SE868Kx-Ax Family Product User Guide

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PRODUCT APPLICABILITY

PRODUCT
SE868-A
SE868-AS
SE868K3-A
SE868K3-AL
SE868K7-A
SE868K7-AL

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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 **Table 0-1 Product Applicability Table.**

Please refer to Section **2 Product Description** for details of the members of the product family.

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
- TS-SRD@telit.com **for Global Bluetooth support**
- TS-SRD@telit.com **for Global Bluetooth 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 Related Documents and Downloads

Please refer to https://www.telit.com/m2m-iot-products/positioning-timing-modules// for current documentation and downloads

1.3.1 Related Documents and downloads

- Datasheets
- Product User Guides
- EVK User Guides
- Software User Guides
- Application Notes
- TelitView installation and documentation

1.3.2 Related Documents Requiring a Non-Disclosure Agreement

- Authorized Software User Guides
- Product firmware

1.4 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.

2 PRODUCT DESCRIPTION

The SE868Kx-A GNSS family of GNSS receiver modules (with built-in antenna) provides complete position, velocity, and time (PVT) engines featuring high performance, high sensitivity, and low power consumption.

All modules compute a navigation solution using GPS signals. Multi-constellation modules add GLONASS and Galileo signals to yield better coverage, greater accuracy, and improved availability.

- Multi-constellation (MT3333): SE868-A and SE868K3-A/AL
- GPS-only (MT3337): SE868-AS and SE868K7-A/AL

Special features -

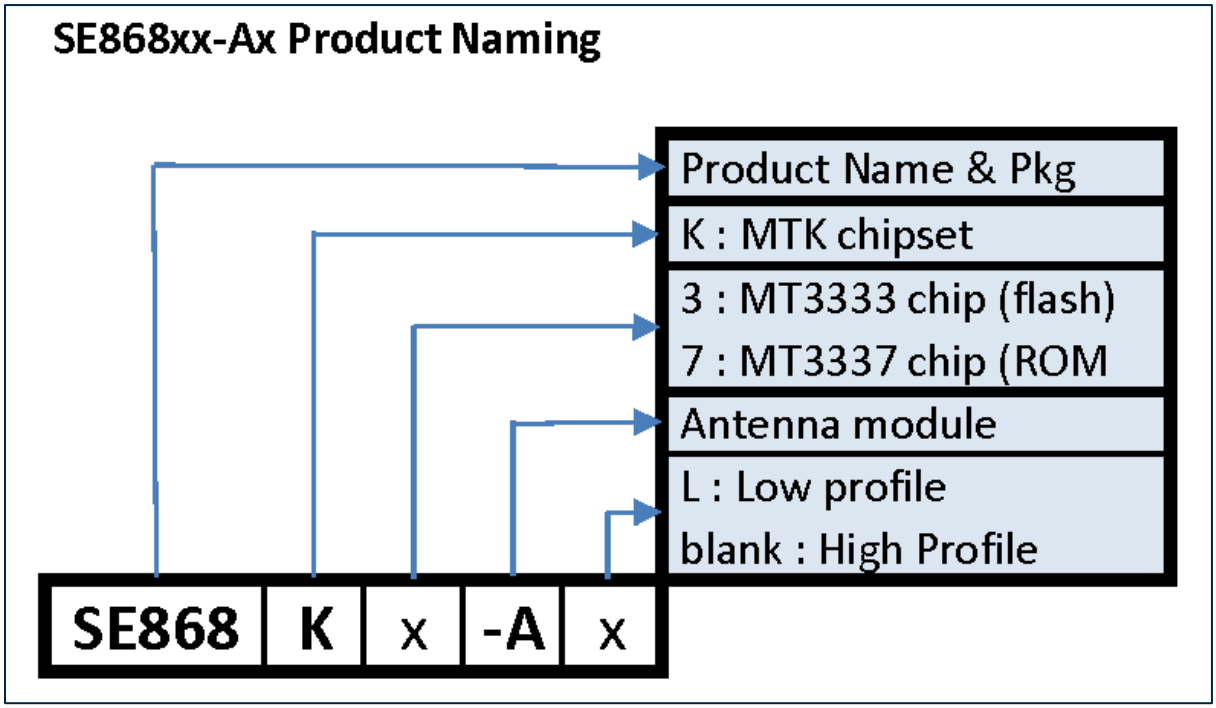
- These modules include a built-in 9 x 9 mm SMT patch antenna

2.1 Product Overview

- Complete GNSS receiver module including memory, LNA, TCXO, and RTC plus a built-in patch antenna
- Constellations:
  - SE868-A and SE868K3-A: GPS (L1), Glonass (L1), and BeiDou B1with 99 search and 33 tracking channels. Galileo ready.
  - SE868-AS and SE868K7-A: GPS(L1) and QZSS ranging with 66 search and 22 tracking channels
- SBAS corrections capable (WAAS, EGNOS, etc.) (SE868-A and SE868K3-Ax only)
- 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 (AIC)
- NMEA command input and data output
- Configurable fix reporting - Default: 1Hz, Max: 10 Hz
- Two serial ports for input commands and output messages
  - SE868-A and SE868K3-Ax: The secondary serial port is I^2C, but is configurable for UART via command
- 1PPS output
- SE868-A and SE868K3-Ax: 8 Megabit built-in flash memory
- SE868-AS and SE868K7-Ax: ROM memory
- Less than 100 mW total power consumption (Full Power mode – typical, GNSS)
- Power management modes for extended battery life
- Supported by evaluation kits
- -40°C to +85°C industrial temperature range
- 11 x 11 x 6.1 mm (nominal) 32-pad LGA package.
- Low profile (-AL) module height is 4.1 mm.
- Surface mountable by standard SMT equipment
- RoHS compliant design

Note 1: Please refer to Section **4.6 Assisted GPS (AGPS).**

2.2 SE868xx-A Product Naming



Note - Early production modules:

- The ”K x x” fields are not present,
- The “–A” was replaced by “-AS” on SE868-AS and SE868K7-Ax (ROM) GPS-only modules

2.3 Product Variants

Module	Chipset	Constellations	Memory	Antenna	Notes
SE868-A	MT3333	Multi	Flash	High	Early production
SE868-AS	MT3337E	GPS only	ROM	High	Early production
SE868K3-A	MT3333	Multi	Flash	High	
SE868K3-AL	MT3333	Multi	Flash	Low	
SE868K7-A	MT3337E	GPS only	ROM	High	
SE868K7-AL	MT3337E	GPS only	ROM	Low	

Table 2-1 Product Variants

Please refer to Section **9.4 SE868-Ax to SE868Kx-Ax Comparison and Migration** for detailed pinout differences.

2.3.1 Multi-constellation modules (SE868-A and SE868K3-Ax) features

- MediaTek MT3333 engine
- GPS, QZSS, and GLONASS satellite signals. Galileo ready
- SBAS satellite signals
- Flash memory with Upgradable firmware
- AGPS: Local (EASY) and server-based (EPO)
- Force-On pin
- I^2C (default) on the 2nd port. May be configured for UART or SPI

Feature	SE868-A	SE868K3-A	SE868K3-AL
Additional LNA	No	Yes	Yes
Antenna Profile	High	High	Low

Table 2-2 Multi-constellation (SE868-A and SE868K3-A) variants

2.3.2 GPS-only modules (SE868-AS and SE868K7-Ax) features

- MediaTek MT3337 (early production) or MT3337E (enhanced) engine
- GPS and QZSS satellite signals
- ROM memory
- AGPS: Local (EASY) and server-based (EPO)
  - EASY requires MT3337E ROM.EASY data is stored in RTC RAM.
  - EPO is host-based
- No Force-On pin
- Only UART on the 2nd port. I^2C is not available.

Feature	SE868-AS	SE868K7-A	SE868K7-AL
GNSS chip	MT3337 or MT3337E	MT3337E	MT3337E
Antenna Profile	High	High	Low
AGPS (EASY)	MT3337E only		

Table 2-3 GPS-only (SE868-AS and SE868K7-Ax) variants

2.3.2.1 ROM Features (SE868-AS and SE868K7-Ax modules)

Feature	SE868-AS (early production) P/N SE868ASA210Rxxx	SE868-AS P/N SE868ASA232Rxxx	SE868K7-Ax
ROM version	3337	3337E (enhanced)	3337E (enhanced)
EASY	No	Yes	Yes
SBAS	Yes	No	No
AlwaysLocate	Yes	No	No
LOCUS	Yes	No	No

Table 2-4 ROM Features changes

2.3.3 Related Products

The SE878Kx-Ax module is similar to the SE868Kx-Ax. Major differences are:

- Module size is 18 x 18 x 6.2 mm.
- The antenna is larger (17 x 17 mm)
- An RF switch and antenna input pin is provided to accept signals from an external antenna

