SYD DYNAMICS

TransducerM TM100 Series

Part Number / Order Number: TM151 / TM171

TransducerM TM151 / TM171 is an attitude and heading reference system (AHRS) with 9-axis IMU

Version	Date	Revision Information
V1.1.1 (P1)	May 28, 2024	Preview Version.
V1.1.2	May 29, 2024	Update reverse voltage protection, add TM1xx comparison table.
V1.1.3	Jun 6, 2024	Update parameters, optimize file layout.
V1.1.4	Jun 12, 2024	Update product main image.
V1.1.5	Jun 4, 2024	Main product image color adjustment.
V1.1.6 (R)	Nov 5, 2024	Update comparison table. Error fix and add precaution notes.

* This document is non-public and is only for intended recipients.
* Actual product might be different from the photo illustrated.
* Specifications are subject to change without notice.

TransducerM TM100 Series Introduction

The SYD Dynamics TransducerM TM100 series consists of Attitude and Heading Reference System (AHRS) products.

- The TransducerM is a series of motion sensing modules introduced by SYD Dynamics. It detects an object's attitude and motion in three-dimensional space. With simple configuration, the module outputs such as pitch, roll, heading (yaw), and quaternion data. The sensor module comes with built-in calibration data and a data processing unit, allowing it to directly output 3D attitude information. The module's adaptive magnetic field filter effectively resists magnetic interference; it can also output calibrated raw sensor data, including three-axis angular velocity, three-axis linear acceleration, and three-axis magnetometer measurements. The TransducerM includes a graphical configuration interface software and C/C++ communication interface libraries.

- Models TM131, TM151, and TM171 are economical 9-axis attitude and heading reference instruments (with calibrated IMU). Among these, the TM131 offers a cost advantage over the TM151 and TM171, while TM171 has better overall performance.

Product comparisons as below [2]

FEATURES		TM1xx Series (a.k.a TM100 Series)		
		TransducerM TM131	TransducerM TM151	TransducerM TM171
Sensor	3-axis：Gyroscope	●	●	●
	3-axis：Accelerometer	●	●	●
	3-axis：Magnetometer	●	●	●
Features	Sensor Fusion	●	●	●
	Sensor Fusion Profiles	-	-	●
	Vibration Resistant	●(Basic[3])	-	●(Basic[3])
	Configuration GUI	●	●	●
	Run-time static calibration API	●	●	●
	Digital Compass Function	●(Basic)	●	●
	Essential Factory Calibration	●	●	●
	Calibration Temperature	Room temperature (by 22.5°C)	Room temperature (by 22.5°C)	Room temperature (by 22.5°C)
Interface	UART Serial Port	●	●	●
	CAN Bus	-	-	-
	USB (Type-C)	●	●	●
Output	Calibrated Raw Data Output	●	●	●
	Roll, Pitch, Yaw Output	●	●	●
	Internal Update Rate (Typical)	200Hz	400Hz	800Hz
	Max Output Data Rate (ODR)	200Hz	400Hz	800Hz
	Precision ODR selectable by Hz	●	●	●
Typical Performance[4]	Static Accuracy (Roll-Pitch)	<0.6° RMS	<0.5° RMS	<0.5° RMS
	Static Accuracy (Yaw)	<1.0° RMS	<1.0° RMS	<0.8° RMS
	Dynamic Accuracy (Roll-Pitch)	<1.0° RMS (Low dynamic tests[5])	<1.5° RMS	<1.0°RMS
	Dynamic Accuracy (Yaw, pure inertial)[6]	5.0° error every 25 minutes	3.0° error every 25 minutes	2.6° error every 25 minutes
Operation Condition	Temperature	-40~85°C	-40~85°C	-40~85°C
	Voltage	5V	5V	5V
	IP Rate	No IP Rate	No IP Rate	No IP Rate
Application		Consumer, Education, DIY, Laboratory, Robot, AGV	Consumer, Education, DIY, Laboratory, Robot, AGV	Consumer, Education, DIY, Laboratory, Robot, AGV
Standard Warranty[7]		1 year	1 year	1year

