BUILDING AUTOMATION

Cabling Infrastructure

LAPP

COMPANY HISTORY

LAPP Group

LAPP Connects

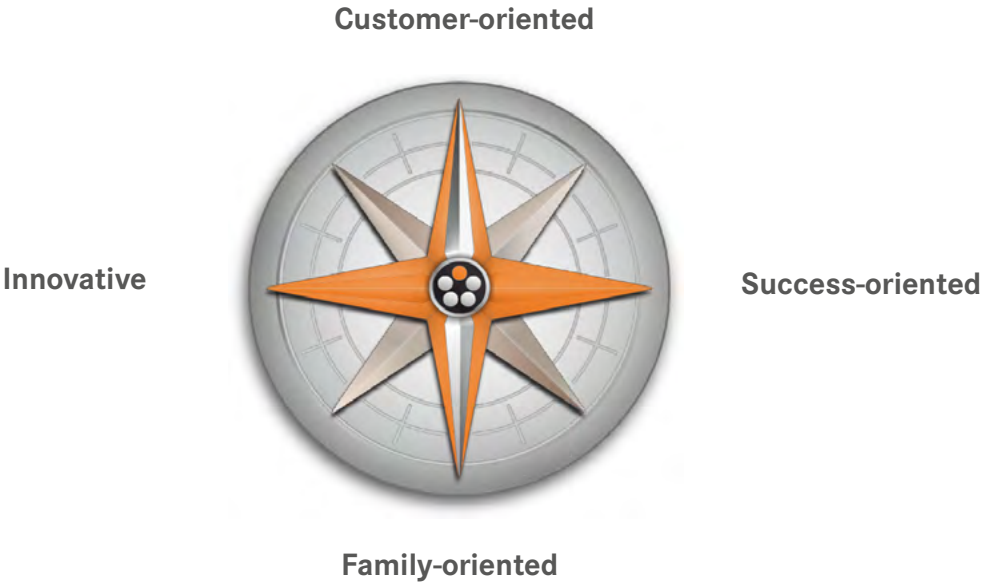
LAPP: This name stands for innovative connection solutions like no other. Our brand stands for quality, customer service and a deep understanding of the industries and applications in which our products are used. We are the world market leader, supplying everything from cable, connectors and accessories to fully integrated connection solutions. LAPP products are used in production machinery, industrial robots, public transport, food processing, alternative energy, charging systems for electric vehicles, oil drilling platforms and much more. They are the product of choice for mountain climbers and polar explorers. With a global workforce of 4,575 people, we generated 1,128 million euros of turnover in the past year.

Our customers appreciate our expertise and service. The 40,000 products in our catalogue reflect our manufacturing prowess. We always want to offer the best solution. If the customer cannot find what they are looking for in our catalogue, our experts are on hand to develop a solution together.

LAPP delivers to every corner of the world, with most products ready to be delivered quickly off the shelf. To guarantee this, we have development centres, production facilities and warehouses all over the globe. With 43 sales companies and around 100 sales partners, our customers always have someone to talk to.

LAPP is well positioned for the future, just like Oskar and Ursula Ida Lapp were when they founded the company in 1959. In 1957, Oskar Lapp created the ÖLFLEX® control cable, the first protected trademark in the industry. More quickly followed. Throughout its history, the business has always been in family ownership. In Matthias Lapp, the third generation of the family has now begun to assume responsibility for the Company.

COMPANY VALUES



CUSTOMER-ORIENTED

We find quick and simple solutions for our customers – at a competitive price-performance ratio. We hold our customers and partners in the highest regard and guarantee them worldwide security of supply through international production sites. This enables them to be successful in their markets.

FAMILY-ORIENTED

We work together toward our goal in a spirit of trust. Respect and appreciation are just as important to us as personal responsibility and transparency. We actively train and develop our staff .

SUCESS-ORIENTED

Our company is very versatile. It is our flexibility above all that secures profitable growth: our reaction to new challenges is quick and well-considered. Our processes are transparent, and we make sustainable, long-term-oriented decisions. We remain conscious of our risks while driving our growth. We also set standards for your benefit.

INNOVATIVE

We continuously develop our products, solutions and services. To ensure that there is no compromise when it comes to quality, we manufacture in our own plants. We pledge ourselves to ensure the well-being of our employees and the conservation of environmental resources.

