Technical Documentation

MT9 and MT6

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Xsens Technologies B.V.
Hengelosestraat 705
P.O. Box 545
7500 AM Enschede
The Netherlands

phone +31-(0)53-4836444
fax +31-(0)53-4836445
e-mail support@xsens.com
internet www.xsens.com

The MT9 and the MT6 miniature inertial measurement units comply with the following regulatory standards:

Europe:

CE

EN 60601-1-2	Electromagnetic compatibility and immunity. Standard for Medical Environments.
EN 61326	Electrical Equipment for measurements, control and laboratory use.
EN 61000-3-2	Electromagnetic compatibility (EMC) limits, part 3-2.
EN 61000-3-3	Electromagnetic compatibility (EMC) limits, part 3-3.
EN 61010 (1993) + A2 (1995)	Safety requirements for electrical equipment for measurement, control and laboratory use.

United States:

FC

FCC part 15	This device complies with part 15 of the FCC regulatory standards. *Other digital devices, unintentional radiators, verification. Product is a digital device used exclusively as industrial, commercial, or medical test equipment.*

Xsens motion technologies

CE FC

Motion Tracker MT9-A-xxxxx S/N xxxxxxxx
made in the Netherlands www.xsens.com

refer to documentation 6V DC/35mA
complies with Part 15 of the FCC rules
FOR HOME, OFFICE AND INDUSTRIAL USE

Table of Contents

1 MT9 software/SDK output

1.1 Overview

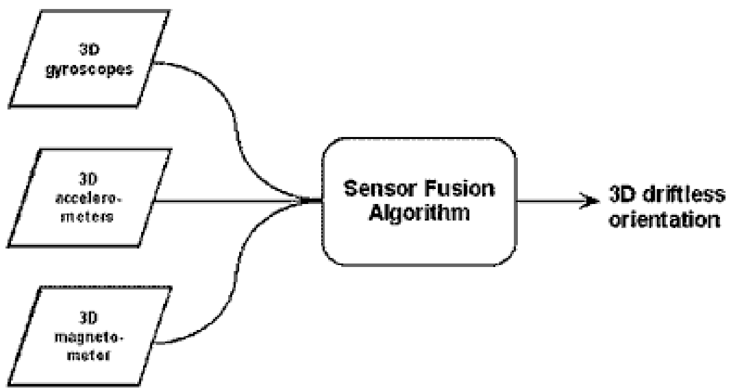
Platform: Windows 2000/XP [(1)]

Output:

- 3D orientation
  - Quaternions
  - Euler Angles (xyz)
  - Rotation Matrix
- 3D rate of turn
- 3D acceleration
- 3D magnetic field strength
- Temperature

Algorithm description

The MT9 Software/SDK contains a proprietary algorithm developed by Xsens tailor-made to the MT9 that can accurately calculate absolute orientation in three-dimensional space from miniature rate of turn sensors (gyroscopes), accelerometers and magnetometers in real-time.



The design of the algorithm can be explained as a sensor fusion algorithm where the measurement of gravity (accelerometers) and magnetic north (magnetometers) compensate for otherwise unlimited increasing errors from the integration of rate of turn data.

[1] Other platforms on request, including embedded. Windows98SE works but is not officially supported.

1.2 Co-ordinate systems

Calibrated Sensor readings

All calibrated sensor readings (accelerations, rate of turn, earth magnetic field) are in the right handed Cartesian co-ordinate system as defined in figure 1. This co-ordinate system is body-fixed to the MT9 or the MT6 (together referred to as MTx in this documentation).

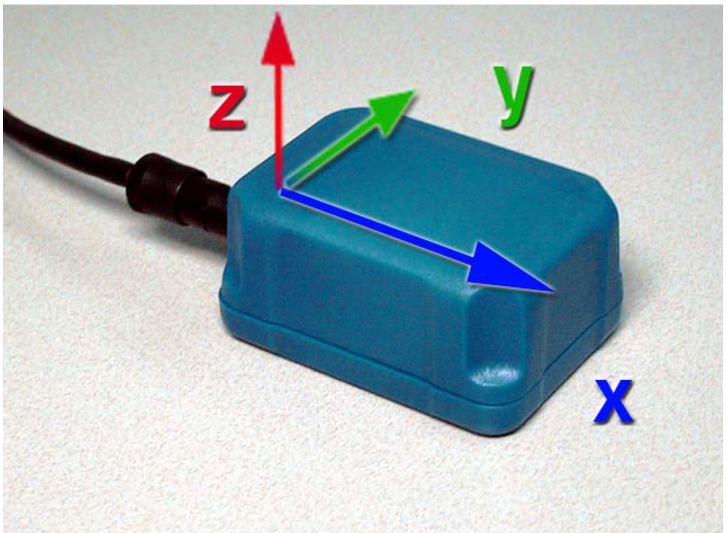


Figure 1 MT9 with body-fixed co-ordinate system overlay.

