TISTAR15

GPS Module
User's Guide

EverMore Technology Inc.

Manual Revision History

Revision	Date	Update Summary
Issue A	December 2002	Initial release
Issue B	February 2003	Add pins electrical characteristics
Issue C	August 2003	Add pages 6~10, 17~18; Delete protocol

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1 Introduction

1.1 Overview

The TISTAR15 GPS Receiver is intended for use in a wide range of applications. The receiver simultaneously tracks up to twelve satellites, provides accurate satellite positioning data with fast time-to-first-fix (TTFF) and low power consumption. It is designed for high performance and maximum flexibility in a wide range of applications including mobile asset tracking, in-vehicle automotive guidance, location sensing, telematics and so on. The highly integrated receiver achieves high performance, minimizes board size and power consumption requirements. The TISTAR15 is designed to withstand harsh operating environments; however, it should be used inside an enclosure as a part of the application product designed by the system integrator.

1.2 Features

The TISTAR15 GPS receiver offers following features:

- Receiver, WAAS supported, Twelve parallel tracking channels
- Compatible EB-X305
- Programmable Input/Output pins
- On-board rechargeable battery sustained real-time clock and memory for fast satellite acquisition during power-up
- Automatic cold start with no user initialization required
- LED navigation indication

1.3 Applications

- Land/Marine Navigation
- Telematics
- Fleet Management
- Asset Tracking
- Timing Reference

2 Receiver Operation

Upon power up, after initial self-test has completed, the TISTAR15 will begin satellite acquisition and tracking process. Under normal open-sky condition, position-fix can be achieved within approximately 45 seconds (within 15 seconds if valid ephemeris data is already collected from recent use). After receiver position has been calculated, valid position, velocity and time information are transmitted through the on board serial interface.

The receiver uses the latest stored position, satellite data, and current RTC time to achieve rapid GPS signal acquisition and fast TTFF. If the receiver is transported over a large distance across the globe, cold-start automatic-locate sequence is invoked. The first position fix may take up to five minutes searching the sky for the GPS signal. The acquisition performance can be improved significantly if the host initializes the receiver with a rough estimate of time and user position.

As soon as GPS signal is acquired and tracked, the TISTAR15 will transmit valid navigation information through its serial interface. The navigation data contains following information:

- Receiver position in latitude, longitude, and altitude
- Receiver velocity
- Time
- DOP error-magnification factor
- GPS signal tracking status

The TISTAR15 will perform 3D navigation when four or more satellites are tracked. When three or fewer satellites are tracked, altitude-hold is enabled using the last computed altitude and 2D navigation mode is entered.

With signal blockage or rising and setting of the satellites, where a change in satellite constellation used for position fix occurred, large position error may result. The TISTAR15 incorporates a proprietary algorithm to compensate the effect of satellite constellation change, and maintains an accurate smooth estimate of the receiver's position, velocity, and heading.

2.1 TISTAR15 GPS Module Specification

FEATURES	DESCRIPTION
General	L1 1575.42MHz, C/A code, 12-channel, Carrier-Aided with HWTrack©
Sensitivity	-165 dBW minimum
Update Rate	1Hz
Accuracy	Position: 15m CEP without S/A Velocity: 0.1 m/sec without S/A Time: $\pm 1\mu s$
DGPS/WAAS Accuracy	Position: 5m CEP Velocity: 0.05 m/sec
Acquisition	Cold start: < 120sec (typical) Warm start: < 45sec (typical) Hot start: < 15sec
Reacquisition	<100msec
Dynamics	Altitude: -1000m to 18,000m Velocity: 500 m/sec Acceleration: ±4g
Operation Temperature	-30°C to +80°C
Storage Temperature	-40°C to +90°C
Operating Humidity	5% to 95%
Primary Power	5Vdc, ±0.5Vp-p ripple, (Option 3.3V)
Current Consumption	Max. 125mA
Serial Interface	Port 1: NMEA 0183 Output, Port 2: RTCM Input
Protocol	EverMore Private @ 4800/9600 baud, 8-None-1 NMEA-0183 v2.20 @ 4800/9600 baud, 8-None-1
Datum	219 standard datum, default WGS-84
Antenna	MCX Jack for external active antenna
NMEA Message	GGA, GLL, GSA, GSV, RMC, and VTG
Dimension; Weight	71mm x 40 mm x 10 mm; 16g

