

“Jupiter” Global Positioning System (GPS) Receiver (Part No. TU30-D140-221/231)

Introduction

Rockwell's “Jupiter” GPS receiver is a single-board, 12 parallel-channel receiver engine intended as a component for an Original Equipment Manufacturer (OEM) product. The receiver (shown in Figures 1 and 2) continuously tracks all satellites in view, thus providing accurate satellite positioning data. It is designed for high performance and maximum flexibility in a wide range of OEM configurations including handhelds, panel mounts, sensors, and in-vehicle automotive products.

The highly integrated digital receiver uses the Zodiac chip set composed of two custom Rockwell devices: the “Gemini/Pisces” MonoPac™ and the “Scorpio” Digital Signal Processor (DSP). These two custom chips, together with suitable memory devices and a minimum of external components, form a complete low-power, high-performance GPS receiver solution for OEMs.

Product Overview

The “Jupiter” receiver decodes and processes signals from all visible GPS satellites. These satellites, in various orbits around the Earth, broadcast radio frequency (RF) ranging codes and navigation data messages. The receiver uses all available signals to produce a highly accurate and robust navigation solution that can be used in a wide variety of end product applications.

The “Jupiter” is packaged on a 28 square centimeter printed circuit board intended for harsh industrial applications. The receiver requires conditioned DC power and a GPS signal from a passive or active antenna.

The all-in-view tracking of the “Jupiter” receiver provides robust performance in applications that require high vehicle dynamics and in applications that operate in areas of high signal blockage such as dense urban centers. The receiver continuously tracks all visible GPS satellites and uses all the measurements to produce an overdetermined, smoothed navigation solution. This solution is relatively immune to the position jumps induced by blockage that can occur in receivers with fewer channels.

The 12-channel architecture provides rapid Time-To-First-Fix (TTFF) under all startup conditions. While the best TTFF performance is achieved when time of day and current position estimates are provided to the receiver, the flexible signal acquisition system takes advantage of all available information to provide a rapid TTFF. Acquisition is guaranteed under all initialization conditions as long as visible satellites are not obscured.

To minimize TTFF when prime power is removed from the receiver, an external OEM-supplied DC supply voltage is required to maintain power to the Static Random Access Memory (SRAM) and to the Real-Time Clock (RTC). In this case, the shortest possible TTFF is achieved by using the RTC time data and prior position data stored in the receiver's Electrical Erasable Programmable Read-Only Memory (EEPROM).

The receiver supports Two-Dimensional (2-D) operation when less than four satellites are available or when required by operating conditions. Altitude information required for 2-D operation is determined by the receiver or may be provided by the OEM application.

Communication with the receiver is established through two identical, independent, asynchronous serial I/O ports that support full duplex data communication. The receiver's primary serial port (the host port) outputs navigation data and accepts commands from the OEM application in National Marine Electronics Association (NMEA-0183) format or Rockwell binary message format.

The secondary port (the auxiliary port) is configured to accept Differential GPS (DGPS) corrections in the Radio Technical Commission For Maritime Services (RTCM SC-104) format (a summary of the supported RTCM message types is listed in Table 9). A complete description of the serial data interface is contained in the Rockwell document, *Zodiac GPS Receiver Family Designer's Guide*.

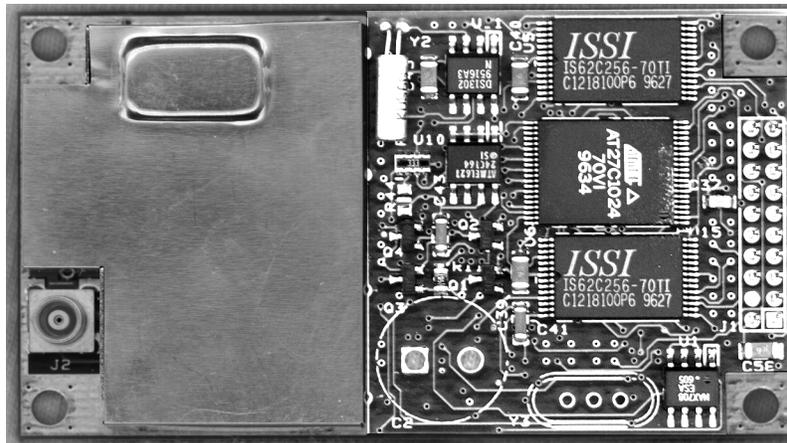


Figure 1. The Rockwell "Jupiter" GPS Receiver (Top View -- Shown Approximately Twice Actual Size)

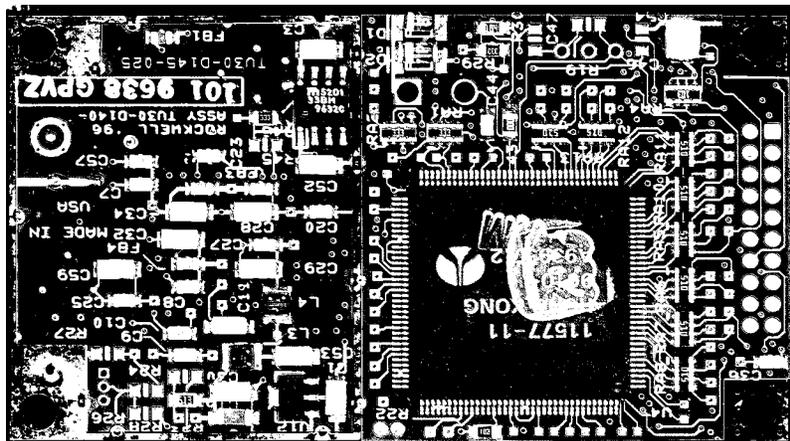


Figure 2. The Rockwell "Jupiter" GPS Receiver (Bottom View -- Shown Approximately Twice Actual Size)

Receiver Architecture. The functional architecture of the "Jupiter" receiver is shown in Figure 3. The receiver design is based on the Rockwell Zodiac chip set: the "Gemini/Pisces" MonoPac™ and the "Scorpio" DSP, which contain the required GPS functionality. The "Gemini/Pisces" MonoPac™ contains all the RF downconversion and amplification circuitry, and presents the In-Phase (I) and Quadrature-Phase (Q) Intermediate Frequency (IF) sampled data to the "Scorpio" device. The "Scorpio" device contains an integral microprocessor and all the required GPS-specific signal processing hardware. Memory and other external supporting components configure the receiver into a complete navigation system.