The co-ordinate system is substantially aligned to the external housing of the MTx. The actual alignment between the body-fixed co-ordinate system and the housing is guaranteed to <3°.

The non-orthogonality between the axes of the body-fixed co-ordinate system is <1°. This means that calibrated MTx data will have orthogonal XYZ readings within at least <1° as defined in figure 1.

The non-orthogonality of **un-calibrated** MT9/MT6 data is <5° due to potential mis-alignment of the physical sensors inside the electronics. This means that calibrated MTx data will have orthogonal readings within at least <5° as defined in figure 1. The sign of the gain of **un-calibrated** MTx data may not be according to figure 1.

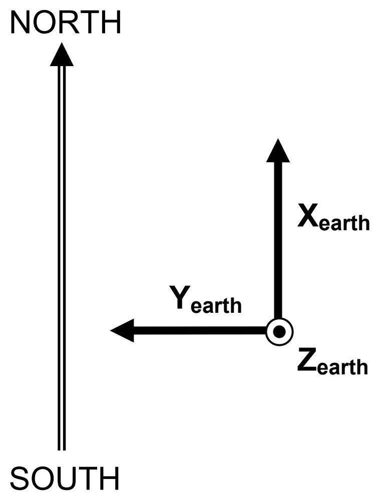
Orientation co-ordinate system (MT9 only)

The MT9 Software/SDK will calculate the orientation between the MT9 body-fixed co-ordinate system and a earth-fixed reference co-ordinate system. By default the earth-fixed reference co-ordinate system used is defined as a right handed Cartesian co-ordinate system with:

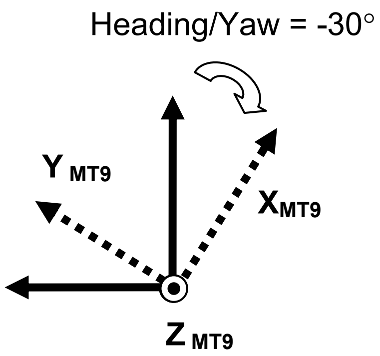
- X positive when pointing to the local magnetic north.
- Y according to right handed co-ordinates.
- Z positive when pointing up.

The 3D orientation output (independent on output mode, see chapter 3) is defined as the orientation between the body-fixed co-ordinate system and the earth-fixed co-ordinate system using the earth-fixed co-ordinate system as the reference co-ordinate system.

Example:



Earth-fixed reference co-ordinate system



MT9 co-ordinate system with respect to reference co-ordinate system

1.3 Orientation performance specification

Typical performance characteristics of calibrated MT9 in a homogeneous earth-magnetic field.

Dynamic Range: all angles in 3D
Angular Resolution: 0.05° RMS [(2)]
Static Accuracy: <1° [(3)]
Dynamic Accuracy: 3° RMS [(4)]
Turn On Time: 50 ms [(5)]
Sample Frequency: 100 Hz [(6)]

[2] standard deviation of angular random walk
[3] no drift in 3D orientation output
[4] may depend on type of motion
[5] 3D orientation is accurate <10s after initialization
[6] other sample frequencies on request

1.4 Orientation output formats

The orientation as calculated by the MT9 Software from the MT9 data is the orientation of the MT9 body-fixed co-ordinate system with respect to a Cartesian earth-fixed co-ordinate system (see chapter 2). The output orientation can be presented in different conventions:

- Unit Quaternions (also known as Euler parameters)
- Euler angles[7], roll, pitch, yaw (XYZ Earth fixed type, also known as Cardan)
- Rotation Matrix

A positive rotation is always defined according to the right hand rule (corkscrew rule).

Quaternion log-file

Quaternion introduction

A quaternion vector represents a rotation about a unit vector (u_x, u_y, u_z) through an angle θ. A unit quaternion itself has unit magnitude, and can be written in the following vector format;

$$q = \begin{bmatrix} q_0 \\ q_1 \\ q_2 \\ q_3 \end{bmatrix} = \begin{bmatrix} \cos(\theta/2) \\ \sin(\theta/2)u_x \\ \sin(\theta/2)u_y \\ \sin(\theta/2)u_z \end{bmatrix}$$

An alternative representation of a quaternion is as a complex number;

$$q = q_0 + \boldsymbol{i}q_1 + \boldsymbol{j}q_2 + \boldsymbol{k}q_3$$

Here, it is defined that for the purposes of multiplication;

$$\begin{aligned} \boldsymbol{i}^2 = \boldsymbol{j}^2 = \boldsymbol{k}^2 &= -1 \\ \boldsymbol{ij} = -\boldsymbol{ji} &= \boldsymbol{k} \\ \boldsymbol{jk} = -\boldsymbol{kj} &= \boldsymbol{i}, \\ \boldsymbol{ki} = -\boldsymbol{ik} &= \boldsymbol{j} \end{aligned}$$

Please note that due to the definition of a quaternion, q = -q.

