Fully Integrated GPS Modules Including Antenna

ORG-1100 Data Sheet

Contents

1. Introduction

ORG-1100 receiver module with built-in antenna has been designed to address markets where performance, highest level of integration, power and flexibility are very important. The ORG-1100 is OriginGPS smallest, autonomous, fully featured GPS receiver. The module provides a miniature multi-channel receiver that continuously tracks all satellites in view and provides accurate positioning data.
Featuring OriginGPS microstrip patch antenna and OriginGPS Noise-Free Zones technology the ORG-1100 offers the ultimate in high sensitivity GPS performance, capable of both autonomous and aided modes of operation.
The module can track down extremely weak signals and offers unparalleled accuracy and extremely fast fixes even under weak or noisy GPS signal conditions such as in built-up urban areas, dense foliage, indoors or while subject to challenging temperature profiles.
The ORG-1100 module is a complete SiP (System-in-Package) featuring advanced miniature packaging technology and an ultra small footprint designed to commit unique integration features for high volume, low cost and low power applications where tighter integration is required.
OriginGPS innovative material engineering approach resulted in microstrip patch antenna with outstanding narrow band performance.
OriginGPS case study of the specifications of key components through involvement in R&D effort of major vendors derived in highest performance in industry's smallest footprint parts available. These components placement using OriginGPS NFZ (Noise-Free Zones) technology created hard-to-achieve laboratory performance in heavy-duty environment.

2. Description

OriginGPS has revised and enhanced the architecture of classic GPS receivers.
In-house designed microstrip patch antenna with highest GPS-band performance and notch filtering for out-of band signals provides high selectivity. Furthermore, combined with internal shielding and built-in ground plane features, the ORG-1100 shows good noise immunity and exceptional sensitivity.
Carefully selected key components including TCXO and LNA resulted in faster TTFF and operation stability under rapid environmental changes.
On-board Power Management comprising high temperature stability with high PSRR allows operation over a wide input voltage range down to 3.0 VDC with single voltage supply.

2.1 Features

- Fully integrated multi channel GPS receiver
- Microstrip patch antenna
- Acquisition sensitivity: -157dBm
- Tracking sensitivity: -159dBm
- Fast TTFF: <40s (typical) under cold start conditions
- Sophisticated baseband algorithms for complicated signal environments
- Hosted architecture for stand alone operation

- Control plane and user plane A-GPS advanced aiding capability
- Automatic and user defined power saving scenarios
- Low power consumption: 135mW
- UART communication
- Single operating voltage: 3.3V to 5.5V
- Small size: 17mm x 17mm x 3.2mm
- Industrial operating temperature range: -40 to 85^{0}C
- Pb-Free RoHS compliant