"Jupiter" Product Features

- OEM product development is fully supported through applications engineering.
- One of the smallest, most compact GPS receiver footprints measuring 2.800" x 1.600" x 0.442" (approximately 71 x 41 x 11 mm).
- Twelve parallel satellite tracking channels for fast acquisition and reacquisition.
- Support for true NMEA-0183 data protocol.
- Direct, differential RTCM SC-104 data capability to dramatically improve positioning accuracy (in both Rockwell binary and NMEA host modes).
- Enhanced algorithms provide superior navigation performance in "urban canyon" and foliage environments.
- Adaptive threshold-based signal detection for improved reception of weak signals.
- Static navigation enhancements to minimize wander due to Selective Availability (SA).
- Compatible with passive antennas for lowest total system cost or active antennas for installation flexibility.
- Maximum navigation accuracy achievable with the Standard Positioning Service (SPS).
- Enhanced TTFF upon power-up when in a "Keep-Alive" power condition before start-up.

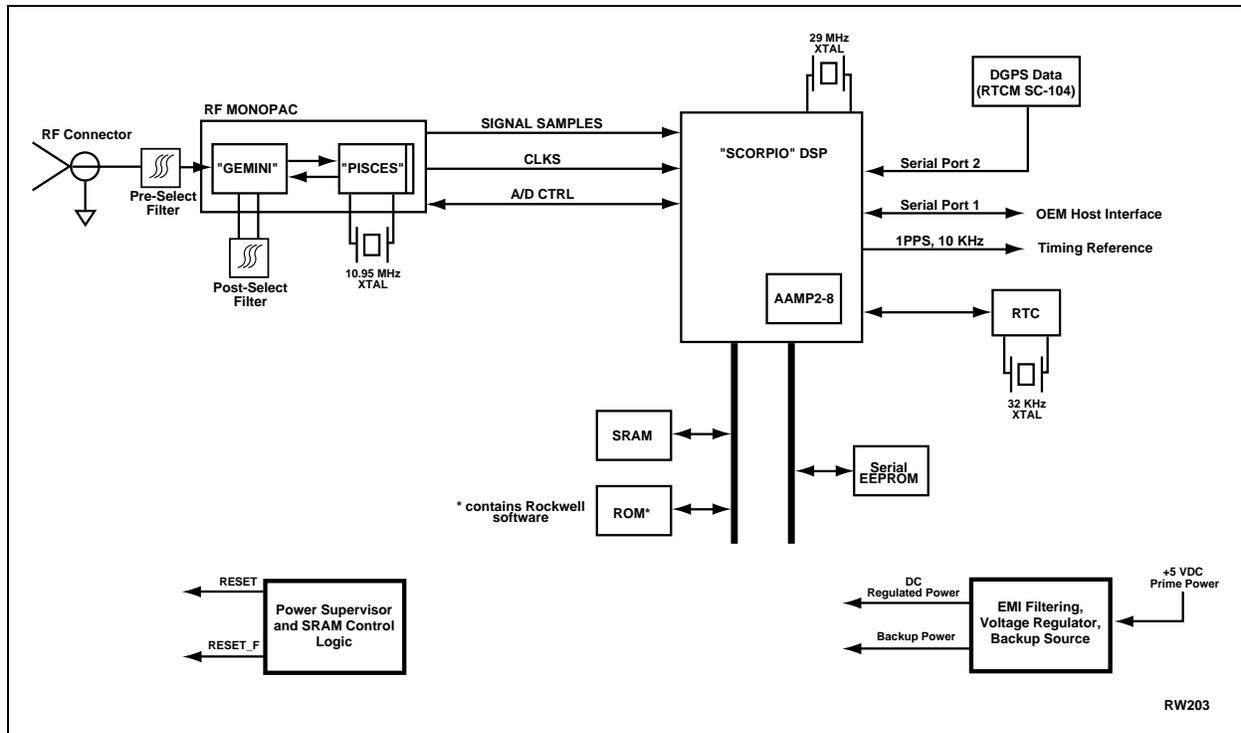


Figure 3. "Jupiter" Receiver Architecture

- Meets rigid shock and vibration requirements.
- Automatic Altitude Hold Mode from Three-Dimensional to Two-Dimensional navigation.
- Automatic cold start acquisition process (when no initialization data is entered by the user).
- Maximum operational flexibility and configurability via user commands over the host serial port.
- Ability to accept externally supplied initialization data over the host serial port.
- User selectable satellites.
- User selectable visible satellite mask angle.
- Standard straight OSX subminiature, snap-on, coaxial RF jack receptacle.
- Standard 2x10 pin-field I/O connector.
- Operation/storage over an extended temperature range (-40° C to +85° C).

Product Applications

The "Jupiter" GPS receiver is suitable for a wide range of OEM highly integrated GPS design applications such as:

- Handheld GPS receiver applications.
- Automotive applications.
- Marine navigation applications.
- Aviation applications.
- Timing applications.

Figure 4 illustrates an architecture that might be used to integrate the receiver with an applications processor that drives peripheral devices such as a display and keyboard. The interface between the applications processor and the receiver is through the serial data interface.

Ordering Information

To order the receiver, use Rockwell part number TU30-D140-221/231. For the complete part number, pricing, and delivery information, contact any one of the Rockwell Regional Sales Offices shown on the last page of this Data Sheet.

Technical Description

General Information. The "Jupiter" GPS receiver requires +5 volts primary DC input power. The receiver can operate from either an active or passive GPS antenna, supplied by the OEM, to receive L1 band frequency GPS carrier signals.

