



HEXAGON



**OEM7500
Data Sheet**

OEM7500 Data Sheet

Publication Number: OM-20000178

Revision Level: v5

Revision Date: May 2023

To download the latest firmware and/or software visit: novatel.com/support/support-materials/firmware-download.

Warranty

NovAtel Inc. warrants that its GNSS products are free from defects in materials and workmanship, subject to the conditions set forth on our web site: novatel.com/products/novatel-warranty-and-return-policies.

Return Instructions

To return products, refer to the instructions found at: novatel.com/products/novatel-warranty-and-return-policies.

Proprietary Notice

This document and the information contained herein are the exclusive properties of NovAtel Inc. and/or its affiliates within the Hexagon Autonomy & Positioning division (“Hexagon”).

No part of this document may be reproduced, displayed, distributed, or used in any medium, in connection with any other materials, or for any purpose without prior written permission from Hexagon. Applications for permission may be directed to contact.ap@hexagon.com. Unauthorized reproduction, display, distribution or use may result in civil as well as criminal sanctions under the applicable laws. Hexagon aggressively protects and enforces its intellectual property rights to the fullest extent allowed by law.

This document and the information contained herein are provided AS IS and without any representation or warranty of any kind. Hexagon disclaims all warranties, express or implied, including but not limited to any warranties of merchantability, non-infringement, and fitness for a particular purpose. Nothing herein constitutes a binding obligation on Hexagon.

The information contained herein is subject to change without notice.

ALIGN, NovAtel, OEM7, SPAN and TerraStar are trademarks of Hexagon AB and/or its subsidiaries and affiliates, and/or their licensors. All other trademarks are properties of their respective owners.

©2023 NovAtel Inc. All rights reserved. NovAtel is part of Hexagon. NovAtel makes no representation or warranty regarding the accuracy of the information in this publication. This document gives only a general description of the product(s) or service(s) offered by NovAtel and, except where expressly provided otherwise, shall not form part of any contract. Such information, the products and conditions of supply are subject to change without notice.

Table of Contents

OEM7500 Notices

Customer Support

Chapter 1 Overview

1.1 Electrostatic Discharge (ESD) Precautions	12
1.2 Related Documents and Information	13

Chapter 2 Integration

2.1 Current Requirements	14
2.2 Module Pinout and Descriptions	15
2.3 Recommended Operating Conditions	21
2.3.1 Antenna Recommendations	22
2.4 RF Layout Constraints	22
2.5 Module Initialization	24
2.6 LEDs	24
2.7 Module Customization	24
2.8 SPAN	25
2.9 LNA Status and LNA Power Enable Control Integration	25
2.10 Package Information	25
2.11 Mechanical Drawings	26
2.11.1 Land Pattern and Solder Stencil Design	27
2.12 Manufacturing Process Information	29
2.13 Example Use Cases Diagrams	30

Chapter 3 Troubleshooting

Chapter 4 Firmware Upgrade

APPENDIX A OEM7500 Technical Specifications

A.1 OEM7500 Performance Specifications	35
A.2 OEM7500 Electrical and Environmental Specifications	37
A.3 OEM7500 Absolute Maximum Ratings	39
A.4 OEM7500 Data Communication Specifications	40

OEM7500 Notices

The following notices apply to the OEM7500 receiver.



Changes or modifications to this equipment, not expressly approved by NovAtel Inc., could void the user's authority to operate this equipment.

FCC

The devices covered by this manual comply with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The equipment listed has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. The Class B limits are designed to provide reasonable protection against harmful interference in a residential installation. The equipment listed generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and the receiver
- Connect the equipment to an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

Innovation, Science and Economic Development (ISED) Canada

OEM7 Class B digital device complies with Canadian ICES-003.

OEM7 appareils numérique de la classe B sont conforme à la norme NMB-003 du Canada.

This device complies with ISED license-exempt RSS-GEN and RSS-247. Operation is subject to the following two conditions: (1) this device may not cause interference and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil est conforme à la norme ISED RSS-GEN et RSS-247. Son fonctionnement est soumis aux deux conditions suivantes: (1) cet appareil ne doit pas provoquer d'interférences et (2) cet appareil doit accepter toute interférence, y compris les interférences pouvant entraîner un fonctionnement indésirable de l'appareil.

European Union (EU) / United Kingdom (UK)

NovAtel Inc. declares that the OEM7 GNSS receiver is in compliance with:


1. EU Directive 2014/53/EU
2. UK Regulations S.I. 2017/1206

The full text of the Declaration of Conformity may be obtained from the NovAtel website at:

novatel.com/products/novatel-compliance.

WEEE

If you purchased your OEM7 family product in Europe or the United Kingdom, please return it to your dealer or supplier at the end of life. The objectives of NovAtel's environment policy are, in particular, to preserve, protect and improve the quality of the environment, protect human health and utilise natural resources prudently and rationally. Sustainable development advocates the reduction of wasteful consumption of natural resources and the prevention of pollution. Waste Electrical and Electronic Equipment (WEEE) is a regulated area. Where the generation of waste cannot be avoided, it should be reused or recovered for its material or energy. WEEE

products may be recognized by their wheeled bin label ()

See novatel.com/products/novatel-compliance/novatel-environmental-compliance for more information.

RoHS

The OEM7 GNSS receivers are in conformity with:

1. Directive 2011/65/EU of the European Parliament and of the council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
2. the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (Amendment) Regulations 2012 (S.I. 2012/3032).

Lightning Protection

For a permanent or a fixed station installation, NovAtel recommends the installation of a lightning protection device for the GNSS antenna cable and/or radio antenna cable at the building entry point in accordance with the local electrical code.

Equipment protection measures should include:

- Selection of a suitable Lightning/Surge protection device
- Safety/Equipment rack grounding
- Lightning/Surge Protection of power lines and communication ports at the building entry point

For more information regarding the selection of surge protection devices for your application, the following websites are provided as a reference.

www.polyphaser.com/

www.hubersuhner.com



Only qualified personnel, such as electricians mandated by the governing body in the country of installation, may install lightning protection devices.

Conventions

The following conventions are used in this manual:



Information that supplements or clarifies text.



A caution that actions, operation or configuration may lead to incorrect or improper use of the hardware.



A warning that actions, operation or configuration may result in regulatory noncompliance, safety issues or equipment damage.

Customer Support

NovAtel Knowledge Base

If you have a technical issue, visit the NovAtel Support page at novatel.com/support. Through the *Support* page you can contact Customer Support, find papers and tutorials or download the latest firmware. To access the latest user documentation, visit docs.novatel.com/OEM7.

Before Contacting Customer Support

Before contacting NovAtel Customer Support about a software problem, perform the following steps:



If logging data over an RS-232 serial cable, ensure that the configured baud rate can support the data bandwidth (see **SERIALCONFIG** command). NovAtel recommends a minimum suggested baud rate of 230400 bps.

1. Use the information in the *Troubleshooting* on page 32 section to diagnose and troubleshoot your receiver's symptoms.
2. Log the data suggested in the appropriate *Troubleshooting Logs* section to a file on your computer for 15 minutes.
 - *General Troubleshooting Logs* on the next page
 - *Tracking and Interference Troubleshooting Logs* on the next page
 - *SPAN Troubleshooting Logs* on page 9
 - *RTK Troubleshooting Logs* on page 9
 - *PPP Troubleshooting Logs* on page 10
 - *ALIGN Troubleshooting Logs* on page 10

If using NovAtel Application Suite, log the Troubleshooting message set for 15 minutes.

3. Send the data file to NovAtel Customer Support: support.novatel@hexagon.com
4. You can also issue a **FRESET** command to the receiver to clear any unknown settings.



The **FRESET** command will erase all user settings. You should know your configuration (by requesting the RXCONFIGA log) and be able to reconfigure the receiver before you send the **FRESET** command.

If you are having a hardware problem, send a list of the troubleshooting steps taken and the results.

Contact Information

Log a support request with NovAtel Customer Support using one of the following methods:

Log a Case and Search Knowledge:

Website: novatel.com/support

Log a Case, Search Knowledge and View Your Case History: (login access required)

Web Portal: shop.novatel.com/novatelstore/s/login/

E-mail:

support.novatel@hexagon.com

Telephone:

U.S. and Canada: 1-800-NOVATEL (1-800-668-2835)

International: +1-403-295-4900

General Troubleshooting Logs

LOG RXSTATUSB ONCHANGED
LOG RAWEPHEMB ONNEW
LOG GLORAWEPHEMB ONNEW
LOG BESTPOSB ONTIME 1
LOG RANGEB ONTIME 1
LOG RXCONFIGA ONCE
LOG VERSIONA ONCE
LOG LOGLISTA ONCE
LOG PORTSTATSA ONTIME 10
LOG PROFILEINFOA ONCE
LOG HWMONITORA ONTIME 10

