# 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 realtime 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 realtime 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; odometer / VMS
- 32 GByte internal non-volatile memory (“black-box”)
- several versions with surveying grade GNSS, economic grade GNSS, standard noise as well as low-noise inertial sensors are available
- easy to use, easy to configure; powerful GUI

Depending on the application, environmental environment and required realtime accuracy, the data fusion method can be loosely or tightly coupled INS/GNSS/VMS.

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 engine with less robust GNSS solution in difficult environment.


iNAT-M200/SLN: loosely coupled INS/GNSS


iNAT-M200/STN: tightly coupled INS/GNSS

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 and iNAT-M200/MLN (typical, rms):

| | Rate | Acceleration | Attit./Heading | Position | Velocity | Height |
|---|---|---|---|---|---|---|
| Range[1]: | ± 400 °/s | ± 10 g (opt. 30 g) | unlimited | unlimited | 515 m/s (without export control) | unlimited |
| Bias Stability (AV): | < 0.5 °/h | < 0.06 mg | | | | |
| 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]: | | *for **iNAT-M200/SLN:*** | +/- 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) | | |
| | | | | 0.15 % of DT CEP (with VMS, during GNSS outages)[6] | | |
| | | | | +/- 1.8 m CEP (INS/GNSS) | | |
| | | *for **iNAT-M200/MLN:*** | 1 % of DT CEP (with VMS, during GNSS outages)[7] | | | |
| Velocity: | | | | | 0.02 m/s (INS / RTK GNSS) | |
| Noise: | 0.15 °/sqrt(hr) | 60 µg/√Hz | 0.03 ° | < 0.01 m | < 0.01 m/s | |
| Resolution: | < 0.000'1 °/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.: | 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)<br>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 (options): | 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 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);<br>odometer / VMS (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), M12 (Ethernet) |
| Integrated Data Storage: | 32 GByte non-vlatime memory (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,<br>visualization, data recording, data converting and playback operation |
| Power Supply: | 9...34 V DC, two independent and isolated inputs available; reverse an overvoltage protection;<br>approx. 8.5 …11 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, 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. 900 grams , approx. 102 x 138 x 65 mm; IP67 environmental protection |
| Deliverables: | - MEMS based INS with integrated GNSS receiver, GNSS antenna, cable set<br>- iXCOM-CMD MS Windows or LINUX or MacOS based GUI software |
| Options: | - tightly (iNAT-M200/STN) instead of loosely coupled (iNAT-M200/SLN) data fusion<br>- SW-Development Kit with DLL (with SDK under Qt / C)<br>- L1L2 RTK accuracy of the integrated GNSS receiver<br>- dual-antenna GNSS based true heading (**iNAT-M200/SLN-DA**, iATTHEMO-C)<br>allows heading determination even at standstill conditions -> typ. 0.2° at 1 m baseline<br>- odometer (VMS) interface for velocity aiding during longer GNSS outages (position error is then correlated to wheel sensor performance, typically 0.1 % longitudinal error of distance travelled)<br>- interface to iMAR's iDMN Dynamic Mesh Network for Swarm Communication & Control<br>- specific algorithms for heave, dead-reckoning, pedestal control etc. (also customized solutions) |

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[1] Option: **iNAT-M200/SLN-HRR** for high rate range tasks: up to 1'200 deg/s
Option: **iNAT-M200/SLN-HRA** for high range acceleration tasks: up to 30 g [then it might require an export license]
Option: **iNAT-M200/SLN-HRS** for high range speed tasks: > 515 m/s (requires 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-SLN provides 10 deg/hr bias stability for several hours duration at const. temperature
[4] GNSS based altitude deviation is abut 1.5 times of GNSS based horizontal error; position error of iNAT-M200/**M**LN: < 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), after suffic. GNSS
[7] Position error in relation to distance travelled (DT) during GNSS outages (requires a vehicle motion sensor / wheel sensor), after suffic. GNSS