DORIS
Offshore Facilities Monitoring Robots

Collaboration among

Group 2

Group Area
Electronics

Project Memorandum

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DORIS

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2			
3			
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Chapter 1

Introduction

This memorandum presents the executive project of DORIS electronics system. The main objective of this document is to provide: a) the description of the architecture of the embedded electronics subsystems on both DORIS and remote control base; b) the list of devices (and their manufacturers) that compose the system; c) detailed manual for the assembly, installation, testing and commissioning of the electronics system; d) detailed description of tests conducted in LEAD to validate parts of the system; e) summary of bibliographic references.

1.1 Document structure

- Technical nomenclature
- System architecture
  - DORIS
    - Overall system
    - Computers
    - Video, audio and sensor devices
    - LAN: Ethernet / Wi-Fi communication
    - Traction system / CAN communication
    - Supervisory circuits / Radio
  - Remote Control Base
- System devices and components / Manufacturers
  - Computers

    - Data acquisition system
    - Network devices
    - Motor and drivers
    - Printed circuit boards (PCBs)
    - Electronic components
    - Cables
    - Connectors
    - Tools and utilities
- Procedures for installation
- Performed tests for validation
- Bibliographic references

1.2 Technical nomenclature

Before continuing, we shall propose a technical nomenclature to use as standard in this memorandum: ESCREVER

Chapter 2

System architecture

This chapter presents the description of the architecture of the embedded electronics subsystems on both DORIS and remote control base. The architecture is divided into subparts of interest in order to facilitate the understanding of both overall system and detailed subsystems.

2.1 DORIS overall system

As described in mechanics project, DORIS is composed by interconnected mobile modules, and each one is responsible for specific functions to achieve the main objective of this project: monitor, inspect and supervise the operation of a generic offshore facility. The modules resemble connected wagons moving along a rail installed throughout the facility, and each "wagon" carries specific devices to perform specific functions.
There are four different modules in this project:

- Traction module (module #1)
  - This module is responsible for the traction of all modules along the rail, including itself. Besides all mechanic parts, it carries electric motors, power drivers for their control and other electronic circuits.
- Power supply module (module #2)
  - This module is responsible for the power supply of the electronics system of all modules, including itself. Besides all mechanic parts, it carries battery packs, circuits for battery management, circuits for the system startup/shutdown, emergency system, radio and other electronic circuits.

- Manipulator module (module #3)
  - This module contains the manipulator of the robot, a computer, a data acquisition system (DAQ) and few sensors.
- Signal processing module (module #4)
  - This module contains a powerful computer for heavy processing, cameras, microphones and devices for wireless interface.

These modules can be interconnected in any order. Considering a simple system using only one unit of each module type (basic system), the most recommendable module arrangement would be the described above because:

- Power supply and signal processing modules are heavier. These module configuration balances the total robot weight.
- The system traction have better performance if the traction module is placed ahead the other modules, pulling the robot.
- Video and audio capture can be taken in a wider area if cameras and microphones are allocated in/on end modules.

All modules, regardless of how many will compose DORIS, are interconnected by: a) a Ethernet Network; b) a Controller Area Network (CAN); c) power cables. This means that all electronic devices in all modules are interconnected. In addition, an Wi-Fi access point located on the signal processing modules ensure a fast communication between the robot Ethernet system and a remote control base fixed at some point on the offshore facility.
The following subsections describes in detail each part of interest within DORIS electronics system.

2.1.1 Communications diagram

The following diagram (Figure 2.1) describes the communications of the overall DORIS electronics system that was designed. However, in practice, DORIS electronic system is flexible and can rely on expansions, such as:

- Addition of new modules.
- Reconfiguration of modules order.

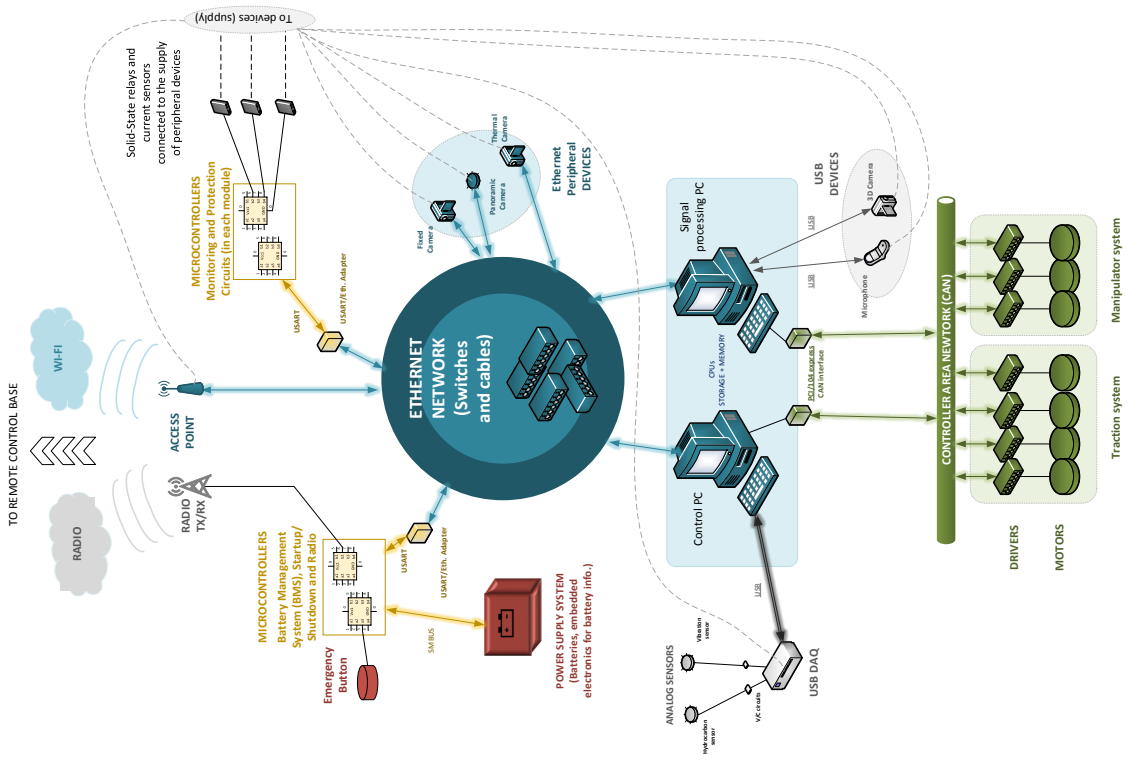


Figure 2.1: Overall communications diagram of the designed system

- Addition of new peripheral devices, as long as they are compatible with the system available interfaces, software/driver, and meet size and weight requirements from mechanical project.

Thus, the following diagram (Figure 2.2) describes the communications of the overall DORIS electronics system considering its possible expansions.

2.1.2 Module diagram

The following diagrams describe the system architecture inside each module type, not considering any expansion.

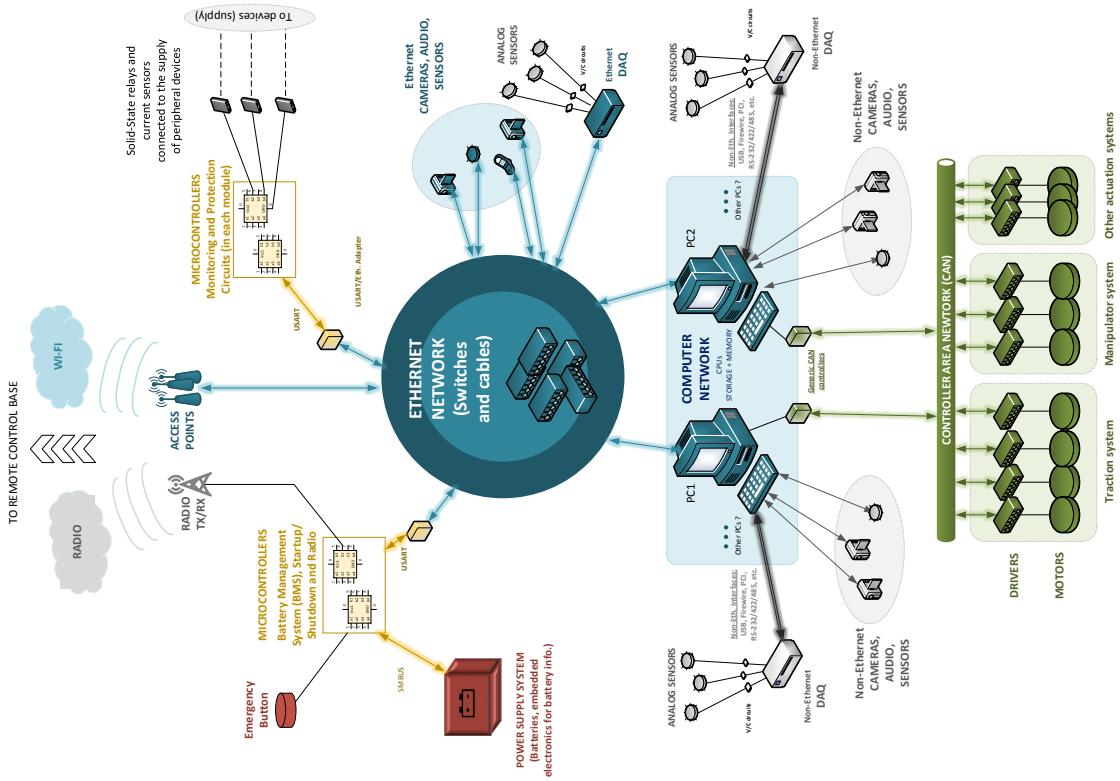


Figure 2.2: Overall communications diagram considering system expansions

2.1.2.1 Traction module diagram: Module #1

2.1.2.2 Power supply module diagram: Module #2

2.1.2.3 Manipulator module diagram: Module #3

2.1.2.4 Signal processing module diagram: Module #4

2.2 Computers

DORIS basic system is composed by two computers.

2.2.0.5 Control PC

Control PC description:

- Main function: control DORIS motors. Thus, it controls both traction system and manipulator.
- Secondary functions: a) mission control management; b) navigation; c) input for data acquisition system; d) data transmission.
- Running software: this PC runs ROS (Ubuntu-Linux based software).

- Location: manipulator module (#3).
- Model: ADL (manufacturer) ADLQM67PC-2715QE (model). For more details, see section 3.1.
- Accessories:
  - CAN controller. PEAK (manufacturer) CAN Interface for PCI/104-Express IPEH-003057 (model).
  - ESCREVER SSD
  - ESCREVER
- The computer and the storage card (Solid-State Drive) are both supplied by 5VDC and 12VDC, which are available at DORIS power buses (see G3 project).

The following diagram (Figure **??**) shows the control PC and its main interfaces and connections.

2.2.0.6 Signal processing PC

Signal processing PC description:

- Main function: signal processing. Thus, this PC: a) receives audio and video data from all cameras, microphones and sensors; b) runs signal processing and compression algorithms developed by G5 team.
- Secondary function: data transmission. Thus, this PC can transmit the processed/-compressed data to DORIS local network and, hence, to the remote base via Wi-Fi.
- Running software: this PC runs ROS (Ubuntu-Linux based software).
- Location: signal processing module (#4).
- Model: ADL (manufacturer) ADLQM67PC-2715QE (model). For more details, see section 3.1.
- Accessories:
  - CAN controller. PEAK (manufacturer) CAN Interface for PCI/104-Express IPEH-003057 (model).
  - ESCREVER SSD
  - ESCREVER

- The computer and the storage card (Solid-State Drive) are both supplied by 5VDC and 12VDC, which are available at DORIS power buses (see G3 project).

The following diagram (Figure **??**) shows the signal processing PC and its main interfaces and connections.

2.3 Video, audio and sensor devices

ESCREVER

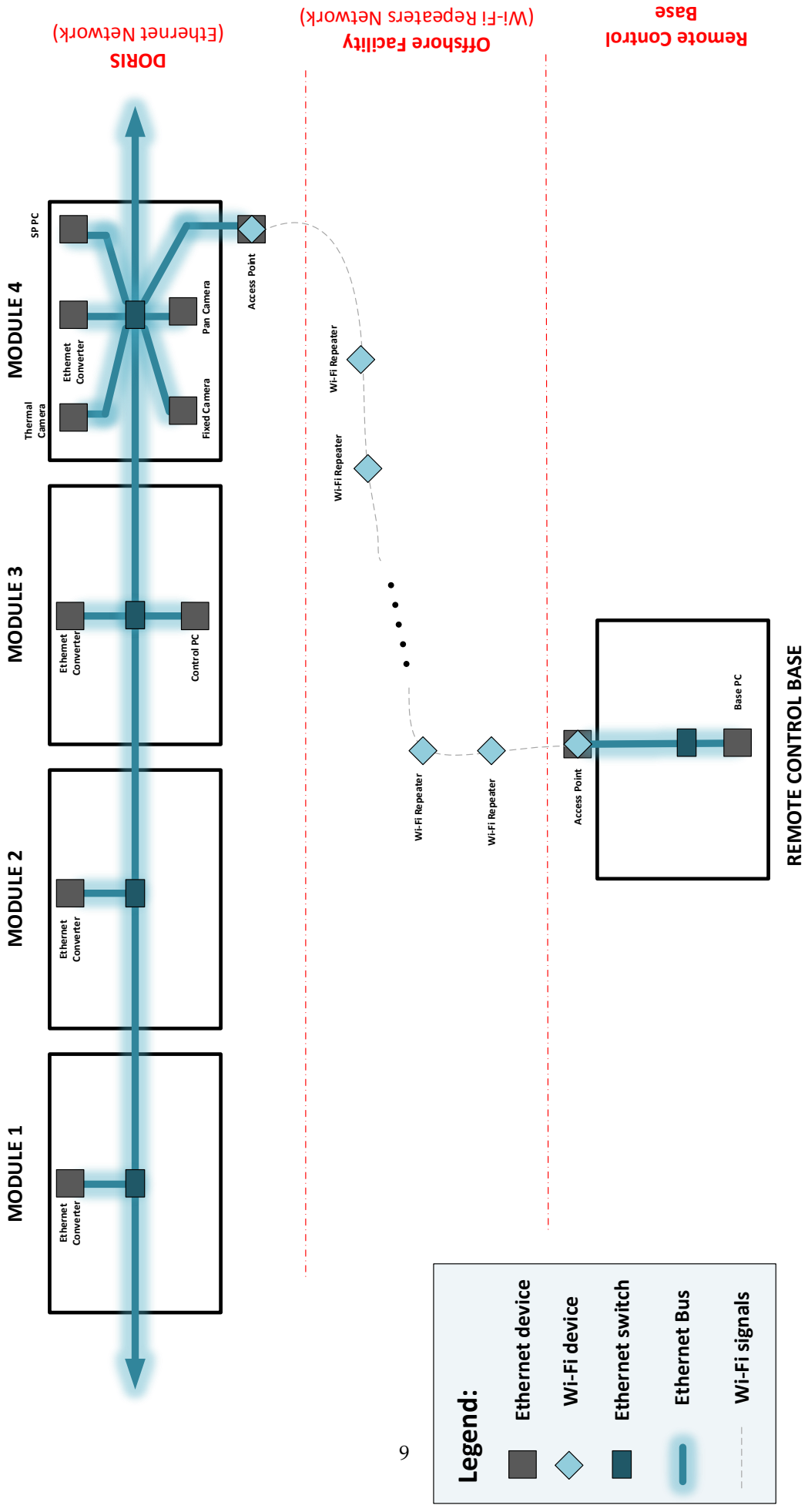
2.4 Local Area Network (LAN)

The system have a main local area network (LAN), which is responsible for most of the data traffic flowing through all modules and between DORIS and the remote control base. The LAN physical layer inside DORIS is Ethernet based, whereas the LAN physical layer between DORIS and the base is Wi-Fi based. The following diagram (Figure 2.3) depicts the overall system LAN.

2.4.1 Ethernet communication

DORIS local area network is Gigabit Ethernet (IEEE 802.3-2005) based. The structure of DORIS Ethernet network has the following features:

- Each module has two Ethernet outputs: front and rear.
- Each module contains an Ethernet Switch, which joins the Ethernet bus inside the module and extends the Ethernet network to other peripheral devices.
- Traction and power supply modules contain a 5-Gigabit port Ethernet Switch. Manufacturer: Korenix. Model: 3005G. For more details, see section 3.5.3.
- Manipulator and signal processing modules require more ports due to the great number of peripheral devices on them. Each of them contains a 8-Gigabit port Ethernet Switch. Manufacturer: Korenix. Model: 3008G. For more details, see section 3.5.2.
- All four Ethernet switches are supplied by 24VDC, which is available at DORIS power buses (see G3 project).


DORIS
(Ethernet Network)
Offshore Facility
(Wi-Fi Repeaters Network)
Remote Control
Base
MODULE 4
MODULE 3
MODULE 2
MODULE 1
SP PC
Thermal Camera
Ethernet Converter
Pan Camera
Fixed Camera
Access Point
Ethernet Converter
Control PC
Ethernet Converter
Ethernet Converter
Wi-Fi Repeater
Wi-Fi Repeater
Wi-Fi Repeater
Wi-Fi Repeater
Access Point
Base PC
REMOTE CONTROL BASE
Legend:
Ethernet device
Wi-Fi device
Ethernet switch
Ethernet Bus
Wi-Fi signals

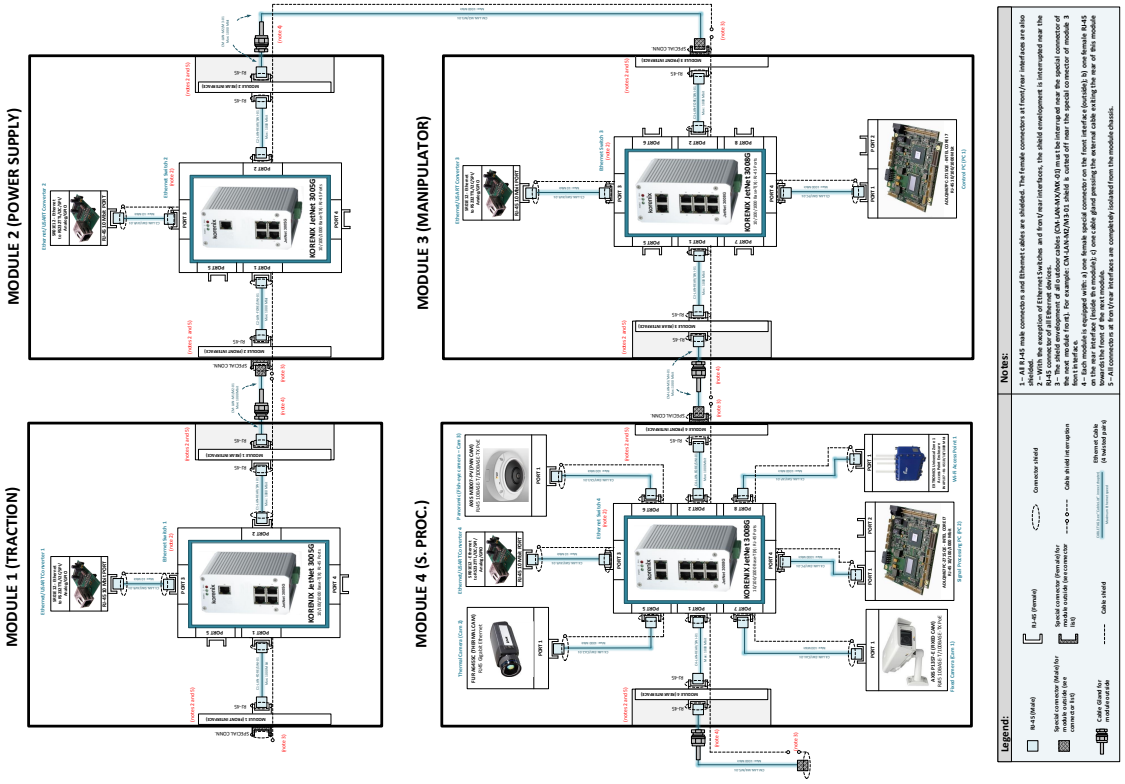


Figure 2.4: DORIS Ethernet Network - Detailed architecture

- Independently of the chosen DORIS module arrangement, there will be always an Ethernet bus passing through all modules.
- The Ethernet cables inside the modules are all flexible and shielded CAT.5e, 6 or 7 standard (see model in section **??**)
- The Ethernet cables outside modules are all flexible and shielded CAT.5e, 6 or 7 standard (see model in section **??**). These outdoor cables must be more flexible and resistent to meet mechanical requirements, such as: resistance against stress, water, chemicals, heat and non-release of toxic fumes in case of fire.
- All Ethernet cables and connectors can be checked in sections **??** and **??**.

The following diagram (Figure 2.4) depicts DORIS Ethernet network.

2.4.2 Wi-Fi communication

The system Wi-Fi network follows IEEE 802.11n standard, which means that data transmission via Wi-Fi can reach a 300Mbps baud rate. The structure of the system Wi-Fi network has the following features:

- An Access Point located on DORIS signal processing module (#4), connected to one port of the respective Ethernet switch.
- An Access Point located on the remote control base (the remote control base project is detailed further, in section 2.8.
- Wi-Fi repeaters distributed over specific point on the offshore facility. The repeater network topology may vary with the structure of each facility type.
- DORIS Access Point is supplied by 24VDC, which is available at DORIS power buses (see G3 project).
- The remote control base Access Point is supplied by 24VDC, which is available at the facility (ESCREVER).
- Repeaters must receive electric power from the available electric structure at the facility.
- The Access Point model is iWAP107 (Manufacturer: Extronics). It is equipped with the antenna ESCREVER. For more details, see sections **??** and **??**.
- The repeater model is ESCREVER. For more details, see section **??**.
- Since Wi-Fi is a wireless mean of transmission, it must comply with the requirements for safe operation of RF (Radio Frequency) signals in hazardous areas (which is the case of any offshore facility). In most circumstances, low-power radios operating at less then 100mW EIRP (Equivalent Isotropically Radiated Power) and 2.4 and 5.8 GHz do not offer any risk under normal circumstances. Nevertheless, we strongly recommend that the facility's safety administration is consulted beforehand to determine its policy on the use of RF devices. The are extremely low chances that RF interferences will lead to a safety problem or cause an accident by heating effect, but caution is always required.
- The specified Wi-Fi devices for this system are protected with:
  - Explosion proof enclosure (Ex d compliant), which means that any possible ignition caused by device circuits will be contained in the enclosure and not come into contact with the explosive atmosphere. Since there are many different classifications for a hazardous area (Zones, Groups, Div., see ESCREVER for more information)

- Intrinsically safe RF outputs (Ex i). This means that the antenna output power meets the safety parameters of the barrier and the RF EIRP allowed limitations in hazardous areas. For more information, see ESCREVER.
- The Wi-Fi system must comply with ESCREVER standards. See ESCREVER.

The following diagram (Figure **??**) depicts Wi-Fi system network.

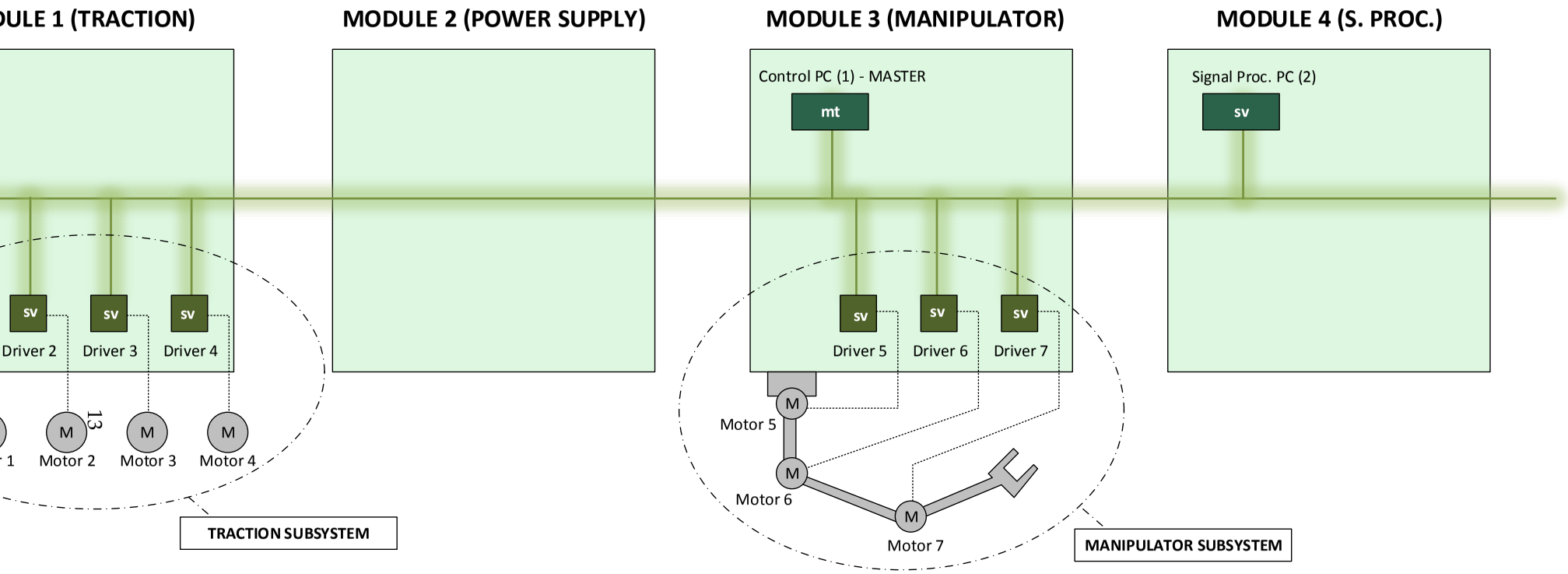
2.5 Actuation system

DORIS actuation system is responsible for the control of two DORIS subsystems: traction and manipulator. These two subsystem are controlled by DORIS computers via Controller Area Network-CAN (see section 2.5.3 for more details). The following diagram (Figure 2.5) summarizes the overall actuation system and its subsystems:

2.5.1 Traction subsystem

DORIS traction system is responsible for its movement along the rail installed in the facility. As mentioned before, the traction system is part of the Traction module (#1). The electronics of the traction system is composed by:

- 4x (four) actuator combinations by Maxon Motor (Part Number: 470625), each containing:
  - One EC brushless electric motor. Model: Maxon Motor EC-4pole 30 diam. 30 mm, brushless, 200 Watt High Power, Part Number: 305013 (for more details, see ESCREVER).
  - One reduction gear (reduction of 299/14). Model: Maxon Motor Planetary Gearhead GP 32 HP diam. 32 mm, 4.0-8.0 Nm, Metal Version, High Power, Part Number: 326660 (for more details, see ESCREVER).
  - One encoder installed at motor base (not in the gear). Model: Encoder MR, Type ML, 500 CPT, 3 Channels, with Line Driver, Part Number: 225778 (for more details, see ESCREVER).
- 4x Power Drivers for each motor control. Model: Maxon Motor EPOS2 70/10, Digital positioning controller, 10 A, 11-70 VDC, Part Number: 375711 (for more details, see ESCREVER).
- Cable set to connect (for more details, see ESCREVER):



Driver (Motor controller)	**mt**	Master of the CAN bus
	sv	Slave of the CAN bus
Computer (controller of the CAN bus)		CAN bus physical mean

Notes:

1 – A 3-revolution joint manipulator (one motor per joint) was used as an example.