2.4 Block Diagrams

2.4.1 Early Production

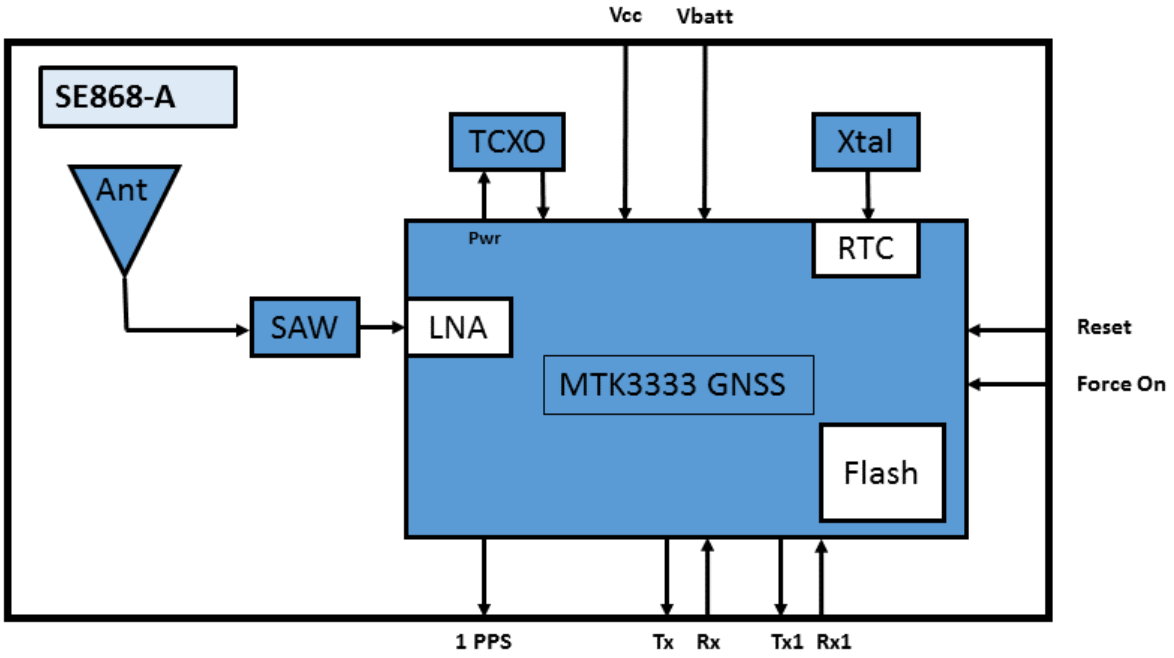


Figure 2-2 SE868-Ax Block Diagram

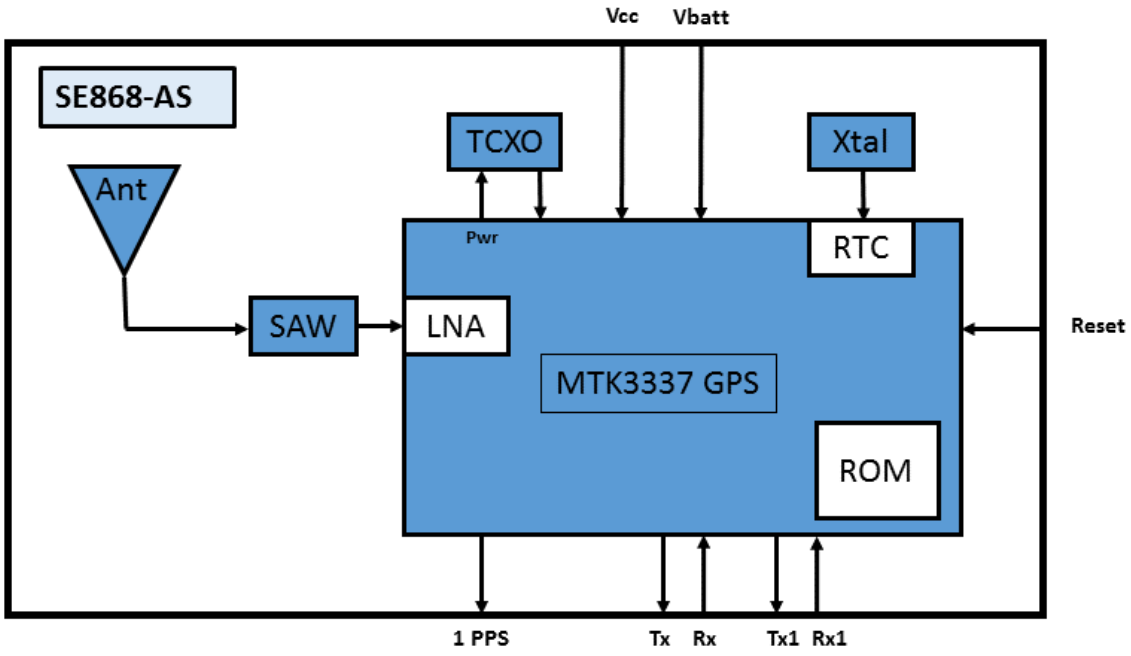


Figure 2-3 SE868-ASx Block Diagram

2.4.2 Current Production

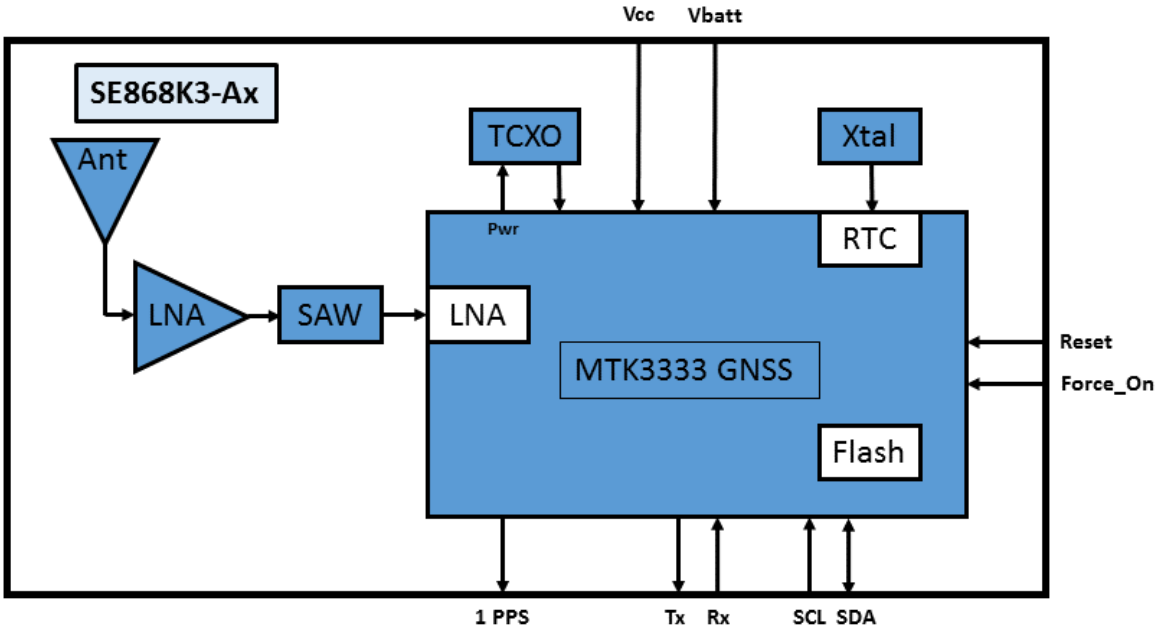


Figure 2-4 SE868K3-Ax Block Diagram

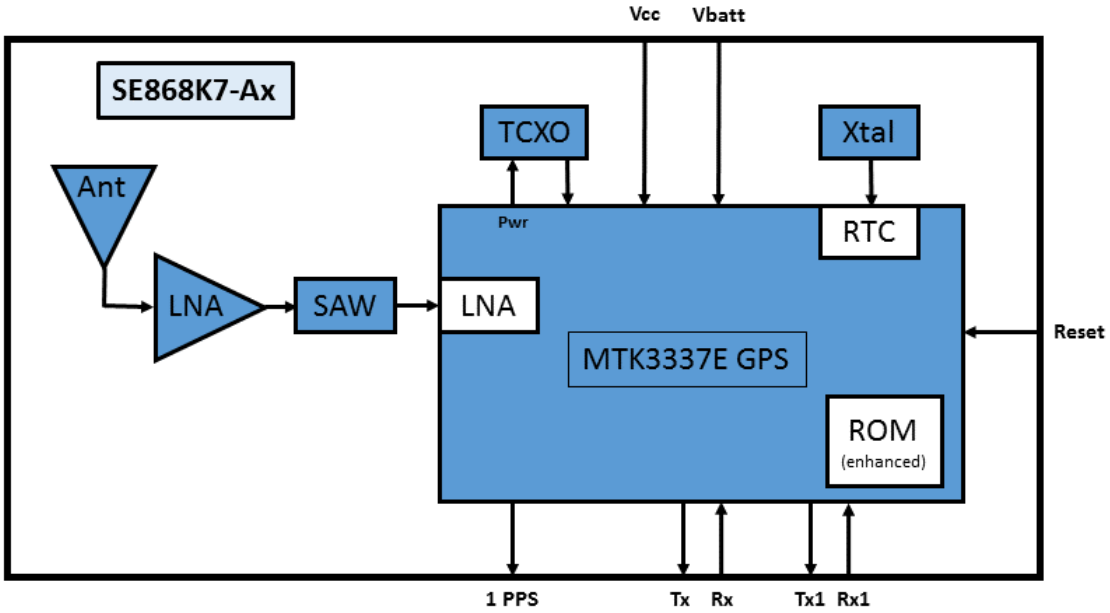


Figure 2-5 SE868K7-Ax Block Diagram

2.5 Module Photos

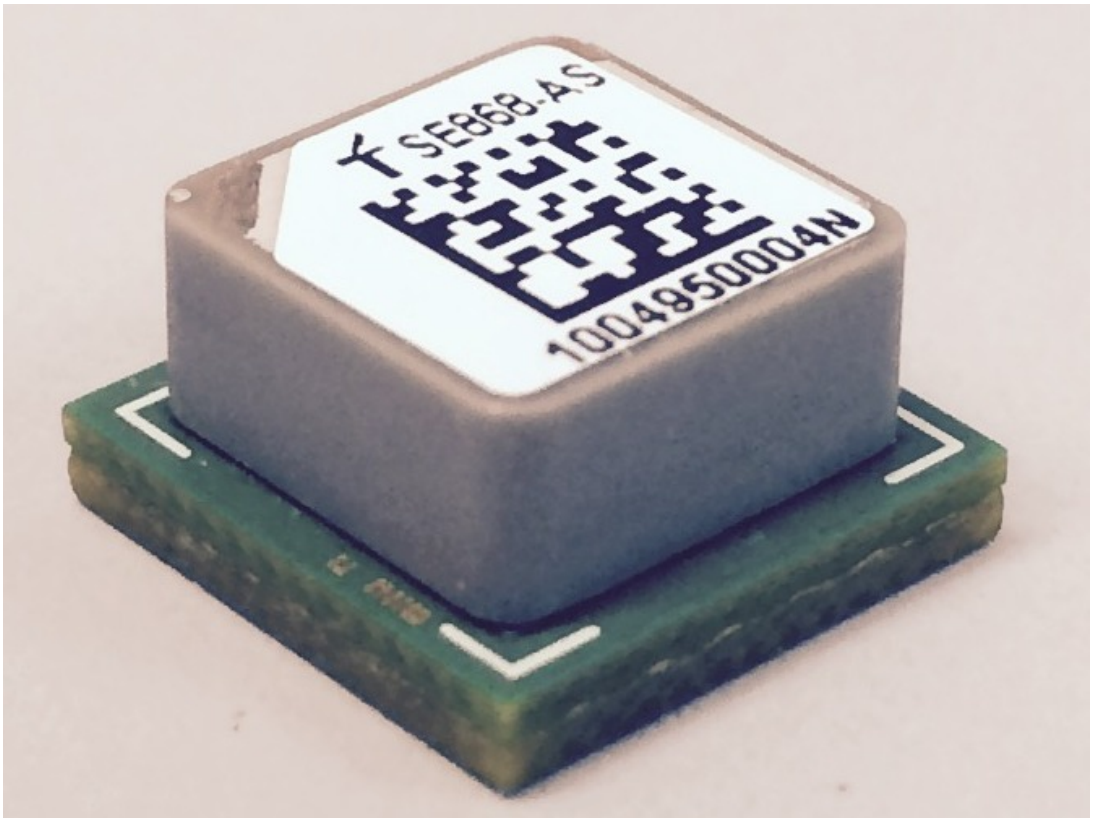


Figure 2-6 SE868 Family Photo

Note: All modules in the applicability table have a similar appearance.

The SE868Kx-AL (low profile) modules are 2 mm shorter that the SE868-AS shown

Figure 2-7 SE868xx-Ax Top View Photos

3 EVALUATION BOARD (EVB)

The EVB contains the module mounted on a PC Board to facilitate development and testing.

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

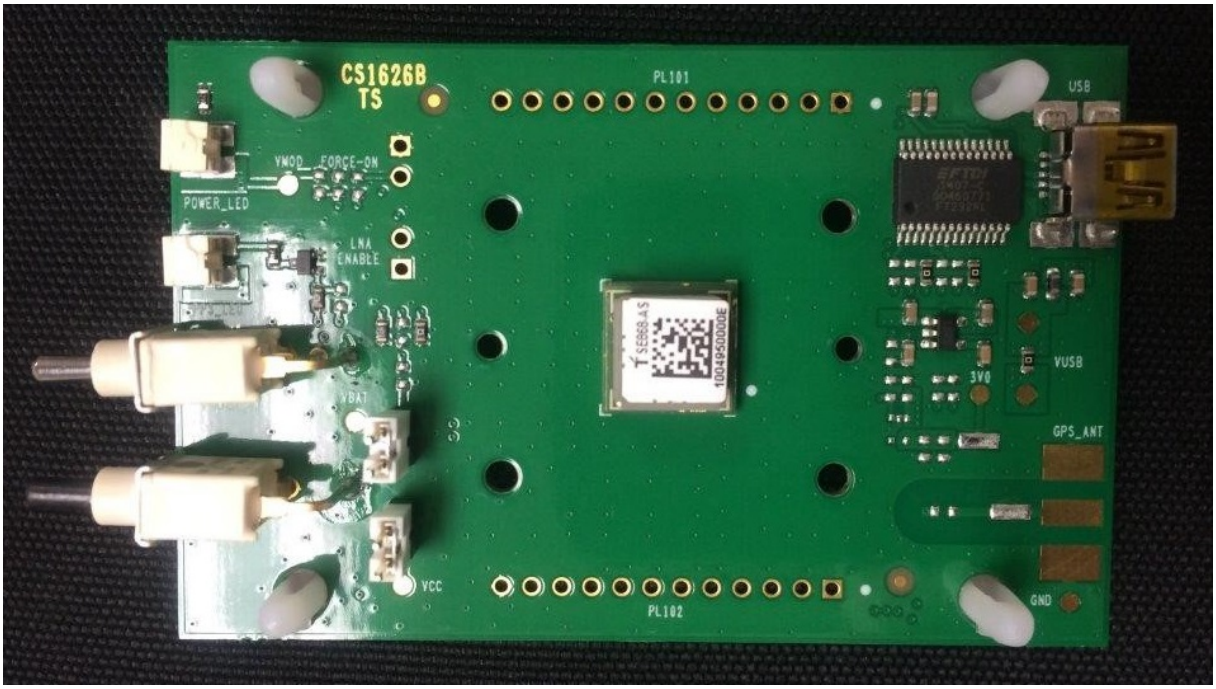


Figure 3-1 SE868 Family Evaluation Board Photo

4 PRODUCT FEATURES

4.1 Built-in Antenna

The module includes a built-in antenna for GPS, Galileo and GLONASS signals. See section **10.2 GNSS Antenna (included in the module)** for constellations supported by each module.

4.2 Multi-Constellation Navigation (SE868-A and SE868K3-Ax only).

GPS and GLONASS constellations are enabled by default. BeiDou and Galileo are also supported. If BeiDou is enabled, GLONASS and Galileo are disabled.

The user may enable or disable constellations via the **$PMTK353** command.

4.3 Quasi-Zenith Satellite System (QZSS)

The satellites of the Japanese regional system are in a highly inclined, elliptical geosynchronous orbit, allowing continuous high-elevation coverage over Japan using only three satellites plus one geostationary satellite. PRNs 193, 194, and 195 are supported. They provide ranging signals for augmentation of the GPS system

QZSS constellation usage is controlled by the **$PMTK352** command and is disabled by default. NMEA reporting for QZSS may be enabled/disabled by the **$PMTK351** command.

4.4 Satellite-Based Augmentation System (SBAS)

SBAS is not supported on the current production SE868-AS and SE868K7-Ax modules (with the enhanced ROM).

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

Enabling SBAS 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 $**PTMK313**. Either SBAS or DGPS corrections can be used and are set by the $**PMTK301** command.

4.4.1 SBAS Corrections

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

4.5 Differential GPS (DGPS)

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, either by radio to a DGPS receiver or over the internet.

The DGPS receiver can then send them to the module 2nd serial port (RX2) using the RTCM SC-104 Version 2.3 protocol message types 1, 2, 3, and 9.

These corrections can significantly improve the accuracy of the position reported to the user.

The MT3333-based modules can accept either the RTCM SC-104 messages or SBAS differential corrections via command $**PMTK501**.

4.6 Assisted GPS (AGPS)

Assisted GPS (or Aided GPS) is a method by which information from a source other than broadcast GPS signals is used to improve (i.e. reduce) TTFF.

The necessary ephemeris data is calculated either by the receiver itself (locally-generated ephemeris) or a server (server-generated ephemeris) and is then stored in the module.

Please refer to Section **2.3 Product Variants** for applicability.

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

Proprietary algorithms within the module perform GPS 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 disabled if the fix rate is > 1 Hz.
EASY is on by default, but can be disabled by command **PMTK869**.

Please refer to **Section 2.3 Product Variants** for applicability.

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

(SE868-A and SE868K3-Ax only)

Server-generated 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 a serial port. These predictions do not require local broadcast ephemeris collection, and are valid for up to 14 days.

The SE868-A and SE868K3-Ax modules support server-based AGPS as a standard feature.
Please refer to the next section regarding EPO support (Host EPO) on the SE868-AS and SE868K7-Ax modules.

Note that the EPO data stream does not conform to the NMEA-0183 standard.

Please refer to the Telit EPO Application Note for details. Example source code is available under NDA.

Contact TELIT for support regarding this service.

4.6.3 Host EPO

The SE868-AS and SE868K7-Ax modules do not have flash memory. However, they 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 module over the serial port. This data is valid for six hours.

Host EPO data is not retained over a power cycle.

Note that the EPO data stream does not conform to the NMEA-0183 standard.

Please refer to the MT333x Host EPO Application Note.

Contact Telit support for further details.

4.7 Elevation Mask Angle

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

4.8 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 (10 m) from the frozen position (indicating that the receiver is again in motion). The speed threshold can be set via the $**PMTK386** command.

Set this threshold to zero to disable static navigation.

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 the **$PMTK386** command.

4.9 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 with the $**PMTK286** command.

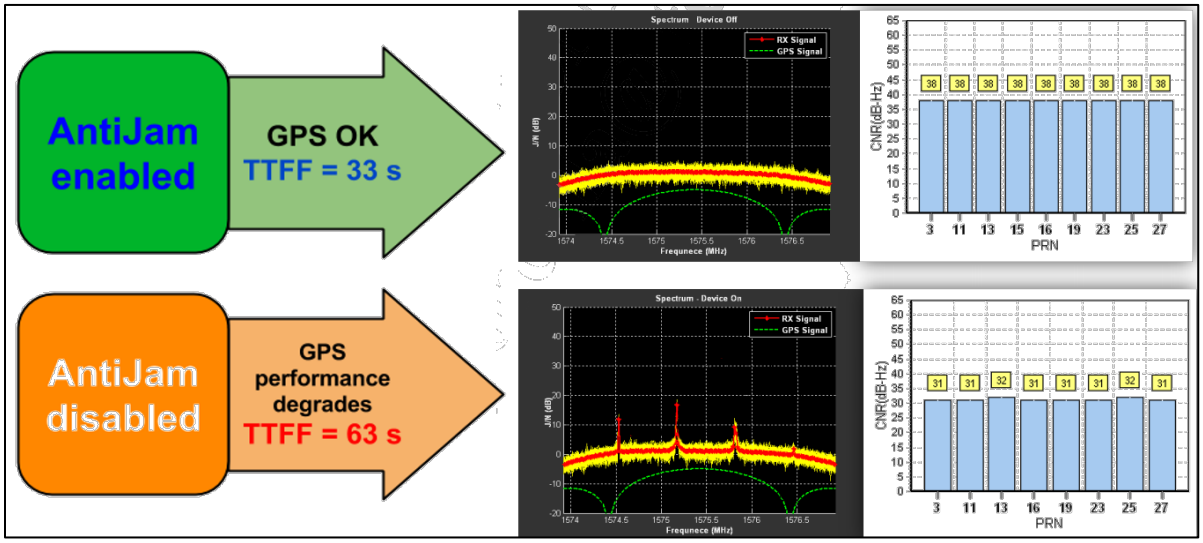


Figure 4-1Jamming Rejection

4.10 Internal LNA (SE868Kx-A/AL modules only)

The current-production modules include a built-in LNA to improve sensitivity.

4.11 10 Hz Navigation

The default rate of 1 Hz can be changed by command $**PMTK500** to a maximum of 10 Hz.
The SE868-AS and SE868K7-A maximum is 5 Hz.
Enabling the SBAS feature limits the maximum fix rate to 5 Hz.

4.12 1PPS

1PPS is a one pulse per second output signal.

Please refer to **Section 9.6.3.1 1PPS** for details.

4.13 Serial I/O Ports

Port 0:

All modules include a primary UART serial port.

Port 1:

The secondary port on MT3333-based modules is I^2C by default, but can be changed to UART or SPI via command.

The secondary port on MT3337-based modules is UART and cannot be changed.

Please refer to **Section 9.7 Serial I/O** Ports for details.

4.14 Power Management Modes

The receiver supports operating modes that reduce overall current consumption with less frequent position fixes. 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.

