PRODUCT GUIDE

BD990

GNSS RECEIVER MODULE

Version 5.60 and 6.20
Revision H
May 2023

Trimble®

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Legal Notices

Release Notice

This is the May 2023 release (Revision H) of the *BD990 GNSS Receiver Module Product Guide*. It applies to version 5.60 and 6.20 of the receiver firmware.

LIMITED WARRANTY TERMS AND CONDITIONS

Product Limited Warranty

See the terms and conditions of the product(s) purchase agreement or contract. If not otherwise specified, the following applies to these products:

– AX940 and AX940i smart antennas.
– BD940, BD940-INS, BD970, BD982, BD990, BD992-INS, and BD9250 receiver modules.
– BX940, BX982, and BX992 receiver enclosures.

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– a copy of this Trimble warranty

– a description of the nonconforming Product including the model number

– an explanation of the problem

The customer service representative may need additional information from you depending on the nature of the problem.

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Official Language

THE OFFICIAL LANGUAGE OF THESE TERMS AND CONDITIONS IS ENGLISH. IN THE EVENT OF A CONFLICT BETWEEN ENGLISH AND OTHER LANGUAGE VERSIONS, THE ENGLISH LANGUAGE SHALL CONTROL.

COCOM limits

This notice applies to the BD990 receiver module.

The U.S. Department of Commerce requires that all exportable GPS products contain performance limitations so that they cannot be used in a manner that could threaten the security of the United States. The following limitations are implemented on this product:
– Immediate access to satellite measurements and navigation results is disabled when the receiver velocity is computed to be greater than 1,000 knots, or its altitude is computed to be above 18,000 meters. The receiver GPS subsystem resets until the COCOM situation clears. As a result, all logging and stream configurations stop until the GPS subsystem is cleared.

Notices

Restriction of Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS)

Trimble products in this guide comply in all material respects with DIRECTIVE 2002/95/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment

(RoHS Directive) and Amendment 2005/618/EC filed under C(2005) 3143, with exemptions for lead in solder pursuant to Paragraph 7 of the Annex to the RoHS Directive applied.

Waste Electrical and Electronic Equipment (WEEE)

Recycling in Europe: For product recycling instructions and more information, please go to www.trimble.com/en/our-commitment/responsible-business/corporate-compliance/environmental-compliance.

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Introduction

This guide describes how to set up, configure, and use the Trimble® BD990 GNSS receiver module. The BD990 receiver module uses advanced navigation architecture to achieve real-time centimeter accuracies with minimal latencies.

For more information including configuring the receiver, the web interface, application notes, and output messages, please go to https://receiverhelp.trimble.com/oem-gnss.

About the BD990 GNSS receiver module

The Trimble BD990 receiver module (also referred to as a *receiver*) is part of a family of receivers that support advanced functionality. In the same mechanical footprint and pin-out as the Trimble BD970 receiver module, industry professionals trust Trimble embedded positioning technologies as the core of their precision applications. Moving the industry forward, the Trimble BD990 receiver module redefines high-performance positioning.

This receiver is used for a wide range of precise positioning and navigation applications. These uses include unmanned vehicles and port and terminal equipment automation, and any other application requiring reliable, centimeter-level positioning at a high update rate and low latency.

The BD990 receiver module offers centimeter-level accuracy based on carrier phase RTK and submeter accuracy code-based solutions.

Automatic initialization and switching between positioning modes allow for the best position solutions possible. Low latency (less than 20 ms) and high update rates give the response time and accuracy required for precise dynamic applications.

The BD990 receiver module can be configured as an autonomous base station (sometimes called a *reference station*) or as a rover receiver (sometimes called a *mobile receiver*). Streamed outputs from the receiver provide detailed information, including the time, position, heading, quality assurance (figure of merit) numbers, and the number of tracked satellites. The receiver also outputs a one pulse-per-second (1PPS) strobe signal which lets remote devices precisely synchronize time.

Designed for reliable operation in all environments, the receiver provides a positioning interface to an office computer, external processing device, or control system.

About Trimble Maxwell 7 technology

The BD990 GNSS products supports triple-frequency for the GPS, GLONASS, BeiDou, and Galileo constellations. As the number of satellites in the constellations grows, the receiver is ready to take advantage of the additional signals. This delivers the quickest and most reliable RTK initializations for centimeter positioning.

With the latest Trimble Maxwell™ 7 technology, the receivers provide:

- 336 tracking channels
- Trimble EVEREST™ Plus multipath mitigation
- Advanced RF Spectrum Monitoring and Analysis
- Proven low-elevation tracking technology

With the option of utilizing OmniSTAR or RTX services, the GNSS receivers delivers varying levels of performance down to centimeter level without the use of a base station.

Flexible interfacing

The receiver is designed for easy integration and rugged dependability.

Customers benefit from the ethernet connectivity available on the board, allowing high-speed TCP and UDP communications and configuration via standard web browsers. USB, RS-232, and CAN are supported. Just like other Trimble embedded technologies; easy-to-use software commands simplify integration and reduce development times.

Different configurations are available, from an Autonomous/SBAS GPS-only configuration to the full-featured RTK/RTX system with using all available constellations and frequencies/signals.

All features are password-upgradeable, allowing functionality to be upgraded as your requirements change.

Features

The following features are applicable to these receivers.

Technical specifications

- Trimble Maxwell™ 7 technology
- 336 tracking channels:
  - GPS: L1 C/A, L1C, L2E, L2C, L5
  - BeiDou: B1, B1C, B2, B2A, B2B, B3
  - GLONASS: L1 and L2 C/A, L3 CDMA
  - Galileo: E1, E5A, E5B, E5AltBOC, E6
  - IRNSS L5
  - QZSS: L1 C/A, L1C, L1 SAIF, L2C, L5, LEX, L6/LEX
  - SBAS: L1 C/A, L5
  - MSS L-Band: OmniSTAR, Trimble RTX
- High precision multiple correlator for GNSS pseudorange measurements
- Trimble EVEREST™ Plus multipath mitigation
- Advanced RF Spectrum Monitoring and Analysis
- Unfiltered, unsmoothed pseudorange measurement data for low noise, low multipath error, low time domain correlation and high dynamic response
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Proven Trimble low elevation tracking technology
- Reference outputs/inputs: CMR, CMR+™, sCMRx, RTCM 2.2, 2.3, 2.4, 3.0, 3.1, 3.2, 3.3.
- The functionality to input or output any of these corrections depends on the installed options.

  Different manufacturers may have established different packet structures for their correction messages. Thus, Trimble OEM GNSS receivers may not receive corrections from other manufacturers' receivers, and other manufacturers' receivers may not be able to receive corrections from Trimble OEM GNSS receivers.
- Navigation outputs:
  - ASCII: NMEA-0183: GBS; GGA; GLL; GNS; GRS; GSA; GST; GSV; HDT; LLQ; AVR; GDP; DTM; BPQ; GGK; PJK; PJT; VGK; VHD; RMC; ROT; VTG; ZDA.
  - Binary: Trimble GSOF, NMEA 2000

  NOTE – Galileo support is developed under a license of the European Union and the European Space Agency.

  NOTE – There is no public GLONASS L3 CDMA ICD. The current capability in the receivers is based on publicly available information. As such, Trimble cannot guarantee that these receivers will be fully compatible.
- 1 pulse-per-second (1PPS) output
- Event Marker Input support
- Supports Fault Detection and Exclusion (FDE), Receiver Autonomous Integrity Monitoring (RAIM)

Communication

- BD990:
  - CAN is multiplexed with RS-232 port 3 and Event port 2; only one is usable at a time
  - Up to 3 × RS-232 ports (baud rates up to 921,600)
  - Up to 1 × CAN port
- 1 × USB 2.0 device port
- 1 × LAN Ethernet port
- All functions are performed through a single IP address simultaneously—including web interface access and raw data streaming
- Network protocols supported:
  - HTTP (web interface)
  - NTP Server
  - NMEA, GSOF, CMR over TCP/IP or UDP
  - NTripCaster, NTripServer, NTripClient
  - mDNS/uPnP Service discovery
  - Dynamic DNS
  - eMail alerts
  - Network link to Google Earth
  - Support for external modems through PPP
  - RDNIS support
- Control software: HTML web browser, Internet Explorer, Firefox, Safari, Opera, Google Chrome

Typical applications

The receiver can be used in a multitude of applications that require robust high-precision positioning. The receiver can be used within systems being developed for:

- Precision agriculture
- Autonomous vehicles
- Unmanned aircraft
- Field robotics
- Machine guidance and control
- Timing
- Construction
- GNSS heading and attitude measurements for marine equipment

The receivers can be set up and installed as:

- an on-board GNSS rover in SBAS DGPS mode.
- an on-board GNSS rover connected to an external communication device (radio, GPRS, CDMA) and used in DGPS, Flying RTK or RTK mode.

- a low-cost solution for vector determination applications.
- a relative positioning combined with an absolute RTK position (machine guidance and control).
- a relative movement monitoring, heave compensation, wing deformation, and so forth.

Default settings

All settings are stored in application files. The default application file, Default.cfg, is stored permanently in the receiver, and contains the factory default settings. Whenever the receiver is reset to its factory defaults, the current settings (stored in the current application file, Current.cfg) are reset to the values in the default application file.

These settings are defined in the default application file.

Function	Settings	Factory default
SV Enable	-	All SVs enabled
General Controls	Elevation mask	10°
	PDOP mask	99
	RTK positioning mode	Low Latency
	Motion	Kinematic
Ports	Baud rate	115,200
	Format	8-None-1
	Flow control	None
Input Setup	Station	Any
NMEA/ASCII (all supported messages)		All ports Off
Streamed Output		All types Off
		Offset=00
RT17/Binary		All ports Off
Reference Position	Latitude	0°
	Longitude	0°
	Altitude	0.00 m HAE
Antenna	Type	Unknown
	Height (true vertical)	0.00 m
	Measurement method	Antenna Phase Center
1PPS		Enabled
Event Ports		Disabled

If a factory reset is performed, the above defaults are applied to the receiver.

When receivers are factory reset, if they had a static IP address configured, the receiver is returned to a DHCP mode. Security is enabled (with a default login of **admin** and the password of **password**), or for units with Enhanced Security enabled, the password will be reset to the serial number of the unit (which you must change at first login).

To perform a factory reset:

- From the web interface, select **Receiver Configuration** / **Reset** and then clear the **Clear All Receiver Settings** option.

- Send the Command 58h with a 03h reset value. Refer to receiverhelp.trimble.com/oem-gnss/ICD_Pkt_Command58hRESETRCVR.html.
- Use the Configuration Toolbox utility and from the **Communications** menu, select **Reset Receiver**. Select both the **Erase Battery-Backed RAM** and **Erase File System** options.

