KUKA
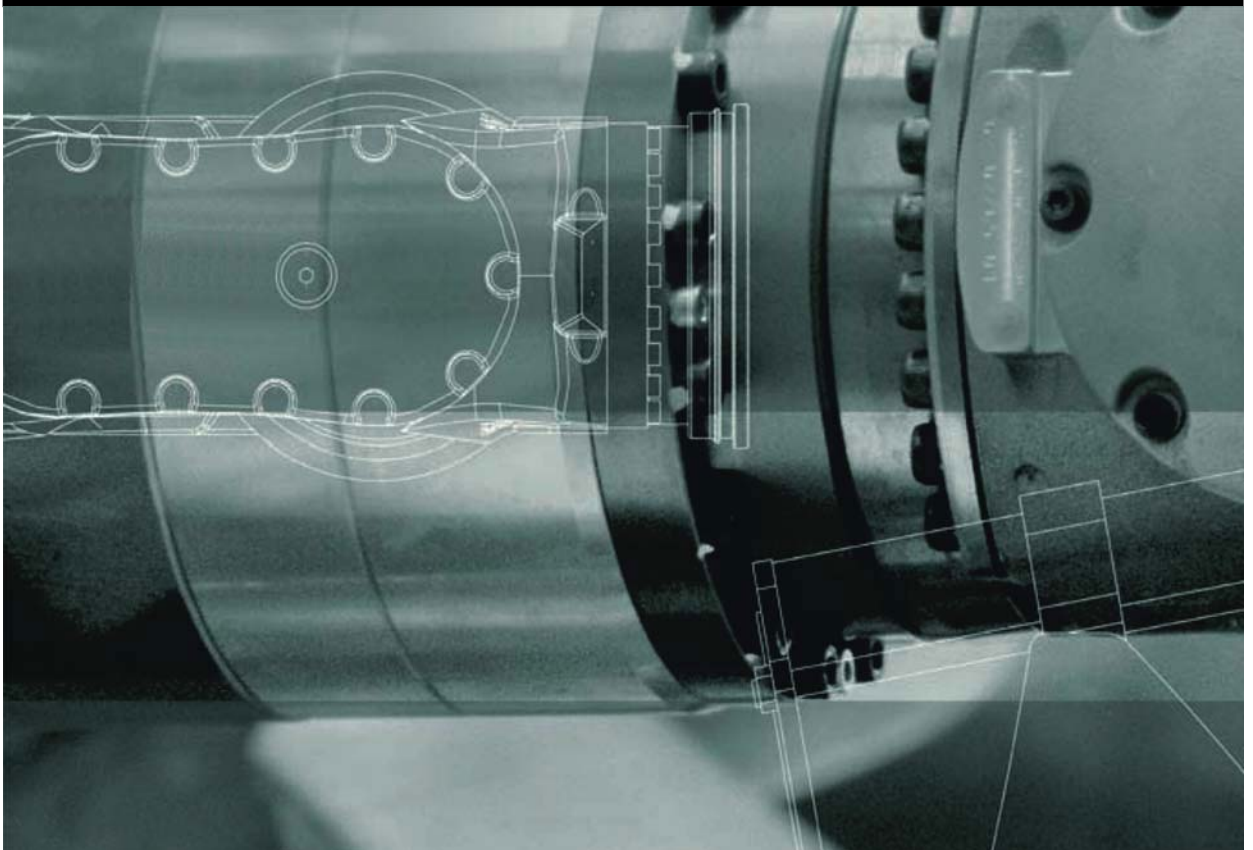
Controller Option

KUKA Roboter GmbH

Optional Interfaces

For KR C4 compact

Assembly and Operating Instructions

Contents

1 Introduction

1.1 Industrial robot documentation

The industrial robot documentation consists of the following parts:

- Documentation for the manipulator
- Documentation for the robot controller
- Operating and programming instructions for the System Software
- Instructions for options and accessories
- Parts catalog on storage medium

Each of these sets of instructions is a separate document.

1.2 Representation of warnings and notes

Safety   These warnings are relevant to safety and **must** be observed.

> ⚠ **DANGER**   These warnings mean that it is certain or highly probable that death or severe injuries **will** occur, if no precautions are taken.

> ⚠ **WARNING**   These warnings mean that death or severe injuries **may** occur, if no precautions are taken.

> ⚠ **CAUTION**   These warnings mean that minor injuries **may** occur, if no precautions are taken.

> **NOTICE**   These warnings mean that damage to property **may** occur, if no precautions are taken.

> ⚠ These warnings contain references to safety-relevant information or general safety measures.
> These warnings do not refer to individual hazards or individual precautionary measures.

This warning draws attention to procedures which serve to prevent or remedy emergencies or malfunctions:

> **SAFETY INSTRUCTIONS**   The following procedure must be followed exactly!

Procedures marked with this warning **must** be followed exactly.

Notices   These notices serve to make your work easier or contain references to further information.

> **i**   Tip to make your work easier or reference to further information.

1.3   Terms used

Term	Description
CIP Safety	**C**ommon **I**ndustrial **P**rotocol Safety CIP Safety is an Ethernet/IP-based safety interface for connecting a safety PLC to the robot controller. (PLC = master, robot controller = slave)
CCU_SR	**C**abinet **C**ontrol **U**nit **S**mall **R**obot
CIB_SR	**C**abinet **I**nterface **B**oard **S**mall **R**obot
Dual NIC card	Dual network card
EDS	**E**lectronic **D**ata **S**torage (memory card)
EMD	**E**lectronic **M**astering **D**evice
EMC	Electromagnetic compatibility
KCB	**K**UKA **C**ontroller **B**us
KEB	**K**UKA **E**xtension **B**us
KEI	**K**UKA **E**xtension **I**nterface
KLI	**K**UKA **L**ine **I**nterface. Connection to higher-level control infrastructure (PLC, archiving)
KOI	**K**UKA **O**ption **I**nterface
KONI	**K**UKA **O**ption **N**etwork **I**nterface
KPC	Control PC
KPP_SR	**K**UKA **P**ower **P**ack **S**mall **R**obot
KRL	KUKA robot programming language (**K**UKA **R**obot **L**anguage)
KSB	**K**UKA **S**ystem **B**us. Internal KUKA bus for internal networking of the controllers with each other
KSI	**K**UKA **S**ervice **I**nterface
KSP_SR	**K**UKA **S**ervo **P**ack Small Robot
KSS	**K**UKA **S**ystem **S**oftware
Manipulator	The robot arm and the associated electrical installations
PMB_SR	**P**ower **M**anagement **B**oard **S**mall **R**obot
RDC	**R**esolver **D**igital **C**onverter
SATA connections	Data bus for exchanging data between the processor and the hard drive
USB	**U**niversal **S**erial **B**us. Bus system for connecting additional devices to a computer
EA	External axis (linear unit, Posiflex)

2 Purpose

2.1 Target group

This documentation is aimed at users with the following knowledge and skills:

- Advanced knowledge of electrical and electronic systems
- Advanced knowledge of the robot controller
- Advanced knowledge of the Windows operating system

> **i** For optimal use of our products, we recommend that our customers take part in a course of training at KUKA College. Information about the training program can be found at www.kuka.com or can be obtained directly from our subsidiaries.

