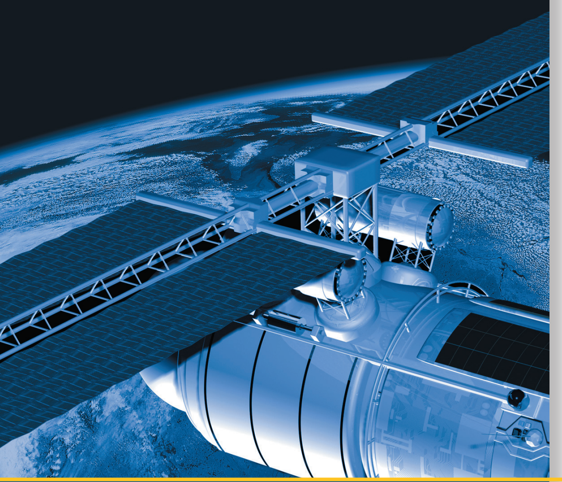

USER GUIDE

Trimble Condor Series GPS Modules

The right one.™

Trimble®

USER GUIDE

Condor Series GPS Modules

For use with:
Condor C1011 GPS module (P/N 68674-00)
Condor C1216 GPS module (P/N 68676-10)
Condor C1722 GPS module (P/N 68675-00)
Condor C1919A GPS module (P/N 67650-10)
Condor C1919A GPS module on carrier board (P/N 63531-10)
Condor C1919A GPS module starter kit (P/N 70291-10)
Condor C1919B GPS module (P/N 67650-00)
Condor C1919C GPS module (P/N 67650-20)
Condor C2626 GPS module (P/N 70896-00)
Condor C2626 GPS module starter kit (P/N 70897-05)
Silvana antenna companion module (P/N 68677-00)
Anapala antenna companion module (P/N 68677-55)
Silvana starter kit (P/N 75976-10)

Version 2.0
Revision C
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Trimble®

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This is the January 2011 release (Revision C) of the *Condor Series GPS Modules User Guide*, part number 75263-00.

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- your name, address, and telephone numbers
- proof of purchase
- a copy of this Trimble warranty
- a description of the nonconforming Product including the model number
- an explanation of the problem

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Notice to Our European Union Customers

For product recycling instructions and more information, please go to www.trimble.com/ev.shtml.

Recycling in Europe: To recycle Trimble WEEE (Waste Electrical and Electronic Equipment, products that run on electrical power.), Call +31 497 53 24 30, and ask for the "WEEE Associate". Or, mail a request for recycling instructions to:
Trimble Europe BV
c/o Menlo Worldwide Logistics
Meerheide 45
5521 DZ Eersel, NL

Safety Information

Warnings and Cautions

An absence of specific alerts does not mean that there are no safety risks involved. Always follow the instructions that accompany a Warning or Caution. The information they provide is intended to minimize the risk of personal injury and/or damage to the equipment. In particular, observe safety instructions that are presented in the following formats:

WARNING – A Warning alerts you to a likely risk of serious injury to your person and/or damage to the equipment.

CAUTION – A Caution alerts you to a possible risk of damage to the equipment and/or loss of data.

Operation and storage

WARNING – The Condor™ GPS receiver is ready to accept NMEA commands approximately 2 seconds after power-up. If a command is sent to the receiver within this 2 second window, the receiver will ignore the command. The Condor GPS receiver will not respond to commands sent within the 2 second window and will discard any associated command data.

WARNING – Operating or storing the Condor GPS receiver outside the specified temperature range can damage it. For more information, see the product specifications on the data sheet.

Routing any cable

CAUTION – Be careful not to damage the cable. Take care to avoid sharp bends or kinks in the cable, hot surfaces (for example, exhaust manifolds or stacks), rotating or reciprocating equipment, sharp or abrasive surfaces, door and window jambs, and corrosive fluids or gases.

AC adaptor safety

An international adaptor kit is provided with the Condor Starter Kit.

WARNING – Using an incorrect AC adaptor can damage your product and may void your warranty. To use AC adaptors safely:
– Use only the AC adaptor intended for the Condor GPS receiver. Using any other AC adaptor can damage your product and may void your warranty.
– Do not use the AC adaptor with any other product.
– Make certain that the input voltage on the adaptor matches the voltage and frequency in your location.
– Make certain that the adaptor has prongs compatible with your outlets.
– AC adaptors are designed for indoor use only. Avoid using the AC adaptor in wet outdoor areas.
– Unplug the AC adaptor from power when not in use.
– Do not short the output connector.
– There are no user-serviceable parts in this product.
– Should damage to the AC adaptor occur, replace it with a new Trimble AC adaptor.

Handling

CAUTION – The Condor GPS module is packed according to ANSI/EIA-481-B and JSTD-033A. All of the handling and precaution procedures must be followed. Deviation from following handling procedures and precautions voids the warranty.

CAUTION – Operators should not touch the bottom silver solder pads by hand or with contaminated gloves. Ensure that no hand lotion or regular chlorinated faucet water comes in contact with the module before soldering.

CAUTION – Do not bake the units within the tape and reel packaging. Repeated baking processes will reduce the solderability.

CAUTION – Follow the thermal reflow guidelines from IPC-JEDEC J-STD-020C.

Contents

CHAPTER

1

Setting up the Condor Starter Kit

In this chapter:

This chapter describes the elements of the Condor starter kit and how to set it up.

The hardware integration is described in Chapter 4, Condor Carrier Board.

System requirements

Hardware

- The Trimble Condor Starter Kit, see page 13.
- User-provided connectors and extension cords to connect the Condor GPS module to the computer, antenna interface, and other devices as required.
- +24 VDC power supply.
- User-provided equipment to analyze the PPS accuracy and a BNC connector to connect it to the Condor starter kit.

Computer

- An office computer running a version of the Windows® operating system (Windows 2000 or later)
- The computer must have one of the following service packs installed:
  - Service Pack 2, for Windows Vista® or Windows XP
  - Service Pack 4, for Windows 2000

System software

- Trimble GPS Studio software. The software is used to monitor the GPS performance of the Condor and to change its settings. The software is compatible with the Windows 2000, Windows XP, and Windows Vista operating system.
- The National Marine Electronics Association (NMEA) protocol is an industry standard navigation data protocol. There are also proprietary query and set packets. See Appendix B, NMEA 0183 Protocol.

Removing the Condor carrier board from the motherboard

WARNING – Before opening the interface unit, disconnect the unit from any external power source and confirm that both you and your work surface are properly grounded for ESD protection.

The Condor GPS module is secured to a carrier board and is then attached to the motherboard standoffs with Phillips head screws, allowing for removal and integration with the user's application. Follow these steps to remove the receiver from the motherboard:

1. Disconnect power to the enclosure.
2. Remove the base plate and unplug the RF cable from the receiver.

3. Use a small Phillips screwdriver to remove the hardware that holds the Condor GPS receiver to the motherboard.
4. Gently slip the board loose from the motherboard I/O connector.

Interface protocols

The Condor family of GPS modules uses the NMEA 0183 protocol. This is an industry standard protocol that is common to marine applications. NMEA provides direct compatibility with other NMEA-capable devices such as chart plotters, radar, and so on. The Condor GPS module supports the GGA, GSV, GSA, and RMC NMEA messages.

Condor C1919A starter kit

The Condor C1919A GPS module is available in a starter kit or as an individual receiver and associated antenna. The starter kit includes all the components necessary to quickly test and integrate the receiver.

The starter kit includes the Condor C1919A GPS module on a carrier board, mounted on an interface motherboard in a durable metal enclosure. The kit also contains:

- Miniature magnetic mount antenna
- Two additional sample Condor C1919A GPS modules
- Interface cable, USB
- AC/DC power supply adapter:
  - Input: 100 – 240 VAC
  - Output: 24 VDC

***Note** – The Condor C1919A GPS module is available as an individual receiver, or with the Condor C1919A module mounted on a carrier board.*

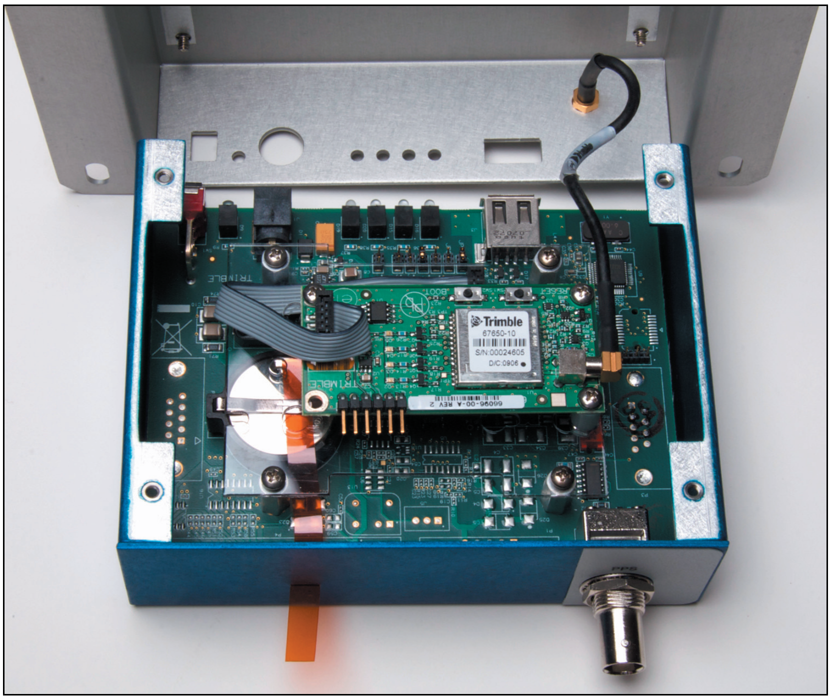
You can download software tools used to communicate with the receiver and documentation from the Support section of www.trimble.com, including the *Condor Series GPS Modules User Guide* (this document), the Trimble GPS studio application, and the *Trimble GPS Studio Application User Guide*.

Starter kit interface unit

The starter kit interface unit consists of a USB interface that is compatible with most computer communication ports. Power (24 VDC) is supplied through the power connector on the front of the interface unit. The motherboard features a switching power supply which converts this voltage input to the 3.3 V required by the receiver and the antenna. The USB connector allows for an easy connection to an office computer using the USB interface cable provided in the starter kit. The metal enclosure protects the receiver and the motherboard for testing outside of the laboratory environment.

The Condor C1919A GPS receiver, installed in the Starter Kit interface unit, is a single port receiver. Only port B is available from the carrier board header pins. A straight-in, panel-mounted RF MCX connector supports the GPS antenna connection. The center conductor of the MCX connector also supplies +3.3 VDC for the low-noise amplifier of the active antenna.

This following figure shows the receiver in the metal enclosure:



The following figure shows the starter kit interface unit:

Pulse-per-second (PPS)

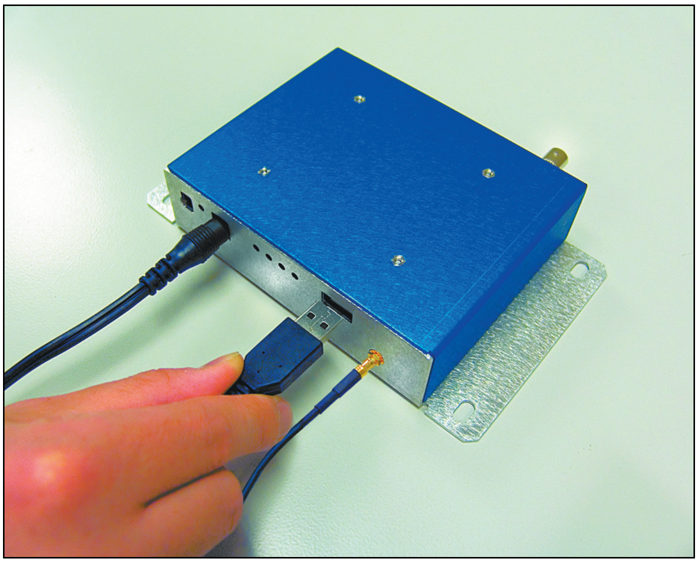
The receiver provides a 4 us wide, TTL-compatible Pulse-Per-Second (PPS). The PPS is a positive pulse available on the BNC connector of the interface unit. The rising edge of the pulse is synchronized to GPS. The timing accuracy is ±25 ns 1 sigma. The PPS from the BNC connector can drive a 50 Ω load.

Setting up the starter kit

***Note** – You can either set up the starter kit temporarily for testing or evaluation purposes, or embed it permanently into your system. The procedure is largely the same.*

1. Start up an office computer that is running a suitable Windows operating system and service pack (see page 12) and that has a free USB port.
2. Download the required software from www.trimble.com/support.shtml. Select and then save all the relevant files to a directory on the hard drive.
3. To use the Trimble GPS Studio application to communicate with the GPS receiver, you must install the FTDI driver on your computer. The starter kit uses a USB 2.0 dual serial port emulator interface chip from Future Technology Devices International Ltd. (FTDI).

   To do this, click the CDM_Setup.exe file that you downloaded earlier. If the installation is successful, a message FTDI CDM Drivers have been successfully installed appears.
4. Click **OK**.
5. Connect one end of the USB cable (supplied) to the USB connector on the interface unit:



6. Connect the other end of the USB cable to your computer. The USB cable now supplies power to the unit.

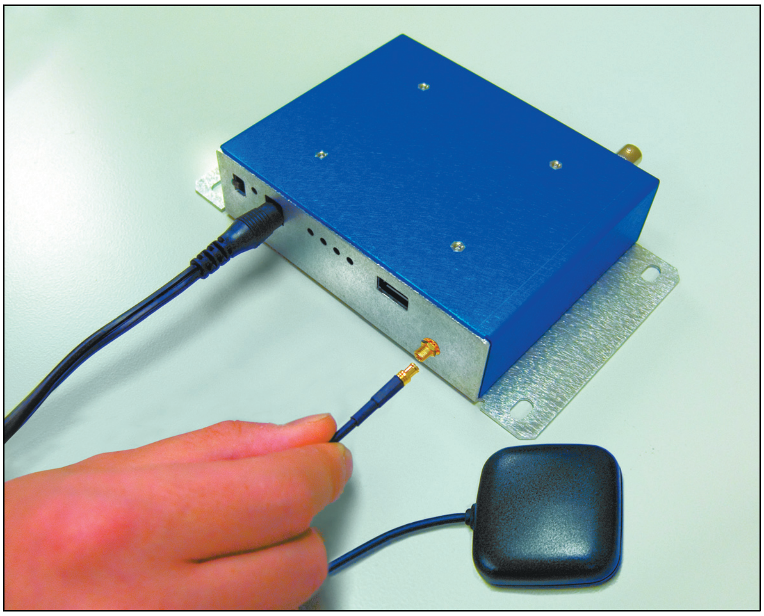
7. Turn on the interface unit. The Power LED lights up green.

***Note** – Two additional power adapters are supplied—an international AC / DC adapter and an automotive DC/DC adapter.*

8. The FTDI driver automatically assigns two virtual COM ports to the USB port. When you need to assign the virtual COM ports, they appear on the monitor screen. To view the ports, select *System Properties / Device Manager / Ports*.

   Use the COM port for Port B of the starter kit. This is usually the higher number of the two virtual ports.

9. Connect the magnetic mount GPS antenna to the interface unit:



10. Place the antenna outside.
11. Connect to the BNC connector on the rear of the interface unit for the PPS output:

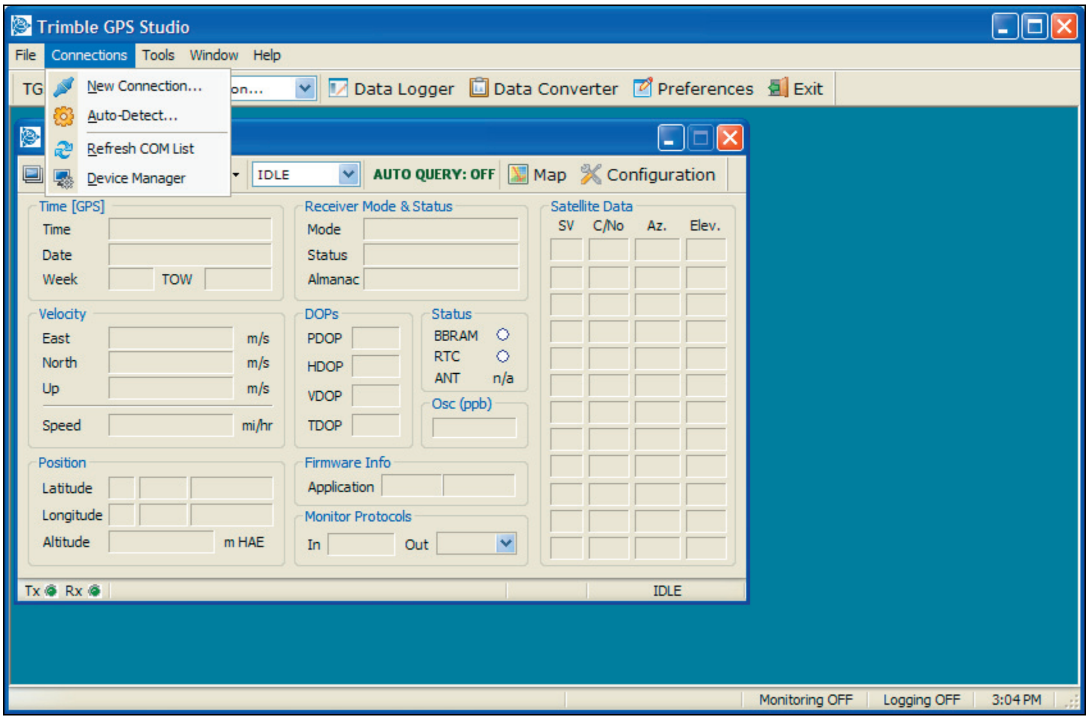
12. Set up the Trimble GPS Studio application as described in the next section.

Setting up the software toolkit

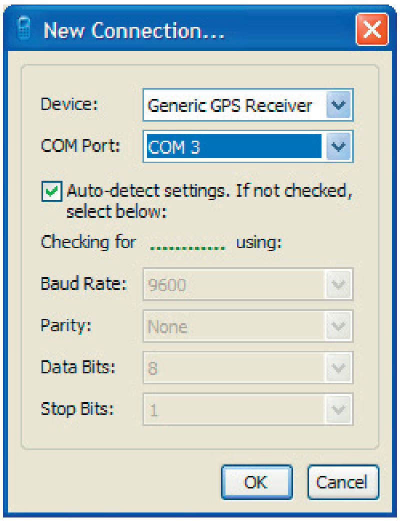
The Trimble GPS Studio application is used to monitor GPS performance and to assist system integrators in developing a software interface for the GPS module. It runs on the Windows 2000/XP and Windows Vista platforms.

To use the Trimble GPS Studio application to monitor the receiver's performance:

1. Use the USB cable to connect the starter kit to the computer.
2. Download the Trimble GPS Studio application onto your computer's hard drive.
3. Start the Trimble GPS Studio application and then select *Connections / New Connection* from the main window menu bar:



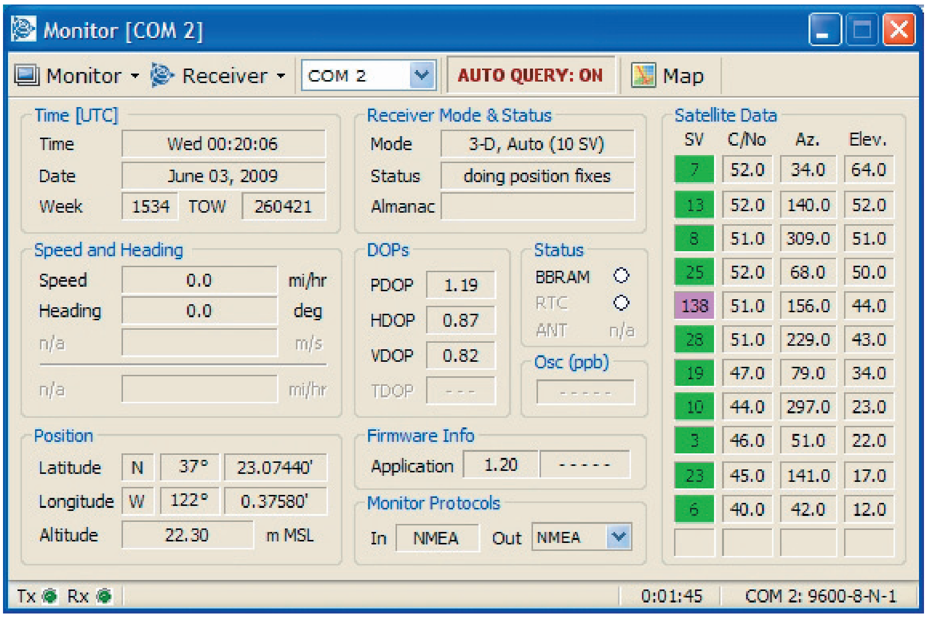
4. In the *New Connection* dialog, select the correct COM port for Port B of the starter kit and then select the *Auto-detect settings* checkbox:



5. Click **OK**.

   When the Trimble GPS Studio application has started communication with the receiver, a success message appears.

6. Connect a GPS antenna to the receiver. Once the receiver has a position fix, the following information appears:
   - position
   - time
   - satellites tracked
   - GPS receiver status



Notes –
The receiver also sends a health report every few seconds, even if satellites are not being tracked.
By default, Port B is set to NMEA protocol, 9600 baud, 8 data bits, parity none, 1 stop bit, no flow control.
If there is no data in the Monitor window, or if some data fields remain blank for a long time, the GPS module may not be communicating with the computer. Check the interface cable connections again and verify the serial port selection and settings. If the communication failure continues, please call Trimble Support at 1 (800) 767-4822.

CHAPTER

2

Features and Specifications

In this chapter:

This chapter describes the features and performance specifications of the Condor series GPS modules.

Key features

The Condor family of value-optimized GPS modules includes different form factors and feature sets, allowing the system designer to choose the optimal module solution for a particular application.

- Pick-and-place assembly, tape and reel packaging, reflow solderable
- Low power usage
- World class tracking and acquisition sensitivity
- Supports active and passive antenna designs
- Built in antenna open and short detection on C1919C, C1216, C2626, and C1722
- 22 tracking channels
- Supports NMEA 0183 protocol
- Carrier board and starter kit available
- RoHS compliant (lead-free)

Quick comparison tables

Model	Part No.	Internal LNA	RTC	Antenna detection	USB	UART	Protocol
C2626	70896-00	x	x	x		1	NMEA
C1919A	67650-10	x	x			1	NMEA
C1919B	67650-00	x				1	NMEA
C1919C	67650-20	x	x	x		1	NMEA
C1722	68675-00	x	x	x	x	1	NMEA
C1216	68676-10	x	x	x	x	1	NMEA
C1011	68674-00					1	NMEA

Model	Part No.	Package	Dimensions (mm)	Packaging options	Starter kit
C2626	70896-00	Shielded module with 8-pin header and H.FL RF connector	26.00 x 26.00 x 26.00	250-piece box	70897-05
C1919A	67650-10	28 surface mount edge castellations	19.00 x 19.00 x 2.54	20-piece tray, 100 or 500 piece reel	70291-10
C1919B	67650-00	28 surface mount edge castellations	19.00 x 19.00 x 2.54	20-piece tray 100 or 500 piece reel	70291-10
C1919C	67650-20	28 surface mount edge castellations	19.00 x 19.00 x 2.54	20-piece tray, 100 or 500 piece reel	70291-10
C1722	68675-00	28 surface mount edge castellations	17.00 x 22.10 x 2.13	36-piece tray 500 piece reel	
C1216	68676-10	24 surface mount edge castellations	16.00 x 12.20 x 2.13	50-piece tray or 500 piece reel	
C1011	68674-00	38 surface mount pads, quad flat no leads LGA package	10.00 x 11.00 x 2.01	20-piece tray, 100 or 500 piece reel	70897-05

Specifications

Condor C1919A, C1919B, C1919C, C1722, C1216, and Condor C1011 receiver performance

These are L1 frequency (1575.42 MHz), C/A code, 22-channel, continuous tracking receivers.

Update rate[1]	NMEA	1 Hz (default), up to 5 Hz
Accuracy (24 hour static)	Horizontal (without SBAS)	<2.5 m 50%, <5 m 90%
	Horizontal (with SBAS)	<2.0 m 50%, <4 m 90%
	Altitude (without SBAS)	<5 m 50%, <8 m 90%
	Altitude (with SBAS)	<3 m 50%, <5 m 90%
	Velocity	0.06 m/sec
	PPS (static)	±25 ns 1 sigma
Acquisition (autonomous operation)	Reacquisition	2 sec 50%
	Hot start	2 sec 50%
	Warm start	35 sec 50%
	Cold start	38 sec 50%
Sensitivity[2]	Tracking	-160 dBm
	Acquisition sensitivity	-146 dBm
Operational	Speed limit	515 m/s

[1]If using an update rate that is faster than 1 Hz, always use a communication baud rate of 115200.

[2]Results when the Condor C1011 receiver is tested with an external low-noise amplifier (LNA).

Interface

Condor C1919A, C1919B, and C1919C

Connectors	28 surface mount edge castellations
Serial port	1 UART, 2.8 V LVTTL compatible
PPS	2.8 V LVTTL compatible
Protocols	National Marine Electronics Association (NMEA) 0183

Condor C1722

Connectors	28 surface mount edge castellations
Serial port	1 UART, 2.8 V LVTTL compatible
PPS	2.8 V LVTTL compatible
Protocols	National Marine Electronics Association (NMEA) 0183

Condor C1216

Connectors	24 surface mount edge castellations
Serial port	1 UART, 2.8 V LVTTL compatible
PPS	2.8 V LVTTL compatible
Protocols	National Marine Electronics Association (NMEA) 0183

Condor C1011

Connectors	38 surface mount, quad flat no leads package
Serial port	1 UART, 2.8 V LVTTL compatible
PPS	2.8 V LVTTL compatible
Protocols	National Marine Electronics Association (NMEA) 0183

Physical

Condor C1919A and C1919C

Dimensions (W x L x H)	19 mm x 19 mm x 2.54 mm
Weight	1.724 grams, including metal shield

Condor C1919B

Dimensions (W x L x H)	19 mm x 19 mm x 2.54 mm
Weight	1.633 grams, including metal shield

Condor C1722

Dimensions (W x L x H)	17.0 mm x 22.4 mm x 2.13 mm
Weight	0.953 grams

Condor C1216

Dimensions (W x L x H)	16.0 mm x 12.2 mm x 2.13 mm
Weight	0.544 grams

Condor C1011

Dimensions (W x L x H)	10 mm x 11 mm x 2.01 mm
Weight	0.364 grams

Environmental

Operating temperature	-40 °C to +85 °C
Storage temperature	-55 °C to +105 °C
Vibration	0.008 g^2/Hz, 5 Hz to 20 Hz 0.05 g^2/Hz, 20 Hz to 100 Hz -3 dB/octave, 100 Hz to 900 Hz
Operating humidity	5% to 95%, R.H., non-condensing, at +60 °C

Absolute maximum limits

CAUTION – Absolute maximum ratings indicate conditions beyond which permanent damage to the device may occur. Electrical specifications do not apply when you are operating the device outside its rated operating conditions.

Condor C1919A, C1919B, C1919C, C1722, and C1216 absolute maximum limits

Parameter		Min	Max	Unit
Power supply	Power supply voltage (V_{CC}) on Pin 12	-0.3	3.6	V
	Standby voltage (V_{CC}) on Pin 12 *	-0.3	3.6	V
Antenna	Input power at RF input		+10	dBm

Condor C1011 absolute maximum limits

Parameter		Min	Max	Unit
Power supply	Power supply voltage (V_{CC}) on Pin 15, 24, and 32	-0.3	3.6	V
	Standby voltage (V_{CC}) on Pin 4	-0.3	3.6	V
Antenna	Input power at RF input		+10	dBm

Recommended operating conditions

Minimum and maximum limits apply over the full operating temperature range unless otherwise noted.