When high-rate outputs are enabled (50 Hz or 100 Hz positioning), the defaults and the configuration changes to optimize the CPU and power usage for positioning. You will notice:

- The elevation mask cannot be set lower than 5 degrees.
- L2C + L2E tracking is no longer allowed. If both signals are tracked, this will switch to either L2C or L2E.
- GLONASS L1-C/A and L2-C/A tracking are allowed. GLONASS L1-P and L2-P tracking are not allowed.
- Galileo E5-AltBOC tracking is allowed. Galileo E5-A and/or E5-B tracking are not allowed.

Receiver hardware and accessories

The following support hardware and accessories can be ordered for the BD990 receiver module:

Part number	Description
112076-00	Trimble BD99x Evaluation Kit (receiver not included)
105679-00-B	Trimble BD99x Interface board
A02503	18 V Power Supply, 3 Ah
A02584	CBL ASSY TNC-MMCX

Evaluation kit

For system integrators/evaluators, Trimble offers an evaluation kit. This kit comes with a specially designed board that can mate with the receiver. Once mated, the evaluation board provides the integrator or tester with a platform to gain an in-depth understanding of the receiver. It also allows for development of custom applications that can effectively implement the precision GNSS information that the receiver is capable of outputting. The evaluation board gives access to the following:

- Power connector
- Four serial ports through 2 × DB9 and 2 × USB Type-B connectors
- Ethernet through 1 × RJ45 connector
- USB port 1 × Type-B receptacle
- Three LEDs to indicate satellite tracking, receipt of corrections, and power; optional LED for IMU state

Technical support

If you have a problem and cannot find the information you need in the product documentation, send an email to GNSSOEMSupport@trimble.com.

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Specifications

This chapter details the specifications for the receiver.

Specifications are subject to change without notice.

Positioning specifications

NOTES –

- The following specifications are provided at 1 sigma level when using a Trimble Zephyr 2/3 antennas. Add 1 ppm for RTK position accuracies. These specifications may be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality. Trimble RTX and OmniSTAR accuracies depend on the correction service chosen.
- Trimble CenterPoint RTX provides <4 cm horizontal accuracy 95 % of the time with initializations of less than 30 minutes.
- Also available in configurations with RTK accuracies limited to 10 and 30 centimeters.

Feature		**Specification**	
Initialization time		Typically <8 seconds	
Initialization accuracy		>99.9%	
Mode	**Accuracy**	**Latency (at max. output rate)**	**Maximum Rate**
Single Baseline RTK (<30 km)	0.008 m + 1 ppm horizontal 0.015 m + 1 ppm vertical	<20 ms	50 Hz
DGPS	0.25 m + 1 ppm horizontal 0.5 m + 1 ppm vertical	<20 ms	50 Hz
SBAS [1]	0.5 m horizontal 0.85 m vertical	<20 ms	50 Hz
Autonomous	1.00 m horizontal 1.50 m vertical	<20 ms	50 Hz

1 GPS only and depends on SBAS system performance. FAA WAAS accuracy specifications are <5 m 3DRMS.

Performance specifications

NOTE – The Time to First Fix specifications are typical observed values. A cold start is when the receiver has no previous satellite (ephemerides/almanac) or position (approximate position or time) information. A warm start is when the ephemerides and last used position is known.

Feature	Specification	
Time to First Fix (TFF)	Cold Start	<45 seconds
	Warm Start	<30 seconds
	Signal Re-acquisition	<2 seconds
Velocity Accuracy [1]	Horizontal	0.007 m/sec
	Vertical	0.020 m/sec
Maximum Operating Limits [2]	Velocity	515 m/sec
	Altitude	18,000 m
Acceleration	11 g	
RTK initialization time	Typically <8 seconds	
RTK initialization reliability	>99%	
Position latency	<20 ms	
Maximum position/attitude update rate	50 Hz 100 Hz INS	

1 1 sigma level when using a Trimble Zephyr 3 antenna. These specifications may be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.

2 As required by the US Department of Commerce to comply with export licensing restrictions.

Physical and electrical characteristics

Feature	Description
Dimensions (L × W × H)	100 mm × 60 mm × 11.6 mm
Power	3.3 V DC +5%/–3% Typically, 1.45 W (L1/L2 GPS) Typically, 1.55 W (L1/L2 GPS and G1/G2 GLONASS) Typically, 2.35 W (L1/L2/L5 GPS, G1/G2 GLONASS, B1/B2 BeiDou, L1/E5 Galileo)
Weight	54 grams
Connectors - I/O	44-pin Header
Connectors - Antenna	1 × MMCX receptacle
Antenna LNA Power Output	Input voltage: 3.3 to 5 V DC Maximum current: 400 mA
Minimum required LNA gain	32 dB **NOTE –** This receiver is designed to operate with the Zephyr Model 2 antenna which has a gain of 50 dB. Higher-gain antennas have not been tested.

Environmental specifications

Feature	Specification
Temperature	Operating: -40 °C to 75 °C (-40 °F to 167 °F)
	Storage: -55 °C to 85 °C (-67 °F to 185 °F)
Vibration	MIL810F, tailored Random 6.2 gRMS operating Random 8 gRMS survival
Mechanical shock	MIL810D +/- 40 g operating +/- 75 g survival
Operating humidity	5% to 95% R.H. non-condensing, at +60 °C (140 °F)

Communication specifications

Feature	Specification
Communications	1 × LAN port Supports links to 10BaseT/100BaseT networks. All functions are performed through a single IP address simultaneously including web interface access and data streaming.
	2 × RS-232 ports Baud rates up to 921,600 1 × USB 2.0 port 1 × CAN bus (optional) 2 × event ports (the second event port is optional on the BD990 | BD992 | BD992-INS) **NOTE –** On the BD990, BD992 and BD992-INS one port is multiplexed, which you can set this to be a third RS-232 port, a CAN bus, or a second event port.
Receiver position update rate	1 Hz, 2 Hz, 5 Hz, 10 Hz, 20 Hz, and 50 Hz positioning 100 Hz positioning output for INS
Correction data input	CMR, CMR+™, sCMRx, RTCM 2.0 to 2.4, RTCM 3.x, 3.2, 3.3
Correction data output	CMR, CMR+, sCMRx, RTCM 2.1 to 2.4, RTCM 3.x, 3.3
Data outputs	NMEA-0183, 1PPS & ASCII Time Tags, Binary GSOF, Binary RT17 / RT27, BINEX, NMEA2000 (over CAN when available)

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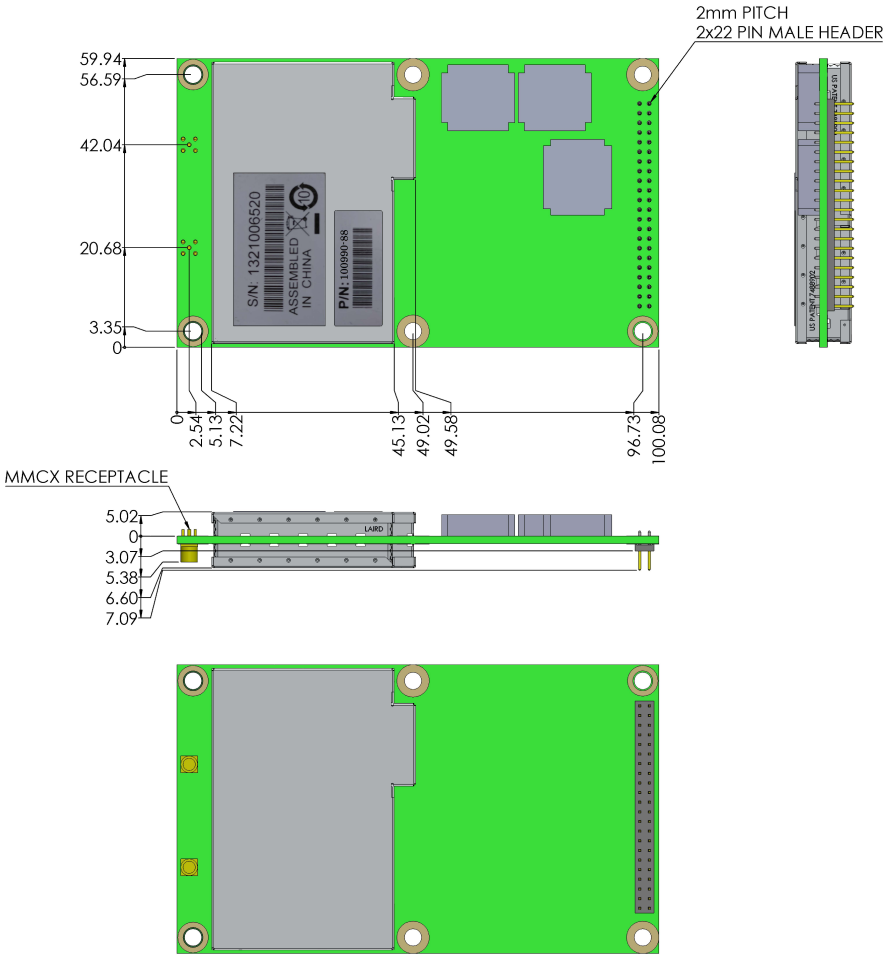
Drawings

If you require a 3D CAD model of the module, please send a request to GNSSOEMSupport@trimble.com.

Key dimensions on the BD990



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Electrical System Integration

- Receiver pinout information
- 1PPS and ASCII time tag
- Power input
- Event input using the evaluation board
- Antenna power output
- LED control lines
- Power switch and reset
- Event input using the evaluation board
- Serial port
- USB
- Ethernet
- CAN

Receiver pinout information

44-pinout connector

Pin	Usage	Integration notes
1	GND	
2	RTK LED	
3	Power Switch ***	Drive high with a 3.3 V to turn off. Leave floating or ground to keep the unit on. Integrators should not drive TTL signals when the unit is not powered.
4	PPS Out	
5	Power In	3.3 V DC
6	Power In	3.3 V DC
7	COM3 RX or CAN RX or EVENT 1	3.3 V level, multiplexed
8	EVENT 0	
9	Power LED	
10	Satellite LED	
11	COM2 CTS	3.3 V level
12	RESET IN ***	Low = reset, NC = normal function, 100 k pull-up
13	COM2 RTS	3.3 V level
14	COM2 RX	3.3 V level
15	COM1 CTS RS232	RS-232 level
16	COM2 TX	3.3 V level
17	COM1 RTS RS232	RS-232 level
18	COM1 RX RS232	RS-232 level
19	COM3 TX or CAN TX	3.3 V level, multiplexed
20	COM1 TX RS232	RS-232 level
21	USB DM	
22	USB DP	
23	GND	
24	GND	
25	RESERVED	USB ID
26	RESERVED	USB VBUS
27	ETHERNET RD-	
28	ETHERNET RD+	
29	NC	
30	ETHERNET TD+	
31	ETHERNET TD-	
32	NC	
33	VOUT	3.3 V DC

Pin	Usage	Integration notes
34	NC	
35	RESERVED	I2C SCL
36	RESERVED	I2C SDA
37	DMI1	
38	DMI2	
39	GND	
40	GND	
41	10 MHz in	
42	Enable external 10 MHZ	High = external enabled, low or NC = internal TCXO enabled. 10 k pull-down
43	IMU LED	
44	GND	

44-pin connector details

MFG - SAMTEC (P/N TMM-122-03-S-D)

Recommended mating connector

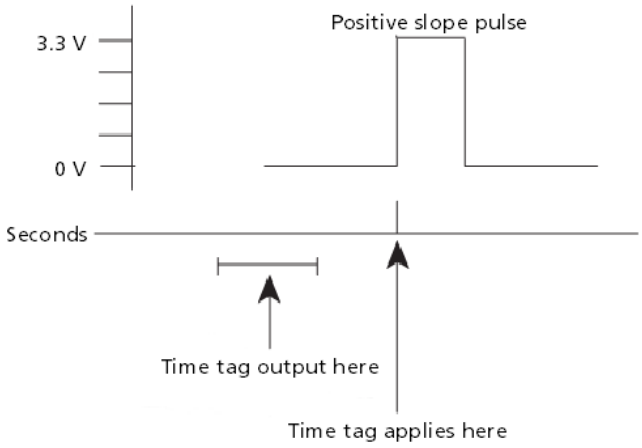
MFG - SAMTEC (P/N SQW-122-01-L-D)

1PPS and ASCII time tag

The receiver can output a 1 pulse-per-second (1PPS) time strobe and an associated time tag message. The time tags are output on a user-selected port.

