

SE867-AGPS

Assisted GPS Application Note

80000nt10036a r0 – 2010-03-25



APPLICABILITY TABLE

PRODUCT
SE867-AGPS
EVB-867 Evaluation Board



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1. Introduction

1.1. Scope

This application note describes how to add AGPS functionality to a mobile device that incorporates the Telit SE867-AGPS GPS receiver along with internet capability (WiFi, GPRS, ...).

1.2. Audience

This note is intended to assist customers who need the basic AGPS assistance data (Ephemeris, Almanac, IONO, UTC) and do not require an "industry standard" interface protocol (such as SUPL, IS-801, etc).

1.3. 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
TS-NORTHAMERICA@telit.com
TS-LATINAMERICA@telit.com
TS-APAC@telit.com

Alternatively, use:

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

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

<http://www.telit.com>

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

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

Telit appreciates feedback from the users of our information.



1.4. Document Organization

This document contains the following chapters:

[“Chapter 1: “Introduction”](#) provides a scope for this document, target audience, contact and support information, and text conventions.

[“Chapter 2: “SE867-AGPS Firmware and Assistance Protocol Support”](#) describes SE867-AGPS firmware releases and Assistance Protocol versions dependencies.

[“Chapter 3: “Orion Assistance Protocol”](#) describes SE867-AGPS Assistance Protocol and how customers can use it.

1.5. 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.

1.6. Related Documents

[1] Telit_SE867-AGPS_User_Guide_r1.pdf

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



1.7. Document History

Revision	Date	Changes
Issue#0	2010-03-25	first issue



2. SE867-AGPS Firmware and Assistance Protocol Support

SE867-AGPS implements a simple proprietary assistance protocol called OAP (Orion Assistance Protocol).

The OAP has evolved over time and currently two revisions are actively supported: the most recent version 2.00 and the older version 1.52.

Which version of the protocol to use depends on the SE867-AGPS Orion firmware version: Orion version 3.2 and higher must use version 2.00 while Orion version 3.1 and below must use version 1.52.

Programming-wise, other than using a different protocol identifier, there is not much difference since the AGPS origin server maintains assistance files for both formats. Note that the examples in this Application Note are using version 1.52.

Please refer to [1] for information on how to retrieve SE867-AGPS Orion firmware version number.



3. Orion Assistance Protocol

Many of the messages described in this document are derived from IS-801 and GSM/3GPP industry standard protocols. Customers only have to access one pre-formatted file from the AGPS server to get all the assistance they need.

3.1. Orion Software Configuration

A version of the Orion GPS software (Orion 3.0.0-472 or greater) that supports assistance injection is required.

- Output protocol: NMEA default
- Input protocol: NMEA default on power-up, can be switched to 3GPP.
- Baud Rate: 4800 default on power-up, change to 38.4K for assistance applications.

3.2. Assumptions

SE867-AGPS will have access to a source of time (either GPS RTC or system RTC or network time source) and its last known position (LKP) stored in non-volatile memory. This will reduce the TTFF in low signal conditions because the satellite search time will be minimized. Typically Almanac will also be in non volatile memory also. This means when the receiver powers up it will be essentially in a WARM start condition. When the ephemeris is injected the TTFF should be short (< 16 seconds typical) because it will not have to collect this data from the satellites (30 seconds to 5 minutes or more).

3.3. Assistance File Format

The file that is fetched from the AGPS server is actually a sequence of proprietary 3GPP formatted message packets.

The format of these message packets is shown below.

PREFIX	PACKET ID	PACKET LENGTH	ARGUMENTS	SUFFIX
6 Bytes	1 Byte	2 Bytes	Less than 1024 Bytes	3 Bytes



Where:

- **PREFIX** is a text string that identifies the protocol and is the same for all messages
 - (#!GSMa for version 1.52 and OAP200 for version 2.00)
- **PACKET ID** is the unique ID for the message
- **PACKET LENGTH** is the length of the argument field in bytes
- **ARGUMENTS** is the content of the message and is detailed in the following sections
- **SUFFIX** is the message terminator *<Checksum><CR> where the checksum is the modulo 256 sum of the each byte in the message up to and including the "*" in the suffix

The ephemeris (and almanac) data consist of 5 or 6 messages with information for up to 6 satellites in each message.

To simplify the implementation the server will always make available one file that contains the latest almanac, ephemeris, iono, and utc data.

Since ephemeris is the largest block (~75% of the total) this is a minor tradeoff in network bandwidth (~3K for ephemeris only, ~4K for all data). Alternatively the server could also make available an ephemeris only file.

The data is updated approximately once/hour on the server.

3.4. Typical Operating Flow

- Fetch assistance file from AGPS server.
- Turn on or wakeup GPS receiver.
- Wait for NMEA output from GPS receiver.
- Switch GPS input protocol from NMEA to 3GPP.
- If the receiver does have a valid time estimate
 - (The following example assumes this):
 - o Send assistance data to GPS.
- If the receiver does not have a valid time estimate (see 3.5):
 - o Send time to GPS (see end of document)
 - o Send Assistance data to GPS
- Switch input protocol back to NMEA.