LEGEND FOR ICONS


Fire resistance


Suitable for indoor use


Suitable for outdoor use


Cold-resistant


Oil-resistant


Interference signals


Waterproof

Low Smoke Zero Halogen

Construction Products Regulation

INDEX


LAPP
A1

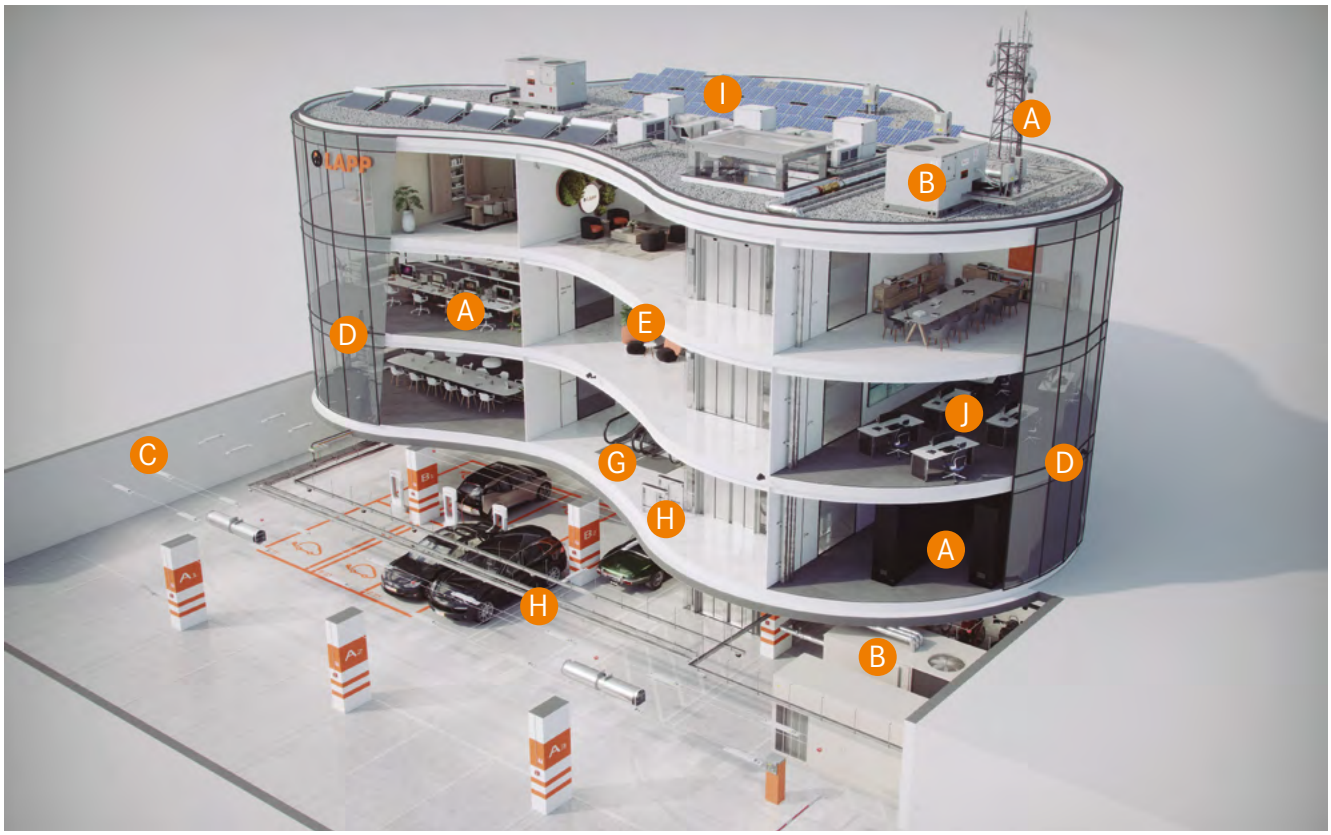
1 BUILDING AUTOMATION SOLUTIONS FOR EACH APPLICATION

BUILDING AUTOMATION SOLUTIONS FOR EACH APPPLICATION

A Building Automation System (BAS), also known as a Building Management System (BMS) or Building Control System (BCS), is a centralized control system that is used to monitor and manage various mechanical, electrical, and plumbing systems within a building.

Implementing a Building Management System can lead to increased energy efficiency, reduced operational costs, improved occupant comfort, and better overall building performance.

LAPP has the cabling solutions to allow implementation of BA System.



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BUILDING AUTOMATION SOLUTIONS FOR EACH APPPLICATION

APPLICATION	Instalation Area	Sheath Material	Shield	Fire Beaviour	Other Specs	Material
Data Network	Indoor	LSZH	Unshield	D_{ca}	CAT6	POLILAN® CAT6
		LSZH	Unshield	D_{ca}	$CAT6_A$	POLILAN® $CAT6_A$
		LSZH	Shield	D_{ca}	$CAT6_A$	POLILAN® $CAT6_A$
	Outdoor	PE	Unshield	F_{ca}	CAT6	POLILAN® CAT6
		PE	Shield	F_{ca}	CAT6	POLILAN® CAT6
		PE	Shield	F_{ca}	CAT7	ETHERLINE® CAT7
		PE	NA	F_{ca}	Hybrid (energy cable + fiber)	POLILAN® FIBER OPTIC
	Indoor/outdoor	LSZH	NA	D_{ca}	Fiber optic	POLILAN® FIBER OPTIC
HVAC	Indoor	LSZH	Unshield or shield	D_{ca}	CAT6 or $CAT6_A$	POLILAN®
	Outdoor	PE	Unshield or shield	D_{ca}	CAT6, $CAT6_A$ or CAT7	POLILAN®, ETHERLINE®
	Indoor	PVC or LSZH	Shield	E_{ca}	For RS-485 or RS-422	POLISCREEN®, ETHERLINE®
		PVC or LSZH	Unshield or shield	C_{ca}	For Digital or analog signals	OLFLEX®, UNITRONIC®
	Indoor or Outdoor	PVC or LSZH	Shield	up to C_{ca}	Sensor	POLISCREEN®, UNITRONIC®
Lighting – DALI/EIB/KNX	Indoor	LSZH	Unshield or shield	C_{ca} E_{ca}		POLICONTROL® DALI UNITRONIC® EIB
Surveillance	Indoor	LSZH	Unshield or shield	D_{ca}	Ethernet Cat6, $CAT6_A$ Fiber Optic	POLILAN®
	Outdoor	PE	Unshield or shield	F_{ca}	Ethernet Cat6, $CAT6_A$ Fiber Optic or Hybrid cables	POLILAN®, ETHERLINE®
Fire Security	Indoor	LSZH	Shield	Fire resistant	FE180/E30	POLIFLAM®
					Fiber Optic Cable	HITRONIC® FIRE
					Cat6 Cat5e	ETHERLINE® FIRE
Car Parking and Escalator	Indoor	PVC or LSZH		E_{ca}	RS-485	POLISCREEN®
		LSZH		up to C_{ca}	Lightinhg Control (DALI)	POLICONTROL® UNITRONIC®
	Indoor/Outdoor	LSZH		D_{ca}	Fiber	POLILAN®
Lift and Escalator	Indoor/outdoor					UNITRONIC®
Field Devices	Indoor	LSZH				POLISCREEN®, UNITRONIC®