Condor C1919A, C1919B, C1919C, C1722, and C1216 Input/Output pin threshold voltages

Parameter	Status	Min	Max	Unit
Input pin voltage (RXD, Reserved Pins, XRESET)	High	2.0	3.6	V
	Low	-0.3	0.8	V
Output pin voltage (TXD)	High (loh = 1.6~14 mA)	2.4	V_{CC}	V
	Low (lol = 1.6~14 mA)	-0.3	0.4	V

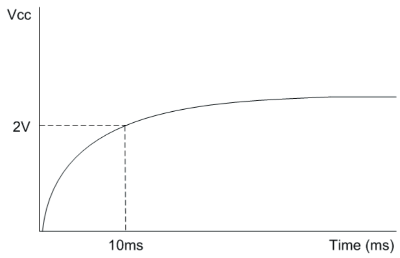
C1011 Input/Output pin threshold voltages

Parameter	Status	Min	Max	Unit
Input pin voltage (RXD, Reserved Pins, XRESET, XSTANDBY)	High	2.0	3.6	V
	Low	-0.3	0.8	V
Output pin voltage (TXD)	High (loh = 1.6~14 mA)	2.4	V_{CC}	V
	Low (lol = 1.6~14 mA)	-0.3	0.4	V

Condor C1919A and C1919C recommended operating conditions

Parameter	Conditions	Min	Typical	Max	Unit
Primary supply voltage[1]		3.0		3.6	V
Current draw, continuous tracking (excluding antenna supply)	Maximum: 85 °C, 3.6 V Minimum: -40 °C, 3.0 V Typical: 25 °C, 3.3 V	31	37	42	mA
Power consumption, continuous tracking	Maximum: 85 °C, 3.6 V Minimum: -40 °C, 3.0 V Typical: 25 °C, 3.3 V	93.00	122.10	151.20	mW
Current draw	Typical: 20 °C				
Standby mode with V_{rtc} applied	V_{rtc} = 2.96 V		5		uA
Standby mode using serial command	V_{cc} = 3.3 V		2.42		mA
Supply ripple noise	1 Hz to 1 MHz			50	mV_{pp}
	GPS TCXO frequency ±5 kHz			1	mV_{pp}
Hardware XRESET	Assert XRESET pin	100			ms
Input gain at RF input		0 (passive antenna)		25	dB
External LNA noise				2	dB

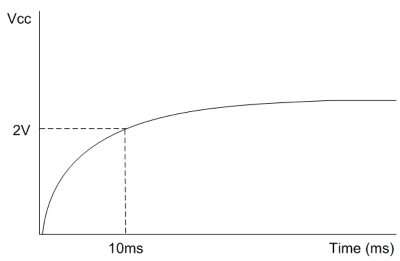
[1]The primary supply voltage slope from 0 V to 2V must have a rise time that is less than 10 ms:



Condor C1919B recommended operating conditions

Parameter	Conditions	Min	Typical	Max	Unit
Primary supply voltage[1]		3.0		3.6	V
Current draw, continuous tracking	Maximum: 85 °C, 3.6 V Minimum: -40 °C, 3.0 V Typical: 25 °C, 3.3 V	31	37	42	mA
Power consumption, continuous tracking	Maximum: 85 °C, 3.6 V Minimum: -40 °C, 3.0 V Typical: 25 °C, 3.3 V	93.00	122.10	151.20	mW
Current draw	Typical: 20 °C				
Standby mode with V_{rtc} applied	V_{rtc} = 2.96 V		5		uA
Standby mode using serial command	V_{cc} = 3.3 V		2.42		mA
Supply ripple noise	1 Hz to 1 MHz			50	mV_{pp}
	GPS TCXO frequency ±5 kHz			1	mV_{pp}
Hardware XRESET	Assert XRESET pin	100			ms
RTC input	The Condor C1919B GPS module must have an RTC signal on pin 17.		Frequency: 32.768 kHz Amplitude: 1.5 V		
Input gain at RF input		0 (passive antenna)		25	dB
External LNA noise				2	dB

[1]The primary supply voltage slope from 0 V to 2V must have a rise time that is less than 10 ms:



Condor C1722 recommended operating conditions

Parameter	Conditions	Min	Typical	Max	Unit
Primary supply voltage		3.0		3.6	V
USB supply voltage	See Appendix E, USB Guide for C1722 and C1216 GPS Modules for design details.	3.0		3.6	V
Current draw, continuous tracking	Temperature 85 °C to -40 °C Excluding antenna LNA supply			<37	mA
Power consumption, continuous tracking	Temperature 85 °C to -40 °C Excluding antenna LNA supply			<133	mW
Standby current (V_{rtc} only)	Temperature 85 °C to -40 °C		5	<14.5	uA
Supply ripple noise	1 Hz to 1 MHz			50	mV_{pp}
	GPS TCXO frequency ±5 kHz			1	mV_{pp}
Hardware RESET	Assert RESET	100			us
Input gain at RF input		0 (passive antenna)		25	dB
External LNA noise				2	dB

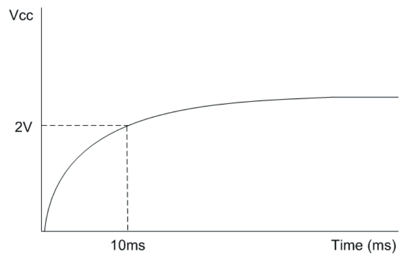
Condor C1216 recommended operating conditions

Parameter	Conditions	Min	Typical	Max	Unit
Primary supply voltage		3.0		3.6	V
USB supply voltage	See Appendix E, USB Guide for C1722 and C1216 GPS Modules for design details.	3.0		3.6	V
Current draw, continuous tracking	Temperature 85 °C to -40 °C Excluding antenna LNA supply			<37	mA
Power consumption, continuous tracking	Temperature 85 °C to -40 °C Excluding antenna LNA supply			<133	mW
Current draw, during acquisition	Temperature 85 °C to -40 °C Excluding antenna LNA supply			<35	mA
Power consumption, during acquisition	Temperature 85 °C to -40 °C Excluding antenna LNA supply			<126	mW
Standby current, V_{rtc} only	Temperature 85 °C to -40 °C		6	<13.5	uA
Standby current, V_{cc} and V_{rtc} only	Temperature 85 °C to -40 °C		2.5	<2.8	mA
Supply ripple noise	1 Hz to 1 MHz			50	mV_{pp}
	GPS TCXO frequency ±5 kHz			1	mV_{pp}
Hardware RESET	Assert RESET	100			us
Input gain at RF input		0 (passive antenna)		25	dB
External LNA noise				2	dB
Standby current (V_{rtc} only)	Temperature 85 °C to -40 °C		5	<14.5	uA
Supply ripple noise	1 Hz to 1 MHz			50	mV_{pp}
	GPS TCXO frequency ±5 kHz			1	mV_{pp}

Condor C1011 recommended operating conditions

Parameter	Conditions	Min	Typical	Max	Unit
Primary supply voltage[1]		3.0		3.6	V
Current draw, continuous tracking	Maximum: 85 °C, 3.6 V Minimum: -40 °C, 3.0 V Typical: 25 °C, 3.3 V	31	33	42	mA
Power consumption, continuous tracking	Maximum: 85 °C, 3.6 V Minimum: -40 °C, 3.0 V Typical: 25 °C, 3.3 V	93.00	122.10	151.20	mW
Current draw	Typical: 20 °C				
Standby mode with V_{rtc} applied	V_{rtc} = 2.96 V		5		uA
Standby mode using serial command	V_{cc} = 3.3 V		2.42		mA
Standby mode using XSTANDBY pin	V_{cc} = 3.3 V		840		uA
Supply ripple noise	1 Hz to 1 MHz			50	mV_{pp}
	GPS TCXO frequency ±5 kHz			1	mV_{pp}
Hardware XRESET	Assert XRESET pin	100			ms
RTC input	RTC signal on pin 2 from either an XTAL or buffered clock.		32.768		kHz
Input gain at RF input		17		25	dB
External LNA noise				2	dB

[1]The primary supply voltage slope from 0 V to 2V must have a rise time that is less than 10 ms:



ESD protection

ESD testing was performed using test standard IEC 1000-4-2. All inputs and outputs are protected to ±500 V ESD level.

The RF IN pin is protected up to 1 kV. If you require a higher level of compliance, you must add additional electrostatic and surge protection.

CHAPTER

3

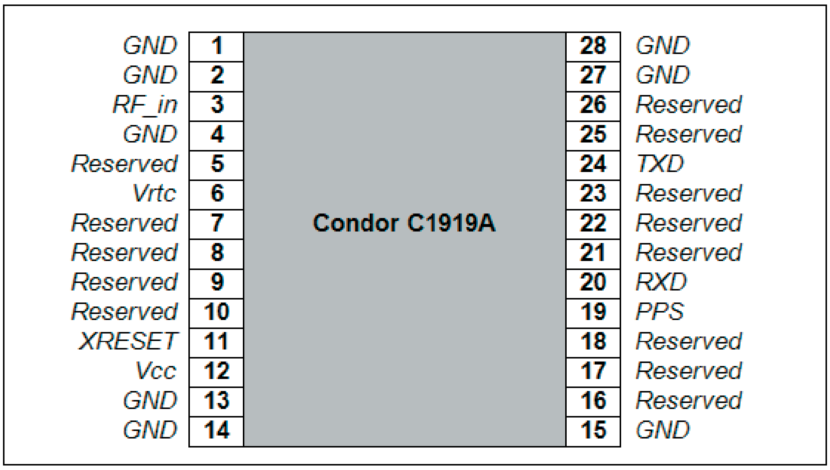
Interface Characteristics

In this chapter:

- Condor C1919A pin assignments
- Condor C1919B pin assignments
- Condor C1919C pin assignments
- Condor C1722 pin assignments
- Condor C1216 pin assignments
- Condor C1011 pin assignments

This chapter provides a detailed description of the Condor GPS receiver interface.

Condor C1919A pin assignments



Pin description

Pin	Name	Description	Function	Note
1	GND	Ground	Ground	Connect to common ground.
2	GND	Ground	Ground	Connect to common ground.
3	RF_in	GPS RF input	Input	50 Ω unbalanced (coaxial) RF input.
4	GND	Ground	Ground	Connect to common ground.
5	Reserved	Reserved		Do not connect
6	V_{rtc}	RTC backup power	Input	2.0 V to V_{cc}. If not used, leave disconnected or connect to V_{cc}.
7	Reserved	Reserved		Do not connect.
8	Reserved	Reserved		Do not connect.
9	Reserved	Reserved		Do not connect.
10	Reserved	Reserved		Do not connect.
11	XRESET	System reset	Input	100 ms active low. Do not connect if not used.
12	V_{cc}	Main power	Input	3.0 V to 3.6 V, typical 3.3 V.
13	GND	Ground	Ground	Connect to common ground.
14	GND	Ground	Ground	Connect to common ground.
15	GND	Ground	Ground	Connect to common ground.
16	Reserved	Reserved		Do not connect.
17	Reserved	Reserved		Do not connect.
18	Reserved	Reserved		Do not connect.
19	PPS	Pulse per second	Output	1 Hz timing pulse. Do not connect if not used.
20	RXD	UART Receive	Input	LVTTL logic level serial port receive.
21	Reserved	Reserved		Do not connect.
22	Reserved	Reserved		Do not connect.
23	Reserved	Reserved		Do not connect.

Pin	Name	Description	Function	Note
24	TXD	UART Transmit	Output	TTL Logic level serial port transmit.
25	Reserved	Reserved		Do not connect.
26	Reserved	Reserved		Do not connect.
27	GND	Ground	Ground	Connect to common ground.
28	GND	Ground	Ground	Connect to common ground.

Detailed pin descriptions

RF_in (pin 3)

The RF input pin is the 50 Ω unbalanced GPS RF input, and can be used with active or passive antennas.

Refer to the application designs for examples of antenna power circuits.

V_{rtc} (pin 6)

Supply can range from 2.0 V to $V_{cc.}$ Maintains non-volatile RAM and the RTC for hot and warm starts. If not used, leave disconnected or connect to V_{cc}.

XRESET (pin 11)

Connects to the host system reset controller or GPIO for host-controlled resetting of the GPS module.

Vcc (pin 12)

This is the primary voltage supply pin for the module.

PPS (pin 19)

Pulse-per-second. This logic level output provides a 1 Hz timing signal to external devices. The pulse width of this signal is 4.2 us.

RXD (pin 20)

This logic level input is the serial port receive line (data input to the module).

TXD (pin 24)

This logic level output is the serial port transmit line (data output from the module). Do not hold the Tx port "low" or pull to ground while the GPS module is starting up.

Reserved pins

There are several reserved pins on the Condor C1919A GPS module. Do not connect these pins.

Protocols

NMEA 0183 is available on the Condor C1919A GPS module.

Serial port default settings

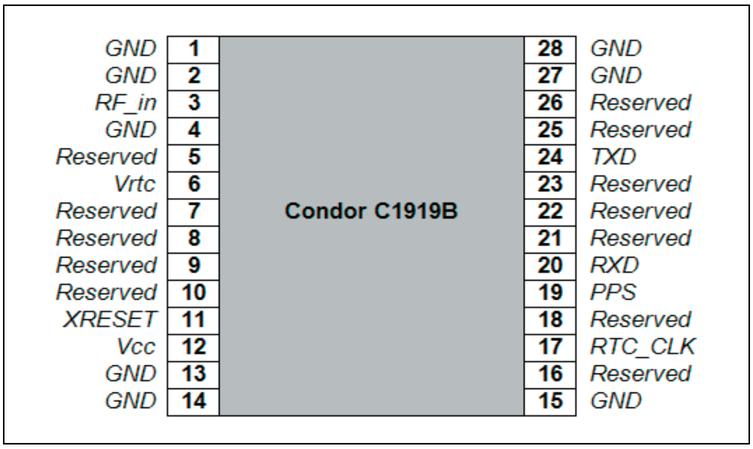
The Condor C1919A GPS module supports one serial port. The default settings are as follows:

Port direction	Pin #	Protocol	Characteristics				
			Baud rate	**Data bits**	**Parity**	**Stop bits**	**Flow control**
TXD	24	NMEA out	9600	8	None	1	None
RXD	20	NMEA in	9600	8	None	1	None

- Baud rate, data bits, parity, and stop bits are user configurable.
- Flow control is not available on the serial ports.

A detailed description of the protocol is given in Appendix B, NMEA 0183 Protocol.

Condor C1919B pin assignments



Pin description

Pin	Name	Description	Function	Note
1	GND	Ground	Ground	Connect to common ground.
2	GND	Ground	Ground	Connect to common ground.
3	RF_in	GPS RF input	Input	50 Ω unbalanced (coaxial) RF input.
4	GND	Ground	Ground	Connect to common ground.
5	Reserved	Reserved		Do not connect.
6	V_{rtc}	RTC backup power	Input	2.0 V to V_{CC}. If not used, leave disconnected or connect to V_{CC}.
7	Reserved	Reserved		Do not connect.
8	Reserved	Reserved		Do not connect.
9	Reserved	Reserved		Do not connect.
10	Reserved	Reserved		Do not connect.
11	XRESET	System reset	Input	100 ms active low. Do not connect if not used.
12	Vcc	Main power	Input	3.0 V to 3.6 V, typical 3.3 V.
13	GND	Ground	Ground	Connect to common ground.
14	GND	Ground	Ground	Connect to common ground.
15	GND	Ground	Ground	Connect to common ground.
16	Reserved	Reserved		Do not connect.
17	RTC_CLK	32 kHz RTC input	Input	Real Time Clock input.
18	Reserved	Reserved		Do not connect.
19	PPS	Pulse per second	Output	1 Hz timing pulse. Do not connect if not used.
20	RXD	UART Receive	Input	LVTTL logic level serial port receive.
21	Reserved	Reserved		Do not connect.
22	Reserved	Reserved		Do not connect.
23	Reserved	Reserved		Do not connect.
24	TXD	UART Transmit	Output	LVTTL logic level serial port transmit.

Pin	Name	Description	Function	Note
25	Reserved	Reserved		Do not connect.
26	Reserved	Reserved		Do not connect.
27	GND	Ground	Ground	Connect to common ground.
28	GND	Ground	Ground	Connect to common ground.

Detailed pin descriptions

RF_in (pin 3)

The RF input pin is the 50 Ω unbalanced GPS RF input, and can be used with active or passive antennas.

Refer to the application designs for examples of antenna power circuits.

V_{rtc} (pin 6)

Supply can range from 2.0 V to V_{CC}. Maintains non-volatile RAM and the RTC for hot and warm starts. If not used, leave disconnected or connect to V_{CC}.

XRESET (pin 11)

Connects to the host system reset controller or GPIO for host controlled resetting of the GPS module.

VCC (pin 12)

This is the primary voltage supply pin for the module.

RTC_CLK (pin 17)

A clock signal at 1.2–1.5 V logic levels capable of driving the Condor C1919B GPS module RTC. The limits are 0 V through 2.0 V on this input. Best results are achieved with a sine wave.

PPS (pin 19)

Pulse-per-second. This logic level output provides a 1 Hz timing signal to external devices. The pulse width of this signal is 4.2 us.

RXD (pin 20)

This logic level input is the serial port receive line (data input to the module).

TXD (pin 24)

This logic level output is the serial port transmit line (data output from the module). Do not hold the Tx port "low" or pull to ground while the GPS module is starting up.

Reserved pins

There are several reserved pins on the Condor C1919B GPS module. Do not connect these pins.

Protocols

NMEA 0183 is available on the Condor C1919B GPS module.

Serial port default settings

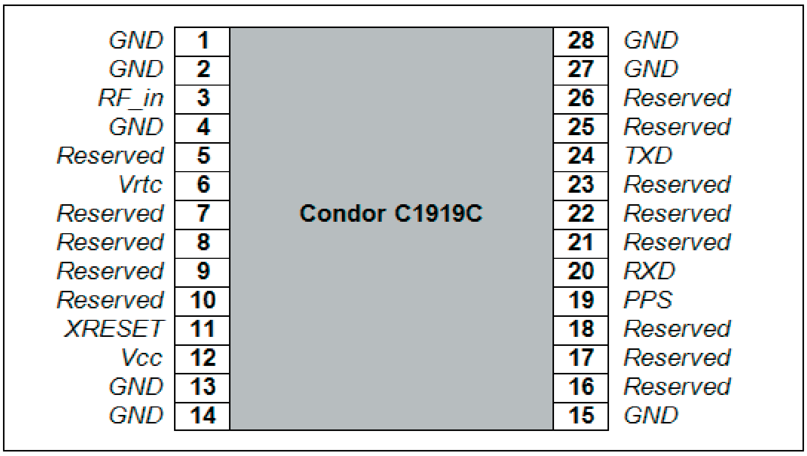
The Condor C1919B GPS module supports one serial port. The default settings are as follows:

Port direction	Pin #	Protocol	Characteristics				
			Baud rate	**Data bits**	**Parity**	**Stop bits**	**Flow control**
TXD	24	NMEA out	9600	8	None	1	None
RXD	20	NMEA in	9600	8	None	1	None

- Baud rate, data bits, parity, and stop bits are user configurable.
- Flow control is not available on the serial ports.

A detailed descriptions of the protocol is given in Appendix B, NMEA 0183 Protocol.

Condor C1919C pin assignments



Pin description

Pin	Name	Description	Function	Note
1	GND	Ground	Ground	Connect to common ground.
2	GND	Ground	Ground	Connect to common ground.
3	RF_in	GPS RF input	Input	50 Ω unbalanced (coaxial) RF input.
4	GND	Ground	Ground	Connect to common ground.
5	Reserved	Reserved		Do not connect
6	V_{rtc}	RTC backup power	Input	2.0 V to V_{cc}. If not used, leave disconnected or connect to V_{cc}.
7	Reserved	Reserved		Do not connect.
8	Reserved	Reserved		Do not connect.
9	Reserved	Reserved		Do not connect.
10	Reserved	Reserved		Do not connect.
11	XRESET	System reset	Input	100 ms active low. Do not connect if not used.
12	V_{cc}	Main power	Input	3.0 V to 3.6 V, typical 3.3 V.
13	GND	Ground	Ground	Connect to common ground.
14	GND	Ground	Ground	Connect to common ground.
15	GND	Ground	Ground	Connect to common ground.
16	Reserved	Reserved		Do not connect.
17	Reserved	Reserved		Do not connect.
18	Reserved	Reserved		Do not connect.
19	PPS	Pulse per second	Output	1 Hz timing pulse. Do not connect if not used.
20	RXD	UART Receive	Input	LVTTL logic level serial port receive.
21	Reserved	Reserved		Do not connect.
22	Reserved	Reserved		Do not connect.
23	Reserved	Reserved		Do not connect.
24	TXD	UART Transmit	Output	LVTTL Logic level serial port transmit.

Pin	Name	Description	Function	Note
25	Reserved	Reserved		Do not connect.
26	Reserved	Reserved		Do not connect.
27	GND	Ground	Ground	Connect to common ground.
28	GND	Ground	Ground	Connect to common ground.

Detailed pin descriptions

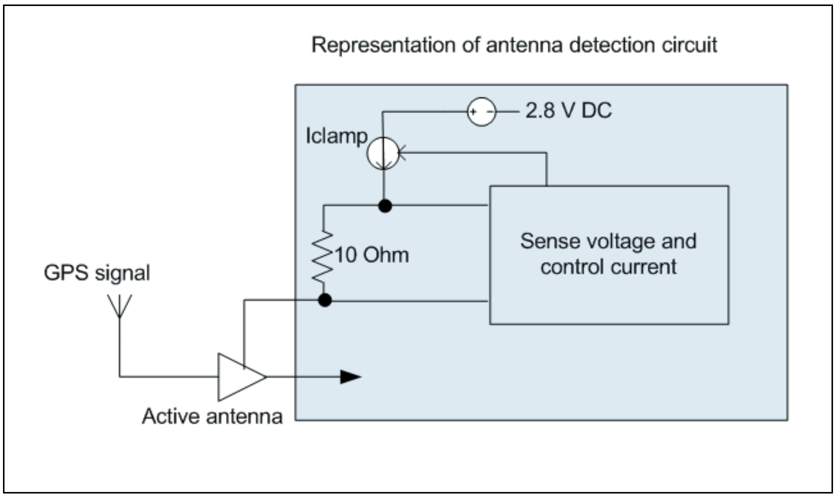
RF_in (pin 3)

The RF input pin is the 50 Ω unbalanced GPS RF input, and can be used with active or passive antennas.

The C1919C has built-in antenna detection for open and short circuit conditions. By default, the open and short alerts are turned on. You can turn them off using the $PMTK324 command. For more information, see Appendix B, NMEA 0183 Protocol.

The SHORT alert is triggered if more than approximately 19 mA is drawn from the antenna pin and the current is further restricted to a maximum of 33 mA by a current clamp.

The diagram shows the active antenna drawing current through a 10 Ω sense resistor, supplied by an internal 2.8 V regulator. As a result, there will be an associated voltage drop as the current increases:



Refer to the application designs for examples of antenna power circuits.

V_{rtc} (pin 6)

Supply can range from 2.0 V to V_{cc}. Maintains non-volatile RAM and the RTC for hot and warm starts. If not used leave disconnected or connect to V_{cc}.

XRESET (pin 11)

Connects to the host system reset controller or GPIO for host-controlled resetting of the GPS module.

Vcc (pin 12)

This is the primary voltage supply pin for the module.

PPS (pin 19)

Pulse-per-second. This logic level output provides a 1 Hz timing signal to external devices. The pulse width of this signal is 4.2 us.

RXD (pin 20)

This logic level input is the serial port receive line (data input to the module).

TXD (pin 24)

This logic level output is the serial port transmit line (data output from the module). Do not hold the Tx port "low" or pull to ground while the GPS module is starting up.

Reserved pins

There are several reserved pins on the Condor C1919C GPS module. Do not connect these pins.

Protocols

NMEA 0183 is available on the Condor C1919C GPS module.

Serial port default settings

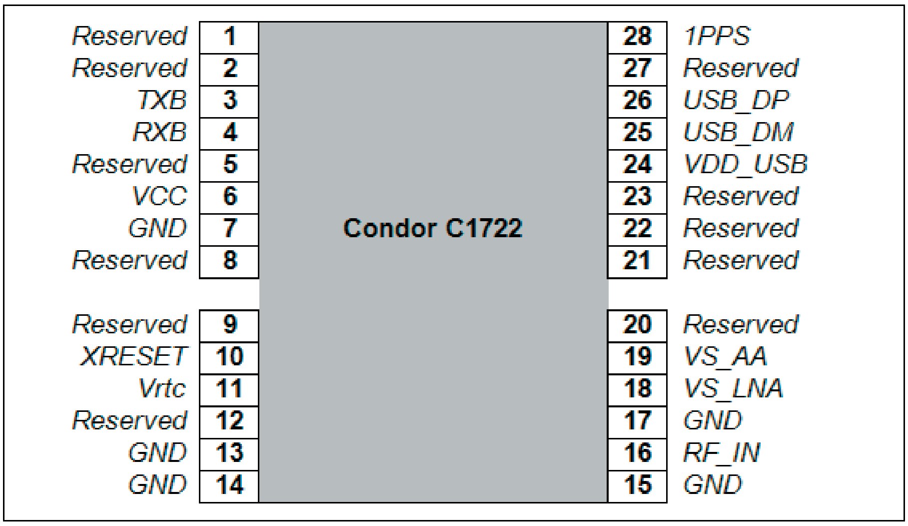
The Condor C1919C GPS module supports one serial port. The default settings are as follows:

Port direction	Pin #	Protocol	Characteristics				
			Baud rate	Data bits	Parity	Stop bits	Flow control
TXD	24	NMEA out	9600	8	None	1	None
RXD	20	NMEA in	9600	8	None	1	None

- Baud rate, data bits, parity, and stop bits are user configurable.
- Flow control is not available on the serial ports.

A detailed description of the protocol is given in Appendix B, NMEA 0183 Protocol.

Condor C1722 pin assignments



Pin descriptions

Pin	Name	Description	Function	Note
1	Reserved	Reserved		Do not connect
2	Reserved	Reserved		Do not connect
3	TXB	Serial port 1	Output	LVTTL Logic level serial port transmit.
4	RXB	Serial port 1	Input	LVTTL logic level serial port receive.
5	Reserved	Reserved		Do not connect
6	VCC	Supply voltage	Input	3.0 V to 3.6 V, typical 3.3 V.
7	GND	Ground	Ground	Connect to common ground.
8	Reserved	Reserved		Do not connect
9	Reserved	Reserved		Do not connect
10	XRESET	Pull low 100 ms for reset	Input	100 ms active low. Do not connect if not used.
11	Vrtc	Backup voltage supply	Input	2.0 V to V_{cc}. If not used, leave disconnected or connect to V_{cc}.
12	Reserved	Reserved		Do not connect
13	GND	Ground	Ground	Connect to common ground.
14	GND	Ground	Ground	Connect to common ground.
15	GND	Ground	Ground	Connect to common ground.
16	RF_IN	GPS signal input	Input	50 Ω unbalanced (coaxial) RF input.
17	GND	Ground	Ground	Connect to common ground.
18	VS_LNA	Output voltage RF section	Output	Connect to pin 19 if antenna status detection is not used.
19	VS_AA	Antenna bias voltage	Input	Connect to pin 18 if antenna status detection is not used.
20	Reserved	Reserved		Do not connect.

Pin	Name	Description	Function	Note
21	Reserved	Reserved		Do not connect.
22	Reserved	Reserved		Do not connect.
23	Reserved	Reserved		Do not connect.
24	VDD_USB	USB supply	Input	See Appendix E, USB Guide for C1722 and C1216 GPS Modules for design details.
25	USB_DM	USB data	IO	
26	USB_DP	USB data	IO	
27	Reserved	Reserved		Do not connect.
28	1PPS	Time pulse	Output	1 Hz timing pulse. Do not connect if not used.

Detailed pin descriptions

TXD (pin 3)

This logic level output is the serial port transmit line (data output from the module).

Do not hold the Tx port "low" or pull to ground while the GPS module is starting up.

RXD (pin 4)

This logic level input is the serial port receive line (data input to the module).

Vcc (pin 6)

This is the primary voltage supply pin for the module.

XRESET (pin 10)

Connects to the host system reset controller or GPIO for host-controlled resetting of the GPS module.

Vrtc (pin 11)

Supply can range from 2.0 V to V_{CC}. Maintains non-volatile RAM and the RTC for hot and warm starts. If not used, leave disconnected or pulled toV_{CC}.

RF_in (pin 16)

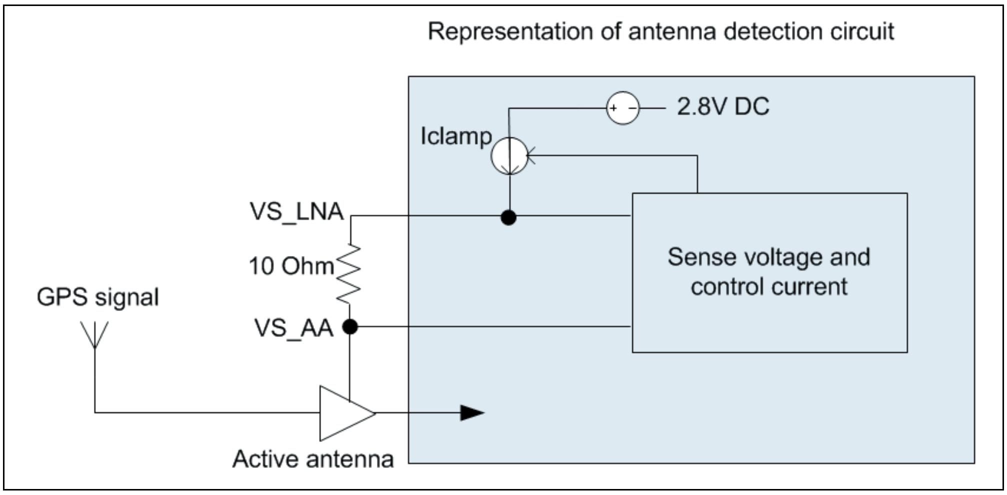
The RF input pin is the 50 Ω unbalanced GPS RF input, and can be used with active or passive antennas.

The C1722 has built-in antenna detection for open and short circuit conditions. By default, the open and short alerts are turned on. You can turn them off using the $PMTK324 command.

For more information, see Appendix B, NMEA 0183 Protocol.

The SHORT alert is triggered if more than approximately 19 mA is drawn from the antenna pin and the current is further restricted to a maximum of 33 mA by a current clamp.

The diagram shows the active antenna drawing current through an 10 Ω sense resistor, supplied by an internal 2.8 V regulator. As a result, there will be an associated voltage drop as the current increases:



Refer to the application designs for examples of antenna power circuits.

VS_LNA (pin 18)

Output voltage RF section. Connect to pin 19 if antenna status detection is not used.

VS_AA (pin 19)

Antenna bias voltage. Connect to pin 18 if antenna status detection is not used.

VDD_USB (pin 24)

USB power. See Appendix E, USB Guide for C1722 and C1216 GPS Modules for design details.

USB_DM (pin 25)

USB data minus

USB_DP (pin 26)

USB data plus

1PPS (pin 28)

Pulse-per-second. This logic level output provides a 1 Hz timing signal to external devices. The pulse width of this signal is 4.2 us.

Reserved pins

There are several reserved pins on the Condor C1722 GPS module. Do not connect these pins.

Protocols

NMEA 0183 is available on the Condor C1722 GPS module.

Serial port default settings

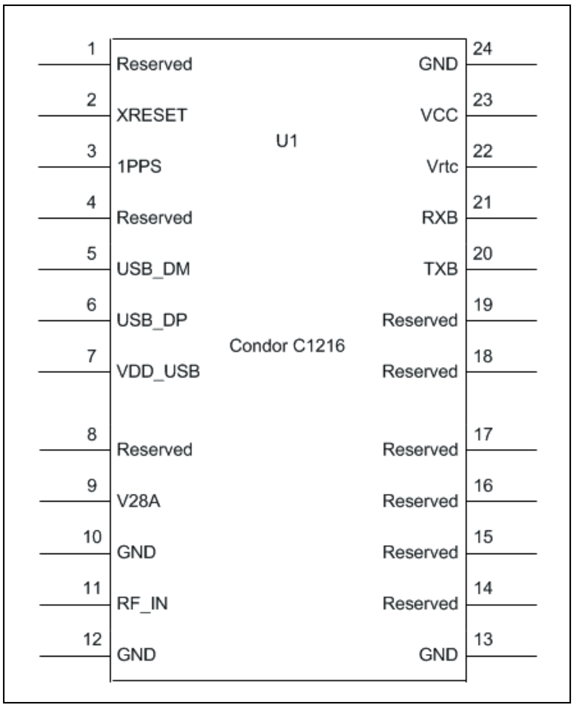
The Condor C1722 GPS module supports one serial port. The default settings are as follows:

Port direction	Pin #	Protocol	Characteristics				
			Baud rate	**Data bits**	**Parity**	**Stop bits**	**Flow control**
TXD	3	NMEA out	9600	8	None	1	None
RXD	4	NMEA in	9600	8	None	1	None

- Baud rate, data bits, parity, and stop bits are user configurable.
- Flow control is not available on the serial ports.

A detailed description of the protocol is given in Appendix B, NMEA 0183 Protocol.

Condor C1216 pin assignments



Pin descriptions

Pin	Name	Description	Function	Note
1	Reserved	Reserved		Do not connect
2	XRESET	Pull low 100ms for reset	Input	100 ms active low. Do not connect if not used.
3	1PPS	Time pulse	Output	1 Hz timing pulse. Do not connect if not used.
4	Reserved	Reserved		Do not connect
5	USB_DM	USB data	IO	
6	USB_DP	USB data	IO	
7	VDD_USB	USB supply	Input	See Appendix E, USB Guide for C1722 and C1216 GPS Modules for design details.
8	Reserved	Reserved		Do not connect.
9	V28A	Output RF section	Output	
10	GND	Ground	Ground	Connect to common ground.
11	RF_IN	GPS signal input	Input	50 Ω unbalanced (coaxial) RF input.
12	GND	Ground	Ground	Connect to common ground.
13	GND	Ground	Ground	Connect to common ground.
14	Reserved	Reserved		Do not connect.
15	Reserved	Reserved		Do not connect.
16	Reserved	Reserved		Do not connect.

Pin	Name	Description	Function	Note
17	Reserved	Reserved		Do not connect.
18	Reserved	Reserved		Do not connect.
19	Reserved	Reserved		Do not connect.
20	TXB	Serial port 1	Output	LVTTL Logic level serial port transmit.
21	RXB	Serial port 1	Input	LVTTL logic level serial port receive.
22	Vrtc	Backup voltage supply	Input	2.0 V to V_{CC}. If not used, leave disconnected or connect to V_{CC}.
23	VCC	Supply voltage	Input	3.0 V to 3.6 V, typical 3.3 V.
24	GND	Ground	Ground	Connect to common ground.

Detailed pin descriptions

XRESET (pin 2)

Connects to the host system reset controller or GPIO for host-controlled resetting of the GPS module.

1PPS (pin 3)

Pulse-per-second. This logic level output provides a 1 Hz timing signal to external devices. The pulse width of this signal is 4.2 us.

USB_DM (pin 5)

USB data minus

USB_DP (pin 6)

USB data plus

VDD_USB (pin 7)

USB power. See Appendix E, USB Guide for C1722 and C1216 GPS Modules for design details.

V28A (pin 9)

A 2.8V reference output that can supply up 25 mA.

