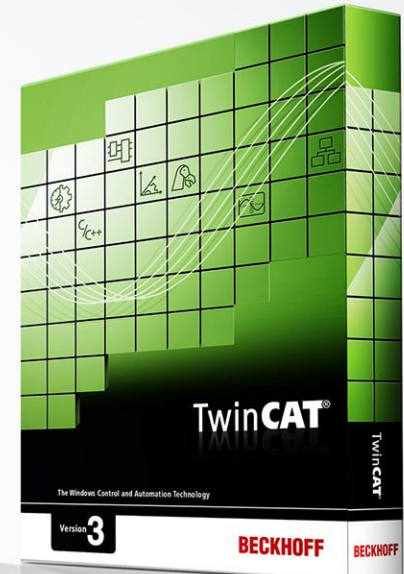
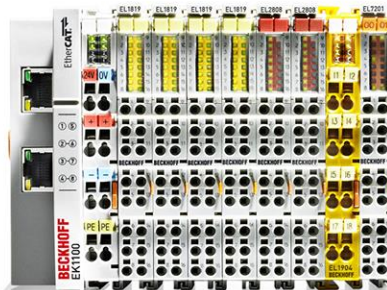
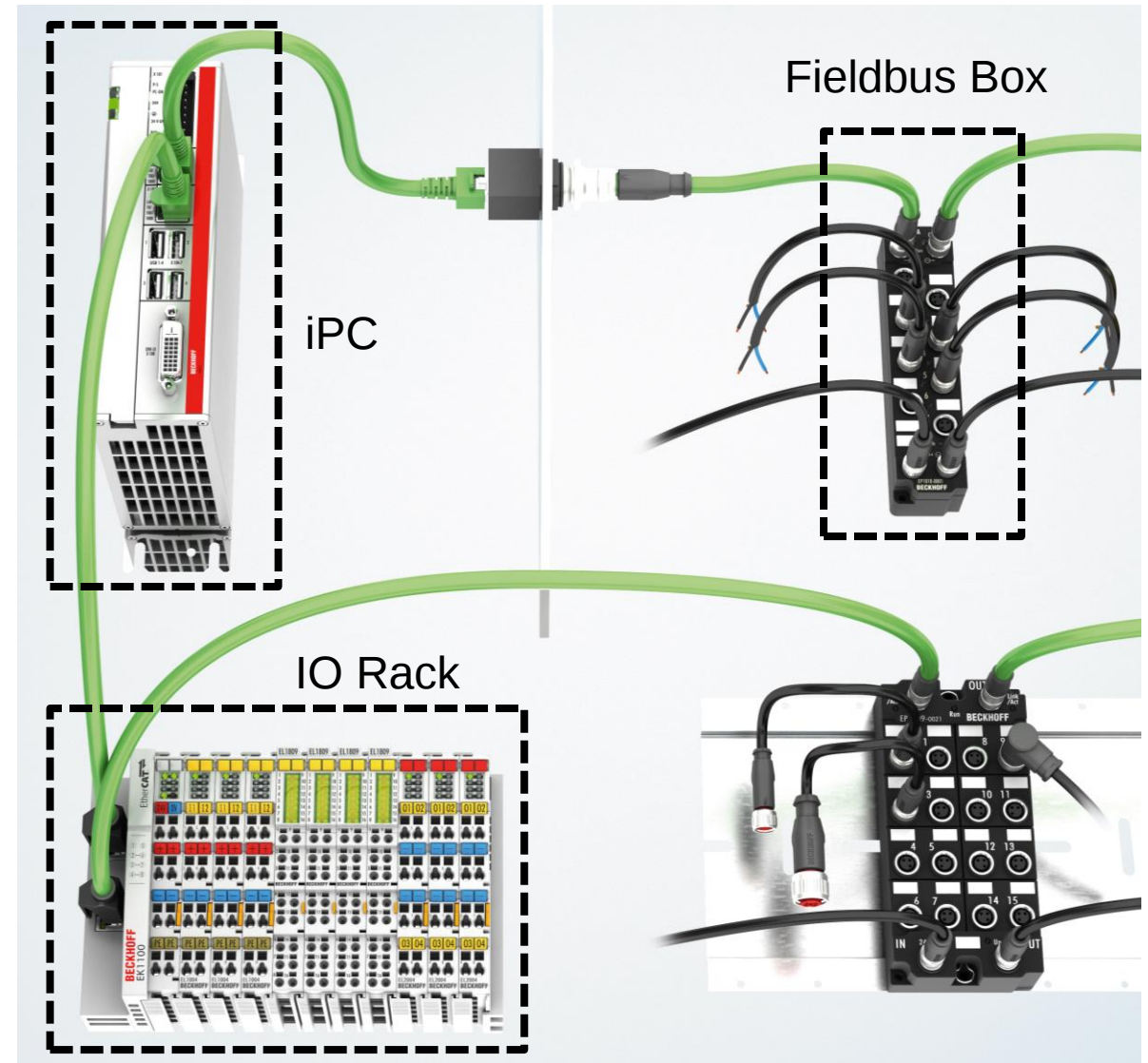




- **IO Introduction**
- Application Examples
- Hardware Replacement
- Wiring
- Powering Hardware
- Shielding, Grounding
- Additional Considerations

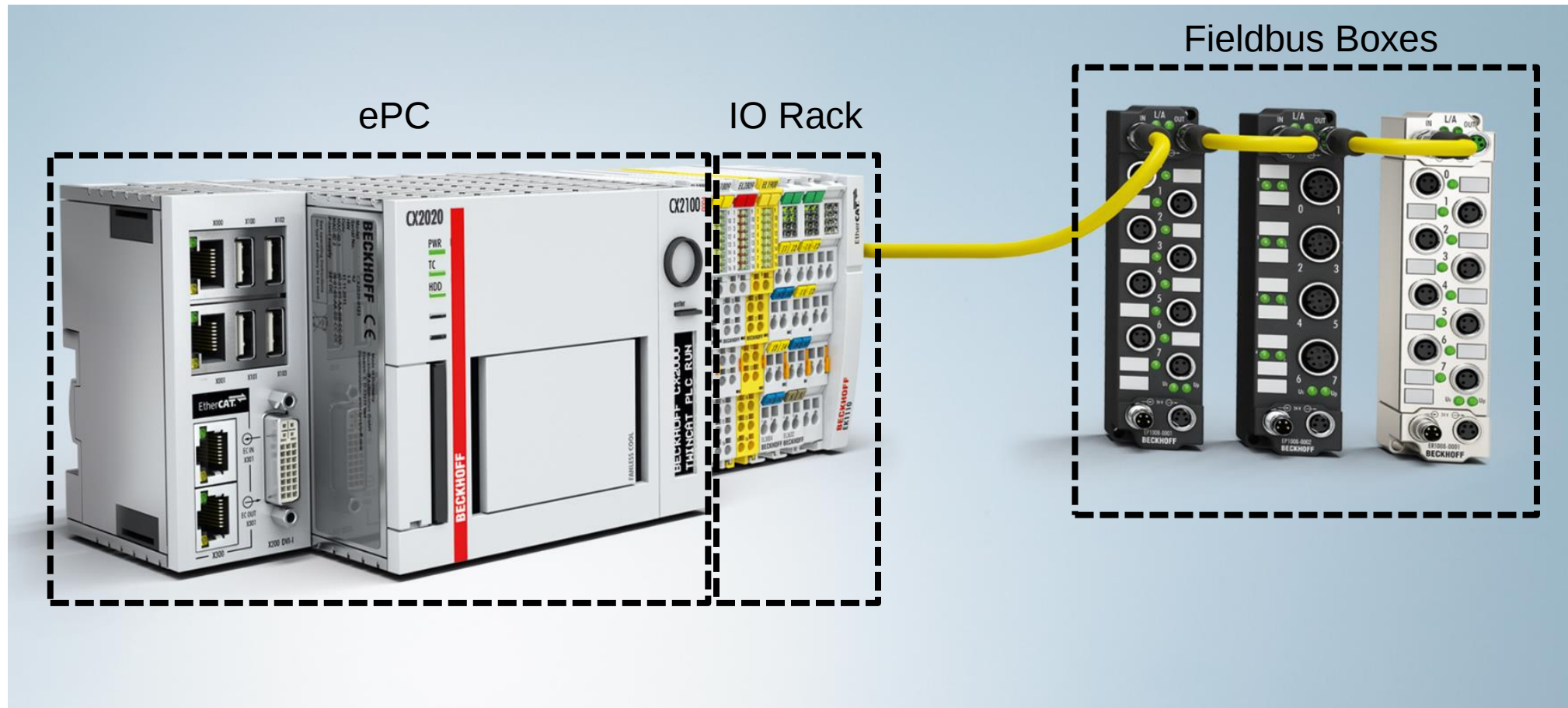
- Beckhoff Machine Components are:
 - ***iPCs***
 - IO Racks (IP20)
 - Fieldbus Boxes (IP67+)
- ***IO Racks*** live within cabinet
- ***Fieldbus Boxes*** live outside cabinet



ePCs offer iPC Alternative

BECKHOFF

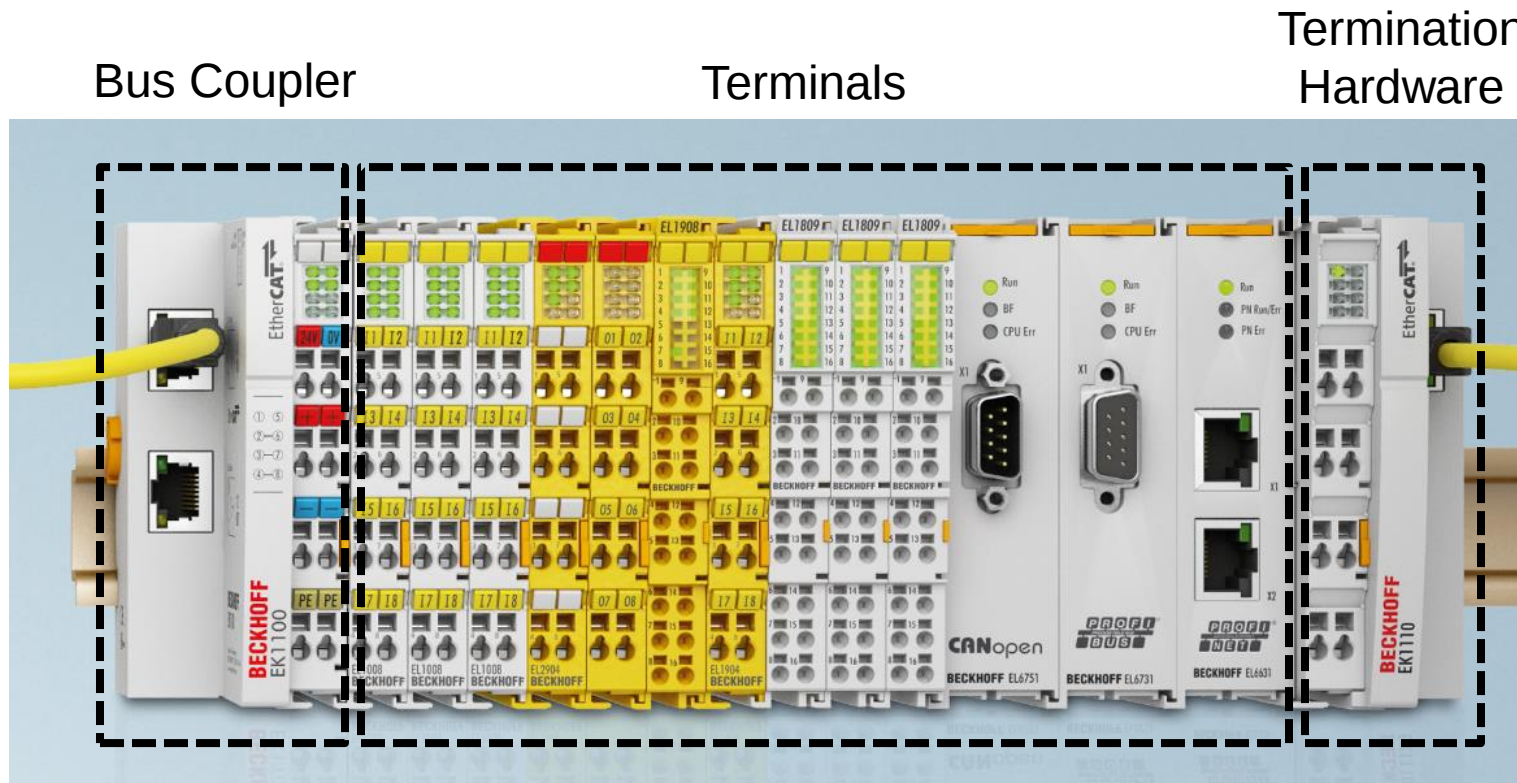
- ePCs begin IO racks for direct IO connection



IO Racks Contain Set of Components

BECKHOFF

- IO Racks within cabinet consist of:
 - Bus Coupler** or **ePC** begins rack, provides fieldbus interface
 - Terminals** wire to machine peripherals, reading or generating signals
 - Termination hardware** ends rack



Two Main Types of IO Racks Exist

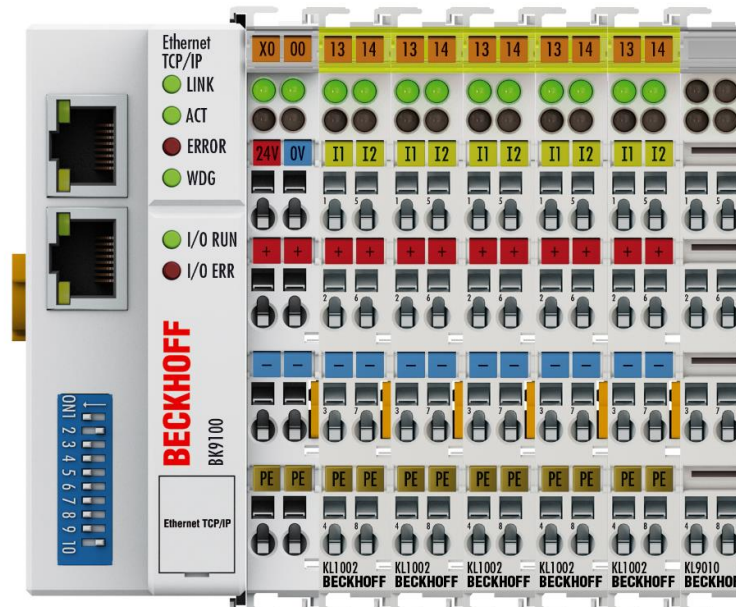
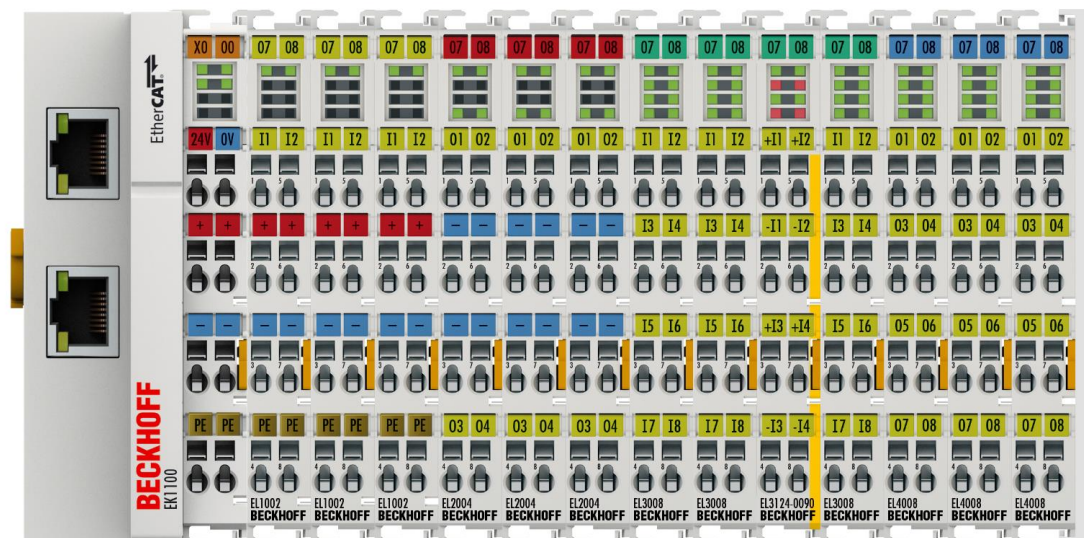
BECKHOFF

