Rexroth IndraDrive
Integrated Safety Technology
for Firmware MPH03
Standard Application
This documentation shows an example for the quick and easy application of the safety systems of Rexroth IndraDrive drive controllers. It helps the user to realize project planning and setup of the drives in a short time.

<table>
<thead>
<tr>
<th>Description</th>
<th>Release Date</th>
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<td>06_06_23</td>
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NOTE .
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>1-1</td>
</tr>
<tr>
<td>1.1</td>
<td>Purpose of this Documentation</td>
<td>1-1</td>
</tr>
<tr>
<td>1.2</td>
<td>This Documentation Describes a Concrete Example with Wiring and Parameterization</td>
<td>1-1</td>
</tr>
<tr>
<td>1.3</td>
<td>Risk Analysis</td>
<td>1-2</td>
</tr>
<tr>
<td>1.4</td>
<td>Other Applicable Documentations</td>
<td>1-2</td>
</tr>
<tr>
<td>2</td>
<td>Instructions on Use</td>
<td>2-1</td>
</tr>
<tr>
<td>2.1</td>
<td>Information in this Documentation</td>
<td>2-1</td>
</tr>
<tr>
<td>3</td>
<td>Safety Instructions for Electric Drives and Controls</td>
<td>3-1</td>
</tr>
<tr>
<td>3.1</td>
<td>General Information</td>
<td>3-1</td>
</tr>
<tr>
<td>3.2</td>
<td>Instructions with Regard to Specific Dangers</td>
<td>3-5</td>
</tr>
<tr>
<td>3.3</td>
<td>Protection Against Contact with Electrical Parts</td>
<td>3-5</td>
</tr>
<tr>
<td>3.4</td>
<td>Protection Against Electric Shock by Protective Low Voltage (PELV)</td>
<td>3-6</td>
</tr>
<tr>
<td>3.5</td>
<td>Protection Against Dangerous Movements</td>
<td>3-7</td>
</tr>
<tr>
<td>3.6</td>
<td>Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting</td>
<td>3-9</td>
</tr>
<tr>
<td>3.7</td>
<td>Protection Against Contact with Hot Parts</td>
<td>3-10</td>
</tr>
<tr>
<td>3.8</td>
<td>Protection During Handling and Mounting</td>
<td>3-11</td>
</tr>
<tr>
<td>3.9</td>
<td>Battery Safety</td>
<td>3-11</td>
</tr>
<tr>
<td>3.10</td>
<td>Protection Against Pressurized Systems</td>
<td>3-12</td>
</tr>
<tr>
<td>4</td>
<td>Drive Sizing</td>
<td>4-1</td>
</tr>
<tr>
<td>5</td>
<td>Hardware and Firmware Used</td>
<td>5-1</td>
</tr>
<tr>
<td>5.1</td>
<td>Power Section</td>
<td>5-1</td>
</tr>
<tr>
<td>5.2</td>
<td>Type Codes Control Sections</td>
<td>5-2</td>
</tr>
<tr>
<td>5.3</td>
<td>Firmware Type Codes</td>
<td>5-2</td>
</tr>
<tr>
<td>5.4</td>
<td>Motors</td>
<td>5-3</td>
</tr>
<tr>
<td>5.5</td>
<td>Software Tool Rexroth DriveTop</td>
<td>5-3</td>
</tr>
<tr>
<td>6</td>
<td>General Connection, Block Diagram</td>
<td>6-1</td>
</tr>
<tr>
<td>6.1</td>
<td>General Design of the HCS Drive Controllers</td>
<td>6-1</td>
</tr>
</tbody>
</table>
6.2 Overview Connection Plan / Block Diagram ................................................................. 6-2
6.3 General Power Connection .......................................................................................... 6-3
  Example: Supply with HCS ......................................................................................... 6-3
  Example for Group Supply with HCS ........................................................................ 6-3
6.4 Control Circuits for Power Connection of Rexroth IndraDrive C Drive Controllers .... 6-4
6.5 EMC-Optimized Installation in the Control Cabinet ..................................................... 6-5

7 Interfaces ...................................................................................................................... 7-1
  7.1 Overview Interfaces for the Control Section .............................................................. 7-1
  7.2 Connectors X31 and X32 - Channel 1 of Safety Systems .......................................... 7-2
  7.3 Connector X41 - Channel 2 of Safety Systems ......................................................... 7-4
  7.4 Connector X2, Serial Interface (RS232) for Setup and Programming ......................... 7-5

8 Functioning of the Safety Systems .............................................................................. 8-1
  8.1 General Functioning .................................................................................................. 8-1
    Monitoring of the safety functions is effected by the following criteria: ....................... 8-1
  8.2 Which Safety Functions are Possible? ........................................................................ 8-2
  8.3 List of Safety Functions in Dependence on the Hardware ........................................ 8-3

9 Involved Parameter ....................................................................................................... 9-1
  9.1 Parameter ................................................................................................................ 9-1

10 Example for one Axis Equipped with Safety Technology .......................................... 10-1
  10.1 Example with One Drive .......................................................................................... 10-1
  10.2 Specification of Functions and Inputs of Channel 1 and Channel 2 ......................... 10-1
    Channel 1: Hardware Inputs of E1 / E2 / E3 / E4 / A10 .............................................. 10-2
    Channel 2: Functions of the Hardware Inputs E1n / E2n / E3n / E4n ..................... 10-3
  10.3 Parameter Set - Example ....................................................................................... 10-3
  10.4 Exemplary Wiring Diagram for an Axis ................................................................... 10-3

11 Setup Information ...................................................................................................... 11-1
  The Setup Assistant for the Safety Systems ................................................................. 11-1

12 FAQs .......................................................................................................................... 12-1
  12.1 What is the password for the safety systems in this documentation? ....................... 12-1
  12.2 Can the safety guard be opened manually? ............................................................... 12-1
  12.3 How do I delete Safety Systems completely? ......................................................... 12-1
  12.4 Do I need to re-run the approval process after exchange of a drive controller? ......... 12-1
  12.5 Diagnostic indications at the drive controller while Safety systems is activated ........ 12-1

13 SI Glossary .................................................................................................................. 13-1
1 Introduction

1.1 Purpose of this Documentation

This documentation shows an example for the quick and easy application of the safety systems of Rexroth IndraDrive drive controllers. It helps the user to realize project planning and setup of the drives in a short time.

This documentation comprises of:
- Basic information on safety systems
- A representative circuit diagram for wiring
- Information for project planning and setup

1.2 This Documentation Describes a Concrete Example with Wiring and Parameterization.

Axis in a protected zone with guard
The following functions are wired and parameterized:
1. e.g. for operators
   - safe velocity and safe incremental dimension
2. e.g. for setup personnel status
   - safe limited velocity
3. Safe drive inhibit action
4. Safe max. velocity

Fig. 1-1: Protected zone

Required Components from External Suppliers
(These components are not comprised in the BoschRexroth delivery program)
- Safe guard lock with plotter
- Confirmation device
- Operating mode switch for normal or special mode
- Safety switch (1 or 2 pieces)
1.3 Risk Analysis

It is imperative that the user runs a risk analysis and specifies the safety categories and values for parameterization required in the individual case. The parameter values suggested in this Documentation must not be taken over in blind confidence.

1.4 Other Applicable Documentations

For additional technical information on the products and components mentioned in this documentation, please refer to the respective product documentations, as amended.

<table>
<thead>
<tr>
<th>Documentation</th>
<th>Document Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>IndraDrive Integrated Safety Systems - Description of Functions and Application</td>
<td>R911 297837</td>
</tr>
<tr>
<td>IndraDrive Description of Functions</td>
<td>R911 308328</td>
</tr>
<tr>
<td>IndraDrive Drive Controllers-Description of Parameters</td>
<td>R911 297316</td>
</tr>
<tr>
<td>IndraDrive Information on Trouble Shooting</td>
<td>R911 297318</td>
</tr>
<tr>
<td>IndraDrive C Drive Controllers</td>
<td></td>
</tr>
<tr>
<td>Power Section HCS02.1 - Project Planning</td>
<td>R911 306137</td>
</tr>
<tr>
<td>IndraDrive C Drive Controllers</td>
<td></td>
</tr>
<tr>
<td>Power Section HCS03.1 - Project Planning</td>
<td>R911 307048</td>
</tr>
<tr>
<td>IndraDrive M Drive Controllers</td>
<td></td>
</tr>
<tr>
<td>Power Sections - Project Planning</td>
<td>R911 295013</td>
</tr>
<tr>
<td>IndraDrive Supply Units - Project Planning</td>
<td>R911 307048</td>
</tr>
<tr>
<td>IndraDrive Drive Contr. Power Section-Project Planning</td>
<td>R911 295011</td>
</tr>
<tr>
<td>IndraDrive Drive Systems - Project Planning</td>
<td>R911 309635</td>
</tr>
<tr>
<td>IndraDrive Additional Components - Project Planning</td>
<td>R911 306139</td>
</tr>
<tr>
<td>IndraDyn S Synchronous Motors MSK Project Planning</td>
<td>R911 296288</td>
</tr>
</tbody>
</table>

The currently applicable versions of these documentations can be downloaded from
2 Instructions on Use

2.1 Information in this Documentation

The information in this Documentation on utilization of devices and components are mere sample applications and suggestions and are not to be interpreted as warranted properties in the legal sense.

For each individual application, machine manufacturer and system designer are liable
• to check themselves suitability of the supplied components and the information given in this Documentation on their utilization,
• to adjust their application to the valid safety regulations and standards and to take the required measures and implement the required modifications and extensions.

When using the devices and components named in this Documentation, it is imperative to observe the respective technical documentations (also refer to Chapter 1.4), in particular the Instructions on Use and Instructions on Safety.

DANGER

Caution! Before specifying the relevant parameters for the safety systems (e.g. safe limited max. velocity), the user must first complete a risk analysis. The values must be specified accordingly!
⇒ In all design and construction, the applicable standards and regulations must be observed!
3 Safety Instructions for Electric Drives and Controls

3.1 General Information

Using the Safety Instructions and Passing them on to Others

Do not attempt to install or commission this device without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation prior to working with the device. If you do not have the user documentation for the device, contact your responsible Bosch Rexroth sales representative. Ask for these documents to be sent immediately to the person or persons responsible for the safe operation of the device.

If the device is resold, rented and/or passed on to others in any other form, then these safety instructions must be delivered with the device.

---

**WARNING**

Improper use of these devices, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, may result in material damage, bodily harm, electric shock or even death!