2.2 Intended use

Use The following interfaces are options for the KR C4 compact robot controller:

- X61 PROFIBUS master
    - Optionally expandable with X12 digital inputs and outputs 16/16
    - Optionally expandable with X60 PickControl
    - Optionally expandable with X42 mastering test
- X15A and X15B PROFIBUS slave IN and OUT
    - Optionally expandable with X12 digital inputs and outputs 16/16
    - Optionally expandable with X60 PickControl
- X14A DeviceNet master
    - Optionally expandable with X12 digital inputs and outputs 16/16
    - Optionally expandable with X60 PickControl
- X14C and X14D DeviceNet slave
    - Optionally expandable with X12 digital inputs and outputs 16/16
    - Optionally expandable with X60 PickControl
- X61 with X15A and X15B PROFIBUS master with PROFIBUS slave IN and OUT
- X14A with X14C and X14D DeviceNet master with DeviceNet slave
- X12 digital inputs and outputs 16/16
    - Optionally expandable with X60 PickControl
    - Optionally expandable with X42 mastering test
- X12 digital inputs and outputs 16/16/4
    - Optionally expandable with X42 mastering test
- X55 external power supply
- X33 Fast Measurement
- X42 reference switch
- X67.1 and X67.2 EtherCAT bridge master/master
- X67.1 and X67.2 VARAN slave EtherCAT IN/OUT
- X70 and X71 RoboTeam input and output
- X28 drive box interface for external axes
- X60 PickControl
    - Optionally expandable with X12 digital inputs and outputs 16/16
    - Optionally expandable with X42 mastering test

Misuse   Any use or application deviating from the intended use is deemed to be misuse
                          and is not allowed. This includes e.g.:

                          ■ Use as a climbing aid
                          ■ Operation outside the permissible operating parameters
                          ■ Use in potentially explosive environments
                          ■ Use in underground mining

3 Product description

3.1 Description of the industrial robot

The industrial robot consists of the following components:

- Manipulator
- Robot controller
- smartPAD teach pendant
- Connecting cables
- Software
- Options, accessories
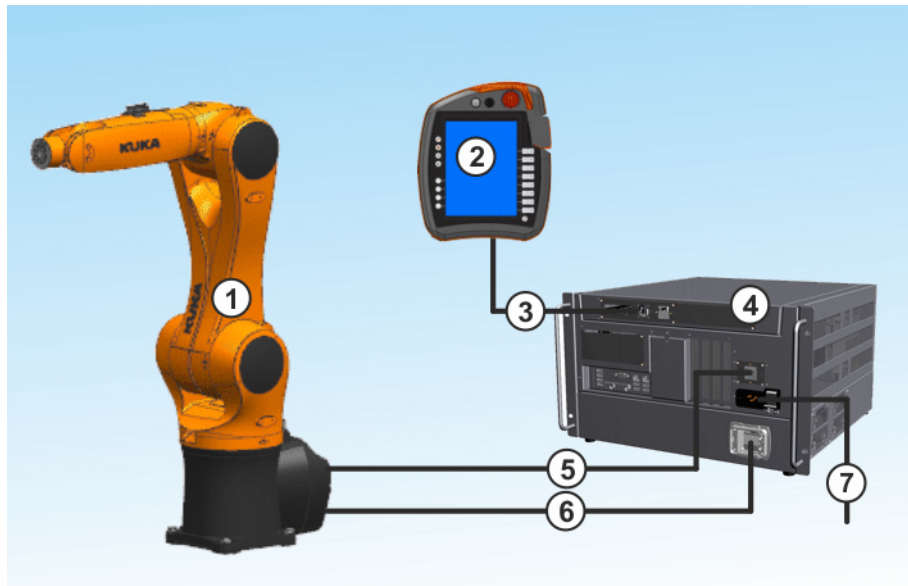
Fig. 3-1: Example of an industrial robot

1	Manipulator
2	Control panel
3	Connecting cable for smartPAD
4	Robot controller
5	Connecting cable, data cable
6	Connecting cable, motor cable
7	Device connection cable

3.2 Overview of the robot controller

The robot controller is used for controlling the following systems:

- KUKA small robots

The robot controller consists of the following components:

- Control PC
- Power unit
- Safety logic
- smartPAD teach pendant
- Connection panel

The robot controller can be installed in a 19" rack.
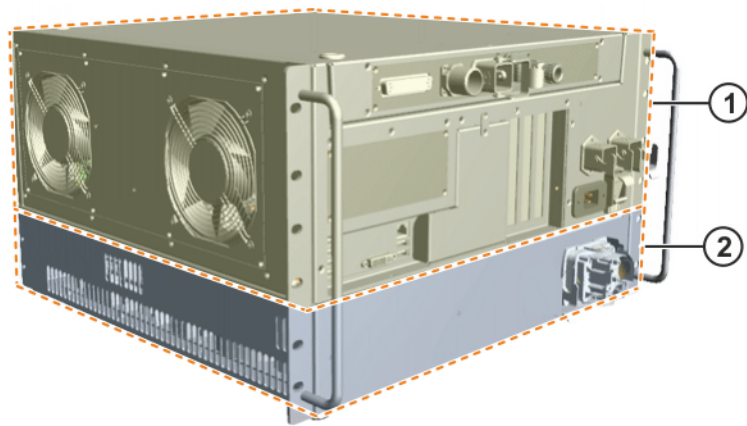
Fig. 3-2: Overview of KR C4 compact

1	Control unit (control box)
2	Power unit (drive box)

3.3   Optional KR C4 compact interfaces

Overview

The connection panel of the robot controller consists of connections for the following cables:

- Power cable / infeed
- Motor cables to the manipulator
- Data cables to the manipulator
- KUKA smartPAD cable
- PE cables
- Peripheral cables

The configuration of the connection panel varies according to the customer-specific version and the options required.

Connection panel
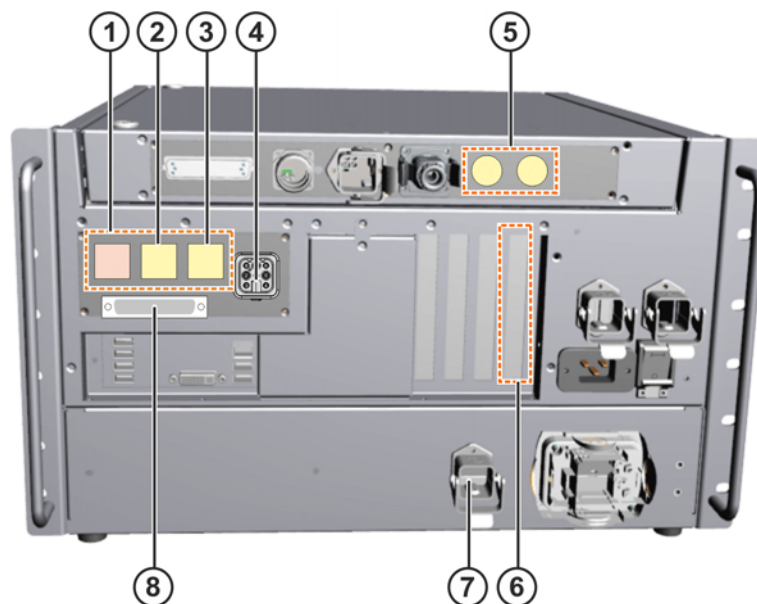
Fig. 3-3: Connection panel

1	Slot 1
2	Slot 2
3	X42 reference switch

4   X55 external power supply interface

5   Slot 4

6   X12 interface with IOB-16-16B

7   X28 drive box interface for external axes

8   X12 Beckhoff interface, digital I/O

> **i** All contactor, relay and valve coils that are connected to the robot controller by the user must be equipped with suitable suppressor diodes. RC elements and VCR resistors are not suitable.

Assignment of slot 1
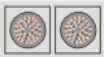
Slot 1 can be assigned the following interfaces:

Slot	Connector	Description	Comment
	X61	PROFIBUS master	X61 can be selected individually.
	X15A	PROFIBUS slave IN	-
	X15B	PROFIBUS slave OUT	-
	X61	PROFIBUS master	X61 can be selected individually
	X60	PickControl	-
	X61	PROFIBUS master	X61 can be selected individually
	X42	Mastering test	-
	X61	PROFIBUS master	X61 can be selected individually
	X60	PickControl	-
	X42	Mastering test	-
	X60	PickControl	X60 can be selected individually.
	X15A	PROFIBUS slave IN	-
	X15B	PROFIBUS slave OUT	-
	X14A	DeviceNet master	X14A can be selected individually.
	X14C	DeviceNet slave IN	-
	X14D	DeviceNet slave OUT	-
	X60	PickControl	X60 can be selected individually.
	X14A	DeviceNet master	-
	X60	PickControl	X60 can be selected individually.
	X14C	DeviceNet slave IN	-
	X14D	DeviceNet slave OUT	-

Slot	Connector	Description	Comment
	X60	PickControl	X60 can be selected individually.
	X42	Mastering test	-
	X67.1	■ VARAN slave EtherCAT ■ EtherCAT bridge (master/master)	Signal IN
	X67.2	■ VARAN slave EtherCAT ■ EtherCAT bridge (master/master)	Signal OUT

Assignment of slot 2

Slot 2 can be assigned the following interfaces:

Slot	Connector	Description	Comment
	X15A	PROFIBUS slave IN	-
	X15B	PROFIBUS slave OUT	-
	X60	PickControl	-
	X60	PickControl	X60 can be selected individually.
	X42	Mastering test	-
	X14C	DeviceNet slave IN	-
	X14D	DeviceNet slave OUT	-
	X14A	DeviceNet master	-

Combinations

The following combinations of interfaces are possible:

PROFIBUS:

■ X61 with X55
■ X61 with X55 and X12
■ X61 with X55 and X60
■ X61 with X55 and X42
■ X61 with X15A/X15B and X55
■ X15A/X15B with X55
■ X15A/X15B with X55 and X12
■ X15A/X15B with X55 and X60

DeviceNet:

■ X14A with X55
■ X14A with X55 and X12
■ X14A with X55 and X60
■ X14A with X14C/X14D and X55
■ X14C/X14D with X55

- X14C/X14D with X55 with X12
- X14C/X14D with X55 with X60

External power supplies:

- X55
- X55 with X12 with 16/16 I/Os
- X55 with X12 with 16/16 I/Os and X60
- X55 with X12 with 16/16/4 I/Os
- X55 with X67.1 and X67.2
- X55 with X60
- X55 with X60 and X12 with 16/16 I/Os

Assignment of slot 4

Slot 4 can be assigned the following interfaces:

Slot	Con-nec-tor	Description	Comments
	X33	Fast Measurement	-
	X70	RoboTeam input	-
	X71	RoboTeam output	-

3.4 Digital I/O modules and bus coupler

3.4.1 Digital I/O modules 16/16

Overview

The digital I/O interface 16/16 consists of the following components:

- EtherCAT bus coupler
- EtherCAT 16x input terminal
- EtherCAT 16x output terminal
- EtherCAT bus end cap
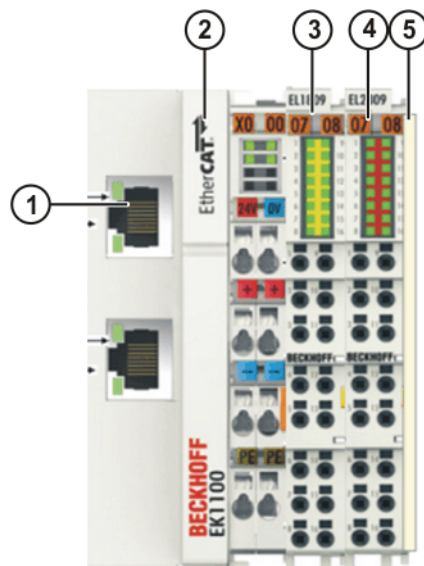
Fig. 3-4: Overview of digital modules 16/16

1   KEI connection X1
2   EK1100 EtherCAT bus coupler A20

3   EL1809/ EL1889 input terminal A21

4   EL2809/ EL2889 output terminal A22

5   EL9011 bus end cap

> ℹ️ Detailed information about the EtherCAT bus coupler and the I/O modules can be found in the manual from Beckhoff.

3.4.2   Digital I/O modules 16/16/4

Overview   The digital I/O interface 16/16/4 consists of the following components:

- EtherCAT bus coupler
- EtherCAT 16x input terminal
- EtherCAT 16x output terminal
- EtherCAT infeed terminal
- EtherCAT 4x output terminal
- EtherCAT bus end cap
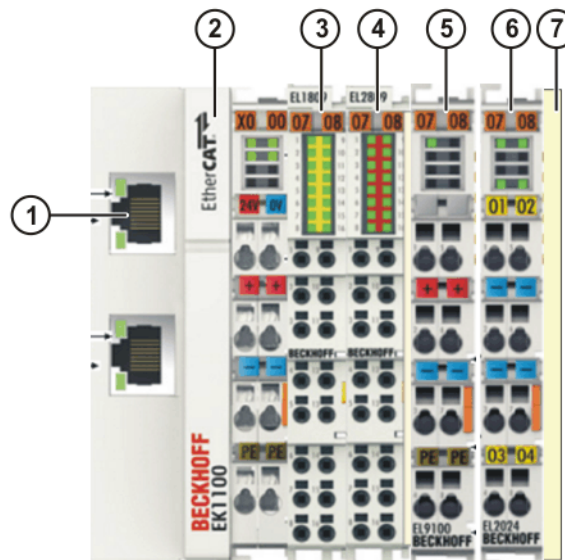
Fig. 3-5: Digital module 16/16/4

1   KEI connection X1

2   EK1100 bus coupler A20

3   EL1809/ EL1889 input terminal A21

4   EL2809/ EL2889 output terminal A22

5   EL9100 infeed terminal A23

6   EL2024 output terminal A27

7   EL9011 bus end cap

> ℹ️ Detailed information about the EtherCAT bus coupler and the I/O modules can be found in the manual from Beckhoff.

3.5   External 24 V power supply

External 24 V power supply is possible via interface X55 for the following components:

- Beckhoff digital I/O modules and bus coupler
- VARAN slave

4 Technical data

4.1 External 24 V power supply

PELV external power supply

External voltage	PELV power supply unit acc. to EN 60950 with rated voltage 27 V (18 V ... 30 V), safely isolated
Continuous current	> 8 A
Cable cross-section of power supply cable	≥ 1 mm^2
Cable length of power supply cable	< 50 m, or < 100 m wire length (outgoing and incoming lines)

⚠️ The cables of the power supply unit must not be routed together with power-carrying cables.

⚠️ The minus connection of the external voltage must be grounded by the customer.

⚠️ Parallel connection of a basic-insulated device is not permitted.

4.2 IOB board

Inputs

Signal voltage **0**	-3 … +5 V (EN 61131-2, type 1/3)
Signal voltage **1**	11 … 30 V (EN 61131-2, type 3)
Input current	3 mA typ. (EN 61131-2, type 3)
Maximum cable length	50 m wire length (outgoing and incoming lines)

Outputs

Output type	High-side and low-side (can be selected for each output)
Voltage	18 … 30 V
Maximum current	0.5 A for each output
Load type	Ohmic
	Inductive
	Lamp load
t_ON	≤ 100 µs
t_OFF	≤ 300 µs
Maximum cable length	50 m wire length (outgoing and incoming lines)

5 Safety

This documentation contains safety instructions which refer specifically to the product described here. The fundamental safety information for the industrial robot can be found in the "Safety" chapter of the operating or assembly instructions for the robot controller.

> ⚠ **WARNING** The "Safety" chapter in the operating instructions or assembly instructions of the robot controller must be observed. Death to persons, severe injuries or considerable damage to property may otherwise result.

6 Planning

Overview

Step	Description
1	X42 reference switch (>>> 6.1.1 "Reference switch X42" Page 21)
2	X55 external power supply (>>> 6.2.1 "X55 External power supply " Page 22)
3	X67.1 X67.2 EtherCAT bridge interfaces (>>> 6.3.1 "X67.1 and X67.2 EtherCAT bridge interfaces" Page 23) X14 DeviceNet interfaces (>>> 6.3.2.1 "X14A DeviceNet master" Page 24) (>>> 6.3.2.2 "X14C and X14D DeviceNet interface" Page 25)
4	X12 Digital I/O interfaces (>>> 6.4.1.1 "Digital I/O modules 16/16" Page 26) (>>> 6.4.1.2 "Digital I/O modules 16/16/4" Page 28)
5	X15A and X15B PROFIBUS interface (>>> 6.5.1 "X15A and X15B PROFIBUS interface" Page 37) X61 PROFIBUS master (>>> 6.5.2 "X61 PROFIBUS master" Page 39)
6	X67.1 X67.2 VARAN slave interfaces (>>> 6.6.1 "X67.1 and X67.2 VARAN slave interfaces" Page 39)
7	X33 Fast Measurement inputs (>>> 6.7.1 "X33 Fast Measurement inputs" Page 40) X60 PickControl interface (>>> 6.7.2 "X60 PickControl interface" Page 42)
8	X28 Drive box for external axes interface (>>> 6.8 "X28 Drive box interface for external axes interface" Page 44)
9	RoboTeam interface X70 and X71 (>>> 6.9 "X70 and X71 RoboTeam interface" Page 44)
10	Performance level (>>> 6.10 "Performance level" Page 45)

6.1 Discrete interfaces for safety options

6.1.1 Reference switch X42

Description The reference switch is connected to interface X42. The reference switch is needed to carry out the mastering test.

