iNAT-RQT-4000 … -4003

Inertial INS/GNSS/ODO/xxx Navigation and Surveying System

for Advanced Applications on Land, at Sea and in the Air

iNAT-RQT-400x is part of the IMS product family of systems for inertial navigation and guidance, gyro compassing, stabilization, true heading determination and for dynamically motion analysis with ring laser gyros, that covers applications, which require accuracy, reliability, a flexible interface and easy usage.

- High performance ring laser gyro based inertial navigation and surveying system for airborne, naval, underwater, surface and railway applications; self gyro compassing. Additional dual-antenna GNSS heading setup as option (iNAT-RQT-400x-DA)
- Integrated time synchronization module and all-frequencies / all constellation GNSS / PPP / RTK engine with single or dual antenna. External atomic clock as option.
- High data rate, open interface: UART RS422 / RS232, Ethernet TCP/IP - UDP, CAN, ARINC429, ARINC825, NMEA 183.
- Integrated VMS / odometer interface.
- Internal 32 GByte non-volatile memory (“black-box”), up to 128 GByte on demand
- Small size, low weight, low power; integrated surveying markers and aiding support points on the enclosure (to support also advanced surveying applications).

The iNAT-RQT consists of three high precision ring laser gyroscopes, three servo accelerometers, a powerful strapdown processor and an open and modular architecture, which allows also adaptations to customer’s demands.

The system contains an up to all-frequencies / all-constellations RTK / PPP capable GNSS receiver (GPS, GLONASS, GALILEO, Beidou), several Dig-I/Os (e.g. for odometer, laser altimeter, DVL), DAC. Optional communication I/Os are Ethernet (TCP/IP, UDP), RS422/232 UART, CAN, ARINC429, ARINC825 as well as internal data storage on non-volatile memory.

Data processing (strapdown navigation, gyro compassing or motion monitoring) is performed inside of the iNAT-RQT, and also data transmission and storage of pure or corrected raw data is available.

A key feature is its high data rate of up to 400 Hz and its unique resolution (0.001 degree in roll/pitch/yaw) as well as its superior accuracy (e.g., for stabilization tasks). As an option, special designed algorithms and features are available, e.g. the Multi-Vehicle-Tracking Mode (MVT), which allows an exchange of information between several iNAT systems without the need of any additional computation power. iNAT-RQT can also operate as PTP / NTP time server as an option.

The iNAT-RQT contains iMAR’s highly sophisticated 42+ state extended Kalman filter based INS/GNSS/ODO/xxx data fusion incl. gyrocompassing, free inertial or dead-reckoning navigation etc.

iNAT-RQT is usually operated in online mode, however, it also provides the possibility of post-processing, e.g. to perform additional reverse Kalman filtering and smoothing.

The systems iNAT-RQT are <u>not</u> ITAR controlled. The systems iNAT-RQT-4002 / -4003 are only covered by standard European dual-use export control. With iNAT-Rx/Fx several fit-function (FF) compatible systems are provided on RLG, HRG and FOG technology. With iNAT-FSSG-1-DA a compatible system with dual-antenna GNSS technology is provided, which even does not require any export license.




Technical Data of iNAT-RQT-4000 / -4001 / -4002 / -4003 (rms values)

Data Output:	Heading, Roll, Pitch, Angular Velocity, Velocity (Body and World), Position, Raw Data of INS / GNSS / VMS incl. time-stamp, Internal Status Information
True Heading	iNAT-RQT-4000: 0.028° [0.5 mils] sec(lat) free inertial; < 0.01° with GNSS[1], < 0.005° post-proc[2] RTK iNAT-RQT-4001: 0.028° [0.5 mils] sec(lat) free inertial; < 0.01° with GNSS[1], < 0.006° post-proc[2] RTK iNAT-RQT-4002: 0.057° [1.0 mils] sec(lat) free inertial; < 0.01° with GNSS[1], < 0.008° post-proc[2] RTK iNAT-RQT-4003: 0.086° [1.5 mils] sec(lat) free inertial; < 0.01° with GNSS[1], < 0.008° post-proc[2] RTK option: Dual-Antenna Setup with 0.2 °/L[m] with L = antenna baseline; e.g. 0.02 ° @ 10 m baseline (iNAT-RQT-400x-DA)
Attitude Accuracy:	< 0.025° [0.5 mils] (< 0.01° with GNSS, < 0.0025° postproc with RTK aiding)
Position Accuracy	iNAT-RQT-4000: < 0.5 nm/hr free inertial [CEP][3]; typically < 1.6 m GPS (S/A off) and < 10 cm RTK[1] online iNAT-RQT-4001: < 0.8 nm/hr free inertial [CEP][3]; typically < 1.6 m GPS (S/A off) and < 10 cm RTK[1] online iNAT-RQT-4002: < 1.2 nm/hr free inertial [CEP][3]; typically < 1.6 m GPS (S/A off) and < 10 cm RTK[1] online iNAT-RQT-4003: < 1.5 nm/hr free inertial [CEP][3]; typically < 1.6 m GPS (S/A off) and < 10 cm RTK[1] online < 0.6 m [rms] SBAS (WAAS/EGNOS), < 0.1 m DGPS / TerraStar and 2 cm RTK/INS (post-proc.) < 0.1 % distance travelled [CEP] (with odometer and GPS, application dependant) < 0.2 % distance travelled [CEP] on underwater vehicles (with sufficient DVL aiding)
Velocity Accuracy:	5 mm/s (aided with L1/L2 RTK GPS, < 3 mm/s postproc RTK)