---

Instructions for Use

Read these instructions before the initial startup of the equipment in order to eliminate the risk of bodily harm or material damage. Follow these safety instructions at all times.

- Bosch Rexroth AG is not liable for damages resulting from failure to observe the warnings provided in this documentation.
- Read the operating, maintenance and safety instructions in your language before starting up the machine. If you find that you cannot completely understand the documentation for your product, please ask your supplier to clarify.
- Proper and correct transport, storage, assembly and installation as well as care in operation and maintenance are prerequisites for optimal and safe operation of this device.
- Only assign trained and qualified persons to work with electrical installations:
  - Only persons who are trained and qualified for the use and operation of the device may work on this device or within its proximity. The persons are qualified if they have sufficient knowledge of the assembly, installation and operation of the equipment as well as an understanding of all warnings and precautionary measures noted in these instructions.
  - Furthermore, they must be trained, instructed and qualified to switch electrical circuits and devices on and off in accordance with technical safety regulations, to ground them and to mark them according to the requirements of safe work practices. They must have adequate safety equipment and be trained in first aid.
- Only use spare parts and accessories approved by the manufacturer.
- Follow all safety regulations and requirements for the specific application as practiced in the country of use.
• The devices have been designed for installation in industrial machinery.

• The ambient conditions given in the product documentation must be observed.

• Only use safety-relevant applications that are clearly and explicitly approved in the Project Planning Manual. If this is not the case, they are excluded. Safety-relevant are all such applications which can cause danger to persons and material damage.

• The information given in the documentation of the product with regard to the use of the delivered components contains only examples of applications and suggestions. The machine and installation manufacturer must
  • make sure that the delivered components are suited for his individual application and check the information given in this documentation with regard to the use of the components,
  • make sure that his application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.

• Startup of the delivered components is only permitted once it is sure that the machine or installation in which they are installed complies with the national regulations, safety specifications and standards of the application.

• Operation is only permitted if the national EMC regulations for the application are met.

• The instructions for installation in accordance with EMC requirements can be found in the documentation "EMC in Drive and Control Systems".

  The machine or installation manufacturer is responsible for compliance with the limiting values as prescribed in the national regulations.

• Technical data, connections and operational conditions are specified in the product documentation and must be followed at all times.
Explanation of Warning Symbols and Degrees of Hazard Seriousness

The safety instructions describe the following degrees of hazard seriousness. The degree of hazard seriousness informs about the consequences resulting from non-compliance with the safety instructions:

<table>
<thead>
<tr>
<th>Warning symbol with signal word</th>
<th>Degree of hazard seriousness according to ANSI Z 535</th>
</tr>
</thead>
<tbody>
<tr>
<td>DANGER</td>
<td>Death or severe bodily harm will occur.</td>
</tr>
<tr>
<td>WARNING</td>
<td>Death or severe bodily harm may occur.</td>
</tr>
<tr>
<td>CAUTION</td>
<td>Bodily harm or material damage may occur.</td>
</tr>
</tbody>
</table>

Fig. 3-1: Hazard classification (according to ANSI Z 535)
Hazards by Improper Use

- **DANGER**
  - High electric voltage and high working current! Risk of death or severe bodily injury by electric shock!

- **DANGER**
  - Dangerous movements! Danger to life, severe bodily harm or material damage by unintentional motor movements!

- **WARNING**
  - High electric voltage because of incorrect connection! Risk of death or bodily injury by electric shock!

- **WARNING**
  - Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

- **CAUTION**
  - Hot surfaces on device housing! Danger of injury! Danger of burns!

- **CAUTION**
  - Risk of injury by improper handling! Risk of bodily injury by bruising, shearing, cutting, hitting, or improper handling of pressurized lines!

- **CAUTION**
  - Risk of injury by improper handling of batteries!
3.2 Instructions with Regard to Specific Dangers

Protection Against Contact with Electrical Parts

Note: This section only concerns devices and drive components with voltages of more than 50 Volt.

Contact with parts conducting voltages above 50 Volts can cause personal danger and electric shock. When operating electrical equipment, it is unavoidable that some parts of the devices conduct dangerous voltage.

High electrical voltage! Danger to life, electric shock and severe bodily injury!

⇒ Only those trained and qualified to work with or on electrical equipment are permitted to operate, maintain and repair this equipment.

⇒ Follow general construction and safety regulations when working on electrical power installations.

⇒ Before switching on the device, the equipment grounding conductor must have been non-detachably connected to all electrical equipment in accordance with the connection diagram.

⇒ Do not operate electrical equipment at any time, even for brief measurements or tests, if the equipment grounding conductor is not permanently connected to the mounting points of the components provided for this purpose.

⇒ Before working with electrical parts with voltage potentials higher than 50 V, the device must be disconnected from the mains voltage or power supply unit. Provide a safeguard to prevent reconnection.

⇒ With electrical drive and filter components, observe the following: Wait 30 minutes after switching off power to allow capacitors to discharge before beginning to work. Measure the voltage on the capacitors before beginning to work to make sure that the equipment is safe to touch.

⇒ Never touch the electrical connection points of a component while power is turned on.

⇒ Install the covers and guards provided with the equipment properly before switching the device on. Before switching the equipment on, cover and safeguard live parts safely to prevent contact with those parts.

⇒ A residual-current-operated circuit-breaker or r.c.d. cannot be used for electric drives! Indirect contact must be prevented by other means, for example, by an overcurrent protective device according to the relevant standards.

⇒ Secure built-in devices from direct touching of electrical parts by providing an external housing, for example a control cabinet.
European countries: according to EN 50178/1998, section 5.3.2.3.
USA: See National Electrical Code (NEC), National Electrical Manufacturers' Association (NEMA), as well as local engineering regulations. The operator must observe all the above regulations at any time.

With electrical drive and filter components, observe the following:

**High housing voltage and large leakage current! Risk of death or bodily injury by electric shock!**
⇒ Before switching on, the housings of all electrical equipment and motors must be connected or grounded with the equipment grounding conductor to the grounding points. This is also applicable before short tests.
⇒ The equipment grounding conductor of the electrical equipment and the units must be non-detachably and permanently connected to the power supply unit at all times. The leakage current is greater than 3.5 mA.
⇒ Over the total length, use copper wire of a cross section of a minimum of 10 mm² for this equipment grounding connection!
⇒ Before start-up, also in trial runs, always attach the equipment grounding conductor or connect with the ground wire. Otherwise, high voltages may occur at the housing causing electric shock.

**Protection Against Electric Shock by Protective Low Voltage (PELV)**

All connections and terminals with voltages between 5 and 50 Volt at Rexroth products are protective extra-low voltage systems which are provided with touch guard according to the product standards.

**High electric voltage by incorrect connection! Risk of death or bodily injury by electric shock!**
⇒ To all connections and terminals with voltages between 0 and 50 Volt, only devices, electrical components, and conductors may be connected which are equipped with a PELV (Protective Extra-Low Voltage) system.
⇒ Connect only voltages and circuits which are safely isolated from dangerous voltages. Safe isolation is achieved for example by isolating transformers, safe optocouplers or battery operation without mains connection.
Protection Against Dangerous Movements

Dangerous movements can be caused by faulty control of connected motors. Some common examples are:

- improper or wrong wiring of cable connections
- incorrect operation of the equipment components
- wrong input of parameters before operation
- malfunction of sensors, encoders and monitoring devices
- defective components
- software or firmware errors

Dangerous movements can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.

The monitoring in the drive components will normally be sufficient to avoid faulty operation in the connected drives. Regarding personal safety, especially the danger of bodily harm and material damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.
Dangerous movements! Danger to life, risk of injury, severe bodily harm or material damage!

⇒ For the above reasons, ensure personal safety by means of qualified and tested higher-level monitoring devices or measures integrated in the installation. They have to be provided for by the user according to the specific conditions within the installation and a hazard and fault analysis. The safety regulations applicable for the installation have to be taken into consideration. Unintended machine motion or other malfunction is possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, bodily harm and/or material damage:

⇒ Keep free and clear of the machine’s range of motion and moving parts. Possible measures to prevent people from accidentally entering the machine’s range of motion:
  - use safety fences
  - use safety guards
  - use protective coverings
  - install light curtains or light barriers

⇒ Fences and coverings must be strong enough to resist maximum possible momentum.

⇒ Mount the emergency stop switch in the immediate reach of the operator. Verify that the emergency stop works before startup. Don’t operate the device if the emergency stop is not working.

⇒ Isolate the drive power connection by means of an emergency stop circuit or use a safety related starting lockout to prevent unintentional start.

⇒ Make sure that the drives are brought to a safe standstill before accessing or entering the danger zone.

⇒ Additionally secure vertical axes against falling or dropping after switching off the motor power by, for example:
  - mechanically securing the vertical axes,
  - adding an external braking/ arrester/ clamping mechanism or
  - ensuring sufficient equilibration of the vertical axes.

The standard equipment motor brake or an external brake controlled directly by the drive controller are not sufficient to guarantee personal safety!
⇒ Disconnect electrical power to the equipment using a master switch and secure the switch against reconnection for:
- maintenance and repair work
- cleaning of equipment
- long periods of discontinued equipment use

⇒ Prevent the operation of high-frequency, remote control and radio equipment near electronics circuits and supply leads. If the use of such devices cannot be avoided, verify the system and the installation for possible malfunctions in all possible positions of normal use before initial startup. If necessary, perform a special electromagnetic compatibility (EMC) test on the installation.

Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

Magnetic and electromagnetic fields generated by current-carrying conductors and permanent magnets in motors represent a serious personal danger to those with heart pacemakers, metal implants and hearing aids.

![WARNING]

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

⇒ Persons with heart pacemakers and metal implants are not permitted to enter following areas:
- Areas in which electrical equipment and parts are mounted, being operated or commissioned.
- Areas in which parts of motors with permanent magnets are being stored, repaired or mounted.

⇒ If it is necessary for somebody with a pacemaker to enter such an area, a doctor must be consulted prior to doing so. The interference immunity of present or future implanted heart pacemakers differs greatly, so that no general rules can be given.

⇒ Those with metal implants or metal pieces, as well as with hearing aids must consult a doctor before they enter the areas described above. Otherwise health hazards may occur.
Protection Against Contact with Hot Parts

Hot surfaces at motor housings, on drive controllers or chokes! Danger of injury! Danger of burns!

⇒ Do not touch surfaces of device housings and chokes in the proximity of heat sources! Danger of burns!

⇒ Do not touch housing surfaces of motors! Danger of burns!

⇒ According to operating conditions, temperatures can be higher than 60 °C, 140 °F during or after operation.

