SE867-AGPS User Guide

1VV0300860 Rev. 4 - 2010-07-16

Making machines talk.

This document is relating to the following products:

PRODUCT
SE867-AGPS

Contents

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1. Introduction

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1.1. Audience

This document is intended for customers who are evaluating one or more products in the applicability table.

1.2. Contact Information, Support

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

TS-EMEA@telit.com
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For detailed information about where you can buy the Telit modules or for recommendations on accessories and components visit:
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1.3. Text Conventions

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

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

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

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

1.4. Related Documents

The following documents are related to this user guide:

[1] "SE867-AGPS Product description"
[2] "SE867-AGPS Evaluation Board User Guide"

All documentation can be downloaded from Telit official web site www.telit.com if not otherwise indicated.

1.5. Document change log

Revision	Date [yyyy-mm-dd]	Changes
Issue #0	2009-10-23	First release
Issue #1	2010-03-11	Added Chap 7 "Connection guidelines" UART default speed changed to 9600bp
Issue #2	2010-04-28	Changed paragraph 7.2 Added paragraph 7.5
Issue #3	2010-05-10	Corrected paragraph 5.2 Paragraph 1.2: added reference to Telit's Web Site Download Zone Updated Chapter 10 with firmware 4.0.1 features Changed Appendix A into Appendix B Added Appendix A - Abbreviations and Acronyms
Issue #4	2010-07-16	Updated paragraph 6.1

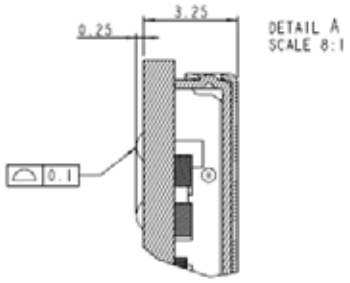
2. Overview

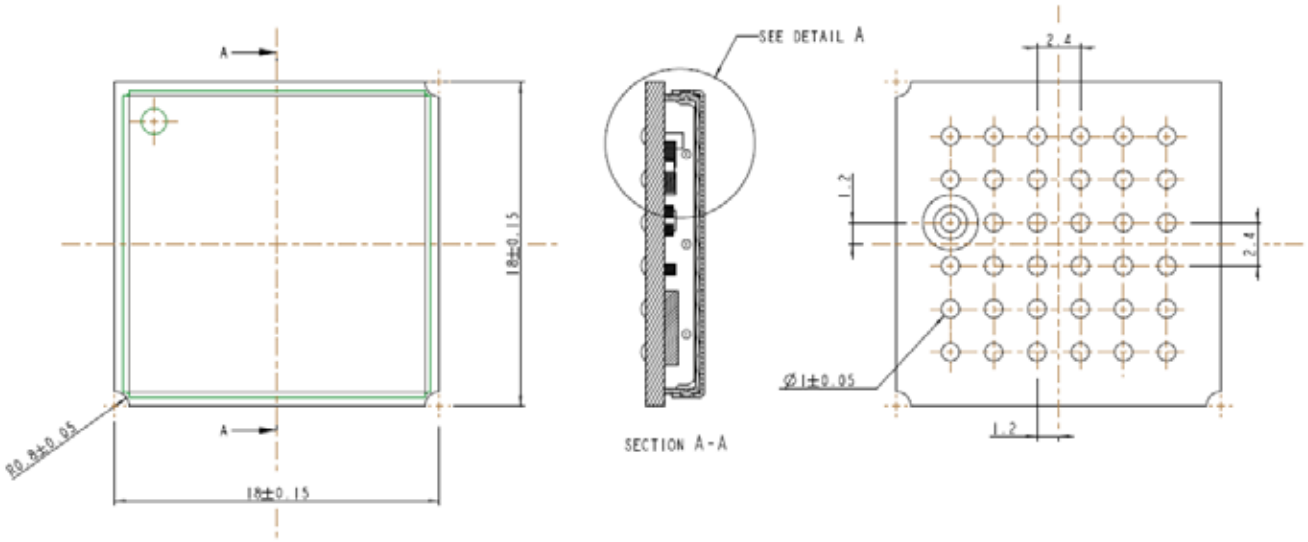
This document is a user guide for developing a GPS application based on Telit SE867-AGPS stand-alone GPS module.
This document cannot embrace the whole hardware solutions and products that may be designed using the SE867-AGPS module. The information given is a guideline and a starting point for proper product development with the Telit stand-alone module.

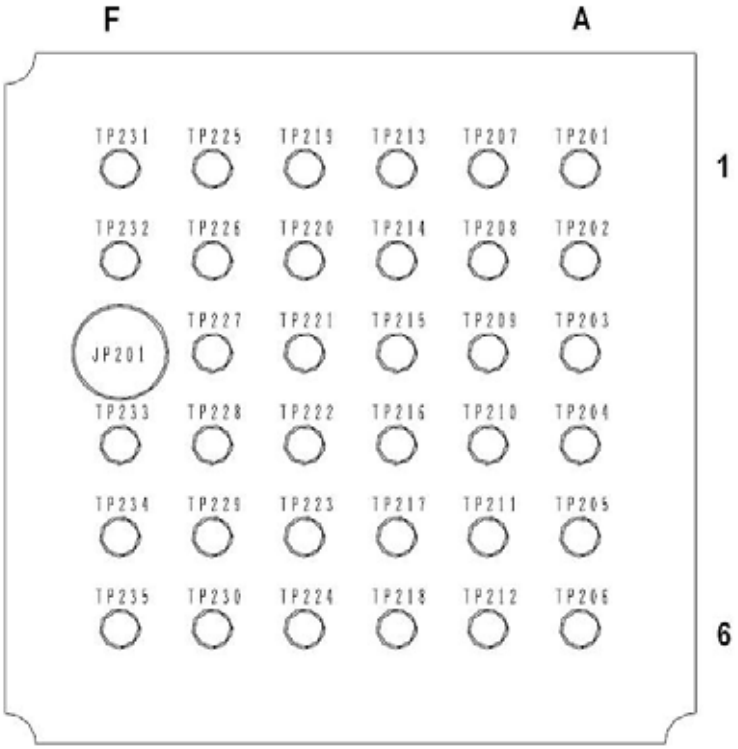
3. Mechanical Dimensions

The Telit SE867-AGPS module overall dimensions are:

- Length: 18 mm
- Width: 18 mm
- Thickness: 3.5 mm
- Weight 1.8 g



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Bottom side

4. GPS module connections

4.1. PIN-OUT

Ball	Signal	I/O	Function	Type	Notes
Miscellaneous Functions					
A1	RFEN	O	Active high enable signal of RF section	Control	
B1	RFXEN	O	Active low enable signal of RF section	Control	
B2	BOOTSEL	I	Boot mode selection signal	Control	Internal pull-up
C2	WAKE1	I	Wake signal input	Control	
A3	RTC_IN	I	Input of the external RTC crystal	Timing	
A4	RTC_OUT	O	Output of the external RTC crystal	Timing	
D2	1V8_RF_EN	I	Active low enable signal of the 1V8_RF voltage regulator	Control	Internal pull-up
E2	1V8_DIG_EN	I	Active low enable signal of the 1V8_DIG voltage regulator	Control	Internal pull-up
D4	RESET	I	Active low reset signal	Control	Schmitt trigger input
F4	RF_IN	I	RF input	RF	
B6	PPS	O	Precise timing signal	Timing	
UART					
B4	TX_UART	O	UART TX signal	UART	
B5	RX_UART	I	UART RX signal	UART	
POWER					
D1	1V8_RF	PWR	RF section power supply	-	
E1	1V8_DIG	PWR	BB section power supply	-	
F1	VIN	PWR	Internal dual regulator input	-	
B3	VDD_CTRL	PWR	CTRL power island supply	-	
C3	IOVDD_AIN	PWR	Analog input power island supply	-	
D3	VREG_OUT	PWR	Output of the internal single output regulator	-	
A2	VDD_REG_IN	PWR	Input of the internal single output regulator	-	
A6	V_IO	PWR	I/O power island supply	-	
GROUND					
C1	GND			-	
F2	GND			-	
E3	GND			-	
E4	GND			-	
A5	GND			-	
C5	GND			-	
D5	GND			-	-
F5	GND			-	-
E6	GND			-	-
F6	GND			-	-
RESERVED					

Ball	Signal	I/O	Function	Type	Notes
E5			N.C.	-	-
C6			N.C.	-	-
D6			N.C.	-	-
C4			N.C.	-	-

4.2. Pin-out view

	A	B	C	D	E	F
1	RFEN	RFXEN	GND	1V8_RF	1V8_DIG	VIN
2	VDD_REG_IN	BOOTSEL	WAKE1	1V8_RF_EN	1V8_DIG_EN	GND
3	RTC_IN	VDD_CTRL	IOVDD_AIN	VREG_OUT	GND	
4	RTC_OUT	TX_UART	NC	RESET	GND	RF_IN
5	GND	RX_UART	GND	GND	NC	GND
6	V_IO	PPS	NC	NC	GND	GND

NOTE: The drawing above is a top view.

5. Electrical description

Having power supply circuitry, RF path and board layout properly designed is key to get a successfully application design. So, the below requirements and guidelines have to be carefully read and taken into account for correct device operations.

5.1. Available power supply configurations

In order to give a higher flexibility to the required power configuration, different powering options have been devised:

1) Wide range voltage input from 2.5V up to 4.2V plus an additional 3V ± 10% reference voltage for I/O peripherals (for 3V logic level interfaces)
2) Wide range voltage input from 2.5V up to 4.2V plus an additional 1.8V ± 10% reference voltage (internally or externally generated) for I/O peripherals (for 1.8V logic level interfaces)
3) Externally generated 1.8V ± 5% supply plus 3V ± 10% or 1.8V ± 10% for I/O peripherals (bypassing the internal regulator). This solution allows for a lower flexibility but assures lower power consumptions (no dissipation in the internal linear regulator).

5.1.1. Configuration 1

The first available power supply configuration exploits the internal voltage regulators to generate the required 1V8_DIG and 1V8_RF supplies. In order to do so, the internal regulators must be enabled via the 1V8_DIG_EN and 1V8_RF_EN signals (active low). Additional 3V voltage must be supplied on the V_IO pin (this voltage regulate the I/O voltage levels for the UART signals). VDD_REG_IN pin and IOVDD_AIN must be tied together and must be equal to or greater than every other voltage supplied to the internal GPS chipset (they must be compared with V_IO and VDD_CTRL but not with VIN because VIN is internally regulated). VDD_CTRL is responsible of powering the SYSCTRL island and must be connected with the output of the internal regulator (VREG_OUT). SYSCTRL island includes the RFEN, RFXEN and RESET signals, plus the RTC circuitry (so it's responsible of the system powering during power save modes involving the RTC). The diagram reported in the figure below shows the power connections for this configuration.