Since the receiver determines its position by ranging signals from four or more GPS satellites orbiting the Earth, its antenna must have reasonable visibility of the sky. This is generally not a problem when the receiver is used outdoors in the open. However, when used indoors or inside of an automobile, the antenna should be positioned in such a way as to have an unobstructed "view" of the sky. To establish an initial navigation fix, the receiver

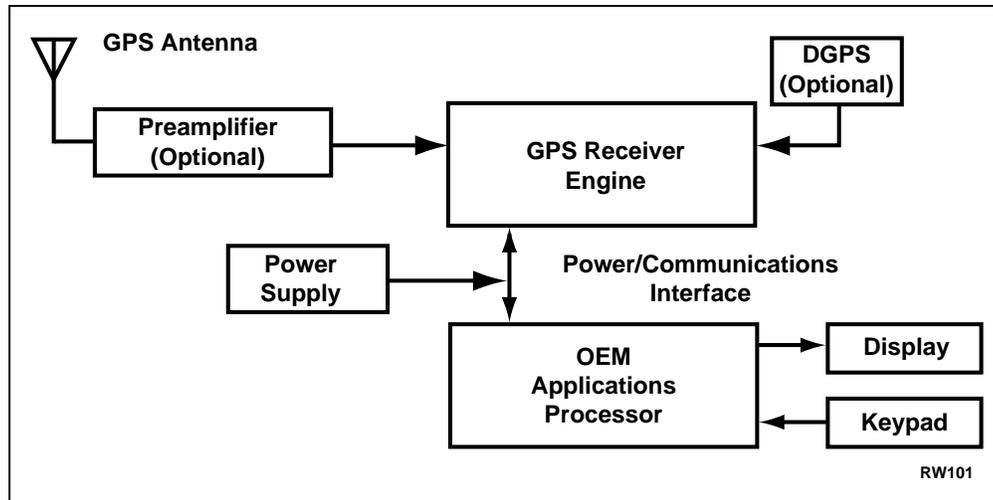


Figure 4. Typical "Jupiter"/OEM Architecture

requires a minimum of four satellites in track with good geometry (Geometric Dilution of Precision [GDOP]<10).

If satellite signals are blocked, the length of time for the receiver to receive those signals and determine its position will be longer. If fewer than four satellites are being tracked, or if the satellite geometry is degraded, signal blockage may result in a failure to navigate.

Satellite Acquisition. The "Jupiter" GPS receiver supports four types of satellite signal acquisition depending on the availability of critical data. Table 1 provides the corresponding TTFF times for each of the following acquisition states.

- **Warm Start.** A warm start results from a software reset after a period of continuous navigation or a return from a short idle period (i.e., a few minutes) that was preceded by a period of continuous navigation. In this state, all of the critical data (position, velocity, time, and satellite ephemeris) is

valid to the specified accuracy and available in SRAM.

- **Initialized Start.** An initialized start typically results from user-supplied position and time initialization data or continuous RTC operation with an accurate last known position available from EEPROM. In this state, position and time data are present and valid but ephemeris data validity has expired.
- **Cold Start.** A cold start acquisition state results when position and/or time data is unknown, either of which results in an unreliable satellite visibility list. Almanac information is used to identify previously healthy satellites.
- **Frozen Start.** A frozen start acquisition state occurs if there are no valid internal data sources available.

Table 1. "Jupiter" Receiver Signal Acquisition

Satellite Acquisition State	Time-To-First-Fix		Initial Error Uncertainties (3 Sigma)			Maximum Almanac Age	Maximum Ephemeris Age
	Typical (minutes)	90% Probable (minutes)	Position (km)	Velocity (m/sec)	Time (minutes)	Weeks	Hours
Warm	0.30	0.4	100	75	5	1	4
Initialized	0.8	1.0	100	75	5	1	N/A
Cold	2.0	2.5	N/A	N/A	N/A	1	N/A
Frozen	(*)	(*)	N/A	N/A	N/A	N/A	N/A

N/A = Not available in real-time to the receiver. Note that times are valid at 25 degrees Celsius with no satellite signal blockage.

(*) = Frozen start is considered to be a recovery mode. An "out-of-the-box" board that has not operated for a significant amount of time (months) may approximate this state because the data in EEPROM may be valid but expired or partially complete.

Table 2. GPS Receiver Navigational Accuracies

	Position (meters)				Velocity (meters/sec)
	Horizontal		3-D	Vertical	
	CEP	(2 dRMS)			3-D (2 sigma)
Full Accuracy C/A	25	50	93	78	0.1
Standard Positioning Service (SPS)	50	100 (95%)	200 (95%)	173 (95%)	(*)

(*) Velocity accuracies for SPS are not specified for the GPS system.

Navigation Modes. The “Jupiter” GPS receiver supports three types of Navigation Mode operations: Three-Dimensional (3-D), Two-Dimensional (2-D), and DGPS. Each of these modes is briefly described below:

- **Three-Dimensional Navigation (3-D).** The receiver defaults to 3-D navigation whenever at least four GPS satellites are being tracked. In 3-D navigation, the receiver computes latitude, longitude, altitude, and time information from satellite measurements. The accuracies that can be obtained in 3-D navigation are shown in Table 2.
- **Two-Dimensional Navigation (2-D).** When less than four GPS satellite signals are available or when a fixed value of altitude can be used to produce an acceptable navigation solution, the “Jupiter” receiver will enter the 2-D navigation mode from 3-D navigation using a fixed value of altitude determined either during prior 3-D navigation or as provided by the OEM. Forced operation in 2-D mode can be commanded by the OEM.

In 2-D navigation, the navigational accuracy is primarily determined by the relationship of the fixed value of altitude to the true altitude of the antenna. If the fixed value is correct, the horizontal accuracies shown in Table 2 apply. Otherwise, the horizontal accuracies will degrade as a function of the error in the fixed altitude.

- **DGPS Navigation.** The “Jupiter” receiver processes DGPS corrections through its Auxiliary serial port (port 2). These corrections must be compliant with the RTCM recommended standards for differential Navstar GPS service, also known as RTCM SC-104.

Depending on the DGPS configuration, navigational accuracies can be improved dramatically in 3-D DGPS mode and the “Jupiter” supports the accuracies described in the RTCM SC-104 document.

Table 3. “Jupiter” GPS Receiver External Power Requirements

INPUT VOLTAGE	REQUIREMENT BY MODE		
	OPERATE	“KEEP-ALIVE” (5 VDC)	“KEEP-ALIVE” (3 VDC)
PWRIN Voltage	+5 ± 0.25V	0V or GND	0V or GND
PWRIN (Typical)	195 mA (975 mW)	N/A	N/A
PWRIN (Maximum)	230 mA (1150 mW)	N/A	N/A
PWRIN Ripple P-P (mV)	100	N/A	N/A
VBATT Voltage	N/A	+5 ± 0.25V	+3 ± 0.50V
VBATT Current (*)	N/A	75 µA	40 µA
VBATT Maximum Power (*)	N/A	0.38 mW	0.12 mW

(*) Typical, measured at 25° C.

Power Modes And Power Sequencing Requirements.

The "Jupiter" receiver has three power modes: Off, Operate, and "Keep-Alive." Table 3 summarizes the signal conditions and current requirements for each of these modes. The Off mode assumes that neither prime power nor external "Keep-Alive" voltage is available.