The leading edge of the pulse coincides with the beginning of each UTC second. The pulse is driven between nominal levels of 0.0 V and 3.3 V (see below). The leading edge is positive (rising from 0 V to 3.3 V). The receiver PPS out is a 3.3 V TTL level with a maximum source/sink current of 4 mA. If the system requires a voltage level or current source/sink level beyond these levels, you must have an external buffer. This line has ESD protection.

The illustration below shows the time tag relation to 1PPS wave form:



The pulse is about 8 microseconds wide (although this is adjustable), with rise and fall times of about 100 ns. Resolution is approximately 40 ns RMS. Factors such as signal tracking quality (which affect position-time computation quality) may limit accuracy. Additionally, cable length adds delay which can be accounted for, each meter of cable adds a delay of about 2 ns to satellite signals and a corresponding delay in the 1PPS pulse.

Each time tag is output about 0.8 second before the corresponding pulse. Time tags are in ASCII format on a user-selected serial port. The format of a time tag is:

```
UTC yy.mm.dd hh:mm:ss ab
```

Where:

- `UTC` is fixed text.
- `yy.mm.dd` is the year, month, and date.
- `hh:mm:ss` is the hour (on a 24-hour clock), minute, and second. The time is in UTC, not GPS.
- `a` is an integer number representing the position-fix type:

  1 = time solution only

  2 = 1D position and time solution

  3 = currently unused

  4 = 2D position and time solution

  5 = 3D position and time solution

- b is the number of GNSS satellites being tracked. If the receiver is tracking nine or more satellites, b will always be displayed as 9.
- Each time tag is terminated by a *carriage return*, *line feed* sequence. A typical printout looks like:

  UTC 02.12.21 20:21:16 56

  UTC 02.12.21 20:21:17 56

  UTC 02.12.21 20:21:18 56

> **NOTE –** If the receiver is not tracking satellites, the time tag is based on the receiver clock. In this case, a and b are represented by "??". The time readings from the receiver clock are less accurate than time readings determined from the satellite signals.

Power input

The unit, excluding the antenna, operates at 3.3 V +5%/-3%. The 3.3 V should be able to supply 2.0 A of worst-case surge current. The typical power consumption based on band usage is:

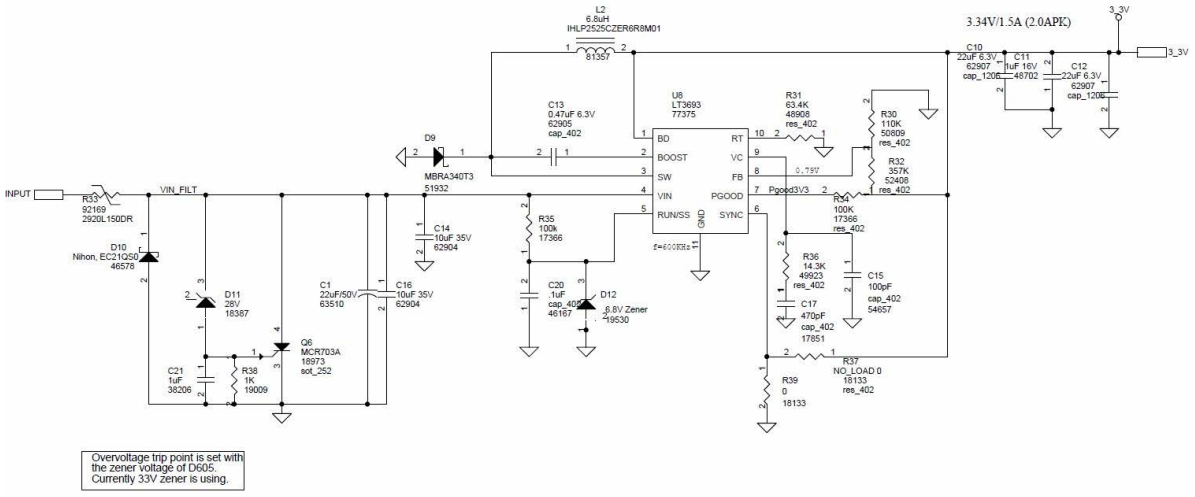
- L1/L2 GPS + GLONASS = 2.0 W
- L1/L2/L5 GPS + GLONASS + BeiDou + Galileo = 2.5 W

Worst case full-load power consumption including the antenna is 5.0 W. (Note: Worst case was tested with all features, including RF bands, LEDs, enabled, at +85 °C). There are multiple power rails in the system. Voltage rails 1.2 V, 1 V, 1.8 V, 2.35 V, 5.7 V, or 7.6 V (antenna outputs) are provided by switching supplies. 3.1 V, 3.0 V, and 1.95 V use LDOs to achieve low-noise voltage rails.

Power protection

The 3.3 V input is monitored by an LTC2912 for over- and under-voltage conditions. (Basically, a window comparator). If the voltage exceeds 3.64 V or is under 3.01 V, the IC turns off the gate of a MOSET to disconnect the input voltage to the system. Limited protection above 3.64 V is offered by a varistor, which has a clamping voltage of 5.5 V.

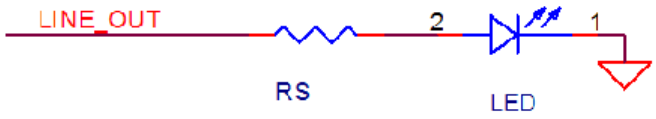
Evaluation board power supply circuit



Antenna power output

Each antenna connector can supply DC power independently. Each output is supplied by a dedicated boost regulator. The primary antenna regulator can switch voltage between 5.7 V to 7.6 V by using a GPIO to change the feedback and can source a maximum of 150 mAmps. Switching is done to select narrow versus wideband filtering for MSS jam-immunity in capable Trimble antennas. The output antenna features a constant 5.7 V output. Each antenna has a PTC with a hold current of 200 mA, which limits the output current and provides short circuit protection.

LED control lines

Item	Description
Driving LEDs	The outputs are 3.3 V TTL level with a maximum source/sink current of 4 mA. An external series resistor must be used to limit the current. The value of the series resistor in Ohms is determined by: (3.3-Vf)/(If) > Rs > (3.3 V - Vf)/(.004) Rs = Series resistor If = LED forward current, max typical If of the LED should be less than 3 mA Vf = LED forward voltage, max typical Vf of the LED should be less than 2.7 V Most LEDs can be driven directly as shown in the circuit below:  LEDs that do not meet If and Vf specification must be driven with a buffer to ensure proper voltage level and source/sink current.
Power LED	This active-high line indicates that the unit is powered on.
Satellite LED	This active-high line indicates that the unit has acquired satellites. A rapid flash indicates that the unit has less than five satellites acquired while a slow flash indicates greater than five satellites acquired. This line will stay on if the unit is in monitor mode.
RTK Correction	A slow flash indicates that the unit is receiving corrections. This will also flash when the unit is in monitor mode.

Power switch and reset

Power switch

The integrator may choose to power on or power off the unit. If a 3.3 V level signal is applied to pin 3, Power_Off pin, the unit will disconnect VCC. The system integrator must ensure that other TTL level pins remain unpowered when Power_Off is asserted. Powering TTL-level pins while the unit is powered off will cause excessive leakage current to be sinked by the unit.

The integrator may choose to always have the unit powered on. This is accomplished by leaving the Power_Off pin floating or grounded.

Reset switch

Driving Reset_IN_L, Pin 12, low will cause the unit to reset. The unit will remain reset at least 140 mS after the Reset_IN_L is deasserted. The unit remains powered while in reset.

Event input using the evaluation board

This topic describes how to condition and analyze event input signals when using the OEM GNSS I/O development boards. This knowledge also applies to the customers' implementation of event inputs on their carrier board for the BD9xx.

Useful links:

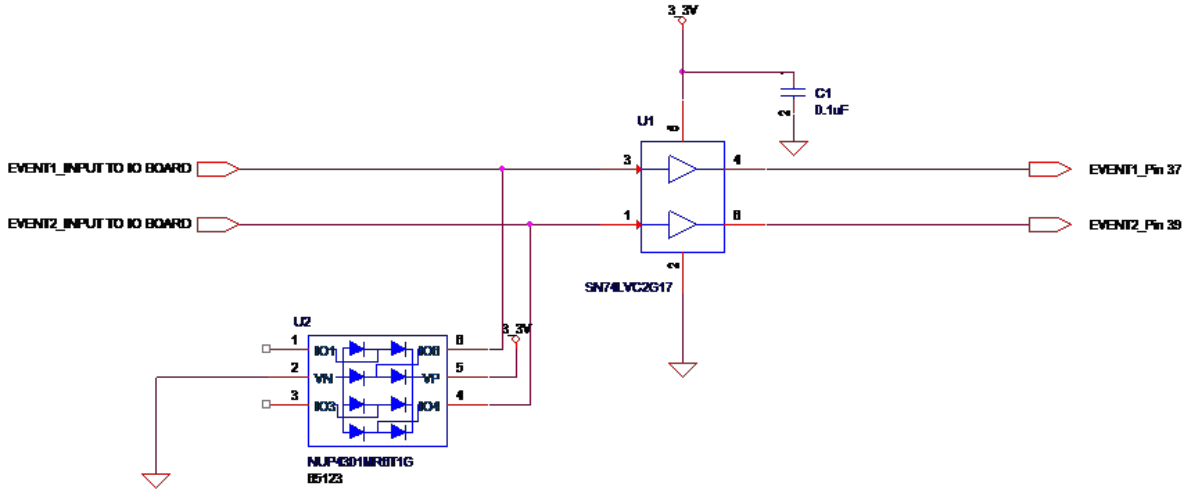
- For information about the web interface settings, see the topic, Receiver Configuration – General in the OEM GNSS help.
- Application note: Event (0) 1PPS Input Example in the OEM GNSS help.
- For Event 1 and Event 2 information, see below.

