4 (-) of **J2**. An externally connected battery should be rated at 3.5V ±.2V. The jumper block at **J5** is used to select the GPS backup battery source as shown below. The jumper may be removed or moved to the external position for long-term storage of boards for battery preservation.



On-board battery selection



Off-board connector selection

External Battery **J2** (pin 1)

GPS Antenna

Visual Index

The PCM-GPS requires an external outdoor antenna with a clear view of the sky in order to receive and track satellites in the GPS constellation. **J1** is a standard SMA connector for attachment of the antenna. It must be an active antenna powered by the 3.3V supplied by the GPS and with a typical gain of 28 dB. WinSystems offers an optional magnetic mount antenna P/N ANTENNA-MAGNETIC built by Trimble® for this module. Other antennas meeting the above specifications should work as well.

Optional Cellular Modem Interface

Visual Index

The PCM-GPS supports optional CDMA and GPRS/GSM cellular SocketModem™ modules from Multi-Tech Systems (www.multitech.com). The modem modules are installed in the **U9** position and secured with screws and standoffs, Velcro, or double-stick tape as desired. The SocketModems™ use the secondary serial port on the PCM-GPS and are controlled in software by a number of **AT** commands. Cellular data service must be purchased from one of the supported cellular providers. Contact Multi-Tech or one of their distributors directly for answers to all questions regarding the installation, configuration, programming or usage of the Multi-Tech cellular modem modules.

The Multi-Tech part numbers for compatible SocketModems™ are :

MTSMC-C	CDMA Modem
MTSMC-G	GSM/GPRS Modem

Note: The PCM-GPS can support either: cellular modem, ZigBee® or Modem56K modules. WinSystems can package the PCM-GPS board with either add-on module. Please contact a WinSystems Applications Engineer for additional information.

Optional IEEE 802.15.4 Support

Visual Index

The PCM-GPS supports an optional IEEE 802.15.4 ZigBee® wireless interface from Digi (www.digi.com) . This interface provides low-power wireless networking solutions. ZigBee® modules are installed in the **U10** position, a 20-pin socket which is compatible with Digi XBee™/XBee-PRO™ OEM RF modules. The ZigBee® interface is PC/104-compatible, and is configurable using AT and API Command modes.

The ZigBee® transceiver is configured as either an XBee™ or XBee-PRO™ module that is wired to a SMA RF connector on the edge of the board. The difference between the two modules is the amount of power consumed (1 mW vs. 60 mW) and signal range.

Note: The PCM-GPS can support either: cellular modem, ZigBee® or Modem56K modules. WinSystems can package the PCM-GPS board with either add-on module. Please contact a WinSystems Applications Engineer for additional information.

For more information on XBee™, see the ZigBee® Product manual.

Optional Modem56K Interface

Visual Index

The **U11** position provides support for Wintec®'s PC/104-compatible 56 kbps modem. This modem replaces WinSystems' PCM-33.6 board and supports data rates up to 56,000 bps. The modem also supports MNP error correction and data compression. Based on the DSP hardware chipset, the modem uses the AT command set to control its operation and register settings.

Note: The PCM-GPS can support either: cellular, ZigBee® or Modem56K modules. WinSystems can package the PCM-GPS board with either add-on module. Please contact a WinSystems Applications Engineer for additional information.

PC/104 Bus Interface

The PCM-GPS connects to the processor through the PC/104 bus connector at **J6**. The pin definitions for the 8-bit and 16-bit halves of **J6** are provided here for reference. Refer to the PC/104 Bus Specification for specific signal and mechanical specifications.