Alignment Duration:

				On-shore Alignment Duration to achieve true heading of (static):					
Class of System	Gyroscopes		Accelerometer	0.25°	0.15°	0.10°	0.086°	0.06°	0.028° (sec lat)
iNAT-RQT-4000:	< 0.0012 °/√h	0.004 °/hr	< 12 µg/√Hz	50 µg | 2 min	2 min	2 min	2 min	3 min	5 min
iNAT-RQT-4001:	< 0.0016 °/√h	0.004 °/hr	< 12 µg/√Hz	50 µg | 2 min	2 min	2 min	3 min	5 min	9 min
iNAT-RQT-4002:	< 0.0025 °/√h	0.007 °/hr	< 12 µg/√Hz	75 µg | 2 min	3 min	4 min	5 min	6 min	
iNAT-RQT-4003:	< 0.0050 °/√h	0.010 °/hr	< 12 µg/√Hz	100 µg | 2 min	4 min	6 min	8 min		

Off-shore Alignment Duration = On-shore Alignment Duration + 15…60 minutes (depends on v-aiding)

Range:	± 395 °/s	± 20 g
Bias Stability:	< 0.001 °/hr	< 12 µg (AllanVar)
Resolution:	0.00033 ° (1,2"), < 0.001 °/s	< 5 µg (depends on data rate)
Scale/Linearity Error:	< 15 ppm / < 10 ppm	< 100 ppm / < 30 µg/g²
Axis Misalignment:	< 30 µrad	< 50 µrad

GNSS Receiver (integrated):	up to L1L2 / all frequency / all constellation GPS+GLONASS+GALILEO+BEIDOU, SBAS, RTK / PPP; high speed range version (< 515 m/s) available as option (iNAT-RQT-HRS, requires export license)
Input Interfaces (options):	external GNSS receiver (standard: integrated GNSS receiver); event trigger (PPS / SYNC, RS422 level), odometer (opto-coupler input up to 32 V, A/B quadrature or counts & direction, RS422 level compliant)
Output Interfaces (options):	UART RS232/422, Ethernet TCP/IP / UDP, CAN, ARINC429, ARINC825, HDLC/SDLC, PPT (Pulse Per Time), PPS, SYNC; PTP / NTP Server (since HW rev. 4); NTRIP caster; PPD (Pulse-per Distance)
Data Output Rate:	1…400 Hz, internal data rate 3'200 Hz
Data Latency:	< 5.3 ms (sampling accuracy better 1 µs, time-stamped according to PPS; jitter < 1 ms)
Data storage:	32 GByte on internal non-volatile memory (option: 128 GByte)
Atomic Clock TimeRef. (opt.):	External high precision clock, drift < 100 ps/s (= 90 µs / 10 days) for -15…+55 °C ambient temperature
Dual-Antenna GNSS (opt.):	Additionally providing independent heading from dual-antenna GNSS setup: Accuracy = 0.2 deg/L[m] where L is the baseline between both antennas (example: 0.02 deg @ 10 m baseline)
Connectors:	MIL-C-38999 Series III for signals and power, TNC for antenna
Temperature (case):	-30...+65°C operating, (-40…+71°C degraded), -55...+85°C storage
Rel. Humidity:	8...100%, IP67
Magnetic insensitivity:	< 300 µTesla (3 Gauss)[4]
MTBF / MTTR:	> 50,000 hrs (field tested for surveying applications) / < 30 minutes
Shock, Vibration, Altitude:	6 g, 20 ms (operating); 5…2'000 Hz, 6.3 g rms (operating); 60'000 ft
Qualification:	MIL-STD-810G, MIL-STD-461G, MIL-STD-704F, DO160G
Power:	10...35 V DC, < 20 W (incl. GNSS); 50 ms hold up time according to DO160E; continuous overvoltage protection up to 60 V
Weight / Size:	approx. 6.9 kg / approx. 187 x 128 x 296 mm³ (w/o connectors);
Installation:	Installation in all arbitrary orientations allowed
Software:	internal real-time OS with INS/GNSS/ODO/xxx data fusion; real-time data output; iXCOM communication protocol; iXCOM-CMD GUI software under MS Windows and Linux available; Python scripts for easy interfacing available; INS/GNSS post-proc iWP+ available

iMAR Navigation GmbH manufactures and designs inertial navigation, surveying, guidance, control and stabilization systems for airborne, industrial, automotive, agriculture, mining, drilling, surveying, defence and many other applications. All systems are manufactured and maintained by iMAR Navigation in Europe / Germany.

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[1] Assuming that sufficient GNSS observations as well as sufficient motion dynamics are available
[2] post-processing, depends on environment
[3] Smaller values achievable, if the iNAT-RQT is aided sufficiently with GNSS before switching to free inertial mode
[4] other on request