Power Management - Command Summary		
$PMTK Cmd	**Type**	**State**
Full Power	To exit (wake) from a commanded low-power state	
225	0	Full
Perpetual Backup	To wake: Force_On signal (MT3333 only)	
225	4	Backup
Standby	To wake: Character to RX	
161	0	Stop
161	1	Backup
Periodic (MT3333 only)		
223	-	Specify Extended Parameters
225	1	Backup
225	2	Standby
Always Locate (MT3333 and old MT3337 only. Not on new MT3337E)		
223	-	Specify Extended Parameters
225	8	Standby
225	9	Backup
GLP (MT3333 only)		
262	0	Disable
262	3	Enable

Table 4-1 Power Management command summmary

4.14.1 Full Power Continuous Mode

The receiver 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 then 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

To return to Full Power mode from a low power mode, send a **$PMTK225,0*2B** command just after the module wakes up from its previous sleep cycle.

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

4.14.2 Backup Mode (Perpetual) (SE868-A and SE868K3-Ax 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 Perpetual Backup mode, use the NMEA command: **$PMTK225,4**.

Only the SE868-A and SE868K3-Ax have a Force_On pin.
This command will be rejected on the other modules (SE868-AS and SE868K7-Ax).

To exit the Perpetual Backup mode, bring the Force_On signal high, then return to low.
Please refer to Section **9.6.2.2 FORCE_ON (SE868-A and SE868K3-Ax only)** for details.

4.14.3 Standby Modes

In these modes, the receiver stops navigation, the internal processor enters the standby state, and the current drain at main supply VCC_IN is substantially reduced.

STOP: ARM baseband, RF, and TCXO are powered down
SLEEP: ARM baseband and RF are powered down

To enter a Standby mode, send the following command:
$PMTK161,0*28 (STOP Mode)
$PMTK161,1*29 (SLEEP Mode)

To exit a Standby mode, send any byte to the host port (RX).

4.14.4 GLP Mode (SE868-A and SE868K3-Ax only)

In the GNSS Low Power (GLP) mode, power consumption is reduced for some time during a one second period. The module will alternate this cycling with periods of full power when necessary, for example weak signals or decoding the navigation message.
A typical current draw is 10 to 14 mA, depending on conditions.
Note that position accuracy will be reduced during GLP operation, therefore the user must determine the tradeoff between power consumption and desired accuracy.
A timeline is shown below:

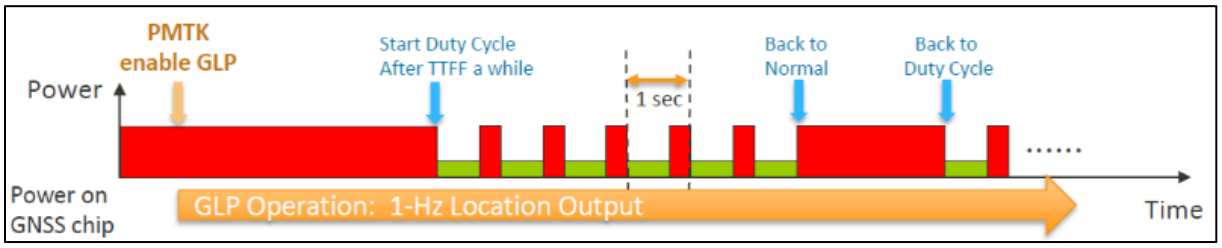


Figure 4-2 GNSS Low Power (GLP) mode diagram

To enter the GLP mode, send the command:
$PMTK262,3

To exit the GLP mode and return to full-power mode, send the command:
$PMTK262,0

4.14.5 Periodic Modes (SE868-A and SE868K3-Ax only)

These modes allow 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.

- STANDBY(SLEEP): ARM baseband and RF are powered down.
- BACKUP: ARM baseband, RF, and TCXO are powered down. RTC is powered up.

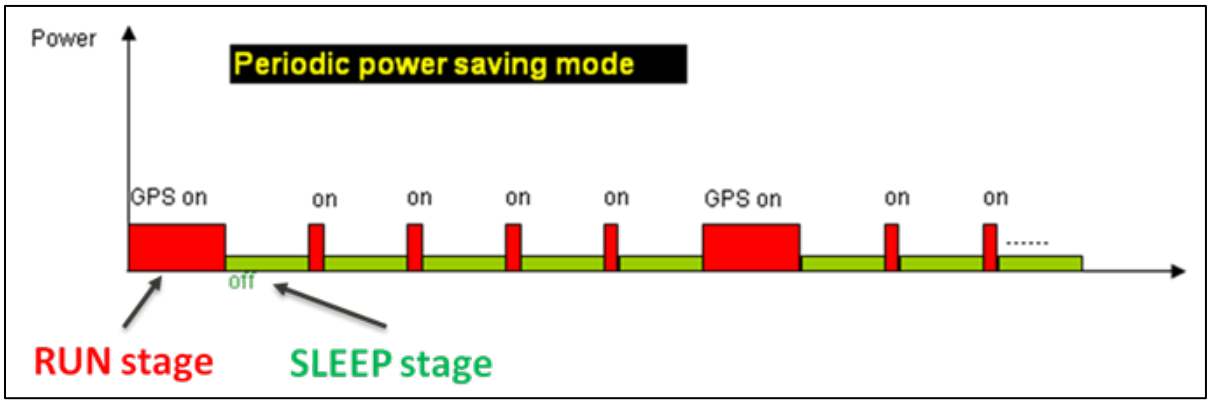


Figure 4-3 Periodic Modes diagram

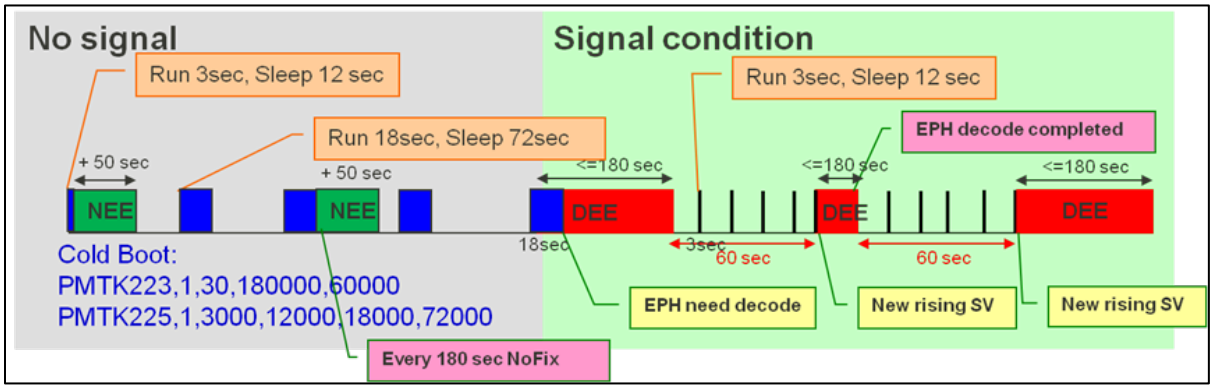


Figure 4-4 Periodic Mode example 1

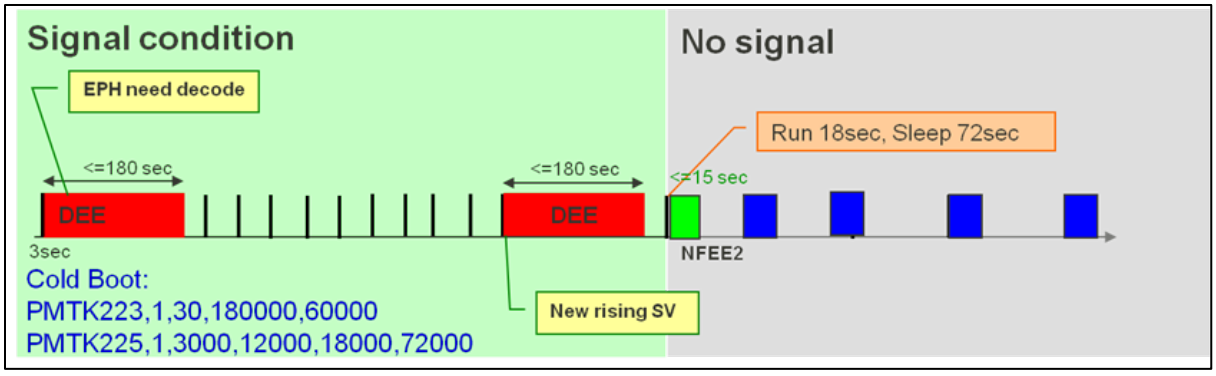


Figure 4-5 Periodic Mode example 2

To enter a Periodic mode, send the following NMEA command(s):

$PMTK223,<SV>,<SNR>,<Extension threshold>,<Extension gap>*<checksum> (Optional)

Where:

SV = 1 to 4, default = 1
SNR = 25 to 30, default = 28
Ext. threshold = 40 000 to 180 000 ms, default = 180 000
Ext. gap = 0 to 3 600 000 ms, default = 180 000
This is the limit between successive DEE

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

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

To exit Periodic Sleep mode, send the NMEA command
$PMTK225,0*2B
just after the module wakes up from a previous sleep cycle.

4.14.6 AlwaysLocate™ Modes (SE868-A and SE868K3-Ax only)

AlwaysLocate is not included in the 3337E (enhanced) ROM in the SE868K7-Ax modules.

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.

To enter an AlwaysLocate mode, send 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

To exit AlwaysLocate mode, send the NMEA command:
$PMTK225,0*2B
just after the module wakes up from its previous sleep cycle.

5 DATA RETENTION

(SE868-A and SE868K3-Ax only)

The receiver is capable of retaining data elements under the various initialization types.

If Vbatt is maintained, no data will be lost.

The following table shows which data elements are saved under each type of initialization if both Vcc and Vbatt are removed.

To erase EPO data, use the **$PMTK127** command.

Data Retention (1)							
Initialization	**Almanac**	**Ephemeris**	**EPO**	**Host EPO**	**EASY**	**Position**	**Time**
Power Cycle			Y (2)				
Reset (signal)			Y				
Full Cold Start			Y				(3)
Cold Start			Y	Y	Y		Y (3)
Warm Start	Y		Y	Y	Y	Y	Y
Hot Start	Y	Y	Y	Y	Y	Y	Y
Reacquisition	Y	Y	Y	Y	Y	Y	Y
Note 1: Commanded parameters (e.g. UART speed, feature enables, etc.) are not preserved over a power cycle.							
Note 2: EPO is not available on the MT3337 (ROM-based modules). Use Host EPO.							
Note 3: The standard definition of “Cold Start” does not allow time to be preserved. . Use “Full Cold Start” to compare with other vendor’s products’ “Cold Start”.							

Table 5-1 Data Retention

6 PRODUCT PERFORMANCE

6.1 Horizontal Position Accuracy

Constellation	CEP (m)
GPS	≤ 2.5
GLONASS	2.6
GPS + Glonass	≤ 2.5
Test Conditions: 24-hr Static, Live signals, Full Power mode	
Note: SE868-AS and SE868K7-Ax modules support GPS only	

Table 6-1 SE868xx-A Horizontal Position Accuracy

6.2 Time to First Fix

Constellations(s)	Start Type	Max TTFF (s)
GPS	Hot	≤ 1.0
	Warm	32
	Cold	33
Glonass	Hot	1.4
	Warm	32
	Cold	33
GPS + GLO	Hot	≤ 1.0
	Warm	28
	Cold	31
Test Conditions: Static scenario, -130 dBm, Full Power mode		
Note: SE868-AS and SE868K7-Ax modules support GPS only		

Table 6-2 SE868xx-A Time to First Fix

6.3 Sensitivity

Constellations	State	Minimum Signal Level (dBm) - SE868-A
GPS	Acquisition	-145
	Navigation	-158
	Tracking	-160
GLO	Acquisition	-145
	Navigation	-158
	Tracking	-159
GPS + GLO	Acquisition	-145
	Navigation	-158
	Tracking	-160

Table 6-3 SE868-A Sensitivity

Const	State	Minimum Signal Level (dBm)			
		SE868K3-A	SE868K3-AL	SE868K7-A	SE868K7-AL
GPS	Acquisition			-148	-146
	Navigation			-163	-159
	Tracking			-164	-160
GPS + GLO	Acquisition	-148	-146		
	Navigation	-161	-157		
	Tracking	-164	-160		

Table 6-4 SE868Kx-Ax Sensitivity

6.4 Jamming Mitigation Performance example

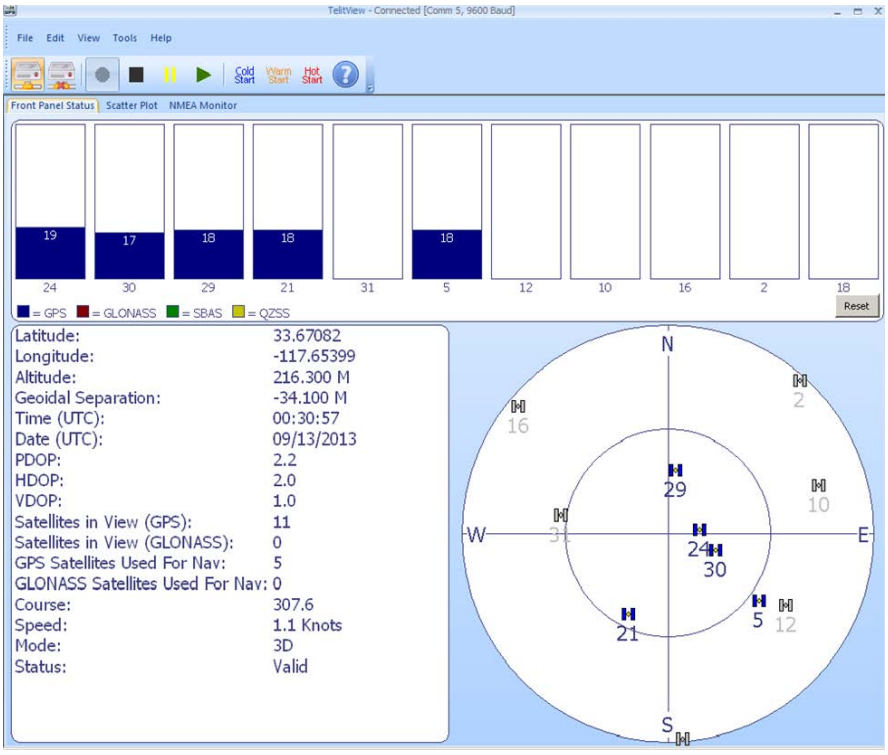


Figure 6-1 Jamming with AIC Disabled

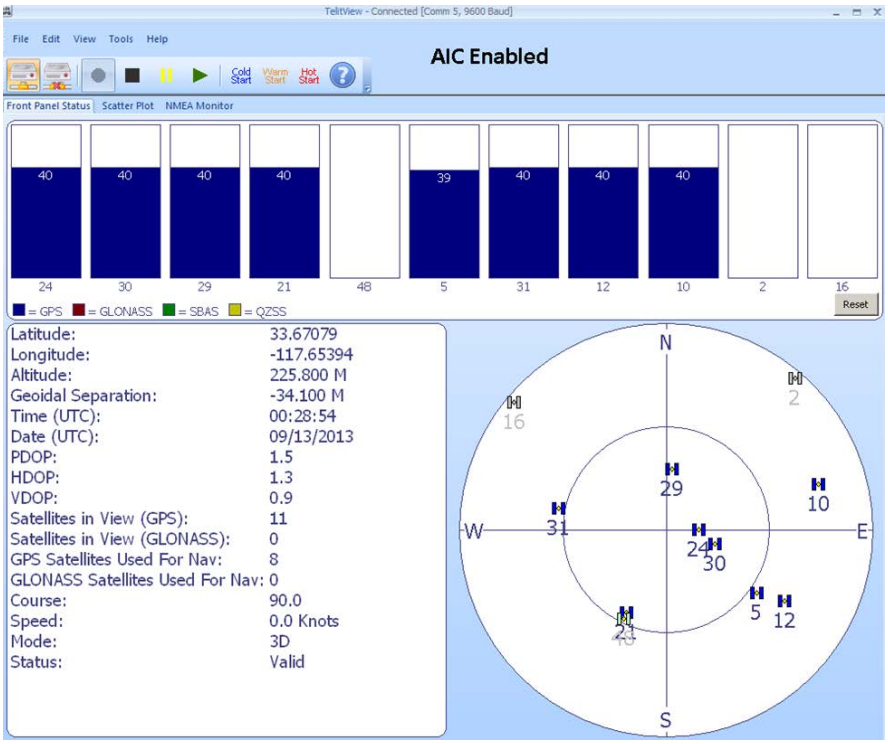


Figure 6-2 Jamming with AIC Enabled

7 MESSAGE INTERFACE

Serial I/O port 1 (RX0 & TX0 pins) supports full duplex communication between the receiver and the user.

