# iNAT-M-II / -III / -IV

## Family of highly Shock and Vibration resistant precise Inertial/GNSS/VMS based Navigation Systems

iNAT-M-II…IV is the product family of highly shock and vibration resistant precise Inertial Navigation and Timing systems (iNAT).

It is used e.g. on heavy trucks, construction machineries, mining applications or tunneling for true north indication (gyro compassing), navigation, localization and surveying and contains most robust ring laser gyros (RLG) and a special internal vibration and shock damping system, similar to those being used for military applications (so-called gun-fire hardened design). The iNAT-M-II/III/IV covers applications, which require highest accuracy and reliability under challenging environmental conditions, where fiber optical or Coriolis based vibrating gyros are not suitable.

- High performance inertial navigation and surveying systems for demanding applications
- True North Reference, fast and accurate gyro compassing
- Integrated multi-constellation / multi-frequency GNSS receiver (up to RTK / PPP)
- Various interfaces: Ethernet TCP/IP, UDP, CAN, RS422/RS232 UART, ARINC825 /429. NTP server capability
- Small size, low weight, low power, high reliability
- Military environment qualified (MIL-STD-810G, MIL-STD-461G, MIL-STD-704F)
- Three classes of performance available

iNAT-M-II…IV consists of three high precision ring laser gyroscopes (RLG), three accelerometers, a powerful strapdown processor and an open and configurable interface.

The system contains a GNSS receiver for GPS, GLONASS, GALILEO, BEIDOU etc.; it can also be operated with external GNSS receivers. Available COM I/Os are Ethernet (TCP/IP, UDP), RS422/232 UART, CAN, ARINC429, ARINC825, CANaero, NMEA 0183 as well as a large internal data storage on solid-state non-volatile memory.

Data processing (strapdown navigation, gyro compassing / north seeking, north keeping or motion monitoring) is performed inside of the iNAT as well as data transmission and data storage.

A key feature is its high data rate of up to 400 Hz and its long-term supreme accuracy stability, which is a key factor of RLG technology.

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iMAR's HMI software iXCOM-CMD allows the user full control of the system, data storage and visualization as well as configuration and maintenance activities (e.g. download of stored data).

The iNAT-M-II/III/IV systems come with the major advantages of ring laser gyros (e.g. no significant aging, i.e. long term performance of gyro bias and scale factor as well as high reliability), and they do not suffer from the typical strong disadvantages of higher performance FOG or CVG / HRG based systems (like aging or degraded bias accuracy under vibration or temperature gradients etc.).

Due to the modular system architecture, the iNAT-M-II/III/IV systems can be delivered with customized data interfaces and connectors, e.g. to replace obsolete navigation systems of any other provider in a form, fit & function manner.

The iNAT-M-II/II/IV systems are only covered by European dual-use export control (no ITAR restrictions).

