



# B111

## **GNSS Receiver Board**

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Hardware Integration Guide



# **B111**

## **Hardware Integration Guide**

Part Number 1018409-01

Rev A

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# Table of Contents

.....

<b>Preface</b> .....	<b>iv</b>
Terms and Conditions .....	iv
Use .....	iv
Copyrights .....	iv
Trademarks .....	iv
Disclaimer of Warranty .....	iv
License Agreement .....	v
Confidentiality .....	v
Website; Other Statements .....	v
Safety .....	v
Miscellaneous .....	v
About This Guide .....	v
Manual Conventions .....	vi
Intended Audience and Qualification .....	vi
Hardware and Firmware Versions .....	vi
Additional Documentation .....	vi
Revision History .....	vii
Getting Technical Assistance .....	vii
Check This First! .....	vii
Contacting Technical Support .....	vii
E-mail .....	vii
Website .....	viii
<b>Getting Acquainted</b> .....	<b>1</b>
Before You Start .....	1
Preventing Electrostatic Damage .....	1
Checking the Package Contents .....	2
Handling of the B111 Board .....	2
Installing TRU Software .....	2
Overview .....	3
Features .....	3
Board Layout and Main Hardware Components .....	4
Block Diagram .....	5
Minimum Requirements to Run the B111 .....	5

Hardware Components and Interfaces . . . . .	6
Connector Types . . . . .	6
Interface Connector . . . . .	6
GNSS Antenna Connectors . . . . .	6
Power System . . . . .	7
Primary Power Rail . . . . .	7
Backup Power Rail . . . . .	7
USB Device Power Rail . . . . .	8
Power Controls . . . . .	8
PBTN . . . . .	8
PORESET . . . . .	9
Sleep Mode . . . . .	9
STAT LED . . . . .	9
REC LED . . . . .	10
GNSS Antenna . . . . .	10
UART . . . . .	11
USB . . . . .	12
CAN . . . . .	13
1PPS . . . . .	13
Event Marker . . . . .	13
SD/SDIO . . . . .	14
General Purpose I/O . . . . .	14
Function Control . . . . .	15
Firmware Features . . . . .	15
Real-Time Kinematic Engine . . . . .	15
Network-based RTK Techniques . . . . .	16
Enhanced Positioning Engine (DION) . . . . .	16
Satellite Based Augmentation System (SBAS) . . . . .	17
Quartz Lock Loop . . . . .	17
File System . . . . .	17
Option Authorization File (OAF) . . . . .	18
Design Guidelines . . . . .	19
Board Orientation and Mounting . . . . .	19
Pin Numbering and Connectivity to Target Hardware . . . . .	19
Cooling/Heating Requirements . . . . .	20
General Guidelines . . . . .	20
Power . . . . .	20
USB . . . . .	20
SD/SDIO . . . . .	20

Approved SD Cards . . . . .	21
Product Compliance . . . . .	21
<b>Using Evaluation Board . . . . .</b>	<b>22</b>
Overview . . . . .	22
Connector and Component Locations . . . . .	23
Quick-Start to Run the B111 Installed on the Evaluation Board . . . . .	24
B111 Evaluation Board Components and Connectors . . . . .	26
GNSS Antenna Inputs . . . . .	26
Power Connectors . . . . .	27
Keys . . . . .	27
LEDs . . . . .	28
Jumpers . . . . .	28
Interface Connector . . . . .	29
Test Pads and Points . . . . .	31
UART Interfaces . . . . .	32
USB . . . . .	32
CAN . . . . .	33
SD Card . . . . .	33
Backup battery . . . . .	34
1PPS . . . . .	34
Event Marker . . . . .	34
<b>Specifications . . . . .</b>	<b>35</b>
Board Specifications . . . . .	35
Connector Specifications . . . . .	39
Interface Connector . . . . .	39
GNSS Antenna Connectors . . . . .	41
Mechanical and Schematic Drawings. . . . .	42
B111 Dimensions . . . . .	42
B111EVB Schematics . . . . .	43

# Preface



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Please read the terms and conditions carefully.

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## About This Guide

Welcome to the B111 Hardware Integrator Guide!

This manual is designed to be a comprehensive hardware guide to the B111 GNSS board. The material in this manual describes the features, hardware components, installation, operation, and specifications of the B111 board.

In addition, this manual describes the features and functionality of the B111 Development Kit, which includes the evaluation board, software, and all necessary cables.

## Manual Conventions

This manual uses the following conventions:

Convention	Description	Example
<b>Bold</b>	Menu, or drop-down menu selection	<b>File</b> ▶ <b>Exit</b> (Click the <b>File</b> menu and click <b>Exit</b> )
	Name of a dialog box or screen	From the <b>Connection</b> screen...
	Button or key commands	Click <b>Finish</b> .
Mono	User supplied text or variable	Type <code>guest</code> , and click <b>Enter</b> .
<i>Italic</i>	Reference to another manual or help document	Refer to the <i>Topcon Reference Manual</i> .



Further information to note about system configuration, maintenance, or setup.



Supplementary information that can have an adverse affect on system operation, system performance, data integrity, measurements, or personal safety.



Notification that an action has the potential to result in system damage, loss of data, loss of warranty, or personal injury.

## Intended Audience and Qualification

This manual is intended for system engineers, system designers, and programmers who are integrating the B111 board to their products to achieve GNSS positioning capabilities.

It is highly recommended that installation, commissioning, use, and maintenance of the B111 board are preformed by personnel trained in electronics.

## Hardware and Firmware Versions

The information in this manual corresponds to the following hardware and firmware versions:

- B111 board hardware revision 6.7.
- B111EVB board hardware revision 2.3
- GNSS firmware version 5.1p1

## Additional Documentation

The following documentation can be useful while working with the B111 board:

- *Maintenance Guide* (1020733-01) – explains how to maintain the B111 for various tasks using GRIL commands.
- *GRIL Reference Manual* (27-040004-01) – contains an exhaustive description of the GNSS Receiver Interface Language (GRIL) used to communicate and control a TPS receiver, including the B111.
- *TRU Help* – explains how to install, set up, and use the TRU software on desktop computers and hand-held controllers.



## Revision History

Revision	Date (yyyy-mm-dd)	Changes
A	2017-Apr-03	Initial release of the B111 Hardware Integration Guide.

## Getting Technical Assistance

Should you have any questions about the B111 or experience any problems with this board, contact Topcon OEM Solutions technical support for immediate and comprehensive assistance.



Do not attempt to repair equipment yourself. Doing so will void your warranty and may damage the hardware.

## Check This First!

Before contacting Topcon OEM Solutions technical support, check the following:

- Check all external board connections carefully to ensure correct and secure connections. Double check for worn or defective cables.
- Check all power sources to ensure their correct operation.
- Check that the most current software is downloaded onto the computer and that the most current firmware is loaded into the board. Check the Topcon [TotalCare](#) support website for the latest updates.
- Check that the desired OAF options are enabled in the board.  
Then, try the following:
  - Reset the board using TRU (**Tools ▶ Reset Receiver**) or a GRIL command (`set,/par/reset,yes`).
  - Restore default settings using TRU (**Tools ▶ Reset Parameters**) or a GRIL command (`init,/setup/`).
  - Clear the NVRAM using TRU (**Tools ▶ Factory Reset**) or a GRIL command (`init,/dev/nvm/a`).

If the problem persists, see the following section for contact information.

## Contacting Technical Support

If the troubleshooting hints and tips in this guide fail to remedy the problem, contact Topcon OEM Solutions technical support.

### E-mail

To contact Topcon OEM Solutions technical support via e-mail, use the [OEMsupport@topcon.com](mailto: OEMsupport@topcon.com) electronic mail address.

When e-mailing TPS technical support, provide the following information for better, faster service:

1. The board model and configuration settings. This information can be retrieved using TRU **▶ Information ▶ Save to File**. Save the receiver's output to a text file. Attach this file to the email and submit it to Topcon OEM Solutions technical support.
2. The system/hardware specifications for the computer running TRU or a custom application; such as, operating system and version, memory and storage capacity, processor speed, etc.
3. The symptoms and/or error codes/messages that precede and follow the problem.
4. The activities being tried when the problem occurs. If possible, include the exact steps being taken up to when the error message or other problem occurs.
5. How regularly the problem occurs.

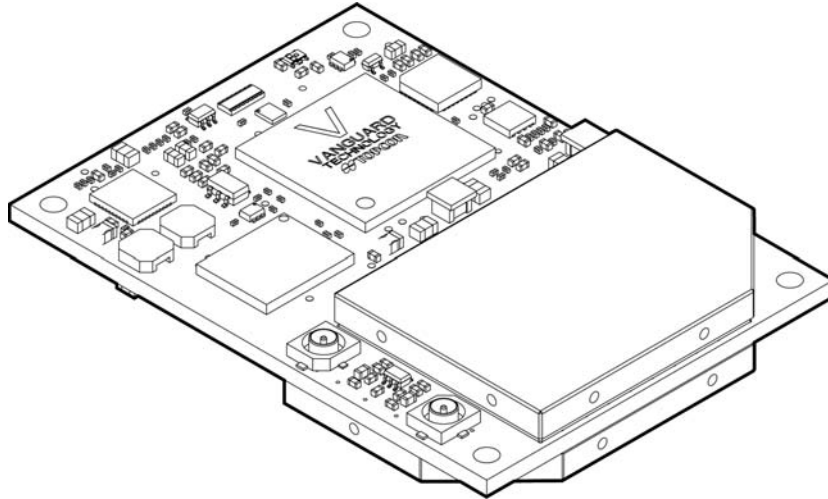
Generally, an OEM Solutions technical support representative will reply within 8 business hours or less, depending on the severity of the problem.

**Website**

The Topcon Positioning Systems website provides current information about Topcon's line of OEM products. For more information about OEM products, visit [www.topconpositioning.com/oem](http://www.topconpositioning.com/oem).

# Getting Acquainted

The B111 board is the advanced and flexible multi-frequency GNSS receiver designed for OEM applications. Building on the proven platform of the B110 and the success of the Vanguard™ chip, the B111 offers expanded tracking capabilities while maintaining the B110 heritage of compact footprint and low power consumption.



**Figure 1: B111 Board**

## Before You Start

Before using the B111 board, it is recommended to read the following sections. They were especially designed to help you correctly integrate, setup, and operate the board.

## Preventing Electrostatic Damage

The B111 board contains electronic components that are sensitive to electrostatic discharge (ESD). It can occur suddenly and without any visible effect at any point throughout unpacking, installing, test, or operational processes. If not properly controlled, a discharge of static electricity can badly affect or even damage the board. To protect your board from the effects of static damage, implement the following methods of ESD control:

- All manipulations with the board must be performed within an ESD-protected area. Such an area must meet certain environment conditions and contain materials and equipment designed to minimize the damage from ESD.
  - The relative humidity must be maintained above a minimum of 30% in the ESD-protected area.
  - The board must be kept and transferred in an ESD-protective container, for example, in a static-safe bag.
- All personnel and equipment within the ESD-protected area must be properly grounded to ensure they are at the same electrical potential.
  - A wrist strap must be worn snugly against the user's bare skin and be connected to the common point ground. The wrist strap must also have a current limiting resistor with a minimum of one megohm  $\pm 20\%$  resistance in the ground cord.
  - When standing or walking around in your working area, it is highly recommended to use ESD protective floors in conjunction with ESD control footwear or foot straps. All these items must also be properly grounded to the common point ground.

For additional information about ESD control procedures visit the ESD Association website at [www.esda.org](http://www.esda.org).

## Checking the Package Contents

When you unpack the B111 package, verify that you received all of the items listed in this section. Inspect the B111 board and other items included to ensure that they have not been damaged during shipment. Verify that all components are mounted on the board and appear intact.

If any of the items are missing or damaged, contact your Topcon dealer or Topcon technical support. See [“Contacting Technical Support” on page vii](#) for contact information.

Retain the factory packaging for storage and/or in case there is a need to return the board.

The development kit (p/n 1006143-01) includes the following items:

- B111EVB evaluation board with assembled standoffs and jumpers (p/n 05-100702-01LF)
- two RF cables (p/n 14-004159-01LF)
- standard null-modem cable (p/n 14-008086-01)
- USB cable (p/n14-008081-01)
- three jumpers (p/n 280060LF)
- power supply with cable for North America (p/n 60815)

The B111 board is available as a standalone module in single unit and volume quantities. A standalone package does not include the B111EVB board, cables, jumpers, and power supply.

## Handling of the B111 Board

Handle the board by the edges only. Avoid touching the connector pins or any other electronic components of the board.

## Installing TRU Software

TRU is a Windows® software application designed for configuring GNSS receivers, including GNSS OEM boards, modem boards, and Bluetooth modules.

Computer requirements for TRU are: Microsoft® Windows XP or newer and an RS-232C or USB port or computer with Bluetooth wireless technology.

This software is available on the Topcon [TotalCare](#) support website to registered users.

After downloading the program from the website, extract the program’s files into a folder on your hard drive.

To install TRU on a PC:

1. Navigate to the TRU folder, and double-click **TRU.zip**.
2. Extract **TRU.exe** to a folder.
3. Double-click **TRU.exe** to run the installer, and then follow the on-screen instructions.

To uninstall TRU, use **Add or Remove Programs** in Microsoft® Windows.

# Overview

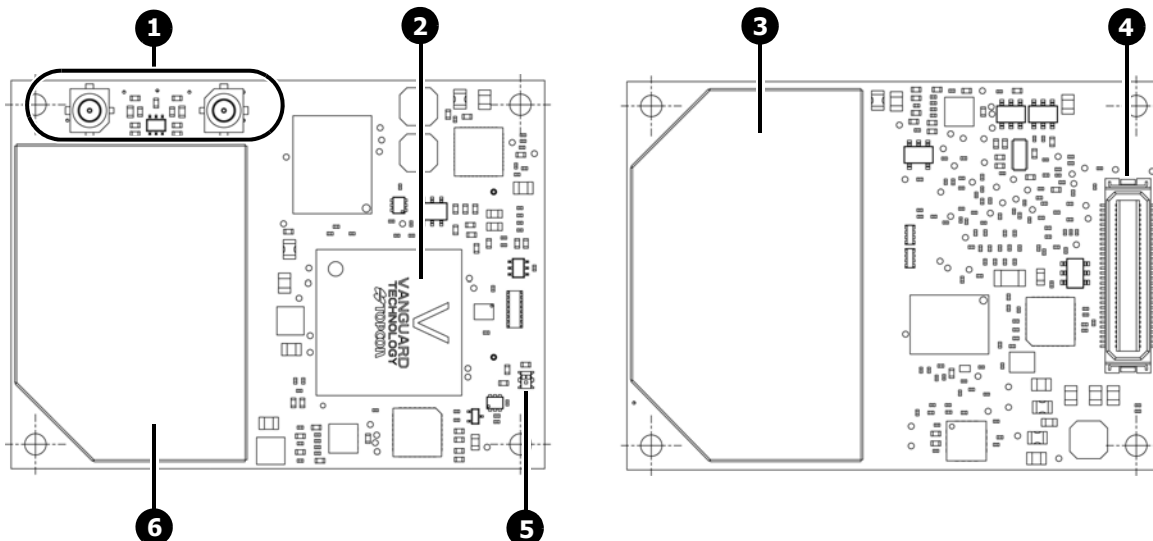
## Features

- **Vanguard RF™** and **Vanguard™** chips – A potent blend of the latest Topcon developments in digital and analog processing that delivers 224 universal channels and up to 100 Hz measurement and position-velocity-time update rates.
- **Future-proof signal tracking** – Receiving and processing GPS, Glonass, Galileo, BeiDou, and QZSS signals.
- **Multi-frequency RTK engine** – Powerful and robust RTK engine designed for single-base and network operations.
- **DGNSS** – Ground-based and satellite-based submeter positioning using L1 code measurements.
- **Doppler filter** – Configurable bandwidth to minimize the noise and dynamic errors in the velocity output.
- **Velocity filter** – Second stage of velocity filtering for even smoother velocity output.
- **DION** – Enhanced absolute positioning engine that allows you to use a single B111 to compute smoothed and consistent position solutions.
- **HD2** – 2-D attitude determination using a pair of B111 boards.
- **1PPS** – Highly-reliable and very accurate reference timing source for external devices.
- **Event input** – Accurately record the time an external event occurs in the specified reference time.
- **Multipath mitigation** – Considerable mitigation of C/A code and carrier phase multipath errors using a proprietary signal processing algorithm.
- **Quartz-Locked Loop (QLL)** – Permanent monitoring, detection, and isolation of the vibration-induced frequency deviations for improved survivability and performance of a B111 in dynamic applications.
- **Adjustable phase-locked and delay-locked loops** – Optimize the tracking performance by adjusting the parameters of the PLLs and DLLs.
- **Two RS-232C interfaces and two LVTTTL interface** – Full-duplex, independent, and fully configurable RS-232C and LVTTTL serial ports with data rates of up to 460.8 Kbit/s.
- **High-speed USB 2.0 interface** – USB device for board configuration and control from a PC.
- **SD/SDIO interface** – Record raw data files to a compact, removable, and solid storage medium.
- **CAN interface without transceiver** – CAN bus connection that conforms to the CAN specification 2.0 A/B and provides output of two NMEA 2000 messages.
- **On-board LED for tracking and operation awareness** – The board provides a STAT LED to view satellites and position status.
- **Five dedicated GPIOs for external LEDs** – Control the behavior of STAT and REC LEDs with the five dedicated GPIOs.
- **Command interface** – A rich set of commands, text and binary messages to control every part of your B111 board.
- **Dedicated pin for backup power source** – Implement a backup power source to ensure your settings and other valuable data are instantly saved to the NVRAM where they are securely retained for future usage.
- **File system** – A part of the firmware is a Topcon file system that allows you to create, store, retrieve, and delete the raw data files day by day with guaranteed file system integrity.
- **Automatic File Rotation Mode** – Automatically close and open tps files at scheduled, evenly spaced times.
- **Advanced Input Mode** – Enable any port to handle multiple formats of data simultaneously. Whether they are GRIL commands or RTCM messages, AIM will recognize them and forward each to the proper decoder, all through the same port.
- **Job Programming** – Configure time-based scheduling to run single or multiple GRIL commands for automatic processing 24 hours a day, 7 days a week.
- **Output Duplication** – Duplicate the same output data to ports without making the board to generate these data for each port.

