SCITOS G5

User Manual

Version 1.2

Serial Number: 10388-001 (Mobile Robot Base)
10388-002 (Human-Machine-Interface)
10388-003 (Docking Station)

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suggestions.

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Contents

1 Introduction

1.1 Description

Congratulations on your purchase of the new mobile robot SCITOS G5! It is designed to accelerate your research activities, e.g. in the fields of mapping, localization, path-planning, experimental studies associated with SLAM procedures or human-machine-interaction. To get your SCITOS G5 working, please have a look at the relevant sections in this manual first – we have tried to pack all important information. In the following section you find important notices relating to a safe handling of your new SCITOS G5. To get a general idea about important functions and the daily usage of your SCITOS G5 read chapter 2. If you want to change or extend your mobile robot platform please have a look at chapter 3. There is an extra software documentation available which informs you about the programming.

SCITOS G5 is thoroughly designed, engineered and produced. Therefore, we have merged state-of-the-art knowledge from robot research with industrial standards for robust products. SCITOS G5 can be enlarged and improved to a fully-fledged interactional robot. Therefore, a set of various optional extension modules like an omni-directional camera, front cameras, a touch screen monitor, different microphones, and loudspeakers et cetera, is available and ready for implementation. Packed with this equipment, you can accomplish research and studies in detection, tracking or identification of individuals and objects as well as developments and investigations of techniques for an adaptive conversational control.

Our mobile robotic platforms are subject to severe quality checks. However, if you notice any deficiencies or if you have any suggestions for improvement do not hesitate to contact us. We are interested in a close partnership to our customers.

We thank you for your confidence and hope that the daily work with your SCITOS G5 will give you pleasure many years!

1.2 Scope of delivery

Please check the components carefully after you unpack them from the shipping box:

- 1 fully assembled mobile robot platform SCITOS G5 with a battery package inside
- 1 SCITOS G5 Human-Machine-Interface (HMI) with a SCITOS G5 RoboHead
- 3 replacement fuses (two for main power supply: 10 A, one for the battery: 20 A)
- Power cable
- Tool kit
  - torx screwdriver for exchanging the electronic modules
  - hexagon wrench key for opening the enclosure
- USB flash drive (recovery, manuals, software)
- Set of manuals

Please keep the shipping box in a dry place. It is reusable and intended for your own safe transport of the robot.

1.3 Important safety instructions

A mobile robot platform is a motor driven device which should be treated with caution. Allow us to call your attention to the following safety instructions during the life cycle of your SCITOS G5:

Shipping

- Use the shipping box and clamping fixtures for transportation (Figure 1.1).
- The mobile robot platform including shipping box weighs about 85 kg. The weight differs from optional equipment. So you need at least two or three persons to lift or carry the mobile robot platform including shipping box. Pay attention to your hands, fingers and feet.
- Pay attention to the balance point if you use a trolley.
- Fix the shipping box, e.g. by using belts, during transportation in a car.

Setting up

- Only unpack and store the shipping box on a flat surface.
- Check the mobile robot platform for transportation damages.

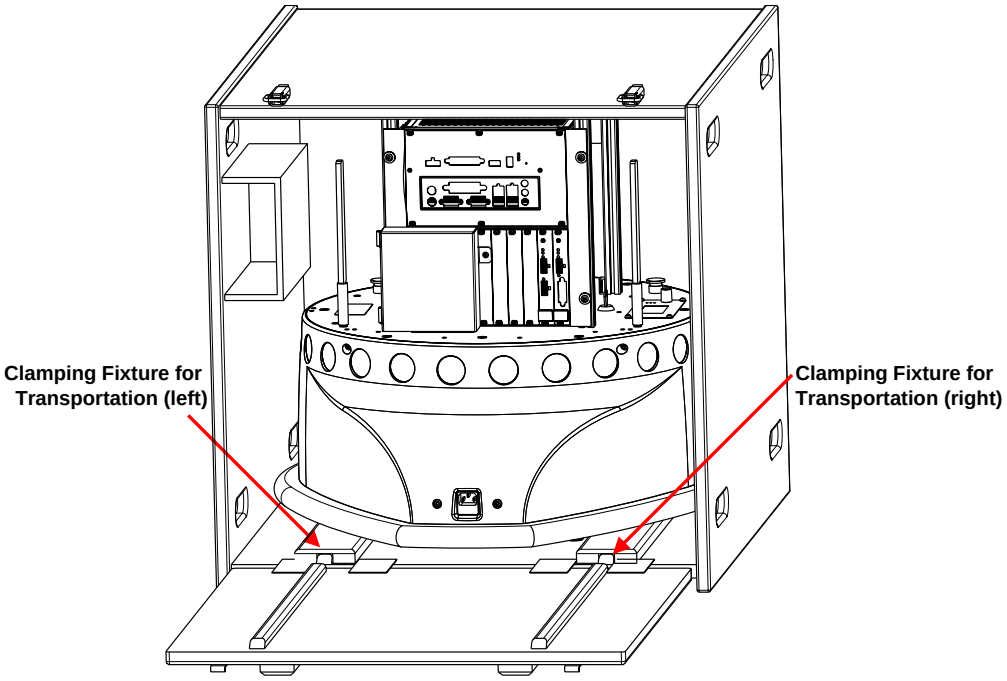

Figure 1.1: SCITOS G5 clamped to plywood transportation-box.

Usage SCITOS G5 is a professional all-purpose mobile robot platform. In delivery status its intended usage is limited to scientific elaborations for mapping, localization and path-planning of autonomous mobile robots as well as human-machine-interactions. These elaborations have to be conducted in a closed dry room on a hard, flat surface which is entirely bordered by walls. See chapter 3 before changing the usage or installing optional equipment.

General safety instructions

- Before charging always check the power cable if there are any damages. Do not use a damaged cable.
- Do not use an extension cord for charging the mobile robot platform.
- Do not use the robot platform to transport people.
- Before opening the robot platform, disconnect mains.
- Do not use the platform in environments with stairs.

Driving mode Before you run your software on the robot, make sure that the mobile robot platform

- Will move on a hard, flat surface in a closed, dry room
- Does not leave the surface (in delivery status the mobile platform cannot detect stairs, holes et cetera)
- Does not clash with persons
- Does not pass over edges that are higher than 15 mm.
- The both buttons on the first metal plate stop the motors of the robot base only. They do not stop any optional equipment!

Figure 1.2: Stop Buttons.

Programming and extensions

- Analyse hazards and risk first (see section 3.1). Evaluate solutions for a safe operation of the mobile robot platform in combination with new components.
- Before opening the robot platform, disconnect mains.
- Do not mount components which protrude over the bumper. Otherwise the bumper does not detect collisions.
- The maximum payload of the total optional equipment is limited to 50 kg.
- Verify the center of gravity of the mobile robot in combination with the newly mounted components and changes of steadiness in driving modes, especially during emergency stops.

