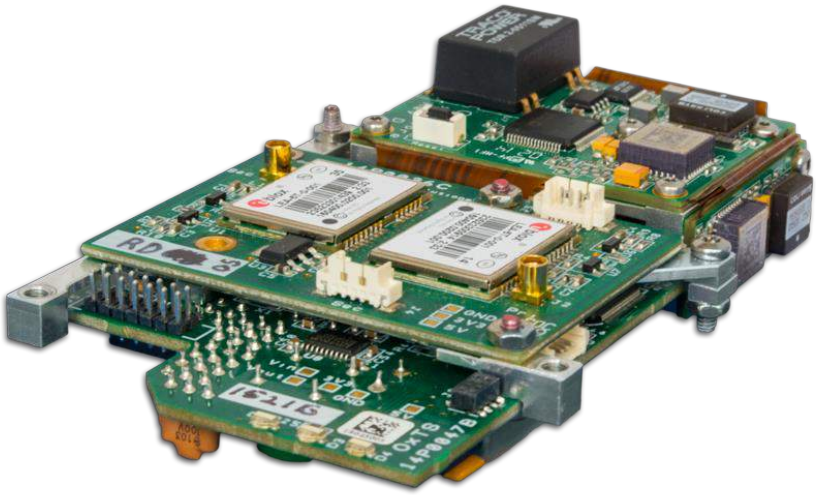
xOEM500

Inertial and GNSS measurement system



Hardware Integration Manual

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Revision

Document Revision: 141016 *(See Revision History for detailed information).*

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Introduction

Thank you for choosing the xOEM500. This OEM board set version of the xNAV500 combines embedded dual GNSS receivers and tactical-grade IMU in one easy to integrate package. The compact form factor does not sacrifice accuracy, it provides system integrators with a high performance GNSS-aided inertial navigation system perfect for any application where continuous position and orientation is required.

The xOEM500 retains all the features and performance of the xNAV500, including dual GNSS receivers, real-time 100 Hz outputs, DGPS corrections, tight-coupling and advanced gx/ix processing technology, but without an enclosure. This cuts the weight by more than half and makes the xOEM500 ideal for integrating into space limited or weight restricted systems. Standard NMEA messages and a 1PPS signal are available to synchronise with other sensors and decoders are freely available for the full NCOM outputs.

This manual covers the technical information required to successfully integrate the xOEM500 into your system. For information on configuring and operating the xOEM500, please see the full xNAV User Manual. The following chapter lists additional available documentation that may be of use when using the xOEM500. It is beyond the scope of this manual to provide details on service or repair. Contact OxTS support or your local representative for any customer service related inquiries.

Related documents

There are separate manuals available for further information on some of the software and communication types mentioned in this manual. Table 1 lists related manuals and where to find them.

Table 1. Supplementary manuals

Manual	Description
xNAV User Manual	User manual covering the full operation of the xNAV systems. The xOEM500 behaves identically to the xNAV500. http://www.oxts.com/Downloads/Support/Manuals/xNAV_manual.pdf
NAVgraph Manual	User manual for the graphing and display software NAVgraph. www.oxts.com/Downloads/Support/Manuals/NAVgraphman.pdf
NCOM Manual	NCOM description manual. www.oxts.com/Downloads/Support/NCOM Manual and Code Drivers/ncomman.pdf
NCOM C Code Drivers	A collection of C functions that can be used to decode the binary protocols from the xOEM. www.oxts.com/Downloads/Support/NCOM Manual and Code Drivers/ncomrx.zip
NMEA 0183 Description	NMEA description manual for the NMEA outputs. www.oxts.com/Downloads/Support/NMEA/nmeaman.pdf
RT Post-process Manual	User manual for the post-processing software RT Post-process. www.oxts.com/Downloads/Support/Manuals/rtppman.pdf

Precautions

The xOEM500 contains delicate, exposed electronic circuits and components that can be damaged by electrostatic discharge (ESD). When handling, care must be taken so that the device is not damaged. Damage due to inappropriate handling is not covered by the warranty.