- **Pass-through Mode** – Any board port becomes a transparent channel, which passes through all input data to another port of your choice with or without interpretation of input data. Furthermore, a bidirectional transparent channel which passes through all input data from one port to another and vice versa can easily be established.
- **Universal Break Sequence** – Never have your board locked up because of unresponsive ports.
- **Sleep mode** – Minimize power consumption by putting the board in a dormant state and awake it up at a specified GPS time.

## Board Layout and Main Hardware Components

Figure 2 shows the B111 board layout and identifies major hardware components.



**Figure 2: B111 Layout**

Table 1 describes component functions and features.

**Table 1. B111 Components**

No.	Component (Board Reference)	Description
1	Antenna connectors (J100, J101)	The GNSS antenna connectors of Hirose H.FL Straight Through Hole are used for connecting GNSS antennas. For antenna requirements, see <a href="#">"GNSS Antenna" on page 10</a> . For connector details and pin descriptions, see <a href="#">"GNSS Antenna Connectors" on page 41</a> .
2	Vanguard chip (U301)	The Vanguard chip manages satellite measurement data from the RF section, controls system memory, navigation processing and communication interfaces.
3, 6	RF section with Vanguard RF chip	The radio frequency section receives, amplifies, and filters the incoming satellite signals.
4	Interface connector (J400)	The interface connector is used for data transfer, board management, and power distribution. For connector details and pin descriptions, see <a href="#">"Hardware Components and Interfaces" on page 6</a> and <a href="#">"Interface Connector" on page 39</a> .
5	STAT LED (D302)	The STAT LED displays the status of the tracked satellites. For blinking patterns and their meaning, see <a href="#">"STAT LED" on page 9</a> .

## Block Diagram

A simplified hardware architecture of the B111 is shown in Figure 3.

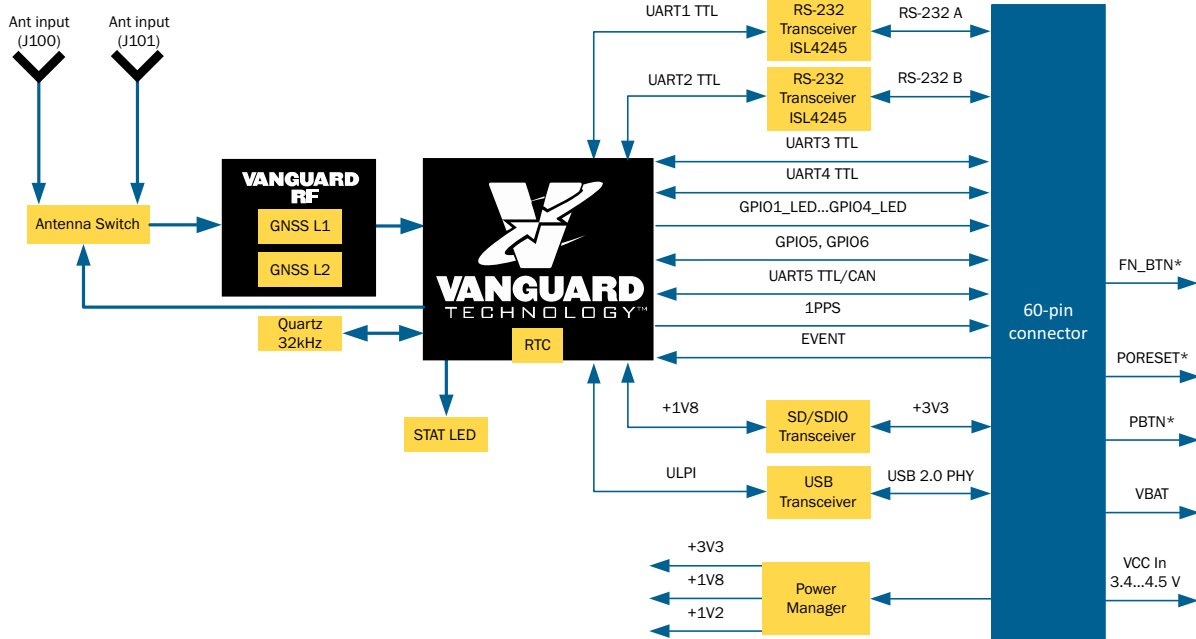


Figure 3: B111 Block Diagram

## Minimum Requirements to Run the B111

For a basic operation, the B111 requires a power supply with a constant voltage between +3.4 Vdc and +4.5 Vdc at a loading current of 2 A, corresponding GND connections, a single UART interface, and an active GNSS antenna connection.

The pins for the power supply, GND, and UART are located at the J400 connector as shown in Table 2. Pin no.1 is bottom-left and pin no.2 is top-left when you look at the connector with a metallic RF shield below.

Table 2. Minimum Pin Connection

Signal Name	Pin No.	Pin Locations
PWR_IN	55, 57, 59	
GND	56, 58, 60	
RS_RXDA, RS_TXDA	35, 36	
RS_CTSA, RS_RTSA	37, 38	

The GNSS antenna connection is at the J101.

# Hardware Components and Interfaces

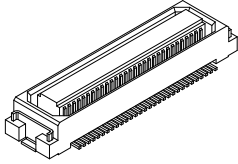
## Connector Types

The B111 uses a single interface connector and two GNSS antenna connectors.

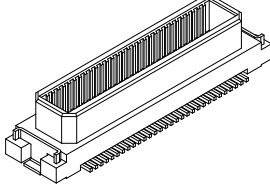
### Interface Connector

The interface connector J400 is used for data transfer, board management, and power distribution.

**Table 3. Interface Connector**

Manufacturer	Hirose ( <a href="http://www.hirose-connectors.com">http://www.hirose-connectors.com</a> )	
Manufacturer part number	DF17(3.0)-60DS-0.5V(57)	
Connector type	Female	
Number of rows	2	
Number of contacts per row	30	
Total number of contacts	60	

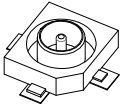
**Table 4. Mating Interface Connector**

Manufacturer	Hirose ( <a href="http://www.hirose-connectors.com">http://www.hirose-connectors.com</a> )	
Manufacturer part number	DF17(2.0)-60DP-0.5V(57)	
Connector type	Male	
Number of rows	2	
Number of contacts per row	30	
Total number of contacts	60	

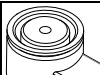
### GNSS Antenna Connectors

The B111 uses two GNSS antenna J100 and J101 connectors for connecting GNSS antennas.

**Table 5. GNSS Antenna Connectors**

Manufacturer	Hirose ( <a href="http://www.hirose-connectors.com">http://www.hirose-connectors.com</a> )	
Manufacturer part number	H.FL-R-SMT(10)	
Connector type	Male	

**Table 6. Mating GNSS Antenna Connectors**

Manufacturer	Any	
Connector type	H.FL Female Jack	



## Power System

The B111 operates various on-board components via three power rails:

- Primary power rail
- Backup power rail
- USB device power rail

### Primary Power Rail

The B111 uses the primary power rail to power Vanguard RF and Vanguard chips, system memory, communication interfaces, antennas, and other electronic components. The primary power rail requires an input voltage range from +3.4 Vdc to +4.5 Vdc at a loading current of 2 A and less than a 150 mV ripple voltage.



A 2-Amps power supply is required to handle a peak inrush current generated upon the board startup.

Connect all PWR\_IN pins on the connector J400 to an external power supply and the corresponding GND pins to a solid ground plane.

- PWR\_IN pins: 55, 57, 59
- Corresponding GND pins: 56, 58, 60

After connecting the external power supply to the PWR\_IN pins, an integrated power management IC (U303) generates three different, continuous voltages 1.2 V, 1.8 V, and 3.3 V required by the various on-board components.



The on-board power management IC filters out input noise and ripple, allowing you to use a loosely regulated power supply provided the input voltage falls within an acceptable range.



Applying inappropriate voltages to power pins can damage the B111 board or make its operations unstable, specifically:

- Exceeding the maximum input voltage can damage the B111 board or the connected equipment.
- Dropping below the minimum input voltage can cause improper performance of the B111 board or damage to the B111 board.

### Further Reading:

- Pin descriptions in ["Interface Connector" on page 39](#).
- Design guidelines about power system integration in ["Power" on page 20](#).

### Backup Power Rail

The B111 board uses the backup power rail to supply the power to an internal real-time clock (RTC) and the Non-Volatile Random Access Memory (NVRAM) when an external power supply has been discharged or removed.

The RTC stores the time and date information while the NVRAM keeps data required for satellite tracking and the current settings (such as elevation masks, serial port baud rate, etc.).

An on-board supervisory circuit monitors power supply conditions and automatically switches between the primary power rail and the backup power rail when needed.



A backup power source is not installed on the B111 board.

To implement backup functionality, you need to connect a backup power source to VBAT pin (no. 51) of the interface connector (J400). The backup power source must supply the voltage in the range of 1.8 V to 3.6 V. The recommended backup power source is either the Tadiran Batteries' lithium battery TL-4986/P or OmniCel battery ER22G68. These batteries are rated at about 5 years of operation at typical consumption and ambient temperature of 25° C.

The RTC and NVRAM draw approximately 14  $\mu$ A at ambient temperature of 25° C when the voltage from an external power supply is not applied. As long as the B111 is powered through the primary power rail, the RTC and NVRAM are sourced from this rail and draw no current from the backup power rail.

If you do not need a backup power for the RTC and NVRAM, leave the VBAT pin unconnected.



Without a backup power supply connected, the B111 will reset all settings to default values and a cold start condition will occur each time the B111 is power cycled.

#### Further Reading:

- Pin descriptions in ["Interface Connector" on page 39](#).
- Design guidelines about power system integration in ["Power" on page 20](#).
- An example of how the backup battery connects to the evaluation board in ["Backup battery" on page 34](#).

### USB Device Power Rail

If you use the USB interface in device mode, you need to provide a 5V input on the USB\_PWR pin (no. 25) of the interface connector J400 to power the USB device interface of the B111.

If you do not use a USB device, leave the USB\_PWR pin unconnected.

#### Further Reading:

- Pin descriptions in ["Interface Connector" on page 39](#).
- Design guidelines about power system integration in ["Power" on page 20](#).

### Power Controls

#### PBTN

The PBTN\* signal (pin no. 53 on J400) is an active-low input that powers up or down the B111 depending on how long the signal is LOW (GND).

**Table 7. PBTN\* Functions**

Function	Duration of LOW state	Description
Power-up	1-3 seconds	To power up the board, pull the signal LOW (GND) for more than 1 second and less than 3 seconds.
Power-down	3-10 seconds	To power down the board, pull the signal LOW (GND) for more than 3 seconds and less than 10 seconds.

The PBTN\* signal has an on-board pull-up resistor of 100 KOhm to 3.3 V and can be left unconnected if unused.

#### Further Reading:

- Pin descriptions in ["Interface Connector" on page 39](#).
- Design guidelines about power system integration in ["Power" on page 20](#).

## PORESET

The PORESET\* signal (pin no. 28 on J400) is an active-low input that causes the B111 board to enter the reset state.

To reset the board, pull the signal LOW (GND) for at least 0.1 second.

The PORESET\* signal has an on-board pull-up resistor of 10 KOhm to 3.3V and can be left unconnected if unused.

### Further Reading:

- Pin descriptions in ["Interface Connector"](#) on page 39.
- Design guidelines about power system integration in ["Power"](#) on page 20.

## Sleep Mode

You can put the B111 board into a dormant state to minimize power consumption without turning off the board completely. The board enters into sleep mode immediately after you send the corresponding GRIL command and stays in this mode until you turn on the board manually or the board detects any activity on serial ports A or B. You can also awaken the board from sleep mode at a specified GPS time using the wake-up option.

### Further Reading:

How to enter and exit sleep mode in [GRIL Reference Manual](#).

## STAT LED

The B111 board provides one STAT LED (D302) that displays the status of the tracked satellites. Table 8 lists the colors of the STAT LED blinks and their functions when the B111 is powered on.

**Table 8. STAT LED Color**

STAT LED Color	Description
Red	No satellites being tracked.
Green	The board is tracking GPS satellites; one blink per tracked GPS satellite.
Yellow	The board is tracking GLONASS satellites; one blink per tracked GLONASS satellite.
Cyan	The board is tracking GALILEO satellites; one blink per tracked GALILEO satellite.
Purple/magenta	The board is tracking BeiDou satellites; one blink per tracked BeiDou satellite.
Blue	The board is tracking QZSS satellites; one blink per tracked QZSS satellite.

When satellites are tracked, the sequence of blinks is as follows:

- One green blink for each tracked GPS satellite.
- One yellow blink for each tracked GLONASS satellite.
- One cyan blink for each tracked GALILEO satellite.
- One purple blink for each tracked BeiDou satellite.
- One blue blink for each tracked QZSS satellite.
- One red blink if the board is not tracking satellites or cannot compute a position. Otherwise, the board produces a pause.

The STAT LED is available through GPIO1\_LED...GPIO3\_LED (nos. 40, 34, and 33) pins of the J400 connector.

### Further Reading:

["General Purpose I/O"](#) on page 14.

## REC LED

The REC LED displays the data recording status of the SD card and other memory related information, such as memory initialization process, fault condition, etc., as shown in Table 9. The REC LED is available through GPIO4\_LED (no. 32) and GPIO5 (no. 30) pins of the J400 connector.

**Table 9. REC LED Color**

REC LED Color	Description
Blinking green	Data recording is in progress. Each blink indicates that data is being written to the storage medium. A maximum rate of the green blinks is 1 Hz.
Dark	No data are being recorded or the files are being deleted.
Blinking yellow	The storage medium is being initialized.
Solid red	Fault condition with the memory/file system: no more memory, no storage medium, no OAF for file logging, faulty memory or other hardware problem.

### Further Reading:

["General Purpose I/O" on page 14.](#)

## GNSS Antenna

The B111 board is primarily designed for use with Topcon active antennas. However, flexibility exists to accommodate for custom active antennas.



Topcon cannot guarantee the correct performance with other brands of GNSS antenna. Do not use passive GNSS antennas with the B111.

