Telecontrol Technology with

IEC 60870/61850/61400

WAGO®

Sustainable Investment

Successful Communication Begins with a Common Language.

Previously, the world of automated distributed energy resources (DER) spoke a variety of languages. Increasing internationalization of energy markets has led to interface problems and to a staggering array of communication protocols.

Loosely based on the motto, "One world, one language," the IEC 60870/61850/61400 standards created a global communication standard for infrastructure automation.

Since the mid1990s, WAGO has successfully integrated these telecontrol protocols into select controllers from its modular, fieldbus-independent I/O system used in automation technology. WAGO's telecontrol PLC supports the following protocols: **IEC 60870-5-101** for serial transmission, **IEC 60870-5-104** for TCP/IP-based communication.

Within these signal-oriented protocols, messages, measurement values, bit patterns, counter values and (set) commands are exchanged – each with and without time stamp.

This also fulfills **IEC 61850** Standard requirements for protection and control systems within electrical substations of medium- and high-voltage applications. It applies to the monitoring and control of DER, such as combined heat and power stations, biogas plants, solar or wind farms.

Scalable telecontrol solutions: From a 32-bit PLC to an IPC. Field measurement values are recorded via connected I/O modules. WAGO's 400+ I/O modules for various analog or digital inputs/outputs meet a wide variety of industrial requirements. Intrinsically safe (Ex-i-compliant) compo-

nents provide solutions for gas supply applications. Time synchronization is performed via **IEC Object 103, SNTP, NTP, DCF77 or GPS.**

Wireless communication via GPRS is an option. Data exchange with other configuration tools is possible by importing/exporting CSV files. Building automation protocols can also be integrated into the system.

From engineering to implementation, WAGO provides a single system for standard telecontrol and automation applications.
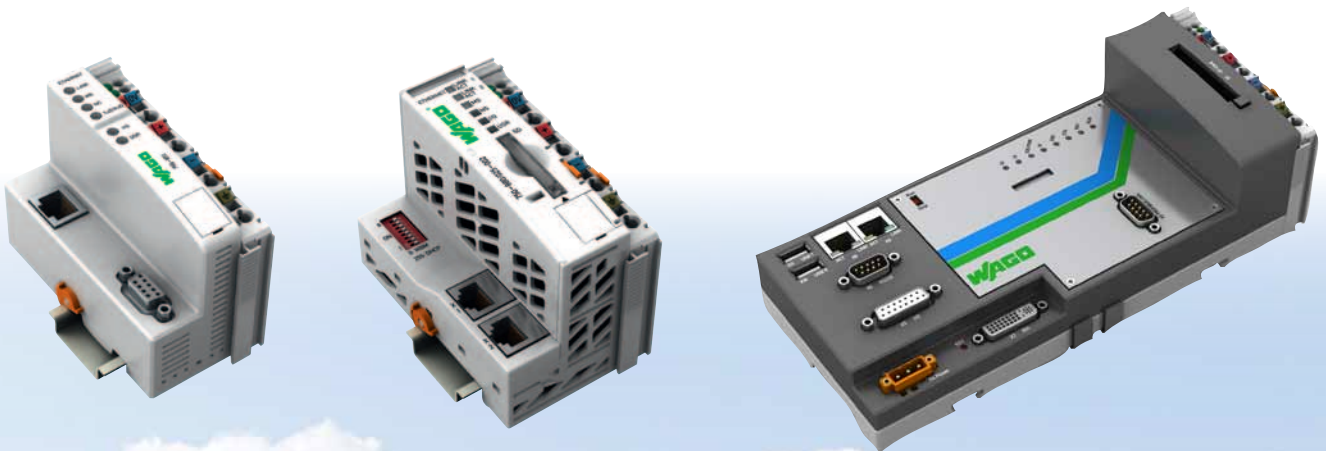
PLC for telecontrol technology: 750-872, 750-880/025-001 and 750-880/025-002

WAGO-I/O-IPC for telecontrol technology: 758-874 and 758-875

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**WAGO
complies with IEC
60870/61850/61400**

Smart Grid:

