Venus638FLPx GPS Receiver

Data Sheet

Venus638FLPx-L / Venus638FLPx-D
FEATURES

- 20Hz update rate
- -148dBm cold start sensitivity
- -165dBm tracking sensitivity
- 29 second cold start TTFF
- 3.5 second TTFF with AGPS
- 1 second hot start
- 2.5m accuracy
- Multipath detection and suppression
- Jamming detection and mitigation
- SBAS (WAAS / EGNOS) support
- 7-day extended ephemeris AGPS
- 67mW full power navigation
- Works directly with active or passive antenna
- Internal flash for optional 75K point data logging
- Supports external SPI flash memory data logging
- Complete receiver in 10mm x 10mm x 1.3mm size
- Contains LNA, SAW Filter, TCXO, RTC Xtal, LDO
- Pb-free RoHS compliant

Venus638FLPx is a high performance, low cost, single chip GPS receiver targeting mobile consumer and cellular handset applications. It offers very low power consumption, high sensitivity, and best in class signal acquisition and time-to-first-fix performance.

Venus638FLPx contains all the necessary components of a complete GPS receiver, includes 1.2dB cascaded system NF RF front-end, GPS baseband signal processor, 0.5ppm TCXO, 32.768kHz RTC crystal, RTC LDO regulator, and passive components. It requires very low external component count and takes up only 100mm² PCB footprint.

Dedicated massive-correlator signal parameter search engine within the baseband enables rapid search of all the available satellites and acquisition of very weak signal. An advanced track engine allows weak signal tracking and positioning in harsh environments such as urban canyons and under deep foliage.

The self-contained architecture keeps GPS processing off the host and allows integration into applications with very little resource.

Venus638FLPx is very easy to use, minimizes RF layout design issues and offers very fast time to market.

<table>
<thead>
<tr>
<th>Product Series</th>
<th>Product Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venus638FLPx-L</td>
<td>Flash version GPS receiver (internal 1.2V LDO version)</td>
</tr>
<tr>
<td></td>
<td>Suitable for Venus634FLPx direct drop-in replacement</td>
</tr>
<tr>
<td>Venus638FLPx-D</td>
<td>Flash version GPS receiver (external 1.2V version)</td>
</tr>
<tr>
<td></td>
<td>Suitable for lower power application using external 1.2V supply</td>
</tr>
</tbody>
</table>
TECHNICAL SPECIFICATIONS

Receiver Type
L1 frequency
GPS C/A code
SBAS capable
65-channel architecture
8 million time-frequency searches per second

Accuracy
Position 2.5m CEP
Velocity 0.1m/sec
Timing 60ns

Open Sky TTFF
29 second cold start
3.5 second with AGPS
1 second hot start

Reacquisition
< 1s

Sensitivity
-165dBm tracking
-148dBm cold start

Update Rate
1 / 2 / 4 / 5 / 8 / 10 / 20 Hz (default 1Hz)

Dynamics
4G

Operational Limits
Altitude < 18,000m\(^1\), Velocity < 515m/s\(^1\)

Datum
Default WGS-84

Interface
UART LVTTL level

Baud Rate
4800 / 9600 / 38400 / 115200

Protocol
NMEA-0183 V3.01, GGA, GLL, GSA, GSV, RMC, VTG (default GGA, GSA, GSV, RMC, VTG)
SkyTraq Binary

Main Supply Voltage
2.8V ~ 3.6V (Venus638FLPx-L)
2.8V ~ 3.6V, 1.08V ~ 1.32V (Venus638FLPx-D)

Backup Voltage
1.5V ~ 6V

Current Consumption

<table>
<thead>
<tr>
<th></th>
<th>Enhanced Acquisition</th>
<th>Low Power Acquisition</th>
<th>Tracking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venus638FLPx-L</td>
<td>68mA @ 3.3V</td>
<td>50mA @ 3.3V</td>
<td>29mA @ 3.3V</td>
</tr>
<tr>
<td>Venus638FLPx-D</td>
<td>18mA @ 3.3V</td>
<td>18mA @ 3.3V</td>
<td>18mA @ 3.3V</td>
</tr>
<tr>
<td></td>
<td>50mA @ 1.2V</td>
<td>32mA @ 1.2V</td>
<td>11mA @ 1.2V</td>
</tr>
</tbody>
</table>

