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TIM-4H, TIM-4P, TIM-4R, TIM-4S, TIM-4A

ANTARIS® 4 GPS Modules

Data Sheet

Abstract
Technical Data Sheet describing the economical and flexible ANTARIS®4 based TIM-4x series (TIM-4H, TIM-4P, TIM-4R, TIM-4S, TIM-4A) of GPS Modules. The available features include serial interface, SuperSense® indoor GPS, AssistNow® Online, AssistNow® Offline and Dead Reckoning. The modules are integrated within a compact 25.4 x 25.4 mm housing, and support passive and active antennas.

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Data Sheet

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The current document replaces the following Data Sheets:		
Data Sheet Document Name	**Identification of applicable hardware**	**Comments**
GPS.G4-MS4-05025	TIM-4H	
GPS.G4-MS4-05027	TIM-4P	
GPS.G4-MS4-06136	TIM-4R	
GPS.G4-MS4-05074	TIM-4S	
GPS.G4-MS4-05023	TIM-4A	

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1 Functional Description

1.1 Overview

The TIM-4H, TIM-4P, TIM-4R, TIM-4S and TIM-4A are a series of low-cost GPS modules featuring u-blox's 16-channel ANTARIS®4 receiver technology. They combine exceptional performance with minimal power consumption. The ANTARIS®4 GPS engine provides outstanding navigation even in the most challenging urban situations. The 16 parallel channels and 8192 search bins provide fast start-up times.

As the successors to the highly successful TIM-Lx series, the TIM-4x modules also share the 25.4 x 25.4 mm form factor. The small form factor and SMT pads allow for fully automatic assembly processes with standard pick-and-place equipment and reflow soldering, enabling cost-efficient, high-volume production. The combination of these features make these modules suitable for a broad range of GPS products whose key requirements include high performance, low cost, low power consumption and small size.

The TIM-4x modules are interchangeable, providing the flexibility to use the module with the optimal features for application specific requirements. The series even includes Dead Reckoning functionality with the TIM-4R module.

1.2 Highlights and Features

- **Cost-optimized and flexible architecture**
- **Low power consumption**
- **A-GPS and autonomous operation, support AssistNow® Online and AssistNow® Offline capable**
- **Up to 4Hz Position Update rate**
- **Support DGPS, WAAS, EGNOS and MSAS**
- **Dead Reckoning functionality with 40 Hz calculation rate (TIM-4R)**

For an overview of the various features available with the different TIM-4 models please see Table 1.

Module	16 Channel ANTARIS®4 GPS Engine	SuperSense®	Nonvolatile Memory	Serial Ports	AssistNow® Online®	AssistNow® Offline®	Configuration Pins	Programmable	Dead Reckoning	Antenna Supervisor	Antenna Bias Voltage	Operating Temperature Range (°C)
TIM-4H	✓	✓	Flash	2	✓	✓		✓		✓	✓	-40 ... +85
TIM-4P	✓		Flash	2	✓	✓		✓		✓	✓	-40 ... +85
TIM-4R	✓		Flash	2	✓			✓	✓	✓	✓	-40 ... +85
TIM-4S	✓	✓	ROM	2	✓		✓			✓	✓	-40 ... +85
TIM-4A	✓		ROM	2	✓		✓			✓	✓	-40 ... +85