2.2 Architecture

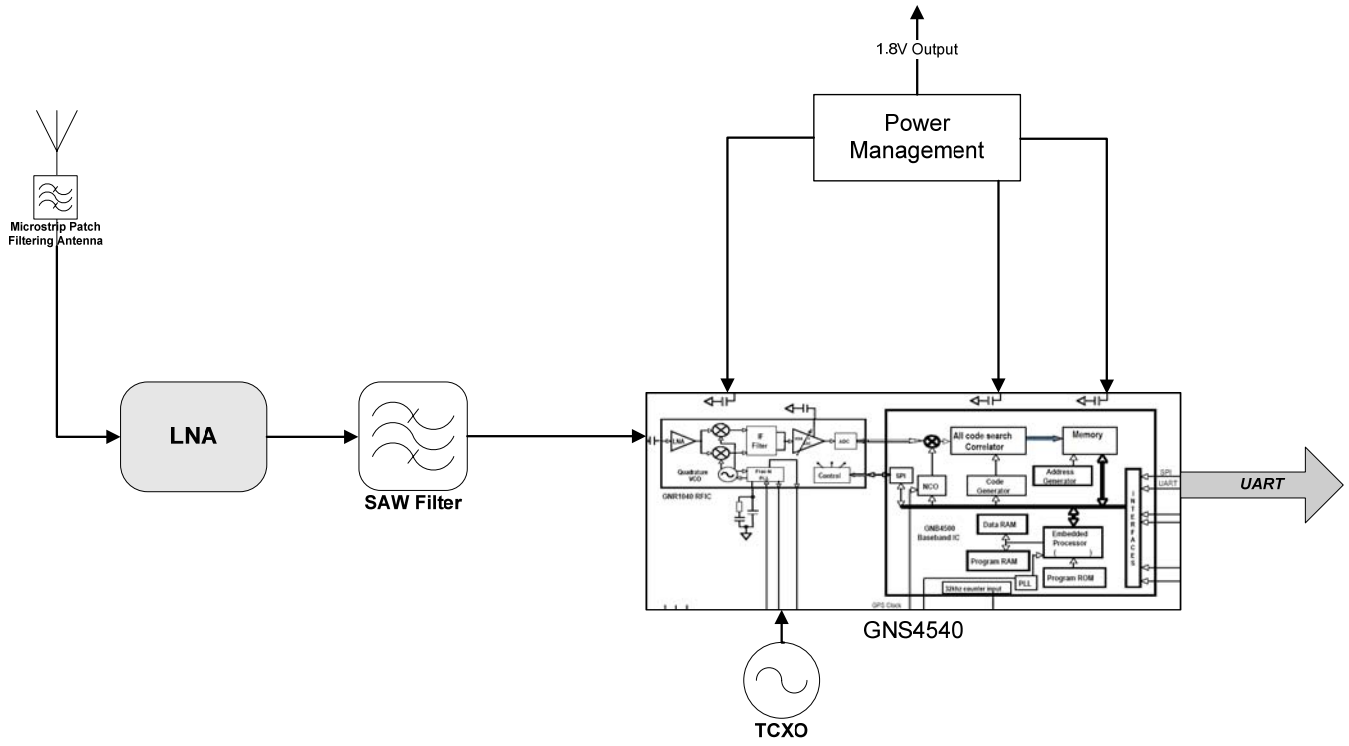

Figure 2-1: ORG-1100 architecture

- **Microstrip Patch Antenna**
  OriginGPS microstrip patch antenna collects signals at 1575.42 MHz from the medium and blocks out of GPS L1 band frequencies.

- **LNA (Low Noise Amplifier)**
  The LNA amplifies the GPS signal to meet GNS4540 RF front-end signal chain input threshold. Noise figure optimizing design was implemented to provide maximum sensitivity.

- **Band-pass SAW Filter**
  Band-pass SAW filter eliminates inter-modulated out-of-band signals that may corrupt

receiver performance.

- **GNS4540 IC**
  GNS4540 comprises RF and Baseband sections.

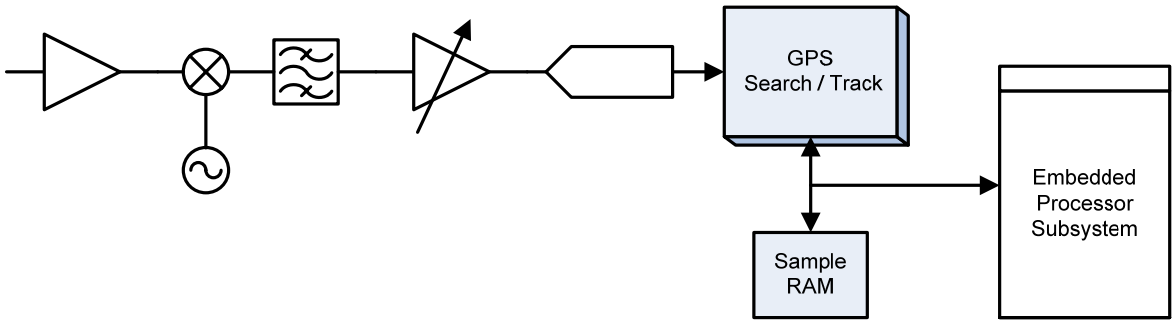

Figure 2-2: GNS4540 block diagram

GPS RF section includes the following features:
- Mixer
- IF band-pass filter
- VCO and high performance fractional-N PLL

