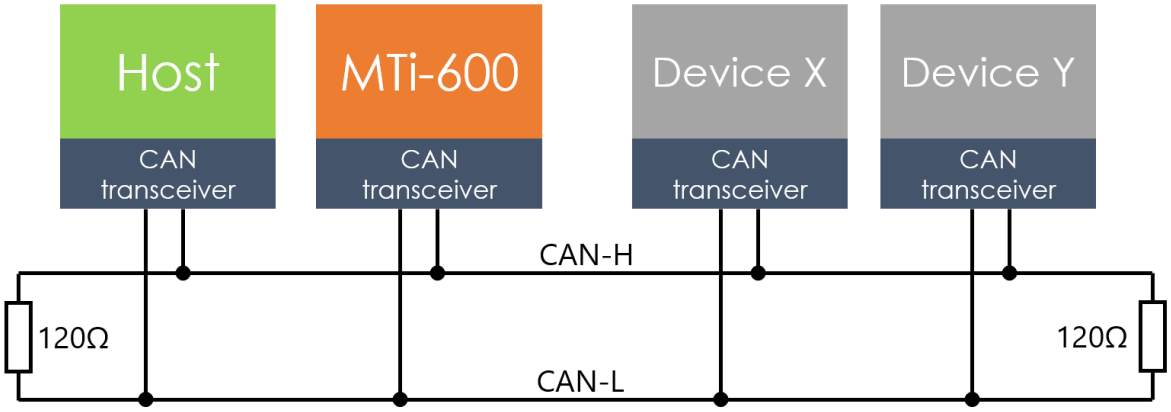

Document MT1604P, Revision 2020.A, June 2020

MT CAN Protocol Documentation

MTi 600-series

Revision	Date	By	Changes
A	Sept 2019	AKO	Initial Version
B	Nov 2019	AKO	Xsens brand update
C	Nov 2019	EKA	Fixed some offsets
2020.A	Jun 2020	AKO	Corrected definition of SampleTime output Added MTI-680G Included link to .dbc file in chapter 6

Table of Contents

List of Tables

List of Abbreviations

The MT Family Reference Manual[1] provides a list of abbreviations used across our MT documentation.

List of Figures

[1]The latest available documentation can be found in your MT Software Suite installation folder or via the following link: *https://xsens.com/xsens-mti-documentation*

1 Xsens Help Center and User Community

Xsens has an extensive help center, a place where users of Xsens and Xsens employees (support, field application engineers, sales and R&D engineers) meet. The knowledge base contains tips and tricks, guidance and answers to frequently asked questions. News is also shared at the knowledge base and it is possible to ask additional questions (registration required).

The user community is the place to ask questions. Answers may be given by other users or by Xsens employees. The response time in the user community is significantly shorter than the response time at Xsens support.

The knowledge base and user community are searchable simultaneously. A search query thus shows results irrespective of the source.

Please visit https://base.xsens.com to complete your 1 minute registration.

Table 1 summarizes all available official documents for the Xsens MTi product line.

Table 1: MTi product documentation overview

<table>
<tr><th>MTi 1-series</th><th>MTi 600-series</th><th>MTi 10/100-series</th></tr>
<tr><td colspan="2">MTi Family Reference Manual</td><td rowspan="5">MTi User Manual</td></tr>
<tr><td>MTi 1-series Datasheet</td><td>MTi 600-series Datasheet</td></tr>
<tr><td>MTi 1-series DK User Manual</td><td>MTi 600-series DK User Manual</td></tr>
<tr><td rowspan="2">MTi 1-series HW Integration Manual</td><td>MTi 600-series HW Integration Manual</td></tr>
<tr><td>MT CAN protocol Documentation</td></tr>
<tr><td colspan="3">MT Manager Manual</td></tr>
<tr><td colspan="3">Magnetic Calibration Manual</td></tr>
<tr><td colspan="3">MT Low Level Communication Protocol Documentation</td></tr>
<tr><td colspan="3">Firmware Updater User Manual</td></tr>
</table>

Note: The latest available documentation can be found in your MT Software Suite installation folder or via the following link: *https://xsens.com/xsens-mti-documentation*

2 Introduction

This document describes how to communicate over CAN with Xsens' range of miniature MEMS based inertial Motion Trackers; MTi 600-series.

This document assumes at least a basic understanding of CAN protocols, hardware, interfacing and general workings.

