RTV

Transformer Voltage Regulator

Instructions Manual for **RTV** Models
M0RTVP1812Iv04

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Chapter 1.

Description and Start-Up

1.1 Functions

The generic name **RTV** groups equipment that include tap changer control functions for power transformer voltage regulation. This is leading-edge technology based on powerful microprocessors and DSP's.

RTV systems are used in applications where constant voltage level must be maintained without service interruption. Voltage is regulated from voltage and current measurements at power transformer terminals through current transformers (CTs) and voltage transformers (VTs), sending command signals to the applicable transformer tap changer to raise or lower the voltage to set-point value.

1.1.1 Voltage Regulation

The regulator measures the transformer output voltage and compares it with the set-point value to decide whether a command signal must be sent to the tap changer or else remains inactive. The adjustable **Insensitivity Degree** defines the difference between measured and set-point voltages.

1.1.2 Adjustable Delay Time

Raise or **Lower the Tap** commands are released according to adjustable delays. First tap changer operation may occur after a time delay (T1) according to **Inverse Time** or **Definite Time** curves. If additional operations are required, these will occur after time delay setting T2.

1.1.3 Remote Voltage Set-point Value Control

Voltage set-point value can be set in a number of ways: From the **HMI** keyboard, through communications protocols, through Logic Inputs, etc.

1.1.4 Suppression of Time Delay in Operations

Timer action may be cancelled to reduce overvoltage upon certain operations such as the connection and disconnection of capacitor banks for two reasons: When voltage rises above **Fast Backlash Voltage** setting value or activation of a **Logic Input**. In both cases, the tap change command is executed immediately.

1.1.5 Automatic/Manual Operation

It is possible to manually **Raise** or **Lower the Tap**. For the regulator to compute command values to **Raise** or **Lower the Tap**, it must be in **Automatic Mode**.

1.1.6 Local/Remote Operation

Local/Remote operation modes are used for changing regulator voltage set-point value.

1.1.7 Current Compensation

As load voltage must be maintained, transformer secondary busbar voltage must also be maintained. Voltage drop between load and transformer is a function of transformer current. The **RTV** takes into account said current and compensates the voltage drop between the transformer and the load.

To this end, two separate methods are used:

LDC-Z: Magnitude sum.
LDC-R&X: Vector sum.

1.1.8 Reactive Current Compensation

When some parallel transformers with different tap/voltage ratio operate in the same installation, a reactive current between both transformers is established. The **RTV** measures the unbalance produced by the transformers and takes it into account for computing voltage set-point value.

1.1.9 VTs and CTs Connection Phase Difference

Phase difference introduced by connection of voltage and current measuring transformers can be corrected by setting.

1.1.10 Tap/Voltage Ratio

Regulator type can be selected by setting:

- **Direct Tap/Voltage Ratio**: Tap rise is equivalent to voltage rise.
- **Inverse Tap/Voltage Ratio**: Tap rise is equivalent to voltage lowering.

1.1.11 Pulse or Level Operating Outputs

Activation of **Raise** or **Lower the Tap** operating outputs can be set to operate by **pulse** (of adjustable duration), or by **level** (only when **Tap Monitoring** is enabled).

1.1.12 Blocking of Regulator

The equipment can be blocked under given circumstances. Examples of these circumstances are **Undervoltage**, **Voltage out of Range** (RTV-P model), **Switching Overcurrent** or **Logic Input** activation.

Any of **Raise** or **Lower Tap** action blockings can be programmed separately.

1.1.13 Tap Signaling and Monitoring

By connecting the inputs designed for the purpose (according to the model), the **Active Tap** can be read, whether in **direct form**, in **BCD code**, through **Input converter** or through **Resistor Chain**, as well as giving the relevant instructions and activating through setting the **Tap supervision**, in which case, the appropriate operation sequence and time are checked.

1.1.14 Protection Units

According to the model Selection table, the **RTV** may include an overvoltage element and an underfrequency element, as well as a fuse failure element.

1.1.15 Power Reversal Detection

The **RTV** can detect **Power Reversal** situations, activating the applicable signal. Then, the user can decide on actions to be taken.

1.1.16 Voltage Band Recorder

The **RTV** is equipped with a data recorder that logs the voltage duration in 7 operating bands the limits of which are defined through settings. The number of times the voltage remained in each band is recorded, as well as the total residence time for each band. Recorder has been set up to give monthly readings of the residence time.

1.1.17 Operations Counter

Two counters for **Raise** or **Lower the Tap** operations are provided, as well as a reset facility through the activation of a Logic Input, communications command, etc.

1.1.18 Transformers in parallel

RTV regulators can regulate up to 5 transformers in parallel for IEC-61850 systems and 3 transformers in case of conventional systems communicating through **Virtual Inputs / Outputs** and by the method of **Circulating current**. Operating with the **Negative Reactance** method, the equipment does not require communication and using **Master-Slave** the number of transformers in parallel can be greater than 5 in IEC-61850 systems.

1.2 Additional Functions

1.2.1 Local Control

Eight buttons are provided on the front panel to operate the system elements set up in the equipment (automatic controls, protection units, Local/Remote, Auto/Manual, Settings Active Table, etc.) or reset operation signals.

1.2.2 Programmable Logic

An operation logic can be defined to establish blockings, automatic controls, control and trip logic, command hierarchy, etc., from logic gates connected to any signal captured or calculated by the equipment.

Events, oscillographic records, digital inputs and outputs, HMI and communications will be provided with all equipment-generated signals as a function of how the programmable logic has been configured.

Outputs generated by input signal processing can be directed to the different connections between the **RTV** and the outside: output contacts, display, LEDs, communications, HMI, etc.

1.2.3 Communications Ports and Protocols

RTV equipment are provided with a number of communications ports:

- 1 front local port type RS232C and USB.
- Up to 3 remote ports with the following configurations:
  - Remote port 1: Fiber Optic interface (ST glass or plastic 1mm) or electrical interface RS232/RS232 FULL MODEM.
  - Remote port 2: Fiber Optic interface (ST glass or plastic 1mm) or electrical interface RS232/RS485.
  - Remote port 3: electrical interface RS232/RS485.
- 2 LAN ports with RJ45 connector or MT-RJ Glass Fiber Optic for ETHERNET communications.
- 1 remote port with connection BUS for CAN protocol.