The Off mode implies that the receiver is completely de-energized. The Operate mode implies that the receiver is completely energized. The "Keep-Alive" mode implies that prime power has been removed but that an external DC voltage source is provided for backup of the SRAM and RTC.

- **Off mode.** The receiver is completely de-energized including all DC supply input signals, serial data input signals, and control input signals.
- **Operate mode.** The receiver enters its Operate power mode when the receiver's components are fully energized at $+5 \pm 0.25$ VDC. The M_RST control signal must be asserted or at a CMOS "high" logic level.
- **"Keep-Alive" mode.** From Operate mode, the receiver will enter a "Keep-Alive" mode when PWRIN voltage is removed, provided that an external DC supply voltage is available at the VBATT signal input. In this state, the external voltage supply provides power for the SRAM and RTC. If the board is subsequently powered up from this state, the receiver uses the current time maintained by the RTC as well as critical satellite data stored in SRAM to achieve rapid TTFB.

CAUTION:

During the OFF or "Keep-Alive" modes, de-energizing (i.e., not driven to a CMOS "high" level) the following I/O functions is recommended:

- *Master Reset (pin J1-5).*
- *NMEA Protocol Select (pin J1-7).*
- *ROM Default Select (pin J1-8).*
- *Time Mark Pulse (pin J1-19).*
- *Host Port Serial Data Output and Input (pins J1-11 and 12).*
- *Auxiliary Port Serial Data Input (pin J1-15).*

Violation of the specified operating voltages will result in erratic receiver operation. The voltage threshold level at which the receiver's power supervisory circuit places the receiver's microprocessor in reset is $+4.5 (+0/-0.2)$ VDC, in which case PWRIN will continue to supply power to the receiver. No damage will occur if PWRIN dwells in this uncertainty region, but power dissipation will be affected. Also, critical SRAM data and RTC time keeping may

become corrupted, affecting TTFB when the receiver is returned to normal operating conditions.

Power-Up Sequencing. The power-up sequence for the "Jupiter" receiver is the same from either the OFF mode or the "Keep-Alive" mode. Primary DC power, as specified in Table 3, is applied to the PWRIN pin of the receiver's OEM interface connector by the host system. If the M_RST pin on the interface connector is asserted high when DC power is applied, the receiver will begin normal operation after 200 milliseconds.

Technical Specifications

Operational Characteristics

Signal Acquisition Performance. Refer to Table 1. The values shown are based on unobscured satellite signals.

Accuracy. Accuracy is a function of the entire Navstar system and geometry of the satellites at the time of measurement. In general, individual receivers have very little influence over the accuracy provided. Navigational accuracies using Full Accuracy C/A Code (SA Off) and the SPS (SA On) are shown in Table 2. These accuracies are based on a Position Dilution of Precision (PDOP) of 6.0 and the maximum vehicle dynamic of 500 m/sec.

Solution Update Rate. Once per second.

Reacquisition. 2 seconds typical with a 10 second blockage.

RTCM SC-104 Differential Compatibility. Direct data input over the Auxiliary serial port.

Time Mark. Once per second.

Serial Data Output Protocol. Rockwell binary serial I/O messages or NMEA-0183 serial I/O messages.

Power Requirements

Regulated power for the "Jupiter" GPS receiver is required according to the information provided in Table 3.

When the receiver is operated with an active GPS antenna, the antenna's maximum preamp "pass-through" current is 100 mA at voltages up to +12 volts. This current must be limited outside of the receiver.

Radio Frequency Signal Environment

RF Input. 1575.42 MHz (L1 band) at a level between -130 dBW and -163 dBW to an OSX high-retention female connector.

Burnout Protection. -10 dBW signal within a bandwidth of 10 MHz centered about the L1 carrier frequency.

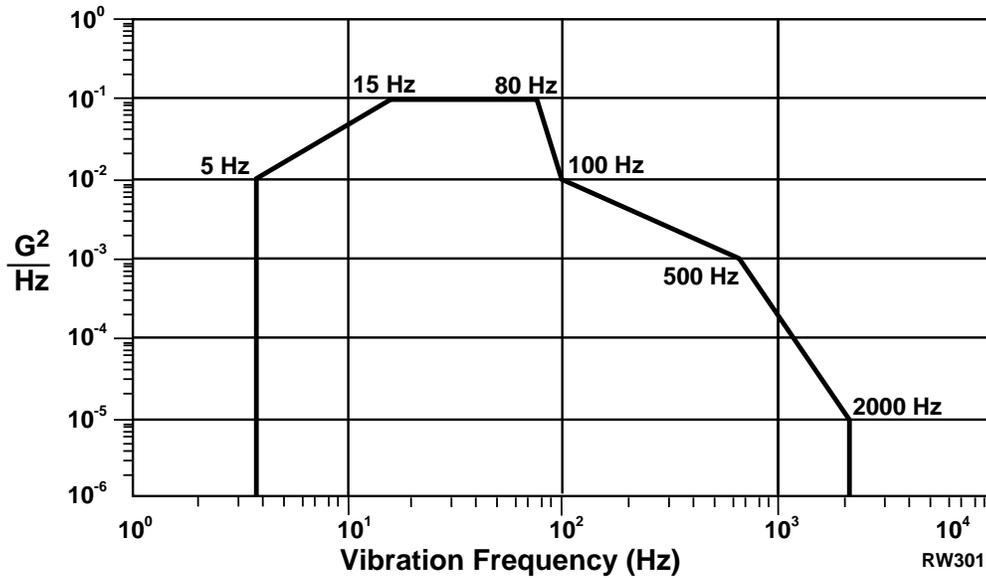


Figure 5. SAE Composite Curve (Random Noise)

Physical _____

Dimensions. 2.800" x 1.600" x 0.442" (71 mm x 41 mm x 11 mm) with an OSX straight (or optional right angle), coaxial RF jack receptacle and a standard 2x10 pin-field I/O connector.

Weight. 0.85 ounces (23.8 gm)

Environmental _____

Cooling (operating/storage). Convection

Temperature. -40°C to +85°C

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

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

Maximum Vehicle Dynamic. 500 m/sec (acquisition and navigation).

Vibration. Full Performance, see the composite SAE curve in Figure 5. Survival, 18G peak, 5 msec duration.

Shock. Shipping (in container): 10 drops from 75 cm onto a concrete floor.