Table 1: Available features of the TIM-4x series

1.3 Block Diagram

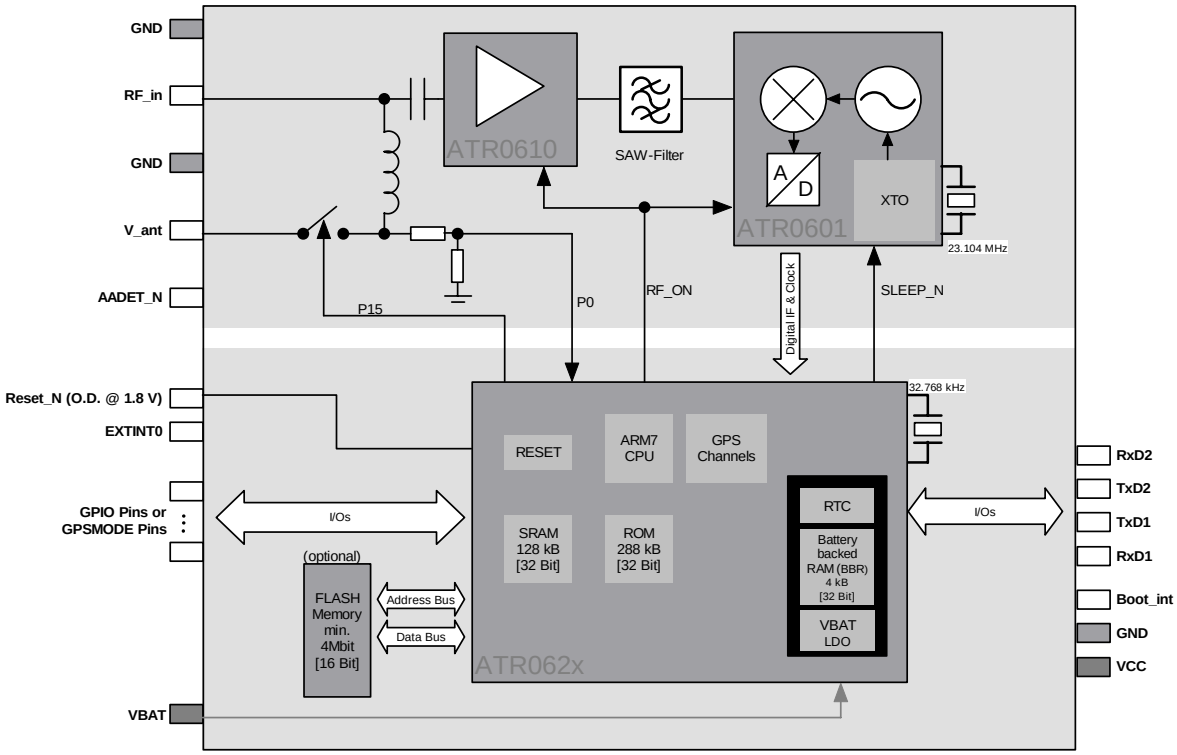

Figure 1: Block Diagram

1.4 Operating Modes

The ANTARIS®4 GPS Technology supports the following Operating Modes:

Operating Modes	Description
Continuous Tracking Mode (CTM)	In this mode, the Autonomous Power Management (APM) automatically optimizes power consumption. It powers off parts of the receiver when they are not used. Also, the CPU speed is reduced when the CPU workload is low.
Power Saving Modes	A configurable power saving mode is available where the GPS is put into sleep mode and activated up on a selectable time interval or upon external request (signal activity on serial port or EXTINT input). This mode is ideally suited in applications with stringent power budget requirements in mobile and battery operated end products.

Table 2: Operating Modes

For more information see the *ANTARIS®4 System Integration Manual* [1].

1.5 Assisted GPS (A-GPS)

The ANTARIS®4 GPS engine supports Mobile Station (MS) based A-GPS for accelerated acquisition and position computation in the GPS receiver. Supply of aiding information like ephemeris, almanac, rough last position and time and satellite status and an optional time synchronization signal will reduce time to first fix significantly.

All TIM-4x modules support the u-blox AssistNow® Online A-GPS service. The TIM-4H and TIM-4P support AssistNow® Offline.

1.6 Dead Reckoning (TIM-4R)

Dead reckoning GPS receivers supplement the GPS information with an incoming signal from a gyroscope (turn rate sensor) and odometer pulses to do dead reckoning navigation through periods of poor GPS reception. Depending on the quality of the available GPS signals, the TIM-4R uses an algorithm specially developed by u-blox in order to compute the next positions accurately by using an automatically weighted average of the GPS and sensor inputs. This provides precise navigation in locations with no or impaired GPS reception, for example tunnels, indoor car parks and deep urban canyons.

The TIM-4R is a low power dead reckoning GPS receiver module. It is the ideal solution for high-volume applications requiring a cost-effective and tightly integrated product that provides a continuous and reliable positioning fix 100% of the time.

