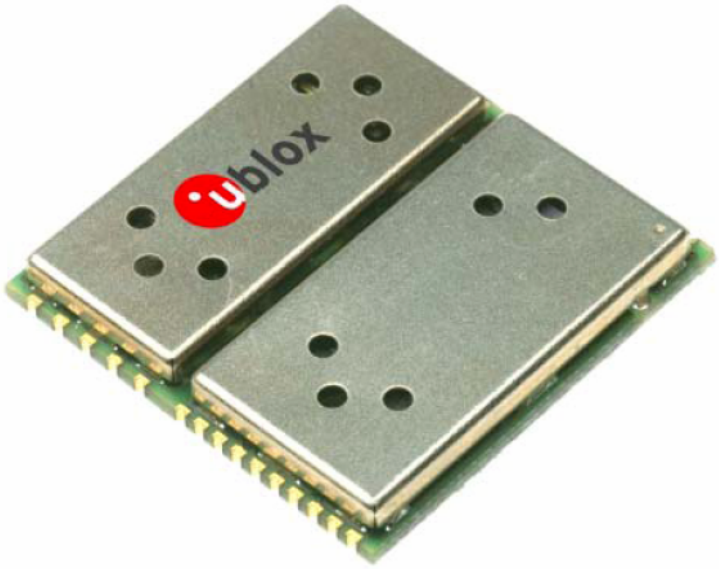
# TIM-LC
# GPS Receiver Module

## Data Sheet



**Abstract**

This document describes the features and specifications of the TIM-LC module suitable for active antennas. Based on the ANTARIS® GPS technology, it offers best GPS performance at very low power consumption.

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Data Sheet

| | |
|---|---|
| **Title** | TIM-LC |
| **Subtitle** | GPS Receiver Module |
| **Doc Type** | Data Sheet |
| **Doc Id** | GPS.G3-MS3-03019-D |

| Revision Index | Date | Name | Status / Comments |
|---|---|---|---|
| P1 | 2. Apr. 03 | GzB | Preliminary release |
| P2 | 16. Jun. 03 | GzB | Updated electrical and performance characteristics |
| P3 | 30. Oct. 03 | GzB | New: Section 1.8 (Antenna), table 5 (Timepulse accuracy), table 9 (sleep mode current) |
| P4 | 21. Nov. 03 | GzB | Modified sections 1.1, 1.3 and Table 6 |
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| A | 6. July 04 | GzB | Updated ordering information |
| B | 6. Aug. 04 | GzB | Modified Table 10: Sustained supply current;<br>Modified sections 1.1, 1.2, 3.1, 3.3, Table 10 and 6.1 because serial port 2 is available |
| C | 15. Se.p 04 | GzB | Modified section 1.8 |
| D | 02. Feb. 06 | GzB | Modified section 1.8, table 7 (RESET_N) |

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| Data Sheet Revisions | Identification of applicable hardware | Comments |
|---|---|---|
| P1 - P3 | TIM-LC with data codes<br>130100.**0211**.000, 130100.**0311.**000 | ANTARIS GPS Firmware Version 2.11 inside |
| P4, -, A | TIM-LC with data codes<br>130100.**0320**.000, 130100.**0420**.000 | ANTARIS GPS Firmware Version 3.0 inside |
| B, C, D | TIM-LC with data codes<br>130100.**0500**.000 and higher | ANTARIS Chipset with ROM 3.0 |




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# 1 Functional Description

## 1.1 Overview

The TIM-LC is an ultra-low power OEM GPS module suitable for active antennas to run standard PVT applications. It provides two 3V (5V TTL input compatible) serial ports and easy-to-use boot time configuration pins. The combination of lowest power consumption, cost-optimized architecture (no Flash EPROM inside) and innovative packaging technology makes the TIM-LC suitable for high-volume applications where small size, low cost and simplicity are key issues.

The leading ANTARIS® GPS Engine, jointly developed by Atmel and u-blox, provides excellent navigation performance under dynamic conditions in areas with limited sky view like urban canyons, high sensitivity for weak signal operation without compromising accuracy, and support of DGPS and multiple SBAS systems like WAAS and EGNOS. The 16 parallel channels and 8192 search bins provide fast start-up times. The aiding functionality accelerates start-up times even further. The low power consumption and FixNow™ power saving mode make this product suitable for handheld and battery-operated devices.

