iNAT-U200/RLD-M-DA

Economic ultra-small MEMS based Inertial Navigation System with integrated MF/MC RTK Dual-Antenna INS/GNSS/ODO/xxx Data Fusion

The **iNAT-U200/RLD-M-DA** 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 PNT (positioning, navigation & timing) relevant data as all kinematic measurements like acceleration, angular rate, attitude, true heading, velocity and position of the target vehicle in real-time incl. timestamp and standard deviation with a data output rate of up to 500 Hz.

iNAT-U200/RLD-M-DA comes in a miniature, lightweight enclosure of the iNAT-M300/-M200 series. It is also available as open-frame OEM version without enclosure (**iNAT-U200/RLD-OEM-DA**) and can also be provided in an alternative enclosure (**iNAT-U200/RLD-CB-DA**). All versions provide single antenna and dual antenna GNSS support.

- robust, compact, light weight system, ~440 grams, excellent SWaP; fully **IP67** protected enclosure
- **Low power consumption: typ. < 5 W**
- based on high grade MEMS Gyro, Accel technology with integrated GNSS
- single or dual antenna GNSS, multi-frequencies, multi-constellations GPS, GALILEO, GLONASS, BeiDou, RTK
- options for high/low range angular rate (-HRR/-LRR) and high range acceleration (-HRA) available
- odometer / wheel sensor / CAN aiding capability
- output of angular rate, acceleration, attitude, true heading, CoG, velocity, position, timestamp and standard deviations in realtime with up to 500 Hz (adjustable). Also raw data for post-proc available
- several processing modes: Standard mode with 1 m position accuracy and RTK mode with 0.02 m position accuracy
- interfaces: UART / CAN / Ethernet / USB / PPS_OUT, TRIG for realtime data output and DGPS/RTK correction input; odometer / VMS; connectivity to magnetometer, barometer / TAS via ARINC825-lite
- up to 128 GByte internal memory ("black-box")
- easy to use, easy to configure; powerful GUI

Depending on the application, environmental conditions and required realtime accuracy, the 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-U200/RLD supports an all GNSS constellation data fusion. The 42+ state Extended Kalman Filter processing provides a significant better and more robust position and velocity result compared to standard solutions.

For ground vehicles additionally an odometer aiding capability is available as an option, the scale factor of the wheel sensor is estimated automatically.

The [iNAT-U200/RLD](#) 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.
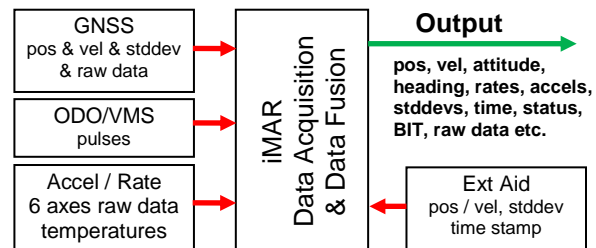
The iNAT-U200 is delivered with the MS Windows (or LINUX or MacOS alternatively) based configuration software [iXCOM-CMD](#). This software allows to configure the output interfaces. Furthermore, all output data can be displayed and stored online on the user's notebook, tablet or process computer. It also allows powerful playback capabilities and provides data export in many formats (csv, xml, GoogleEarth, InertialExplorer, GrafNav). With [iREF-GNSS](#), iMAR presents a GNSS reference station to provide RTK corrections for centimeter level accuracy on demand.

A powerful postproc software is available for post-mission processing, including a multi station GNSS correction data solution and a direct visualisation of the results in Google Earth™.

Technical Data iNAT-U200/RLD-M-DA (typical, rms):

	Rate	Acceleration	Attit./Heading	Position	Velocity	Height
Range[1]:	± 500 °/s	± 8 g	unlimited	unlimited	515 m/s	unlimited
Bias Stability (AV)[1]:	< 2.5 °/h	< 0.1 mg			(without	
Bias (filtered[2]):	< 5 °/h	< 1 mg			export	
Bias day-to-day[3],[1]:	< 0.2 °/s	< 2 mg			control)	

Angles (Attitude, Hdg.):		0.1° / 0.3° | 0.05° / 0.15° RP/Y	(INS / GNSS, w/o | with RTK)	
		0.15° / 0.35° | 0.1° / 0.2° RP/Y	(after 10 s GNSS outage, w/o | with RTK)	
		0.1 deg heading for 2 m baseline in dual-antenna setup (/RLD-DA) [2]		

Position (horizontal plane) [4]:	for iNAT-U200/RLD:	+/- 0.03 m CEP (INS/GNSS RTK real-time)
		+/- 0.02 m CEP (INS/GNSS RTK post-proc)
		+/- 0.4 m CEP (INS/GNSS with SBAS)
		+/- 1.8 m CEP (INS/GNSS)
		0.8 % of DT CEP (with VMS, during GNSS RTK outage)[5]
Velocity:		0.02 m/s (INS / RTK GNSS)