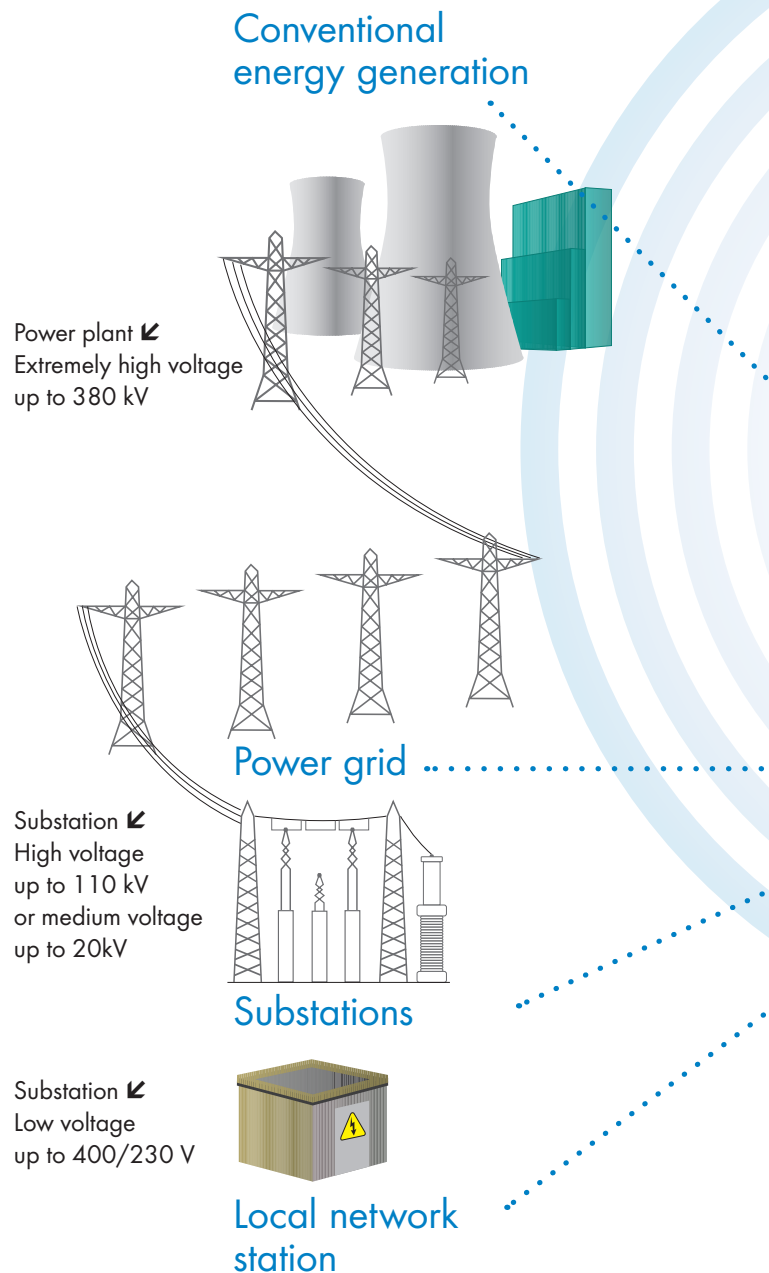## Intelligent Network for Smart Solutions

How do smart grids work?

The expansion of regenerative energies has been very dynamic. The inclusion of distributed energy sources is gaining increasing importance, primarily in wind and solar energies. The network infrastructure must also be adapted to these new demands. The development of an intelligent organization of modern electrical grids for controlling, load distribution, storage and generation of electrical energy – known as smart grids – is urgent.

By networking a number of distributed energy generation stations, even small producers can participate in the energy market, stimulating marketplace competition.

Distributed energy production changes energy markets and offers the opportunity for community and regional energy companies to develop new business segments. For example: Generating and distributing both electricity and heat creates added value for network operators.

These developments, however, have also lead to an increased volume of data transferred and to increasing communication tasks. The smart grid, and the entire network, must remain stable and operate seamlessly. Those responsible for smooth grid operation are being presented with new challenges. These include increased loads and expanded utilization of the supply to the network by distributed and/ or weather-dependent energy generation plants, whose production can be difficult to predict.

Conventional energy generation

Power plant ↙
Extremely high voltage
up to 380 kV

Power grid

Substation ↙
High voltage
up to 110 kV
or medium voltage
up to 20kV

Substations

Substation ↙
Low voltage
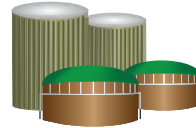up to 400/230 V

Local network station

Smart grid:

The networking and control of electrical generators, energy storage, and electrical heat consumption assume a **smart grid**.
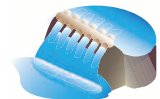
Flexible distributed energy producers

Combined heat and power plant

Biogas plants

Hydro power

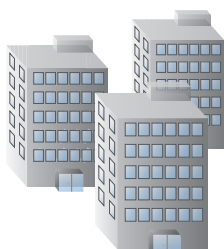## Control center

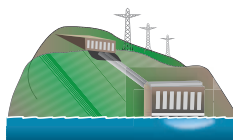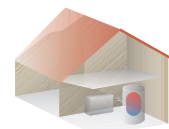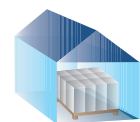## Modern renewable energy producers

Wind farms

Solar farms

Consumers

Energy storage facilities

Pumped-storage power plant

Building with heat pumps

Cold store

Compact Telecontrol Technology per IEC Stantard

Your Need: Monitoring Local Network Stations

Historically, knowledge about the states of medium- and high-voltage levels was largely sufficient for monitoring and controlling electrical supply networks. Continuous monitoring of lower voltage levels and local network stations was generally waived as it was not cost-effective.

The shift to **smart grids** and the integration of several smaller renewable energy production units, has created a pressing need for precise information about network states — even at lower voltage levels. Local network stations that were previously excluded, now must be connected into the continuous monitoring systems.

Three essential points should be considered in the selection of a suitable monitoring system:

1) Limited space:
Compact local network stations and substations pose a problem — there is hardly any space for additional monitoring and telecontrol systems. The WAGO-I/O-SYSTEM addresses this by being among the most compact systems on the market. For example, I/O modules for 16 digital inputs or outputs are available in a module that's just 12 mm wide. Additionally, its modular, granular design enables users to cost-effectively tailor a solution to suit a particular task.