Assuming 75% efficiency switch-mode 3.3V-to-1.2V regulator is used, then

<table>
<thead>
<tr>
<th></th>
<th>Enhanced Acquisition</th>
<th>Low Power Acquisition</th>
<th>Tracking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venus638FLPx-D</td>
<td>42mA @ 3.3V</td>
<td>33mA @ 3.3V</td>
<td>23mA @ 3.3V</td>
</tr>
</tbody>
</table>

Operating Temperature
-40 ~ +85 deg-C

Storage Temperature
-40 ~ +125 deg-C

Package
LGA69 10mm x 10mm x 1.3mm, 0.8mm pitch

\(^1\): COCOM limit, either may be exceeded but not both
Figure-1 GPS Receiver based on Venus638FLPx

BLOCK DIAGRAM
VENUS638FLPx PIN-OUT DIAGRAM

Venus638FLPx-L / Venus638FLPx-D Top View

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Signal Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RSTN</td>
<td>Input</td>
<td>Active LOW reset input, 3.3V LVTTL</td>
</tr>
<tr>
<td>2</td>
<td>VCC33I</td>
<td>Power Input</td>
<td>Main voltage supply input, 2.8V ~ 3.6V</td>
</tr>
<tr>
<td>3</td>
<td>NC</td>
<td></td>
<td>Not connected, empty pin</td>
</tr>
<tr>
<td>4</td>
<td>PIO12</td>
<td>Bidir</td>
<td>General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>5</td>
<td>GPIO2</td>
<td>Bidir</td>
<td>General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>6</td>
<td>GPIO1</td>
<td>Bidir</td>
<td>General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>7</td>
<td>LED / GPIO0</td>
<td>Bidir</td>
<td>Navigation status indicator or General purpose I/O. 3.3V LVTTL</td>
</tr>
<tr>
<td>8</td>
<td>GPIO24</td>
<td>Bidir</td>
<td>General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>9</td>
<td>BOOT_SEL</td>
<td>Bidir</td>
<td>Boot mode selection. Pull-high or pull-low using 10K resistor. Must not connect to VCC or GND directly. 1: execute from internal ROM 0: execute from internal Flash memory</td>
</tr>
<tr>
<td>10</td>
<td>GND</td>
<td>Power</td>
<td>System ground</td>
</tr>
<tr>
<td>11</td>
<td>GND</td>
<td>Power</td>
<td>System ground</td>
</tr>
<tr>
<td>12</td>
<td>GPIO22</td>
<td>Bidir</td>
<td>General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>13</td>
<td>GPIO23</td>
<td>Bidir</td>
<td>General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>14</td>
<td>GPIO20</td>
<td>Bidir</td>
<td>General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>15</td>
<td>GND</td>
<td>Power</td>
<td>System ground</td>
</tr>
<tr>
<td>16</td>
<td>GPIO29</td>
<td>Bidir</td>
<td>General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>17</td>
<td>V12O_RTC</td>
<td>Power Output</td>
<td>1.2V LDO output for RTC &amp; backup memory. Normally unused.</td>
</tr>
</tbody>
</table>

