iNAT-M200/SLN • iNAT-M200/MLN

Precise MEMS Based Inertial Navigation System with Tightly or Loosely 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, light weight system, 800 grams
- 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 real-time with up to 500 Hz (adjustable) with minimum latency
- 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 / USB for realtime data output and RS232 for DGPS/RTK correction input
- 32 GByte internal non-volatile 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:

<table>
<thead>
<tr>
<th>Air or Sea or Land, with or w/o RTK resp. postproc: loosely coupling</th>
<th>Air or Land without RTK resp. with or w/o post-proc: tightly coupling</th>
<th>Most difficult environment, urban canyons and with RTK: tightly coupling</th>
</tr>
</thead>
<tbody>
<tr>
<td>iNAT-M200/SLN</td>
<td>iNAT-M200/STN</td>
<td>iNAT-M200/STN</td>
</tr>
</tbody>
</table>

In urban canyons often the number of observable satellites is quite limited and therefore the iNAT-M200/STN supports 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/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/MLN provides the same features, but containing a cheaper commercial grade L1 GPS+GLONASS engine with less robust GNSS solution in difficult environment.

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/SLN (typical, rms):

<table>
<thead>
<tr>
<th></th>
<th>Rate</th>
<th>Acceleration</th>
<th>Attit./Heading</th>
<th>Position</th>
<th>Velocity</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>± 400 °/s</td>
<td>± 10 g (opt. 30 g)</td>
<td>unlimited</td>
<td>unlimited</td>
<td>515 m/s</td>
<td>18°288 m</td>
</tr>
<tr>
<td>Bias Stability (AV)</td>
<td>&lt; 0.5 °/h</td>
<td>&lt; 0.06 mg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bias (filtered)</td>
<td>3 °/h</td>
<td>&lt; 1.5 mg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bias day-to-day</td>
<td>&lt; 0.07 °/s</td>
<td>&lt; 6 mg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angles (Attitude, Hdg.):</td>
<td></td>
<td></td>
<td>0.03° / 0.1° RP/Y (INS / GNSS)</td>
<td>0.05° / 0.12° RP/Y (after 10 s GNSS outage)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position (horizontal plane):</td>
<td></td>
<td></td>
<td>+/- 0.1 m CEP (INS/GNSS RTK real-time)</td>
<td>+/- 0.03 m CEP (INS/GNSS RTK post-proc)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>+/- 0.4 m CEP (INS/GNSS with SBAS)</td>
<td>+/- 1.8 m CEP (INS/GNSS)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.15 % of DT CEP (with VMS, during GNSS outages)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Velocity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td>0.15 μg/sqrt(hr)</td>
<td>60 μg/√Hz</td>
<td>0.03 °</td>
<td>&lt; 0.01 m</td>
<td>&lt; 0.01 m/s</td>
<td></td>
</tr>
<tr>
<td>Resolution</td>
<td>&lt; 0.0001 °/s</td>
<td>&lt; 10 μg</td>
<td>0.001 °</td>
<td>&lt; 0.001 m/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linearity error</td>
<td>&lt; 0.01 %</td>
<td>&lt; 0.05 %</td>
<td>&lt; 0.1 %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scale factor error</td>
<td>&lt; 0.1 %</td>
<td>&lt; 0.1 %</td>
<td>&lt; 0.1 %</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

INS / GNSS / ODO proc.: integrated advanced 42+ state INS/GNSS/+ extended Kalman filter data fusion
Internal GNSS Engine: version /SLN: up to L1L2 GPS/GLONASS, Beidou, SBAS, QZSS, RTK (Galileo option) version /MLN: L1 GPS+GLONASS, SBAS, Beidou, QZSS (commercial grade)
Data Processing Rate: up to 500 Hz; PPS timing accuracy better 10 ns
Data Output Rate: 1...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 < 2 ms)
Output: USB, 2 x CAN, 4 x UART RS232/422, Ethernet 100 Mbit/s, NMEA183, ARINC825, TCP/IP, UDP, NTRIP caster with RTCM104 rev 3 - can operate as GNSS reference station (opt.)
Inputs: DGPS/RTK correction data from base station, if available (RS232); odometer (A or A/B at RS422 level) as an option
Data Latency: < 11.3 ms (sampling accuracy better 1 μs, time-stamped according to PPS; jitter < 1 ms)
Connectors: MIL-C-38999 III (data), SMA (antenna), MIL2 (Ethernet)
Integrated Data Storage: 32 GByte non-volatile memory (lasts for several days continuous data sampling as "black-box")
Graphical User Interface: MS Windows or LINUX or MacOS based software \texttt{xCOM-CMD} for configuration, visualization, data recording, data converting and playback operation
Power Supply: 9...34 V DC, two independent and isolated inputs available; reverse an overvoltage protection; 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...+65 °C storage; 35'000 hrs
Shock, Vibration, Altitude: 60 g, 11 ms, 10...2'000 Hz 5 g rms (endurance); 10...2'000 Hz 2 g rms (operational); 60'000 ft
Mass, size, IP: approx. 800 grams, approx. 102 x 138 x 65 mm; IP67 environmental protection
Deliverables: - MEMS based INS with integrated GNSS receiver, GNSS antenna, cable set
- iXCOM-CMD MS Windows or LINUX or MacOS based GUI software
Options: - tightly (iNAT-M200/STN) integrated of loosely coupled (iNAT-M200/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/SLN-DA, iATTHEMO-C) 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)
- interface to iMAR’s iDMN Dynamic Mesh Network for Swarm Communication & Control
- specific algorithms for heave, dead-reckoning, pedestal control etc.
(Also customized solutions)

iMAR Navigation GmbH • Im Reihersbruch 3 • D-66386 St. Ingbert / Germany
Phone: +49-(0)-6894-9657-0 • Fax: +49-(0)-6894-9657-22
www.imar-navigation.de • sales@imar-navigation.de

1 other ranges on request (up to 1'200 deg/s and up to 30 g) [then it might require an export license]
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-GLN 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/MLN: < 2 m (CEP)
5 GNSS based algorithm converging under motion with GPS aiding at const. temperature
6 Position error in relation to distance travelled (DT) during GNSS outages (requires a vehicle motion sensor / wheel sensor), after suffic. GNSS