SL871 Family Product User Guide

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PRODUCT APPLICABILITY TABLE

PRODUCT
SL871
SL871L
SL871-S
SL871L-S

Table 0-1 Product Applicability Table

CONTENTS

TABLES

FIGURES

1 INTRODUCTION

1.1 Purpose

The purpose of this document is to provide information regarding the function, features, and usage of the Telit products listed in the **PRODUCT APPLICABILITY** TABLE.

Please refer to **Chapter 2 PRODUCT DESCRIPTION** for details of product features and product variants.

1.2 Contact and Support Information

For general contact, technical support services, technical questions, and to report documentation errors contact Telit Technical Support at:

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

Alternatively, use:
http://www.telit.com/support

For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:
http://www.telit.com

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

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

Symbol	Description
	Danger – This information MUST be followed or catastrophic equipment failure and/or bodily injury may occur.
	Caution or Warning – This is an important point about integrating the product into a system. If this information is disregarded, the product or system may malfunction or fail.
	Tip – This is advice or suggestion that may be useful when integrating the product.

1.4 Related Documents

- SL871 Data Sheet
- SL871-S Data Sheet
- SL871 & SL869-V2 Families Evaluation Kit User Guide
- Telit MT GNSS Software User Guide

1.4.1 Related Documents Requiring a Non-Disclosure Agreement

- SL871 & SL869-V2 Families Authorized Software User Guide

2 PRODUCT DESCRIPTION

The SL871 family of GPS/GNSS receivers provide a navigation solution using either the GPS constellation only (SL871-S and SL871L-S) or multiple GNSS constellations (SL871 and SL871L).

The modules are complete position, velocity, and time (PVT) engines featuring high performance and low power consumption.

2.1 Product Overview

- Complete GNSS receiver modules including memory, TCXO, and RTC
- SL871L and SL871L-S modules also include a built-in LNA and DC blocking cap
- Based on the MediaTek MT3333 (SL871) or MT3337 (SL871-S)
- Constellations:
  SL871: GPS (L1), QZSS, and either Glonass (L1) or BeiDou (B1) signals,
  Galileo ready
  SL871-S: GPS (L1) and QZSS
- SBAS capable (WAAS, EGNOS, MSAS, GAGAN) including ranging
- DGPS capable using the RTCM SC-104 protocol
- AGPS support for extended ephemeris using local or server-based solutions:
- Local: Embedded Assist System (EASY) [1]
- Server: Extended Prediction Orbit (EPO) [1]
- Jamming Rejection - Active Interference Cancellation
- Supports active or passive antenna
- 1PPS output
- Configurable fix reporting, Default: 1Hz, Max: 10 Hz
- NMEA command input and data output
- 2 standard UART serial ports for input commands and output messages
- SL871: Second serial port is I^2C, configurable for UART interface
- Memory:
  SL871: 8 Megabit built-in flash.
  SL871-S: ROM
- 76 mW typical power consumption (Full Power, GPS + GLONASS)
- Power management modes for extended battery life
- SL871: 99 search channels and 33 simultaneous tracking channels
- SL871-S: 66 search and 22 tracking channels
- Supported by evaluation kits
- -40°C to +85°C industrial temperature range
- Surface mountable by standard SMT equipment
- 18-pad 10.1 x 9.7 x 2.4 mm Industry Standard LLC castellated edge package
- RoHS compliant design

Note 1: See **Section 4.5 Assisted GPS (AGPS)** for EASY/EPO support details.

2.2 Product Naming

SL871: Product family name

L: Added LNA and DC blocking capacitor

S: GPS-only receiver

2.3 Product Variants

The SL871 family includes the following variants:

- SL871 – Flash memory based, Multi-constellation
- SL871 (Gen 1): EOL in July 2015
- SL871 (Gen 2): Switching Mode Power Supply;
  Added Antenna On, Antenna Sense, and Force On pins
- SL871L: Added an LNA and DC blocking capacitor

- SL871-S – ROM based, GPS-only
- SL871-S: Switching Mode Power Supply and Antenna On pin
- SL871 L-S: Added an LNA and DC blocking capacitor

2.3.1 SL871-S and SL871L-S Features

- GPS-only
- ROM-based
- The current SL871-S and SL871L-S have the MT3337E (enhanced) ROM with the following changes:

  Added features:
  - Improved TTFF and Position,
  - EASY
  - PPS sync with NMEA

  Deleted features:
  - SBAS
  - Always Locate
  - LOCUS
  - The 2^{nd} port is UART only and does not support I^2C.

- Locally generated AGPS (EASY - Embedded Assist System) on SL871-S and SL871L-S is supported only on MT3337E ROM (version 2.3) after Oct. 2015.

  Earlier ROM versions did not support EASY.
- Server-generated AGPS (EPO - Extended Prediction Orbit) is supported via a host system for the SL871-S and SL871L-S.

2.3.2 SL871 Product Features Table

Feature	SL871	SL871L	SL871-S	SL871L-S
Constellations Supported	GPS QZSS Glonass BeiDou		GPS QZSS	
Memory	Flash		ROM	
Power Supply	Switching		Switching	
Internal LNA	No	Yes	No	Yes
DC blocking cap	No	Yes	No	Yes
2nd Port	Yes (UART / I^2C)		Yes (UART only)	
Antenna Sense	Yes		No	
Antenna On	Yes		Yes	
Force On	Yes		No	
Software Upgradable	Yes		No	
EPO	Yes		Yes (host)	
ROM version	not applicable		3337E (enhanced)	
EASY	Yes		No	Yes
SBAS	Yes		Yes	No
AlwaysLocate	Yes		Yes	No
LOCUS	Yes		Yes	No