1.6.1 Supported Peripheral Components (TIM-4R)

The TIM-4R supports the following peripheral components (Table 3):

A/D converters with SPI interface	digital temperature sensors with SPI interface
Linear Technology, LTC1860, 12-bit A/D converter	National Semiconductors, LM70, precision: 10 bits plus sign

Table 3: Supported peripheral components

Gyroscopes should at least meet the requirements listed below:

Parameter	Specification
Supply Voltage	5.0V ±0.25V
Zero Point	2.5V ±0.4V
Scale factor	25mV/°/s ±5mV/°/s
Dynamic Range	±60°/s to ±125°/s
Linearity	±0.5% (Full Scale)
Recommended operating temp. range	-40 -to +85°C

Table 4: Required Specifications for Gyroscopes

Gyroscopes with a sensitivity (scale factor) of lower than 20mV/°/s may work but the performance will be degraded. For this reason u-blox does not recommend using gyros with a lower sensitivity.

For implementation details as well as a list of supported gyroscopes that u-blox is currently aware of, or for more information about Dead Reckoning and other special features of the TIM-4R please refer to the *TIM-4R System Integration Manual* [2].

1.7 Protocols

The TIM-4x series 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 5: Available Protocols

For specification of the various protocols see the *Protocol Specification* [3].

1.8 Antenna

The TIM-4x modules are designed for use with passive and 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®4 System Integration Manual* [1].

Parameter	Specification		
Antenna Type	Passive and active		
Active Antenna Recommendations	Minimum gain	15-20 dB	to compensate signal loss in RF cable
	Maximum noise figure	1.5 dB	
	Maximum gain	50 dB	

Table 6: Antenna Specifications

Parameter	Specification	
Antenna Supply		Using **VCC_RF** or external voltage source
Antenna Supervisor	Short circuit detection	Built-in
	Open circuit detection	Enabled with external circuit

Table 7: Antenna Supervisor Specifications

1.9 Configuration

1.9.1 Configuration (TIM-4A, TIM-4S)

The TIM-4A and TIM-4S provide five GPSMODE pins for boot-time configuration. They become effective immediately after start-up. Once the module 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.

GPSMODE2	GPSMODE3	GPS sensitivity settings
0	0	Auto
0	1	Normal sensitivity mode
1	0	Fast mode
1	1	High sensitivity mode

Table 8: GPSMODE

The other sensitivity settings can be enabled with configuration messages.

GPSMODE			Activated Message Set	Serial Port 1		Serial Port 2	
12	6	5	See Table 10	Baud Rate	Protocol	Baud Rate	Protocol
0	0	0	High	19.2 Kbaud	NMEA	57.6 Kbaud	UBX
0	0	1	Low	4.8 Kbaud	NMEA	19.2 Kbaud	UBX
0	1	0	Medium	9.6 Kbaud	NMEA	38.4 Kbaud	UBX
1	1	1	Reserved for factory use	115.2 Kbaud	UBX	19.2 Kbaud	NMEA

Table 9: Supported GPSMODE settings

Protocol	Medium (additional messages)	High (additional messages)
UBX	+ NAV-POSECEF, NAV-POSLLH, NAV-STATUS, NAV-DOP, NAV-VELECEF, NAV-VELNED, NAV-TIMEGPS, NAV-TIMEUTC, NAV-CLOCK	+ MON-SCHD MON-IO MON-IPC
NMEA	+ GSA, GSV, GLL, VTG, ZDA	+ GRS, GST, PUBX00, PUBX03, PUBX04

Table 10: Message Sets

1.9.2 Configuration (TIM-4H, TIM-4P, TIM-4R)

With the TIM-4H, TIM-4P and TIM-4R the configuration settings can be modified with UBX configuration messages. The modifications can be saved to the Flash memory.

For more information see the *ANTARIS®4 System Integration Manual* [1].

