MULTI MICRO SPIDER
ORG4033-MK05
GPS / GNSS RECEIVER MODULE

Datasheet

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1. SCOPE
This document describes the features and specifications of Multi Micro Spider ORG4033 GNSS receiver module.

2. DISCLAIMER
All trademarks are properties of their respective owners. Performance characteristics listed in this document do not constitute a warranty or guarantee of product performance. OriginGPS assumes no liability or responsibility for any claims or damages arising out of the use of this document, or from the use of integrated circuits based on this document. OriginGPS assumes no liability or responsibility for unintentional inaccuracies or omissions in this document. OriginGPS reserves the right to make changes in its products, specifications and other information at any time without notice. OriginGPS reserves the right to conduct, from time to time, and at its sole discretion, firmware upgrades. As long as those FW improvements have no material change on end customers, PCN may not be issued. OriginGPS navigation products are not recommended to use in life saving or life sustaining applications.

3. SAFETY INFORMATION
Improper handling and use can cause permanent damage to the product.

4. ESD SENSITIVITY
This product is ESD sensitive device and must be handled with care.

5. CONTACT INFORMATION
Support - support@origingps.com or Online Form
Marketing and sales - marketing@origingps.com
Web – www.origingps.com

6. RELATED DOCUMENTATION

<table>
<thead>
<tr>
<th>№</th>
<th>DOCUMENT NAME</th>
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<tbody>
<tr>
<td>1</td>
<td>Multi Micro Spider – ORG4033 Evaluation Kit Datasheet</td>
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<tr>
<td>2</td>
<td>MTK NMEA Manual Packet 3.5</td>
</tr>
<tr>
<td>3</td>
<td>Feature List and Command Usage- ORG4033-MK05 and ORG1510MK-05</td>
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TABLE 1 – RELATED DOCUMENTATION

7. REVISION HISTORY

<table>
<thead>
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<th>REVISION</th>
<th>DATE</th>
<th>CHANGE DESCRIPTION</th>
<th>Author</th>
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<td>1.0</td>
<td>January 21, 2016</td>
<td>First release</td>
<td>Ori A.</td>
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<tr>
<td>2.0</td>
<td>August 15, 2016</td>
<td>Pin 12 update, backup mode update</td>
<td>Mark K.</td>
</tr>
<tr>
<td>2.1</td>
<td>August 17, 2016</td>
<td>RESET, WAKEUP updates</td>
<td>Ori A.</td>
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<tr>
<td>2.2</td>
<td>November 24,2016</td>
<td>Table 8 - Sensitivity test remark.</td>
<td>Mark K.</td>
</tr>
<tr>
<td>2.3</td>
<td>February 12, 2017</td>
<td>Periodic backup/standby modes update</td>
<td>Mark K.</td>
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<td>2.4</td>
<td>July 2, 2018</td>
<td>Backup</td>
<td>Gil M.</td>
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<td>2.5</td>
<td>July 12,2018</td>
<td>Pinout</td>
<td>Gil M.</td>
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<td>2.6.1</td>
<td>August 5, 2018</td>
<td>Update section backup mode</td>
<td>Gil M</td>
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<tr>
<td>2.6.2 / 2.6.3</td>
<td>August 27, 2018</td>
<td>Update Dynamic constrains / I2C</td>
<td>Gil M</td>
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### TABLE 2 – REVISION HISTORY

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<td>2.6.4</td>
<td>Dec 12, 2018</td>
<td>Update P/N MK04 → MK05</td>
<td>Gil M</td>
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<td>2.6.5</td>
<td>Jan 21, 2018</td>
<td>Updated V_BACKUP</td>
<td>Igor M</td>
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<tr>
<td>2.7</td>
<td>May 19, 2019</td>
<td>Updated Schematics, Footprint and default constellations support also Galileo</td>
<td>Igor M</td>
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<td>2.8</td>
<td>May 30, 2019</td>
<td>Data correction</td>
<td>Gil M</td>
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<td>2.9</td>
<td>June 17, 2019</td>
<td>Standby mode</td>
<td>Gil M</td>
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<td>3.0</td>
<td>September 26, 2019</td>
<td>Updated tolerance for mechanical specifications</td>
<td>Ron T</td>
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### 8. GLOSSARY

- **A-GPS** Assisted GPS
- **AC** Alternating Current
- **ADC** Analog to Digital Converter
- **AGC** Automatic Gain Control
- **BPF** Band Pass Filter
- **C/N0** Carrier to Noise density ratio [dB-Hz]
- **CDM** Charged Device Model
- **CE** European Community conformity mark
- **CEP** Circular Error Probability
- **CMOS** Complementary Metal-Oxide Semiconductor
- **CPU** Central Processing Unit
- **CTS** Clear-To-Send
- **CW** Continuous Wave
- **DC** Direct Current
- **DOP** Dilution Of Precision
- **DR** Dead Reckoning
- **DSP** Digital Signal Processor
- **ECEF** Earth Centred Earth Fixed
- **ECHA** European Chemical Agency
- **EGNOS** European Geostationary Navigation Overlay Service
- **EIA** Electronic Industries Alliance
- **EMC** Electro-Magnetic Compatibility
- **EMI** Electro-Magnetic Interference
- **ENIG** Electroless Nickel Immersion Gold
- **ESD** Electro-Static Discharge
- **ESR** Equivalent Series Resistance
- **EU** European Union
- **EVB** Evaluation Board
- **EVK** Evaluation Kit
- **FCC** Federal Communications Commission
- **FSM** Finite State Machine
- **GAGAN** GPS Aided Geo-Augmented Navigation
- **GNSS** Global Navigation Satellite System
- **GPIO** General Purpose Input or Output
- **GPS** Global Positioning System
- **HBM** Human Body Model
- **HDOP** Horizontal Dilution Of Precision
I²C Inter-Integrated Circuit
I/O Input or Output
IC Integrated Circuit
ICD Interface Control Document
IF Intermediate Frequency
ISO International Organization for Standardization
JEDEC Joint Electron Device Engineering Council
KA Keep Alive
KF Kalman Filter
LDO Low Dropout regulator
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
MSL Moisture Sensitivity Level
NFZ™ Noise-Free Zones System
NMEA National Marine Electronics Association
NVM Non-Volatile Memory
PCB Printed Circuit Board
PLL Phase Lock Loop
PMU Power Management Unit
POR Power-On Reset
PPS Pulse Per Second
PRN Pseudo-Random Noise
PSRR Power Supply Rejection Ratio
PTF™ Push-To-Fix
QZSS Quasi-Zenith Satellite System
RAM Random Access Memory
REACH Registration, Evaluation, Authorisation and Restriction of Chemical substances
RF Radio Frequency
RHCP Right-Hand Circular Polarized
RMS Root Mean Square
RoHS Restriction of Hazardous Substances directive
ROM Read-Only Memory
RTC Real-Time Clock
RTS Ready-To-Send
SAW Surface Acoustic Wave
SBAS Satellite-Based Augmentation Systems
SID Sub-Identifier
SIP System In Package
SMD Surface Mounted Device
SMPS Switched Mode Power Supply
SMT Surface-Mount Technology
SOC System On Chip
SPI Serial Peripheral Interface
SV Satellite Vehicle
TCXO Temperature-Compensated Crystal Oscillator
9. ABOUT SPIDER 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 - all are very important. OriginGPS Spider family breaks size barrier, offering the industry’s smallest fully integrated, highly-sensitive GPS / GNSS modules.