Table 2-1 SL871 Family Product Features

2.4 Block Diagrams

2.4.1 SL871 (Gen 2) Block Diagram

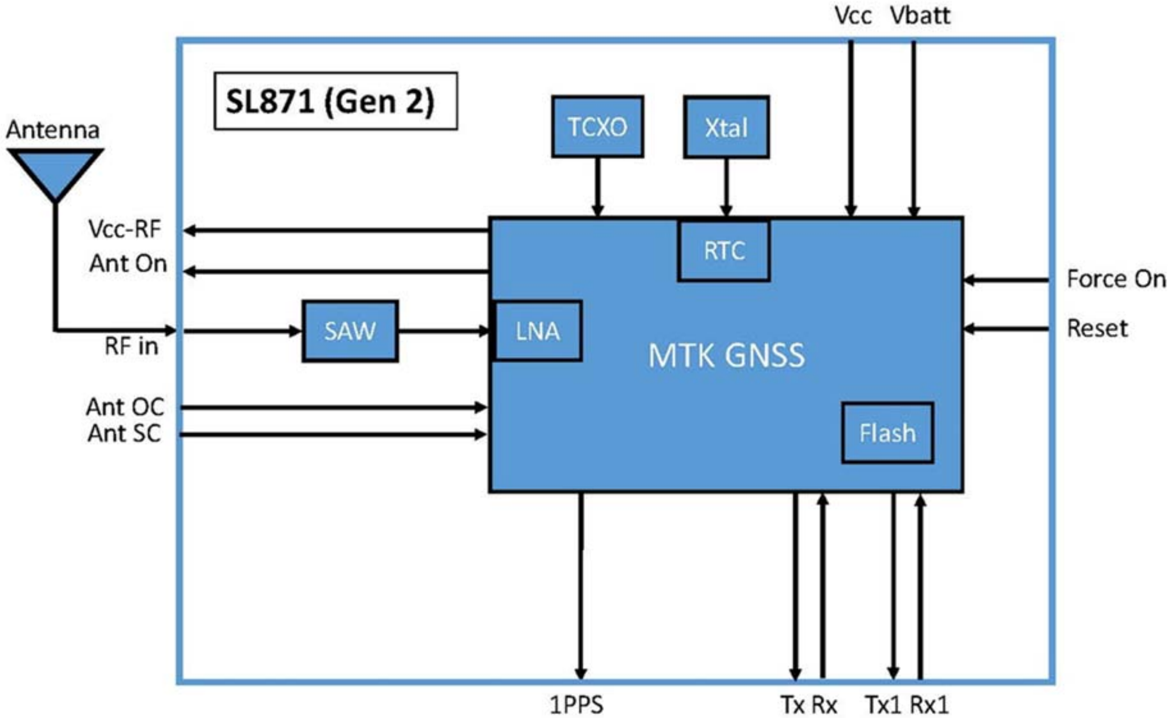


Figure 2-1 SL871 (Gen 2) Block Diagram

2.4.2 SL871L Block Diagram

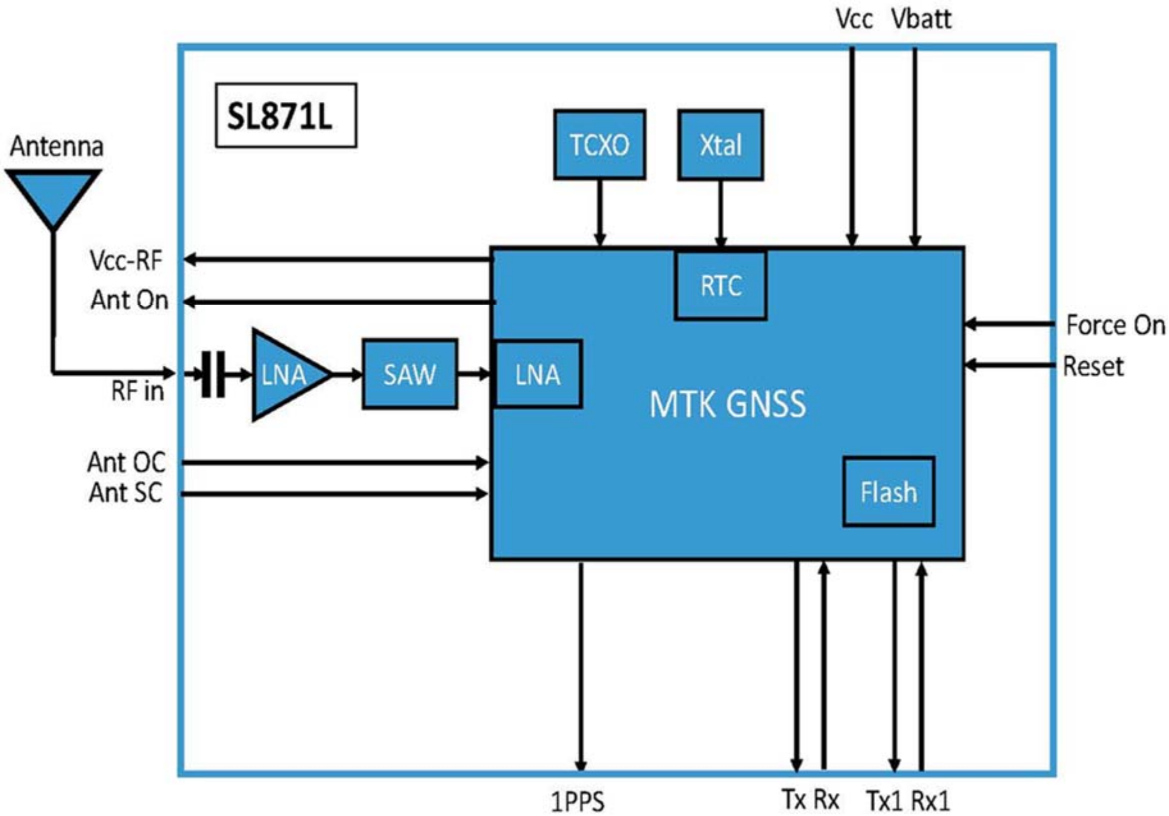


Figure 2-2 SL871L Block Diagram

2.4.3 SL871-S Block Diagram

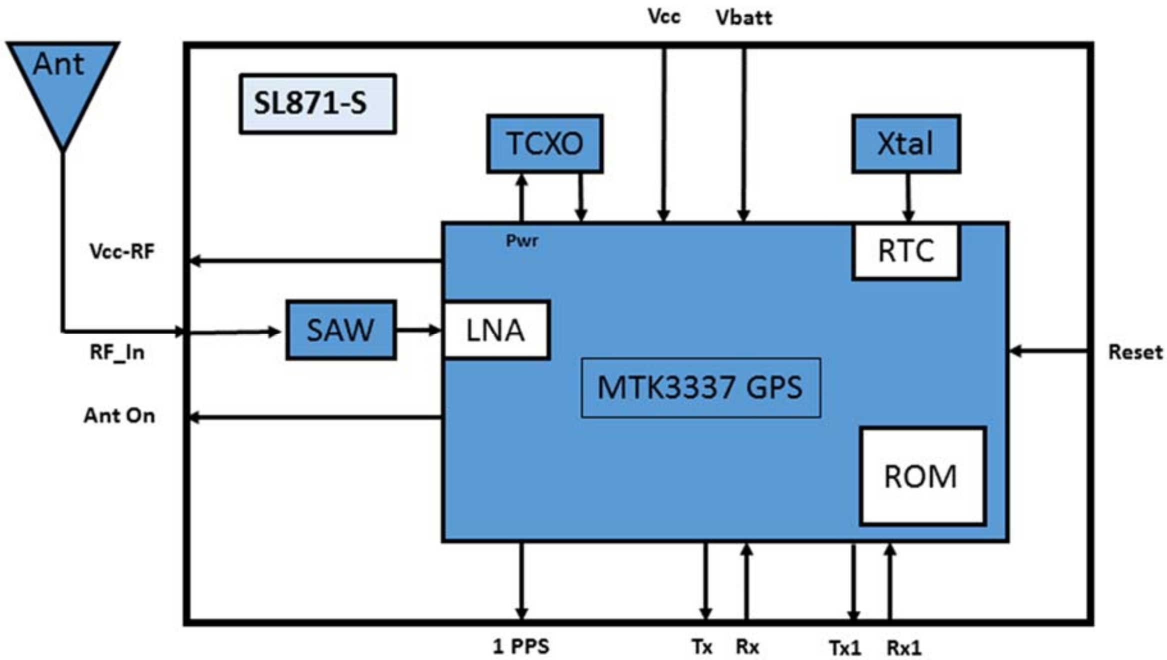


Figure 2-3 SL871-S - Block Diagram

2.4.4 SL871L-S Block Diagram

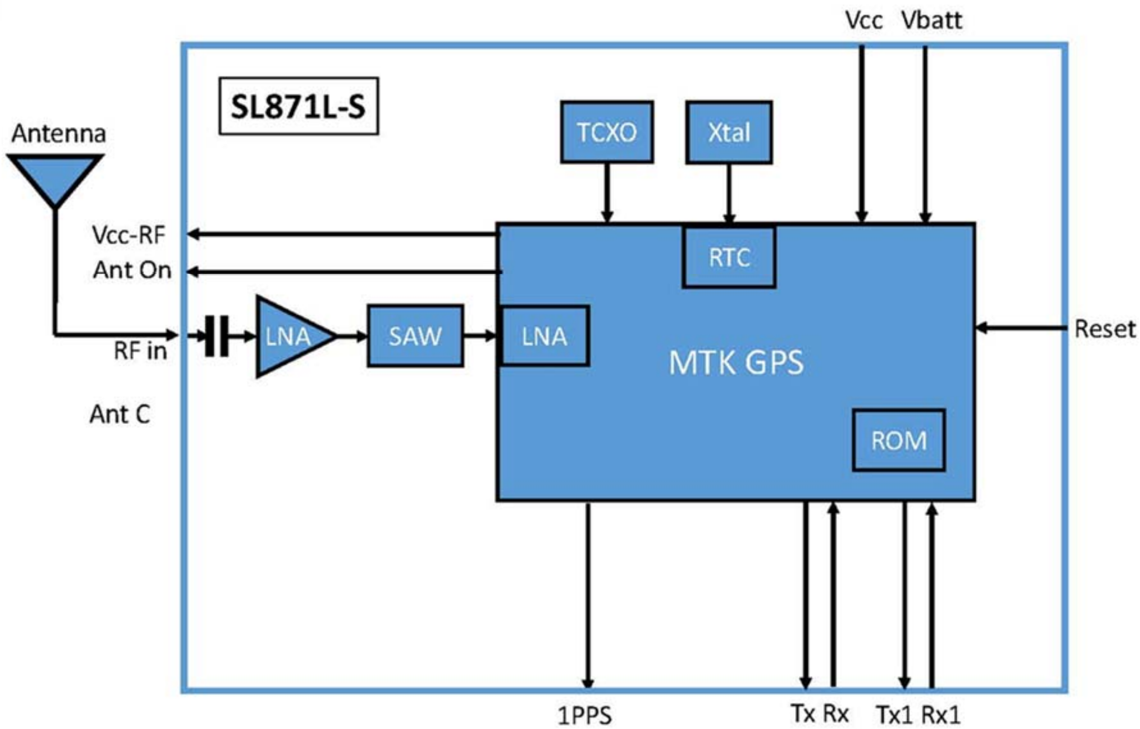


Figure 2-4 SL871L-S - Block Diagram

2.5 Module Photo

Figure 2-5 SL871 Family Module – Photo

Note: All variants have similar appearance (except for the product name).

3 EVALUATION KIT

Please refer to the product Evaluation Kit User Guide for detailed information.

Figure 3-1 Evaluation Kit contents

Note: The SL871 kit includes a GPS/GLONASS / BeiDou antenna.

3.1 Evaluation Unit

Figure 3-2 SL871 Evaluation Unit

4 PRODUCT FEATURES

4.1 Multi-Constellation Navigation

(SL871 and SL871L only)

GPS and GLONASS constellations are enabled by default.

The user may enable or disable GPS, GLONASS, and/or BDS constellations via command. Use of GLONASS or BDS alone may not give optimum positioning results depending on the region where the receiver is located. The SL871-S and SL871L–S support GPS only.

4.2 Quasi-Zenith Satellite System (QZSS)

The satellites of the Japanese SBAS are in a highly-inclined geosynchronous orbit, allowing continuous coverage over Japan using only three satellites. Their primary purpose is to provide augmentation to the GPS system, but the signals may also be used for ranging. NMEA reporting for QZSS may be enabled/disabled by the user.

4.3 Satellite-Based Augmentation System (SBAS)

The receiver is capable of using SBAS satellites as a source of both differential corrections and satellite ranging measurements. These systems (WAAS, EGNOS, GAGAN and MSAS) use geostationary satellites to transmit signals similar to that of GPS and in the same L1 band.

The SBAS feature limits the maximum fix rate to 5 Hz. If disabled, the maximum is 10 Hz.

The module is enabled for SBAS by default, but can be disabled by command.

SBAS is not supported on the SL871L-S or the SL871-S with enhanced ROM (from Oct 2015).

4.3.1 SBAS Corrections

The SBAS satellites transmit a set of differential corrections to their respective regions. The use of SBAS corrections can improve positioning accuracy.

4.3.2 SBAS Ranging

The use of SBAS satellites can augment the number of measurements available for the navigation solution, thus improving availability and accuracy.

4.4 Elevation Mask Angle

The default elevation mask angle is 5°. It can be changed via the **PMTK311** command.

4.5 Assisted GPS (AGPS)

Assisted GPS (or Aided GPS) is a method by which TTFF is improved (reduced) 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.

See **§ 2.3 Product Variants** for applicability.

4.5.1 Locally-generated AGPS - Embedded Assist System (EASY)

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. The module must operate in Full Power mode for at least 5 minutes to collect ephemeris data from visible satellites, or 12 hours for the full constellation.

EASY is off by default, but can be enabled by command.

This feature is not supported on the SL871-S until ROM MT3337E version (enhanced) of Oct 2015. It is supported on the SL871L-S.

4.5.2 Server-generated AGPS - Extended Prediction Orbit (EPO)

(SL871 and SL871L only)

Server-based ephemeris predictions are maintained on Telit AGPS servers. The predicted ephemeris file is obtained from the AGPS server and is transmitted to the module over serial port 1 (RX). These predictions do not require local broadcast ephemeris collection, and are valid for up to 14 days.

The SL871 supports server-based AGPS as a standard feature. Contact TELIT for support regarding this service.

See the next section regarding EPO support (Host EPO) on the SL871-S and SL871L-S.

4.5.3 Host EPO

(SL871-S and SL871L–S only)

The SL871-S and SL871L-S do 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 EPO data and send it to the SL871-S or SL871L-S over the primary serial port (which must be temporarily changed to binary mode). This data is valid for six hours.

Please contact Telit support for further details.

4.6 Static Navigation

Static Navigation is an operating 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 and altitude are 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.

This feature is useful for applications in which very low dynamics are not expected, the classic example being an automotive application.

Static Navigation is disabled by default, but can be enabled by command.

4.7 Jamming Rejection – Active Interference Cancellation (AIC)

The receiver module detects 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 of up to –80 dBm (total power signal levels). 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.

Jamming rejection is enabled by default, but can be disabled by command.

4.8 Internal LNA

(SL871L and SL871L-S only)

The SL871L and SL871L-S modules include a built-in LNA to improve sensitivity.

4.9 10 Hz Navigation

The default rate of 1 Hz can be changed by command to a maximum of 10 Hz.

Enabling the SBAS feature limits the maximum fix rate to 5 Hz.

4.10 1PPS

The module provides a 1PPS output signal. Please see **§ 8.7.4.1 1PPS** for detailed information.

4.11 Differential GPS (DGPS) (SL871 and SL871L only)

DGPS is a Ground-Based Augmentation System (GBAS) for reducing position errors by applying corrections from a set of accurately-surveyed ground stations located over a wide area. These reference stations measure the range to each satellite and compare it to the known-good range. The differences can then be used to compute a set of corrections which are transmitted to a DGPS receiver, either by radio or over the internet. The DGPS receiver can then send them to the SL871 serial port 2 (RX1) using the RTCM SC-104 message protocol. The corrections can significantly improve the accuracy of the position reported to the user.

The receiver can accept either the RTCM SC-104 messages or SBAS differential data.

RTCM is not supported on the I^2C interface.

4.12 Serial I/O Port considerations

The receiver module includes two serial ports.

4.12.1 UART

When configured as UART, they are full-duplex and support configurable baud rates. The signal input and output levels are LVTTL compatible (see **§ 8.7.3 I/O Ports**). Note that the idle state of the interface lines is logic high. Care must be used to prevent backdriving the RX line(s) when the module is powered down or in a low-power state.

4.12.2 I^2C

(SL871 and SL871L only)

The 2nd serial port is configured to use the I^2C interface by default. A custom firmware build supports UART.

The SL871-S and –LS support UART interface only.

4.13 Power Management Modes

The receiver supports operating modes that provide less frequent position fixes at reduced overall current consumption. Availability of GNSS signals in the operating 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 various power management modes can be enabled by sending the desired command using the host serial port (RX).

The power management modes are described below:

4.13.1 Full Power Continuous Mode

The module starts in full power continuous mode when powered up. This mode uses the acquisition engine to search for all possible satellites at full performance, resulting in the highest sensitivity and the shortest possible TTFF. 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.

If power is removed from both Vcc and Vbatt, Time, Ephemeris, Almanac, EASY, EPO data, and PMTK configuration data will be lost. If Vbatt is present, no data will be lost.

