

## White Paper



## DuplineSafe

**How to limit downtime costs due to emergency stops in material conveyors**

**Alessio Costantini**  
International Product Manager

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# DuplineSafe.

## How to limit downtime costs due to emergency stops in material conveyors



### INTRODUCTION

This document aims at enabling system integrators, engineers and maintenance managers to make the best design choices, while designing and planning a safety system onto conveyors. Also installers could take advantage by reading this document, especially in the commissioning and maintenance phase of their installation's lifecycle.

Plant owners and purchasers could eventually find useful information on how to improve the total cost of ownership of their assets, so to save money in the short/medium/long terms.

### ABSTRACT

Bulk material conveyors are a fundamental part of mines, tunnels, cement factories, steelworks, pulp and paper plants. Stopping conveyors means stopping the whole process, meaning big money losses due to missed production; nonetheless due to safety reasons, along conveyors there are several emergency stop switches connected to a pull-wire, enabling workers to stop the belt at any point and time, in case of an emergency situations or faults. Automatic switches are also included in the loop.

Emergency stops are part of the lifecycle of conveyors: the key to avoid wasting time and money is to find and solve the stops' issue in the shortest time possible.

## WHY A PROPER EMERGENCY STOP SYSTEM IS SO IMPORTANT IN A MINE



### MINES ARE POTENTIALLY RISKY ENVIRONMENTS

In mines, conveyors are used to transport bulk materials, sometimes over long distances. In big installations where dust, high temperature and hostile environmental conditions are the usual scenario, the risk rate for issues and hazards is quite high.



### MINES ARE BIG ENVIRONMENTS

Safety switches are distributed along the conveyor, where operators monitor the proper conveyors functioning. Maintenance workers travel through the mine facility to fix issues, being warned about problems.



### TIME PRESSURE

Any stop of the conveyors means a production interruption and money loss. The longer the stop, the bigger the loss.

The ideal solution to be efficient and to save time and money would be to have at any time a clear idea about the ongoing alerts in a control room: this way, the right people could be sent to the right place in the shortest time, so to analyse and fix the problem and restore the standard operation conditions of the conveyor. In the following sections, we describe the relevant safety regulations, and analyse the available technical solutions so that you can find out the one which fits better into the above scenario.

## ▶ THE ISO EN 13849-1

European Rule ISO EN 13849-1 "Safety of machinery – Safety-related parts of control systems - General principles for design" introduced in 2006 and released in a consolidated version in 2015, rapidly became the universally-known reference for safety approaches in automation system of industrial plants, replacing the previous EN954-1 standard.

The base philosophy of EN954-1 was quite simple:

1. identify which are the safety functions required by the application (a list of the characteristic safety functions is included in the rule);
2. define if a faulty condition in a part of the system can lead to the loss of the safety function or not.

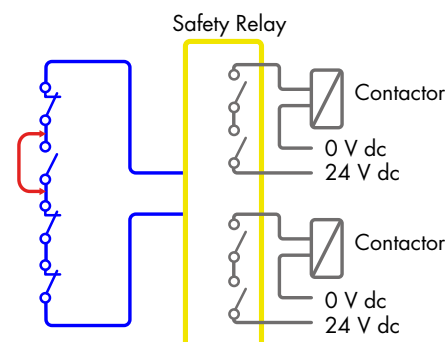
The EN 13849-1 focuses on the established categories of EN 954-1 and contains special requirements for safety related parts of control systems with programmable electronics. EN ISO 13849-1 goes beyond the qualitative approach of EN 954-1 to include a quantitative assessment of the safety functions. Performance levels (PL) are defined in EN ISO 13849-1 to classify different safety-related capacities into their respective categories. EN13849-1 carries on the so called "Safety Categories" of EN954-1. The usual solution to comply with Cat.3 and Cat.4, that prescribes to avoid the loss of the safety function in case of a single fault, is to use a redundant configuration of the command chain; in case of fault in one chain, the other is able to guarantee the safety function. The difference between these Categories is increased Diagnostic Coverage. While Category 3 is Single Fault Tolerant, Category 4 has additional diagnostic capabilities so that additional faults cannot lead to the loss of the safety function. The concept of Categories is extended into EN 13849-1, so to define 5 Performance Levels (PL), based on the average probability of dangerous failure per hour.