2 – In case of the control PC (PC1) failure, the SP PC (PC2) can become the CAN bus new master, hence taking control of the actuation system.

- Each motor power (winding) to each driver.
- Each motor Hall effect sensor to each driver.
- Each motor encoder to each driver.
- Driver power supply and grounding.
- CAN connection between each driver.
- CAN connection between one driver and the rest of CAN network.

- Connector set (for more details, see ESCREVER).

2.5.2 Manipulator subsystem

ESCREVER

2.5.3 Controller Area Network (CAN) communication

As mentioned, CAN is the chosen network standard to interconnect and control DORIS actuation system. This standard is distinguished for being suitable for real-time vehicle control applications involving sensors and actuators, with a strict error control.

2.5.3.1 CAN physical layer

CAN physical layer is composed by 4 channels:

- CAN High
- CAN Low
- Ground (GND)
- Shield (SH)

All CAN data is transmitted using differential (balanced) signals, which means that a voltage difference is generated in CAN High and CAN Low at the transmitter, and the same voltage difference is recognized by the receiver. Both CAN High and Low are referenced to GND. Cables for CAN transmission must be shielded twisted pair. With this configuration, crosstalk effect is minimized. Noise interference is also minimized since the transmission is differential, i.e., any noise addition in one line will cause the same addition in another line, but the voltage difference remains the same. The shield channel is a protecting metallic mesh that envelops the other cable wires in order to block existing electromagnetic field on the environment and, hence, reduce interference.

Cables and connectors that compose CAN network are described in ESCREVER. For more information about CAN physical layer, see ESCREVER.

2.5.3.2 DORIS CAN network and connections

Independently of the chosen DORIS module arrangement, there will be always a CAN bus passing through all modules. The CAN bus has branches in all modules except for power supply module (#2). The branches are:

- In traction module (#1): one branch to each traction motor driver.
- In manipulator module (#3):
  - One branch to the CAN controller, located on the control PC.
  - One branch to each driver of the manipulator.
- In signal processing module (#4): one branch to the CAN controller, located on the signal processing PC.

With this configuration, either the control or the signal processing PC can be the master of CAN bus, and the other devices (other PC and drivers), the slaves. By default, the control PC is the bus master, but it can be changed by software, especially if any fault occurs in this PC.
The CAN interface at the drivers are very simple, because each driver is equipped with the needed hardware and software (CAN Open, see ESCREVER for more details). However, the computers are not equipped with CAN interfaces by themselves. A peripheral interface/expansion is needed. The chosen model fore the CAN interface is the product: PEAK CAN Interface for PCI/104-Express IPEH-003057 (see ESCREVER for more details). This CAN interface has the following features:

- Compatible with PCI/104 express, which is the computer main data bus.
- Galvanic isolated dual channel CAN controller, which allows the control of two independent CAN buses (if needed) and electric isolation of between the bus and the computer, preventing ground current loops and common node noise (for more details about these problems, see ESCREVER and ESCREVER).
- Two male DB-9 connectors.

The following diagram (figure **??**) describes the detailed CAN bus architecture in DORIS:
The following diagram (figure **??**) describes the CAN connections in traction module

(#1): The following diagram (figure **??**) describes the CAN connections in manipulator module (#3): The following diagram (figure **??**) describes the CAN connections in signal processing module (#4):

2.6 Supervisory circuits

Figure **??** illustrates the actuator interfaces. The motors for both locomotion and manipulator are controlled by drivers, which are connected to a CAN Bus. On the other hand, the CAN interface is converted to Ethernet and connected to the computer network by switch.

2.6.1 Monitoring system

2.6.2 Device protection system

2.6.3 Battery Management System (BMS)

2.6.4 Startup/Shutdown and Emergency system

2.7 Grounding system

2.8 Remote Control Base

Chapter 3

System devices/components - Models and Manufacturers

This chapter presents the equipment that will compose the electronics architecture of DORIS. The following equipment are considered in this scope:

- Computers and accessories
- Network devices
- Motor and peripheral components
- Motor drivers
- Electronic components for printed circuit boards (PCBs)
- Cables
- Connectors
- General tools and utilities

For each equipment, this chapter presents:

- Selected model and manufacturer.
- Main features and considerations.
- Datasheet and manual references.
- Contact for purchasing.
- Alternate models/manufacturers.

3.1 Computers

3.1.1 1st option: ADLQM67PC-2715QE

- Manufacturer: ADL Embedded Solutions™
- Description:
  - This computer model was chosen as the first option for use in DORIS. It can be used for both control and signal processing PC. Its main bus interface is PCI/104-Express, which makes easier the system expansion using PCI/104-Express compatible modules, such as: CAN controller, Ethernet switch, analog-digital converter, frame-grabber, etc. The processor is a 2nd generator Intel Core i7. The fast processing combined with 8GB RAM and 512GB SSD (Solid-State Drive) guarantees DORIS main software requirements: large data amount real-time processing (video, image, audio), traction and manipulator control, mission control management, navigation and data transmission. The SSD drive is a solution for a storage device with no-moving parts, which is suitable for DORIS operation.
- Main features:
  - Processor: Intel®Core™i7 Gen2 Quad 2.1GHz - 3GHz
  - Chipset: Intel®QM67 PCH with PCI/104 Express v1.0a Form Factor
  - Memory: Up to 8GB DDR3-1333 DRAM SoDIMM204
  - Storage interface: 2x SATA 600 Ports with RAID (6000MHz)
  - Operational system: Ubuntu (version 12.04) kernel 3.2.0 running ROS. See G4 project for more information.
  - Watchdog Timer
  - Power supply: 5VDC and 12VDC
  - Power consumption: 45W (full load)
  - Approx. dimensions: 115mm x 96mm
- Main interfaces:
  - 2x 10/100/1000 Mbit Ethernet LAN Port
  - 2x RS232 COM Ports, 8x USB2.0 Ports

- Documentation:
  - Website: http://adl-usa.com/products/detail/6/adlqm67pc2715qe
  - Datasheet: see website.
  - Manual: see website.
  - Sales contact: sales@adl-usa.com; sales@adl-europe.com. For more info, see http://adl-usa.com/contact.

ADLQM67PC-2715QE picture can be seen in figure 3.1.

3.1.2 2nd option: ADLQM87PC

- Manufacturer: ADL Embedded Solutions™
- Description:
  - The preliminary tests involving DORIS PC were performed using the first option (ADLQM67PC-2715QE). But later, this new model was launched onto the market. It was selected as DORIS second PC option, since it is similar to the first option and is superior in some features. Like ADLQM67PC-2715QE, this new model can also be used for both control and signal processing PC.
- Enhancements:
  - Faster and newer processor, newer chipset, more interface ports (including 5 extra USB ports with different data rates).
- Main features:
  - Processor: 4th Gen Intel®Core™Dual and Quad Core; BGA1364
  - Chipset: Intel®8-Series PCH Lynx Point QM87 Chipset with PCI/104 Express v1.0a Form Factor
  - Memory: Up to 8 GB DDR3L-1333/1600; 1.35V SoDIMM204 Socket
  - Storage interface: 4x SATA 6 Gb/s with RAID 0/1/5/10, Backward Compatible (6000MHz)
  - Operational system: Ubuntu (version 12.04) kernel 3.2.0 running ROS. See G4 project for more information.
  - Watchdog Timer

Figure 3.1: Computer (Option 1): ADLQM67PC-2715QE

- Power supply: 5VDC and 12VDC
- Approx. dimensions: 115mm x 96mm

- Main interfaces:
  - 2x 10/100/1000 Mbit Ethernet LAN Port
  - 13x USB 2.0. Total:
    - 8x Onboard
    - 2x PCIe Connector
    - 1x Mini PCIe Socket
    - 2x USB 3.0
    - Backward USB 2.0 Compatible

- Documentation:
  - Website: http://adl-usa.com/products/detail/100/adlqm87pc
  - Datasheet: see website.
  - Manual: see website.
  - Sales contact: sales@adl-usa.com; sales@adl-europe.com. For more info, see http://adl-usa.com/contact.

ADLQM87PC picture can be seen in figure 3.2.

3.1.3 3rd option: Small PC SC240ML-i724 Waterproof Computer

- Manufacturer: Small PC, A Division of ICI Controls, Inc.

- Description:
  - This PC is a more complete solution for DORIS PC, since it is already designed for reliable operation in hazardous areas and under abnormal situations, which release the user from the need to purchase/fabricate a protection cover. The system is waterproof (IP67), sealed and vibration proof. An specialized heat pipe provides fanless cooling. A SSD drive provides a no-moving parts solution. It is based on a Intel Core i7 processor, with a wide and customizable variety of configurations and I/O options. The system supports optional removal hot swap drives and comes complete with a sealed cable and connectors set.

Figure 3.2: Computer (Option 2): ADLQM87PC

- Superior features:
  - Waterproof chassis (IP67), heat-pipe for cooling, sealed cable and connector set, vibration proof, hot swap drives for system expansion.
- Main features:
  - Processor: Intel®Core™i7 2.4GHz
  - Chipset: Intel®NF9G-QM77 Express
  - Memory: Up to 16GB
  - Storage interface: Hard Drive capacity up to 1 TB; SSD drive up to 512GB
  - Operational system: Ubuntu (version 12.04) kernel 3.2.0 running ROS. See G4 project for more information.
  - Watchdog Timer
  - Power supply: 12VDC to 32VDC input range (option for "Integrated 6-24VDC wide input range Vehicle Power supply", which includes: intelligent shut-down controller, engine cranks survival, battery deep discharge prevention, automotive fuse)
  - Power consumption: 20-25W (standby), 65-70W (full load)
  - Approx. dimensions: 11.74mm x 23.44mm x 23.05mm
  - Approx. weight: 2.5 kg
- Main interfaces (customizable):
  - Multiple 10/100/1000 Gigabit LAN
  - USB ports (3x USB 3.0)
  - CAN interface via USB
  - Firewire
  - RS232 and RS485
  - SATA
  - Expansion slots via 1x (one) PCIe x 16 and 2x (two) Mini PCI-E sockets
- Documentation:
  - Website: http://www.smallpc.com/prod_sc240ml.php
  - Price list for system customizations: http://www.smallpc.com/prod_sc240ml_pricelist.php

- Chipset website: http://www.jetway.com.tw/jw/ipcboard_view.asp?productid=996&pfname QM77
- Datasheet: contact sales department.
- Manual: contact sales department.
- Sales contact: salesinfo@smallpc.com; dallen@smallpc.com. For more info, see http://www.smallpc.com/contact.php.

SC240ML-i724 picture can be seen in figure 3.3. SC240ML-i724 cable set and heat pipe pictures can be seen in figure 3.4. SC240ML-i724 technical drawing (in inches) using a specific customization can be seen in figure 3.5.

3.2 Storage Devices

3.3 1st option: ESCREVER

3.4 Data acquisition system

3.5 Network devices

3.5.1 Ethernet Switches

3.5.2 1st option: Korenix JetNet 3008G

- Manufacturer: Korenix
- Description:
  - This Ethernet switch is an industrial product suitable for reliable Local Area Networks that demands high Ethernet speed. These objectives are achieved with its 8 Gigabit Ethernet ports, IP31 rugged aluminium case, Quality of Service (QoS) for packet forwarding and wide operating temperature (-10 to 70Â°C). In DORIS, it is suitable for use in modules 3 and 4, which can carry a great number of Ethernet devices.
- Main features:
  - Case: IP31 grade aluminum metal

Figure 3.3: Computer (Option 3): SC240ML-i724

Figure 3.4: Computer (Option 3): SC240ML-i724 cable set and heat pipe

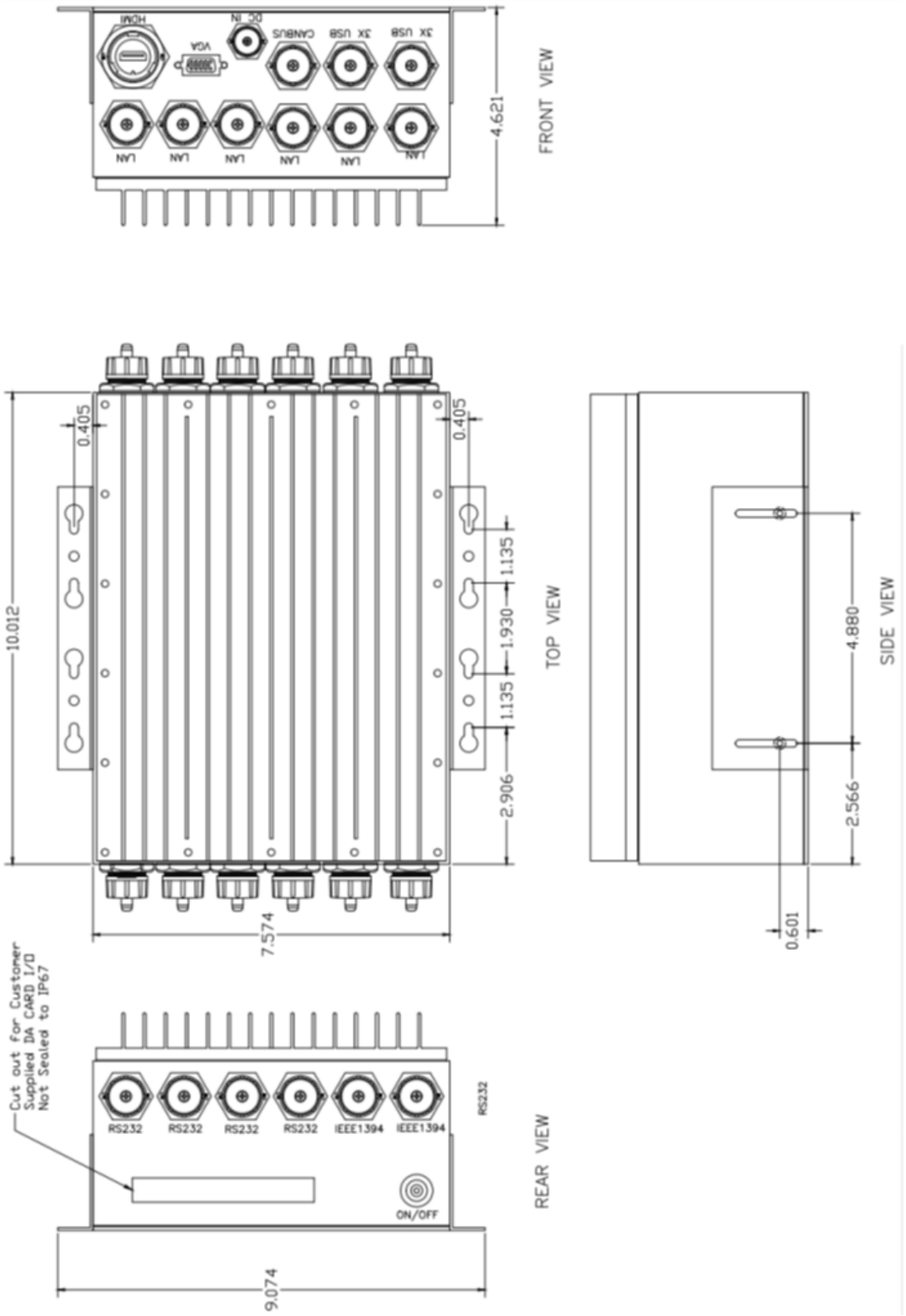


Figure 3.5: Computer (Option 3): SC240ML-i724 technical drawing (in inches)

- QoS: Compliance with IEEE802.1p class of service with Tag Based Priority. Each port support 4 priority queues with 8(Higher):4(High):2(Lo w):1(Lowest) scheduling. The Tag Priority ID as following: Higher (6,7), High (4,5), Low (0,3), Lowest (1,2)
- Operating Temperature: -10 to 70Â°C
- Storage Temperature: -40 to 85Â°C
- Power supply: 12-48VDC input range (nominal 24VDC)
- Power consumption: max 8W at 48VDC
- Approx. dimensions: 120mm x 55mm x 108mm
- Weight: 0.775kg with package, 0.525kg without package

- Main interfaces:
  - 8x (eight) Gigabit Ethernet 10/100/1000 Base-T(X) (female RJ-45)
- Documentation:
  - Website: http://www.korenix.com/jetnet-ethernet-switch-3008G-overview.htm
  - Datasheet: see website.
  - Manual: see website.
  - Sales contact: sales@korenix.com; sales@korenix.com. For more info, see http://www.korenix.co us.htm.
  - Brazil sales: Marcelo.Reboucas@beijerinc.com; Flavio.Grassi@beijerinc.com. For more info, see http://www.korenix.com/where-to-buy.htm.

Korenix JetNet 3008G picture can be seen in figure 3.6. Korenix JetNet 3008G technical drawing (in millimeters) can be seen in figure 3.7.

3.5.3 2nd option: Korenix JetNet 3005G

- Manufacturer: Korenix
- Description:
  - This Ethernet switch is similar to the first option above, except that this model has only five ports. Hence, it is suitable for use in DORIS modules 1 and 2, which carry a few number of Ethernet devices.

Figure 3.6: Ethernet Switch (Option 1): Korenix JetNet 3008G

- Main features:
  - Case: IP31 grade aluminum metal
  - QoS: Compliance with IEEE802.1p class of service with Tag Based Priority. Each port support 4 priority queues with 8(Higher):4(High):2(Lo w):1(Lowest) scheduling. The Tag Priority ID as following: Higher (6,7), High (4,5), Low (0,3), Lowest (1,2)
  - Operating Temperature: -10 to 70Â°C
  - Storage Temperature: -40 to 85Â°C
  - Power supply: 12-48VDC input range (nominal 24VDC)
  - Power consumption: max 8W at 48VDC
  - Approx. dimensions: 120mm x 55mm x 108mm
  - Weight: 0.775kg with package, 0.525kg without package
- Main interfaces:
  - 5x (eight) Gigabit Ethernet 10/100/1000 Base-T(X) (female RJ-45)

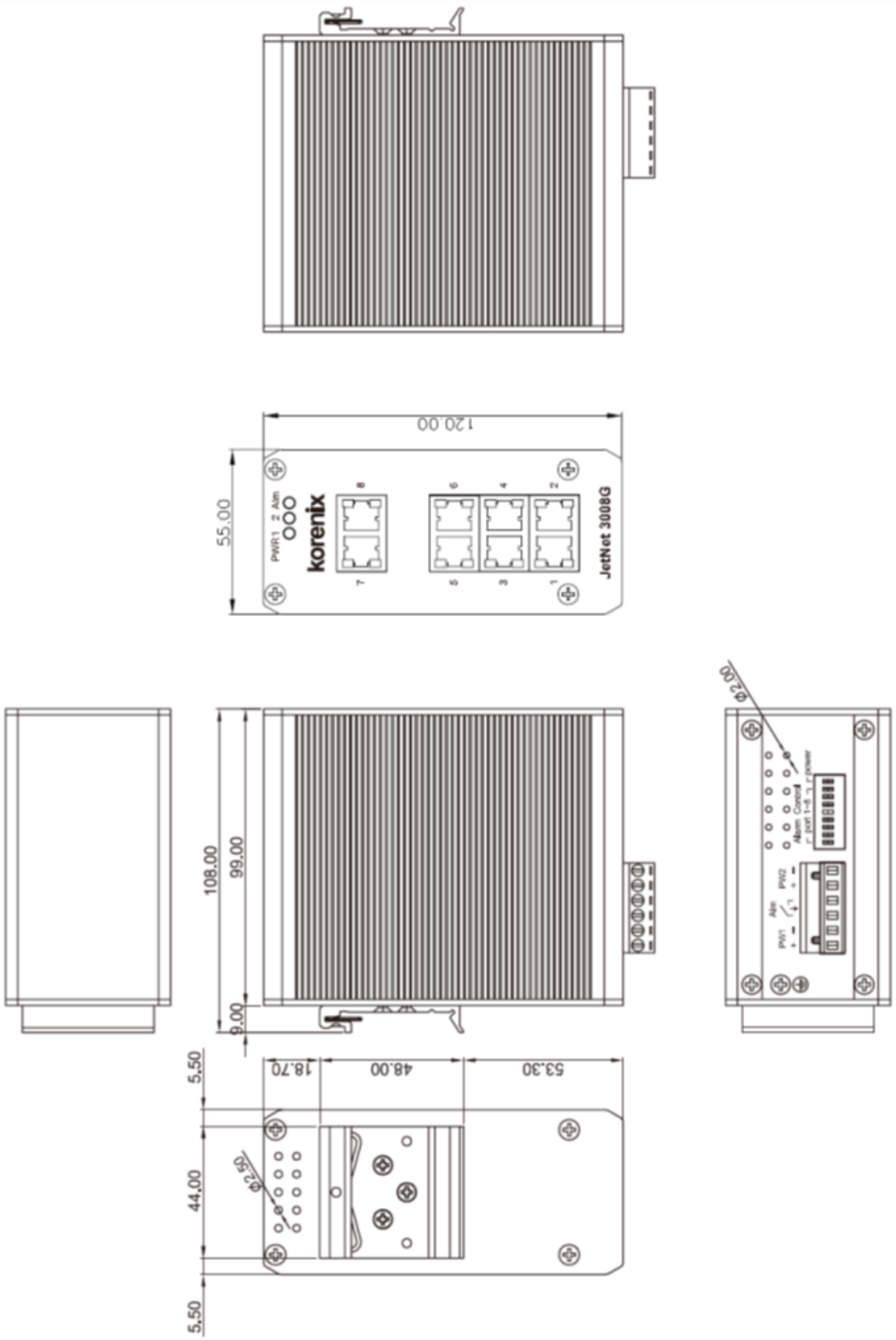


Figure 3.7: Ethernet Switch (Option 1): Korenix JetNet 3008G technical drawing (in inches)

Figure 3.8: Ethernet Switch (Option 2): Korenix JetNet 3005G

- Documentation:
  - Website: http://www.korenix.com/jetnet-ethernet-switch-3005G-overview.htm
  - Datasheet: see website.
  - Manual: see website.
  - Sales contact: sales@korenix.com; sales@korenix.com. For more info, see http://www.korenix.co us.htm.
  - Brazil sales (Beijer Brasil): Marcelo.Reboucas@beijerinc.com; Flavio.Grassi@beijerinc.com. For more info, see http://www.korenix.com/where-to-buy.htm.

Korenix JetNet 3005G picture can be seen in figure 3.8. Korenix JetNet 3005G technical drawing (in millimeters) can be seen in figure 3.9.