4.13.2 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 (STOP Mode)

$PMTK161,1*28 (SLEEP Mode)

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

4.13.3 Backup Mode

(SL871 and SL871L only)

In the backup mode, the internal Power Management Unit is turned off, leaving only BBRAM and the RTC powered up. This reduces power consumption to the minimum required that still provides data retention to enable hot and warm starts.

To enter the Backup mode, use the NMEA command:

$PMTK225,4

To exit the BACKUP mode, bring Force-On high, then return it to low after the first $PMTK message is output (about 1 second).

4.13.4 Periodic Mode

This mode allows autonomous power on/off control with reduced fix rate to decrease average power consumption. The main power supply pin VCC_ON is still powered, but power distribution to internal circuits is internally 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>*<checksu m>

Where:

- Type = 1 for Periodic (backup) mode or 2 for Periodic (standby) 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.

4.13.5 AlwaysLocate™ Mode

(Not available on the SL871L-S and SL871-S with enhanced ROM)

AlwaysLocate™ is an intelligent controller of the Periodic mode where the main supply pin VCC_IN 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. RF 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 = 8 for AlwaysLocate (standby) mode or 9 for AlwaysLocate (backup) mode

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 PERFORMANCE

5.1 Performance - SL871 and SL871L

For best performance it is recommended that multi-constellation navigation be used.

Earlier variants have different performance values.

5.1.1 Horizontal Position Accuracy - SL871 and SL871L

Horizontal Position Accuracy	
Constellation(s)	**CEP (m)**
GPS	2.5
Glonass	2.6
BeiDou	10.2
GPS + Glonass	2.5
GPS + BeiDou	2.5
Test Conditions: 24-hr Static, -130 dBm, Full Power m	

Table 5-1 SL871 and SL871L Horizontal Position Accuracy

5.1.2 Time to First Fix - SL871 and SL871L

Constellation(s)	Start Type	Max TTFF (s)
GPS	Hot	1
	Warm	32
	Cold	33
Glonass	Hot	1.4
	Warm	32
	Cold	33
BeiDou	Hot	1.5
	Warm	35
	Cold	46
GPS + GLO	Hot	1
	Warm	28
	Cold	31
GPS + BeiDou	Hot	1
	Warm	32
	Cold	33
Test Conditions: Static scenario, -130 dBm, Full Power mode		

Table 5-2 SL871 and SL871L Time to First Fix

5.1.3 Sensitivity - SL871 (Gen 2) and SL871L

Constellation(s)	State	Minimum Signal Level (dBm)	
		SL871 (Gen 2)	SL871L
GPS	Acquisition	-145	-147
	Navigation	-159	-160
	Tracking	-162	-163
GLONASS	Acquisition	-144	-146
	Navigation	-156	-159
	Tracking	-158	-161
BeiDou	Acquisition	-143	-146
	Navigation	-156	-159
	Tracking	-158	-162
Note: The above performance values were measured under ideal lab conditions using a GNSS simulator generating a static scenario.			

Table 5-3 SL871 (Gen 2) and SL871L Receiver Sensitivity

5.1.4 Jamming Mitigation Performance

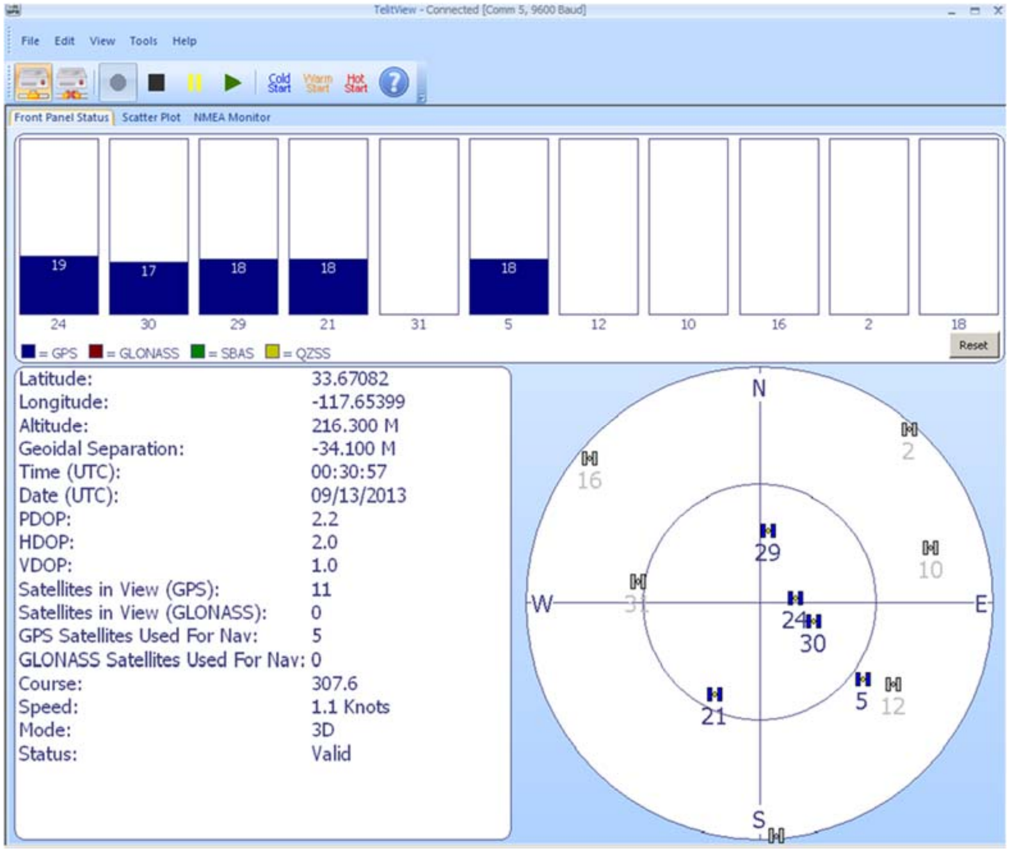


Figure 5-1 Jamming with AIC Disabled

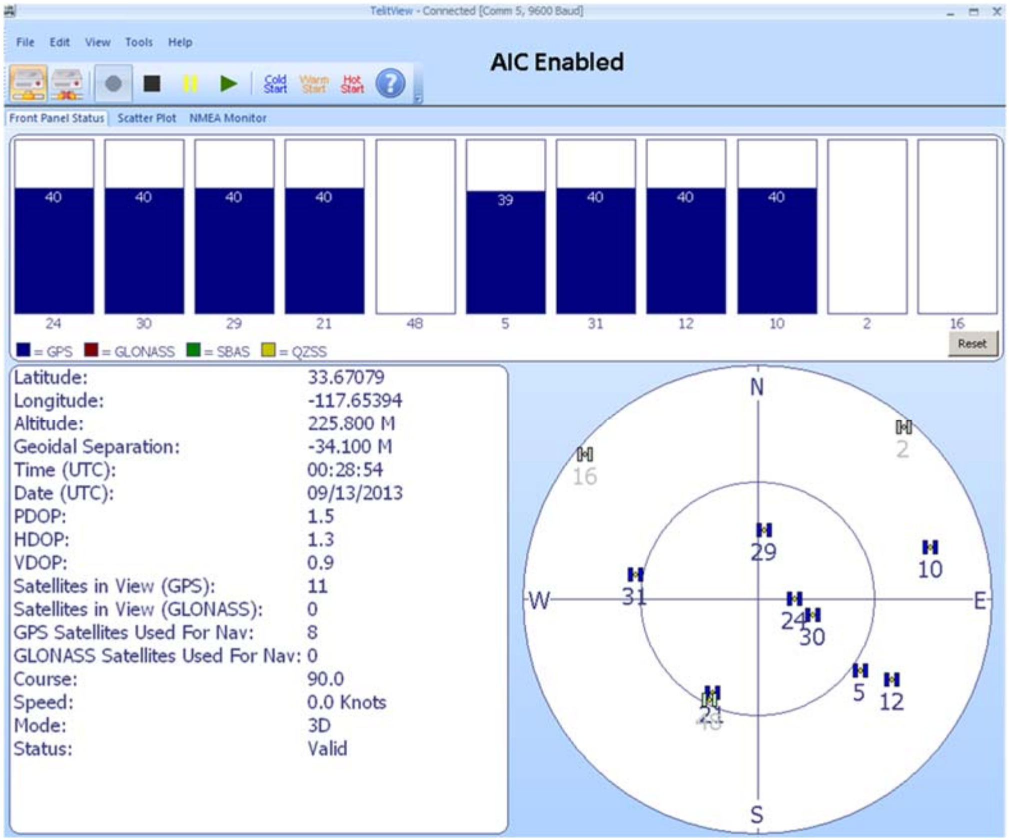


Figure 5-2 Jamming with AIC Enabled

5.2 Performance - SL871-S and SL871L-S

5.2.1 Position Accuracy - SL871-S and SL871L-S

Parameter	Constellation	CEP (m)
Horizontal Position Accuracy	GPS	2.5
Test Conditions: 24-hr Static, -130 dBm, Full Power mode		

Table 5-4 SL871-S and SL871L-S Position Accuracy

5.2.2 Time to First Fix - SL871-S and SL871L-S

Constellation	Start Type	Max TTFF (s)
GPS	Hot	1.0
	Warm	32
	Cold	33
Test Conditions: -130 dBm, Full Power mode, Static scenario		

Table 5-5 SL871-S and SL871L-S Time to First Fix

5.2.3 Sensitivity - SL871-S and SL871L-S

Constellation	State	Minimum Signal Level (dBm)	
		SL871-S Gen 2	SL871L-S
GPS	Acquisition	-144	-147
	Navigation	-159	-161
	Tracking	-163	-164
Note: The above performance values were measured under ideal lab conditions using a GNSS simulator generating a static scenario.			

Table 5-6 SL871-S and SL871L-S Sensitivity

6 SOFTWARE INTERFACE

Serial I/O port 1 (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 Telit MT Software User Guide.

Customers that have executed a Non-Disclosure Agreement (NDA) with Telit Wireless may obtain the SL869-V2 and SL871 Families Authorized Software 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.

Default: GPS and QZSS constellations enabled. GLONASS is also enabled for SL871.

Default fix rate: 1 Hz. Maximum rate is 10 Hz.

Note: Multiple GSA and GSV messages may be output on each cycle.

6.1.1 Standard Messages

Message ID	Description
RMC	GNSS Recommended minimum navigation data
GGA	GNSS position fix data
VTG	Course Over Ground & Ground Speed
GSA	GNSS Dilution of Precision (DOP) and active satellites
GSV	GNSS satellites in view.
$PMTK010	System messages (e.g. to report startup, etc.)

Table 6-1 Default NMEA output messages

The following messages can be enabled by command:

Message ID	Description
GLL	Geographic Position – Latitude & Longitude
ZDA	Time & Date

Table 6-2 Available Messages

Talker ID	Constellation
BD	BeiDou
GA	Galileo
GL	GLONASS
GP	GPS
QZ	QZSS

Table 6-3 NMEA Talker IDs

6.1.2 Proprietary Output Messages

The SL871 and SL871-S support several proprietary NMEA output messages which report additional receiver data and status information.

6.2 NMEA Input Commands

The SL871 and SL871-S use NMEA proprietary messages for commands and command responses. This interface provides configuration and control over selected firmware features and operational properties of the module. Wait time is about 50 to 100 ms.

The format of a command is:

$<command-ID>[,<parameters>]*<cr><lf>

Commands are NMEA proprietary format and begin with **“$PMTKxxx**”.

Parameters, if present, are comma-delimited as specified in the NMEA protocol.

Unless otherwise noted in the Software User Guide, commands are echoed back to the user after the command is executed.