> Detailed information about the mastering test can be found in the **KUKA.SafeOperation** documentation.
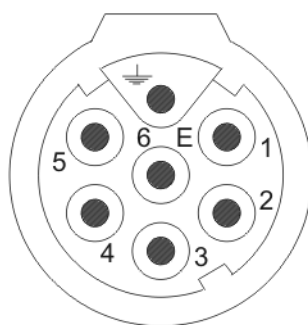
Fig. 6-1: Connector pin allocation for reference cable X42 - XS Ref

Connector pin allocation X42

Pin	Description
1	Test output A 24 V
2	Input A, reference switch 24 V
3	GND
4	Test output B 24 V
5	Input B, reference switch 24 V

6.2 External power supplies

6.2.1 X55 External power supply

Description

The power can be supplied either directly from an external source to contacts 3/4 and/or 5/6, or by jumpering the internal voltage (contacts 7/8) on X55.

> ⚠ The 4x2 A output module must only be supplied with power externally to contacts 1/2. The module must not be supplied with power internally.

The following couplers can be supplied with power via connector X55:

- Switch
- EtherCAT bridge
- VARAN slave

Necessary equipment

- Male insert, HAN 8D

Fig. 6-2: Contact diagram, view from contact side

- Cable clamping range: Ø9 ... Ø13 mm
- Recommended wire cross-section: 1 mm^2

Connector pin allocation X55 with bus coupler

Pin	Description
1	+24 V external
2	0 V external
3	+24 V external
4	0 V external
5	+24 V external
6	0 V external
7	24 V internal
8	0 V internal
-	PE

Connector pin allocation X55 with EtherCAT bridge

Pin	Description
1	+24 V external
2	0 V external
3	+24 V external
4	0 V external
5	+24 V external
6	0 V external
7	24 V internal
8	0 V internal
-	PE

Connector pin allocation X55 with VARAN slave

Pin	Description
5	+24 V external
6	0 V external
7	+24 V internal
8	0 V internal
-	PE

6.3 EtherCAT interfaces

6.3.1 X67.1 and X67.2 EtherCAT bridge interfaces

Description EtherCAT bridge interfaces X67.1 and X67.2 enable communication between an EtherCat master and the robot controller via the EtherCat bridge.

Necessary equipment
- Connector V14 RJ45
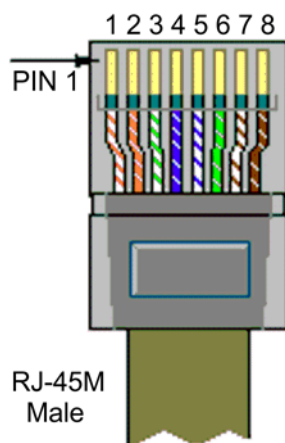
Fig. 6-3: RJ-45 pin assignment

■ Recommended connecting cable: Ethernet-compatible, min. category CAT 5e

■ Maximum cable cross-section: AWG22

Connector pin allocation X67.1

Pin	Description
1	TD+ Master IN
2	TD- Master IN
3	RD+ Master IN
6	RD- Master IN
-	PE

Connector pin allocation X67.2

Pin	Description
1	TD+ Master OUT
2	TD- Master OUT
3	RD+ Master OUT
6	RD- Master OUT
-	PE

6.3.2 X14 DeviceNet interfaces, overview

Description   DeviceNet enables the communication between the robot controller and the external periphery.

The following DeviceNet variants are available:

■ X14A DeviceNet master

■ X14C DeviceNet slave IN

X14D DeviceNet slave OUT

■ X14A DeviceNet master

X14C DeviceNet slave IN

X14D DeviceNet slave OUT

6.3.2.1 X14A DeviceNet master

Necessary equipment   ■ Male connector, 5-pole
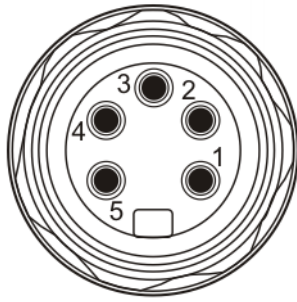
Fig. 6-4: Contact diagram, X14A, view from contact side

- Cable clamping range: Ø10 ... Ø12 mm
- Recommended connecting cable: DeviceNet cable 2xAWG17, 2xAWG20, drain AWG20

Connector pin allocation X14A

Pin	Description
1	DRAIN
2	+24 V
3	0 V
4	CAN_H
5	CAN_L

6.3.2.2 X14C and X14D DeviceNet interface

Necessary equipment

- Female connector, 5-pole
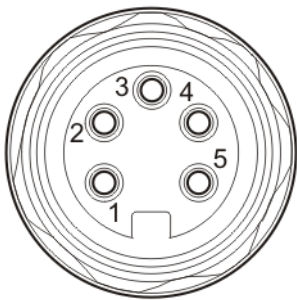
Fig. 6-5: Contact diagram, X14C, view from contact side

- Cable clamping range: Ø10 ... Ø12 mm
- Recommended connecting cable: DeviceNet cable 2xAWG17, 2xAWG20, drain AWG20
- Male connector, 5-pole
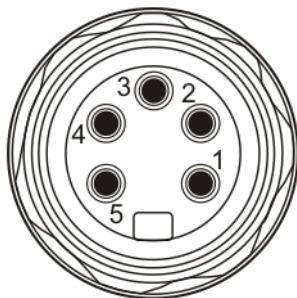
Fig. 6-6: Contact diagram, X14D, view from contact side

- Cable clamping range: Ø10 ... Ø12 mm

■ Recommended connecting cable: DeviceNet cable 2xAWG17, 2xAWG20, drain AWG20

Connector pin allocation X14C

Pin	Description
1	DRAIN
2	+24 V
3	0 V
4	CAN_H
5	CAN_L

Connector pin allocation X14D

Pin	Description
1	DRAIN
2	+24 V
3	0 V
4	CAN_H
5	CAN_L

6.4 EtherCAT input/output modules

> **i** The EtherCAT devices must be configured with WorkVisual.

6.4.1 Digital I/O interfaces

6.4.1.1 Digital I/O modules 16/16

Overview of 16-channel inputs

Fig. 6-7: Connections, 16-channel inputs

Connections, 16-channel inputs

Signal	Item	Description	
Input 1	1	Digital input 1	EL1809: Reference point 0 V external 1-16
Input 2	2	Digital input 2	
Input 3	3	Digital input 3	
Input 4	4	Digital input 4	EL1889: Reference point 24 V external 1-16
Input 5	5	Digital input 5	
Input 6	6	Digital input 6	
Input 7	7	Digital input 7	
Input 8	8	Digital input 8	
Input 9	9	Digital input 9	
Input 10	10	Digital input 10	
Input 11	11	Digital input 11	
Input 12	12	Digital input 12	
Input 13	13	Digital input 13	
Input 14	14	Digital input 14	
Input 15	15	Digital input 15	
Input 16	16	Digital input 16	

Overview of 16-channel 0.5 A outputs

Fig. 6-8: Connections, 16-channel 0.5 A outputs

Connections, 16-channel 0.5 A outputs

Signal	Item	Description	
Output 1	1	Digital output 1	EL2809: 0.5 A per output, 24 V external power supply 1-16 EL2889: 0.5 A per output, 0 V external power supply 1-16
Output 2	2	Digital output 2	
Output 3	3	Digital output 3	
Output 4	4	Digital output 4	
Output 5	5	Digital output 5	
Output 6	6	Digital output 6	
Output 7	7	Digital output 7	
Output 8	8	Digital output 8	
Output 9	9	Digital output 9	
Output 10	10	Digital output 10	
Output 11	11	Digital output 11	
Output 12	12	Digital output 12	
Output 13	13	Digital output 13	
Output 14	14	Digital output 14	
Output 15	15	Digital output 15	
Output 16	16	Digital output 16	

i	If the internal power supply is used, the reference potentials can be tapped at interface X55.