The equipment is also provided with the following communications protocols: PROCOME 3.0, DNP 3.0 and MODBUS (any of them can be allocated to remote ports and, for PROCOME, also to LAN ports); IEC-61850 (LAN ports) and CAN (CAN BUS electrical). At the local port the support protocol is PROCOME 3.0, used for equipment data parameterization, configuration and retrieval.

Control changes queues are totally independent for each port, it being possible to have the same protocol at both remote ports.

1.2.4 LED Targets

2U and 3U height models are equipped with five optical indicators (LEDs). Four are user-definable and the remainder indicates that the equipment is “Ready”. Models 4U or more are provided with 16 user-definable LEDs and one more that indicates relay “Ready”.

1.2.5 Digital Inputs

The equipment is provided with a variable number of digital inputs (according to model), all of them configurable. There can be from 8 to 44 inputs.

1.2.6 Auxiliary Outputs

The equipment is provided with a variable number of digital outputs (according to model). Only one is not configurable, as it corresponds to equipment “Ready”. There can be from 6 to18 outputs.

1.2.7 Time Synchronization

The equipment is provided with an internal clock accurate to 1 millisecond. Synchronization can be carried out through GPS (IRIG-B 003 and 123 protocols) or through remote port communications (PROCOME 3.0 or DNP 3.0 protocols).

1.2.8 Event Recording and Programmable Metering Data Logging

Storage capacity of 400 annotations in a non-volatile memory. Event-generated signals can be selected by the user and are annotated with 1ms resolution and a maximum of 12 measurements also user-selected.

1.2.9 Historical Metering Data Logging

Historical metering data logging allows for obtaining twelve maximum and twelve minimum values from a group of four magnitudes selected out of all available measurements (acquired or calculated), except meters, for each time window. This window can be adapted to the application by adjustment of day and interval masks. Up to 168 records can be saved.

1.2.10 Oscillographic Recording

The oscillographic recording function comprises two different subfunctions: **Capture** Function and **Display** Function. Both analog magnitudes as well as equipment internal signals and digital inputs are recorded, up to 64 oscillographs in cyclical memory. Sampling and storage frequency is 32 samples per cycle, with 15 seconds of total storage.

The equipment delivers the oscillographs in COMTRADE 99 format.

The equipment comes with a program for displaying and analysing the captured oscillographs.

1.2.11 Supply Voltage Monitoring

Some models incorporate a function for monitoring the voltage supplied by the substation DC batteries, which is used to feed the equipment proper.

Through this monitoring function, overvoltage and undervoltage alarms can be generated, as well as historic logs of said voltage values saving the same into the oscillographic records that might follow to every relay operation.

Said monitoring can be made thanks to an input converter specifically designed to measure common substation DC voltage values.

1.2.12 Alphanumeric Display and Keypad

- Changing and displaying settings.
- Input and Output status.
- Event recording.
- Log file of current, voltage, power, power factor and energy or other calculated magnitudes.
- Control event recording.
- Metering values used by the regulator:
  - Local and Parallel Currents and their angles.
  - Phase Voltage.
  - Maximum and Minimum Current.
  - Maximum and Minimum Voltage.
  - Active, Reactive and Apparent Powers and Power Factor.
  - Maximum and Minimum Powers.
  - Energies.

1.2.13 Self-test and Monitoring

The equipment is provided with a monitoring program that verifies the correct operation of all the components.

1.3 Local Interface

1.3.1 Alphanumeric Display & Keypad

The liquid crystal alphanumeric display has 80 characters (4 rows of 20 characters per row) through which alarms, settings, metering, states, etc. are displayed. There are 4 auxiliary function keys (F1, F2, F3 and F4) under the display. The functions associated to these keys are described in the next section. Figure 1.3.1 shows the layout of the default graphic display and the auxiliary function keys.

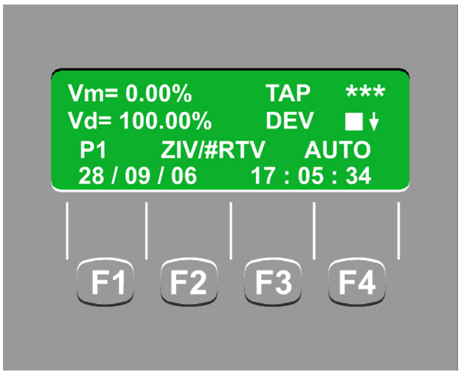


Figure 1.3.1: Alphanumeric Display.

- **Default Display**

As shown in figure 1.3.1, the default display shows the relay model, the date, the time and specific information of the voltage regulator. Also, the upper line left end describes the connection mode (if communication has been established) as follows (depending on model):

[PL] Local connection (communication through the front port).
[P1] Remote connection (communication through rear port 1).
[P2] Remote connection (communication through rear port 2).
[P3] Remote connection (communication through rear port 3).
[P4] Remote connection (communication through rear port 4).

The specific information related to the voltage regulator is the following one:

Vm VPH measured voltage. It is displayed in percentage, primary voltage values or secondary voltage values depending on a setting.
Vd Setpoint. Depending on the model, the IED will display the setpoint setting or the compensated setpoint value. It is displayed in percentage, primary voltage values or secondary voltage values depending on a setting.
Tap Current tap value.
Dev Indicates if the measured voltage (Vm) is inside or outside the regulation area.
AUTO/MAN Automatic or manual status.

- **Keypad associated with the Alphanumeric Display**

The keypad consists of 16 keys arranged in a 4 x 4 matrix. Their properties are specified next. Figure 1.3.2 shows the layout of this keypad.

Besides the keys corresponding to the digits (keys 0 to 9) there are the selection keys (↓ and ↑), the confirmation key (**ENT**), the escape key (**ESC**) and the contrast key (◑).

Starting from the default display, operations on **RTV** model functions can be performed in two different ways: Using one single key (**F2**) or using the whole keypad

Figure 1.3.2: Keypad.

1.3.2 Command Buttons

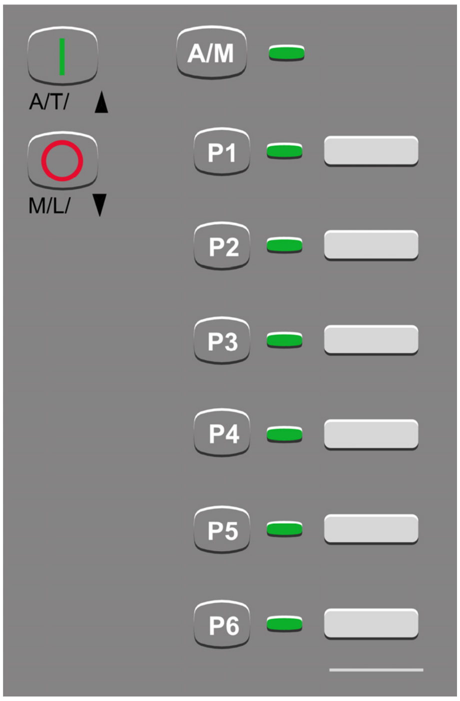
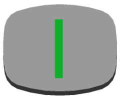


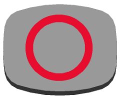
Figure 1.3.3: Command and Programmable Buttons in a 1RTV.

