MTi 600-series User Manual

User Manual

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Created: Monday, November 29, 2021

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This document provides information on the usage and technical details of the MTi 600-series. The MTi 600-series module (MTi-600) is a fully functional, self-contained module that is easy to design-in. The MTi-600 module (IP51) can be connected to a host through RS232, CAN or UART interfaces, or through USB using the UART to USB converter (included in the MTi 600-series Development Kit). In contrast, the MTi 600-series robust trackers (MTi-630R, MTi-670G and MTi-680G) are rugged (IP68) devices which can be connected to a host through RS232 or CAN interface, or through USB using the RS232 to USB converter dongle (included in the MTi 600-series Starter Kit).

The *MTi Family Reference Manual* supplements this document. It reports generic information on the MTi 1-series and MTi 600-series, such as output definitions, algorithm details and installation tips.

The *MTi 600-series Hardware Integration Manual* supplements this document. In this document, notes on typical application scenarios, printed circuit board (PCB) layout, origin of measurement reference system, stress related considerations, reference designs and handling information can be found.

For testing and prototyping, Xsens provides the MTi-630, MTi-670 and MTi-680 Development Kits (MTi-630-DK, MTi-670-DK and MTi-680-DK) as well as Starter Kits (SK) for the robust MTi-630R, MTi-670G and MTi-680G. In addition to the RS232, CAN and UART pin connectors of the MTi 600-series module, the Development Kit offers a direct USB, RS232, RS422 and CAN interface. Technical details of the Development Kit and its usage can be found in the *MTi 600-series DK User Manual*.

The *MT Low Level Communication Protocol* document provides a complete reference for the protocols used to communicate with Xsens Motion Trackers on low-level basis. The MT Low Level Communication Protocol document also describes the synchronization messages and settings in detail.

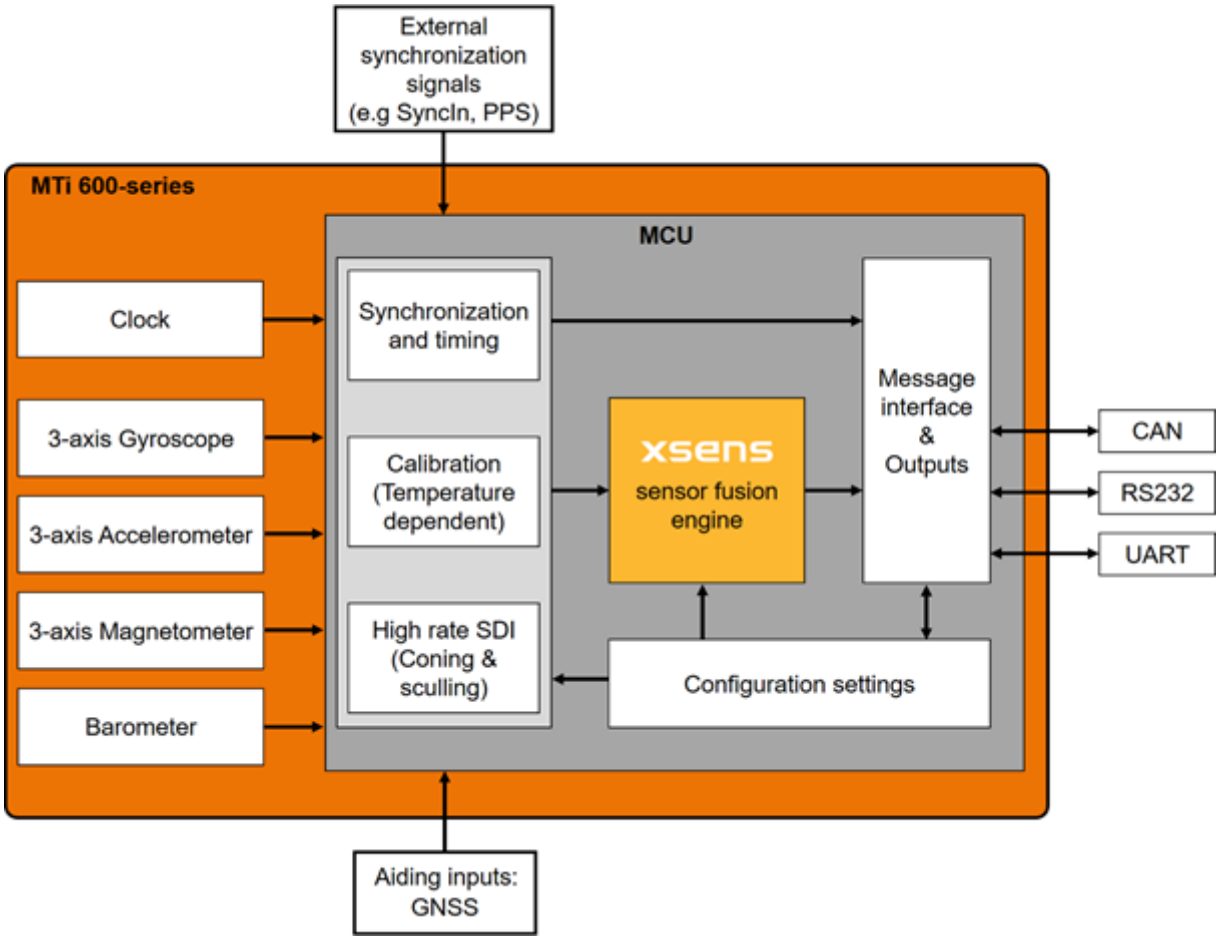
Ordering information

Ordering information for MTi 600-series products

Part Number	Description	Packing
MTi-610	IMU Inertial data	Box (MOQ 5 units)
MTi-620	VRU Inertial data, roll/pitch/yaw (unreferenced)	Box (MOQ 5 units)
MTi-630	AHRS Inertial data, roll/pitch/yaw (referenced)	Box (MOQ 5 units)
MTi-630R	AHRS Inertial data, roll/pitch/yaw (referenced)	Box
MTi-670	GNSS/INS Inertial data, roll/pitch/yaw (referenced), velocity, position	Box (MOQ 5 units)
MTi-670G	GNSS/INS Inertial data, roll/pitch/yaw (referenced), velocity, position	Box
MTi-680	RTK GNSS/INS Inertial data, roll/pitch/yaw (referenced), velocity, position	Box (MOQ 5 units)
MTi-680G	RTK GNSS/INS Inertial data, roll/pitch/yaw (referenced), velocity, position	Box
MTi-630-DK	Development Kit for MTi-630 AHRS (also applicable for MTI-610 IMU and MTi-620 VRU)	Box
MTi-630R-SK	Starter Kit for MTi-630R AHRS	Box
MTi-670-DK	Development Kit for MTi-670 GNSS/INS	Box
MTi-670G-SK	Starter Kit for MTi-670G GNSS/INS	Box

Part Number	Description	Packing
MTi-680-DK	Starter Kit for MTi-680 RTK GNSS/INS	Box
MTi-680G-SK	Starter Kit for MTi-680G RTK GNSS/INS	Box

MTi 600-series architecture



MTi 600-series module diagram

The diagram in the figure above shows a simplified architecture of the MTi 6x0-series module. The MTi-6x0 contains a 3-axis gyroscope, 3-axis accelerometer, 3-axis magnetometer, barometer, a high-accuracy crystal and a low-power micro controller unit (MCU). The MTi-670/680 module can also accept signals from an external GNSS receiver. The MCU coordinates the timing and synchronization of the various sensors. The module offers the possibility to use external signals in order to accurately synchronize the clock and/or outputs of the MTi-6x0 with any user application. The MCU applies calibration models (unique to each sensor and including orientation, gain and bias offsets, plus more advanced relationships such

as non-linear temperature effects and other higher order terms) and runs the Xsens optimized strapdown algorithm, which performs high-rate dead-reckoning calculations up to 2 kHz, allowing accurate capture of high frequency motions and coning & sculling compensation. The Xsens sensor fusion engine combines all sensor inputs and optimally estimates the orientation, position and velocity at an output data rate of up to 400 Hz. The output data of the MTi-600 is easily configured and customized for an application's needs and can be set to use one of various filter profiles available within the Xsens sensor fusion engine. In this way, the MTi-600 limits the load and the power consumption on the user application's processor. The user can communicate with the module by means of three different communication interfaces; RS232, CAN and UART[1]. Other interfaces are available using an MTi Development Kit or by using third party equipment (e.g. UART/RS232 to USB converter).

Contrary to the above image, the robust MTi-670G and MTi-680G include an internal GNSS receiver.

MTi 600-series product variants

The MTi-6x0 module is a fully tested self-contained module available as an:

- Inertial Measurement Unit (IMU),
- Vertical Reference Unit (VRU),
- Attitude and Heading Reference System (AHRS)
- GNSS aided Inertial Navigation System (GNSS/INS).

It can output 3D orientation data (Euler angles, rotation matrix or quaternions), orientation and velocity increments (Δq and Δv), position and velocity quantities and calibrated sensor data (acceleration, rate of turn, magnetic field and pressure). Depending on the product variant, output options may differ.

MTi-610 IMU

The MTi-610 module is an IMU that outputs calibrated 3D rate of turn, 3D acceleration, 3D magnetic field and barometric pressure. The MTi-610 also outputs coning and sculling compensated orientation increments and velocity increments (Δq and Δv). Advantages over a simple gyroscope-accelerometer combo-sensor are the inclusion of synchronized magnetic field and barometric data, on-board signal processing and the easy-to-use synchronization and communication protocol. The signal processing pipeline and the suite of output options allow access to the highest possible accuracy at any output data rate up to 2000 Hz. Moreover, the

testing and calibration is already performed by Xsens and results in a robust and reliable sensor module, which enables a short time to market for the users.

MTi-620 VRU

The MTi-620 is a 3D VRU. On top of the functionality of the MTi-610 IMU, its algorithm computes 3D orientation data with respect to a gravity referenced frame: drift-free roll, pitch and unreferenced yaw. Although the yaw is unreferenced, it is superior to only gyroscope integration as a result of advanced on-board sensor fusion. The 3D acceleration is also available as so-called free acceleration, which has the local-gravity subtracted. The drift in unreferenced heading can be limited by using the Active Heading Stabilization (AHS) functionality, see Signal processing and algorithms for more details. The raw sensor signals are combined and processed at a high frequency to produce a real-time data stream with device's 3D orientation (roll, pitch and yaw) up to 400 Hz.

MTi-630(R) AHRS

The MTi-630 supports all features of the MTi-610 and MTi-620, and in addition is a full magnetometer-enhanced AHRS. In addition to the roll and pitch, it outputs a yaw (heading) output that is referenced to the Earth's magnetic field and calibrated sensor data: 3D acceleration, 3D rate of turn, 3D orientation and velocity increments (Δq and Δv) and 3D magnetic field data. The raw sensor signals are combined and processed at a high frequency to produce a real-time data stream with the device's 3D orientation (roll, pitch and yaw) up to 400 Hz.
In contrast to the MTi-630, the MTi-630**R** comes as a robust (IP68) module.

MTi-670(G) GNSS/INS

The MTi-670 provides a GNSS/INS solution offering a position and velocity output in addition to orientation estimates. The MTi-670 uses advanced sensor fusion algorithms developed by Xsens to synchronize the inputs from the module's on-board gyroscope, accelerometer, magnetometer and barometer, with the data from an external GNSS receiver. The raw sensor signals are combined and processed at a high frequency to produce a real-time data stream with device's 3D position, velocity and orientation (roll, pitch and yaw) up to 400 Hz.
In contrast to the MTi-670, the MTi-670**G** comes as a robust (IP68) module with an integrated GNSS receiver.

MTi-680(G) RTK GNSS/INS

The MTi-680 provides a GNSS/INS solution offering a centimeter-accurate position and velocity output in addition to orientation estimates. The MTi-680 uses advanced sensor fusion algorithms developed by Xsens to synchronize the inputs from the module's on-board gyroscope, accelerometer, magnetometer and barometer, with the data from an external, RTK-enabled GNSS receiver. The raw sensor signals are combined and processed at a high frequency to produce a real-time data stream with device's 3D position, velocity and orientation (roll, pitch and yaw) up to 400 Hz.
In contrast to the MTi-680, the MTi-680G is a robust tracker that uses an internal L1/L2 RTK enabled GNSS receiver.

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[1] UART port is not available on robust trackers (MTi-630R, MTi-670G, MTi-680G)

Sensor Specifications

This section presents the performance and the sensor component specifications for the calibrated MTi-6x0 series products. Each product has passed the Xsens calibration process individually. The Xsens calibration procedure calibrates for many parameters, including bias (offset), alignment of the sensors with respect to the PCB and to each other, and gain (scale factor). All calibration values are temperature dependent and temperature calibrated. The calibration values are stored in the non-volatile memory of the module.
In addition, some calibration parameters are continuously improved and/or re-estimated through the on-board sensor fusion algorithms during normal operation of the product.

MTi 600-series performance specifications

Orientation performance specifications

Parameter	Condition	MTi-610 IMU	MTi-620 VRU	MTi-630(R) AHRS	MTi-670(G) GNSS/INS	MTi-680(G) RTK GNSS/INS
Roll/Pitch	Static [RMS]	N/A	0.2°	0.2°	0.2°	0.2°
	Dynamic (car, 25m/s) [RMS]	N/A	0.25°	0.25°	0.25°	0.25°
Yaw	Dynamic (car, 25m/s) [RMS]	N/A	Unreferenced	1°	0.8°	0.5°

Position and velocity performance specifications for MTi-670-DK and MTi-670G-SK

Parameter	Direction	Specification	Dynamic (car, 25m/s)
Position	Horizontal [CEP]	<1.0 m	<1.0 m
	Vertical [CEP]	2.0 m	2.0 m
Velocity	3D [RMS]	0.05 m/s	0.05 m/s

Position and velocity performance specifications for MTi-680-DK and MTi-680G with RTK correction signals provided

Parameter	Direction	Specification	Dynamic (car, 25m/s)
Position	Horizontal [CEP]	0.01 m	<0.05 m
	Vertical [CEP]	0.1 m	0.1 m
Velocity	3D [RMS]	0.05 m/s	0.05 m/s

The specifications mentioned in tables above are with Development/Starter Kit reference designs.

MTi 600-series sensor specifications

MTi 600-series gyroscope specifications

Gyroscope specification[1]	Unit	Value
Standard full range	[°/s]	±2000
In-run bias stability	[°/h]	8
Bandwidth (-3dB)	[Hz]	520
Noise density	[°/s/√Hz]	0.007
g-sensitivity (calibrated)	[°/s/g]	0.001
Non-linearity	[%FS]	0.1
Scale Factor variation	[%]	0.5 (typical) 1.5 (over life)

MTi 600-series accelerometer specifications

Accelerometer[1]	Unit	Value
Standard full range	[g]	±10
In-run bias stability (x, y)	[µg]	10
In-run bias stability (z)	[µg]	15
Bandwidth (-3dB)	[Hz]	500
Noise density	[µg/√Hz]	60

Accelerometer[1]	Unit	Value
Non-linearity	[%FS]	0.1

MTi 600-series magnetometer specifications

Magnetometer[1]	Unit	Value
Standard full range	[G]	±8
Non-linearity	[%]	0.2
Total RMS noise	[mG]	1
Resolution	[mG]	0.25

MTi 600-series barometer specifications

Barometer[1]	Unit	Value
Full range	[hPa]	300-1250
Total RMS Noise	[Pa]	1.2
Relative accuracy	[Pa]	±8 [2]

MTi 600-series orthogonality specifications

Parameter[1]	Unit	Value
Non-orthogonality (accelerometer)	[°]	0.05
Non-orthogonality (gyroscope)	[°]	0.05
Non-orthogonality (magnetometer)	[°]	0.05

MTi-670G and MTi-680G internal GNSS receiver specifications

GNSS[1]		Unit	Value	Note
Acquisition	Cold start	[s]	24 [3]	
	Hot start	[s]	2	
Convergence time	RTK	[s]	< 10 [4]	MTi-680G only
Horizontal pos. accuracy	PVT	[m]	1.5	

GNSS[1]		Unit	Value	Note
	RTK[5]	[m]	0.01	MTi-680G only
Vertical pos. accuracy	RTK[5]	[m]	0.01	MTi-680G only
Supported GNSS signals:				
GPS	L1C/A	[MHz]	1575.42	
	L2C	[MHz]	1227.60	
GLONASS	L1OF	[MHz]	1598.0 - 1605.4	
	L2OF	[MHz]	1242.9 – 1248.6	
Galileo	E1-B/C	[MHz]	1575.42	
	E5b	[MHz]	1207.14	
BeiDou	B1I	[MHz]	1561.098	
	B2I	[MHz]	1207.14	

[1] As Xsens continues to update the sensors on the module, these specifications are subject to change.
[2] Equivalent to 0.5 m.
[3] Using GPS + GLONASS + Galileo + BeiDou.
[4] < 30 s for GPS only.
[5] Measured using 1 km baseline and patch antennas with good ground planes. Does not account for possible antenna phase center offset errors.

Functional description

This chapter describes the MTi 600-series pinout and gives details about the supported communication interfaces.

Pin description module

The pin map below shows the peripheral interfaces.

Pin configuration of the MTi 600-series module (bottom view)

Pin descriptions of the MTi 600-series module

Pin	Name	I/O type	Description
1	VIN	PWR	Power input
2	GND	PWR	Ground
3	CAN_H	I/O	CAN bus differential high side
4	CAN_L	I/O	CAN bus differential low side

Pin	Name	I/O type	Description
5	RS232_TxD	O	RS232 transmitter output to host
6	RS232_RTS	O	RS232 Ready To Send output to host
7	RS232_RxD	I	RS232 receiver input from host
8	RS232_CTS	I	RS232 Clear To Send input from host
9	SYNC_IN1	I	Multifunctional synchronization input
10	SYNC_IN2	I	Multifunctional synchronization input
11	GNSS_TxD[1]	O	RS232 transmitter output to GNSS module
12	GNSS_RxD9	I	RS232 receiver input from GNSS module
13	SYNC_OUT	O	Configurable synchronization output
14	GND	PWR	Ground
15	UART_TxD	O	UART transmitter output
16	UART_RxD	I	UART receiver input

[1] Only available for MTi-670. Do not connect for other models.

Pin description robust trackers (MTi-630R/670G/680G)

The figure below shows the three connectors on the rugged housing of the MTi-670G/680G. The MTi-630R only features the Host Interface connector.

Connectors and pin numbers on the MTi-670G/680G housing

The table below shows the pin descriptions of the MTi-630R/670G/680G Host Interface connector.

Pin descriptions MTi-630R/670G/680G Host Interface

Pin	Name	I/O type	Description
1	CAN_H	I/O	CAN bus differential high side
2	CAN_L	I/O	CAN bus differential low side
3	SYNC_IN1	I	Multifunctional synchronization input
4	SYNC_IN2	I	Multifunctional synchronization input
5	VIN	PWR	Power input
6	RS232_CTS	I	RS232 Clear To Send input from host
7	RS232_RxD	I	RS232 receiver input from host
8	RS232_TxD	O	RS232 transmitter output to host
9	RS232_RTS	O	RS232 Ready To Send output to host
10	GND	PWR	Ground
11	SYNC_OUT	O	Configurable synchronization output
12	GND	PWR	Ground

The table below shows the pin descriptions of the MTi-680G RTCM corrections connector.

> ⚠ The MTi-680G RTCM corrections connector is also present on the MTi-670G, but it is unused. It should therefore be left unconnected.

Pin descriptions MTi-680G RTCM corrections connector

Pin	Name	I/O type	Description
1	V_BCKP	PWR	Backup supply for GNSS (3V3).
2	GND	PWR	Ground
3	RTCM_RxD	I	RS232 receiver input from host
4	RTCM_TxD	O	RS232 transmitter output to host

Peripheral interfaces

The MTi 600-series supports CAN, RS232, and UART interfaces for host communication. For more detailed information on the interfaces please refer to the *MTi 600-series Hardware Integration Manual.*

CAN (Controller Area Network)

A Controller Area Network (CAN bus) is a robust standard designed to allow communication between devices in applications without a host computer. The CAN interface of the MTi-600 does not include a termination resistor. It can be used in a CAN bus that already incorporates the required termination. If used in a single device connection, a 120 Ω termination resistor needs to be added between the CAN_H and CAN_L pins.

RS232 with RTS/CTS flow control

The RS232 interface complies with the standard RS232 voltage levels. It includes hardware flow control through RTS and CTS lines.

UART

The UART interface can be used to directly connect to an MCU with 3.3 V IO-levels. The user can configure the MTi 600-series module to communicate over UART. The UART frame

configuration is 8 data bits, no parity and 1 stop bit (8N1). The UART protocol only has the TX and RX lines without any flow control.
Due to the rugged build, the UART port is not available on robust trackers (MTi-630R, MTi-670G, MTi-680G).

RTCM input port

> ⚠ The MTi-680G RTCM corrections connector is also present on the MTi-670G, but it is unused. It should therefore be left unconnected.

The RTCM input port on the MTi-680G can be used to provide RTCM correction messages. The port uses RS232 signalling with 8 data bits, no parity and 1 stop bit. The default baud rate on this port is 38400 bit/s, but a higher baud rate can be configured. Refer to the table below for available baud rates. Setting the baud rate is possible using MT Manager or using low level commands. Please refer to the low-level communication document for details on the SetPortConfig command and how to configure it.
The RTCM input port also outputs a GGA message at a 1Hz interval, this GGA message is often required by NTRIP providers.

RTCM input port baud rates

baud rate [bit/s]
38k4 (default)
57k6
115k2
230k4
460k8
921k6

Signal processing and algorithms

This section discusses the MTi 600-series signal processing and algorithm description.

Signal processing pipeline

The MTi 600-series is a self-contained product. All calculations and processes such as

sampling, coning & sculling compensation and the Xsens sensor fusion algorithm run on board.

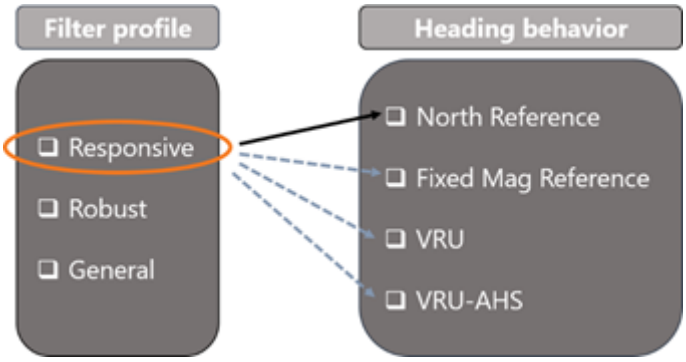
Strapdown integration

The Xsens optimized strapdown algorithm performs high-rate dead-reckoning calculations up to 2000 Hz allowing accurate capture of high frequency motions. This approach ensures a high bandwidth. Orientation and velocity increments are calculated with full coning & sculling compensation. These orientation and velocity increments are suitable for any 3D motion tracking algorithm. Increments are internally time-synchronized with other sensors. The output data rate can be configured for different frequencies, see #Output data rates. The inherent design of the signal pipeline with the computation of orientation and velocity increments ensures there is absolutely no loss of information at any output data rate. This makes the MTi 600-series also attractive for systems with limited communication bandwidth.

Xsens sensor fusion algorithm for VRU and AHRS product types

MTi-620 and MTi-630(R) run the newest Xsens sensor fusion algorithm implementing the latest Xsens insights. It optimally estimates the orientation with respect to an Earth fixed frame utilizing the 3D inertial sensor data (orientation and velocity increments) and 3D magnetometer data.

