iNAT-M300/TLE-SP1

Precise MEMS Based Inertial Navigation System with integrated advanced INS/GNSS/xxx Sensor Data Fusion

The **iNAT-M300/xLE**[1] 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 ground / land / rail, at 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, ~850 grams
- based on high grade MEMS Gyro, Accel technology and up to multi-frequency / multi-constellation GNSS with optional dual-antenna heading and RTK support; gyros highly resistant against vibration impacts
- integrated GNSS engine, up to RTK all frequ./const. (3 types of engines available: /TLE, /SLE, /RLE)
- iNAT-M300/TLE-SP1: **standard performance version**
- 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 (rms)
- interfaces: UART RS232 & RS422 / CAN / Ethernet / USB for realtime data output and RS232 for DGPS/RTK correction input; odometer / VMS
- up to 128 GByte internal 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 with wizard; drivers for C++, Python and ROS 2 node

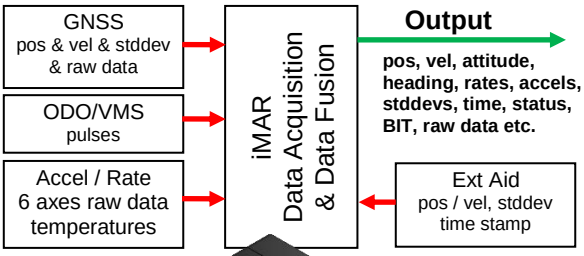
Depending on the application and ambient conditions, the integrated sensor data fusion includes INS, GNSS, VMS or any other external sensor providing position and/or velocity, standard deviation and time stamp.

In urban canyons often the number of observable satellites is quite limited and therefore the iNAT-M300/TLE supports an all GNSS constellation data fusion. The 42+ state Kalman filter processsing provides a significant better and more robust position and velocity result compared to standard solutions.

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-M300/TLE** provides system performance and system reliability which is required in general 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-M300/RLE** provides the same features, but containing an economic grade GNSS engine with less robust GNSS solution in difficult environment.



The iNAT-M300 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, iPosCAL, 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 iPosCAL-SURV for batch processing 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™.

iNAT-M300 is a leading solution of its class also for applications in GNSS denied environment.

[1] Meaning of „x“: the iNAT-M300/**x**LE can be delivered with 3 classes of integrated GNSS engines. Standard device is iNAT-M300/**T**LE (multi-freqency multi-constellation GPS/GALILEO/GLONASS/BEIDOU)

Technical Data iNAT-M300/TLE-SP1 and iNAT-M300/xLE-SP1 (rms):

	Rate	Acceleration	Attit./Heading	Position	Velocity	Height
Range[1]:	± 450 °/s	± 8 /16 g	unlimited	unlimited	515 m/s	unlimited
Bias Stability (AV):	< 1.2 °/h	< 0.03 mg			(without	
Bias (filtered[2]):	5 °/h	< 1 mg			export	
Bias day-to-day[3]:	< 0.1 °/s	< 3 mg			control)	
Angles (Attitude, Hdg.):			0.05° / 0.1° RP/Y (INS / GNSS) 0.06° / 0.12° RP/Y (after 10 s GNSS outage) 0.1 deg heading for 2 m baseline in dual-antenna setup (/TLE-DA) [2]			
Position (horizontal plane) [4]:		*for **iNAT-M300/TLE-SP1:***		+/- 0.1 m CEP (INS/GNSS RTK real-time) +/- 0.03 m CEP (INS/GNSS RTK post-proc) +/- 0.45 m CEP (INS/GNSS with SBAS) +/- 1.8 m CEP (INS/GNSS) 0.3 % of DT CEP (with VMS, during GNSS outages)[5]		
Velocity:					0.02 m/s (INS / RTK GNSS)	
Noise / ARW:	0.08 °/√hr[6]	60 µg/√Hz	0.03 °	< 0.01 m	< 0.01 m/s	
Resolution:	< 0.000'1 °/s	< 30 µg	0.001 °	< 0.001 m	< 0.001 m/s	
Linearity error:	< 0.05 %	< 0.1 %	< 0.1 %			
Scale factor error:	< 0.2 %	< 0.1 %	< 0.1 %			
Non-orthogonality:	< 0.2 mrad	< 0.2 mrad				