Figure-2b Venus638FLPx Pin-Out Diagram
<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>VBAT</td>
<td>Power Input</td>
</tr>
<tr>
<td>19</td>
<td>GND</td>
<td>Power System ground</td>
</tr>
<tr>
<td>20</td>
<td>NC</td>
<td>Not connected, empty pin</td>
</tr>
<tr>
<td>21</td>
<td>GND_RF</td>
<td>Power RF section system ground</td>
</tr>
<tr>
<td>22</td>
<td>GND_RF</td>
<td>Power RF section system ground</td>
</tr>
<tr>
<td>23</td>
<td>NC</td>
<td>Not connected, empty pin</td>
</tr>
<tr>
<td>24</td>
<td>GND_RF</td>
<td>Power RF section system ground</td>
</tr>
<tr>
<td>25</td>
<td>GND_RF</td>
<td>Power RF section system ground</td>
</tr>
<tr>
<td>26</td>
<td>NC</td>
<td>Not connected, empty pin</td>
</tr>
<tr>
<td>27</td>
<td>GND_RF</td>
<td>Power RF section system ground</td>
</tr>
<tr>
<td>28</td>
<td>GND_RF</td>
<td>Power RF section system ground</td>
</tr>
<tr>
<td>29</td>
<td>GND_RF</td>
<td>Power RF section system ground</td>
</tr>
<tr>
<td>30</td>
<td>NC</td>
<td>Not connected, empty pin</td>
</tr>
<tr>
<td>31</td>
<td>GND_RF</td>
<td>Power RF section system ground</td>
</tr>
<tr>
<td>32</td>
<td>RFIN</td>
<td>Input GPS signal input, connect to GPS antenna.</td>
</tr>
<tr>
<td>33</td>
<td>GND_RF</td>
<td>Power RF section system ground</td>
</tr>
<tr>
<td>34</td>
<td>NC</td>
<td>Not connected, empty pin</td>
</tr>
<tr>
<td>35</td>
<td>NC</td>
<td>Not connected, empty pin</td>
</tr>
<tr>
<td>36</td>
<td>REG ENA</td>
<td>Input Connect to pin-2 VCC33I</td>
</tr>
<tr>
<td>37</td>
<td>PIO14</td>
<td>Bidir General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>38</td>
<td>MOSI / PIO9</td>
<td>Bidir SPI data output or general purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>39</td>
<td>MISO / PIO8</td>
<td>Bidir SPI data input or general purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>40</td>
<td>P1PPS</td>
<td>Output 1 pulse per second output. Active after position fix; goes HIGH for about 4msec, 3.3V LVTTL</td>
</tr>
<tr>
<td>41</td>
<td>SPI_CLK / PIO07</td>
<td>Output SPI clock or general purpose output pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>42</td>
<td>RXD0</td>
<td>Input Received input of the asynchronous UART port. Used to input binary command to the GPS receiver. 3.3V LVTTL</td>
</tr>
<tr>
<td>43</td>
<td>SPI_CS N / PIO6</td>
<td>Bidir SPI chip select output or general purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>44</td>
<td>TXD0</td>
<td>Output Transmit output of the asynchronous UART port. Used to output standard NMEA-0183 sentence or response to input binary command. 3.3V LVTTL</td>
</tr>
<tr>
<td>45</td>
<td>SDA</td>
<td>Bidir I2C data, 3.3V I/O</td>
</tr>
<tr>
<td>46</td>
<td>SCL</td>
<td>Bidir I2C clock, 3.3V I/O</td>
</tr>
<tr>
<td>47</td>
<td>GPIO4</td>
<td>Bidir General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>48</td>
<td>GPIO3</td>
<td>Bidir General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>49</td>
<td>GND</td>
<td>System ground</td>
</tr>
<tr>
<td>50</td>
<td>PIO5</td>
<td>Output General purpose output pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>51</td>
<td>PIO11</td>
<td>Bidir General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>52</td>
<td>RXD1</td>
<td>Input Received input of the asynchronous UART port. 3.3V LVTTL</td>
</tr>
<tr>
<td>53</td>
<td>GPIO25</td>
<td>Bidir General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>54</td>
<td>GPIO30</td>
<td>Bidir General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>55</td>
<td>PIO15</td>
<td>Bidir General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>56</td>
<td>NC / V12</td>
<td>NC pin for Venus638FLPx-L 1.2V supply input pin for Venus638FLPx-D</td>
</tr>
<tr>
<td>57</td>
<td>TXD1</td>
<td>Output Transmit output of the asynchronous UART port. 3.3V LVTTL</td>
</tr>
<tr>
<td>58</td>
<td>VCC33I</td>
<td>Power Input Main voltage supply input, 2.8V ~ 3.6V</td>
</tr>
<tr>
<td>59</td>
<td>GPIO28</td>
<td>Bidir General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>60</td>
<td>GND</td>
<td>Power System ground</td>
</tr>
<tr>
<td>61</td>
<td>GND_RF</td>
<td>Power RF section system ground</td>
</tr>
<tr>
<td>62</td>
<td>GND_RF</td>
<td>Power RF section system ground</td>
</tr>
<tr>
<td>63</td>
<td>GPIO6</td>
<td>Bidir General purpose I/O pin, 3.3V LVTTL</td>
</tr>
<tr>
<td>64</td>
<td>GND</td>
<td>Power System ground</td>
</tr>
<tr>
<td>65</td>
<td>GND_RF</td>
<td>Power RF section system ground</td>
</tr>
<tr>
<td>66,67,68</td>
<td>NC</td>
<td>Not connected, empty pin</td>
</tr>
<tr>
<td>69</td>
<td>GND_RF</td>
<td>Power RF section system ground</td>
</tr>
</tbody>
</table>

When using Venus638FLPx-L to replace Venus634FLPx, pin-45 ~ pin-69 can all be left unconnected.
When using Venus638FLPx-D, 1.2V need to be supplied at pin-56
The NC pins are to be left unconnected.
**DC CHARACTERISTICS OF DIGITAL INTERFACE**

