System Description

LION–Lütze Input/Output Network

Version 01
07/26/2018
Content

1 Instruction Content 6

2 General Information 7
  2.1 Symbol Description 7
  2.1.1 Safety Messages 7
  2.1.2 Handling Notes 7
  2.1.3 Special Notes 7
  2.2 Copyright 7
  2.3 Disclaim of Liability 8
  2.4 Standards 8
  2.5 Labeling 8
  2.5.1 QR Code – Product Information 9

3 Safety 10
  3.1 Related Documents 10
  3.1.1 Bus coupler 10
  3.1.2 I/O Modules 10
  3.1.3 Infrastructure Components 10
  3.2 Intended Use 10
  3.3 Recepients 10
  3.4 Operating Employees 11
  3.5 Responsibility of the Operator 11
  3.6 Protective Clothing and Equipment 11
  3.7 Electrostatic Discharge (ESD) 11
  3.8 Reconstruction and Modifications of the Product 12
  3.9 Special Safety Messages 12

4 System Planning 13
  4.1 Safety Integrity Level 13
  4.1.1 Standards 13
  4.2 System Approvals 14
  4.3 Safety Target 14
  4.3.1 Bus Coupler 14
  4.3.2 I/O Modules 14
  4.3.3 Power Supplies 15
  4.4 HR (Hazard Rate) 15
  4.5 Process Safety Time 15
  4.6 System Overview 16
  4.6.1 Bus Coupler – SIL2 17
  4.6.2 Digital Input Modules – SIL0 17
  4.6.3 Digital Output Modules – SIL0 18
  4.6.4 Analog Input Modules – SIL0 19
  4.6.5 Analog Output Modules – SIL0 20
  4.6.6 Digital Input/Output Modules – SIL2 21
  4.6.7 Infrastructure Modules – SIL0/SIL2 21
  4.7 System Architecture 23
  4.7.1 Smallest System 23
  4.7.2 Maximum System 24
  4.7.3 One-Line-System 24
  4.7.4 Line Change 25
  4.7.5 Energy Supply Range 25

5 System Function 26
  5.1 L-Bus2 26
  5.1.1 Databus 26
5.1.2 Address Bus 27
5.1.3 Technical Data 28
5.1.4 Bus Termination 28
5.1.5 Dummy Connector 28

6 Installation 29
6.1 Mounting Options 29
6.2 Mounting Distances 29
6.3 DIN Rail Mounting 30
6.4 Demounting 31
6.5 Grounding the Modules 32
6.6 Wiring the Modules 33
6.7 Terminal coding 34
6.7.1 Locking the Push-In Terminals 34
6.7.2 Releasing the Push-In Terminals 34
6.8 EMC Shield Clip Set 35
6.8.1 Measurements 35
6.8.2 Mounting 35
6.8.3 Wiring 36
6.9 Connecting the Modules 36
6.10 Disconnecting the Modules 37
6.11 System Termination 38
6.11.1 Bus Termination Connector 38
6.11.2 Bus Dummy Connector 38

7 System Configuration 39
7.1 LION Framework 39
7.1.1 Download and Installation of the LION Framework 39
7.1.2 LION I/O Station Configuration 40
7.1.3 LION MVB Slave Configuration 42
7.2 LION Webserver 43
7.2.1 Webserver Connection 44
7.2.2 Webserver Monitoring 44

8 Initial Operation of the System 45
8.1 Powering/Starting Up 45
8.1.1 Start-up time 45
8.1.2 LED Test 45
8.1.3 Checking the Configuration during the Start-up Time 45
8.2 Addressing 45
8.2.1 Restrictions 46
8.3 Structure Checking 46
8.4 Configuration 46
8.5 Run 46
8.6 Starting the System 47
8.6.1 Local init 47
8.6.2 Adjust Diagnostic Monitor 47
8.6.3 Addressing 47
8.6.4 Configuration 47
8.6.5 Run 48
8.6.6 Limited Run 48
8.6.7 Fail Safe 48
8.6.8 Power-down 48

9 Operation of the System 49
9.1 Data Transfer Times 49
9.2 Cyclic Communication 50
9.3 Error Handling 50
10 Checklists 51
10.1 System Planning 51
10.2 Mounting 51
10.3 Environmental Conditions 51
10.4 Configuration 53
10.5 Initial Operation 55
10.5.1 Operation 56
10.5.2 Maintenance 56

11 Appendix 57
11.1 Accessories 57
11.2 Revision of the Document 57
1 Instruction Content

The system description is about the LION product family. It contains information about the single components and the bus system. Additional it contains special safety information regarding the safety integrity.

To avoid hazardous situations read the document before installing one of the modules and using it.

Store the manual at a handy place. If selling, renting or in case of a divestiture pass the manual to the authorize person.
2 General Information

2.1 Symbol Description

2.1.1 Safety Messages
The manual contains several safety messages. Each safety message contains a defined signal word and a color. The color and the word are referring to an alert level. There are 4 levels. The safety messages point out hazardous situations and give information to avoid those.

**Indicates a hazardous situation which, if not avoided, will result in death or serious injury.**

**Indicates a hazardous situation which, if not avoided, could result in death or serious injury.**

**Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.**

**Is used to address practices, not related to personal injury.**

2.1.2 Handling Notes

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

Points out technical information.

Points out the use of tools.

2.1.3 Special Notes

Points out a safety-related application condition.

These notes are marked with an ID for example: LION-001. The IDs refer to the handling checklists in the system manual.

2.2 Copyright

This manual is intended for the operator and his staff. It is forbidden to give the content to a third party, to duplicate, exploit or impart it. The Lütze Transportation GmbH has to allow it explicit in writing.

General data, text, images and drawings are copyrighted and are liable to the industrial property right. Contravention can be prosecuting criminally. The named brands and product names in this document are trademarks or registered trademarks by titleholder.
2.3 Disclaim of Liability

The manual was written under consideration of the applied standards, regulations and the current state of technology. The content is verified of accuracy. Discrepancies are not excluded. For those discrepancies we disclaim liability. Applicable changes and additional information will be in the next version of the manual.

The Lütze Transportation GmbH does not assume liability for any damages and accidents of following reasons:

- Nonobservance of the manual
- Untrained and unqualified employees
- Non conventional use
- Non approved reconstructions and functional modifications of the product
- Using non original or non admitted parts or equipment

2.4 Standards

The products are constructed and designed according following standards:

- EN 50155:2007-07, Railway applications – Electronic equipment used on rolling Stock
- EN 50121-3-2:2016-01, Railway applications – Electromagnetic compatibility, Part 3-2: Rolling stock apparatus
- EN 61373:2010-09, Railway applications – Rolling stock equipment. Shock and vibration tests
- EN 50124-1:2005-06, Railway applications – Insulation coordination, Part 1
- EN 50126:2000-03 Railway applications - The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS)
- EN 50128:2011-06 Railway applications - Software for railway control and protection systems
- EN 50129:2003-12 Railway applications - Safety related electronic systems for signaling
- N FF 16-101:1988-10-01 Railway rolling stock, Fire behavior, Material choosing – application for electrical system I0 to I2 and F0 to F2
- House standard 2008-04, grounded conductor test (30 A for 2 min)

2.5 Labeling

The following label can be found on the product:
Mind the adhesive labels.

- Keep them readable.
- In case of a malfunction the part number and the serial number might be needed.

2.5.1 QR Code – Product Information

The code links to further product information in the online catalogue on the LÜTZE Transportation website. To reach the page proceed as follows:

1. Scan the QR code with a smart phone or another device which can read such codes.
2. A standard browser will open with the linked page.
3. Choose a language.
4. The product will be displayed. Under Downloads it is possible to download further technical documentation.
3 Safety

3.1 Related Documents

**CAUTION** Risk of injury and property damages caused by non observance of the related documents.
- The manual of the components is insufficient if operating in a system with other modules.
- To avoid injuries and damages also read the related documents before planning the system.