Space-saving installation through low module width

Our Solutions:

WAGO-I/O-SYSTEM for telecontrol technology:
750-872, 750-880/025-001 and 750-880/025-002

2) Economic value:

By using scalable telecontrol solutions, economical solutions can be readily scaled to an application, beginning with a PLC for a small number of digital and analog signals up to high-performance telecontrol IPC.

3) Sustainable:

WAGO telecontrollers are suitable for protocols according to IEC 60870 and IEC 61850. The controllers are also ready for any changes to a provider's control system.

As components for the modular, fieldbus-independent I/O system, a large selection of I/O bus modules are available – from highly-compact 16-channel digital modules to specialty modules, such as 3-phase power measurement modules for monitoring transformer stations. Communication via GPRS can be integrated as well.

Communication via

- IEC 60870
- IEC 61850
- IEC 61400-25

2-channel DI: 750-400

4-channel: DI 750-402

8-channel DI: 750-430

16-channel DI: 750-1405

Everything in a 12 mm width!
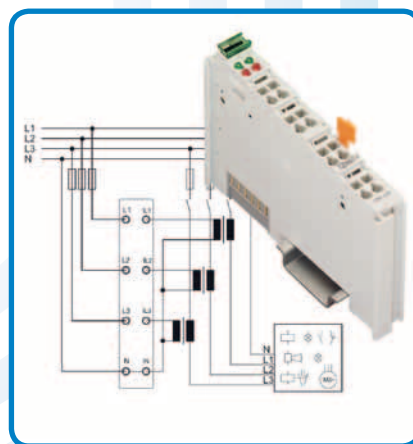
WAGO's 3-phase power measurement module collects the current and voltage levels for all three phases of a supply network via six analog/digital converters.
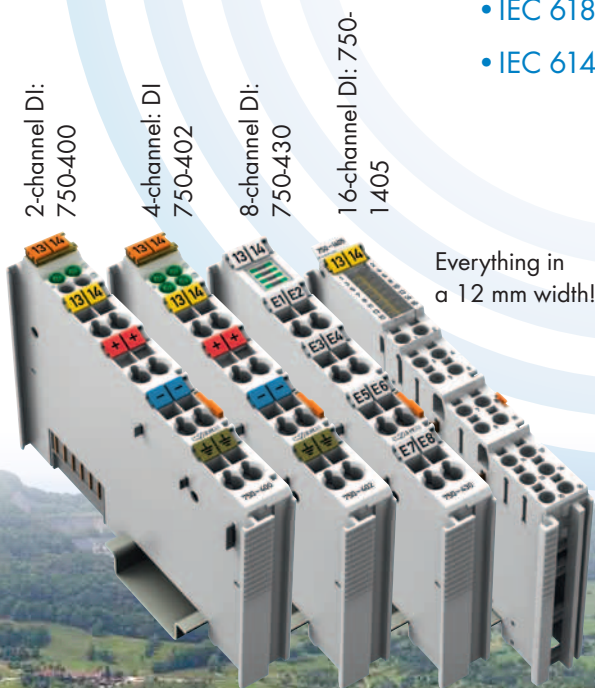
Renewable Energy Production Plants

Control and Monitoring via WAGO-I/O-SYSTEM per Renewable Energy Sources Act (EEG)

A large challenge for the network integration of renewable power producers is maintaining reliable voltage quality in the distribution network.

According to the German Renewable Energy Sources Act (EEG), photovoltaic systems with an installed capacity of more than 30 kW, for example, must be able to remotely reduce the feed-in power. This provision should ensure that while the greatest possible quantity is

drawn by network operators from EEG and CHP systems, network safety is also guaranteed.

Network monitoring is processed via a network control system. Power regulation typically occurs by reductions in four steps: 90%, 60%, 30% and 0%. The compact WAGO-I/O-SYSTEM is particularly well-suited to this application. Minimally equipped with four digital outputs, this results in a very small, economical unit for power reduction.

The flexible I/O system additionally offers the possibility of gradually balancing the power via analog outputs.

In addition to power reductions, the distributed power generation installations can also be monitored using **WAGO's intelligent 750 Series automation system**.

Our Solution:

- WAGO-I/O-SYSTEM 750-872, 750-880/025-001 and 750-880/025-002 Telecontrollers

- Compact and flexible system
- Expands for exact power control via optional analog output cards
- Integrated IEC protocols
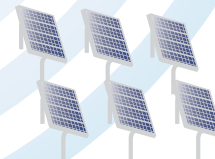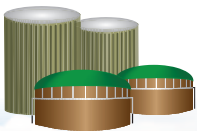- Economical solution

Control center

Wind farm

Communication via

• IEC 60870-5-101/-104

• IEC 61850

• IEC 61850-7-420

• IEC 61400-25

Biogas

Solar plant

Control Power for Free Market (Electricity Stock Exchange)

Monitoring Energy Transfer and Distribution Networks

Many energy and heat suppliers are closely investigating the successful and economical integration of renewable energy into their systems. Solutions must be found for storing and controlling energy for this purpose. One approach: converting electricity into thermal energy.

This solution provides both storage possibilities and the option of direct use in heating systems. To accomplish this, **combined heat and power plants (CHP plants) and heat pumps** are combined into a networked, flexible, adjustable and centrally controlled multi-plant system. This "power plant" is able to both generate electricity via CHP plants and sensibly use surplus **wind and solar energy** via **heat pumps**.