Note: not all products support the same functionality. There are 4 different products described in this document, the description of each message ID contains a table showing the supported products:

610	620	630	670	680

The numbers in this table correspond to the following products:

- 610: MTi-600 IMU
- 620: MTi-600 VRU
- 630: MTi-600 AHRS
- 670: MTi-600 GNSS/INS
- 680: MTi-680G RTK GNSS/INS

An empty field indicates that the corresponding product does not support the message.

3 Hardware hook up

The MTi-600 follows the basic CANbus 2.0 A/B hardware guidelines. It is able to work in a normal CANbus environment. See Figure 1 for a typical CANbus network.

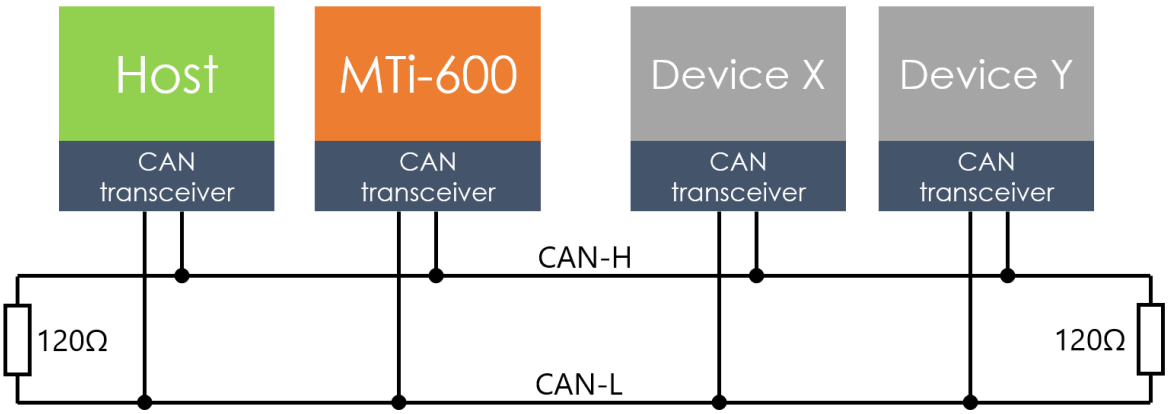

Figure 1 A schematic CAN setup using the MTi-600

Please refer to the *MTi 600-series Hardware integration manual*[2] for more details on the Pinout definition and other details.

[2] Links to the latest available documentation can be found via the following link: Xsens MTi Documentation

4 Enabling CAN through MT Manager

The easiest way to get started with the CAN interface is through MT Manager. With an MTi-600 connected, open the Device Settings menu, see Figure 2. Check the 'Enable' checkbox and select the desired Baudrate to enable the CAN output.

