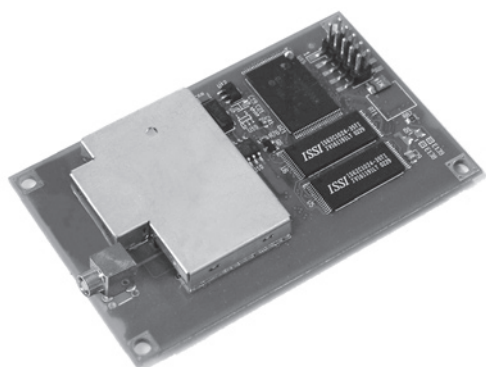


Jupiter-T GPS timing receiver module Data sheet (TU60-D120 series)



Related products

- Development kit TU10-D007-121

Related documents

- Product brief LA010039
- Development kit: Quick start guide LA010088
- Development kit: Guide LA010089
- Designer's guide MN002000
- Labmon application note LA010103
- Timing Application Software application note LA010105

Contents

Features	4
1.0 Introduction	5
1.1 Receiver architecture.....	6
1.2 Product applications	7
2.0 Technical description	7
2.1 General information.....	7
2.2 Satellite acquisition.....	7
2.2.1 Hot start	7
2.2.2 Warm start	7
2.2.3 Cold start.....	7
3.0 Software description	8
3.1 Operating modes.....	8
3.1.1 Position-hold mode.....	8
3.1.2 Self-survey mode	8
3.1.3 TRAIM functionality.....	8
4.0 Technical specification	9
4.1 Operational characteristics	9
4.1.1 Signal acquisition performance	9
4.1.2 Accuracy.....	9
4.1.3 Solution update rate	9
4.1.4 Re-acquisition	9
4.1.5 Serial data output protocol	9
4.2 Power requirements	9
4.3 Radio frequency signal environment	9
4.4 Physical characteristics.....	9
4.5 Environmental	9
4.5.1 Operating temperature	9
4.5.2 Vibration.....	9
4.5.3 Shock.....	9
4.6 OEM interface connector	9
4.7 Mechanical layout	9
5.0 ESD sensitivity	9
6.0 Hardware interface	11
6.1 DC input/output signals	11
6.1.1 Pin J1-6: 1PPS output	11
6.1.2 Pin J1-4: 10 KHz output	11
6.2 Serial communication signals.....	11
7.0 Jupiter-T mechanical layout	14
8.0 Glossary and acronyms	15

Figures

Figure 1-1 Jupiter-T receiver (top view).....	5
Figure 1-2 Jupiter-T receiver (bottom view).....	5
Figure 1-3 Typical 1PPS output performance.....	6
Figure 1-4 Jupiter T receiver architecture.....	6
Figure 4-1 SAE composite curve (random noise).....	10
Figure 4-2 10-pin interface connector (J1).....	10
Figure 7-1 Jupiter-T mechanical layout.....	14

Tables

Table 1-1 Jupiter-T module descriptions.....	5
Table 2-1 Jupiter-T receiver signal acquisition.....	7
Table 2-2 Jupiter-T navigational accuracies.....	7
Table 4-1 Jupiter-T operational power requirements (measured at 25°C).....	9
Table 4-2 GPS antenna current detector circuit.....	9
Table 6-1 Jupiter-T receiver J1 interface pin descriptions.....	11
Table 6-2 Jupiter-T digital signal requirements.....	11
Table 6-3 Jupiter-T default command set.....	12
Table 6-4 Zodiac binary data messages (1 of 2).....	12
Table 6-5 Zodiac binary data messages (2 of 2).....	13
Table 6-6 Zodiac NMEA data messages (1 of 2).....	13
Table 6-7 Zodiac NMEA data messages (2 of 2).....	13

Features

- 12 parallel satellite tracking channels for fast acquisition and re-acquisition
- Timing Receiver Autonomous Integrity Monitoring (TRAIM) functions
- TRAIM user selectable alarm parameters
- both 1PPS and 10 kHz timing outputs
- EEPROM for storage of critical parameters
- +5.0 V operation includes active GPS antenna voltage supply and antenna current-monitoring capability
- enhanced algorithms provide superior timing application performance
- adaptive threshold-based signal detection for improved reception of weak signals
- asynchronous serial interface with multiple baud rates available
- position-hold mode to permit going from Three-Dimensional (3D) to Two-Dimensional (2D), even to a single satellite for best timing accuracy
- automatic cold start acquisition process (when no initialisation data is entered by the user)
- maximum operational flexibility and configurability with user commands over the host serial port
- ability to accept externally supplied initialisation data over the host serial port
- user-selectable satellites for common view applications
- user-selectable visible satellite mask angle or highest in the sky for best timing performance
- mechanical form factor compatible with other popular timing receivers
- OEM product development is fully supported through applications engineering
- antenna voltage output with short circuit protection

1.0 Introduction

The Navman Jupiter-T is a single-board, 12 -channel GPS (Global Positioning System) receiver designed especially for precision timing applications. The Jupiter-T is intended as a component for an OEM (Original Equipment Manufacturer) product. The receiver (shown in Figures 1-1 and 1-2) continuously tracks all satellites in view, providing accurate satellite positioning and timing data. It is designed for high performance and maximum flexibility in a wide range of OEM configurations including time measurement equipment, cellular telephone base stations and E911 emergency applications.

