CONTROL FOR VOLTAGE REGULATORS
MODEL CTR-2



INSTRUCTION MANUAL
MIC-002 | EN

REV202412

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SECURITY AND IMPORTANCE OF LIFE

ITB, as a manufacturer of electrical equipment, takes all necessary actions 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.

SECURITY 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 in the installation and use of ladders in columns, necessary signs on public roads and local legislation.

For the installation and operation of this equipment be sure to read and understand all information, notices and warnings 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

We suggest considering the following information when installing, operating, maintaining, or maneuvering devices installed in high-voltage networks:



DANGER: Dangerous voltage. Contact or proximity to high voltage will cause death or very serious injury. Follow all approved safety procedures when working in high voltage line and equipment surroundings.



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



DANGER: Power distribution equipment must be properly selected for the intended application. It must be installed and maintained by competent personnel, trained and aware of the appropriate safety procedures. These instructions are written for such persons and are not a substitute for proper formal training and experience in safety procedures. Lack of proper selection, installation, setup, and maintenance of electrical power distribution equipment can result in death, serious body injuries, and / or equipment damage

INTRODUCTION

The ITB control for single-phase voltage regulator bank, model CTR-2, is a measurement and activation device, equipped with a microcontroller, **capable of monitoring and commanding up to 3 single-phase step voltage regulators** type A or type B, de 33 positions (32 steps) designed as per ABNT® NBR 11809 or IEEE Std C57.15™.

CTR-2 controls are capable of monitoring in real time the position of the on-load tap changers of ITB single phase voltage regulators models, RAV-1 and RAV-2 which have an absolute encoder coupled to their on load tap changers and, therefore, offer full functionality and operational safety.

Through the sensors installed in the motor drive circuit together with the operations counter device, it can monitor the position of any on load tap changer even without an absolute encoder, making it compatible with any brand and model of single phase step voltage regulator.



CAUTION: The on-load tap changer position tracking mode, which detects the motor's rotation direction and uses the operation counter, makes the position indication unreliable due to the inability to read it in real time.



DANGER: The on load tap changer position tracking mode is not recommended when the voltage regulator does not have a mechanical position indicator or 5-bit absolute encoder coupled to it and a microswitch to read polarity reversal of the series winding.

All ITB controls are factory tested and are pre-adjusted based on standardized parameters that are given as a suggestion for operation. In order to obtain an adequate operation to the specific needs of user application, it is necessary that users configure the control with appropriate parametrization.



NOTICE: Reading and understanding all the present manual will help proper installation, safe handling, efficient equipment operation and its maintenance in safe and reliable conditions.

DESCRIPTION

The CTR-2 control is presented in a cabinet or cubicle containing a control device with a configurable interface for a single-phase step voltage regulator, in accordance with the ABNT® NBR 11809 or IEEE Std C57.15TM standards.

It offers full functionality with efficiency, safety, and ensures the lifespan of the controlled active components for ITB regulators by providing real-time monitoring of the switch position. It also includes operational features for regulators from any other manufacturer.

The ITB CTR-2 model control includes voltage and current measurement devices with true RMS, with a maximum error limited to 1.0% for 120V AC voltage and 200mA current. As a result, voltage and current measurements are made in real-time.

The motor power supply for the tap changers is provided by the regulator itself, which, together with the monitoring algorithm, forms an architecture that enables the CTR-2 to perform and monitor tap changes without data loss.

All analog inputs are galvanically isolated through isolating Transformers and all digital inputs are galvanically isolated through optocouplers.

The voltage and current on the regulator's source side are always calculated, with the use of an additional potential transformer (PT) only required for delta connections, to read the source-side voltage in case of reverse power flow.

The neutral position signal is electrical and independent of tap changer monitoring system, indicated by the lighting of a green LED.



DANGER: When monitoring is done by tracking, a single physical reference is used to determine the neutral position and, consequently, the other tap changer positions. To guarantee that the equipment is safe to bypass switching, whether being put into operation or removed, the redundancy necessary to guarantee the neutral position in regulators is obtained by verifying the reading of the external mechanical position indicator by the operator.

RECEPTION

Before packaging, the control is tested and inspected at the factory. Upon receipt, another inspection must be conducted to identify any damage that may have occurred during transportation. The control enclosure, electrical cables, outlets, and other external components must be intact and free from cracks and deformations. The packaging should also show no signs of tampering, impact, or drops.

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

STORAGE

When supplying the control along with the regulator, it is recommended to store it in its original enclosure, protected from the elements, in a well-ventilated, dry area, away from heat sources, and protected from sparks. In the case of individual supply, the maximum stacking should be 5 packages, and it should be done in a manner that prevents the possibility of mechanical damage.

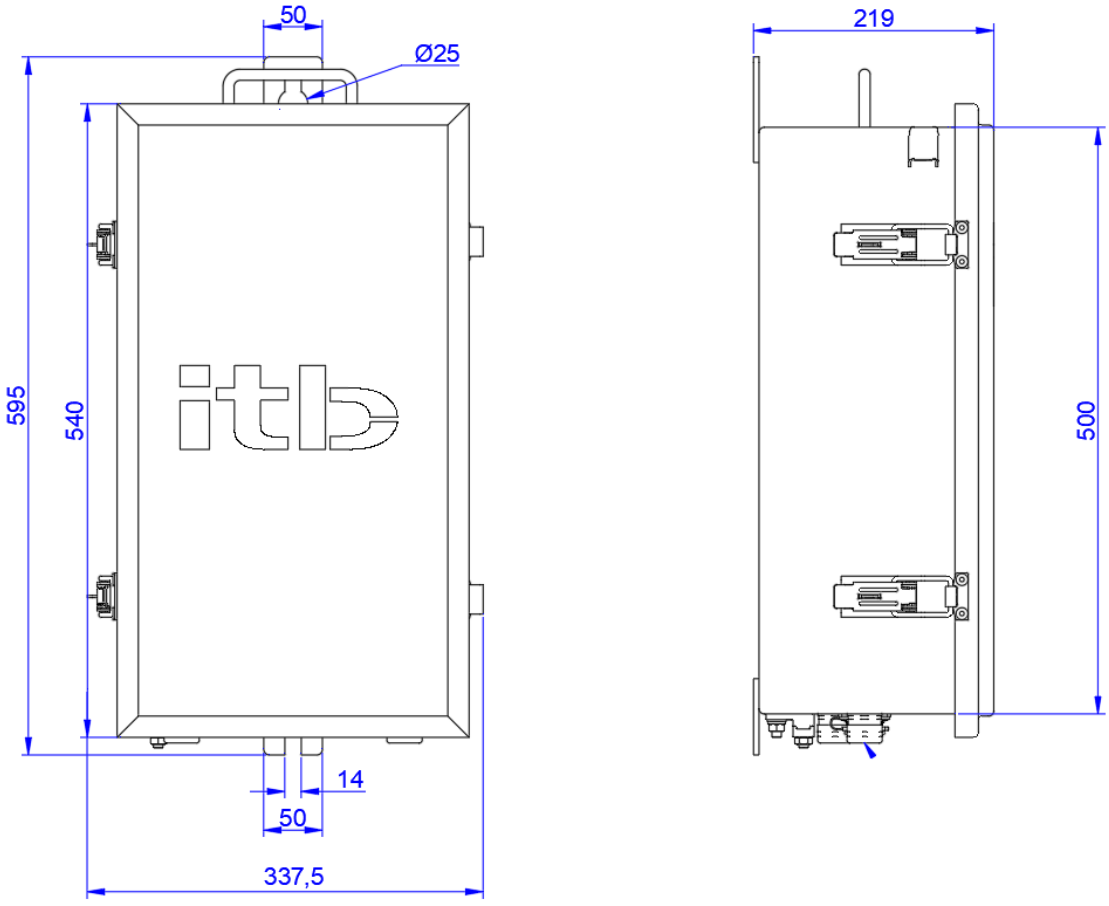
CONTROL BOX CTR-2 – OVERVIEW

CTR-2 electronic control unit is housed in a metal box made of carbon steel and coated with liquid or powder paint in light gray color, MUNSELL N. 6.5 notation

Upon request, or in accordance with the customer's technical specification, it is possible to change the finish system and material of the box.

The box has mounting handles for installation on the regulator body and, if necessary, can also be used for securing the box to the pole. The dimensions and details of the handles are illustrated in Figure 1.

Figure 1: External dimensions of the control box (measurementes in mm).



CTR-2 control box have the following features:

- IP54 protection degree suitable for outdoors;
- IK9 protection degree against external mechanical impacts;
- Power plug 90 to 145Vac (up to 4A) as per NBR 14136 standard with 2 poles and 1 ground for field equipment supply;
- Fuse for the protection of the control and motor (with fuses in use and spare fuses).
- Interruptor de alimentação *"INTERNAL / OFF / EXTERNAL"*, que seleciona o modo de alimentação do controle e evita energizar os terminais de buchas durante o fornecimento de energia externa,
- Terminals for external source (90 to 145Vac);
- Voltmeter connection terminals;
- Motor overvoltage protection system (varistors);
- Knife-type switch to short-circuit the CT, ensuring the safe removal of the CTR-2 control;
- Additional input for external PT signal (optional, must be requested at the time of purchase order);
- Manual motor activation keys;
- Selector switches for Reseting the external position indicator, which can be by phase or neutral;
- Neutral light actuation selectors, which can be by phase or neutral;
- Drawer for accommodating a remote terminal unit (RTU);
- Cable glandes for the passag of additional signals (antenna, logic contacts, etc.).

