



# MTLT335D

Triple-Redundant 1.3°/h Dynamic Tilt Sensor with CAN Output



The ACEINNA MTLT335 is an easy-to-use high-performance 6-DOF IMU packaged in a rugged sealed over-molded plastic housing. The MTLT335 includes triple-redundant 3-Axis MEMS accelerometers and rate gyros, which are fully calibrated over the full operating temperature range. The processing power is provided by a 168MHz ARM M4 CPU with a Floating Point Unit. An internal Kalman Filter provides gyro-compensated and corrected pitch and roll outputs with Excavator and General Purpose modes. Excavator mode uses rotation as primary indicator for motion detection and general purpose mode uses linear acceleration for motion detection. The MTLT335 has been developed in accordance with the ISO13849 Machine Safety standard, and fulfills the requirements of category 2 as specified in DIN EN ISO 13849-1:2016. It can be used in safety functions up to Performance Level d as specified in DIN EN ISO 13849-1:2016.





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The ACEINNA MTLT335D is designed for use in 12 V and 24 V vehicle platforms. The sealed packaging meets the challenging performance, reliability and cost requirements of the automotive, construction and agriculture vehicle markets. Advanced features allow the axes to be re-assigned by the user to accommodate any mounting orientation. A user accessible rotation matrix is available to adjust for mounting errors. MTLT335D can consume and use Wheel Speed CAN messages available on the CAN bus to further improve accuracy. Supports user lever arm input.



## Applications

- Autonomous Vehicles
- Construction Vehicles
  - Boom, Bucket and Cab Attitude
- Agriculture Vehicles and Implements
- Forklifts
- Self-Driving Taxis / Delivery Vehicles
- Robotics Control / Feedback
- Antenna / Camera Gimballing and Stabilization



## Features

- 0.1° accuracy over temperature and angle
- 6DOF IMU and Dynamic Inclination
- Triple redundant sensors with fault detection
  - Precision 3-axis MEMS Accelerometers
  - Low-Drift 3-axis MEMS angular rate sensors
- CAN 2.0 J1939 and RS232 Interfaces
- Built in 16-State EKF algorithm for pitch/roll
  - Excavator Mode
  - General Purpose mode
- Wide Temp Range, -40C to +85C
- Wide Supply Voltage Range, 9 V – 32 V
- IP67 Ampseal 16 6P Connector
- Fulfills ISO 13849-1:2016
  - DC > 68%
  - MTTFd > 500 years
- Field Upgradable
- 1PPS in (CAN Only)

This product has been developed exclusively for commercial applications. It has not been tested for, and makes no representation or warranty as to conformance with, any military specifications or its suitability for any military application or end-use. Additionally, any use of this product for nuclear, chemical or biological weapons, or weapons research, or for any use in missiles, rockets, and/or UAV's of 300km or greater range, or any other activity prohibited by the Export Administration Regulations, is expressly prohibited without the written consent and without obtaining appropriate US export license(s) when required by US law. Diversion contrary to U.S. law is prohibited. Specifications are subject to change without notice.





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## Performance Specification

Ta = 25°C, VDC = 12 V, unless otherwise stated

Angular Rate	MIN	TYP <sup>2</sup>	MAX
Range (°/s)	-400		+400
Bias Instability (°/hr) <sup>1</sup>		1.3	
Bias Stability over Temp (°/s)		0.1	
Scale Factor Accuracy (%FSR)		0.1	
Cross-Axis Error (%FSR)		0.1	
Non-linearity Error (%FSR)		0.1	
Angle Random Walk (°/√hr) <sup>1</sup>		0.15	
Configurable Bandwidth (Hz)	5		50
Acceleration	MIN	TYP <sup>2</sup>	MAX
Range (g)	-8		+8
Bias Instability (μg) <sup>1</sup>		20	
Bias Stability over Temp (mg)		1.3	
Scale Factor Accuracy (%FSR)		0.1	
Cross-Axis Error (%FSR)		0.1	
Linearity Error (%FSR)		0.1	
VRW (m/s/√hr) <sup>1</sup>		0.02	
Configurable Bandwidth (Hz)	2		50
Pitch / Roll	MIN	TYP <sup>2</sup>	MAX
Pitch Angle Range (°)	-70		+70
Roll Angle Range (°)	-180		+180
Angle Accuracy over Temp (°) <sup>3</sup>		0.05	
Angle Accuracy over Angle Range (°) <sup>4</sup>		0.05	

Note 1: Allan variance curve, constant temperature

Note 2: Typical values are 1-sigma values unless otherwise noted

Note 3: RMS deviation from 25C value (Pitch and Roll = 0 degrees)

Note 4: RMS error over entire angle operating range

## Electrical Specifications

Characteristic	Specification
Input voltage	9 – 32 V
Over voltage	36 V
Reverse voltage	-36 V
Current	40 mA @ 12 V Typ
Power	500 mW Typ
Reset response	Automatic after voltage dropout
Start-up time	<2 seconds
Max Output Data Rate	100 / 200 Hz (CAN / Serial)
CAN Baud rate	250k – 1M
RS232 Baud Rate	38400 – 230400

## Physical Specifications

Characteristic	Specification
Dimensions	65 x 66 x 27 mm
Weight	< 75 g
Interface Connector	Ampseal 16 – 6 Position IP67
Mating Connector	TE Connectivity 776531-1

