OriginGPS
mini+mighty

ORG1511-MK05

GPS / GNSS Module with Integrated Antenna

DATASHEET

OriginGPS.com

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ABBREVIATIONS

Abbreviation	Description
AC	Alternating Current
ADC	Analog to Digital Converter
AGC	Automatic Gain Control
AGPS	Assisted GPS
AIC	Active Interference Cancellation
BEE	Broadcast Ephemeris Extension
CE	European Community conformity mark
CGEE	Client Generated Extended Ephemeris
CMOS	Complementary Metal-Oxide Semiconductor
CPU	Central Processing Unit
CTS	Clear-to-Send
CW	Continuous Wave
DC	Direct Current
DGPS	Differential GPS
DI	Distilled
DSP	Digital Signal Processor
EASY	Embedded Assist System
EC	European Community
ECHA	European Chemical Agency
EGNOS	European Geostationary Navigation Overlay Service
EIA	Electronic Industries Alliance
ENIG	Electroless Nickel Immersion Gold
EPO	Extended Prediction Orbit
SD	Electro-Static Discharge
ESR	Equivalent Series Resistance
EU	European Union
EVK	Evaluation Kit
FCC	Federal Communications Commission
FDMA	Frequency Division Multiple Access
FIFO	First in first out
FTP	File Transfer Protocol
GAGAN	GPS-Aided Geo-Augmented Navigation
GBAS	Ground-Based Augmentation System
GPIO	General Purpose Input or Output
HBM	Human Body Model
IF	Intermediate Frequency
IPC	Indoor Positioning System
ISO	International Organization for Standardization
JEDEC	Joint Electron Device Engineering Council

Abbreviation	Description
KA	Keep Alive
KF	Kalman Filter
LC	Filter combination of inductor and capacitor
LDO	Low Dropout regulator
LF	Line Feed (ASCII 10)
LGA	Land Grid Array
LNA	Low Noise Amplifier
LP	Low Power
LS	Least Squares
LSB	Least Significant Bit
MID	Message Identifier
MM	Machine Model
MSAS	Multi-functional Satellite Augmentation System
MSB	Most Significant Bit
MSD	Material Safety Data
MSL	Moisture Sensitivity Level
MTK	MediaTek
NFZ	Noise Free Zone
NMEA	National Marine Electronics Association
NPB	n-Propyl Bromide
NVM	Non-Volatile Memory
ØA	Diameter of A
OHSAS	Occupational Health and Safety Assessment Series
PCB	Printed Circuit Board
PCN	Product Change Notification
PIN	Input Power Range
PLL	Phase Lock Loop
PMTK	Proprietary MediaTek
PMU	Power Management Unit
PO	Purchase Order
POR	Power-On Reset
PPS	Pulse Per Second
PRF	RF Power
PRN	Pseudo-Random Noise
PS	Paste-side
PSRR	Power Supply Rejection Ratio
PTF	Push To Fix
QZSS	Quasi-Zenith Satellite System
RAM	Random Access Memory
REACH	Registration, Evaluation, Authorization, and Restriction of Chemical substances
RF	Radio Frequency

Abbreviation	Description
RFID	Radio Frequency Identification
RH	Relative Humidity
RHCP	Right-Hand Circular Polarized
RLIN	Input Return Loss
RMS	Root Mean Square
ROM	Read-Only Memory
RTC	Real-Time Clock
RTCM	Real Time Correction Measure
RTS	Ready-to-Send
RX	Receiver
SAW	Surface Acoustic Wave
SBAS	Satellite-Based Augmentation Systems
SC	Special Committee
SGEE	Server Generated Extended Ephemeris
SID	Sub-Identifier
SiP	System-in-Package
SMD	Surface Mounted Device
SMPS	Switched Mode Power Supply
SMT	Surface-Mount Technology
SoC	System-on-a-chip
SP	Standard Precision
SPI	Serial Peripheral Interface
SPQ	Standard Pack Quantity
STD	Standard Technical Design
SV	Satellite Vehicle
TAMB	Operating Temperature
TC	Classification Temperature
TCXO	Temperature-Compensated Crystal Oscillator
TL	Liquidous Temperature
TLEAD	Lead Temperature
TP	Package Temperature
TS	Soak/Preheat Temperature
TST	Storage Temperature
TTFF	Time to First Fix
TTL	Transistor-Transistor Logic
TTM	Time-to-Market
TX	Transmit
TYP	Typical
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
UTC	Universal Time Coordinated
VCC	Voltage Common Collector

Abbreviation	Description
VCCI	Voluntary Control Council for Interference by information technology equipment
VEP	Vertical Error Probability
VGA	Variable-Gain Amplifier
VIA	Electrical Connection Between Copper Layers In A Printed Circuit Board
VIO	I/O Voltage
VRF	RF Input Voltage
VTCXO	TCXO Voltage
WAAS	Wide Area Augmentation System
XVII	Number 17
ZIN	Input Impedance

RELATED DOCUMENTATION

Table 1. Related Documentation

№	Document Name
1	ORG1510 Evaluation Kit Datasheet
2	OriginGPS MTK NMEA Packet
3	MTK FAQ

REVISION CHANGES

Table 2. Revision History

Revision	Date	Change Description	Author
1.0	September 12, 2022	First release	Orel Nimni
1.1	October 12, 2022	Updated format for the following sections: 4.1, 4.2, 4.3.2, 4.3.9, 4.3.9.1, 4.4, 6.1, 8.2.2, 8.3.1, 15, 16.1. Updated constellation in section 4.1. Updated accuracy table in section 7.5 Updated 1PPS, updated the link in section 10.	Mark Rimer, Orel Nimni
1.2	November 24, 2022	Updated 1PPS, updated the link in the section 10.	Mark Rimer, Orel Nimni
1.3	May 22, 2023	Updated reference design, supply voltage ripple, accuracy (CEP)	Mark Rimer

SCOPE

This document describes the features and specifications of the ORG1511-MK05 GNSS module.

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OriginGPS navigation products are not recommended to use in lifesaving or life-sustaining applications.

SAFETY INFORMATION

Incorrect handling or misuse of the product can cause permanent damage.

This product is an electronic sensitive device (ESD) and must be handled with care.

DISPOSAL INFORMATION

This product must not be treated as household waste.

For more detailed information about recycling electronic components, contact your local waste-management authority.

CONTACT INFORMATION

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1. ABOUT THE HORNET FAMILY

OriginGPS GNSS receiver modules have been designed to address markets where size, weight, stand-alone operation, highest level of integration, power consumption, and design flexibility are all very important.

The OriginGPS Hornet family breaks the size barrier, offering the industry's smallest fully integrated, highly sensitive GPS and GNSS modules with integrated antennas or on-board RF connectors.

The Hornet family features OriginGPS' proprietary NFZ technology for high sensitivity and noise immunity even under marginal signal condition, commonly found in urban canyons, under dense foliage, or when the receiver's position in space rapidly changes.

The Hornet family enables the shortest TTM (Time-to-Market) with minimal design risks. Just connect the power supply to a single layer PCB.

2.   ABOUT THE ORG1511-MK05 MODULE

The ORG1511-MK05 module is a complete SiP featuring a miniature LGA SMT footprint designed to provide unique integration features for high volume, cost sensitive applications.

Designed to support compact and traditional applications such as smart watches, wearable devices, and asset trackers, the ORG1511-MK05 module is a miniature, multi-channel GPS, GLONASS, Galileo, SBAS, QZSS overlay system receiver that continuously tracks all satellites in view, providing real-time positioning data in industry standard NMEA format.

The ORG1511-MK05 module delivers superior sensitivity and outstanding performance, achieving rapid TTFF in less than one second, location accuracy of approximately two meters, and tracking sensitivity of -165dBm.

At only 10mm x 10mm in size, the ORG1511-MK05 module is the industry's smallest sized, module of its kind.

The ORG1511-MK05 module introduces the industry's lowest energy per fix ratio, unparalleled accuracy, and extremely fast fixes even under challenging signal conditions such as in built-up urban areas and dense foliage.

An integrated GPS system-on-a-chip (SoC) with a high-performance microprocessor and sophisticated firmware keeps positioning payload off the host, enabling the module to be integrated in embedded solutions while consuming only low computing resources.

The innovative architecture can detect changes in context, temperature, and satellite signals to achieve a state of near-continuous availability by maintaining and opportunistically updating its internal fine time, frequency, and satellite ephemeris data, while consuming mere microwatts of battery power.

3.   ABOUT ORIGINGPS

OriginGPS is a world leading designer, manufacturer, and supplier of miniature positioning modules, antenna modules, antenna solutions, and IoT devices.

OriginGPS develops fully integrated, miniaturized GPS/GNSS and integrated IoT solutions for developers. OriginGPS modules introduce unparalleled sensitivity and noise immunity by incorporating Noise-Free-Zone system (NFZ™) proprietary technology for faster position fixing and navigation stability even under challenging satellite signal conditions.

Founded in 2006, OriginGPS specializes in developing unique technologies that miniaturize RF modules, thereby addressing the market need for smaller wireless solutions. For over a decade, our experts have been developing ultra-sensitive, reliable, high-performance modules with the smallest footprint on the market, supporting a range of categories, such as asset tracking, fleet management, industrial IoT, law enforcement, pet/people tracking, precise agriculture, smart cities, sports and wearables.

