ADMA

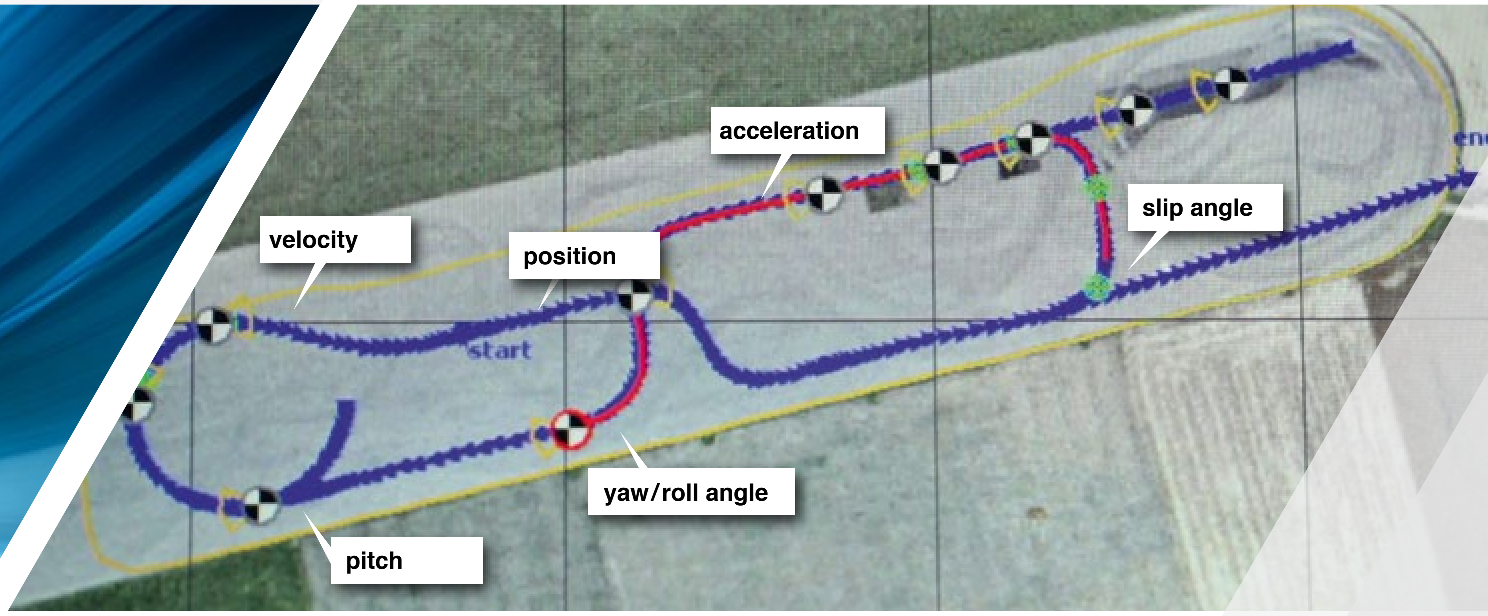
Automotive Dynamic Motion Analyzer with 1000 Hz

State of the art:
ADMA GPS/Inertial System for vehicle dynamics testing

ADMA Applications

The strap-down technology ensures that the ADMA is stable and resistant to unwanted vibration during use. This means the ADMA is very well suited for evaluation of Vehicle Dynamics and Driver Assistance Systems.

The ADMA system is successfully used for Motorsports, Driverless Systems and Construction Machines. It is proven itself in the areas of Route, Track Wear and Railway measurements.



