ELECTRONIC CONTROL FOR DYNAMIC REACTIVE POWER COMPENSATOR BANKS MODEL CTR-3X



INSTRUCTION MANUAL

MIC-005 | PT-BR

REV202508

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SAFETY AND THE IMPORTANCE OF LIFE

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

Our main references to ensure these levels of safety are the official standards that represent accumulated experiences in various different conditions and for enough time to be adopted as good practices of operational, contingent and effectiveness safety.

We consider it our obligation to actively promote conscious and safe practices, both in the choice of the most suitable equipment for each application, as well as in its correct handling and proper maintenance, as well as we understand that disseminating the knowledge involved, through technical service literature and training programs, constitute the most efficient means of continuous improvement of both our products and services and the set of these good practices.

We recommend observing all safety procedures stipulated by local regulations, approved, instituted and required, as well as the use of all safety equipment, individual or global, recommended for activities around equipment and high voltage lines.

SAFETY INFORMATION

The instructions contained in this manual are not intended to replace the proper training and accumulation of experience required in the installation, maneuvering, and safe operation of the single-phase reactive compensator. Only competent technicians who are familiar with network equipment should install, operate, and maintain it.

A technician competent for such functions must have the following qualifications:

- Be familiar with these instructions;
- Be trained in safe operation, procedures and practice accepted by the high and low voltage industry;
- Be trained and authorized to energize, de-energize, and handle grounded power distribution equipment.
- Be trained on the proper care and use of personal protective equipment, such as: FR clothing, goggles, visors, helmets, rubber gloves, maneuvering rods, etc.;
- Be trained for the installation and use of stairs on poles, necessary signage on public roads and allusive legislation.

For installation and operation of this equipment, be sure to read and understand all warnings and warnings.

This manual contains three types of warning phrases:



DANGER: Indicates an imminently hazardous situation which, if not avoided, will result in death or injury of any kind to the operator or persons near the network or equipment.



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



WARNING: Indicates a potentially unwanted situation which, if not avoided, could 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 or proximity to high voltage will cause death or very serious injury. Follow all approved safety procedures when working around high-voltage lines and equipment.



WARNING: 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 dynamic reactive power compensator banks, model CTR-3X, is a measurement and actuation device, equipped with a microcontroller, **capable of monitoring and controlling up to 3 single-phase reactive compensators.** It allows the operation of the bank with single-phase or three-phase compensation with references taken by the master and applied in star or delta connections.

The CTR-3X controls are capable of real-time monitoring of the position of the ITB CAQ-1 compensator switches, which have the absolute encoder attached to their switches, and therefore offer full functionality and operational safety.



DANGER: The switch position tracking mode is not recommended when the reactive compensator is not equipped with a mechanical position indicator or 5-bit absolute encoder.

All ITB controls are tested and adjusted to standardized parameters, offered as an operation suggestion, and in order to achieve adequate operation for specific needs, it will be necessary to configure it.



WARNING: 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-3X control is a cabin containing a control device for CAQ-1 reactive compensators and that offers full functionality and efficiency, safety and guarantee of the useful life of the active parts commanded for ITB reactive compensators because they have means of real-time monitoring of the commutator position.

The ITB control model CTR-3X has independent true rms voltage and current measurement devices for 3 voltages and 3 currents, with a maximum error limited to 1.0% for a voltage of 120Vac and a current of 200mA, so that the measurements of voltages and currents of each of the connected compensators are made in real time.

The power of each motor of the switches is done by the compensator itself, which, together with the monitoring algorithm, form an architecture that enables the CTR-3X to promote and monitor simultaneous switching without data loss and without overloading the TPs of any of the compensators.

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

Based on current and voltage values, the CTR-3X is able to perform the calculations for the power factor and thus perform the appropriate compensation.

The reactive compensator, called CQ-1, is solely responsible for powering the CTR-3X control system.

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

The neutral position signaling is electrical and independent of the switchgear position monitoring system, shown by the illumination of a green *LED* for each compensator on the secondary panel of the control box.



DANGER: To ensure that the equipment is manoeuvred, whether it is start-up or withdrawal, the redundancy required to ensure the neutral position on the compensators to be switched is obtained 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.

CTR-3X CONTROL BOX – OVERVIEW

The CTR-3X electronic control is housed in a metal cubicle made of carbon steel and coated with a liquid or powder coating system, in light gray, MUNSELL notation N. 6.5.

Currently, two distinct control box models for the CTR-3X are available for supply.

A model, called STANDARD, as illustrated in Figure 1, and another model, called *UPS*[1], as illustrated by Figure 2.

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 next two figures.

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

[1] *For more information about UPS, see the topic* ***UPS Neutralization System****.*

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).

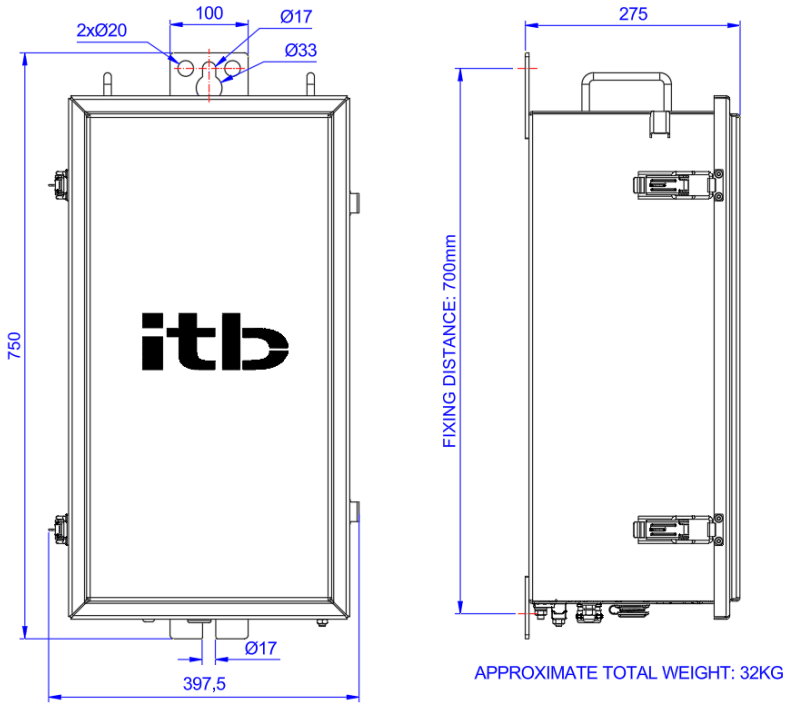
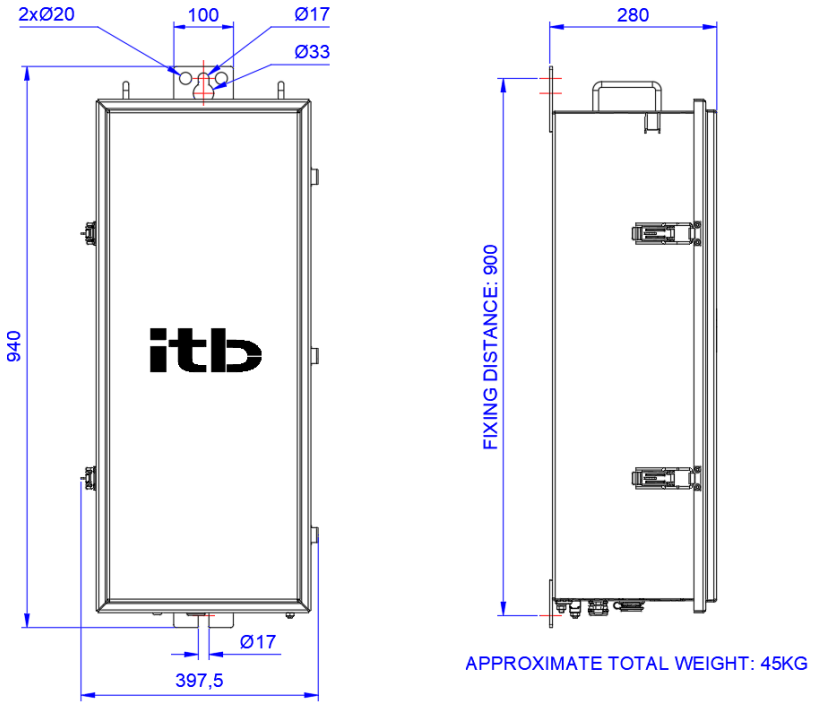


Figure 2: External dimensional of the NOBREAK control box (measured in mm).



Both CTR-3X control box models have the following features:

- IP54 degree of protection prepared to work over time;
- IK9 degree of protection 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" *power switches*, which selects the power mode of the control and avoids energization of the bushing terminals during an external power, one for each compensator;
- Terminal blocks for external power input (90 to 145Vac);
- Terminal blocks for voltmeter connection, one for each compensator;
- Motor surge protection system (varistors), one for each compensator;
- Switches, knife type, for short circuit TC, ensuring safe removal from the CTR-3X cabinet, one for each compensator;
- Motor current sensors, one for each compensator;
- Keys for manual motor activation, one for each compensator;
- Reset closing selectors of the external position indicator, which can be for phase or neutral, one for each compensator;
- Neutral light closing selectors, which can be for phase or neutral, one for each compensator;
- Control power switch selector (compensator or *UPS);*
- Drawer for accommodating a remote terminal unit (RTU);
- Terminal strip for input and output of programmable auxiliary contacts;
- Grounding terminal for copper or aluminum cables and section up to 70mm^2, produced in forged brass;
- Cable glands for additional cable runs (antenna, logic contacts, etc.).

Secondary Panel Components

With a simple and intuitive design, the secondary panels fixed to the front of the control box, have all the fundamental components for powering, operating and signaling the voltage compensators connected to the control.

Each panel has the inscriptions *CQ-1*, *CQ-2* and *CQ-3* visible, arranged on the right side of the panels, to identify the compensator to be controlled.

The location and description of each of these components can be seen in the Figure 3 and Table 1.

Figure 3: Components of the secondary panels.