Spider 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.

Spider family enables the shortest TTM (Time-To-Market) with minimal design risks. Just connect an antenna and power supply on a 2-layer PCB.

10. ABOUT MULTI MICRO SPIDER MODULE
Multi Micro Spider is a complete SiP featuring miniature LGA SMT footprint designed to commit unique integration features for high volume cost sensitive applications.

Designed to support compact and traditional applications such as smart watches, wearable devices, asset trackers, Multi Micro Spider ORG4033 module is a miniature multi-channel GPS, Galileo and GLONASS/BEIDOU, SBAS, QZSS overlay systems receiver that continuously tracks all satellites in view, providing real-time positioning data in industry’s standard NMEA format.

Multi Micro Spider ORG4033 module offers superior sensitivity and outstanding performance, achieving rapid TTFF in less than one second, accuracy of approximately two meters, and tracking sensitivity of -165dBm.

Sized only 5.6mm x 5.6mm Multi Micro Spider ORG4033 module is industry’s small sized, record breaking solution.

Multi Micro Spider ORG4033 module is introducing 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, dense foliage or even indoor.

Integrated GPS SoC incorporating high-performance microprocessor and sophisticated firmware keeps positioning payload off the host, allowing integration in embedded solutions with low computing resources.

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.

11. ABOUT ORIGINGPS
OriginGPS is a world leading designer, manufacturer and supplier of miniature positioning modules, antenna modules and antenna solutions.

System (NFZ™) proprietary technology for faster position fix and navigation stability even under challenging satellite signal conditions.

Founded in 2006, OriginGPS is specializing in development of unique technologies that miniaturize RF modules, thereby addressing the market need for smaller wireless solutions.
12. DESCRIPTION

12.1. FEATURES

- Autonomous operation
- OriginGPS Noise Free Zone System (NFZ™) technology
- Active or Passive antenna support
- Fully integrating: Dual-stage LNA, SAW filter, TCXO, RTC crystal, GNSS SoC, LDO regulator, RF shield, PMU
- Concurrent tracking of multiple constellations
- Uses GPS, Galileo and GLONASS/BEIDOU, QZSS constellations.
- GPS L1 1575.42 frequency, C/A code
- GLONASS L1 FDMA 1598-1606MHz frequency band, SP signal.
- BEIDOU B1 1561.098MHz frequency band.
- SBAS (WAAS, EGNOS, MSAS and GAGAN)
- Concurrent tracking of multiple constellations
- DGPS capability
- 99 search channels and 33 simultaneous tracking channels
- Ultra-high Sensitivity down to -165dBm enabling Indoor Tracking
- 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
- AGPS support: Embedded Assist System (EASY) and Extended Prediction Orbit (EPO) and HotStill
- 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
- High update messages rate of 1,2,5,10Hz
- 1PPS Output
- Static Navigation
- Single voltage supply 3.3V with battery input
- Ultra-small LGA footprint of 5.6mm x 5.6mm
- Ultra-low weight of 0.2g
- Surface Mount Device (SMD)
- Optimized for automatic assembly and reflow equipment
- Operating from -40°C to +85°C
- FCC, CE, VCCI compliant
- RoHS II/REACH compliant
12.2. ARCHITECTURE

**+ GNSS SAW Filter**
Band-Pass SAW filter eliminates out-of-band signals that may interfere to GNSS reception. GNSS SAW filter is optimized for low Insertion Loss in GNSS band and low Return Loss outside it.

**+ GNSS LNA**
Dual-stage cascaded LNAs amplify GNSS signals to meet RF down converter input threshold. Noise Figure optimized design was implemented to provide maximum sensitivity.

**+ TCXO**
Highly stable 26MHz oscillator controls down conversion process in RF block of the GNSS SoC. Characteristics of this component are important factors for higher sensitivity, shorter TTFF and better navigation stability.

**+ RTC crystal**
RTC 32.768 KHz quartz crystal with very tight specifications is necessary for maintaining Hot Start and Warm Start capabilities of the module.

**+ MT3333 GNSS SoC**
The MT3333, multi-GNSS System on Chip designed by MediaTek, which is the world’s leading digital media solution provider and largest fab-less IC Company in Taiwan. It is a hybrid positioning processor that combines GPS, GLONASS, GALILEO, BEIDOU, 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, GNSS baseband, integrated navigation solution software, ARM® processor and serial flash.
MT3333 SoC includes the following units:

- GNSS radio subsystem containing single input dual receive paths for concurrent GPS, GLONASS and Galileo or GPS and BEIDO, mixer with current mode interface between the mixer and multi-modes low pass filter, fractional-N synthesizer, integrated self-calibrating filters, IF VGA with AGC, high-sample rate ADCs with adaptive dynamic range.
- Measurement subsystem including DSP core for GNSS signals acquisition and tracking, interference scanner and detector, interference removers, multipath and cross-correlation detectors, dedicated DSP code ROM and DSP cache RAM.
- Measurement subsystem interfaces GNSS radio subsystem.
- Navigation subsystem comprising ARM7® microprocessor system for position, velocity and time solution, program ROM, data RAM, cache and patch RAM and SPI flash.
- Peripheral Controller subsystem containing UART Host interface, RTC block, wake up signal option, and GPIO.
- Peripheral Controller subsystem interfaces navigation subsystem, PLL and PMU subsystems.
- Navigation subsystem interfaces measurement subsystem.
- PMU subsystem containing voltage regulators for RF and baseband domains.
12.3. ORG4033 FEATURES DESCRIPTION:

12.3.1 CONSTITUTIONAL CONFIGURATION
- GPS, GLONASS and Galileo - default.
- GPS and BEIDOU - available.
For ordering this option contact marketing@origingps.com

12.3.2 1PPS
1PPS (Pulse Per Second) signal output available on configuration:
- At 2D Fix only.
- At 3D Fix only.
- After the first Fix.
- Always on default configuration.
For ordering other 1PPS options contact marketing@origingps.com

The pulse is configurable for required duration, frequency and active high/low via command. The pulse may vary 30nS (1 σ). The relationship between the PPS signal and UTC is unspecified.