6.3 NMEA Commands List

Command ID	Description
$PMTK000	Test. This command will be echoed back to the sender (for testing the communications link).
$PMTK101	Perform a HOT start
$PMTK102	Perform a WARM start
$PMTK103	Perform a COLD start
$PMTK104	Perform a system reset (erasing any stored almanac data) and then a COLD start
$PMTK120	Erase aiding data stored in flash memory
$PMTK127	Erase EPO data stored in flash memory
$PMTK161,0	Standby - Stop mode
$PMTK161,1	Standby - Sleep mode
$PMTK251,Baudrate	Set NMEA Baud rate
$PMTK313,0	Disable SBAS feature
$PMTK313,1	Enable SBAS feature
$PMTK353,1,0,0,0,0	Enable GPS only mode
$PMTK353,0,1,0,0,0	Enable GLO only mode
$PMTK353,0,0,0,0,1	Enable BDS only mode
$PMTK353,1,1,0,0,0	Enable GPS and GLO mode
$PMTK353,1,0,0,0,1	Enable GPS and BDS mode

NOTE: Multi-constellation commands are not supported by the SL871-S modules

Table 6-4 NMEA Input Commands

7 FLASH UPGRADABILITY

(SL871 and SL871L only)

Note: The SL871-S and SL871L-S have ROM and are not upgradable.

The firmware stored in the internal Flash memory of the SL871 may be upgraded via the serial port TX/RX pins. In order to update the FW, the following steps should be performed to re-program the module.

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

8 ELECTRICAL INTERFACE

8.1 SL871 (Gen 2) and SL871L Pin-out diagram

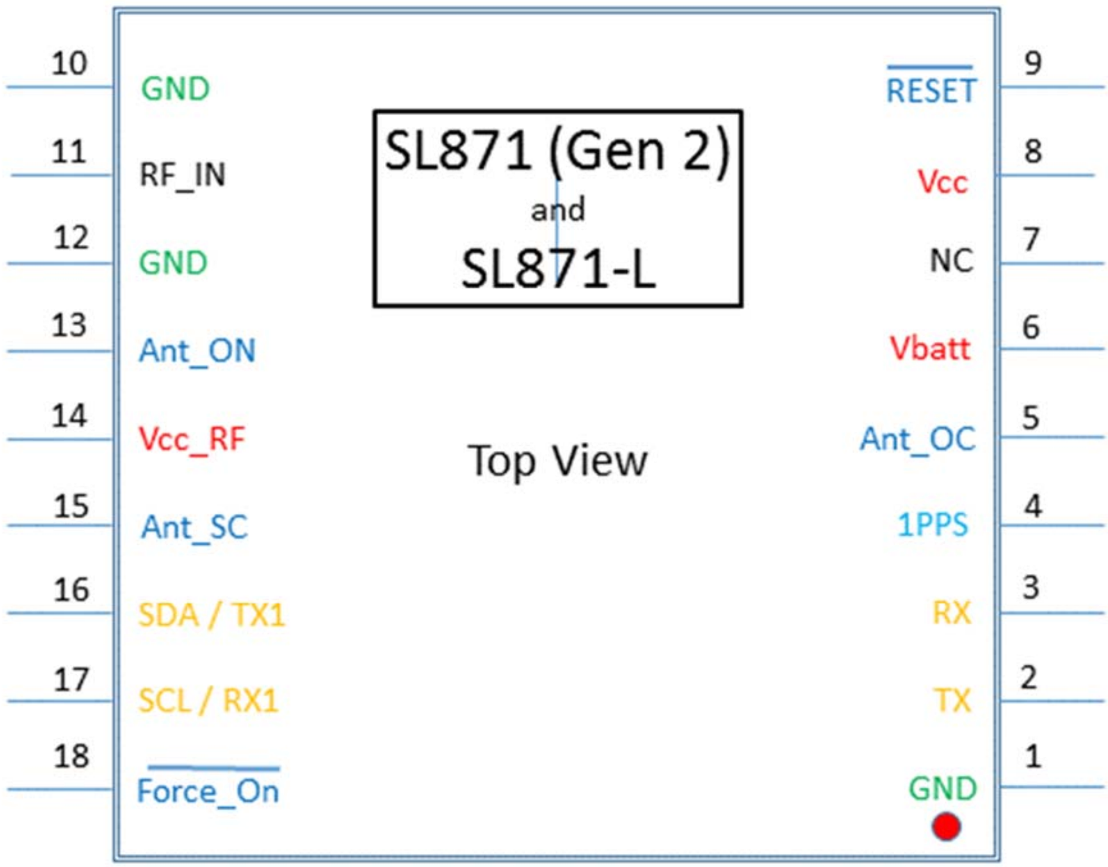


Figure 8-1 SL871 (Gen 2) and SL871L Pin-out diagram

8.2 SL871 (Gen 2) and SL871L Pin-out table

Pin	Name	Type	Description	Notes
1	GND	GND	Ground	
2	TX	O	TX0	
3	RX	I	RX0	
4	1PPS	O	Time mark Pulse, (1PPS)	
5	ANT-OC	I	Antenna-Open (high true)	
6	VBATT	PWR	Backup Voltage Supply	
7	NC	NC	Can be connected to VCC (for compatibility) or left unconnected	
8	VCC	PWR	Supply Voltage	
9	RESET-N	I	RESET-N (Active Low, open drain) May be left unconnected	
10	GND	GND	Ground	
11	RF-IN	I	GNSS RF Input. 50 Ω Max DC voltage: ± 3.0 V (Gen 2)	1
12	GND	GND	Ground	
13	ANT-ON	O	Antenna On	
14	VCC-RF	PWR	Output Voltage for a bias-T (max 50 mA)	
15	ANT-SC-N	I	Antenna Shorted (low true)	
16	SDA / TX1	I/O	TX1 / SDA	2
17	SCL / RX1	I/O	RX1 / SCL	2
18	FORCE-ON-N	I	FORCE ON	

1. DC Blocking capacitor has been added in SL871L.
2. UART on Port 1 (pins 16 &17) requires a custom software build.

Table 8-1 SL871 (Gen 2) & SL871L Pin-out Table

8.3 SL871-S and SL871L-S Pin-out diagram

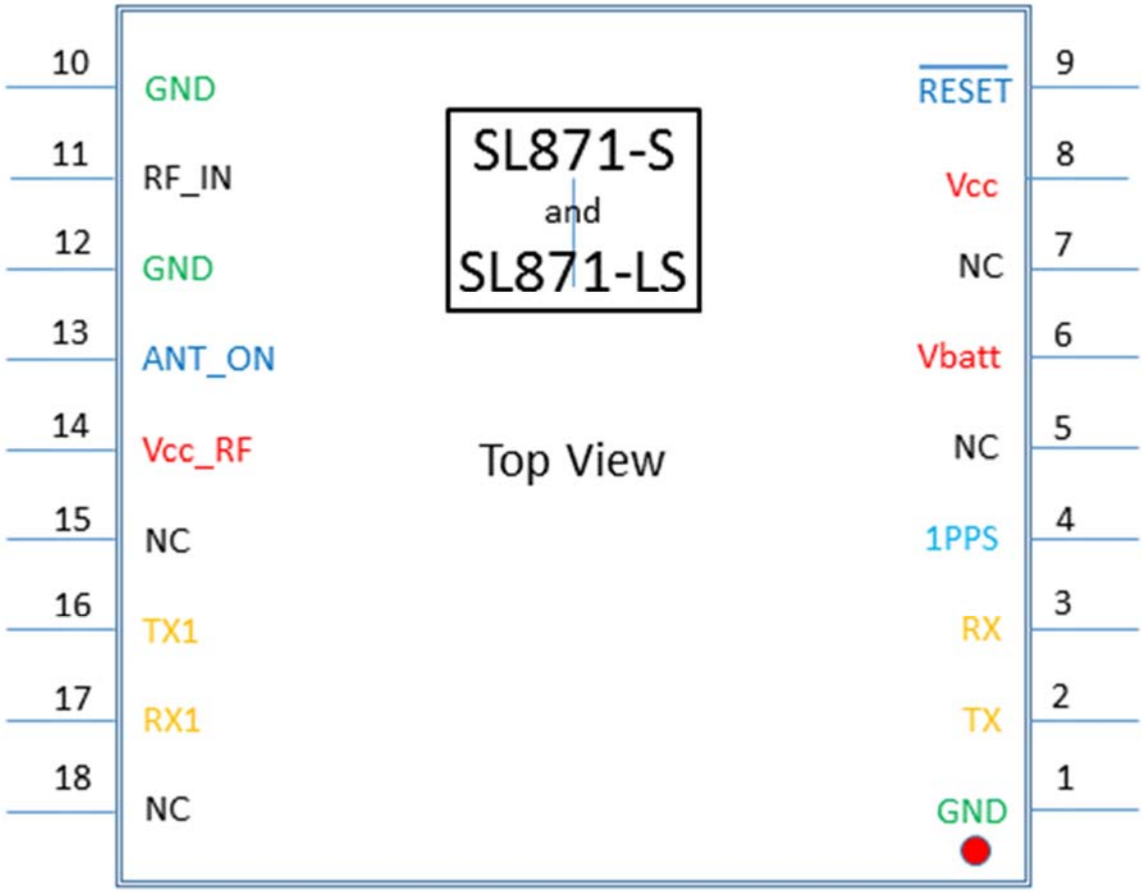


Figure 8-2 SL871-S and SL871L-S Pin-out diagram

8.4 SL871-S and SL871L-S Pin-out table

Pin	Name	Type	Description	Notes
1	GND	GND	Ground	
2	TX	O	TX0	
3	RX	I	RX0	
4	1PPS	O	Time mark Pulse, (1PPS)	
5	NC	NC	No Connection	
6	VBATT	PWR	Backup Voltage Supply	
7	NC	NC	Can be connected to VCC (for compatibility) or left unconnected	
8	VCC	PWR	Supply Voltage	
9	RESET-N	I	RESET-N (Active Low, open drain). May be left unconnected	
10	GND	GND	Ground	
11	RF-IN	I	GNSS RF Input. 50 Ω Max DC voltage: ± 3.0 V (Gen 2)	1
12	GND	GND	Ground	
13	ANT-ON	O	Antenna On	
14	VCC-RF	PWR	Output Voltage for a bias-T (max 50 mA)	
15	NC	NC	No Connection	
16	TX1	O	TX1	
17	RX1	I	RX1	
18	NC	NC	No Connection	

1. DC Blocking capacitor has been added in SL871L-S.

Table 8-2 SL871-S & SL871L-S Pin-out Table

8.5 Power Supply

The SL871 module has two power supply pins VCC and VBATT.

8.5.1 VCC

This is the main power input. The supply voltage must be in the range specified in **Table 8-3 DC Supply Voltage** below. VBATT must be powered up (externally) during any time that power is applied to VCC. This may be accomplished by tying VBATT to VCC.

When power is first applied the module will start 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 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.

8.5.2 VBATT

The battery backup power input range is specified in the table below.

VBATT must be powered up (externally) during any time that power is applied to VCC. This may be accomplished by tying VBATT to VCC.

In case of a power failure on VCC, VBATT supplies power to the following:

- real-time clock (RTC)
- battery backed RAM (BBRAM)
- EASY data
- Default configuration options (not commanded options)

This allows the module to retain time and ephemeris information, thus enabling hot and warm starts which will shorten TTFF.

For the SL871 and SL871-L, if VBATT is removed EPO data is also retained in flash memory.

