Features

- Very small footprint, 66 x 40 x 4.5 mm.
- Fast satellite acquisition with twelve parallel tracking channels.
- Enhanced time to first fix (TTFF) from battery back-up to power-on condition.
- NMEA (National Marine Electronics Association)-0183 data protocol support.
- Direct differential RTCM (Radio Technical Commission for Maritime Services) SC-104 data capability improves positioning accuracy in both IBM binary and NMEA host modes.
- Maximum achievable Standard Positioning Service (SPS) accuracy.
- Meets rigid vibration and shock requirements.
- Automatic altitude hold mode from three- to two-dimensional navigation.
- Automatic cold-start acquisition process.
- Complete operational flexibility and configurability through user commands via the host serial port.
- Static navigation enhancements minimize wander due to selective availability (SA).
- The receiver can accept externally supplied initialization data via the host serial port.
- User selectable satellites.
- User selectable satellite mask angle.
- Right angle MCX type, snap-on coaxial RF jack.
- Standard 2 x 5 pin input/output connector.
- Operation over an extended temperature range (-40° C to +85° C)

Description

IBM's GPS receiver is a single-board, twelve parallel-channel GPS receiver engine designed for inclusion in larger GPS systems. The receiver tracks all satellites in view to provide the most accurate positioning data. The GPS receiver is designed for a wide variety of applications, including hand-held devices, marine, and in-vehicle automotive.

The receiver processes signals from all visible GPS satellites. GPS satellites broadcast radio frequency (RF) navigation information. IBM's GPS receiver uses all available signals to produce highly accurate navigation data that can be used in many types of end products.

The IBM GPS receiver is designed to withstand harsh industrial environments. The receiver requires a GPS signal from an active antenna and 3.3 VDC conditioned power.

The IBM GPS receiver performs "all-in-view" satellite tracking. This provides robust performance in situations where extreme vehicle movement or high signal blockage (like dense urban areas) are concerns. The receiver continuously tracks all visible GPS satellites, using the navigation information from all of them to produce smoothed, accurate data. This data is relatively immune to position jumps that can occur with receivers that monitor fewer satellites.

Rapid TTFF under all start-up conditions is a feature of the twelve parallel-channel architecture of the IBM GPS receiver. While providing time-of-day and current position estimates to the receiver assures the best TTFF, the flexible satellite acquisition system takes advantage of all available information to provide rapid TTFF. Satellite acquisition is guaranteed under all initialization situations, as long as the receiver can 'see' the satellites.

To minimize TTFF when primary power is removed

from the receiver, a DC supply voltage to maintain the real-time clock (RTC) must be provided. This reduces TTFF since prior position data and satellite information are stored in the receiver's flash memory.

With less than four satellites available or when operating conditions require, the IBM GPS receiver supports two-dimensional (2-D) operation. Altitude information required for 2-D operation can be determined by the receiver using the last known altitude or can be supplied.

The receiver has two independent, asynchronous serial input/output ports. The host port (the receiver's primary serial port) outputs navigation data and accepts commands in NMEA-0183 or IBM binary message formats. The auxiliary port (the receiver's secondary serial port) accepts differential GPS (DGPS) corrections in RTCM SC-104 format. See the message definitions for more information.