Maintenance

- Only carry out maintenance that is described for users in the manual. Service and repairs of the SCITOS G5 relating to power supply, drive section or electronic modules must be carried out only by MetraLabs GmbH or authorised support partners.
- For electric works, disconnect the batteries first. If you are using metal tools, explosions are possible. Use protective gloves and glasses.
- Before opening the robot platform, disconnect mains.
- Be careful with your fingers during adjustment and assembly works (risk of injuries).

2 Getting your SCITOS G5 started

2.1 SCITOS G5 at a glance

SCITOS G5 platform combines the reliability of industrial standards with the flexibility of contemporary embedded systems. As power engines of the platform two three-phase EC-motors come into operation. Due to their technology they have a higher degree of efficiency as well as longer durability than conventional direct current motors. The batteries are located in the lower part of the robot, only about 5 cm away from the ground. During operation they are securely positioned. Together with its robust construction of laser cut aluminum discs a very low balancy point is being achieved. The superstructure of the platform is marked by standardized aluminum profiles, which enable a very flexible arrangement of diverse add-ons. Consequently, you have a lot of possibilities to attach e.g. camera systems.

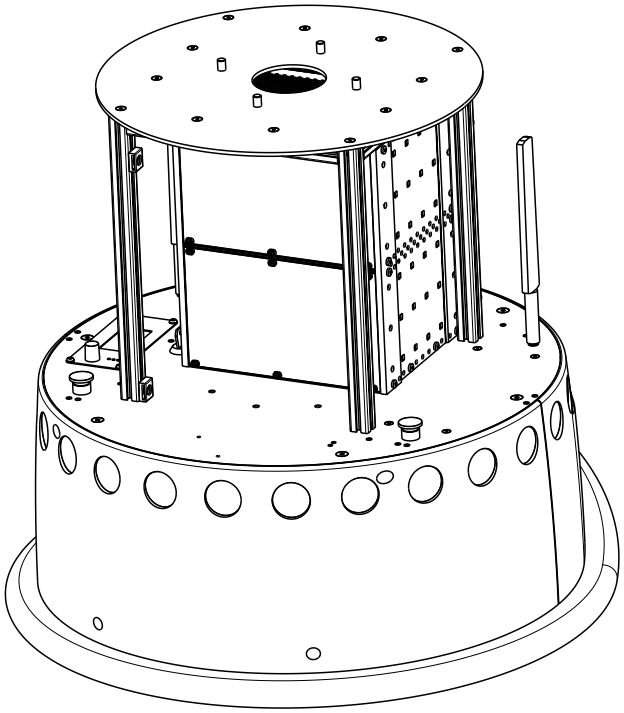

Figure 2.1: Frontview of SCITOS G5.

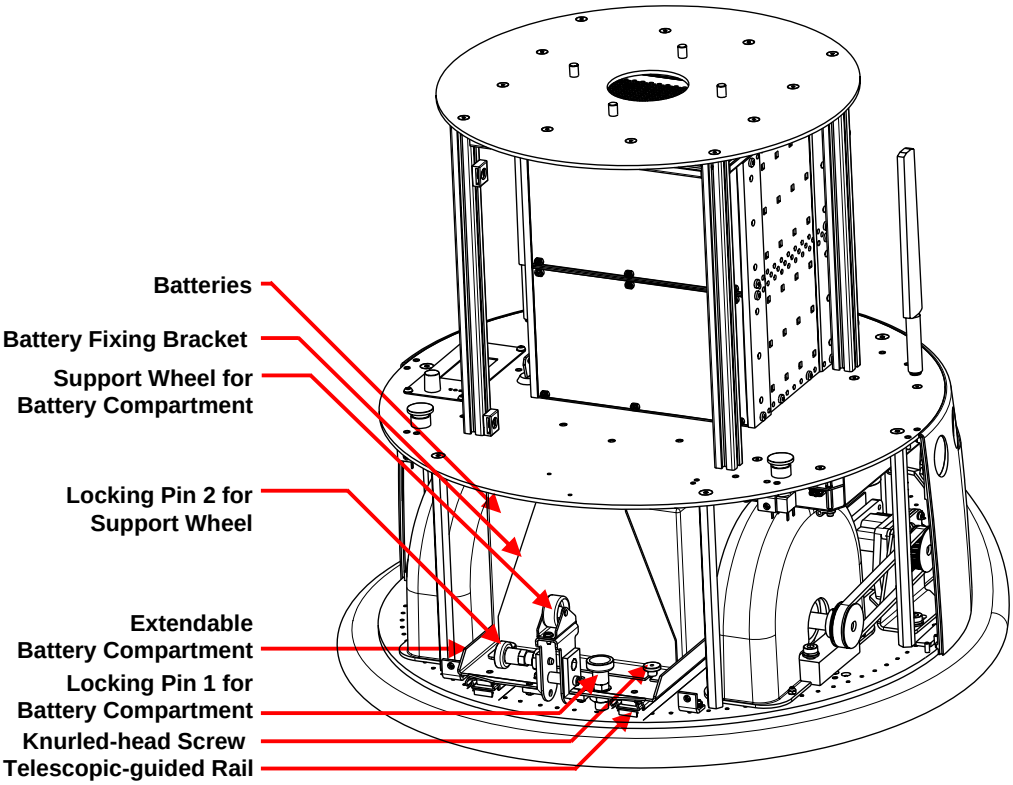

Figure 2.2: Frontview SCITOS G5 (opened front chassis).

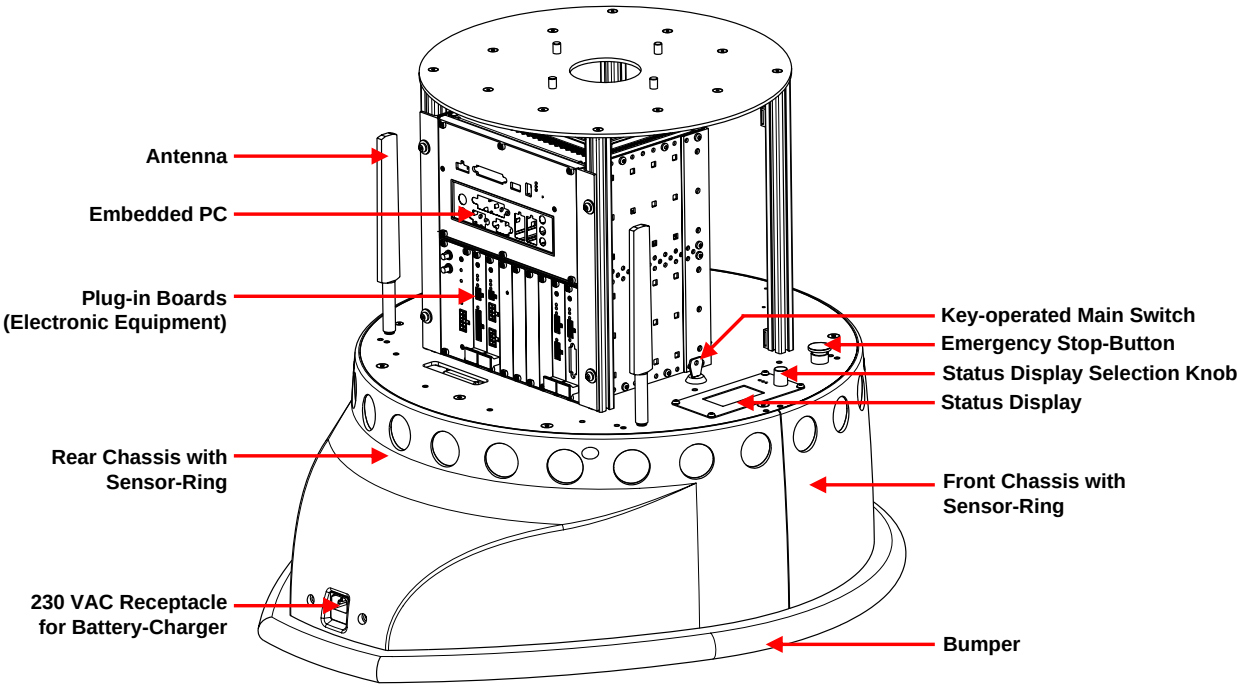

Figure 2.3: Rearview of SCITOS G5.

