

## DALI-Box components of the MV/LV automation system

DALI-Box is a comprehensive, advanced solution for the automation and supervision of medium- and low-voltage grid providing 'cyber security' at the highest level. It implements mechanisms that enable installation, operation and versioning of software in a secure manner, in accordance with the latest standards.

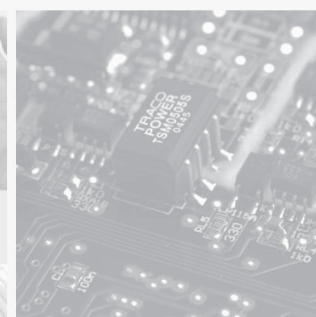
The DALI-Box components are designed to build a surveillance and automation system for the distribution of electricity in MV and LV grid. A system based on these devices performs the following tasks:

- control of public lighting
- monitoring of low-voltage transformer loads
- monitoring of short-circuit indicators
- reading of any data from energy meters
- modification of billing tariffs
- transmission of all data to a central database

The transmitted data are collected in a unified database, the so-called 'data lake'. These enable the creation of advanced optimization and analysis algorithms for, among other things, SAIDI reduction and detection of illegal energy consumption.

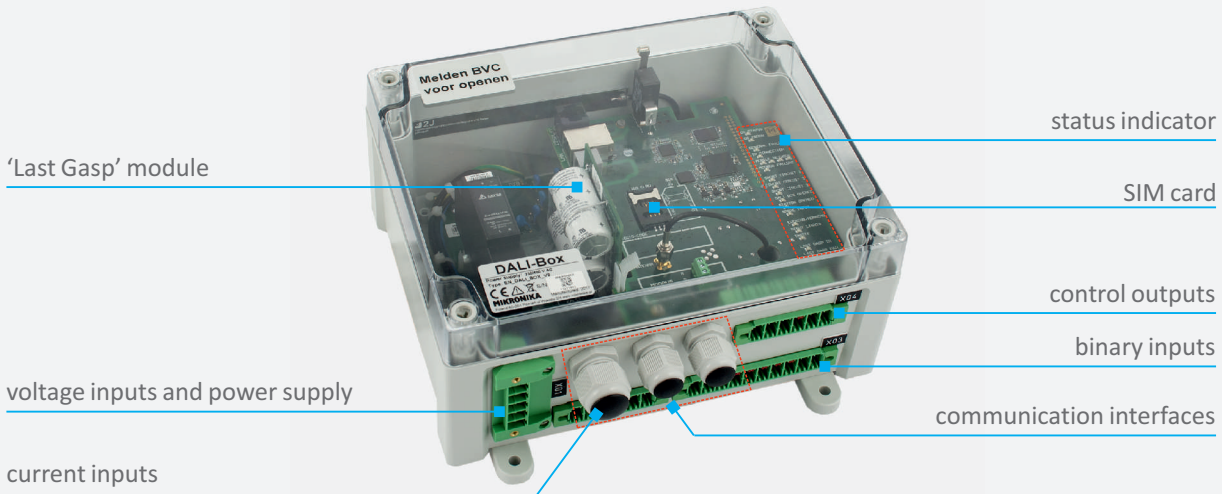
The system is made up of the following components:

- RTU controllers DALI-Box type, installed in MV/LV grid
- external terminals for data visualization, diagnostics and commissioning assistance
- LastGasp emergency power supply modules, using supercap capacitors
- software for central remote management of DALI-Box controllers, including simultaneous configuration of multiple controllers
- software for central secure management of the DALI-Box's internal firmware and simultaneous firmware updates