The Xsens sensor fusion algorithm uses assumptions to obtain the orientation estimations. Since the assumptions may be more or less valid based on the characteristics of the typical dynamics of the application, and since the magnetic field differs per application, the Xsens algorithm makes use of a set of filter profiles to be able to use the correct assumptions given the application. This way, the algorithm can be optimized for different types of movements and conditions.
With the MTi-620 and MTi-630(R), the user can configure different algorithm behaviours by selecting a “base” filter profile and, next to it, a heading behaviour, see image below.



Filter profile and heading behaviour selection: a tiered approach

The “base” filter profile selection affects the general behaviour of the device, mainly based on the nature of the typical expected dynamics of the application. The heading behaviour, as the name suggests, affects the heading/yaw output of the MTi, and determines how the magnetometer measurements are interpreted. This tiered approach gives more freedom to select the desired behaviour for different user application scenarios. The tables below summarize the filter profile and heading behaviour options.

Every application is different and results may vary from setup to setup. It is recommended to reprocess recorded data with different filter profiles in MT Manager to determine the best filter profile for your specific application.#1

Filter profiles for MTi-620 and MTi-630(R)

Name	Product	Description	Typical applications
Responsive	MTi-620 MTi-630(R)	This filter profile is designed for indoor applications as well as applications that experience high dynamics and jerky movements. When the MTi is static, an automatic gyro bias estimation is performed in the background.	• Outdoor/Indoor handling objects • Indoor ground vehicles • Outdoor/Indoor head tracker • Indoor mapping, outdoor mapping if handheld (e.g. tripods with camera, backpack) • Industrial robotic arm
Robust	MTi-620 MTi-630(R)	This filter profile is suitable for most of the applications. Compared to the other filter profiles it has a more robust tuning. When the MTi is static, an automatic gyro bias estimation is performed in the background.	• Ships/vessels • Automotive • Ground vehicles outdoor • Outdoor mapping with vehicles
General#2	MTi-620 MTi-630(R)	This filter profile behaves like the General filter profile implemented for the previous generation Xsens Products (e.g. MTi-30). It is more sensitive to the magnetic field changes. It does not perform an automatic gyro bias estimation in background. This filter profile cannot be combined with the FixedMagRef heading behaviour.	• Automotive • Ground vehicles outdoor • Outdoor mapping with vehicles

Heading Behaviour

Name	Product	Description	Typical applications
NorthReference	MTi-630(R)	This heading behaviour assumes a homogeneous magnetic environment that can be used to estimate a stable North referenced[#3] heading.	All applications that require a North referenced heading and are used in a homogeneous magnetic field.
FixedMagRef	MTi-630(R)	This heading behaviour is based on the idea that the heading is not necessarily referenced to the local magnetic North. Instead, it maintains a fixed heading reference frame based on what is defined when the MTi is powered up (based on the initially observed magnetic field). This means that there is no drift with respect to the starting frame when the local magnetic field changes. For example, when moving from room A to room B, where room B has a different local magnetic field direction than room A, the heading output of the MTi does not change. This is in contrast to the NorthReference heading behaviour, which forces the MTi to estimate the heading based on the local magnetic field.	All applications that are used in environments where different magnetic fields are present (e.g. mixed indoor/outdoor applications).

Name	Product	Description	Typical applications
VRU	MTi-620 MTi-630(R)	The yaw is unreferenced. This means that it is initialized at 0° when the MTi is powered up and the yaw will be computed relative to this initial orientation. The magnetic field is not used to estimate the yaw. Because of small inaccuracies that originate when integrating gyroscope data, the Yaw output will contain an error that builds up over time, also known as “drift”. Note however, that because of the working principle of the sensor fusion algorithm, the drift in yaw will be much lower than when gyroscope signals would be simply integrated.	Applications where only roll and pitch is of interest and/or applications that are used in environments where the magnetic field cannot be trusted (e.g. stabilized antenna platforms or pipeline inspection tools).
VRUAHS	MTi-620 MTi-630(R)	This heading behaviour activates the Active Heading Stabilization (AHS) on top of the above described VRU behaviour. AHS is a software component within the sensor fusion engine designed to give a low-drift unreferenced heading solution, even in a disturbed magnetic environment. The yaw remains unreferenced, but the drift is limited.#4	Scenarios where the magnetic field cannot be trusted completely, but a stable yaw is needed.

Xsens sensor fusion algorithm for the GNSS/INS product type

The Xsens sensor fusion algorithm in the GNSS/INS products has several advanced features. The algorithm adds robustness to the orientation and position estimates by combining measurements and estimates from the inertial sensors, magnetometer, barometer and a GNSS receiver in order to compensate for transient accelerations and magnetic disturbances.

The GNSS status is continuously monitored and the filter accepts GNSS data when available and sufficiently trustworthy. When the product has limited/mediocre GNSS reception or even no

GNSS reception at all (e.g. during outages), the fusion algorithm seamlessly adjusts the filter settings in such a way that the highest possible accuracy output is maintained. The MTi will continue to output position, velocity and orientation estimates, although the accuracy is likely to degrade over time as the filters can only rely on dead-reckoning. If the GNSS outage lasts longer than 45 seconds, the MTi stops the output of the position and velocity estimates, and resumes sending these outputs once the GNSS data becomes acceptable again.

Smoothers

The GNSS/INS products (MTi-670(G) and MTi-680(G) have optional sensor fusion functions called *smoothers* for reducing sudden jumps in the output data that may arise from fusing low-rate GNSS receiver messages with high-rate inertial sensor data. There is a smoother for orientation data for both the MTi-670(G) and MTi-680(G), and a position/velocity smoother for the MTi-680(G). The smoothers can be enabled from the Device Settings window in MT Manager, or by using the setOptionFlags low-level communication command (see the *MT Low Level Communication Protocol Document* for details).

Continuous Zero Rotation Update

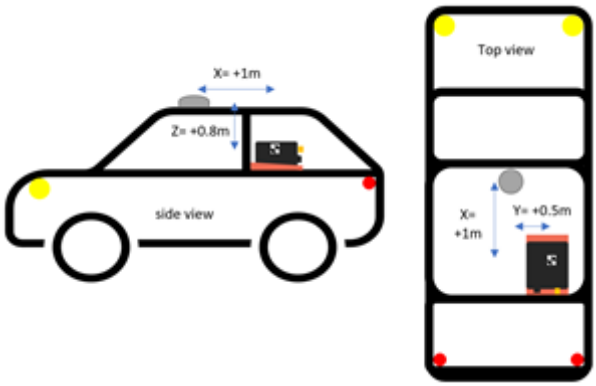
The Continuous Zero Rotation Update (CZRU) is a feature that is currently only available for the MTi-680(G). The purpose of the CZRU is to reduce the undesired effects of gyroscope bias, such as drift of the orientation output. Although all MTi products are individually calibrated for various parameters, including sensor bias, the aging and use of Motion Trackers in industrial environments can cause sensor biases to change during the product's lifetime. Because of that, the filters of the MTi are continuously re-restimating calibration parameters such as sensor bias while they are powered up. If enabled, the Continuous Zero Rotation Update will execute a background algorithm that will automatically initiate a gyroscope bias estimation sequence whenever the Motion Tracker is motionless.

The Manual Gyro Bias Estimation function is similar to the Continuous Zero Rotation Update, except for the fact that for each individual update, the Manual Gyro Bias Estimation function has to be initiated by the user through a command. For more information, refer to BASE: Manual Gyro Bias Estimation

The Continuous Zero Rotation Update can be enabled through the Device Settings window in MT Manager, or through the SetOptionFlags low-level command (see *MT Low Level Communication Protocol Document*).

Lever Arm Correction

Due to the improvement in position accuracy on MTi-680(G) devices with RTK support, the option to configure a GNSS lever arm is available. The figure below highlights the effect of the lever arm on measurements taken with cm-level accuracy.
The lever-arm describes the position of the GNSS antenna with respect to the origin of measurement of the MT device (see Design and Packaging). The algorithm uses this information to correct its position and velocity measurements accordingly. The lever arm can be set from the Device Settings window in MT Manager, or by using the setGnssLeverArm low-level communication command (refer to the *MT Low Level Communication Protocol Document* for details).



Example of lever arm measurements

Lever arm correction for MTi-680G

Filter profiles

The table below reports the different filter profiles the user can set based on the application scenario. Every application is different and results may vary from setup to setup. It is recommended to reprocess recorded data with different filter profiles in MT Manager to determine the best results in your specific application.#1

Filter profiles for MTi-670(G) and MTi-680(G) (GNSS/INS)

Name	GNSS	Barometer	Magnetometer	Description
General / General_RTK	•	•		This filter profile is the default setting. The yaw output of the MTi is north-referenced#3 (when GNSS data is available). Altitude (height) is determined by combining static pressure, GNSS altitude and accelerometers. The barometric baseline is referenced by GNSS, so during GNSS outages, accuracy of height measurements is maintained.
GeneralNoBaro / GeneralNoBaro_RTK	•			This filter profile is very similar to the general filter profile except for the use of the barometer.
GeneralMag / GeneralMag_RTK	•	•	•	This filter profile bases its yaw estimate mainly on magnetic heading and GNSS measurements. A homogenous magnetic environment and a proper magnetic calibration are essential for a good performance. This filter profile produces a north-referenced#3 yaw output directly after powering up the MTi.

GNSS Platform

u-blox GNSS receivers support different dynamic platform models in order to adjust the navigation engine to the expected application environment. The GNSS/INS products can be configured to communicate a desired platform model upon start-up. This enables the user to adjust the u-blox receiver platform to match the dynamics of the application. The setting influences the estimates of Position and Velocity and therefore it affects the behavior of the Xsens filter output.

The platform model can be configured through the Device Settings window in MT Manager (version 2021.4 and later) or using low-level communication by providing the GNSS Platform ID. For more details on the low-level commands used to set the GNSS Platform (*SetGnssReceiverSettings*), refer to the *MT Low Level Communication Protocol Document.* For more details on GNSS platform settings, refer to the *u-blox Receiver Description Manual*.

Alternatively, when interfacing with a GNSS receiver through NMEA communication, the received NMEA position data is used ‘as is’, independent of the GNSS platform setting.

Real-Time Kinematics

The MTi-680G supports centimeter-level position accuracy through RTK (Real-Time Kinematic), which uses correction messages from a base station with a known position. The RTK correction data must be supplied as RTCM3 messages, either via the dedicated RTCM input connector (see Functional description) or via the host interface as RTCM messages embedded in xbus (see XMID_ForwardGnssData in the *MT Low-Level Communication Protocol Document*). In the latter case, the NTRIP client in MT Manager can be setup to provide the correction data.
The MTi-680 supports centimeter-accurate position data from an external GNSS receiver. The method of providing correction messages to the external GNSS receiver is entirely up to the end user.

Data output

The MTi 600-series product variants can output many different data types at many different frequencies. Below is a summary of the most relevant data and maximum output data rates. A full overview is available in the *MT Low Level Communication Protocol Documentation.*

Output data rates

Data Type	Max Output Data Rate
Orientation data (Euler angles, Rotation Matrix, Quaternions)	400Hz
Position, Velocity, Altitude	400Hz
DeltaQ, DeltaV	400Hz
Acceleration, Rate of Turn, Free Acceleration	400Hz
Acceleration HR (High Rate)	2000Hz
Rate of Turn HR (High Rate)	1600Hz

Xbus output

The Xbus protocol is Xsens' standard output protocol utilizing the MTDATA2 data message structure. This output provides a lot of flexibility and enables users to access all functionality of

the MTi product range. The Xbus output format is shared with all other MTi products in the Xsens portfolio, so switching between hardware platforms is very easy. More information is available in the *MT Low Level Communication Protocol Documentation.*

NMEA output

NMEA output is a string output mode which outputs data in the commonly used NMEA 0183 format. More information is available in the *MT Low Level Communication Protocol Documentation.*

CAN output

The CAN output is an industrial standard interface over which the MTi 600-series can output its data. More information on this output can be found in the *MT Low Level Communication Protocol Documentation* and *Family Reference Manual*.

GNSS input

The MTi-670 and MTi-680 require data from an external GNSS receiver to provide a full GNSS/INS solution. This can be achieved by connecting a GNSS receiver that communicates with one of the following supported protocols:

- u-blox' UBX protocol
- NMEA sentences (officially supported with firmware version 1.6.0 and up)
- Septentrio's SBF protocol (beta support with firmware version 1.8.0 and up)
- Trimble's GSOF protocol (beta support with firmware version 1.8.0 and up)

The use of each of these supported protocols is discussed in more detail in the paragraphs below.

u-blox (UBX) input

When connecting a u-blox receiver (e.g. u-blox MAX-M8), the MTi will configure it correctly on start-up. No prior configuration of the u-blox receiver is required. It is however recommended to inform the MTi of what type of u-blox receiver is connected. This can be done using the Device Settings window in MT Manager (version 2021.4 and later), or using an Xbus message called SetGnssReceiverSettings, described in the *MT Low Level Communication Protocol Documentation*. The user can select one of the officially supported u-blox receiver series: MAX-M8 (default), NEO-M8 or ZED-F9.

NMEA input

Almost all GNSS receivers support the output of NMEA messages, which means that this functionality enables the use of virtually any external GNSS receiver. It is important to note that both the GNSS receiver and the MTi must be configured prior to connecting both systems to each other. The NMEA input mode can be enabled using the Device Settings window in MT Manager (version 2021.4 and later), or using an Xbus message called SetGnssReceiverSettings, described in the *MT Low Level Communication Protocol Documentation*.

The table below summarizes the settings needed to configure the MTi-670/680 to use the NMEA input mode. This will enable the MTi to use the GNSS data and provide the user with a full GNSS/INS solution. The MTi will also synchronize its internal clock with the UTC time that is present in the sentences.

Settings required to enable the NMEA input mode for the MTi-670/680

Setting	Description
Baudrate	Minimum 115200 bps
GNSS Message frequency	4 Hz recommended/default, 10 Hz maximum
Talker ID	GN, GP or GL
Required messages	GGA, GSA, GST and RMC High precision coordinate formats such as GGALONG are also supported.

An example of how to setup an external GNSS receiver using the NMEA protocol can be found on BASE.

Septentrio (SBF) input

Please note that both the GNSS receiver and the MTi must be configured prior to connecting both systems to each other. The Septentrio input mode can be enabled using the Device Settings window in MT Manager (version 2021.4 and later), or using an Xbus message called SetGnssReceiverSettings, described in the *MT Low Level Communication Protocol Documentation*.

The table below summarizes the settings needed to configure the MTi-670/680 to use the Septentrio input mode. This will enable the MTi to use the GNSS data and provide the user with a full GNSS/INS solution. The MTi will also synchronize its internal clock with the UTC time that is present in the sentences.

Settings required to enable the Septentrio input mode for the MTi-670/680

Setting	Description
Baudrate	Minimum 230400 bps
GNSS Message frequency	5 Hz recommended/default, 10 Hz maximum
Required messages	ReceiverTime, PVTGeodetic, PosCovGeodetic, VelCovGeodetic, DOP, MeasEpoch, ChannelStatus

Trimble (GSOF) input

Please note that both the GNSS receiver and the MTi must be configured prior to connecting both systems to each other. The Trimble input mode can be enabled using the Device Settings window in MT Manager (version 2021.4 and later), or using an Xbus message called SetGnssReceiverSettings, described in the *MT Low Level Communication Protocol Documentation*.

The table below summarizes the settings needed to configure the MTi-670/680 to use the Trimble input mode. This will enable the MTi to use the GNSS data and provide the user with a full GNSS/INS solution. The MTi will also synchronize its internal clock with the UTC time that is present in the sentences.

Settings required to enable the Trimble input mode for the MTi-670/680

Setting	Description
Baudrate	Minimum 115200 bps
GNSS Message frequency	5 Hz recommended/default, 10 Hz maximum
Required messages	Position Time [#01], Lat,Long,Ht [#02], Velocity [#08], DOP Info [#09], Position Sigma [#12], Current Time UTC [#16], Detail All SV [#34]

Magnetic interference

Magnetic interference can be a major source of error for the heading accuracy of any AHRS, as an AHRS uses the magnetic field to reference the estimated orientation on the horizontal plane with respect to the (magnetic) North#3. A severe and prolonged distortion in that magnetic field will cause the magnetic reference to be inaccurate. The MTi 600-series has several ways to cope with these distortions to minimize the effect on the estimated orientation, which are discussed in the sections below.

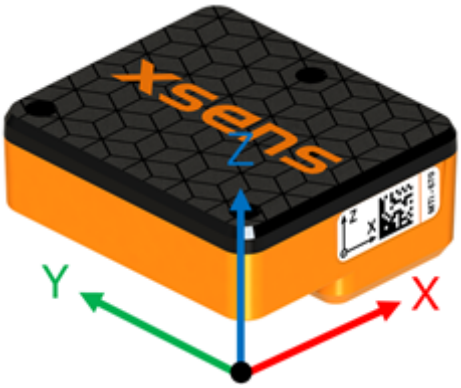
Magnetic Field Mapping (MFM)

When the distortion moves with the MTi (i.e. when a ferromagnetic object solidly moves with the MTi module), the MTi can be calibrated for this distortion. Examples are the cases where the MTi is attached to a car, aircraft, ship or other platforms that can distort the magnetic field. It also handles situations in which the sensor has become magnetized. These types of errors are usually referred to as soft and hard iron distortions. The Magnetic Field Mapping procedure compensates for both hard iron and soft iron distortions.

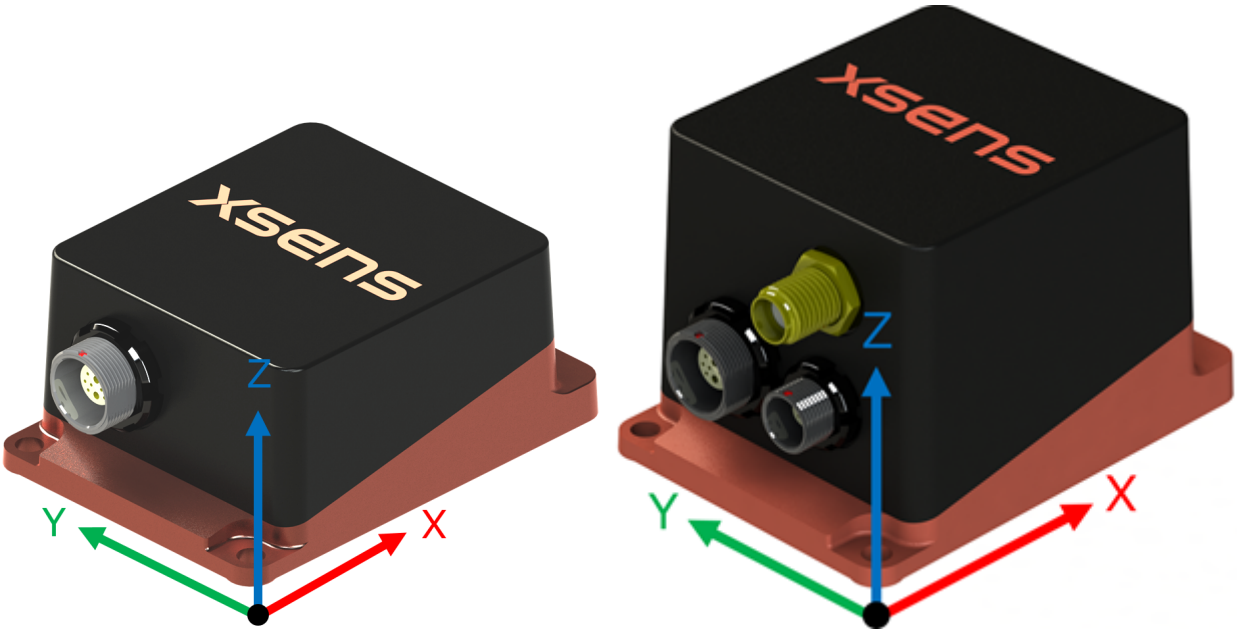
The magnetic field mapping (calibration) is performed by moving the MTi mounted on the object/platform that is causing the distortion. The results are processed on an external computer (Windows or Linux), and the updated magnetic field calibration values are written to the non-volatile memory of the MTi 600-series. The magnetic field mapping procedure is extensively documented in the *Magnetic Calibration Manual*.

Frames of reference

The MTi 600-series uses a right-handed coordinate system. The default sensor-fixed frame (S_{xyz}) is defined as shown in the figures below. The frame is also printed on the side of the module or the back side of robust trackers. For a more exact location of the sensor frame origin, refer to Design and Packaging. When the sensor is rigidly attached to another object or vehicle, it is possible to rotate the sensor-fixed frame S_{xyz} to an object coordinate frame (O_{xyz}).#5 The default local earth-fixed frame (L_{XYZ}) is East-North-Up (ENU). In addition, the MTi-6x0 has predefined output options for North-East-Down (NED) and North-West-Up (NWU). Specifically for the GNSS/INS models, the Local Tangent Plane (LTP) is a local linearization of the Ellipsoidal Coordinates (Latitude, Longitude, Altitude) in the WGS-84 Ellipsoid, based on the real time position data retrieved from the GNSS receiver. Since the MTi-620 and MTi-630(R) cannot receive real time positioning from a GNSS receiver, the user must set correct positional coordinates to allow the MTi-620 or MTi-630(R) to construct the reference frame, magnetic and gravity models.



Default sensor fixed coordinate system (S_{xyz}) for the MTi 600-series module



Default sensor coordinate system for the MTi-630R and MTi-680G

[1] Refer to the BASE article: Recording a data file to be reprocessed in MT Manager.
[2] The General filter profile is only recommended for users who are looking for similar behaviour to the previous generation Xsens products in the typical applications suggested in the table. Using the General filter profile is not recommended for new designed applications.
[3] Note: Under default settings, Yaw (heading) equals 90 degrees when the X-axis of the MTi points North.
[4] For more information on the capabilities of AHS, refer to the BASE article: AHS. Note that in the previous Xsens products, AHS was activated by means of a separate setting.
[5] How to define a new object coordinate system can be found in the *MTi Family Reference Manual.*

Synchronization options

This chapter describes the synchronization functionalities of the MTi-600 series. In the remainder of this chapter, synchronization will be abbreviated as sync, synchronization input as SyncIn and synchronization output as SyncOut. A set of one or more synchronization options and their corresponding parameters are stored in a structure referred to as SyncSettings.
The sync functionalities are in line with the other Xsens motion trackers, however, some minor differences exist because of the different architecture of the MTi-600.

The MTi-600 series has two input lines available for SyncIn, and one for SyncOut (see Functional description). It is not possible to configure a SyncIn line as SyncOut or vice versa.

On devices which employ an external GNSS receiver, a 1PPS signal can be gathered directly from the GNSS receiver. However, it is also possible to configure a 1 Hz output reference signal using the SyncOut functionalities. The output reference signal is synchronized with the 1PPS signal of the external GNSS receiver when using an MTi-670 or MTi-680, or the internal GNSS receiver when using an MTi-670G or MTi-680G.

Trigger signal

A trigger signal is expected to be a pulse wave. When using a SyncIn function the trigger is an input signal. When using a SyncOut function it is a output signal generated by the MTi. When configuring a sync function, various parameters can be set by the user to interpret/generate the

trigger signal. This parameters are reported in the table below.