● Standard   ○ Optional   − Not Available

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[1] For accelerometers and magnetometers, they are calibrated to 'units' and are accurate in terms of vector direction but not their absolute values. E.g. accelerometers may output （0.0， 0.0， -1.0） meaning Z-axis is relatively equal to earth gravity magnitude, and the sensor is placed horizontally with Z-axis pointing to the sky.
[2] Specifications are subject to change without notice.
[3] Basic level Vibration Resistant refers to mild vibrations, such as that from an autonomous guided vehicle (AGV), a moving robot arm or a cloud deck, etc. Products without Vibration Resistant are susceptible to low frequency linear acceleration (low Hz vibration) such as long and smooth breaking motion of a vehicle approaching a red light, or when a robot arm swinging out an object or doing a long-period rotation.
[4] According to tests mostly in laboratory environment, typical performance. Actual performance may vary.
[5] Typical low-dynamic movements include indoor robotic vehicles, such as low-speed driving, stopping, turning, moving up and down slopes, and moderate acceleration or deceleration.
[6] Typical city car driving dynamic condition, including sharp and slow turning, with fast and gentle accelerations and traffic light stops.
[7] Please contact your supplier for exact warrant period.

TransducerM TM151 / TM171 Introduction

SYD Dynamics TransducerM Model no. TM151 and TM171 motion sensing modules are Attitude and Heading Reference Systems (AHRS), both models consist of 3-axis gyroscopes, 3-axis accelerometers and 3-axis magnetometers. With simple configuration, the module outputs calibrated raw sensor measurement, and angular data such as Roll-Pitch-Yaw and Quaternion.

Both the TM151 and TM171 models share identical mechanical dimensions, mounting holes and electrical interfaces. The gyroscopes, accelerometers and magnetometers of both models are carefully factory calibrated by 22.5°C.

The TM171 model is noted for its enhanced dynamic measurement performance compared to the TM151.

Application Range:

TM151 and TM171 are designed for consumer and industrial applications in non-critical safety systems such as ground vehicles, drones, and robots. TM151 and TM171 feature a compact structure with a solder-able baseboard, suitable for integration into user circuit boards. To achieve lightweight, compact dimensions, and easy installation, the TM100 series does not include surge or over-voltage protection circuits for power input and signal interfaces. Therefore, users are responsible for appropriately setting up protection circuits where applicable.

TransducerM TM151 / TM171 Specifications

1. Physical and Electrical Parameters

Operating Coordination				
PARAMETER	**MIN**	**TYP**	**MAX**	**UNIT**
Operating Voltage	4.5	5.0	5.5	V
Current	-	80	-	mA
Power Consumption	-	0.4	-	W
Power Input	Recommended: regulated 5V through UART / USB interface			
Power Input Protection	Reverse voltage protection up to -15V, Not immune to lightning transients (For industrial applications, please ensure proper protection and isolation.)			
Operation Temperature Range	-40	22.5	85	°C
Calibration Temperature	-	22.5	-	°C
Shock	-10	-	+10	g

Physical Data		
PARAMETER		**UNIT**
Size （L x W x H）	40×34×12.6	mm
Weight	19 （Typical）	g
Compliance	RoHS No IP Rate	
Casing Material	Aluminum Alloy PCBA	
Connectors	Type-C USB、 2.54mm pin and solder pads for UART	

System Parameters		
Star-up time （cold[1], use Auto boot mode）	3.2	Second
Star-up time （cold[1], use Static boot mode）	10 ~ 30 (Default is 30 seconds, configurable)	Second

Communication Interface	UART (TTL 3.3V compatible TTL 5.0V) USB 2.0 (Full speed，Type-C interface，Virtual COM Port) *Both communication interfaces can be accessed simultaneously	
Data Rate	UART：2400~921600, 1Mbps standard baud rate, 250kbps, 500kbp and baud rate customization. *The ImuAssistant GUI configuration software allows for higher baud-rate but use with caution as the signal may easily be corrupted using bare UART cable wiring.) * Use with caution with baud rate customization and do not try strange baud rates as not all baud rates are fully tested, some may bring the module to irrecoverable state. Consult tech support before trying. USB 2.0：Adaptive, full-speed	bps