6.4.1.2 Digital I/O modules 16/16/4

Overview of 16-channel inputs
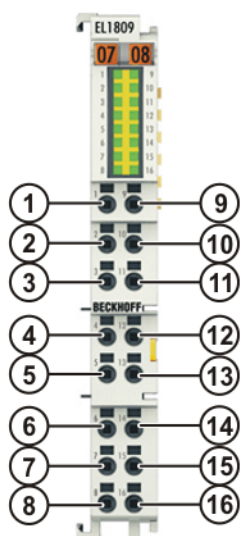
Fig. 6-9: Connections, 16-channel inputs

Connections, 16-channel inputs

Signal	Item	Description	
Input 1	1	Digital input 1	EL1809: Reference point 0 V external 1-16
Input 2	2	Digital input 2	
Input 3	3	Digital input 3	
Input 4	4	Digital input 4	
Input 5	5	Digital input 5	EL1889: Reference point 24 V external 1-16
Input 6	6	Digital input 6	
Input 7	7	Digital input 7	
Input 8	8	Digital input 8	
Input 9	9	Digital input 9	
Input 10	10	Digital input 10	
Input 11	11	Digital input 11	
Input 12	12	Digital input 12	
Input 13	13	Digital input 13	
Input 14	14	Digital input 14	
Input 15	15	Digital input 15	
Input 16	16	Digital input 16	

Overview of 16-channel 0.5 A outputs

Fig. 6-10: Connections, 16-channel 0.5 A outputs

Connections, 16-channel 0.5 A outputs

Signal	Item	Description	
Output 1	1	Digital output 1	EL2809: 0.5 A per output, 24 V external power supply 1-16
Output 2	2	Digital output 2	
Output 3	3	Digital output 3	
Output 4	4	Digital output 4	
Output 5	5	Digital output 5	EL2889: 0.5 A per output, 0 V external power supply 1-16
Output 6	6	Digital output 6	
Output 7	7	Digital output 7	
Output 8	8	Digital output 8	
Output 9	9	Digital output 9	
Output 10	10	Digital output 10	
Output 11	11	Digital output 11	
Output 12	12	Digital output 12	
Output 13	13	Digital output 13	
Output 14	14	Digital output 14	
Output 15	15	Digital output 15	
Output 16	16	Digital output 16	

Overview of 4-channel 2 A outputs
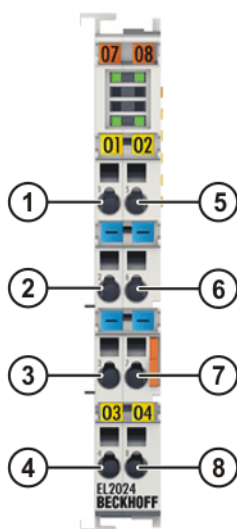
Fig. 6-11: Connections, 4-channel 2 A outputs

Connections, 4-channel 2 A outputs

Signal	Item	Description	
Output 17	1	Digital output 17	2 A per output, 24 V external power supply 17-20
0 V	2	0 V	
0 V	3	0 V	
Output 19	4	Digital output 19	
Output 18	5	Digital output 18	
0 V	6	0 V	
0 V	7	0 V	
Output 20	8	Digital output 20	

> **i** If the internal power supply is used, the reference potentials can be tapped at interface X55.

6.4.1.3   16-channel inputs EL1889, negative switching

Overview

Fig. 6-12: Connections, 16-channel inputs

Signal	Item	Description	
Input 1	1	Digital input 1	Reference point 24 V external 1-16
Input 2	2	Digital input 2	
Input 3	3	Digital input 3	
Input 4	4	Digital input 4	
Input 5	5	Digital input 5	
Input 6	6	Digital input 6	
Input 7	7	Digital input 7	
Input 8	8	Digital input 8	
Input 9	9	Digital input 9	
Input 10	10	Digital input 10	
Input 11	11	Digital input 11	
Input 12	12	Digital input 12	
Input 13	13	Digital input 13	
Input 14	14	Digital input 14	
Input 15	15	Digital input 15	
Input 16	16	Digital input 16	

6.4.1.4 16-channel outputs EL2889, negative switching

Overview

Fig. 6-13: Connections, 16-channel 0.5 A outputs

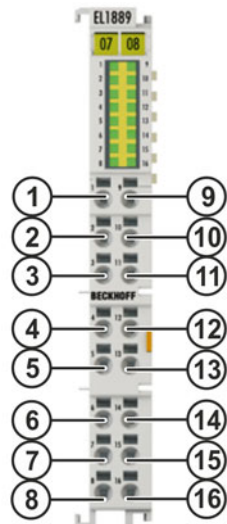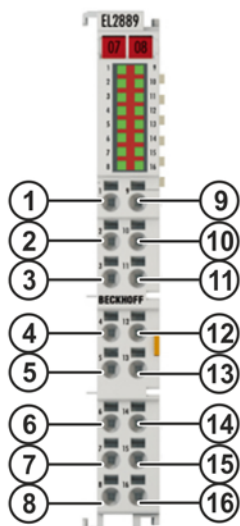| Signal	Item	Description	
Output 1	1	Digital output 1	0.5 A per output, 0 V external power supply 1-16
Output 2	2	Digital output 2	
Output 3	3	Digital output 3	
Output 4	4	Digital output 4	
Output 5	5	Digital output 5	
Output 6	6	Digital output 6	
Output 7	7	Digital output 7	
Output 8	8	Digital output 8	
Output 9	9	Digital output 9	
Output 10	10	Digital output 10	
Output 11	11	Digital output 11	
Output 12	12	Digital output 12	
Output 13	13	Digital output 13	
Output 14	14	Digital output 14	
Output 15	15	Digital output 15	
Output 16	16	Digital output 16	

6.4.1.5 X12 IO digital I/O interfaces 16/16 or 16/16/4

Description The I/O interface X12 has 16 non-safe inputs, 16 non-safe NPN outputs or 16 non-safe PNP outputs.

Necessary equipment
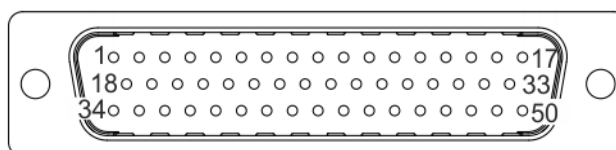- D-Sub connector IP67 50-pole

Fig. 6-14: Contact diagram, view from connection side

- Outer diameter of cable: max. 14 mm
- Recommended wire cross-section: AWG 20 (0.75 mm^2)
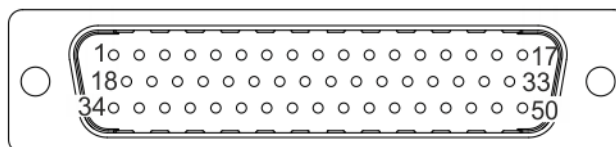
Connector pin allocation X12

Pin	Description	Function
1	Digital input 1	EL1809: Reference point 0 V external 1-16
2	Digital input 2	
3	Digital input 3	EL1889: Reference point 24 V external 1-16
4	Digital input 4	
5	Digital input 5	
6	Digital input 6	
7	Digital input 7	
8	Digital input 8	
9	Digital input 9	
10	Digital input 10	
11	Digital input 11	
12	Digital input 12	
13	Digital input 13	
14	Digital input 14	
15	Digital input 15	
16	Digital input 16	
17	Digital output 1	EL2809: 0.5 A per output, 24 V external power supply 1-16
18	Digital output 2	
19	Digital output 3	EL2889: 0.5 A per output, 0 V external power supply 1-16
20	Digital output 4	
21	Digital output 5	
22	Digital output 6	
23	Digital output 7	
24	Digital output 8	
25	Digital output 9	
26	Digital output 10	
27	Digital output 11	
28	Digital output 12	
29	Digital output 13	
30	Digital output 14	
31	Digital output 15	
32	Digital output 16	
33	Digital output 17	2 A per output, 24 V external power supply 17-20
34	0 V reference point	
35	0 V reference point	Option
36	Digital output 19	
37	Digital output 18	
38	0 V reference point	
39	0 V reference point	
40	Digital output 20	

6.4.2 X12 IOB digital I/O interfaces

Description The I/O interface X12 IOB has 16 non-safe inputs, 16 non-safe NPN outputs and 16 non-safe PNP outputs. The component is powered via a 27 V power supply or externally via an X55 jumper plug ().