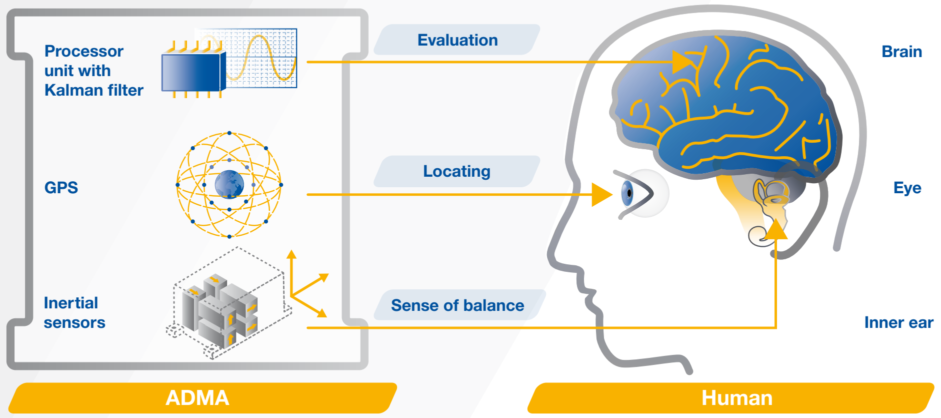
What is ADMA?

ADMA stands for **A**utomotive **D**ynamic **M**otion **A**nalyzer. This acronym refers to our highly precise Inertial Measurement Unit (IMU) using DGPS (Differential Global Positioning System). The system was developed particularly for Vehicle Dynamics Testing in the automotive sector. The Genesys ADMA system allows for constant measurement of acceleration, speed and position of moving vehicles in all three dimensional axes. Pitch, roll and course angles can be continuously and precisely measured with ADMA as well as course and side-slip angles as well as angular rates. This makes GeneSys ADMA system the best choice where challenging measurements with maximum accuracies are required.

How does it work?

Thanks to a keen sense of balance, humans orientate themselves very quickly and control their movements with extreme accuracy.

ADMA is based on this same principle. Like the inner ear, the accelerometers of the inertial platform measure linear motion and create a reference to gravitational acceleration. Three orthogonally positioned gyroscopes sense the rotational motion. From this, speed, location and spatial position are calculated in real-time by the signal processor via Kalman filter with centimeter precision.
Potential sensor drift is compensated for by using GNSS (Global Navigation Satellite System, e.g. GPS). This is similar to visual information in support of sense of balance, of humans. In this regard, it does not make any difference if the GNSS signal is disturbed or briefly interrupted. As such, the acceleration dependency and high data latency of the GNSS signals do not have any significant impact on the measurement.



The function of ADMA corresponds to the human sense of balance.

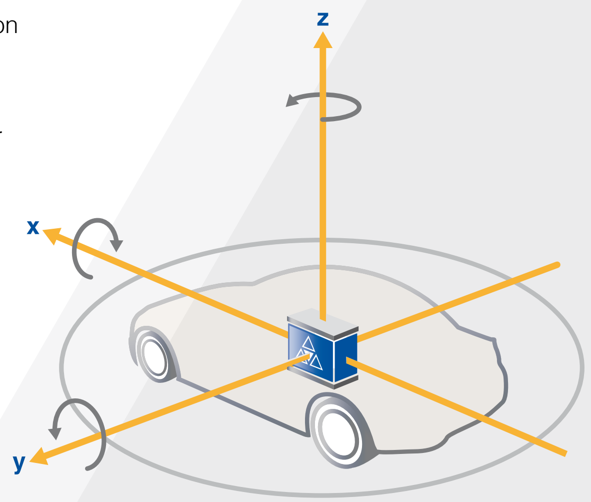
The Measurement System

Inertial technology corrected by GPS

The algorithms used by the ADMA have been optimized for vehicle dynamics testing like slalom and steady-state circular testing. Even the Earth's gravitational acceleration and rotation are taken into account. Due to the fact that the ADMA has no moving parts, the systems are fault-tolerant. So reliability and robustness are assured.

Our latest ADMA 3.0 generation also uses the CAN bus or Ethernet interface to output the data. This guarantees easy and reliable operation and data synchronization utilizing conventional data acquisition systems.