⇒ Before accessing motors after having switched them off, let them cool down for a sufficiently long time. Cooling down can require up to 140 minutes! Roughly estimated, the time required for cooling down is five times the thermal time constant specified in the Technical Data.

⇒ After switching drive controllers or chokes off, wait 15 minutes to allow them to cool down before touching them.

⇒ Wear safety gloves or do not work at hot surfaces.

⇒ For certain applications, the manufacturer of the end product, machine or installation, according to the respective safety regulations, has to take measures to avoid injuries caused by burns in the end application. These measures can be, for example: warnings, guards (shielding or barrier), technical documentation.
Protection During Handling and Mounting

In unfavorable conditions, handling and assembling certain parts and components in an improper way can cause injuries.

Risk of injury by improper handling! Bodily injury by bruising, shearing, cutting, hitting!
⇒ Observe the general construction and safety regulations on handling and assembly.
⇒ Use suitable devices for assembly and transport.
⇒ Avoid jamming and bruising by appropriate measures.
⇒ Always use suitable tools. Use special tools if specified.
⇒ Use lifting equipment and tools in the correct manner.
⇒ If necessary, use suitable protective equipment (for example safety goggles, safety shoes, safety gloves).
⇒ Do not stand under hanging loads.
⇒ Immediately clean up any spilled liquids because of the danger of skidding.

Battery Safety

Batteries consist of active chemicals enclosed in a solid housing. Therefore, improper handling can cause injury or damages.

Risk of injury by improper handling!
⇒ Do not attempt to reactivate low batteries by heating or other methods (risk of explosion and cauterization).
⇒ Do not recharge the batteries as this may cause leakage or explosion.
⇒ Do not throw batteries into open flames.
⇒ Do not dismantle batteries.
⇒ Do not damage electrical parts installed in the devices.

Note: Environmental protection and disposal! The batteries installed in the product are considered dangerous goods during land, air, and sea transport (risk of explosion) in the sense of the legal regulations. Dispose of used batteries separate from other waste. Observe the local regulations in the country of assembly.
Protection Against Pressurized Systems

According to the information given in the Project Planning Manuals, motors cooled with liquid and compressed air, as well as drive controllers, can be partially supplied with externally fed, pressurized media, such as compressed air, hydraulics oil, cooling liquids, and cooling lubricating agents. In these cases, improper handling of external supply systems, supply lines, or connections can cause injuries or damages.

Risk of injury by improper handling of pressurized lines!
⇒ Do not attempt to disconnect, open, or cut pressurized lines (risk of explosion).
⇒ Observe the respective manufacturer's operating instructions.
⇒ Before dismounting lines, relieve pressure and empty medium.
⇒ Use suitable protective equipment (for example safety goggles, safety shoes, safety gloves).
⇒ Immediately clean up any spilled liquids from the floor.

Note: Environmental protection and disposal! The agents used to operate the product might not be economically friendly. Dispose of ecologically harmful agents separate from other waste. Observe the local regulations in the country of assembly.
4 Drive Sizing

Rexroth IndraSize

IndraSize - the comfortable program for sizing drives - helps you to find the optimum drive for your machine or system at once.

The user sizes all common drive mechanisms as e.g.

- ball-and-screw spindle drive with rotating spindle or nut,
- rack and pinion combinations,
- toothed belts,
- linear and rotating direct drives, etc.

Supported by the graphic features, simply mirror your machine kinematics with graphical support. To this end, connect the motor and the selected mechanical system with the different transmission elements (e.g. gears, belt drive, ...).

IndraSize allows you to freely assemble a complete motion profile from individual motion sequences and leads you to the optimum drive in a menu-driven selection process.

Download IndraSize from [www.boschrexroth.com/indrasize](http://www.boschrexroth.com/indrasize)
5 Hardware and Firmware Used

The drive controller to be used with converters comprises 3 parts: Power section, control section, and firmware. When used with inverters, a supply device is required in addition to power section, control section and firmware.

5.1 Power Section

HCS Converter

HCS02 types are available for max. currents of 12, 28, 54, and 70A.
HCS03 types are available for max. currents of 70, 100, 150, and 210A.

Type Keys

HCS02.1E-Wxxxx-A-03-NNNN Basic version
HCS02.1E-Wxxxx-A-03-NNNV Version with integrated power supply

HCS03.1E-Wxxxx-A-03-NNNN Basic version
HCS03.1E-Wxxxx-A-03-NNNV Version with integrated power supply

Wxxxx stands for the temporarily available maximum current in A, e.g. W0070 => maximum current 70 A

HMS and HMD Converters

Type Key HMS or HMD

HMS01.1N-Wxxxx-A-07-NNNN Basic version
Wxxxx stand for the available 400ms peak current in A, e.g. W0070 => maximum current 70 A
Available versions: max. current 20, 36, 54, 70,110, 150, 210A

The converter module for 2 axes (HMD) can likewise be equipped with safety systems.
HMD01.1N-W0020-A-07-NNNN e.g. for 20A max. current
Available versions: max. current 12, 20, 36 A
When converters (HMS, HMD) are used, an additional supply device (HMV) is required for power infeed.

Type Key Supply Devices (HMV)

HMV01.1E-Wxxxx-A-07-NNNN without recovery
HMV01.1R-Wxxxx-A-07-NNNN with recovery
Wxxxx stands for the continuous power when operated with external line reactor, e.g. W0030 => continuous power 30 kW
5.2  Type Codes Control Sections

For drive controllers with parallel interface (24V I/Os), safety systems (24V I/Os), and in case of use of IndraDyn motors (MSK motors) with relative (incremental) or absolute standard encoders (Hiperface type encoders), the following type code is applicable:

CSH01.1C-PL-ENS-NNN-NN-S1-S-NN-FW  Single axis ADVANCED

BASIC control sections for one axis are not available with the 'Safety systems' options. However, double axis modules can be used with safety systems, e.g. with Sercos as control communication; MSK motors and encoders of the Hiperface type.

CDB01.1C-SE-ENS-ENS-NNN-NNN-S1-S-NN-FW  Double axis Basic

Contact us to ask about other control section options, also with different encoder types.

! Note:

Square-wave sine-cosine encoder (TTL or HTTL) are not permissible for safety systems.

5.3  Firmware Type Codes

FWA-INDRV*-MPD-03VRS-D5-1-NNN-NN  Double axis BASIC UNIVERSAL
FWA-INDRV*-MPH-03VRS-D5-1-NNN-NN  Single axis ADVANCED

The firmware is available in scalable function packages. For this application, the basic version kit specified here is sufficient.

Various extension packages are available, e.g. internal Motion Logic control, synchronization, etc.
5.4 Motors

An extensive range of robust housing and assembly kit motors provides the right motor for various applications.

**IndraDyn S**: Synchronous servo motors (MSK) for all requirements up to 230 Nm.

**IndraDyn A**: Asynchronous servo motors (MAD or MAF) for high ratings of up to 83 KW continuous power.

**IndraDyn L**: Synchronous linear motors (MLP, MLS) for feedrates of up to 21,500 N, or continuous power of up to 6720 N.

**IndraDyn T**: Synchronous torque motors (MST, MRT) for torques of up to 13,800 Nm and speeds up to 2,000 min⁻¹; (higher forces on request)

**IndraDyn H**: High-speed assembly kit motors (MSH, MSR) of up to 30,000 rpm and up to 41 KW.

5.5 Software Tool Rexroth DriveTop

For setup, operation and visualization of the drive, the Rexroth DriveTop software tool is available which has been used in the following descriptions. Thanks to the self-explanatory menu navigation, standard knowledge of servo drives is sufficient to set up the drive.

![Rexroth DriveTop](DriveTop.jpg)

Fig. 5: DriveTop start screen

This program can be ordered under order no. SWA-DTOP**-INB-16VRS-MS-CD650-COPY.

To connect the drive to the PC, a ready-made interface cable (IKB0041/005,0) is available in various lengths (2m / 5m / 10m / 15m).

Order no. for 5 m: IKB0041/005,0; R911296710
6 General Connection, Block Diagram

6.1 General Design of the HCS Drive Controllers

Fig. 6-1:
1. Power section converter (HCS) or inverter (HMS or HMD with double axis).
2. Control Section Advances (CSH) or double axis (CBD)
6.2 Overview Connection Plan / Block Diagram

Fig 6-2: EN_Anschlussplan_HCS_V01

1° not for HCS02.1E-W0012-A-03-NNNX
2° only for multi axis application or with HMS-Geräte

For more information see Application Manual HCS02.1 and HCS03.1
6.3 General Power Connection

Example: Supply with HCS

The optionally required components are shown shaded in grey.

Additional drive controllers and accessories can be connected to the HCS drive controller.

Example for Group Supply with HCS

Note:

1. In addition to the connection of the drive controller to the mains, the following connections must be wired:
   - ‘Ready for operation’ Bb contact at the control section (see project planning control section)
   - Control voltage supply
   - Protective conductor, (grounding equipment conductor)

2. If the components HCS03.1E to HNK01.1 are used, the internal line contactor is to be connected electrically between the power connection and the HNK.

3. DC bus linking of devices which are not connected to the mains via various internal line contactors is not permissible.
6.4 Control Circuits for Power Connection of Rexroth IndraDrive C Drive Controllers

The upstream internal line contactor controls the energy flow to the drive controller, thus permitting its separation from the mains in case of error. The control circuit is mainly operated by the 'ready for operation' Bb contact at the drive controller's control section or the 'ready for operation' Bb contract of the prime power.

General Functions

The power voltage is connected to the drive package only after the 'ready for operation' Bb contact, by being closed, signals readiness for connection of power voltage.

Activation via External Internal Line Contactor - HCS02 and HCS03

Standard Version for HCS02 and HCS03 Drive Controllers...

1. Integration of the 'ready for operation' Bb contacts of other devices (also see description of firmware functions: "Power supply" and firmware parameter description P-0-0300 and P-0-0861).
2. take switching capacity Bb contact into account

Fig. 6-5: control circuit
6.5 EMC-Optimized Installation in the Control Cabinet

Separation of interference-free and interference-prone areas in the control cabinet

Fig. 6-6: EMC-Optimized Installation

Area A: Interference-free area
Area B: Interference-prone area
Area C: Heavily interference-prone area

Under no circumstances may lines from one area be routed parallel to lines from another area.

Motor power cables and motor encoder cables must likewise not be routed parallel to each other.