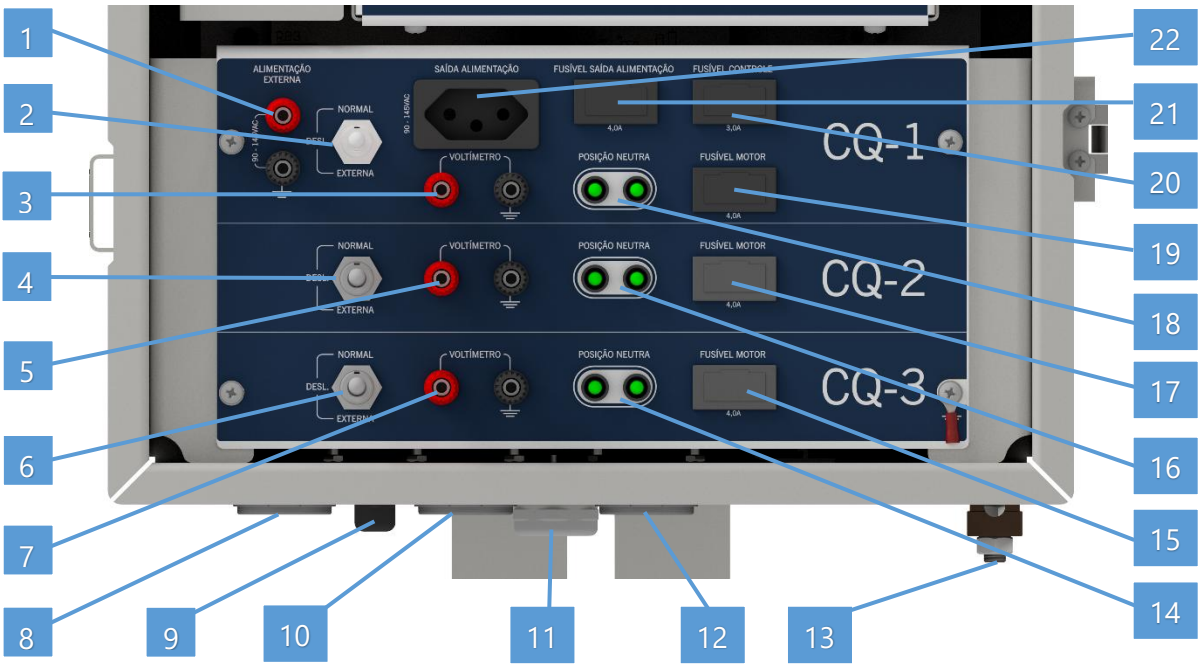


Table 1: Components of the secondary panels.

Item	Description
1	Terminal blocks for external power supply (90 to 145Vac)
2	Power selector switch "*NORMAL / OFF / EXTERNAL*" for CQ-1
3	Terminal blocks for connecting voltmeter for load side measurement of CQ-1
4	Power selector switch "*NORMAL / OFF / EXTERNAL*" for CQ-2
5	Terminal blocks for connecting voltmeter for load side measurement of the CQ-2
6	"NORMAL/OFF/EXTERNAL" Power *Selector Switch* for CQ-3
7	Terminal blocks for connecting voltmeter for load side measurement of the CQ-3
8	18-way male circular socket for CQ-1 connection
9	PG7 Cable Gland
10	18-way male circular socket for connection of the CQ-2
11	PG21 Cable Gland
12	18-way male circular socket for CQ-3 connection
13	Grounding terminal for copper or aluminum cables and cross-section up to 70mm^2
14	*CQ-3 neutral position signal* LEDs
15	Motor protection fuse (standard 4A for ITB compensators) of the CQ-3
16	*CQ-2 neutral position signal* LEDs
17	Motor protection fuse (standard 4A for ITB compensators) of the CQ-2
18	*CQ-1 neutral position signal* LEDs
19	Motor protection fuse (standard 4A for ITB compensators) of the CQ-1
20	CTR-3X Control Protection Fuse (3A)
21	Accessory Power Socket Protection Fuse (4A)
22	Socket for powering equipment in the field (90 to 145Vac), standard NBR 14136, 2 poles and 1 ground

Connecting the control to the compensator

The connection between the CTR-3X control box and the junction box of the single-phase compensator is made through a multicable with 18 independent conductors and female sockets at the ends. The Figure 4 illustrates the standard plug and the Table 2 details the position of each terminal.

Figure 4A: Connecting multiple plug from CTR-3X to compensator pass box.



Table 2A: Multiple plug terminals.

Pin	Description
1	Neutral (grounded)
2	Operations counter
3	Neutral Light
4	Current Measurement Phase
5	Voltage measurement phase
6	Motor drive to lift
7	Lowering the motor
8	Reset the position indicator
9	Motor Retention
10	- No connection -
11	- No connection -
12*	Bit 0 for reading the *encoder*
13*	Bit 1 for reading the *encoder*
14*	2 bit for reading the *encoder*
15*	3 bit for reading the *encoder*
16*	4 bit for reading the *encoder*
17*	Voltage Measurement Phase for Auxiliary PT
18*	Phase current measurement for auxiliary CT

The interconnection cables from the CTR-3X control box to the compensators can be specified between 3 to 10 meters in length. Your connection is driven by descriptions *CQ-1*, *CQ-2* and *CQ-3* engraved on the caseback, as illustrated by Figure 5.

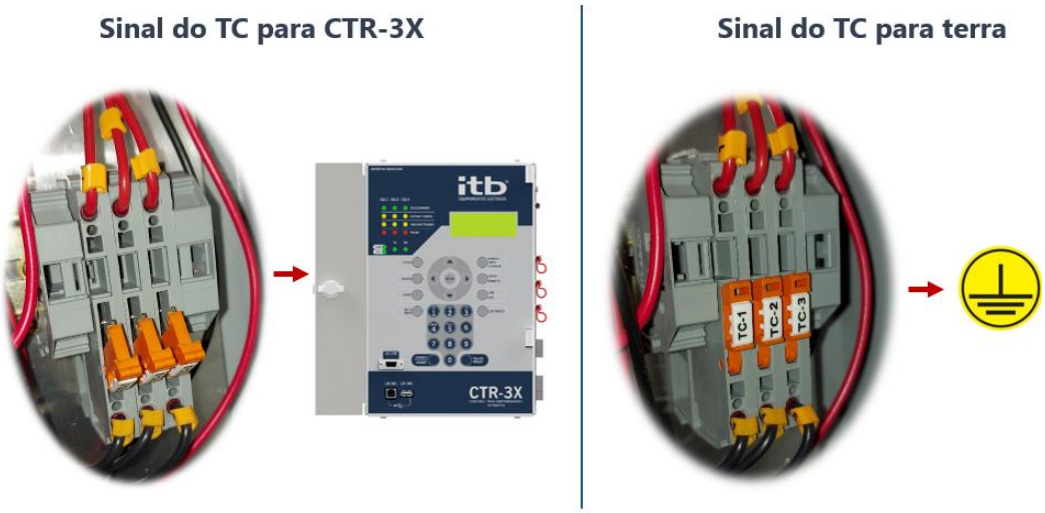
Figure 5: Connection detail between the CTR-3X control and the compensator.



CT short-circuiting

Before removing the CTR-3X control cabinet, it is necessary to short-circuit the current signals coming from the CT of each compensator 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 6 illustrates this procedure.

Figure 6: Procedure of short-circuiting the CTs.



CAUTION: Do not remove the connectors from the CTR-3X control without first short-circuiting the CTs. The circuits of the CTs MUST be short-circuited when removing the CTR-3X control. Failure to follow these instructions will result in damage to the equipment.

Neutral position *LED* lock setting

The CTR-3X control system can operate in two modes of operation in relation to the neutral position LED circuit feed , for this reason it is necessary to select the LED circuit closure method, which can be phase or neutral.

Located on the bottom of the control box, on the printed circuit board labeled *PCI CTR-3X-P3-BACKGROUND* and in the positions *RB5*, *RB6* and *RB7*, respectively to *the CQ-1*, *CQ-2* and *CQ-3*, are the six-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: 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: Because the CAQ-1 ITB compensator is standardized with a neutral signal for zero position, the phase signal closure should not be used. If you use the phase lock, the equipment will be damaged.

Indicator reset lock setting

The CTR-3X 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-3X-P3-BACKGROUND* and in the positions *RB8*, *RB9* and RB10, respectively for *the CQ-1*, *CQ-2* and *CQ-3*, are the three-terminal terminals for manual closing as informed by the Table 4.

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

Table 4: 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 compensators with a digital indicator.

Auxiliary Contacts (I/O)

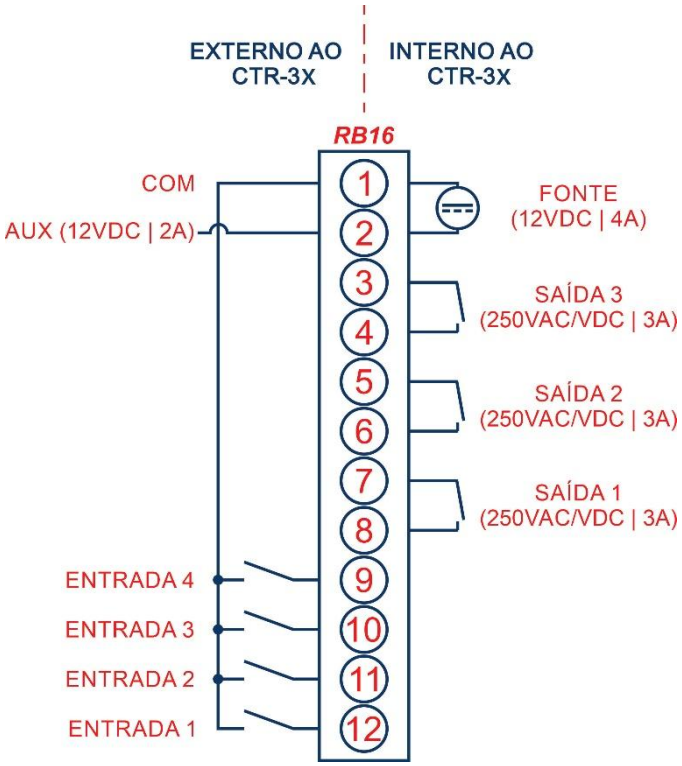
The CTR-3X control system has programmable input logic ports that allow the connection of devices such as thermometers, oil level indicators, pressure relief valves, and other devices that have contacts. It also has programmable outputs through dry contact relays, free of potential for triggering indication devices such as alarms, lamps, relays, fans, fire fighting systems, among others.

On the printed circuit board named *PCI CTR-3X-P3-FUNDO* and in the *RB16* position, four digital inputs (COM-driven) and three outputs with dry contacts (up to 250Vac or Vdc/3A) are available.

Use the *CTR-3XComm* communication **software** (available for download and installation in *http://www.itb.ind.br*) for configuration of the logic gates. Refer to ***the CTR-3XComm Communication Software Manual***, available in the program's help tab, for additional information on setting up the control logics.

The I/O port connection diagram is available on the main port of the CTR-3X control. A representation of this diagram can be seen through the Figure 7.

Figure 7: Diagram of auxiliary contacts.



CAUTION: It is recommended that you read the additional connection and configuration information for logic ports available in *the CTR-3XComm Communication Software Manual in its entirety*.

Neutralization system via *UPS*

Compensator banks can be connected in series to the extension of a feeder. When there is a power outage from the main system and, consequently, the shutdown of all loads, the compensators have their operating positions parked where they were before the fault. Under these conditions, with the return of the main feed and due to the loading inertia itself, power factor values above the programmed may occur along the feeder due to the "lifting" positions in which the compensators were located. This disordered power factor can be harmful to all consumers connected to the system.

In order to avoid this problem, the CTR-3X control can be equipped, at the request of the customer in its specification and/or purchase order, with a *UPS* system that has the ability to neutralize a bank of reactive energy compensators in the event of a power failure.