2 GPS Performance

Parameter	Module	Specification				
Receiver Type	All	L1 frequency, C/A Code, 16-Channels				
Max Navigation Update Rate	TIM-4A	4 Hz				
	TIM-4H	4 Hz				
	TIM-4P	4 Hz				
	TIM-4S	4 Hz				
	TIM-4R	1 Hz				
Accuracy	All	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, 5]	All	GPS Mode:	Fast Acq.	Normal	High Sens.	Auto
		Cold Start	34 s	36 s	41 s	34 s
		Warm Start	33 s			
		Hot Start	<3.5 s			
		Reacquisition	<1 s			
Sensitivity[6]	TIM-4A TIM-4P TIM-4R	Tracking	-150 dBm			
		Acquisition & Reacquisition	-140 dBm			
		Cold Starts	-140 dBm			
	TIM-4H TIM-4S	Tracking	-158 dBm			
		Acquisition & Reacquisition	-148 dBm			
		Cold Starts	-142 dBm			
Accuracy of Timepulse Signal	All	RMS	50 ns			
		99%	<100 ns			
		Granularity	43 ns			
		Time Pulse	Configurable: 0.1 … 1000 Hz			
Dynamics	All	≤ 4 g				
Operational Limits	All	Maximum Speed	515 m/s			

Table 11: GPS Performance

[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 *ANTARIS®4 System Integration Manual [1]*.
[5] Measured with good visibility and -125 dBm signal strength
[6] Demonstrated with a good active antenna

3 Mechanical Specifications

3.1 Dimensions

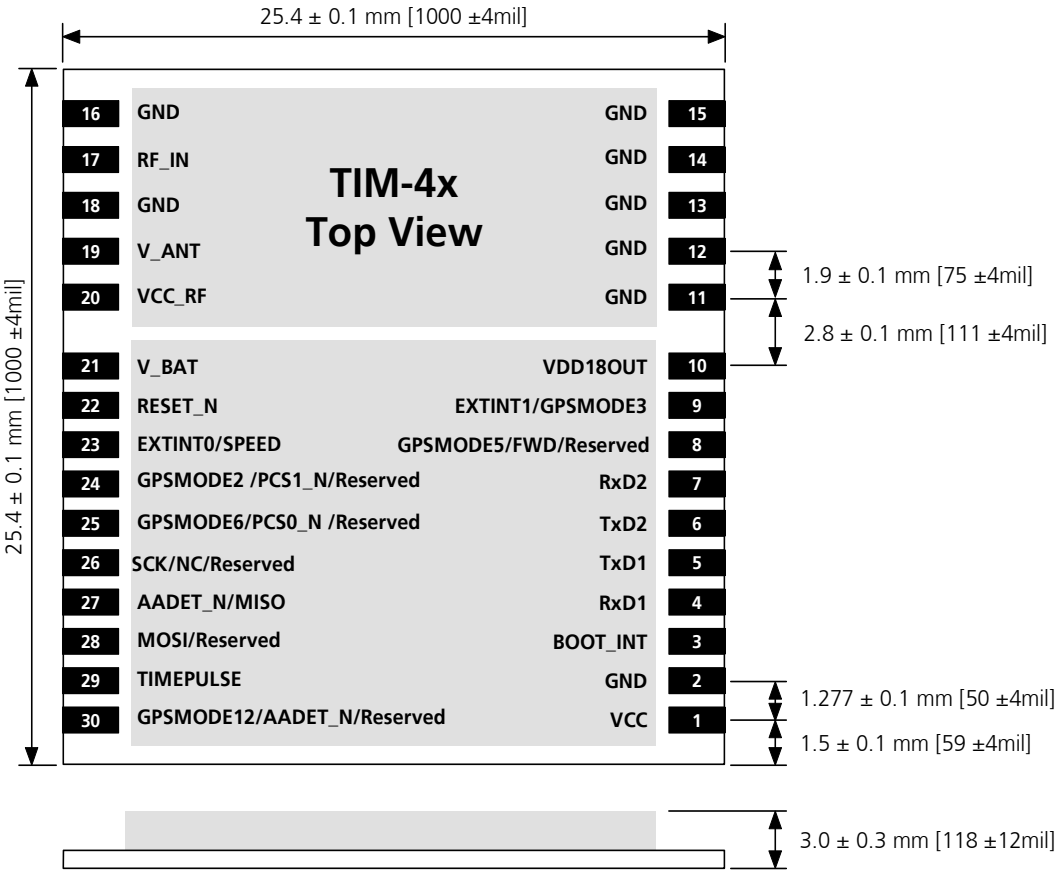

Figure 2: Dimensions

! **Note** For detailed information for a design in, including detailed dimensional diagrams, footprints, paste mask recommendations, pinout tables and a recommended pad layout please see the *ANTARIS®4 System Integration Manual* [1].