Below is when VCC3I is at nominally 3.3V

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Low Voltage</td>
<td></td>
<td>0.8</td>
<td></td>
<td>Volt</td>
</tr>
<tr>
<td>Input High Voltage</td>
<td>2.0</td>
<td></td>
<td></td>
<td>Volt</td>
</tr>
<tr>
<td>Output Low Voltage, Iol = 2 ~ 16mA</td>
<td></td>
<td>0.4</td>
<td></td>
<td>Volt</td>
</tr>
<tr>
<td>Output High Voltage, Ioh = 2 ~ 16mA</td>
<td>2.9</td>
<td></td>
<td></td>
<td>Volt</td>
</tr>
</tbody>
</table>
MECHANICAL DIMENSION

**Figure-3** Recommended PCB Footprint.

**RECOMMENDED PCB FOOTPRINT**

- **Package size:** 10 mm x 10 mm x 1.3 mm
- **Package Pad:** 15 x 21 mil
- **Package Pitch:** 0.8 mm

Unit = mm
RECOMMENDED REFLOW PROFILE

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>25</th>
<th>82.5</th>
<th>140</th>
<th>150</th>
<th>160</th>
<th>170</th>
<th>180</th>
<th>190</th>
<th>200</th>
<th>225</th>
<th>250</th>
<th>250</th>
<th>215</th>
<th>185</th>
<th>155</th>
<th>125</th>
<th>95</th>
<th>65</th>
<th>35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time(minute)</td>
<td>0</td>
<td>0.5</td>
<td>1</td>
<td>1.5</td>
<td>2</td>
<td>2.5</td>
<td>3</td>
<td>3.5</td>
<td>4</td>
<td>4.5</td>
<td>5</td>
<td>5.5</td>
<td>6</td>
<td>6.5</td>
<td>7</td>
<td>7.5</td>
<td>8</td>
<td>8.5</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Profile Description</th>
<th>SnPb Eutectic Process</th>
<th>Lead Free Process</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preheat</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Temperature</td>
<td>100+/−10 °C</td>
<td>140+/−10 °C</td>
</tr>
<tr>
<td>Time(ΔT)</td>
<td>40~60s</td>
<td>50~70s</td>
</tr>
<tr>
<td><strong>Ramp-Up</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ramp-Up Rate</td>
<td>1 °C/s Max.</td>
<td>1 °C/s Max.</td>
</tr>
<tr>
<td>Time(ΔT)</td>
<td>120~150s</td>
<td>160~200s</td>
</tr>
<tr>
<td><strong>Reflow</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Temperature</td>
<td>Peak Temp.</td>
<td>Peak Temp.</td>
</tr>
<tr>
<td>Minimum Temperature</td>
<td>180+/−5°C</td>
<td>200+/−10°C</td>
</tr>
<tr>
<td>Peak Temperature</td>
<td>220+/−2°C</td>
<td>250+/−2°C</td>
</tr>
<tr>
<td>Time(ΔT) during Peak Temp.+/−2°C</td>
<td>10~30s</td>
<td>20~40s</td>
</tr>
<tr>
<td>Reflow Time(ΔT)</td>
<td>120~150s</td>
<td>120~150s</td>
</tr>
<tr>
<td><strong>Cooling</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling Rate</td>
<td>1.5 °C/s Max</td>
<td>1.5 °C/s Max</td>
</tr>
<tr>
<td>Time(ΔT)</td>
<td>60~120s</td>
<td>150~180s</td>
</tr>
</tbody>
</table>
3V rechargeable lithium battery

Optional for data logging application

For Venus634FLPx replacement application, these pins can be left unconnected

Optional biasing for active antenna
Optional for data logging application

3V rechargeable lithium battery

DCDC Converter (1.2V)

Optional for data logging application
APPLICATION CIRCUIT INTERFACE SIGNALS

GND_A: RF ground

LED: Signal to indicate GPS position status, 3.3V LVTTL.
Active low for no-fix, toggle every second after position fix.

PSE_SEL: Search engine mode selection, sampled only at end of power-on reset cycle
1: Low power acquisition mode
0: Enhanced acquisition mode

GND: Digital ground

P1PPS: 1 pulse per second time-mark (3.3V LVTTL)

RSTN: Active low reset input

VCC33: 3.3V power input

FRXD0: UART input (3.3V LVTTL)

FTXD0: UART output (3.3V LVTTL)

VBAT: Battery-backed RTC and SRAM supply input, 1.5V ~ 6V, must not be unconnected.
APPLICATION INFORMATION

1. For fast-rising power supply, a simple series R/C reset delay to pin-1, RSTN, as indicated in the application circuit is suitable. For system having slow-rising power supply, a reset IC providing 2~5ms reset duration may be necessary.