Finally, the concept of Safety Integrity Level (SIL) is introduced and related to PL. The level named SIL3 corresponds to the best performance level (PL) which is "e", and basically to Category 4.

## ▶ TRADITIONAL SAFETY CIRCUIT WITH SERIES WIRED NORMALLY CLOSED CONTACTS

This solution is quite easy to implement: a series of safety loops is implemented with standard wiring. This solution has some serious drawbacks:

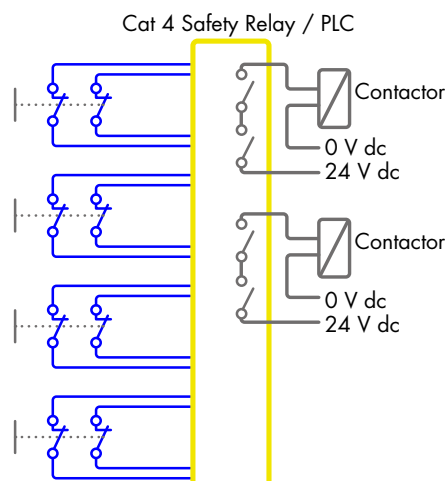
- Short circuit across the safety loop can create undetected loss of safety
- Lack of diagnostics do not solve one of the main targets: finding faults in a short time
- Resistance in contacts becomes a problem over time
- Solution not compliant with ISO 13849-1 Cat 3 and 4 standards



## ▶ TRADITIONAL SAFETY CIRCUIT WITH PARALLEL WIRED NORMALLY CLOSED CONTACTS

Even though this solution is quite easy to implement, and it is compliant with ISO 13849-1 Cat 3 and 4, it has some big cons:

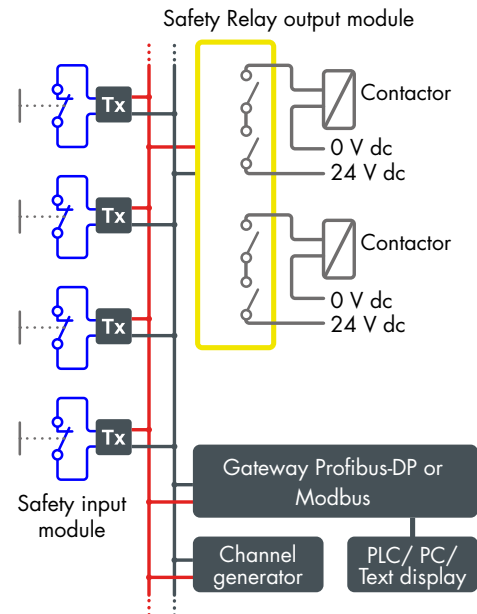
- High wiring costs (imagine the cost of wiring the safety circuits over kilometers of length)
- Limited number of inputs: it depends on the available inputs of the ISO 13849-1 Cat 4 relay
- Lack of flexibility



## BUS BASED SOLUTION







The power of BUS based solution is in their digital treatment of data communication. By using the right BUS based solution the aforementioned issues of the traditional wirings can be solved:

- Short circuits on the bus can be detected
- Short circuits over the input leads can be excluded if the safety input module is mounted in the same cabinet as the safety switch, according to ISO/EN 13849-1 standards
- No issues due to contact resistance
- One input can trip several relays at different locations
- Thanks to the digital flow of information, real time diagnostics can be displayed wherever is needed (HMI devices, supervisor PC).



## NO DOUBT ABOUT THE CHOICE, A COMPARISON AMONG WIRING SOLUTIONS

There is no doubt about which should be the choice if we need it to be safe, reliable and effective, meeting the initial requirements.

<b>Traditional: series</b>		<ul style="list-style-type: none"> <li>• Cheap wiring</li> </ul>
		<ul style="list-style-type: none"> <li>• More wires</li> <li>• Problem on contacts due to current flow</li> <li>• Unsafe</li> <li>• No monitoring</li> </ul>
<b>Traditional: parallel</b>		<ul style="list-style-type: none"> <li>• Compliant with ISO/EN 13849-1 PL Cat. 3</li> </ul>
		<ul style="list-style-type: none"> <li>• Not flexible</li> <li>• Not reliable over time</li> <li>• No monitoring</li> </ul>
<b>BUS based</b>		<ul style="list-style-type: none"> <li>• Safe</li> <li>• Reliable</li> <li>• Monitored</li> <li>• Best TCO</li> </ul>
		<ul style="list-style-type: none"> <li>• Training to learn BUS basics and set-up</li> </ul>

## THE BASIC BUILDING BLOCKS OF A BUS BASED SOLUTION

There are many BUS systems, designed for different application, but the most of them have in common a subset of basic building blocks.

