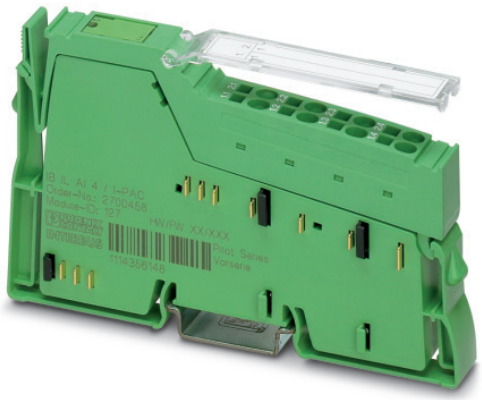
# IB IL AI 4/I-PAC



## Inline analog input terminal, 4 inputs for connecting current signals

Data sheet
8079_en_01_C01



## 1 Description

The terminal is designed for use within an Inline station.

It is used to acquire analog current signals.

### Features

- 4 analog differential input channels for connecting current signals
- Connection of sensors in 2-wire technology
- Current ranges: 0 mA ... 20 mA, 4 mA ... 20 mA
- Mean-value generation of the inputs
- Process data update of all channels in 250 µs
- Diagnostic and status indicators

| |
|---|
| This data sheet is only valid in association with the IL SYS INST UM E user manual. |

| |
|---|
| Make sure you always use the latest documentation.<br>It can be downloaded from the product at www.phoenixcontact.net/catalog. |

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INSPIRING INNOVATIONS

## 2 Table of contents

# 3 Ordering data

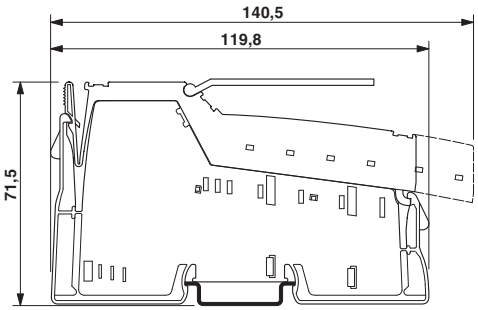
| Description | Type | Order No. | Pcs. / Pkt. |
|---|---|---|---|
| Inline analog input terminal, complete with accessories (connector and labeling field), inputs: 0-20 mA, 4-20 mA, 2-wire connection method | IB IL AI 4/I-PAC | 2700458 | 1 |

| Accessories | Type | Order No. | Pcs. / Pkt. |
|---|---|---|---|
| Shield connection clamp, for shield on busbars, contact resistance < 1 mOhm (Assembly) | SK 8 | 3025163 | 10 |
| Shield connection clamp, for shield on busbars, contact resistance < 1 mOhm (Assembly) | SK 14 | 3025176 | 10 |
| Shield connection clamp, for shield on busbars, contact resistance < 1 mOhm (Assembly) | SK 20 | 3025189 | 10 |
| Shield connection clamp, for shield on busbars, contact resistance < 1 mOhm (Assembly) | SK 35 | 3026463 | 10 |
| Support for busbars (Assembly) | AB-SK | 3025341 | 10 |
| Support, Length: 95.5 mm, Width: 6.2 mm, Color: gray (Assembly) | AB-SK 65 | 3026489 | 10 |
| Support, Length: 10 mm, Width: 56 mm, Height: 20 mm, Color: silver (Assembly) | AB-SK/E | 3026476 | 10 |
| PEN conductor busbar, 3mm x 10 mm, length: 1000 mm (Assembly) | NLS-CU 3/10 SN 1000MM | 0402174 | 10 |
| Power terminal block, Connection method Screw connection, Load current : 41 A, Cross section: 0.5 $mm^2$ - 6 $mm^2$, Width: 7 mm, Color: silver | AK 4 | 0404017 | 50 |
| Power terminal block, Connection method Screw connection, Load current : 41 A, Cross section: 0.5 $mm^2$ - 6 $mm^2$, Width: 7 mm, Color: green-yellow | AKG 4 GNYE | 0421029 | 50 |
| Power terminal block, Connection method Screw connection, Load current : 41 A, Cross section: 0.5 $mm^2$ - 6 $mm^2$, Width: 7 mm, Color: black | AKG 4 BK | 0421032 | 50 |

| Documentation | Type | Order No. | Pcs. / Pkt. |
|---|---|---|---|
| User manual, English, Automation terminals of the Inline product range | IL SYS INST UM E | - | - |
| Data sheet, English, INTERBUS addressing | DB GB IBS SYS ADDRESS | - | - |