2.2 Start-up Modes

Definitions	DESCRIPTION
Cold Start	The Cold Start takes the longest startup time among EMT GPS receivers. In this scenario, the receiver has no acknowledgment on the last position, time, and satellite constellation. The receiver is initiated to search blindly for satellite signals in the cold start mode. Another situation is that when no backup battery is connected, the GPS receiver will be in the cold start mode and there is no data stored in SRAM.
Warm Start	In this scenario, the receiver was off less than one week but more than 2-hour time. The receiver knows its last position, time and almanac because it has a backup battery to keep current almanac, position and time stored in SRAM. In the warm start mode, the receiver can quickly acquire satellites and get a position fix faster than it does in the cold start mode.
Hot Start	In this scenario, the receiver was off less than 2-hour time. With the back up battery connected and the current almanac, position, time and ephemeris stored in SRAM, the receiver applies its last ephemeris data to calculate and get a position fix.
Reacquisition	In the reacquisition mode, the receiver takes time to lock on satellites if buildings or obstacles are blocking the signals for a short while. This is very common in urban areas, but please be noted that reacquisition time has nothing to do with the time-to-first-fix (TTFF).

3 Hardware Interface

3.1 TISTAR15 System Block Diagram

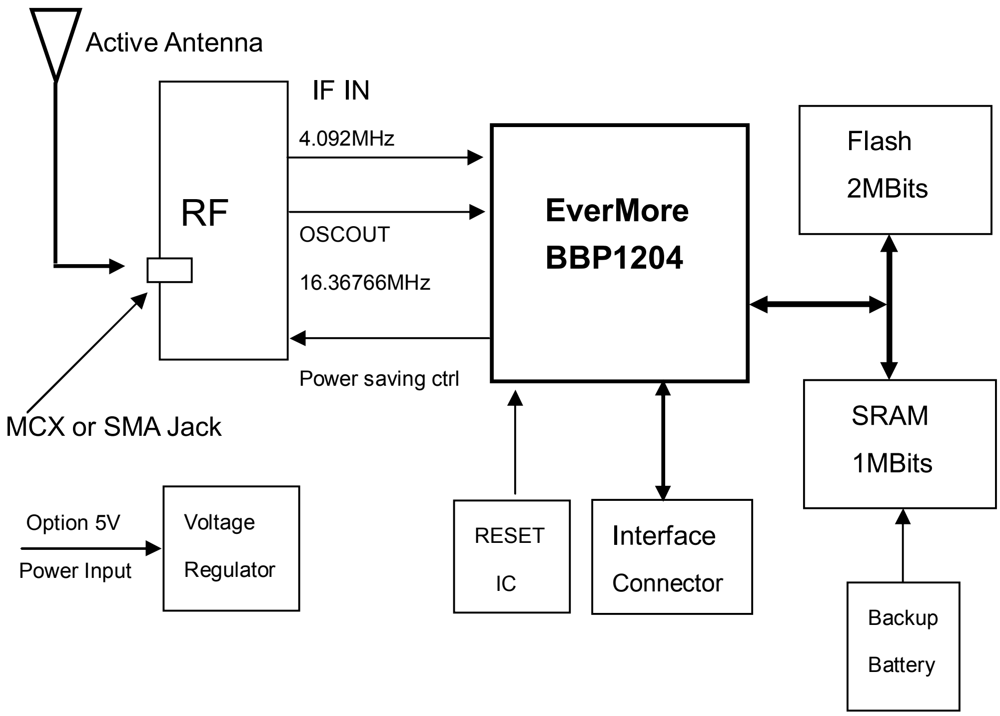

Figure 1: System Block Diagram for TISTAR15

Outline:

The GPS receiver completes signal processing that starts from antenna gains to serial output, and the above diagram illustrates such process. With at least four satellites, the receiver can evaluate satellite signals to determine a three-dimensional position fix by calculating longitude, latitude, height, time, speed, and acceleration. The GPS receiver provides information of the satellite constellation, satellite status, the number of visible satellites, etc.

RF:

The RF amplifier acts like the mixer, the A/D converter, and the producer of 16.367667MHz reference oscillator that offers the necessary carrier wave for frequency conversion. The analogue intermediate frequency is converted into digital format by means of a 1-bit ADC.

BBP1204 BaseBand Functions:

The BBP1204 BaseBand performs the following functions:

1. Processes IF 4.124MHz signal
2. Provides 12 parallel satellite channels that can be shut down individually
3. Built-in carrier/code close-loop control
4. Built-in RTC with timeout interrupt
5. Buffered demodulated data bits
6. 1pps 10pps 1000pps output
7. CPU and I/O interface

BBP1204 Processor Functions:

The BBP1204 processor performs the following functions:

1. Calculating longitude, latitude, height, speed and acceleration to figure out position
2. Storing the above data to SRAM
3. Initiating and configuring the whole system
4. Executing the firmware installed
5. Converting NMEA-0183 code into proprietary EMT binary code

Flash:

The Flash stores firmware that allows the system to run automatically. The Flash also allows users to update with newer firmware versions via specific application programs.