Secondary Panels Componentes

With a simple and intuitive design, secondary panels which are fixed to the front of the control box, have all the essential components for power supply, operation and signaling of the voltage regulators connected to the control. The location and description of each of these components can be seen Figure 2 and Table 1

Figure 2: Secondary Panels Componentes

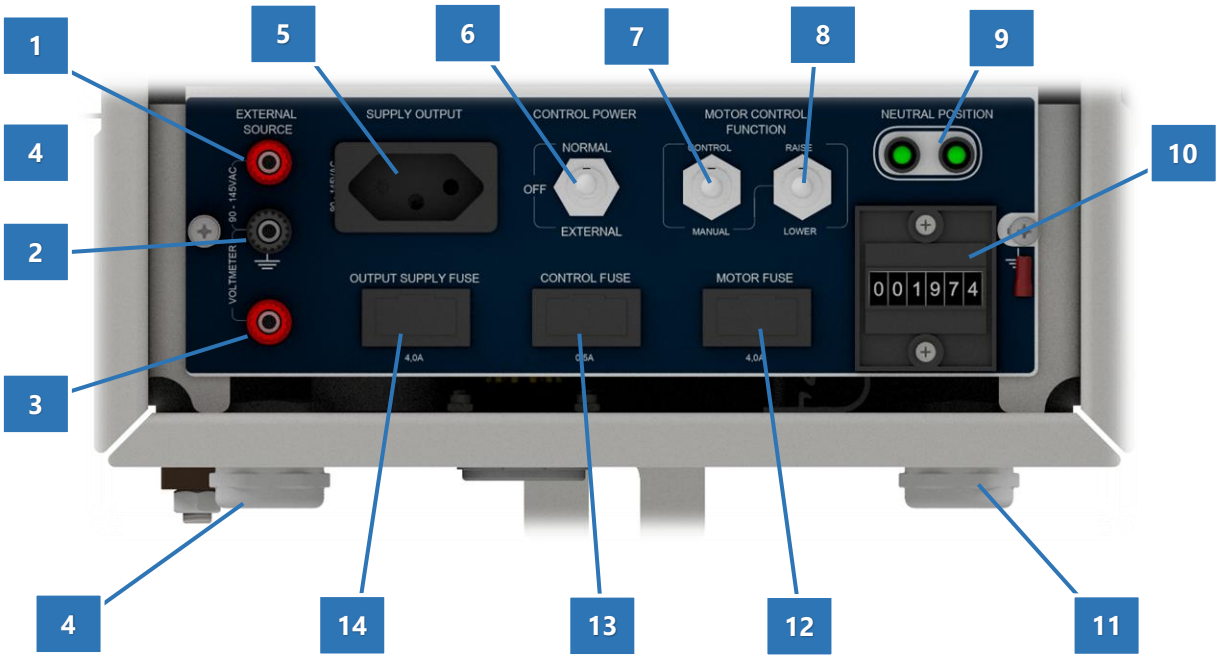


Table 1: Secondary panel components

Item	Description
1	External source terminals (90 to 145Vac)
2	Neutral terminal for external power supply and voltmeter.
3	Terminal for voltmeter connection on the load side measurement
4	PG21 cable gland for the input of the regulator signals.
5	Field equipment power supply plug (90 to 145Vac), NBR 14136 standard, 2 poles and 1 ground
6	*"NORMAL / OFF / EXTERNAL"* Power selector key
7	Motor power selector switch *"CONTROL / MANUAL"*.
8	Manual auxiliary switch for motor operation *"RAISE / LOWER"*.
9	Neutral position indicator Leds
10	Electromechanical operation counter
11	PG21 cable gland for auxiliary signal connections
12	Motor protection fuse (4A)
13	Control protection fuse of CTR-2 (0,5A)
14	Accessory Power Plug Protection Fuse (4A)



NOTICE: For automatic voltage regulation, the motor power selector switch (item 7) must remain in the *"CONTROL"* position, and the *"AUTO"* function of the control must be enabled.

Internal Components of the Control Box

The control box contains the components necessary for the proper functioning of the equipment. The location and description of each of these components can be seen in Figure 3 and Table 2

Figure 3: Internal componentes of the control box

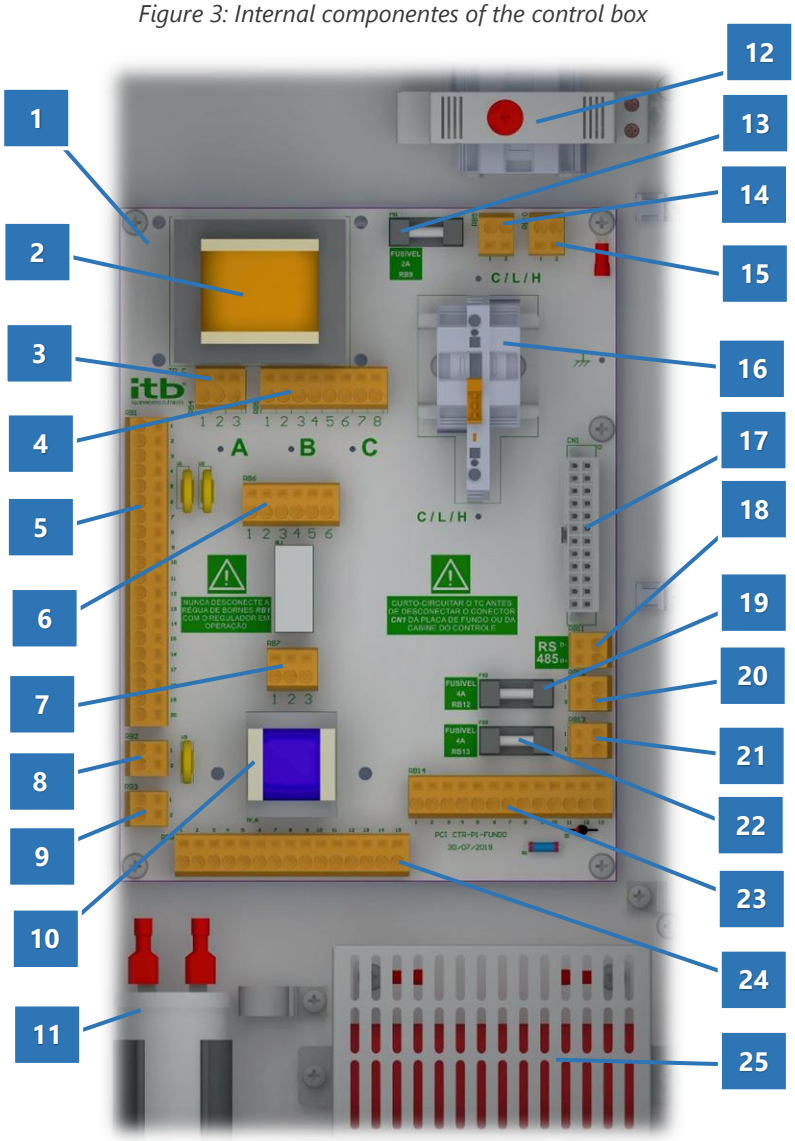


Table 2: Internal components of the control box.

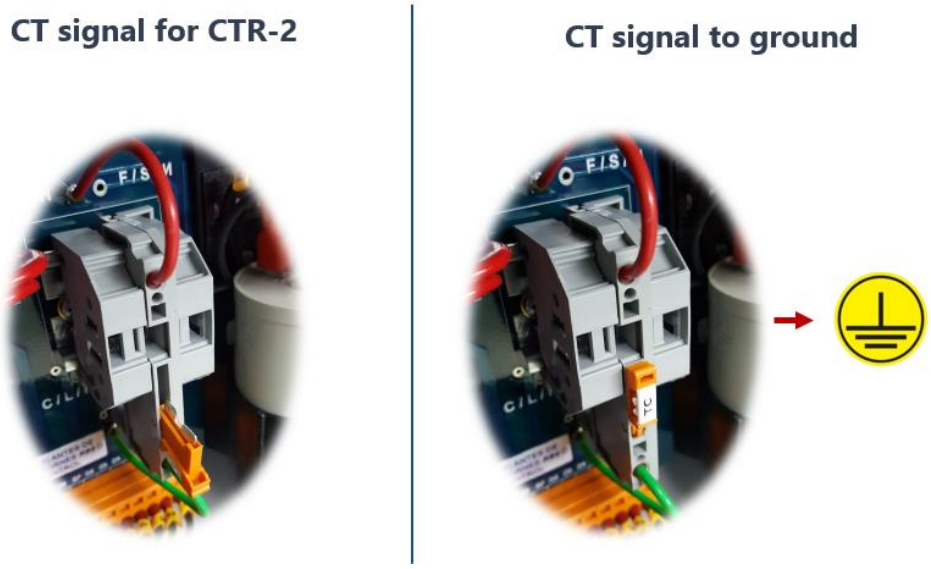
Item	Description
1	Printed circuit board PCI CTR-P1 – FUNDO
2	Compensation PT (if applied)
3	Terminal block *RB4* – Connection and selection of terminal A
4	Terminal block *RB5* – Connection and selection of terminals B and C
5	Terminal block *RB1* – Input for regulator signals
6	Terminal block *RB6* – Adjustment and closure of the neutral position LED
7	Terminal block *RB7* – Adjustment and closure of the reset for the indicator
8	Terminal block *RB2* – Input for additional external PT signals (1=Neutral | 2=Phase)
9	Terminal block *RB3* – Motor capacitor connection
10	Auxiliary PT for real voltage measurement on the source side
11	Motor capacitor (20uF / 380V)
12	Adjustable thermostat for heating (if applied)
13	2A fuse – Connected to the phase of RB9

Item	Description
14	Terminal Block *RB9* – 120VAC / 2A socket (1=Neutral | 2=Phase)
15	Terminal Block *RB10* – Socket for motor lock logic (factory sealed)
16	Manual device to short-circuit the CT
17	Connector *CN1* – Output for regulator signals to the CTR-2 control
18	Terminal Block *RB11* – Serial port connector COM-2 EIA485 (D- | D+)
19	4A fuse – Connected to the phase of RB12
20	Terminal Block *RB12* – 120VAC / 4A socket (1=Neutral | 2=Phase)
21	Terminal Block *RB13* – 120VAC / 4A socket (1=Neutral | 2=Phase)
22	4A fuse – Connected to the phase of RB13
23	Terminal Block *RB14* – Secondary panel connection
24	Terminal Block *RB8* – Connection for male circular socket for single control
25	Resistor for heating (if applied)

Short-circuiting of Current Transformer (CT)

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

Figure 4: Procedure for short-circuiting the CT



CAUTION: Do not remove the circular connectors from the CTR-2 control without first short-circuiting the CTs. CT circuits MUST be shorted when removal or disconnection of the CTR-2 control occurs. Failure to follow these instructions will result in damage to the equipment.