The system description – Safety manual and the manuals for the Lütze bus coupler and infrastructure components can be found on: www.luetze-transportation.de

3.1.1 Bus coupler

The bus coupler instruction contains important information about the handling and configuration of the bus coupler and the communication with the I/O modules.

3.1.2 I/O Modules

The instruction of the I/O modules contains important information about the handling and configuration of the I/O modules.

3.1.3 Infrastructure Components

The instruction of the infrastructure components contains important information about the supply of the system and the structure.

3.2 Intended Use

The infrastructure components are designed for the exclusive use in railway vehicles, as a power supply and line coupler of the LION system.

The intended use also involves the use according to the operation instructions.

**DANGER** Danger of life, serious injuries and property damages caused by an unsafe system. Use the modules only for
- the listed cases and according to the system architecture.
- with external devices recommended and allowed by Lütze Transportation GmbH.

3.3 Recipients

The operating manual addresses planers, project managers and programmers. It also addresses the operating employees who are responsible for the initial operation, the operation and for the maintenance of the products and systems. Regarding the employees, three qualification levels are differentiated.
### 3.4 Operating Employees

**Risk of injury by deploying insufficient qualified operating employees.**
Inappropriate appoint of not qualified or insufficient personnel can cause property damages and personal injuries.

- Tasks which apply special procedures should be done by trained and qualified employees or experts, especially electricians.

**Trained Employees**
The employee was trained by the employer on the task and possible hazardous situations. The employee does not have any technical knowledge.

**Experts**
The employee has a technical education, knowledge and/or experience in the required field. The employee is capable to do specific operations on and with the product.

**Electrically qualified persons**
The employee has a technical education in the required field. The employee is capable to do special operations on and with the product.

The different sections of the manual referring to the qualification level of the operating employees.

### 3.5 Responsibility of the Operator

The operator is obligated by the law of occupational safety, if the product is used in a commercial field.

- The operator is responsible to train the employees and to inform himself about the industrial safety regulation.
- The operator is responsible that safety, environment protection regulations and rules for accident prevention are observed.
- The operator has to run a risk assessment at the working environment/place of installation to expose hazards and to alert those.
- The manual has to be stored near the product.
- The manual has to be obeyed.
- The product can just be run in a faultless technical condition.
- The operator is responsible for a validation of the LION system before the initial operation.

### 3.6 Protective Clothing and Equipment

**NOTICE**

- Destroyed parts and malfunction of the product. Inappropriate clothes can cause electrification and can damage the product. If working with or on the components, wear special ESD clothing.
- Also follow the instructions and regulations of the employer.

### 3.7 Electrostatic Discharge (ESD)

Electrostatic discharge can destroy electronical components by voltage and energy, which are not noticeable by humans. Damages can occur if an electronical component is touched by an electrostatic discharged person. Modules will not immediately recognized as malfunctioned, the maloperation will
occur after a longer operating time.

- Switch off the voltage before working with or on the module and work according the ESD guidelines.
- Electronic components should not be contact electronic insulated material like plastic foil, plastic parts, insulated table pads or clothing.
- Place the modules only on conductive surfaces.

3.8 Reconstruction and Modifications of the Product

**WARNING**

Personal injuries and property damages caused by reconstructions and modifications of the product.

- Do not reconstruct or modify the product if the manufacturer does not allow it explicit in writing.

3.9 Special Safety Messages

**WARNING**

Electric shocks and product damages caused by wrong voltage application.

- Use the nominal operating voltage (see technical data of the individual devices).
- The lower and upper thresholds are given in the technical data of the individual devices.

**NOTICE**

Product damages caused by compensating current.

- Dismount all electronic modules and their connections of the frame if intended to do some welding.
4 System Planning

DANGER

Danger of life, serious injuries and property damages if planning a system with an incorrect system architecture.

- Check the technical data of each module.
- Read the operating instruction, especially the system and product description.
- Check the surrounding conditions of the operating place.
- Check whether the modules are designed for the operating case and the application.
- Qualified employees, especially experts like engineers, should plan the system.

4.1 Safety Integrity Level

Depending on the application, the infrastructure modules can be used in a safety application (up to SIL2). If the components are used in an environment which is not SIL certified, the components cannot work as safety components.

The technical data for all modules can be found in the regarding operating instruction.

4.1.1 Standards

The safety life cycle, as well as the safety management process, is implemented according to

- EN 50126:2000-03
  Railway applications - The specification and demonstration of reliability, availability, maintainability and safety (RAMS)

- EN 50128:2012-03
  Railway applications - Communication, signalling and processing systems - Software for railway control and protection systems and

- EN 50129:2003-12
  Railway applications - Communications, signalling and processing systems - Safety related electronic systems for signalling

The modules are divided into two classes:

- **Class 1 – SIL0**
  The software on the modules is programmed according EN 50128 SIL0 regarding error prevention and organized procedures.

- **Class 2 – SIL2**
  The hardware was developed according to EN 50129 SIL2.
  The software on the modules is programmed according EN 50128 SIL2 regarding error prevention and organized procedures.
4.2 System Approvals

The system is certified. The system integrator or vehicle manufacturer can use the certificate for vehicle registration.

**The approval is only valid for the whole LION SIL2 system.**
- The single infrastructure modules do not have an approval.

The approval is not valid if a non certified component or a non reactive component is build in an I/O station.

The following components are in scope of approval:

![Fig. 3: Scope of approval](image)

**SIL relevant** LION-005

**SIL relevant** LION-006

---

**SIL relevant** LION-030

The system is approved by TÜV Süd

The approval/certificate is available on request at the Lütze Transportation GmbH.

4.3 Safety Target

**SIL relevant** LION-010

4.3.1 Bus Coupler
- Safe transmitting of process information from the PLC to the connected I/O modules on the local system bus and vice versa in an environment up to SIL2.

4.3.2 I/O Modules
- Safe recording, processing of the data and the providing of process information of the I/O system on the fieldbus in an environment up to SIL2.
• Safe receiving, processing and putting out the received process information via fieldbus in an environment up to SIL2.

4.3.3 Power Supplies

• Safe voltage supplying of the internal system regarding the specified thresholds for the upper voltage limit of the modules on the local bus in an environment up to SIL2.

4.4 HR (Hazard Rate)

According to EN 50129 the THR for a SIL2 system must be:

\[ 10^{-7} \leq \text{THR} < 10^{-6} \]

The calculation of the THR for the single LION modules is done with the help of a fault tree analysis and according to the IEC 61709 (SN 29500).

If further information are needed, please contact the Lütze Transportation GmbH.

Below the values for the hazard rate of the single modules and functions can be found. Based on those values the hazard rate for the whole LION system has to be calculated.

<table>
<thead>
<tr>
<th>System Components</th>
<th>HR in fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-Bus(^2)</td>
<td>0.9</td>
</tr>
<tr>
<td>Power supply</td>
<td>5.83</td>
</tr>
<tr>
<td>Bus coupler</td>
<td>23.37</td>
</tr>
<tr>
<td>Digital input (one channel)</td>
<td>27.94</td>
</tr>
<tr>
<td>Digital input (two channel)</td>
<td>27.84</td>
</tr>
<tr>
<td>Digital output (one channel, plus switching)</td>
<td>126.56</td>
</tr>
<tr>
<td>Digital output (one channel, minus switching)</td>
<td>90.55</td>
</tr>
<tr>
<td>Digital output (two channel)</td>
<td>28.92</td>
</tr>
</tbody>
</table>

4.5 Process Safety Time

The process safety time for the whole system is: 250 ms.
4.6 System Overview

*LION (Lütze Input Output Network)* is a decentral safety input and output system for railway vehicles.

![Image of LION System](image)

The LION product line contains modular components and modules for capturing and releasing digital and analog signals.

