VOLTAGE REGULATOR BANK ELETRONIC CONTROL MODEL CTR-4



INSTRUCTION MANUAL

MIC-006 | EN

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SAFETY AND IMPORTANCE OF LIFE

ITB, as a manufacturer of electrical equipment, takes all measures to guarantee the safety of people who may be in contact with its products, of the other equipment that may be connected to them and the environment in which they are installed.

Our main references for guaranteeing these levels of security are International standards, which represent experiences accumulated in various different conditions and for periods of time long enough to be adopted as good operational, contingency and effectiveness safety.

We consider our obligation to actively promote conscious and safe practices, both in choosing the most suitable equipment for each application as well as in its correct handling and proper Maintenance. We understand that distributing the accumulated knowledge, through technical service literature and Training programs, constitute the most efficient means of continuous improvement of such best practices of both, our products and services.

We recommend observing all safety procedures approved, instituted or requested by local regulations, as well as stressing the use of all safety devices and equipment, individual or collective, recommended for activities around high voltage equipment and power lines.

SAFETY INFORMATION

The instructions contained in this manual are not intended as a substitute for proper training and/or accumulation of experience necessary for safe installation, bypass switching and operation of single-phase voltage regulators. Only competent technicians who are familiar with medium voltage electrical network equipment should install, operate and maintain them.

A competent technician for such functions must meet at least the following qualifications:

- Be familiar with these instructions;
- Be trained in operation, procedures and safe practices accepted by the high and low voltage industry;
- Be trained and authorized to energize, de-energize, and manipulate equipment once connected to power distribution grid;
- Be trained on the proper care and use of personal protective equipment, such as: flameproof clothing, glasses, visors, helmets, insulating gloves, operation devices, etc.;
- Be trained for the installation and use of ladders in columns, necessary signs on public roads and local legislation.

For installation and operation of this equipment, be sure to read and understand all information, notices and notices in this manual.

This manual contains three types of alert phrases:



DANGER: Indicates an eminently dangerous situation that, if not avoided, will result in death or injury of any nature to the operator or to people close to the network or equipment.



CAUTION: Indicate a potentially critical situation that, if not avoided, may result in operational damage to the equipment, the network, or its surroundings.



NOTICE: Indicates a potentially unwanted situation that, if not avoided, may result in equipment malfunction.

GENERAL SAFETY INSTRUCTIONS

In general, we suggest taking into account the following information when installing, operating, maintaining, or maneuvering devices installed in high-voltage networks:



DANGER: Dangerous voltage. Contact with high voltage will cause death or very serious injury. Follow all approved safety procedures when working around high-voltage lines and equipment.



NOTICE: Before installing, operating, maintaining, or testing the equipment, carefully read and understand the contents of this manual. Improper operation, use, or maintenance may result in damage to the equipment or the network on which it is installed.



DANGER: Power distribution equipment must be properly selected for the intended application. They must be installed and maintained by competent personnel who are trained and aware of proper safety procedures. These instructions are written for such persons and are not a substitute for adequate formal training or experience in safety procedures. Failure to properly choose, install, configure, and maintain electrical power distribution equipment can result in death, serious bodily injury, and equipment damage.

INTRODUCTION

The ITB control for single-phase voltage regulator banks, model CTR-4, is a measuring and actuation device, equipped with a microcontroller, **designed to operate both individually and in conjunction with other CTR-4s.** It is dedicated to the control of a single single-phase regulator, being able to act in isolation in each phase of the bank. However, when interconnected with each other, the controls allow coordination between regulators, enabling joint action as a synchronized three-phase system**.** The controller is compatible with type A or B regulators, with 33 positions (32 steps), in compliance with ABNT® NBR 11809 and IEEE Std C57.15™ standards. This interconnectivity makes it possible to operate in single-phase or three-phase regulation, using references taken by the master or the average, applying to star, open delta or closed delta configurations.

Through its sensors installed in the motor drive circuit and operation counter device, it can monitor the position of the switch, making it compatible with any voltage regulator.



DANGER: The switch position tracking mode is not recommended when the voltage regulator is not equipped with devices that electrically lock the switches.

All ITB controls are tested and adjusted to standardized parameters, offered as an operation suggestion, and, to obtain a
Adequate functioning to specific needs, it will be necessary to
set it up.



NOTICE: Reading this manual completely will assist in proper installation, safe handling, efficient operation of the equipment, and maintenance of the equipment in a safe and reliable manner.

DESCRIPTION

The CTR-4 control is a cabin containing a control device and an interfacing set configurable for all single-phase voltage regulators according to ABNT® NBR 11809 or IEEE Std C57.15™ standard.

They offer full functionality and efficiency, safety and guarantee of the useful life of the active parts commanded for ITB regulators and have operational capabilities also for regulators of any other manufacturer.

The ITB model CTR-4 control has voltage and current measurement devices, *true RMS* with maximum error limited to 1.0% for 120Vac voltage and 200mA current, so that voltage and current measurements of the regulator are made in real time.

The power supply of each motor of the switches is done by the regulator itself, which, together with the monitoring algorithm, form an architecture that enables the CTR-4 to promote and monitor simultaneous switches without data loss and without overloading the TPs of any of the regulators.

All analog inputs are galvanically isolated via isolating transformers, just as all digital inputs are galvanically isolated via optocouplers.

The voltage and current on the source side of each regulator are always calculated, even when in sync, based on the position of the regulators, and no additional TP or CT installation is required at the source, not even at delta connections.

The voltage regulator is solely responsible for powering the CTR-4 control system.

Connections to the regulator junction boxes are made through cables with multiple outlets at both ends, which facilitates transport and handling.

Neutral position signaling is electrical and independent of the switchgear position monitoring system, shown by the lighting of a green *LED* for each regulator on the secondary control box panel that operates even with the CTR-4 removed.



DANGER: When monitoring is done by tracking, a single physical reference is used to determine the neutral position and, consequently, the other positions of the switch. To ensure that the equipment is manoeuvred, whether it is start-up or withdrawal, the redundancy required to ensure the neutral position in regulators to be switched is achieved by checking the external mechanical position indicator.

RECEIPT

Before packaging, the control is tested and inspected at the factory. Upon receiving it, another inspection should be done to locate damage that may result from transport. The control cabinet, electrical cables, sockets and other external components must be intact and free of cracks and deformations. The packaging must also show no signs of tampering, impact, or falling.

Any irregularity must be reported to ITB as soon as possible and even before proceeding with the unloading.

STORAGE

Storage must be done in a place sheltered from bad weather, ventilated, dry, away from heat sources, protected from sparks, with a maximum stacking of 2 packages and where there is no possibility of mechanical damage.

CONTROL BOX CTR-4 – OVERVIEW

The CTR-4 electronic control is housed in a metal box made of carbon steel and coated with a liquid or powder coating system, in light gray, MUNSELL notation N. 6.5.

The model provided will be according to the customer's purchase order.

On request, or according to the customer's technical specification, it is possible to change the finishing system and material of the casing.

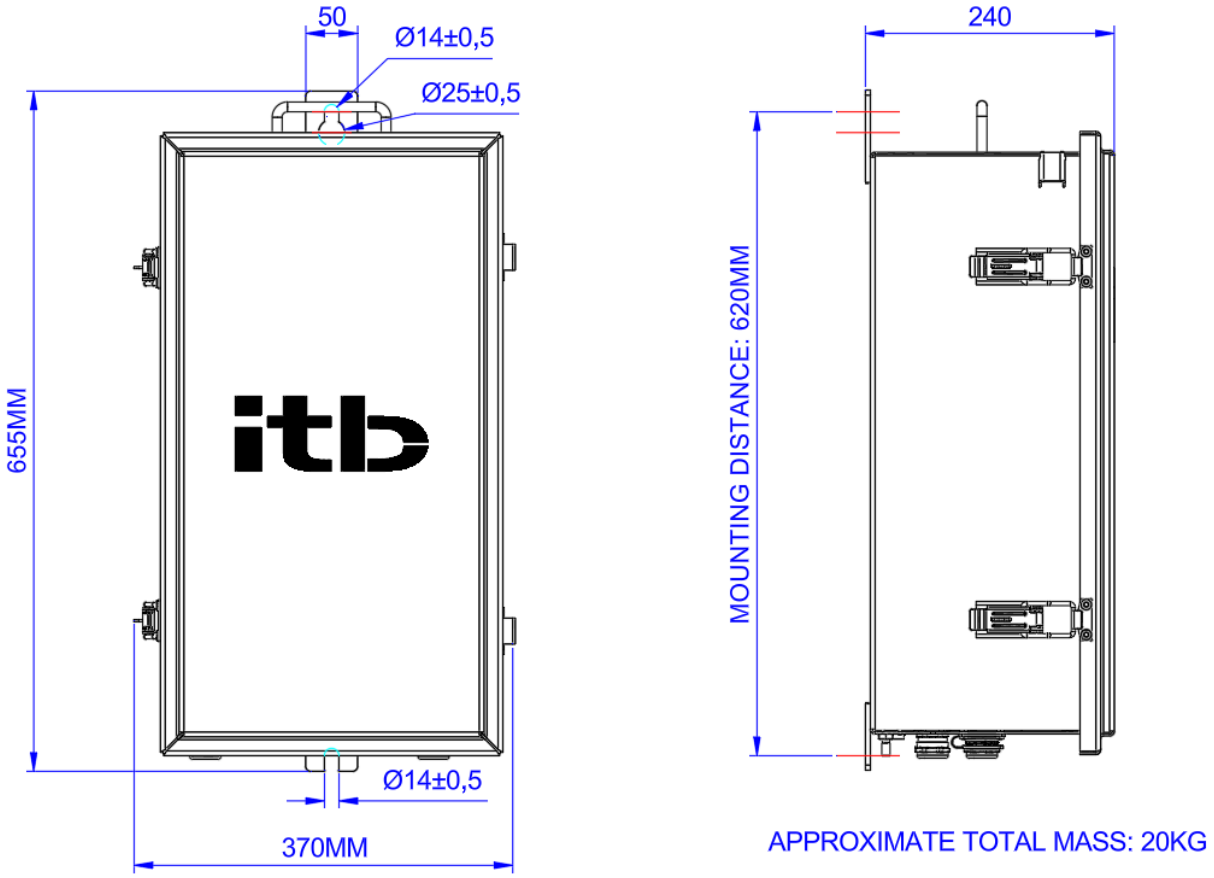
The dimensions, approximate net weights and fixture details for assembly are illustrated in the Figure 1.

Note: Weights and dimensions are for reference only. Final construction details will be issued after the purchase order in agreement between manufacturer and customer.



CAUTION: To avoid damage to the equipment, use only the upper handles of the control box for full lifting.

Figure 1: External dimensional of the STANDARD control box (measurements in mm).



Both CTR-4 control enclosure models have the following features:

- IP54 protecton degree prepared to work over time;
- IK9 protecton degree against external mechanical impacts;
- Power outlet from 90 to 145Vac (up to 4A), standard NBR 14136, 2 poles and 1 ground, for use of equipment in the field;
- Fuse protection system (with spare unit) for the circuits of the general purpose socket, control, motors, remote terminal unit (RTU) and humidity heating system or condensation hygrostat;
- "NORMAL / OFF / EXTERNAL" *supply switch*, which selects the power mode of the control and avoids energization of the bushing terminals during an external power;
- Terminal blocks for external power input (90 to 145Vac);
- Terminal blocks for voltmeter connection;
- Motor overvoltage protection system (varistors);
- Switches, knife type, for short circuit TC, ensuring safe removal of the CTR-4 cabinet, one for each regulator;
- Motor current sensors;
- Manual motor activation key;
- Reset closing selectors of the external position indicator, which can be for phase or neutral;
- Neutral light actuation selectors, wich can be by phase or neutral;
- Control power switching selector (regulator or *UPS);*

- Drawer for accommodating a remote terminal unit (RTU);
- Terminal block for programmable input and output auxiliary contacts;
- Cable glands for the passag of additional signals (antenna, logic contacts, etc.).

Secondary Panel Components

With a simple and intuitive design, the secondary panel fixed to the front of the control box, has all the fundamental components for power, operation and signaling of the voltage regulator connected to the control.

The location and description of each of these components can be seen in the Figure 2 and Table 1.

Figure 2: Secondary panel components.

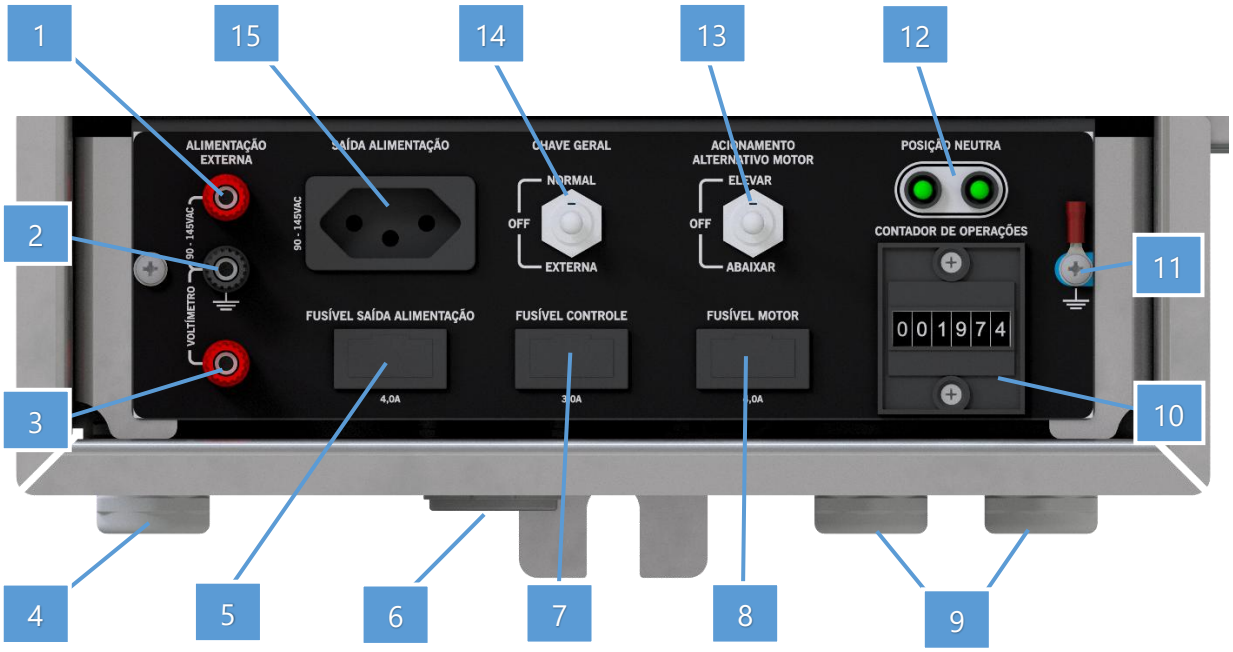


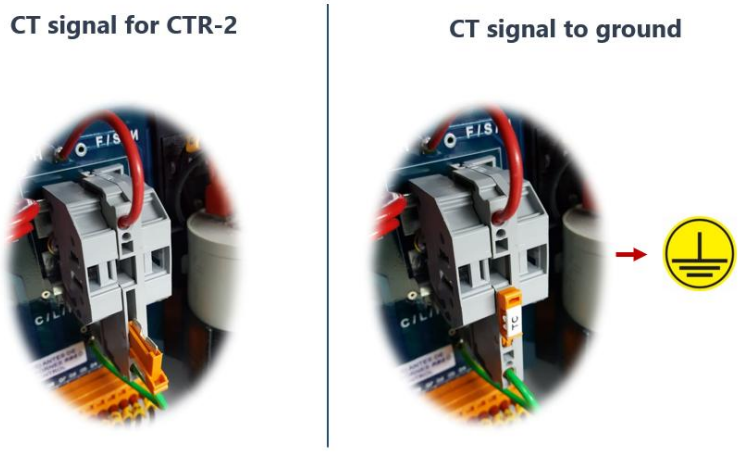
Table 1: Components of the secondary panels.