Building block	Function	Notes
<b>BUS generator</b>	In charge of generating the necessary signal levels and logic for exchanging information among blocks	In our case, the module generates a very robust and noise-immune bus
<b>Physical layer</b>	It is the “physical bus”: there are wireless and wired bus systems, buses based on proprietary wires, other based on simple twisted pairs	In our case, ease of wiring, and achievable distances is very important for the effectiveness of the solution
<b>Input modules</b>	Modules in charge of accepting inputs	In our use case, the modules are digital inputs
<b>Output modules</b>	Modules in charge of sending output signals to an external subsystem	In our use case, the modules are relay modules
<b>Gateways</b>	Modules allowing communication between different buses or protocol	Gateways are needed for example to allow the safety bus to communicate with the digital backbone of the system



## THE DESIGNER DILEMMA: WHICH BUS SHOULD I CHOOSE?




Back from the list of standard requirements for the safety function in a Mining application it is clear that the basic requirements for the BUS system of choice should be:

Requirement	Description
 <p>Safety of people</p>	<p>The safety of people comes first. The machineries must be turned in safe position immediately to provide the highest level of safety for people who operates in the production plants.</p>
 <p>Reliability</p>	<p>This is for sure an important feature: reliability in our case means that it should be able to operate in harsh conditions, over extended time intervals and provide the necessary diagnostics in case of malfunctioning.</p>
 <p>Easy wiring</p>	<p>Wiring should not be a nightmare: otherwise the risk is to vanish good technical specs because of the impossibility of getting the job done in the target schedule.</p>
 <p>Wiring distance</p>	<p>Reaching kilometers of distance with a BUS in mining applications is not so uncommon.</p>
 <p>Smooth learning curve</p>	<p>If the learning curve to set-up a working system is too steep, the risk is to prevent maintenance and engineering people to do their job.</p>
 <p>Safe</p>	<p>An accredited third party certifying that the solution complies with a specific safety standard is definitely a need to avoid headaches</p>