System elements, settings tables or protection elements configured in the relay are operated through three columns of buttons.

The first column contains the command buttons, as well as the **A/M** (Automatic / Manual) mode selection button. This button is accompanied by 1 LED (red / green) to indicate the Automatic / Manual operation mode. The buttons can be configured by the user through the logic so that functions are allocated to said buttons.



Button to Activate, switch over Automatic mode, switch over Remote control or Raise Tap.



Button to Deactivate, switch over Manual mode, switch over Local or Lower Tap.

1.3.2.a Programmable Buttons

The next 2 columns comprise six configurable buttons (P1 to P6), for operating the elements / units that the user determines through the communications program, together with a space for displaying the description of that button's function. Each of these six buttons is in turn provided with a configurable LED that indicates the state of the object / function associated with that button. The function of these buttons is to select the element to be operated upon. The command is sent to the element through buttons [I] and [O].

The push button system is provided with a general interlock that can be configured from the HMI and communications ports providing the required security for proper operation.

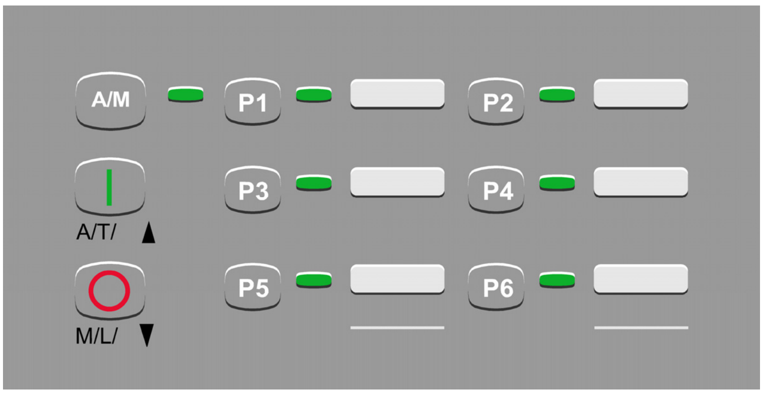


Figure 1.3.4: Command and Programmable Buttons in a 6RTV.

1.3.3 Keys, Functions and Operation Modes

Available key functions, both for function keys associated with the alphanumeric display and the keypad keys are given below.

1.3.3.a Keypad

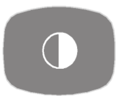
Confirmation Key
The ENT key is used to confirm an action: After making a selection, after editing a setting or to step forward to view all the records. After any operation (selection, change of settings, information, etc.) press ENT again to access the immediate preceding level.

Escape Key
The ESC key is used to exit a screen if no change is to be entered into the setting or simply to exit an information screen. In any case, press this key to return to the immediate preceding screen.

Display Selection Keys
Selection keys are used to move forward or backward, in sequential order, to any of the existing menu or submenu options. When there are more than four options in a menu, an arrow (↓) appears at the lower right corner of the display indicating that there are more options. Access to these options is made through ∇ key and the first options will go out of sight, in sequence.

Then, an arrow (↑) appears at the upper right corner of the display indicating in turn the existence of these first options.

The ∇ key is also used to delete digits within a setting that is being modified. It only has this function when the setting is being entered.



Contrast Key and Minus (-) Sign
Pressing this key brings up the screen for adjusting the display contrast. Modification of the contrast value is by the selection keys: Greater value = Less contrast. Also, a negative sign (-) can be entered when setting floating point values.

1.3.3.b Auxiliary Function Keys

F1

Changes in settings or the activation of a settings table are confirmed by pressing F1 (when the relay requests confirmation of said changes or activation).

When pressed from the stand-by screen, access to the information provided by the control change recorder is obtained.

F2

The F2 key is used to look into the information on measurements of current, voltage, power, etc.

F3

Pressing F3 displays the state of the relay's digital inputs and outputs.

F4

The F4 key is used to reject the setting changes entered (when the relay requests confirmation of said changes) and to reject the activation of a reserve settings table (also when confirmation is requested).

1.3.3.c Accessing the Options

Digit keys (0 to 9) allow for direct access to the various options (settings, information, measurements, etc.). Said direct access is made by consecutive pressing the identification numbers displayed on the screen prior to each setting or option within the corresponding setting.

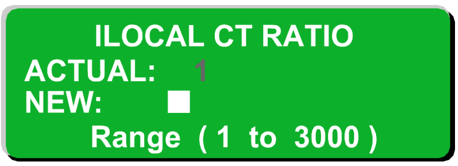
Another way of access is by scrolling the menus with the selection keys and then confirming the selected option with ENT.

1.3.3.d Operation

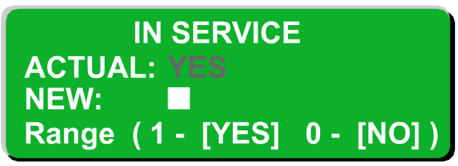
- **Change of Settings (Range)**

The Change of Settings (Range) is arranged as follows: The operational setting value is shown in the place labelled with the word ACTUAL. The new value is entered in the next line, into the place labelled with the word NEW, where a blinking cursor appears.

A new value is edited with the digit keys, which must agree with the range specified in the last line of the display. If a wrong value is entered, it can be erased with the ∇ key. Once the new value has been edited, pressing ENT confirms it and exits to the previous menu.

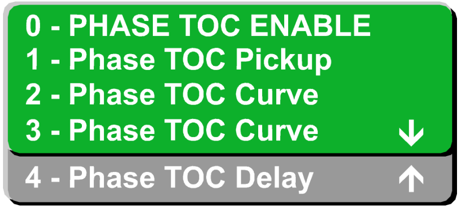


A type of setting exists that follows this outline the range of which is limited to the YES and NO options. In this case, the 1 and 0 keys correspond to the values YES and NO. Then pressing ENT confirms the setting and returns to the previous screen.



