GPS

locate, communicate, accelerate

UP501

Fastrax GPS patch antenna module

Data Sheet

Highlights:

- Embedded, pre-tuned GPS patch antenna
- Low power consumption
- Ultra high sensitivity of -165dBm
- Configurable fix update rate Up to 10 Hz

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Document Information	
Title	UP501
Subtitle	Fastrax GPS patch antenna module
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Document status	Preliminary

Document status information	
Objective Specification	This document contains target values. Revised and supplementary data will be published later.
Advance Information	This document contains data based on early testing. Revised and supplementary data will be published later.
Preliminary	This document contains data from product verification. Revised and supplementary data may be published later.
Released	This document contains the final product specification.

This document applies to the following products:

Name	Type number	ROM/FLASH version	PCN reference
UP501	UP501-0	Flash	N/A
UP501B	UP501B	Flash	N/A
UP501D	UP501D	Flash	N/A
UP501R	UP501R	Flash	N/A

Contents

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.

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:

Port 0: NMEA 9600 baud

NMEA output: GGA, RMC, GSV, GSA (all 1 sec interval)

DGPS/SBAS: Disabled (Module supports WAAS/EGNOS)

Datum: WGS84

1.2 UP500 vs. UP501

The table below identifies the differences between UP500 and UP501. This information is useful for customers who already have products with UP500 and would like to upgrade to UP501.

Item	UP500	UP501	Note
VDD Range	+3.0V…+5.5V	+3.0V…+4.2V	
SBAS default status	Enabled	Disabled	Enable/disable with NMEA command.
Max. fix rate	5Hz	10Hz	Configurable via NMEA.
Navigation sensitivity	-158dBm	-165dBm	
Cold start sensitivity	-146dBm	-148dBm	
Power consumption	90mW@3.0V	75mW@3.0V	Typical in navigation.
AGPS	NA	14-days predicted ephemeris.	

Table 1: UP500 vs. UP501

2 Specifications

2.1 General

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	-158 dBm (1)
Navigation Sensitivity	-165 dBm (1)
Supply voltage, VDD	+3.0 V…+4.2 V
Back up supply voltage, VDD_B	+2.0 V…+4.2 V
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).
Operating temperature range	-40 °C…+85 °C (4)
Serial port protocol	Port 0: NMEA
Serial data format	8 bits, no parity, 1 stop bit
Serial data speed (default)	NMEA: 9600 baud
CMOS I/O signal levels (3)	VIL: -0.3V…0.8V, VIH: 2.0V…3.6V, VOL:-0.3V…0.4V, VOH: 2.4V…3.2V
I/O sink/source capability	+/- 2 mA max.
PPS output	+/- 50 ns (RMS) accuracy

Table 2: General Specifications for UP501

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.
Note (4): UP501 backup battery operating range is -10 °C…+60 °C.

2.2 Absolute maximum ratings

Item	Min	Max	unit
Operating temperature	-40	+85	°C
Storage temperature	-40	+85	°C
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

Table 3: Absolute maximum ratings

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.

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

Table 4: Connections

Notes:

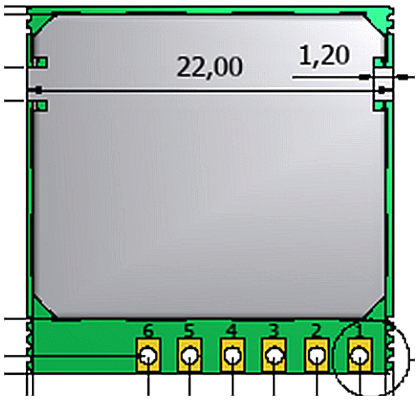


Figure 1: Pin numbering in the Fastrax UP501 module

4.2 Power supply

The Fastrax UP501 module (including all variants, except UP501B) 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. VDD_B has to be connected always when VDD is connected.

Backup 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 (VDD_B) should 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 4 hours (typical 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.

