Modular
Robust
High-performance

cSCALE
Control Solutions

WIKA
MOBILE CONTROL

cSCALE controller

Solutions for mobile machines

Performance in harsh environments

In a networked and increasingly complex world the requirements on efficient and reliable control solutions for mobile applications are continually on the rise.
Off-highway vehicles, construction machinery, and agricultural mobile machinery as well as machinery for hoisting and material handling have to operate under extreme environmental conditions. Stringent safety regulations have to be fulfilled to ensure the protection of persons, environment and machine.
Therefore, flexible adaption to changing market conditions is essential. The cSCALE controller is built into extremely robust housings and is highly protected against shock, vibration, dust and water.

Safety with high availability

The certified cSCALE contains a unique combination of a high-performance functional CPU in combination with a certified safety CPU. Hardware as well as software are completly certified. That allows highly sophisticated application programs to run in the same PLC control system as the SIL 2 safety applications.

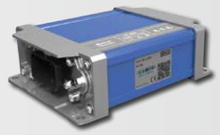
- Certified SIL 2/PL d Cat.2 controller according to IEC 62061 and EN 13849
- TÜV certified in conformity with EN ISO 13849 PL d and IEC 62061 SIL 2
- Complete control solutions according to EN13849/EN13000
- High-performance application CPU
- Certified arithmetic floating point and trigonometric functions
- Support of redundant system architectures

Tailored Control Solutions for mobile machinery

- Individually tailored control solutions based on scalable architecture
- Support of central or distributed control architectures for mobile automation
- Modular I/O configurations according to machine requirements
- Protection class IP20 or IP66/67, depending on the preferred installation, fulfilling the same level of sinusoidal vibrations, broadband noise and temperature range
- Flexibility in application programming, CoDeSys 2.3 and C/C++
- Flexible selection of communication interfaces (embedded Ethernet, up to 6 independent CAN interfaces, USB)

Product Overview: cSCALE controller

cSCALE controllers provide control solutions that grow in line with any requirements.

cSCALE S-Series 1 Modular PLC control – safe or non safe	cSCALE IMC A0525 2 Intelligent Mobile Controler	cSCALE I2 3 Compact Solution with integrated PLC Control into graphical HMI
Any HMI connectable	Any HMI connectable	HMI
PLC control	PLC control	PLC control
		
Integrated safety	–	–
		

1 cSCALE S-Series

Modular controller for harsh environments

- Ethernet, USB, CANopen, CANopen Safety, J1939 interfaces
- Higher electromagnetic compatibility levels than standards require
- Rugged design and high resistance to shock and vibration for rough operating conditions and the influence of dirt, moisture and water (IP66/67 and IP20)
- Extremely high temperature range from -40°C to +70°C

NEW **cSCALE S9**

- Processor
  - NXP: i.MX6.UL
  - ARM Cortex A7@528MHz
  - FPU for fast arithmetic calculation integrated
  - Longevity: 15 years
- CAN extension
- Memory Back-up
  - CPU power supply back-up based on industrial grade SuperCAP
  - 2 MByte DDR3 RAM to FLASH
- Update-medium: Windows formated USB-Stick
- Time from switch-off to possible switch-on: 0s

PL d/SIL 2 certified PLC control with rugged design

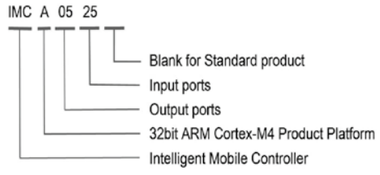
- trueSafety: PL d Cat.2/SIL 2 certified controller according to IEC 62061 and EN 13849 and corresponding to the requirements of the Machine Directive 2006/42/EC
- Certified hardware and software
- Certified safety CPU
- High-performance application CPU
- Certified arithmetic floating point and trigonometric functions
- Support of redundant system architectures
- Programmable with CoDeSys 2.3 or C++
- Optimum safety with high availability
- Robust and shock-proof in extreme conditions

2 cSCALE IMC A0525

Intelligent Mobile Controller

cSCALE IMC A0525 is a powerful mobile controller for the use under demanding conditions in off-highway applications. It is part of a compatible product family and protected by a robust housing designed for the off-highway industry.