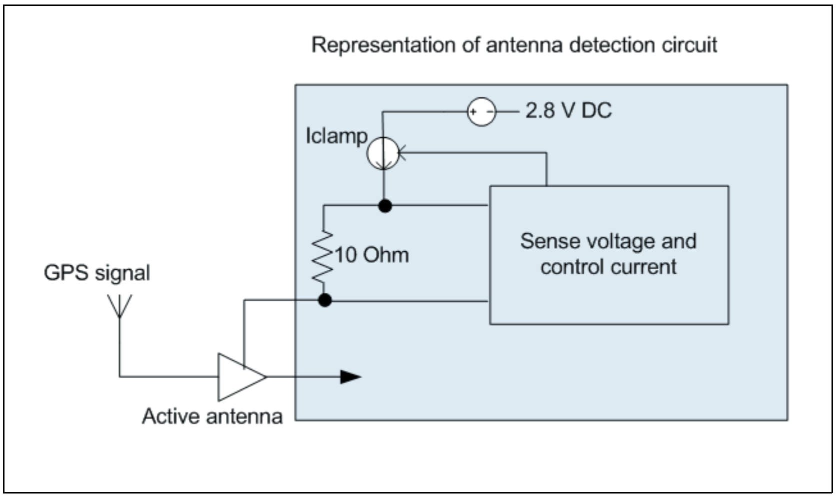
RF_in (pin 11)

The RF input pin is the 50 Ω unbalanced GPS RF input, and can be used with active or passive antennas.

The C1216 has built-in antenna detection for open and short circuit conditions. By default, the open and short alerts are turned on. You can turn them off using the $PMTK324 command. For more information, see Appendix B, NMEA 0183 Protocol.

The SHORT alert is triggered if more than approximately 19 mA is drawn from the antenna pin and the current is further restricted to a maximum of 33 mA by a current clamp.

The diagram shows the active antenna drawing current through an 10 Ω sense resistor, supplied by an internal 2.8 V regulator. As a result, there will be an associated voltage drop as the current increases:



Refer to the application designs for examples of antenna power circuits.

TXD (pin 20)

This logic level output is the serial port transmit line (data output from the module). Do not hold the Tx port "low" or pull to ground while the GPS module is starting up.

RXD (pin 21)

This logic level input is the serial port receive line (data input to the module).

Vrtc (pin 22)

Supply can range from 2.0 V to V_{cc}. Maintains non-volatile RAM and the RTC for hot and warm starts. If not used, leave disconnected or pulled to V_{cc}.

VCC (pin 23)

This is the primary voltage supply pin for the module.

Reserved pins

There are several reserved pins on the Condor C1216 GPS module. Do not connect these pins.

Protocols

NMEA 0183 and RTCM are available on the Condor C1216 GPS module.

Serial port default settings

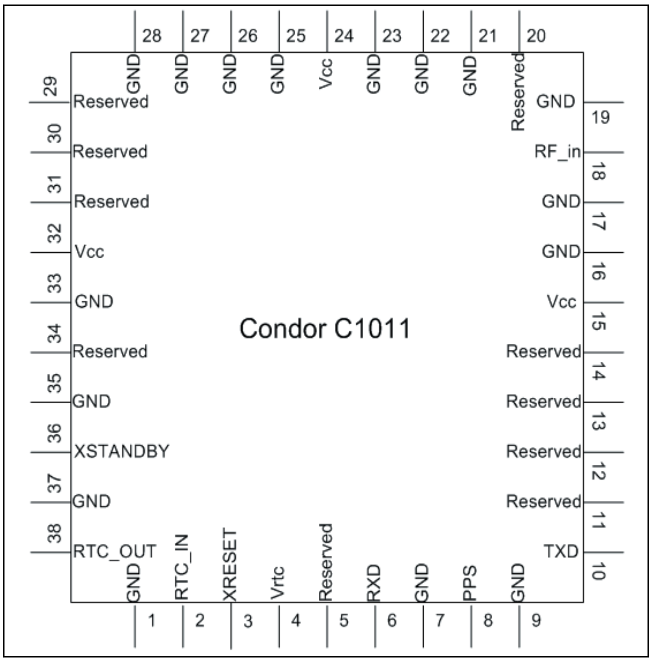
The Condor C1216 GPS module supports one serial port. The default settings are as follows:

Port direction	Pin #	Protocol	Characteristics				
			Baud rate	**Data bits**	**Parity**	**Stop bits**	**Flow control**
TXD	20	NMEA out	9600	8	None	1	None
RXD	21	NMEA in	9600	8	None	1	None

- Baud rate, data bits, parity, and stop bits are user configurable.
- Flow control is not available on the serial ports.

A detailed description of the protocol is given in Appendix B, NMEA 0183 Protocol.

Condor C1011 pin assignments



Pin description

Pin	Name	Description	Function	Note
1	GND	Ground	Ground	Connect to common ground.
2	RTC_IN	32 kHz input	Input	Can be XTAL or buffered signal.
3	XRESET	System reset	Input	100 ms active low. Do not connect if not used.
4	V_{rtc}	RTC backup power	Input	2.0 V to V_{CC}. Always connect to battery or V_{CC}.
5	Reserved	Reserved		
6	RXD	UART Receive	Input	LVTTL logic level serial port receive.
7	GND	Ground	Ground	Connect to common ground.
8	PPS	Pulse per second	Output	1 Hz timing pulse. Do not connect if not used.
9	GND	Ground	Ground	Connect to common ground.
10	TXD	UART Transmit	Output	LVTTL logic level serial port transmit.
11	Reserved	Reserved		Do not connect.
12	Reserved	Reserved		Do not connect.
13	Reserved	Reserved		Do not connect.
14	Reserved	Reserved		Do not connect.
15	V_{cc}	Main power	Input	3.0 V to 3.6 V, typical 3.3 V.
16	GND	Ground	Ground	Connect to common ground.
17	GND	Ground	Ground	Connect to common ground.
18	RF_in	GPS RF input	Input	50 Ω unbalanced (coaxial) RF input. LNA required.
19	GND	Ground	Ground	Connect to common ground.

Pin	Name	Description	Function	Note
20	Reserved	Reserved		Do not connect.
21	GND	Ground	Ground	Connect to common ground.
22	GND	Ground	Ground	Connect to common ground.
23	GND	Ground	Ground	Connect to common ground.
24	V_{cc}	Main power	Input	3.0 V to 3.6 V, typical 3.3 V.
25	GND	Ground	Ground	Connect to common ground.
26	GND	Ground	Ground	Connect to common ground.
27	GND	Ground	Ground	Connect to common ground.
28	GND	Ground	Ground	Connect to common ground.
29	Reserved	Reserved		Do not connect.
30	Reserved	Reserved		Do not connect.
31	Reserved	Reserved		Do not connect.
32	V_{cc}	Main power	Input	3.0 V to 3.6 V, typical 3.3 V.
33	GND	Ground	Ground	Connect to common ground.
34	Reserved	Reserved		Do not connect.
35	GND	Ground	Ground	Connect to common ground.
36	XSTANDBY	Run / Standby		Selects Run or Standby mode. Do not connect if not used.
37	GND	Ground	Ground	Connect to common ground.
38	RTC_OUT	32 kHz XTAL output	Output	

Detailed pin descriptions

RTC_IN (pin 2)

The 32 kHz clock can be supplied by either a XTAL or a buffered clock.

A buffered clock signal at 1.2—1.5 V logic levels can drive the Condor C1011 GPS module RTC. The limits are 0 V through 2.0 V on this input. Best results are achieved with a sine wave.

XRESET (pin 3)

Connects to the host system reset controller or GPIO for host-controlled resetting of the GPS module.

V_{rtc} (pin 4)

Supply can range from 2.0 V to V_{cc}. Maintains non-volatile RAM and the RTC for hot and warm starts.

RXD (pin 6)

This logic level input is the serial port receive line (data input to the module).

PPS (pin 8)

Pulse-per-second. This logic level output provides a 1 Hz timing signal to external devices. The pulse width of this signal is 4.2 us.

TXD (pin 10)

This logic level output is the serial port transmit line (data output from the module). Do not hold the Tx port "low" or pull to ground while the GPS module is starting up.

V_{CC} (pins 15, 24, 32)

These are the primary voltage supply pins for the module. Place decoupling capacitors as close as possible to the V_{cc} inputs.

RF_in (pin 18)

The RF input pin is the 50 Ω unbalanced GPS RF input, and can be used with active antennas.

Refer to the application designs for examples of antenna power circuits.

XSTANDBY (pin 36)

This logic level transition input is used to control the RUN/STANDBY state of the module:

- If the signal is High, the unit runs normally.
- If the signal changes from High is Low, the unit goes to STANDBY mode.
- If the signal changes from Low to High, the unit goes into RUN mode.

Leave disconnected if not used.

RTC_OUT (pin 38)

32 kHz RTC for unbuffered XTAL. This pin is not used if you are using a buffered clock.

Reserved pins

There are several reserved pins on the Condor C1011 GPS module. Do not connect these pins.

Protocols

NMEA 0183 is available on the Condor C1011 GPS module.

Serial port default settings

The Condor C1011 GPS module supports one serial port. The default settings are as follows:

Port direction	Pin #	Protocol	Characteristics				
			Baud rate	Data bits	Parity	Stop bits	Flow control
TXD	10	NMEA out	9600	8	None	1	None
RXD	6	NMEA in	9600	8	None	1	None

- Baud rate, data bits, parity, and stop bits are user configurable.
- Flow control is not available on the serial ports.

A detailed description of this protocol is given in Appendix B, NMEA 0183 Protocol.

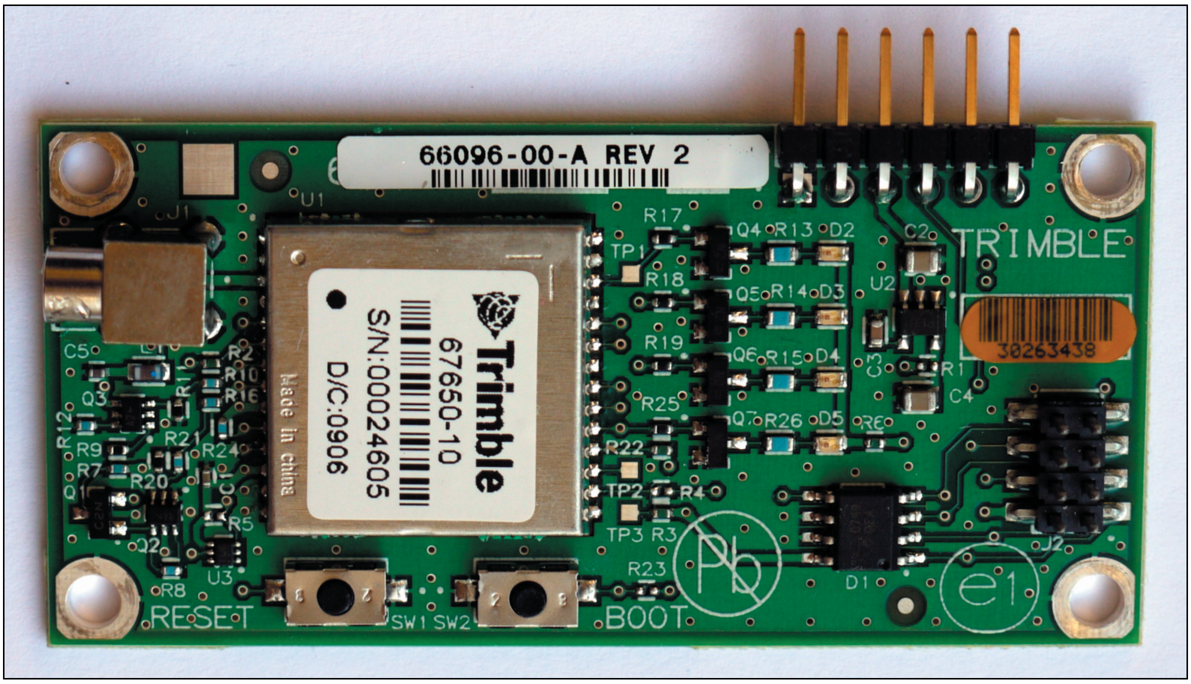
CHAPTER

4

Condor Carrier Board

In this chapter:

Condor carrier board



Connectors

Digital IO/Power connector

The Condor carrier board GPS receiver uses a single 8-pin (2x4) male header connector for both power and data I/O. The power and I/O connector, J4, is a surface mount micro terminal strip. This connector uses 3.2 mm (0.126 inch) high pins on 2 mm (0.079 inch) spacing.

The manufacturer of this connector is Samtec, part number TMM104-01-T-D-SM.

Mating connectors

A surface mount mating connector from those specified by Samtec as compatible to Samtec part number TMM-104-01-T-D-SM is recommended.

RF connector

The RF connector mounted on the Condor carrier board receiver is a right-angle MCX.

Antenna options

Trimble offers a 3 V DC mini magnetic or unpackaged antenna and cable for use with the Condor GPS module.

Digital IO/Power connector pin-out

The digital IO/Power connector pin-out information is provided below:

Pin Number	Function	Description
1	TXD	UART transmit, 2.8 V TTL
2	Prime power input	3.0 V DC to 3.6 V DC
3	Reserved	Do not connect
4	V_{rtc}	The RTC backup supply, 2.0 V DC to V_{cc}
5	Reserved	Do not connect
6	1 PPS	One Pulse-Per-Second, 2.8 V TTL
7	RXD	UART receive, 2.8 V TTL
8	GND	Ground, power, and signal

Serial interface

The Condor GPS module provides direct TTL-compatible serial I/O. The RX and TX signals on the J4 I/O connector are driven directly by the UART on the Condor module. Interfacing these signals directly to a UART in your application circuitry provides direct serial communication without the complication of RS-232 or RS-422 line drivers.

Pulse-per-second (PPS)

The Condor GPS receiver provides a 4.2 us wide, TTL-compatible Pulse-Per-Second (PPS). The PPS is a positive pulse available on pin 6 of the power and I/O connector.

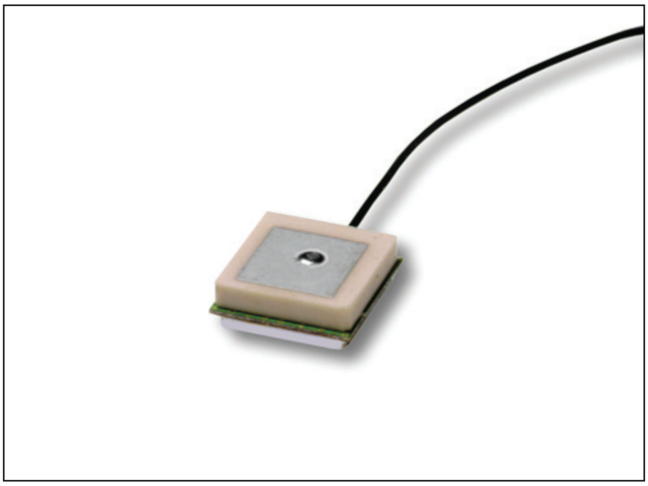
Mounting

There are four mounting holes at the corners of the PCB that accept 3/16" hex or round standoffs with a 3/8" height, and #2-2-56 or M2 mounting screws. Space-constrained environments may require a different standoff.

GPS antenna

Trimble offers the following two antenna options for use with the Condor GPS module:

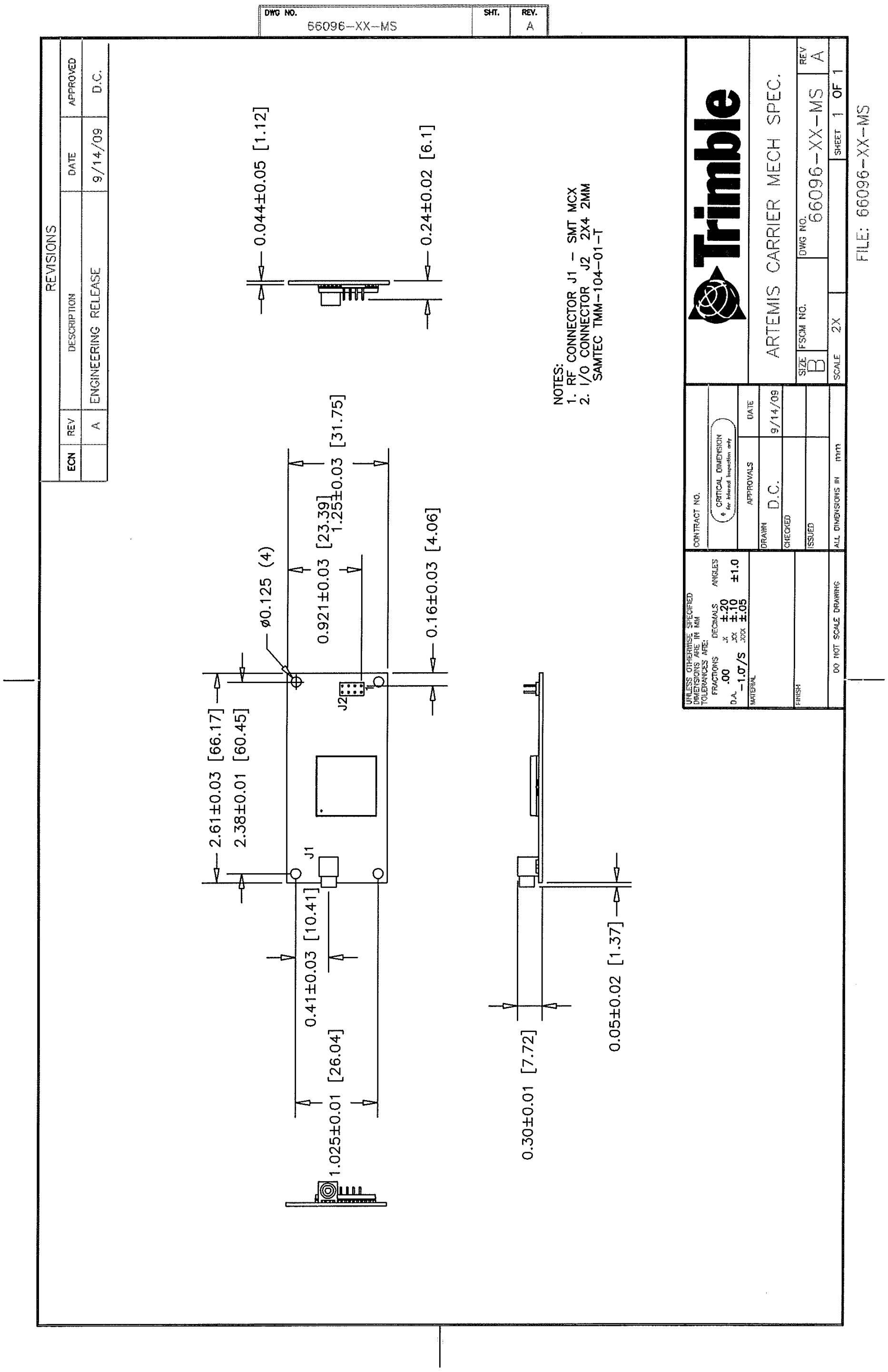
- A 3 VDC unpackaged antenna.



- A magnetic mount antenna:

The antenna receives the GPS satellite signals and passes them to the receiver. The GPS signals are spread-spectrum signals in the 1575 MHz range and do not penetrate conductive or opaque surfaces. Therefore, the antenna must be located outdoors with a clear view of the sky.

Mechanical specification



CHAPTER

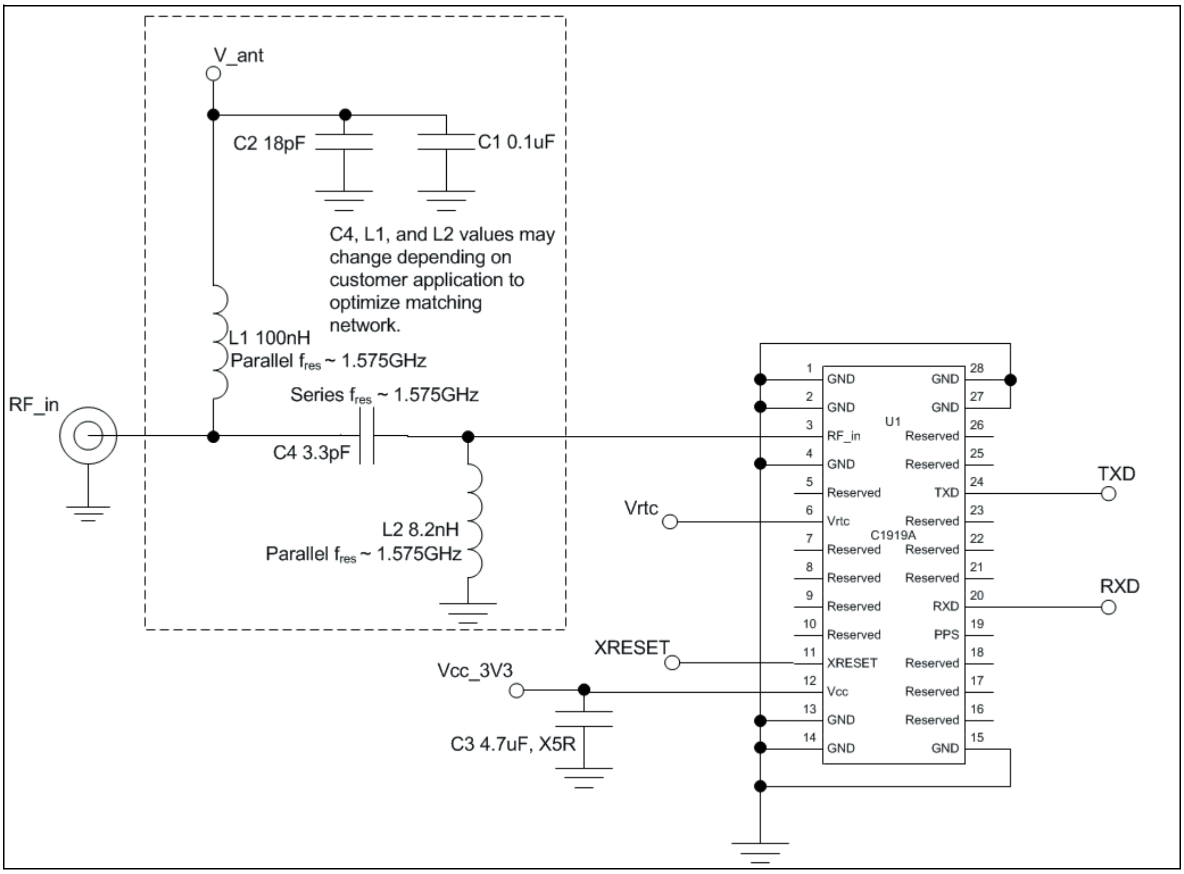
5

Application Circuits

In this chapter:

This chapter describes the Condor GPS module with different antenna connections.

Condor C1919A GPS module with an active antenna



In the schematic:

- The external XRESET pin pulled low for 100 ms after power is applied to V_{cc}.
- V_{rtc} is connected to battery backup to preserve current GPS data.
- The PPS output pin is not used and is left disconnected.
- Do not connect reserved pins.
- The external LNA gain range is 17 dB ~ 25 dB.

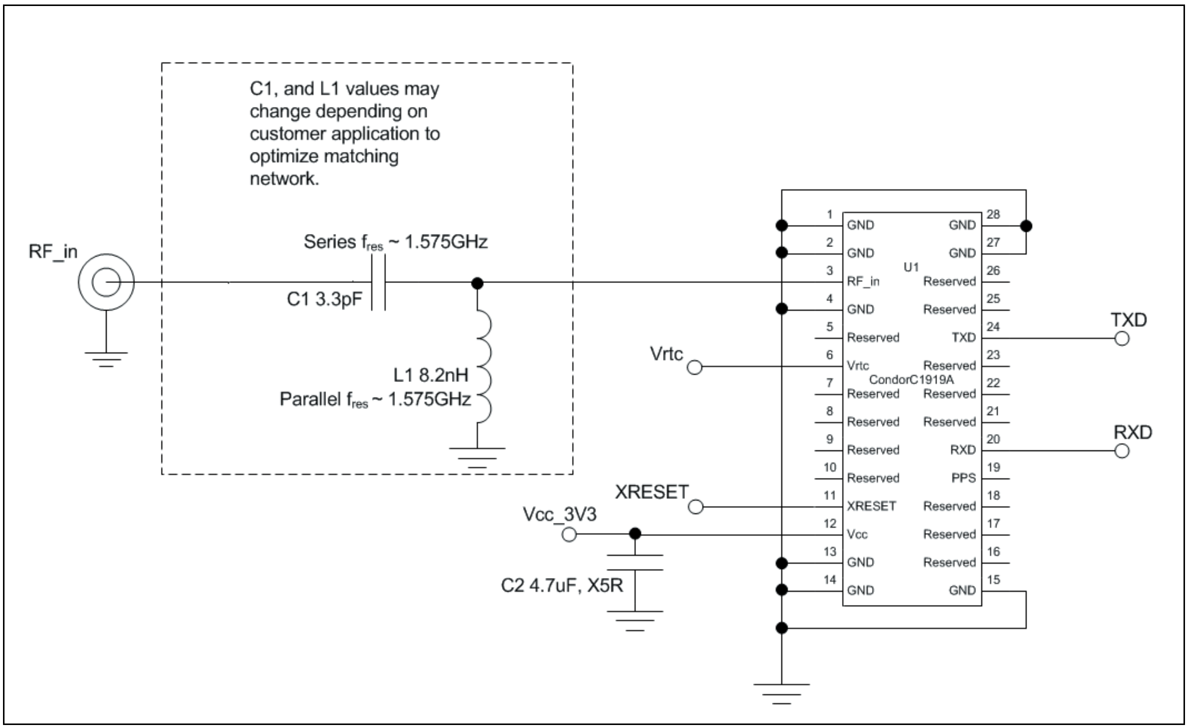
You can optimize the values of L2 and C4 by applying a GPS signal from a simulator and adjusting the component values (up and down) to determine the best combination that provides the maximum displayed C/N value from the constant-level GPS signal. Alternatively, use a network analyzer to optimize the input return loss.

For more information on PCB layout and tuning, see Chapter 6, RF Layout Considerations.

The following table shows the component information:

Component	Description	Manufacturer	Part Number
C1	0.1 μF, 0402 capacitor	CAL-CHIP	GMC04X7R104K16NTLF
C2	18 pF, 0402 capacitor	KEMET	C0402C180J5GAC
C3	4.7 μF, 0603 capacitor	Panasonic	ECJ-1VB0J475M
C4	3.3 pF, 0402 capacitor	KEMET	C0402C339C5GACTU
L1	100 nH, 0603 inductor, surface mount	Coil Craft	0603CS-R10XJLU
L2	8.2 nH, 0402 inductor, surface mount	Panasonic	ELJRF8N2ZFB
U1	Condor C1919A GPS module	Trimble	67650-10
J1	MCX connector	Tyco	1061027-1

Condor C1919A GPS module with a passive antenna



In the schematic:

- The external XRESET pin pulled low for 100 ms after power is applied to V_{cc}.
- V_{rtc} is connected to battery backup to preserve current GPS data.
- The PPS output pin is not used and is left disconnected.
- Do not connect reserved pins.

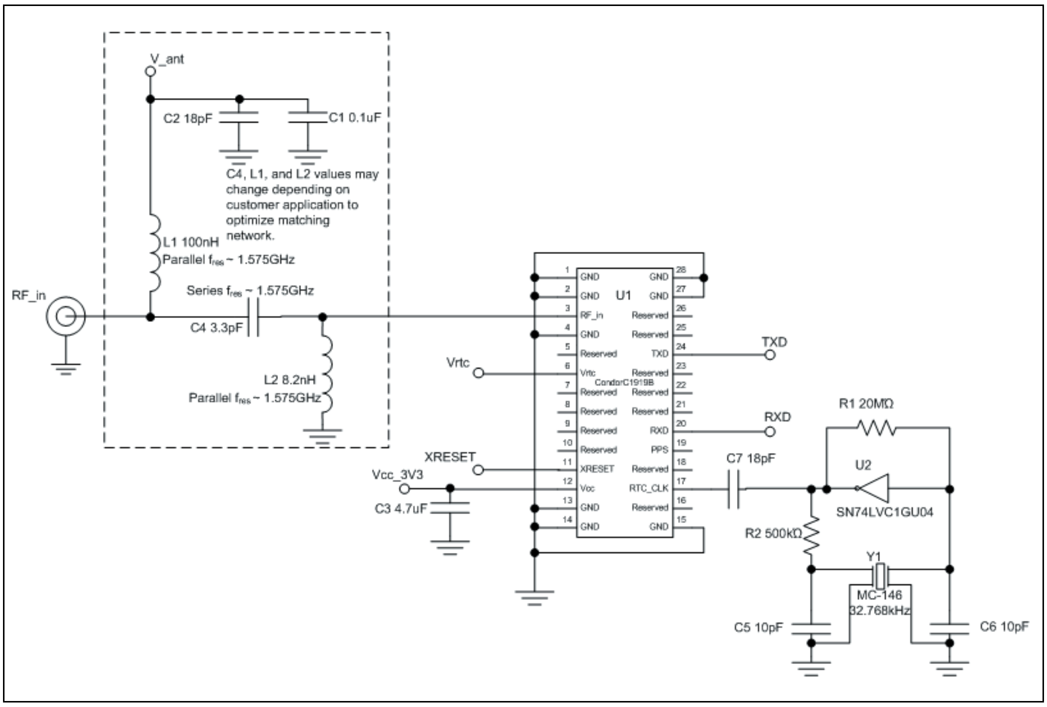
You can optimize the values of L1 and C1 by applying a GPS signal from a simulator and adjusting the component values (up and down) to determine the best combination that provides the maximum displayed C/N value from the constant-level GPS signal. Alternatively, use a network analyzer to optimize the input return loss.

For more information on PCB layout and tuning, see Chapter 6, RF Layout Considerations.

The following table shows the component information:

Component	Description	Manufacturer	Part Number
C1	3.3 pF, 0402 capacitor	KEMET	C0402C339C5GACTU
C2	4.7 µF, 0603 capacitor	Panasonic	ECJ-1VB0J475M
L1	8.2 nH, 0402 inductor, surface mount	Panasonic	ELJRF8N2ZFB
U1	Condor C1919A GPS module	Trimble	67650-10
J1	MCX connector	Tyco	1061027-1

Condor C1919B GPS module with an active antenna



In the schematic:

- An active antenna is used.
- The external XRESET pin pulled low for 100 ms after power is applied to V_{cc}.
- V_{rtc} is connected to battery backup to preserve current GPS data.
- The external LNA gain range is 17 dB ~ 25 dB.