The highly integrated digital receiver uses the Zodiac chipset composed of two custom SiRF devices: the Gemini/Pisces MonoPac™ and the Scorpio baseband processor. These two custom chips, together with memory devices and a minimum of external components, form a complete low-power, high-performance GPS receiver solution for OEMs.

The Jupiter-T receiver decodes and processes signals from all visible GPS satellites. These satellites, in various orbits around the Earth, broadcast RF (Radio Frequency) ranging codes, timing information and navigation data messages. The receiver uses all available signals to produce a highly accurate and robust navigation solution that provides superior timing performance for a wide variety of end product applications.

The Jupiter-T is packaged on a miniature printed circuit board. The typical operating power requirement is +5.0 V at 195 mA. The all-in-view tracking of the Jupiter-T receiver provides robust performance in applications that require a fixed position or that operate in areas of high signal blockage, such as dense urban centres. The receiver continuously tracks all visible GPS satellites and uses all the measurements to produce an over-determined, smoothed navigation solution.

This solution is relatively immune to the position jumps induced by blockage that can occur in receivers with fewer channels.

Figure 1-3 (next page) shows the typical 1PPS performance of the Jupiter-T GPS receiver. The 10 kHz output is also available from the receiver and is phase coherent with the 1PPS signal. This output is made available for functions such as phase locking of crystal oscillators, frequency synthesisers, and similar applications.

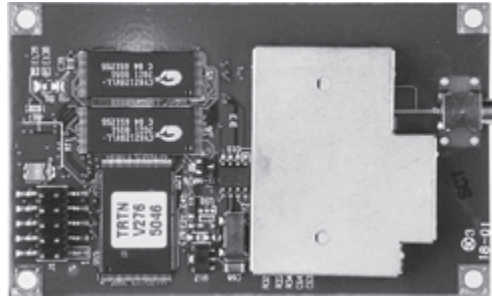


Figure 1-1 Jupiter-T receiver (top view)

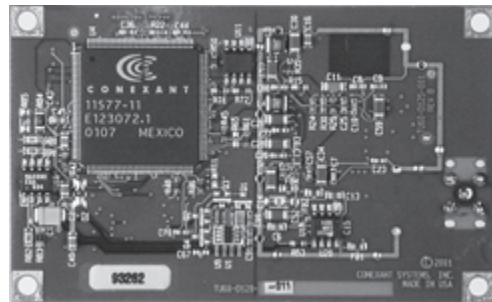


Figure 1-2 Jupiter-T receiver (bottom view)

The 12-channel architecture provides rapid TTFF (Time To First Fix) under all start-up 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 initialisation conditions as long as visible satellites are not obscured.

Part No.	Model	Antenna
TU60-D120-001	Jupiter-T, 5.0V, Motorola compatible command set default with Navman Binary, fully enclosed RF shield	right angle OSX
TU60-D120-031	Jupiter-T, 5.0V, Motorola compatible command set default with Navman Binary	right angle OSX
TU60-D120-041	Jupiter-T, 5.0V, Motorola compatible command set default with Navman Binary	straight OSX
TU60-D120-011	Jupiter-T, 5.0V, Navman Binary default code	right angle OSX
TU60-D120-021	Jupiter-T, 5.0V, Navman Binary default code	straight OSX

Table 1-1 Jupiter-T module descriptions

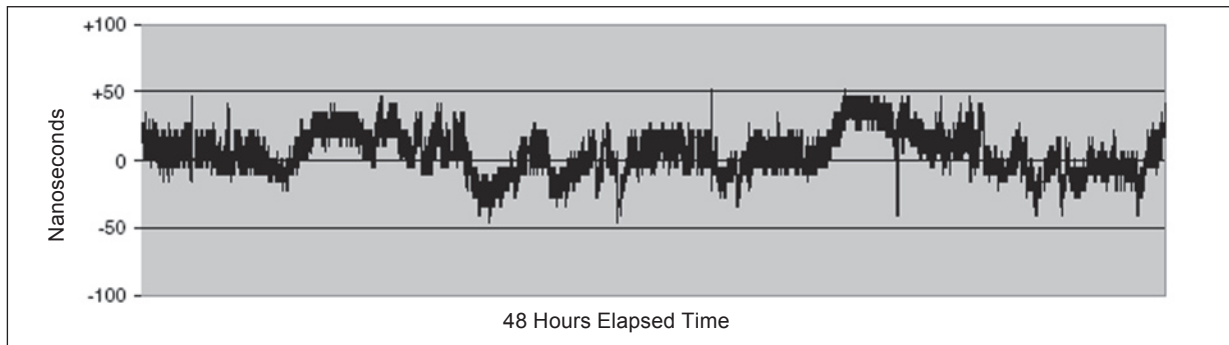


Figure 1-3 Typical 1PPS output performance

The receiver supports single satellite or 2D operation (when less than four satellites are available) when required by operating conditions. Altitude information required for 2D operation is determined by the receiver or may be provided by the OEM application. For timing, only a single satellite is required and the user may enter position and altitude data where obstructions limit satellite view.