The modules can be differentiate between two colors:

- SIL2 modules are yellow
- Non SIL modules are grey

Also the modules are differentiate between Lütze and Brandlabel modules. All part numbers ending with .XX are Brandlabel products, as listed in the following tables.
4.6.1 Bus Coupler – SIL2

The SIL2 bus coupler can be a gateway to a superior network, like the vehicle control, or it can be connected via fieldbus to a PLC. The bus coupler uses a safe fieldbus protocol. Via the safe fieldbus protocol, non-safe data can be transmitted or received to or from non-safe I/O modules. A safe operation of the I/O Modules is possible, because of an error detection and evaluation done by the SIL2 bus coupler.

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Type</th>
<th>Part-No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVB Bus coupler, SIL2</td>
<td>Operates with a safe MVB fieldbus protocol.</td>
<td>LION-BC-MVB</td>
<td>803001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>803001.XX</td>
</tr>
</tbody>
</table>

4.6.2 Digital Input Modules – SIL0

The modules capture digital input signals in the defined voltage range via galvanic insulated input ranges. The information are transmitted via L-Bus² to the SIL2 bus coupler. The modules are supplied via internal bus.

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Type</th>
<th>Part-No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 Digital Inputs DC 24...36 V, SIL0</td>
<td>Reads 16 inputs in the nominal voltage wide range for battery supplies.</td>
<td>LION-DI16-24V-36V</td>
<td>803101</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>803101.XX</td>
</tr>
<tr>
<td>16 Digital Inputs DC 72 ...110 V, SIL0</td>
<td>Reads 16 inputs in the nominal voltage wide range for battery supplies.</td>
<td>LION-DI16-72V-110V</td>
<td>803102</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>803102.XX</td>
</tr>
</tbody>
</table>
4.6.3 Digital Output Modules – SIL0

The modules release digital information on the galvanic insulated output ranges via L-Bus². The outputs can have relays or semiconductors for a defined nominal voltage.

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Type</th>
<th>Part-No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 Digital Outputs DC 24 V, SIL0</td>
<td>Writes the information on 16 semiconductor outputs in the nominal voltage value for battery supply.</td>
<td>LION-DO16-24V</td>
<td>803202</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>803202.XX</td>
</tr>
<tr>
<td>8 Digital Outputs DC 24...110 V,</td>
<td>Writes the information on 8 semiconductor outputs in the nominal voltage value for battery supply.</td>
<td>LION-DO8-24V-110V</td>
<td>803203</td>
</tr>
<tr>
<td>SIL0</td>
<td></td>
<td></td>
<td>803203.XX</td>
</tr>
<tr>
<td>8 Relay Outputs, SIL0</td>
<td>Writes the information on 8 relay outputs.</td>
<td>LION-RO8</td>
<td>803201</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>803201.XX</td>
</tr>
</tbody>
</table>
### 4.6.4 Analog Input Modules – SIL0

The modules capture analog input signals in the defined voltage range via galvanic insulated input ranges. The information are transmitted via L-Bus² to the SIL2 bus coupler.

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Type</th>
<th>Part-No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Analog Inputs 0...10 V, SIL0</td>
<td>Reads 4 voltage inputs in a range of 0 to 10 V.</td>
<td>LION-AI4-U</td>
<td>803301</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>803301.XX</td>
</tr>
<tr>
<td>4 Analog Inputs 0...20 mA, SIL0</td>
<td>Reads 4 current inputs in a range of 0 to 20 mA.</td>
<td>LION-AI4-I</td>
<td>803302</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>803302.XX</td>
</tr>
<tr>
<td>4 Analog Inputs PT 100, SIL0</td>
<td>Reads 4 PT100 temperature sensors.</td>
<td>LION-AI4-PT100</td>
<td>803303</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>803303.XX</td>
</tr>
<tr>
<td>4 Analog Inputs PT 1000, SIL0</td>
<td>Reads 4 PT1000 temperature sensors.</td>
<td>LION-AI4-PT1000</td>
<td>803304</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>803304.XX</td>
</tr>
</tbody>
</table>
4.6.5  Analog Output Modules – SIL0

The modules release analog information on the galvanic insulated output ranges via L-Bus². The outputs can base on relays or semiconductors for a defined nominal voltage.

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Type</th>
<th>Part-No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Analog Outputs 0...10 V, SIL0</td>
<td>Writes information on 4 voltage outputs in a range of 0 to 10 V.</td>
<td>LION-AO4-U</td>
<td>803401, 803401.XX</td>
</tr>
<tr>
<td>4 Analog Outputs 0...20 mA, SIL0</td>
<td>Writes information on 4 current outputs in a range of 0 to 20 mA.</td>
<td>LION-AO4-I</td>
<td>803402, 803402.XX</td>
</tr>
</tbody>
</table>
4.6.6 Digital Input/Output Modules – SIL2

The modules capture digital input signals in the defined voltage range via galvanic insulated input ranges. The information are transmitted via L-Bus to the SIL2 bus coupler. From there, the data is send via safe protocol to the PLC.

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Type</th>
<th>Part-No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 Digital Inputs, DC 24...36 V, 8 Digital Outputs DC 24...110 V, SIL2</td>
<td>Reads 16 inputs in the nominal voltage wide range for battery supplies with DC 24 V ...36 V. Writes the information on 8 outputs.</td>
<td>LION-SAFE-DI16-DO8-LV</td>
<td>803501, 803501.XX</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Type</th>
<th>Part-No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 Digital Inputs, DC 72...110 V, 8 Digital Outputs DC 24...110 V, SIL2</td>
<td>Reads 16 inputs in the nominal voltage wide range for battery supplies with DC 24 V ...36 V. Writes the information on 8 outputs.</td>
<td>LION-SAFE-DI16-DO8-HV</td>
<td>803502, 803502.XX</td>
</tr>
</tbody>
</table>

4.6.7 Infrastructure Modules – SIL0/SIL2

For the infrastructure, two SIL2 power supplies and a SIL0 line coupler are available.
With the SIL0 line coupler, the bus can be interrupted and continued in the next line, an additional SIL2 bus coupler is not mandatory.
If using a SIL0 line coupler, also a SIL2 power supply must be used. Every new line starts with a SIL2 power supply, followed by the SIL0 line coupler. The SIL0 line coupler is transparent for the system and the transmission protocol. The power supply converts the train power voltage into the voltage of DC 24 V, according to the standard EN 50155. A voltage of DC 24 V is necessary to power all modules in the internal bus system (L-Bus²). The SIL2 power supply can be used at the beginning or in the middle of the bus system. It always powers all following modules to the next SIL2 power supply or the end of the line. Depending on the layout, there will be a galvanic insulation between the train power voltage and the voltage supply of the internal bus system.