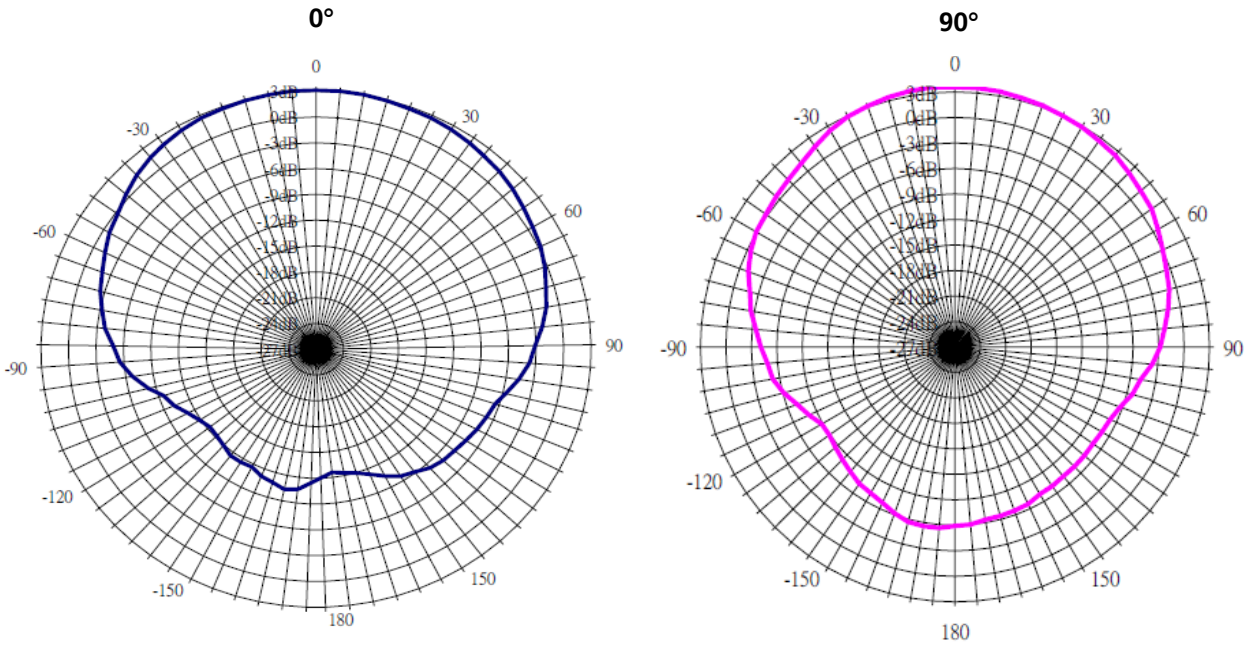
4.5 PPS

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 3D position fix available.

4.6 Patch antenna

The Fastrax UP501 modules are designed with integrated 18 x 18 mm patch antenna provides RHCP polarization. UP501 antenna modules are relatively wideband and tuned a few MHz above L1, customer housing (plastic) usually will de-tune center frequency back to L1.

Figure 2 illustrates the normalized patch antenna gain chart for UP501.



TX: Right hand circular polarized signal Frequency = 1580MHz
Radiation Pattern (with 50mm square ground plane)

Figure 2: The Normalized Antenna Gain Chart (For Example: 1580MHz)