RF Connector _____

The RF connector is a 50 Ohm standard straight OSX subminiature, snap-on coaxial RF jack receptacle. An optional right angle OSX connector is also available.

OEM Interface Connector _____

The OEM communications interface is a dual row, straight 2x10 pin field connector header. The pins are spaced on 2.0 mm (0.0787 in) centers and the pin lengths are 6.4 mm (0.250 in) on the board configuration containing a straight OSX RF connector. The pin lengths are 7.62 mm (0.300 in) on the board configuration containing the optional right angle OSX connector. Figure 6 diagrams the pin 1 reference location.

Mechanical Layout _____

The mechanical drawing for the "Jupiter" board is shown in Figures 7 and 8. Figure 7 illustrates the board with a straight OSX connector and Figure 8 illustrates the board with an optional right angle OSX connector.

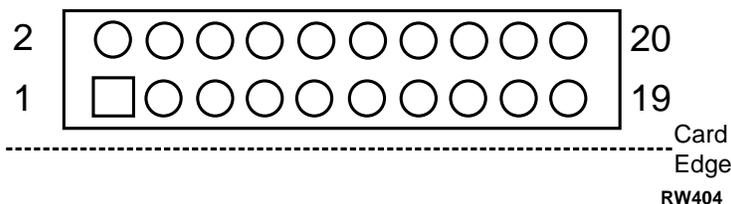


Figure 6. 2x10 Pin Field Connector (J1) Pin 1 Reference Location (Top View)

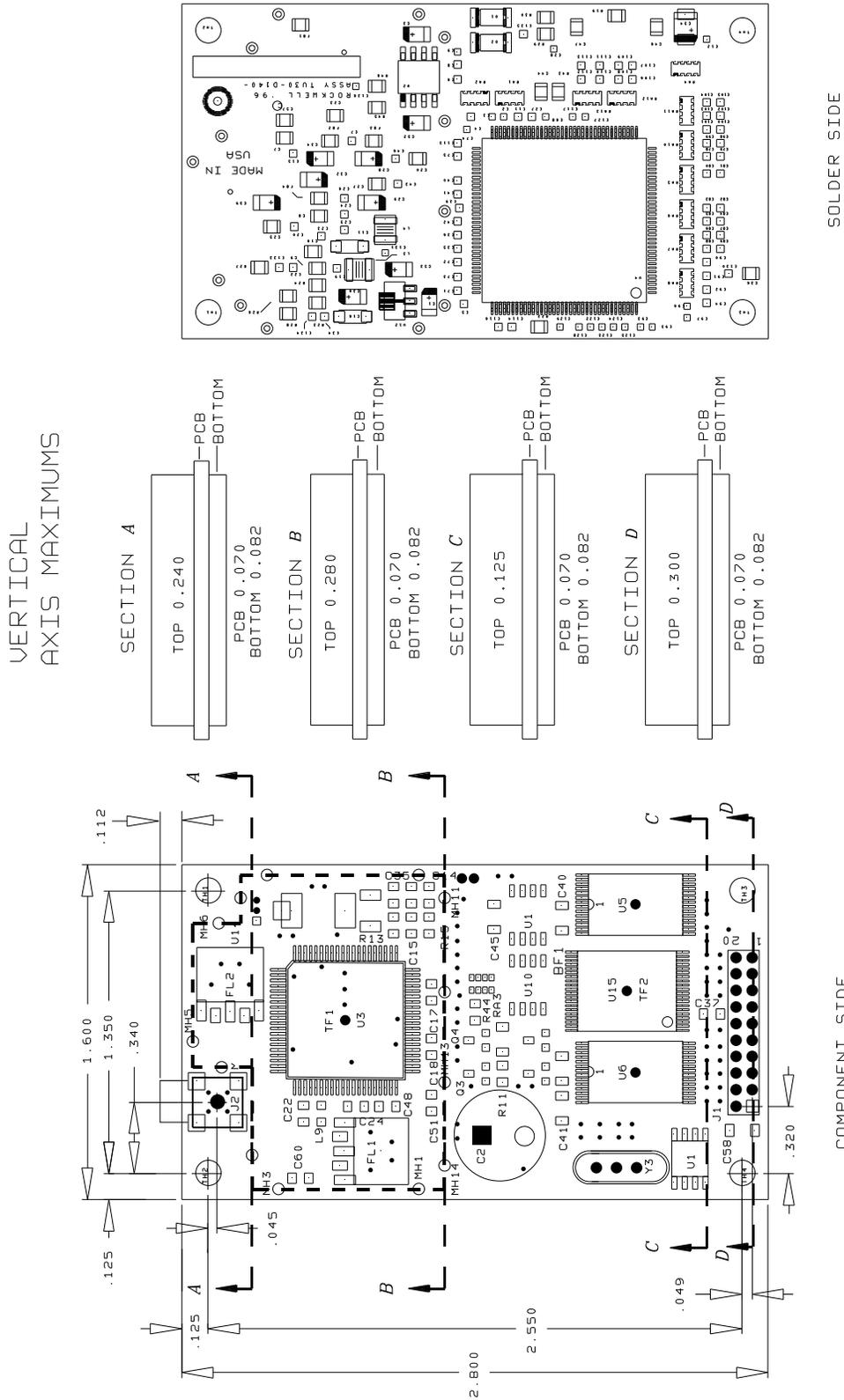


Figure 8. "Jupiter" Board Mechanical Drawing Right Angle OSX Connector Configuration

Table 4. “Jupiter” Receiver Standard 2x10 Pin Field OEM Interface Connector Pinout

PIN	NAME	DESCRIPTION	PIN	NAME	DESCRIPTION
1	PREAMP	Preamp power input	11	SDO1	Serial data output port #1
2	PWRIN_5	Primary +5 VDC power input	12	SDI1	Serial data input port #1
3	VBATT	Battery backup voltage input	13	GND	Ground
4	N/C	Reserved (no connect)	14	N/C	Reserved (no connect)
5	M_RST	Master reset input (active low)	15	SDI2	Serial data input port #2
6	N/C	Reserved (no connect)	16	GND	Ground
7	GPIO2	NMEA protocol select	17	GND	Ground
8	GPIO3	ROM default select	18	GND	Ground
9	GPIO4	Reserved (no connect)	19	TMARK	1PPS time mark output
10	GND	Ground	20	10KHZ	10 KHz clock output

Hardware Interface

The electrical interface for the “Jupiter” receiver is a standard 2x10 pin field connector header that is used for all data input and output. A pinout description for this connector is provided in Table 4.