4. MODULE DESCRIPTION

The following section provides a detailed description of the ORG1511-MK05 GNSS module.

4.1. Features

The ORG1511-MK05 is a feature-rich module, listed below are the main features included in the product.

- Autonomous operation
- Active on-board antenna
- Pin-to-pin compatibility with all OriginGPS 10x10 mm modules
- OriginGPS Noise Free Zone System (NFZ™) technology
- Fully integrated: Antenna element, Dual-stage LNA, SAW filter, TCXO, RTC crystal, GNSS SoC, LDO regulator, and RF shield
- Concurrent tracking of multiple constellations
- GPS, GLONASS and Galileo, and QZSS constellations
- GPS L1 1575.42 frequency, C/A code
- GLONASS L1 FDMA 1598-1606MHz frequency band SP signal
- Galileo E1 1575.42MHz frequency
- SBAS (WAAS, EGNOS, MSAS, and GAGAN)
- DGPS capability
- 99 search channels and 33 simultaneous tracking channels
- Ultra-high sensitivity down to -165dBm
- TTFF of < 1s in 50% of trials under Hot Start conditions
- Low power consumption of ≤ 15mW
- High accuracy of < 2.5m in 50% of trials
- High accuracy of 1.9m@CEP, open sky conditions during 24 hours
- AGPS support: Embedded Assist System (EASY) and Extended Prediction Orbit (EPO)
- Indoor and outdoor multipath and cross-correlation mitigation
- Jamming rejection – 12 multi-tone Active Interference Cancellation (AIC)
- 8 Megabit built-in flash
- Power management modes: Full Power Continuous, Standby, Periodic, and AlwaysLocate™
- NMEA commands and data output over UART serial interface or I2C
- High update message rate of 1, 2, 5, and 10Hz
- 1PPS output
- Static navigation
- Single voltage supply 3.3V
- Ultra-small LGA footprint of 10mm x 10mm

- Ultra-low weight of 1.43g
- Surface Mount Device (SMD)
- Optimized for automatic assembly and reflow equipment
- Operating from -40°C to +85°C
- FCC, CE, and VCCI compliant
- RoHS II/REACH compliant

4.2. Architecture
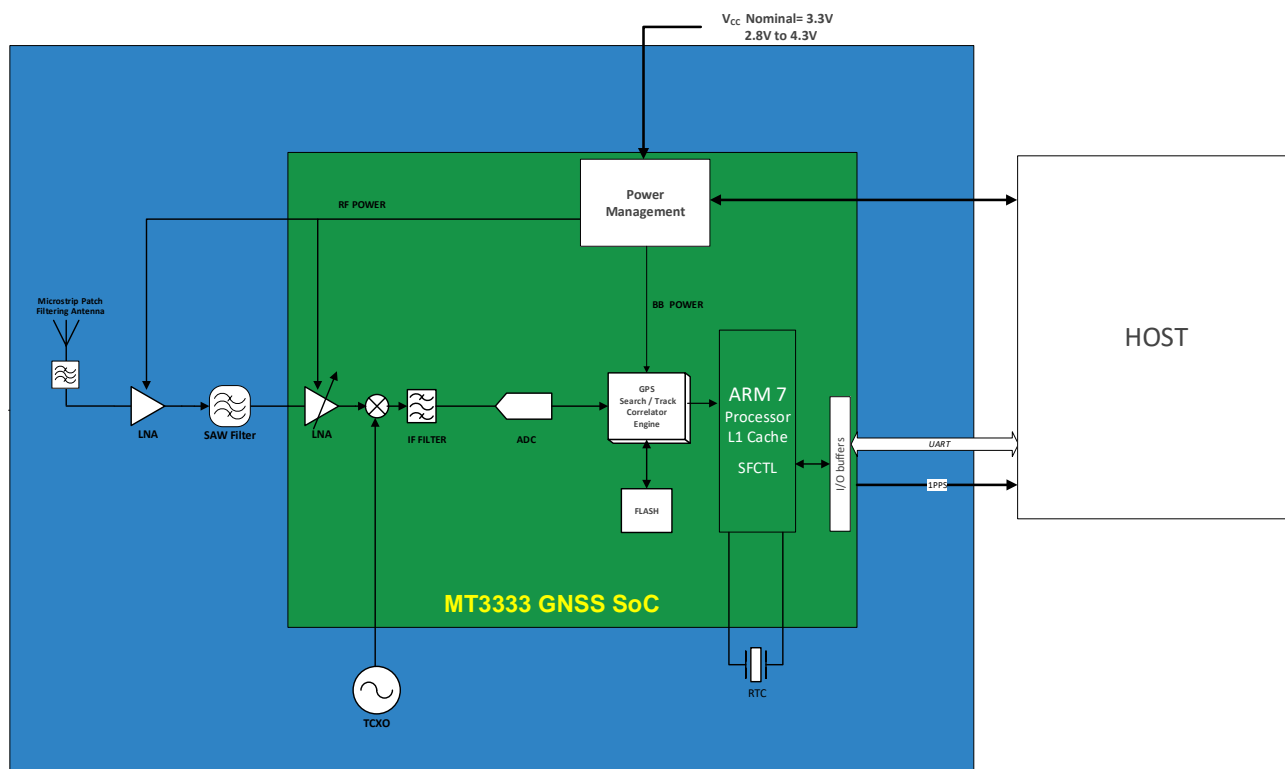
Figure 1. ORG1511-MK05 Architecture

- **Antenna**

The OriginGPS proprietary microstrip patch antenna collects GNSS signals from the medium.

The antenna is built from a hi-K ceramic element mounted on top of an RF shield, providing stable resonance.

- **GNSS SAW Filter**

A band-pass SAW filter eliminates out-of-band signals that could interfere with the reception of GNSS signals.

A GNSS SAW filter is optimized for low insertion loss in the GNSS band and low return toss outside of it.

- **GNSS LNA**

Dual stage cascaded LNAs amplify GNSS signals to meet the RF down converter input threshold.

Noise figure optimized design was implemented to provide maximum sensitivity.

- **TCXO**

A highly stable 26MHz oscillator controls the down conversion process in the RF block of the GNSS SoC.

Characteristics of this component are important factors for higher sensitivity, shorter TTFF, and better navigation stability.

- **RTC crystal**

An RTC 32.768KHz quartz crystal with very tight specifications is necessary to maintain Hot Start and Warm Start capabilities of the module.

- **RF Shield**

An RF enclosure avoids external interference from compromising sensitive circuitry inside the module.

An RF shield also blocks the module's internal high frequency emissions from radiation.

- **MT3333 GNSS SoC**

The MT3333, multi-GNSS system-on-a-chip (Soc) is designed by MediaTek, the world's leading digital media solution provider and the largest fab-less IC company in Taiwan.

It is a hybrid positioning processor that combines GPS, GLONASS, Galileo, SBAS, QZSS, DGPS, and AGPS to provide a high-performance navigation solution.

MT3333 is a full SoC built on a low-power RF CMOS, incorporating GNSS RF receiver, GNSS baseband, integrated navigation solution software, an ARM® processor, and a serial flash.
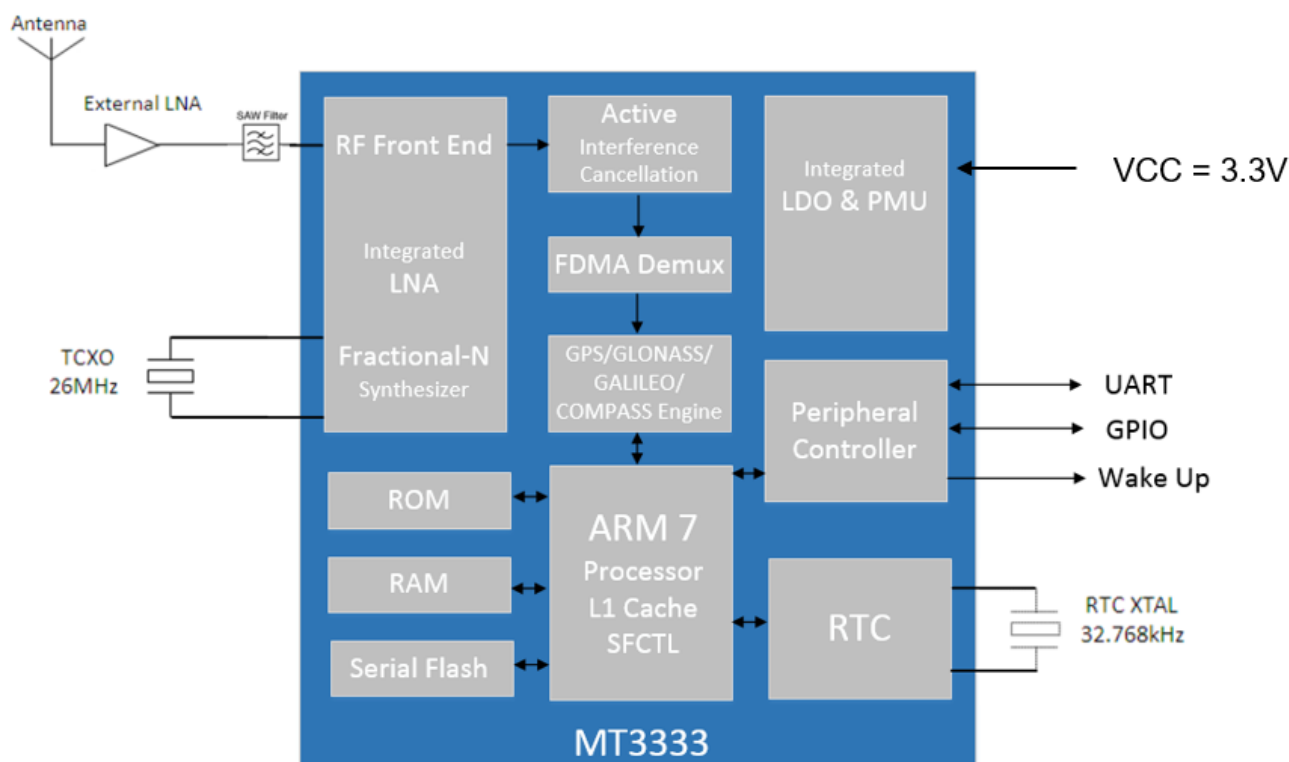
Figure 2. MT3333 System Block Diagram and Peripheral