## THE CARLO GAVAZZI SOLUTION

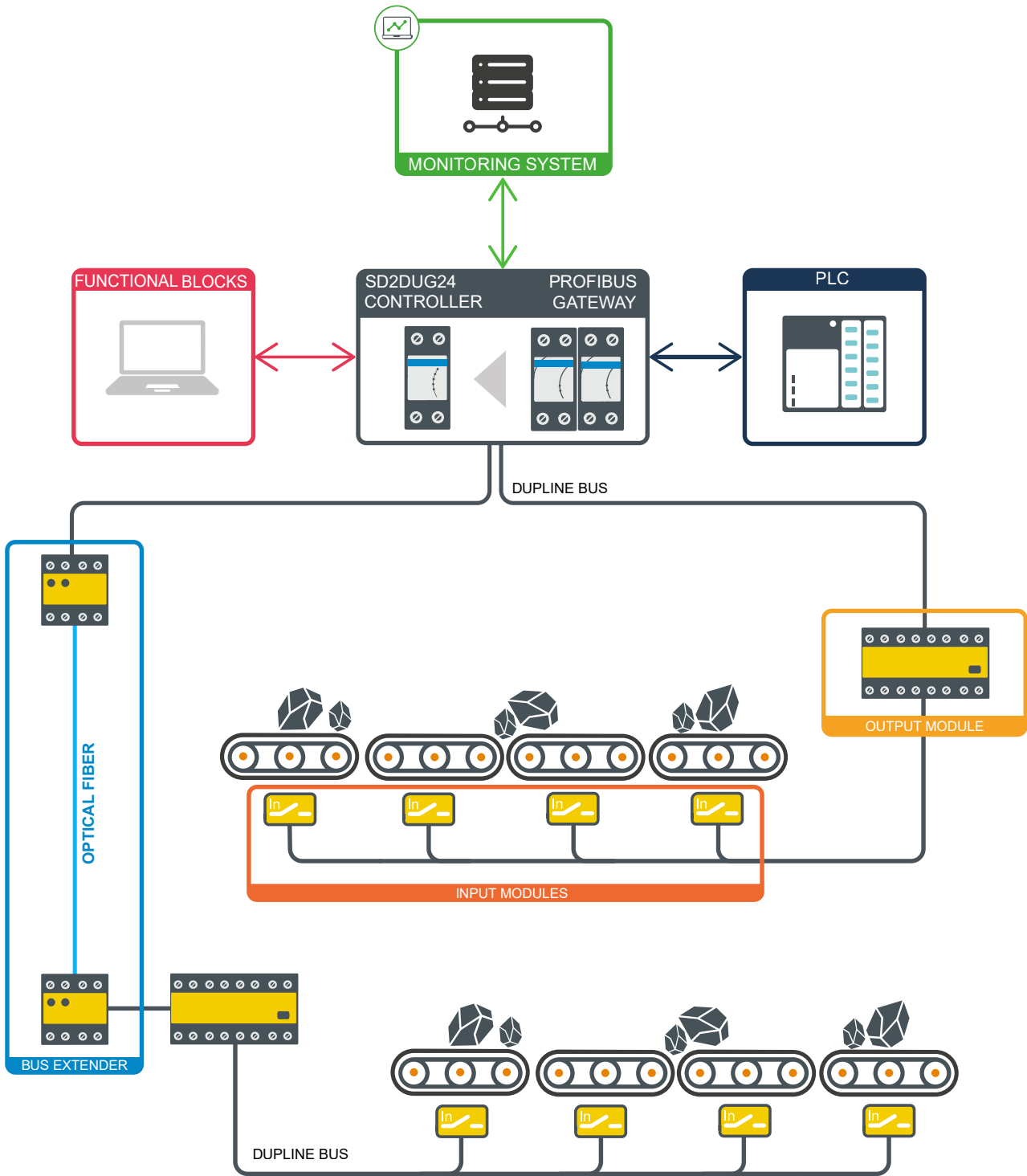
Carlo Gavazzi has a solution which has been designed exactly with one purpose in mind: allowing to limit downtime costs due to emergency stops in material conveyors.

To meet that target, it needs to meet the minimum requirements mentioned above:

Requirement	Description
 <p>Traceability</p>	<p>Unique location ID shows where pull-cord switch was actuated. Sometimes long conveyors can span several miles or kilometers and in a traditional pull-cord system it is difficult to determine where the incident occurred. With our DuplineSafe system, each transmitter has a unique location identifier that will indicate exactly where the problem has occurred thus greatly reducing rescue and recovery time that will save lives.</p>
 <p>Reliability</p>	<p>Dupline® is a bus based on simple concepts, whose reliability has been proven by more than 250k installations around the world</p>
 <p>Easy wiring</p>	<p>It could not be easier than this: one twisted pair is what you need to connect modules, using any layout (star, daisy chain, loop...). The customer saves money in installation and materials making for a much lower cost solution compared with other safety bus systems that require custom cable and special connectors.</p>
 <p>Wiring distance</p>	<p>Long transmission distance without repeaters</p>
 <p>Smooth learning curve</p>	<p>DuplineSafe including just the modules you need to set your safety system up: no need to read complex manuals. DuplineSafe's intrinsic simplicity will lead to high throughput and uptime of the system</p>
 <p>Safe</p>	<p>The product complies with the requirements of Cat. 4 / PL e acc. to EN ISO 13849-1 and SIL 3 acc. to EN 62061 / IEC 61508 and can be used in safety related applications up to these safety levels (certified by TÜV Rheinland)</p>






## DUPLINESAFE, THE BUILDING BLOCKS






### ARCHITECTURE





DuplineSafe includes all the necessary building blocks to deploy a reliable safety system for emergency stops managing.