	Rate	Acceleration	Attit./Heading	Position	Velocity
Noise:	0.15 °/sqrt(hr)	23 µg/√Hz	0.02 °	< 0.01 m	< 0.01 m/s
Resolution:	< 0.000'1 °/s	< 20 µg	0.001 °	< 0.001 m	< 0.001 m/s
Linearity error:	< 0.2 %	< 0.5 %	< 0.2 %		
Scale factor error:	< 0.3 %	< 0.1 %			
Scale factor (filtered):	< 0.1 %	< 0.07 %	< 0.1 %		
Axes Orthogonality:	< 0.5 mrad	< 0.5 mrad			
Misalignment to case:	< 3 mrad OTR		(with standard calibration)		
	< 1 mrad OTR		(with extended calibration – option to be ordered with PO)		

g / g² depenent gyro drift:	< 32 °/h/g / 1.8 °/h/g² (internally compensated)
INS / GNSS / ODO proc.:	integrated advanced 42+ state INS/GNSS/+ extended Kalman filter data fusion
Internal GNSS Engine:	multi-frequency / multi-constellation GPS / GLONASS / GALILEO / BeiDou, SBAS, QZSS, RTK; > 150 channels
Data Processing Rate:	up to 500 Hz; PPS timing accuracy better 10 ns
Data Output Rate:	integer divisor of 500 Hz; all data available in real time, latency < 3 ms, jitter < 1 ms
Synchronisation:	1 x PPS_OUT (RS422 level, latency < 1 µs); 1x EVENT_IN (opto-coupler, latency < 3 ms)
Communication Interfaces:	Ethernet 100 Mbit/s (TCP/IP, UDP), 2 x UART RS422/232, 1 x CAN, PPS (RS422 level), 1 x EVENT-IN (opto-coupler input), USB; NTRIP caster capability with RTCM-104-rev 3, NTP time server capability
Odomeer Input / VMS:	Odometer (A or A/B opto-coupler; 3.5 …28 V, 6 mA)
Data Latency:	< 1 ms (sampling accuracy better 1 µs, time-stamped according to PPS; jitter < 1 ms) in RTK mode
Connectors:	MIL-C-38999 III (data), SMA (antenna), M12 (Ethernet)
Integrated Data Storage:	32 GByte (option: 128 GByte); lasts for several days continuous data sampling as "black-box"
Graphical User Interface:	MS Windows or LINUX or MacOS based GUI / HMI software iXCOM-CMD for configuration, visualization, data recording, data converting and playback operation
Power Supply:	9...34 V DC; < 5 W; reverse an overvoltage protection up to 60 V;
Temperature; MTBF:	-40...+71 °C (outer case temperature) operating, -40…85 °C storage; >50'000 hrs (AUC, Airborne Uninhabited Cargo, 25 °C)
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
Qualification:	designed to meet MIL-STD-810G, MIL-STD-461G, NIL-STD-704F and partially DO160G
Mass, size; IP:	440 grams , ≈ 101 x 81 x 63 mm³ (without connectors); IP67
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)
Part Number:	**00190-00504-0407** (iNAT-U200/RLD-M-DA, ultra small enclosure, standard range +/- 500 deg/s, +/- 8 g)
Deliverables:	- MEMS based INS with integrated GNSS receiver, GNSS antenna, cable set
	- dual-antenna GNSS based true heading (**iNAT-U200/RLD-M-DA**) allows heading determination even at standstill conditions → typ. 0.2° at 1 m baseline; this feature is default deilvery for standard purchases
	- 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)
	- iXCOM-CMD MS Windows or LINUX or MacOS based GUI software
Options:	- SW-Development Kit with DLL available (with SDK under Qt / C); ROS-2, Python
	- EMI shield or IP67 enclosure to wrap the iNAT-U200/RLD-OEM for partial EMI/EMC and general environmental protection
	- Version also available in "small (-MS)" instead of "ultra small (-M)" enclosure (compatible to iNAT-M300/xLD)
	- interface to iMAR's iDMN Dynamic Mesh Network for Swarm Communication & Control
	- version with aviation certified operational system (OS) on request
	- specific algorithms (also customized solutions)

---

[1] Option: **iNAT-U200/RLD-LRR/HRR-MS** for low range and high range rate tasks: ±120 °/s (0.15 °/sqrt(hr)), ±2000 °/s (0.3 °/sqrt(hr)) [factory set, can also be combined with –DA option]
 Option: **iNAT-U200/RLD-HRA-MS** for high range acceleration tasks: ±40 g °/s (100 µg/sqrt(Hz), 3 mg bias day-to-day) [factory set, can also be combined with –LRR or -HRR]
 Option: **iNAT-U200/RLD-HRS-MS** for high range speed tasks: > 515 m/s (requires an export license)
[2] after algorithm converging under sufficient motion excitation with sufficient GPS aiding conditions
[3] values without sufficient INS/GNSS data fusion conditions; the bias are estimated / compensated during GNSS aiding under motion automatically (Kalman filter); iNAT-U200/SLD provides 20 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
[5] position error in relation to distance travelled (DT) during short GNSS outages (requires a vehicle motion sensor / wheel sensor) – after suffic. GNSS