Event

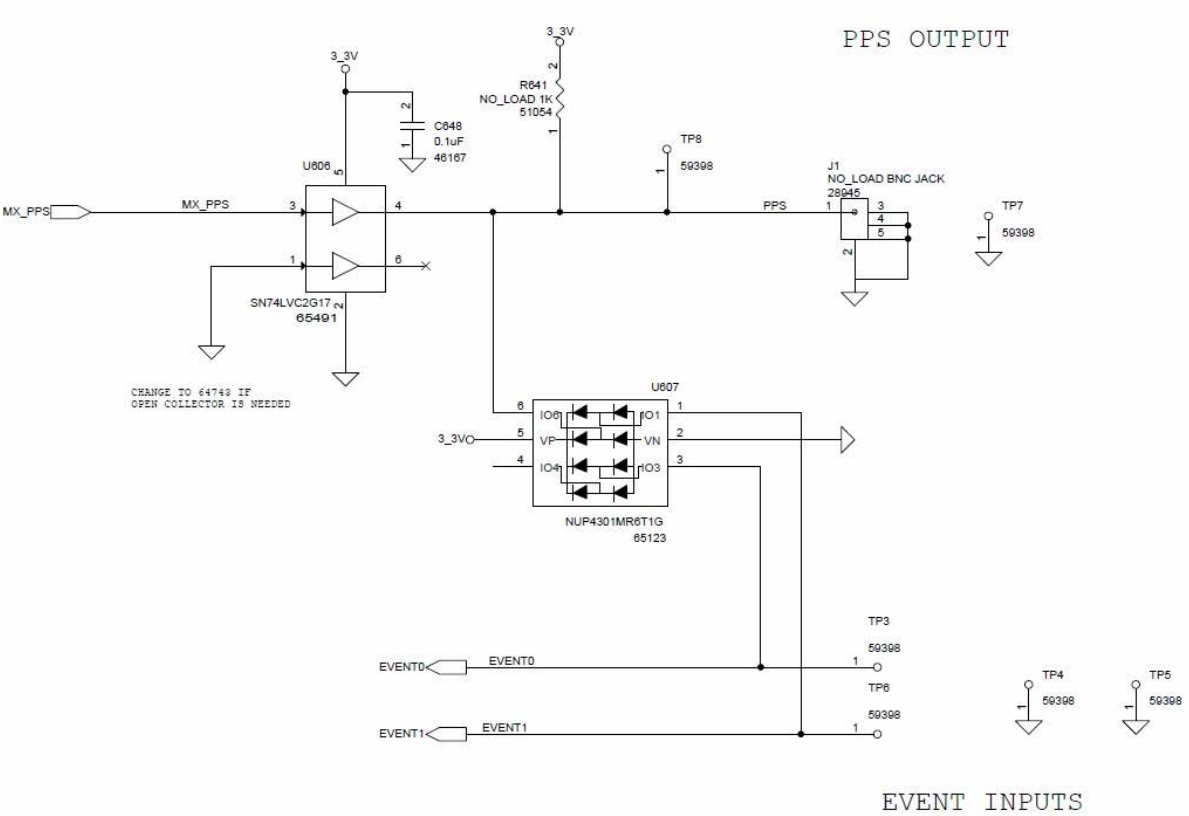
Item	Description
Event 1	On the BD990 receiver module, pin 8 is dedicated as an Event_In pin. This is a TTL only input; it is not buffered or protected for any inputs outside of 0 V to 3.3 V. It does have ESD protection. If the system requires event to handle a voltage outside this range, the system integrator must condition the signal before connecting to the unit.
Event 2	On the BD990 receiver module, pin 7 is Event 2; however, it is multiplexed with COM3_RX and CAN_RX. The default setting is to have this line set to COM3_RX. The Event 2 must be enabled to use Event2. This is a TTL only input; it is not buffered or protected for any inputs outside of 0 V to 3.3 V. It does have ESD protection. If the system requires event to handle a voltage outside this range, the system integrator must condition the signal before connecting to the unit.

Event schematrics of the BD9xx evaluation PCB

Trimble recommends adding a Schmitt trigger and ESD protection to the Event_In pin. This prevents any "ringing" on the input from causing multiple and incorrect events to be recognized.



PPS output and event inputs BD990



Serial port

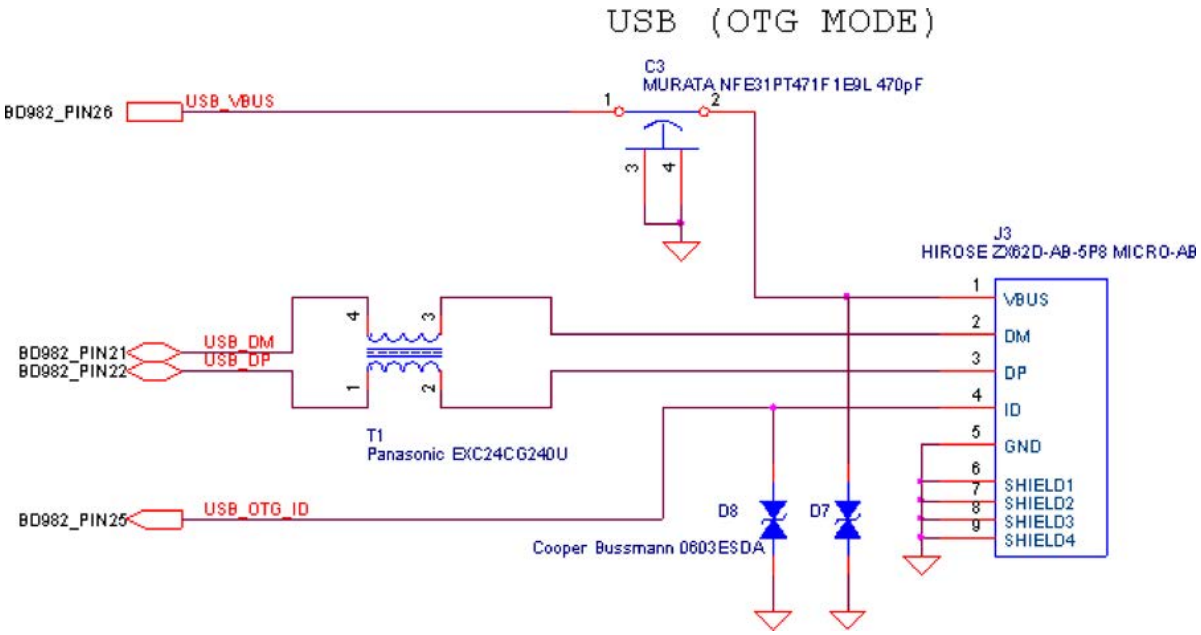
Item	Description
Port 1 (with flow control)	COM 1 is already at RS-232 level and already has 8 kV contact discharge/15 kV air gap discharge ESD Protection. This port has RTS/CTS to support hardware flow control. This is labeled Port 1 on the I/O board.
Port 2 (with flow control)	COM 2 is at 0-3.3 V TTL. This port has RTS/CTS to support hardware flow control. If the integrator needs this port to be at RS-232 level, a proper transceiver powered by the same 3.3 V that powers the receiver must be added. For development using the I/O board, this COM port is already connected to an RS-232 transceiver. This is labeled Port 2 on the I/O board.
Port 3 (no flow control)	COM 3 is at 0-3.3 V TTL. If the integrator needs this port to be at RS-232 level, a proper transceiver powered by the same 3.3 V that powers the receiver must be added. For development using the I/O board, this COM port is already connected to an RS-232 transceiver. This is labeled Port 3 on the I/O board.

USB

The CPU of the receiver has an integrated PHY that supports both USB 2.0 Device and Host configuration at low-speed, full-speed, and high-speed. In Host mode, the receiver supplies 5 V to a USB device, such as a memory stick. In Device mode, the receiver behaves like an external storage device to a computer.

USB OTG reference design

To be OTG-compliant, the connector must be MICRO AB. An OTG-compliant cable has A and B ends. When the B-side of the cable is inserted, the ID pin is not connected (floating) and the receiver enters Device mode through a pull-up resistor. The A-side of the cable connects the ID pin to ground, which enables Host mode on the receiver.



To reduce EMI, place a USB 2.0 compliant common mode choke on the data lines. To ensure best EMI performance, locate the choke near the USB MICRO AB connector. Trimble recommends that you use an L-C-L type EMI filter for the output power.

For product robustness and protection, place ESD protection diodes on both the USB_VBUS and USB_OTG_ID lines. The receiver has internal high-speed ESD protection on the USB data lines.

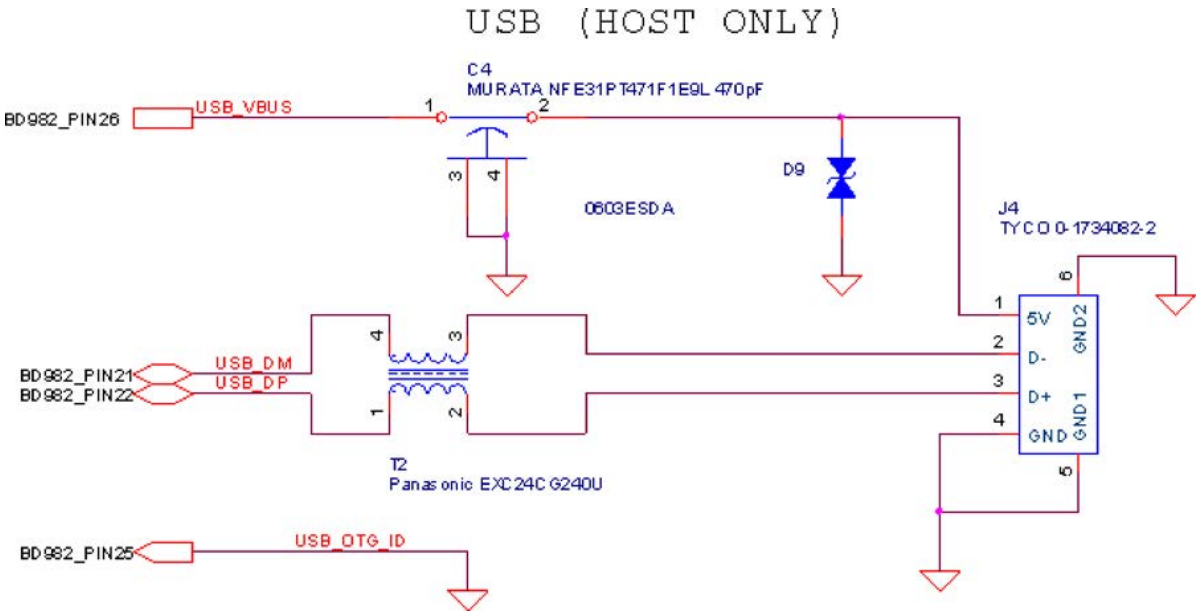
To ensure best USB high-speed performance, carefully consider PCB routing and placement practices:

- Place components so the trace length is minimized.
- Do not have stubs on data lines more than 0.200".
- Route data lines differentially but as parallel as possible.
- Data lines must be controlled to 90 Ohms differential impedance, and 45 Ohms single-ended impedance.
- Route over continuous reference plane (either ground or power).

