# TM1000A

# GPS Based Network Time Server

# Installation and Operation Manual

## Version 3.3

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# 1  Introduction

The Time Machines GPS Network Time Server is a simple to use GPS based time server that will supply accurate time for all computers and time keeping devices on the network.  By placing a time server on the local network, (S)NTP time packets are provided without requiring systems to go to the Internet to get a Stratum 1 time synchronization.  The system uses an active GPS antenna to maintain the current time as broadcast by United States GPS satellites.  With this device installed on your local network, there is no longer the worry that if the Internet connection goes down, time synchronization is lost across the network.

The unit is small and can be placed anywhere within the network layout.  The built in high sensitivity GPS receiver is able to lock multiple satellites from within many buildings or from a window location, removing the requirement that outdoor antennas be installed.

Setup and use of this time server is straightforward.  Simply connect both the included power supply and the GPS antenna to the base unit and then connect the base unit to the local network.  Go to a computer on the network and browse to the device at its default address to enter the software setup within the control box.  Set parameters to match your network and the system will start to send out time packets to any device on the system that asks for an update from it.    Two servers can be setup to provide redundancy and more capacity.

When paired with our digital Power Over Ethernet (PoE) or WiFi clocks, synchronized time is assured no matter the state of your network, or the state of the internet time server the clocks are pointed to.  Accuracy is also improved because the network delay of the internet is highly variable, while the local LAN connection is likely sub-millisecond delay.

TimeMachines GPS based time servers are suited to any application where coordination of events at multiple locations is required.  Without coordinated network time, searching for problems across multiple system logs becomes much more difficult.  Education, industrial facilities, military installations, public safety command rooms,  government, broadcasting, and hospitals are all candiates for synchronized time systems.

## 1.1  Serial Number Notes:

The TM1000A has been in the market a number of years and has undergone a couple of significant hardware revisions.  The serial number on the bottom of of the unit will reveal the HW revision.  Some features will be available for later models only.

- **TM1000A serial numbers that start with a number or the letter 'A' use versions 1.XX of the firmware.  Units that start with a number only, use the Navman GPS module.  Units that start with the letter 'A' were updated to the Global Top GPS module when the Navman module became obsolete.**
- **TM1000A serial numbers that start with the letter 'B' use version 2.X and greater of the firmware.  The major change in this version was that a newer processor is used that supports a greater code space and opportunities for feature increases.**
- **Failure to observe this will cause a failure in the programming and require the unit to be returned to TimeMachines for firmware update**

# 2 Installation

## 2.1 Location

To receive GPS signals the Time Server's antenna must be located in a location where it can "see" the sky. The GPS module itself is highly sensitive and able to "see" the GPS satellite signals from within many structures. Multi-Story, concrete, or metal structures may block the GPS signals such that the antenna must be located elsewhere. In these cases, the GPS antenna may be located in a window, although some windows employ a coating to block solar radiation that will also block GPS signals. The Time Server box can be located anywhere on the network.

All that is required is power and a wired network connection.

In the worst case, an outdoor antenna may be required.

## 2.2 Connections

## 2.2.1 Antenna

The GPS antenna is connected through the circular female SMA connector on the rear of the Time Server. By default, the GPS antenna connection provides 3.3V to power the LNA in the GPS antenna. This is correct for the supplied GPS patch antenna with the magnetic base. This voltage can be changed with a jumper on the inside of the Time Server. The Time Server has to be opened up and the jumper moved.

**Jumper J2**                                    **Jumper J8**
**A:  5.0V        B: 3.3V (default)**        **A: Reset to Factory  B: Normal Operation**

The only time this jumper would be change would be to allow use of a different antenna that requires +5V for the LNA in the antenna, or to overcome the voltage drop of a longer cable run. This might be the case for an outdoor installation.

## 2.2.2 Power

A multi-country +5V power supply is supplied with the unit. Connect one end to a standard 110-240V outlet and the barrel connector to the rear of the Time Server. The time server will begin trying to find the GPS satellites. On power-up, synchronization to the GPS satellites will take several minutes. No battery backup of position is provided to allow for a warm start so the Time Server is always starting from scratch in determining its location to achieve GPS lock.

## 2.2.3 Network

Connect the 10/100 RJ45 port on the back of the Time Server to a network connection. Verify that the network settings are correct for your system. See the configuration section of this manual for more information on doing this.