- **Change of Settings (Options)**

These settings are presented in a menu, the options of which must be selected by the two known procedures: By the direct access number associated with the option or by the selection keys and confirmation with ENT. In both cases, the system returns to the previous screen.



- **Mask Settings**

As shown in the display image, the various options are presented vertically. Their current settings are shown adjacent to each of them: A filled or empty square means activation (■) or deactivation (□) respectively.

The mask can be changed (in the line with the square brackets) by 1 (activation) or 0 (deactivation) keys.

If there are more options that can be displayed on a single screen, an arrow (↓) at the end of the last line will appear, which indicates the existence of the second screen. This second screen appears as soon as the settings of the last option of the first screen have been entered.

- **Exiting Menus and Settings**

To exit a menu or setting without changing it, press the ESC key. To exit an information screen, press either ENT or ESC, indistinctly. In either case, the display returns to the previous menu.

1.4 Model Selection

1.4.1 Model Selection

	RTV										
1		2	3	4	5	6	7	8	9	10	11	12

1	**Mounting Type**			
	1	Vertical format and programmable buttons	**6**	Horizontal format and programmable buttons
2	**Functions**			
	P	90 + Compensations + Tap Changer Monitoring + Model for up to 5 Transformer Paralleling		
3	**Communication Interfaces for IEC 61850**			
	1	None.	**5**	Two 100BASE-FX Connectors (Multimode FOC LC).
	3	Two 100BASE-TX Connectors (RJ45).	**6**	One 100BASE-TX Connector (RJ 45) + One 100BASE-FX Connector (Multimode FOC LC).
	4	Two 100BASE-FX Connectors (Multimode FOC ST).		
4	**Additional Functions**			
	N	Standard Model		
5	**Power Supply Voltage**			
	1	24VDC / VAC (+-20%)	**2**	48 - 250 VDC / VAC (+-20%)
6	**Digital Inputs Voltage**			
	0	24 VDC	**3**	250 VDC
	1	48 VDC	**6**	125 VDC (Activ. Threshold >65% of rated voltage)
	2	125 VDC	**7**	250 VDC (Von=158VDC / Voff = 132VDC)
7	**Communications Ports [COM1-LOC] [COM 2-REMP1] [COM3-REMP2] [COM4-REMP3] [COM5-REMP4]**			
	0	[RS232 2xUSB(*)] [--] [--] [--] [--]	**J**	[RS232 + USB] [ETHERNET] [ETHERNET] [RS232 / RS485] [ELECTRIC CAN]
	1	[RS232 + USB] [PFO] [RS232/RS485] [ETHERNET] [ELECTRIC CAN]	**K**	[RS232 + USB] [RS232F.M.] [RS232 / RS485] [ETHERNET] [ELECTRIC CAN]
	2	[RS232 + USB] [GFO ST] [GFO ST] [GFO ST] [ELECTRIC CAN]	**M**	[RS232 + 2xUSB(*)] [GFO ST] [GFO ST] [--] [ELECTRIC CAN]
	3	[RS232 + USB] [GFO ST] [RS232/RS485] [ETHERNET] [ELECTRIC CAN]	**P**	[RS232+2xUSB(*)] [PFO] [RS232 / RS485] [ETHERNET] [ELECTRIC CAN]
	9	[RS232 + USB] [PFO] [PFO] [--] [ELECTRIC CAN]	**Q**	[RS232+2xUSB(*)] [ETHERNET] [RS232 / RS485] [RS232 / RS485] [ELECTRIC CAN]
	C	[RS232 + USB] [GFO ST] [GFO ST] [RS232/RS485] [ELECTRIC CAN]	**R**	[RS232 + USB] [RS232F.M.] [RS232 / RS485] [RS232 / RS485] [ELECTRIC CAN]
	D	[RS232 + USB] [ETHERNET] [RS232 / RS485] [RS232 / RS485] [ELECTRIC CAN]	**S**	[RS232+2xUSB(*)] [GFO ST] [RS232 / RS485] [ETHERNET] [ELECTRIC CAN]
	E	[RS232 + USB] [GFO ST] [RS232/RS485] [RS232/RS485] [ELECTRIC CAN]	**T**	[RS232 + USB] [PFO] [GFO ST] [RS232 / RS485] [ELECTRIC CAN]
	F	[RS232 + USB] [[DOUBLE RING PFO]] [RS232 / RS485] [ELECTRIC CAN]	**U**	[RS232+2xUSB(*)] [PFO] [GFO ST] [RS232 / RS485] [ELECTRIC CAN]
	G	[RS232 + USB] [PFO] [GFO ST] [GFO ST] [ELECTRIC CAN]	**Y**	[RS232 + 2xUSB(*)] [RS232] [RS232 / RS485] [ETHERNET] [ELECTRIC CAN]
	H	[RS232 + USB] [PFO] [RS232/RS485] RS232/RS485] [ELECTRIC CAN]	**W**	[RS232 + 2xUSB(*)] [GFO ST] [ETHERNET] [ETHERNET] [ELECTRIC CAN]
	I	[RS232 + USB] [ETHERNET] [GFO ST] [RS232/RS485] [ELECTRIC CAN]		
	(*) Additional USB FRONT PORT for management of IEC 61850 system.			
8	**Inputs and Outputs**			
	0	8DI + 6DO + 4 Outputs to Raise / Lower Taps + 1 Alarm Output + 4 LEDs	**4**	25DI + 12DO + 4 Outputs to Raise / Lower Taps + 1 Alarm Output + 2 Input Transducers (4-20mA) + 4 LEDs
	1	25DI + 12DO + 4 Outputs to Raise / Lower Taps + 1 Alarm Output + 2 Input Transducers (0-5mA or ±2.5mA) + 4 LEDs	**5**	42DI + 18DO + 4 Outputs to Raise / Lower Taps + 1 Alarm Output + 4 Input Transducers (4-20mA) + 16LEDs
	2	25DI + 12DO + 4 Outputs to Raise / Lower Taps + 1 Alarm Output + 1 Input Transducers (0-5mA or ±2.5mA) + 1 Input Transducer for VDC Supervision (0-300VDC) + 4 LEDs	**6***	8DI (Vdc) + 12DI (Vac) + 10DO + 1 output transducer (0-20mA) + Input for resistor chain + 2 Lower contacts + 2 Riser contacts + 1 Alarm Output + 4 LEDs
	3	44DI + 18DO + 4 Outputs to Raise / Lower Taps + 1 Alarm Output + 1 Input Transducers (0-5mA or ±2.5mA) + 1 Input Transducer for VDC Supervision (0-300VDC) + 16 LEDs	**7**	82DI + 30DO + 4 Outputs to Raise / Lower Taps + 1 Alarm Output + 2 Input Transducers (0-5mA or ±2.5mA) + 16LEDs
	All inputs are VDC. (*) Only for resistor chain aplication.			