Log file format

The file name structure is: MT9_quat_SID_XXX.log

[7] Please note that due to the definition of Euler angles there is a mathematical singularity when the body-fixed x-axis is pointing up or down in the earth-fixed reference frame (i.e. pitch approaches ±90°). This singularity is in no way present in the quaternion or rotation matrix output mode.

Where XXX is an incremental number (each number follows the highest number in selected directory) and SID is the sensor ID (MT9 unique identifier).

The log-file is in standard ASCII format, with TAB-separated values (easily imported in Excel, Matlab, etc.). Values are in floating point format with 6 decimals. Each sample is stored on a single line in the log-file, lines are separated with a 'new line' character ('\n'). The default sample frequency is 100 Hz[8].

Sample time (not included in log file!)	SID (HEX)	q_0	q_1	q_2	q_3
t = 0.00 s	202A	0.999999	0.000028	0.000855	-0.000690
t = 0.01 s	202A	0.999998	-0.000012	0.001459	-0.001251
t = 0.02 s	202A	0.999997	-0.000013	0.001596	-0.002511
t = 0.03 s	202A	0.999998	-0.000012	0.001459	-0.001251
…	…	…	…	…	…

Euler log-file

Euler angles introduction

The definition used for 'Euler-angles' here is equivalent to 'roll, pitch, yaw/heading' (also known as Cardan). The Euler-angles are of XYZ Earth fixed type (subsequent rotation around, X, Y and Z axis).

- φ = roll = rotation around X, defined from [-180°…180°]
- θ = pitch = rotation around Y, defined from [-90°…90°]
- ψ = yaw/heading = rotation around Z, defined from [-180°…180°]

The Euler-angles can be interpreted in terms of the components of the rotation matrix, ***R***, or in terms of the unit quaternion;

$$
\begin{aligned}
\phi &= \operatorname{atan}(R(2,3)/R(3,3)) \\
&= \operatorname{atan}(2(q_2q_3+q_0q_1)/(q_0^2-q_1^2-q_2^2+q_3^2)) \\
\theta &= \operatorname{asin}(-R(1,3)) \\
&= \operatorname{asin}(-2(q_1q_3-q_0q_2)) \\
\psi &= \operatorname{atan}(R(1,2)/R(1,1)) \\
&= \operatorname{atan}(2(q_1q_2+q_0q_3)/(q_0^2+q_1^2-q_2^2-q_3^2))
\end{aligned}
$$

[8] This may vary for custom made MT9/MT6.

Log file format

The file name structure is: MT9_euler_SID_XXX.log

Where XXX is an incremental number (each number follows the highest number in selected directory) and SID is the sensor ID (MT9 unique identifier).

The log-file is in standard ASCII format, with TAB-separated values (easily imported in Excel, Matlab, etc.). Values are in floating point format with 6 decimals. Each sample is stored on a single line in the log-file, lines are separated with a 'new line' character ('\n'). The default sample frequency is 100 Hz[9].

Sample time (not included in log file!)	SID (HEX)	**φ (roll) [deg]**	**θ (pitch) [deg]**	**ψ (heading/yaw) [deg]**
t = 0.00 s	202A	134.465912	-18.929155	0.811353
t = 0.01 s	202A	134.093460	-18.992971	0.673081
t = 0.02 s	202A	133.698212	-19.109470	0.490710
t = 0.03 s	202A	133.264557	-19.352758	0.227078
…	…	…	…	…

Note that the output is in **degrees** and not radians.

[9] This may vary for custom made MT9 or MT6.

Rotation Matrix log-file

Rotation matrix introduction

The rotation matrix (also known as direction cosine matrix) is a well-known, redundant and complete representation of orientation. The rotation matrix, R, can be interpreted in terms of quaternions;

$$R = \begin{bmatrix} (q_0^2+q_1^2-q_2^2-q_3^2) & 2(q_1q_2+q_0q_3) & 2(q_1q_3-q_0q_2) \\ 2(q_1q_2-q_0q_3) & (q_0^2-q_1^2+q_2^2-q_3^2) & 2(q_2q_3+q_0q_1) \\ 2(q_1q_3+q_0q_2) & 2(q_2q_3-q_0q_1) & (q_0^2-q_1^2-q_2^2+q_3^2) \end{bmatrix}$$

or in terms of Euler-angles;

$$R = \begin{bmatrix} \cos\theta\cos\psi & \cos\theta\sin\psi & -\sin\theta \\ (\sin\phi\sin\theta\cos\psi-\cos\phi\sin\psi) & (\sin\phi\sin\theta\sin\psi-\cos\phi\cos\psi) & \sin\phi\cos\theta \\ (\cos\phi\sin\theta\cos\psi+\sin\phi\sin\psi) & (\cos\phi\sin\theta\sin\psi-\sin\phi\cos\psi) & \cos\phi\cos\theta \end{bmatrix}$$

Log file format

The file name structure is: MT9_matrix_SID_XXX.log

Where XXX is an incremental number (each number follows the highest number in selected directory) and SID is the sensor ID (MT9 unique identifier).