Generic synchronization parameters

Parameter	Description
Line	Defines the physical line to be used for the sync function. Valid values: • In1 • In2 • ReqData • Out1 All SyncIn functions can be employed on both input lines. If a function has to be enabled on both SyncIn lines, the functions must be included twice in the configuration settings, i.e. once for each line. ReqData is specifically used for the Send Latest function.
Polarity	Valid values: • Rising edge: the trigger is sensitive to the rising edge of the pulse wave • Falling edge: the trigger is sensitive to the falling edge of the pulse wave • Falling & Rising edge: the trigger is sensitive to both edges
SkipFirst	Ignore the first “n” input triggers.
SkipFactor	Periodically skips every n input triggers. This skipping starts after the “n” SkipFirst pulses.
Trigger Once	If the Once option is set, the sync function is only triggered once and the following pulses are ignored. The Once feature is considered only after the SkipFirst count is reached. Its state is reset when the MTi enters a new Measurement mode.
Pulse width	Pulse duration in microseconds.
Delay	Delay in microseconds to react at the trigger event.

SyncIn

This chapter describes the functionality and behaviour of the SyncIn line. The SyncIn lines can be used to synchronize the sampling of data or data output of the MTi 600-series to an external device or clock by inputting a trigger signal through the SyncIn lines. See System and electrical specifications for the trigger signal requirements.

TriggerIndication function

With this function the user can input a trigger signal to mark the output data (e.g. orientation) with the trigger event. Upon receiving a trigger, this function will set the trigger indication status

bit (SyncIn Marker) of the Status Word to 1. Furthermore, the user can configure the MTi to output also a TriggerIndication message through the MtData2 stream. The advantage is that this message is timestamped with the trigger moment, so it has better accuracy than just the status flag.

SendLatest function

Enabling this function, the last measured/computed desired data available at the trigger instant is outputted by the MTi. The internal signal pipeline of the MTi works as usual, but the desired data is outputted only when a trigger is received.
The trigger can be sent either on a SyncIn line or by means of a software command (Line must be set to ReqData).

StartSampling function

When this function is enabled, the device will start outputting data after a SyncIn trigger has been received. It does not trigger every consequent sample, but it accurately starts outputting the first sample, after which the next samples will follow the selected output data rate. A skipFirst value can be set to ignore the first *n* pulses before considering a pulse as a trigger. Similarly, a delay parameter can be set to tune when to start the sampling after the trigger.

Clock Bias Estimation function

This function enables the user to synchronize the sampling clock of the MTi with an external reference signal. The internal clock of the MTi-600 has an accuracy of about 10 ppm. When a reference clock of better accuracy is available, it is possible to use this clock to improve the sampling accuracy of the MTi-600. Furthermore, it could be beneficial to have all devices in a setup to run at the same clock speed.

If the user does not have a reference clock that is better than 10 ppm, but it is still preferred to run multiple devices at the same clock speed, it is better to use the SyncOut line of the MTi-600 as a clock source for other devices.

On the MTi-670G/680G the internal clock is always referenced to the internal GNSS receiver. Therefore, on the MTi-670G/680G the clock bias estimation is not user-configurable. On the MTi-670 and MTi-680, the internal clock is by default referenced to the external GNSS receiver, but it is user-configurable (although not recommended).

1PPS Time-pulse function

When an MTi-670/680 is connected with an external GNSS receiver, the 1PPS signal of the receiver can be used as input to synchronize the MTi-670/680 with the external receiver (using the Clock Bias Estimation function). This function is enabled by default, and will configure a connected (u-blox) GNSS receiver to output a 1PPS signal. On the MTi-670G/680G, this function is always enabled (and not user configurable) with the time pulse from the internal GNSS receiver.

This function is not available for the MTi-610/MTi-620/MTi-630(R).

SyncOut

The MTi 600-series has one output synchronization function.

Interval Transition Measurement function

The *Interval Transition Measurement* function gives a sampling time indication letting the user to synchronize external applications with the same clock employed by the MTi-600 to output the data. It generates a SyncOut trigger based on the internal 400 Hz SDI sampling clock.

Combining multiple Sync functions

The following list of possible sync functions are available:

- ClockSync [in]
- TriggerIndication [in]
- SendLatest [in]
- StartSampling [in]
- Interval Transition Measurement [out]

Remarks on combining multiple Sync functions

Function	Description
ClockSync	If ClockSync is configured on a SyncIn line, no other function can be configured on this line at the same time.
TriggerIndication	Is a somewhat passive function in the sense that it does not change the state or timing of the system. It can therefore be freely combined with all other functions. It can also be configured on both SyncIn lines with different settings.

Function	Description
SendLatest/StartSampling	Only one of these functions can be active and only on one line.
SamplingIndication	Can be configured next to all possible SyncIn functions.

System and electrical specifications

- System and electrical specifications
  - Interface specifications
  - System specifications
  - Electrical specifications
  - Absolute maximum ratings

Interface specifications

Communication interfaces

Interface	Symbol	Min	Typ	Max	Unit	Description
CAN	f_{CAN}	10.0	250.0	1000	kbps	Host CAN Interface Baud Rate
RS232	f_{RS232}	4.8	115.2	1000	kbps	Host RS232 Interface Baud Rate
UART[1]	f_{UART}	4.8	115.2	2000	kbps	Host UART Interface Baud Rate

System specifications

System specifications of MTi 600-series modules

		Min	Typ	Max	Unit	Comments
Size	Width		31.5		mm	
	Length		28.0		mm	
	Height		13.0		mm	
Weight			8.9		gram	
IP-rating			IP51			Connector facing down
			IP50			Connector facing up

		Min	Typ	Max	Unit	Comments
Temperature	Operating temperature	-40		+85	ºC	Ambient temperature, non-condensing
Power consumption		310	340	530	mW	Depends on used interface and supplied voltage. 5V over UART is most power efficient
Timing accuracy			10		ppm	Output clock accuracy of 1 ppm can be achieved with the MTi-670/680 with external GNSS module
MTBF GM			40.000		hours	
MTBF GB			360.000		hours	
Output data rate			400	2000	Hz	Data rates larger than 400 Hz available for RateOfTurnHR (1600 Hz) and AccelerationHR (2000 Hz) only

System specifications of MTi-630R

		Min	Typ	Max	Unit	Comments
Size	Width		40.9		mm	
	Length		56.5		mm	
	Height		24.75		mm	
Weight			75		gram	
IP-rating			IP68			48 hours at 1 meter under water
Temperature	Operating temperature	-40		+85	ºC	Ambient temperature, non-condensing
Power consumption		620	720	1000	mW	Depends on used interface and supplied voltage

		Min	Typ	Max	Unit	Comments
Size	Width		40.9		mm	
	Length		56.5		mm	
	Height		24.75		mm	
Weight			75		gram	
IP-rating			IP68			48 hours at 1 meter under water
Temperature	Operating temperature	-40		+85	ºC	Ambient temperature, non-condensing
Power consumption		620	720	1000	mW	Depends on used interface and supplied voltage
Timing accuracy			10		ppm	Output clock accuracy can be increased using ClockSync functionality
Output data rate			400	2000	Hz	Data rates larger than 400 Hz available for RateOfTurnHR (1600 Hz) and AccelerationHR (2000 Hz) only

System specifications of MTi-670G/680G

		Min	Typ	Max	Unit	Comments
Size	Width		40.9		mm	
	Length		56.5		mm	58.1 mm including SMA connector
	Height		36.8		mm	
Weight			98		gram	

		Min	Typ	Max	Unit	Comments
IP-rating			IP68			48 hours at 1 meter under water
Temperature	Operating temperature	-40		+85	ºC	Ambient temperature, non-condensing
Power consumption		620	720	1000	mW	Depends on used interface and supplied voltage.
Timing accuracy			1		ppm	
Output data rate			400	2000	Hz	Data rates larger than 400 Hz available for RateOfTurnHR (1600 Hz) and AccelerationHR (2000 Hz) only

Electrical specifications

Supply voltage specifications

Symbol	Min	Typ	Max	Unit	Description
V_{IN}	4.5	5	24	V	Power input voltage
V_{BCKP}[2]	1.7	3.0	3.6	V	GNSS backup input voltage

I/O electrical specifications

I/O interface	Symbol	Min	Typ	Max	Unit	Description
CAN	$V_{I(DIFF)(R)}$	-4.0		0.5	V	Recessive differential input voltage -12V < $V_{(CANH, CANL)}$ < +12V
	$V_{I(DIFF)(D)}$	0.9		9.0	V	Dominant differential input voltage -12V < $V_{(CANH, CANL)}$ < +12V
	$V_{O(DIFF)(R)}$	-500	0	50	mV	Recessive differential output voltage
	$V_{O(DIFF)(D)}$	1.3	2.0	5.0	V	Dominant differential output voltage
	$V_{O(L)(D)}$	0.5	1.5	2.25	V	CAN_L dominant output voltage
	$V_{O(H)(D)}$	2.75	3.5	4.5	V	CAN_H dominant output voltage
RS232[3] (GNSS/RTCM)	V_{IL}	-25		0.6	V	Low input voltage
	V_{IH}	2.4		+25	V	High input voltage
	V_{OT}	±5	±5.4		V	Driver Output Voltage swing
UART[4]	V_{IL}	0		0.88	V	Low input voltage
	V_{IH}	2.29		3.6	V	High input voltage
	V_{OL}	0		0.44	V	Low output voltage
	V_{OH}	2.6		3.3	V	High output voltage
SYNC_IN1/ SYNC_IN2	V_{IL}	-25		0.6	V	Low input voltage
	V_{IH}	2.4		+25	V	High input voltage
SYNC_OUT	V_{OL}	0		0.44	V	Low output voltage
	V_{OH}	2.6		3.3	V	High output voltage
	I_O			±4	mA	Output current

Absolute maximum ratings

Absolute maximum ratings

Parameter		Min	Max	Unit	Comments
Storage temperature	T_S	-40	+90	ºC	
Operating temperature	T_O	-40	+85	ºC	
Power input voltage[5]	V_{IN}	-0.3	30	V	+/- 100 mV, max ripple 100 mVp-p
CAN DC[5]	V_{CAN_DC}	-58	58	V	Common mode voltage of CAN_H and CAN_L with respect to ground
CAN Differential	V_{CAN_DIFF}	-17	17	V	Differential voltage between CAN_H and CAN_L
RS232 inputs[5]	V_{RS232}	-25	25	V	
SYNC inputs[5]	V_{SYNC}	-25	25	V	
SYNC output	I_{SYNC}		±20	mA	SYNC output current
UART input[5]	V_{UART}	-0.3	3.6	V	
Acceleration[6]			10,000	g	Any axis, unpowered, for 0.2 ms
ESD protection			±8000	V	Human body model

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Particular attention must be paid handling the device. Torques on the connector of the MTi 600-series must be avoided at all times.

[1] Not available for robust trackers (MTi-630R/670G/680G).

[2] Only available for MTi-670G/680G.

[3] Also applies to the GNSS (MTi-670/680) and RTCM (MTi-680G) ports.

[4] Not available for robust trackers (MTi-630R/670G/680G).

[5] All voltages with respect to GND.

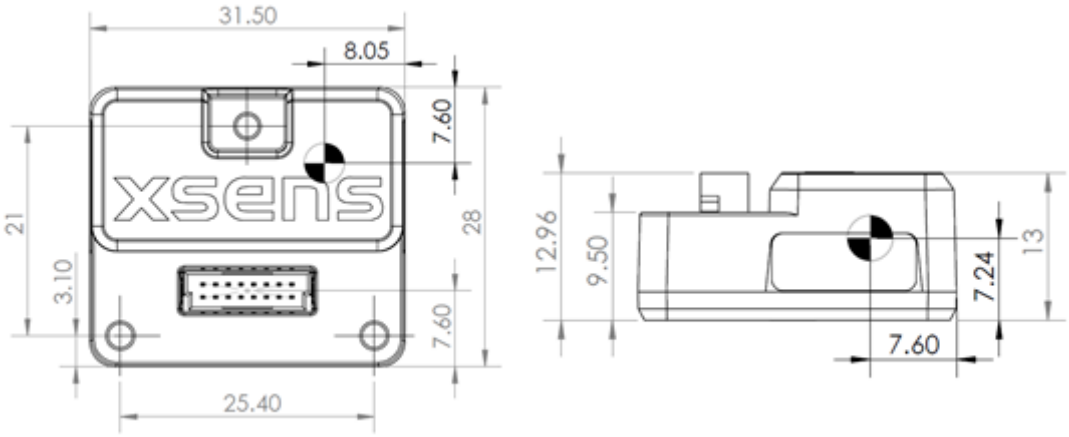
[6] This is a mechanical shock (g) sensitive device. Proper handling is required to prevent damage to the part.

Design and packaging

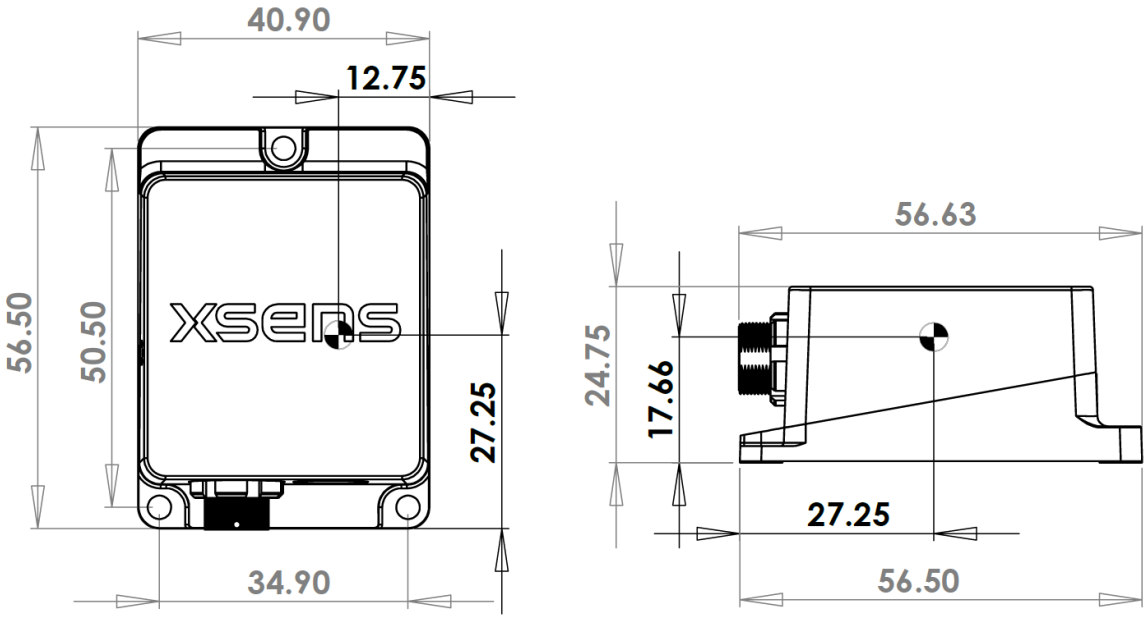
- Design and packaging
  - Design
  - Packaging information
    - MTi 600-series modules
    - MTi 600-series robust trackers

Design

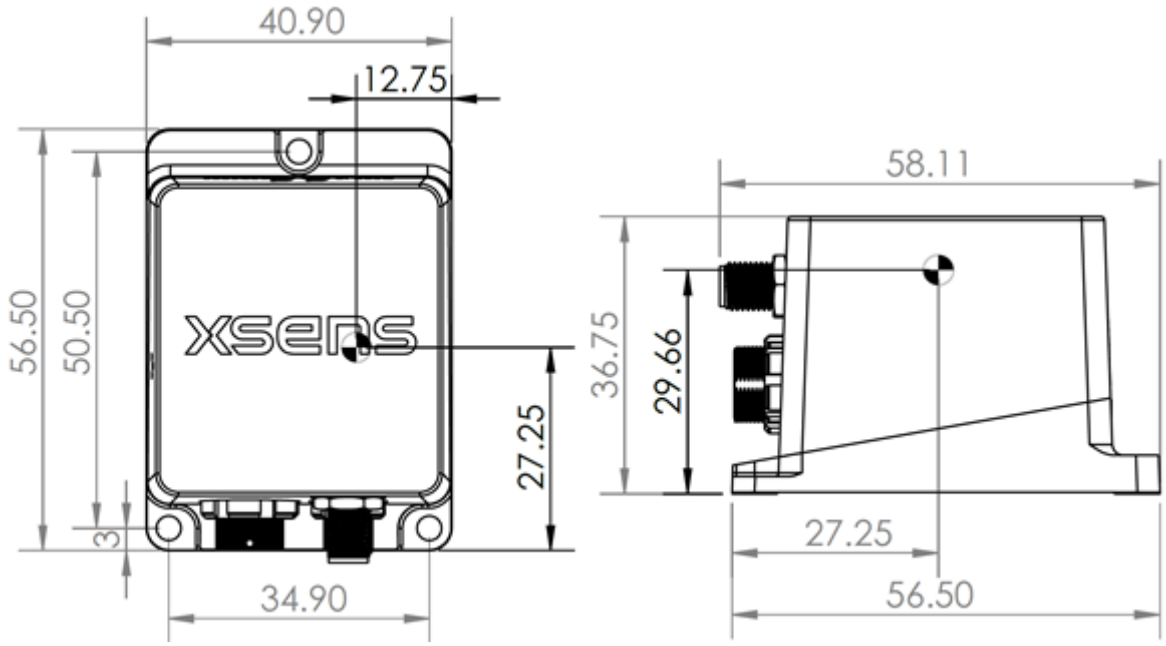
The figures shows the dimensions of the MTi-600 module and robust trackers together with the origin of measurements (located by the ◔ symbol). More information about the mounting options and recommended mating/mounting parts can be found in the *MTi 600-series Hardware Integration Manual*.



Location origin of measurements MTi-600 module (dimensions in mm)



Location origin of measurements MTi-630R (dimensions in mm)

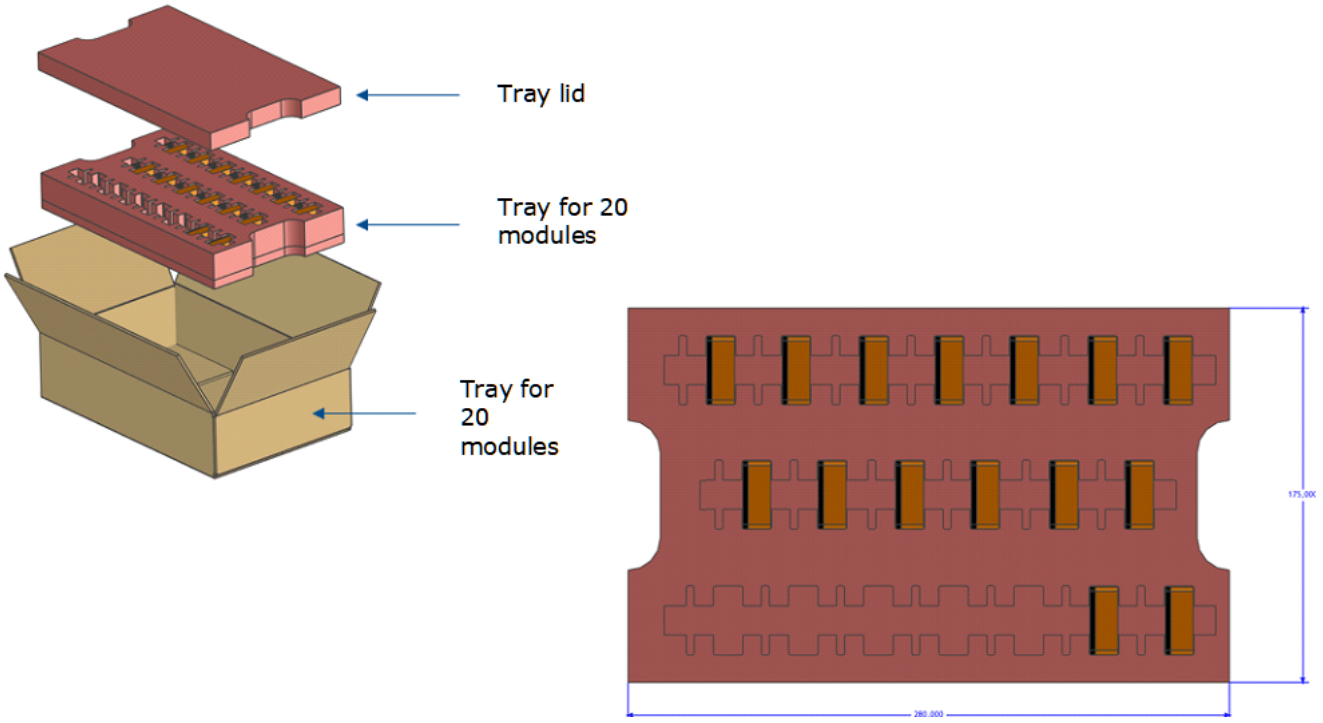


Location origin of measurements MTi-670G/680G (dimensions in mm)

Packaging information

MTi 600-series modules

The MTi 600-series module packaging boxes contain from 5 up to 20 modules.



Box Dimensions (mm)			Box packaging information	
Length	Width	Height	Qty/Tray MOQ 5	Qty/Box MOQ 5
285	185	75	5-20 units	5-20 units

NOTES:

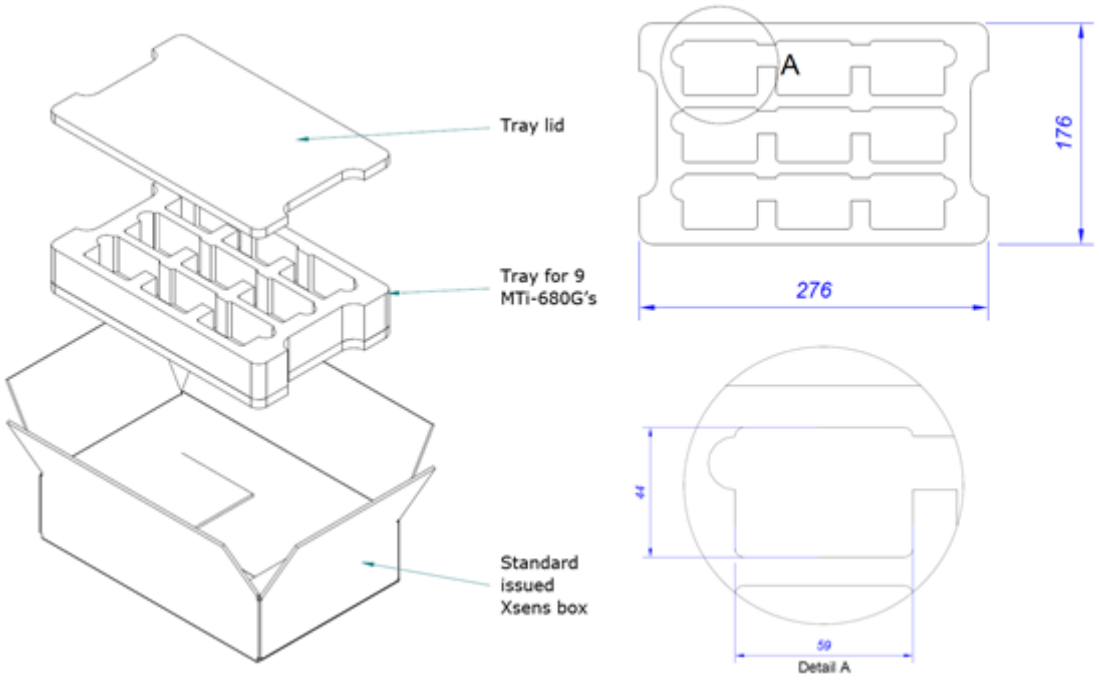
- All dimensions are in millimeters.
- Pictured tray and box representative only, actual tray may look different.