- At the heart of ADMA are three gyroscopes, all recording rotational motion in space.
- The gyro system also includes three accelerometers to record linear movements.
- Absolute position is accurately determined by an internal GNSS receiver by means of WAAS or RTK DGNSS correction. All components for DGNSS data acquisition are included. If required, the ADMA system is also available with an external GNSS receiver.
- Inertial sensor signals and GNSS information are applied by an integrated processor unit featuring DSP and FPGA to continuously determine the orientation angle, speed and position.



ADMA highlights

- Data output rate up to 1000 Hz
- Data output via 5 CAN bus interfaces and Ethernet
- Configuration via Ethernet
- Forwarding of GNSS correction data and relative data calculation (e.g. distance) via WiFi in real-time for multi-vehicle operation
- GNSS synchronized DAQ synchro-nization signal, high clock frequency
- Inputs for the recording of analog signals
- Output of GNSS raw data via Ethernet interface
- Indoor GNSS interface
- Dual GNSS antenna option
- Data latency < 1 ms
- Compatible with all common steering and driving robots

ADMA features

- Measurement of vehicle motion in three axes, even during GNSS signal loss
- Dynamic attitude and heading angle determination
- Precise acceleration, speed and position data due to extended Kalman filter
- Precise position data with integrated WAAS/EGNOS-DGNSS receiver (< 1 m)
- High precision position data (2 cm) with internal RTK2 DGNSS receiver and GNSS Base Station
- Robust inertial sensors and strapdown technology without moving parts

Our Products for any Requirements

The ADMA models differ in performance of the applied inertial sensors. Higher precision sensors are less sensitive to GNSS interferences or outages. All models are available with variable GNSS accuracy, ranging from simple L1 receivers with meter accuracy to L1/L2 RTK receivers with centimeter accuracy. Our gyro systems do not require an export license.

▲ ADMA-G-PRO+

The fiber-optic gyro system with three fiber-optic rotation rate sensors and three servo acceleration sensors class 1 mg provides high-precision data even in the case of strong GNSS interferences. Complies with all international test standards.

▲ ADMA-G-ECO+

Even in the event of slight GNSS interferences, this economic model precisely records all movements according to international standards thanks to fiber-optic rotation rate sensors and servo acceleration sensors class 1 mg.

▲ ADMA-G-ECO

This system corresponds to ADMA-G-Eco+, however, it is equipped with MEMS class 5 mg accelerometers

▲ ADMA-G-EntryLevel+

Thanks to the applied sensor technology, this cost-efficient model provides the same look and feel as the standard version. It is recommended for vehicle dynamics testing with predominantly undisturbed GPS reception.

▲ ADMA-G-EntryLevel

This system corresponds to ADMA-G-EntryLevel+, however, is equipped with MEMS class 5 mg accelerometers.

▲ ADMA-Speed

Similar performance as ADMA-G-EntryLevel. Easy installation due to inertial sensors and GNSS antenna in a single housing.

▲ ADMA-Slim

Similar performance as ADMA-G-EntryLevel. Miniaturised version.

Please refer to the comparison chart on page 8/9.

ADMA Fields of Application

Applications	ADMA-G-PRO+	ADMA-G-ECO+	ADMA-G-ECO	ADMA-G-EntryLevel+	ADMA-G-EntryLevel	ADMA-Speed	ADMA-Slim
General vehicle dynamics testing	✓	✓	✓	✓	✓	✓	✓
Vehicle dynamics testing according to test standards e.g. ISO lane change	✓	✓	✓				
Determination of track deviation	✓	✓	✓	✓	✓	✓	✓
Sideslip angle measurement	+++	++	++	+	+	+	+
Braking/Acceleration measurement	✓	✓	✓	✓	✓	✓	✓
Chassis tuning	+++	++	++	+	+	+	+
Validation of driver assistance systems, e.g. ACC, FCW, AEB (VRU, Car2Car), LSS (LDW, LKA)	+++	++	++	+	+	+	+
Assessment of inertial sensors	✓	✓	✓	✓	✓	✓	✓
ABS/ESP ISO 26262 certification	✓	✓	✓	✓	✓	✓	✓
Driving comfort analysis	✓	✓	✓	✓	✓	✓	✓
Validation of simulation models	+++	++	++	+	+	+	+
Navigation of steering robots	✓	✓	✓	✓	✓	✓	✓
Road survey	✓						
Track analysis (e.g. for PEMS)	✓						
Test drives on public roads. Validation of autonomous driving Level 1 to 5, Platooning	✓						
Robustness against GNSS interference	+++	++	++	+	+	+	+