Innovative packaging technologies enable high integration of a GPS receiver in a small module measuring just 25.4 x 25.4 mm and allowing straightforward integration in particularly small end products and new application fields. The small form factor and the SMT pads allow a fully automatic assembly process with standard pick-and-place equipment and reflow soldering, enabling cost-efficient high-volume production.

## 1.2 Block Diagram

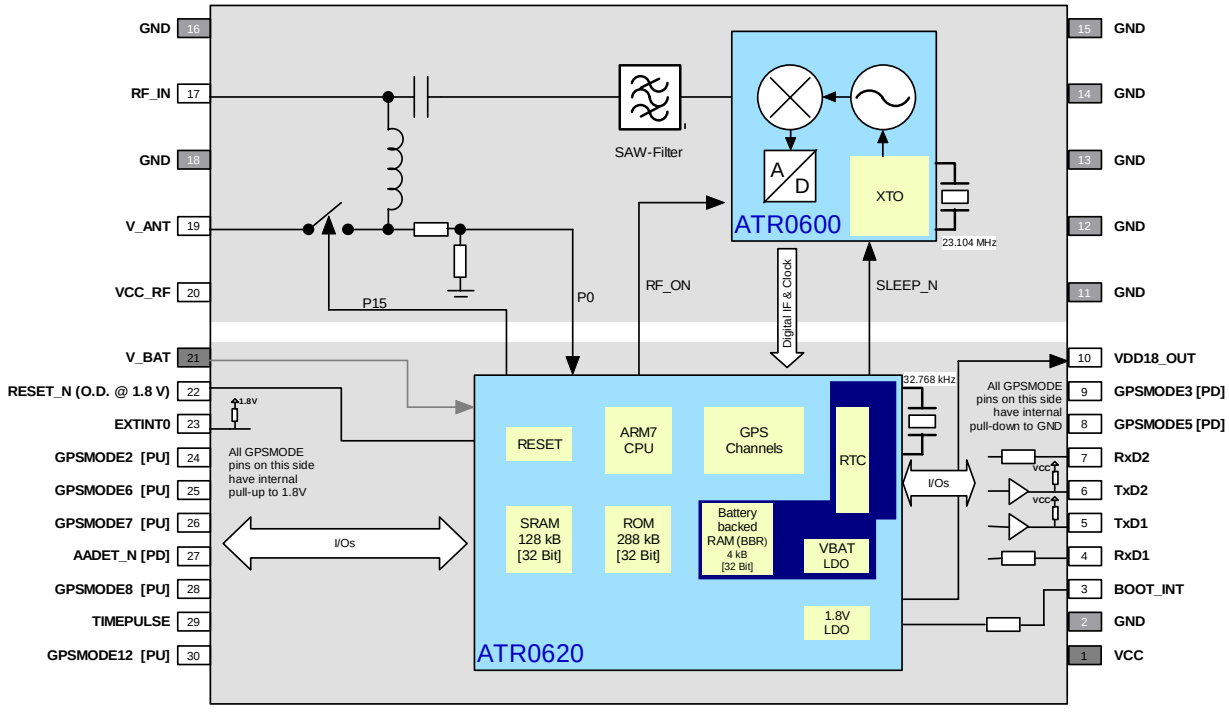



**Figure 1: Block Diagram**

## 1.3 Benefits

- High acquisition and tracking sensitivity
- Ultra-low power consumption
- Excellent GPS performance
  - Excellent navigation accuracy, even at low signal levels
  - Active multipath detection and removal
  - Fast Time-To-First-Fix (TTFF)
  - Accelerated TTFF with aiding functionality
- No Flash EPROM inside
  - Independence from memory market and price fluctuations
- Highly integrated GPS module
  - Automatic pick and place assembly
  - Reflow solderable
- Maximum flexibility
  - Extensively configurable
  - Boot-time configuration pins
- Fully EMI shielded
- Active antenna support