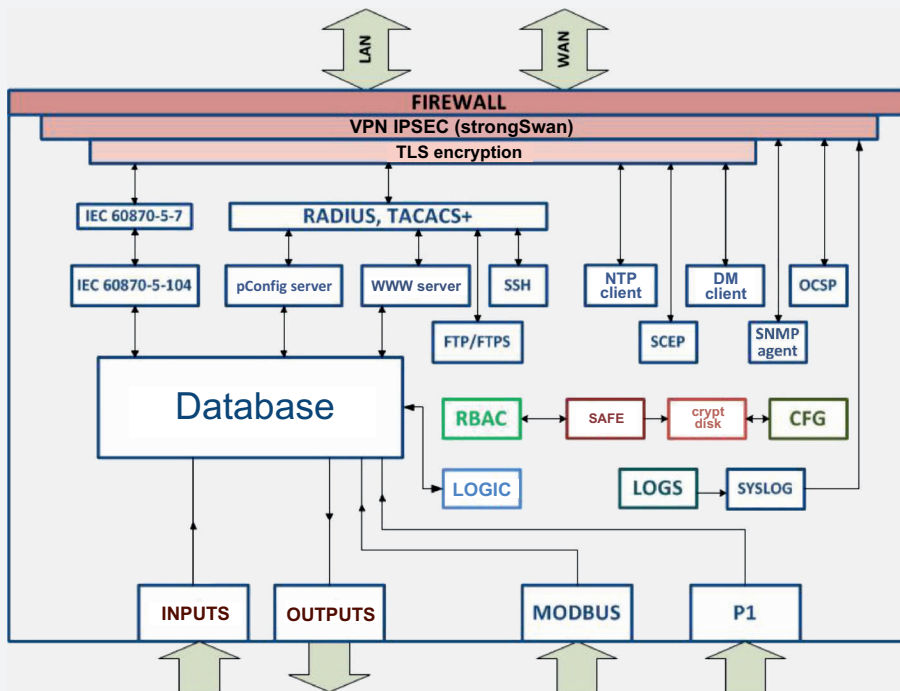
# Design of the DALI-Box controller

The fundamental component of the system is the RTU DALI-Box controller, depicted in the figure below. This device is specifically designed for installation in medium- and low-voltage grid substations. It consists of a specialized high-performance processor board with interfaces for current and voltage measurement, a three-phase electricity meter with THD measurement and binary inputs and outputs. The unit is equipped with a communication modem providing connectivity in public GPRS/LTE communication networks. In the event of a power outage, the operation of the RTU DALI-Box is backed up by an innovative capacitor-based 'LastGasp' circuit, providing sufficient energy to register the outage and send an appropriate message to the centre in up to a minimum of 30s. All the electronics are enclosed in an IP44-rated housing with a transparent cover for easy inspection of the unit's status.



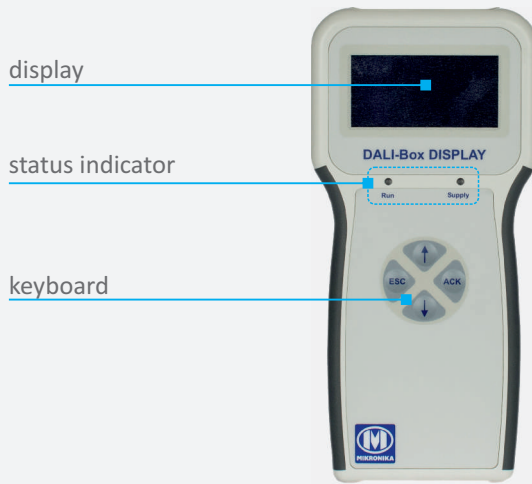
## Internal structure of the DALI-Box controller

A block of binary input interfaces is used to acquire the status of fuse-links at substations and other binary signals, for example tripping of relay protections. The output signals are used for street lighting- and tariff control. The DALI-Box supports energy meters via the P1 protocol interface or other devices via the MODBUS interface. The measurements made also include the measurement of energy quality parameters. All measured data is transmitted securely via IPsec VPN tunnels. Access to the device is protected by a built-in FIREWALL. Mechanisms are implemented for secure configuration and software management. Access control can be implemented using RADIUS, TACACS+ or LDAP central authentication. OSCP certificate validation is also possible. All certificates used on the device can be renewed automatically using SCEP or EST protocols.