Tracking and Interference Troubleshooting Logs

LOG VERSIONA ONCE
LOG RXCONFIGA ONCE
LOG CHANCONFIGLISTB ONCE
LOG PASSTHROUGHHA ONNEW
LOG RXSTATUSB ONCHANGED
LOG CLOCKSTEERINGB ONCHANGED
LOG RAWEPHEMB ONNEW
LOG GLORAWEPHEMB ONNEW
LOG GALINAVRAWEPHEMERISB ONNEW
LOG BDSEPPHEMERISB ONNEW
LOG QZSSEPPHEMERISB ONNEW
LOG NAVICEPPHEMERISB ONNEW
LOG RAWALMB ONNEW
LOG GLORAWALMB ONNEW
LOG GALALMANACB ONNEW
LOG BDSALMANACB ONNEW
LOG QZSSALMANACB ONNEW
LOG NAVICALMANACB ONNEW
LOG IONUTC B ONNEW
LOG GLOCLOCKB ONNEW
LOG GALCLOCKB ONNEW
LOG BDESCLOCKB ONNEW
LOG TRACKSTATB ONTIME 1
LOG RANGEB ONTIME 1
LOG BESTPOSB ONTIME 1
LOG SATVIS2B ONTIME 30
LOG ITDETECTSTATUSB ONCHANGED

For interference issues add this log.

```
LOG ITPSDDETECTB ONNEW
```

For interference issues, when you have enough datalink bandwidth to handle large logs, add this log:

```
LOG ITPSDFINALB ONNEW
```

SPAN Troubleshooting Logs

```
LOG RXSTATUSB ONCHANGED
LOG RAWEPHEMB ONNEW
LOG GLORAWEPHEMB ONNEW
LOG GALINAVRAWEPHEMERISB ONNEW
LOG BDSEPEHEMERISB ONNEW
LOG BESTPOSB ONTIME 1
LOG RANGE B ONTIME 1
LOG RXCONFIGA ONCE
LOG VERSIONA ONCE
LOG RAWIMUSXB ONNEW
LOG INSUPDATESTATUSB ONCHANGED
LOG INSPVAXB ONTIME 1
LOG INSCONFIGA ONCHANGED
LOG BESTGNSSPOSB ONTIME 1
```

RTK Troubleshooting Logs

```
LOG RXSTATUSB ONCHANGED
LOG RAWEPHEMB ONNEW
LOG GLORAWEPHEMB ONNEW
LOG QZSSRAWEPHEMB ONNEW
LOG BDSRAWNAVSUBFRAMEB ONNEW
LOG GALFNAVRAWEPHEMERISB ONNEW
LOG GALINAVRAWEPHEMERISB ONNEW
LOG RANGE B ONTIME 1.0
LOG BESTPOSB ONTIME 1.0
LOG RXCONFIGB ONCE
LOG VERSIONB ONCE
LOG TRACKSTATB ONTIME 1.0
LOG RTKPOSB ONTIME 1.0
LOG MATCHEDPOSB ONNEW
LOG MATCHEDSATS B ONNEW
LOG RTKSATS B ONTIME 1.0
LOG PSRPOSB ONTIME 1.0
LOG RAWALMB ONNEW
LOG IONUTCB ONNEW
LOG GLORAWALMB ONNEW
LOG GLOCLOCKB ONNEW
LOG PASSTHROUGH B ONNEW
LOG CLOCKMODEL B ONTIME 1.0
LOG REFSTATIONB ONNEW
LOG RTKVELB ONTIME 1.0
```

PPP Troubleshooting Logs

LOG RXSTATUSB ONCHANGED
LOG GPSEPHEMB ONNEW
LOG GLOEPHEMERISB ONNEW
LOG QZSSEPHEMERISB ONNEW
LOG BDSEPHEMERISB ONNEW
LOG BDSBCNAV1EPHEMERISB ONNEW (firmware versions 7.08.03 and 7.08.10 and later)
LOG BDSBCNAV2EPHEMERISB ONNEW (firmware versions 7.08.03 and 7.08.10 and later)
LOG BDSBCNAV3EPHEMERISB ONNEW (firmware versions 7.08.03 and 7.08.10 and later)
LOG GALFNAVEPHEMERISB ONNEW
LOG GALINAVEPHEMERISB ONNEW
LOG RANGE B ONTIME 1.0
LOG BESTPOS B ONTIME 1.0
LOG RXCONFIG B ONCE
LOG VERSION B ONCE
LOG TRACKSTAT B ONTIME 10.0
LOG LBANDTRACKSTAT B ONTIME 1.0
LOG PPPPOS B ONTIME 1.0
LOG PPPSAT B ONTIME 1.0
LOG TERRASTARINFO B ONCHANGED
LOG TERRASTARSTATUS B ONCHANGED
LOG PSRPOS B ONTIME 1.0
LOG ALMANAC B ONNEW
LOG GLOALMANAC B ONNEW
LOG GALALMANAC B ONNEW
LOG BDSALMANAC B ONNEW
LOG QZSSALMANAC B ONNEW
LOG IONUTCB ONNEW
LOG GLOCLOCK B ONNEW
LOG LBANDBEAMTABLE B ONCHANGED

ALIGN Troubleshooting Logs

LOG RXSTATUSB ONCHANGED
LOG RAWEPHEMB ONNEW
LOG GLORAWEPHEMB ONNEW
LOG GALINAVRAWEPHEMERISB ONNEW
LOG BDSEPHEMERISB ONNEW
LOG BESTPOS B ONTIME 1
LOG RANGE B ONTIME 1
LOG RXCONFIG A ONCE
LOG VERSION A ONCE
LOG LOGLISTA ONCE
LOG PORTSTATSA ONTIME 10
LOG ALIGNBSLNENUB ONNEW
LOG ALIGNBSLNXYZB ONNEW
LOG ALIGNDOPB ONNEW
LOG HEADING2B ONNEW
LOG MASTERPOS B ONNEW
LOG ROVERPOS B ONNEW (This log can only be output if you have Y model ALIGN)
LOG HEADINGSATSA ONNEW (This log can only be output on the ALIGN rover)
LOG DUALANTENNAHEADING B ONTIME 1.0

Chapter 1 Overview

The multi-frequency OEM7500 offers future ready, precise positioning for space constrained applications. This single-sided Surface Mount Device (SMD) package solders down directly, eliminating the need for connectors and mounting hardware.

Key product features include:

- Centimetre level precise positioning GNSS receiver
- Small, cost effective multi-frequency, multi-constellation support
- RTK, PPP and SBAS precise positioning modes
- Support various differential correction formats (RTCM 2.1, 2.3, 3.0, 3.1, CMR, CMR+ and RTCA)
- NovAtel binary/ASCII logs and NMEA-0183
- Current and future GNSS signals support
- PAC multipath mitigation technology
- GNSS Resilience and Integrity Technology (GRIT)
- Solder down module with effective thermal mitigation features
- Deeply-coupled GNSS+INS SPAN support with SPI interface to external IMU (contact Sales for supported models)

Figure 1: Receiver Functional Block Diagram

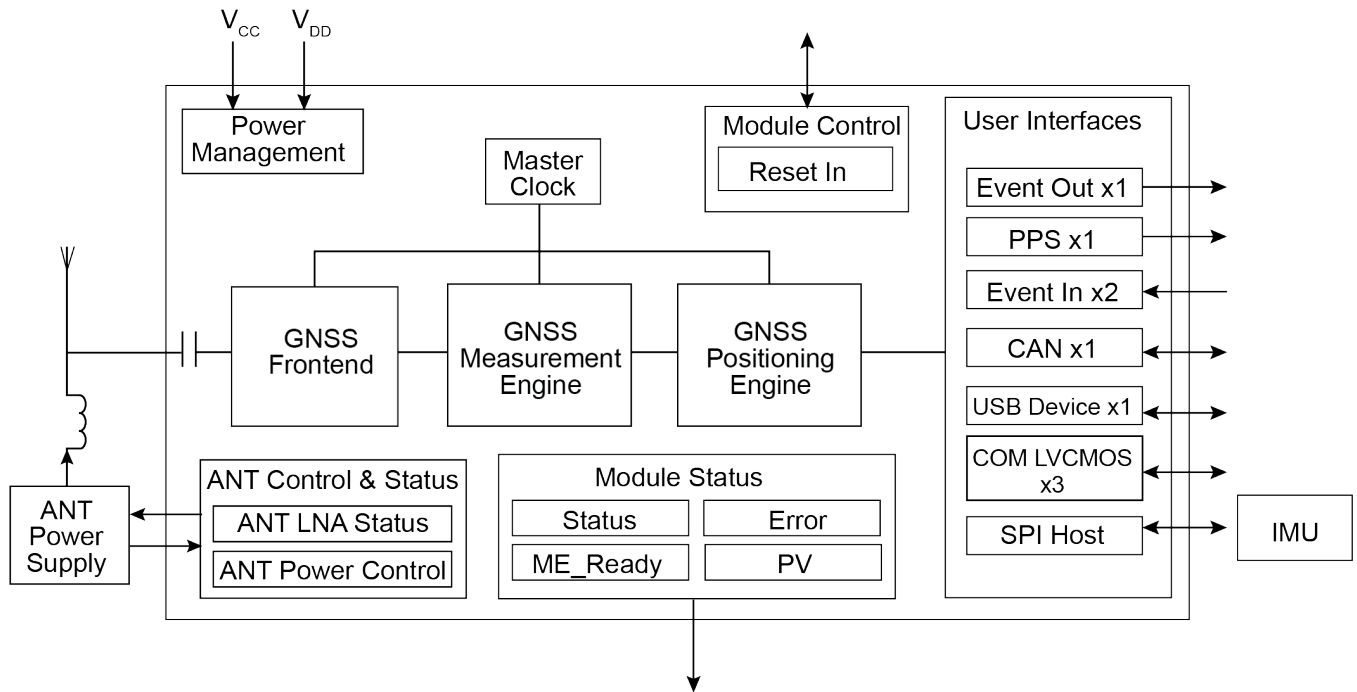


Table 1: Supported Signals and Frequencies

GNSS Signal	Frequency (MHz)
GPS L5*	1176.45

GNSS Signal	Frequency (MHz)
GPS L2 C & P	1227.60
GPS L1 C/A	1575.42
GPS L1C*	1575.42
GLONASS L3*	1202.025 MHz
GLONASS L2CA & L2P	1242.9375 – 1248.625
GLONASS L1 C/A	1598.0625 – 1605.375
BeiDou B2a*	1176.45
BeiDou B2I	1207.14
BeiDou B2b*	1207.14
BeiDou B1I	1561.098
BeiDou B1C*	1575.42
Galileo E5a*	1176.45
Galileo E5-AltBOC*	1191.80
Galileo E5b	1207.14
Galileo E1C	1575.42
QZSS L5*	1176.45
QZSS L2C	1227.60
QZSS L1C/A & L1C & L1-SAIF	1575.42
NavIC (IRNSS) L5*	1176.45
SBAS L5*	1176.45
SBAS L1	1575.42
TerraStar L-Band	1545 – 1560

*Hardware ready for future firmware upgrade.