The MT3333 SoC includes the following units:

- A GNSS radio subsystem including single input dual receive paths for concurrent GPS, GLONASS and Galileo, a mixer with a mode interface between the mixer and a multi-mode low pass filter, a fractional-N synthesizer, integrated self-calibrating filters, an IF VGA with AGC, and ADCs with a high-sample rate with an adaptive dynamic range.

- A measurement subsystem including a DSP core for GNSS signal acquisition and tracking, an interference scanner and a detector, interference removers, multipath and cross-correlation detectors, dedicated DSP code, a ROM, and a DSP cache RAM. The measurement subsystem interfaces with a GNSS radio subsystem and the navigation system.

- A navigation subsystem comprised of an ARM7® microprocessor system providing a position, velocity and time solution, a programmable ROM, a data RAM, a cache and a patch RAM, and an SPI flash.

- A peripheral controller subsystem including a UART host interface, an RTC block, a wake-up signal option, and a GPIO. The peripheral controller subsystem interfaces with a navigation subsystem, PLL, and PMU subsystems.

- A PMU subsystem with voltage regulators for RF and baseband domains.

4.3. Features Description

4.3.1. Constellation Configuration

- GPS, GLONASS, and GALILEO.

4.3.2. 1PPS

1PPS (Pulse Per Second) signal output available on the following configurations:

- Output PPS in either 2D or 3D fix mode
- Output PPS only in 3D fix mode
- Output PPS After the first Fix
- Always output PPS - default configuration

The following features may be configured via a command:

- Pulse duration
- Pulse frequency
- Active high or active low pulse

The pulse may vary $\pm$30nS (1 σ). There is no correlation between the PPC signal and the UTC.

4.3.3. Static Navigation

Static navigation is an operational mode in which the receiver freezes the position fix when the speed falls below a threshold (indicating that the receiver is stationary).

The course is also frozen, and the speed is reported as zero. The navigation solution is unfrozen when the speed increases above a threshold. The speed threshold can be set via a command (PMTK 386).

Static navigation is disabled by default but can be enabled with a command. This feature is useful for applications in which very low dynamics are not expected, the classic example being an automotive application.

4.3.4. Assisted GPS (AGPS)

Assisted GPS (or Aided GPS) is a method by which TTFF is reduced using information from a source other than broadcast GPS signals. The necessary ephemeris data is calculated either by the receiver itself (locally generated ephemeris) or by a server (server-generated ephemeris) and stored in the module.

The ORG1511-MK05 module has EASY, EPO, and HotStill technology enabling Hot Starts even in weak signal conditions and non-stationary states. The EPO (Extended Prediction Orbit) is one of MediaTek's innovative proprietary off-line server based AGPS solutions. The host can use an application to store and load the EPO files into the device. With a multi-constellation EPO, the user experience is enhanced by the improved Time-To-First-Fix (TTFF) and better first fix accuracy.

4.3.4.1. Locally-generated AGPS (Embedded Assist System – EASY)

The EASY™ is an embedded assist system for quick positioning. The GPS engine calculates and automatically predicts the single ephemeris (maximum up to 3 days) when the power is on and saves the prediction information into the memory. The GPS engine then uses this information for positioning. If insufficient information is received from the satellites, then the function is useful for positioning and TTFF improvement in dense urban conditions.

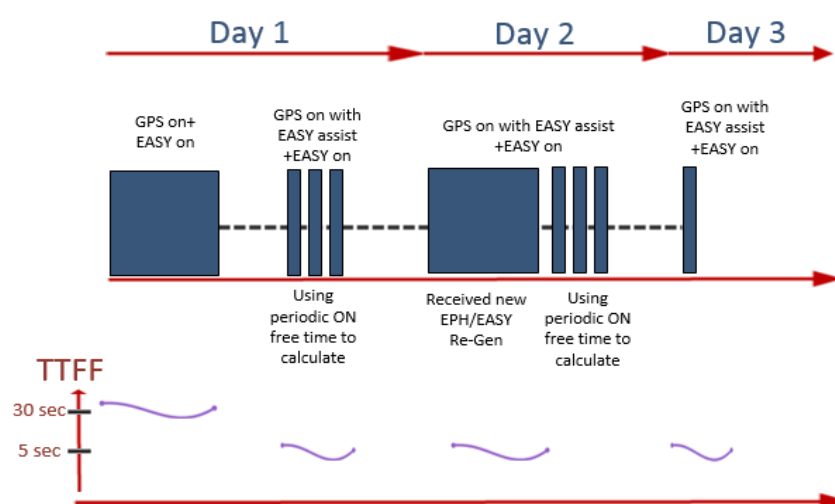**<u>Up to 3 days</u> extension for single received ephemeris:**

Figure 3. EASY™ TTFF Timing

4.3.4.2. Server-generated AGPS (Extended Prediction Orbit – EPO)

The AGPS (EPO™) supplies the predicated Extended Prediction Orbit data to speed up the TTFF, and users can download the EPO data to the GNSS engine from the FTP server by Internet or wireless network. The GNSS engine then uses the EPO data to assist position calculation when the navigation information of satellites is not sufficient or there is a weak signal zone. The acting host, an MCU or controller, can use an application to store and load the EPO files into the device. With multi-constellation EPO, the user experience is enhanced by the improved Time to First Fix (TTFF) and better first fix accuracy. The predicted ephemeris file is obtained from the AGPS server and is injected into the module over the serial port 1 (RX1). These predictions are valid for up to 14 days.

4.3.4.3. HotStill – EASY (Extended Prediction Orbit)

HotStill (EASY) is one of MTK's innovative proprietary, off-line, client-based A-GPS solutions that can greatly accelerate the GPS TTFF (Time to First Fix) in urban canyons or in a weak signal environment from several minutes to only a few seconds. It works as background software running on the host processor to predict satellite orbit navigation data and to generate a Broadcast Ephemeris Extension (BEE) from the received broadcast ephemeris as well and has no network connection requirements. The Hotstill feature is designed for use on smartphones and is not suitable for standalone designs.

4.3.5. Quasi-Zenith Satellite System (QZSS)

The three satellites of the Japanese SBAS are in a highly inclined elliptical orbit which is geosynchronous (not geostationary) and has analemma-like ground tracks. This orbit provides continuous coverage over Japan using only three satellites. Their primary purpose is to provide augmentation to the GPS system, but the signals may also be used for satellite ranging. NMEA reporting for QZSS may be enabled/disabled by the user.

4.3.6. Satellite-Based Augmentation System (SBAS)

The ORG1511-MK05 receiver is capable of using Satellite-Based Augmentation System (SBAS) satellites as a source of both differential corrections and satellite range measurements. These systems (WAAS, EGNOS, MSAS, and GAGAN) use geostationary satellites to transmit regional differential corrections via a GNSS-compatible signal. The use of SBAS corrections can significantly improve position accuracy and is enabled by default.

4.3.7. Differential GPS (DGPS)

DGPS is a Ground-Based Augmentation System (GBAS) used for reducing position errors by applying corrections from a set of accurately surveyed ground stations located over a wide area. These reference stations measure the range to each satellite and compare it to the predicted known range. Once correction data is received by the DGPS receiver, the difference between the known and the measured ranges may be used to compute a set of corrections that are transmitted to a DGPS receiver, either by radio or over the Internet. The DGPS receiver can then send correction data to the serial port 1 (RX1) using the RTCM SC-104 message protocol. These corrections can

significantly improve the accuracy of the position reported to the user. The receiver can accept and apply either the RTCM SC-104 messages or SBAS differential data.

4.3.8. Jamming Rejection – Active Interference Cancellation (AIC)

The ORG1511-MK05 module detects, tracks, and removes narrow-band interfering signals (jamming signals) without additional external components or tuning. It tracks and removes up to 12 CW (Continuous Wave) type signals up to −80 dBm (total power signal levels). By default, the jamming detection is enabled but can be disabled by a command. This feature is useful both in the design stage and during the production stage for uncovering issues related to unexpected jamming. When enabled, the AIC increases current consumption by about 1 mA. The impact on GNSS performance is minimal at low jamming levels, however at high jamming levels (e.g., -90 to -80 dBm), the RF signal sampling ADC starts to become saturated, after which the GNSS signal levels start to diminish.