CONTENT:

- 5 to 20 modules per box.
- Calibration certificate.

MTi 600-series robust trackers

The MTi-630R/670G/680G packaging boxes contain from 1 up to 9 trackers.



Box Dimensions (mm)			Box packaging information	
Length	Width	Height	Qty/Tray MOQ 1	Qty/Box MOQ 1
285	185	75	1-9 units	1-9 units

NOTES:

- All dimensions are in millimeters.
- Pictured tray and box representative only, actual tray may look different.

CONTENT:

- 1 to 9 trackers per box.
- Calibration certificate.

Declaration of conformity

EU Declaration of Conformity MTi-600 module

EU Declaration of Conformity

Applicable objects:

MTi-610[1]
MTi-620[1]
MTi-630[1]
MTi-670[1]
MTi-6##-DK

Manufacturer:

Xsens Technologies B.V.
Pantheon 6a
7521 PR ENSCHEDE
THE NETHERLANDS

This declaration of conformity is issued under the sole responsibility of the manufacturer.

The objects of the declaration described above are in conformity with the relevant Union harmonization legislation, based on the tested mode of operation(s), the applicable performance criteria, and specified acceptance criteria:

Short name	Directive
Electromagnetic compatibility (EMC)	2014/30/EU
Restriction of the use of certain hazardous substances (RoHS)	2011/65/EU

Relevant harmonized standards used:

Standard description	Standard	Result
Emission	EN 61326-1 (2013), class B	Passed
Immunity	EN 61326-1 (2013), Industrial	Passed
Radiated emission up to 1 GHz (SAC)	EN 55011 (2009) + A1 (2010)	Passed
Radiated immunity	EN-IEC 61000-4-3 (2006) + A1 (2008) + A2 (2010)	Passed
Power Frequency Magnetic field	EN-IEC 61000-4-8 (2010)	Passed

Signed for and on behalf of:

Enschede 2019 August, 28

Igor Ikink, System Solutions Director

[1] When pre-mounted on the MTi-6##-DK

EU Declaration of Conformity MTi-600 rugged

EU Declaration of Conformity

Applicable objects MTi 600-series Rugged:
MTi-610R
MTi-620R
MTi-630R
MTi-680G
MTi-6##R
MTi-6##G
MTi-6##R-SK
MTi-6##G-SK

Manufacturer:
Xsens Technologies B.V.
Pantheon 6a
7521 PR ENSCHEDE
THE NETHERLANDS

This declaration of conformity is issued under the sole responsibility of the manufacturer.

The objects of the declaration described above are in conformity with the relevant Union harmonization legislation,
based on the tested mode of operation(s), the applicable performance criteria, and specified acceptance criteria:

Short name	Directive
Electromagnetic compatibility (EMC)	2014/30/EU
Restriction of the use of certain hazardous substances (RoHS)	2011/65/EU

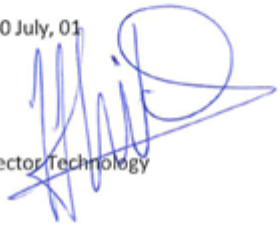
Relevant harmonized standards used:

Standard description	Standard	Result
Emission	EN 61326-1 (2013), class B	Pass
Immunity	EN 61326-1 (2013), Industrial	Pass
Radiated emission up to 1 GHz (SAC)	EN 55011 (2009) + A1 (2010)	Pass
Radiated immunity	EN-IEC 61000-4-3 (2006) + A1 (2008) + A2 (2010)	Pass
Power Frequency Magnetic field	EN-IEC 61000-4-8 (2010)	Pass

The following test report is subject to this declaration:
Test report number: 20200302RPT01.pdf Issue date: 2020 June, 18

Signed for and on behalf of:

Enschede 2020 July, 01



Igor Ikink, Director Technology

FCC Declaration of Conformity MTi-600 module

FCC Declaration of Conformity

Applicable objects:

MTi-610[1]	Manufacturer:
MTi-620[1]	Xsens Technologies B.V.
MTi-630[1]	Pantheon 6a
MTi-670[1]	7521 PR ENSCHEDE
MTi-6##-DK	THE NETHERLANDS

The objects of the declaration described above is in conformity with the relevant FCC regulations, based on the tested mode of operation(s), the applicable performance criteria, and specified acceptance criteria

Object classification	Directive
Computers and other digital devices, unintentional radiator	47 CFR 15

Relevant standards used:

Test description	Standard	Result
Emission	47 CFR 15 & ICES-003 (Issue 6), class B	Passed
Radiated emission up to 1 GHz (SAC)	ANSI C63.4 (2014)	Passed
Radiated emission above 1 GHz (FAC)	ANSI C63.4 (2014)	Passed

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 following test report is subject to this declaration:

Test report number:	Issue date:
19C00379RPT03.pdf	2019 August, 28

The following manufacturer/importer/entity is responsible for this declaration:

Company name:	Xsens Technologies B.V.
Name Title:	Igor Ikink, System Solutions Director
Address:	Pantheon 6a, 7521 PR ENSCHEDE, THE NETHERLANDS
Phone:	+31 (0)889736700
Fax:	+31 (0)889736701

[1] When pre-mounted on the MTi-6##-DK

FCC Declaration of Conformity MTi-600 rugged

FCC Declaration of Conformity

Applicable objects:
MTi-610R
MTi-620R
MTi-630R
MTi-680G
MTi-6##R
MTi-6##G
MTi-6##R-SK
MTi-6##G-SK

Manufacturer:
Xsens Technologies B.V.
Pantheon 6a
7521 PR ENSCHEDE
THE NETHERLANDS

The objects of the declaration described above is in conformity with the relevant FCC regulations, based on the tested mode of operation(s), the applicable performance criteria, and specified acceptance criteria

Object classification	Directive
Computers and other digital devices, unintentional radiator	47 CFR 15

Relevant standards used:

Test description	Standard	Result
Emission	47 CFR 15 & ICES-003, class B	Pass
Radiated emission up to 1 GHz (SAC)	ANSI C63.4 (2014)	Pass
Radiated emission above 1 GHz (FAC)	ANSI C63.4 (2014)	Pass

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.

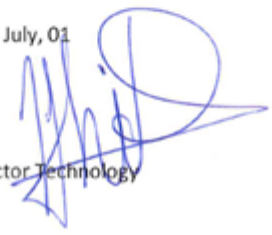
The following test report is subject to this declaration:
Test report number: 20200307RPT0.1.pdf Issue date: 2020 June, 18

The following manufacturer/importer/entity is responsible for this declaration:

Company name: Xsens Technologies B.V.
Name Title: Igor Ikink, Director Technology
Address: Pantheon 6a, 7521 PR ENSCHEDE, THE NETHERLANDS
Phone: +31 (0)889736700
Fax: +31 (0)889736701

Signed for and on behalf of:

Enschede 2020 July, 01



Igor Ikink, Director Technology

Reach Declaration

Xsens Technologies B.V.
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F + 31 88 973 67 01
E info@xsens.com

Pantheon 6A
P.O. Box 559
7500 AN Enschede
The Netherlands

www.xsens.com

REACH Declaration

Date: August 2020

According to the definition in Article (3) of the REACH Regulation, Xsens is a producer of articles and consequently a downstream user. Therefore, we are not subject to the obligation to register chemicals.

Xsens affirms that it follows the REACH-Regulation updates and it compares these updates with the substance information on hand. The expansion of the Candidate List and the inclusion of substances in the Annex XIV of REACH receives special attention.

We hereby confirm that the products manufactured by Xsens do not contain substances listed in Annex XIV in concentrations exceeding the permitted limiting value of 0.1%. *

This statement is based on our current knowledge. We cannot issue a warranty or assume liability for factors that lie outside the state of our knowledge and control.

Xsens Technologies B.V.

Xsens Technologies B.V.

Jeroen Weijts

Sr. Operations Manager

* this excludes substances exempt under ROHS regulations

DK User Manual

General information

This document provides information on the contents and usage of the MTi 600-series Development/Starter Kit. The MTi 600-series Development Kit (MTi-600-DEV) enables users to evaluate features of the MTi-600 module. In addition to the MTi-600 interfaces, this Development Kit includes a USB and RS422 interface. The MTi 600-series Starter Kit contains all cables and accessories that are required to get started with a robust MTi 600-series tracker. In addition to the MTi-600 interfaces, this Starter Kit includes an RS232 to USB converter dongle.

The *MTi 600-series Datasheet* provides information on the usage and technical details of the MTi 600-series. The MTi 600-series module (MTi-600) is a fully functional, self-contained module that is easy to design-in. The MTi-600 module can be connected to a host through RS232, CAN or UART interfaces, or through USB using the UART to USB converter (included in the MTi 600-series Development Kit). The robust MTi 600-series tracker supports an RS232 and CAN interface, as well as USB using the Starter Kit's RS232 to USB converter dongle.

The *MTi Family Reference Manual* supplements this document. It reports generic information on the MTi 1-series and MTi 600-series, such as output definitions, algorithm details and installation tips.

The *MTi 600-series Hardware Integration Manual* supplements this document. In this document, notes on typical application scenarios, printed circuit board (PCB) layout, origin of measurement reference system, stress related considerations, reference designs and handling information can be found.

The *MT Low Level Communication Protocol* document provides a complete reference for the protocols used to communicate with Xsens Motion Trackers on low-level basis. The MT Low Level Communication Protocol document also describes the synchronization messages and settings in detail.

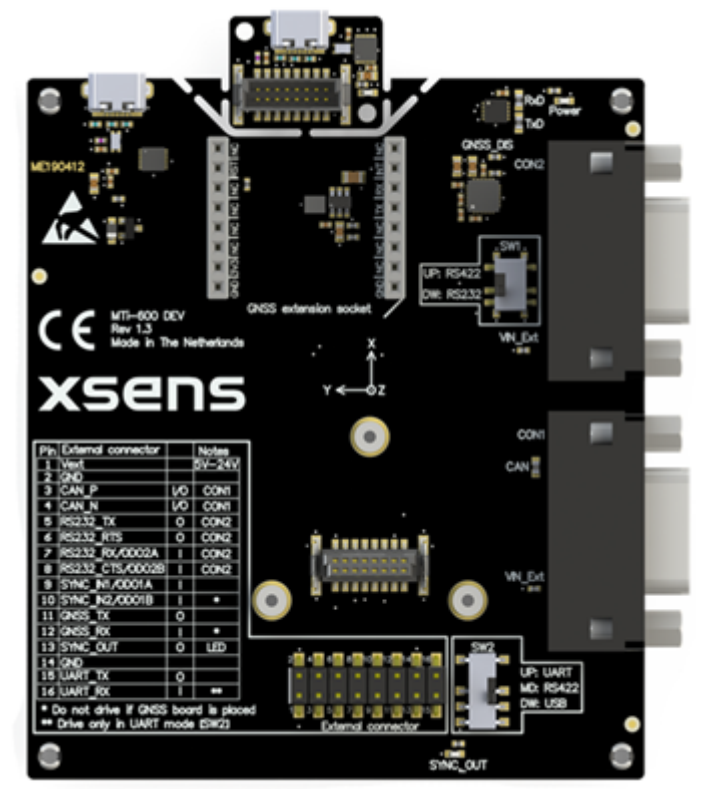
The table below summarizes all available official documents for the Xsens MTi product line.

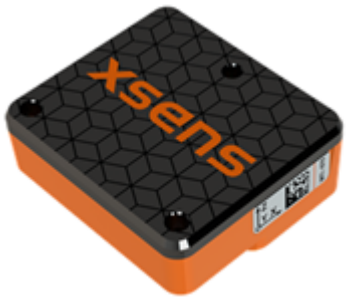
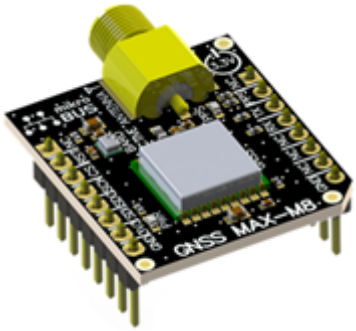
MTi product documentation overview

MTi 1-series	MTi 600-series	MTi 10/100-series
MTi Family Reference Manual		MTi User Manual
MTi 1-series Datasheet	MTi 600-series Datasheet	
MTi 1-series DK User Manual	MTi 600-series DK User Manual	
MTi 1-series HW Integration Manual	MTi 600-series HW Integration Manual	
	MT CAN protocol Documentation	
MT Manager Manual		
Magnetic Calibration Manual		
MT Low Level Communication Protocol Documentation		
Firmware Updater User Manual		

Package information

Package contents for MTi 600-series Development Kit

Component	Name
	MTi-600 Development Board (MTi-600-DEV)

	MTi 600-series module (MTi-630, MTi-670, MTi-680)
	3x M2 x 12 mm brass screws (MTi-600-MP)
	GNSS daughter card #1 (MTI-DK-GNSS)
	GNSS RTK daughter card #2 (MTI-DK-RTK)

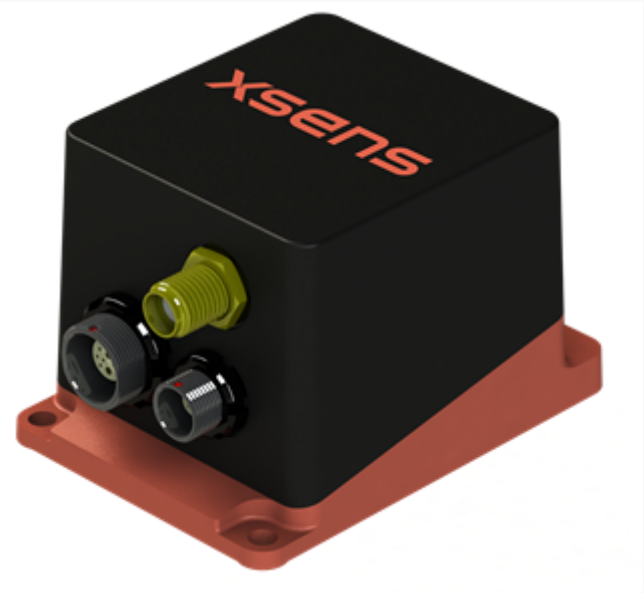
	GNSS antenna #1 (ANT-MULTI)
	GNSS antenna #2 (ANT-GNSS-RTK)
	Micro USB cable (CA-USB-MTW)
	Ribbon cable (CA-MTI-FLAT)

Package contents for MTi-630R Starter Kit

Component	Name
	MTi-630R AHRS (MTi-630R)

	RS232 converter (CA-USB-CONV)
	12-pin Host interface cable (CA-MP-MTI-12)

Package contents for MTi-670G/680G Starter Kit

Component	Name
	MTi-670G GNSS/INS (MTi-670G) **or** MTi-680G RTK GNSS/INS (MTi-680G)
	RS232 converter (CA-USB-CONV)

12-pin Host interface cable
(CA-MP-MTI-12)

4-pin RTCM corrections cable #3
(CA-MP-MTI-4)

GNSS antenna
(ANT-GNSS-RTK)

Ordering information

Ordering information for MTi 600-series Development Kit

Kit	Description	Package contents	Packing Method
MTi-630-DK #4	Development Kit for MTi-630 AHRS	• MTi 600-series Development Board (incl. USB to UART converter) • MTi-630 AHRS module • 3x M2 x 12 mm brass screws • Ribbon cable	Single unit
MTi-670-DK	Development Kit for MTi-670 (GNSS/INS)	• MTi 600-series Development Board (incl. USB to UART converter) • MTi-670 GNSS/INS module • 3x M2 x 12 mm brass screws • GNSS daughter card • GNSS antenna • Ribbon cable	Single unit

MTi-680-DK	Development Kit for MTi-680 (RTK GNSS/INS)	• MTi 600-series Development Board (incl. USB to UART converter) • MTi-680 RTK GNSS/INS module • 3x M2 x 12 mm brass screws • GNSS RTK daughter card • GNSS antenna • Ribbon cable	Single Unit
MTi-630R-SK	Starter Kit for MTi-630R (AHRS)	• MTi-630R AHRS • RS232-USB converter • 12-pin Host Interface cable	Single unit
MTi-670G-SK	Starter Kit for MTi-670G (GNSS/INS)	• MTi-670G GNSS/INS • RS232-USB converter • 12-pin Host Interface cable • 4-pin RTCM cable • GNSS antenna	Single unit
MTi-680G-SK	Starter Kit for MTi-680G (RTK GNSS/INS)	• MTi-680G RTK GNSS/INS • RS232-USB converter • 12-pin Host Interface cable • 4-pin RTCM cable • GNSS antenna	Single unit

[1] Only with MTi-670-DK
[2] Only with MTi-680-DK
[3] Only with MTi-680G-SK
[4] Development Kits for the MTi-610-IMU and MTi-620-VRU are not available. Instead, the MTi-630-DK can be used for testing purposes as it covers all functionality of the MTi-610 IMU and MTi-620 VRU.

Introduction

Software and documentation

The MTi-600 series Development Kit and Starter Kit are supported by the MT Software Suite, which includes the following software components:

- MT Manager
- Magnetic Field Mapper
- MT SDK including programming examples and documentation

Additionally, the latest firmware for the MTi-6x0 can be downloaded and updated using the Firmware Updater which is separately available.

All software components can be downloaded from the Xsens website – www.xsens.com.

Programming examples

Inside the MT SDK folder of the MT Software Suite, programming examples can be found for various programming languages, including C++, C#, Python and Matlab. A ROS node is also available. These examples are based on the (open source) Xsens Device API (XDA). For more information and a complete overview, refer to this article.

Getting Started

- Getting Started
  - Setting up the Development Kit
  - Installing MT Software Suite
  - Displaying data in MT Manager
  - Configuring the MTi 600-series

Setting up the Development Kit

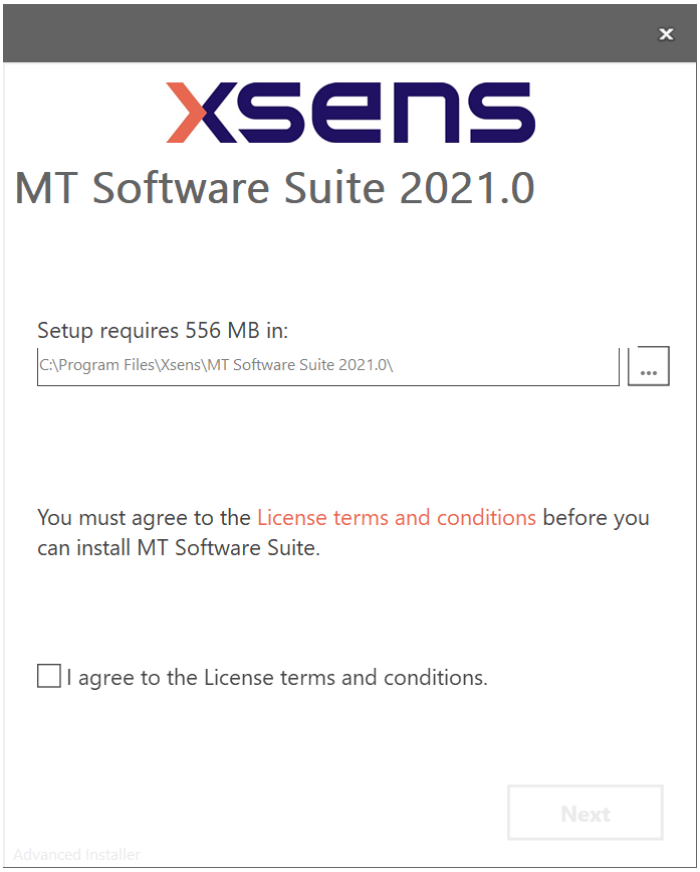
Before testing the MTi-600 Development Kit, the MTi-600 needs to be installed onto the MTi-600 DEV. Place the MTi-600 onto the socket between the spacers. Secure the MTi-600 by screwing the three M2 brass screws in the spacers. Ensure that switch SW2 is set to DW: USB.

For the MTi-670-DK and MTi-680-DK the GNSS daughter card is already installed on the MTi-600 DEV. To use the GNSS receiver, the included GNSS antenna needs to be connected to the SMA connector of the GNSS daughter card.

Installing MT Software Suite

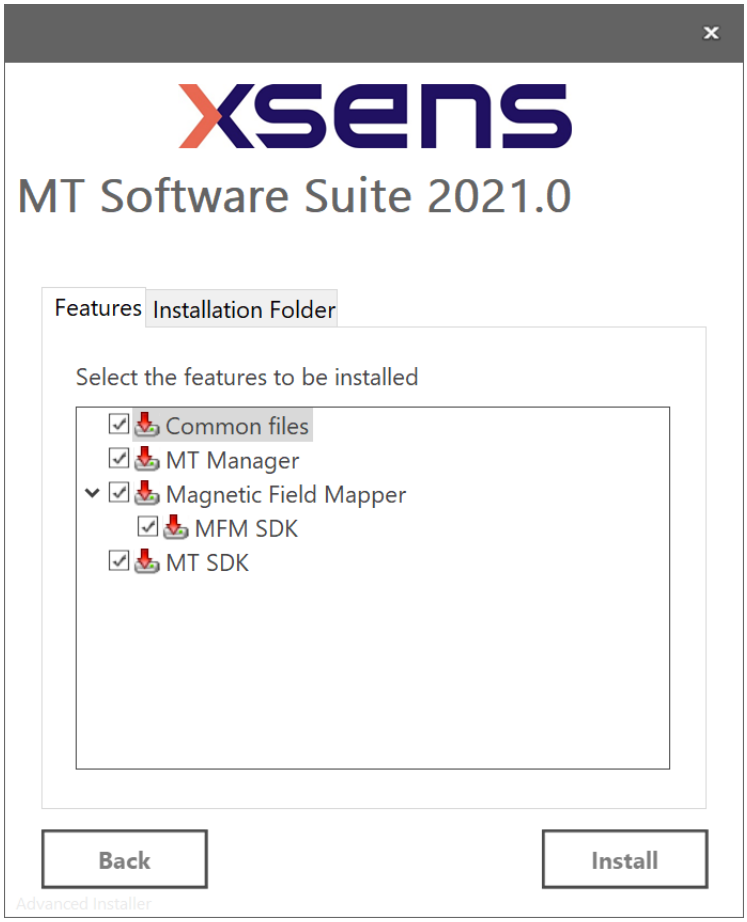
The MT Software Suite is available from the Xsens website (www.xsens.com/mt-software-suite).

The installation procedure consists of a set of several installers and starts with the GUI as shown below.