Necessary equipment

■ D-Sub connector IP67 50-pole

Fig. 6-15: Contact diagram, view from connection side

■ Outer diameter of cable: max. 14 mm

■ Recommended wire cross-section: AWG 20 (0.75 mm^2)

Connector pin allocation X12 IOB

Pin	Description	Function
1	Digital input 1	Reference point 0 V
2	Digital input 2	
3	Digital input 3	
4	Digital input 4	
5	Digital input 5	
6	Digital input 6	
7	Digital input 7	
8	Digital input 8	
9	Digital input 9	
10	Digital input 10	
11	Digital input 11	
12	Digital input 12	
13	Digital input 13	
14	Digital input 14	
15	Digital input 15	
16	Digital input 16	
17	Digital output 17 high-side	24 V switching
18	Digital output 18 high-side	
19	Digital output 19 high-side	
20	Digital output 20 high-side	
21	Digital output 21 high-side	
22	Digital output 22 high-side	
23	Digital output 23 high-side	
24	Digital output 24 high-side	
25	Digital output 25 high-side	
26	Digital output 26 high-side	
27	Digital output 27 high-side	
28	Digital output 28 high-side	
29	Digital output 29 high-side	
30	Digital output 30 high-side	
31	Digital output 31 high-side	
32	Digital output 32 high-side	
33	GND	max. 4A fuse (FH12-N)

Pin	Description	Function
34	Digital output 1 low-side	0 V switching
35	Digital output 2 low-side	
36	Digital output 3 low-side	
37	Digital output 4 low-side	
38	Digital output 5 low-side	
39	Digital output 6 low-side	
40	Digital output 7 low-side	
41	Digital output 8 low-side	
42	Digital output 9 low-side	
43	Digital output 10 low-side	
44	Digital output 11 low-side	
45	Digital output 12 low-side	
46	Digital output 13 low-side	
47	Digital output 14 low-side	
48	Digital output 15 low-side	
49	Digital output 16 low-side	
50	External power supply	24 V, 4A fuse (FH12-P)

> **i** The external power supply (at pins 50 and 33) is protected with a 4 A fuse (FH-12-P, FH-12-N).

> **i** The maximum current for the customer outputs for internal or external power supply must not exceed a total of 10 A.
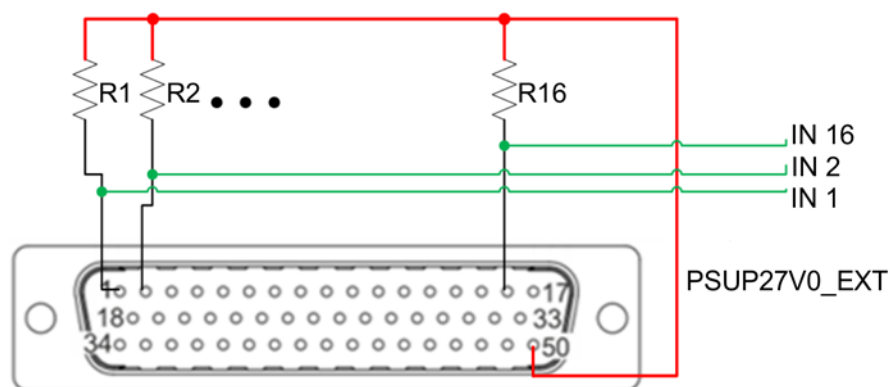
Conversion to NPN character

The following measures must be taken in order for the IOB to be able to process inputs (pins 1 - 16) with NPN character (reference point 24 V):

> **i** The inputs of the IOB are displayed inverted on the smartPAD.

Pin	connected via	to pin
1	R1	50 (PSUP27V0_EXT)
2	R2	
3	R3	
4	R4	
5	R5	
6	R6	
7	R7	
8	R8	
9	R9	
10	R10	
11	R11	
12	R12	
13	R13	
14	R14	
15	R15	
16	R16	

Fig. 6-16: X12 with NPN character

The resistance value per input channel must have the following characteristics:

Resistance value	2.0 kΩ
Tolerance	< 10%
Power	≥ 0.5 W

Connector pin allocation X12 IOB

Connector pin allocation X12 IOB with NPN character:

Pin	Description	Function
1	Digital input 1	Reference point 24 V
2	Digital input 2	
3	Digital input 3	
4	Digital input 4	
5	Digital input 5	
6	Digital input 6	
7	Digital input 7	
8	Digital input 8	
9	Digital input 9	
10	Digital input 10	
11	Digital input 11	
12	Digital input 12	
13	Digital input 13	
14	Digital input 14	
15	Digital input 15	
16	Digital input 16	

Pin	Description	Function
17	Digital output 17 high-side	24 V switching
18	Digital output 18 high-side	
19	Digital output 19 high-side	
20	Digital output 20 high-side	
21	Digital output 21 high-side	
22	Digital output 22 high-side	
23	Digital output 23 high-side	
24	Digital output 24 high-side	
25	Digital output 25 high-side	
26	Digital output 26 high-side	
27	Digital output 27 high-side	
28	Digital output 28 high-side	
29	Digital output 29 high-side	
30	Digital output 30 high-side	
31	Digital output 31 high-side	
32	Digital output 32 high-side	
33	GND	max. 4A fuse (FH12-N)
34	Digital output 1 low-side	0 V switching
35	Digital output 2 low-side	
36	Digital output 3 low-side	
37	Digital output 4 low-side	
38	Digital output 5 low-side	
39	Digital output 6 low-side	
40	Digital output 7 low-side	
41	Digital output 8 low-side	
42	Digital output 9 low-side	
43	Digital output 10 low-side	
44	Digital output 11 low-side	
45	Digital output 12 low-side	
46	Digital output 13 low-side	
47	Digital output 14 low-side	
48	Digital output 15 low-side	
49	Digital output 16 low-side	
50	External power supply	24 V, 4A fuse (FH12-P)

6.5 PROFIBUS interfaces

6.5.1 X15A and X15B PROFIBUS interface

Description   The interfaces PROFIBUS X15A and X15B are universal field buses which enable communication between devices from different manufacturers without special interface adaptations. Data exchange is carried out on a master-slave basis.

Power supply   The power can be supplied either directly from an external source, or by jumpering the internal voltage on X55.
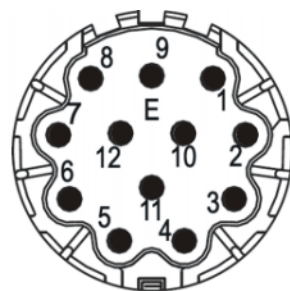
Necessary equipment   ■   Male insert, HAN 8D
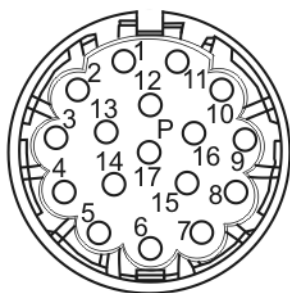
Fig. 6-17: Contact diagram, X15A, view from contact side

- Cable clamping range: Ø9 ... Ø14.7 mm
- Recommended connecting cable: Multibus cable
-

Fig. 6-18: Contact diagram, X15B, view from contact side

- Cable clamping range: Ø9 ... Ø14.7 mm
- Recommended connecting cable: Multibus cable

Connector pin allocation X15A

Pin	Description
1	0 V
2	Not assigned
3	Not assigned
4	+24 V DC
5	PE
6	Not assigned
7	PROFI A
8	PROFI B
9-17	Not assigned

Connector pin allocation X15B

Pin	Description
1	0 V
2	Not assigned
3	Not assigned
4	+24 V DC
5	PE
6	Not assigned
7	PROFI A
8	PROFI B
9-17	Not assigned

> The PROFIBUS interface must be configured with Work Visual.

6.5.2 X61 PROFIBUS master

Description   PROFIBUS is a universal field bus which enables communication between devices from different manufacturers without special interface adaptations. Data exchange is carried out on a master-slave basis.