3.5.4 3rd option: Korenix JetNet 3005G V2

- Manufacturer: Korenix
- Description:

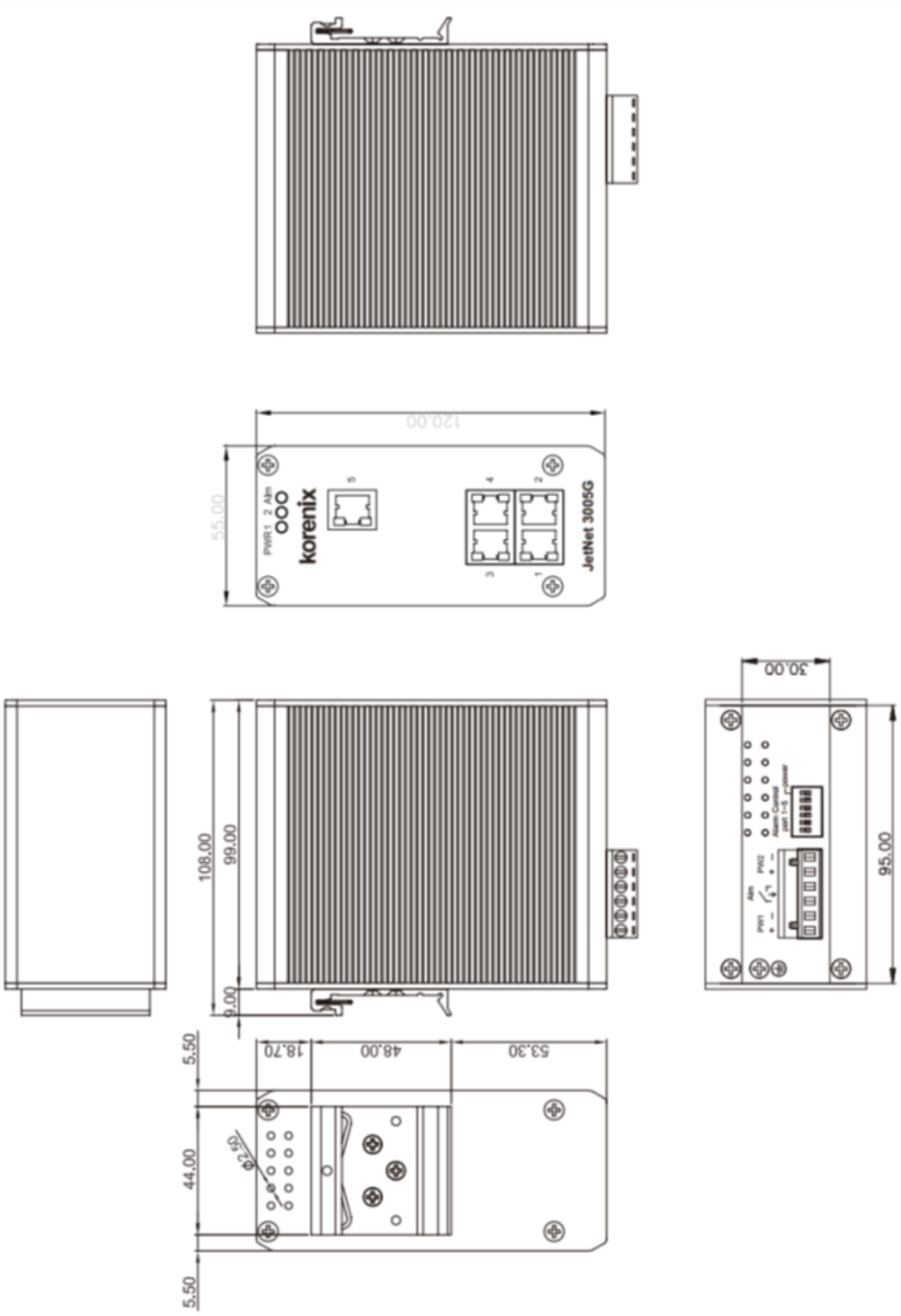


Figure 3.9: Ethernet Switch (Option 2): Korenix JetNet 3005G technical drawing (in inches)

Figure 3.10: Ethernet Switch (Option 3): Korenix JetNet 3005G V2

  - This Ethernet switch is similar to the second option above. However, this model is smaller, which makes it suitable for DORIS, since the robot inside devices must be as smaller as possible. This is an ultimate model from Korenix, still not available for purchase.

- Information:
  - Website: http://www.korenix.com/jetnet-ethernet-switch-3005G-V2-overview.htm
  - Sales contact: sales@korenix.com; sales@korenix.com. For more info, see http://www.korenix.co us.htm.
  - Brazil sales: Marcelo.Reboucas@beijerinc.com; Flavio.Grassi@beijerinc.com. For more info, see http://www.korenix.com/where-to-buy.htm.

Korenix JetNet 3008G picture can be seen in figure 3.10.

3.5.5 4th option: Korenix JetNet 5010G-w

- Manufacturer: Korenix
- Description:
  - This Ethernet switch model belongs to the same family of the above options. However, the previous models are not managed switch, and the QoS setting

depends on which port each network branch is connected. On the other hand, the model Korenix JetNet 5010G-w is equipped with a managed QoS system (QoS in Layer 3 TOS/DiffServ), which allows the visualization and optimization of data traffic via software, hence improving the network speed and performance. In general, the managed Ethernet Switches models found in the market are extremely big and heavy, and few models have Gigabit speed at all ports. The model Korenix JetNet 5010G-w offers a trade-off between size, weight and number of Gigabit Ethernet ports.

- Main features:
  - Case: IP31 protection, aluminum metal case
  - QoS: Four priority queues per port, IEEE802.1p COS and Layer 3 TOS/DiffServ
  - Operating Temperature: -40 to 75Â°C
  - Storage Temperature: -40 to 85Â°C
  - Power supply: 10.5-60VDC input range (nominal 24VDC)
  - Power consumption: max 8W at 48VDC
  - Approx. dimensions: 137mm x 96mm x 119mm
  - Weight: 0.915kg with package
- Main interfaces:
  - 7x 10/100TX (Fast Ethernet) RJ-45
  - 3x 10/100/1000TX (Gigabit Ethernet) RJ-45 combo with SFP
  - Gigabit Fiber/100Base-FX: 3 x SFP with Hot Swappable
- Documentation:
  - Website: http://www.korenix.com/jetnet-ethernet-switch-5010G-overview.htm
  - Datasheet: see website.
  - Manual: see website.
  - Sales contact: sales@korenix.com; sales@korenix.com. For more info, see http://www.korenix.com/us.htm.
  - Brazil sales (Beijer Brasil): Marcelo.Reboucas@beijerinc.com; Flavio.Grassi@beijerinc.com. For more info, see http://www.korenix.com/where-to-buy.htm.

Figure 3.11: Ethernet Switch (Option 4): Korenix JetNet 3010G-w

Korenix JetNet 3010G-w picture can be seen in figure 3.11. Korenix JetNet 3010G-w technical drawing (in millimeters) can be seen in figure 3.12.

3.5.6 Wi-Fi Access Points

3.5.7 1st option: EXTRONICS Universal Zone 1 Access Point Enclosure iWAP107

- Manufacturer: Extronics
- Description:
  - This Access point provides Wi-Fi IEEE 802.11n/ac and 1 Gigabit Ethernet port. The standard IEEE 802.11n/ac can provide a maximum of 300 Mbit rate for wireless. This product also complies with ATEX and IECEx certification, which meets the requirement for safe operation in classified Zone 1. According to ATEX certification for this model, the compliance with the Essential Health and Safety Requirements has been assured by compliance with EN60079 standards, specially EN60079-11:2012, which defines an intrinsically safe (Ex i) operation by the definition of RF EIRP allowed limitations in hazardous areas. This is achieved by using an embedded device (Extronics iSOLATE500 RF, see section **??** for more info.), which makes all the antenna points intrinsically safe.Furthermore, this product meets explosion proof (Ex d) requirements. As iWAP107 has an special Ex d enclosure, it is considerably heavy for use in vehicle applications.
- Main features:
  - Case: marine grade cooper free aluminum light alloy, epoxy powder coated (IP66 protection)
  - Operating Temperature: -40 to 60Â°C
  - Power supply: DC (unknown voltage)
  - Power consumption: 25W (basic configuration), 125W (with heaters)
  - Approx. dimensions: 415mm x 315mm x 250mm
  - Approx. weight: 30 kg
- Main interfaces:
  - 1x (one) Gigabit Ethernet 100/1000 Base-T

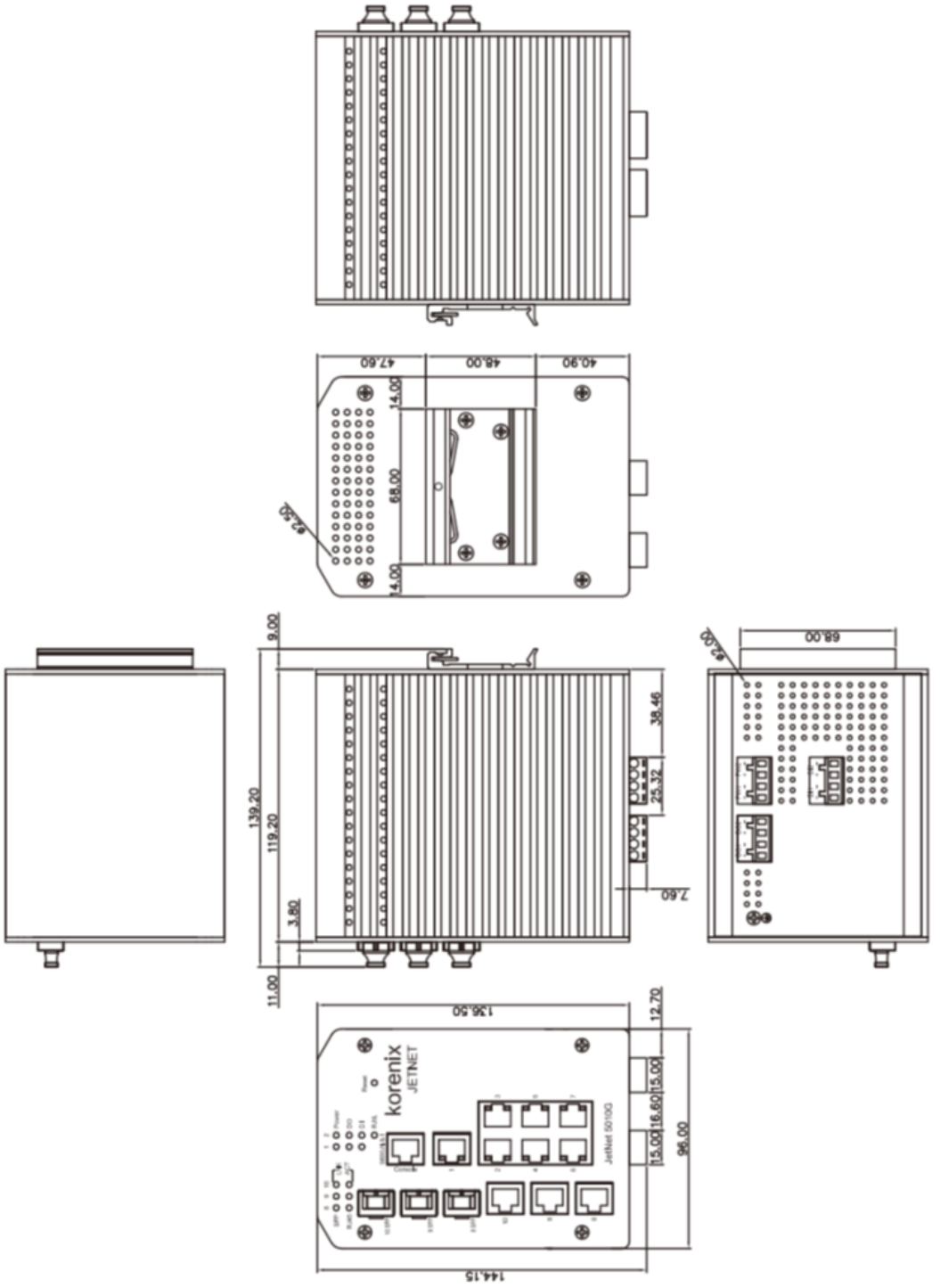


Figure 3.12: Ethernet Switch (Option 4): Korenix JetNet 3010G-w technical drawing (in inches)

Figure 3.13: Wi-Fi Access Point (Option 1): Extronics iWAP107

  - Wi-Fi (802.11n/ac) customizable antennas

- Customization:
  - For DORIS, the ideal customization requires 4 antennas for ESCREVER.
- Documentation:
  - Website: http://www.extronics.com/wireless/zone_1__21_wireless_access_points/iwap107
  - Datasheet: see website.
  - Manual: see website.
  - Certifications: see website.
  - Sales contact: info@extronics.com; karen.bentley@extronics.com; james.eastwood@extronics.com
    For more info, see http://www.extronics.com/contact_us.

Extronics iWAP107 picture can be seen in figure 3.13.

3.5.8 CAN devices

3.6 Traction devices

3.6.1 Motors

3.6.1.1 1st option: Maxon Motor EC-4pole 30 diam 30 mm, brushless, 200 Watt Part Number: 305013

- Manufacturer: Maxon Motor
- Description:
  - This EC brushless motor was specified by mechanics team (G1) with the aid guidelines of the electronics team (G2). Its main features (output power/-torque, maximum electric current, efficiency, thermal constant etc.) satisfy both mechanical and electronics project requirements for DORIS traction system, which demands 4 motors.
- Main features:
  - Nominal speed: 15900 rpm
  - Nominal torque: (max. continuous torque) 135 mNm
  - Nominal current: (max. continuous current) 10.5 A
  - Max. efficiency: 89%
  - Torque constant: 13.6 mNm/A
  - Ambient temperature: -20 to 100 Â°C
  - Number of pole pairs: 2
  - Thermal constant: 2.11s
  - Weight: 300g
- Documentation:
  - Website: http://www.maxonmotor.com/maxon/view/product/motor/ecmotor/ec4pole/305
  - Datasheet: see website.
  - Manual: see website.
  - Sales contact: see G1 project.

Maxon Motor EC-4pole 200W 305013 picture can be seen in figure 3.14.


maxon EC-4pole
1 2 3 4 5 6
swiss made

3.6.2 Encoders

3.6.2.1 1st option: Maxon Motor Encoder MR, Type ML, 500 CPT, 3 Channels, with Line Driver Part Number: 225778

- Manufacturer: Maxon Motor
- Description:
  - This encoder was specified by mechanics team (G1) with the aid guidelines of the electronics team (G2). Its main features satisfy both mechanical and electronics project requirements for DORIS traction system, which demands an encoder for each of the 4 motors. This encoder should be used together with the motor 1st option (see section above).
- Main features:
  - Counts per turn: 500
  - Number of channels: 3
  - Max. mechanical speed: 24000 rpm
  - Supply voltage Vcc: 4.7. to 5.2VDC
  - Index synchronized to AB: No
  - Operating temperature: -25 to 85 Â°C
- Documentation:
  - Website: http://www.maxonmotor.com/maxon/view/product/sensor/encoder/Encoder-MR-TypML-128-1000imp-3Kanal/225778
  - Datasheet: see website.
  - Manual: see website.
  - Sales contact: see G1 project.

3.6.3 Reduction gears

3.6.3.1 1st option: Maxon Motor Planetary Gearhead GP 32 HP diam 32 mm, 4.0 - 8.0 Nm, Metal Version, High Power Part Number: 326660

- Manufacturer: Maxon Motor
- Description:

- This reduction gear was specified by mechanics team (G1). Its reduction factor (21:1) satisfy mechanical parameters for the traction module project.

- Main features:
  - Reduction: 21:1
  - Absolute reduction: 299:14
  - Outer diameter: 32 mm
  - Number of stages: 2
  - Max. continuous torque: 4 Nm
  - Max. intermittent torque: 6 Nm
  - Max. transmittable power (continuous): 160 W
  - Max. transmittable power (intermittent): 240 W
  - Weight: 170g

- Documentation:
  - Website: http://www.maxonmotor.com/maxon/view/product/gear/planetary/gp32/326660
  - Datasheet: see website.
  - Manual: see website.
  - Sales contact: see G1 project.

Maxon Motor Planetary Gearhead 21:1 326660 picture can be seen in figure **??**.

3.6.4 Controller drivers

3.6.4.1 1st option: Maxon Motor EPOS2 70/10, Digital positioning controller, 10 A, 11 - 70 VDC Part Number: 375711

- Manufacturer: Maxon Motor

- Description:
  - This controller driver was specified by mechanics team (G1) with the aid guidelines of the electronics team (G2). Its main features (power supply range, max. output current/tension, CAN/USB interfaces, etc.) satisfy both mechanical and electronics project requirements for DORIS traction system, which demands 4 EC motors like the model described in section 3.6.1.1.

Figure 3.15: Reduction gear (Option 1): Maxon Motor Planetary Gearhead 21:1 326660

- Main features:
  - EC motors: up to 700W
  - Supports Digital Incremental Encoder (3 channel, differential)
  - Supports Digital Hall Sensors (EC Motors)
  - Performs Current/Speed/Position control
  - Operating voltage Vcc: 11VDC to 70VDC
  - Max. output current: 25A
  - Max. time of peak output current: 1s
  - Continuous output current: 10A
  - Max. efficiency: 94%
  - Hall sensor signals: H1, H2, H2
  - Encoder signals: A, A/, B, B/, I, I/
  - Digital inputs: 10
  - Functionality of the digital inputs: limit switch, reference switch, general purpose, enable, quickstop, SSI encoder, 2nd incremental encoder, step/direction set value, master encoder, position marker, power stage enable
  - Analog inputs: 2
  - DIP switch: 8
  - Functionality of the DIP switch: set CAN Node-ID, set CAN-Bus Termination
  - Digital outputs: 5
  - Functionality of the digital outputs: holding brake, general purpose, position compare, ready
  - Hall sensor supply voltage: 5VDC, max. 30mA
  - Encoder supply voltage: 5VDC, max. 100mA
  - Interfaces: RS232/USB 2.0/CAN (CAN Open Software)
  - Graphical User Interface: EPOS Studio
  - Status indicator READY: green LED
  - Status indicator ERROR: red LED
  - Operation temperature: -10 to 45Â°C
  - Storage temperature: -40 to 85Â°C

- Dimensions: 150mm x 93mm x 27mm
- Weight: 330g

- Documentation:
  - Website: http://www.maxonmotor.com/maxon/view/product/control/Positionierung/37571
  - Datasheet: see website.
  - Manual: see website.
  - Sales contact: see G1 project.

Maxon Motor EPOS2 70/10 375711 picture can be seen in figure 3.16. Maxon Motor EPOS2 70/10 375711 interfaces/pinouts can be seen in figure 3.17.

3.6.5 Motor Combinations

3.6.5.1 1st option: Maxon Motor Combination Part Number: 470625 - Items: Motor 305013 / Encoder 225778 / Reduction Gear 326660

- Manufacturer: Maxon Motor
- Description:
  - This motor combination was was specified by mechanics team (G1) with the aid guidelines of the electronics team (G2). This is an assembly of the motor 305013 (described in section 3.6.1.1), the encoder 225778 (described in section 3.6.2.1) and the reduction gear 326660 (described in section 3.6.3.1) in a single combination. The gear is placed at the motor shaft output, and the encoder is placed at the motor base (see figure 3.19). Thus, the transmitted torque will always have passed through the gear reduction factor, but the encoder will be measuring the actual shaft speed (not considering the reduction).
- Documentation:
  - Website: http://www.maxonmotor.com/maxon/view/service_search?query=470625
  - Datasheet: see website.
  - Manual: see website.
  - Sales contact: see G1 project.

Maxon Motor Combination 470625 picture can be seen in figure 3.18. Maxon Motor EPOS2 70/10 375711 scheme and interfaces and can be seen in figure 3.19.

Figure 3.16: Controller driver (Option 1): Maxon Motor EPOS2 70/10 375711

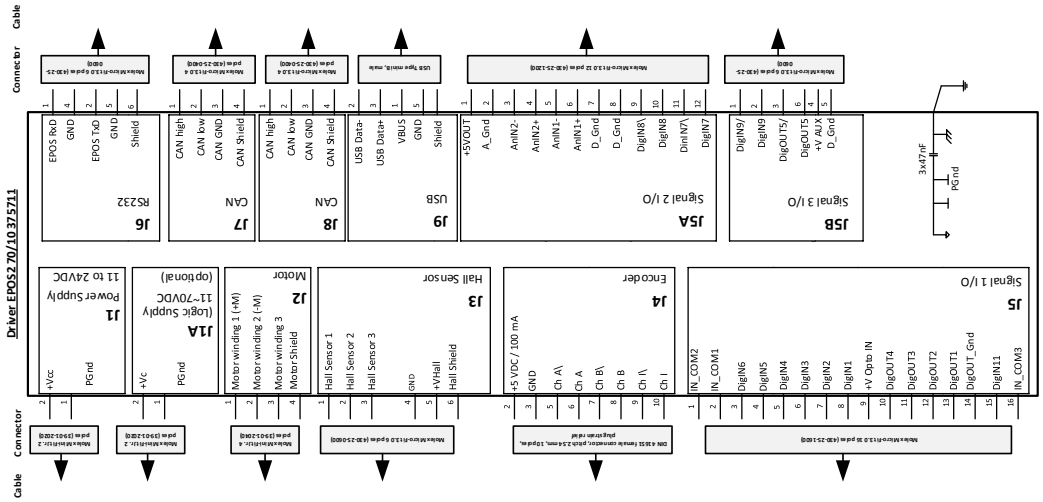


Figure 3.17: Controller driver (Option 1): Maxon Motor EPOS2 70/10 375711 interfaces/pinout

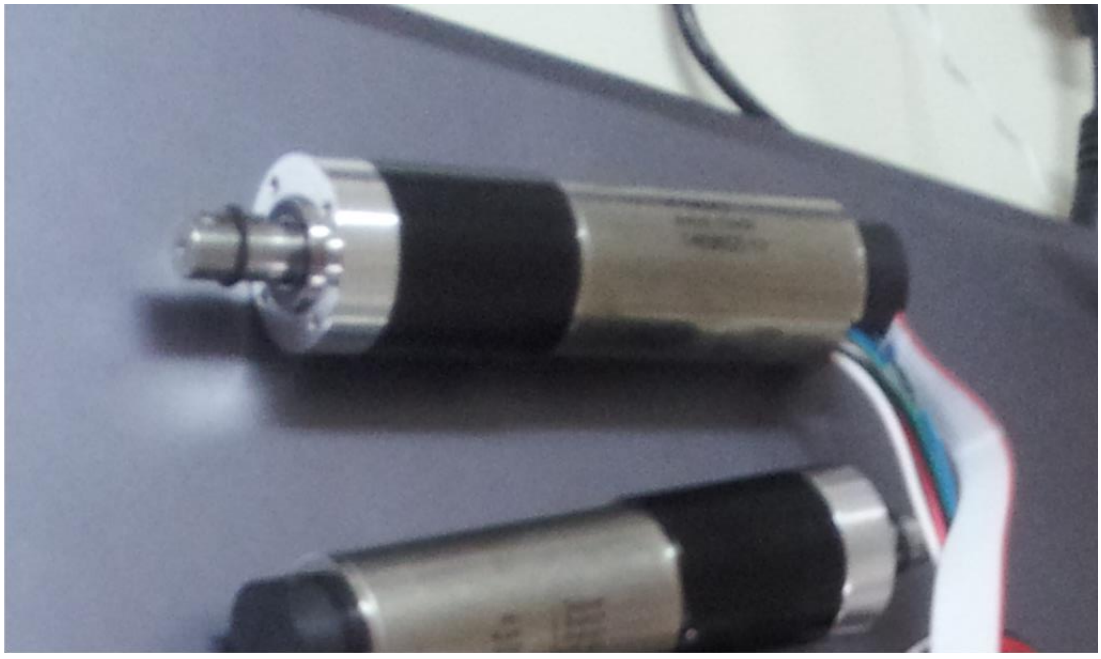


Figure 3.18: Motor combination (Option 1): Maxon Motor Combination 470625

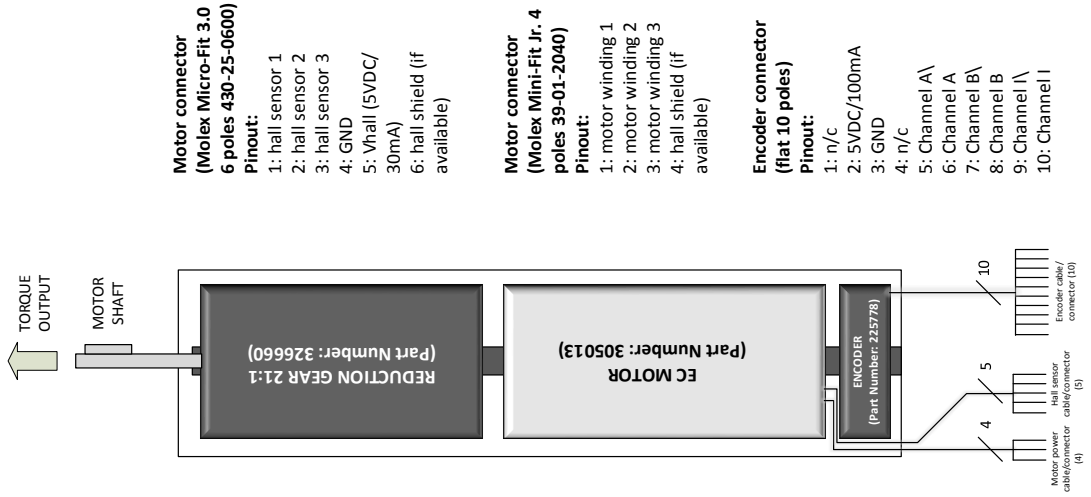


Figure 3.19: Motor combination (Option 1): Maxon Motor Combination 470625 scheme and interfaces

3.7 Printed circuit boards

3.8 Electronic components

ESCREVER colocar os componentes minimos, a proposta de reserva e os molex Manufacturer: *PCB (IMI)*

Model: *623C00 High Frequency Industrial ICP Accelerometer*

Interface: *Analog Voltage Signal*

Specified by: G5

Model picture, main specifications and input/output diagram are shown in figure 3.20.

References in [1].

Performance		Electrical Specifications	
Sensibility	10 mV/g	Supply Tension	18-28 VDC
Dynamic Range	±500 g	Supply Current	2-20 mA
Frequency Range	0.8-15000 Hz	Output Tension	8-12 VDC
Physical Specifications		**Observations**	
Diameter	17.5 mm	Use in Hazardous Areas	Yes
Height	50.0 mm	Price	R$ 2 242.00
Weight	51 g	***	***

Figure 3.20: Vibration Sensor - Specifications.