12.3.3 Static Navigation
Static Navigation is an operational mode in which the receiver will freeze 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 0. The navigation solution is then unfrozen when the speed increases above a threshold or when the computed position exceeds a set distance from the frozen position (indicating that the receiver is again in motion). The speed threshold can be set via a command (PMTK 386). Static Navigation is disabled by default but can be enabled by command. This feature is useful for applications in which very low dynamics are not expected, the classic example being an automotive application.

12.3.4 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 a server (server-generated ephemeris) and stored in the module.

ORG4033 has EASY, EPO and HotStill technology to allow for Hot Starts even in weak signal conditions. EPO (Extended Prediction Orbit) is one of MediaTek’s innovative proprietary off-line server based AGPS solution. Host could use an application to store and load the EPO files into device. With multi-constellation EPO, the user experience will be enhanced by the improved Time To First Fix (TTFF) and better first fix accuracy.
12.3.4.1 Locally-generated AGPS (Embedded Assist System – EASY)

Easy is the abbreviation of Embedded Assist System. The benefits of using this feature are:

- EASY works as embedded software which accelerates TTFF by predicting satellite navigation messages from received Ephemeris.
- No additional computing interval for EASY task. EASY is efficiently scheduled and computed during GPS workflow.
- World leading technology with no additional design – in efforts.

**Up to 3 days** extension for single received ephemeris:

![FIGURE 3 – EASY™ TTFF TIMING](image)

12.3.4.2 Server-generated AGPS (Extended Prediction Orbit – EPO)

The AGPS (EPO™) supply the predicted Extended Prediction Orbit data to speed TTFF, users can download the EPO data to GNSS engine from the FTP server by internet or wireless network, the GNSS engine will use the EPO data to assist position calculation when the navigation information of satellites are not enough or weak signal zone.

Host could use an application to store and load the EPO files into device. With multi-Constellation EPO, the user experience will be 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 serial port 1 (RX1). These predictions do not require local broadcast ephemeris collection, and they are valid for up to 14 days.
12.3.4.3. HotStill (Extended Prediction Orbit)
HotStill is one of MTK's innovative proprietary Off-line client based A-GPS solution which could greatly accelerate GPS TTFF (Time to First Fix) in urban canyon or weak signal environment from several minutes to only few seconds. It works as a background software running on the host processor to predicate satellite orbit navigation data and generate Broadcast Ephemeris Extension (BEE) from received broadcast ephemeris as well as no network connection requirements. Hotstill feature is designed for use on smartphones and it's not suitable for standalone designs.

12.3.5 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 allows 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 ranging. NMEA reporting for QZSS may be enabled/disabled by the user.

12.3.6 Satellite-Based Augmentation System (SBAS)
The ORG4033-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.

12.3.7 Differential GPS (DGPS)
DGPS is a Ground-Based Augmentation System (GBAS) 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 known-good range. The differences can then be used to compute a set of corrections which are transmitted to a DGPS receiver, either by radio or over the internet. The DGPS receiver can then send them to the serial port 1 (RX1) using the RTCM SC-104 message protocol. The 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.

12.3.8 Jamming Rejection – Active Interference Cancellation (AIC)
The ORG4033 detect, track and removes narrow-band interfering signals (jamming signals) without the need for 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 command. This feature is useful both in the design stage and during the production stage for uncovering issues related to unexpected jamming. When enabled, AIC will increase current consumption by about 1 mA. 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.
12.3.9 Power Management Modes

The ORG4033 support operational modes that allow them to provide positioning information at reduced overall current consumption. Availability of GNSS signals in the operating environment will also be a factor in choice of power management modes. The designer can choose a mode that provides the best trade-off of performance versus power consumption.

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

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

12.3.9.1 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 and 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].

12.3.9.2 Standby Mode

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

- `PMTK161,0` - Standby stop mode = Turn off VTCXO, RF a, baseband
- `PMTK161,1` - Standby sleep mode = Turn off RF and baseband

The host can then wake up the module from Standby mode to Full Power mode by sending any byte to the serial port.
12.3.9.3 Periodic Mode

This mode allows autonomous power on/off with 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.

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 and switched back to Full Power Continuous Mode by sending the command: `PMTK225,0`

just after the module wakes up from a previous sleep cycle.
12.3.9.4 AlwaysLocate™ Mode

AlwaysLocate™ is an intelligent controller of the Periodic mode; the main power supply VCC is still powered up, 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. ON/OFF ratio and fix rate to achieve a balance in positioning accuracy and power consumption. The average current can vary based on conditions.

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 NMEA command:
PMTK225,0

Just after the module wakes up from its previous sleep cycle.
12.3.9.5 Backup Mode

Backup Mode means a low quiescent power state where receiver operation is stopped. V_backup is powered on but the current consumption is minimal. After waking up, the receiver uses all internal aiding, including GNSS time, Ephemeris, and Last Position, resulting in the fastest possible TTFF in either hot or warm start modes. During Backup State, the I/O block is powered off. The suggestion is that the host forces its outputs to a low state or to a high-Z state during the Backup State to minimize small leakage currents at receiver’s input signals.

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

**Entering Backup Mode:**

**First option**

Entering to backup mode is done by a NMEA software command – PMTK225,4 (+checksum).

Important: Before sending the command the FORCE_ON pin must be tied to ground. While in Backup mode, the module will consume ~12uA from VCC & V_BACKUP.

In case the command is sent while the FORCE_ON is not tied to the ground – the module would get into idle state, but not BACKUP mode, and the current consumption would be significantly higher. The Current consumption is ~12uA in BACKUP mode while FORCE_ON pin of module is tied to ground with jumper. In real cases FORCE_ON pin is grounded by active device with residue resistance differ from zero so current consumption may be 2-3 times higher i.e. 25uA.

FORCE_ON must be tied to ground if you need to stay in BACKUP mode.

Example:

PMTK225,4 Enter backup mode

NMEA Return feedback:

PMTK001,225,3

Module will stay in BACKUP mode while FORCE ON is tied to ground.