<table>
<thead>
<tr>
<th>Product Description</th>
<th>Type</th>
<th>Part-No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply 72 W, SIL2</td>
<td>Redundant wide range input for nominal supply values for the battery supply from DC 24 V to DC 110 V with galvanic insulation. The output rating is 72 W.</td>
<td>LION-PS-24V-110V-72W-LB</td>
</tr>
<tr>
<td>Power Supply 72 W, SIL0</td>
<td>Redundant wide range input for nominal supply values for the battery supply from DC 24 V to DC 110 V with galvanic insulation. The output rating is 72 W.</td>
<td>LION-PS-24V-110V-72W-LB</td>
</tr>
<tr>
<td>Power Supply 36 W, SIL2</td>
<td>For nominal supply values for the battery supply from DC 24 V to DC 110 V with galvanic insulation. The output rating is 36 W.</td>
<td>LION-PS-24V-110V-36W-LB</td>
</tr>
<tr>
<td>Power Supply 36 W, SIL0</td>
<td>For nominal supply values for the battery supply from DC 24 V to DC 110 V with galvanic insulation. The output rating is 36 W.</td>
<td>LION-PS-24V-110V-36W-LB</td>
</tr>
<tr>
<td>Line Coupler, SIL0</td>
<td>For spacial and galvanic insulation of the bus system (L-Bus²)</td>
<td>LION-LC-M12</td>
</tr>
</tbody>
</table>
4.7 System Architecture

Different system architectures can be realized with the LION product family. Following points are important to realize a system:

- The SIL2 bus coupler is the master of the LION system, the SIL0/SIL2 I/O modules are slaves.
- Max. 3 lines are possible.
- The maximum distance between two lines should be no longer than 10 m.
- The first component of every line must be a SIL2 power supply. Other SIL2 power supplies can follow.
- The second component of the first line must be the SIL2 bus coupler.
- If the system consist of different lines, the last component of the line is a SIL0 line coupler and in the following line the second component must be also a SIL0 line coupler.
- It is possible to connect max. 32 SIL0/SIL2 I/O modules to the SIL2 bus coupler.
- It is not allowed to create a line which is longer than 2 m.
- SIL0 (non safe) and SIL2 (safe) I/O modules can be combined in the system.
- The I/O modules are the smallest exchangeable unit in the system.

Different system architectures can be found below:

4.7.1 Smallest System

The smallest system contains:
1. one SIL2 power supply,
2. one SIL2 bus coupler and
3. one SIL0/SIL2 I/O module.

All components are in one line.

Fig. 12: System Architecture – Smallest System
### 4.7.2 Maximum System

The maximum system contains:
- three lines and two line changes
- one SIL2 bus coupler
- 32 SIL0/SIL2 I/O modules and
- a SIL2 power supply at the beginning of every line.

With the help of an additional SIL2 power supply, SIL0/SIL2 I/O modules can be attached galvanic insulated.

The SIL0/SIL2 I/O modules can be combined randomly.

The maximum energy requirement depends on the used SIL0/SIL2 I/O modules. If the energy requirement is too high, another SIL0/SIL2 power supply has to be added. *Chapter “Energy Supply Range” on page 25.*

![System Architecture – Maximum Unit](image)

**Fig. 13: System Architecture – Maximum Unit**

### 4.7.3 One-Line-System

A system with different SIL0/SIL2 I/O modules and a SIL2 bus coupler in one line.

![System Architecture – One-Line-System](image)

**Fig. 14: System Architecture – One-Line-System**
4.7.4 Line Change

The LION system can be subdivided in three galvanic insulated sections (lines). For the galvanic insulation, a SIL0 line coupler must be installed at the end of the line and at the beginning of the following line. The SIL0 line couplers are transparent and not visible as a SIL2 bus subscriber. The SIL0 line couplers have no address and do not communicate.

4.7.5 Energy Supply Range

A SIL2 power supply supplies all components that are on the right. The system can be subdivided in different sections. If the maximum energy requirement of the modules exceeds the nominal value of the power supply, the sections need to be supplied by an additional SIL2 power supply. The SIL2 power supplies are transparent and not visible as a SIL2 bus subscriber. The SIL2 power supplies have no address and do not communicate.
5 System Function

5.1 L-Bus²

All modules of the LION system are connected via the L-Bus² (Lütze Bus 2). It is a network with a line topology. The L-Bus² is responsible for the data communication, the addressing and the power supply of the I/O modules. The L-Bus² is used for transmitting data in the LION system.

Two different kinds of components are connected via the bus:

- Master (buscoupler) and
- Slave modules (I/O modules)

If a module in the system is defect, the L-Bus² is still transmitting data in each direction (from and to the master). If more modules are defect, the L-Bus² is also still running, but the modules between the defect ones can also not be addressed anymore.

5.1.1 Databus

The databus of the L-Bus² is for transmitting data between the master and the connected slaves.

Every bus subscriber contains a transmitting-/receiving component for the data transfer on the bus. At an error voltage potential or an open bus wire the component fades into a defined bus status.

Transmitting parameter:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical power-on</td>
<td>RS485</td>
</tr>
<tr>
<td>Baudrate</td>
<td>4.5 MBaud</td>
</tr>
<tr>
<td>Communication mode</td>
<td>Half duplex</td>
</tr>
<tr>
<td>Physical protocol</td>
<td>1 start bit, 8 data bits, 1 stop bit (≈10 Bits/RS485 frame)</td>
</tr>
<tr>
<td>Maximum telegram length L-Bus² (LTELmax)</td>
<td>256 Bytes including the protocol overhead</td>
</tr>
</tbody>
</table>
5.1.2 Address Bus

The Bus is only active during the addressing. Process data are not transmitted.

Transmitting parameter:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical power-on</td>
<td>12 V Logic Signal</td>
</tr>
<tr>
<td>Baudrate</td>
<td>9.6 kBits/s</td>
</tr>
<tr>
<td>Communication mode</td>
<td>Half duplex-bidirectional</td>
</tr>
<tr>
<td>Physical protocol</td>
<td>1 Start Bit, 8 Data bits, 1 Stopp Bit (=10 Bits/RS485-Frame)</td>
</tr>
</tbody>
</table>
## 5.1.3 Technical Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of participants</td>
<td>max. 32 Slaves (+1 master)</td>
</tr>
<tr>
<td>Transfer rate</td>
<td>4.5 Mbit/s</td>
</tr>
<tr>
<td>Transfer data</td>
<td>max. 256 Byte per frame</td>
</tr>
<tr>
<td>Response time (2 participants)</td>
<td>max. 2 ms (user data 4 Byte / diagnosis 4 byte)</td>
</tr>
<tr>
<td>Response time (32 participants)</td>
<td>max. 10 ms (at max. process data length)</td>
</tr>
<tr>
<td>Topology</td>
<td>bus structure</td>
</tr>
<tr>
<td>Physical medium</td>
<td>RS 485</td>
</tr>
<tr>
<td>Communication procedure</td>
<td>Master/Slave</td>
</tr>
<tr>
<td>Configuration</td>
<td>automatically by bus coupler</td>
</tr>
<tr>
<td>Number of line couplers</td>
<td>2x2</td>
</tr>
<tr>
<td>Length of line</td>
<td>2 m</td>
</tr>
<tr>
<td>Length between the line couplers</td>
<td>10 m</td>
</tr>
</tbody>
</table>

### 5.1.4 Bus Termination

On the last module the L-Bus² has to be terminated by a bus termination connector, because of following reasons:

- activates the bus terminal resistor
- ring closure for the addressbus (left – right)
- activates the signal: “remaining successor or bus termination connector”

If no bus termination is connected the L-Bus² will stop.

### 5.1.5 Dummy Connector

The dummy connector is without any electrical function. The connector is for the not used bus extension (for example the line coupler). It protects the connection.

---

For further module specific information read the related documents.
6 Installation

**CAUTION**

Risk of injury by electric shock.
People can be injured by electric shocks and the product can be damaged.

- Deenergize the system before mounting.

The modules have to be handled by electrically qualified persons.

### 6.1 Mounting Options

The Modules can be mounted on DIN rail TS35. Following mounting options are possible:

**Fig. 17: Mounting Option – horizontal**

**Fig. 18: Mounting Option – top**

**Fig. 19: Mounting Option – vertical**

**Fig. 20: Mounting Option – bottom**

### 6.2 Mounting Distances

Possibly for wiring more space is needed. The values below are the minimum values.
6.3 DIN Rail Mounting

- The modules resist up to 100 times of mounting and demounting.
- Mount an end clamp at the beginning and end of each module line.

1. Snap the module on the upper part of the DIN rail.
2. Push the module up a little bit.
3. Push the module back, so that it catches the DIN rail.
6.4 Demounting

Each module can be demounted separately.

1. Release the wired terminals of the modules.
2. Push up the module.
3. Pull the module from the DIN rail.
4. Push down the module and take the module off the rail.
6.5 Grounding the Modules

**WARNING**

Electric shocks and injuries because of wrong grounding.