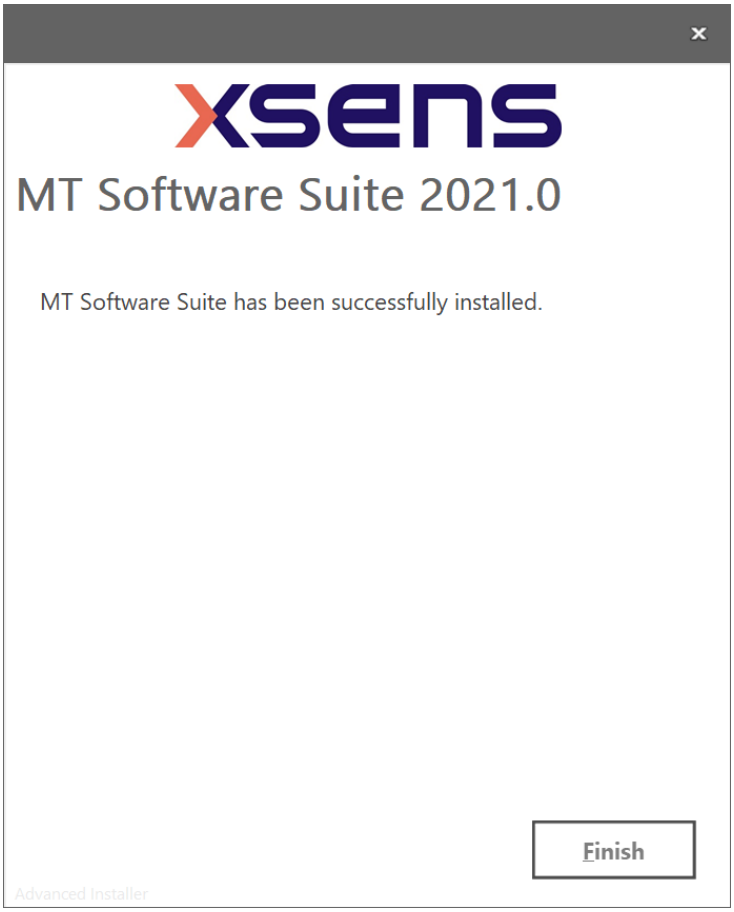
Start up screen for the MT Software Suite installer

It is possible to choose the components that you wish to install:



Software components installation

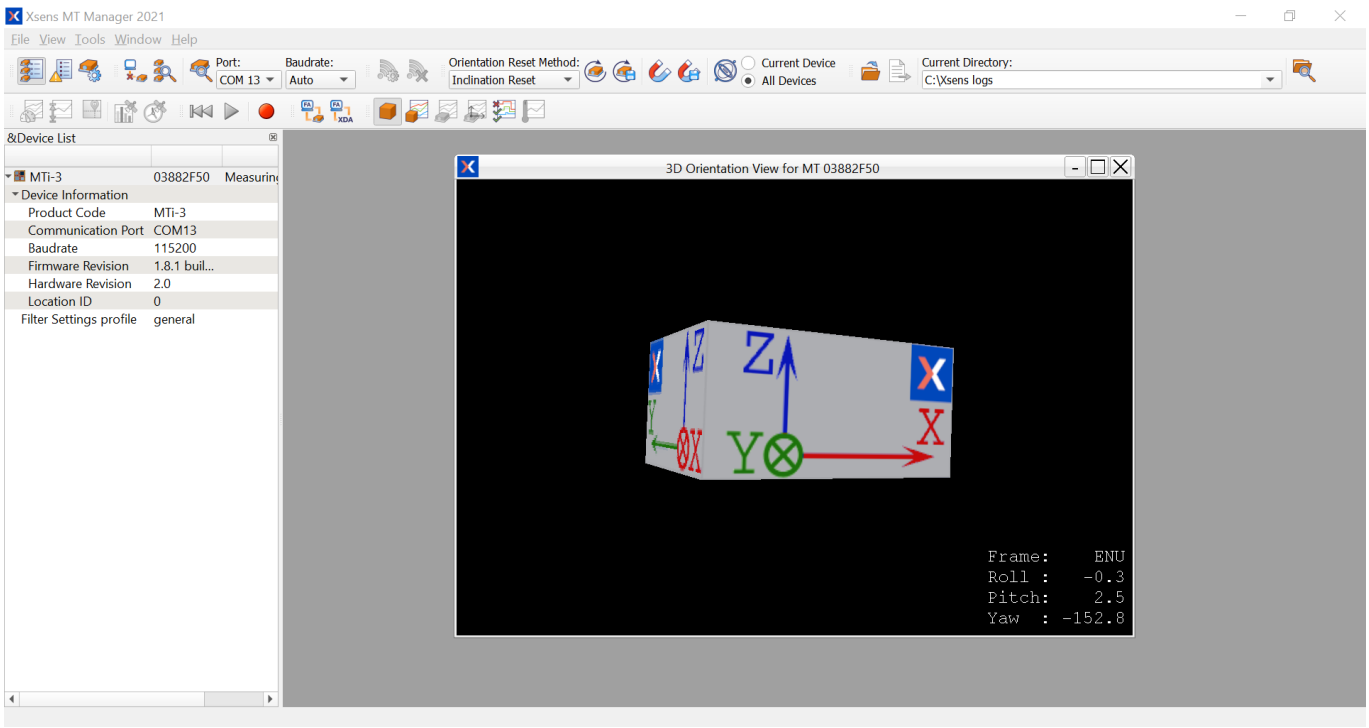
When you cancel the installation of a particular component, the installer will continue with the next component. Make sure to accept the End-User License agreement and Software License Agreements, and then wait for the successful installation screen to appear as shown below.



Successful installation screen

Displaying data in MT Manager

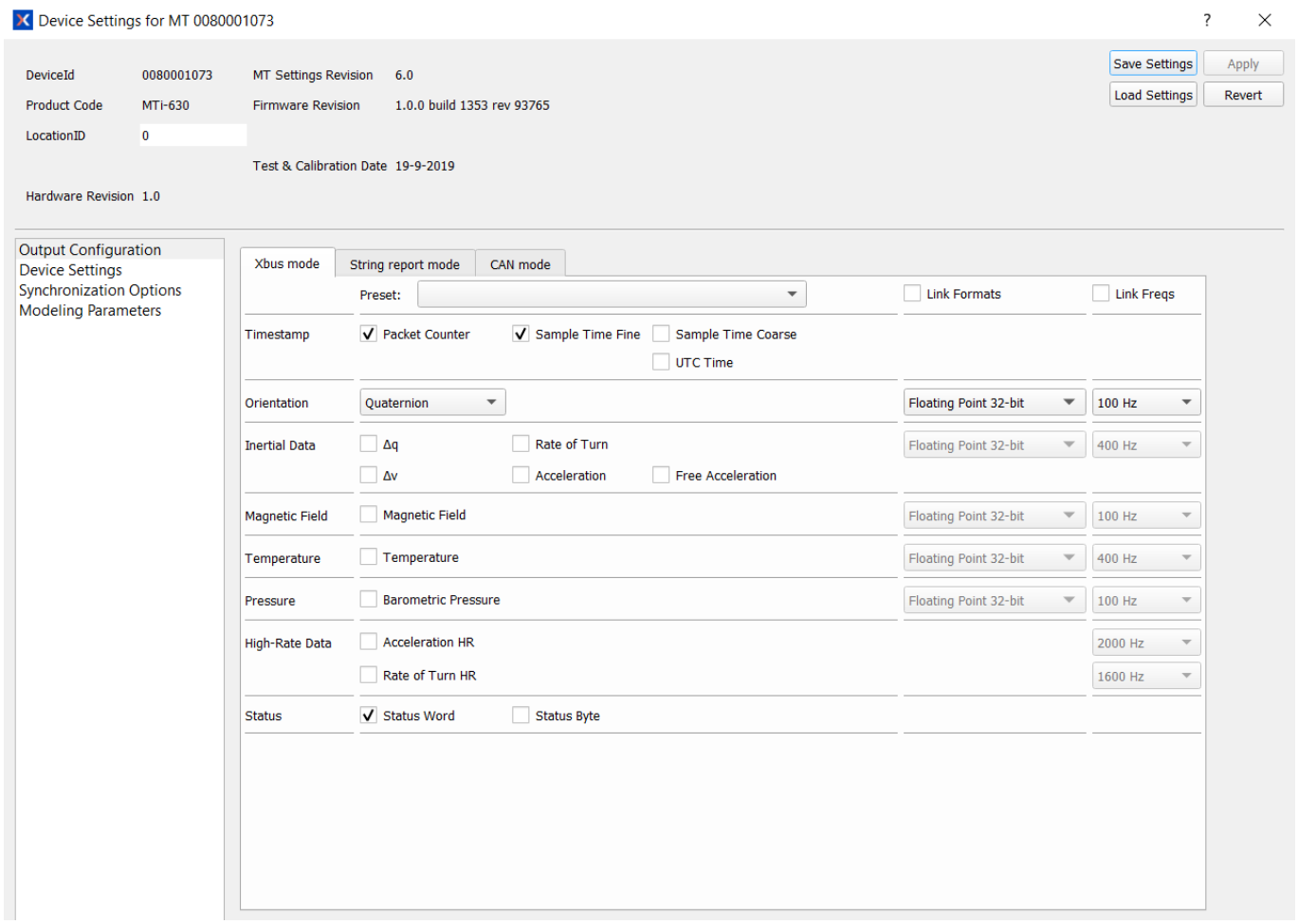
When the MTi 600-series Development Board or standalone tracker is connected in MT Manager, the device description is shown in the “Device List” on the left side of the screen (see below figure). To see a real time 3D visualization of the orientation of the MTi, click the 3D View icon . The inertial data , orientation data in Euler angles and the status data can be visualized by clicking their respective icons. In order to open these windows, the corresponding data outputs of the MTi need to be configured. Otherwise, the window icons will be grey.



MT Manager overview

Configuring the MTi 600-series

The MTi 600-series can be directly configured by means of MT Manager. Click the Device Settings button to open the Output Configuration dialog.



Output configuration dialog in MT Manager using an MTi-630

By default, the output of the MTi-600 is set to the ‘Onboard Processing’ preset, Click “Inertial Data” (Δq/Δv or Rate of Turn/Acceleration) and “Magnetic Field” to be able to show this data in MT Manager.

With MT Manager, it is possible to record data and export that data for use in other programs, set alignment matrices, configure synchronization options and to review the test and calibration report. More information on the functions and features can be found in the *MT Manager User Manual*.

Development board

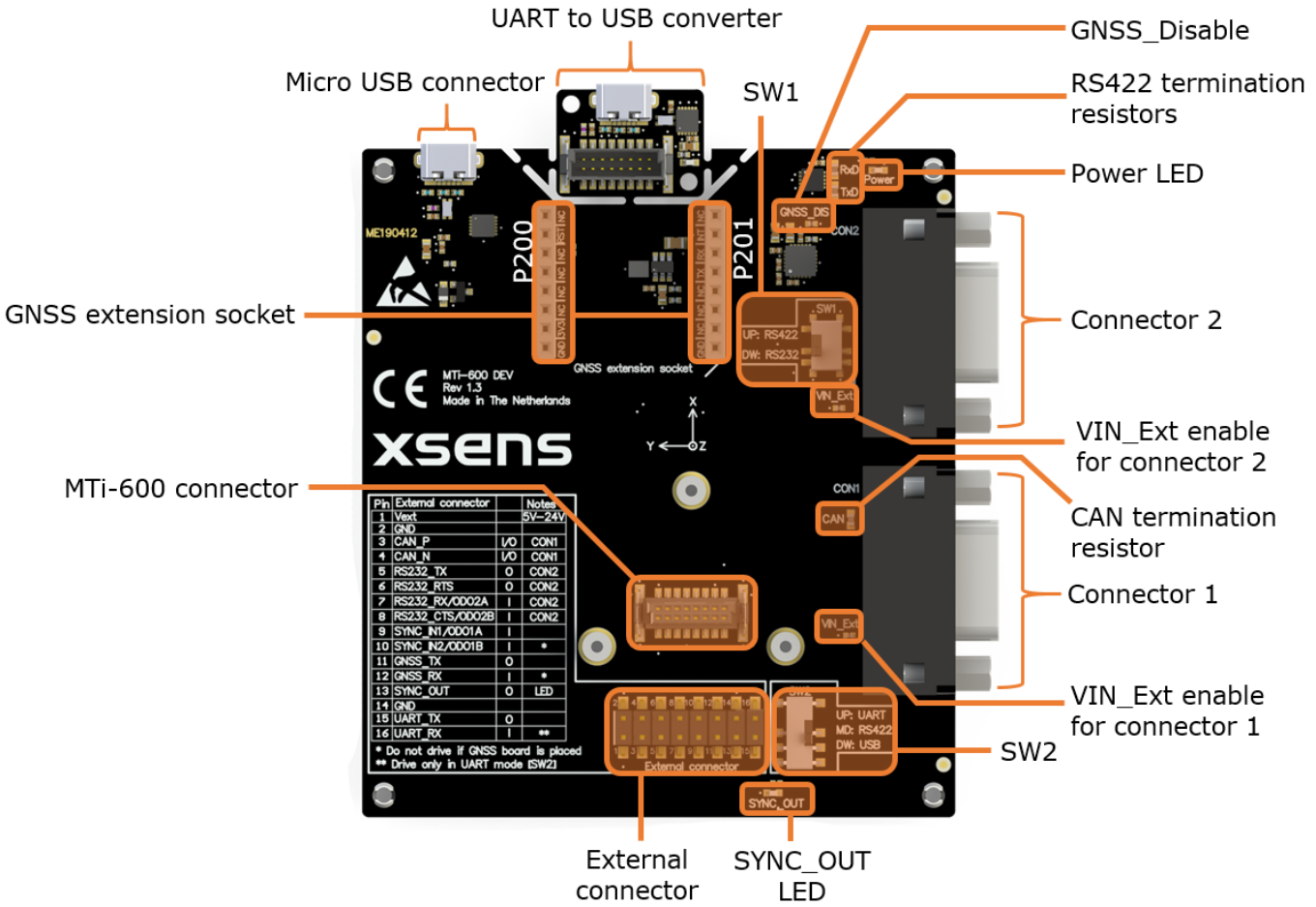
The MTi 600-series Development Board (MTi-600 DEV) exposes the pins of the MTi-600 on the *External connector,* a 2.54 mm pitch header, making it easier for the user to test all the features and the peripherals offered by the MTi-600. Next to that, the MTi-600 DEV has a micro USB connector and two *DSUB9* connectors for testing different communication protocols. It also includes a mikroBUS™ compatible *GNSS extension socket* to connect a GNSS module for the MTi-670-DK and MTi-680-DK. This chapter discusses in more detail the connections and peripherals available on the MTi-600 DEV.

Overview

The MTi-600 DEV has the following connections as shown in the figure below:

- *External connector*.
- Main connector for the MTi-600.
- *DSUB9* female connector 1 for CAN interface.
- *DSUB9* female connector 2 for RS232 or RS422 interface.
- *Micro USB connector*.
- Peripheral selection switches (*SW1* & *SW2*).

- *GNSS extension socket* (*P200* and *P201* female sockets).
- Zero-Ohm resistor positions for disabling the GNSS UART and enabling VIN_Ext.
- 120-Ohm termination resistors for CAN and RS422.
- UART to USB breakout board.



MTi 600-series Development Board overview with connector designators

External Connector

The External Connector makes all of the MTi-600 pins available on a 2.54 mm pitch header. The pin numbering is an exact copy of the MTi-600 pinning itself. All pins have a direct connection to the MTi-600 except for pin 1 (Vext). Pin 1 is connected through a diode and can only be used to power the MTi-600 (not for monitoring). The pinning can be seen in the following table.

Pin descriptions of External Connector

Pin	Name	I/O	Description
1	Vext	PWR	Power input
2	GND	PWR	Ground

3	CAN_H	I/O	CAN bus differential low side
4	CAN_L	I/O	CAN bus differential high side
5	RS232_TxD	O	RS232 transmitter output to host
6	RS232_RTS	O	RS232 Ready To Send output to host
7	RS232_RxD	I	RS232 receiver input from host
8	RS232_CTS	I	RS232 Clear To Send input from host
9	SYNC_IN1	I	Multifunctional synchronization input
10	SYNC_IN2	I	Multifunctional synchronization input
11	GNSS_TxD	O	RS232 transmitter output to GNSS module
12	GNSS_RxD	I	RS232 receiver input from GNSS module
13	SYNC_OUT	O	Configurable synchronization output
14	GND	PWR	Ground
15	UART_TxD	O	UART transmitter output
16	UART_RxD	I	UART receiver input

Power

The MTi-600-DK can be supplied by USB or through the External Connector. In case the External Connector is used to power the board, the USB power will be disconnected from the MTi-600. Additionally, pin 9 of both DSUB9 connectors can be connected directly to pin 1 (Vext) of the External connector by placing the corresponding zero-Ohm resistor.

⚠ The DSUB9 VIN_Ext pins are directly connected to pin 1 of the External connector when the zero-Ohms resistors are placed. Do not supply power to more than one of these pins at the same time!

Host connections

USB

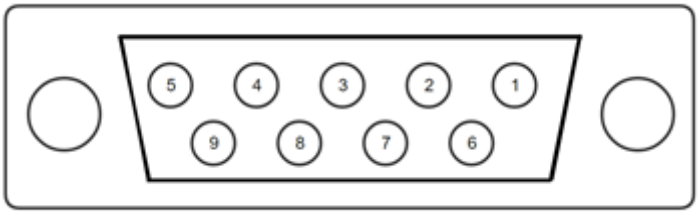
The micro USB port on the main board can be used to connect the MTi-600 to a host though the included micro USB cable. The USB device requires the drivers that are automatically included when downloading the MT Software Suite. The following table shows the required switch configuration for this connection.

Switch configuration USB

Switch	Position
SW1	-
SW2	Down (default)

CAN

Connector 1 can be used to connect a CAN bus to the MTi-600 with a DSUB9 connector. The table below shows the pinning of this connector. The DSUB9 connector connects directly to the MTi-600 without relying on any switch. The CAN bus interface includes a 120 Ohm termination resistor on the MTi-600 DEV.



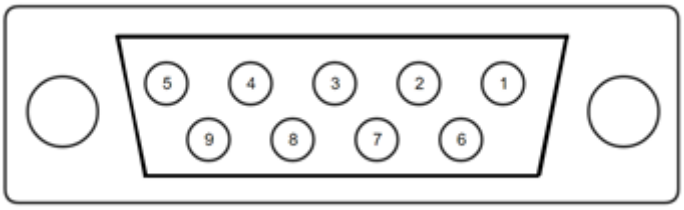
Pin out of DSUB9 connector CAN

DSUB9 connector 1 pinning for CAN

Pin	Name	Description
2	CAN_L	CAN bus differential low side
3	GND	Ground
5	GND	Ground
7	CAN_H	CAN bus differential high side
9	VIN_Ext	Supply input (requires zero-Ohm resistor)

RS232

Switch SW1 needs to be set in the downward position to enable the RS232 connections on DSUB9 connector 2. The table below shows the pinning of DSUB9 connector 2 if the RS232 interface is enabled.



Pin out of DSUB9 connector RS232

DSUB9 connector 2 pinning for RS232

Pin	Name	Description
2	RS232_TxD	RS232 transmitter output to host
3	RS232_RxD	RS232 receiver input from host
5	GND	Ground
7	RS232_CTS	RS232 Clear To Send input from host
8	RS232_RTS	RS232 Ready To Send output to host
9	VIN_Ext	Supply input (requires zero-Ohm resistor)

Switch configuration for enabling RS232

Switch	Position
SW1	Down (default)
SW2	-

RS422

To activate the RS422 interface, switch SW1 should be in the upward position and switch SW2 in the middle position. The table below shows the pinning of DSUB9 connector 2 if the RS422 connections are enabled. The RS422 interface includes a 120 Ohm termination resistor on both the RxD and TxD lines.

Connector 2 pinning for RS422

Pin	Name	Description
1	RS422_RxD-	RS422 negative receiver input from host
2	RS422_RxD+	RS422 positive receiver input from host
3	RS422_TxD+	RS422 positive transmitter output to host

4	RS422_TxD-	RS422 negative transmitter output to host
5	GND	Ground
9	VIN_Ext	Supply input (requires zero-Ohm resistor)

Switch configuration for enabling RS422

Switch	Position
SW1	Up
SW2	Mid

UART

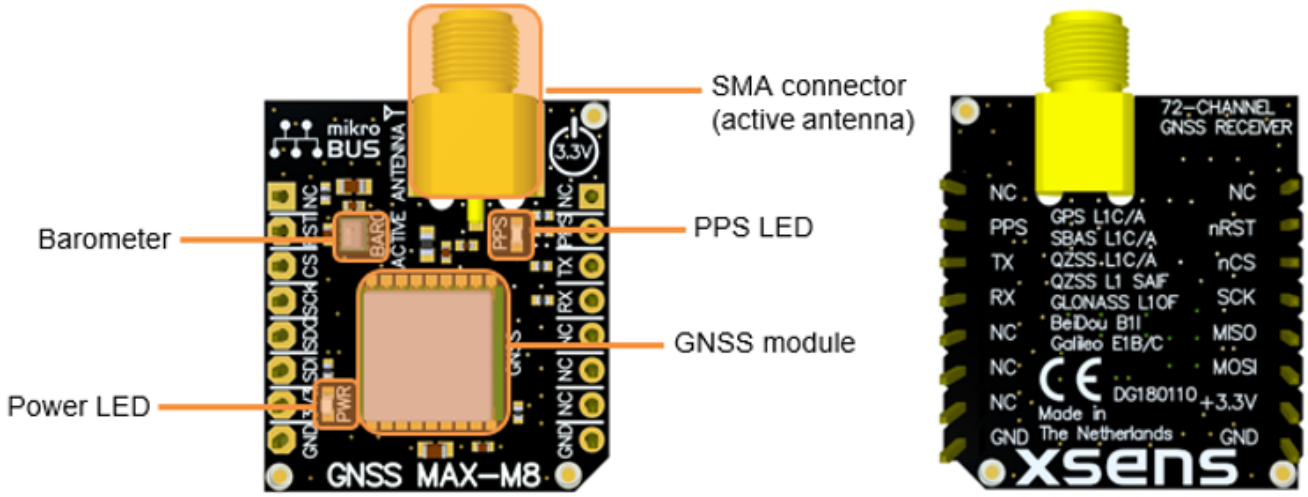
To be able to use the UART pins on the External Connector, switch SW2 needs to be set in the upward position. This will ensure that the UART_RxD is not controlled by any of the transceivers of the MTi-600 DEV. The UART_TxD will still transmit over USB and RS422 (when enabled), allowing to monitor the MTi-600 output. The UART pinning on the External Connector can be seen in table #Pin descriptions of External Connector.