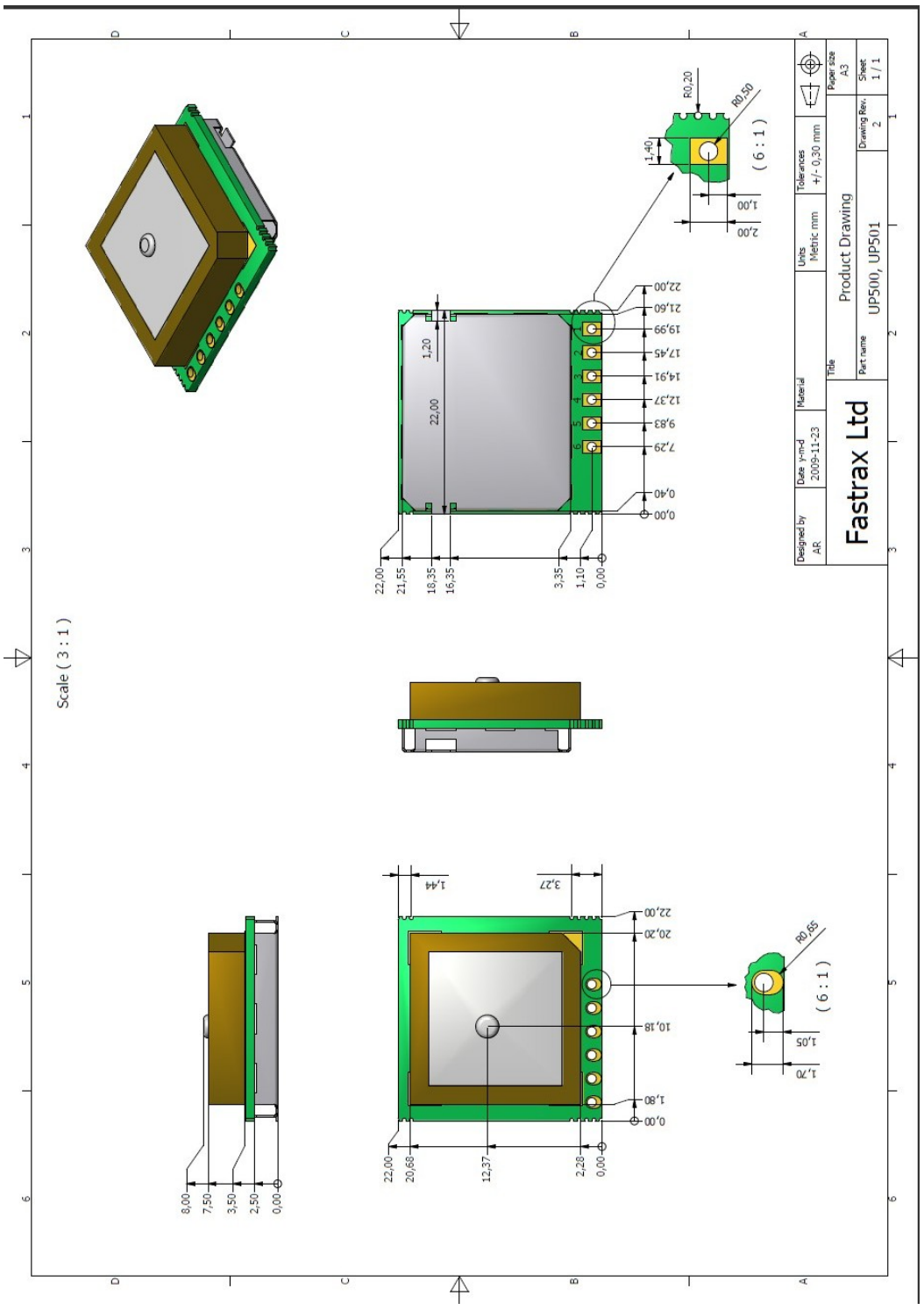


Figure 3: Mechanics drawing of the Fastrax UP501 module

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.

	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.
	UP501D	CMOS	NO	3.0V - 4.2V	Dual SAW filter for enhanced out-of-band interference immunity.
Custom Modules	UP501R	RS232	YES	3.0V - 4.2V	Easy connectivity to RS232 level UART systems. On-board backup battery.

Table 5: Fastrax UP501 HW options

Fastrax UP501 is available as a standard product with normal lead time. Fastrax UP501B and UP501D are also available as standard products but lead times may be longer than with UP501.

Minimum order quantity (MOQ) is applied on UP501R as this module is 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 2.54 mm pitch 1x 6 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 4.

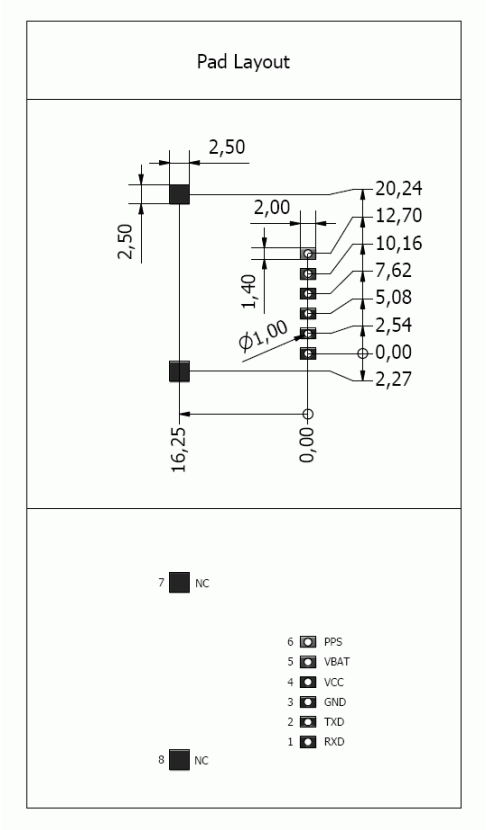


Figure 4: Pad layout of mounting side for UP501 module

There are some rules that need 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 5).
- 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.

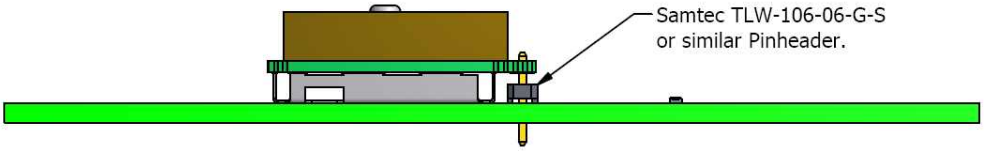


Figure 5: Side view of the pin header assembly for the UP501 module

7 Tray dimensions

UP501 is delivered on trays of 100 pcs. The tray dimensions are presented below.