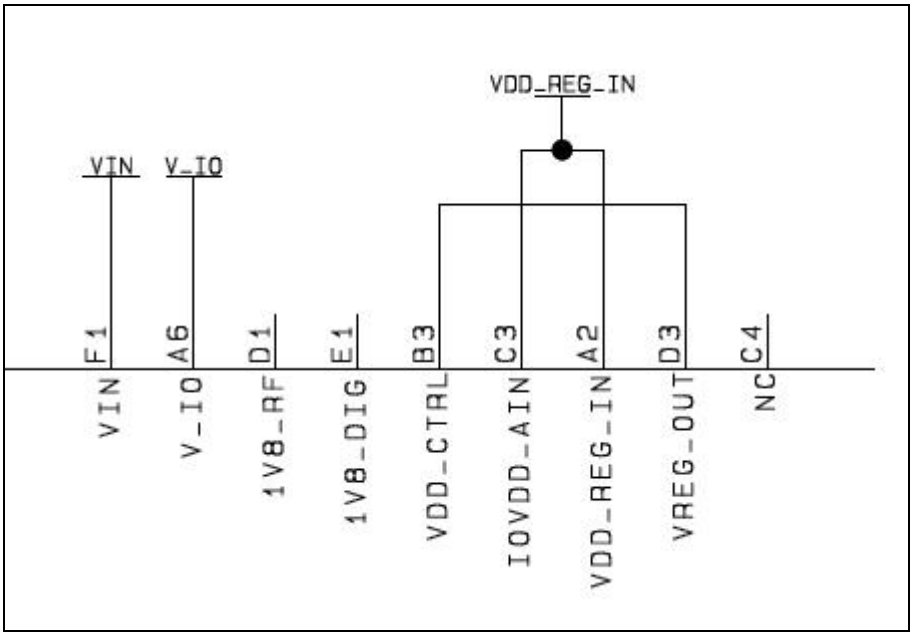


Figure 1 Power supply connections for configuration 1

The voltage ranges for this configuration are:

Voltage	Min	Max
VIN	2.5V	4.2V
V_IO	2.7V	3.3V
VDD_REG_IN	2V	3.6V

The condition VDD_REG_IN ≥ V_IO must be satisfied for every module power mode (included power save modes).

Note: Please note that the diagram above reports only the required connections. For detailed circuit with all the required components (including bypass and decoupling capacitors) please refer to the suggested designs.

5.1.2. Configuration 2

This configuration is similar to the previous one with the difference that the V_IO is now set to 1.8V and the I/O logic levels have changed consequently. This change in the V_IO levels requires also a change in the IOVDD_AIN supply. Indeed this supply control the logic level of the WAKE1 pin and so, in order to have all the I/O pin at the same logic is necessary to change also the IOVDD_AIN configuration, although always respecting the condition of IOVDD_AIN being the higher voltage in the system. In this configuration, the internal regulator with input VDD_REG_IN is not exploited in order to have IOVDD_AIN connected to the 1V8_DIG voltage and 1.8V logic levels on the WAKE1 pin. The diagram below indicates the connections required for this configuration.

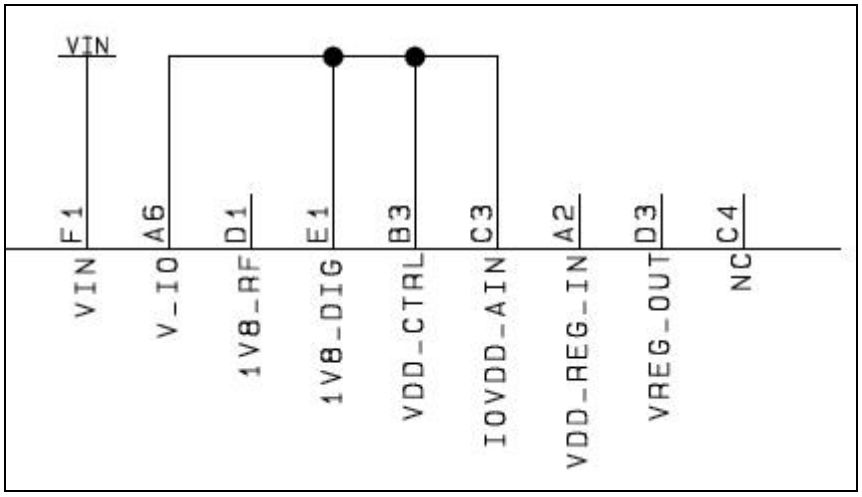


Figure 2 Power supply connections for configuration 2

The VIN voltage range is the same reported for the previous configuration. Please consider that in place of exploiting the internally generated 1V8_DIG an external 1.8V supply is allowed to be used as well (in this case please verify to have a not noisy and clear 1.8V supply). The voltage range for this external 1.8V supply is 1.62V ÷ 1.98V.

Note: Please note that the diagram above reports only the required connections. For detailed circuit with all the required components (including bypass and decoupling capacitors) please refer to the suggested designs.

5.1.3. Configuration 3

In this configuration, the internal regulators are bypassed and the module power consumption is reduced. The internal LDO must be disabled via 1V8_DIG_EN and 1V8_RF_EN signals and to separate 1.8V supplies must be connected to the 1V8_DIG and 1V8_RF pins. The two 1.8V supplies must be generated from two separate regulators (or from the separate outputs of a dual regulator) in order to prevent low frequency digital noise coupling in the module. Passive filtering of such a noise is not sufficient and this solution allows gaining 1 or 2 dB in sensitivity with a proper power supply design. If 3V logic level I/O interfaces are required is necessary to connect V_IO, VDD_REG_IN, IOVDD_AIN and VDD_CTRL as in configuration 1, while if 1.8V logic levels are required the connections are similar to configuration 2 with V_IO, IOVDD_AIN and VDD_CTRL connected to 1V8_DIG (externally generated) and VDD_REG_IN and VDD_REG_OUT left floating. The diagrams below illustrate connections for both of the situations.

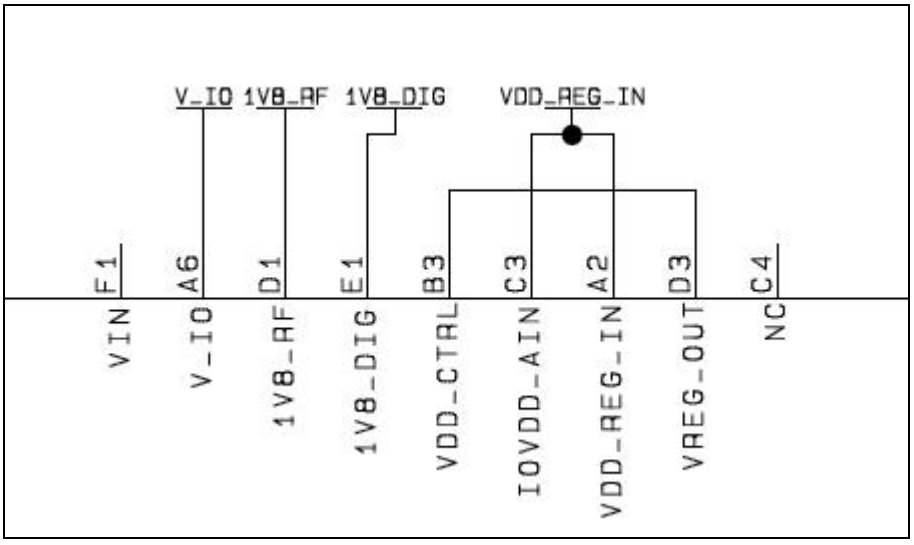


Figure 3 Power supply connections for configuration 3 (I/O at 3V)

The V_IO and VDD_REG_IN ranges are the same as in configuration 1, the 1V8_RF and 1V8_DIG signals have a nominal value of 1.8V with range 1.71V ÷ 1.89V.

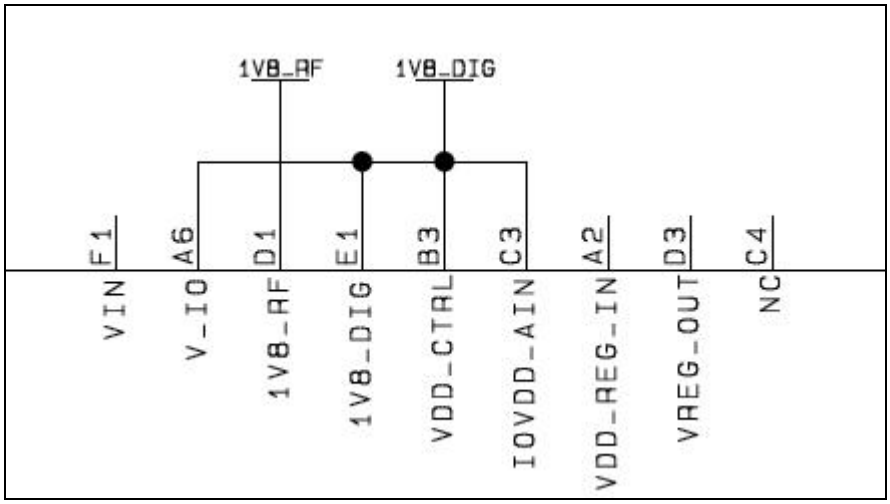


Figure 4 power supply connections for configuration 3 (I/O at 1.8V)

1V8_DIG and 1V8_RF limits are the same reported above.

Note: Please note that the diagrams above report only the required connections. For detailed circuit with all the required components (including bypass and decoupling capacitors) please refer to the suggested designs.

5.2. Power-On Sequence

A few rules must be respected when powering the SE867-AGPS module. When using a configuration with a 3V power supply on the V_IO pin attention must be paid in order to avoid asserting V_IO when the 1V8_DIG is not asserted as well. Indeed applying 3V without the core voltage will cause improper internal biasing of the GPS chipset with a subsequent large current flow and potential device damage. In order to allow correct power-on of the module and according to the chipset vendor recommendations an internal network on the V_IO power has been inserted. However attention must be paid in order to avoid asserting V_IO without 1V8_DIG asserted for long intervals.
Furthermore, the module requires a power-on reset and fault detection. At the power up the active low reset signal must be asserted, after the reset signal is received the module is forced in a power-on state and boots up at the negation of the reset signal. The reset signal must be asserted also when a power fault is detected in the 1V8_DIG signal in order to avoid conditions which can cause corruption of the internal flash memory. The reset signal can be asserted by either an external power-on-reset supervisor or a host processor.

5.3. Logic levels

Digital Signals				
Item	**Condition**	**Min**	**Max**	**Unit**
VIH	VDDIO ± 10%	0.7 x VDDIO		V
VIL	VDDIO ± 10%		0.3 x VDDIO	V
VOH	IOH = -3.5mA @3V ± 10% VDDIO IOH = -2.25mA @1.8V ± 10% VDDIO	0.8 x VDDIO	VDDIO	V
VOL	IOL = 3.5mA @3V ± 10% VDDIO IOL = 2.25mA @1.8V ± 10% VDDIO	GND	0.2 x VDDIO	V
RESET: Schmitt trigger low to high threshold VT+	VDDIO = 1.8V ± 10%	0.85	1.4	V
RESET: Schmitt trigger high to low threshold VT-	VDDIO = 1.8V ± 10%	0.53	1.05	V
RESET: Schmitt trigger hysteresis window	VDDIO = 1.8V ± 10%	0.12	0.64	V
1V8_RF_EN High		1.2		V
1V8_RF_EN Low			0.3	V
1V8_DIG_EN High		1.2		V
1V8_DIG_EN Low			0.3	V

Important: in the previous table VDDIO represents the reference voltage of the different signals. Please refer to the following table for a signal-to-reference voltage mapping.