■ E-Bus Racks:

- Begin with EK Coupler*
- Contain EL terminals (no KL allowed)
- End with either:
 - EL9011 to terminate** OR
 - EK1110 to extend

■ K-Bus Racks:

- Begin with BK Coupler*
- Contain KL terminals (no EL allowed)
- End with either:
 - KL9010 to terminate OR
 - KL9020 to extend

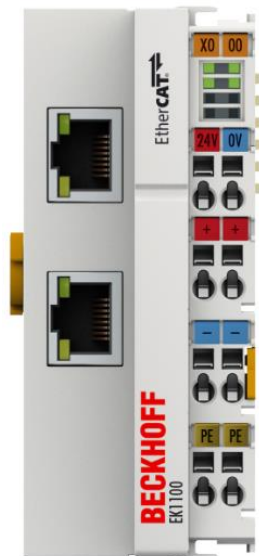


*ePC can also begin E-bus OR K-bus rack

**No termination required as EtherCAT is self terminating

Bus Coupler Identification

BECKHOFF



BK	52	10
XX	XX	XX
EK	11	00

Coupler Type:

- Denotes functionality, capability
- BK types shown here

Fieldbus Interface:

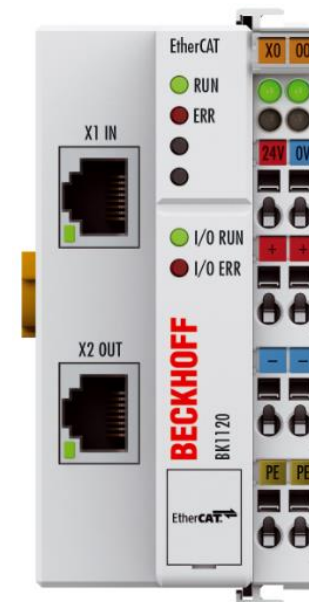
- Number Changes when the following change:
 - Communication Protocol
 - Number of Ports
 - Cable Medium

BK: K-Bus Coupler to KL Terminal Rack

EK: E-Bus Coupler to EL Terminal Rack

LC: Low Cost K-Bus Coupler to KL Terminal Rack

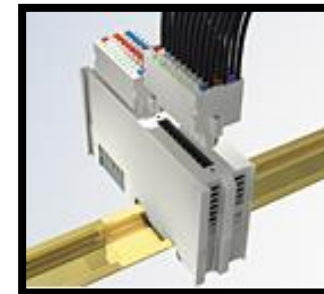
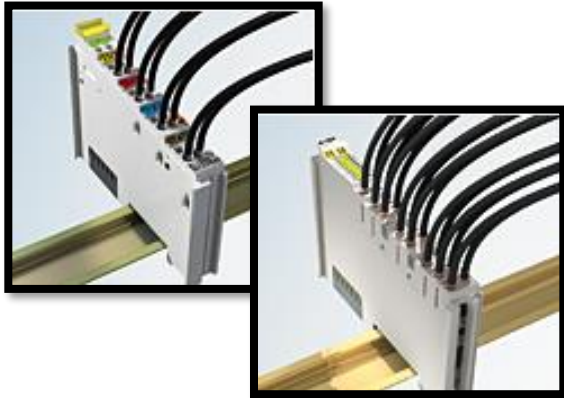
Features	Standard BKxx00	Economy BKxx10	Economy plus BKxx20	Compact BKxx50	Low Cost LCxx00
Function	fieldbus slave	fieldbus slave	fieldbus slave	fieldbus slave	fieldbus slave
Power supply	1750 mA	500 mA	1750 mA	1750 mA	500 mA



- **E**xxxxx – E-Bus Terminals
 - **K**xxxxx – K-Bus Terminals
-
- x**L**xxxx – Cage Clamp
 - x**S**xxxx – Cage Clamp, Detachable Face
 - x**M**xxxx – Pluggable Wiring Module

**First Letter
Signifies Bus**

**Second Letter
Signifies Wire
Attachment**



-
- xxxxxx-**0010**

**Suffix Number Designates
Alternate Terminal Purpose**

- xx**1**xxx – Digital Input terminal 
- xx**2**xxx – Digital Output terminal 
- xx**3**xxx – Analog Input 
- xx**4**xxx – Analog Output 
- xx**5**xxx – Measurement Terminals 
- xx**6**xxx – Communication Terminals 
- xx**7**xxx – Motion Terminals 
- xx**9**xxx – System Terminals 

**First Number
Signifies
Terminal Type**

-
- xxxxx**1** - One Channel Card
 - xxxxx**2** – Two Channel Card
 - xxxxx**N** – N Channel Card
 - xxxxx**9** - Sixteen Channel Card

**Last Number
Signifies Number
of Channels**

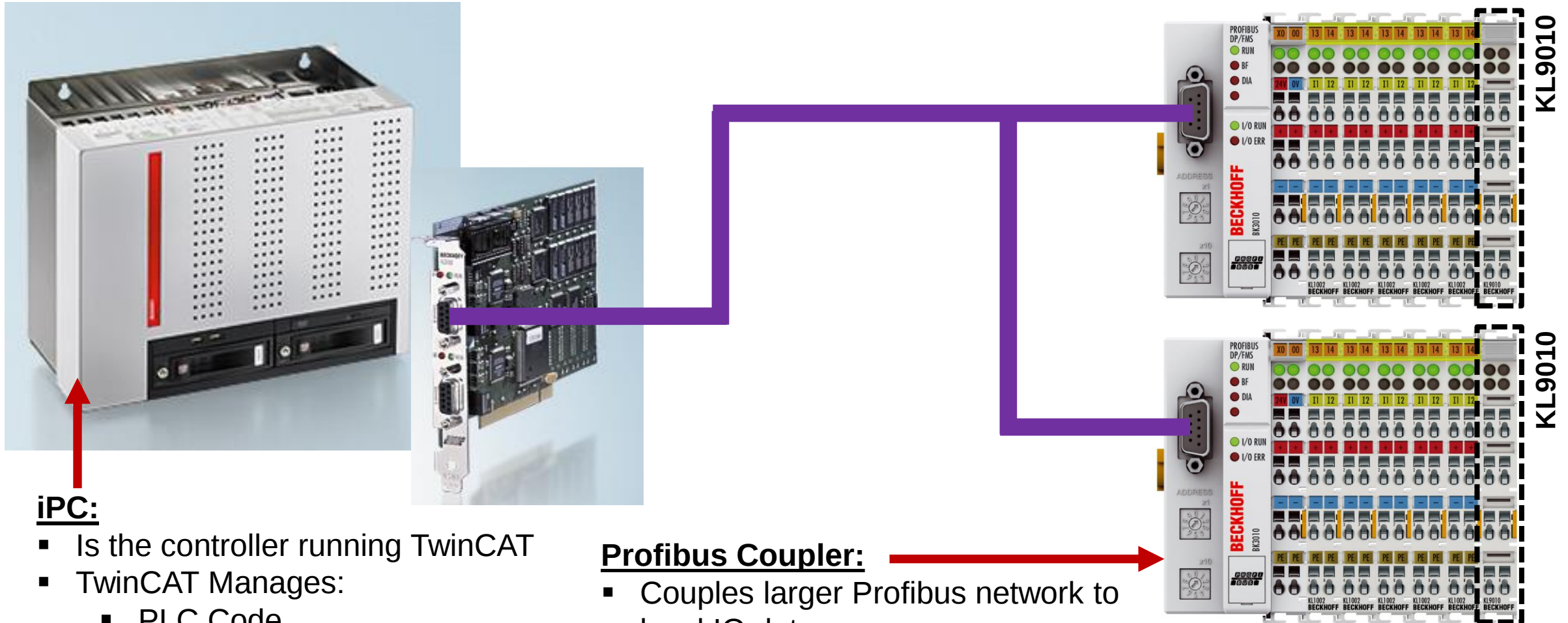
-
- xxx**9**xx – Safety Card 

‘9’ Signifies Safety

- IO Introduction
- **Application Examples: K-Bus**
- Hardware Replacement
- Wiring
- Powering Hardware
- Shielding, Grounding
- Additional Considerations

Application Example: Profibus, KL IO

BECKHOFF



IPC:

- Is the controller running TwinCAT
- TwinCAT Manages:
 - PLC Code
 - Fieldbus
 - Etc.

Profibus Coupler:

- Couples larger Profibus network to local IO data.
- Is slave on Profibus network
- Is master of K-bus
- Separates larger fieldbus, local bus

Application Example: Ethernet TCP / IP, KL IO

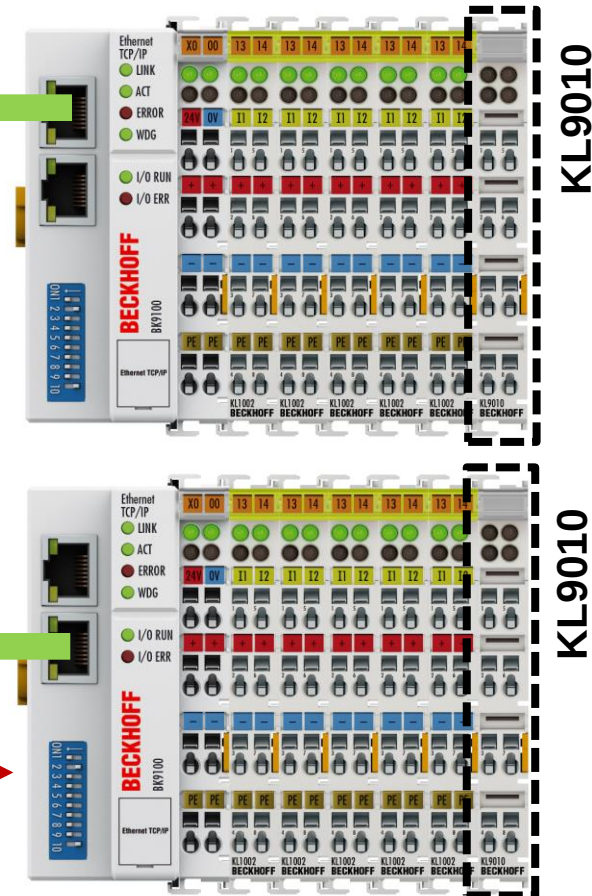
BECKHOFF



Controller



Switch



KL9010

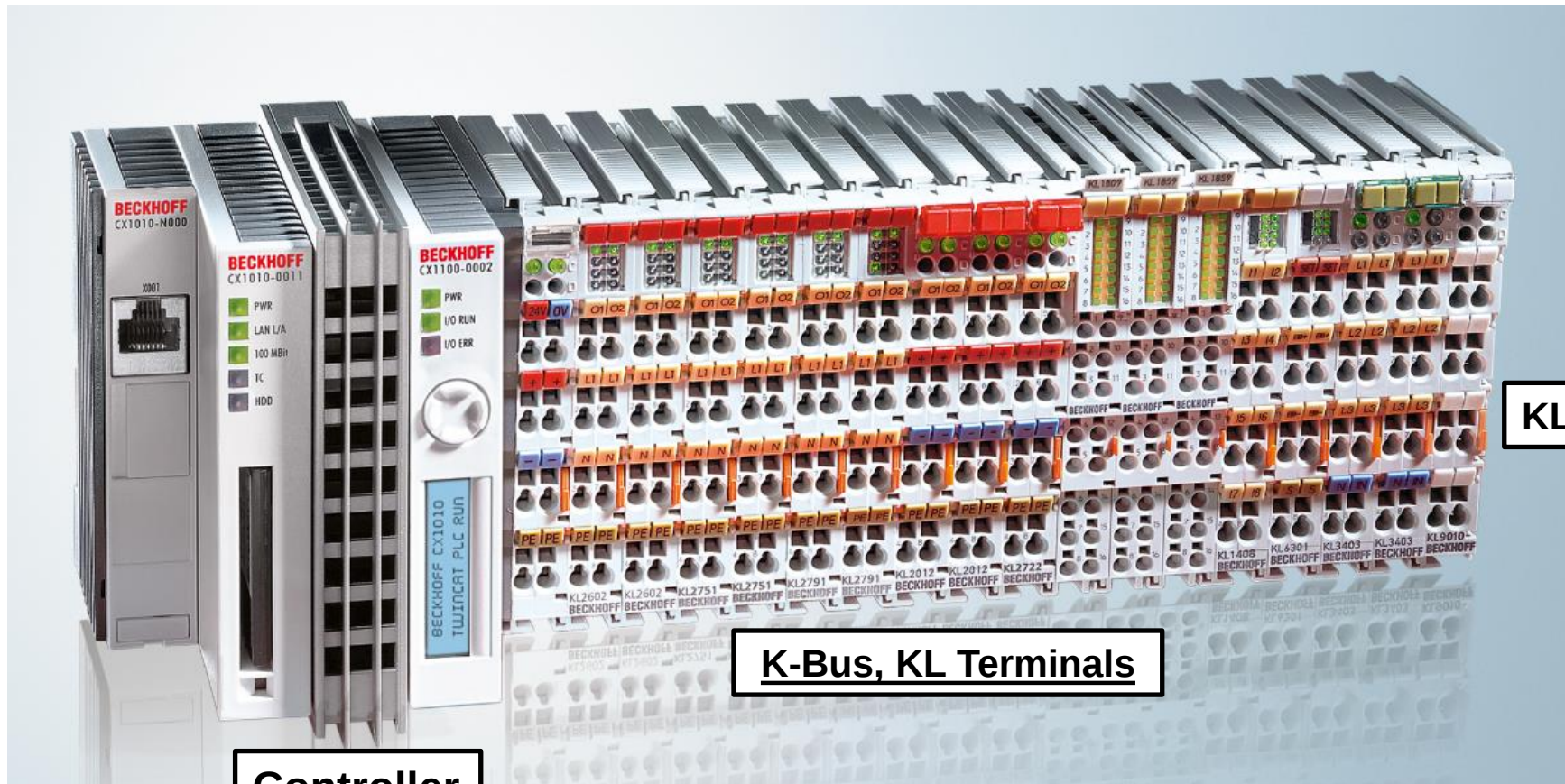
KL9010

Ethernet Coupler:

- Couples larger Ethernet network to local IO data.
- Is slave on Ethernet TCP/IP network
- Is master of K-bus
- Separates larger fieldbus, local bus