- Do not ground the modules via top hat rail.
- Always ground the modules via the PE connection.
- It is also mandatory to ground the DIN rail for EMC reasons.
- The modules has to be grounded by an expert employee.

Mount a ring cable lug via bolt with Torx mechanism.

1. Loose the bolt (3) of the PE clamp.
2. Take a ring cable lug (2).
3. Fix the ring cable lug between the Schnorr washer (1) and the bolt (3).
4. Ground the module.
6.6 Wiring the Modules

All modules have terminals with Push-In technology. The terminals are printed with white pin numbers, starting with 1. Via terminals, the sensors and actuators of the modules will be connected. It is possible to connect the modules with pre-assembled cables.

Technical Data – Push-In Terminal

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact spacing (CS)</td>
<td>5.8 mm</td>
</tr>
<tr>
<td>Nominal current</td>
<td>12 A</td>
</tr>
<tr>
<td>Color</td>
<td>black</td>
</tr>
<tr>
<td>Conductor Size</td>
<td>0.2 – 2.5 mm / AWG min 24, max 12</td>
</tr>
<tr>
<td>Stripping Length</td>
<td>10 mm</td>
</tr>
<tr>
<td>Protection</td>
<td>against incorrect insertion</td>
</tr>
</tbody>
</table>

- More information can be found in each chapter of the module.
- The maximum length of the cable on each input and output is 50 m (unshielded), regarding the EMC directive.
- Even if the terminal is not used for wiring, the terminal has to be plugged in to reach IP20.

For wiring the modules, a 3.5×0.6 mm screwdriver is mandatory.

1. Push the orange slots down with a slotted screwdriver 3.5×0.6 mm.
2. While pushing the slots down, put the wires in the regarding pin holes. Each pin hole has its own orange slot.
3. Release the screw driver.

![Fig. 24: Wiring](image)
6.7 Terminal coding

It is possible to code the Push-In terminals with coding pins, which are in the scope of delivery. The coding prevents polarity reversal.

1. Push in the coding pin for the terminal.
2. Push in the coding pin at the same pin on the terminal connector.

The locking and releasing of the terminals is described below.

6.7.1 Locking the Push-In Terminals

1. Put the terminal in the terminal connector.
2. Push the terminal down.
   The terminal is locked.

6.7.2 Releasing the Push-In Terminals

Depends on the mounting place of the module (upside/down).

1. Push the lock and release levers back or forward.
2. Pull the terminal out of the terminal connector.
6.8 EMC Shield Clip Set

To ensure EMC performance, according to the EN 50155, it is mandatory to install a shield clip set on the analog modules.

The EMC shield set (Part-No. 800204) is not in the scope of delivery.

6.8.1 Measurements

![Fig. 28: Measurements – I/O Module with EMC Shield Clip Set](image)

6.8.2 Mounting

1. Mount the shield clip (1) and the shield sheet (2) with the two screws (3) in the slot (4) on the backside of the module.

![Fig. 29: Mounting EMC Shield Clip Set](image)
6.8.3 Wiring

1. Connect the modules with the single conductors of the cable.
2. Remove the jacket of the cable, where the shield clip will be, until the cable shield can be seen.
3. Fix the cable with the shield clip, the cable shield must have contact to the shield clip. The shield clip can be adjusted in 3 levels, depending on the cable size.
4. For strain relieve fix the cable with a wire strap (2) to the module as shown in the drawing.
5. Insulate the cable.

6.9 Connecting the Modules

**WARNING**

Electric currents can cause injuries and can damages the whole system.
- Switch off the power of the system when connecting or disconnecting the modules.
- Hot plugging is not supported by the system.

In the LION system, the modules are connected to each other via internal BUS system L-Bus\(^2\). The BUS is a special fieldbus, invented by LÜTZE. For connecting the modules, follow the description below.

**Technical Data – L-Bus\(^2\) Interface**

<table>
<thead>
<tr>
<th>Plugging cycles</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contacts</td>
<td>14</td>
</tr>
<tr>
<td>Protection</td>
<td>against incorrect insertion</td>
</tr>
</tbody>
</table>
1. Plug in the L-Bus\textsuperscript{2} connector and push it down.

2. Push down the sides of the plug until a \textit{click} can be heard.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{fig32.png}
\caption{L-Bus\textsuperscript{2} – Module Connection}
\end{figure}

\textbf{6.10 Disconnecting the Modules}

1. Push the sides of the connector.
2. Pull up the connector.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{fig33.png}
\caption{L-Bus\textsuperscript{2} – Module Disconnection}
\end{figure}
6.11 System Termination

6.11.1 Bus Termination Connector

The termination connector can be found in the scope of delivery of bus coupler (Part-No. 800201).

On the last module of the L-Bus², a bus termination connector must be installed. The terminator is responsible for:
- activating the bus termination resistance
- closing the ring of the addressbus (left-right)
- activating the signals “successor/termination connector exists”.

6.11.2 Bus Dummy Connector

The dummy connector can be found in the scope of delivery of the power supply (Part-No. 800202).

At the beginning of the system, the first module with an open L-Bus² connection a dummy connector has to be plugged in.
7 System Configuration

7.1 LION Framework
The system has to be configured with the LION Framework.
The framework contains:

▪ LION I/O Station Configurator
  Creating a LION system which is saved as an IODB file.

▪ LION MVB Slave Configurator
  Configuration of the MVB slaves and saving it as an NSDB file.

▪ LION MVB NSDB Validator
  Validation of the safe MVB Configuration (NSDB with safety checksum)

7.1.1 Download and Installation of the LION Framework
The installation file of the LION Framework can be downloaded on the LÜTZE Transportation website:

www.luetze-transportation.com

1. Download the LION Framework zip file.
2. Unpack the downloaded zip file.
3. Double click on the exe file.
The LION Configuration Framework starts.
There is no installation necessary.
7.1.2 LION I/O Station Configuration

Before starting the NSDB configuration, an IODB must be generated. The IODB shows the set up of the LION System.

1. Create a new IODB.
2. Choose the modules from the toolbox which you installed in your system.
3. Via drag and drop, the modules can be moved from the toolbox to the IODB window.
4. Set up the system.
5. Save the set up system in an IODB.

7.1.2.1 Composition of the I/O modules

It is possible to determine the composition of the I/O system, depending on the entry of:
• Number of digital inputs and specification of the voltage and granularity
• Number of digital outputs and specification of the voltage and granularity
• Number of relay outputs
• Number and type of analog input channels
• Number and type of analog output channels
• Number of the available DIN rail width

It is also possible to generate a configuration of already existing modules. The position of the I/O module can be changed flexible.

7.1.2.2 Calculation of the Performance

With the LION I/O Station Configurator it is also possible to determine the performance of the I/O unit.

Following values are generated
• L-Bus² cycle time
• Delay times for the output of an analog or digital signal, hardware run time/ software run time
• Delay time for allocation of an analog or digital input data on the fieldbus, hardware run time/ software run time

7.1.2.3 Determining the Current Consumption

Depending on the configuration (number of modules and types, power supply), the maximum current consumption of the unit can be determined.

7.1.2.4 Calculation of Size and Weight

Depending on the configuration the size and the weight of the I/O unit can be calculated.

7.1.2.5 Fieldbus dependent Configuration

Depending on the used fieldbus it is necessary to fieldbus configuration of the bus coupler.
7.1.3  LION MVB Slave Configuration

The NSDB file is the configuration file which will be downloaded on the LION bus coupler, the master of the LION system. The download is done via webserver.

All information about the configuration and validation can be found in the LION MVB SIL2 bus coupler operating instructions.
7.2 LION Webserver

The displayed data of the webserver are refreshed cyclic. The reading of the error memory data must be repeated when the page is updated.