- 32-bit ARM Cortex-M4 processor, 180 MHz, 256 kB int. RAM, Optional: 2 MB int. Flash
- 2 KB FRAM
- 1 x RS-232 serial interfaces
- 2 x CAN 2.0 B, 50 kbit/s up to 1 Mbit/s
- 8 x analog input, 0...5 V or 4...20 mA/12bit, can be configured by software
- 2 x frequency input, 10 Hz to 15 kHz
- 12 x digital input, high valid > 4 V
- 3 x digital input, low valid < 2 V
- 4 x digital output, 1 A high-side, PWM, open load detection,
- 12 bit current feedback, current output accuracy 0.5 %
- 1 x sensor supply 5 V, 100 mA
- 3 x status LED, PWR, SYS, USER
- Internal: monitoring of board temperature, sensor supply and battery
- Software: C/C++, KW Multiprog



Description	cSCALE IMC A0525
Operating voltage	8...36 V DC
Idle current	< 100 mA@24 V DC
Operating temperature	-40°C to +70°C
Storage temperature	-40°C to +85°C
Weight	0.691 kg
Housing material	Aluminum
Protection class	IP66/IP67
EMC	IEC 61000-6-2:2005, IEC 61000-6-4:2007, ISO7637-2, ISO7637-3, ISO16750-2
Vibration	IEC 60068-2-6:2008

3 cSCALE I2

Compact Solution with integrated PLC Control into graphic HMI

cSCALE I2 combines a rea l PLC control with graphic HMI in only one device. This represents an ideal and cost-effective alternative for small applications where a HMI console and some PLC control functions are required.
Both parts of the application program (HMI and PLC control) are programmed on the same unit with CoDeSys 3.5. Due to the fact that both application parts are running on the device, an easy and fast exchange of data is given without communication via any network.

cSCALE I2-C

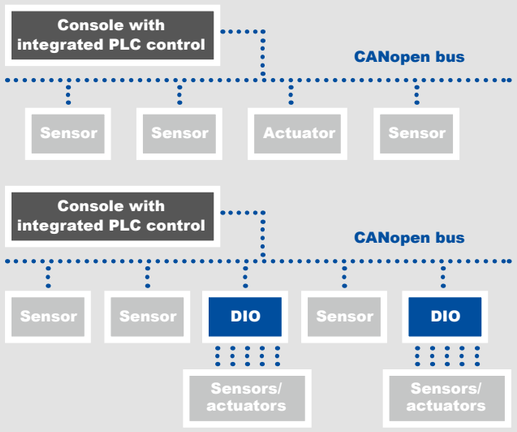
cSCALE I2-D

cSCALE I2 with I/O expansion over distributed I/O

cSCALE I2-C cSCALE DIO

cSCALE I2-D cSCALE DIO

Collecting I/O data via CANopen, cSCALE I2 can be used on its own or in combination with a cSCALE DIO (distributed I/O).



cSCALE I2 – Technical Data

Description	cSCALE I2
Supply voltage	8…36 $V_{max.}$ DC
Operating temperature	-30 °C to +70 °C (-22 °F to +158 °F) -40 °C (-40 °F) optional
Mounting	in-dash or on-dash (only requires different mounting accessories)
Protection class	IP66
Buzzer	internal buzzer 65 dBA, output for external buzzer
Ethernet interface	10/100 Mbit/s Base T, TCP/IP, M12 connector
CAN protocols	CANopen, J1939, others on request
Display	4,3" (480 x 272 resolution)

cSCALE S-Series Modularity

Basics

CPU

cSCALE
- Different CPU modules

+ Integrated SLI = **qSCALE**

Power supply

- 8...48 V
- 8...33 V for safety applications
- Cut-off relay

- 8.2 V/500 mA i.e. NAMUR
- 12 V/500 mA (stabilized CAN 1 V)

