Rev 1.0

TECHNICAL DESCRIPTION

Fastrax UP501 GPS Receiver

This document describes the electrical connectivity and main functionality of the Fastrax UP501 hardware.

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CHANGE LOG

Rev.	Notes	Date
1.0	First Release	2010-05-11

CONTENTS

COMPLEMENTARY READING

The following Fastrax reference documents are complementary reading for this document.

Ref. #	Document name
1	Fastrax UP500 GPS Receiver – Technical Description
2	NMEA Manual for Fastrax IT500 Series GPS receivers

1. GENERAL DESCRIPTION

The Fastrax UP501 is a GPS receiver module with embedded antenna and tiny form factor 22.0 x 22.0mm x 8mm. The size, mechanics and interface connectivity is an exact match with the Fastrax UP500 [1]. Therefore, customers may replace UP500 with UP501 to gain improved performance with minimal design effort.

The Fastrax UP501 receiver provides very fast TTFF together with market leading weak signal acquisition and tracking sensitivity figures. The Fastrax UP501 module supports enhanced navigation accuracy by utilizing WAAS/EGNOS corrections, which may be enabled via NMEA command [2]. The Fastrax UP501 can also utilize 14-days predicted ephemeris data in AGPS applications.

The Fastrax UP501 module provides complete signal processing from internal antenna to serial data output in NMEA messages. The module requires a power supply VDD and a backup supply VDD_B voltage for non-volatile RTC & RAM blocks. There is a variant of the module available with on-board backup battery, which will eliminate the need for external backup voltage source. PPS signal output is available for accurate timing applications.

The Fastrax UP501 module interfaces to the customer's application via one serial port, which uses CMOS voltage levels. If RS232 signal levels are required, there is a variant of Fastrax UP501 available with on-board CMOS-to-RS232 level converter. UP501U is communicating via USB port. PPS output is available from the module as CMOS level signal.

There is also a Dual-SAW filter version of the UP501 available. This module variant is named as Fastrax UP501D. The Dual-SAW filter is targeted for telematic applications where a radio transmitter is placed close to the GPS receiver. The dual filter design will provide higher attenuation outside of the GPS band and it helps to reduce the risk of EMC issues that are sometimes present when high-gain systems (GPS receiver) that are in strong signal field (radio transmitter).

1.1 Default firmware configuration

Fastrax UP501 default firmware configuration:

1. Port 0: NMEA 9600 baud
2. NMEA output: GGA, RMC, GSV, GSA (all 1 sec interval)
3. DGPS/SBAS: Disabled (Module supports WAAS/EGNOS)
4. Datum: WGS84

2. SPECIFICATIONS

2.1 General

Table 1 General Specifications for UP501.

Receiver	GPS L1 C/A-code, SPS
Channels	66 acquisition and 22 tracking
Update rate	1 Hz default (fix rate configurable up to 10Hz)
Acquisition Sensitivity (Cold start)	-148 dBm (1)
Re-acquisition Sensitivity	-160 dBm (1)
Navigation Sensitivity	-165 dBm (1)
Supply voltage, VDD	+3.0 V…+4.2 V (+3.0V…+5.5V for UP501U/H)
Back up supply voltage, VDD_B	+2.0 V…+4.2 V (+2.0V…+5.5V for UP501H)
USB supply voltage	+4.0V…+5.5V (UP501U only)
Power consumption, VDD	75 mW typical @ 3.0 V (2) (Typ. 115mW@3.0V in satellite search phase)
Power consumption, VDD_B	15 uW typical @ 3.0 V (during battery backup state). Current at VDD_B pin may peak up to 100uA in full operating state.
Operating temperature range	-40 ºC…+85 ºC
Serial port protocol	Port 0: NMEA
Serial data format	8 bits, no parity, 1 stop bit
Serial data speed (default)	NMEA: 9600 baud
I/O signal levels	CMOS compatible: low state: 0.0…0.8V; high state: 2.0…3.6 V. (3)
I/O sink/source capability	+/- 2 mA max.
PPS output	+/- 50 ns accuracy

Note (1): measured by conducted measurement from GPS simulator.

Note (2): Navigation with good signals, max. 12 satellites in view.

Note (3): Fastrax UP501R UART signals are RS232 compatible.