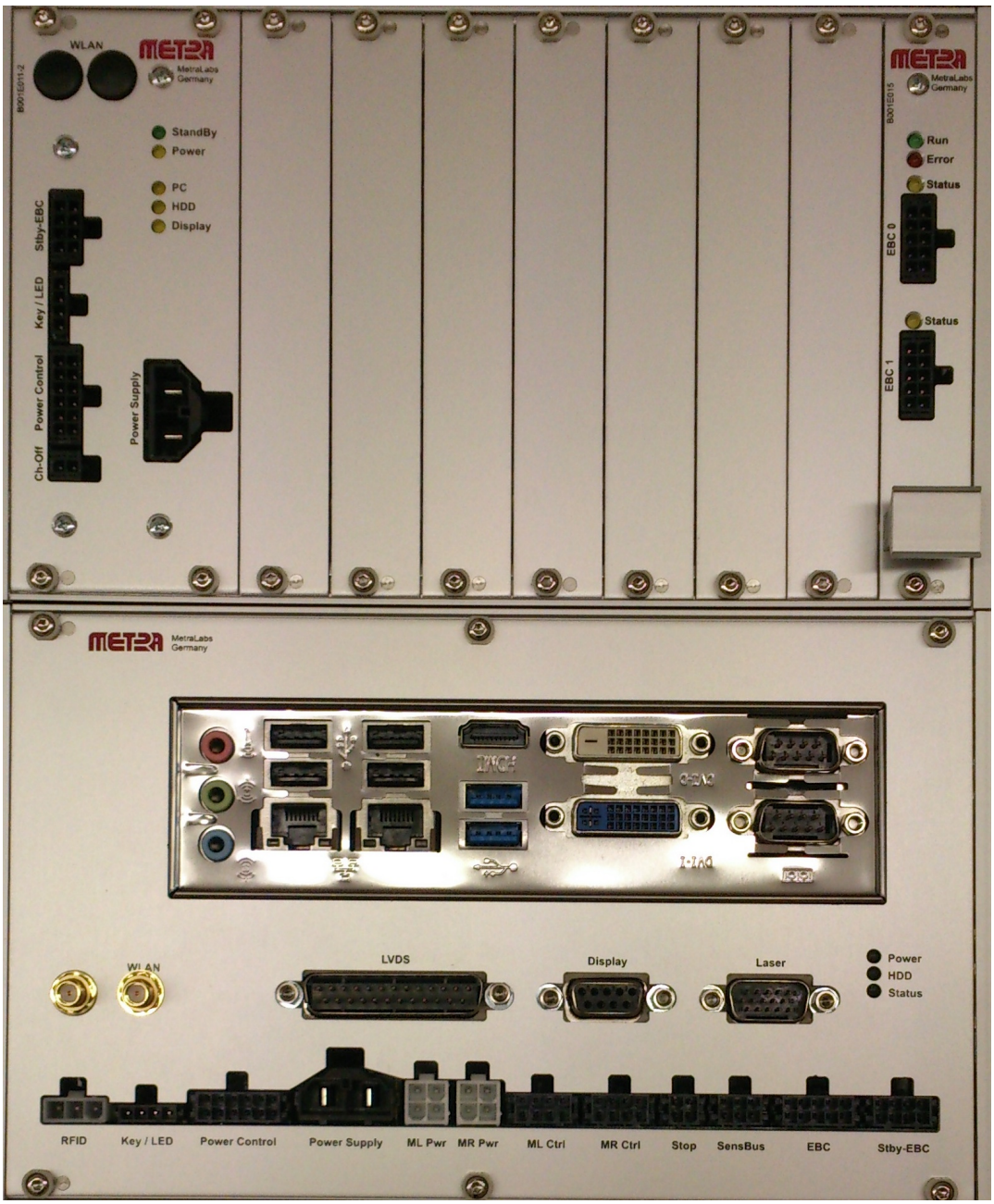

Figure 2.4: Electronic-Case of SCITOS G5.

Description of connecting cables

RFID:	RFID floor antenna (optional)
Key/LED:	key switch
Power Control:	contol of the charging unit
Power Supply:	power supply of the charging unit (input)
ML Pwr:	power-out for left motor

MR Pwr:	power-out for right motor
ML Ctrl:	control for left motor
MR Ctrl:	control for right motor
Stop:	Bumper / Stop-button
SensBus:	Sonar sensors (optional)
EBC:	External Bus Connector (voltage outputs: 5 VDC, 12 VDC, 24 VDC battery voltage, CAN)
Stby-EBC:	Status Display / Monitoring

The mobility of the SCITOS G5 system is made available by a maintenance-free differential drive. The drive moves the 60 kg platform with a speed of up to 1.1 m/s (top-speed limited electronically) and handles payloads of up to 50 kg without any difficulties.

The standard SCITOS G5 houses a ring of 24 ultrasonic range finders to obtain an image of the environment around the robot. Its safety system involves a closed bumper.

Most of the electronic components are situated in the electronic cage. Hardware modifications or expansions can be conducted easily. The hardware configuration, which is currently integrated, is identified by the system itself, and accordingly activated.

SCITOS G5 is controlled by an embedded PC with an Intel multicore processor and a multitude of small hardware units which monitor several functions of the robot. The remote cross linking is carried out by CAN-bus. Communication is highly reliable due to reciprocal condition checks.

The hierarchical energy-saving concept in conjunction with the energy-saving units enables a long run time. Two lead-acid gel batteries with an overall capacity of 912 Watt-hours operate the platform for up to 12 hours in normal usage. The integrated charging unit ensures that SCITOS G5 is also easy to use outside the lab.

2.2 Charging

The battery-system consists of a 25.6 Volts lithium battery with 60 Ampere-hours. The total charge accumulates to nominal 1,536 Watt-hours. The voltage range of the battery is between 20.0 Volts and 30.4 Volts.

Lifetime The life of the applied rechargeable battery operating under normal conditions is around 1,200 charge-discharge cycles. This translates into at least five years of battery life for the average usage. Actual battery run-time depends upon the power demands made by the equipment. As the rechargeable battery begins to die, the user will

notice a decline in the running time of the robot.