INS / GNSS / ODO proc.:	integrated advanced 42+ state INS/GNSS/+ extended Kalman filter data fusion (GPS, GALILEO, GLONASS, BEIDOU)
Internal GNSS Engine:	version /TLE-x: high performance all frequencies / all constellation RTK GNSS engine (single & dual antenna available) version /SLE-x: performance up to all frequency / constellation geodedic class RTK GNSS engine (single or dual antenna) version /RLE-x: commercial multi frequencies / multi constellation RTK GNSS engine (single & dual antenna available)
Data Processing Rate:	up to 500 Hz; PPS timing accuracy better 10 ns; sensor bandwidth > 450 Hz (gyros) / > 300 Hz (accels)
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); NTP Time Server; integrated Real-Time-Clock (RTC) as option.
Inputs:	DGPS/RTK correction data from base station, if available (RS232); odometer / VMS (A or A/B at RS422 level) as an option
Data Latency:	< 10 ms (sampling accuracy better 1 µs, time-stamped according to PPS; jitter < 1 ms)
Connectors:	MIL-C-38999 III (data), SMA (antenna), M12 (Ethernet); optional external USB stick (IP67)
Integrated Data Storage:	32 GByte non-vlatime memory, optional up to 128 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, playback
Power Supply:	10...34 V DC, two independent and isolated inputs available; reverse polarity and overvoltage protection; 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; 49’000 hrs (AUC, Airborne Uninhabited Cargo, 25 °C)
Shock, Vibration, Altitude:	10 g / 11 ms (operational), 1’000 g / 0.5 ms (endurance); 10...2’000 Hz 2 g rms (operational), 20 g rms (endurance); 60’000 ft
Qualification:	designed to meet MIL-STD-810G, MIL-STD-461G, NIL-STD-704F and partially DO160G
g / g² depenent gyro drift:	< 0.005 °/s/g (internally compensated)
Mass, size; IP:	approx. 670 grams , approx. 102 x 65 x 112 mm (W x H x D); IP67 environmental protection
Operational Support:	Airborne, Ground (with and without odometer), Sea, Subsea; ZUPT (auto or on demand), open interface to feed in application specific aiding information (position, velocity, attitude, heading, standard deviations, time stamp)
Deliverables:	- MEMS based INS with integrated GNSS receiver, GNSS antenna, cable set - ROS-2 node, Python driver, SDK for C++ available for easy integration - iXCOM-CMD MS Windows or LINUX or MacOS based GUI / HMI software

PartNumber:

standard performance version:	iNAT-M300/TLE-SP1-DA	P/N 00193-000E2-0517 (dual-antenna)
	iNAT-M300/RLE-SP1-DA	P/N 00193-000E2-0417 (dual-antenna)
	iNAT-M300/SLE-SP1-DA	P/N 00193-000E2-0317 (dual-antenna, incl. L-Band)
low noise version:	iNAT-M300/TLE-LN1-DA	P/N 00193-000C2-0517 (dual-antenna)
	iNAT-M300/RLE-LN1-DA	P/N 00193-000C2-0417 (dual-antenna)
	iNAT-M300/SLE-LN1-DA	P/N 00193-000C2-0317 (dual-antenna, incl. L-Band)
Systems also available with single GNSS antenna setup:		P/N 00193-* * * * * -0*16 (single-antenna)

Features and Options:
- **low noise version** available: iNAT-M300/TLE-LN1 (range: +/- 450 deg/s, ARW 0.06 deg/sqrt(hr))
- dual-antenna GNSS based true heading solution available (**iNAT-M300/xLE-SP1-DA**) allows heading determination even at standstill conditions -> typ. 0.2° at 1 m baseline
- 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)
- interface to iMAR’s iDMN Dynamic Mesh Network for Swarm Communication & Control
- specific algorithms like HEAVE OUTPUT for marine / naval applications (also customized solutions)

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[1] Option: **iNAT-M300/xLE-HRS** for high range speed tasks: > 515 m/s (requires an export license)
[2] after algorithm converging under motion with GNSS 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-M300-xLE provides 3 deg/hr bias stability over longer duration at const. temperature
[4] GNSS based altitude deviation is abut 1.5 times of GNSS based horizontal error
[5] Position error in relation to distance travelled (DT) during short GNSS outages (requires a vehicle motion sensor / wheel sensor), after suffic. GNSS

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