2.2 Absolute maximum ratings

Table 2 Absolute maximum ratings

Item	Min	Max	unit
Operating temperature	-40	+85	ºC
Storage temperature	-40	+85	ºC
Power dissipation	-	500	mW
Supply voltage, VDD	-0.3	+4.3 (1)	V
Supply voltage, VDD_B	-0.3	+4.3 (1)	V
Input voltage on any input connection	-0.3	+3.6	V
RF input level	-	+15	dBm

(1) UP501U and UP501H module variants are 5.5V tolerant on VDD and VDD_B. Contact Fastrax sales for details on availability and Lead Time for these variants.

3. OPERATION

3.1 Operating modes

After power up the receiver boots from the internal flash memory for normal operation. Modes of operation:

- Tracking/navigating mode
- Low power tracking/navigating mode
- Backup mode

3.1.1 Tracking/Navigating mode

In tracking/navigating mode the Fastrax UP501 receiver module will search for additional satellites and collects almanac data. Once the receiver has collected almanac data (this takes about 12 minutes from Cold Start), it will enter Low Power Tracking mode. The VDD power consumption in table 1 is measured in Low Power Tracking/Navigating mode.

3.1.2 Low Power Tracking/Navigating mode

In Low power tracking/navigating mode the receiver continues normal navigation but does not collect further Almanacs data. Therefore the current consumption is reduced to level of <75 mW (<85 mW for UP501R with default UART baud rate).

3.1.3 Backup mode

When the operating voltage VDD is removed from the Fastrax UP501, the module enters Backup mode. In this mode, the module is keeping time by the RTC oscillator. Also, satellite ephemeris data is stored in battery backup RAM in order to get fast TTFF when VDD is connected again. Any user configuration settings are also valid as long as the backup supply VDD_B is active. When the VDD_B is powered off, the configuration is reset to factory configuration on next power up.

4. CONNECTIVITY

4.1 Connection assignments

The I/O connections are available on the 6-pin, 2.54mm pitch pin-header pads.

Table 3 Connections

Contact	Signal name	I/O	Signal description
1	RXD (1)	I	UART Port 0 async. input. Internal pull high resistor 75kΩ.
2	TXD (1)	O	UART Port 0 async. output.
3	GND	-	Ground
4	VDD	I	Main power supply
5	VDD_B (2)	I	Backup supply
6	PPS	O	Pulse per second output.

Notes:

(1) For UP501U USB D- and USB D+ signals are at pins #1 and #2, respectively.

(2) Pin #5 is for USB Supply voltage on the UP501U module variant.

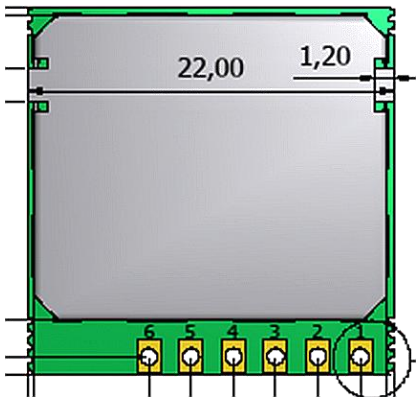

Figure 1. Pin numbering in the Fastrax UP501 module.

4.2 Power supply

The Fastrax UP501 module requires two separate power supplies: VDD_B for non-volatile back up block and the VDD for digital parts and I/O. VDD can be switched off when navigation is not needed but if possible keep the backup supply VDD_B active all the time in order to keep the non-volatile RTC & RAM active for fastest possible TTFF.

Back up supply VDD_B draws typically 5 uA current in back up state. During navigation (while VDD is active) VDD_B current may peak up to 100 uA, while staying at <30 uA average level.

On-board backup battery is available as an assembly option (UP501B). In this case the Backup supply can be left open and the module handles the backup state power supply automatically. The backup battery is charged when VDD supply is connected. A fully charged internal back-up battery is able to keep the UP501B in back-up state for at least 4hours (typically 7-8h at room temperature).

Main power supply VDD current varies according to the processor load and satellite acquisition. Typically VDD peak current is up to 40mA during Search mode. In Low Power Tracking mode the average VDD current is typically below 25 mA for the Fastrax UP501 and UP501B modules, and below 28 mA for Fastrax UP501R module with default baud rate of 9600 baud.

4.3 Reset

Reset can be initiated by switching off VDD supply for >150 ms.

4.4 UART

The device supports UART communication via Port 0 of the GPS IC. With the standard firmware the Port 0 is configured by default to NMEA protocol (9600 baud).

I/O levels at the serial ports are CMOS compatible (see table 1). On-board RS232 level converter is available with the Fastrax UP501R module.