The default serial configuration is: NMEA, 9600 bps, 8 data bits, no parity, and 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 may obtain the **Telit MT-GNSS Authorized Software User Guide**, which contains additional proprietary information.

7.1 NMEA Output Messages

Some sentences may exceed the NMEA length limitation of 80 characters.

Default: GPS constellation is enabled.

GLONASS is also enabled for SE868-A and SE868K3-Ax modules.

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

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

7.1.1 Standard Messages

Message ID	Description
RMC	GNSS Recommended minimum navigation data
GGA	GNSS position fix data
GSA	GNSS Dilution of Precision (DOP) and active satellites
GSV	GNSS satellites in view.

Table 7-1 Default NMEA output messages

The following messages can be enabled by command:

Message ID	Description
GLL	Geographic Position – Latitude & Longitude
VTG	Course Over Ground & Ground Speed
ZDA	Time & Date

Table 7-2 Available Messages

The following table shows the Talker IDs used:

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

Table 7-3 NMEA Talker IDs

7.1.2 Proprietary Output Messages

The receivers support several proprietary NMEA output messages which contain additional receiver data and status information.

Message ID	Description
$PMTK010	System messages (e.g. to report startup, etc.)

Table 7-4 Proprietary Output Messages

7.2 NMEA Input Commands

The modules 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.

7.2.1 NMEA Commands List

Please refer to **Table 4-1 Power Management command summmary** for power management commands.

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. However, Time is preserved.
$PMTK104	Perform a FULL COLD start - 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
$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
$PMTK353,1,1,0,0,0	Enable GPS and GLO mode
NOTE: Multi-constellation commands are not supported by the MT3337-based modules	

Table 7-5 NMEA Input commands

8 FLASH UPGRADABILITY

(SE868-A and SE868K3-Ax only)

Note: The SE868-AS and SE868K7-Ax modules use ROM memory and therefore are not upgradable.

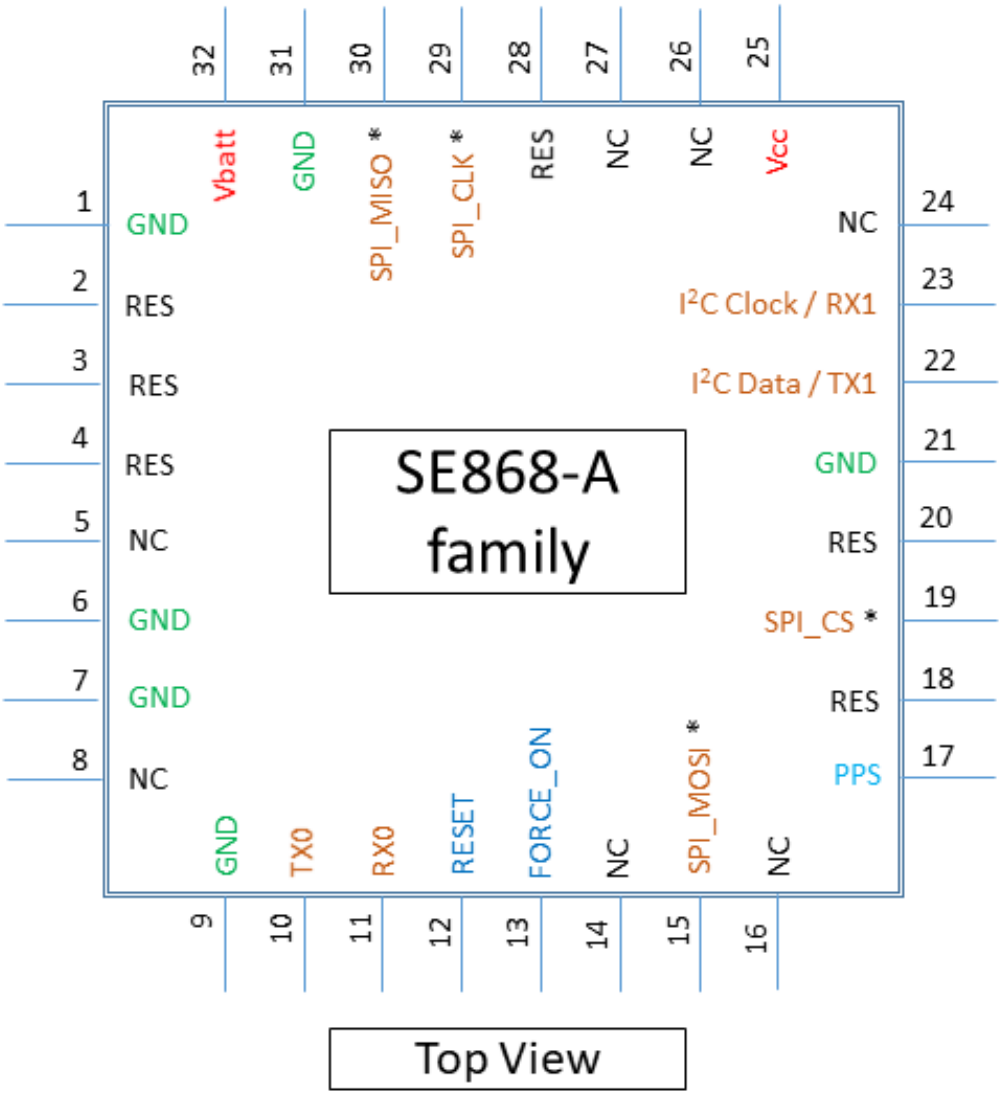
Please refer to the product EVK User Guide for more detailed information.

The firmware stored in the internal Flash memory may be upgraded via the primary 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.

9 ELECTRICAL INTERFACE

9.1 SE868-A Family Pinout Diagram



9.2

	Notes (Please refer to the detailed pinout tables below):
1.	All Ground (GND) pins are to be grounded
2.	Reserved pins (RES) are to be left floating
3.	FORCE_ON is connected only on the SE868-A and SE868K3-Ax modules. See section **9.6.2.2 FORCE_ON (SE868-A and SE868K3-Ax only)**
4.	I²C and SPI pins are implemented only on the SE868-A and SE868K3-Ax. The I2C pins are UART on the SE868-AS andSE868K7-Ax.
5.	The 2nd port is I²C on MT3333-based modules and UART on MT3337-based modules.

Figure 9-1 SE868-A Family Pinout Diagram

9.3 SE868-A Module Pinout Tables

9.3.1 SE868-A Pinout Table

PIN	SIGNAL	TYPE	DESCRIPTION	NOTES
1	Ground	GND	Ground	
2	Reserved	RES	Reserved. Do not connect	
3	Reserved	RES	Reserved. Do not connect	
4	Reserved	RES	Reserved. Do not connect	
5	No Connection	NC	Not connected	
6	Ground	GND	Ground	
7	Ground	GND	Ground	
8	No Connection	NC	Not connected	
9	Ground	GND	Ground	
10	TX0	O	Serial_Output_UART0	
11	RX0	I	Serial_Input_UART0	
12	HRST_B	I	System Reset – Active Low	
13	FORCE_ON	I	Force full-power mode	3
14	No Connection	NC	Not connected	
15	No Connection	NC	Not connected	
16	No Connection	NC	Not connected	
17	PPS	O	Pulse Per Second signal	
18	Reserved	RES	Reserved. Do not connect	
19	Reserved	RES	Reserved. Do not connect	
20	Reserved	RES	Reserved. Do not connect	
21	Ground	GND	Ground	
22	I^2C Data / TX1	I/O	I^2C Data / UART1_Tx	
23	I^2C Clock / RX1	I/O	I^2C Clock / UART1_Rx	
24	No Connection	NC	Not connected	
25	VCC	PWR	Main power supply	
26	No Connection	NC	Not connected	
27	No Connection	NC	Not connected	
28	DRI	O	Data Ready Indicator	
29	No Connection	NC	Not connected	
30	No Connection	NC	Not connected	
31	Ground	GND	Ground	
32	VBATT	PWR	Backup Power supply	
Note 3: Force-On is not implemented in the MT3337				

Table 9-1 SE868-A Pinout Table

9.3.2 SE868-AS Pinout Table

PIN	SIGNAL	TYPE	DESCRIPTION	NOTES
1	Ground	GND	Ground	
2	Reserved	RES	Reserved. Do not connect	
3	Reserved	RES	Reserved. Do not connect	
4	Reserved	RES	Reserved. Do not connect	
5	No Connection	NC	Not connected	
6	Ground	GND	Ground	
7	Ground	GND	Ground	
8	No Connection	NC	Not connected	
9	Ground	GND	Ground	
10	TX0	O	Serial_Output_UART0	
11	RX0	I	Serial_Input_UART0	
12	HRST_B	I	System Reset – Active Low	
13	No Connection	NC	No Connection	3
14	No Connection	NC	Not connected	
15	No Connection	NC	Not connected	
16	No Connection	NC	Not connected	
17	PPS	O	Pulse Per Second signal	
18	Reserved	RES	Reserved. Do not connect	
19	Reserved	RES	Reserved. Do not connect	
20	Reserved	RES	Reserved. Do not connect	
21	Ground	GND	Ground	
22	TX1	O	Serial_Output_UART1	
23	RX1	I	Serial_Input_UART1	
24	No Connection	NC	Not connected	
25	VCC	PWR	Main power supply	
26	No Connection	NC	Not connected	
27	No Connection	NC	Not connected	
28	Reserved	RES	Reserved. Do not connect	
29	No Connection	NC	Not connected	
30	No Connection	NC	Not connected	
31	Ground	GND	Ground	
32	VBATT	PWR	Backup Power supply	
Note 3: Force-On is not implemented in the MT3337				

Table 9-2 SE868-AS Pinout Table

9.3.3 SE868K3-A Pinout Table

PIN	SIGNAL	TYPE	DESCRIPTION	NOTES
1	Ground	GND	Ground	
2	Reserved	RES	EIT0 / GPIO12	
3	Reserved	RES	GPIO9	
4	Reserved	RES	Reserved. Do not connect	
5	No Connection	NC	Not connected	
6	Ground	GND	Ground	
7	Ground	GND	Ground	
8	No Connection	NC	Not connected	
9	Ground	GND	Ground	
10	TX0	O	UART0 Serial Output (Transmit)	
11	RX0	I	UART0 Serial Input (Receive)	
12	S_RESET	I	System Reset – Active Low	
13	FORCE_ON	I	Force full-power mode	3
14	No Connection	NC	Not connected	
15	SPI_MOSI	I/O	SPI Data MOSI	4
16	No Connection	NC	Not connected	
17	PPS	O	Pulse Per Second signal	
18	No Connection	NC	Not connected	
19	SPI_CS	I/O	SPI Chip Select	4
20	Reserved	RES	GPIO10	
21	Ground	GND	Ground	
22	I^2C Data / TX1	I/O	I^2C Data / UART1 Tx	4
23	I^2C Clock / RX1	I/O	I^2C Clock / UART1 Rx	4
24	No Connection	NC	Not connected	
25	VCC	PWR	Main power supply	
26	No Connection	NC	Not connected	
27	No Connection	NC	Not connected	
28	DRI	O	Data Ready Indicator	
29	SPI_CLK	I/O	SPI Clock	4
30	SPI_MISO	I/O	SPI Data MISO	4
31	Ground	GND	Ground	
32	VBATT	PWR	Backup Power supply	

Note 3: Force-On is not implemented in the MT3337
Note 4: TX1/RX1 are UART-only on the MT3337

Table 9-3 SE868K3-Ax Pinout Table

9.3.4 SE868K7-A Pinout Table

PIN	SIGNAL	TYPE	DESCRIPTION	NOTES
1	Ground	GND	Ground	
2	Reserved	RES	EIT0 / GPIO 12 on MT3333	
3	Reserved	RES	GPIO9 on MT3333.	
4	Reserved	RES	Reserved. Do not connect	
5	No Connection	NC	Not connected	
6	Ground	GND	Ground	
7	Ground	GND	Ground	
8	No Connection	NC	Not connected	
9	Ground	GND	Ground	
10	TX0	O	UART0 Serial Output (Transmit)	
11	RX0	I	UART0 Serial Input (Receive)	
12	S_RESET	I	System Reset – Active Low	
13	Reserved	RES	Reserved. Do not connect	3
14	No Connection	NC	Not connected	
15	Reserved	RES	Reserved. SPI on MT3333.	
16	No Connection	NC	Not connected	
17	PPS	O	Pulse Per Second signal	
18	No Connection	NC	Not connected	
19	Reserved	RES	Reserved. SPI on MT3333.	
20	Reserved	RES	GPIO10 on MT3333.	
21	Ground	GND	Ground	
22	TX1	I/O	UART1 Tx	4
23	RX1	I/O	UART1 Rx	4
24	No Connection	NC	Not connected	
25	VCC	PWR	Main power supply	
26	No Connection	NC	Not connected	
27	No Connection	NC	Not connected	
28	Reserved	RES	EIT1 / GPIO13 on MT3333.	
29	Reserved	RES	Reserved. SPI on MT3333.	
30	Reserved	RES	Reserved. SPI on MT3333.	
31	Ground	GND	Ground	
32	VBATT	PWR	Backup Power supply	
Note 3: Force-On is not implemented in the MT3337 Note 4: TX1/RX1 are UART-only on the MT3337				

Table 9-4 SE868K7-Ax Pinout Table

9.4 SE868-Ax to SE868Kx-Ax Comparison and Migration

This section contains information relating to migrating from the early production modules to current production as follows:

- MTK3333-based: SE868-A to SE868K3-Ax
- MTK3337-based: SE868-AS to SE868K7-Ax

As shown in the following tables, the main differences for the SE868-A and SE868K3-Ax modules are the addition of SPI pins (which require a custom FW build) and the change of pin 18 from Reserved to No Connection.

For the SE868-AS and SE868K7-A modules, the main differences are the change from “No Connection” to “Reserved” for the FORCE_ON and SPI pins that are used on the SE868K3-Ax. This is to allow a compatible board design for the two modules as long as FORCE_ON, I^2C and SPI are not required.

There are also differences in the firmware (in flash memory for the SE868K3-Ax or ROM for the SE868K7-Ax).