	RTV										
1		2	3	4	5	6	7	8	9	10	11	12

9	**Spare (to be defined in the factory)**			
	D0	Standard Model + overvoltage unit + new improvement in the LDC and the circulating current automatism + underfrequency unit + VT failure unit + reset signal for the out of voltage block + 5 selectable setpoint values + different selectable increments of the setpoint + under voltage timer + runaway block + compensated setpoint value displayed in default MMI + event signals for tap value and manual mode.	**D6**	D0 + IEC61850 (MMS services and GOOSE service) v.4 (SBO) with Non-Redundancy, Bonding Redundancy or PRP Redundancy.
			D8	D0 + IEC61850 (MMS services and GOOSE service) v.4 (SBO) with Non-Redundancy, Bonding Redundancy or PRP Redundancy or RSTP redundancy + 8 Goose Control Blocks.
			DB	D8 + Number of XSWI and CSWI logical nodes increased to 24 and 30 respectively.
10	**Enclosure / Chassis**			
	M	2U x 19" 1 Rack (Inputs / Outputs type 0)	**0**	2U x 19" 1 Rack + cover (Inputs / Outputs type 0)
	S	3U x 19" 1 Rack (Inputs / Outputs type 1, 2, 4, 6 and type 0 in vertical format)	**1**	3U x 19" 1 Rack + cover (Inputs / Outputs type 1, 2, 4, 6 and type 0 in vertical format)
	Q	4U x 19" 1 Rack (Inputs / Outputs type 3 and 5)	**2**	4U x 19" 1 Rack + cover (Inputs / Outputs type 3 and 5)
	V	6U x 19" 1 Rack (Inputs / Outputs type 7)	**4**	6U x 19" 1 Rack + cover (Inputs / Outputs type 7)
11	**Communications Protocol for Remote Communications**			
	K	Standard [PROCOME 3.0/DNP 3.0 (Profile v.2)/MODBUS RTU - SERIAL and over ETHERNET for Remote Ports 1, 2 & 3]	**N**	Standard plus Virtual I/O Protocol for Remote Ports 1 & 2 + [DNP3 and MODBUS RTU over the IEC61850 ports]*
	M	Standard plus Virtual I/O Protocol for Remote Ports 1 & 2		
	(*) Not available when the selection in digit 3 is 1.			
12	**Mounting and Finishing**			
	--	Horizontal Rack Mount + [O] Red / [I] Green	**Q**	Horizontal Rack Mount + Conformal Coated Circuit Boards + [O] Green / [I] Red + For both User Interfaces (with texts in english)
	A	Vertical Rack Mount + [O] Red / [I] Green		
	L	Horizontal Rack Mount + Conformal Coated Circuit Boards + [O] Red / [I] Green	**S**	Vertical Rack Mount + Conformal Coated Circuit Boards + [O] Green / [I] Red + For both User Interfaces (with texts in english)
	N	Vertical Rack Mount + Conformal Coated Circuit Boards + [O] Red / [I] Green		
			T	Horizontal Rack Mount + Conformal Coated Circuit Boards + [O] Green / [I] Red + Texts in Spanish / Portuguese (only for Models with graphic display) + Box with front IP51

ANSI	Functions	Number of Units
		RTV-P U, ILOC, IREM
90	Voltage Regulation	1
	Line Drop Compensation (LDC Z and LDC R-X)	1
	Reactive Compensation	1
	Tap Monitoring	1
	Up to 5 transformer Paralleling with IEC61850	1
	Up to 3 transformer Paralleling with standard model	1
	Power Flow Reversal	1
	Blocking due to Voltage out of Range	1
59	Phase Overvoltage	1