The following paragraphs describe the basic functions allocated to the various pins on the 2x10 pin field interface connector. These functions are divided into three groups: Configuration and timing signals, serial communication signals, and DC input signals.

Configuration And Timing Signals

Pin J1-5: Master Reset (M_RST)

This signal allows the OEM to generate a system hardware reset to the receiver. This signal is capable of being driven directly by an external microprocessor or by external logic without the need for any external pull-up or pull-down resistors. The OEM can generate a system reset to the receiver by pulling the M_RST control signal low to ground.

NOTE: The M_RST signal must be pulled to a CMOS logic “high” level coincident with, or after, the application of prime DC power for the receiver to enter its Operate mode. The M_RST must be held at ground level for a minimum of 150 nanoseconds to assure proper generation of a hardware reset to the receiver.

This signal can also be used to provide control of the “Jupiter” receiver’s Operate mode without removing prime input power from the receiver. When M_RST is pulled to ground, the receiver will enter a low power state for as long as the M_RST signal is asserted low. In this state, a portion of the receiver’s RF circuitry is de-energized, the SRAMs are transitioned into their low power data retention state, and the RTC device is maintained. When the

receiver is placed into this low power state through the use of the M_RST control signal, the receiver will continue to draw current from the primary input power (PWRIN) but at a reduced level.

When the M_RST signal is subsequently asserted high by the OEM, RF power is re-applied, a system reset is generated, and the receiver will return to its normal Operate mode.

Pin J1-4: Reserved

This signal is reserved and **NO** electrical connections should be made to the OEM application.

Pin J1-6: Reserved

This signal is reserved and **NO** electrical connections should be made to the OEM application.

Pin J1-7: NMEA Protocol Select (GPIO2)

The “Jupiter” receiver has two hardware selectable message protocols that may be used to communicate over the host serial I/O port. These message protocols are a Rockwell binary message format and a NMEA ASCII message format. When this signal is pulled “low,” the receiver communicates over the host serial port using the NMEA message format (4800 bps, no parity, 8 data bits, and 1 stop bit).

When this signal is pulled “high,” the receiver communicates over the host serial I/O port using the format determined by the setting of the Read-Only Memory (ROM) Default Select pin (J1-8).

Binary and NMEA messages are both described in the Rockwell document, *Zodiac GPS Receiver Family Designer’s Guide*.

The relationship between the user-selectable functions (GPIO2 and GPIO3) is shown in Table 5.

Table 5. “Jupiter” Receiver Serial Port Configuration Truth Table

NMEA Protocol Select (pin 7)	ROM Default Select (pin 8)	Result
0	0	NMEA message format; host port communication settings = 4800 bps, no parity, 8 data bits, 1 stop bit. The receiver operates from default initialization values stored in ROM and will output the default NMEA message set from ROM.
0	1	NMEA message format; host port communication settings = 4800 bps, no parity, 8 data bits, 1 stop bit. The receiver selects the default NMEA output message set and uses initialization values from the data stored in SRAM or EEPROM (*).
1	0	Binary message format; host port communication settings = 9600 bps, no parity, 8 data bits, 1 stop bit. The receiver operates from default initialization values stored in ROM.
1	1	Data stored in SRAM or EEPROM determines message format, host port communication settings, and default message set (*).

(*) For further information, refer to the description of the ROM Default Select pin (J1-8) below.

Pin J1-8: ROM Default Select (GPIO3)

This signal determines whether the message format, host port communication settings, receiver default message set, and initialization data parameters are obtained from default values stored in ROM or from user-configurable settings stored in SRAM/EEPROM. If this signal is pulled “low,” the ROM-based factory default values are used.

Note: when the ROM defaults select (GPIO3) signal is pulled “low,” each power cycle or reset of the receiver will result in a longer TTFF. This is because the receiver will use default initialization parameters stored in ROM rather than the current initialization parameters that may be available in SRAM or EEPROM.

The default values for NMEA protocol are 4800 bps RX/TX, no parity, 8 data bits, and 1 stop bit. The default values for binary protocol are 9600 bps RX/TX, no parity, 8 data bits, and 1 stop bit.

If this signal is pulled “high,” the port configuration parameters are accessed in the following priority:

1. If SRAM checksums are valid, the communication parameters and initialization data parameters will be read from SRAM.
2. If SRAM checksums are invalid and EEPROM checksums are valid, the communication parameters and initialization data parameters will be read from EEPROM.
3. If SRAM checksums are invalid and EEPROM checksums are invalid, the default values in ROM will be used.

The relationship between the user-selectable functions (GPIO2 and GPIO3) is shown in Table 5.

Pin J1-9: Reserved (GPIO4)

This signal is reserved and **NO** electrical connections should be made to the OEM application.

Pin J1-14: Reserved

This signal is reserved and **NO** electrical connections should be made to the OEM application.

Pin J1-19: UTC Time Mark Pulse (TMARK)

The Time Mark output provides a one pulse-per-second (1 pps) signal to the OEM application processor. When the receiver provides a valid navigation solution, the rising edge of each TMARK pulse is synchronized with the UTC one second epochs to within ±1 microsecond.

The receiver software produces a binary format data message containing the UTC time associated with each time mark pulse. The relationship between the UTC Time Mark Pulse Output message and the TMARK pulse is shown in Figure 9. When the receiver’s serial data communication port is set to 9600 bps, the UTC Time Mark Pulse Output message precedes the TMARK pulse by 400 to 500 milliseconds (typically).

The TMARK pulse waveform is shown in Figure 10. This signal is a positive logic, buffered CMOS level output pulse that transitions from a logic “low” condition to a logic “high” at a 1 Hz rate. The TMARK output pulse rise time is typically less than 2 nanoseconds and the pulse duration is typically 25.6 milliseconds.