3.9 Wiring

3.9.1 Connectors

The following table (figure **??**) summarizes all the connectors that must be purchased for DORIS assembly. Each connector type has a respective connector acronym that appears in the cable list (section 3.9.2) as a easy reference for the cable connectors. In the next subsections, the most important connector types and pinouts are detailed. The possible commercial models for purchase are also suggested for each connector type. ESCREVER TABELA

3.9.1.1 10pinF(CAN): DIN 41651 connector, pitch 2.54 mm, 10 poles, plug strain relief (Female)

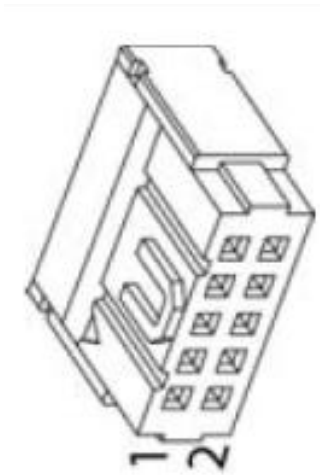
- Acronym for cable/connector lists: 10pinF
- Name: DIN 41651 connector, pitch 2.54 mm, 10 poles, plug strain relief (Female)
- Picture and pinout: see figure 3.21

3.9.1.2 10pinF(Encoder): DIN 41651 connector, pitch 2.54 mm, 10 poles, plug strain relief (Female)

- Acronym for cable/connector lists: 10pinF(Encoder)
- Name: DIN 41651 connector, pitch 2.54 mm, 10 poles, plug strain relief (Female)
- Model references (Website): this connector type is provided together with the motor/driver combination package (described in sections 3.6.5.1 and 3.6.5.1).
- Picture and pinout: see figure 3.22

3.9.1.3 CG(CAN): Cable Gland for CAN

- Acronym for cable/connector lists: CG(CAN)
- Name: Cable Gland for CAN
- Description: each CAN cable gland is used to fit one side of the outdoor CAN cable on the rear interface of each module. The presented option for this item can fit cables with 5mm to 10mm diameter, and is IP68 certified.



Pins	Wire
1	not connected
2	not connected
3	CAN-Low
4	CAN-High
5	GND
6	not connected
7	not connected
8	not connected
9	Cable Shield (if available)
10	not connected

Figure 3.21: 10pinF(CAN): DIN 41651 connector, pitch 2.54 mm, 10 poles, plug strain relief (Female)

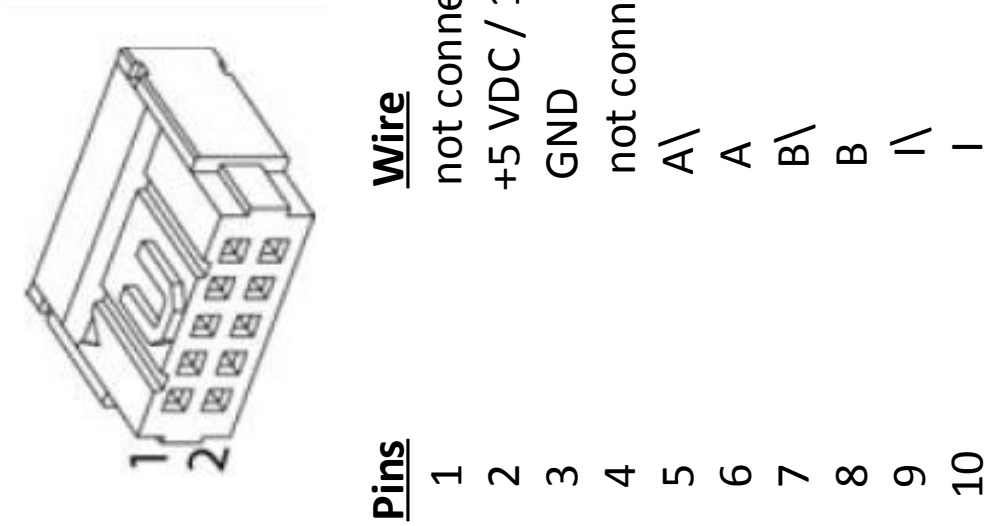


Figure 3.22: 10pinF(Encoder): DIN 41651 connector, pitch 2.54 mm, 10 poles, plug strain relief (Female)

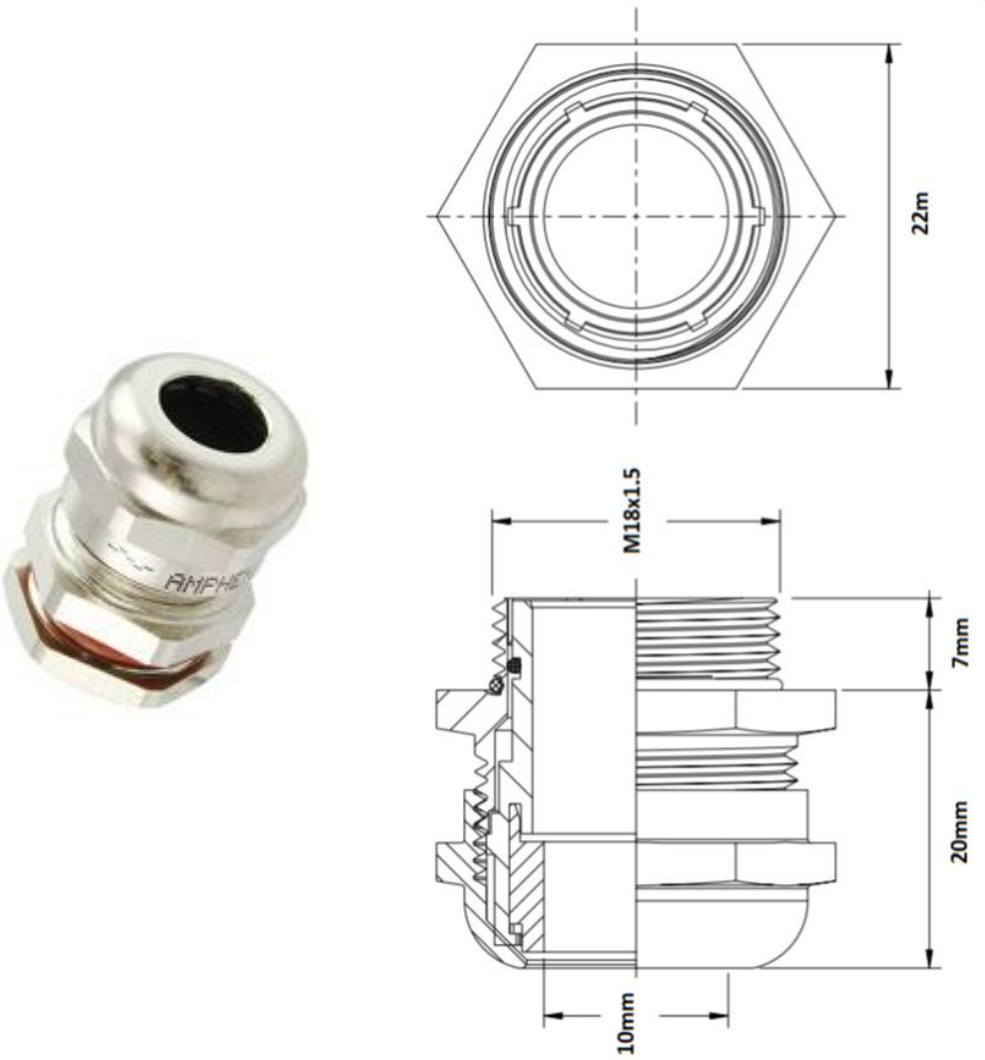


Figure 3.23: CG(CAN): Cable Gland for CAN

- Commercial option (Website): http://www.digikey.com/product-detail/en/AIO-CSJM18/AIO-CSJM18-ND/3904970
- Picture and dimensions: see figure 3.9.1.3

3.9.1.4 CG(LAN): Cable Gland for Ethernet LAN

- Acronym for cable/connector lists: CG(LAN)
- Name: Cable Gland for Ethernet
- Description: each Ethernet cable gland is used to fit one side of the outdoor Ethernet cable on the rear interface of each module. The presented option for this item can

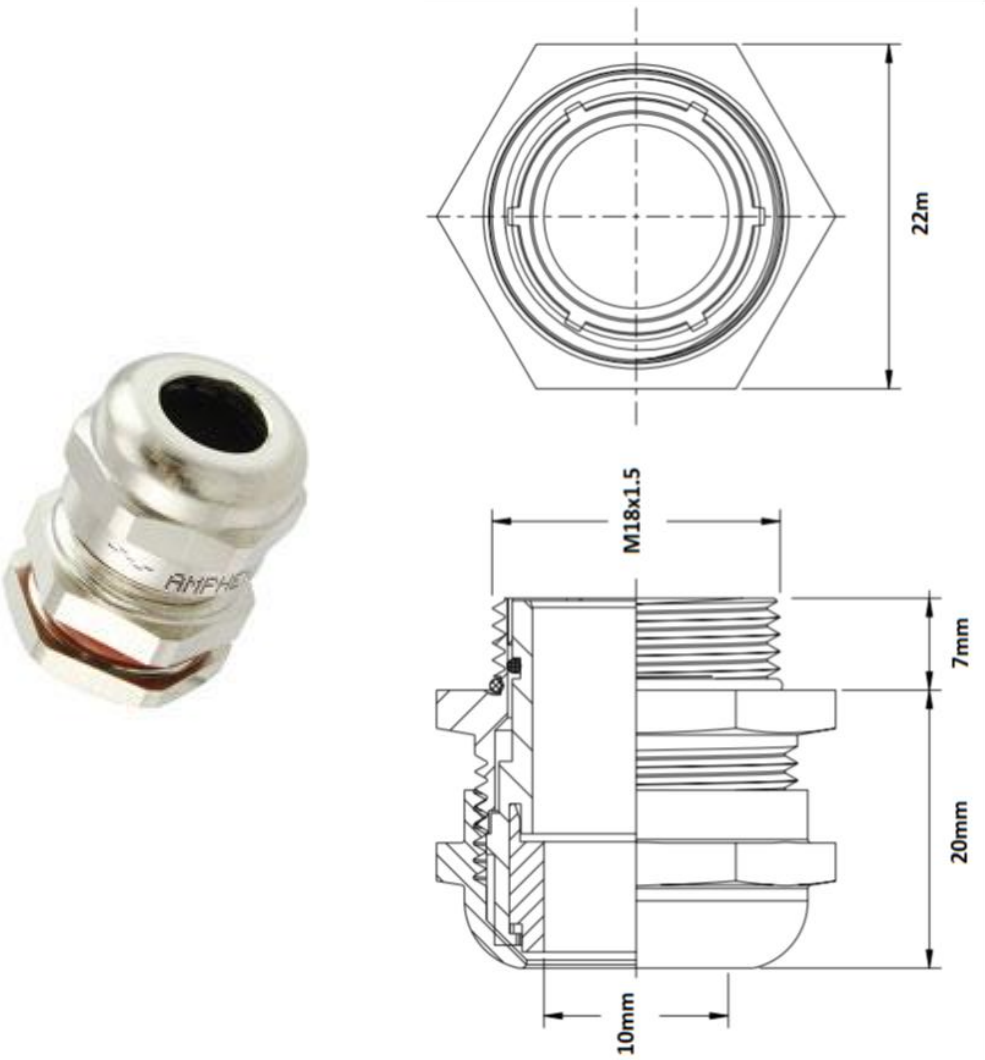


Figure 3.24: CG(LAN): Cable Gland for Ethernet

fit cables with 5mm to 10mm diameter, and is IP68 certified.

- Commercial option (Website): http://www.digikey.com/product-detail/en/AIO-CSJM18/AIO-CSJM18-ND/3904970
- Picture and dimensions: see figure 3.9.1.4

3.9.1.5 DB9F(SH): Shielded DB9 (Female)

- Acronym for cable/connector lists: DB9F(SH)
- Name: Shielded DB9 (Female)

- Commercial option (Website): http://www.digikey.com/product-detail/en/D09S13A4GL00LF/609-1482-ND/1001796
- Picture and pinout: see figure 3.25

3.9.1.6 DB9M(SH): Shielded DB9 (Male)

- Acronym for cable/connector lists: DB9M(SH)
- Name: Shielded DB9 (Male)
- Commercial option (Website): http://www.digikey.com/product-detail/en/DE09P064TXLF/609-1524-ND/1001838
- Picture and pinout: see figure 3.26

3.9.1.7 microCAN: Molex Micro-Fit 3.0™4 poles (43025-0400)

- Acronym for cable/connector lists: microCAN
- Name: Molex Micro-Fit 3.0™4 poles, Part Number: 43025-0400
- Model references (Website): http://www.molex.com/molex/products/datasheet.jsp?part=active/04
- Picture and pinout: see figure 3.27
- Commercial option (Website): http://www.digikey.com/product-search/en?WT.z_header=search_g 0400&x=0&y=0&formaction=on

3.9.1.8 microHall: Molex Micro-Fit 3.0™6 poles (43025-0600)

- Acronym for cable/connector lists: microHall
- Name: Molex Micro-Fit 3.0™6 poles, Part Number: 43025-0600
- Model references (Website): http://www.molex.com/molex/products/datasheet.jsp?part=active/04
- Commercial option (Website): http://www.digikey.com/product-search/en?WT.z_header=search_g 0600&x=0&y=0&formaction=on
- Picture and pinout: see figure 3.28

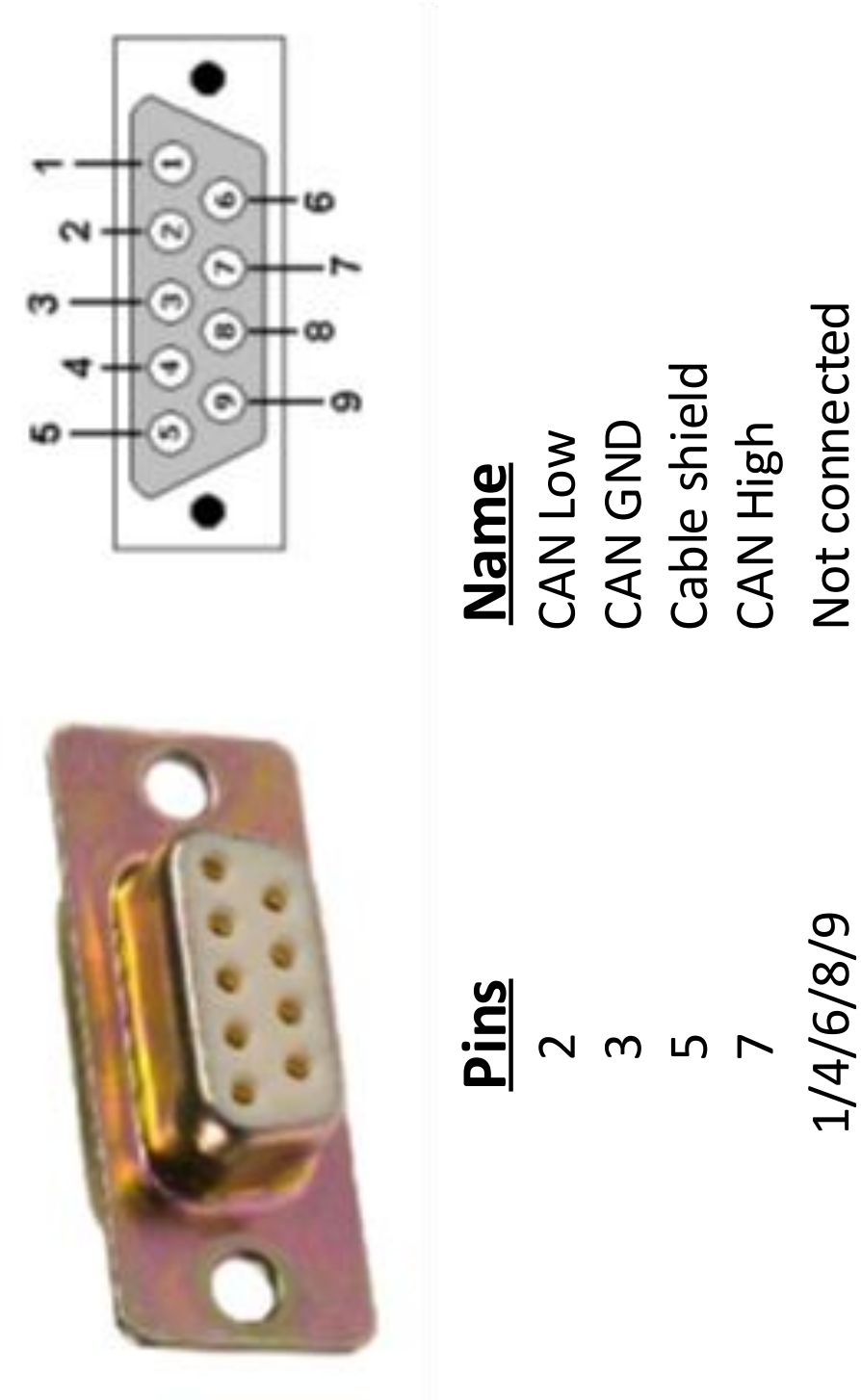


Figure 3.25: DB9F(SH): Shielded DB9 (Female)

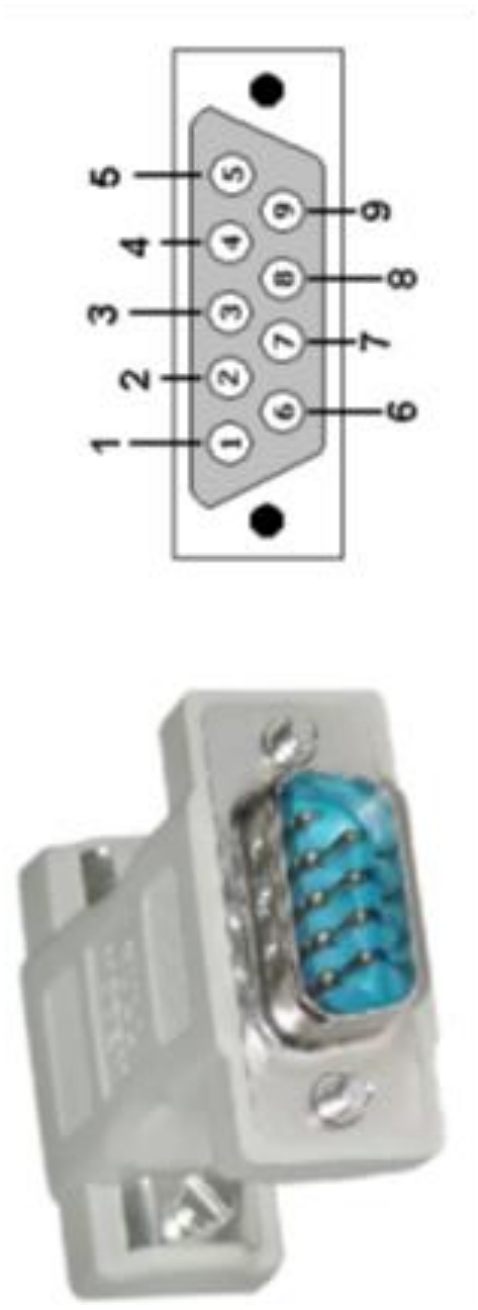


Figure 3.26: DB9M(SH): Shielded DB9 (Male)

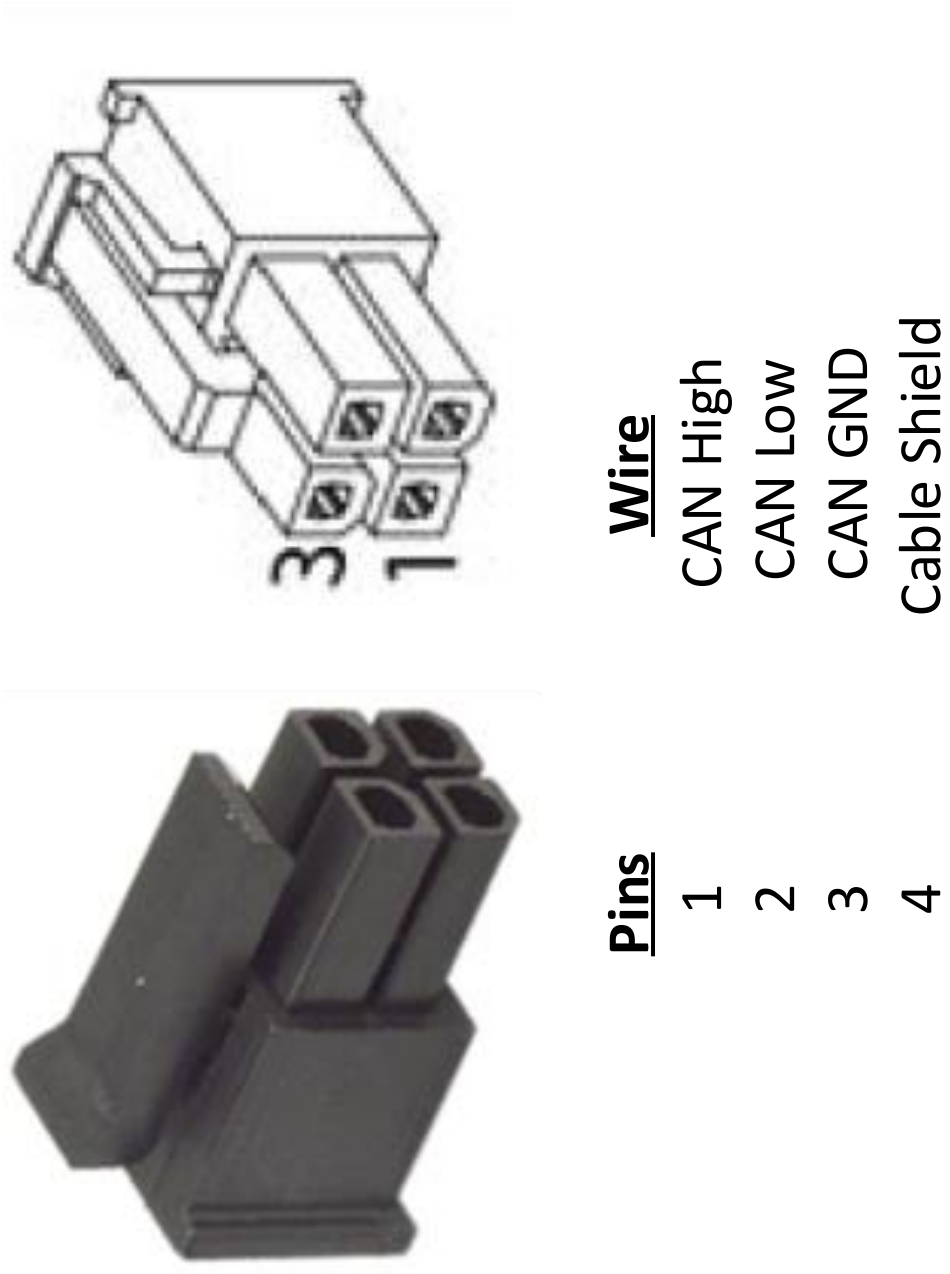


Figure 3.27: microCAN: Molex Micro-Fit 3.0™4 poles (43025-0400)

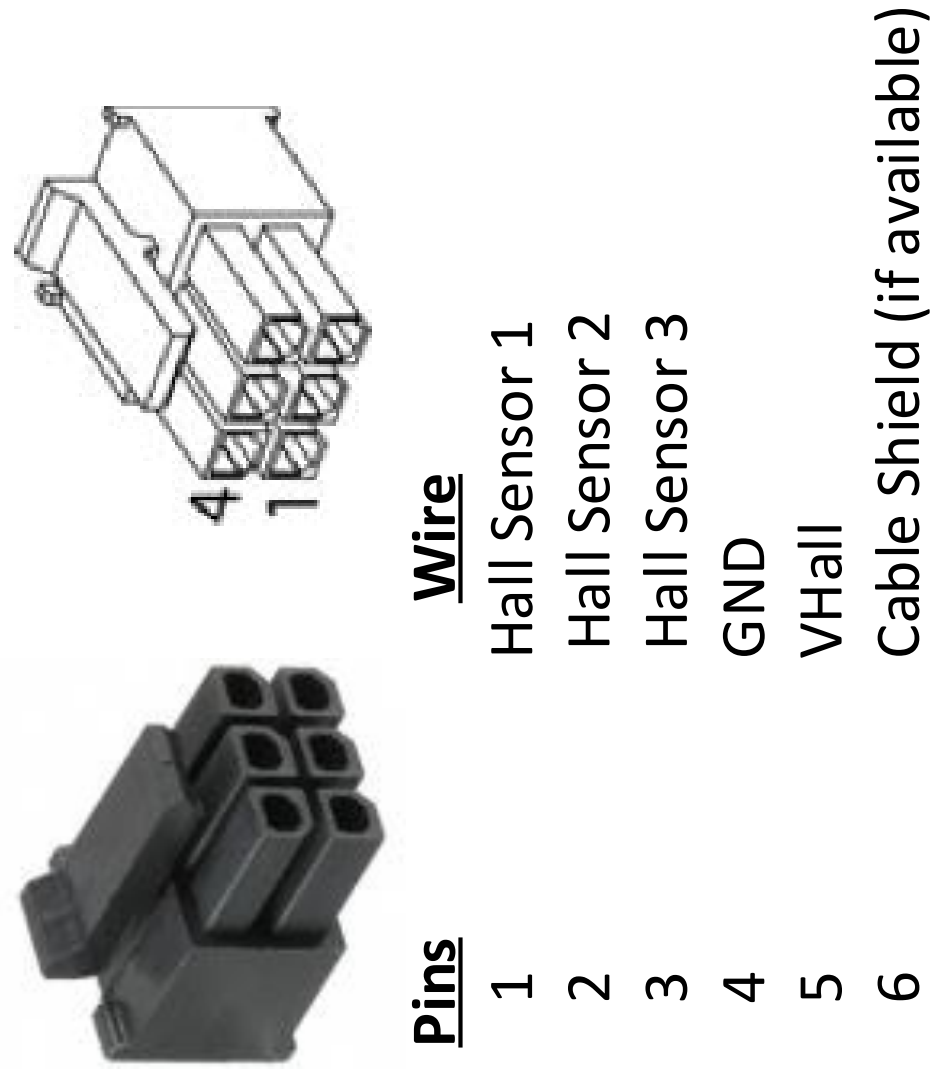


Figure 3.28: microHall: Molex Micro-Fit 3.0™6 poles (43025-0600)