Neutral position LED Activation Adjustment

The CTR-2 control system is designed to operate with single-phase voltage regulators that comply with ABNT® NBR 11809 or IEEE Std C57.15™, regardless of brand. Due to the lack of standardization of specific construction details in these standards, it is necessary to select the method for activating the neutral position LED circuit, which can be done using either phase or neutral.

Located at the bottom of the control box, on the printed circuit board labeled *PCI CTR-P1 – BACK*, at position *RB6*, there are six terminal blocks for manual closure as indicated in Table 3. Use a terminal-type screwdriver (1/8"x4") to remove and reconnect the jumper.

Table 3: Neutral position LED handling

Terminais	Description
1-2 5-6	When neutral position LED goes to neutral
2-3 4-5	When neutral position LED goes to phase (90 to 145Vac)



CAUTION: In regulators produced by ITB phase activation must NEVER BE USED. For more information, consult the instruction manual of the voltage regulators to be controlled by the CTR-2.

Adjust the Activation of Indicator Reset

CTR-2 control system has the possibility of resetting the position indicator by activating the circuit by phase or neutral.

Located at the bottom of the control box, on the printed circuit board called *PCI CTR-P1- FUNDO* and at position *RB7*, there are six terminal blocks for manual closure as specified in Table 4. Use a screwdriver of the terminal type (1/8"x4") to remove and reconnect the jumper.

Table 4: Indicator reset handling

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



CAUTION: Do not use phase activation in voltage regulator with digital indicator.



CAUTION: In regulators produced by ITB phase activation must NEVER BE USED. For more information, consult the instruction manual of the voltage regulators to be controlled by the CTR-2.

Alternative Motor Drive

The motor's alternative drive switch is located on the secondary panel, as item 8 of Table 1. It is a momentary 3-position switch, normally off, that activates the motor in the indicated direction, according to the silkscreen printing on the panel sticker.

For it to operate, it is necessary that the motor power selector switch "CONTROL / MANUAL" (item 7 of Table 1) is in the “MANUAL” position.



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



NOTICE: For automatic voltage level regulation, the motor power selector switch must remain in the "CONTROL" position, and the "AUTO" function of the control must be enabled.

Operation Through External Source

The CTR-2 control can be powered for testing and configuration purposes through an external voltage source between 90 to 145Vac, connected to the terminals on the front panel of the control box identified as "EXTERNAL POWER" (item 6 of Table 1), respecting the phase and neutral indication, and positioning the switch "NORMAL / OFF / EXTERNAL" to the "EXTERNAL" position.



CAUTION: Correct polarity must be connected to the control. Failure to follow this recommendation can cause a short circuit in the power supply and damage the control.



DANGER: Do not connect any voltage source to the "*VOLTMETER*" terminals, because this may induce high voltages at the high power terminals of the regulator, constituting a serious risk of accident to the operator and damage to the regulator.



CUIDADO: Do not connect any loads to the *“VOLTMETER”* terminals, because this may cause the burning of the reference voltage adjustment PT.

CTR-2 CONTROL – OVERVIEW

The CTR-2 control is a micro-controlled equipment capable of performing functions inherent to voltage regulation, timed delay actuation and data acquisition to control the voltage level in electrical power systems, making them available through its built-in communication system to be accessed remotely.

The CTR-2 electronic control has the following resources;

- Real time, continuous measurement of electrical line magnitudes;
- Digital non-resettable on load tap changer operations counter;
- Digital resettable on load tap changer operations counter*;*
- Indicator LEDs to identify the need to increase the voltage;
- Indicator LEDs to identify the need to lower the voltage;
- Indicator LEDs to identify a fault;
- Neutral position confirmation LED (ZEROED);
- Data acquisition:
    - Obtains, stores, and displays the number of records, in adjustable periods between 1 and 60 minutes, the instantaneous values for each record, including date and time, power factor, switch position, voltage, current, operations conter, operating mode, power, and the panel door status, until the total number of record reaches 9,362. From this point, a new records is made every period, descarding the oldest record.
- Operation in direct power flow, reverse power flow, and cogeneration without the need for a special PT (potential transformer) for this purpose. Except in cases where the regulator bank is connected in a closed delta configuration and the reverse power flow is caused by substation switching, in which case, the use of an external measurement PT between the sources or the use of a single regulator control (three-phase) is required;
- "Auto Zero" function moves the switch from any position to the zero position;
- Two simultaneous communication ports;
- Allow the comunication via EIA232, EIA485, USB and/or fiber optics;
- Serial communication with a computer can be done through any of the DNP3.0 communication ports or through the communication program, **ITBComm3_A** (available for free download and installation at *http://www.itb.ind.br*) running on Microsoft® Windows® 7 or newer operating system. If you use the software, you must have a connection between the serial, USB or optical port of the computer and the EIA232, DB-9 port of the front of the control through a serial cable or USB type A or ST optical available in the CTR-2. If the serial port of the computer is a DB-9 Male, the cable to be used must be direct, that is, pin to pin;
- The communication ports can also be used for communication using cellular modem, simply by using **ITBComm3_A** communication program and setting the "*Connection type*" to "*TCP / IP*" and configuring the "*IP*" address and "*Door*" corresponding to the modem connected to the control you wish to access;
- Pin 9 of each of the DB-9s are active with + 5Vdc (optionally this function can be disabled at factory);
- DNP3.0 Communication Protocol through all doors;
- Independent adjustments for direct, reverse and cogeneration power flows;
- Clock and calendar in real time;
- On load tap changer protection in case of overload;
- Voltage limiting function to protect first consumers downstream;
- Accuracy of measured nominal values up to 1.0%.

NOTICE: Access to the log stack can be done with the help of a computer connected to the control in which the ITBComm communication program is installed and running

Control Panel Components

The CTR-2 control allows visualization, configuration adjustment, and reading of instantaneous system measurements without the need for any additional accessories. Upon initialization, the CTR-2 control will light up all the LEDs and the display back-light to test the functionality of these components. Using the navigation keys and the keypad, it is possible to access and adjust the functions for each situation. Its front panel features a monochrome alphanumeric liquid crystal display and a keypad, as shown in Figure 5 and detailed in Table 5.

All controls are individually tested and calibrated at the factory, and all function parameters can be manually adjusted through the front interface of the CTR-2.

Figure 5: Front panel of the CTR-2 control.

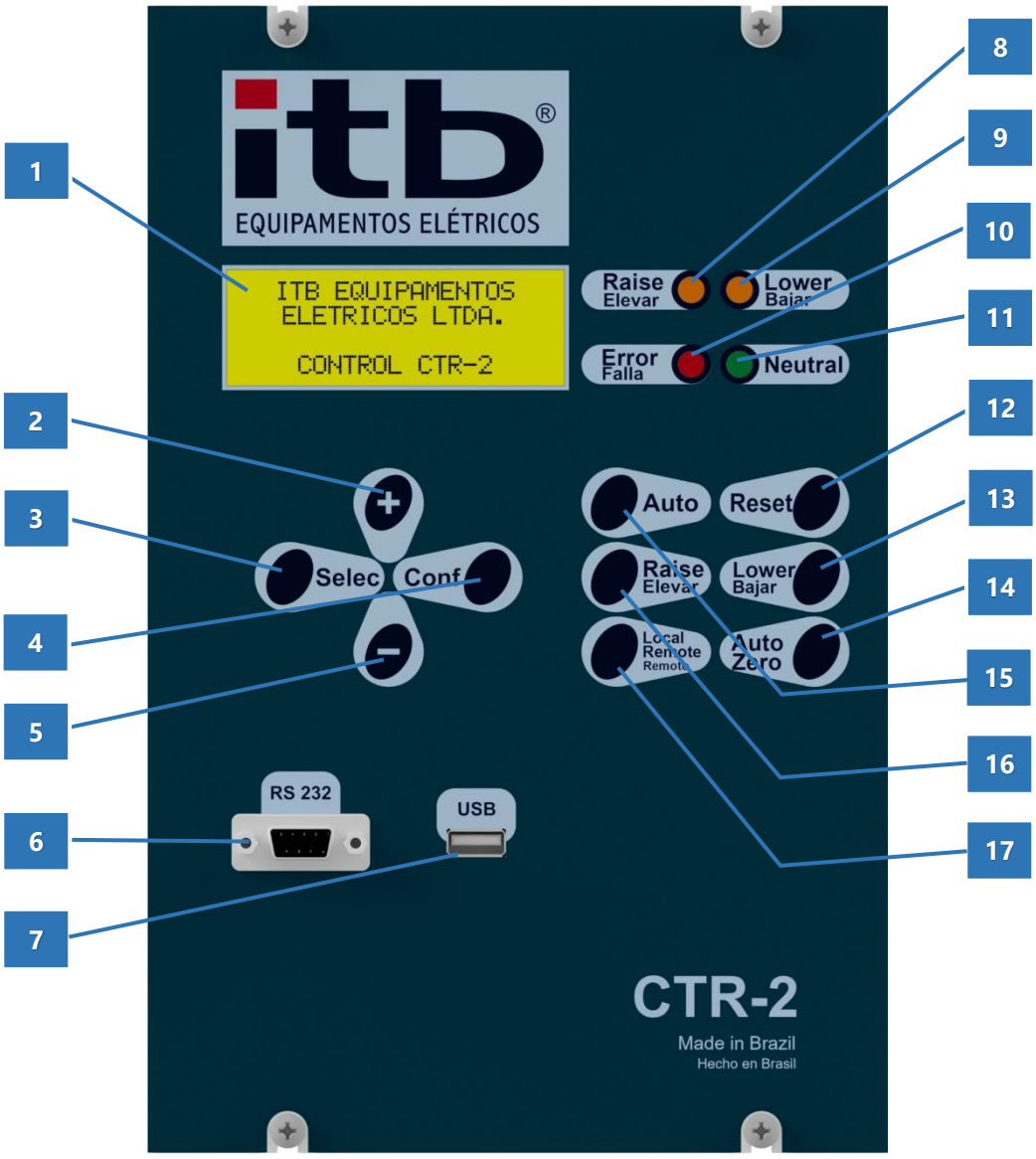


Table 5: Components of the front panel

Item	Description
1	Monochrome liquid crystal display 4 lines of 20 characters
2	The "+" key allows navigation through measurement screens, adjustments, and values as selected.
3	The *"Select"* key allows choosing measurement screens, adjustments, and shortcuts, and moves the adjustment cursor to the left when in configuration mode.
4	The *"Conf"* key, on the main screen, toggles the voltage and current values between primary and secondary, enters configuration mode when in adjustment screens, and confirms the selected value of each digit.
5	The "-" key allows navigation through measurement screens, adjustments, and subtracts values as selected.
6	DB-9 EIA232 COM-1 connector
7	USB-A COM-1 connector
8	*"Raise voltage"* indicator LEDs (increase voltage)
9	*"Lower voltage"* indicator LEDs (decrease voltage)
10	*"Fault"* indicator LEDs
11	Neutral position range indicator LED.
12	The *"Reset"* key updates or resets values that allow this operation if they are displayed
13	The *"Lower"* key operates the switch to lower the voltage when the *"Manual"* mode is active
14	The "Auto Zero" key sets the regulator to the zero position
15	The *"Auto"* key toggles between automatic or manual operation mode
16	The *"Raise"* key operates the switch to raise the voltage when the *"Manual"* mode is active
17	The *"Local/Remote"* key locks or allows commands from remote sources

On the top of the control, the COM-1 and COM-2 communication ports, power supply, and digital and analog signals from the voltage regulator are available.