Signal-to-reference voltage mapping		
Signal	**I/O**	**Reference voltage**
RFEN	O	VDD_CTRL
RFXEN	O	VDD_CTRL
BOOTSEL	I	IOVDD_AIN
WAKE1	I	IOVDD_AIN
RTC_IN	I	VDD_CTRL
RTC_OUT	O	VDD_CTRL
RESET	I	VDD_CTRL
PPS	O	V_IO
TX_UART	O	V_IO
RX_UART	I	V_IO

6. RF path and antenna

When dealing with very low RF signal, as in the case of GPS applications, it is crucial to have a proper PCB layout. In particular it is of paramount importance designing the RF path according to the best practices as far as the EMC/EMI and propagation aspects are concerned. Hence, the below requirements and guidelines have to be read and followed carefully to have a high-performing application design.

6.1. RF design guidelines

The SE867-AGPS module can work with both active and passive antennas.

When working with passive antennas an additional external LNA on the RF path is mandatory. Indeed a >16dB net gain and a <1.5dB noise figure are required to optimize performances of a passive antenna design, so taking into account typical path losses we recommend LNAs featuring gains of 20dB. Even if the path gain requirement asks for a gain of 16dB or more it's important to take into account that the recommended value for a RF design based on passive antenna is roughly 16dB, because in this king of design, due to jamming issues, a gain increase far beyond this limit will create a very low improvement in performances.

When using an active antenna the RF path gain can be increased up to 30dB, but in this case it's mandatory concentrating the whole gain in the active antenna, avoiding the use of any additional external LNA. The noise figure must be <1.5dB also in this case and in order to reduce out-of-band jamming and improve GPS performances we recommend using active antennas with additional frequency selectivity (e.g. with an integrated SAW filter) if possible.

The table below reports the main features of the suggested antennas (please note that some features applies only to active antennas):

ANTENNA REQUIREMENTS	
Central frequency	1575.42 MHz (GPS L1)
Bandwidth	±1.023MHz
Amplification (active antenna only)	25dB typ. (30dB max)
Noise figure (active antenna only)	< 1.5dB
Impedance [Ohm]	50
Supply voltage (active antenna only)	Depends on customer design
Coupling with other signals is not allowed	

The chosen active antenna must be properly biased using a correctly design bias tee. The figure below shows a bias tee example (including ESD protection diode).

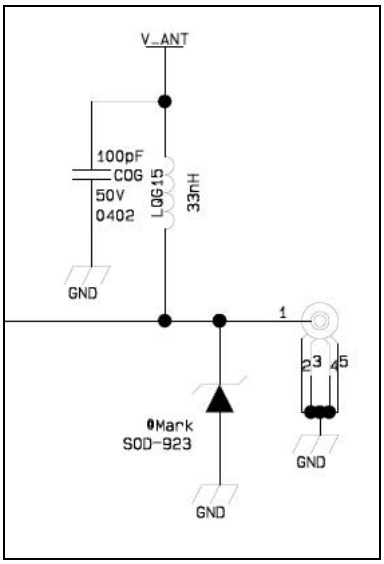


Figure 5. Antenna bias tee

ANTENNA LINE ON PCB REQUIREMENTS	
Impedance [Ohm]	50
Coupling with other signals is not allowed	

6.2. GPS antenna PCB line guidelines

- Ensure that the antenna line impedance is 50 ohm.
- Keep the antenna line on the PCB as short as possible in order to limit losses.
- Antenna line must have uniform characteristics (unchanging cross section and dielectric constant). Meanders and abrupt curves should be avoided.
- Discontinuity in the PCB GND plane should be avoided. Also, the GND plane should NOT be used to route any other signal.
- Surround (on the sides, above and below) the antenna line on PCB with GND, avoid having other signal tracks facing directly the antenna line track.
- The ground around the antenna line on PCB has to be strictly connected to the Ground Plane by placing GND vias every 2mm at least.
- Place EM noisy devices as far away as possible from SE867-AGPS antenna line.
- Keep the antenna line far away from the SE867-AGPS power supply lines.
- If EM noisy devices, such as fast switching ICs, are placed close to the PCB hosting the SE867-AGPS, the antenna line should be realized in stripline technology (signal trace between the up and down reference GND plan plus a coplanar GND guard trace parallel to the signal trace),or shielded with a metal frame cover.
- If EM noisy devices are NOT placed close to the PCB hosting the SE867-AGPS, the antenna line should be realized in microstrip technology (signal trace on the top or bottom layer with only one reference GND plane, plus coplanar GND guard trace parallel to the signal trace), in order to reduce the ohmic losses of the trace.

6.3. Antenna installation guidelines

- Install the antenna in a place covered by the GPS signal.
- Antenna shall not be installed inside metal cases.
- Antenna shall be installed also according Antenna manufacturer instructions.

7. Connection guidelines

7.1. Reset

The active low reset signal must be pulled up to VDD_CTRL and controlled in order to have the possibility to assert a reset at the start-up and in case of power fail. To perform a correct reset control the use of a power-on-reset monitoring the 1V8_DIG power supply is recommended, this will allow a correct reset assertion on both power-up and power fail putting the module in the correct working configuration and protecting it from damages. We also suggest providing a manual reset feature in order to have the possibility to bypass the power-on-reset circuit in case of necessity. The manual reset signal can be controlled either with a button or a GPIO coming from the controller.

7.2. WAKE1

WAKE1 is an input signal responsible for the module wake-up from sleep mode. The wake-up functionality is performed simply driving this signal low, in order to avoid the necessity of a GPIO dedicated to this signal it can be connected to the RX_UART so that the module can be woken simply sending data on the RX_UART line. Attention to logic levels compliance between the signals must be paid while connecting RX_UART with WAKE1, indeed the two signals belong to different power islands and have different reference voltages (V_IO for RX_UART and IOVDD_AIN for WAKE1, please refer to paragraph 5.3 for logic levels details).

7.3. PPS and RTC crystal

The PPS signal outputs a precise reference timing pulse with frequency 1Hz and length 100ms. For pulse voltage level please refers to paragraph 5.3.

The SE867-AGPS module requires an external 32.768 kHz crystal connected to RTC_IN and RTC_OUT balls in order to generate the Real Time Clock. The suggested crystal load capacitance and frequency tolerance are reported in the table below:

Parameter	Value	Unit
Load capacitance	12.5	pF
Frequency Tolerance	±20	ppm

7.4. RFEN and RFXEN

RFEN and RFXEN are output control signal generated from the module which can be used to control power switching. When the module is running in normal mode operation the RFXEN signal is set to logic 0 and RFEN to logic 1, when the module is in sleep RFXEN is logic 1 and RFEN is logic 0. When exploiting the SE867-AGPS internal regulators to generate 1V8_DIG and 1V8_RF (power configurations 1 and 2) RFXEN must be connected to the 1V8_RF_EN ball in order to disable the corresponding regulator during sleep mode. When using external regulators the enable of the 1V8_RF supply must be connected to RFXEN or RFEN, based on the enable logic (active high or active low). In order to reduce undesired leakage on the RFEN pin we recommend using regulators with active low enable logic in order to connect it to RFXEN rather than RFEN.

7.5. BOOTSEL and flash mode

The SE867-AGPS is supplied flashed and fully functional, however it is highly recommended that the application PCB is designed so that the SE867 AGPS can be re-flashed onboard, in case the need for an update of the module FW should arise during the product lifetime.

In order to correctly perform the flashing procedure 4 signals are required to be externally controlled: TX_UART, RX_UART, Reset and BOOTSEL. The latest is the control signal used to put the module in flash mode and proceed with a firmware flashing. The signal has an internal pull-up and can be left floating during normal mode functioning, driving it low puts the module in flash mode.

It's important to avoid supplying V_IO voltage without supplying 1V8_DIG because such a power configuration could cause leakage currents and even damages to the module. At start-up V_IO and 1V8_DIG can be supplied at the same time without any need of a delay network on the V_IO line (such a network has already been implemented inside the module), but V_IO can not be supplied before 1V8_DIG. For the same reasons all the input signals coming to the SE867-AGPS must be driven low when 1V8_DIG is not present.

8. Mounting the SE867-AGPS on the application board

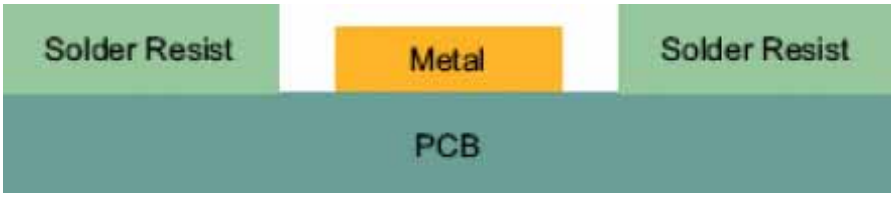
The Telit SE867-AGPS module has been designed in order to be compliant with a standard lead-free SMT process.

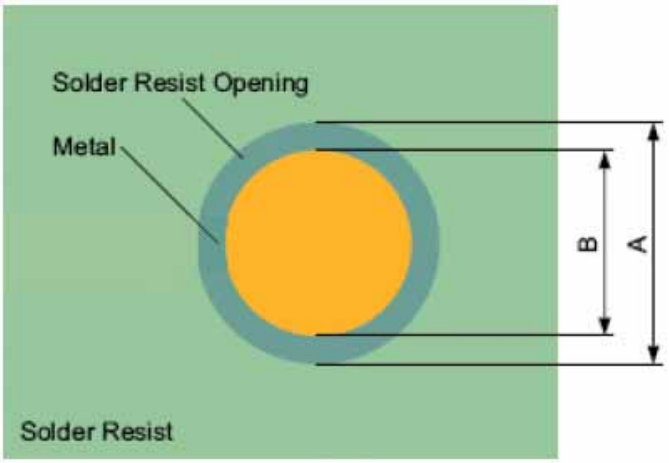
8.1. Stencil

Stencil's apertures layout can be the same of the recommended footprint (1:1), we suggest a thickness of stencil foil ≥ 120μm.

8.2. PCB pad design

"Non solder mask defined" (NSMD) type is recommended for the solder pads on the PCB.