If the sun shines brightly during the day, and the wind blows steadily, an energy surplus in the network can be predictably harvested. The control center can activate heat pumps in a targeted manner to convert the electricity into heat and store it for later use. If the opposite is true, and there is neither much sun nor wind, the combined heat and power plants are activated to produce electricity — thus, conventionally produced electricity is not required.

Integrating this type of power plant into an existing network, requires a **controller act as a gateway** to existing CHP plants and heat pumps. This enables the connection to the **supplier's control center**.

Our Solution:

For optimized monitoring in energy transmission and distribution networks, WAGO offers ideal components to ensure the supply of electricity based on an efficient and reliable system operator – **the WAGO-I/O-SYSTEM!**

It speaks the "language" of the supplier: IEC protocols 60870-5-101 and -104 as well as IEC 61850/61400. Due to a configurator that allows it to generate IEC messages without extensive programming, WAGO offers a simple solution.

Example of a virtual power plant

Electrical current at **low** renewable energy levels

Energy storage facilities

Combined heat and power plant:

If there is little sun or wind, CHP plants are activated and conventionally produced electricity is not required.

Pumped-storage plants

Excess electricity is converted back into hydro power via a pumped-storage plant and can be reconverted into electricity as needed.

— Electricity
— Heat
— Control power

The WAGO-I/O-SYSTEM –
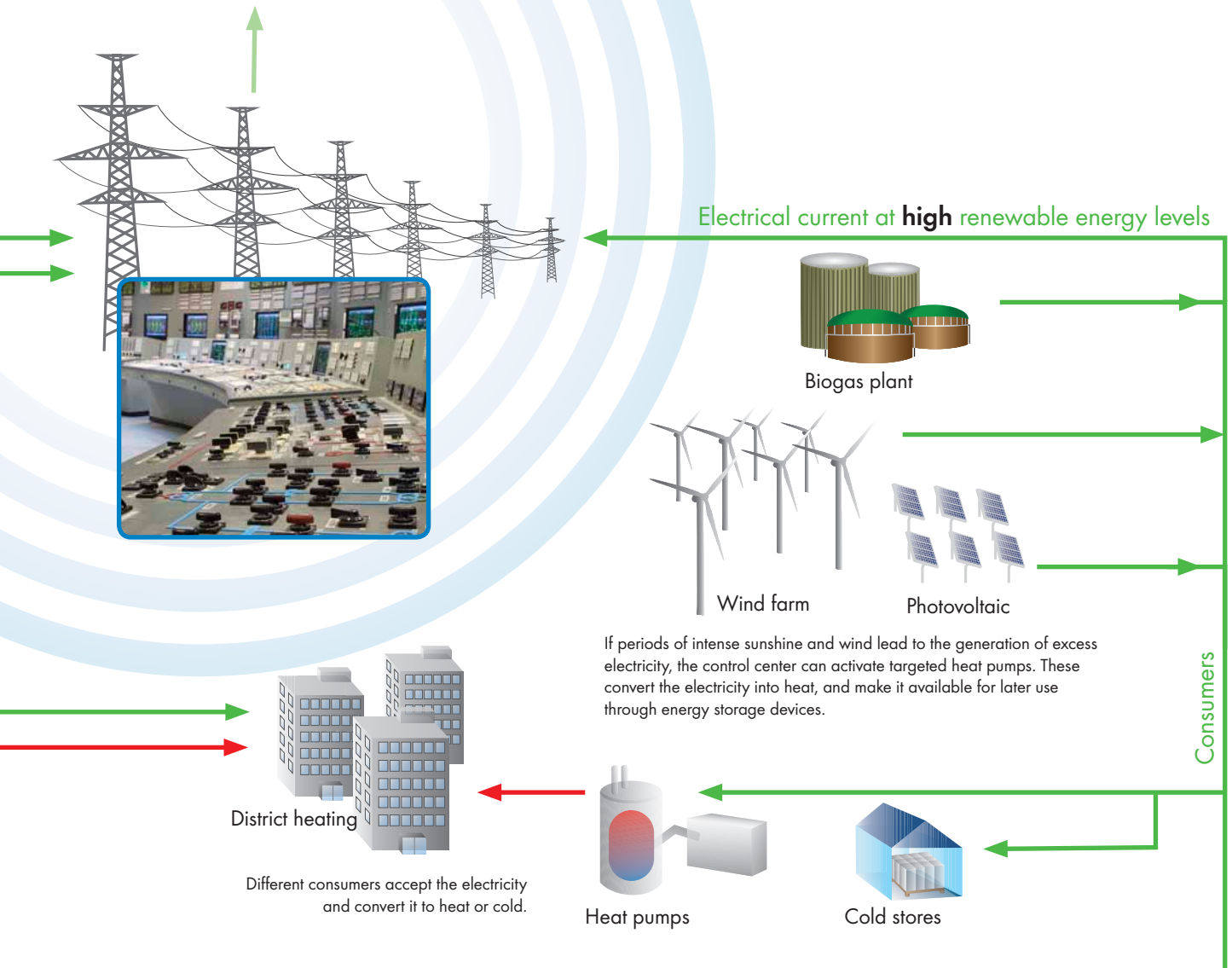## Innovative Automation

More than 400 different I/O modules provide the flexibility needed to integrate existing plants — especially those with varying numbers and signal types.

