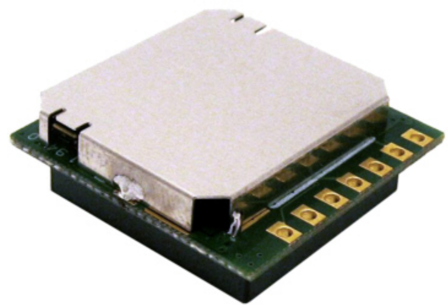
SkyTraq Venus 6 GPS Module
ST22

Datasheet



Revision History

Revision	Change
V1.0	Initial version
V1.1	Addition of standby supply current
V1.2	Additional information about 1PPS signal. Table of module options
V1.3	Additional information about Backup Supply, Acquisition and Filter Modes

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Overview

The ST22 is a compact size GPS module with high sensitivity and very low power consumption. It is based on Skytraq's VENUS 6 baseband processor and is equipped with a matched patch antenna to provide a modular solution. The ST22 interfaces to the application system via TTL level serial port (UART) with NMEA protocol and offers RS232 as an option.

The GPS receivers -160dBm tracking sensitivity allows continuous position coverage in nearly all application environments. Its high performance search engine is capable of testing 8,000,000 time-frequency hypotheses per second, offering industry-leading signal acquisition and TTFF speed.

Dedicated massive-correlator signal parameter search engine within the baseband enables rapid search of all the available satellites and acquisition of very weak signal. An advanced track engine allows weak signal tracking and positioning in harsh environments such as urban canyons and under deep foliage.

The ST22 is designed as a drop-in replacement for Fastrax UP500.

Key Features

- SkyTraq chipset with 65 channels "All-in-View" tracking.
- Cold/Hot start time: 29/1 sec. (average)
- Update rate: 1 - 10Hz
- High sensitivity: -160 dBm
- Large voltage supply range: 3-5.5V
- Low power consumption: 25mA tracking, 50mA acquisition, 75mA enhanced acquisition.
- Support of SBAS (WAAS / EGNOS)
- Size 22 x 22 x 8mm (with patch antenna)
- TTL UART communication interface, RS232 as option
- Optional internal backup supply
- Cost efficient

Options

Name	Integrated Backup Supply	TTL (LV) UART	RS232 interface	Flash Memory
ST22	No	Yes	No	No
ST22B	Yes	Yes	No	No
ST22R	Yes	No	Yes	No

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Specification

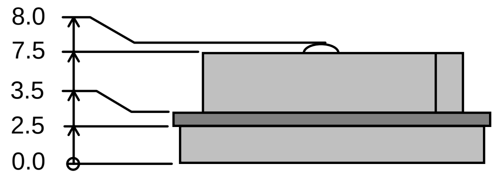
Chipset	Skytraq low power VENUS 6
Frequency	L1, 1575.42 MHz
C/A Code	1.023MHz chip rate
Channels	65 (51 acquisition channels and 14 tracking channels)
Datum	WGS-84 (default), user definable
Antenna	Built-in 18x18x4mm patch antenna
Sensitivity	Tracking: -160 dBm Reacquisition: -158 dBm Cold start (autonomous): -148 dBm
Time to First Fix (TTFF)	Cold start: 29sec average Hot start: 1sec average
Update rate	1, 2, 4, 5, 8, 10 Hz (1 Hz default)
Accuracy	Position: 2.5m CEP, 5m 2D RMS Velocity: 0.1m/sec Time: +/-300ns synchronized to GPS time
Altitude	Up to 18km
Velocity	Up to 500m/s
Current draw	Tracking: 25mA typ. Acquisition:50mA typ. Enhanced acquisition: 75mA typ.
Supply	3V – 5.5V DC
Internal backup supply	None (default), integrated rechargeable battery as option
Backup supply current	Receiver on: 1.5mA typ. Receiver off: 0.01mA typ.
Operating temperature	-40 to +85 °C (with integrated battery -20 to +60 °C)
Device dimensions	22x22x8mm
Device weight	9 grams
Compliance	RoHS, FCC E911
Protocol	8 data bits, 1 stop bit, no parity NMEA-0183 (GGA, GSA, GSV, RMC, VTG), Skytraq Binary
Baud rate	4800/9600/38400/115200bps (default: 9600)
Interface	LVTTL UART, RS232 as option
UART logic levels	see table below