Switch configuration for enabling UART

Switch	Position
SW1	-
SW2	Up

External GNSS extension socket and daughter card (MTi-670/680 DK only)

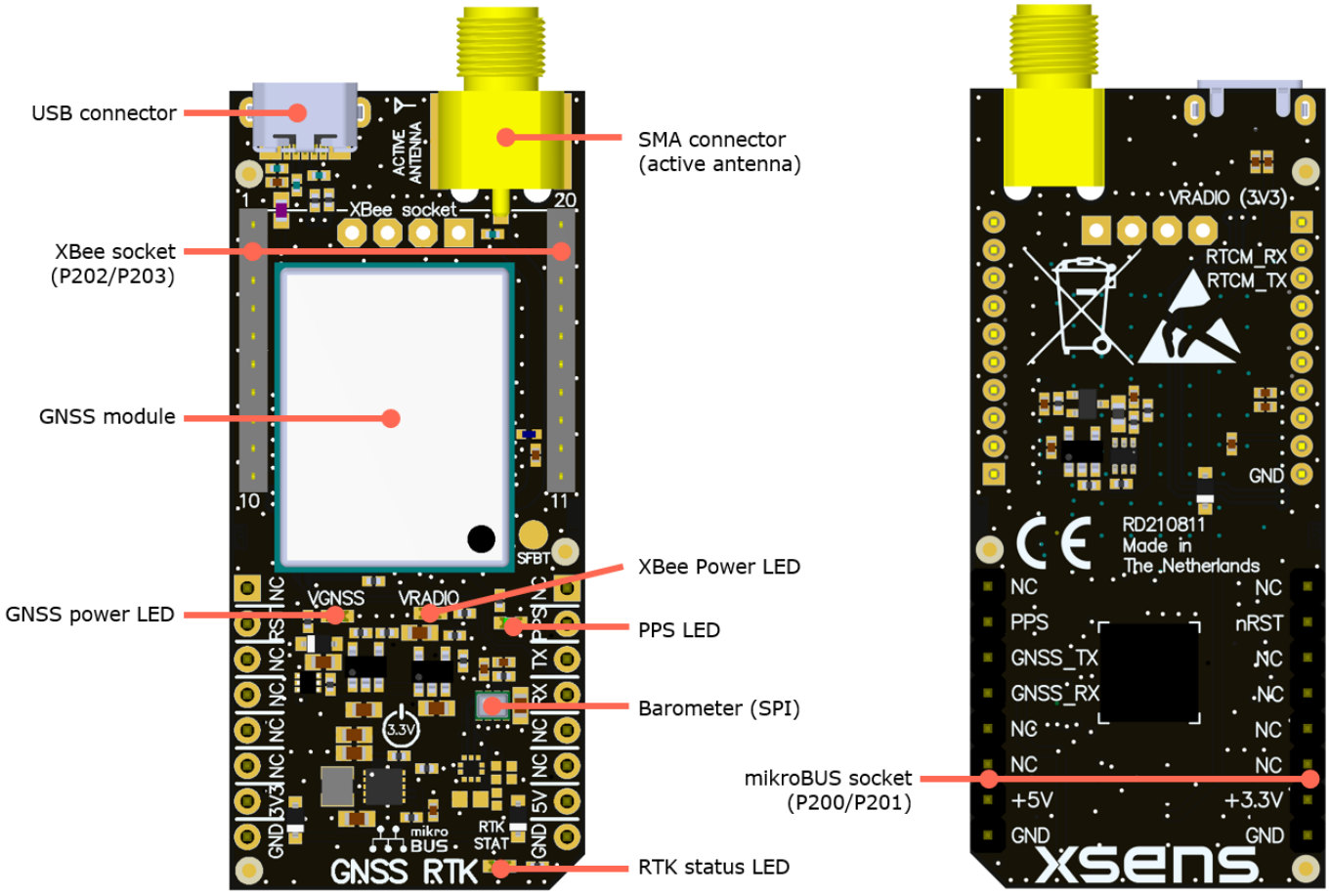
The MTi-670-DK comes with the GNSS daughter card installed in the *GNSS extension socket*. As shown in the figures below, the GNSS daughter card consists of a GNSS receiver and a barometer sensor component. The barometer is not used/connected for the MTi-670-DK, since the MTi-600 has an internal barometer. The LEDs (Power and PPS) give indication of proper functioning of the GNSS daughter card. The supplied GNSS antenna can be connected to the SMA connector.



Top view (left) and the bottom view (right) of the MTi-670-DK GNSS daughter card

The MTi-600 DEV board translates the RS232 signal levels from the MTi-600 to the 3V3 UART levels used on the extension board. This transceiver can be disabled by placing a zero-Ohm resistor on the *GNSS_Disable* resistor position (see #MTi 600-series Development Board overview with connector designators). In this case, the GNSS pins on the *External connector* can be used to connect a RS232 level enabled GNSS receiver.

The MTi-680-DK comes with the RTK GNSS daughter card installed in the *GNSS extension socket*. As shown in the figures below, the RTK GNSS daughter card consists of an RTK GNSS receiver, a barometer sensor component, an Xbee socket and a USB connector. The barometer is not used/connected for the MTi-680-DK, since the MTi-600 has an internal barometer.
The LEDs (Power, PPS, Xbee and RTK status) give indication of proper functioning of the RTK GNSS daughter card and Xbee power. The supplied GNSS antenna can be connected to the SMA connector.



Top view (left) and the bottom view (right) of the MTi-680-DK RTK GNSS daughter card

The power consumption of the MTi-680 DK RTK GNSS daughter card (MTi-DK-RTK) is higher than the MTi-670 DK GNSS daughter card. Use only with MTi-600-DEV Hardware Revision 1.7 and higher!

The MTi-680-DK is equipped with an XBee module socket. XBee modules are embedded solutions providing wireless end-point connectivity to devices. The XBee socket can be used to feed RTCM correction messages to the MTi-680-DK RTK GNSS receiver or to connect to an XBee wireless module.

XBee socket pinning

Pin	GNSS board
P202-1	VRADIO (3V3)
P202-2	RTCM_RxD

P202-3	RTCM_TxD
P202-[4..9]	NC
P202-10	GND
P203-[11..20]	NC

The *GNSS extension socket* has mikroBUS™ compatible pinning. This enables the user to connect alternate GNSS daughter card modules with mikroBUS™ pinning to the MTi-600-DEV. The pinning connections for the *GNSS extension socket* are listed in Table 13. This extension only uses the 3.3V supply pin, which is connected to the 3V3 that is generated on the MTi-600 DEV.

Connections on UART communication GNSS extension sockets.

Pin	Mikro BUS	MTi-670/680	Pin	Mikro BUS	MTi-670/680
P200-1	AN	NC	P201-1	PWM	NC
P200-2	RST	Pull-up	P201-2	INT	SYNC_IN2
P200-3	CS	NC	P201-3	TX	GNSS_RxD
P200-4	SCK	NC	P201-4	RX	GNSS_TxD
P200-5	MISO	NC	P201-5	SCL	NC
P200-6	MOSI	NC	P201-6	SDA	NC
P200-7	3.3V	3V3	P201-7	5V	5V
P200-8	GND	GND	P201-8	GND	GND

Electrical specifications

MTi-600 DEV power supply specifications

	Min	Typ	Max	Unit
V_{USB}	4.5	5	5.5	V
V_{ext}	4.5	-	24	V

Absolute maximum ratings

Absolute maximum ratings MTi-600 DEV

Parameter	Min	Max	Unit	Comments
Operating temperature	-40	+85	ºC	
V_{ext}	-0.3	30	V	Power input on *External connector* or *DSUB9* connectors
V_{USB}	-0.3	6.0	V	USB power input
V_{UART}	-0.3	3.6	V	
$V_{RS232/SYNC}$	-25	25	V	
V_{RS422}	-15	15	V	
V_{CAN_DC}	-58	58	V	Common mode voltage of CAN_H and CAN_L with respect to ground
V_{CAN_DIFF}	-17	17	V	Differential voltage between CAN_H and CAN_L
Acceleration[1]		10,000	g	Any axis, unpowered, for 0.2 ms
ESD protection[2]		±2000	V	Human body model

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

[1] This is a mechanical shock (g) sensitive device. Proper handling is required to prevent damage to the part.

[2] This is an ESD-sensitive device. Proper handling is required to prevent damage to the part.

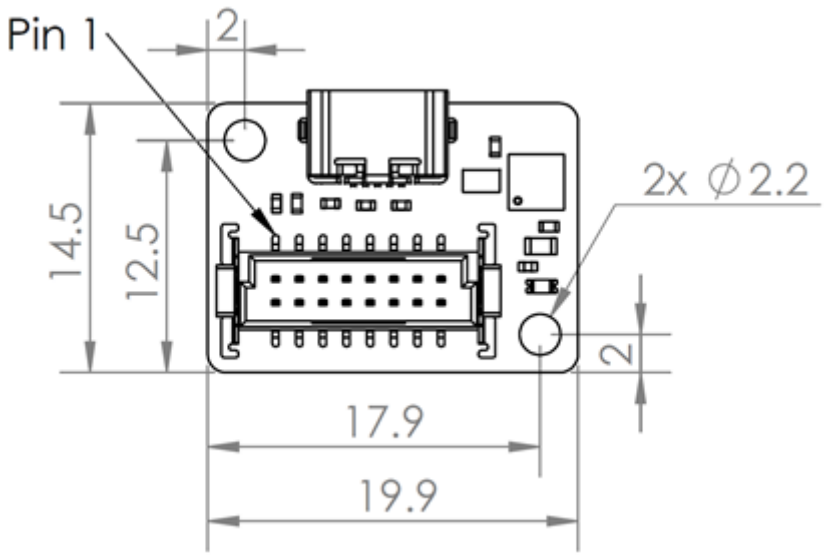
Standalone configuration

The MTi-600 DEV includes a UART to USB breakout board that can be used for a minimalistic connection to a host through the supplied ribbon cable. This board can be separated from the main MTi-600 DEV board by breaking it off gently. With this board the MTi-600 can be mounted up-side-down, with the connector facing up, onto any surface by using the mounting holes of the MTi-600. The location of the MTi-600 mounting holes can be found in the *MTi 600-series Datasheet* or *MTi 600-series Hardware Integration Manual*.

The UART to USB breakout board uses the 5V power supply of the USB to power the MTi-600 and the UART pins of the MTi-600 for communication.

UART to USB board drawing

The figure below shows the dimensions of the UART to USB breakout board together with its mounting holes.



UART to USB converter

Starter Kit

This chapter describes the technical specfications of all components included in the MTi-630R-, MTi-670G- and MTi-680G Starter Kit.

- Starter Kit
  - CA-USB-CONV
    - SYNC connections
  - Cables
    - CA-MP-MTI-12
    - CA-MP-MTI-4 (MTi-680G-SK only)
  - ANT-GNSS-RTK

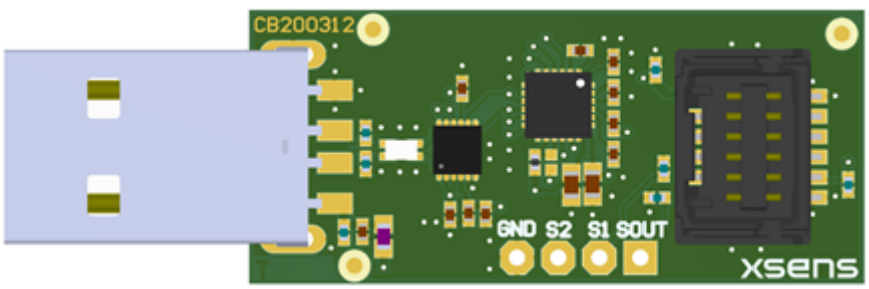
CA-USB-CONV

The CA-USB-CONV is a USB to RS232 converter that can be connected directly to the Molex connector of the 12-pin Host Interface cable. The RS232 converter uses the RxD, TxD, RTS and CTS pins of the RS232 communication lines and powers the MTi-600 with the 5V power line of the USB.

SYNC connections

The SYNC signals of the MTi-600 can be easily accessed on the PCB of the RS232 converter. To reveal the PCB the two housing components need to be pulled apart. The housing parts are fixed with press fit connections in each corner.

The figure below shows the PCB of the RS232 converter. The SYNC signals are available on pads with a 2.54 mm spacing and can be used to solder on a standard 2.54 mm pitch through hole header or wires. Table 16 shows the signal definitions of the pads.



RS232 converter PCB

RS232 converter I/O pad definitions

Pin number	Designator	Function (MTi)
1 (square)	SOUT	SYNC_OUT
2	S1	SYNC_IN1
3	S2	SYNC_IN2
4	GND	Ground

Cables

CA-MP-MTI-12

The CA-MP-MTI-12 is the 12-pin Host Interface cable assembly and consists of the following parts:

- Molex connector: 5054321201; 1.25mm pitch, dual row, positive lock, 12 circuits
- ODU connector: A10WAMP12XMM0-0000; AMC HD, break-away plug, 12 circuits
- Cable: 2.9 m, 12 core, AWG28, shielded, UL, 40ºC - +85ºC, 6.1 mm diameter
- Molex crimp terminals: 5054311100; gold (Au) plating, 2630 AWG

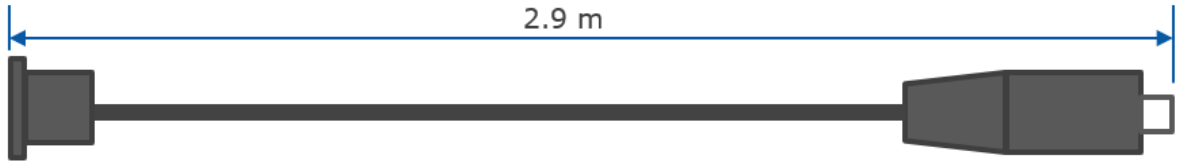
The table below shows the pinning of the connections. The shield of the cable is only connected on the ODU connector side.

Connector pinning Host Interface cable assembly

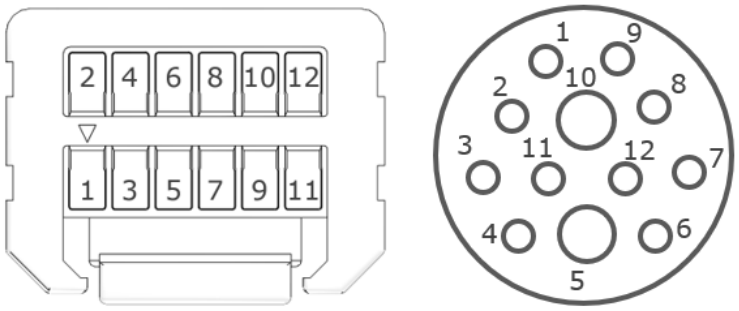
Function (MTi)	Wire colour	Wire number	Molex pin no.	ODU pin no.
VIN	Red	5	1	5
GND	Black	6	2	10
CAN_H	Green	1	3	1
CAN_L	White	2	4	2
RS232_TxD	Yellow	9	5	8
RS232_RTS	Violet	10	6	9
RS232_RxD/SYNC_IN3	Grey	8	7	7
RS232_CTS/SYNC_IN4	Orange	7	8	6

SYNC_IN1/ODO_1A	Black/White	3	9	3
SYNC_IN2/ODO_1B	Red/White	4	10	4
SYNC_OUT	Blue/White	11	11	11
GND	Blue	12	12	12
SHIELD	-	-	-	SH

The figures below show the cable length definition (from connector end-to-end) and the pinning of both the Molex connector and the ODU connector. The table underneath shows the recommended mating parts for the Molex connector.



Host Interface cable length definition



Numbering 12-pin connectors; left Molex (cable entry view), right ODU (solder cup view).

Recommended mating parts for 12-pins Molex connector

Part number	Manufacturer	Mounting	Description
5054331291	Molex	Vertical	1.25mm Pitch, Micro-Lock Plus PCB Header, Dual Row, Surface Mount, 0.10µm Gold Plating, 12 Circuits
5054481291	Molex	Right-Angle	

CA-MP-MTI-4 (MTi-680G-SK only)

The CA-MP-MTI-4 is the 4-pin RTCM corrections cable assembly and consists of the following parts:

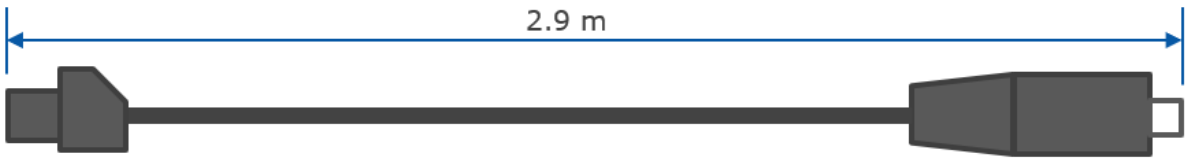
- Molex connector: 2045320401; 1.25mm pitch, single row, positive lock, 4 circuits
- ODU connector: A1CWAMP04XBC0-0000; AMC HD, break-away plug, 4 circuits
- Cable: 2.9 m, 12 core, AWG28, shielded, UL, 40ºC - +85ºC
- Molex crimp terminals: 5054311100; gold (Au) plating, 2630 AWG

The table below shows the pinning of the connections. The shield of the cable is only connected on the ODU connector side.

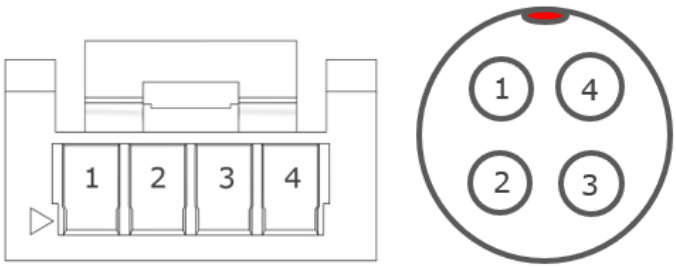
Connector pinning RTCM cable assembly

Function (MTi)	Wire colour	Molex pin no.	ODU pin no.
V_BCKP	Red	1	1
GND	Black	2	2
RTCM_TxD	Green	3	4
RTCM_RxD	White	4	3
SHIELD	-	-	SH

The figures below show the cable length definition (from connector end-to-end) and the pinning of both the Molex connector and the ODU connector. The table underneath shows the recommended mating parts for the Molex connector.



RTCM cable length definition



Numbering 4-pin connectors; left Molex (cable entry view), right ODU (solder cup view).

Recommended mating parts for 4-pins Molex connector

Part number	Manufacturer	Mounting	Description
5055680481	Molex	Vertical	1.25mm Pitch, Micro-Lock Plus PCB Header, Single Row, Surface Mount, Gold Plating, 4 Circuits
5055670481	Molex	Right-Angle	

ANT-GNSS-RTK

The supplied GNSS antenna in the MTi-670G/680G Starter Kit is the TW8889 of Tallysman (manufacturer order code: 33-8889NM-12-2900). The specifications of this antenna are listed in the following table.

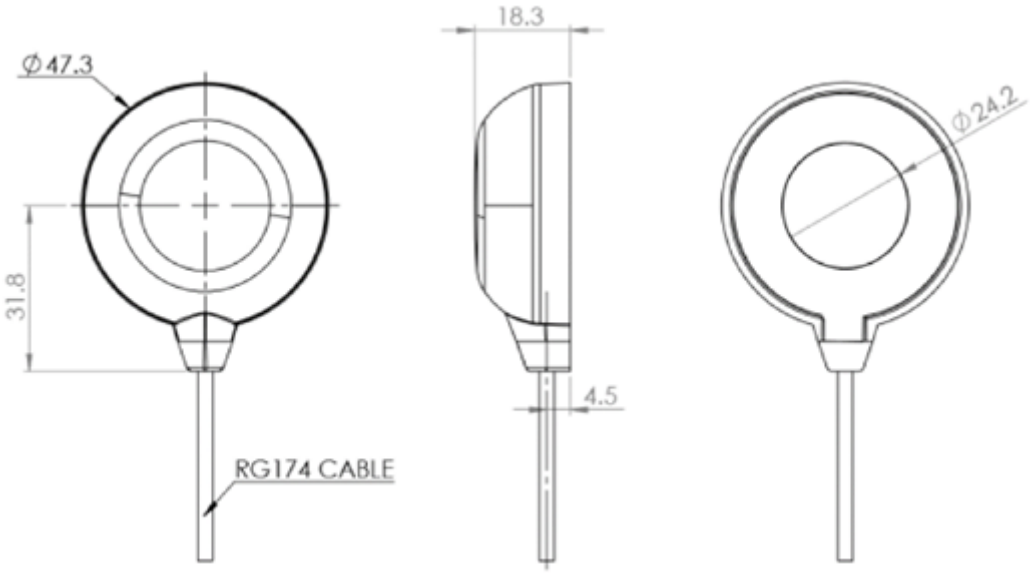
GNSS RTK antenna specifications

Parameter	Specification
Typical LNA gain	27 dB
Typical LNA noise figure	2.5 dB
L1 peak band antenna gain (1575.42 – 1606 MHz)[1]	4 dBic
L2 peak band antenna gain (1215 – 1240 MHz)[1]	4 dBic
G2 peak band antenna gain (1237 – 1246 MHz)[1]	3 dBic
E5b/G3 peak band antenna gain (1189 – 1214 MHz)[1]	1 dBic
Axial ratio (max at Zenith)	1 dB
Polarization	RHCP
EMI immunity out-of-band	50 V/m
ESD circuit protection (air discharge)	15 kV
Weight	52 g
Cable length	2.9 m

Other specifications:

- Covering GPS/QZSS L1/L2, GLONASS G1/G2/G3, Galileo E1/E5b, BeiDou B1/B2, as well as SBAS (WAAS/EGNOS/GAGAN/MSAS)
- Tight Phase Center Variation
- Low current: 12 mA typ.

- IP67, REACH and RoHS compliant



GNSS antenna dimensions (mm)

[1] Peak gain at Zenith with 100 mm diameter ground plane.

Hardware Integration Manual

General information

This document provides hardware design instructions for the MTi 600-series module (MTi-610/620/630/670/680) and robust tracker (MTi-630R/670G/680G). The MTi 600-series is a fully functional, self-contained module that is easy to design-in with limited external hardware components to be added. The MTi-600 module can be embedded in an application by mounting it directly on a PCB or as a standalone module by connecting it via a flat-ribbon cable. The MTi-600 module can be connected to a host through RS232, CAN or UART interfaces. In contrast, the MTi 600-series robust trackers (MTi-630R, MTi-670G and MTi-680G) are rugged (IP68) devices which can be connected to a host through RS232 or CAN interface, or through USB using the RS232 to USB converter dongle (included in the MTi 600-series Starter Kit).

The *MTi 600-series Datasheet* provides information on the usage and technical details of the MTi 600-series.

The *MTi Family Reference Manual* supplements this document. It reports generic information on the MTi 1-series and MTi 600-series, such as output definitions, algorithm details and installation tips.

For testing and prototyping, Xsens provides the MTi-630, MTi-670 and MTi-680 Development Kits (MTi-630-DK, MTi-670-DK and MTi-680-DK) as well as Starter Kits (SK) for the robust MTi-630R, MTi-670G and MTi-680G. In addition to the RS232, CAN and UART pin connectors of the MTi 600-series module, the Development Kit offers a direct USB, RS232, RS422 and CAN interface. Technical details of the Development Kit and its usage can be found in the *MTi 600-series DK User Manual*.

The *MT Low Level Communication Protocol Document* provides a complete reference for the protocols used to communicate with Xsens Motion Trackers on low-level basis. The *MT Low Level Communication Protocol Document* also describes the synchronization messages and settings in detail.

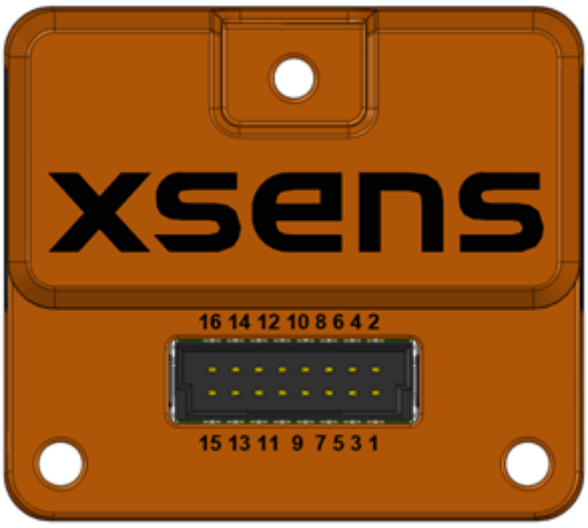
Interfaces

- Interfaces
  - Pin Configuration
    - MTi 600-series module
    - Robust trackers (MTi-630R/670G/680G)
  - Communication to host
    - CAN
    - RS232
    - UART
  - GNSS receiver interface
  - RTCM corrections interface
  - SYNC

Pin Configuration

MTi 600-series module

Below figure shows the pin configuration of the MTi 600-series module.



Pin configuration of the MTi 600-series module

Below table shows the pin descriptions of the MTi 600-series module.