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[1] The cold start-up means to power on the TransducerM from power-off state (differs from hot-reboot without disconnecting the power supply)

2. IMU Sensor and AHRS Specification

Gyroscope

PARAMETER	MIN	TYP	MAX	UNIT	DESCRIPTION
Measurement Range	-1000	-	+1000	°/s	X, Y, Z axis
Resolution	-	0.01	-	°/s	
Bandwidth	68	-	-	Hz	-3db
Noise	-	≤ ±0.5	-	°/s	Peak-to-Peak (sampled at 100Hz)
Bias Stability	-	5.5	-	°/h	Constant temperature, measured by pure noise integration
Non-linearity Error	-	<0.3	-	% FS	TM151
		<0.2	-	% FS	TM171
Acceleration Sensitivity (G sensitivity)	-	<0.1	-	°/s/g	

Accelerometer

PARAMETER	MIN	TYP	MAX	UNIT	DESCRIPTION
Measurement Range	-10	-	+10	g	X, Y, Z axis
Resolution	-	0.40	-	mg	
Bandwidth	70	-	-	Hz	-3db
Noise	-	≤12	-	mg	Peak-to-Peak (sampled at 100Hz)
Noise Density	-	190	-	ug/√Hz	
Bias instability	-	0.05	-	mg	Allan Variance
Bias drift with temperature	-	<5.5	-	mg	At the Calibration Temperature
Non-linearity	-	0.500	-	% FS	-1g ~ +1g range At the Calibration Temperature
Misalignment	-	<0.5	-	°	TM151
	-	<0.3	-	°	TM171

Magnetometer

PARAMETER	MIN	TYP	MAX	UNIT	DESCRIPTION
Measurement Range	-1.3	-	+1.3	Gauss	
Resolution	-	0.001	-	Gauss	
Internal sampling rate	-	-	75	Hz	
Non-linearity	-	0.1	-	% FS	

Module Output

PARAMETER	MIN	TYP	MAX	UNT
Update rate (TM171)	780	800	820	Hz
Update rate (TM151)	390	400	410	Hz
Output rate (User configurable)	800 (TM171 Only), 400, 200, 100, 50, 25, 10, 5, 1 * Recommend 921600bps or 1Mbps for UART when 400Hz or higher ODR is requested from UART. * Recommend 460800bps for UART when 200Hz ODR is requested from UART. * When 200Hz or higher ODR is selected, the ImuAssistant GUI application may require higher computer performance to refresh the data in the set frequencies.			Hz
Output format	(1) Roll/Pitch/Yaw (heading), Quaternion, Gravity direction, Calibrated raw sensor data: 3-axis rotation rate, 3-axis linear acceleration sensor reading, 3-axis magnetometer data; (2) Timestamps and sensor status indications.			

	FEATURE NAME	HIGHLIGHTS
Other features	Self-adapting filter	Improve heading accuracy.
	Digital Compass API	Work as a digital compass when API is called.
	Factory Calibration	Fine calibration.
	Run-time static calibration	Remove gyroscope bias when installed on a ground vehicle and when the vehicle is parked even in a noisy environment, such as without stopping the vehicle engine idling.
	Easy debug	Access the sensor with UART and at the same time the USB port can be used to acquire data or connect to the ImuAssistant GUI application and to monitor its output in real-time, logging measured data, or changing sensor configurations.