Storage Period A charged battery will lose its charge if unused. It may therefore be necessary to recharge the battery after a storage period: If the robot will not be in use for a month or longer, it is recommended that it should be stored in a cool, dry, clean place. Also a new battery has to be charged before use.

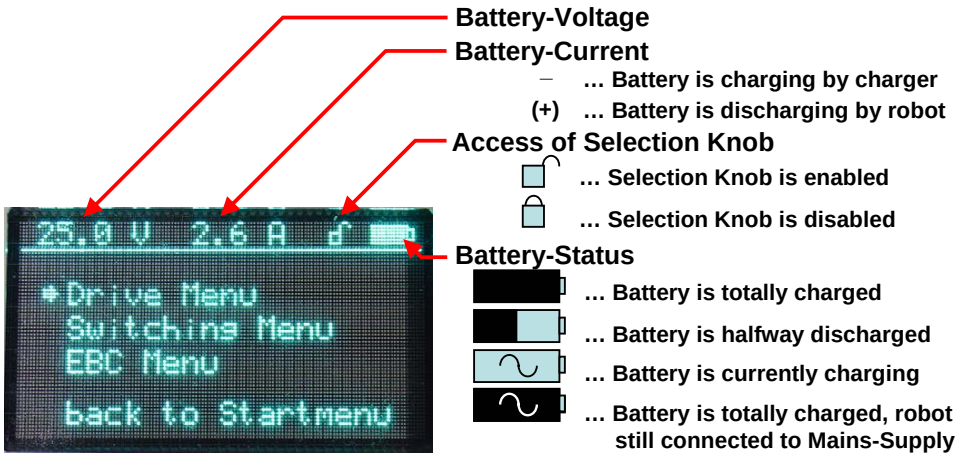

Figure 2.5: Display of Charging Status.

Battery Don'ts

- Do not drop, hit or otherwise abuse the battery / robot as this may result in the exposure of the cell contents, which are corrosive.
- Do not expose the battery / robot to moisture or rain.
- Misuse of the battery may result in the battery generating heat, exploding or igniting.
- Do not immerse the battery / robot in water or sea water or allow it to get wet.
- Do not use the battery with the positive and negative terminals reversed.
- Do not short circuit the battery. Do not pierce the battery with nails, strike the battery with a hammer or subject it to other strong shocks.
- Do not disassemble or modify the battery.

- Do not place the battery / robot in or near fires, stoves or other high temperature locations. Do not incinerate. Exposure of battery to extreme heat may result in an explosion.
- Do not use or store the battery inside cars during hot weather. Doing so may cause the battery to generate heat, explode or ignite. Using the battery in this manner may also result in deterioration in performance and service life.

In case of discharged batteries If the voltage of the batteries drops below 22.2 V, SCITOS G5 will automatically start a shut down procedure. At first it beeps every two seconds and the charge-scale on the Status Display flashes. After 8 minutes, the embedded PC shuts down and the charge-scale flashes more frequently. After 10 minutes, the robot shuts down completely. Put the IEC plug in the 230 V Receptacle for Battery-recharge.

Warning: Batteries are not designed for deep discharge and can easily be damaged by deep discharge. Repeated deep discharges will result in capacity loss and ultimately in premature failure, as the electrodes disintegrate due to mechanical stresses that arise from cycling.

2.3 Setup

Preparation If you operate a SCITOS G5 without any corresponding *Human-Machine-Interface* and you want to configurate the (W)LAN-interface of the robot after booting, you need to connect a keyboard via USB to the embedded PC.

Switch-on

- Turn the key-operated *Main Switch* (Figure 2.3) clockwise: The *Status Display* illuminates. (If it does not, the batteries could be totally discharged and/or there might be a defect in the power supply or the integrated battery charger.)
- In main menu of the *Status Display*:
  1. *Start Robot & PC* or
  2. *Start only Robot*

  Select menu item 1) for starting the robot and the internal PC.

Please wait until the robot has finished its booting procedure.

Log-in and configuration: Please refer to document "SCITOS G5 – Embedded PC and Operating System".

2.4 Status Display

After you turned on your SCITOS G5 and chose *Start Robot & PC* or *Start only robot*, the *Status Display* will show the *Main Menu* (see also section 2.3). You will see the following options:

- *Drive Menu*
- *Switching Menu*
- *EBC Menu*
- *Back to Start menu*

Drive Menu The drive Menu shows the odometry of the robot. You can see the x, y and ϕ coordinates. Select *Reset Odometry* to reset them.

Also the status of the motors is being shown. Depending on the *Free Run* mode (see *Switching Menu*) it behaves in the following way:

- *Free Run* OFF

  If neither the bumper nor one of the emergency stop buttons are engaged, *Normal* is being displayed. As long as the bumper or one of the emergency buttons are pressed, the brakes engage and *Bumper* or *EmerButton* is being displayed. After they are released again, the motor status shows *Stop*. Go to the *Switching Menu* to turn off the motor stop.

- *Free Run* ON

  If neither the bumper nor one of the emergency stop buttons are engaged, *Brakes Off* is being displayed. As long as the bumper or one of the emergency buttons are pressed, *Bumper* or *EmerButton* is being displayed. After they are released again, the motor goes automatically back to *Brakes Off*. This prevents you from having to reset the motor stop each time you drag the robot around freely and hit the bumper by accident.

Back to Mainmenu brings you back to the *Main menu*.

Switching Menu In the *Switching Menu* you have the following options:

- *Motor Stop*

  Shows the status of the brakes. If the bumper or one of the emergency buttons were engaged, the robots stops automatically. Select to release the motor again.

- *Free Run*

  Use the *Free Run* mode if you want to drag the robot around easily. The brakes will not engage when pressing the bumper or the emergency buttons.

- *Sonar Sensors*

  Turn the sonar sensors ON or OFF

Back to Mainmenu brings you back to the *Main menu*.

EBC Menu The *EBC Menu* lets you turn ON or OFF each EBC port individually. Select the desired port and press the selection knob to change its status.

3 Maintain & extend your SCITOS G5

3.1 Review sources of hazards

SCITOS G5 is a professional all-purpose mobile robot platform. In delivery status its intended usage is limited to scientific elaborations for mapping, localisation and path-planning of autonomous mobile robots as well as human-machine-interactions. These elaborations have to be done in closed dry rooms on hard, flat surfaces which are entirely bordered by walls. Please ensure that the mobile robot platform

- cannot leave the surface (in delivery status the mobile platform cannot detect stairs in the floor, holes et cetera)
- cannot clash with persons, especially with children, elderly or disabled persons
- cannot encounter steps that are higher than 15 mm.

The specialty with SCITOS G5 mobile robot platform is, that with the proper combination of software and additional hardware you can develop a wide range of applications. MetraLabs GmbH itself offers mobile service robots for the public domain which are based on the SCITOS G5 mobile robot platform. SCITOS G5 is designed to make it easy for you to implement, to develop or to test your software or to extend the platform with further sensors, cameras, actuators or displays. But keep in mind that any software programming or hardware extension could cause hazards. Like a motorist you decide about the robot movements. Like a motorist, who can avoid accidents by a careful manner of driving, your software determines the movements of the robot. Furthermore, your hardware configuration decides what kind of obstacles the mobile robot platform can detect.