Pin descriptions MTi-610/620/630/670/680

Pin	Name	I/O type	Description
1	VIN	PWR	Power input
2	GND	PWR	Ground
3	CAN_H	I/O	CAN bus differential high side
4	CAN_L	I/O	CAN bus differential low side
5	RS232_TxD	O	RS232 transmitter output to host
6	RS232_RTS	O	RS232 Ready To Send output to host
7	RS232_RxD	I	RS232 receiver input from host
8	RS232_CTS	I	RS232 Clear To Send input from host
9	SYNC_IN1	I	Multifunctional synchronization input
10	SYNC_IN2	I	Multifunctional synchronization input
11	GNSS_TxD	O	RS232 transmitter output to GNSS module
12	GNSS_RxD	I	RS232 receiver input from GNSS module
13	SYNC_OUT	O	Configurable synchronization output
14	GND	PWR	Ground
15	UART_TxD	O	UART transmitter output
16	UART_RxD	I	UART receiver input

Robust trackers (MTi-630R/670G/680G)

The figure below shows the three connectors on the rugged housing of the MTi-670G/680G. The MTi-630R only features the Host Interface connector.

Pin configuration of the MTi-670G/680G

The table below shows the pin descriptions of the MTi-630R/670G/680G Host Interface connector.

Pin descriptions MTi-630R/670G/680G Host Interface

Pin	Name	I/O type	Description
1	CAN_H	I/O	CAN bus differential high side
2	CAN_L	I/O	CAN bus differential low side
3	SYNC_IN1	I	Multifunctional synchronization input
4	SYNC_IN2	I	Multifunctional synchronization input
5	VIN	PWR	Power input
6	RS232_CTS	I	RS232 Clear To Send input from host
7	RS232_RxD	I	RS232 receiver input from host
8	RS232_TxD	O	RS232 transmitter output to host
9	RS232_RTS	O	RS232 Ready To Send output to host
10	GND	PWR	Ground
11	SYNC_OUT	O	Configurable synchronization output
12	GND	PWR	Ground

Below table shows the pin descriptions of the MTi-680G RTCM corrections connector.

⚠ The MTi-680G RTCM corrections connector is also present on the MTi-670G, but it is unused. It should therefore be left unconnected.

Pin descriptions MTi-680G RTCM corrections

Pin	Name	I/O type	Description
1	V_BCKP	PWR	Backup supply for GNSS (3V3).
2	GND	PWR	Ground
3	RTCM_RxD	I	RS232 receiver input from host
4	RTCM_TxD	O	RS232 transmitter output to host

Communication to host

The MTi 600-series is designed to be used as a peripheral device in embedded systems or as a standalone unit. The MTi 600-series supports Controller Area Network (CAN) and RS232 protocols for the communication between the MTi and a host. The module supports an additionally Universal Asynchronous Receiver/Transmitter (UART). See below table for interface specifications.

Host communication interfaces specifications

Interface	Symbol	Min	Typ	Max	Units	Description	Note
CAN	f_{CAN}	10.0	250.0	1000	kbps	Host CAN Interface Baud Rate	
RS232	f_{RS232}	4.8	115.2	1000	kbps	Host RS232 Interface Baud Rate	
UART	f_{UART}	4.8	115.2	2000	kbps	Host UART Interface Baud Rate	Not available on robust trackers

A USB and RS422 interface is possible through a UART to USB/RS422 converter (see example in the MTi 600-series Development Kit).

At its core, the MTi uses the Xsens-proprietary Xbus protocol which is compatible with all Xsens Motion Tracker products. This protocol is available on all interfaces; UART, RS232 and CAN. The *MT Low Level Communication Protocol Documentation* is a complete reference for the protocol.

CAN

The CAN interface of the MTi-600 does not include a termination resistor; it can be used in a CAN bus that already incorporates the required termination. If used in a single device connection, a 120 Ω termination resistor needs to be added between the CAN_H and CAN_L pins.

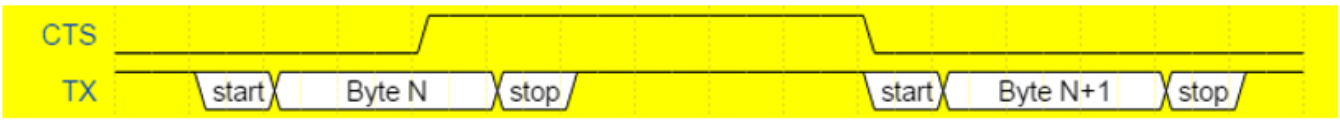
For more information please review the *MT CAN Protocol Documentation.*

RS232

The RS232 interface complies with the standard RS232 voltage levels. It includes hardware flow control through RTS and CTS lines.

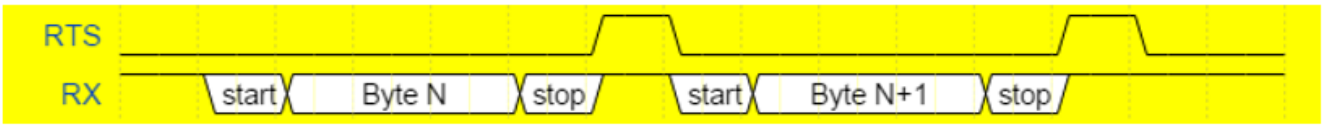
The RTS signal is an output of the MTi-600. If the RTS line is low, the module is busy and unable to receive new data. Otherwise, the module's UART is idle and ready to receive. The CTS signal is an input for the MTi 600-series. The module checks the state of the CTS line at the start of every byte it transmits. If CTS is high, the module transmits the byte. Otherwise, it postpones transmission until CTS is raised. If flow control is not used the CTS input should be connected to a logic high to make sure that the MTi 600-series can transmit data. A RS232 logic high voltage should be between +3 V and +25 V.

The CTS signal is an input for the module. The module checks the state of the CTS line at the start of every byte it transmits. If CTS is high, the module transmits the byte. Otherwise, it postpones transmission until CTS is raised. When during the transmission of a byte the user lowers the CTS signal, then the module completes transmission of that byte before postponing further output. The module will not retransmit this byte. Below figure shows the behaviour of the TX and CTS lines.



Data transmit behaviour under CTS

The RTS signal is an output of the module. If the RTS line is low, the module is busy and unable to receive new data. Otherwise, the module's UART is idle and ready to receive. After receiving a byte the direct memory access (DMA) controller of the module will transfer the byte to its receive first-in-first-out (FIFO) buffer. The module will pull down the RTS signal during this transfer. Therefore, with every byte received, the module lowers the RTS line shortly. Below figure shows this behaviour.



RTS behaviour during data reception

The user can use this communication mode without hardware flow control. In this case, the user must tie the CTS line high (e.g. VIN) to make the module transmit.

UART

The UART interface can be used to directly connect to an MCU with 3.3 V IO-levels. The user can configure the MTi 600-series module to communicate over UART. The UART frame configuration is 8 data bits, no parity and 1 stop bit (8N1). The UART protocol only has the TX and RX lines without any flow control. The UART interface is not available on the MTi-630R/670G/680G.

GNSS receiver interface

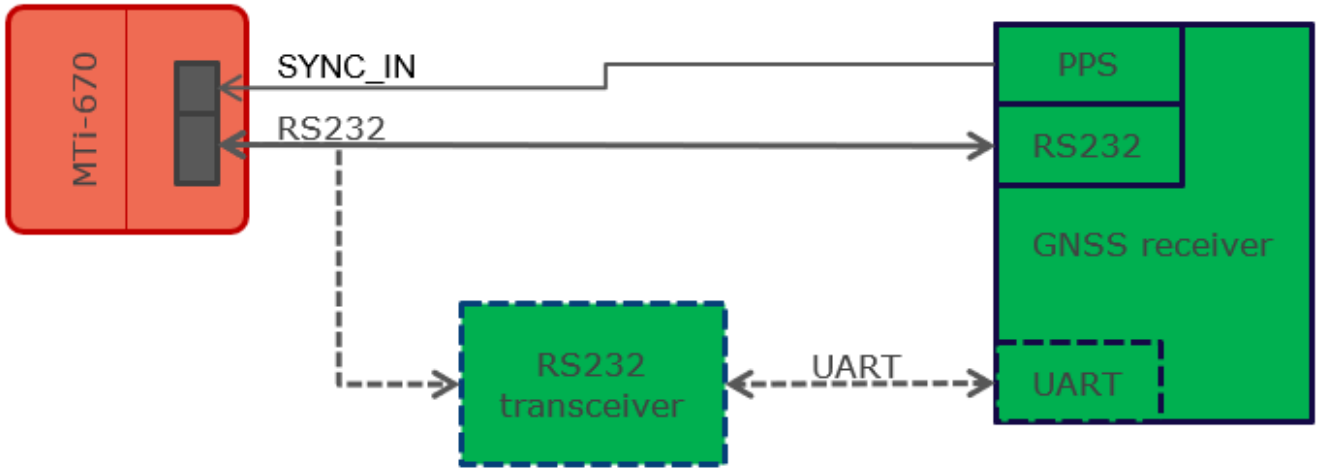
The MTi-670/680 variants of the MTi 600-series module family supports external inputs from a GNSS receiver, such as the u-blox MAX-M8 GNSS receiver. For the GNSS receiver, the RS232 or UART communication pins of the receiver need to be connected to the GNSS_TxD and GNSS_RxD pins of the MTi-670/680 module. In case of a UART interface on the GNSS receiver an additional RS232 transceiver should be connected in-between the MTi-600 and the GNSS receiver. See below figure for connection details and below table for interface specifications.

The PPS/TIMEPULSE output of the GNSS receiver should be connected to either one of the SYNC inputs of the MTi-670/680. The used SYNC input needs to be configured in software

accordingly. Under default configurations, the PPS/TIMEPULSE output should be connected to SYNC_IN1

GNSS receiver interface specifications

Interface	Symbol	Typ	Max	Units	Description
RS232	f_{GNSS}	115.2	1000	kbps	GNSS Interface Baud Rate



Connections for the GNSS interface

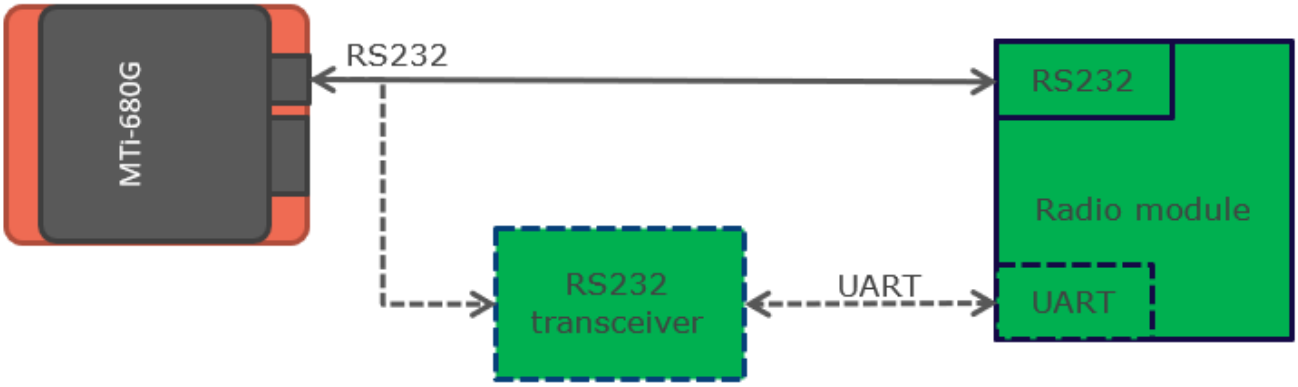
RTCM corrections interface

The MTi-680G variant of the MTi 600-series family supports RTCM correction inputs from an external device (e.g. radio module). This input can be found on the 4-pin connector and uses RS232 levels. In case of a UART interface on the radio module an additional RS232 transceiver should be connected in-between the MTi-680G and the radio module. See below figure for connection details and below table for interface specifications.

RTCM input port baud rates

baud rate [bit/s]
38k4 (default)
57k6

baud rate [bit/s]
115k2
230k4
460k8
921k6



Connections for the RTCM corrections interface

SYNC

The MTi 600-series has two multifunctional synchronization inputs and one synchronization output. The electrical specifications can be seen in the next chapter: Electrical Specifications. Refer to the *MTi 600-series Datasheet* for configuration details.

Electrical specifications

This section lists the recommended electrical operating conditions for the MTi-600 series module.

Supply voltage

The MTi 600-series module has a single supply pin that can be supplied with a voltage within the range specified in below table. The MTi-680G has an additional backup voltage input for the GNSS module to support a warm start. The input supply range of this backup voltage is also specified in below table.

Supply voltage specifications

Symbol	Min	Typ	Max	Unit	Description
V_{IN}	4.5	5.0	24	V	Power input voltage
V_{BCKP}	1.7	3.0	3.6	V	GNSS backup input voltage. Only available on MTi-680G.

Power consumption

The power consumption of an MTi 600-series module depends, among others, on the input voltage, sample rate and communication protocol. Below table shows some typical power consumption values for different MTi 600-series types.

Power consumption specifications

	Typ	Unit	Conditions
MTi-630	320	mW	5V, UART, measurement mode, 400Hz, 921.6 kbps
MTi-630	350	mW	5V, RS232, measurement mode, 400Hz, 921.6 kbps
MTi-630	495	mW	24V, UART, measurement mode, 400Hz, 921.6 kbps
MTi-630	525	mW	24V, RS232, measurement mode, 400Hz, 921.6 kbps
MTi-670/680	310	mW	5V, UART, measurement mode, 400Hz, 921.6 kbps

	Typ	Unit	Conditions
MTi-670/680	340	mW	5V, RS232, measurement mode, 400Hz, 921.6 kbps
MTi-670/680	495	mW	24V, UART, measurement mode, 400Hz, 921.6 kbps
MTi-670/680	530	mW	24V, RS232, measurement mode, 400Hz, 921.6 kbps
MTi-680G	720	mW	5V, RS232, measurement mode, 400Hz, 921.6 kbps
MTi-680G	1000	mW	24V, RS232, measurement mode, 400Hz, 921.6 kbps

I/O pins

The I/O interface specifications are listed in below table.

I/O interface specifications

I/O interface	Symbol	Min	Typ	Max	Unit	Description
CAN	$V_{I(DIFF)(R)}$	-4.0		0.5	V	Recessive differential input voltage -12V < $V_{(CANH, CANL)}$ < +12V
	$V_{I(DIFF)(D)}$	0.9		9.0	V	Dominant differential input voltage -12V < $V_{(CANH, CANL)}$ < +12V
	$V_{O(DIFF)(R)}$	-500	0	50	mV	Recessive differential output voltage
	$V_{O(DIFF)(D)}$	1.3	2.0	5.0	V	Dominant differential output voltage
	$V_{O(L)(D)}$	0.5	1.5	2.25	V	CAN_L dominant output voltage
	$V_{O(H)(D)}$	2.75	3.5	4.5	V	CAN_H dominant output voltage
RS232#1 (GNSS/RTCM)	V_{IL}	-25		0.6	V	Low input voltage
	V_{IH}	2.4		+25	V	High input voltage
	V_{OT}	±5	±5.4		V	Driver Output Voltage swing

I/O interface	Symbol	Min	Typ	Max	Unit	Description
UART#2	V_{IL}	0		0.88	V	Low input voltage
	V_{IH}	2.29		3.6	V	High input voltage
	V_{OL}	0		0.44	V	Low output voltage
	V_{OH}	2.6		3.3	V	High output voltage
SYNC_IN1/ SYNC_IN2	V_{IL}	-25		0.6	V	Low input voltage
	V_{IH}	2.4		+25	V	High input voltage
SYNC_OUT	V_{OL}	0		0.44	V	Low output voltage
	V_{OH}	2.6		3.3	V	High output voltage

[1] Also applies to the GNSS (module) and RTCM (MTi-680G) ports.

[2] Not available on MTi-630R/670G/680G.

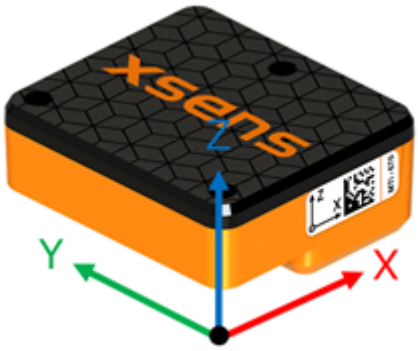
Design

- Design
  - Sensor reference frames
  - Origin of measurements
  - Physical connections of the Module
    - Footprint for PCB layout
    - Footprint for standalone mounting
  - Physical connections robust trackers
    - Cables
    - Required antenna specifications
  - Mechanical stress
    - Torque
    - Vibrations
  - Magnetometer
    - Ferromagnetic materials
    - High currents

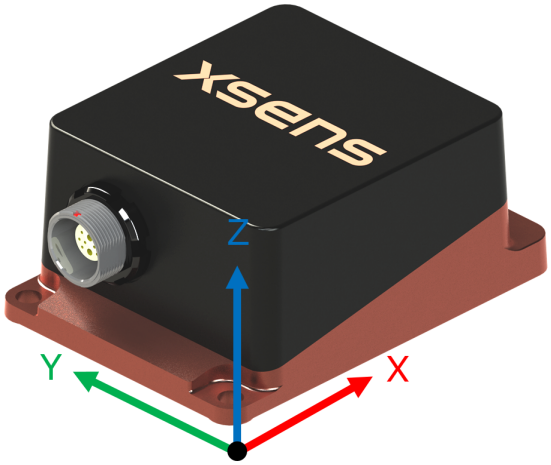
This section describes the (mechanical) design and hardware integration considerations of the MTi 600-series module. 3D models of the module and robust trackers are available and found on BASE.

Sensor reference frames

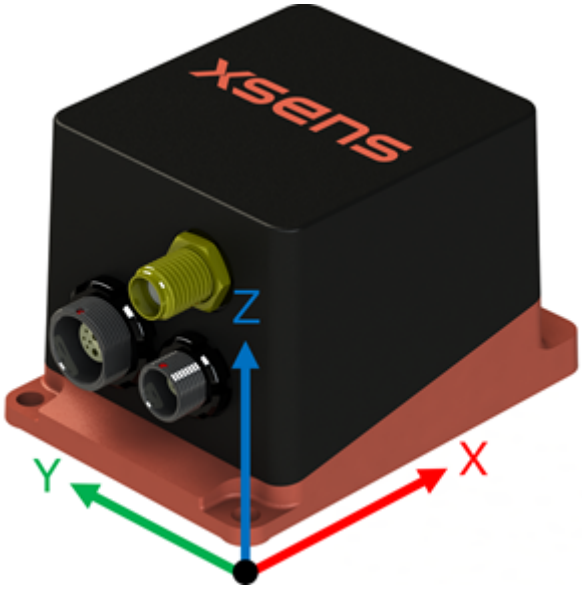
The MTi 600-series uses a right-handed coordinate system as the basis of the sensor frame. The default sensor coordinate system is printed on the side of the MTi and is indicated in the figures below. More details regarding (the modification of) the reference frames of the MTi can be found in the *MTi 600-series Datasheet* and *MTi Family Reference Manual.*



Default sensor coordinate system for the MTi 600-series module



Default sensor coordinate system for the MTi-630R

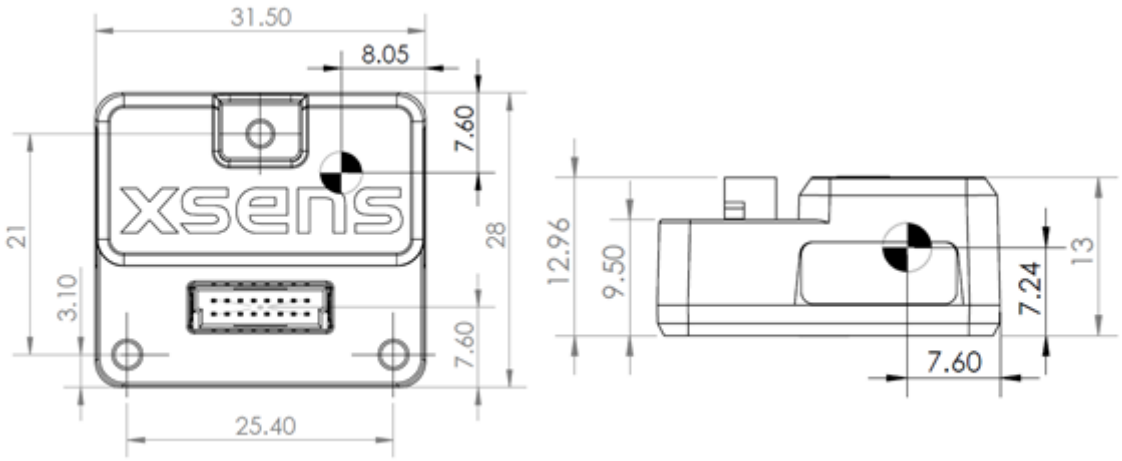


Default sensor coordinate system for the MTi-670G/680G

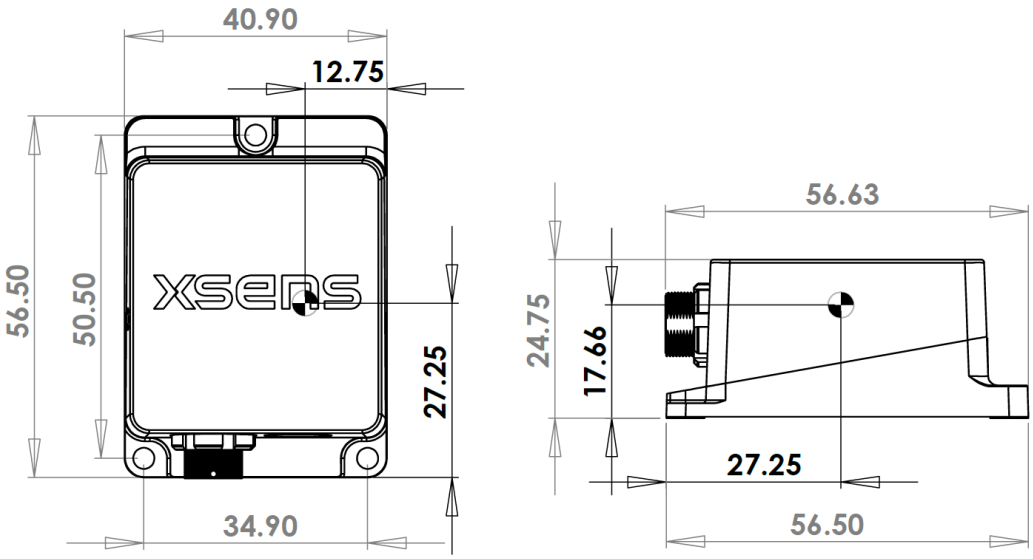
Origin of measurements

The accelerometer determines the origin of measurements. The in below figures shows the

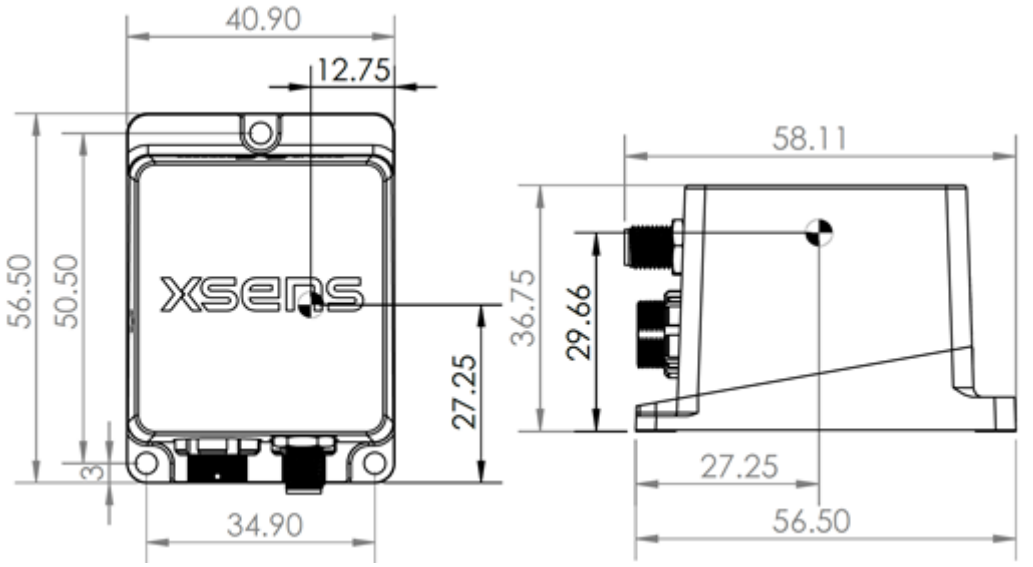
location of the accelerometer of the MTi 600-series module and robust trackers.