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

**Important:** It is not possible to wake up the module from backup mode by software command.

**Second option**

Entering the BACKUP mode is done by disconnecting VCC and keeping the V_backup connected. The module will consume 7uA from V_backup. Ones the VCC is connected again, wait about 1 sec and then release it to logic low again, the module would switch into active state and acquire a hot start.

12.3.10 Configuration settings

Currently, the configuration settings will be erased after turning down the power.

Be aware to this issue on power cycles while shutting down the module.
### 12.4. PADS ASSIGNMENT

<table>
<thead>
<tr>
<th>PAD</th>
<th>NAME</th>
<th>FUNCTION</th>
<th>DIRECTION</th>
<th>Logic level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1PPS</td>
<td>UTC Time Mark</td>
<td>Output</td>
<td>2.8V</td>
</tr>
<tr>
<td>2</td>
<td>RX</td>
<td>UART Receive (Serial Input)</td>
<td>Input</td>
<td>2.8V</td>
</tr>
<tr>
<td>3</td>
<td>TX</td>
<td>UART Transmit (Serial Output)</td>
<td>Output</td>
<td>2.8V</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>System Ground</td>
<td>Power</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>RF IN</td>
<td>RF input</td>
<td>Input</td>
<td>50Ω</td>
</tr>
<tr>
<td>6</td>
<td>GND</td>
<td>System Ground</td>
<td>Input power</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>CTS</td>
<td>UART Clear To Send/ I2C Data</td>
<td>Input</td>
<td>2.8V</td>
</tr>
<tr>
<td>8</td>
<td>RTS</td>
<td>UART Ready To Send/ I2C Clock</td>
<td>Output</td>
<td>2.8V</td>
</tr>
<tr>
<td>9</td>
<td>FIX LED</td>
<td>FIX LED indicator</td>
<td>Output</td>
<td>2.8V</td>
</tr>
<tr>
<td>10</td>
<td>GND</td>
<td>System Ground</td>
<td>Power</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>FORCE ON</td>
<td>Forced full-power mode signal – Active Low</td>
<td>Input</td>
<td>2.8V</td>
</tr>
<tr>
<td>12</td>
<td>V_ BACKUP</td>
<td>Input for battery backup</td>
<td>Input power</td>
<td>2.8-4.2V</td>
</tr>
<tr>
<td>13</td>
<td>NC</td>
<td>Do not connect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>WAKEUP</td>
<td>WAKEUP</td>
<td>Output</td>
<td>2.8V</td>
</tr>
<tr>
<td>15</td>
<td>Vcc</td>
<td>System Power</td>
<td>Power</td>
<td>3.3V</td>
</tr>
<tr>
<td>16</td>
<td>GND</td>
<td>System Ground</td>
<td>Power</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>RESET</td>
<td>System Reset– Active Low</td>
<td>Input</td>
<td>2.8V</td>
</tr>
<tr>
<td>18</td>
<td>NC</td>
<td>spare</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 3 – PIN-OUT**

![Figure 6 – ORG4033 Top View](image-url)
13. MECHANICAL SPECIFICATIONS

- ORG4033 module has advanced ultra-miniature LGA SMD packaging sized 5.6mm x 5.6mm.
- ORG4033 built on a PCB assembly enclosed with metallic RF shield box.
- There are 18 LGA SMT pads made Cu base and ENIG plating on bottom side.

**FIGURE 7 – MECHANICAL DRAWING**

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Length</th>
<th>Width</th>
<th>Height</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>5.6 +0.15/-0.05</td>
<td>5.6 +0.15/-0.05</td>
<td>2.6 +0.1/-0.05</td>
<td>gr</td>
</tr>
<tr>
<td>inch</td>
<td>0.22 +0.0059/-0.002</td>
<td>0.22 +0.0059/-0.002</td>
<td>0.102 +0.004/-0.02</td>
<td>oz</td>
</tr>
</tbody>
</table>
### 14. ELECTRICAL SPECIFICATIONS

#### 14.1. ABSOLUTE MAXIMUM RATINGS

Stresses exceeding Absolute Maximum Ratings may damage the device.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>MIN</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Voltage</td>
<td>VCC</td>
<td>-0.30</td>
<td>+4.3</td>
<td>V</td>
</tr>
<tr>
<td>Backup Battery Supply Voltage</td>
<td>Vbackup</td>
<td>-0.30</td>
<td>+4.3</td>
<td>V</td>
</tr>
<tr>
<td>Power Supply Current(^1)</td>
<td>I(_{CC})</td>
<td>120</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>RF Input Voltage(^2)</td>
<td>V(_{RF})</td>
<td>-0.30</td>
<td>+3.6</td>
<td>V</td>
</tr>
<tr>
<td>I/O Voltage</td>
<td>V(_{IO})</td>
<td>-0.30</td>
<td>+3.6</td>
<td>V</td>
</tr>
<tr>
<td>I/O Source/Sink Current</td>
<td>I(_{IO})</td>
<td>8</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>ESD Voltage(^3)</td>
<td>V(_{IO/RF, HBM Model}) (^4)</td>
<td>(-/+ 1000</td>
<td>(-/+ 3000</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>V(_{IO/RF, MM Model}) (^4)</td>
<td>(-/+ 100</td>
<td>(-/+ 300</td>
<td>V</td>
</tr>
<tr>
<td>RF Power(^5)</td>
<td>P(_{RF})</td>
<td>+10</td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>(f_{IN} = 1560MHz \pm 1630MHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(f_{IN} &lt; 1560MHz, &gt; 1630MHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>T(_{AMB})</td>
<td>-45</td>
<td>+90</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>T(_{ST})</td>
<td>-50</td>
<td>+125</td>
<td>°C</td>
</tr>
<tr>
<td>Lead Temperature(^6)</td>
<td>T(_{LEAD})</td>
<td>-5</td>
<td>+260</td>
<td>°C</td>
</tr>
</tbody>
</table>

**TABLE 5 – ABSOLUTE MAXIMUM RATINGS**

Notes:
1. Inrush current of up to 100mA for about 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 from case for 10s duration.
### 14.2. RECOMMENDED OPERATING CONDITIONS