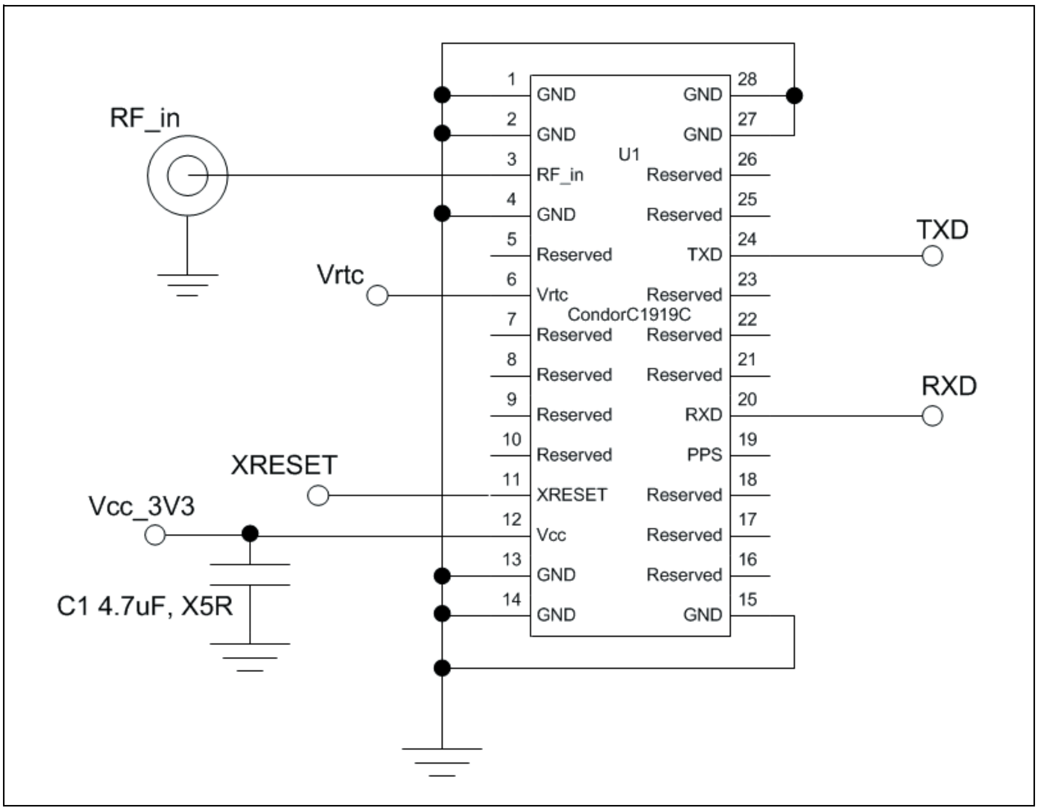
You can optimize the values of L2 and C4 by applying a GPS signal from a simulator and adjusting the component values (up and down) to determine the best combination to provide the maximum displayed C/N value from the constant-level GPS signal. Alternatively, use a network analyzer to optimize the input return loss.

For more information on PCB layout and tuning, see Chapter 6, RF Layout Considerations.

The following table shows the component information:

Component	Description	Manufacturer	Part Number
C1	0.1 µF, 0402 capacitor	CAL-CHIP	GMC04X7R104K16NTLF
C2	18 pF, 0402 capacitor	KEMET	C0402C180J5GAC
C3	4.7 µF, 0603 capacitor	Panasonic	ECJ-1VB0J475M
C4	3.3 pF, 0402 capacitor	KEMET	C0402C339C5GACTU
C5	10 pF, 0402 capacitor		
C6	10 pF, 0402 capacitor		
C7	18 pF, 0402 capacitor	KEMET	C0402C180J5GAC
L1	100 nH, 0603 inductor, surface mount	Coil Craft	0603CS-R10XJLU
L2	8.2 nH, 0402 inductor, surface mount	Panasonic	ELJRF8N2ZFB
U1	Condor C1919B GPS module	Trimble	67650-00
U2	IC INVERTER SN74LVC1GU04DCK	TI	SN74LVC1GU04DCKR
Y1	XTAL 32.768 kHz 7PF ROHS 1.5 x 7 mm	EPSON	MC-146 32.768KA-AG0:ROHS
J1	MCX connector	Tyco	1061027-1
R1	RES CHP MOHM 20 5% 1/16 W 0402		
R2	RES CHP KOHM 500 1% 1/16 W 0402		

Condor C1919C GPS module with an active or passive antenna



In the schematic:

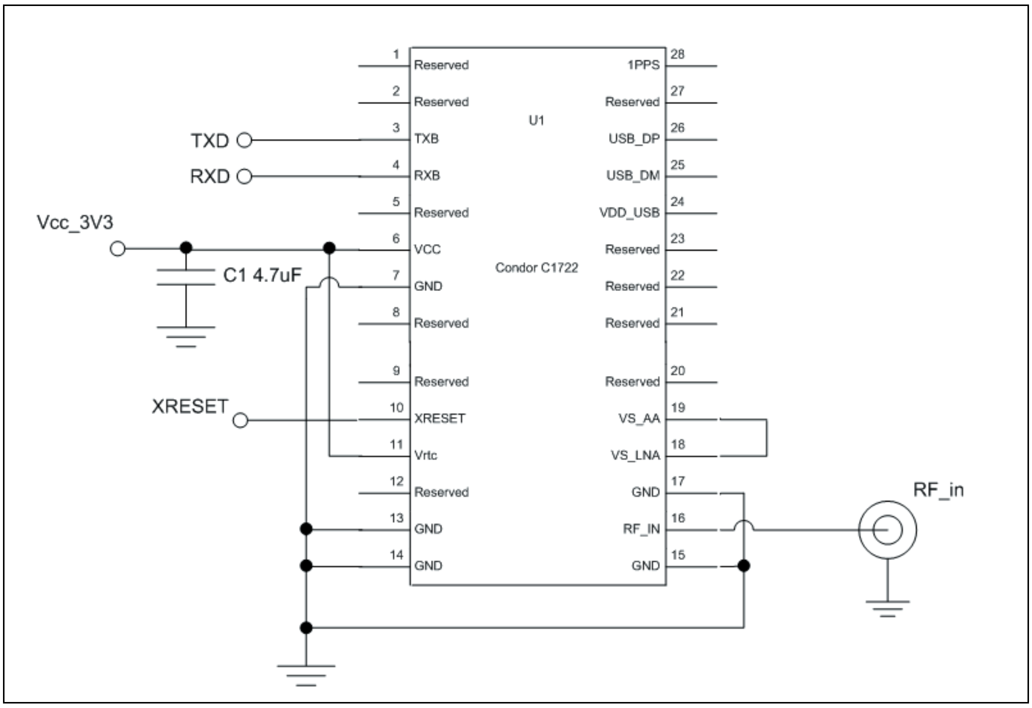
- The external XRESET pin pulled low for 100 ms after power is applied to V_{cc}.
- Battery backup for the RTC is connected to preserve current GPS data.
- The PPS output pin is not used and is left disconnected.
- Do not connect reserved pins.
- The C1919C has built-in antenna detection for open and short circuit conditions. By default, the open and short alerts are turned on. You can turn them off using the $PMTK324 command. For more information, see Appendix B, NMEA 0183 Protocol.
- The SHORT alert is triggered if more than approximately 19 mA is drawn from the antenna pin and the current is further restricted to a maximum of 33 mA by a current clamp.

For more information on PCB layout and tuning, see Chapter 6, RF Layout Considerations.

The following table shows the component information:

Component	Description	Manufacturer	Part Number
C1	4.7 µF, 0603 capacitor	Panasonic	ECJ-1VB0J475M
U1	Condor C1919C GPS module	Trimble	67650-20
J1	MCX connector	Tyco	1061027-1

Condor C1722 GPS module with a passive antenna



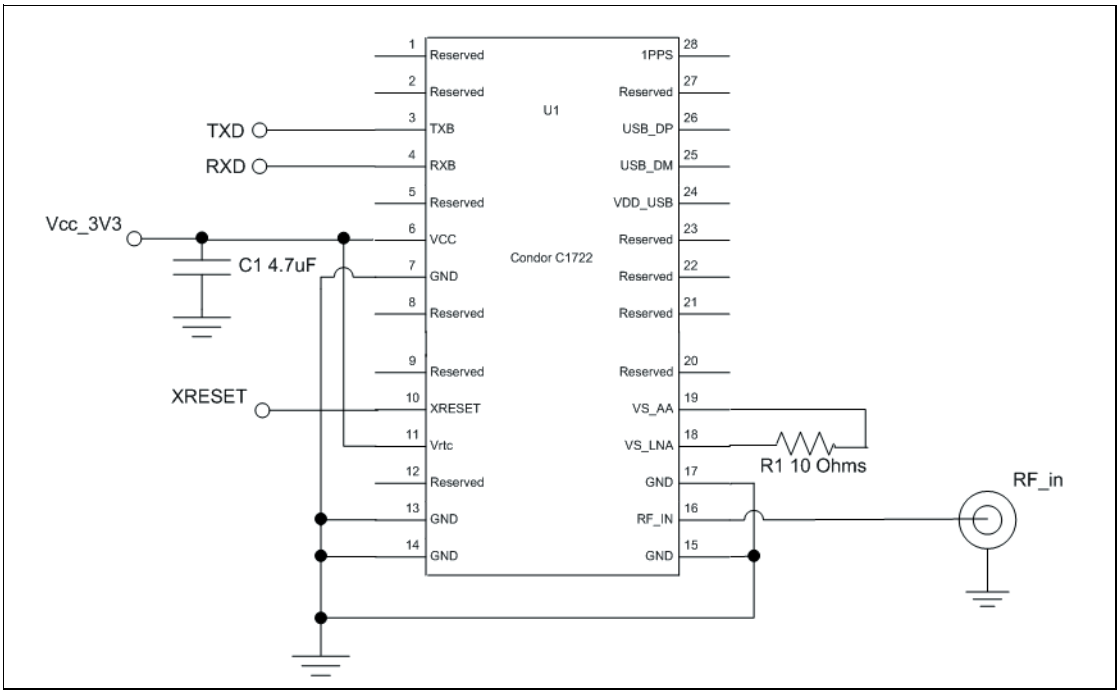
In this schematic:

- A backup battery is not connected to pin 11 in this example, but may be added to maintain user configuration and RTC if mains power is removed.

  When a backup battery is not used, pin 11 must be connected to $V_{cc.}$
- VS_LNA on pin 18 must be connected to pin 19.
- XRESET is connected to the host micro controller or host reset controller.
- Do not connect any of the reserved pins.
- Trimble recommends the use of X5R dielectric for the capacitor.

For more information on PCB layout and tuning, see Chapter 6, RF Layout Considerations.

Condor C1722 GPS module with an active antenna



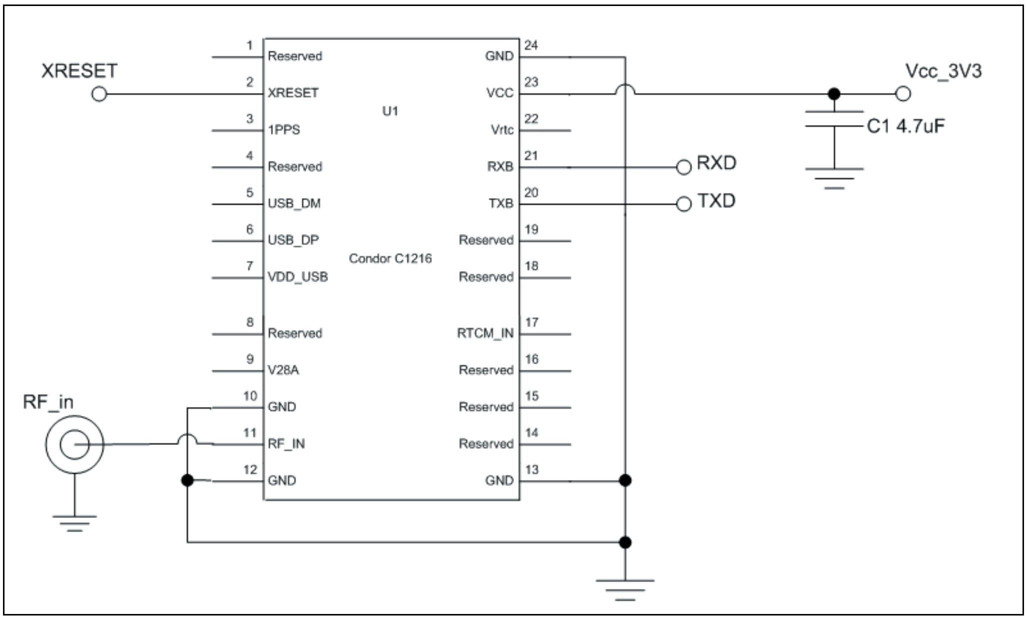
In this schematic:

- A backup battery is not connected to pin 11 in this example, but may be added to maintain user configuration and RTC if main power is removed.

  When a backup battery is not used, pin 11 must be connected to V_{CC}.
- VS_LNA on pin 18 is connected via a 10 Ω sense resistor to pin 19 for determination of antenna open, short, or normal operation.
- XRESET is connected to the host micro controller or host reset controller.
- Do not connect any of the reserved pins.
- The external LNA gain range is 17 dB ~ 25 dB.
- Trimble recommends the use of X5R dielectric for the capacitor.
- The C1722 has built-in antenna detection for open and short circuit conditions. For current sensing to take place, a 10 Ω resistor should be placed between pins 18 and 19. If no detection is required connect pins 18 and 19 together with no resistor.
- By default, the open and short alerts are turned on. You can turn them off using the $PMTK324 command. For more information, see Appendix B, NMEA 0183 Protocol.
- The SHORT alert is triggered if more than approximately 19 mA is drawn from the antenna pin and the current is further restricted to a maximum of 33 mA by a current clamp.

For more information on PCB layout and tuning, see Chapter 6, RF Layout Considerations.

Condor C1216 GPS module with an active or passive antenna

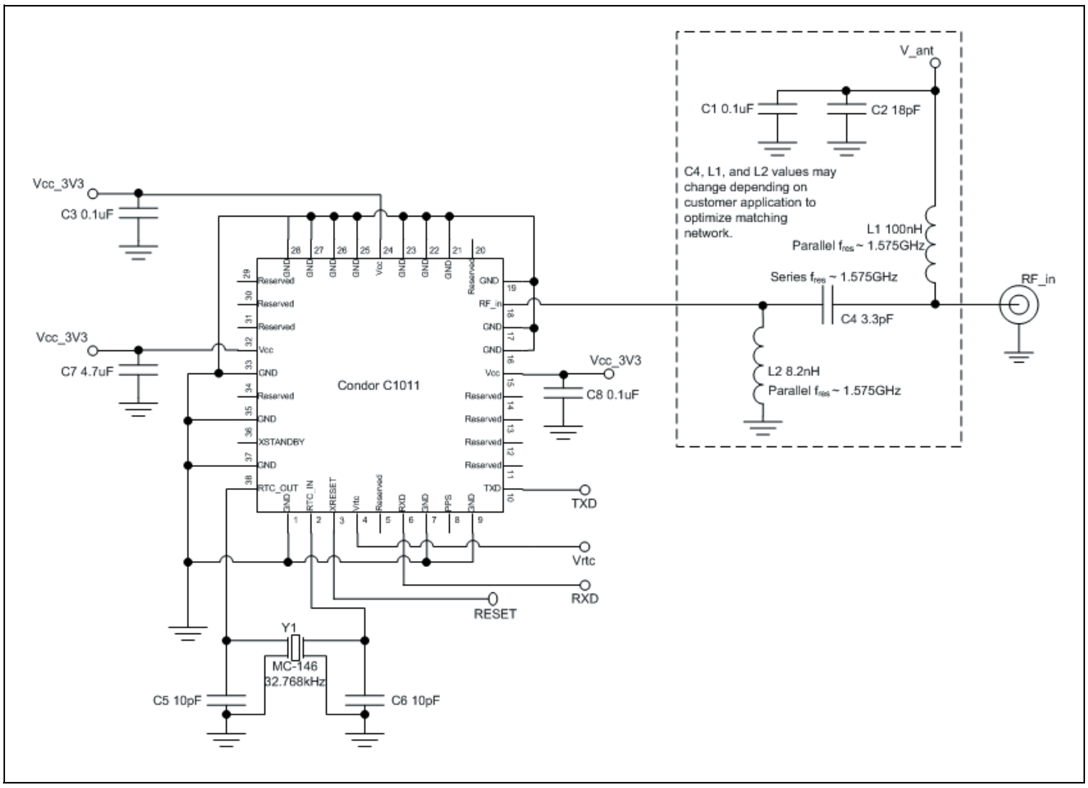


In this schematic:

- Backup battery is not connected to pin 22 in this example, but may be added to maintain user configuration and RTC.
- V28A on pin 9 is a 2.8 V reference. It may be used to power an LNA up to 25 mA.
- XRESET is connected to the host micro controller or host reset controller.
- Do not connect any of the reserved pins.
- The external LNA gain range is 17 dB ~ 25 dB.
- Trimble recommends the use of X5R dielectric for the capacitor.
- The C1216 has built-in antenna detection for open and short circuit conditions. By default, the open and short alerts are turned on. You can turn them off using the $PMTK324 command. For more information, see Appendix B, NMEA 0183 Protocol.
- The SHORT alert is triggered if more than approximately 19 mA is drawn from the antenna pin and the current is further restricted to a maximum of 33 mA by a current clamp.

For more information on PCB layout and tuning, see Chapter 6, RF Layout Considerations.

Condor C1011 GPS module with an active antenna



In the schematic:

- An active antenna is used.
- The external XRESET pin pulled low for 100 ms after power is applied to V_{cc}.
- V_{rtc} is connected to battery backup to preserve current GPS data. If no battery backup is used V_{rtc} must be connected to V_{cc}.
- The external LNA gain range is 17 dB ~ 42 dB.

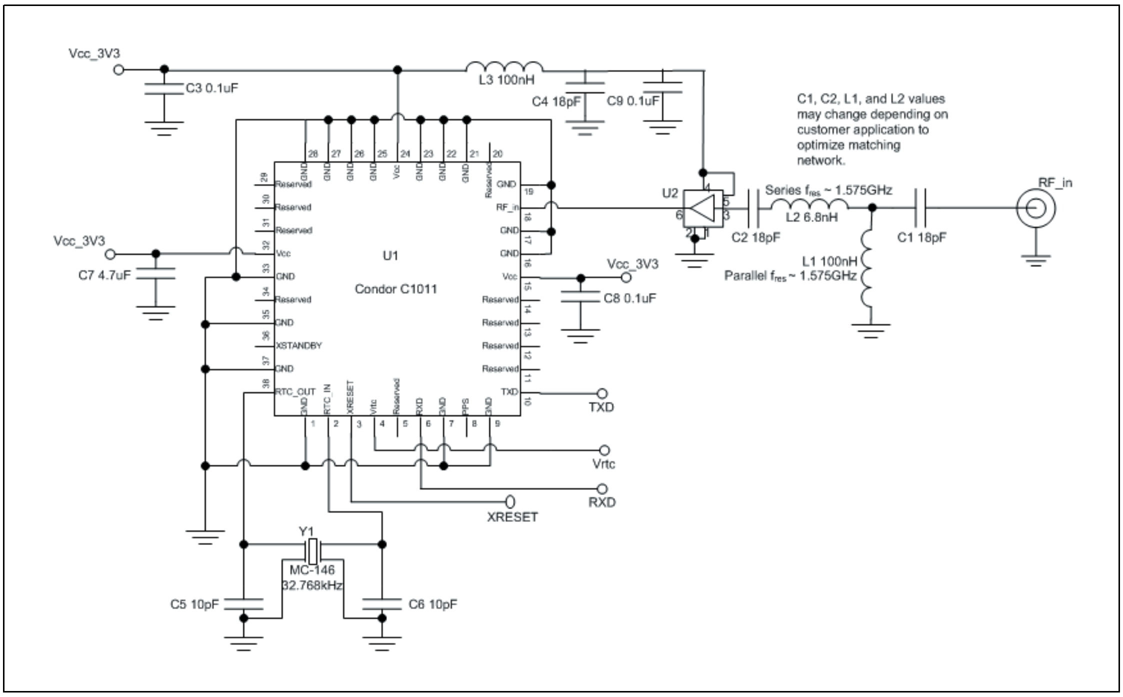
You can optimize the values of L2 and C4 by applying a GPS signal from a simulator and adjusting the component values (up and down) to determine the best combination to provide the maximum displayed C/N value from the constant-level GPS signal. Alternatively, use a network analyzer to optimize the input return loss.

For more information on PCB layout and tuning, see Chapter 6, RF Layout Considerations.

The following table shows the component information:

Component	Description	Manufacturer	Part Number
C1	0.1 µF, 0402 capacitor	CAL-CHIP	GMC04X7R104K16NTLF
C2	18 pF, 0402 capacitor	KEMET	C0402C180J5GAC
C3	0.1 µF, 0402 capacitor	CAL-CHIP	GMC04X7R104K16NTLF
C4	3.3 pF, 0402 capacitor	KEMET	C0402C339C5GACTU
C5	10 pF, 0402 capacitor		
C6	10 pF, 0402 capacitor		
C7	4.7 µF, 0603 capacitor	Panasonic	ECJ-1VB0J475M
C8	0.1 µF, 0402 capacitor	CAL-CHIP	GMC04X7R104K16NTLF
L1	100 nH, 0603 inductor, surface mount	Coil Craft	0603CS-R10XJLU
L2	8.2 nH, 0402 inductor, surface mount	Panasonic	ELJRF8N2ZFB
U1	Condor C1011 GPS module	Trimble	68674-00
Y1	XTAL 32.768 kHz 7PF ROHS 1.5X7MM	EPSON	MC-146 32.768KA-AG0:ROHS
J1	MCX connector	Tyco	1061027-1

Condor C1011 receiver with a passive antenna and external LNA



In the schematic:

- A passive antenna is used.
- XSTANDBY is not connected.
- V_{rtc} is connected to battery backup to preserve current GPS data.
- External LNA enable pin is connected to Vcc.
- The external XRESET pin pulled low for 100 ms after power is applied to V_{cc}.
- The external LNA gain range is 17 dB ~ 42 dB.

You can optimize the values of C1, C2, L1, and L2 by applying a GPS signal from a simulator and adjusting the component values (up and down) to determine the best combination to provide the maximum displayed C/N value from the constant-level GPS signal. Alternatively, use a network analyzer to optimize the input return loss.

For more information on PCB layout and tuning, see Chapter 6, RF Layout Considerations.

The following table shows the component information:

Component	Description	Manufacturer	Part Number
C1	18 pF, 0402 capacitor	KEMET	C0402C180J5GAC
C2	18 pF, 0402 capacitor	KEMET	C0402C180J5GAC
C3	0.1 µF, 0402 capacitor	CAL-CHIP	GMC04X7R104K16NTLF
C4	18 pF, 0402 capacitor	KEMET	C0402C180J5GAC
C5	10 pF, 0402 capacitor		
C6	10 pF, 0402 capacitor		
C7	4.7 µF, 0603 capacitor	Panasonic	ECJ-1VB0J475M
C8	0.1 µF, 0402 capacitor	CAL-CHIP	GMC04X7R104K16NTLF
C9	0.1 µF, 0402 capacitor	CAL-CHIP	GMC04X7R104K16NTLF
L1	6.8 nH, 0603 inductor, surface mount	Coil Craft	
L2	100 nH, 0603 inductor, surface mount	Coil Craft	0603CS-R10XJLU
L3	100 nH, 0603 inductor, surface mount	Coil Craft	0603CS-R10XJLU
U1	Condor C1011 GPS module	Trimble	68674-00
U2	GPS LNA	MAXIM	MAX2659
Y1	XTAL 32.768 kHz 7PF ROHS 1.5 x 7 mm	EPSON	MC-146 32.768KA-AG0:ROHS
J1	MCX connector	Tyco	1061027-1

CHAPTER

6

RF Layout Considerations

In this chapter:

- General recommendations
- Design considerations for RF track topologies
- PCB considerations

This chapter outlines RF design considerations for the layout of the Condor GPS receiver.

General recommendations

The design of the RF transmission line that connects the GPS antenna to the Condor module is critical to system performance. If the overall RF system is not implemented correctly, the Condor module performance may be degraded.

The radio frequency (RF) input on the Condor module is 50 Ω, unbalanced. There are ground castellations (pins 2 and 4) on both sides of the RF input castellation (pin 3). This RF input may be connected to the output of an LNA that has a GPS antenna at its input, or to a passive antenna through a low-loss 50 Ω, unbalanced transmission line system.

If the GPS antenna needs to be located at a significant distance from the Condor module, the use of an LNA at the antenna location is necessary to overcome the transmission losses from the antenna to the Condor module. Trimble recommends that, in the case of a passive antenna, the transmission line losses from the antenna to the module be less than 2 dB. Otherwise, add an LNA to the system.

Determine the specifications for the external LNA as follows:

- The specification of noise figure for the Condor C1919A, C1919B, or C1919C GPS module is 3 dB at room temperature and 4 dB over the temperature range -40 °C to +85 °C.
- The specification of noise figure for the Condor C1011 GPS module is 7 dB at room temperature and 8 dB over the temperature range -40 °C to +85 °C.
- The noise figure for the external LNA should be as low as possible, with a recommended maximum of 1.5 dB. Trimble recommends that the gain of the LNA exceeds the loss that is measured from the LNA output to the module input by 10 dB. For example, if the loss from the external LNA output is 7 dB, the recommended minimum gain for the LNA is 17 dB. In order to keep losses at the LNA input to a minimum, Trimble recommends that you connect the antenna directly to the LNA input, to ensure the minimum loss.
- To connect to the LNA output or to a passive antenna, use a 50 Ω, unbalanced transmission system. This transmission system may take any form, such as microstrip, coaxial, stripline, or any other 50 Ω characteristic impedance unbalanced, low-loss system.

You must keep noise sources with frequencies at or near 1575 MHz away from the RF input. In the case of a passive antenna, make sure that the antenna is not placed in a noisy location (such as too close to digital circuitry) as performance may be degraded. You can use as shielded transmission line system (stripline, coaxial) to route the signal if noise ingress is a concern.

When using an active antenna and if you want to power this antenna from the RF transmission line, you will need a bias-tee connector at the Condor module end. A simple series inductor (parallel resonant at 1575 MHz), and shunt capacitor (series resonant at 1575 MHz) to which the bias voltage is supplied is sufficient.

In the printed circuit board (PCB) layout, Trimble recommends that you keep the copper layer on which the Condor module is mounted clear of solder mask and copper (vias or traces) under the module. This is to ensure mating of the castellations between the Condor module and the board to which it is mounted, and to ensure that there is no interference with features beneath the Condor module that may cause it to lift during the reflow solder process.

For a microstrip RF-transmission line topology, Trimble recommends that the layer immediately below the one to which the Condor module is mounted is ground plane:

- For the Condor C1919A, C1919B, or C1919C modules, pins 2 and 4 should be directly connected to the ground plane with low inductance connections.
- For the Condor C1011 module, pins 17 and 19 should be directly connected to the ground plane with low inductance connections.
- Pin 3, the RF input, can be routed on the top layer using the proper geometry for a 50 Ω system.

Design considerations for RF track topologies

You must take the following into consideration when designing the RF layout for the Condor module:

- The PCB track connection to the RF antenna input must:
  - Have a 50 Ω impedance.
  - Be as short as possible.
  - Be routed away from potential noise sources such as oscillators, transmitters, digital circuits, switching power supplies, and other sources of noise.
  - Transition from the circuit board to the external antenna cable, which is typically a RF connector, if an external antenna is used.
- The PCB track connection to the RF antenna input must not have:
  - Sharp bends.
  - Components overlaying the track.
  - Routing between components (to avoid undesirable coupling).
- RF and bypass grounding must be direct to the ground plane through its own low-inductance via.
- You can use an active or a passive antenna. If you use a passive antenna, the connection to the antenna input must be very short.
- You can mount a patch antenna on the same PCB as the Condor module. Designers must be aware of noise-generating circuitry and must take proper design precautions (for example, shielding).

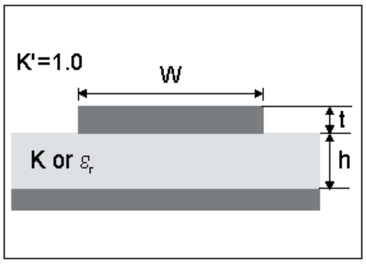
- If there are any ground planes on the same layer as the microstrip trace, refer to the Coplaner Waveguide design. ***This aspect is not covered in this manual.***
- As a general help to prevent radiation and coupling, it helps to think of voltages and currents as electrical and magnetic fields. The electric field forms ***between*** a positive and negative charge. The magnetic field forms ***around*** a trace with current flow. You can minimize the radiation by keeping the fields under control, which means minimizing the area in which the fields form out and by separating areas with stronger fields.
- Keep the path of supply currents and their GND return currents as close as possible together. The same applies for signal currents and their GND return currents.
- Keep signal traces, which are likely to interfere with each other, apart and separate them with GND areas.
- Route supply traces and their corresponding GND return paths to separate functional blocks with separate traces and connect them only at the feed point.
- Have at least one uninterrupted GND plane on or in your PCB. The GND plane should be separated by functional blocks, but within a functional block, do not route signals across the GND plane. Route signals on another layer.

  Signal traces on a GND plane can block the way for GND return currents thereby opening up current loops and increase radiation. Even worse, slots in a GND plane can act as a slot-antenna structure and radiate or receive radiation on the resonating frequency.
- Surround the PCB edges with GND on top and bottom and stitch them together with many vias. This reduces edge radiation from traces nearby the PCB edge. On a PCB with separated GND planes, do the same on every GND area to prevent radiation from one area into another.
- Do not route signal traces across the borders of GND areas. Route them first to the GND star point and from there back to another GND area. Thereby you reduce GND coupling between the functional groups and you reduce the size of the current loop thereby reducing radiation.
- In digital circuits, lower the rising time of edges if possible. Fast rising edges (sharp square wave signals) generate many harmonics at higher frequencies. Lowering the rising time of digital outputs at the source, for example by inserting series resistors near digital output pins of ICs, will reduce the generated harmonics and thereby reduce the radiation of high frequencies.
- Always aim to minimize the sources of radiation. It is much easier and less costly to not generate radiation than trying to get rid of radiation by shielding.

PCB considerations

The minimum implementation is a two-layer PCB substrate with all the RF signals on one side and a solid ground plane on the other. You may also use multilayer boards. Two possible RF transmission line topologies include microstrip and stripline.

Microstrip transmission lines



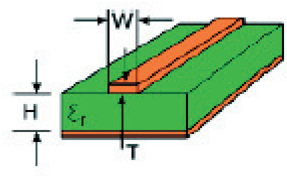
Ground plane design recommendation

Use a complete ground plane immediately under the PCB layer on which the Condor GPS module is mounted. On the same layer as the module, flood or "copper pour" around the signal tracks and then connect to the ground plane using low inductance vias. A single ground plane is adequate for both analog and digital signals.

Designing a microstrip transmission line

Use a 50 Ω unbalanced transmission system for connections to the LNA output. The following PCB parameters affect impedance:

- Track width (W)
- PCB substrate thickness (H)
- PCB substrate permittivity (ε_r)
- PCB copper thickness (T) and proximity of same layer ground plane (to a lesser extent)



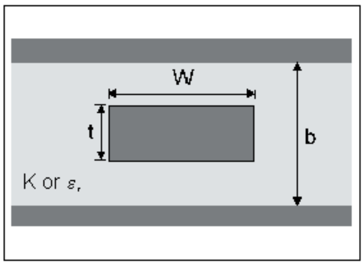
The following table shows typical track widths for an FR4 material PCB substrate (permittivity ε_r of 4.6 at 1.5 GHz) and different PCB thickness. The thickness of the top layer is assumed as being one ounce copper. If using a multi-layer PCB, the thickness is the distance from the signal track to the nearest ground plane.

Substrate material	Permittivity	Substrate thickness H (mm)	Track width W (mm)
		1.6	2.91
		1.2	2.12
		1.0	1.81
FR4	4.6	0.8	1.44
		0.6	1.07
		0.4	0.71
		0.2	0.34

Microstrip design recommendations

Trimble recommends that the antenna connection PCB track is routed around the outside of the module outline, kept on a single layer, and has no bends greater than 45 degrees. For production reasons, Trimble recommends that you do not route the track under the module.

Stripline transmission lines



Ground plane design recommendation

The stripline topology requires three PCB layers: two for ground planes and one for signal. One of the ground plane layers may be the layer to which the Condor GPS module is mounted. If this is the case:

- The top layer must be flooded with ground plane and connected to all ground castellations on the Condor module.
- The RF input should be connected to the signal layer below using a via.
- The layer below the signal layer is the second ground plane.
- Connect the two ground planes with vias, typically adjacent to the signal trace.
- Other signals of the Condor module may be routed to additional layer using vias.

