SL869 V2 Family Product User Guide

1VV0301175 r0 - 2014-10-17

APPLICABILITY TABLE

PRODUCT
SL869 V2
SL869 V2S

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1. Introduction

1.1. Scope

This document provides hardware information and product features for the following modules:

- SL869 V2 GNSS receiver
- SL869 V2S GPS receiver

1.2. Contact Information and Support

For general contact, technical support, to report documentation errors and to order manuals, contact Telit Technical Support Center (TTSC) at:

TS-EMEA@telit.com
TS-AMERICAS@telit.com
TS-APAC@telit.com

Alternatively, use:

http://www.telit.com/en/products/technical-support-center/contact.php

For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:

http://www.telit.com

To register for product news and announcements or for product questions contact Telit Technical Support Center (TTSC).

Our aim is to make this guide as helpful as possible. Keep us informed of your comments and suggestions for improvements.

Telit appreciates feedback from the users of our information.

1.3. Text Conventions

- All dates are in ISO 8601 format, i.e. YYYY-MM-DD.

Danger – This information MUST be followed or catastrophic equipment failure or bodily injury may occur.

Caution or Warning – Alerts the user to important points about integrating the module, if these points are not followed, the module and end user equipment may fail or malfunction.

Tip or Information – Provides advice and suggestions that may be useful when integrating the module.

V2 only **This text does not apply to the SL869 V2S.**

V2S only **This text applies only to the SL869 V2S.**

1.4. Related Documents

- SL869 V2 Data Sheet
- SL869 V2S Data Sheet
- SL871 and SL869 V2 Families Software User Guide
- SL871 & SL869 V2 Family Evaluation Kit User Guide

2. Product Description

The SL869 V2 family of GNSS/GPS receivers provide a navigation solution using either the GPS constellation only (SL869 V2S) or multiple GNSS constellations (SL869 V2).

2.1. Product Overview

- Complete GNSS receiver module including memory, TCXO and RTC
- Based on the Mediatek MT3333 (SL869 V2) or MT3337 (SL869 V2S)
- Same footprint as JN3 and SL869 modules (see **Product Compatibility** section)
- 99 search channels and 33 simultaneous tracking channels (66 search and 22 tracking channels for SL869-V2S)
- GPS (L1), QZSS, and Glonass (L1) or BeiDou (B1) signals (only GPS L1 and QZSS for SL869-V2S)
- SBAS capable (WAAS, EGNOS, MSAS, GAGAN)
- AGPS support for extended ephemeris using server based or local[1] solutions
  Embedded Assist System (EASY) and Extended Prediction Orbit (EPO)
- Jamming Rejection - Active Interference Cancellation
- Supports active or passive antenna
- 1PPS output
- Default 1Hz reporting, Max 10 Hz
- NMEA commands and data output
- Standard UART serial port for input commands and output messages
- 8 Megabit built-in flash (ROM memory for SL869-V2S)
- Less than 90 mW total power consumption (typical)
- Power management for extended battery life
- Supported by evaluation kits
- -40°C to +85°C industrial temperature range
- Surface mountable by standard SMT equipment
- 24-pad 16 x 12.2 x 2.4 mm Industry Standard LLC castellated edge package
- RoHS compliant design

2.2. Block Diagram – SL869 V2

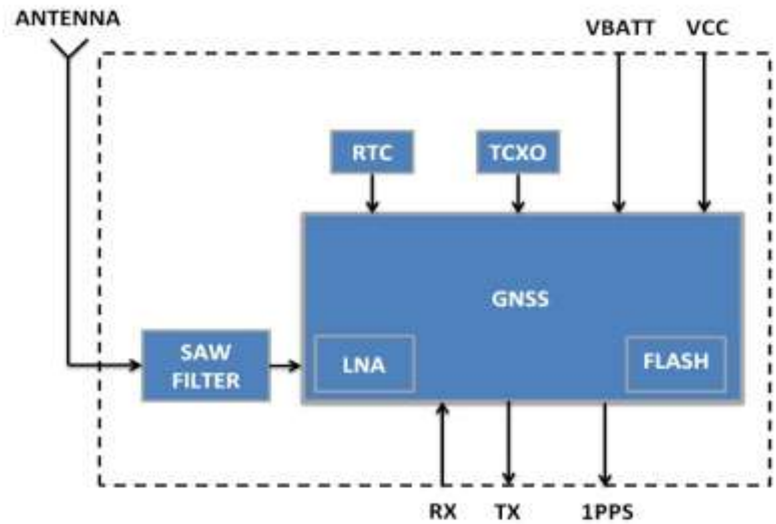
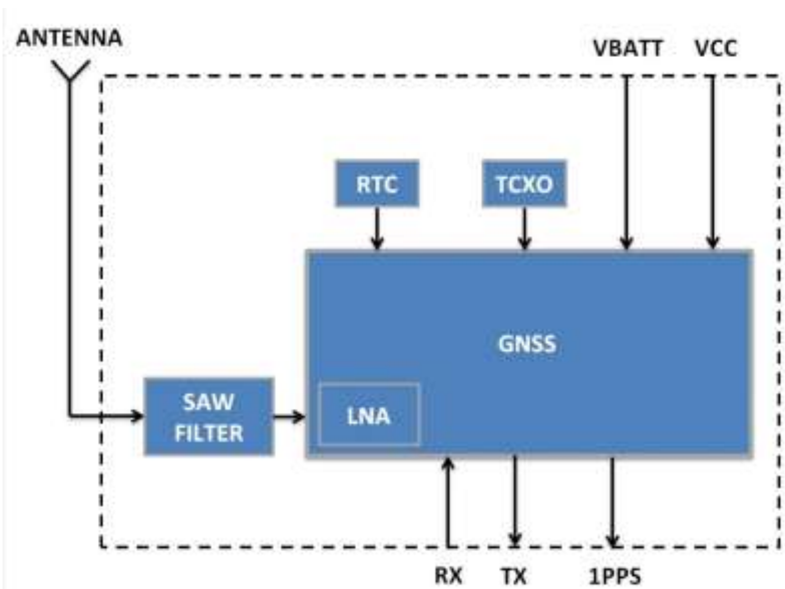


Figure 2-1 SL869 V2 Block diagram

2.3. Block Diagram – SL869 V2S



Note: The SL869 V2S does not include Flash memory

Figure 2-2 SL869 V2S Block diagram

2.4. Product Configurations

The SL869 V2 family is available in the following configurations:

- SL869 V2 GNSS module
- SL869 V2S GPS module

Feature	SL869 V2	SL869 V2S
Constellations Supported	GPS QZSS Glonass BeiDou	GPS QZSS
Flash memory	Yes	No
EASY	Yes	No
EPO	Yes	No
Host EPO	No	Yes

Table 2-1 SL869 V2 Product Configurations

2.4.1. SL869 V2S Compatibility

- The SL869 V2S does not support locally-generated ephemeris (Embedded Assist System - EASY) since it does not have flash memory.
- The SL869 V2S supports server-generated ephemeris (Extended Prediction Orbit - EPO) via a host system.

2.5. Product Compatibility

The SL869 V2 and SL869 V2S modules use the same footprint as the JN3 and SL869 module families, and are generally pin compatible for basic designs (i. e. those using only 3.3V power, Antenna input, TX, RX, and 1PPS). However, there are interface differences that must be considered for more advanced designs.

Pin #	JN3	SL869	SL869 V2 and V2S
1	NC	CAN0_TX	NC
2	NC	CAN0_RX	NC
3	1PPS	1PPS	1PPS
4	EXT_INT	EXT_INT	NC
5	NC	USB_DM	NC
6	NC	USB_DP	NC
7	BOOT	VDD_USB	NC
8	NC	NC	NC
9 [1]	VCC_IN	VCC_IN	VCC_IN
10	GND	GND	GND
11	RF_IN	RF_IN	RF_IN
12	GND	GND	GND
13	GND	GND	GND
14	NC	TX2/nBOOT	NC
15	NC	RX2	NC
16	NC	NC	NC
17	NC	NC	NC
18	SDA2	SDA2	NC
19	SCL2	SCL2	NC
20	TX	TX	TX
21	RX	RX	RX
22	VBATT	VBATT	VBATT
23 [1]	VCC_IN	VCC_IN	VCC_IN
24	GND	GND	GND

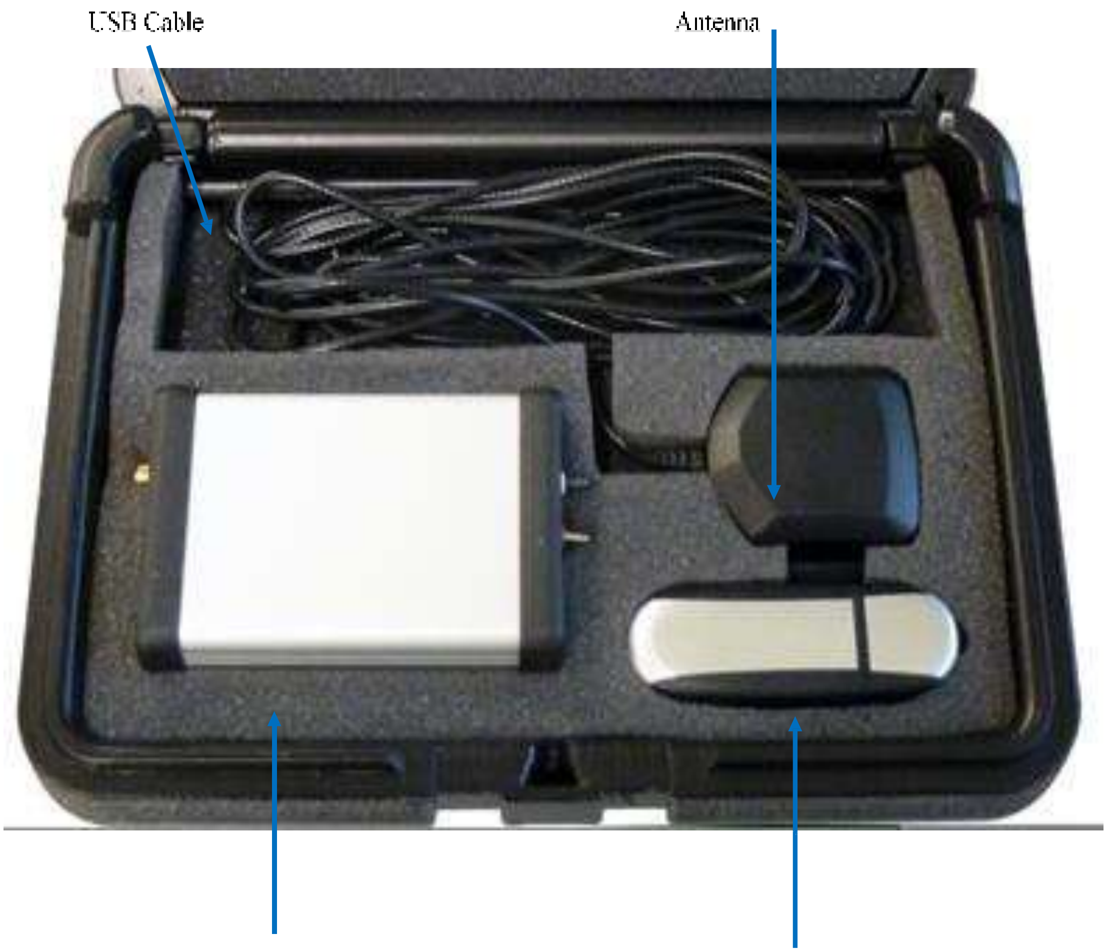
Compatible | No Connection | See Documentation

Note 1: VCC_IN and VBATT have different min & max values.

Table 2-2 JN3, SL869, and SL869 V2 Compatibility

3. Evaluation Kit

The SL869 V2/V2S Evaluation Kit (EVK) is available to assist in the evaluation and integration of the receiver module in custom applications. The EVK contains all of the necessary hardware and software to carry out a thorough evaluation of the module.



Evaluation Kit USB Drive

Note: The SL869 V2 kit includes two antennas: one for GPS/BeiDou and another for GPS/GLONASS.

Figure 3-1 SL869 V2 and SL869 V2S Evaluation Kits

4. Product Features

4.1. 1PPS

The module provides a 1PPS output signal during 3D navigation. See section 8.5.1.3 for detailed information.

4.2. Static Navigation

Static Navigation is an operational mode in which the receiver will freeze the position fix when the speed falls below a set threshold (indicating that the receiver is stationary). The course is also frozen, and the speed is reported as “0”. The navigation solution is unfrozen when the speed increases above a threshold or when the computed position exceeds a set distance from the frozen position (indicating that the receiver is again in motion). The speed threshold can be set via a command.

Static Navigation is disabled by default, but can be enabled by command. This feature is useful for applications in which very low dynamics are not expected, the classic example being an automotive application.

4.3. Assisted GPS (AGPS)

Assisted GPS (or Aided GPS) is a method by which TTFF is improved using information from a source other than broadcast GPS signals. The necessary ephemeris data is calculated either by the receiver itself (locally-generated ephemeris) or a server (server-generated ephemeris) and stored in the module.