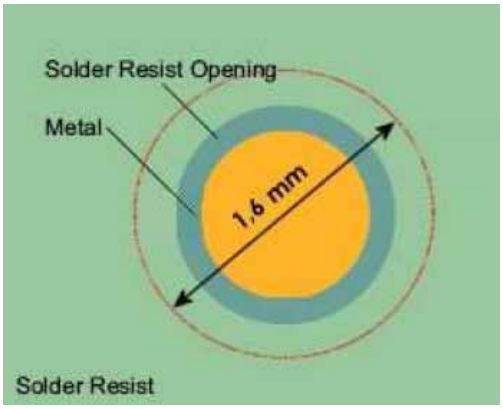




Recommendations for PCB pad dimensions

Dimension	Value [mm]
Ball pitch	2.4
Solder resist opening diameter A	1,150
Metal PAD diameter B	1 +/- 0,05

Placement of microvias not covered by solder resist is not recommended inside the inhibit area (1.6 mm - red circle in the picture) unless the microvia carry the same signal of the pad itself



Holes in pad are allowed only for blind holes and not for through holes.
Recommendations for PCB pad surfaces:

Finish	Layer tickness [um]	Properties
Electro-less Ni / Immersion Au	3-7 / 0,05-0,15	good solder ability protection, high shear force values

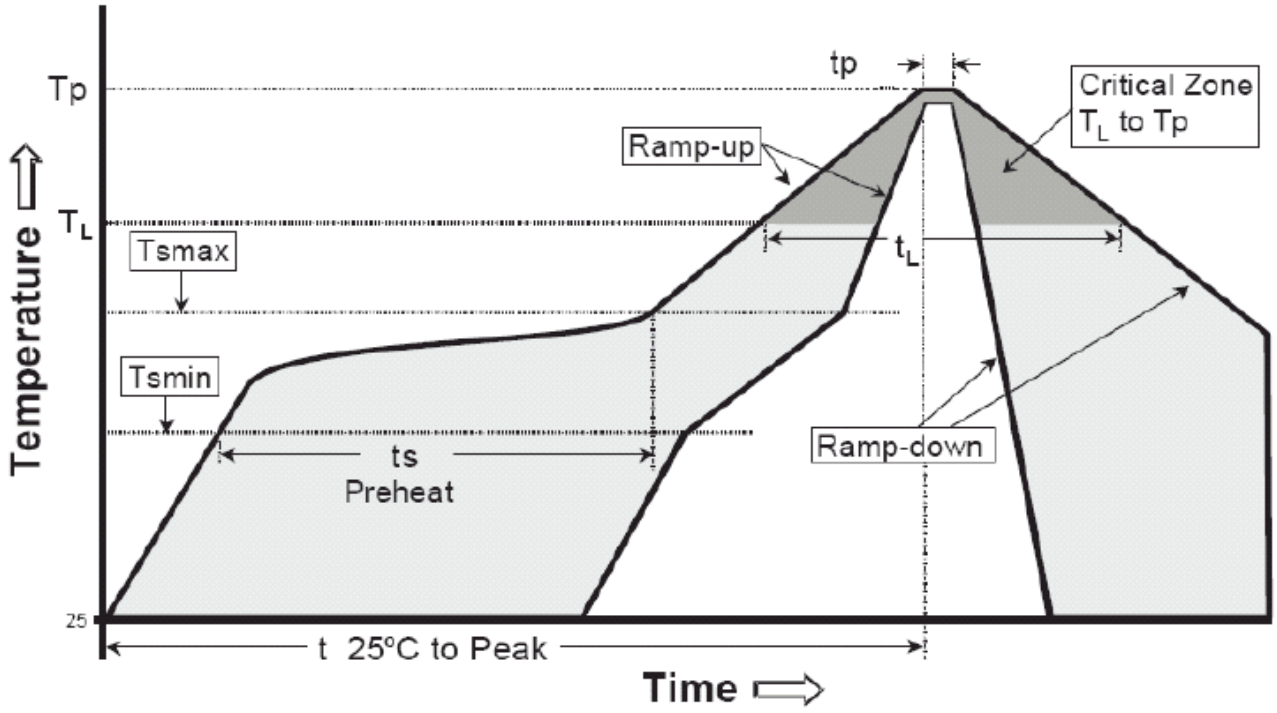
The PCB must be able to resist the higher temperatures, which are occurring at the lead-free process.
This issue should be discussed with the PCB-supplier. Generally, the wet-ability of tin-lead solder paste on the described surface plating is better compared to lead-free solder paste.

8.3. Solder paste

	Lead free
Solder paste	Sn / Ag / Cu

8.4. SE867-AGPS solder reflow

The following is the recommended solder reflow profile



Profile Feature	Pb-Free Assembly
Average ramp-up rate (TL to TP)	3 °C / second max
Preheat: - Temperature Min (Tsmin) - Temperature Max (Tsmax) - Time (min to max) (ts)	 150 °C 200 °C 60-180 seconds
Tsmax to TL: - Ramp-up rate	 3 °C / second max
Time maintaned above: - Temperature (TL) - Time (tL)	 217 °C 60-150 seconds
Peak Temperature (Tp):	245 + 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	8 minutes max

NOTE: All temperatures refer to topside of the package, measured on the package body surface.

IMPORTANT: SE867-AGPS module can accept only one reflow process

9. Moisture sensitivity

The level of moisture sensibility of Telit SE867-AGPS modules is "3", according with standard IPC/JEDEC J-STD-020, take care of all the relative requirements for using this kind of components.

Moreover, the customer has to take care of the following conditions:

- The shelf life of SE867-AGPS inside of the dry bag shall be 12 month from the bag seal date, when stored in a non-condensing atmospheric environment of <40°C / 90% RH
- Environmental condition during the production: ≤ 30°C / 60% RH according to IPC/JEDEC J-STD-033A paragraph 5
- The maximum time between the opening of the sealed bag and the reflow process shall be 168
- Hours if the condition b) "IPC/JEDEC J-STD-033A paragraph 5.2" is respected
- A baking is required if conditions b) or c) are not respected
- A baking is required if the humidity indicator inside the bag indicates 10% RH or more

10. Software Features

This chapter details the standard NMEA supported output messages and describes the format and usage of the SE867-AGPS custom NMEA messages.

10.1. GPS NMEA

SE867-AGPS relays GPS data stream conform to NMEA 0183 format.
Default output format configuration is 9600bps, 8N1.
Other available output configuration speeds are: 9600, 19200, 38400, 57600 and 115200 bps.

Each GPS NMEA message (data set) is formatted as shown below:

*$GPDTS,Inf_1,Inf_2,Inf_3,Inf_4,Inf_5,Inf_6,Inf_n*CS<CR><LF>*

The table below explains each field and character set of an NMEA message:

Field	Description
$	Start of the data set
GP	Information originating from a GPS appliance
DTS	Data set (NMEA Message) identifier (e.g. RMC)
Inf_1 bis Inf_n	Information with number 1…n (e.g. 175,4 for course data)
,	Comma used as a separator for different items of information
*****	Asterisk used as a separator for checksum
CS	Checksum (control word) for checking the entire data set
<CR><LF>	End of the data set: carriage return <CR> and line feed <LF>

10.1.1. Standard NMEA Sentences

SE867-AGPS supports the following standard NMEA messages:

- DTM – Datum Being Used: contains information on datum code, Latitude/Longitude/Altitude offsets and datum name.
- GGA – GPS Fix Data: contains information on time, longitude and latitude, the quality of the system, the number of satellites used and the height.
- GLL – GPS Geographic Position: contains information on latitude and longitude, time and health.
- GSA – GPS DOP and Active Satellites: contains information on the measuring mode (2D or 3D), the number of satellites used to determine the position and the accuracy of the measurements (DOP: Dilution of Precision).
- GSV – Satellites in View: contains information on the number of satellites in view, their identification, their elevation and azimuth, and the signal-to-noise ratio.

- **RMC** – Recommended Minimum Specific GPS Data: contains information on time, latitude, longitude and height, system status, speed, course and date.
- **VTG** – Course over Ground and Ground Speed: contains information on course and speed.
- **ZDA** – GPS Time and Date: contains information on UTC time, date and local time.

Please refer to NMEA 0183 standard (http://www.nmea.org) for a deeper description about information carried by each NMEA data set.

10.1.2. Custom NMEA Sentences

SE867-AGPS custom NMEA messages are structured according to the standard template of NMEA format:

"*$PUNV,<command/response>*cc<carriage return><new line>*"

'PUNV' is the SE867-AGPS custom command prefix coming first a *<command/response>* field as below:

Command/Response	In/Out	Description
ASSIST	In	UTC time assistance input message
STORELGF	In	Force immediate LGF store operation
START	In	Request for immediate restart
SLEEP	In	Request to stop the navigation and enter to sleep mode
WAKEUP	In	Wake up from sleep
STOP	In	Request to stop the navigation
CONFIG	In	Request to configure configuration section
SET	In	Change configuration in RAM only
GETCONFIG	In	Request to read configure information of configuration section
VERSION	In	Request Version, alias to *PUNV,GETCONFIG,09*
FOM	Out	Navigation quality indicator (figure-of-merit)
SDB	Out	Satellites' data Information
AGC	Out	Automatic gain control debug data
CLKOFFSET	Out	Master clock offset data
CFG_R	Out	Reply message for read configure information
CFG_S	Out	Reply message for write configure information
ERR	Out	Error message
OK	Out	Success message

Important: Each custom NMEA command shall be sent with an interval of 1s from the previous one. Time interval less than 1s can bear module to work not in a proper way.

If the NMEA string can be decoded to explicit command for the SE867-AGPS, the same message will be echoed back to sender.

According to the NMEA standard the maximum number of characters between the starting delimiter '$' or '!' and the terminating <CR><LF> should be 79, i.e. the maximum buffer size should be 82 for one sentence.

For the custom NMEA messages the maximum size of the input messages is 128 characters and for the output messages 200 characters.

10.1.2.1. ASSIST

With ASSIST command the user can inject time assistance into the navigation software. The format of ASSIST command is the following:

$PUNV,ASSIST,*hhmmss.ss*,*ddmmyy**cc

hhmmss.ss is the UTC time: *hh* – hours (00...23), *mm* – minutes (00...59), *ss.ss* – seconds (00.00...59.99)

ddmmyy is the UTC date: *dd* – day (01...31), *mm* – month (01...12), *yy* – year (00...99)

$PUNV,ASSIST,*tow*,*wn**cc

tow is time of the week in milliseconds (0...604699999) and *wn* is a week number (starting from January 6, 1980).

10.1.2.2. STORELGF

With STORELGF command the user can force immediate LGF storage.

$PUNV,STORELGF*23

10.1.2.3. START

With START command the user can restart the navigation and erase different kind of data at the same time.

$PUNV,START,*bitmask**cc

bitmask is a hexadecimal number (without '0x' prefix) specifying the data to be erased.

Bitmask	Description
0x001	Erase position from NVRAM, FSH and RAM
0x002	Erase accurate time, leave inaccurate time
0x004	Erase RTC time
0x008	Erase TCXO offset and drift values from NVRAM, FSH and RAM
0x010	Erase UTC parameters from FSH and RAM
0x020	Erase ionospheric correction parameters from FSH and RAM
0x040	Erase all almanacs from FSH and RAM
0x080	Erase NVRAM
0x100	Reset configurations from FSH and RAM (Output, Zone, Debug, Datum, VSDSP, pinning)
0x200	Erase all ephemerides from FSH and RAM
0x400	Erase all prehistory information collected so far in FSH and RAM
0x8000	Erase SV configurations

There is a number of predefined mnemonics to be used with the START command. When alias is used the command has the following form:

$PUNV,START,*alias**cc

alias is a mnemonic specifying the particular bitmask.