## 1.4 Features

- 16 channel GPS receiver
- 8192 simultaneous time-frequency search bins
- 4 Hz position update rate
- ANTARIS Positioning Engine
  - ATR0600 RF front-end IC
  - ATR0620 Baseband IC with ARM7TDMI inside
- DGPS and SBAS (WAAS, EGNOS) support
- FixNOW™ power saving mode
- Operating voltage 2.7 to 3.3 V
- Battery supply pin for internal backup memory and real time clock
- Industrial operating temperature range –40 to 85°C
- Small size
  - Size 25.4mm x 25.4mm
  - Height 3mm
  - Weight 3g

## 1.5 Operating Modes

The ANTARIS GPS Technology defines the following Operating Modes:

| Operating Modes | Description |
|---|---|
| **Continuous Tracking Mode (CTM)** | The Continuous Tracking Mode is configured for optimal position accuracy. This mode is optimized for power consumption based on the ANTARIS Autonomous Power Management (APM) saving as parts of the receiver are switched off when they are not required; also the CPU clock speed is reduced when the CPU is not loaded.<br>There is no need for a user to configure this mode as it is built into the architecture of the module. |
| **Power Saving Modes** | |
| **FixNOW™ (FXN)** | FixNOW™ Mode allows an application a navigation solution on request. It includes additional Power Saving Functions and is the best mode for any Mobile, Tracking Unit application where low power consumption requirements are primary consideration.<br>This mode can be configured to meet application requirements. |

**Table 1: Operating Modes**

For more information see the *ANTARIS System Integration Manual* [1].

## 1.6 Protocols

The TIM-LC supports different serial protocols.

| Protocol | Type | Runs on |
|---|---|---|
| NMEA | Input/output, ASCII, 0183, 2.3 (compatible to 3.0) | All Serial ports |
| UBX | Input/output, binary, u-blox proprietary | All Serial ports |
| RTCM | Input, message 1,2,3,9 | All Serial ports |

**Table 2: Available Protocols**

For specification of the various protocols see the *Protocol Specification* [2].

## 1.7 Boot-Time GPSMODE Configuration

The TIM-LC provides seven GPSMODE pins which provide boot-time configuration capabilities. These configuration settings will be effective immediately after start-up. Once the TIM-LC has started, the configuration settings may be modified with UBX configuration messages. The modified settings remain effective until power-down or reset. If these settings have been stored in battery-backup RAM (with CFG-CFG message), then the modified configuration will be retained as long backup battery supply is not interrupted.

| GPSMODE | | |
|---|---|---|
| **3** | **2** | **GPS sensitivity settings** |
| 0 | 0 | Reserved |
| **0** | **1** | **Fast acquisition mode (default)** |
| 1 | 0 | Normal sensitivity mode |
| 1 | 1 | High sensitivity mode |

| GPSMODE | | |
|---|---|---|
| **8** | **7** | **Navigation rate settings** |
| 0 | 0 | CTM 2 Hz |
| 0 | 1 | CTM 0.5 Hz |
| 1 | 0 | CTM 4 Hz update rate |
| **1** | **1** | **CTM 1 Hz update rate (default)** |