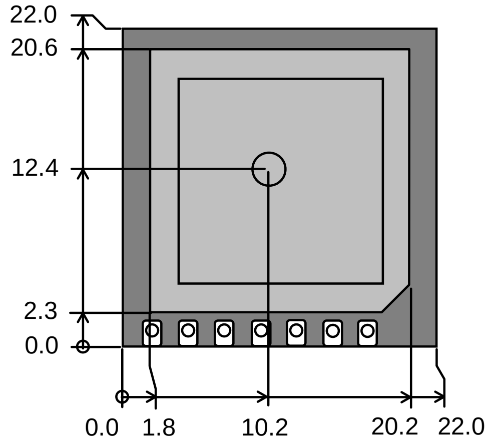
UART logic levels:

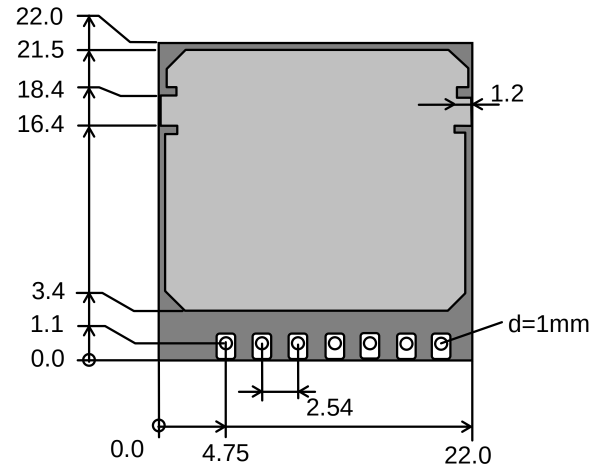
Signal	Min	Max
TX0 High	2.9V	-
TX0 Low	-	0.4V
RX0 High	2.0V	-
RX0 Low	-	0.8V

Specification can change without notice.
All values are preliminary.

Mechanical Dimensions

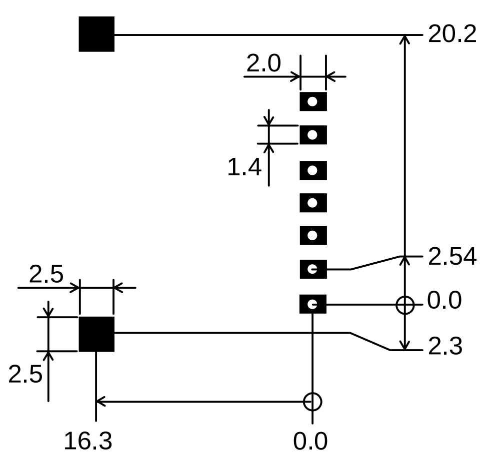






PCB Footprint

The module can soldered onto a PCB using standard 2.54mm pitch 1x7 pin header. The module shielding is soldered to 2 supportive pads in order to provide mechanical stability. All dimensions in mm.



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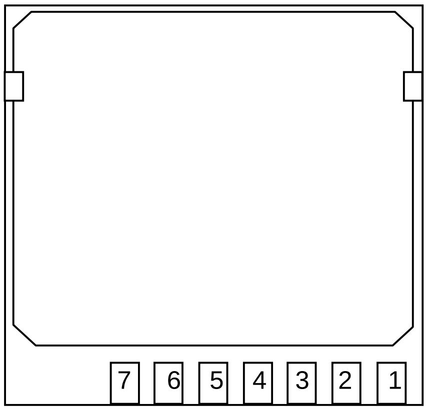
Pinout



Pin	Name	Description
1	RXD	UART Serial data input
2	TXD	UART Serial data output
3	GND	Ground
4	VIN	Voltage supply (3 to 5.5V)
5	VBAK	Backup voltage supply (1.5 to 5.5V). If not used connect to VIN.
6	1PPS	One pulse per second output (available after position lock)
7	MODE	Search engine mode selection input: 1: Low power acquisition mode (default), acquisition current approx. 50mA 0: Enhanced acquisition mode, acquisition current approx. 70mA

1PPS Time Signal

The 1PPS (One Pulse Per Second) output is meant to be precise timing signal with positive edge aligned to the UTC second. For a normal GPS receiver the time offset between higher tolerance TCXO used in the receiver and the synchronized atomic clock used in GPS satellites can only be determined when there is position fix with at least 4 satellites; i.e. needing at least 4 satellites for solving unknown (x,y,z,t) in 4 equations with (x,y,z) being GPS receiver location and t being clock offset bias. This provides the high accuracy of +/-0.3us compared to +/-80ms for systems that enable the 1PPS signal already with 1 satellite.