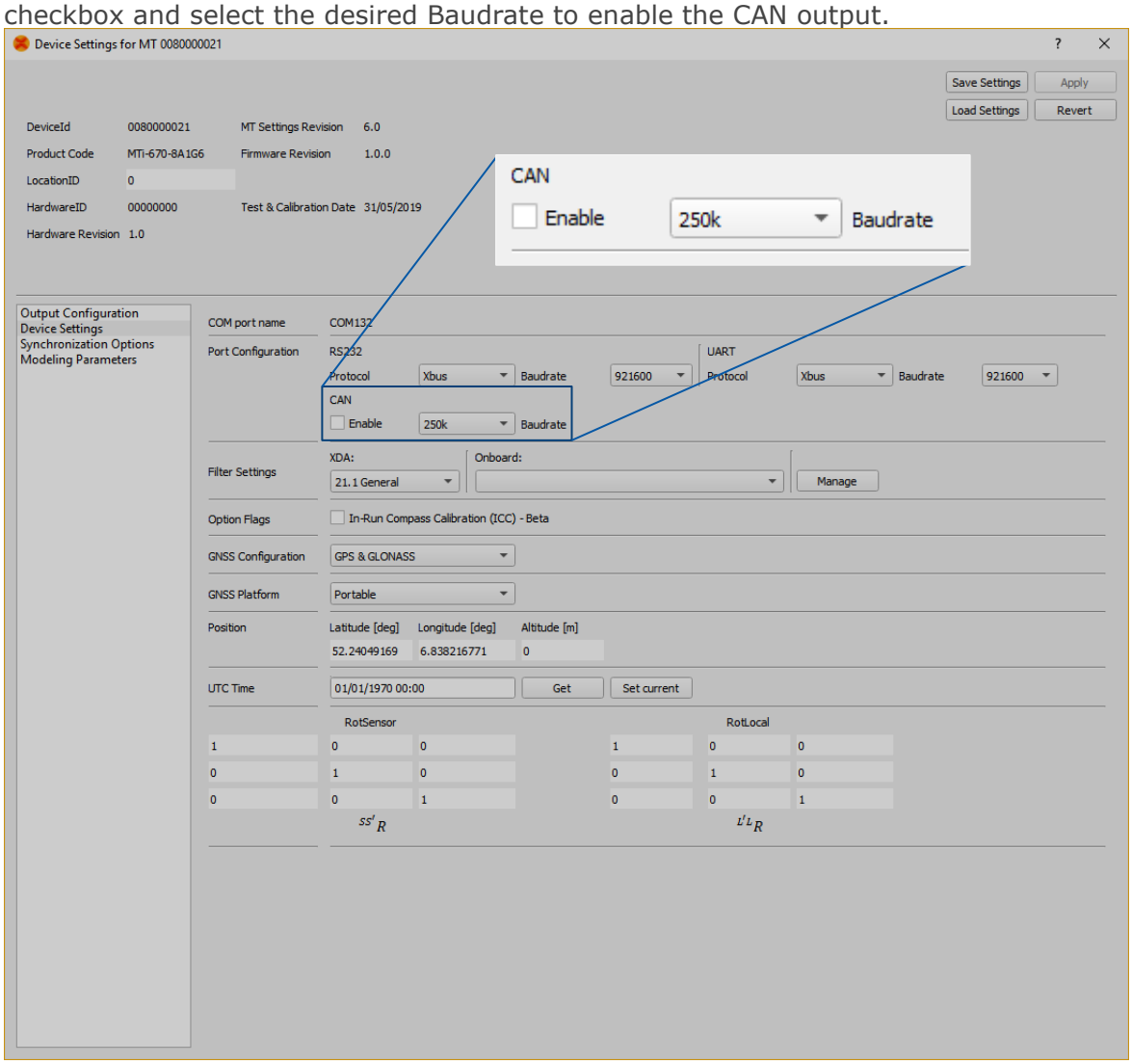

Figure 2 Enabling CAN output in Device Settings

Following this, you can select which data messages you would like to output (see Figure 3 and chapter 6) and their output frequencies. Note that with many outputs at a high frequency the CANbus van be saturated easily. After pressing 'Apply' the CAN output configuration is sent to the MTi-600 and the configured output is available on the CANbus (see *MTi-600 Hardware Integration Manual*[3] for more details on the pin out).

[3] Links to the latest available documentation can be found via the following link: Xsens MTi Documentation

When configuring the CAN outputs using the Device Settings screen (see Figure 3) the ID's are in hexadecimal format. At the top right of the CAN output configuration screen the CAN frame Format can be set, (11-bit or 29-bit)