I/O

- Digital & analog standard or diagnostic inputs and outputs

- Further I/O

Housing

- IP20
- IP66/67

- Modular housing sizes
- Basic housing + expansion

Communication

- Ethernet
- USB
- CAN

- CAN extensions

Optional & Modular extendable

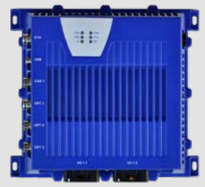
cSCALE S-Series Configuration Examples

cSCALE IP66/67

28 I/Os, 1x ETH, USB, 3x CAN

I/Os:
- 4x digital input DI with HSC option
- 8x digital input DI DIAG with extended diagnostics
- 8x analog input 4…20 mA (up to 4 could be used also as 0...10 V)
- 4x digital output with 1 Aav
- 4x digital output with PWM and current control and 2 Aav
- 1x output with 2 cut-off relay in serial (1+1)

Interfaces:
- 1x Ethernet 10/100 Base-T
- 3x CANopen/CANopen Safety/J1939
- 1x USB



cSCALE IP20

16 I/Os, 1x ETH, USB, 1x CAN, SYS-Ext.

I/Os:
- 8x digital input DI DIAG with extended diagnostics
- 4x digital output with 1 Aav
- 4x digital output with PWM and current control and 2 Aav
- 1x output with 2 cut-off relay in serial (1+1)

Interfaces:
- 1x Ethernet 10/100 Base-T
- 1x USB
- 1x CANopen/CANopen Safety/J1939
- 1x cSCALE SYS-Ext. for local I/O expansion

cSCALE IP66/67

100 I/Os, 1x ETH, USB, 1x CAN, SYS-Ext., 8.2 V PS (500 mA)

I/Os:
- 8x digital input DI with HSC option
- 20x digital input DI DIAG with extended diagnostics
- 24x analog input 4...20 mA (up to 4 could be used also as 0...10 V)
- 32x digital output with 1 Aav
- 14x digital output with PWM and current control and 2 Aav
- 2x digital output with PWM and current control and 4 Aav
- 1x output with 2 cut-off relay in serial (1+1)

Interfaces:
- 1x Ethernet 10/100 Base-T
- 1x USB
- 1x CANopen/CANopen Safety/J1939
- 1x cSCALE SYS-Ext. for local I/O expansion (max. 128 further I/O)

cSCALE IP20

168 I/Os, 1x ETH, USB, 1x CAN, SYS-Ext., 8.2 V PS (500 mA)

I/Os:
- 24x digital input DI with HSC option
- 40x digital input DI DIAG with extended diagnostics
- 16x analog input 4...20 mA (up to 4 could be used also as 0...10 V)
- 60x digital output with 1 Aav
- 24x digital output with PWM and current control and 2 Aav
- 4x digital output with PWM and current control and 4 Aav
- 1x output with 2 cut-off relay in serial (1+1)

Interfaces:
- 1x Ethernet 10/100 Base-T
- 1x USB
- 1x CANopen/CANopen Safety/J1939
- 1x cSCALE SYS-Ext. for local I/O expansion (max. 208 further I/O)

CPU Modules

CoDeSys C++

A wide range of powerful 32-bit CPUs cover a large variety of applications, from the integrated controller into a graphic HMI with safety CPU, PL d and SIL 2 certification.

Flexible programming

One common software platform for the complete controller range offers overall software compatibility. For this reason the same application software can run on all CPUs. Program or firmware updates can be easily implemented by using a USB memory stick. All cSCALE CPUs are designed for usage under extreme external environmental conditions, i. e. in an extended temperature range from -40°C up to +70°C. They are also shock and vibration resistant. Furthermore, systems without CPUs are available as expansion rack (IP20) or module (IP66/67).