- Open application that uses GPS NMEA data (navigation, Google maps, etc.).

3.4.1. Fetching the Assistance File

Fetching the assistance file (eph/alm/iono/utc) from the AGPS server is as simple as specifying one of the appropriate URL for downloading.

Different URLs are available for development and real mode assisted data.

Ask to TTSC for the appropriate URL.

3.4.2. Turning SE867-AGPS On and Switching the Input Protocol

After SE867-AGPS is turned on and outputting NMEA data (\$GGA, \$RMC ...), the following NMEA command must be sent to change the input protocol to 3GPP.

SE867-AGPS will continue to output NMEA but now will only accept proprietary 3GPP commands.

The SET command [1] is a volatile version of the CONFIG command. When the receiver is powered down it will go back to the default NMEA IN/NMEA OUT configuration with default baud rate on power-up. The 01 is the NMEA mask. This enables only the GGA message for faster response to commands.

\$PUNV,SET,00,0004,0,1000,38400,01*cc<CRLF>

(38400 is baud rate, cc is the 8 bit checksum)

3.4.3. Sending the message data to SE867-AGPS

The individual messages in the agps-latest.agps file must then be sent to SE867-AGPS. The GPS receiver will send an “acknowledge” after each message for flow control.

A binary dump of the file shows the data in Figure 1 (partial). One complete ephemeris message is shown starting with the #!GSMA header and finishing with the *cc<CR>.

The parsing of the message is described below.



```

while (!EndOfFile())
{
    Find and Read Header (!GSMA) and send to receiver
    Read MsgID (one byte) and send to receiver
    Read Length (2 bytes) and send to receiver
    NumOfBytes = 0.
    while (NumOfBytes++ != Length)
        Read Byte and send to receiver
    Read 3 byte Suffix (* + 8 bit checksum + CR) and send to receiver.
    Wait for ACK ($PUNV,OK is ACK, $PUNV,ERR is NAK) from receiver.
}

```

Note: Specify #!GSMA for version 1.52 and OAP200 for version 2.00.

3.4.4. Switching Input Protocol Back to NMEA

To switch input protocol back to NMEA, the switch protocol command in 3GPP format must be sent:

{#!GSMA<0x14><0x0001><0x01>*cc<CR>}, in hex this would be 13 bytes:

0x23 0x21 0x47 0x53 0x4D 0x41 0x14 0x0001 0x01 0x2A 0xAC 0x0D

AC = checksum

When the protocol is switched back to NMEA IN/NMEA OUT the NMEA mask reverts to a full set (Mask = 7F). To reduce the data to only the needed messages, the NMEA SET command below can be sent. A mask value of 1D gives RMC, GGA, GSA, and GSV messages [1].

\$PUNV,SET,00,0000,0,1000,38400,1D*cc<CRLF>

(38400 is baud rate, cc is the 8 bit checksum)

Note: Specify #!GSMA for version 1.52 and OAP200 for version 2.00.



Finally the program that needs the GPS NMEA data (Navigation program, Google Maps, etc.) can be run.

```

23 21 47 53 4D 41 10 01 9F 50 44 80 0C 80 00 00 #!GSMA...PD...
00 00 00 00 00 00 00 00 36 CA 1B 80 3F FA 06 68 .....6...?.h
9E 01 28 37 BC 40 BF 03 40 01 3F 04 79 4F ED 0E ..(7.@.@?.yO..
E4 A1 0E 10 01 28 6E 00 00 CB 03 5F 2B 70 01 28 .....(n.....+p.(
99 9B BB 30 73 41 AB B0 D0 03 FE 9D 53 9C 50 80 ...0sA.....S.P.
80 1C 00 00 00 00 00 00 00 00 00 00 00 3D CA 1E .....=...
80 00 0B 88 CA F0 00 B2 3E C1 32 9E 24 50 00 F7 .....>.2.$P...
05 9D 00 32 0F 43 A1 0D 82 46 28 6E 03 FE D2 48 ...2.C...F(n...H
CD D8 F0 01 90 96 F1 7B C0 6F 9C 87 DF 67 83 FE .....{o...g..
88 C8 1B 90 C4 80 1B C0 00 00 00 00 00 00 00 00 .....<...?.{i...7..
00 00 3C CA 1B 80 3F E9 7B 69 C1 00 FA 37 2E B1 F.....4-.....(
46 93 F0 00 D7 04 34 2D 0D 0F C6 A1 0C 81 90 28 n.....n9..H.~.`P`
6E 00 00 1F 06 6E 39 C3 FF 48 99 7E 14 60 70 60 >.M.....A?.....
3E D2 4D 83 FE 9D FB BD 41 05 3F 0A 80 00 00 00 .....=...}.....
00 00 00 00 00 00 00 3D CA 1B 80 7D 8A D5 CB 0D ..>5...@.&...B...
F8 3E 35 0B A2 0B 10 40 F9 26 04 B1 C7 42 12 0A .....(n.....d...
A1 0D B3 B1 28 6E 00 00 FD A0 A0 64 F3 FF DC 99 ...d...vc...Fq@...
C6 A4 80 64 C4 CC C1 76 63 FE A5 C4 46 71 40 80 .....=...
0A 00 00 00 00 00 00 00 00 00 00 3D 8A 1B 80 ...v.....;...Er@...
00 02 C5 76 81 00 FA 3B D9 9D 45 72 40 01 0D 02 }X.....(n...rSc
FB 7D 58 0D EA A1 0D BB C1 28 6E 00 00 72 53 6F L.....*...u..R.3...
4C C0 01 00 98 2A B3 10 75 06 FA 52 8B 33 FE 98 ..Q.....
A8 2E 51 80 80 0C C0 00 00 00 00 00 00 00 00 00 ..J.....>...0...
00 3A 4A 1B 80 00 09 00 3E 02 F4 03 30 0F FE BE ...:.....+.....1(n
0A F0 F5 97 01 0E FD 2B 09 0B A1 0D A3 31 28 6E ...m...(c...
00 00 6D 05 00 28 63 FF E8 9C F8 85 10 93 F1 B2 *-#!GSM
BC EA B3 FE 9C 14 05 A0 2A 2D 0D 23 21 47 53 4D
A1 10 01 9F 51 C0 80 1A C0 00 00 00 00 00 00