1.1 Electrostatic Discharge (ESD) Precautions

The OEM7500 module is an ESD sensitive device and necessary precautions must be taken when handling the module.

- Always wear a properly grounded anti-static wrist strap when handling the module.
- Never let the module come in contact with clothing. The ground strap cannot dissipate static charges from fabrics.
- Failure to follow accepted ESD handling practices could cause damage to the module.

For a detailed guide to ESD practices, refer to docs.novatel.com/OEM7/Content/Appendix/ESD_Practices.htm.

1.2 Related Documents and Information

The NovAtel OEM7 User Documentation portal is the primary source for command and log information as well as receiver configuration, SPAN setup and other functionality.

docs.novatel.com/OEM7

Contact NovAtel Customer Support for any other inquiries related to the OEM7500 (refer to *Customer Support* on page 7 for contact details).

Chapter 2 Integration

The following sections provide information needed to integrate an OEM7500 receiver into your design.

2.1 Current Requirements

The following table is indicative of the current requirements for the module. The actual power required is dependent on the firmware version used, the number of satellites and signals tracked and the logging rate of the receiver.

Table 2: Module Current Requirements

Symbol	Parameter	Typical L1	Typical L1/L2	Maximum	Units
VDD	1.2 V Digital core power supply voltage	471	582	800 ¹	mA
VCC	3.3 V Module power supply voltage	119	193	280 ¹	mA

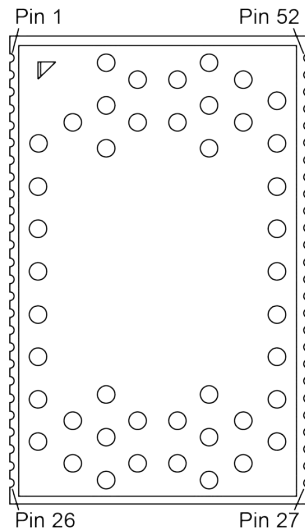
It is recommended that a minimum of 3 x 22 μ F bulk capacitance is provided on the interface board for each rail. Place the bulk capacitors close to the respective power pins on the module.

¹Current requirements increase with the temperature. These numbers are indicative of the current requirements at room temperature.

2.2 Module Pinout and Descriptions

Table 3: Module Pin Outs

Name	Pin	Pin	Name
GND	1	52	GND
nRESET_IN	2	51	RF_IN
ME_RDY	3	50	GND
PV	4	49	ANT_POWER_CTRL
GND	5	48	ANT_LNA_STATUS
SPI_NCS2	6	47	ERROR
SPI_NCS1	7	46	GND
Reserved	8	45	VCC
GND	9	44	VCC
VDD	10	43	GND
VDD	11	42	STATUS_GREEN
Reserved	12	41	STATUS_RED
SPI_MISO	13	40	GND
SPI_SCLK	14	39	COM1_RXD
GND	15	38	COM1_TXD
SPI_MOSI	16	37	GND
EVENT_OUT	17	36	CAN_RXD
GND	18	35	CAN_TXD
EVENT_IN1	19	34	COM2_RXD
EVENT_IN2	20	33	COM2_TXD
GND	21	32	GND
Reserved	22	31	USB_D+
USB_VBUS	23	30	USB_D-
COM3_RXD	24	29	GND
COM3_TXD	25	28	TIMEMARK
GND	26	27	GND



Module has a solder pad for thermal mitigation. This pad is tied to GND net.



Except as noted in the *Table 4: Module Pin Out Descriptions* below, all signals are 3.3 V LVCMOS inputs/outputs.

Table 4: Module Pin Out Descriptions

Pin	Pin Name	I/O	Internal Pull Resistance	Drive Strength	Description and Notes
1	GND				Ground
2	nRESET_IN	Input	10kΩ pull up		Manual reset input Active low – Pull this pin low to hold the module in reset. Use a component with an open drain output to pull this pin low to hold module in reset. Do not actively drive this pin high.
3	ME_RDY	Output	2.2kΩ pull down	8 mA	Measurement engine ready Active high – this signal goes high when the module has initialized itself and is ready to send and receive data via its communication ports. This signal is not asserted while booting or during a reset.
4	PV	Output	2.2kΩ pull down	8 mA	Position valid Active high, firmware default = Low This signal goes high when a position has been calculated.
5	GND				Ground
6	SPI_NCS2	Output		6 mA	SPI chip select 2 Active low IMU secondary default
7	SPI_NCS1	Output		6 mA	SPI chip select 1 Active low Firmware default: use for IMU SPI chip select
8	Reserved	Output	2.2kΩ pull up		Leave this pin unconnected. Do not connect this pin to power, ground or any signal.
9	GND				Ground

Pin	Pin Name	I/O	Internal Pull Resistance	Drive Strength	Description and Notes
10	VDD	Input			1.2 V +5%/-3% Supply Input Pin 10 and Pin 11 are tied together on the module. See <i>Table 2: Module Current Requirements</i> on page 14 for continuous current draw on this rail.
11	VDD	Input			1.2 V +5%/-3% Supply Input Pin 11 and Pin 10 are tied together on the module. See <i>Table 2: Module Current Requirements</i> on page 14 for continuous current draw on this rail.
12	Reserved	Input/ Output	2.2k Ω pull up		Leave this pin unconnected. Do not connect this pin to power, ground or any signal.
13	SPI_MISO	Input	10k Ω pull up		SPI master data input
14	SPI_SCLK	Output		8 mA	SPI clock Module is always the SPI bus master and this pin is always an output. The SPI_SCLK signal is source serial terminated (33 Ω).
15	GND				Ground
16	SPI_MOSI	Output		8 mA	SPI master data output The SPI_MOSI signal is source serial terminated (33 Ω).
17	EVENT_OUT	Output		8 mA	Event output Programmable variable frequency output. The Event output signal is source serial terminated (22 Ω)
18	GND				Ground
19	EVENT_IN1	Input	10k Ω pull up		Event input 1 IMU interrupt or input mark Minimum pulse width is 150 ns. Firmware default = Disabled This pin must not be driven until power is applied to the module VDD and VCC pins. Polarity is configurable using the EVENTINCONTROL command.

Pin	Pin Name	I/O	Internal Pull Resistance	Drive Strength	Description and Notes
20	EVENT_IN2	Input	10K Ω pull up		<p>Event input 2</p> <p>Rising or falling edge triggered. This is used to provide position or time data on an external trigger.</p> <p>Firmware default = Disabled</p> <p>This pin must not be driven until power is applied to the module VDD and VCC pins.</p> <p>Polarity is configurable using the EVENTINCONTROL command.</p>
21	GND				Ground
22	Reserved	Input	10k Ω pull up		<p>Leave this pin unconnected. Do not connect this pin to power, ground or any signal.</p>
23	USB_VBUS	Input	1.2k Ω pull down		<p>USB 5 V tolerant VBUS input</p> <p>Pin must be pulled high when the module is physically connected to a USB host. The module sinks nominally 4.1 mA on this pin – the applied voltage on this pin is for indication purposes.</p> <p>Leave unconnected if the USB interface is not used.</p>
24	COM3_RXD	Input	33k Ω pull up		<p>UART COM3 receive data input</p> <p>Firmware default = 9600 bit/s, hardware flow control is not supported</p> <p>Maximum data rate 460,800 bit/s</p>
25	COM3_TXD	Output		4 mA	<p>UART COM3 transmit data output</p> <p>Firmware default = 9600 bit/s, hardware flow control is not supported</p> <p>Maximum data rate 460,800 bit/s</p> <p>The COM3_TXD signal is source serial terminated (33 Ω)</p>
26	GND				Ground
27	GND				Ground