SRAM:

The SRAM save current acquisition almanac, position, time and ephemeris that enhance GPS performance – the above can be kept by backup battery for a long time. The battery life lasts approximately for two weeks, and the data might be lost if the backup battery is not recharged then.

Backup Battery:

The Backup Battery supplies SRAM with data retention current and voltage to store GPS data. Being button like, the battery also supplies real time clock power. With the rechargeable lithium backup battery, the time-to-first-fix (TTFF) can be reduced.

RESET IC:

The Reset IC sends a “reset” signal to initiate the processor.

Voltage Regulator:

The Voltage Regulator converts 5V voltage to 3.3V, and it provides a clean and stable voltage output.

Interface Connector:

Interface connector provides input power that includes VCC, battery and antenna power. The connector also provides RXD, TXD, 1PPS and LED digital signals.

MCX or SMA Jack:

The MCX or SMA Jack is a connector for external active antenna.

3.2 TISTAR15 Real Picture

Figure 2: TISTAR15 Real Picture

3.3 Antenna Connector

The antenna connector is a 50-ohm straight MCX or SMA snap-on coaxial RF jack receptacle.

3.4 Interface Connector Type

There are two 20-pin header interface connectors.

3.5 Mechanical Dimensions and Interface Connector

Unit: mil

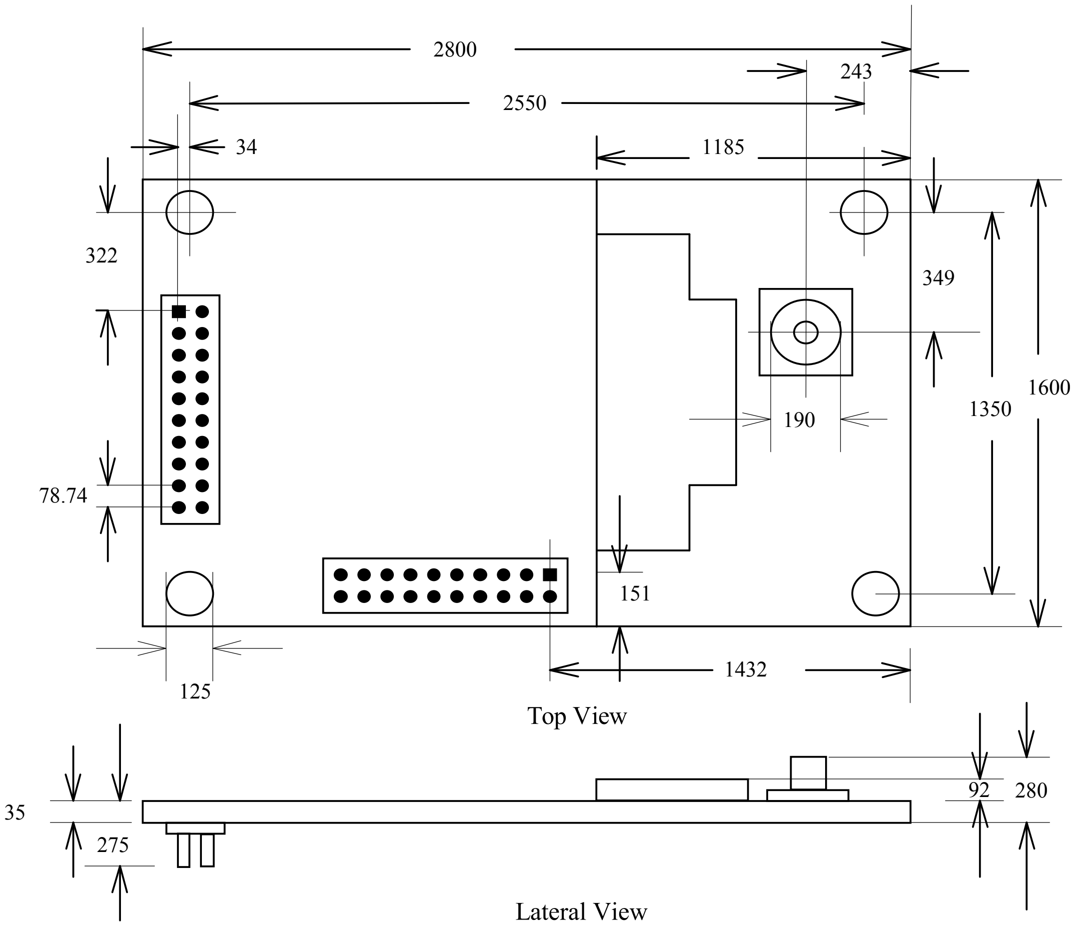

Figure 3

3.6 Interface Connector Pin Out

3.6.1 Pin Header Connector JP2

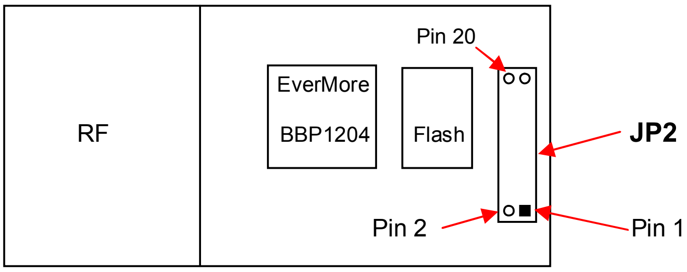

Figure 4

Pin	Function	Input/Output	Level	Pin	Function	Input/Output	Level
1	ANT_PWR	Input		2	NC		
3	VBAT	Input	3.3V	4	DVCC	Input	* *
5	PIO 6	In/Out	LVTTL	6	PIO5	In/Out	LVTTL
7	LED0	In/Out	LVTTL	8	PIO3	In/Out	LVTTL
9	PIO4	In/Out	LVTTL	10	GND	Ground	0V
11	TXD0	Output	LVTTL	12	RXD0	Input	LVTTL