9.4.1 SE868-A and SE868K3-Ax Pinout Comparison

PIN	SE868-A Signal	SE868K3-Ax Signal	Comparison	Notes
1	Ground	Ground	=	
2	Reserved	Reserved	=	
3	Reserved	Reserved	=	
4	Reserved (DR-IN)	Reserved	=	
5	No Connection	No Connection	=	
6	Ground	Ground	=	
7	Ground	Ground	=	
8	No Connection	No Connection	=	
9	Ground	Ground	=	
10	TX0	TX0	=	
11	RX0	RX0	=	
12	HRST_B	S_RESET	=	
13	FORCE_ON	FORCE_ON	=	3
14	No Connection	No Connection	=	
15	No Connection	SPI_MOSI	SPI MOSI	4
16	No Connection	No Connection	=	
17	PPS	PPS	=	
18	Reserved (ECLK)	No Connection	NC	
19	Reserved (SYNC_PULSE)	SPI_CS	SPI CS	4
20	Reserved (GIO10)	Reserved	=	
21	Ground	Ground	=	
22	I^2C Data / TX1	I^2C Data / TX1	=	5
23	I^2C Clock / RX1	I^2C Clock / RX1	=	5
24	No Connection	No Connection	=	
25	VCC	VCC	=	
26	No Connection	No Connection	=	
27	No Connection	No Connection	=	
28	DRI	DRI	=	
29	No Connection	SPI_CLK	SPI CLK	4
30	No Connection	SPI_MISO	SPI MISO	4
31	Ground	Ground	=	
32	VBATT	VBATT	=	

Note 3: Force-On is not implemented in the MT3337
Note 4: TX1/RX1 are UART-only on the MT3337
Note 5: The 2nd port is I^2C on MT3333-based modules and UART on MT3337-based modules.

Table 9-5 SE868-A and SE868K3-A Pinout Comparison

9.4.2 SE868-AS and SE868K7-Ax Pinout Comparison

PIN	SE868-AS Signal	SE868K7-Ax Signal	Comparison	Notes
1	Ground	Ground	=	
2	Reserved	Reserved	=	
3	Reserved	Reserved	=	
4	Reserved (DR_IN)	Reserved	=	
5	No Connection	No Connection	=	
6	Ground	Ground	=	
7	Ground	Ground	=	
8	No Connection	No Connection	=	
9	Ground	Ground	=	
10	TX0	TX0	=	
11	RX0	RX0	=	
12	HRST_B	S_RESET	=	
13	No Connection	Reserved	Reserved	3
14	No Connection	No Connection	=	
15	No Connection	Reserved	Reserved	4
16	No Connection	No Connection	=	
17	PPS	PPS	=	
18	Reserved (NC)	No Connection	NC	
19	Reserved (SYNC_PULSE)	Reserved	=	4
20	Reserved (NC)	Reserved	=	
21	Ground	Ground	=	
22	TX1	TX1	=	5
23	RX1	RX1	=	5
24	No Connection	No Connection	=	
25	VCC	VCC	=	
26	No Connection	No Connection	=	
27	No Connection	No Connection	=	
28	Reserved (NC)	Reserved	=	
29	No Connection	Reserved	Reserved	4
30	No Connection	Reserved	Reserved	4
31	Ground	Ground	=	
32	VBATT	VBATT	=	

Notes are under ***Figure 9-1 SE868-A Family Pinout Diagram***

Table 9-6 SE868-AS and SE868K7-A Pinout Comparison

9.5 DC Power Supply

The modules have two power supply pins V_{CC} and V_{BATT}.

Note that I/O voltage ranges are different from supply voltages V_{CC} and V_{BATT}.

9.5.1 VCC

This is the main power input. The supply voltage must be in the range specified in **Table 9-7 DC Supply Voltage** below.

Vcc does not supply the RTC domain, therefore Vbatt must be supplied any time that Vcc is powered. 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.

9.5.2 VBATT

Battery backup power input (as specified in the table below) must be supplied any time that Vcc is powered up. This may be accomplished by tying Vbatt to Vcc.

Vbatt supplies power to the following elements (the RTC domain):

- real-time clock (RTC)
- battery backed RAM (BBRAM)
- EASY data
- Persistent data elements (not commanded option values).

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

9.5.3 DC Power Requirements

Main Supply Voltage & Backup Voltage					
Supply	**Name**	**Min**	**Typ**	**Max**	**Units**
Vcc and Vbatt	Vcc & Vbatt	2.8	3.3	4.3	V
The drop from 2.7 V to 0 V must be > 1 ms. Also, keep the supply ripple as low as possible (< 50 mV)					

Table 9-7 DC Supply Voltage

9.5.4 DC Power Consumption: SE868-A

State & Constellation	Typ	Max	Units
Acquisition			
GPS Only	84	123	mW
GPS and Glonass	103	146	mW
Navigation/Tracking			
GPS Only	74	120	mW
GPS and Glonass	81	139	mW
Low Power Mode – Always Locate			
GPS Only	19		mW
GPS and Glonass	25		mW
Vbatt	50	99	µW
Operating temperature: 25°C Supply voltages: 3.3 VDC nominal SBAS: enabled 1PPS sync: enabled			

Table 9-8 SE868-A Power Consumption

9.5.5 DC Power Consumption: SE868-AS

State (GPS only)	Typ	Max	Units
Acquisition	79	102	mW
Navigation/Tracking	74	102	mW
Low Power – AlwaysLocate Standby (3337 early production ROM only)	16		mW
Vbatt	25	66	µW
Operating temperature: 25°C Supply voltages: 3.3 VDC nominal SBAS: not supported 1PPS sync: disabled			

Table 9-9 SE868-AS Power Consumption

9.5.6 DC Power Consumption: SE868K3-Ax

State & Constellation	Typ	Max	Units
Acquisition			
GPS Only	107	151	mW
GPS and Glonass	111	163	mW
Navigation/Tracking			
GPS Only	73	93	mW
GPS and Glonass	99	132	mW
Low Power Mode – Periodic (500 ms On)			
GPS Only			mW
GPS and Glonass	53		mW
Vbatt	50	99	µW
Operating temperature: 25°C Supply voltages: 3.3 VDC nominal SBAS: enabled 1PPS sync: enabled			

Table 9-10 SE868K3-Ax Power Consumption

9.5.7 DC Power Consumption: SE868K7-Ax

State (GPS only)	Typ	Max	Units
Acquisition	85	119	mW
Navigation/Tracking	71	89	mW
Vbatt	25	66	µW
Operating temperature: 25°C Supply voltages: 3.3 VDC nominal SBAS: not supported 1PPS sync: disabled			

Table 9-11 SE868K7-Ax Power Consumption

9.6 Control and Status Signals

9.6.1 I/O Signal Levels

Note that I/O voltage ranges are different from supply voltages V_{CC} and V_{BATT}.

Several different logic levels are utilized by the digital signal interfaces of the module:

9.6.1.1 Logic Levels – Inputs

RX0, RX1, Reset-N					
Signal	**Symbol**	**Min**	**Typ**	**Max**	**Units**
Input Voltage (L)	V_{il}	0		0.5	V
Input Voltage (H)	Vih	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 9-12 Input Logic Levels: RX and Reset-N

Force_On					
Signal	**Symbol**	**Min**	**Typ**	**Max**	**Units**
Input Voltage (L)	V_{il}	0		0.275	V
Input Voltage (H)	Vih	0.825		3.4	V
Note: Force_On has no pullup or pulldown. For typical applications, use a pulldown of 10k Ω.					

Table 9-13 Input Logic Levels: Force_On

9.6.1.2 Logic Levels – Outputs

TX0, TX1, and 1PPS					
Signal	**Symbol**	**Min**	**Typ**	**Max**	**Units**
Output Voltage (L)	Vol			0.4	V
Output Voltage (H)	Voh	2.14		2.89	V
Normal Current (L)	Iol		-2		mA
Output Current (H)	Ioh		-2		mA

Table 9-14 Output Logic Levels: TX and 1PPS

9.6.2 Control and Input Signals

9.6.2.1 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 module to operate properly, so this pin may be left unconnected. However, it is recommended to bring it out to a test point.

If used the signal can only be driven low, never high since it has an internal pullup.

The logic levels are shown in **Table 9-12 Input Logic Levels: RX and Reset-N**

9.6.2.2 FORCE_ON (SE868-A and SE868K3-Ax only)

For typical operation, connect this pin through a 10 KΩ resistor to ground to create a pulldown (which will prevent noise from accidentally activating this pin).

Upon command, the module will enter the backup (low power) state.
To exit this state, 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 released 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 SE868-A and SE868K3-Ax modules.

Note that this pin has a maximum input voltage of 3.4 V (which is lower than the max for Vcc or Vbatt).

Logic levels are shown in **Table 9-13 Input Logic Levels: Force_On.**

9.6.3 Output Signals

9.6.3.1 1PPS

1PPS is a one pulse per output second signal. Its default characteristics are:

- Pulse duration: 100 ms
- Active: during 3D navigation.

The pulse availability and duration can be configured via the **$PMTK285** command.

Options for availability are:

- Disable
- After 1st fix
- 3D Fix only
- 2D/3D Fix only
- Always.

NMEA output (timestamp) can be configured to have a fixed latency behind the 1PPS pulse of 460 to 485 ms via the **$PMTK255** command. Default is variable latency.

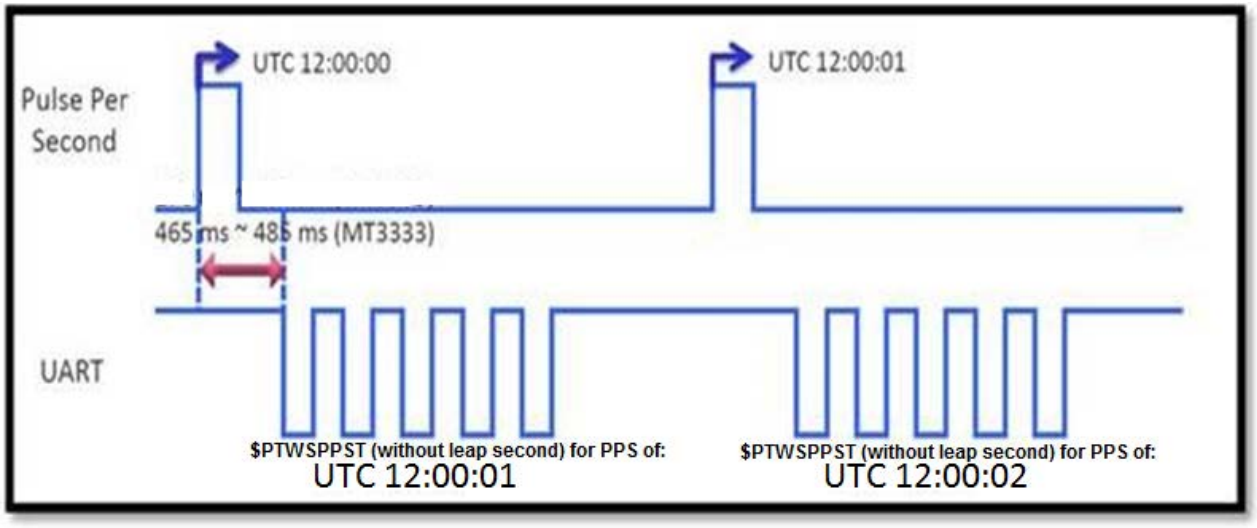


Figure 9-2 1PPS NMEA Synchronization

These configurations will not be preserved across a power cycle or reset.

1PPS is disabled if the fix rate > 1 Hz.

Variation is ≈ 30 ns (1 σ).

9.7 Serial I/O Ports

Port 0:
All modules include a primary UART serial port (TX0 / RX0).
Port 1:
The secondary port on MT3333-based modules is I^2C by default, but can be changed to UART (TX1/RX1) or SPI via command. The module will reset when the interface is changed.

The secondary port on MT3337-based modules is UART (TX1 / RX1) and cannot be changed.

9.8 Port Usage

9.8.1 Primary (Port 0) Usage

TX0: NMEA message output
RX0: NMEA proprietary commands, RTCM SC-104 input and EPO data

TX0 / RX0 is also used to re-flash the module (MT3333-based modules only).

9.8.2 Secondary (Port 1) Usage

TX1: NMEA message output
RX1: DGPS input using the RTCM SC-104 protocol and NMEA commands.

I^2C and SPI support the same data streams as UART.

The interface is selected via the **$PMTK258** command.
Note that the module will reset when the interface is changed.

9.8.3 UART Port Operation

UART ports are full-duplex and support configurable baud rates.
Frame is 8 bits, no parity bit, and 1 stop bit.

The default rate of 9600 bps can be changed via the following commands -
Primary port: **$PMTK251**
Secondary port: **$PMTK250**

The idle state of UART interface lines is logic high.
UART TX logic levels are shown in **Table 9-14 Output Logic Levels: TX and 1PPS.**
UART RX logic levels are shown in **Table 9-12 Input Logic Levels: RX and Reset-N**

Note that the RX pins have a maximum input voltage of 3.4 V (which is lower than the maximum for Vcc or Vbatt).
Care must be used to prevent backdriving the RX lines when the module is powered down or in a low-power state.

9.8.4 I²C Port Operation (MT3333-based modules only)

MT3337-based modules do not support I²C interface.
MT3333-based modules 2nd serial port (port 1) is configured to use the I²C interface by default but can be changed to UART or SPI via command: **$PMTK258**

The I²C_Clock and I²C_Data lines require external pullups (example value: 10 KΩ).

Features -

- Slave mode only (default address = 0x10)
- Fast mode (up to 400 Kbps)
- 7-bit address
- 255-byte buffer
- The module operates in the polled mode (with the host as the master)
- Data Ready Indicator

Transmit -
The host must be able to read several packets each report cycle. A minimum pause of 2 ms is required between reads to allow the module to fill the buffer. A longer delay is permissible. For example, if the report cycle is 1 second, set the polling sleep time to 500 ms for the next output interval to start.
The buffer will contain up to 254 data bytes plus an <LF> (x'0A") character.
Each NMEA sentence will be terminated by the (standard) <CR-LF> (x'0D, x'0A') characters, and a NMEA sentence can span buffers.
If necessary, the buffer is padded with x'0A' characters. x'0A' is also used for idle characters.

Receive -
The maximum length for commands sent to the module.is 255 bytes.
A minimum of 10 ms is required between packets.

Further details and sample code are available under NDA from the **MediaTek MT3339/MT3333 I²C Application Note**.

9.8.5 SPI Port Operation (MT3333-based modules only)

The MT3333-based modules support SPI interface on the 2nd port via command **PMTK258**.

- Data rate = 700 kbit/s
- Slave mode only.

Two methods are supported for the host to receive NMEA messages: Polling mode and Interrupt mode.

During a SPI transmission, data is transmitted (shifted out serially) and received (shifted in serially) simultaneously by the module. If no data is ready to be transmitted, the host (master) still needs to send padding bytes. It is suggested to set the value of the padding byte to "0xFF" since the module will ignore these padding bytes.

Further details and sample code are available under NDA from the **MediaTek MT3339/MT3333 SPI Application Note**.

10 RF FRONT-END DESIGN

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 navigation data (e.g. time and ephemeris) and compute its position within a period of 5 minutes. In the GNSS signal acquisition process, decoding 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 and/or ephemeris aiding is available, acquisition can be accomplished at lower signal levels.

The GPS signal is defined by the Interface Specification 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 (currently 2008 Version 5.1). This document states that the power level of the received RF signal from a 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 of 5 degrees or more above the horizon.

The receiver will display a reported C/No of 40 dB-Hz for a GPS signal level of -130 dBm at the RF input, assuming a SEN (system equivalent noise) of the receiver of 4 dB. System Equivalent Noise includes the Noise Figure of the receiver plus signal processing or digital noise. For an equivalent GLONASS signal level, the GLONASS signal will report a C/No of approximately 39 dB-Hz. This is due to the receiver’s higher losses (NF) for GLONASS signals and a higher signal processing noise for GLONASS signals.

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:

- Satellite transmit power
- Satellite elevation angle
- Free space path loss
- Extraneous path loss (e.g. 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 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 be worse (higher DOP) and will result in a lower position accuracy. The receiver reports this geometry effect in the form of PDOP, HDOP and VDOP numbers.