Alias	Bitmask	Description
FACTORY	0xFF7F	Start-up with no prior information and reset configuration (FSH and RAM) to compiled–in factory defaults
ALL	0x7E7F	Same as COLD, but also erase TCXO offset and drift values
COLD	0x7E77	Retain TCXO and configurations
LGFCOLD	0x7E76	Same as COLD, but retain a position
WARM	0x0202	Retain TCXO, position, RTC time and configurations
NOTIME	0x0006	Erase time, retain everything else
MEDIUM	0x0002	Erase time, but leave RTC
HOT	0x0000	Do not erase anything
AUTO	0x0000	Do not erase anything

START command in its simplest form is also supported:

$PUNV,START*71

,which just restarts navigation without erasing anything. So effectively it is equal to

$PUNV,START,HOT*0E

and

$PUNV,START,AUTO*52

and

$PUNV,START,0*6D

commands.

10.1.2.4. SLEEP

With the SLEEP command the user can put the system into the sleep mode. The system stays in the sleep mode until it is forced to wake up by activity on UART0 or after a specified timeout.
The NMEA command for the sleep mode without timeout is:

$PUNV,SLEEP,*bitmask**cc

bitmask is a hexadecimal number (without '0x' prefix) specifying the data to be erased and has the same set of possible values as for START command described in 10.1.2.3.

SLEEP command in its simplest form is also supported:

$PUNV,SLEEP*7E

,which effectively equals to

$PUNV,SLEEP,0*62

The NMEA command for sleep mode for a predefined time has the following form:

$PUNV,SLEEP,*hh*,*mm*,*ss**cc

hh is hours (00...24)

mm is minutes (00...59)

ss is seconds (00...59).

The total sleeping time specified should be less than 90000 seconds.

Please note that the specified sleep time determines exactly the period of time, when power consumption of single-chip GPS receiver stays low. If measuring sleep time by watching NMEA stream, it might be several seconds longer due to processing overhead

in SE867-AGPS firmware, which is related to messages processing, the UART queue flushing delays etc.

10.1.2.5. WAKEUP

To wake up from sleep, the user should send any kind of NMEA message to UART0 port. The content of this message is disregarded by the system. After the wakeup from sleep, the system is always started in auto mode just like if $PUNV, START, AUTO*52 command would be sent.
For distinctness sake the following command can be used:

$PUNV,WAKEUP*2C

10.1.2.6. STOP

With STOP command the user can stop the navigation and erase different kind of data at the same time.

$PUNV,STOP,*bitmask**cc

bitmask is a hexadecimal number (without '0x' prefix) specifying the data to be erased. It has the same set of possible values as for START command described in 10.1.2.3. The exception is "Reset Configurations from FSH and RAM", which should not be used with STOP command.

There is a number of predefined mnemonics to be used with the STOP command. When alias is used the command has the following form:

$PUNV,STOP,*alias**cc

alias is a mnemonic specifying the particular bitmask. It has the same set of possible values as for START command described in 10.1.2.3. The only exceptions are FACTORY, HOT and AUTO aliases, which are not supported for STOP command.

STOP command in its simplest form is also supported:

$PUNV,STOP*29

,which just stops navigation without erasing anything. So effectively it is equal to

$PUNV,STOP,0*35

Please note that the confirmation for STOP command will be echoed only after the system has stopped. Until that time SE867-AGPS will produce navigation data.

10.1.2.7. CONFIG

With CONFIG command the user can change the configuration of the system. The configuration takes effect immediately and it is also stored in non-volatile media.
The format of CONFIG command is the following:

$PUNV,CONFIG,*section ID*,*Various number of comma separated fields**cc

section ID is a decimal number specifying the section ID. It is two fixed decimal digits and the leading zeros are mandatory.

The reply to this command is CFG_S sentence described in 10.1.2.16.

10.1.2.8. SET

With SET command the user can change the configuration of the system. The configuration takes effect immediately, but the new configuration is not stored in nonvolatile media.
The format of SET command is the following:

$PUNV,SET,*section ID*,*Various number of comma separated fields**cc

section ID is a decimal number specifying the section ID. It is two fixed decimal digits and leading zeros are mandatory.

10.1.2.9. GETCONFIG

By GETCONFIG command the user can read the configuration of the system. The format of this message is as follows:

$PUNV,GETCONFIG,*section ID**cc

section ID is a decimal number specifying the section ID. It is two fixed decimal digits and the leading zeros are mandatory.

Reply to this command is CFG_R sentence described in 10.1.2.15.

10.1.2.10. VERSION

By VERSION command the user can read version number string. The format of this message is as follows:

$PUNV,VERSION*6B

The reply to this command is CFG_R sentence described in 10.1.2.15.

This command is an alias to the command

$PUNV,GETCONFIG,09*48

10.1.2.11. FOM

This message is navigation (PVT) quality indicator, i.e. figure-of-merit. It has the following format:

$PUNV,FOM,*fomcc**

fom an integer number (0...9). Value 0 indicates invalid Fix. Value 1 indicates the poorest Fix quality and value 9 indicates the highest quality.

Please see section 10.1.3.1 describing the way how this message can be enabled.

10.1.2.12. SDB

This message provides satellites' data

$PUNV,SDB,GPS,*EPHMASK*,*ALMMASK*,*RSIVMASK*,*SIVMASK*,*IONOFLAGcc**

EPHMASK is a bitmask showing for which SVs SE867-AGPS has valid ephemeris data. It has a hexadecimal format with the bit index 0 associated with PRN 1, bit index 1 associated with PRN 2 etc.

ALMMASK is a bitmask showing for which SVs SE867-AGPS has valid almanac data. It has a hexadecimal format with the bit index 0 associated with PRN 1, bit index 1 associated with PRN 2 etc.

RSIVMASK is a bitmask of SVs for which SE867-AGPS has signal strength information (ones for which it shows signal strength in GSV NMEA sentence). It has a hexadecimal format with the bit index 0 associated with PRN 1, bit index 1 associated with PRN 2 etc.

SIVMASK is a bitmask of SVs that SE867-AGPS lists in GSV message. It has a hexadecimal format with the bit index 0 associated with PRN 1, bit index 1 associated with PRN 2 etc.

IONOFLAG is a Boolean indicator ('T' or 'F') showing if SE867-AGPS has broadcast ionospheric model.

Example:

$PUNV,SDB,GPS,80142480,80142480,80142480,80142480,T*cc

Please see section 10.1.3.1 describing the way how this message can be enabled.

10.1.2.13. AGC

This message provides an automatic gain control debug data.

$PUNV,AGC,*I-gain*,*Q-gain*,*I-mag*,*Q-mag*,*i[1]*,*i[-1]*,*i[3]*,*i[-3]*,*q[1]*,*q[-1]*,*q[3]*,*q[-3]*,*Gain*,*Rail*,*Meas*,*Cnt*,*Start*,*Stop**cc

I-gain is an RF I-setting value used for driving the RF gain [decibels].

Q-gain is an RF Q-setting value used for driving the RF gain [decibels].

I-mag is the current IF power level for I-channel (in %).

Q-mag is the current IF power level for I-channel (in %).

I[1] is a [1] bin loading of a sample distribution of the IF/BB signal for I-channel (in %).

I[-1] is a [-1] bin loading of a sample distribution of the IF/BB signal for I-channel (in %).

I[3] is a [3] bin loading of a sample distribution of the IF/BB signal for I-channel (in %).

I[-3] is a [-3] bin loading of a sample distribution of the IF/BB signal for I-channel (in %).

Q[1] is a [1] bin loading of a sample distribution of the IF/BB signal for Q-channel (in %).

Q[-1] is a [-1] bin loading of a sample distribution of the IF/BB signal for Q-channel (in %).

Q[3] is a [3] bin loading of a sample distribution of the IF/BB signal for Q-channel (in %).

Q[-3] is a [-3] bin loading of a sample distribution of the IF/BB signal for Q-channel (in %).

Gain is an amount of gain signals.

Rail is an amount of rail signals.

Meas is an amount of meas signals.

Cnt is a value of a counter that is increased at every gain change on I, Q or both channels.

Start is a return value of AGC_start API in GE867-AGPS firmware
(0 – success, 1 - failure).

Stop is a return value of AGC_stop API in GE867-AGPS firmware
(0 – success, -1 - failure).

Example:

$PUNV,AGC,35,35,51.7,51.7,30.8,33.5,17.3,18.4,30.8,33.5,17.3,18.4,4,0,0,5,0,0*75

Please see section 10.1.3.1 describing the way how this message can be enabled.

10.1.2.14. CLKOFFSET

This message provides the master clock offset data

$PUNV,CLKOFFSET,*nn.nnnnn*,*fff.fff**cc

nn.nnnnn is a floating point number representing a nominal clock frequency (TCXO frequency) in MHz.

fff.fff is a floating point number representing a current clock offset in Hz, in relation to the nominal clock frequency.

The current measured absolute clock frequency is then (*nn.nnnnn* + *fff.fff*/1e6) in MHz.

Example with about 0.5ppm offset over 16.3676MHz nominal clock frequency:

$PUNV,CLKOFFSET,16.36760,8.126*cc

The offset can also be negative, for example:

$PUNV,CLKOFFSET,16.36760,-8.126*cc

In case of 19.2MHz nominal clock frequency, for example:

$PUNV,CLKOFFSET,19.20000,21.427*cc

Please see section 10.1.3.1 describing the way how this message can be enabled.

10.1.2.15. CFG_R

CFG_R sentence is a reply message for request of reading configuration. This NMEA message contains all configuration information about the selected section.

$PUNV,CFG_R,*section ID*,*Comma separated list of parameters in selected section**cc

section ID is a decimal number specifying the section ID. It is two fixed decimal digits with leading zeros if necessary.

10.1.2.16. CFG_S

CFG_S sentence is a reply message for request of changing configuration by *$PUNV,CONFIG* command. The format of the message is as follows.

$PUNV,CFG_S,*section ID**cc

section ID is a decimal number specifying the modified section ID. It is two fixed decimal digits with leading zeros if necessary.

This reply message is sent when configuration data is already successfully stored into non-volatile memory (flash).

10.1.2.17. ERR

ERR is a reply message of an error in the system. The format of the message is as follows:

$PUNV,ERR,*ID*,*error*,*data**cc

ID is the ID of subsystem, which detected the error. Two decimal digits with leading zero if necessary.

error is the subsystem specific error number. Five decimal digits with leading zero if necessary.

data is the error specific optional data. Five decimal digits with leading zero if necessary.

This document describes only those error codes that occur with NMEA commands.

ID	Subsystem	Error	Data	Description
4	AGPS	message ID	sub-code*	AGPS message processing error. Message ID in the error code field specifies which message processing is failed.
5	NMEA	1	0	Illegal command form
5	NMEA	2	0	Illegal command prefix
5	NMEA	3	0	Illegal command
5	NMEA	4	0	Illegal section ID
5	NMEA	5	0	Illegal parameter
5	NMEA	6	0	Illegal CRC
5	NMEA	7	0	Illegal message
7	SAPP	1	sub-code*	Reading file data: file open operation is failed
7	SAPP	2	sub-code*	Reading file data: file seek operation is failed
7	SAPP	3	sub-code*	Reading file data: file read operation is failed
7	SAPP	4	sub-code*	Reading file data: file close operation is failed
7	SAPP	5	sub-code*	Reading file data: get file size operation is failed
7	SAPP	6	sub-code*	Writing data to file: file open operation is failed
7	SAPP	7	sub-code*	Filling data into file: file seek operation is failed
7	SAPP	8	sub-code*	Filling data into file: file write operation is failed
7	SAPP	9	sub-code*	Writing data to file: file seek operation is failed
7	SAPP	10	sub-code*	Writing data to file: file write operation is failed
7	SAPP	11	sub-code*	Writing data to file: file close operation is failed
7	SAPP	12	sub-code*	Memory allocation failed
7	SAPP	13	sub-code*	Incoming request is rejected
7	SAPP	14	sub-code*	Error detected in the incoming request. Possible reason is the store request for incorrect data.
7	SAPP	15	sub-code*	Erase file operation failed
7	SAPP	16	sub-code*	Illegal configuration data is detected in the flash.

