


Rev.: 1.35c Date: 20.12.2017 Page: 1 von 208	<b>iXCOM-CMD</b> <b>User Manual for all iNAT Systems</b>	 NAVIGATION & CONTROL
Document No.: Reference:	DOC151112010 IEP-I000260	

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# *iXCOM-CMD*

## *User Manual*

*Operational Software / GUI for all iMAR Systems of Types*  
*iNAT • iATTHEMO • iTraceRT-MVT*  
*iSULONA • iCOMBANA • iPRENA*

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### Acronyms of Functions


#### Industrial/MIL Projects / Industrie- & MIL-Projekte

CEO	Chief Executive Officer (Geschäftsführer)
CUST	Customer (Kunde)
DE	Design Engineer / Development Engineer (Entwicklungsingenieur)
HD	Head of Development (Entwicklungsleiter)
PGM	Program Manager (Projektmanager)
PJM	Project Manager (Projektleiter)
PM	Production Manager (Fertigungsleiter)
QA	Quality Assurance (Qualitätssicherung)
QM	Quality Manager (Qualitätsmanagementbeauftragter)

#### Aviation & Space Projects / Luft- und Raumfahrtprojekte


AM	Accountable Manager
CUST	Customer (Kunde)
DE	Design Engineer / Development Engineer (Entwicklungsingenieur)
HD	Head of Design (Entwicklungsleiter)
HoA	Head of Office of Airworthiness (Leiter Musterprüfstelle)
HoD	Head of Design Organisation
PGM	Program Manager (Projektmanager)
PJM	Project Manager (Projektleiter)
PM	Production Manager (Fertigungsleiter)
CVE	Compliance Verification Engineer (Musterprüfingenieur)
QA	Quality Assurance (Qualitätssicherung)
QM	Quality Manager (Qualitätsmanagementbeauftragter)

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## Related Documents

	Name	Content	DocNumber
[1]	iNAT-Fx/-Rx/-Hx datasheets	Technical Product Specifications	
[2]	ICD iXCOM Protocol Spec	Communication Specification	DOC141126064
[3]	iMAR ARINC825 ICD	ARINC825 CAN iMAR Implementation	DOC141106133
[4]	iMAR ARINC429 ICD	ARINC429 iMAR Implementation	
[5]	MAN User Manual iNAT-Rx/Fx	User manual for iNAT-Rx/Fx/Hx Systems	DOC150715034
[6]	ICD iNAT-Rx/Fx	ICD iNAT-Rx/Fx/Hx Systems	DOC141203029
[7]	ICD iNAT-M200	ICD iNAT-M200 Systems	DOC140301006
[8]	MAN_iXCOM-CMD	Manual of iXCOM-CMD Software	DOC151112010
[9]	MAN_Introduction-into-Inertial-Measuring-Technology	Overview to IMS coordinate systems etc.	DOC151228003
[10]	iXCOM-CMD and iNAT Training	Powerpoint presentation for iXCOM training	DOC160113001
[11]	MAN_iXCOM-CDSK	SDK User Manual for customers	DOC160929099
[12]	MAN_UserManual_iNAT-Systems	User manual for all iNAT systems (general introduction)	DOC151228001