GPS Baseband section includes the following features:
- Embedded DSP (Digital Signal Processing) block for GPS acquisition and tracking
- ROM for embedded DSP firmware
- Correlation engine
- GPS Code generation.
- Coherent and Incoherent summation block
- Doppler wipe off.
- Magnitude calculation.
- Compare & threshold signal detection.
- Timing and control.
- Power saving features.
- Clocking architectures.
- UART interface to host

- **TCXO (Temperature Compensated Crystal Oscillator):**
  This highly stable 16.368 MHz oscillator controls the down conversion process for the RFIC block. Highest characteristics of this component are key factors in fast TTFF.

- **Power Management:**
  This supplies a regulated voltage for the internal circuitry and 1.8V output for external load. The characteristics of this section of the circuit define the low power consumption and high PSRR performance.

2.3 Applications

The ORG-1100 was specially designed to meet wide range of OEM configurations and applications.
The small size of the module and full integration feature makes it ideal for integration in:

- Cellular handsets - for navigation and location-based services.
- Handheld consumer navigation and multifunction devices.
- Precise timing devices.

The high sensitivity of the module makes it ideal for application in:

- Vehicle and people tracking devices – while weak GPS signal reception or indoor tracking.
- Asset tracking – while dense foliage impacts GPS signal reception.
- Automotive navigation systems – while module installation position and orientation limits satellites visibility.
- Marine navigation systems – while multipath reception degrades receiver performance.

3. Specifications

3.1 Mechanical specifications

- The ORG-1100 module has advanced miniature packaging and a LGA footprint.
- It is a surface mount device packaged on a miniature printed circuit board with a metallic RF enclosure on one side and microstrip patch antenna on top.
- There are 22 surface mount connection pads with a base metal of copper and an Electroless Nickel / Immersion Gold (ENIG) finish.
- The ORG-1100 module has been designed for automated pick and place assembly and reflow soldering processes.
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Dimensions	Length	Width	Height
mm	17 0.1	17 ± 0.1	3.2 ± 0.1
inch	0.67 ± 0.004	0.67 ± 0.004	0.125 ± 0.004