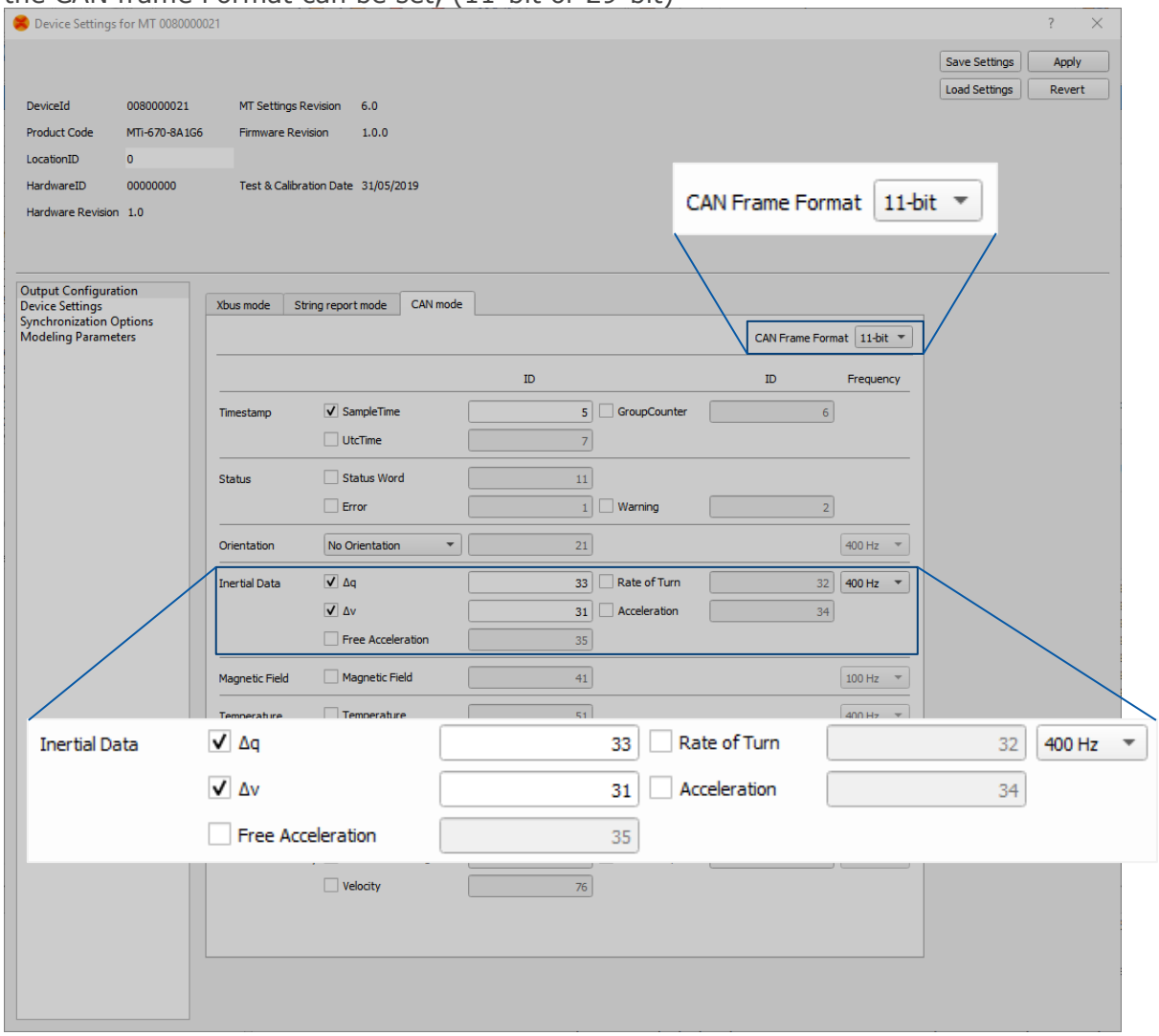

Figure 3 Configuring CAN output in MT Manager

5 XBus Messages

The MTi 600-series support a CAN output, but the CAN output must be configured using the UART or RS232 interface using XBus messages. The way of configuring is described below.

5.1 Configuring CAN output through XBus

As the MTi-600 only supports CAN output, the configuration of the CAN messages is done through XBus messages over the UART or RS232 interface. For more information on XBus and its message structure, please review *MT Low Level Communication Protocol Documentation*[4].

5.2 Message listing

5.2.1 General CAN configuration messages

ReqCanConfig

MID	230 (0xE6)
DATA	n/a
Direction	To MT
Valid in	Config State

610	620	630	670	680

Request the current can configuration – see **SetCanConfig** for information about data field of received **ReqCanConfigAck** acknowledgement message.

SetCanConfig

MID	230 (0xE7)
DATA	CAN enable flag (1bit) , Baud rate code (1byte)
Direction	To MT
Valid in	Config State

610	620	630	670	680

Set the general configuration settings of the CAN-Bus

BAUDRATE
The BAUDRATE is a 1byte code that specifies at which rate the CAN bus will send data. The CAN peripheral is internally automatically configured to best as possible match a Sample-Point of 70% to 75%.

[4] Links to the latest available documentation can be found via the following link: Xsens MTi Documentation

Table 2: CAN config settings

(bits)	Setting	Size (bit)	Description
31:9	reserved		
8	Enable flag	1	Enable CAN interface if set
7:0	Baud rate code	8	BAUDRATE (see Table 3)

Table 3: Available CAN baud rates

CAN Baud rate (bps)	BAUDRATE
1M	12 (0x0C)
800k	11 (0x0B)
500k	10 (0x0A)
250k (default)	0 (0x00)
125k	1 (0x01)
100k	2 (0x02)
83k3	3 (0x03)
62k5	4 (0x04)
50k	5 (0x05)
33k3	6 (0x06)
20k	7 (0x07)
10k	8 (0x08)
5k	9 (0x09)

ReqCanOutputConfig

MID 232 (0xE8)
DATA n/a
Direction To MT
Valid in Config State

610	620	630	670	680

Request the general configuration settings of the CANBus

SetCanOutputConfig

MID 232 (0xE8)
DATA Xsens CAN data id (7 bits) , ID length flag (1bit), ID mask (29 bits), Output frequency (11 bits)
Direction To MT
Valid in Config State

610	620	630	670	680

Set the output configuration of the CAN-Bus

The data is a repeating sequence of Xsens CAN data id, ID length flag (11- or 29-bit length), ID mask, Output frequency. See Figure 4 for the message structure, and Table 4 for the Xsens CAN Data Identifiers.
NOTE: If this message is sent without using XDA, make sure to serialize to BigEndian prior to sending the message, also adhere to the block size.