Before connecting an active GNSS antenna, consider the following operating conditions:

- For powering an LNA of the GNSS antenna connected to J100, the board supplies a voltage of +5.0 V to the central pin with the maximum antenna current equal to 100 mA.
- For powering an LNA of the GNSS antenna connected to J101, the board supplies a voltage of +3.3 V to the central pin with the maximum antenna current equal to 100 mA.
- Antenna's LNA gain should be in the range of 26 dB to 34 dB.
- The total attenuation of a cable running between the antenna and the B111 should not be more than 10–12 dB at 1.6 GHz.
- Antenna's VSWR should be  $\leq 2:1$ .
- Impedance should be 50 Ohm.
- The J100 connector corresponds to the `ext` value of the GRIL parameter `/par/ant/rcv/inp` and to the **External** value of the *GNSS Antenna* setting on the *Antenna* tab of Tracking & Positioning in the TRU software. The J101 connector corresponds to the `int` value of the GRIL parameter `/par/ant/rcv/inp` and to the **Internal** value of the *GNSS Antenna* setting on the *Antenna* tab of Tracking & Positioning in the TRU software.
- The B111 uses only one connector at a time. If you attach each connector to a separate antenna simultaneously, the board will by default use the satellite signals received from the antenna connected to J101. You can activate the J100 connector using the GRIL command `%%set, /par/ant/rcv/inp, ext`. To revert to the default connector J101, use the command `%%set, /par/ant/rcv/inp, int`.
- Antenna connectors J100 and J101 provide the same tracking performance and you can choose whichever you prefer. However, bear in mind that the antennas require different supply voltages as described earlier on this page.
- Do not connect J100 with J101.



When you are integrating the B111 to your final product, great care should be taken to shield GNSS antenna, its connectors and RF cables within the enclosure from other electronic equipment within the same enclosure.

The B111 board incorporates antenna detection circuitry, which senses the amount of current supplied to the antenna's LNA. This circuitry indicates one of the two conditions:

- normal – the antenna draws normal current or is not connected to the board.
- overload – the antenna draws current higher than expected. This condition occurs when the B111 board is subjected to a load (i.e., antenna) larger than it was designed for. It could also be reported when a short circuit occurs in the antenna, antenna cable, or the board.  
When an overload condition is detected, the board maintains a constant, safe level of output current until the overload condition is removed.

#### Further Reading:

- Details about the GNSS antenna connectors in ["GNSS Antenna Connectors"](#) on page 41.
- Overcurrent values used to trigger the overload condition in ["Board Specifications"](#) on page 35.

## UART

The B111 board features six UART interfaces:

- two UARTs are connected to an RS-232 transceiver (U405, ISL4245EIRZ from Intersil) and then routed to the J400 connector. You can connect these UARTs directly to RS-232 compliant devices.
  - serial interface A with flow control
  - serial interface B without flow control
- four LVTTTLs are connected directly to the J400 connector. External RS-232 transceivers are required if you want to translate these signals to the standard RS-232 voltage levels. The evaluation board uses the RS-232 transceivers MAX3225EEAP+ from Maxim Integrated.
  - serial interface D with flow control
  - serial interfaces C, E, and F without flow control

The RS-232C and LVTTTL interfaces support data rates up to 460.8 Kbit/s.

The serial interface E (UART5) and the [CAN interface](#) share the same pins and can be selected with jumpers as shown in ["Jumpers"](#) on page 28.



Serial ports A, B, C (UART3), and D (UART4) are the only ports you can use for control and data transfer. Ports E (UART5) and F (UART6) are used for internal communications.

**Table 10. B111 UART Signals**

Pin No.	Signal Name	I/O	Signal Level	Description
1	CAN_RX/UART5_CTS	I	LVTTTL	CAN Receive/UART 5, Clear to Send
2	CAN_TX/UART5_RTS	O	LVTTTL	CAN Transmit/UART 5, Request to Send
12	UART6_RXD	I	LVTTTL	Serial data input to UART 6
14	UART6_TXD	O	LVTTTL	Serial data output from UART 6
16	UART5_RXD	I	LVTTTL	Serial data input to UART 5
18	UART5_TXD	O	LVTTTL	Serial data output from UART 5
20	UART4_CTS	I	LVTTTL	UART 4, Clear to Send
22	UART4_TXD	O	LVTTTL	Serial data output from UART 3
24	UART4_RXD	I	LVTTTL	Serial data input to UART 4
26	UART4_RTS	O	LVTTTL	UART 4, Request to Send
35	RS_RXDA	I	RS-232	Serial data input to port A

**Table 10. B111 UART Signals (Continued)**

Pin No.	Signal Name	I/O	Signal Level	Description
36	RS_TXDA	O	RS-232	Serial data output from port A
37	RS_CTSA	I	RS-232	Port A, Clear to Send
38	RS_RTSA	O	RS-232	Port A, Request to Send
41	RS_RXDB	I	RS-232	Serial data input to port B
42	RS_TXDB	O	RS-232	Serial data output from port B
47	UART3_CTS	I	LVTTTL	UART 3, Clear to Send
48	UART3_RTS	O	LVTTTL	UART 3, Request to Send
49	UART3_RXD	I	LVTTTL	Serial data input to UART 3
50	UART3_TXD	O	LVTTTL	Serial data output from UART 3

**Further Reading:**

- General design guidelines in ["General Guidelines" on page 20](#).
- An example of how the UART interfaces connect to the 9-pin D-shell male connectors on the B111EVb in ["UART Interfaces" on page 32](#).
- GRIL commands used to configure UARTs in the [GRIL Reference Manual](#).

**USB**

The B111 incorporates one USB 2.0 device controller and a USB 2.0 transceiver chip (U402, TUSB1210BRHBR from Texas Instruments). The transceiver is connected to the device controller through a ULPI interface.

The USB 2.0 device (peripheral) interface supports high-speed and full-speed data rates.



The actual speed of data transfer over the USB interface is normally slower than the speed of the USB specification. This is dictated by various factors, including the board's processor loading, the performance of a host (usually, a computer), etc.

The device interface enables a USB host, such as a computer to connect to the B111 board for configuration and data exchange. In device mode, you need to install a USB driver onto a computer and provide a 5V input on the +USB\_PWR pin (no. 25) of the interface connector J400 to power the USB device interface.

Table 11 shows the USB signals and their functions.

**Table 11. B111 USB Signals**

Pin No.	Signal Name	I/O	Signal Level	Description
25	USB_PWR	I/O	+5V	+5V input in device mode
27	USB_D+	I/O	TTL	USB data plus
29	USB_D-	I/O	TTL	USB data minus

**Further Reading:**

- General design guidelines in ["General Guidelines" on page 20](#).
- Guidelines about USB device in ["USB" on page 20](#).
- An example of how the USB interface connects to the USB connector in ["USB" on page 32](#).
- A description of the file system in ["File System" on page 17](#).
- GRIL commands used to configure the B111 to record, store, and transfer TPS data files to and from the USB flash memory devices in the [GRIL Reference Manual](#).

## CAN

The Controller Area Network (CAN) is a serial communication protocol that allows multiple devices to communicate with one another using a common pair of wires. It has a high-integrity and high-performance architecture resistant to harsh environments. Because of these features CAN is now widely used in various embedded control applications. This protocol has been standardized internationally by the ISO (International Organization for Standardization).

The B111 board incorporates one CAN controller embedded to the Vanguard™ chip. The CAN controller conforms to the CAN specification 2.0 A/B and provides output of two NMEA 2000 messages, specifically PGN 129029 (GNSS Position Data) and PGN 129025 (GNSS Position Rapid Update).

The RX and TX lines of the CAN controller are extended directly to the interface connector J400 where the lines are shared with the [serial interface E](#) (UART5 RTS/CTS). You can select the functionality of these pins using jumpers as shown in ["Jumpers" on page 28](#).

**Table 12. B111 CAN Signals**

Pin No.	Signal Name	I/O	Signal Level	Description
1	CAN_RX/UART5_CTS	I	LVTTTL	CAN Receive/UART 5, Clear to Send
2	CAN_TX/UART5_RTS	O	LVTTTL	CAN Transmit/UART 5, Request to Send

To connect the CAN controller to the CAN bus line, you must use an external CAN transceiver. The evaluation board uses the CAN transceiver SN65HVD230QD from Texas Instruments.

### Further Reading:

- General design guidelines in ["General Guidelines" on page 20](#).
- How to configure various CAN settings, including the baud rate and node addresses, output of NMEA 2000 messages, etc., in the [GRIL Reference Manual](#).
- An example of how the CAN interface connects to a 9-pin D-shell female connector on the B111EV in ["CAN" on page 33](#).

## 1PPS

Modern synchronization and time transfer applications require a highly-reliable timing source. The B111 delivers the 1PPS (pulse-per-second) signals that provide a very accurate reference source for external devices. You can program the period, offset, edge, and time reference of the 1PPS signal using the GRIL commands. The board accommodates a single 1PPS output which is available through pin no. 44 of the interface connector J400.

### Further Reading:

- General design guidelines in ["General Guidelines" on page 20](#).
- Details on configuring the 1PPS functionality in the [GRIL Reference Manual](#).
- Specifications about the 1PPS signal, in ["Board Specifications" on page 35](#).

## Event Marker

The B111 can accurately record the time that an external event occurs in the specified reference time. You can program the period, offset, edge, and reference time of the event marker signal using the GRIL commands. The source of events may be a digital camera, sounding equipment, etc. The board accommodates a single event input which is available through pin no. 23 of the interface connector J400.

### Further Reading:

- General design guidelines in ["General Guidelines" on page 20](#).
- Details on configuring the event marker functionality in the [GRIL Reference Manual](#).
- Specifications about the event marker signal in ["Board Specifications" on page 35](#).



## SD/SDIO

The B111 boards includes an SD/SDIO host controller to interface with an SD/SDHC memory card for TPS data recording and storage.

The controller supports 1-bit protocol (one data channel) and 4-bit protocol (four data channels) with a built-in 512-byte buffer for read and write.

The signal levels of the host controller are shifted from 1.8 V on the board to 3.3 V at the J400 connector by the voltage-translation transceiver U406, TXS0206YFPR from Texas instruments.

**Table 13. B111 SD/SDIO Signals**

Pin No.	Signal Name	I/O	Signal Level	Description
3	SDCLKB	O	3.3V	SD clock
4	SDCMB	I/O	3.3V	SD command/response
6	SDCD	I	3.3V	SD card detect; internally pulled-up to 1.8V with a 100 KOhm resistor
7	SDAT3	I/O	3.3V	SD read/write data line 3
8	SDPWR	O	3.3V	Power +3.3V
10	SDWP	I	3.3V	SD write protect; internally pulled-up to 1.8V with a 100 KOhm resistor
11	SDAT2B	I/O	3.3V	SD read/write data line 2
15	SDAT1B	I/O	3.3V	SD read/write data line 1
19	SDAT0B	I/O	3.3V	SD read/write data line 0

### Further Reading:

- A description of the file system in ["File System" on page 17](#).
- General design guidelines in ["General Guidelines" on page 20](#).
- Guidelines about SD/SDIO in ["SD/SDIO" on page 20](#).
- SD cards approved for use in ["Approved SD Cards" on page 21](#).
- An example of how the SD/SDIO interface connects to the SD card slot in ["SD Card" on page 33](#).
- GRIL commands to record, store, and transfer TPS data files in the [GRIL Reference Manual](#).

## General Purpose I/O

The B111 board provides five dedicated GPIO signals with particular functions assigned to them. GPIO1\_LED through GPIO4\_LED and GPIO5 are configured as outputs. These GPIOs are not user-configurable. Table 15 lists GPIO signals and functions assigned to them.

**Table 14. B111 GPIO Signals**

Pin No.	Signal Name	I/O	Signal Level	Description
30	GPIO5	O	0...+3.3V	REC LED, red color; active-high
32	GPIO4_LED	O	0...+3.3V	REC LED, green color; active-high
33	GPIO3_LED	O	0...+3.3V	STAT LED, blue color; active-high
34	GPIO2_LED	O	0...+3.3V	STAT LED, green color; active-high
40	GPIO1_LED	O	0...+3.3V	STAT LED, red color; active-high

Although you can drive STAT and REC LEDs directly from these GPIOs through series resistors, it is highly recommended that you add buffers for ESD protection as shown in the evaluation board schematics on [page 43](#).

### Further Reading:

- For STAT LED blinking patterns and colors, see ["STAT LED" on page 9](#).
- For REC LED blinking patterns and colors, see ["REC LED" on page 10](#).



## Function Control

The GPIO6 signal (pin no. 54 on J400) is an active-low input that performs multiple functions depending on how long the signal is LOW (GND).

**Table 15. FN Functions**

Function	Duration of LOW state
Start/stop data recording to file(s)	More than 1 second and less than 5 seconds
Toggle occupation mode between static and dynamic	Less than 1 second while the file(s) is open <sup>a</sup>
Turn the baud rate of serial port A to 9600 bps	More than 5 seconds and less than 8 seconds
No action	More than 8 seconds

a. Occupation mode switch is selected in TRU.

You can also clear the NVRAM, set all parameters to default values, and power cycle the board using a combination of PBTN\* and GPIO6. Here is how you can do this:

- Pull the PBTN\* signal LOW (GND) for more than 3 seconds and less than 10 seconds to turn the board off.
- Pull the GPIO6 signal LOW (GND).
- Pull the PBTN\* signal LOW (GND) for about one second. Pull the PBTN\* signal HIGH (3.3V) while continuing to hold the GPIO6 signal LOW.
- Wait until the STAT and REC LEDs are green.
- Wait until the STAT and REC LEDs blink orange.
- Pull the GPIO6 signal HIGH (3.3V) while the STAT and REC LEDs blink orange.

Use an external pull-up resistor of 10 kOhm to 3.3V for the GPIO6 signal.

## Firmware Features

### Real-Time Kinematic Engine

The B111 board incorporates a highly innovative RTK engine developed at Topcon. It offers a host of new features and benefits blended with exceptional processing power. With the new RTK engine, the B111 provides unrivaled positioning system efficient, secure, and appropriate for any real-time application that requires accurate positioning solutions.

The following are some of the unique abilities available in the Topcon's proven RTK engine.

- Designed for world-wide use and ready for GNSS challenges of the field
- A greatly reduced amount of time needed for getting a fix
- Perfectly tailored to both network and single reference station RTK techniques
- Well suited for all kinds of baselines (short, medium, long)
- Continuous monitoring, catching and removing measurement anomalies to secure reliable positioning
- Carefully geared to handle up to 1 minute data-link delays
- Selecting among different linear combinations of observations
- New GNSS observations, such as GPS/GLONASS L2C, as well as Galileo E1, BeiDou B1/B2 and SBAS L1 are readily and seamlessly accommodated
- Instant controllability and flexibility that lets you optimize the engine performance over an extensive set of commands
- A variety of advanced options, specifically: a dedicated minimal signal-to-noise ratio for each satellite signal; feeding the engine with various observations; number of ambiguity subsets resolved per epoch, and more.

#### Further Reading:

How to configure the B111 for RTK base/rover using GRIL commands in the [GRIL Reference Manual](#).

## Network-based RTK Techniques

The RTK engine in the B111 board supports three widely used network RTK implementation techniques, specifically, VRS, FKP, and MAC.

**Virtual reference station (VRS).** The network software collects raw data measurements from several reference stations that belong to a network. These data are then estimated and processed to produce ionospheric and tropospheric corrections for each station and each satellite. After the rover receiver transmits its approximate position to the network software using an NMEA GGA message, the corrections are interpolated to the position of the rover. Interpolated corrections are used to reconstruct the measurements of pseudo range and carrier phase of a virtual reference station located close to the rover. The reconstructed measurements are transmitted to the rover as RTCM or CMR messages.

### Further Reading:

How to configure the B111 for VRS rover mode using GRIL commands in the [GRIL Reference Manual](#).

**Area correction parameters (FKP).** Unlike the VRS approach, the network software calculates coefficients for modeling ionospheric, tropospheric, and orbital effects for each satellite over a specific network area. The coefficients are then transmitted to the rover as RTCM message type 59, so that the rover can generate the corrections and apply them to its own observations to compute the position with high accuracy.

### Further Reading:

How to configure the B111 for FKP rover mode using GRIL commands in the [GRIL Reference Manual](#).

**Master-auxiliary concept (MAC).** This approach assumes the usage of one master reference station and a number of auxiliary reference stations to generate network correction messages. The master station transmits full raw observations and coordinate information while auxiliary stations transmit ionospheric and geometric correction differences and coordinate differences calculated between the master and each auxiliary station. The rover accepts all these data as RTCM 3 messages and applies them to get its own accurate position.

### Further Reading:

How to configure the B111 for MAC rover mode using GRIL commands in the [GRIL Reference Manual](#).