Weight	
gr	2.2
oz	0.1

Table 3-1: Mechanical information

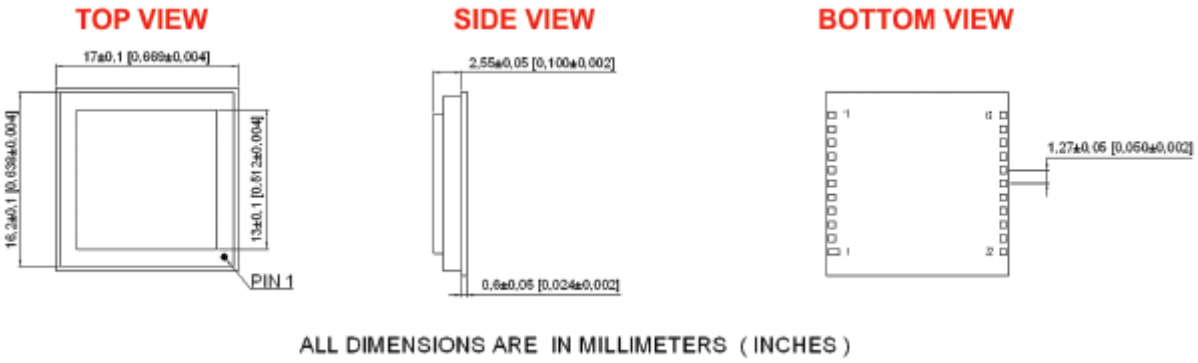

Figure 3-2: Mechanical outline drawing

3.2 Pin Assignment

Pin Number	Pin Name	Pin Description	Direction	Default
1	BOOTSEL	XTAL Source Selection	Input	Low
2	TxDA	Host UART Transmit	Output	High
3	RxDA	Host UART Receive	Input	Low
4	1PPS	1 Pulse Per Second	Output	Low
5	GND	System Ground	Power	
6	GND	System Ground	Power	
7	RxDB	Test UART Receive	Input	Low
8	TxDB	Test UART Transmit	Output	High
9	GND	System Ground	Power	
10	V_HOST_3V3	Vcc	Power Input	
11	RESET	Asynchronous Reset	Input	High
12	GND	System Ground	Power	
13	GND	System Ground	Power	
14	NC	Not Connected		
15	GND	System Ground	Power	
16	VDD1V8OUT	1.8V	Power Output	
17	GND	System Ground	Power	
18	GND	System Ground	Power	
19	GPIOA	General Purpose	Output	High
20	GPIOC	General Purpose	Input/Output	Low
21	GPIOB	General Purpose	Output	High
22	GPIOD	General Purpose	Output	High

Table 3-3: ORG-1100 Module pin-out

3.3 Electrical Specifications

Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units
Power supply voltage	Vcc	0	7	V
UARTA Input voltage	V_{RxDA}		3.6	V
UARTB Input voltage	V_{RxDB}		3.6	V
Digital input voltage	V_I		2.75	V
Storage temperature	T_{ST}	-40	+125	^{0}C

Table 3-4: Absolute maximum ratings

Operating Characteristics

Parameter	Symbol	Mode / Pin	Test Conditions	Min	Typ	Max	Units
Power supply voltage	V_{CC}			3	3.3	5.5	V
Power supply current	I_{CC}	Normal	V_{CC} = 3.3V T_{AMB} = 25^{0}C		41		mA
		Sleep			17.5		mA
		Standby			5.5		mA
Power supply rejection ratio	PSRR				60		dB
1.8V output voltage	V_{1V8}			1.76	1.8	1.84	V
1.8V output current	I_{1V8}					200	mA
Input voltage low state	V_{IL}	UART A				0.93	V
		UART B				0.93	V
		Dig. inputs				0.7	V
Input voltage high state	V_{IH}	UART A		2.3			V
		UART B		2.3			V
		Dig. inputs		1.7			V
Input leakage current	I_{in}					±10	µA
Output voltage low state	V_{OL}	UART A				0.1	V
		UART B	I_{OL} = 2.4mA			0.7	V
		Dig. outputs	I_{OL} = 2.4mA			0.7	V

Parameter	Symbol	Mode / Pin	Test Conditions	Min	Typ	Max	Units
Output voltage high state	V_{OH}	UART A	I_{OH} = -50µA	V_{CC} – 0.1			V
			I_{OH} = -4mA	V_{CC} – 0.5			V
		UART B	I_{OH} = -2.4mA	1.7			V
		Dig. outputs	I_{OH} = -2.4mA	1.7			V
Output current low state	I_{OL}		V_{OL} = 0.7V			3.4	mA
Output current high state	I_{OH}		V_{OH} = 1.7V			2	mA
Input capacitance	C_{in}				2		pF
Operating temperature	T_{AMB}			-40	25	85	^{0}C

Table 3-5: Operating characteristics

4. Performance

4.1 Receiver capabilities

Receiver Chipset	Glonav GNS4540
Frequency	GPS L1 – 1575.42 MHz, C/A Code
Channels	42 search capacity
	14 parallel tracking

Table 4-1: Receiver capabilities

4.2 Acquisition times

TTFF (Time To First Fix) – is the period of time from GPS power-up till position estimation.

Hot start

A hot start results from software reset after a period of continuous navigation or a return from a short idle period that was preceded by a period of continuous navigation. In this state, all of the critical data (position, velocity, time, and satellite ephemeris) is valid to the specified accuracy and available in SRAM.

Warm start

A warm start typically results from user-supplied position and time initialization data or continuous RTC operation with an accurate last known position available in memory. In this state, position and time data are present and valid but ephemeris data validity has expired.

Cold start

A cold start acquisition results when either position or time data is unknown. Almanac information is used to identify previously healthy satellites.

Aided start

Aiding is a method of effectively reducing the TTFF by making every start Hot or Warm.