ADMA-options – extending capabilities

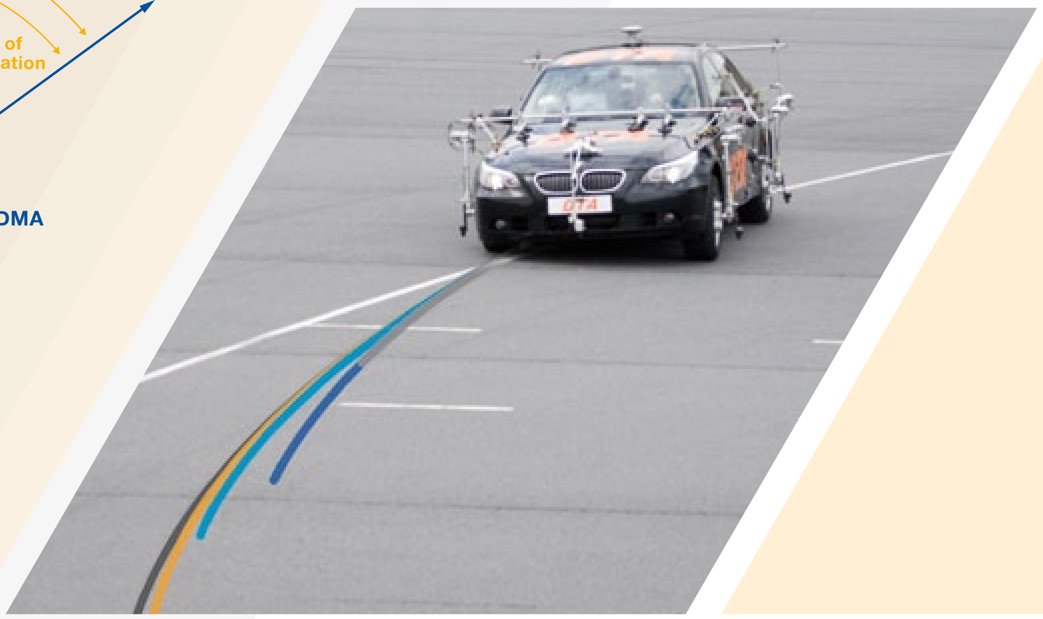
With ADMA3 product family we are proud to have established new functions, driven by the customer's requirements.