# Technical Data of iNAT-M-II/-III/-IV (rms values)

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|---|---|
| Data Output: | Azimuth (True Heading) and elevation, position and velocity (including standard deviations), roll, pitch, angular rates, acceleration, system status (BIT) etc. |
| Azimuth / True Heading [1] | [all values: sec Lat, free inertial / gyro compassing]: |
| iNAT-M-II: | < 0.3 mil gyro compassing within 10 min.; 0.2 mil with GNSS on the move[2]<br>< 0.8 mil gyro compassing within 5 min.; 0.2 mil with GNSS on the move[2] |
| iNAT-M-III: | < 1.0 mil gyro compassing within 6 min.; 0.2 mil with GNSS on the move[2]<br>< 3.0 mil gyro compassing within 3 min.; 0.2 mil with GNSS on the move[2] |
| iNAT-M-IV: | < 1.5 mil gyro compassing within 7 min.; 0.2 mil with GNSS on the move[2]<br>< 3.0 mil gyro compassing within 4 min.; 0.2 mil with GNSS on the move[2] |
| Elevation (Pitch), Roll: | < 0.18 mil (< 0.1 mil dynamically[2] with GNSS aiding) |
| Position and Velocity Accuracy: | < 2 m [CEP50] and < 0.05 m/s with GNSS aiding (S/A off, sufficient visibility);<br>< 0.5 nm/hr [CEP50] and < 1 m/s free inertial drift (iNAT-M-II)[3]<br>< 1.0 nm/hr [CEP50] and < 1.3 m/s free inertial drift (iNAT-M-III) [3]<br>< 1.5 nm/hr [CEP50] and < 1.5 m/s free inertial drift (iNAT-M-IV) [3]<br>< 0.1 % distance travelled [CEP50] (with odometer / VMS aiding, during GNSS outages)<br>< 18 m horizontal [CEP50] / 10 m vertical [PE50] without GNSS and each 10 minutes ZUPT (given accuracy for up to 10 ZUPTs or 20 km distance) |
| Altitude Accuracy (all versions): | < 5 m [PE50] under sufficient GNSS constellation and visibility, S/A off<br>< 0.04…0.1 % distance travelled [PE50] (with odometer/VMS aiding during GNSS outages) |
| Alignment Methods: | Static and Dynamic Alignment, Stored Heading/ Stored Position Alignment |
| Aiding Methods: | GNSS and/or VMS and/or ZUPT and/or position aiding |
| Data storage: | up to 128 GByte on internal non-volatile memory; processed data and sensor raw data |
| Software: | iXCOM communication protocol; iXCOM-CMD HMI software under MS Windows and Linux available; integrated real-time Kalman filter (42+ states) |
| Inertial Sensor Ranges: | ± 395 °/s and ± 20 g (option: ± 40 g); GNSS altitude unlimited |
| Data Output Rate: | integer divisor of 400 Hz; internal data rate > 3 kHz |
| GNSS Receiver (integrated): | up to all-frequencies / all constellations GPS+GLONASS+GALILEO+BEIDOU, RTK/PPP, L-Band; option: independent heading determination with GNSS dual-antenna support, providing 4 mil / L [m] with L = antenna baseline (according to SIL demands) |
| GNSS external receiver support: | on request |
| Output Interfaces (options): | RS232/422 UART, Ethernet TCP/IP / UDP, PPT (Pulse Per Time), PPS, CAN, ARINC429, ARINC825, CANaero, NMEA 0183, USB; NTP Time Server |
| Input Interfaces (options): | internal/external GNSS (standard: integrated GNSS engine), marker event, PPS, trigger, odometer (opto-coupler input up to 32 V, RS422 level compliant) |
| Qualification: | MIL-STD-810G, MIL-STD-461G, MIL-STD-704F, DO160G |
| Temperature (case); rel humid.: | -40...+65 °C operating, -55...+85 °C storage; 8...100 %, IP67 |
| Shock, Vibration, Altitude: | iNAT-M-II/III/IV [A]: 6 g / 20 ms half sinus (MIL-STD-810G); 60'000 ft<br>iNAT-M-II/III/IV [B]: 60 g / 5 ms half sinus (MIL-STD-810G); 60'000 ft<br>iNAT-M-II/III/IV [C]: 60 g / 7 ms half sinus (MIL-STD-810G); 60'000 ft |
| MTBF / MTTR: | > 25,000 hrs (estimated for surveying applications) / < 30 minutes |
| Power Supply & Consumption: | 10...35 V DC, < 28 W (incl. internal GNSS receiver);<br>50 ms hold up time according to DO160G |
| Weight / Size: | iNAT-M-II/III/IV: approx. 16 kg / 383 x 276 x 221 mm$^3$ (LxWxH; without connectors) |
| Connectors: | MIL-C-38999 Series III, TNC |
| User Software: | iXCOM-CMD, Python inteface, standard and customized interfaces; iPosCAL |
| Part-Numbers: | 00190-0020X-05YZ (X = performance, Y = shock protection [0,A,B,C], Z = single/dual antenna) |
| Export license: | Standard Dual-Use equipment, not covered by ITAR |

iMAR is manufacturing and developing inertial navigation and guidance systems for all application areas. All systems manufactured by iMAR are maintained at iMAR in Europe / Germany.

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[1] 1 mil = 0.057 deg (explanation: an angular deviation in heading of 1 mil leads to a position error of 1 m after 1'000 m without position aiding)
[2] with sufficient GNSS aiding and sufficient moton dynamics
[3] can be improved if sufficient GNSS aiding and motion is available before switching to free inertial mode