# 4 Technical data

## Dimensions (nominal sizes in mm)




| | |
|---|---|
| Width | 12.2 mm |
| Height | 119.8 mm |
| Depth | 71.5 mm |
| Note on dimensions | Housing dimensions |

## General data

| | |
|---|---|
| Color | Green |
| Weight | 66 g (With connector) |
| Ambient temperature (operation) | -25 °C ... 55 °C |
| Ambient temperature (storage/transport) | -25 °C ... 85 °C |
| Permissible humidity (operation) | 10 % ... 95 % (according to DIN EN 61131-2) |
| Permissible humidity (storage/transport) | 10 % ... 95 % (according to DIN EN 61131-2) |
| Air pressure (operation) | 70 kPa ... 106 kPa (up to 3000 m above sea level) |
| Air pressure (storage/transport) | 70 kPa ... 106 kPa (up to 3000 m above sea level) |
| Degree of protection | IP20 |
| Protection class | III, IEC 61140, EN 61140, VDE 0140-1 |

## Connection data Inline connectors

| | |
|---|---|
| Connection method | Spring-cage connection |
| Conductor cross section, solid | 0.08 mm² ... 1.5 mm² |
| Conductor cross section, stranded | 0.08 mm² ... 1.5 mm² |
| Conductor cross section [AWG] | 28 ... 16 |

## Interface Inline local bus

| | |
|---|---|
| Connection method | Inline data jumper |
| Transmission speed | 500 kBit/s |

## Inline potential routing / Power consumption

| | |
|---|---|
| Communications power $U_L$ | 7.5 V DC (via voltage jumper) |
| Current consumption from $U_L$ | Typ. 55 mA |
| I/O supply voltage $U_{ANA}$ | 24 V DC |
| Current consumption from $U_{ANA}$ | Typ. 30 mA |
| Power consumption | Typ. 0.94 W (total) |

| Analog inputs | |
|---|---|
| Number of inputs | 4 (differential inputs, current) |
| Connection method | 2-wire |
| Resolution A/D | 12 bit |
| A/D conversion time | Max. 6.5 µs |
| Measured value representation | 13 bits (12 bits + sign bit) |
| Data formats | IB IL, S7-compatible |
| Process data update | Typ. 250 µs (all channels) |
| Filtering | None or mean-value generation over 4, 16, or 32 measured values |
| Current input signal | 0 mA ... 20 mA (Default) , 4 mA ... 20 mA |
| Input resistance current input | Typ. 113 Ω |
| Limit frequency (3 dB) | 300 Hz |
| Open circuit response | Going to 0 mA; open-circuit detection from 4 mA ... 20 mA |
| Permissible voltage | Max. 5.2 V (between positive and negative current connection; corresponds to 50 mA, maximum, through the resistance detectors) |

| Programming Data | |
|---|---|
| ID code (hex) | 7F |
| ID code (dec.) | 127 |
| Length code (hex) | 04 |
| Length code (dec.) | 04 |
| Process data channel | 64 Bit |
| Input address area | 8 Byte |
| Output address area | 8 Byte |
| Parameter channel (PCP) | 0 Byte |
| Register length (bus) | 64 Bit |

| PROFIBUS telegram data | |
|---|---|
| Required parameter data | 10 Byte |
| Need for configuration data | 5 Byte |

| Error messages to the higher level control or computer system | |
|---|---|
| Failure of the internal I/O supply | I/O error message sent to the bus coupler |
| I/O supply failure | Message in the diagnostic code (in the IB IL format) |
| Overrrange or underrange | Message in the diagnostic code (in the IB IL format) |
| Configuration invalid | Message in the diagnostic code (in the IB IL format) |

| Electrical isolation/isolation of the voltage areas | |
|---|---|
| 5 V supply, incoming remote bus/7.5 V supply (bus logics) | 500 V AC, 50 Hz, 1 min |
| 5 V supply, outgoing remote bus/7.5 V supply (bus logics) | 500 V AC, 50 Hz, 1 min |
| 7.5 V supply (bus logic), 24 V supply $U_{ANA}$ / I/O | 500 V AC, 50 Hz, 1 min |
| 7.5 V supply (bus logic), 24 V supply $U_{ANA}$/functional earth ground | 500 V, 50 Hz, 1 s |
| I/O / functional earth ground | 500 V, 50 Hz, 1 s |