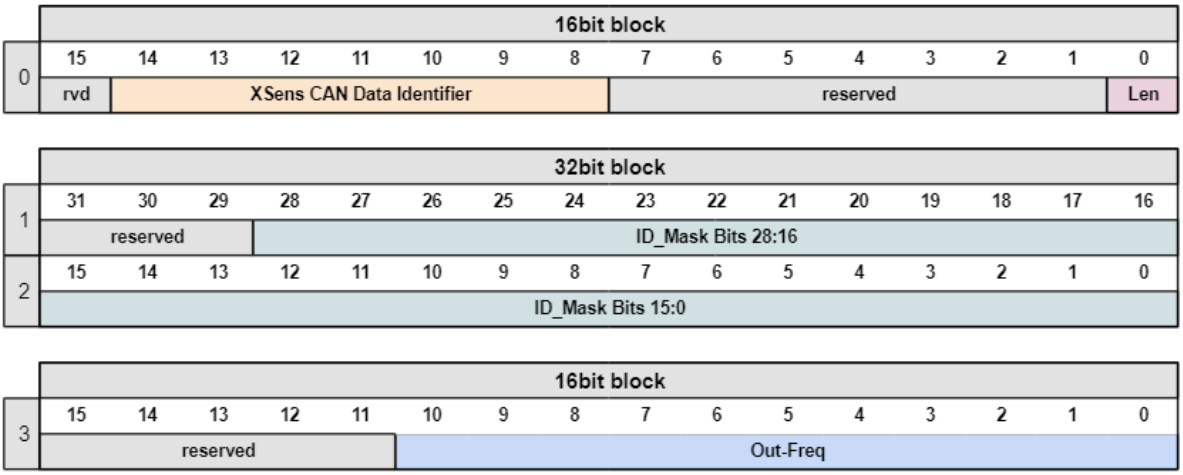

Figure 4 SetCanOutputConfig structure

Table 4 Xsens CAN Identifiers

ID	XsCanDataIdentifier		ID	XsCanDataIdentifier
0x00	XCDI_Invalid		0x34	XCDI_Acceleration
0x01	XCDI_Error		0x35	XCDI_FreeAcceleration
0x02	XCDI_Warning		0x41	XCDI_MagneticField
0x05	XCDI_SampleTime		0x51	XCDI_Temperature
0x06	XCDI_GroupCounter		0x52	XCDI_BaroPressure
0x07	XCDI_UtcTime		0x61	XCDI_RateOfTurnHR
0x11	XCDI_StatusWord		0x62	XCDI_AccelerationHR
0x21	XCDI_Quaternion		0x71	XCDI_Latitude
0x22	XCDI_EulerAngles		0x72	XCDI_Longitude
0x23	XCDI_RotationMatrix		0x73	XCDI_AltitudeEllipsoid
0x31	XCDI_DeltaV		0x74	XCDI_PositionEcef
0x32	XCDI_RateOfTurn		0x75	XCDI_VelocityXYZ
0x33	XCDI_DeltaQ			