We recommend to analyse possible hazards and risks in the following way before you change and run the mobile robot platform:

1. Find out adequate official directives regarding to the planned specific application of your mobile robot

2. Determine the steps involved in operating the robot. There are a number of steps incorporated in operating any machine, including transport, setup and start-up procedures, usage, adjustments, trouble shooting, maintenance, cleaning or disposal.

3. Identify potential or existing hazards for each operating step. There may be one or more existing or potential hazards for each step associated with any actions the operator is taking. The following table gives you a review about typical mechanical, electrical, thermal and other hazards. As you analyze each step for hazards, ask yourself questions such as

   - Are persons in the environment of the robot located in a way that is potentially dangerous?
   - Can the user be struck by an object, lean against or strike a robot part or object?
   - Are there objects, such as sharp robot edges, that may cause injury?
   - Is the user wearing jewelry, clothing or long hair that could get caught in the robot?
   - Is the user required to make movements that could cause hand or foot injuries?
   - Can the user or persons in the environment of the robot get caught in or between robot parts?
   - Can persons in the environment of the robot be injured by reaching moving robot parts or materials?
   - Do suspended loads or potential energy (such as compressed springs, hydraulics, or jacks) pose hazards?
   - Can the materials being used cause injury?
   - Do environmental hazards, like dust, chemicals, radiation, welding rays, excessive heat or noise, result from the robot?

4. Evaluate the cause of the hazard so that preventive measures can be taken. When the reasons users are exposed to hazards become clear, then effective steps can be taken to deal with hazards.

5. Choose the most effective measures to prevent injuries and accidents.

6. An element of risk remains in the majority of cases. So in the last step you should estimate the remaining risk regarding to the possible hazards. Ask yourself what could be the most dangerous injury regarding to the hazard considered. Then categories the risk. You can use the following classes:
   a) Severity of injury: 1 (healable, reversible), 2 (not healable, deathly, not reversible)
   b) Frequency and duration of the hazard: 1 (rarely / short duration), 2 (often / long duration)
   c) Possibilities to avoid injuries: 1 (possible under certain conditions), 2 (hard to avoid / impossible)

For an example see our analysis of hazards of the mobile robot platform SCITOS G5 in delivery status. If you need further information feel free to contact us. Reference books will also give you further instructions.[1] Furtermore, it is advisable to work together with safety experts.

[1] E.g. ERICSON, CLIFTON A. Hazard analysis techniques for system safety, Hoboken, NJ: Wiley-Interscience, 2005. Basically, the described analysis is taken from SCHULZ, M. : Gefahrenanalyse und Risikobeurteilung. Ed.: GFT Gesellschaft für Technische Dienstleistung. Abtsgmünd : Schulz, Fachverl. für Techn. Dokumentation, 2003 (German).

no.	hazards	event / safety target	solution	standards				risk evaluation			
				annex I Mach. D.	EN 12100-1	EN 12100-2	other	S	F	P	TR CC
1	Mechanical hazards due to							–	–	–	–
	Robot parts or tools, e.g.: • shape • relative location • mass and stability (potential energy of elements which may move under the effect of gravity) • mass and velocity (kinetic energy of elements in controlled or uncontrolled motion) • inadequacy of mechanical strength, which may generate hazardous breakages or bursts,	SCITOS RoboHead (optional equipment) could suddenly move	SCITOS RoboHead moves inside a transparent plastic encasement, no other peripheral moving parts	1.3	4.2	4.2, 5					
	Accumulation of energy inside the robot, e.g. • elastic elements (springs) • liquids or gases under pressure • vacuum			1.5.3, 1.6.3	4.2	4.10, 5.5.4					
1.1	Crushing • too small minimum gap • mass and/or velocity of parts • inadequate mechanical strength • actuation force	• In driving mode: robot could clash with a person • In driving mode: sloping or undefined ground could lead to uncontrollable movements of the robot; in delivery status the robot cannot detect such situations • During programming: changes of the robot software could lead to sudden movements; persons around the robot could be hurt	• A bumper stops the robot after a collision. • Two emergency stop buttons on the top of the robot • Note in the users manual: There must not be persons in the environment of the robot during driving mode. • Note in the users manual: The environment of the robot has to be entirely bordered by walls. • The robot does not move during updates of the firmware.	1.3	4.2.1, 4.2.2	4.2,5	EN 294, EN 349	1	1	1	B/1

no.	hazards	event / safety target	solution	standards				risk evaluation			
				annex I Mach. D.	EN 12100-1	EN 12100-2	other	S	F	P	TR CC
1.2	Shearing • too small minimum gap • shape of shearing elements • mass and/or velocity of parts • inadequate mechanical strength • actuation force			1.3	4.2.1, 4.2.2	4.2,5	EN 294, EN 349				
1.3	Cutting / Severing • too small minimum gap • shape of cutting elements: sharp edges/corners, rough surfaces) • mass and/or velocity of parts • inadequate mechanical strength • actuation force			1.3.4	4.2.1, 4.4.4	4.2, 5	EN 294, EN 349, EN 811				
1.4	Entanglement • movement of parts • shape and relative location of parts • mass and/or velocity of parts • driving force	In case of being close to the driving wheels, they could wind up hairs, fur, yarns etc.	Moving parts of the robot are covered as far as possible.		4.2.1, 4.2.2	4.2, 5		1	1	1	B/1
1.5	Drawing-in / Trapping • devices that could entrap people • elements that cannot be moved manually upon emergency stop • elements that may suddenly move in the opposite direction • moving parts • automatic feeding and output devices • hazards while resolving errors (between devices and machine parts, between materials processed)				4.2.1	4.2, 5					

no.	hazards	event / safety target	solution	standards				risk evaluation			
				annex I Mach. D.	EN 12100-1	EN 12100-2	other	S	F	P	TR CC
1.6	Impact	see 1.1	see 1.1		4.2.1	4.2, 5		–	–	–	–
1.7	Stabbing / Puncture				4.2.1	4.2, 5		–	–	–	–
1.8	Friction / Abrasion of materials • general properties • corrosion, aging, wear • homogeneity • toxity				4.2.1	4.3 b					
1.9	High pressure fluid injection or ejection • exceeding of maximum pressure admissible • pressure loss • loss of vacuum • leakiness • failure of a component • vessel and accumulator do not meet requirements for such components • inadequate fastening of lines • plant section, especially pipes and horses, are not protected from damaging exterior influences • accumulators and vessels are not automatically relieved form pressured when the robot is disconnected from the energy supply			1.3.2 ZH 1/74	4.2.1	4.10, 5		–	–	–	–