4.3.9. Power Management Modes

The ORG1511-MK05 module supports operational modes that enable providing positioning information at reduced overall current consumption. The availability of GNSS signals in the operating environment is also a factor in the choice of power management modes. The designer can choose a mode that provides the best trade-off between performance and power consumption.

The power management modes are described below, and can be enabled via a command:

- Full Power Continuous - for best GNSS performance
- Power Saving mode to optimize power consumption:
- Standby
- Periodic
- AlwaysLocate™
- Backup mode

4.3.9.1. Full Power Continuous Mode

The modules start up in Full Power Continuous mode. This mode uses the acquisition engine at full performance resulting in the shortest possible TTFF with the highest sensitivity. It searches for all possible satellites. The receiver then switches to the tracking engine to lower the power consumption when:

- A valid GPS/GNSS position is obtained
- The ephemeris for each satellite in view is valid

To return to Full Power mode (from a low power mode, excluding Backup mode), send the following command: **PMTK225,0** (just after the module wakes up from its previous sleep cycle).

4.3.9.2. Standby Mode

In this mode, the receiver stops navigation, the internal processor enters standby state, and the current drain at the main supply (VCC) is reduced. Standby mode is entered by sending only one of following commands:

PMTK161,0 – Standby Stop mode = Turn off VTCXO, RF, and baseband

PMTK161,1 – Standby Sleep mode = Turn off RF and baseband

After sending one of the above commands, the host can then wake up the module from Standby mode, and switch to Full Power mode by sending any byte to the serial port.

Note: It is not possible to wake up the module from Standby mode via the I2C interface. If you are using an I2C interface, you will need to use Backup mode (see Backup mode section).
It is possible to exit from Backup mode, and return to Active mode only using hardware, by applying a high signal on the FORCE_ON pad (see FORCE_ON section).

4.3.9.3. Periodic Mode

This mode enables autonomous power on/off with a reduced fix rate to reduce average power consumption. In Periodic mode, the main power supply VCC is still powered, but power distribution to internal circuits is controlled by the receiver.

Figure 4. Periodic Power Saving Mode

Enter Periodic mode by sending the following command:

PMTK225,<Type>,<Run_time>,<Sleep_time>,<2nd_run_time>,<2nd_sleep_time>*<checksum>

Where:

- Type = 1 for Periodic Backup mode
  Type = 2 for Periodic Standby mode

- Run_time = Full Power period (ms)

- Sleep_time = Standby period (ms)

- 2nd_run_time = Full Power period (ms) for extended acquisition if GNSS acquisition fails during Run_time.

- 2nd_sleep_time = Standby period (ms) for extended sleep if GNSS acquisition fails during Run_time

- Example: **PMTK225,2,3000,12000,18000,72000**

for Periodic mode with 3 s navigation and 12 s sleep. The acknowledgement response for this command is: **PMTK001,225,3**

Periodic mode is exited back to Full Power Continuous mode by sending the command: **PMTK225,0** just after the module wakes up from a previous sleep cycle.

4.3.9.4. AlwaysLocate™ Mode

AlwaysLocate™ is an intelligent controller for the Periodic mode; the main power supply VCC is still powered, but power distribution is internally controlled. Depending on the environment and motion conditions, the module can autonomously and adaptively adjust the parameters of the Periodic mode, e.g., the ON/OFF ratio and fix rate, to achieve a balance in positioning accuracy and power consumption. The average current varies based on the environment and motion conditions, that affect the power distribution as depicted below.
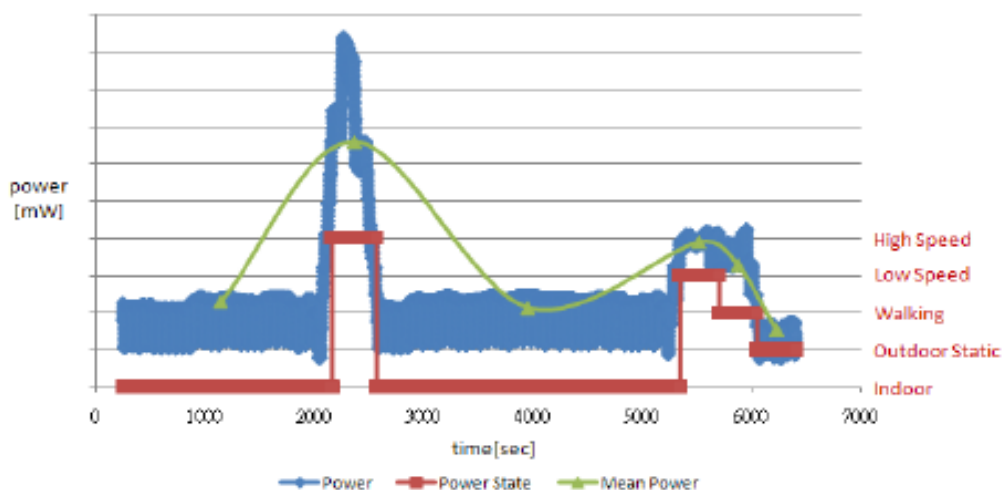
Figure 5. AlwaysLocate™ Mode: Power vs. Time

Enter AlwaysLocate™ mode by sending the following NMEA command: **PMTK225,<mode>*<checksum><CR><LF>**

Where: mode=9 for AlwaysLocate™

Example:

PMTK225,9

The acknowledgement response for the command is:

PMTK001,225,3

The user can exit low power modes to full power by sending the following NMEA command, just after the module wakes up from its previous sleep cycle:

PMTK225,0

4.3.9.5. Backup Mode

Backup Mode is essentially a low quiescent power state when receiver operation is stopped.

During backup mode, V_backup is powered on, but the current consumption is minimal.

After waking up from backup mode, the receiver uses all internal aiding, including GNSS Time, Ephemeris, and Last Position, to achieve the fastest possible TTFF in either hot or warm start modes. During backup mode, the I/O block is powered off. The suggestion is that the host might force its outputs to a low state or to a high-Z

state when in backup mode to minimize minor leakage currents from the receiver's input signals.

The current consumption in BACKUP mode (VCC & V_BACKUP) is ~12uA.

Entering Backup Mode:

There are 2 options through which backup mode may be initiated.

<u>**Option One**</u>

Entering backup mode is performed using the following NMEA software command:

PMTK225,4 (+checksum).

Important: The FORCE_ON pin must be tied to ground before sending the backup command.

While in backup mode, the module consumes ~12uA from VCC and V_BACKUP.

If the command is sent while the FORCE_ON is not tied to ground, the module will enter idle state, will not initiate BACKUP mode and will have a significantly higher current consumption.

The current consumption is ~12uA in BACKUP mode when the FORCE_ON pin of the module is tied to ground with a jumper. In real life cases, the FORCE_ON pin is grounded by an active device with a residue resistance different from zero, and the current consumption may reach 2-3 times higher i.e., 25uA.

FORCE_ON must be tied to ground as long as the module is in backup mode.

- Example: **PMTK225,4 Enter Backup mode**
- NMEA returns feedback: **PMTK001,225,3**

The module remains in BACKUP mode while FORCE_ON is tied to ground.

To exit BACKUP mode, disconnect FORCE_ON from the ground, pull the FORCE_ON to the high level, wait about 1 second, and then release the FORCE_ON to the logic low level again.

Important - It is not possible to wake up the module from Backup mode using a software command.

<u>**Option Two**</u>

The backup mode can be entered by disconnecting the VCC.

Connect the V_backup to an external battery, and then disconnect the VCC from the module. The module will now enter the backup mode.

To return to Full Power, reconnect the VCC and the module will switch to the active state and acquire a hot start.

During this process, make sure to keep the FORCE_ON pin at a low level.

4.3.10. Configuration Settings

The configuration settings will be erased after turning down the power. It is important to be aware to this point when shutting down the module.

4.4. Pads Assignment — ORG1511-MK05

Table 3. ORG1511-MK05 Pin-Out

Pad	Name	Function	Direction	Logic level (V/0)
1	FORCE ON	Forced full-power mode signal - Active Low	Input	2.8
2	1PPS	UTC Time Mark	Output	2.8
3	TX	UART Transmit (Serial Output)	Output	2.8
4	VCC	System Power	Power	3.3
5	GND	System Ground	Power	-
6	WAKEUP	GPIO12/ WAKEUP/ EINT0	Output	2.8
7	RTS	UART Ready-to-Send / I2C DATA	Input /Output	2.8
8	Vbackup	Input for battery backup	Input	2.8 – 4.3 (battery)
9	CTS	UART Clear-to-Send/ I2C CLOCK	Input /Output	2.8
10	RX	UART Receive (Serial Input)	Input	2.8

BOTTOM VIEW
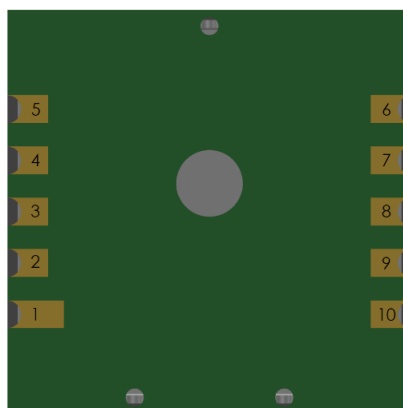
Figure 6. Pads Assignment

5.   MECHANICAL SPECIFICATIONS

The following section provides the mechanical specifications of the ORG1511-MK05 GNSS module.