For more detailed information, refer to the *Intel High Speed USB Platform Design Guidelines*.

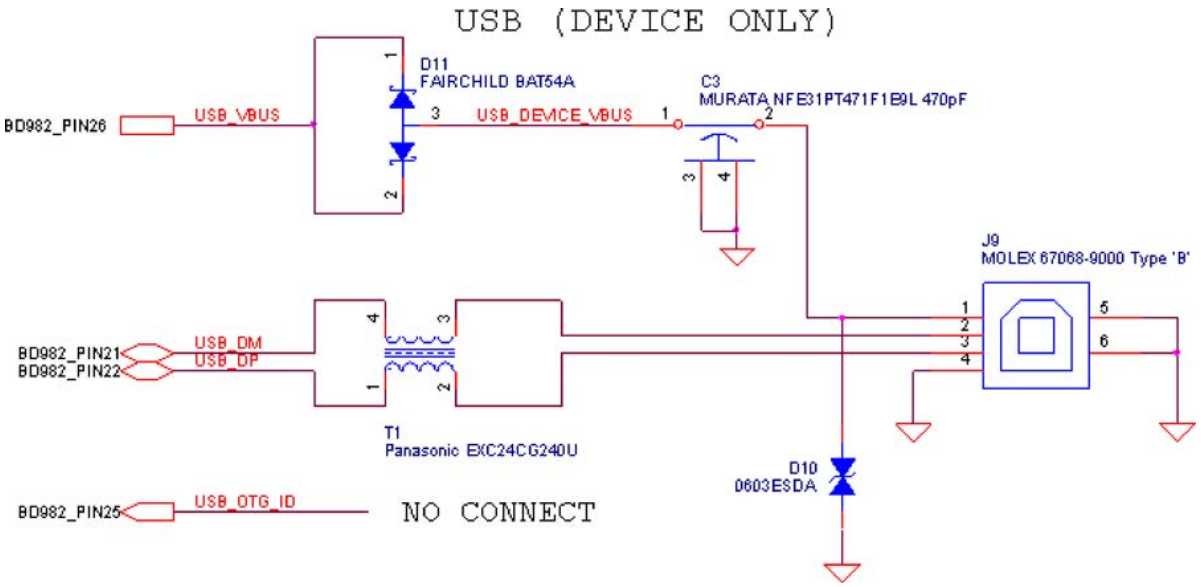
USB host-only reference design

For USB host-only support, a type-A connector is required. Since the receiver dos not support dynamic role switching, the ID pin should be grounded on the receiver. In Host mode, the receiver supplies nominal 5 V output at 500 mA to the USB device.



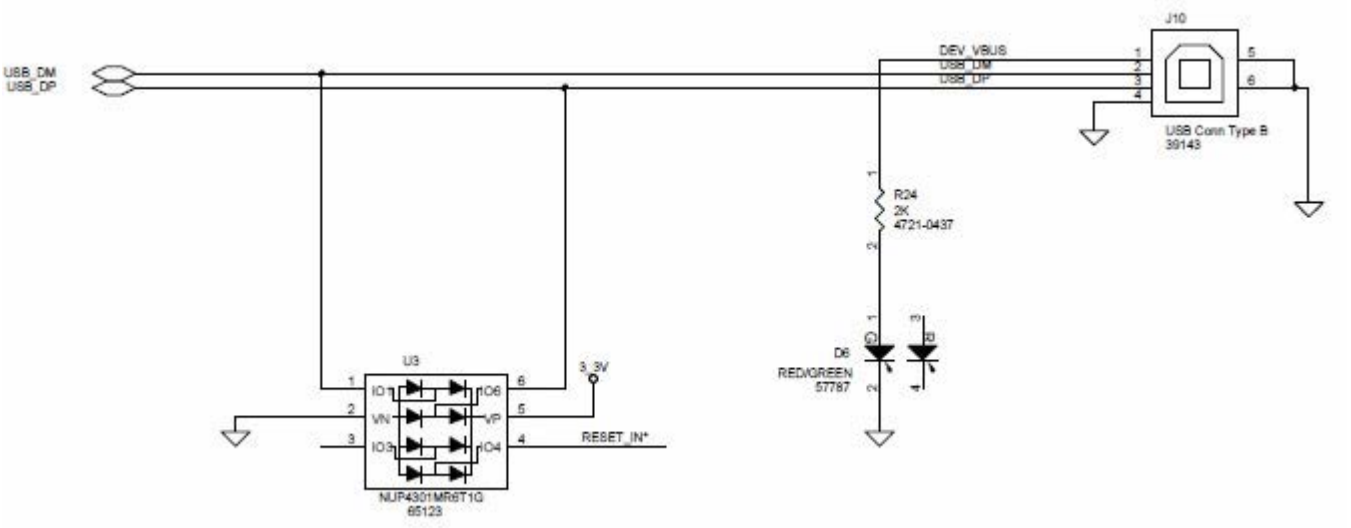
USB device-only reference design

For device-only operation, the USB_OTG_ID pin is left floating. For reference, the receiver has an internal 10 K Ohm pull-up to 3.3 V. In this mode, the USB_DEVICE_VBUS is used only by receiver to detect if host power is connected.



BD99x evaluation board

The BD99X evaluation board has one USB device port. The following is the schematic for this communication port:



Ethernet

The receiver contains the ethernet MAC and PHY, but requires external magnetics. The BD990, BD992, BD992-INS PHY layer is based on the Micrel KSZ9031RNX. These are set to default to 100 Mbps, full duplex with auto-negotiation enabled. The PHY layer is based on the Micrel KSZ8041NLI; it is set to default to 100 Mbps, full duplex with auto-negotiation enabled.

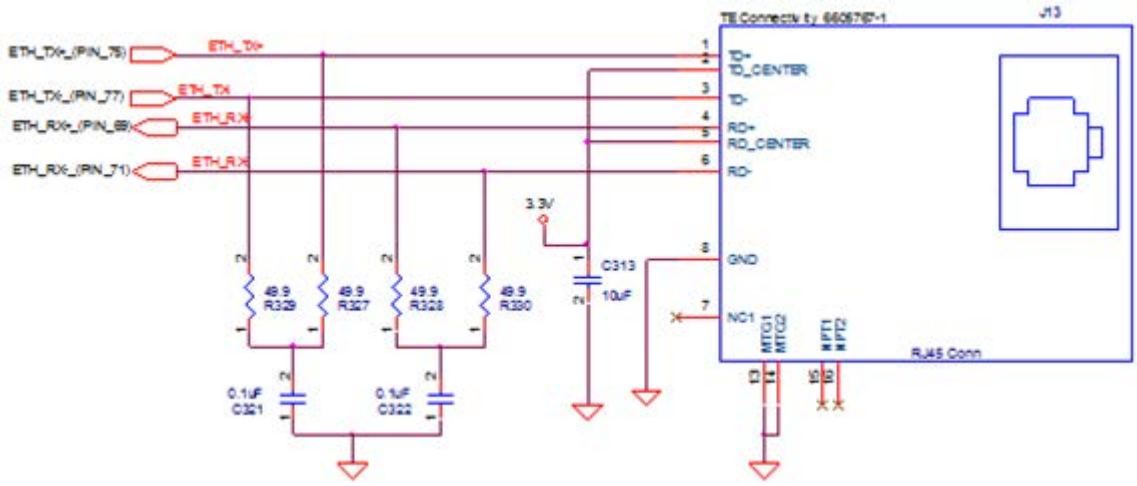
Isolation transformer selection

Parameters	Value	Test condition
Turns ratio	1CT:1CT	
Open-circuit inductance (min.)	350 uH	100 mV, 100 kHz, 8 mA
Leakage inductance (max.)	0.4 uH	1 MHz (min.)
DC resistance (max.)	0.9 Ohms	
Insertion loss (max.)	1.0 dB	0 MHz to 65 MHz
HiPot (min.	1500 Vrms	

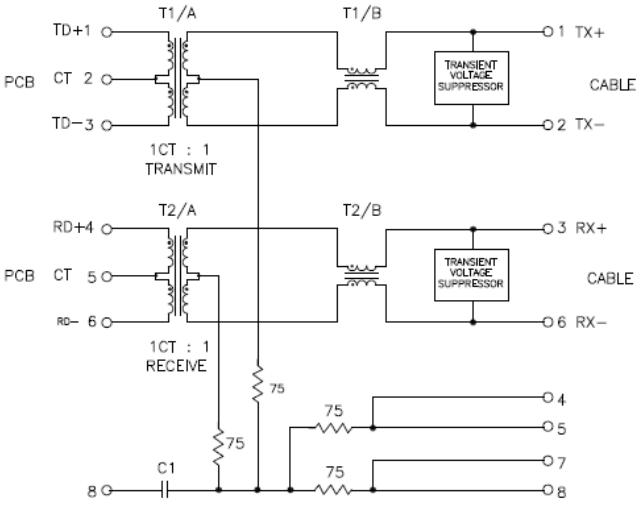
Ethernet design using RJ-45 with integrated magnetics

The ethernet interface can be implemented with a single part by using an integrated part like TE Connectivity's 6605767-1, which has magnetics, common mode choke, termination and transient voltage suppression fully integrated in one part.