The LION webserver is for projecting the MVB bus coupler with the NSDB file and for diagnosis monitoring. Also some general configuration settings can be done:

For diagnosis, use following data and informations are displayed:

- the firmware version of the fieldbus controller (netX)
- the firmware version of the L-Bus\(^2\) controller (Cortex)
- the CPU load of the fieldbus controller
- the IP address of the bus coupler
- the default IP address of the bus coupler
- the network mask of the bus coupler
- the gateway address of the bus coupler
- the MAC address of the bus coupler
- the serial number of the bus coupler and connected I/O modules
- the configured L-Bus\(^2\) topology
- the configuration of the I/O modules
- the connected L-Bus\(^2\) topology
- the module status of all components (bus coupler and I/O modules)
- the L-Bus\(^2\) status
- the network status of the fieldbusses
- the error memory of the bus coupler
- diagnosis messages of the I/O modules (for example switching cycles of the relay modules)
The configuration via webserver is password protected. Following configuration settings can be made:

- Change of the network parameter (for example IP addresses)
- Import of a bus coupler configuration file
- Displays the version of the imported bus coupler configuration file
- Import of fieldbus configuration file
- Displays the version of the import configuration file of the fieldbus
- Mechanisms for downloading, uploading and deleting of files on the bus coupler
- Display of the internal flashdisk directory structure
- Mechanism for the firmware update of the fieldbus controller (netX)
- Reset of the whole system
- Mechanism for deleting the error memory
- Mechanism for resetting all configuration parameter to default

7.2.1 Webserver Connection

To get a connection to the webserver, proceed as follows:

1. Connect the bus coupler to the PC via ethernet diagnosis interface X5.
2. Open a browser.
3. Type the IP address of the bus coupler in the address file of the browser.
   The bus coupler has the default IP address 192.168.1.69.

The webserver will be displayed.

7.2.2 Webserver Monitoring

For the specific monitoring sites, please read the MVB SIL2 bus coupler operating instructions.
8 Initial Operation of the System

The complete system has to run faultless at the initial operation of the bus coupler or after a change of the bus coupler. The initial operation is the validation of the system.

8.1 Powering/Starting Up

The bus coupler keeps the I/O modules in the reset mode. Controlled start of the I/O modules by the bus coupler.

8.1.1 Start-up time

I/O unit with MVB Bus Coupler
In an error-free status the start-up time of the unit is maximum 20 seconds long. The time contains the initial start-up time of the L-Bus² as well as the communication of the MVB.

I/O unit with Ethernet Bus Coupler
In an error-free status the start-up time of the unit is maximum 40 seconds long. The time contains the initial start-up, the start-up of the L-Bus² and the receiving and processing of the DHCP configuration.

For starting the L-Bus² the configuration of the I/O modules must be present for the PLC.

Digital and Analog Outputs
For the start-up time the modules will be in the failsafe mode.

Digital and Analog Inputs
For the start-up time the input signals will be not valid.

8.1.2 LED Test

The LED of all modules, except the power supplies, will be switched on during the start up of the system. The LED will be on for about 500 ms to check the function of all modules and LED.

8.1.3 Checking the Configuration during the Start-up Time

If no error occurs during the start-up time the system is in the operational mode.

If an error occurs the bus coupler and the I/O modules are running and transferring the valid process data of the modules. The modules are in the mode limited run. A diagnosis information is generated.

The failsafe mode of missing or defect modules is saved in the processing data.

8.2 Addressing

The master addresses the connected I/O modules via right address bus. The addressing starts with "0". The bus coupler addresses the modules from "1" ascending (+1) via the right address bus. 32 modules can be addressed. The bus coupler has to address the 33rd module to recognize that the number of connected modules is too high.

If the modules do not answer, the bus coupler will try to address the modules two times.
more times. If there is still no answer, the bus coupler will address the modules descending (starting with “-1”) via left address bus from right to left.

1. The bus coupler addresses the modules.
2. If an unaddressed module receives an address it starts the addressing process itself.
3. The module returns distinct parameters:
   ▪ Address
   ▪ Module Type
   ▪ Serial Number
   ▪ Safe and non safe Data Length
4. The next module will be addressed
5. The bus coupler receives the address telegram via left adress bus back and knows that all modules are addressed.
   If an addressing was made via left address bus, the bus coupler recognizes the end of the addressing by the expire time.
6. The bus coupler creates a table with all configured slave modules (physical image) and their parameter.

8.2.1 Restrictions

▪ If a slave answers more then one time to an addressing message of the bus coupler, a bus reset will be done by the bus coupler. After three times the station will go in the failsafe mode.

▪ If the bus coupler receives an addressing confirmation several times, a bus reset will be done by the bus coupler. After three times the station will go in the failsafe mode.

8.3 Structure Checking

The bus coupler compares the physical image to the saved data. In the second step, the bus coupler compares the physical image to the configured data (e.g. NSDB).

8.4 Configuration

After finishing the addressing the bus coupler (master) and the slave modules will be in the configuration status:

1. The master sends “start configuration”.
2. The master sends a configuration data frame to the slaves.
3. The slaves acknowledges the receiving of the telegram by sending a slave application frame.
4. The master is doing that procedure till all slaves which are expecting configuration data, received those.

8.5 Run

The bus coupler is sending a telegram to the slave. In a defined time the buscoupler expects an answer. If the buscoupler does not receive an answer it will send a telegram to the next slave.
8.6 Starting the System

If starting the system, it will run through different status as described below.

8.6.1 Local init

Initialization of the micro controller and the local module peripherals and selftest after a power up or a reset.

<table>
<thead>
<tr>
<th>LED</th>
<th>Color</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-Bus² (LB)</td>
<td>red/green</td>
<td>off</td>
</tr>
<tr>
<td>Module status (MS)</td>
<td>red/green</td>
<td>off</td>
</tr>
</tbody>
</table>

8.6.2 Adjust Diagnostic Monitor

Running the diagnostic monitor.

<table>
<thead>
<tr>
<th>LED</th>
<th>Color</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-Bus² (LB)</td>
<td>red/green</td>
<td>flashing (5 Hz)</td>
</tr>
<tr>
<td>Module status (MS)</td>
<td>red/green</td>
<td>flashing (5 Hz)</td>
</tr>
</tbody>
</table>

8.6.3 Addressing

Waiting for addressing via the addressbus with acknowledgement of the communication parameter. No process data communication is done. The inputs and outputs are in the defined safe condition.

<table>
<thead>
<tr>
<th>LED</th>
<th>Color</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-Bus² (LB)</td>
<td>green</td>
<td>fast flashing (2 x 5 Hz + pause)</td>
</tr>
<tr>
<td>Module status (MS)</td>
<td>green</td>
<td>on</td>
</tr>
</tbody>
</table>

8.6.4 Configuration

Receiving of the optional configuration data of the master. If configuration data were registered during the the exchange of communication parameter (e.g. I/O parameter, interface types, etc.) There is now process data communication. The input and output side is in the defined safe mode.

<table>
<thead>
<tr>
<th>LED</th>
<th>Color</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-Bus² (LB)</td>
<td>green</td>
<td>slow flashing (2 Hz)</td>
</tr>
</tbody>
</table>
8.6.5 Run
L-Bus\(^2\) is running. A cyclic communication of the process data corresponding to the real data is done. No time exceedance. All slave modules in RUN or limited run.

<table>
<thead>
<tr>
<th>LED</th>
<th>Color</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-Bus(^2) (LB)</td>
<td>green</td>
<td>on</td>
</tr>
</tbody>
</table>

8.6.6 Limited Run
A limited run is possible. The L-Bus\(^2\) runs accurate from the view of the slave. The process data communication is running. Incorrect process data are transferred with the safe defined status.

No time exceedance.