4.5 PPS

The pulse-per-second (PPS) output provides an output for timing purposes. There is a 100ms pulse once per second synchronized to

UTC second at rising edge when the receiver has a valid position fix available.

4.6 Mechanical dimensions and contact numbering

Module size is 22.0 mm (width) x 22.0 mm (length) x 8 mm (thickness). General tolerance is ±0.3 mm. Detailed mechanical drawing is presented in figure 2. Mechanically the UP501 is fully compatible with the UP500 module.

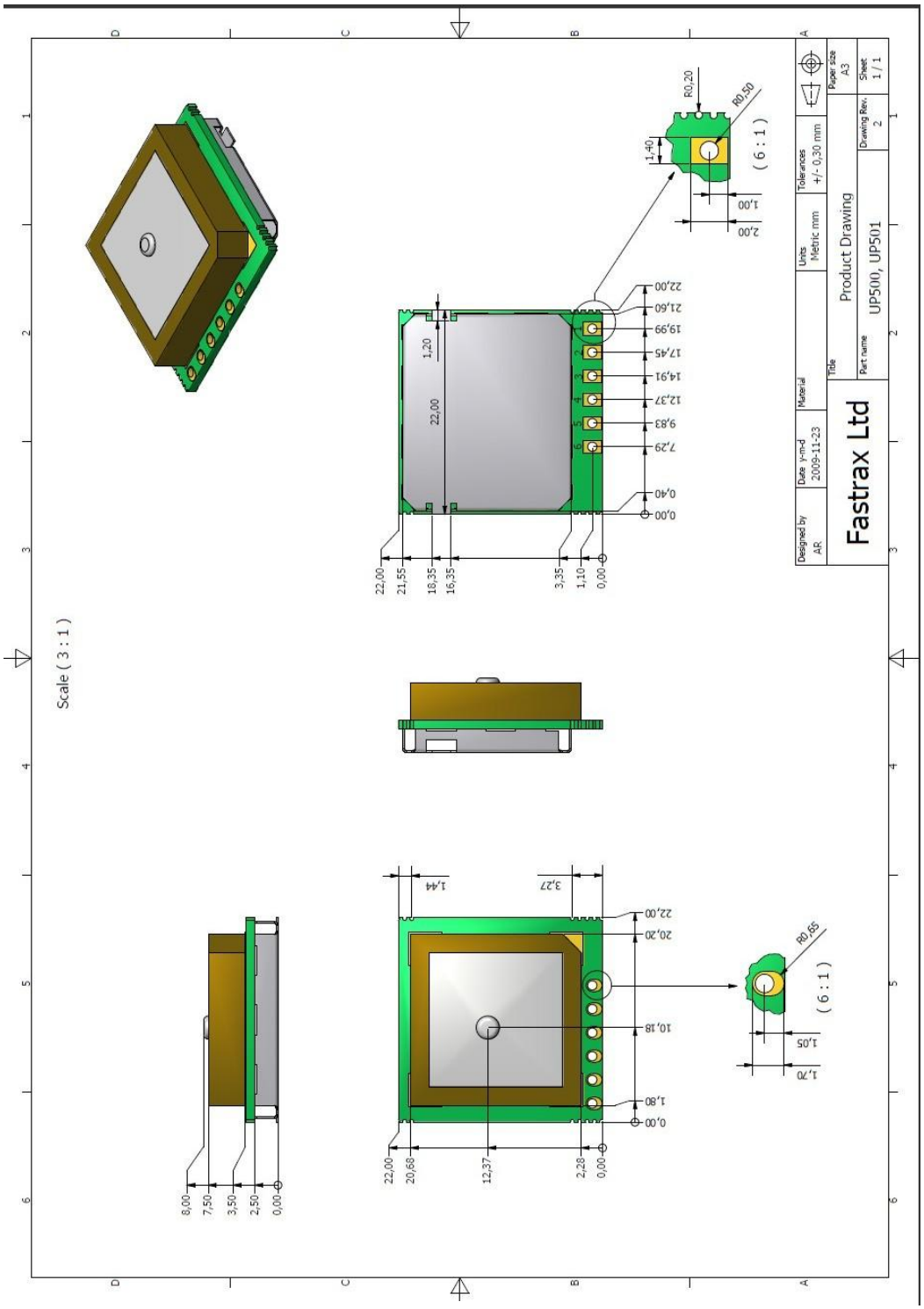

Figure 2. Mechanics drawing of the Fastrax UP501 module.