**Table 3: Supported GPSMODE settings (Default settings apply if not connected)**

| GPSMODE | | | | |
|---|---|---|---|---|
| **12** | **6** | **5** | **Baud Rate** | **Output Message Set** |
| 0 | 0 | 0 | 57.6 Kbaud, UBX | NAV-SOL, NAV-SVINFO<br>NAV-POSECEF, NAV-POSLLH, NAV-STATUS, NAV-DOP, NAV-VELECEF, NAV-VELNED, NAV-TIMEGPS, NAV-TIMEUTC, NAV-CLOCK<br>MON-SCHD, MON-IO, MON-IPC |
| 0 | 0 | 1 | 38.4 Kbaud, UBX | NAV-SOL, NAV-SVINFO<br>NAV-POSECEF, NAV-POSLLH, NAV-STATUS, NAV-DOP, NAV-VELECEF, NAV-VELNED, NAV-TIMEGPS, NAV-TIMEUTC, NAV-CLOCK |
| 0 | 1 | 0 | 19.2 Kbaud, UBX | NAV-SOL, NAV-SVINFO |
| 0 | 1 | 1 | Autobauding | None. Must be activated explicitly with CFG-PRT / CFG-MSG messages |
| 1 | 0 | 0 | 19.2 Kbaud, NMEA | GGA, RMC, GSA, GSV, GLL, VTG, ZDA, GRS, GST, TXT<br>PUBX00, PUBX03, PUBX04 |
| 1 | 0 | 1 | 4.8 Kbaud, NMMA | GGA, RMC, TXT |
| **1** | **1** | **0** | **9.6 Kbaud, NMEA (default)** | **GGA, RMC, GSA, GSV, GLL, VTG, ZDA, TXT** |
| 1 | 1 | 1 | 115.2 Kbaud, UBX | NAV-SOL, NAV-SVINFO<br>NAV-POSECEF, NAV-POSLLH, NAV-STATUS, NAV-DOP, NAV-VELECEF, NAV-VELNED, NAV-TIMEGPS, NAV-TIMEUTC, NAV-CLOCK<br>MON-SCHD, MON-IO, MON-IPC<br>RXM-RAW |

**Table 4: Supported GPSMODE settings (Default settings apply if not connected)**

For more information see the *ANTARIS System Integration Manual* [1].

## 1.8 Antenna

This GPS receiver is designed for use with active antennas. An antenna supervisor is provided. If activated, the GPS receiver is capable of detecting short circuits to the active antenna by checking the bias voltage level and can shut down the voltage bias immediately. A series resistor is needed in front of the **V_ANT** input. UBX and NMEA messages are provided to report the condition of the antenna supply. Open circuit detection can also be supported with an additional external circuit. For details, please refer to the *ANTARIS System Integration Manual* [1].

| Parameter | Specification | |
|---|---|---|
| Antenna Type | | Active only |
| Active Antenna Recommendations | Minimum gain | 25 dB |
| | Maximum noise figure | 1.5 dB |
| | Maximum gain | 60 dB |
| Antenna Supply | | Using **VCC_RF** or external |
| Antenna Supervisor | Short circuit detection | Built-in |
| | Open circuit detection | Enabled with external circuit |

**Table 5: Antenna Specification**

# 2 Performance Specification

| Parameter | Specification | | | |
|---|---|---|---|---|
| Receiver Type | | L1 frequency, C/A Code,<br>16-Channels<br>8192 search bins | | |
| Max Update Rate | | 4 Hz | | |
| Accuracy<br>(Selective Availability off) | Position | 2.5 m CEP[2] | 5.0 m SEP[3] | |
| | Position DGPS / SBAS[1] | 2.0 m CEP | 3.0 m SEP | |
| Acquisition[4] | | Fast Acquisition Mode | Normal Mode | High Sensitivity Mode |
| | Cold Start[5] | 34 s | 36 s | 41 s |
| | Warm Start | 33 s | | |
| | Hot Start | <3.5 s | | |
| | Aided Start[6] | 5 s | | |
| Signal Reacquisition | | <1 s | | |
| Sensitivity[7] | | Fast Acquisition Mode | Normal Mode | High Sensitivity Mode |
| | Acquisition | -134 dBm | -138 dBm | -140 dBm |
| | Tracking | -143 dBm | -146 dBm | -149 dBm |
| Timepulse Accuracy | RMS | 50 ns | | |
| | 99% | <100 ns | | |
| | Granularity | 43 ns | | |
| Dynamics | | ≤ 4 g | | |
| Operational Limits | | COCOM restrictions | | |

**Table 6: Performance Specification**

[1] Depends on accuracy of correction data of DGPS or SBAS service
[2] CEP = Circular Error Probability: The radius of a horizontal circle, centered at the antenna's true position, containing 50% of the fixes.
[3] SEP = Spherical Error Probability. The radius of the sphere, centered at the true position, contains 50% of the fixes.
[4] The different start-up modes like cold, warm and hot start are described in the System Integration Manual [1]
[5] Measured with good visibility and -125 dBm signal strength
[6] Time synch. signal from aiding source must be supplied to **EXTINT0** pin, having accuracy of better than 200 µs
[7] Demonstrated with a good active antenna