<table>
<thead>
<tr>
<th>LED</th>
<th>Color</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-Bus(^2) (LB)</td>
<td>green</td>
<td>on</td>
</tr>
<tr>
<td>Module status (MS)</td>
<td>red</td>
<td>slow flashing (2 Hz)</td>
</tr>
</tbody>
</table>

8.6.7 Fail Safe
Defined safe condition. No communication. The module can only be activated by a reset or a de-energization.

<table>
<thead>
<tr>
<th>LED</th>
<th>Color</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-Bus(^2) (LB)</td>
<td>red</td>
<td>on</td>
</tr>
<tr>
<td>Module status (MS)</td>
<td>red</td>
<td>on</td>
</tr>
</tbody>
</table>

8.6.8 Power-down
During the phasing out the modules are in the failsafe mode.
9 Operation of the System

9.1 Data Transfer Times

The data transfer time contains:

- the processing time in the bus coupler (for fieldbus and L-Bus2)
- the L-Bus2 transfer time
- the processing time of the micro controller in the I/O module
- the hardware delay time of the input and output channel

The data transfer time is defined as follows:

**Inputs**

The time between the signal on the physical Input and the available data on the fieldbus.

**Outputs**

The time between the available data on the fieldbus and the signal on the physical output.

**Example Configuration:**

- 1× Power supply
- 1× Bus coupler
- 4× 16 Digital input modules
- 4× 8 Digital output modules
- 1× Analog input module
- 1× Analog output module

<table>
<thead>
<tr>
<th>Channel Type</th>
<th>max. System Data Transfer Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>digital Input</td>
<td>12 ms</td>
</tr>
<tr>
<td>digital Output</td>
<td>10 ms</td>
</tr>
<tr>
<td>analog Input</td>
<td>25 ms</td>
</tr>
<tr>
<td>analog Output</td>
<td>20 ms</td>
</tr>
</tbody>
</table>
9.2 Cyclic Communication

If the master is sending a telegram to a slave, it expects a response within $t_{\text{expect}} = 2.0 \text{ ms}$.

After a response the master will communicate with the next module. If the slave is not responding the master also tries to communicate with the next slave, but in the next cycle the master tries to send the telegram again.

The minimal cycle time is $t_{\text{round}} = 250 \mu\text{s}$.

The master tries to send telegrams to the slave for a set tolerance limit $t_{\text{tolerance}}$. If the limit is exceeded the communication to the slave is stopped by the master.

The slave also monitors if it receives a valid telegram by the master.

To reach a high system availability there are two other tolerance limits.

- For non SIL modules – $t_{\text{ToleranceUNSAVE}}$
  Normal tolerance limit – the processing and the effect in an exceedance case is the same

- For SIL2 modules – $t_{\text{ToleranceSAVE}}$
  The tolerance has influence on the calculation of the error disclosure time

<table>
<thead>
<tr>
<th>Number of bytes for I/O Station</th>
<th>$t_{\text{ToleranceSAVE}}$</th>
<th>$t_{\text{ToleranceUNSAVE}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1500 byte</td>
<td>30 ms</td>
<td>250 ms</td>
</tr>
<tr>
<td>&lt;6000 byte</td>
<td>100 ms</td>
<td>250 ms</td>
</tr>
<tr>
<td>&gt;6000 byte</td>
<td>250 ms</td>
<td>250 ms</td>
</tr>
</tbody>
</table>

9.3 Error Handling

The bus coupler recognizes if an I/O module fails and the addressing and responding via the databus is not possible. In a case of an error the master is addressing the remaining modules via left address bus. The system is still running except for the malfunction module.

If a second module fails, all modules between the failed modules cannot be addressed anymore.

If the master fails, the whole system would fail (see also chapter “L-Bus2” on page 26.)
10 Checklists

10.1 System Planning

<table>
<thead>
<tr>
<th>ID</th>
<th>CHECKPOINT</th>
<th>CHECKED</th>
</tr>
</thead>
<tbody>
<tr>
<td>LION-005</td>
<td>The certificate/approval of the system is available.</td>
<td></td>
</tr>
<tr>
<td>LION-006</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LION-029</td>
<td>The labeling of the modules is readable.</td>
<td></td>
</tr>
<tr>
<td>LION-035</td>
<td>The MTBF values were checked.</td>
<td></td>
</tr>
<tr>
<td>LION-046</td>
<td>Only LION Power Supplies are used in the system.</td>
<td></td>
</tr>
</tbody>
</table>

10.2 Mounting

<table>
<thead>
<tr>
<th>ID</th>
<th>CHECKPOINT</th>
<th>CHECKED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The modules are mounted regarding the described mounting options.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The modules are mounted with the described mounting distances.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The modules are snapped on a DIN rail.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The modules are grounded as described.</td>
<td></td>
</tr>
</tbody>
</table>

10.3 Environmental Conditions

<table>
<thead>
<tr>
<th>ID</th>
<th>CHECKPOINT</th>
<th>CHECKED</th>
</tr>
</thead>
<tbody>
<tr>
<td>LION-066</td>
<td>The leakage current because of component defects is considered.</td>
<td></td>
</tr>
</tbody>
</table>
The modules are supplied with the nominal voltage as described in the regarding data sheet.

The environmental temperature is not higher than +70°C and not lower than -40°C.

Maximum 32 I/O modules are used in the system.

The system has only two lines.

The necessary dummy and termination connectors are installed.

<table>
<thead>
<tr>
<th>LION–046</th>
<th>For power supply only LION power supplies are used in the system.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LION–045</td>
<td>The used line coupler cable is based insulated to the shield.</td>
</tr>
<tr>
<td></td>
<td>If necessary, an EMC shield clip set is installed on the modules.</td>
</tr>
<tr>
<td>LION–007</td>
<td>The MVB interface is galvanic insulated to all other module potentials.</td>
</tr>
<tr>
<td>LION–042</td>
<td>The power supplies are galvanic insulated between input and output voltage.</td>
</tr>
<tr>
<td>LION–047</td>
<td>The buscoupler is galvanic insulated to the fieldbus interface and the diagnosis interface.</td>
</tr>
<tr>
<td>LION–048</td>
<td></td>
</tr>
<tr>
<td>LION–052</td>
<td>The Ethernet interface of the buscoupler is galvanic insulated to all other module potentials.</td>
</tr>
<tr>
<td>LION–011</td>
<td>The wiring of the safe I/O modules is checked regarding the SIL level.</td>
</tr>
<tr>
<td>LION–010</td>
<td></td>
</tr>
<tr>
<td>LION–043</td>
<td>During the recognition of overvoltage the power supplies do not transfer energy.</td>
</tr>
<tr>
<td>LION–044</td>
<td>The maximum error voltage of the power supplies is not more than DC 24 V + 25 % over the whole temperature and load range.</td>
</tr>
</tbody>
</table>
## 10.4 Configuration