8.5.3 VCC_RF

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

8.5.4 DC Power Requirements

Main Supply Voltage & Backup Voltage					
Supply	**Name**	**Min**	**Typ**	**Max**	**Units**
Main Voltage	VCC	3.0	3.3	3.6	V
Backup Voltage	VBATT	3.0	3.3	3.6	V

Table 8-3 DC Supply Voltage

8.5.5 DC Power Consumption - SL871 (Gen 2)

State & Constellation	Typ	Max	Units
Acquisition			
GPS Only	61	88	mW
GPS and Glonass	83	111	mW
GPS and BeiDou	78	104	mW
Navigation/Tracking			
GPS Only	48	80	mW
GPS and Glonass	66	99	mW
GPS and BeiDou	70	100	mW
Low Power Mode			
GPS Only	17		mW
GPS and (Glonass or BeiDou)	24		mW
Battery Backup	36		uW
Operating temperature: 25°C. Supply voltages: 3.3 VDC nominal Low Power mode: 500 ms duty cycle.			

Table 8-4 SL871 (Gen 2) Power Consumption

8.5.6 DC Power Consumption – SL871L

State & Constellation	Typ	Max	Units
Acquisition			
GPS Only	71	98	mW
GPS + Glonass	93	121	mW
GPS + BeiDou	88	114	mW
Navigation/Tracking			
GPS Only	58	90	mW
GPS + Glonass	76	110	mW
GPS + BeiDou	81	110	mW
Low Power - Periodic			
GPS Only	37		mW
GPS + Glonass	41		mW
GPS + BeiDou	40		mW
Low Power – AlwaysLocate Standby			
GPS Only	27		mW
GPS + Glonass	34		mW
GPS + BeiDou	33		mW
Low Power - Backup			
GPS Only	40		uW
GPS + Glonass	42		uW
GPS + BeiDou	48		uW
Operating temperature: 25°C. Supply voltages: 3.3 VDC nominal Low Power mode: 500 ms duty cycle.			

Table 8-5 SL871L Power Consumption

8.5.7 DC Power Consumption - SL871-S

State & Constellation	Typ	Max	Units
Acquisition			
GPS Only	51	66	mW
Navigation/Tracking			
GPS Only	44	59	mW
Low Power Mode			
GPS Only	9		mW
Battery Backup	17		uW
Operating temperature is 25°C. Supply voltages were nominal 3.3 VDC. Low Power mode: 500 ms duty cycle.			

Table 8-6 SL871-S Power Consumption

8.5.8 DC Power Consumption - SL871L-S

State & Constellation	Typ	Max	Units
Acquisition			
GPS Only	61	76	mW
Navigation/Tracking			
GPS Only	54	69	mW
Low Power Mode			
GPS Only	9		mW
Battery Backup	17		uW
Operating temperature is 25°C. Supply voltages were nominal 3.3 VDC. Low Power mode: 500 ms duty cycle.			

Table 8-7 SL871L-S Power Consumption

8.6 Antenna RF Interface

8.6.1 RF-IN

The 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 SL871-S) at a level between -125 dBm and -165 dBm into 50 Ohm impedance.

The RF input pin is ESD sensitive.

(SL871 (Gen 2) and SL871-S)

Max ± 3V DC can be applied to the RF input for “Gen 2” modules.

(SL871L and SL871L-S)

The SL871 (Gen 2) & SL871L and SL871L-S modules include a DC blocking capacitor.

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.

The receiver contains a preselect SAW filter. This allows it 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.

Antenna Gain:

- Passive antenna: isotropic gain of greater than -6 dBi.
- Active antenna: optimum gain is 15 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.).

8.6.2 Frequency Plan

Signal	Frequency (MHz)
TCXO Frequency	26.000
LO Frequency	1588.6

Table 8-8 Frequency Plan

8.6.3 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.

8.6.4 Jamming Rejection – Active Interference Cancellation

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.

Please refer to **§ 4.7 Jamming Rejection – Active Interference Cancellation (AIC)** for further details.

8.7 Digital Interface Signals

8.7.1 Antenna Related

8.7.1.1 VCC-RF (Active Antenna Supply 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 out-of-range DC voltage from being applied to RF-IN except for SL871L and SL871L-S modules (which include a DC blocking capacitor).

8.7.1.2 ANT-ON

Antenna on (ANT-ON) is an output logic level to control the power supplied to an external LNA or active antenna (e.g. using an external FET switch connected from VCC-RF to a bias-T). When logic high, the external antenna or LNA should be active; when logic low the external antenna should be powered down.

This signal is not available on the SL871 Gen 1.

The logic levels are shown in Table 8-12 Logic Levels: ANT_ON.

8.7.1.3 ANT-OC

(SL871 and SL871L only)

This signal is a high true input. When the input is at logic 1, the receiver will output a special NMEA message indicating the antenna line is open. The circuitry to drive this input is external to the SL871 module. This signal is only available on the SL871.

The logic levels are shown in **Table 8-9 Logic Levels: RX and Reset-N, & Ant Sense.**

8.7.1.4 ANT-SC-N

(SL871 and SL871L only)

This signal is a low true input. When the input is at logic 0, the receiver will output a special NMEA message indicating the antenna line is shorted. The circuitry to drive this input is external to the SL871 module. This signal is only available on the SL871.

The logic levels are shown in **Table 8-9 Logic Levels: RX and Reset-N, & Ant Sense.**

8.7.2 Control Signals

8.7.2.1 RESET-N

The Reset-N input is a low true input to reset the receiver to the default starting state. This signal is not required for the SL871 to operate properly, so this pin may be left unconnected. However, if used, the signal can only be driven low, never high since it has an internal pullup.

The logic levels are shown in **Table 8-9 Logic Levels: RX and Reset-N, & Ant Sense.**

8.7.2.2 FORCE-ON

(SL871 and SL871L only)

The SL871 will enter the perpetual backup state when so commanded. Drive the Force-on signal high (true) to force the module to return to the full power state.

Force-on should be held high until the PMTK101 message is received (about 1 second), then be returned to logic low.

If Force-on is high when a low-power command is received, the module will enter the Standby (stop) state rather than the Backup state, since the PMU is still on.

This signal is only available on the SL871 (Gen 2) and SL871L. The logic levels are shown in **Table 8-10 Logic Levels: Force-On.**

8.7.3 I/O Ports

8.7.3.1 TX

The TX serial data line outputs NMEA messages from the receiver to the host at a default rate of 9600 bps. When no serial data is being output, the TX data line idles high.

When the SL871 is powered down, do not back drive this or any other GPIO line.

The logic levels are shown in **Table 8-11 Logic Levels: TX and 1PPS.**

8.7.3.2 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 8-9 Logic Levels: RX and Reset-N, & Ant Sense.**

8.7.3.3 TX1

The TX1 data line is TX (UART) or SDA (I^2C) of the second serial port of the SL871. For the SL871-S and SL871L-S, it is UART only.

The logic levels are shown in **Table 8-11 Logic Levels: TX and 1PPS.**

8.7.3.4 RX1

(SL871 only)

The RX1 (UART) data line accepts proprietary DGPS commands using the RTCM SC-104 protocol from the host CPU to the SL871 at a default bit rate of 9600 bps.

When the SL871 is powered down, do not back drive this or any other GPIO line. The idle state for serial data from the host computer must be logic 1.

The logic levels are shown in **Table 8-9 Logic Levels: RX and Reset-N, & Ant Sense**

The 2nd port can be configured for I^2C, but RTCM data will not be accepted.

8.7.4 Other

8.7.4.1 1PPS

1PPS is a one pulse per second signal with approximately 100 ms duration which is active 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 8-11 Logic Levels: TX and 1PPS.**

8.7.5 Signal Levels

Several distinct logic levels are utilized by the digital signal interfaces of the module. They are given in the tables below:

8.7.5.1 Logic Levels - Inputs

RX, RX1, Reset-N, ANT-SC-N, and ANT_OC					
Signal	**Symbol**	**Min**	**Typ**	**Max**	**Units**
Input Voltage (L)	V_{il}	0		0.5	V
Input Voltage (H)	V_{ih}	1.9		3.4	V
Note: These inputs have an internal pullup of 40 kΩ to 190 kΩ. Do not drive the Reset-N line high.					

Table 8-9 Logic Levels: RX and Reset-N, & Ant Sense

Force-On (SL871 and SL871L only)					
Signal	**Symbol**	**Min**	**Typ**	**Max**	**Units**
Input Voltage (L)	V_{il}	-0.3		0.25	V
Input Voltage (H)	V_{ih}	0.75		1.0	V
Note 1: Force-on is only available on the SL871 and SL871L.					

Table 8-10 Logic Levels: Force-On

8.7.5.2 Logic Levels - Outputs

TX, TX1, and 1PPS					
Signal	**Symbol**	**Min**	**Typ**	**Max**	**Units**
Output Voltage (L)	Vol			0.4	V
Output Voltage (H)	Voh	2.14		VCC	V
Normal Current (L)	Iol		-2		mA
Output Current (H)	Ioh		-2		mA

Table 8-11 Logic Levels: TX and 1PPS

ANT-ON					
Signal	**Symbol**	**Min**	**Typ**	**Max**	**Units**
Output Voltage (L)	Vol			0.4	V
Output Voltage (H)	Voh	2.71		2.89	V
Normal Current (L)	Iol		-2		mA
Output Current (H)	Ioh		-2		mA

Table 8-12 Logic Levels: ANT_ON

9 REFERENCE DESIGN

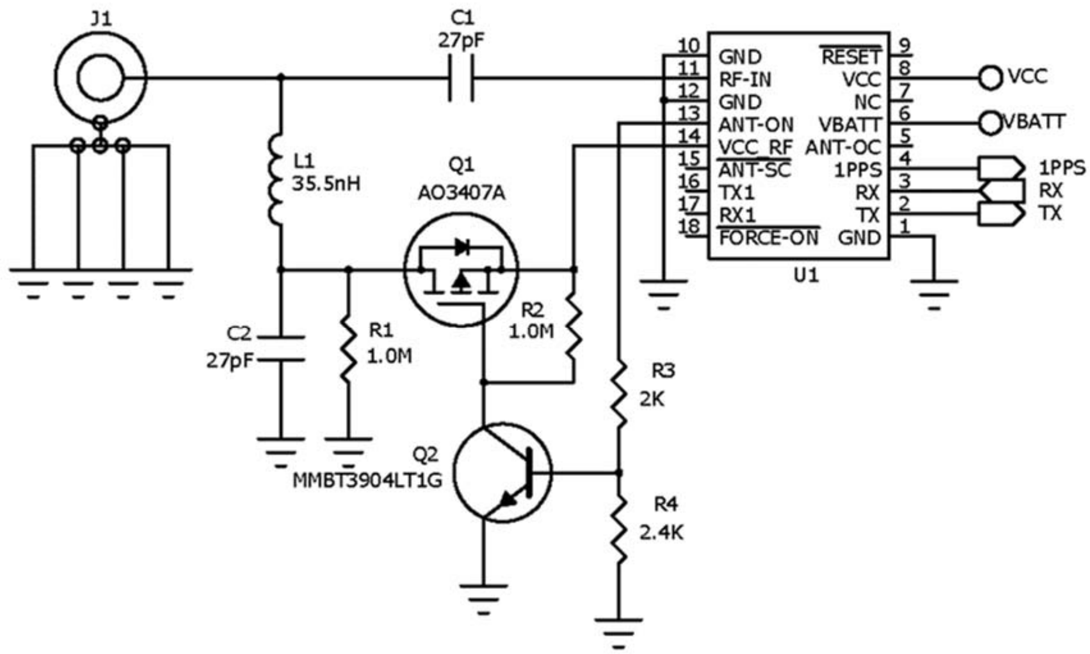


Figure 9-1 SL871 Family Reference Design

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.

C1 is used to block the DC voltage from entering the module, but is not required on SL871L modules since they include an internal DC blocking capacitor.

Inductor L1 is chosen to be self-resonant at the GNSS frequency (approximately 1.57542 GHz) to minimize loading on the RF trace. Capacitor C2 is chosen to be self-resonant so that it is close to an RF short at the GNSS frequency.