Prior to installation it is recommended to carefully read this manual and ensure the following precautions are taken:

- Do not open the protective packaging until you have read the following, and are at an approved anti-static work station.
- It is best to wear an ESD wrist strap when handling electronic components. If you do not have an ESD wrist strap, keep your hands dry and first touch a metal object to eliminate static electricity.
- When handling the system, avoid touching any metal leads or connectors.
- If working on a prototyping board, use a soldering iron or station that is marked as ESD-safe.
- Always discharge yourself by touching a grounded bare metal surface or approved anti-static mat before picking up an ESD-sensitive electronic component.
- Use an approved anti-static mat to cover your work surface.

Compliance testing

OxTS has not carried out any regulatory compliance testing for this product as it is solely intended for system integration and development purposes. This product should not be used in an end user application without undergoing regulatory compliance testing as part of another complete product.

The xNAV500, the standard enclosed version of the xOEM500, has passed regulatory compliance testing so there is no reason to believe that the xOEM500 would affect the outcome of testing when properly integrated into an end product.

Hardware description

Overview

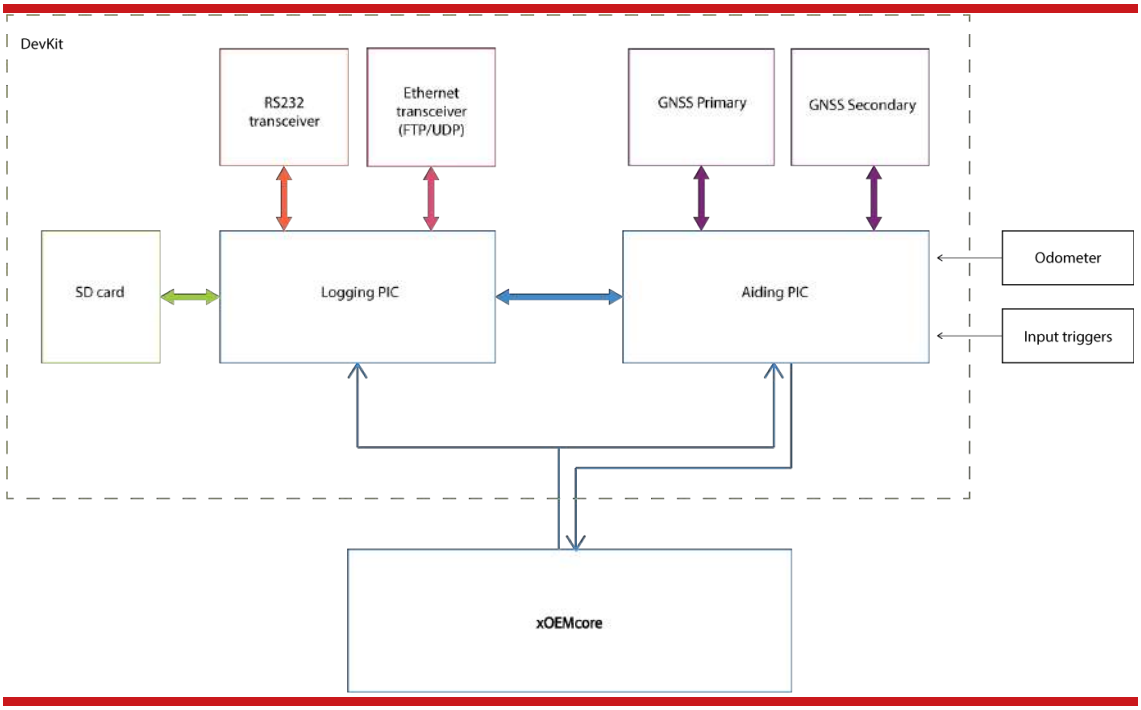
The xOEM500 is a miniature GNSS-aided inertial navigation system. It combines dual GNSS receivers with a tactical-grade IMU to provide a compact navigation solution.