6 CAN Output Messages

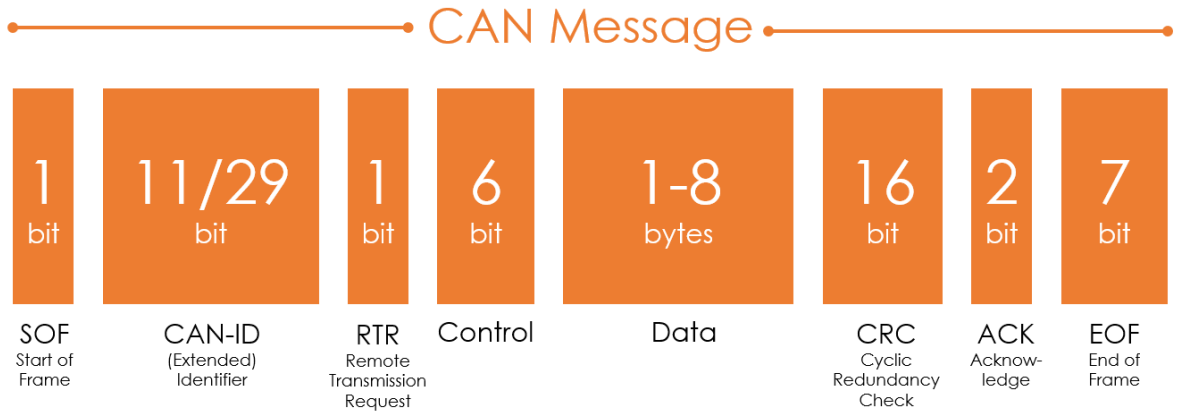

Figure 5 Basic CAN message layout

The MTi-600 follows the basic CAN protocol. Each message starts with an 11- or 29-bit identifier which also handles arbitration. The message with the lowest identifier value has the highest priority.
Each message can contain up to 8 bytes of data, with a data rate of up to 1 Mbps.

A CAN database (.dbc) file is available to automatically translate the CAN output data messages of the MTi. The file can be downloaded from our Knowledge Base:
https://base.xsens.com/hc/en-us/articles/360011224360

6.1 Group Information & Timestamp Messages (0x00x)

6.1.1 Error

610	620	630	670	680

Message name (ID)	**XCID_Error** (0x001)				
Field	**Scaling**	**Unit**	**Format**	**Size**	**Offset**
Error Code	-	-	uint8	1	0
			Total size		1

Error	**Code**	**Message**
CEI_OutputBufferOverflow	0x01	Output Buffer is full, at least one Message was dropped

Note: This error message can be disabled.

6.1.2 SampleTime

610	620	630	670	680

Message name (ID)	**XCID_SampleTime** (0x005)				
Field	**Scaling**	**Unit**	**Format**	**Size**	**Offset**
SampleTime	-	-	uint32	4	0

			Total size	4

Xbus equivalent: XDI_SampleTimeFine
Note: This is a timestamp expressed in 10 kHz (100 µs) clock ticks.

6.1.3 GroupCounter

610	620	630	670	680

Message name (ID)	**XCID_GroupCounter** (0x006)				
Field	**Scaling**	**Unit**	**Format**	**Size**	**Offset**
GroupCounter	-	-	uint16	2	0
			Total size		2

Xbus equivalent: XDI_PacketCounter → Packet Counter
Note: This is a CAN Frame counter or Group counter that is independent from the packet counter in the XBus.

6.1.4 UTC

610	620	630	670	680

Message name (ID)	**XCID_UTC** (0x007)				
Field	**Scaling**	**Unit**	**Format**	**Size**	**Offset**
YEAR	1	year	uint8	1	0
MONTH	1	month	uint8	1	1
DAY	1	d	uint8	1	2
HOUR	1	h	uint8	1	3
MIN	1	min	uint8	1	4
SEC	1	s	uint8	1	5
TENTHMS	10^{-4}	s	uint16	2	6
			Total size		8

Xbus equivalent: XDI_UtcTime → UTC Time

6.2 Status Messages (0x010)

6.2.1 StatusWord

610	620	630	670	680

Message name (ID)	**XCDI_StatusWord** (0x011)				
Field	**Scaling**	**Unit**	**Format**	**Size**	**Offset**
StatusWord	-	-	uint32	4	0
			Total size		4

Xbus equivalent: XDI_StatusWord
Note: Refer to the Low-Level Communication Protocol Document for an explanation of the contents of this message.[5]

6.3 Orientation Messages (0x020)

6.3.1 Quaternion

	620	630	670	680

Message name (ID)		**XCDI_Quaternion** (0x021)					
Field	**Range**	**Scaling**	**Resolution**	**Unit**	**Format**	**Size**	**Offset**
Q0	±1	$(2^{15}-1)^{-1}$	3.0519e-05	N/A	int16	2	0
Q1	±1	$(2^{15}-1)^{-1}$	3.0519e-05	N/A	int16	2	2
Q2	±1	$(2^{15}-1)^{-1}$	3.0519e-05	N/A	int16	2	4
Q3	±1	$(2^{15}-1)^{-1}$	3.0519e-05	N/A	int16	2	6
					Total size		8