# 3 Mechanical Specification

## 3.1 Dimensions

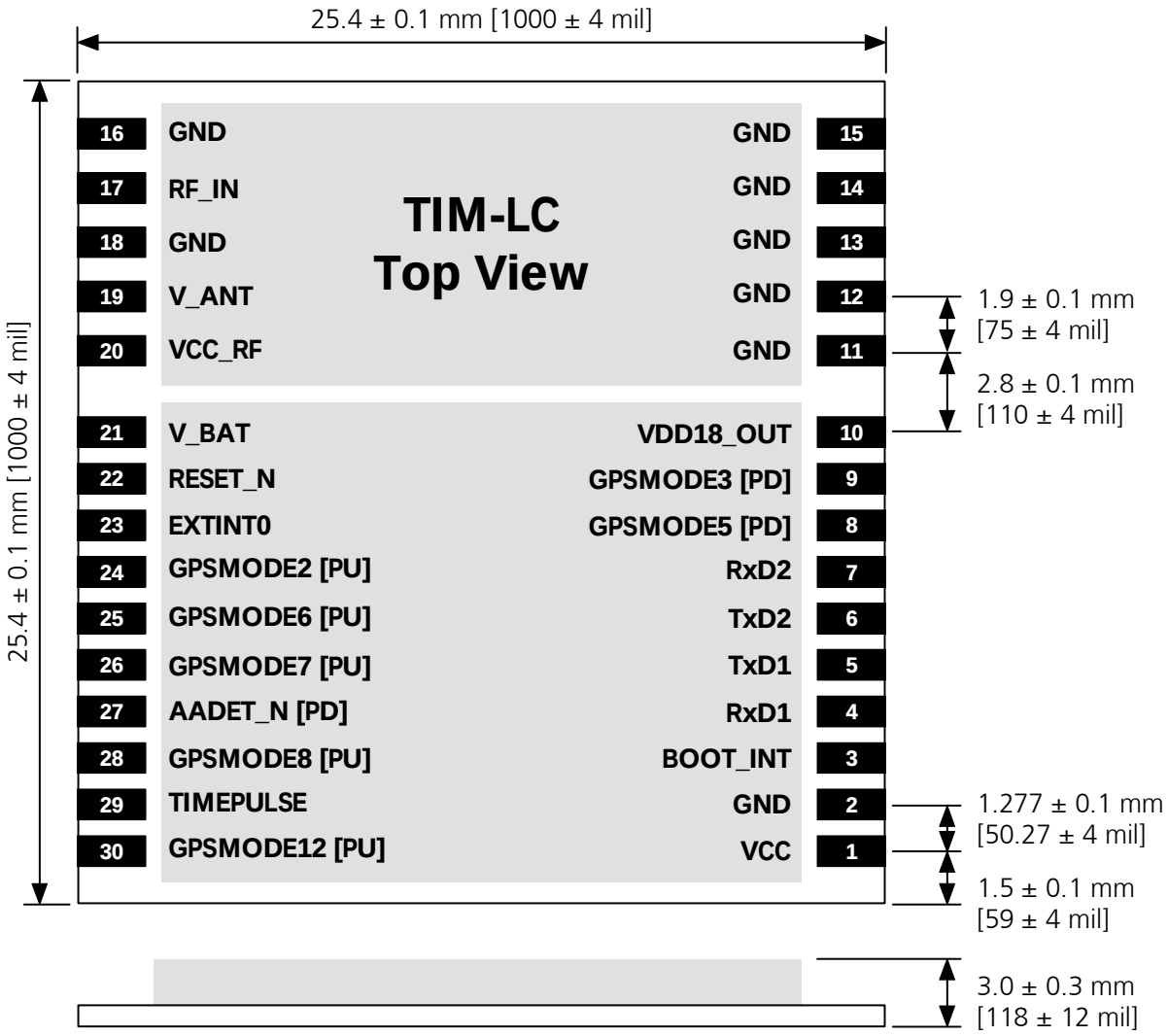



**Figure 2: TIM-LC Dimensions**

## 3.2 Specification

| Parameter | Specification | Tolerance | Unit |
|---|---|---|---|
| Length | 25.4 | ±0.1 | mm |
| Width | 25.4 | ±0.1 | mm |
| Thickness | 3.0 | ±0.3 | mm |
| Pitch RF pins | 1.9 | ±0.1 | mm |
| Pitch Digital pins | 1.277 | ±0.1 | mm |
| Weight | 3 | | g |