When detecting the lack of power and the detection and actuation functions enabled according to the steps below, the CTR-3X control will start the neutralization process, which will be sequential, being, respectively: *CQ-1*, *CQ-2* and *CQ-3*.

Figure 8: CTR-3X Control with UPS



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

- Connect the positive (+) terminals of the batteries, cables labeled with washer No. 1, as per Figure 9;
- Position the wrench "*UPS UPS*" towards "*ON*"according to Figure 10. Key located on the printed circuit board labeled *PCI CTR-3X-P3-BACKGROUND*, internally attached to the control box;
- Set the function *39 - Time for neutralization via UPS (TNOBREAK)*[2] to a value above zero.



WARNING: It is recommended for long periods of inactivity of the control, where there will be no supply voltage, the removal of the cables connected to the positive (+) terminals of the batteries. This will protect the battery from deep discharges and maintain its ability to recharge when used in the future.

[2] *For more information about this function, see topic* ***P39 – TNOBREAK.***

Figure 9: Positive (+) terminals of batteries

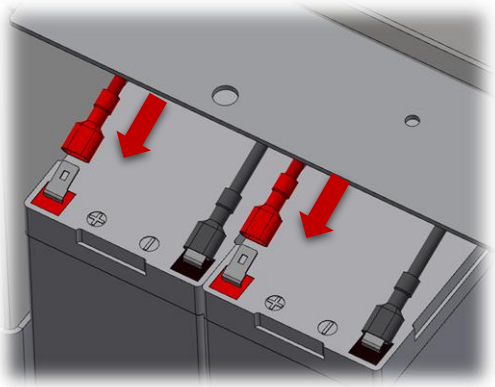
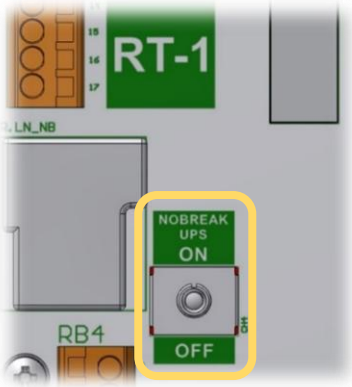


Figure 10: UPS Switch

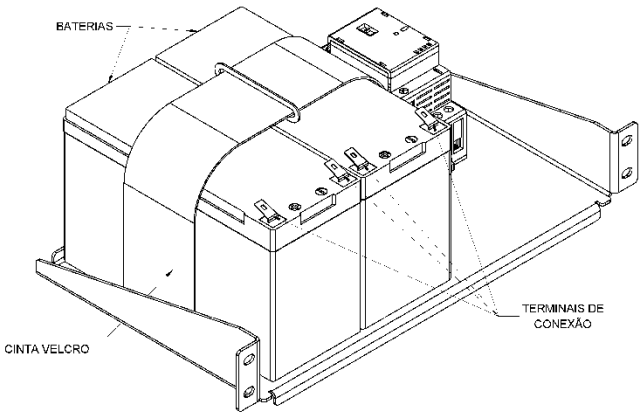


The *UPS* system consists of a set of 2 lead-acid batteries (VRLA-AGM), 12V and 7Ah connected in parallel (or as guaranteed in a technical proposal). The average battery life is approximately 2 years.

To change the battery, the following procedures are recommended:

- Position the wrench "*UPS UPS*" towards "*OFF*"according to Figure 10;
- Disconnect the connection terminals from the batteries;
- Partially unbuckle the Velcro strap;
- Remove the old batteries (if necessary, remove the shelf from the box);
- Position the new batteries;
- Buckle the Velcro strap;
- Connect the connection terminals of the batteries;
- Position the wrench "*NOBREAK USP*" towards "*ON*"according to Figure 10.

Figure 11: Battery shelf



CAUTION: It is not recommended to dispose of batteries in common garbage, due to the risk of causing damage to the environment and human health. After use, these items must be disposed of properly, in accordance with current environmental standards.

Reciprocating drive

The reciprocating switches of the motors are located at the bottom of the control box, on the printed circuit board named *PCI CTR-3X-P3-FUNDO* and at positions *CH1, CH2 and CH3* respectively, for *the CQ-1*, *CQ-2* and *CQ-3*.

These switches allow the operation of raising or lowering the position of the switch without the presence of the control.

They are momentary 3-position switches, usually turned off, that activate the motor in the direction indicated according to the *CTR-3X-P3-FUNDO PCB serigraphy*.



DANGER: Do not operate this function when the reactive compensator is without an external mechanical position indicator.



DANGER: The reciprocating activation of the motors must be carried out with care, as inside the control box there are several energized points.

Operating with external power supply

The CTR-3X control can be energized for testing and configuration by means of an external source of voltage between 90 and 145Vac, connected to the terminals of the front panel of the control box identified as "*EXTERNAL POWER*" respecting the phase and neutral indication and positioning the "*NORMAL / OFF / EXTERNAL*" switches to *the* "*EXTERNAL*" position.



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 compensator bushings and pose a serious risk of accident to the operator and damage to the compensator.



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

CTR-3X CONTROL – OVERVIEW

The CTR-3X electronic control is a microcontrolled equipment capable of performing functions inherent to reactive power compensation, actuation time delay and data acquisition for the control of the power factor in electrical systems and making them available through its built-in communication system.

The CTR-3X electronic control has the following features:

- Continuous, real-time and independent measurements of line electrical quantities for 3 phases;
- Digital counter of operations of the independent, zeroable switchgear for the 3 phases;
- *LEDs* indicators selected for each seat compensator;
- *LEDs* indicating the need for power factor adjustment for each seat compensator;
- *Fault LEDs* for each seat compensator;
- Data acquisition:
    - Obtains, stores and displays the number of records, in adjustable periods between 1 and 60 min, the instantaneous values of voltage, current, power factor, current position of the switch, date and time of each record 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 direct, reverse power flow without the need for special TP for this purpose;
- "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-3XComm** (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 serial, USB, or optical port of the computer and the EIA232 port, on DB-9 plug, from the front of the control via a serial cable or USB Type-A or ST optics available on the CTR-3. 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"** to "*TCP/IP*" *in* the *CTR-3XComm* communication program by configuring *the* "*IP*" address and "*Port*" corresponding to the modem connected to the control to be accessed.
- Pin 9 of each of the DB-9s are active with +5Vdc (optionally this function can be disabled from the factory);
- DNP3.0 Communication Protocol on all ports;
- Independent adjustments for direct, reverse power flows;
- Real-time clock and calendar;
- Protection of switches in the event of overload;
- Power factor limiter function for network protection.
- Accuracy in measured nominal values of up to 1.0%.



WARNING: The log stack can be accessed with the aid of a computer connected to the controller on which the CTR-3XComm communication program is installed or via a pen drive.

Control Panel Components

The CTR-3X control allows for instant viewing, setting adjustment, and reading of system measurements without the need for any other accessories.

When it is initialized, the CTR-3X 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 *display* monochromatic alphanumeric liquid crystal and a keyboard as shown in the Figure 12 and detailed in the Table 5.



WARNING: The CTR-3X control display has a screen saver function to save energy and prolong 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-3X's front interface.

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

Figure 12: CTR-3X control front panel.

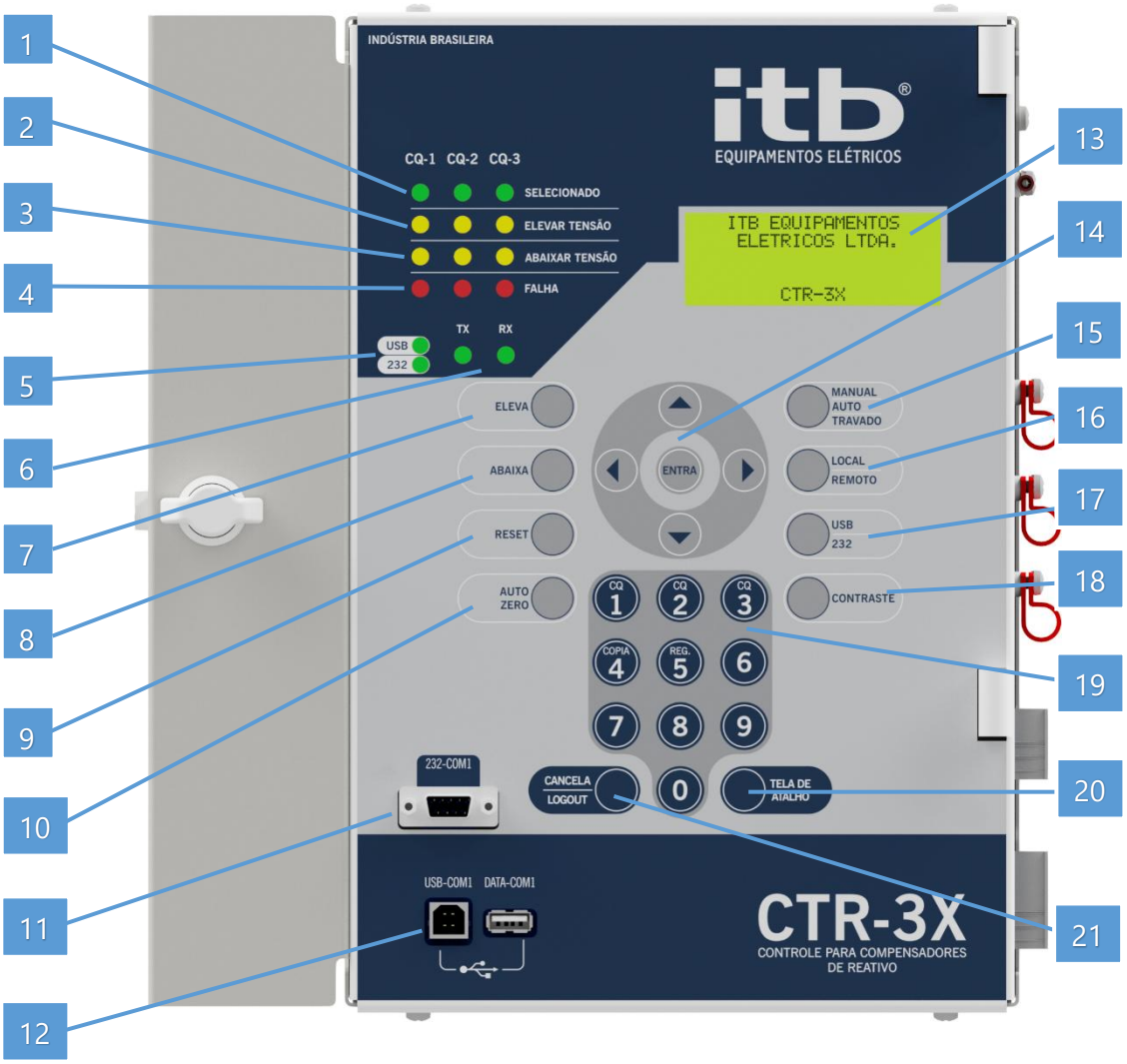


Table 5: Front Panel Components

Item	Description
1	*LEDs* that signal which trim is selected
2	"Raise Voltage" *Signal LEDs*
3	"Lower voltage" *signal LEDs*
4	"Fault" *signal LEDs*
5	"USB/232" *Signal LEDs*
6	"Tx/Rx" *signal LEDs*
7	"*Elevate*" key operates the switch in the direction of elevate when the "*Manual*" mode is active
8	"Lower" *key* operates the switch to lower when "*Manual*" *mode* is active
9	"Reset" *key* updates or resets the values that allow this operation
10	"Auto Zero" *key* brings the compensator(s) to the zero position
11	DB-9 EIA232 COM-1 Socket
12	USB A DATA-COM-1 and USB B to USB-COM-1 socket
13	Monochrome Liquid Crystal Display 4 lines of 20 characters
14	"Navigation" *and* "Enter" *keys*
15	"Mode" *key* selects the operating mode of each compensator in automatic, manual or locked
16	"Local/Remote" *key* blocks or allows remote commands
17	"USB/232" *key* for communication interface selection
18	Display "Contrast" key
19	"Numeric" *keys* for quick parameter adjustment
20	"Shortcut Screen" *key*
21	"Cancel/Logout" *button*

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

Figure 13A: CTR-3X control rear panel.

