iRAD-Multi / iRailLoc-R

Smart Odometer for Sub-Decimeter Localization & Timing System
for all kinds of local & high speed Passenger Trains, Freight Trains and Trams

iRailLoc-R / iRAD-Multi is a member of the advanced iNAT system family (iMAR Navigation and Timing) and is specially designed to the needs of modern train positioning, localization and operation up to ATO (automatic train operation). It provides the required PNTC features (positioning, navigation, timing & communication), all in one device mountable on the vehicle's axle, designed according to the relevant European railway standards regarding EMI/EMC, power supply and environmental impacts (EN 50121).

iRAD-M / iRailLoc-R provides the relevant motion and position data for train location, train guidance and train control tasks and provides also open interfaces to auxiliary sensors on demand. All kinematic measurements like acceleration, angular rate, attitude, true heading, velocity and position of the rail vehicle are provided in real-time incl. timestamp and standard deviation with a data update rate of up to 500 Hz.

- robust, compact, lightweight system, excellent SWaP; fully IP67 protected enclosure
- Low power consumption: typ. < 15 W
- based on robust MEMS Gyro, Accel technology with integrated GNSS and RTK/PPP support
- support of simultaneous GPS, GALILEO, GLONASS, BeiDou (up to all frequency / all constellation GNSS)
- wheel sensor supported
- automatic odometer scale factor estimation
- I/F: UART, Ethernet, odometer
- up to 128 GByte internal memory ("black-box")
- maintenance-free operation
- easy to use, easy to configure; powerful GUI

iRailLoc-R / iRAD-M comes in a small, sturdy, light-weight enclosure. Interfaces for communication (Ethernet, CAN, UART) and for odometer are included, the GNSS antenna is directly integrated. It also provides a corrected odometer output (A/B pulses) to be fed into an ETCS OBU to enlarge the distance of ETCS balises.

Depending on the application, environmental conditions and required real-time accuracy, the data fusion includes INS, GNSS, VMS.

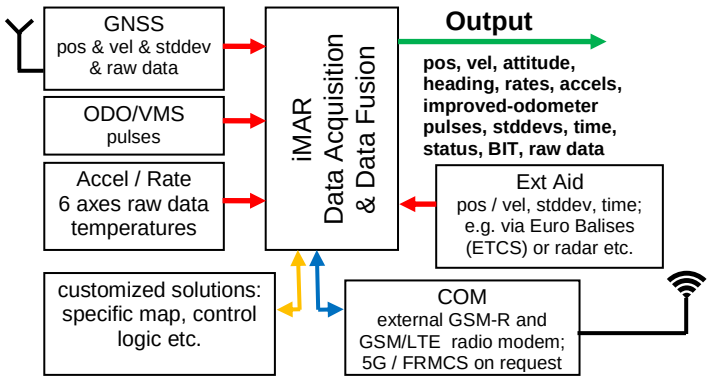
In urban canyons the number of observable satellites is quite limited and therefore the system supports an all GNSS constellation data fusion. The 42+ state Extended Kalman Filter processing guarantees a significant better and more robust position and velocity result compared to standard solutions. System functions and interfaces can be adapted to specific customer needs – contact our technical sales engineers for details!

iRailLoc-R / iRAD-Mobile

Due to the high reliability of the system architecture the iNAT series is used in most challenging railway, surface vehicle, shipborne, airborne and defense applications.

The **iRailLoc-R / iRAD-M** is based on the real-time operating system QNX, which is the choice to serve safety relevant applications.

iRailLoc-C/ iRAD-M is, as all iNAT systems,



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™ etc.). Python, ROS-2 amd C++ SDK and MatLab interface available.

Technical Data iRailLoc-R / iRAD-Multi (typical, rms):

	Rate	Acceleration	Attit./Heading	Position	Velocity	Height
Range:	± 500 °/s	± 40 g	unlimited	unlimited	unlimited	unlimited
Bias Stability (AV)[1]:	< 2.5 °/h	< 0.1 mg				
Bias (filtered[1]):	< 5 °/h	< 1 mg				
Bias day-to-day[2]:	< 0.2 °/s	< 2 mg				
Angles (Attitide, Hdg.):			0.1° / 0.2° | 0.05° / 0.1° RP/Y (INS / GNSS, w/o | with RTK) 0.15° / 0.25° | 0.1° / 0.15° RP/Y (after 10 s GNSS outage, w/o | with RTK)			
Position (horizontal plane) [3]:				+/- 0.1 m CEP (INS/GNSS RTK real-time) +/- 0.6 m CEP (INS/GNSS with SBAS) +/- 1.8 m CEP (INS/GNSS) 0.1 % of DT CEP (with odometer, during GNSS RTK outage)[4]		
Velocity:					0.02 m/s (INS / RTK GNSS)	
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 %			

INS / GNSS / ODO proc.:	advanced 42+ state INS/GNSS/+ extended Kalman filter data fusion
Internal GNSS Engine:	multi-frequency / multi-constellation GPS / GLONASS / GALILEO / / BeiDou, SBAS, QZSS, RTK
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
Synchronization:	PPS_OUT (RS422 level, latency < 1 µs); NTP output (GPS time)
Interfaces:	- UART RS422, - PPS trigger output (RS422 level), - Ethernet 100 MBit/s (TCP/IP, UDP), NTP Time Server, - odometer interface (A or A/B opto-coupler; 3.5 …30 V, 5 mA) with isolated supply output (15 V DC, 6 W max.), types of Knorr-Bremse, Baumer, Sick etc. supported - improved odometer output provided (A/B, RS422) to provide velocity with high accuracy (from data fusion, typically better 0.1 %) to ETCS-OBU to allow enlargement distances of ETCS balises (as option)
GNSS Correction Data:	DGPS/RTK correction data from base station, if available (via Ethernet / UART)
Data Latency:	< 10 ms (sampling accuracy better 1 µs, time-stamped according to PPS; jitter < 1 ms) in RTK mode
Connectors:	see ICD
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:	nom. 10 - 32 V DC
Temperature; MTBF:	-40...+71 °C (outer case temperature) operating, -40…85 °C storage; 50'000 hrs (surveying applications)
Shock, Vibration:	90 g, 11 ms, 10…2'000 Hz 5 g rms (endurance); 10...2'000 Hz 2 g rms (operational)
Applied Standards:	EN 45545, EN 50121, EN 50155-2017
Mass, size; IP:	~2'500 grams, X25 compatible or similar; IP67
Operational Support:	railway environment / train applications / ATO
Deliverables:	- iRailLoc-R / iRAD-Multi MEMS based INS with integrated GNSS, odometer interface, lab or customized cable set - iXCOM-CMD MS Windows or LINUX or MacOS based GUI software
Options:	- SW drivers / toolkits under C++ and Python and ROS-2 (with SDK under Qt / C) - support in architecture design for integration into applications requiring SIL 3 / SIL 4 on system level (incl. diversity / redundancy, ETCS integration, CENELEC requirements, RAMS aspects etc.)

iRailLoc-C

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[1] after algorithm converging under sufficient motion excitation with sufficient GPS aiding conditions
[2] values without sufficient INS/GNSS data fusion conditions; the bias are estimated / compensated during GNSS aiding under motion automatically (Kalman filter)
[3] GNSS based altitude deviation is abut 1.5 times of GNSS based horizontal error
[4] position error in relation to distance travelled (DT) during GNSS outages (requires a vehicle motion sensor / wheel sensor) – after suffic. GNSS