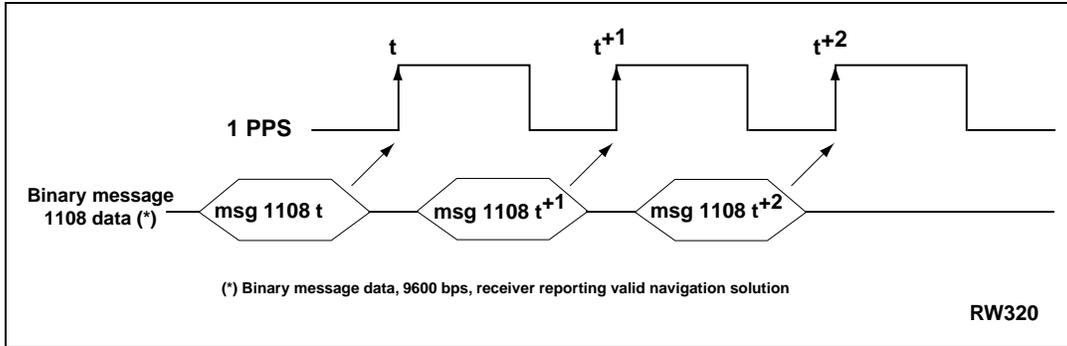


Figure 9. UTC Time Mark Pulse Output Message/UTC TMARK Pulse Relationship

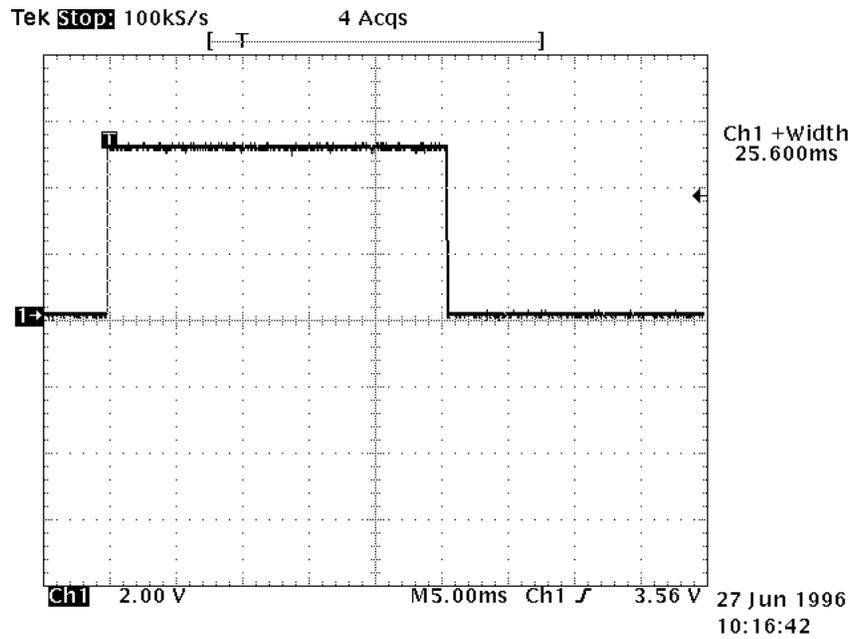


Figure 10. Jupiter GPS Receiver Time Mark Pulse Waveform

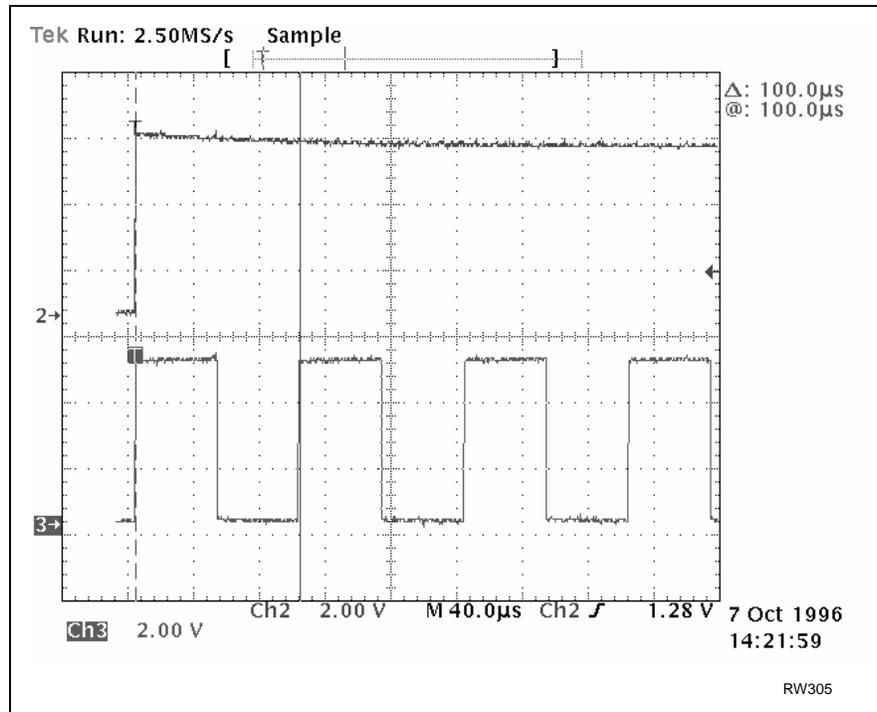


Figure 11. 10 KHz Clock/UTC TMARK Pulse Relationship

Pin J1-20: 10 KHz UTC Synchronized Clock

This is a 10 KHz clock waveform that is synchronized to the UTC TMARK pulse. The relationship between the 10 KHz clock and the TMARK UTC pulse is shown in Figure 11. This clock signal is a positive logic, buffered CMOS level output.

Serial Communication Signals

Note: both the Configuration and Timing signals, described in the previous section, and the Serial Communication signals described below must be applied according to the limits shown in Table 6.

Pins J1-11 and 12: Host Port Serial Data Output And Input (SDO1 and SDI1)

The host port consists of a full-duplex asynchronous serial data interface. Both binary and NMEA initialization and configuration data messages are transmitted and received across this port.

The OEM application must provide any Line Driver/Line Receiver (LD/LR) circuitry to extend the range of the interface. Port Idle is nominally a CMOS logical high (+5 VDC).

Pin J1-15: Auxiliary Port Serial Data Input (SDI2)

The auxiliary port consists of a second half-duplex asynchronous serial data interface. This port is configured to receive RTCM DGPS correction data messages.

The OEM application must provide any LD/LR circuitry to extend the range of the interface. Port Idle is nominally a CMOS logical high (+5 VDC).

DC Input Signals

Pin J1-1: Preamp Power Input (PREAMP)

The OEM may optionally supply power to a preamplifier using the antenna cable center conductor. The maximum voltage is +12 VDC and the current must not exceed 100 mA.

WARNING: DO NOT APPLY POWER TO A PASSIVE ANTENNA OR DAMAGE TO THE RECEIVER WILL OCCUR.