Note: Be careful when converting the value 1
Xbus equivalent: XDI_Quaternion

6.3.2 EulerAngles

	620	630	670	680

Message name (ID)		**XCDI_EulerAngles** (0x022)					
Field	**Range**	**Scaling**	**Resolution**	**Unit**	**Format**	**Size**	**Offset**
Roll	±180	2^{-7}	0.0078	deg	int16	2	0
Pitch	±90	2^{-7}	0.0078	deg	int16	2	2
Yaw	±180	2^{-7}	0.0078	deg	int16	2	4
					Total size		6

Xbus equivalent: XDI_EulerAngles

6.4 Inertial Data Messages (0x030)

6.4.1 DeltaV

610	620	630	670	680

[5] Links to the latest available documentation can be found via the following link: Xsens MTi Documentation

Message name (ID)	XCDI_DeltaV (0x031)				
Field	**Scaling**	**Unit**	**Format**	**Size**	**Offset**
Δv.x	See table below	m/s	int16	2	0
Δv.y	See table below	m/s	int16	2	2
Δv.z	See table below	m/s	int16	2	4
Exponent of 2^{-x}	Based on the table below		uint8	1	6
			Total size		7

Note: The DeltaV values are scaled according to the selected output frequency and the scaling can be either read from a lookup-table such as the one below or by using the exponent sent as part of every message

Δv scaling based on ODR

Exponent 2^{-x}	Freq	Range	Scaling	Resolution
17	400	±0.25	2^{-17}	7.6294e-06
16	200	±0.50	2^{-16}	1.5259e-05
15	100	±1	2^{-15}	3.0518e-05
14	80	±1.25	2^{-14}	6.1035e-05
14	50	±2	2^{-14}	6.1035e-05
13	40	±2.5	2^{-13}	1.2207e-04
13	25	±4	2^{-13}	1.2207e-04
12	20	±5	2^{-12}	2.4414e-04
12	16	±6.25	2^{-12}	2.4414e-04
11	10	±10	2^{-11}	4.8828e-04
11	8	±12.5	2^{-11}	4.8828e-04
10	5	±20	2^{-10}	9.7656e-04
10	4	±25	2^{-10}	9.7656e-04
9	2	±50	2^{-9}	0.0020
8	1	±100	2^{-8}	0.0039

Xbus equivalent: XDI_DeltaV → Delta V

6.4.2 RateOfTurn

610	620	630	670	680

Message name (ID)	XCDI_RateOfTurn (0x032)						
Field	**Range**	**Scaling**	**Resolution**	**Unit**	**Format**	**Size**	**Offset**
gyrX	±35	2^{-9}	0.0020	rad/s	int16	2	0
gyrY	±35	2^{-9}	0.0020	rad/s	int16	2	2
gyrZ	±35	2^{-9}	0.0020	rad/s	int16	2	4
					Total size		6

Xbus equivalent: XDI_RateOfTurn

6.4.3 DeltaQ

610	620	630	670	680

Message name (ID)	XCDI_DeltaQ (0x033)						
Field	**Range**	**Scaling**	**Resolution**	**Unit**	**Format**	**Size**	**Offset**
Δq0	±1	$(2^{15}-1)^{-1}$	3.0518 e-05	m/s^2	int16	2	0
Δq1	±1	$(2^{15}-1)^{-1}$	3.0518 e-05	m/s^2	int16	2	2
Δq2	±1	$(2^{15}-1)^{-1}$	3.0518 e-05	m/s^2	int16	2	4
Δq3	±1	$(2^{15}-1)^{-1}$	3.0518 e-05	m/s^2	int16	2	6
					Total size		8

Note: Be careful when converting the value 1
Xbus equivalent: XDI_DeltaQ

6.4.4 Acceleration

610	620	630	670	680

Message name (ID)	XCDI_Acceleration (0x034)						
Field	**Range**	**Scaling**	**Resolution**	**Unit**	**Format**	**Size**	**Offset**
accX	±100	2^{-8}	0.0039	m/s^2	int16	2	0
accY	±100	2^{-8}	0.0039	m/s^2	int16	2	2
accZ	±100	2^{-8}	0.0039	m/s^2	int16	2	4
					Total size		6

Xbus equivalent: XDI_Acceleration
Note: +/- 10g

6.4.5 FreeAcceleration

	620	630	670	680

Message name (ID)	XCDI_FreeAcceleration (0x035)						
Field	**Range**	**Scaling**	**Resolution**	**Unit**	**Format**	**Size**	**Offset**
freeAccX	±100	2^{-8}	0.0039	m/s^2	int16	2	0
freeAccY	±100	2^{-8}	0.0039	m/s^2	int16	2	2
freeAccZ	±100	2^{-8}	0.0039	m/s^2	int16	2	4
					Total size		6