The behavior of the ST22 receiver is that the 1PPS only is present when there is a valid position fix upon power up. Afterwards the 1PPS is present continuously even without fix, in that case the 1PPS will gradually drift away.

The 1PPS pin is multiplexed with some debug mode function whose mode is to be determined at end of power on reset cycle. To avoid incorrect function do not pull-up or pull-down this signal.

Acquisition Modes (MODE)

In low power acquisition mode the number of calculations is reduced. This results in a lower power consumption but also in a reduced accuracy in case of weak satellite signal reception conditions. The enhanced acquisition mode requires more power but provides a better position performance.

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Backup Battery Input (VBAK)

In case there is no internal backup battery populated this input supplies the GPS receiver core memory during power off. This keeps the last satellite data in memory allowing a faster power-up time and a quicker position fix.
Note: If there is no external backup source (battery, capacitor) connected to this input then connect it to supply (VIN), otherwise the receiver is not turning on.

Ground Plane

In antenna design a ground plane affects the center frequency as well as the antenna gain. Although the ST22 module is designed to work without additional ground plane the reception can be improved in placing it on one.

Baud Rate Adjustment

Baud rate is pre-set by hardware to 9600 bps. This can be changed during manufacturing. During application the baud rate can be easily changed by software using the Skytraq binary protocol (please see application note AN0003 from Skytraq). The software setting will override the hardware pre-set.

Example:
To switch the baud rate to 38400 send the following hexadecimal bytes to the receiver:

```
A0 A1 00 04 05 00 03 01 07 0D 0A
```

Note: the above shown bytes are in hexadecimal format, do not send as text string.

Update Rate Adjustment

The position update rate can be adjusted via configuration commands (see app Note AN0003). For higher update rates the default baud rate is too low and need to be increased at least to 38400 bps. After this the update rate can be increased.

Example:
To switch to 10Hz position update rate the following hex bytes need to be send to the receiver:

```
A0 A1 00 03 0E 0A 01 05 0D 0A
```

Filter Modes

Two position filter modes can be selected using Skytraq binary protocol (see App. Note AN0003). Default mode is “car”. Using “pedestrian” will reduce the filter impact and provide a more sensitive position but also more noise in case of low signal reception conditions.

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NMEA Format

The general NMEA format consists of an ASCII string beginning with a '$' character and terminating with a <CR><LF> sequence. NMEA standard messages begin with 'GP' then a 3-letter message identifier.
The message header is followed by a comma delimited list of fields optionally terminated with a checksum consisting of an asterisk '*' and a 2 digit hex value representing the checksum. There is no comma preceding the checksum field. When present, the checksum is calculated as a bitwise exclusive of the characters between the '$' and '*'. As an ASCII representation, the number of digits in each number will vary depending on the number and precision, hence the record length will vary. Certain fields may be omitted if they are not used, in which case the field position is reserved using commas to ensure correct interpretation of subsequent fields.
The tables below indicate the maximum and minimum widths of the fields to allow for buffer size allocation.

NMEA Message $GPGGA

This message transfers global positioning system fix data. Example:
$GPGGA,060932.448,2447.0959,N,12100.5204,E,1,08,1.1,108.7,M,,,,0000*0E<CR><LF>