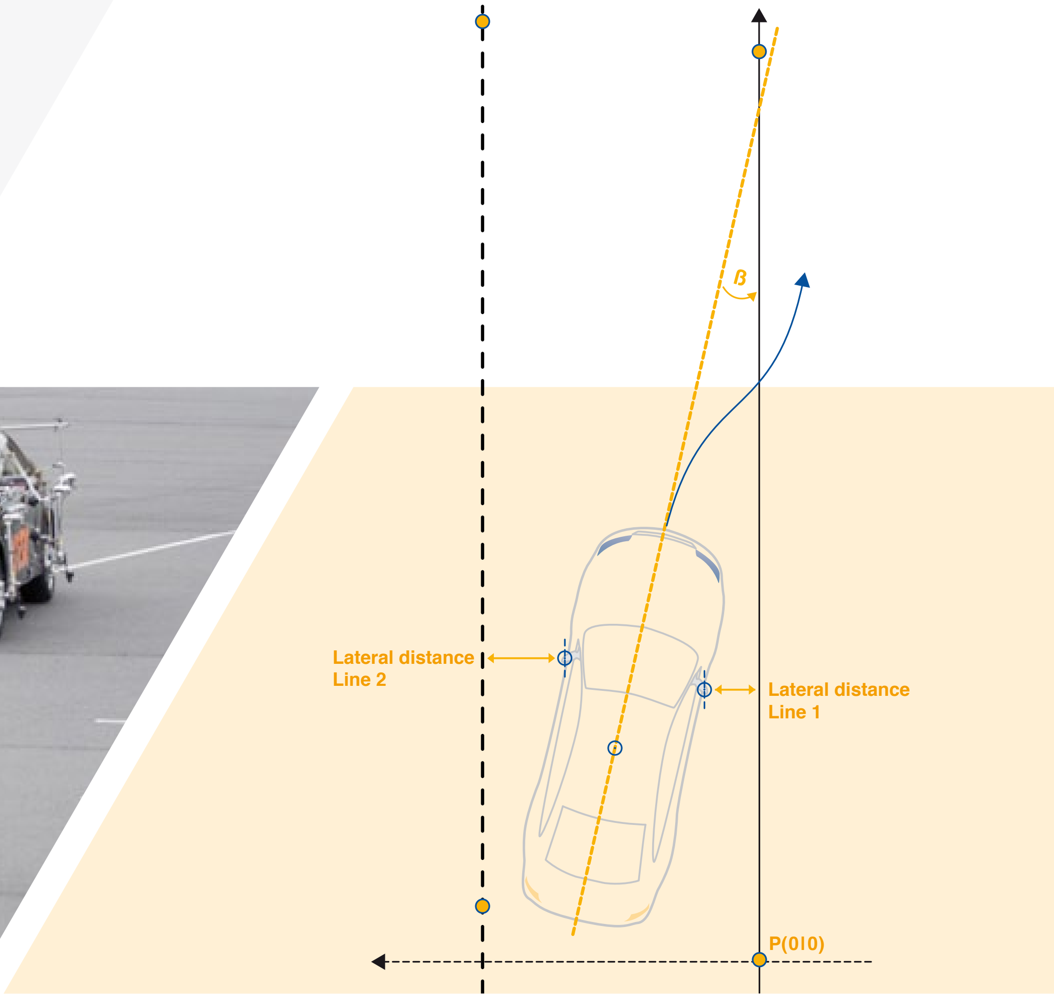
The goal is to improve the usability and to increase the productivity.

We have created firmware options, called ADMA Add-Ons. The options are activated by upload of a license code to the ADMA.

The license upload can be done at any instant giving the highest degree of flexibility.


DELTA option





Overview

▲ DELTA option

Relative data calculation (e.g., distance) via WiFi in real-time for multi-vehicle operation
The "DELTA" option enables the direct output of relative data between two vehicles, for example distance, velocity and angle. Other than a WiFi connection between the two ADMAs, no additional hardware is required. Data is provided in real time with minimum latency. This option is widely used for ADAS tests, especially AEB, FCW and ACC. Our customers rely on the ADMA option both when establishing a precise distance reference and for distance control of steering robots.

DELTA option is available for all ADMA models.

▲ BRAKING option

Real-time calculation of brake performance data according to international regulations
The "Braking" option is the sophisticated solution for brake performance measurement. Enabling brake pedal triggered as well as velocity threshold triggered measurement, all relevant parameters, including mean deceleration, brake distance and trigger speed are provided. Both full brake and fading test are supported.

BRAKING option is available for all ADMA models.
For ADMA-Speed it is included, even in the basic version.


BRAKING option Ethernet Logger software

The **GeneSys Ethernet Logger software** includes acoustic driver guidance features and is provided free of charge. Running on a Laptop or Tablet PC, it allows for real time monitoring of measured parameters. All braking results can be stored both as a result chart and a full data stream.

▲ DGPS option

Correction data via Ethernet
The "DGPS" option provides the capability to receive DGNSS correction data forwarded from several ADMAs via WiFi. This is the preferred option for multi-vehicle applications, e.g., LSS, ACC, AEB and FCW testing.
This option is used in place of radio modems, increasing the availability of DGNSS correction data, especially on public roads.