3.9.1.9 miniMotor: Molex Mini-Fit®Jr. 4 poles (39-01-2040)

- Acronym for cable/connector lists: miniMotor
- Name: Molex Mini-Fit®Jr. 4 poles, Part Number: 39-01-2040
- Model references (Website): http://www.molex.com/molex/products/datasheet.jsp?part=active/00
- Commercial option (Website): http://www.digikey.com/product-search/en?vendor=0&keywords=3 01-2040
- Picture and pinout: see figure 3.29

3.9.1.10 miniPower: Molex Mini-Fit®Jr. 2 poles (39-01-2020)

- Acronym for cable/connector lists: miniPower
- Name: Molex Mini-Fit®Jr. 2 poles, Part Number: 39-01-2020
- Model references (Website): http://www.molex.com/molex/products/datasheet.jsp?part=active/00
- Commercial option (Website): http://www.digikey.com/product-search/en?WT.z_header=search_g 01-2020&x=0&y=0&formaction=on
- Picture and pinout: see figure 3.30

3.9.1.11 RJ45F(SH): Shielded RJ-45 (Female)

- Acronym for cable/connector lists: RJ45F(SH)
- Name: Shielded RJ-45 (Female)
- Model references (Website): ESCREVER
- Picture and pinout: see figure 3.31

3.9.1.12 RJ45M(SH): Shielded RJ-45 (Male)

- Acronym for cable/connector lists: RJ45M(SH)
- Name: Shielded RJ-45 (Male)
- Model references (Website): ESCREVER
- Picture and pinout: see figure 3.32

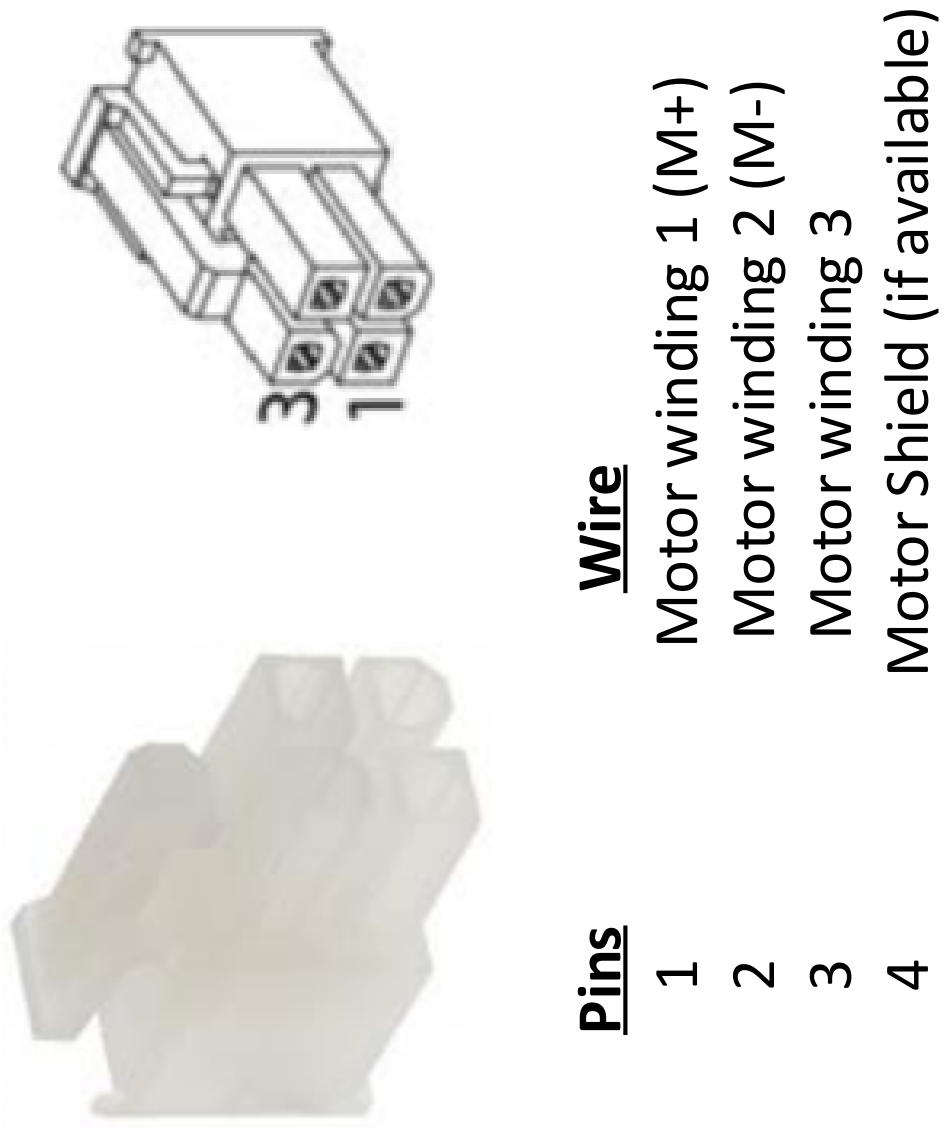


Figure 3.29: miniMotor: Molex Mini-Fit®Jr. 4 poles (39-01-2040)

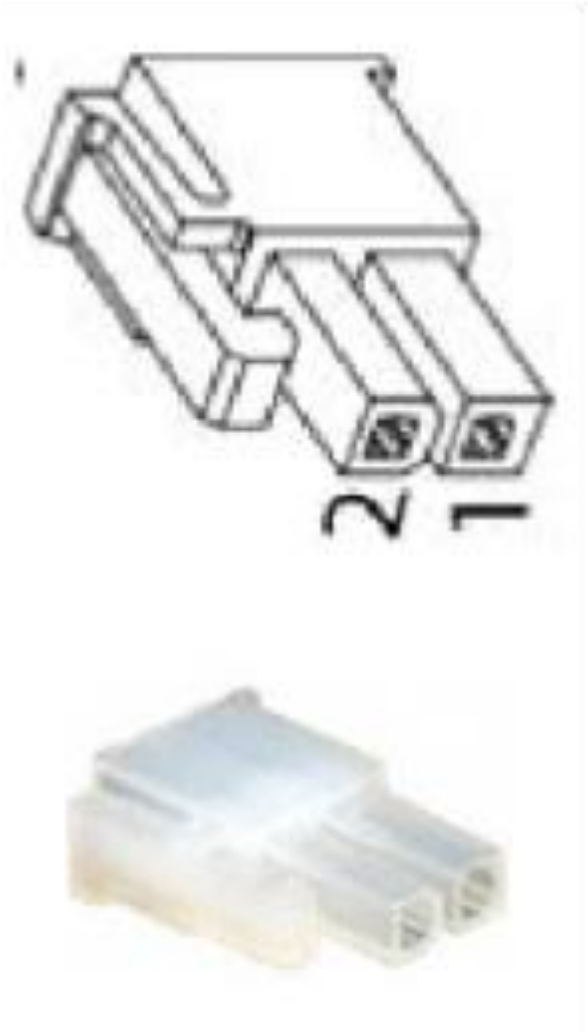


Figure 3.30: miniPower: Molex Mini-Fit®Jr. 2 poles (39-01-2020)

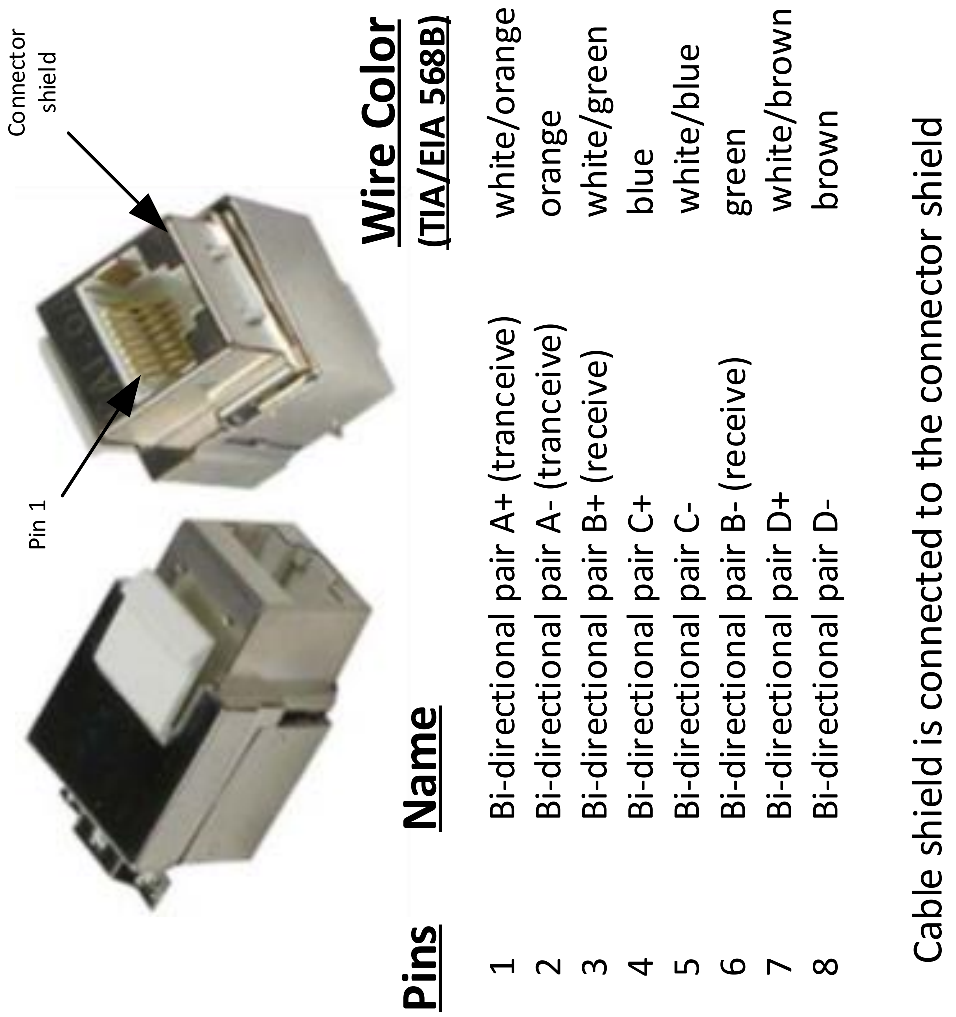


Figure 3.31: RJ45F(SH): Shielded RJ-45 (Female)

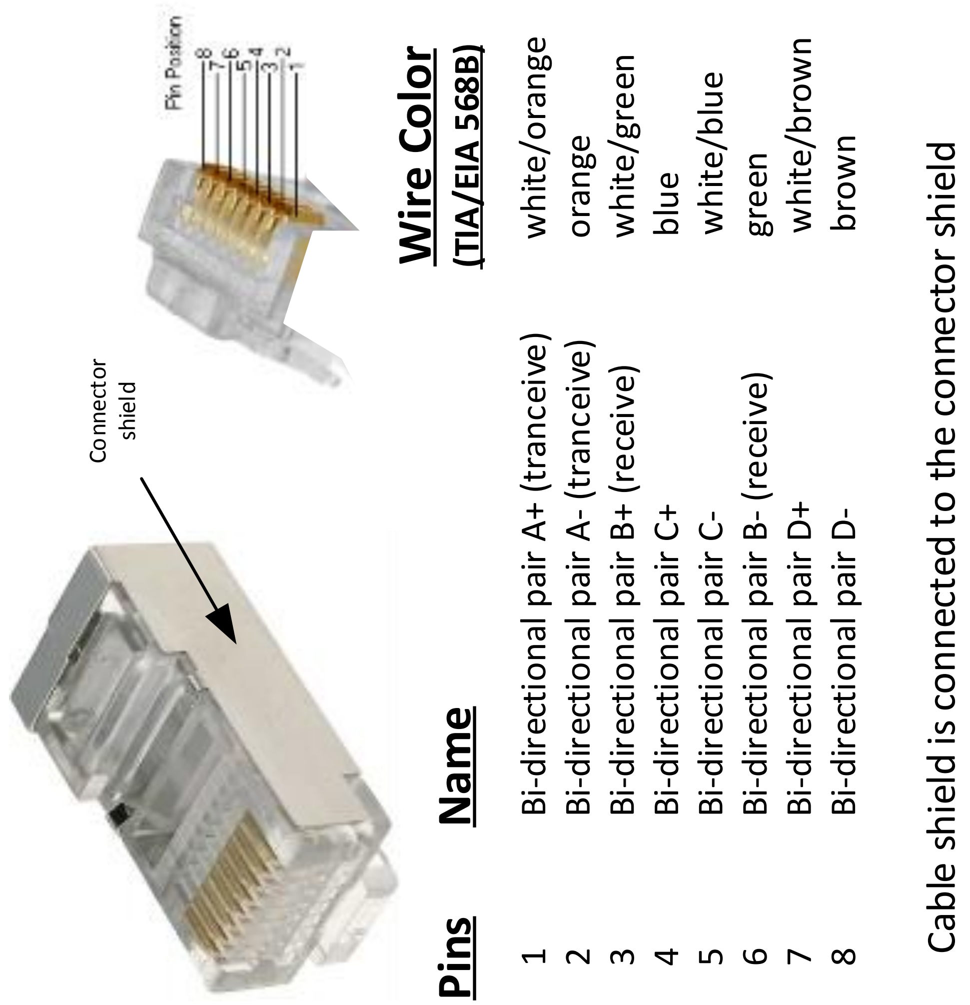


Figure 3.32: RJ45M(SH): Shielded RJ-45 (Male)

3.9.1.13 SCANF(SH): Shielded Special CAN Industrial Connector (Female)

- Acronym for cable/connector lists: SCANF(SH)
- Name: Shielded Special CAN Industrial Connector (Female)
- Description: This connector type is used for the CAN cables that are used outside DORIS modules. Hence, its protection level is higher. The presented option for this connector is a 4 position M12 (Female) with IP67 certification.
- Commercial option (Website): http://www.digikey.com/product-detail/en/1838274-2/A97641-ND/1764156
- Picture and pinout: see figure 3.33

3.9.1.14 SCANM(SH): Shielded Special CAN Industrial Connector (Male)

- Acronym for cable/connector lists: SCANM(SH)
- Name: Shielded Special CAN Industrial Connector (Male)
- Description: This connector type is used for the CAN cables that are used outside DORIS modules. Hence, its protection level is higher. The presented option for this connector is a 4 position M12 (Male) with IP67 certification.
- Commercial option (Website): http://www.digikey.com/product-detail/en/1838277-2/A97670-ND/1764185
- Picture and pinout: see figure 3.34

3.9.1.15 SLANF(SH): Shielded Special Ethernet Industrial Connector (Female)

- Acronym for cable/connector lists: SLANF(SH)
- Name: Shielded Special Ethernet Industrial Connector (Female)
- Description: This connector type is used for the Ethernet cables that are used outside DORIS modules. Hence, its protection level is higher. The presented option for this connector is a RJ-45 (Female) with IP67 certification.
- Commercial option (Website): http://www.digikey.com/product-search/en?v=626&mpart=17-10017
- Picture and pinout: see figure 3.35

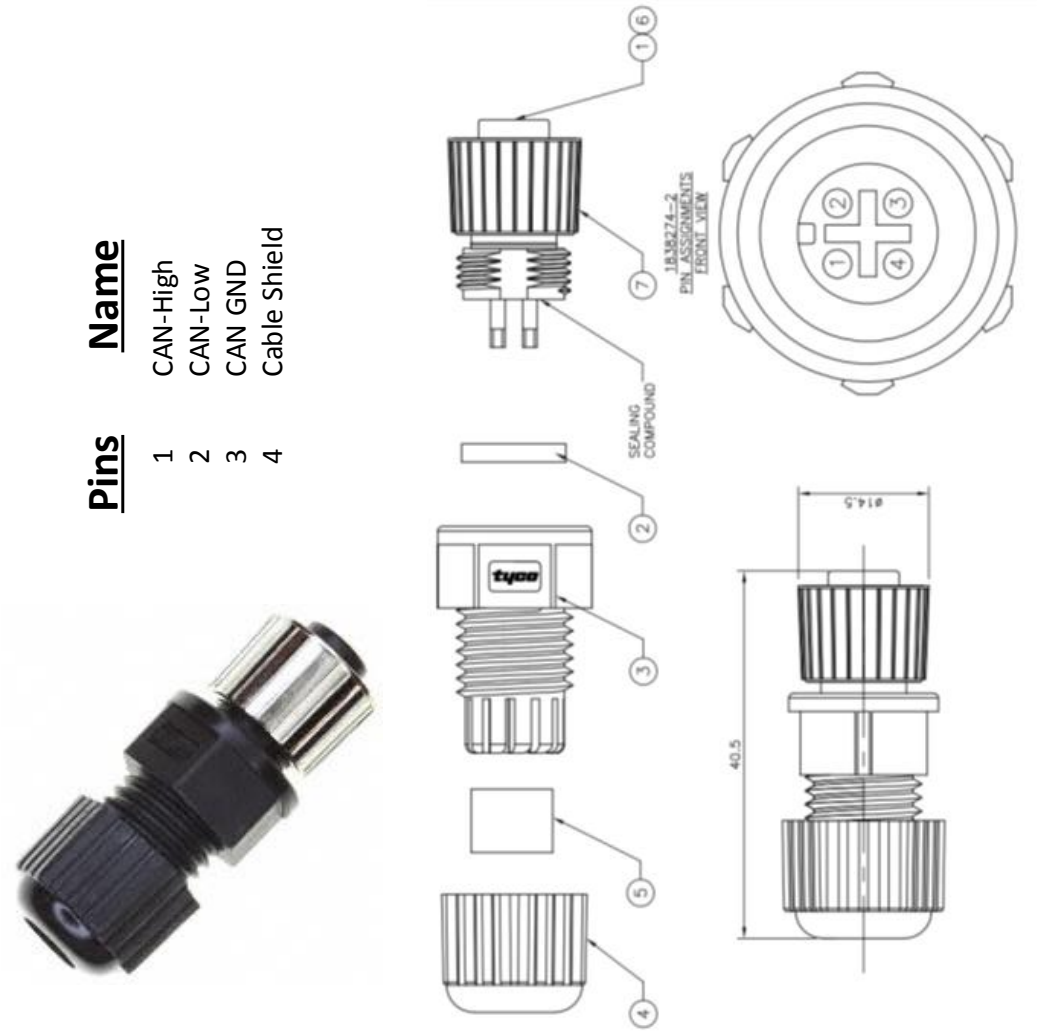


Figure 3.33: SCANF(SH): Shielded Special CAN Industrial Connector (Female)

Figure 3.34: SCANM(SH): Shielded Special CAN Industrial Connector (Male)

Figure 3.35: SLANF(SH): Shielded Special Ethernet Industrial Connector (Female)

3.9.1.16 SLANM(SH): Shielded Special Ethernet Industrial Connector (Male)

- Acronym for cable/connector lists: SLANM(SH)
- Name: Shielded Special Ethernet Industrial Connector (Male)
- Description: This connector type is used for the Ethernet cables that are used outside DORIS modules. Hence, its protection level is higher. The presented option for this connector is a RJ-45 (Male) with IP67 certification and a cable gland.
- Commercial option (Website): http://www.digikey.com/product-detail/en/17-10001/626-1294-ND/1618640
- Picture and pinout: see figure 3.36

3.9.2 Cables

ESCREVER The table (figure 3.37) summarizes all the communication cables that must be prepared for DORIS assembly. For each cable, you must check at the cable list:

- Cable tag:
  - For each communication cable, a tag is assigned in order to facilitate its identification. The cable tagging follows the standard described in figure **??**.
  - Each cable must be physically identified with a cable mark showing its tag. It is recommended the use of ovalgrips, as shown in figure 3.39.
- Connectors:
  - At the cable list, the connectors at both origin and destination are defined by an acronym. Check the acronyms at the connector section (section 3.9.1) and at the connector table (figure **??**) to understand the specifications of each connector type, such as: pinout, commercial model, IP protection, shield.
  - Also check at the connector table (figure **??**) if the cable shield (if present) must pass through the connector or if it must be interrupted near the connector.
- Cable signal type:
  - Each cable is used for a different purpose. For each purpose, a different cable type is required. The cable type list is presented in figure 3.38.

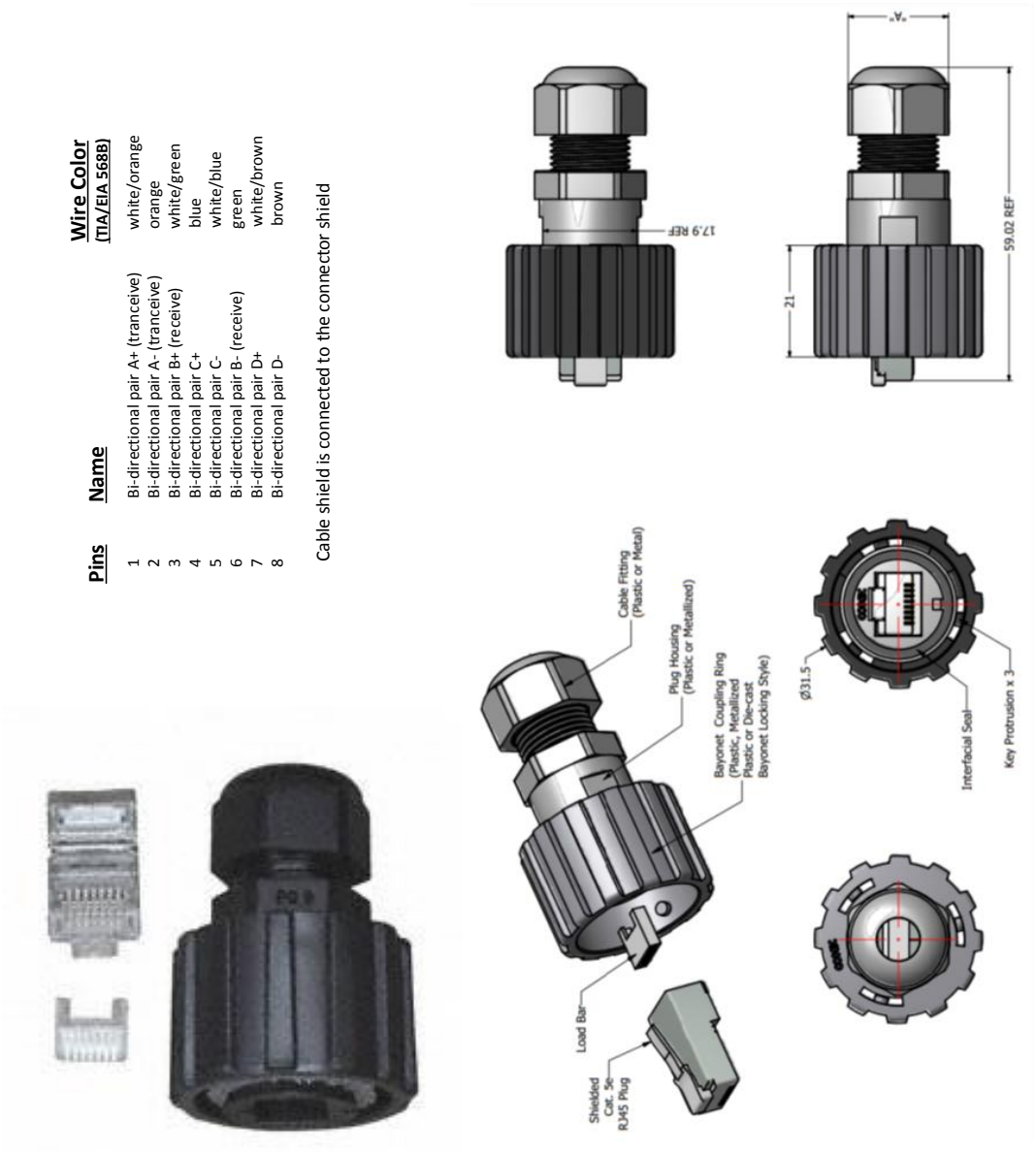


Figure 3.36: SLANM(SH): Shielded Special Ethernet Industrial Connector (Male)

- Construction type:
  - Each cable has a different way to be constructed. Construction types are distinguished by:
    - Commercial cable model to be used.
    - Connector types to be used.
    - Presence (or not) of shield envelopment.
    - Shield passage, i.e., if the shield envelopment or wire passes through the connector or not.
  - Each construction type is defined by an acronym.
  - Details of each construction type can be found at the section **??**.
- Length:
  - The lengths defined in the cable list are estimated values. Updates may occur in future revisions of this memorandum.

3.9.2.1 Cable signal type: CAN

3.9.2.2 Cable signal type: Electric (Encoder)

3.9.2.3 Cable signal type: Electric (Hall)

3.9.2.4 Cable signal type: Electric (Motor)

3.9.2.5 Cable signal type: Ethernet

- Purpose: transmission of Ethernet
- Speed: 10/100/1000 Mbit
- Mean of transmission: 4 twisted pairs
- Shielding: 1 shield envelop for all pairs; 1 shield

3.9.2.6 Cable signal type: USB 2.0

3.10 Tools and utilities

This section presents a list of tools and utilities that must be used for DORIS assembly. In chapter 4, some DORIS assembly procedures need the tools that are listed here. This will be indicated as a reference.