## Enhanced Positioning Engine (DION)

DION is an enhanced absolute positioning engine that allows you to use a single B111 to compute smoothed and consistent position solutions. Instead of using instantaneous yet rather noisy pseudorange measurements of an ordinary single point positioning, you can activate the DION engine to get more accurate and reliable results without the requirement of any additional hardware or software. What sets DION apart from other positioning engines is an innovative approach to combining the simplicity and availability inherent in the absolute positioning with the reliability and accuracy of the relative positioning.

Currently DION can be used in standalone and DGPS positioning modes. You can also enable it on a TPS receiver acting as a moving RTK base.

DION has two modes of operation:

- Smooth mode, used when you need to get a smooth variation of absolute or DGPS positions. In this mode, the absolute and DGPS positions obtained from pseudorange measurements will be smoothed by the refined delta positions obtained from the corresponding carrier phase measurements thus reducing the noise level of pseudorange measurements and removing position jumps.
- Local mode, used when you need to get a stable pass-to-pass accuracy at the decimeter level. This mode is ideal for applications where a vehicle (e.g, tractor) must follow and replicate the designated route. Local mode requires coordinates of the starting point entered in the B111.

### Further Reading:

How to configure the B111 for DION mode using GRIL commands in the [GRIL Reference Manual](#).

## Satellite Based Augmentation System (SBAS)

SBAS is designed to improve the accuracy and availability of, as well as ensure the integrity of, information broadcast from GPS satellites. It works by providing a net of ground stations that receive GPS signals, generating correction messages and uploading them to geostationary satellites. These correction messages are then broadcast to a GPS receiver using the GPS L1 frequency. The receiver applies these messages to correct for various errors that affect the measurements. In addition, the geostationary satellites can be used for positioning as ordinary GPS satellites, improving system availability.

The B111 supports the following SBAS services:

- The Wide Area Augmentation System (WAAS) – developed and operated by the Federal Aviation Administration (FAA) in the United States. WAAS uses two geostationary satellites, Galaxy 15 (PRN 135) and Anik F1R (PRN 138) to broadcast correction messages over the majority of the continental U.S. and large parts of Canada, Alaska, and Mexico. The system is fully operational and delivers submeter position accuracy provided all WAAS corrections for at least four GPS satellites are available.
- The European Geostationary Navigation Overlay Service (EGNOS) – developed and operated by the European Space Agency (ESA), the European Commission (EC), Eurocontrol, and the European Organization for the Safety of Air Navigation. EGNOS uses three geostationary satellites—AOR-E (PRN 120), ARTEMIS (PRN 124), and IOR-W (PRN 126)—to broadcast correction messages. Starting with 2 March 2011, EGNOS is fully operational and delivers submeter position accuracy using Open and Safety-of-Life services.
- The Multi-functional Satellite Augmentation System (MSAS) – developed and operated by the Japan Civil Aviation Bureau (JCAB) for civil Aviation and Meteorological Agency. MSAS uses two geostationary satellites, MTSAT-1R (PRN 129) and MTSAT-2 (PRN 137), to broadcast correction messages.

### Further Reading:

- Official information on WAAS at the GPS.gov website ([www.gps.gov](http://www.gps.gov)).
- Official information on EGNOS at the ESA website ([http://www.esa.int/Our\\_Activities/Navigation/The\\_present\\_-\\_EGNOS/What\\_is\\_EGNOS](http://www.esa.int/Our_Activities/Navigation/The_present_-_EGNOS/What_is_EGNOS)).
- Official information on MSAS at the Japan Meteorological Agency website (<http://www.jma.go.jp/jma/jma-eng/satellite/index.html>).
- Details on how to configure the B111 for SBAS using GRIL commands in the [GRIL Reference Manual](#).

## Quartz Lock Loop

GNSS receivers are often deployed in high-vibration environment such as machine control and construction equipment. In these severe environmental conditions, shock and vibration can cause significant frequency shifts in the receiver's quartz crystal. Such large frequency excursions degrade the receiver performance, leading to difficulties in maintaining continuous tracking of the satellite signals.

Topcon's Quartz Lock Loop (QLL) technology minimizes the vibration-induced impact through permanent monitoring, detection, and isolation of the frequency deviations thus improving survivability and performance of the B111 in dynamic applications.

### Further Reading:

Details on how to enable QLL in the [GRIL Reference Manual](#).

## File System

The B111 board records TPS data to a storage medium with a file system in which files and folders are organized in a hierarchical structure for storage and retrieval. As a storage medium, the B111 supports [SD/SDHC cards](#).

A storage medium must be formatted to a Topcon file system. The capacity of a storage medium is limited to 32 GB. You can record TPS data to up to a maximum of 2 simultaneous files at the rates shown in Table 16.

**Table 16. Recording Rates vs Number of Simultaneous Files**

<b>Recording Rate, Hz</b>	20	10
<b>Simultaneous Files</b>	1	≤2

The B111 supports faster recording rates (up to 100 Hz) but this may lead to a high CPU usage, which in turn will likely affect the overall performance of the board, including the positioning engines and the integrity of recorded files. To reduce the CPU usage and ensure the highest possible data recording rate, consider the following guidelines:

- Set the position update rate to a minimum, for example, 1 second.
- Change the maximum number of satellites used in positioning from the default of 64 to a lower number, for example, 15.
- Configure the board to track only relevant satellite measurements for your application.
- Optimize the number of recorded messages by excluding messages that are unnecessary for your application.

A total of 3000 files can be recorded and stored on a storage medium. When no memory remains, you can program the B111 to remove the oldest files automatically to make room for the newest files without having to replace the storage medium. You can also instruct the board what to do with data recording in the event of power failure.

The files that reside on the storage medium can be accessed and transferred to a computer via serial and USB ports of the B111 board. You can also access the files by connecting the SD/SDHC card to a Windows computer and using Windows Explorer or any other file utility to copy and delete the files from them.

#### Further Reading:

- Storage medium details in ["SD/SDIO" on page 14](#).
- SD cards approved for use in ["Approved SD Cards" on page 21](#).
- GRIL commands used to configure the B111 to record, store, and transfer TPS data files in the [GRIL Reference Manual](#).

## Option Authorization File (OAF)

Topcon Positioning Systems issues an Option Authorization File (OAF) to enable the specific options that customers purchase. An Option Authorization File allows customers to customize and configure the board according to particular needs, thus only purchasing those options needed.

Typically, all boards ship with a temporary OAF that allows it to be used for a predetermined period of time. When the board is purchased, a new OAF permanently activates desired, purchased options. The options remain intact when clearing the NVRAM or resetting the board.

The OAF enables the following kinds of functions. For a complete list of available options and details, visit the TPS website or consult your TPS dealer.

- Type of signal (standard L1 GPS; optional L2, GPS, GLONASS, BeiDou, QZSS; GALILEO E1)
- Update rate standard 20 Hz (optional up to 100 Hz)
- RTK at 1, 5, 10, and 20 Hz
- RTCM/CMR Input/Output
- 1PPS and Event Marker
- Quartz-looked loop
- Advanced multipath reduction
- Satellite Based Augmentation System (WAAS/EGNOS/MSAS)
- DION positioning
- RS-232C and USB port connectivity

## Design Guidelines

### Board Orientation and Mounting

The B111 board can be installed in any number of orientations within an enclosure. The board will operate and meet all specifications regardless of the mounting orientation.

The board has four mounting holes to install M2 metric machine screws. Always secure the board using all four mounting holes.

Care should be taken that the recommended tightening torque does not exceed 700 N/m (4 lbf/in).

#### Further Reading:

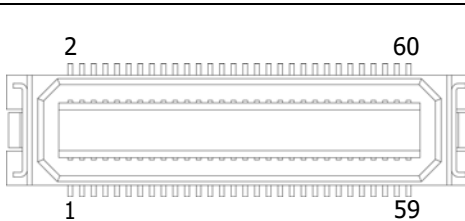
For mechanical layout, see ["Mechanical and Schematic Drawings"](#) on page 42.

### Pin Numbering and Connectivity to Target Hardware

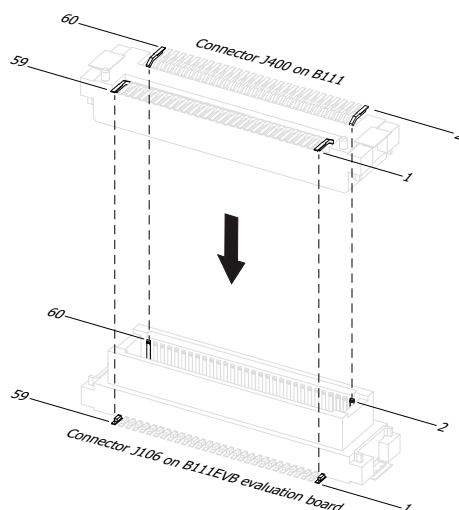
Make sure you attach the J400 connector to your target hardware properly. The J400 connector is unkeyed, which means that a potential risk exists to attach it to the mating connector backward.

To avoid attaching the connectors incorrectly, locate pin nos. 1, 2, 59, and 60 on the B111 as shown in Table 17 and make sure that these pins attach to the mating connector in your target hardware properly oriented.

**Table 17. J400 Pin Locations**

Pin No.	On-board Label	Location	Drawing
1	1	bottom-left	 <p>Also see <a href="#">"Interface Connector"</a> on page 39.</p>
2	2	top-left	
59	59	bottom-right	
60	60	top-right	

The following figure shows you how the J400 connector on the B111 attaches to the mating connector on the B111EVB evaluation board.



**Figure 4: Pins Orientation**

## Cooling/Heating Requirements

The board does not require any special thermal management when using within the operating temperature range. However, if you expect to use the board outside the specified operating range, you must provide adequate cooling/heating to maintain proper thermal management of the board.

### Further Reading:

“Board Specifications” on page 35 for operating and storage temperature ranges.

## General Guidelines

- The J400 connector provides 11 ground pins. Ensure that all of them are connected to a solid ground plane.
- Always power off the B111 and B111EVB before connecting/disconnecting cables, SD cards, and jumpers.
- Identify pin no. 1 of each interface or jumper by looking at the back side of the B111EVB. Pin no. 1 is always marked by a square soldering pad.

## Power

When designing a power supply for the B111, observe the following guidelines to ensure secure and continuous operation of all system components:

- Make sure that the total impedance of the power source is below 100 mOhm.
- The response time of the power source must be as quick as possible.
- Use decoupling capacitors to deliver high peak current pulses without too much drop in the input voltage.
- For the correct power-up sequence, the B111 must be powered up before any connected peripheral devices receive power.
- For the correct power-down sequence, remove power from any connected peripheral devices, then power down the B111.

## USB

Observe the following guidelines for connecting a USB2.0 PHY transceiver chip to an external USB mini-AB connector using the USB interface signals of the B111 connector.

- Verify with an impedance calculator that trace spacing and trace width used on the specific board stackup results in 90 Ohm differential impedance.
- Maintain parallelism between USB differential signals needed to achieve 90 Ohm differential impedance between D+ and D- for the entire routed length.
- Minimize the length of high-speed clock and periodic signal traces that run parallel to the USB signal lines to minimize crosstalk. High speed and periodic signals should be kept at least 50 mils away from USB D+/D-.
- All other signals should be kept at least 20 mils away from the high-speed USB signal pairs to help prevent crosstalk.
- Use an external pull-down resistor of 10 kOhm for a USB device.

### Further Reading:

These guidelines are also available at [www.usb.org](http://www.usb.org) in the Developers area.

## SD/SDIO

- Design an SD card placement as close as possible to the B111 board to minimize trace lengths from the B111 to the SD card connector. Total trace length should not exceed 5 cm (1.97 in).
- Maintain equal trace lengths.
- Trace widths should be uniform.
- Minimize signal noise and ensure signal integrity by installing series resistors of 22 to 32 Ohm on all data, clock, and command lines.
- Avoid crossing plane splits as this will degrade signal integrity and increase radiated emissions.

- Preserve data integrity by installing or removing the SD card only when the B111 board is powered off.

## Approved SD Cards

SD cards used with the B111 must be industrial-grade and have single-level cell (SLC) memory. Many other SD cards may work but Topcon cannot guarantee their performance and reliability.

## Product Compliance

TPS does not consider the B111 to be a finished end product. The B111 must only be used for incorporation into a final product. The user is then responsible for ensuring that the final product has been tested for electromagnetic compatibility and found to comply with the regulation standards before the product can be marketed.

# Using Evaluation Board

The [development kit](#) includes the B111 evaluation board (B111EVB). The B111EVB is a hardware development platform that will help you rapidly explore and evaluate features and performance of B111 and develop hardware and software solutions for designs based on the B111 board. You can also use the evaluation board as a reference design for development of your hardware in which the B111 is installed. Complete schematics and BOM are available under a Non Disclosure Agreement (NDA) to reduce your development costs and time as well as minimize design risks and test time.



The B111EVB is designed for use in controlled laboratory environments only.

## Overview

The B111EVB provides the following features and communication interfaces:

- Two GNSS antenna inputs
- Interface connector for the B111
- Two power supply connectors
- Six RS-232 D-sub serial interfaces
- One USB device type mini-AB connector
- One CAN 2.0 A/B port
- One SD slot
- One 1PPS output
- One event marker input
- Backup battery
- Three push buttons for power on, reset, and function
- Two LEDs for satellite tracking and recording files
- Three jumpers
- Two test pads and 62 test points



Observe the following safety precautions before performing any installation procedures.

Always ground yourself to remove any static electricity before you begin the installation procedure. Use a grounding wrist strap at all times.

Alternatively, you can touch an unpainted, grounded metallic surface to discharge any static charges from your body or clothing.

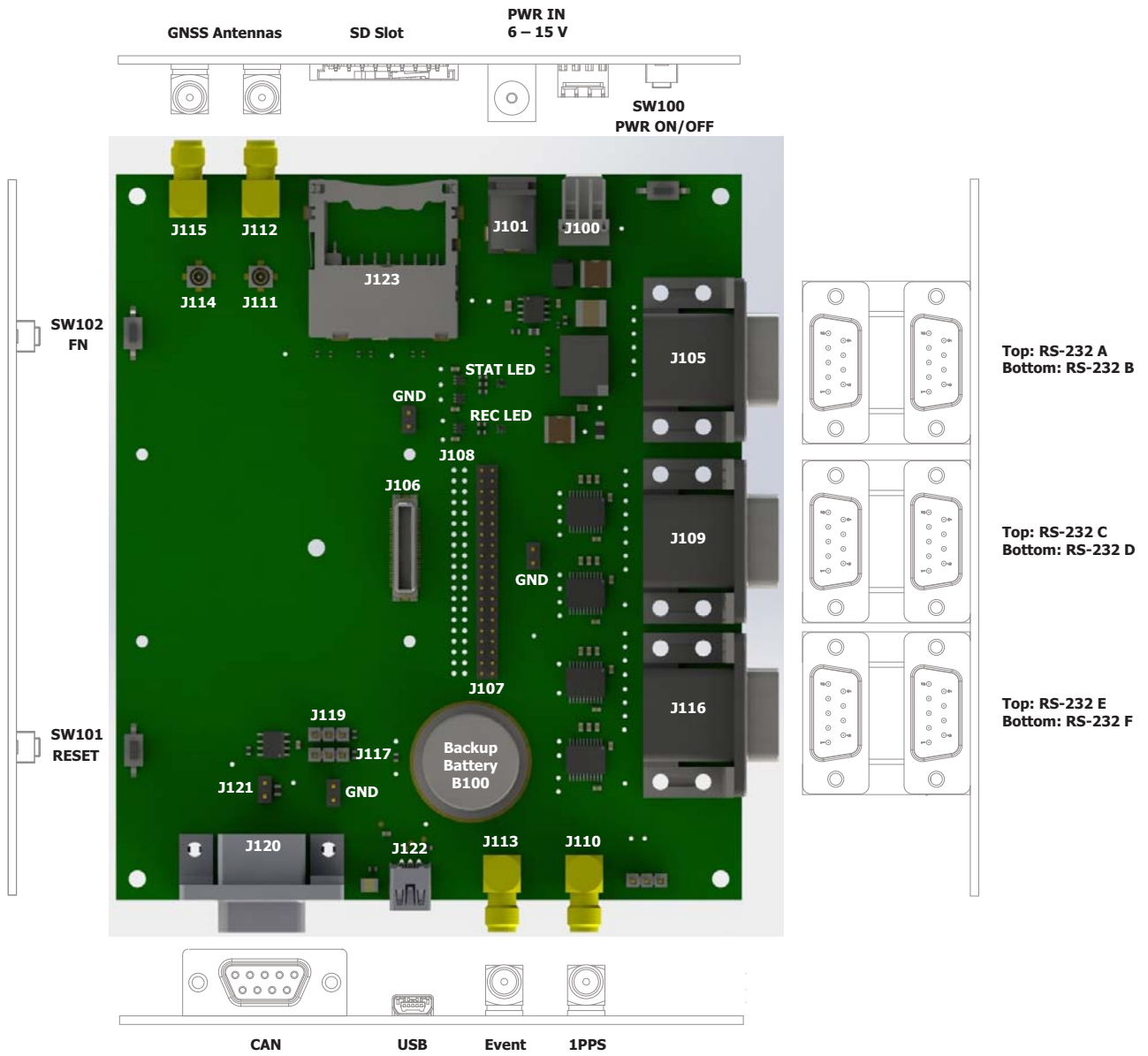
Place the B111, B111EVB, and other electronic components on a static-dissipative surface or in anti-static packaging when they are not in use.