The ORG1511-MK05 module has advanced ultra-miniature 10mm x 10mm LGA SMD packaging. The ORG1511-MK05 module is built on a PCB assembly enclosed within a metallic RF shield box with an antenna element on top of it. There are 10 castellated LGA SMT pads made with a copper base and ENIG plating on the bottom side.
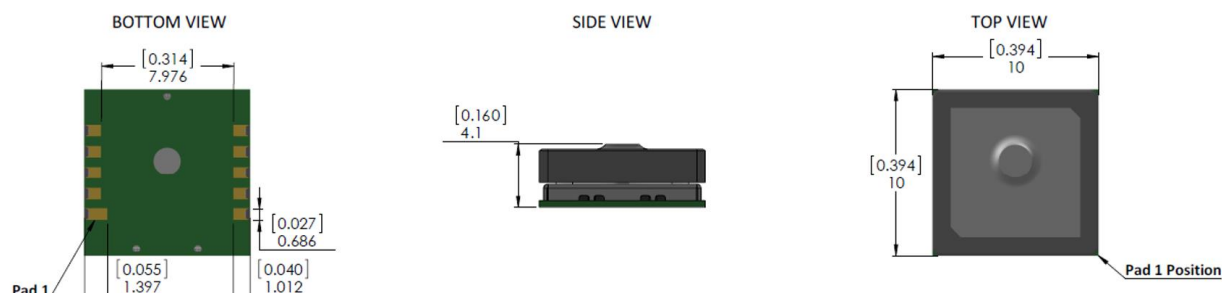
Figure 7. Mechanical Drawing

Table 4. Mechanical Summary

Dimensions	Length	Width	Height
mm	10.00 +0.20/ -0.05	10.00 +0.30/ -0.05	4.1 +0.20/ -0.05
inch	0.394 +0.008/ -0.002	0.394 +0.012/ -0.002	0.16 +0.008/ -0.002

*Weight: 1.43 Gram, 0.05 Oz

6. ELECTRICAL SPECIFICATIONS

The following section provides the electrical specifications of the ORG1511-MK05 GNSS module.

6.1. Absolute Maximum Ratings

Note: Stresses exceeding Absolute Maximum Ratings may damage the device.

Table 5. Absolute Maximum Ratings

Parameter		Symbol	Min	Max	Unit
Power Supply Voltage		V_{CC}	-0.30	+4.3	V
Backup Battery Supply Voltage		V_{backup}	-0.30	+4.3	V
Power Supply Current[1]		I_{CC}		100	mA
RF Input Voltage[2]		V_{RF}	-0.30	+3.6	V
I/O Voltage		V_{IO}	-0.30	+3.6	V
I/O Source/Sink Current		I_{IO}		+8	mA
ESD Voltage		$V_{IO/RF,\ HBM\ Model}$[3]	(-/+) 1000	(-/+) 3000	V
		$V_{IO/RF,\ MM\ Model}$[4]	(-/+) 100	(-/+) 300	V
RF Power[5]	f_{IN} = 1560MHz÷1630MHz	P_{RF}		+10	dBm
	f_{IN} <1560MHz, >1630MHz			+30	dBm
Operating Temperature		T_{AMB}	-45	+90	°C
Storage Temperature		T_{ST}	-50	+125	°C
Lead Temperature[6]		T_{LEAD}	-5	+260	°C

Notes:
1. Inrush current is up to 100mA for up to 20µs duration
2. Voltage applied on antenna element
3. Human Body Model (HBM) contact discharge per EIA/JEDEC JESD22-A114D. Step: 500V (+/-)
4. Machine Model (MM) contact discharge per EIA/JEDEC JESD22-A115C. Step: 50V (+/-)
5. Power delivered to antenna element.
6. Lead temperature at 1mm distance from case for 10s duration.

6.2. Recommended Operating Conditions

Exposure to stresses above the Recommended Operating Conditions may affect device reliability.

Table 6. Recommended Operating Conditions

Parameter	Symbol	Mode / Pad	Test Conditions	Min	Typ	Max	Unit
Power Supply Voltage	VCC	VCC		+3	+3.3	+3.6	V
Backup Battery Supply Voltage	Vbackup	Vbackup		+2.8	+3.3	+4.3	V
Input Pin Voltage Range	Vin			-0.3		+3.6	V
Digital IO Pin Low Level input	Vil			-0.3		+0.7	V
Digital IO Pin High Level Input	Vih			+2.1		+3.6	V
Digital IO Pin Low Level Output	Vol		Iol=2mA	-0.3		+0.4	V
Digital IO Pin High Level Output	Voh		Ioh=2mA	+2.4	+2.8	+3.1	V
Power Supply Current1	ICC	Acquisition	GPS		23	32	mA
			GPS+GLONASS		28	32	mA
		Tracking	GPS		20.2		mA
			GPS+GLONASS		24		mA
		Standby				0.5	mA
		backup			10		µA
Input Impedance	ZIN	RF Input	fIN = 1575.5MHz		50		Ω
Input Return Loss	RLIN			-7			dB
Input Power Range	PIN		GPS or GLONASS	-162		-110	dBm
Input Frequency Range	fIN			1560		1620	MHz
Operating Temperature	TAMB			-40	+25	+85	°C
Storage Temperature2	TST			-50	+25	+125	°C
Relative Humidity3	RH		TAMB	5		95	%

Notes:
1. Typical values under static signal conditions of -130dBm and ambient temperature of +25°C and low gain configuration
2. Longer TTFF is expected while operating below -30°C to -40°C.
3. Relative Humidity is within Operating Temperature range

7. PERFORMANCE

The following section provides information on the performance of the ORG1511-MK05 GNSS module.

7.1. Acquisition Time

TTFF (Time-to-First-Fix) – is the period of time from the module's power-up until its valid position estimation.

7.1.1. Hot Start

A Hot Start results either from a 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.

During Hot Start, all critical data (position, velocity, time, and satellite ephemeris) is valid to the specified accuracy and is available in RAM.

7.1.2. Signal Reacquisition

Reacquisition follows temporary blocking of GNSS signals.

A typical reacquisition scenario includes driving through a tunnel.

7.1.3. Aided Start

Aided Start is a method of effectively reducing TTFF by providing valid satellite ephemeris data.

Aiding can be implemented using the Embedded Assist SYstem (EASY) and Extended Prediction Orbit (EPO).

7.1.4. Warm Start

Warm Start typically results from user-supplied position and time initialization data or continuous RTC operation with an accurate, last-known position available in RAM.

In this state, position and time data are present and valid, but satellite ephemeris data validity has expired.

7.1.5. Cold Start

Cold Start occurs when satellite ephemeris data, position, and time data are unknown.

A typical Cold Start scenario includes the first power application.

Table 7. Acquisition Time

Operation[1]	Mode	Value	Unit
Hot Start		< 1	s
Aided Start[3]		< 3	s
Warm Start	GPS + GLONASS	< 23	s
	GPS	< 29	s
Cold Start	GPS + GLONASS	< 23	s
	GPS	< 31	s
Signal Reacquisition[2]		< 3	s

Notes: 1. EVK is 24-hrs. Static under signal conditions of -130dBm and ambient temperature of +25°C.
2. Outage duration ≤ 30s.
3. Dependent on aiding data connection speed and latency.

7.2. Sensitivity

This section includes information on sensitivity data.

7.2.1. Tracking

Tracking is the ability of a receiver to maintain valid satellite ephemeris data.

During tracking, the receiver may stop the output of valid position solutions.

Tracking sensitivity is defined as the minimum GNSS signal power required for tracking.

7.2.2. Reacquisition

Reacquisition follows temporary blocking of GNSS signals.

Reacquisition sensitivity is defined as the minimum GNSS signal power required for reacquisition.

7.2.3. Navigation

During navigation, the receiver consequently outputs valid position solutions.

Navigation sensitivity is defined as the minimum GNSS signal power required for reliable navigation.

7.2.4. Hot Start

Hot Start sensitivity is defined as the minimum GNSS signal power required for a valid position solution under Hot Start conditions.

7.2.5. Aided Start

Aided Start sensitivity is defined as the minimum GNSS signal power required for a valid position solution following the aiding process.

7.2.6.   Cold Start

Cold Start sensitivity is defined as the minimum GNSS signal power required for a valid position solution under Cold Start conditions. It is sometimes referred to as the ephemeris decode threshold.

Table 8. Sensitivity

Operation[1]	Mode	Value	Unit
Tracking	GPS	-162	dBm
	GLONASS	-158	dBm
Navigation	GPS	-160	dBm
	GLONASS	-156	dBm
Reacquisition[2]	GPS+GLONASS	-157	dBm
Hot Start	GPS+GLONASS	-160	dBm
Aided Start	GPS+GLONASS	-163	dBm
Cold Start	GPS+GLONASS	-151	dBm

**The above values have been tested at an update rate of 1 Hz. While working at a higher update rate there is some signal degradation.

7.3.   Received Signal Strength

Table 9. Received Signal Strength

Parameter[4]	Value	Unit
C/N$_0$	42	dB-Hz

Notes:
1. EVK is static, ambient temperature is +25°C.
2. Outage duration ≤ 30s.
3. Aiding using Broadcast Ephemeris (Ephemeris Push™) or Extended Ephemeris (CGEE™ or SGEE™).
4. Average C/N0 is reported for 4 SVs, EVK is 24-hrs. Static, outdoor, ambient temperature is +25°C.