**Table 7: Mechanical Specification**

## 3.3 Pinout

| Standard Function | | | | Remarks |
|---|---|---|---|---|
| Pin | Name | I/O | Description | |
| **1** | VCC | I | Supply voltage | |
| **2** | GND | I | Ground | |
| **3** | BOOT_INT | I | Boot mode | Leave open if not used (normal operation) |
| **4** | RxD1 | I | Serial Port 1 | Pull up if not used |
| **5** | TxD1 | O | Serial Port 1 | Leave open if not used |
| **6** | TxD2 | O | Serial Port 2 | Leave open if not used |
| **7** | RxD2 | I | Serial Port 2 | Pull up if not used |
| **8** | GPSMODE5 | I | Boot time configuration pin | Internal pull-down, leave open if not used |
| **9** | GPSMODE3 | I | Boot time configuration pin | Internal pull-down, leave open if not used |
| **10** | VDD18_Out | O | 1.8V supply output | Suitable for setting GPSMODE pins high<br>Suitable as reference for external level shifter |
| **11 – 16** | GND | I | Ground | |
| **17** | RF_IN | I | GPS signal input | Apply no DC through this pin |
| **18** | GND | I | Ground | |
| **19** | V_ANT | I | Antenna Bias voltage | Connect to GND if not used |
| **20** | VCC_RF | O | Output Voltage RF section | May be connected to V_ANT |
| **21** | V_BAT | I | Backup voltage supply | Connect to GND if not used |
| **22** | RESET_N | I/O | Reset (Active low) | Concerning use of RESET_N signal, please refer to the ANTARIS System Integration Manual [1] |
| **23** | EXTINT0 | I | External Interrupt Pin | Internal pull-up, leave open if not used |
| **24** | GPSMODE2 | I | Boot time configuration pin | Internal pull-up, leave open if not used |
| **25** | GPSMODE6 | I | Boot time configuration pin | Internal pull-up, leave open if not used |
| **26** | GPSMODE7 | I | Boot time configuration pin | Internal pull-up, leave open if not used |
| **27** | AADET_N | I | Active Antenna Detect | Internal pull-down, leave open if not used |
| **28** | GPSMODE8 | I | Boot time configuration pin | Internal pull-up, leave open if not used |
| **29** | TIMEPULSE | O | Timepulse signal | Leave open if not used |
| **30** | GPSMODE12 | I | Boot time configuration pin | Internal pull-up, leave open if not used |

Shaded pins operate with 1.8V signal levels

**Table 8: Signals and Module Interface**

# 4 Electrical Specification

## 4.1 Absolute Maximum Ratings

| Parameter | Symbol | Min | Max | Units |
|---|---|---|---|---|
| **Power Supply (VCC and V_BAT)** | | | | |
| Power supply voltage | Vcc | -0.3 | 3.6 | V |
| **Input Pins** | | | | |
| Input pin voltage (1.8V inputs, RESET_N) | Vio | -0.3 | 1.95 | V |
| Input pin voltage (RxD1) | Vrxd | -0.3 | 8 | V |
| BOOT_INT pin | Vboot | -0.3 | 3.3 | V |
| **Voltage Supply output for Active Antenna and RF Section** | | | | |
| VCC_RF output current | Iccrf | | 50 | mA |
| **RF Input** | | | | |
| Antenna bias voltage (applied via V_ANT | Vant | 0 | 8 | V |
| Antenna bias current (applied via V_ANT) | Iant | | 100 | mA |
| Input power at RF_IN<br>(source impedance 50Ω, continuous wave) | Prfin | | 0 | dBm |
| Input power at RF_IN<br>(824-829 MHz, 890-915 MHz, 1710-1785 MHz) | Prfin | | 10 | dBm |
| **Environment** | | | | |
| Storage temperature | Tstg | -40 | 125 | °C |

**Table 9: Absolute Maximum Ratings**

**! Warning** Stressing the device beyond the "Absolute Maximum Ratings" may cause permanent damage. These are stress ratings only. The product is not protected against overvoltage or reversed voltages. If necessary, voltage spikes exceeding the power supply voltage specification, given in table above, must be limited to values within the specified boundaries by using appropriate protection diodes.