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

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>MODE / PAD</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply voltage</td>
<td>$V_{CC}$</td>
<td>$V_{CC}$</td>
<td></td>
<td>+3.00</td>
<td>+3.3</td>
<td>+3.60</td>
<td>V</td>
</tr>
<tr>
<td>Backup Battery supply voltage</td>
<td>$V_{backup}$</td>
<td>$V_{backup}$</td>
<td></td>
<td>+2.80</td>
<td>+3.60</td>
<td>+4.20</td>
<td>V</td>
</tr>
<tr>
<td>Digital IO Pin Low level input voltage</td>
<td>$V_{IL}$</td>
<td></td>
<td></td>
<td>-0.3</td>
<td>+0.7</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Digital IO Pin High level input voltage</td>
<td>$V_{IH}$</td>
<td></td>
<td></td>
<td>+2.1</td>
<td>+3.6</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Digital IO Pin Low level output voltage</td>
<td>$V_{OL}$</td>
<td>$V_{OL}\text{=}2\text{mA}$</td>
<td>-0.3</td>
<td>+0.4</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Digital IO Pin High level output voltage</td>
<td>$V_{OH}$</td>
<td>$V_{OH}\text{=}2\text{mA}$</td>
<td>+2.4</td>
<td>+2.8</td>
<td>+3.1</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

#### Power Supply Current\(^1\)

<table>
<thead>
<tr>
<th>MODE / PAD</th>
<th>I(_{CC})</th>
<th>Acquisition</th>
<th>GPS</th>
<th>40</th>
<th>mA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>GPS+GLONASS</td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tracking</td>
<td>GPS</td>
<td>28</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>GPS+GLONASS</td>
<td>35</td>
<td>mA</td>
</tr>
<tr>
<td>Standby</td>
<td></td>
<td></td>
<td></td>
<td>0.5</td>
<td>mA</td>
</tr>
<tr>
<td>Backup</td>
<td></td>
<td></td>
<td></td>
<td>7</td>
<td>12</td>
</tr>
</tbody>
</table>

#### RF Input

<table>
<thead>
<tr>
<th>f(_{IN}) = 1575.5MHz</th>
<th>-7</th>
<th>dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS or GLONASS</td>
<td>-165</td>
<td>-110</td>
</tr>
<tr>
<td>Input Frequency Range</td>
<td>1560</td>
<td>1607</td>
</tr>
</tbody>
</table>

#### Operating Temperature

<table>
<thead>
<tr>
<th>T(_{AMB})</th>
<th>-40</th>
<th>+25</th>
<th>+85</th>
<th>°C</th>
</tr>
</thead>
</table>

#### Storage Temperature\(^2\)

<table>
<thead>
<tr>
<th>T(_{ST})</th>
<th>-50</th>
<th>+25</th>
<th>+125</th>
<th>°C</th>
</tr>
</thead>
</table>

#### Relative Humidity\(^3\)

<table>
<thead>
<tr>
<th>R(_H)</th>
<th>5</th>
<th>95</th>
<th>%</th>
</tr>
</thead>
</table>

**Notes:**
1. Typical values under signal conditions of -130dBm and ambient temperature of +25°C and low gain configuration. Tested on the EVB with 12x12mm passive antenna.
2. Longer TTFF is expected while operating below -30°C to -40°C.
3. Relative Humidity is within Operating Temperature range.

**TABLE 6 – RECOMMENDED OPERATING CONDITIONS**
15. PERFORMANCE

15.1. ACQUISITION TIME

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

15.1.1. HOT START

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 available in RAM.

15.1.2. SIGNAL REACQUISITION

Reacquisition follows temporary blocking of GNSS signals. Typical reacquisition scenario includes driving through tunnel.

15.1.3. AIDED START

Aided Start is a method of effectively reducing TTFF by providing valid satellite ephemeris data. Aiding can be implemented using Embedded Assist System (EASY) and Extended Prediction Orbit (EPO) and HotStill.

15.1.4. 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.

15.1.5. COLD START

Cold Start occurs when satellite ephemeris data, position and time data are unknown. Typical Cold Start scenario includes first power application.

<table>
<thead>
<tr>
<th>OPERATION¹</th>
<th>MODE</th>
<th>VALUE</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Start</td>
<td>&lt; 1</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>Aided Start³</td>
<td>&lt; 3</td>
<td>s</td>
<td></td>
</tr>
<tr>
<td>Warm Start</td>
<td>GPS + GLONASS</td>
<td>&lt; 26</td>
<td>s</td>
</tr>
<tr>
<td></td>
<td>GPS</td>
<td>&lt; 29</td>
<td>s</td>
</tr>
<tr>
<td>Cold Start</td>
<td>GPS + GLONASS</td>
<td>&lt; 23</td>
<td>s</td>
</tr>
<tr>
<td></td>
<td>GPS</td>
<td>&lt; 31</td>
<td>s</td>
</tr>
<tr>
<td>Signal Reacquisition²</td>
<td>&lt; 3</td>
<td>s</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 7 – ACQUISITION TIME

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
4. Tested on the EVB with 12x12mm passive antenna
15.2. SENSITIVITY

15.2.1. TRACKING
Tracking is an ability of receiver to maintain valid satellite ephemeris data. During tracking receiver may stop output valid position solutions. Tracking sensitivity defined as minimum GNSS signal power required for tracking.

15.2.2. REACQUISITION
Reacquisition follows temporary blocking of GNSS signals. Reacquisition sensitivity defined as minimum GNSS signal power required for reacquisition.

15.2.3. NAVIGATION
During navigation receiver consequently, outputs valid position solutions. Navigation sensitivity defined as minimum GNSS signal power required for reliable navigation.

15.2.4. HOT START
Hot Start sensitivity defined as minimum GNSS signal power required for valid position solution under Hot Start conditions.

15.2.5. AIDED START
Aided Start sensitivity defined as minimum GNSS signal power required for valid position solution following aiding process.

15.2.6. COLD START
Cold Start sensitivity defined as minimum GNSS signal power required for valid position solution under Cold Start conditions, sometimes referred as ephemeris decode threshold.

<table>
<thead>
<tr>
<th>OPERATION¹</th>
<th>MODE</th>
<th>VALUE</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracking</td>
<td>GPS</td>
<td>-165</td>
<td>dBm</td>
</tr>
<tr>
<td></td>
<td>GLONASS</td>
<td>-165</td>
<td>dBm</td>
</tr>
<tr>
<td>Navigation</td>
<td>GPS</td>
<td>-163</td>
<td>dBm</td>
</tr>
<tr>
<td></td>
<td>GLONASS</td>
<td>-163</td>
<td>dBm</td>
</tr>
<tr>
<td>Reacquisition²</td>
<td>GPS+GLONASS</td>
<td>-160</td>
<td>dBm</td>
</tr>
<tr>
<td>Hot Start</td>
<td>GPS+GLONASS</td>
<td>-163</td>
<td>dBm</td>
</tr>
<tr>
<td>Aided Start</td>
<td>GPS+GLONASS</td>
<td>-160</td>
<td>dBm</td>
</tr>
<tr>
<td>Cold Start</td>
<td>GPS+GLONASS</td>
<td>-148</td>
<td>dBm</td>
</tr>
</tbody>
</table>