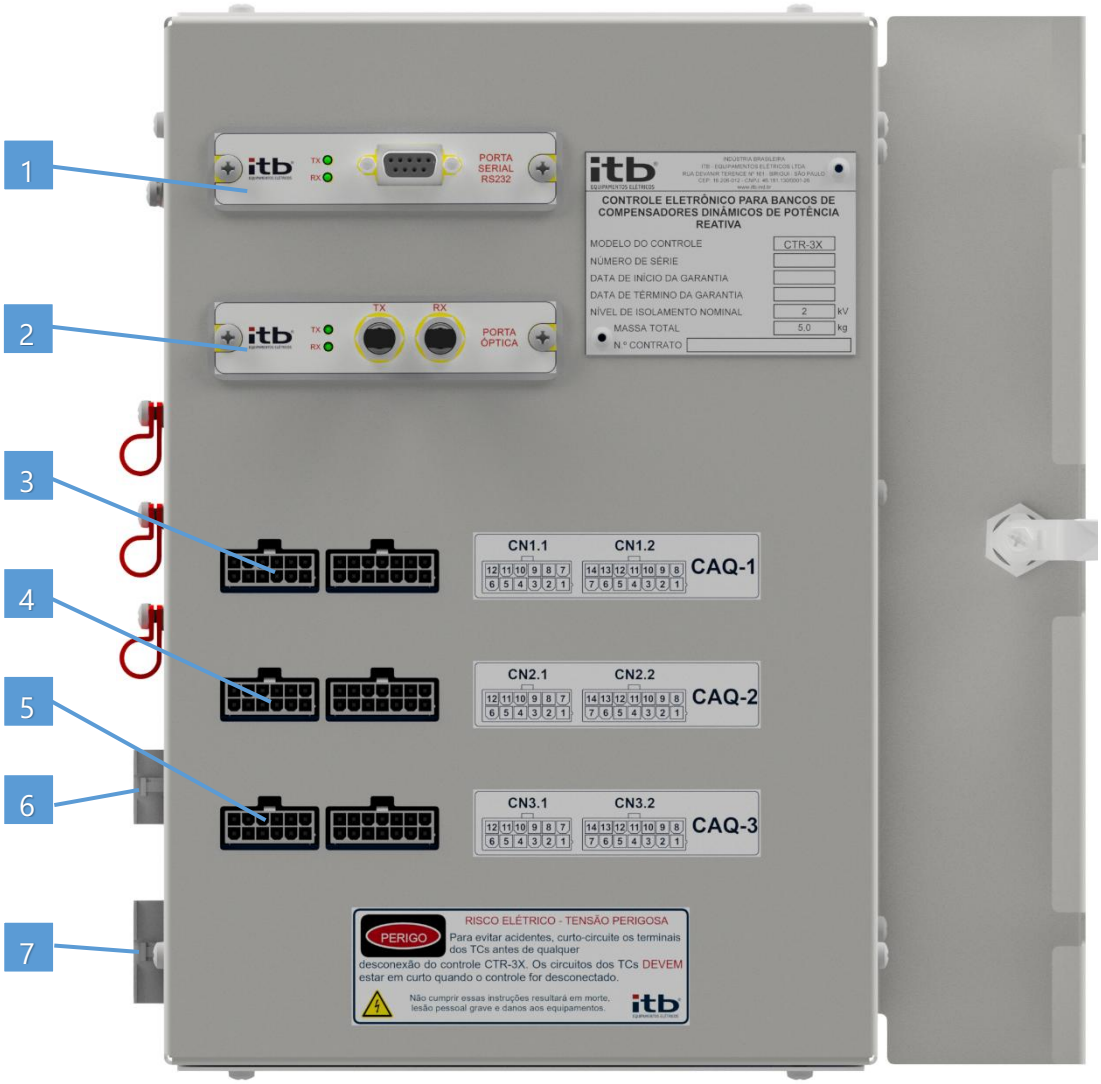


Table 6: Back panel components.

Item	Description
1	ST fiber optic socket COM-2 (by default, can be changed via specification)
2	DB-9 EIA232 COM-3 socket (by default, can be changed via specification)
3	CQ-1 *(CN1)* Signal Inputs and Outputs
4	CQ-2 *(CN2)* Signal Inputs and Outputs
5	CQ-3 *(CN3)* Signal Inputs and Outputs
6	I/O Signal Input (CNA)
7	Feed Input (CNF)

Navigation of screen groups

The CTR-3X control screens have been arranged to deliver fast and accurate navigation. The screens were divided into 8 groups, namely: main screens, *login*, measurement screens (numbered 01 to 19), function screens (numbered 20 to 53), motor drive screen, date and time screen, file management screen via *pen drive* and shortcut 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 7 or Table 8 respectively, from the ▼ or ▲ keys.

Navigation between the active clearers of the bank can be performed using the number keys 1, 2 and 3 for the *CQ-1*, *CQ-2* and *CQ-3* respectively. From the main screens, measurement screens and function screens, you can switch the active compensators of the bank.

Figure 14: Navigation keys.



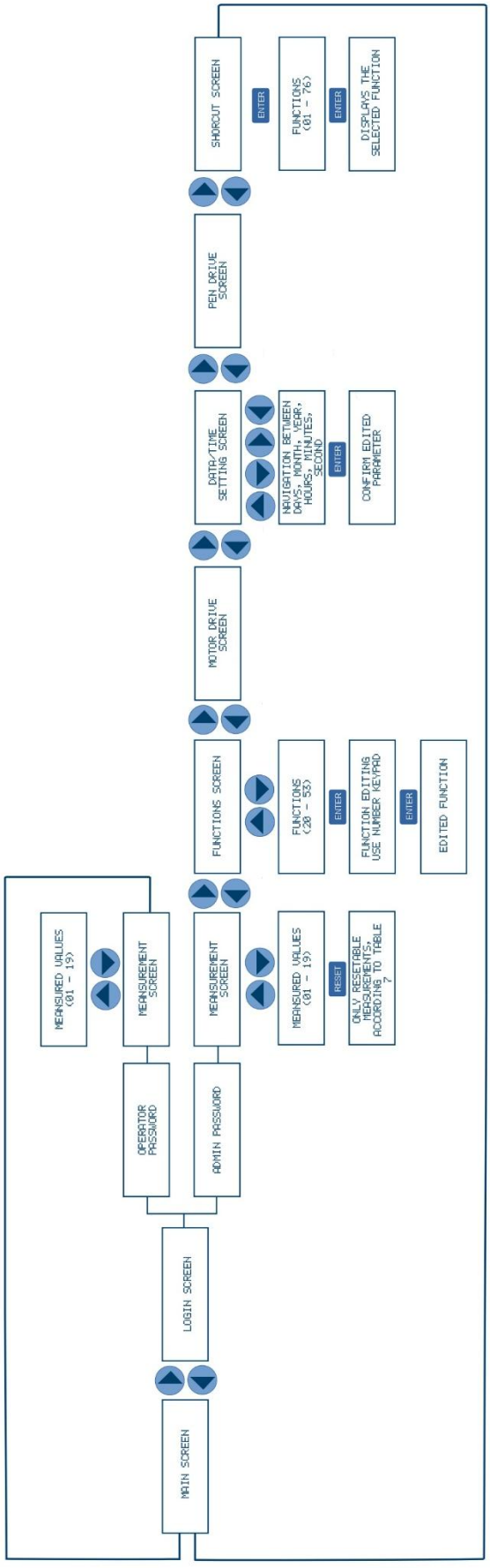
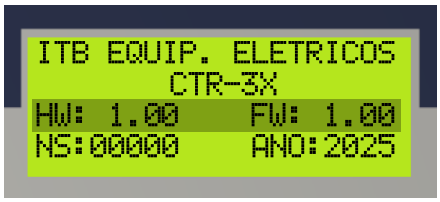


Figure 15: Navigation between screens.

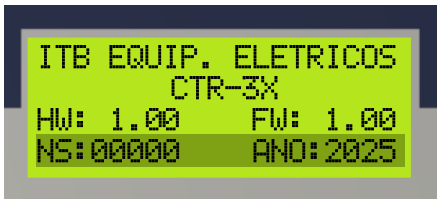
Welcome screen

When initialized, the CTR-3X control will perform a test operation as explained in the "Control Panel Components" item. During this test, a welcome screen will be presented with information about the controller. The
Figure *16* details each line and function displayed on the screen.

Figure 16: Welcome screen



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

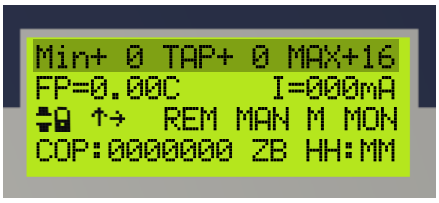


Line 4 – Serial number and year of manufacture
- ✓ NS: Serial Number;
- ✓ YEAR: Year of manufacture.

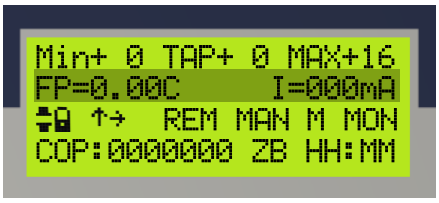
Main Screen

The CTR-3X control features an easy-to-read main screen that displays the most important information inherent in reagent compensation at the same time. The Figure 17 Detail each line and function displayed on the main screen by compensator

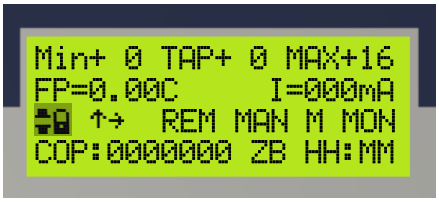
Figure 17: Main screen information.



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*).

