NAVMAN

Navman Jupiter 20
GPS receiver module
Data sheet

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Navman Jupiter 20

• Product brief LA010509
• Application note LA010508
• SiRF NMEA protocol
• SiRF Binary protocol
• Development kit guide LA000510
• DR gyro Application note LA010090

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1.0 Introduction

This document defines the specifications of the Navman Jupiter 20 GPS (Global Positioning System) receiver module. Topics not covered in this document should not be assumed to be similar to other Navman Jupiter products.

The Jupiter 20 is a very small surface mount receiver that is intended as a component for OEM (Original Equipment Manufacturer) products. The module provides a 12-channel receiver that continuously tracks all satellites in view and provides accurate positioning data. The module is designed for high performance and maximum flexibility in a wide range of OEM configurations including hand-helds, sensors, and in-vehicle automotive products.

The highly integrated digital receiver incorporates and enhances the established technology of the SiRFstarII chipset. It is designed to meet the needs of the most demanding applications, such as vehicle tracking in dense urban areas. The interface configuration allows incorporation into many existing devices and legacy designs. Different configurations allow selection of standard navigation, or DR (Dead Reckoning) navigation using vehicle sensors when GPS satellite signals are unavailable.

The Jupiter 20 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 navigation solution. The 12-channel architecture provides rapid TTFF (Time To First Fix) under all start-up conditions. Acquisition is guaranteed under all initialisation conditions as long as visible satellites are not obscured.

The receiver supports 2D positioning when less than four satellites are available or when required by operating conditions. Altitude information required for 2D operation is assumed by the receiver or may be provided by the OEM application.

Communication with the receiver is established through one of two asynchronous serial I/O ports that support full duplex data communication. The receiver's serial port provides navigation data and accepts commands from the OEM application in NMEA (National Marine Electronics Association) message format. SiRF binary message protocol is also available with software selection.

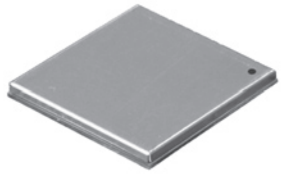

Figure 1-1 Jupiter 20 GPS receiver (top view)

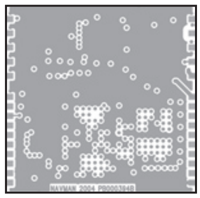

Figure 1-2 Jupiter 20 GPS receiver (bottom view)

The Jupiter 20 receiver (shown in Figures 1-1 and 1-2) is packaged on a miniature printed circuit board with a metallic RF enclosure on one side. The standard or DR configuration must be selected at the time of ordering and is not available for field retrofitting.

Receiver architecture
The functional architecture of the Jupiter 20 receiver is shown in Figure 1-3.

Product applications
The Jupiter 20 receiver is suitable for a wide range of module based, OEM GPS design applications. Figure 1-4 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.

Part Number	Description
TU20-D410-001	Standard module
TU20-D410-101	Standard module with higher sensitivity
TU20-D420-201	Standard module with Dead Reckoning capability