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 results when the signal from a particular satellite is reflected from a surface (e.g. a building or the roof of a car) and is received by the GNSS antenna either 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 surrounded 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 (included in the module)

The SE868xx-Ax modules include a SMT 9 x 9 mm ceramic patch antenna shown in the following table:

Module	Antenna	Constellations supported
SE868K3-A	9 x 9 x 4 mm	GPS, Galileo, GLONASS
SE868K3-AL	9 x 9 x2 mm	GPS, Galileo, GLONASS
SE868K7-A	9 x 9 x4 mm	GPS
SE868K7-AL	9 x 9 x2 mm	GPS

Table 10-1 Supported Constellations

In order to optimize antenna performance, it is strongly recommended to design a 30mm by 30mm ground plane under the module on the application PCB.

If the ground plane size is smaller than 30x30mm, center frequency detuning may occur.

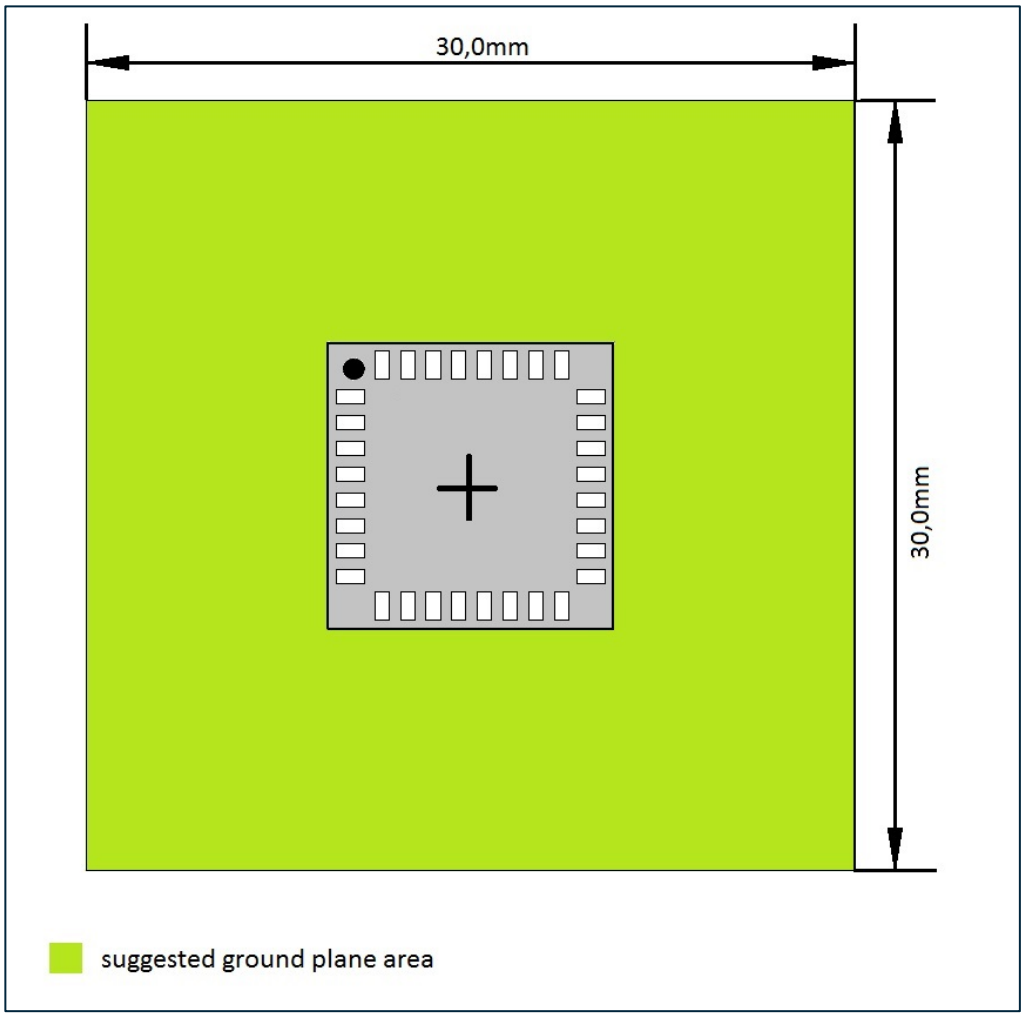
Please refer to Section **10.3 Ground Plane** for details.

10.3 Ground Plane

It is recommended to include a 30 mm by 30 mm (square) ground plane around the module in the PCB design as shown below in order to optimize antenna performance.

The ground plane should be on the top layer of the PCB (directly under the module) with the module centered on it.

Please refer to **Section 10.2 GNSS Antenna (included in the module)** for details.



Note: The ground plane should be continuous. There is no “keepout” area under the module.

Figure 10-1 SE868 Family Ground Plane

10.4 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 CW jamming signals in each band (GPS and GLONASS), 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.

10.5 Shielding

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

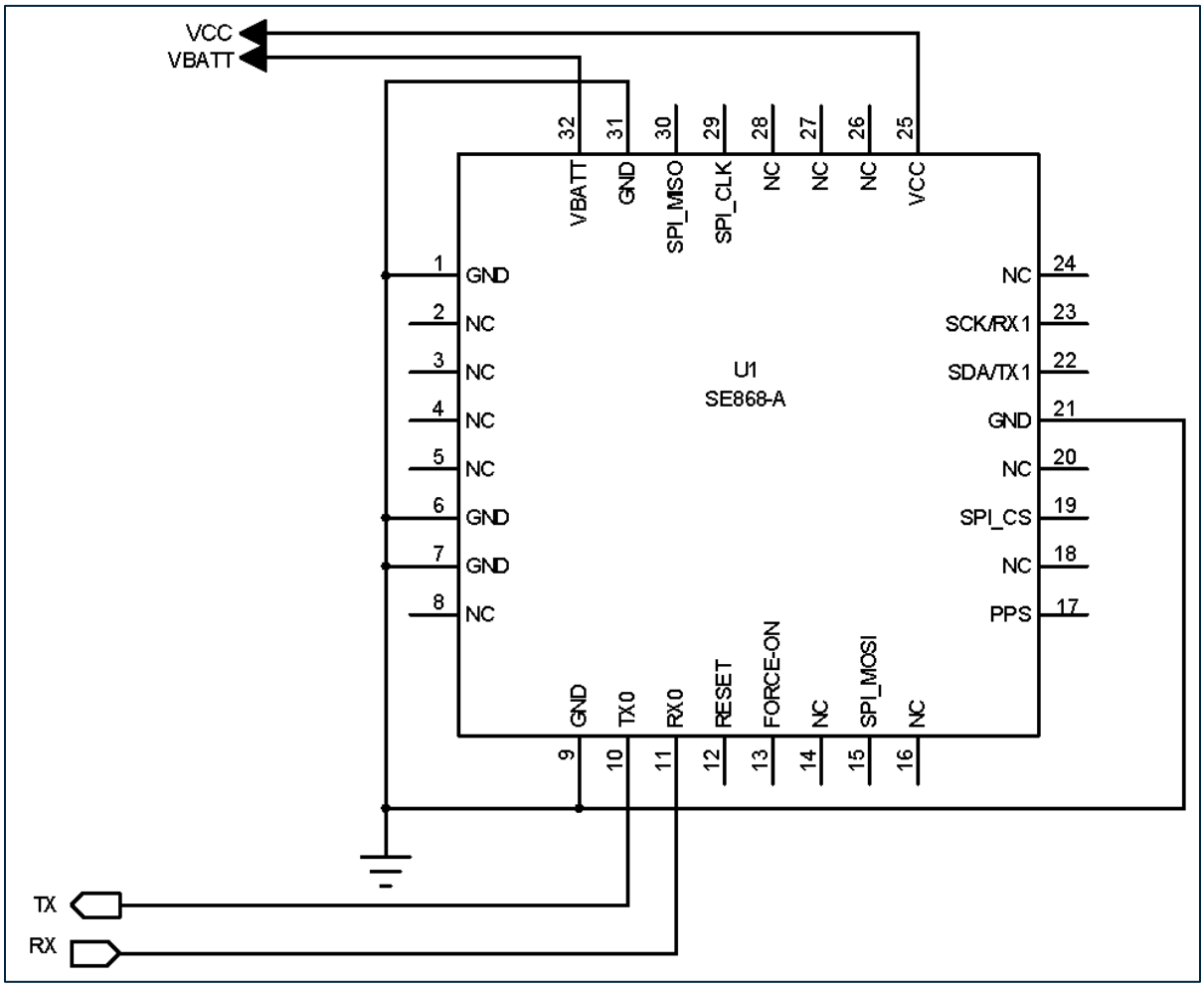


Figure 11-1 SE868 Family Reference Design

Along with power and grounds, the minimum signals required to operate the receiver properly are the RF input signal and two digital I/O signals (TX0 and RX0).

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.

Please refer to **Section 9 Electrical Interface** for important details.

12 MECHANICAL DRAWINGS

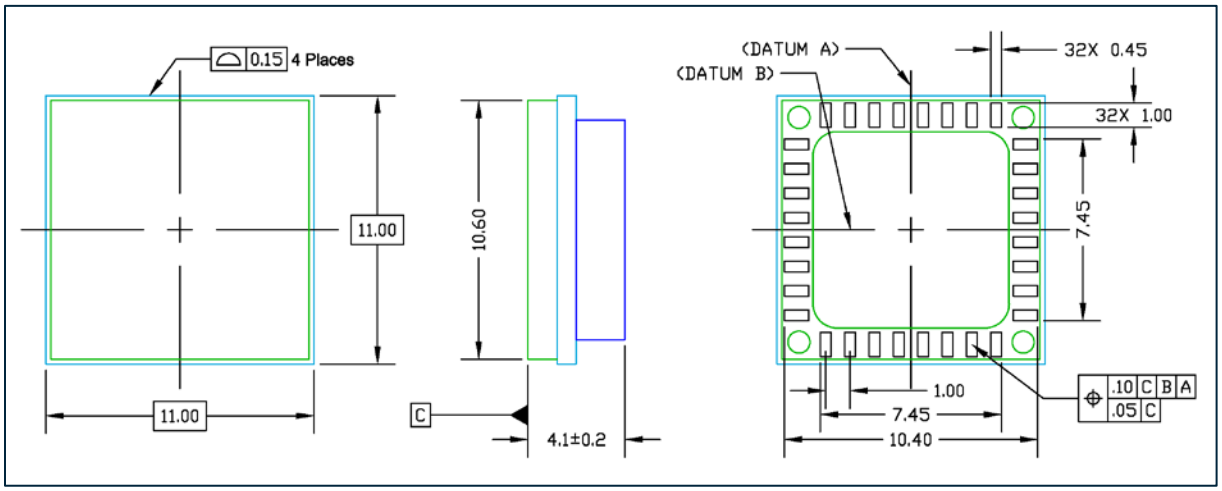


Figure 12-1 SE868 Family (low profile) Mechanical Drawing

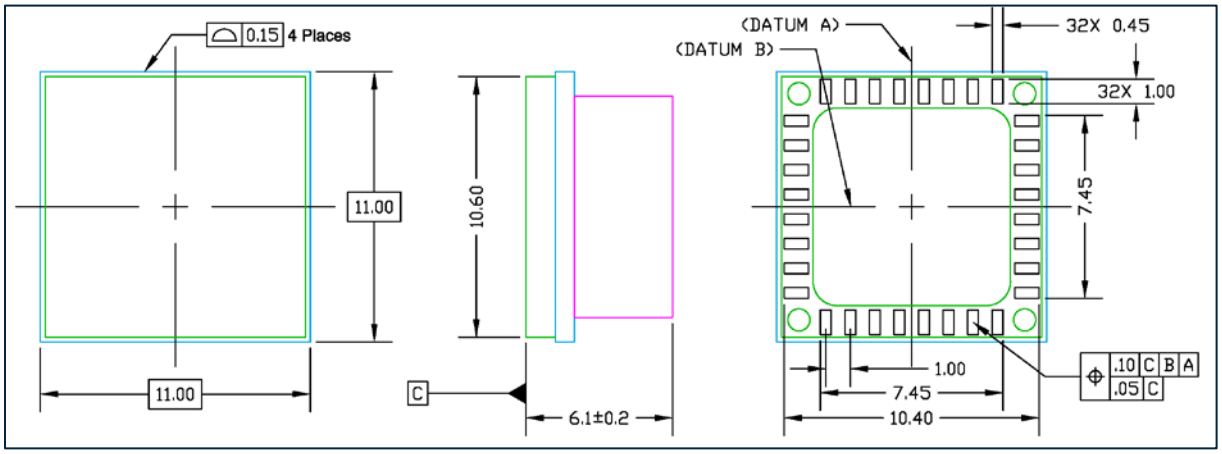


Figure 12-2 SE868 Family (high profile) Mechanical Drawing

13 PCB FOOTPRINT

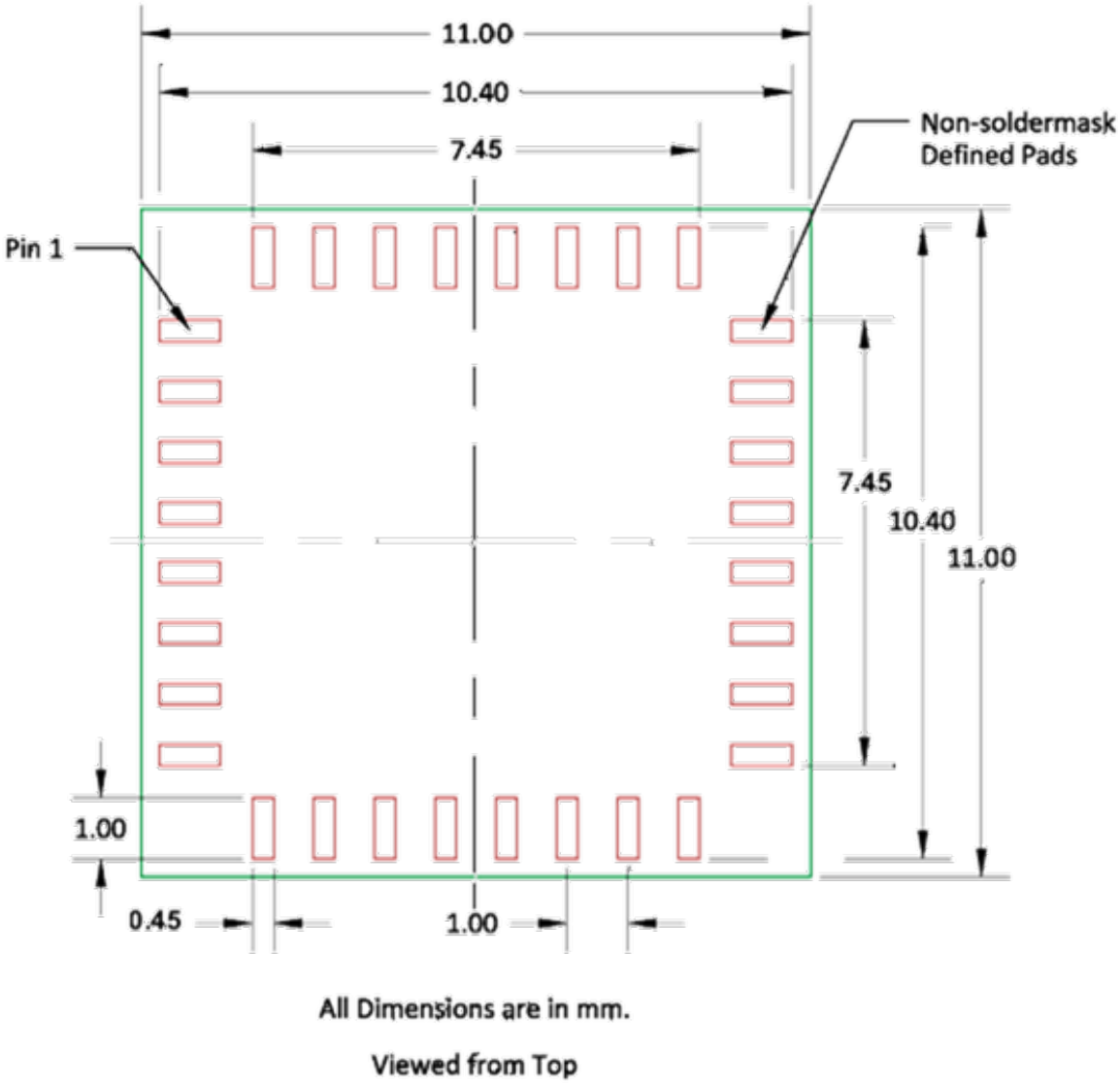


Figure 13-1 SE868 Family Footprint

14 PACKAGING AND HANDLING

14.1 Product Marking and Serialization

The SE868xx-A module label has a 2D Barcode identifying the module and its serial number. Contact a Telit representative for information on specific module serial numbers.