The cSCALE Controller is programmable with CoDeSys according to IEC 61131-3 or alternatively in C/C++.

cSCALE (IP20 & IP66/67) CPU Modules

	cSCALE I2 Integrated control/HMI*	cSCALE IMC A0525*	cSCALE S6 trueSafety	cSCALE S9 NEW
	not modular		modular	
CPU	32-bit/ 532 MHz	32-bit/ 180 MHz	32-bit/ 500 MHz	32-bit/ 528 MHz
Flash	0.5 GB	2 MB	48 MB	256 MB
RAM	256 MB	256 kB	128 MB	144 MB
RAM battery buffered	–	–	2 MB	–
FRAM	–	2 kB	–	–
Optional Micro SD Card	–	–	•	up to 2 GB
FPU (HW)	•	–	–	•
Ethernet 10/100 Base-T	•	–	•	•
USB 2.0	• (up to 2 USB)	–	•	•
CANopen/CANopen Safety	• (2 CANopen)	–	•	•
Support of J1939 on standard CANopen interface	•	–	•	•
SYS expansion	–	–	•	•
FBAS, 1 analog video input	•	–	–	–
HMI	4.3" TFT color graphic LCD with LED backlight	–	–	–
Integrated SLI/LMI libary (optional)	with qSCALE I2	–	with qSCALE S6	with qSCALE S9
CoDeSys	3.5	–	2.3	2.3
EN13849-1 architecture	–	–	Cat. 2	Cat. 2
SIL/PL d classification	–	–	PL d/SIL 2	PL d/SIL2

* Not expandable with PS and I/O

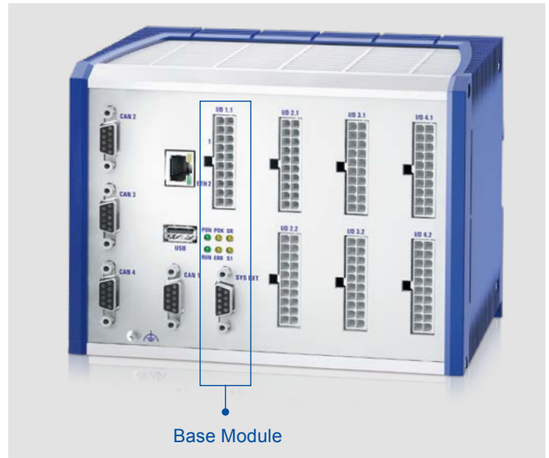
cSCALE S-Series Base Module: Power Supply & I/O Module included

The power supplies of the cSCALE Controller are designed for mobile applications. The DC/DC power supply is fully developed according to ISO 7637-2.

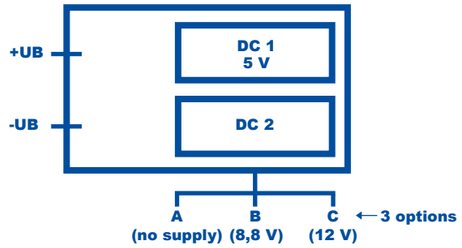
The power supplies are already equipped with some I/Os as well as 2 serially connected safety cut-off relays. Three power supply options are available with the IP20 and IP66/67 housings:

- Type A: Internal power source only
- Type B: External 8.2V NAMUR input
- Type C: 12V CAN bus power

- Reverse voltage protection up to 100 V
- Short circuit protection
- Low-pass filter
- Active over voltage protection
- Redundant safety cut-off relays
- Diagnostic LEDs: power ON, power OK, safety relay ON, RUN, Error, S1-free programmable LED



