Trimble's FirstGPS Architecture:
A Better Way to Add Location to Your Product

Trimble

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Abstract

A new GPS receiver/processor architecture breakthrough from Trimble lets OEMs add GPS location capability to their products using far less power and space than any other means.

Introduction

In today's mobile, wireless, digital world, the rush is on to integrate positioning capability into automobile navigation systems, cell phones, pagers, personal digital assistants (PDAs), digital cameras, and many other products. The Global Positioning System (GPS) is a worldwide resource from which the user's exact location can be derived. Until now, adding GPS capability to a product has almost always required treating GPS as a standalone function. That is, adding a GPS module that provides the entire function from tracking the GPS satellites to computing the finished position, velocity, and time (PVT) solutions, which then are communicated to the host computer for use in the overall application.

This standalone integration has been necessary because GPS signal tracking and processing is a very time-critical task that requires intensive digital signal processing (DSP); frequent CPU interrupts are generated and require stringent response times, placing heavy demands on a real-time operating system (RTOS). Most GPS chipsets require CPU response within 20 milliseconds of each request. If the RTOS cannot support this continuous demand, the GPS chipset will lose track of the satellite signals. Therefore, it has typically been necessary to provide a dedicated CPU, memory, and processing circuits to handle the entire GPS function, outputting a final PVT solution to the host processor for use at its convenience.

FirstGPS Architecture Changes the GPS Integration Game

Trimble's new FirstGPS™ architecture changes all that. The "First" in the name stands for Flexible Integration of Real-time Software Tasks. FirstGPS is the only host-based architecture available today that allows flexible integration of GPS with other real-time software tasks.

Trimble's FirstGPS architecture is already proven in more than one year of field use in Japan. The architecture is implemented in Seiko Epson's Locatio, the world's first combination PDA, wireless phone, personal navigator and digital camera capable of accessing the Internet.

Host-Based Architecture

By adapting this innovative architecture to the CPU and RTOS used in the OEM product, redundant CPUs and memory are eliminated and the overall component count and product cost reduced. The architecture uses two integrated circuits and Trimble software. The ICs handle the processor-intensive GPS tracking and processing tasks. The FirstGPS software leverages the host CPU and memory to calculate the GPS PVT solutions, without burdening the other applications running on the mobile device.

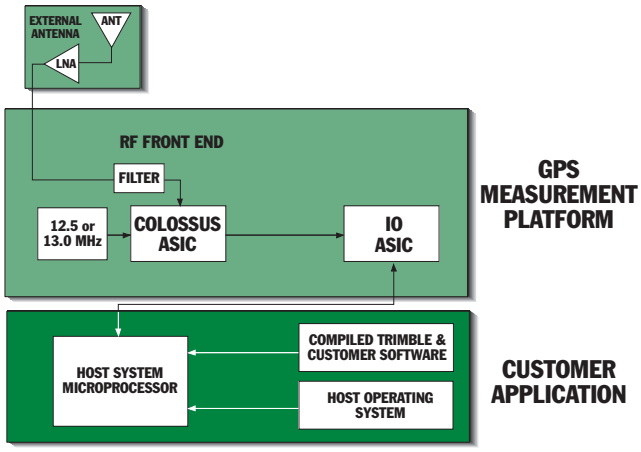

Figure 1. Integration of FirstGPS Measurement Platform with Host Application

The FirstGPS architecture, available in 12-channel chipsets or in modular form, can tolerate up to 5-second delays between interrupt services from the host CPU—250 times longer than the previous 20-ms maximum period. It uses very low-speed

serial communications interrupt and data rates to get the data into the host CPU. The CPU can treat GPS as a simple I/O interrupt service routine that the CPU can easily handle along with other application requirements.

Ultra-low Power Consumption

FirstGPS architecture offers the lowest power consumption of any GPS receiver on the market today. Requiring only about 1/3 the power of most receivers (30–50 milliwatts at 3.3 volts when updating positions every second), FirstGPS is ideal for power-sensitive applications. Several sleep and low-power modes allow for even greater power savings and longer battery life for devices that need location only on demand.

Very Small Size

FirstGPS architecture is extremely compact. Its high level of integration and low component count enables a footprint as small as one square inch (25mm x 25mm). This small footprint enables the integration of GPS functionality into a variety of mobile devices without adversely affecting product form factor and size.