Table 1-1 Jupiter 20 module description

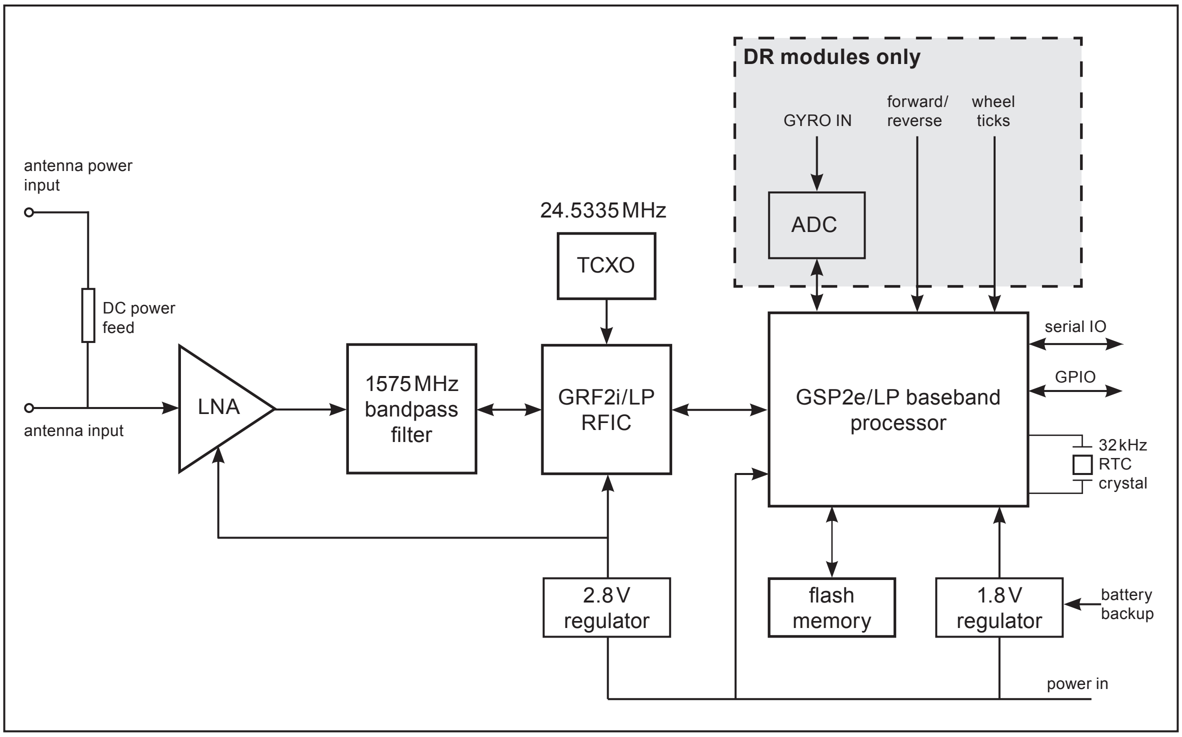

Figure 1-3 Jupiter 20 functional architecture

2.0 Specifications

2.1 Environmental

2.1.1 Operating temperature

temperature	–40°C to +85°C
altitude	–304 m to 18000 m
vibration	random vibration IEC68-2-64
maximum vehicle dynamics	500 m/s (acquisition and navigation)

Table 2-1 Environmental operating conditions

2.1.2 Storage environment

temperature	–40°C to +85°C
humidity	Up to 95% non-condensing or a wet bulb temperature of +35°C, whichever is less
shock (non-operating)	18 G peak, 5 ms duration

Table 2-2 Environmental storage conditions

2.1.3 EMI/EMC

The Jupiter 20 complies with CISPR22 and FCC Part 15 Sub-part J Class B for radiated emissions.

2.1.4 EU vehicle environment compliance

The Jupiter 20 complies with the following EU vehicle environmental requirements:

Automotive production standard TS 16949

Production standard ISO 9000-2000

3.0 Mechanical

The physical dimensions of the Jupiter 20 module are detailed in Table 3-1 and Figure 3-1.

Dimensions	Units
length	25.4 mm
width	25.4 mm
thickness	3.0 mm
weight	3 g

Table 3-1 Jupiter 20 module dimensions

3.1 External antenna surface mount pads

The RF surface mount pad for the external antenna has a characteristic impedance of 50 Ω.

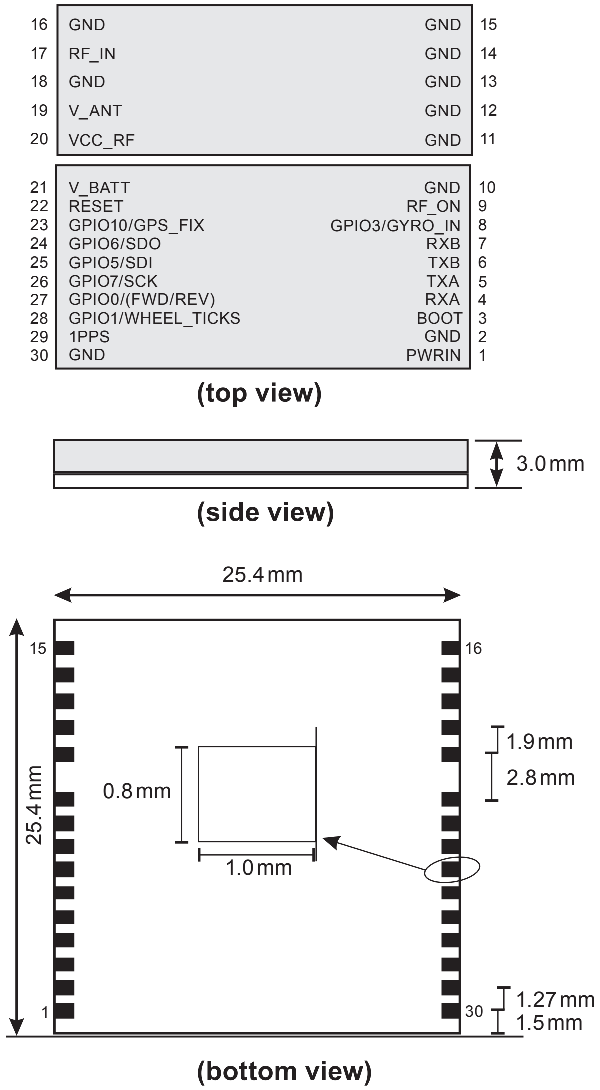

Figure 3-1 Jupiter 20 pad configuration

3.2 I/O and power connections

The I/O (Input Output) and power connections use surface mount pads around the edge of the module as illustrated in Figure 3-1. The pad dimensions are also shown in Figure 3-1.