## Environmental Specifications

Characteristic	Specification
Operating Temperature	-40 – 85 °C
Storage Temperature	-40 – 85 °C
Ingress Protection	IP69K, (IP67 Mated)

## Qualification Plan Summary (Not inclusive of all tests)

Electrical Loads	DUTs	Op Mode <sup>3</sup>	Function Class <sup>3</sup>	Summary
Over Voltage (V)	3	3.2	A	SAE J1455 4.13.1: 36 V, 1 hour
Reverse Voltage (V)	3	1.1	C	SAE J1455 4.13.1: -36 V, 5 minutes
Short Circuit	3	3.2	C	ISO167507-2 4.10.2: Signal Circuits
Starting Profile	3	3.2	A	ISO16750-2 4.6.3: 10 pulses, 24 V System, Level 2
Load dump	3	3.2	A	5 pulses, 56V, 90 s pulse rate; 95 pulses 56V 120 s pulse rate
Reset Behavior at Voltage Drop	3	3.2	B	ISO 16750-2 4.6.2
Mechanical Loads				
Vibration Swept Sine	4	3.2	A	5 – 500 Hz; <10 Hz Displacement = ± 12 mm; >10 Hz = 5 g Pk
Vibration Random	4	3.2	C	5 – 2000 Hz; 15.35 g RMS, 48 hrs/axis
Mechanical Bump	4	3.2	C	100 bumps x 3 axis/DUT (600 Total/DUT) 400m/s <sup>2</sup> , ½ sine, 6 ms pulse
Mechanical Shock	4	3.2	C	3 Shocks x 3 axis x 2 directions (18 total) 981m/s <sup>2</sup> , ½ sine, 11 ms pulse
Mechanical Drop	2	1.1	C	1 m to steel plate, 1 drop x 3 axis x 2 directions (6 total)

Note 3: ISO 16750-1 Operation Mode and Function Class definition



### EMC Specifications

Characteristic	Standard	Test Level / Frequency	
ESD direct contact discharge	ISO 10605	8 kV - Function Class A, Reference Limits IV	
ESD air discharge	ISO 10605	15 kV - Function Class A, Reference Limits IV	
Radiated Immunity Stripline	ISO 11452-5	200 V/m, 0.5 – 250 MHz	
Radiated Immunity ALSE	ISO 11452-2	200 – 1000 MHz	125 V/m
		1000 – 2000 MHz	40 V/m
		2000 – 2400 MHz	15 V/m
		2400 – 2700 MHz	10 V/m
EMC Conducted Transmission	ISO 16750-2; ISO 7637	24V Parameters, Pulse 1, 2a, 2b, 3a, 3b,, 4, 5b	

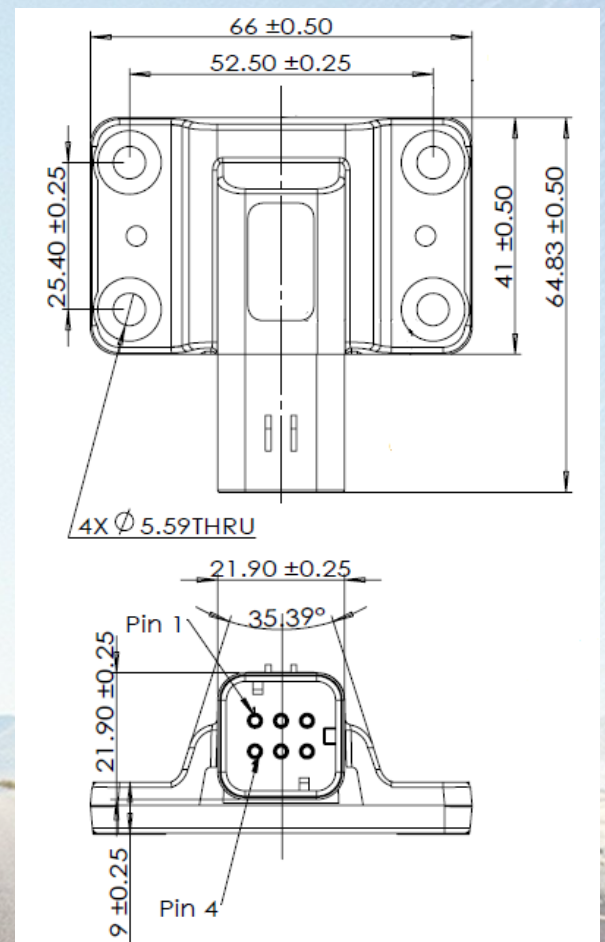
### Tools and Support

- NAV-VIEW provides a free, easy to use software evaluation tool, which includes a graphical user interface to display, record, playback and analyze MTLT335 sensor data using your PC.
- NAV-VIEW can also be used to set and experiment with a wide range of user configuration parameters, to optimize system performance for different applications.
- NAV-VIEW is available for download at [www.aceinna.com/support](http://www.aceinna.com/support) (see manuals)

### Connector Pin Definition

Pin #	Signal
1	CAN H
2	CAN L
3	Gnd
4	RS-232 RX
5	RS-232 TX
6	Power

### Dimensioned Drawing (MTLT335D) mm



### Ordering Information

Part Ordering Information	
Rugged High-Performance IMU / Tilt Sensor	
MTLT335D	6DOF IMU/VG in Plastic/Over molded Housing
MTLT305 Cable	Mating Connector with flying leads