Visual Index

GND	**D0 o o C0**	GND
MEMCS16#	**D1 o o C1**	SBHE#
IOCS16#	**D2 o o C2**	LA23
IRQ10	**D3 o o C3**	LA22
IRQ11	**D4 o o C4**	LA21
IRQ12	**D5 o o C5**	LA20
IRQ15	**D6 o o C6**	LA19
IRQ14	**D7 o o C7**	LA18
DACK0#	**D8 o o C8**	LA17
DRQ0	**D9 o o C9**	MEMR#
DACK5#	**D10 o o C10**	MEMW#
DRQ5	**D11 o o C11**	SD8
DACK6#	**D12 o o C12**	SD9
DRQ6	**D13 o o C13**	SD10
DACK7#	**D14 o o C14**	SD11
DRQ7	**D15 o o C15**	SD12
+5V	**D16 o o C16**	SD13
MASTER#	**D17 o o C17**	SD14
GND	**D18 o o C18**	SD15
GND	**D19 o o C19**	KEY

= Active Low Signal

IOCHK#	**A1 o o B1**	GND
SD7	**A2 o o B2**	RESET
SD6	**A3 o o B2**	+5V
SD5	**A4 o o B4**	IRQ9
SD4	**A5 o o B5**	-5V
SD3	**A6 o o B6**	DRQ2
SD2	**A7 o o B7**	-12V
SD1	**A8 o o B8**	SRDY#
SD0	**A9 o o B9**	+12V
IOCHRDY	**A10 o o B10**	KEY
AEN	**A11 o o B11**	SMEMW#
SA19	**A12 o o B12**	SMEMR#
SA18	**A13 o o B13**	IOW#
SA17	**A14 o o B14**	IOR#
SA16	**A15 o o B15**	DACK3#
SA15	**A16 o o B16**	DRQ3
SA14	**A17 o o B17**	DACK1#
SA13	**A18 o o B18**	DRQ1
SA12	**A19 o o B19**	REFRESH#
SA11	**A20 o o B20**	BCLK
SA10	**A21 o o B21**	IRQ7
SA9	**A22 o o B22**	IRQ6
SA8	**A23 o o B23**	IRQ5
SA7	**A24 o o B24**	IRQ4
SA6	**A25 o o B25**	IRQ3
SA5	**A26 o o B26**	DACK2#
SA4	**A27 o o B27**	TC
SA3	**A28 o o B28**	BALE
SA2	**A29 o o B29**	+5V
SA1	**A30 o o B30**	OSC
SA0	**A31 o o B31**	GND
GND	**A32 o o B32**	GND

NOTES:

1. Rows C and D are not required on 8-bit modules.
2. B10 and C19 are key locations. WinSystems uses key pins as connections to GND.
3. Signal timing and function are as specified in ISA specification.
4. Signal source/sink current differ from ISA values.

PCM-GPS Programming Reference

Introduction

The software standard for commercial GPS receivers is TSIP format (www.trimble.com). The Trimble Lassen® IQ GPS module is also capable of transmitting and receiving serial data in a Trimble proprietary format known as TSIP. This is a binary protocol which ordinarily runs at 9600 baud, an 8-bit word, and odd parity. PCM-GPS boards as shipped, default to this TSIP standard.

The Trimble Lassen® IQ GPS module is also capable of transmitting and receiving serial data in NMEA 0183 format. This is a simple ASCII, serial communications protocol that defines how data is transmitted. Users requiring a NMEA interface to the GPS should see the Software Drivers & Examples section of this manual or contact WinSystems Technical Support for details on converting the PCM-GPS to NMEA.

TSIP Software Interface

The serial port driver in the iQ_CHAT Tool Kit matches the Lassen iQ GPS receiver serial port characteristics. The TSIPPRNT program converts binary data logged with the iQ_CHAT program into text that may be printed and displayed. Both of these tools are included in the Software Developer's Toolkit.

Warning – When using the TSIP protocol to change port assignments or settings, confirm that your changes do not affect the ability to communicate with the receiver (e.g., selecting the PC COM port settings that do not match the receiver's, or changing the output protocol to TSIP while not using iQ_CHAT).

Communicating with the Lassen iQ GPS Receiver

The Lassen iQ GPS Receiver supports three message protocols: TSIP, TAIP, and NMEA. Communication with the module is through two CMOS compatible, TTL level serial ports. The port characteristics can be modified to accommodate your application requirements. Port parameters can be stored in non-volatile memory (FLASH) which does not require backup power. Table 3.1. lists the default port characteristics.