**Table 1: Related Documents**

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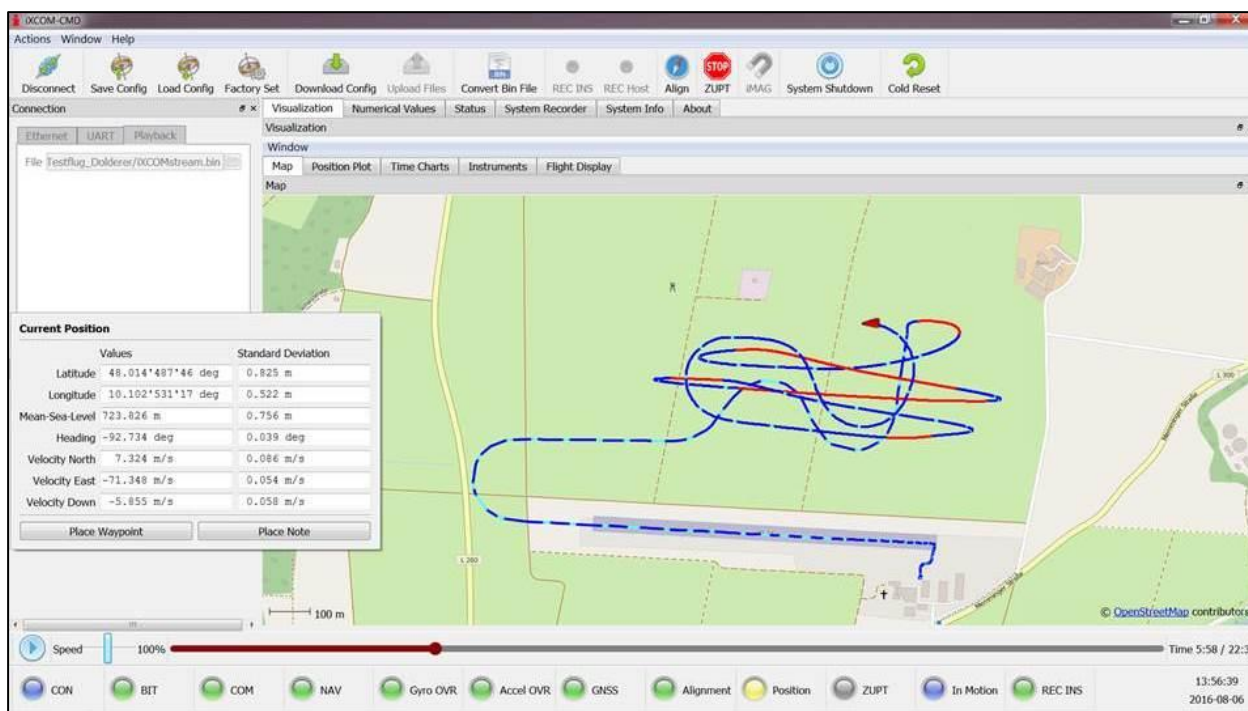
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# 1 INTRODUCTION

## 1.1 General Overview

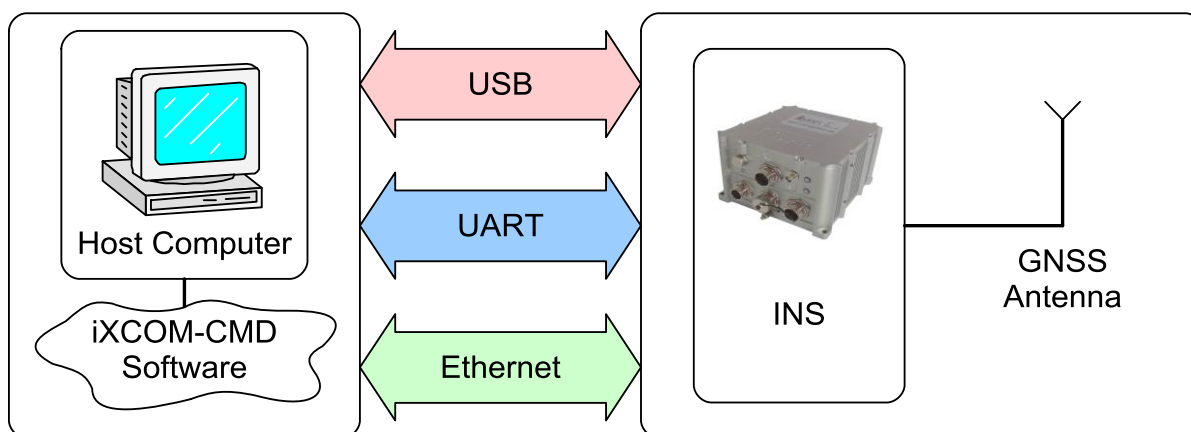
This manual gives an overview about the iXCOM command software (iXCOM-CMD), being used to monitor and configure iMAR systems which support iMAR's generic XCOM interface. These systems are mainly from iMAR's product families iNAT-xxx, iATTHEMO-B/C, iCOMBANA, iPRENA and iSULONA (sometimes also named IMS [inertial measuring system] or INS [inertial navigation system] or "device" in the following manual).