Application Example: ePC, Local K-Bus IO

BECKHOFF



Controller

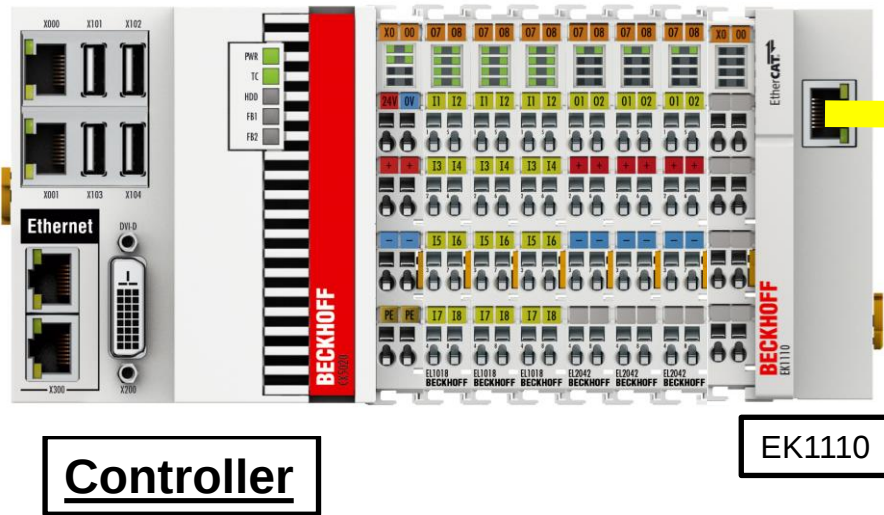
K-Bus, KL Terminals

KL9010

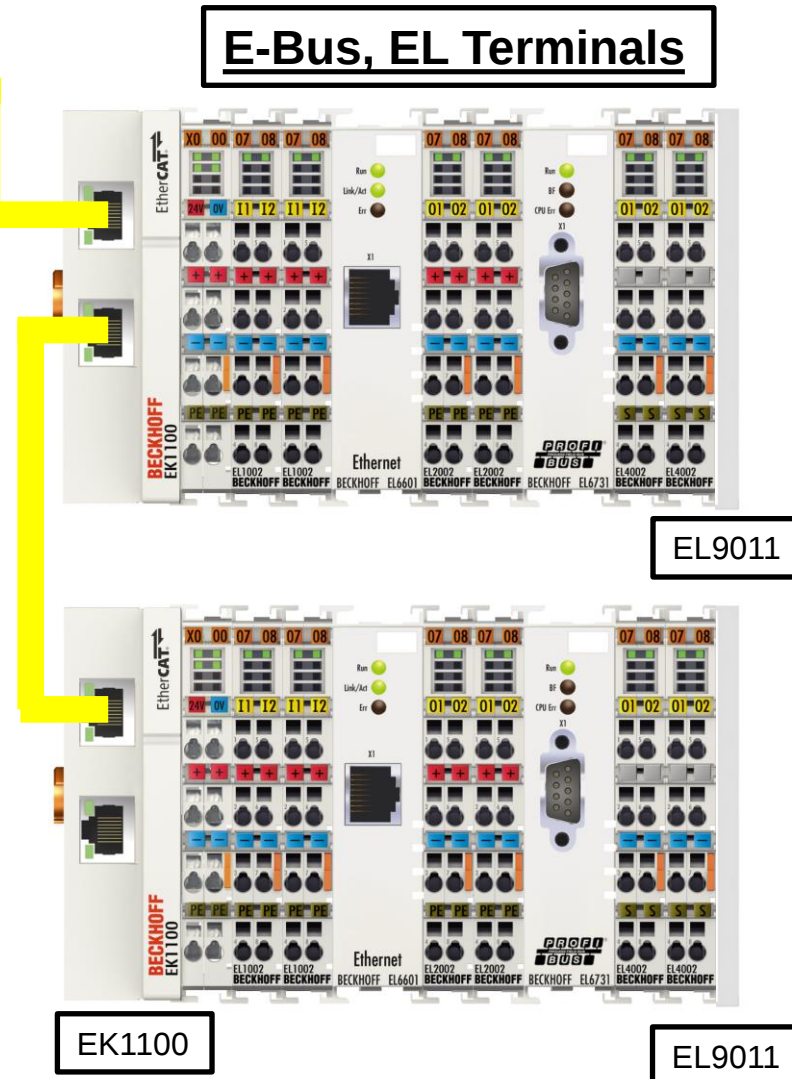
- IO Introduction
- **Application Examples: E-Bus**
- Hardware Replacement
- Wiring
- Powering Hardware
- Shielding, Grounding
- Additional Considerations

Application Example: EtherCAT Local and Remote IO

BECKHOFF

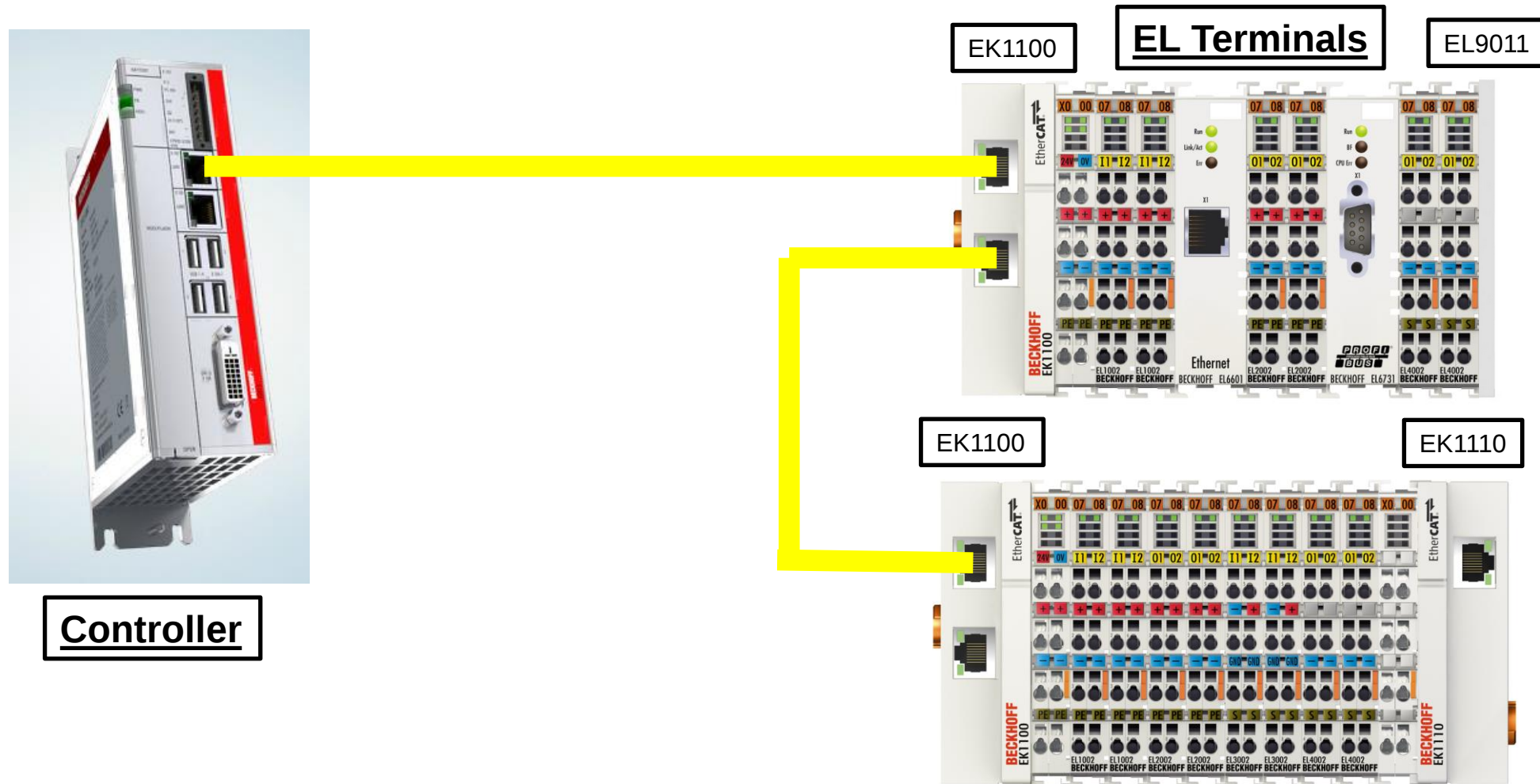


- EtherCAT coupler (EK) is slave on EtherCAT fieldbus
- Terminals are also slaves on EtherCAT fieldbus
- Communication continuity exists from incoming EK connection to rack IO



Application Example: EtherCAT Remote IO

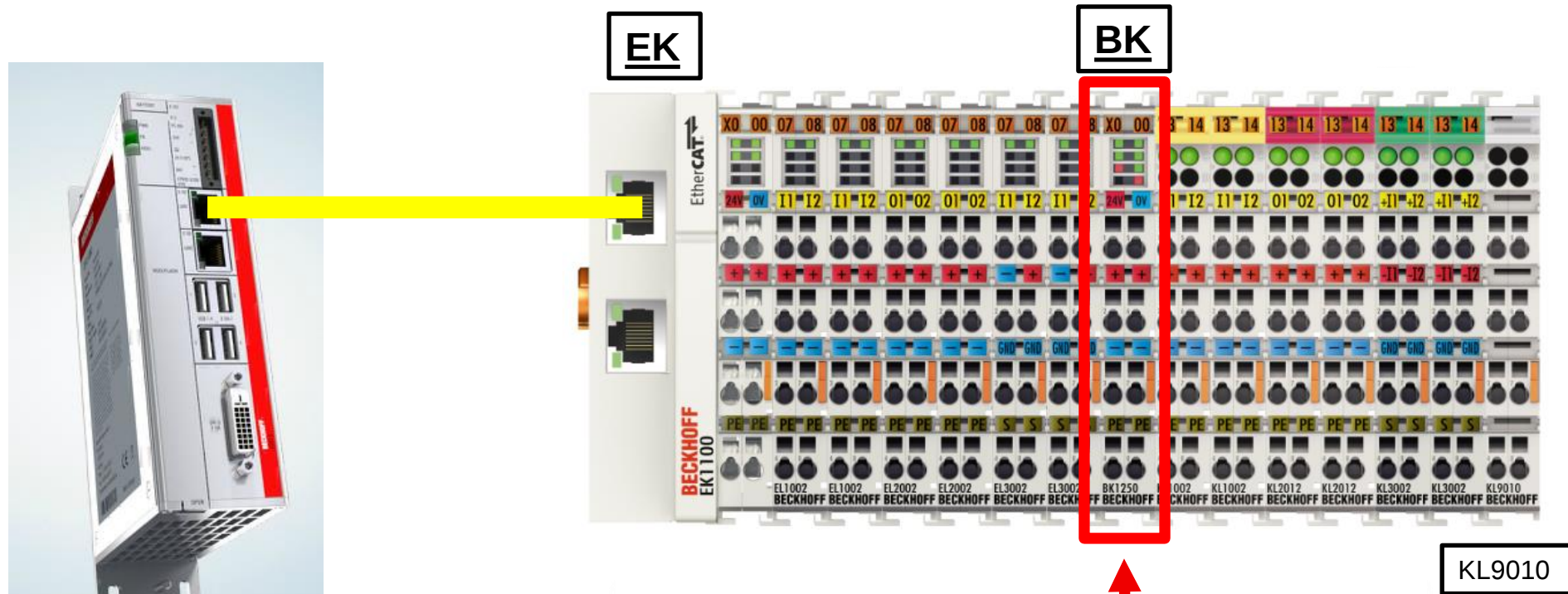
BECKHOFF



- EtherCAT coupler, terminals are slaves on EtherCAT fieldbus.
- EK1100: No communication break occurs from incoming cable to IO terminals

Application Example: EL and KL on One Rack

BECKHOFF



BK1250:

- Is a coupler in the form of a terminal

Bus Coupler Summary:

- EK connects to EtherCAT IO downstream until...
- BK connects to K-Bus IO downstream

- IO Introduction
- Application Examples: E-Bus
- **Hardware Replacement**
- Wiring
- Powering Hardware
- Shielding, Grounding
- Additional Considerations

Bus Coupler Serial Numbers and Replacement

BECKHOFF

■ Serial Number* Identifies:

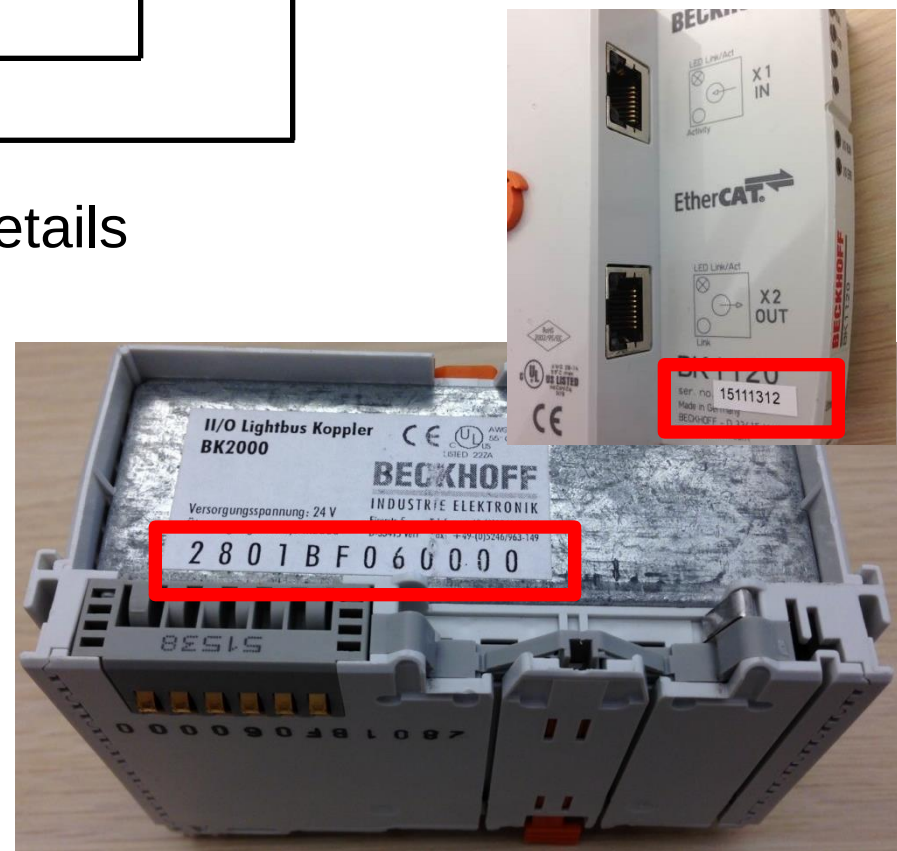
- 2 8 0 1 B F 0 6 (0 0 0 0)
- Week of Manufacture _____
 - Year of Manufacture _____
 - Firmware* _____
 - Hardware* _____

■ Check documentation for firmware or hardware details

- Obtain newest document

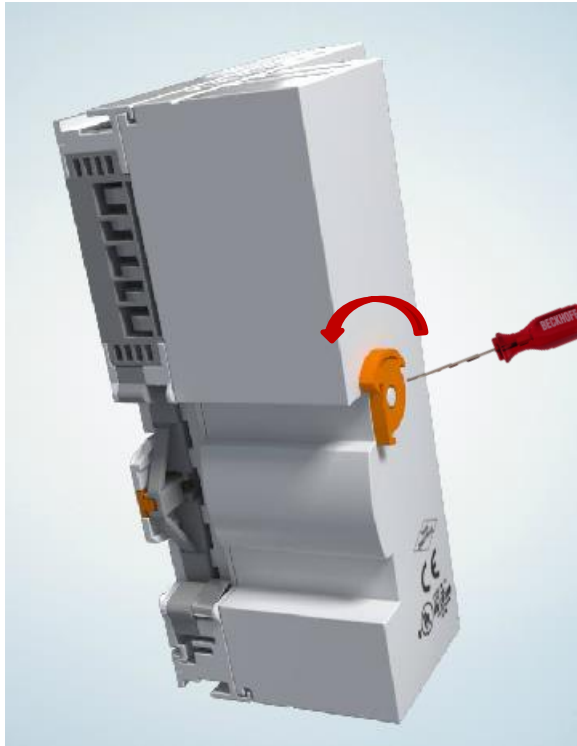
■ Coupler Replacement

- Manufacturing date does not matter
- Firmware code to be equal or newer
 - If not, order a new terminal
 - In limited cases support can update firmware