For the symmetric stripline topology where the signal trace is an equal distance from each ground plane, the following applies:

Substrate material	Permittivity	Substrate thickness H (mm)	Track width W (mm)
FR4	4.6	1.6	0.631
		1.2	0.438
		1.0	0.372
		0.8	0.286
		0.6	0.2
		0.4	0.111
		0.2	N/A

CHAPTER

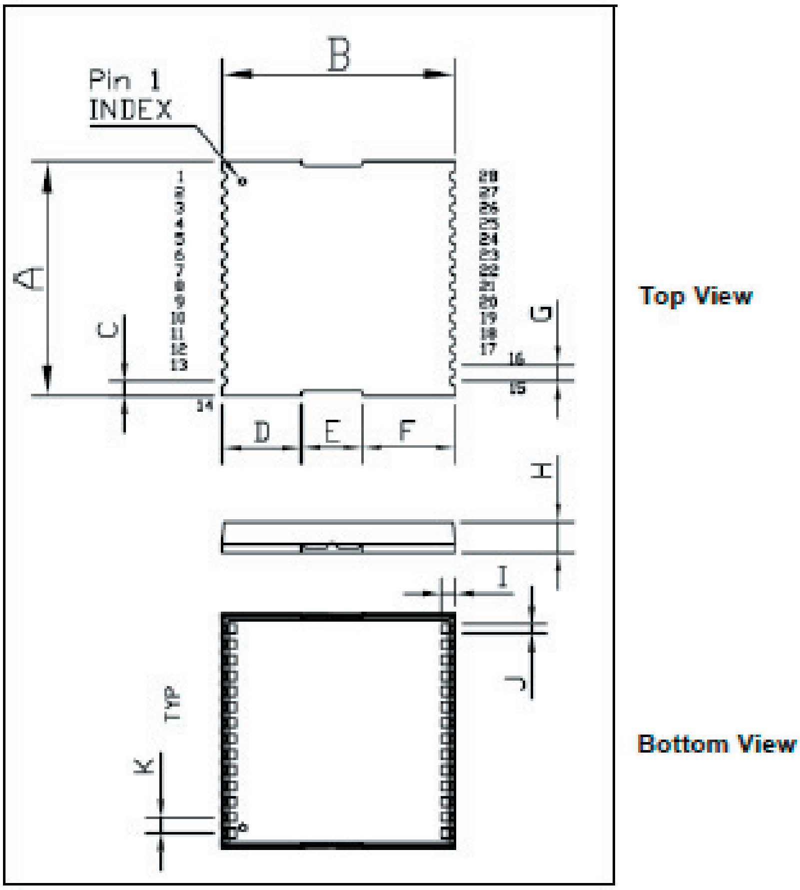
7

Mechanical Specifications

In this chapter:

This chapter provides product drawings and instructions for soldering the Condor GPS receiver to a printed circuit board.

Condor C1919A, C1919B, and C1919C modules—mechanical outline drawing

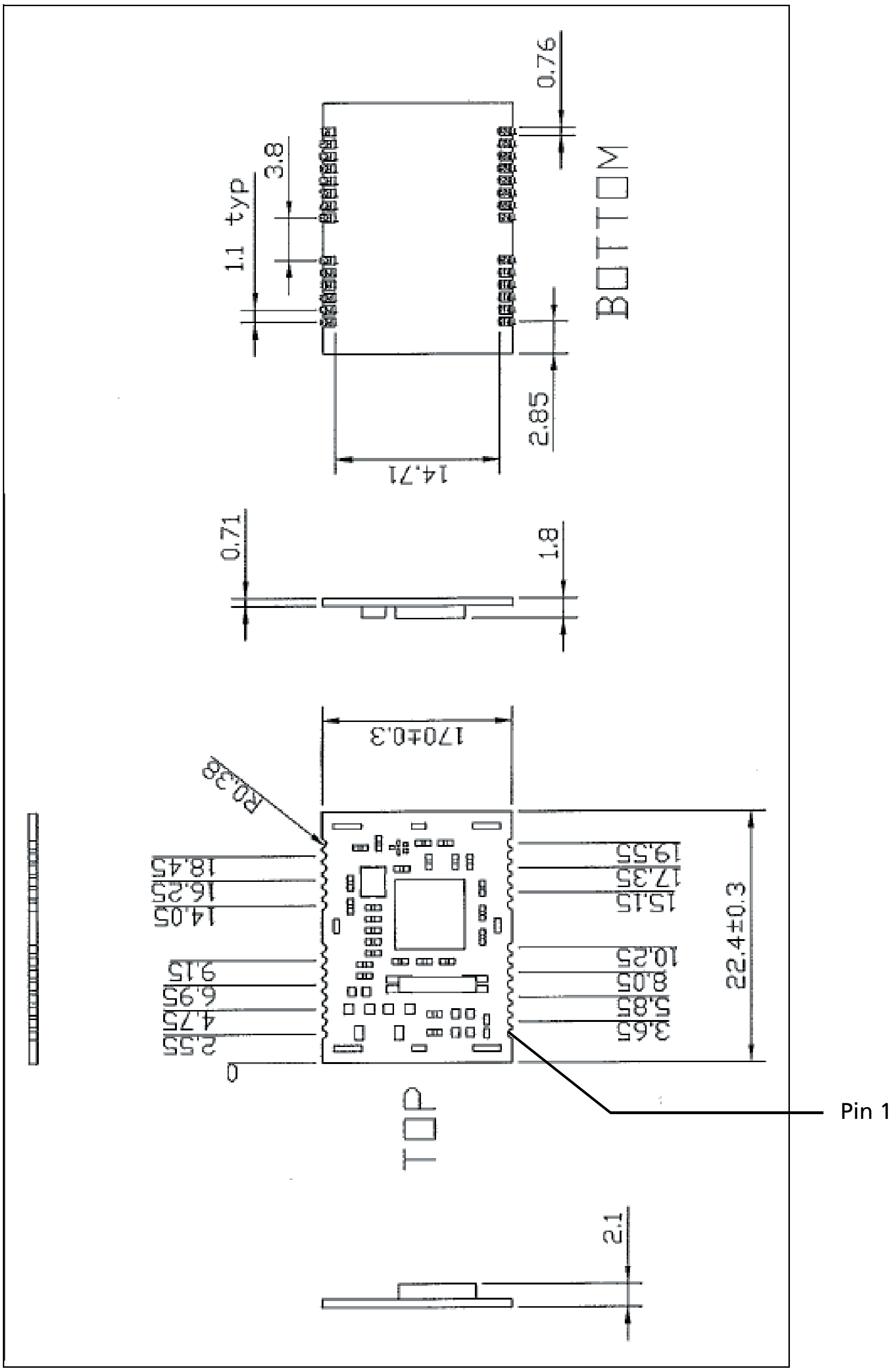


Condor GPS receiver, footprint

Outline Dimensions (Inch ±0.004 / mm ±0.10)

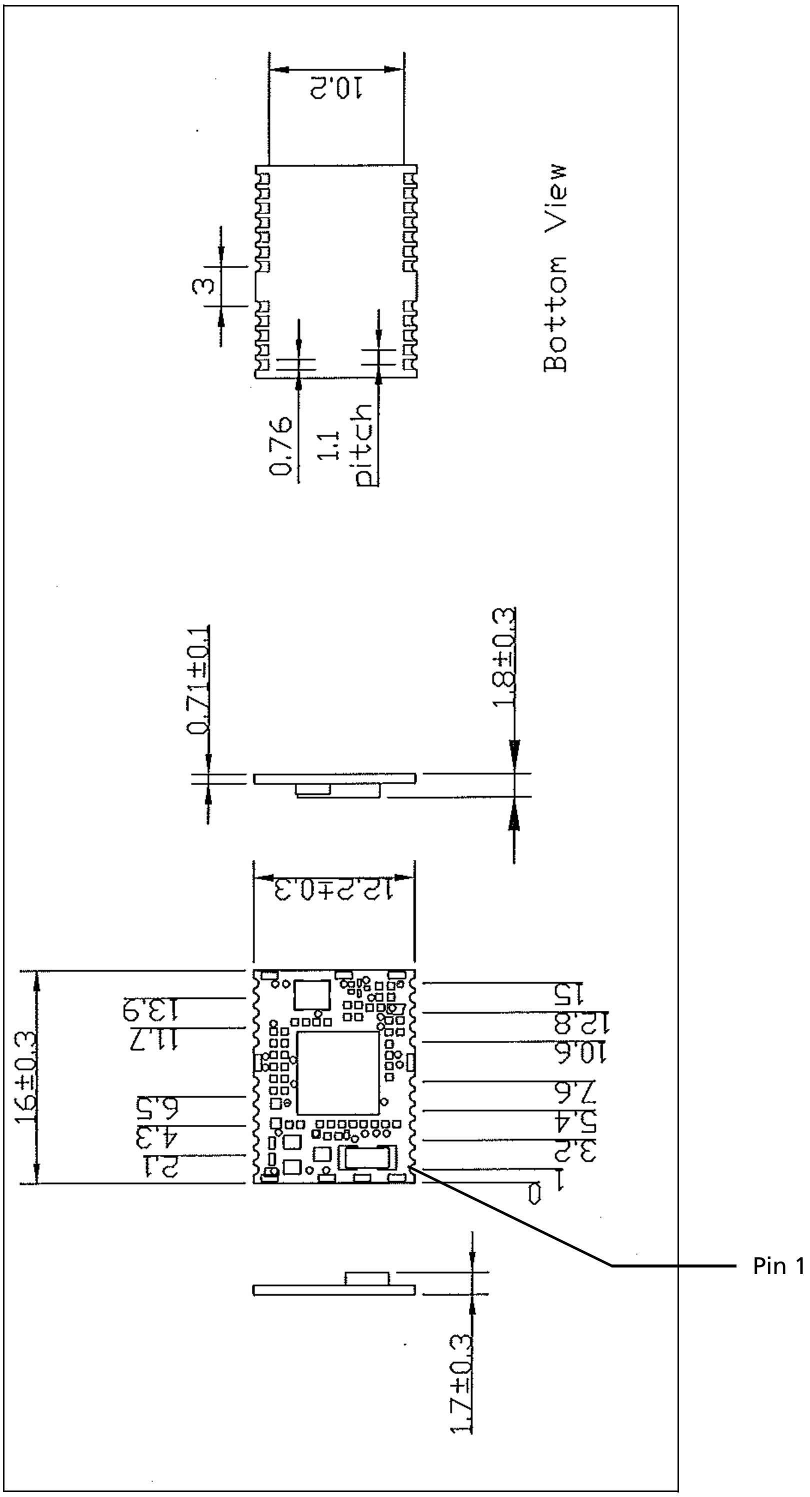
A	B	C	D	E	F	G	H	I	J	K
0.75	0.75	0.049	0.256	0.197	0.295	0.050	0.100	0.045	0.030	0.050
19.00	19.00	1.25	6.50	5.00	7.50	1.27	2.54	1.14	0.76	1.27

Condor C1722 module—mechanical outline drawing



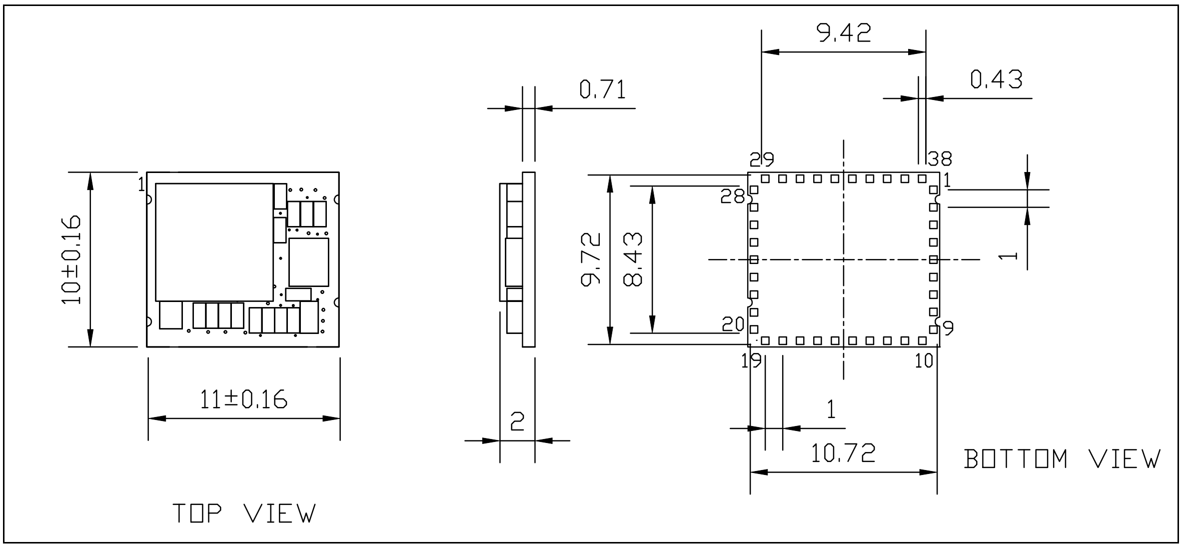
Note: *All dimensions are in mm.*

Condor C1216 module—mechanical outline drawing



Note: *All dimensions are in mm.*

Condor C1011 module—mechanical outline drawing

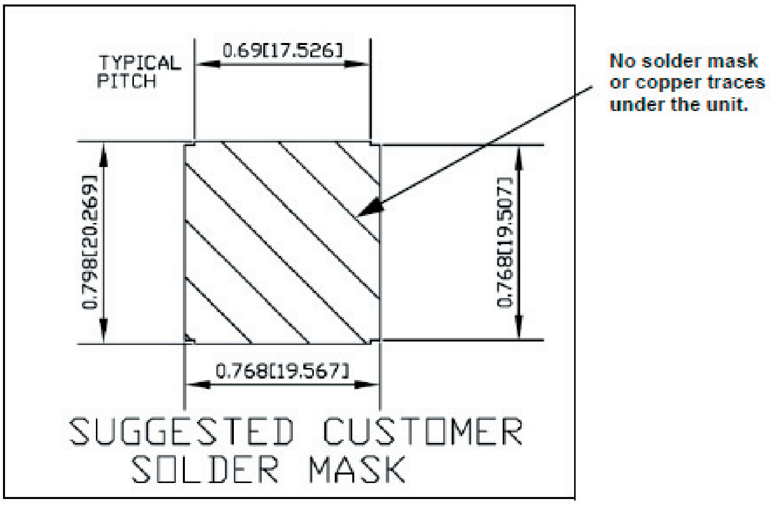


Note: All dimensions are in mm.

Soldering a Condor C1919A, C1919B, or C1919C module to a printed circuit board

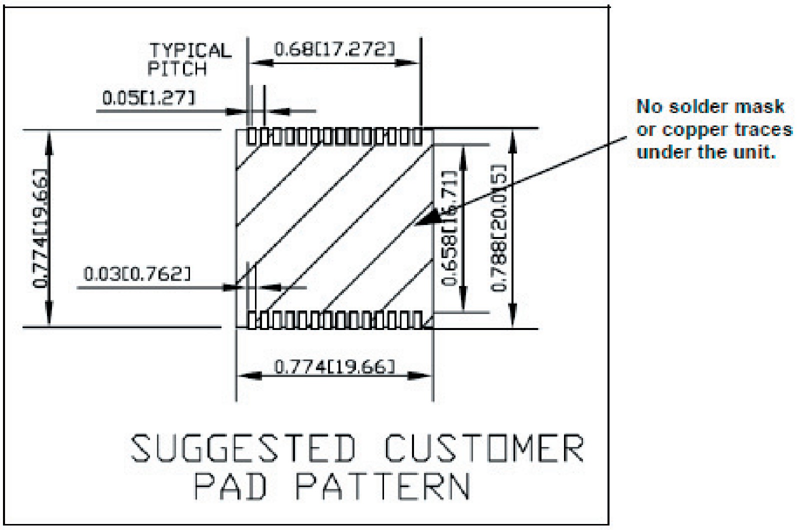
Solder mask

When soldering the Condor module to a PCB, keep an open cavity underneath the Condor module (that is, do not place copper traces or solder mask underneath the module). The diagram below illustrates the required solder mask.



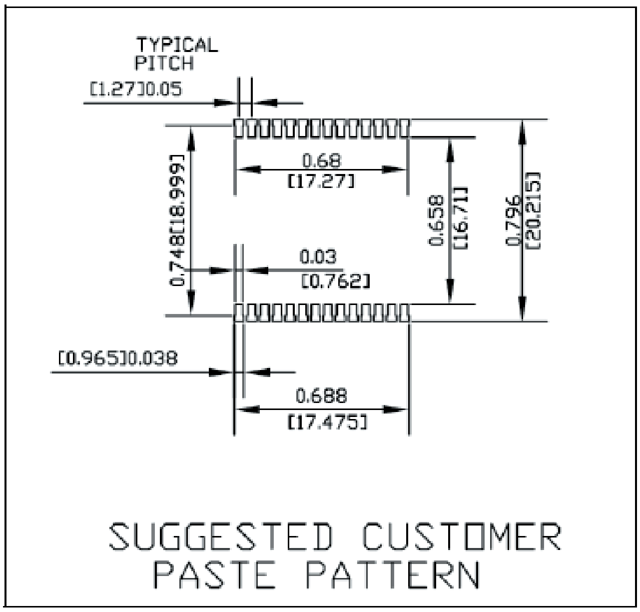
Pad pattern

The required user pad pattern is shown below.



Paste mask

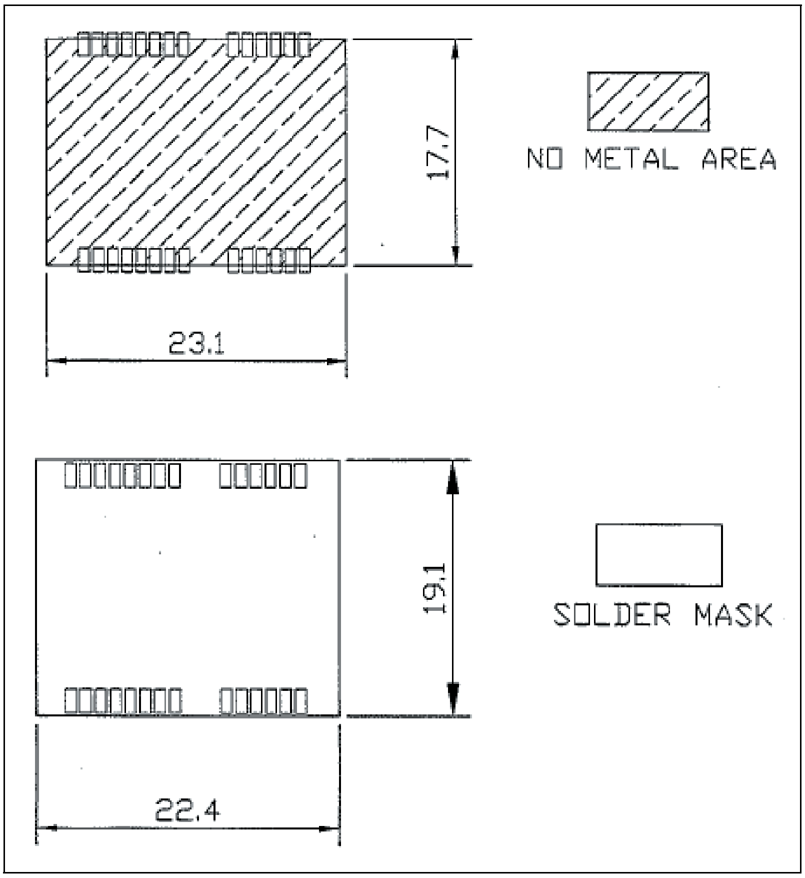
To ensure good mechanical bonding with sufficient solder to form a castellation solder joint, use a solder mask ratio of 1:1 with the solder pad. When using a 5 ±1 mil stencil to deposit the solder paste, Trimble recommends a 4 mil toe extension on the stencil.



Soldering a Condor C1722 module to a printed circuit board

Solder mask

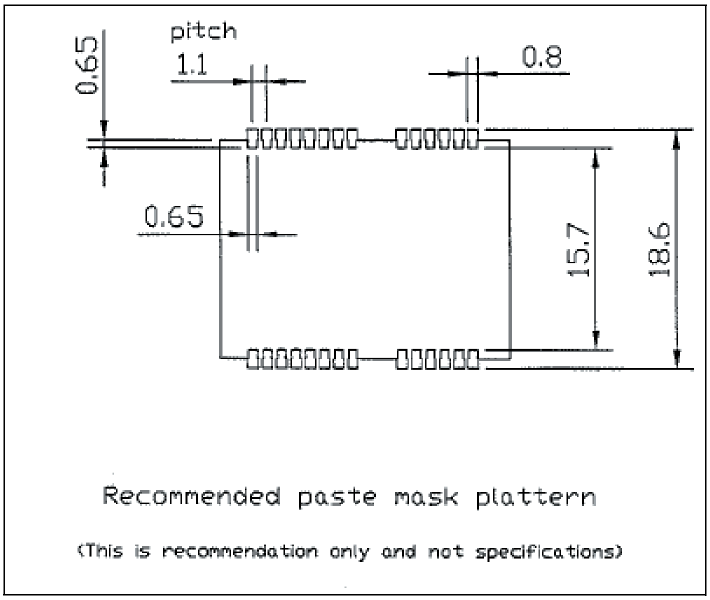
When soldering the Condor module to a PCB, keep an open cavity underneath the Condor module (that is, do not place copper traces or solder mask underneath the module). The diagram below illustrates the required solder mask.



Note: *All dimensions are in mm.*

Paste mask

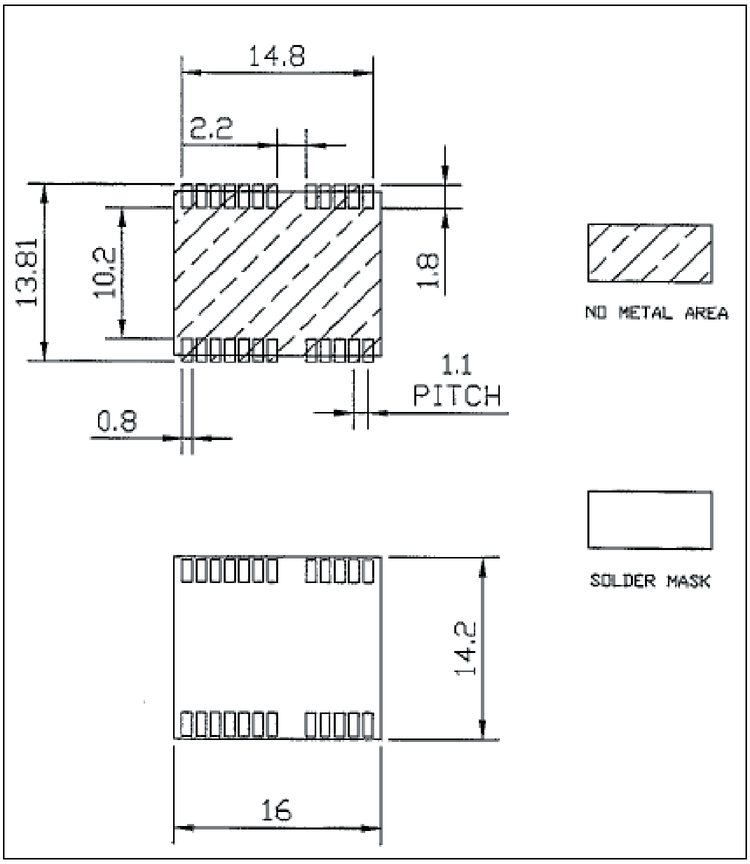
To ensure good mechanical bonding with sufficient solder to form a castellation solder joint, use a solder mask ratio of 1:1 with the solder pad. When using a 5 ±1 mil stencil to deposit the solder paste, Trimble recommends a 4 mil toe extension on the stencil.



Soldering a Condor C1216 module to a printed circuit board

Solder mask

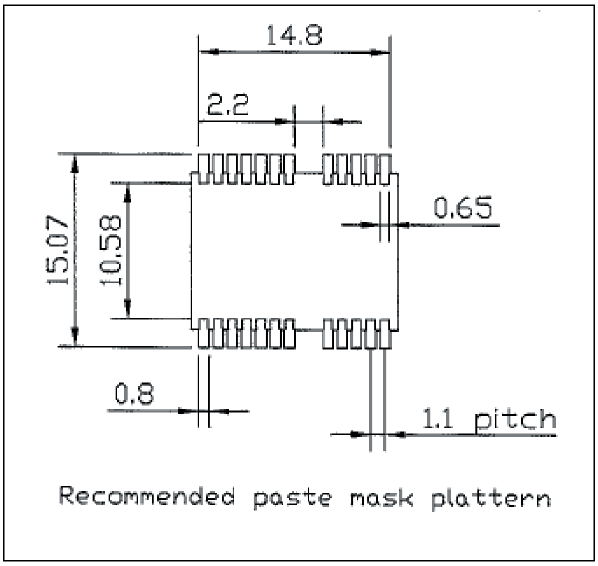
When soldering the Condor module to a PCB, keep an open cavity underneath the Condor module (that is, do not place copper traces or solder mask underneath the module). The diagram below illustrates the required solder mask.



Note: *All dimensions are in mm.*

Paste mask

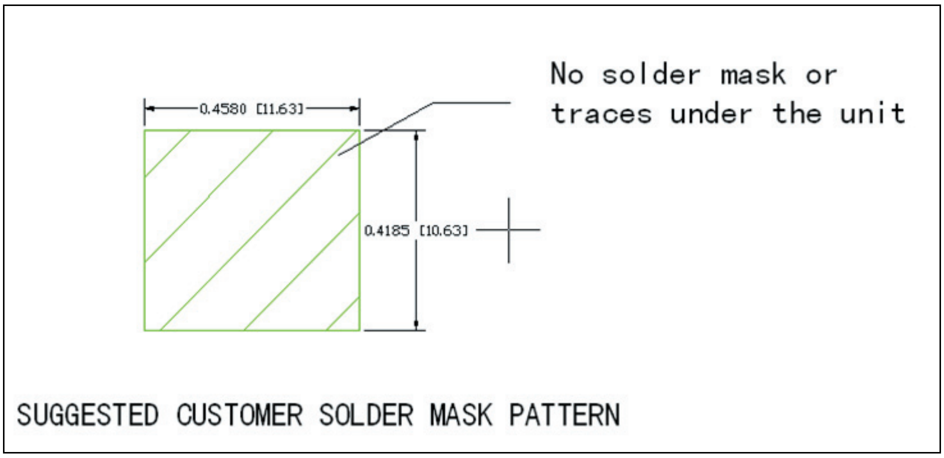
To ensure good mechanical bonding with sufficient solder to form a castellation solder joint, use a solder mask ratio of 1:1 with the solder pad. When using a 5 ±1 mil stencil to deposit the solder paste, Trimble recommends a 4 mil toe extension on the stencil.



Soldering a Condor C1011 module to a printed circuit board

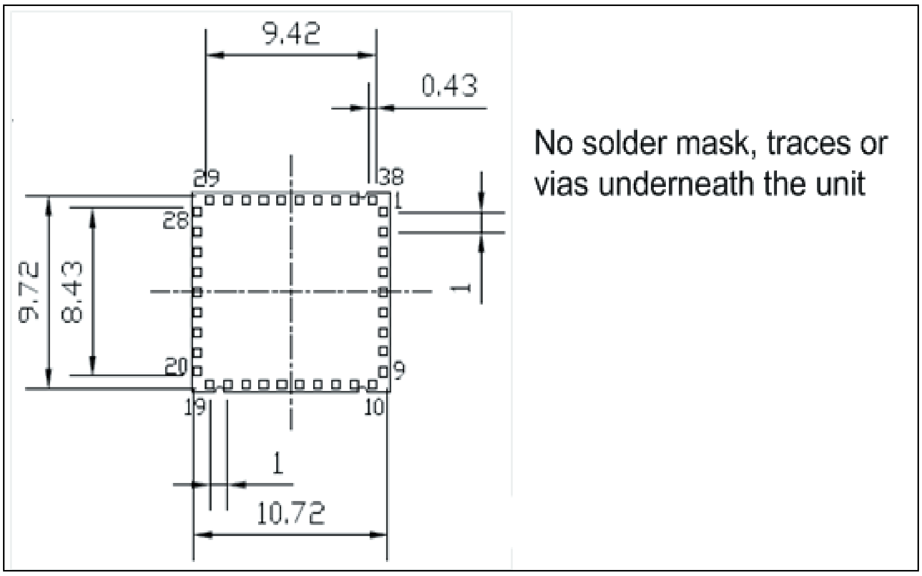
Solder mask

When soldering the Condor C1011 GPS module to a PCB, keep an open cavity underneath the module (that is, do not place copper traces or solder mask underneath the module). The diagram below illustrates the required solder mask:



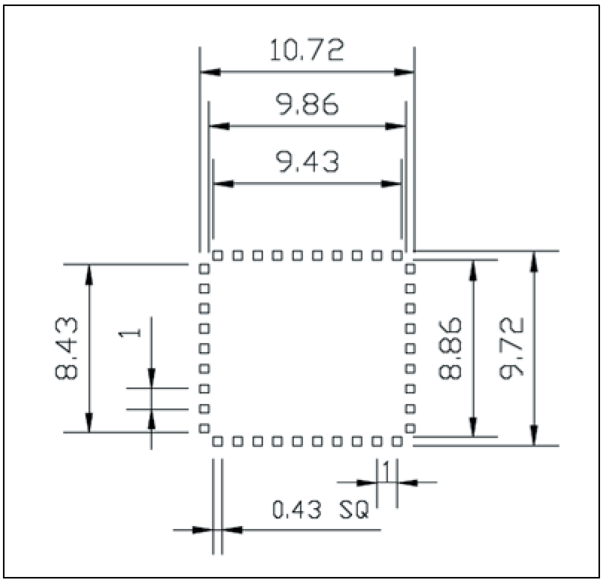
Pad pattern

The required user pad pattern is shown below:



Paste mask

To ensure good mechanical bonding with sufficient solder to form a castellation solder joint, use a solder mask ratio of 1:1 with the solder pad. When using a 5 ±1 mil stencil to deposit the solder paste, Trimble recommends a 4 mil toe extension on the stencil:



CHAPTER

8

Packaging

In this chapter:

- Introduction
- Reel
- Tapes

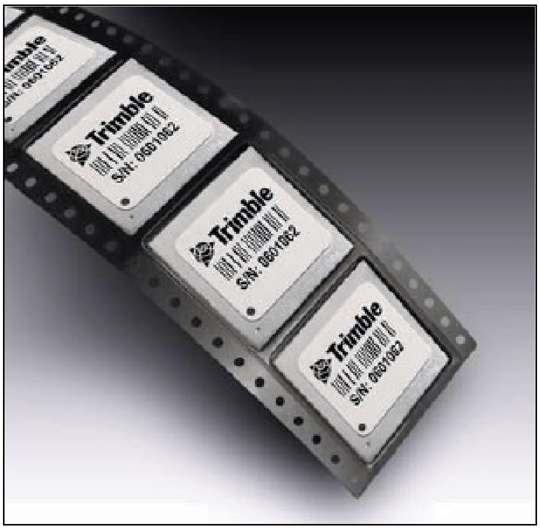
Follow the instructions in this chapter to ensure the integrity of the packaged and shipped Condor GPS receiver modules.

Introduction

The Condor GPS modules are packaged in tape and reel for mass production.