4.3.1. Locally-generated AGPS - Embedded Assist System (EASY)

V2 only

Proprietary algorithms within the module perform ephemeris prediction locally from stored broadcast ephemeris data (received from tracked satellites). The algorithms predict orbital parameters for up to three days. EASY is on by default. This feature requires flash memory, and therefore is not supported on the SL869 V2S.

4.3.2. Server-generated AGPS - Extended Prediction Orbit (EPO)

The SL869 V2 supports server-based AGPS as a standard feature. Contact TELIT for support regarding this service.

V2 only

Server-based ephemeris predictions are generated by a third party and are maintained on Telit AGPS servers. The predicted ephemeris file is obtained from the AGPS server and is injected into the module over serial port 1 (RX). These predictions do not require local broadcast ephemeris collection, and they are valid for up to 14 days. See the next section regarding EPO support (Host EPO) on the SL869 V2S.

4.3.3. Host EPO

V2S only

The SL869 V2S does not have flash memory. However, it can still make use of Assisted GPS. If the system design includes a host processor, it can access server-generated data and send it to the SL869 V2S over the primary serial port (which must be temporarily changed to binary mode). This data is valid for six hours.

4.4. SBAS

The receiver is capable of using Satellite-Based Augmentation System (SBAS) satellites as a source of both differential corrections and satellite range measurements. These systems (WAAS, EGNOS, GAGAN and MSAS) use geostationary satellites to transmit regional differential corrections via a GNSS-compatible signal. The use of SBAS corrections can significantly improve position accuracy. The SL869 V2 receiver is enabled for SBAS by default.

4.5. Jamming Rejection–Active Interference Cancellation(AIC)

The receiver module detects, tracks and removes narrow-band interfering signals (jamming signals) without the need for external components or tuning. It rejects up to 12 CW (Continuous Wave) type signals up to –80 dBm (total power signal levels). By default, jamming rejection is enabled but can be disabled by command. This feature is useful both in the design stage and during the production stage for uncovering issues related to unexpected jamming. When enabled, Jamming Rejection will increase current drain by about 1 mA, and impact on GNSS performance is low at modest jamming levels. However, at high jamming levels (e. g. –90 to –80 dBm), the RF signal sampling ADC starts to become saturated after which the GNSS signal levels start to diminish.

4.6. Serial I/O Port considerations

The receiver module includes a full-duplex Universal Asynchronous Receiver Transmitter (UART) serial interface that supports configurable baud rates. The signal output and input levels are LVTTL compatible (see **Electrical Interface** below). Note that the idle state of the interface lines is logic high. Care must be used to prevent backdriving the RX line when the module is powered down.

4.7. Power Management Modes

The receiver supports operational modes that allow it to provide positioning information at reduced overall current consumption.

Availability of GNSS signals in the operational environment will be a factor in choosing power management modes. The designer can choose a mode that provides the best trade-off of navigation performance versus power consumption.

The power management modes can be enabled by sending the desired command using the host serial port (RX).

The following power management modes are described below:

- Full Power Continuous
- Standby
- Periodic
- AlwaysLocate™

4.7.1. Full Power Continuous Mode

The module starts in full power continuous mode when powered up. This mode uses the acquisition engine searching for all possible satellites at full performance, resulting in the highest sensitivity and the shortest possible TTFF. It. The receiver switches to the tracking engine to lower the power consumption when:

- A valid GPS/GNSS position is obtained
- The ephemeris for each satellite in view is valid

The user can return to Full Power mode from a low power mode by sending the following NMEA command:

$PMTK225,0*2B

just after the module wakes up from its previous sleep cycle.

4.7.2. Standby Mode

In this mode the receiver stops navigation, the internal processor enters the standby state, and the current drain at main supply VCC_IN is substantially reduced. Standby mode is entered by sending the following NMEA command:

$PMTK161,0*28.

The host can then wake up the module from Standby mode to Full Power mode by sending any byte to the host port (RX).

4.7.3. Periodic Mode

This mode allows autonomous power on/off, with reduced fix rate, to reduce average power consumption. The main power supply VCC_ON is still powered, but power distribution to internal circuits is controlled by the receiver.

Periodic mode is entered by sending the following NMEA command:

$PMTK225,<Type>,<Run_time>,<Sleep_time>,<2nd_run_time>,<2nd_sleep_time>*<checksum>

Where:

- Type = 1 for Periodic mode
- Run_time = Full Power period (ms)
- Sleep_time = Standby period (ms)
- 2nd_run_time = Full Power period (ms) for extended acquisition if GNSS acquisition fails during Run_time
- 2nd_sleep_time = Standby period (ms) for extended sleep if GNSS acquisition fails during Run_time

Example: **$PMTK225,1,3000,12000,18000,72000*16** for periodic mode with 3 s navigation and 12 s sleep in backup state.

The acknowledgement response for the command is **$PMTK001,225,3*35**.

Periodic mode is exited by sending the NMEA command

$PMTK225,0*2B

just after the module wakes up from a previous sleep cycle.

4.7.4. AlwaysLocate™ Mode

AlwaysLocate™ is an intelligent controller of the Periodic mode where the main supply pin VCC_ON is still powered, but power distribution is controlled internally. Depending on the environment and motion conditions, the module can autonomously and adaptively adjust the parameters of the Periodic mode, e.g. on/off ratio and fix rate, to achieve a balance in positioning accuracy and power consumption. The average current drain will vary based on conditions.

AlwaysLocate™ mode is entered by sending the following NMEA command:
$PMTK225,<mode>*<checksum><CR><LF>
Where mode = 9 for AlwaysLocate™

Example: **$PMTK225,9*22**.

The acknowledgement response for the command is **$PMTK001,225,3*35**.

AlwaysLocate™ mode is exited by sending the NMEA command:
$PMTK225,0*2B
just after the module wakes up from its previous sleep cycle.

5. Product Specifications

5.1. Performance Specifications - SL869 V2

5.1.1. Position Accuracy – SL869 V2

Parameter	Constellation	CEP	Units
Horizontal Position Accuracy	GPS	2.6	m
Horizontal Position Accuracy	Glonass	2.6	m
Horizontal Position Accuracy	BeiDou	10.2	m
Horizontal Position Accuracy	GPS + Glonass	2.6	m
Horizontal Position Accuracy	GPS + BeiDou	2.6	m
Test Conditions: 24 hr. static, -130 dBm, Full Power			

Table 5-1 SL869 V2 Position Accuracy

5.1.2. Time to First Fix – SL869 V2

Constellations(s)	Start Type	Max TTFF	Units
GPS	Hot	1.0	s
	Warm	32	s
	Cold	33	s
Glonass	Hot	1.4	s
	Warm	29	s
	Cold	33	s
BeiDou	Hot	1.5	s
	Warm	35	s
	Cold	46	s
GPS + GLO	Hot	1.0	s
	Warm	28	s
	Cold	31	s
GPS + BeiDou	Hot	1.0	s
	Warm	32	s
	Cold	33	s
Test Conditions: -130 dBm, Full Power			

Table 5-2 SL869 V2 Time to First Fix

5.1.3. Sensitivity – SL869 V2

Constellation(s)	State	Minimum Signal Level	Units
GPS	Acquisition	-148	dBm
	Navigation	-163	dBm
	Tracking	-165	dBm
GLONASS	Acquisition	-145	dBm
	Navigation	-157	dBm
	Tracking	-161	dBm
BeiDou	Acquisition	-144	dBm
	Navigation	-156	dBm
	Tracking	-161	dBm
GPS + GLO	Acquisition	-148	dBm
	Navigation	-163	dBm
	Tracking	-165	dBm
GPS + BeiDou	Acquisition	-148	dBm
	Navigation	-163	dBm
	Tracking	-165	dBm
Test Conditions: In-line LNA used with 1 dB noise figure (NF) and 20 dB gain NOTE: The above performance values were achieved under ideal lab conditions using a GNSS Simulator.			

Table 5-3 SL869 V2 Receiver Sensitivity

5.2. Performance Specifications - SL869 V2S

5.2.1. Position Accuracy – SL869 V2S

Parameter	Constellation	CEP	Units
Horizontal Position Accuracy	GPS	2.6	m
Test Conditions: 24 hr. static, -130 dBm, Full Power			

Table 5-4 SL869 V2S Position Accuracy

5.2.2. Time to First Fix – SL869 V2S

Constellation	Start Type	Max TTFF	Units
GPS	Hot	1.0	s
	Warm	32	s
	Cold	33	s
Test Conditions: -130 dBm, Full Power			

Table 5-5 SL869 V2S Time to First Fix

5.2.3. Sensitivity – SL869 V2S

Constellation	State	Minimum Signal Level	Units
GPS	Acquisition	-148	dBm
	Navigation	-163	dBm
	Tracking	-165	dBm
Test Conditions: In-line LNA used with 1 dB noise figure (NF) and 20 dB gain NOTE: The above performance values were achieved under ideal lab conditions using a GNSS simulator.			

Table 5-6 SL869 V2S Sensitivity

6. Software Interface

The host serial I/O port (RX and TX pins) supports full duplex communication between the receiver and the user.
The default serial configuration is: NMEA, 9600 bps, 8 data bits, no parity, 1 stop bit.
More information regarding the software interface can be found in the SL869 V2 Family Software User Guide.
Customers that have executed a Non-Disclosure Agreement (NDA) with Telit Wireless may obtain the SL869 V2 Family Software Authorized User Guide, which contains additional proprietary information.

6.1. NMEA Output Messages

NMEA-0183 v4.10 is the default protocol.

In the current Firmware release, some sentences may exceed the NMEA length limitation of 80 characters.

By default, GPS and QZSS constellations are enabled.
For the SL869 V2, GLONASS is also enabled by default.

- **Standard Messages**

The following NMEA sentences are output by default at a rate of 1 per second:

- GPRMC
- GPGGA
- GxGSA (talker ID is dependent on constellation - SL869 V2 only)
- GxGSV (talker ID is dependent on constellation - SL869 V2 only)
- QZGSV if enabled and QZSS satellites are visible

The following NMEA sentences can be enabled by command:

- GLL
- VTG
- ZDA

The talker ID “GP” is replaced by “GN” in RMC, GGA, GLL, and VTG sentences based upon multi-constellation data.
The talker ID “GP” is replaced in GSA and GSV sentences by:

- GN – Multi-constellation (not used for GSV)
- GL – GLONASS
- BD – BeiDou
- QZ - QZSS

- **Proprietary Messages**
  The SL869 V2 supports several proprietary NMEA periodic output messages which report additional receiver data and status information.

6.2. NMEA Input Commands

The SL869 V2 uses NMEA proprietary messages for commands and command responses. This interface provides configuration and control over selected firmware features and operational properties of the module.
Please refer to the SL871_SL869 V2 Family Software User Guide.

7. Flash Upgradability

V2 only

The firmware stored in the internal Flash memory of the SL869 V2 may be upgraded via the serial port TX/RX pads. In order to update the FW, the following steps should be performed to perform re-programming of the module.

1. Remove all power to the module.
2. Connect serial port USB cable to a PC.
3. Apply main power.
4. Run the software utility to re-flash the module. Clearing the entire flash memory is strongly recommended prior to programming.
5. Upon successful completion of re-flashing, remove main power to the module for a minimum of 10 seconds.
6. Apply main power to the module.
7. Verify the module has returned to the normal operating state.

8. Electrical Interface

8.1. SL869 V2 and SL869 V2S Pin-out diagram

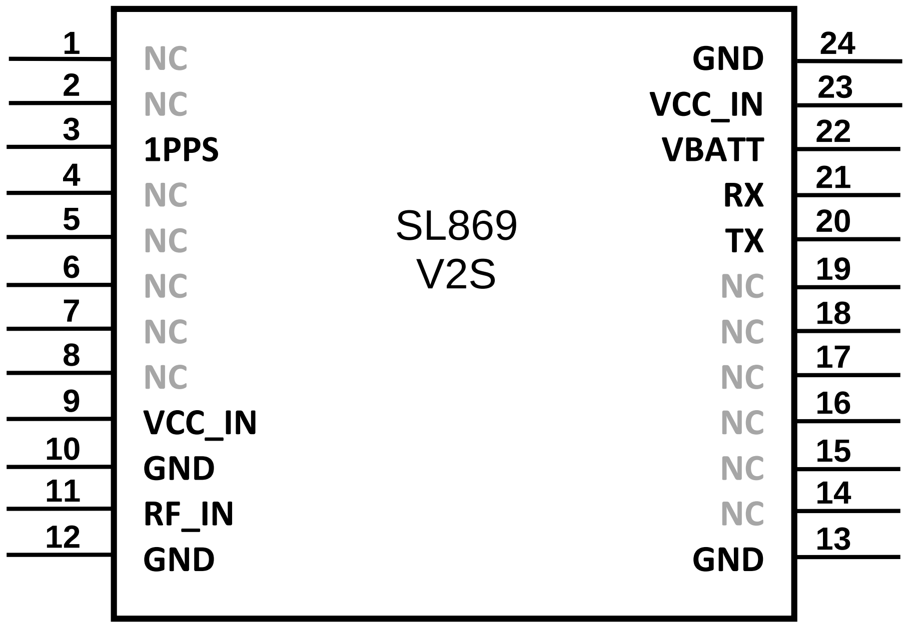


Table 8-1 SL869 V2 and SL869 V2S Pin-out

8.2. Module Pin-out tables

8.2.1. SL869 V2 and SL869 V2S Pin-out Table

Pad Number	Pad Name	Type	Description
1		NC	No Connection
2		NC	No Connection
3	1PPS	O	Pulse Per Second
4		NC	No Connection
5		NC	No Connection
6		NC	No Connection
7		NC	No Connection
8		NC	No connection
9	VCC_RF	PWR	Bias-T Supply Voltage (internally connected to pin 22)
10	GND	GND	Ground
11	RF_IN	I	RF Input, 50 Ohm
12	GND	GND	Ground
13	GND	GND	Ground
14		NC	No connection
15		NC	No connection
16		NC	No connection
17		NC	No connection
18		NC	No connection
19		NC	No connection
20	TX	O	UART TX
21	RX	I	UART RX
22	VBATT	PWR	Backup Battery input
23	VCC_IN	PWR	Main Supply Voltage
24	GND	GND	Ground
Note: All GROUND pins must be connected to ground.			