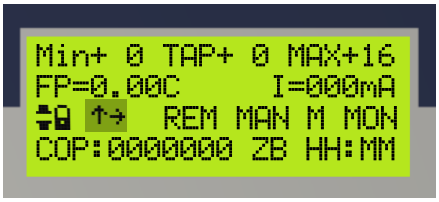


Line 2 – Measurements
- ✓ FP: In-line power factor (inductive or capacitive)
- ✓ I: Current in line.



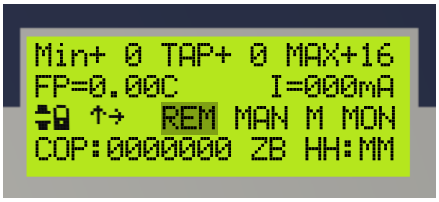
Line 3 – Visual indicators

- ✓ : Indication of connection with the reading board;
- ✓ : Indication of *login* and *logout*.



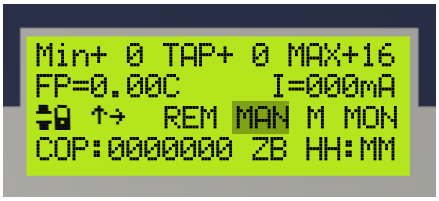
Line 3 – Power Flow

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



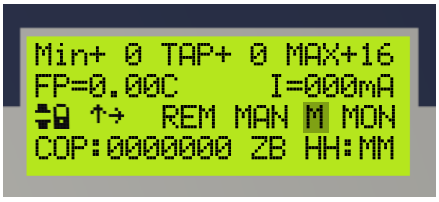
Line 3 – Remote access

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



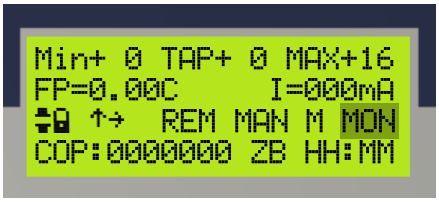
Line 3 – Mode of operation

- ✓ AUT: Automatic operation;
- ✓ MAN: Manual operation;
- ✓ INT: Inactive compensator;
- ✓ TRV: Operation stuck (engine inoperative).



Line 3 – Compensation mode

- ✓ M: Operating in single-phase mode;
- ✓ T: Operating in three-phase mode;



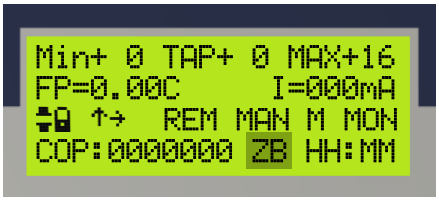
Line 3 – Compensation mode

- ✓ MON: Operating in single-phase capacitor or reactor mode;
- ✓ TMT: Operating in three-phase mode by master capacitor or reactor;



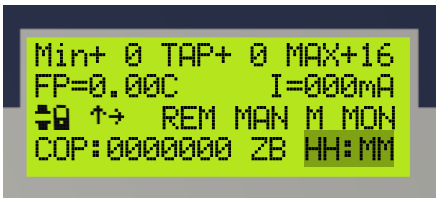
Line 4 – Operations counter

- ✓ 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 Compensator is inactive;
- ✓ S: Performing synchronism;
- ✓ ZB: Zeroing the bank.



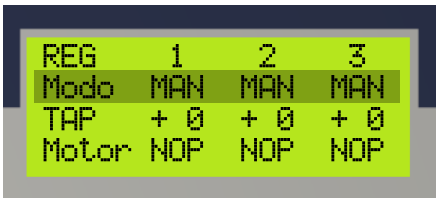
Line 4 – Clock/Timer

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

Motor drive screen

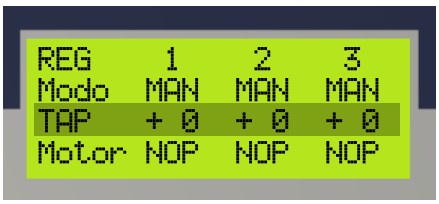
To make it easier to see the operating mode, commutator position, and operating *status* of the motors of each active compensator in the bank, the CTR-3X control has a screen that gathers all this information and displays it in real time at the same time.

Figure 18: Engine screen information.



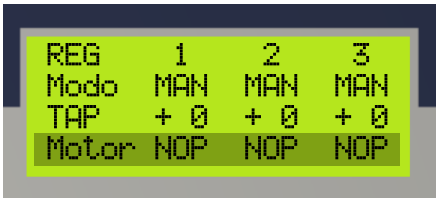
Line 2 – Mode

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



Line 3 – Indication of taps

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



Line 4 – *Commutator Motor* Status

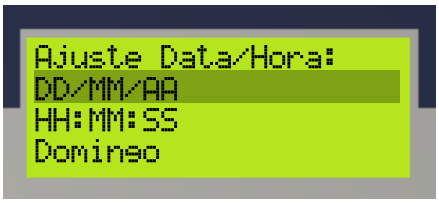
- ✓ NOP: Motor not operating;
- ✓ TAP+: Motor operating in the direction of lifting;
- ✓ TAP-: Motor operating in the lowering direction;
- ✓ BT: Motor locked for both directions;
- ✓ BA: Motor locked to the lowering direction;
- ✓ BE: Motor locked to the direction of lifting.

Date/Time Adjustment Screen

The CTR-3X control has a unique screen for viewing and adjusting date and time.

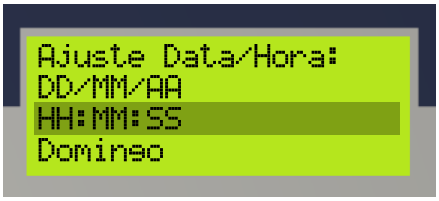
Use the navigation arrows, number keys, and the Enter key to change the values.

Figure 19: 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

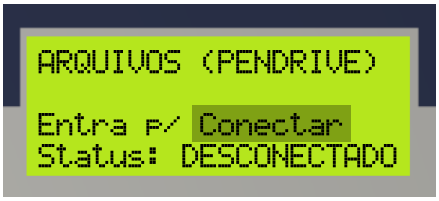
- ✓ Set up the day of the week between Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, or Saturday.

Pen Drive Screen

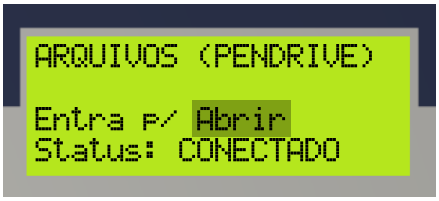
In order to facilitate human-machine interfacing, the CTR-3X control has an active USB port for connecting a *pen drive*. Through this feature, it is possible to import or export parameter settings and export records from mass storage.

Before connecting a *pen drive* Access the files screen *pen drive* and follow the steps detailed by the Figure 20.

Figure 20: Screen information of pen drive



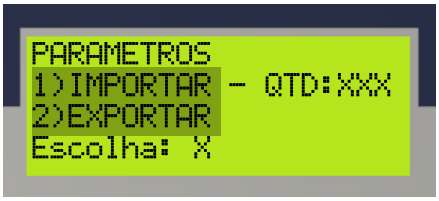
Connect a *USB flash drive*
- ✓ Wait for the *Connect status* to change to Open.



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-3X control writes and reads only files that are in the ITB_CTR3X directory **.** If this directory does not exist at the time of export, the control will create this directory at the root of the *flash drive*.

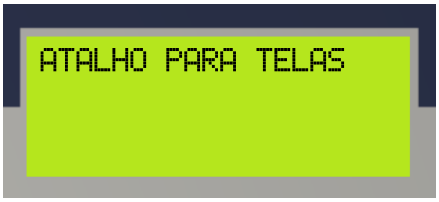


WARNING: The CTR-3X control only accepts pen drives formatted with FAT32 file partitions up to 8Gb in capacity.

Shortcut screen

From the default screen, you can press the **"*SHORTCUT SCREEN*"**, 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 7 or Table 8.

Figure 21: Shortcut screen.



The shortcut selection screen will be shown as per
Figure *21* and, when the button is pressed **ENTERS** it will change as in the Figure 22 that allows the modification of the field "*Choose the screen*" by the following procedure:

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

Press the number 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;

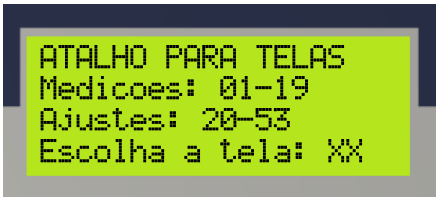


WARNING: If the adjusted value is outside the ranges indicated in the Figure 22 The message "*Invalid number*" will be shown on the bottom row of the screen and the shortcut screen will look like Figure 21, requiring the repetition of the steps.

If the ◄ key is pressed while the cursor is under the most significant digit, no action is taken by the CTR-3X controller;

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

Figure 22: Shortcut screen – Insert.



Direct command keys

The CTR-3X control has 10 direct command keys with specific functions that are described below:

- ELEVA **key**: Activates the commutator motor in the direction of lifting;
- LOWER **button**: Activates the commutator motor in the lowering direction;
- 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*;
- AUTO ZERO **key**: Controls the switches to the "*NEUTRAL*" position from any screen or operating mode (see the Auto **Zero topic**, available in this manual;
- MANUAL/AUTO/LOCKED **key**: Selects manual, auto, or locked operation modes for switching to each trim;
- LOCAL/REMOTE **key**: Enables priority communication modes for adjusting function parameters locally or remotely;
- USB/232 **key**: Switches communication interfaces between USB or RS232;
- CONTRAST **key**: Enters display contrast calibration mode, which can be changed using the ◄ or ► keys;
- Number keys **1, 2 and 3**: Changes the view between the active compensators in the bank on the main screens, measurement screens and function screens;
- Number key **4**: From any function screen, this key allows you to copy all parameters from a reference compensator and paste them to a destination compensator;



WARNING: The copy and paste function changes all parameters of the target compensator based on the settings of the reference compensator, with the exception of *function 22 – HCOMP*.

- Number key **5**: From the main screen of any active compensator in 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;
- CANCEL/LOGOUT **key**: Returns to the main screen or cancels a certain value that is being edited or ends the section by blocking access, indicated by a symbol of a padlock. The control can be accessed again by entering the user or administrator password;
- Key **SHORTCUT SCREEN**: Displays the functions quick access screen in the *display*, according to the Table 7 and Table 8.

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 nominal one, the control checks if there is a need to command the switch to 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;
5. When the zero position is reached, the control verifies that the redundancy of this information is coherent by comparing the encoder reading with the microswitch closing of the nominal position, which have electrically and mechanically independent systems;
6. Lights up the "*Neutral Position*" *LED* on the secondary panels;
7. Displays on the display, following the compensator information, the message "*NEUTRALIZED*" for the compensator that has already reached the neutral position, "*INACTIVE*" when the compensator is inactivated and "*FAILS*" for the compensator that has an inconsistency between the "Neutral Position" *LED* and the encoder reading and/or the position tracked by the position tracking algorithm, in this case, the "Failure" *LED* on the front panel of the control will light up;
8. 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 individually verifying the neutralization of all active bank clearers.