Type	Power Supply (PS)	IP20	IP66/67
A	PS 5	X	X
B	PS 5N	X	X
C	PS 512		X



Base Module: Power Supply with I/O

	IP20 power supplies		IP66/67 power supplies					
	PS5-I/O 01	PS5N-I/O 01	PS5-I/O 03-02	PS5N-I/O 03-02	PS5C-I/O 03-02	PS5-I/O 11-12	PS5C-I/O 11-12	PS5C-I/O 11
	SIL 2/PL d							
DI with HSC option	–	–	4	4	4	14***	14***	10****
DI DIAG	8	8	8	8	8	2 (Pos. logic only)	2 (Pos. logic only)	2 (Pos. logic only)
AI 4...20 mA AI 0 ..10 V	–	–	8-4 0-4*	8-4 0-4*	8-4 0-4*	8 see AI 0-UB	8 see AI 0-UB	8 –
AI 0-UB (max. 36 V), usable also as AI 0 ...10 V or DI	–	–	–	–	–	8	8	0
DO (1 Aav)	4**	4**	4**	4**	4**	16	16	4**
DO PWM with CC (2 Aav)	4**	4**	4**	4**	4**	8	8	4**
DO PWM with CC (4 Aav)	–	–	–	–	–	–	–	–
8.2 V power supply (500 mA)	–	•	–	•	–	–	–	–
CANopen power supply (12 V) (500 mA) for CAN1	–	–	–	–	•	–	•	•
Voltage	8…48 V	8…48 V	8…48 V	8…48 V	8…48 V	6…33 V	6…33 V	6…33 V

[1] Future release

* Selection of voltage input reduces number of current input

** Sum of current 8 Aav

*** 8 with HSC option

**** 4 with HSC option

I/O Modules of cSCALE Control Systems

The modular design of the cSCALE controllers allows a wide range of specialized input and output options including PWM outputs with current control or DIAG inputs with additional diagnostics. The DI DIAG inputs on safety I/Os provide self-testing acc. to PL d EN 13849:

- Short to battery
- Short to ground
- Open load

In addition, within the safety system all safety I/Os provide self tests to fulfill PL d and SIL 2 acc. to EN 13849 Cat. 2. They provide diagnostic information to the system integrator.
All digital outputs are equipped with the latest generation of high voltage PROFET technology with integrated short-circuit, TVS and overheating protection. The PWM outputs offer a high crest factor 4 for 2 A and 2.25 for 4 A outputs. The frequency of the PWM outputs can be configured between 50 Hz and 400 Hz.

Intelligent I/Os have a complex, flexibly configurable diagnosis function. The powerful self-diagnosis and monitoring functions on the CPU board and each individual I/O card have been designed to recognize faults immediately. The machine returns into a safe operating condition.
Each I/O cell has an autonomous safety system consisting of a particular processor and separate watchdog. When a fault is recognized every cell immediately switches off.

The safe programming can be realized flexibly in CoDeSys/ IEC61131 languages (FUP, KOP, ST, AWL) or C/C++. Up to 2 GB flash storage space is available for program and data storage. A battery-buffered storage area (RAM) permanently ensures safe data.

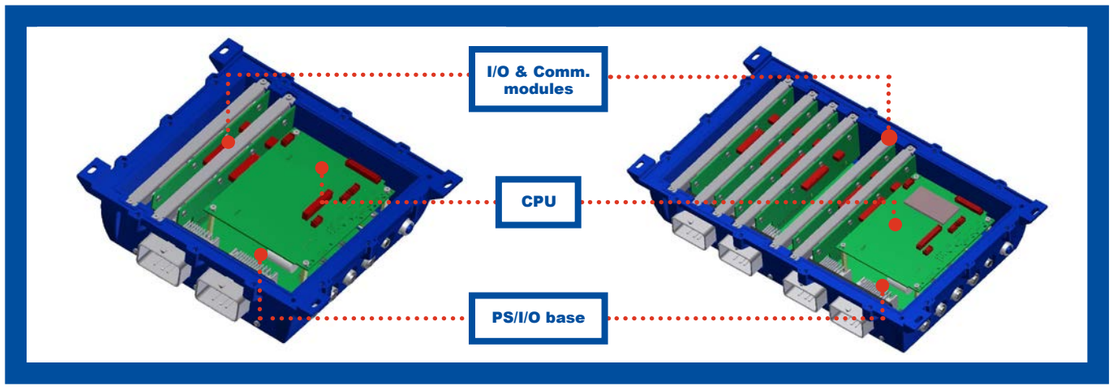
The following I/Os can be used as safety declared I/Os according to EN ISO 13849-1 Cat. 2 with performance level PL d (or SIL 2):