Ensure that there is enough space between the cables. Preferably, the cables should be routed in separated cable ducts.
7 Interfaces

7.1 Overview Interfaces for the Control Section

Fig. 7-1: Control section CSH01.1C-PL-ENS-NNN-NNN-S1-S

Connector X8 e.g., für optional Encoder

Slot X7 for memory card

Connector X31 and X32 is needed for channel 1 integrated safety technology

Connector X41 is needed for channel 2 integrated safety

Connector X4 for motor encoder

Connector X30 Feld bus and others control interfaces e.g. Sercos, Profibus, Canbus, Devicenet and Parallelinterface (24VE/As)

Connector X2 RS232 Drive to PC

Interface 15 pins and 9 pins

X4 Interface 15 pins

X8 Interface 9 pins
7.2 Connectors X31 and X32 - Channel 1 of Safety Systems -

The assignment of the inputs and outputs described in the following does correspond to the exemplary parameter set defined in this description (Chapter 10). This parameter set can be loaded into the drive via the Rexroth DriveTop setup tool. The setup instructions in Chapter 11 are based on this assignment.

It is imperative that the user establishes and enters the parameters valid for their machine (e.g. the safe maximum velocities).

---

**Connector X31**  
(The subsequent assignment corresponds to the example in this documentation)

<table>
<thead>
<tr>
<th>Pin</th>
<th>I/O</th>
<th>Parameter</th>
<th>Bit</th>
<th>Function:</th>
<th>Note:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2</td>
<td>P-0-0115</td>
<td>0</td>
<td>‘Ready for operation’ contact with converters</td>
<td>1 A operating cycles &gt; 100,000</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>P-0-3212</td>
<td>0</td>
<td>Operating mode switch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I</td>
<td>P-0-3212</td>
<td>2</td>
<td>Enabling control</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I</td>
<td>P-0-3212</td>
<td>3</td>
<td>Safety switch (S1)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I</td>
<td>P-0-03212</td>
<td>1</td>
<td>Drive interlock</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>I</td>
<td>P-0-3212</td>
<td>9</td>
<td>Diagnosis input channel 1 (E10) (feedback from relay of protective device)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>Power supply +24V</td>
<td>from outside</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td>Power supply 0 V</td>
<td>from outside</td>
</tr>
</tbody>
</table>

*With multi-axis applications, enter here bit 9 of parameter P-0-0861 bit 9. This parameter indicates the status of DC bus voltage. The status message is transmitted via the module bus.*

---

**Connector X32**  
(The subsequent assignment corresponds to the example in this documentation)

<table>
<thead>
<tr>
<th>Pin</th>
<th>I/O</th>
<th>Parameter</th>
<th>Bit</th>
<th>Function:</th>
<th>Note:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>An</td>
<td>S-0-0000</td>
<td>0</td>
<td>not assigned, freely available</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>An</td>
<td>S-0-0000</td>
<td>0</td>
<td>not assigned, freely available</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>P-0-0223</td>
<td>0</td>
<td>E stop input</td>
<td>&quot;Emergency stop&quot; signal to the drive</td>
</tr>
<tr>
<td>4</td>
<td>I / (O)*</td>
<td>S-0-0000</td>
<td>0</td>
<td>not assigned, freely available</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I / (O)*</td>
<td>S-0-0000</td>
<td>0</td>
<td>not assigned, freely available</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I</td>
<td>P-0-3214</td>
<td>0</td>
<td>SI status output controller</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>I / (O)*</td>
<td>S-0-0000</td>
<td>0</td>
<td>not assigned, freely available</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>O</td>
<td>P-0-3214</td>
<td>0</td>
<td>SI status output controller</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>I / (O)*</td>
<td>S-0-0000</td>
<td>9</td>
<td>not assigned, freely available</td>
<td></td>
</tr>
</tbody>
</table>

*can also be parameterized as output*
Screen shot from Rexroth Drive Top => Extras => I/O => X31/X32

Fig. 7-1: Assignment of the connectors X31 and X32;

After clicking Status Digital I/O... the following screen will appear:

Fig. 7-2: Connectors X31 and X32 Status of the inputs and outputs
7.3 Connector X41 - Channel 2 of Safety Systems -

Parameter P-0-3211 provides a list for linking the functions of the individual inputs and outputs of the safety systems options module with pre-defined SI control signals.

The **list elements** 0...3 correspond to the input signals E1n, E2n, E3n, and E4n.

The **list elements** 4 ... 7 are the copy of the **list elements** 0 ... 3 by reason of double input.

**Caution:** Parameter P-0-0211 **does not have to be handled separately; the list elements are defined by means of the DriveTop setup tool, the assistant for safety systems.**

**Channel 2: Parameter P-0-3211**

<table>
<thead>
<tr>
<th>Content of the list element</th>
<th>Function of the individual list element</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x0000</td>
<td>free</td>
</tr>
<tr>
<td>0x0001</td>
<td>Operating mode switch</td>
</tr>
<tr>
<td>0x0002</td>
<td>Drive stop</td>
</tr>
<tr>
<td>0x0003</td>
<td>Confirmation button</td>
</tr>
<tr>
<td>0x0004</td>
<td>Homing switch</td>
</tr>
<tr>
<td>0x0005</td>
<td>Safety switch 1 (S1)</td>
</tr>
<tr>
<td>0x0006</td>
<td>Safety switch 2 (S2)</td>
</tr>
</tbody>
</table>

**State of channel 2**

The state of the list elements inputs can be determined in P-0-3217. The better way: DriveTop => Extras => Drive diagnosis => Safety systems ..
7.4 Connector X2, Serial Interface (RS232) for Setup and Programming

Interface X2 is an RS232 interface to the drive. The drive controller is parameterized and set up via this connector. The setup program is called Rexroth DriveTop. Thanks to self-explanatory menu guidance, standard knowledge of servo drives is sufficient to set up the drive. An interface cable of 5 m length is available from Bosch Rexroth under number IKB0041/005.0.

**Note:** The interfacedoes not have an electrical isolation. The electrode voltage between control section and connected data terminal equipment must not exceed 1V
8 Functioning of the Safety Systems

8.1 General Functioning

Monitoring of the safety functions is effected by the following criteria:

- All safety inputs and outputs are 2-channel and inverted
- Dynamizing impulse on the 24V inputs for discovering sleeping errors
- Evolution of 2 encoder signals (sine and cosine signal)
- 2 processor systems
- Crosswise data comparison of both systems (firmware and hardware)
- Password protection for all Si parameters

Possible realization of the Si technology

<table>
<thead>
<tr>
<th>Channel 1</th>
<th>Channel 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 24V E/A X31/32</td>
<td>24V E/A X41</td>
</tr>
<tr>
<td>2. Sercos Interface</td>
<td>24V E/A X41</td>
</tr>
<tr>
<td>3. Profibus DP</td>
<td>24V E/A X41</td>
</tr>
<tr>
<td>4. CANopen</td>
<td>24V E/A X41</td>
</tr>
<tr>
<td>5. DeviceNet</td>
<td>24V E/A X41</td>
</tr>
<tr>
<td>6. PROFIsafe</td>
<td>PROFIsafe (both channels are in one bus cable)</td>
</tr>
</tbody>
</table>
8.2 Which Safety Functions are Possible?

**Standard mode**  
In "standard mode" state, the following safety function is supported with "Safety on Board":

- **Safe limited maximum velocity**  
  → defines a safe maximum velocity in standard mode

**Safe standstill**  
In "safe standstill" state, the following safety functions are supported with "Safety on Board":

- **Safe stop**  
  → corresponding to stop category 1 according to EN60204-1; with drive-controlled optimum stopping and timeout; energy supply to the motor is **safely interrupted**.
  - alternatively -

- **Safe operating stop**  
  → corresponding to stop category 2 according to EN 60204-1; this means that drive control remains active, transfer into standstill is done by the NC; the drive monitors reaching of standstill in the specified tolerance time via 2 channels; energy supply to the motor is **not interrupted!**
  - additionally -

**Safe drive interlock**  
→ same as "Safe stop", but switching to "Safe motion" by pressing the confirmation key is not possible; selection of Safe stop/Operating stop via safety switches BA; selection of starting lockout via dedicated switches ASP1/ASP2.

**Safe motion**  
In "Safe motion" state, the following safety functions are supported with "Safety on Board":

- **Safely reduced velocity**  
  → 2-channel monitoring of exceeding a speed limit

- **Safe direction of motion**  
  → 2-channel monitoring of permissible direction of motion

- **Safe limited incremental dimension**  
  → 2-channel monitoring of permissible distance to be traversed
Auxiliary functions

The following auxiliary functions are available:

- **Safe limited absolute position**
  → 2-channel monitoring of permissible absolute position
  To implement safe absolute position, safe reference must be established!

- **Safe stopping**
  → 2-channel monitoring of transfer into safe standstill

- **Safe referencing**
  → to establish reference for channel 1 and channel 2
  The establishment of safe reference is the precondition for the safety functions "Safe end position" and "Safe limited absolute position"!

Safety functions

"Safe feedback"

The following safety functions are available for "Safe feedback":

- **Safe diagnosis outputs**
  → to transmit the "Safe status" to other system components

- **Safe activation of a guard tumbler** (not with PROFIsafe)
  → A drive which functions as a Diagnosis master can centralize the safe state of several axes within a protected zone to activate one guard.