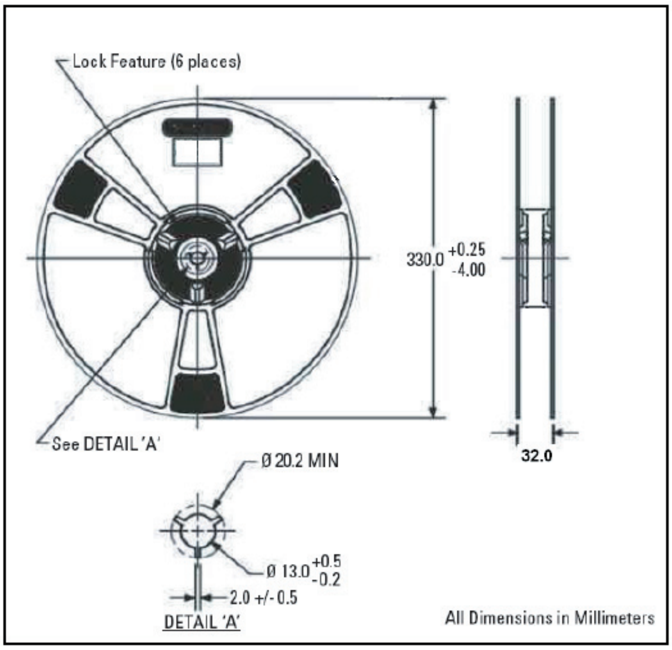
CAUTION – The reel is sealed in a moisture proof Dry Pac bag. Please follow all the directions printed on the package for handling and baking.

The Condor GPS modules are packaged in a reel with 100 or 500 pieces.



Reel

You can mount the 13-inch reel in a standard feeder for the surface mount pick and place machine.



Weight

Condor C1919A, C1919B, and C1919C modules

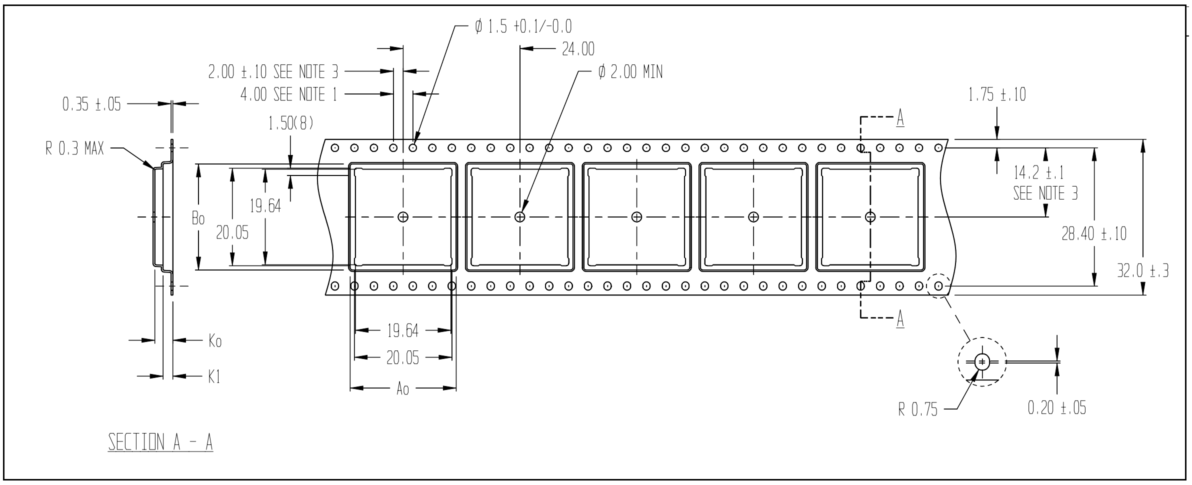
Description	Weight (approx)
100 pieces with reel packaging, desiccant, and humidity indicator	0.79 kg (1.74 lb.)
100 pieces with reel packaging, desiccant, humidity indicator, and brown pizza box	1.02 kg (2.25 lb.)
500 pieces with reel packaging, desiccant, and humidity indicator	1.47 kg (3.24 lb.)
500 pieces with reel packaging, desiccant, humidity indicator, and white pizza box	1.70 kg (3.74 lb.)

Condor C1011 modules

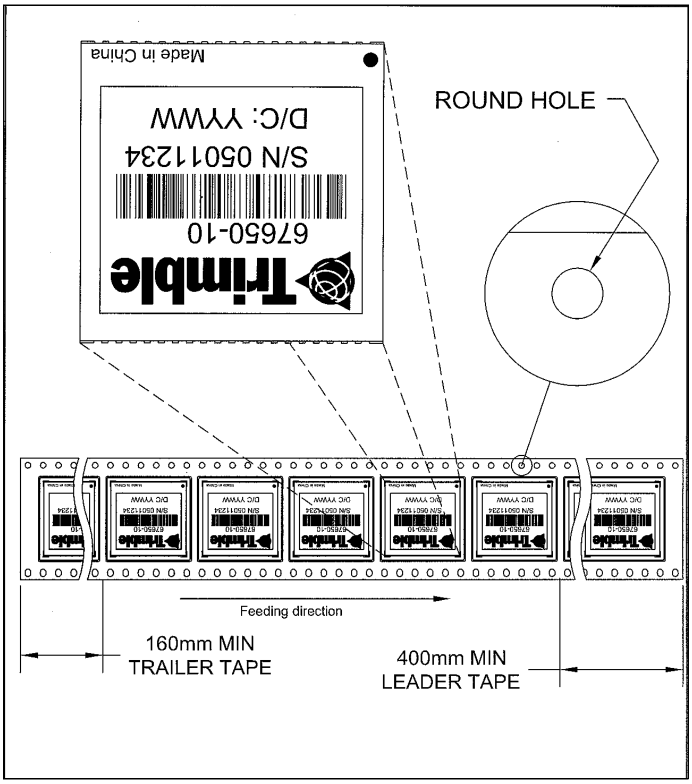
Description	Weight (approx)
100 pieces with reel packaging, desiccant, and humidity indicator	0.321 kg (0.7 lb.)
100 pieces with reel packaging, desiccant, humidity indicator, and brown pizza box	0.455 kg (1.00 lb.)
500 pieces with reel packaging, desiccant, and humidity indicator	0.457 kg (1.01 lb.)
500 pieces with reel packaging, desiccant, humidity indicator, and brown pizza box	0.592 kg (1.31 lb.)

Tapes

The tape dimensions illustrated in the diagram below are in inches. The metric units appear in brackets [ ].



The feeding direction is illustrated below:



CHAPTER

9

Shipping and Handling

In this chapter:

- Shipping and handling guidelines
- Moisture precondition
- Baking procedure
- Soldering paste
- Solder reflow
- Recommended soldering profile
- Optical inspection
- Cleaning
- Soldering guidelines
- Rework
- Conformal coating
- Grounding the metal shield

This chapter provides detailed guidelines for shipping and handling the Condor GPS receiver to ensure compliance with the product warranty.

Shipping and handling guidelines

Handling

The Condor GPS module is shipped in tape and reel for use with an automated surface mount machine. This is a lead-free module with silver plating. Do not allow bodily fluids or lotions to come in contact with the bottom of the module.

CAUTION – The Condor GPS module is packed according to ANSI/EIA-481-B and JSTD-033A. All of the handling and precaution procedures must be followed. Deviation from the following handling procedures and precautions voids the warranty.

Shipment

The reel of Condor GPS modules is packed in a hermetically sealed moisture barrier bag (DryPac) and then placed in an individual carton. Handle with care to avoid breaking the moisture barrier.

Storage

The shelf life for the sealed DryPac is 12 months if stored at <40 °C and with <90% relative humidity.

Moisture indicator

A moisture indicator is packed individually in each DryPac to monitor the environment—it has five indicator spots that are blue when the pack leaves the factory. If the indicator changes to pink, follow the instructions printed on the moisture barrier and bake as required. See Baking procedure, page 103.

Floor life

The reel of Condor GPS modules is vacuum sealed in a moisture barrier bag (DryPac). Once the bag is opened, moisture will bond with the modules. In a production floor environment, an open reel needs to be processed within 72 hours, unless it is kept in a nitrogen-purged dry chamber. If the moisture indicator changes to pink, follow the baking instructions printed on the moisture barrier.

The Condor GPS module is a lead-free component and is RoHS compliant. This unit is also plated with immersion silver that makes soldering easier. The silver may tarnish over time and appear yellowish, but this should not affect the solderability.

CAUTION – Operators should not touch the bottom silver solder pads by hand or with contaminated gloves. Ensure that no hand lotion or regular chlorinated faucet water comes in contact with the module before soldering.

Moisture precondition

You must take precautions to minimize the effects of the reflow thermal stress on the module. Plastic molding materials for integrated circuit encapsulation are hygroscopic and absorb moisture. This is dependent on the time and the environment.

Absorbed moisture will vaporize during the rapid heating of the solder reflow process, generating pressure to all the interface areas in the package, followed by swelling, delamination, and even cracking of the plastic. Components that do not exhibit external cracking can have internal delamination or cracking which affects yield and reliability.

CAUTION

THIS BAG CONTAINS MOISTURE SENSITIVE DEVICES. 4 Level
Do not open except under controlled conditions.
shelf life in sealed bag: 12 months @ <40C and <90% RH.
1) Peak package body temperature 245C.
2) After this bag is opened, devices that will be subjected to IR reflow vapor-phase reflow, or equivalent processing must be:
a. Mounted within 72 hrs @ factory conditions of <30C/60% RH or
b. Stored at <20% RH.
3) Devices require baking, before mounting if:
a. Humidity card is >20% when read at 23C+-5C or
b. 2a or 2b are not met.
4) if baking is required, devices may be baked for 24 hrs minimum at 125C-0/+5C.
Bag Seal Date: mm/dd/yy
expiration date: 12 months from seal date.

Baking procedure

If baking is necessary, Trimble recommends baking in a nitrogen-purge oven.

Temperature	125 °C
Duration	24 hours
After baking	Store in a nitrogen-purged cabinet or dry box to prevent absorption of moisture

CAUTION – Do not bake the units within the tape and reel packaging. Repeated baking processes will reduce the solderability.

Soldering paste

The Condor GPS module itself is not hermetically sealed. Trimble strongly recommends using the "No Clean" soldering paste and process. The castellation solder pad on this module is plated with silver plating. Use Type 3 or above soldering paste to maximize the solder volume. The following is an example:

Solder paste	Kester EM909
Alloy composition	Sn96.5Ag3Cu.5 (SAC305) 96.5% Tin / 3%Silver / 0.5% Copper
Liquidus Temperature	221 °C
Stencil Thickness	5 mil (0.005") Stencil opening requires 4 mil toe over-paste in the X and Y directions.

Consult the solder paste manufacturer and the assembly process for the approved procedures.

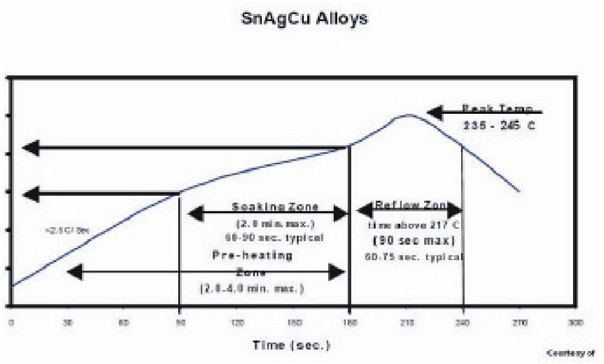
Solder reflow

A hot air convection oven is strongly recommended for solder reflow. For the lead-free solder reflow, Trimble recommends using a nitrogen-purged oven to increase the solder wetting. Reference IPC-610D for the lead free solder surface appearance.

CAUTION – Follow the thermal reflow guidelines from the IPC-JEDEC J-STD-020C.

The size of this module is 916.9 mm^3. According to J-STD-020C, the peak component temperature during reflow is 245+0 °C.

Recommended soldering profile



Select the final soldering thermal profile very carefully. The thermal profile depends on the choice of the solder paste, thickness and color of the carrier board, heat transfer, and the size of the penalization.

CAUTION – For a double-sided surface-mount carrier board, the unit must be placed on the secondary side to prevent falling off during reflow.

Optical inspection

After soldering the Condor GPS module to the carrier board, follow the IPC-610 specification and use a 3x magnification lens to verify the following:

- Each pin is properly aligned with the mount pad.
- The pads are properly soldered.
- No solder is bridged to the adjacent pads. X-ray the bottom pad if necessary.

Cleaning

When the Condor GPS module is attached to the user board, a cleaning process voids the warranty. Please use a “no-clean” process to eliminate the cleaning process. The silver-plated Condor GPS module may discolor with cleaning agent or chlorinated faucet water. Any other form of cleaning solder residual may cause permanent damage and will void the warranty.

Soldering guidelines

Repeated reflow soldering

The Condor GPS lead-free silver plated module can withstand two reflow solder processes. If the unit must mount on the first side for surface-mount reflow, add glue on the bottom of the module to prevent it falling off when processing the second side.

Wave soldering

The Condor GPS module cannot soak in the solder pot. If the carrier board is mixed with through-hole components and surface mount devices, it can be processed with one single lead-free wave process. The temperature of the unit will depend on the size and the thickness of the board. Measure the temperature on the module to ensure that it remains under 180 °C.

Hand soldering

For the lead-free Condor GPS module, use a lead-free solder core, such as Kester 275 Sn96.5/Ag3/Cu0.5. When soldering the module by hand, keep the soldering iron below 260 °C.

Rework

The Condor GPS module can withstand one rework cycle. The module can heat up to the reflow temperature to precede the rework. Never remove the metal shield and rework on the module itself.

Conformal coating

Conformal coating on the Condor GPS module is not allowed and will void the warranty

Grounding the metal shield

The Condor GPS module is designed with numerous ground pins that, along with the metal shield, provide the best immunity to EMI and noise. Any alteration by adding ground wires to the metal shield is done at the customer's own risk and may void the warranty.

APPENDIX

A

Datum List

This appendix includes an international datum list.

No	Datum	Region
0	WGS1984	International
1	Tokyo	Japan
2	Tokyo	Mean For Japan, South Korea, Okinawa
3	User Setting	User Setting
4	Adindan	Burkina Faso
5	Adindan	Cameroon
6	Adindan	Ethiopia
7	Adindan	Mali
8	Adindan	Mean For Ethiopia, Sudan
9	Adindan	Senegal
10	Adindan	Sudan
11	Afgooye	Somalia
12	Ain El Abd1970	Bahrain
13	Ain El Abd1970	Saudi Arabia
14	American Samoa1962	American Samoa Islands
15	Anna 1 Astro1965	Cocos Island
16	Antigua Island Astro1943	Antigua(Leeward Islands)
17	Arc1950	Botswana
18	Arc1950	Burundi
19	Arc1950	Lesotho
20	Arc1950	CuMalawi
21	Arc1950	Mean for Botswana, Lesotho, Malawi, Swaziland, Zaire,Zambia, Zimbabwe
22	Arc1950	Swaziland
23	Arc1950	Zaire
24	Arc1950	Zambia
25	Arc1950	Zimbabwe
26	Arc1960	Mean For Kenya Tanzania
27	Arc1960	Kenya
28	Arc1960	Tanzania
29	Ascension Island1958	Ascension Island
30	Astro Beacon E 1945	Iwo Jima
31	Astro Dos 71/4	St Helena Island
32	Astro Tern Island (FRIG) 1961	Tern Island
33	Astronomical Station 1952	Marcus Island
34	Australian Geodetic 1966	Australia, Tasmania
35	Australian Geodetic 1984	Australia, Tasmania
36	Ayabelle Lighthouse	Djibouti
37	Bellevue (IGN)	Efate and Erromango Islands
38	Bermuda 1957	Bermuda

No	Datum	Region
39	Bissau	Guuinea-Bissau
40	Bogota Observatory	Colombia
41	Bukit Rimpah	Indonesia (Bangka and Belitung Ids)
42	Camp Area Astro	Antarctica (McMurdi Camp Area)
43	Campo Inchauspe	Argentina
44	Canton Astro1966	Phoenix Island
45	Cape	South Africa
46	Cape Canaveral	Bahamas, Florida
47	Carthage	Tunisia
48	Chatham Island Astro1971	New Zealand(Chatham Island)
49	Chua Astro	Paraguay
50	Corrego Alegre	Brazil
51	Dabola	Guinea
52	Deception Island	Deception Island, Antarctia
53	Djakarta (Batavia)	Indonesia(Sumatra)
54	Dos 1968	New Georgia Islands (Gizo Island)
55	Easter Island 1967	Easter Island
56	Estonia Coordinate System1937	Estonia
57	European 1950	Cyprus
58	European 1950	Egypt
59	European 1950	England, Channel Islands, Scotland, Shetland Islands
60	European 1950	England, Ireland, Scotland, Shetland Islands
61	European 1950	Finland, Norway
62	European 1950	Greece
63	European 1950	Iran
64	European 1950	Italy (Sardinia)
65	European 1950	Italy (Sicily)
66	European 1950	Malta
67	European 1950	Mean For Austria, Belgium,Denmark, Finland, France, W Germany, Gibraltar, Greece, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland
68	European 1950	Mean For Austria, Denmark, France, West Germany, Netherland, Switzerland
69	European 1950	Mean For Iraq, Israel, Jordan, Lebanon, Kuwait, Saudi Arabia, Syria
70	European 1950	Portugal, Spain
71	European 1950	Tunisia
72	European 1979	Mean For Austria, Finland, Netherlands, Norway, Spain, Sweden, Switzerland
73	Fort Thomas 1955	Nevis St Kitts (Leeward Islands)
74	Gan 1970	Republic Of Maldives
75	Geodetic Dataum 1970	New Zealand
76	Graciosa Base SW1948	Azores (Faial, Graciosa, Pico, Sao, Jorge, Terceria)

No	Datum	Region
77	Guam1963	Guam
78	Gunung Segara	Indonesia (Kalimantan)
79	Gux l Astro	Guadalcanal Island
80	Herat North	Afghanistan
81	Hermannskogel Datum	Croatia-Serbia, Bosnia-Herzegoivna
82	Hjorsey 1955	Iceland
83	Hongkong 1963	Hongkong
84	Hu Tzu Shan	Taiwan
85	Indian	Bangladesh
86	Indian	India,Nepal
87	Indian	Pakistan
88	Indian 1954	Thailand
89	Indian 1960	Vietnam (Con Son Island)
90	Indian 1960	Vietnam (Near 16 deg N)
91	Indian 1975	Thailand
92	Indonesian 1974	Indonesia
93	Ireland 1965	Ireland
94	ISTS 061 Astro 1968	South Georgia Islands
95	ISTS 073 Astro 1969	Diego Garcia
96	Johnston Island 1961	Johnston Island
97	Kandawala	Sri Lanka
98	Kerguelen Island 1949	Kerguelen Island
99	Kertau 1948	West Malaysia and Singapore
100	Kusaie Astro 1951	Caroline Islands
101	Korean Geodetic System	South Korea
102	LC5 Astro 1961	Cayman Brac Island
103	Leigon	Ghana
104	Liberia 1964	Liberia
105	Luzon	Philippines (Excluding Mindanao)
106	Luzon	Philippines (Mindanao)
107	M'Poraloko	Gabon
108	Mahe 1971	Mahe Island
109	Massawa	Ethiopia (Eritrea)
110	Merchich	Morocco
111	Midway Astro 1961	Midway Islands
112	Minna	Cameroon
113	Minna	Nigeria
114	Montserrat Island Astro 1958	Montserrat (Leeward Island)
115	Nahrwan	Oman (Masirah Island)
116	Nahrwan	Saudi Arabia
117	Nahrwan	United Arab Emirates
118	Naparima BWI	Trinidad and Tobago

No	Datum	Region
119	North American 1927	Alaska (Excluding Aleutian Ids)
120	North American 1927	Alaska (Aleutian Ids East of 180 degW)
121	North American 1927	Alaska (Aleutian Ids West of 180 degW)
122	North American 1927	Bahamas (Except San Salvador Islands)
123	North American 1927	Bahamas (San Salvador Islands)
124	North American 1927	Canada (Alberta, British Columbia)
125	North American 1927	Canada (Manitoba, Ontario)
126	North American 1927	Canada (New Brunswick, Newfoundland, Nova Scotia, Quebec)
127	North American 1927	Canada (Northwest Territories, Saskatchewan)
128	North American 1927	Canada (Yukon)
129	North American 1927	Canal Zone
130	North American 1927	Cuba
131	North American 1927	Greenland (Hayes Peninsula)
132	North American 1927	Mean For Antigua, Barbados, Barbuda, Caicos Islands, Cuba, Dominican, Grand Cayman, Jamaica, Turks Islands
133	North American 1927	Mean For Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua
134	North American 1927	Mean For Canada
135	North American 1927	Mean For Conus
136	North American 1927	Mean For Conus (East of Mississippi, River Including Louisiana, Missouri, Minnesota)
137	North American 1927	Mean For Conus (West of Mississippi, Rive Excluding Louisiana, Minnesota, Missouri)
138	North American 1927	Mexico
139	North American 1983	Alaska (Excluding Aleutian Ids)
140	North American 1983	Aleutian Ids
141	North American 1983	Canada
142	North American 1983	Conus
143	North American 1983	Hawaii
144	North American 1983	Mexico, Central America
145	North Sahara 1959	Algeria
146	Observatorio Meteorologico 1939	Azores (Corvo and Flores Islands)
147	Old Egyptian 1907	Egypt
148	Old Hawaiian	Hawaii
149	Old Hawaiian	Kauai
150	Old Hawaiian	Maui
151	Old Hawaiian	Mean For Hawaii, Kauai, Maui, Oahu
152	Old Hawaiian	Oahu
153	Oman	Oman
154	Ordnance Survey Great Britian 1936	England
155	Ordnance Survey Great Britian 1936	England, Isle of Man, Wales

No	Datum	Region
156	Ordnance Survey Great Britian 1936	Mean For England, Isle of Man, Scotland, Shetland Island, Wales
157	Ordnance Survey Great Britian 1936	Scotland, Shetland Islands
158	Ordnance Survey Great Britian 1936	Wales
159	Pico de las Nieves	Canary Islands
160	Pitcairn Astro 1967	Pitcairn Island
161	Point 58	Mean For Burkina Faso and Niger
162	Pointe Noire 1948	Congo
163	Porto Santo 1936	Porto Santo, Maderia Islands
164	Provisional South American 1956	Bolovia
165	Provisional South American 1956	Chile (Northern Near 19 deg S)
166	Provisional South American 1956	Chile (Southern Near 43 deg S)
167	Provisional South American 1956	Colombia
168	Provisional South American 1956	Ecuador
169	Provisional South American 1956	Guyana
170	Provisional South American 1956	Mean For Bolivia Chile,Colombia, Ecuador, Guyana, Peru, Venezuela
171	Provisional South American 1956	Peru
172	Provisional South American 1956	Venezuela
173	Provisional South Chilean 1963	Chile (Near 53 deg S) (Hito XVIII)
174	Puerto Rico	Puerto Rico, Virgin Islands
175	Pulkovo 1942	Russia
176	Qatar National	Qatar
177	Qornoq	Greenland (South)
178	Reunion	Mascarene Island
179	Rome 1940	Italy (Sardinia)
180	S-42 (Pulkovo 1942)	Hungary
181	S-42 (Pulkovo 1942)	Poland
182	S-42 (Pulkovo 1942)	Czechoslovakia
183	S-42 (Pulkovo 1942)	Latvia
184	S-42 (Pulkovo 1942)	Kazakhstan
185	S-42 (Pulkovo 1942)	Albania
186	S-42 (Pulkovo 1942)	Romania
187	S-JTSK	Czechoslovakia (Prior 1 Jan1993)
188	Santo (Dos) 1965	Espirito Santo Island
189	Sao Braz	Azores (Sao Miguel, Santa Maria Ids)
190	Sapper Hill 1943	East Falkland Island
191	Schwarzeck	Namibia
192	Selvagem Grande 1938	Salvage Islands
193	Sierra Leone 1960	Sierra Leone
194	South American 1969	Argentina
195	South American 1969	Bolivia

No	Datum	Region
196	South American 1969	Brazil
197	South American 1969	Chile
198	South American 1969	Colombia
199	South American 1969	Ecuador
200	South American 1969	Ecuador (Baltra, Galapagos)
201	South American 1969	Guyana
202	South American 1969	Mean For Argentina, Bolivia, Brazil,Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Trinidad and Tobago, Venezuela
203	South American 1969	Paraguay
204	South American 1969	Peru
205	South American 1969	Trinidad and Tobago
206	South American 1969	Venezuela
207	South Asia	Singapore
208	Tananarive Observatory 1925	Madagascar
209	Timbalai 1948	Brunei, E Malaysia (Sabah Sarawak)
210	Tokyo	Japan
211	Tokyo	Mean For Japan, South Korea, Okinawa
212	Tokyo	Okinawa
213	Tokyo	South Korea
214	Tristan Astro 1968	Tristam Da Cunha
215	Viti Levu 1916	Fiji (Viti Levu Island)
216	Voirol 1960	Algeria
217	Wake Island Astro 1952	Wake Atoll
218	Wake-Eniwetok 1960	Marshall Islands
219	WGS 1972	Global Definition
220	WGS 1984	Global Definition
221	Yacare	Uruguay
222	Zanderij	Suriname

APPENDIX

B

NMEA 0183 Protocol

In this appendix:

This appendix provides a brief overview of the NMEA 0183 protocol, and describes both the standard and optional messages offered by the Condor modules.

Introduction

NMEA 0183 is a simple, yet comprehensive ASCII protocol which defines both the communication interface and the data format. The NMEA 0183 protocol was originally established to allow marine navigation equipment to share information. Since it is a well established industry standard, NMEA 0183 has also gained popularity for use in applications other than marine electronics.

For those applications requiring output only from the GPS receiver, NMEA 0183 is a popular choice since, in many cases, an NMEA 0183 software application code already exists. The Condor is available with firmware that supports a subset of the NMEA 0183 messages: GGA, GSA, GSV, and RMC.

For a complete copy of the NMEA 0183 standard, contact:

NMEA National Office
Seven Riggs Avenue, Severna Park, MD 21146
Phone: +1-410-975-9425 or 800-808-6632 (NMEA)
Fax: +1-410-975-9450

NMEA 0183 communication interface

NMEA 0183 allows a single source (talker) to transmit serial data over a single twisted wire pair to one or more receivers (listeners). The table below lists the standard characteristics of the NMEA 0183 data transmissions.

Signal	NMEA standard
Baud rate	4800 ***Note –*** *The Condor GPS module has a default 9600 baud rate.*
Data bits	8
Parity	None (Disabled)
Stop bits	1

NMEA 0183 message structure

The NMEA 0183 protocol covers a broad array of navigation data. This broad array of information is separated into discrete messages which convey a specific set of information. The entire protocol encompasses over 50 messages, but only a sub-set of these messages apply to a GPS receiver like the Condor module. The NMEA message structure is described below.

```
$IDMSG,D1,D2,D3,D4,.......,Dn*CS[CR][LF]
```

Where:

$	Signifies the start of a message
ID	The talker identification is a two letter mnemonic which describes the source of the navigation information. The GP identification signifies a GPS source.
MSG	The message identification is a three letter mnemonic which describes the message content and the number and order of the data fields.
,	Commas serve as delimiters for the data fields.
Dn	Each message contains multiple data fields (Dn) which are delimited by commas.
*	The asterisk serves as a checksum delimiter.
CS	The checksum field contains two ASCII characters which indicate the hexadecimal value of the checksum.
[CR][LF]	The carriage return [CR] and line feed [LF] combination terminate the message.

NMEA 0183 messages vary in length, but each message is limited to 79 characters or less. This length limitation excludes the "$" and the [CR][LF]. The data field block, including delimiters, is limited to 74 characters or less.

Field definitions

Many of the NMEA data fields are of variable length, and the user should always use the comma delineators to parse the NMEA message data field. The following table specifies the definitions of all field types in the NMEA messages supported by Trimble:

Type	Symbol	Definition
Status	A	Single character field: A=Yes, data valid, warning flag clear V=No, data invalid, warning flag set
Special Format Fields		
Latitude	llll.lll	Fixed/variable length field: Degreesminutes.decimal-2 fixed digits of degrees, 2 fixed digits of minutes and a variable number of digits for decimal-fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required.
Longitude	yyyyy.yyy	Fixed/Variable length field: Degreesminutes.decimal-3 fixed digits of degrees, 2 fixed digits of minutes and a variable number of digits for decimal-fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required.
Time	hhmmss.ss	Fixed/Variable length field: hoursminutesseconds.decimal-2 fixed digits of minutes, 2 fixed digits of seconds and a variable number of digits for decimal-fraction of seconds. Leading zeros always included for hours, minutes, and seconds to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required.
Defined		Some fields are specified to contain pre-defined constants, most often alpha characters. Such a field is indicated in this standard by the presence of one or more valid characters. Excluded from the list of allowable characters are the following that are used to indicated field types within this standard: "A", "a", "c", "hh", "hhmmss.ss", "llll.ll", "x", "yyyyy.yy"

Type	Symbol	Definition
Numeric Value Fields		
Variable	x.x	Variable length integer or floating numeric field. Optional leading and trailing zeros. The decimal point and associated decimal-fraction are optional if full resolution is not required (example: 73.10=73.1=073.1=73).
Fixed HEX	hh	Fixed length HEX numbers only, MSB on the left
Information Fields		
Fixed Alpha	aa	Fixed length field of upper-case or lower-case alpha characters.
Fixed Number	xx	Fixed length field of numeric characters

Notes –
- Spaces should only be used in variable text fields.
- Units of measure fields are appropriate characters from the Symbol column unless a specified unit of measure is indicated.
- Fixed length field definitions show the actual number of characters. For example, a field defined to have a fixed length of 5 HEX characters is represented as hhhhh between delimiters in a sentence definition.

NMEA 0183 message options

The Condor GPS module can output the messages listed in the table below. In its default configuration (as shipped from the factory), the Condor module outputs only the messages in the table below. Typically NMEA messages are output at a 1 second interval with the "GP" talker ID and checksums. These messages are output at all times during operation, with or without a fix.

Message	Description
GGA	GPS fix data (default)
GSA	GPS DOP and active satellites (default)
GSV	GPS satellites in view (default)
RMC	Recommended minimum specific GPS/Transit data (default)
CHN	GPS channel status
GLL	Geographic position - Latitude/Longitude
VTG	Track Made Good and Ground Speed
ZDA	Time and date

Note – *Only RMC, GGA, GSV, and GSA are default. If you change the output contents, the receiver only keeps them while V_{cc} or V_{rtc} is present. If V_{cc} or V_{rtc} are removed, the output goes back to the default settings.*

NMEA 0183 message formats

CHN - Channel Usage Status

The CHN message identifies the GPS satellites, including their PRN number, SNR value, and status.

