

iNAT-M200-FLAT & -OEM

Ultra Flat Precise MEMS Based Inertial Navigation System with Loosely or Tightly Coupled INS/GNSS Data Fusion

iNAT-M200/SLN is a member of the advanced iNAT series (iMAR Navigation and Timing) and one of the smallest powerful MEMS based INS/GNSS inertial navigation, measurement, surveying and control systems on the market for applications on the surface (land/sea) and in the air. It provides all kinematic measurements like acceleration, angular rate, attitude, true heading, velocity and position of the target vehicle in real-time with an data update rate of up to 500 Hz.



- robust, compact, miniature, light weight system, 550 grams with enclosure (-FLAT), down to 320 grams w/o enclosure (-OEM)
- based on high grade MEMS gyro & accel technology and up to L1/L2 GNSS with optional dual-antenna heading and RTK support
- GPS, GLONASS, BeiDou; GALILEO prepared
- odometer / wheel sensor aiding capability
- output of angular rate, acceleration, attitude, true heading, CoG, velocity and position in realtime with up to 500 Hz (adjustable)
- several processing modes: Standard mode with 1 m position accuracy and RTK mode with 0.02 m position accuracy
- interfaces: UART RS232 & RS422 / CAN / Ethernet for realtime data output and RS232 for DGPS/RTK correction input; minimum latency
- up to 32 GByte internal memory ("black-box")
- easy to use, easy to configure; powerful GUI

Depending on the application and required realtime accuracy (1 m GNSS or 2 cm RTK with correction data), data fusion methods can be as follows:

Air or Sea or Land, with or w/o RTK resp. postproc: loosely coupling	Air or Land without RTK resp. with or w/o post-proc: tightly coupling	Most difficult environment, urban canyons and with RTK: tightly coupling
iNAT-M200-x/SLN	iNAT-M200-x/STN	iNAT-M200-x/STN

In urban canyons often the number of observable satellites is quite limited and therefore the iNAT-M200-FLAT/STN and iNAT-M200-OEM/STN support a tightly coupled data fusion which also improves the accuracy of the inertial solution if even less than 4 satellites (down to 1 satellite) are available. This processing provides a significant better and more robust position and velocity result compared to a standard loosely coupled GNSS solution.

For land vehicles additionally an odometer aiding capability is available as an option, the scale factor of the wheel sensor is estimated automatically.

The iNAT-M200-FLAT/SLN provides system performance and system reliability which is required in standard tasks of navigation, guidance and control, mapping, vehicle motion dynamics testing, trajectory surveying and platform control tasks for cars, trucks, naval vessels, civil and military aircrafts etc.

The iNAT-M200-OEM provides the same electronics and features, but comes without any enclosure. As an option this version can be supplied with additional vibration isolators (two versions available, i.e. long or wide body, see figure) for extreme environmental requirements.

The iNAT-M200 is delivered with the MS Windows (or LINUX or MacOS alternatively) based configuration software iXCOM-CMD. This software allows to configure the output interfaces, furthermore all output data can be displayed and stored online on the user's notebook,



tablet or process computer. It also allows powerful playback capabilities and provides data export in many formats (csv, xml, GoogleEarth, InertialExplorer, GrafNav). With iREF-GNSS, iMAR also provides a GNSS reference station to provide RTK corrections for centimeter level accuracy on demand.

A powerful postproc software is available to allow post-mission processing including a multi station GNSS correction data solution and a direct visualisation of the results in Google Earth™.



Technical Data iNAT-M200-FLAT/SLN, iNAT-M200-OEM/SLN (typical, rms):