Note that the ANT-ON signal is not available on the SL871 Gen 1, so the reference design must be modified to function correctly.

The circuit shown does not provide input to ANT-OC and ANT-SC-N (SL871 only).

TX and RX are UART lines with a default of 9600-8-N-1. They are used for message output and command input. Be careful not to drive the RX line if the module is turned off.

Refer to the tables in **§ 8.7.5 Signal Levels** for logic levels.

Note that some pins are different for the SL871-S. See **§ 8 ELECTRICAL INTERFACE** Error! Reference source not found.

10 RF FRONT-END DESIGN

The SL871 and SL871-S modules contain a preselect SAW filter in front of the RF input. The SL871L and SL871L-S modules add an LNA in front of the (post-select) SAW filter which allows the modules to work well with passive GNSS antennas. 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.

10.1 RF Signal Requirements

The receiver can achieve Cold Start acquisition with a signal level above the specified minimum 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, demodulating the navigation message 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, acquisition can be accomplished at lower signal levels.

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 transmit slightly more power than specified, and the signal level typically increases if a satellite has higher elevation angles.

The GLONASS signal is defined by GLONASS ICD 2008 Version 5.1. This document states that the power level of the received RF signal from GLONASS satellite at the output of a 3dBi linearly polarized antenna is not less than -131dBm for L1 sub-band provided that the satellite is observed at an angle 5 degrees or more above the horizon.

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, it is heavily influenced by attenuation due to foliage (such as tree canopies, etc.) as well as outright blockage caused by buildings, terrain or other objects near the line of sight to each 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 phenomenon 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 (as well as the partial sky obscuration) 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 its polarization to reverse. The implications of this are covered in the next section.

10.2 GNSS Antenna Polarization

The GPS, Glonass and BeiDou satellites all a broadcast signal that 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 often 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 includes a built- in low noise amplifier (LNA) to overcome RF trace and cable losses. Also, many active antennas have a pre-select filter, a post-select filter, or both.

Important specifications for an active antenna LNA are gain and noise figure.

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).

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 requirements 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.

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 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.

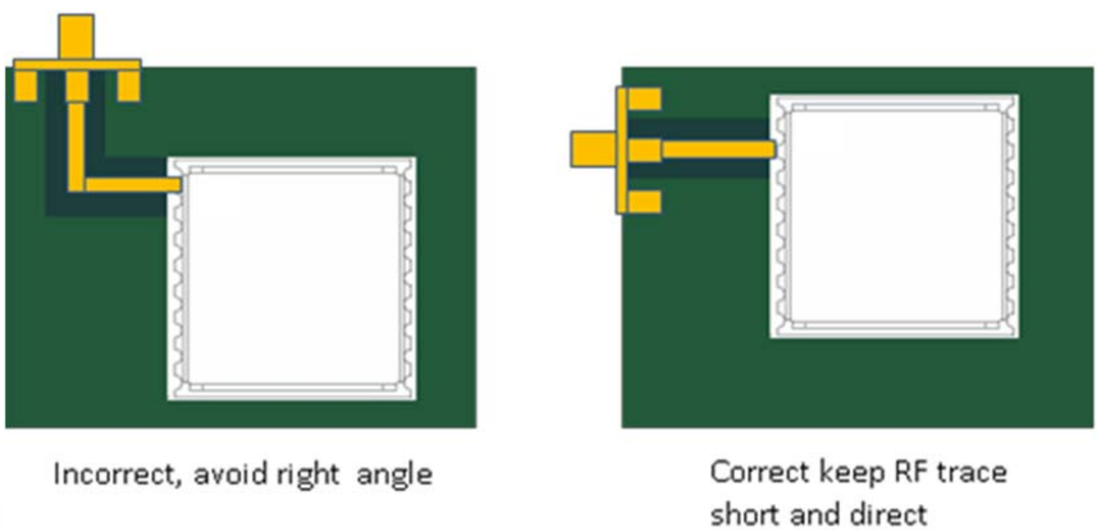


Figure 10-1 RF Trace Examples

10.6 PCB Stack and Trace Impedance

It is important to maintain a 50 Ω impedance on the RF path trace. Design software for calculating trace impedance can be found from multiple sources on the internet. The best method is to contact your PCB supplier and request a stackup for a 50 Ω controlled impedance board. They will give you a suggested trace width along with PCB stackup needed to create the specified impedance.

It is also important to consider the effects of component pads that are in the path of the 50 Ω trace. If the traces are shorter than a 1/16th wavelength, transmission line effects will be minimized, but stray capacitance from large component pads can induce additional RF losses. It may be necessary to ask the PCB vendor to generate a new PCB stackup and suggested trace width that is closer to the component pads, or modify the component pads themselves.

10.7 Input to the Pre-select SAW Filter

(SL8721 Gen 2 and SL871-S only)

The SL871 and SL871-S modules include a pre-select SAW filter at the RF input 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 poor 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.

10.8 Input to the LNA

(SL871L AND SL871L-S only)

The SL871L and SL871L-S modules add an LNA followed by a post select SAW filter in the RF path. Thus, the RF input of the module presents a relatively broad and flat return loss from the LNA. However, out-of-band signals at high level could drive this LNA into saturation, reducing the performance of the LNA for the desired in-band GNSS signals.

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. However, unlike the Gen 2 implementation, a resistive pad would not be required between the external SAW filter and the module.

10.9 Powering an External LNA (or 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:

- 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, also with self-resonance at the L1 frequency.
- 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 (1.57542 GHz), 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 results:

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

Table 10-1 Inductor Loss

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.

10.10 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 strength.

10.11 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 DRAWINGS

The SL871 modules have advanced miniature packaging with a base metal of copper and an Electroless Nickel Immersion Gold (ENIG) finish.

There are 18 interface pads with castellated edge contacts. The shield is tin-plated.

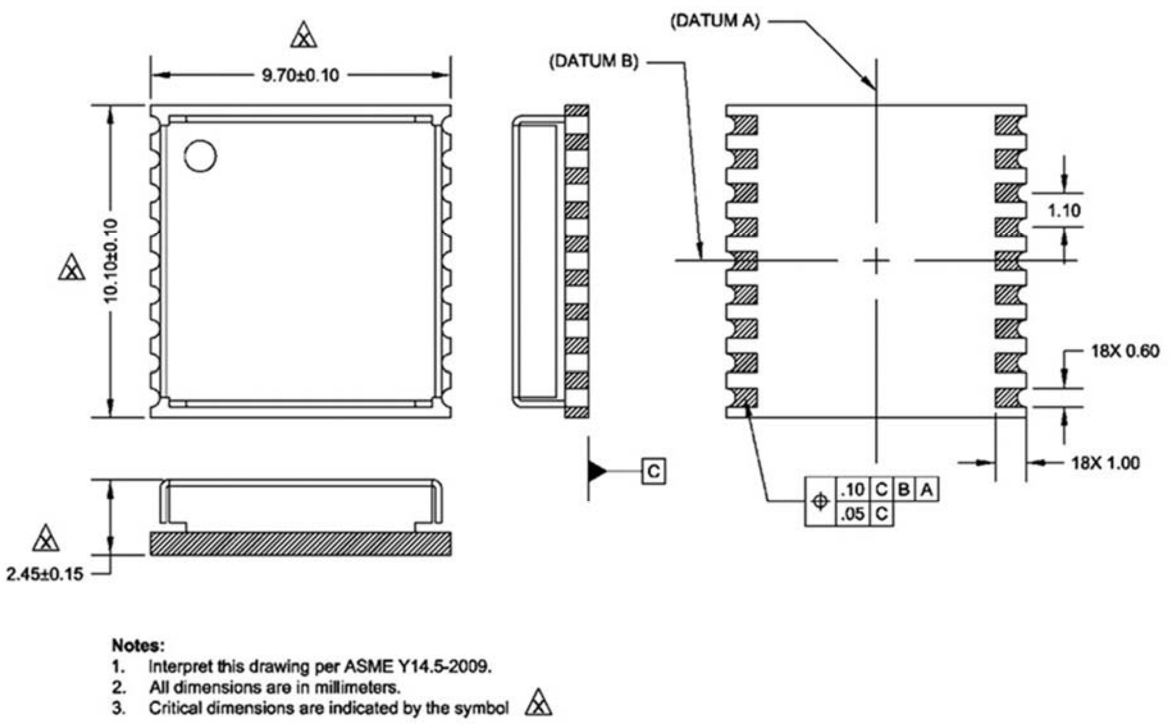


Figure 11-1 SL871 Family Mechanical Drawing

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.

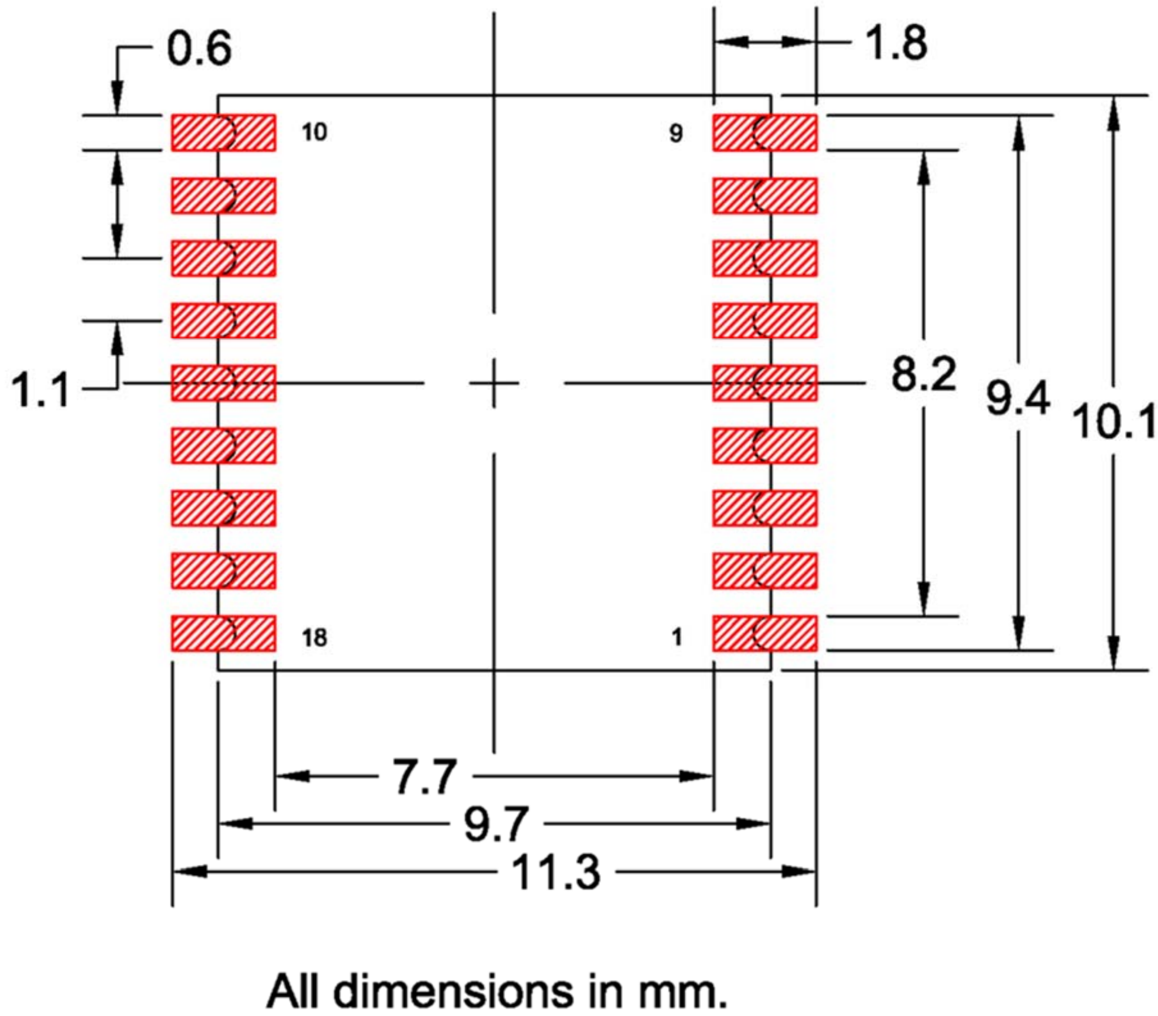


Figure 12-1 SL871 Family PCB Footprint

13 PACKAGING & HANDLING

13.1 Product Marking and Serialization

The SL871 modules have a 2D barcode label identifying the product (**SL871**, **SL871L**, **SL871-S** or **SL871L-S**) and its serial number.