13	GND	Ground	0V	14	TXD1	Output	LVTTL
15	RXD1	Input	LVTTL	16	GND	Ground	0V
17	GND	Ground	0V	18	GND	Ground	0V
19	1PPS	Output	LVTTL	20	NC		

* * :Order option for 3.3V or 5V

The following is a functional description of the pins on the JP2 20-pin interface connector.

Pin 1. ANT_PWR: External active antenna power input

Pin 2. DVCC: Power supply input

Pin 3. VBAT: External backup battery charging input

Pin 4. DVCC: Power supply input

Pin 5. PIO 6: Reserved I/O port 6 from CPU

Pin 6. PIO 5: Reserved I/O port 5 from CPU

Pin 7. LED0: Reserved I/O port 31 from CPU

Pin 8. PIO 3: Reserved I/O port 3 from CPU

Pin 9. PIO 4: Reserved I/O port 4 from CPU

Pin 10. GND: Ground

Pin 11. TXD0: Serial port output # 1 (GPS navigation output)

Pin 12. RXD0: Serial port input # 1 (command input)

Pin 13. GND: Ground

Pin 14. TXD1: Serial port output #2 (currently unused)

Pin 15. RXD1: Serial port input #2 (DGPS input)

Pin 16. GND: Ground

Pin 17. GND: Ground

Pin 18. GND: Ground

Pin 19. 1PPS: 1-pulse-per-second output. Active high for approx. 1usec

Pin 20. NC: No Connection

3.6.2 Pin Header Connector JP3

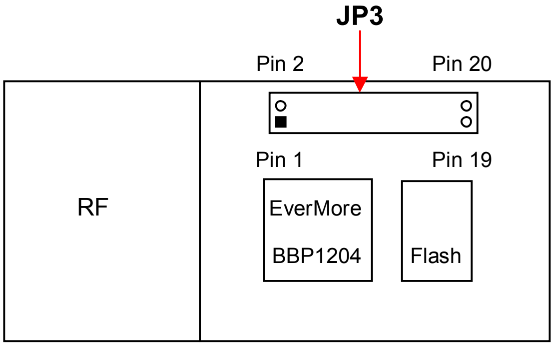

Figure 5

Pin	Function	Input/Output	Level	Pin	Function	Input/Output	Level
1	NC			2	PIO30	In/Out	LVTTL
3	DVCC	Input	* *	4	GND	Ground	0V
5	NC			6	PIO 21	In/Out	LVTTL
7	PIO 1	In/Out	LVTTL	8	PIO 19	In/Out	LVTTL
9	PIO 3	In/Out	LVTTL	10	PIO 18	In/Out	LVTTL
11	PIO 4	In/Out	LVTTL	12	PIO 17	In/Out	LVTTL
13	PIO 5	In/Out	LVTTL	14	PIO 16	In/Out	LVTTL
15	PIO 10	In/Out	LVTTL	16	PIO 15	In/Out	LVTTL
17	PIO 11	In/Out	LVTTL	18	PIO 14	In/Out	LVTTL
19	PIO 12	In/Out	LVTTL	20	PIO 13	In/Out	LVTTL

* * :Order option for 3.3V or 5V

The following is a functional description of the pins on the JP3 20-pin interface connector.