RJ-45 drawing



JX10-0006NL schematic



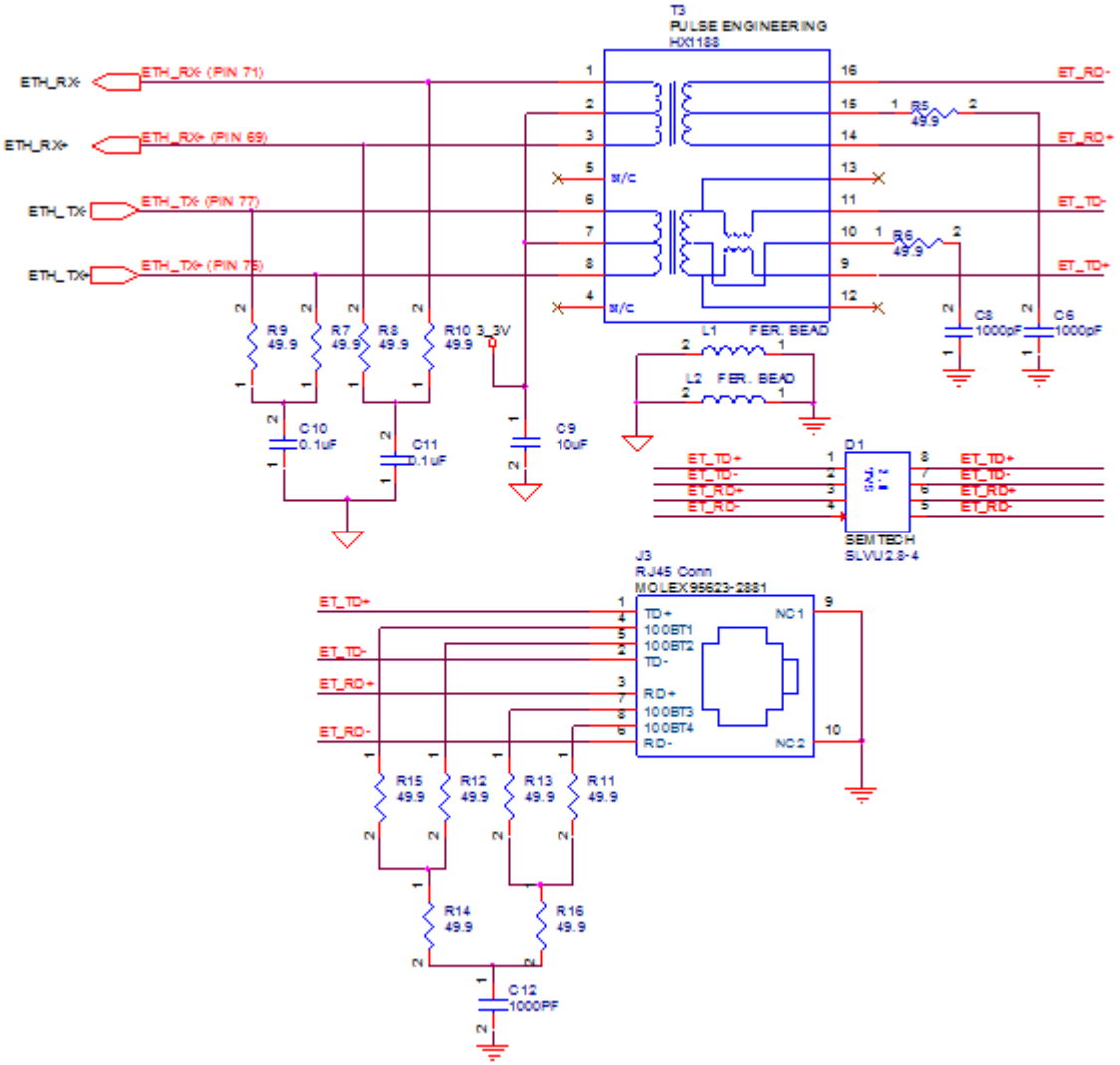
Electrical characteristics

Parameter	Specifications	
Insertion loss	100 kHz	1 to 125 MHz
	-1.2 dB max.	-0.2–0.002*f^1.4 db max.
Return loss (Z out = 100 Ohm +/- 15%)	0.1 to 30 MHz:	-16 dB min.
	30 to 60 MHz:	-10+20*LOG_{10} (f/60 MHz dB min.)
	60 to 80 MHz:	-10 dB min.
Inductance (OCL) (Media side -40°C + 85°C)	350 uH min.	Measured at 100 kHz, 100 mVRMS and with 8 mA DC bias)
Crosstalk, adjacent channels	1 MHz	10 to 100 MHz
	-50 dB min.	-50+17*LOG_{10}(f/10) dB min.
Common mode rejection radio	2 MHz	30 to 200 MHz
	-50 dB min.	-15+20*LOG_{10} (f/200) dB min.
DC resistance ½ winding	0.6 Ohms max.	
DC resistance imbalance	± 0.065 Ohms max. (center tap symmetry)	
input - output isolation	1500 Vrms min. at 60 seconds	

Ethernet design using discrete components

For maximum flexibility, a system integrator may choose to implement the ethernet using discrete parts. The design below shows an example of such a design. It includes the ethernet magnetics, termination of unused lines as well as surge protection. The magnetics used is a Pulse Engineering HX1188. Surge protection is provided by a Semtech SLVU2.8-4. To meet electrical isolation requirements, it is recommended to use capacitors with a greater than 2 kV breakdown voltage.

Ethernet schematic



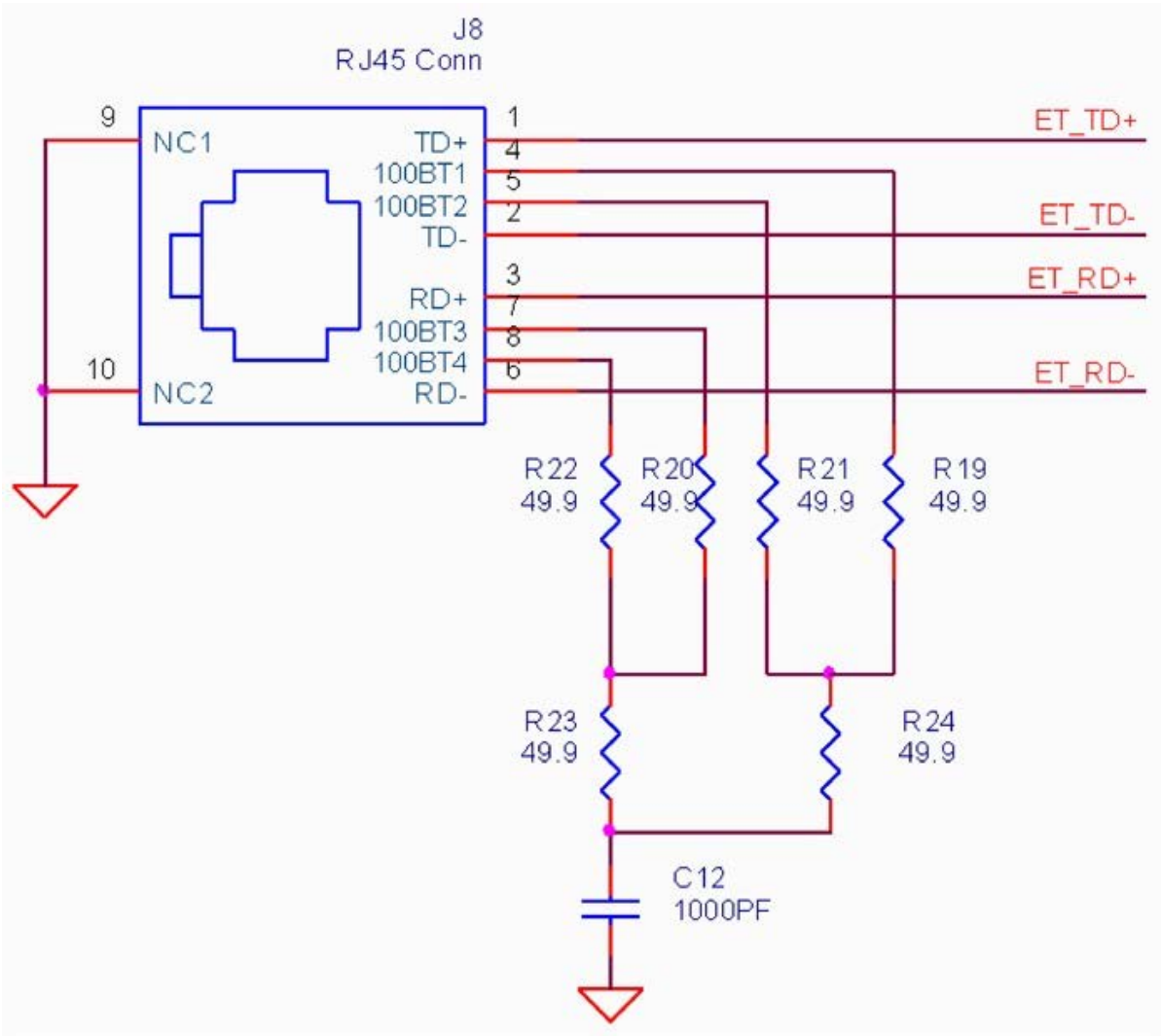
Part Reference	Value
C4–C6	1000 pF 2 kV
C3	10 uF X5R 6.3 V
D1	SEMTECH SLVU2.8–4
J1	RJ45 Conn
L1, L2	Ferrite Bead
R1–R11	49.9 0402 1%
T1	Pulse engineering HX1188

Ethernet routing

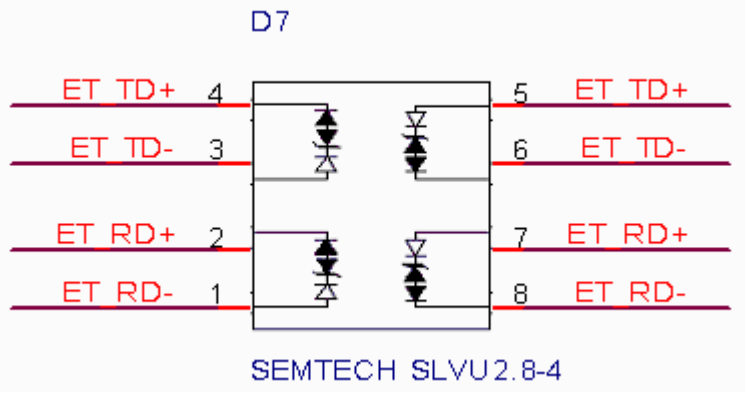
The distance from the connector, the ethernet connector and the magnetics should be less than 2 inches. The distance from the RJ-45 and the magnetics should be minimized to prevent conducted emissions issues. In this design, the chassis ground and signal ground are separated to improve radiated emissions. The integrator may choose to combine the ground. The application note from the IC vendor is provided below for more detailed routing guidelines.