Table 8-2 SL869 V2 and SL869 V2S Pin-out table

8.3. Power Supply

The module has two power supply pins VCC_IN and VBATT.

8.3.1. VCC_IN

This is the main power input. The supply voltage must be in the range 3.0 to 3.6 VDC. When power is first applied the module will come up in full power continuous operation mode. During operation, the current drawn by the module can vary greatly, especially if enabling low-power operation modes. The supply must be able to handle the current fluctuation including any inrush surge current.
GPS/GNSS receiver modules require a clean and stable power supply. In designing such a supply, any resistance in the VCC_IN line can negatively influence performance. Consider the following points: All supplies should be within the rated requirements. At the module input, use low ESR capacitors that can deliver the required current for switching from backup mode to normal operation. Keep the rail short and away from any noisy data lines or switching supplies, etc. Wide power lines and power planes are preferred.

8.3.2. VBATT

The battery backup power input range is 3.0 to 3.6 VDC. It is required for HOT/WARM starts (which depend on retention of GPS data).
In case of a power failure on VCC_IN, VBATT supplies power to the real-time clock (RTC) and battery backed RAM (BBRAM). Use of valid time and the GPS/GNSS ephemeris data at start-up will improve the TTFF by allowing hot and warm starts. If no backup battery is connected, the module performs a cold start at power up.
VBATT has an internal diode to VCC_IN and therefore the pin can be tied to VCC_IN or left unconnected.

8.3.3. VCC_RF

VCC_RF is directly connected to VCC_IN internally and may be used to power an external LNA or bias-T. Maximum current available is 50 mA. It may be left unconnected.

8.3.4. DC Power Requirements

Main Supply Voltage & Backup Voltage					
Supply	**Name**	**Min**	**Typ**	**Max**	**Units**
Main Voltage	VCC_IN	3.0	3.3	3.6	V
Backup Voltage	VBATT	3.0	3.3	3.6	V
Note: VBATT cannot exceed VCC					

Table 8-3 DC Supply Voltage

8.3.5. DC Power Consumption

State & Constellation	Symbol	Typ	Max	Units
Acquisition				
GPS and (Glonass or BeiDou)	I_{cc}	35	49	mA
GPS Only	I_{cc}	28	41	mA
Glonass or BeiDou Only	I_{cc}	28	44	mA
Navigation/Tracking				
GPS and (Glonass or BeiDou)	I_{cc}	27	46	mA
GPS Only	I_{cc}	25	40	mA
Glonass or BeiDou Only	I_{cc}	26	48	mA
Low Power Modes				
GPS and (Glonass or BeiDou) Standby	I_{cc}	0.49		mA
GPS and (Glonass or BeiDou) Periodic	I_{cc}	6.76		mA
GPS Only Standby	I_{cc}	0.48		mA
GPS Only Periodic	I_{cc}	5.66		mA
Always Locate		7		mA
Battery Backup	I_{BATT}	7		uA
Operating temperature: 25°C. Supply voltages: 3.3 VDC nominal Low Power mode: 500 ms duty cycle. Periodic Mode: default settings - asleep for 12 s, then awake for 3 s.				

Table 8-4 SL869 V2 Power Consumption

State & Constellation	Symbol	Typ	Max	Units
Acquisition				
GPS Only	I_{cc}	27	41	mA
Navigation/Tracking				
GPS Only	I_{cc}	24	40	mA
Low Power Mode				
GPS Only	I_{cc}	0.4		mA
Battery Backup	I_{BATT}	6.5	6.6	uA
Operating temperature is 25°C. Supply voltages were nominal 3.3 VDC. Low Power mode: 500 ms duty cycle. Periodic Mode: default settings - asleep for 12 s, then awake for 3 s.				

Table 8-5 SL869 V2S Power Consumption

8.4. RF Interface

8.4.1. RF-IN

The SL869 V2 RF input (RF-IN) pin accepts GNSS signals in the range of 1561 MHz to 1606 MHz (1573.42 to 1577.42 MHz for the SL869 V2S) at a level between -125 dBm and -165 dBm into 50 Ohm impedance.
No DC voltage can be applied to the RF input.
Antenna Gain:

- Passive antenna: isotropic gain of greater than -6 dBi.
- Active antenna: optimum gain is 14 dB to 20 dB (including cable losses).
  A noise figure of less than 1.0 dB will offer the best performance.

The maximum total external gain is 36 dB (including all external gain - i. e. antenna gain, external LNA gain, and any passive losses due to cables, connectors, filters, matching networks, etc.).

Optimum performance is realized only if the firmware build matches the type of antenna used (active or passive). The firmware must set the internal LNA gain to correspond to the installed antenna.

8.4.2. External Active Antenna Voltage

If an active antenna or external LNA is used, an external bias-T is required to provide voltage to it. A DC blocking capacitor is also required to prevent DC voltage from being applied to RF-IN.

8.4.3. Burnout Protection

The receiver accepts without risk of damage a signal of +10 dBm from 0 to 2 GHz carrier frequency, except in band 1560 to 1610 MHz where the maximum level is –10 dBm.

8.4.4. Jamming Rejection – Active Interference Cancellation

Please see section 4.5 Jamming Rejection–Active Interference Cancellation for further information.
Jamming Rejection can be used for solving narrow band (CW) EMI problems in the customer’s system. It is effective against narrow band clock harmonics. Jamming Rejection is not effective against wide band noise, e.g. from a host CPU memory bus or switching power supply because these sources typically cannot be distinguished from thermal noise. A wide band jamming signal effectively increases the noise floor and reduces GNSS signal levels.

8.4.5. Frequency Plan

Signal	Frequency	Units
TCXO Frequency	16.368	MHz
LO Frequency	1588.6	MHz
LO Leakage	-70 (typical)	dBm

Table 8-6 Frequency Plan

8.5. Digital Signal Interfaces

8.5.1. Signal Descriptions

8.5.1.1. TX

The TX serial data line outputs NMEA messages data at a default rate of 9600 bps from the receiver to the host. When no serial data is being output, the TX data line idles high. The logic levels are shown in Table 8-7 TX and 1PPS Logic Levels.

8.5.1.2. RX

The RX serial data line accepts proprietary NMEA commands at a default rate of 9600 bps from the host to the receiver. When the module is powered down, do not back drive this (or any other) GPIO line. The idle state from the host computer must be high.
The logic levels are shown in Table 8-8 RX Logic Levels.

8.5.1.3. 1PPS

1PPS is a one pulse per second signal with approximately 10% duty cycle. When the receiver is in 3D navigation, the 1PPS pulse may vary 30 ns (1 σ). The relationship between the 1PPS signal and UTC is unspecified.
The logic levels are shown in Table 8-7 TX and 1PPS Logic Levels.

8.5.2. Signal Levels

Several distinct logic levels are utilized by the digital signal interfaces of the module.

They are given in the tables below:

TX and 1PPS					
Signal	**Symbol**	**Min**	**Typ**	**Max**	**Units**
Output Voltage (L)	V_{ol}			0.4	V
Output Voltage (H)	V_{oh}	2.14			V
Normal Current (L)	I_{ol}		-2		mA
Output Current (H)	I_{oh}		-2		mA

Table 8-7 TX and 1PPS Logic Levels

RX, and Reset-N					
Signal	**Symbol**	**Min**	**Typ**	**Max**	**Units**
Input Voltage (L)	V_{il}	0		0.6	V
Input Voltage (H)	V_{ih}	1.9		Vcc	V
Note: These inputs have an internal pullup of between 40k Ohm and 190k Ohm. Do not drive the Reset-N line high.					

Table 8-8 RX Logic Levels

9. Reference Design

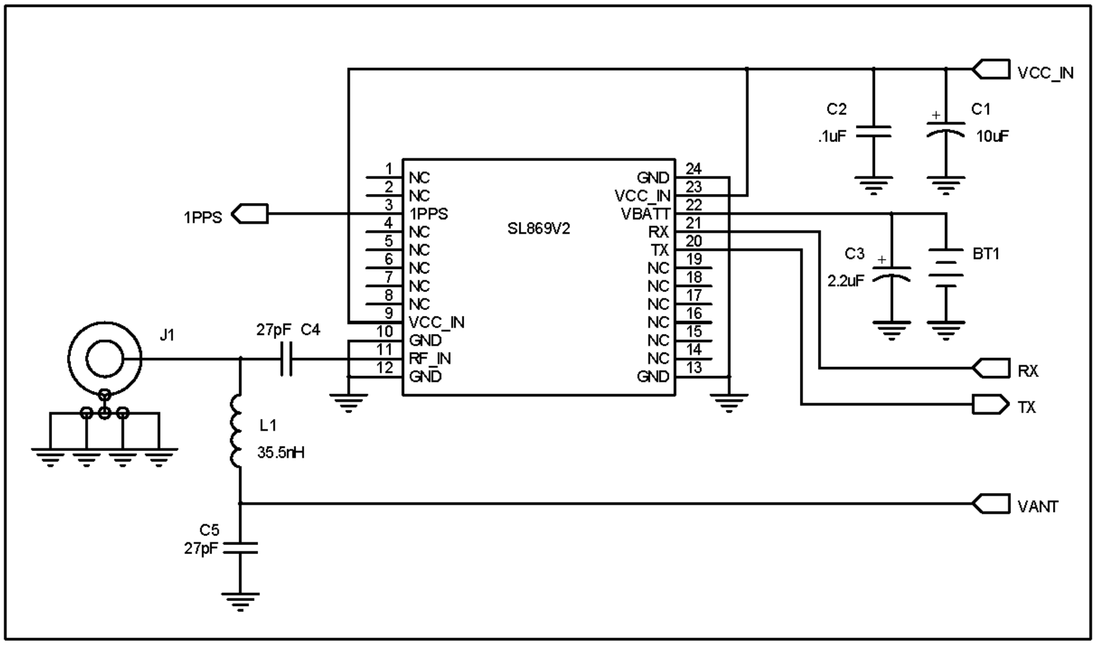


Figure 9-1 SL869 V2 Reference Design

Along with power and grounds, the minimum signals required to operate the receiver properly are the RF input signal and two digital signals (TX and RX). The RF input can be connected directly to a passive GNSS antenna. The reference design shows a DC power feed for an active antenna. C4 is used to block the DC voltage from entering the module. The inductor L1 is chosen to be self-resonant at the GNSS frequency, approximately 1.57542 GHz, to minimize loading on the RF trace. Capacitor C5 is chosen to be self-resonant so that it is close to an RF short at the GNSS frequency.

TX and RX are UART lines with a default bit rate of 9600 bps, 8 data bits, no parity and 1 stop bit. They are used for message output and command input.
Be careful not to drive the RX line if the module is turned off.

10. RF Front End Design

The SL869 V2 and SL869 V2S receiver modules contain a preselect SAW filter. This allows them to work well with a passive GNSS antenna. For improved performance, or if the antenna cannot be located near the receiver, an active antenna (that is, an antenna with a built-in low noise amplifier) can be used.

Optimum performance is realized only if the firmware build matches the type of antenna used (active or passive). The firmware must set the internal LNA gain to correspond to the installed antenna.

10.1. RF Signal Requirements

The SL869 V2 can achieve Cold Start acquisition with a signal level of -148 dBm at its input. This means that it can acquire and track visible satellites, download the necessary ephemeris data and compute the location within a 5 minute period. In the GNSS signal acquisition process, downloading and decoding the data is the most difficult task, which is why Cold Start acquisition requires a higher signal level than navigation or tracking. For the purposes of this discussion, autonomous operation is assumed, which makes the Cold Start acquisition level the dominant design constraint. If assistance data in the form of time or ephemeris aiding is available, lower signal levels can be used for acquisition.