1.4.2 Models replaced by others with Higher Functionality and not Available Options

	RTV										
1		2	3	4	5	6	7	8	9	10	11	12

Digit	Code	Description	Code	Description
2	**Functions**			
	D	90 + Compensations + Tap Changer Monitoring		
3	**Options**			
	2	100TX and 100TX Ports – Ethernet F.O. (MT-RJ) and RJ45 (IEC 61850/UCA 2.0)		
4	**Hardware Options**			
	S	Integrated Simulator		
7	**Communications Ports [COM1-LOC] [COM 2-REMP1] [COM3-REMP2] [COM4-REMP3] [COM5-REMP4]**			
	5	[RS232 + USB] [RS232 F.M.] [RS232 / RS485] [--] [ELECTRIC CAN]	**B**	[RS232 + USB] [ETHERNET] [RS232 / RS485] [--] [ELECTRIC CAN]
	6	[RS232 + USB] [--] [--] [--] [--]	**L**	[RS232 + 2xUSB] [ETHERNET] [RS232 / RS485] [GFO ST] [ELECTRIC CAN]
	7	[RS232 + USB] [GFO ST] [GFO. ST] [--] [ELECTRIC CAN]	**N**	[RS232 + 2xUSB] [RS232 F.M.] [RS232/RS485] [--] [ELECTRIC CAN]
	8	[RS232 + USB] [GFO ST] [RS232 / RS485] [ELECTRIC CAN]	**Z**	[RS232 + 2xUSB] [GFO ST] [RS232/RS485] [--] [ELECTRIC CAN]
	A	[RS232 + USB] [PFO] [RS232 / RS485] [--] [ELECTRIC CAN]		
9	**Spare (to be defined in the factory)**			
	01	Data Profile Rev. 01	**B6**	B0 + IEC61850 (MMS services and GOOSE service) v.4 (SBO) without redundancy, with Bonding type redundancy or with PRP type redundancy.
	02	Data Profile Rev. 02	**B7**	B6 + RSTP Redundancy.
	03	Data Profile Rev. 03	**B8**	B7 + 8 Goose Control Blocks.
	04	Data Profile Rev. 03 + Bonding redundancy	**C0**	Standard Model + overvoltage unit + new improvement in the LDC and the circulating current automatism + underfrequency unit + VT failure unit + reset signal for the out of voltage block + 5 selectable setpoint values + different selectable increments of the setpoint + under voltage timer + runaway block + compensated setpoint value displayed in default MMI.
	06	Data Profile Rev. 04+ Bonding or PRP redundancy	**C6**	C0 + IEC61850 (MMS services and GOOSE service) v.4 (SBO) with Non-Redundancy, Bonding Redundancy or PRP Redundancy
	A0	Standard Model + Overvoltage Unit + Extended setting ranges	**C8**	C0 + IEC61850 (MMS services and GOOSE service) v.4 (SBO) with Non-Redundancy, Bonding Redundancy or PRP Redundancy or RSTP redundancy + 8 Goose Control Blocks.
	A3	A0 + IEC61850 (MMS and GOOSE services) v.3	**C9**	C8 + CID load by frontal port.
	A4	A0 + IEC61850 (MMS and GOOSE services) v.3 with Bonding redundancy		
	A6	A0 + IEC61850 (MMS and GOOSE services) v.4 (SBO) without redundancy, with Bonding type redundancy or with PRP type redundancy.		
	A7	IEC61850 (MMS services and GOOSE service) v.4 (SBO) with Non-Redundancy, Bonding Redundancy or PRP Redundancy or RSTP redundancy.		
	A8	A7 + 8 Goose Control Blocks.		
	B0	Standard Model + Overvoltage Unit + Extended Setting Ranges + 5 Set-Point values + Underfrequency Unit + Breaker Failure + Runaway Logic + Voltage Blocking Time + Variable regulation + Reset signal for the out of voltage block+ Different selectable increments of the setpoint.		
11	**Communications Protocols for Remote Communications**			
	B	[PROCOME 3.0] [--] [--] [CAN]	**G**	[PROCOME 3.0] [PROCOME 3.0 / DNP3.0 Profile II / MODBUS] [PROCOME 3.0 / DNP3.0 Profile II / MODBUS] [--]
	C	[PROCOME 3.0] [PROCOME 3.0 / DNP3.0 / MODBUS] [PROCOME 3.0 / DNP3.0 / MODBUS] [--]	**H**	[PROCOME 3.0] [PROCOME 3.0 / DNP3.0 Profile II / MODBUS / Virtual Inputs and Outputs] [PROCOME 3.0 / DNP3.0 Profile II / MODBUS] [--]
	E	[PROCOME 3.0] [PROCOME 3.0 / DNP3.0 / MODBUS / Virtual Inputs and Outputs] [PROCOME 3.0 / DNP3.0 / MODBUS] [--]	**L**	[PROCOME 3.0] [PROCOME 3.0 / DNP3.0 Profile II / MODBUS (2) / Virtual Inputs and Outputs] [PROCOME 3.0 / DNP3.0 Profile II / MODBUS (2) SERIAL and ETHERNET] [--]
	F	[PROCOME 3.0] [PROCOME 3.0 / DNP3.0 / MODBUS] [PROCOME 3.0/DNP3.0/MODBUS] [CAN Multimaster]	**P***	Standard + Virtual I/O Protocol by Remote Ports 1 & 2 + [5 instances by the IEC61850 ports, 1 PROCOME and 4 configurable DNP3 or MODBUS]
	(*) Just when the selection of the communication interfaces for IEC61850, digit 3, all options except 1 option. Only available with *6 options in 9 digit.			

1	RTV	2	3	4	5	6	7	8	9	10	11	12

12	Mounting and Finishing			
	M	Horizontal Rack Mount + Printed Circuit Board Tropicalized + [O] Red / [I] Green + Texts in English	R	Horizontal Rack Mount + Printed Circuit Board Tropicalized + [O] Green / [I] Red + Texts in Spanish/Portuguese (only for Models with graphic display)
	P	Vertical Rack Mount + Printed Circuit Board Tropicalized + [O] Red / [I] Green + Texts in English		

ANSI	Functions	Number of Units
		RTV-D (U, ILOC, IREM)
90	Voltage Regulation	1
	Line Drop Compensation (LDC Z and LDC R-X)	1
	Reactive Compensation	1
	Tap Monitoring	1
	Up to 5 transformer Paralleling with IEC61850	0
	Up to 3 transformer Paralleling with standard model	0
	Power Flow Reversal	1
	Blocking due to Voltage out of Range	0

1.5 Installation and Commissioning

1.5.1 General

Improper handling of electrical equipment is extremely dangerous, therefore, only skilled and qualified personnel familiar with appropriate safety procedures and precautions should work with this equipment. Damage to equipment and injury to personnel can result when proper safety precautions are not followed.

The following general safety precautions are provided as a reminder:

- **High magnitude voltages are present in Power Supply and metering circuits even after equipment has been disconnected.**
- **Equipment should be solidly grounded before handling or operating.**
- **Under no circumstances should the operating limits of the equipment be exceeded (voltage, current, etc.).**
- **The Power Supply Voltage (ac or dc) should be disconnected from the equipment before extracting or inserting any module; otherwise damage may result.**

The tests defined next are those indicated for the start-up of a **RTV** IED. They do not necessarily coincide with the final manufacturing tests to which each manufactured IED is subjected. The number, the type and the specific characteristics of the acceptance tests are model dependent.

1.5.2 Accuracy

The accuracy of the measuring instruments and test source signals (auxiliary power supply voltage, AC currents and AC voltages) is key in electrical testing. Therefore, the information specified in the Technical Data section (2.1) of this manual can only be reasonably verified with test equipment under normal reference conditions and with the tolerances indicated in the UNE 21-136 and IEC 255 standards in addition to using precision instruments.

It is extremely important that there be little or no distortion (<2%) in the test source signals as harmonics can affect internal measuring of the equipment. For example, distortions will affect this IED, made up of non-linear elements, differently from an AC ammeter, because the measurement is made differently in both cases.

It must be emphasized that the accuracy of the test will depend on the instruments used for measuring as well as the source signals used. Therefore, tests performed with secondary equipment should focus on operation verification and not on measuring accuracy.

1.5.3 Installation

- **Location**

The place where the equipment is installed must fulfill some minimum requirements, not only to guarantee correct operation and the maximum duration of useful life, but also to facilitate placing the unit in service and performing necessary maintenance. These minimum requirements are the following:

- Absence of dust.
- Absence of humidity.
- Absence of vibration.
- Good lighting.
- Easy access.
- Horizontal or vertical mounting.

Installation should be accomplished in accordance with the dimension diagrams.