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



WARNING: The "*AUTO ZERO*" function brings the switches of all active clearings in the bank to the neutral position simultaneously.



DANGER: After neutralization, it must be checked that the mechanical position indicator is in position 0 (zero), otherwise, do not perform the maneuver without de-energizing the system.



DANGER: Before performing manoeuvres to insert or remove the voltage compensators from the mains, consult the operating instructions of the reactive power compensators or competent technical specifications.

CTR-3X CONTROL – MEASUREMENTS AND FUNCTION ADJUSTMENTS VIA HMI

The CTR-3X control has a measurement screen group with the main electrical quantities inherent to the distribution network and the compensator and another function screen group, where it is possible to configure the parameters for operation as required.

Navigating the measurement screens

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

Figure 23: 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 the "Name" column of the Table 7;

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 field "*dd/mm/yyyy hh:mm*" will be presented at the time of the occurrence, if applicable, according to the *column* "*Date-time*";

The word "*Resettable*" will be seen in the bottom row of the screen, if applicable, as per column "*Resettable*" Of Table 7.

The figures will be presented following the Table 7 for consecutive press of the ▼ key and the ▲ key allows the return to the previously read value.

Table 7: Sequence of measured values.

Shortcut	Name	Description	Unit	*Reset*	Remote
1	FREQ	Line Frequency	Hz	No	Show
2	FP	Power factor	-	No	Show
3	FPIMIN	Minimum inductive power factor	-	Yes	Show and Reset
4	FPCMIN	Minimum capacitive power factor	-	Yes	Show and Reset
5	VSEC	Secondary voltage on the *"SOURCE" side*	V	No	Show
6	VPRIM	Primary voltage on the *"SOURCE" side*	Kv	No	Show
7	VMAX	Maximum tension on line	Kv	Yes	Show and Reset
8	ISEC	Secondary current on the *"SOURCE" side*	Ma	No	Show
9	IPRIM	Primary current on the *"SOURCE" side*	The	No	Show
10	INEUT	Neutral current (*"star" bank*)	The	No	Show
11	POT_S	Apparent rated power	Kva	No	Show
12	POT_P	Active power	Kw	No	Show
13	POT_Q	Reactive power	Kvar	No	Show
14	CNFI	Reverse flow neutralization counter	-	Yes	Show and Reset
15	CACS	Undercurrent actuation counter	-	Yes	Show and Reset
16	CBMA	Maximum block counter reached	-	Yes	Show and Reset
17	CEMT	Input counter in three-phase mode	-	Yes	Show and Reset
18	CNFE	Power outage neutralization counter	-	Yes	Show and Reset
19	QTREG	Number of records stored	-	Yes	Show and Reset



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

Navigating the Function Screens

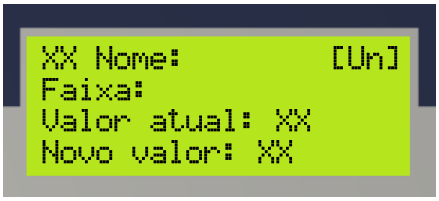
The screen number to be adjusted will be displayed in the "*XX*" *field,* displayed in the upper left field. This number corresponds to the function code and can be used, through the "*Screen shortcut*" feature, to reduce navigation time.

The field "*Name*" presents an acronym that identifies the function displayed, according to the column "*Name*" Of Table 8.

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 24: Settings modification screen.



Press the ◄ or ► keys until the function screen is displayed, as shown Figure 24.

Press the ▼ or ▲ keys to navigate between the parameterizable functions that are sequenced as per Table 8. Navigation is sequential and cyclical.

Press the Enter key to enable editing the current value as per Figure 24.

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

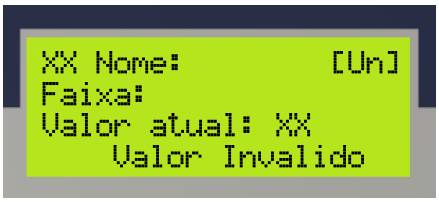
A "*New Value*" *field* that will initially show the same "*Current Value*" but with a cursor at the position of the most significant digit.

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



WARNING: If the adjusted value is outside the "*Banner*", the message "*Invalid value*" will be shown on the bottom line, as per Figure 25 and the screen returns to the same as the one displayed in the Figure 23.

Figure 25A: Settings Modification Screen



The functions for control are in accordance with the Table 8.

Table 8: Sequence of parameterizable functions

Shortcut	Function Name	Function Description	Und.	Belt	Incr.	Default Value	Adjustment Type
20	PSTN	TP interface for control	-	1 to 500	0,1	115	By phase
21	RTCC	CT Interface for Control	-	1 to 6000	1	1000	By phase
22	HCOMP	Enable compensator	-	0 to 1	1	1	By phase
23	TCON	Connection type for compensation	-	0 to 3	1	2	Unique
24	CCP	Criteria for compensation	-	0 to 3	0	1	By phase
25	FP1	Power Factor – Limit 1	-	0 to 1	0,01	1	By phase
26	FP2	Power Factor – Limit 2	-	0 to 1	0,01	1	By phase
27	VREF	Reference voltage	[V]	90 to 135	0,1	120	By phase
28	INS	Insensibility	[V]	0.8 to 5	0,1	3	By phase
29	TMP	Timing	[s]	10 to 180	1	30	By phase
30	BMAX	Maximum position lock	-	8 to 16	1	16	By phase
31	BSUBC	Undercurrent blocking	[%]	0 to 100	1	0	By phase
32	BSOBC	Overcurrent Blocking	[%]	50 to 200	1	200	By phase
33	PBCS	Locking position in case of undercurrent	-	0 to 8	0	1	By phase
34	DEFVC	Voltage and current lag	-	0 to 2	1	1	By phase
35	GDL	Degree of freedom	-	0 to 16	1	16	Unique
36	MTR	Selects the master compensator	-	1 to 3	1	1	Unique
37	DTAP	Fixed difference to master	-	-5 to 5	1	0	By phase
38	TPES	Stay time in sync	[min]	10 to 1440	1	1440	Unique
39	TNOBREAK	Time to neutralize with UPS	[s]	0 to 600	1	0	Unique
40	MIPCOM	Switch Reading and Indication Mode	-	0 to 2	1	0	By phase
41	DTAQ	Data acquisition period	[min]	1 to 60	1	15	Unique
42	HCMP	Time for Tracking Audit	[hr]	0 to 23	1	0	Unique
43	SCMP	Day for tracking audit	-	0 to 8	1	0	Unique
44	HESP_P2	Enables P2 spontaneous messaging	-	0 to 1	1	0	Unique
45	ENDREM_P2	Spontaneous message address P2	-	0 to 65535	1	0	Unique
46	HESP_P3	Enables P3 spontaneous messaging	-	0 to 1	1	0	Unique
47	ENDREM_P3	Spontaneous Message Address P3	-	0 to 65535	1	0	Unique
48	ESERIAL	Address for serial communication	-	0 to 65519	1	0	Unique
49	BAUD1	P1 data transmission rate	-	0 to 7	1	2	Unique
50	BAUD2	P2 data transmission rate	-	0 to 7	1	2	Unique
51	BAUD3	P3 data transmission rate	-	0 to 7	1	2	Unique
52	SENHA	Operator Password	-	0 to 999999	1	0	Unique
53	SENHA ADMIN	Password for administrator	-	0 to 999999	999999	1	Unique

20 – PSTN: TP interface for control

The set value shall be equal to the ratio of voltage at load to voltage at control obtained from the data recorded on the voltage compensator nameplate. Example: 13800/120 = 115.

21 – RTCC: CT to control ratio

The set value shall be equal to the ratio of the rated compensator current to the CT secondary rated current (0,2A) obtained from the data recorded on the voltage compensator rating plate. Example: 200/0.2 = 1000.

22 – HCOMP: Enables compensator

The CTR-3X control can command up to 3 compensators at the same time. To do this, it is necessary to adjust whether compensators 2 and 3 are active, since compensator 1 can never be disabled.

Table 9: Enables compensator.

Value	Description
0	Disables compensator
1	Enable compensator

When set to "*0*", the CTR-3X considers the corresponding compensator to be inactive and its monitoring, measurements, and commands will be disregarded.

If the chosen option is "*1*", the CTR-3X starts to consider the monitoring, measurements and commands for the corresponding compensator.



WARNING: The voltage compensator, called CQ-1, is solely responsible for powering the CTR-3X control system, so it cannot be disabled.

23 – TCON: Type of connection for compensation

The CAQ-1 can compensate capacitive and inductive reactives, so the CTR-3X has four configuration modes for reactive compensation, as per Table 10.

Table 10: Connection type for compensation

Value	Description
0	Capacitive single phase with three-phase alignment for the master (compensates for inductive FP)
1	Inductive single-phase with three-phase alignment for the master (compensates for capacitive FP)
2	Three-phase capacitive master (compensates for inductive FP)
3	Three-phase master inductive (compensates for capacitive FP)

0 – Capacitive single phase with three-phase alignment for the master

It operates in single-phase mode for inductive reactive compensation and when extrapolated the *35 – Degree of Freedom (GDL)* switches to three-phase compensation following the master compensator, configured at *36 – Selects the master compensator (MTR).* It remains in three-phase mode until the end of the time set in function *38 – Synchronism Permanence Time (TPES).*

1 – Inductive single-phase with three-phase alignment for the master

It operates in single-phase mode for capacitive reactive compensation and when extrapolated the *35 – Degree of Freedom (GDL)* switches to three-phase compensation following the master compensator, configured in *36 – Selects the master compensator (MTR).* It remains in three-phase mode until the end of the time set in function *38 – Synchronism Permanence Time (TPES).*



WARNING: For single-phase modes, functions *36 – Selects Master Compensator (MTR), 35 – Degree of Freedom (GDL), 37 – Fixed Difference to Master (DTAP)* and *38 – Timing Dwell Time (TPES)* must be adjusted. For purely single-phase operation, the 35 – *Degree of Freedom (GDL)* function should be set to 16.

2 – Three Phase Master Capacitive

Three-phase operation by the master compensator makes all active compensators of the bank follow the variations in the power factor of the master compensator and the consequent compensation imposed by the programmed compensator. In this function, the compensation of inductive reagents is performed. In this function, the fixed difference of TAPs is taken into account, programmed in function *37 – Fixed difference to the master (DTAP).*

3 – Three Phase Inductive Master

Three-phase operation by the master compensator makes all active compensators of the bank follow the variations in the power factor of the master compensator and the consequent compensation imposed by the programmed compensator. In this function, capacitive reactive compensation is performed. In this function, the fixed difference of TAPs is taken into account, programmed in function *37 – Fixed difference to the master (DTAP).*



WARNING: For three-phase modes, functions *36 – Select Master Compensator (MTR)* and *37 – Fixed Difference to Master (DTAP)* must be adjusted.