Pin	Pin Name	I/O	Internal Pull Resistance	Drive Strength	Description and Notes
28	TIMEMARK	Output		8 mA	Timemark output Pulse Per Second (PPS) Firmware default = enabled, positive polarity, 1 Hz (configurable) The Timemark signal is source serial terminated (10 Ω)
29	GND				Ground
30	USB_D-	Input/ Output			USB data signal line D- USB 2.0 full speed (12 Mbps)
31	USB_D+	Input/ Output			USB data signal line D+ USB 2.0 full speed (12 Mbps)
32	GND				Ground
33	COM2_TXD	Output		4 mA	UART COM2 transmit data output Firmware default = 9600 bit/s, hardware flow control is not supported Maximum data rate 460,800 bit/s The COM2_TXD signal is source serial terminated (33 Ω)
34	COM2_RXD	Input	33k Ω pull up		UART COM2 receive data input Firmware default = 9600 bit/s, hardware flow control is not supported Maximum data rate 460,800 bit/s
35	CAN_TXD	Output		6 mA	CAN Bus transmit data output Firmware default = Disabled Maximum data rate 1Mbit/s
36	CAN_RXD	Input	33k Ω pull down		CAN Bus receive data input Firmware default = Disabled Maximum data rate 1 Mbit/s
37	GND				Ground

Pin	Pin Name	I/O	Internal Pull Resistance	Drive Strength	Description and Notes
38	COM1_TXD	Output		4 mA	UART COM1 transmit data output Firmware default = 9600 bit/s, hardware flow control is not supported Maximum data rate 460,800 bit/s The COM3_TXD signal is source serial terminated (33 Ω)
39	COM1_RXD	Input	33k Ω pull up		UART COM1 receive data input Firmware default = 9600 bit/s, hardware flow control is not supported Maximum data rate 460,800 bit/s
40	GND				Ground
41	STATUS_RED	Output	Buffered	24 mA	Red Status LED control Active high, firmware default = High Used to indicate the state of the receiver or provide error codes. The Status_Red signal is source serial terminated (22 Ω)
42	STATUS_GREEN	Output	Buffered	24 mA	Green Status LED control Active high, firmware default = Low Used to indicate the state of the receiver or provide error codes. The Status_Green signal is source serial terminated (22 Ω)
43	GND				Ground
44	VCC	Input			3.3 V \pm 5% supply input Pin 44 and Pin 45 are tied together on the module. See <i>Table 2: Module Current Requirements</i> on page 14 for continuous current draw on this rail.
45	VCC	Input			3.3 V \pm 5% supply input Pin 45 and Pin 44 are tied together on the module. See <i>Table 2: Module Current Requirements</i> on page 14 for continuous current draw on this rail.
46	GND				Ground

Pin	Pin Name	I/O	Internal Pull Resistance	Drive Strength	Description and Notes
47	ERROR	Output	2.2kΩ pull down	8 mA	Error indicator Active high, firmware default = Low, Error signal is asserted high to indicate the receiver is in an error state.
48	ANT_LNA_STATUS	Input	33kΩ pull up		Antenna power status pin Assert this line low to report an overcurrent fault on the external antenna power control circuit.
49	ANT_POWER_CTRL	Output	33kΩ pull up	8 mA	Antenna power control pin Active High This signal is asserted high to turn on the external power to the antenna. Note: This signal has a relatively strong pull-up when the module is in the reset state. To hold this signal in a low state during module reset, a strong pull down is required on the interface board (2.2 K)
50	GND				Ground
51	RF_IN	Input			GNSS RF signal input 50 ohm controlled impedance RF input from the GNSS antenna. This input is AC coupled internally. <i>See RF Layout Constraints on the next page for RF layout considerations.</i>
52	GND				Ground
Tab	GND				Solder tab for thermal mitigation

2.3 Recommended Operating Conditions

Table 5: Recommended Operating Conditions

Symbol	Parameter	Minimum	Typical	Maximum	Units
V _{DD}	Digital core power supply voltage	1.14	1.2	1.26	V
V _{CC}	Module power supply voltage	3.14	3.3	3.46	V
V _{IH}	Input high voltage	3.3V I/O	2.0	V _{CC} + 0.3	V
V _{IL}	Input low voltage	3.3V I/O	-0.3	0.8	V

Symbol	Parameter	Minimum	Typical	Maximum	Units
V_{OH}	Output high voltage	3.3V I/O ¹	$V_{CC} - 0.2$		V
V_{OL}	Output low voltage	3.3V I/O ²		0.2	V
V_{IH}	Input high voltage	USB_VBUS	2.5	5.25	V
V_{IL}	Input low voltage	USB_VBUS	-0.3	0.8	V
T_A	Ambient temperature	-40		85	°C



V_{CC} and V_{DD} pins must come up within 20 ms of each other. Input pins must not be driven until both rails are stable and within 5% of their target voltage. Module may not come up properly if used otherwise.

2.3.1 Antenna Recommendations

A nominal cascaded antenna gain is required for the OEM7500.

- 20 dB or higher with a nominal 26 dB to 30 dB for GNSS
- 35 dB or higher for L-Band

2.4 RF Layout Constraints

Proper layout between the RF input pad (Pin 51) on the OEM7500 module and RF input connector on the customer's interface board is critical for best overall system performance.

- The RF interface (Pin 51) on the OEM7500 module has been optimized to 50 Ω , therefore the interface to Pin 51 (traces into the pin and the entry into the pin pad) must be designed to 50 Ω to ensure proper signal integrity. The RF trace routing on the interface board must be kept away from any digital signals (NovAtel recommends 2 to 4 mm between RF trace and digital trace), such as clock traces or vias that may inject noise into the RF signal.
- As shown in the RF traces on the interface board, the component (L302) which is on the bottom side of the PCB for the antenna power coupling should be placed as close as possible to Pad 51 on OEM7500 module. Vias should be used to connect the top side ground fill to the ground plane on an inner layer of the PCB. The copper pour on the outer layer is important for the RF trace on the interface board as it allows better noise rejection.

¹Test condition $I_{OH} = -100\mu A$

²Test condition $I_{OL} = 100\mu A$

Figure 2: RF Interface Circuit

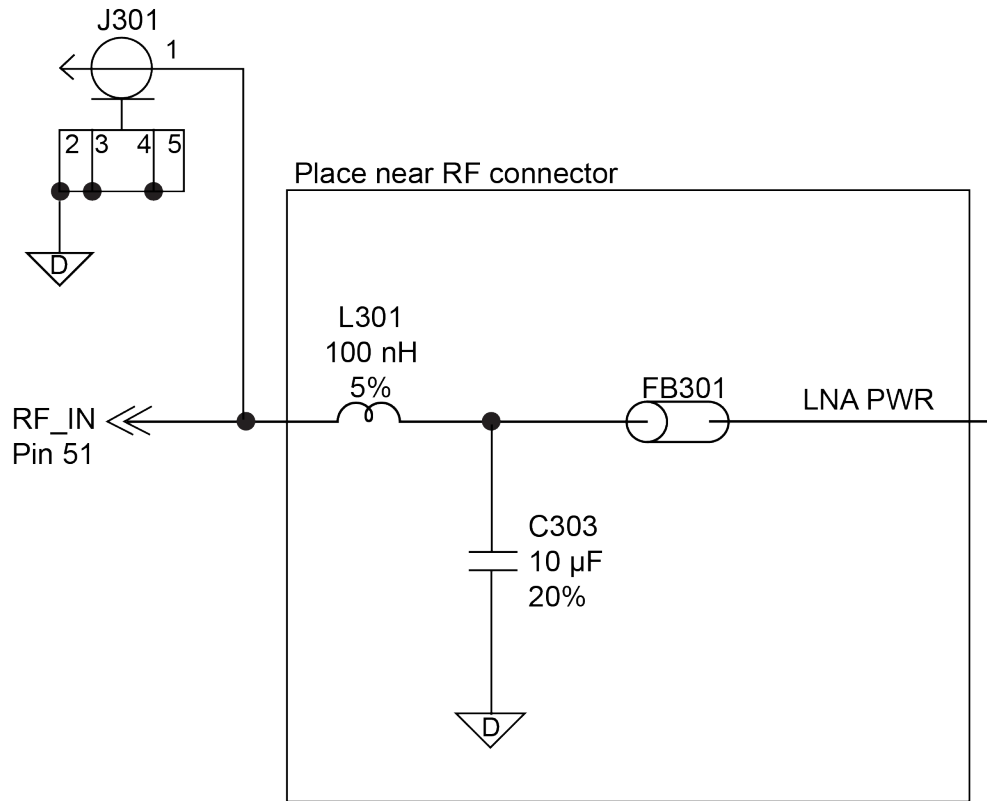
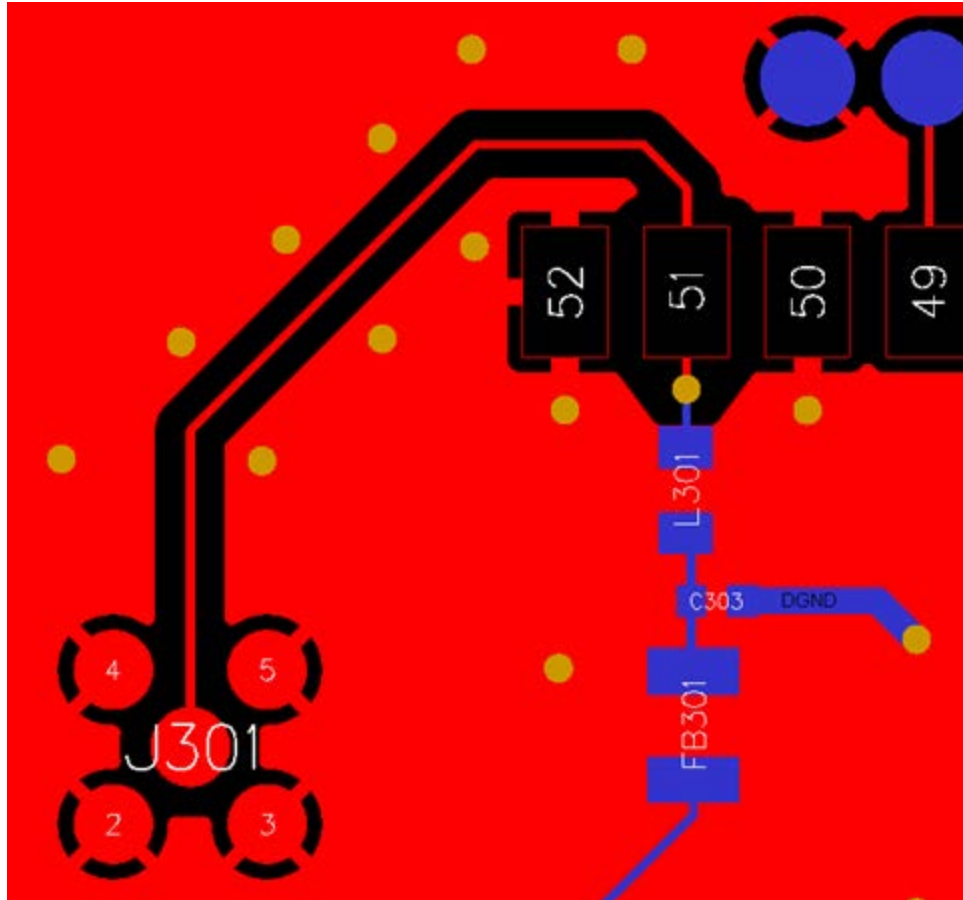