The log-file is in standard ASCII format, with TAB-separated values (easily imported in Excel, Matlab, etc.). Values are in floating point format with 6 decimals. Each sample is stored on a single line in the log-file, lines are separated with a 'new line' character ('\n'). The default sample frequency is 100 Hz[10].

Definition:

As defined here ${}^{GS}R$, rotates a vector in the sensor co-ordinate system (S) to the global reference system (G):

$${}^{GS}R = \begin{bmatrix} a & d & g \\ b & e & h \\ c & f & i \end{bmatrix}$$

[10] This may vary for custom made MT9/MT6.

Hence, ${}^{SG}R$ rotates a vector in the global reference co-ordinate system (G) to the sensor co-ordinate system (S):

$$ {}^{SG}R = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix} $$

Since, by definition:

$$ {}^{GS}R = \left[{}^{SG}R \right]^T $$

Example:

Sample time (not included in log file!)	SID (HEX)	a	b	c	d	e	f	g	h	i
t = 0.00 s	202A	0.999988	0.004866	0.000671	-0.004870	0.999988	0.000316	-0.000670	-0.000310	1.000000
t = 0.01 s	202A	0.999953	0.009600	0.001388	-0.009600	0.999954	0.000861	-0.001380	-0.000850	0.999999
t = 0.02 s	202A	0.999896	0.014298	0.001959	-0.014290	0.999897	0.001173	-0.001940	-0.001160	0.999997
t = 0.03 s	202A	0.999833	0.018067	0.002633	-0.018050	0.999835	0.001645	-0.002600	-0.001620	0.999995
…	…	…	…	…	…	…	…	…	…	…

1.5 Calibrated data output format

The physical sensors used for the MTx (accelerometers, gyroscopes and magnetometers) are all assumed to sense their respective physical quantity, Q, linearly. Hence, they can be modeled by the following simple formula;

$$ U_{sens} = K \cdot Q + U_{bias} $$

From factory calibration each Motion Tracker has been assigned a unique gain matrix, K and the bias vector. This calibration data is used to relate the sampled digital voltages, U_{sens}, (unsigned integers) streaming from the Motion Tracker to the respective physical quantity, Q. From, the above equation we can relate Q to U_{sens};

$$ Q = K^{-1} \cdot (U_{sens} - U_{bias}) $$

Unique Calibration File Format

The *.xmu file is in standard ASCII format, with comma separated values (CSV). Values are in floating point format with 3 decimals.

The file name structure is: SID_ddmmyyyy_XXX.xmu

Example: 2025_07082002_000.xmu

Where XXX is an incremental number (each number follows the highest number in selected directory) and SID is the sensor ID (MT9 unique identifier).

$$U_{bias} = \begin{bmatrix} a & b & c \end{bmatrix}$$

$$K = \begin{bmatrix} a & b & c \\ d & e & f \\ g & h & i \end{bmatrix}$$

Value	Sensor			
Bias (U_{bias})	Accelerometer	a	b	c
Bias (U_{bias})	Rate of turn	a	b	c
Bias (U_{bias})	Magnetometer	a	b	c
Gain (K)	Accelerometer	a	b	c
Gain (K)	Accelerometer	d	e	f
Gain (K)	Accelerometer	g	h	i
Gain (K)	Rate of turn	a	b	c
Gain (K)	Rate of turn	d	e	f
Gain (K)	Rate of turn	g	h	i
Gain (K)	Magnetometer	a	b	c
Gain (K)	Magnetometer	d	e	f
Gain (K)	Magnetometer	g	h	i

Unit definition:

- Acceleration units = [m/s^2]
- Rate-of-turn-units = [rad/s]
- Magnetic field units = [a.u.][11]

[11] normalized arbitrary units, local Dutch earth magnetic field strength defined as 1.

Calibrated MT9 data log-file format

The file name structure is: MT9_cal_SID_XXX.log (calibrated MT9 data)

Where XXX is an incremental number (each number follows the highest number in selected directory) and SID is the sensor ID (MT9 unique identifier).

Sample time (not included in log file!)	acc X_{MT} [m/s^2]	acc Y_{MT} [m/s^2]	acc Z_{MT} [m/s^2]	gyr X_{MT} [rad/s]	gyr Y_{MT} [rad/s]	gyr Z_{MT} [rad/s]	mag X_{MT} [a.u.]	mag Y_{MT} [a.u.]	mag Z_{MT} [a.u.]	temp T_{MT} [°C]
t = 0.00 s	2.661967	0.311211	9.516666	0.40514	3.787364	0.562274	0.703191	-0.31554	-0.99124	21.0625
t = 0.01 s	2.670269	0.319165	9.513756	0.426022	3.782059	0.559081	0.703191	-0.31554	-0.99124	21.0625
t = 0.02 s	2.666907	0.312891	9.50742	0.402496	3.795521	0.562483	0.703191	-0.31554	-0.99124	21.0625
t = 0.03 s	2.671661	0.304962	9.501168	0.418168	3.784724	0.559248	0.74198	-0.28047	-1.04848	21.0625
…	…	…	…	…	…	…	…	…	…	…