| Conformance with EMC Directive 2004/108/EC | |
|---|---|
| **Noise immunity test in accordance with EN 61000-6-2** | |
| Electrostatic discharge (ESD) EN 61000–4–2/IEC 61000–4–2 | Criterion B; 6 kV contact discharge, 8 kV air discharge |
| Electromagnetic fields EN 61000–4–3/IEC 61000–4–3 | Criterion A; Field intensity: 10 V/m |
| Fast transients (burst) EN 61000–4–4/IEC 61000–4–4 | Criterion B, 2 kV |
| Transient surge voltage (surge) EN 61000–4–5/IEC 61000–4–5 | Criterion B; supply lines DC: ±1 kV/±1 kV (symmetrical/asymmetrical); shielded I/O cables: ±1 kV |

| Conformance with EMC Directive 2004/108/EC | |
|---|---|
| Conducted interference EN 61000–4–6/IEC 61000–4–6 | Criterion A; Test voltage 10 V |
| **Noise emission test according to EN 61000-6-3** | |
| Radio interference properties EN 55022 | Class A |

| Approvals |
|---|
| For the latest approvals, please visit www.phoenixcontact.net/catalog. |

# 5 Tolerance data

**The following applies for tolerance values:**

The data is valid for nominal operation ($U_A$= 24 V in the default configuration (unless documented otherwise).

Default configuration: 16-sample mean-value, IB IL format

| Tolerances at $T_A$ = 25°C; 500 kbps, without mean-value | | | | |
|---|---|---|---|---|
| | Absolute | | Relative | |
| | Typ. | Max. | Typ. | Max. |
| 0 mA ... 20 mA, 4 mA ... 20 mA | ±60 µA | ±120 µA | ±0.3% | ±0.6% |

Typical data contains offset error, gain error, and linearity error in the respective default setting.

All tolerances indicated as a percentage are related to the positive measuring range final value.

Please also observe the values for temperature drift and the tolerances under influences of electromagnetic interferences.

| Tolerance and temperature response at $T_A$ = -25°C ... +55°C | | |
|---|---|---|
| | Drift | |
| | Typical | Maximum |
| 0 mA ... 20 mA, 4 mA ... 20 mA | ±100 ppm/K | ±140 ppm/K |

The drift values refer to the relevant measuring range final value.

| Tolerances influenced by electromagnetic interference | | |
|---|---|---|
| Electromagnetic fields | EN 61000-4-3/ IEC 61000-4-3 | < ±1.0% |
| Fast transients (burst) | EN 61000-4-4/ IEC 61000-4-4 | < ±1.0% |
| Conducted interference | EN 61000-4-6/ IEC 61000-4-6 | < ±1.0% |

Additional tolerances may occur due to the influence of high-frequency electromagnetic interference caused by wireless transmission systems in the near vicinity. The values specified refer to nominal operation in the event of direct interference to components without additional shielding such as a steel cabinet, etc.

The above mentioned tolerances can be reduced by providing further shielding measures for the I/O module (e.g., use of a shielded control box/control cabinet, etc.).

## 6 Internal circuit diagram

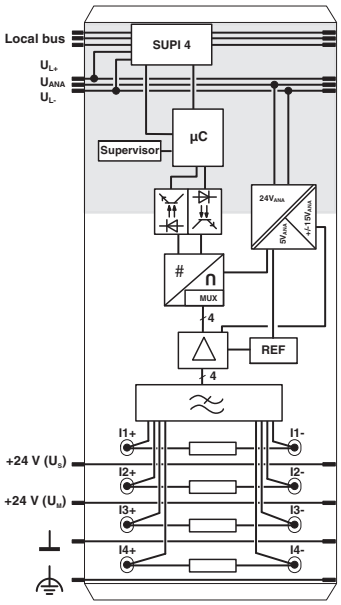


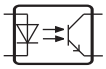

Figure 1 Internal wiring of the terminal points

Key:


Protocol chip


Microprocessor


Hardware monitoring



Optocoupler

Power supply unit with electrical isolation


Analog-digital converter with integrated multiplexer

Input amplifier

Low pass filter

Electrically isolated area


Reference voltage source

Explanation for other used symbols has been provided in the IL SYS INST UM E user manual.