Figure 6: Top view of the CTR-2 control.



Table 6: Conectors

Item	Description
1	DB-9 EIA232 COM-1 connectors
2	ST fibra óptica COM-2 connectors
3	Input and output of control and power supply signals for the control system and motor.
4	Grounding connector.

Navigation of Screen Groups

The screens of the CTR-2 control have been organized to provide fast and precise navigation. The screens are divided into 4 groups: standard screen, measurement screens (66 to 84), function screens (01 to 65), and shortcut screen. The **SELECT** button toggles between these 4 screen groups, in the order described, always displaying the first screen of each group. From the standard screen, you can press the **"+"** key to view the first measurement screen, screen 66, or press the **"-"** key to view the last measurement screen, screen 84. From any numbered screen, you can navigate through the screen group by pressing **"+"** or **"-"**. The functions and measurements are shown in Table 7 and Table 25, respectively.

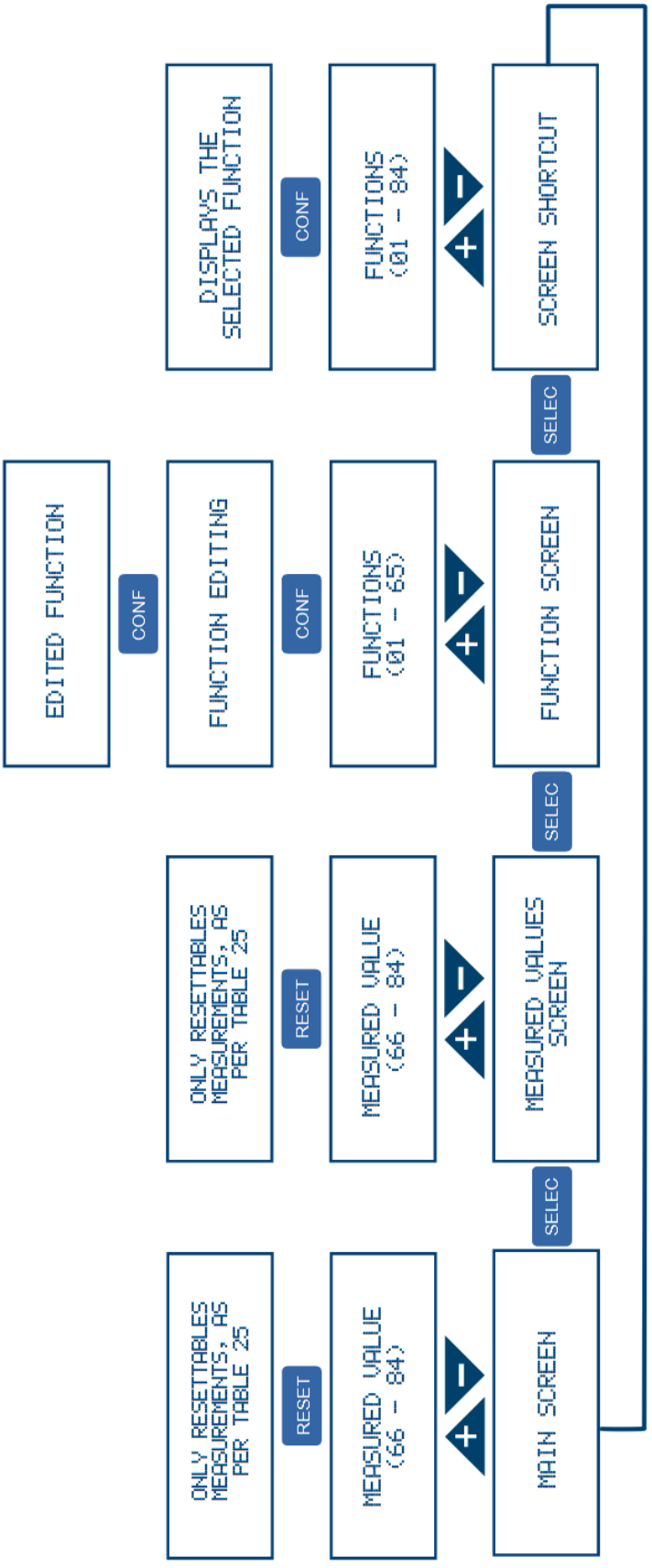


Figure 7: Navigation between screens.

Welcome Screen

When initialized, the CTR-2 control will perform a functional test as described in the 'Control Panel Components' section. During this test, the screen will display information about the control. Figure 8 explains each line and function displayed on the screen.

Figure 8: Welcome screen



Line 3 – Firmware version

- ✓ Version: Indicates the version of the installed firmware



Line 4 – Serie number and year of manufacture

- ✓ SN: Serial number
- ✓ Year: Year of manufacture.

Main Screen

The CTR-2 control features an easy-to-read main screen that simultaneously displays the most important information related to regulation. Figure 9 details each line and function displayed on the main screen for the regulator.

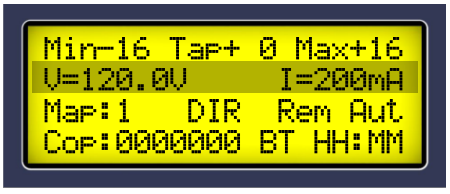
Figure 9: Main Screen.



Line 1 – Indication of taps

- ✓ Min: Minimum tap achieved since last reset;
- ✓ Tap: Actual tap changer position;
- ✓ Max: Maximum tap achieved since last reset.

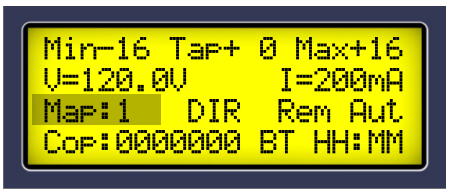
* "Reset" button: Resets the *"Min"* and *"Man"* values.



Line 2 – Measurements

- ✓ V: Line voltage on the load side (V ou kV);
- ✓ I: Line current on the load side (A ou mA).

* *"Conf"* button: toggles the values of V and I between primary and secondary



Line 3 – Maps

- ✓ Map 1
- ✓ Map 2
- ✓ Map 3
- ✓ Reverse flow map



Line 3 – Power flow

- ✓ DIR: Direct flow
- ✓ INV: Reverse flow



Line 3 – Remote access

- ✓ LOC: Local (does not accept remote commands);
- ✓ REM: Remote (accepts remote commands).



Line 3 – Operation mode

- ✓ AUT: Automatic operation;
- ✓ MAN: Manual operation.



Line 4 – Operations counter

- ✓ COP: Total operations counter.



Line 4 – Switch motor status

- ✓ BA: Motor locked in the lowering direction;
- ✓ BE: Motor locked in the raising direction;
- ✓ BT: Motor locked in both directions.



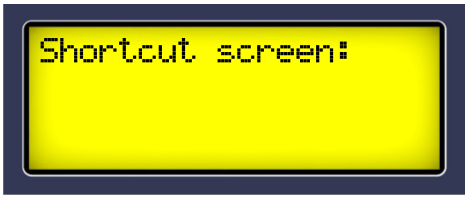
Line 4 – Clock/Timer

- ✓ Clock;
- ✓ Timer: When the voltage profile exceeds the deadband, this area of the display starts showing a progressive stopwatch. Once this value reaches the set time, the control activates the on-load switch to perform the regulation.

Shortcut Screen

From the default screen, you can press the **SELECT** button three times, and the control will display the screen that allows you to enter the number corresponding to the function or measurement you wish to view, as per the "*Shortcut*" columns in Table 7 or Table 25.

Figure 10: Shortcut Screen.



The shortcut selection screen will be displayed as shown in Figure 10 nd when the **CONF** button is pressed again, it will change to the layout shown in Figure 11, which allows the modification of the "*Choose Screen*" field through the following procedure:

- Under one of the digits in the *"New Value"* field, there is a cursor that will indicate the adjustable digit;
- Press the **+** and **-** buttons to change the digit from 0 to 9;
- Press the **SELEC** or **CONF** buttons to move the cursor through the digits;
- Repeat the process until all two digits are filled, obtaining the desired value;
- With the cursor under the least significant digit, press the **CONF** button to accept the value for the entire *"New Value"*
- After repeating the process, the selected screen will be immediately displayed. If the least significant digit does not need to be changed, you can press the **CONF** button to accept the entered value, and the requested screen will be displayed immediately.



NOTICE: If the adjusted value is outside the ranges indicated in Figure 11 , the message "Invalid number" will be displayed on the bottom line of the screen, and the shortcut screen will return to the layout shown in Figure 10, requiring the steps to be repeated.



NOTICE: If the CONF button is pressed while the cursor is under the most significant digit, no action will be taken by the CTR-2.

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

Figure 11: Shortcut Screen – Insertion.