Software Tools

The Software Tools provided on the Starter Kit CD-ROM include both user friendly Windows and DOS applications to facilitate communication with the receiver, via the Trimble Standard Interface Protocol (TSIP). This CD also includes sample C source code and reusable routines to aid in developing applications.

Note – *The TSIP, TAIP, and NMEA protocols are discussed beginning on page 42 of this chapter, and in the Appendices of this document.*

The serial port driver in the iQ_CHAT Tool Kit matches the Lassen iQ GPS receiver serial port characteristics. The TSIPPRNT program converts binary data logged with the iQ_CHAT program into text that may be printed and displayed. Both of these tools are included in the Software Developer's Toolkit.

Warning – When using the TSIP protocol to change port assignments or settings, confirm that your changes do not affect the ability to communicate with the receiver (e.g., selecting the PC COM port settings that do not match the receiver's, or changing the output protocol to TSIP while not using iQ_CHAT).

TSIP Data Output Modes

TSIP is the default protocol for Port 1 on the Lassen iQ GPS receiver. This binary language offers users a wide variety of commands and reports. TSIP enables the Lassen iQ GPS receiver to operate in two data output modes, both available during operation. In Query Mode, packet data is returned in response to input query packets. In Automatic Mode, a selected group of data packets is output continuously at two fixed rates – every second and every five seconds. The format and ensemble of the automatic output packets is configured using packets 0x35, 0x70, and 0x8E-20 (see Appendix A for packet details). Packet settings are stored in BBRAM. They can also be saved in non-volatile memory (Flash) using command packet 0x8E-26. See Appendix A for additional information on Flash storage for custom operation.

Default TSIP Output Settings

Default 0x35 setting (byte 0=2, 1= 2, 2=0, 3=0):

- Position and velocity data precision: single precision floating point
- Position output option and format (byte 0 setting):
  - Latitude – radian
  - Longitude – radian
  - Altitude – meters (WGS-84)
- No super-packet output
- Velocity output option and format:
  - East Velocity – meters/sec.; + for East
  - North Velocity – meters/sec.; + for North
  - Up Velocity – meters/sec.; + for Up
- Timing
  - GPS Time Output
  - PPS Always ON

Default 0x70 setting (byte 0=1, 1=1. 2=1. 3=0):

- Position-Velocity Dynamic Filter enabled
- Position-Velocity static Filter enabled
- Altitude Filter enabled

Default 0x8E-20 setting (byte 1 = 1):

- 0x8F-20 output is included in the super-packet for automatic output IF packet 0x35 selects the super-packet for automatic output options

Automatic TSIP Output Packets (fixed rate)

One second interval:

- 0x4A – (1) GPS position fix; (2) clock bias and time of fix; {20 byte format}
- 0x56 – velocity fix
- 0x6D – (1) list of satellites used for position fixes; (2) PDOP, HDOP, VDOP; (3) fix mode
- 0x82 – DGPS position fix mode

Five second interval:

- 0x41 – (1) GPS time of the week (seconds); (2) extended GPS week number; (3) GPS UTC offset (seconds)
- 0x46 – health of receiver
- 0x4B – (1) Machine/Code ID; (2) Real-time-clock availability status; (3) almanac validity status; (4) having super-packet support status

Default 0x70 setting (byte 0=1, 1=1. 2=1. 3=0):

- Position-Velocity Dynamic Filter enabled
- Position-Velocity static Filter enabled
- Altitude Filter enabled

Default 0x8E-20 setting (byte 1 = 1):

- 0x8F-20 output is included in the super-packet for automatic output IF packet 0x35 selects the super-packet for automatic output options

Automatic TSIP Output Packets (fixed rate)

One second interval:

- 0x4A – (1) GPS position fix; (2) clock bias and time of fix; {20 byte format}
- 0x56 – velocity fix
- 0x6D – (1) list of satellites used for position fixes; (2) PDOP, HDOP, VDOP; (3) fix mode
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Five second interval:

- 0x41 – (1) GPS time of the week (seconds); (2) extended GPS week number; (3) GPS UTC offset (seconds)
- 0x46 – health of receiver
- 0x4B – (1) Machine/Code ID; (2) Real-time-clock availability status; (3) almanac validity status; (4) having super-packet support status