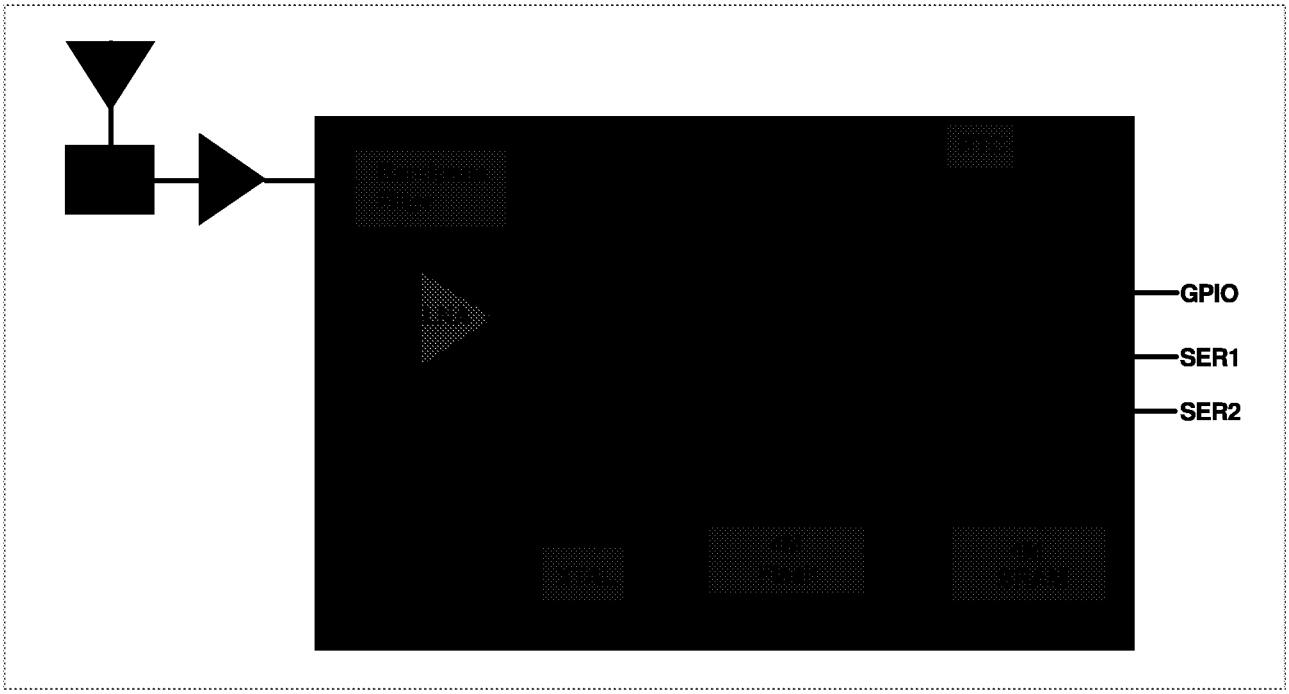
Receiver Architecture

The functional architecture of the IBM GPS Receiver is shown in the block diagram below. The receiver is based on the IBM GPS receiver chip set, which includes all the RF direct conversion and amplification circuitry. These circuits present two-bit sign and magnitude sampled data to the digital signal processor (DSP). The DSP contains an integral microprocessor (401 PowerPC) and all GPS signal processing hardware. Memory and other supporting components are needed to make a complete navigation system.

Product Applications

- Handheld GPS receiver
- Automotive navigation
- Marine navigation
- Timing
- Asset Tracking

Block Diagram



Technical Description

The receiver requires 3.3 VDC primary input power.

The receiver's antenna must have visibility of the sky in order to acquire enough satellites to operate. While this is usually not a problem out-of-doors, indoors or in a vehicle may require that the antenna be located so as to have an unobstructed view of the sky. If the satellites are blocked from the receiver's antenna, the receiver will take longer to acquire a position, or may not acquire a position at all if fewer than three satellites are available.

The IBM GPS Receiver supports three signal acquisition modes, depending on the availability of critical data; warm start, initialized start, and cold start. See table 1 for the TTFF times for each mode.

Table 1: Signal Acquisition Modes

	Time to First Fix 95% Probable (seconds)	Initial Error Uncertainties (3 Sigma)			Maximum Almanac Age	Maximum Ephemeris Age
Acquisition Mode		Position (km)	Velocity (m/sec)	Time (minutes)	Weeks	Hours
hot start	15	500	75	5	1	4
warm start	40	500	75	5	1	N/A
cold start	90	N/A	N/A	N/A	1	N/A

N/A = Not available in real time to the receiver.
Times given are valid at 25° C with no signal blockage.

Navigation Modes

The IBM GPS Receiver supports three navigation modes; three-dimensional, two-dimensional, and differential GPS (DGPS).

When four or more satelittes are available with good geometry, the receiver will use the three-dimensional navigation mode. See table 2 below for the three-dimensional mode navigation accuracy.

When less than four GPS satellites are available, or when a fixed altitude can be used to produce an acceptable result, the IBM GPS receiver will enter the 2-D navigation mode. 2-D navigation uses a fixed altitude value either determined through previous 3-D operation or as provided to the receiver. In 2-D navigation, navigational accuracy is primarily determined by the relationship of the fixed value of altitude to the true altitude of the antenna.

The IBM GPS receiver processes DGPS corrections through its auxiliary serial port (port 2). These corrections must be compliant with the RTCM standard for differential GPS service, RTCM-104. Depending on the GPS configuration, navigational accuracies can be improved dramatically in 3-D GPS mode. The IBM GPS Receiver supports the accuracies described in the RTCM-104 recommended standard.

Table 2: Navigational Accuracy

	Position (meters)			
	Horizontal		3-D	Vertical
	CEP	(2 dRMS)		
Standard Positioning Service (SPS)	42	100 (95%)	187 (95%)	156 (95%)

Power Modes

The IBM GPS Receiver has three power modes; off mode, operate mode, and battery backup mode.

In off mode the receiver is completely de-energized at all DC supplies, input signals, and control signals.

The receiver operates normally when energized by +3.3 ±.3 VDC. The RESET control signal must be at a CMOS logic “high” level.