no.	hazards	event / safety target	solution	standards				risk evaluation			
				annex I Mach. D.	EN 12100-1	EN 12100-2	other	S	F	P	TR CC
1.10	Ejection of objects • mass and velocity • acceleration • inadequate mechanical strength • exceeding of maximum pressure admissible • pressure drop/loss of vacuum • areas that remain pressurised even after the machine has been disconnected from the energy supply	Parts of driving chain (motor, gearbox, belt) dissipate	All moving parts are enclosed or covered	1.3.2, 1.3.3	4.2.2	4.10, 5					
1.11	Loss of stability in the robot or its components (overtuning, falling, unexpected movement) • disregard for technical rules concerning: design and construction of machinery (calculation rules), external forces, e.g. vibration, wind, climatic conditions • internal forces, e.g. gravity • dynamic forces, e.g. vibrations, electrodynamic forces • inadequate mechanical strength • disregard for operating conditions • unsuitable foundation (e.g. single-sided lowering). The consequences could be overturning, falling, crushing or indention.			1.3.1	4.2.2	4.3 a, 4.6, 5.2.6					
1.12	Slipping / Tripping / Falling due to mechanical properties • slippery materials in areas frequently by pedestrians • unsuitable rails, posts, foot rails and hand guides • unsafe access (stairs, ladders, etc.) for all relevant locations: operating procedure, tooling, maintenance			1.6.2	4.2.3	4.3 b, 4.8, 5.5.6					
2	Electrical hazard due to										

no.	hazards	event / safety target	solution	standards				risk evaluation			
				annex I Mach. D.	EN 12100-1	EN 12100-2	other	S	F	P	TR CC
2.1	direct contact of persons with live parts	The robot is supplied by 230 V during charging.	• Non harmful voltages accessible on the outside of the mobile robot platform • Note in the users manual: Before opening disconnect mains. • Protective plate on the back of the ICE power socket • Extra enclosure for the charging unit inside the mobile robot platform	1.5.1, 1.6.3	4.3	4.9, 5.5.4	EN 60204-1				
2.2	direct or indirect contact of persons with parts which have become live under fault conditions (especially insulation failure)	Insulation failure, dismantling of contacts during charging	• Tangible electroconductive parts which have become live under fault conditions are connected to the protective earth conductor • Note in the users manual: Before opening disconnect mains.	1.5.1	4.3		EN 60204-1				
2.3	approach of persons to live parts in the range of high voltage			1.5.1, 1.6.3	4.3	4.9, 5.5.4					
2.4	electrostatic phenomena	depending on the movements of the robot on different surfaces	one grounded wheel so electric charges can flow off	1.5.2	4.3	4.9, 5.5.4					
2.5	thermal radiation or phenomena, such as projection of molten particles, and chemical effect from short-circuits, overloads, etc.			73 / 23 / EEC	4.3	4.9					
3	Thermal hazard resulting in										

no.	hazards	event / safety target	solution	standards				risk evaluation			
				annex I Mach. D.	EN 12100-1	EN 12100-2	other	S	F	P	TR CC
3.1	burns, scalds, frost bites and other injuries from contact with objects or materials with an extremely high or low temperature, flames or explosions and radiation from heat sources	If the wheels are locked the motors could overheat.	• The bumper stops the motors in case of collisions • The bumper is directly connected to the motors. No software switch off. • Bumper or emergency stop failures are detected by software. • The maximum current of the motors is speed controlled.	1.5.5, 1.5.6, 1.5.7	4.4	4.8.4	EN 563	2	1	1	1/2
3.2	Health-damaging effects generated by hot or cold work environment			1.5.5	4.4	4.8.4					
4	Hazards generated by noise resulting in										
4.1	impaired hearing acuteness, permanent loss of hearing acuteness (deafness) or their physiological effects (e.g. tinnitus, tiredness, stress, loss of balance, loss of awareness			1.5.8	4.5	4.2, 4.8.4					
4.2	interference with speech communication, acoustic signals, etc.			1.5.8	4.5	4.2, 4.8.4					
5	Hazards generated by vibration										
5.1	use of hand-guided tools for a prolonged period with the result of neurological and vascular disorders, etc.			1.5.9	4.6	4.8.4					
5.2	vibration transmitted to the whole body , especially in connection with unhealthy postures			1.5.9	4.6	4.8.4					
6	Hazards generated by radiation										
6.1	low frequency, radio frequency and micro-waves			1.5.10	4.7						
6.2	infra-red, visible and ultra-violet light			1.5.10	4.7						
6.3	X and gamma rays			1.5.10	4.7						
6.4	alpha, beta, electron, ion or neutron radiation				1.5.10, 1.5.11	4.7	4.2.5				
6.5	laser radiation	laser range finder (optional equipment)	Referenced to the users manual of the laser range finder	1.5.12							

no.	hazards	event / safety target	solution	standards				risk evaluation			
				annex I Mach. D.	EN 12100-1	EN 12100-2	other	S	F	P	TR CC
7	Hazards generated by materials and substances (and their components), processes, used or exhausted by robot										
7.1	resulting from contact with, inhalation of, fluids, gases, mists, furness and dusts			1.1.3; 1.5.13	4.8						
7.2	resulting from overheating, fire or explosion			1.5.6, 1.5.7	4.8						
7.3	biological (e.g. mould) or micro-biological (viral or bacterial) hazards			1.1.3	4.8						
8	Hazards generated gy neglecting ergonomic principles in robot design, such as hazards from										
8.1	unhealthy postures, excessive or repetitive efforts			1.1.2 d, 1.1.5, 1.6.2, 1.6.4	4.9	4.8.5					
8.2	mismatch of the robot with human characteristics hand/arm or foot/leg			1,1,2 d, 2.2	4.9	4.8.3					
8.3	negligent use of equipment for personal protection			1.1.2 e	4.9						
8.4	unsuitable local illumination			1.1.4	4.9	4.8.6					
8.5	mental overload or underload, stress			1.1.2 d	4.9	4.8.5					
8.6	human errors, human behaviour			1.1.2 d, 1.2.2, 1.2.5, 1.2.8, 1.5.4, 1.7	4.9	4.8, 4.11.8, 4.11.9, 4.11.10					
8.7	unsuitable design, positioning or identification of operating elements			1.2.2		4.8.7					
8.8	unsuitable design and positioning of displays and indicators			1.7.1		4.8.8					
9	Hazard combinations				4.11						
10	Hazards generated by unexpected start-up, unexpected racing / overspeed (or any comparable malfunction) resulting from										
10.1	failure / malfunction of the control system			1.2.7, 1.6.3	3.29 to 3.32	4.11.4					

no.	hazards	event / safety target	solution	standards				risk evaluation			
				annex I Mach. D.	EN 12100-1	EN 12100-2	other	S	F	P	TR CC
10.2	interruption of the energy supply, re-establishment of energy supply after an interruption			1.2.6		4.11.5					
10.3	external influences on electrical equipment			1.2.7, 1.6.3		4.11					
10.4	other external influences (gravity, wind, etc.)					4.11					
10.5	software errors			1.2.1		4.11.7	IEC 61508, EN 61511				
10.6	operating errors (traceable to inadequate adaption of the robot to human characteristics an capabilities				4.9	4.8					
11	Missing option to stop the robot under optimum conditions			1.2.4, 1.2.6, 1.2.7		4.11.3	EN 60204-1				
12	Change of rotational speed of tools			1.3.6		4.2, 4.3	EN 60204-1				
13	Failure of energy supply			1.2.6		4.11, 4.11.5					
14	Failure of control and closed loop control circuits			1.2.1, 1.2.3, 1.2.5, 1.2.7, 1.6.3		4.11, 5.5.4					
15	Faulty assembly			1.5.4	4.9	4.7, 6.5					
16	Breakage during operation			1.3.2	4.2.2	4.3					
17	Falling or ejected objects or high pressure jet of fluids			1.3.3	4.2.2	4.3, 4.10, 5					
18	Loss of stability / overturning of the robot			1.3.1	4.2.2	4.6, 5.2.6					
19	Slipping, tripping of falling of persons			1.5.15	4.2.3	4.3 b, 4.8, 5.6					