Field	Format	Min chars	Max chars	Notes
Message ID	$GPGGA	6	6	GGA protocol header
UTC Time	hhmmss.sss	1,2,2.1	2, 2, 2.3	Fix time to 1ms accuracy
Latitude	float	1,2.1	3,2.4	Degrees * 100+minutes
N/S Indicator	char	1	1	N=North, S=South
Longitude	float	1,2.1	3,2.4	Degrees * 100+minutes
E/W Indicator	Char	1	1	E=East, W=West
Position Fix Indicator	Int	1	1	0: position fix unavailable 1: valid position fix, SPS mode 2: valid position fix, differential GPS mode 3: GPS PPS Mode, fix valid 4: Real Time Kinematic. 5: Float RTK 6: Estimated (dead reckoning) Mode 7: Manual Input Mode 8: Simulator Mode
Satellites Used	Int	2	2	Number of satellites used to calculate fix.
HDOP	float	1.1	3.1	Horizontal Dilution of Precision.
MSL Altitude	float	1.1	5.1	Altitude above mean seal level
Units	Char	1	1	M stands for "meters".
GeoID Separation	Int	(0) 1	4	Separation from Geoids can be blank.
Units	Char	1	1	M stands for "meters".
Age of Differential Corrections	Int	(0) 1	5	Age in seconds. Blank (Null) fields when DGPS is not used.
Diff Reference Corrections	Int	4	4	0000
Checksum	*xx	(0) 3	3	2 digits
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

NMEA Message $GPGLL

This message transfers Geographic position, Latitude, Longitude, and time. Example:
$GPGLL,4250.5589,S,14718.5084,E,092204.999,A,A*2D<CR><LF>

The $GPGLL message structure is shown below:

Field	Format	Min chars	Max chars	Notes
Message ID	$GPGLL	6	6	GLL protocol header
Latitude	float	1,2.1	3,2.4	Degrees * 100+minutes
N/S Indicator	char	1	1	N=North, S=South
Longitude	float	1,2.1	3,2.4	Degrees * 100+minutes
E/W Indicator	Char	1	1	E=East, W=West
UTC Time	hhmmss.sss	1,2,2.1	2,2,2.3	Fix time to 1ms accuracy
Status	Char	1	1	A = Data valid V = Data not valid
Mode Indicator	Chat	1	1	N = Data not valid A = Autonomous mode D = Differential mode E = Estimated mode M = Manual input mode S = Simulator mode
Checksum	*xx	(0) 3	3	2 digits
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

NMEA Message $GPGSA

This message transfers DOP and active satellites information. Example:
$GPGSA,A,3,01,20,19,13,,,,,,,,,40 .4,24.4,32.2*0A<CR><LF>

The $GPGSA message structure is shown below:

Field	Format	Min chars	Max chars	Notes
Message ID	$GPGSA	6	6	GSA protocol header
Mode	Char	1	1	M = Manual, forced to operate in selected mode. A = Automatic switching between modes.
Mode	Int	1	1	1 = Fix not available. 2 = 2D position fix. 3 = 3D position fix.
Satellites Used	Int	2	2	SV on channel 1
Satellites Used	Int	2	2	SV on channel 2
…	…	…	…	…
Satellites Used	Int	2	2	SV on channel 12
PDOP	Float	1.1	3.1	
HDOP	Float	1.1	3.1	
VDOP	Float	1.1	3.1	
Checksum	*xx	0	3	2 digits
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

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NMEA Message $GPGSV

This message transfers information about satellites in view. The $GPGSV message structure is shown below. Each record contains the information for up to 4 channels, allowing up to 12 satellites in view. In the final record of the sequence the unused channel fields are left blank with commas to indicate that a field has been omitted.

Example:
$GPGSV,3,1,09,28,81,225,41,24,66,323,44,20,48,066,43,17,45,336,4 1*78<CR><LF>
$GPGSV,3,2,09,07,36,321,45,04,36,257,39,11,20,050,41,08,18,208,43*77<CR><LF>