Packet Output Order

After power up or a software reset (packet 0x1E), seven start-up packets are sent, only once, by the receiver in this order: 45, 46, 4B, 4A, 56, 41, 82

Before position fixes are available, the 1 second and 5 second interval packets are sent in this order, periodically:

- Every one second for 5 seconds: 6D, 82
- Every five seconds 41, 46, 4B

When position fixes are available, the 1 second and 5 second interval packets are sent in this order, periodically:

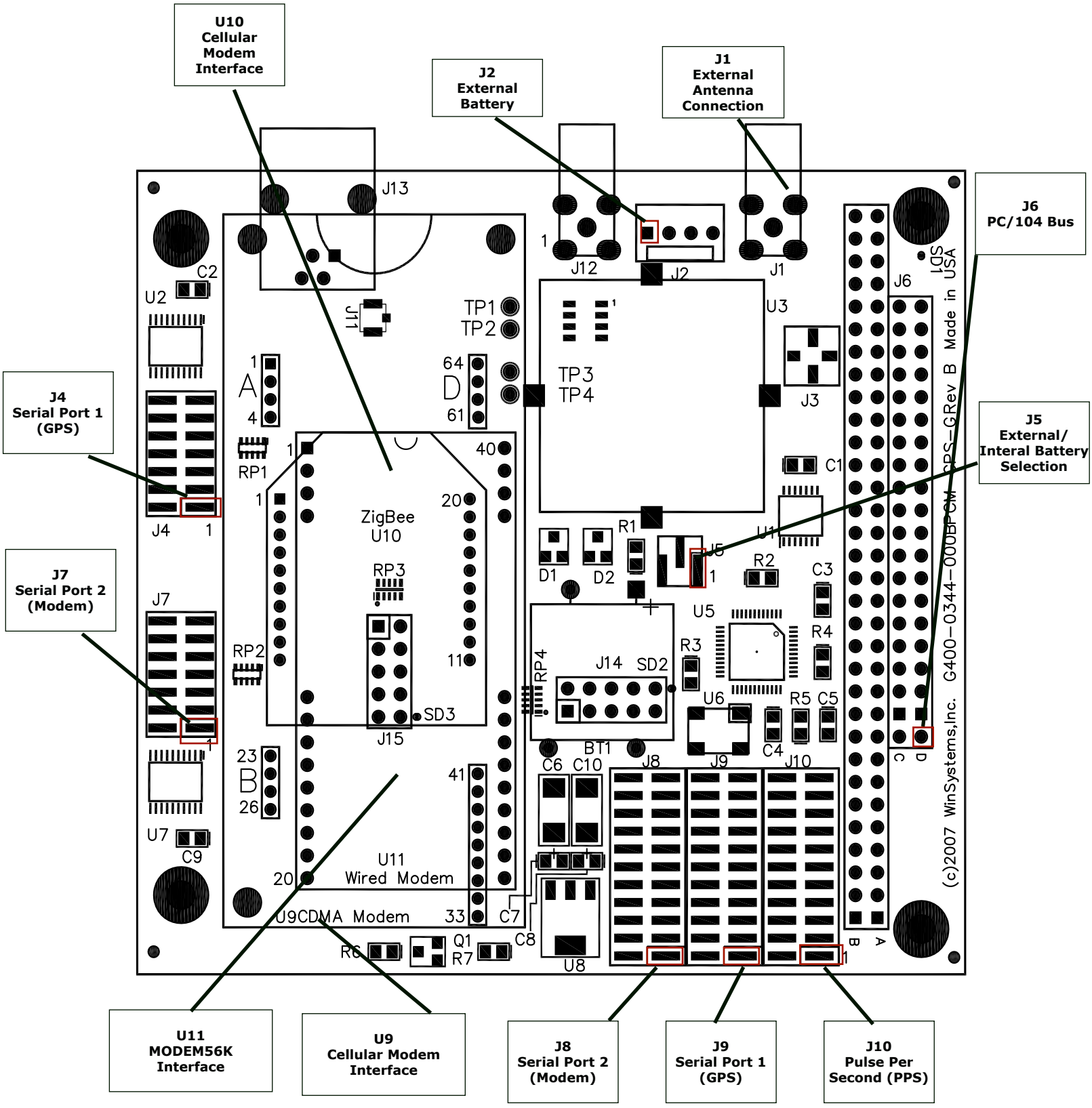
- Every one second for 4 seconds: 4A, 56, 6D, 82
- Every 5 seconds: 4A, 56, 41, 46, 4B, 6D, 82