** The above values have been tested at update rate of 1 Hz. While working in a higher update rate there is some signal degradation.
15.3. RECEIVED SIGNAL STRENGTH

<table>
<thead>
<tr>
<th>PARAMETER&lt;sup&gt;4&lt;/sup&gt;</th>
<th>VALUE</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>C/N&lt;sub&gt;0&lt;/sub&gt;</td>
<td>45</td>
<td>dB-Hz</td>
</tr>
</tbody>
</table>

**TABLE 9 – RECEIVED SIGNAL STRENGTH**

Notes:
1. EVK is static, ambient temperature is +25°C, RF signals are conducted
2. Outage duration ≤ 30s.
3. Aiding using Broadcast Ephemeris (Ephemeris Push™) or Extended Ephemeris (CGEE™ or SGEE™).
4. Average C/N<sub>0</sub> reported for 4 SVs, EVK is 24-hrs. Static, outdoor, ambient temperature is +25°C.

15.4. POWER CONSUMPTION

<table>
<thead>
<tr>
<th>OPERATION&lt;sup&gt;1&lt;/sup&gt;</th>
<th>MODE</th>
<th>VALUE</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition</td>
<td>GPS</td>
<td>132</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>GPS + GLONASS</td>
<td>148.5</td>
<td>mW</td>
</tr>
<tr>
<td>Tracking</td>
<td>GPS</td>
<td>92.4</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td>GPS + GLONASS</td>
<td>115.5</td>
<td>mW</td>
</tr>
<tr>
<td>Standby state</td>
<td>1.65</td>
<td>mW</td>
<td></td>
</tr>
<tr>
<td>Backup state</td>
<td>39.6</td>
<td>μW</td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 10 – POWER CONSUMPTION**

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Constellation</th>
<th>CEP (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Position Accuracy</td>
<td>GPS</td>
<td>2.5</td>
</tr>
<tr>
<td>Horizontal Position Accuracy</td>
<td>Glonass</td>
<td>2.6</td>
</tr>
<tr>
<td>Horizontal Position Accuracy</td>
<td>BeiDou</td>
<td>10.2</td>
</tr>
<tr>
<td>Horizontal Position Accuracy</td>
<td>GPS + Glonass</td>
<td>2.5</td>
</tr>
<tr>
<td>Horizontal Position Accuracy</td>
<td>GPS + BeiDou</td>
<td>2.5</td>
</tr>
</tbody>
</table>

TABLE 11 – ORG4033 POSITION ACCURACY

Notes:
1. Module is static under signal conditions of -130dBm, ambient temperature is +25°C.
2. EVK is 24-hrs. Static, ambient temperature is +25°C.
3. Speed over ground ≤ 30m/s.

15.6. DYNAMIC CONSTRAINS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>Metric</th>
<th>Imperial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velocity</td>
<td>515m/s</td>
<td>1,000knots</td>
</tr>
<tr>
<td>Altitude</td>
<td>10000m</td>
<td>32808 ft</td>
</tr>
<tr>
<td>Altitude Balloon mode</td>
<td>80000m</td>
<td>262467 ft</td>
</tr>
<tr>
<td>Acceleration</td>
<td>4g</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 12 – DYNAMIC CONSTRAINS

Note:
1. Standard dynamic constrains according to regulatory limitations.
16. INTERFACE

16.1. POWER SUPPLY
It is recommended to keep the power supply on all the time in order to maintain RTC block active and keep satellite data in RAM for fastest possible TTFF. When V\text{CC} is removed settings are reset to factory default and the receiver performs Cold Start on next power up.

16.1.1. Nominal V\text{CC} = 3.3V
V\text{CC} is 3.3v DC and must be provided from regulated power supply. During tracking the processing is less intense compared to acquisition, therefore power consumption is lower. Filtering is important to manage high alternating current flows on the power input connection. An additional LC filter on ORG4033 power input may be needed to reduce system noise. The high rate of ORG4033 input current change 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 with a given inductor size. Large low ESR output capacitors are beneficial for low noise.

16.1.2. GROUND
Ground pad must be connected to host PCB Ground with shortest possible trace or by multiple VIAs.

16.2. CONTROL INTERFACE

16.2.1 UART- HOST INTERFACE
Multi Micro SPIDER ORG4033 has a standard UART ports:

16.2.1.1 TX
TX used for GPS data reports. 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 being output the TX data line idles high.

16.2.1.2 RX
RX used for receiver control. 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.

16.2.1.3 I2C
I2C interface in enabled by default starting from F.W version 5.1.1. The I2C interface pads are: I2C Data – pad 7 and I2C Clock – pad 8. I2C host interface features are:
- I2C Slave mode – host initiates clock and data, operating speed 400kpbs.
- ORG4033-mk support 7 bit I2C address.
- I2C default slave address ‘0x10’.
- Individual Tx FIFO buffer length of 255 bytes. Master can read one I2C data packet of max. 255 bytes at a time.
- In order to read entire NMEA packet of one second, master need to read several I2C data packets and extract valid NMEA data. After reading one I2C data packet, sleep 2ms before reading the next packet. In case entire packet of 1 second was read, wait for a longer period for the next NMEA packet.
DATA INTERFACE

16.2.2.1 FORCE-ON

Force-ON is an input signal that can be used to wake up the ORG4033-MK05 from the sleep mode. It has active-low logic, i.e. the module wakes up when FORCE_ON is tied to ground. When inactive, it should be floating.

Note:
Keeping FORCE_ON tied to ground will not prevent the ORG4033-MK05 from going into sleep mode since this signal is sensitive only to the high-low transition.

16.2.2.2 RESET

In addition, to NMEA command for reset- $PMTK104*37, external reset is available through RESET pin. Active low signal. Signal logic level of 2.8V.

The module continuously monitors the VCC supply and issue an internal hardware reset if the voltage drops below 2.7 (±0.1) V. This reset protects the memory from accidental writes during a power down condition. To prevent this, the supply must be regulated to be within the 2.8-4.3 voltage range, inclusive of load regulation and power supply noise and ripple. Noise and ripple outside of these limits can affect positioning sensitivity and risk tripping the internal voltage supervisors, thereby shutting down the module unexpectedly.

Regulators with good load regulation are recommended in order to prevent power supply glitches as the receiver transitions between power states.