3.2 Installing optional equipment

Your mobile robot platform SCITOS G5 is equipped ex works with the following optional components:

- Laser range finder: SICK S 300. See additional users manual and data sheets for safety instructions.
- SCITOS G5 Human-Machine-Interface (HMI).
- SCITOS G5 RoboHead.
- Copper contacts for electric floor and specific electronic modules.
- Pan-Tilt-Unit PTU-D46-17
- Asus Xtion Pro

To install the SCITOS HMI: Switch the platform off at first. We recommend 2 persons for installing the SCITOS G5 HMI: While the aluminum profile is being hold the cables can be fed through the top plate. For connecting the cables please refer to figure 3.4.

If you plug in or plug off the display cable please always make sure that the platform is switched off.

Most of the optional components have to be switched "On" first. Just switch "On" the applicable EBC port by using the Status Display or the provided interface of MLRobotic (see SCITOS G5 Software Guide). Switch "On" an EBC 24 V for the SICK laser range finder. Basically, you can choose every EBC port for connecting optional equipment, but we recommend to connect the laser range finder to EBC-slot 6, port 1. The SCITOS G5 HMI is directly connected to the embedded PC. No engaging is required in these cases.

If you would like to extend your SCITOS G5 with further components please pay attention to the following points:

- Analyse hazards and risk first (see section 3.1). Evaluate solutions for a safe operation of the mobile robot platform in combination with new components.
- Do not mount components which protrude over the bumper. Otherwise the bumper does not detect collisions.
- The maximum payload of the total optional equipment is limited to 50 kg.

- Verify the center of gravity of the mobile robot in combination with the newly mounted components and changes of steadiness in driving modes, especially during emergency stops.

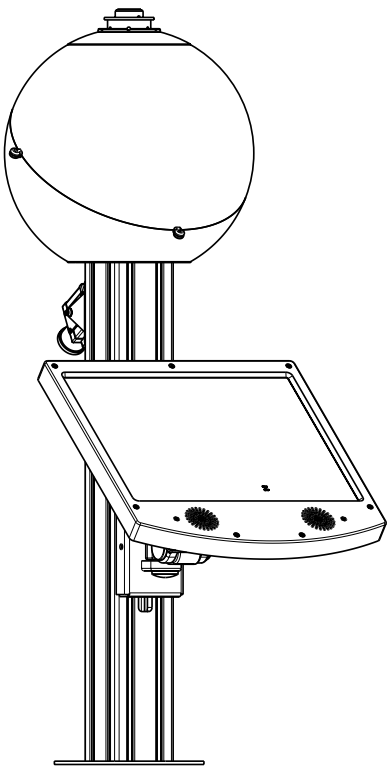

Figure 3.1: Option: Human-Machine-Interface.

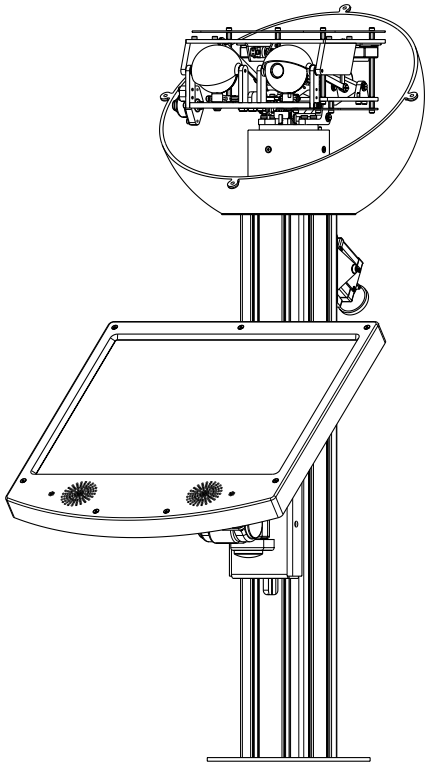

Figure 3.2: Option: RoboHead (mounted on top of pillar).

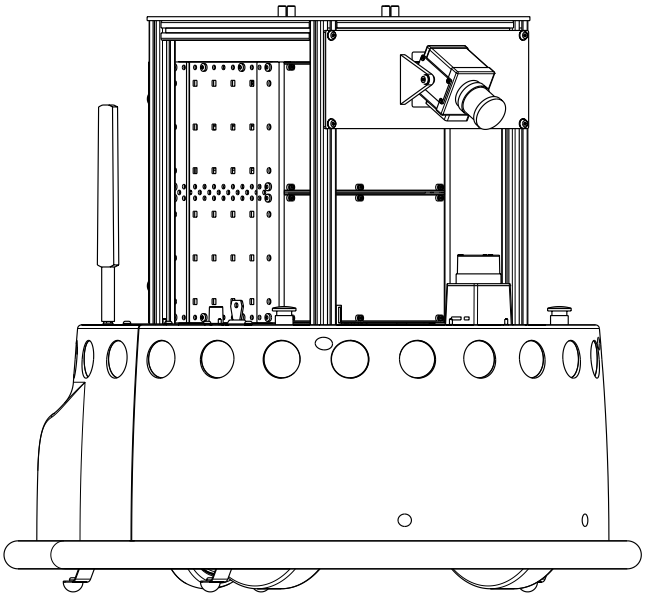

Figure 3.3: Option: Laser range finder (URG-04LX) and camera (DFK 21BF04, mounted at low position).