## 2.2.4 Front Panel Indications

The front panel of the Time Server is very basic in its appearance. Three LEDs show the current status of the unit. The POW indicator indicates that the unit is receiving power through its wall power supply. The LOCK indication indicates that the GPS has located at least three satellites. The SEC LED will blink each second showing that the GPS module is now synchronized to the GPS time signals.

## 3  Configuration

### 3.1  Web Page – Default password is 'tmachine'

### 3.2  Default IP address is 192.168.1.15

All Time Server parameters are accessed on the configuration web page. The page can be accessed by pointing any web browser at the IP address of the Time Server.  The initial IP address is 192.168.1.15 from the factory.  It can also be found by connecting a straight RS-232C serial cable to the back of the Time Server and a computer running a terminal program at 115200,N81.
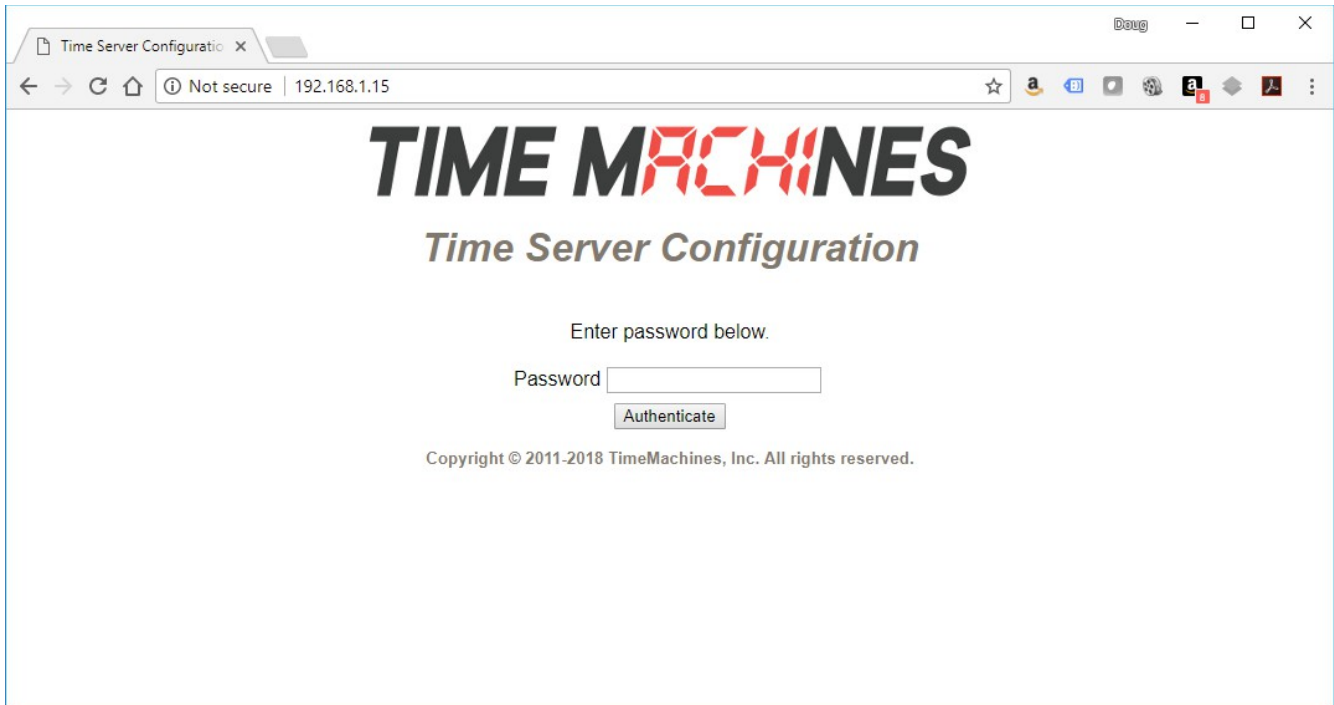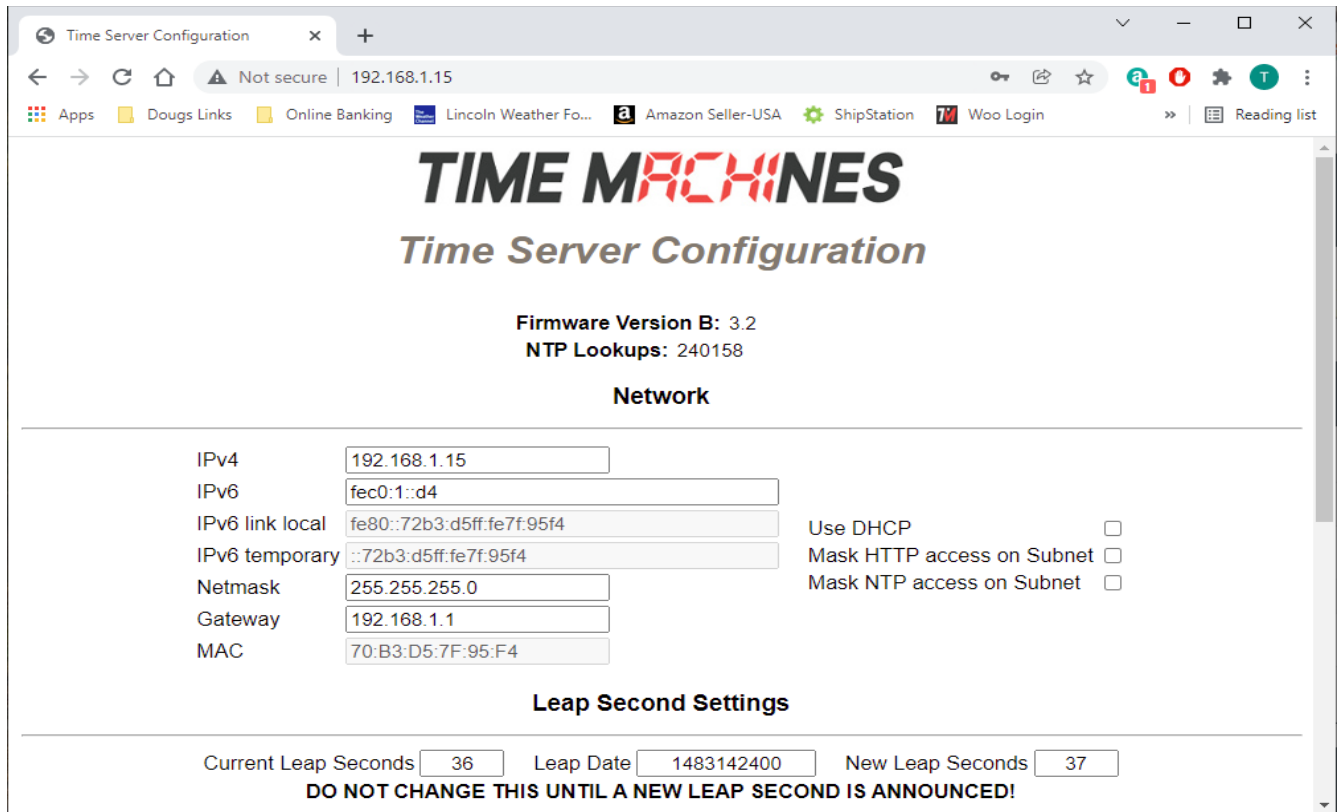