<table>
<thead>
<tr>
<th>ID</th>
<th>CHECKPOINT</th>
<th>CHECKED</th>
</tr>
</thead>
<tbody>
<tr>
<td>LION–058</td>
<td>The SIL I/O modules are wired according to the described block diagram to reach the regarding SIL level.</td>
<td>☐</td>
</tr>
<tr>
<td>LION–059</td>
<td></td>
<td>☐</td>
</tr>
<tr>
<td>LION–060</td>
<td></td>
<td>☐</td>
</tr>
<tr>
<td>LION–061</td>
<td></td>
<td>☐</td>
</tr>
<tr>
<td>LION–062</td>
<td></td>
<td>☐</td>
</tr>
<tr>
<td>LION–012</td>
<td>The THR was considered and calculated correctly.</td>
<td>☐</td>
</tr>
<tr>
<td>LION–004</td>
<td>The procedure to get a safe and valid NSDB file was done.</td>
<td>☐</td>
</tr>
<tr>
<td>LION–006</td>
<td>The bus coupler is communicating with a safe fieldbus protocol (SDTv2) to reach the SIL2 level.</td>
<td>☐</td>
</tr>
<tr>
<td>LION–072</td>
<td></td>
<td>☐</td>
</tr>
<tr>
<td>LION–006</td>
<td>All components used in the system are certified.</td>
<td>☐</td>
</tr>
<tr>
<td>LION–014</td>
<td>The safe process data status of the bus coupler is set with “0” or set with a defined application specific replacement value.</td>
<td>☐</td>
</tr>
<tr>
<td>LION–015</td>
<td>The safe status of the input data is defined as “0”, not controlled.</td>
<td>☐</td>
</tr>
<tr>
<td>LION–015</td>
<td>The safe status of the output data is defined as switched off or potential free.</td>
<td>☐</td>
</tr>
<tr>
<td>LION–016</td>
<td>The safe status of the power supplies is defined as potential free.</td>
<td>☐</td>
</tr>
<tr>
<td>LION–018</td>
<td>The maximum use data length was set regarding the static minimum error probability for the required safety level with the help of the CRC. (SDTv2 according to IEC61375-2-3, Annex B)</td>
<td>☐</td>
</tr>
<tr>
<td>LION–019</td>
<td>A diagnosis port in the NDSB configuration was set.</td>
<td>☐</td>
</tr>
<tr>
<td>LION–020</td>
<td>The Bit “SFT_Error” is set in the diagnosis port, if the bus coupler detects any inconsistencies in the safety dataset.</td>
<td>☐</td>
</tr>
<tr>
<td>LION–021</td>
<td>The NSDB format: single NSDB is used.</td>
<td>☐</td>
</tr>
<tr>
<td>LION-025</td>
<td>The error reactions of the fail safe status were checked.</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>LION-027</td>
<td>All process and diagnosis data of the modules were checked regarding the process data image.</td>
<td></td>
</tr>
<tr>
<td>LION-030</td>
<td>The cycle time of the fieldbus is set regarding the tolerance limit.</td>
<td></td>
</tr>
<tr>
<td>LION-031</td>
<td>The safe status of the SIL inputs is logic “0” (LOW), if an error occurs the status bit is set to “1”.</td>
<td></td>
</tr>
<tr>
<td>LION-033</td>
<td>The safe status of the SIL outputs is “switched off”.</td>
<td></td>
</tr>
<tr>
<td>LION-037</td>
<td>The checking of the process and diagnosis data is implemented in the vehicle control.</td>
<td></td>
</tr>
<tr>
<td>LION-038</td>
<td>Safety arrangements and maintenance intervals for connected sensors and actuators were done and defined.</td>
<td></td>
</tr>
<tr>
<td>LION-041</td>
<td>The THR values for all modules were calculated and considered.</td>
<td></td>
</tr>
<tr>
<td>LION-050</td>
<td>The MVB safety dataset is implemented.</td>
<td></td>
</tr>
<tr>
<td>LION-003</td>
<td>The CRC (safety checksum) of the NSDB is valid.</td>
<td></td>
</tr>
<tr>
<td>LION-024</td>
<td>The valid NSDB is uploaded on the bus coupler.</td>
<td></td>
</tr>
<tr>
<td>LION-017</td>
<td>The sink time supervision was set correctly.</td>
<td></td>
</tr>
</tbody>
</table>
## 10.5 Initial Operation

<table>
<thead>
<tr>
<th>ID</th>
<th>CHECKPOINT</th>
<th>CHECKED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The modules are wired correctly</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The right supply voltage is pending.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The bus termination is connected at the last module of the system.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>At the end of each line a dummy connector is connected.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Only 32 IO modules are in the system.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The system has only two lines.</td>
<td></td>
</tr>
<tr>
<td>LION–032</td>
<td>The I/O modules are booting without any errors.</td>
<td></td>
</tr>
<tr>
<td>LION–054</td>
<td>During the initialization phase all outputs are in the safe mode.</td>
<td></td>
</tr>
<tr>
<td>LION–055</td>
<td>During the initialization phase all input signals are not valid.</td>
<td></td>
</tr>
<tr>
<td>LION–056</td>
<td>Modules with safety critical errors during the initialization phase will be in the failsafe mode during the operation phase.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The system was planned by qualified employees like an engineer.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The system planner was advised by a specialized safety engineer.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The system was tested and checked in a test environment.</td>
<td></td>
</tr>
</tbody>
</table>
The system was tested and checked by a safety engineer.

LION–002 The validity of the generated NSDB data was checked in the system.

10.5.1 Operation

<table>
<thead>
<tr>
<th>ID</th>
<th>CHECKPOINT</th>
<th>CHECKED</th>
</tr>
</thead>
<tbody>
<tr>
<td>LION–001</td>
<td>Before operation the function of the circuit was checked. The checking of the circuit is done cyclic every day.</td>
<td>☐</td>
</tr>
<tr>
<td>LION–034</td>
<td>The operating and maintenance personnel is instructed that malfunction modules can be exchanged within 10 minutes during the operation of the system.</td>
<td>☐</td>
</tr>
<tr>
<td>LION–053</td>
<td>The LION system is monitored via LION webserver.</td>
<td>☐</td>
</tr>
<tr>
<td>LION–040</td>
<td>The SIL2 I/O modules monitoring the outputs correctly.</td>
<td>☐</td>
</tr>
</tbody>
</table>

10.5.2 Maintenance

<table>
<thead>
<tr>
<th>ID</th>
<th>CHECKPOINT</th>
<th>CHECKED</th>
</tr>
</thead>
<tbody>
<tr>
<td>LION–057</td>
<td>The operating and maintenance personnel is instructed that operating modules have to be maintained by the manufacturer every 15 years.</td>
<td>☐</td>
</tr>
</tbody>
</table>
11 Appendix

11.1 Accessories

<table>
<thead>
<tr>
<th>Description</th>
<th>Type</th>
<th>Part-No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-Bus² Termination Connector</td>
<td>LION-LB-TERM-CON</td>
<td>800201</td>
</tr>
<tr>
<td>L-Bus² Dummy Connector</td>
<td>LION-LB-DUM-CON</td>
<td>800202</td>
</tr>
<tr>
<td>L-Bus² 1:1 Connecting Cable</td>
<td>LION-LB-1:1-CON</td>
<td>800203</td>
</tr>
<tr>
<td>EMC Shield Clip Set</td>
<td>LION-SHIELD-CLIP-SET</td>
<td>800204</td>
</tr>
<tr>
<td>Connection cable for Line Coupler (LC)</td>
<td>LION-LC-CABLE-10M</td>
<td>800205</td>
</tr>
<tr>
<td>Length = 10 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connection cable for Line Coupler (LC)</td>
<td>LION-LC-CABLE-5M</td>
<td>800206</td>
</tr>
<tr>
<td>Length = 5 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connection cable for Line Coupler (LC)</td>
<td>LION-LC-CABLE-2M</td>
<td>800207</td>
</tr>
<tr>
<td>Length = 2 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set I/O Connector</td>
<td>LION-IO-CON-SET-5</td>
<td>800208</td>
</tr>
<tr>
<td>5-pin plus coding elements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set I/O Connector</td>
<td>LION-IO-CON-SET-6</td>
<td>800209</td>
</tr>
<tr>
<td>6-pin plus coding elements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set I/O Connector</td>
<td>LION-IO-CON-SET-10</td>
<td>800210</td>
</tr>
<tr>
<td>10-pin plus coding elements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set I/O Connector</td>
<td>LION-IO-CON-SET-12</td>
<td>800211</td>
</tr>
<tr>
<td>12-pin plus coding elements</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11.2 Revision of the Document

<table>
<thead>
<tr>
<th>Version</th>
<th>Revision</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Release of Document</td>
<td>03/08/2017</td>
</tr>
<tr>
<td>01</td>
<td>Corrections in chapter 6.11.1</td>
<td>07/26/2018</td>
</tr>
</tbody>
</table>