* sub-code is used for detailed description of error. It is implementation specific code.

Examples of error messages:

Illegal CRC:

*$PUNV,ERR,05,00006,00000*5B*

Illegal command:

*$PUNV,ERR,05,00003,00000*5E*

10.1.2.18. OK

OK is an acknowledgement message, which is sent as reply of successful execution of command, which is sent via different protocol than NMEA. The format of the message is as follows:

$PUNV,OK,*ID*,*data**cc

ID is the ID of responding subsystem. The two decimal digits with leading zero if necessary.

data is a protocol specific data. For example, it can be the ID of the successfully executed command: five decimal digits with leading zeros if necessary.

10.1.3. Configuration Sections

10.1.3.1. Output Configuration

The Output configuration is used to configure the input/output protocol.

The current output configuration can be read in the system with the following command:

$PUNV,GETCONFIG,00*41

The answer is as follows:

$PUNV,CFG_R,00,*CM-OutCM-In*,0,1000,*UART*,*NMEA_MASK**cc

The configuration command template for output configuration is as follows:

$PUNV,CONFIG,00,*CM-OutCM-In*,0,1000,*UART*,*NMEA_MASK* *cc

or

$PUNV,SET,00,*CM-OutCM-In*,0,1000,*UART*,*NMEA_MASK**cc

Name	Format	Valid values	Default value	Description
CM-In	Two hex digits	00 – NMEA 01 – UBP 04 – AGPS 3GPP 05 – AGPS 3GPP2 09 – AGPS custom 10 – User specific	00 - NMEA	Input communication protocol
CM-Out	Two hex digits	00 – NMEA 01 – UBP 04 – AGPS 3GPP 05 – AGPS 3GPP2 09 – AGPS custom 10 – User specific	00- NMEA	Output communication protocol
UART	Decimal	300,1200,2400,4800, 9600,14400,19200, 28800,57600,115200	9600	UART communication speed (bps)
NMEA_MASK	Three hex digits	0001 – GGA 0002 – GLL 0004 – GSA 0008 – GSV 0010 – RMC 0020 – VTG 0040 – ZDA 0080 – DTM 0100 – FOM 0400 – CLKOFFSET 0800 – SDB 1000 – AGC	1D	NMEA mask. It is a hexadecimal number that enables selected output NMEA messages. Different combinations of the outputting messages can be selected by calculating the final hexadecimal number after adding all wanted hexadecimal masks together. FOM message is described in section 10.1.2.11, CLKOFFSET message is described in section 10.1.2.14, SDB message is described in section 10.1.2.12, AGC message is described in section 10.1.2.13.

Important: If the user changes the input communication protocol to other than NMEA, then to return to NMEA as an input protocol the new protocol specific command should be used.

Please note that there is no comma or space between CM-Out and CM-In fields.

The SE867-AGPS firmware will check the maximum length of the NMEA messages when changing output section. For example, if the speed is set to 4800 bps, the output

protocol is NMEA and the selected NMEA messages will take bandwidth, which is more than 450 characters per second, the SE867-AGPS firmware will produce an error message and reject the changes.

In case of successful execution of

*$PUNV,CONFIG,00,CM-OutCM-In,0,*1000*,UART,NMEA_MASK *cc*

command, the receiver sends confirmation in a following form:

$PUNV,CFG_S,00,00*7F

In case of failure of execution of GETCONFIG, CONFIG or SET command the receiver sends the ERR reply message. Please see the ERR section for details (10.1.2.17).

Examples:

To produce all other messages but DTM and FOM at the speed of 115200 bps:

*$PUNV,CONFIG,00,0000,0,1000,115200,1C7F*cc*

To disable the default NMEA messages:

*$PUNV,CONFIG,00,0000,0,1000,9600,0*cc*

10.1.3.2. Time Zone Configuration

The Time Zone configuration is used to configure the user's localization data.

The current configuration can be read in the system by the following command:

$PUNV,GETCONFIG,03*42

The answer is as follows:

$PUNV,CFG_R,03,*HZ*,*MZ**cc

The configuration command template for the Time Zone configuration is

$PUNV,CONFIG,03,*HZ*,*MZ**cc

or

$PUNV,SET,03,*HZ*,*MZ**cc

Name	Format	Valid values	Default value	Description
HZ	Decimal	-11, -10, -9,...,12 999 (not set)	999	Hour zone. It is an amount of full hour difference from the GMT.
MZ	Decimal	0, 15, 30, 45 999 (not set)	999	Minute zone. It is an amount of extra minutes over the full hours.

In case of successful execution of

$PUNV,CONFIG,03,*HZ*,*MZcc**

command, the receiver sends confirmation in a following form:

$PUNV,CFG_S,03*50

In case of failure of execution of GETCONFIG, CONFIG or SET command the receiver sends the ERR reply message. Please see the ERR section for details (10.1.2.17).

Examples:

To set the -8 hour time zone:

$PUNV,CONFIG,03,-8,0*31

10.1.3.3. Version Number

The Version configuration is used to deliver the GE867-AGPS firmware version numbers. If output protocol is NMEA, then version numbers message is also reported after power-on, any commanded start command described in 10.1.2.3 section and after exiting sleep mode. In this case version numbers message is used for notification that SE867-AGPS initialization sequence is complete and it is ready to accept commands.

The version numbers can be read by using the following command:

$PUNV,GETCONFIG,09*48

The answer is as follows:

$PUNV,CFG_R,09,*Orion*,*UBP*,*BB*,*Flash*,*DeviceID*,*RF-mode*,*RF-CS*,*TCXO-PPB*,*TCXO-Freqcc**

Orion is the Orion version string

UBP is the UBP version number

BB is the baseband type

Flash is the flash type

DeviceID is the device identifier (hexadecimal number)

RF-mode is RF chip mode

RF-CS is RF IC chip select

TCXO-PPB is the TCXO uncertainty

TCXO-Freq is the TCXO frequency

In case of failure of execution of this command the receiver sends the ERR reply message. Please see the ERR section for details (10.1.2.17).

10.1.3.4. Navigation Mode Configuration

The Navigation mode configuration is used to configure SE867-AGPS for different use-cases.
Currently SE867-AGPS supports two navigation modes: PEDESTRIAN and VEHICLE. Please note that the configuration parameters described in the sections 10.1.3.5 and 10.1.3.9 are mode specific and changing them affects the current navigation mode only.

The current navigation mode configuration can be read in the system with the following command:

$PUNV,GETCONFIG,11*41

The answer is as follows:

$PUNV,CFG_R,11,*NavMode*,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*Xcc**

Name	Format	Valid values	Default value	Description
NavMode	Decimal Number	0,1	1	SE867-AGPS Navigation Mode: 0 – PEDESTRIAN mode 1 – VEHICLE mode
X	N/A	N/A	N/A	N/A

The navigation mode can be switched by the following command

$PUNV,CONFIG,NAVMODE,*Modecc**

or

$PUNV,SET,NAVMODE,*Modecc**

Name	Format	Valid values	Default value	Description
Mode	String	PED, VEHICLE	VEHICLE	SE867-AGPS navigation mode: PED – PEDESTRIAN VEHICLE – VEHICLE

In case of the successful execution of

$PUNV,CONFIG,NAVMODE,*Modecc**

command, the receiver sends the confirmation in the following form:

$PUNV,CFG_S,11*53

In case of failure of the execution of GETCONFIG, CONFIG or SET command the receiver sends the ERR reply message. Please see the ERR section for details (10.1.2.17).

10.1.3.5. SBAS Configuration

SBAS configuration is used to configure the SBAS functionality.
Please note that SBAS configuration through NMEA command affects the current navigation mode only. Please see section 10.1.3.4 for the navigation models details.

The current SBAS configuration can be read in the system with the following command:

$PUNV,GETCONFIG,11*41

The answer is as follows:

$PUNV,CFG_R,11,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*X*,*Sbas*,*X*,*X*,*Xcc**

Name	Format	Valid values	Default value	Description
X	N/A	N/A	N/A	N/A
Sbas	Decimal Number	0,1	1	SBAS master control: 0 - SBAS is switched off, 1 - SBAS is switched on.
X	N/A	N/A	N/A	N/A

The SBAS functionality can be switched on or off by following command:

$PUNV,CONFIG,SBAS,*Statuscc**

or

$PUNV,SET,SBAS,*Statuscc**

Name	Format	Valid values	Default value	Description
Status	String	ON, OFF	ON	SBAS status: ON – SBAS is switched on, OFF- SBAS is switched off.

In case of successful execution of

$PUNV,CONFIG,SBAS,*Statuscc**

command, the receiver sends confirmation in a following form:

$PUNV,CFG_S,11*53

In case of failure of execution of GETCONFIG, CONFIG or SET command the receiver sends the ERR reply message. Please see the ERR section for details (10.1.2.17).

10.1.3.6. 2D Configuration

The 2D configuration is used to configure SE867-AGPS 2D fix control.
The current 2D fix control configuration can be read in the system with the following command:

$PUNV,GETCONFIG,11*48

The answer is as follows:

$PUNV,CFG_R,11,*x,2DControlReacquisition_2DControlAll_2DControlCold,AltAidingVal,StartFallbackTimeout2D,ReacqFallbackTimeout2D,x,x,x,x,x,x,x*cc

The SE867-AGPS 2D control can be changed by the following command

$PUNV,CONFIG,2D,*2DControlReacquisition_2DControlAll_2DControlCold,AltAidingVal,StartFallbackTimeout2D,ReacqFallbackTimeout2Dcc**

or

$PUNV,SET,2D,*2DControlReacquisition_2DControlAll_2DControlCold,AltAidingVal, StartFallbackTimeout2D,ReacqFallbackTimeout2D*cc

Name	Format	Valid values	Default value	Description
X	N/A	N/A	N/A	N/A
2DControlReacquisition	Hex	0,1	0	Indicates if 2D start-up mode is enabled in reacquisition: 0 – disabled 1 – enabled Please see usage example below.
2DControlAll	Hex	0,1	0	Indicates if 2D start-up mode is enabled in all start modes except COLD start: 0 – disabled, 1 – enabled Please see usage examples below.
2DControlCold	Hex	0,1	0	Indicates if 2D start-up mode is enabled in COLD start: 0 – disabled, 1 – enabled Please see usage examples below.
AltAidingVal	Decimal Number	• 20000	100	Altitude aiding value in respect to geoid (in meters)
StartFallbackTimeout2D	Decimal Number	≥ 0	0	SE867-AGPS tries to produce a 3D fix at start-up. If producing a 3D fix is not feasible within this timeout then fallback to 2D fix is tried if allowed by *2DControl...*
ReacqFallbackTimeout2D	Decimal Number	≥ 0	0	SE867-AGPS tries to produce a 3D fix at reacquisition. If producing a 3D fix is not feasible within this timeout then fallback to 2D fix is tried if allowed by *2DControl...*
X	N/A	N/A	N/A	N/A

In case of successful execution of

$PUNV,CONFIG,2D,*2DControlReacquisition_2DControlAll_2DControlCold,AltAiding Val,StartFallbackTimeout2D,ReacqFallbackTimeout2D*cc

command, the receiver sends the confirmation in the following form:

$PUNV,CFG_S,11*5A

In case of a failure of execution of GETCONFIG, CONFIG or SET command the receiver sends the ERR reply message. Please see the ERR section for details (10.1.2.17).