Item	Description
1	External source terminals (90 to 145Vac)
2	Neutral terminal block for external power supply and voltmeter
3	Load side measurement voltmeter connection
4	PG21 cable gland for input of regulator signals
5	Accessory power plug protection fuse (4A)
6	18-way male circular plug for three-phase synchronizer control connection
7	Control protection fuse (3A)
8	Motor protection fuse (4A)
9	Additional PG21 cable gland
10	Electromechanical Operations Counter
11	Grounding point secondary panel/box
12	Neutral position signal LEDs
13	Manual auxiliary switch for "RAISE / LOWER" motor operation
14	Power selector switch "NORMAL / OFF / EXTERNAL"
15	Field equipment power supply plug (90 to 145Vac), NBR 14136 standard, 2 poles and 1 ground

Short-circuiting of Current Transformer (CT)

Before removing the CTR-4 control cabinet, it is necessary to short-circuit the current signals, coming from the CT of each regulator, to avoid overvoltage in the secondary. This operation must be carried out through knife-type keys, fixed to the bottom of the control box, behind the main panel. The Figure 3 illustrates this procedure.

Figure 3: Procedure of short-circuiting the CTs.



CAUTION: Do not remove the connectors from the CTR-4 control without first short-circuiting the CTs. The circuits of the CTs MUST be short-circuited when removing the CTR-4 control. Failure to follow these instructions will result in damage to the equipment.

Neutral Position LED Activation Adjustment

The CTR-4 control system is able to operate with single-phase voltage regulators according to ABNT® NBR 11809 or IEEE Std C57.15™ standard, regardless of their brand. Due to the non-standardization, it is necessary to select the method of closing the led *circuit* from the neutral position, which can be for phase or neutral.

Located on the bottom of the control box, on the printed circuit board labeled *PCI CTR-P6-BACKGROUND* and in the position *RB10*, are the six-terminal terminals for manual closing as informed by the Table 2.

To close the terminals, it is necessary to use a terminal type screwdriver (1/8"x4") to remove and reconnect the bridge (jumper).

Table 2: Neutral position led lock.

Terminals	Description
1-2 5-6	When the LED ***signal*** from neutral position is to neutral
2-3 4-5	When the ***neutral position*** LED signal is for phase (90 to 145Vac)



CAUTION: Do not use phase lock on ITB regulators. For more information, see the instruction manuals for the voltage regulators to be controlled by the CTR-4.

Indicator Reset Closing Adjustment

The CTR-4 control system has a position indicator *reset* function with circuit closure for phase or neutral.

Located on the bottom of the control box, on the printed circuit board labeled *PCI CTR-P6-BACKGROUND* and in the positions *RB11*, are the three-terminal terminals for manual closing as informed by the Table 3.

To close the terminals, it is necessary to use a terminal type screwdriver (1/8"x4") to remove and reconnect the bridge (*jumper).*

Table 3: Indicator reset closure.

Terminals	Description
1-2	A phase signal (90 to 145Vac) will be emitted ***on the reset pin***
2-3	A neutral signal will be emitted ***on the reset pin***



CAUTION: Do not use phase lock on regulators with a digital indicator.

Alternative Drive

The alternative motor activation switch is located on the secondary panel, according to item 13 of the Table 1. It is a 3-position momentary switch, normally turned off, that activates the motor in the direction indicated, according to the screen printing of the panel sticker.



DANGER: Do not operate this function on voltage regulators without an external mechanical position indicator.

Operating with External Power Supply

The CTR-4 control can be energized for testing and configuration via an external voltage source between 90 to 145Vac, connected to the front panel terminals of the control box labeled "*EXTERNAL POWER*" (item 15 of the Table 1 respecting the phase and neutral indication and positioning the switches "*NORMAL/OFF/EXTERNAL*" for position "*EXTERNAL*".



CAUTION: The correct polarity must be linked to the controller. Failure to obey this recommendation may cause a short circuit in the power supply and damage to the control.



DANGER: Do not connect any voltage source to the "*VOLTMETER*" *terminals,* as this may induce high voltages in the regulator bushings and pose a serious risk of accident to the operator and damage to the regulator.



CAUTION: Do not connect any load to the "*VOLTMETER*" *terminals.*

CTR-4 CONTROL – OVERVIEW

The CTR-4 electronic control is a micro-controlled equipment capable of performing functions inherent to voltage regulation, actuation time delay and data acquisition for the control of the voltage level in electrical systems and making them available through its built-in communication system.

The CTR-4 electronic control has the following features:

- Measurements of line electrical quantities continuously, in real time;
- Digital counter of operations of the non-resettable switch;
- Digital counter of operations of the resettable switch;
- *LEDs* indicating the need to raise the voltage;
- *LEDs* indicating the need to lower the voltage;
- fault LEDs;
- *Neutral* position confirmation LEDs (ZERO);
- Data acquisition:
    - Obtains, stores, and displays the quantity of records, in adjustable periods between 1 and 60 min, the instantaneous values for each timestamp, power factor, switch position, voltage, current, operation counter, mode of operations, powers, and state of the panel door until the total number of records reaches 6,180. From this point on, each period a new record is made with abandonment of the oldest record.
- Operation in all directions of power flow (direct, reverse and cogeneration) and, when in sync with other bank controls in operation in the closed delta configuration, does not require additional external potential transformer;
- "Auto Zero" *and* "Remotely Neutralize" *function* that takes the tap switch from any position to the zero position;
- Three simultaneous communication ports;
- Allows communication via EIA232, EIA485, USB, fiber optics and/or Ethernet;
- Serial communication with a computer can be done through any of the DNP3.0 communication ports or the communication program, **CTR-4Comm** (available for download and installation in *http://www.itb.ind.br*) installable on Microsoft® Windows® 7 or newer operating system, and a connection between the computer's serial, USB, or optical port and the EIA232 port, in DB-9 plug, from the front of the control via a serial cable or USB Type-A or ST optics available on the CTR-4. If the computer's serial port is a DB-9 Male socket, the cable to be used should be straight-through, i.e., pin-to-pin.
- The communication ports can also be used for communication via cellular modem, simply by selecting the **"Connection type"** for "*TCP/IP*" *in* the *CTR-4Comm* communication program by configuring *the* "*IP*" address and "*Port*" corresponding to the modem connected to the control to be accessed.
- DNP3.0 Communication Protocol on all ports;
- Independent adjustments for direct, reverse and cogeneration power flows;
- Real-time clock and calendar;
- Protection of switches in the event of overload;
- Voltage limiter function for first consumer protection.
- Synchronization function, allowing it to operate with a master/follower arrangement in a bank of voltage regulators with up to 3 CTR-4 controls;
- Accuracy in measured nominal values of up to 1.0%.



NOTICE: The log stack can be accessed with the aid of a computer connected to the control on which the CTR-4Comm communication program is installed or via a USB stick.

Control Panel Components

The CTR-4 control allows you to view, adjust the setting, and read instant system measurements without the need for any other accessories.

When initialized, the CTR-4 control will light up all the LEDs and the back-light of the display to test the operation of these components.

Its front panel has a monochrome alphanumeric liquid crystal display and a keyboard as shown in the Figure 4 and detailed in the Table 4.



NOTICE: The CTR-4 control display has a screen saver function to save energy and extend its lifespan. After 15 minutes without any access via keyboard, the display turns off and lights up again only when there is a new access.

All controls are individually tested and calibrated at the factory and all function parameters can be adjusted manually via the CTR-4's front interface.

Through the navigation keys and keyboard it is possible to access the functions and thus adjust them for each situation.

Figure 4: CTR-4 control front panel.

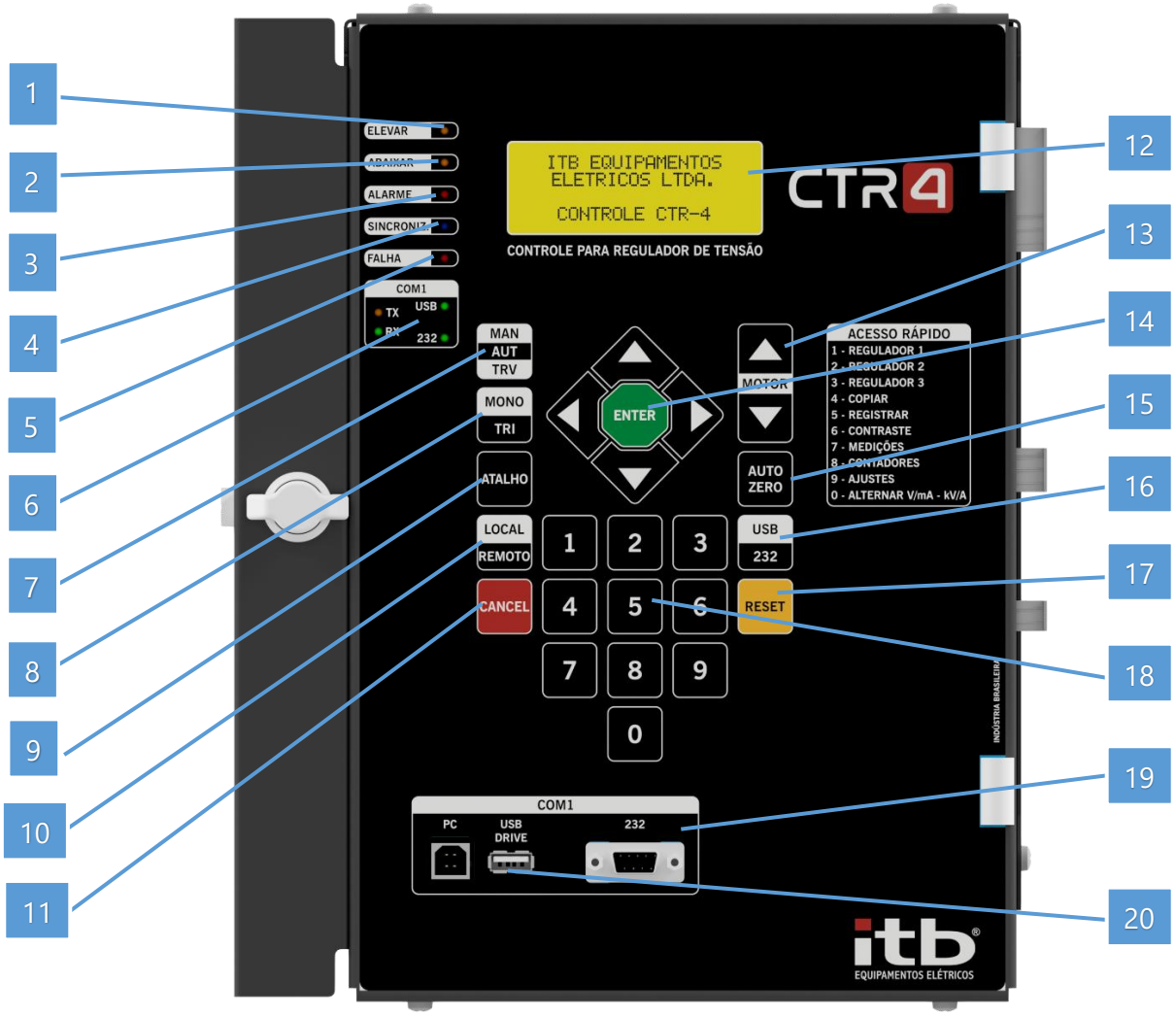


Table 4: Front Panel Components

Item	Description
1	*LED* "raise voltage" *signal*
2	*LED* "*Lower Voltage*" *Signal*
3	*LED* "alarm" *beacon*
4	*LED* signal synchronization between controls
5	*LED* "Fault" *Signal*
6	"Tx/Rx" and "USB/232" *signal LEDs*
7	"MAN/AUT/TRV" *key* selects the operating mode as automatic, manual or locked
8	"Mono/Tri" *button* selects the mode of operation of the regulator in single-phase or three-phase
9	"Shortcut" *key* allows direct access to the selected parameter screen
10	"Local/Remote" *key* blocks or allows remote commands
11	"*Cancel*" *button*
12	Monochrome Liquid Crystal Display 4 lines of 20 characters
13	"Elevate" *key* operates the switch in the direction of elevate when the "*Manual*" mode is active
14	"Navigation" *and* "Enter" *keys*
15	"Lower" *key* operates the switch to lower when "*Manual*" *mode* is active
16	"USB/232" *key* for communication interface selection
17	"Reset" *key* updates or resets the values that allow this operation
18	"Numeric" *keys* for quick parameter adjustment
19	DB-9 EIA232 COM-1 Socket
20	USB A DATA-COM-1 and USB B to USB-COM-1 socket

On the back of the control are available the inputs for the additional communication modules (COM-2 and COM-3 ports), power supply, digital and analog signals coming from the controller.

Figure 5: CTR-4 control rear panel.

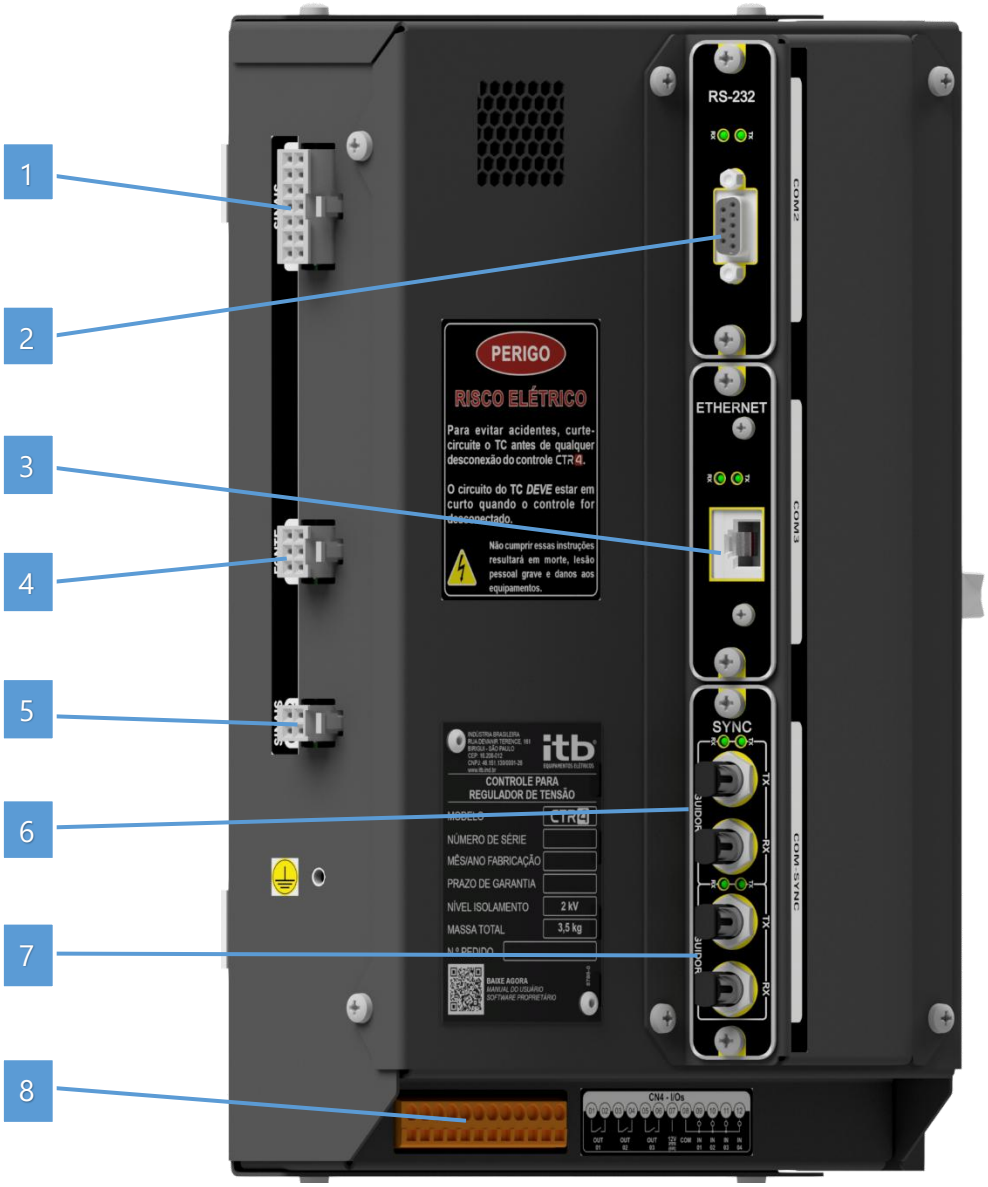


Table 5: Back panel components.