Field	**Format**	**Min chars**	**Max chars**	**Notes**
Message ID	$GPGSV	6	6	GSV protocol header
Number of messages	Int	1	1	Number of messages in the message sequence from 1 to 3.
Message number	Int	1	1	Sequence number of this message in current sequence, form 1 to 3.
Satellites in view	Int	1	2	Number of satellites currently in view.
Satellite ID	Int	2	2	Satellite vehicle 1.
Elevation	Int	1	3	Elevation of satellite in degrees.
Azimuth	Int	1	3	Azimuth of satellite in degrees.
SNR	Int	(0) 1	2	Signal to noise ration in dBHz, null if the SV is not in tracking.
Satellite ID	Int	2	2	Satellite vehicle 2.
Elevation	Int	1	3	Elevation of satellite in degrees.
Azimuth	Int	1	3	Azimuth of satellite in degrees.
SNR	Int	(0) 1	2	Signal to noise ration in dBHz, null if the SV is not in tracking.
Satellite ID	Int	2	2	Satellite vehicle 3.
Elevation	Int	1	3	Elevation of satellite in degrees.
Azimuth	Int	1	3	Azimuth of satellite in degrees.
SNR	Int	(0) 1	2	Signal to noise ration in dBHz, null if the SV is not in tracking.
Satellite ID	Int	2	2	Satellite vehicle 4.
Elevation	Int	1	3	Elevation of satellite in degrees.
Azimuth	Int	1	3	Azimuth of satellite in degrees.
SNR	Int	(0) 1	2	Signal to noise ration in dBHz, null if the SV is not in tracking.
Checksum	*xx	0	3	2 digits
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

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NMEA Message $GPRMC

This message transfers recommended minimum specific GNSS data.

Example:
$GPRMC,092204.999,A,4250.5589,S,14718.5084,E,0.00,89.68,211200, ,A*25<CR><LF>

Field	Format	Min chars	Max chars	Notes
Message ID	$GPRMC	6	6	RMC protocol header
UTC Time	hhmmss.sss	1,2,2.1	2,2,2.3	Fix time to 1ms accuracy
Status	Char	1	1	A=Data valid V=Data invalid
Latitude	float	1,2.1	3,2.4	Degrees * 100+minutes
N/S Indicator	char	1	1	N=North, S=South
Longitude	float	1,2.1	3,2.4	Degrees * 100+minutes
E/W Indicator	Char	1	1	E=East, W=West
Speed over ground	Float	1,1	5.3	Speed over ground in knots
Course over ground	Float	1.1	3.2	Course over ground in degrees
Date	ddmmyy	2,2,2	2,2,2	Current date
Magnetic variation	Blank	(0)	(0)	Not used
E/W indicator	Blank	(0)	(0)	Not used
Mode	Char	1	1	N = Data not valid A = Autonomous mode D = Differential mode E = Estimated (dead reckoning) mode M = Manual input mode S = Simulator mode
Checksum	*xx	0	3	2 digits
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

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NMEA Message $GPVTG

This message transfers velocity, course over ground, and ground speed.

Example:
$GPVTG,89.68,T,,M,0.00,N,0.0,K,A*5F<CR><LF>

The $GPVTG message format is shown below.

Field	Format	Min chars	Max chars	Notes
Message ID	$GPVTG	6	6	VTG protocol header
Course (true)	Float	1.1	3.2	Measured heading in degrees
Reference	Char	1	1	T=true heading
Course (magnetic)	Float	1.1	3.2	Measured heading
Reference	Char	1	1	M=magnetic heading
Speed	Float	1.1	4.2	Speed in knots
Units	Char	1	1	N=knots
Speed	Float	1.1	4.2	Speed in km/h
Units	Char	1	1	K=km/h
Mode	Char	1	1	N = not valid A = Autonomous mode D = Differential mode E = Estimated (dead reckoning) mode M = Manual input mode S = Simulator mode
Checksum	*xx	0	3	2 digits
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

NMEA Message $GPZDA

This message transfers UTC Time and Date. Since the latency of preparing and transferring the message is variable, and the time does not refer to a particular position fix, the second precision is reduced to 2 decimal places.
The $GPZDA message format is shown below.

Field	Format	Min chars	Max chars	Notes
Message ID	$GPZDA	6	6	ZDA protocol header
UTC time	hhmmss.ss	2,2,2.2	2,2,2.2	00000000.00 to 235959.99
UTC day	dd	2	2	01 to 31, day of month
UTC month	mm	2	2	01 to 12
UTC Year	yyyy	4	4	1989-9999
Local zone hours	Int	(-)2	(-)2	Offset of local time zone (-13) to 13
Local zone minutes	Unsigned	2	2	
Checksum	*xx	0	3	2 digits
Message terminator	<CR> <LF>	2	2	ASCII 13, ASCII 10.

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