2. The RF input of Venus638FLPx is already matched to 50-ohm. Passive antenna matched to 50-ohm can be directly applied.

3. For using Venus638FLPx with active antenna, one with gain in range of 10~30dB and noise figure < 2dB can be used. Power to the active antenna needs to be applied externally.

4. Pin-18 VBAT supplies backup power to the real-time clock and backup SRAM for fast startup. For portable applications where there is battery with voltage in range of 1.5V ~ 6.0V as the main source, the VBAT pin can be directly connected to it. If VBAT is connected to main power as pin-2, no supply voltage as Venus638FLPx is powered off, then it’ll cold start every time and GPS performance will not be optimal.

5. Like BGA device, the Venus638FLPx is moisture sensitive. It needs to be handled with care to void damage from moisture absorption and SMT re-flow. The device should be baked for 24 hours at 125-degC before mounting for SMT re-flow if it has been removed from the protective seal for more than 48 hours.

6. The supported SPI Flash memory verified for data logging application are:

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Device ID</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>EON</td>
<td>EN25F040</td>
<td>4Mbit</td>
</tr>
<tr>
<td>EON</td>
<td>EN25F080</td>
<td>8Mbit</td>
</tr>
<tr>
<td>MXIC</td>
<td>MX25L400</td>
<td>4Mbit</td>
</tr>
<tr>
<td>MXIC</td>
<td>MX25L800</td>
<td>8Mbit</td>
</tr>
<tr>
<td>MXIC</td>
<td>MX25L1605</td>
<td>16Mbit</td>
</tr>
<tr>
<td>MXIC</td>
<td>MX25L3205</td>
<td>32Mbit</td>
</tr>
<tr>
<td>MXIC</td>
<td>MX25L6405</td>
<td>64Mbit</td>
</tr>
<tr>
<td>WINBOND</td>
<td>W25X40</td>
<td>4Mbit</td>
</tr>
<tr>
<td>WINBOND</td>
<td>W25X80</td>
<td>8Mbit</td>
</tr>
<tr>
<td>WINBOND</td>
<td>W25X16</td>
<td>16Mbit</td>
</tr>
<tr>
<td>WINBOND</td>
<td>W25X32</td>
<td>32Mbit</td>
</tr>
<tr>
<td>WINBOND</td>
<td>W25X64</td>
<td>64Mbit</td>
</tr>
<tr>
<td>SST</td>
<td>SST25LF040</td>
<td>4Mbit</td>
</tr>
<tr>
<td>SST</td>
<td>SST25LF080</td>
<td>8Mbit</td>
</tr>
<tr>
<td>SST</td>
<td>SST25VF016</td>
<td>16Mbit</td>
</tr>
<tr>
<td>SST</td>
<td>SST25VF032</td>
<td>32Mbit</td>
</tr>
</tbody>
</table>

7. The P1PPS pin must not be pulled-high during power on reset, or it’ll enter into debug mode and freeze.

*1: Actual will be longer, moisture sensitivity level still undergoing verification.
SLEEP MODE

For application requiring sleep mode, it can be implemented using regulator with enable control as below figure shows. To put Venus638FLPx to sleep, the power to Venus638FLPx is cut off by disabling the regulator via host processor GPIO pin. In sleep mode, VBAT consume less than 10uA. Fast start up operation is provided by keeping supply voltage to VBAT constant, retaining the internal data and keep RTC running while Venus638FLPx is put to sleep or when supply 3.3V power is removed.

For applications needing sleep mode but cannot have extra cost of adding a rechargeable backup supply battery, it can be implemented as below figure shows. It will provide fast start up when Venus638FLPx is put to sleep and awakened, but will cold start every time when the 3.3V supply voltage is removed and re-applied again.

When using sleep mode, add 10K series resistor on pin-42 RXD0 and pin-44 TXD0.
NMEA MESSAGES

The full descriptions of supported NMEA messages are provided at the following paragraphs.

**GGA - Global Positioning System Fix Data**

Time, position and fix related data for a GPS receiver.