Examples:

The default settings:

$PUNV,CONFIG,2D,7,100,0,0*cc

The default settings plus the enabling of the 2D start-up mode for all start modes only, except COLD start:

$PUNV,CONFIG,2D,2,100,0,0*cc

The default settings plus the enabling of the 2D start-up mode for the cold start mode only:

$PUNV,CONFIG,2D,1,100,0,0*cc

10.1.3.7. Antenna Configuration

The Antenna configuration is used to configure the antenna delay in nanoseconds. It is used for the calibration of PPS accuracy.

The current antenna configuration can be read in the system with the following command:

$PUNV,GETCONFIG,11*48

The answer is as follows:

$PUNV,CFG_R,11,*x,x,x,x,x,x,x,AntennaDelay,x,x,x,x*cc

Name	Format	Valid values	Default value	Description
X	N/A	N/A	N/A	N/A
AntennaDelay	Decimal Number	-500...500	0	Antenna cable delay configuration (in nanoseconds)
X	N/A	N/A	N/A	N/A

The antenna delay can be changed by the following command

$PUNV,CONFIG,ANT,*Delaycc**

or

$PUNV,SET,ANT,*Delaycc**

Name	Format	Valid values	Default value	Description
Delay	Decimal Number	-500...500	0	Antenna cable delay configuration (in nanoseconds). Typical cable types such as RF58, RG174 and RG214 cause a delay of 5ns per meter, i.e. the signal propagates in them 20cm in one nanosecond.

In case of successful execution of

$PUNV,CONFIG,ANT,*Delaycc**

command, the receiver sends the confirmation in the following form:

$PUNV,CFG_S,11*5A

In case of a failure of execution of GETCONFIG, CONFIG or SET command the receiver sends the ERR reply message. Please see the ERR section for details (10.1.2.17).

10.1.3.8. Datum Configuration

The Datum configuration is used to select the output datum.

The current configuration can be read in the system by the following command:

$PUNV,GETCONFIG,13*43

The answer is as follows:

$PUNV,CFG_R,13,*Dx*,*Dy*,*Dz*,*Da*,*Df*,*Name*,*Id**cc

The configuration command template for custom datum is as follows:

$PUNV,CONFIG,13,*Dx*,*Dy*,*Dz*,*Da*,*Df*,*Name**cc

or

$PUNV,SET,13,*Dx*,*Dy*,*Dz*,*Da*,*Df*,*Name**cc

To select one of the predefined data, the syntax is as follows:

$PUNV,CONFIG,16,*Id**cc

or

$PUNV,SET,16,*Id**cc

Name	Format	Valid values	Default value	Description
Dx	Decimal	-2^{15}-1...2^{15}-1	0	Datum centre X shift in respect to WGS84 ellipsoid (in meters).
Dy	Decimal	-2^{15}-1...2^{15}-1	0	Datum centre Y shift in respect to WGS84 ellipsoid (in meters).
Dz	Decimal	-2^{15}-1...2^{15}-1	0	Datum centre Z shift in respect to WGS84 ellipsoid (in meters).
Da	Decimal with fractional part	> 0	6378137	Datum semi-major axis (in meters).
Df	Fractional decimal	0...1	0.003352810664	Flattening of datum
Name	String up to 8 characters long	Please see Appendix B – datum codes for possible datum names	WGS864	The name of the selected datum
Id	Decimal	Please see Appendix B – datum codes for possible Id numbers	1	Identifier of a predefined datum

In case of successful execution of

$PUNV,CONFIG,13,*Dx*,*Dy*,*Dz*,*Da*,*Df*,*Namecc**

and

$PUNV,CONFIG,16,*Idcc**

commands, the receiver sends confirmation in a following form:

$PUNV,CFG_S,13*51

In case of failure of execution of GETCONFIG, CONFIG or SET command the receiver sends the ERR reply message. Please see the ERR section for details (10.1.2.17).

Examples:

Default settings:

*$PUNV,CONFIG,16,1*0D*

10.1.3.9. Position Pinning Configuration

The Position pinning configuration is for static case parameter configuration.
Please note that the position pinning configuration through NMEA command affects the current navigation mode only. Please see section 10.1.3.4 for the navigation modes details.

The current configuration can be read in the system by the following command:

$PUNV,GETCONFIG,17*47

The answer is as follows:

$PUNV,CFG_R,17,*Position threshold*,*Velocity threshold*,*Position update timeout*,*Deep mode delay**cc

The configuration command template for control configuration is as follows:

$PUNV,CONFIG,17,*Position threshold*,*Velocity threshold*,*Position update timeout*,*Deep mode delay**cc

or

$PUNV,SET,17,*Position threshold*,*Velocity threshold*,*Position update timeout*,*Deep mode delay**cc

Name	Format	Valid values	Default value (pedestrian)	Default value (vehicle)	Description
Position Threshold	Decimal with fractional part	≥ 0	0	50	The threshold value for position jump. Position pinning will be disabled if this value is reached (in meters). Zero values for position and velocity thresholds effectively mean that position pinning is disabled.
Velocity Threshold	Decimal with fractional part	≥ 0	0	1	The threshold value for velocity calculation. Position pinning will be disabled if this value is reached (in meters per second). Zero values for position and velocity thresholds effectively mean that position pinning is disabled.
Position update timeout	Decimal	> 0	1	120	In position pinning mode, pinned position is updated based on this timeout (in seconds).
Deep mode delay	Decimal	≥ 0	0	600	When in position pinning mode, deep pinning mode is activated after this delay (in seconds). If 0, then deep pinning mode is disabled.

In case of successful execution of

$PUNV,CONFIG,17,*Position threshold*,*Velocity threshold*,*Position update timeout*,*Deep mode delay**cc

command, the receiver sends confirmation in the following form:

$PUNV,CFG_S,17*55

In case of failure of execution of GETCONFIG, CONFIG or SET command the receiver sends the ERR reply message. Please see the ERR section for details (10.1.2.17).

10.2. Assisted GPS – AGPS

SE867-AGPS supports Assisted GPS (AGPS) technology to speed up navigation in challenging environments: indoors, urban canyons and other locations where broadcast satellite signals are obscured. AGPS can also accelerate the navigation process in conditions where broadcast ephemeris is available, by quickly securing location information from non-broadcast sources, thus reducing power consumed in satellite search mode.
See 80000nt10036a_SE867-AGPS_Assisted_GPS_Application_Note for details.

10.3. Analysis Tool

Telit suggests using Orion Analyzer; a Windows® application used to connect the GPS receiver via RS-232 to a PC, for visualizing and analyzing the NMEA received data.
Orion Analyzer can be downloaded from Telit's Download Zone (see 1.2).
This software tool will allow users to view:

- Navigation Data (2D/3D Fix, Latitude, Longitude, Altitude, Speed, Heading, TTFF, Date, Time, HDOP, VDOP, PDOP)
- Position Plot
- Sky Plot
- History
- Signal Strength
- NMEA Output Stream

NOTE: In this tool the baud rate of the Virtual COM Port connection must be set to 9600bps.

11. SE867-AGPS evaluation kit

11.1. Short description

In order to give the customer the possibility to evaluate the performances of Telit SE867-AGPS module in all the available configurations, an evaluation kit has been developed.

The evaluation kit consists in a single board with:

- SE867-AGPS module
- Mini USB connector for power supply and data communication with a PC
- FTDI chip for USB to UART conversion
- SMA RF connector for optional external active antenna or instrument connection
- On board passive antenna + LNA (currently non available, future use only)
- DIP switches for configuration options selection

Thanks to the onboard FTDI chip the USB connection is seen as a Virtual COM Port by the PC after the installation of the FTDI VCP drivers (available for free at http://www.ftdichip.com/Drivers/VCP.htm).

All the customer needs to work with this evaluation board is a PC to connect with the evaluation kit and software to perform NMEA data flow reading and position fixing (e.g. Visual GPS, available for free in Internet).

12. Conformity assessment issues

Assessment of the final product must be made against the essential requirements of the EMC and the LVD Directives.

The SE867-AGPS module is conform to the following European Union Directives:

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

In order to satisfy the essential requirements SE867-AGPS module is compliant with the following standards:

- Electromagnetic compatibility and Radio spectrum Matters (ERM). Standard: EN 300 440-2 (v1.2.1)
- EMC (Electromagnetic Compatibility). Standards: EN 301 489-1 and EN 301 489-3 (1.4.1)
- LVD (Low Voltage Directive) Standards: EN 60 950 (2005)

13. Safety recommendations

READ CAREFULLY

Make sure that the use of this product is allowed in the country and in the environment where used. The use of this product may be dangerous and has to be avoided in the following areas:

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

It is responsibility of the user to enforce the country regulation and the specific environment regulation

Do not disassemble the product; any mark of tampering will compromise the warranty validity.

We recommend following the instructions of the hardware user guides for a correct wiring of the product. The product has to be supplied with a stabilized voltage source and the wiring has to be conforming to the security and fire prevention regulations.

The product has to be handled with care, avoiding any contact with the pins because electrostatic discharges may damage the product itself.

The system integrator is responsible for the functioning of the final product; therefore, care has to be taken to the external components of the module, as well as of any project or installation issue, because of the risk of disturbing external networks or devices or having impact on the security. Should there be any doubt, please refer to the technical documentation and the regulations in force.

Every module has to be equipped with a proper antenna with specific characteristics. The antenna has to be installed with care in order to avoid any interference with other electronic devices.