Direct Commando Key

CTR-3 control has 6 direct command keys with specific functions that are described below:

- **AUTO** button: Switches between manual operation modes;
- **RESET** button: Updates or reset values that allow this operation, as indicated by the word *"Resettable"* written on the bottom line of the display;
- **RAISE** button: Activates the tap changer to raise;
- **LOWER** button: Activates the tap changer to lower;
- **LOCAL/REMOTE** button: Enables priority communication modes for parameter adjustments of functions or commands, either locally or remotely;
- **AUTO ZERO** button: Commands the switch to the "*NEUTRAL*" position from any screen or operation mode (see the **Auto Zero** section, available in this manual).

Auto Zero Function

The **AUTO ZERO** key is used to prepare the control for energization or de-energization maneuvers. Once pressed, it initiates the following algorithm:

- Displays the message ***"Confirm by pressing AUTO ZERO again"*** and waits for 7 seconds for confirmation, which is done by pressing the **AUTO ZERO** button again. (Only in version 2.6 and beyond);
- If the position is not zero position, the control checks whether it is necessary to command the tap changer to raise or lower taps;
- Activates the tap changer motor in the direction to bring the switch to the zero position;
- Waits until the switch reaches the zero position;
- When the zero position is reached, the control checks the redundancy of this information by comparing the encoder reading (if applied) or the STCMS reading (if applied), the closure of the zero position microswitch, and the change in the state of the polarity reversing switch (if applied);
- Turns on the **"*Neutral Position*"** LED on the secondary panel and **"*Neutral*"** LED on the control panel;
- Displays the message ***"Tap changer in neutral position. Ready for maneuver"*** on the display;
- Turns on the **"*Fault*"** LED on the control panel if there is a discrepancy in the redundancy check of the neutral position information;
- In case of failure, displays the message ***"Tap changer locked. Auto Zero failure!"*** on the display.



NOTICE: The AUTO ZERO function locks the control commands until the next restart. After the restart, the control returns to manual mode.

CONTROL CTR-2 – MEASUREMENTS AND FUNCTION ADJUSTMENTS VIA IHM

The CTR-2 control has a set of measurement screens displaying the main electrical quantities related to the distribution network and the regulator, as well as another set of function screens, where it is possible to configure the parameters for operation in direct or reverse flow.

CONTROL CTR-2 - FUNCTIONS

Navigation Through the Function Screens

From the default screen or any measurement reading screen, press the **SELEC** button once. The first adjustable parameter will be displayed on the configuration screen, as shown in Figure 12, along with its current value.

In the "*XX*" field at the top, the screen number will be shown, which can be used to directly access it via the "***SCREEN SHORTCUT***", reducing navigation time.

The "*Name*" field displays an abbreviation that identifies the function being viewed, as per the "*Name*" column in Table 7.

The "*Current value*" field shows the value adjusted for this function and, in the upper-right corner, in brackets, its unit of measurement (if applicable).

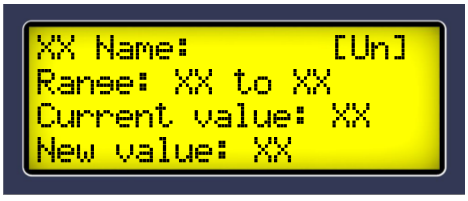
Figure 12: Parameter Visualization Screen.



To adjust the parameters of a control function:

- Press the **"+"** or **"-"** keys to navigate between the adjustable parameters, which are sequenced as per Table 7. Once the last parameter is reached, pressing the **"+"** key will bring back the first adjustment screen.
- On any adjustment visualization screen, press the **CONF** key to enter the adjustment mode for the displayed parameter, which will be shown on an adjustment screen, as shown in Figure 13;
- A "*Range*" field will display the minimum and maximum values for the displayed parameter;
  A "*New value*" field will initially show the same "*Current value*" but with a cursor positioned at the most significant digit.

Figure 13: Parameter Modifcation Screen.



To modify the value of the selected parameter, follow the sequence of operations below:

- Press the **"+"** or **"-"** keys to navigate through the digits from 0 to 9 under the cursor;
- Press the **SELEC** or **CONF** key to move the cursor through the digits;
- Repeat the operation until all digits are filled, obtaining the desired value.



NOTICE: If the adjusted value is outside the "*Range*", the message "*Invalid value*" will be displayed on the bottom line, and the screen will return to the display shown in Figure 13.

The functions for control with firmware and IEEE® standard are in accordance with Table 7

Table 7: Sequence of Configurable Functions

Shortcut	Function Name	Function Description	Unit	Range	Incr.	Default Value
1	RTPC	PT ratio for control	-	25 a 300	0,1	115
2	RTCC	CT ratio for control	-	25 a 6000	1	1000
3	VREFM1	Set voltage – Map 1	V	90 a 135	1	120
4	INSM1	Bandwidth – Map 1	V	0,8 a 5,0	0,1	3
5	TMPM1	Timing delay – Map 1	s	10 a 180	1	30
6	DVQLRM1	Voltage compensation R – Map 1	V	-25 a 25	0,1	0
7	DVQLXM1	Voltage compensation X – Map 1	V	-25 a 25	0,1	0
8	VREFM2	Set voltage – Map 2	V	90 a 135	1	120
9	INSM2	Bandwidth – Map 2	V	0,8 a 5,0	0,1	3
10	TMPM2	Timing delay – Map 2	s	10 a 180	1	30
11	DVQLRM2	Voltage compensation R – Map 2	V	-25 a 25	0,1	0
12	DVQLXM2	Voltage compensation X – Map 2	V	-25 a 25	0,1	0
13	SEMIM2	Week to start validity of map 2	-	0 a 8	1	0
14	HRIM2	Hour to start validity of map 2	-	0 a 23	1	0
15	MINIM2	Minute to start validity of map 2	-	0 a 59	1	0
16	SEMFM2	Week to end validity of map 2	-	0 a 8	1	0
17	HRFM2	Hour to end validity of map 2	-	0 a 23	1	0
18	MINFM2	Minute to end validity of map 2	-	0 a 59	1	0
19	VREFM3	Set voltage – Map 3	V	90 a 135	0,1	120
20	INSM3	Bandwidth – Map 3	V	0,5 a 6,0	0,1	3
21	TMPM3	Timing delay – Map 3	s	10 a 180	1	30
22	DVQLRM3	Voltage compensation R – Map 3	V	-25 a 25	0,1	0
23	DVQLXM3	Voltage compensation X – Map 3	V	-25 a 25	0,1	0
24	MESIM3	Month to start validity of map 3	-	0 a 12	1	0
25	SEMIM3	Week to start validity of map 3	-	0 a 8	1	0
26	HRIM3	Hour to start validity of map 3	-	0 a 23	1	0
27	MINIM3	Minute to start validity of map 3	-	0 a 59	1	0
28	QMESM3	Number of months validity for map 3	-	0 a 12	1	0
29	SEMFM3	Week to end validity of map 3	-	0 a 8	1	0
30	HRFM3	Hour to end validity of map 3	-	0 a 23	1	0
31	MINFM3	Minute to end validity of map 3	-	0 a 59	1	0

Shortcut	Function Name	Function Description	Unit	Range	Incr.	Default Value
32	VREFFI	Set voltage – reverse flow	V	90 a 135	0,1	120
33	INSFI	Bandwidth reverse flow	V	0,5 a 6,0	0,1	3
34	TMPFI	Reverse flow timing delay	s	0 a 180	1	30
35	DVQLRFI	Voltage compensation R – Reverse flow	V	-25 a 25	1	0
36	DVQLXFI	Voltage compensation X – Reverse flow	V	-25 a 25	1	0
37	MODABL	Enable automatic load bonus	-	0 a 1	1	1[1]
38	BMAX	High limit tap position	-	1 a 16	1	16
39	BMIN	Low limit tap position	-	-1 a -16	-1	-16
40	LVMIN	Minimum voltage limiter	V	1 a 15	1	15
41	LVMAX	Maximum voltage limiter	V	1 a 15	1	15
42	BSC	Current limit setting	-	0,5 a 2,1	0,1	2
43	MAFI	Mode of operation in case of reverse flow	-	0 a 8	1	0
44	TAC	Actuation type on the tap changer	-	0 a 5	1	2
45	MLPCOM	Tap changer position reading mode	-	0 a 3	1	0
46	DEFVC	Phase angle setting	-	0 a 2	1	0
47	OPMEDF	Enable real measurement on the source side	-	0 a 1	1	0
48	HRAUT	Timed return to automatic mode	-	0 a 1	1[2]	0
49	LIMBL	Reverse current sense threshold	%	1 a 5	1	1
50	DTAQ	Data acquisition period	Min	1 a 60	1	15
51	HTINV	Enable reverse timing	-	0 a 1	1	0
52	MODOP	Switching mode	-	0 a 1	1	0
53	ESERIAL	Serial communication address	-	0 a 65535	1	0
54	MCPS1	Port 1 communication mode	-	0 a 2	1	0
55	MCPS2	Port 2 communication mode	-	0 a 1	1	1
56	BAUD1	Port 1 data transmission rate	-	0 a 7	1	2
57	BAUD2	Port 2 data transmission rate	-	0 a 7	1	2
58	HESP	Enable "Spontaneous Responses"	-	0 a 1	1	0
59	ENDREM	Address for "Spontaneous Messages"	-	0 a 65535	1	0
60	MINREL	Clock minute	-	0 a 59	1	Current
61	HREL	Clock hour	-	0 a 23	1	Current
62	DIAREL	Clock day	-	1 a 31	1	Current
63	MESREL	Clock month	-	1 a 12	1	Current
64	SEMREL	Clock week	-	1 a 7	1	Current
65	ANOREL	Clock year	-	0 a 99	1	Current

Adjustments in the control

The CTR-2 control has 3 adjustment groups for operation in forward flow, whose validity depends on the date and time for entry and exit. These groups are called **MAPS** and include only the parameters that may vary seasonally. It also has an independent adjustment group for the validity when reverse power flow is detected.

[1] For controls with firmware version 2.12 and onwards

[2] For controls with firmware version 2.13a and onwards, this function will not be enabled.

CONTROL CTR-2 – DESCRIPTION OF FUNCTIONS

1 – RTPC: PT ratio for control

Configured value must be equal to the ratio between voltage in the load and voltage in the control obtained through the data engraved on the nameplate of the voltage regulator Example: 13800/120 = 115.