Structure:

$GPGGA,hhmmss.sss,ddmm.mmmm,a,dddmm.mmmm,a,x,xx,x.x,x.x,M,,,xxxx*hh<CR><LF>

Example:

$GPGGA,111636.932,2447.0949,N,12100.5223,E,1,11,0.8,118.2,M,,,,0000*02<CR><LF>

<table>
<thead>
<tr>
<th>Field</th>
<th>Name</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>UTC Time</td>
<td>111636.932</td>
<td>UTC of position in hhmmss.sss format, (000000.000 ~ 235959.999)</td>
</tr>
<tr>
<td>2</td>
<td>Latitude</td>
<td>2447.0949</td>
<td>Latitude in ddmm.mmmm format</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leading zeros transmitted</td>
</tr>
<tr>
<td>3</td>
<td>N/S Indicator</td>
<td>N</td>
<td>Latitude hemisphere indicator, 'N' = North, 'S' = South</td>
</tr>
<tr>
<td>4</td>
<td>Longitude</td>
<td>12100.5223</td>
<td>Longitude in dddmm.mmmm format</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leading zeros transmitted</td>
</tr>
<tr>
<td>5</td>
<td>E/W Indicator</td>
<td>E</td>
<td>Longitude hemisphere indicator, 'E' = East, 'W' = West</td>
</tr>
<tr>
<td>6</td>
<td>GPS quality indicator</td>
<td>1</td>
<td>GPS quality indicator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0: position fix unavailable</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1: valid position fix, SPS mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2: valid position fix, differential GPS mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3: GPS PPS Mode, fix valid</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4: Real Time Kinematic. System used in RTK mode with fixed integers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5: Float RTK. Satellite system used in RTK mode. Floating integers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6: Estimated (dead reckoning) Mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7: Manual Input Mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8: Simulator Mode</td>
</tr>
<tr>
<td>7</td>
<td>Satellites Used</td>
<td>11</td>
<td>Number of satellites in use, (00 ~ 12)</td>
</tr>
<tr>
<td>8</td>
<td>HDOP</td>
<td>0.8</td>
<td>Horizontal dilution of precision, (00.0 ~ 99.9)</td>
</tr>
<tr>
<td>9</td>
<td>Altitude</td>
<td>108.2</td>
<td>mean sea level (geoid), (-9999.9 ~ 17999.9)</td>
</tr>
<tr>
<td>10</td>
<td>DGPS Station ID</td>
<td>0000</td>
<td>Differential reference station ID, 0000 ~ 1023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NULL when DGPS not used</td>
</tr>
<tr>
<td>11</td>
<td>Checksum</td>
<td>02</td>
<td></td>
</tr>
</tbody>
</table>
**GLL – Latitude/Longitude**

Latitude and longitude of current position, time, and status.

Structure:

```
$GPGLL,ddmm.mmmm,a,dddmm.mmmm,a,hhmms.sss,A,a*hh<CR><LF>
```

1              2            3             4               5       6  7    8

Example:

```
$GPGLL,2447.0944,N,12100.5213,E,112609.932,A,A*57<CR><LF>
```

<table>
<thead>
<tr>
<th>Field</th>
<th>Name</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Latitude</td>
<td>2447.0944</td>
<td>Latitude in ddmm.mmmm format</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leading zeros transmitted</td>
</tr>
<tr>
<td>2</td>
<td>N/S Indicator</td>
<td>N</td>
<td>Latitude hemisphere indicator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'N' = North</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'S' = South</td>
</tr>
<tr>
<td>3</td>
<td>Longitude</td>
<td>12100.5213</td>
<td>Longitude in dddmm.mmmm format</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leading zeros transmitted</td>
</tr>
<tr>
<td>4</td>
<td>E/W Indicator</td>
<td>E</td>
<td>Longitude hemisphere indicator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'E' = East</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'W' = West</td>
</tr>
<tr>
<td>5</td>
<td>UTC Time</td>
<td>112609.932</td>
<td>UTC time in hhmmss.sss format (000000.000 ~ 235959.999)</td>
</tr>
<tr>
<td>6</td>
<td>Status</td>
<td>A</td>
<td>Status, 'A' = Data valid, 'V' = Data not valid</td>
</tr>
<tr>
<td>7</td>
<td>Mode Indicator</td>
<td>A</td>
<td>Mode indicator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'N' = Data not valid</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'A' = Autonomous mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'D' = Differential mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'E' = Estimated (dead reckoning) mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'M' = Manual input mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'S' = Simulator mode</td>
</tr>
<tr>
<td>8</td>
<td>Checksum</td>
<td>57</td>
<td></td>
</tr>
</tbody>
</table>
GSA – GNSS DOP and Active Satellites

GPS receiver operating mode, satellites used in the navigation solution reported by the GGA or GNS sentence and DOP values.