The iXCOM-CMD software has the iMAR part number P/N 00028-00016-0000




**Figure 1: iXCOM-CMD visualizes Aerobatic Flights**

The software covers all common tasks to operate and configure an inertial navigation and measurement system (INS, IMS) and to visualize the acquired data in real-time and in post-mission.



**Figure 2: iXCOM-CMD / INS Setup**

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A brief list of supported features:

- Sensor & Interface Configuration
- System and Health Monitoring
- Data Visualization in real-time and in playback / post-mission mode
- Data Recording on the IMS and on the local host computer
- GUI Profile Management (multi user configurable)
- Export of measurement data in several file formats (XCOM, KML, XML, CSV, Waypoint InertialExplorer) including an integrated file converter
- Multi-Instances support, access to data of several systems
- Supports also operation within GNSS denied area by waypoint aiding within the map navigation feature of the GUI

The iXCOM-CMD software can be operated under MS WINDOWS™ or LINUX or Mac OS.

Additionally to the explanation of the iXCOM-CMD software, this manual contains some helpful information about inertial reference systems like GEOID / Ellipsoid / WGS84 / MSL definition (chapter 12) and general inertial navigation basics (chapter 13).

iMAR also provides some training information for the iXCOM-CMD software on request [10] (Table 1) as well as a software development kit (SDK) for the used XCOM protocol.

## 1.2 Hardware Coordinate Systems Required for IMS Installation

In [12] the definition of used coordinate systems is given, which are used to define the lever arms from the IMS to the GNSS antenna(s), to the odometer and to the virtual measurement point (VMP). The following figure gives an excerpt of those explanations.

### 1.2.1 Lever Arms for GNSS Antenna and Odometer

To achieve best system performance of the INS/GNSS/ODO solution, it is mandatory to know the lever arms from the INS to the GNSS antenna(s) as well as to the odometer inside the integrated data fusion algorithms with an accuracy which is at least better than the data accuracy achieved from the GNSS receiver or the odometer (i.e.  $\ll 2$  cm in case of using an aiding source of RTK level, i.e. about 1 cm accuracy). The same is valid for any other external aiding information regarding position or velocity (DVL, LIDAR, RADAR etc.).


Typically, the lever arm to these devices (GNSS antenna, odometer) or to the virtual measurement point(s) is surveyed with a theodolite or with a laser tracker inside of the application once the IMS is installed. An alternative method will be to acquire the lever arm coordinates from the mechanical drawings of the setup. A third alternative is to let the lever arm be estimated by the data fusion algorithms inside the IMS – this typically requires a high performance position aiding by RTK GNSS.

To make the acquisition of the lever arm measures more easy for the operator / surveyor, in all iNAT systems (i.e. using the iXCOM protocol or/and iXCOM-CMD software) the reference point for surveying any lever arm is the circular fitting / mounting through hole at the bottom plate of the IMS, and there specifically the mid of this hole<sup>1</sup>. The embedded software inside the IMS automatically performs the right transformation into the sensor's intersection point (for each enclosure the mechanical relations between the circular fitting hole and the sensor intersection point are stored inside the factory setup).