DGPS option is available for all ADMA models.

▲ GPS-RAW option

Output of GPS raw data via Ethernet interface
The "GPS-RAW" option provides raw GNSS data via Ethernet connection. GNSS raw data is required to improve GNSS accuracy in post processing, for instance with our ADMA-PP post processing engine. We provide Ethernet logger software free of charge which can be used to record the data.

GPS-RAW option is available for all ADMA models.

NEW!

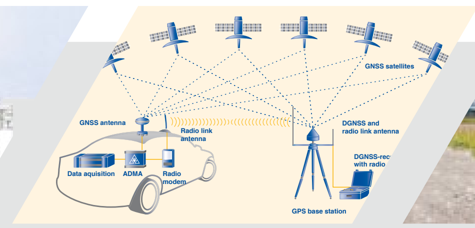
▲ LATDEV option

Real-time calculation of lateral deviation.
The Addon LATDEV is used to test and validate lane departure warning systems (LDW/LSS systems).
It calculates the distance to two predefined straight lines, a fixed object, angle to the straight lines, the lateral speed and acceleration in real time, related to three user defined POIs (Point of Interests).

LATDEV option is available for all ADMA models.


Brake test


DGPS correction on public roads




GNSS RAW data logging for precise positioning

System	ADMA-G-PRO+	ADMA-G-ECO+	ADMA-G-ECO	ADMA-G-EntryLevel+	ADMA-G-EntryLevel
GYROS					
Quantity/Type	3 closed-loop fiber optic gyros	3 open-loop fiber optic gyros	3 open-loop fiber optic gyros	3 MEMS gyros	3 MEMS gyros
Measurement range	± 320 °/s	± 200 °/s	± 200 °/s	± 100 °/s	± 100 °/s
Resolution roll/pitch/yaw	0.00004 °/s	0.0012 °/s	0.0012 °/s	0.004 °/s	0.004 °/s
Bias variation over temperature range	better than 6 °/h, optional 1 °/h	0.005 °/s / °C	0.005 °/s / °C	0.025 °/s / °C	0.025 °/s / °C
In-run-bias typically	0.1 °/h	1 °/h	1 °/h	4 °/h	4 °/h
Gyro noise typically	0.12 °/√h	0.08 °/√h	0.08 °/√h	0.15 °/√h	0.15 °/√h
Scale factor accuracy	better than 0.1 %, typ. 0.05 %	better than 0.1 %	better than 0.1 %	better than 2 %, typ. 0.7 %	better than 2 %, typ. 0.7 %
Sensor bandwidth	8000 Hz	1000 Hz	1000 Hz	60 Hz	60 Hz
ACCELEROMETERS					
Quantity/Type	3 servo accelerometers	3 servo accelerometers	3 MEMS accelerometers	3 servo accelerometers	3 MEMS accelerometers
Measurement range	± 5 g	± 5 g	± 2 g	± 5 g	± 2 g
Measurement accuracy (without Kalman filter corrections)	better than 1 mg	better than 1 mg	better than 5 mg	better than 1 mg	better than 5 mg
In-run-bias typically	10 µg (1 σ)	10 µg (1 σ)	10 µg (1 σ)	10 µg (1 σ)	10 µg (1 σ)
Scale factor stability	0.015 % (1 σ)	0.015 % (1 σ)	0.025 % (1 σ)	0.015 % (1 σ)	0.025 % (1 σ)
Measurement resolution digitized	100 µg	100 µg	250 µg	100 µg	250 µg
Sensor bandwidth	500 Hz	500 Hz	200 Hz	500 Hz	200 Hz
GPS-RECEIVER					