Table 6: RF Interface Circuit Bill of Materials

Reference Designator	Description	Manufacturer	Part Number
C303	CAP CER 10UF 10V 20% X5R 0402	Samsung	CL05A106MP5NUNC
FB301	BEAD FERRITE ILHB 250 OHM 3A SMD	VISHAY-DALE	ILHB0805ER251V
J301	CONN MMCX STRAIGHT PCB RECEPT W/STANDOFF	JOHNSON COMPONENTS	135-3701-201
L301	INDUCTOR CHIP 100nH 5% 0603CS	COILCRAFT INC	0603CS-R10XJLW

Figure 3: RF Input Layout – Top Layer (red)/Bottom Layer (blue)



2.5 Module Initialization

It is recommended to put the OEM7500 in hardware reset (using the RESET_IN pin) until the host system is booted up and ready to talk to peripherals. A way to issue a HW RESET via the RESET_IN pin on the module is also recommended in case a software reset does not work and a power cycle of the system is not desirable.

It is strongly suggested to monitor the ME_RDY line from the module and start communication with the module once the line is set high.

2.6 LEDs

The OEM7500 provides a few status lines to facilitate the integration of the module into a user system, e.g. STATUS_RED and STATUS_GREEN lines can be used to drive Status LEDs to indicate the state of the receiver and provide error codes. Consult the NovAtel OEM7 User Documentation portal docs.novatel.com/OEM7 for Built-In Status LED Tests details.

Contact NovAtel Customer Service to obtain the OEM7500 Evaluation Kit Schematics Package for an example circuit of how to wire the STATUS_RED and STATUS_GREEN lines.

2.7 Module Customization

Consult the NovAtel OEM7 User Documentation portal docs.novatel.com/OEM7 to determine the appropriate commands needed to configure the receiver for proper operation. Generally, the commands needed to

initialize the receiver can be entered at a receiver command prompt and then the **SAVECONFIG** command is used to save those commands for execution every time the receiver boots.

Once the final commands needed to initialize the receiver have been determined, those commands can be incorporated into the installation image for volume production.

It is important that customers work with NovAtel sales and support team to ensure the correct receiver model has been identified for inclusion within the final firmware image. The receiver model controls functionality including tracked constellations and positioning rate allowed for the receiver.

2.8 SPAN

When paired with a supported Inertial Measurement Unit (IMU), the OEM7500 can use SPAN technology to provide reliable, continuously available, position, velocity and attitude even through short periods of time when satellite signals are blocked or unavailable.

For information about configuring a receiver with SPAN technology, refer to the NovAtel OEM7 User Documentation portal (docs.novatel.com/OEM7).

2.9 LNA Status and LNA Power Enable Control Integration

The OEM7500 provides GPIOs:

- (Pin 49 – ANT_POWER_CTRL) Output pin to control the enabling and disabling of antenna DC voltage output.
- (Pin 48 – ANT_LNA_STATUS) Input pin to indicate to the receiver module that an LNA fault has occurred.

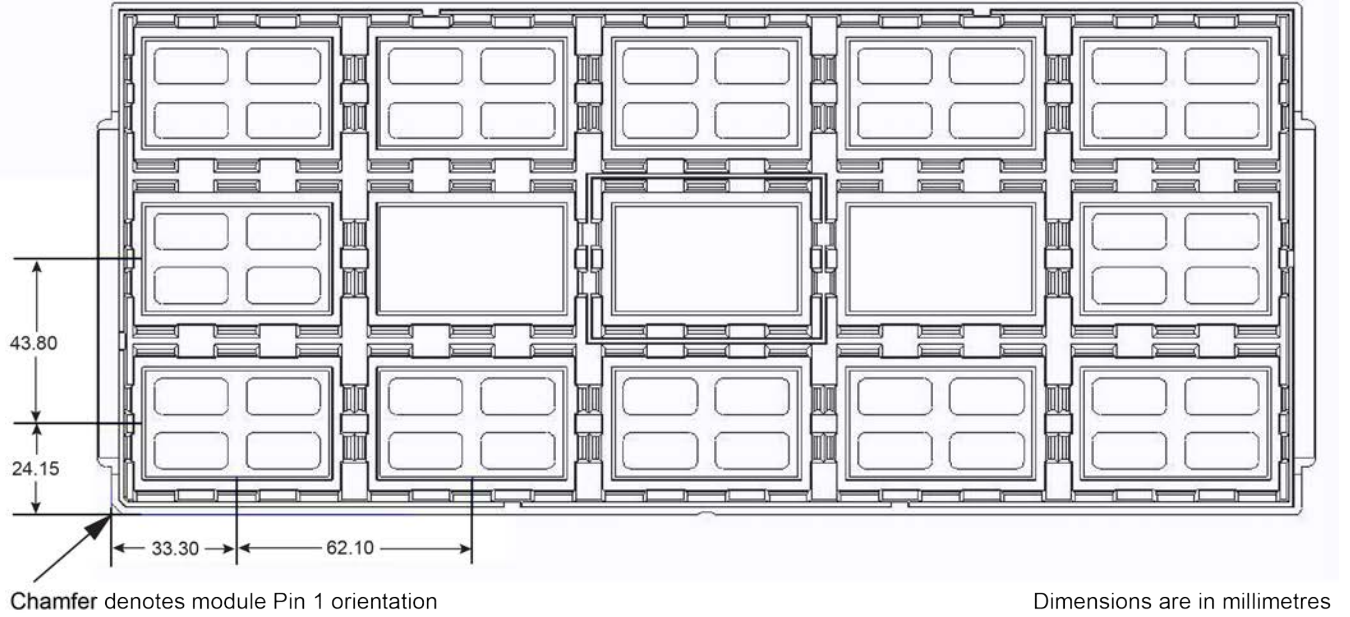
Refer to the **RXSTATUS** log on the NovAtel OEM7 User Documentation portal (docs.novatel.com/OEM7) for instructions on monitoring the receiver for errors.

Contact NovAtel Customer Service to obtain the OEM7500 Evaluation Kit Schematics Package for an example of this integration.

2.10 Package Information

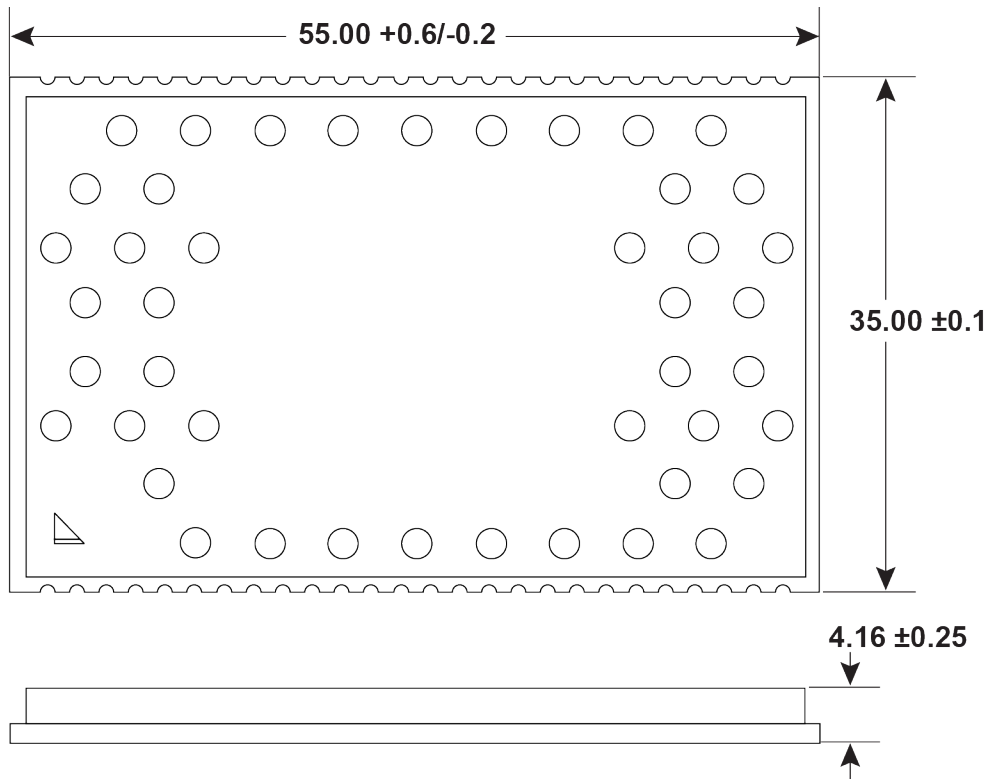
Modules are delivered in 15-up JEDEC Thick Style Matrix trays.