`$PMTKCHN,xxxxx *hh<CR><LF>`

Position number	Description
1 -2	Satellite number
3-4	SNR in dB
5	Channel status 0 - Idle 1 - Searching 2 - Tracking
hh	Checksum

Example:

```
$PMTKCHN,23502,28452,16352,19452,13512,07512,10402,08452,03462,06442,
48502,00000,20352,00000,00000,00000,00000,00000,00000,00000,00000,000
00,00000,00000,00000,00000,00000,00000,00000,00000,00000,00000*43
```

GGA-GPS Fix Data

The GGA message includes time, position and fix related data for the GPS receiver.

```
$GPGGA,hhmmss.ss,llll.lll,a,nnnnn.nnn,b,t,uu,
v.v,w.w,M,x.x,M,y.y,zzzz*hh <CR><LF>
```

Field number	Description
1	UTC of Position
2, 3	Latitude, N (North) or S (South)
4, 5	Longitude, E (East) or W (West)
6	GPS Quality Indicator: 0 = No GPS, 1 = GPS, 2 = DGPS / SBAS
7	Number of Satellites in Use
8	Horizontal Dilution of Precision (HDOP)
9, 10	Antenna Altitude in Meters, M = Meters
11, 12	Geoidal Separation in Meters, M=Meters. Geoidal separation is the difference between the WGS-84 earth ellipsoid and mean-sea-level.
13	Age of Differential GPS Data. Time in seconds since the last Type 1 or 9 Update
14	Differential Reference Station ID (0000 to 1023)
hh	Checksum

GLL Geographic Position - Latitude/Longitude

The GLL message contains the latitude and longitude of the present vessel position, the time of the position fix and the status.

```
$GPGLL,llll.lllll,a,yyyyy.yyyyy,a,hhmmss.ss,A,i*hh<CR>
<LF>
```

Field	Field Description
1,2	Latitude, N (North) or S (South)
3,4	Longitude, E (East) or W (West)
5	UTC of position (when UTC offset has been decoded by the receiver)
6	Status: A = Valid, V= Invalid
7	Mode Indicator A=Autonomous Mode D=Differential Mode E=Estimated (dead reckoning) Mode M=Manual Input Mode S=Simulated Mode N-Data Not Valid
hh	Checksum

GSA - GPS DOP and Active Satellites

The GSA messages indicates the GPS receiver's operating mode and lists the satellites used for navigation and the DOP values of the position solution.

```
$GPGSA,a,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,
xx,x.x,x.x,x.x*hh<CR><LF>
```

Field number	Description
1	Mode: M = Manual, A = Automatic. In manual mode, the receiver is forced to operate in either 2D or 3D mode. In automatic mode, the receiver is allowed to switch between 2D and 3D modes subject to the PDOP and satellite masks.
2	Current Mode: 1 = fix not available, 2 = 2D, 3 = 3D
3 - 14	PRN numbers of the satellites used in the position solution. When less than 12 satellites are used, the unused fields are null
15	Position dilution of precision (PDOP)
16	Horizontal dilution of precision (HDOP)
17	Vertical dilution of precision (VDOP)
hh	Checksum

GSV - GPS Satellites in View

The GSV message identifies the GPS satellites in view, including their PRN number, elevation, azimuth and SNR value. Each message contains data for four satellites. Second and third messages are sent when more than 4 satellites are in view. Fields #1 and #2 indicate the total number of messages being sent and the number of each message respectively.

```
$GPGSV,x,x,xx,xx,xx,xxx,xx,xx,xx,xxx,xx,xx,xx,
xxx,xx,xx,xx,xxx,xx*hh<CR><LF>
```

Field number	Description
1	Total number of GSV messages
2	Message number: 1 to 3
3	Total number of satellites in view
4	Satellite PRN number
5	Satellite elevation in degrees (90° Maximum)
6	Satellite azimuth in degrees true (000 to 359)
7	Satellite SNR (C/No), null when not tracking
8, 9, 10, 11	PRN, elevation, azimuth and SNR for second satellite
12, 13, 14, 15	PRN, elevation, azimuth and SNR for third satellite
16, 17, 18, 19	PRN, elevation, azimuth and SNR for fourth satellite
hh	Checksum

RMC - Recommended Minimum Specific GPS/Transit Data

The RMC message contains the time, date, position, course, and speed data provided by the GPS navigation receiver. A checksum is mandatory for this message and the transmission interval may not exceed 2 seconds. All data fields must be provided unless the data is temporarily unavailable. Null fields may be used when data is temporarily unavailable.

```
$GPRMC,hhmmss.ss,A,llll.ll,a,yyyyy.yy,a,x.x,x.
x,xxxxxx,x.x,a,i*hh<CR><LF>
```

Field number	Description
1	UTC of Position Fix (when UTC offset has been decoded by the receiver).
2	Status: A - Valid V - Navigation receiver warning
3, 4	Latitude, N (North) or S (South).
5, 6	Longitude, E (East) or W (West).
7	Speed over the ground (SOG) in knots
8	Track made good in degrees true.
9	Date: dd/mm/yy
10, 11	Magnetic variation in degrees, E = East / W= West

Field number	Description
12	Position System Mode Indicator: A = Autonomous D = Differential E = Estimated M = Manual input S = Simulation mode N = Data not valid
hh	Checksum (mandatory for RMC)

VTG Track Made Good and Ground Speed

The VTG message conveys the actual track made good (COG) and the speed relative to the ground (SOG).

`$GPVTG,x.x,T,x.x,M,x.x,N,x.x,K,i*hh<CR><LF>`

Field	Description
1,2	Track Made Good in degrees true.
3,4	Track Made Good in degrees magnetic.
5,6	Speed Over Ground (SOG) in knots.
7,8	SOG in kilometer per hour.
9	Mode indicator: A=Autonomous mode D=Differential mode E=Estimated (dead reckoning) mode M=Manual input mode S=Simulated mode N=Data not valid
hh	Checksum

ZDA Time and Date

The ZDA message contains Time of Day in UTC: the day, the month, the year and the local time zone.

`$GPZDA,hhmmss.ss,xx,xx,xxxx,,*hh<CR><LF>`

Field	Description
1	UTC (when UTC offset has been decoded by the receiver)
2	Day (01 to 31)
3	Month (01 to 12)
4	Year
5	Null (empty)
6	Null (empty)
hh	Checksum

Notes –

- *Field 5 and 6 are null fields in the Condor receiver output. A GPS receiver cannot independently identify the local time zone offsets.*
- *The time between the leading edge of the PPS pulse and message output depends on the calculation time of about 300 ms (using a fixed interval = 1000 ms).*
- *The GPS module will finish all calculations before outputting NMEA messages. The delay time depends on the fix interval setting as shown in the following table:*

Fix interval	max (ms)	min (ms)
1500	300	280
1000	300	280
500	84	76
333	84	76
250	84	76
200	84	76

See also the command for setting the fix interval, Packet Type: 300 PMTK_API_SET_FIX_CTL, page 128.

CAUTION – The UTC time is only correct when there is a position fix.

Exception behavior

When no position fix is available, some of the data fields in the NMEA messages will be blank. A blank field has no characters between the commas.

Interruption of GPS signal

If the GPS signal is interrupted temporarily, the NMEA will continue to be output according to the user-specified message list and output rate. Position and velocity fields will be blank until the next fix, but most other fields will be filled.

Condor GPS module proprietary NMEA messages

Packet type	Description
000	Test packet
001	Acknowledgement of PMTK command
010	Output system message
101	Hot start
102	Warm start
103	Cold start
104	Full cold start

Packet type	Description
107	Factory reset
120	Erase aiding data
161	Sleep / Wake command
251	Set NMEA baud rate
300	Set fix interval
301	Set DGPS mode
313	Set SBAS enable
314	Set NMEA sentence and frequency
324	Set TSIP / antenna / PPS configuration
330	Set Datum
331	Set Datum advance
390	Set user option
400	Query fix interval
401	Query DGPS mode
413	Query SBAS enable
414	Query current NMEA output
424	Query TSIP / antenna / PPS configuration
430	Query Datum
431	Query Datum advance
457	UTC Correction
473	Get Ephemeris
474	Get Almanac
477	Get Almanac status
490	Query user option
500	Current fix interval
501	Current DGPS mode
513	Current SBAS enable
514	Current NMEA output
530	Current Datum
557	Current UTC correction
577	Current Almanac status
590	Current user option
605	Query firmware release version
705	Firmware release information
ANT	Returns antenna status
710	GPS Ephemeris for a single satellite, see Condor aGPS module, page 137.
711	Almanac data for a single satellite, see Condor aGPS module, page 137.
712	Contains current GPS reference time, see Condor aGPS module, page 137.
713	Contains the reference location for GPS receiver, see Condor aGPS module, page 137.

The message structure is:

`Preamble, TalkerID, PktType, DataField, *, CHK1, CHK2, CR, LF`

Packet length

The maximum length of each packet is restricted to 255 bytes.

Packet contents

Field	Description
Preamble	One byte character. '$'
TalkerID	Four bytes character string. "PMTK"
PktType	An identifier used to tell the decoder how to decode the packet. Three byte character string, from "000" to "999"
DataField	The DataField has variable length depending on the packet type. A comma symbol ',' must be inserted ahead each data filed to help the decoder process the DataField.
*	1 byte character. The star symbol is used to mark the end of the DataField.
CHK1, CHK2	Two byte character string. CHK1 and CHK2 are the checksum of the data between Preamble and '*'.
CR, LF	Two bytes binary data. The two bytes are used to identify the end of a packet.

Sample packet: `$PMTK000*32<CR><LF>`

NMEA packet protocol

In order to inform the sender whether the receiver has received the packet, an acknowledge packet PMTK_ACK should return after the receiver receives a packet.

Packet Type: 000 PMTK_TEST

Packet meaning	Test Packet
DataField	None

Example: `$PMTK000*32<CR><LF>`

Packet Type: 001 PMTK_ACK

Packet meaning	Acknowledge of PMTK command
DataField	PMTK001,Cmd,Flag
Cmd	The command / packet type that the acknowledgement responds to.
Flag	0 - Invalid command / packet. 1 - Unsupported command / packet type. 2 - Valid command / packet, but action failed. 3 - Valid command / packet, and action succeeded

Example: `$PMTK001,604,3*32<CR><LF>`

Packet Type: 010 PMTK_SYS_MSG

Packet meaning	Output system message
DataField	Msg: The system message. 0 - UNKNOWN 1 - STARTUP

Example: `$PMTK010,001*2E<CR><LF>`

Packet Type: 101 PMTK_CMD_HOT_START

Packet meaning	Hot Restart: Use all available data in the NV store.
DataField	None

Example: `$PMTK101*32<CR><LF>`

Packet Type: 102 PMTK_CMD_WARM_START

Packet meaning	Warm Restart: Do not use Ephemeris at re-start.
DataField	None

Example: `$PMTK102*31<CR><LF>`

Packet Type: 103 PMTK_CMD_COLD_START

Packet meaning	Cold Restart: Do not use Time, Position, Almanacs, and Ephemeris data at re-start.
DataField	None

Example: `$PMTK103*30<CR><LF>`

Packet Type: 104 PMTK_CMD_FULL_COLD_START

Packet meaning	Full Cold Restart: Essentially a cold restart, but the system/user configurations are also cleared on restart, that is, the receiver is reset to the factory default.
DataField	None

Example: `$PMTK104*37<CR><LF>`

Packet Type: 107 PMTK_CMD_TRIMBLE_START

Packet meaning	Essentially a full cold start, but with additional reset factory defaults.
DataField	None

Example: `$PMTK107*3A<CR><LF>`

Packet Type: 120 PMTK_CMD_CLEAR_FLASH_AID

Packet meaning	Erase aiding data stored in the Flash memory.
DataField	None

Example: `$PMTK120*31<CR><LF>`

Packet Type: 161 PMTK_SLEEP_CTL

Packet meaning	Controls the Sleep mode of the receiver.
DataField	PMTK161,Mode 0 - Sleep 1 - Wake

Example: `$PMTK161,0*28<CR><LF>`

Packet Type: 251 PMTK_SET_NMEA_BAUDRATE

Packet meaning	Set NMEA port baud rate.
DataField	PMTK251,Baudrate ***Baudrate setting:*** 4800 9600 (default) 19200 38400 57600 115200

Example: `$PMTK251,38400*27<CR><LF>`

Packet Type: 300 PMTK_API_SET_FIX_CTL

Packet meaning	API_Set_Fix_Ctl This parameter controls the rate of position fixing activity.
DataField	PMTK300,FixInterval,0,0,0,0 FixInterval: Position fix interval [msec]. Must be larger than 200.

Example: `$PMTK300,1000,0,0,0,0*1C<CR><LF>`

Notes –
– If the Fix Interval is set to 1000 ms or less, then the PPS is produced at 1 Hz.
– If the Fix Interval is set to > 1000 ms, then the PPS is no longer produced at every second.
– With settings of 2000, 3000, 4000 ms, and so on, the PPS will be produced at every 2nd, 3rd or 4th second respectively.
– If the Fix Interval is not a multiple of 1000 ms, then the PPS will be produced infrequently. It still arrives at the full second, but not at regular intervals.

Packet Type: 301 PMTK_API_SET_DGPS_MODE

Packet meaning	API_Set_Dgps_Mode DGPS correction data source mode.
DataField	PMTK301,Mode Mode: DGPS data source mode. 0 - Reserved 1 - Reserved 2 - WAAS (Default)

Example: `$PMTK301,1*2D<CR><LF>`

Packet Type: 313 PMTK_API_SET_SBAS_ENABLED

Packet meaning	API_Set_Sbas_Enabled Enable to search a SBAS satellite or not.
DataField	Enabled: Enable or disable 0 = Disable 1 = Enable (Default)

Example: `$PMTK313,1*2E<CR><LF>`

Packet Type: 314 PMTK_API_SET_NMEA_OUTPUT

Packet meaning	API_Set_NMEA_Out Set NMEA sentence output frequencies. ***Note –*** *Only RMC, GGA, GSV, and GSA are default. If you change the output contents, the receiver will only keep them while Vcc or Vrtc is present, unless you use packet type 390 to save the settings to Flash memory so that they are maintained during a power cycle.*
DataField	There are 19 data fields that individually present output frequencies for the 8 supported NMEA sentences. **Supported NMEA sentences**:

Sentence	**Description**
0 NMEA_SEN_GLL,	// GPGLL interval - Geographic position, latitude and longitude
1 NMEA_SEN_RMC,	// GPRMC interval - Recommended minimum specific GNSS sentence
2 NMEA_SEN_VTG,	// GPVTG interval - Course over ground and ground speed
3 NMEA_SEN_GGA,	// GPGGA interval - GPS fix data
4 NMEA_SEN_GSA,	// GPGSA interval - GNSS DOPS and active satellites
5 NMEA_SEN_GSV,	// GPGSV interval - GNSS satellites in view
17 NMEA_SEN_ZDA,	// GPZDA interval – Time & date
18 NMEA_SEN_MCHN,	// PMTKCHN interval – GPS channel status

Supported frequency settings:

Setting	**Description**
0	Disabled or not supported sentence
1	Output once every one position fix
2	Output once every two position fixes
3	Output once every three position fixes
4	Output once every four position fixes
5	Output once every five position fixes

Example: `$PMTK314,1,1,0,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0,0*29<CR><LF>`

This command sets GLL output frequency to once every 1 position fix, and RMC to output once every 1 position fix, and so on.

To restore the system default setting: `$PMTK314,-1*04<CR><LF>`

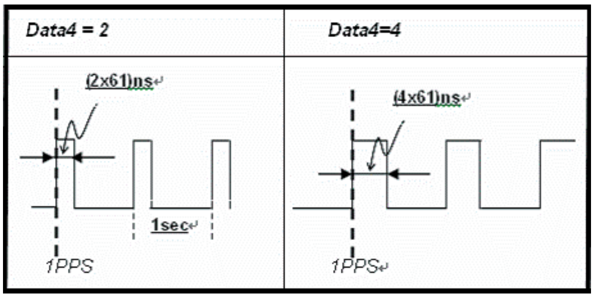
Packet Type: 324 PMTK_API_SET_OUTPUT_CTL

Packet meaning	Write the TSIP / antenna / PPS configuration data to the Flash memory.
DataField	**[Data0]:TSIP Packet[on/off]** 0 - Disable TSIP output (Default). 1 - Enable TSIP output. **[Data1]:Antenna Detect[on/off]** 0 - Disable antenna detect function (Default). 1 - Enable antenna detect function. **[Data2]:PPS on/off** 0 - Disable PPS function. 1 - Enable PPS function (Default). **[Data3]:PPS output timing** 0 - Always output PPS (Default). 1 - Only output PPS when GPS position is fixed. **[Data4]:PPS pulse width** 1~16367999: 61 ns~(61x 16367999) ns (Default = 69)

Return:

`$PMTK001,324,,3` is returned if the configuration setting is successful.

`$PMTK001,324,,2` is returned if the configuration setting fails.



Example: `$PMTK324,1,1,1,1,1*<checksum><CR><LF>`

Packet Type: 330 PMTK_API_SET_DATUM

Packet meaning	API_Set_Datum Set datum.
DataField	Datum: 0: WGS84 1: TOKYO-M 2: TOKYO-A Supports 219 different datums. The total datums are listed in Appendix B. If you change the default WGS84, the receiver only keeps the new value while Vcc or Vrtc is present. If Vcc and Vrtc are removed the output will go back to the default settings.

Example: `$PMTK330,0*2E<CR><LF>`

Packet Type: 331 PMTK_API_SET_DATUM_ADVANCE

Packet meaning	API_Set_Datum_Advance Set user defined datum.
DataField	***PMTK331,majA,ecc,dX,dY,dZ*** majA: User defined datum semi-major axis [m] ecc: User defined datumeccentric [m] dX: User defined datum to WGS84 X axis offset [m] dY: User defined datum to WGS84 X axis offset [m] dZ: User defined datum to WGS84 X axis offset [m]

Example:
`$PPMTK331, 6377397.155, 299.1528128, -148.0, 507.0,685.0*16<CR><LF>`

Packet Type: 390 PMTK_API_SET_USER_OPTION

Packet meaning	API_Set_Flash_User_Option Writes the user setting to the Flash memory to override the default setting. ⚠ **CAUTION –** You may use this command a maximum of eight (8) times. After this, the Flash memory must be erased by reloading the firmware.
DataField	***PMTK390, Lock, Update_Rate, Baud_Rate, GLL_Period, RMC_Period, VTG_Period, GSA_Period, GSV_Period, GGA_Period, ZDA_Period, MCHN_Period, Datum, DGPS_Mode, RTCM_Baud_Rate*** Lock: Not zero—freeze the setting; 0—allow further settings Update_Rate: 1~5 Hz Baud_Rate: 115200, 57600, 38400, 19200, 9600, 4800 RTCM_Baud_Rate: 115200, 57600, 38400, 19200, 9600, 4800 XXX_Period: NMEA sentence output period DGPS_Mode: 0—disable; 1—RTCM; 2—SBAS Datum: More than 200 datums are supported. See Appendix A, Datum List. The typical value is 0 (WGS84), 1 (Tokyo-M), 2 (Tokyo-A).

Example: `$PMTK390,1,1,38400,1,1,1,1,1,1,1,0,0,2,9600*2B<CR><LF>`

***Note –** If you are using an update rate greater than 1 Hz, you must use a baud rate of 115200.*

Packet Type: 400 PMTK_API_Q_FIX_CTL

Packet meaning	API_Query_Fix_Ctl
DataField	None
Return	PMTK_DT_FIX_CTL

Example: `$PMTK400*36<CR><LF>`

Packet Type: 401 PMTK_API_Q_DGPS_MODE

Packet meaning	API_Query_Dgps_Mode
DataField	None
Return	PMTK_DT_DGPS_MODE

Example: `$PMTK401*37<CR><LF>`

Packet Type: 413 PMTK_API_Q_SBAS_ENABLED

Packet meaning	API_Query_Sbas_Enabled
DataField	None
Return	PMTK_DT_SBAS_ENABLED

Example: `$PMTK413*34<CR><LF>`

Packet Type: 414 PMTK_API_Q_NMEA_OUTPUT

Packet meaning	API_Query_NMEA_Out Query current NMEA sentence output frequencies.
DataField	None
Return	PMTK_DT_NMEA_OUTPUT

Example: `$PMTK414*33<CR><LF>`

Packet Type: 424 PMTK_API_Q_OUTPUT_CTL

Packet meaning	Write the TSIP / antenna / PPS configuration data to the Flash memory.
DataField	**[Data0]:TSIP Packet[on/off]** 0 - Disable TSIP output. 1 - Enable TSIP output. **[Data1]:Antenna Detect[on/off]** 0 - Disable antenna detect function. 1 - Enable antenna detect function. **[Data2]:PPS on/off** 0 - Disable PPS function. 1 - Enable PPS function. **[Data3]:PPS output timing** 0 - Always output PPS. 1 - Only output PPS when GPS position is fix. **[Data4]:PPS offset** 1~16367999: 61 ns~(61x 16367999) ns

Example: `$PMTK424*<checksum><CR><LF>`

Packet Type: 430 PMTK_API_Q_DATUM

Packet meaning	API_Query_Datum Query default datum
DataField	None
Return	PMTK_DT_DATUM

Example: `$PMTK430*35<CR><LF>`

Packet Type: 431 PMTK_API_Q_DATUM_ADVANCE

Packet meaning	API_Query_Datum_Advance Query user defined datum
DataField	None
Return	PMTK_DT_DATUM

Example: `$PMTK431*34<CR><LF>`

Packet Type: 457 PMTK_API_GET_UTC_COR

Packet meaning	API_Get_UTC_Cor
DataField	None
Return	PMTK_DT_UTC_COR

Example: `$PMTK457*34<CR><LF>`

Packet Type: 473 PMTK_API_GET_GPS_EPH

Packet meaning	API_Get_GPS_Eph Get a single GPS Ephemeris. Returns the most recently processed GPS Ephemeris sub-frame data block.
DataField	PMTK473,PRN PRN (in HEX format): Which GPS satellite ephemeris to return.
Return	PMTK_DT_EPH

Example: `$PMTK473,1*2F<CR><LF>`

Packet Type: 474 PMTK_API_GET_GPS_ALM

Packet meaning	Get a single GPS Almanac. Return the most recently processed GPS Almanac sub-frame data block.
DataField	PMTK474,PRN PRN(In HEX format): Which GPS satellite almanac to return (1–32).
Return	PMTK_DT_ALM

Example, query almanac data for satellite PRN 1: `$PMTK474,1*28<CR><LF>`

Packet Type: 477 PMTK_API_GET_GPS_ALMSTATUS

Packet meaning	Get a status of almanac complete or not complete..
DataField	None
Return	PMTK_DT_ALMSTATUS

Example: `$PMTK477*36<CR><LF>`

Packet Type: 490 PMTK_API_GET_USER_OPTION

Packet meaning	API_Get_Flash_User_Option Returns the current user setting from the Flash memory. For detailed information, see Packet Type: 590 PMTK_DT_FLASH_USER_OPTION, page 136.
DataField	None
Return	PMTK_DT_FLASH_USER_OPTION

Example: `$PMTK490*33<CR><LF>`

Packet Type: 500 PMTK_DT_FIX_CTL

Packet meaning	These parameters control the rate of position fixing activity.
DataField	FixInterval: Position fix interval. (msec). [>= 200]

Example: `$PMTK500,1000,0,0,0,0*1A<CR><LF>`

Packet Type: 501 PMTK_DT_DGPS_MODE

Packet meaning	DGPS data source mode
DataField	Mode: DGPS data source mode 0 = Reserved 1 = Reserved 2=WAAS

Example: `$PMTK501,1*2B<CR><LF>`

Packet Type: 513 PMTK_DT_SBAS_ENABLED

Packet meaning	Enable to search a SBAS satellite or not.
DataField	Enabled: Enable or disable 0 = Disable 1 = Enable

Example: `$PMTK513,1*28<CR><LF>`

Packet Type: 514 PMTK_DT_NMEA_OUTPUT

Packet meaning	NMEA sentence output frequency setting
DataField	There are 19 data fields that present output frequencies for the 19 supported NMEA sentences individually. For more information, see Packet Type: 314 PMTK_API_SET_NMEA_OUTPUT, page 129.

Example: `$PMTK514,0,1,0,1,1,1,0,0,0,0,0,0,0,0,0,0,0,0,1*2F<CR><LF>`

Packet Type: 530 PMTK_DT_DATUM

Packet meaning	Current datum used.
DataField	PMTK530,Datum Datum: 0=WGS84 1=TOKYO-M 2=TOKYO-A

Example: `$PMTK530,0*28<CR><LF>`

Packet Type: 557 PMTK_DT_UTC_COR

Packet meaning	The current (GPS - UTC) time difference [seconds].
DataField	UTC_Cor: Current (GPS - UTC) time difference. (Seconds)

Example: `$PMTK557,13.0*05<CR><LF>`

Packet Type: 577 PMTK_DT_ALMSTAUTS

Packet meaning	Report the status of almanac complete or not complete.
DataField	1: Almanac is complete. 0: Almanac is not complete.

Example: `$PMTK577,.0*2B<CR><LF>`

Packet Type: 590 PMTK_DT_FLASH_USER_OPTION

Packet meaning	User setting in the Flash memory.
DataField	There are a total of 11 data fields that represent the following: 1. Number of times available for recording the user setting. 2. Update_Rate: 1~5 3. NMEA baud rate in bps 4–11 NMEA sentence output period (GLL, RMC, VTG, GSA, GSV, GGA, ZDA, MCHN) 12 Datum 13 DGPS mode: 0 (disable), 1 (RTCM), 2 (SBAS) 14 RTCM baud rate in bps

Example: `$PMTK590,0,1,9600,1,1,0,1,5,1,0,0,0,2,9600*2A<CR><LF>`

Packet Type: 605 PMTK_Q_RELEASE

Packet meaning	Query the firmware release information.
DataField	None.
Return	PMTK_DT_RELEASE

Example: `$PMTK605*31<CR><LF>`

Packet Type: 705 PMTK_DT_RELEASE

Packet meaning	Firmware release information.
DataField	PMTK705, ReleaseStr, Build_ID, Date Code, Checksum ReleaseStr -Firmware release name and version Build_ID - Build ID set in CoreBuilder for firmware version control. Date code - YYYYMMDD Checksum

Example: `$PMTK705,AXN_1.30,0000,20090609,*20<CR><LF>`

Packet Type: PMTKANT

Packet meaning	Antenna status (must be enabled by the PMTK324 command).
DataField	PMTKANT,N N (antenna status) 0 = Open. 1 = Normal 2 = Short
Return	None

Example: `$PMTKANT,0`

Condor aGPS module

Aiding data is available from ftp://ftp.trimble.com/pub/sct/aiding/.

The directory contains the current emphemeris and almanac files. Its use is governed by the following terms and conditions for **Products and Services**:

Trimble's obligations with respect to its products and services are governed solely by the terms and conditions of sale and agreements under which they are provided. For example, if you download software from this Site, use of the software shall be governed by the provisions of the End User License Agreement or other software license agreement that accompanies or is provided with the software. If you obtain a product or service from Trimble through this Site that is provided without an agreement, that product or service is provided "AS-IS" with no warranties whatsoever, express or implied, and your use of that product or service is at your own risk.

Packet Type: 710 PMTK_DT_EPH

Packet meaning	The packet contains GPS Ephemeris data for a single satellite.
DataField	$PMTK710,SV,W[1],…W[24]*CS<CR><LF>, where:

Name	Description
$PMTK710	GPS ephemeris data (navigation model) for a single satellite.
SV	Satellite PRN number (represented in HEX characters) for the ephemeris data to follow.
W[1] ~ W[24]	24 words of the ephemeris subframe data from words 3 to 10 of subframes 1, 2, and 3. Each word has 24-bit data represented in 6 HEX characters. See ICD-GPS-200C for the navigation data format.
CS	8-bit accumulative checksum of all bytes in between the $ and * characters in hexadecimal.

Example: The packet contains ephemeris data of satellite PRN 5.

```
$PMTK710,05,629000,574EE4,3AAA7A,554163,A948F7,761A5E,000004,059B35,7
6FBA7,37B25E,48A37C,FBD803,EE48ED,1036A1,0E9E5E,1A5E51,FFF5E2,5410DE,
FFC226,477F89,1AF42E,DDE7C0,FFA7D6,7607AB*1A <CR><LF>
```

Packet Type: 711 PMTK_DT_ALM

Packet meaning	The packet contains GPS Almanac data for a single satellite.
DataField	$PMTK711,SV,Week,W[1],…W[8]*CS<CR><LF>, where:

Name	Description
$PMTK711	GPS Almanac data for a single satellite.
SV	Satellite PRN number (represented in HEX characters) for the almanac data to follow.
Week	Almanac reference GPS week number represented in HEX characters).
W[1] ~ W[8]	8 words of the almanac data from words 3 to 10 of subframes 1,2,3. Each word has 24-bit data represented in 6 HEX characters. See ICD-GPS-200C for the almanac data format.
CS	8-bit accumulative checksum of all bytes inbetween the $ and * characters in hexadecimal.

Example: The packet contains almanac data of satellite PRN 1.

```
$PMTK711,1,1368,41330D,631D59,FD7600,A10D2F,913D43,BA5512,C118C1,0500
39*08<CR><LF>
```

Packet Type: 712 PMTK_DT_TIME

Packet meaning	The packet contains current GPS reference time. For quick TTFF, the accuracy of reference time must be less than 2 seconds.
DataField	$PMTK712,week,TOW,TOW_rms,FS_TOW,FS_rms*CS<CR><LF>, where:

Name	Description
$PMTK712	Reference GPS time.
week	GPS week number.
TOW	GPS time of week of the transmission of the $ character at the start of the message
TOW_rms	RMS accuracy of the above TOW relative to when the $ character was transmitted [ms]
FS_TOW	GPS time of week of the last Frame Synch pulse inserted (outdated, no longer used).
FS_rms	RMS accuracy [ns] (outdated, no longer used).
CS	8-bit accumulative checksum of all bytes inbetween the $ and * characters in hexadecimal.

Example: The packet indicates that the current GPS week number 1368, GPS TOW 192657.291, and the accuracy of the time information is 30 ms.

```
$PMTK712,1368,192657.291,30,0,0*0F<CR><LF>
```

Packet Type: 713 PMTK_DT_LOC

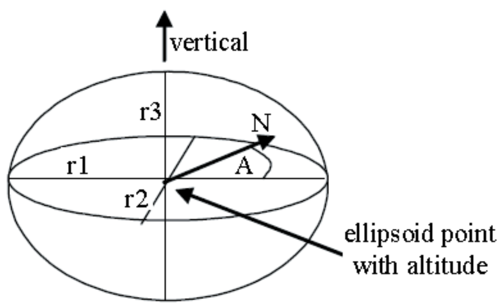
Packet meaning	The packet contains reference location for the GPS receiver. For quick TTFF, the accuracy of the location shall be less than 30 km.
DataField	$PMTK713,Lat,Long,Alt,Unc_SMaj,Unc_SMin,Bear,Unc_Vert,Conf *CS<CR><LF>, where:

Name	Description
$PMTK713	Reference Location
Lat	WGS84 geodetic latitude [degrees]
Long	WGS84 geodetic longitude [degrees]
Alt	WGS84 ellipsoidal altitude in [m]
Unc_SMaj	Horizontal uncertainty semi-major axis [m]
Unc_Smin	Horizontal uncertainty semi-minor axis [m]
Bear	Error ellipse semi-major axis bearing [degrees]
Unc_Vert	Vertical uncertainty [m]
Conf	The confidence by which the position of a target entity is known to be within the shape description, expressed as a percentage between 0—100.
CS	8-bit accumulative checksum of all bytes inbetween the $ and * characters in hexadecimal.

Example: The packet indicates that the GPS receiver is at latitude 24.772816, longitude 121.022636 with uncertainty of 333 m in semi-major axis, 333 m in semi-minor axis, and 50 m in vertical..