## 4.2 Operating Conditions

| Parameter[8] | Symbol | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Power Supply** | | | | | | |
| Power supply voltage | Vcc | | 2.7 | | 3.3 | V |
| Power supply voltage ripple | Vcc_PP | | | | 50 | mV |
| Sustained supply current [9] | Icc | Vcc = 3.0 V | | 47 | | mA |
| Peak supply current [10] | Iccp | Vcc = 3.3 V | | | 125 | mA |
| Sleep mode current | Iccs | Vcc = 3.0 V | | 100 | | µA |
| Backup battery voltage | Vbat | | 1.95 | | 3.6 | V |
| Backup battery current | Ibat | Vbat = 3.3V | | 15 | 40 (prelim.) | µA |
| 1.8V output voltage (VDD18_Out pin) | Vdd18out | | 1.65 | 1.8 | 1.95 | V |
| 1.8V output current (VDD18_Out pin) | Idd18out | | | | 20 | mA |

**Table 10: Operating Conditions**

[8] All specification are at an ambient temperature of 25°C.
[9] Average current drawn during Continuous Tracking Mode with 1 Hz update rate, using 6 satellites for tracking and navigation. Use this figure to determine required battery capacity
[10] Peak current drawn during initial acquisition phase. Use this figure to dimension maximum current capability of power supply

| Parameter[11] | Symbol | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **1.8V Digital I/Os and RESET_N** | | | | | | |
| Input pin voltage range | Vin18 | | 0V | | Vdd18out | V |
| Input pin low voltage | Vin_low18 | | | | 0.45 | V |
| Input pin high voltage | Vin_high18 | | 1.4 | | | V |
| Input pin voltage range | Vout18 | | 0V | | Vdd18out | V |
| Output pin low voltage | Vout_low18 | Iout < 0.3 mA (sink) | | | 0.1 | V |
| Output pin high voltage | Vout_high18 | Iout < 0.3 mA (source) | 1.55 | | | V |
| Output pin current at low voltage | Iout_low18 | Vout_low18 = 0.28 V | | | 2 | mA |
| Output pin current at high voltage | Iout_high18 | Vout_high18 = 1.35 V | | | 2 | mA |
| Input leakage current | Iin_leak18 | | | | 1 | µA |
| **TxD1, TxD2 Pins** | | | | | | |
| Output Pin voltage range | VoutT | | 0V | | Vcc | V |
| Output pin low voltage | Vout_lowT | Iout < 100µA (sink) | | | 0.1 | V |
| | Vout_lowT | Iout < 16mA (sink) | | | 0.4 | V |
| Output pin high voltage | Vout_highT | Iout < 10µA (source) | Vcc - 0.2 | | | V |
| | Vout_highT | Iout < 40µA (source) | Vcc - 0.5 | | | V |
| Output pin current at low voltage | Iout_lowT | Vout_lowT = 0.24 V | | | 4 | mA |
| Output pin current at high voltage | Iout_highT | Vout_highT = Vcc-0.5 V | | | 40 | µA |
| **RxD1, RxD2 Pins** | | | | | | |
| Input Pin voltage range | VinR | | 0 | | 5.5 | V |
| Input pin low voltage | Vin_lowR | | | | 0.4 | V |
| Input pin high voltage | Vin_highR | | 1.5 | Vcc | | V |
| **BOOT_INT Pin** | | | | | | |
| Input Pin voltage range | VinB | | 0 | | Vcc | V |
| Input pin low voltage | Vin_lowB | | | | 0.4 | V |
| Input pin high voltage | Vin_highB | | 2.7 | Vcc | | V |
| **RF input** | | | | | | |
| Input power | Prfin | | | | -46 | dBm |
| V_ANT antenna bias voltage (must connect to ground if not used) | Vant | | 1.8 | | 8 | V |
| Antenna bias voltage drop | Vant_drop | Iant=10mA | | | 50 | mV |
| VCC_RF voltage | Vccrf | | | Vcc – 0.1 | | V |
| **Environment** | | | | | | |
| Operating temperature | Topr | | -40 | | 85 | °C |