The GNSS receivers are capable of tracking the GPS L1 frequency and SBAS giving sub-metre position accuracy. The dual receiver configuration allows greater heading accuracy with wider antenna baselines and ensures stable heading performance even when stationary and during low dynamics.

Architecture

The xOEM500 is made up of two main building blocks, the DevKit and the xOEMcore. The DevKit consists of the GNSS receivers, interfaces, logging and storage. The xOEMcore contains the IMU block and main processor. Figure 1 shows the xOEM500 block diagram.

Figure 1. xOEM500 block diagram



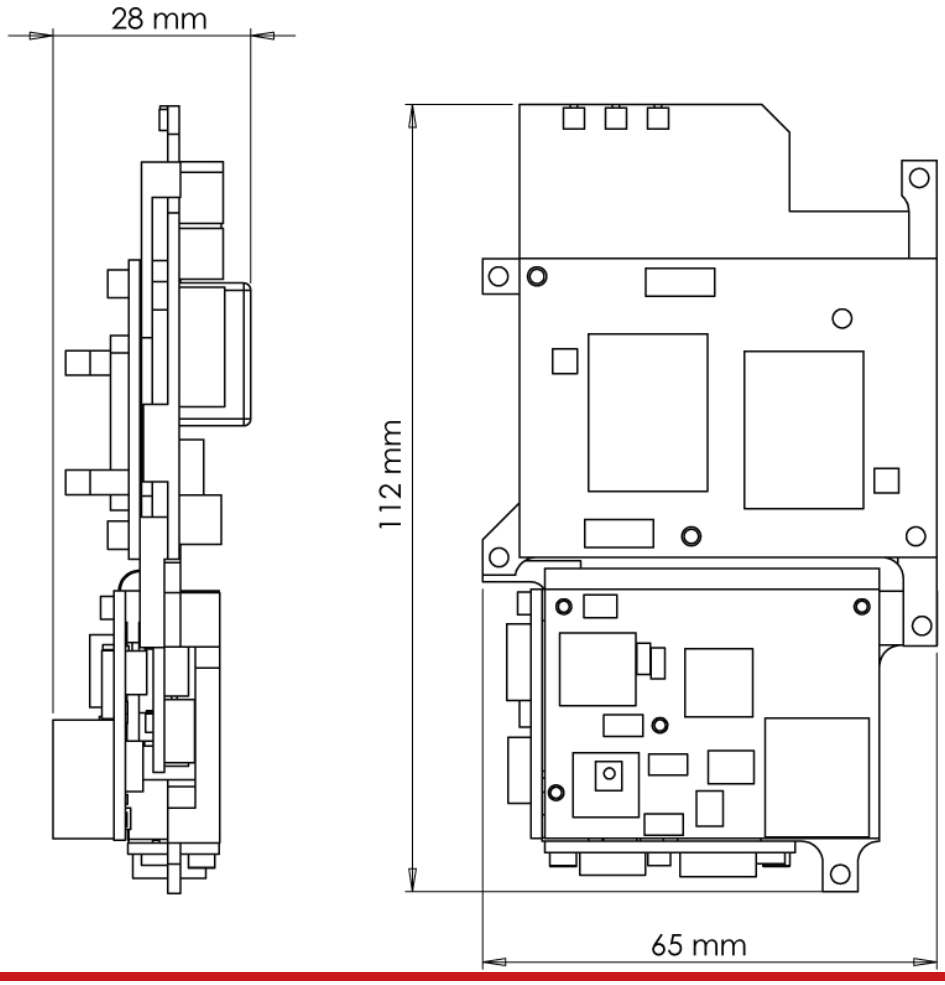
The xOEMcore houses the 6-axis IMU and the main processor that calculates the navigation solution. The DevKit feeds aiding data, configuration files and commands to

the xOEMcore; it takes raw data (rd) and navigation data from the xOEMcore, writes rd files and sends the navigation data out over serial and Ethernet interfaces.

Board dimensions

Figure 2 shows the outer dimensions of the xOEM500 board set.