3.3 Marking/serialisation

The Jupiter 20 receiver supports a 2D barcode indicating the unit serial number.

The Navman serial number convention is:

first character

sequential month, from A to L

(e.g. A = Jan, B = Feb)

next 2 characters

year (e.g. 02 = 2002, 03=2003)

next 6 characters

sequential serial number

4.0 Electrical

4.1 Power supply

4.1.1 Primary power

The Jupiter 20 GPS receiver is designed to operate from a single supply voltage, meeting the requirements shown in Table 4-1 below.

voltage	2.9 to 3.6 V DC
current (typ)	75 mA full duty cycle
current (max)	100 mA
ripple	not to exceed 50 mV peak to peak

Table 4-1 Operating power for the Jupiter 20

4.1.2 Low supply voltage detector

The module will enter a reset mode if the main supply drops below 2.8 V.

4.1.3 VCC_RF power supply

The VCC_RF (pad 20) provides a regulated 2.8 V power source. The specifications for this supply are shown in Table 4-2.

voltage tolerance	2.8 V ± 2%
maximum current	50 mA

Table 4-2 VCC_RF power supply

4.1.4 VBATT power (SRAM/RTC backup)

During ‘powered down’ conditions, the SRAM and RTC (Real Time Clock) may be kept operating by supplying power from the VBATT as shown in Table 4-3. The Jupiter 20 can accept slow VBATT supply rise time (unlike many other SiRFstarII based receivers) due to an on-board voltage detector.

VBATT voltage	1.95 V to 3.3 V
current	10 µA typical at 25°C
maximum rise time	unlimited

Table 4-3 SRAM/RTC power

4.1.5 External antenna voltage

DC power is supplied to the external antenna through the antenna power input pad (VANT). The receiver does not use this supply. The DC supply to the RF connection does not current limit in the event of a short circuit.

external antenna voltage typical	3.3 V
external antenna voltage max	12 V
external antenna current max	100 mA

Table 4-4 External antenna electrical requirements

4.1.6 RF (Radio Frequency) input

RF input is 1575.42 MHz (L1 Band) at a level between –135 dBm and –152 dBm into a 50 Ω impedance. This input may have a DC voltage impressed upon it to supply power to an active antenna. The maximum input return loss is –9 dB.

4.1.7 Antenna gain

The receiver will operate with a passive antenna with unity gain. However, GPS performance will be optimum when an active antenna is used. The gain of this antenna should be in the range of 20 to 30 dB.

4.1.8 Burnout protection

The receiver accepts without risk of damage a signal of +10 dBm from 0 to 2 GHz carrier frequency, except in band 1560 to 1590 MHz where the maximum level will be –10 dBm.

4.1.9 Jamming performance

Table 4-5 shows the jamming performance of the receiver based upon a 3 dB degradation in C/No performance. This is with reference to the external antenna.

Frequency MHz	Jamming signal power dBm
1400	-8
1530	-16
1555	-55
1575.42	-106
1625.42	-13
1425.42	-16
1725.42	-13

Table 4-5 Jamming performance

4.1.10 Flash upgradability

The firmware programmed in the Flash memory may be upgraded via the serial port. The user can control this by pulling the voltage applied to the Serial BOOT pad (3) high, then downloading the code from a PC with suitable software (e.g. SiRFflash).

4.2 Data input output specifications

All communications between the Jupiter 20 receiver and external devices are through the I/O surface mount pads. These provide the contacts for power, ground, serial I/O and control. Power requirements are discussed in previous sections.

4.2.1 Voltage levels

The input output voltage levels are shown below in Table 4-6.

Connection	Parameter	Value	Units
TXD & RXD GPIOs SPI bus 1PPS	VIH (min)	2.0	V
	VIH (max)	PWR_IN +0.1	V
	VIL (min)	0.1	V
	VIL (max)	0.8	V
	VOH (min) at Io min 4 mA	2.4	V
	VOH (max)	PWR_IN	
	VOL (min)	0	V
	VOL (max) at Io = –4 mA	0.4	V
Reset input	max capacitance Cmax	100	pF
	input current max	–600	μA

Table 4-6 Interface voltage levels

4.2.2 I/O surface mount pads

Details of the surface mount pad functions are provided in Table 4-7 (next page).