The European Community provides some Directives for the electronic equipments introduced on the market. All the relevant information's are available on the European Community website:

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

The text of the Directive 99/05 regarding telecommunication equipments is available, while the applicable Directives (Low Voltage and EMC) are available at:

http://ec.europa.eu/enterprise/sectors/electrical/lvd/index_en.htm

14. Appendix A – Abbreviations and Acronyms

Acronym	Description
AEUI	Almanac, Ephemeris, UTC and Ionospheric
AGC	Automatic Gain Controls
AGPS	Assisted GPS
ASCII	American Standard Code for Information Interchange
bps	Bits Per Second
CRC	Cyclic Redundancy Check
ESP	Ephemeris Self Prediction
FOM	Figure Of Merit
FSH	Flash memory
GMT	Greenwich Mean Time
GPS	Global Positioning System
HW	Hardware
ID	Identifier
LGF	Last Good Fix
LSE	Least Square Estimation
N/A	Not Applicable
NMEA	The National Marine Electronics Association
NVRAM	Non Volatile RAM
PVT	Position-Velocity-Time
Ppb	Parts per billion
Ppm	Parts per million
PPS	Pulse Per Second
PRN	Pseudo Random Noise. Identifier for SV.
RAIM	Receiver Autonomous Integrity Monitoring
RAM	Random Access Memory
RF	Radio Frequency
RTC	Real Time Clock
SAPP	Storable Application Profile Subsystem
SBAS	Satellite Based Augmentation System
SDK	Software Development Kit
SV	Space Vehicle. Another name for satellite.
TCXO	Temperature Controlled Crystal Oscillator
TOW	Time Of Week
UART	Universal Asynchronous Receiver / Transmitter
UBP	u-Nav Binary Protocol
UTC	Universal Time Coordinated
VSDSP	VLSI Solution DSP
WGS84	World Geodetic System reference frame for the earth, for use in geodesy and navigation

15. Appendix B – Datum Codes

ID NMBR	NAME	Region of use
0	0	User defined
1	WGS84	Global
2	ADI-M	Ethiopia; Sudan
3	ADI-E	Burkina Faso
4	ADI-F	Cameroon
5	ADI-A	Ethiopia
6	ADI-C	Mali
7	ADI-D	Senegal
8	ADI-B	Sudan
9	AFG	Somalia
10	AIN-A	Bahrain
11	AIN-B	Saudi Arabia
12	AMA	American Samoa Islands
13	ANO	Cocos Islands
14	AIA	Antigua (Leeward Islands)
15	ARF-A	Botswana
16	ARF-H	Burundi
17	ARF-B	Lesotho
18	ARF-C	Malawi
19	ARF-M	MEAN FOR Botswana; Lesotho; Malawi; Swaziland; Zaire; Zambia; Zimbabwe
20	ARF-D	Swaziland
21	ARF-E	Zaire
22	ARF-F	Zambia
23	ARF-G	Zimbabwe
24	ARS-M	MEAN FOR Kenya; Tanzania
25	ARS-A	Kenya
26	ARS-B	Tanzania
27	ASC	Ascension Island
28	ATF	Iwo Jima
29	SHB	St Helena Island
30	TRN	Tern Island
31	ASQ	Marcus Island
32	AUA	Australia; Tasmania
33	AUG	Australia; Tasmania
34	PHA	Djibouti
35	IBE	Efate & Erromango Islands
36	BER	Bermuda
37	BID	Guinea-Bissau
38	BOO	Colombia
39	BUR	Indonesia (Bangka & Belitung Ids)
40	CAZ	Antarctica (McMurdo Camp Area)

41	CAI	Argentina
42	CAO	Phoenix Islands
43	CAP	South Africa
44	CAC	Bahamas; Florida
45	CGE	Tunisia
46	CHI	New Zealand (Chatham Island)
47	CHU	Paraguay
48	COA	Brazil
49	DAL	Guinea
50	DID	Deception Island; Antarctica
51	BAT	Indonesia (Sumatra)
52	GIZ	New Georgia Islands (Gizo Island)
53	EAS	Easter Island
54	EST	Estonia
55	EUR-E	Cyprus
56	EUR-F	Egypt
57	EUR-G	England; Channel Islands; Scotland; Shetland Islands
58	EUR-K	England; Ireland; Scotland; Shetland Islands
59	EUR-C	Finland; Norway
60	EUR-B	Greece
61	EUR-H	Iran
62	EUR-I	Italy (Sardinia)
63	EUR-J	Italy (Sicily)
64	EUR-L	Malta
65	EUR-M	MEAN FOR Austria; Belgium; Denmark; Finland; France; W Germany; Gibraltar; Greece; Italy; Luxembourg; Netherlands; Norway; Portugal; Spain; Sweden; Switzerland
66	EUR-A	MEAN FOR Austria; Denmark; France; W Germany; Netherlands; Switzerland
67	EUR-S	MEAN FOR Iraq; Israel; Jordan; Lebanon; Kuwait; Saudi Arabia; Syria
68	EUR-D	Portugal; Spain
69	EUR-T	Tunisia
70	EUS	MEAN FOR Austria; Finland; Netherlands; Norway; Spain; Sweden; Switzerland
71	FOT	Nevis; St. Kitts (Leeward Islands)
72	GAA	Republic of Maldives
73	GEO	New Zealand
74	GRA	Azores (Faial; Graciosa; Pico; Sao Jorge; Terceira)
75	GUA	Guam
76	GSE	Indonesia (Kalimantan)
77	DOB	Guadalcanal Island
78	HEN	Afghanistan
79	HER	Croatia-Serbia, Bosnia-Herzegovina
80	HJO	Iceland
81	HKD	Hong Kong
82	HTN	Taiwan
83	IND-B	Bangladesh
84	IND-I	India; Nepal

85	IND-P	Pakistan
86	INF-A	Thailand
87	ING-B	Vietnam (Con Son Island)
88	ING-A	Vietnam (Near 16øN)
89	INH-A1	Thailand
90	IDN	Indonesia
91	IRL	Ireland
92	ISG	South Georgia Islands
93	IST	Diego Garcia
94	JOH	Johnston Island
95	KAN	Sri Lanka
96	KEG	Kerguelen Island
97	KEA	West Malaysia & Singapore
98	KUS	Caroline Islands
99	KGS	South Korea
100	LCF	Cayman Brac Island
101	LEH	Ghana
102	LIB	Liberia
103	LUZ-A	Philippines (Excluding Mindanao)
104	LUZ-B	Philippines (Mindanao)
105	MPO	Gabon
106	MIK	Mahe Island
107	MAS	Ethiopia (Eritrea)
108	MER	Morocco
109	MID	Midway Islands
110	MIN-A	Cameroon
111	MIN-B	Nigeria
112	ASM	Montserrat (Leeward Islands)
113	NAH-A	Oman (Masirah Island)
114	NAH-C	Saudi Arabia
115	NAH-B	United Arab Emirates
116	NAP	Trinidad & Tobago
117	NAS-D	Alaska (Excluding Aleutian Ids)
118	NAS-V	Alaska (Aleutian Ids East of 180øW)
119	NAS-W	Alaska (Aleutian Ids West of 180øW)
120	NAS-Q	Bahamas (Except San Salvador Id)
121	NAS-R	Bahamas (San Salvador Island)
122	NAS-F	Canada (Alberta; British Columbia)
123	NAS-H	Canada (manitoba; Ontario)
124	NAS-G	Canada (New Brusnick; Newfoundland; Nova Scotia; Quebec)
125	NAS-I	Canada (Northwest Territories; Saskatchewan)
126	NAS-J	Canada (Yukon)
127	NAS-O	Canal Zone
128	NAS-T	Cuba

129	NAS-U	Greenland (Hayes Peninsula)
130	NAS-P	MEAN FOR Antigua; Barbados; Barnuda; Caicos Islands; Cuba; Dominican Republic; Grand Cayman; Jamaica; Turks Islands
131	NAS-N	MEAN FOR Belize; Costa Rica; El Salvador; Guatemala; Honduras; Nicaragua
132	NAS-E	MEAN FOR Canada
133	NAS-C	MEAN FOR CONUS
134	NAS-A	MEAN FOR CONUS (East of Missisipi River including Louisiana; Missouri; Minnesota)
135	NAS-B	MEAN FOR CONUS (West of Missisipi River excluding Louisiana; Missouri; Minnesota)
136	NAS-L	Mexico
137	NAR-A	Alaska (Excluding Aletuian Ids)
138	NAR-E	Aleutian Ids
139	NAR-B	Canada
140	NAR-C	CONUS
141	NAR-H	Hawaii
142	NAR-D	Mexico; Central America
143	NSD	Algeria
144	FLO	Azores (Corvo & Flores Islands)
145	OEG	Egypt
146	OHA-A	Hawaii
147	OHA-B	Kauai
148	OHA-C	Maui
149	OHA-M	MEAN FOR Hawaii; Kauai; Maui; Oahu
150	OHA-D	Oahu
151	FAH	Oman
152	OGB-A	England
153	OGB-B	England; Isle of Man; Wales
154	OGB-M	MEAN FOR England; Isle of Man; Scotland; Shetland Islands; Wales
155	OGB-C	Scotland; Shettland Islands
156	OGB-D	Wales
157	PLN	Canary Islands
158	PIT	Pitcairn Island
159	PTB	MEAN FOR Burkina faso & Niger
160	PTN	Congo
161	POS	Porto Santo; Madeira Islands
162	PRP-A	Bolivia
163	PRP-B	Chile (Northern; Near 19øS)
164	PRP-C	Chile (Sourthern; Near 43øS)
165	PRP-D	Colombia
166	PRP-E	Ecuador
167	PRP-F	Guyana
168	PRP-M	MEAN FOR Bolivia; Chile; Colombia; Ecuador; Guyana; Peru; Venezuela

169	PRP-G	Peru
170	PRP-H	Venezuela
171	HIT	Chile (Near 53øS) (Hito XVIII)
172	PUR	Puerto Rico; Virgin Islands
173	PUK	Russia
174	QAT	Qatar
175	QUO	Greenland (South)
176	REU	Mascarene Islands
177	EUR-I	Italy (Sardinia)
178	SPK-A	Hungary
179	SPK-B	Poland
180	SPK-C	Czechoslovakia
181	SPK-D	Latvia
182	SPK-E	Kazakhstan
183	SPK-F	Albania
184	SPK-G	Romania
185	CCD	Czechoslovakia (Prior 1 JAN 1993)
186	SAE	Espirito Santo Islands
187	SAO	Azores (Sao Miguel; Santa Maria Ids)
188	SAP	East Falkland Islands
189	SCK	Namibia
190	SGM	Salvage Islands
191	SRL	Sierra Leone
192	SAN-A	Argentina
193	SAN-B	Bolivia
194	SAN-C	Brazil
195	SAN-D	Chile
196	SAN-E	Colombia
197	SAN-F	Ecuador
198	SAN-J	Ecuador (Baltra; Galapagos)
199	SAN-G	Guyana
200	SAN-M	MEAN FOR Argentina; Bolivia; Brazil; Chile; Colombia; Ecuador; Guyana: Paraguay; Peru; Trinidad & Tobago; Venezuela
201	SAN-H	Paraguay
202	SAN-I	Peru
203	SAN-K	Trinidad & Tobago
204	SAN-L	Venezuela
205	SOA	Singapore
206	TAN	Madagascar
207	TIL	Brunei; E. Malaysia (Sabah Sarawak)
208	TOY-A	Japan
209	TOY-M	MEAN FOR Japan; South Korea; Okinawa
210	TOY-C	Okinawa
211	TOY-B	South Korea
212	TDC	Tristan da Cunha
213	MVS	Fiji (Viti Levi Island)

214	VOR	Algeria
215	WAK	Wake Atoll
216	ENW	Marshall Islands
217	WGS72	Global Definition
218	YAC	Uruguay
219	ZAN	Suriname
220	-	Reserved
221	KKJ	Finland