Item	Description
1	Voltage regulator signal inputs and outputs (CN2.1)
2	Slot for COM-2 port communication (as per customer specification)
3	Slot for COM-3 port communication (as per customer specification)
4	Feed inlet (CN-3)
5	Input of CT and TP measurement signals (CN2.2)
6	Slot for COM-SYNC1 port communication (per customer specification)
7	Slot for COM-SYNC2 port communication (per customer specification)
8	I/O signal input (CN4)

Auxiliary Contacts (I/O)

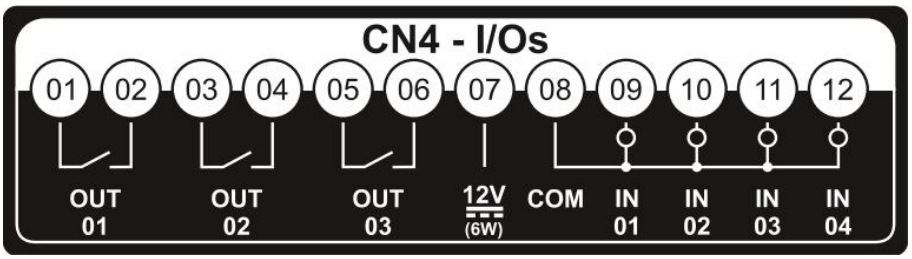
The CTR-4 control system has programmable input logic ports that allow the connection of devices such as thermometers, oil level indicators, pressure relief valves, and other devices that have contacts. It also has programmable outputs through dry contact relays, free of potential for triggering indication devices such as alarms, lamps, relays, fans, fire fighting systems, among others.

Located on the lower left rear (rear view) are available four digital inputs (COM-driven) and three outputs with dry contacts (up to 250Vac or Vdc/3A).

Use the *CTR-4Comm* communication **software** (available for download and installation in *http://www.itb.ind.br*) for configuration of the logic gates. Refer to the ***CTR-4Comm Communication Software Manual***, available in the "*Help*" tab of the program, for additional information on setting up the control logics.

The I/O port connection diagram is available on the main port of the CTR-4 control. A representation of this diagram can be seen through the Figure 6.

Figure 6: Diagram of auxiliary contacts.



CAUTION: It is recommended to read the additional connection and configuration information for logic ports available in *the CTR-4Comm Communication Software Manual in its entirety*.

Sistema de neutralização via *nobreak* (UPS)

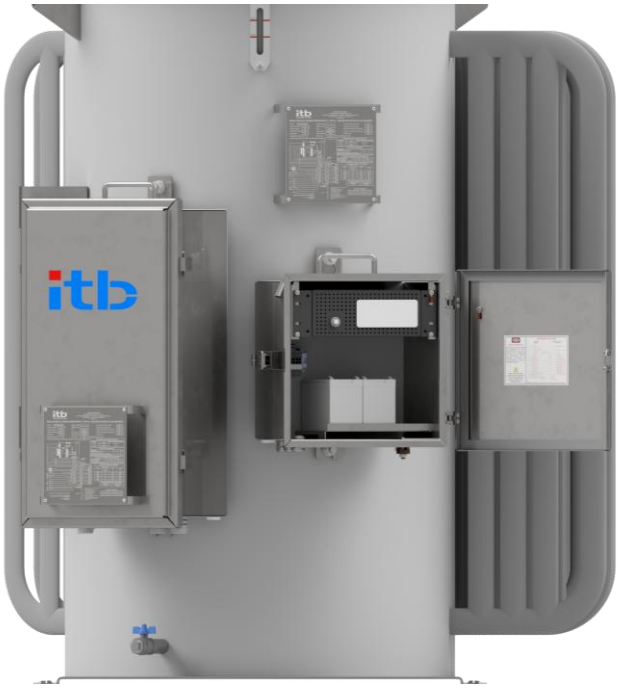
Voltage regulators banks can be connected in series in the extension of a feeder. When there is lack of power to the main system and consequently the disconnection of all the loads in such system, voltage regulators remain in the operative position in which they were regulating before the failure. In these conditions, upon returning the main power supply and due to the inertia of the load itself, overvoltages could occur throughout the feeder due to the position of the tap changer. This overvoltage can cause damage to consumers connected to the system.

To avoid such problem, CTR-3 control can include, if requested by client, a UPS (uninterruptible power supply) that can tapping to the neutral position the bank of voltage regulators in case of a power failure.

Upon detecting the lack of power being the detection and actuation functions adequately enabled, the CTR-3 control will initiate the tapping process (move tap changer to neutral position) which will be done sequentially, in other words *VR-1*, *VR- 2*, and *VR-3*.

The CTR-4 *UPS* system is installed in a separate enclosure. The enclosure is mounted on the voltage regulator next to the control enclosure, forming a compact assembly that is easily accessible for installation and maintenance, as illustrated in Figure 7. One *UPS* enclosure can serve a bank of up to three regulators.

Figure 7: UPS enclosure



The UPS enclosure, shown in Figure 8, consists of the frequency inverter, power supply batteries, and terminal block strip intended for the system's electrical connections. The UPS power supply connections, as well as the distribution of the output voltage to the controls of the regulator bank, are made through the terminal block strip. The main components are identified in Figure 8 and Table 6.

Figure 8: Terminal Block Strip

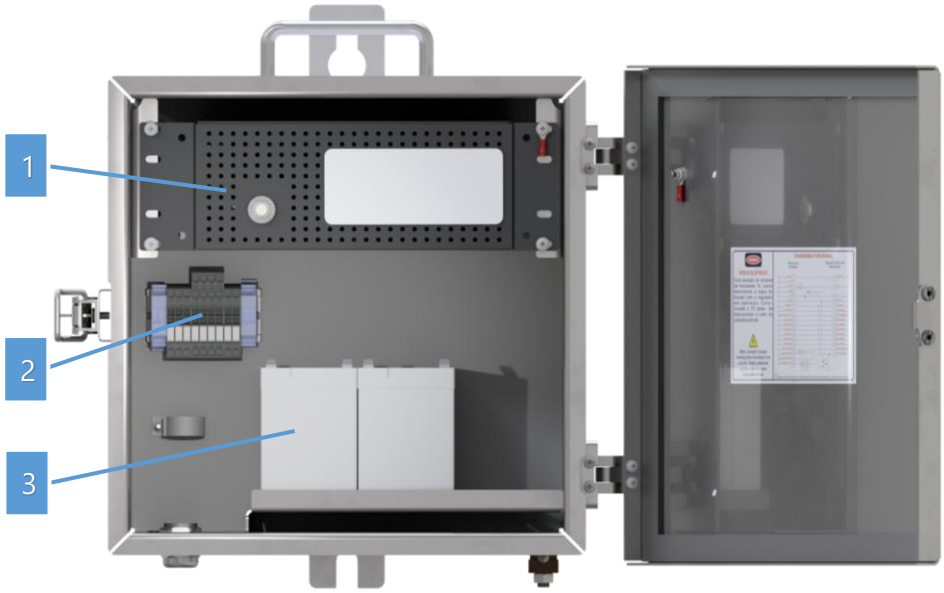


Table 6: UPS Description

Item	Description
1	Integrated UPS/Charger
2	Terminal Block Strip
3	12 Vdc Batteries

The *UPS* must be powered by the control installed on the same voltage regulator on which the *UPS* enclosure is mounted. In the event of a failure or loss of the main power supply, the *UPS* automatically takes over the power supply, keeping all controls interconnected with the system energized, including the control responsible for supplying power to the *UPS* under normal operating conditions.

The *UPS* power supply connections and the distribution of its output to the regulator controls must be made in accordance with the connection diagram shown in Figure 9 observing the terminal identification and the correct polarity of the connections.

CAUTION: If the bank consists of only two regulators, one of the follower controls' power supply cables must have its terminals insulated, because, in the event of a loss of mains power, these terminals will be energized by the *UPS* output.

Figure 9: UPS Connection Diagram

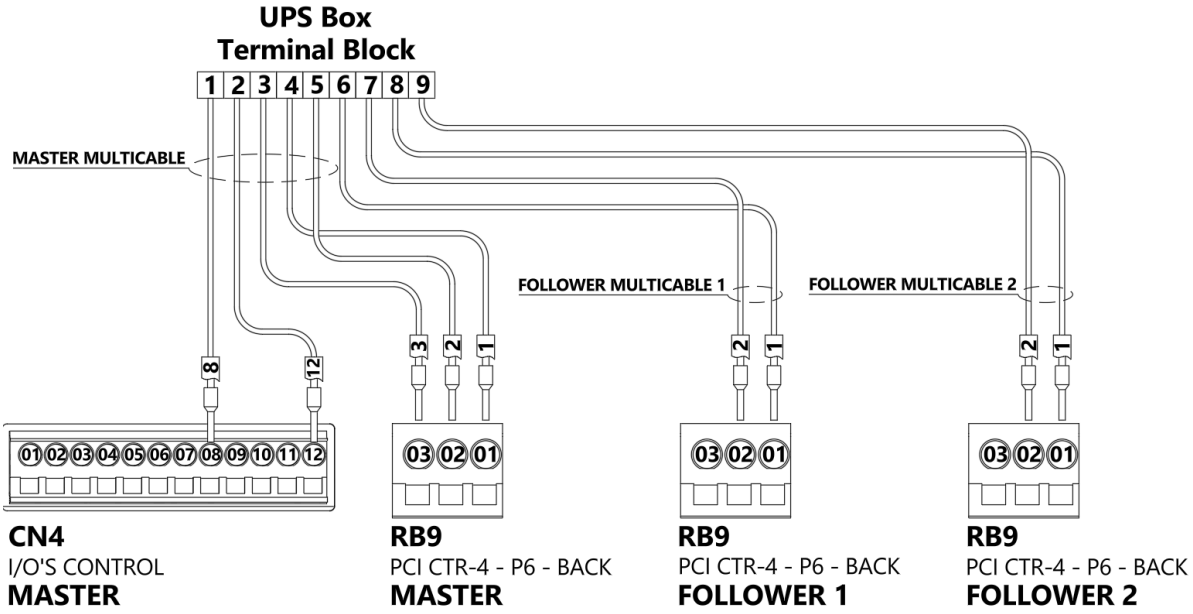


Figure 10: RB9 Location



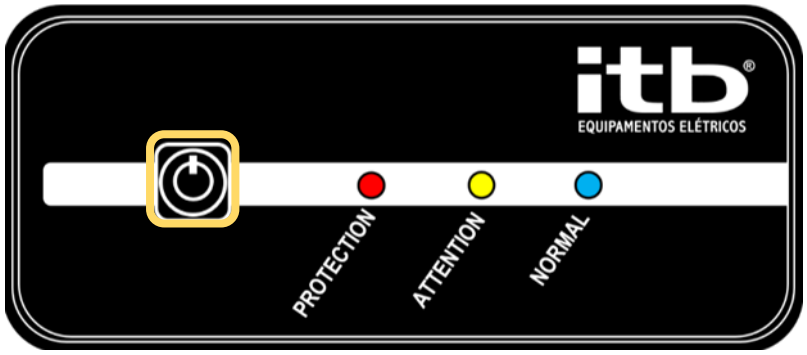
Figure 11: CN-4 Location



To use the *UPS* system, the following steps must be followed:

- Turn on the UPS by pressing the front button once, as shown in Figure 12;
- Set function *A53 - Neutralization via UPS* [1] to a value greater than zero.

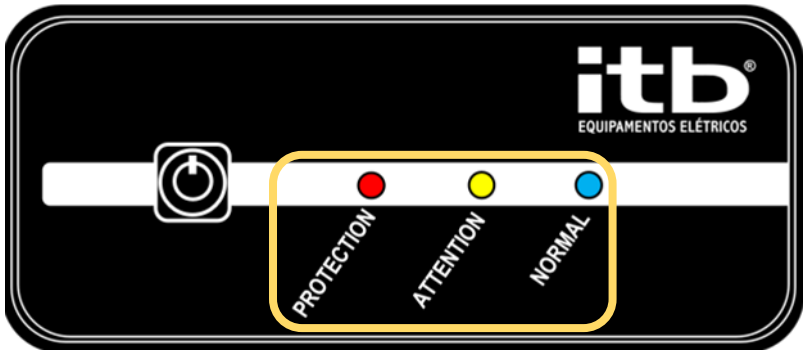
Figure 12: UPS Power Button



Front UPS LED Status and Audible Signaling

The UPS has three LEDs located on the front of the unit, as shown in Figura 13 and also features an audible alarm.

Figura 13: UPS LEDs



Each LED, together with specific audible alarm patterns, indicates a particular warning or the current operating condition, as described below:

Table 7: Normal LED (Blue)

NORMAL LED (BLUE)	
GRID OK	**Steady: Indicates that the electrical grid is present and the battery is fully charged.**
	Flashing: Indicates that the electrical grid is present and the battery is charging.

[1] *For more information about this function, see section **A53 – Neutralização via UPS**.*

In battery mode, it indicates the power consumed by the loads connected to the UPS output, as shown in Table 8 below:

Table 8: Normal LED (Blue) – Battery Status

NORMAL LED (BLUE)		
GRID NOT OK	NUMBER OF FLASHES	LOAD CONSUMPTION
	2	20%
	4	40%
	6	60%
	8	80%
	10	100%

Tabela 9: Attention LED (Yellow)

ATTENTION LED (YELLOW)	
Nº OF FLASHES	INDICATION
1	Low or absent electrical grid voltage
2	UPS has no load
3	High electrical grid voltage
4	Overheating
4	Synchronized with the buzzer, indicates an overload at the UPS output sockets
5	Battery discharged
6	Shutdown due to output overvoltage; the UPS must be switched off and then switched on again
Steady	Battery has no backup autonomy

Tabela 10: Protection LED (Red)

PROTECTION LED (RED)	
Nº OF FLASHES	INDICATION
1	Synchronized with the buzzer, indicates an overload or short circuit at the UPS output. Switch off the UPS, remove the connected load, and switch it on again.

Tabela 11: Audible Signaling

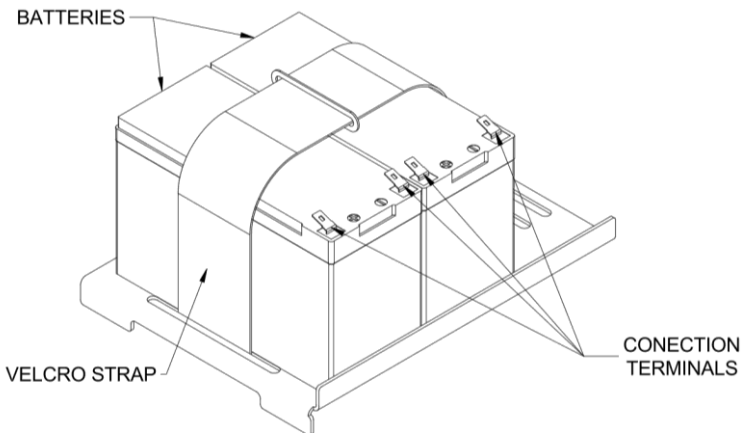
PROTECTION LED (RED)	
DESCRIPTION	INDICATION
Excessive power indication	Beeps in synchronization with the yellow LED until the excessive load is removed from the UPS.
Shutdown due to short-circuit or overload protection	Beeps in synchronization with the red LED. Switch off the UPS and switch it on again.
UPS in battery mode	Beeps at 30-second intervals, indicating that the UPS is operating in battery mode.
UPS with critically low battery	Rapid and continuous beeps indicate that shutdown is imminent because the battery is depleted.

The *UPS* system consists of a set of two 12 V, 7 Ah lead-acid batteries (VRLA-AGM) connected in parallel (or as specified in the technical proposal). The average battery service life is approximately 2 years.

For battery replacement, the following procedures are recommended:

- Press the front button for slightly more than 1 second to switch off the equipment;
- Disconnect the battery connection terminals;
- Partially loosen the Velcro strap;
- Remove the old batteries (if necessary, remove the shelf from the cabinet);
- Position the new batteries;
- Fasten the Velcro strap;
- Connect the battery connection terminals;
- Turn the inverter on again.