	TTFF	Signal Level	Test Conditions
Hot Start	< 1s	-130 dBm (Outdoor)	The receiver has estimates of time/date/position and valid Almanac and Ephemeris data
Warm Start	< 15s	-130 dBm (Outdoor)	The receiver has estimates of time/date/position and Almanac
Cold Start	< 38s	-130 dBm (Outdoor)	The receiver has no estimate of time/date/position and no recent Almanac
Aided Start	< 15s	-152 dBm (Indoor)	GSM (coarse) and WCDMA/3G Aiding - time known to <2 sec, location known to <3Km, oscillator known to 0.05ppm, known Ephemeris for available satellites
	< 10s	-152 dBm (Indoor)	CDMA Aiding – time known to <100us, location known to <3Km,Oscillator known to 0.05ppm, known Ephemeris for available satellites
Signal Reacquisition	< 1s	-130 dBm (Outdoor)	The receiver's calibrated clock is not stopped

Table 4-2: Acquisition times

4.3 Sensitivity

	Signal Level
Acquisition	-157 dBm (Deep Indoor)
Tracking	-159 dBm (Deep Indoor)
Cold Start	-144 dBm

Table 4-3: Sensitivity

4.4 Power management

The ORG-1100 has four main operating modes, which are switched by internal state-machine and controlled by the High Level Software located on the host. These modes provide different levels of power and performance.

Normal Mode

In Normal Mode the ORG-1100 is active as a GPS receiver.
The ORG-1100 will automatically acquire and track GPS satellites.
In Normal Mode the GNS4540 IC will automatically enable or disable clocks to adapt power consumption for the operating environment parameters like satellite signal strength, user dynamics, Ephemeris validity etc.

When signal levels drop the receiver returns to full power so that message output rates remain constant.

Sleep Mode

The RF front-end is active while the GNS4540 is switched to a sleep state and most baseband clocks are disabled.
The ORG-1100 is placed into Sleep Mode either by a command from the Host Based Navigation Software or after staying idle for 30 sec. and woken from this state by either communications from the Host Based Navigation Software or from an internal wakeup function. Sleep Mode is supported for a maximum time of 60 sec. and after this the ORG-1100 will automatically transit to Deep Sleep Mode.
In Sleep Mode local time is maintained using the RF Clock. On exit from Sleep Mode tracking of GPS satellites previously being tracked will continue.

Deep Sleep Mode

All baseband clocks are disabled except RTC, the RF front-end is in power-save mode while the ORG-1100 is switched to a *Deep Sleep Mode*.
The ORG-1100 is placed into *Deep Sleep Mode* by a command from the Host Based Navigation Software and woken from this state by either communications from the Host Based Navigation Software or from an internal wakeup function. *Deep Sleep Mode* is supported for a maximum time of 19 hours (optionally 49 days).
In Deep Sleep Mode local time is maintained using the RTC clock.
On exit from *Deep Sleep Mode* GPS satellites previously being tracked will be reacquired rapidly while the satellite Ephemeris are still valid If a RTC is not available the ORG-1100 will switch to Shutdown Mode.

Shutdown Mode

The GNS4540 has all clocks disabled and the the RF front-end is in power-save mode.
The ORG-1100 is placed into Shutdown Mode by a command from the Host Based Navigation Software.
The only way to wake up from this mode is a via a Power On Reset.
This would be used whilr the system does not require any GPS functionality enabled.

Operation Mode	Power Consumption
Normal	135mW
Sleep	55mW
Shutdown	18mW

Table 4-4: Acquisition times

4.5 Timing and position accuracy

	Accuracy	Units	Test Conditions
1 PPS	< 1	µs	-130 dBm (Outdoor)
Position	< 5	2dRMS	-130 dBm (Outdoor)
	< 20		-148 dBm (Indoor)
	< 50		-152 dBm (Indoor)

Table 4-5: Timing

4.6 Dynamic constrains

Velocity	< 1500m/s (515m/s – software limited)
Acceleration	< 2g
Altitude	< 60,000ft (18,270m) – software limited