2 – RTCC: CT ratio for control

Configured value must be equal to the ratio between the nominal current of the regulator and the secondary nominal current of the CT (0.2A) obtained through the data engraved on the nameplate of the voltage regulator. Example: 200/0.2 = 1000.

3, 8, 19 e 32 – VREF: Set voltage

The adjusted value in this function is used as a regulation parameter. When the power flow is direct, the reference voltage defined in functions 3 (map 1), 8 (map 2), or 19 (map 3) will be adopted, according to the active map. This parameter establishes the output voltage level on the load side. In the case of reverse power flow, the reference voltage defined in function 32 (reverse map) will be used, which determines the output voltage level on the source side.

4, 9, 20 e 33 – INS: Bandwidth

The adjusted value in this function defines a symmetrical deadband limit around the reference voltage. When the measured voltage value is within the band limits, the control considers that no correction is needed, and in this case, the indicators for **RAISE VOLTAGE** or **LOWER VOLTAGE**, available on the front panel of the control, will remain off. When the voltage profile is outside the band range, the **RAISE VOLTAGE** or **LOWER VOLTAGE** indicators will light up, indicating the direction in which the control will perform the regulation. Functions 4, 9, and 20 correspond to maps 1, 2, and 3, respectively. Function 33 is for the reverse power flow map.



CAUTION: The coordination of the insensitivity and timing functions should be done to minimize the wear of the switch, thereby reducing the maintenance frequency.

5, 10, 21 e 34 – TMP: Time delay

The adjusted value in this function defines the period, in seconds, that the control waits before starting regulation. Its purpose is to avoid switching due to short-duration voltage variations in the system, such as electrical machine startups. Functions 5, 10, and 21 correspond to maps 1, 2, and 3, respectively. Function 34 is for the reverse power flow map.



CAUTION: Banks of voltage regulators connected in series (cascade) must have a coordinated time delay in order to minimize interactions between them (tap changing excess operations). It is recommended that the regulator closest to the source respond to variations in less time and the others, downstream of the circuit, have time delay adjustments with a minimum difference of 15 seconds more than its predecessores.



CAUTION: Coordination of bandwidth and time delay functions should be made to minimize contact erosion of the tap changer and therefore decrease the maintenance frequency.

6 and 7, 11 and 12, 22 and 23, 35 and 36 - DQLR and DVQLX: Line voltage drop compensation

The configured values in these functions simulate the impedance of the line creating a real image of the circuit from the regulators to the theoretical center of loads. Together with the value of the load current, this function establishes a new regulation parameter referred to the parameter already established in the reference voltage box (parameters 3, 8, 19 and 32). When the power flow is forward (parameters 3, 8 and 19) these R and X values determine the output voltage level on the load side. When the power flow is reverse (parameters 32), these values determine the output voltage level on the source side.

13, 16, 25 and 29 – Week to start validity of map 2 and 3

With these parameters, the CTR-2 is instructed on which day of the week it needs to change the active map. There will then be a correspondence between the adjusted value and the day of the week when the maps enter or exit validity, as per Table 8.

Table 8: Option of days

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



NOTICE: If the setting is made to *"0"*, the validity will not change state. That is, if it is deactivated, it will not activate, and if it is activated, it will not deactivate.



NOTICE: If the setting is made to *"8"*, the validity will change state considering only the parameters of Hour and minute, and it will be repeated for all days of the week.

14, 17, 26 and 30 – Hour to start validity of map 2 and 3

The adjusted value will be used directly as the hour value and, together with parameters 15, 18, 27, and 31, will form the activation or deactivation times of the map validity to which they correspond.

15, 18, 27 and 31 – Minute to start validity of map 2 and 3

The adjusted value will be used directly as the minute value and, together with parameters 14, 17, 26 and 30, will form the activation or deactivation times of the map validity to which they correspond.

24 – MESIM3: Month for the validity of map 3

When this parameter is set to the value *"0"*, the validity of map 3 will begin according to the weekly, hour, and minute programming made for this map. For values different from *"0"* (i.e., between 1 and 12), map 3 will come into effect at the first moment of the month corresponding to the programmed value, disregarding the weekly, hour, and minute settings for starting validity, as shown in Table 9

Table 9: Options for months

Value	0	1	2	3	4	5	6	7	8	9	10	11	12
Month	All	January	February	March	April	May	June	July	August	September	October	November	December

28 – QMESM3: Number of months validity for map 3

In this parameter, we inform the CTR-2 control the number of months during which map 3 will remain active when it is triggered by an adjustment different from *"0"* for parameter 40. In this case, the week, hour, and minute parameters for deactivating map 3 will be disregarded, and map 3 will deactivate when the specified number of months has elapsed.



NOTICE: It should be noted that the validity of map 3 takes priority over the validity of map 2, just as the validity of map 2 takes priority over the validity of map 1. Therefore, map 1 will only be active when none of the other maps are in effect.



NOTICE: The map related to reverse flow will take priority over all others due to the detection of reverse power flow by the CTR-2 control, as well as the value set for parameter 26.

37 – MODABL: Enable automatic load bonus

Single-phase voltage regulators manufactured in accordance with ABNT® NBR 11809 or IEEE Std C57.15TM standards, with the exception of those whose nominal current is greater than 668A, allow operation with currents higher than that declared in the nameplate without violating the guaranteed temperature elevation limit, but with restricted regulation range according to Table 11.

Table 10: Control of automatic load bonus

Item	Description
0	Disable – Load bonus is done manually
1	Enable – Load bonus is done automatically

This function set to "0" keeps the regulator in normal function following the tap position locks programmed in parameters 44 and 45. If it is set to "1", it makes the CTR-3 control limit the regulator regulation range according to current measured passing through the regulator in accordance with Table 11. Thus, if for example the line current reaches 1.25 times the nominal current, the CTR-3 will regulate the output voltage while the tap changer position does not pass the +10 derivation or is less than -10. If the tap changer is in a position outside the configured range the switch will go into configured range even when the voltage is not at the desired level.

38 and 39 – BMAX & BMIN: Tap position limits and Manual Load Bonus

These functions define the limits of the maximum and minimum positions that the on-load tap changer can reach. Reducing the regulation range allows an increase in the current without violating the temperature rise limits according to Table 11.

Table 11: Load bonus

Range of voltage regulation	± 10%	± 8,75%	± 7,5 %	± 6,25%	± 5%
High limit tap position	16	14	12	10	8
Low limit tap position	-16	-14	-12	-10	-8
Continuous-current rating	0%	10%	20%	35%	60%



NOTICE: If the tap position limits are programmed asymmetrically, the effective load bonus will correspond to that of the limit with the highest absolute value.



AVISO: Data in Table 11 is defined by IEEE Std C57.15TM and by ABNT® NBR 11809 for regulators with currents up to 668A. It is important that the current values are verified on the nameplate of the single-phase regulator commanded by the CTR-3.

40 and 41 – LVMAX & LVMIN: Voltage limiters

When using the line drop compensation functions it may be necessary to limit the voltage so as not to harm the first consumers. The way to do this is to use the high and low voltage limits. When the regulators voltage level reaches one of those limits, the control will not allow this limit to be exceeded.

The values of the voltage limiters are determined through the following functions:

UPPER LIMIT = VREF + INS + LVMAX

LOWER LIMIT = VREF – INS – LVMIN

Where:

VREF is the reference voltage, in volts, of the active map;

INS is the banwith, in volts, of the active map;

LVMAX is the upper voltage limit, in volts, of the active map;

LVMIN is the lower voltage limit, in volts, of the active map.

42 – BSC: Current limit setting

This function inhibits on load tap changing when the measured current exceeds the value of the nominal current multiplied by the chosen percentage. With that, the tap changer will be blocked for switching when there are overcurrents in the network, possibly generated by a short circuit.

43 – MAFI: Power Flow Handling Mode

This function determines how CTR-3 control will operate according to the power flow imposed by the network. Table 12 shows the treatment options that the CTR-3 control has, the work group and the direction of regulation for each of the alternatives chosen.

Detailed description of each of the settings and their respective functional diagrams is below the Table 12.

Table 12: Handling of operational modes for power flow.

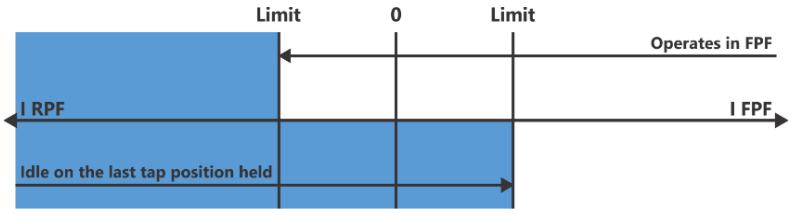
Firmware			Description	Operating Map	Regulation Direction
>2,05	=2,05	<2,05			
0	0	0	Forward flow and blocking in case of reverse flow	Forward	Load
1	3	3	Forward flow and neutralization in case of reverse flow	Forward	Load
2	5	-	Constant forward flow	Forward	Load
3	1	1	Reverse flow and lockout in case of forward flow	Reverse	Source
4	7	-	Reverse flow and neutralization in case of forward flow	Reverse	Source
5	6	-	Constant reverse flow	Reverse	Source
6	-	-	Bidirectional flow blocked for current below threshold	Forward / Reverse	Load/Source
7	2	2	Bidirectional flow active until opposite threshold	Forward / Reverse	Load/Source
8	4	4	Reverse flow by cogeneration	Forward / Reverse	Source

Below is the description of each parameter, based on the function numbering of the CTR-2 from firmware version 2.5 onwards.

0 – Forward flow and blocking in case of reverse flow

It operates in forward flow and blocks switching in case of reverse flow detection. The CTR-2 control, when detecting a reverse current higher than 1% of the nominal current held the tap position until the current is equal to or greater than the same value, but in a forward direction.