*Illustration 1: Login Web Page*

*Illustration 2: Setup Web Page-Version, Lookups, and Network Setup*

### 3.2.1 Version and NTP Lookups

Starting in version 2.6, the upper header was updated to include the firmware version, and a running counter of NTP lookups. This counter increments by 1, for each NTP time requested by a client device on the network. Please make a note of the Firmware version before calling TimeMachines for technical support.

### 3.2.2 Network Setup

By default the network parameters are setup to static address 192.168.1.15. The Time Server is able to use DHCP, but the rest of the network will need to be able to automatically adjust to its IP address should it change. This would involve setup with DHCP and DNS systems. Usually, static setup is recommended. Addresses in the Network section must be entered in IPv4, dotted quad, format.

## All Network parameters require a restart to take effect.

### 3.2.3 Use DHCP

Checking this option will tell the Time Server to ignore the other IP address settings and request an IP address from the network's DHCP server at startup.

### 3.2.4 IPv4 Address

If the DHCP option is not being used, then the IP address of the unit set to by entering a standard IPv4

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dotted quad in this field.  192.168.1.15 or 10.10.0.96 are examples of acceptable formats for this field.

### 3.2.5  IPv6 Address

This is the 128 bit IPv6 address of the device either statically entered of determined by DHCP.  The first 64 bits indicate the network address and the last 64 bits are user defined for their network.  Please note that a user should still setup the device initially using IPv4. They can then set an IPv6 address and/or view the IPv6 temporary.  The web page can be accessed using an IPv4 and/or IPv6. The TM1000 will respond to Ping, Ping6, rdate and rdate -6.

### 3.2.6  IPv6 Link Local

This address is only valid for communications within the network segment (link) and is required for stateless address auto-configuration. Neighbor Discovery Protocol is part of the IPv6 protocol and uses stateless address auto-configuration. This address begins with prefix fe80::/64. The last 64-bits are based on the MAC address of the TM1000. This address is unique to each TM1000 and not modifiable.

### 3.2.7  IPv6 Temporary

This is a default address based on the network address and the MAC address.  The TM1000 uses Neighbor Discovery Protocol to find the network address. The last 64-bits are based on the TM1000's MAC address. This address is unique to each TM1000 and not modifiable. The TM1000 will default to this address to serve time if the IPv6 address has not been set, otherwise the modifiable IPv6 address is used to serve time.

### 3.2.8  Mask HTTP access on Subnet

This checkbox will enable HTTP (web browser) access only on the timeservers configured subnet. This has the effect that the TM1000A will only respond to requests for the web page if they come from the same subnet the TM1000A is configured on.  This is a security feature to limit the access to the configuration of the device only to the local subnet.

### 3.2.9  Mask NTP access on Subnet

This checkbox will enable NTP access only on the timeservers configured subnet.  This allows the time server to ignore requests for time from all devices that are not on the same subnet and provides a measure of security and protection from denial of service attacks.

### 3.2.10  Netmask

The Netmask entry determines what addresses on on the local network and what addresses are reached through the Gateway.  Typical Netmasks are 255.255.0.0 or 255.255.255.0.  Consult the network administrator for more information on who this entry should be set.

### 3.2.11  Gateway

The Gateway IP address is used when a destination address is determine to not be on the local network. Consult the network administrator for this setting.

### 3.2.12  MAC

This is an information only field and displays the MAC address of the Time Server.

### *3.3 Leap Second Settings*

Version 3.3 of the TM1000A firmware added setup to allow the next leap second to be reported to client devices. Its setup is done through the next three entries. As of the writing of this document, the last leap second was on December 31st, 2016 at midnight (1483142400 seconds after Unix epoch date of January 1, 1970). It went from 36 leap seconds, separating atomic time from UTC, to 37 seconds. These are the default settings for the device. **These should NOT be changed until another leap second is announced. Correct values for these settings will be posted on the FAQ of our website when the next announcement occurs.** When that occurs, the Current Leap Seconds setting will be changed to 37, the Day adjusted to midnight of the day it will occur (always June 30th, or December 31st), and the New Leap Seconds setting will be updated as well to the new number of leap seconds. There is some thought that the next leap second may be negative due to the earths rotation slowing. Both positive and negative leap seconds are supported through this interface. NTP will report the entire day of the leap second whether it is a positive or negative second change. Both will adjust appropriately for the lost or additional second at midnight UTC time.

### *3.3.1 Current Leap Seconds*

This is the number of leap seconds prior to the next leap second change. The last leap second was added on December 31$^{st}$, 2016 (1483142400 Unix time) and when from 36 to 37 leap seconds. This value will be changed to 37 when the next leap second is announced, whether it is a positive or negative second.

### *3.3.2 Leap Date*

The Unix epoch date of January 1, 1970 is used for setting the date for the next leap second. It will be either December 31$^{st}$ or June 30$^{th}$ of some year. Right now there is no leap second announced. The same web page entry time scale is used in our TM2X00 products.

### *3.3.3 New Leap Seconds*

Depending on whether the next leap second announced is positive or negative, will determine the value of the New Leap seconds. If the earth continues to slow, its value may be 36. If it speeds up, it may be 38. Time will tell.

## 3.4 Satellite Status

The second half of the Time Server configuration page is status information from the GPS module in the Time Server.

### 3.4.1 GPS Fix, Sats, and Time Information

The "GPS Fix:" label will state whether the GPS is locked to satellite signals or not. A "2D LOCK" is required for operation, however a 3D Lock is preferred. Antenna location and obstructions will govern this. The early stages of a 2D lock may have timing errors that will clear as the lock improves. A 3D Lock will provide the most stable timing, however a strong 2D lock is sufficient to obtain accurate NTP time.