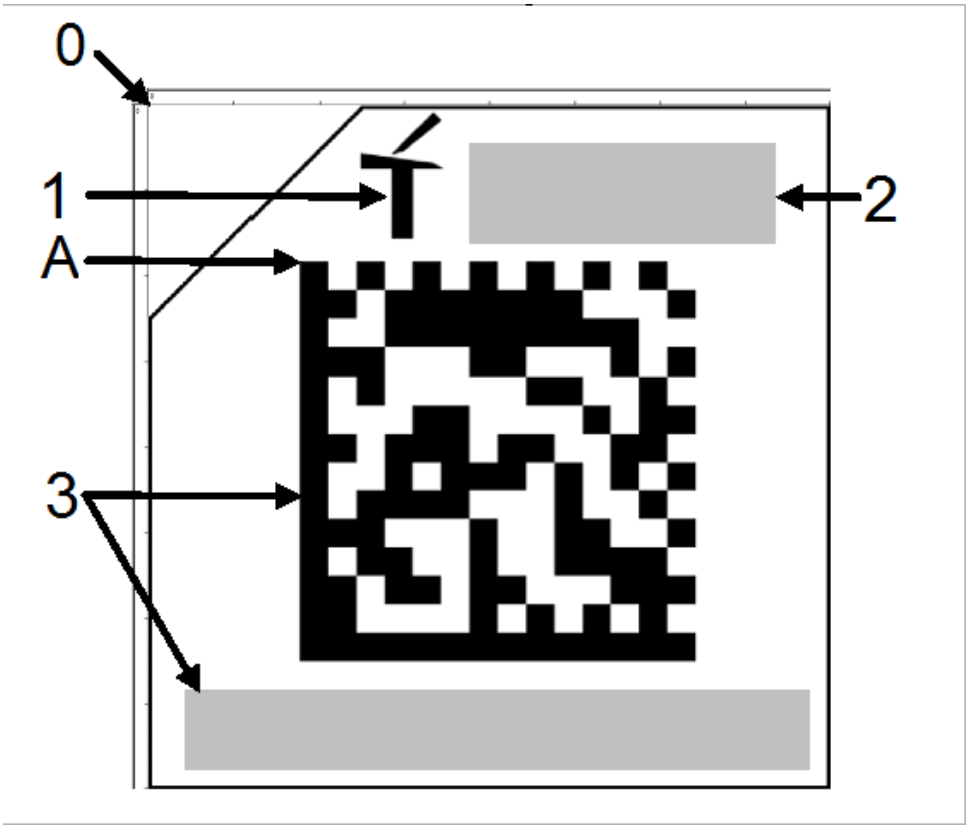


Figure 14-1 Product Label

Key	Description
1	Telit logo
2	Product Name
3	Telit Serial Number barcode (type 2D datamatrix) 11 digit (base 36 – 0 to 9 followed by A to Z)

Figure 14-2 SE868 Family Label Description

14.2 Product Packaging

SE868xx-Ax modules are shipped in Tape and Reel form. The reeled modules are shipped in 24mm 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 placed in a carton.

The minimum order quantity for shipping is 250 units.

All packaging is ESD protective lined.

The SE868-A/AS receivers are Moisture Sensitive Devices (MSD). Please follow the MSD and ESD handling instructions on the labels of the MBB and exterior carton.

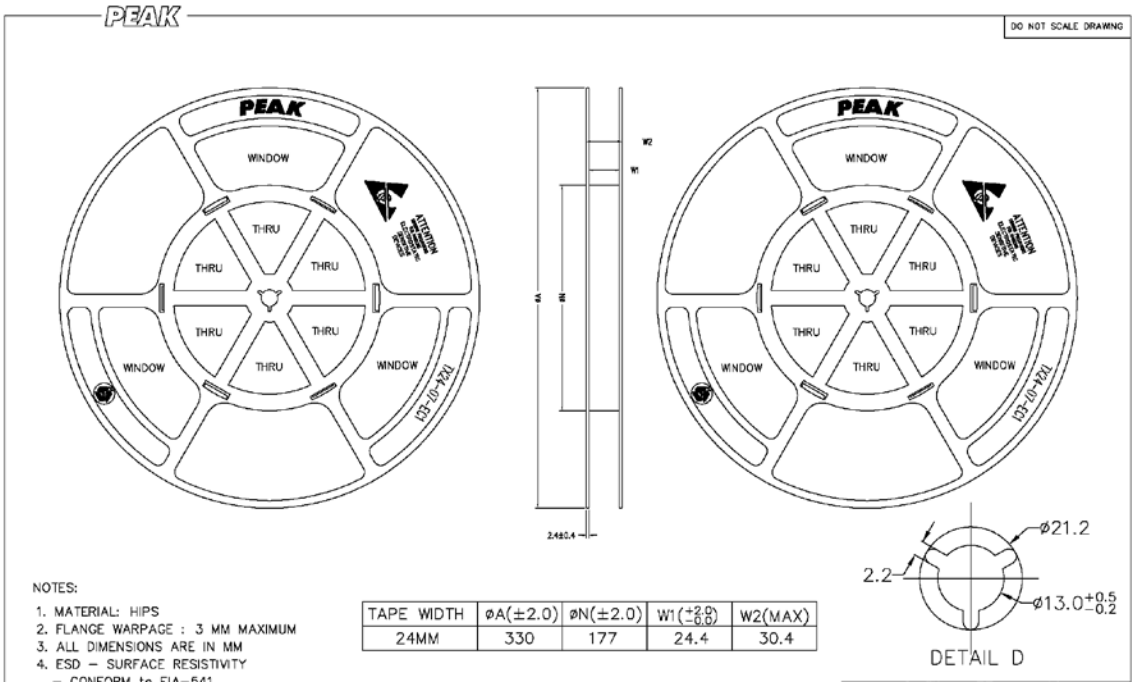


Figure 14-3 SE868 Family - Tape Reel

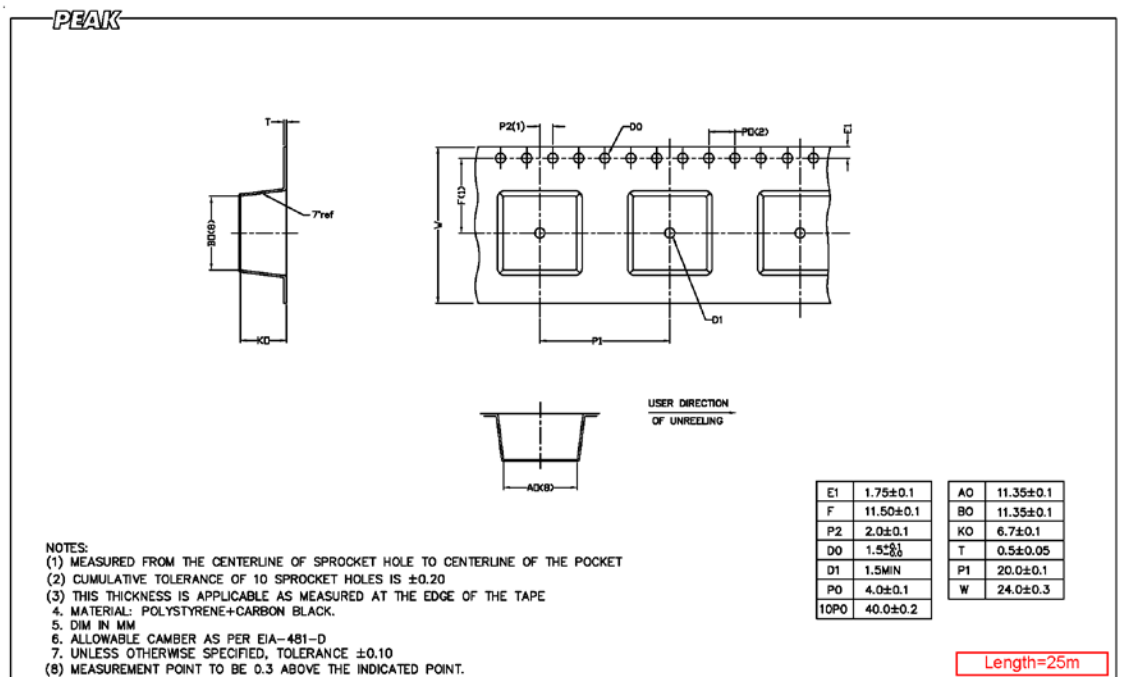


Figure 14-4 SE868 Family - Tape Detail

14.3 Moisture Sensitivity

Precautionary measures are required in handling, storing and using these electronic 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 or damage.

The module has a moisture sensitivity level rating of 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 modules are supplied in a hermetically sealed bag with desiccant and humidity indicator cards. The parts must be placed and reflowed within 168 hours of first opening the hermetic seal provided the factory conditions are less than 30°C and less than 60% 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 packaging materials (tape and reel or trays) can NOT withstand that temperature.

Lower temperature baking is feasible if the humidity level is low and time is available.

Additional information can be found on the MSL tag affixed to the outside of the hermetically sealed bag and **IPC/JEDEC J-STD-033**.

NOTE: JEDEC standards are available free of charge from the JEDEC website http://www.jedec.org.

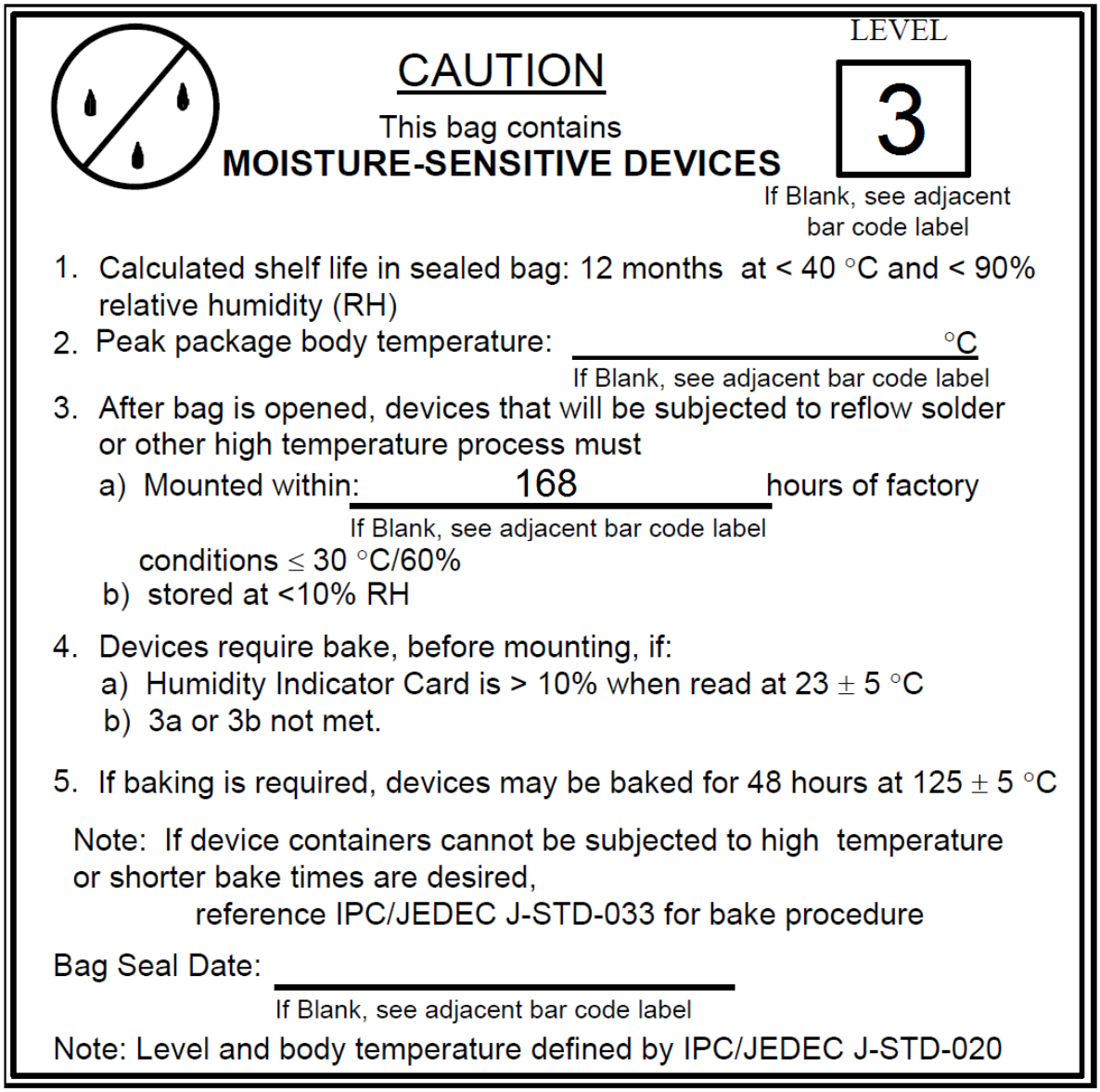


Figure 14-5 Moisture Sensitive Device Label

14.4 ESD Sensitivity

The modules contain class 1 devices and are Electro-Static Discharge Sensitive (ESDS).

Telit recommends the two basic principles of 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.

14.5 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 assembly and singulation process steps, pay careful attention to unwanted vibrations, resonances and mechanical shocks, e.g. those introduced by manufacturing equipment.

14.6 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. The 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

14.7 Reflow

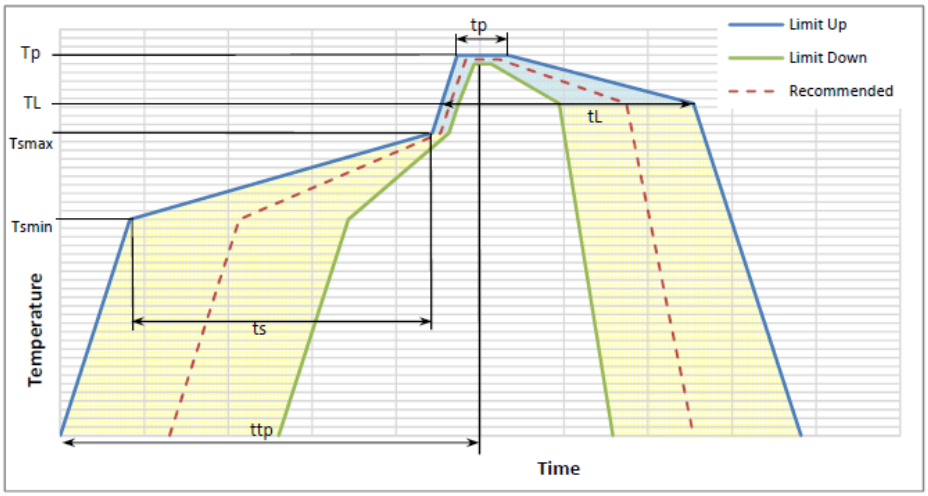
The modules are compatible with lead free soldering processes as defined in **IPC/JEDEC J-STD-020**. The reflow profile must not exceed the profile given **IPC/JEDEC J-STD-020 Table 5-2, "Classification Reflow Profiles".**

Although **IPC/JEDEC J-STD-020** allows for three reflows, the assembly process for the module uses one of those profiles, therefore the module is limited to two reflows.