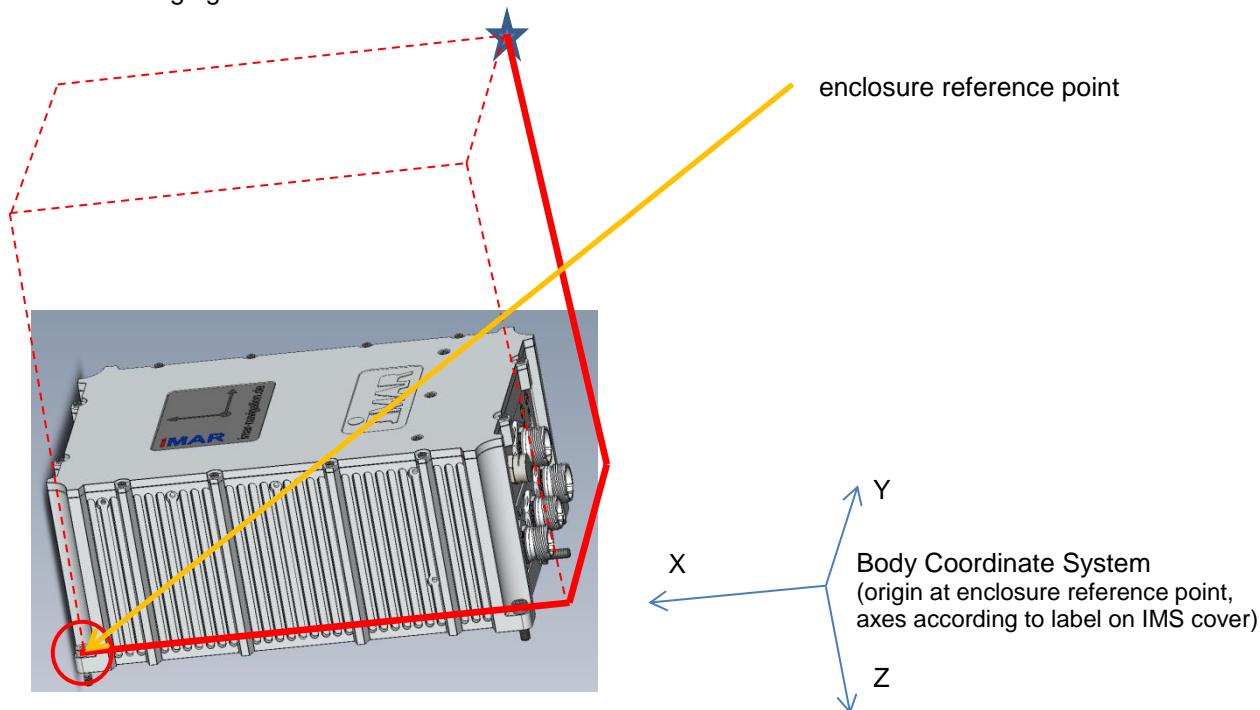
<sup>1</sup> Note: there are several fits available. Make sure that you use the through hole circular fit.

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The following figure shows this in detail.



**Figure 3: Lever Arm Definition**

The lever arm, to be entered by the user, is measured in all iNAT systems from the red circled fitting hole, called enclosure reference point (it is always the IMS' base plate rear hole on the left side, if you look from onto the front side of the system with the connectors, and cover upwards) to the blue marked star (location of GNSS antenna, odometer, virtual measurement point etc.). The lever arm is measured in Body Frame axes, as printed on the coordinate label being applied on the IMS (see chapter). Example:


lever arm x	=	- 364 mm
lever arm y	=	+ 232 mm
lever arm z	=	- 312 mm

Take care, whether the body z axis is directed down or up on the label of the IMS coordinate system (both is possible, depending on system factory setting according to the foreseen application).