Communication with the receiver is established through an asynchronous serial I/O port that supports full duplex data communication. The receiver's serial port outputs timing and navigation data and accepts commands from the OEM application in a variety of message formats. See Tables 6-3, 6-4 and 6-5 for more details.

1.1 Receiver architecture

The functional architecture of the Jupiter-T receiver is shown in Figure 1-4. The receiver design is based on the SiRF Zodiac chipset, the Gemini/Pisces MonoPac and the Scorpio baseband processor, which contains the required GPS functionality. The Gemini/Pisces MonoPac contains all the RF down conversion and amplification circuitry, and presents the In-Phase (I) and Quadrature-Phase (Q) Intermediate Frequency (IF) sampled data to the Scorpio device. The Scorpio 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 timing system.

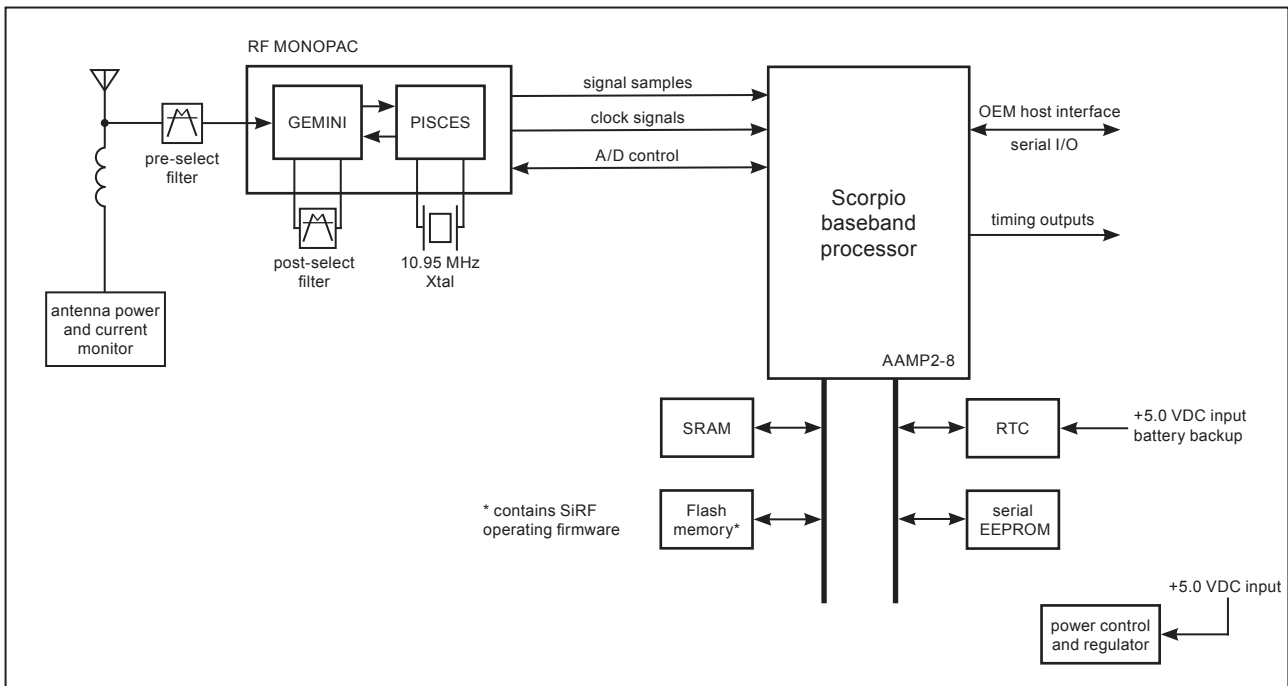


Figure 1-4 Jupiter T receiver architecture

1.2 Product applications

The Jupiter-T receiver is suitable for a wide range of modular OEM GPS design applications such as:

- wireless telecommunication network synchronisation
- E911 caller location systems
- frequency standards
- cable and broadcast television
- wide area networks

2.0 Technical description

2.1 General information

Since the receiver determines its position by receiving signals from three or more GPS satellites orbiting the Earth, its antenna must have reasonable visibility of the sky. This is generally not a problem. However, since GPS timing receivers are generally kept at a fixed location, care should be taken to install the antenna without obstruction (full view of the sky) and away from interference causing apparatus.

If satellite signals are blocked, it takes a longer time for the receiver to use those signals to determine its position. If fewer than three satellites are being tracked, or if the satellite geometry is degraded, signal blockage may result in a failure to provide adequate timing accuracy.

2.2 Satellite acquisition

The Jupiter-T supports three types of satellite signal acquisition depending on the availability of critical data: hot, warm, and cold starts. Table 2-1 shows the corresponding TTFF times for each of these acquisition states.