5.0 GPS performance

5.1 General information

The receiver can operate from either an active or passive GPS antenna to receive L1 band frequency GPS carrier signals.

Since the receiver determines its position by receiving signals from four or more GPS satellites orbiting the Earth, its antenna must have good visibility of the sky. This is generally not a problem when the receiver is used outdoors in a clear area. However, when used indoors or inside a vehicle, the antenna should be positioned to have an unobstructed 'view' of the sky. To establish an initial navigation fix, the receiver requires a minimum of four satellites in track with good geometry, i.e. GDOP (Geometric Dilution of Precision) <10.

Pad No.	Name	Type	Description
1	PWRIN	P	main power input (3.3 V)
2	GND	P	ground
3	BOOT	I	serial boot init
4	RXA	I	CMOS level asynchronous input for UART A
5	TXA	O	CMOS level asynchronous output for UART A
6	TXB	O	CMOS level asynchronous output for UART B
7	RXB	I	CMOS level asynchronous input for UART B
8*	GPIO3/ ADC_CONV/ NANT_SC	IO	general purpose IO/ output for external A/D converter control/ antenna S/C sensor input
9	RF_ON	O	output to indicate whether the RF section is enabled
10	GND	P	ground
11	GND	P	ground
12	GND	P	ground
13	GND	P	ground
14	GND	P	ground
15	GND	P	ground
16	GND	P	ground
17	RF_IN	I	antenna signal input
18	GND	P	ground
19	V_ANT	P	external power supply for active antenna
20	VCC_RF	O	RF Power (+2.8 V) supply output
21	V_BATT	P	backup battery input
22	RESET	I	master reset
23	GPIO10/GPS_FIX	IO	general purpose IO or GPS fix indication
24	GPIO6/SDO	IO	general purpose IO or SPI serial data out
25	GPIO5/SDI	IO	general purpose IO or SPI serial data in
26	GPIO7/SCK	IO	general purpose IO or SPI serial clock
27*	GPIO0/ANT_OC	IO	general purpose IO/antenna DC power control output
28*	GPIO1/ANT_CTRL	IO	general purpose IO/antenna O/C sensor input
29	1PPS	O	1 pulse per second output
30	GND	P	ground
* See also Table 4-8 for DR only pad functions			

Table 4-7 Jupiter 20 receiver pad functions (non DR)

Pad No.	Name	Type	Description
8	GYRO_IN	IO	gyro input
27	FWD/REV	IO	fwd/rev input
28	WHEEL_TICKS	IO	wheel tick input

Table 4-8 Jupiter 20 receiver pad functions (DR only)

5.2 Satellite acquisition

The GPS receiver supports three types of satellite signal acquisition depending on the availability of critical data.

Hot start: A hot 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. Hot start mode requires battery backup of the SRAM and RTC in the event of power loss.

Warm start: A warm start typically results from user-supplied position and time initialisation data or continuous RTC operation with an accurate last known position available in memory. 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 or time data is unknown, either of which results in an unreliable satellite visibility list. Almanac information is used to identify previously healthy satellites.

5.3 Navigation modes

The GPS receiver supports two types of navigation mode operation: Three-Dimensional (3D) and Two-Dimensional (2D). Each of these modes is described briefly below.

Three-dimensional navigation (3D): The receiver defaults to 3D navigation when at least four GPS satellites are being tracked. In 3D navigation, the receiver computes latitude, longitude, altitude, and time information from satellite measurements.

Two-dimensional navigation (2D): When three GPS satellite signals are available, or when a fixed altitude value can be used to produce an acceptable navigation solution, the receiver will enter 2D navigation using a fixed altitude value determined by the host.