BD99X Ethernet design considerations

The BD940-INS and BD99x board series have their own magnetics, therefore, the ethernet interface can be implemented using only a RJ-45 connector, and termination discretes. See design example below:

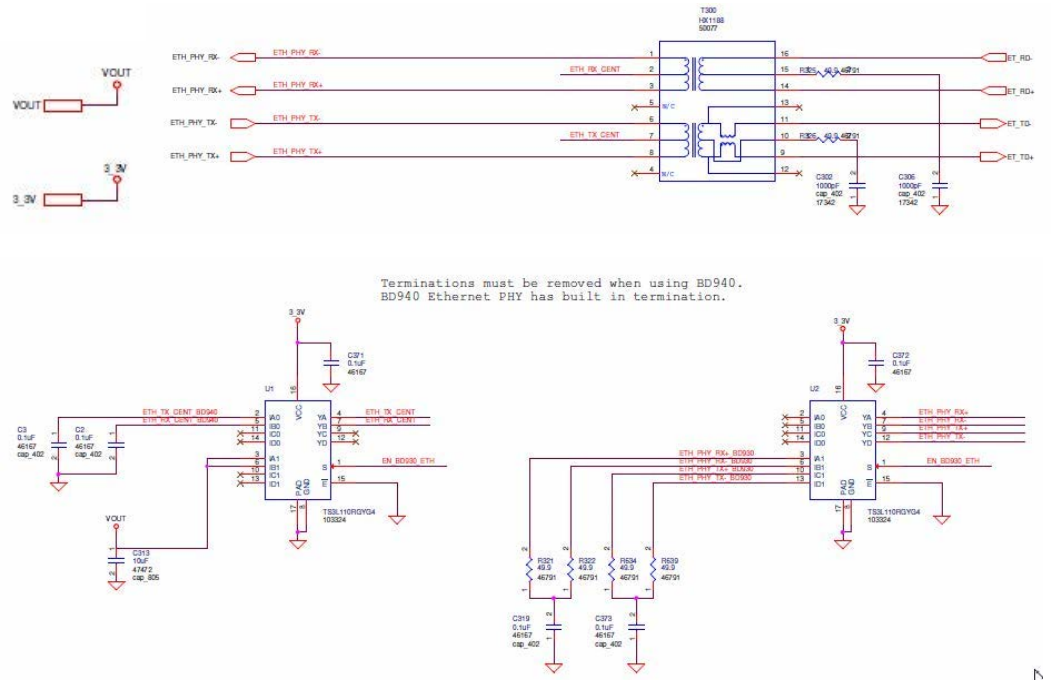


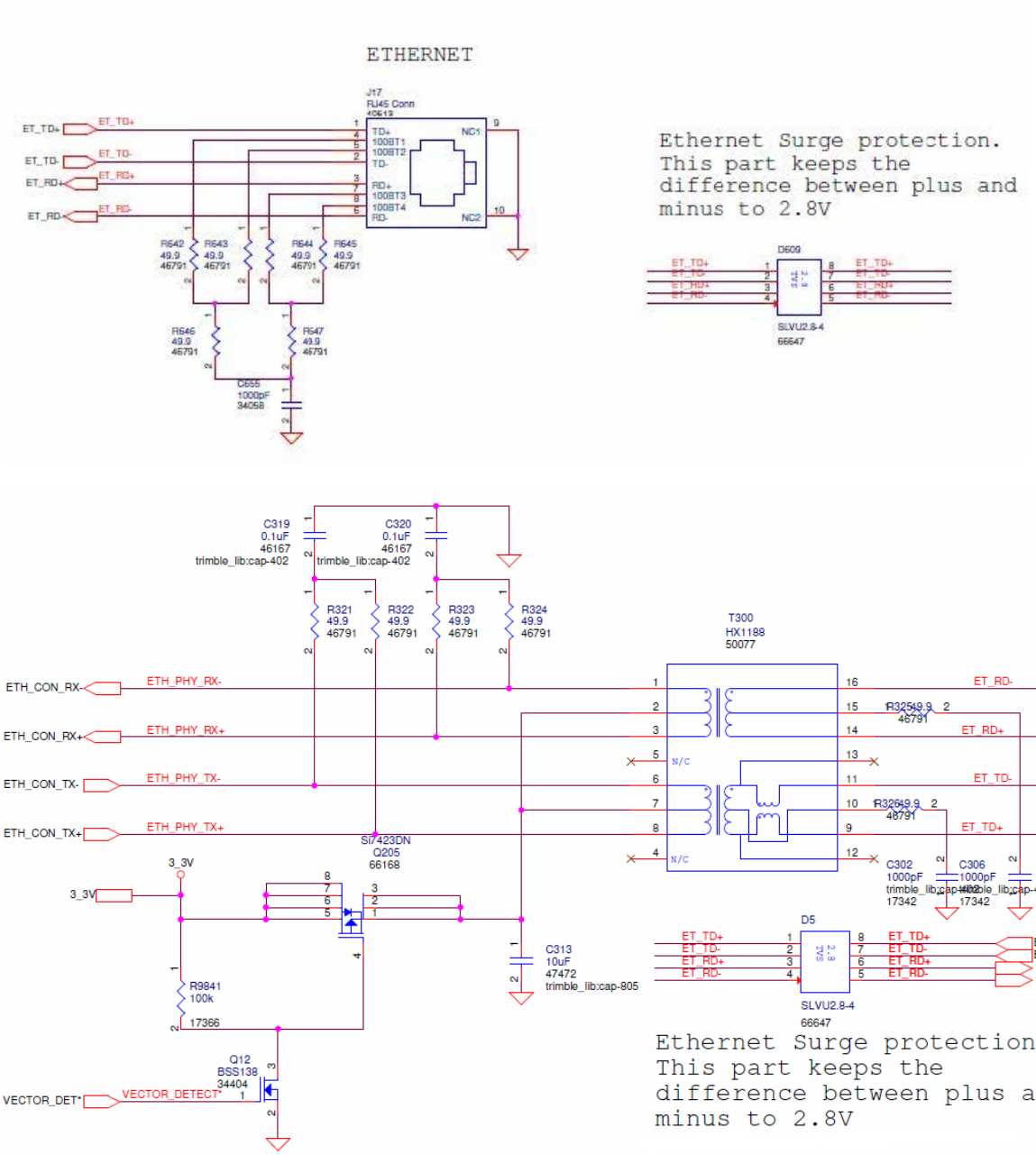
Optional surge protection is provided by a Semtech SLVU2.8-4. To meet electrical isolation requirements, Trimble recommends using capacitors with a greater than 2 kV breakdown voltage.



Evaluation board ethernet schematics

The evaluation board has the necessary magnetics to run the ethernet interface. Below are the schematics of the ethernet implementation on the BD990 evaluation board:



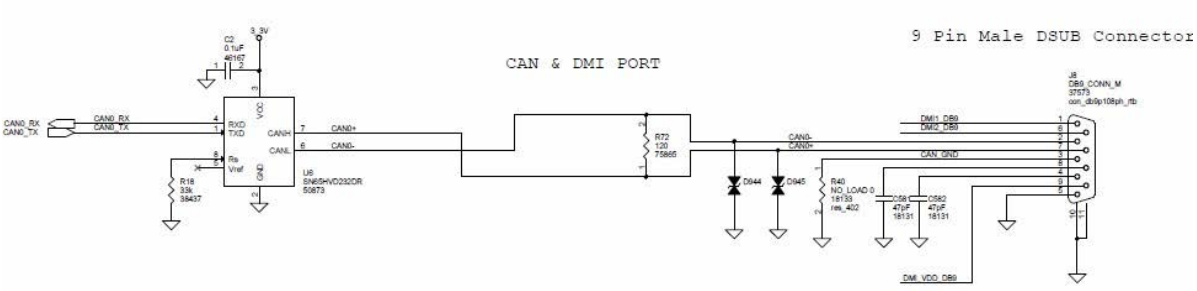

ETHERNET
J17
RJ45 Conn
40613
ET_TD+
ET_TD-
ET_RD+
ET_RD-
R642 49.9 46791
R643 49.9 46791
R644 49.9 46791
R645 49.9 46791
R646 49.9 46791
R647 49.9 46791
C555 1000pF 34058
Ethernet Surge protection. This part keeps the difference between plus and minus to 2.8V
D609
SLVU2.8-4
66647
C319 0.1uF 46167 trimble_lib:cap-402
C320 0.1uF 46167 trimble_lib:cap-402
R321 49.9 46791
R322 49.9 46791
R323 49.9 46791
R324 49.9 46791
T300
HX1188
50077
ETH_CON_RX-
ETH_CON_RX+
ETH_CON_TX-
ETH_CON_TX+
ETH_PHY_RX-
ETH_PHY_RX+
ETH_PHY_TX-
ETH_PHY_TX+
ET_RD-
ET_RD+
ET_TD-
ET_TD+
N/C
Si7423DN
Q205
66168
3_3V
C302 1000pF 17342
C306 1000pF 17342
C313 10uF 47472 trimble_lib:cap-805
R9841 100k 17366
Q12 BSS138 34404
VECTOR_DET*
VECTOR_DETECT*
D5
SLVU2.8-4
66647
Ethernet Surge protection. This part keeps the difference between plus and minus to 2.8V
ETHERNET
J14
RJ45 Conn

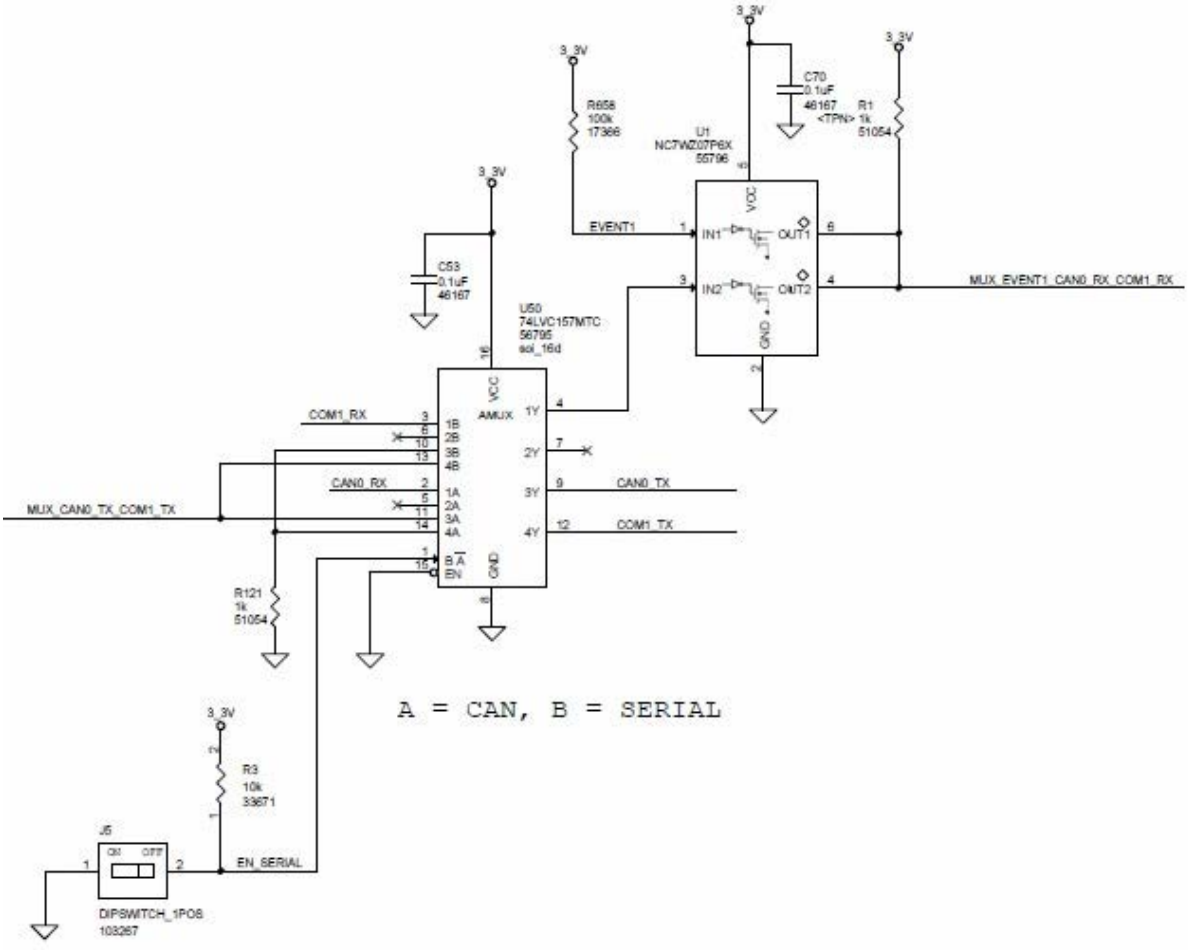
CAN

BD99X evaluation board CAN port

Com 4 is at 0 – 3.3 V TTL and is multiplexed with CAN. The receive line is also multiplexed with Event 1. The integrator must have a receiver configured to use the CAN port in order to use this port as a serial port. The functionality cannot be multiplexed in real time.