**Table 10: Operating Conditions (continued)**

Operation beyond the "Operating Conditions" is not recommended and extended exposure beyond the "Operating Conditions" may affect device reliability.

[11] All specification are at an ambient temperature of 25°C.

# 5 Environmental Specification

Detailed description of the test series:

| Test | | Standard |
|---|---|---|
| Visual inspection | | IPC-A-610 "Acceptability of electronic assemblies"<br>I.T.R.I. Publication No. 700<br>IPC-SM-840B Class 2. |
| Thermal shock | -40°C...+125°C, 100 cycles | IEC 68-2-14 |
| Function at various temperatures | -40°C/2 hours; RT/2 hours;<br>+85°C/2 hours; function tests at stable temperature | IEC 68-2-1 and IEC 68-2-2 |
| Lifespan test | +85°C/1000 hours, in function | IEC 68-2-2 |
| Damp heat, cyclic | +25°C...+55°C; >90% rH | IEC 68-2-30 |
| Vibration<br>Shock | 10-500 Hz; 2 hours/axis; 5g<br>30g/11ms (halfsine); 3 Shock/axis; no function | IEC 68-2-6<br>IEC 68-2-27 |
| Metallographic investigations | | IPC-QE-650 |

**Note:** This specification is preliminary and yet subject to confirmation.

**Table 11: Environmental Specification**

# 6 Product Lineup

## 6.1 Default Settings

Following default settings apply if the GPSMODE pins are left unconnected:

| Interface | Settings |
|---|---|
| Serial Port 1 Output | 9600 Baud, 8 bits, no parity bit, 1 stop bit<br>Configured to transmit both NMEA and UBX protocols, but only following NMEA and no UBX messages have been activated at start-up:<br>**GGA, GLL, GSA, GSV, RMC, VTG, ZDA, TXT**<br>Additional messages can be activated with appropriate input messages or with GPSMODE pins. |
| Serial Port 1 Input | 9600 Baud, 8 bits, no parity bit, 1 stop bit, Autobauding disabled<br>Automatically accepts following protocols without need of explicit configuration:<br>**UBX, NMEA, RTCM**<br>The GPS receiver supports interleaved UBX and NMEA messages. |
| Serial Port 2 Output | 38400 Baud, 8 bits, no parity bit, 1 stop bit<br>Configured to transmit both NMEA and UBX protocols, but only following UBX and no NMEA messages have been activated at start-up:<br>**NAV-POSLLH, NAV-SOL, NAV-SVINFO, NAV-STATUS, NAV-POSECEF NAV-DOP, NAV-VELECEF, NAV-VELNED, NAV-TIMEGPS, NAV-TIMEUTC, NAV-CLOCK**<br>MON-IO, MON-SCHD, MON-IPC, INF-Warning, INF-Error, INF-Notice<br>Additional messages can be activated with appropriate input messages. |
| Serial Port 2 Input | 38400 Baud, 8 bits, no parity bit, 1 stop bit, Autobauding disabled<br>Automatically accepts following protocols without need of explicit configuration:<br>**UBX, NMEA, RTCM**<br>The GPS receiver supports interleaved UBX and NMEA messages. |
| TIMEPULSE | 1 pulse per second, synchronized at rising edge, pulse length 100ms |

**Table 12: Available Protocols**

## 6.2 Ordering Information

| Ordering No. | Product |
|---|---|
| TIM-LC-0-000-0 | TIM-LC GPS Receiver Module<br>Delivery Packing<br>**0** = Single samples<br>**1** = Tape on reel (100 pieces)<br>**5** = Tape on reel (500 pieces) |

**Table 13: Ordering Information**

Parts of this product are patent protected.