2.2.1 Hot start

A hot start occurs when the receiver has been reset while navigating. Most recent position and time are valid in memory. Ephemerides of visible satellites are in SRAM, and are less than four hours old.

2.2.2 Warm start

A warm start typically results from user-supplied position and time initialisation, or from a stored previous position and backed up RTC (Real Time Clock). Table 2-2 shows the required accuracy of initialisation data.

2.2.3 Cold start

A cold start acquisition state results when position and time data is unknown, either of which results in an unreliable satellite visibility list. Almanac information is used to identify previously healthy satellites.

Satellite acquisition state	Time to first fix (s)		Initial error uncertainties ¹		
	Typical	90% Probable	Position (km)	Velocity (m/s)	Time (min)
Hot start	18	24	100	75	5
Warm start	48	60	100	75	5
Cold start	120	150	N/A ²		

Times are for a receiver operating at 25 °C with no satellite signal blockage.
¹ required accuracy of data used for warm start
² initial error uncertainties do not apply to cold start

Table 2-1 Jupiter-T receiver signal acquisition

	Position (m)				Velocity (m/s)
	Horizontal		3D	Vertical	
	CEP	2 dRMS			3D (2 sigma)
full accuracy C/A	2.8	4.9	5	78	0.1
Standard Positioning Service (SPS)	50	100 (95%)	200 (95%)	173 (95%)	Note ¹

¹ velocity accuracies for SPS are not specified for the GPS system

Table 2-2 Jupiter-T navigational accuracies

3.0 Software description

The Timing Application software is developed from standard Zodiac software and contains all of the standard features with the following added features:

- a self-survey mode to determine precise position
- a position-hold mode in which the navigation solution is used only to update the timing rather than to change the position of the receiver
- ability to monitor and report on the receiver's own timing integrity using TRAIM
- an adjustable 1PPS time mark signal
- new timing-application serial messages

3.1 Operating modes

Besides normal Zodiac operations, two new modes have been added to the Timing Application software: position-hold mode and self-survey mode.

3.1.1 Position-hold mode

In position-hold mode, the receiver creates satellite observations but the navigation solution computed from those observations only adjusts the receiver timing rather than creates a new position fix. Entry into this mode is from either an operator command, automatically after successful completion of a self-survey, or at start-up when the operator sets the appropriate configuration (see message 1255).

In the case of an operator command entry into position-hold mode, the current system position can be used as the reference position or the operator can specify another reference position. If the receiver is configured to enter position-hold mode at start-up, and there is no valid position stored in the system either from a self-survey, operator entry, or prior navigation, the receiver does not enter position-hold mode. The receiver instead enters self-survey mode and begins a 24-hour survey.

Once the system transitions to, or is commanded into position-hold mode, the timing solution becomes valid once the first valid-measurement, valid-ephemeris satellite is in track. Once position-hold mode successfully starts, the receiver can continue to indicate that its timing solution is valid with a minimum of one satellite in track. Once the receiver is in position-hold mode, it only leaves this mode in response to an operator command, or due to a restart.

3.1.2 Self-survey mode

In self-survey mode, the receiver navigates as a fixed receiver and computes an averaged position from the accumulated solutions to refine the final position. It also counts the number of fixes used to compute the position to indicate the estimated quality of the solution.

Self-survey mode may be started either by operator command or automatically at power-up or restart. Timing receiver software defaults to starting in self-survey mode at power-on or reset, but this can be changed by operator commands (see message 1255).

When the operator commands the receiver to either enter or remain in self-survey mode, the duration of the survey can be specified, or it can be allowed to remain in this mode continuously. When self-survey mode is entered automatically on reset, or because the system was unable to start in position-hold mode, it remains in this mode for 24 hours by default.

Self-survey mode may be ended at any time by operator command. When the receiver is given a fixed time for the survey, upon completion of the appropriate number of valid measurements, the receiver exits self-survey mode, stores the computed position in EEPROM as a valid position, and transitions to position-hold mode.

The time specified for a self survey implies a fixed number of valid measurements rather than an explicit time. A 24-hour survey means that the receiver accumulates data from 86 400 valid measurements. If the receiver experiences loss of signal or periods with insufficient satellites to compute valid positions, measurements made during those times are not added to the total, and cause the survey to require more time than specified.

3.1.3 TRAIM functionality

TRAIM detects and isolates faulty satellites that can cause timing errors with the following limits:

- >150 ns (one sigma) when in position-hold mode using three or more satellites.
- >100 ns (one sigma) when in position-hold mode using four to six satellites.
- >50 ns (one sigma) when in position-hold mode using seven or more satellites.

TRAIM also prevents >1.0 ms timing errors at all times when the position is valid (and accurate to within 20 metres) using two or more satellites.

4.0 Technical specification

4.1 Operational characteristics

4.1.1 Signal acquisition performance

The values shown in Table 2-1 are based on unobstructed satellite signals.