8.3 List of Safety Functions in Dependence on the Hardware

<table>
<thead>
<tr>
<th>Hardware option</th>
<th>Integrated safety systems (Safety on Board)</th>
<th>Safe starting lockout</th>
<th>Safe motion</th>
<th>Safe standstill</th>
<th>Drive interlock</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASIC OPENLOOP</td>
<td></td>
<td>L1</td>
<td>S1</td>
<td>S1</td>
<td>S1</td>
</tr>
<tr>
<td>(CSB01.1N-FC)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BASIC SERCOS</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(CSB01.1N-SE)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BASIC PROFIBUS</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(CSB01.1N-PB)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BASIC ANALOG</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(CSB01.1N-AN)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BASIC UNIVERSAL</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(CSB01.1C; single-axis)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BASIC UNIVERSAL</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(CSB01.1C; double-axis)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>ADVANCED</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>(CSH01.1C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note on type code:** Safe starting lockout is realized only by wiring. Select L1 in the order key. For Integrated Safety Systems via I/O, select S1.
## Safety related functions

<table>
<thead>
<tr>
<th>Operating mode selection switch</th>
<th>Enabling control</th>
<th>Safety switch 1</th>
<th>Safety switch 2</th>
<th>Drive interlock</th>
<th>Home switch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety related limited max. speed</td>
<td>NM</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Off</td>
</tr>
<tr>
<td>Safety related limited abs. position</td>
<td>NM</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Off</td>
</tr>
<tr>
<td>Special mode with stopping process</td>
<td>Drive interlock</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>On</td>
</tr>
<tr>
<td>Safety related stopping process</td>
<td>SS or SOS</td>
<td>Off</td>
<td>-</td>
<td>-</td>
<td>Off</td>
</tr>
<tr>
<td>SOS + SBM</td>
<td>SM</td>
<td>Off</td>
<td>-</td>
<td>-</td>
<td>Off</td>
</tr>
<tr>
<td>Special mode with motion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRS1 + SA1 + SD1 + SI1</td>
<td>SM</td>
<td>On</td>
<td>Off</td>
<td>□</td>
<td>Off</td>
</tr>
<tr>
<td>SRS2 + SA2 + SD2 + SI2</td>
<td>SM</td>
<td>On</td>
<td>On</td>
<td>□</td>
<td>Off</td>
</tr>
<tr>
<td>SRS1 + SA1 + SD1 + SI1 + SP1</td>
<td>SM</td>
<td>On</td>
<td>Off</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SRS2 + SA2 + SD2 + SI2 + SP2</td>
<td>SM</td>
<td>On</td>
<td>On</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SRS3 + SA3 + SD3 + SI3</td>
<td>SM</td>
<td>On</td>
<td>Off</td>
<td>On</td>
<td>□</td>
</tr>
<tr>
<td>SRS4 + SA4 + SD4 + SI4</td>
<td>SM</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>□</td>
</tr>
<tr>
<td>Safety related limited max. speed</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Off</td>
</tr>
<tr>
<td>Safety related limited abs. end position</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Off</td>
</tr>
<tr>
<td>Safely monitored stopping for SS / SOS</td>
<td>SM</td>
<td>Off</td>
<td>-</td>
<td>-</td>
<td>Off</td>
</tr>
<tr>
<td>Safely monitored stopping for drive interlock</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>On</td>
</tr>
</tbody>
</table>

NM: Normal mode  
SM: Special mode  
SS: Safety related standstill (no torque)  
SOS: Safety related operation stop (control loops are active)  
SRS: Safety related reduced speed  
SA: Safety monitored acceleration/deceleration ramp  
SD: Safety related direction of motion  
SI: Safety related limited increment  
SP: Safety related limited absolute position  
SBM: Safety related brake management  
□: Input for control element is not queried  
☐: No input for control element available (max. 4 inputs)
9 Involved Parameter

9.1 Parameter

- P-0-3200, Safety technology firmware code
- P-0-3201, Change counter of safety technology memory
- P-0-3202, Operating hours at last change of memory
- P-0-3203, Memory image of safety technology memory
- P-0-3204, C3000 Synchronize and store safety technology
  IND command
- P-0-3205, Safety technology device identifier
- P-0-3206, Safety technology password
- P-0-3207, Safety technology password -level
- P-0-3208, Backup of safety techn. Data channel 2
- P-0-3209, Safety technology commissioning identifier
- P-0-3210, Safety technology control word
- P-0-3211, Safety technology I/O control word, channel 2
- P-0-3212, Safety technology signal control word, channel 1
- P-0-3213, Safety technology status
- P-0-3214, Safety technology signal status word, channel 1
- P-0-3215, Selected safety technology operating status
- P-0-3216, Active safety technology signals
- P-0-3217, I/O status channel 2 (optional safety technology module)
- P-0-3218, C3700 Manually unlocking the safety door
- P-0-3219, Diagnostic safety technology message
- P-0-3220, Tolerance time transition from normal operation
- P-0-3221, Max. tolerance time for different channel states
- P-0-3222, Max. activation time of enabling control
- P-0-3223, Time interval for dynamization of safety function selection
- P-0-3224, Duration of dynamization pulse of safety function selection
- P-0-3225, Tolerance time transition from safety rel. oper.
- P-0-3228, C4000 Homing procedure command channel 2
- P-0-3229, Tolerance window for safety related homing procedure
- P-0-3230, Monitoring window for safety related operational stop
- P-0-3231, Safety related reference position channel 2
- P-0-3232, Monitoring window for safety related direction of motion
- P-0-3233, Velocity threshold for safety related stopping process
- P-0-3234, Safety related maximum speed
- P-0-3235, Safty limited end position positiv
- P-0-3236, Safty limited end position , negativ
- P-0-3240, Control word for safety related motion 1
- P-0-3241, Safety related limited absolute position 1, positive
- P-0-3242, Safety related limited absolute position 1, negative
- P-0-3243, Safety related limited increment 1
- P-0-3244, Safety related reduced speed 1
- P-0-3250, Control word for safety related motion 2
- P-0-3251, Safety related limited absolute position 2, positive
- P-0-3252, Safety related limited absolute position 2, negative
- P-0-3253, Safety related limited increment 2
- P-0-3254, Safety related reduced speed 2
- P-0-3260, Control word for safety related motion 3
- P-0-3263, Safety related limited increment 3
- P-0-3264, Safety related reduced speed 3
- P-0-3270, Control word for safety related motion 4
- P-0-3273, Safety related limited increment 4
- P-0-3274, Safety related reduced speed 4
- P-0-3280, Actual position value, channel 2
- P-0-3281, Actual velocity value, channel 2
- P-0-3282, Safety related monitored deceleration
- P-0-3290, PROFIsafe: F_Destination_Address
- P-0-3291, PROFIsafe: F_Source_Address
- P-0-3292, PROFIsafe: F_Parameters
10 Example for one Axis Equipped with Safety Technology

10.1 Example with One Drive

At a system with a safety-relevant axis, it should be possible to open the guard under observation of "safe motions". Thus, the machine operator (or setup specialist) will be able to enter the danger zone of the machine under observation of all applicable regulations.

1. For the operator
The axis may only move at a safe reduced velocity 1. When this velocity is exceeded, the axis will stop with an error message and the preselected error response.

The motion is limited by the incremental dimension. By a contact change of the confirmation switch, a path smaller than the incremental dimension can be overtraveled once more. The axis will stop the motion on excess of the incremental dimension with error message and breaking of the circuit.

2. For the setup specialist
The axis may only move at a safe reduced velocity 2. In this example, no restriction of the incremental dimension is requested.

3. Safe drive stop:
It must be possible to stop the drive safely. The power supply to the motor must be interrupted safely (2-channel). Power infeed to the drive controller remains intact. The motor is torque-free.

4. Safely limited maximum velocity.
In automatic mode, the max. velocity of the machine must be safely monitored.

10.2 Specification of Functions and Inputs of Channel 1 and Channel 2

<table>
<thead>
<tr>
<th>Function</th>
<th>Chann 1</th>
<th>Connector</th>
<th>Channe l 2</th>
<th>Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating mode switch</td>
<td>E1</td>
<td>X31/3 P3212 Bit 0</td>
<td>E1n</td>
<td>X41/4</td>
</tr>
<tr>
<td>Enabling control</td>
<td>E2</td>
<td>X31/4 P3212 Bit 2</td>
<td>E2n</td>
<td>X41/5</td>
</tr>
<tr>
<td>Safety switch 1</td>
<td>E3</td>
<td>X31/5 P3212 Bit 3</td>
<td>E3n</td>
<td>X41/6</td>
</tr>
<tr>
<td>Drive interlock</td>
<td>E4</td>
<td>X31/6 P3212 Bit 1</td>
<td>E4n</td>
<td>X41/7</td>
</tr>
<tr>
<td>Diagnostic input channel 1</td>
<td>E10</td>
<td>X31/7 P3212 Bit 9</td>
<td>----</td>
<td>----</td>
</tr>
</tbody>
</table>

Fig. 10-1: Specification of inputs of channel 1 and channel 2

The assignment of the inputs of channel 1 and channel 2 is specified by the user (compare to the wiring diagram in Chap. 10.14).

Channel 1 and channel 2 are parameterized in different windows in the DriveTop.
Channel 1: Hardware Inputs of E1 / E2 / E3 / E4 / E10 / A10

The safety assistant in DriveTop does not specify channel 1. Here, a standard menu is used.

**DriveTop=> Extras=> I/O=>X31/X32...**

Fig. 10-2: Hardware specification and function assignment of Channel 1

Select four inputs from the table below: The selection must coincide with the selection of Channel 2!

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Bit</th>
<th>Designation / Function</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-0-3212</td>
<td>0</td>
<td>Operating mode switch (&quot;BA&quot;) Standard or safe mode</td>
<td>Input: used in the example</td>
</tr>
<tr>
<td>P-0-3212</td>
<td>1</td>
<td>Drive interlock (&quot;ASP&quot;)</td>
<td>Input: used in the example</td>
</tr>
<tr>
<td>P-0-3212</td>
<td>2</td>
<td>Enabling control (&quot;ZT&quot;)</td>
<td>Input: used in the example</td>
</tr>
<tr>
<td>P-0-3212</td>
<td>3</td>
<td>Safety switch (S1)</td>
<td>Input: used in the example</td>
</tr>
<tr>
<td>P-0-3212</td>
<td>4</td>
<td>Safety switch (S2)</td>
<td></td>
</tr>
<tr>
<td>P-0-3212</td>
<td>9</td>
<td>Diagnostic input Channel 1 (E10) (feedback from the guard tumbler); also see the parameter description</td>
<td>Input: used in the example</td>
</tr>
<tr>
<td>P-0-3214</td>
<td>0</td>
<td>Status output controller; (activation of the door contact relay, +24V)</td>
<td>Output: used in the example</td>
</tr>
</tbody>
</table>

Fig. 10-3: Table of selection options Channel 1
Channel 2: Functions of the Hardware Inputs E1n / E2n / E3n / E4n

DriveTop => Setup => Initial setup => Safety systems..

Fig. 10-4: Specification of the functions of Channel 2

Of the following 6 available functions, a maximum of 4 inputs can be assigned with functions:

1. Reference cam Channel 2 (not used in the example)
2. Confirmation device (used in the example; E2n x41/5)
3. Safety switch 1 (used in the example; E3n X41/6)
4. Operating mode switch (used in the example; E1n X41/4)
5. Drive stop switch 1 (used in the example; E4n X41/7)
6. Safety switch 2 (not in Chap. 10-4)

10.3 Parameter Set - Example -

Please ask your field service contact for the parameter set belonging to this example which is provided under exclusion of any liability. In this example, the values for “safe limited max. velocity” are 0.0 rpm.

It is obligatory for the user to define their own Si parameters. BoschRexroth waives all liability.