Power up the B111 and B111EVB boards only after you complete all other connections. Making connections while the boards are energized can damage them.



# Connector and Component Locations

Figure 5 shows an annotated board layout with major components.



**Figure 5: B111 Evaluation Board Layout**



Hover the pointer over the desired connector or component. Once the pointer changes to a hand icon, click it. You will be automatically navigated to the page where the selected element is described in detail.



To return to the evaluation board layout figure on this page, click the evaluation board icon shown in the left margin.

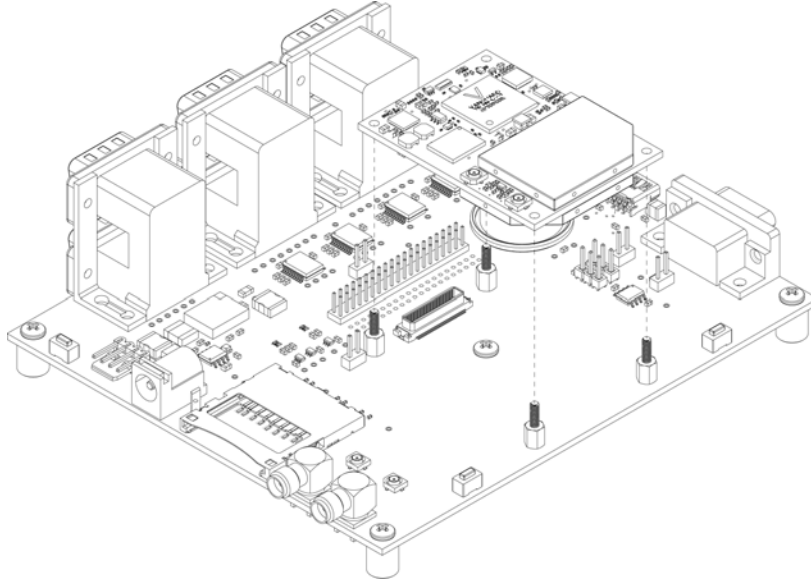
## Quick-Start to Run the B111 Installed on the Evaluation Board



Before taking the procedure, make sure the following conditions are met:

- You are discharged from electrostatic charges.
- The B111 and B111EVB boards are taken out of their protective bags.
- The B111EVB is positioned on an even, concrete surface.
- An active GNSS antenna has a clear view of the sky.

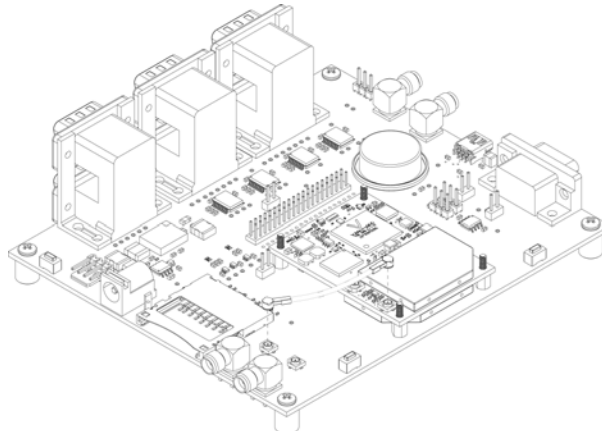
1. Locate the interface connector J400 on the B111 and align it with its mating connector J106 on the B111EVB board.
2. Mount the B111 board horizontally, with the interface connector J400 side down, onto the four standoffs of the B111EVB board until it is lying flat against the B111EVB board (Figure 6).



**Figure 6: Mounting the B111 onto the B111EVB**

Make sure that the B111 board is firmly seated in the place and the J400 connector is inserted to the J106 connector on the B111EVB all the way in for a secure mating contact.

3. Connect either end of the RF cable (p/n 14-004159-01LF) to the J101 connector on the B111 board. Connect the other end of the RF cable to the J111 connector on the B111EVB board.



**Figure 7: Antenna Connection – J101-J111 Connection**

Make sure that you insert the RF cable all the way in.



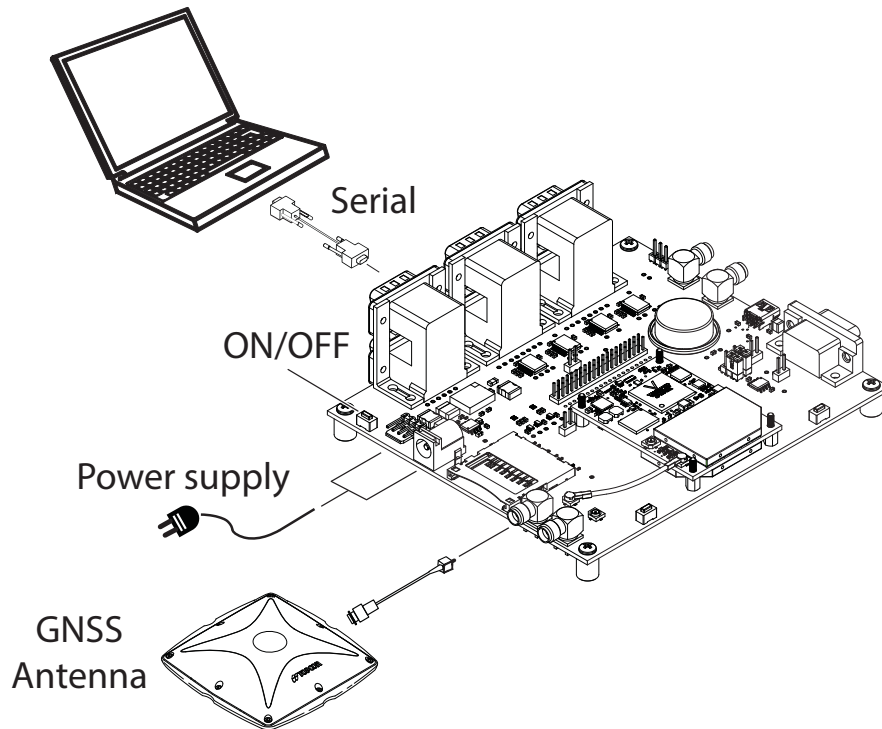
Do not connect J100 with J111 and J101 with J114.

- Connect the SMA end of GNSS antenna cable to the J112 connector on the B111EVB board. Connect the other end of GNSS antenna cable to an active antenna.



Although the [development kit](#) includes some cables and adapters, your cabling system may require additional cable/adapters not included in the kit.

- Using a null modem cable, connect the corresponding port of your computer to the serial port A of the B111EVB. You can use a USB-to-serial port adapter, if your computer does not have a dedicated serial port.
- Connect the appropriate power supply unit to the power input J100 or J101 of the B111EVB board. Then plug the power supply to an available outlet.
- Turn on the B111 and B111EVB boards by pressing the **ON/OFF** key (SW100) for more than 1 second and less than 3 seconds until the LEDs will light up. The STAT LEDs on the B111 and B111EVB boards will start blinking for each tracked satellite as described in "[STAT LED](#)" on [page 9](#).

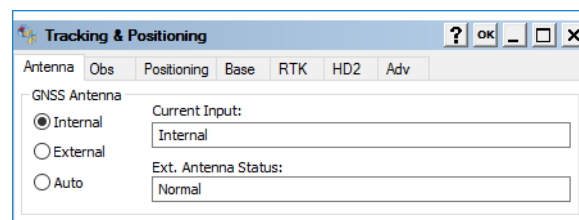


**Figure 8: Quick Connection**



Do not connect power supplies to J100 and J101 simultaneously. This might destroy the B111EVB and B111 boards.

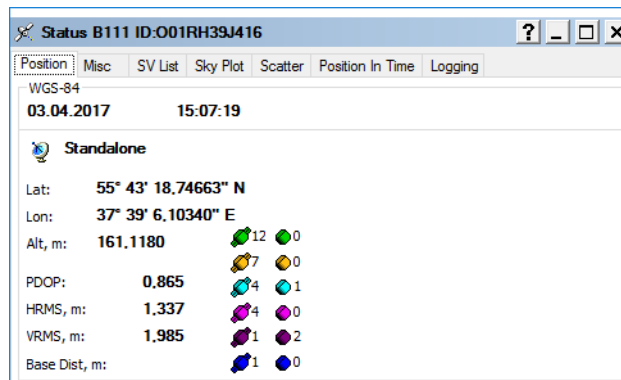
- Run TRU, click **Device ► Connect**, select **Serial Port** in **Connect Using** and your COM port in **Port Name**. Click **Connect**.
- Click **Receiver Settings ► Tracking & Positioning**. Make sure **GNSS Antenna** on the **Antenna** tab is set to Internal and **Current Input** shows Internal.



**Figure 9: J101 Antenna Status in TRU**

Click **OK** and **Back**.

10. Click **Status**. The **Position** tab will show you the current position of the receiver's antenna and basic tracking information for locked satellites.



**Figure 10: Position Tab in TRU**

11. You are successfully connected to the B111 and can continue with other configuration or operation functions as needed. For further information on how to configure the B111 for various tasks using the GRIL commands, parameters, and messages, see the [GRIL Reference Manual](#).

To turn off the B111 and B111EVB boards, press the **ON/OFF** key (SW100) for more than 3 seconds and less than 10 seconds until the LEDs go out, then release.

## B111 Evaluation Board Components and Connectors

### GNSS Antenna Inputs

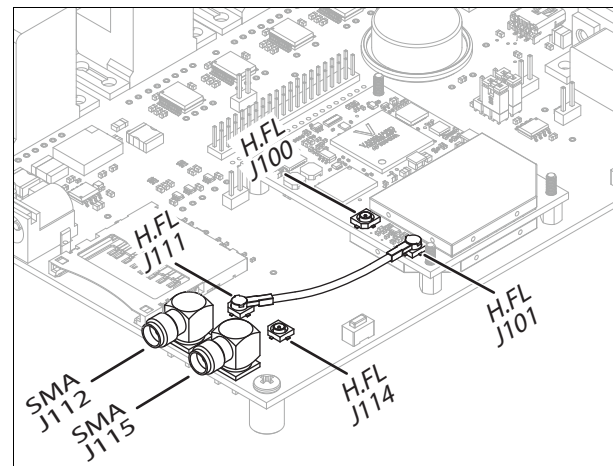


The B111EVB board provides two GNSS antenna inputs as shown on Figure 11. Each input consists of the Hirose H.FL receptacle (J111 or J114) and the SMA R/A receptacle (J112 or J115).

The connected B111 board will use only one input at a time. The B111 board must be connected to the antenna inputs on the B111EVB as follows:

- J100(B111) ▶ J114-J115(B111EVB)
- J101(B111) ▶ J111-J112(B111EVB)

If you attach each input to a separate antenna simultaneously, the B111 board will by default use the signals received from the antenna connected via J111-J112 input.



**Figure 11: Antenna Inputs**

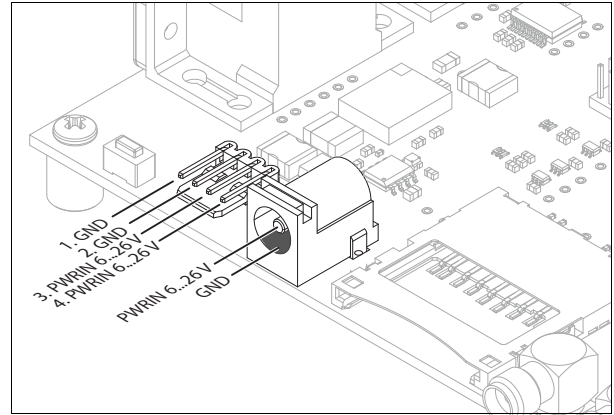
#### Further Reading:

- Guidelines on how to select and use a GNSS antenna in ["GNSS Antenna"](#) on page 10.
- Evaluation board schematics on ["B111EVB Schematics"](#) on page 43.

## Power Connectors



The B111EVB operates from an external power supply connected to either the power input J100 or J101. J100 is a 4-pin, 2.5 mm pitch, Molex PCB header of 5046 series (p/n 22-05-1042). It mates with the Molex Wire-to-Board headers of 51191 series. J101 is a 2mm/6.5mm, barrel-style, 16V/2.5A, RA power jack from CUI (p/n PJ-002A). The input voltage must be in the range of +6 Vdc to +26 Vdc. The DC voltage is then reduced and is distributed to the various components on the B111EVB and B111 boards. The power supply (p/n 60815) included to the [development kit](#) connects to the power input J101. For a connection to J100, you may use a custom cable or a Molex-to-banana plugs Topcon cable (p/n 14-008021-01LF) and the appropriate power supply.



**Figure 12: Power Connectors**

The power supply rail is protected against reverse input voltage polarity with a Schottky diode.



Do not connect power supplies to J100 and J101 simultaneously. This might destroy the B111EVB and B111 boards.

### Further Reading:

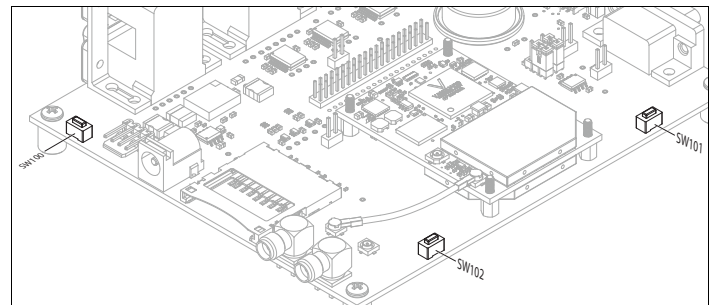
Evaluation board schematics on ["B111EVB Schematics"](#) on page 43.

## Keys



The B111EVB features three keys:

- SW100 – powers on and off the B111EVB and the connected B111.
- SW101 – resets the B111 and B111EVB boards.
- SW102 – starts and stops data files, toggles occupation mode, sets the baud rate of serial port A to 9600 bps, and is used in factory reset.



**Figure 13: Keys**

Pressed for less than 1 second while the data file is open <sup>a</sup>	Toggles occupation mode between static and dynamic.
Pressed for 1–5 seconds	Starts/stops data recording to file(s).
Pressed for 5–8 seconds	Turns the baud rate of serial port A to 9600 bps.
Pressed for more than 8 seconds	No action.

a. Occupation mode switch is selected in TRU.

You can also clear the NVRAM, set all parameters to default values, and power cycle the B111 board using a combination of SW100 and SW102. Here is how you can do this:

1. Press the **ON/OFF** key (SW100) to turn off the B111 board.
2. Press and hold the **FN** key (SW102).
3. Press and hold the **ON/OFF** key for about one second. Release the **ON/OFF** key while continuing to hold the **FN** key.
4. Wait until the STAT and REC LEDs are green.
5. Wait until the STAT and REC LEDs blink orange.
6. Release the **FN** key while the STAT and REC LEDs blink orange.

## LEDs



The B111EVB features two LEDs:

- STAT – the STAT LED (D102) displays the status of the tracked satellites. The sequence of blinks, their colors, and pin assignments are described in ["STAT LED" on page 9](#).
- REC – the REC LED (D103) displays the data recording status and other memory related information. The sequence of blinks, their colors, and pin assignments are described in ["REC LED" on page 10](#).

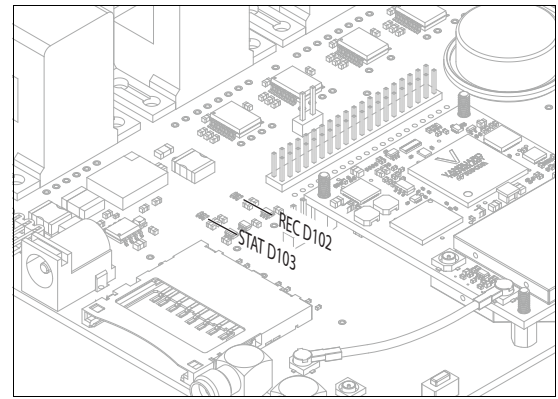


Figure 14: STAT and REC LEDs

### Further Reading:

Evaluation board schematics on ["B111EVB Schematics" on page 43](#).