4.1.2 Accuracy

Accuracy is a function of the entire Navstar system and geometry of the satellites at the time of measurement. In general, timing accuracy is within 10 to 20 ns of GPS (UTC) time. In position-hold mode, The Jupiter-T is accurate to within ± 40 ns of UTC time.

4.1.3 Solution update rate

Once per second (maximum).

4.1.4 Re-acquisition

Typically one second following a 10-second blockage.

4.1.5 Serial data output protocol

Navman binary serial I/O messages and NMEA 0183.

4.2 Power requirements

The Jupiter-T receiver operates from a DC power source as shown in Table 4-1.

Input power	Power requirement
Voltage	+5 VDC $\pm 5\%$
Current (typical)	195 mA typical (not including antenna pre-amp)
Current (max)	230 mA (not including antenna pre-amp)
Ripple	150 mV

Table 4-1 Jupiter-T operational power requirements (measured at 25°C)

Current	Alarm
15 to 80 mA	normal
<5 mA	under current
>110 mA	over current

Table 4-2 GPS antenna current detector circuit

4.3 Radio frequency signal environment

1575.42 MHz (L1 band) at a level between -130 dBW and -163 dBW.

4.3.1 Burnout Protection

-10 dBW signal within a bandwidth of 10 MHz centred about the L1 carrier frequency.

4.4 Physical characteristics

Dimensions: 50.8 mm x 82.6 mm x 16.3 mm
Weight: 35 g

4.5 Environmental

4.5.1 Operating temperature

cooling	convection
temperature	-40°C to $+85^{\circ}\text{C}$
altitude	-304 m to 18 000 m
humidity	up to 95% non-condensing, or a wet-bulb temperature of $+35^{\circ}\text{C}$, whichever is less

4.5.2 Vibration

Full performance, refer to the composite SAE curve Figure 4-1.

4.5.3 Shock

18 G peak, 5 ms duration.

4.5.3 Transportation shock

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

4.6 OEM interface connector

The OEM communications interface is a standard, dual-in-line 10-pin male connector with 2.54 mm contact spacing. Figure 4-2 illustrates the pin 1 reference location.

4.7 Mechanical layout

The mechanical drawing for the Jupiter-T board is shown in Figure 7-1.

5.0 ESD sensitivity

The Jupiter-T contains Class 1 devices. The following ESD (ElectroStatic Discharge) precautions are recommended when handling the receiver board:

- protective outer garments
- handle device in ESD safeguarded work area
- transport device in ESD shielded containers
- monitor and test all ESD protection equipment

Note: treat the Jupiter-T as extremely sensitive to ESD when not installed in operating circuitry.

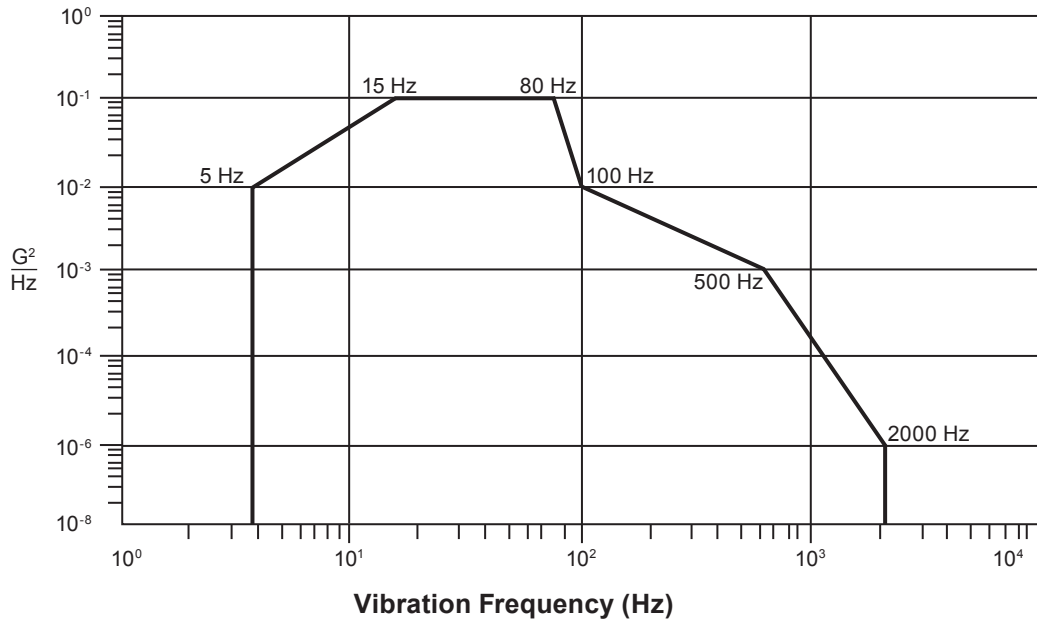


Figure 4-1 SAE composite curve (random noise)