- **Connections**

The first terminal of the terminal block corresponding to the auxiliary power supply must be connected to ground so that the filter circuits can operate. The cable used for this connection should be 14 AWG stranded wire, with a minimum cross section of 2.5 mm^2. The length of the connection to ground should be as short as possible, but not more than 75 inches (30 cm). In addition, the ground terminal of the case, located on the rear of the unit, should be connected to ground.

1.5.4 Preliminary Inspection

The following equipment aspects should be examined:

- The unit is in good physical condition, mechanical parts are securely attached and no assembly screws are missing.
- The unit model number and specifications agree with the equipment order.

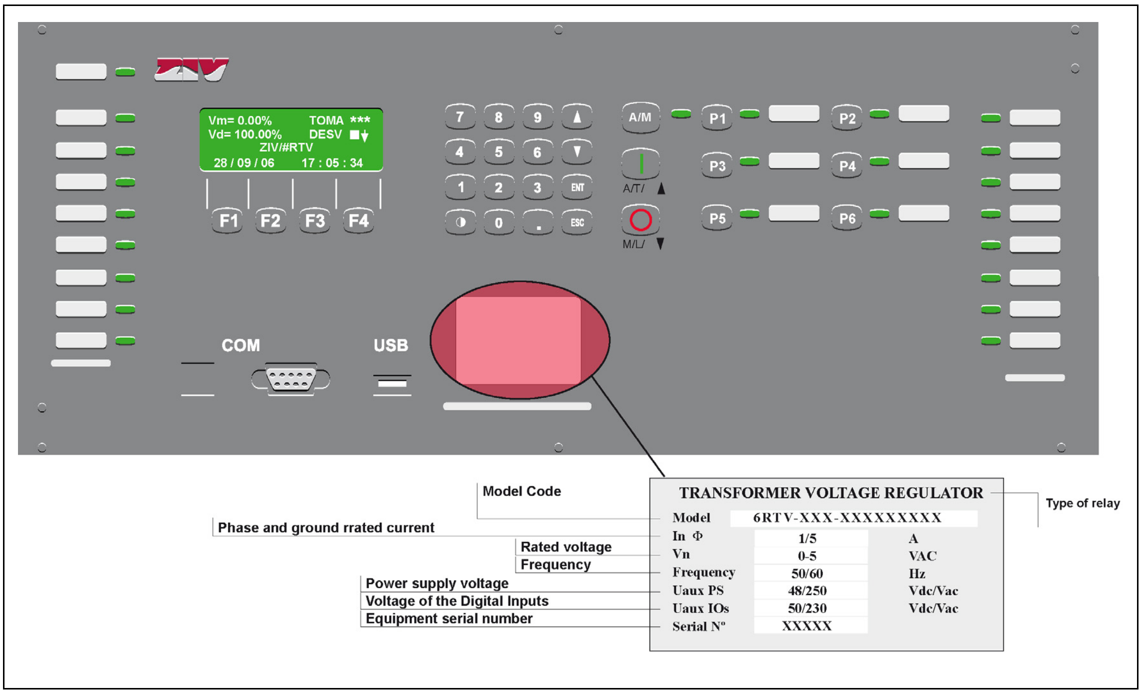


Figure 1.5.1: Name Plate (4U High).

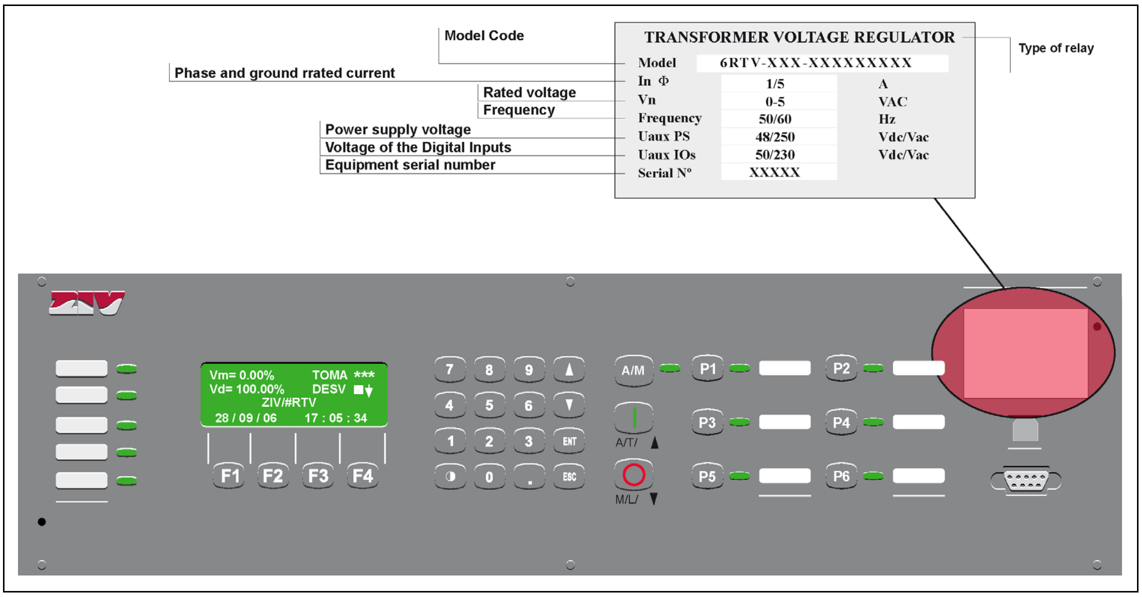


Figure 1.5.2: Name Plate (3U High)

1.5.5 Tests

1.5.5.a Isolation Test

While testing for isolation of switchgear and external wiring, the IED must be disconnected to avoid damage in case the test is not performed properly or if there are shorts in the harness, since the manufacturer has performed isolation testing on 100% of the units.

- **Common Mode**

All the terminals of the IED must be short-circuited, except those that relate to the power supply. The enclosure ground terminal must also be disconnected. Then 2000 Vac are applied between the interconnected terminals and the metal case for 1 min or 2500 Vac during 1s between the terminal group and the metal enclosure.

- **Transverse Mode**

The isolation groups are comprised of the current and voltage inputs (independent channels), digital inputs, auxiliary outputs, trip contacts and power supply. Reffer to the connection's schematic to identify the terminals to group for performing the test. Then 2500 VAC are applied during 1 sec. between each pair of groups.

WARNING!

There are internal capacitors that can generate high voltage if the test points are removed for the insulation test without reducing the test voltage.

1.5.5.b Power Supply Test

Connect the power supply as indicated in following table.