## Jumpers



The B111EVB features three jumpers:

- J121 – terminates the CAN\_H and CAN\_L lines of the CAN interface. Place a jumper over the pins to apply a load of 120 Ohm across the CAN data lines. If you do not need a CAN termination resistor, remove the jumper.
- J117, J119 – control the function of pin nos. 1 and 2 on the connector J400 of the B111 board. These pins can be configured for CAN TX/RX or UART5 RTS/CTS. Use of these interfaces is mutually exclusive.



Both jumpers are placed over pin nos. 1 and 2 of J117 and J119. On the B111, pin no. 71 will function as CAN\_TX and pin no. 72 as CAN\_RX.



Both jumpers are placed over pin nos. 2 and 3 of J210 and J211. On the B111, pin no. 71 will function as UART5\_RTS and pin no. 72 as UART5\_CTS.

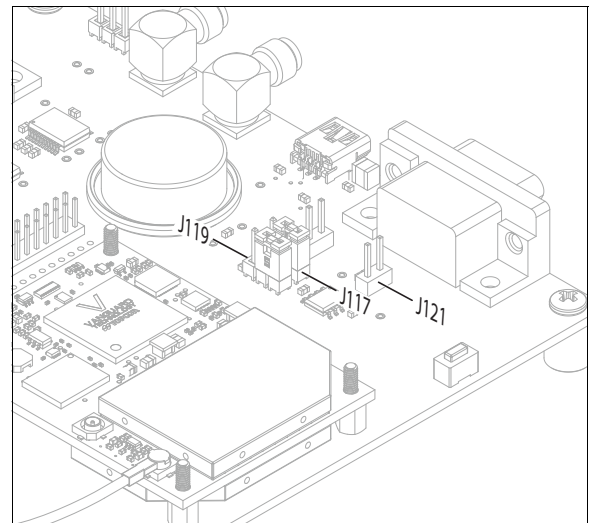


Figure 15: Jumpers



You can identify pin no. 1 of each interface or jumper by looking at the back side of the B111EVB. Pin no. 1 is always marked by a square soldering pad.



Before you move any jumpers, power off the B111EVB and B111.

### Further Reading:

Evaluation board schematics on ["B111EVB Schematics" on page 43](#).



## Interface Connector



The interface connector J106 connects the B111EVB with the B111. The connector is a 60-pin header of Hirose DF17 series, part number DF17(2.0)-60DP-0.5V(57).

Table 18 gives pin assignments of the interface connector J106.

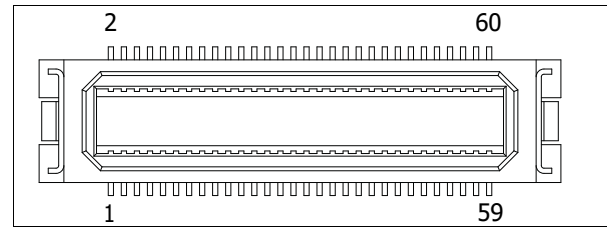


Figure 16: B111EVB Interface Connector

Table 18. Interface Connector J106

Pin No.	Signal Name	I/O	Signal Level	Description
1	CAN_RX/UART5_CTS	I	LVTTL	CAN Receive/UART 5, Clear to Send
2	CAN_TX/UART5_RTS	O	LVTTL	CAN Transmit/UART 5, Request to Send
3	SDCLKB	O	3.3V	SD clock
4	SDCMDB	I/O	3.3V	SD command/response
5	GND		GND	Ground
6	SDCD	I	3.3V	SD card detect; internally pulled-up to 1.8V with a 100 KOhm resistor
7	SDAT3	I/O	3.3V	SD read/write data line 3
8	SDPWR	O	3.3V	Power +3.3V
9	GND		GND	Ground
10	SDWP	I	3.3V	SD write protect; internally pulled-up to 1.8V with a 100 KOhm resistor
11	SDAT2B	I/O	3.3V	SD read/write data line 2
12	UART6_RXD	I	LVTTL	Serial data input to UART 6
13	GND		GND	Ground
14	UART6_TXD	O	LVTTL	Serial data output from UART 6
15	SDAT1B	I/O	3.3V	SD read/write data line 1
16	UART5_RXD	I	LVTTL	Serial data input to UART 5
17	GND		GND	Ground
18	UART5_TXD	O	LVTTL	Serial data output from UART 5
19	SDAT0B	I/O	3.3V	SD read/write data line 0
20	UART4_CTS	I	LVTTL	UART 4, Clear to Send
21	GND		GND	Ground
22	UART4_TXD	O	LVTTL	Serial data output from UART 3
23	EVENT0	I	LVTTL	Event marker input
24	UART4_RXD	I	LVTTL	Serial data input to UART 4
25	USB_PWR	I/O	+5V	+5V input in device mode
26	UART4_RTS	O	LVTTL	UART 4, Request to Send
27	USB_D+	I/O	TTL	USB data plus

Table 18. Interface Connector J106

Pin No.	Signal Name	I/O	Signal Level	Description
28	PORESET*	I/O	LVTTTL	Reset board; active-low
29	USB_D-	I/O	TTL	USB data minus
30	GPIO5	O	0...+3.3V	REC LED, red color; active-high
31	GND		GND	Ground
32	GPIO4_LED	O	0...+3.3V	REC LED, green color; active-high
33	GPIO3_LED	O	0...+3.3V	STAT LED, blue color; active-high
34	GPIO2_LED	O	0...+3.3V	STAT LED, green color; active-high
35	RS_RXDA	I	RS-232	Serial data input to port A
36	RS_TXDA	O	RS-232	Serial data output from port A
37	RS_CTSA	I	RS-232	Port A, Clear to Send
38	RS_RTSA	O	RS-232	Port A, Request to Send
39	GND		GND	Ground
40	GPIO1_LED	O	0...+3.3V	STAT LED, red color; active-high
41	RS_RXDB	I	RS-232	Serial data input to port B
42	RS_TXDB	O	RS-232	Serial data output from port B
43				Factory reserved. Leave this pin unconnected.
44	1PPSA	O	LVTTTL	1PPS output
45				Factory reserved. Leave this pin unconnected.
46	GND		GND	Ground
47	UART3_CTS	I	LVTTTL	UART 3, Clear to Send
48	UART3_RTS	O	LVTTTL	UART 3, Request to Send
49	UART3_RXD	I	LVTTTL	Serial data input to UART 3
50	UART3_TXD	O	LVTTTL	Serial data output from UART 3
51	VBAT	I	0...+3.6V	Backup power supply
52				Factory reserved. Leave this pin unconnected.
53	PBTN*	I	0...+3.3V	Power button, active-low
54	GPIO6	I	0...+3.3V	Function button, active-low
55	PWR_IN	I	+3.4...+4.5 V	Primary power supply input
56	GND		GND	Ground
57	PWR_IN	I	+3.4...+4.5 V	Primary power supply input
58	GND		GND	Ground
59	PWR_IN	I	+3.4...+4.5 V	Primary power supply input
60	GND		GND	Ground

**Further Reading:**

Evaluation board schematics on "[B111EVB Schematics](#)" on page 43.



## Test Pads and Points



For greater testability during the evaluation and development process, the B111EVb board has the following testing facilities:

- two test pads, J107 and J108, that duplicate some of the pins on the interface connector J106. You may use an oscilloscope, multi-meter, or any other measuring device to connect to the pins of test pads for signal inspection.

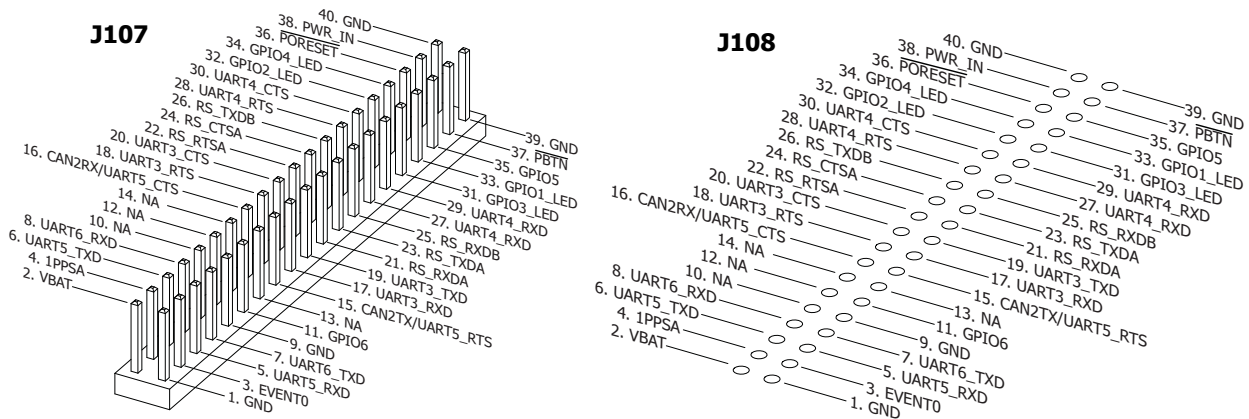


Figure 17: Test Pads

- 62 test points (Figure 18)
  - ten ground test points, TP102, TP103, TP110...TP113, TP116...TP119 that are connected to a ground plane. These test points make it easier to connect a measuring device to ground when you are probing B111EVb components.
  - three voltage test points, TP104, TP105, and TP106 that are used to verify the voltages across the B111EVb.
    - TP104 connects with the positive terminal of the backup battery and with one of the terminals of a 1 kOhm resistor R139; TP105 connects with the other terminal of a 1 kOhm resistor R139 and with the VBAT rail, which extends directly to the VBAT pin no. 51 on the J106 connector. You can use these two test points to measure the current drawn by the connected B111 board when an external power supply has been discharged or removed.
    - TP106 measures the voltage of the 3V3 power rail, which is used to power various components of the B111EVb.
  - five GPIO test points, TP107, TP108, TP109, TP114, and TP115 that are used to verify the voltages across the STAT and REC LEDs.
  - 45 interface test points that are used to verify signals of RS232 and USB interfaces.

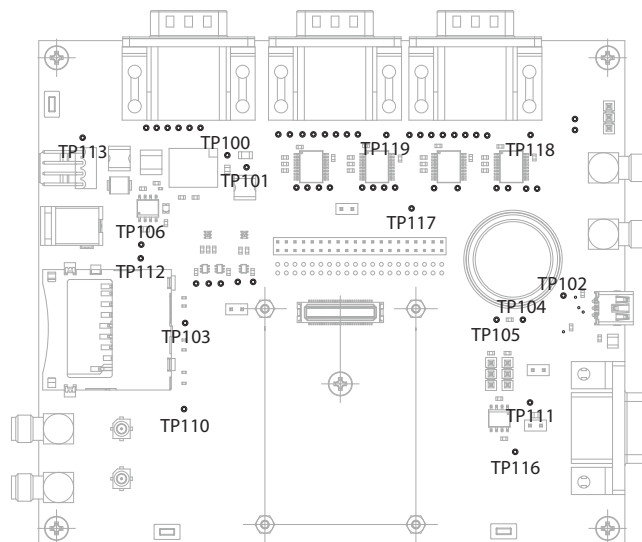


Figure 18: Test Points

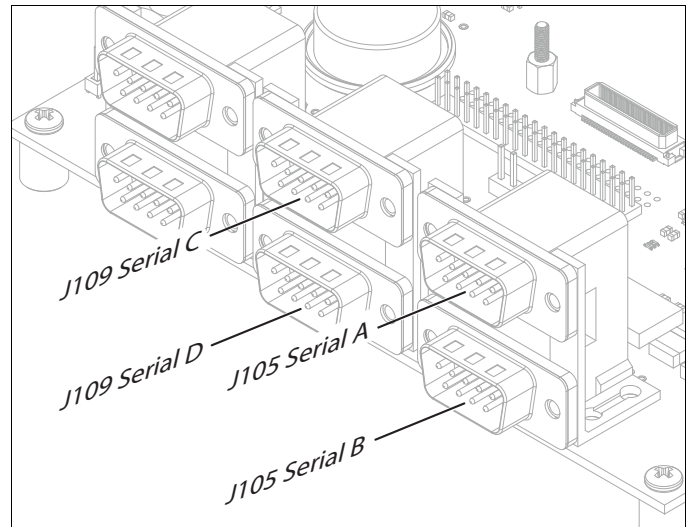
## UART Interfaces



The B111EVB board accommodates six UART interfaces that are used for communication between the B111 board and external devices at the data rate of up to 460.8 Kbit/s. These interfaces are converted from TTL inputs to RS-232 outputs and are then connected to 9-pin D-shell male connectors:

- J105:A (port A) and J105:B (port B) use an RS-232 transceiver ISL4245EIRZ from Intersil, which is installed on the B111 board.
- J109:3 (port C), J109:4 (port D), J116:5 (port E), and J116:6 (port F) use RS-232 transceivers MAX3225EEAP+ from Maxim Integrated, which are installed on the B111EVB board.

Serial ports A and D provide flow control, while serial ports B and C have only three essential lines TX, RX, and GND.



**Figure 19: UART Interfaces**

For communication with a computer, a 9-pin female to 9-pin female null modem cable is required. This cable (p/n 14-008086-01) is included to the [development kit](#).



Serial ports A, B, C, and D are the only ports you can use for control and data transfer. Ports E and F are used for internal communications.

### Further Reading:

- General design guidelines in ["General Guidelines"](#) on page 20.
- Evaluation board schematics on ["B111EVB Schematics"](#) on page 43.

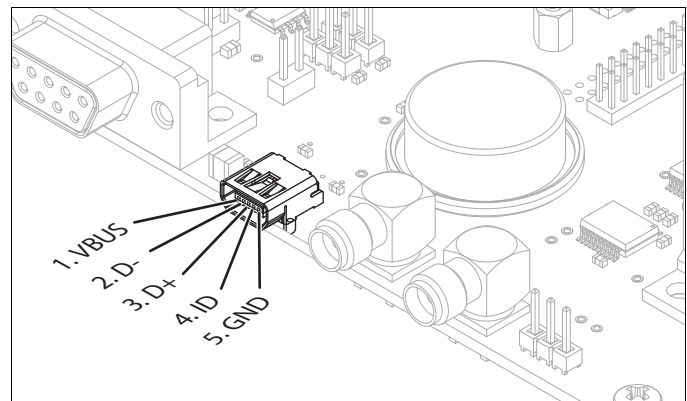
## USB



The B111EVB board integrates a single USB type mini-AB connector J122, which extends to the J106 connector. You can use the USB device interface of the B111 to connect to a computer for configuration and data exchange. Before establishing a USB connection in device mode, make sure that the TPS USB driver is installed on the host (i.e., computer).

### Further Reading:

- A description of the USB functionality on the B111 board in ["USB"](#) on page 12.
- A description of the file system in ["File System"](#) on page 17.



**Figure 20: USB Interface; J223 Jumper**

- General design guidelines in ["General Guidelines"](#) on page 20.
- Design guidelines about USB device in ["USB"](#) on page 20.
- Evaluation board schematics on ["B111EVB Schematics"](#) on page 43.
- GRIL commands used to configure the B111 to record, store, and transfer TPS data files to and from the USB flash memory devices in the [GRIL Reference Manual](#).

## CAN



The B111EVB board incorporates an independent CAN port that conforms to the CAN specification 2.0 A/B and NMEA 2000 standard. This port is a 9-pin D-shell female connector J120 with a discrete CAN transceiver SN65HVD230QD from Texas Instruments. To activate the CAN port, place the jumpers over header pin nos. 2 and 3 of J117 and J119 as shown in “Jumpers” on page 28. Also, the CAN port has a termination header, J121, where you can set a jumper. By placing the jumper over the pins, you apply a load of 120 Ohm across the CAN data lines. If you do not need a CAN termination resistor, remove the jumper.