### 1.2.2 Data Output Reference Point and Virtual Measurement Point

All output data of the iNAT systems like position, velocity, acceleration etc. as well as the IMS raw data are physically referenced to the center point of the inertial sensor cluster inside the IMS (Figure 3). If the "virtual measurement point" usage is deactivated, the output data are not transformed to any other point. It is possible to transform these data (with exception of the inertial raw data) into a virtual measurement point, if the usage of the virtual measurement point is activated (can be done via the GUI iXCOM-CMD or via direct command on the XCOM interface) and if the lever arm values (x,y,z) are set in Body Frame coordinates (according to the enclosure reference point [red circled in Figure 3] within the coordinate system given on the label on the IMS as defined in chapter 1.2.1). By default (factory set) the center of the inertial sensor cluster is given as value. If the user has overwritten this default lever arm and wants to return, he can reload the factory settings of the IMS configuration (or extract the values from the IMS drawings).

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## 2 SOFTWARE INSTALLATION

The latest version of this software can be found on iMAR's FTP server – please ask our support engineers for access data.

A new version of iXCOM-CMD can be typically installed without the need to de-install the previous or an elder version. Shut down all other software on your computer before starting the installation process and take into account all standard issues which have to be taken into account when installing software on your computer. iMAR cannot be held liable for any damages which might be caused by installing of software being provided by iMAR.

### 2.1 MS Windows™

Please execute the setup file on your installation CD or installation-USB-stick and follow the wizard instructions.

### 2.2 Linux

Please extract the contents of the zip-archive on your installation CD or installation-usb-stick to any folder of your choice.

The iXCOM-CMD software can be started by executing the start.sh script.

### 2.3 Deinstallation


In general a new software version can be installed on top of the existing version (if any), without the need to deinstall the elder version. The so far by the user created profiles (see following description) will not be overwritten and are available also in the new installation.

Nevertheless, with major changes in the profile structure with the new software version, it might be useful to deinstall the current version and to install the new version from the scratch. To do this, use the common deinstallation procedure for software being provided by the operational system. Additional make sure, that all configuration files within the folder (here as example under MS Windows™)

`C:\Users\username\AppData\Roaming\iMAR GmbH`

which are related to iXCOM-CMD (especially the iXCOM-CMD.xml file), are deleted completely.

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## 3 OVERVIEW AND USAGE


### 3.1 Cross Reference for Quick Start (Read before Use!)

The iXCOM-CMD software provides a graphical user interface (GUI) for easy operation of an inertial measurement system (IMS) or inertial navigation system (INS) of the iNAT / iATTHEMO / iSULONA / iCOMBANA / iPRENA system families (for simplification reasons, in the following of this manual we only talk about “iNAT” instead of all available system families).

To bring the IMS into operational mode, you may follow the following steps (incl. hyperlinks for a fast setup):

1. Mount the IMS on a rigid mounting area inside your vehicle / carrier with the desired mounting tolerances and make sure that the mounting area is suitable to operate an IMS (e.g. not affected by unwanted Eigenfrequencies under vibration impact).
2. Connect the GNSS antenna (in case you use a single antenna system, use always the input connector of GNSS Antenna #1). Mount the GNSS antenna(s) with a sufficient view to the sky / satellites (consider that in case of dual-antenna applications both antennas shall observe the *same* satellites to provide sufficient heading results). Use low-loss antenna cable in case of longer distances between IMS and GNSS antenna(s). Make sure, that the distance (“lever arm”) between GNSS antenna and IMS enclosure reference point (see [12] for details) will remain constant over time. In case of using a dual-antenna system make sure, that at least the primary antenna (GNSS Antenna #1) has sufficient view to the satellites in case you want to use GNSS aiding). Keep at least 1 m distance to all other electronic devices to achieve best GNSS signal quality (mounting the GNSS antenna e.g. directly on top of the INS enclosure might decrease RTK performance – as an example).
3. Connect the odometer (also named vehicle motion sensor or wheel speed sensor) with its A/B signals to the IMS (check electrical levels first!). Determine the operational mode of the used odometer (e.g. pulses on A, forward/backward signal on B, or e.g. quadrature signals on A and B).
4. Connect the IMS via Ethernet to the host computer or to your DHCP capable Ethernet network and install iXCOM-CMD on the host computer (see [chapter 2](#)). Depending on the settings of the IMS (see IMS configuration sheet, which should be provided together with the IMS) the network connection (operation inside a DHCP network or using a peer-to-peer Ethernet link to the host computer) and depending on the adjusted communication setup on the IMS (DHCP or static address) the setup has to be chosen.  
In case that the Ethernet settings of the IMS are not known, the connection can be built up via UART or USB interface. In this case the proper UART / USB cabling has to be done (if your computer has only USB interfaces available and you want to use the RS422 interface of the IMS, use an adequate converter and load the dedicated driver for those converter).
5. Provide a sufficient power supply and connect the IMS. Switch on the supply voltage. After about 20 seconds the system is ready to communicate with the host computer.
6. Start the iXCOM-CMD software ([chapter 2.1, 2.2](#)) and chose the “iExperienced” profile to configure the screen layout ([chapter 4.4.2.4](#)). This allows to insert later on all required lever