```

Figure 1. One complete ephemeris message.

3.5. How to Inject Time

Time assistance must be injected if the receiver does not have a valid time estimate. To determine if the receiver has time the NMEA RMC message has to be checked. When the receiver outputs a RMC message the time and date is part of the message.

```
$GPRMC,223938.899,V,3339.1063,N,11742.9915,W,,,110808,,,N*66
```

Time NOW is 22 hours, 39 minutes, 38.899 seconds (UTC)

Date is 11 August, 2008



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An internet time server could be also pinged to get the present time. If it looks like SE867-AGPS does not have correct time then it must be fed before the ephemeris injection or wait until SE867-AGPS gets time from the satellites.

To feed the receiver time the proprietary 3GPP message ID 0x04 must be used as follows.

Time uncertainty from a network server is typically < 2 seconds so a default of 2000ms is used in the example below. This is not critical, just a number less than 1000ms should not be used unless the uncertainty really is less than that.

Example (Feed time):

Positioning mode = Autonomous = 10b (2 bit)

Information included = Time only = 001b (3 bit)

Spare = 000b (3 bit)

GPS Week = 455d = 0x1C7 = 0111000111b (10 bit)

GPS Tow = 123456d = 0x1E240 = 000 0001 1110 0010 0100 0000b (23 bit)

Time unc (ms) = 2000d = 0x07D0 = 0000 0111 1101 0000b (16 bit)

Spare = 0000000b (7 bit)

So, the **argument** of the message in bit order (MSB to LSB, left to right, in binary) would be:

10 001 000 0111000111 00000011110001001000000 0000011111010000 0000000

Grouped in 4's:

1000 1000 0111 0001 1100 0000 1111 0001 0010 0000 0000 0011 1110 1000 0000 0000

In hex bytes (8) = **0x88 0x71 0xC0 0xF1 0x20 0x03 0xE8 0x00**

The complete message (20 bytes):

0x23 0x21 0x47 0x53 0x4D 0x41 0x04 0x00 0x08 (#!GSM + Msg ID + Argument Length)

0x88 0x71 0xC0 0xF1 0x20 0x03 0xE8 0x00 (argument)



0x2A 0x57 0x0D (* + checksum + CR)

Note: Specify #!GSMA for version 1.52 and OAP200 for version 2.00

PREFIX	PACKET ID	PACKET LENGTH	ARGUMENTS	SUFFIX
#!GSMA	0x04	As Required	See Table A	*<Checksum><CR>

Figure 2. Message used to feed time to SE867-AGPS.

PARAMETER	# BITS	SCALE FACTOR	RANGE	UNITS	NEED
Positioning Mode	2		Enumerated (MS-Assisted, MS-Based, Autonomous)	0=MS-Assisted 1=MS-Based 2=Autonomous	M
Information Included	3	Bit Mask	xx1b = Ref. Time incl. x1xb = Ref Loc incl.	N/A	M
Spare	3	N/A	Set to 000b		M
Reference Time					
>GPS WEEK	10	1	0...1023	Weeks	C
>GPS TOW	23	0.08	0...604799.92	Seconds	C
>GPS Time Uncertainty	16	1	0...65535,(2000 typical)	+/- Milliseconds	C
Spare	7		Set to 0	N/A	C

Table A. GPS measurement request.