7.4. Power Consumption

Table 10. Power Consumption

Operation[1]	Mode	Value	Unit
Acquisition	GPS	75.5	mW
	GPS + GLONASS	91.8	mW
Tracking	GPS	66.2	mW
	GPS + GLONASS	78.7	mW
Periodic: Low Power Tracking	15 sec asleep 3 sec awake	14.5	mW
Standby State		1.65	mW
Backup state		49.5	uW

Note: Typical values under static signal conditions of -130dBm and ambient temperature of +25°C. Measured voltage= 3.28V.

7.5. Position Accuracy

Table 11. ORG1511-MK05 Position Accuracy

Parameter	Constellation	CEP[1] (m)
Horizontal Position Accuracy	GPS	2.5
Horizontal Position Accuracy	GLONASS	2.6
Horizontal Position Accuracy	BeiDou	10.2
Horizontal Position Accuracy	GPS + GLONASS	2.5
Horizontal Position Accuracy	GPS + BeiDou	2.5

Note: Module is static under signal conditions of -130dBm, ambient temperature is +25°C.

7.6. Dynamic Constraints

Table 12. Dynamic Constraints

Parameter	Metric	Imperial
Velocity	515m/s	1,000 knots
Altitude	10,000 m	32,808 ft
Altitude Balloon mode	80,000 m	262,467 ft
Acceleration	4g	

Note: Standard dynamic constraints according to regulatory limitations.

8. INTERFACE

The following section provides information on the interface of the ORG1511-MK05 GNSS module.

8.1. Power Supply

It is recommended to keep the power supply on at all times in order to maintain the RTC block active and to keep satellite data in RAM with the fastest possible TTFF. When V_{CC} is removed, settings are reset to factory default and the receiver will perform a Cold Start on the next power up.

8.1.1. Nominal VCC = 3.3V

V_{CC} is 3.3v DC and must be provided from regulated power supply.

During tracking, processing is less intense compared to acquisition, therefore power consumption is lower.

Filtering is necessary to manage high alternating current flows on the power input connection. An additional LC filter on the power input of the ORG1511-MK05 module may be required to reduce system noise.

The high rate of the input current change of the ORG1511 module requires low ESR bypass capacitors.

Additional higher ESR output capacitors can provide input stability damping.

The ESR and size of the output capacitors directly define the output ripple voltage according to the inductor size which was selected. Large low ESR output capacitors are beneficial for low noise. Voltage ripple below 40mVPP is allowed. Higher voltage ripple may compromise ORG1511 performance.

8.1.2. Ground

The Ground pad must be connected to the host PCB ground with the shortest possible trace or by multiple VIAs.

8.2. Control Interface

The ORG1511-MK05 module has two host interfaces: UART and I2C.

8.2.1. UART- Host Interface

The ORG1511-MK05 module has a standard UART port:

8.2.1.1. TX

TX is used for GPS data reports. The output logic high voltage level is 2.8V.

The TX serial data line outputs NMEA serial data at a default bit rate of 9600 bps.

When no serial data is output, the TX data line idles high.

8.2.1.2. RX

RX is used for receiver control. The input logic high voltage level is 2.8V.

The RX data line accepts NMEA commands at a default bit rate of 9600 bps.

When the receiver is powered down, do not back drive this or any other GPIO line.

The idle state for serial data from the host computer is logic 1.

8.2.2. I2C- Host Interface

ORG1511-MK05 has a standard I2C interface.

The I2C interface in enabled using default FW.

I2C host interface features are:

- I2C Slave mode – host initiates clock and data at an operating speed of 400kbps.

- Supporting a 7-bit I2C address

- An I2C default slave address of '0x10'

- Individual Tx FIFO buffer length of 255 bytes. The Master can read one I2C data packet of maximum 255 bytes at a time.

In order to read the entire NMEA packet of one second, the master must read several I2C data packets and extract valid NMEA data. After reading one I2C data packet, it will sleep for 2ms before reading the next packet. If the entire packet of one second was read, wait for a longer period for the next NMEA packet.

8.3. Hardware Interface

This section includes information on the hardware interface of the ORG1511 module.

8.3.1. Force-On

FORCE-ON is an input pin that controls the power states of the module.

There are two possible states for this pin – **LOW** and **HIGH**.

LOW state:

If we run the command "**PMTK225,4**", the module enters a Backup mode. In this mode, the module enters the lowest power consumption mode.

*Return to full power mode:

- Set FORCE_ON to HIGH

- Wait one second

- Set FORCE_ON to LOW

Run the command "**PMTK225,1,....**", and the module will enter a periodic backup mode.

*Return to full power mode:

- Set FORCE_ON to HIGH

- Run command "**PMTK225,0**"

- Wait for 100ms

- Set FORCE_ON to LOW

HIGH state:

- Note - in this state, the module cannot enter a backup mode.
- When the command "**PMTK225,4**" is run, the module will enter a standby-stop mode.

There are two ways to return to Full Power mode:

First way:

- Send any byte on the Rx line

Second way:

- Set FORCE_ON to LOW
- Wait one second
- Set FORCE_ON to HIGH.

8.3.1.1.   1PPS

Pulse-per-Second (PPS) output provides a pulse signal for timing purposes.

The pulse may be configured for a specific duration, a specific frequency, and to be active high or low, via a command.

The pulse may vary 30 nS (1 σ). The relationship between the PPS signal and UTC is unspecified.

Use Proprietary MediaTek command **PMTK255** to enable or disable this functionality:

- **PMTK255,1** => enable PPS
- **PMTK255,0** => disable PPS
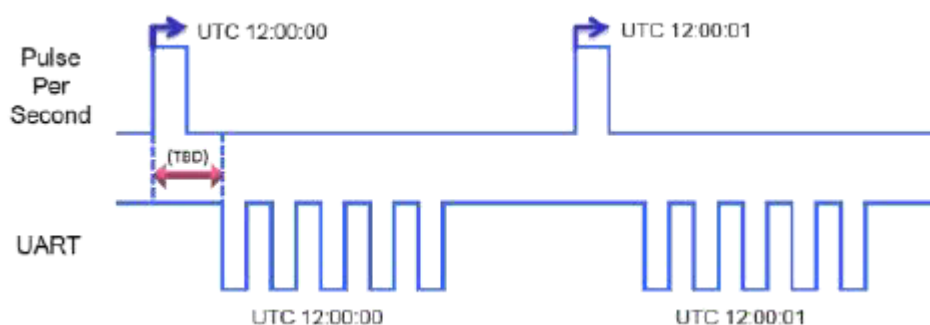
Figure 8. 1PPS and UTC

1PPS supports 1Hz NMEA output, but at a baud rate of 9600 bps, if there are many NMEA sentences output, the per-second transmission may exceed one second.

(*)Please refer to OriginGPS MTK NMEA Packet document to read more about 1pps related commands.

8.3.2. **Wakeup**

When the ORG1511-MK05 module is on (full power), the output is high at ~2.5V level.

When the ORG1511-MK05 module is in Standby, or Backup mode, the output is low (Ground).

In low power modes (Periodic and AlwaysLocate) when the ORG1511-MK05 module is off, the Wakeup level is low (and the Wakeup returns to a high level when the module returns to full power).

The Wakeup output is designed only for probing to determine if the module is in active mode or in standby/backup states. Different types of probes may influence on the voltage high level.

9. TYPICAL APPLICATION CIRCUIT

The following section provides a typical application circuit for the ORG1511-MK05 GNSS module.
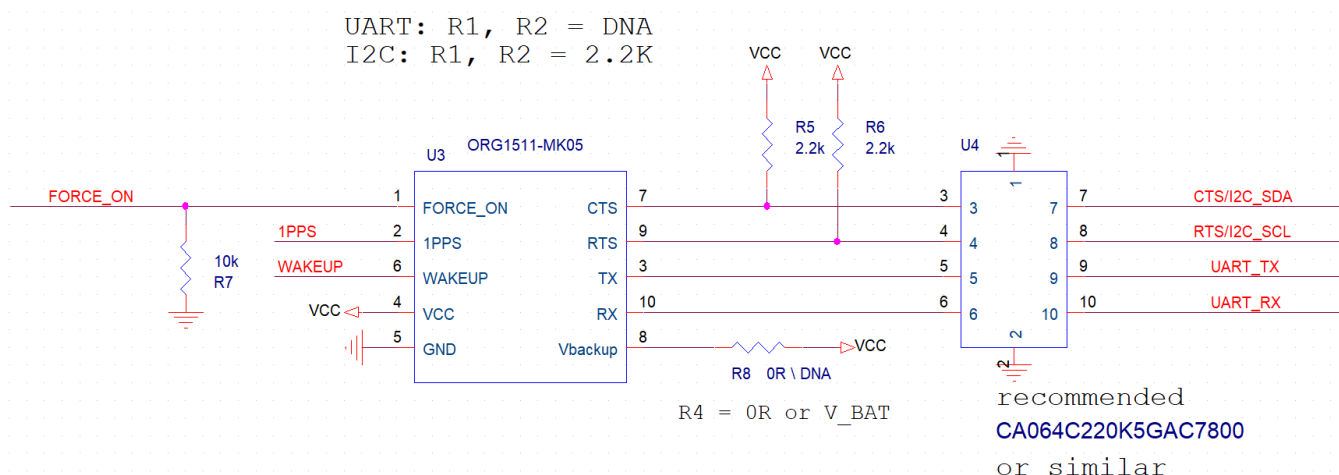
Figure 9. Reference Schematic Diagram

The ORG1511-MK05 module includes an option to connect a coin battery (for example, an ECR2025 coin battery), to provide power in Backup mode. The minimum voltage that the backup battery supports is 2.8V (typical battery 2.8-4.3V).