Figure 14: Battery Shelf



CAUTION: It is not advisable to dispose batteries in regular garbage due to the risk of causing damage to the environment and health. Once life time is achieved, they must be properly disposed according to current environmental regulations.

Operating in Sync

The CTR-4 control features a dedicated optical timing functionality between controls, allowing it to operate in a three-phase mode, with one master control and the other controls as followers.

The CTR-4 control is equipped with two rear fiber-optic synchronization ports, intended exclusively for communication between controls, and are not used for external communication. For a control to operate in sync with the others, it is necessary that these ports are properly connected between the devices.

In an application with multiple regulators, such as in the case of a system with one CTR-4 Master and two CTR-4 Followers, the Master control must establish connections with each Follower individually:

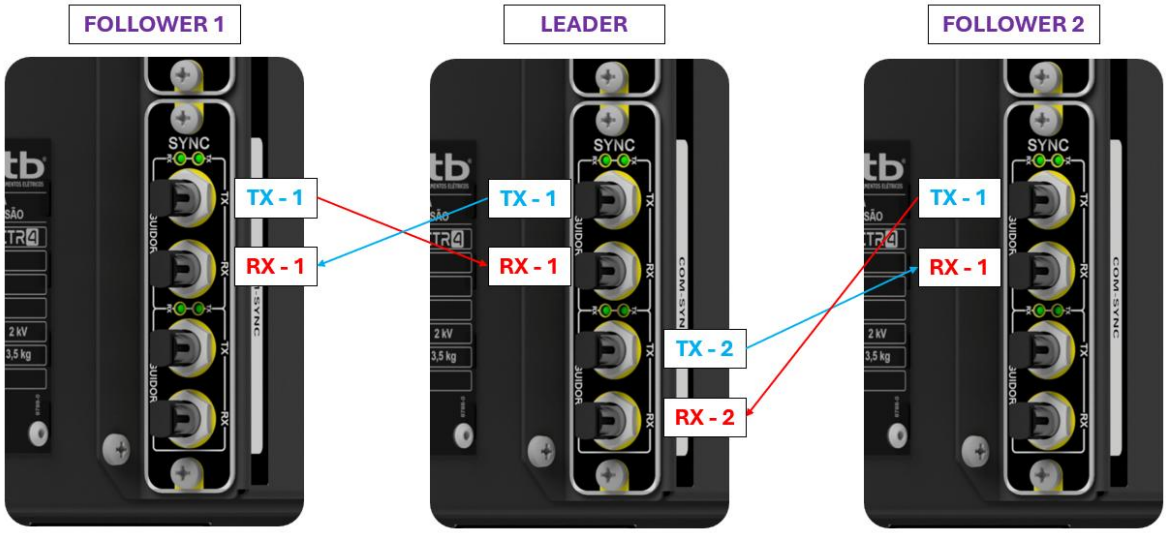
Master port 1 (RX/TX) must be connected to the Follower 1 control;

Port 2 (RX/TX) of the Master must be connected to the Follower 2 control.

Each of these rear fiber optic ports has two terminals: RX (receive) and TX (transmit). The connection must respect the correct polarity, i.e., the Master's TX must be connected to the follower's RX and the master's RX must be connected to the follower's TX, thus ensuring the proper exchange of timing data.

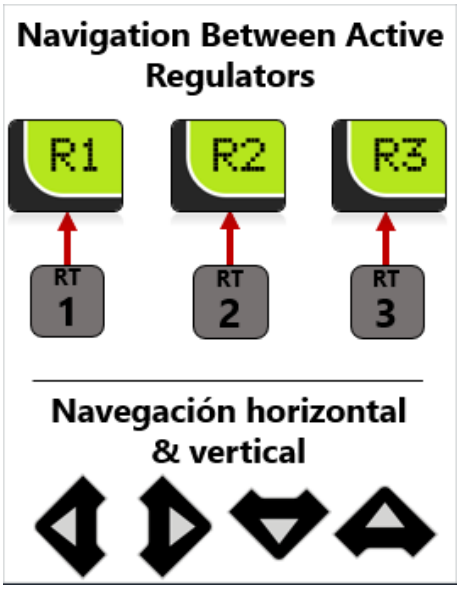
This arrangement allows the CTR-4 Master to keep the follower controls perfectly synchronized during the operation of the regulator bank.

Figure 15: Optical Loop Example



Navigating Screen Groups

Figure 16: Navigation keys.



The CTR-4 control screens have been arranged with the aim of delivering fast and accurate navigation. The screens were divided into 7 groups: main screen, login screen, measurements screen (identified from M01 to M26), counter screen (identified from C01 to C06), adjustment screens (identified from A01 to A68), date and time screen, file management screen via *pen drive*, contrast screen to control *LCD brightness* and shortcut screen.

With the CTR-4 in master/follower mode, three new screens are enabled in the master control, namely: LED operation screen, engine screen and auto zero – *status screen*.

The ◄ or ► keys switch between these groups of screens, in the order in which they were described, always showing the first screen of each group. On the measurement and function screens, you can navigate between the numbered points according to Table 12, Table 13 and Table 14 respectively, from the ▼ or ▲ keys.

When the CTR-4 is in master/follower mode, navigation between the active bank regulators can be performed via the number keys 1, 2 and 3 for the *VR-1*, *VR-2* and *VR-3* respectively. From the main screens, measurement screens and function screens, you can switch the bank's active regulators. As shown in the Figure 16, in the lower left corner is identified which regulator is the information displayed on the main screen.

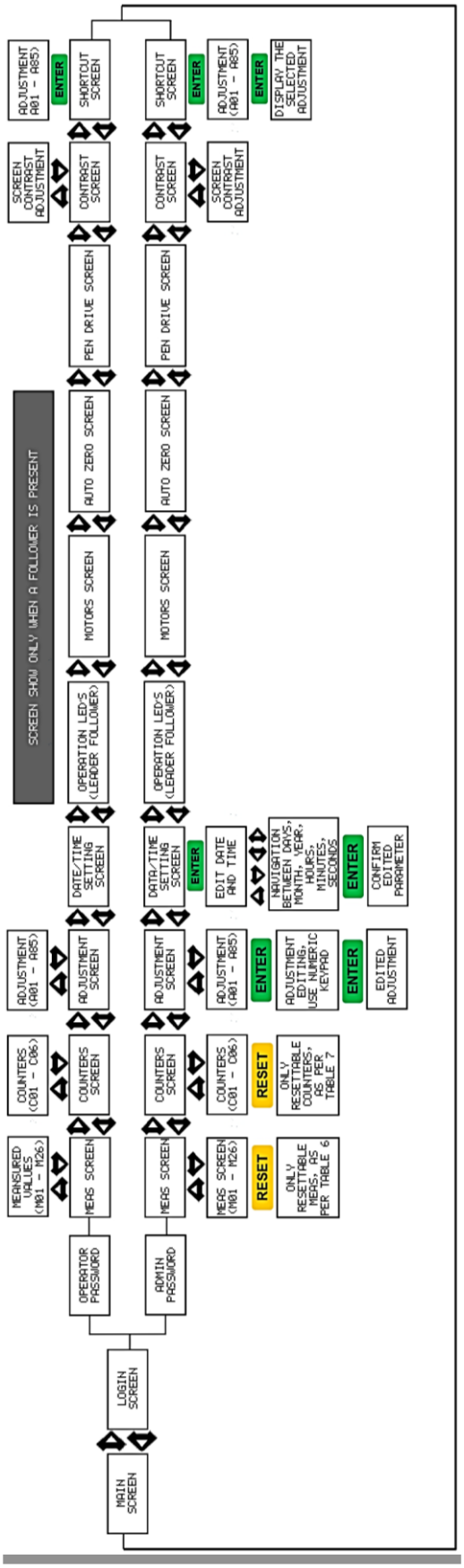
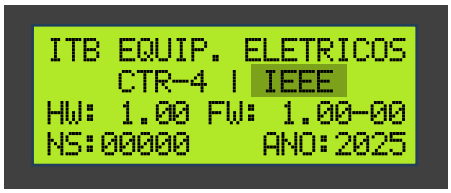


Figure 17: Navigation between screens – With follower controls.

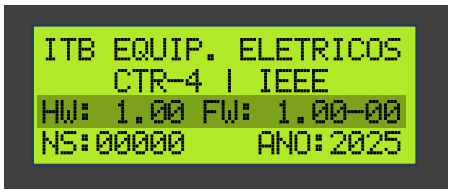
Welcome Screen

When initialized, the CTR-4 control will perform a function test, as explained in the item "*Control Panel Components*". During this test, a welcome screen will be presented with information about the controller. The Figure 18 details each line and function displayed on the screen.

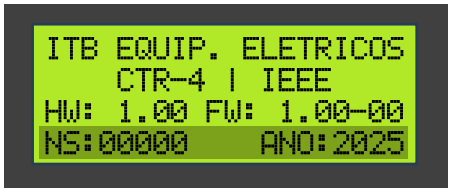
Figure 18: Welcome screen



Line 2 – Firmware Standard
- ✓ ABNT: Version according to ABNT® NBR 11809;
- ✓ IEEE: Version according to IEEE Std C57.15™.



Line 3 – Hardware and *firmware versions*
- ✓ HW: Hardware version;
- ✓ FW: Firmware *version*.



Line 4 – Serial number and year of manufacture
- ✓ NS: Serial Number;
- ✓ YEAR: Year of manufacture.

Main Screen

The CTR-4 control features an easy-to-read main screen that displays the most important information inherent to the regulation at the same time. The Figure 19 details each line and function displayed on the main screen by regulator.

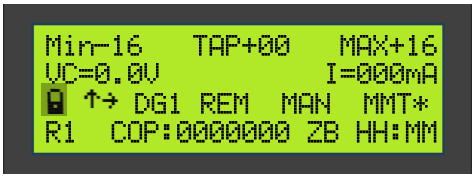
Figure 19: Main screen information.



Line 1 – Indication of taps
- ✓ MIN: Minimum tap reached (since last *reset*);
- ✓ TAP: Current tap of the switch;
- ✓ MAX: Maximum tap reached (since last *reset*).



Line 2 – Measurements
- ✓ VC: Voltage on the load side line;
- ✓ VF: Voltage on the source side line (bidirectional);
- ✓ I: Current in line on the load side.



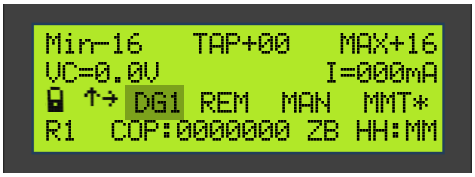
Line 3 – Visual indicators

✓ : Indication of *login* and *logout*.



Line 3 – Power Flow

✓ Vector indication of the direction (forward or reverse) and characteristics (inductive or capacitive) of the power flow.



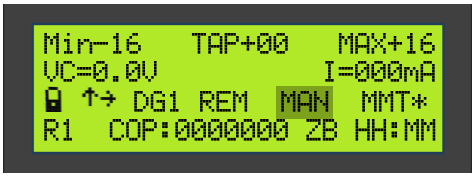
Line 3 – Flow and the Active Working Group

✓ D: Forward flow map;
✓ I: Inverse flow map;
✓ G1: Active Group 1;
✓ G2: Active Group 2;



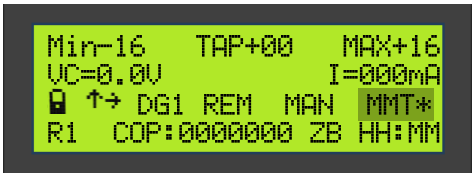
Line 3 – Remote access

✓ LOC: Local (DOES NOT accept remote commands).
✓ REM: Remote (accepts remote commands);



Line 3 – Mode of operation

✓ AUT: Automatic operation;
✓ MAN: Manual operation;
✓ INT: Regulator inactive;
✓ TRV: Operation stuck (engine inoperative).



Line 3 – Adjustment mode

✓ MON: Operating in single-phase mode;
✓ MMT: Operating in master single-phase mode;
✓ MMD: Operating in single-phase mode by average;
✓ TMT: Operating in three-phase mode by the master;
✓ TMD: Operating in three-phase mode by average;
✓ * : Operating in sync. When operated without synchronism, the "*" will not be displayed.



Line 4 – Regulator Identification

- ✓ R1: Regulator 1;
- ✓ R2: Regulator 2;
- ✓ R3: Regulator 3.

*When in sync;



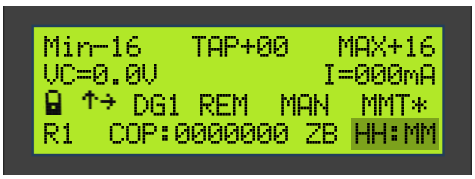
Line 4 – Operations Counter

- ✓ COP: Totalizer counter of operations.



Line 4 – *Commutator Motor* Status

- ✓ AN: Auto Zero via UPS (UPS);
- ✓ BA: Motor locked to the lowering direction;
- ✓ BE: Motor locked to the lift direction;
- ✓ BT: Motor locked for both directions;
- ✓ CT: Performing check-tap;
- ✓ FI: Neutralizing by reverse flow;
- ✓ MI: Master Regulator is inactive;
- ✓ S: Performing synchronism;
- ✓ ZB: Zeroing the bank.

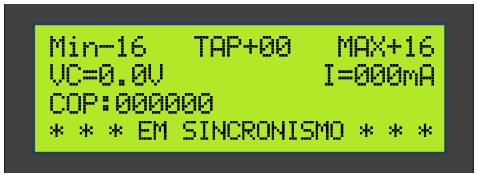


Line 4 – Clock/Timer

- ✓ Clock;
- ✓ Timer: When the voltage profile exceeds the insensitivity band, this area of the display starts to display a progressive timer. After this value reaches the value set in the timing, the control activates the changer under load to perform the regulation;
- ✓ Timer: Neutralization via UPS (UPS).

When the CTR-4 is in sync with the other controllers in the regulator bank, the main follower screen will conform to the Figure 20:

Figure 20: Main screen information in sync



LED Screen

The CTR-4 will have a feature that simulates, on its screen, the state of the LEDs of the follower controls connected to it. In systems configured with a bank of regulators, as in the case of interconnected CTR-4s, the control designated as Master will be able to display, in real time, which LEDs are lit on each of the follower controls. This allows for fast, centralized verification without the need for physical inspection of remote devices, optimizing system monitoring and operation. The screen will be displayed as per the Figure 21:

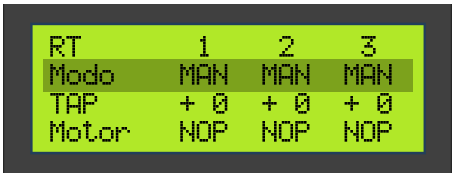
Figure 21: LED Screen's



Motor Drive Screen

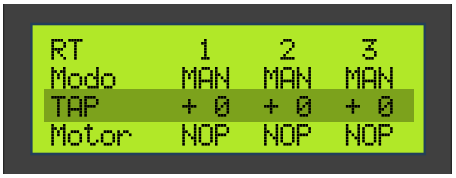
When the CTR-4 is in Master/Follower mode, the master controller will display the status information of the other following regulators' motors. To make it easier to see the operating mode, switch position, and operating *status* of the motors of each active regulator in the bank, the CTR-4 control has a screen that gathers all this information and displays it in real time at the same time.

Figure 22: Engine screen information.



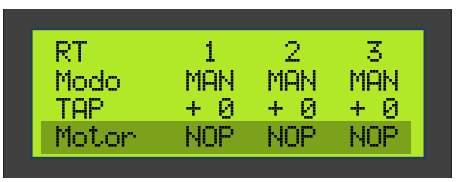
Line 2 – Mode

- ✓ MAN: Manual operation;
- ✓ AUT: Automatic operation;
- ✓ TRV: Operation locked (motor inoperative);
- ✓ INT: Regulator idle.



Line 3 – Indication of taps

- ✓ Displays real-time information on the position of all active regulators of the bank.