## 7 Terminal point assignment

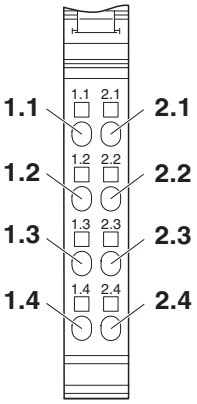



Figure 2 Terminal point assignment

| Terminal point | Signal | Meaning |
|---|---|---|
| 1.1 | +I1 | Positive current connection for channel 1 |
| 1.2 | +I2 | Positive current connection for channel 2 |
| 1.3 | +I3 | Positive current connection for channel 3 |
| 1.4 | +I4 | Positive current connection for channel 4 |
| 2.1 | -I1 | Negative current connection for channel 1 |
| 2.2 | -I2 | Negative current connection for channel 2 |
| 2.3 | -I3 | Negative current connection for channel 3 |
| 2.4 | -I4 | Negative current connection for channel 4 |

## 8 Connection notes

Always connect the analog sensors using shielded, twisted pair cables.

Connect the shielding with the shielding accessories given in the ordering data.

Insulate the shielding at the sensor or connect it with a high resistance and a capacitor to the PE potential.

## 9 Installation instructions

High current flowing through potential jumpers $U_M$ and $U_S$ leads to a temperature rise in the potential jumpers and inside the terminal. To keep the current flowing through the potential jumpers of the analog terminals as low as possible, always place the analog terminals after all the other terminals at the end of the main circuit (for the sequence of the Inline terminals: see also IL SYS INST UM E user manual).

## 10 Connection examples

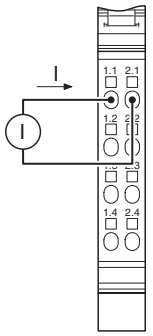



Figure 3 Connection for current measurment

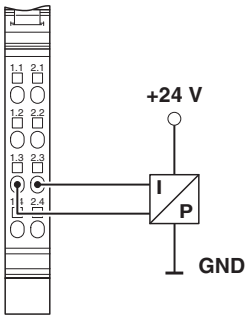



Figure 4 Passive pressure sensor at a differential current input

## 11 Electrical isolation

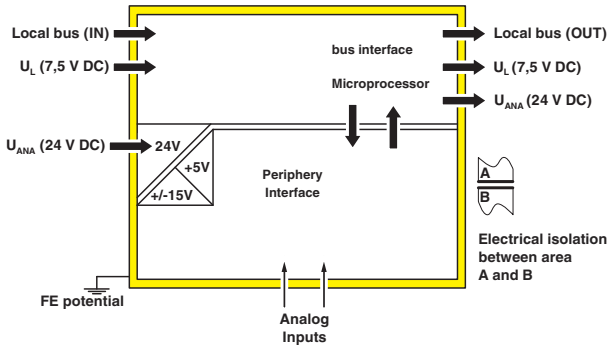



Figure 5 Electrical isolation of the individual function areas

## 12 Local status and diagnostic indicators

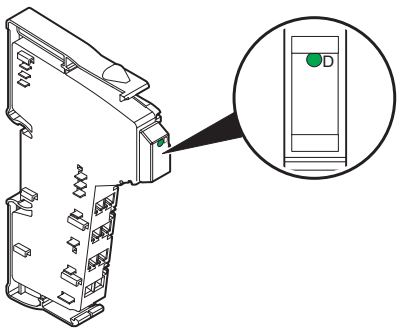



Figure 6 Local status and diagnostic indicators

| Designation | Color | Meaning |
|---|---|---|
| D | green | Diagnostics (bus and logic voltage) |

For detailed information on diagnostics, please refer to the IL SYS INST UM E user manual.

**Function identification**

Green

## 13 Process data

The terminal uses four input process data words and four output process data words.

Each channel is mapped to a word.

The analog values are transmitted via the input process data.

The configuration is specified via the output process data.

### 13.1 OUT process data

The terminal can be configured channel-by-channel with the output process data.

Order of the process data words:

| OUT1 | OUT2 | OUT3 | OUT4 |
|---|---|---|---|
| Channel 1 | Channel 2 | Channel 3 | Channel 4 |

Assignment of the configuration words (OUT1 ... OUT4):

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Config-uration | 0 | 0 | 0 | 0 | 0 | Fil-ter | | 0 | 0 | For-mat | | Measur-ing range | | | |

**Bit 15**

| Code (bin) | Configuration |
|---|---|
| 0 | Do not accept |
| 1 | Accept |

The configuration specified in the word is accepted if bit 15 is set. If bit 15 is not set, the last accepted configuration is used.