In particular, observe steps 3, 6, 7, 11, and 12 of the setup information! (Chap. 11)

10.4 Exemplary Wiring Diagram for an Axis

Sequence of the circuit diagram from Chap. 10.4 (safe max. velocity)

1. Operating mode selection: Special mode Safety systems (E1)
2. Feedback ‘Safe mode’ is given   Diagnosis indication SSH
3. The guard can be opened.
4. Press confirmation button (E2); Diagnosis indication SBB
5. Activate safety switch 1.
6. Preselect velocity setpoint value => drive moves “safely”.

Attention:
The Hardware inputs E1... E4 are hard connected to the pins at connector X41.
The functions can be freely assigned to the pins.
10.4 Example: Schematic for one axis

**Operating mode selection**

- **24 V = Standard mode (closed)**
- **0 V = Safety mode (open)**

**Safety switch**

Safety switch 1

Select safety function

ASP safety related drive interlock

**Enabling control**

**External Safety Components**

No responsibility is taken for the correctness of this information

Date: 23.06.2006
11 Setup Information (DriveTop 16V13 is used)

The Setup Assistant for the Safety Systems

Caution: This information relates to the example from Chapter 10

Fig. 11-1: DriveTop initial setup safety system

Password for the parameter set: testsi
Note: only lower-case characters

This password is applicable only for the parameter set "060201 STA04 Si_Technik" - Beispiel ohne Gewähr - .par"

It is imperative that the user change the password - see Fig. 11-13 too.

Fig. 11-2: DriveTop setup assistant step 1
**11-2 Setup Information (DriveTop 16V13 is used)**

**StA04 Integrated Safety Technology**

**Fig. 11-3:** DriveTop setup assistant step 2

The inputs E1n, E2n, E3n and E4n are on the connector X41 pin 4, 5, 6 and 7.

**Fig. 11-4:** DriveTop setup assistant step 3

---

**Rexroth**

Bosch Group
StA04 Integrated Safety Technology

Setup Information (DriveTop 16V13 is used) 11-3

Fig. 11-5: DriveTop setup assistant step 4

Set values

Fig. 11-6: DriveTop setup assistant step 5
11-4 Setup Information (DriveTop 16V13 is used)

Fig. 11-7: DriveTop setup assistant step 6

Fig. 11-8: DriveTop setup assistant step 7
Setup Information (DriveTop 16V13 is used) 11-5

Fig. 11-9: DriveTop setup assistant step 8

Fig. 11-10: DriveTop setup assistant step 9
11-6 Setup Information  (DriveTop 16V13 is used)  

**Fig. 11-11:** DriveTop setup assistant step 10

**Fig. 11-12:** DriveTop setup assistant step 11

**click on**
Fig. 11-13: DriveTop setup assistant password administration step 12
The password used for the exemplary parameter set = testsi

Fig. 11-14: DriveTop status indication of the SI functions
**Useful functions**

In the DriveTop screen shown in Fig. 11-14, press the right mouse key to reach the following context menu:

**Caution:** The mouse pointer must be in the left section of the screen.

![Status Hilfreiche Funktionen.jpg](attachment:Status_Hilfreiche_Funktionen.jpg)

**Fig. 11-15: Useful functions state**

---

**Acceptance Test**

When the machine is commissioned and in the case of any software or hardware change relevant for functional safety (e.g. changes by remote data transmission), a complete acceptance test has be carried out by authorized staff.

For more information see Functional and Application Description: Rexroth IndraDrive Integrated Safety Technology
Path: DriveTop => Extras => Drive diagnosis => Safety systems

Fig. 11-16: Safety systems approval report
12 FAQs

12.1 What is the password for the safety systems in this documentation?

This password is only valid for the provided parameter set. It is imperative that the user changes it!

**testsi**  (Note: only lower-case characters!)

12.2 Can the safety guard be opened manually?

P-0-3218 allows for manual opening of the guard.
The command is triggered via C3700.
Alternatively, enter ....0000011 in parameter P-0-03218 to trigger the command.

12.3 How do I delete Safety Systems completely?

The steps described here are valid only for FW version 3.

**Step 1:** Set the drive to parameterizing mode
DriveTop => Extras => Parameterizing mode

**Step 2:** Into parameter P-0-4090, enter 165.
Right mouse key => single parameter => enter P4090

**Step 3:** Execute the C07 command 'Load defaults procedure' (S-0-262)
Select DriveTop => Extras => Drive command => S262 and click Execute.
Once these steps are completed, Safety systems is deleted, and the internal safety counter is incremented by 1.

12.4 Do I need to re-run the approval process after exchange of a drive controller?

**Exchange of power section:** You do not need to re-run the approval process.
**Exchange of control section:** Download (2 times) the stored parameter set into the new control section.
The modification counter is automatically counted up by 1. The approval log must be saved once more, printed out, and signed.

12.5 Diagnostic indications at the drive controller while Safety systems is activated

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH</td>
<td>Safe stop</td>
</tr>
<tr>
<td>SBH</td>
<td>Safe operating stop</td>
</tr>
<tr>
<td>SBB</td>
<td>Special mode safe motion</td>
</tr>
<tr>
<td>ASP</td>
<td>Safe drive interlock</td>
</tr>
<tr>
<td>AS</td>
<td>Drive interlock</td>
</tr>
</tbody>
</table>
13 SI Glossary

A

A Standards
Basic safety standards. A Standards comprise basic requirements applicable for all products from the respective range (e.g. product range machines). The A Standards include standards on basic principles, terminology, and design principles (e.g. ISO 12100 - basic concept, general design principles, general terminology, methodology).

ABC Standards
Harmonized Standards are classified in three levels to avoid unnecessary repetitions in the individual standards.
- A Standards are basic standards specifying terms and design principles of the CE regulations.
- B Standards are group standard commonly affecting certain product groups.
- C Standards are product standards which apply to individual products.

Accreditation
Accreditation is the formal recognition by an independent third party that a conformity evaluation authority meets the defined requirements and is competent to execute certain conformity evaluation tasks.

System
Comprises several machines and possibly other components, e.g. control, measuring instruments.

Start, unexpected
Any unplanned start resulting in a dangerous situation. May be due to various causes, e.g.: following re-establishment of power supply after interruption, control failure (EN ISO 12100-1)

Slings
Slings are used to establish the connection between load suspension means and load bearing means, or directly between between load and bearing means. Slings are for example chain slings, lifting ropes with hook, sling bands, ropes with eyelets, round loops, crane slings, plus all respective removable connecting parts.

Exhibition of products
'Exhibition' is the installation or presentation of products for advertising purposes (§ 2 para. 9 GPSG [German Devices and Product Safety Act])

B

B standards
Safety group standards
B standards concern safety requirements valid for several machine types. We differentiate type B1 and type B2 standards.
- B1 standards: special safety aspects (e.g. EN 349 - minimum distances to avoid crushing of body parts)
- B2 standards: Safety equipment (e.g. EN 574 - two-hand controls).

Prototype Test (EC)
The Prototype Test is completed by the named agency. The named agency checks whether the product confirms with the EC regulations; if so, it issues the prototype test certificate.

Qualified individual
Certain obligatory tests of systems subject to compulsory monitoring must only be done by qualified individuals. A qualified individual is a person who can submit evidence of
- vocational training
- job experience, and
- recent employment in the field
(§ 2 para. 7 Betr.Sich [German Safety of Operations Act])
Named Agency
The Named Agency must complete the relevant certification process before the CE label may be applied. Is appointed by the state authorities when the requirements according to DIN EN 45000 ff. have been met.

User Information
The User Information is intended for the operator or user of a device or product. The User Information comprises all documents required for safe operation of a device:
- Instructions on Safety
- Operating Instructions
- Maintenance Instructions
- Spare Parts Lists
- etc.

Intended Use
The Intended Use must be specified by the manufacturer and described in the Operating Instructions. The Intended Use includes information on permissible utilization of a product and the permissible application range of a product.

Operator
The operator exploits devices and machines for the Intended Use. The operator does not have to use the devices and machines for economic purposes.

Operating Instructions
In the Operating Instructions, the manufacturer or marketing agent instructs the user about the intended and safe use of the product. The Operating Instructions can be a part of Operator's operating directives.

Operating Directive
The Operator or employer issues internal directives to its employees concerning operational processes or actions. Issuing Operating Directives is obligatory according to the accident prevention regulations. Among other elements, they comprise
- safety regulations,
- descriptions of work processes,
- process instructions,
- etc.

Agent
A manufacturer having its place of business outside of the EU shall name an agent. The agent appoints a person or an institution. Frequently, this will be the importer that has its place of business within the EU. This importer performs the manufacturer's duties with

Assumption of Evidence
If the manufacturer developed and manufactured its product in accordance with the harmonized standards, Assumption of Evidence applies. In this case, the market supervisory authorities within the EU are obliged to assume that the product corresponds to the respective EU regulations, and to allow the product to be brought into circulation within the EU without interfering.

C
C Standards
Product safety standards
C Standards include safety requirements for special machines or a type of machine (e.g. EN 775 - industrial robot, safety). If there is a C Standard for a machine, it takes priority over the A and B standards.

CE Labeling
CE Labeling has become obligatory within the EU for certain products to assure that only safe products are brought into circulation within the EU. If a product is CE-consistent, the product conforms to the basic safety standards within the EU which are defined in the respective regulations. The CE sign is not a sign of above-average quality.

CE Regulations
CE Regulations are European regulations requiring CE labeling for certain products. They are drafted according to the New Conception. Currently (as of July 2004), there are 23 European regulations calling for CE Labelling.

CE Sign
With the CE Sign, the manufacturer confirms that its product confirms with the applicable EC Regulations on bringing products into circulation within the European Union. The authorities must not interfere with the sale of such goods within the European Union. The CE Sign is a legal label and serves as a "goods passport" for the market supervision authorities. It is not a seal of
approval and must not be used for advertising purposes!

**CEN**
Abbreviation for: Comité Européen de Normalisation - European Standardization Committee. By order of the European Commission, the CEN draws up the harmonized standards. It is seated in Brussels.

**CENELEC**
Abbreviation for: Comité Européen de Normalisation Electrotechnique - European Committee for Standardization in Electrical Engineering. By order of the European Commission, the CENELEC draws up the harmonized standards. It is seated in Brussels.

**D**

**DIN**
The “Deutsches Institut für Normung” (German Standardization Institute) is responsible for standardization in Germany, representing Germany’s interests in the global and European standardization organizations.