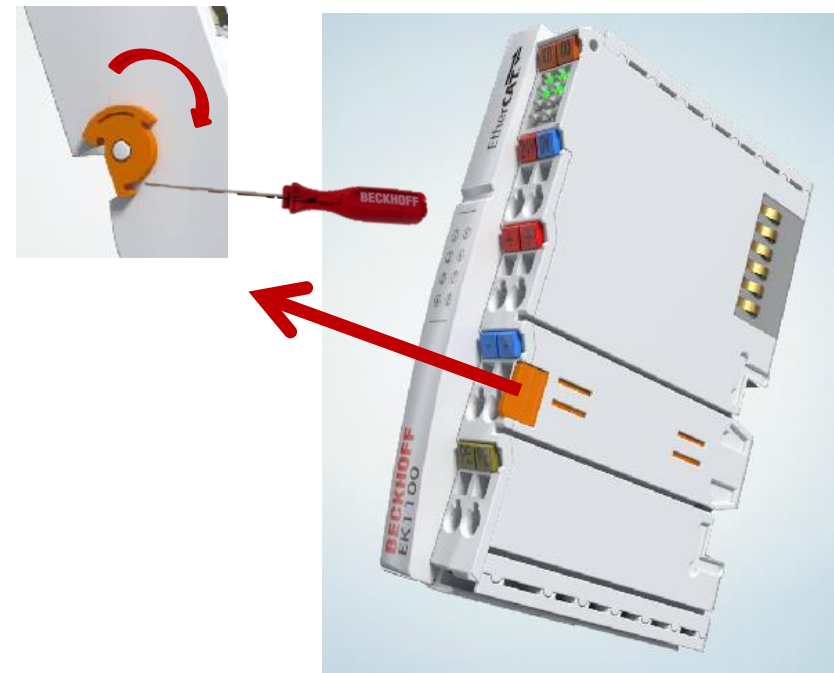
Mounting Bus Coupler:

- Snap Assembly to Rail
- Rotate Lock on Left CCW
 - Use terminal tool, top of groove



Removing Bus Coupler:

- Rotate Lock on Left CW
 - Use terminal tool, bottom of groove
- Pull Orange Tab

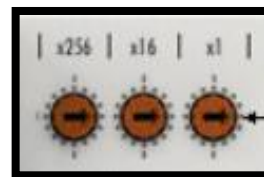


Switches Change Registry Settings on Power Up

BECKHOFF

Switches May Change:

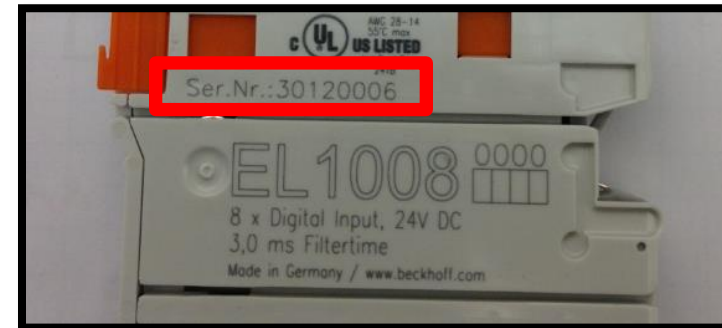
- **Address**(on fieldbus)
- Baud Rate
- Signal Intensity(light)
- Switches can be binary OR decimal or hex
- Pay attention to ON direction
- Side of Coupler Gives Quick Explanation
 - Go to documentation for more detail...



- **When replacing coupler ensure correct switch bank position**

Serial Number Identifies:

- 3 0 1 2 0 0 0 6
- Week of Manufacture _____
 - Year of Manufacture _____
 - Firmware _____
 - Hardware _____



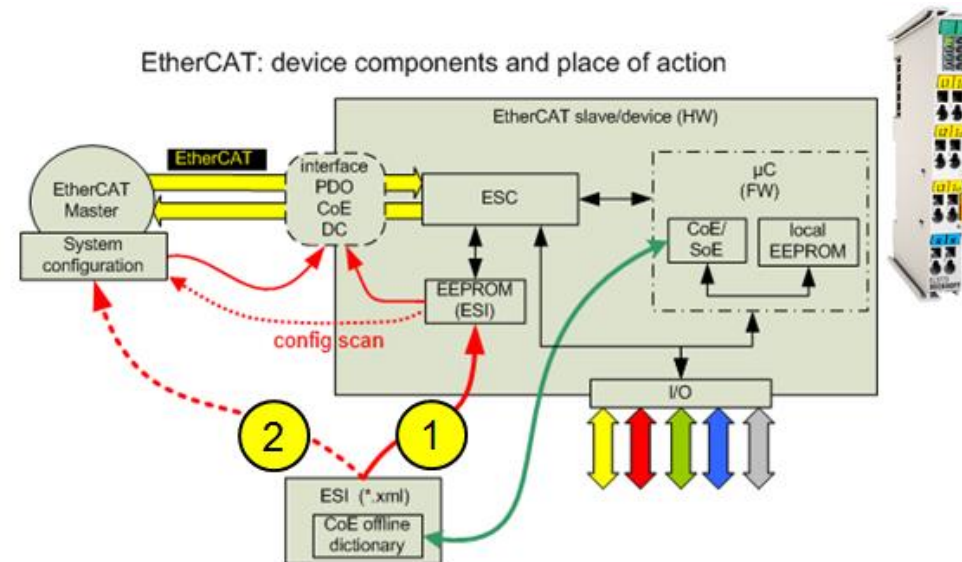
Terminal Replacement Rules

- Manufacturing date does not matter
- Firmware code to be equal to or newer than old terminal.
 - If Not:
 - Order a new terminal
 - In limited cases a firmware update may be possible. Call support to confirm compatibility and perform update.

EL Terminals Have Revision Number

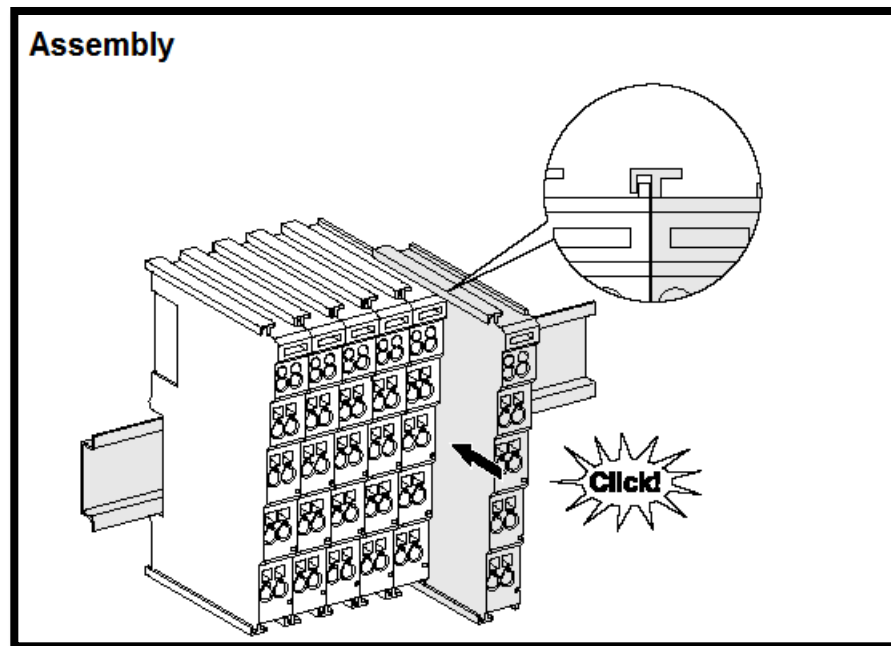
BECKHOFF

- A revision number identifies the feature set of an EL terminal to the master
- The revision is stored in the EEPROM[ESI] and also written on the outside of the terminal (after Jan 1, 2014)
- For replacement, the revision need not be considered; just firmware.



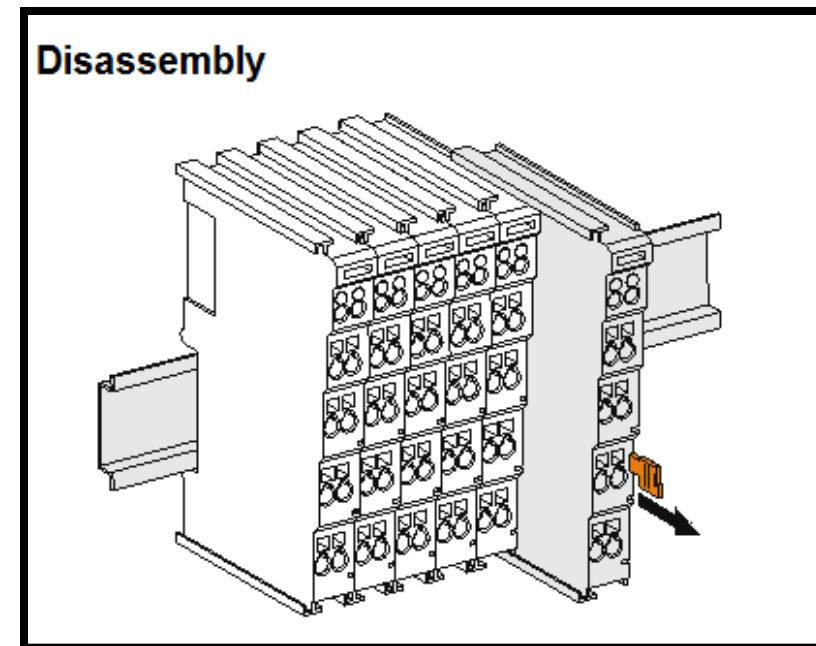
Installation:

- Tabs slide into slots on top and bottom
- Fully seat terminal to rail
- No gap between terminals allowed



Removal:

- Pull tab to release clamp on back
- Grab top and bottom of terminal to assist with removal



⚠ WARNING

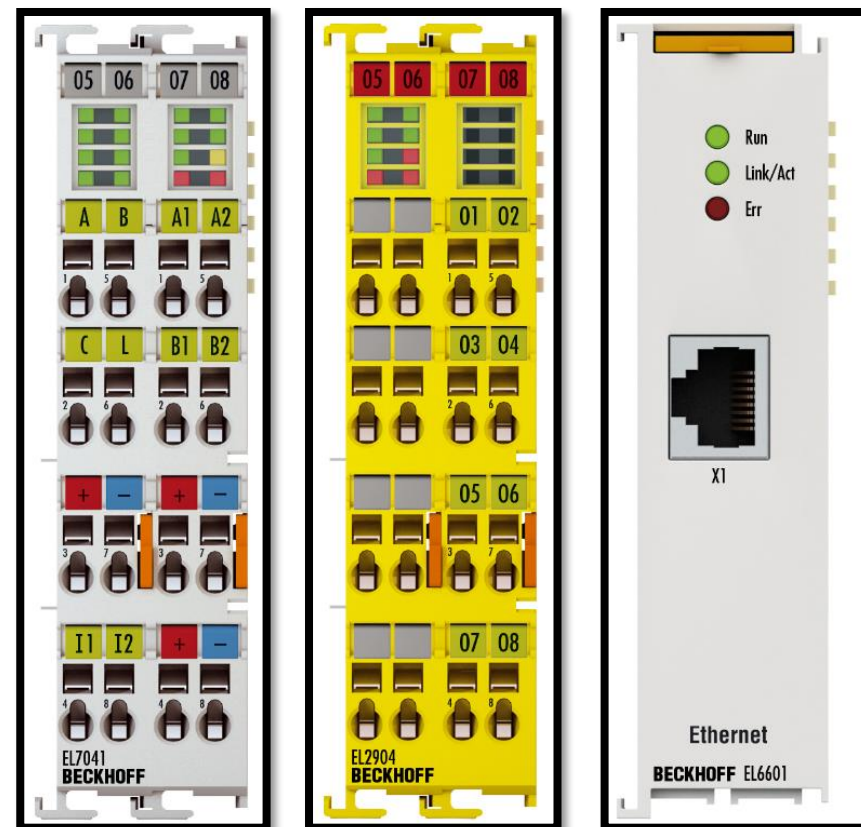
Risk of electric shock and damage of device!

Bring the bus terminal system into a safe, powered down state before starting installation, disassembly or wiring of the Bus Terminals!

Double Wide Terminals

BECKHOFF

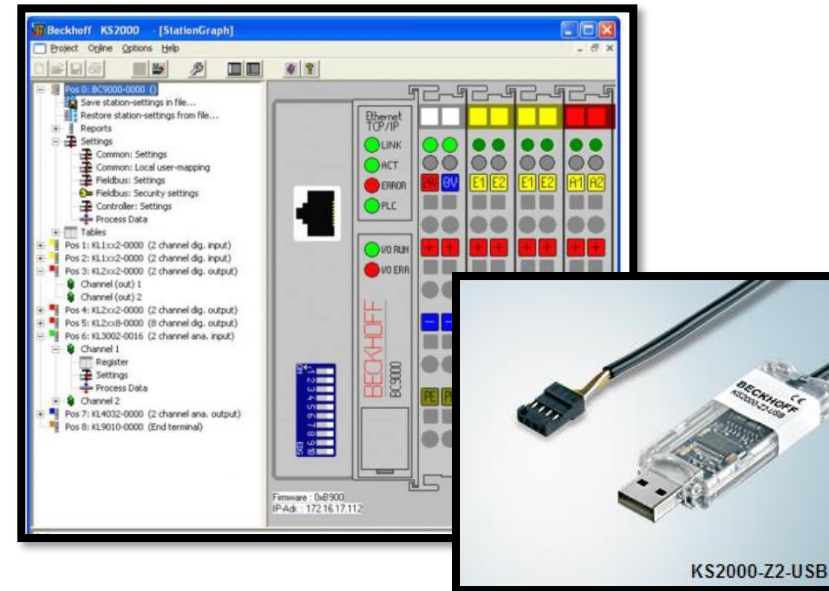
- Name will be either:
 - Stacked on left side only OR
 - Unstacked using both sides
- Any terminal appearing single-wide without a stacked name is actually double-wide
- The BECKHOFF text will be on the left of the double-wide card.
- **Removal requires** pulling:
 - Both tabs
 - OR
 - Top tab



Bus Coupler Door Used to Configure Settings

BECKHOFF

- Each coupler and its terminals store their settings in internal memory called a registry
- You can change some of these settings using **KS2000 (K-Bus)**
 - Cable and KS2000 software required