Contact a Telit representative for information on specific module serial numbers.

The label format is as follows:

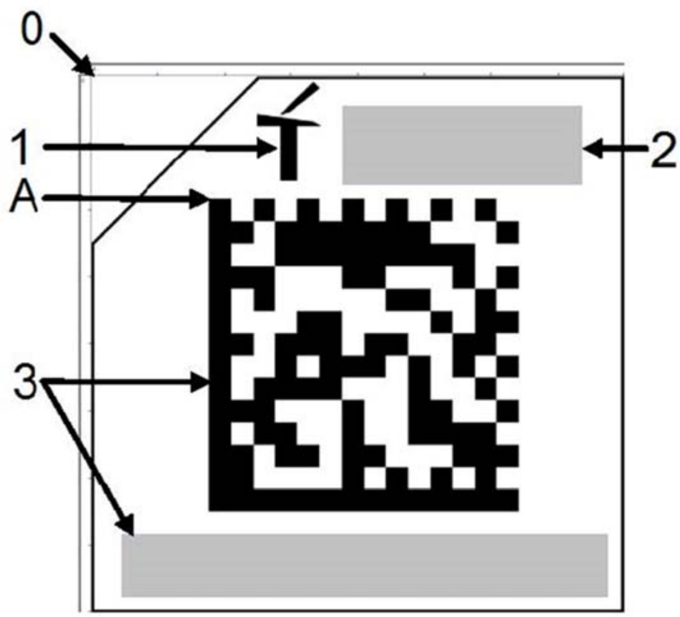


Figure 13-1 Product Label

Key	Description
1	Telit logo
2	Product Name
3	Barcode type 2D datamatrix and text of Telit Serial Number

Table 13-1 Product Label Description

13.2 Product Packaging

SL871 modules are shipped in Tape and Reel form on 24 mm reels with 1000 units per reel and mini-reels with 250 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.

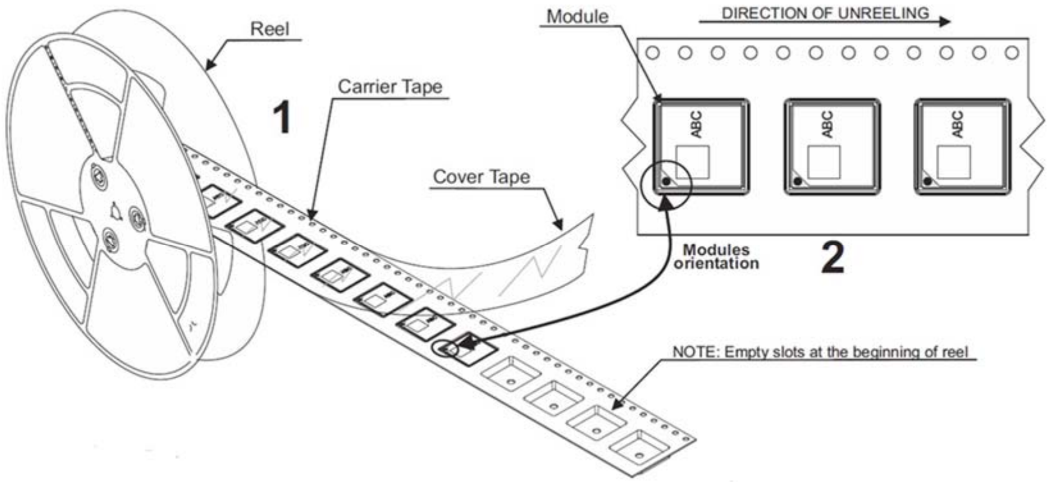
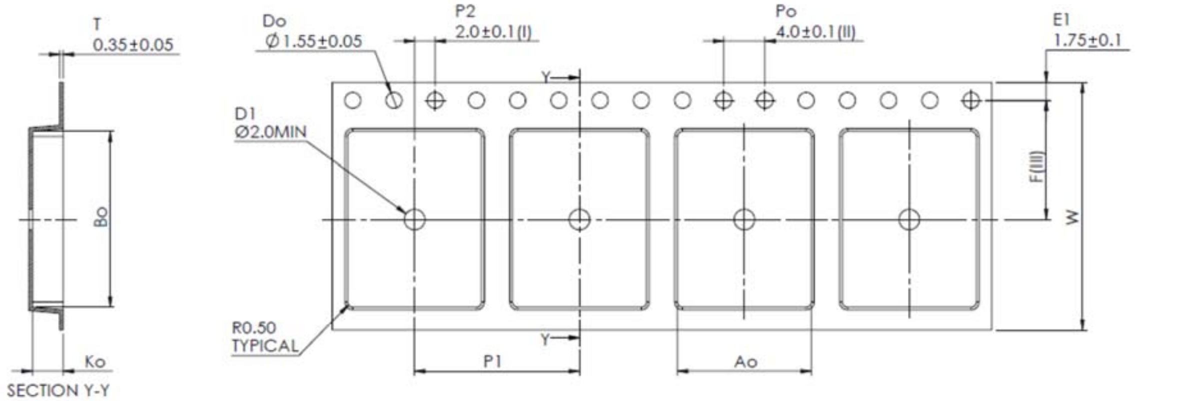


Figure 13-2 Tape and Reel Packaging



Ao	13.00 +/− 0.1
Bo	17.00 +/− 0.1
Ko	3.00 +/− 0.1
F	11.50 +/− 0.1
P1	16.00 +/− 0.1
W	24.00 +/− 0.3

Figure 13-3 Tape and Reel Detail

13.3 Moisture Sensitivity

Precautionary measures are required in handling, storing and using these 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 receiver module is a Moisture Sensitive Device (MSD) Level 3 as defined by IPC/JEDEC J-STD-020. This rating is assigned due to some of the components used within the module.

Please follow the MSD and ESD handling instructions on the labels of the MBB and exterior carton.

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 +90°C ± 5°C for 96 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 hours, at factory conditions
   If blank see adjacent bar code label
   ≤ 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 13-4 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.

The RF-IN pin is considered to be ESD sensitive.

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.

Please note that the JEDEC document includes important information in addition to the above figure. Please see: http://www.jedec.org/sites/default/files/docs/jstd020d-01.pdf

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 Washing Considerations

After assembly, the module can be washed with de-ionized water using standard PCB cleaning procedures. The shield does not provide a water seal to the internal components of the module, so it is important that the module be thoroughly dried prior to use by blowing excess water and then baking the module to drive residual moisture out. Depending upon the board cleaning equipment, the drying cycle may not be sufficient to thoroughly dry the module, so additional steps may need to be taken. Exact process details will need to be determined by the type of washing equipment as well as other components on the board to which the module is attached. The module itself can withstand standard JEDEC baking procedures

13.8 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.

13.9 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 / minute maximum
Humidity	Up to 95% non-condensing or a wet bulb temperature of +35°C, whichever is less
Maximum Vehicle Dynamics	2G acceleration

Table 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
Shock (in shipping container)	10 drops from 75 cm onto concrete floor

Table 14-2 Storage Environmental Limits

15 COMPLIANCES

The module complies 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
- Manufactured to TS 16949 requirement (upon request)

The module conforms 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

EU DECLARATION OF CONFORMITY

1. **SL871 (2nd gen)** (product name)
2. Telit Wireless Solutions, 27422 Portola Parkway, Suite 320, Foothill Ranch, CA 92610 USA (manufacturer)
3. This declaration of conformity is issued under the sole responsibility of the manufacturer
4. Standalone GNSS receiver module

5. The object of the declaration described above is in conformity with the relevant Community harmonisation: European Directive 1999/05/EC (R&TTE)
6. The conformity with the essential requirements of the 1999/05/EC has been demonstrated against the following harmonized standards

EN 60950-1:2006 + A11:2009 + A1:2010+A12:2011 + AC:2011	For article 3.1 (a): Health and Safety of the User
EN 301 489-1 V1.9.2 EN 301 489-3 V1.6.1	For article 3.1 (b): Electromagnetic Compatibility
EN 300 440-1 V.1.6.1. EN 300 440-2 V.1.4.1.	For article 3.2 : Effective use of spectrum allocated

7. The conformity assessment procedure referred to in Article 10 and detailed in Annex V of Directive 1999/05/EC has been followed with the involvement of the following Notified Body:
   CETECOM ICT Services GmbH - Untertürkheimer Straße 6-10, D-66117 Saarbrücken, Germany .
   Notified Body Number: 0682

   Thus CE 0682 is placed on the product
8. The Technical Construction File (TCF) relevant to the product described above and which supports this Declaration of Conformity, is held at: Telit Communications S.p.A. - Via Stazione di Prosecco, 5/b 34010 Sgonico, TRIESTE, ITALY
9. Signed for and on behalf of Telit Location Solutions and Telit Communications S.p.A.

Trieste, ***2015-02-24***

Quality Director
Guido Walcher

VP R&D GNSS,
Georgia Frousiakis

Technical Construction File: 30434TCF00050A

Mod 0211 2012-11 Rev.3- This declaration is issued according to 768/2008/EC

Figure 15-1 CE Declaration of Conformity - SL871

15.2 CE Declaration of Conformity – SL871L

Telit

EC DECLARATION OF CONFORMITY

1 **SL871L**

2 Telit Wireless Solutions
27422 Portola Parkway, Suite 320 Foothill Ranch, CA 92610

3 This declaration of conformity is issued under the sole responsibility of the manufacturer.

4 Standalone GNSS module.
Note: All variants have similar appearance (except for the product name).

5 The object of the declaration described above is in conformity with the relevant Community harmonisation: European Directive 1999/5/EC (R&TTE).

6 The conformity with the essential requirements of the 1999/5/EC has been demonstrated against the following harmonized standards:

Harmonized Standard reference	Article of Directive 1999/5/EC
EN 60950-1:2006/A11:2009/A1:2010/A12:2011/A2:2013	3.1 (a): Health and Safety of the User
EN 300 440-1 V1.6.1 EN 300 440-2 V1.4.1	3.1 (b): Electromagnetic Compatibility
EN 301 489-1 V1.9.2 EN 301 489-3 V1.6.1	3.2 : Effective use of spectrum allocated

7 The conformity assessment procedure referred to in Article 10 and detailed in Annex V of Directive 1999/5/EC has been followed with the involvement of the following Notified Body:

CETECOM ICT Services GmbH - Untertürkheimer Straße 6-10, D-66117 Saarbrücken, Germany .