Figure 2. xOEM500 dimensions



Board layout

Figure 3 shows the xOEM board layout with main components labelled. Table 2 lists details for the corresponding labels.

Figure 3. Layout of the xOEM500 board set

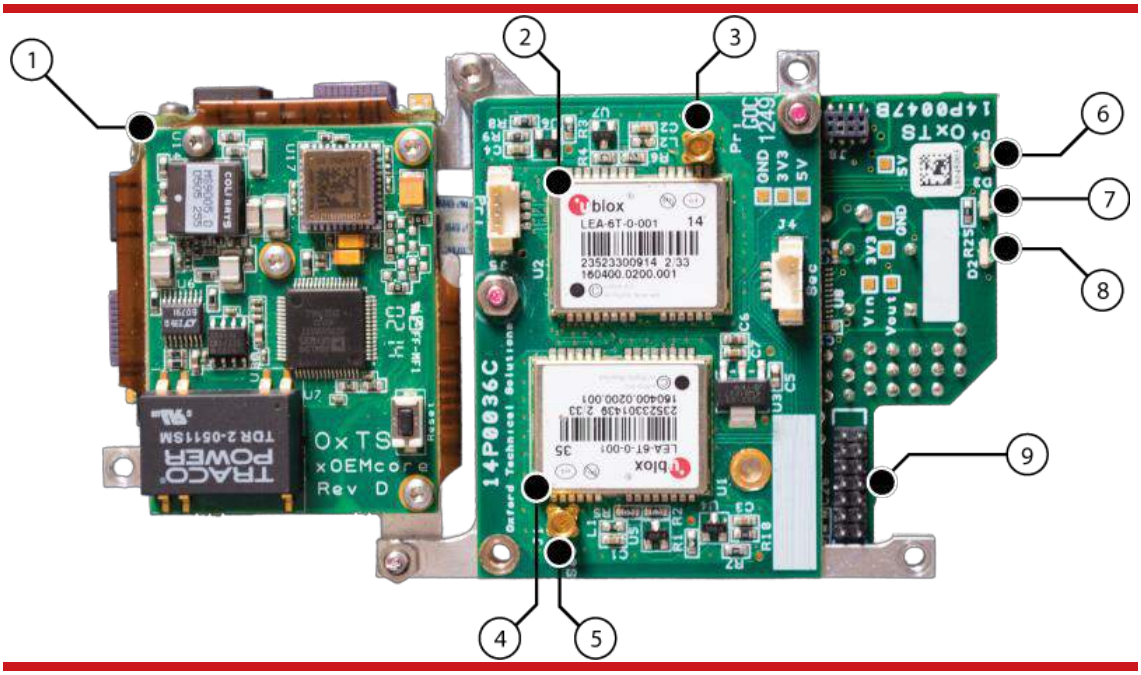


Table 2. xOEM500 board descriptions

Label no.	Description
1	xOEMcore
2	Primary GNSS receiver
3	Primary antenna connector
4	Secondary GNSS receiver
5	Secondary antenna connector
6	GNSS LED
7	Status LED
8	Power LED
9	Main connector pin header

LED definitions

Three LEDs on the xOEM500 board set show the system's state when power is applied. Table 3, Table 4, and Table 5 give details on the meanings of the states of each LED.

Table 3. GNSS LED states

Colour	Description
Off	GNSS receiver fault (valid only after start-up).
Red flash	GNSS receiver is active, but has been unable to determine heading.
Red	The GNSS has a differential heading lock.
Orange	The GNSS receiver has a floating (poor) calibrated heading lock.
Green	The GNSS receiver has an integer (good) calibrated heading lock.