CAUTION: The control disregards the individual power factor measurements of the follower comps when operating in three-phase mode by the master, leaving them subject to power factors and inversion of flow without proper treatment by the control.

24 – CCP – Criterion for compensation

This function determines how the CTR-3X control will operate over the power flow imposed by the grid.

The Table 11 shows the negotiations that the CTR-3X control has, the work map and the direction of compensation for each of the chosen alternatives.

The detailed description of each of the parameters and their respective functional diagrams is found below the Table 11

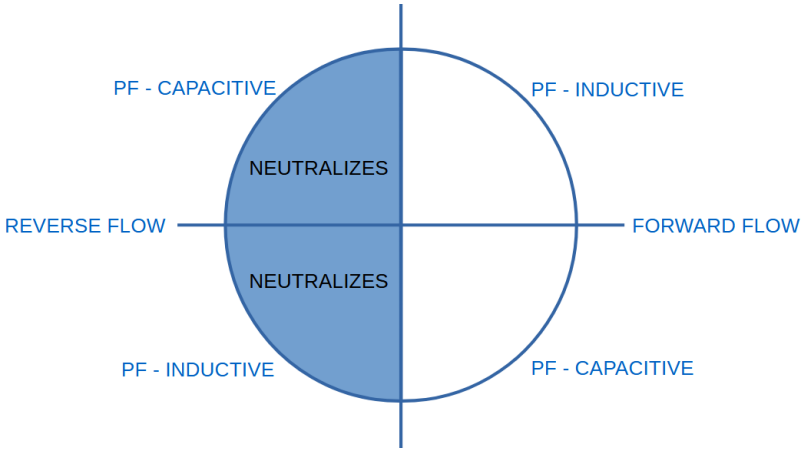
Table 11: Dealing with the working modes for the flow of power.

Value	Description	Job Map	Sense of Compensation
0	Compensates for power factor in direct flow and neutralizes in reverse flow	Direct	Load
1	Compensates for power factor in direct flow and locks in reverse flow	Direct	Load
2	Compensates for power factor in direct flow and compensates for voltage in case of reverse flow	Direct/Reverse	Load
3	Compensates power factor for voltage in case of direct or reverse flow	Direct/Reverse	Load

0 – Direct flow through the FP and neutralization in case of reverse flow | Reverse flow TAP=0

It operates in direct flow and neutralizes the compensator in case of detection of reverse flow. CTR-3X control when detecting a reverse power flow and staying for a longer time than programmed in the *29 – Timing (TMP) function*, the CTR-3X brings the switch to the neutral position and locks operations until the flow is back to direct

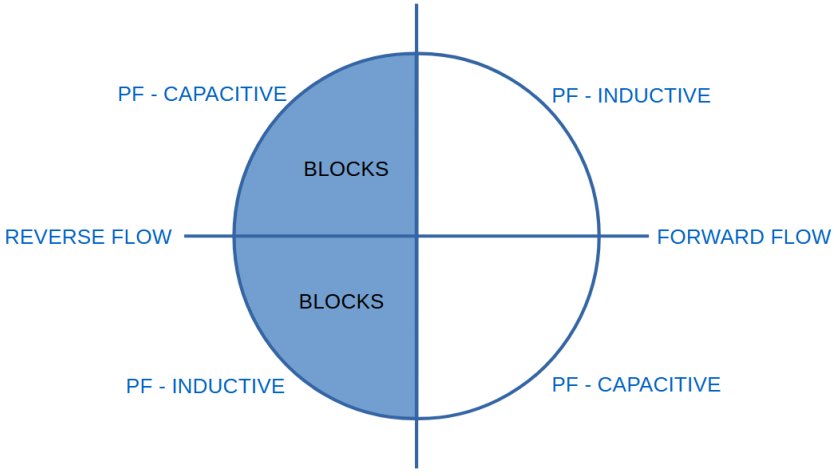
Figure 26: Direct flow and neutralization in case of reverse flow.



1 – Direct flow through the FP and blockage in case of reverse flow

It operates in direct flow and blocks switching in case of reverse flow detection. The CTR-3X control when detecting a reverse power flow and staying for a longer time than programmed in function *29 – Timing (TMP),* the CTR-3X blocks the switches until the power flow is direct again.

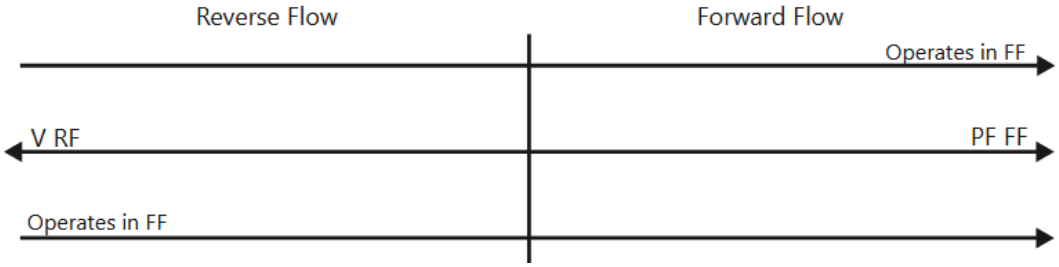
Figure 27: Direct flow and blockage in case of reverse flow.



2 – Direct flow through the FP and compensates from the voltage in case of reverse flow

It operates in direct flow and in case of reverse flow the CTR-3X compensates for the power factor based on the voltage value. The CTR-3X control when detecting a power flow in reverse and remaining for a longer time than programmed in function *29 – Timing (TMP),* the CTR-3X will perform reactive compensation based on the voltage value programmed in function *27 – Reference Voltage (VREF)* and comparing it with the measured voltage value. The CTR-3X will return to operation, it will only adopt parameters 25 and 26 as a basis for compensation as soon as the flow returns to being direct.

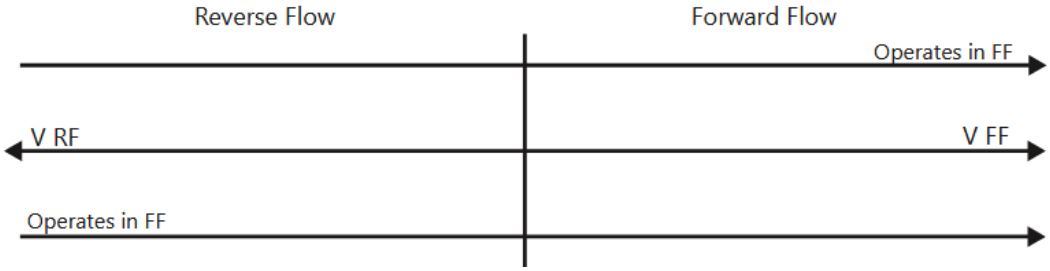
Figure 28: Direct flow through the FP and compensates from the voltage in case of reverse flow.



3 – Forward and reverse flow by voltage

It operates in forward or reverse flow based only on the difference between function *27 – Reference Voltage (VREF)* and the measured voltage. In this mode, parameters 25 and 26 will not be adopted as a basis.

Figure 29A: Backward and direct flow by voltage.



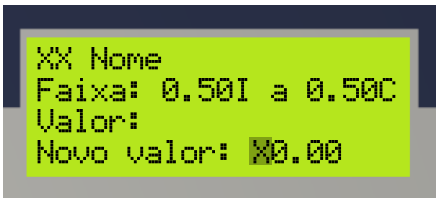


WARNING: In three-phase mode by the master, the CTR-3X control uses only the same reference compensator for power flow detection. If individual treatment is required per phase, single-phase compensation should be used.

25 and 26 – FP: Power Factor Limit 1 and Limit 2

These two parameters have the function of determining the maximum and minimum limits of the power factor. On the screen of this parameter it is possible to indicate the desired value and whether it will be capacitive or inductive, as shown in the Figure 30:

Figure 30 - Limiting power factor

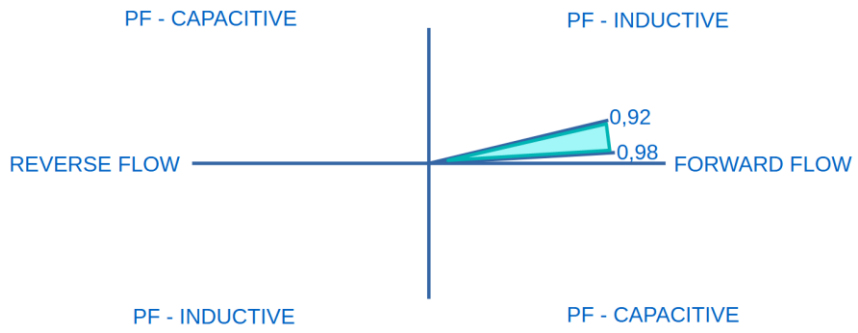


"X" – Power factor characteristic

- ✓ C – Capacitive
- ✓ I - Inductive

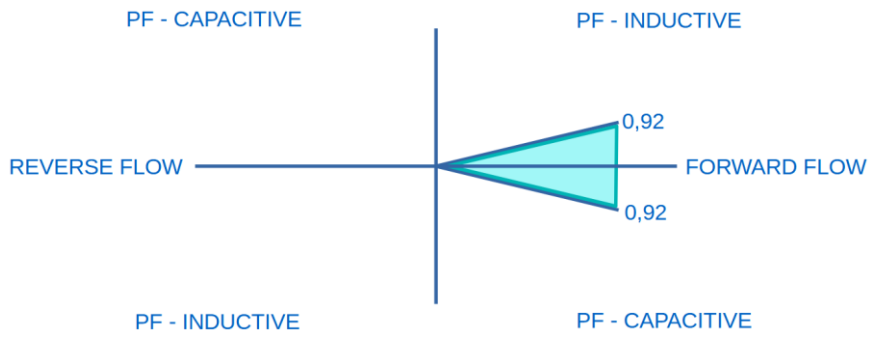
Example 1: If the programmed power factor is 0.92I and 0.98I. The CTR-3X will always switch to ensure that the power factor stays within this programmed value. The Figure 31 illustrates what an inductive power factor would look like within the range of 0.92 and 0.98 in direct flow:

Figure 31 - Inductive power factor.



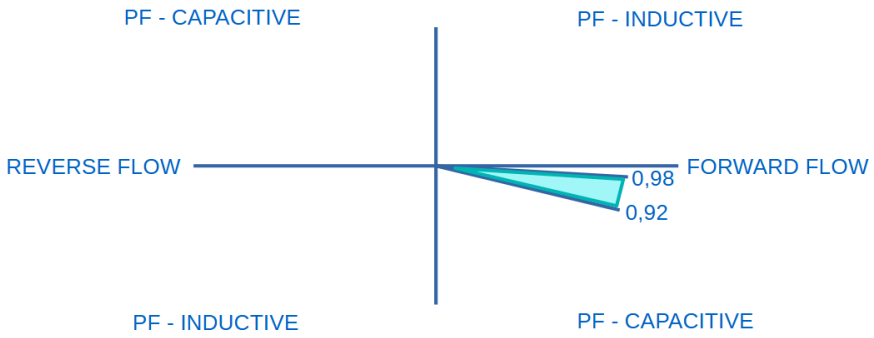
Example 2: If the programmed power factor is 0.92I and 0.92C. The CTR-3X will always switch to ensure that the power factor stays within this programmed value. The Figure 32 illustrates what a power factor within the range of 0.92 inductive and 0.95 capacitive in direct flow would look like:

Figure 32 - Inductive and capacitive power factor.