When the module with a battery connection wakes up, the receiver will use all internal aiding, including RTC time, Ephemeris, and Last Position, resulting in the fastest possible TTFF in either hot or warm start modes.

Configuration settings are stored in the Flash memory after turning the power off.

To keep the RTC time alive, the following circuit implementation using a 3V coin battery can be used.

Important - If a battery is not connected to pad 4 in ORG1511-MK05, connection between pads 4 and 8 is mandatory to operate the module.
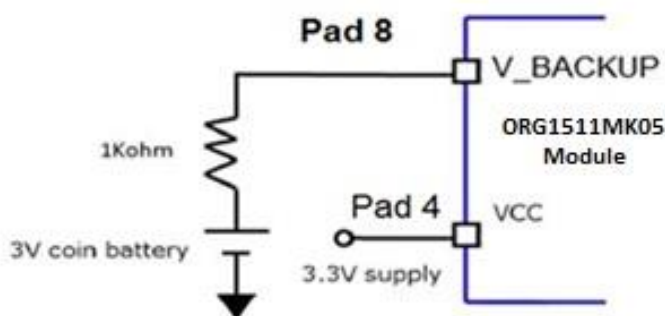
Figure 10. Circuit Implementation with 3V coin Battery

10. RECOMMENDED PCB LAYOUT

Please refer to the Application Note in the following link:

https://origingps.com/gnss-modules/gnss-resources/

Scroll down and click "Hornet Modules Layout Recommendations and Integration – Application Note".

11.   DESIGN CONSIDERATIONS

The ORG1511 module incorporates an on-board antenna element that is perfectly matched to the receiver front-end, frequency trimmed to GPS band, and Right-Hand Circularly Polarized (RHCP).

The proprietary module structure of OriginGPS provides a stable resonance of an antenna in the GPS band with very low dependence on the host PCB size, its conducting planes geometry, and stack-up.

To prevent a PCB factor on antenna resonance, avoid pouring copper on the module side.

To prevent module orientation from causing polarization losses in an on-board antenna, long and narrow copper planes under the module should be avoided.

The ORG151 1module operates with received signal levels down to -167dBm and can be affected by high absolute levels of RF signals out of the GNSS band, moderate levels of RF interference near GNSS band, and by low-levels of RF noise in the GNSS band.

RF interference from nearby electronic circuits or radio transmitters can contain enough energy to desensitize ORG1511. These systems may also produce levels of energy outside of the GNSS band high enough to leak through RF filters and degrade the performance of the ORG1511.

This issue becomes more critical in small products, where there are industrial design constraints.

In those products, transmitters for Wi-Fi, Bluetooth, RFID, cellular, and other radios may have antennas physically close to the ORG1511 module.

To prevent degrading performance of the ORG1511 module, it is recommended to perform EMI/jamming susceptibility tests for radiated and conducted noise on prototypes and to assess the risks of other factors.

12. COMMAND DESCRIPTIONS

The following section provides a description of the commands used in the ORG1511-MK05 GNSS module.

Table 13. NMEA Input Commands

Command ID	Description
PMTK000	Test. This command will be echoed back to the sender (for testing the communications link).
PMTK101	Perform a HOT start
PMTK102	Perform a WARM start
PMTK103	Perform a COLD start
PMTK104	Perform a system reset (erasing any stored almanac data) and then a COLD start
PMTK120	Erase aiding data stored in flash memory
PMTK127	Erase EPO data stored in flash memory
PMTK161,0	Standby - Stop mode
PMTK161,1	Standby - Sleep mode
PMTK251,Baudrate	Set NMEA Baudrate
PMTK313,0	Disable SBAS feature
PMTK313,1	Enable SBAS feature
PMTK353,1,0,0,0,0	Enable GPS only mode
PMTK353,0,1,0,0,0	Enable GLO only mode
PMTK353,0,0,0,0,1	Enable BDS only mode
PMTK353,1,1,0,0,0	Enable GPS and GLO mode
PMTK353,1,0,0,0,1	Enable GPS and BDS mode

13. FIRMWARE UPDATES

The firmware stored in the internal Flash memory may be upgraded via the serial port TX/RX pads. In order to update the firmware, the following steps must be performed:

1. Remove all power to the module.

2. Connect the serial port to a PC.

3. Connect the main power to the module.

4. Run the software utility to reflash the module. Clearing the entire Flash memory is strongly recommended prior to programming.

5. Upon successfully flashing the module, remove the main power to the module for at least 10 seconds.

6. Connect the main power to the module.

7. Verify the module has returned to its normal operating state.

14. HANDLING INFORMATION

The following section provides handling information for the ORG1511-MK05 GNSS module.

14.1. Moisture Sensitivity

ORG1511 modules are MSL 3 designated devices according to IPC/JEDEC J-STD-033B standard.

A module in a sample or bulk package needs to be baked at 125°C for 48 hours prior to assembly.

14.2. Assembly

The module supports automatic pick-and-place assembly and reflow soldering processes.

To ensure sufficient solder volume, the recommended solder paste stencil is 5 mil.

14.3. Soldering

Reflow soldering of the module should be conducted on the component side (top side) of the host PCB according to standard IPC/JEDEC J-STD-020D for LGA SMD.

To avoid exposure, the ORG1511 should not be placed face-down during the reflow soldering process.
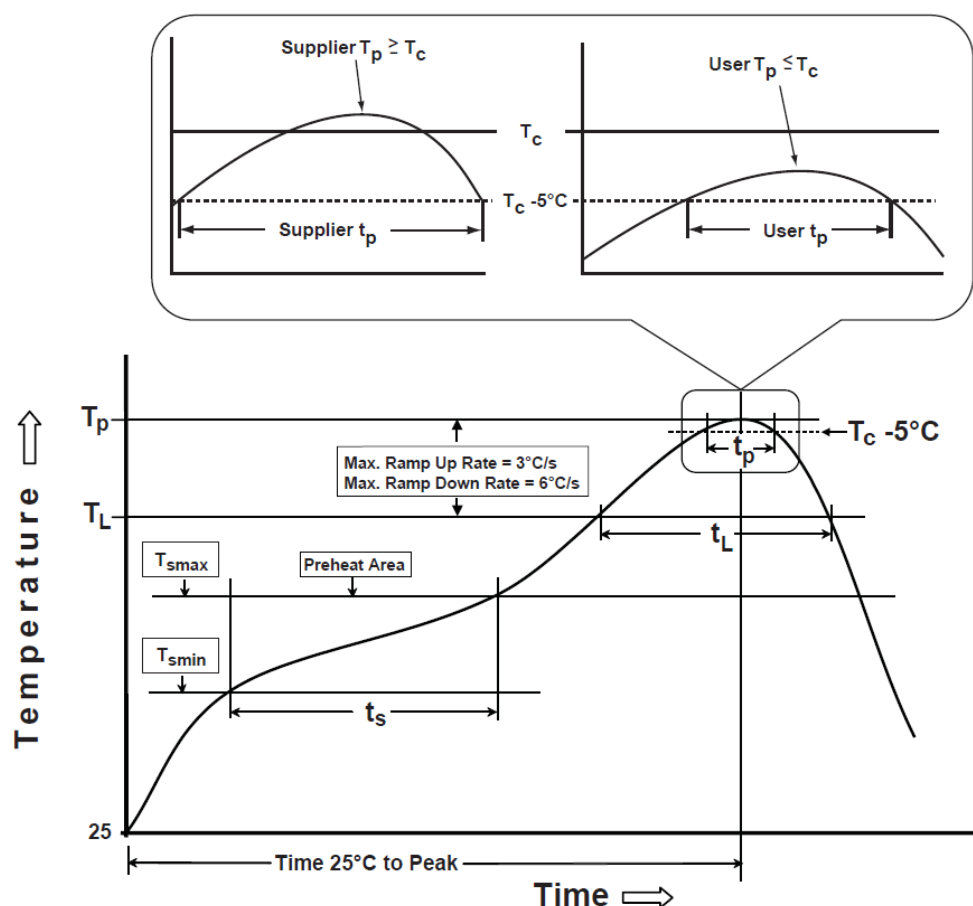
Figure 11. Recommended Soldering Profile

The temperature is measured on the top surface of the package during the entire soldering process.

The recommended peak reflow temperature is 250°C for 30 seconds for Pb-free solder paste.

The actual board assembly reflow profile must be developed individually according to the specific characteristics of the furnace used.

Reflow furnace settings depend on the number of heating/cooling zones, type of solder paste/flux used, board design, component density, and packages used.