Table 4-6: Dynamic constrains

5. Software interface

5.1 Embedded firmware

All real time critical or high interrupt rate functions are performed within the embedded DSP firmware.
The embedded DSP Firmware performs the following functions:

- Interfaces to GPS baseband hardware:
- Searches for Satellites either autonomously or commanded using acquisition data from Host
- When a satellite has been acquired - transitions to track the satellite.
- Where possible - demodulates the satellite navigation message data.
- During satellite tracking - monitors the signals for validity and multipath.
- At the required update rate (typically 1Hz) sends the latest Raw Satellite Measurements to the host based navigation software

5.2 Interface settings

Host interface of the ORG-1100 is serial port. Additional serial port used for test and debug purposes (optional).

Serial Ports	UART A – Host Communication
	UART B - Test Communication
Serial Ports Mode	Full Duplex UART, 8-N-1 , Flow
Baud rate	9600 (default) to 115200 bps
Output stream	Glonav API, NMEA convertible

Table 5-1: Interface settings

5.3 Hardware software interface

The UART Interface typically uses an 115.2KBaud data rate, transferring about 4Kbytes of data per update.
The Host based navigation software sends requests for when the next raw satellite measurements are required and also provides satellite acquisition aiding data and channel/satellite reset commands.
The Host Based Navigation Software also sends commands for the ORG-1100 to go to Sleep, Deep Sleep or Standby Modes.
The Sleep command also specifies a time-out for the automatic transition from Sleep to Deep Sleep Mode.
A wakeup command is also provided.
The ORG-1100 responds by sending raw satellite measurements to the host based navigation Software at the requested time and also provides the parity checked raw sub frames of the satellite navigation messages (when available).

5.4 Host based navigation software

The host based navigation software is provided separately and will run on a range of processors, notably ARM processors and a variety of high level and real-time OSs.
The purpose of this software is to provide the user application with GPS position information. To do this, the GPS Navigation Software interfaces between the host processor software, the OS and the ORG-1100.
The Host Based Navigation Software performs the following functions:

- Interface to the GNS4540
- API Interface to Host Software
- Satellite Navigation Message Data Decode and State Table Generation
- Satellite Measurement Generation (Pseudo range, Doppler etc.)

5.5 Software functions

Table 5-2 shows the software features available to the ORG-1100

Feature	Description
Channels	Dynamic channel and dynamically configurable architecture management
Positioning Modes	Autonomous/Standalone, Mobile-Assisted, Mobile-Based, Simultaneous/Mixed Modes, Navigation (Kalman Filter)
Update Rate	User Selectable – event, position, command/request, periodic (10 per sec to 1 per hour)
Host SW Protocol Support	NMEA-0183, GLONAV API, Air Interface
Processor Requirements	No real-time processing requirements – only C compiler and floating point libraries

Table 5-2: Dynamic constrains

6. Handling information

6.1 Product packaging and delivery - TBD

6.2 Moisture sensitivity

Precautionary measures are required in handling, storing and using such devices to avoid damage from moisture absorption.
If localised heating is required to rework or repair the device, precautionary methods are required to avoid exposure to solder reflow temperatures that can result in performance degradation.
Further information can be obtained from the IPC/JEDEC standard *J-STD-033: Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices.*

6.3 ESD sensitivity

The ORG-1100 is ESD protected device according to +/- 2000KV HBM (JEDEC Human Body Model (JESD22, Method A114D)

6.4 Environmental information - TBD

6.5 Compliances

The ORG-1100 complies with the following:

- Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)
- Manufactured in an ISO 9000 : 2000 accredited facility

6.6 Safety information

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

6.7 Disposal information

We recommend that this product should not be treated as household waste.
For more detailed information about recycling this product, please contact your local waste management authority or the reseller from whom you purchased the product.

7. Ordering information

The part numbers of the ORG-1100 variants are shown in Table 7-1.

Part Number	Description
ORG-1100 - TR	ORG-1100 (standard)
ORG-1100 - USB	ORG-1100 evaluation USB stick
ORG-1100 - UAR	ORG-1100 evaluation demo

Table 7-1: ORG-1100 ordering information