Parameter	Specification
Length	25.4 ±0.1mm [1000 ±4mil]
Width	25.4 ±0.1mm [1000 ±4mil]
Thickness	3.0 ±0.3mm [118 ±12mil]
Pitch RF pins	1.9±0.1mm [75 ±4mil]
Pitch Digital pins	1.277±0.1mm [50 ±4mil]
Weight	3 g

Table 12: Dimensions

3.2 Pinout

Standard Function				
Pin	Module	Name	I/O	Description
1	All	VCC	I	Supply voltage
2	All	GND	I	Ground
3	All	BOOT_INT	I	Boot mode
4	All	RxD1	I	Serial Port 1
5	All	TxD1	O	Serial Port 1
6	All	TxD2	O	Serial Port 2
7	All	RxD2	I	Serial Port 2
8	TIM-4A, TIM-4S	GPSMODE5	I	Boot-time config. pin
	TIM-4H, TIM-4P	Reserved	I	Reserved
	TIM-4R	FWD	I	Direction indication (1 = Forward)
9	TIM-4A, TIM-4S	GPSMODE3	I	Boot-time config. pin
	TIM-4H, TIM-4P, TIM-4R	EXTINT1	I	External Interrupt
10	All	VDD18_OUT	O	1.8V output
11-16	All	GND	I	Ground
17	All	RF_IN	I	GPS signal input
18	All	GND	I	Ground
19	All	V_ANT	I	Antenna Bias voltage
20	All	VCC_RF	O	Output Voltage RF section
21	All	V_BAT7	I	Backup voltage supply
22	All	RESET_N	I/O	Reset (Active low)
23	TIM-4A, TIM-4S, TIM-4H, TIM-4P	EXTINTO	I	External Interrupt Pin
	TIM-4R	SPEED	I	Odometer Speedpulses
24	TIM-4A, TIM-4S	GPSMODE2	I	Boot-time config. pin
	TIM-4H, TIM-4P	Reserved	I	Reserved
	TIM-4R	PCS1_N	O	SPI Chip Select 1 (A/D Converter)
25	TIM-4A, TIM-4S	GPSMODE6	I	Boot-time config. pin
	TIM-4H, TIM-4P	Reserved	I	Reserved
	TIM-4R	PCS0_N	O	SPI Chip Select 0 (Temperature Sensor)
26	TIM-4A, TIM-4S	NC	I	Not Connected
	TIM-4H, TIM-4P	Reserved	I	Reserved
	TIM-4R	SCK	O	SPI clock
27	TIM-4A, TIM-4S, TIM-4H, TIM-4P	AADET_N	I	Active Antenna Detect
	TIM-4R	MISO	I	SPI MISO
28	TIM-4A, TIM-4S, TIM-4H, TIM-4P	Reserved	I	Reserved
	TIM-4R	MOSI	O	SPI MOSI
29	All	TIMEPULSE	O	Timepulse signal
30	TIM-4A, TIM-4S	GPSMODE12	I	Boot-time config. pin
	TIM-4H, TIM-4P	Reserved	I	Reserved
	TIM-4R	AADET_N 8	I	Active Antenna Detect
Shaded pins have dead reckoning specific function. For implementation details see the *TIM/LEA-4R System Integration Manual* [2].				

Table 13: Pinout

! **Note** Pins designated Reserved should only be used with caution. For more information about Pinouts see the *ANTARIS®4 System Integration Manual* [1].

[7] Battery backup voltage is necessary for the TIM-4R to store the last vehicle position and direction. This is particularly important when the previous trip ended in an obstructed place, for example a parking garage, and reliable dead reckoning navigation shall continue when driving again.

[8] AADET_N will only be operated as input pin if "Open Circuit Detection" for active antennas is activated or configured.