PROTOCOL	Network Type	Material
BACnet	MS/TP (master Slave/token Passing)	POLISCREEN®
	Ethernet	POLILAN®
LonWorks	Ethernet	POLILAN®
	TP/FT-10 (twist Pair/Free Topology)	POLISCREEN®
Modbus	ModBus RTU	UNITRONIC® LIYCY(TP) 2x1
	ModBus TCP/IP	POLILAN®; UNITRONIC®; ETHERLINE®
M-BUS	2 wire	POLISCREEN®
DALI	2 wire	POLICONTROL® LiHH DALI
KNX	Ethernet	POLILAN®
	Twisted Pair	UNITRONIC® BUS EIB H

A. INFRASTRUCTURE COMMUNICATIONS CABLE

The Ethernet technology is everywhere, besides given the ability to create a transversal infrastructure for high speed communications (copper or fiber) it is also used for field devices interconnection.

The $CAT6_A$ or CAT6 cables, with or without shielding, must be terminated with correspondent modules (male or female) and patch panel given in the table below:

Ethernet Copper

	CPR	Specs	$CAT6_A$		CAT6	
			U/UTP	U/FTP	U/UTP	F/UTP
Ethernet Copper Cable						
Indoor	D_{ca} -s_2,d_2,a_1		2311089912	2311003643	2311002223	2311003029
Outdoor	F_{ca}				2311002858	2311090392
Module						
Module Tooless (RJ45 Female)			2311089913	2311002859	2311001807	2311002860
Plug (Rj45 Male)			2311003855			
Patch Panel						
			2311002861			

Other category cables and accessories are available.

Fiber Optic

Material	Nº Fibers	Fiber Type	CPR	Specs	PN
FIBER OPTIC SINGLEMODE	4x	Singlemode G652D	D_{ca} -s_2,d_2,a_1		2311001124
	12x				2311001125
	24x				2311004355
	8x	Singlemode G657A2			2311090920
	24x				2311091091
FIBER OPTIC MULTIMODE	4x	Multimode 50/125 OM4			2311004341
	12x				2311004344

Other cables with different quantities of fibers, types and specs are available.

Fiber Optic (Accessories)

Material	Description	Application	Specs	PN
FIBER OPTIC ORGANIZER FOR RACKS	PATCH PANEL FO LCD/SC with covers and tray	Fiber Patch panel for 19" racks		2311002064
FIBER OPTIC ORGANIZER FOR DIN RAIL CABINETS	PATCH PANEL FO for DIN RAIL, must include front plate	Fiber Patch panel for din-rail racks		2311001191
	Pigtails + adaptors + Patch cords (view....)			

Other accessories to terminate the FO cables are available.

A. INFRASTRUCTURE COMMUNICATIONS CABLE

Enclosures and Racks

Material	Description	Application	Specs	PN
RACK ENCLOSURE FLOOR MOUNT	RACK Network 42U 80x80 Glass + blind doors + 2 side panels Black	Enclosure floor mount for patching inside buildings		2311001080
	RACK Network 24U 80x80 Glass + blind doors + 2 side panels Black			2311003338
RACK ENCLOSURE WALL MOUNT	RACK Wall mount 12U 60x60 Glass door + 2 side panels Black	Enclosure wall mount for patching inside buildings		2311003657

Other enclosures and accessories are available.

RS-485/RS422

Material	Description	B Type	CPR	Specs	PN
POLISCREEN® 120 OHM	1x2xAWG24	9841	E_{ca}		2311000056
UNITRONIC® Li2YCY (TP)	1x2x0.25, shield 85% coverage	9841	E_{ca}		0031370
POLISCREEN® 9842 RS-485	2x2xAWG24	9842	E_{ca}		2311091549
UNITRONIC® Li2YCY (TP)	2x2x0,25, shield 85% coverage	9842	E_{ca}		0031371
POLISCREEN® RS-485 NH	2x2xAWG22 LSZH Outer sheath	3107A	E_{ca}	LSZH	2311091213

Other RS-485/RS-422 cables are available

Digital or Analog Signal

Material	Description	CPR	Specs	PN
ÖLFLEX® 135 CH	Halogen free, flexible and screened	D_{ca} -s_{1b},d_2,a_1	LSZH	1123267
ÖLFLEX® 130 H	Halogen free, flexible and unscreened	D_{ca} -s_{1b},d_2,a_1	LSZH	1123013
ÖLFLEX® 127 HSLH	Halogen free, flexible and unscreened	C_{ca} -s_{1a},d_2,a_1		1127400
UNITRONIC® LiYCY	Low frequency, PVC “n”x1.0	E_{ca}		0034804