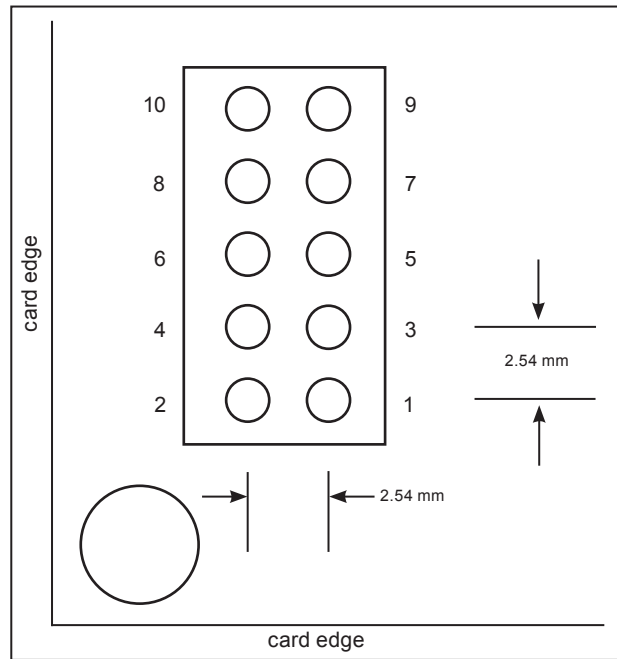


Figure 4-2 10-pin interface connector (J1)

6.0 Hardware interface

The electrical interface of the Jupiter-T GPS receiver is through a 10-pin miniature connector. The function of each pin is described in Table 6-1.

Pin	Name	Description
J1-1	Batt	battery backup (+5.0 VDC)
J1-2	PWR	main power +5.0 VDC
J1-3	GND	ground
J1-4	10 KHz	10 KHz clock output
J1-5	NC	no connection
J1-6	1 PPS	1 PPS clock output
J1-7	1 PPS RTN	1 PPS return (ground)
J1-8	TXD	transmit data output (CMOS levels)
J1-9	RXD	receive data input (CMOS levels)
J1-10	RTN	return (ground)

Table 6-1 Jupiter-T receiver J1 interface pin descriptions

6.1 DC input/output signals

This signal is the main power input to the Jupiter T receiver. DC power requirements are shown in Tables 4-2 and 6-1.

6.1.1 Pin J1-6: 1PPS output

This signal is a positive going pulse with the leading edge being the point of measurement for synchronisation with the GPS satellite transmissions. The pulse width is approximately 26 ms.

6.1.2 Pin J1-4: 10 KHz output

This is a 10 kHz square wave signal that is phase coherent with the leading edge of the 1PPS output.

6.2 Serial communication signals

Note: The serial communication signals described in this section must be applied according to the limits shown in Table 6-2.

The host port is the primary communications port for the receiver. Commands to the receiver are entered through RXD (pin J1-9) and data from the receiver is transmitted through TXD (pin J1-8). Both binary and NMEA messages are transmitted and received across the host port's serial I/O interface. This is a full-duplex, asynchronous serial data interface. Binary initialisation, configuration, and data messages are transmitted and received across this port.

Symbol	Parameter	Limits	Units
PWRIN	main power to the GPS Jupiter-T	+5.0 ± 5%	V
VIH (min)	min high-level input voltage	0.7xPWRIN	V
VIH (max)	max high-level input voltage	PWRIN	V
VIL (min)	min low-level input voltage	-0.3	V
VIL (max)	max low-level input voltage	0.3xPWRIN	V
VOH (min)	min high-level output voltage	0.8xPWRIN	V
VOH (max)	max high-level output voltage	PWRIN	V
VOL (min)	min low-level output voltage	0	V
VOL (max)	max low-level output voltage	0.2xPWRIN	V
tr, tf	input rise and fall time	50	ns
C out	max output load capacitance	25	pF

Table 6-2 Jupiter-T digital signal requirements

The logic needed to select between binary and NMEA messages is a function of the OEM software. All of the output and input binary messages for the Jupiter-T receiver are listed in Tables 6-4 and 6-5, along with their corresponding message IDs.

All of the output and input NMEA messages are listed in Tables 6-6 and 6-7, along with their corresponding message IDs. The OEM application must provide any LD/LR (Line Driver/Line Receiver) circuitry to extend the range of the interface. Port idle is nominally a logical high (+5 VDC).

Table 6-3 shows the Jupiter-T default command set on power-up or reset.

@@Ad	manually enters latitude
@@Ae	manually enters longitude
@@Af	manually enters altitude
@@Ag	sets antenna mask angle
@@As	manually enters position hold
@@At	sets position hold mode
@@Aw	selects UTC or GPS time formats
@@Ay	sets 1 PPS time offset
@@Az	offsets the 1 PPS signal for antenna cable delays or othe system advance/delay parameters
@@Bb	reports on visible satellites and status
@@Bj	acquires pending leap second information
@@Bo	provides UTC offset status
@@Cj	responds with manufacturer name, model, serial number and software revision
@@Cf	sets receiver default parameters
@@Ea	status, position and other general data
@@En	sets alarm limits for TRAIM and controls output (turns off/on) of 1 PPS and 10 KHz timing signals
@@Fa	runs a self-test on the receiver's hardware

Table 6-3 Jupiter-T default command set

The following command is available only on the Navman Jupiter-T receiver:

@@Wb: commands the receiver to go to Navman binary protocol

Note: *the receiver will always revert to the above protocol on power cycling by using the Navman binary command 1331 (message protocol control) when in the Navman binary mode. When set to the Navman binary mode, all of the standard Navman messages are supported as well as additional commands relating to timing applications.*

Output message name	Message ID
geodetic position status output	1000
channel summary	1002
visible satellites	1003
channel corrections	1006
channel measurement	1007
best user measurement	1008
reduced ECEF position status output	1009
receiver ID	1011
user-settings output	1012
raw almanac output	1040
raw ephemeris output	1041
raw ionospheric and UTC corrections output	1042
RAM status	1050
timing receiver configuration output	1055
timing receiver status output	1056
built-in test results	1100
global output control parameters	1101
measurement time mark	1102
UTC time mark pulse output	1108
frequency standard parameters in use	1110
serial port communication parameters in use	1130
EEPROM update	1135
EEPROM status	1136
frequency standard table output data	1160
flash boot status (flash builds only)	1180
error/status	1190

Table 6-4 Zodiac binary data messages (1 of 2)

Input message name	Message ID
geodetic position and velocity initialisation	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 input	1217
user-entered altitude input	1219
application platform control	1220
nav configuration	1221
raw almanac input	1240
raw ephemeris input	1241
raw ionospheric and UTC corrections input	1242
timing receiver configuration port	1255
perform built-in test command	1300
restart command	1303
factory test	1304
frequency standard input parameters	1310
serial port communication parameters	1330
message protocol control	1331
factory calibration input	1350
raw DGPS RTCM SC-104 data	1351
frequency standard table input data	1360
flash reprogram (flash builds only)	1380

Table 6-5 Zodiac binary data messages (2 of 2)

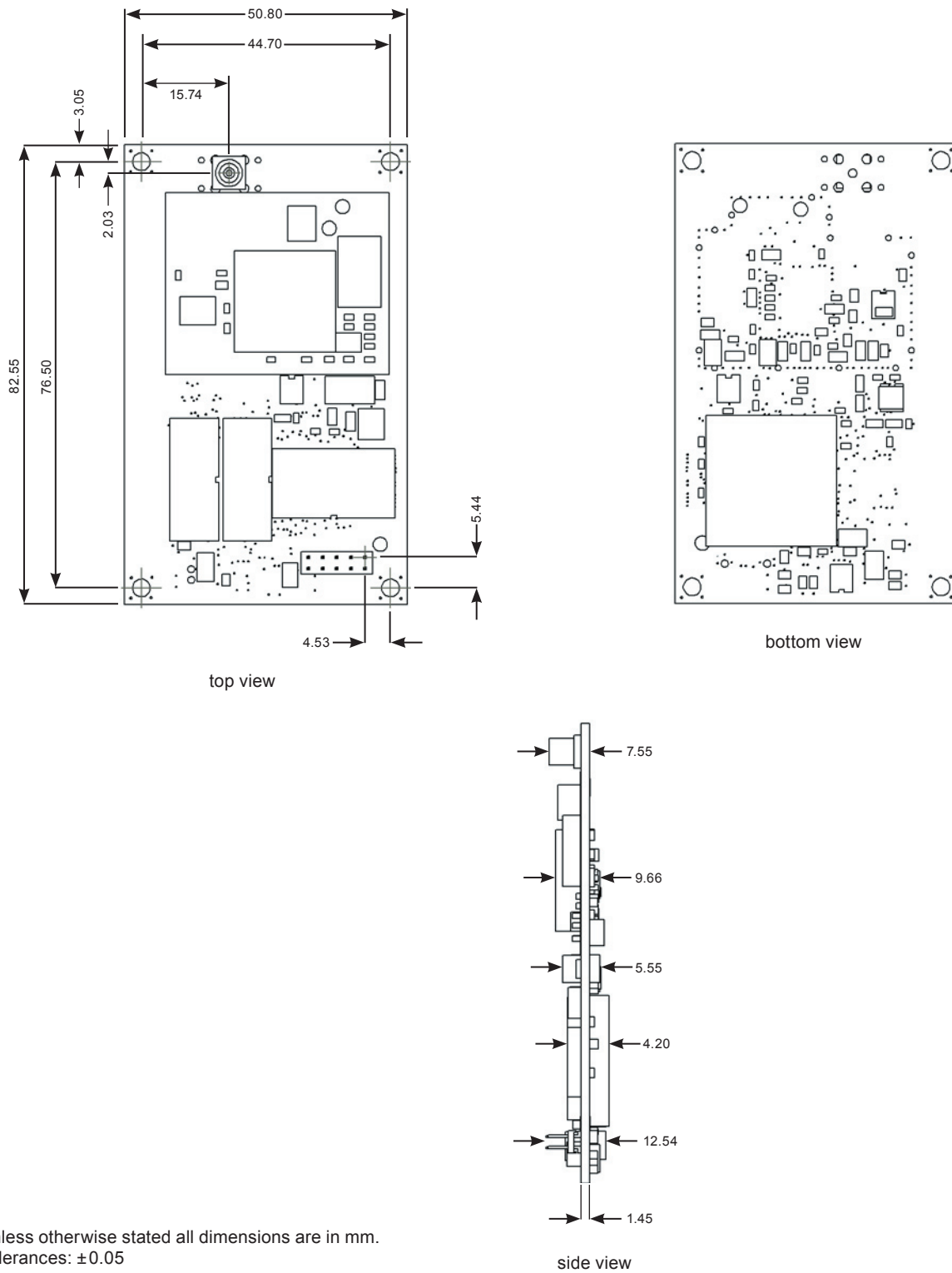
Output message name	Message ID
Navman proprietary built-in test results	BIT
Navman proprietary error/status	ERR
GPS fix data	GGA
GPS DOP and active satellites	GSA
GPS satellites in view	GSV
Navman proprietary receiver ID	RID
recommended minimum specific GPS data	RMC
course over ground and ground speed	VTG
Navman proprietary zodiac channel status	ZCH
time and data	ZDA