NOTE:
MT9 Software release version 1.8 and lower calibrated data log-file format (no temperature):

Sample time (not included in log file!)	acc X_{MT} [m/s^2]	acc Y_{MT} [m/s^2]	acc Z_{MT} [m/s^2]	gyr X_{MT} [rad/s]	gyr Y_{MT} [rad/s]	gyr Z_{MT} [rad/s]	mag X_{MT} [a.u.]	mag Y_{MT} [a.u.]	mag Z_{MT} [a.u.]
t = 0.00 s	2.661967	0.311211	9.516666	0.40514	3.787364	0.562274	0.703191	-0.31554	-0.99124
t = 0.01 s	2.670269	0.319165	9.513756	0.426022	3.782059	0.559081	0.703191	-0.31554	-0.99124
t = 0.02 s	2.666907	0.312891	9.50742	0.402496	3.795521	0.562483	0.703191	-0.31554	-0.99124
t = 0.03 s	2.671661	0.304962	9.501168	0.418168	3.784724	0.559248	0.74198	-0.28047	-1.04848
…	…	…	…	…	…	…	…	…	…

NOTE:
Due to initialization of the temperature sensors inside the MT9 electronics the first 4-6 samples sent immediately after power up of the MT9 do not correspond to the actual temperature inside the MT9.

Uncalibrated binary MT9 data format

The file name structure is: MT9_data_SID_XXX.bin (raw binary data)

Where XXX is an incremental number (each number follows the highest number in selected directory) and SID is the sensor ID (MT9 unique identifier).

The raw binary data format saved and/or used by the MT9 software is the same as what is transmitted on the serial line (see hardware section), without Sensor ID and Checksum:

1. Preamble = 2 bytes, FAAF hex
2. Accelerometer = 6 bytes, 3 ch x 2 bytes
3. Gyroscope = 6 bytes, 3 ch x 2 bytes
4. Magneto = 6 bytes, 3 ch x 2 bytes
5. Temperature = 2 bytes

The *.bin files can be used as input to the MT9 Software to re-process the same sensor data with other filter settings.

PLEASE NOTE: When using the **Xbus Master** to log raw binary data, the file format is different. See the Xbus Master Technical Documentation for more information. All output from the Xbus Master is logged. These *.xm files can also be used as input to the MT9 Software.

2 Motion Tracker Hardware

2.1 Physical sensor overview

MT9 Sensor Fact Table	
Accelerometers	Solid state, capacitative readout
Rate of turn sensor 'Gyroscope'	Solid state, “tuning fork concept”
Magnetometer	Thin film magnetoresistive

MT6 Sensor Fact Table	
Accelerometers	Solid state, capacitative readout
Rate of turn sensor 'Gyroscope'	Solid state, “tuning fork concept”

2.2 Physical sensor specification

		rate of turn	**acceleration**	**magnetic field**[12]	**temperature**
Unit		deg/s	m/s^2	mGauss	°C
Dimensions		3	3	3	-
Full Scale	(units)	+/- 900	+/- 20	+/- 750	-55…+125
Linearity	(% of FS)	1 (13)	0.2	1	<1
Bias stability	(units per °C)	15	0.02	-	-
Scale factor stability	(% per °C)	0.3 (14)	0.02	0.5	-
Noise	(units RMS)	0.7	0.01	4.5	0.0625 (15)
Bandwidth	(Hz)	50	10	10	-

[12] Not applicable for MT6
[13] specified up to 100 deg/s
[14] specified between 10 and 30 °C, 0.5% per °C between 5 and 45 °C
[15] minimal resolution of digital readout, absolute accuracy is ±0.5 °C

2.3 Motion Tracker binary output format

RS-232 Serial Connection Settings

Setting	Value
Bits/second:	**115200**
Data bits:	**8**
Parity:	**none**
Stop bits:	**1**
Flow control:	**none**

General definitions for binary data

All binary data communication is done in **big-endian** format.

Example:

16 bits accelerometer output = 1275 (decimal) = 0x04FB (hexadecimal)
big-endian: 04 FB

The bit-order in a byte is always:

[MSB…LSB] → [bit 7 …bit 0]

Data packet MT9

A total of 25 bytes transmitted every 10ms at a baud rate of 115k2 (115200 bits/s).The data communication is RS232 or RS485. The data communication physical layer depends the output specification of the MT9, i.e. RS232 or RS485.