Basic Module Architecture

The building blocks of FirstGPS architecture are two Trimble-developed integrated circuits (Colossus™ and IO) and Trimble's FirstGPS software. Controlled by the software, the ICs form the "measurement platform" for basic GPS processing. The measurement platform searches for, acquires, and tracks satellites, handles all the high-speed, interrupt-driven tracking tasks, and develops the GPS measurement information (including code phase, carrier phase, Doppler, signal strength, and other data). The measurement platform then outputs these results to the host-based "navigation platform," where the data is used to compute PVT solutions.

Colossus RF ASIC

Trimble's Colossus RF ASIC is a tightly integrated, single-chip, double-conversion radio receiver with pseudo-baseband I and Q outputs. It includes a low-noise amplifier, a programmable frequency synthesizer for two reference clock frequencies (12.5 MHz or 13.0 MHz), two built-in baseband samplers, and power-down circuitry. Its on-chip, voltage-controlled oscillator (VCO) eliminates the need for external VCO components. The Colossus uses just 20 mW of power.

IO Enhanced GPS Correlator

Trimble's IO (pronounced EEH-ooh) ASIC[1] receives and decodes the digital signals from the Colossus RF ASIC. The IO chip contains its own micro-controller to handle the intensive DSP demands of the GPS measurement platform. The 12-channel design enables parallel tracking of the GPS L1 (1.575 GHz) frequency. The IO chip uses 8 mW of power and has four power-control states.

FirstGPS Navigation Software

The FirstGPS software controls the operation of the measurement platform and the host-based navigation platform.

Three Ways to Implement FirstGPS Technology

Trimble's FirstGPS technology is planned for availability in a variety of forms to suit the needs of a wide range of OEM companies—as standalone GPS modules, a new measurement platform adaptation, and as chipsets for direct integration.

Standalone Modules

Trimble has long provided board-level GPS receiver modules that deliver complete PVT solutions. The next generation of these modules will use FirstGPS technology to achieve significant power and/or size reductions while still providing full PVT functionality.

Measurement Platform

The FirstGPS architecture is ideally suited for forming a GPS Measurement Platform for high-volume, cost-sensitive OEM applications. The physical components, mounted on a small (roughly 1 square inch) circuit card, deliver GPS measurements data to the host application, where the host

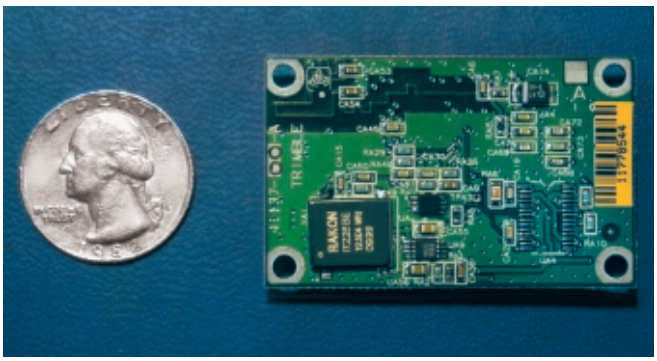

Figure 2. Preliminary engineering model of potential FirstGPS Measurement Platform configuration

[1] IO is a moon of the planet Jupiter.

CPU and memory produce accurate PVT solutions using the FirstGPS software.

The Measurement Platform will be microprocessor and RTOS independent, and need only 2 MIPS from the CPU in steady-state tracking and 4 MIPS during acquisition. The Measurement Platform will consume less than 60 mW, even at a 1-Hz update rate. Several sleep modes will be available for power-sensitive applications. The target size of less than one square inch (approximately 25 mm x 25 mm) makes it readily useable in most product designs.

Direct Chipset Integration

The Colossus and IO chips and the FirstGPS software are also available for direct integration into OEM products. This provides the ultimate in flexibility and potential cost savings in high-volume applications, for customers with the resources and design capability to achieve the most effective integration. The chips will be produced by a semiconductor foundry under license from Trimble.

The chipsets will be available by the end of 2000. The first of the standalone modules and a prototype Measurement Platform are scheduled for availability during the first half of 2001.