Table 6-6 Zodiac NMEA data messages (1 of 2)

Input message name	Message ID
Navman proprietary built-in test command	IBIT
Navman proprietary log control message	ILOG
Navman proprietary receiver initialisation	INIT
Navman proprietary protocol	IPRO
standard query message	Q

Table 6-7 Zodiac NMEA data messages (2 of 2)

7.0 Jupiter-T mechanical layout



Unless otherwise stated all dimensions are in mm.
Tolerances: ± 0.05

Figure 7-1 Jupiter-T mechanical layout

8.0 Glossary and acronyms

2D: Two Dimensional.

3D: Three Dimensional.

Almanac: a set of orbital parameters that allows calculation of approximate GPS satellite positions and velocities. The almanac is used by a GPS receiver to determine satellite visibility and as an aid during acquisition of GPS satellite signals. The almanac is a subset of satellite ephemeris data and is updated weekly by GPS Control.

C/A code: Coarse Acquisition code. A spread spectrum direct sequence code that is used primarily by commercial GPS receivers to determine the range to the transmitting GPS satellite.

CEP: Circular Error Probable.

CMOS: Complimentary Metal Oxide Semiconductor.

Ephemeris: a set of satellite orbital parameters that is used by a GPS receiver to calculate precise GPS satellite positions and velocities. The ephemeris is used to determine the navigation solution and is updated frequently to maintain the accuracy of GPS receivers.

GPS: Global Positioning System. A space-based radio positioning system that provides accurate position, velocity, and time data.

I/O: Input/output.

NMEA: National Marine Electronics Association.

OEM: Original Equipment Manufacturer.

PPS: Pulse Per Second.

RTC: Real-Time Clock.

Re-acquisition: The time taken for a position to be obtained after all satellites have been made invisible to the receiver.

SRAM: Static Random Access Memory.

TRAIM: Time Receiver Autonomous Integrity Monitoring.

TTFF: Time To First Fix. The actual time required by a GPS receiver to achieve a position solution. This specification will vary with the operating state of the receiver, the length of time since the last position fix, the location of the last fix, and the specific receiver design.

UTC: Universal Time Coordinated. This time system uses the second defined true angular rotation of the Earth measured as if the Earth rotated about its conventional terrestrial pole. However, UTC is adjusted only in increments of one second. The time zone of UTC is that of Greenwich Mean Time (GMT).

© 2005 Navman NZ Ltd. All Rights Reserved.

Information in this document is provided in connection with Navman NZ Ltd. ('Navman') products. These materials are provided by Navman as a service to its customers and may be used for informational purposes only. Navman assumes no responsibility for errors or omissions in these materials. Navman may make changes to specifications and product descriptions at any time, without notice. Navman makes no commitment to update the information and shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to its specifications and product descriptions. No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document. Except as provided in Navman's Terms and Conditions of Sale for such products, Navman assumes no liability whatsoever.

THESE MATERIALS ARE PROVIDED 'AS IS' WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, RELATING TO SALE AND/OR USE OF NAVMAN PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, CONSEQUENTIAL OR INCIDENTAL DAMAGES, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT. NAVMAN FURTHER DOES NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, TEXT, GRAPHICS OR OTHER ITEMS CONTAINED WITHIN THESE MATERIALS. NAVMAN SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, LOST REVENUES OR LOST PROFITS, WHICH MAY RESULT FROM THE USE OF THESE MATERIALS.

Navman products are not intended for use in medical, lifesaving or life sustaining applications. Navman customers using or selling Navman products for use in such applications do so at their own risk and agree to fully indemnify Navman for any damages resulting from such improper use or sale. Product names or services listed in this publication are for identification purposes only, and may be trademarks of third parties. Third-party brands and names are the property of their respective owners. Additional information, posted at www.navman.com, is incorporated by reference. Reader response: Navman strives to produce quality documentation and welcomes your feedback. Please send comments and suggestions to tech.pubs@navman.com. For technical questions, contact your local Navman sales office or field applications engineer.