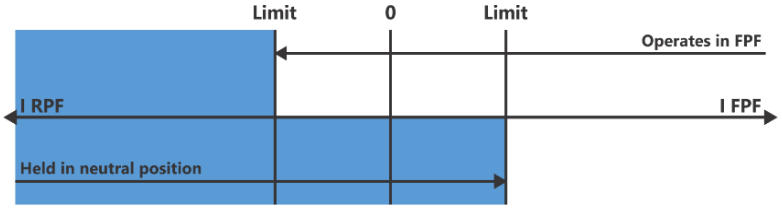
Figure 14: Direct flow and lockout in case of reverse flow



1 – Forward flow and neutralization in case of reverse flow

It operates in forward power flow and tapping to neutral position in case of detection of reverse power flow. The CTR-2 control, when detecting a reverse current higher than the percentage value of the nominal current programmed in function *49 – Reverse current sense threshold (LIMBL)* takes the voltage regulator to the neutral position and blocks operations until the current is equal to or greater than the same value, but in the forward direction.

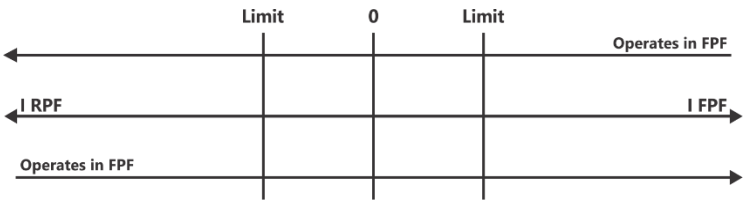
Figure 15: Forward flow and neutralization in case of reverse flow



2 – Constant forward flow

It operates only in forward power flow even when detecting reverse power flow. The use of this parameter is not indicated where there is the possibility of reverse power flow caused by switching sources.

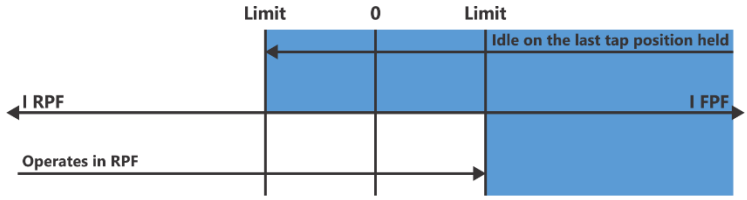
Figure 16: Constant forward flow



3 – Reverse flow and blocking in case of forward flow

It operates in reverse flow and blocks switching in case forward flow is detected. The CTR-2 control, upon detecting a forward current higher than 1% of the nominal current, blocks switching until the current returns to being equal to or greater than the same value, but in the reverse direction.

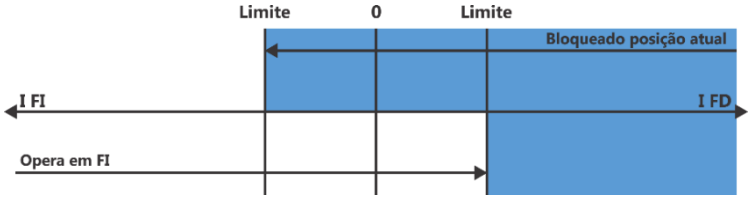
Figure 17: Reverse flow and blocking in case of forward flow



4 – Reverse flow and neutralization in case of forward flow

It operates in reverse power flow and tapping to neutral position in case of detection of forward power flow. The CTR-3 control, when detecting a forward current higher than the percentage value of the nominal current programmed in function *49 – Reverse current sense threshold (LIMBL)* takes the voltage regulator to the neutral position and blocks operations until the current is equal to or greater than the same value, but in the reverse direction.

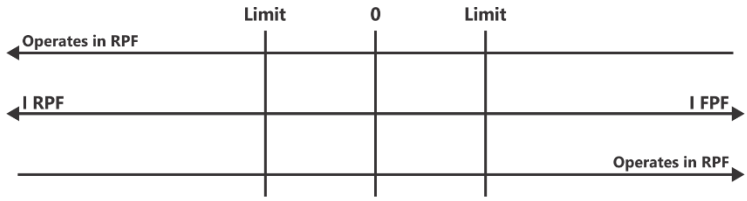
Figure 18: Fluxo inverso e neutralização em caso de fluxo direto.



5 – Constant reverse flow

It operates only in reverse power flow even when detecting forward power flow. The use of this parameters not indicated where there is the possibility of forward power flow caused by switching sources.

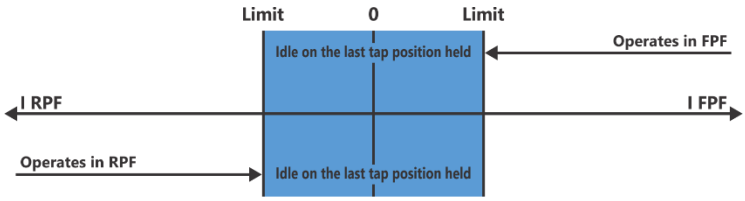
Figure 19: Constant reverse flow



6 – Bidirectional flow blocked for current below threshold

Regulates in both directions of power flow. The use of this parameter is recommended when there is possibility of forward and reverse power flow caused by switching of sources. CTR-2 control when detecting a current higher than the percentage value of the nominal current programmed in function *49 – Reverse current sense threshold (LIM)* analyzes the flow direction and operates in the detected flow direction. When the detected current is between the detection limit values, the control remains at the last held tap position until the current exceeds the limits in either direction, at which point it resumes operation. For a **DELTA** bank, the voltage at the source must be measured by an external PT.

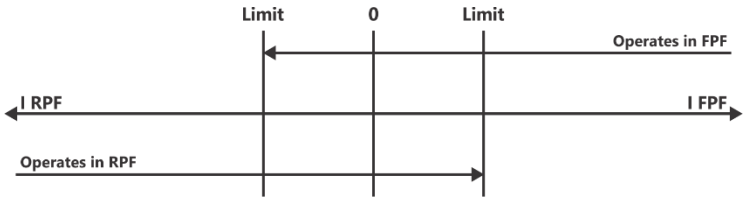
Figure 20: Bidirectional flow blocked for current below threshold



7 – Bidirectional flow active until opposite threshold

Regulates in both directions of power flow. The use of this parameter is recommended when there is possibility of forward and reverse power flow caused by switching of sources. CTR-3 control operates in forward flow until the reverse flow current is greater than the percentage value of the nominal current programmed in function *49 – Reverse current sense threshold (LIMB)*. From that point on, it will work in reverse flow, remaining in such condition until the forward flow current is higher than the percentage value of the nominal current programmed in function *49 – Reverse current sense threshold (LIMB)*.

Figure 21: Bidirectional flow active until oppositve threshold



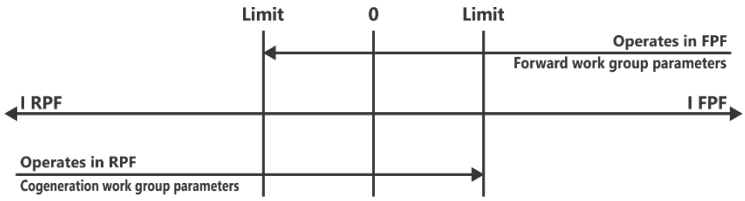


NOTICE: Parameters 6 and 7 should not be configured in regulators that are connected to the three-phase system in a CLOSED DELTA configuration. For these cases, an external PT, installed between the sources of the regulators, should be used.

8 – Reverse flow by cogeneration

Regulates only the load side in both directions of flow and assumes that all reverse flow is caused by cogeneration. This function is recommended when there is a possibility of both direct and reverse power flow, and the reverse flow is generated by a small-scale power plant. The CTR-2 control, when detecting a reverse current higher than the percentage value of the nominal current programmed in function *49 – Power flow threshold current (LIMBL)*, will start operating in reverse flow due to cogeneration, remaining in this state until the direct flow current exceeds the percentage value of the nominal current programmed in function *49 – Power flow threshold current (LIMBL)*.

Figura 22: Reverse flow by cogeneration



44 – TAC – Actuation type on the tap changer

To allow the controls for ITB single-phase voltage regulators with CTR-2 to operate with regulators from other manufacturers, it will be necessary to configure the method of motor power supply, either continuous or pulsed, and whether or not there are switches that block the extreme positions. Additionally, it is possible to choose whether the regulator, after activating its motor, will switch until the voltage exceeds the reference voltage or until it exceeds the deadband limit. The settings can be selected according to Table 13.

Table 13: Operation of the switch, deadband handling, and blocking of extreme positions.

Value	Mode of operation of blocking		
	Motor operation	Deadband handling	Blocking of extreme positions
0	Continuous	For the reference voltage	Without switch
1	Pulsed	For the reference voltage	With switch
2	Continuous	For the deadband range	Without switch
3	Pulsed	For the deadband range	With switch
4	Continuous	For the reference voltage	Without switch
5	Continuous	For the deadband range	With switch



NOTICE: For ITB voltage regulators without the external switch position indicator or with the external digital indicator, parameter 44 must be set to "*0*" or "*2*".



NOTICE: For ITB voltage regulators with the optional mechanical external switch position indicator, parameter 44 must be set to "*4*" or "*5*".

45 – MLPCOM – Method of reading the switch position

The CTR-2 control has two different ways of obtaining the current switch position, which can be selected by adjusting this parameter as shown in Table 14.

Table 14: Switch position reading options

Value	Switch reading mode	Indication Mode
0	Real-time reading of the BCD absolute encoder	-16 a +16
1	Real-time reading of the BCD absolute encoder	1 a 33
2	By tracking	-16 a +16
3	By tracking	1 a 33



NOTICE: Options 2 or 3 should be used when the absolute encoder cannot be used. They make functions such as load boost and position locking unreliable.

46 – DEFVC: Phase angle setting

The angle phase between voltage and current need to be configured to ensure functions such as compensation of line voltage drop, power factor and power indications work properly. This adjustment is different depending on the type of connection of the regulators in the bank. Table 15 shows values that can be adjusted.

Table 15: Phase angle setting

Value	Description
0	No phase shift (0°)
1	Leading current in reference to voltage (+30°)
2	Lagging current in reference to voltage (-30°)

0 – For voltage regulator connected between phase and neutral

When voltage regulator is connected between phase and neutral, as in single-phase or three-phase star connection function 46 – *Phase angle setting (DEFVC)* must be configured to 0. This corresponds to the non-existent phase shift condition between voltage and current when the load is purely resistive. This situation occurs and is to be used in the grounded wye (earth to ground) and single-phase connections

1 and 2 – For voltage regulators connected between phases

When voltage regulator is connected between phases (phase to phase), as in Delta connection, we need to determine if function *46 – Phase angle setting (DEFVC) of* CTR-3 to be configured in *"1"* or *"2"*, as it cannot be configured in *"0"*.