Position accuracy (DGNSS receiver RMS dependent)	0.01 / 0.2 / 0.4 / 0.6 / 1.2 / 1.5 m (depending on license model and DGNSS corrections)	0.01 / 0.2 / 0.4 / 0.6 / 1.2 / 1.5 m (depending on license model and DGNSS corrections)	0.01 / 0.2 / 0.4 / 0.6 / 1.2 / 1.5 m (depending on license model and DGNSS corrections)	0.01 / 0.2 / 0.4 / 0.6 / 1.2 / 1.5 m (depending on license model and DGNSS corrections)	0.01 / 0.2 / 0.4 / 0.6 / 1.2 / 1.5 m (depending on license model and DGNSS corrections)
Data update rate	up to 50 msec (internally interpolated from 20 to 2,5 msec. optional 1 msec)	up to 50 msec (internally interpolated from 20 to 2,5 msec. optional 1 msec)	up to 50 msec (internally interpolated from 20 to 2,5 msec. optional 1 msec)	up to 50 msec (internally interpolated from 20 to 2,5 msec. optional 1 msec)	up to 50 msec (internally interpolated from 20 to 2,5 msec. optional 1 msec)
WAAS/EGNOS-DGNSS-correction	via satellite	via satellite	via satellite	via satellite	via satellite
DGNSS- or RTK2-DGPS-correction	via NTRIP-/ RF Modem or Ethernet (optional)	via NTRIP-/ RF Modem or Ethernet (optional)	via NTRIP-/ RF Modem or Ethernet (optional)	via NTRIP-/ RF Modem or Ethernet (optional)	via NTRIP-/ RF Modem or Ethernet (optional)
Satellite tracking	GNSS single antenna (standard)	GNSS single antenna (standard)	GNSS single antenna (standard)	GNSS single antenna (standard)	GNSS single antenna (standard)
GLONASS / Galileo / BeiDou / L-Band	optional	optional	optional	optional	optional
Dual antenna version	optional	optional	optional	optional	optional
COMPLETE SYSTEM					
Angle Measurement range heading/roll/pitch	± 180 / 60 / 60 °	± 180 / 60 / 60 °	± 180 / 60 / 60 °	± 180 / 60 / 60 °	± 180 / 60 / 60 °
Angle Measurement accuracy roll & pitch/ heading/sideslip	0.01 (1 σ) / 0.015 (1 σ) / 0.05 ° RMS	0.01 (1 σ) / 0.025 (1 σ) / 0.1 ° RMS	0.015 (1 σ) / 0.025 (1 σ) / 0.1 ° RMS	0.015 (1 σ) / 0.05 (1 σ) / 0.15 ° RMS	0.02 (1 σ) / 0.05 (1 σ) / 0.15 ° RMS
Angle resolution	0.005 °	0.005 °	0.005 °	0.005 °	0.005 °
Velocity accuracy*	0.03 km/h RMS	0.03 km/h RMS	0.04 km/h RMS	0.04 km/h RMS	0.05 km/h RMS
Lateral velocity*	0.05 % RMS	0.1 % RMS	0.15 % RMS	0.15 % RMS	0.2 % RMS
GNSS outage position error*	after 10 / 30 / 60 sec: 0.1 / 0.6 / 2.0 m RMS	after 10 / 30 / 60 sec: 0.2 / 1.2 / 5.0 m RMS	after 10 / 30 / 60 sec: 0.3 / 2.5 / 10.0 m RMS	after 10 / 30 / 60 sec: 0.3 / 4.0 / 30.0 m RMS	after 10 / 30 / 60 sec: 0.4 / 5.0 / 40.0 m RMS
GNSS outage velocity error*	after 10 / 30 / 60 sec: 0.01 / 0.03 / 0.07 m/sec RMS	after 10 / 30 / 60 sec: 0.03 / 0.12 / 0.25 m/sec RMS	after 10 / 30 / 60 sec: 0.04 / 0.2 / 0.4 m/sec RMS	after 10 / 30 / 60 sec: 0.05 / 0.4 / 1.2 m/sec RMS	after 10 / 30 / 60 sec: 0.06 / 0.5 / 1.8 m/sec RMS