16.2.2.3 1PPS

Pulse-Per-Second (PPS) output provides a pulse signal for timing purposes. The pulse is configurable for required duration, frequency and active high/low via 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

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

When the ORG4033 is on (full power) the output will be high at 3.3V level. When the ORG4033 is in on Standby or backup mode the output will be low (ground). Typical output voltage is 3.3V.

On low power modes (Periodic and AlwaysLocate) when the ORG4033 is off the wakeup level is low (and the wakeup returns to high level when the module returns to full power).

17. TYPICAL APPLICATION CIRCUIT

FIGURE 9 – REFERENCE SCHEMATIC DIAGRAM
18. RECOMMENDED PCB LAYOUT

18.1. FOOTPRINT

![Footprint Diagram]

**FIGURE 10 – FOOTPRINT**

18.2. HOST PCB

![Host PCB Image]

**FIGURE 11 – HOST PCB**
18.3. RF TRACE

![RF Trace Diagram]

FIGURE 12 – TYPICAL MICROSTRIP PCB TRACE ON FR-4 SUBSTRATE

18.4. PCB STACK-UP

![PCB Stack-Up Diagram]

FIGURE 13 – TYPICAL PCB STACK-UP

18.5. PCB LAYOUT RESTRICTIONS

Switching and high-speed components, traces and VIAs must be kept away from ORG4033 module. Signal traces to/from module should have minimum length. Recommended minimal distance from adjacent active components is 3mm. Ground pads must be connected to host PCB Ground with shortest possible traces or VIAs. In case of tight integration constrain or co-location with adjacent high speed components like CPU or memory, high frequency components like transmitters, clock resonators or oscillators, LCD panels or CMOS image sensors, contact OriginGPS for application specific recommendations.

19. DESIGN CONSIDERATIONS

19.1. ANTENNA

Antennas for GPS and GLONASS have a wider bandwidth than pure GPS antennas. Some wideband antennas may not have a good axial ratio to block reflections of RHCP GPS and GLONASS signals. These antennas have lower rejection of multipath reflections and tend to degrade the overall performance of the receiver.

19.2. RF

Multi Micro Spider ORG4033 operates with received signal levels down to -167dBm and can be affected by high absolute levels of RF signals, moderate levels of RF interference near the GNSS bands and by low-levels of RF noise in GNSS band. RF interference from nearby electronic circuits or radio transmitters can contain enough energy to desensitize ORG4033. These systems may also produce levels of energy outside of GNSS band, high enough to leak through RF filters and degrade the operation of the radios in ORG4033. This issue becomes more critical in small products, where there are industrial design constraints. In that environment, transmitters for Wi-Fi, Bluetooth, RFID, cellular and other radios may have antennas physically close to the GNSS receiver antenna. To prevent degraded performance of ORG4033, OriginGPS recommends performing EMI/jamming susceptibility tests for radiated and conducted noise on prototypes and assessing risks of other factors. Contact OriginGPS for application specific recommendations and design review services.
20. COMMANDS DESCRIPTION

<table>
<thead>
<tr>
<th>Command ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMTK000</td>
<td>Test. This command will be echoed back to the sender (for testing the communications link).</td>
</tr>
<tr>
<td>PMTK101</td>
<td>Perform a HOT start</td>
</tr>
<tr>
<td>PMTK102</td>
<td>Perform a WARM start</td>
</tr>
<tr>
<td>PMTK103</td>
<td>Perform a COLD start</td>
</tr>
<tr>
<td>PMTK104</td>
<td>Perform a system reset (erasing any stored almanac data) and then a COLD start</td>
</tr>
<tr>
<td>PMTK120</td>
<td>Erase aiding data stored in flash memory</td>
</tr>
<tr>
<td>PMTK127</td>
<td>Erase EPO data stored in flash memory</td>
</tr>
<tr>
<td>PMTK161.0</td>
<td>Standby - Stop mode</td>
</tr>
<tr>
<td>PMTK161.1</td>
<td>Standby - Sleep mode</td>
</tr>
<tr>
<td>PMTK251.Baudrate</td>
<td>Set NMEA Baudrate</td>
</tr>
<tr>
<td>PMTK315.0</td>
<td>Disable SBAS feature</td>
</tr>
<tr>
<td>PMTK315.1</td>
<td>Enable SBAS feature</td>
</tr>
<tr>
<td>PMTK333,1,0,0,0,0</td>
<td>Enable GPS only mode</td>
</tr>
<tr>
<td>PMTK333,0,1,0,0,0</td>
<td>Enable GLO only mode</td>
</tr>
<tr>
<td>PMTK333,0,0,0,1</td>
<td>Enable BDS only mode</td>
</tr>
<tr>
<td>PMTK333,1,0,0,0,0</td>
<td>Enable GPS and GLO mode</td>
</tr>
<tr>
<td>PMTK333,1,0,0,0,1</td>
<td>Enable GPS and BDS mode</td>
</tr>
</tbody>
</table>

TABLE 13– NMEA INPUT COMMANDS

21. FIRMWARE UPDATES

The FW stored in the internal Flash memory may be upgraded via the serial port TX/RX pads. In order to update the FW, the following steps should be performed to perform reprogramming:
1. Remove all power to the module.
2. Connect serial port to a PC.
3. Apply main power.
4. Run the software utility to re-flash the module. Clearing the entire flash memory is strongly recommended prior to programming.
5. Upon successful completion of re-flashing, remove main power to the module for a minimum of 10 seconds.
6. Apply main power to the module.
7. Verify the module has returned to the normal operating state.
22. HANDLING INFORMATION

22.1. MOISTURE SENSITIVITY
ORG4033 modules are MSL 3 designated devices according to IPC/JEDEC J-STD-033B standard. Module in sample or bulk package should be baked prior to assembly at 125°C for 48 hours.

22.2. ASSEMBLY
The module supports automatic pick-and-place assembly and reflow soldering processes. Suggested solder paste stencil is 5 mil to ensure sufficient solder volume.

22.3. SOLDERING
Reflow soldering of the module always on component side (Top side) of the host PCB according to standard IPC/JEDEC J-STD-020D for LGA SMD. Avoid exposure of ORG4033 to face-down reflow soldering process.

![Recommended Soldering Profile Diagram]

Reflected temperature is measured on top surface of the package during the entire soldering process. Suggested peak reflow temperature is 245°C for 30 sec. for Pb-Free solder paste. Actual board assembly reflow profile must be developed individually per furnace characteristics. Reflow furnace settings depend on the number of heating/cooling zones, type of solder paste/flux used, board design, component density and packages used.
22.4. CLEANING
If flux cleaning is required, module is capable to withstand standard cleaning process in vapor degreaser with the Solvon® n-Propyl Bromide (NPB) solvent and/or washing in DI water. Avoid cleaning process in ultrasonic degreaser, since specific vibrations may cause performance degradation or destruction of internal circuitry.