Requirement	WIKA Mobile Control solution
Digital input	DI DIAG
Digital input for NAMUR sensor	DI NAMUR
Analog input (11 Bit)	AI (4...20 mA)
Digital PWM output with current control	DO PWM with CC
Digital static output	DO

Application safe used I/Os:

Requirement	WIKA Mobile Control solution
Digital static input	DI dual channel
High Speed Counter input	DI with HSC option dual channel
Analog input (11 Bit)	AI (4...20 mA)/AI (0...10 V) dual channel
Digital PWM output with current control	DO PWM with CC dual channel
Digital static output	DO dual channel

Visualization of I/O Modularity in a IP66/67 Housing



Communication Options

To adapt the cSCALE Control System to specific communication requirements, several CANopen modules are available in addition to the standard CANopen interface on the CPU. CAN extensions are certified according to EN 13849 PL d and IEC 62061 SIL 2.

IP20	
CAN extensions	3x CANopen with sub-D connector
	5x CANopen with M12 connector

IP66/67	
CAN extensions	2x CANopen and SYS-Ext with M12 connector
	3x CANopen w/o SYS-Ext with M12 connector

The cSCALE control is suitable in mobile applications when a high-end CPU performance, a tailor-made I/O configuration or a special I/O (diagnosis, Namur ...) is required.
The basic versions can be extended by up to six safe CAN interfaces. Apart from the flexibility of the I/O configuration in the basic housing, the certified decentral extension by other I/O cells is possible. In addition to the standard communication interfaces Ethernet and CAN are also CANopen Safety, J1939, TCP/IP and TCP/UDP available.

The integrated USB interface offers extensive possibilities, such as software/ data updates or data logger via USB stick.

Local I/O Expansions

In case additional I/Os are required, both cSCALE controller IP20 and IP66/67 can be expanded through the SYS-Ext interface with one expansion rack (max. 6 additional I/O modules).

I/O Modules for cSCALE IP66/67

	I/O 02	I/O 03	I/O 04	I/O N4	I/O 05	I/O 15	I/O 06
DI with HSC option	4	–	8	8	–	–	–
DI DIAG	4	4	8	–	–	–	–
DI NAMUR	–	–	–	8	–	–	–
AI 4...20 mA AI 0...10 V	–	8-4 0-4*	–	–	– –	– –	–
AI 0-UB (max. 36 V), usable also as AI 0…10 V or DI	–	–	–	–	–	–	–
DO (1 Aav)	4**	–	–	–	12**	–	–
DO low-side (1 Aav)	–	–	–	–	–	12**	–
DO PWM with CC high-side (2 Aav)	4**	–	–	–	–	–	6***
DO PWM with CC high-side (4 Aav)	–	–	–	–	–	–	2***

* Selection of voltage input reduces number of current input
** Sum of current 8 Aav
*** I/O 06 cell/DO PWM with CC: Sum of current 12 Aav

I/O Modules for cSCALE IP20

	I/O 03-02	I/O 05-05	I/O 06-06	I/O 04-03	I/O N4-N3
DI with HSC option	4	–	–	8	8
DI DIAG	8	–	–	12	–
DI NAMUR	–	–	–	–	12
AI 4...20 mA AI 0...10 V	8-4 0-4*	–	–	8-4 0-4*	8-4 0-4*
DO (1 Aav)	4**	24**	–	–	–
DO PWM with CC high-side (2 Aav)	4**	–	12***	–	–
DO PWM with CC high-side (4 Aav)	–	–	4***	–	–

* Selection of voltage input reduces number of current input
** I/O 02, I/O 05 cell/DO (1 Aav): sum of current 8 Aav
*** I/O 06 cell/DO PWM with CC: sum of current 12 Aav

Safety Technology for Mobile Applications

The cSCALE safety controller is setting standards in safety technology for mobile applications. The controller meets the current requirements of the new Machinery Directive as well as the safety-specific norms DIN EN ISO 13849 PL d/IEC 62061 SIL 2.