GPS Sats is the number of Satellites currently being used by the GPS for its lock algorithm.

GPS Time is updated on each page refresh and shows a static representation of UTC time at the time page was refreshed from the GPS module.

### 3.4.2 Location

This shows the current Latitude and Longitude of the GPS receiver

### 3.4.3 Satellite ID and Signal Strength

The "Signal Strength" line will give the signal strength of the top 12 satellites being received. The possible range is from 0 to 99dB SNR. The TM1000A will use as many satellites as it can receive for the greatest possible accuracy. Satellite signals in mid to upper 30's for first 2-3 satellites is best. Signal strengths below 30 will create lock inconsistencies and potential timing problems. The TM1000A must have a signal lock to serve time. An inconsistent lock, can create inaccurately reported time.

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### 3.4.4  Echo GPS Strings Checkbox

Checking this option will tell the unit to copy all received data from the GPS module's serial port to the serial port on the back of the Time Server.  The copied strings are the standard NMEA GPS data strings.

### 3.4.5  Serial TTL Level Outputs Checkbox

Checking this option will enable the TTL level outputs of the serial port.  These are found on Pins 7, 8, and 1.  To receive the actual NMEA strings, the "Echo GPS Strings Checkbox" must be checked.

Pin 1 is the 1 PPS signal at TTL (+3.3V) levels

Pin 2 is RS232 TX pin and will be the output from the GPS module, NMEA strings (DCE pinout)

Pin 3 is the RS232 RX pin (DCE pinout)

Pin5 is signal ground.

Pin 7 is the data from the GPS module at TTL Levels and is the same as Pin 2 which is at RS-232C levels

Pin 8 is data the RX data from the RS-232 serial port Pin 3.

Data received on pins 3/8 is NOT echoed to the GPS module.  No GPS settings can be changed from this port as it is blocked by the processor.

### 3.4.6  Debug Output Checkbox

The debug output checkbox will tell the unit to output debug and operational information to the serial port.

### 3.4.7  Unit Name

This can be any alpha numeric name up to 20 characters long.

### 3.4.8  Password

The password field displays the current password. To change it, enter a new password, push  Save and then Reboot for it to take effect. Time Server passwords are limited to12 characters. The default password is "**tmachine**"

# 4  Locator Data Query

Starting in version 2.6, the Locator service employed by TimeMachines clock products is also included in the TM1000A.  This makes it easier to manage and monitor a time system on a local network using the TM-Mangaer software.  See the TM-Manager documentation for more information on this feature.

## Locator Data Format

The Locator Data Service is a simple UDP/IP protocol that can be used by other network applications to extract status and location information from the TM1000A.

Requesting information from the TM1000A is done by sending a 3 byte message to the TM1000A, using UDP/IP, to port 7372.  The three bytes, in hexadecimal, are: 0xA1 0x04 0xB2  The TM1000A will also respond to a broadcast to the same port.

The response packet is 80 bytes and will be formatted as follows:

| Bytes | Description |
|---|---|
| 0 | TM1000A response value = 0x04 |
| 1 to 4 | client IP address |
| 5 to 10 | MAC address |
| 11 and 12 | firmware version Major:Minor |
| 13 | Lock status 0=No Lock, 1=2D Lock, or 2=3D Lock |
| 14 to 17 | NTP Sync count, 32 bits, MSB to LSB |
| 18 to 20 | Current Time, H:M:S, UTC |
| 21 to 45 | Location of unit 25 bytes, Latitude, Longitude, null terminated |
| 46 to 80 | Name of Time Server, null terminated |

TM-Manager uses this protocol to find a monitor TM1000A's on the network.  A Wireshark capture of that software can be used to see an example of the data transfer.

# 5  Troubleshooting

## 5.1 GPS Lock

Getting GPS lock on the Time Server is required for it to function.  Most GPS lock issues come down to issues with Antenna location, or cabling.  If there are problems getting GPS lock (I.e.the Lock LED doesn't turn on and the 1 PPS LED doesn't flash each second) trying moving the antenna outside and see if that resolves the issue.  If it does, try a window and see if lock is maintained.  If that works, move the antenna back to its original location and see if lock is lost.  This will help determine where lock can be received and where it cannot.  If no lock is achieved outdoors, then something is either wrong with the cabling or the Time Server itself.  Contact Time Machines for help.