4 Electrical Specifications

4.1 Absolute Maximum Ratings

Parameter	Symbol	Module	Min	Max	Units
Power Supply					
Power supply voltage (VCC)	Vcc	All	-0.3	3.6	V
Backup battery voltage (V_BAT)	Vbat	All	-0.3	3.6	V
Input Pins					
Digital input pin voltage (except RESET_N)	Vin	All	-0.3	5	V
Input pin voltage of RESET_N	Vin_reset	All	-0.3	1.95	V
Voltage Supply output for Active Antenna and RF Section					
VCC_RF output current	Iccrf	All		50	mA
RF Input					
Antenna bias voltage (applied via V_ANT)	Vant	All	0	6	V
Antenna bias current (applied via V_ANT)	Iant	All		100	mA
Input power at RF_IN (source impedance 50Ω, continuous wave)	Prfin	All		-5	dBm
Environment					
Storage temperature	Tstg	TIM-4H, TIM-4S	-40	85	°C
		TIM-4A, TIM-4P, TIM-4R	-40	125	°C

Table 14: 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[9]	Symbol	Module	Min	Typical	Max	Units	Condition
Power Supply							
Power supply voltage (VCC)	Vcc	All	2.7		3.3	V	
I/O supply voltage (VDDIO)	Vddio	All	1.65		3.6	V	
Power supply voltage ripple	Vcc_PP	All			50	mV	
Sustained supply current [10]	Icc	TIM-4A TIM-4H TIM-4P TIM-4R TIM-4S		35 39 36 48 38		mA	Vcc = 3.0 V
Peak supply current [11]	Iccp	All			70	mA	Vcc = 3.3 V
Sleep mode current	Iccs	All		65		µA	Vcc = 3.0 V
Backup battery voltage	Vbat	All	1.5		3.6	V	
Backup battery current	Ibat	All		5		µA	Vbat = 3.3V
1.8V output voltage (VDD18OUT pin)	Vdd18out	All	1.65	1.8	1.95	V	
1.8V output current (VDD18OUT pin)	Idd18out	All			30	mA	
UART and all I/O Signals[12]							
Input pin voltage range	Vin	All	0		5	V	
Input pin low voltage	Vin_low	All			0.41	V	
Input pin high voltage	Vin_high	All	1.46			V	
Output pin low voltage	Vout_low	All			0.4	V	Iout = 1.5mA
Output pin high voltage	Vout_high	All	VDDIO-0.5			V	Iout = -1.5 mA
RESET_N Input (Open-Drain I/O)[13]							
Input and output pin voltage range	VinR	All	0		VDD18OUT	V	
Input pin low voltage	Vin_lowR	All			0.46	V	
Input pin high voltage	Vin_highR	All	1.3			V	
Output pin low voltage	Vout_lowR	All			0.1	V	Iout = 0.3 mA
Output pin high voltage	Vout_highR	All	VDD18OUT -0.2			V	Iout = 0.1 mA
Dead Reckoning Signals							
Input frequency (pin 23, SPEED)	fspeed	TIM-4R	1 [14]		5000	Hz	
Odometer Scale Factor	Skf_t	TIM-4R	1000		40000	Pulse /km	Odometer Scale Factor
DR calculation rate		TIM-4R			40	Hz [15]	

[9] All specification are at an ambient temperature of 25°C.
[10] Average current drawn during Continuous Tracking Mode with 1 Hz update rate, using 9 channels for tracking and navigation and 3 channels for searching satellites (= acquisition). Use this figure to determine required battery capacity.
[11] Peak current drawn during initial acquisition phase. Use this figure to dimension maximum current capability of power supply.
[12] RxD1, RxD2 and EXTINT0 provide internal pull-up to V_BAT18 (Battery supply regulated to 1.8V) and not VCC.
[13] Do not drive High. Internal pull-up provided.
[14] Frequencies below this threshold will be recognized as standstill of the vehicle.
[15] Internal calculation rate for high accuracy in DR calculation. Not to be confused with Max Update Rate.

Parameter[9]	Symbol	Module	Min	Typical	Max	Units	Condition
RF input							
Antenna gain	Gant	All			50	dB	
V_ANT antenna bias voltage (must connect to ground if not used)	Vant	All	2		6	V	
Antenna bias voltage drop	Vant_drop	All		20	50	mV	Iant=10mA
VCC_RF voltage	Vccrf	All		Vcc – 0.1		V	
VCC_RF output current	Iccrf	All		20	50	mA	
Environment							
Operating temperature	Topr	All	-40		85	°C	

Table 15: Operating Conditions

Running this device beyond the "Operating Conditions" is not recommended and extended exposure beyond them may affect its reliability.