The GPS signal is defined by IS-GPS-200. This document states that the signal level received by a linearly polarized antenna having 3 dBi gain will be a minimum of -130 dBm when the antenna is in the worst-case orientation and the satellite is 5 degrees or more above the horizon.

In actual practice, the GPS satellites are transmitting slightly more power than specified by IS-GPS-200, and the signal level typically increases if a satellite has higher elevation angles.

The SL869 V2 will display a reported C/No of 40 dB-Hz for a signal level of -130 dBm at the RF input.

Each GNSS satellite presents its own signal to the receiver, and best performance is obtained when the signal levels are between -130 dbm and -125 dBm. These received signal levels are determined by:

- GNSS satellite transmit power
- Free space path loss
- GNSS satellite elevation and azimuth
- Extraneous path loss (such as rain)
- Partial or total path blockage (such as foliage or buildings)
- Multipath interference (caused by signal reflection)
- GNSS antenna characteristics
- Signal path after the GNSS antenna

The satellite transmit power is specified in each constellation’s reference documentation, readily available online.

The GNSS signal is relatively immune to attenuation from rainfall.

However, the GNSS signal is heavily influenced by attenuation due to foliage (such as tree canopies, etc.) as well as outright blockage caused by buildings, terrain or other items near the line of sight to the specific GNSS satellite. This variable attenuation is highly dependent upon satellite location. If enough satellites are blocked, say at a lower elevation, or all in one general direction, the geometry of the remaining satellites will result is a lower accuracy of position. The receiver reports this geometry effect in the form of PDOP, HDOP and VDOP.

For example, in a vehicular application, the GNSS antenna may be placed on the dashboard or rear package tray of an automobile. The metal roof of the vehicle will cause significant blockage, plus any thermal coating applied to the vehicle glass can attenuate the GNSS signal by as much as 15 dB. Again, both of these factors will affect the performance of the receiver.

Multipath interference is a phenomena where the signal from a particular satellite is reflected and is received by the GNSS antenna in addition to or in place of the line of sight signal. The reflected signal has a path length that is longer than the line of sight path and can either attenuate the original signal, or, if received in place of the original signal, can add error in determining a solution because the distance to the particular satellite is actually shorter than measured. It is this phenomenon that makes GNSS navigation in urban canyons (narrow roads surround by high rise buildings) so challenging. In general, the reflection of a GNSS signal causes the polarization to reverse. The implications of this are covered in the next section.

10.2. GNSS Antenna Polarization

The GPS broadcast signal is Right Hand Circularly Polarized (RHCP).

An RHCP antenna will have 3 dB gain compared to a linearly-polarized antenna (assuming the same antenna gain specified in dBic and dBi respectively).

An RHCP antenna is better at rejecting multipath interference than a linearly polarized antenna because the reflected signal changes polarization to LHCP. This signal would be rejected by the RHCP antenna, typically by 20 dB or greater.

If the multipath signal is attenuating the line of sight signal, then the RHCP antenna would show a higher signal level than a linearly polarized antenna because the interfering signal is rejected.

However, in the case where the multipath signal is replacing the line of sight signal, such as in an urban canyon environment, then the number of satellites in view could drop below the minimum needed to determine a 3D position. This is a case where a bad signal may be better than no signal. The system designer needs to understand trade-offs in their application to determine the better choice.

10.3. Active versus Passive Antenna

If the GNSS antenna is placed near the receiver and the RF trace losses are not excessive (nominally 1 dB), then a passive antenna may be used. This would normally be the lowest cost option and most of the time the simplest to use. However, if the antenna needs to be located away from the receiver, then an active antenna may be required to obtain the best system performance. An active antenna has its own built- in low noise amplifier (LNA) to overcome RF trace or cable losses.

The active antenna LNA has specifications for gain and noise figure. Also, many active antennas have a pre-select filter, a post-select filter, or both.

10.4. GNSS Antenna Gain

Antenna gain is defined as the amplified signal power from the antenna compared to a theoretical isotropic antenna (equally sensitive in all directions).

Optimum performance is realized only if the firmware build matches the type of antenna used (active or passive). The firmware must set the internal LNA gain to correspond to the installed antenna.

For example, a 25 mm by 25 mm square patch antenna on a reference ground plane (usually 70 mm by 70 mm) may give an antenna gain at zenith of 5 dBic. A smaller 18 mm by 18 mm square patch on a reference ground plane (usually 50 mm by 50 mm) may give an antenna gain at zenith of 2 dBic.

An antenna vendor should specify a nominal antenna gain (usually at zenith, or directly overhead) and antenna pattern curves specifying gain as a function of elevation, and gain at a fixed elevation as a function of azimuth. Pay careful attention to the requirement to meet the required design, such as ground plane size and any external matching components. Failure to follow these requirements could result in very poor antenna performance.

It is important to note that GNSS antenna gain is not the same as external LNA gain. Most antenna vendors will specify these numbers separately, but some combine them into a single number. Both numbers are significant when designing the front end of a GNSS receiver.

For example, antenna X has an antenna gain of 5 dBic at azimuth and an LNA gain of 20 dB for a combined total of 25 dB. Antenna Y has an antenna gain of -5 dBiC at azimuth and an LNA gain of 30 dB for a combined total of 25 dB. However, in the system, antenna X will outperform antenna Y by about 10 dB (Refer to section 10.5 for more details on external LNA gain).

An antenna with higher gain will generally outperform an antenna with lower gain. However, once the signals are above about -130 dBm for a particular satellite, no improvement in performance would be realized. But for those satellites with a signal level below about -135 dBm, a higher gain antenna would amplify the signal and improve the performance of the GNSS receiver. In the case of really weak signals, a good antenna could mean the difference between being able to use a particular satellite signal or not.

10.5. External LNA Gain and Noise Figure

The SL869 V2 and SL869 V2S can be used with an external LNA (built into an active antenna). Because of the internal LNA, the overall gain (including signal losses past the external LNA) should not exceed 20 dB for best performance. Levels higher than that may affect the jamming detection capability of the receiver. If a higher gain LNA is used, either a resistive Pi or T attenuator after the LNA is recommended to reduce the gain to 20 dB.

The external LNA should have a noise figure better than 1 dB. This will give an overall system noise figure of around 2 dB (assuming the LNA gain is 14 dB) or higher if the low gain mode is selected within the module. The overall system noise figure can be calculated using the Friss formula for cascaded noise figure. The simplified formula is:

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \frac{F_4 - 1}{G_1 G_2 G_3} + \cdots + \frac{F_n - 1}{G_1 G_2 G_3 \cdots G_{n-1}},$$

Equation 10-1 Cascade Noise Figure

Where F is the total system noise figure, F1 is the noise figure of the external LNA, F2 is the noise figure of the internal LNA, and G1 is the gain of the external LNA. In the GNSS receiver, digital noise is an additive number and cannot be reduced by reducing the System Noise figure.

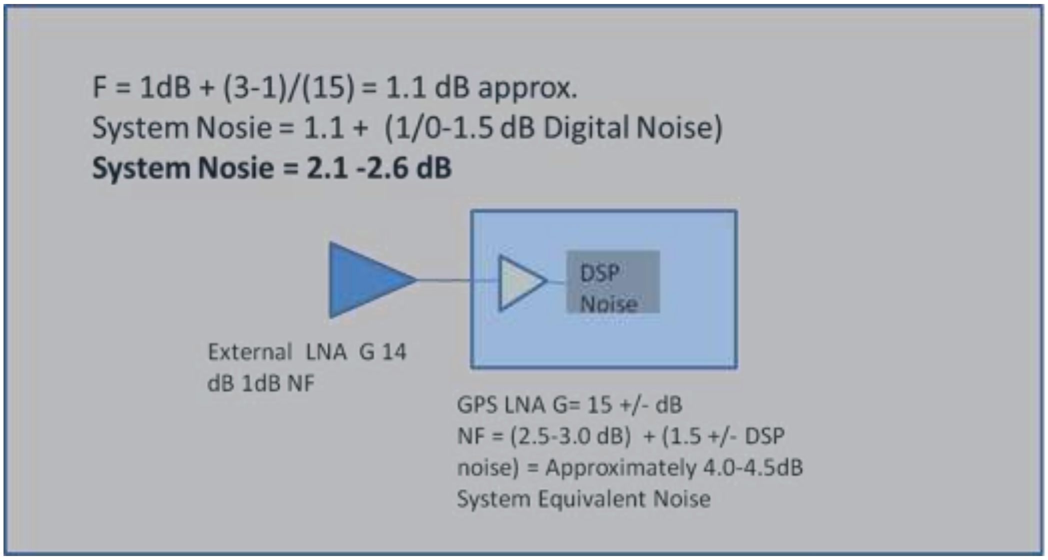


Figure 10-1 Cascade Noise Figure calculations with external LNA

If the external LNA has no pre-select filter, it needs to be able to accomodate signals outside the GNSS passband, which are typically at much higher levels than GNSS. The amplifier must stay in the linear region when presented with these other signals. Again, the system designer needs to determine all of the unintended signals and their possible levels that can be presented making sure the external LNA will not be driven into compression. If this were to happen, the GNSS signal itself would start to be attenuated and the GNSS performance would suffer.

10.6. System Noise Floor

The SL869 V2 will display a reported C/No of 40 dB-Hz for an input signal level of -130 dBm. The C/No number means the carrier (or signal) is 40 dB greater than the noise floor measured in a one Hz bandwidth. This is a standard method of measuring GNSS receiver performance. The simplified formula is

C/No = GNSS Signal level – Thermal Noise – System NF

Equation 10-2 Carrier to Noise Ratio

Thermal noise is -174 dBm-Hz at 290K.

We can estimate a system noise figure of 4 dB for the SL869 V2, consisting of the pre-select SAW filter loss, the LNA noise figure, and implementation losses within the digital signal processing unit. The DSP noise is typically 1.0 to 1.5 dB.
However, if a good quality external LNA is used, the noise figure of that LNA (typically better than 1dB) could reduce the overall system noise figure from 4 dB to approximately 2 dB.

10.7. RF Trace Losses

RF Trace losses on a PCB are difficult to estimate without having appropriate tables or RF simulation software. A good rule of thumb would be to keep the RF traces as short as possible, make sure they are 50 ohm impedance and don’t contain any sharp bends.

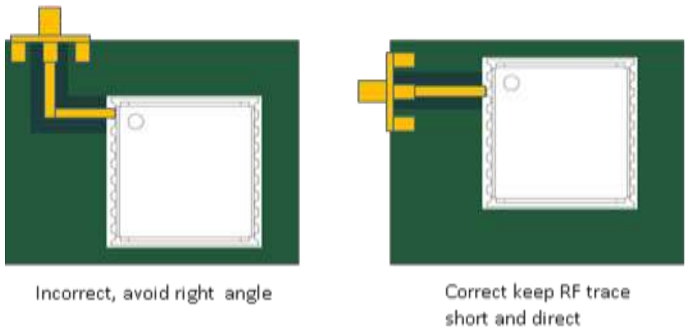


Figure 10-2 RF Trace Examples

10.8. PCB stack and Trace Impedance

It is important to maintain a 50 ohm trace impedance on the RF path. Design software for calculating trace impedance can be found from multiple sources on the internet. Below is the Agilent design software App CAD which can be downloaded at no charge. Using a typical FR4 board stack up, the calculated trace width for this board is 900 microns or approximately 35mill. This may not be an acceptable trace width, and board material may need to be adjusted accordingly.