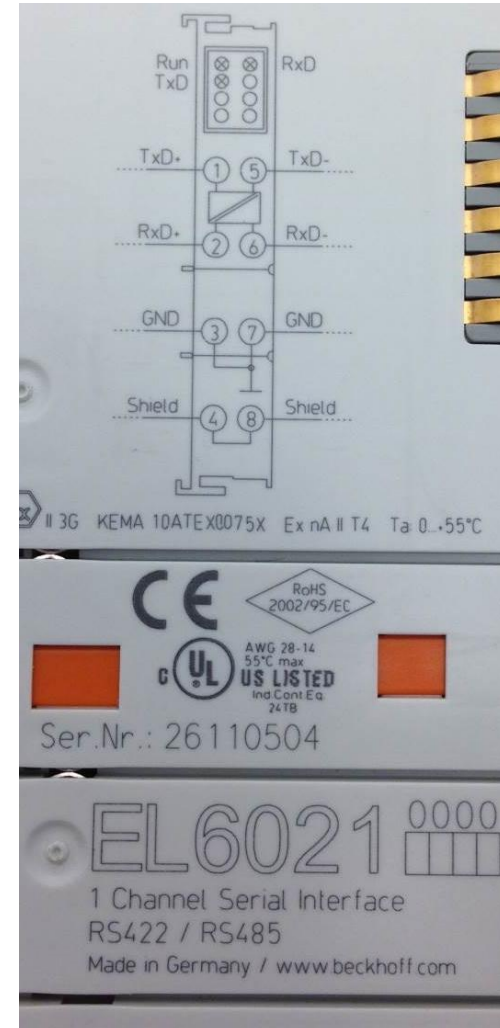


Terminal Replacement Example

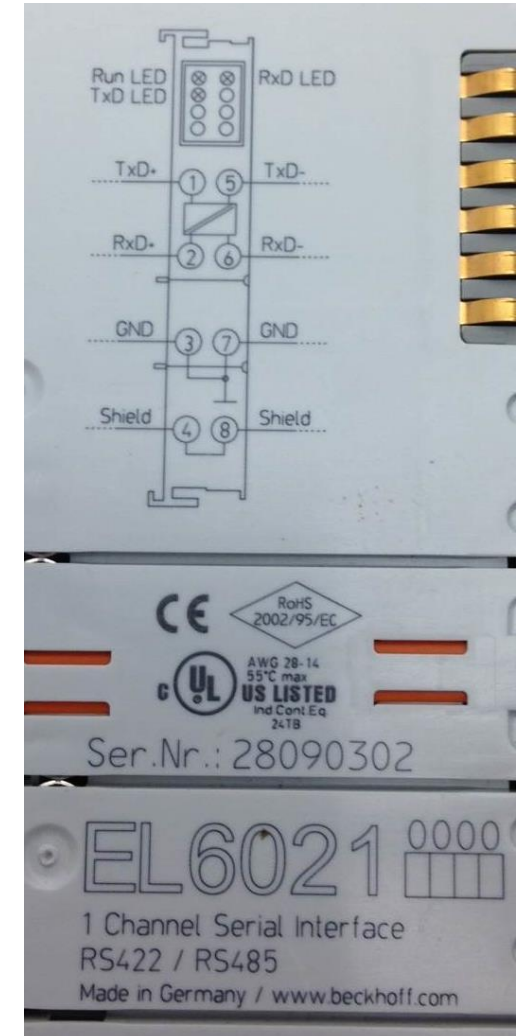
BECKHOFF

- The left picture is in need of replacement:
 - Firmware:05
 - Hardware:04
- The right picture is the available working part to be used for replacement
 - Firmware:03
 - Hardware:02
- Replacement is not recommended because the firmware is too old
- A newer terminal should be acquired

Bad Terminal



Replacement Option



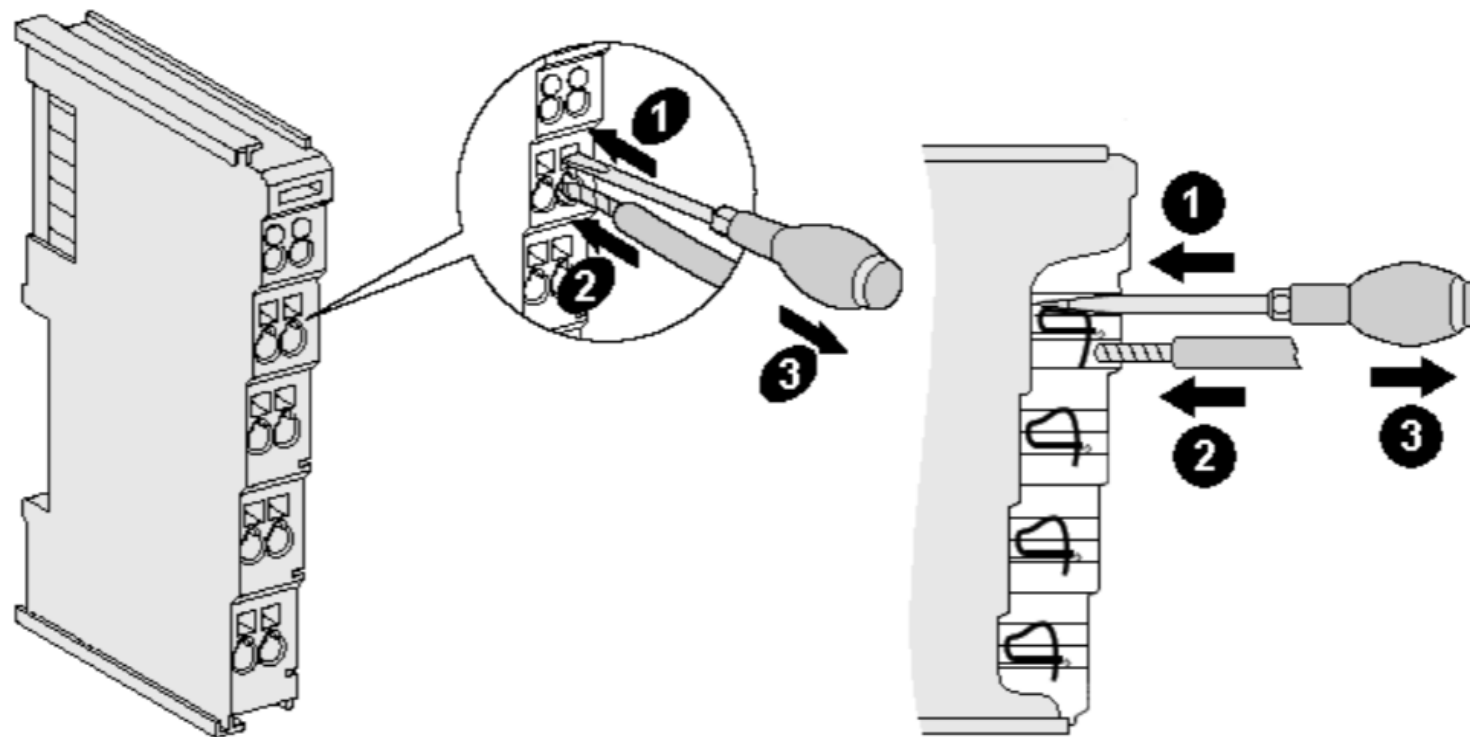
- **Warranty on Hardware**
 - 6 months grace period for storage
 - 1 year from installation date
- **Hardware Broken?**
 - Return to us for evaluation
 - If bad and under warranty, we will send you a new one.
 - If good, we will charge you an evaluation fee and return part to you.
- **Need an immediate replacement?**
 - We will charge you for hardware and ship it immediately
 - If you return bad hardware and it tests bad under warranty, we will credit your account

- IO Introduction
- Application Examples: E-Bus
- Hardware Replacement
- **Wiring**
- Powering Hardware
- Shielding, Grounding
- Additional Considerations

Wire Connections

BECKHOFF

- Terminals and Couplers have a cage clamp style wire connection
- Insert terminal tool to the back of square hole above round wire hole, push firmly back to hold clamp open
 - Use only 28-14 AWG wire
- Stranded preferred, solid and ferrules ok



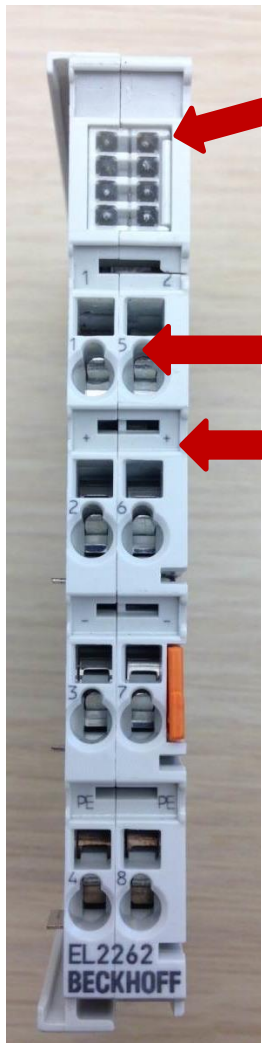
Beckhoff Terminal Tool: Part Number ZB8100

Terminal housing	ELxxxx, KLxxxx	ESxxxx, KSxxxx
Wire size width (single core wires)	0.08 ... 2.5 mm ²	0.08 ... 2.5 mm ²
Wire size width (fine-wire conductors)	0.08 ... 2.5 mm ²	0,08 ... 2.5 mm ²
Wire size width (conductors with a wire end sleeve)	0.14 ... 1.5 mm ²	0.14 ... 1.5 mm ²
Wire stripping length	8 ... 9 mm	9 ... 10 mm



- Slide-able Label Depository
 - Pulls out for label insertion
- See documentation for meaning of lights
 - Solid Green is Good
 - Red is Bad (May mean unwired channel: OK)
 - Examples:
 - Digital Input OR Output On
 - System In Run: Terminal Data Updating
- Label Cover Orderable
- Contact Labels Orderable
 - 
- **Note: These numbers are not the channel numbers**
 - Numbers Only Identify the Contact for Wiring Diagram Correlation





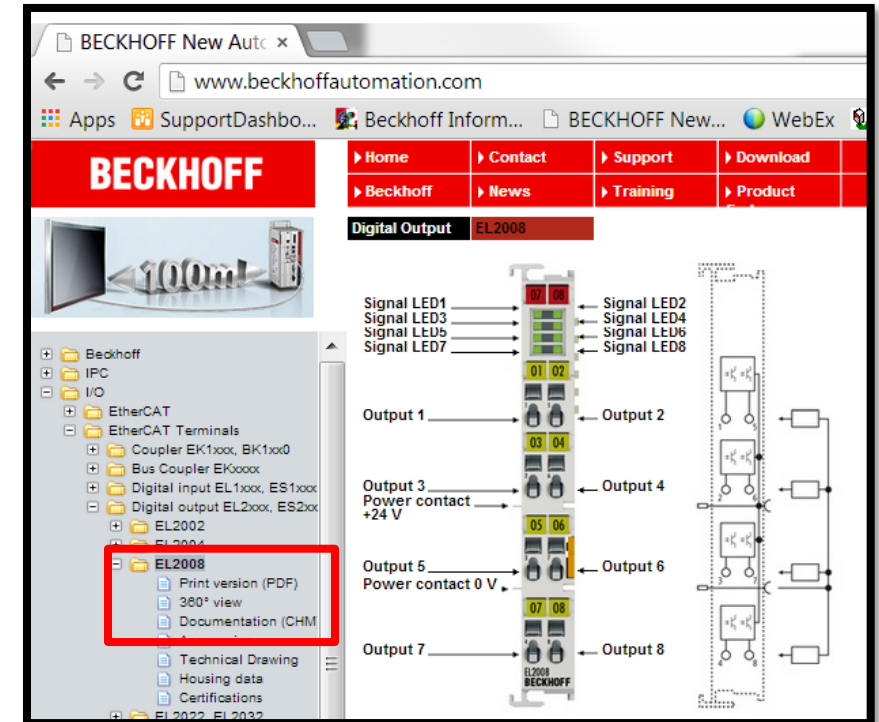
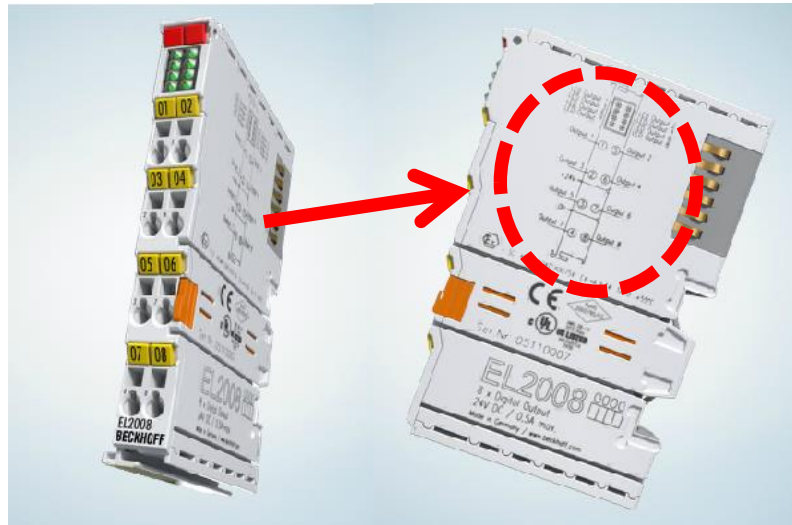
- See documentation for meaning of lights
 - Solid Green is Good
 - Red is Bad
- **Hole numbers are not channel numbers**
 - They correlate to the wiring diagram
- Markings above terminal tool hole specify function of contact
 - Labels available for clearer marking

+ + - - I1 I2 O1 O2 PE PE

Location of Wiring Diagrams

BECKHOFF

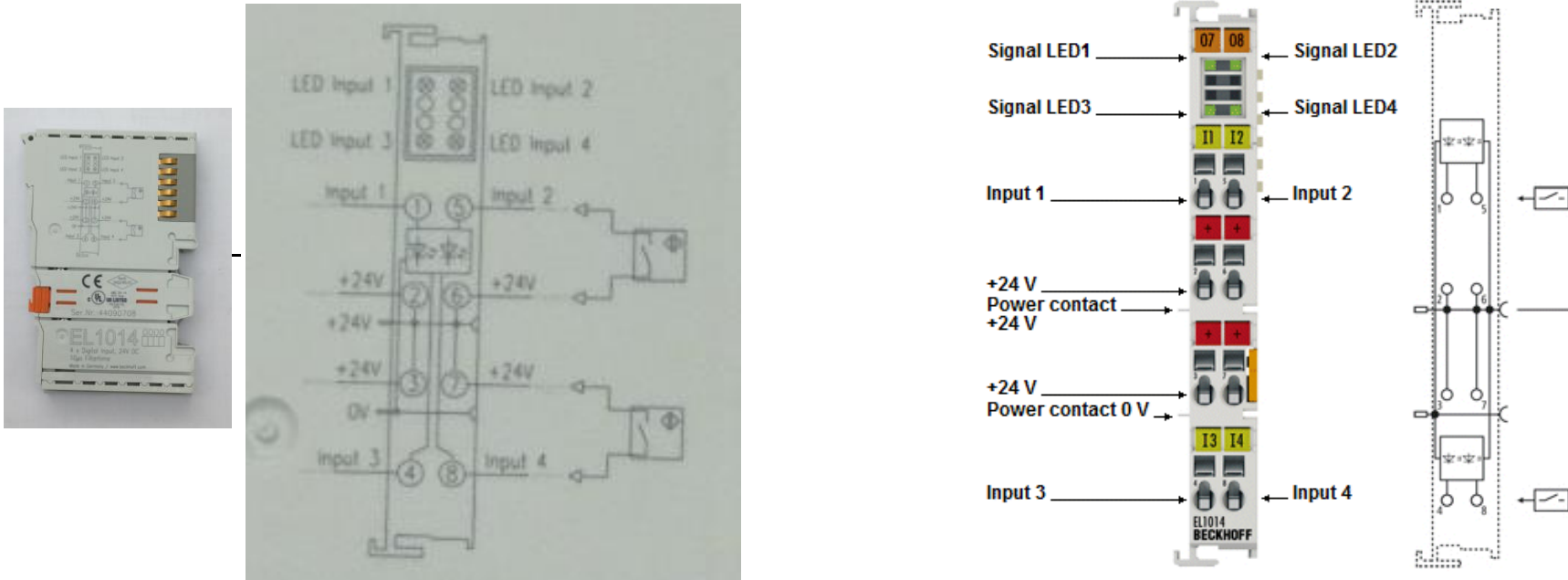
- Terminal Itself
 - Never Remove Powered Terminals!
- Infosys
 - Online: http://infosys.beckhoff.com/index_en.htm
 - Downloaded: <http://www.beckhoffautomation.com/english/download/tcinfo.htm>
- PDFs OR CHMs (www.beckhoffautomation.com chm files need to be unblocked)
- Catalog