5. MODULE OPTIONS

The Fastrax UP501 module is available in three different HW-configurations. This makes it possible for a customer to select optimal solution for different applications depending on required functionality and/or price target.

The following table will summarize the differences in the Fastrax UP501 module options.

Table 4 Fastrax UP501 HW options.

	UP501 Variant	Serial Data Interface	On-board Backup Battery	VDD Range	Notes
Standard Modules	UP501	CMOS	NO	3.0V - 4.2V	Standard module, lowest price. CMOS level UART.
	UP501B	CMOS	YES	3.0V - 4.2V	On-board backup battery, simplifies host power management. CMOS level UART.
	UP501R	RS232	YES	3.0V - 4.2V	Easy connectivity to RS232 level UART systems. On-board backup battery.
Custom Modules	UP501D	CMOS	NO	3.0V - 4.2V	Dual SAW filter for enhanced out-of-band interference immunity.
	UP501H	CMOS	NO	3.0V - 5.5V	Extended VDD range. Eliminates need for external GPS voltage regulator in 5V systems.
	UP501U	USB	NO	3.0V - 5.5V	USB data interface and extended VDD range.

Fastrax UP501 is available as a standard product with normal lead time. Fastrax UP501B and UP501R are also available as standard products but lead times may be longer than with UP501.

Minimum order quantity (MOQ) of 5kpcs is applied on UP501D, UP501U and UP501H as these modules are not offered as standard products. Please contact Fastrax sales for details on availability.

6. PCB MOUNTING

The Fastrax UP501 can be mounted on a customer PCB ("motherboard" in the instructions below) by using standard 2.54mm pitch 1x6 pin header (for example Samtec TLW-106-06-G-S). Two dummy pads are used to solder the module metal shield on the motherboard. Reference pad layout is shown in figure 3.

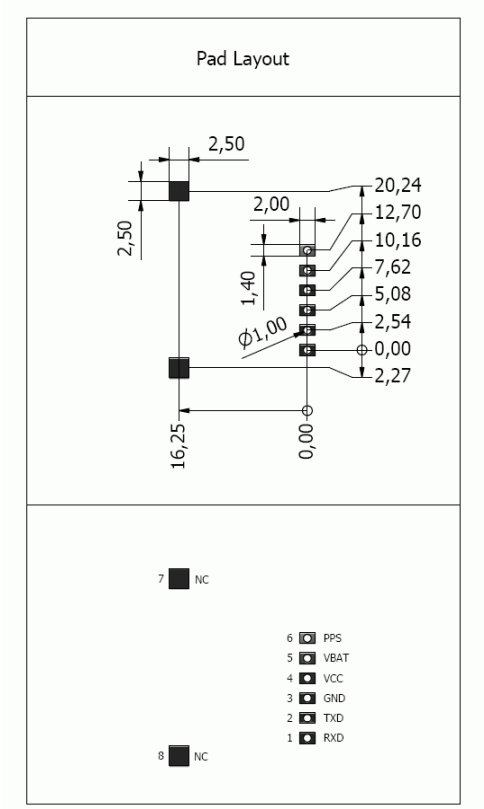

Figure 3. Pad layout of mounting side for UP501 module.

There are some rules that needs to be followed in order to maintain good performance for the on-board patch antenna of the UP501:

- Solder the pin header to the module in such way that the pins are as short as possible on the antenna side of the UP501 module (see figure 4).

- Place any active circuitry (processors, memory busses, switching regulators, etc.) on the motherboard as far away as possible from the UP501 module.

- Design a solid VDD source for the UP501 module (VDD supply voltage ripple should be <50 mVp-p).

- If UP501B is used and there is no need for the PPS signal, a 4-pin header (for example Samtec TLW-104-06-G-S) can be used to contact pins #1 through #4. However, the 6-pin header is recommended since it is mechanically more robust. In this case pins #5 and #6 may be left floating on the motherboard.

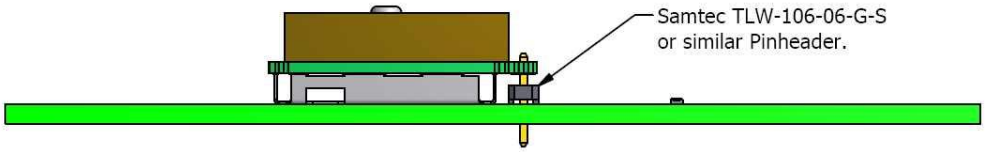

Figure 4. Side view of the pin header assembly for the UP501 module.

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