Other cables with different conductors and sections are available

Sensor

Material	Conductors	Sensor Type	CPR	Specs	PN
POLISCREEN® LiHCH	4x0.5	0..5V; 0..10V	C_{ca} -S_{1b},d_1,a_1	LSZH	2311000101
	2x1	Pt 1000	C_{ca} -S_{1b},d_1,a_1	LSZH	2311000111
	3x1	0..10V	C_{ca} -S_{1b},d_1,a_1	LSZH	2311000112
	5x1	Pt1000 NTC1k8 NTC10k (10k2) NTC10k Pre (10k3)	C_{ca} -S_{1b},d_1,a_1	LSZH	2311000114
POLISCREEN® 9842 RS-485	2x2xAWG24 120 OHM	Modbus RTU	E_{ca}		2311091549
UNITRONIC® SENSOR	5x0.34	UL recognized (LifYY A)	PVC		7038902

Other sensor cables are available

For M8 and M12 Connectors

Acessory	Description	Specs	PN
EPIC® SENSOR M12A	M12A Screw termination	UL recognized	381166327

B. HVAC

In HVAC systems, that also includes the AHU, various communication cables facilitate the interaction between different components, ensuring efficient operation and control. Here are the main types:

Cable Type	Description	Link
High Speed Data comunication cables	CAT6 or $CAT6_A$	Please check: Ethernet copper CAT6 UTP
Low Speed Communication Systems	RS 232 or RS485	Please check: RS-485/RS422
Control Cables	For Relays or actuators	Please check: Digital or analog signal
Sensors	For temperature, humidity, or pressure sensors	Please check: Sensor

C. LIGHTING - DALI/EIB/KNX

Material	Conductor x Section	CPR	Specs	PN
POLICONTROL® LiHH DALI	2x1.5	C_{ca} -s_{1b},d_1,a_1	LSZH	2311090843
UNITRONIC® BUS EIB H	2x2x0.8	E_{ca}	LSZH	2170241
UNITRONIC® BUS EIB PVC	2x2x0.8	E_{ca}		2170240

D. SURVEILLANCE

Communication cables are typically used as infrastructure for surveillance. Please check the following :

Ethernet Indoor

Material	Description	CPR	Specs	PN
CAT6$_A$ U/UTP	CABLE CAT6$_A$ U/UTP LSZH VIOLET POLILAN	D_{ca} -s_2,d_2,a_1		2311089912
CAT6$_A$ U/FTP	CABLE CAT6$_A$ U/FTP LSZH VIOLET POLILAN	D_{ca} -s_2,d_2,a_1		2311003643

Other ethernet cables and accessories are available.

Ethernet Outdoor

Material	Description	CPR	Specs	PN
CAT6 U/UTP	CABLE CAT6 U/UTP PE OUTDOOR POLILAN	F_{ca}		2311002858
CAT6 F/UTP	CABLE CAT6 F/UTP PE OUTDOOR POLILAN	F_{ca}		2311090392
CAT 7 S/FTP	CABLE CAT7 S/FTP PE DIRECT BURIAL, WATERTIGHT	F_{ca}		2170977

Fiber Optic Cable

Material	Description	CPR	Specs	PN
FIBER OPTIC SINGLEMODE	FO UNIVERSAL 4X 9/125 SM POLILAN	D_{ca} -s_2,d_2,a_1		2311001124
FIBER OPTIC MULTIMODE OM4	FO UNIVERSAL 4X 50/125 OM4 POLILAN	D_{ca} -s_2,d_2,a_1		2311004341

Other cables with different quantities of fibers, types and specs are available.

Hybrid Cable – Fiber + Energy

Material	Description	CPR	Specs	PN
Cable with Fiber OM4 and LV conductors	FO HYBRID 4X9/125 SM + 2X1,5 PE BK POLILAN	F_{ca}		2311090711
Cable with Fiber SM and LV conductors	FO HYBRID 4X9/125 SM + 3X2,5 PE BK POLILAN	F_{ca}		2311090714

Other types of cabling infrastructure please check in **Infrastructure Communications cable** (page 11).

E. FIRE SECURITY

Fire security infrastructure utilizes cabling with enhanced fire-resistant specifications.

The level of fire resistance is determined by tests conducted according to specific standards:

Fire Resistance	Standard	Test Conditions	Meaning
PH120	EN50200	Fire temperature:830ºC, 2A Include Mechanical Impacts and Vibrations.	The cable pass the fire test maintaining is circuit operational for 120 minutes.
FE180	IEC60331	Fire temperature: 750ºC, 2A	The cable pass the fire test maintaining is circuit operational without creating short circuit for 180 minutes.
E30	DIN 4102-12	The fire test is made together with fixing systems for a period of time	The system integrity maintain working for 30 minutes in case of fire.
E90	DIN 4102-12		The system integrity maintain working for 90 minutes in case of fire.

Digital or Analog Signal Cable

Material	Conductor x Section	Fire Resistance	Specs	PN
POLIFLAM® JE-H(ST)H FE180/E30	1x2x0.8	PH120/FE180/E30		2311004284
	2x2x0.8	PH120/FE180/E30		2311004285
	4x2x0.8	PH120/FE180/E30		2311004286
	4x2x1.5	PH120/FE180/E30		2311091072
POLIFLAM® JE-H(ST)H FE180/E90	1x2x0.8	PH120/FE180/E90		2311000076
	2x2x0.8	PH120/FE180/E90		2311000074
	4x2x0.8	PH120/FE180/E90		2311000077
POLIFLAM® LIH(ST)H FE180/E30	12x1.5	PH120/FE180/E30		2311004291
	2x1	PH120/FE180/E30		2311004287
	2x1.5	PH120/FE180/E30		2311004288
	2x2.5	PH120/FE180/E30		2311004289
	4x1.5	PH120/FE180/E30		2311004290
POLIFLAM® LIH(ST)H FE180/E90	12x1.5	PH120/FE180/E90		2311002756
	2x1	PH120/FE180/E90		2311002753
	2x1.5	PH120/FE180/E90		2311002754
	2x2.5	PH120/FE180/E90		2311002982
	4x1.5	PH120/FE180/E90		2311002755

Other cables are available with different number of conductors and section.