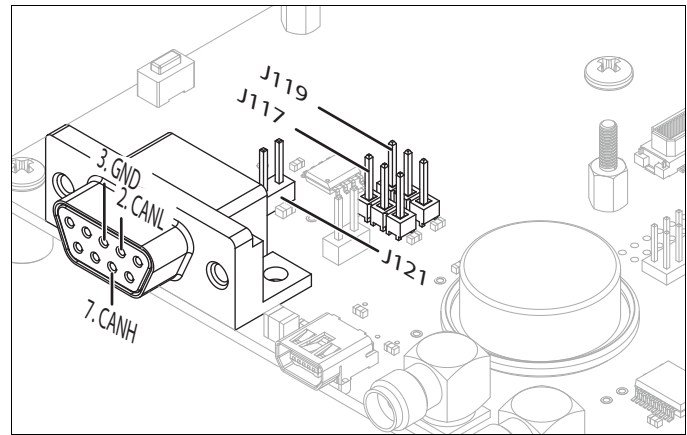


Figure 21: CAN Interface

### Further Reading:

- A description of the CAN functionality on the B111 board in “CAN” on page 13.
- General design guidelines in “General Guidelines” on page 20.
- A description of CAN-related jumpers in “Jumpers” on page 28.
- Evaluation board schematics on “B111EVB Schematics” on page 43.
- How to configure various CAN settings, including the baud rate and node addresses, output of NMEA 2000 messages, etc., in the [GRIL Reference Manual](#).

## SD Card



The B111EVB provides one SD card slot J123 for connection to an [SD/SDIO interface](#) on the B111 board. You can use this slot to connect an SD/SDHC card for TPS data recording and storage.

### Further Reading:

- Storage medium details and design guidelines in “SD/SDIO” on page 14 and “SD/SDIO” on page 20.
- A description of the file system in “File System” on page 17.
- General design guidelines in “General Guidelines” on page 20.
- SD cards approved for use in “Approved SD Cards” on page 21

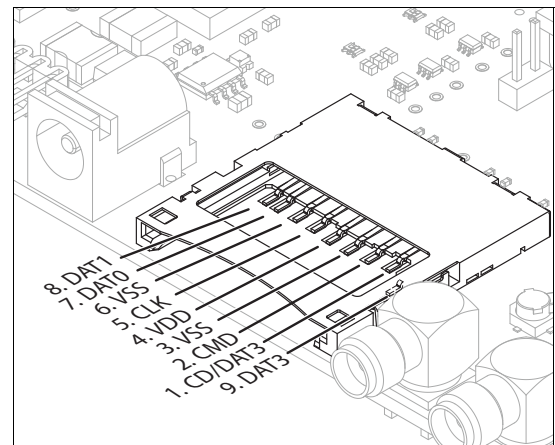


Figure 22: SD Card

- Evaluation board schematics on “B111EVB Schematics” on page 43.
- GRIL commands to record, store, and transfer TPS data files in the [GRIL Reference Manual](#).

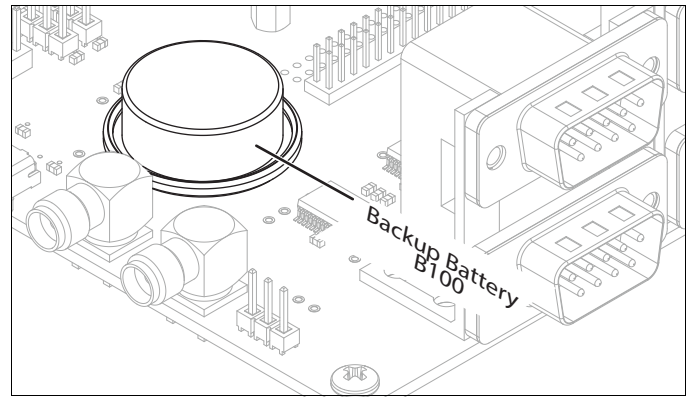
## Backup battery



The B111EVB board contains a backup battery (B100) shown on [Figure 23](#). The backup battery preserves the contents of the NVRAM and runs the real-time clock when the connected B111 is turned off. The B111EVB uses either the Tadiran Batteries' lithium battery TL-4986/P or OmniCel battery ER22G68. These batteries are rated at about 5 years of operation at typical consumption and ambient temperature of 25° C.

### Further Reading:

- Details about the backup functionality in ["Backup Power Rail" on page 7](#).
- Evaluation board schematics on ["B111EVB Schematics" on page 43](#).



**Figure 23: Backup Battery**

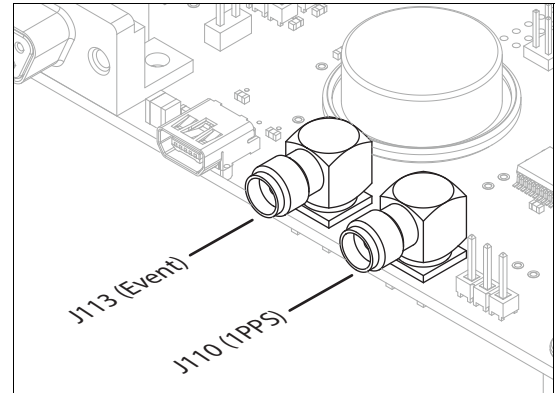
## 1PPS



The B111EVB features a single 1PPS output. It extends from pin no. 44 on the J106 connector to a 50-Ohm SMA R/A Jack, J110.

### Further Reading:

- A description of the 1PPS signal in ["1PPS" on page 13](#) and ["Board Specifications" on page 35](#).
- General design guidelines in ["General Guidelines" on page 20](#).
- Evaluation board schematics on ["B111EVB Schematics" on page 43](#).
- How to configure the 1PPS functionality in the [GRIL Reference Manual](#).



**Figure 24: 1PPS and Event Marker**

## Event Marker



The B111EVB features a single event marker input. It extends from pin no. 23 on the J106 connector to a 50-Ohm SMA R/A Jack, J113 ([Figure 24](#)).

### Further Reading:

- A description of the event marker signal in ["Event Marker" on page 13](#) and ["Board Specifications" on page 35](#).
- General design guidelines in ["General Guidelines" on page 20](#).
- Evaluation board schematics on ["B111EVB Schematics" on page 43](#).
- How to configure the event marker functionality in the [GRIL Reference Manual](#).

## Board Specifications

Table 19 provides specifications for the B111 board, including hardware and firmware components.

**Table 19. B111 Board Specifications**

<b>Physical</b>	
Dimensions	L: 55 mm x W: 40 mm x H: 10 mm (2.17 in x W: 1.57 in x H: 0.39 in)
Weight	0.02 kg (0.04 lbs)
Mounting	Four holes to install M2 screws
Connector	60-pin receptacle of DF17 series, Hirose DF17(3.0)-60DS-0.5V(57)
<b>Environment</b>	
Operating temperature	-40° C to +85° C
Storage temperature	-40° C to +85° C
Humidity	95%, non-condensing
Vibration	4g Sine Vibe (SAEJ1211) 7.7g Random Vibe (MIL-STD 810F)
Acceleration	20g
Jerk	3g/sec
Shock	Operational IEC68-2-27,11ms,40g Survival IEC68-2-27,11ms,75g
<b>Power</b>	
Input voltage	+3.4 to +4.5 Vdc
Voltage ripple	150 mV p-p max
Consumption <sup>a</sup>	1.3 W typical; 1.8 W max
<b>Antenna</b>	
Number of connectors	2
Connector type	Hirose H.FL Straight Through Hole
Nominal impedance	50 Ohm
RF input frequencies	1560 – 1614 MHz (GPS/GLONASS L1, Galileo E1, BeiDou B1, QZSS L1) 1205 – 1257 MHz (GPS/GLONASS L2, Beidou B2, QZSS L2)
LNA power	+5.0 Vdc @ 0 - 100 mA (J100) +3.3 Vdc @ 0 - 100 mA (J101)
Overcurrent values	min: 100mA, typ: 115 mA, max: 135 mA

Table 19. B111 Board Specifications (Continued)

<b>Communication Interfaces</b>	
RS-232 interface Number of interfaces Electrical and mechanical Connection method Transmission mode Baud rate Data length Stop bit Parity Flow control	2 Conforms to EIA RS-232 Point-to-point Full-duplex 4800, 9600, 19200, 38400, 57600, 115200 (default), 230400, and 460800 7 or 8 (default) bits 1 (default) or 2 bits No parity (default), even, or odd RTS/CTS (hardware handshaking) on serial port A
LVTTTL interface Number of interfaces Electrical specifications Connection method Transmission mode Baud rate Data length Stop bit Parity Flow control	4 LVTTTL Point-to-point Full-duplex 4800, 9600, 19200, 38400, 57600, 115200 (default), 230400, 460800 7 or 8 (default) bits 1 (default) or 2 bits No parity (default), even, or odd RTS/CTS (hardware handshaking) on serial ports C, D, and E
USB interface Number of interfaces Architecture Electrical and mechanical Data rate	1 USB device Conforms to USB Rev. 2.0 480 Mbps max
CAN interface Number of interfaces Electrical and mechanical Format of output data	1 (w/o transceivers) Conforms to CAN 2.0 A/B NMEA 2000
<b>I/O Signals</b>	
1PPS Number of outputs Polarity Signal level Pulse width Rise/Fall time Synchronization edge Resolution Period Offset Reference time	1 Positive pulse $\geq 2$ V, LVTTTL into 50 Ohm load 3.3 msec (normal pulse); 5.3 msec (marked pulse) $\leq 3$ nsec Rising/Falling (user selectable) 5 nsec 10 to 1000000000 msec (user selectable) -500000000 to 500000000 msec; -500000 to 500000 nsec (user selectable) GPS, GLONASS, UTC (USNO), UTC (SU) (user selectable)

**Table 19. B111 Board Specifications (Continued)**

Event Marker	
Number of inputs	1
Polarity	Positive pulse
Input low voltage levels	from 0.0 V to +0.8 V
Input high voltage levels	from +2.0 V to +3.3 V
Internal pull-up resistor value	10 kOhm to +3.3 V
Pulse width	≥ 100 nsec
Synchronization edge	Rising/Falling (user selectable)
Resolution	5 nsec
Reference time	GPS, GLONASS, UTC (USNO), UTC (SU) (user selectable)
LED	One on-board LED – STAT satellite and receiver status Five GPIO signals for external STAT and REC LEDs
<b>Tracking Specifications</b>	
Standard Channels	224 universal channels
Tracked Signals	GPS: L1C/A, L1P, L2P, L2C GLONASS: L1C/A, L1P, L2C/A, L2P Galileo: E1 Beidou: B1, B2 QZSS: L1C/A, L1C, L1-SAIF, L2C SBAS:WAAS L1, EGNOS, MSAS, GAGAN
Time to First Fix (50%)	Hot (almanac & recent ephemeris and approx. position) <10 sec Warm (almanac, approx. position & time, no recent ephemeris) <35 sec Cold (no almanac or ephemeris and no approx. position or time) <60 sec
Reacquisition	<1 sec
<b>Tracking Functions</b>	
Multipath reduction	C/A code phase and carrier phase
PLL/DLL/QLL settings	User-configurable
Pseudorange smoothing	Adjustable
Cinderella days	Cinderella days is an option that turns a single frequency board into a dual-frequency, GPS+GLONASS board for 24 hours every other Tuesday at GPS midnight. Refer to Topcon's website at <a href="http://www.topconpositioning.com">www.topconpositioning.com</a> for more information and specific Cinderella day dates.
<b>Data Features</b>	
Formats	Proprietary (TPS) data format NMEA 0183 versions 2.1, 2.2, 2.3, 3.0, 3.01, 4.0 NMEA 2000 over CAN RTCM SC104 versions 2.1, 2.2, 2.3, 3.0, 3.1, 3.2 CMR/CMR+ (public version) <sup>b</sup> BINEX

Table 19. B111 Board Specifications (Continued)

Supported Messages TPS BINEX NMEA 0183 NMEA 2000 RTCM 2.x RTCM 3.x  CMR/CMR+	Binary and ASCII messages; see the <a href="#">GRIL Reference Manual</a> for a list. 00_00, 01_01, 7E_00, 7D_00, 7F_02, 7F_03, 7F_04 GGA, GLL, GNS, GRS, GSA, GST, GSV, HDT, RMC, VTG, ZDA, ROT, GMP, ATT, VHD 129029, 129025 1, 3, 6, 9, 15, 16, 18...24, 31, 32, 34, 36, 59t 1003...1008, 1011, 1012, 1014...1017, 1019...1028, 1030...1033, 4087G, 4087N, 4091i, 4091t, 4091h, 1071...1077, 1081...1087, 1091...1097, 1111...1117, 1121...1127, 1230 0, 1, 2, var (3), 5, +
Update and output rates Raw measurements Position (Standalone, DGPS, RTK)	up to 100 Hz up to 100 Hz
<b>Memory</b>	
Media type	industrial SLC SD card (removable)
Capacity	up to 32 GB
File system	Topcon proprietary
Number of files	up to 3000
Logging size	3.5 MB per hour (18 SVs, 1 sec, L1/L2, default message set)
Logging interval	0.05 to 86400 seconds, depending on purchased options
<b>Accuracy<sup>c</sup> (rms)</b>	
Standalone	Horizontal 1.2 m Vertical 1.8 m
RTCM based DGPS	Horizontal 0.3 m Vertical 0.5 m
SBAS	Horizontal 0.8 m Vertical 1.2 m
Static/Fast Static	Horizontal 3 mm + 0.5ppm (x baseline length) Vertical 5 mm + 0.8ppm (x baseline length)
RTK Static	Horizontal 3 mm + 0.5ppm (x baseline length) Vertical 5 mm + 0.8ppm (x baseline length)
RTK Kinematic/Stop&Go/Network	Horizontal 5 mm + 0.5ppm (x baseline length) Vertical 10 mm + 0.8ppm (x baseline length)
Heading (HD2 mode)	0.2°/D, where D is the inter-antenna distance in meters
Inclination (HD2 mode)	0.3°/D, where D is the inter-antenna distance in meters
Velocity	0.02 m/sec
Time	30 nsec

a. Without a connected GNSS antenna.

b. CMR/CMR+ is a third-party proprietary format. Use of this format is not recommended and performance cannot be guaranteed. Use of industry standard RTCM 3.x is always recommended for optimal performance.

c. These specifications will vary depending on the number of satellites used, obstructions, satellite geometry (PDOP), occupation time, multipath effects, and atmospheric conditions. Performance may be degraded in conditions with high ionospheric activity, extreme multipath, or under dense foliage. For maximum system accuracy, always follow best practices for GNSS data collections.

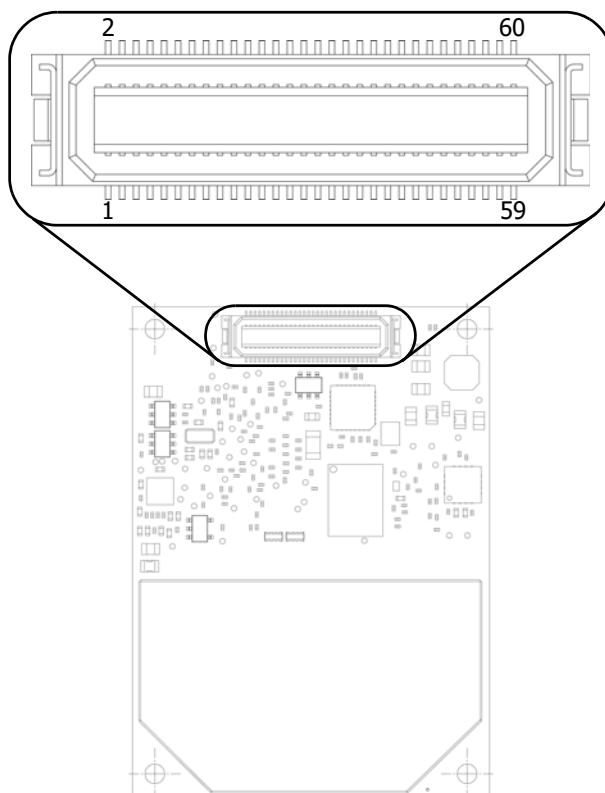


## Connector Specifications

The B111 board has a single interface connector for power and data management, and two GNSS antenna connectors.

### Interface Connector

The interface connector is a 60-pin receptacle of Hirose DF17 series, part number DF17(3.0)-60DS-0.5V(57). This connector mates with a Hirose header DF17(2.0)-60DP-0.5V(57).



**Figure 25: Interface Connector**

Table 20 gives pin assignments of the interface connector J400.