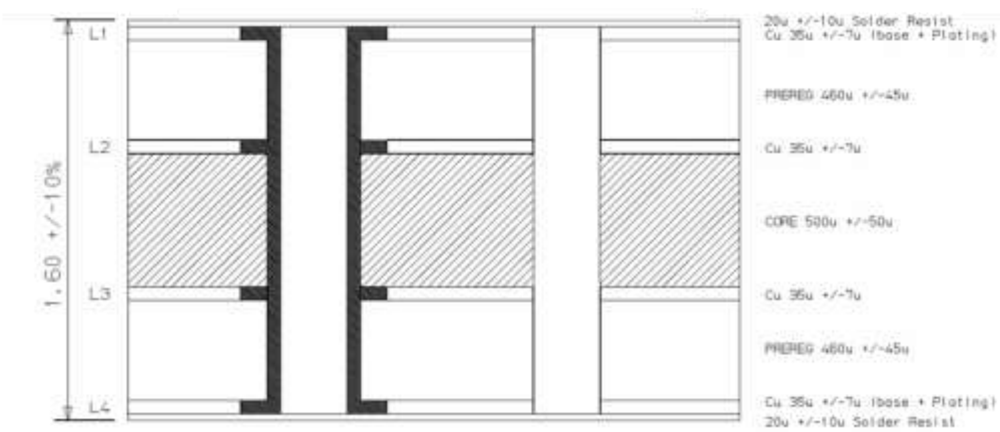


Figure 10-3 Example PCB Stackup

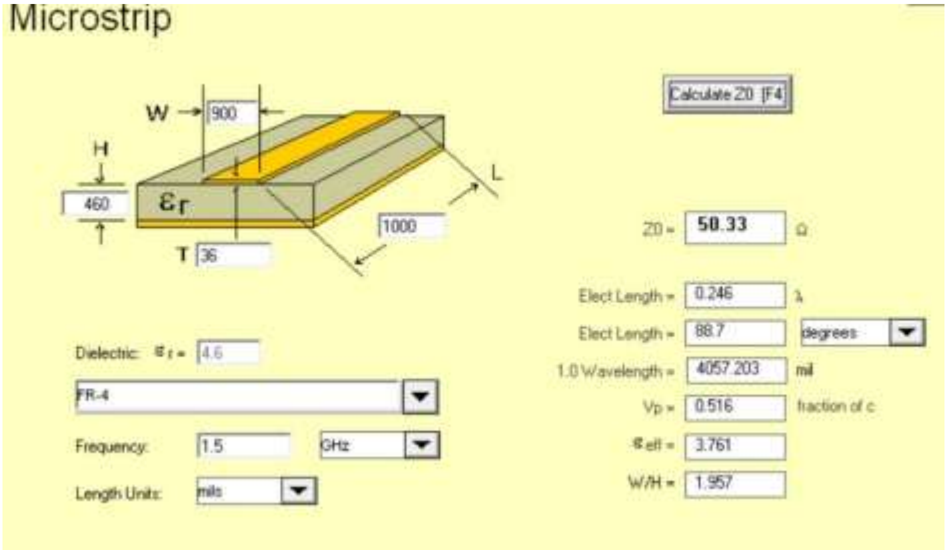


Figure 10-4 Typical Board stackup and calculated trace width

The board material may be dictated by other applications that are included on the host PCB. The board thickness may dictate a very narrow trace. This may not be acceptable and can also lead to issues where the trace meets a component pad. In situations like this, the ground layer directly under the RF trace path can be removed and the RF ground is then moved to the next layer. This may result in a more acceptable trace width.

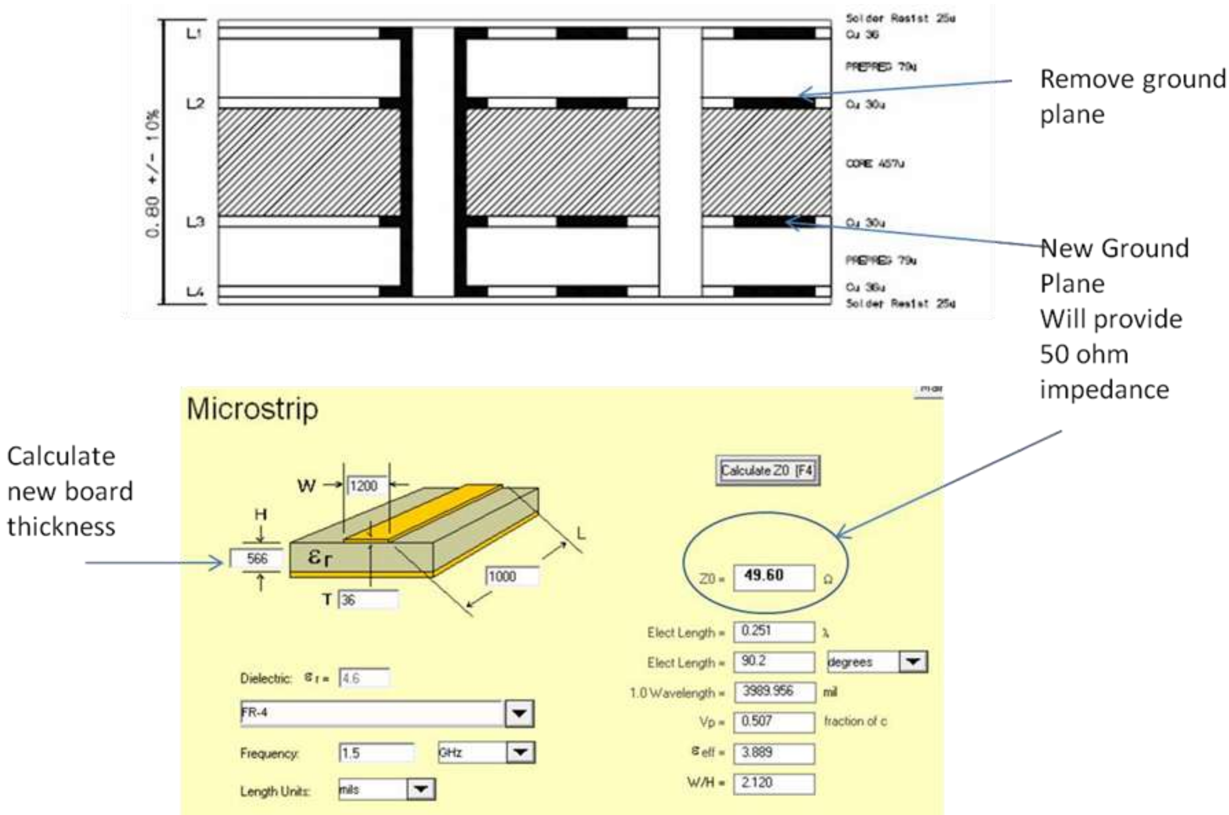


Figure 10-5 Example of wider trace width achieved by moving ground plane

10.9. Implications of the Pre-select SAW Filter

The SL869 V2 and V2S modules include a pre-select SAW filter in front of the internal LNA. Thus the RF input of the module is connected directly to the SAW filter. Any circuit connected to the RF input pin would see a complex impedance presented by the SAW filter (especially out of band), rather than the relatively broad and flat return loss presented by an LNA. Filter devices pass the desired in-band signal, resulting in low reflected energy (good return loss), and reject the out-of-band signals by reflecting it back to the input, resulting in bad return loss.

If an external amplifier is to be used with the receiver, the overall design should be checked for RF stability to prevent the external amplifier from oscillating. Amplifiers that are unconditionally stable at the output will function correctly.

If an external filter is to be connected directly to the module, care needs to be used in making sure the external filter or the internal SAW filter performance is not compromised. These components are typically specified to operate into 50 ohms impedance, which is generally true in-band, but would not be true out of band. If there is extra gain associated with the external filter, then a 6 dB Pi or T resistive attenuator is suggested to improve the impedance match between the two components.

10.10. Powering an External LNA (active antenna)

An external LNA requires a source of power. Many active antennas accept a 3 volt or 5 volt DC voltage that is impressed upon the RF signal line.

Two approaches can be used. The first is to use an inductor to tie directly to the RF trace. This inductor should be at self-resonant at L1 (1.57542 GHz) and should have good Q for low loss. The higher the inductor Q, the lower the loss will be. The side of the inductor connecting to the antenna supply voltage should be bypassed to ground with a good quality RF capacitor, again with self-resonance at the L1 frequency.

The second approach is to use a quarter wave stub in place of the inductor. The length of the stub is designed to be exactly a quarter wavelength at L1, which has the effect of making an RF short at one end of the stub to appear as an RF open at the other end. The RF short is created by the good quality RF capacitor operating at self-resonance.

The choice between the two would be determined by:

- RF path loss introduced by either the inductor or quarter wave stub.
- Cost of the inductor.
- Space availability for the quarter wave stub.

Simulations done by Telit show the following:

Inductor	Additional signal loss (dB)
Murata LQG15HS27NJ02 Inductor	0.65
Quarter wave stub on FR4	0.59
Coilcraft B09TJLC Inductor (used in ref. design)	0.37

Since this additional loss occurs after the LNA, it is generally not significant unless the circuit is being designed to work with both active and passive antennas.

10.11. RF Interference

RF Interference into the GNSS receiver tends to be the biggest problem when determining why the system performance is not meeting expectations. As mentioned earlier, the GNSS signals are at -130 dBm and lower. If signals higher than this are presented to the receiver, the RF front end can be overdriven. The receiver can reject up to 12 in-band CW jamming signals, but would still be affected by non-CW signals.

The most common source of interference is digital noise, often created by the fast rise and fall times and high clock speeds of modern digital circuitry. For example, a popular netbook computer uses an Atom processor clocked at 1.6 GHz. This is only 25 MHz away from the GNSS signal, and depending upon temperature of the SAW filter, can be within its passband. Because of the nature of the address and data lines, this would be broadband digital noise at a relatively high level.

Such devices are required to adhere to a regulatory standard for emissions such as FCC Part 15 Subpart J Class B or CISPR 22. However, these regulatory emission levels are far higher than the GNSS signal.

10.12. Shielding

Shielding the RF circuitry generally is ineffective because the interference is received by the GNSS antenna itself, the most sensitive portion of the RF path. The antenna cannot be shielded because then it could not receive the GNSS signals.

There are two solutions, one is to move the antenna away from the source of interference, and the other is to shield the digital interference source to prevent it from getting to the antenna.

11. Mechanical Drawing

The SL869 V2 and SL869 V2S modules use advanced miniature packaging with a base metal of copper and an Electro-less Nickel Immersion Gold (ENIG) finish.
It has a tin-plated shield and 24 interface pads with castellated edge contacts.

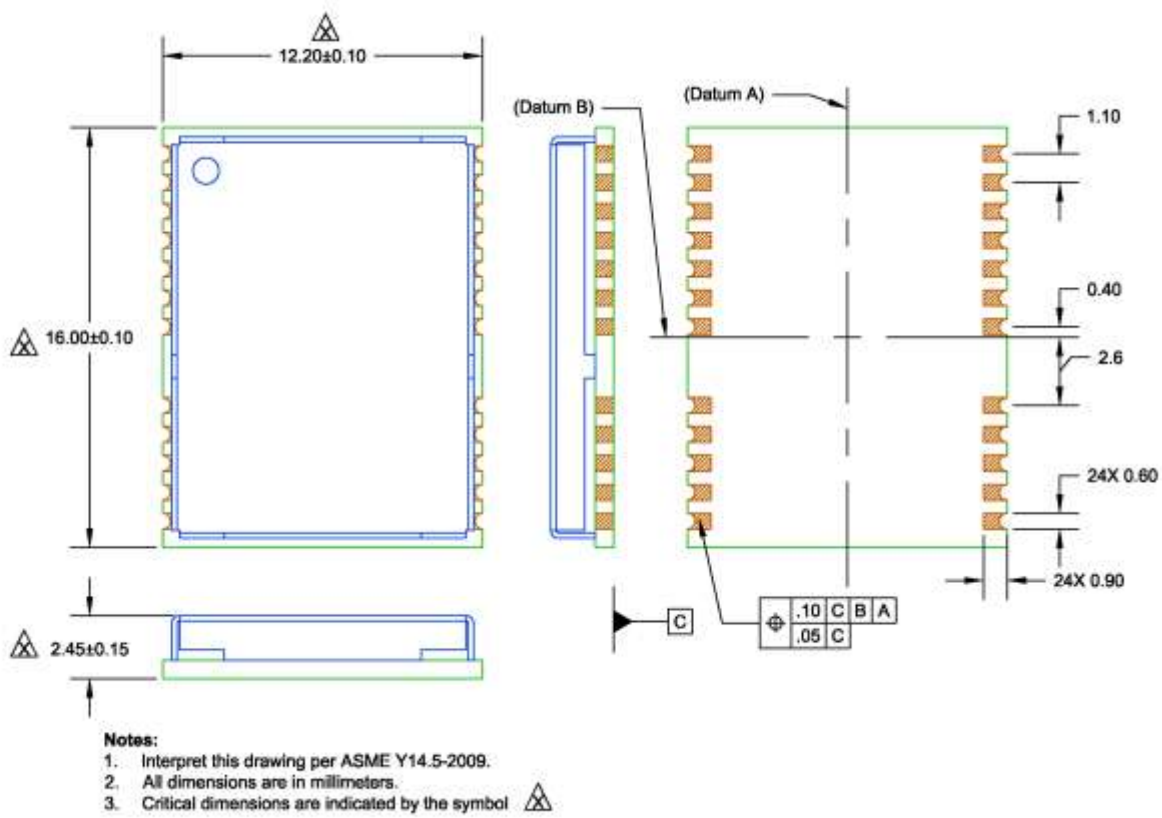


Figure 11-1 SL869 V2 and SL869 V2S Mechanical Drawing

12. PCB Footprint

The PCB footprint on the PC board should match the module pad design shown below. The solder mask opening is generally determined by the component geometry of other parts on the board and can be followed here.