## 5.2 Finding the IP Address

If the IP address of the Time Server is forgotten, there are a few ways to go about finding its IP address.  The first is to use a serial terminal program such as Hyper-Terminal or something similar.  Set the communications parameters of the terminal program to 115200,N81.  Connect a straight through cable between the computer and the Time Server and cycle power on the Time Server.  The IP address is printed during startup.

If the Time Server is using DHCP, then it is possible to look up the units IP address on the DHCP server by looking at the list of leases.  Look for a MAC address in the lease list that starts with 00:50:C2.  This will likely be unique in the DHCP lease list.  The IP address associated with this MAC address should be tried.

The third possible way to determine the IP address is to simply check several of the devices using the Time Server on the  network to see how they are programmed.  If they have a specific IP address programmed into them for time keeping, then that may be the Time Server's base IP address.  If a domain name has been assigned to the Time Server, doing a command like "ping timeserver.your-company.com" might show the time servers address as well.

The TM-Manager application is a great way to monitor all TM1000A's on a network.

## 5.3 Resetting to Factory Defaults

**Jumper J8**
**A: Reset to Factory  B: Normal Operation**

Jumper J8 on the inside of the TM1000A is used to reset the units software settings to factory original.  This is useful when a password is forgotten or the IP address cannot be determined.  To do this, remove the 4 screws from the front panel.  With some care, the jumper can be reached from the front of the unit without removing the PCB.  Move J8 to the "A" position and apply power.  After a few seconds, remove the power connection, replace J8 to the "B" position and reassemble the unit.  It should now have the factory default password and IP address information.

# 6 Specifications

## 6.1 Time Server Features and Specifications

- Receive time information from GPS satellites anywhere on the surface of the earth

- RFC1119/1305 NTP Protocol to serve time (Network Time Protocol)

- RFC1769/2030/4330 SNTP Protocol (Simple Network Time Protocol)

- Server Time Level: Stratum 1

- Server Time Precision: better than 5mS + network jitter.

- All networked computing platforms support time synchronization either natively or with add on drivers including: Windows, Macintosh, and Linux.  Many other devices can access the device as well including VoIP phones and digital clocks.

- 10M/100M adaptive network interface

- Unit is capable of serving 135+ synchronizations per second.  That provides support for over 120,000+ devices updating every 15 minutes on the network.

- Active Patch GPS antenna included.  Magnetic base.

- Compliant with FCC Part 15, class B and CE marked for radiated emissions.  Lead free.

- Power Requirements:  less than 4 Watts continuous.

- Environmental Requirements:  Commercial temperature range, -40C to +70C, 95% humidity non-condensing.  Altitude -304m to 18,000m.  Startup temperate is around -20C.

- Networking:  Static or DHCP IPv4 addressing.  Standard browser interface for setup.

- Serial port supports both RS-232C levels and TTL (+3.3V) outputting standard NMEA information strings, as well as the 1PPS signal at TTL levels.  TTL signals can be turned off via software control.

- Indications: Power, GPS Signal Lock, and 1PPS indications

- Rear Connections:  Power, Cat5 Ethernet, Serial, and GPS antenna via SMA connection. Supports +3.3V and 5V active GPS antennas with internal jumper setting.

- Mechanical Dimensions:  5 in. x 4.2 in. x 1.3in.

## 6.2 GPS Module Specifications

- Based on SiRF GSC3e Lpx chipset.

- 20 channel low power receiver module

- Sensitivity: -144dBm, C/N0=26dBHz

- GPS Time Precision: <1us, typical +/- 300ns ref UTC.

- Antenna Connection: 1575.42MHz (L1 Band) at a level between -135dBm and -159dBm into

50 Ohm impedance.  Maximum input return loss is -9dB.

- TTFF (Time To First Fix)

- Cold start @-125dBm typically 33 seconds

- Re-acquisition (<10s obstruction) typically 1 second

## 6.3 Antenna Specifications

- Active patch antenna with magnetic base.

- Size: 1.57 in. x 1.89 in. x 0.51 in thick, 43 grams.

- Amplifier: LNA +20dB  Noise: 1.5dB  VSWR: 2.0 Voltage: 2.7-6.0V.

- Cable:  RG174, 5m length, SMA male.

- Environmental: -40 to +85C

- Waterproof to IPx6

(Specifications are subject to change without notice)