Table 14. Soldering Profile Parameters

Symbol	Parameter	Min	Typ	Max	Unit
T_C	Classification Temperature		250		°C
T_P	Package Temperature			250	°C
T_L	Liquidous Temperature		217		°C
T_S	Soak/Preheat Temperature	150		200	°C
t_S	Soak/Preheat Time	60		120	s
t_L	Liquidous Time	60		150	s
t_P	Peak Time		30		s

14.4.   Cleaning

If flux cleaning is required, the module is capable of withstanding a standard cleaning process in a vapor degreaser with the Solvon® n-Propyl Bromide (NPB) solvent and/or washing in DI water.

Avoid cleaning processes in an ultrasonic degreaser since specific vibrations may cause performance degradation or destruction of the internal circuitry.

14.5.   Rework

If localized heating is required to rework or repair the module, precautionary methods are required to avoid exposure to solder reflow temperatures that can result in permanent damage to the device.

14.6.   ESD Sensitivity

This product is an ESD-sensitive device and must be handled with care.

14.7.   Safety Information

Incorrect handling and use can cause permanent damage to the product.

14.8.   Disposal Information

This product must not be treated as household waste.

For information about recycling electronic components, contact your local waste management authority.

15. COMPLIANCE

The following standards are applied in the production of ORG1511 modules:

- IPC-6011/6012 Class2 for PCB manufacturing
- IPC-A-600 Class2 for PCB inspection
- IPC-A-610D Class2 for SMT acceptability

ORG1511 modules are manufactured in ISO 9001:2008 accredited facilities.

ORG1511 modules are manufactured in ISO 14001:2004 accredited facilities.

ORG1511 modules are manufactured in OHSAS 18001:2007 accredited facilities.

ORG1511 modules are designed, manufactured, and handled in compliance with the Directive 2011/65/EU of the European Parliament and of the Council of June 2011 on the Restriction of the use of certain Hazardous Substances in electrical and electronic equipment, referred to as RoHS II.

ORG1511 modules are manufactured and handled in compliance with the applicable substance bans as of Annex XVII of Regulation 1907/2006/EC on Registration, Evaluation, Authorization, and Restriction of Chemicals including all amendments and candidate list issued by ECHA, referred to as REACH.

ORG1511 modules comply with the following EMC standards:

- EU CE EN55022:06+A1(07), Class B
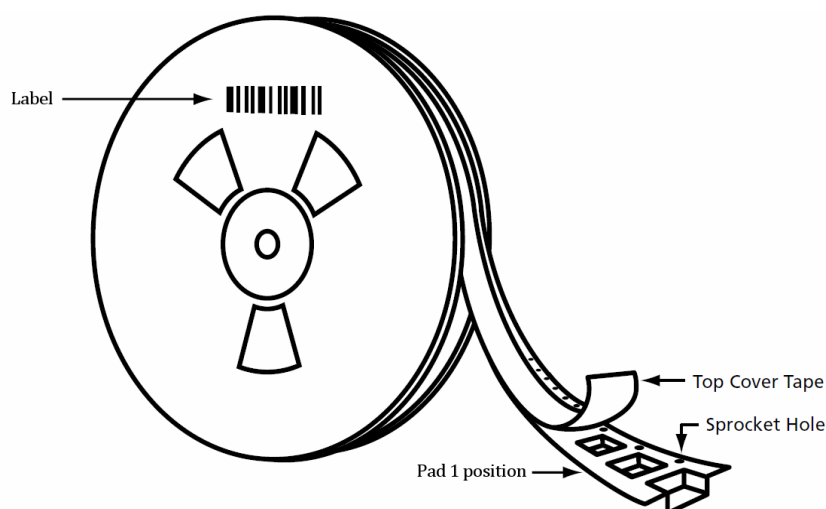- US FCC 47CFR Part 15:09, Subpart B, Class B
- JAPAN VCCI V-3/2006.04

16. PACKAGING AND DELIVERY

The following section provides packaging and delivery information for the ORG1511-MK05 GNSS module.

16.1. Appearance

ORG1511 modules are delivered in reeled tapes for an automatic pick-and-place assembly process.

Figure 12. Module Position

ORG1511 modules are packed in two different reel types (TR1 and TR2).

Table 15. Reel Quantity

Suffix	TR1	TR2
Quantity	150	500

Reels are dry-packed with a humidity indicator card and a desiccant bag according to the IPC/JEDEC J-STD-033B standard for MSL 3 devices.

Reels are vacuum sealed inside anti-static moisture barrier bags.

Sealed reels are labeled with MSD sticker providing information about:

- MSL
- Shelf life
- Reflow soldering peak temperature
- Seal date

Sealed reels are packed inside cartons.

Reels, reel packs, and cartons are labeled with a sticker providing the following information:

- Description
- Part number
- Lot number

- Customer PO number
- Quantity
- Date code

16.2.   Carrier Tape

Carrier tape material: Polystyrene with carbon (PS+C).

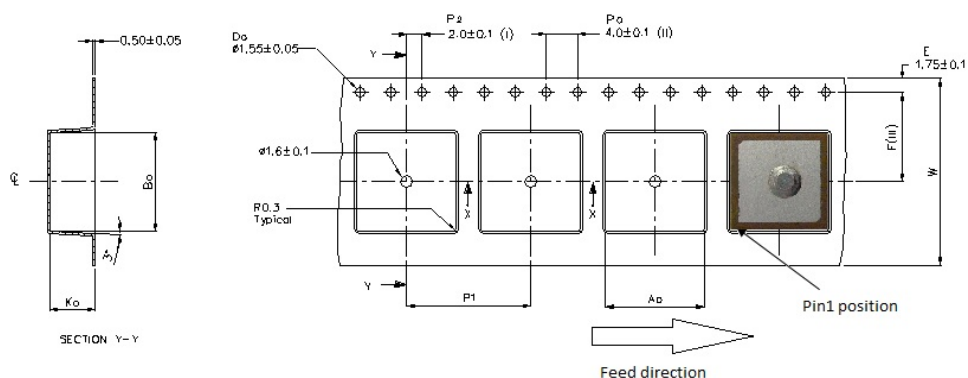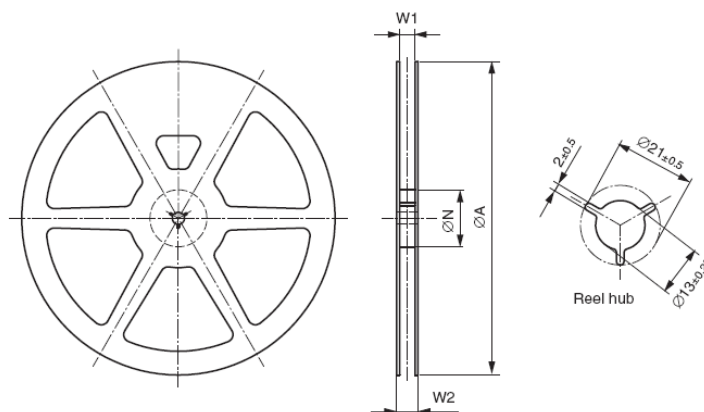**Cover tape material:** Polyester-based film with a heat-activated adhesive coating layer.

Figure 13. Carrier Tape

Table 16. Carrier Tape Dimensions

	mm	inch
A_0	10.9 ± 0.1	0.429 ± 0.004
B_0	10.7 ± 0.1	0.421 ± 0.004
K_0	6.1 ± 0.1	0.240 ± 0.004
F	7.5 ± 0.1	0.295 ± 0.004
P1	12.0 ± 0.1	0.472 ± 0.004
W	16.0 ± 0.3	0.630 ± 0.012

16.3.   Reel

Reel material: Antistatic plastic.

Figure 14. Reel

Table 17. Reel Dimensions

Suffix	TR1		TR2	
	mm	inch	mm	inch
ØA	178.0 ± 1.0	7.00 ± 0.04	330.0 ± 2.0	13.00 ± 0.08
ØN	60.0 ± 1.0	2.36 ± 0.04	102.0 ± 2.0	4.02 ± 0.08
W1	16.7 ± 0.5	0.66 ± 0.02	16.7 ± 0.5	0.66 ± 0.02
W2	19.8 ± 0.5	0.78 ± 0.02	22.2 ± 0.5	0.87 ± 0.02

17.   ORDERING INFORMATION
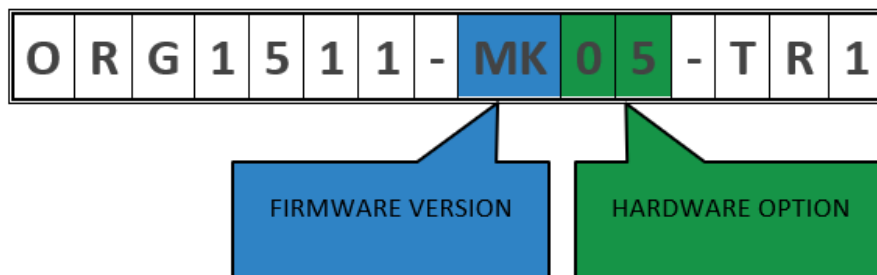
Figure 15. Ordering Options

Table 18. Orderable Devices

Part Number	FW Version	HW Option	VCC Range	Description	SPQ
ORG1511-MK05-TR1	MK	05	3.3V	Tape and reel	150
ORG1511-MK05-TR2	MK	05	3.3V	Tape and reel	500
ORG1511-MK05-UAR	MK	05	5V USB	Evaluation Kit	1