PERFORMANCE	ROLL	PITCH	YAW	
Resolution	0.01°	0.01°	0.01°	
Angle range	-180° ~ 180°	-90° ~ 90°	0° ~ 360°	
Static accuracy	<0.5°	<0.5°	<1.0° (TM151)	RMS Error[1]
	<0.5°	<0.5°	<0.8° (TM171)	RMS Error[1]
Dynamic accuracy (Inertial)	<1.5°	<1.5°	3.0° error[1,3] every 25 minutes (TM151)	RMS Error[1,2]
	<1.0°	<1.0°	2.6° error[1,3] every 25 minutes (TM171)	RMS Error[1,2]

1. According to test results in mostly laboratory environment, actual performance may vary depending on the motion dynamics.
2. Roll and Pitch error includes error introduced by communication latency at 115200 bps.
3. Typical city car driving dynamic condition, including sharp and slow turning, slopes, with fast and gentle accelerations and traffic light stops.

Software

IMU Assistant	Windows 7, 8, 8.1, 10, 11
Functionally	Sensor configuration, user calibration, data visualization, data recording

⚠ Note: Adjusting the module configuration may cause certain sensor behaviors to differ from what's described in this document. (Some features might be enabled or disabled, which could affect sensor performance.)

3. Pin Definition

The TransducerM TM151 and TM171 share the same mechanical design and connector configuration.

The TransducerM TM151 / TM171 comes with a communication baseboard featuring USB Type-C, pin-through holes, and stamp holes, as shown below. The baseboard's stamp holes are designed for easy soldering and seamless integration onto system circuit boards.

Along the edges at the top and bottom of the baseboard, there is a stamp hole on each of the four corners. By soldering these to the corresponding pads on the system circuit board, they can be used to provide additional mounting support for the TransducerM.

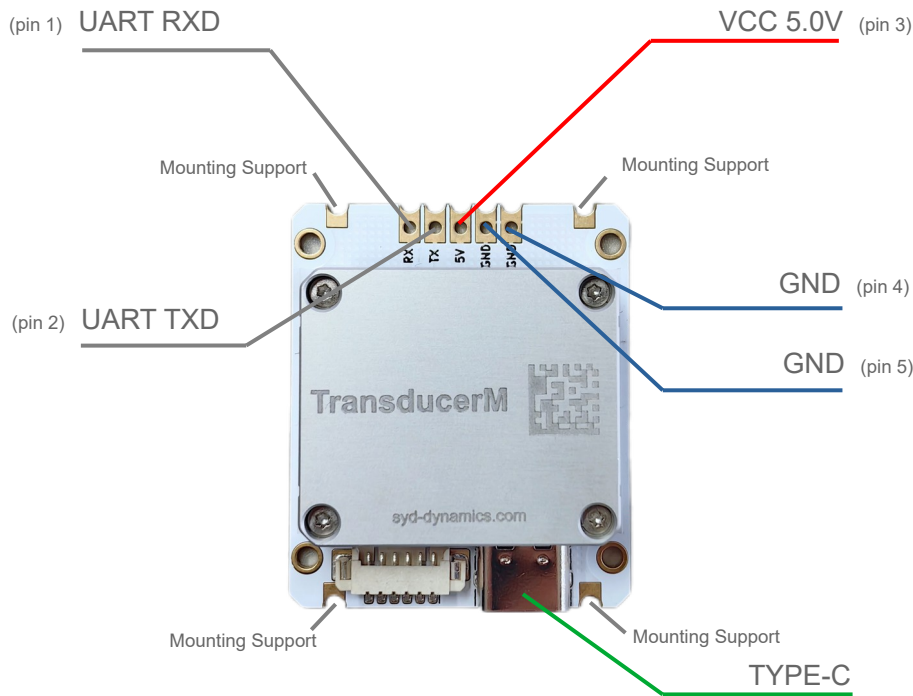**TransducerM TM151 / TM171 Connector Pin Definition:**

Figure 1: TransducerM TM151 / TM171 pins and connectors illustration
(Pins and connectors not notated above are reserved and should be left as default)

The connector pin definition is as follows. For pin numbers, please refer to the illustration above.