CTR-2 itself will help determine how to configure when perfoming the following

- Voltage regulator is powered on;
- There is enough current so that it can be measured;
- This steps are followed;
  - Place the switch/es) *"INTERNAL / OFF / EXTERNAL"* na posição *"NORMAL"*;
  - Set the *"DEFVC"* function of the CTR-3 control to *"1";*
  - Read and record the power factor value indicated by CTR-3 control;
  - Set the *"DEFVC"* function of the CTR-3 control to *"2";*
  - Read and record the power factor value indicated by CTR-3 control;
  - Set the *"DEFVC"* function to the value (*"1"* or *"2"*) that corresponds to value read that seems reasonable.

Repeat the above procedure for the other bank regulators.



NOTICE: For wye (star) connected regulator banks, this function will always be set to *"0"*. For open delta regulator banks, one of the regulators will have the function set to *"1"* and the other to *"2"*. For closed delta regulator banks, the setting for this function will be *"1"* or *"2"* for all regulators that make up the bank.

47 – OPMEDF: Enable real measurement on the source side

In the CTR-2 control, the source side voltage, whether measured or calculated, and the setting must be in accordance with Table 16.

Table 16: Source side voltage

Value	Description
0	Calculated source voltage
1	Measured source voltage



NOTICE: For regulators connected to a closed DELTA three-phase system that can operate in reverse power flow, provided this reverse flow is not caused by cogeneration, the use of an additional external PT is mandatory. The installation of this PT should be on the source side of the regulator. The primary terminals of the PT must be connected between the source (F or S) and the common (FC or SL) of the referenced regulator. The secondary terminals must be connected to the control box, on a specific terminal strip, as per the diagram provided in the purchasing process. The sequence of connection for the external PTs must be followed and maintained in the same phase sequence as the regulator bank connection (closed delta, advanced or delayed).



NOTICE: The additional external measurement PT on the source side is optional and may be sold by ITB, provided it is requested in advance through a purchase order and/or technical specification.

48 – HRAUT: Timed return to automatic mode

In this parameter, it is possible to configure the CTR-2 control to react or not to the energized abandonment situation. With this function enabled, if the CTR-2 control remains energized in manual operation mode for more than 15 minutes without any access to the keyboard or communication ports, the automatic operation mode will be initiated. Table 17 shows the options for this function.

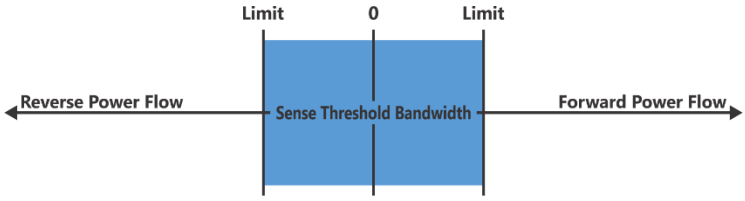
Table 17: Timed return to automatic mode options

Value	Description
0	Disabled
1	Enabled

49 – LIMBL: Reverse current sense threshold

This function defines the current limit as a percentage of the nominal current, which the control uses to ensure safe flow detection. If the effective current on the load is a percentage lower than the programmed value, the CTR-2 will not consider changes in the flow direction, and its regulation will proceed as programmed in function *43 - MAFI: Mode of operation in case of reverse flow*

Figure 23: Current detection flow direction limit band width



50 – DTAQ: Data acquisition period

The DTAQ function determines the data acquisition period for records in the mass memory and has an adjustment range of 1 to 60 minutes. The CTR-2 control is capable of obtaining and storing up to 9,362 records of the date and time, power factor, switch position, voltage, current, operation counter, operation mode, power values, and panel door status.

51 – HTINV: Enable reverse timing

Reverse timing allows reducing the programmed timing of the active map based on voltage variation.

Table 18: Reverse timing

Value	Description
0	Disables reverse timing
1	Enebles reserve timing

If this function is set to 0, the timing is linear and follows functions 05, 10, 21, and 35. However, if this function is set to 1, the CTR-2 control will define a new timing based on the following equation:

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

Where:

Tef is the effective delay time of the activation;

T is the programmed time for the active map;

Vref is the programmed voltage for the active map;

Vmed is the instantaneous measured voltage.

52 – MODOP – Switching mode

Modifies the operating mode to manual or automatic for the CTR-2 control, as shown in Table 19

Table 19: Switching mode options

Value	Description
0	Operates in automatic mode
1	Operates in manual mode

53 – ESERIAL: Serial communication address

Since the communication ports allow the simultaneous connection of more than one control to a single computer or remote system, addressing programming is necessary to avoid communication conflicts. This function can be adjusted between 0 and 65535. It is recommended to set distinct values for equipment connected to the same data bus.

54 – MCPS1: Port 1 communication mode

The CTR-2 control has 2 simultaneous communication ports, named COM-1 and COM-2. The COM-1 port can be used in 3 different interface standards, which can be selected from:

Table 20: COM-1 port interfaces

Value	Description
0	Frontal DB-9 Serial EIA232 connector
1	USB-A connector
2	Rear DB-9 Serial EIA232 connector

55 – MCPS2: Port 2 communication mode

The COM-2 port can be used in 2 different interface standards, which can be selected from:

Tabela 21: COM-2 port interfaces

Value	Description
0	RB11 connector located on the backplate of the control box, Serial EIA485
1	Rear ST connector, Optical Fiber (820 nm wavelength)

56 e 57 – BAUD1 & BAUD2: Data transmission baud rate

The CTR-2 control has 2 communication ports that can be used simultaneously and via the DNP3.0 protocol. These communication ports can have their data transfer rates adjusted independently in functions 56 for COM-1 and 57 for COM-2.

The data transmission rates can be adjusted as shown in Table 22.

Table 22: Adjustable data transfer rates

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

In addition to the values in Table 22, the communication ports of the personal computer or server must be configured as highlighted in Figure 24:

Figure 24: Configuration of the PC's COM communication port



58 – HESP: Enable "Spontaneous Messages"

The CTR-2 control allows the generation of unsolicited messages in DNP3.0. These messages are events generated each time there is a change in the state of the digital functions.

It is possible to define whether the data acquisition system (supervisory system) in which it is installed will receive these messages, according to Table 23.

Table 23: COM-2 port interfaces

Value	Description
0	Disables the sending of unsolicited messages
1	Enables the sending of unsolicited messages

59 – ENDREM: Address for "Spontaneous Messages"

Once function 58 is programmed to send unsolicited messages, the CTR-2 will generate the messages (events) in DNP3.0 and send them to a specific address in the system. This function defines the address, which can be programmed between 0 and 65535.

60, 61, 62, 63, 64 e 65 – Clock adjustment

These parameters allow the adjustment of the minute, hour, day of the month, month, day of the week, and year of the control's internal clock. The values for minute, hour, day of the month, month, and year are set directly, with the year represented by only two digits. The days of the week must be programmed between "1" and "7" for each day, as shown in Table 24

Table 24: Weekday options

Value	1	2	3	4	5	6	7
Days of the week	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday

CTR-2 CONTROL – MEASUREMENTS

Navigation through measurement screens

The "+" and "-" keys navigate through screens where detailed measured values of the system can be viewed as follows:

Figure 25: Measurement screen



- In the "XX" field, the screen number will be displayed, which should be used to access it directly via the shortcut screen;
- In the "Name:" field, the measurement identifier will appear, as shown in the "Name" column of da Table 25;
- In the "Un" field, the unit of measurement will appear in brackets, if applicable;
- In the "Value:" field, the instantaneous value for that measurement will be displayed;

- The field mm/dd/yyyy hh:mm will show the occurrence time, if applicable, as per the "Date-time" column of Table 25;
- The word "Resettable" will appear in the bottom line of the screen, if applicable, as per the "Reset" column of Table 25.
- The values will be displayed in the sequence of Table 25 for consecutive pressing of the "+" key, and the "-" key will allow returning to the previously read value.

Table 25: Sequence of measured values

Shortcut	Measured Value Name	Measured Value Description	Date and Time	Unit	Reset	Remote
66	TBLC	Voltage referred to low voltage, *"Load"* side	-	V	-	Show
67	TBLF	Voltage referred to low voltage, *"Source"* side	-	V	-	Show
68	FREQ	Frequency	-	Hz	-	Show
69	FPOT	Power factor	-	-	-	Show
70	DMAXTC	Maximum demand voltage at *"Load"* side	Yes	V	Yes	Show and reset
71	DMINTC	Minimum demand voltage at *"Load"* side	Yes	V	Yes	Show and reset
72	TLC	Voltage on the line at *"Load"* side	-	kV	-	Show
73	CLC	Current referred to low voltage, *"Load"* side	-	A	-	Show
74	DMAXCC	Maximum current demand at *"Load"* side	Yes	mA	Yes	Show and reset
75	DMINCC	Minimum current demand at *"Load"* side	Yes	mA	Yes	Show and reset
76	PNOM	Nominal power at *"Load"*	-	kVA	-	Show
77	PATV	Active power at *"Load"*	-	kW	-	Show
78	PRTV	Reactive power at *"Load"*	-	kVAr	-	Show
79	COC	Partial operation counter	-	-	Yes	Show and reset
80	QTREG	Number of stored records	-	-	Yes	No
81	CBLC	Current at low side *"Load"*	-	mA	-	Show
82	CBLF	Current at low side *"Source"*	-	mA	-	Show
83	DHTV	Voltage harmonic distortion rate	-	%	-	Show
84	DHTI	Current harmonic distortion rate	-	%	-	Show



NOTICE: The calculation for obtaining the demands is performed with integration intervals every 15 minutes.



NOTICE: When the value of "*QTREG*" is reset, the stored data is discarded.

DNP3.0

The control for voltage regulators model CTR-2 communicates via the DNP3.0 Protocol Level 2, according to the general object table (device profile), with the specification of the points defined in the specific items for each object.

Life Cycle

ITB Equipamentos Elétricos Ltda. Undertakes to receive and give adequate treatment in accordance with current legislation on manufactured equipment when these are considered unusable.

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