Preamble (2B)	Sensor ID (2B)	Accelerometer (6B)	Gyroscoop (6B)	Magneto (6B)	Temperature (2B)	Checksum (1B)

The MT9 sends sensor data @ 100 Hz or 250 Hz (depending on version) on the RS232 connection as soon as its powered, the raw binary data format from the MT9 sensor unit is the following:

1. Preamble = 2 bytes, FAAF hex
2. Sensor ID = 2 bytes
3. Accelerometer = 6 bytes, 3 ch x 2 bytes
4. Gyroscope = 6 bytes, 3 ch x 2 bytes
5. Magneto = 6 bytes, 3 ch x 2 bytes
6. Temperature = 2 bytes
7. Checksum = 1 byte, all data (except preamble) added, low byte transmitted

Data packet MT6

A total of 19 bytes transmitted every 10ms at a baud rate of 115k2 (115200 bits/s).The data communication is RS232 or RS485. The data communication physical layer depends the output specification of the MT6, i.e. RS232 or RS485.

Preamble (2B)	Sensor ID (2B)	Accelerometer (6B)	Gyroscoop (6B)	Temperature (2B)	Checksum (1B)

The MT6 sends sensor data @ 100 Hz or 300 Hz (depending on version) on the RS232 connection as soon as its powered, the raw binary data format from the MT9 sensor unit is the following:

1. Preamble = 2 bytes, FAAF hex
2. Sensor ID = 2 bytes, each sensor has its own number
3. Accelerometer = 6 bytes 3D x 2 bytes
4. Gyroscope = 6 bytes 3D x 2 bytes
5. Temperature = 2 bytes
6. Checksum = 1 byte, all data (except preamble) added, low byte transmitted

Temperature output format

The temperature readout of the MTx can be interpreted as a 16 bits, 2-complement number. However, please note that the resolution of the temperature sensor is not actually 16-bit but 12-bit.

For example you can interpret the 2-byte temperature as follows:

00.00hex = 0.0 °C
00.80hex = +0.5 °C
FF.80hex = -0.5 °C
19.10hex = +25.0625°C
E6.F0hex = -25.0625 °C

NOTE:
Due to initialization of the temperature sensors inside the MT9 electronics the first 4-6 samples sent immediately after power up of the MT9 do not correspond to the actual temperature inside the MT9.

2.4 Resolution

This may vary for different MT9's, especially for special orders with deviating dynamic ranges. Please contact Xsens Tech Support (support@xsens.com) for details.

Accelerometers:
1 bit is roughly[16] the same as 0.16 mg = 0.0016 m/s^2

Rate of turn sensors:
1 bit is roughly the same as 1.91 mrad/s = 0.11°/s

Magnetometers:[17]
1 bit is roughly the same as 0.12 mGauss[18]

Temperature:
1 bit = 0.0625°C

For noise data please refer to the Specification Section.

[16] depends on calibration values unique for each sensor ID (SID).
[17] Not applicable for MT6
[18] Keep in mind that when calibrated the output from the magnetometer is normalized.

2.5 Normal Operating Temperature

The temperature sensor is placed in the middle of the Motion Tracker electronics. The temperature will increase when the ambient temperature increases or when the power supply voltage is higher than the nominal 6V;

Typical temperature @ ambient T ≈ 22 °C

- MTx on for >30 minutes at 6V/34mA, the temperature is ~ 33-34°C
- MTx on for >30 minutes at 10V/37mA, the temperature is ~34-35°C

3 Physical

3.1 Physical Specifications overview

	MT9	MT6
Interface:	Serial digital (RS-232/RS-485)	Serial digital (RS-232/RS-485)
Operating Voltage:	6 V (adapter included)	6 V (adapter included)
Power Consumption:	35 mA	28 mA
Temperature Operating Range:	5°C - 45°C	5°C - 45°C
Outline Dimensions:	39 x 54 x 28 mm (W x L x H)	39 x 54 x 28 mm (W x L x H)
Weight:	40 g	36.5 g

3.2 Power supply

The nominal power supply of the Motion Trackers is 6V.

The minimum operating supply voltage is >5.1V and the absolute maximum is <10V.

- The sensor works at a power supply of >5.1-10V
- The power consumption is 35 mA for the MT9 (28 mA for MT6)
- When operated in room temperature the temperature inside the sensor will be 33-40°C in normal conditions.