# DAI-Box DISPLAY Terminal

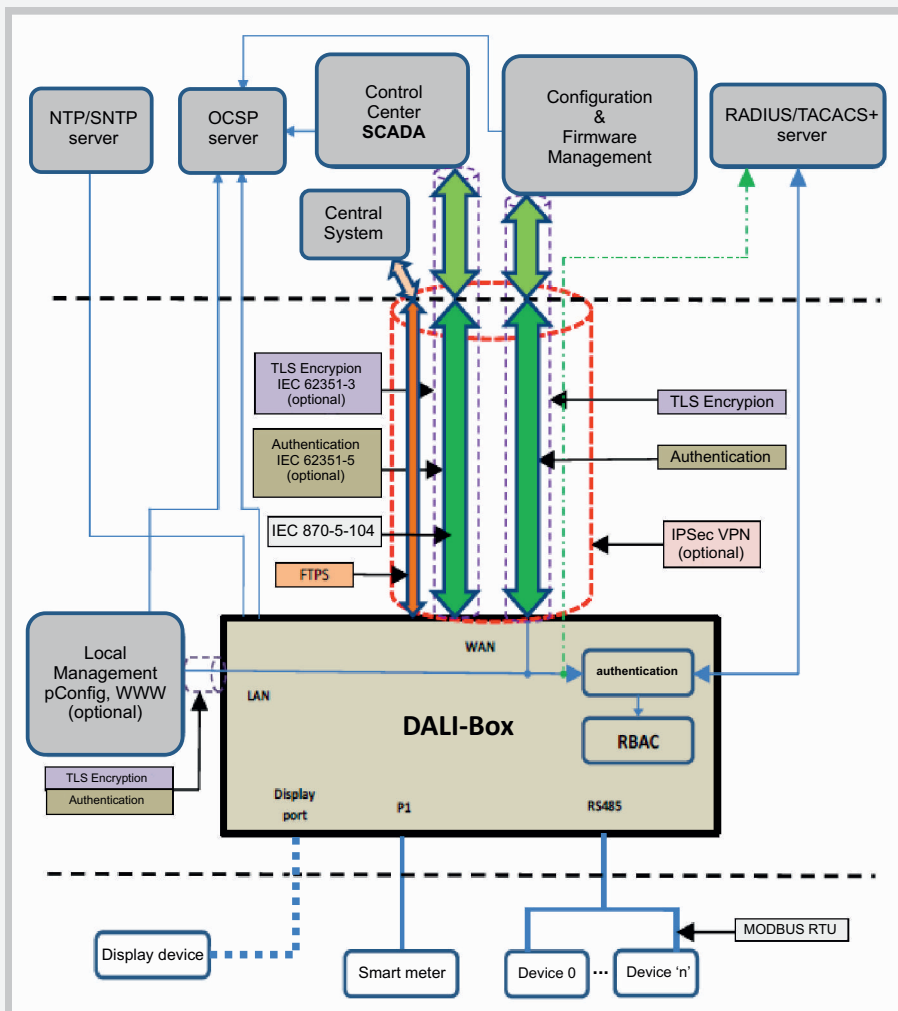
The dedicated terminal, shown below, is used for the local visualization of data during the installation of the controller, as well as during testing and service work on site.



## Cyber security

The block diagram illustrates the individual components of the safe environment in which the DALI-Box RTUs operate. This environment complies with the safety recommendations according to the following publications/standards:

- ECRYPT - CSA, 'D5.4 Algorithms, Key Size and Protocols Report'
- NIST Recommendation
- IEC 'IEC 62351 Power systems management and associated information exchange', Parts 1-9
- ISA / IEC 'ISA 62443-4-2 Security for industrial automation and control systems – Technical security requirements for IACS components'



## Environmental conditions

PARAMETER	STANDARD OF REQUIREMENT	RANGE
working temperature range	PN-EN 60870-2-2 class C2	from -25 to 55°C
relative humidity	PN-EN 60870-2-2 class C1	5÷95%
atmospheric pressure	PN-EN 60870-2-2 class C2	86±106kPa, 0...2 000m
humidity condensation	PN-EN 60870-2-2 class C2	occasionally permitted, without aggressive steam and gases
enclosure resistance	PN-EN 60529	IP44

## Insulation

PARAMETER	RANGE
dielectric withstand	2.5kV; RMS for 1min
surge immunity	5kV; 1.2/50µs

## Power supply

PARAMETER	RANGE
voltage	100÷440V AC phase or phase-to-phase, absolute value
energy consumption	min. 4W, average 6W, maximum 10W

## Analog inputs

CONNECTOR MARKING	NUMBER OF INPUTS	PARAMETER	RANGE
X1	3	voltage measurement	0÷280V AC
X2	3	current measurement	0÷6A AC
-	-	class of measurement	0.5

## Control outputs

CONNECTOR MARKING	QUANTITY OF OUTPUTS	CURRENT SWITCHING
X4	2	1A (class AC14)
X4	1	16A (class AC2)

## Binary inputs

CONNECTOR MARKING	QUANTITY OF OUTPUTS	REMARKS
X3	5	monitoring of non-potential, normally open interfaces
X3	1	monitoring the opening of the enclosure lid