WAGO's intelligent IEC 61131-programmable automation system generates daily schedules (e.g., maintenance and production) enabling energy plants to be self-sufficient.

The WAGO-I/O-SYSTEM can be used in temperatures ranging from -20°C to +60°C. Certifications, such as GL and ATEX, make it suitable for applications operating under extreme conditions.

Control Power for Free Market (Electricity Stock Exchange)

Electrical current at **high** renewable energy levels

Biogas plant

Wind farm

Photovoltaic

If periods of intense sunshine and wind lead to the generation of excess electricity, the control center can activate targeted heat pumps. These convert the electricity into heat, and make it available for later use through energy storage devices.

District heating

Different consumers accept the electricity and convert it to heat or cold.

Heat pumps

Cold stores

Consumers

Water Management

Process Data Transmission from Pumping Stations and Reservoirs

The current task facing water and wastewater management consists of accommodating the various demands on their respective suppliers. Within the context of water supply, data is recorded about water levels, the operating figures for collecting tanks and reservoirs, as well as discharge data from pumping stations. Integration with the entire waste-

water infrastructure is part and parcel of this task, and is based on the size of the water supplier.

WAGO's 750-872 and 750-880/025-001 PLCs for telecontrol technology and WAGO-I/O-SYSTEM form the ideal basis for cross-process transmission of the parameters belonging to individual sectors via IEC 60870 protocol. At the

same time, the WAGO-I/O-SYSTEM offers a control platform for automating and monitoring the entire process.

This guarantees the system operator will have uniform hardware for data transmission (in accordance with IEC 60870-5-101/-104 protocols and via GPRS) along with the benefit of reliable planning – even within a mixed network.

Control center

IEC 60870-5-104

WAGO Telecontrol Gateway*
759-200 with WAGO-I/O-IPC
758-875/000-130

IEC 60870-5-104

GSM/GPRS

IEC 60870-5-101
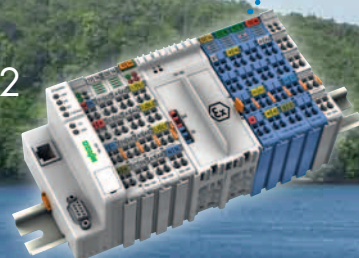
IEC 60870-5-104

Pumping station 1
Telecontrol PLC
750-880/025-001

Pumping station 2
Telecontrol PLC
750-880/025-001

Pumping station 3
750-872 Telecontrol PLC

Pumping station 4
Telecontrol PLC 750-880/025-001

Wastewater Management

Error Reporting and Networking of Pumping Stations and Control Centers

The requirements for wastewater management are complex. For example, the control center connection to existing pumping stations may have not yet undergone modernization. At the same time, maintenance must be integrated into the framework of the error reporting.

The WAGO *TO-PASS®* family provides solutions tailor-made for these applications. *TO-PASS®* Compact offers the possibility of sending relevant error messages via SMS to the operational readiness team and process data via GSM/GPRS directly to the control center server. Data is then further processed via connection to the free SQL databank.

The WAGO-I/O-SYSTEM with *TO-PASS®* Web Connector is an alternative to direct connection. It bundles data from several *TO-PASS®* Compact devices into one bus node. Data is then transferred in a targeted manner, e.g., via IEC 60870-5-101/-104 protocols, to the control center.

TO-PASS® Compact:
· Cyclical data transmission via GSM/GPRS
· Connection to control center via complimentary SQL data bank
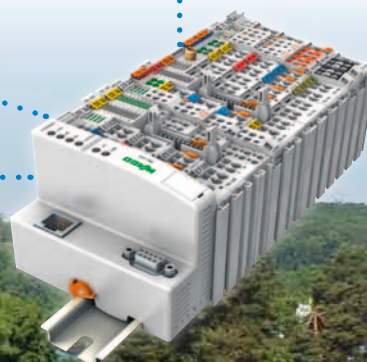
Control center

GSM/GPRS

GSM/GPRS

TO-PASS® Compact:
· 4 DI to 8 DI and 8 AI
· Data logger function
· SMS and GPRS communication
· Direct server connection
· Optional use of *TO-PASS®* Web Portal

GSM/GPRS

GSM/GPRS

TO-PASS® Web Connector*
IEC 60870-5-101/-104

Gas Distribution Stations

Progress and Safety, Even in Hazardous Areas

The WAGO-I/O-SYSTEM can serve hazardous areas - particularly when used in conjunction with the telecontrol technology employed in gas distribution and regulation stations. It allows intrinsically safe signals to be directly processed from Ex zones within the system.

Eight different modules allow various signal forms to be connected, partly even from **Zone 0.** This keeps the system compact, as any external Ex-barriers are eliminated. Additionally, wiring expenses are substantially reduced.

If the station does not allow on-site installation in a non-hazardous area, this is not a problem. The entire I/O system is **Zone 2 certified**, and thus can be directly installed in an hazardous area – when protected by an approved housing.

### Products used:

- *PERSPECTO®* Panel
- PLC for telecontrol technology, 750-880/025-001
- 852-111 ETHERNET Switch

Certified:

The WAGO-I/O-SYSTEM 750 is approved for use in Zone 2/22 hazardous areas.