Location origin of measurements for the module (dimensions in mm)



Location origin of measurements for the MTi-630R (dimensions in mm)

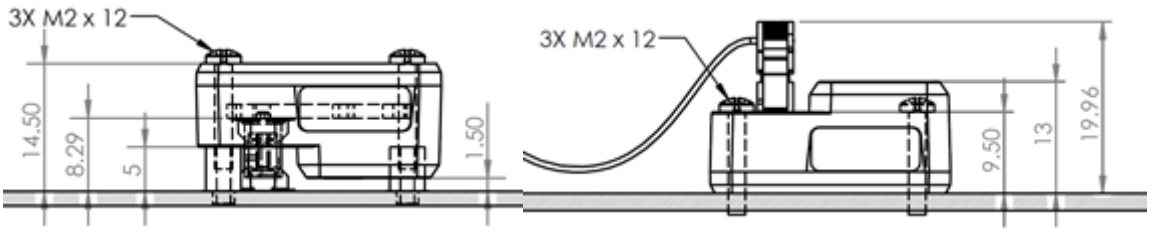


Location origin of measurements for the MTi-670/680G (dimensions in mm)

Physical connections of the Module

The connector on the MTi 600-series module is a 16 pins, 1.27 mm pitch male connector of Phoenix Contact (FP 1,27/ 16-MV 1,75 – 1714936). This connector supports an SMD counterpart that can be soldered onto a PCB as well as a ribbon cable (IDC) counterpart. In order to mount the MTi 600-series onto a PCB, the connector should be facing down and the housing should be supported with M2 spacers that can be soldered onto the PCB. When using a ribbon cable the MTi 600-series can be mounted upside-down to create easy access to the connector.

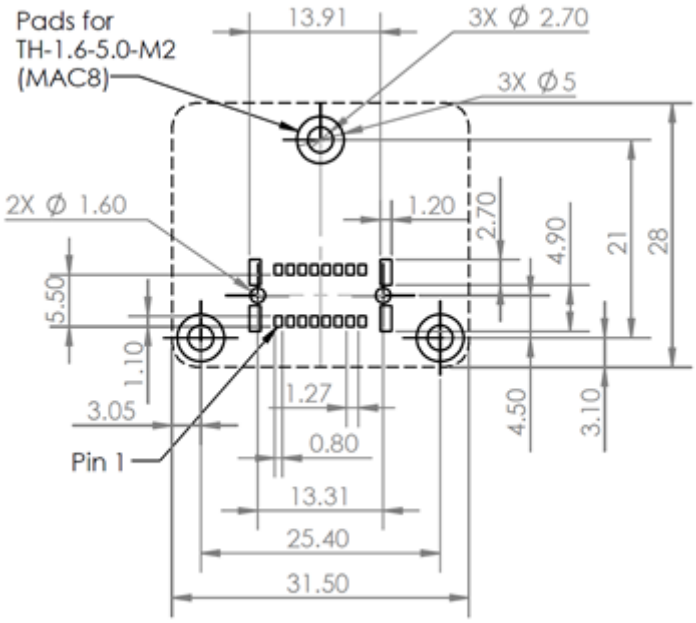
Below figure shows both mounting options. In both cases, the module is fixated with three M2 screws with a length of at least 12 mm. It is recommended to use screws and spacers with weak magnetic properties to reduce the influence on the internal magnetometer.



Connection options (left: PCB, right: standalone, dimensions in mm)

Footprint for PCB layout

Below figure shows the recommended footprint of the MTi 600-series counterpart connector together with the three spacers.
Below table shows the recommended parts for this mounting option.



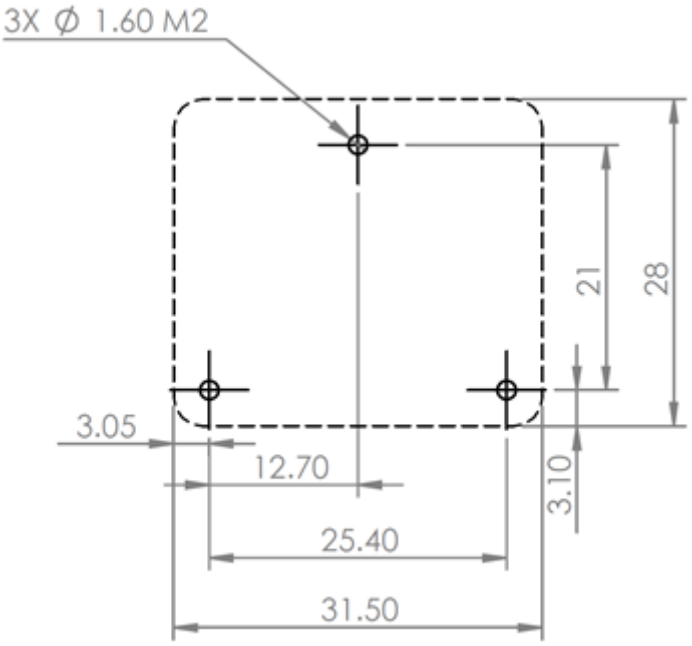
Layout footprint example (dimensions in mm)

Recommended mating/mounting parts

Part	Manufacturer + part number	Description
SMD connector	Phoenix Contact: 1714892 (FP 1,27/ 16-FV 6,25)	To be used in combination with 5 mm spacers (shown in figure #Connection options)
	Phoenix Contact: 1715000 (FP 1,27/ 16-FV 9,05)	To be used in combination with 8 mm spacers
PCB spacers	MAC8: TH-1.6-5.0-M2	M2 x 5 mm, recommended
	Würth Elektronik: 9774050243R	M2 x 5 mm, alternative
Screws		Brass, M2 x 12 mm

Footprint for standalone mounting

Below figure shows the mounting hole positions for the MTi 600-series when mounted upside-down for the IDC connection. Below table shows the recommended parts for this mounting option.



Standalone mounting hole positions (dimensions in mm)

Recommended mating/mounting parts

Part	Manufacturer + part number	Description
IDC connector	Phoenix Contact: 1714903 (FP 1,27/ 16-FWL)	Single IDC connector
	Phoenix Contact: 1010258/P/xxx (FP 1,27/ 16-FWL-10/P/xxx)	Cable assembly with one IDC connector; replace xxx with cable length in m (0.05 – 0.95)
	Phoenix Contact: 1010251/P/xxx (FP 1,27/ 16-FWL-11/P/xxx)	Cable assembly with two IDC connectors; replace xxx with cable length in m (0.05 – 0.95)
Screws		Brass, M2 x 12 mm

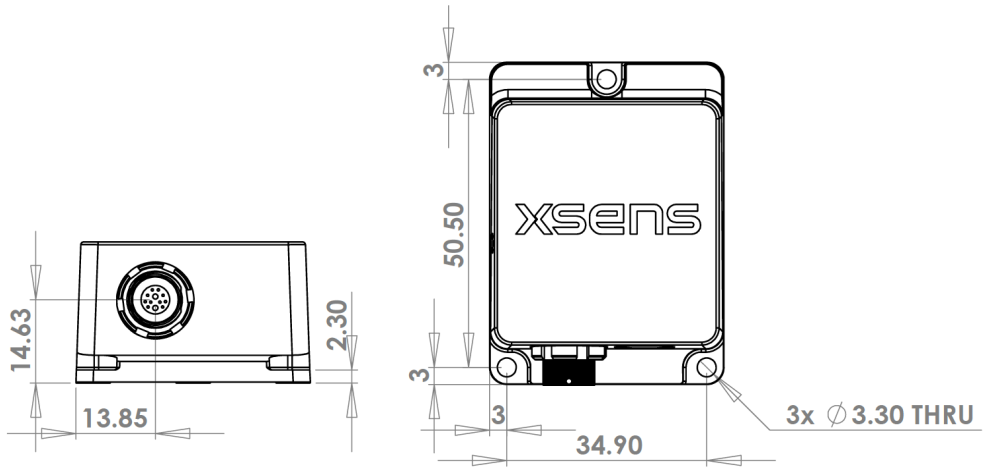
At www.phoenixcontact.com pre-assembled cables can ordered.

Physical connections robust trackers

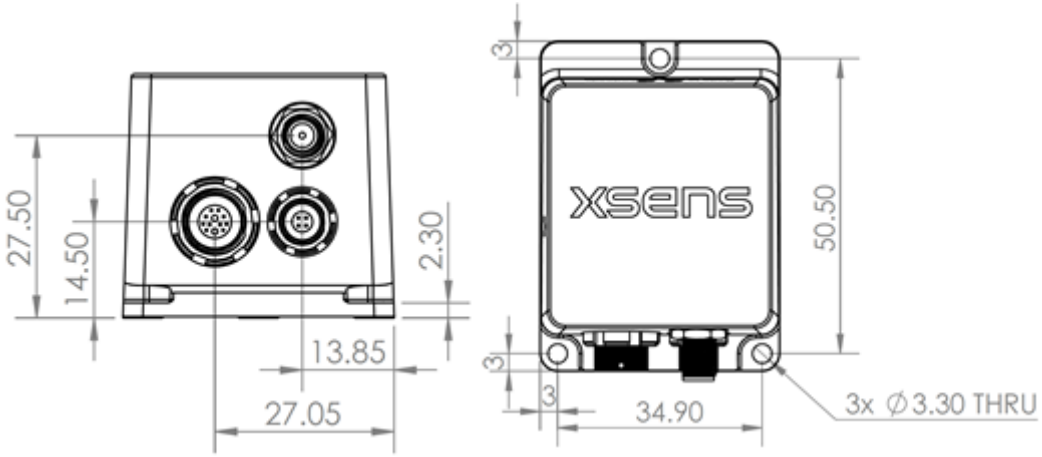
The MTi-630R/670G/680G only supports wire connectors. The MTi-670G/680G have three different connectors: a 12-pin ODU connector for main supply and communication, a 4-pin ODU connector for RTCM corrections (unused/unconnected for MTI-670G) and a SMA connector for

the GNSS antenna. The MTi-630R only features the 12-pin ODU connector for main supply and communication.

All robust trackers have three (M3) mounting holes to mount it on a flat service. Below figures show the connector and mounting hole positions on the MTi-630R and MTi-670G/680G.

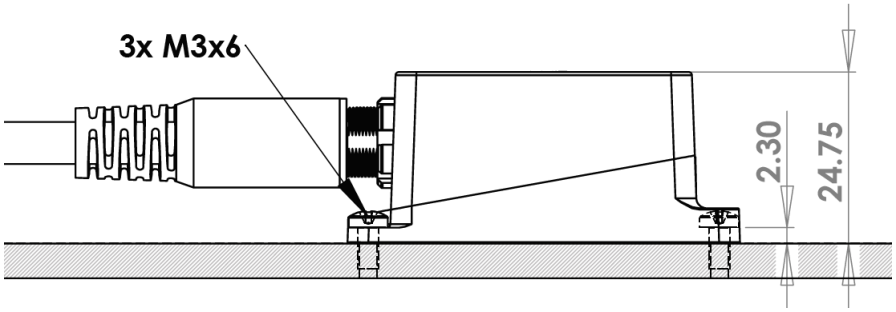


MTi-630R connector and mounting hole positions (dimensions in mm)

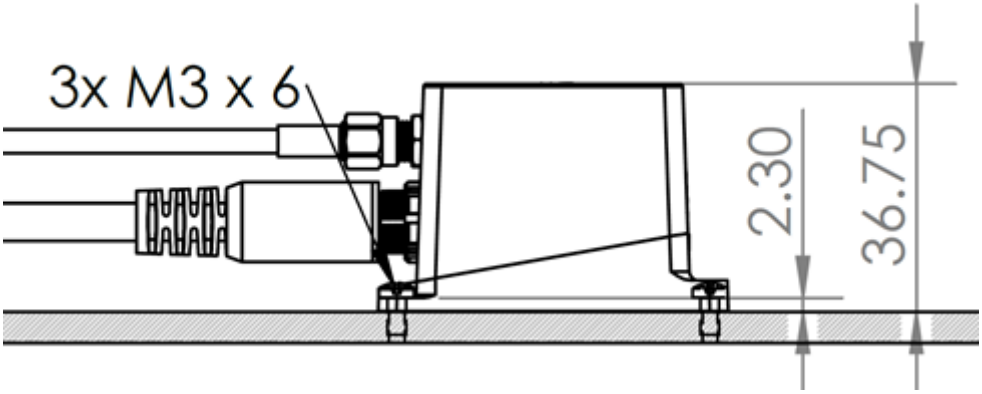


MTi-670G/680G connector and mounting hole positions (dimensions in mm)

Below figures show examples of the MTi-630R and MTi-670G/680G mounted on a surface.



MTi-630R mounting example (dimensions in mm)



MTi-670G/680G mounting example (dimensions in mm)

Recommended mating/mounting parts

Part	Manufacturer	Part number	Description
Host Interface connector	ODU	A10WAM-P12XMM0-0000	AMC HD, break-away, 12 circuits
	ODU	C10WAM-P12XMM0-0000	AMC HD, screw lock, 12 circuits
RTCM connector	ODU	A1CWAM-P04XBC0-0000	AMC HD, break-away, 4 circuits
	ODU	C1CWAM-P04XBC0-0000	AMC HD, screw lock, 4 circuits
SMA connector	Tallysman	TW8889	Recommended GNSS antenna
Screws			Brass, M3 x 6 mm

Cables

The following cables can be ordered from Xsens.

CA-MP-MTI-12

The CA-MP-MTI-12 is the 12-pin Host Interface cable that consists of the following parts:

- Molex connector: 5054321201; 1.25mm pitch, dual row, positive lock, 12 circuits

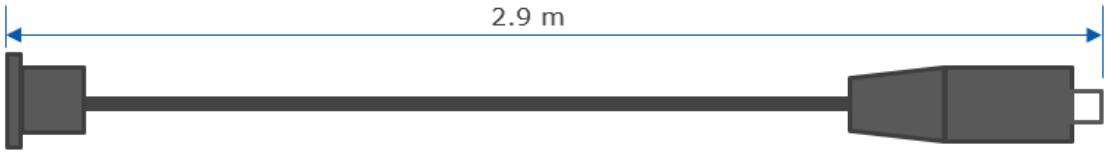
- ODU connector: A10WAMP12XMM0-0000; AMC HD, break-away plug, 12 circuits
- Cable: 2.9 m, 12 core, AWG28, shielded, UL, 40ºC - +85ºC, 6.1 mm diameter
- Molex crimp terminals: 5054311100; gold (Au) plating, 2630 AWG

Below table shows the pinning of the connections. The shield of the cable is only connected on the ODU connector side.

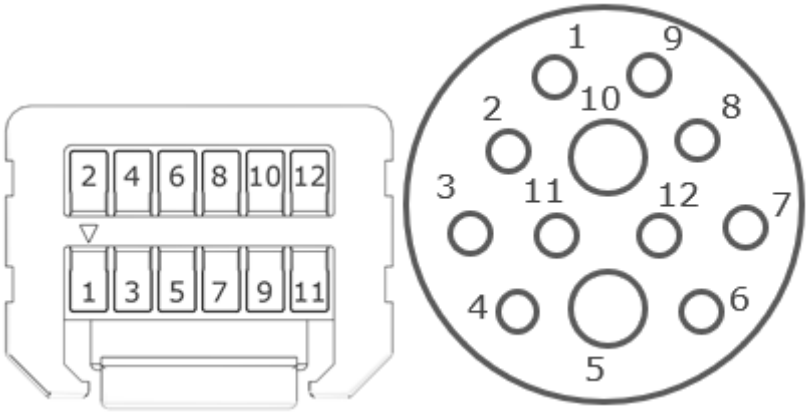
Connector pinning for the host interface cable assembly

Function (MTi)	Wire colour	Wire number	Molex pin no.	ODU pin no.
VIN	Red	5	1	5
GND	Black	6	2	10
CAN_H	Green	1	3	1
CAN_L	White	2	4	2
RS232_TxD	Yellow	9	5	8
RS232_RTS	Violet	10	6	9
RS232_RxD/SYNC_IN3	Grey	8	7	7
RS232_CTS/SYNC_IN4	Orange	7	8	6
SYNC_IN1/ODO_1A	Black/White	3	9	3
SYNC_IN2/ODO_1B	Red/White	4	10	4
SYNC_OUT	Blue/White	11	11	11
GND	Blue	12	12	12
SHIELD	-	-	-	SH

Below figures show the cable length definition (from connector end-to-end) and the pinning of both the Molex connector and the ODU connector. Below table shows the recommended mating parts for the Molex connector.



Host Interface cable length definition



Numbering 12-pin connectors; left Molex (cable entry view), right ODU (solder cup view).

Recommended mating parts for 12-pins Molex connector

Part number	Manufacturer	Mounting	Description
5054331291	Molex	Vertical	1.25mm Pitch, Micro-Lock Plus PCB Header, Dual Row, Surface Mount, 0.10µm Gold Plating, 12 Circuits
5054481291	Molex	Right-Angle	

CA-MP-MTI-4

The CA-MP-MTI-4 is the RTCM corrections cable that consists of the following parts:

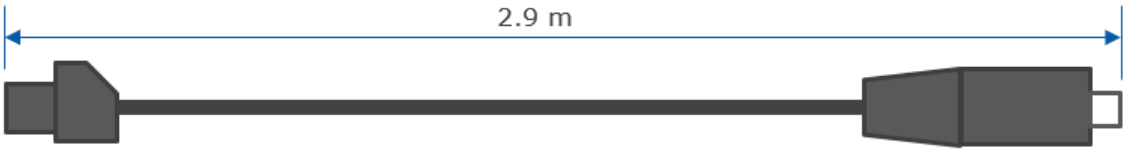
- Molex connector: 2045320401; 1.25mm pitch, single row, positive lock, 4 circuits
- ODU connector: A1CWAM-P04XBC0-0000; AMC HD, break-away plug, 4 circuits
- Cable: 2.9 m, 12 core, AWG28, shielded, UL, -40ºC - +85ºC
- Molex crimp terminals: 5054311100; gold (Au) plating, 26-30 AWG

Below table shows the pinning of the connections. The shield of the cable is only connected on the ODU connector side.

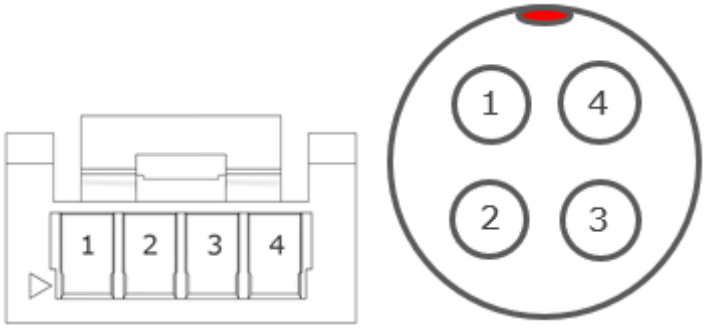
Connector pinning RTCM cable assembly

Function (MTi)	Wire colour	Molex pin no.	ODU pin no.
V_BCKP	Red	1	1
GND	Black	2	2
RTCM_TxD	Green	3	4
RTCM_RxD	White	4	3
SHIELD	-	-	SH

Below figures show the cable length definition (from connector end-to-end) and the pinning of both the Molex connector and the ODU connector. Below table shows the recommended mating parts for the Molex connector.



RTCM cable length definition



Numbering 4-pin connectors; left Molex (cable entry view), right ODU (solder cup view).

Recommended mating parts for 4-pins Molex connector

Part number	Manufacturer	Mounting	Description
5055680481	Molex	Vertical	1.25mm Pitch, Micro-Lock Plus PCB Header, Single Row, Surface Mount, Gold Plating, 4 Circuits
5055670481	Molex	Right-Angle	

Required antenna specifications

The MTi-670G/680G requires an active antenna with at least the following specifications.

Required antenna specifications for MTi-670G/680G

Parameter	Specification
Minimum active antenna gain#1	17 dB
Maximum active antenna gain#1	50 dB
Maximum noise figure	4 dB
Typical L1 band antenna gain (1559 – 1606 MHz)#2	3 dBic
Typical L2/E5b band antenna gain (1197 – 1249 MHz)#2	2 dBic
Axial ratio (max at Zenith)	2 dB
Phase centre variation (max over elevation/azimuth)	10 mm
Maximum group delay variation in-band#3	10 ns
Typical out-of-band rejection	40 dB
Polarization	RHCP
EMI immunity out-of-band	30 V/m
ESD circuit protection (human body model air discharge)	15 kV

[1] Including passive losses (filters, cables, connectors etc.)
[2] Measured with a ground plane with 150 mm diameter
[3] At each GNSS system bandwidth. Inter-signal requirement is 50 ns max.

Mechanical stress

In general, it is recommended to place the MTi 600-series module in an area on the PCB where mechanical stress is minimal. The following paragraphs describe possible causes of mechanical stress and ways to reduce it.

Torque

The connector of the MTi 600-series module is soldered onto the PCB board which also contains the sensing elements. Care should be taken to design the mounting such that there is no stress on the connector when mounted on the PCB or connected with a ribbon cable. Any stress on the connector could potentially result in torque on the PCB which can lead to unwanted biases and signal noise.

Vibrations

The MTi 600-series features an industry-leading signal processing pipeline (AttitudeEngine™) which rejects vibrations. For best results however, it is recommended that the MTi 600-series is mechanically isolated from vibrations as much as possible. Especially in applications where vibrations are likely to occur, the anchor points of the PCB that holds the MTi 600-series module should be dampened. The required type of dampening varies from application to application.

Magnetometer

The MTi 600-series uses a 3D magnetometer for measuring the geomagnetic field. This part is sensitive to magnetic disturbances. Magnetic disturbances can be calibrated for or identified and rejected by the MTi, however it is recommended to avoid their influence during hardware integration.

Ferromagnetic materials

Ferromagnetic materials can be magnetized and the magnetic behaviour can change during operation. This behaviour will influence the measurements of the 3D magnetometer of the MTi 600-series.
Therefore, it is recommended to keep these ferromagnetic materials away from the MTi 600-series.

High currents

High current power lines on the PCB will introduce magnetic fields that may influence the measurements of the 3D magnetometer of the MTi 600-series. Place high current power lines away from the MTi 600-series. Example: a power line with a current of 100 mA at a distance of 10 mm from the magnetometer, will introduce an error of 2 µT.

More information on magnetic interference can be found in the *MTi Family Reference Manual*.

Static magnetic disturbances can be calibrated for, see the *Magnetic Calibration Manual*.