Necessary equipment
- Male insert, HAN 8D
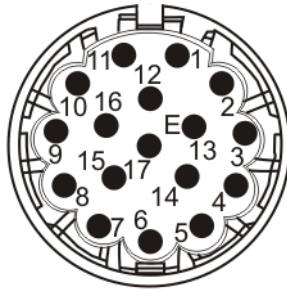
Fig. 6-19: Contact diagram, view from contact side

- Cable clamping range: Ø9 ... Ø14.7 mm
- Recommended connecting cable: Multibus cable

Connector pin allocation X61

Pin	Description
11	PROFI A
6	PROFI B
5	PE
4	+24 V
1	0 V
3	24 V
2	0 V
7	Not assigned
8	Not assigned
9	Not assigned
10	Not assigned
12	Not assigned
13	Not assigned
14	Not assigned
15	Not assigned
16	Not assigned
17	Not assigned

6.6 Euromap interfaces

6.6.1 X67.1 and X67.2 VARAN slave interfaces

Description   Interfaces X67.1 and X67.2 are used to connect the robot controller to a VARAN bus system.

Necessary equipment

- RJ45 connector
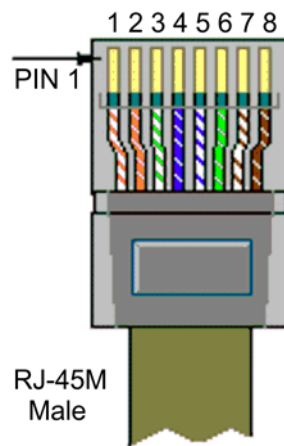
Fig. 6-20: RJ-45 pin assignment

- Recommended connecting cable: Ethernet-compatible, min. category CAT 5e
- Maximum cable cross-section: AWG22

Connector pin allocation X67.1

Pin	Description
1	TD+ VARAN IN
2	TD- VARAN IN
3	RD+ VARAN IN
6	RD- VARAN IN
-	PE

Connector pin allocation X67.2

Pin	Description
1	TD+ VARAN OUT
2	TD- VARAN OUT
3	RD+ VARAN OUT
6	RD- VARAN OUT
-	PE

6.7 Fast Measurement

6.7.1 X33 Fast Measurement inputs

Description

Fast measurement is activated with $MEAS_PULSE by means of an interrupt. When the interrupt is activated, $MEAS_PULSE must have the value "false", otherwise an acknowledgement message is generated and the program is stopped.

Necessary equipment

- Circular connector, M23, 9-pole, P-part
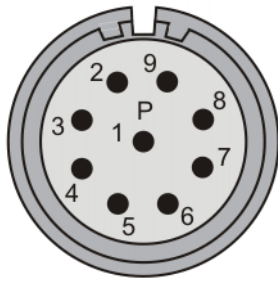
Fig. 6-21: Contact diagram, X33, view from contact side

■ Cable clamping range: Ø6 ... Ø10 mm

■ Recommended cable cross-section: 1 mm^2

Connector pin allocation X33

Pin	Description
1	Fast Measurement 1
2	Fast Measurement 2
3	Fast Measurement 3
4	Fast Measurement 4
5	Spare
6	+24 V-P
7	GND-Input
8	0 V-P

6.7.1.1 Power supply for Fast Measurement

Internal power supply

If the sensors for Fast Measurement are supplied with power by the robot controller (pin 6 +24V-P, pin 8 GND-P), pins 7 and 8 in the customer's mating piece for X33 must be connected. In this way, the reference ground for the Fast Measurement inputs (pin 7 GND input) is connected to the power supply ground of the sensors (pin 8 GND-P).

The diagram (>>> Fig. 6-22) illustrates the internal voltage supply.
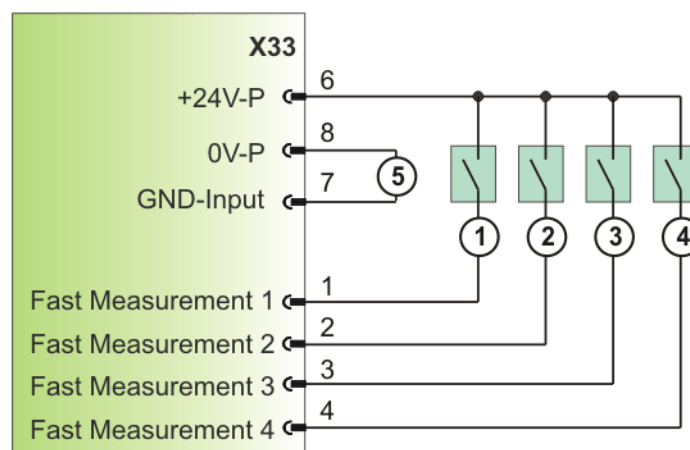
Fig. 6-22: Internal power supply for "Fast Measurement"

1	Sensor 1	4	Sensor 4
2	Sensor 2	5	Jumper between GND-INPUT and 0V-P in connector X33
3	Sensor 3		

External power supply   If the sensors for Fast Measurement are supplied externally with power (not via X33 of the robot controller), the reference ground of the sensors must be connected to pin 7 GND-Input.
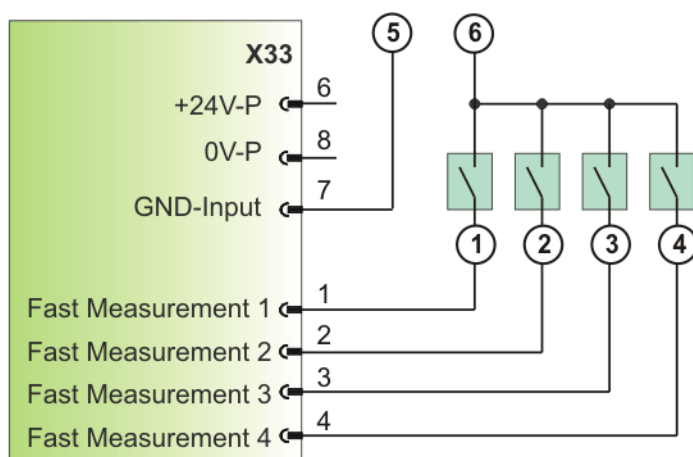
Fig. 6-23: External power supply for "Fast Measurement"

1	Sensor 1	4	Sensor 4
2	Sensor 2	5	0 V external to GND-INPUT
3	Sensor 3	6	24 V DC external

6.7.2   X60 PickControl interface

Description   Fast measurement is activated with $MEAS_PULSE by means of an interrupt. When the interrupt is activated, $MEAS_PULSE must have the value "false", otherwise an acknowledgement message is generated and the program is stopped.

Necessary equipment   ■ Circular connector, 19-pole
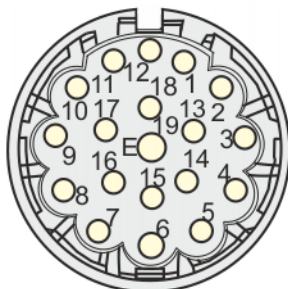
Fig. 6-24: Contact diagram, view from contact side

■ Cable clamping range: Ø9 ... Ø14.7 mm

■ Recommended cable cross-section: 0.5 mm^2

Connector pin allocation X60

Pin	Description
1	Fast Measurement 1
2	Fast Measurement 2
3	Fast Measurement 3
4	Fast Measurement 4
5	Spare
	Fast Measurement 5
8	GND-Input

Pin	Description
7	+24 V-P
9	0 V-P
10	Digital output 1
11	0 V
13	0 V
14	Digital output 3
15	Digital output 2
16	0 V
17	0 V
18	Digital output 4

Digital outputs 0.5 A per output, 24 V power supply

6.7.2.1 Power supply for Fast Measurement X60

Internal power supply

If the sensors for Fast Measurement are supplied with power by the robot controller (pin 7 +24V-P, pin 9 GND-P), pins 8 and 9 in the customer's mating piece for X60 must be connected. In this way, the reference ground for the Fast Measurement inputs (pin 8 GND input) is connected to the power supply ground of the sensors (pin 9 GND-P).
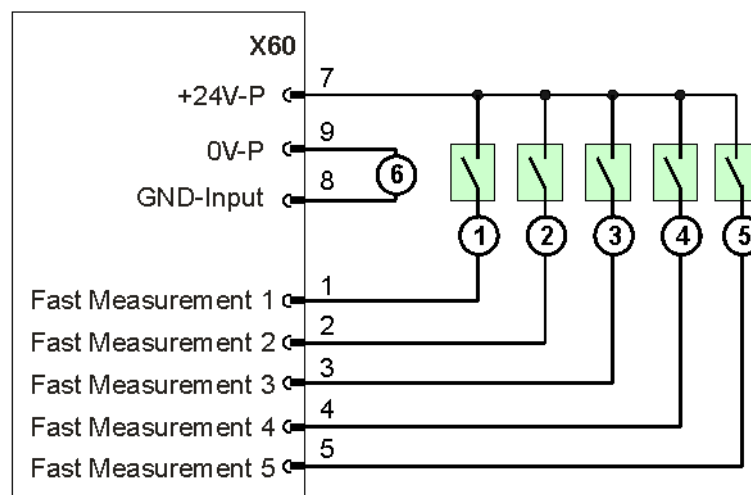
Fig. 6-25: Internal power supply for "Fast Measurement" X60