Table 4. Status LED states

Colour	Description
Off	The operating system has not yet booted and the program is not yet running. This occurs at start-up.
Red-green flash	The xOEM is asleep. Contact OxTS support for further information.
Red flash	The operating system has booted and the program is running. The GNSS receiver has not yet output a valid time, position, or velocity.
Red	The GNSS receiver has locked-on to satellites and has adjusted its clock to valid time (the 1PPS output will now be valid). The strapdown navigator is ready to initialise. If the vehicle is travelling faster than the value set for "Initialisation speed" during configuration then the strapdown navigator will initialise and the system will become active. If static initialisation has been enabled the system will initialise once the GNSS receiver has determined heading, even if the vehicle is stationary or moving slowly.
Orange	The strapdown navigator has initialised and data is being output, but the system is not real-time yet. It takes 10 s for the system to become real-time after start up.
Green	The strapdown navigator is running and the system is real-time.

Table 5. Power LED states

Colour	Description
Off	There is no power to the system or the system power supply has failed.
Green	Power is applied to the system.
Orange	The system is powered and traffic is present on Ethernet.

Connections

The main connector for the xOEM500 is a Samtec TMM-107-01-T-D. This is a 14 pin header with 2 mm spacing.

The antenna connectors are MMCX.

Co-ordinate frame and origin point

The xOEM500 uses a co-ordinate frame that is popular with most navigation systems. Figure 4 shows how the axes relate to the xOEM board. All measurements to and from the xOEM should be made from the measurement origin point shown in Figure 4.

Figure 4. xOEM co-ordinate frame and measurement origin

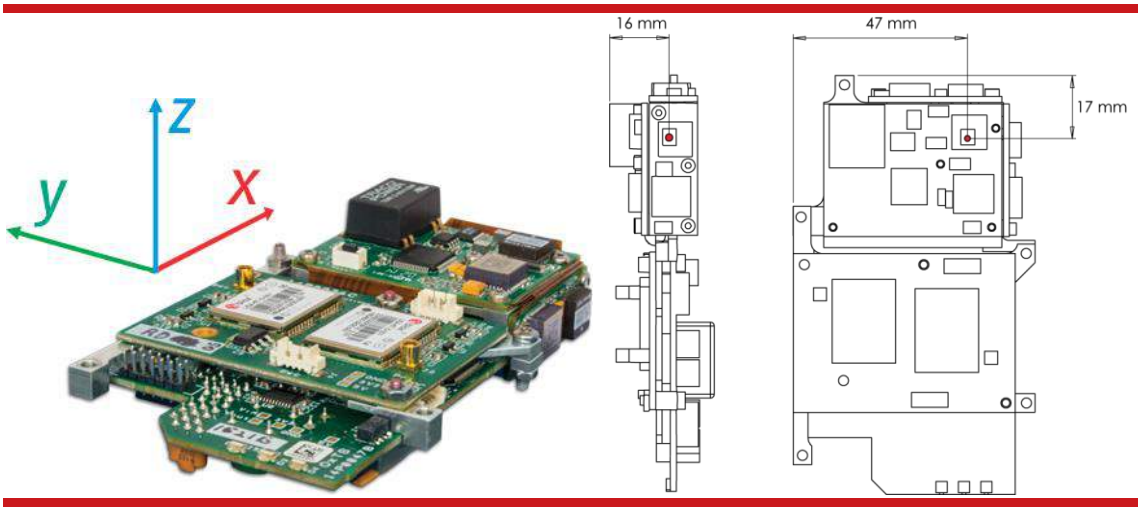


Table 6 lists the directions that the axes should point for zero heading, pitch and roll outputs when the default mounting orientation is used.

Table 6. Direction of axes for zero heading, pitch and roll outputs

Axis	Direction	Host axis
x	North	Forward
y	East	Right
z	Down	Down

The xOEM can be mounted in any orientation, it is not necessary for its axes to match those in Table 6. If a different mounting orientation is used then it must be specified in the configuration file. This can be accomplished with the NAVconfig software.

Design-in

Main connector

OxTS recommends that you mount directly to the xOEM500 with a connecting board using Samtec part SQW-107-01-F-D. 10 mm space should be left between the mounting points for the xOEM500 and the mounting points for the mating board to allow room for the two connectors. Alternative mating connectors are available from Samtec or from alternative suppliers but please note the Samtec cable assemblies cannot be used as they clash with the xOEM500 frame.