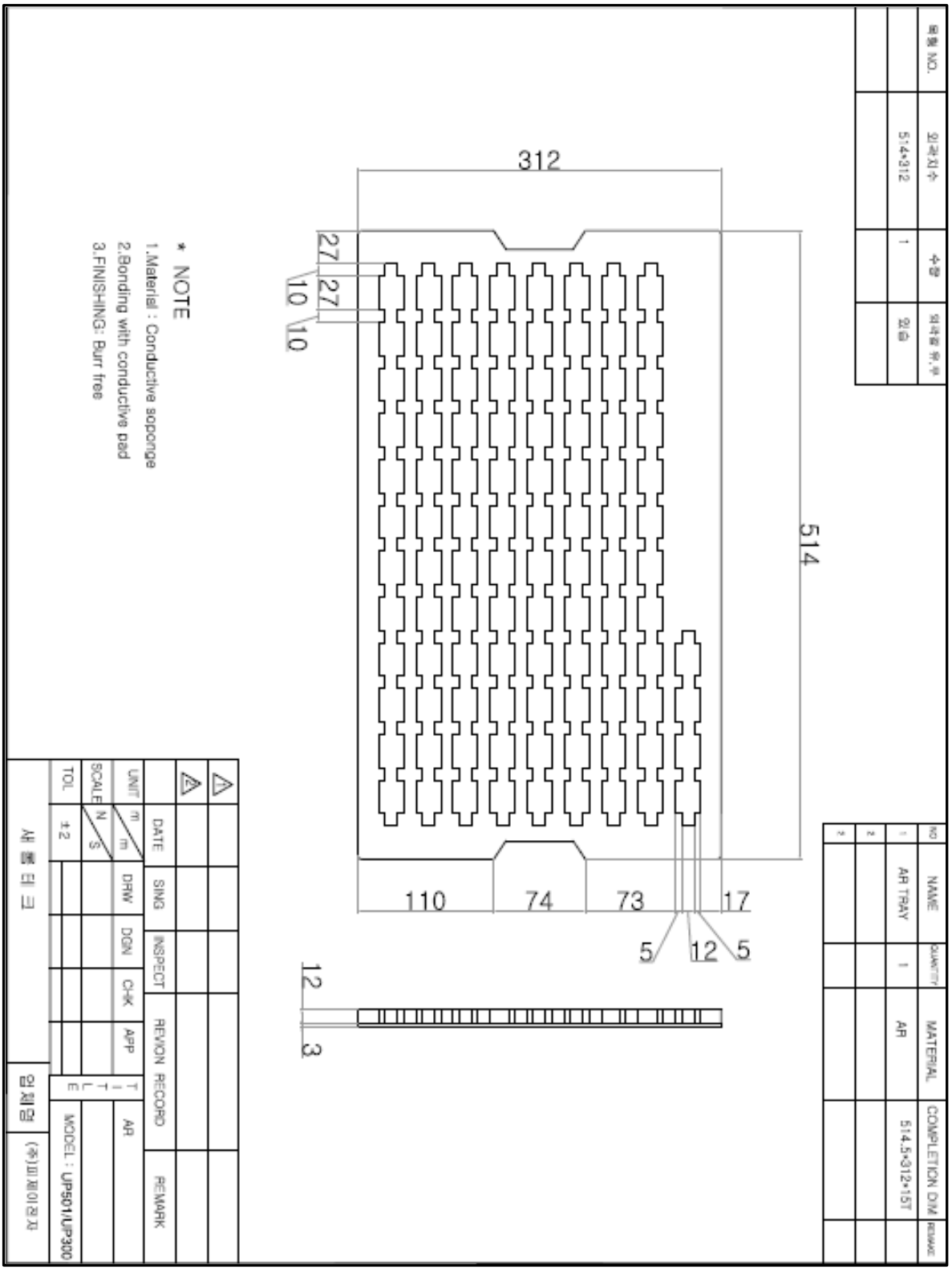


Figure 6: UP501 tray dimensions (in mm)

Related documents

[1] Fastrax UP500 GPS Receiver – Technical Description, Docu. No. FTX-HW-13007

[2] NMEA Manual for Fastrax IT500 Series GPS receivers, Docu. No. FTX-HW-13002

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Revision history

Revision	Date	Name	Status / Comments
1.0	11.May.2010	kkai	First Release.
1.1	01.Jul.2010	kkai	Added chapter on UP500 vs. UP501, added UP501H, IO voltage specification clarified, tray dimensions added in chapter 7. Table 2 updated. Table 4 updated.
1.2	29.Oct.2010	kkai	VDD_B mandatory connection clarified in 4.2. UP501D is now standard product, UP501R is custom product, UP501U removed (Table 5).
A	18.Jan.2013		Transfer to u-blox version.
B1	21.May.2013	julu	Add section 4.6 patch antenna including radiation pattern figure. Update tray dimensions (Figure 6). Delete UP501H related contents.

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