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arms etc. If you only want to configure the system first, you can also select the “iConfiguration” profile (**chapter 4.4.2.2**).

7. Select the desired way how to connect to the IMS. It can be via Ethernet, UART or USB according to the above done choice (**chapter 4.4.3**)
8. Build up a communication with the IMS by pressing the “Connect” button on the Application Bar (left button – will change to “Disconnect once the IMS has been connected”). See **Figure 9**
9. Now relevant parameters have to be adapted to inform the software being operated on the IMS about the real hardware and sensor configuration. E.g. a wrong (or not) inserted lever arm from the IMS to the GNSS antenna or to the odometer will cause wrong measurement results.

- a. Mounting angles (delta-roll, delta-pitch, delta-yaw) of the IMS can be applied to receive the measurement data in a desired vehicle coordinate frame while the IMS measures inside its body coordinate system (see **chapter 4.16.2** and [9] of **Table 1**).


**Hint:** After inserting the values, do not forget to press (as usual; see also the general description of this software) the “Apply” button (see **chapter 4.3.2**) and press the “Safe Config” button (see **Figure 9**) to make the changes permanent available on the IMS before switching off the power supply.

- b. Measure the lever arm from IMS (in body frame) from the enclosure reference point (details see [12]) to the GNSS antenna(s) and insert it in the software (**chapter 4.16.1**). Alternatively use the automatic lever arm estimation feature (Figure 69, chapter 4.16.1). Also adjust the correct aiding parameters for the GNSS data usage (see **chapter 4.18.2**).
  - c. Measure the lever arm from IMS enclosure reference point (in body frame) to the odometer and insert it in the software (**chapter 4.16.3**). Also adjust the other parameters which are required for the odometer signal processing (operational mode, mounting direction, scale factor etc.). Also adjust the correct aiding parameters for the odometer usage (see **chapter 4.18.3**).
  - d. If any, perform accordingly the settings of the zero velocity aiding (ZUPT, see **chapter 4.18.1**), magnetometer (**chapter 4.18.4**), of gravity aiding or any other aiding source.

**Hint:** As above mentioned, do not forget the “Apply” button and “Safe Config” in case you want to make the changes permanent.

10. Now configure the availability of desired data logs on specific data channels (**chapter 4.7**). Here it can be defined which data shall be displayed on the GUI, which data shall be stored on the “System Recorder”, which data shall be stored on the local “Host Computer” and which data shall be transmitted on which physical interface of the IMS (e.g. NMEA183 sequences on UART COM3).
11. Adjust the desired alignment procedure (how to find initial position, attitude and heading after IMS’ power on), if it is not already configured on the IMS (**chapter 4.17**). Examples: Waiting for GNSS position after power-on or using a stored position, performing a gyro compassing or an “in-flight” alignment etc.
12. Now the basis settings are made. If stored with “Apply” and “Safe Config” as described above, they are also permanent and available also after next power-up – and they can also downloaded from the IMS as a backup with “Download Config” (see **Figure 9**).