Connector pin out

Figure 5 shows the pin layout for the main connector on the xOEM500. Table 7 lists the pin numbers and their corresponding functions.

Figure 5. Connector pin layout

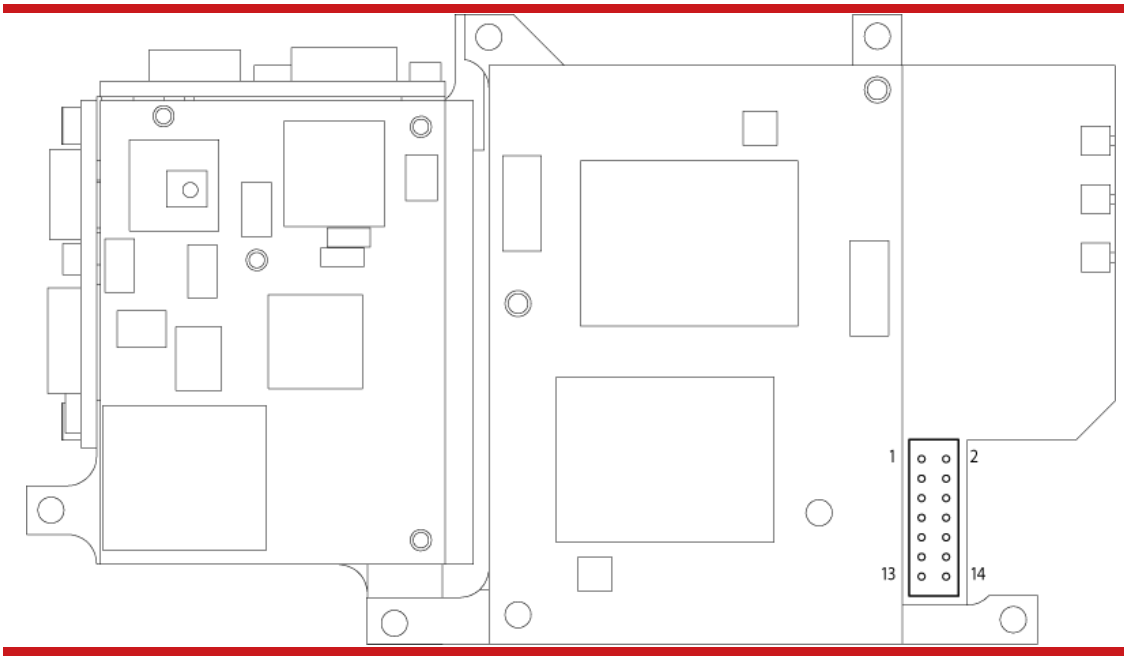


Table 7. Main connector pin allocations

Pin	Function	Description
1	- Supply	Power supply -
2	+ Supply	Power supply +
3	Trigger 2	Configurable trigger 2
4	Trigger 1	Configurable trigger 1
5	RS232 Rx	Serial RS232 receive
6	RS232 Tx	Serial RS232 transmit
7	Odometer 2	TTL input for quadrature odometer
8	Odometer 1	TTL input from odometer
9	Signal GND	Ground
10	1PPS	1 pulse per second output signal
11	ETX+	Ethernet transmit +
12	ERX-	Ethernet receive -
13	ETX-	Ethernet transmit -
14	ERX+	Ethernet receive +

Connector specifications

The power supply input for the xOEM500 is 10–31 V DC.

When configured as an input, the triggers see less than 0.6 V as low and more than 2.6 V as high. The input range should be kept between 0 V and 5 V. The inputs have pull-up resistors so they can be used with a switch or as a CMOS input. The resistors are 10 kΩ and pull-up to 3.3 V.

When configured as an output, the triggers have 0.8 V or less as low and 2.4 V or more as high. The pulse width is 1 ms.

The odometer input requires less than 0.8 V for a low pulse and more than 2.4 V for a high pulse. Limited protection is provided on this input, however the input voltage should not exceed 12 V.