Line 4 – *Commutator Motor* Status

- ✓ NOP: Engine not operating;
- ✓ TAP+: Motor operating in the direction of lifting;
- ✓ TAP-: Motor operating in the lowering direction;
- ✓ BT: Motor locked for both directions;
- ✓ BA: Motor locked to the lowering direction;
- ✓ BE: Motor locked to the direction of lifting.

Date/Time Adjustment Screen

The CTR-4 control has a unique screen for viewing and adjusting the date and time.

Use the navigation arrows, number keys, and the Enter key to change the values.

Figure 23: Date/time screen information.



Line 2 – Date

✓ Set the date in the format day (DD), month (MM), and year (YYY).



Line 3 – Time

✓ Set the time in hour (HH), minute (MM), and second (SS) format.



Line 4 – Weekday

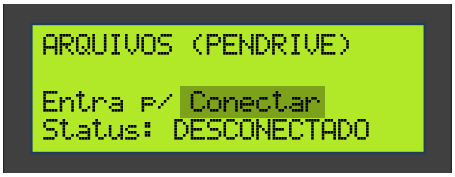
✓ Set up the day of the week between Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, or Saturday.

Pen Drive *Screen*

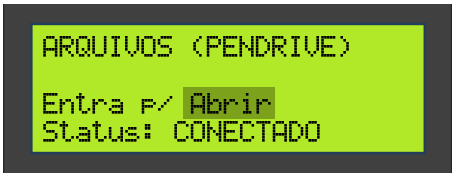
In order to facilitate human-machine interfacing, the CTR-4 control has an active USB port for connecting a *pen drive*. Through this feature, it is possible to import or export parameter settings and export records from mass storage.

Before connecting a *pen drive* Access the files screen *pen drive* and follow the steps detailed by the Figure 24.

Figure 24: Screen information of pen drive



Connect a *USB flash drive*
✓ Wait for the *Connect status* to change to Open.



Connect a *USB flash drive*
✓ When the *status* is set to Open, press Enter.



Choose from one of the options
✓ 1) Parameters;
✓ 2) Records;
✓ Choose the desired option and press Enter.



1) Parameters, choose between import or export
✓ 1) Import;
✓ 2) Export;
✓ Choose the desired option and press Enter.



2) Records
✓ Enter the number of records to export and press Enter.

The CTR-4 controller reads only files located in the ITB_CTR4 directory. For file export operations, the controller saves the files in the root directory of the USB flash drive.

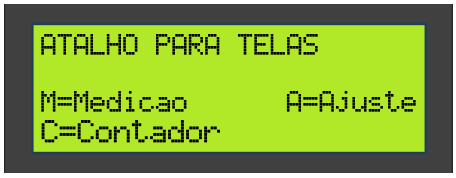


NOTICE: The CTR-4 control only accepts formatted pen drives with FAT32 file partitions up to 8Gb in capacity.

Shortcut Screen

From the default screen, you can press the ***"SHORTCUT"***, or ◄, so that the control starts to show the screen that allows you to enter the number corresponding to the parameter or measurement that you want to view according to columns "*Shortcut*" Of Table 12, Table 13 or Table 14.

Figure 25: Shortcut screen.



The shortcut selection screen will be shown as per Figure 25 and, when the button is pressed **ENTERS** it will change as in the Figure 26 that allows the modification of the field "*Choose the screen*" by the following procedure:

Under one of the digits of the "*Screen*" *field* there is a cursor that will indicate the adjustable digit;

Press the ▲ ▼ keys to select between "M" for measurements, "A" for adjustments and "C" for counters, and to select the number, use the keys from 0 to 9 to vary the value of this digit;

Press the ◄ or ► keys to make the cursor navigate through the digits;

Repeat the operation until you fill in the two digits obtaining the desired value;

With the cursor under the least significant digit, press the **ENTER key** to accept the entered value and immediately the requested screen will be displayed;

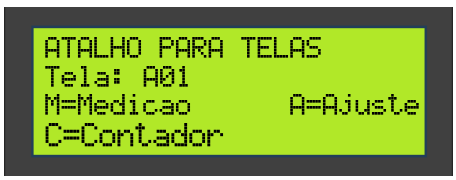


NOTICE: If the adjusted value is outside the ranges indicated in the Figure 26 The message "*Invalid*" will be shown on the same line as the adjusted value and the shortcut screen will again be equal to Figure 25, requiring the repetition of the steps.

If the ◄ key is pressed while the cursor is under the most significant digit, no action is taken by the CTR-4 controller;

To return to the default screen from the shortcut screen, simply press the **CANCEL** key once.

Figure 26: Shortcut screen – Insert.



Direct Command Keys and Quick Access

The CTR-4 control has direct command keys and quick access with specific functions that are described below:

- MANUAL/AUTO/LOCKED **key**: Selects manual, automatic, or locked operating modes for the switches;
- MONO/TRI **key**: If the control is in sync, this key changes the operating mode between single-phase and three-phase;
- Key **SHORTCUT**: : Displays the quick access screen of the functions in the *display*, according to the Table 12, Table 13, Table 14;
- LOCAL/REMOTE **key**: Enables priority communication modes for adjusting function parameters locally or remotely;
- CANCEL **key**: Returns to the main screen or cancels a certain value that is being edited or ends the section blocking access, indicated by a symbol of a padlock. The control can be accessed again by entering the user or administrator password;
- ▲ key: Activates the commutator motor in the direction of lifting;
- ▼ key: Activates the commutator motor in the direction of lowering;
- AUTO ZERO **key**: Controls the switch to the "*NEUTRAL*" position from any screen or operating mode (see the Auto **Zero topic**, available in this manual);
- USB/232 **key**: Switches communication interfaces between USB or RS232;
- RESET key: Updates or resets the values that allow this operation, which is indicated by the word "*Resettable*" written on the bottom line of the *display*;
- Number keys **1, 2 and 3**: From the main screen, change the view between the active regulators in the bank on the main screens, measurement screens and function screens;
- Number key **4**: From any settings screen, this key allows you to copy all parameters from a reference regulator and paste to a target regulator;
- Number key **5**: From the main screen of any active regulator of the bank, once key 5 is pressed, the control registers values of voltage, current, power factor, date and time, among other parameters that can be recorded in the mass memory;
- Number key **6**: From the main screen, this key allows you to adjust the display counter;
- Number key **7**: From the main screen, this key displays the measurement screen, covering the parameters from M01 to M26;
- Number key **8**: From the main screen, this key displays the counter screen, covering the parameters from C01 to C06;
- Number key **9**: From the main screen, this key displays the settings screen, covering the parameters from A01 to A68;



NOTICE: The copy and paste function, available via the number key 5, changes all parameters of the target slider based on the settings of the reference ruler, except for settings A54 and A55, which are related to the Master/Follower function.

Auto Zero Function

The **AUTO ZERO key** has the function of preparing the control for energizing or de-energizing maneuver and, once activated, initializes the following algorithm:

1. Displays the message "*To confirm AUTO ZERO, keep pressing*", hold down for approximately 4 seconds;
2. If the position is not the zero position, the control checks to see if there is a need to command the switch to raise or lower taps;
3. Switches on the commutator motor to bring the commutator to the zero position;
4. Waits until the switch reaches the zero position, certified by the change of state of the polarity inverter switch;
5. When the zero position is reached, the "*Neutral Position*" *LED lights* up on the secondary panels;
6. Displays on the display, following the information from the regulator, the message "*NEUTRALIZED*" for the regulator that has already reached the neutral position, "*INACTIVE*" when the regulator is inactivated and "*FAILURE*" for the regulator that does not receive the signal from the neutral position sensor, in which case the "Failure" *LED*, on the front panel of the control, will light up;
7. After the routine is finished, the message "*AUTO ZERO FINISHED*" will be displayed on the last line of the *display*. Only proceed with the maneuver after individual verification of neutralization by all active regulators of the bank.



NOTICE: The "*AUTO ZERO*" function locks the control commands until the next control reset. After rebooting, the controller returns in manual mode.



NOTICE: When in sync, the command of "*AUTO ZERO*" must be given by the CTR-4 called as master, thus, the master will take the switches of all active regulators of the bank to the neutral position simultaneously.



NOTICE: When in single-phase mode, that is, there is no master/follower (synchronism), each control will be responsible for the "*AUTO ZERO*" of the regulator in which it is installed.



DANGER: Before carrying out manoeuvres to insert or remove voltage regulators from the mains, consult the operating instructions for voltage regulators or relevant technical specifications.

CTR-4 CONTROL – MEASUREMENTS, COUNTERS AND FUNCTION ADJUSTMENTS VIA HMI

The CTR-4 control has a measurement screen group with the main electrical quantities inherent to the distribution network and the regulator, a group of meter screens and another function screen group, where it is possible to configure the parameters for operation in forward flow, reverse flow and cogeneration.

NAVIGATING THE MEASUREMENT AND COUNTER SCREENS

The ◄ and ► keys navigate through screens on which you can view the detailed measured values and counters as follows:

Navigating the Measurement Screens

Figure 27: Example of a measurement screen.



In the "*XX*" *field,* the screen number that must be used to access it directly through the shortcut screen will be displayed;

In the field "*Name:*" The measurement identifier will appear according to column "*Name*" Of Table 12;

In the "*UN*" *field* in brackets, the unit of measurement will appear, if applicable;

In the "*Value:*" *field,* the instantaneous value for this measurement will be displayed;

The "*dd/mm/yyyy hh:mm*" *field* will be displayed at the time of the occurrence, if applicable.

The word "*Resettable*" will be seen in the bottom row of the screen, if applicable, as per column "*Resettable*" Of Table 12.

The figures will be presented following the Table 12 for consecutive press of the ▲ key and the ▼ key allows the return to the previously read value.

Table 12: Sequence of measured values.

Shortcut	Name	Description	Unit	*Reset*	Remote
M01	FREQ	Frequency	[Hz]	No	Show
M02	FP	Power Factor	-	No	Show
M03	VSC	Secondary voltage at *"LOAD"*	[V]	No	Show
M04	VPC	Primary voltage at *"LOAD"*	[kV]	No	Show
M05	ISC	Secondary current at *"LOAD"*	[mA]	No	Show
M06	IPC	Primary current at *"LOAD"*	[mA]	No	Show
M07	VSF	Secondary voltage at *"SOURCE"*	[V]	No	Show
M08	VPF	Primary voltage at *"SOURCE"*	[kV]	No	Show
M09	ISF	Secondary current at *"SOURCE"*	[mA]	No	Show
M10	IPF	Primary current at *"SOURCE"*	[A]	No	Show
M11	POT_S	Apparent power	[kVA]	No	Show
M12	POT_P	Active power	[kW]	No	Show
M13	POT_Q	Reactive power	[Kvar]	No	Show
M14	L_NEU	Neutral current	[A]	No	Show
M15	THD_V	Voltage harmonic distortion rates	[%]	No	Show
M16	THD_I	Current harmonic distortion rates	[%]	No	Show
M17	VPF_DMAX	Primary voltage at *"SOURCE"* – Maximum demand	[kV]	Yes	Show and Reset
M18	VPF_DMIN	Primary voltage at *"SOURCE"* – Minimum demand	[kV]	Yes	Show and Reset
M19	VPC_DMX	Primary voltage at *"LOAD"* – Maximum Demand	[kV]	Yes	Show and Reset
M20	VPC_DMIN	Primary voltage at *"LOAD"* – Minimum Demand	[kV]	Yes	Show and Reset
M21	IPC_DMAX	Primary current at *"LOAD"* – Maximum Demand	[A]	Yes	Show and Reset
M22	IPC_DMIN	Primary current at *"LOAD"* – Minimum demand	[A]	Yes	Show and Reset
M23	P_DMAX	Active power – Maximum demand	[kW]	Yes	Show and Reset
M24	P_DMIN	Active power – Minimum demand	[kW]	Yes	Show and Reset
M25	Q_DMAX	Reactive power – Maximum demand	[kVAr]	Yes	Show and Reset
M26	Q_DMIN	Reactive power – Minimum demand	[kVAr]	Yes	Show and Reset

Navigating the Counter Screens

Figure 28: Example of counters screen.



In the "*XX*" *field,* the screen number that must be used to access it directly through the shortcut screen will be displayed;

In the field "*Name:*" The measurement identifier will appear according to column "*Name*" Of Table 12;

In the "*UN*" *field* in brackets, the unit of measurement will appear, if applicable;

In the "*Value:*" *field,* the instantaneous value for this measurement will be displayed;

The word "*Resettable*" will be seen in the bottom row of the screen, if applicable, as per column "*Resettable*" Of Table 13.

The figures will be presented following the Table 13 for consecutive press of the ▲ key and the ▼ key allows the return to the previously read value.

Table 13: Counter sequence

Shortcut	Name	Description	Unit	*Reset*	Remote
C01	COP_P	Operations Counter – Partial	-	Yes	Show and Reset
C02	CEMT	Counter – Inputs in three-phase mode	-	Yes	Show and Reset
C03	CNFE	Meter – Neutralization due to power failure	-	Yes	Show and Reset
C04	CNIF	Counter – Neutralization due to reverse power flow	-	Yes	Show and Reset
C05	CRA	Counter – Stored records	-	Yes	Show and Reset
C06	CAA	Counter – Stored alarms	-	Yes	Show and Reset

NAVIGATING THE FUNCTION SCREENS

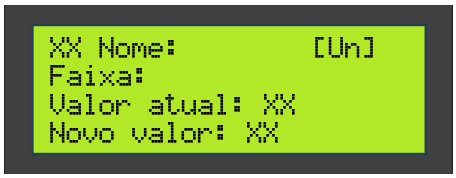
The screen number to be adjusted will be displayed in the "*XX*" field, displayed in the upper left field. This number corresponds to the function code and can be used, through the "*Screen shortcut*" feature, to reduce navigation time.

The field "*Name*" presents an acronym that identifies the function displayed, according to the column "*Name*" Of Table 14.

The Current Value field shows the adjusted value for this function and, in the upper right corner, in square brackets, its unit of measurement.

To make the parameters setting of a control function:

Figure 29: Settings modification screen.



Press the ◄ or ► keys until the function screen is displayed, as shown Figure 29.

Press the ▼ or ▲ keys to navigate between the parameterizable functions that are sequenced as per Table 14. Navigation is sequential and cyclical.

Press the ***"Enter"*** to enable editing the current value as per Figure 29.

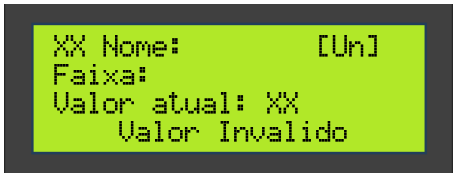
A "*Range*" *field* will show the minimum and maximum values that can be parameterized for the function.

A "*New Value*" *field* that will initially show the same "*Current Value*" but with a cursor at the position of the most significant digit.

To modify the value of the selected setting, use the numeric keypad and press the ***"Enter"*** key to save it.

NOTICE: If the adjusted value is outside the "*Banner*", The message "*Invalid value*" will be shown on the bottom line, as per Figure 30 and the screen returns to the same as the one displayed in the Figure 27.

Figure 30: Settings Modification Screen



The functions for control with IEEE® standard firmware are in accordance with the Table 14.

Table 14: Sequence of parameterizable functions – IEEE® firmware.