Structure:
$GPGSA,A,x,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,x.x,x.x,x.x*hh<CR><LF>

Example:
$GPGSA,A,3,05,12,21,22,30,09,18,06,14,01,31,,1.2,0.8,0.9*36<CR><LF>

<table>
<thead>
<tr>
<th>Field</th>
<th>Name</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mode</td>
<td>A</td>
<td>Mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>‘M’ = Manual, forced to operate in 2D or 3D mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>‘A’ = Automatic, allowed to automatically switch 2D/3D</td>
</tr>
<tr>
<td>2</td>
<td>Mode</td>
<td>3</td>
<td>Fix type</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 = Fix not available</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 = 2D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 = 3D</td>
</tr>
<tr>
<td>3</td>
<td>Satellite used 1~12</td>
<td>05,12,21,22,3</td>
<td>Satellite ID number, 01 to 32, of satellite used in solution, up to 12 transmitted</td>
</tr>
<tr>
<td></td>
<td></td>
<td>09,18,06,14,01,31,,</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>PDOP</td>
<td>1.2</td>
<td>Position dilution of precision (00.0 to 99.9)</td>
</tr>
<tr>
<td>5</td>
<td>HDOP</td>
<td>0.8</td>
<td>Horizontal dilution of precision (00.0 to 99.9)</td>
</tr>
<tr>
<td>6</td>
<td>VDOP</td>
<td>0.9</td>
<td>Vertical dilution of precision (00.0 to 99.9)</td>
</tr>
<tr>
<td>7</td>
<td>Checksum</td>
<td>36</td>
<td></td>
</tr>
</tbody>
</table>
**GSV – GNSS Satellites in View**

Number of satellites (SV) in view, satellite ID numbers, elevation, azimuth, and SNR value. Four satellites maximum per transmission.

Structure:

$GPGSV,x,x,xx,xx,xxx,xx,...,xx,xx,xxx,xx *hh<CR><LF>

```
1 2 3 4 5 6 7 4 5 6 7 8
```

Example:

$GPGSV,3,1,12,05,469,45,12,44,061,44,21,07,184,46,22,78,289,47*72<CR><LF>

$GPGSV,3,2,12,30,65,118,45,09,12,047,37,18,62,157,47,06,08,144,45*7C<CR><LF>

$GPGSV,3,3,12,14,39,330,42,01,00,06,299,38,31,30,256,44,32,36,320,47*7B<CR><LF>

<table>
<thead>
<tr>
<th>Field</th>
<th>Name</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Number of message</td>
<td>3</td>
<td>Total number of GSV messages to be transmitted (1-3)</td>
</tr>
<tr>
<td>2</td>
<td>Sequence number</td>
<td>1</td>
<td>Sequence number of current GSV message</td>
</tr>
<tr>
<td>3</td>
<td>Satellites in view</td>
<td>12</td>
<td>Total number of satellites in view (00 ~ 12)</td>
</tr>
<tr>
<td>4</td>
<td>Satellite ID</td>
<td>05</td>
<td>Satellite ID number, GPS: 01 ~ 32, SBAS: 33 ~ 64 (33 = PRN120)</td>
</tr>
<tr>
<td>5</td>
<td>Elevation</td>
<td>54</td>
<td>Satellite elevation in degrees, (00 ~ 90)</td>
</tr>
<tr>
<td>6</td>
<td>Azimuth</td>
<td>069</td>
<td>Satellite azimuth angle in degrees, (000 ~ 359 )</td>
</tr>
<tr>
<td>7</td>
<td>SNR</td>
<td>45</td>
<td>C/No in dB (00 ~ 99)</td>
</tr>
<tr>
<td>8</td>
<td>Checksum</td>
<td>72</td>
<td>Null when not tracking</td>
</tr>
</tbody>
</table>
**RMC – Recommended Minimum Specific GNSS Data**

Time, date, position, course and speed data provided by a GNSS navigation receiver.