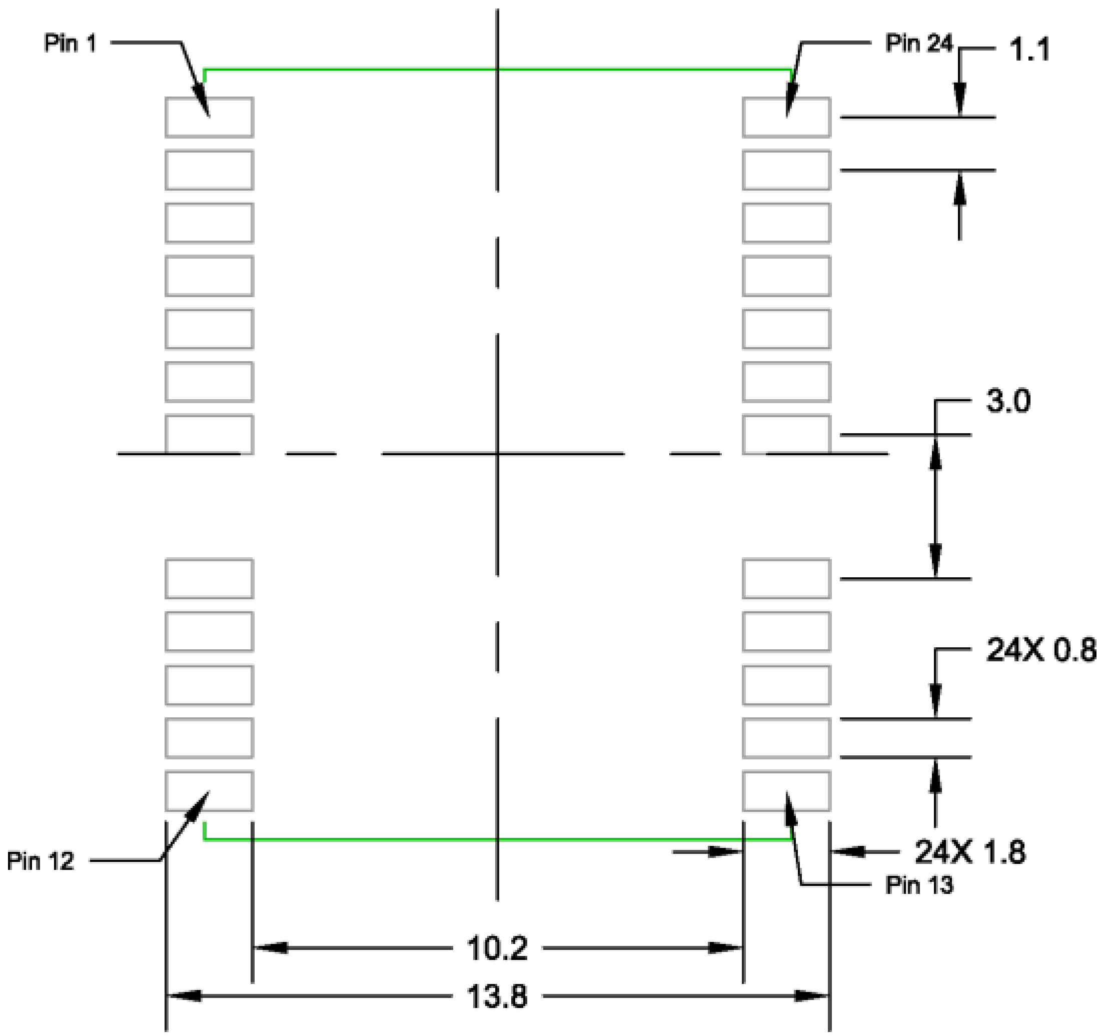


Figure 12-1 SL869 V2 and SL869 V2S PCB Footprint

13. Product Packaging and Handling

13.1. Product Marking and Serialization

The SL869 V2 and SL869 V2S modules have a 2D barcode label identifying both the product ("SL869 V2" or "SL869 V2S") and its serial number. The label format is as follows:

Positions	Description
1 and 2	Year of manufacture (e.g. 13 = 2013, 14 = 2014)
3 and 4	Week of manufacture (01 to 52, starting first week in January)
5	Manufacturer code
6 and 7	Product and type
8	Product revision
9-13	Sequential serial number

Table 13-1 Product Label Format

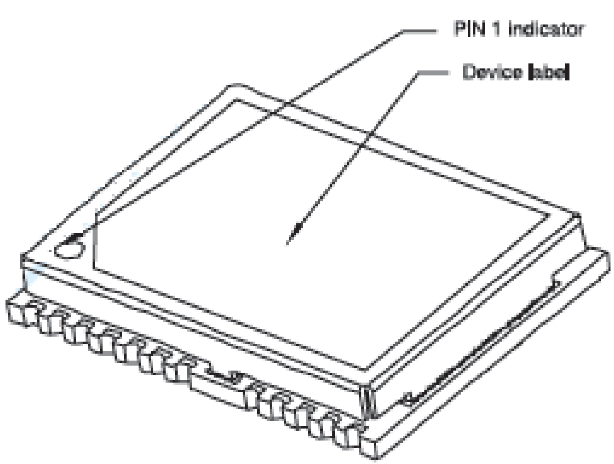


Figure 13-1 Product Marking

13.2. Product Packaging and Delivery

SL869 V2 and SL869 V2S modules are shipped in either Tape and Reel or Tray form. The reeled modules are shipped in 24 mm reels with 1000 units per reel. Each reel is 'dry' packaged and vacuum sealed in a Moisture Barrier Bag (MBB) with two silica gel packs and a humidity indicator card which is then placed in a carton.
All packaging is ESD protective lined.

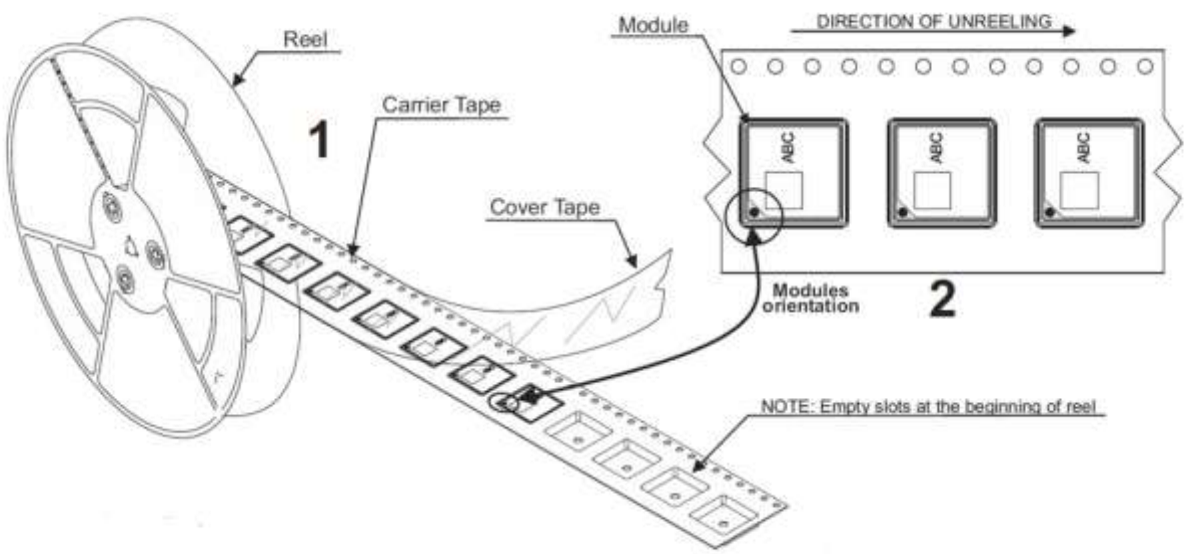


Figure 13-2 Tape and Reel Packaging

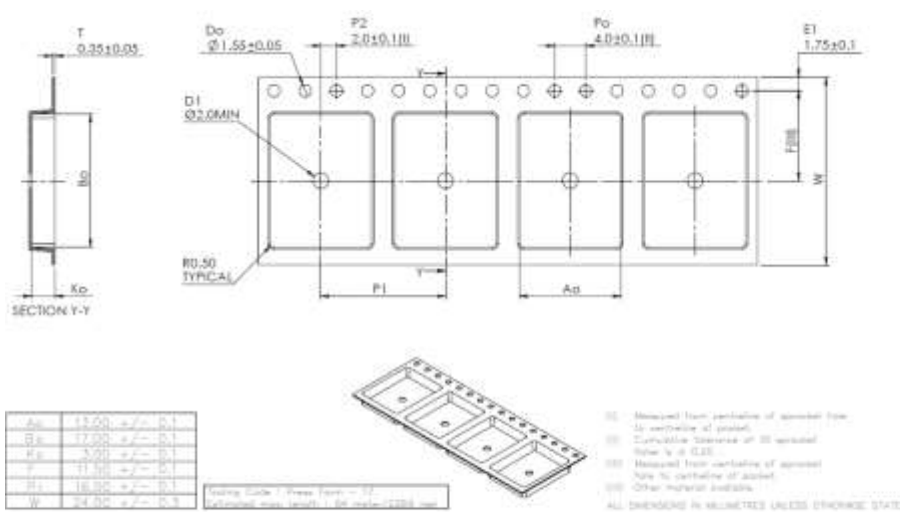


Figure 13-3 Tape and Reel Detail

The modules shipped in trays have 72 units per tray. Five trays are ‘dry’ packaged and vacuum sealed in a Moisture Barrier Bag (MBB) with a silica gel pack and a humidity indicator card which is then placed in a carton.