	Rate	Acceleration	Attit./Heading	Position	Velocity	Height
Range ¹ :	± 400 °/s	± 10 g (opt. 30 g)	unlimited	unlimited	515 m/s	unlimited
Bias Stability (AV):	< 0.5 °/h	< 0.06 mg			(higher speed requires export license)	
Bias (filtered ²):	3 °/h	< 1.5 mg				
Bias day-to-day ³ :	< 0.07 °/s	< 6 mg				
Angles (Attitude, Hdg.):			0.03° / 0.1° RP/Y (INS / GNSS) ⁵ 0.05° / 0.12° RP/Y (after 10 s GNSS outage) ⁵ 0.1 deg heading for 2 m baseline in dual-antenna setup (/SLN-DA) ²			
Position (horizontal plane) ⁴ :				+/- 0.1 m CEP (INS/GNSS RTK real-time) ⁵ +/- 0.03 m CEP (INS/GNSS RTK post-proc) ⁵ +/- 0.4 m CEP (INS/GNSS with SBAS) +/- 1.8 m CEP (INS/GNSS) 0.1 % of DT CEP (with VMS, during GNSS outages) ⁶		
Velocity:					0.05 m/s (INS/GNSS)	
Noise:	0.15 °/sqrt(hr)	60 µg/√Hz	0.03 °	< 0.01 m	< 0.01 m/s	
Resolution:	< 0.0001 °/s	< 10 µg	0.001 °	< 0.001 m	< 0.001 m/s	
Linearity error:	< 0.01 %	< 0.05 %	< 0.1 %			
Scale factor error:	< 0.1 %	< 0.1 %	< 0.1 %			
INS / GNSS / ODO proc.: Internal GNSS Engine:	integrated advanced 42+ state INS/GNSS/+ extended Kalman filter data fusion version /SLN: up to L1L2 GPS+GLONASS, Beidou, SBAS, QZSS, RTK (Galileo option); high speed range version (< 515 m/s) available as option (iNAT-M200-xxx/SLN-HRS, requires export license)					
Data Processing Rate:	up to 500 Hz; PPS timing accuracy better 10 ns					
Data Output Rate:	integer divisor of 500 Hz; all data available in real time, latency < 3 ms, jitter < 1 ms					
Synchronisation:	PPS_OUT (RS422 level, latency < 1 µs); 2x EVENT_IN (RS422 or TTL level, latency < 3 ms)					
Output (options):	2 x CAN, 4 x UART RS232/422, Ethernet 100 Mbit/s, NMEA183, ARINC825, TCP/IP, UDP; NTRIP caster with RTCM 104 rev 3 (can serve as a GNSS reference station); PTP / NTP Time Server (since HW rev. 4)					
Inputs:	DGPS/RTK correction data from base station, if available (RS232); odometer (A or A/B at RS422 level) as an option					
EMI/EMC Protection:	galvanic insulated voltage input stage with surge and over-voltage protection; I/O ESD protection					
Connectors:	iNAT-M200-FLAT: LEMO EGG / EGJ Series, SMA (antennas) iNAT-M200-OEM: HARWIN M80 Series, MCX (antennas)					
Integrated Data Storage:	32 GByte (lasts for several days continuous data sampling as "black-box")					
Graphical User Interface:	MS Windows or LINUX or MacOS based software iXCOM-CMD for configuration, visualization, data recording, data converting and playback operation					
Power Supply:	9...34 V DC, approx. 8.5 ...10 W (dep. on options); < 14 W for < 1 sec after power-on					
Temperature; MTBF:	-40...+71 °C (outer case temperature) operating, -40...85 °C storage; 35'000 hrs					
Shock / Vibration:	60 g, 11 ms, 10...2'000 Hz 5 g rms (endurance); 20...2'000 Hz 2 g rms (operation)					
Environmental Protection:	iNAT-M200-OEM device in light weight open frame design (protection to be provided by user if any); IP41 for iNAT-M200-FLAT enclosed version; Note: See iNAT-M200/SLN (no "FLAT" / "OEM" version) for our fully protected versions					
Mass, size:	approx. 320 grams, 125 x 100 x 29 mm (iNAT-M200-OEM version, w/o enclosure); approx. 550 grams, 195 x 104 x 33 mm (iNAT-M200-FLAT version, with IP41 enclosure) (plus carrier with vibration isolators, if desired [for iNAT-M200-OEM only])					
Deliverables:	- iNAT-M200-FLAT: MEMS based INS with integrated L1L2 GNSS receiver, GNSS antenna(s) or iNAT-M200-OEM: MEMS based INS with integrated L1L2 GNSS receiver, GNSS antenna(s) - Windows based GUI software iXCOM-CMD					
Options:	- tightly (iNAT-M200-FLAT/OEM/STN) instead of loosely coupled (iNAT-M200-FLAT/OEM/SLN) data fusion - SW-Development Kit with DLL (with SDK under Qt / C) - L1L2 RTK accuracy of the integrated GNSS receiver - dual-antenna GNSS based true heading (iNAT-M200-FLAT/OEM/SLN-DA) allows heading determination even at standstill conditions -> typ. 0.2° at 1 m baseline - odometer interface for velocity aiding during longer GNSS outages (position error is then correlated to wheel sensor performance, typically 0.1 % of distance travelled) - specific algorithms for heave, dead-reckoning, pedestal control etc. (also customized solutions)					

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¹ other ranges on request (up to 1'200 deg/s and up to 30 g) [then it might require an export license]; increased accel. orthogonality of 0.6 mrad

² after algorithm converging under motion with GPS aiding at const. temperature

³ values without sufficient INS/GNSS data fusion conditions; the bias are estimated / compensated during GNSS aiding under motion automatically (Kalman filter); iNAT-M200-SLN provides 10 deg/hr bias stability for several hours duration at const. temperature

⁴ GNSS based altitude deviation is about 1.5 times of GNSS based horizontal error; position error of iNAT-M200/SLN: < 2 m (CEP)

⁵ dependent on trajectory and satellite constellation; in challenging environments (e.g. urban canyons) use iNAT-M200/STN

Hint: Under best GNSS and motion conditions the accuracy is 2 cm CEP.

⁶ Position error in relation to distance travelled (DT) during GNSS outages (requires a vehicle motion sensor / wheel sensor)