Fiber Optic

Material	Nº fibers	Type	Fire Resistance	Specs	PN
HITRONIC® FIRE	4G	50/125 OM3	FE180/E30		27560304
	8G	50/125 OM3	FE180/E30		27560408

Ethernet Copper

Material	Category	Fire Resistance	Specs	PN
ETHERLINE® FIRE	Cat.6 4x2x 22/1 AWG	PH120		2170913
	Cat.5e 4x2x 23/1 AWG	PH120		2170905

F. CAR PARKING

Parking Sensors

Material	Conductor x Section	Comm. Type	CPR	Specs	PN
POLISCREEN® 9842	2x2xAWG24	RS-485	E_{ca}		2311091549

Lighting

Material	Conductor x Section	CPR	Specs	PN
POLICONTROL® LiHH DALI	2x1.5	C_{ca} -s_{1b},d_1,a_1	LSZH	2311090843
UNITRONIC® BUS EIB H	2x2x0.8	E_{ca}	LSZH	2170241
UNITRONIC® BUS EIB PVC	2x2x0.8	E_{ca}		2170240

Barrier

Material	Conductor x Section	Comm. Type	CPR	Specs	PN
POLISCREEN® 9842	2x2xAWG24	RS-485	E_{ca}		2311091549
ETHERNET CAT6$_A$ SHIELDED POLILAN®	U/FTP CAT6$_A$	Ethernet	D_{ca} -s_2,d_2,a_1		2311003643
FIBER OPTIC CABLE POLILAN®	UNIVERSAL 4X 50/125 OM4 POLILAN	Ethernet Fiber	D_{ca} -s_2,d_2,a_1		2311004341

G. LIFT AND ESCALATOR

Material	Conductor x Section	Comm. Type	CPR	Specs	PN
ÖLFLEX® LIFT F	12x1.0	Flat PVC control cable for conveyour technology/lift applications	NA		0042020
ÖLFLEX® 130 H	12x1.0	LSZH, flexible, unshielded	D_{ca} -S_{1b},d_2,a_1	LSZH	1123081
ÖLFLEX® 135 CH	5G0.75	LSZH, control cable, flexible, shielded	D_{ca} -S_{1b},d_2,a_1	LSZH	1123237
ÖLFLEX® SERVO 2YSLCY-JB	4G10	EMC Motor Cable	E_{ca}		0036429
UNITRONIC® FD P PLUS A	2x0.34	LSZH, flexible, PUR cable	NA		0028667
UNITRONIC® LiYCY (TP)	8x2x0.5	PVC, Twisted pair, Screened	E_{ca}		0035814
UNITRONIC® LiYCY	12x0.5	PVC, Screened	E_{ca}		0034612

H. FIELD DEVICES

Temp and Air Sensors

The Sensors can be indoor, outdoor, with tension, current or other interfaces.
Mainly exist the following communication type: PT100/PT1000 and NTC. The main differences are:

Communication Type	Material	Resistance		Other Specs
PT100	Platinium	100 ohms at 0°C	Linear	
PT1000	Platinium	1000 ohms at 0°C	Linear	More sensitive with cable length
NTC	Ceramic	NTC varies with type	Non-Linear	Less stable over time

Please check **Sensor** cable table.

Velocity Sensor / Differential Pressure Transmitter across blower

Material	Conductor x Section	Sensor Type	CPR	Specs	PN
POLISCREEN® LiHCH	7x1	0..10V ; 4..20mA	C_{ca} -S_{1b},d_1,a_1		2311000167
POLISCREEN® LiHCH	3x1	0..10V	C_{ca} -S_{1b},d_1,a_1		2311000112

T/RH/DP Display

T/RH/DP Displays are wall-mounted transmitters, indicators, and regulators designed to measure and monitor environmental parameters, including Relative Humidity (RH), Ambient Temperature (T), Carbon Dioxide (CO2), and Dewpoint Temperature (DP, a calculated value).

Material	Conductor x Section	Sensor Type	CPR	Specs	PN
POLISCREEN® 9842 RS-485	2x2xAWG24	Modbus RTU	E_{ca}		2311091549
POLILAN® CAT6$_A$	4P AWG23	Ethernet	D_{ca}		2311003643

Motorized Return Damper

A motorized return damper, commonly used in HVAC systems, regulates airflow and is equipped with an actuator—an electric motor that opens and closes the damper in response to signals from the HVAC system's control unit.

Differential Pressure Switch

Material	Conductor x Section	Sensor Type	CPR	Specs	PN
POLISCREEN® LiHCH	7x1	0..10V ;4..20mA	C_{ca} -S_{1b},d_1,a_1		2311000167
POLISCREEN® LiHCH	3x1	0..10V	C_{ca} -S_{1b},d_1,a_1		2311000112

Smoke Detector

For smoke detectors using Ethernet, ensure the **infrastructure communication cables** meet the necessary specifications. However, as part of a fire security system, we recommend using **fire-resistant cables** designed for enhanced safety and compliance with relevant standards.