Shortcut	Function Name	Function Description	Und.	Belt	Incr.	Default Value	Adjustment Type
A01	TP_PRI	Primary voltage	[V]	1000 to 38000	1	13800	By phase
A02	TP_SEC	Secondary voltage	[V]	95.0 to 150.0	0,1	120,0	By phase
A03	TC_PRI	Primary current	[A]	25 to 1500	1	200	By phase
A04	P_TC	CT Polarity	-	0 to 1	1	0	By phase
A05	CSP	Permanent overload capacity – 12%	-	0 to 1	1	0	By phase
A06	VLF	Supply side voltage	-	0 to 1	1	0	By phase
A07	TFR	Regulator manufacturing type	-	0 to 1	1	1	By phase
A08	TCB	Bank Connection Type	-	0 to 2	1	0	By phase
A09	C_ML	Position reading mode	-	0 to 3	1	1	By phase
A10	C_MAT	Mode of actuation and timing of the motor	[ms]	0 to 5000	1	0	By phase
A11	CR_D	Tracking – Day for audit	-	0 to 8	1	0	Single
A12	CR_H	Tracking – Hour for audit	[h]	0 to 23	1	0	Single
A13	G1_D_VREF	Forward flow – Set voltage	[V]	100.0 to 135.0	0,1	120,0	By phase
A14	G1_D_INS	Forward flow – Bandwidth	[V]	0.5 to 5.0	0,1	3,0	By phase
A15	G1_D_TMP	Forward flow – Timing delay	[s]	10 to 180	1	30	By phase
A16	G1_D_UR	Forward flow – Resistive compensation	[V]	-25.0 to 25.0	0,1	0,0	By phase
A17	G1_D_UX	Forward flow – Reactive compensation	[V]	-25.0 to 25.0	0,1	0,0	By phase
A18	G1_D_VMAX	Forward flow – Maximum voltage limiter	[V]	1.0 to 15.0	0,1	15,0	By phase
A19	G1_D_VMIN	Forward flow – Minimum voltage limiter	[s]	1.0 to 15.0	0,1	15,0	By phase
A20	G1_I_VREF	Reverse flow – Set voltage	[V]	100.0 to 135.0	0,1	120,0	By phase
A21	G1_I_INS	Reverse flow – Bandwidth	[V]	0.5 to 5.0	0,1	3,0	By phase
A22	G1_I_TMP	Reverse flow – Timing delay	[s]	10 to 180	1	30	By phase
A23	G1_I_UR	Reverse flow – Resistive compensation	[V]	-25.0 to 25.0	0,1	0,0	By phase
A24	G1_I_UX	Reverse flow – Reactive compensation	[V]	-25.0 to 25.0	0,1	0,0	By phase
A25	G1_I_VMAX	Reverse flow – Maximum voltage limiter	[V]	1.0 to 15.0	0,1	15,0	By phase
A26	G1_I_VMIN	Reverse flow – Mininum voltage limiter	[V]	1.0 to 15.0	0,1	15,0	By phase
A27	G1_BMAX	Position blocking – Maximum	[Tap]	8 to 16	2	16	By phase
A28	G1_BMIN	Position blocking – Minimum	[Tap]	-8 to -16	2	-16	By phase
A29	G2_1_VREF	Forward flow – Set voltage	[V]	100.0 to 135.0	0,1	120,0	By phase
A30	G2_1_INS	Forward flow – Bandwidth	[V]	0.5 to 5.0	0,1	3,0	By phase
A31	G2_1_TMP	Forward flow – Timing delay	[s]	10 to 180	1	30	By phase
A32	G2_1_UR	Forward flow – Resistive compensation	[V]	-25.0 to 25.0	0,1	0,0	By phase
A33	G2_1_UX	Forward flow – Reactive compensation	[V]	-25.0 to 25.0	0,1	0,0	By phase
A34	G2_1_VMAX	Forward flow – Maximum voltage limiter	[V]	1.0 to 15.0	0,1	15,0	By phase
A35	G2_1_VMIN	Forward flow – Minimum voltage limiter	[V]	1.0 to 15.0	0,1	15,0	By phase
A36	G2_2_VREF	Reverse flow – Set voltage	[V]	100.0 to 135.0	0,1	120,0	By phase
A37	G2_2_INS	Reverse flow – Bandwidth	[s]	0.5 to 5.0	0,1	3,0	By phase
A38	G2_2_TMP	Reverse flow – Timing delay	[s]	10 to 180	1	30	By phase
A39	G2_2_UR	Reverse flow – Resistive compensation	[V]	-25.0 to 25.0	0,1	0,0	By phase
A40	G2_2_UX	Reverse flow – Reactive compensation	[V]	-25.0 to 25.0	0,1	0,0	By phase
A41	G2_2_MAX	Reverse flow – Maximum voltage limiter	[V]	1.0 to 15.0	0,1	15,0	By phase

Shortcut	Function Name	Function Description	Und.	Belt	Incr.	Default Value	Adjustment Type
A42	G2_2_MIN	Reverse flow – Minimum voltage limiter	[V]	1.0 to 15.0	0,1	15,0	By phase
A43	G2_BMAX	Position lock – Maximum	[Tap]	8 to 16	2	16	By phase
A44	G2_BMIN	Position lock – Minimum	[Tap]	-8 to -16	2	-16	By phase
A45	BA_A	Load bonus – Automatic	-	0 to 1	1	0	By phase
A46	FLP_MT	Processing mode	[-]	0 to 9	1	2	By phase
A47	FLP_CLD	Detection threshold current	[%]	1 to 5	1	2	By phase
A48	BC_SL	Switching lockout – Line overcurrent	[%]	50 to 210	1	160	Single
A49	I_MT	Bandwidht – Processing mode	-	0 to 1	1	0	Single
A50	T_MT	Timing delay – Processing mode	-	0 to 1	1	0	Single
A51	IT_CR	Time interval – Log capture	[min]	1 to 1440	1	15	Single
A52	IT_CD	Time interval – Demand calculation	[min]	3 to 60	1	15	Single
A53	IT_NUPS	Time interval – Neutralization via UPS	[s]	0 to 600	1	0	Single
A54	MS_HD	Enables and designates	-	0 to 6	1	0	Single
A55	MS_QS	Number of followers	-	0 to 2	1	0	Single
A56	MS_DFM	Fixed offset for master	[Tap]	-5 to 5	1	0	By phase
A57	MS_GL	Degree of freedom	[Tap]	0 to 33	1	33	Single
A58	MS_TRT	Time for three-phase regulation	[min]	10 to 1440	1	1440	Single
A59	ID_CTR	Controller identification address	-	0 to 65534	1	0	Single
A60	HME_C2	Enable spontaneous message COM2	-	0 to 1	1	0	Single
A61	HME_C3	Enable spontaneous message COM3	-	0 to 1	1	0	Single
A62	EME_C2	Spontaneous message address COM2	-	0 to 65534	1	0	Single
A63	EME_C3	Spontaneous message address COM3	-	0 to 65534	1	0	Single
A64	TTD_C1	Data transmission rate COM1	[kbps]	0 to 7	1	2	Single
A65	TTD_C2	Data transmission rate COM2	[kbps]	0 to 7	1	2	Single
A66	TTD_C3	Data transmission rate COM3	[kbps]	0 to 7	1	2	Single
A67	S_AD	Password – Administrator	-	000000 to 999999	1	000000	Single
A68	S_OP	Password - Operator	-	000000 to 999999	1	999999	Single

CTR-4 CONTROL – DESCRIPTION OF THE COUNTERS

C01 – COP_P: Operations Counter – Partial

Number of operations recorded since the last reset.

C02 – CEMT: Meter – Inputs in three-phase mode

Counter the number of times the regulator is automatically switched to three-phase mode due to excessive position difference between the regulators during single-phase mode operation.

C03 – CNFE: Meter - Neutralization due to power failure

Totalizer of the number of neutralizations carried out due to the lack of power in the network.

C04 – CNIF: Counter - Neutralization due to reverse power flow

Totalizer of the amount of neutralizations performed as a function of the reversal of the direction of power flow.

C05 – CRA: Accountant - Stored Records

Totalizer of the total amount of mass memory records stored.

C06 – ACSR: Counter - Stored alarms

Totalizer of the total number of alarms that are dead.

CTR-4 CONTROL – DESCRIPTION OF FUNCTIONS

REGULATOR PARAMETERS

The CTR-4 control has parameters intended to define the main characteristics of the regulator that is being controlled by the control. The functions described below correspond to the parameters between A01 and A12 of the Table 14.

A01 – TP_PRI: Primary Voltage of the PT

This function sets the primary operating voltage of the voltage regulator as specified on the equipment nameplate. For example, in a regulator designed to operate on a 13,800 V network, the primary voltage of the potential transformer (PT) will be 13,800 V.

A02 – TP_SEC: Secondary Voltage of the PT

The set value must match the voltage that will be read by the control on the low voltage side of the potential transformer (TP). This value will also be indicated on the regulator's identification plate. In ITB regulators this information is present in the "control reference voltage" field. For example, if the board specifies a voltage of 120 V, the value set on the control must also be 120 V.



NOTICE: The values set in functions A01 and A02 are used as control parameters. Therefore, the control uses this information to calculate the voltage ratio and make appropriate adjustments to the TAPs, raising or reducing the voltage as needed.

A03 – TC_PRI: Regulator – Primary Current

This function sets the rated operating current of the voltage regulator as specified on the equipment nameplate. For example, in a regulator designed to operate at 200A, the current set in the control should be 200A.

A04 – P_TC: CT Polarity

In cases where the current transformer (CT) has been installed with reversed polarity, the control will interpret the **reverse** flow as **direct** and vice versa. To correct this situation without the need for physical intervention in the equipment, this function allows you to logically reverse the reading of the flow direction. If the regulator is operating with **forward flow**, but the control indicates **reverse flow**, set this function to **"1".** If the flow direction is being interpreted correctly, keep the value at **"0".**

This feature eliminates the need to open the regulator or relocate connections to reverse the CT reading, making it easier to correct quickly and safely.

A05 – CSP: Permanent Overload Capacity – 12%

Determines whether the 12%, 55/65 °C, no loss of life permanent overload function is enabled.

Table 15: Permanent overload.

Value	Description
0	Overload disabled
1	Overload enabled



NOTICE: Permanent overload capability is available on the regulator's nameplate.



NOTICE: When this function is enabled, the automatic control of the load bonus is carried out according to the nominal current increased by 12%. If the current (nominal + 12%) is higher than 668 A, the limiting range will not be limited.

A06 – VLF: Supply Side Voltage

This function defines whether the voltage on the source side, used for display and calculations by the control, is obtained by direct measurement or by calculation.



NOTICE: If it is configured that the voltage on the source side will be obtained by measurement and not by calculation, the regulator that the control is installed on must have TP connected on the source side. By default, the CTR-4 has this function as "0", i.e. the voltage on the source side will be calculated.

A07 – TFR: Regulator Manufacturing Type

In order for the voltage calculation on the source side to be done correctly and accurately, it will be necessary to inform the type of regulator. According to the ABNT® NBR 11809 and IEEE Std C57.15™ standards, the regulator architecture can be type **"A"** or type **"B".** This function determines that if set to **"0"** the regulator is type **"A",** if it is parameterized to **"1"** the regulator is type **"B".**

A08 – TCB: Bank connection type

This function determines what type of connection the voltage regulator bank will be. The parameters should be configured as below:

Table 16: Control of the automatic load bonus.

Value	Description
0	Star connection
1	Lagging Delta (-30º)
2	Leading Delta (+30th)



NOTICE: When the regulator bank is delta open, one of the regulators will be delta late and the other delta early. When the bank is closed delta all regulators will be late delta or early delta.

A09 – C_ML: Position Reading Mode

The CTR-4 was developed to operate with voltage regulators from other manufacturers, considering that some manufacturers adopt methods of tracking TAP positions other than the ITB standard, this functionality was incorporated into the CTR-4 in order to expand its compatibility with these technology variations. The Table 17 presents the recommended adjustment values according to the tracking method used by the regulator that the control will be installed:

Table 17: Method of indicating the current position.

Value	Description
0	Tracking – Engine Retention
1	Tracking – Change of status
2	Tracking - Pulsed
3	Tracking – Pulsed with delay



Notice: The reading indication mode will be from -16 to +16.

Tracking – Engine Hold: In this tracking mode, the control sends a pulse to the switch, signaling the need for a TAP change. The drive device then energizes the motor and keeps it energized until the TAP change is complete. The end of the maneuver is detected by means of the limit switch integrated into the commutator, which automatically turns off the motor at the end of the movement. The control continuously monitors the current drawn by the commutator motor. When this chain ceases, the control interprets that the TAP change has been completed successfully.

Tracking – Change of State: This reading method is based on detecting the electrical state (ON/OFF) of the limit switch during operation. When initiating a move, the controller monitors the transition between the ON/OFF states or vice versa. Each complete switching cycle generates a state change, allowing control to account for advanced or backward TAPs.

Tracking – Pulsed: In pulsed mode, tracking is done based on the electrical pulses emitted by the limit switch generated with each movement of the switch. With each TAP advance or retreat, a switch limit switch emits a momentary pulse, which is read by the controller. Each pulse is interpreted as a change of TAP. The direction (forward or reverse) is determined from the command sent by the controller.

Tracking – Pulsed with delay: Operates similarly to pulsed mode; however, after changing TAP, the motor remains energized for 1 second. Only after this interval does the control interpret that the TAP change has been completed

A10 – C_MAT: Mode of Actuation and Timing of the Motor

The CTR-4 is designed to operate with voltage regulators from other manufacturers. In this function, you can define the commutator motor control method as Table 18.

Table 18: Actuation method and engine timing.

Value	Description
0	Continuous action
1 to 5000 ms	Pulsed actuation

If the desired motor actuation is of the continuous type, this function must be set to the value 0 (zero). For pulsed actuation, the function must be adjusted between 1 and 5000 milliseconds, this value corresponding to the time in which the motor will remain actuated to perform the TAP change.

A11 and A12 – CR_D & CR_H: Tracking – Day and Hour for Audit

This function allows you to schedule a day of the week and time at which the CTR-4 operates a position monitoring audit routine to verify that the position recorded in the control matches the actual position of the switch.

On the scheduled days and times, the bank's active regulators that operate by tracking are simultaneously taken to the neutral position to check the neutral *LED* on.

The value programmed in function A12 can be from 0:00 to 23:00, which corresponds to the start time of the position audit run.

The value programmed in the A11 function must be in accordance with the Table 19.

Table 19: Actuation method and engine timing.

Value	0	1	2	3	4	5	6	7	8
Day of the Week	No day	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Every day

BASIC REGULATION PARAMETERS: GROUP 1 AND GROUP 2.

The CTR-4 control operates with two working groups, called Group 1 and Group 2. Each group has adjustable parameters used in voltage regulation. The functions described below apply to both groups and correspond to the parameters between A13 and A44 of the Table 14.

A13 & A20 | A29 & A36 – D_VREF: Set voltage

The voltage value set in functions A13, A20 (Group 1) and A26, A36 (Group 2) are used as the control parameter for forward flow (A13 and A23) and reverse flow (A20 and A36). The reference voltage corresponds to the target value that the control system will seek to maintain.

A14 & A21 | A30 & A37 – D_INS - Bandwidth

The value adjusted in this function defines a symmetrical bandwidth around the reference voltage. When the measured voltage value remains within the limits of this bandwidth, the control considers that no corrective action is required; therefore, the RAISE VOLTAGE or LOWER VOLTAGE indicator LEDs, available on the front panel of the control, will remain off. When the voltage profile falls outside the bandwidth limits, the RAISE VOLTAGE or LOWER VOLTAGE indicator LEDs will illuminate, indicating the direction in which the control will perform the voltage regulation.

Parameters A14 and A21 belong to Group 1 and parameters A30 and A37 correspond to Group 2. Parameters A14 and A30 were used for forwardflow, and parameters A21 and A37 for reverse flow.



CAUTION: The coordination of the insensitivity and timing functions must be done to minimize wear and tear on the switch, which reduces the frequency of maintenance.

A15 & A22 | A31 & A38 – D_TMP: Timing delay

The value set in this function defines the period, in seconds, that the control waits before starting the adjustment. Its purpose is to avoid switching due to short-term voltage variations in the system, such as starting electrical machines. Parameters A15 and A22 belong to Group 1 and parameters A31 and A38 correspond to Group 2. Parameters A15 and A31 are used for forward flow, and parameters A22 and A38 for reverse flow



CAUTION: Voltage regulator banks connected in series (cascade) must have a coordinated timing function in order to minimize interactions between them (avalanche of switches). It is recommended that the regulator closest to the source respond to variations in a shorter time, and the others, downstream of the circuit, have timing adjustments with a minimum difference of 15 seconds more than its previous one.



CAUTION: The coordination of the insensitivity and timing functions must be done to minimize wear and tear on the switch, which reduces the frequency of maintenance.

A16 & A17 & A23 & A24 | A32 & A33 & A39 & A40 – D_UR & D_UX: Line Voltage Drop Compensation – Resistive and Inductive.