Power Adapter

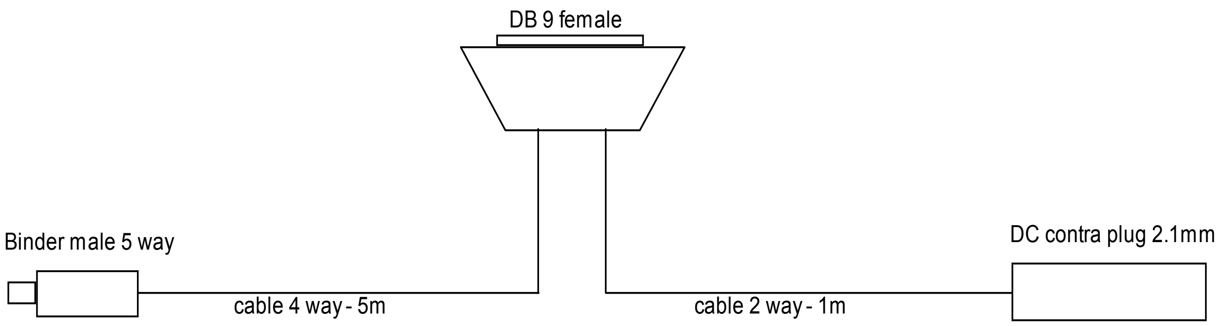
The power adapter delivered with the MT9 Starters Kit or the MT9 Software Development Kit is available in EU/UK/US plug standard 6V DC output (100-240 V AC @ 50-60 Hz).

The operating temperature of the power adapter is 0 °C - 40 °C.

Motion Trackers (MT9/MT6) are designed to be used with the power adapter supplied by Xsens. It is possible to use other power supplies, however this is not recommended. For safety and EMC any power supply used with the MT9 must comply with the following specification; EN 60601-1-2 or EN 61326 and EN 61000-3-2, EN 61000-3-3, EN 61010.

3.3 Cable and Connectors

Overview

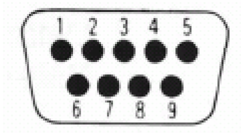


Cables

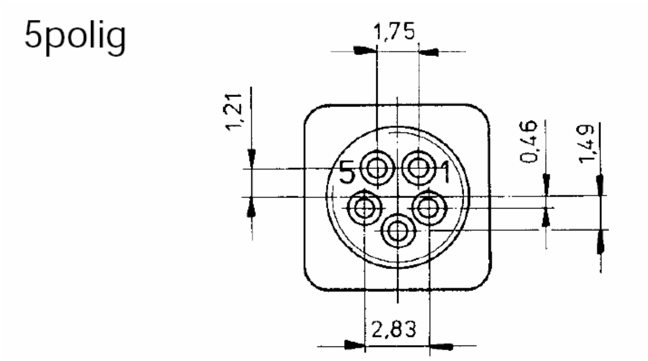
Wire color (4-way cable)	Definition	DB9 solder bucket female
Yellow	B or TX (from sensor point of view)	Pin 2
Red	VCC (5.5-6V)	Put through Vcc inside DB9 shell
	NC	
Green	GND	Pin5
Blue	A or RX (from sensor point of view)	Pin 3

Wire color (2-way cable)	Definition	DB9 solder bucket female
Red	VCC (5.5-6V)	Put through Vcc inside DB9 shell
Blue	GND	Pin5