Two Way Modulating Valves for Chilled water and Hot water

Material	Conductor x Section	CPR	Specs	PN
OLFLEX® 135 CH **Halogen free, flexible and screened**	3G1.0	D_{ca} -S_{1b},d_2,a_1		1123267
	5G1.0	D_{ca} -S_{1b},d_2,a_1		1123271
	7G1.0	D_{ca} -S_{1b},d_2,a_1		1123275
	12 G 1.0	D_{ca} -S_{1b},d_2,a_1		1123281

I. SOLAR

Cable

Low data rate, Ethernet copper or fiber optic communication cables:

Material	Conductor x Section	Sensor Type	CPR	Specs	PN
POLISCREEN® 9842 RS-485	2x2xAWG24	Modbus RTU	E_{ca}		2311091549
POLILAN® CAT6$_A$	4P AWG23	Ethernet	D_{ca}		2311003643
FO UNIVERSAL OM4	4xOM4	Fiber	D_{ca}		2311004341

J. CENTRALIZED SYSTEMS (SCADA)

Ethernet CAT6$_A$ U/FTP

Material	Description	CPR	Specs	PN
CAT6$_A$ U/FTP	CABLE CAT6$_A$ U/FTP LSZH VIOLET POLILAN	D_{ca} -s_2,d_2,a_1		2311003643
PATCHPANEL 24x RJ45	PATCHPANEL FOR RACK 19'' RJ45			2311002861
MODULE RJ45 SHIELDED	MODULE RJ45 CAT6$_A$ STP POLILAN			2311002859

Other category cables and accessories are available.

See also: **Ethernet copper** (page 12).


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2 WHAT ARE THE BENEFITS OF BAS

WHAT IS BAS

A Building Automation System (BAS) serves as a centralized platform designed to oversee and manage the mechanical, electrical and plumbing systems within a building.

By utilizing such a system, buildings can achieve enhanced energy efficiency, lower operational costs, improved occupant comfort and optimized overall performance.

Depending on the depth of automation, control levels and areas covered, the system may be referred to by other acronyms:

- **IBMS – Integrated Building Management System**
  The most advanced system, integrating all subsystems into a “smart building.”
- **BMS – Building Management System**
  A centralized control system for traditional building systems.
- **BAS – Building Automation System**
  Focused on automating specific subsystems, such as HVAC or lighting.
- **BACS – Building Automation Control System**
  Combines features of BMS and BAS with centralized control.
- **EMS – Energy Management System**
  A management system specifically designed for energy optimization.
- **BA – Building Automation**
  A general term referring to automation in buildings.

We at **LAPP** are committed to providing innovative cabling solutions for these systems.

Temperature Control

Energy

Light Control

Security

Money Saving

WHAT ARE COMPONENTS OF BAS

Key components and functionalities of a Building Automation System include:

Sensors and Actuators: BAS integrates sensors to collect data on various environmental factors such as temperature, humidity, lighting levels, and occupancy. Actuators are used to control devices like HVAC (Heating, Ventilation, and Air Conditioning) systems, lighting, and security systems.

Centralized Control System: The BAS provides a centralized platform or interface that allows building operators or facility managers to monitor and control different systems. This centralization enables more efficient and coordinated management of the entire building.

Data Logging and Analysis: The system logs data from various sensors over time, allowing for historical analysis. This data can be used to identify patterns, trends, and anomalies, helping operators make informed decisions to improve energy efficiency and system performance.

Energy Management: BAS plays a crucial role in energy conservation by optimizing the operation of HVAC and lighting systems based on occupancy, time of day, and other factors. This helps reduce energy consumption and operational costs.

Alarm and Fault Detection: The BAS can detect abnormalities or faults in different building systems and issue alarms or notifications to building operators. This proactive approach allows for quick identification and resolution of issues, preventing potential system failures.

Remote Monitoring and Control: Many modern BAS systems offer remote access, allowing facility managers to monitor and control building systems from anywhere with an internet connection. This is particularly useful for managing multiple buildings or sites.

Integration with Other Systems: BAS often integrates with other building systems, such as fire alarm systems, security systems, and access control, creating a comprehensive and cohesive approach to building management.


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3 DEFINITON OF BAS (BUILDING AUTOMATION SYSTEMS)

LEVELS

Management Level

The management level in a BAS is the top-tier layer where strategic decisions and overarching control functions are executed. This level is primarily concerned with data analysis, system optimization, and high-level management of building operations. It provides the interface for building operators, facility managers, and other stakeholders to monitor and manage the building's performance.

Key Functions of the Management Level:

- **Data Collection and Analysis**: At the management level, data from various subsystems (HVAC, lighting, security, etc.) is collected and analyzed to ensure optimal performance.
- **System Integration**: The management level integrates data from different subsystems to provide a holistic view of building operations.
- **User Interface:** This level provides user-friendly interfaces, such as dashboards and graphical displays, that allow facility managers to monitor system performance, identify issues, and make informed decisions.
- **Alarm Management**: The management level is responsible for setting and managing alarms for various system parameters.
- **Energy Management:** One of the critical functions at this level is energy management. By analyzing energy consumption patterns, the system can suggest or implement measures to reduce energy usage and improve efficiency, leading to cost savings and sustainability.
- **Maintenance Scheduling:** The management level can schedule and track maintenance activities to ensure that all systems are operating optimally and to prevent unexpected breakdowns. Predictive maintenance strategies can be employed based on data trends and analysis.