A DIN standard with exclusively or primarily national significance, or one which is published as a preliminary stage of an international document (drafts of DIN standards are additionally marked with an “E”, preliminary standards with a “V”). The number is insignificant in terms of classification.

European Standards are DIN standards. This is the German version of a European standard which has been taken over without any changes by all members of the common European standardization organization CEN/CENELEC. (Standards by the European Institute for Telecommunication Standards are marked DIN ETS.)

This code mirrors all three levels on which a standard can be effective: national, European, global. The process is as follows: based on a standard by the international standardization organization ISO, a European standard was drawn up which was taken over as DIN standard.

This is an ISO standard taken over without any changes as a national standard.

The Three-Steps-Method is a gradual process for removal of risks. Its application is obligatory. Potential risks for individuals and the environment must be removed in the following steps:

- **Step 1:** Removal of risks by constructive measures.
- **Step 2:** Removal of risks by technical protective measures (e.g. guard rails).
- **Step 3:** Cautioning of the user in respect of any potential risks remaining (e.g. by Instructions on Safety in the Operating Instructions)

**E**

**Importer**
According to § 2 para. 12, an importer is a natural person or legal body with a place of Business in the European Economic Area that imports a product from a third country into the European Economic Area or causes such product to be imported.

**EMC**
Electromagnetic Compatibility is the ability of a device to work satisfactorily in its electromagnetic environment without causing electromagnetic interferences which would be unacceptable for other devices present in this environment (EMC Act).

**EN**
Europäische Norm (European Standard)
EN standards must be harmonized to be valid in all EU member states - also refer to Harmonized Standards.
**EEA**

**European Economic Area**
Consists of the EU countries plus the EFTA countries Iceland, Norway, Liechtenstein and Switzerland as associated state. In the EEA, free traffic of goods is subject to the same regulations as within the EU.

**External Documentation**
Comprises all information a user must receive on a product. It includes the Operating Instructions and all information required for the safe application of a product. The External Documentation is part of the Technical Documentation - see Internal Documentation.

**F**

**Incorrect Application, reasonably predictable**
Application of a machine in a manner other than the intended use, such incorrect application being reasonably predictable from common human behavior (According to EN ISO 12100-1).

**Fault**
Depending on the context, the word "Fault" has different meanings:
- Lack of a guaranteed property (impairment of value or suitability) Faulty Operating Instructions are a product fault.
- A fault in respect of safety and risk-free state which could technically avoidable if economically reasonable measures were taken (Product Liability Act)
- State of an object which is characterized by its inability to perform a required function…" (EN 954-1).

**FMEA**
Failure Mode and Effects Analysis is a process for preventive avoidance of faults. Faults should be identified and avoided already in the planning phase, not only after the product has been built. The later a fault is identified, the more difficult and expensive it is to correct it.

**G**

**Used Machine**
A used machine is one which has already been in circulation. It is partly subject to other legal regulations than a new machine.

**Danger Zone**
The zone in or around a machine where an individual runs a risk of injury or impaired health.  
*Note*: The danger causing the risk may either exist permanently or occur unexpectedly 8EN 292-1, 3.10). (in new suggestions, this is also described as "Hazard zone".

**Risk Analysis**
Risk Analysis must be performed in the development phase. It describes all potential hazards emanating from a product, as well as the solutions for removing such potential hazards. Risk Analysis is an obligatory part of the Technical Documentation and must be retained. The periods of obligatory safekeeping are defined in the respective EC Regulations.

**Hazard**
The source of a potential injury or health impairment is described as Hazard.

**Hazard Evaluation**
Extensive identification and evaluation of all potential hazards posed by a tool or machine; used for risk evaluation of workspaces. An employer is obliged to draw up Hazard Evaluations in accordance with the Operational Safety Act.

**Hazardous Event**
Event which may cause a damage (= a physical injury and/or damage to health or objects) (EN 1050, 3.1) or:
- A hazardous situation which may cause an injury or damage to health (ISO/IEC Guide 51, rev. 97/01, 3.4).
| **Hazard Exposition** | Probability of occurrence of an injury or damage to health. It is related to the frequency or period of exposition to a hazard (EN 292-1, 6.2a). |
| **Hazard Situation** | Each situation where an individual is exposed to one or several hazards; (EN 292-1,3.6; similar to ISO/IEC-Guide 51, rev: 97/01.3.3). |
| **Hazard Minimization** | The order of measures for preventing or minimizing hazards is specified by EN ISO 12100. 1. Constrictive measures 2. Protective measures (e.g. safeguard devices) 3. Description and documentation of remaining hazards |
| **GPSG - German Devices and Product Safety Act** | In the German Devices and Product Safety Act GPSG, the regulations in accordance with the New Concept are implemented in German law. The GPSG has come into force on May 1, 2004. It replaces the GSG (German Devices Safety Act). The machine regulation has for example been implemented in German law in the 9th decree of the GPSG. |
| **GS Sign** | Abbreviation for: “Geprüfte Sicherheit” (Safety Tested). The GS sign is a voluntary quality label for industrial products and has no legal effect outside of Germany. It is impermissible to mark a product with the GS and the CE sign! |
| **H Liability** | If a faulty product causes injury or death of an individual or damage to another product than the faulty one, the faulty product’s manufacturer shall take liability. |
| **Dealer** | A Dealer brings a product into circulation in the frame of its business without being manufacturer, agent, or importer. |
| **Harmonized Standard** | A Harmonized Standard is a standard drawn up by order of the European Commission by the CEN or CENELEC which has been published in the Official EC Gazette. Not all standards marked with ”EN” are published in the Official EC Gazette. Accordingly, unpublished standards are no Harmonized Standards in the sense of the EC Regulations. The application of Harmonized Standards effects the so-called Assumption of Evidence. |
| **Harmonizing Concept, New** | The Harmonizing Concepts intends to create identical technical standards and requirements in all EU member states. It is based on the following 4 basic principles:  
- Harmonization of the basic requirements in product brought into circulation within the EU. In most cases, these are safety requirements.  
- From the basic requirements, the European standardization organizations CEN / CENELEC draw up concrete technical specifications (Harmonized Standards).  
- The application of Harmonized Standards by the manufacturer is not obligatory.  
- When Harmonized Standards are used, it is assumed that the product in question will conform with the main requirements of the regulation(s) (assumption of evidence). |
| **Manufacturer** | The Manufacturer is the natural person or legal body or partnership with legal capacity responsible for the design or manufacture of the device, or that describes himself, herself or itself as Manufacturer by applying a name, a brand or another sign on the product. A party that produces new device from existing finished products, or that modifies, converts or adapts a device is likewise a Manufacturer. |
| **Manufacturer's Declaration** | The Manufacturer's Declaration is valid only for partial machines not ready for use. With this Declaration, the Manufacturer bindingly states that its product meets all requirements of the respective EC regulation. For the partial machine, all steps must be followed that are required for the Declaration of Conformity. No CE sign is applied to the product. |
**I**

**Importer**  
A party that imports a product into the EU. It is considered the Manufacturer.

**Setup**  
The initial utilization of a product by the end user.

**Duty of Instruction**  
The Manufacturer of a product is obliged to provide the user with all information required for safe operation of the product.

**Internal Documentation**  
Comprises all documents from development up to production of a product. The internal documentation remains with the Manufacturer (e.g. Risk Analysis). It is part of the Technical Documentation. Also refer to "External Documentation".

**Bringing into Circulation**  
In the sense of the EC regulations, Bringing into Circulation is understood as the action of making a product available for the first time within the European Union. Here, it is insignificant if the product  
- is made available for remuneration or for free,  
- has been manufactured within the EU or imported from third countries,  
- is new or used,  
- is manufactured individually or mass-produced,  
- has been manufactured before or after the respective EC regulation came into force.  
A product is considered brought into circulation for the first time when  
- it has left the factory gates provided the manufacturer is not involved in the subsequent initial setup;  
- the final acceptance has been given by the operator or user if the manufacturer is involved in the initial setup.

**J**  
No entry

**K**

**Conformity**  
Conformity of a product exists when all requirements according to the applicable EC regulation(s) have been met.

**Evaluation of Conformity**  
The examination of a product in view of conformity with the EC regulations is described as Evaluation of Conformity. Conformity with the EC regulations exists when all requirements according to the applicable EC regulation(s) have been met. The manufacturer is obliged to perform an Evaluation of Conformity.  
The conformity of products is evaluated in accordance with Modules (A - H):
- **Module A**: The manufacturer certifies his own product.
- **Module B**: The product is submitted to a Prototype Test. This module is combined with one of the modules C, D, E or F.
- **Modules C, D, E, F**: The manufacturer must keep a quality management system.
- **Module G**: The product is subject to an individual test by a named authority.

**Evaluation of Conformity**  
With this Declaration of Conformity, the Manufacturer bindingly states that its product meets all requirements of the applicable EC regulation(s). Depending on the EC regulation, there are 3 types of Evaluation of Conformity:
- The Declaration of Conformity with CE Labeling (e.g. for machines that are ready for operation)  
- The Declaration of Conformity without CE Labeling (e.g. for safety component)  
- The Manufacturer's Declaration without CE Labeling (e.g. for partial machines not ready for operation)  
- After completion of the Evaluation of Conformity, the Declaration of Conformity must be signed by the management.
Assumption of Conformity

If a machine is built in accordance with the Harmonized Standards valid for the applicable Regulations, it is assumed that it conforms with the basic safety requirements. The machine is assumed to conform with the regulation and meet the minimum safety requirements.

Structure, inherently safe

Means of protection which removes risks without requiring that safeguard devices are used, or which reduces the risks from the hazards (according to EN ISO 12199-1).

L

Load Suspension Equipment

This is a component not connected with the hoisting gear which enables the load to be gripped and which is placed between the machine and the load or directly at the load. The term 'Load Suspension Equipment' comprises load suspension means, slings, and load bearing means.

Load Bearing Means

Load Bearing Means are devices not comprised in the hoisting gear which are used to pick up a load. This includes for example container hoists, load suspension magnets, and crossheads for connection with the load bearing means of the hoisting gear.

Life Phases of a Product

These are the Life Phases experienced by a product, e.g.:
- assembly
- transport
- setup
- operation
- maintenance
- disassembly

Supplier

If the manufacturer or importer of a product cannot be identified (within a certain period of time), this product's Supplier is considered its manufacturer.

M

Market Supervision

The EU member states are obliged to organize and execute market supervision. In Germany, market supervision is executed by the commercial regulatory authorities, the Accident Prevention & Insurance Association, and the regulatory authority for telecommunication, RegTP. Products are checked for conformity. If products are found to have faults, fines can be imposed, or the product may be withdrawn from circulation in all of the EU.