Example 3: In case the programmed power factor is 0.92C and 0.98C. The CTR-3X will always switch to ensure that the power factor stays within this programmed value. The Figure 33 What would a capacitive power factor within the range of 0.92 and 0.98 in direct flow look like:

Figure 33 - Capacitive power factor.



27 – VREF: Reference Voltage

The value adjusted in this function is used as a clearing parameter when function *24 – Criterion for Clearing (CCP)* is set to 2 or 3. In this case, the control will adopt the voltage value programmed in this function as a compensation parameter. When the CTR-3X detects that the measured voltage level is in disagreement with the programmed one, it will switch to adjust the power factor, always seeking to stabilize the measured voltage with the programmed voltage.

WARNING: Voltage operation depends on well-balanced network parameters, such as its impedance and the reactive power of the network and the reactive compensator. Thus, simply implementing reactive loads on the line may not offer sufficient variation in grid voltage for control to detect the variation and switch to maintain the power factor level.

28 – INS: Insensitivity

The value adjusted in this function defines a symmetrical insensitive band boundary around the reference voltage. When the measured voltage value is within the limits of the band, the control considers that there is no need to correct, in which case the RAISE VOLTAGE **or** LOWER VOLTAGE **indicator LEDs**, available on the front panel of the control, will remain off. When the voltage profile is outside the band ranges, the RAISE VOLTAGE **or** LOWER VOLTAGE **indicator LEDs** will illuminate indicating which direction the control will cause the compensation.

WARNING: Coordination of the insensitivity and timing functions should be done to minimize wear and tear on the switch, which decreases the frequency of maintenance.

29 – TMP: Timing

The value set in this function defines the amount of time, in seconds, that the control waits before initiating compensation after the power factor or voltage profile exceeds the imposed limits. It aims to avoid switching due to short-term variations in voltage in the system.



WARNING: Coordination of the insensitivity and timing functions should be done to minimize wear and tear on the switch, which decreases the frequency of maintenance.

30 – BMAX: Maximum position lock

This function sets the maximum position limit that the tap changer can reach. For each nominal voltage level that the compensator can work with, it is necessary to program a maximum arrangement to maintain a safe voltage level on the reactive element, according to the data on the rating plate.



DANGER: The maximum interlock stated on the rating plate for each voltage level must be obeyed. If a blockage level is programmed above the informed one, the voltage on the reactive element will be greater than that supported, causing damage to the equipment.

31 – BSUBC: Undercurrent blocking

This function determines the percentage of the rated current required to drive the undercurrent lockout. When the programmed value is reached, the CTR-3X will position the switch as per the setting set in function *33 – Undercurrent Lock Position (PBCS)* and lock the switches. Unlocking will only occur when the rated current exceeds the previously programmed value.



WARNING: When undercurrent detection occurs, all compensators will be locked in the independent programmed position of function *37 – Fixed Difference to Master (DTAP)*.

32 – BSOBC: Overcurrent Blocking

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.



WARNING: When the nominal currents of the compensators that make up the bank are not equal and the compensation in three-phase mode is chosen, the blocking of the switch of one of the compensators will result in the blocking of the other units.

33 – PBCS: Locking position in case of undercurrent

Due to the measurement error, in cases where there is little current circulating in the network, a blocking position must be programmed. When the measurement value is reached, as programmed in function *31 – Undercurrent Lock (BSUBC),* all active compensators on the bench will be brought to this position and will remain there until a voltage level higher than that programmed in function 31 flows again.



WARNING: When undercurrent detection occurs, all compensators will be locked in the independent programmed position of function *37 – Fixed Difference to Master (DTAP).*

34 – DEFVC: Lag between voltage and current

In order for the power factor calculations to be made correctly, it is necessary to adjust the lag between voltage and current, which are different depending on each type of connection of the compensator bank. The Table 12 informs the values that can be parameterized.

Table 12: Adjustment for voltage and current lag.

Value	Description
0	No lag (0º)
1	Delayed current in reference to voltage (-30º)
2	Forward current in reference to voltage (+30º)

35 – GDL: Degree of freedom

When the operation of the bank is programmed for some single-phase mode of clearing, it is necessary to inform the CTR-3X what will be the maximum distance allowed between tapes of the active clearings. This function allows you to adjust a difference in the distance from 0 to 16 positions.

If the distance between the positions of the switches reaches a value higher than that programmed in this function, the CTR-3X proceeds with the alignment of the seat and starts operating in three-phase mode.



WARNING: For purely single-phase operation the parameter of this function must be set to 16.

36 – MTR: Selects the master compensator

The CTR-3X can be programmed to operate in three-phase mode, in which case it is necessary to set the master compensator. This function determines which of the clearing bank's active clearers will be the master clearer.



WARNING: The value programmed into this function will be disregarded if the CTR-3X control is operating with only 1 compensator or if the chosen value is from a disabled compensator. The master compensator must always be active in the bank!

37 – DTAP: Fixed Difference to Master

When the bank operation is programmed for some three-phase compensation mode, it is possible to inform the CTR-3X control what will be the fixed difference in positions between the following compensators for the master. This function allows you to adjust the fixed difference from -5 to +5 positions, respectively for all bank compensators.



WARNING: Adjusting this function is disregarded for the compensator chosen as the master.

38 – TPES: Time of permanence in synchronism

If the distance between the positions of the compensator switches reaches a value higher than that programmed in function *35 – Degree of Freedom (GDL),* the CTR-3X proceeds with the alignment of the seat and starts operating in three-phase mode, for a period that can vary from 10 to 1440 minutes. After this period, the CTR-3X returns to the programmed mode in function *24 – Criterion for Compensation (CCP).*

39 – TNOBREAK: Time for neutralization via *UPS*

This function must be adjusted to determine the time of operation of the *UPS* after the lack of power to the main system (this fault is monitored only by the measurement of CQ-1) to start the neutralization of the compensators The adjustment of this function is between 0 (function disabled, the *UPS* will not act in case of foul) and 600 seconds. For more information, see the topic ***Neutralization system via UPS***.

40 – MIPCOM: Reading mode and indicating the position of the switch

The CTR-3X control is designed to work with a variety of switches on the market and also to remotely inform the operation center of the position of each compensator in three different ways. The Table 13**Erro! Fonte de referência não encontrada.** describes which adjustment value should be used in each work case.

Table 13: Method of indicating the current position.

Value	Switch reading mode	Indication mode
0	Real-time readout via *encoder*	0 to +16
1	Tracking by change of state	0 to +16
2	Pulse Ratreio	0 to +16



WARNING: For ITB manufacturing compensators, the setting for this function must be set to 0.

41 – DTAQ: Data acquisition period

The DTAQ function determines the period of acquisition of the records in the mass memory and has an adjustment range from 1 to 60 minutes. The CTR-3X control is capable of obtaining and storing up to 6,180 records of hour, minute, day, month, year, record type, power supply, switch position, power factor, power factor characteristics, power flow direction, voltages, currents, and operation counters.

42 and 43 – HCMP & SCMP: Time and day of the week for tracking audit

In case of application of the CTR-3X control with switches without an absolute encoder for real-time reading of the switch, tracking monitoring can be used, adjusting the method of reading the position of each active compensation of the bank, in function *40 – Reading and indicating the switch method (MIPCOM)*. With this, it will be convenient to schedule a day of the week and time when the CTR-3X operates a routine audit of position monitoring.

On the scheduled days and times, the bank's active components that operate by tracking are simultaneously taken to the neutral position to check the neutral *LED* and, after this audit, the compensation continues in the programmed mode in function *24 – Criterion for Compensation (CCP)*.

The value programmed in function 42 can be from 0h to 23h, which corresponds to the start time of the position audit run.

The value programmed in function 43 must be in accordance with the Table 14.

Table 14: Days of the week options for running the trace audit.

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



WARNING: Switches equipped with an absolute encoder will not participate in this routine position monitoring audit.



DANGER: It is not recommended to use the position monitoring method by tracking on a permanent basis due to the additional wear and tear caused by the position audit routine and the loss of reliability.

44 and 46 – HESP_P2 & HESP_P3: Enables spontaneous messaging

The CTR-3X 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 44 corresponds to additional communication port COM-2 and function 46 to additional communication port COM-3.

Table 15: Enables spontaneous messaging.

Value	Description
0	Disables spontaneous messages
1	Enables spontaneous messaging



WARNING: It is recommended that you read the additional spontaneous message configuration information available in *the CTR-3XComm Communication Software Manual in its entirety*.

45 and 47 – ENDREM_P2 & ENDREM_P3: Address for spontaneous message

Once functions 45 and/or 47 have been programmed to send spontaneous messages, the CTR-3X 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-3XComm** communication software, to a given system address. These functions define the addresses that can be programmed between 0 and 65534.

48 – ESERIAL: Address for serial communication

As the communication ports can allow the simultaneous connection of more than one control to a single computer or remote, it is necessary to program addressing so that there are no communication conflicts. This function can be adjusted between 0 and 65534. It is recommended that different values be programmed for equipment connected to the same data bus.

49, 50 and 51 – BAUD1, BAUD2 & BAUD3: Data transmission rate

The CTR-3X 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.

The COM-1, COM-2, and COM-3 communication ports of the CTR-3 can have their data transfer rates adjusted independently in functions 49 for COM-1, 50 for COM-2, and 51 for COM-3.

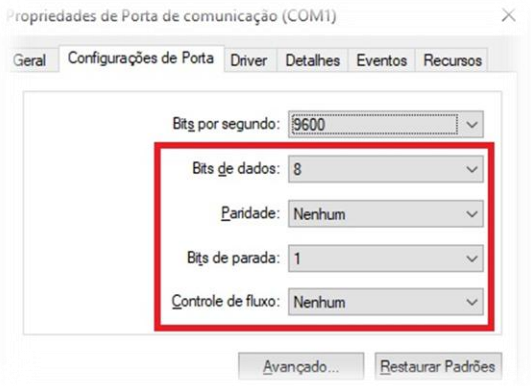
Data transmission rates can be adjusted Table 16.

Table 16: Data throughput options.

Value	0	1	2	3	4	5	6	7	8
Rate [kbps]	Disabled	2400	4800	9600	14400	19200	38400	56000	115200

Beyond the values Table 16, the communication ports of the personal computer or server must be configured as highlighted in the Figure 34:

Figure 34: COM communication port configuration.



52 – SENHA: Operator password

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

53 – SENHA ADMIN: Password for administrator

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

DNP3.0

The control for CTR-3X reactive power compensators 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 slave 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

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