Components of the Management Level:

- Management Software.
- Servers and Databases.
- Workstations.

Automation Level

The automation level is a critical component of a Building Automation System (BAS), acting as the intermediary layer between the field level (where sensors and actuators reside) and the management level (where high-level control and monitoring occur).

The automation level in a BAS is responsible for the direct control and regulation of building systems. It processes data from field devices and executes control commands to maintain desired operational conditions within the building. This level ensures that the building's mechanical and electrical systems operate efficiently and effectively in real-time.

Key Functions of the Automation Level:

- **Data Processing:** The automation level receives raw data from sensors (e.g., temperature, humidity, occupancy sensors) and processes this information to make real-time decisions. It ensures that the data is accurate and timely.
- **Control Execution:** Based on the processed data and predefined control algorithms, the automation level sends commands to actuators (e.g., valves, dampers, relays) to adjust system parameters. For instance, it can regulate the temperature by controlling HVAC equipment or adjust lighting levels based on occupancy.
- **Local Control Loops:** This level implements local control loops (such as Proportional-Integral-Derivative (PID) control loops) to maintain specific environmental conditions. These loops continuously monitor and adjust system outputs to achieve

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desired setpoints, ensuring stability and efficiency.

- **Interfacing with Field Devices:** The automation level interfaces directly with field devices, such as sensors and actuators, using various communication protocols (e.g., BACnet, Modbus, LonWorks). It ensures seamless data exchange and command execution between the field devices and the automation controllers.

Components of the Automation Level:

- **Programmable Logic Controllers (PLCs) / Direct Digital Controllers (DDCs)**: These are specialized devices at the automation level that execute control algorithms and manage the real-time operation of building systems. They are programmed to handle specific control tasks and can operate independently.

- **Control Panels:** These panels house the PLCs/DDCs and other necessary hardware. They provide a centralized location for managing the automation level components.

- **Communication Networks:** The automation level relies on robust communication networks to connect field devices with controllers and ensure reliable data transmission.

Field Level

The field level is the lowest tier in the hierarchy of a Building Automation System. It comprises all the hardware components that directly measure and control the various parameters of a building's environment and systems. This level is responsible for gathering data and executing the commands issued by the higher automation and management levels.

Key Functions of the Field Level:

- **Data Collection**: The field level involves gathering real-time data from the building environment. This data includes temperature, humidity, pressure, occupancy, light levels, and other relevant metrics. The data is collected using various sensors.
- **Direct Control**: The field level executes control actions to maintain desired environmental conditions. This involves using actuators to adjust equipment settings such as opening or closing valves, switching lights on or off, modulating fans, and other similar tasks.
- **Communication**: The field devices communicate with controllers at the automation level. They send data to be processed and receive commands to adjust their operations accordingly.

Components of the Field Level:

- **Sensors:** Sensors are devices that measure physical parameters and convert them into signals that can be read by controllers. Common types of sensors used in BAS include:
    - Temperature sensors
    - Humidity sensors
    - Pressure sensors
    - Occupancy sensors
    - Light sensors
    - Air quality sensors

- **Actuators:** Actuators are devices that perform actions based on commands from the automation level. They can adjust the physical state of building systems. Examples of actuators include:
    - Valves (to control fluid flow)

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  - Dampers (to control air flow)
  - Relays (to switch electrical circuits)
  - Motorized drives (to adjust mechanical components)

- **Meters:** Meters measure consumption and usage metrics such as electricity, water, and gas. They provide critical data for energy management and billing.

PROTOCOLS

BACnet

BACnet is a communication protocol used in building automation and control networks, particularly for HVAC (heating, ventilation, and air conditioning), lighting, security, and other systems.

BACnet (Building Automation and Control Network) was developed in 1985 by ASHRAE (the American Society of Heating, Refrigerating and Air-Conditioning Engineers). BACnet is a standard protocol, ASHRAE/ANSI 135-2012 (in America) – CEN/TC247 (in Europe) ISO 16484-5 (in the world) that allows different building automation devices to communicate with each other, regardless of the manufacturer. It enables integration and interoperability among devices in a building.

Physical Comunication Layer	Cables used
Ethernet TCP/IP	Ethernet copper cables; Fiber optic; Wireless
MSTP (Master Slave / token passing)	LIYCY (TP) 2x1mm^2, 4x1mm^2

Standards applied: ASHRAE/ANSI 135-2012 ; CEN/TC247; ISO 16484-5.

LonWorks

LonWorks or Local Operating Network is an open standard (ISO/IEC 14908) for networking platforms specifically created to address the needs of control applications (HVAC, lighting, building automation) .

The platform is built on a protocol created by Echelon Corporation for networking devices over media such as twisted pair, power lines, fiber optics, and wireless.

Physical Comunication Layer	Cables used
Ethernet	Ethernet copper cables; Fiber optic; Wireless
Radio	NA

Standards applied: ANSI/CEA-709.1-B ; ANSI/CEA-852 ; ISO/IEC 14908 ; GB/Z 20177
More information: https://www.lonmark.org/

Modbus

Modbus is a client/server data communications protocol in the application layer. It was originally designed for use with programmable logic controllers (PLCs), but has become a standard communication protocol for communication between industrial electronic devices in a wide range of buses and networks.

Modbus is popular in industrial environments because it is openly published and royalty-free. It was developed for industrial applications, is relatively easy to deploy and maintain compared to other standards, and places few restrictions on the format of the data to be transmitted.