Parameters A16 and A17 (resistive and inductive components) belong to Group 1 and are used for forward flow control. On the other hand, parameters A23 and A24, also referring to the resistive and inductive components, belong to Group 1, but are applied to reverse flow control.

In Group 2, parameters A32 and A33 (resistive and inductive) are used for forward flow, while parameters A39 and A40 (resistive and inductive) correspond to reverse flow control.

The values set in these functions simulate the impedance of the line, creating a real picture of the circuit, from the regulators to the theoretical center of loads. Together with the charging current value, this function establishes a new control parameter by virtue of the parameter already established in the reference voltage field (functions A13, A20, A29 and A36). When the power flow is direct, (functions A16, A17, A32 and A33), these values, of R and X, determine the output voltage level of the load side. When the power flow is reversed (functions A23, A24, A39 and A40) these values determine the output voltage level on the source side.

A18 & A19 & A25 & A26 | A34 & A35 & A41 & A42 – D_VMAX & D_VMIN: Voltage Limiters

When in-line drop compensation functions are used, it may be necessary to limit the voltage so as not to harm early consumers. The way to do this is by using the maximum and minimum voltage limiter. When the voltage level of the regulators reaches one of these limits, the control will not allow them to be exceeded and will perform the switching without waiting for the programmed timing.

Being:

A18 and A19 – Group 1, forward flow;

A25 and A26 – Group 1, reverse flow;

A34 and A35 – Group 2, forward flow;

A41 and A42 – Group 2, reverse flow.

The calculation of the upper and lower limit is done as follows:

UPPER LIMIT = VREF + INS + VMAX

LOWER BOUND = VREF – INS – VMIN

Where:

VREF is the reference voltage, in volts, of the group and current flow;

INS it is the insensitivity, in volts, of the prevailing group and flow;

VMAX is the upper limit voltage, in volts, of the group and current flow;

VMIN is the lower limit voltage, in volts, of the current group and flow.

A27 & A28 | A43 & A44 – BMAX & BMIN: Maximum and Minimum position blocking

These functions define the limits of the maximum and minimum positions that the load changer can reach. By reducing the control range, an increase in the load current is allowed, without violating the temperature rise limits, as per Table 20.

Table 20: Chain bonus.

Percentage regulation	± 10%	± 8.75%	± 7.5 %	± 6.25%	± 5%
Maximum position lock	16	14	12	10	8
Minimum position lock	-16	-14	-12	-10	-8
Elevation over rated current	0%	10%	20%	35%	60%

Functions A27 (maximum) and A28 (minimum) are Group 1 and functions A43 (maximum) and A44 (minimum) correspond to Group 2.



NOTE: If the blocks are programmed asymmetrically, the effective load bonus will be corresponding to that of the block of the highest absolute value.



NOTICE: The data of the Table 20 are defined by IEEE Std C57.15TM for regulators with currents up to 668A. It is important that the values of additional currents are checked on the plate of the single-phase regulator controlled by the CTR-4.

ADVANCED REGULATION PARAMETERS

The CTR-4 has complementary functions that allow for more fine-grained adjustments to the behavior of the voltage regulator. These parameters are used for specific adjustments that are not directly defined in Groups 1 and 2, allowing the configuration of complementary adjustment strategies, according to the characteristics and needs of the installation. The functions described below correspond to the parameters between A45 and A58 of the Table 14.

A45 – BA_A: Load Bonus - Automatic

Single-phase voltage regulators manufactured in accordance with ABNT® NBR 11809 or IEEE Std C57.15 standards™, except when the rated current is higher than 668A, they allow operation with higher currents without violating the guaranteed temperature rise limits, but with a restricted regulation range as per Table 21.

Table 21: Control of the automatic load bonus.

Value	Description
0	Disabled - Manual Charge Bonus
1	Enabled - Auto Load Bonus

This function configured in *"0"* maintain the regulator following the locks programmed in functions A27 and A28, A43 and A44. If configured in *"1"*, causes the control to limit the regulation field as a function of the measured passing current according to Table 20. Example: the line current is 1.25 times the nominal current, so the CTR-4 will regulate the output voltage as long as its position does not exceed the +10 tap, nor is it lower than the -10 tap. If the control is in a position outside the proper range, the switch will be brought to the range even if the voltage is not at the desired level.



NOTICE: When function A05 – CSP: 12% Permanent Overload Capacity is enabled, automatic control of the load bonus is performed as a function of the rated current increased by 12%. If the current (nominal + 12%) is higher than 668 A, the limiting range will not be limited.

A46 – FLP_MT: Power Flow – Processing Mode

This function determines how the CTR-4 control will operate through the power flow imposed by the grid.

The Table 22 shows the negotiations that the CTR-4 control has, the Working Group and the meaning of regulation for each of the chosen alternatives.

The detailed description of each of the parameters and their respective functional diagrams can be found in the Table 22.

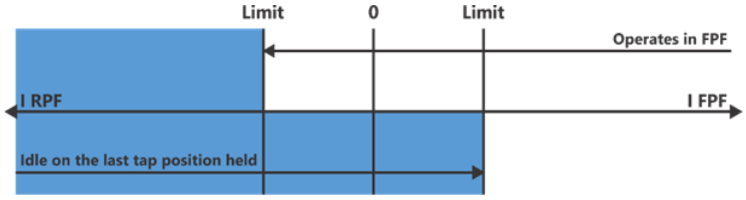
Table 22: Dealing with the working modes for the flow of power.

Value	Description	Group	Direction of Regulation
0	Forward flow and blocking in case of reverse flow	1	Load
1	Forward flow and neutralization in case of reverse flow	1	Load
2	Constant forward flow	1	Load
3	Reverse flow and blockage in case of forward flow	1	Source
4	Reverse flow and neutralization in case of forward flow	1	Source
5	Constant reverse flow	1	Source
6	Bi-directional flow blocked for current below threshold	1	Load / Source
7	Active bidirectional flow up to the opposite threshold	1	Load / Source
8	Reverse flow by cogeneration	2.2	Load
9	Automatic bidirectional power flow detection for full regulation	1 / 2.1 / 2.2	Load / Source

0 – Forward Flow and Blocking in Case of Reverse Flow

It operates in forward flow and blocks the switches in case of detection of the reverse flow. The CTR-4 control, when detecting a current in the opposite direction greater than the percentage value of the nominal current programmed in the *function A47 – FLP_CLD - Power Flow - Current Detection Threshold*, blocks the switches until the current is equal to or greater than the same value, but in the direct direction.

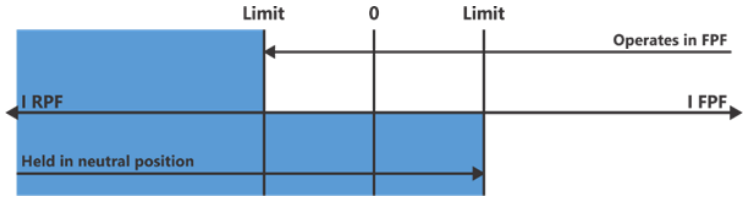
Figure 31: Forward flow and blockage in case of reverse flow.



1 – Forward Flow and Neutralization in Case of Reverse Flow

It operates in forward flow and neutralizes the regulator in case of detection of reverse flow. The CTR-4 control, when detecting a current in the opposite direction greater than the percentage value of the nominal current programmed in the function *A47 – FLP_CLD - Power Flow - Detection Threshold Current*, brings the switch to the neutral position and blocks the operations until the current is equal to or greater than the same value, but in a direct direction.

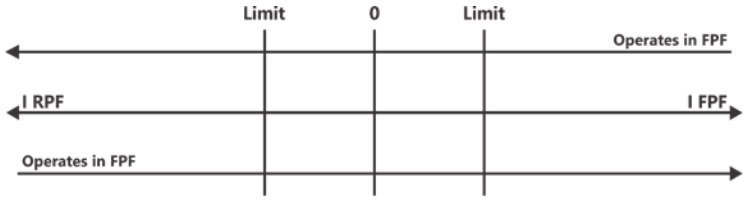
Figure 32: Forward flow and neutralization in case of reverse flow.



2 – Constant Forward Flow

It operates only in direct power flow, including by means of reverse flow detection. It is not recommended to use this function where there is the possibility of inversion of flow caused by switching sources.

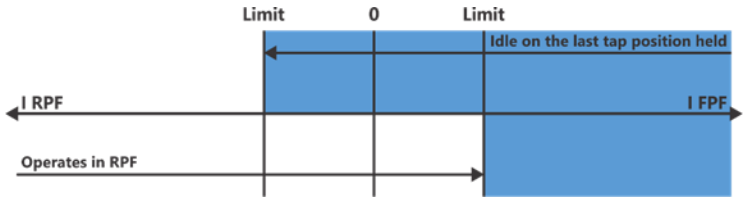
Figure 33: Constant forward flow.



3 – Reverse Flow and Blockage in Case of Forward Flow

It operates in reverse flow and blocks the switches in case of detection of the forward flow. The CTR-4 control, when detecting a current in the direct direction greater than the percentage value of the nominal current programmed in the function *A47 – FLP_CLD - Power Flow - Sensing Threshold Current*, blocks the commutations until the current is equal to or greater than the same value again, but in reverse.

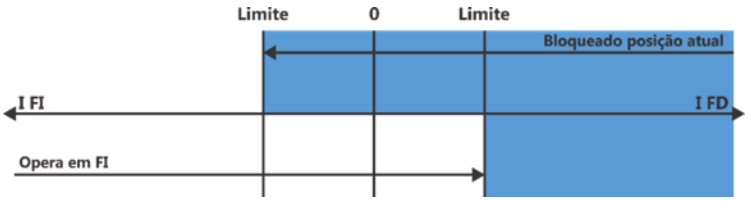
Figure 34: Reverse flow and blockage in case of forward flow.



4 – Reverse Flow and Neutralization in Case of ForwardFlow

It operates in reverse flow and neutralizes the regulator in case of detection of forward flow. The CTR-4 control, when detecting a current in the direct direction greater than the percentage value of the nominal current programmed in the function *A47 – FLP_CLD - Power Flow – Detection Threshold Current*, brings the switch to the neutral position and blocks the operations until the current is equal to or greater than the same value again, but in reverse.

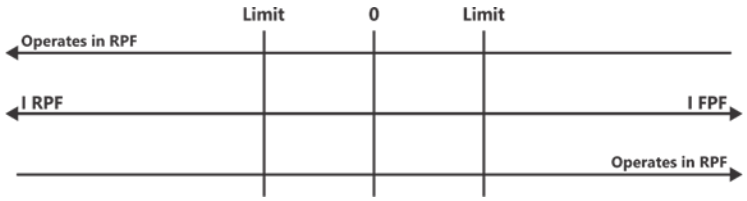
Figure 35: Reverse flow and neutralization in case of forward flow.



5 – Reverse flow

It operates only in reverse power flow, including through forward flow detection. It is not recommended to use this function where there is the possibility of forward flow by switching between sources.

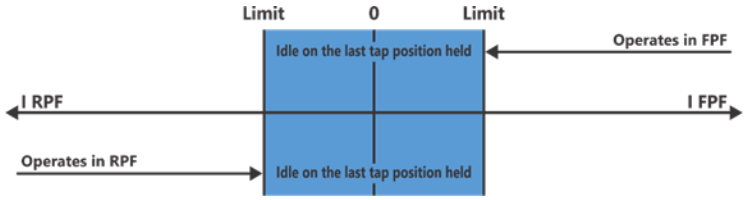
Figure 36: Reverse flow.



6 – Bidirectional Flow Blocked for Current Below Threshold

Regulates in both directions of flow. The use of this function is indicated when there is the possibility of direct and reverse flow of power caused by switching sources. The CTR-4 control, when detecting a current higher than the percentage value of the nominal current programmed in the *A47 – FLP_CLD - Power Flow - Detection Threshold Current function*, analyzes the flow direction and operates in the detected flow direction. When the detected current is between the sensing limit values, the control keeps the switch non-operating and in the same position it is in until it exceeds the limits for some of the directions.

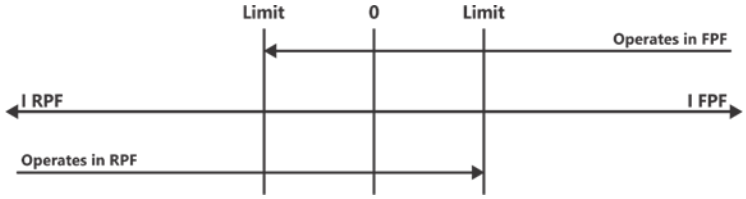
Figure 37: Bi-directional flow blocked for current below the threshold.



7 – Active Bidirectional Flow to the Opposite Threshold

Regulates in both directions of flow. It is recommended to use this function when there is the possibility of direct and reverse flow of power by switching sources. The CTR-4 control operates in forward flow until the reverse flow current is greater than the percentage value of the rated current programmed in the *A47 function – FLP_CLD - Power Flow - Detection Threshold Current*. From this point on, they start to work in reverse flow, remaining so until the current in forward flow is higher than the percentage value of the nominal current programmed in the function *A47 – FLP_CLD - Power flow - Detection threshold current.*

Figure 38: Active bidirectional flow up to the opposite threshold.

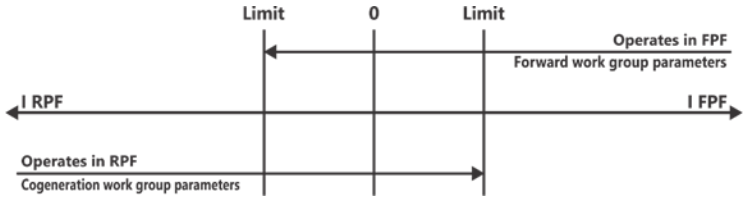


8 – Reverse Flow by Cogeneration

It regulates only the load side in both flow directions and considers that all reverse flow is caused by cogeneration. The use of this function is indicated when there is the possibility of direct and reverse flow of power and that the reverse flow is obtained from a small generating plant. The CTR-4 control, when detecting a current in the opposite direction, the regulation starts to operate in reverse flow by cogeneration. The CTR-4 control, upon detecting a current flowing in the reverse direction, switches to reverse-flow regulation for cogeneration, using the values configured in Group 2.2.

This function does not consider the value configured in the Voltage Drop Compensation parameters on the line *(*A16, A17, A23, A24, A32, A33, A39, and A40)

Figure 39: Reverse flow by cogeneration.



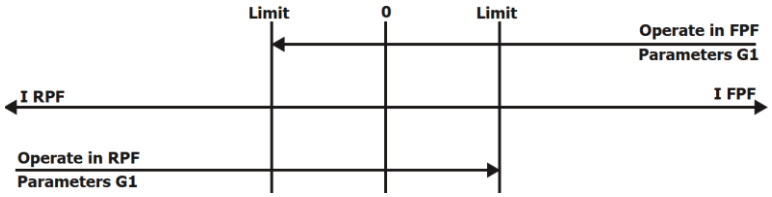
9 – Automatic bidirectional power flow detection for full regulation

This parameter is intended for applications in which the voltage regulator may operate with forward or reverse power flow, according to system conditions, including situations in which changes in the direction of power flow are caused by network switching operations or by the presence of distributed generation/cogeneration. Whenever a change in power flow is detected, the controller will automatically determine its direction and, based on this analysis, select the group of regulation parameters corresponding to the system operating condition: Group 1 (forward or reverse) or Group 2.1 (forward flow due to cogeneration) and 2.2 (reverse flow due to cogeneration). Thus, the Full Regulation function allows automatic voltage regulation to be maintained in both directions of power flow, ensuring proper regulation even in systems subject to changes in topology and operating conditions.

When reverse power flow is detected, the controller will identify the source of the reversal. If it is determined that the reverse power flow was caused by a network switching operation, the controller will automatically apply the reverse flow parameters from Group 1.

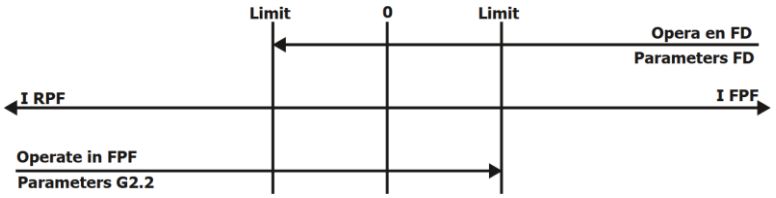
If the voltage regulator is operating with reverse power flow and detects the presence of forward power flow, the controller will identify the source of this flow. If it is determined that the forward power flow was caused by a network switching operation, the controller will automatically apply the forward flow parameters from Group 1.