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13. Start now the “Alignment” (see **Figure 9**) and begin system operation. The Status Bar will give indications about the system status (**Figure 10**). If no GNSS data are available, you may configure the Alignment Startup Initial Position to “Forced” instead of “GNSS” (see chapter 4.17.2) – in this case the system would not wait until receiving GNSS data but would request initial coordinates from the user after the alignment process has been started.
14. Activate data storing if desired and if configured (press button REC INS or REC Host, see **Figure 9**), activate data visualization of moving map, time charts, instruments etc. (**chapter 4.14**) or have a look to the numerical values (to alter the output of measurement data, e.g. to display gravity compensated acceleration instead of accelerometer raw data, select the desired data format; see **Figure 51**) of the measurement results (**chapter 4.12**).
15. If data recording on the IMS is configured (see above) and data have been stored during the mission on the IMS internal memory (REC INS), they can be downloaded via “System Recorder” (see **chapter 4.9**).

This chapter is only a short comprehensive guideline to operate the IMS using the iXCOM-CMD software. It is recommended and also mandatory to study the full manual to be able to use all valuable features of the the IMS and the iXCOM-CMD software.

Furthermore a powerful SDK is available for those users, which like to implement their own interface to control any IMS of the iNAT system family.

## 3.2 General Overview

The iXCOM-CMD software provides a graphical user interface (GUI) for easy operation of an inertial measurement system (IMS) or inertial navigation system (INS) of the iNAT / iATTHEMO-B/C / iSULONA / iCOMBANA / iPRENA system families (for simplification reasons, in the following of this manual we only talk about “iNAT” instead of all available system families).

This manual gives an introduction where to find the commands and parameters being required to configure an iNAT system and to collect measurement data. This manual will not explain in detail how to operate an IMS or INS (in the following we simply name such system IMS or “device”), so a basic understanding about inertial measurement systems is expected from the user. See [9] in Table 1 for more details.

Before reading this manual in detail, please have a look to the chapters “Installation (Hardware & Communication)” and “Quick Start” of the document [5] in Table 1 to gather the required backup information how to install the IMS, how to handle mounting misalignment angles and GNSS antenna lever arms (see [12]) etc.

In chapter 3.1 a quick cross reference is given for a quick start (where to do what to get the IMS running).