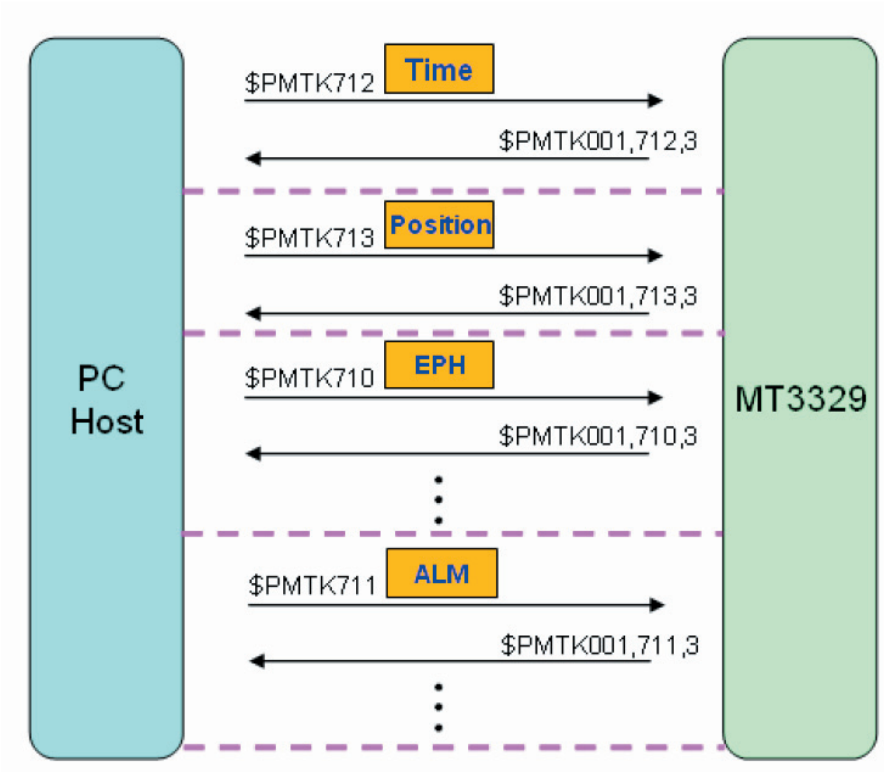
```
$PMTK713,24.772816,121.022636, 160,333,333,6,50*25<CR><LF>
```

***Note** – The ellipsoid point is used with altitude and uncertainty ellipsoid to describe location error shape. See also 3GPP TS 23.032:*



Assistance data transfer protocol

The transfer protocols of assistance data are as follows:



APPENDIX

C

Silvana and Anapala Antenna Companion Modules

In this appendix:

This appendix provides a brief overview of the Silvana and Anapala antenna companion modules:

Antenna companion module	Part Number
Silvana with C1919A and SMA connector	68677-00
Silvana with C1919A and U.FL connector	68677-05
Anapala with C1919A	68677-55
Silvana Starter Kit with Condor C1919A and U.FL connector	75976-10

Introduction

The Silvana and Anapala antenna companion modules both include a Condor C1919A GPS module and a patch antenna built on a PCB with associated circuitry to provide a complete GPS solution in a compact package:

Silvana antenna companion module

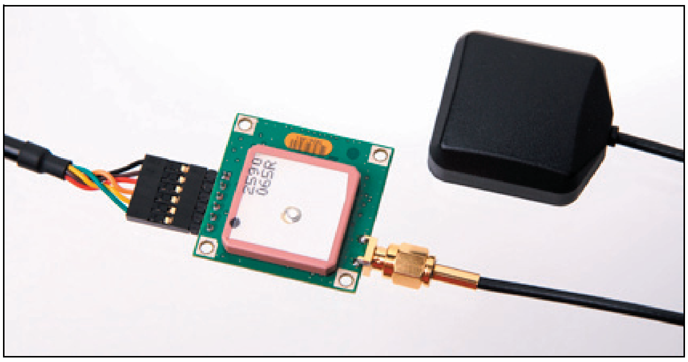
Anapala antenna companion module

For a full description of the characteristics of the Condor C1919A GPS module, see Chapter 2, Features and Specifications.

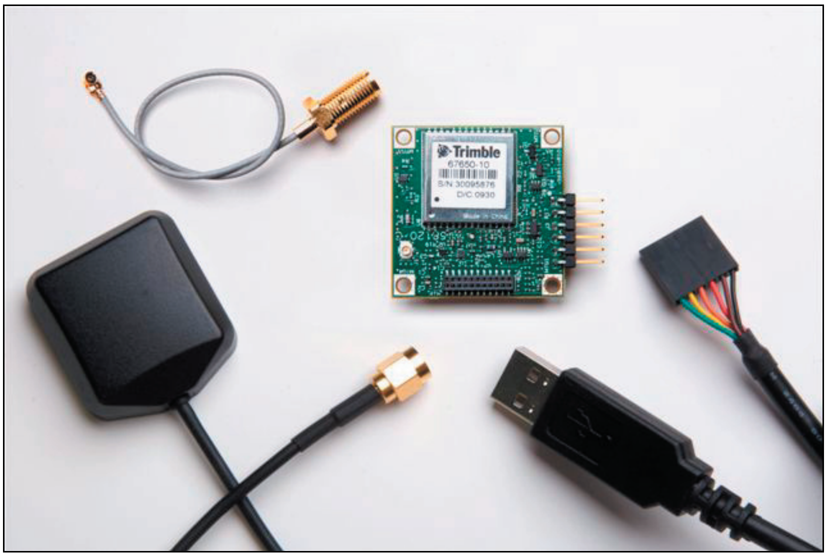
The antenna companion modules are also available with Copernicus® IIA GPS receivers.

Power and serial NMEA data are provided through a single surface-mount connector.

In addition, the Silvana antenna companion module has an SMA or U.FL connector for an external active antenna. If an external antenna is attached, the smart antenna automatically switches to use the GPS signal from the external source:



The Silvana antenna companion module with a U.FL connector is also available in a starter kit version (shown below) with an additional 6-pin connector for a USB cable connection. The starter kit also comes with a USB cable and a magnetic-mount GPS antenna.



The pin-out of the 6-pin USB connection are as follows:

Pin number	Function	Description
1	GND	Device ground supply pin.
2	NC	No connection
3	VUSB	+5 V input
4	RXD	Receive asynchronous data input
5	TXD	Transmit asynchronous data output
6	NC	No connection

Environmental specifications

Temperature	Operating	Between –40 °C to +85 °C
	Storage	–55 °C to +105 °C
Humidity	Operating	Between 5% to 95% R.H. non-condensing at 60 °C
Vibration	0.008 g^2/Hz	5 Hz to 20 Hz
	0.05 g^2/Hz	20 Hz to 100 Hz
	–3 dB/octave	100 Hz to 900 Hz

Product specifications (Silvana and Anapala)

Dimensions (W x L x H)	35.56 mm × 35.56 mm × 8 mm (not including antenna connector)
Weight	17 g (Silvana with SMA) 15 g (Silvana with U.F.L and Anapala)

Tracking

Typical operating current draw, Silvana

	Unit	3.0 V	3.3 V	3.6 V
Tracking[1]	mA	41.4	41.8	42.4
Acquiring	mA	48.6	49	49.8
Enable off	uA	31.5	33.5	36.5

[1]Using an on-board patch antenna.

Typical operating current draw, Anapala

	Unit	3.0 V	3.3 V	3.6 V
Tracking[1]	mA	49.4	49.6	49.8
Acquiring	mA	46.2	46.4	46.6
Enable off	uA	31.5	34	36.5

[1]Using an on-board patch antenna.

Low-profile SMT connector

The antenna companion modules use a single 22-pin (2x11) socket strip for both power and data I/O. The power and I/O connector is surface mount and uses 1.27mm spacing. The manufacturer of this connector is Samtec, part number CLP-111-02-G-D-TR.

The mating connector can be chosen from the Samtec FTSH series.

A white dot is printed on the PCB beside pin 1.

The pin-out of the connector is as follows:

Pin	Description	Pin	Description
1	Reserved	2	Reserved
3	UART B TXD (NMEA Out)	4	Reserved
5	UART B RXD (NMEA In)	6	Reserved
7	Vin (from 3.0 V to 3.6 V)	8	Enable
9	Ground	10	Reserved
11	Reserved	12	Open/Short detect
13	Reserved	14	Reserved
15	Reserved	16	Reserved
17	Reserved	18	Reserved
19	Reserved	20	PPS
21	Reserved	22	XRESET (all models except 68677-00, which is Reserved).

TXD (pin 3)

This logic level output is the serial port transmit line (data output from the module). Do not hold the Tx port "low" or pull to ground while the GPS module is starting up.

RXD (pin 5)

This logic level input is the serial port receive line (data input to the module).

Vin (pin 7)

This is the primary voltage supply pin for the module, from 3.0 V to 3.6 V.

Enable (pin 8)

Active High enable for the module. Pull to Vin to enable and to GND to disable the module.

Open / Short (pin 12)

When an antenna open or short is detected, this pin will go LOW. Otherwise the pin will be HIGH. Applies only to the Silvana smart antenna with an external antenna attached.

PPS (pin 20)

Pulse-per-second. This logic level output provides a 1 Hz timing signal to external devices. The pulse width of this signal is 4 us.

XRESET (pin 22)

Connects to the host system reset controller or GPIO for host-controlled resetting of the GPS module. Active low for 100 ms. Do not connect if not used.

This pin is Reserved for P/N 68677-00.

Reserved pins

There are several reserved pins on the module. Do not connect these pins.

Communicating with the GPS receiver

1. Set the serial port communication settings as follows:

   Baud Rate - 9600

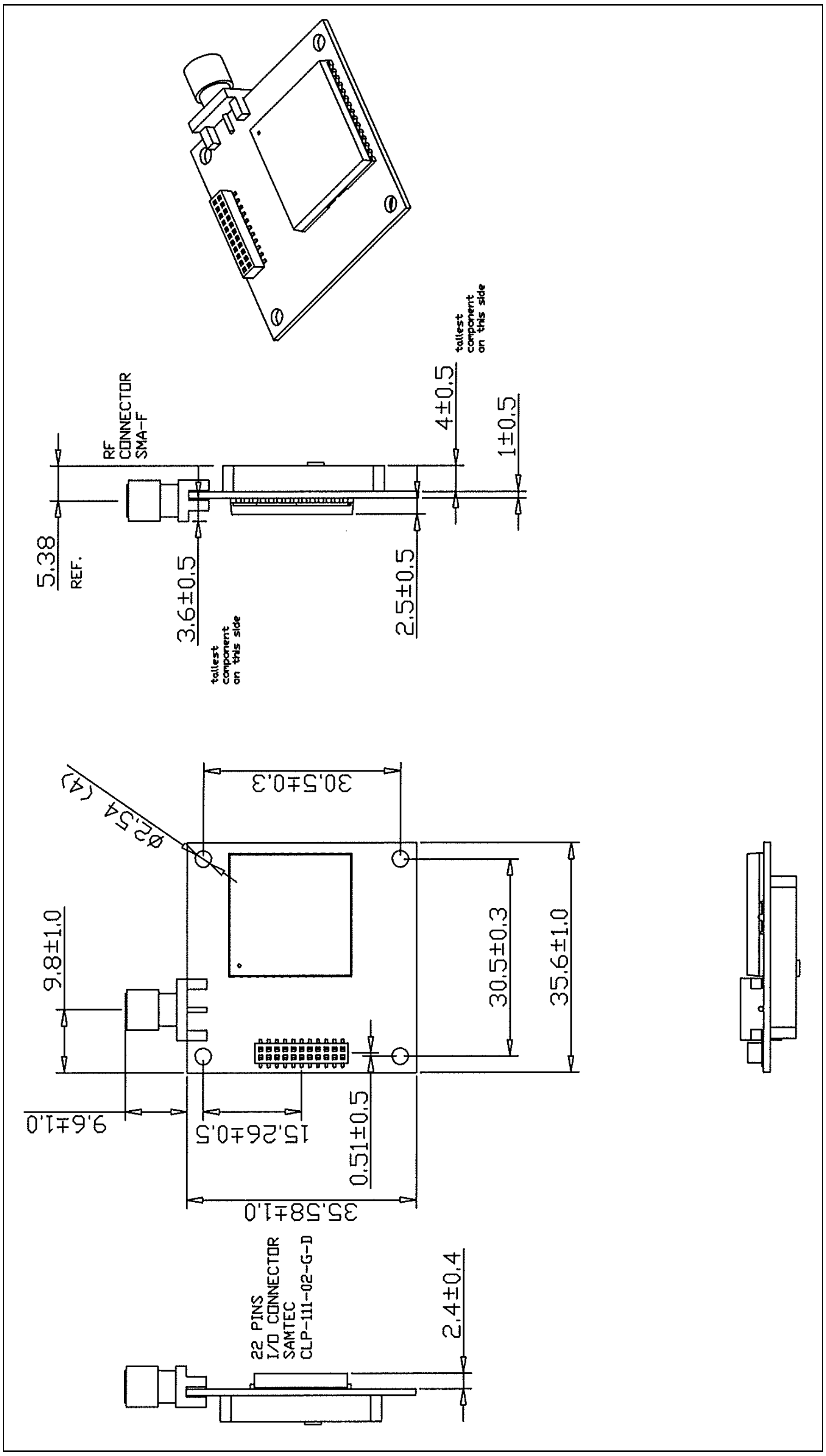
   Parity - None

   Data Bits - 8

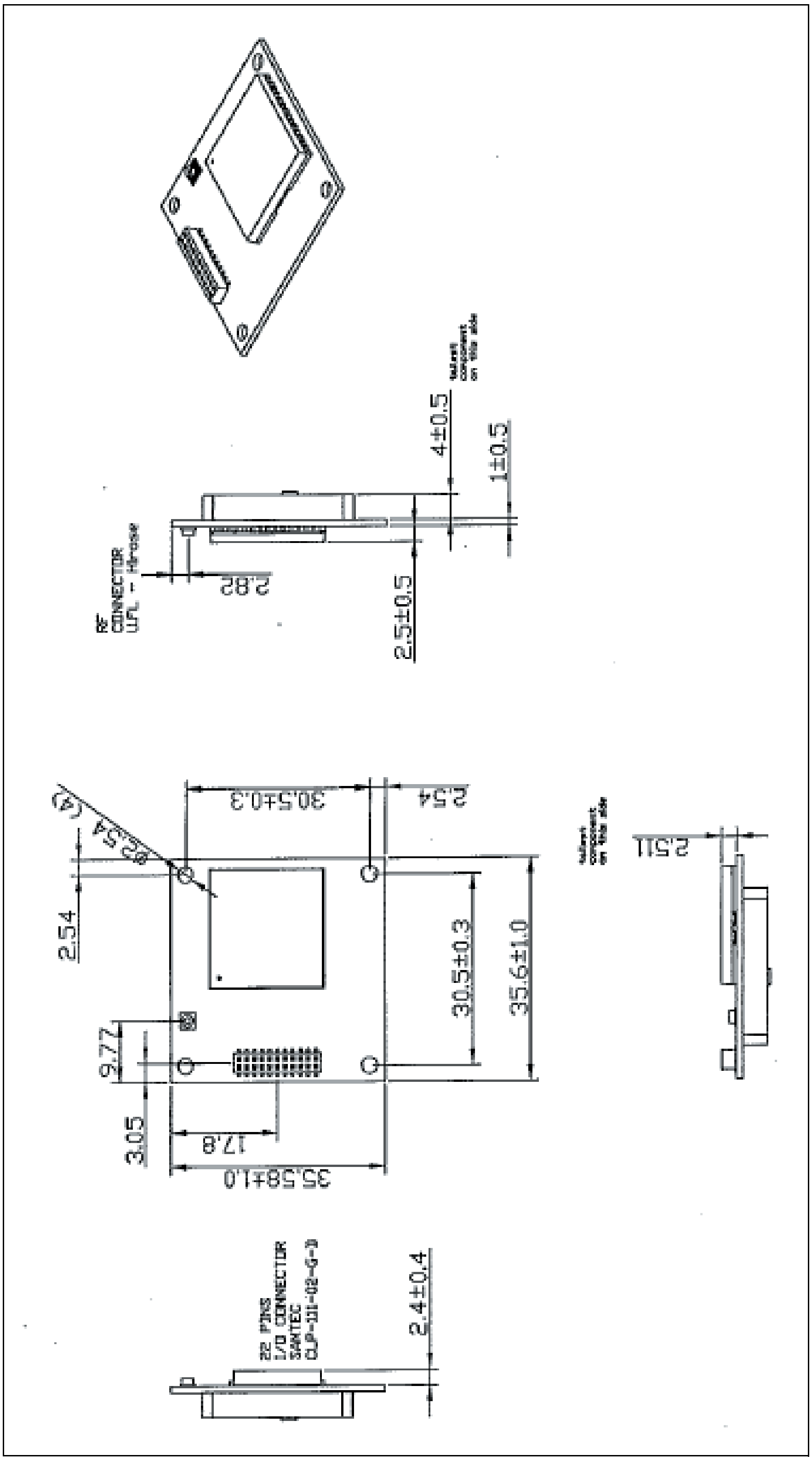
   Stop Bits - 1

2. NMEA Output - The default output is GGA, GSA, GSV, and RMC. For a full list of supported commands and messages, see Appendix B, NMEA 0183 Protocol.

Mechanical specification, Silvana with SMA connector



Mechanical specification Silvana with H.FL connector



APPENDIX

D

Condor C2626 GPS Module

In this appendix:

This appendix provides a brief overview of the Condor C2626 GPS module (P/N 70896-00) and the Condor C2626 GPS module starter kit (P/N 70897-05).

Introduction

The Condor C2626 GPS module is an updated, NMEA protocol only alternative to the Trimble Lassen® iQ module.

The Condor C2626 is supplied in the same mechanical package as the Lassen iQ module, but demonstrates greatly improved sensitivity and tracking abilities.

Other operational characteristics

For features, performance figures, recommended operating conditions and absolute maximum limits please see the tables for the Condor C1919A module in this manual.

RF connector

The RF connector mounted on the Condor C2626 GPS module is a Hirose connector, P/N H.FL-R-SMT (10) 50 Ω

Digital IO/Power connector

The Condor C2626 GPS module uses a single 8-pin (2x4) male header connector for both power and data I/O. The power and I/O connector is a surface mount micro terminal strip. This connector uses 0.09 inch (2.286mm) high pins on 0.05 inch (1.27mm) spacing. The manufacturer of this connector is Samtec, P/N ASP 69533-01.

The pin-out of the connector is as follows:

Pin number	Function	Description
1	Reserved	Can be used instead of pin 5.
2	GND	Ground, Power, and Signal
3	Reserved	Can be used instead of pin 6
4	PPS	Pulse-Per-Second, 3.0V CMOS
5	TXD	Serial port B transmit, 3.3V CMOS
6	RXD	Serial port B receive, 3.3V CMOS
7	Prime Power (Vcc)	+3.0 V to 3.6 V
8	Battery Backup Power	+2.0 V to Vcc

Reserved pin 1

For backward compatibility purposes pin 1 is tied to pin 5. This will enable any previous Lassen iQ designs using port A to use the Condor C2626 module for NMEA output. Use either pin 1 or pin 5, not both.

GND pin 2

Ground for power and signal.

Reserved pin 3

For backward compatibility purposes pin 3 is tied to pin 6. This will enable any previous Lassen iQ designs using port A to use the Condor C2626 module for NMEA input. Use either pin 3 or pin 6, not both.

PPS pin 4

Pulse-per-second. This logic level output provides a 1 Hz timing signal to external devices. The pulse width of this signal is 4 us.

TXD pin 5

This logic level input is the serial port transmit line (data input to the module). Do not hold the Tx port "low" or pull to ground while the GPS module is starting up.

RXD pin 6

This logic level output is the serial port receive line (data output from the module).

VCC pin 7

This is the primary voltage supply pin for the module from 3.0 V to 3.6 V. A 4.7 uF/X5R decoupling capacitor is recommended for this input.

Battery backup pin 8

Supply can range from 2.0 V to Vcc. Maintains non-volatile RAM and the RTC for hot and warm starts.

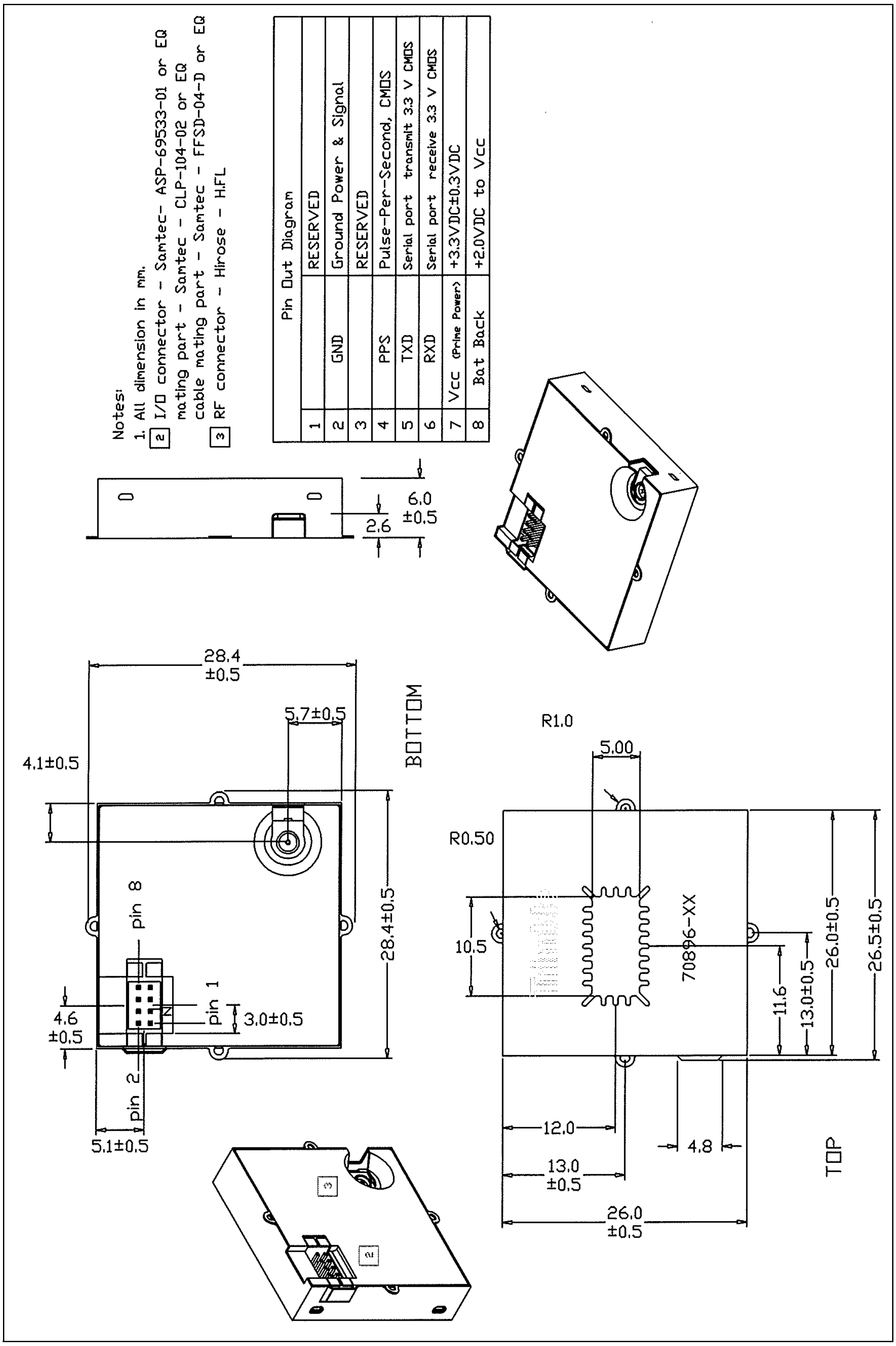
Communication with the GPS module

1. Set the serial port communication settings as follows:

   Baud rate - 9600
   Parity - None
   Data bits - 8
   Stop bits - 1

2. NMEA Output. The default output is GGA, GSA, GSV, and RMC. See Appendix B, NMEA 0183 Protocol for a full list of supported commands and messages.

Mechanical specification



APPENDIX

E

USB Guide for C1722 and C1216 GPS Modules

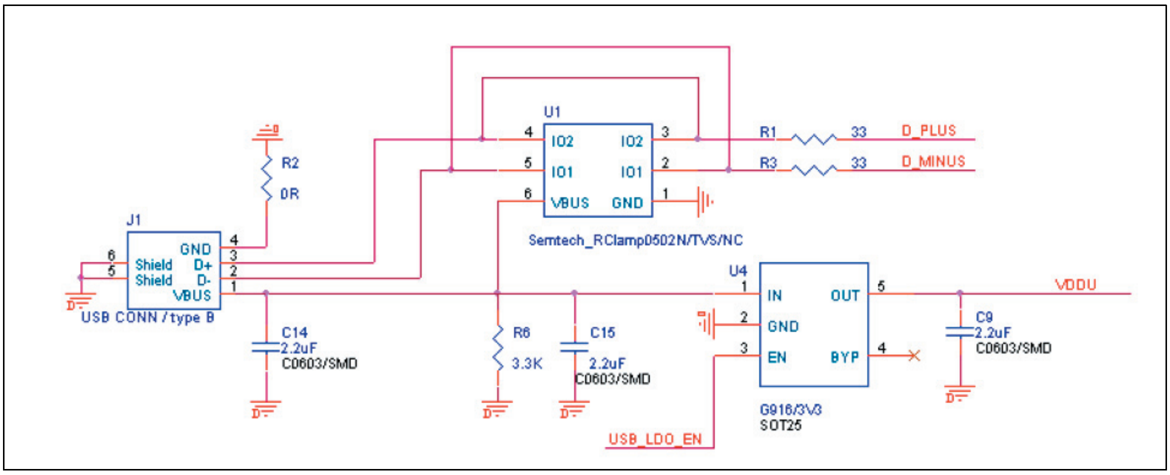
In this appendix:

The C1722 and C1216 GPS modules have an integrated USB 2.0 controller that complies with the USB 2.0 standard for full-speed (12 Mbps) functions. This chapter describes:

- How to select a suitable Low Drop Out (LDO) regulator for the USB, including no voltage leakage and good line regulation properties.
- A layout guide line and layout example of the USB. The USB operates from an external 3.3 V LDO regulator.

3.3 V LDO regulator for USB operation

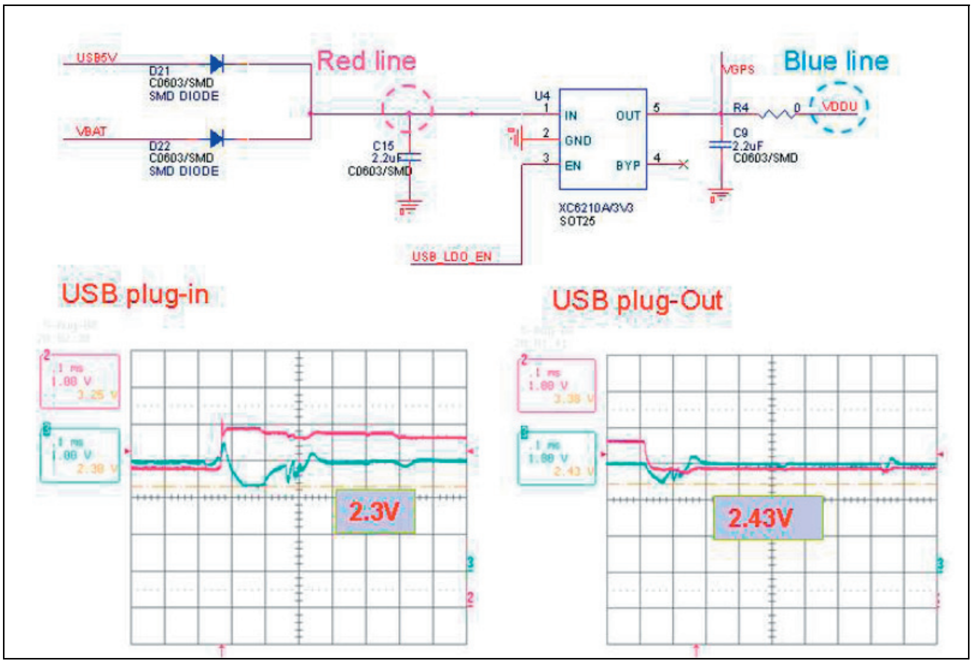
The USB function operates by applying a 3.3 V voltage from an external LDO regulator. In the application circuit below, U4 supplies the voltage for the USB, and R1 (33 Ω) and R3 (33 Ω) are used for USB data bus impedance matching:



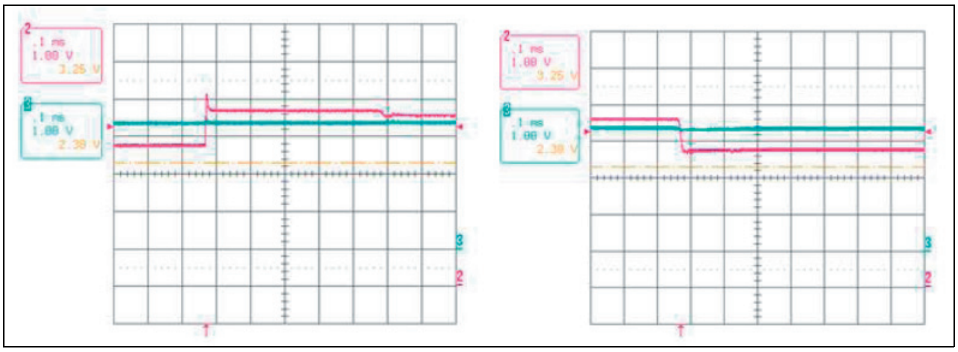
For normal USB operation, select a suitable LDO regulator that meets the following criteria:

- **3.3 V output:** The USB is designed to operate on a 3.3 V voltage supply
- **No voltage leakage:** For some commercial LDO regulators, a voltage appears at the input and output pins even when a voltage is only applied on the enable pin of the LDO device. This can result in the USB not operating correctly as the leakage voltage is presented to the USB supply input on the GPS module. You must select an LDO regulator without voltage leakage on other pins while only applying voltage on the enable pin of the regulator.

- **Good line regulation:** For some applications, you can use a single LDO regulator for both GPS power supply and USB power supply, as shown below. Some commercial LDOs with bad line regulation can show a large variation when the USB connector is plugged in or pulled out:



The following figure shows an LDO with good line regulation. The output voltage variation is small when the USB connector is plugged in or pulled out:



The following LDO components are possible candidates for the USB supply:

Type	Vendor	Part Number	Specification
LDO	GMT	G916-330T	3.3 V
LDO	TOREX	XC6210	3.3 V

USB IF certification and layout guide

The USB performance passes the specifications of the USB IF Forum, as tested by Allion Inc.

To achieve high performance data transfer through the USB port, you must take care of the components and layout of the Vbus line and the differential data bus line. Additional serial 33 Ω resistors are placed between the differential data lines. The loading capacitance of Vbus cannot exceed 10 uF for passing the inrush current criteria. Optional TVS or other ESD protection components are inserted for protection against ESD.

The following provides information on the PCB design for the USB interface. During the PCB design, considerations include controlling differential impedance (90 Ω) on the USB data traces (D+/D-), isolating USB traces from other circuitry and signals to avoid interference.

The USB 2.0 specification requires that USB D+/D- traces nominally maintain 90 Ω differential impedance and thickness. USB data trace width (D+/D-) and spacing is based on the PCB layer material and thickness. You must maintain symmetry between D+/D- with regard to shape, and the trace length should be matched (equal-length for matching the USB electric characteristics).

To avoid interference between USB and other signals, you must keep unrelated signal traces, supplies, and components away from the USB data line (D+/D-). A good rule of thumb is 5 times the trace width.

The above actions can minimize the coupling effects and impedance mismatch along the traces. Pay attention to the following:

- Avoid routing D+/D through vias. If it is necessary, keep the vias small and keep the D+/D- traces on the same layer.
- Keep the GND plane solid under D+/D-. Splitting the GND plane underneath these signals introduces impedance mismatch and increases electrical emission.
- Keep the length of D+/D- as short as possible.
- Keep the D+/D- trace spacing constant along their routes. Varying the trace separation creates impedance mismatch.
- Use two 45° bends or round corners instead of 90° bends.
- Place the GND trace along the D+/D- trace with proper spacing between them.
- Do not create a T-shape PCB trace (more than one stub) while inserting additional ESD protection components; this may damage the impedance matching.

In some PCB designs, the USB connector provides the system power for the device and also serves as the battery charger port for a Lithium cell. It is necessary to make the power-carrying trace VBUS wide enough, based on the calculated PCB fabrication factors. A good rule of thumb is to ensure that the power-carrying traces are wide enough to carry at least twice the amperage rating of the over current.

It is also important to add a bypass capacitor near the power trace to filter out noise and a load capacitance to stabilize the power delivery; however, the total bypass capacitance should not be over 10 uF while the inrush current is considered.

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