This allows sensors/actuators from Zones 1/21 and Zone 0/20 to be connected via the intrinsically safe WAGO I/O module (Ex i).
IEC-Ex, UL, CSA, GL, etc.

ETHERNET

Communication via
IEC 60870-5-104
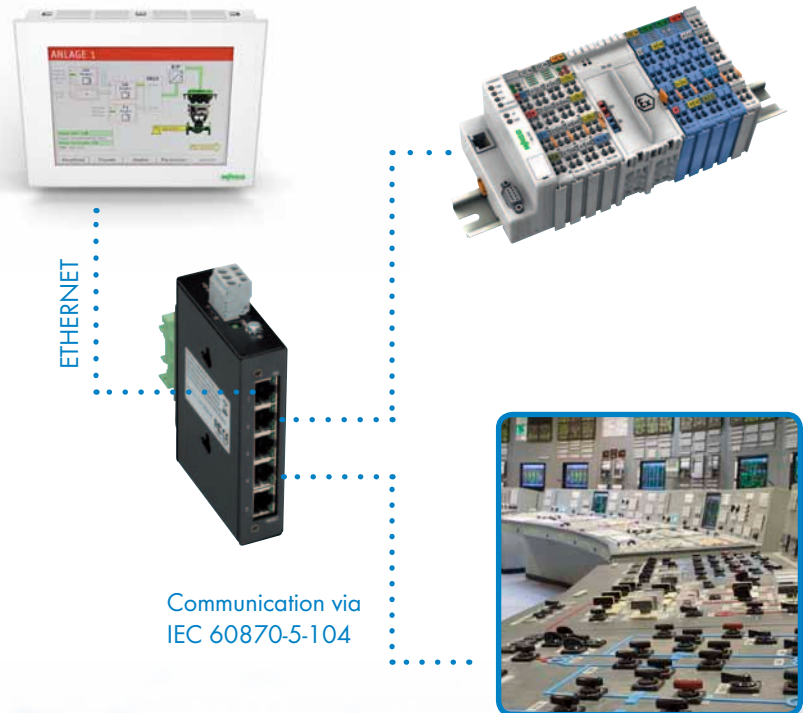
WAGO Solutions for All Requirements

Based on the 750 Series, WAGO offers many application-specific modules to meet respective market requirements. Solutions for hazardous areas include:

- Ex power supply up to 1 A
- Digital input modules, NAMUR
- Digital output modules
- Analog input modules for 4 ... 20 mA, HART® 4 ... 20 mA, resistance sensors and thermocouples
- Analog output modules for 0 ... 20 mA and 4 ... 20 mA
- Up/Down counter module

To learn more about our explosion protection solutions, go to **www.wago.com/ex** or scan the QR code.

Zone 1

Zone 0

Zone 2

Hazardous environment

Non-hazardous environment
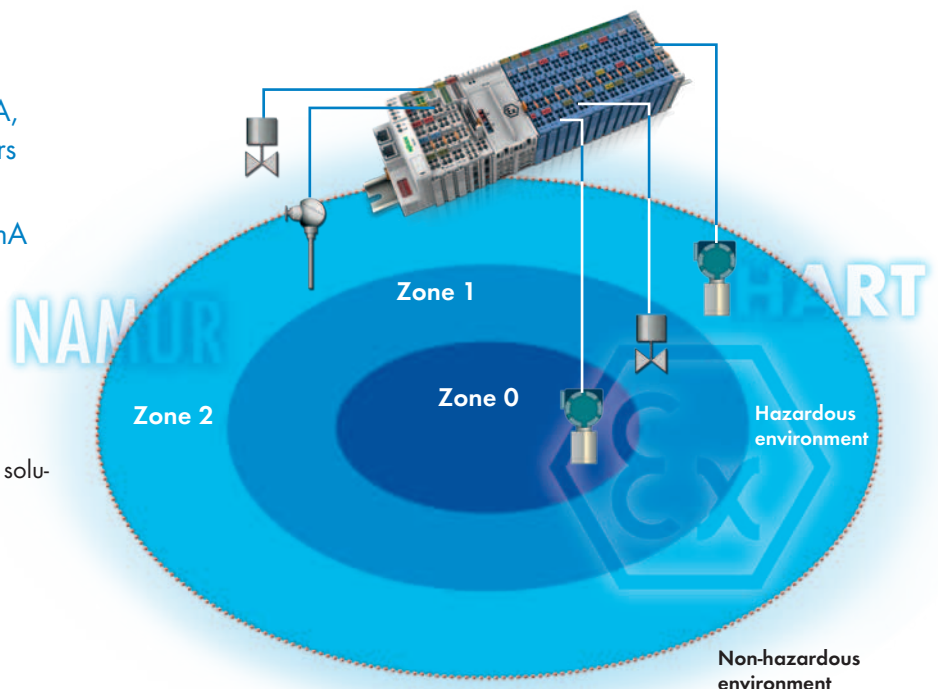
WAGO also offers additional functions for the 750/753 Series, such as:

- Digital inputs and outputs (up to 8 channels)
- Analog inputs and outputs (0 ... 20 mA, 4 ... 20 mA, 0 ... 1 A, 0 ... 10 V, ± 10 V, 0 ... 30 V), resistance sensors and thermocouples
- 3-phase power measurement modules
- SSI transmitter interface
- Stepper controller
- Incremental encoder interface
- Pulse width outputs
- Vibration severity/Roller bearing monitoring

750-455   750-1504   750-652

Telecontrollers

WAGO's IEC 61131-3 program-mable 750-872 and 750-880/025-001 Controllers meets all telecontrol technology requirements. They support a variety of application protocols for I/O data control or system management and diagnostics.