For development using the I/O board, this com port is already connected to a CAN transceiver. This is labeled CAN on the I/O board. J5, labeled ‘CAN’ and ‘SERIAL’, must be set to CAN. There shouldn't be anything connected to TP6, labeled Event 1.





5

Installation

Follow the guidelines in this chapter to install and mount the receiver.

Unpacking and inspecting the shipment

Visually inspect the shipping cartons for any signs of damage or mishandling before unpacking the receiver. Immediately report any damage to the shipping carrier.

Shipment carton contents

The shipment will include one or more cartons depending on the number of optional accessories ordered. Open the shipping cartons and make sure that all of the components indicated on the bill of lading are present.

Reporting shipping problems

Report any problems discovered after you unpack the shipping cartons to both Trimble Customer Support and the shipping carrier.

Trimble's customer support for the GNSS receiver can be reached at GNSSOEMsupport@trimble.com.

Installation guidelines

For the receivers to perform optimally, the following precautions should be taken or followed.

Considering environmental conditions

Install the receiver in a location situated in a dry environment. Avoid exposure to extreme environmental conditions. This includes:

- Water or excessive moisture
- Excessive heat greater than 75 °C (167 °F)
- Excessive cold less than –40 °C (–40 °F)
- Corrosive fluids and gases

Avoiding these conditions improves the receiver's performance and long-term product reliability.

Sources of electrical interference

Avoid the following sources of electrical and magnetic noise:

- Gasoline engines (spark plugs)
- Television and computer monitors
- Alternators and generators
- Electric motors
- Propeller shafts
- Equipment with DC-to-AC converters
- Fluorescent lights
- Switching power supplies

Mounting the antennas

Choosing the correct location for the antenna is critical for a high quality installation. Poor or incorrect placement of the antenna can influence accuracy and reliability and may result in damage during normal operation. Follow these guidelines to select the antenna location:

- If the application is mobile, place the antenna on a flat surface along the centerline of the vehicle.
- Choose an area with clear view to the sky above metallic objects.
- ***Avoid*** areas with high vibration, excessive heat, electrical interference, and strong magnetic fields.
- ***Avoid*** mounting the antenna close to stays, electrical cables, metal masts, and other antennas.
- ***Avoid*** mounting the antenna near transmitting antennas, radar arrays, or satellite communication equipment.

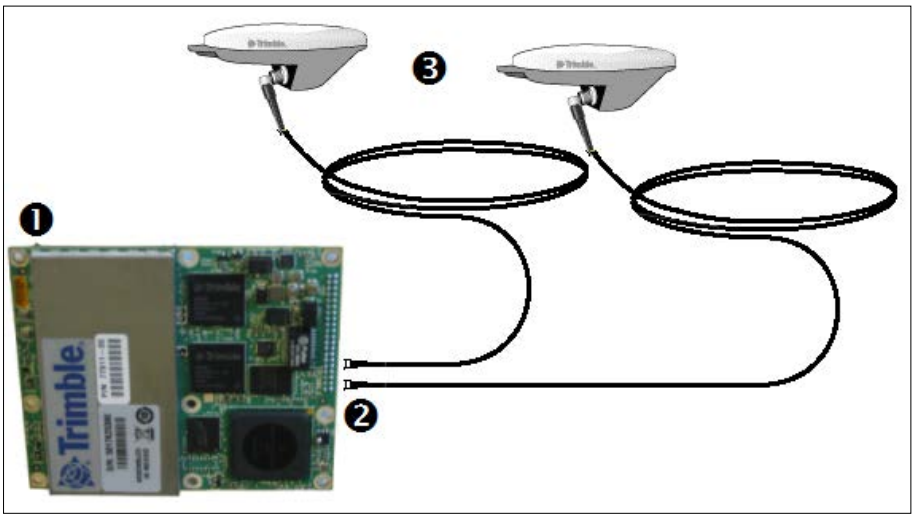
Routing and connecting the antenna cable

1. After mounting the antenna, route the antenna cable from the GPS antenna to the receiver.

   Avoid the following hazards when routing the antenna cable:

   - Sharp ends or kinks in the cable
   - Hot surfaces (such as exhaust manifolds or stacks)
   - Rotating or reciprocating equipment
   - Sharp or abrasive surfaces
   - Door and window jams
   - Corrosive fluids or gases
2. After routing the cable, connect it to the receiver. Use tie-wraps to secure the cable at several points along the route. For example, to provide strain relief for the antenna cable connection, use a tie-wrap to secure the cable near the base of the antenna.

   NOTE – When securing the cable, start at the antenna and work towards the receiver.
3. When the cable is secured, coil any slack. Secure the coil with a tie-wrap and tuck it in a safe place.



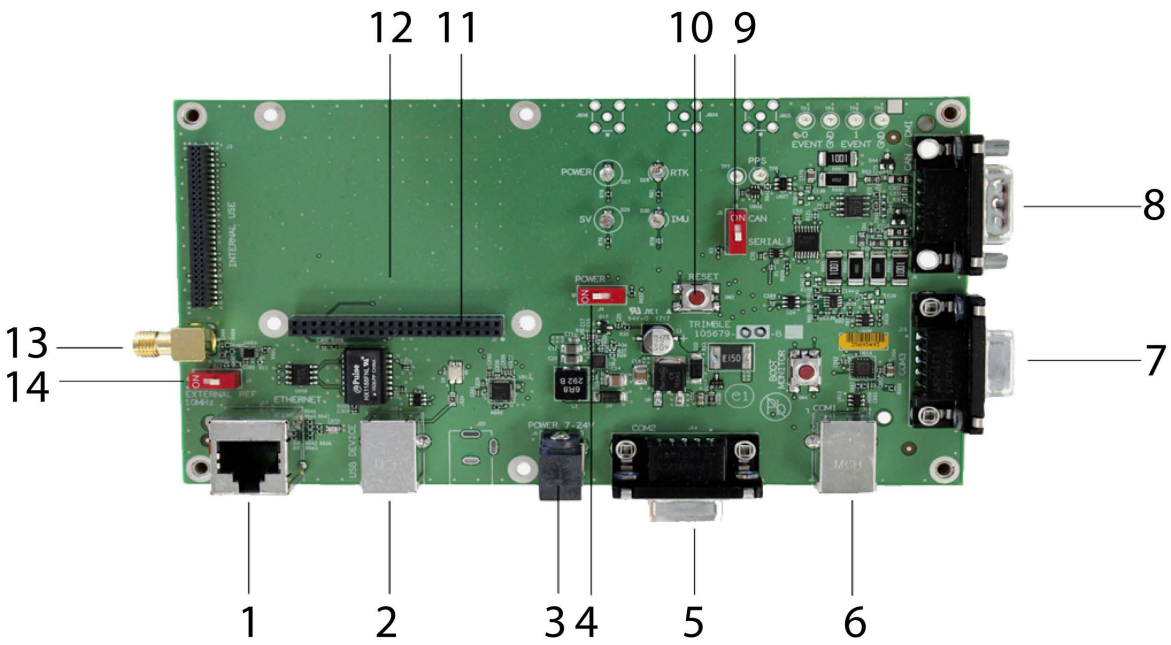
1 GNSS receiver **2** MMCX connectors **3** GNSS antennas

NOTE – The MMCX connector at the end of antenna cable needs a CBL ASSY TNC-MMCX connector to interface with the receiver module.

6

Evaluation Board Layout

Current or prospective customers can obtain schematic drawings of the evaluation I/O board by contacting GNSSOEMSupport@trimble.com.



1	Ethernet	**8**	D-Sub9 RS-232 CAN
2	Type-B USB port device	**9**	CAN/RS-232 switch
3	Power input	**10**	Reset button
4	Power switch	**11**	2 × 22 2 mm FEM header
5	D-Sub9 RS-232 COM 2	**12**	BD99x board location
6	Type-B USB VCP COM 1	**13**	External 10 MHz clock SMA connector
7	D-Sub9 RS-232 COM 3	**14**	Toggle "ON" external 10 MHz clock

The functionality to use an external 10 MHz clock (rather than the internal 10 MHz TCXO) requires that this clock is connected to the SMA connector (13) and that switch (14) is toggled “ON”, then the unit should be powered up. If switch (14) is toggled “ON” with no external 10 MHz clock to SMA connector (13), the CPU will not boot because no clock input is present.

LED operations

The LEDs indicate various operating conditions. Generally, a lit or slowly flashing LED indicates normal operation. A LED that is flashing quickly indicates a condition that may require attention, and an unlit LED indicates that no operation is occurring. The following tables defines each possible LED state.

Power LED

Receiver mode	Power LED
Off	Off
On. Healthy power	On
Monitor mode [1]	On
Logging data internally	Briefly flashes off every three seconds

Satellite LED

Receiver mode	Satellite LED
No satellites tracked	Off
Boot up	On
Monitor mode [1]	On
Searching for satellites	Flashes at 5 Hz

For dual-antenna configurations

Receiver mode	
Tracking satellites on both position and vector antennas.	Flashes at 1 Hz, then a high-frequency burst every five seconds.
Tracking satellites only on the position antenna. The vector antenna is not tracking.	Flashes at 1 Hz (the high-frequency burst does not occur).
Tracking satellites only on the vector antenna. The position antenna is not tracking.	Off, then a high-frequency burst every five seconds.

Correction LED

Radio mode	Correction LED
No receive or transmit	Off.
Monitor mode [1]	Flashes at 1 Hz (off and on equally).
Receive	Off, briefly blinking on when receiving corrections. This LED flashes when a correction is received. When receiving moving base corrections at 5 Hz, 10 Hz, or 20 Hz, the LED may either flash rapidly (at 5 Hz) or remain lit solid.

Radio mode	Correction LED
Transmit	On, briefly blinking off when transmitting corrections. This LED flashes off when a correction is transmitted. When corrections are received, often from MSS sources, the LED is a combination of the transmit and receive LED flashing.

IMU LED

Receiver mode	Power LED
No INS solution	Off
Coarse leveling	Flashes at 5 Hz
Degraded solution	Flashes at 2 Hz
Aligned solution	Flashes at 1 Hz

1 A condition where the receiver has booted into the monitor firmware, but not loaded the application firmware. It indicates firmware corruption or misconfiguration. When this occurs, a multiple LED pattern with the power and satellite LEDs are lit solid and the correction LED flashes at 1 Hz. To resolve monitor mode issues, cycle the power. If the problem persists, reload the firmware. If this does not fix the issue, please contact GNSSOEMsupport@trimble.com.


Trimble®