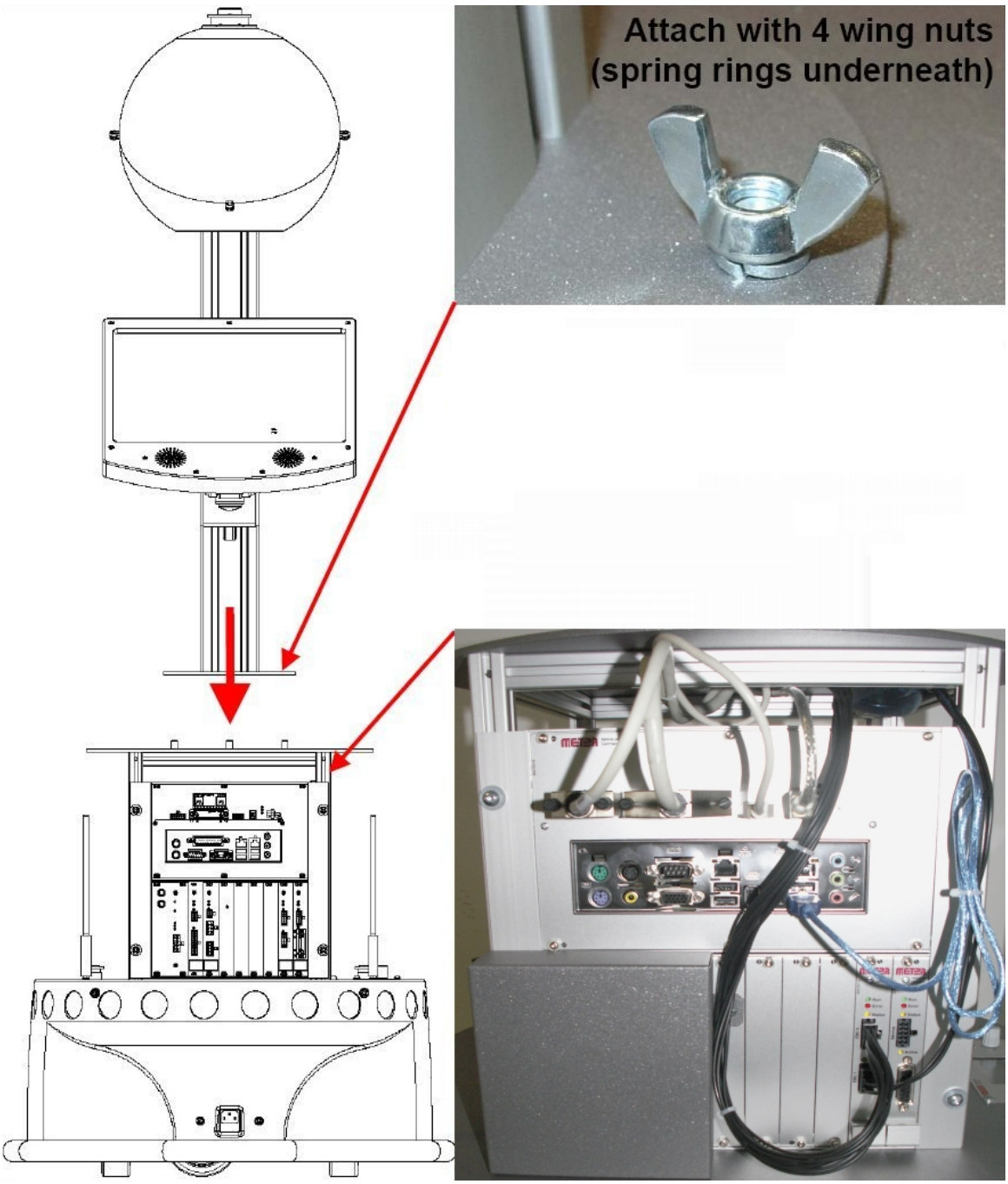

Figure 3.4: Assembly of the SCITOS G5 Human-Machine-Interface.

Use the aluminum profiles for mounting additional components. Applicable fittings and screws are provided by MetraLabs GmbH. Check out for available data and EBC connectors (see section 3.2).

Specifications

Basics

product name:	mobile robot platform
model:	SCITOS G5, revision B
length:	737 mm
width:	617 mm
height:	582 mm (without superstructure or optional equipment)
ground clearance:	20 mm
unloaded weight:	60 kg (without optional equipment)
vehicle payload:	50 kg
ambient temperature:	0 °C .. 35 °C

Power

type:	25.6 V, LiFePO4
capacity:	60 Amps-hours
recharge time:	ca. 6 hours when additional consumer loads are turned off
run time:	up to 14 hrs
power source:	operating input voltage: 115 / 230 VAC
	power input: 750 W
	AC line frequency: 50 / 60 Hz
charger:	integrated in the mobile robot platform

Mobility

type:	differential with two high torque EC gear-motors
actuation wheels:	2 driving wheels
	diameter: 200 mm
	width: 40 mm
	tire equipment: rubber / elastomer (grey)

stabilizer:	support wheel
	diameter: 100 mm
	width: 32 mm
	tire equipment: polyurethane (grey)
gear ratio:	i = 39
turning radius:	1.100 mm
top speed:	translative: 1.1 m/s
	rotatory: 200 °/s
climbing ability:	10° maximum slope
stepheight:	15 mm (maximum, without optional)
pushing force:	15 kg
swing radius:	52 cm
max. step:	15 mm
surface:	wheelchair accessible, indoor only

Embedded PC, displays & I/O-Ports

motherboard:	Mini-ITX with Intel QM57
processor:	Intel Core i7-2640M, 2(4 by HT)x2.8 GHz
RAM:	4 GB
hard disk:	250 GB SATA
connectors:	2 x DVI/DVI-D, 1 x 18/24 bit LVDS (25 pol. SUBD), 1 x HDMI
	2 x 1000 BaseT Ethernet, 4 x USB 2.0, 2 x USB 3.0
	2 x RS232, 1 x LineOut, 1 x Line-In, 1 x Microphone
	audio line out, microphone jacks, LVDS
WLAN:	on-board IEEE 802.11a/b/g
reset switch:	external
operating system:	installed and configured Ubuntu 12.04LTS
software:	MetraLabs MIRA, releas 2013-05-02
I/O-ports:	external bus connector (EBC) module with 3 EBC ports
	(21 .. 29 V / max 4 A (battery voltage), 12 V / 2,5 A, 5 V / 2,5 A),
status display:	type: 126x64 high brightness dot graphic display
	color of illumination: blue-green
	display area: 57.45 x 28.65 mm (X x Y)
indicator LEDs:	embedded PC: hard disc (HDD), PC control module (Run),
	main power (Power)

	status display: control module (Run), Error, Programmable (Status)
human-machine-interface:	aluminum profile for mounting different available add-ons (height: 605 mm)
(optional)	15” TFT display (1024 x 768 pixel) capacitive touch screen stereo speaker HMI-Plugin for MetraLabs MIRA requires 1 x USB 2.0, LVDS, Display
RoboHead: (optional)	turning: - 90° .. + 280° nodding: - 8° .. + 20° synchronous moveable eyes and separately moveable lids clear-transparent plastic encasement RoboHead-Plugin for MetraLabs MIRA requires one external bus connector

Sensors & cameras

sonar:	24 ultrasonic range finders beam angle: 360° beam angle per sensor: 15° detection distance: 200 mm .. 3.000 mm measuring rate: 50 msec
position encoders:	type: incremental encoder integrated in the motor resolution: 460 ticks per wheel rotation
bumper :	closed around the robot
laser: (optional)	model: SICK S 300 laser safety class 1 power source: 24 V DC power consumption: 6 .. 40 W scanning range: 30 m resolution: 30, 40, 50, 70 mm angular resolution: 0,5 ° systematic error: +/- 20 mm statistical error (1 sigma): 28 mm

field of view: 270 °
data interface: RS-232
data transmission rate: 38,4 kBaud

Support

For more information, feel free to contact our support team:

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