Terminal Wiring Diagrams

BECKHOFF

- **More than one representation exists** for the same card
 - Picture on card conveys all information
 - Other sources separate external and internal information

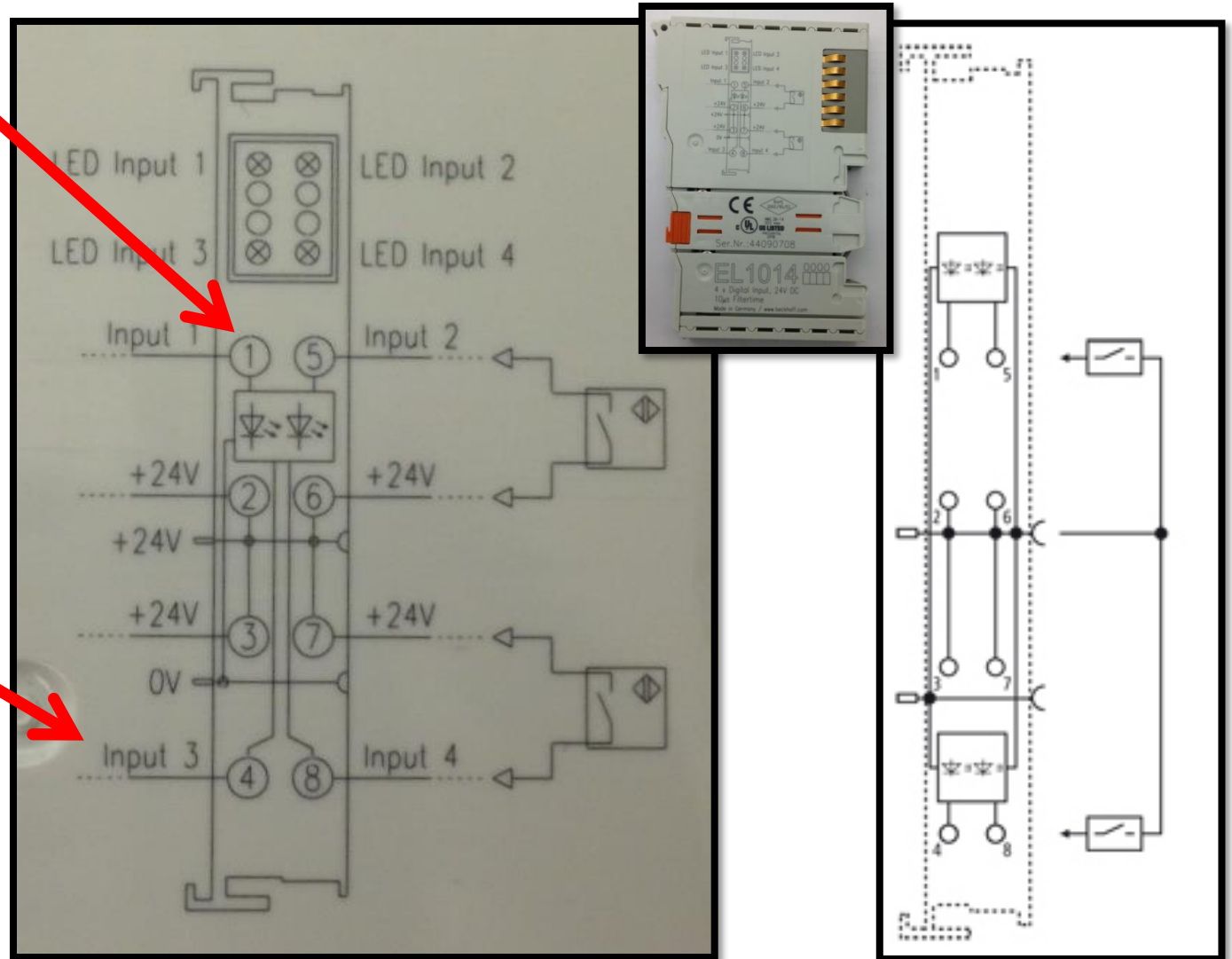


- **Pictures convey the same information.**
- See Technical Data Section for signal information

Wiring Diagram Example

BECKHOFF

- Hole numbers match front of terminal.
- **Crossing Lines:**
 - No connection
- **Dot:**
 - Connection present
- Not all terminals have 24 V or 0 V connection points
- Hole number is not channel number



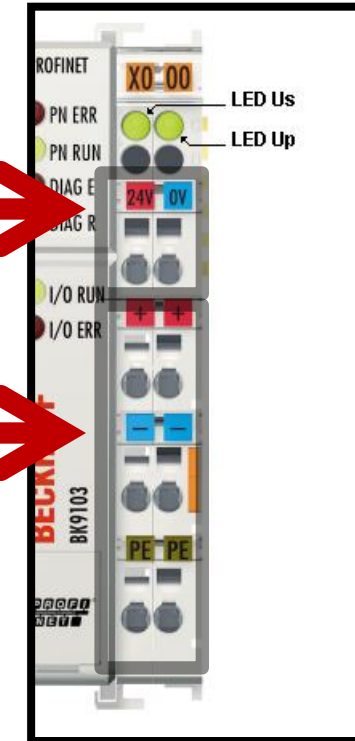
- IO Introduction
- Application Examples: E-Bus
- Hardware Replacement
- Wiring
- **Powering Hardware**
- Shielding, Grounding
- Additional Considerations

Coupler Lights Show Power Supplied

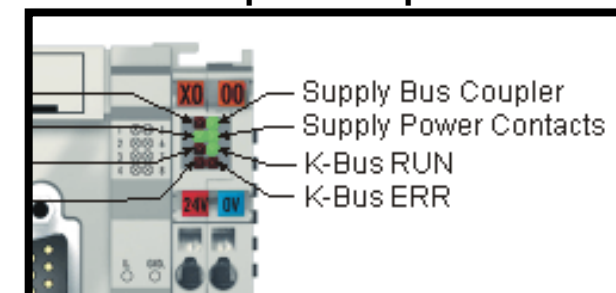
BECKHOFF

- See documentation for light identification
- Each Coupler Has Two Power Supply Inputs:
 - **Supply Power (Us)** feeds:
 - Bus Coupler Electronics
 - Terminal Electronics
 - Fieldbus (sometimes)
 - **Peripheral Power (Up)** provides:
 - A reference, source for Digital IO
 - Break-out power on subsequent terminals
 - Us, Up are generally isolated*

Most Couplers



Compact Couplers



*Low Cost(LC) couplers lack this isolation

Coupler Power Supplies Have Current Limits

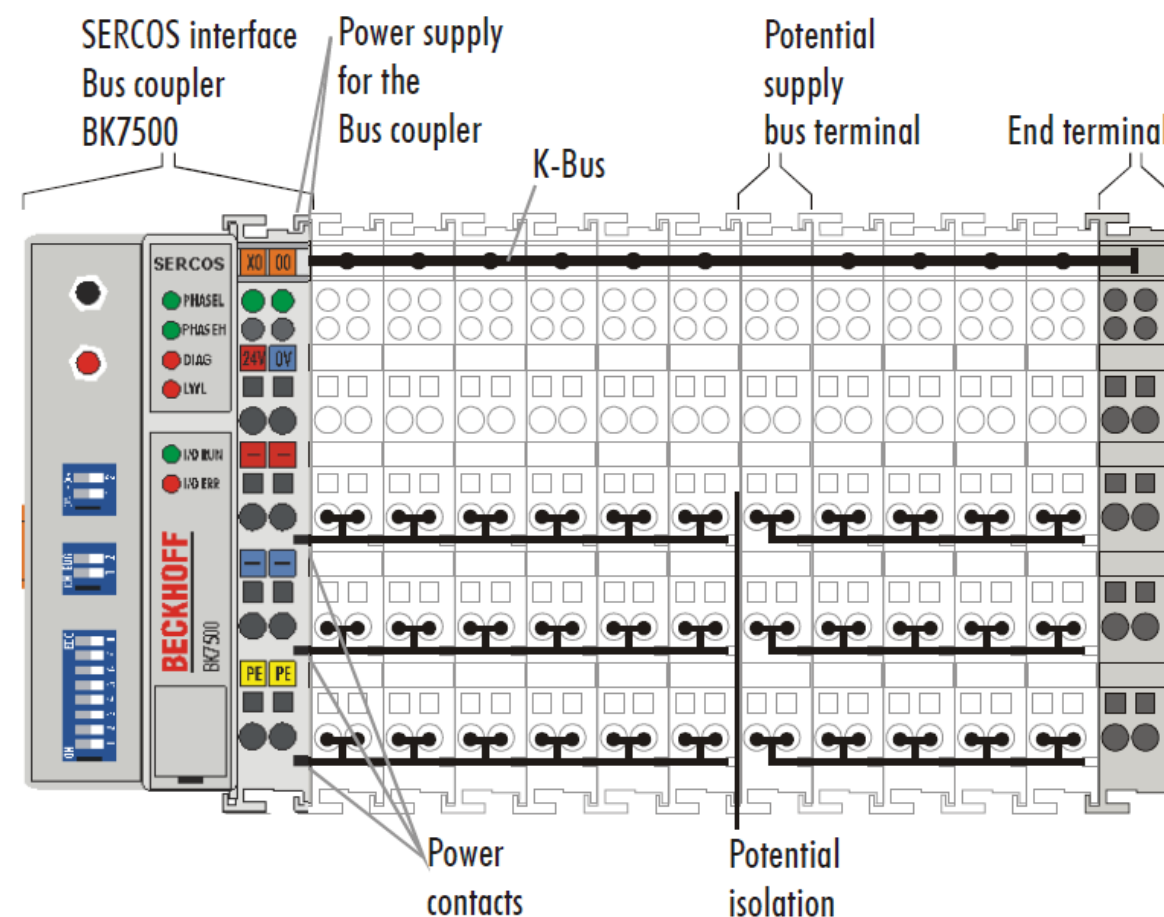
BECKHOFF

Supply Power (Us):

- Most Bus Couplers (BK) provide 1750 mA
- Most EtherCAT Couplers (EK) provide 2A*
- Can be recharged with:
 - KL9400
 - EL9400, EL9410

Peripheral Power (Up):

- Couplers provide 10A
- Can be recharged with:
 - KL9100, KL9110
 - EL9100, EL9110



*excluding integrated couplers

*1A at Operating Temps > 55°C

Supply Power (Us):

- Uses 6 gold plated contacts
- K-Bus and E-Bus not compatible

Peripheral Power (Up):

- Female contacts hidden in slots on side right of part
- Male contacts protrude from left side of part
- Not all terminals have 3 contacts
 - This stops signal continuity
- Terminals of different peripheral groups can fit together, but should not be together.

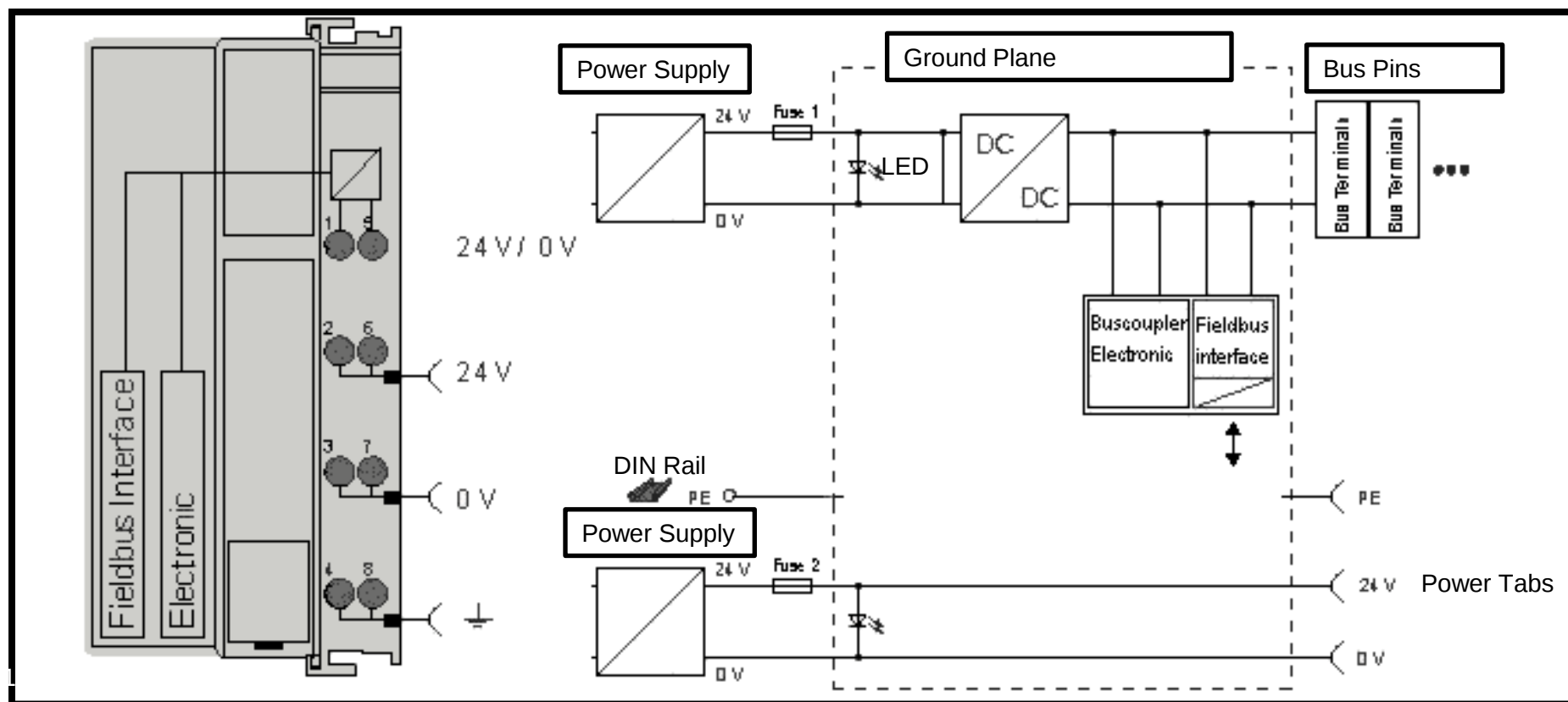


Recommended Power Wiring of Coupler*

BECKHOFF

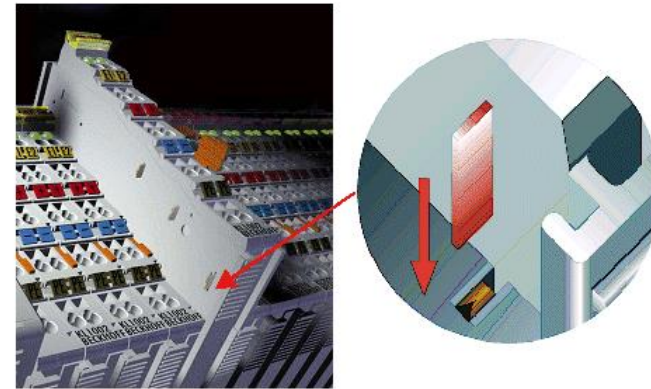
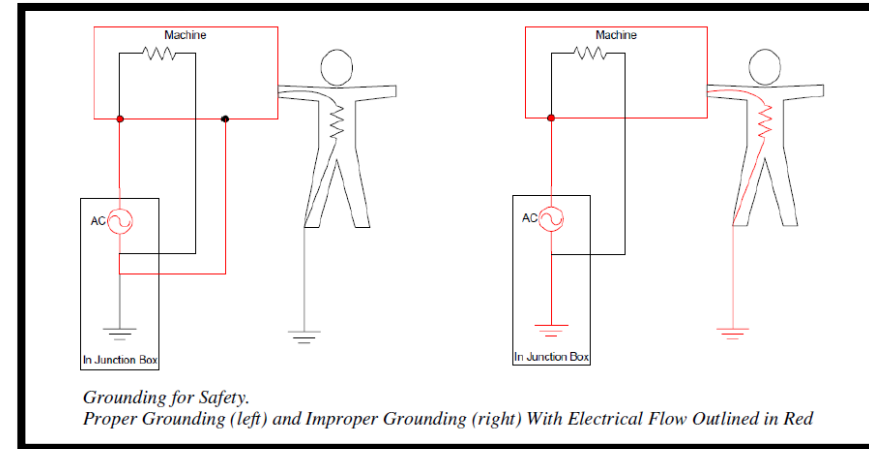
- Use Separate 24V Power Supplies
- Fuse for Max Current Draw
 - Do not exceed capacity of supply
 - **Us**: 2 A typical, **Up**: 10 A typical (slow blow)