For Web-based applications, HTML pages can be generated on an internal server. Programs are directly accessible via XML and ASP. Furthermore, the controller incorporates library functions for e-mail, SOAP, ASP, IP configuration, ETHERNET sockets and file system.

The compact, robust and powerful WAGO I/O-IPC can fully perform comprehensive control, monitoring and visualization applications. The IPC's PROFIBUS DP master version can also function as main control system for industrial applications. A stable and powerful automation system is provided via Linux® operating system and CODESYS.

All WAGO telecontrollers support IEC 60870-5-101/–104, IEC 61850 and IEC 61400-25 telecontrol protocols, which the PLC programmer can access via CODESYS. For users who do not want to write a PLC program, protocols may also simply be configured via CODESYS tool.

	PLC for telecontrol technology	PLC for telecontrol technology	PLC for telecontrol technology	IPC C6 Linux® for telecontrol technology	IPC C10 Linux® for telecontrol technology
Item No.	**750-872**	**750-880/025-001**	**750-880/025-002**	**758-874/000-130 or -131**	**758-875/000-130 or -131**
Approvals	UL 508, CE	UL 508, CE, GL (pending)	CE	UL 508, CE	UL 508, CE, GL (pending)
CPU	ARM 7; 48 MHz	ARM 9; 80 MHz		Celeron® M; 600 MHz	Celeron® M; 1 GHz
Interfaces					
LAN	1 x 10Base-T/ 100Base-TX, RJ-45	2 x 10Base-T/100Base-TX, RJ-45			
I/O interfaces (serial)	1 x D-Sub 9, socket	–		1 x RS-232, 1 x D-Sub 9, socket	
I/O interfaces (USB)	–	–		2 x USB port acc. to Specification 1.1	
Memory					
Non-volatile memory (retain)	24 KB	32 KB		1024 KB	
Program memory	1 MB	1 MB		16 MB	
Data memory	1 MB	1 MB		128 MB	
Memory expansion	–	SD and SDHC up to 8 GB		CompactFlash Type I/II	
Fieldbus (optional)	–	–		for -131: PROFIBUS DP Master	
Programming	WAGO-I/O-PRO v2.3				
Telecontrol protocols	MODBUS/TCP (UDP), ETHERNET/IP, IEC 60870-5-101/-104, IEC 61850 / 61400-25 3964R/RK512				
Operating temperature	0 °C ... +55° C				-20 °C ... +60 °C
EMV: CE-Immunity to interference	acc. to EN 61000-6-2: 2005				
EMV: CE-Emission of interference	acc. to EN 61000-6-4 (2007)				

All technical data and approvals are available online at www.wago.com.

WAGO Telecontrol Gateway

Item No. 759-200 with WAGO-I/O-IPC 758-875/000-130

WAGO Telecontrol Gateway (WTG), in connection with an I/O-IPC-C10, is a gateway software for communication between max. 64 telecontrol substations (IEC 60870-5-101/ -104) and a control system equipped with interface (IEC 60870-5-104). This gateway is ideal for connecting telecontrol substations via dial-up connections, or for control system applications with a restricted number of connections.

In addition to data transfer bundling, the WTG also supports coordination of incoming and outgoing analog, GSM or ISDN dial-up connections to substations.

Advantages

· No I&C system limiting of the number of connections
· Requires no special configuration software (via WBM)
· Transmitted data requires no configuration
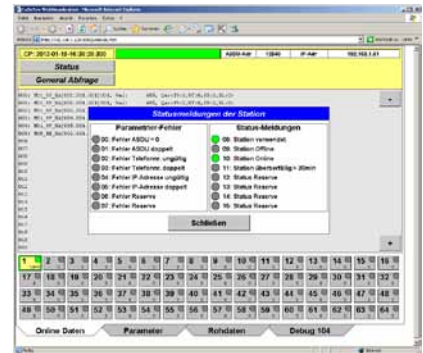
WTG configuration via Web server