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

Note: JEDEC standards are available free from the JEDEC website http://www.jedec.org.

The recommended reflow profile is shown in the following figure:



Profile Feature	Pb-Free Assembly
Average ramp-up rate (TL to Tp)	3°C/seccond max
Preheat	
- Temperature Min (Tsmin)	150°C
- Temperature Max (Tsmax)	200°C
- Time (Tsmin to Tsmax) ts	60-180 seconds
Tsmax to TL	
- Ramp-up rate	3°C/seccond max
Time maintained above:	
- Temperature (TL)	217°C
- Time (tL)	60-150 seconds
Peak Temperature (Tp)	245°C +0/-5 °C
Time within 5°C of actual Peak Temperature (tp)	10-30 seconds
Ramp-down Rate	6°C/second max
Time 25°C to Peak Temperature Tp (ttp)	8 minutes max

Figure 14-6 SE868 Family Recommended Reflow Profile

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

14.8 Safety

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

Please refer to **Section 17 Safety Recommendations** for further safety recommendations.

14.9 Disposal

Telit recommends 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.

15 ENVIRONMENTAL REQUIREMENTS

15.1 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	600 m/sec (acquisition and navigation) 2G acceleration

Table 15-1 SE868 Family Operating Environmental Limits

15.2 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	18 G peak, 5 millisecond duration
Shock (in shipping container)	10 drops from 75 cm onto concrete floor

Table 15-2 SE868 Family Storage Environmental Limits

16 COMPLIANCES

The modules comply with the following:

- Directive 2011/65/EU art. 16 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)
- Manufactured in an ISO 9001: 2008 accredited facility
- Manufactured to TS 16949:2009 requirements
- Directive 2014/53/EU Radio Equipment Directive (RED)

16.1 EU (RED) Declarations of Conformity

Telit

EU DECLARATION OF CONFORMITY [20432DOC00105A]

1 **SE868-A** (product name)

2 Telit Wireless Solutions -3131 RDU Center Dr. Suite 135 Morrisville, NC 27560 USA R&D Center -27422 Portola Parkway Suite 320 Foothill Ranch, CA 92610 (manufacturer)

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

4 GNSS L1 receiver Wireless Module

SW Version(s) MT33-v3.8.4-STD-2.1.008-N96

Operating frequency bands and related max radio-frequency power transmitted:

1559-1607 MHz Receiver Only

5 The object of the declaration described above is in conformity with the relevant Community harmonisation: European Directive 2014/53/EU (RED)

6 The conformity with the essential requirements set out in Art.3 of the 2014/53/EU has been demonstrated against the following harmonized standards:

Harmonized Standard reference	Article of Directive 2014/53/EU
EN 60950-1:2006+A11:2009+A1:2010+A12:2011+A2:2013	3.1 (a): Health and Safety of the User
Draft ETSI 301 489-1 v2.2.0 & 301 489-19 v2.1.0	3.1 (b): Electromagnetic Compatibility
ETSI 303 413 v1.1.1	3.2: Effective use of spectrum allocated

7 The conformity assessment procedure referred to in Article 17 and detailed in Annex III of Directive 2014/53/EU has been followed with the involvement of the following Notified Body:

Compatible Electronics, Inc., 114 Olinda Drive - Brea, California 92823 - United States, Notified Body No: 1925

Thus, CE is placed on the packaging label.

8 The product can be considered compliant to the essential requirements set out in Art.3 of 2014/53/EU only in combination with the above-mentioned SW version(s).

9 The Technical Documentation (TD) 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

Trieste, **2017-10-20**

Group CFO, Corporate
Eran Edri

VP R&D GNSS
Georgia Frousiakis

Variant	Certificate	Technical Documentation
SE868-A	20171012150447	30432TCF00095A
SE868-A Low Profile	20171012151150	30403TCF00096A

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Società soggetta all'attività di direzione e coordinamento da parte di Telit Communications PLC con sede in Londra (art.2497 bis C.C.)

Società con socio unico (Telit Communications PLC)

Mod 243 2017-02 Rev.1- This declaration is issued according to 768/2008/EC

Figure 16-1 SE868-A EU RED Declaration of Conformity

Telit

EU DECLARATION OF CONFORMITY [20432DOC00108A]

1 **SE868-AS** (product name)

2 Telit Wireless Solutions -3131 RDU Center Dr. Suite 135 Morrisville, NC 27560 USA R&D Center -27422 Portola Parkway Suite 320 Foothill Ranch, CA 92610 (manufacturer)

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

4 GPS L1 receiver Wireless Module

SWVersion(s)
AXN_2.10_3337_12080901
AXN_2.32_3337_15010801

Operating frequency bands and related max radio-frequency power transmitted:
1574-1576 MHz Receiver only

5 The object of the declaration described above is in conformity with the relevant Community harmonisation: European Directive 2014/53/EU (RED)

6 The conformity with the essential requirements set out in Art.3 of the 2014/53/EU has been demonstrated against the following harmonized standards:

Harmonized Standard reference	Article of Directive 2014/53/EU
EN 60950-1:2006+A11:2009+A1:2010+A12:2011+A2:2013	3.1 (a): Health and Safety of the User
Draft ETSI 301 489-1 v2.2.0 & 301 489-19 v2.1.0	3.1 (b): Electromagnetic Compatibility
ETSI 303 413 v1.1.1	3.2: Effective use of spectrum allocated

7 The conformity assessment procedure referred to in Article 17 and detailed in Annex III of Directive 2014/53/EU has been followed with the involvement of the following Notified Body:

Compatible Electronics, Inc., 114 Olinda Drive - Brea, California 92823 - United States, Notified Body No: 1925

Thus, CE is placed on the packaging label.

8 The product can be considered compliant to the essential requirements set out in Art.3 of 2014/53/EU only in combination with the above-mentioned SW version(s).

9 The Technical Documentation (TD) 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

Trieste, **2017-10-24**

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Georgia Frousiakis

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Variant	Certificate	Technical Documentation
SE868-AS	20171012151808	30432TCF00097A
SE868-AS Low Profile	20171012152109	30432TCF00098A

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Figure 16-2 SE868-AS EU RED Declaration of Conformity

Telit

EU DECLARATION OF CONFORMITY [20508DOC00083A]

1 **SE868K3-A** (product name)

2 Telit Wireless Solutions -3131 RDU Center Dr. Suite 135 Morrisville, NC 27560 USA R&D Center -27422 Portola Parkway Suite 320 Foothill Ranch, CA 92610 (manufacturer)

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

4 GNSS L1 receiver Wireless Module
SW Version(s) v13-2.2.0-STD-3.8.13-N96

Operating frequency bands and related max radio-frequency power transmitted:
1559-1607 MHz Receiver only

5 The object of the declaration described above is in conformity with the relevant Community harmonisation: European Directive 2014/53/EU (RED)

6 The conformity with the essential requirements set out in Art.3 of the 2014/53/EU has been demonstrated against the following harmonized standards:

Harmonized Standard reference	Article of Directive 2014/53/EU
EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011 + A2:2013	3.1 (a): Health and Safety of the User
Draft ETSI 301 489-1 v1.9.2 & 301 489-19 v1.6.1	3.1 (b): Electromagnetic Compatibility
Draft ETSI 303 413 v1.1.0	3.2: Effective use of spectrum allocated

7 The conformity assessment procedure referred to in Article 17 and detailed in Annex III of Directive 2014/53/EU has been followed with the involvement of the following Notified Body:

Compatible electronics, Inc., 114 Olinda Drive - Brea, California 92823 - United States, Notified Body No: 1925

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8 The product can be considered compliant to the essential requirements set out in Art.3 of 2014/53/EU only in combination with the above-mentioned SW version(s).

9 The Technical Documentation (TD) 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

Trieste, **2017-10-16**

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EU-Type Examination Certificate No. 20170706143511

Technical Documentation: 30508TCF00065A

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Figure 16-3 SE868K3-A EU RED Declaration of Conformity

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EU DECLARATION OF CONFORMITY [20508DOC00082A]

1 **SE868K3-AL** (product name)

2 Telit Wireless Solutions -3131 RDU Center Dr. Suite 135 Morrisville, NC 27560 USA R&D Center -27422 Portola Parkway Suite 320 Foothill Ranch, CA 92610 (manufacturer)

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

4 GNSS L1 receiver Wireless Module
SW Version(s) v13-2.2.0-STD-3.8.13-N96

Operating frequency bands and related max radio-frequency power transmitted:
1559-1607 MHz Receiver only

5 The object of the declaration described above is in conformity with the relevant Community harmonisation: European Directive 2014/53/EU (RED)

6 The conformity with the essential requirements set out in Art.3 of the 2014/53/EU has been demonstrated against the following harmonized standards:

Harmonized Standard reference	Article of Directive 2014/53/EU
EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011 + A2:2013	3.1 (a): Health and Safety of the User
Draft ETSI 301 489-1 v1.9.2 & 301 489-19 v1.6.1	3.1 (b): Electromagnetic Compatibility
Draft ETSI 303 413 v1.1.0	3.2: Effective use of spectrum allocated

7 The conformity assessment procedure referred to in Article 17 and detailed in Annex III of Directive 2014/53/EU has been followed with the involvement of the following Notified Body:

Compatible electronics, Inc., 114 Olinda Drive - Brea, California 92823 - United States, Notified Body No: 1925

Thus, CE is placed on the packaging label

8 The product can be considered compliant to the essential requirements set out in Art.3 of 2014/53/EU only in combination with the above-mentioned SW version(s).

9 The Technical Documentation (TD) 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

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EU-Type Examination Certificate No. 20170711120837

Technical Documentation: 30508TCF00067A

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Figure 16-4 SE868K3-AL EU RED Declaration of Conformity

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EU DECLARATION OF CONFORMITY [20508DOC00081A]

1 **SE868K7-A** (product name)

2 Telit Wireless Solutions -3131 RDU Center Dr. Suite 135 Morrisville, NC 27560 USA R&D Center -27422 Portola Parkway Suite 320 Foothill Ranch, CA 92610 (manufacturer)

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

4 Standalone GPS receiver module
SW Version(s) AXN_2.32_3337_15010801

Operating frequency bands and related max radio-frequency power transmitted:
1574-1576 MHz Receiver only

5 The object of the declaration described above is in conformity with the relevant Community harmonisation: European Directive 2014/53/EU (RED)

6 The conformity with the essential requirements set out in Art.3 of the 2014/53/EU has been demonstrated against the following harmonized standards:

Harmonized Standard reference	Article of Directive 2014/53/EU
EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011 + A2:2013	3.1 (a): Health and Safety of the User
Draft ETSI 301 489-1 v1.9.2 & 301 489-19 v1.6.1	3.1 (b): Electromagnetic Compatibility
Draft ETSI 303 413 v1.1.0	3.2: Effective use of spectrum allocated

7 The conformity assessment procedure referred to in Article 17 and detailed in Annex III of Directive 2014/53/EU has been followed with the involvement of the following Notified Body:

Compatible electronics, Inc., 114 Olinda Drive - Brea, California 92823 - United States, Notified Body No: 1925

Thus, CE is placed on the packaging label

8 The product can be considered compliant to the essential requirements set out in Art.3 of 2014/53/EU only in combination with the above-mentioned SW version(s).

9 The Technical Documentation (TD) 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

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Figure 16-5 SE868K7-A EU RED Declaration of Conformity

Telit

EU DECLARATION OF CONFORMITY [20508DOC00080A]

1 **SE868K7-AL** (product name)

2 Telit Wireless Solutions -3131 RDU Center Dr. Suite 135 Morrisville, NC 27560 USA R&D Center -27422 Portola Parkway Suite 320 Foothill Ranch, CA 92610 (manufacturer)

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

4 Standalone GPS receiver module

SW Version(s) AXN_2.32_3337_15010801

Operating frequency bands and related max radio-frequency power transmitted:

1574-1576 MHz Receiver only

5 The object of the declaration described above is in conformity with the relevant Community harmonisation: European Directive 2014/53/EU (RED)

6 The conformity with the essential requirements set out in Art.3 of the 2014/53/EU has been demonstrated against the following harmonized standards:

Harmonized Standard reference	Article of Directive 2014/53/EU
EN 60950-1:2006 + A11:2009 + A1:2010 + A12:2011 + A2:2013	3.1 (a): Health and Safety of the User
Draft ETSI 301 489-1 v1.9.2 & 301 489-19 v1.6.1	3.1 (b): Electromagnetic Compatibility
Draft ETSI 303 413 v1.1.0	3.2: Effective use of spectrum allocated

7 The conformity assessment procedure referred to in Article 17 and detailed in Annex III of Directive 2014/53/EU has been followed with the involvement of the following Notified Body:

Compatible electronics, Inc., 114 Olinda Drive - Brea, California 92823 - United States, Notified Body No: 1925

Thus, CE is placed on the packaging label

8 The product can be considered compliant to the essential requirements set out in Art.3 of 2014/53/EU only in combination with the above-mentioned SW version(s).

9 The Technical Documentation (TD) 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

Trieste, **2017-10-16**

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EU-Type Examination Certificate No. 20170714080200

Technical Documentation: 30508TCF00068A

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Società con socio unico (Telit Communications PLC)

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Figure 16-6 SE868K7-AL EU RED Declaration of Conformity

17 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.

Since the modules are intended to be built-in, 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. The integrator must take adequate precautions to avoid electrical, mechanical, and fire hazards.

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 EN 60950-1 standard 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.

18 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.
Please refer to 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. Please refer to **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 after a period on inactivity. This typically occurs at power up or being sent a restart command. Almanac information may be used to identify previously visible satellites and their approximate positions. Please refer to **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. Please refer to **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. Please refer to **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. Please refer to **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 regional 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 being sent a restart command, generally used for testing rather than normal operation. A restart can also result from a power-up. Please refer to **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. Please refer to **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..
Please refer to **Restart**.

19 DOCUMENT HISTORY

Revision	Date	Changes
0	2015-02-11	First edition
1	2015-10-19	Removed BeiDou reference from § 2.1, 2.2, 5.1, 5.2
2	2017-03-09	Added SE868Kx-Ax modules and comparison/migration information Revised mechanical drawings Deleted reference to SMPS Added reference diagram Corrected pinout diagram: Pins RX1 and TX1 were swapped. Sensitivity values are preliminary.
3	2018-03-12	QZSS default is “disabled” Added new module photos Added RTCM Version & Message types Removed restriction of RTCM data over I^2C Updated Vcc voltage range Added diagrams: EASY, Jamming, GLP, Periodic, Always Loc Added power management command summary table Added configuration command references Added 1PPS information Rearranged I^2C information Changed MT3333-based 2nd port default configuration to I^2C Corrected some information about the Force-On pin usage Corrected commands for Backup and Standby modes Corrected commands for Periodic Low Power modes Added information on the new GLP low-power mode Corrected checksum on the $PMTK161,1 command Rearranged Electrical Interface information Updated to EU RED Declarations of Conformity Minor text revisions
4	2018-07-20	“Always Locate” is not available on (enhanced) MT3337E SBAS ranging is not supported Added reference to SE878Kx-Ax (larger) modules I/O second port description has changed Added pin 28 : Data Ready Indicator Removed restriction prohibiting fast-discharge LDO Changed pinout diagram to Top View Reorganized I/O Signal section Minor text and formatting revisions

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