GNSS outage pitch/roll angle error*	after 10 / 30 / 60 sec: 0.00 / 0.01 / 0.02 ° RMS	after 10 / 30 / 60 sec: 0.01 / 0.02 / 0.03 ° RMS	after 10 / 30 / 60 sec: 0.02 / 0.03 / 0.06 ° RMS	after 10 / 30 / 60 sec: 0.03 / 0.10 / 0.25 ° RMS	after 10 / 30 / 60 sec: 0.05 / 0.15 / 0.35 ° RMS
GNSS outage heading angle error*	after 10 / 30 / 60 sec: 0.01 / 0.01 / 0.02 ° RMS	after 10 / 30 / 60 sec: 0.03 / 0.1 / 0.2 ° RMS	after 10 / 30 / 60 sec: 0.05 / 0.15 / 0.3 ° RMS	after 10 / 30 / 60 sec: 0.1 / 0.2 / 0.4 ° RMS	after 10 / 30 / 60 sec: 0.1 / 0.3 / 0.5 ° RMS
Axis misalignment	< 1 mrad	< 1 mrad	< 1 mrad	< 1 mrad	< 1 mrad
Initial heading alignment	with internal GNSS receiver or by manual input, northfinding function on request	with internal GNSS receiver or by manual input	with internal GNSS receiver or by manual input	with internal GNSS receiver or by manual input	with internal GNSS receiver or by manual input
Interface	3 x Ethernet, 5 x CAN, 2 x RS232	3 x Ethernet, 5 x CAN, 2 x RS232	3 x Ethernet, 5 x CAN, 2 x RS232	3 x Ethernet, 5 x CAN, 2 x RS232	3 x Ethernet, 5 x CAN, 2 x RS232
Data update rate/calculation latency	50 - 1000 Hz / 1 ms	50 - 1000 Hz / 1 ms	50 - 1000 Hz / 1 ms	50 - 400 Hz (1000 Hz optional) / 1 ms	50 - 400 Hz (1000 Hz optional) / 1 ms
Sync output	4 TTL, galvanically isolated	4 TTL, galvanically isolated	4 TTL, galvanically isolated	4 TTL, galvanically isolated	4 TTL, galvanically isolated
Event input (e.g. for lap index)	4 TTL, galvanically isolated or analogue 16 bit	4 TTL, galvanically isolated or analogue 16 bit	4 TTL, galvanically isolated or analogue 16 bit	4 TTL, galvanically isolated or analogue 16 bit	4 TTL, galvanically isolated or analogue 16 bit
Input for GNSS antenna and radio link for DGPS corrections	✓	✓	✓	✓	✓
Speed input	2 x (Vx, Vy), analogue 16 bit or TTL pulse	2 x (Vx, Vy), analogue 16 bit or TTL pulse	2 x (Vx, Vy), analogue 16 bit or TTL pulse	2 x (Vx, Vy), analogue 16 bit or TTL pulse	2 x (Vx, Vy), analogue 16 bit or TTL pulse
Barometric sensor input	TTL pulse	TTL pulse	TTL pulse	TTL pulse	TTL pulse
Interface for internal software upgrade	✓	✓	✓	✓	✓
Power supply	12 VDC nominal (9 - 32 VDC) max. 25 W	12 VDC nominal (9 - 32 VDC) max. 25 W	12 VDC nominal (9 - 32 VDC) max. 25 W	12 VDC nominal (9 - 32 VDC) max. 25 W	12 VDC nominal (9 - 32 VDC) max. 25 W
Dimensions (W x L x H)	110 x 170 x 197 mm	110 x 170 x 197 mm	110 x 170 x 197 mm	110 x 170 x 197 mm	110 x 170 x 197 mm
Weight	3.3 kg	3.2 kg	3.2 kg	3.2 kg	3.2 kg
Temperature range	-20 to +60 °C	-20 to +55 °C	-20 to +55 °C	-20 to +60 °C	-20 to +60 °C

*typical values according to internal test standards with settled Kalman filter. Technical data ADMA-Slim/ADMA-Speed on page 12/16.

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