The 1PPS signal is output from the primary GNSS receiver when a valid solution is found. The output is a low-voltage CMOS output where 0.8 V or less is low and 2.4 V or more is high.

Antennas

The xOEM500 GNSS modules receive L1 GPS signals at a nominal frequency of 1575.42 MHz. Antennas used with the xOEM500 must be capable of tracking this signal for correct operation.

The total preamplifier gain (minus cable and interconnect losses) must not exceed 50 dB. The total antenna noise figure should be below 3 dB.

When using the xOEM500 in a dual antenna configuration, it is recommended to use the same type of antenna with the same cable lengths for both the primary and secondary receivers.

Mounting

Figure 6 shows the mounting points and required clearances for the xOEM500. It is important when mounting the xOEM board sets not to stress the IMU mechanically in any way as this can change the alignment of the sensors and degrade the calibration.

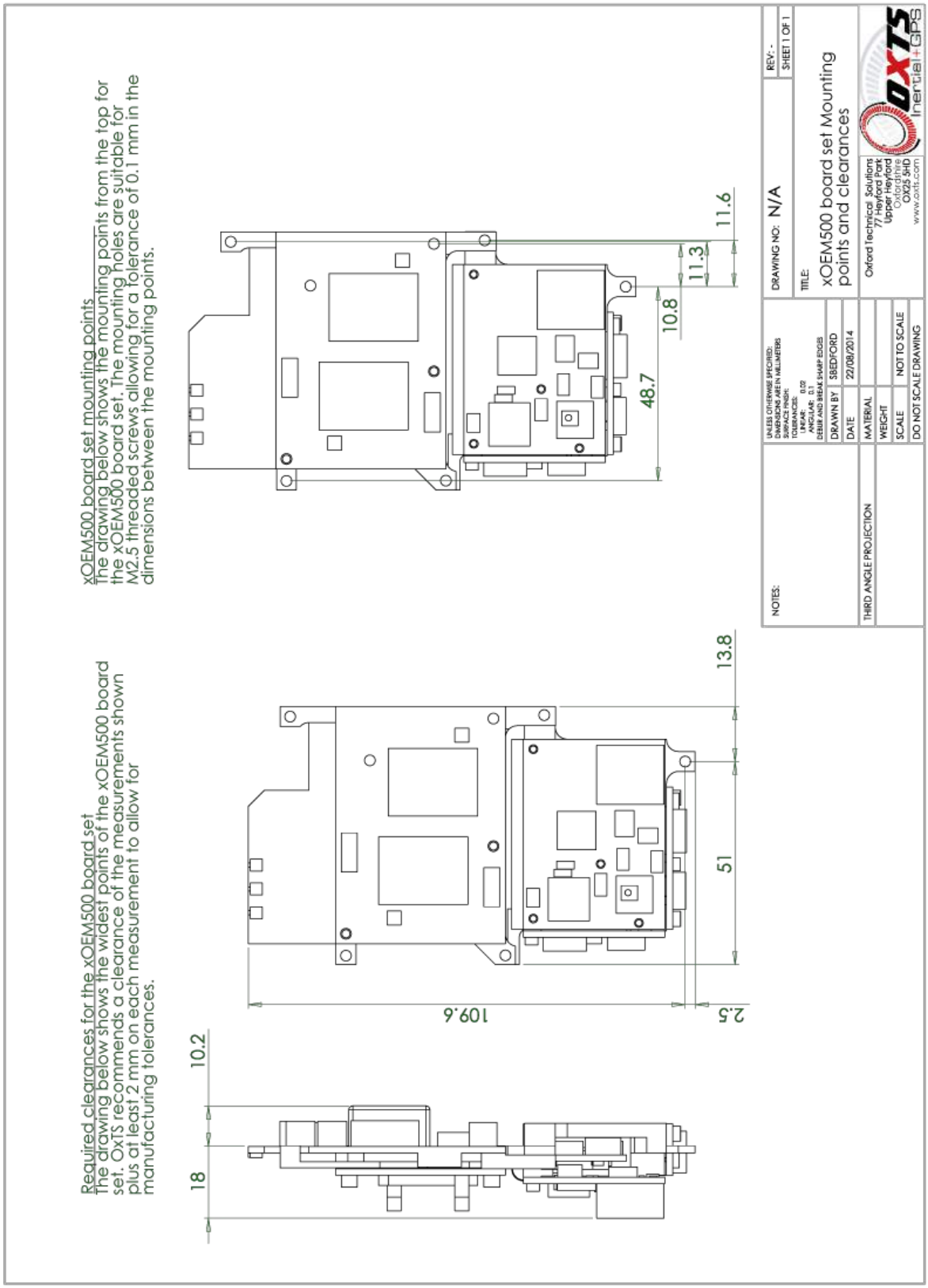
The mounting holes on the xOEM frame are suitable for M2.5 threaded screws. A torque setting of 0.4 Nm should be used. For general use in permanent installations, Loctite 270 threadlocker is recommended. Depending on the installation environment, different threadlock may be needed.