Figure 4: JEDEC Tray



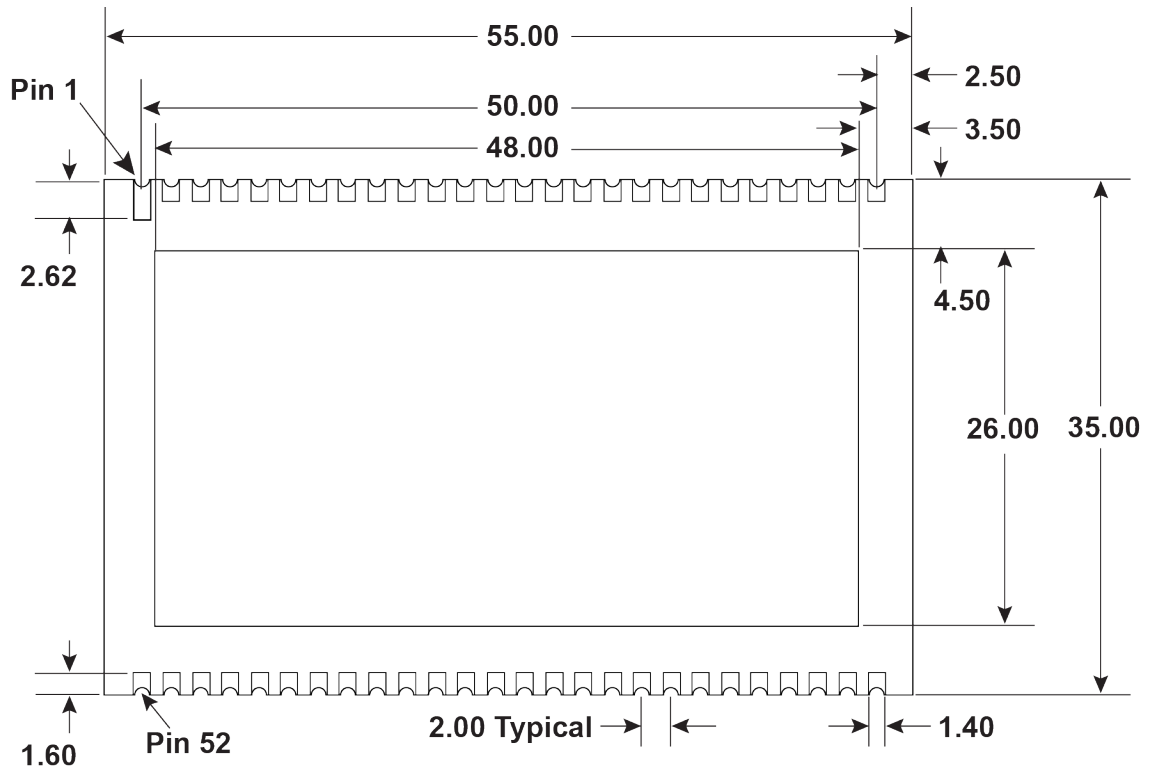
2.11 Mechanical Drawings

Figure 5: Module Outline Dimensions (Top)



Dimensions are in millimetres
Pin 1, lower left corner

Figure 6: Module Dimensions (Bottom)