Pin 1. NC: No Connection

Pin 2. PIO30: Reserved I/O port 30 from CPU

Pin 3. DVCC: Power supply input

Pin 4. GND: Ground

Pin 5. NC: No Connection

Pin 6. PIO 21: Reserved I/O port 21 from CPU

Pin 7. PIO 1: Reserved I/O port 1 from CPU

Pin 8. PIO 19: Reserved I/O port 19 from CPU

Pin 9. PIO 3: Reserved I/O port 3 from CPU

Pin 10. PIO 18: Reserved I/O port 18 from CPU

Pin 11. PIO 4: Reserved I/O port 4 from CPU

Pin 12. PIO 17: Reserved I/O port 17 from CPU

Pin 13. PIO 5: Reserved I/O port 5 from CPU

Pin 14. PIO 16: Reserved I/O port 16 from CPU

Pin 15. PIO 10: Reserved I/O port 10 from CPU

Pin 16. PIO 15: Reserved I/O port 15 from CPU

Pin 17. PIO 11: Reserved I/O port 11 from CPU

Pin 18. PIO 14: Reserved I/O port 14 from CPU

Pin 19. PIO 12: Reserved I/O port 12 from CPU

Pin 20. PIO 13: Reserved I/O port 13 from CPU

3.7 One-Pulse-Per-Second Output

The one-pulse-per-second output is provided for applications requiring precise timing measurements. The output pulse is 1usec in duration. The rising edge of the output pulse is accurate to +/-1usec with respect to the start of each GPS second. The accuracy of the one-pulse-per-second output is maintained only when the receiver has valid position fix.

3.8 RTCM Differential Data

By using differential GPS (DGPS) correction data in RTCM SC-104 format with message types of 1, 2, 3, and 9, position accuracy of less than 5 meters can be achieved. RXD1, pin-15 of the 20-pin connector shown in figure 2, is used as the DGPS input. Differential correction is applied automatically when the correction data is received at 9600baud.

3.9 TISTAR15 Family

1. TiStar-15：HIGH PERFORMANCE GPS ENGINE BOARD

- NEC-1007K; BBP1204
- 3.3V/5V power supply
- SMA/MCX (Straight angle; Right angle)
- 3.3V TTL
- EBII API
- WAAS/EGNOS

1-1 TiStar-15T3M：3.3V；MCX
1-2 TiStar-15T5M：5.0V；MCX
1-3 TiStar-15T3S：3.3V；SMA
1-4 TiStar-15T5S：5.0V；SMA

PS -S：Straight Angle；-R：Right Angle
-N：Normal Pin-Header；-O：Opposite Pin-Header

2. TiStar-25：ENHANCED MINIATURE GPS ENGINE BOARD

- NEC-1007K; BBP1204
- 3.3V power supply
- MCX
- LVTTL
- WAAS/EGNOS

2-1 TiStar-25-T3MG：Gold Finger
2-2 TiStar-25-T3MH：10 pin-header
2-3 TiStar-25-T3MI：16 pin-header
2-4 TiStar-25-T3MJ：6 pin Molex connector
2-5 TiStar-25-T3MK：10 pin Molex connector

PS -N：Normal Pin-Header；-O：Opposite Pin-Header

3. TiStar-25-I：ENHANCED MINIATURE GPS ENGINE BOARD

- NEC-1007K; BBP1204
- 3.3V power supply
- MMCX / HFL
- LVTTL
- WAAS/EGNOS

2-1 TiStar-25-T3MG：Gold Finger
2-2 TiStar-25-T3MH：10 pin-header
2-3 TiStar-25-T3MI：16 pin-header
2-4 TiStar-25-T3MJ：6 pin Molex connector
2-5 TiStar-25-T3MK：10 pin Molex connector

PS -N：Normal Pin-Header；-O：Opposite Pin-Header

4. TiStar-25-II：ENHANCED MINIATURE EBII API GPS ENGINE BOARD

- NEC-1007K; BBP1204
- 5V (Option 3.3V) power supply
- MMCX / HFL
- LVTTL
- EBII API
- WAAS/EGNOS

PS -N：Normal Pin-Header；-O：Opposite Pin-Header