Category	Building Block	Description	
Safety Modules	Safety Relay output module (GS38300143230)	SIL-3 certified by TÜV and cULus approved, it monitors up to 63 safety inputs; easy configuration, status monitoring and automatic/manual restart	
	Safety Input module (GS75102101)	SIL-3 certified by TÜV and cULus approved; powered by the DuplineSafe bus , IP67 rating and small dimensions for easy commissioning	
Gateways	Profibus DP gateway (GS38910125230)	DuplineSafe diagnostics available on Profibus DP; several gateways can be connected to the same bus	
	Profinet gateway (GS3391+GS3390)	DuplineSafe diagnostics available on Profinet; up to 7 DuplineSafe networks can be managed with one gateway  The GS33910060800 is a Profinet gateway and can work together with up to 7 GS33900000800A channel generators. Up to 61 DuplineSafe Inputs can be connected to one channel generator: one Gateway can collect up to 427 DuplineSafe Inputs.	
	Modbus/RTU Gateway (GSTI 50)	DuplineSafe diagnostics available on Modbus/RTU; several gateways can be connected to the same bus	

Category	Building Block	Description	
DuplineSafe Bus modules	Optical converter (GS349x0000)	DuplineSafe communication through optical fibre; up to 5km optical transmission distance with 62.5/125 optical fibre	
	DuplineSafe Bus generator (SD2DUG24)	Generates the DuplineSafe bus for the entire system of DuplineSafe modules. it is fully programmable via a dedicated software	
	Channel generators (GS33900000800A)	The GS33910060800 is a Profinet gateway and can work together with up to 7 GS33900000800A channel generators. Up to 61 DuplineSafe Inputs can be connected to one channel generator: one Gateway can collect up to 427 DuplineSafe Inputs.	
	DuplineSafe Repeater (GS38920000)	For extending DuplineSafe transmission distance (cascading of repeaters possible). Power-booster for applications with several Dupline®-supplied units.	
	DuplineSafe programming tool (GS73800080)	Hand-held programming and diagnostic tool; connectable to any point of the DuplineSafe bus	

## CONCLUSIONS

A reliable solution for monitoring critical situations in conveyors, and alerting people in the control room, reporting the position of the failure, could save the day to maintenance personnel and avoid huge time and money losses due to operational downtime. Carlo Gavazzi's DuplineSafe can definitely play a role in this scenario, thanks to its advantages:

- Simple architecture.
- Free layout BUS solution.
- Long wiring distance.
- Safety certification by accredited body.

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## OUR SALES NETWORK IN EUROPE

### AUSTRIA

Carlo Gavazzi GmbH  
Ketzergasse 374,  
A-1230 Wien  
Tel: +43 1 888 4112  
Fax: +43 1 889 10 53  
office@carlogavazzi.at

### BELGIUM

Carlo Gavazzi NV/SA  
Mechelsesteenweg 311,  
B-1800 Vilvoorde  
Tel: +32 2 257 4120  
Fax: +32 2 257 41 25  
sales@carlogavazzi.be

### DENMARK

Carlo Gavazzi Handel A/S  
Over Hadstenvej 40,  
DK-8370 Hadsten  
Tel: +45 89 60 6100  
Fax: +45 86 98 15 30  
handel@gavazzi.dk

### FINLAND

Carlo Gavazzi OY AB  
Ahventie, 4 B,  
FI-02170 Espoo  
Tel: +358 9 756 2000  
myynti@gavazzi.fi

### FRANCE

Carlo Gavazzi Sarl  
Zac de Paris Nord II, 69, rue de la Belle  
Etoile,  
F-95956 Roissy CDG Cedex  
Tel: +33 1 49 38 98 60  
Fax: +33 1 48 63 27 43  
french.team@carlogavazzi.fr

### GERMANY

Carlo Gavazzi GmbH  
Pfnorstr. 10-14  
D-64293 Darmstadt  
Tel: +49 6151 81000  
Fax: +49 6151 81 00 40  
info@gavazzi.de

### GREAT BRITAIN

Carlo Gavazzi UK Ltd  
4.4 Frimley Business Park,  
Frimley, Camberley, Surrey GU16  
7SG  
Tel: +44 1 276 854 110  
Fax: +44 1 276 682 140  
sales@carlogavazzi.co.uk

### ITALY

Carlo Gavazzi SpA  
Via Milano 13,  
I-20045 Lainate  
Tel: +39 02 931 761  
Fax: +39 02 931 763 01  
info@gavazziacbu.it

### NETHERLANDS

Carlo Gavazzi BV  
Wijkermeerweg 23,  
NL-1948 NT Beverwijk  
Tel: +31 251 22 9345  
Fax: +31 251 22 60 55  
info@carlogavazzi.nl

### NORWAY

Carlo Gavazzi AS  
Melkeveien 13,  
N-3919 Porsgrunn  
Tel: +47 35 93 0800  
Fax: +47 35 93 08 01  
post@gavazzi.no