Cable Tag	Module	Origin	Connector (Origin) Check Connector Table	Destination	Connector (Destination) Check Connector Table	Cable Signal Type	Construction Type Check Cable Construction section	Maximum speed	Length (mm)	Obs.:
C1-CAN-DR1/DR2-01	M1	Driver 1	microCAN / SH-Cut	Driver 2	microCAN / SH-Pass	CAN	CAN/D-D	1 Mbit	250	-
C1-CAN-DR2/DR3-01	M1	Driver 2	microCAN / SH-Cut	Driver 3	microCAN / SH-Pass	CAN	CAN/D-D	1 Mbit	250	-
C1-CAN-DR3/DR4-01	M1	Driver 3	microCAN / SH-Cut	Driver 4	microCAN / SH-Pass	CAN	CAN/D-D	1 Mbit	250	-
C1-CAN-FORE/DR1-01	M1	M1 Front Interface	DB9F(SH) / SH-Pass	Driver 1	microCAN / SH-Pass	CAN	CAN/I-Dp	1 Mbit	500	-
C1-CAN-REAR/DR4-01	M1	M1 Rear Interface	DB9F(SH) / SH-Pass	Driver 4	microCAN / SH-Cut	CAN	CAN/I-Dc	1 Mbit	500	-
C2-CAN-FORE/REAR-01	M2	M2 Front Interface	DB9F(SH) / SH-Pass	M2 Rear Interface	DB9F(SH) / SH-Pass	CAN	CAN/I-I	1 Mbit	850	-
C3-CAN-DR5/DR6-01	M3	Driver 5	microCAN / SH-Cut	Driver 6	microCAN / SH-Pass	CAN	CAN/D-D	1 Mbit	250	-
C3-CAN-DR6/DR7-01	M3	Driver 6	microCAN / SH-Cut	Driver 7	microCAN / SH-Pass	CAN	CAN/D-D	1 Mbit	250	-
C3-CAN-FORE/TCON-01	M3	M3 Front Interface	DB9F(SH) / SH-Pass	T-connector	DB9F(SH) / SH-Pass	CAN	CAN/I-I	1 Mbit	500	-
C3-CAN-REAR/DR7-01	M3	M3 Rear Interface	DB9F(SH) / SH-Pass	Driver 7	microCAN / SH-Cut	CAN	CAN/I-Dc	1 Mbit	500	-
C3-CAN-TCON/DR5-01	M3	T-connector	DB9F(SH) / SH-Pass	Driver 5	microCAN / SH-Pass	CAN	CAN/I-Dp	1 Mbit	500	-
C3-CAN-TCON/PC-01	M3	T-connector	DB9F(SH) / SH-Pass	Control PC	10pinF / SH-Cut	CAN	CAN/I-PC	1 Mbit	500	-
C4-CAN-FORE/TCON-01	M4	M4 Front Interface	DB9F(SH) / SH-Pass	T-connector	DB9F(SH) / SH-Pass	CAN	CAN/I-I	1 Mbit	500	-
C4-CAN-REAR/TCON-01	M4	M4 Rear Interface	DB9F(SH) / SH-Pass	T-connector	DB9F(SH) / SH-Pass	CAN	CAN/I-I	1 Mbit	500	-
C4-CAN-TCON/PC-01	M4	T-connector	DB9F(SH) / SH-Pass	Signal Processing PC	10pinF / SH-Cut	CAN	CAN/I-PC	1 Mbit	500	-
CM-CAN-M1/M2-01	Out	M1 Rear Interface	DB9M(SH) / SH-Pass	M2 Front Interface	SCANM(SH) / SH-Cut	CAN	CAN/Out	1 Mbit	1000	Cable gland on M1 Rear Interface
CM-CAN-M2/M3-01	Out	M2 Rear Interface	DB9M(SH) / SH-Pass	M3 Front Interface	SCANM(SH) / SH-Cut	CAN	CAN/Out	1 Mbit	1000	Cable gland on M2 RearInterface
CM-CAN-M3/M4-01	Out	M3 Rear Interface	DB9M(SH) / SH-Pass	M4 Front Interface	SCANM(SH) / SH-Cut	CAN	CAN/Out	1 Mbit	1000	Cable gland on M3 Rear Interface
CM-CAN-M4/M5-01	Out	M4 Rear Interface	DB9M(SH) / SH-Pass	M5 Front Interface (disconnected)	SCANM(SH) / SH-Cut	CAN	CAN/Out	1 Mbit	1000	Cable gland on M4 Rear Interface
C3-ANA-DAQ/S01-01	M3	DAQ	screwT / SH-No	Vibration Sensor (Sensor 01)	Check G5 Project	Electric (Analog)	Check G5 Project	-	Check G5 Project	-
C3-ANA-DAQ/S02-01	M3	DAQ	screwT / SH-No	Hydrocarbon Sensor (Sensor 02)	Check G5 Project	Electric (Analog)	Check G5 Project	-	Check G5 Project	-
C1-ANA-DR1/MT1-03	M1	Driver 1	10pinF(encoder) / SH-No	Motor 1	noConn / SH-No	Electric (Encoder)	ACT/E	-	600	-
C1-ANA-DR2/MT2-03	M1	Driver 2	10pinF(encoder) / SH-No	Motor 2	noConn / SH-No	Electric (Encoder)	ACT/E	-	600	-
C1-ANA-DR3/MT3-03	M1	Driver 3	10pinF(encoder) / SH-No	Motor 3	noConn / SH-No	Electric (Encoder)	ACT/E	-	600	-
C1-ANA-DR4/MT4-03	M1	Driver 4	10pinF(encoder) / SH-No	Motor 4	noConn / SH-No	Electric (Encoder)	ACT/E	-	600	-
C3-ANA-DR5/MT5-03	M3	Driver 5	10pinF(encoder) / SH-No	Motor 5	noConn / SH-No	Electric (Encoder)	ACT/E	-	600	-
C3-ANA-DR6/MT6-03	M3	Driver 6	10pinF(encoder) / SH-No	Motor 6	noConn / SH-No	Electric (Encoder)	ACT/E	-	600	-
C3-ANA-DR7/MT7-03	M3	Driver 7	10pinF(encoder) / SH-No	Motor 7	noConn / SH-No	Electric (Encoder)	ACT/E	-	600	-
C1-ANA-DR1/MT1-02	M1	Driver 1	microHall / SH-No	Motor 1	noConn / SH-No	Electric (Hall)	ACT/H	-	600	-
C1-ANA-DR2/MT2-02	M1	Driver 2	microHall / SH-No	Motor 2	noConn / SH-No	Electric (Hall)	ACT/H	-	600	-
C1-ANA-DR3/MT3-02	M1	Driver 3	microHall / SH-No	Motor 3	noConn / SH-No	Electric (Hall)	ACT/H	-	600	-
C1-ANA-DR4/MT4-02	M1	Driver 4	microHall / SH-No	Motor 4	noConn / SH-No	Electric (Hall)	ACT/H	-	600	-
C3-ANA-DR5/MT5-02	M3	Driver 5	microHall / SH-No	Motor 5	noConn / SH-No	Electric (Hall)	ACT/H	-	600	-
C3-ANA-DR6/MT6-02	M3	Driver 6	microHall / SH-No	Motor 6	noConn / SH-No	Electric (Hall)	ACT/H	-	600	-
C3-ANA-DR7/MT7-02	M3	Driver 7	microHall / SH-No	Motor 7	noConn / SH-No	Electric (Hall)	ACT/H	-	600	-
C1-ANA-DR1/MT1-01	M1	Driver 1	miniMotor / SH-No	Motor 1	noConn / SH-No	Electric (Motor)	ACT/M	-	600	-
C1-ANA-DR2/MT2-01	M1	Driver 2	miniMotor / SH-No	Motor 2	noConn / SH-No	Electric (Motor)	ACT/M	-	600	-
C1-ANA-DR3/MT3-01	M1	Driver 3	miniMotor / SH-No	Motor 3	noConn / SH-No	Electric (Motor)	ACT/M	-	600	-
C1-ANA-DR4/MT4-01	M1	Driver 4	miniMotor / SH-No	Motor 4	noConn / SH-No	Electric (Motor)	ACT/M	-	600	-
C3-ANA-DR5/MT5-01	M3	Driver 5	miniMotor / SH-No	Motor 5	noConn / SH-No	Electric (Motor)	ACT/M	-	600	-
C3-ANA-DR6/MT6-01	M3	Driver 6	miniMotor / SH-No	Motor 6	noConn / SH-No	Electric (Motor)	ACT/M	-	600	-
C3-ANA-DR7/MT7-01	M3	Driver 7	miniMotor / SH-No	Motor 7	noConn / SH-No	Electric (Motor)	ACT/M	-	600	-
C1-LAN-FORE/SWI-01	M1	M1 Front Interface	RJ45M(SH) / SH-Pass	Ethernet Switch	RJ45M(SH) / SH-Pass	Ethernet	LAN/I-S	1000 Mbit	410	-
C1-LAN-REAR/SWI-01	M1	M1 Rear Interface	RJ45M(SH) / SH-Pass	Ethernet Switch	RJ45M(SH) / SH-Pass	Ethernet	LAN/I-S	1000 Mbit	410	-
C1-LAN-SWI/AVR-01	M1	Ethernet Switch	RJ45M(SH) / SH-Pass	LAN/AVR Adapter	RJ45M(SH) / SH-Cut	Ethernet	LAN/S-D	10 Mbit	170	-
C2-LAN-FORE/SWI-01	M2	M2 Front Interface	RJ45M(SH) / SH-Pass	Ethernet Switch	RJ45M(SH) / SH-Pass	Ethernet	LAN/I-S	1000 Mbit	410	-
C2-LAN-REAR/SWI-01	M2	M2 Rear Interface	RJ45M(SH) / SH-Pass	Ethernet Switch	RJ45M(SH) / SH-Pass	Ethernet	LAN/I-S	1000 Mbit	410	-
C2-LAN-SWI/AVR-01	M2	Ethernet Switch	RJ45M(SH) / SH-Pass	LAN/AVR Adapter	RJ45M(SH) / SH-Cut	Ethernet	LAN/S-D	10 Mbit	170	-
C3-LAN-FORE/SWI-01	M3	M3 Front Interface	RJ45M(SH) / SH-Pass	Ethernet Switch	RJ45M(SH) / SH-Pass	Ethernet	LAN/I-S	1000 Mbit	410	-
C3-LAN-REAR/SWI-01	M3	M3 Rear Interface	RJ45M(SH) / SH-Pass	Ethernet Switch	RJ45M(SH) / SH-Pass	Ethernet	LAN/I-S	1000 Mbit	410	-
C3-LAN-SWI/AVR-01	M3	Ethernet Switch	RJ45M(SH) / SH-Pass	LAN/AVR Adapter	RJ45M(SH) / SH-Cut	Ethernet	LAN/S-D	10 Mbit	170	-
C3-LAN-SWI/PC-01	M3	Ethernet Switch	RJ45M(SH) / SH-Pass	Control PC	RJ45M(SH) / SH-Cut	Ethernet	LAN/S-D	1000 Mbit	170	-
C4-LAN-FORE/SWI-01	M4	M4 Front Interface	RJ45M(SH) / SH-Pass	Ethernet Switch	RJ45M(SH) / SH-Pass	Ethernet	LAN/I-S	1000 Mbit	410	-
C4-LAN-REAR/SWI-01	M4	M4 Rear Interface	RJ45M(SH) / SH-Pass	Ethernet Switch	RJ45M(SH) / SH-Pass	Ethernet	LAN/I-S	1000 Mbit	410	-
C4-LAN-SWI/AP-01	M4	Ethernet Switch	RJ45M(SH) / SH-Pass	Wi-Fi Access Point	RJ45M(SH) / SH-Cut	Ethernet	LAN/S-D	1000 Mbit	190	-
C4-LAN-SWI/AVR-01	M4	Ethernet Switch	RJ45M(SH) / SH-Pass	LAN/AVR Adapter	RJ45M(SH) / SH-Cut	Ethernet	LAN/S-D	10 Mbit	170	-
C4-LAN-SWI/CA1-01	M4	Ethernet Switch	RJ45M(SH) / SH-Pass	Fixed Camera (Cam. 1)	RJ45M(SH) / SH-Cut	Ethernet	LAN/S-D	100 Mbit	800	-
C4-LAN-SWI/CA2-01	M4	Ethernet Switch	RJ45M(SH) / SH-Pass	Infrared Camera (Cam. 2)	RJ45M(SH) / SH-Cut	Ethernet	LAN/S-D	1000 Mbit	800	-
C4-LAN-SWI/CA3-01	M4	Ethernet Switch	RJ45M(SH) / SH-Pass	Pan Camera (Cam. 3)	RJ45M(SH) / SH-Cut	Ethernet	LAN/S-D	100 Mbit	800	-
C4-LAN-SWI/PC-01	M4	Ethernet Switch	RJ45M(SH) / SH-Pass	Signal Processing PC	RJ45M(SH) / SH-Cut	Ethernet	LAN/S-D	1000 Mbit	170	-
CM-LAN-M1/M2-01	Out	M1 Rear Interface	RJ45M(SH) / SH-Pass	M2 Front Interface	SLANM(SH) / SH-Cut	Ethernet	LAN/Out	1000 Mbit	1000	Cable gland on M1 Rear Interface
CM-LAN-M2/M3-01	Out	M2 Rear Interface	RJ45M(SH) / SH-Pass	M3 Front Interface	SLANM(SH) / SH-Cut	Ethernet	LAN/Out	1000 Mbit	1000	Cable gland on M2 RearInterface
CM-LAN-M3/M4-01	Out	M3 Rear Interface	RJ45M(SH) / SH-Pass	M4 Front Interface	SLANM(SH) / SH-Cut	Ethernet	LAN/Out	1000 Mbit	1000	Cable gland on M3 Rear Interface
CM-LAN-M4/M5-01	Out	M4 Rear Interface	RJ45M(SH) / SH-Pass	M5 Front Interface (disconnected)	SLANM(SH) / SH-Cut	Ethernet	LAN/Out	1000 Mbit	1000	Cable gland on M4 Rear Interface
C3-USB-PC/DAQ-01	M3	Computer/PC	USBM-A / SH-No	DAQ	USBM-B / SH-No	USB 2.0	USB/DAQ	-	350	-
C4-USB-PC/AU1-01	M4	Computer/PC	USBM-A / SH-No	Audio Microcone (Audio 1)	Check G5 Project	USB 2.0	Check G5 Project	Check G5 Project	350	-
C4-USB-PC/CA4-01	M4	Computer/PC	USBM-A / SH-No	3D Webcam (Cam. 4)	Check G5 Project	USB 2.0	Check G5 Project	Check G5 Project	350	-

Figure 3.37: Cable list

Cable Signal Type	Length to be purchased (mm)
CAN	10600
Electric (Encoder)	4200
Electric (Hall)	4200
Electric (Motor)	4200
Ethernet	10890
USB 2.0	1050

Figure 3.38: Cable signal type list

Figure 3.39: Cable Mark Type: Ovalgrip

3.10.1 Tools

3.10.1.1 Heat blower

- Description: The heat blower is the tool used for the application of the heat shrink tubes (see section 3.10.2.1). Generally, heat blowers come as an accessory of soldering stations (see section 3.10.1.6).
- Point the heat blower tip towards the tube (which is already placed over the application area). Continue this procedure until the tube shrunk entirely, hence holding the cable and wires. See figure 3.48 as an illustration.
- Examples of models: see figure 3.40

3.10.1.2 Plier: Cutting plier

- Description: This is a cutting plier. It is generally used to cut wires/cables or to strip wire envelops.
- Examples of models: see figure 3.42

3.10.1.3 Plier: Long needle-nose plier

- Description: This is a long needle-nose plier. It is generally used to hold wires/cables and strain wire terminals.
- Examples of models: see figure 3.43

3.10.1.4 Plier: Molex hand crimper for Micro-Fit 3.0 ™crimp terminals (63819-0000)

- Name: Molex hand crimper tool for Micro-Fit 3.0™crimp terminals, Part Number: 63819-0000
- Description: This tool is a special plier for crimping Molex Micro-Fit 3.0™female crimp terminals. In DORIS project, it is specially used for crimping the Molex Micro-Fit 3.0™female crimp terminals (43030-xxxx family)
- Product references (website): http://www.molex.com/molex/products/datasheet.jsp?part=active/0
- Commercial option (Website): http://www.digikey.com/product-search/en/tools/crimpers-applicators-presses/1245292?k=63819-0000


HEAT II

Figure 3.41: Heat blower - Application over the cable/wires

Figure 3.42: Cutting plier examples (out of scale)

Figure 3.44: Plier: Molex hand crimper for Micro-Fit 3.0™crimp terminals (63819-0000)

- Picture: see figure 3.44

3.10.1.5 Plier: Molex hand crimper for Mini-Fit®crimp terminals (63819-0900)

- Name: Molex hand crimper tool for Mini-Fit®crimp terminals, Part Number: 63819-0900
- Description: This tool is a special plier for crimping Molex Mini-Fit®female crimp terminals. In DORIS project, it is specially used for crimping the Molex Mini-Fit®female crimp terminals (44476-xxxx family)
- Product references (website): http://www.molex.com/molex/products/datasheet.jsp?part=active/0
- Commercial option (Website): http://www.digikey.com/product-search/en/tools/crimpers-applicators-presses/1245292?k=63819-0900

Figure 3.45: Plier: Molex hand crimper for Mini-Fit®crimp terminals (63819-0900)

- Picture: see figure 3.45

3.10.1.6 Soldering station

- Description: The soldering station is the tool used for general welding. the application of the heat shrink tubes (see section 3.10.2.1).
- Features: Generally, the soldering station comes with: a soldering iron, support for soldering iron, heat blower, power supply.
- Example of model: see figure 3.46

Figure 3.46: Soldering station

3.10.2 Utilities

3.10.2.1 Heat shrink tube for thermal insulation

- Description: This tube is applied on parts of the cable that require isolation, such as the sections near connectors or striped wire/cable envelops. Commercial models with different diameters can be found. Each tube diameter is suitable for a specific wire/cable gauge on which the application will be done.
- Application procedure: The application of a heat shrink on a cable requires a heat blower(see section 3.10.1.1). First, select the right tube diameter and length (generally, 2cm length are reasonable). Afterwards, place this tube piece over the application area, covering the whole cable and internal wires. Then, point the heat blower tip towards the tube. Continue this procedure until the tube shrunk entirely, hence holding the cable and wires. See figure 3.48 as an illustration.
- Examples of models: see figure 3.47

3.10.2.2 microCrimp: Molex Micro-Fit 3.0™female crimp terminals (43030-xxxx)

- Acronym for cable/connector lists: microCrimp
- Name: Molex Micro-Fit 3.0™female crimp terminals, Part Number: 43030-xxxx (there are many metal and color options). In this section, the part number 43030-0002 is being used as an example.
- Description: This crimp terminal is used to crimp the wire ends which are fitted in Molex Micro-Fit 3.0™connectors 43025-xxxx family (sections 3.9.1.7 and 3.9.1.8).
- Model references (Website): http://www.molex.com/molex/products/datasheet.jsp?part=active/04
- Picture: see figure 3.49
- Commercial option (Website): http://www.digikey.com/product-detail/en/0430300002/WM1125TI ND/467797

3.10.2.3 miniCrimp: Molex Mini-Fit®Jr. female crimp terminals (44476-xxxx)

- Acronym for cable/connector lists: miniCrimp

Figure 3.47: Heat shrink tube for thermal insulation

Figure 3.48: Heat shrink tube for thermal insulation - Application over the cable/wires

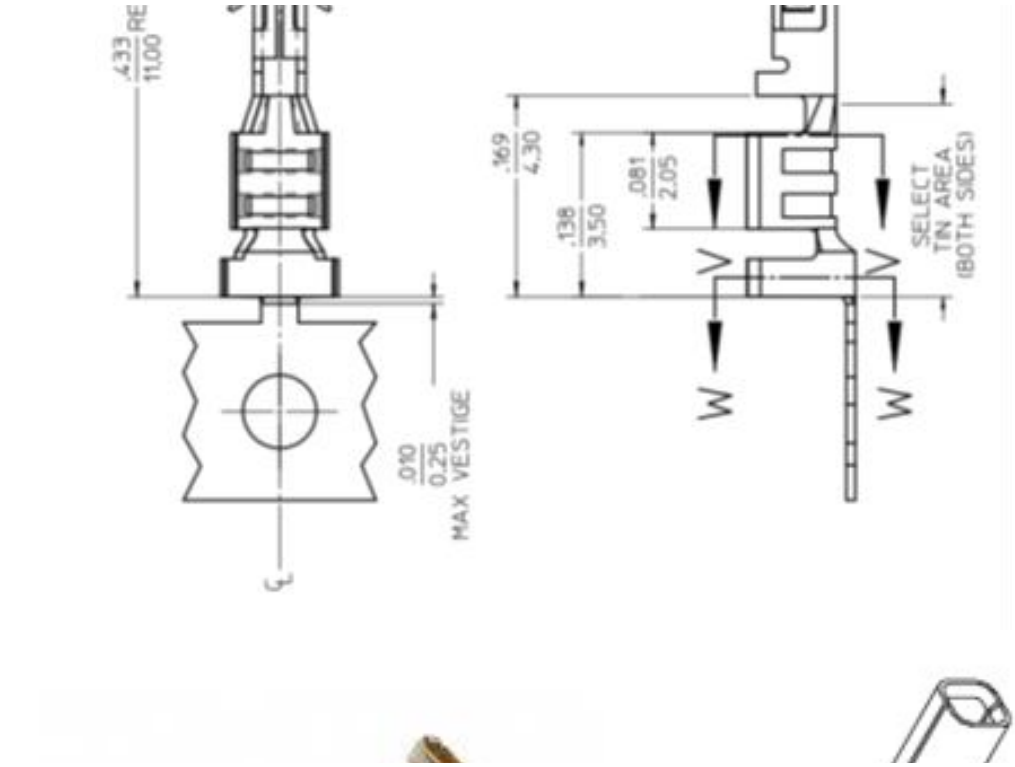


Figure 3.49: microCrimp: Molex Micro-Fit 3.0™female crimp terminals (43030-xxxx)

- Name: Molex Mini-Fit®Jr. female crimp terminals, Part Number: 44476-xxxx (there are many metal and color options). In this section, the part number 44476-1112 is being used as an example.
- Description: This crimp terminal is used to crimp the wire ends which are fitted in Molex Mini-Fit®connectors 44476-xxxx family (sections 3.9.1.10 and **??**).
- Model references (Website): http://www.molex.com/molex/products/datasheet.jsp?part=active/04
- Picture: see figure 3.50
- Commercial option (Website): http://www.digikey.com/product-detail/en/0444761112/WM1914-ND/283456

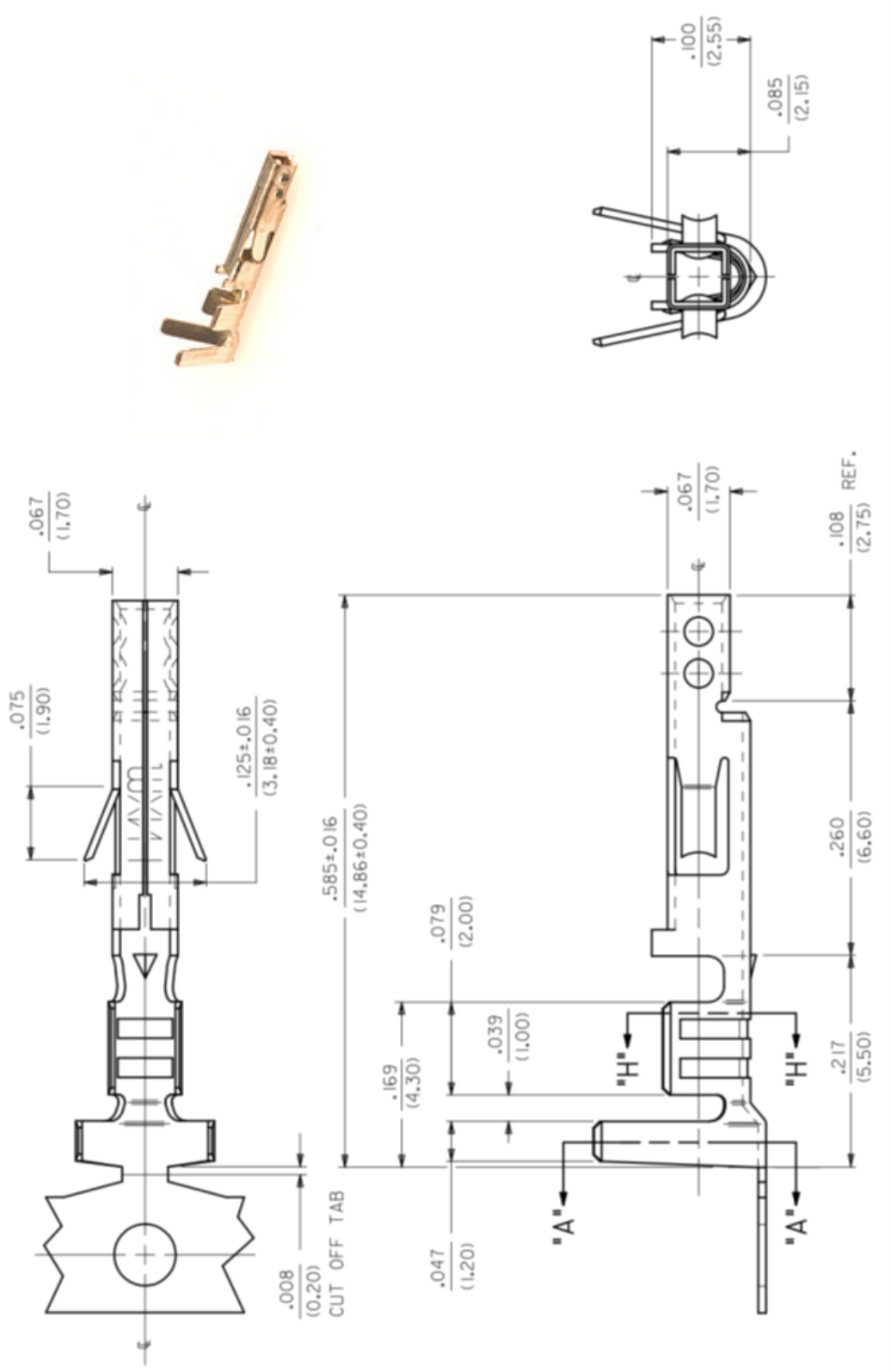


Figure 3.50: miniCrimp: Molex Mini-Fit®Jr. female crimp terminals (44476-xxxx)