Notified Body Number: 0682

Thus, CE 0682 is placed on the product

8 The Technical Construction File (TCF) relevant to the product described above and which supports this Declaration of Conformity, is held at: Telit Communications S.p.A., Via Stazione di Prosecco, 5/b - 34010 Sgonico – TRIESTE - ITALY

Signed for and on behalf of Telit Communications S.p.A

Trieste, **2016-04-26**

Quality Director
Guido Walcher

VP R&D GNSS
Georgia Frousiakis

Technical Construction File: 30434TCF00057A r.0

Mod 0211 2015-09 Rev.5- This declaration is issued according to 768/2008/EC

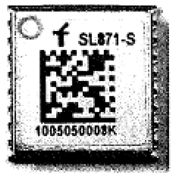
Figure 15-2 CE Declaration of Conformity - SL871L

15.3 CE Declaration of Conformity – SL871-S

Telit

EU DECLARATION OF CONFORMITY

1. **SL871-S** (product name)
2. Telit Wireless Solutions, 27422 Portola Parkway, Suite 320, Foothill Ranch, CA 92610 USA (manufacturer)
3. This declaration of conformity is issued under the sole responsibility of the manufacturer
4. Standalone GNSS receiver module



5. The object of the declaration described above is in conformity with the relevant Community harmonisation: European Directive 1999/05/EC (R&TTE)
6. The conformity with the essential requirements of the 1999/05/EC has been demonstrated against the following harmonized standards

EN 60950-1:2006 + A11:2009 +A1:2010+A12:2011+ AC:2011	For article 3.1 (a): Health and Safety of the User
EN 301 489-1 V1.9.2 EN 301 489-3 V1.6.1	For article 3.1 (b): Electromagnetic Compatibility
EN 300 440-1 V.1.6.1 EN 300 440-2 V.1.4.1	For article 3.2 : Effective use of spectrum allocated

7. The conformity assessment procedure referred to in Article 10 and detailed in Annex V of Directive 1999/05/EC has been followed with the involvement of the following Notified Body:
   CETECOM ICT Services GmbH - Untertürkheimer Straße 6-10, D-66117 Saarbrücken, Germany .
   Notified Body Number: 0682

   Thus CE 0682 is placed on the product
8. The Technical Construction File (TCF) relevant to the product described above and which supports this Declaration of Conformity, is held at: Telit Communications S.p.A. - Via Stazione di Prosecco, 5/b 34010 Sgonico, TRIESTE, ITALY
9. Signed for and on behalf of Telit Location Solutions and Telit Communications S.p.A.

Trieste, *2015-02-24*

Quality Director
Guido Walcher

VP R&D GNSS
Georgia Frousiakis

Technical Construction File: 30434TCF00048A

Mod 0211 2012-11 Rev.3- This declaration is issued according to 768/2008/EC

Figure 15-3 CE Declaration of Conformity - SL871-S

15.4 CE Declaration of Conformity – SL871L-S

Telit

EC DECLARATION OF CONFORMITY

1 **SL871L-S**

2 Telit Wireless Solutions
27422 Portola Parkway, Suite 320 Foothill Ranch, CA 92610

3 This declaration of conformity is issued under the sole responsibility of the manufacturer.

4 Standalone GNSS module.
Note: All variants have similar appearance (except for the product name).

5 The object of the declaration described above is in conformity with the relevant Community harmonisation: European Directive 1999/5/EC (R&TTE).

6 The conformity with the essential requirements of the 1999/5/EC has been demonstrated against the following harmonized standards:

Harmonized Standard reference	Article of Directive 1999/5/EC
EN 60950-1:2006/A11:2009/A1:2010/A12:2011/A2:2013	3.1 (a): Health and Safety of the User
EN 300 440-1 V1.6.1 EN 300 440-2 V1.4.1	3.1 (b): Electromagnetic Compatibility
EN 301 489-1 V1.9.2 EN 301 489-3 V1.6.1	3.2 : Effective use of spectrum allocated

7 The conformity assessment procedure referred to in Article 10 and detailed in Annex V of Directive 1999/5/EC has been followed with the involvement of the following Notified Body:

CETECOM ICT Services GmbH - Untertürkheimer Straße 6-10, D-66117 Saarbrücken, Germany .

Notified Body Number: 0682

Thus, CE 0682 is placed on the product

8 The Technical Construction File (TCF) relevant to the product described above and which supports this Declaration of Conformity, is held at: Telit Communications S.p.A., Via Stazione di Prosecco, 5/b - 34010 Sgonico – TRIESTE - ITALY

Signed for and on behalf of Telit Communications S.p.A

Trieste, **2016-05-24**

Quality Director
Guido Walcher

VP R&D GNSS
Georgia Frousiakis

Technical Construction File: 30434TCF00058A r.0

Mod 0211 2015-09 Rev.5- This declaration is issued according to 768/2008/EC

Figure 15-4 CE Declaration of Conformity - SL871L-S

15.5 RoHS certificate

The Telit SL871 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 SAFETY RECOMMENDATIONS

PLEASE READ CAREFULLY

Be sure that the use of this product is allowed in the country and in the environment required. 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 the responsibility of the user to enforce the country regulations and specific environmental regulations.

Do not disassemble the product. Evidence of tampering will invalidate the warranty.

- Telit recommends following the instructions in product user guides for correct installation of the product.
- The product must be supplied with a stabilized voltage source and all wiring must conform to security and fire prevention regulations.
- The product must be handled with care, avoiding any contact with the pins because electrostatic discharges may damage the product itself.

The system integrator is responsible for the functioning of the final product; therefore, care must be taken with components external to the module, as well as for any project or installation issue. Should there be any doubt, please refer to the technical documentation and the regulations in force.

Non-antenna modules must be equipped with a proper antenna with specific characteristics.

The European Community provides some Directives for electronic equipment introduced on the market. All the relevant information is available on the European Community website:
http://ec.europa.eu/enterprise/sectors/rtte/documents/
The text of the Directive 99/05 regarding telecommunication equipment is available, while the applicable Directives (Low Voltage and EMC) are available at:
http://ec.europa.eu/enterprise/sectors/electrical/

The power supply used shall comply the clause 2.5 (Limited power sources) of the standard EN 60950-1 and the module shall be mounted on a PCB which complies with V-0 flammability class.

Since the module must be built-in to a system, it is intended only for installation in a RESTRICTED ACCESS LOCATION. Therefore, the system integrator must provide an enclosure which protects against fire, electrical shock, and mechanical shock in accordance with relevant standards.

17 GLOSSARY AND ACRONYMS

AGPS: Assisted (or Aided) GPS
AGPS provides ephemeris data to the receiver to allow faster **cold start** times than would be possible using only broadcast data.
This extended ephemeris data could be either server-generated or locally-generated.
See Local Ephemeris prediction data and Server-based Ephemeris prediction data

Almanac:
A reduced-precision set of orbital parameters for the entire GPS constellation that allows calculation of approximate satellite positions and velocities. The almanac may be used by a receiver to determine satellite visibility as an aid during acquisition of satellite signals. The almanac is updated weekly by the Master Control Station. See **Ephemeris**.

BeiDou (BDS) - formerly COMPASS:
The Chinese **GNSS**, currently being expanded towards full operational capability.

Cold Start:
A cold start occurs when a receiver begins operation with unknown position, time, and ephemeris data, typically when it is powered up or restarted after a period on inactivity. Almanac information may be used to identify previously visible satellites and their approximate positions. See **Restart**.

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 European **SBAS** system.

Ephemeris (plural ephemerides):
A set of precise orbital parameters that is used by a GNSS receiver to calculate satellite position and velocity. The satellite position is then used to calculate the navigation solution. Ephemeris data is updated frequently (normally every 2 hours for GPS) to maintain the accuracy of the position calculation. See **Almanac**.

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

GAGAN:
The Indian **SBAS** system.

Galileo:
The European **GNSS** currently being built by the European Union (EU) and European Space Agency (ESA).

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 value of GDOP indicates a smaller error in the solution. Related factors include PDOP (position), HDOP (horizontal), VDOP (vertical) and TDOP (time).

GLONASS: ГЛОбальная НАвигационная Спутниковая Система
GLObal'naya NAvigatsionnaya Sputnikovaya Sistema
(Global Navigation Satellite System)
The Russian **GNSS,** which is operated by the Russian Aerospace Defense Forces

GNSS: Global Navigation Satellite System
Generic term for a satellite-based navigation system with global coverage. The current or planned systems are: **GPS, GLONASS, BDS,** and **Galileo.**

GPS: Global Positioning System
The U.S. **GNSS,** a satellite-based positioning system that provides accurate position, velocity, and time data. GPS is operated by the US Department of Defense.

Hot Start:
A hot start occurs when a receiver begins operation with known time, position, and ephemeris data, typically after being sent a restart command. See **Restart**.

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 which is especially designed to add very little noise to the amplified signal.

Local Ephemeris prediction data:
Extended Ephemeris (i.e. predicted) data, calculated by the receiver from broadcast data received from satellites, which is stored in memory. It is usually useful for up to three days. See **AGPS.**

MSAS: MTSAT Satellite Augmentation System
The Japanese **SBAS** system.

MSD: Moisture sensitive device.

MTSAT: Multifunctional Transport Satellites
The Japanese system of geosynchronous satellites used for weather and aviation control.

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
The Japanese **SBAS** system (part of MSAS).

Reacquisition: A receiver, while in normal operation, loses RF signal (perhaps due to the antenna cable being disconnected or a vehicle entering a tunnel), and re-establishes a valid fix after the signal is restored. Contrast with **Reset** and **Restart.**

Restart: A receiver beginning operation after receiving a restart command, generally used for testing rather than normal operation. A restart can also result from a power-up. See **Cold Start, Warm Start,** and **Hot Start.** Contrast with **Reset** and **Reacquisition.**

Reset: A receiver beginning operation after a (hardware) reset signal on a pin, generally used for testing rather than normal operation**.** Contrast with **Restart** and **Reacquisition.**

RoHS: The Restriction of Hazardous Substances
Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment, which 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. These corrections are transmitted on the same frequency as navigation signals, so the receiver can use the same front-end design to process them. Current examples are **WAAS, EGNOS, MSAS,** and **GAGAN**.

Server-based Ephemeris prediction data:
Extended Ephemeris (i.e. predicted) data, calculated by a server and provided to the receiver over a network. It is usually useful for up to 14 days. See **AGPS.**

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 for testing.

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 North American **SBAS** system developed by the US FAA (Federal Aviation Administration).

Warm Start:
A warm start occurs when a receiver begins operation with known (at least approximately) time and position, but unknown ephemeris data, typically after being sent a restart command..
See **Restart**.

18 DOCUMENT HISTORY

Revision	Date	Changes
0	2014-11-18	First issue
1	2014-12-18	Text changes and updates
2	2015-02-20	§ 4.9.1: Add information on data loss if all power is removed Table 8-4: Update SL871–S Power consumption values Table 8-8: Change RX, etc. IN_H Vmax from Vcc to 3.4 § 17.1: Add Electrical and Fire Safety section
3	2016-03-11	Gen 2: SMPS, Ant-On, Ant Sense, Force-On Gen 3: LNA, DC block, 2nd Port -S Gen 3: LNA, DC block, 2nd port (UART only) Figure 3.1: Updated antenna description § 4.2: Clarify Static Nav description § 4.3.1.1: Correct EASY to off by default § 4.6: Add note for RTCM § 4.8: Add low-power state Table 8.1: Correct text in Footnote 1 § 4.13.5: Add BACKUP mode description § 8.2.2: Correct description of VBATT pin § 8.4.1.9: Correct FORCE-ON pin description Table 8-10: Change pin name from Force-On-N to Force-On Minor text changes
4	2016-03-25	Change product name suffix form “Gen 3” to “L” Minor text changes
5	2017-04-11	New format Change voltage range from 2.8 – 4.3 to 3.0 – 3.6 Replaced Pinout Diagrams and RF Trace Examples figures Corrected 2nd port default for SL871L is I^2C, not UART Correct the SL871-S block diagram Add CE certificates Minor text changes

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Link to **www.telit.com** and contact our technical support team for any questions related to technical issues.

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