1	Sensor 1	4	Sensor 4
2	Sensor 2	5	Sensor 5
3	Sensor 3	6	Jumper between GND-INPUT and 0V-P in connector X60

External power supply

If the sensors for Fast Measurement are supplied externally with power (not via X60 of the robot controller), the reference ground of the sensors must be connected to pin 8 GND-Input.
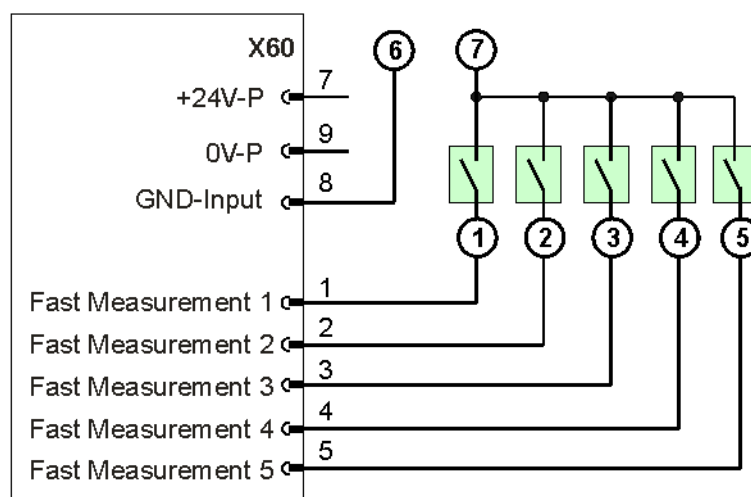
Fig. 6-26: External power supply for "Fast Measurement"

1	Sensor 1	5	Sensor 5
2	Sensor 2	6	0 V external to GND-INPUT
3	Sensor 3	7	24 V DC external
4	Sensor 4		

6.8 X28 Drive box interface for external axes interface

Description Interface X28 in the drive box is for the connection of an optional drive box for external axes.

Connector pin allocation X28

Pin	Description
1	+24 V PS1
2	GND
3	Not assigned
4	Not assigned
5	+24 V network
6	GND
7	Not assigned
8	Not assigned
9	TPF0_P
10	TPFI_P
11	TPF0_N
12	TPFI_N
-	PE

6.9 X70 and X71 RoboTeam interface

Connector pin allocation X70 RoboTeam IN

Pin	Description
1	TPFO_P
2	TPFO_N
3	TPFI_P
6	TPFI_N
4	C+
5	C-

Pin	Description
7	D+
8	D-

Connector pin allocation X71 RoboTeam OUT

Pin	Description
1	TPFO_P
2	TPFO_N
3	TPFI_P
6	TPFI_N
4	C+
5	C-
7	D+
8	D-

6.10 Performance level

The safety functions of the robot controller conform to Category 3 and Performance Level d according to EN ISO 13849-1.

6.10.1 PFH values of the safety functions

The safety values are based on a service life of 20 years.

The PFH value classification of the controller is only valid if the E-STOP device is tested at least once every 12 months.

When evaluating system safety functions, it must be remembered that the PFH values for a combination of multiple controllers may have to be taken into consideration more than once. This is the case for RoboTeam systems or higher-level hazard areas. The PFH value determined for the safety function at system level must not exceed the limit for PL d.

The PFH values relate to the specific safety functions of the different controller variants.

Safety function groups:

- Standard safety functions
    - Operating mode selection
    - Operator safety
    - EMERGENCY STOP device
    - Enabling device
    - External safe operational stop
    - External safety stop 1
    - External safety stop 2
    - Velocity monitoring in T1
- Safety functions of KUKA Safe Robot Technology (optional)
    - Monitoring of axis spaces
    - Monitoring of Cartesian spaces
    - Monitoring of axis velocity
    - Monitoring of Cartesian velocity
    - Monitoring of axis acceleration
    - Safe operational stop
    - Tool monitoring

Overview of controller variant PFH values:

Robot controller variant	PFH value
KR C4 compact	$< 6.37 \times 10^{-8}$

i	For controller variants that are not listed here, please contact KUKA Roboter GmbH.

7 Troubleshooting

7.1 IOB board LED display

Overview
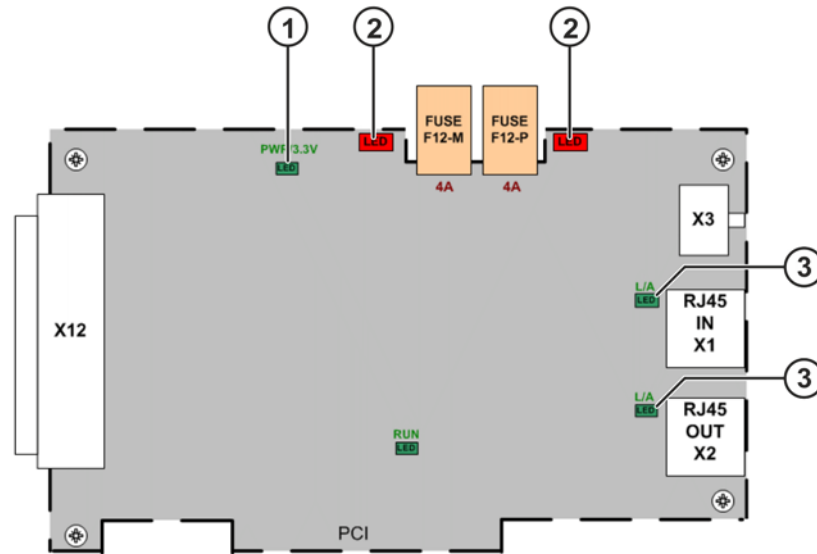
Fig. 7-1: IOB board LED display

Item	Designation	Color	Description	Remedy
1	PWRS/3.3V	Green	On = power supply present	-
			Off = no supply voltage present	Check fuse: ■ For internal power supply, check fuse F301 on CCU ■ For external power supply, check fuse via X55 customer power supply
2	Fuse LEDs The LEDs indicate the status of the fuses.	Red	On = fuse defective	Exchange defective fuse
			Off = fuse OK	-
3	L/A	Green	On = physical connection, network cable is plugged in	-
			Off = no physical connection. Network cable is not plugged in	
			Flashing = data traffic on the line	

8 KUKA Service

8.1 Requesting support

Introduction   This documentation provides information on operation and operator control, and provides assistance with troubleshooting. For further assistance, please contact your local KUKA subsidiary.

Information   **The following information is required for processing a support request:**

- Description of the problem, including information about the duration and frequency of the fault
- As comprehensive information as possible about the hardware and software components of the overall system

  The following list gives an indication of the information which is relevant in many cases:

  - Model and serial number of the kinematic system, e.g. the manipulator
  - Model and serial number of the controller
  - Model and serial number of the energy supply system
  - Designation and version of the system software
  - Designations and versions of other software components or modifications
  - Diagnostic package KRCDiag

    Additionally for KUKA Sunrise: Existing projects including applications

    For versions of KUKA System Software older than V8: Archive of the software (KRCDiag is not yet available here.)
  - Application used
  - External axes used

8.2 KUKA Customer Support

Availability   KUKA Customer Support is available in many countries. Please do not hesitate to contact us if you have any questions.

Argentina   Ruben Costantini S.A. (Agency)
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2400 San Francisco (CBA)
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Tel. +54 3564 421033
Fax +54 3564 428877
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	Fax +32 11 526794
	info@kuka.be
	www.kuka.be
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	Travessa Claudio Armando, nº 171
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	robotec@robotec.cl
	www.robotec.cl
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	www.kuka.fr
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