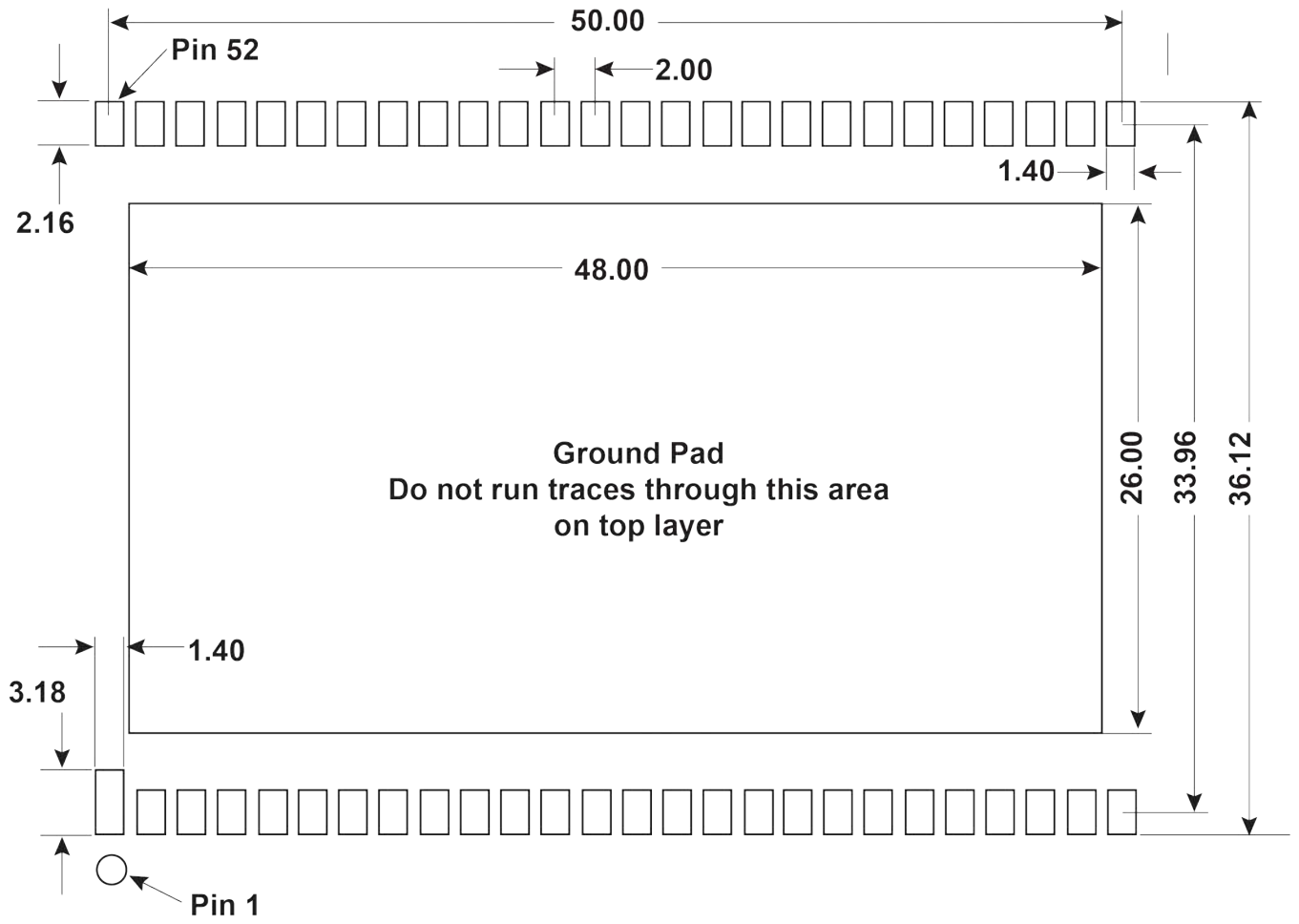


Dimensions are in millimetres

2.11.1 Land Pattern and Solder Stencil Design

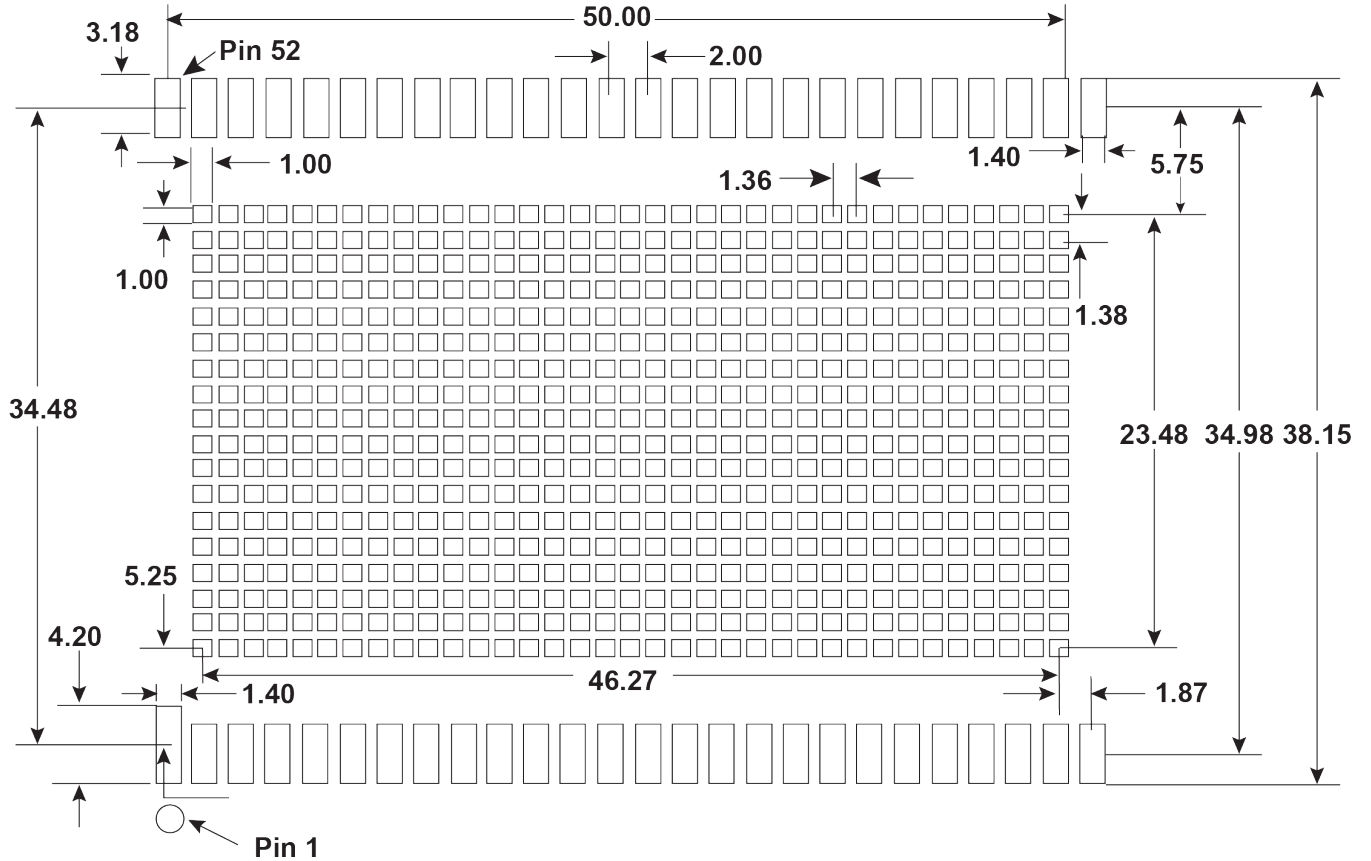
Note that the module has a large solder pad for thermal mitigation. The pad is tied to Ground.

Figure 7: Recommended PCB Pattern (Top)



Dimensions are in millimetres

Figure 8: Recommended Stencil Outline (Top)



Dimensions are in millimetres
 Stencil thickness: 0.102 mm

2.12 Manufacturing Process Information

The module is moisture sensitive (MSL 3). The module must be mounted and reflowed within 168 hours (floor life out of bag). If floor life out of bag time is exceeded and baking is required, refer to IPC/JEDEC J-STD-033 for bake procedure.

Reflow soldering is recommended. A maximum number of 3 reflow passes are allowed. The reflow information is provided for reference only. Users should optimize their own board level parameters to get the desired reflow outcome.



Removing and replacing with the same part is not recommended.
 Replace with a new part.

Table 7: Reflow Profile

Profile Feature	Lead free Assembly
Ramp-to-Peak profile average ramp-up rate	0.7°C to 1.3°C

Profile Feature	Lead free Assembly
Liquidous Temperature	221°C (SAC 305 Solder Alloy)
Time above liquidous	45 s to 75 s
Peak package body temperature	241°C ±4°C

All components on the module are sealed and the module can withstand an aqueous wash process. The module is assembled using Alpha CVP-390 no-clean solder paste and wash solvents used should be compatible. Users should optimize and verify their own wash process to ensure module performance is not negatively affected.

The module and its components must not be disturbed when in reflow, doing so may damage the module. If the module is removed, replacing with a new module is recommended.

2.13 Example Use Cases Diagrams

Figure 9: RTK/PPP/SPAN Use Case

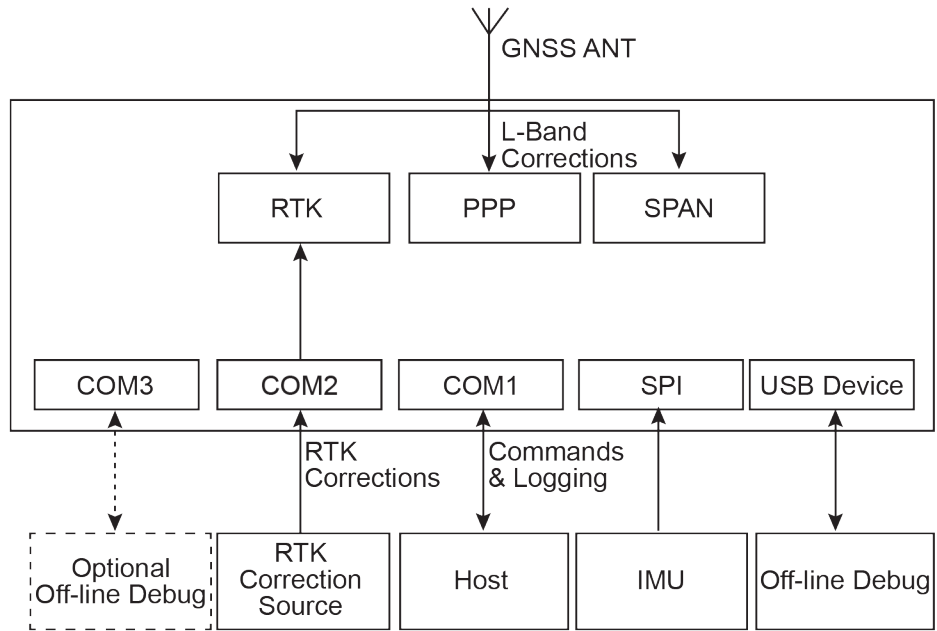
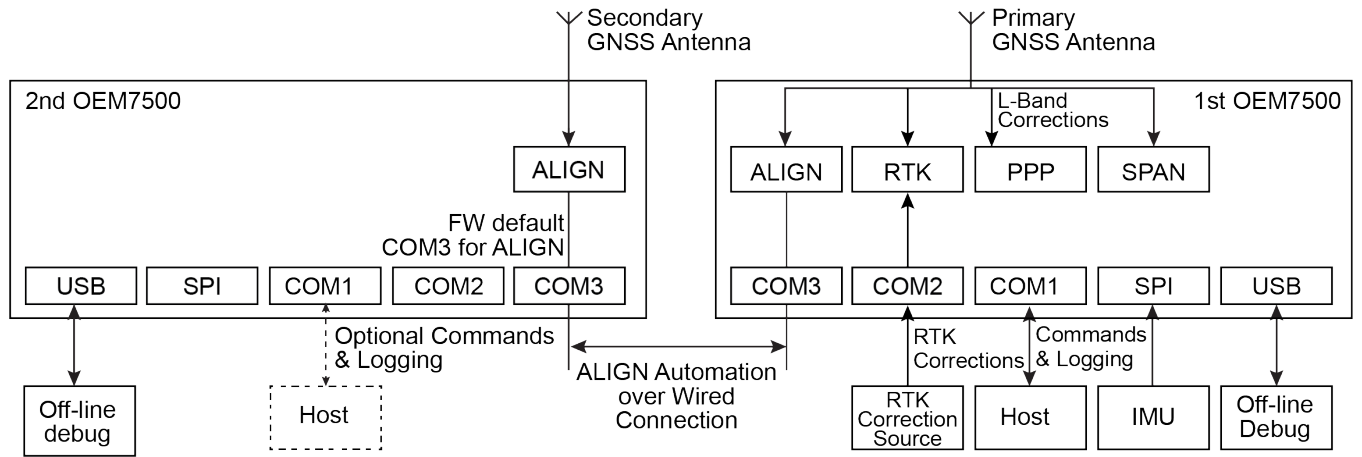



Figure 10: RTK/PPP/SPAN Plus ALIGN with Second Module



Chapter 3 Troubleshooting

Table 8: Available Debugging Options

Interface	Option	Comment
UART and USB	Diagnostic logs	<p>The header of all logs contains a 32 bit value for the Receiver Status, which is a copy of the Receiver Status word from the RXSTATUS log.</p> <p>The RXSTATUS log can be used to monitor the status of different receiver internal operations.</p> <p>Generally, logs can be used to check for satellite visibility and data reception (TRACKSTAT log, LBANDTRACKSTAT log).</p> <p>The HWMONITOR log can be used to monitor various voltage levels on the receiver.</p>
PV line	Position Valid	This signal line is asserted when the receiver has a valid position.
ME_RDY	Receiver is ready	This signal line is asserted when the receiver has completed its internal boot process and is ready to begin processing commands and operate as a GNSS receiver.
ERROR	Receiver has encountered an error condition	<p>This signal is asserted when the receiver has detected an error condition from which it cannot recover. This could be due to a hardware error or the detection of internally inconsistent data or operation.</p> <p>The exact receiver error is shown in the RXSTATUS log.</p>
STATUS_GREEN and STATUS_RED	Red and green LED signals	<p>These signals are used to indicate the state of the receiver or provide error codes. These outputs provide the same information as the Status Indicator LED on OEM7 receiver cards. Refer to Status LED on the OEM7 User Documentation portal (docs.novatel.com/OEM7) for information about using the Status LED for troubleshooting.</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;">  These outputs are used to drive the Status Indicator LED on the OEM7500 Evaluation Kit. </div>

Chapter 4 Firmware Upgrade

If the firmware needs to be updated, NovAtel provides two methods of updating the firmware image:

- Using Softload commands. While the receiver is running, Softload commands can be used to download a firmware image to the receiver. This download can be done over any communication port: COM1, COM2, COM3 and USB. Alternatively, a host controller can issue the Softload commands over COM1, COM2 or COM3 to download new firmware to the receiver module. See the OEM7 User Documentation portal (docs.novatel.com/OEM7/Content/Firmware_Update/Updating_Using_SoftLoad.htm) for information..
- Using NovAtel Application Suite (NAS). NAS is a software program that can be used to upgrade the firmware on the OEM7500. NAS can be downloaded from novatel.com/products/firmware-options-pc-software/novatel-application-suite. For information about using NAS, see docs.novatel.com/Tools.