Pin J1-2: Power Input (PWRIN_5)

This signal is the main power input to the "Jupiter" receiver. Regulated DC power requirements are shown in Table 3.

Pin J1-3: Battery Backup Power Input (VBATT)

This signal is used to provide a DC power input to the SRAM and RTC devices only. The receiver automatically switches to the VBATT input signal when primary DC power (PWRIN) is removed from the board.

This feature is intended to provide the receiver with a "warm start" capability by maintaining an accurate time source and using position and satellite data stored in

Table 6. Jupiter GPS Receiver Digital Signal Requirements

SYMBOL	PARAMETER	LIMITS (*)	UNITS
PWRIN_5	Main Power Input to the "Jupiter" (+5 VDC)	4.75 to 5.25	volts
VIH (min)	Minimum High-Level Input Voltage	0.7 x PWRIN	volts
VIH (max)	Maximum High-Level Input Voltage	PWRIN	volts
VIL (min)	Minimum Low-Level Input Voltage	-0.3	volts
VIL (max)	Maximum Low-Level Input Voltage	0.3 x PWRIN	volts
VOH (min)	Minimum High-Level Output Voltage	0.8 x PWRIN	volts
VOH (max)	Maximum High-Level Output Voltage	PWRIN	volts
VOL (min)	Minimum Low-Level Output Voltage	0	volts
VOL (max)	Maximum Low-Level Output Voltage	0.2 x PWRIN	volts
tr, tf	Input Rise and Fall Time	50	nanoseconds
C out	Maximum Output Load Capacitance	25	picofarads
(*) PWRIN refers to a +5 VDC power input (PWRIN_5).			

SRAM after prime input power (PWRIN) has been removed from the receiver.

Pin J1-4: Reserved

This signal is reserved and no electrical connections should be made to the OEM application.

Pins J1-10, 13, 16, 17, and 18: Ground (GND)

DC grounds for the board. All grounds are tied together through the receiver's printed wiring board (PWB) ground plane and should all be grounded externally to the receiver.

Software Interface

The host serial I/O port of the "Jupiter's" serial data interface supports full duplex communication between the receiver and the OEM application. Data messages can be in the Rockwell binary format or NMEA-0183 format. The receiver also contains an auxiliary port dedicated to direct processing of the RTCM SC-104 messages for DGPS corrections.

Binary Data Messages. All of the output and input binary messages for the "Jupiter" receiver are listed in Table 7, along with their corresponding message IDs. A complete description of each binary message is contained in the Rockwell document, *Zodiac GPS Receiver Family Designer's Guide*.

NMEA Data Messages. All of the output and input NMEA messages for the "Jupiter" receiver are listed in Table 8 along with their corresponding message IDs. A complete description of each NMEA message is contained in the Rockwell document, *Zodiac GPS Receiver Family Designer's Guide*.

RTCM SC-104 Data Messages. Table 9 lists those messages defined in the RTCM SC-104 standard that are used by the "Jupiter" receiver to form a DGPS position solution (not all DGPS messages are necessary for DGPS operation).

Table 7. "Jupiter" Receiver Binary Data Messages

Output Message Name	Message ID
Geodetic Position Status Output (*)	1000
Channel Summary (*)	1002
Visible Satellites (*)	1003
Differential GPS Status	1005
ECEF Position Output	1009
Receiver ID (**)	1011
User-Settings Output	1012
Built-In Test Results	1100
UTC Time Mark Pulse Output (*)	1108
Serial Port Communication Parameters In Use	1130
EEPROM Update	1135
EEPROM Status	1136

Input Message Name	Message ID
Geodetic Position and Velocity Initialization	1200
User-Defined Datum Definition	1210
Map Datum Select	1211
Satellite Elevation Mask Control	1212
Satellite Candidate Select	1213
Differential GPS Control	1214
Cold Start Control	1216
Solution Validity Criteria	1217
User-Entered Altitude Input	1219
Application Platform Control	1220
Nav Configuration	1221
Perform Built-In Test Command	1300
Restart Command	1303
Serial Port Communication Parameters	1330
Message Protocol Control	1331
Raw DGPS RTCM SC-104 Data	1351

(*) Enabled by default at power-up
(**) Once at power-up/reset

Table 8. "Jupiter" Receiver NMEA Data Messages

Output Message Name	Message ID
Rockwell Proprietary Built-In Test (BIT) Results	BIT
GPS Fix Data (*)	GGA
GPS DOP and Active Satellites (*)	GSA
GPS Satellites in View (*)	GSV
Track Made Good and Ground Speed	VTG
Recommended Minimum Specific GPS Data (*)	RMC
Rockwell Proprietary Receiver ID (**)	RID
Rockwell Proprietary Zodiac Channel Status (*)	ZCH

Input Message Name	Message ID
Rockwell Proprietary Built-In Test (BIT) Command	IBIT
Rockwell Proprietary Log Control Message	ILOG
Rockwell Proprietary Receiver Initialization	INIT
Rockwell Proprietary Protocol Message	IPRO
Standard Query Message	Q

(*) Default power-up message
 (**) Once at power-up/reset

Table 9. "Jupiter" Receiver RTCM SC-104 Data Messages

Message ID	Status (*)	Title	Used For DGPS Corrections?
1	F	Differential GPS Corrections	Y
2	F	Delta DGPS Corrections	Y
3	F	Reference Station Parameters	N
4	R	Surveying (message retired)	N
5	F	Constellation Health	N
6	F	Null Frame	N
7	F	Beacon Almanacs	N
8	T	Pseudolite Almanacs	N
9	F	Partial Satellite Set Differential Corrections	Y
10	R	P-Code Differential Corrections	N
11	R	CA Code L1/L2 Delta Corrections	N
12	R	Pseudolite Station Parameters	N
13	T	Ground Transmitter Parameters	N
14	R	Surveying Auxiliary Message	N
15	R	Ionosphere (Troposphere) Message	N
16	F	Special Message	N
17	T	Ephemeris Almanac	N
18	T	Uncorrected Carrier Phase Measurements	N
19	T	Uncorrected Pseudorange Measurements	N
20	T	RTK Carrier Phase Corrections	N
21	T	RTK Pseudo-Range Corrections	N
22-58		Undefined	N
59	T	Proprietary Message	N
60-63	R	Multi-Purpose Usage	N

(*) "F" = Fixed, "T" = Tentative, and "R" = Reserved. Status types are defined in Table 4.3 of the RTCM SC-104 version 2.1 standard.

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