Software Drivers & Examples

Documentation	
Trimble® Manual Reprint	LassenManual.pdf
GSM Programming Quick Start Guide	gsm_quickstart.pdf
Examples	
PCM-GPS Example Program with source	nmea3.zip
GPS Configuration Utility	IQ_CHAT.EXE
Monitoring Software including TSIPCHAT and TSIPPRNT	iQ_Monitor_V1-52.exe
NMEA Software Standard	nmea.pdf
Examples	
(Source Code Sample)	
TSIP	iQSource.zip

Jumper Reference

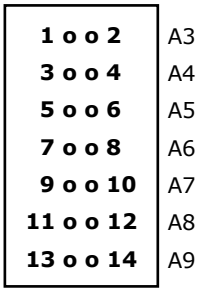
Drawings ONLY - for more detailed information on these parts, refer to the descriptions shown previously in this manual.



I/O Address Selection

J4/J7

I/O Base Address Select jumper
J4/J7 shown jumpered for 300H



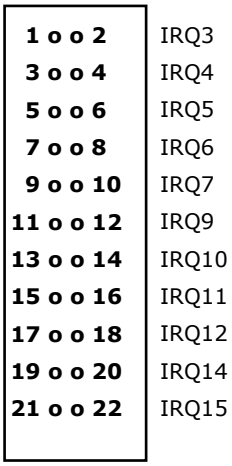
To disable a port, place a jumper on all 7 positions 9Address = 000H.

Interrupt Routing

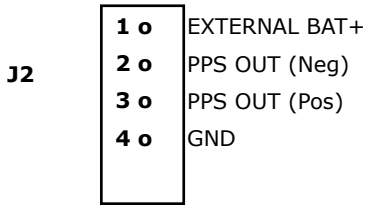
To route an interrupt to a source place a jumper at the desired IRQ position. Unused sources should be left unjumpered. Each source must have its own unique interrupt.

J8/J9/J10

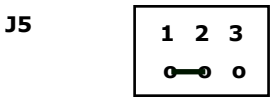
J8 - SocketModem®
J9 - GPS
J10 - PPS Interrupt

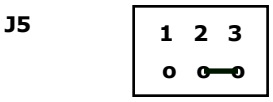


External PPS Usage



GPS Almanac Battery





Specifications

Electrical

Bus Interface	:PC/104 16-Bit, stackthrough
VCC	:+5V required, 50 mA typical, GPS module only. Add 20 mA typical for Trimble® magnetic mount antenna
I/O Addressing	:10-Bit user jumperable address. Each board uses 2 sets of 8 consecutive I/O addresses.
PPS Output	:1PPS (4 µs width) TTL Level both positive and negative available

Mechanical

Dimensions	:3.6" X 3.8" (90 mm x 96 mm)
Weight	:2.5 oz (70.87 gm)
PC Board	:FR-4 Epoxy glass with 2 signal layers 2 power planes, screened component legend, and plated through holes.
Jumpers	:0.020" square posts on 2.0 mm centers
Connectors	:PPS/External Battery : Molex 4 pin :GPS: 50Ω SMA with power for antenna
PC/104	:64-pin, 0.100" (32-pin double row) :40-pin, 0.100" (20-pin double row)

Environmental

Operating Temperature	:-40°C to +85°C (without optional cell modem installed)
Noncondensing humidity	:5% to 95%
MTBF	:54.11 yrs rate based upon MIL-HDBK-217C data

WARRANTY REPAIR INFORMATION

WARRANTY
(http://www.winsystems.com/company/warranty.cfm)

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