Chapter 4

Procedures for system assembly/installation/testing/commisioning

4.1 System assembly

4.1.1 Cable

4.1.1.1 Construction of ACT/E - Cable for motor encoder

4.1.1.2 Construction of ACT/H - Cable for motor Hall effect sensor

4.1.1.3 Construction of ACT/M - Cable for motor supply

4.1.1.4 Construction of CAN/D-D - Cable for CAN between drivers

4.1.1.5 Construction of CAN/I-Dc - Cable for CAN between driver and an interface (shield cut)

4.1.1.6 Construction of CAN/I-Dp - Cable for CAN between driver and an interface (shield pass)

4.1.1.7 Construction of CAN/I-I - Cable for CAN between interfaces

4.1.1.8 Construction of CAN/I-PC - Cable for CAN between PC and an interface

4.1.1.9 Construction of CAN/Out - Outdoor cable for CAN between modules

4.1.1.10 Construction of LAN/I-S - Cable for Ethernet between Ethernet Switch and an interface

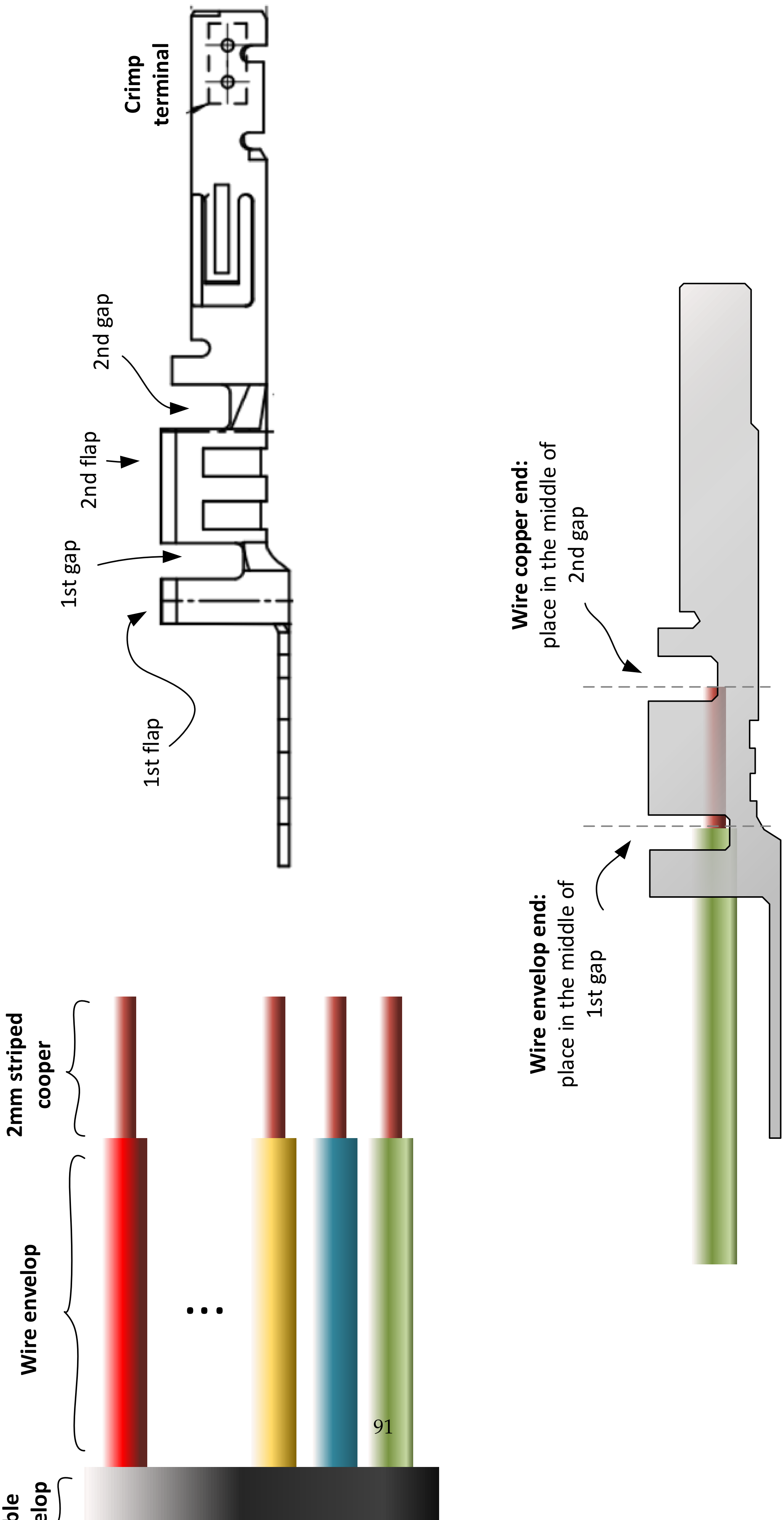
4.1.1.11 Construction of LAN/Out - Outdoor cable for Ethernet between modules

4.1.1.12 Construction of LAN/S-D - Cable for Ethernet between Ethernet Switch and a device

4.1.1.13 Construction of USB/DAQ - Cable for USB between DAQ and PC

crimp terminal from 43030-xxxx family (section 3.10.2.2). For this, you should perform the following steps:

1. Use the tool "Molex Hand Crimper Tool Part Number: 63819-0000" (see section 3.10.1.4).
2. For each wire to be connected, use a cutting plier (like the one described in section 3.10.1.2), strip the wire envelop, leaving 2mm copper exposed.
3. Place the wire and the crimp terminal according to figure 4.1.
4. Use the Molex Hand Crimper (item 1) to crimp the wire.
5. If the crimping tool is not available, perform these steps:
   - Using a preheated soldering station (like the one presented in section 3.10.1.6), tin the 2mm striped copper wire.
   - Place the wire/crimp terminal like described in item 3.
   - Use a long needle-nose plier (like the one presented in section 3.10.1.3) to press the crimp flaps, following the steps described in figure 4.2.
   - Using the preheated soldering station, touch the iron tip over the crimp terminal for long enough until the internal welding tin (on the wire tip surface) gets melted.
6. Repeat the previous steps for each wire.
7. Envelop the whole wire set using 2cm of a heat shrink tube (like the ones described in section 3.10.2.1). Select the correct tube diameter according to your need. Use figure 4.3 as a reference.
8. Use the heat of a thermal blower (like the one described in section 3.10.1.1) to shrink the thermal tube around the cable/wires.
9. Using the correct pinout for the concerning connector (which can be checked in section 3.9.1), insert each crimped terminal into the respective connector hole. A "click" sound must be heard, and this indicates that the crimp terminal is in the correct position and cannot be removed. Use figure 4.4 as a reference.


Crimp terminal
2nd gap
2nd flap
1st gap
1st flap
Wire copper end: place in the middle of 2nd gap
Wire envelop end: place in the middle of 1st gap
2mm striped cooper
Wire envelop
...

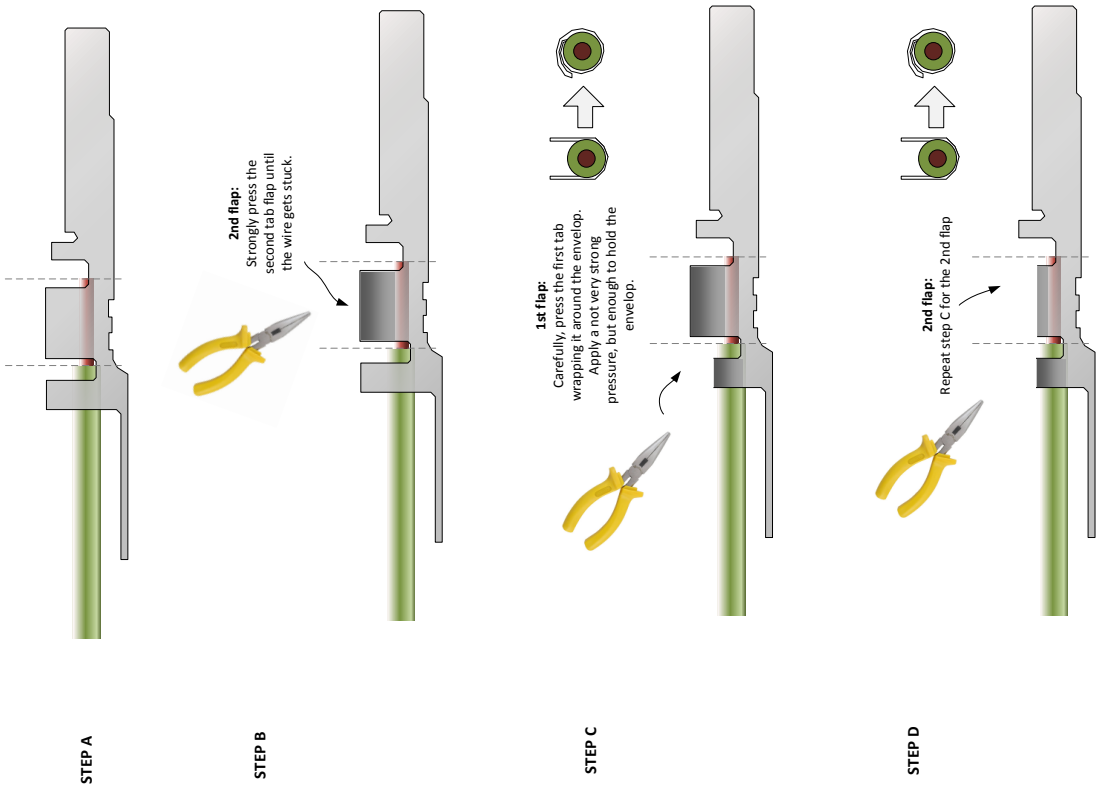


Figure 4.2: Crimping Molex Micro-Fit 3.0™: procedures for manual crimping

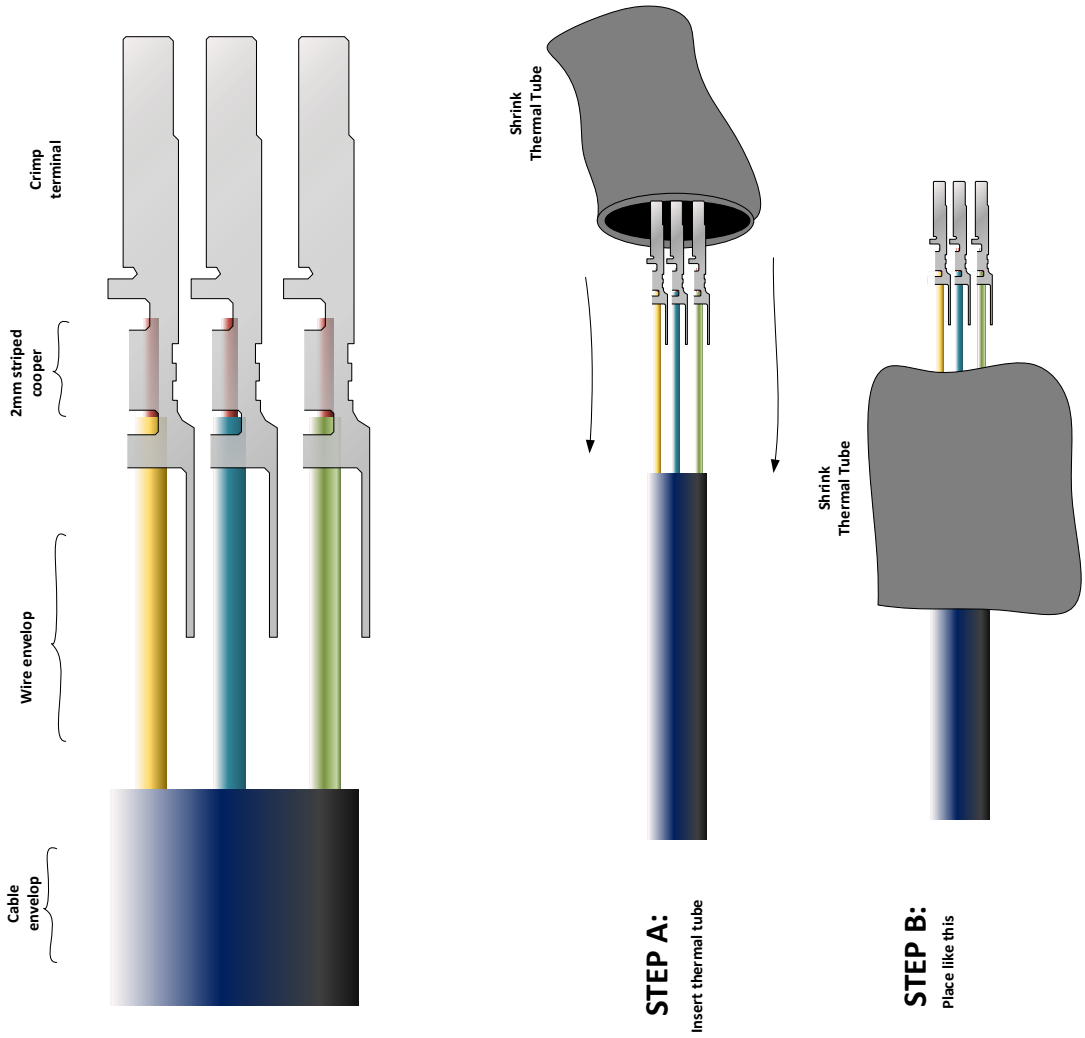


Figure 4.3: Crimping Molex Micro-Fit 3.0™: applying the heat shrink tube

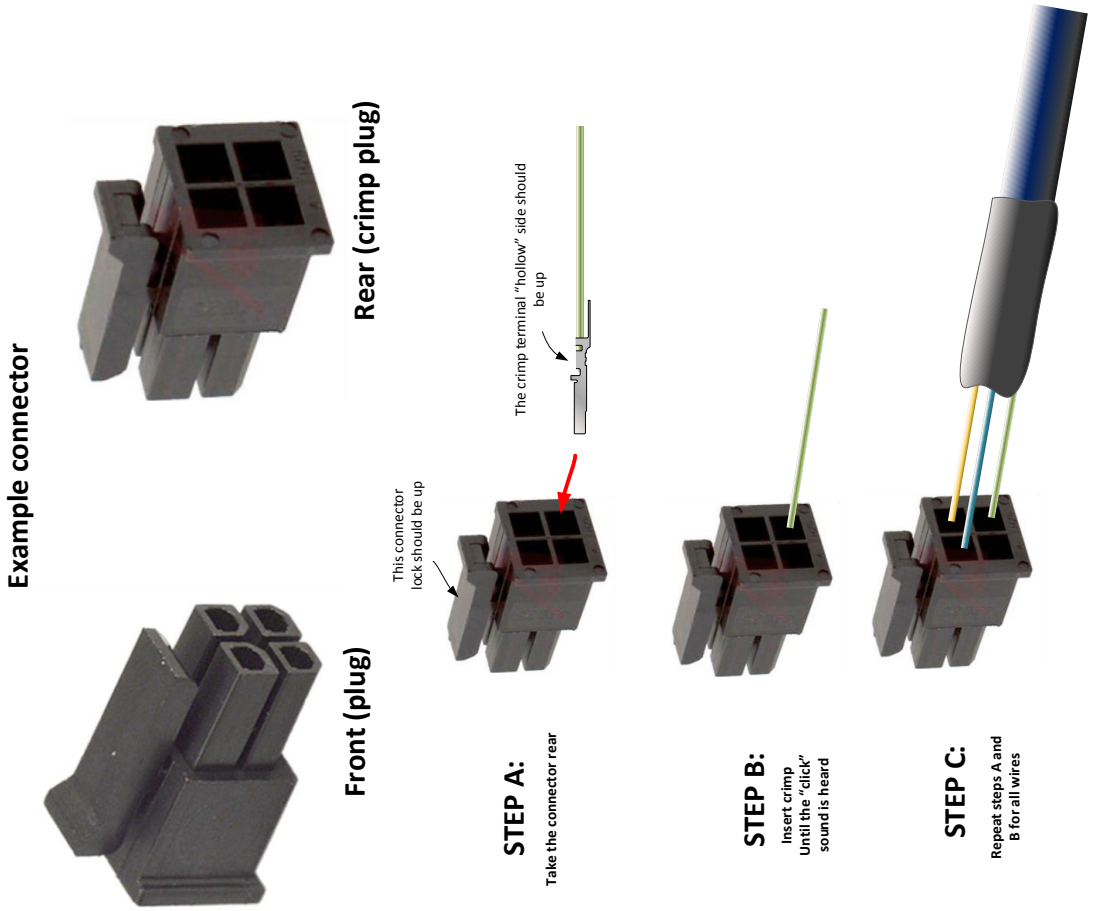
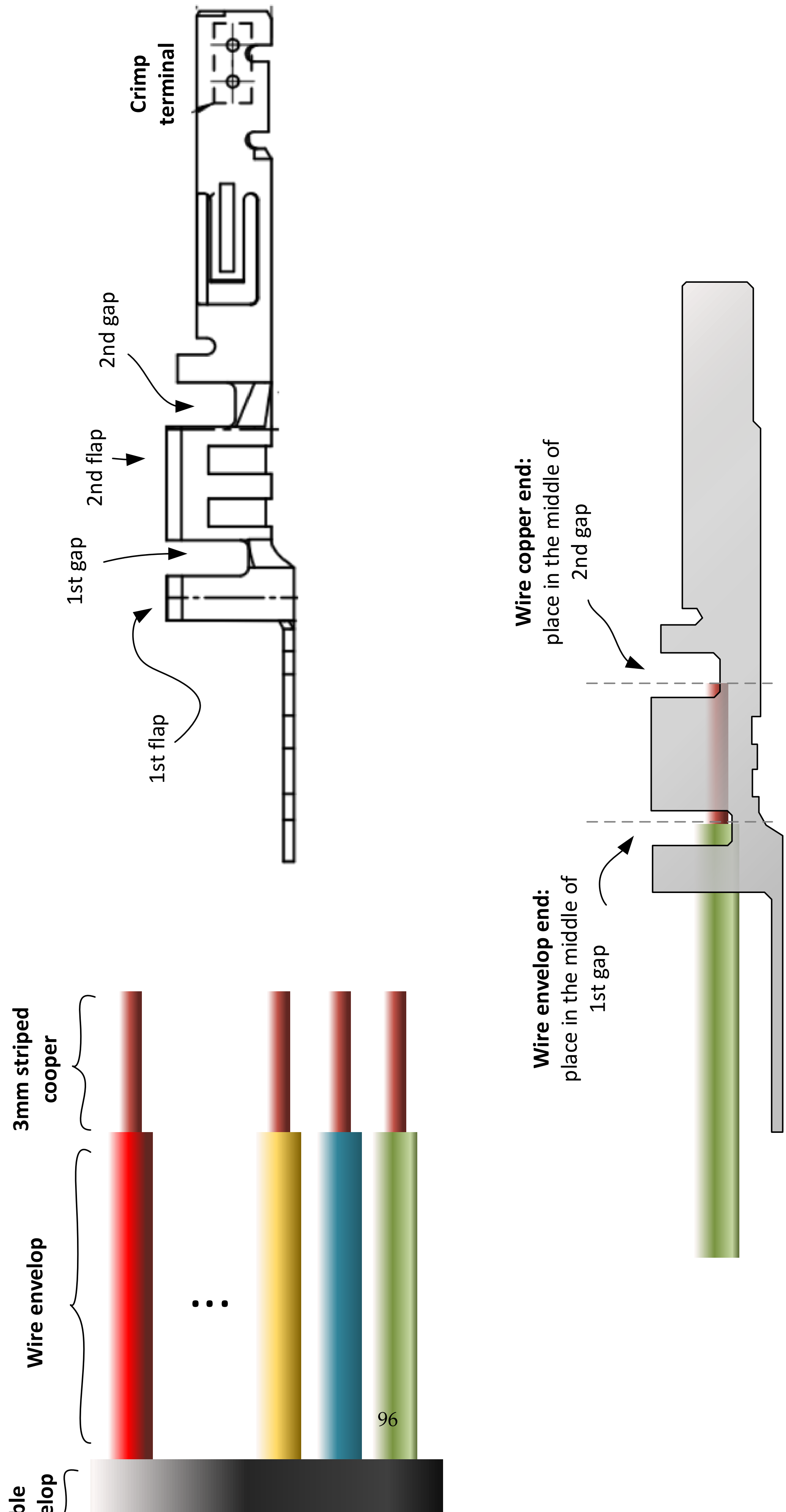


Figure 4.4: Crimping Molex Micro-Fit 3.0™: inserting the crimp terminals into the connector holes

4.1.1.15 Crimping Molex Mini-Fit®Family

For connecting wires to a Molex Mini-Fit®connector from 39-01-xxxx family (sections 3.9.1.10 and **??**), you first need to crimp the edge of these wires in the Molex crimp terminal from 44476-xxxx family (section 3.10.2.3). For this, you should perform the following steps:

1. Use the tool "Molex Hand Crimper Tool Part Number: 63819-0900" (see section 3.10.1.5).
2. For each wire to be connected, use a cutting plier (like the one described in section 3.10.1.2), strip the wire envelop, leaving 3mm copper exposed.
3. Place the wire and the crimp terminal according to figure **??**.
4. Use the Molex Hand Crimper (item 1) to crimp the wire.
5. If the crimping tool is not available, perform these steps:
   - Using a preheated soldering station (like the one presented in section 3.10.1.6), tin the 3mm striped copper wire.
   - Place the wire/crimp terminal like described in item 3.
   - Use a long needle-nose plier (like the one presented in section 3.10.1.3) to press the crimp flaps, following the steps described in figure 4.6.
   - Using the preheated soldering station, touch the iron tip over the crimp terminal for long enough until the internal welding tin (on the wire tip surface) gets melted.
6. Repeat the previous steps for each wire.
7. Envelop the whole wire set using 2cm of a heat shrink tube (like the ones described in section 3.10.2.1). Select the correct tube diameter according to your need. Use figure 4.7 as a reference.
8. Use the heat of a thermal blower (like the one described in section 3.10.1.1) to shrink the thermal tube around the cable/wires.
9. Using the correct pinout for the concerning connector (which can be checked in section 3.9.1), insert each crimped terminal into the respective connector hole. A "click" sound must be heard, and this indicates that the crimp terminal is in the correct position and cannot be removed. Use figure 4.8 as a reference.


Crimp terminal
2nd gap
2nd flap
1st gap
1st flap
Wire copper end: place in the middle of 2nd gap
Wire envelop end: place in the middle of 1st gap
3mm striped cooper
Wire envelop
...