It is recommended that you mount all xOEM products so that the screws go into the mounting points from the top. This makes designing mounting points easier as all the mounting points are in the same plane. The height of the mounting points should all be within +/- 0.2 mm of each other so as to not stress the IMU. If mounting differently please refer to the mechanical models, which can be obtained by contacting OxTS directly, to determine the height required for the mounting points.

The xOEM500 is shipped with the two frames joined by two screws and nuts. These should be removed for mounting and care should be taken not to twist or pull on the FFC cable joining the two parts.

There is no reason that the two frames must be mounted joined in the same way. If you wish to mount them differently please refer to Figure 6 or the mechanical models for the mounting measurements. In this case all measurements and angles are in respect to the xOEMcore part of the arrangement.

Figure 6. Clearances and mounting points



Heat dissipation

The upper operating temperature of the xOEM500 board set is 70°C, therefore it should be mounted in a location where this temperature will not be exceeded. The xOEM500 is designed so that the excess heat is dissipated into its frame. The most effective way to keep it cool is to mount the frame to something thermally conductive and cool. Cooling can be aided by mounting in an area where air can circulate. It is also recommended that the metal canned DCDC converter on the bottom of the xOEM500 board set is thermally connected to something for cooling if possible.

Power consumption

As with other electronic devices the power consumption of the xOEM is affected by the environmental conditions it is operating in and by its power source. Tests carried out by OxTS have shown that the best power consumption is achieved with a 12 V power input and at room temperature (20–25°C). It is also recommended to not use excessively long antenna or power cables to reduce power loss in cabling.

Internal storage

The xOEM500 uses a 4 GB SD micro card for storage of hardware information, configuration files, and navigation data. The card must not be removed from the xOEM500. Files can be sent to or retrieved from the card via FTP or with the software utilities (NAVconfig for configuration files and RT Post-process for data files).

Specifications

Table 8. xOEM500 specification

Parameter	xOEM500
Positioning	GPS L1
Position accuracy (CEP)	2 m SPS 0.5 m DGPS
Velocity accuracy (RMS)	0.1 km/h
Roll/pitch	0.05° 1σ
Heading (2 m antenna baseline) (4 m antenna baseline)	0.15° 1σ 0.06° 1σ
Accelerometers – Bias stability – Linearity – Scale factor – Range	 0.05 mg 1σ 0.05% 0.02% 1σ 5 *g*
Gyros – Bias stability – Linearity – Scale factor – Range	 5°/hr 0.1% 0.05% 300°/s
Update rate	100 Hz
Power	10–31 V dc, 7 W
Dimensions	112 x 65 x 28 mm
Mass	0.12 kg
Operating temperature	-40°–70°C
Vibration	0.002 g^2/Hz, 5–500 Hz
Shock survival	>1000 *g*
Internal storage	4 GB

Valid for open-sky conditions over ± 1 *g* range.

Revision history

Table 9. Revision history

Revision	Comments
141016	Initial version.