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

5.4 GPS receiver performance

Sensitivity type	Measured sensitivity
navigation sensitivity (2D)	–142 dBm
tracking sensitivity	–147 dBm
acquisition sensitivity (3D)	–135 dBm

Table 5-1 GPS receiver performance

5.5 Absolute performance limits

The receiver is programmed to deliberately lose track if any of the following limits is exceeded:

maximum vehicle speed 500 m/s

maximum vehicle acceleration 4 G (39.2 m/s/s)

maximum vehicle jerk 5 m/s

altitude range between –300 m to 18 000 m referenced to MSL

5.6 Position and velocity accuracy (while in GPS NAV modes)

horizontal CEP	3 m full accuracy C/A code (R50)
horizontal (2 dRMS)	5 m full accuracy C/A code
vertical VEP	10 m full accuracy C/A code (R50)
velocity 2D (2 sigma)	0.1 m/s full accuracy C/A code

Table 5-2 Position and velocity accuracy

5.7 TTFF (Time To First Fix)

TTFF values can be affected by changing the values of maximum EHPE (Expected Horizontal Position Error validity), maximum EVPE (Expected Vertical Position Error validity), the criteria for the minimum number of satellites used for a solution and use of held attitude. The default conditions are: 100 m EHPE, 150 m EVPE, number of satellites zero and held altitude is enabled. Table 5-1 shows the TTFF times for the acquisition modes.

Mode	Max	Conditions
TTFF hot	8 s	valid almanac, position, time & ephemeris
TTFF warm	38 s	valid almanac, position & time
TTFF cold	45 s	no information
re-acquisition	100 ms	<10 s obstruction with valid almanac, position, time & ephemeris

Table 5-3 Acquisition times

Note: *The values shown in Table 5-1 apply to GPS acquisition only.*

5.8 Timing 1PPS output

Within 1 μs 95% of the time during tracking.

5.9 Differential aiding DGPS

DGPS (Differential GPS) specification improves horizontal position accuracy to <4 m 2 dRMS (radius of a circle enclosing 95% of all points in horizontal plane).

Note: *Both WAAS and DGPS should improve position accuracy. However, other factors can affect accuracy, such as GDOP, multipath, distance from DGPS reference station and latency of corrections.*

5.10 Differential aiding WAAS/EGNOS

The Jupiter 20 is capable of receiving WAAS differential corrections. WAAS/EGNOS improves horizontal position accuracy to <6 m 2 dRMS. See the Note under DGPS.

6.0 Software interface

The host serial I/O port of the receiver's serial data interface supports full duplex communication between the receiver and the user. Data messages are in NMEA-0183 v2.2 or SiRF Binary format. The default serial mode is NMEA (9600, N, 8, 1).

The module will be able to support SiRF standard GSW2.3 navigation software, as well as XTrac and SiRFdrive1.0.

6.1 NMEA data messages

The output and input NMEA (0183) messages for the receiver are listed in Table 6-1. A complete description of each NMEA message is contained in the SiRF NMEA protocol specification.

Output message name	Message ID
GPS fix data	GGA
GPS DOP and active satellites	GSA
GPS satellites in view	GSV
track made good and ground speed	VTG
recommended min. specific GPS data	RMC

Table 6-1 Default NMEA messages

6.2 SiRF binary

A complete description of each binary message is contained in the SiRF Binary protocol specification.

6.3 Software functions and capabilities

The Jupiter 20 has additional capabilities to the standard SiRF GPS software.

- GPS fix output – GPIO10 Low for 2D or 3D fix
- GPIO command control via serial commands – for use by customer
- Gyro, wheel-tick and forward reverse inputs (DR only)
- Antenna power monitor messages and power control O/P (non DR only)

7.0 Manufacturing

7.1 Lead free process

The module is manufactured using lead free components and processes.

8.0 Receiver frequency plan

For purposes of emission control and immunity, the radio frequency plan is shown in Table 8-1.

Receiver type	Dual conversion
TCXO frequency	24.5535 MHz
first LO	1565.97 MHz
receiver frequency	1575.42 MHz (commonly referred to as L1)
1st IF	9.45 MHz
RTC crystal	32.768 KHz

Table 8-1 Receiver frequency plan

9.0 Glossary and acronyms

GPS: Global Positioning System

C/No: Carrier to noise density ratio

DGPS: Differential GPS. A technique to improve GPS accuracy. DGPS uses pseudo-range errors recorded at a known location to improve measurements made by other GPS receivers within the same general geographical area.

DR: Dead Reckoning

EGNOS: European Geostationary Navigation Overlay Service

EHPE: Expected Horizontal Position Error

EVPE: Expected Vertical Position Error

GDOP: Geometric Dilution of Precision. A factor used to describe the effect of the satellite geometry on the position and time accuracy of the GPS receiver solution.

GPIO: General Purpose Input Output

MSL: Mean Sea Level

NMEA: National Marine Electronics Association

OEM: Original Equipment Manufacturer

RF: Radio Frequency

RTC: Real Time Clock

RXD: Receive Data

SRAM: Static Random Access Memory

SWR: Standing Wave Ratio

TXD: Transmit Data

WAAS: Wide Area Augmentation System