TO-PASS® Web Connector

Telecontrol and monitoring of remote sites or mobile devices is no problem for *TO-PASS®*. Using the Web connector, *TO-PASS®* telecontrol modules can now be integrated to an even greater extent into the control center. The heart of the Web Connector is a special function block for the CODESYS development topology. This function block registers the HTTP queries from the telecontrol modules, saves the process image in a global variable list and transmits a corresponding acknowledgement. The received data can then be processed by the WAGO-I/O-SYSTEM as needed.
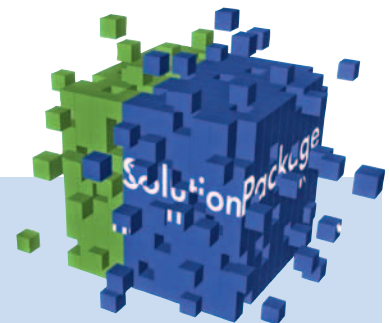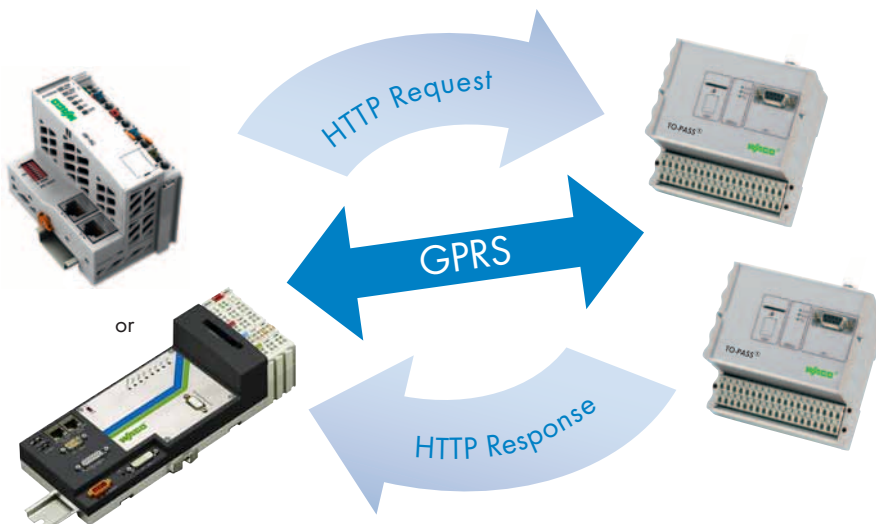
TO-PASS® Web Connector Solution Package provides the following options:

· Fieldbus-independent connection of *TO-PASS®* Compact to the I&C system

· Sending fault and event messages via GPRS data string (<1 KB) to a WAGO I/O controller with fixed IP address

· Data transmission (e.g., via MODBUS/TCP, BACnet, IEC telecontrol protocols 60870, 61850, 61400) to a central control system

HTTP Request

GPRS

HTTP Response

or

WAGO Complies with IEC Standards

Properties, Advantages, Benefits of Telecontrol Protocols

Properties:

- Modular I/O system with IEC telecontrol protocols
- Programmable via CODESYS
- Configuration tool for telecontrol protocols
- Support WAGO 750 Series controllers and WAGO 758 Series I/O-IPCs

- Data exchange import/export options
- Different time synchronization options
- Wireless communication via WAGO GPRS router
- Web server

IEC 60870-5-101 / IEC 60870-5-104

Properties:

- IEC 61131 programmable via CODESYS v2.3
- Integrated configuration tool for IEC 60870-5
- Scalable solution from compact controllers to IPCs
- Solution for telecontrol substation or control center
- Configurable number of connections to the control center from 1 to 4
- Telegram memory in case of connection failure for 8000 measured values (floating point format)
- Data exchange with other configuration tools via CSV import/export
- Time synchronization via IEC-60870 Object 103, SNTP, NTP and DCF77; GPS with 750-640 module
- Wireless communication for IEC 60870-5-104 with 761-520 GPRS Router

Supported information objects according to IEC 60870-5

Monitoring direction:

- Single messages
- Double messages
- Step messages
- 32-bit pattern
- Measured value (normalized value)
- Measured value (scaled value)
- Measured value (floating point)
- Counter values

with or without
CP24-/CP56 time stamp

Command direction:

- Single command
- Double command
- Stepset command
- Set value-set command (normalized value)
- Set value-set command (scalable value)
- Set value-set command (floating point)
- 32-bit pattern

with or without
CP56 time stamp

Additional information upon request

Advantages:
- One device for automation and IEC communication
- Easy parameter setting for IEC communication

Benefits:
- Cost-reducing, all-in-one system
- IEC communication in the familiar CODESYS environment

IEC 61850 / IEC 61400-25

Properties:

- IEC 61131 programmable via CODESYS v2.3
- Integrated configuration tool for IEC 61850/61400-25
- Scalable solution from compact controllers to IPCs
- Manufacturing Messaging Specification (MMS) communication, also for IPC: transmission of GOOSE messages
- Configurable number of client connections from 1 to ∞
- Buffered/Unbuffered messages
- Data exchange with other tools via SCL file export/import
- Time synchronization via SNTP, NTP and DCF77; GPS with 750-640 module
- Wireless communication via 761-520 GPRS Router

Support Logical Node Classes (LNCs)

Control (CALH, CCG)
Further power system equipment (ZAXN, ZBAT, ZCAP, ZON, ZGEN, ZGIL, ZLIN, ZMOT, ZREA, ZRRC, ZSAR, ZTCF, ZTCR)
Generic (GAPC, GGIO, GSAL)
Instrument transformers (TCTR, TVTR)
Metering and measurement (MMTR, MMXN, MMXU, MSQI, MSTA)
Power transformers (YEFN, YLTC, YPSH, YPTR)
Protection (PDIF, PFRC, PHAR, PHIZ, PIOC, PMRI, PMSS, PTOV)
Sensors and monitoring (SARC, SIMG, SIML)
Switchgear (XCBR, XSWI)
System (LLN0, LPHD)
Wind (WALM, WAPC, WCNV, WGEN, WMET, WNAC, WROT, WRPC, WTOW, WTRF, WTRM, WTUR, WYAW)

Additional information upon request

www.wago.com/telecontrol

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