

## GPS TTFF and startup modes

### 1 Introduction

The GPS within the ike module can boot up in one of three modes: Hot Start, Warm Start or Cold Start.

The Time-To-First-Fix (TTFF) depends on the startup mode, with cold starts giving the longest TTFF.

Factors affecting boot mode include:

- Whether or not the GPS has valid almanac and ephemeris data.
- Incoming signal levels.
- The unit is within 60 Miles / 100 KM of location of previous fix.
- Length of time since previous fix.

### 2 Almanac and Ephemeris Data

The almanac contains Satellite Vehicle (SV) orbit information and allows the GPS receiver to predict which satellites are overhead, shortening acquisition time.

The GPS receiver must have a valid almanac to be capable of booting up in warm or hot start modes.

The receiver must have a continuous fix for approximately 15 minutes to receive a complete almanac from the satellites. Once downloaded it is stored in nonvolatile memory. Execution of a cold start will automatically result in a new almanac download.

Ephemeris data contains precision corrections to the almanac data and is required for accurate positioning. It is continuously updated and so Ephemeris data within a deactivated GPS receiver will become stale after 3-6 hours.

### 3 Stored Position and Time Data

When a GPS receiver has established a fix and is deactivated the last valid position and time data are stored. When the unit is powered up again it will attempt to use this stored information with the internal almanac to predict which SVs are overhead.

If the unit has moved too far or the internal clock powers down (GPS inactive for at least three days) the stored data cannot be used to predict SV location.

### 4 GPS Startup Modes

#### 4.1 Cold Start Mode

The GPS starts up in this mode when:

- It is manually reset (see section 6).

- Receiver has moved more than 60 Miles from the location of the previous fix.
- Current time is inaccurate or unknown.
- Incoming signal levels are marginal. The predicted satellites are physically overhead but the receiver cannot see them, for example due to tall buildings, foliage etc.

Any of these situations means that the receiver cannot predict and/or verify which SVs are overhead. The receiver then works through an internal list of all satellites, trying to acquire each one in turn.

This allows the GPS to discover the satellite vehicles which are in view and eventually establish a position. The TTFF for a cold start can be from 2 to 4 minutes, since discovery of the overhead SVs has a random element.

#### **4.2 Warm Start Mode**

The GPS starts up in this mode when:

- It has a valid Almanac.
- The current location is within 60 Miles of the last fix location.
- The current time is known (the GPS has been active in the last three days).
- No Ephemeris data has been stored or it has become stale (see section 2).
- 4 or more SVs with HDOP < 6 and good signal strength (ie the SVs have good geometry and there is an uninterrupted view of the sky) are visible and above the mask angle (section 5).

The receiver can predict which SVs are overhead but needs to download current Ephemeris data. TTFF for this start mode is typically 45 seconds.

#### **4.3 Hot Start Mode**

The GPS starts up in this mode when the 'Warm Start' conditions are met and:

- A fix has been established within the last 2 hours.
- The GPS has valid Ephemeris data for at least 5 satellites.

In this mode the receiver rapidly tracks the overhead SVs and needs to download a minimum of data to establish a position. TTFF for a hot start is typically 22 seconds.

### **5 Constellation Effects**

The TTFF can also be affected by the satellite constellation. More satellites in good locations reduces TTFF and improves accuracy.

#### **5.1 Satellite Vehicles In View**

At least 4 SVs are required to be locked in (colored black on the skyplot) to get a fix. 5 or more are required for good quality fixes.

## 5.2 Satellite Vehicle Geometry

GPS works by triangulation. Satellites directly overhead (90 degree elevation) give less accurate results than SVs with lower elevation.

However signals from satellites which are too low in the sky have to travel through more of the earth's atmosphere which reduces accuracy. On the ike unit the elevation angle limit (mask angle) is usually set to 15 degrees.

## 6 Manual Cold Start

Occasionally a manual Cold Start may be required, for example if the ike unit has been moved more than 60 miles between fixes.

The unit will reference stored position, time and almanac data to predict which SVs are overhead and attempt to acquire them.

However these SVs will not be overhead. It will try to acquire these SVs for up to 15 minutes before reverting to cold start mode, and therefore in these circumstances may take 20 minutes to establish a fix.

A better solution is to force a cold start straight away. This can be done by going into ike utilities >> Diagnostics >> GPS >> 'Advanced' Tab >> Force Cold Start

Note that following a cold start the unit must have a continuous fix for at least 15 minutes to enable Warm and Hot Start modes (section 2).