Ensure that proper voltage levels are used when communicating between the OEM7500 and the computer. Applying high voltages to COM1, COM2 and COM3 pins can damage the OEM7500.

APPENDIX A OEM7500 Technical Specifications

See the following sections for more information about the OEM7500:

Table 9: OEM7500 Physical Description

Size	35 mm x 55 mm x 4 mm
Weight	12 grams

- *OEM7500 Performance Specifications* on the next page
- *OEM7500 Electrical and Environmental Specifications* on page 37
- *OEM7500 Absolute Maximum Ratings* on page 39
- *OEM7500 Data Communication Specifications* on page 40
- *Module Pinout and Descriptions* on page 15

A.1 OEM7500 Performance Specifications

All specifications subject to GNSS system characteristics.

Table 10: OEM7500 Receiver Performance

Signals Tracked ¹	GPS	L1 C/A, L1C, L2C, L2P, L5
	GLONASS	L1 C/A, L2 C/A, L2P, L3
	BeiDou	B1I, B1C, B2I, B2a, B2b
	Galileo ²	E1, E5 AltBOC, E5a, E5b
	NavIC (IRNSS)	L5
	QZSS	L1 C/A, L1C, L1S, L2C, L5
	SBAS	L1, L5
	L-Band	Up to 5 channels
Position Accuracy ³	Single point L1	1.5 m RMS
	Single point L1/L2	1.2 m RMS
	SBAS ⁴	60 cm RMS
	DGPS	40 cm RMS
	TerraStar-L ⁵	40 cm RMS
	TerraStar-C PRO ⁵	2.5 cm RMS
	RTK	1 cm + 1 ppm RMS
Time to First Fix	Hot: <20 s (Almanac and recent ephemeris saved and approximate position and time entered) Cold: <34 s (No almanac or ephemeris and no approximate position or time)	
Signal Reacquisition	<0.5 s L1 (typical) <1.0 s L2 and L5 (typical)	
Data Rates	Measurements	up to 100 Hz
	Position	up to 100 Hz

¹Software selectable; signal plan 1 includes GPS L1/L2, GLO L1/L2, BDS B1/B2, GAL E1/E5b, QZSS L1/L1C/L2C, available Q1 2018; signal plan 2 includes GPS L1/L2/L5, GLO L1, BDS B1/B2, GAL E1/E5a/E5b/AltBOC, IRNSS L5, QZSS L1/L1C/L2C/L5.

²E1bc support only.

³Typical values under ideal, open sky conditions.

⁴GPS-only.

⁵Requires a TerraStar subscription which is available direct from NovAtel novatel.com/products/gps-gnss-correction-services/terrestar-correction-services.

Time Accuracy ¹	<5 ns RMS			
Velocity Accuracy	<0.03 m/s RMS			
Measurement Precision ²			Code	Carrier
	GPS	L1 C/A	4 cm	0.5 mm
		L2 P(Y)	8 cm	1.0 mm
		L2C	8 cm	0.5 mm
		L5	3 cm	0.5 mm
	GLONASS	L1 C/A	8 cm	1.0 mm
		L2 P	8 cm	1.0 mm
		L2 C/A	8 cm	1.0 mm
	Galileo	E1	3 cm	0.5 mm
		E5a	3 cm	0.75 mm
		E5b	3 cm	0.75 mm
		E5 AltBOC	3 cm	0.75 mm
	BeiDou	B1I	4 cm	0.5 mm
		B1C	3 cm	0.5 mm
		B2I	4 cm	0.5 mm
		B2a	3 cm	0.5 mm
B2b ³		3 cm	0.5 mm	
Velocity Limit ⁴	600 m/s			

¹Time accuracy does not include biases due to RF or antenna delay.

²Measurement precision should be compared with measurements using the same correlator spacing.

³Under good CN0 conditions, e.g. 44 dBHz.

⁴Export licensing restricts operation to a maximum of 600 m/s, message output impacted above 585 m/s.

A.2 OEM7500 Electrical and Environmental Specifications

Table 11: OEM7500 Environmental Specifications

Operating Temperature	-40°C to +85°C
Storage Temperature	-55°C to +95°C
Humidity	95% non-condensing at 40°C
Random Vibration	MIL-STD-810G, Method 514.7, Category 24 (7.7 g RMS)
Sinusoidal Vibration	IEC 60068-2-6 (5.0 g)

Table 12: OEM7500 Power Requirements

Input Voltage	VDD +1.2 VDC +5%/-3% VCC +3.3 VDC ±5%
Power Consumption	0.9 W typical, GPS L1 only 1.3 W typical, GPS L1/L2, GLONASS L1/L2 1.5 W typical, all constellations, all frequencies, plus L-Band
Inrush Current	1.7 A for less than 1.5 ms (3.3 VDC) No inrush current for 1.2 VDC

Table 13: OEM7500 Signals to Module Interfaces

GNSS RF In	1
UART Up to	3
USB 2.0 (Device, 12 Mbit/s) ¹	1
SPI (Host for IMU only)	1
PPS (Timemark)	1
Event In	2
Event Out	1
CAN Bus	1
External LNA power control GPIO	2

¹USB driver available for Windows.

Table 14: OEM7500 RF Input

RF Input Frequencies	GPS L1:	1575.42 MHz
	GPS L2:	1227.60 MHz
	GPS L5:	1176.45 MHz
	GLONASS L1:	1593-1610 MHz
	GLONASS L2:	1237-1254 MHz
	GLONASS L3:	1202.025 MHz
	Galileo E1:	1575.42 MHz
	Galileo E5a:	1176.45 MHz
	Galileo E5b:	1207.14 MHz
	Galileo E5:	1191.795 MHz
	BeiDou B1I:	1561.098 MHz
	BeiDou B1C:	1575.42 MHz
	BeiDou B2I:	1207.14 MHz
	BeiDou B2a:	1176.45 MHz
	BeiDou B2b:	1207.14 MHz
L-Band:	1545 to 1560 MHz	

A.3 OEM7500 Absolute Maximum Ratings

Table 15: Absolute Maximum Ratings

Symbol	Parameter	Minimum	Maximum	Units
V_{DD}	Digital core power supply voltage	-0.5	1.6	V
V_{CC}	Module power supply voltage	-0.5	4.6	V
USB_VBUS	USB VBUS	-0.5	5.25	V
V_I/V_O	Module Inputs / Outputs	-0.5	$V_{CC} + 0.5V$ ($\leq 4.6V$)	V
V_{ESD}	Static discharge (HBM)		2000	V
P_{RFIn}	Input power at RF_in (Source impedance 50 Ω , continuous wave)		10	dBm
$T_{storage}$	Storage temperature	-55	95	$^{\circ}C$



The absolute maximum ratings shown above indicates the absolute maximum ratings for the module. Stresses outside of these limits may result in permanent damage to the device. Functional operation of the device is not implied or guaranteed under these conditions.

A.4 OEM7500 Data Communication Specifications

Table 16: Data Communications Interface

COM1	
Electrical format	LVC MOS
Data rates ¹	2400, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400 or 460800 bit/s.
Signals supported	COM1_Tx, COM1_Rx
Electrostatic discharge protection	Yes
COM2	
Electrical format	LVC MOS
Data rates ¹	2400, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400 or 460800 bit/s.
Signals supported	COM2_Tx, COM2_Rx
Electrostatic discharge protection	Yes
COM3	
Electrical format	LVC MOS
Data rates ¹	2400, 4800, 9600 (default), 19200, 38400, 57600, 115200, 230400 or 460800 bit/s.
Signals supported	COM3_Tx, COM3_Rx
Electrostatic discharge protection	Yes
CAN Bus	
Electrical Format	LVC MOS
Data rates	1 Mbps maximum. CAN Bus throughput is determined by slowest device on the bus
Signals supported	CAN1(+), CAN1(-)
USB	
Electrical format	Conforms to USB 2.0
Data rates	Full-speed (12 Mb/s)
Signals supported	USB D+, USB D-

¹Data rates higher than 115200 bit/s are not supported by standard PC hardware. Special PC hardware may be required for higher rates, including 230400 bit/s and 460800 bit/s.

²CAN Bus behavior must be asserted through the NovAtel API software.