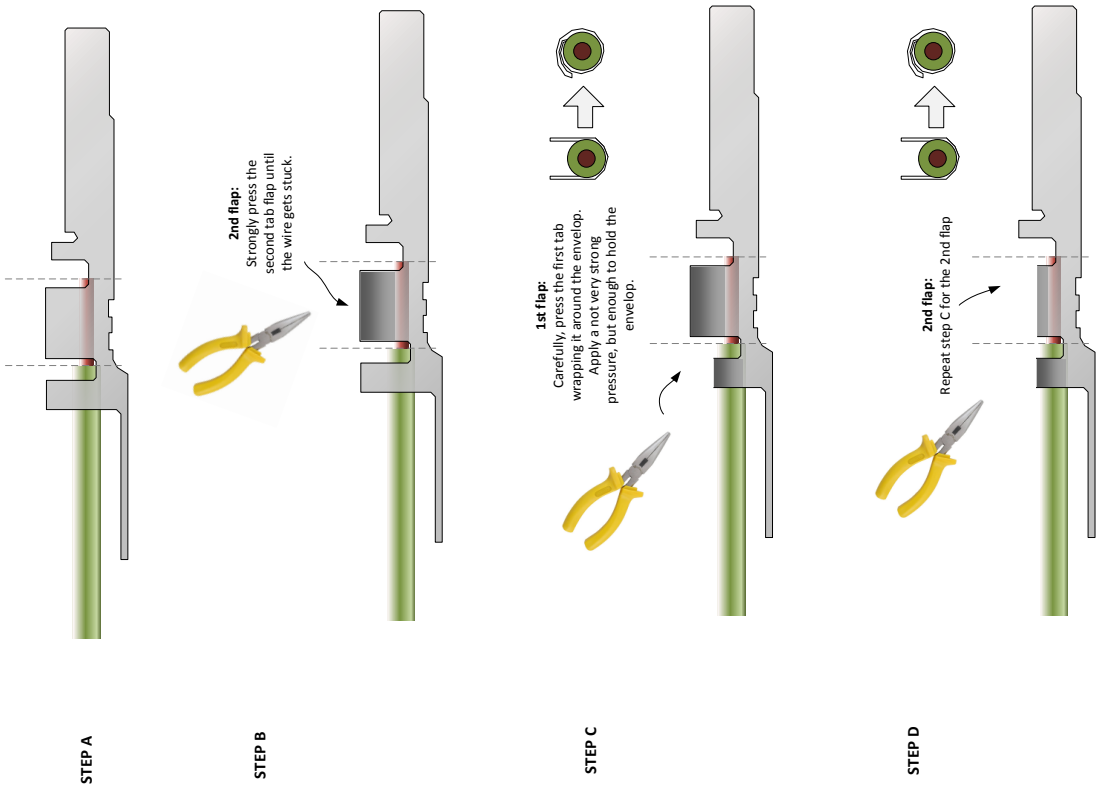


Figure 4.6: Crimping Molex Mini-Fit ®: procedures for manual crimping

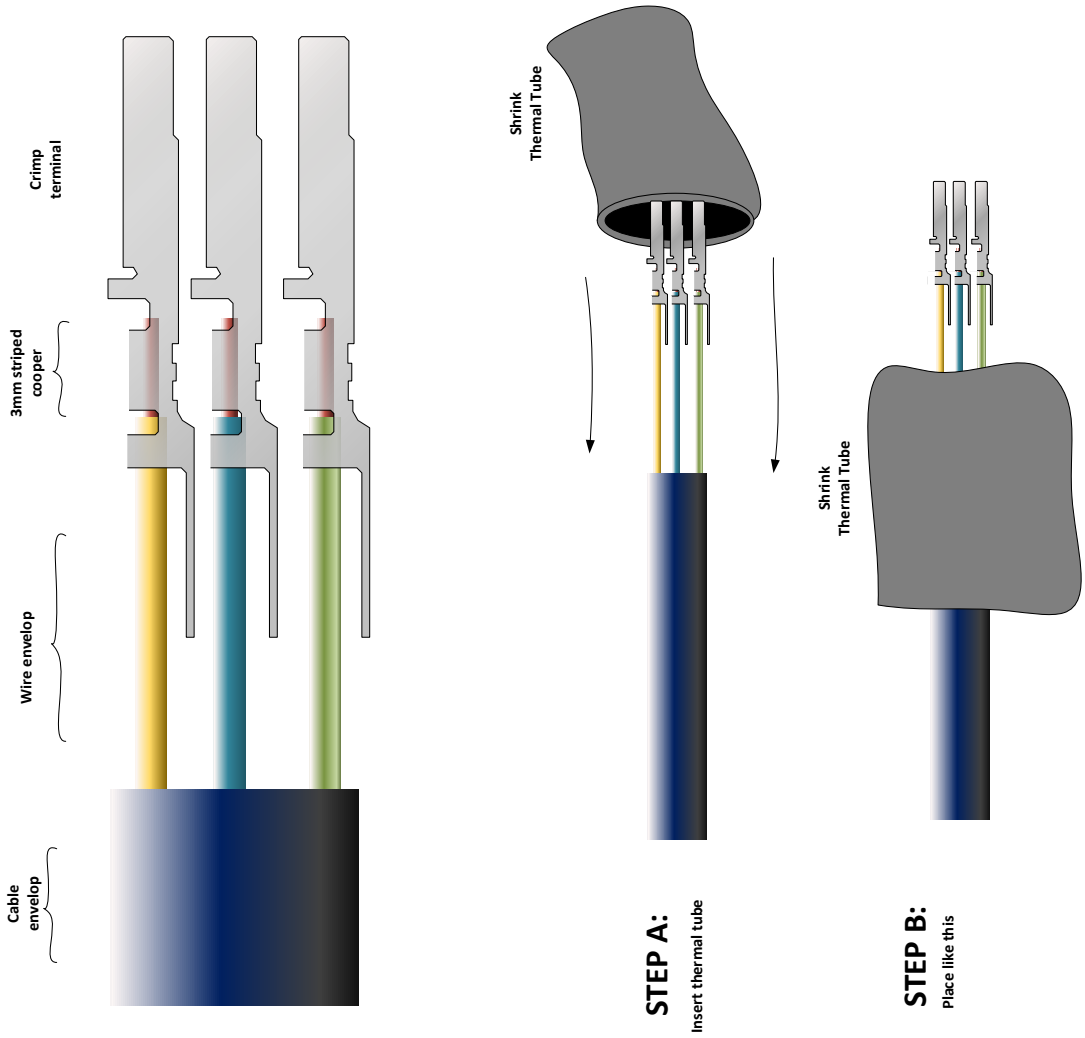


Figure 4.7: Crimping Molex Mini-Fit ®: applying the heat shrink tube

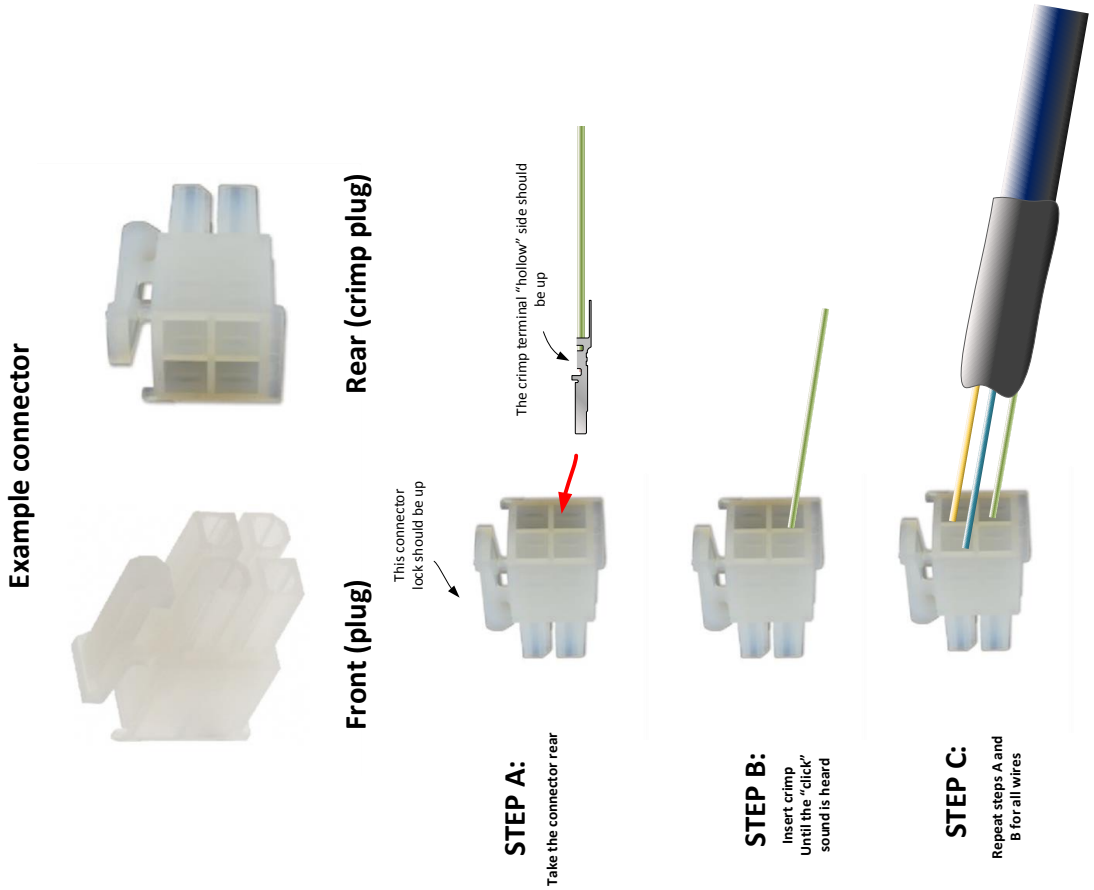


Figure 4.8: Crimping Molex Mini-Fit ®: inserting the crimp terminals into the connector holes

4.1.2 Printed circuit boards (PCB) fabrication and assembly

4.2 System installation on site

4.3 System testing on site

4.4 System commissioning

Chapter 5

Performed tests for validations

This chapter presents the proposed spatial layouts by G2. Each spatial layout represents a different network architecture, wagon arrangement, internal spatial accommodation of the devices, and operational modes (which will be studied in more detail in chapter 6).

Chapter 6

Bibliographic references

Appendix A

Team

A.1 General Organogram

Version: May 23, 2013

The number of participants is 27.

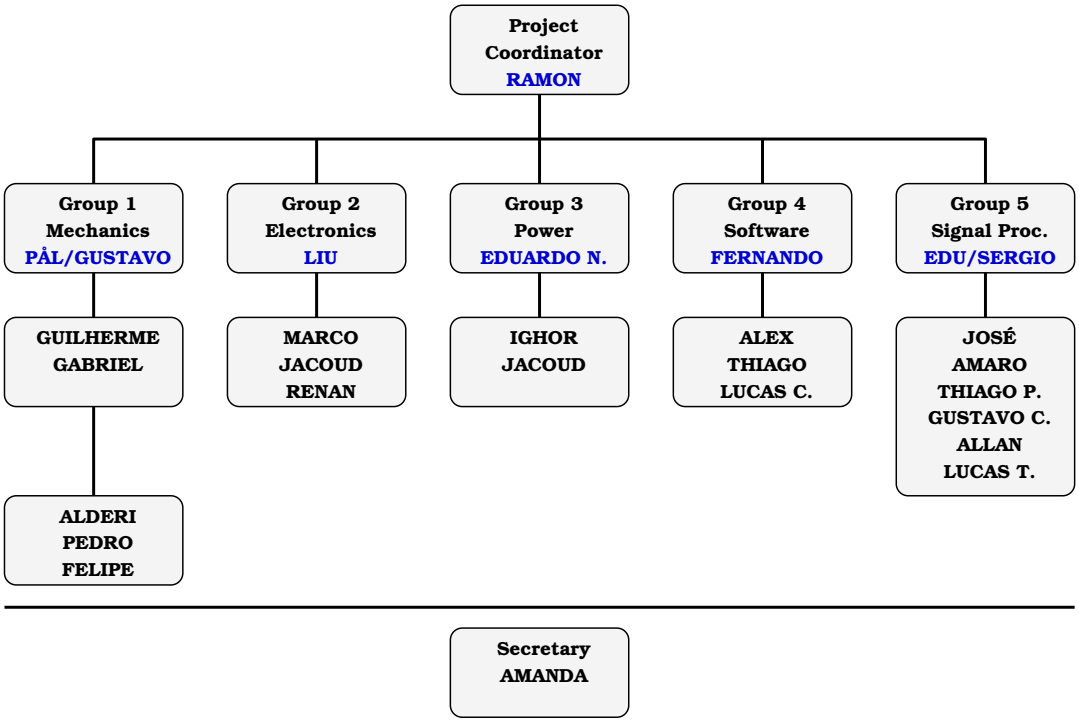
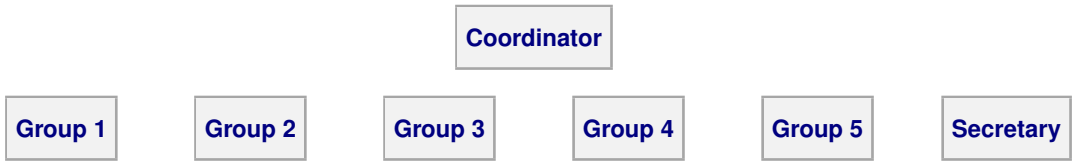


Figure A.1: General organogram.



A.1.1 Project Coordinator

Ramon
Costa

Figure A.2: Project coordinator.

General Organogram

A.1.2 Group 1: Mechanics Organogram

Figure A.3: Mechanics organogram.

General Organogram

A.1.3 Group 2: Electronics Organogram

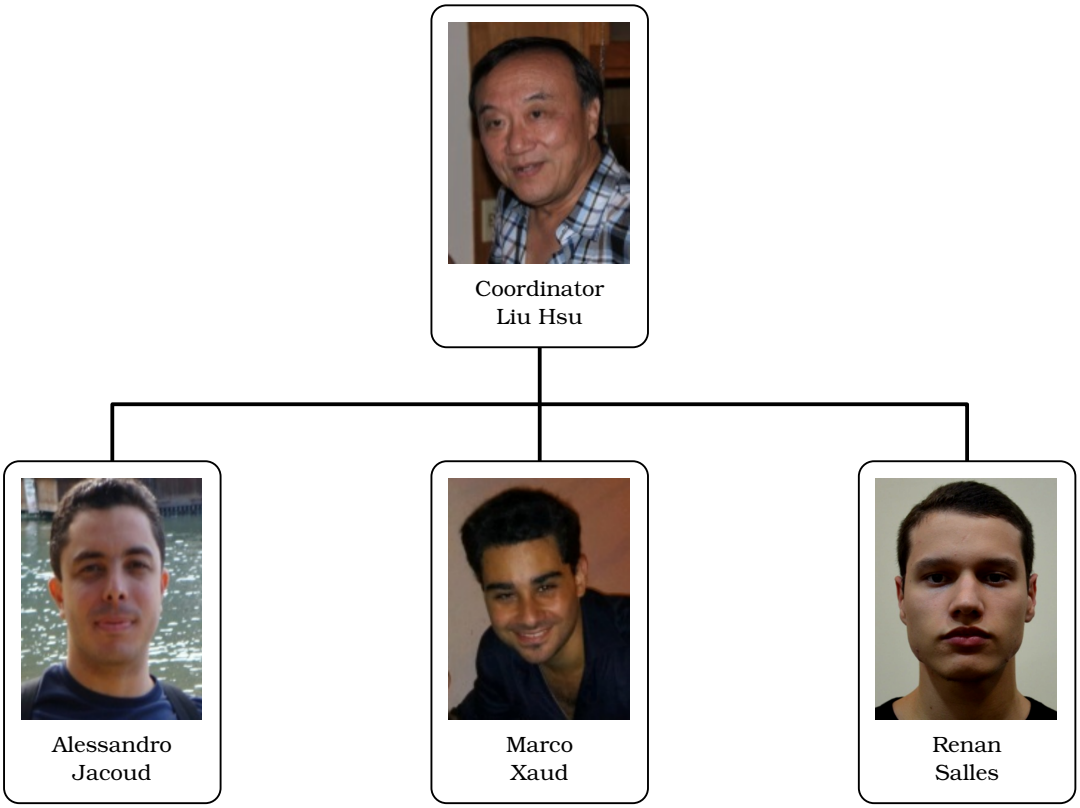


Figure A.4: Electronics organogram.

General Organogram

A.1.4 Group 3: Power Organogram

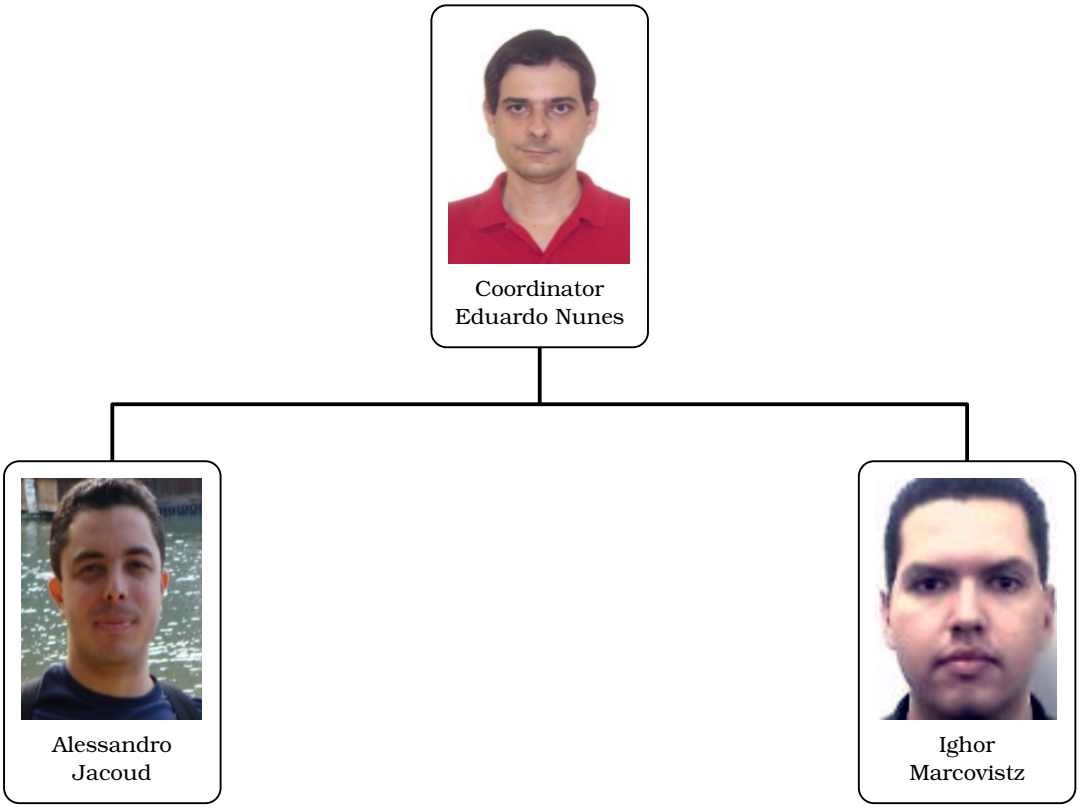


Figure A.5: Power organogram.

General Organogram

A.1.5 Group 4: Software Organogram

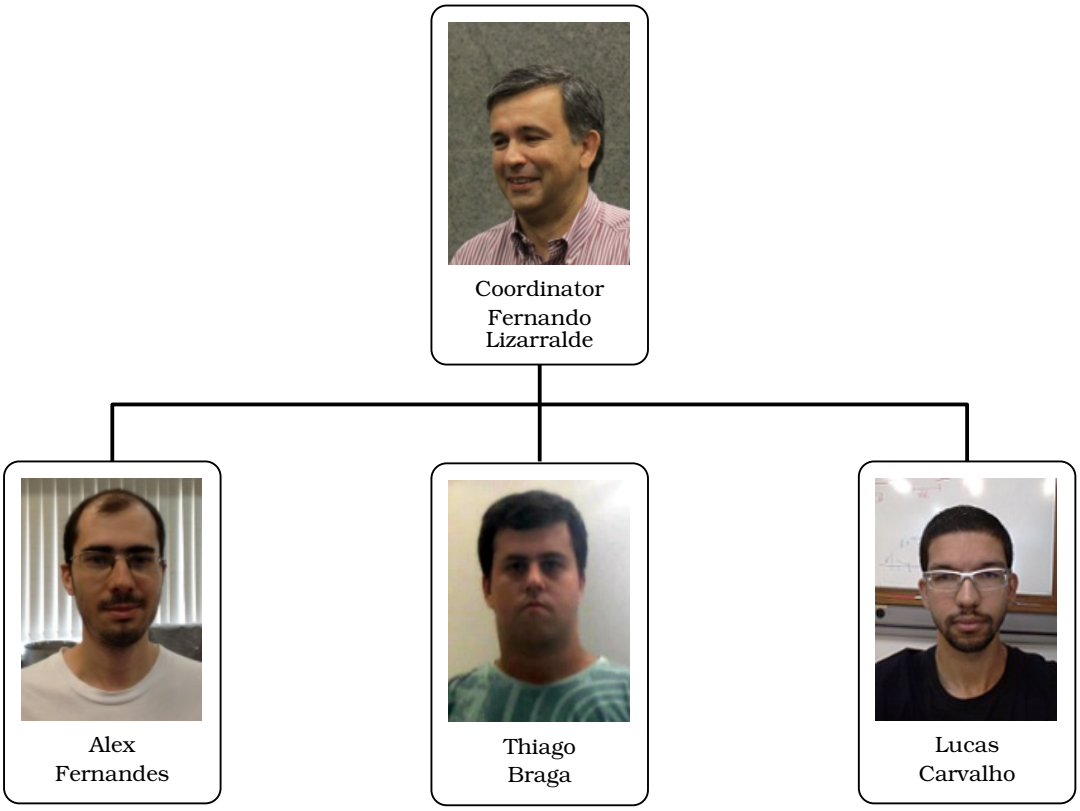


Figure A.6: Software organogram.

General Organogram

A.1.6 Group 5: Signal Processing Organogram

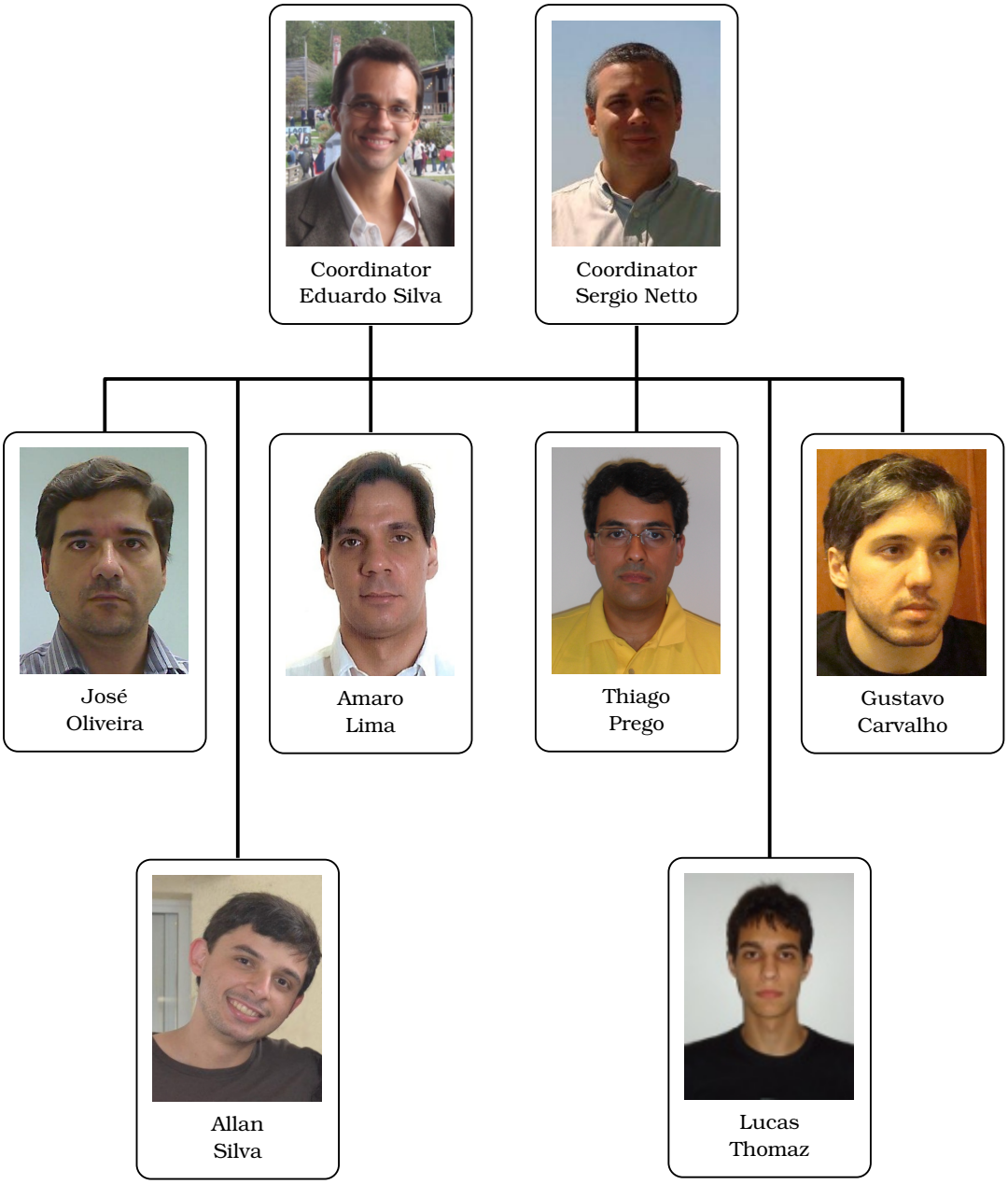


Figure A.7: Signal processing organogram.

General Organogram

A.1.7 Project Secretary

Amanda
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Figure A.8: Project secretary.

General Organogram

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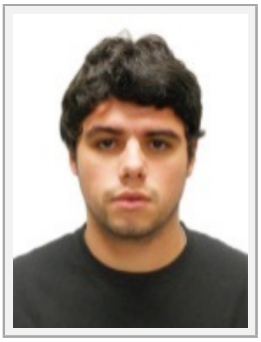

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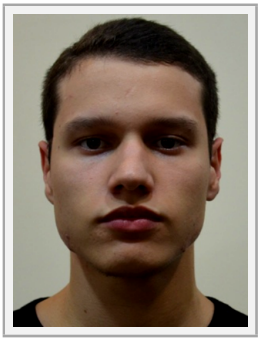

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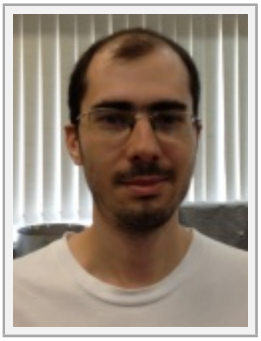

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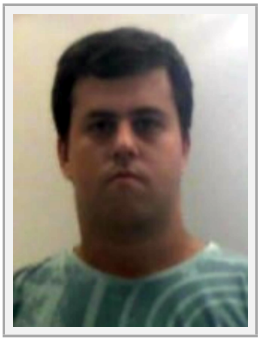

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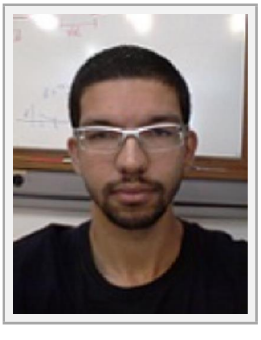

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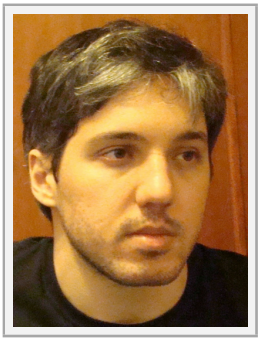

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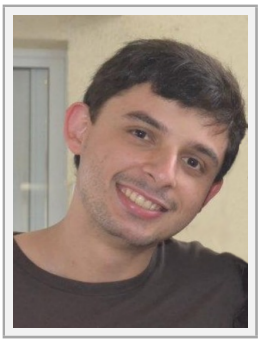

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