Xbus equivalent: XDI_FreeAcceleration

6.5 Magnetic Group (0x040)

6.5.1 MagneticField

610	620	630	670	680

Message name (ID)	XCDI_MagneticField (0x041)						
Field	**Range**	**Scaling**	**Resolution**	**Unit**	**Format**	**Size**	**Offset**
magX	±32	2^{-10}	9.7656e-04	a.u.	int16	2	0
magY	±32	2^{-10}	9.7656e-04	a.u.	int16	2	2
magZ	±32	2^{-10}	9.7656e-04	a.u.	int16	2	4
					Total size		6

Xbus equivalent: XDI_MagneticField

6.6 Temperature and Pressure Messages (0x050)

6.6.1 Temperature

610	620	630	670	680

Message name (ID)	XCDI_Temperature (0x051)						
Field	**Range**	**Scaling**	**Resolution**	**Unit**	**Format**	**Size**	**Offset**
Temperature	[-40,+85]	2^{-8}	0.0039	°C	int16	2	0
					Total size		2

Xbus equivalent: XDI_Temperature

6.6.2 BaroPressure

610	620	630	670	680

Message name (ID)	XCDI_BaroPressure (0x052)						
Field	**Range**	**Scaling**	**Resolution**	**Unit**	**Format**	**Size**	**Offset**
Pressure	[30000,125000]	2^{-15} Considered 32 bits without sign.	3.0518e-05	Pa	uint32	4	0
					Total size		4

Xbus equivalent: XDI_BaroPressure

6.7 High-Rate Data Messages (0x060)

6.7.1 AccelerationHR

610	620	630	670	680

Message name (ID)	XCDI_AccelerationHR (0x061)						
Field	**Range**	**Scaling**	**Resolution**	**Unit**	**Format**	**Size**	**Offset**
accX	±100	2^{-8}	0.0039	m/s^2	int16	2	0
accY	±100	2^{-8}	0.0039	m/s^2	int16	2	2
accZ	±100	2^{-8}	0.0039	m/s^2	int16	2	4
					Total size		6

Xbus equivalent: XDI_AccelerationHR

6.7.2 RateOfTurnHR

610	620	630	670	680

Message name (ID)	XCDI_RateOfTurnHR (0x062)						
Field	**Range**	**Scaling**	**Resolution**	**Unit**	**Format**	**Size**	**Offset**
gyrX	±35	2^{-9}	0.0020	rad/s	int16	2	0
gyrY	±35	2^{-9}	0.0020	rad/s	int16	2	2
gyrZ	±35	2^{-9}	0.0020	rad/s	int16	2	4
					Total size		6

Xbus equivalent: XDI_RateOfTurnHR

6.8 Position & Velocity Messages (0x070)

6.8.1 Latitude and Longitude

			670	680

Message name (ID)	XCDI_Latitude (0x071)						
Field	**Range**	**Scaling**	**Resolution**	**Unit**	**Format**	**Size**	**Offset**
lat	±90	2^{-24}	5.9605e-08 (~7 mm) Note. If we want to use 2^{-23}, resolution = 1.1921e-07 (~13 mm)	deg	int32	4	0
lon	±180	2^{-23}	1.1921e-07 (~13 mm)		int32	4	
					Total size		8

Xbus equivalent: XDI_LatLon

6.8.2 AltitudeEllipsoid

			670	680

Message name (ID)	XCDI_AltitudeEllipsoid (0x072)						
Field	**Range**	**Scaling**	**Resolution**	**Unit**	**Format**	**Size**	**Offset**
altEllipsoid	0 - 50000	2^{-15}	3.0518e-05	m	uint32	4	0
					Total size		4

Xbus equivalent: XDI_AltitudeEllipsoid
Note: lon, lat, alt messages are mutual exclusive with Ecef

6.8.3 VelocityXYZ

			670	680

Message name (ID)	XCDI_VelocityXYZ (0x076)						
Field	**Range**	**Scaling**	**Resolution**	**Unit**	**Format**	**Size**	**Offset**
velX	±500	2^{-6}	0.0156	m/s	int16	2	0
velY	±500	2^{-6}	0.0156	m/s	int16	2	2
velZ	±500	2^{-6}	0.0156	m/s	int16	2	4
					Total size		6

Xbus equivalent: XDI_VelocityXYZ