TM151 / TM171 Pin definition		
Through-hole pin numbers	**Name**	**Comments**
Pin 1	**RXD**	Serial port RXD running at TTL 3.3V and is compatible with TTL 5.0V. Not immune to electric surge.
Pin 2	**TXD**	Serial port TXD running at TTL 3.3V and is compatible with TTL 5.0V. Not immune to electric surge.
Pin 3	**VCC 5V**	Input voltage range: 4.5V ~ 5.5V, recommend regulated 5V. Not immune to power surge.
Pin 4	**GND**	Digital GND

Pin 5	**GND**	Digital GND. It is internally linked together with Pin 4 and thus Pin 4 and Pin 5 play the same role.
-	**USB Type-C**	USB Type-C Connector. The port is running USB 2.0 Virtual COM Port profile and when connecting to a PC, it appears as a serial COM port. Virtual COM Port Driver: (1) The driver is automatically loaded from kernel module for mainstream Linux OS or alike, such as the Ubuntu OS, and appears as /dev/ttyUSBx or /dev/ttyACMx, this is also the case for most embedded Linux systems. To access the serial port, You may need to add your system users to the dialout group to ensure sufficient permissions to access the serial port normally. For example: sudo usermod -a -G dialout <username> (2) The driver may require automatic search and installation with a Windows PC when connecting the TransducerM for the first time (Internet connection may be required, otherwise search and download the offline driver manually).

⚠ The TransducerM TM151 / TM171 should be handled with care to avoid damage to the ESD-sensitive components. It is important to follow proper static control precautions during installation and use to maintain device integrity and performance.

4. Mechanical Drawing

The following figure shows the 2D mechanical drawing of the TransducerM TM151 / TM171. Unit：millimeter.

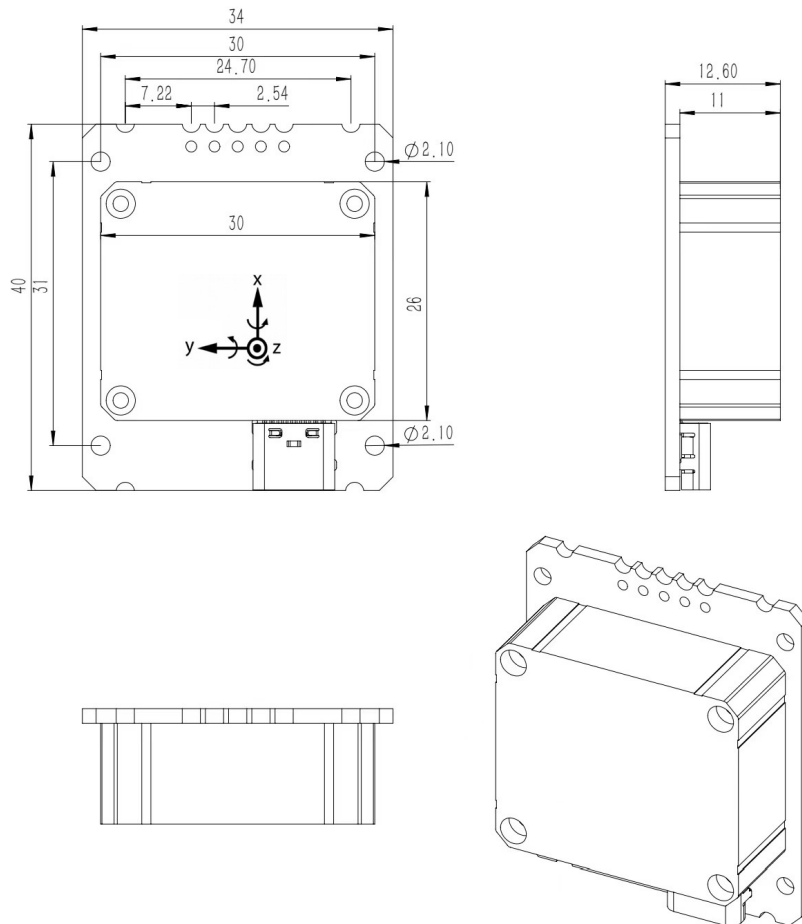The TransducerM TM151 and TM171 share the same mechanical dimension.

Figure 2: TransducerM TM151 / TM171 Mechanical Drawing and Axis Definition
Unit: millimeter