**Structure:**

$GPRMC,hhmmss.sss,A,dddmm.mmmm,a,dddmm.mmmm,a,x.x,x.x,ddmmyy,,,a*hh<CR><LF>

**Example:**

$GPRMC,111636.932,A,2447.0949,N,12100.5223,E,000.0,000.0,030407,,,A*61<CR><LF>

<table>
<thead>
<tr>
<th>Field</th>
<th>Name</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>UTC time</td>
<td>0111636.932</td>
<td>UTC time in hhmmss.sss format (000000.00 ~ 235959.999)</td>
</tr>
<tr>
<td>2</td>
<td>Status</td>
<td>A</td>
<td>Status</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'V' = Navigation receiver warning</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'A' = Data Valid</td>
</tr>
<tr>
<td>3</td>
<td>Latitude</td>
<td>2447.0949</td>
<td>Latitude in dddmm.mmmm format</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leading zeros transmitted</td>
</tr>
<tr>
<td>4</td>
<td>N/S indicator</td>
<td>N</td>
<td>Latitude hemisphere indicator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'N' = North</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'S' = South</td>
</tr>
<tr>
<td>5</td>
<td>Longitude</td>
<td>12100.5223</td>
<td>Longitude in dddmm.mmmm format</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Leading zeros transmitted</td>
</tr>
<tr>
<td>6</td>
<td>E/W Indicator</td>
<td>E</td>
<td>Longitude hemisphere indicator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'E' = East</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'W' = West</td>
</tr>
<tr>
<td>7</td>
<td>Speed over ground</td>
<td>000.0</td>
<td>Speed over ground in knots (000.0 ~ 999.9)</td>
</tr>
<tr>
<td>8</td>
<td>Course over ground</td>
<td>000.0</td>
<td>Course over ground in degrees (000.0 ~ 359.9)</td>
</tr>
<tr>
<td>9</td>
<td>UTC Date</td>
<td>030407</td>
<td>UTC date of position fix, ddmmyy format</td>
</tr>
<tr>
<td>10</td>
<td>Mode indicator</td>
<td>A</td>
<td>Mode indicator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'N' = Data not valid</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'A' = Autonomous mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'D' = Differential mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'E' = Estimated (dead reckoning) mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'M' = Manual input mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'S' = Simulator mode</td>
</tr>
<tr>
<td>11</td>
<td>checksum</td>
<td>61</td>
<td></td>
</tr>
</tbody>
</table>
VTG – Course Over Ground and Ground Speed

The Actual course and speed relative to the ground.

Structure:

GPVTG,x.x,T,,M,x.x,N,x.x,K,a*hh<CR><LF>

    1  2  3  4  5

Example:

$GPVTG, 000.0,T,,M,000.0,N,0000.0,K,A*3D<CR><LF>

<table>
<thead>
<tr>
<th>Field</th>
<th>Name</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Course</td>
<td>000.0</td>
<td>True course over ground in degrees (000.0 ~ 359.9)</td>
</tr>
<tr>
<td>2</td>
<td>Speed</td>
<td>000.0</td>
<td>Speed over ground in knots (000.0 ~ 999.9)</td>
</tr>
<tr>
<td>3</td>
<td>Speed</td>
<td>0000.0</td>
<td>Speed over ground in kilometers per hour (0000.0 ~ 1800.0)</td>
</tr>
<tr>
<td>4</td>
<td>Mode</td>
<td>A</td>
<td>Mode indicator</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'N' = not valid</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'A' = Autonomous mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'D' = Differential mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'E' = Estimated (dead reckoning) mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'M' = Manual input mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>'S' = Simulator mode</td>
</tr>
<tr>
<td>5</td>
<td>Checksum</td>
<td>3D</td>
<td></td>
</tr>
</tbody>
</table>
## ORDERING INFORMATION

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venus638FLPx-L</td>
<td>Flash version GPS receiver (internal 1.2V LDO version)</td>
</tr>
<tr>
<td>Venus638FLPx-D</td>
<td>Flash version GPS receiver (external 1.2V version)</td>
</tr>
</tbody>
</table>

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Change Log

Version 0.7, January 25, 2011
1. Changed latitude, longitude, speed, heading number of digits back to original format due to customer backward compatibility issue

Version 0.6, October 20, 2010
1. Edited performance spec due to firmware enhancement
2. Added 1 more decimal digit to latitude, longitude, speed, heading in NMEA sentence

Version 0.5, August 31, 2010
1. Added application information on P1PPS pin

Version 0.4, August 3, 2010
1. Pin-1 orientation in the shipping tray rotated 90-degree

Version 0.3, April 6, 2010
1. Modified for Flash type

Version 0.2, March 24, 2010
1. Added current consumption number for –D version at 3.3V

Version 0.1, February 24, 2010
1. Initial release