*Taken from EK1100 manual:
See documentation for specific
information when wiring any
Beckhoff hardware



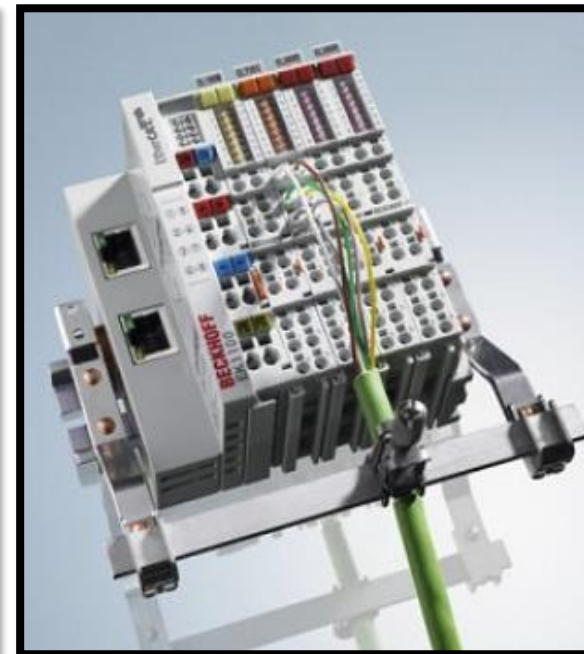
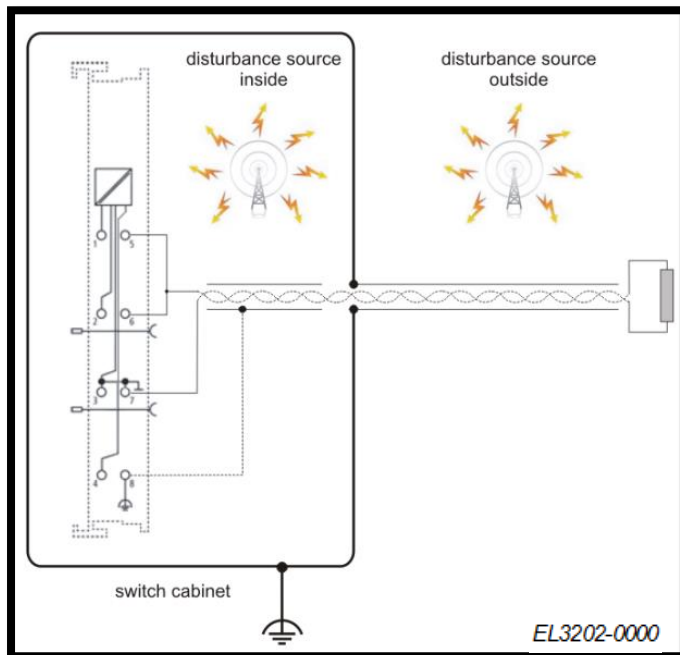
- IO Introduction
- Application Examples: E-Bus
- Hardware Replacement
- Wiring
- Powering Hardware
- **Shielding, Grounding**
- Additional Considerations

- **Two types of earth ground exist:**
 - Protective Earth(PE)
 - Shield
- **PE**
 - **Prevents user injury**
 - **Protects equipment**
 - Begins with coupler, ends at last continuous PE terminal
 - Can carry up to 125 Amps from connected sensor to earth
 - Capacitively coupled to DIN rail



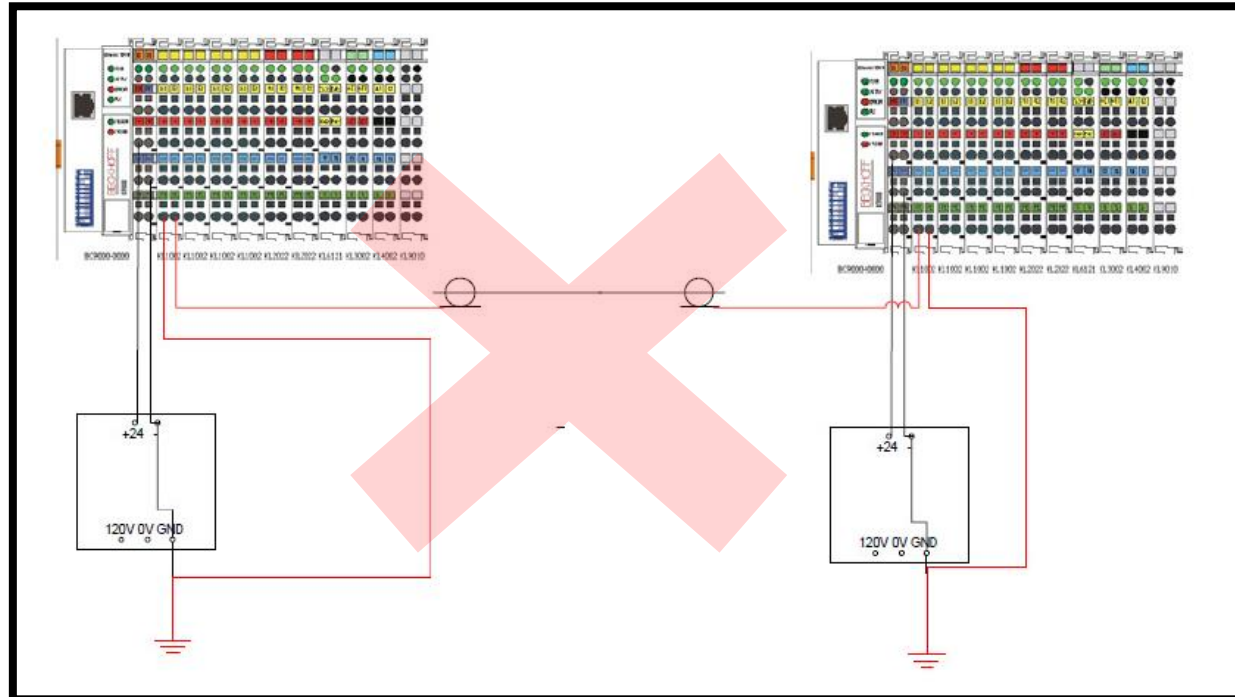
Shield

- **Protects signals** from current induced by electro-magnetic noise
- Bond(360°) *cable shield* to earth grounded DIN rail using:
 - Shield hole found on terminals
 - Connection system offered by Beckhoff



Shield

- Avoid ground loops by:
 - Grounding only one end of cable
 - Grounding both ends of cable to same potential



- IO Introduction
- Application Examples: E-Bus
- Hardware Replacement
- Wiring
- Powering Hardware
- Shielding, Grounding
- **Additional Considerations**

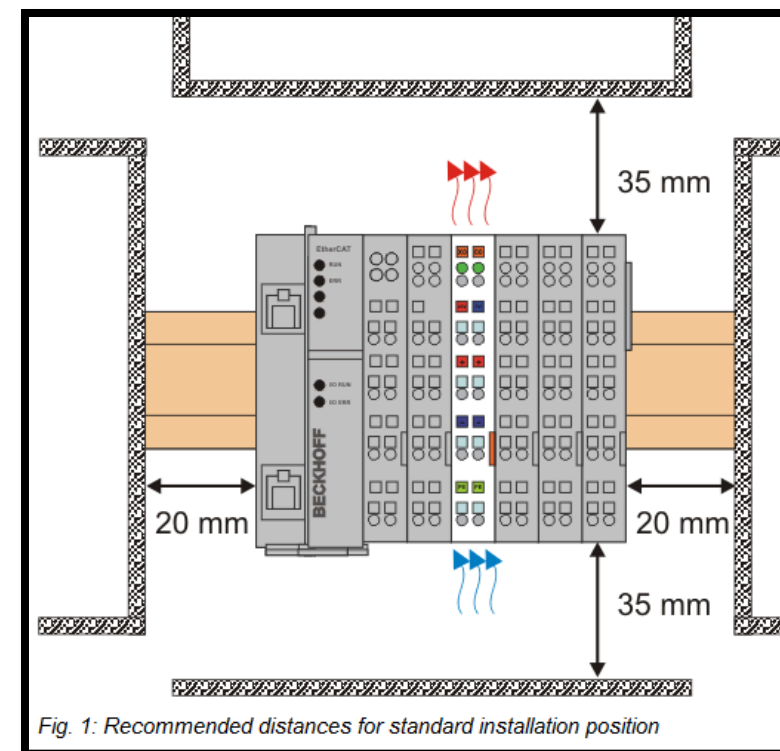
Mounting Orientation and Spacing

BECKHOFF

- Best mounting position for hardware is 'Horizontal' (**Din Rail Orientation**)
- Not all hardware must be mounted 'Horizontally'
 - See Technical Data Section for specification(online, pdf, etc)

EL310x - Technical data	
Technical data	EL3101
Number of analog inputs	1 (differential)
Signal voltage	-10 V ... +10 V
Mounting	on 35 mm mounting rail
Vibration/shock resistance	conforms to EN 60068
EMC resistance burst/ESD	conforms to EN 61000
Protect. class	IP 20
Installation pos.	variable

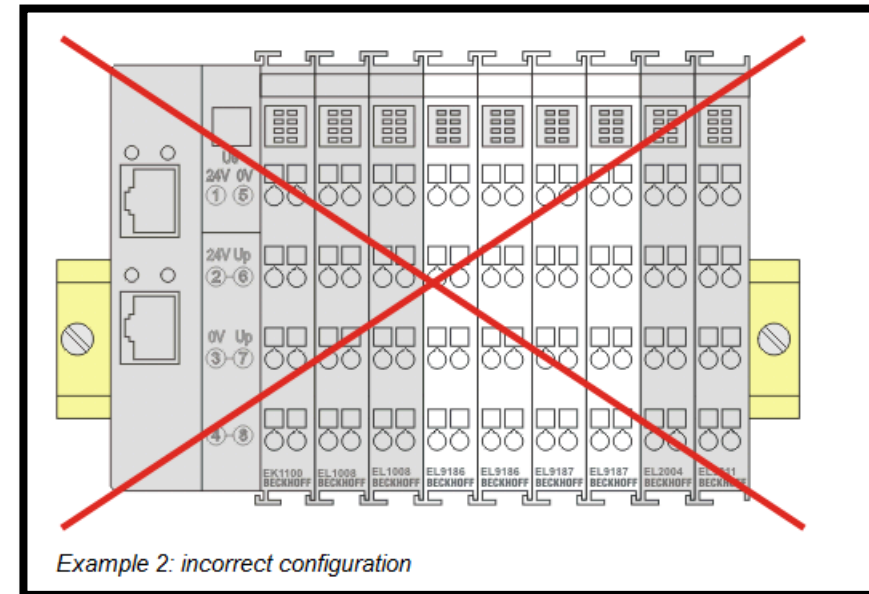
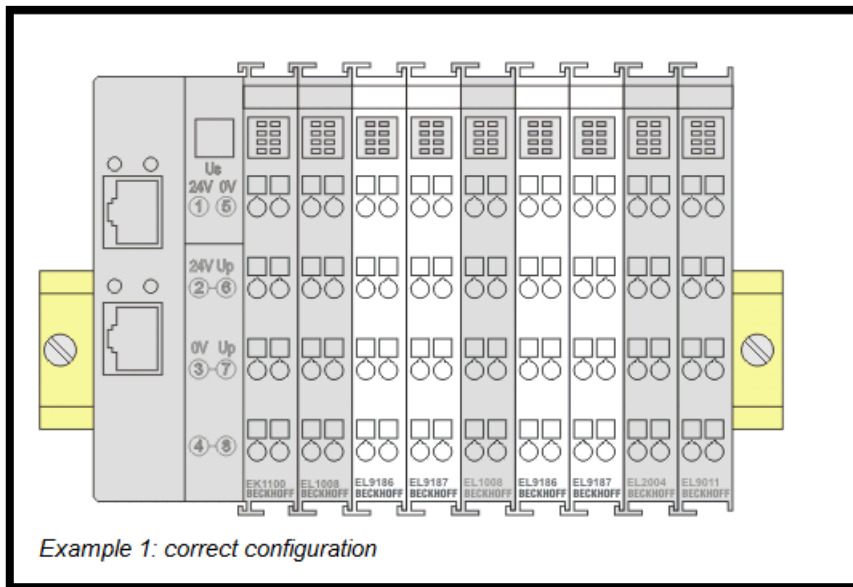
- Incorrect installation position will cause reduced product life(hours-years)



Limit the Number of Passively Mounted Terminals

BECKHOFF

- Passive terminals **do not**:
 - Show up in the TwinCAT software*
 - Draw current from E-Bus or K-Bus
- Bus communication may suffer if more than 2 are used together



*End terminals are an exception to this rule.

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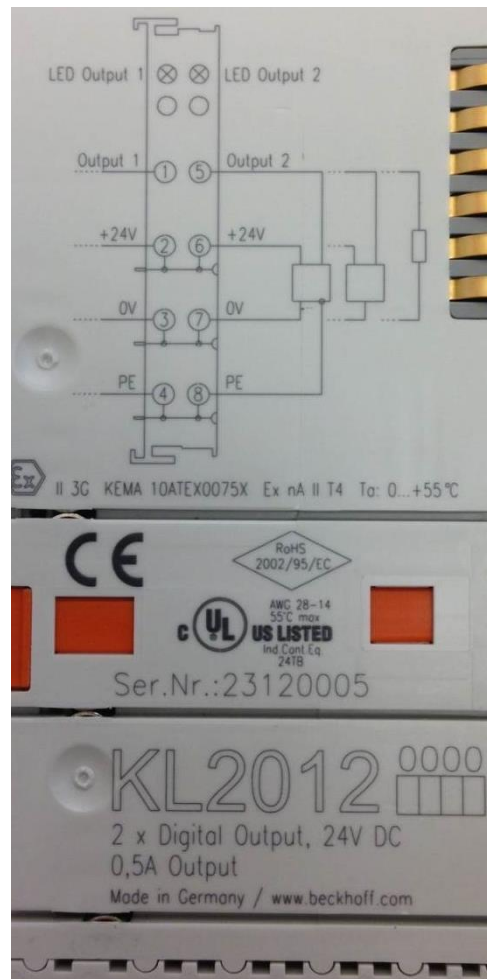
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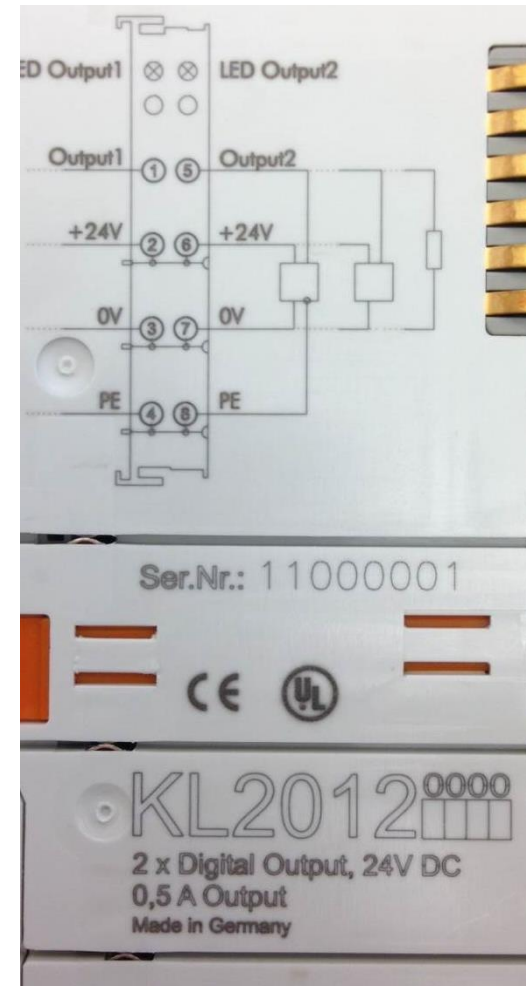
Exercise #1: Is the following an ok replacement?