The configuration is not saved retentively in the terminal.

It is therefore not necessary to transmit the configuration constantly. That means, bit 15 must not be set constantly.

If bit 15 remains set, the transmitted configuration is compared with the configuration of the terminal in every bus cycle.

The terminal is reconfigured if the configurations are different.

Please make sure that the configuration is sent from the master to the terminal in the event of a restart.

**Bits 9 ... 8**

| Code (bin) | Filter |
|---|---|
| 00 | **16-sample mean-value (default)** |
| 01 | No filter |
| 10 | 4-sample mean-value |
| 11 | 32-sample mean-value |

**Bits 5 ... 4**

| Code | Format |
|---|---|
| 00 | **IB IL (default setting)** |
| 10 | S7-compatible |
| Other | Reserved |

See also Section "Measured value representation in the different formats".

**Bits 3 ... 0**

| Code | Measuring range |
|---|---|
| 0100 | **0 mA ... 20 mA (default)** |
| 0110 | 4 mA ... 20 mA |
| Other | Reserved |

### 13.2 IN process data

The measured values and diagnostic messages (in the IB IL format) are transmitted channel-by-channel to the PLC via the process data input words IN1 to IN4.

Order of the process data words:

| IN1 | IN2 | IN3 | IN4 |
|---|---|---|---|
| Channel 1 | Channel 2 | Channel 3 | Channel 4 |

The measured values are transmitted in the IB IL format or in the S7-compatible format (see Section "Measured value representation in the different formats").

### 13.3 Read firmware version

| OUT1 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Assignment (hex) | 3 | | | | C | | | | 0 | | | | 0 | | | |
| Meaning | Read firmware version | | | | | | | | | | | | | | | |

To read the firmware version transmit the value $3C00_{hex}$ in the output data word OUT1. The words OUT2 ... OUT4 still contain the configuration words for channels 2 to 4.

In response you get the firmware version in input data word IN1. The input data of the associated channels are transmitted in the other input data words.

| IN1 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Assignment (hex) | 1 | | | | 2 | | | | 3 | | | | 3 | | | |
| Meaning | Firmware version 1.23 | | | | | | | | | | | | Device ID | | | |

The device ID allows you to distinguish between two devices with the same programming data (ID code, length code).

| Inline terminal | ID code | Length code | Device ID |
|---|---|---|---|
| IB IL AI 4/I-PAC | $7F_{hex}$ | $04_{hex}$ | 3 |
| IB IL AI 4/U-PAC | $7F_{hex}$ | $04_{hex}$ | 6 |

# 14 Measured value representation in the different formats

## 14.1 IB IL format

The measured value is represented in bits 14 to 3.

An additional bit (bit 15) is available as a sign bit.

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SB | Analog value | | | | | | | | | | | | X | X | X |

SB Sign bit

X This bit can have the value 0 or 1. The bit is always 0 when a measured value is transmitted. The bit can have the value 1 only when a diagnostic code is transmitted.

### Significant measured values

| Input data | | 0 mA ... 20 mA | 4 mA ... 20 mA |
|---|---|---|---|
| **hex** | **dec** | **mA** | **mA** |
| 8001 | Overrange | > 21.675 | > 21.339 |
| 7F00 | 32512 | 21.675 | 21.339 |
| 7530 | 30000 | 20.0 | 20.0 |
| 0008 | 8 | 0.00533 | 4.00427 |
| 0000 | 0 | ≤ 0 | 4.0 ... 3.2 |
| 8002 | Open circuit | - | < 3.2 |

In the IB IL format a diagnostic code is mapped to the input data in the event of an error.

| Code (hex) | Cause |
|---|---|
| 8001 | Measuring range exceeded (overrange) |
| 8002 | Open circuit |
| 8004 | Measured value invalid/no valid measured value available |
| 8010 | Configuration invalid |
| 8020 | Faulty supply voltage |
| 8040 | Device faulty |

## 14.2 S7-compatible format

The measured value is represented in bits 14 to 3.

An additional bit (bit 15) is available as a sign bit.