22.5. 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.

22.6. ESD SENSITIVITY
This product is ESD sensitive device and must be handled with care.

22.7. SAFETY INFORMATION
Improper handling and use can cause permanent damage to the product.

22.8. 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.

### TABLE 14 – SOLDERING PROFILE PARAMETERS

<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>PARAMETER</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_C$</td>
<td>Classification Temperature</td>
<td>245</td>
<td></td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>$T_P$</td>
<td>Package Temperature</td>
<td>245</td>
<td></td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>$T_L$</td>
<td>Liquidous Temperature</td>
<td>217</td>
<td></td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>$T_S$</td>
<td>Soak/Preheat Temperature</td>
<td>150</td>
<td>200</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>$t_S$</td>
<td>Soak/Preheat Time</td>
<td>60</td>
<td>120</td>
<td></td>
<td>s</td>
</tr>
<tr>
<td>$t_L$</td>
<td>Liquidous Time</td>
<td>60</td>
<td>150</td>
<td></td>
<td>s</td>
</tr>
<tr>
<td>$t_P$</td>
<td>Peak Time</td>
<td>30</td>
<td></td>
<td></td>
<td>s</td>
</tr>
</tbody>
</table>
23. COMPLIANCE

The following standards are applied on the production of ORG4033 modules:

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

ORG4033 modules are manufactured in ISO 9001:2008 accredited facilities.
ORG4033 modules are manufactured in ISO 14001:2004 accredited facilities.
ORG4033 modules are manufactured in OHSAS 18001:2007 accredited facilities.

ORG4033 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 as RoHS II.

ORG1510 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 as REACH.

ORG1510 modules comply with the following EMC standards:

- EU CE EN55022:06+A1(07), Class B
- JAPAN VCCI V-3/2006.04

24. PACKAGING AND DELIVERY

24.1. APPEARANCE

ORG4033 modules are delivered in reeled tapes for automatic pick and place assembly process.

ORG4033 modules are packed in 2 different reel types.

<table>
<thead>
<tr>
<th>SUFFIX</th>
<th>TR1</th>
<th>TR2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>400</td>
<td>1200</td>
</tr>
</tbody>
</table>

TABLE 15 – REEL QUANTITY
Reels are dry packed with humidity indicator card and desiccant bag according to 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 sticker providing information about:

- Description
- Part number
- Lot number
- Customer PO number
- Quantity
- Date code
24.2. CARRIER TAPE

Carrier tape material - polystyrene with carbon (PS+C).
Cover tape material – polyester based film with heat activated adhesive coating layer.

![Carrier Tape Diagram](image)

**FIGURE 16 – CARRIER TAPE**

<table>
<thead>
<tr>
<th></th>
<th>mm</th>
<th>inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0</td>
<td>6.86 ± 0.1</td>
<td>0.27 ± 0.004</td>
</tr>
<tr>
<td>B0</td>
<td>6.86 ± 0.1</td>
<td>0.27 ± 0.004</td>
</tr>
<tr>
<td>K0</td>
<td>3.8 ± 0.1</td>
<td>0.15 ± 0.004</td>
</tr>
<tr>
<td>P1</td>
<td>12.0 ± 0.1</td>
<td>0.472 ± 0.004</td>
</tr>
<tr>
<td>W</td>
<td>16.0 ± 0.3</td>
<td>0.630 ± 0.012</td>
</tr>
</tbody>
</table>

**TABLE 16 – CARRIER TAPE DIMENSIONS**
24.3. REEL
Reel material - antistatic plastic.

![Reel Diagram]

**FIGURE 17 – REEL**

<table>
<thead>
<tr>
<th>SUFFIX</th>
<th>TR1</th>
<th>TR2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ØA</td>
<td>178.0 ± 1.0 mm ± 0.04</td>
<td>330.0 ± 2.0 mm ± 0.04</td>
</tr>
<tr>
<td>ØN</td>
<td>60.0 ± 1.0 mm ± 0.04</td>
<td>102.0 ± 2.0 mm ± 0.04</td>
</tr>
<tr>
<td>W1</td>
<td>16.7 ± 0.5 mm ± 0.02</td>
<td>16.7 ± 0.5 mm ± 0.02</td>
</tr>
<tr>
<td>W2</td>
<td>19.8 ± 0.5 mm ± 0.02</td>
<td>22.2 ± 0.5 mm ± 0.02</td>
</tr>
</tbody>
</table>

**TABLE 17 – REEL DIMENSIONS**

25. ORDERING INFORMATION

![Ordering Options Diagram]

**FIGURE 18 – ORDERING OPTIONS**

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>FW VERSION</th>
<th>HW OPTION</th>
<th>VCC RANGE</th>
<th>PACKAGING</th>
<th>SPQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORG4033-MK05-TR1</td>
<td>MK</td>
<td>05</td>
<td>3.3V</td>
<td>REELED TAPE</td>
<td>400</td>
</tr>
<tr>
<td>ORG4033-MK05-TR2</td>
<td>MK</td>
<td>05</td>
<td>3.3V</td>
<td>REELED TAPE</td>
<td>1200</td>
</tr>
<tr>
<td>ORG4033-MK05-UAR</td>
<td>MK</td>
<td>05</td>
<td>5V USB</td>
<td>EVALUATION KIT</td>
<td>1</td>
</tr>
</tbody>
</table>

**TABLE 138 – ORDERABLE DEVICES**

The default constellation is GPS, GLONASS and Galileo.
GPS and BEIDOU constellation is also available. For ordering
26. **APPENDIX 1 – MULTI MICRO HORNET ORG4033-MK05**

The ORG4033-MK05 version has an option to connect a coin battery (for example ECR2025 coin battery) to provide power in backup mode. Minimum voltage that the backup battery will support is 2.8V.

With a battery connection, after waking up, the receiver uses:
1. All internal aiding, including RTC time, Ephemeris, and Last Position, resulting in the fastest possible TTFF in either hot or warm start modes.
2. Configuration settings stored in flash after turning power off.

To keep alive the RTC time, the following circuit implementation using a 3V coin battery, can be used. In addition, you need to consider using a charger for the battery or separating the VCC and V_BACKUP with using controlled LDO for each of them.

![FIGURE 21 – BATTERY BACKUP IMPLEMENTATION](image)

If a battery is not connected to pad 12 in ORG4033-MK05, connection between pads 12 and 15 is a MUST in order to operate the module.