BECKHOFF

Bad Terminal



Replacement



Exercise #1 Answer:

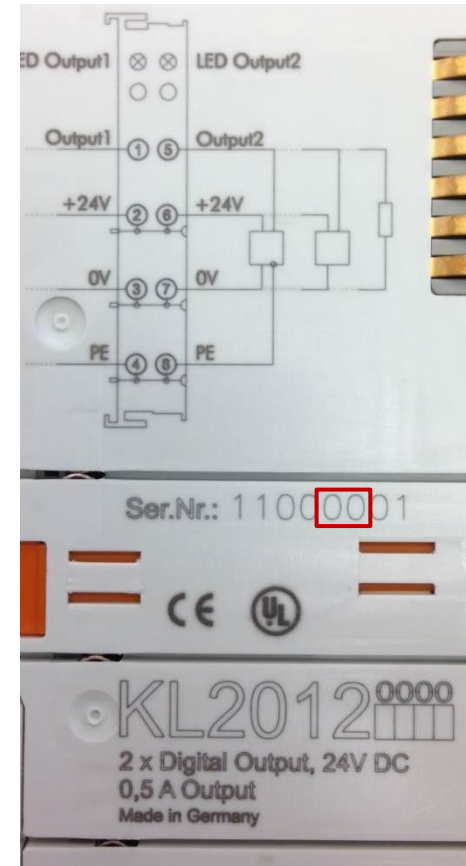
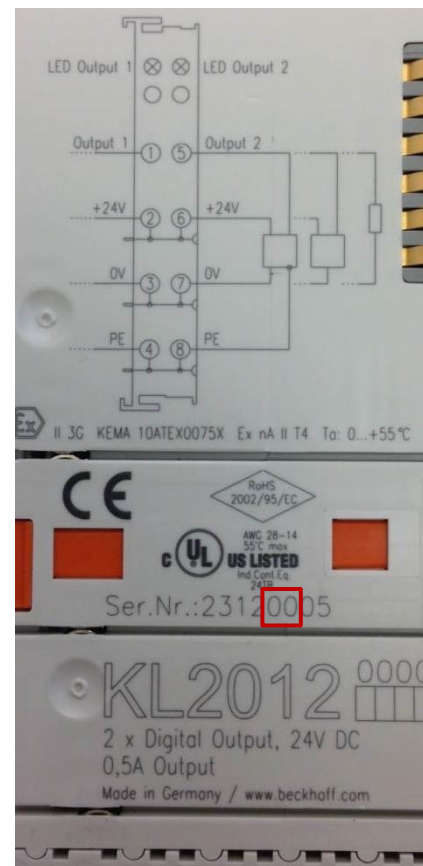
BECKHOFF

Bad Terminal:

- Firmware:00
- Hardware:05

Good Terminal:

- Firmware:00
- Hardware:01



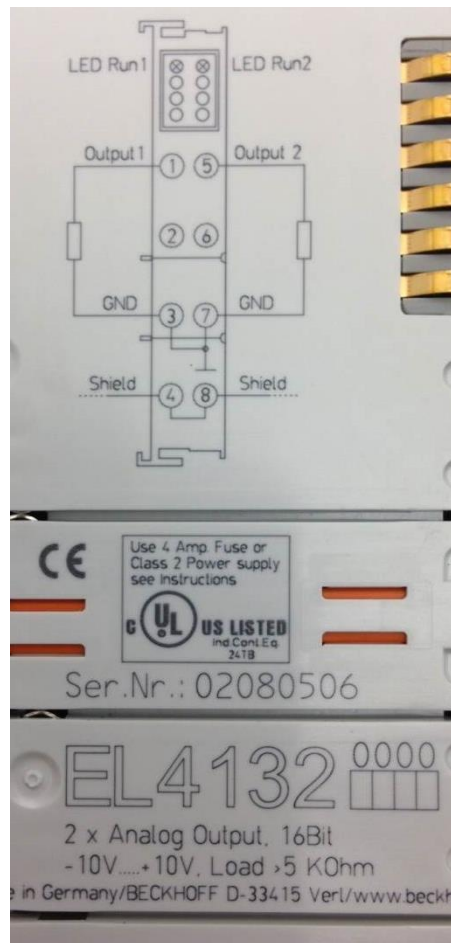
Answer:

This would be an acceptable replacement since the firmware level is the same.

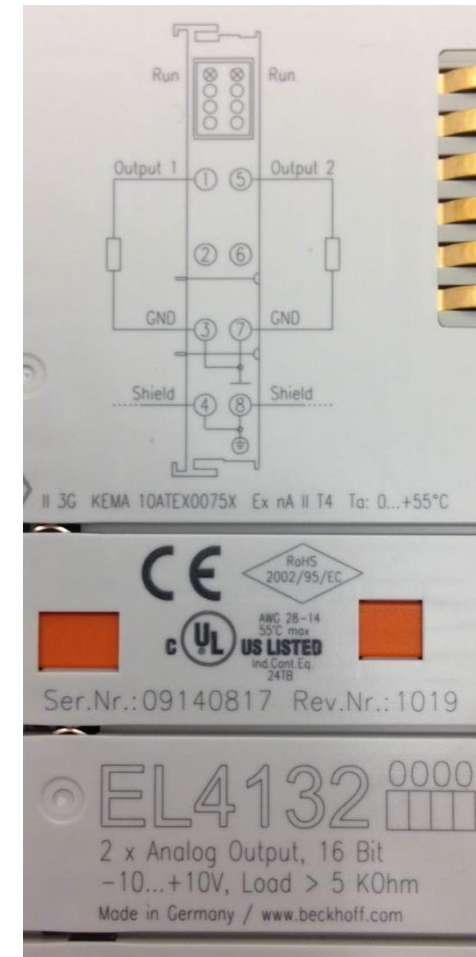
Exercise #2: Is the following an ok replacement?

BECKHOFF

Bad Terminal



Replacement



Exercise #2 Answer:

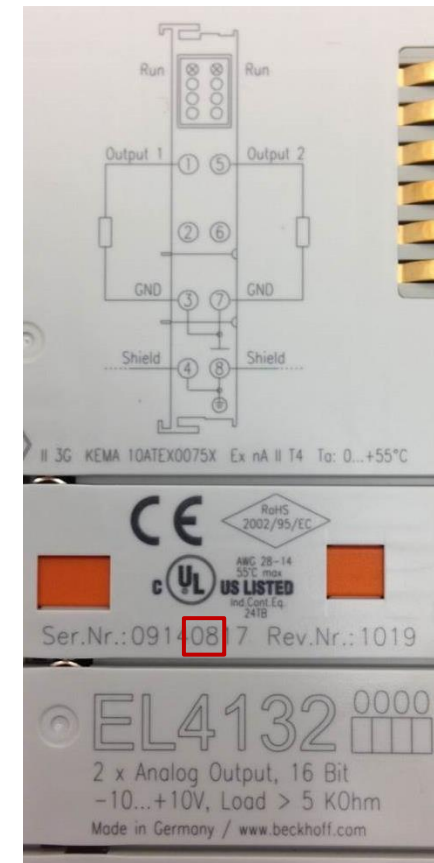
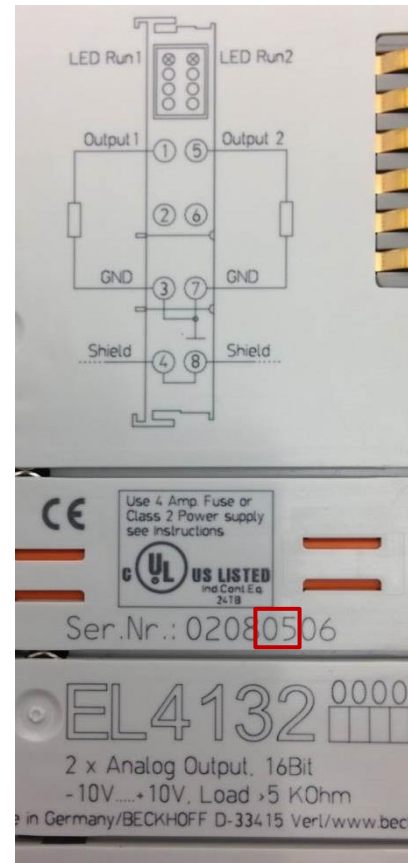
BECKHOFF

Bad Terminal:

- Firmware:05
- Hardware:06

Good Terminal:

- Firmware:08
- Hardware:17



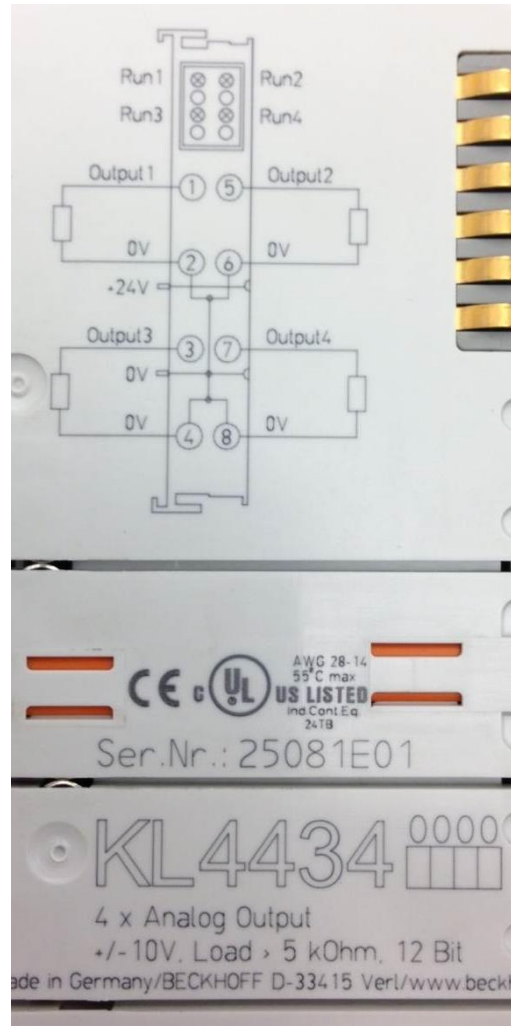
Answer:

Replacement terminal has newer firmware than broken terminal firmware.
This would be an acceptable replacement.

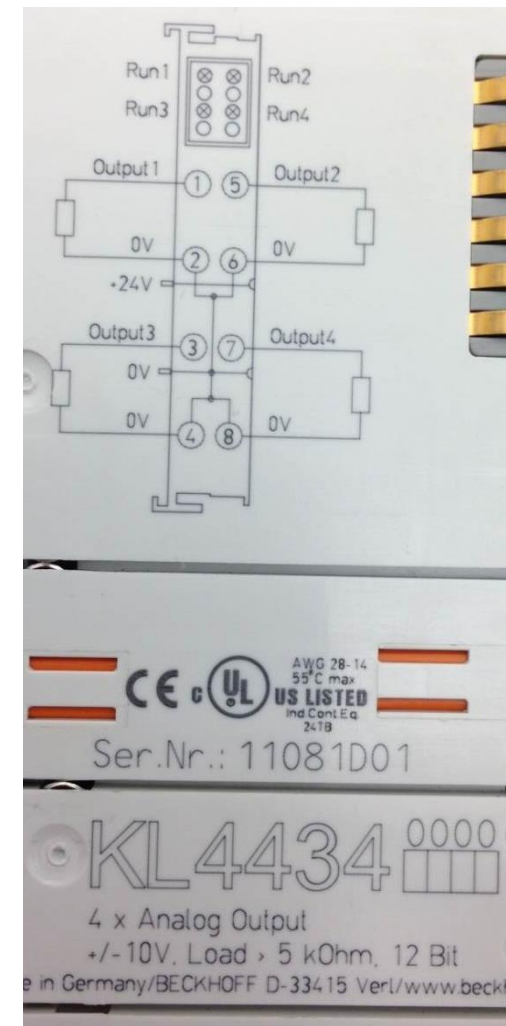
Exercise #3: Is the following an ok replacement?

BECKHOFF

Bad Terminal



Replacement



Exercise #3 Answer:

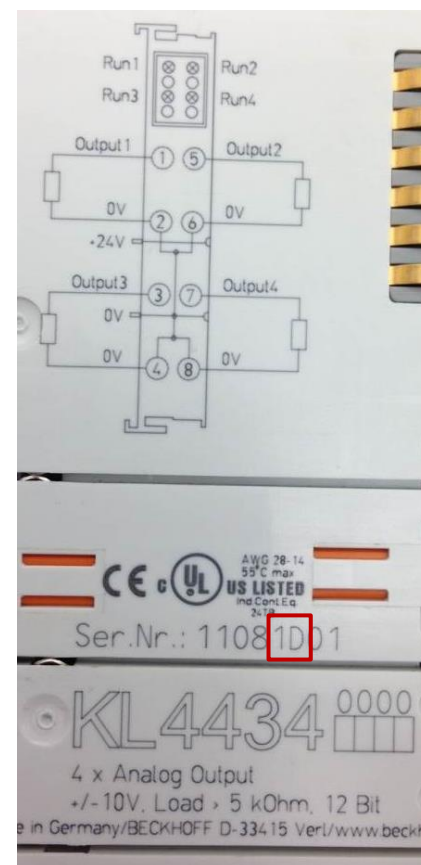
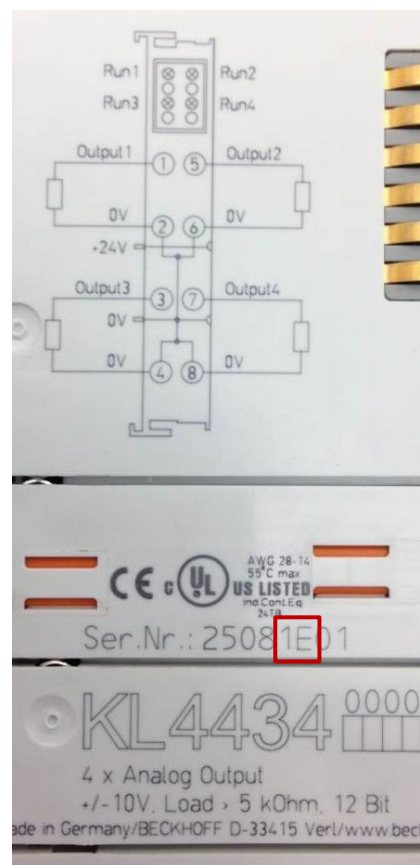
BECKHOFF

Bad Terminal:

- Firmware: 1E
- Hardware: 01

Good Terminal:

- Firmware: 1D
- Hardware: 01



Answer:

The replacement firmware is too old. Ordering a new terminal is required.