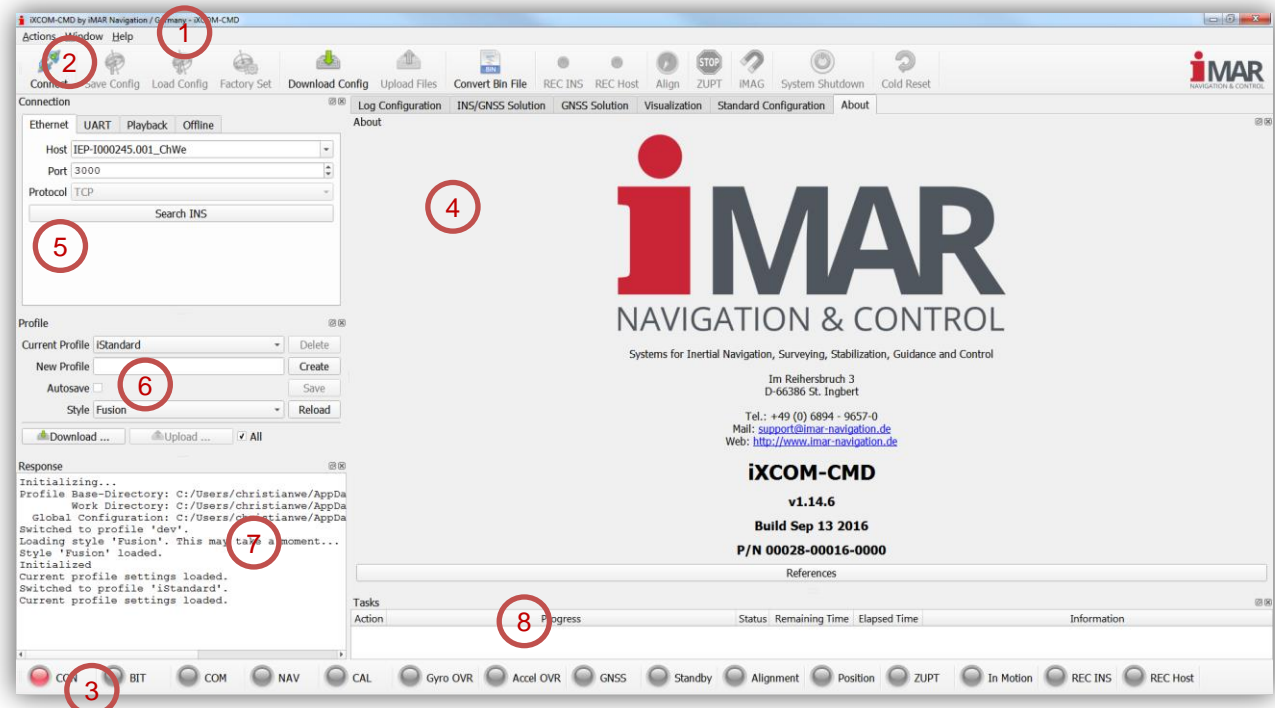
In the following chapters the iXCOM-CMD GUI is described in detail.

## 3.3 Main Screen Overview

The main screen layout can be highly configured by the user. The following screen shows the default layout profile (“iStandard”).

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**Figure 4: Default Application Layout**

The default layout of the graphical user interface (GUI) consists of several core windows as shown in Figure 4. The menu bar (1) is always located at the very top, followed by the application bar (2). The status bar (3) is found at the very bottom. The center (4) consists of several tabbed panes for data visualization and configuration. The connection window (5) configures the connection to the inertial device. The profile window (6) allows users to customize the GUI. The response window (7) provides feedback about what's happening behind the scenes. All tasks, like downloads/uploads etc., are managed by the task window (8).



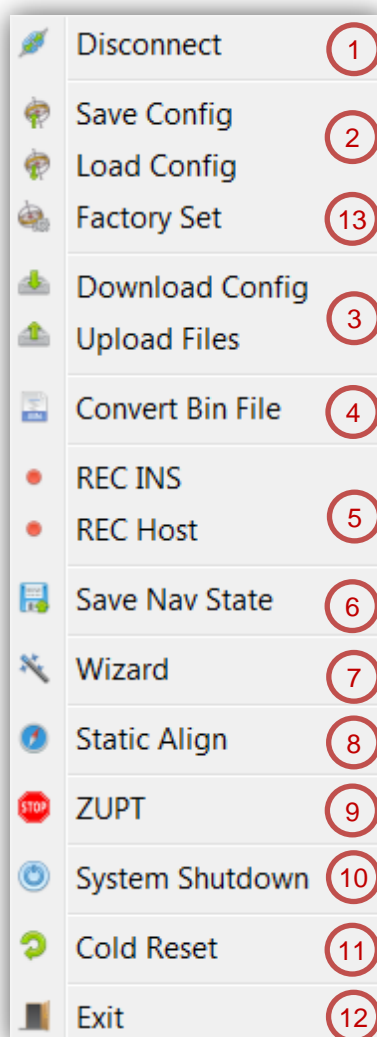
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## 4 DETAILED DESCRIPTION OF FUNCTIONS

### 4.1 Menu Bar

The menu bar consists of the menus **Actions**, **Window** and **Help**, further described below.

#### 4.1.1 Actions Menu



**Figure 5: Action Menu**

The actions menu provides the most important functions.