Physical Comunication Layer	Cables used
Ethernet (MODBUS TCP/IP)	Ethernet copper cables; Fiber optic; Wireless
Modbus RTU	LIYCY(TP) 2x1

PROTOCOLS

M-Bus

M-Bus, short for Meter-Bus, is a European standard (EN 13757) for the remote reading of utility meters. It was developed to meet the specific requirements of remote reading for consumption meters, such as those for electricity, gas, water, and heat.

Here's a detailed overview of M-Bus:

Physical Comunication Layer	Cables used
2 wire MS (master slave)	J-Y(st)Y 2x2x0.8mm^2
Wireles	Without cables

DALI

DALI, which stands for Digital Addressable Lighting Interface, is a standardized protocol (IEC 62386) used for digital communication between lighting control devices. It is designed to provide a flexible, robust, and easy-to-implement system for controlling lighting in various environments, from commercial buildings and industrial sites to residential applications.

Here's an in-depth look at DALI:

Key Features of DALI:

- **Digital Communication:** Unlike analog systems, DALI uses digital signals for communication, allowing for precise and reliable control of lighting devices.
- **Two-Way Communication:** DALI supports two-way communication, enabling not only control commands to be sent to lighting devices but also allowing devices to send status information back to the controller.
- **Addressability:** Each DALI device (such as a light fixture, sensor, or controller) can be individually addressed, allowing for granular control. Up to 64 devices can be connected on a single DALI bus, each with a unique address.
- **Ease of Installation:** DALI uses a simple two-wire bus for communication and power, making it straightforward to install. The bus can be run alongside existing electrical wiring.
- **Interoperability:** As an open standard, DALI ensures interoperability between devices from different manufacturers.
- **Scalability**: DALI systems can be scaled to accommodate various sizes of installations, from small rooms to large buildings. Multiple DALI networks can be integrated using gateways or bridges.
- **Flexibility**: DALI allows for flexible configuration and reconfiguration of lighting groups and scenes without changing the physical wiring. This makes it easy to adapt the lighting system to changing needs.
- **Energy Efficiency:** By enabling precise control over lighting levels, DALI helps in reducing energy consumption, contributing to energy-efficient building management.
- **Data rate 1200bps**

Physical Comunication Layer	Cables used
2 wire	2x1.5

PROTOCOLS

KNX

KNX is an open standard for commercial and residential building automation. KNX devices can manage lighting, blinds and shutters, HVAC, security systems, energy management, audio video, domestic appliances, displays, remote control, etc. KNX evolved from three earlier standards; the European Home Systems Protocol (EHS), BatiBUS, and the European Installation Bus (EIB).

Physical Comunication Layer	Cables used
Ethernet	Ethernet copper cables; Fiber optic; Wireless
TP (Twisted Pair)	JY(st) Y 2x2x0,8

Standards Applied: EN 50090; ISO/IEC 14543; GB/T20965

SNMP

Simple Network Management Protocol (SNMP) is a widely used protocol for network management that allows devices on a network to be monitored, managed, and configured. It is part of the Internet Protocol Suite as defined by the Internet Engineering Task Force (IETF). SNMP is used to collect information about devices on a network and to send commands to manage those devices.

Web services

Web services are a standardized way of integrating web-based applications using open standards over an internet protocol backbone. Unlike traditional client-server architectures, web services use the web (HTTP/HTTPS) to facilitate communication between different software applications, regardless of their underlying platforms, languages, or technologies. Here's an in-depth look at what web services are and how they function:

OPC DA (Data Access)

OPC DA (OLE for Process Control - Data Access) is a communication standard developed by the OPC Foundation, designed to facilitate the exchange of real-time data between different devices and software applications in industrial automation systems.

OPC DA is part of the broader OPC specifications, which aim to ensure interoperability between various hardware and software components from different manufacturers.

Some Key Features of OPC DA:

- **Real-Time Data Access**: OPC DA is specifically designed for accessing real-time data from industrial devices such as PLCs (Programmable Logic Controllers), DCS (Distributed Control Systems), SCADA (Supervisory Control and Data Acquisition) systems, and other control devices.

- **Client-Server Architecture:** OPC DA uses a client-server architecture where the OPC server acts as an intermediary between the data source (like a PLC) and the OPC clients (such as HMI/SCADA systems or data historians). The server collects data from the devices and provides it to the clients upon request.

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IEC 61850 (utility aplications)

IEC 61850 is an international standard defining communication protocols for intelligent electronic devices (IEDs) at electrical substations. The standard was developed by the International Electrotechnical Commission (IEC) and is widely adopted in the utility and energy sectors to facilitate the automation and integration of substation systems. Here's a detailed overview of IEC 61850.

GLOSSARY

AHU	Air Handling Unit
ASHRAE	American Society of Heating Refrigerating and Airconditioning Engineers
BACNET	Building Automation and Control NETworks. ISO-16484-5
BAS	Building Automation Syst
BMS	Building Management System
DALI	Digital Adressable Lighting interface
DDC	Direct Digital Controller
DP	Differential Pressure
EIB	European Installation Bus, is a standard for building automation
GTC	Centralized Technical Management
HVAC	Heating, Ventilation & Air-conditioning
LAN	Local Area Network
PC	Personal Computer
PLC	Programmable Logic Controller
RH	Relative Humidity
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
TDS	Technical Datasheet
UPS	Uninterrupted Power Supply
VFD	Variable Frequency Drive

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