Machine

According to the Machine Regulation:
- "An entirety of interconnected parts or devices at least one of which is movable .... which are assembled for a specific application as e.g. the processing, treatment, transport, and conditioning of a material."
- "An entirety of machines which, to ensure their interacting, are arranged and operated in such a way that they function as an entirety."
- "An exchangeable equipment for modifying the function of a machine, which - once the machine has been brought into circulation - must be mounted to the machine or machine series or tractor by the operator, provided this equipment is not a spare part or a tool."

Machine Component

This is a machine provided for installation into another machine.

Trade Fair Clause

A product exhibited at a trade fair is not considered brought into circulation. The product does not have to bear a CE label. However, safety measures must be taken at the trade fair to prevent any risk to individuals.

Abuse

Abuse is any other than intended use of a product by a user. Here, two points are of significance for the manufacturer of a product:
The manufacturer must warn of the risks arising from predictable abuse and provide constructive remedies, if applicable. The possibility of predictable abuse generally exists when users can evade the restrictions of their freedom of action. The manufacturer does not have to warn of risks
arising from abuse completely contrary to the intended use.

**Module Resolution**

By way of the module resolution of the European Council, the Conformity Evaluation procedure has been classified in Modules A - H.

- **Module A** allows self-certification by the manufacturer.
- **Module B** provides for the prototype test. It is usually combined with the modules C, D, E, or F.
- **The modules D, E, and F** additionally require a quality management system.
- **Module G** provides for the individual test of products by a named authority.

**N**

**Non-separating safeguard device**

This is a safeguard device which guards a hazard zone in a non-mechanical manner, e.g.:

- confirmation device
- two-hands control
- light barrier
- light-grille barrier

**Standards**

There are different types of standards, e.g.:

- national (VDE, DIN, NF, BS)
- European (EN)
- international (ISO, IEC).

The application of the standards is voluntary. It is not forbidden to deviate from them. However, standards can be declared binding in regulations. Furthermore, standards are frequently referred to in the regulations.

Safety standards are classified in A, B, and C standards.

**Emergency**

Hazardous situation which must be terminated or remedied urgently. An emergency can arise during regular operation or as a consequence of a malfunction or failure.

**Notifying authority**

The notified authority must complete the relevant certification process before the CE label may be applied. Is appointed by the state authorities when the requirements according to DIN EN 45000 ff. have been met.

**O**

**No entry**

**P**

**Product observation**

In addition to CE labeling, the manufacturer has the statutory obligation to observe the subsequent utilization of its product and the accessories by the user. This intends to identify abuse and other hazards in good time and to provide a remedy if necessary. The obligation for product observation also includes competitors' products on the market and other manufacturers' accessories. This is of specific importance when other manufacturers have already taken measures for prevention of hazards. The results of the product observation result in continuous updating of the hazard analysis.

**Product liability**

This is the extra-contractual liability for faulty products. Is an integral part of the product liability act.

**Product safety**

In the EU, only safe products may be brought onto the market. A product is considered safe when its normal or reasonably predictable utilization involves no or only minor hazard. Since May 1, 2004, product safety is an integral part of the devices and product safety act.

**Test**

A test is a technical process comprising the identification of one or several characteristics of a product, a process or a service in accordance with a defined procedure (DIN EN 45020:1998, no. 13.1).
| **Test authority** | The named authority must complete the relevant certification process before the CE label may be applied. Is appointed by the state authorities when the requirements according to DIN EN 45000 ff. have been met. |
| **Quality assurance system** | According to DIN ISO 9000 ff. Certifies that the producer has an efficient organization structure where mistakes caused by faulty organization occur infrequently. Does not convey a statement on the quality of the producer's products. |
| **Quasi manufacturer** | Virtual manufacturer. It appears as manufacturer of a product, e.g. by its name or a brand. The quasi manufacturer holds the same liability as a manufacturer. |
| **Remaining hazards** | If, in spite of all precautions taken, there still remain hazards, or in case of potential and non-apparent hazards (e.g. control cabinet, ventilation of a hydraulic circuit, hazard in an invisible part, etc.), the manufacturer must point out these hazards. To this end, warnings in the form of pictograms can be applied at the product, and instructions on safety can be worded in the operating instructions. |
| **Remaining risk** | Any risk remaining after protective measures have been effected (EN 1050, 3.4); or: The (tolerable) risk remaining after protective measures have been effected (ISO/IEC Guide 51, rev.: 97/01, 3.6). |
| **European Regulation** | A European regulation is a European law which is legally binding for each EU member state. It takes priority over the laws of the individual member states. Regulations must be implemented in national laws. The Machine Regulation, for example, has been implemented in German law in the 9th Executive Order on the Safety of Devices Act (since May 1, 2004: Act on Safety of Devices and Products). |
| **Risk** | A combination of the probability and the severity of the potential injury or health damage in a hazardous situation (EN 292-1, 3.7; similar to ISO/IEC Guide 51, rev: 97/01, 3.5). The risk (in respect of the considered hazard) is also defined as a function of the extent (of the potential damage) and the probability of the occurrence of such damage (comp. EN 1050, 7.2.1). |
| **Risk analysis** | The risk analysis examines the degree of probability that one of the identified threats will materialize, and the degree of damage that will occur. The risk is calculated from the probability of materialization and the amount of damage to be expected. |
| **Risk assessment** | Risk analysis and risk evaluation method (ISO/IEC Guide 51, rev. 97/01, 3.14); also see EN 1050, in particular Fig. 1. EN 292-1 does not yet use these terms in the same sense. |
| **Risk evaluation** | Method to decide on the basis of the risk analysis and under consideration of several factors (social, economic, and environmental aspects) whether a risk is bearable or not (ISO/IEC Guide 51, rev.: 97/01); also see EN 1050, 8 and EN 292-1, 6. |
| **Risk estimate** | An extensive estimate of the probability and the severity of the potential injury or health damage in a hazardous situation to allow for selection of suitable safety measures (in 3.8, EN 292-1 still describes this with the term "Risk evaluation". Also refer to EN 292-1, 6 and ISO/IEC Guide 51, rev.: 97/01, 3.14). EN 1050, 7 already uses the term "Risk estimate" (still included in Risk analysis) to describe this concept. |
| **Minimization of risk, sufficient** | Minimization of risk which - considering state-of-the-art technology - at least comes up to the statutory requirements (according to EN ISO 12100-1). |
### Safeguard devices

According to EN 292-2/A1:
- must be of solid design
- must need cause any additional hazards
- must not allow for easy evasion or invalidation
- must be placed in sufficient distance from the hazardous zone
- must not unduly restrict the monitoring of the work cycle

### Protective measure

Measure for removal of a hazard or minimization of a risk

### Safety

Safety exists when the risk is reasonably low, or when there are no unjustifiable risks present (ISO/IEC Guide 2. 1996, 2.5).

### Safety of a machine

The ability of a machine to perform its function(s) and its suitability for transport, assembly, setup, maintenance, disassembly and disposal on the terms of its intended use, as defined by the manufacturer in the operating instructions, without causing injury or health damage.

### Safety component

According to the Machine Regulation: "... a component ... that is intended to guarantee a safety function ... the failure or malfunction of which endangers the safety or health of individuals in the effective range of the machine."

### Safety function

Function of a machine which, should it fail, may cause an immediate increase of the risks (according to EN ISO 12100-1).

### Interference

Electromagnetic radiation emitted by a device.

### Interference immunity

Electromagnetic radiation acting on a device while the device's operability is guaranteed.

### Technical tools and supplies

The term "Technical tools and supplies" originates from the GSG, the German Safety of Devices Act. It describes all technical devices which are ready for use. A ready-for-use technical device can be used as intended without requiring the installation of other parts.

### Technical documentation

The technical documentation comprises all documents drawn up over the course of a product's life. The EC Regulations define in detail which documents and information are comprised in the Technical documentation. Generally, two types of Technical documentation are differentiated:

- **Internal documentation** - Comprises all documents from development up to production of a product. The internal documentation remains with the manufacturer.
- **External documentation** - It comprises the operating instructions and all information required for the safe application of a product. The external documentation addresses the user and must be delivered together with the product.

The compulsory period of record-keeping is defined in the law. The details are specified in the EC regulations. On request, the technical documentation must be submitted to the authorities in charge.

### Load bearing means

These are devices permanently connected to the hoisting gear, used for picking up load suspension devices, slings, or loads. These can for example be permanently installed grippers or tongs.

### Separating safeguard device

A mechanical barrier can prevent a user from getting into the hazard zone of a machine. Separating safeguard devices are classified as:
- solid
- moving
- controlling
- locked
- adjustable safeguard devices.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsafe machine</td>
<td>A machine is unsafe when the risk analysis has shown that protective measures are required to reduce the risk to a minimum.</td>
</tr>
<tr>
<td>Usability Test</td>
<td>This is a usability test for instructions. The test is performed to check whether instructions are understandable and practicable. Several users test the instructions at the device. Then, it is evaluated where there were problems. Thus, the instructions can be optimized. This process involves much work and high costs and usually pays off only for mass products (e.g. by reason of low support costs).</td>
</tr>
<tr>
<td>Validation</td>
<td>Checking of a given value for correctness in a certain context.</td>
</tr>
<tr>
<td>Consumer product</td>
<td>All products intended for consumers, or which may be used by consumers under reasonably predictable conditions even if not originally intended for consumers, are described as &quot;Consumer products&quot; in the GPSG, the German Devices and Product Safety Act.</td>
</tr>
<tr>
<td>Interlinked plant</td>
<td>This is a plant consisting of several partial machines connected by a master control.</td>
</tr>
<tr>
<td>Lock(ing device)</td>
<td>Device which is to prevent the execution of hazardous machine functions under defined conditions (usually for the period of time when the separating safeguard device is open) (according to EN ISO 12100-1).</td>
</tr>
<tr>
<td>Ready-for-use machine</td>
<td>Machine which can be used as intended without requiring any additional assembly work.</td>
</tr>
<tr>
<td>Significant change</td>
<td>A change to a machine is significant if it causes an increase of the machine's hazard potential. The severity, duration, and frequency of the occurrence of the hazard must be identified.</td>
</tr>
<tr>
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<td>Analysis of the previous knowledge and abilities of the users of product. On the basis of this analysis, it is specified which information must be imparted to enable the user to use the product, how detailed such information must be, and how it should be presented.</td>
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<td>Approved institutions</td>
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<td>Reliability (techn.)</td>
<td>The ability to perform a required function without faults</td>
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