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SB | Analog value | | | | | | | | | | | | 0 | 0 | 0 |

SB Sign bit

### Significant measured values

| Input data | | 0 mA ... 20 mA | 4 mA ... 20 mA |
|---|---|---|---|
| **hex** | **dec** | **mA** | **mA** |
| 7FFF | Overrange | > 23.513 | > 23.513 |
| 7EF8 | 32504 | 23.513 | 22.810 |
| 6C00 | 27648 | 20.0 | 20.0 |
| 0008 | 8 | 0.00579 | 4.00463 |
| 0000 | 0 | ≤ 0 | 4.0 |
| FFF8 | -8 | - | 3.999537 |
| 9400 | -27648 | - | 3.0 |
| 8000 | Open circuit | - | < 1.1852 |

The value $8000_{hex}$ is specified in S7-compatible format for all errors for which diagnostic codes $8001_{hex}$ to $8040_{hex}$ are output in IB IL format.

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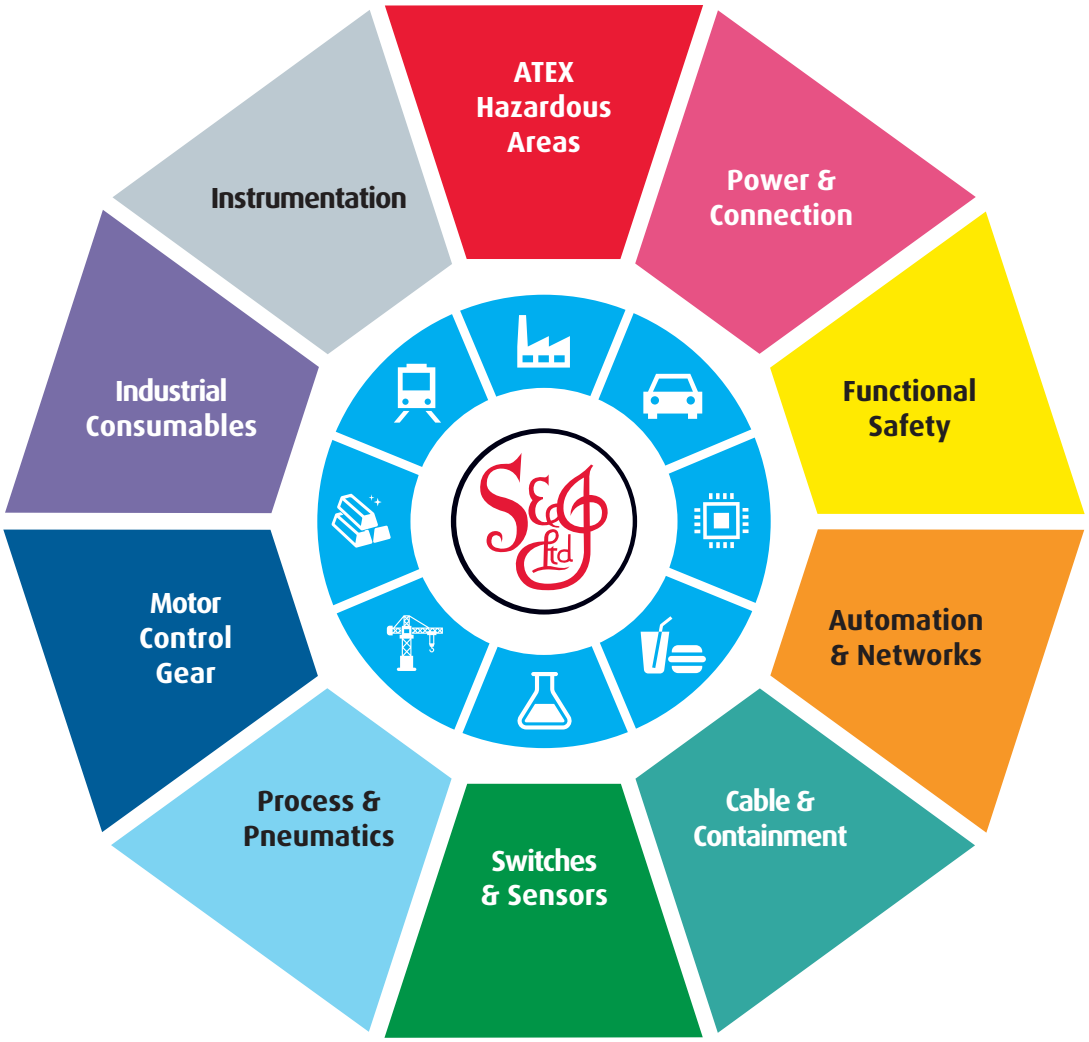


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