With the introduction of the new Machinery Directive (MD) 2006/42/EC in conjunction with the safety enforcing norm DIN EN ISO 13849, new safety considerations and corresponding risk analyses for applications of mobile machines are needed. In order to find potential weak points and increase the technical reliability, functions have to be analyzed and weighted within the scope of safety management in a RISK Analysis. This includes the function of safe cut-off in case of dangerous movements or overloads.

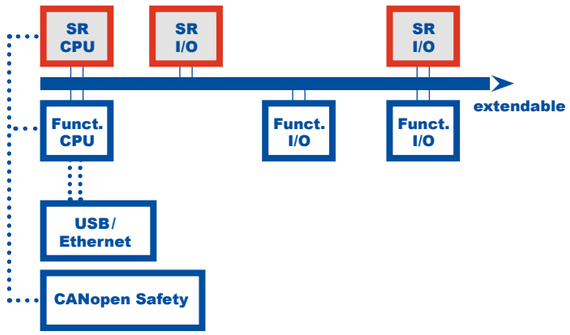
The dangers associated with machinery and plants are classified by performance level in accordance with DIN EN ISO 13849. The classification of the performance level value goes from a to e, the lowest to the highest contribution to risk reduction. For most mobile applications it is sufficient to reach safety level PL d/SIL.

To reach PL d appropriate measures have to be taken.

The cSCALE SIL 2 safety controller

Along with the new cSCALE SIL 2 safety controller, WIKA Mobile Control is offering an integrated certified control solution. Hardware, firmware and runtime system have been certified.
A qualified IEC 61131 development environment for the implementation of safety functions rounds out the universal safety control concept.

WIKA Mobile Control guarantees a non-reactive execution for safety functions and non-safety functions on one control unit. This is accomplished via an integrated certified safety task on the main CPU.
One advantage: due to the modular concept, the I/O combinations can be implemented within the smallest space.



SR = safety relevant
FR = functional relevant

Reliability & Safety

As the leading supplier of advanced technologies WIKA Mobile Control is setting standards for the market of mobile safety critical applications with the new SIL 2 controller.

Due to the certification of the cSCALE safety controller in accordance with safety enforcing requirements as per DIN EN ISO 13849 PL d/IEC 62061 SIL 2, all necessary measures have been taken to prevent accidents by minimization of risk.

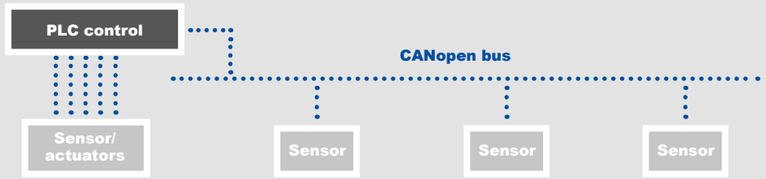
Reasons to work with WIKA Mobile Control

The following points must be taken into consideration when selecting a suitable control system for safety critical applications:

- ✔ A non-reactive execution for safety functions and non-safety functions on one controller has to be guaranteed.
- ✔ Every I/O card has its own safety equipment for error detection. During error detection the I/O cards can be disconnected separately from one another via an independent hardware watch dog. In the process both safety and availability have to be guaranteed.
- ✔ The controller supports both CANopen stacks and CANopen safety stacks.
- ✔ Along with the hardware of the controller, the firmware and corresponding software libraries are certified in accordance with SIL 2 and PL d.
- ✔ The controller has inputs and outputs that are diagnosis capable. In addition to complying with standards, better fault management for reduction of machine downtimes has to be facilitated.
- ✔ Along with the certified SIL 2 control solution, manufacturers of mobile machinery have to be supported according to their specific needs in the type approval of their entire system by the TÜV [German Technical Inspection Association] with the following additional services:
  - Establishment of safety functions / safety chains
  - SISTEMA calculation for assessment of operating safety within the scope of DIN EN ISO 13849-1
  - Application programming (C/C++/IEC 61131/CoDeSys)
  - Support in TÜV certification
- ✔ Pre-programmed, qualified function blocks.
- ✔ Additional communication interfaces such as USB, Ethernet, CAN extensions.
- ✔ The relevant environmental requirements for mobile machinery are supported:
  - Suitable controller for ambient temperatures from -40 °C to +70 °C.
  - Compliance with protection classes IP20 and IP66/67
  - Shock and vibration resistant
  - EMC
- ✔ Certified safety engineers support your system integration
- ✔ Integrated safety system (Hardware and Software) to watch all safety critical functions
- ✔ Real time operating system

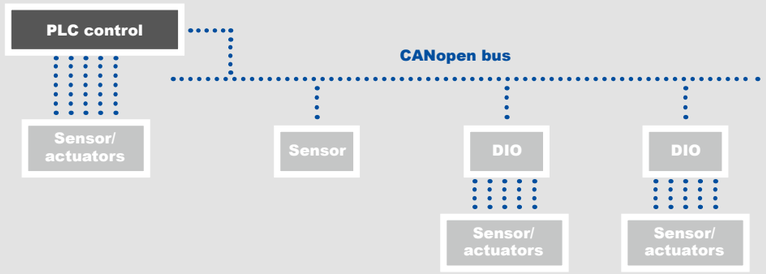
cSCALE controls any kind of Control System Architectures

Standard PLC control with I/Os



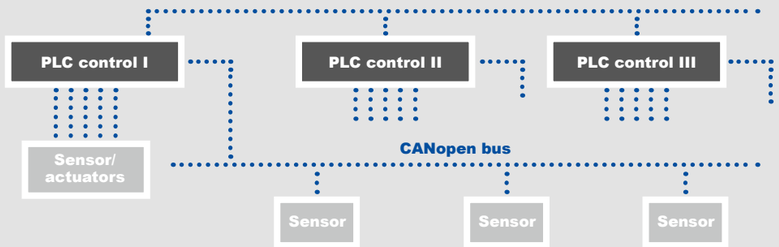
Distributed I/O

One PLC control with distributed I/O



Distributed control

Distributed control with several PLC controls networked together via Ethernet or CANopen



Control System Architectures

Out of Sight but always in Control

The cSCALE Control System for mobile applications

Of any size:

- Scalable architecture delivers tailored control solutions
- From compact controller up to more than 300 I/Os
- High-performance CPU with sufficient data and program memory

Of any complexity:

- Embedded Ethernet connectivity for networked control and HMI systems
- Support for distributed control architectures for mobile plant automation

With any safety requirements:

- PL d/SIL 2-compliant
- Supports redundant system architectures
- Stand-by control system

Requiring any type of communication:

- Embedded Ethernet
- CANopen, CANopen Safety, J1939
- Customized CAN protocols

Worldwide

We make lifting loads safer!

As an experienced specialist, we have spent many years providing reliable safety solutions for lifting loads, setting innovative standards in the process and ensuring dependable communication between machines and their operators, particularly in harsh environments.

By developing application software, mobile controllers and robust sensors, we ensure that our customers benefit from maximum safety and equipment uptime.

We are system integrators, supporting our customers through all project phases: from analysis and concept evaluation, through system design and project planning to prototype testing and field launches. Our safety experts support certification processes and are available for seamless life cycle management.

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