5 Environmental Specifications

Detailed description of the test series:

Test		Standard	Samples
Visual inspection		IPC-A-610 D, class 2 "Acceptability of electronic assemblies"	176
Temperature step	-40°C...+85°C, steps of 5K, operating	ISO 16750-4, IEC68-2-1, IEC68-2-2	176
Metallographic investigations		IPC-A-600 F, Class 2"Acceptability of printed boards"	6
Dry heat	+60°C, 5% rH, 1000 hours, operating	IEC68-2-2	32
Damp heat	+60°C, 95% rH, 1000 hours, operating	IEC68-2-3	32
Thermal shock	-40°C...+125°C, 100 cycles	IEC 68-2-14	42
Lifespan test	+85°C/1000 hours, operating	IEC 68-2-2	50
Dry heat	+125°C, 1000 hours, non-operating	IEC68-2-2	16
Damp heat, cyclic	+25°C...+55°C; >90% rH, operating	IEC 68-2-30, Db variation 1	16
Vibration	5-500 Hz, 5g, 2.5 hours/axis at –40°C, +25° and 85°C, operating	IEC 68-2-6	8
Shock	30g/11ms (half sine), 3 shocks/axis; non-operating	IEC 68-2-27	8

Table 16: Environmental Specification

6 Settings

6.1 Default Settings

Following default settings apply if all GPSMODE pins are left open. Please refer to the *ANTARIS®4 System Integration Manual* [1] for information about further settings.

Interface	Settings
Serial Port 1 Output	9600 Baud, 8 bits, no parity bit, 1 stop bit Configured to transmit both NMEA and UBX protocols, but only following NMEA and no UBX messages have been activated at start-up: **GGA, GLL, GSA, GSV, RMC, VTG, ZDA, TXT**
Serial Port 1 Input	9600 Baud, 8 bits, no parity bit, 1 stop bit, Autobauding disabled Automatically accepts following protocols without need of explicit configuration: **UBX, NMEA, RTCM** The GPS receiver supports interleaved UBX and NMEA messages.
Serial Port 2 Output	TIM-4S, TIM-4A: 38400 Baud, 8 bits, no parity bit, 1 stop bit TIM-4H, TIM-4P, TIM-4R: 57600 Baud, 8 bits, no parity bit, 1 stop bit Configured to transmit both NMEA and UBX protocols, but only following UBX and no NMEA messages have been activated at start-up: **NAV-POSLLH, NAV-SOL, NAV-SVINFO, NAV-STATUS** MON-IO, MON-SCHD, MON-TXBUF, INF-Warning, INF-Error, INF-Notice Additional messages can be activated with appropriate input messages. **! Note** In addition to the above messages the TIM-4R includes **NAV-EFKSTATUS**
Serial Port 2 Input	Automatically accepts following protocols without need of explicit configuration: **UBX, NMEA, RTCM** The GPS receiver supports interleaved UBX and NMEA messages.
TIMEPULSE	1 pulse per second, synchronized at rising edge, pulse length 100ms

Table 17: Available Protocols.

Model	Sensitivity Mode	Remark
TIM-4P, TIM-4R	Normal	The sensitivity mode can be changed with the CFG-RXM message.
TIM-4H	Auto	
TIM-4S, TIM-4A	High	

Table 18: Sensitivity settings

7 Product Lineup

7.1 Ordering Information

Ordering No.	Product
TIM-4A-0-000-1	TIM-4A GPS Module
TIM-4H-0-000-1	TIM-4H GPS Module
TIM-4P-0-000-1	TIM-4P GPS Module
TIM-4S-0-000-1	TIM-4S GPS Module
TIM-4R-0-000-1	TIM-4R GPS Module
└──	Delivery Packing **0** = Single samples **1** = Tape on reel (100 pieces)

Table 19: Ordering Information

Related Documents

[1] ANTARIS®4 System Integration Manual, Doc No GPS.G4-MS4-05007

[2] TIM-4R/LEA-4R System Integration Manual, Doc No GPS.G4-MS4-05043

[3] ANTARIS®4 GPS Technology Protocol Specifications, Doc No GPS.G3-X-03002

All these documents are available on our homepage (http://www.u-blox.com).

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