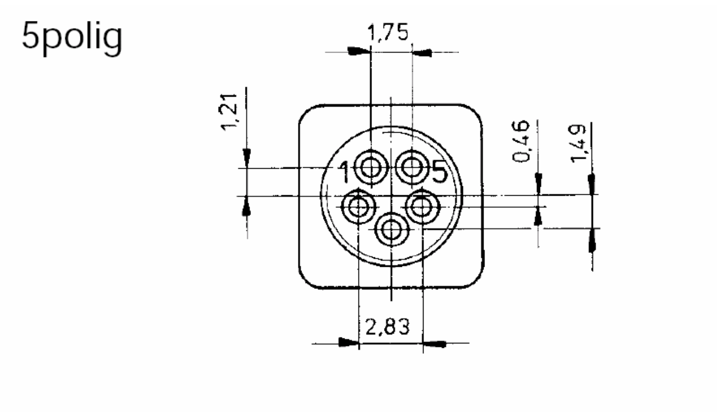
Connectors



Female DB-9 solder bucket back view



Male connector Binder 719, rear (solder side), ridge upper side



Female connector Binder 719, rear (solder side), ridge upper side

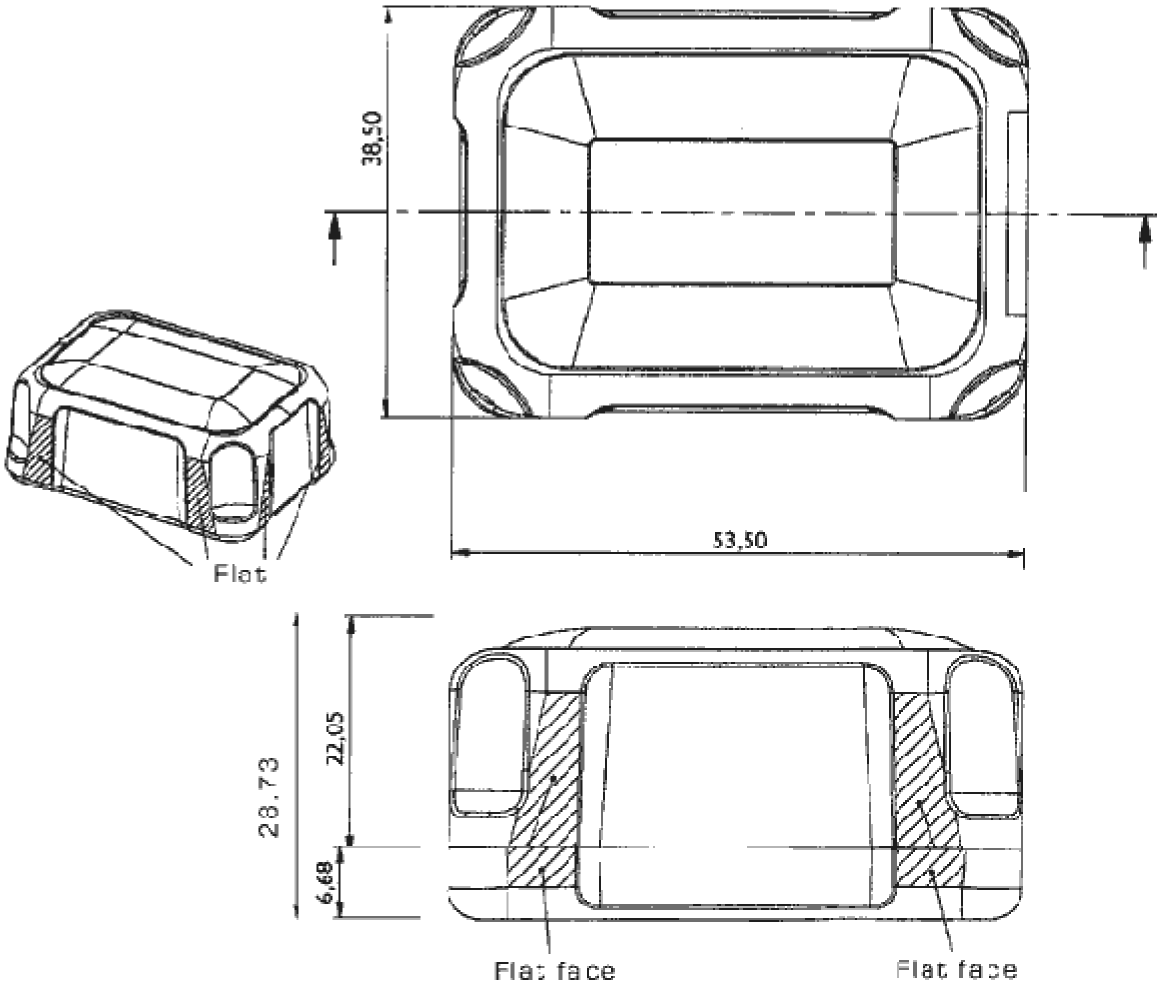
Pin	Definition	Wire color (4-way cable)
1	B or TX (from sensor point of view)	Yellow
2	VCC (5.5-6V)	Red
3	NC	
4	GND	Green
5	A or RX (from sensor point of view)	Blue

RS-232 version: 1x female (five way)
RS-485 version: 1x female (five way) & 1x male (five way)

3.4 Housing

The housing is made of ABS plastic. The housing is dust-proof but not water-proof.

Dimensions



4 Important notices

4.1 Environmental Operating Conditions

The recommended operating temperature of the MTx hardware is around room temperature (~25°C) but it may be operated at other temperature conditions. At temperature conditions significantly deviating from room temperature it is important to carry out the calibration procedure prior to the measurements to obtain the best possible performance. The temperature should remain constant as much as possible *during* the measurement.

The MTx hardware must be kept dry at all times. Condense may damage the internal electronics.

The MTx hardware should be protected from electro static discharges or sources of radiation, as exposure to such source will damage the internal electronics.

The MTx hardware should be protected from violent handling such as drops on hard surfaces. Excessive shocks or violent handling may damage the motion sensors.

4.2 Absolute maximum ratings

Stresses above Absolute Maximum Ratings may cause permanent damage to the device.

Shock (any axis):	5000 m/s^2
Supply Voltage:	-0.3 V … 12 V
Operating/Storage Temperature:	-5 °C - 60 °C

NOTE: Drops onto hard surfaces can cause shocks of greater than 5000 m/s^2 and exceed the absolute maximum rating of the device. Care should be taken when handling to avoid damage.

4.3 Regulatory standards & safety remarks

This product is approved by the regulations mentioned on page 2 in case the Motion Tracker is used with the delivered cable and power adapter. The electrical safety standard EN61010 also oblige that the device (PC, laptop, etc) connected to the Motion Tracker must have a Safety Extra Low Voltage (**SELV**) power supply.

This product is part of over-voltage category II.

4.4 Maintenance

The Motion Tracker will not require any maintenance if properly used (see also chapter 4.1 & 4.2). However, if the Motion Tracker is not functioning according to the specifications please contact Xsens Technologies B.V. (support@xsens.com).

For maintenance it is necessary to remove the power adapter from the 220-240V/110V outlet.