The receiver enters battery backup mode when the PWR voltage is removed, provided that an external DC supply is connected to the V_RTC terminal. The external supply provides power for the real-time clock (RTC). If the receiver is powered up from this state, it uses the current time from the RTC and critical satellite data stored in FLASH to achieve rapid TTFF.

Caution:
During off and battery backup modes, IBM recommends that you de-energize (do not drive to a logic “high” level) the RESET pin and both serial ports.

Power-up Sequence

Power-up works the same way from either the off mode or the from the battery backup mode. The host system supplies power as specified in table 3 to the PWR pin of the GPS receiver connector. If the RESET pin is at logic “high” when DC power is applied, the receiver begins normal operation in 200 milliseconds.

Table 3: External Power Requirements

Power Parameter	Requirement by Mode	
	Operate Mode	Battery Backup Mode
PWR Voltage	3.3 Vdc ±5%	1.0 to 3.0 Vdc
PWRIN Power Consumption (Typical)	250 mA	4 µA
PWRIN Power Consumption (Maximum)	300 mA	10 µA
PWR Ripple P-P	100 mV	n/a

Technical Specifications

Signal Acquisition Performance: See table 1. Values are based on unobstructed satellite signals.

Accuracy: Accuracy is a function of the GPS system, including the geometry of the satellites at the time of measurement. Individual GPS receivers have very little influence over position accuracy. The navigational accuracies using the GPS Standard Positioning Service (SPS) are given in table 2. These figures are based on a geographic dilution of precision (GDOP) of 6.0.

Solution Update Rate: Once per second.

Reacquisition: <1 second typical with a ten second blockage.

RTCM SC-104 Differential GPS Compatibility: Direct DGPS data input over the auxiliary serial port.

Time Mark: Once per second (+/- 300 nS).

Serial Data Output Protocol: IBM binary or NMEA-0183.

Power Requirements

Regulated power required per the information in table 3. When the IBM GPS Receiver is operated with an active GPS antenna, the antenna's maximum pre-amp pass-through current on V_ANT is 100 mA at voltages up to +12 VDC. Pass-through current must be limited outside the receiver.

RF Signal Environment

RF Input: 1575.42 MHz (L1 band) at a level between -100 dBm and -133 dBm to an OSX high-retention female connector.

Physical

Dimensions: 66 mm x 40 mm x 4.5 mm with an MCX right-angle coaxial RF jack and a standard 2 x 5 pin-field input/output connector.

Weight: 18 grams

Environmental

Cooling (operating/storage): Free air convection.

Temperature: -40°C to +85°C.

Humidity: Relative humidity up to 95% non-condensing or a wet-bulb temperature of +35° C, whichever is less.

Altitude (operating/storage): -1000 ft to 60,000 ft.

Maximum Vehicle Dynamic: 515 meters per second (acquisition and navigation).

Vibration and Shock: per MIL-STD-167.