Figure 40: Forward/Reverse Flow due to Network Switching



If the voltage regulator is operating with forward power flow and detects a reversal of the power flow, the controller will identify the source of the reversal. If it is determined that the reverse power flow was caused by cogeneration, the controller will automatically apply the parameters from Group 2.2.

Figure 41: Reverse Flow due to Cogeneration



If the voltage regulator is operating with reverse power flow and detects the presence of forward power flow, the controller will identify the source of this flow. If it is determined that the forward power flow was caused by cogeneration, the controller will automatically apply the parameters from Group 2.1.

Figure 42: Forward Flow due to Cogeneration

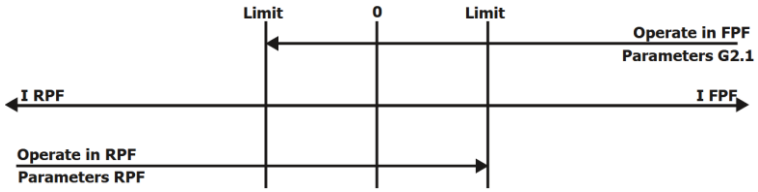


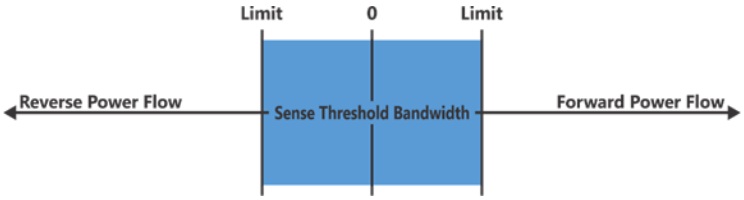
Table 23: Summary of Actions

Flow	Groups
Forward	Group 1 - Forward
Reverse due to switching	Group 1 - Reverse
Reverse due to cogeneration	Group 2.2
Forward due to cogeneration	Group 2.1

A47 – FLP_CLD: Power Flow – Detection Threshold Current

This function sets the current limit as a percentage of the rated current, which the control references to ensure safe flow detection. If the current at the effective load over the nominal load of the regulator is percentage-less than the programmed value, the CTR-4 will not take into account changes in the direction of flow and its regulation will be as programmed in function *A46 - FLP_MT: Power Flow - Treatment Mode*.

Figure 43: Flow direction sensing current limit bandwidth.



A48 – BC_SL: Switching Lockout – Line Overcurrent

This function inhibits switching under load when the measured current exceeds the value of the rated current multiplied by the chosen percentage. As a result, the tap switch will be blocked for switching when there are overcurrents in the network, possibly generated by a short circuit.



NOTICE: When function *A05 – CSP: 12% Permanent Overload Capacity* is active, the lock will take into account the 12% increase in current as a function of the rated current.



CAUTION: When the nominal currents of the voltage regulators that make up the bank are not the same and the regulation in three-phase mode is chosen, the blocking of the switch of one of the regulators will result in the blocking of the other units.

A49 – I_MT: Insensitivity – Processing Mode

Establishes the handling mode of the first switching time count after the control detects an out-of-band condition, as shown Table 24.

Table 24: Insensitivity – Method of Treatment.

Value	Description
0	Pattern
1	Regressive

0 – Standard

In this mode, whenever the voltage exceeds the limits of the insensitive band, the time count for the first switching is initiated.

If the voltage returns to within the band before the programmed time is reached, the count is reset from zero on the next occurrence of out-of-band voltage.



CAUTION: This behavior may be inappropriate in systems with small voltage fluctuations near the band boundary, as the switching time may never be reached, preventing automatic voltage correction.

1 – Regressive

In this mode, the timer also starts when the voltage exceeds the limits of the insensitive band.

If the voltage returns to within the band before the count is complete, the timer starts to regress to zero. If, during this regression, the voltage again exceeds the limits of the band, the count resumes from the point where it left off (does not restart).



NOTICE: This mode is most effective in scenarios with voltage fluctuations close to the band boundary, as it allows switching to occur even if the voltage momentarily fluctuates within the band.

A50 – T_MT: Timing – Processing Mode

Reverse timing allows you to reduce the programmed timing of the current map as a function of voltage variation.

Table 25: Enables reverse timing.

Value	Description
0	Disables reverse timing
1	Enables reverse timing

If this function is set to "*0*", the timing is linear and conforms to functions A15, A22, A31, A38, A47, and A54. However, if this function is set to "*1*", the CTR-4 control will set a new timing by virtue of the equation:

Tef = T x [1 - ({Vref-Vmed} / Vref)]

Where:

Tef is equal to the effective activation delay time;

T it is the time programmed for the map in force;

Vref it is the voltage programmed for the current map;

Vmed is the measured instantaneous voltage.

A51 – IT_CR: Time Interval – Log Capture

This function determines the period of acquisition of the records in the mass memory and has an adjustment range from 1 to 1440 minutes. The CTR-4 control is capable of obtaining and storing up to 6,180 records of the hour, minute, day, month, year, record type, power supply, switch position, power factor, power flow direction, internal temperature (if available), operating state, regulation mode, voltages, currents, and number of operations.

A52 – IT_CD: Time Interval – Demand Calculation

This function determines the time interval during which the control performs the continuous reading of the electrical quantities (such as current and power) in order to calculate the average demand at the end of this period.

The demand readings obtained during this interval represent the actual warming effect on electrical equipment, as they reflect the average active energy consumption over time. In this way, rapid and transient fluctuations in the line do not significantly affect the measured value, allowing a more faithful analysis of the thermal impact on the installation.

A53 – IT_NUPS: Time Interval - Neutralization via UPS

This function must be adjusted to determine the UPS actuation time after the main system fails to power to initiate the regulators' neutralization. The adjustment of this function is between 0 (function disabled, the UPS will not act in case of fault) and 600 seconds.

A54 – MS_HD: Master/Follower - Enables and Designates

This function aims to assign a specific rating to each control unit and to each individual phase that make up the voltage regulator bank, when the system operates in Master/Follower mode. The values to be parameterized for this classification are specified in the Table 26:

Table 26: Master/Follower - Assignments.

Value	Description
0	Function Disabled
1	Master A
2	Master B
3	Master C
4	Follower A
5	Follower B
6	Follower C



NOTICE: When using the Master/Follower function, all controls individually must be classified for some designation (Master or Follower).

A55 – MS_QS: Master/Follower – Number of Followers

When the Master/Follower role is enabled, it is necessary to inform the control designated as Master exclusively of the total number of follower regulators that it should command.

Table 27: Number of Followers

Value	Description
0	No Follower
1	A follower
2	Two Followers



NOTICE: When the Master/Follower function is not used, this function must be set to 0. Otherwise, it is mandatory to connect Follower 1 to port COM_S1 and Follower 2 to port COM_S2 of the sync ports.

A56 – MS_DFM: Master/Follower – Fixed Offset for Master

When the bank operation is programmed for master/follower, it is possible to inform the CTR-4 control what the fixed difference in positions between the follower regulators will be for the master. This function allows you to adjust the fixed difference from -5 to +5 positions, respectively for all bank regulators.



NOTICE: Setting this function is disregarded for the regulator chosen as the master.

A57 – MS_GL: Master/Follower – Degree of Freedom

When the Master/Follower function is used and the bank's operation is programmed for some single-phase mode of regulation, it is necessary to inform, only to the control designated as master, what will be the maximum distance allowed between the tapes of the active regulators. This function allows you to adjust a difference in distance from 0 to 33 positions.

In this case, if the regulation should be purely single-phase, this parameter should be set to 33, but if the distance between the positions of the switches reaches a value higher than that programmed in this function, the CTR-4 proceeds with the alignment of the bank and starts to operate in three-phase mode using as reference the master voltage or the average voltage for a period as programmed in function *A58 – MS_TRT - Time for three-phase* regulation. After this period, the CTR-4 returns to the regulation to the single-phase mode

A58 – MS_TRT: Master/Follower – Time for Three-Phase Regulation

If the distance between the positions of the regulator switches reaches a value higher than that programmed in the *A57 –MS_GL: Master/Follower – Degree of Freedom function*, the CTR-4 proceeds with the alignment of the bank and starts to operate in three-phase mode using the master voltage or the average voltage as a reference, according to the programming of the MS_MR function*: Master/Follower – Regulation Mode*, for a period that can vary from 10 to 1440 minutes. After this period, the CTR-4 returns to the mode selected in the MS_MR function*: Master/Follower – Adjustment Mode*.

A59 – ID_CTR: Control Identification Adress

Because communication ports allow multiple controls to be connected to a single computer or remote unit simultaneously, proper programming of communication addresses is necessary in order to avoid conflicts. The address can be configured with values between 0 and 65534.

A60 & A61 – HME_C2 & HME_C3: Enables spontaneous message

The CTR-4 control allows the generation of spontaneous messages (events) in DNP3.0 and in these functions it is possible to define whether or not the data collection system (supervisory), in which it is installed, will receive these messages. Function A60 corresponds to additional communication port COM-2 and function A61 to additional communication port COM-3.

Table 28: Enables spontaneous messaging.

Value	Description
0	Disables spontaneous messages
1	Enables spontaneous messaging



NOTICE: It is recommended that you read the additional defiled message configuration information available in *the CTR-4Comm Communication Software Manual in its entirety*.

A62 & A63 – EME_C2 & EME_C3: Address for spontaneous messages

Once functions 60 and/or 61 have been programmed to send spontaneous messages, CTR-4 will elaborate the messages (events) in DNP3.0 and send them, when there is a change in the state of a variable and as configured in the **CTR-4Comm** communication software, to a given system address. These functions define the addresses that can be programmed between 0 and 65534.

A64 & A65 & A66 – TTD_C1 & TTD_C2 & TTD_C3: Data transmission rate

The CTR-4 control has 3 communication ports that can be used simultaneously and through the DNP3.0 protocol. The COM-1 port has two interfaces that can be selected between EIA232 or USB, and the COM-2 and COM-3 ports are optional, and can be supplied with EIA232, EIA485, fiber optic (ST) or Ethernet (RJ-45) interfaces. In addition to these, the CTR-4 has two additional fiber optic ports, intended exclusively for synchronization via optical loop between controls, not being used for external communication.

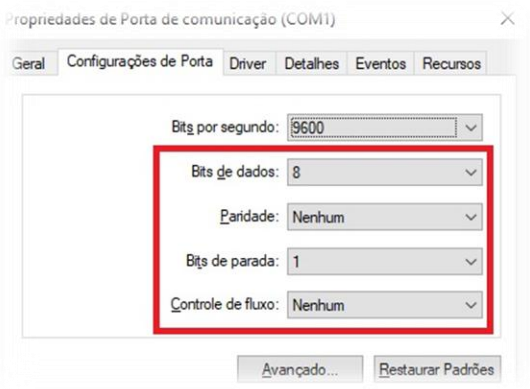
The COM-1, COM-2, and COM-3 communication ports of the CTR-4 can have their data transfer rates adjusted independently in functions A64 to COM-1, A65 to COM-2, and A66 to COM-3. Data transmission rates can be adjusted Table 29.

Table 29: Data throughput options.

Value	0	1	2	3	4	5	6	7
Rate [kbps]	2400	4800	9600	14400	19200	38400	56000	115200

Beyond the values Table 29 , the communication ports of the personal computer or server must be configured as highlighted in the Figure 44:

Figure 44: COM communication port configuration.



A67 – S_AD: Password – Administrator

Changes the password for the "*Administrator*" *profile*. This level of user has full control of the system.

A68 – S_OP – Password - Operator

Changes the password for the "*Operator*" *profile*. This user level only allows you to view measurements, download and delete logs.

MS_MR: Setting Mode

When the CTR-4 is operating in sync, this function must be set in the master control to trigger the regulation as per Table 30. The parameters set in the functions A54, A56, A57 and A58 are also taken into account for regulation. The detailed description of each of the parameters can be found after the Table 30.

Table 30: Way of provoking regulation.

Value	Description
1	Single-phase with three-phase alignment by master regulator voltage
2	Single phase with three-phase alignment by the average
3	Three phase by master voltage
4	Three-phase by the average voltage of the active regulators.

1 – Single-phase with three-phase alignment by the voltage of the master regulator

It operates in single-phase mode and when extrapolated the *A57 – MS_GL: Master/Follower – Degree of Freedom*, it switches to three-phase regulation following the master regulator, configured in *A54 – MS_HD: Master/Follower – Enables and Designates*. It remains in three-phase mode until the end of the time set in function *A58 – MS_TRT: Master/Follower – Time for Three-phase Regulation.*

2 – Single-phase with three-phase alignment by the average

It operates in single-phase mode and when extrapolated the *A57 – MS_GL: Master/Follower – Degree of Freedom*, it switches to three-phase regulation based on the average voltage of the phases of the active regulators. It remains in three-phase mode until the end of the time set in function *A58 – MS_TRT: Master/Follower – Time for Three-phase Regulation.*



NOTICE: For single-phase modes, functions *A54 – MS_HD: Master/Follower – Enable and Designate, A56 – MS_DFM: Master/Follower – Fixed Difference to Master, A57 – MS_GL: Master/Follower – Degree of Freedom,* and *A58 – MS_TRT: Master/Follower – Time for Three-Phase Adjustment* must be adjusted. For purely single-phase operation, the function *A57 – MS_GL: Master/Follower – Degree of Freedom* must be set to 33.

3 – Three-phase by the voltage of the master regulator

Three-phase operation by the voltage of the master regulator makes all active regulators of the bank follow the voltage variations and the consequent regulation imposed by the regulator programmed as master. In this function, the fixed difference of TAPs is taken into account, programmed in function *A56 – MS_DFM: Master/Follower – Fixed Difference for Master.*

4 – Three-phase by the average of the voltages

It uses the average of the voltages of the active regulators as a regulation parameter. In this function, the fixed difference of tapes programmed in function *A56 – MS_DFM: Master/Follower – Fixed Difference to Master is taken into account.*



NOTICE: For three-phase modes, the functions *A54 – MS_HD: Master/Follower – Enable and Designate and A56 – MS_DFM: Master/Follower – Fixed Difference to Master* must be adjusted.



NOTICE: In three-phase average or master mode, the CTR-4 control uses only the master regulator as a reference for power flow detection and dynamic profiling. If you need individual treatment per phase, use the single-phase setting.



CAUTION: The control disregards the individual voltage and current measurements of the follower regulators when operating in three-phase mode by the master or of the active regulators when operating in three-phase mode by the average, leaving them subject to overvoltages and inversion of power flow without proper treatment by the control.

DNP3.0

The control for voltage regulators model CTR-4 communicates through the DNP3.0 protocol according to the general table of objects (*device profile),* and the specification of the points when not remapped is specified in the specific items of each object.

All points of static objects (1, 12, 20 and 30) can be remapped and allocated to classes (1, 2 or 3) using the communication *software* to make the adjustments. The generated events are stored in a queue containing 100 positions, which overwrites the oldest records in cases where the records are not obtained by the master. In case of overflow, the control will indicate *Buffer Overflow* in *Internal Indications*.

Each of the points of the respective objects (1, 20 and 30) can be monitored or not, that is, generate events according to what is programmed via communication *software*, and each of them can be allocated to a class of the user's choice. Events that occur will be indicated through *Internal Indications*. In the case of object 30, only measurements are subject to monitoring, the parameters cannot be monitored.

The date and time synchronization between master and follower can also be adjusted via *communication software* within a range of 1 to 65535 minutes, and the synchronization request will be indicated in *Internal Indications* through the *Need Time Flag*. The Need Time *Flag* is also set when restarting the equipment.

The *Flag Device Restart* is reset every time the machine is restarted and must be reset via *Clear Restart*.

Life cycle

ITB Equipamentos Elétricos Ltda. undertakes to receive and properly dispose of, in accordance with current legislation, the equipment produced by it when it is considered unusable.

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