**Table 20. Interface Connector**

Pin No.	Signal Name	I/O	Signal Level	Description
1	CAN_RX/UART5_CTS	I	LVTTTL	CAN Receive/UART 5, Clear to Send
2	CAN_TX/UART5_RTS	O	LVTTTL	CAN Transmit/UART 5, Request to Send
3	SDCLKB	O	3.3V	SD clock
4	SDCMDB	I/O	3.3V	SD command/response
5	GND		GND	Ground
6	SDCD	I	3.3V	SD card detect; internally pulled-up to 1.8V with a 100 KOhm resistor
7	SDAT3	I/O	3.3V	SD read/write data line 3
8	SDPWR	O	3.3V	Power +3.3V
9	GND		GND	Ground
10	SDWP	I	3.3V	SD write protect; internally pulled-up to 1.8V with a 100 KOhm resistor

Table 20. Interface Connector

Pin No.	Signal Name	I/O	Signal Level	Description
11	SDAT2B	I/O	3.3V	SD read/write data line 2
12	UART6_RXD	I	LVTTTL	Serial data input to UART 6
13	GND		GND	Ground
14	UART6_TXD	O	LVTTTL	Serial data output from UART 6
15	SDAT1B	I/O	3.3V	SD read/write data line 1
16	UART5_RXD	I	LVTTTL	Serial data input to UART 5
17	GND		GND	Ground
18	UART5_TXD	O	LVTTTL	Serial data output from UART 5
19	SDAT0B	I/O	3.3V	SD read/write data line 0
20	UART4_CTS	I	LVTTTL	UART 4, Clear to Send
21	GND		GND	Ground
22	UART4_TXD	O	LVTTTL	Serial data output from UART 3
23	EVENT0	I	LVTTTL	Event marker input
24	UART4_RXD	I	LVTTTL	Serial data input to UART 4
25	USB_PWR	I/O	+5V	+5V input in device mode
26	UART4_RTS	O	LVTTTL	UART 4, Request to Send
27	USB_D+	I/O	TTL	USB data plus
28	PORESET*	I/O	LVTTTL	Reset board; active-low
29	USB_D-	I/O	TTL	USB data minus
30	GPIO5	O	0...+3.3V	REC LED, red color; active-high
31	GND		GND	Ground
32	GPIO4_LED	O	0...+3.3V	REC LED, green color; active-high
33	GPIO3_LED	O	0...+3.3V	STAT LED, blue color; active-high
34	GPIO2_LED	O	0...+3.3V	STAT LED, green color; active-high
35	RS_RXDA	I	RS-232	Serial data input to port A
36	RS_TXDA	O	RS-232	Serial data output from port A
37	RS_CTSA	I	RS-232	Port A, Clear to Send
38	RS_RTSA	O	RS-232	Port A, Request to Send
39	GND		GND	Ground
40	GPIO1_LED	O	0...+3.3V	STAT LED, red color; active-high
41	RS_RXDB	I	RS-232	Serial data input to port B
42	RS_TXDB	O	RS-232	Serial data output from port B
43				Factory reserved. Leave this pin unconnected.
44	1PPSA	O	LVTTTL	1PPS output
45				Factory reserved. Leave this pin unconnected.

**Table 20. Interface Connector**

Pin No.	Signal Name	I/O	Signal Level	Description
46	GND		GND	Ground
47	UART3_CTS	I	LVTTTL	UART 3, Clear to Send
48	UART3_RTS	O	LVTTTL	UART 3, Request to Send
49	UART3_RXD	I	LVTTTL	Serial data input to UART 3
50	UART3_TXD	O	LVTTTL	Serial data output from UART 3
51	VBAT	I	0...+3.6V	Backup power supply
52				Factory reserved. Leave this pin unconnected.
53	PBTN*	I	0...+3.3V	Power button, active-low
54	GPIO6	I	0...+3.3V	Function button, active-low
55	PWR_IN	I	+3.4...+4.5 V	Primary power supply input
56	GND		GND	Ground
57	PWR_IN	I	+3.4...+4.5 V	Primary power supply input
58	GND		GND	Ground
59	PWR_IN	I	+3.4...+4.5 V	Primary power supply input
60	GND		GND	Ground

## GNSS Antenna Connectors

Two GNSS antenna connectors are Hirose H.FL-R-SMT. Table 21 gives specifications of GNSS antenna connectors.

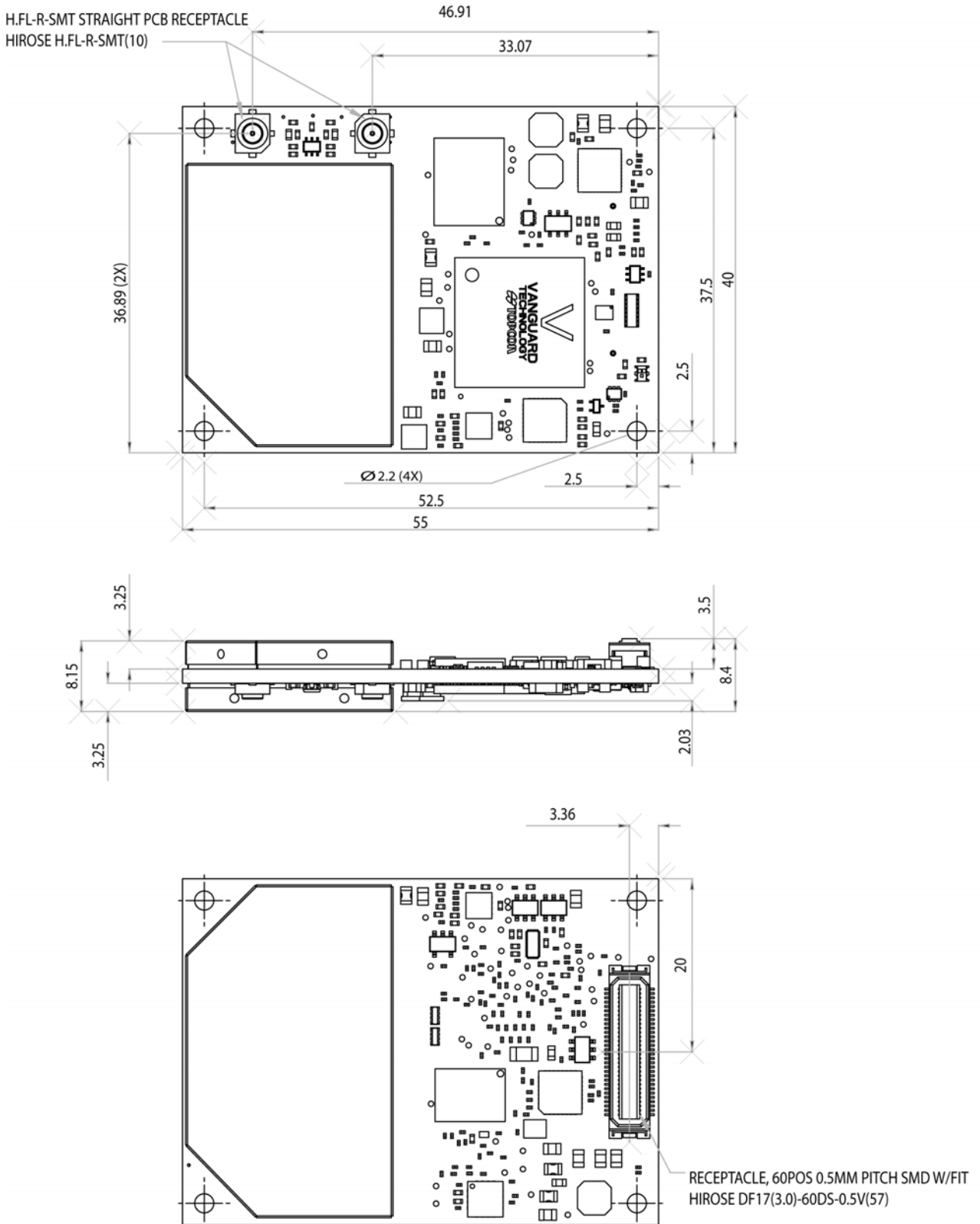
**Table 21. GNSS Antenna Connector Specifications**

Pin No.	Signal	Direction	Description
Central	ANT_IO	I/O	Input: RF signals from antenna J100 Output: +5.0 Vdc @ 0 - 100 mA J101 Output: +3.3 Vdc @ 0 - 100 mA (J101)

# Mechanical and Schematic Drawings

## B111 Dimensions

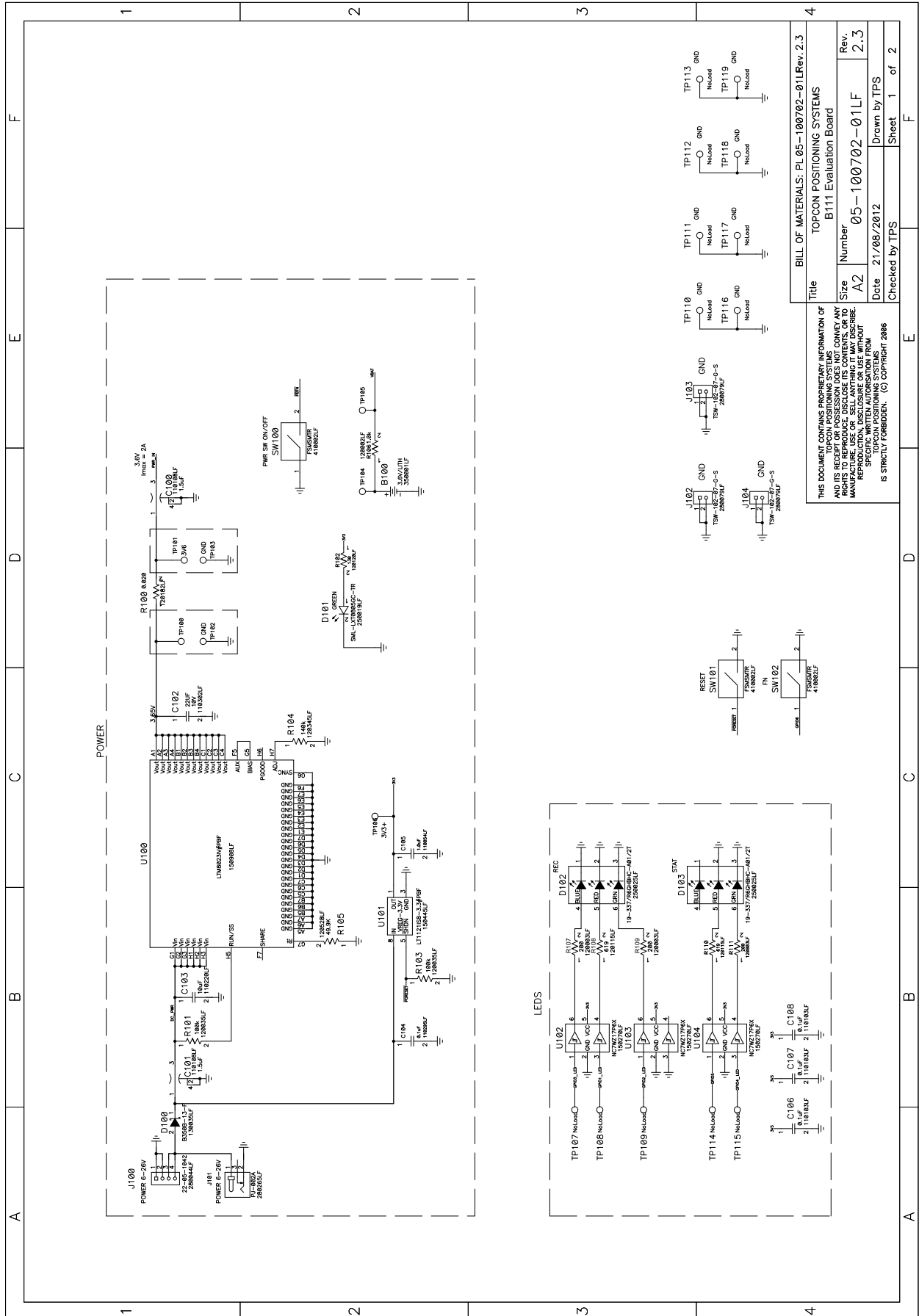
Figure 26 shows overall dimensions of the B111 board with the relative dimensions of the connectors and mounting holes. All values are given in millimeters.



**Figure 26: B111 Mechanical Drawing**

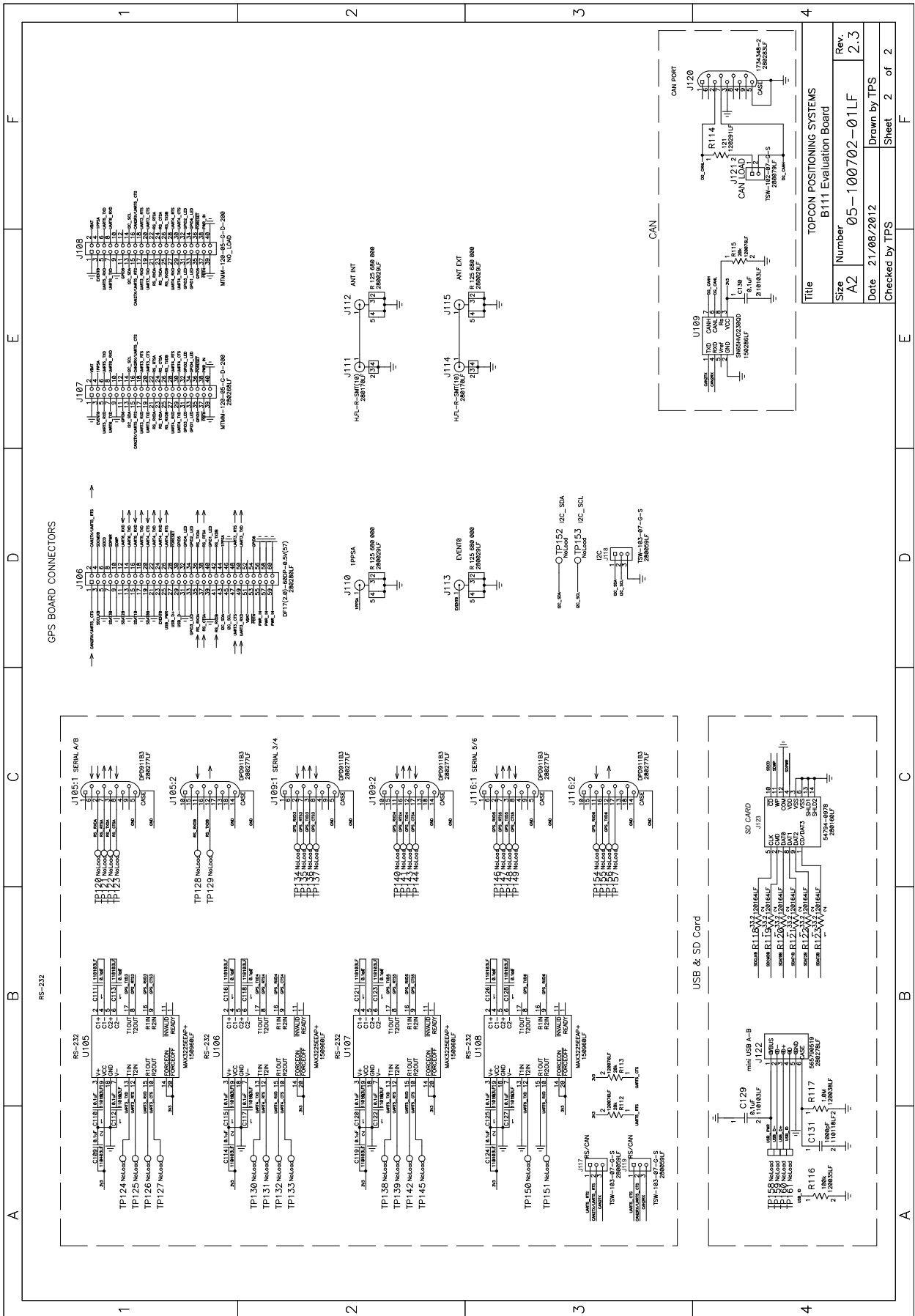
# B111EVB Schematics

The following schematics show circuit components of the B111EVB and how they are electrically connected.



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Title		BILL OF MATERIALS: PL 05-100702-01L Rev. 2.3	
Size		TOPCON POSITIONING SYSTEMS B111 Evaluation Board	
Number	Rev.	Date	Drawn by
A2	2.3	21/08/2012	TPS
Checked by		Sheet 1 of 2	



Title		TOPCON POSITIONING SYSTEMS B111 Evaluation Board	
Size	Number	05-100702-01LF	Rev.
Date		21/08/2012	2.3
Checked by		TPS	Sheet 2 of 2



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