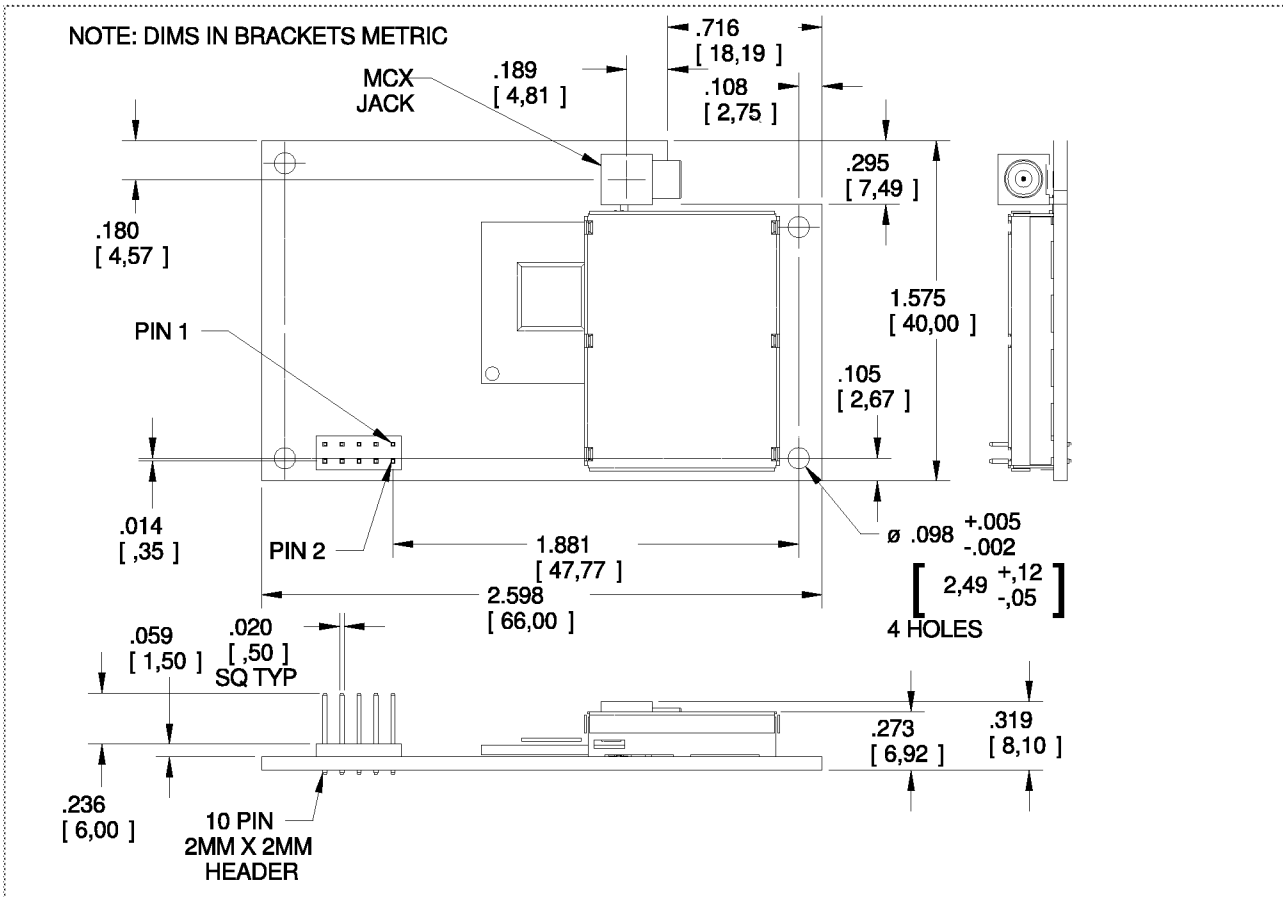
RF Connector: 50Ω standard right-angle MCX snap-on coaxial RF jack.

Input/Output: Refer to the following table.

Table 4: Input/Output Connections

Pin NUmber	Signal Name	Description
1	PWR	Main power input to the receiver. Input power requirements are defined in table 3.
2	GND	DC ground for the receiver.
3	TX1	Primary asynchronous full-duplex serial data port transmit (TX) line. IBM binary and NMEA message protocols are supported. Default settings are IBM binary message format, 9600 bps, no parity, 8 data bits, 1 stop bit.
4	RX1	Primary asynchronous full-duplex serial data port receive (RX) line. IBM binary and NMEA message protocols are supported. Default settings are IBM binary message format, 9600 bps, no parity, 8 data bits, 1 stop bit.
5	GPIO1	No connection — reserved for general purpose input/ouput.
6	RX2	Auxiliary asynchronous serial data port receive (RX) line. Configured to receive RTCM differential GPS (DGPS) correction data. RTCM SC-104 message types 1, 2, and 9 are supported.
7	RESET	Pull low (GND) to generate a system reset. Must be held low for a minimum of 100 nS.
8	V_ANT	Provides a power connection to the pre-amp of the active antenna.
9	V_RTC	Provides a back-up power connection for the receiver real time clock. 1.0 to 3.0 Vdc.
10	TMARK	UTC time-mark pulse, one pulse per second. An IBM binary message contains the UTC time associated with the time-mark pulse.

Mechanical Layout:



Message Definitions

Table 5: Control and Verification Messages

Message ID	Message Description
80	Serial port configuration
81	Navigation settings
82	Ouput message control
84	User time clock parameters
85	GPS time, date, and initial position
86	Satellite tracking control
88	Satellite data
91	Reset control
92	NMEA output message control
99	Observation control

Table 5: Control and Verification Messages

Message ID	Message Description
A1	Program download

Table 6: Status/Response Messages

Message ID	Message Description
0	GPS identification
2	GPS position - latitude, longitude, height
4	Satellite visibility data
A	Postition quality
FF	Message acknowledgement

Table 7: NMEA Output Messages

Sentence Type	Description	Default ON
GGA	GPS past position	•
GLL	geographic position - longitude/latitude	
ZDA	Time and date	
VTG	Course over ground and ground speed	
RMC	Recommended minimum specific GPS/TRANSIT data	•
GSA	DOP, active satellites	•
GSV	Satellites in view	•

Table 8: NMEA Input Messages

Sentence Type	Description
VXG000	Port configuration
VXG026	Receiver initialization
VXG200	Message log control

Revision Log

Date	Revision
10/99	release
10/29/99	Corrections to Table 7: NMEA Output Messages.

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