### PORTUGAL

Carlo Gavazzi Lda  
Rua dos Jerónimos 38-B,  
P-1400-212 Lisboa  
Tel: +351 21 361 7060  
Fax: +351 21 362 13 73  
carlogavazzi@carlogavazzi.pt

### SPAIN

Carlo Gavazzi SA  
Avda. Iparraguirre, 80-82,  
E-48940 Leioa (Bizkaia)  
Tel: +34 94 480 4037  
Fax: +34 94 431 6081  
gavazzi@gavazzi.es

### SWEDEN

Carlo Gavazzi AB  
V:a Kyrkogatan 1,  
S-652 24 Karlstad  
Tel: +46 54 85 1125  
Fax: +46 54 85 11 77  
info@carlogavazzi.se

### SWITZERLAND

Carlo Gavazzi AG  
Verkauf Schweiz/Vente Suisse  
Sumpfstrasse 3,  
CH-6312 Steinhausen  
Tel: +41 41 747 4535  
Fax: +41 41 740 45 40  
info@carlogavazzi.ch

## OUR SALES NETWORK IN THE AMERICAS

### USA

Carlo Gavazzi Inc.  
750 Hastings Lane,  
Buffalo Grove, IL 60089, USA  
Tel: +1 847 465 6100  
Fax: +1 847 465 7373  
sales@carlogavazzi.com

### CANADA

Carlo Gavazzi Inc.  
2660 Meadowvale Boulevard,  
Mississauga, ON L5N 6M6, Canada  
Tel: +1 905 542 0979  
Fax: +1 905 542 22 48  
gavazzi@carlogavazzi.com

### MEXICO

Carlo Gavazzi Mexico S.A. de C.V.  
Circuito Puericultores 22, Ciudad  
Satelite Naucalpan de Juarez, Edo  
Mex. CP 53100 Mexico  
T +52 55 5373 7042  
F +52 55 5373 7042  
mexicosales@carlogavazzi.com

### BRAZIL

Carlo Gavazzi Automação Ltda. Av.  
Francisco Matarazzo, 1752  
Conj 2108 - Barra Funda - São Paulo/  
SP  
Tel: +55 11 3052 0832  
Fax: +55 11 3057 1753  
info@carlogavazzi.com.br

## OUR SALES NETWORK IN ASIA AND PACIFIC

### SINGAPORE

Carlo Gavazzi Automation Singapore  
Pte. Ltd.  
61 Tai Seng Avenue #05-06  
Print Media Hub @ Paya Lebar iPark  
Singapore 534167  
Tel: +65 67 466 990  
Fax: +65 67 461 980  
info@carlogavazzi.com.sg

### MALAYSIA

Carlo Gavazzi Automation (M) SDN.  
BHD.  
D12-06-G, Block D12,  
Pusat Perdagangan Dana 1,  
Jalan PJU 1A/46, 47301 Petaling  
Jaya,  
Selangor, Malaysia.  
Tel: +60 3 7842 7299  
Fax: +60 3 7842 7399  
info@gavazzi-asia.com

### CHINA

Carlo Gavazzi Automation  
(China) Co. Ltd.  
Unit 2308, 23/F.,  
News Building, Block 1,1002  
Middle Shennan Zhong Road,  
Shenzhen, China  
Tel: +86 755 83699500  
Fax: +86 755 83699300  
sales@carlogavazzi.cn

### HONG KONG

Carlo Gavazzi Automation  
Hong Kong Ltd.  
Unit No.16 on 25th Floor, One Midtown,  
No. 11 Hoi Shing Road, Tsuen Wan,  
New Territories, Hong Kong  
Tel: +852 26261332  
Fax: +852 26261316

## OUR COMPETENCE CENTRES AND PRODUCTION SITES

### DENMARK

Carlo Gavazzi Industri A/S  
Hadsten

### MALTA

Carlo Gavazzi Ltd  
Zejtun

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Uab Carlo Gavazzi Industri Kaunas  
Kaunas

### CHINA

Carlo Gavazzi Automation (Kunshan)  
Co., Ltd.  
Kunshan

## HEADQUARTERS

Carlo Gavazzi Automation SpA  
Via Milano, 13  
I-20045 - Lainate (MI) - ITALY  
Tel: +39 02 931 761  
info@gavazziautomation.com



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