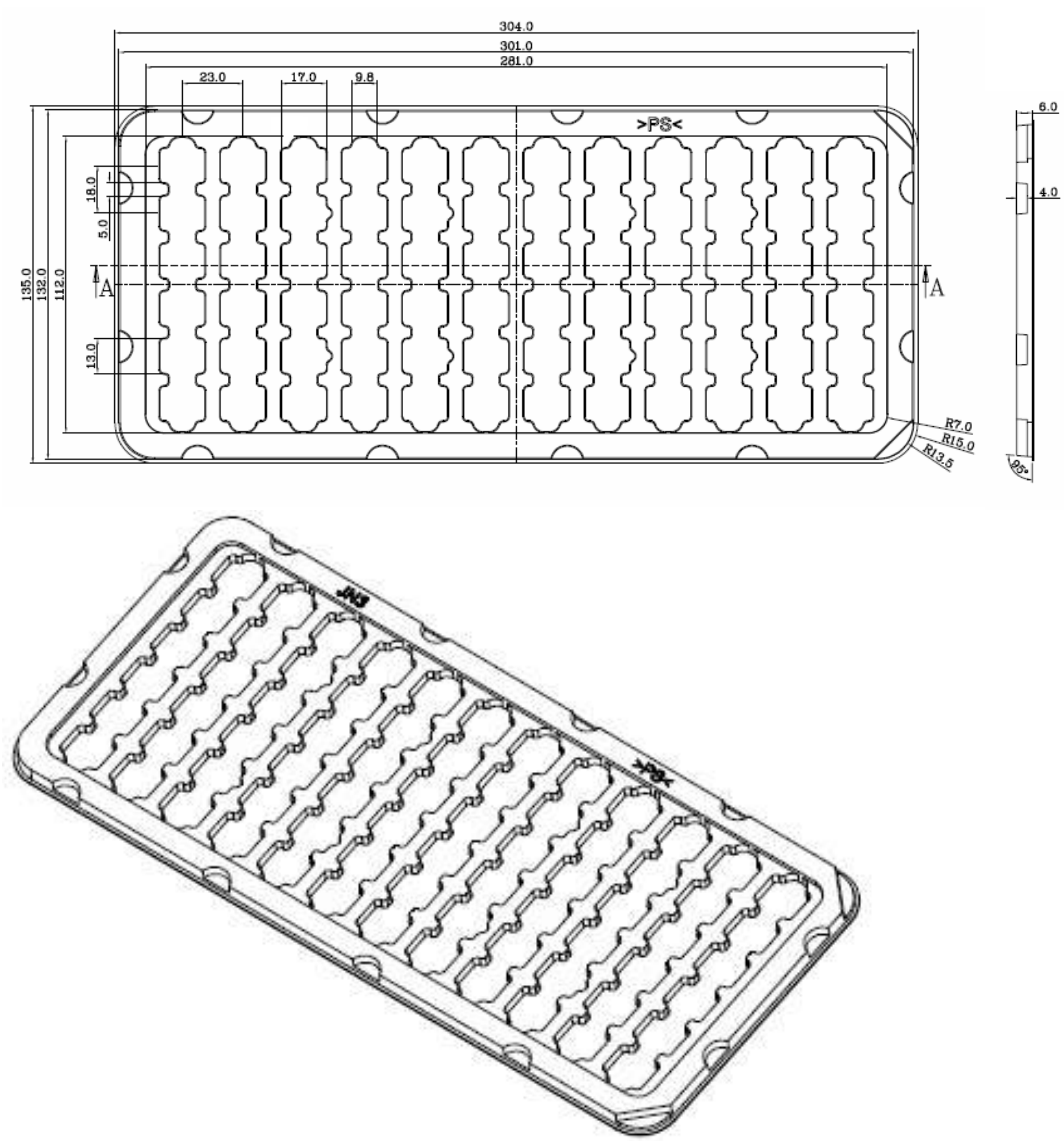


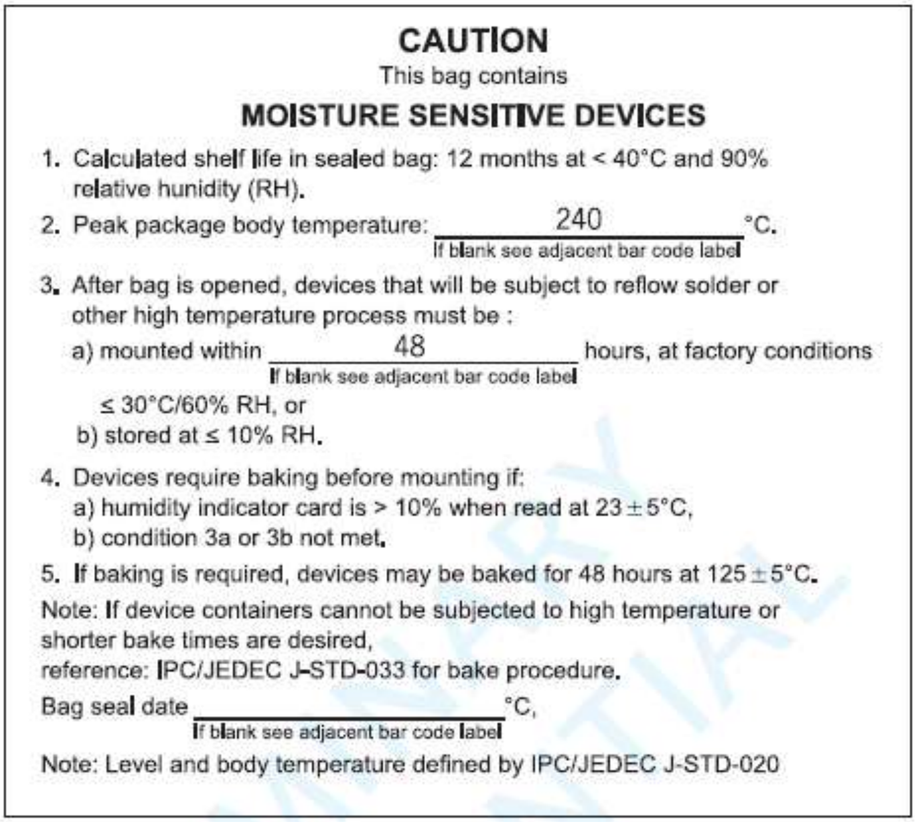
Figure 13-4 Tray Packaging

13.3. Moisture Sensitivity

The receiver module is a Moisture Sensitive Device (MSD) Level 3 as defined by IPC/JEDEC J-STD-020. Please follow the MSD and ESD handling instructions on the labels of the MBB and exterior carton.

Precautionary measures are required in handling, storing and using such devices to avoid damage from moisture absorption. If localized heating is required to rework or repair the device, precautionary methods are required to avoid exposure to solder reflow temperatures that can result in performance degradation.

The module must be placed and reflowed within 48 hours of first opening the hermetic seal provided the factory ambient conditions are < 30°C and < 60% R. H., and the humidity indicator card indicates less than 10% relative humidity.
If the package has been opened or the humidity indicator card indicates above 10%, then the parts will need to be baked prior to reflow. The parts may be baked at +125°C ± 5°C for 48 hours. However, the trays, tape, and reel can NOT withstand that temperature. Lower temperature baking is feasible if the humidity level is low and time is available. Please see IPC/JEDEC J-STD-033 "Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices".for additional information.
Please refer to the MSL tag affixed to the outside of the hermetically sealed bag.
Note: JEDEC standards are available at no charge from the JEDEC website http://www.jedec.org.



CAUTION

This bag contains

MOISTURE SENSITIVE DEVICES

1. Calculated shelf life in sealed bag: 12 months at < 40°C and 90% relative hunidity (RH).
2. Peak package body temperature: 240 °C. (If blank see adjacent bar code label)
3. After bag is opened, devices that will be subject to reflow solder or other high temperature process must be :
   a) mounted within 48 (If blank see adjacent bar code label) hours, at factory conditions ≤ 30°C/60% RH, or
   b) stored at ≤ 10% RH.
4. Devices require baking before mounting if:
   a) humidity indicator card is > 10% when read at 23 ± 5°C,
   b) condition 3a or 3b not met.
5. If baking is required, devices may be baked for 48 hours at 125 ± 5°C.

Note: If device containers cannot be subjected to high temperature or shorter bake times are desired, reference: IPC/JEDEC J-STD-033 for bake procedure.

Bag seal date ______ °C, (If blank see adjacent bar code label)

Note: Level and body temperature defined by IPC/JEDEC J-STD-020

Figure 13-5 Moisture Sensitive Devices Label

13.4. ESD Sensitivity

These modules contain class 1 devices and are Electro-Static Discharge Sensitive (ESDS). Telit recommends two basic techniques for protecting ESD devices from damage:

- Handle sensitive components only in an ESD Protected Area (EPA) under protected and controlled conditions.
- Protect sensitive devices outside the EPA using ESD protective packaging. All personnel handling ESDS devices have the responsibility to be aware of the ESD threat to the reliability of electronic products.

Further information can be obtained from the JEDEC standard JESD625-A “Requirements for Handling Electrostatic Discharge Sensitive (ESDS) Devices”, which can be downloaded free of charge from: www.jedec.org.

13.5. Reflow

These receiver modules are compatible with lead-free soldering processes as defined in IPC/JEDEC J-STD-020. The reflow process profile must not exceed the profile given in its Table 5-2, “Classification Reflow Profiles”. Although the standard allows for three reflows, the assembly process for the module uses one of those profiles. Thus the module is limited to two reflows.

When reflowing a dual-sided SMT board, it is important to reflow the side containing the receiver module last. This prevents heavier components within the module becoming dislodged if the solder reaches liquidus temperature while the module is inverted.

Note: JEDEC standards are available for download without charge from the JEDEC website http://www.jedec.org.

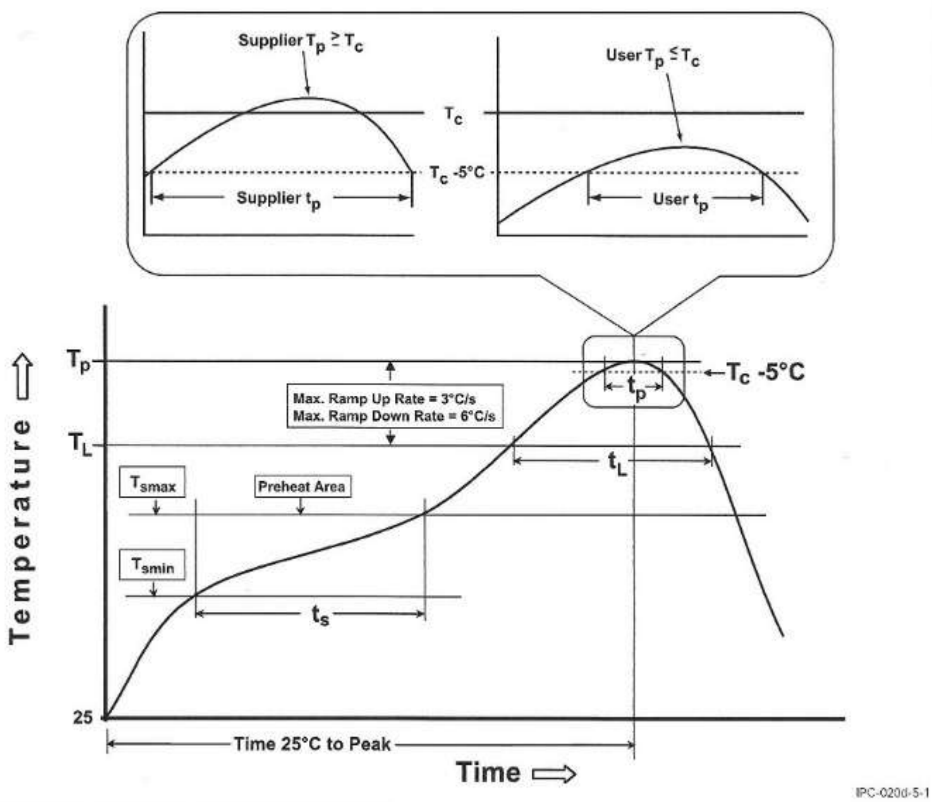


Figure 13-6 Temperature Profile

Please note that the JEDEC document includes important information in addition to the above figure.

13.6. Assembly Considerations

Since the module contains piezo-electric components, it should be placed near the end of the assembly process to minimize mechanical shock to it. During board singulation, pay careful attention to unwanted vibrations and resonances introduced into the board assembly by the board router.

13.7. Safety

Improper handling and use of the receiver module can cause permanent damage. There is also the possible risk of personal injury from mechanical trauma or choking hazard.

13.8. Disposal

We recommend that this product should not be treated as household waste. For more detailed information about recycling this product, please contact your local waste management authority or the reseller from whom you purchased the product.

14. Environmental Requirements

14.1. Operating Environmental Limits

Temperature	-40°C to +85°C
Temperature Rate of Change	±1°C/min maximum
Humidity	Up to 95% non-condensing or a wet bulb temperature of +35°C, whichever is less
Altitude	-1500 m to 100,000 m
Vibration	Full performance (see curve)
Maximum Vehicle Dynamics	600 m/sec (acquisition and navigation) 2G acceleration
ITAR Limits	Speed: 515m/sec and Altitude: 18,000 m

Figure 14-1 Operating Environmental Limits

14.2. Storage Environmental Limits

Temperature	-40°C to +85°C
Humidity	Up to 95% non-condensing or a wet bulb temperature of +35°C, whichever is less
Altitude	-1000 feet to 60,000 feet
Shock	18G peak, 5 millisecond duration
Shock (in shipping container)	10 drops from 75 cm onto concrete floor

Figure 14-2 Storage Environmental Limits

15. Compliances

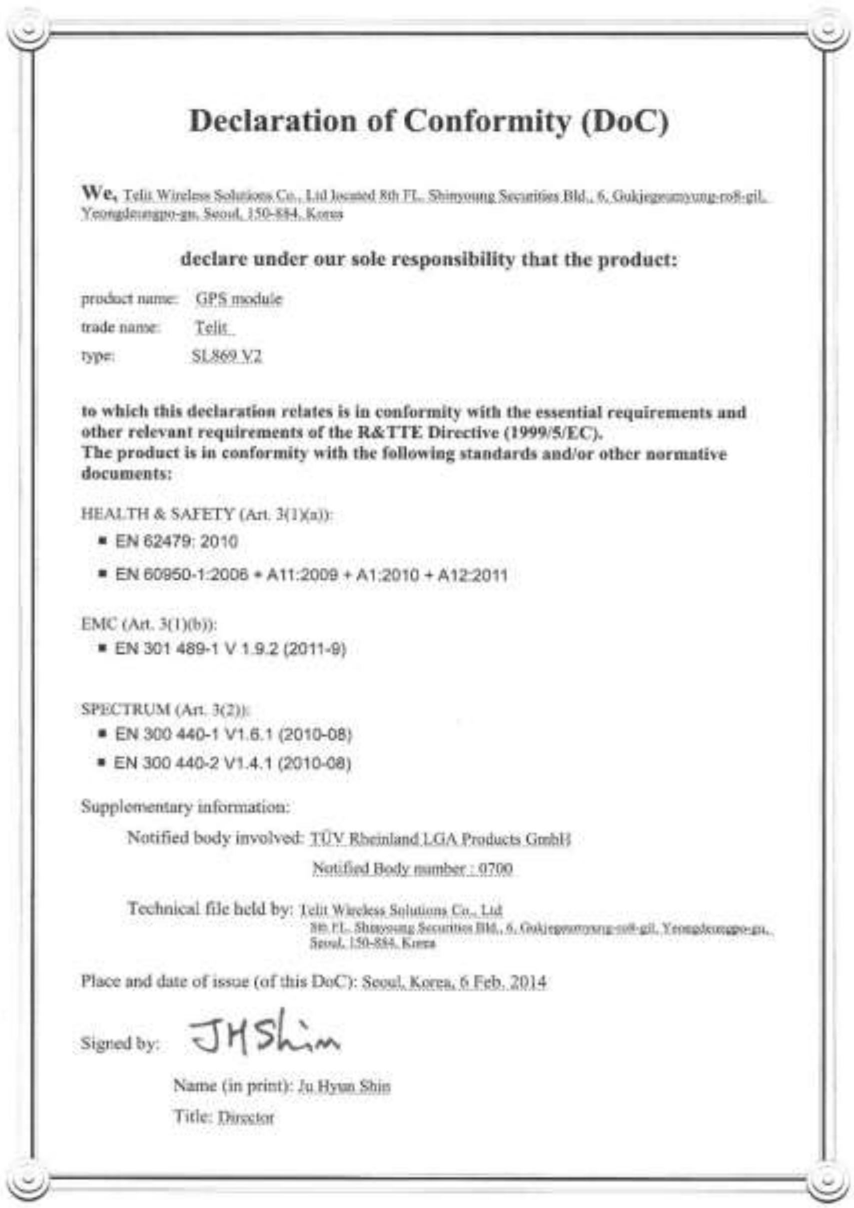
The SL869 V2 and SL869 V2S modules comply with the following:

- **Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)**
- **Manufactured in an ISO 9000: 2008 accredited facility (Certificate upon request)**
- **Manufactured to TS 16949 requirements (Certificate upon request)**

The SL869 V2 and SL869 V2S modules conform to the following European Union Directives:

- **Low Voltage Directive 2006/95/EEC and product safety test**
- **Directive EMC 2004/108/EC for conformity for EMC**

15.1. CE Declaration of Conformity & Conformity Assessment



Declaration of Conformity (DoC)

We, Telit Wireless Solutions Co., Ltd located 8th FL. Shinyoung Securities Bld., 6, Gukjegeumyung-ro8-gil, Yeongdeungpo-gu, Seoul, 150-884, Korea

declare under our sole responsibility that the product:

product name: GPS module
trade name: Telit
type: SL869 V2

to which this declaration relates is in conformity with the essential requirements and other relevant requirements of the R&TTE Directive (1999/5/EC).
The product is in conformity with the following standards and/or other normative documents:

HEALTH & SAFETY (Art. 3(1)(a)):
- EN 62479: 2010
- EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011

EMC (Art. 3(1)(b)):
- EN 301 489-1 V 1.9.2 (2011-9)

SPECTRUM (Art. 3(2)):
- EN 300 440-1 V1.6.1 (2010-08)
- EN 300 440-2 V1.4.1 (2010-08)

Supplementary information:

Notified body involved: TÜV Rheinland LGA Products GmbH
Notified Body number : 0700

Technical file held by: Telit Wireless Solutions Co., Ltd
8th FL. Shinyoung Securities Bld., 6, Gukjegeumyung-ro8-gil, Yeongdeungpo-gu, Seoul, 150-884, Korea

Place and date of issue (of this DoC): Seoul, Korea, 6 Feb. 2014

Signed by: JHShim

Name (in print): Ju Hyun Shin
Title: Director

Figure 15-1 SL869 V2 CE Declaration of Conformity

PHOENIX TESTLAB

Expertise

Expert Opinion of the Notified Body on the Conformity Assessment according to Article 10.5 of R&TTE Directive 1999/5/EC

PHOENIX TESTLAB

EU Identification Number 0700

Recognised by Bundesnetzagentur

Expertise No.	14-110704b
Certificate Holder	Telit Wireless Solutions Co., Ltd.
Address	8th FL. Shinyoung Securities Bld., 6, Gukjegeumyung-ro8-gil, Yeongdeungpo-gu, Seoul, 150-884, Korea
Product Description	GPS module, GNSS with GPS, GLONASS, Beidou
Brand Name / Model Name	Telit / SL869 V2
Opinion on the Essential Requirements	
Article 3.1a): Health and Safety	**No remarks**
Article 3.1b): Electromagnetic Compatibility	**No remarks**
Article 3.2: Effective Use of the Radio Spectrum	**No remarks**
CE-marking	
Marking Example (Class 1)	CE 0700

This certificate is issued in accordance with the Directive 1999/5/EC of the European Parliament and the Council on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity dated 9th March 1999 and is only valid in conjunction with the following annex (2 pages).
This version of the certificate replaces the expertise 14-110704a, which is hereby withdrawn.

Blomberg, 26 February 2014
Place, Date of Issue

Signed by Horst Dreinert
Notified Body

Phone +49(0)5235-9500-24
Fax +49(0)5235-9500-28
notifiedbody@phoenix-testlab.de

PHOENIX TESTLAB GmbH
Königswinkel 10
D-32825 Blomberg, Germany
www.phoenix-testlab.de

Figure 15-2 SL869 V2 R&TTE Notified Body Opinion

Declaration of Conformity (DoC)

We, Telit Wireless Solutions Co., Ltd.
located8th Fl., Shinyoung Securities Bld., 6, Gukjegeumyung-ro8-gil, Yeongdeungpo-gu, Seoul, 150-884, Korea

declare under our sole responsibility that the product:

product name: GPS module

trade name:Telit

type:SL869 V2S

to which this declaration relates is in conformity with the essential requirements and other relevant requirements of the R&TTE Directive (1999/5/EC).
The product is in conformity with the following standards and/or other normative documents:

SAFETY (Art. 3(1)(a)):

- EN 60950-1:2006/A11:2009/A1:2010/A12:2011/A2:2013
- EN 62479: 2010

EMC (Art. 3(1)(b)):

- EN 301 489-1 V 1.9.2 (2011-09)
- EN 301 489-3 V 1.6.1 (2013-08)

SPECTRUM (Art. 3(2)):

- EN 300 440-1 V1.6.1 (2010-08)
- EN 300 440-2 V1.4.1 (2010-08)

Supplementary information:

Notified body involved: PHOENIX TESTLAB GMBH
Notified Body number : 0700

Technical file held by:Telit Wireless Solutions Co., Ltd
8th Fl., Shinyoung Securities Bld., 6, Gukjegeumyung-ro8-gil, Yeongdeungpo-gu, Seoul, 150-884, Korea

Place and date of issue (of this DoC): Seoul, Korea, 15 Apr. 2014

Signed by:

Name (in print): Ju Hyun Shin

Title:Director

JHShin

Figure 15-3 SL869 V2S CE Declaration of Conformity

PHOENIX TESTLAB

Expertise

Expert Opinion of the Notified Body on the Conformity Assessment according to Article 10.5 of R&TTE Directive 1999/5/EC

PHOENIX TESTLAB
EU Identification Number 0700

Recognised by Bundesnetzagentur

BNetzA-bS-02/51-55

Expertise No.	14-112061
Certificate Holder	Telit Wireless Solutions Co., Ltd.
Address	8th FL. Shinyoung Securities Bld., 6, Gukjegeumyung-ro8-gil, Yeongdeungpo-gu, Seoul, 150-884, Korea
Product Description	GPS module
Brand Name / Model Name	Telit / SL869 V2S

Opinion on the Essential Requirements

Article 3.1a): Health and Safety	**No remarks**
Article 3.1b): Electromagnetic Compatibility	**No remarks**
Article 3.2: Effective Use of the Radio Spectrum	**No remarks**

CE-marking

Marking Example (Class 1) CE 0700

This certificate is issued in accordance with the Directive 1999/5/EC of the European Parliament and the Council on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity dated 9th March 1999 and is only valid in conjunction with the following annex (2 pages).

Blomberg, 22 April 2014
Place, Date of issue

BENANNTE STELLE PHOENIX TESTLAB NOTIFIED BODY

Signed by Dieter Griep
Notified Body

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Figure 15-4 SL869 V2S R&TTE Notified Body Opinion

15.2. RoHS certificate

- **The Telit SL869 V2 and SL869 V2S modules are fully compliant with Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)**

16. Glossary and Acronyms

AGPS: Assisted GPS
AGPS provides ephemeris data to the receiver to allow faster cold start times than would otherwise be possible.
This extended ephemeris data could be either server-generated or locally-generated.

Almanac:
A set of orbital parameters for all GPS satellites that allows calculation of approximate GPS satellite positions and velocities. The almanac is used by a receiver to determine satellite visibility and as an aid during acquisition of GPS satellite signals. The almanac is reduced-precision set of ephemeris data and is updated weekly by GPS Control. See

BeiDou (BDNS / formerly COMPASS)
BeiDou Satellite Navigation System (BDS), also known as COMPASS or BeiDou-2, Global satellite navigation system used by China and Asia Pacific region

Cold Start:
A cold start acquisition assumes that the receiver's position and time, along with ephemeris data, is unknown. Almanac information may be used to identify previously healthy satellites and their approximate position.

Cold Start Acquisition Sensitivity:
The lowest signal level at which a GNSS receiver is able to reliably acquire satellite signals and calculate a navigation solution from a Cold Start. Cold start acquisition sensitivity is limited by the data decoding threshold of the satellite messages.

EGNOS: European Geostationary Navigation Overlay Service
The system of geostationary satellites and ground stations developed in Europe to improve the position and time calculation performed by the GPS receiver. Also see WAAS.

Ephemeris (plural ephemerides):
A set of satellite orbital parameters that is used by a GPS receiver to calculate precise GPS satellite positions and velocities. The ephemeris is used to determine the navigation solution and is updated frequently (normally every 2 hours) to maintain the accuracy of the position calculation.

ESD: Electro-Static Discharge
Large, momentary, unwanted electrical currents that cause damage to electronic equipment.

Galileo:
Global navigation satellite system (GNSS) currently being built by the European Union (EU) and European Space Agency (ESA), intended for civilian use.

GDOP: Geometric Dilution of Precision
A factor used to describe the effect of satellite geometry on the accuracy of the time and position solution of a GNSS receiver. A lower the value of GDOP indicates a smaller error in the solution. Related factors include PDOP, HDOP, TDOP and VDOP.

GLONASS: Global Navigation Satellite System
Satellite navigation system operated by the Russian Aerospace Defense Forces

GNSS: Global Navigation Satellite System
Term used for a satellite navigation system with global coverage

GPS: Global Positioning System
The U.S. GNSS space-based radio positioning system that provides accurate position, velocity, and time data.

Hot Start:
A hot start results from a software reset after a period of continuous navigation, or a return from a short idle period (i.e. a few minutes) that was preceded by a period of continuous navigation. All of the critical data (position, velocity, time, and satellite ephemeris) is current and available in memory.

LCC: Leadless Chip Carrier
A module design without pins. In place of the pins are pads of bare gold-plated copper that are soldered to the printed circuit board.

LNA: Low Noise Amplifier
An electronic amplifier used for very weak signals.

Local Ephemeris prediction data:
AGPS prediction of extended ephemeris from broadcast data (downloaded from satellites), which is stored in memory. Useful for up to three days.

MSD: Moisture sensitive device.

Navigation Sensitivity: The lowest signal level at which a GNSS receiver is able to reliably maintain navigation after the satellite signals have been acquired.

NMEA: National Marine Electronics Association

QZSS: Quasi-Zenith Satellite System
Satellite Based Augmentation System for GPS which is receivable within Japan and Oceania

RoHS: The Restriction of Hazardous Substances
Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment, was adopted in February 2003 by the European Union.

RTC: Real Time Clock
An electronic device (chip) that maintains time continuously while powered up.

SAW: Surface Acoustic Wave filter
Electromechanical device used in radio frequency applications. SAW filters are useful at frequencies up to 3 GHz.

SBAS: Satellite Based Augmentation System
A system that uses a network of ground stations and geostationary satellites to provide differential corrections to GNSS receivers. Current examples are EGNOS, WAAS, and MSAS.

Server-based Ephemeris prediction:
A prediction of GPS extended ephemeris accomplished on a server and provided to the receiver over a network. The data is generally usable for up to 14 days.

TCXO: Temperature-Compensated Crystal Oscillator

Tracking Sensitivity:
The lowest signal level at which a GNSS receiver is able to maintain tracking of a satellite signal after acquisition is complete.

TTFF: Time To First Fix
The elapsed time required by a receiver to achieve a valid position solution from a specified starting condition. This value will vary with the operating state of the receiver, the length of time since the last position fix, the location of the last fix, and the specific receiver design. A standard reference level of -130 dBm is used.

UART: Universal Asynchronous Receiver/Transmitter
An integrated circuit (or part thereof) which provides a serial communication port for a computer or peripheral device.

WAAS: Wide Area Augmentation System
The system of satellites and ground stations developed by the FAA (Federal Aviation Administration) that provides DGPS corrections. WAAS satellite coverage is usable in North America. Also see EGNOS.

Warm Start:
A warm start typically results after a period of continuous navigation is followed by an extended period of continuous RTC operation with an accurate last known position available in memory. In this state, position and time data are present and valid but ephemeris data validity has expired.

17. Safety Recommendations

READ CAREFULLY

Be sure the use of this product conforms to all laws and regulations of the country and in the required environment. The use of this product may be dangerous and must be avoided in the following areas:

- Where it can interfere with other electronic devices in environments such as hospitals, airports, aircraft, etc.
- Where there is risk of explosion such as gasoline stations, oil refineries, etc.

It is responsibility of the user to comply with country regulation and the specific environmental regulations.
Do not disassemble the product; tampering will invalidate the product warranty. We recommend following the instructions in user guides for correct operation of the product. The product must be supplied with a stabilized voltage source and the design must conform to security and fire prevention regulations. The product must be handled with care, avoiding any contact with the pins because electrostatic discharge may damage the product.
The system integrator is responsible of the functioning of the final product; therefore, care must be taken regarding components external to the module, as well as any project or installation issue. Should there be any doubt, please refer to the technical documentation and the regulations in force. Every GNSS receiver module must be equipped with a proper antenna with specific characteristics.

The European Community provides Directives for electronic equipment introduced in the market. The relevant information is available on the European Community website:

http://ec.europa.eu/enterprise/sectors/rtte/documents/

Directive 99/05 regarding telecommunication equipment and applicable Directives (Low Voltage and EMC) are available at:

http://ec.europa.eu/enterprise/sectors/electrical/

18. Document History

Revision	Date	Changes
0	2014-04-18	First issue