VDC PROT	CON1P	CON2P
C3(+) - C2(-)	C12-C13	C12-C14

It is important to verify that, when the IED is not energized, the contacts designated CON2P in the table mentioned previously are closed, and those designated CON1P are open. Then it is fed its rated voltage and the contacts designated CON1P and CON2P must change state and the "**Ready**" LED must light up.

1.5.5.c Metering Tests

For this test it should be considered that, if it is required to avoid trips while this is being carried out, the elements should be disabled and the cutoff of the injection of current and/or voltage by the breaker avoided. Subsequently, the currents and voltages which, as an example, are indicated in the following table will be applied to each of the channels and the following measures will be verified:

Applied Current or Voltage	Measured Current or Voltage	Phase of I or V applied	Phase of I or V measured	Freq. Applied (V > 20 Vac)	Freq. Measured (V > 20 Vac)
X	X ±1%	Y	Y ±1º	Z	Z ±5 mHz

Note: to check high current values, they are applied during the shortest possible time; for example, for 20 A, less than 8 seconds. To be able to view the angles, the phase A voltage must be applied the same as for measuring the frequency.

1.6 Onload Test

1.6.1 Introduction

The objectives of Onload Test are the following ones:

- Confirm that the external wiring of the voltage and current analog input channels is correct.
- Check the polarity of the current transformers.
- Check the voltage and current measurements (module and angle).

In order to proceed with the test, primary injections will be done to check the polarity and transformation ratios. These tests can only be carried out if there are no restrictions related to the energization of the bay and all the other devices of the bay where the protection relay is located have already been commissioned.

Before starting the tests, check that all the test leads have been removed and ensure that the external wiring is properly connected (it is possible that during the commissioning tests external wirings have been disconnected).

1.6.2 Voltage Connections

Using a multimeter check that the secondary voltage measurements are correctly rated, and by means of a phase rotation meter confirm that the system phase rotation is the correct one.

Compare the secondary multimeter values with the measurements the relay shows in the measurement screen when the transformation ratio is set to 1. Check not only the module but also the angle. Modify the setting in order to show the measurements in primary values. The measurements that are displays in the HMI of the device or in the communication program should comply with the values which are specified in the Measurement Accuracy paragraph in Chapter 2.1, Technical Data.

1.6.3 Current Connections

Place a multimeter in series with each of the analog current inputs of the relay in order to test the secondary values of each phase. This test will be carried out comparing the value of the multimeter with the value displayed in the HMI of the relay when the transformation ratio is set to 1. Check not only the module but also the angle. Modify the setting in order to show the measurements in primary values. The measurements that are displays in the HMI of the device or in the communication program should comply with the values which are specified in the Measurement Accuracy paragraph in Chapter 2.1, Technical Data.

Check that when injecting a balanced system, the current which is flowing through the neutral circuit of the transformer is negligible.

Ensure the current polarity is the correct one measuring the phase angle between the current and the voltage which are being injected.

Check that for load current flowing outside the bay (forward direction) the active power measurement is positive while for load current flowing inside the bay (reverse direction) the active power measurement is negative.

In those models with ground differential current measurement, check that the current polarity of the polarization channels is the correct one. Inject the same current value in the polarization channel and just in one phase analog input lagging 180º and check that the ground differential current (IGN) is zero or almost zero. In case of having ground differential current, modify the wiring of the polarization channel.

Chapter 2.

Technical Specifications and Physical Description

2.1 Technical Data

2.1.1 Power Supply Voltage

RTV IEDs have two types of auxiliary power supplies. Depending on the model, their values are selectable:

24 VDC (+20% / -15%)
48 - 250 VAC/VDC (±20%)

Note: In case of power supply failure, a maximum interruption of 100 ms is allowed for 110 VDC input.

2.1.2 Power Supply Burden

Quiescent	**7 W**
Maximum	**<20 W**

2.1.3 Current Analog Inputs

Rated current	**In** = **5 A** or **1 A** (selectable in the IED)
Thermal withstand capability	**20 A** (continuously)
	250 A (for 3 s.)
	500 A (for 1 s.)
Dynamic limit	**1250 A**
Current circuit burden	**<0.2 VA** (In = 5 A or 1 A)

2.1.4 Voltage Analog Inputs

Rated voltage	**Vn** = **50** to **230 VAC**
Thermal withstand capability	**300 VAC** (continuously)
	600 VAC (for 10s.)
Voltage circuit burden	**0.55 VA** (110/120 VAC)

2.1.5 Frequency

Operating range	**16 - 81 Hz**

2.1.6 Measurement Accuracy

Measured currents Phases	**±0.1%** or **±2 mA** (the greater) for In = 1A and 5A
Measured voltages Phase-Ground, Phase-Phase	**±0.1%** or **±50 mV** (the greater)
Active and reactive powers (In = 5A and I_{phases}>1A)	
Angles **0º** or **±90º** or **180º**	**±0.33% W/Var**
Angles **±45º** or **±135º**	**±1.6% W/Var**
Angles **±75º** / **±115º**	**±5% W / ±0.65% Var**
Angles	**±0.5º**
Power factor	**±0.013**
Frequency	**±0.005 Hz**

Note: Signal processing

Sampling function adjustment of analogy input signals is made by means of zero pass count of one of the measured signals, and works detecting the change in said signal period. The value of the calculated frequency is used to modify the sampling frequency used by the metering device attaining a constant sampling frequency of 32 samples per cycle. The frequency value is saved for later use in Protection and Control tasks.

Zero crossing is detected by the voltage channel VPH. When VA phase voltage falls below 2 volts is not possible to measure frequency. In case of loosing phase voltage the sampling frequency to consider will be the nominal frequency of the system.

When Protection and Control tasks are readjusted in accordance with the sampling function, phasor real and imaginary components of analogy signals are calculated by means of the Fourier transform. Fourier components are calculated by means of said Discrete Fourier Transform (DFT) using 32 sample/cycle. Using DFT this way the magnitude and phase angle of the fundamental component at power system frequency of every analogy input signal is obtained. The rest of measurements and calculations of Protection functions is obtained based on the fundamental components calculated by the Fourier method. DFT gives a precise measurement of the fundamental frequency component and it is an efficient filter for harmonics and noise.

Harmonics are not completely damped for frequencies other than the nominal frequency. This is not a problem for small deviations of ±1Hz but, in order that a greater deviation from the working frequency can be allowed, the above-mentioned automatic adjustment of the sampling frequency is included. On lack of an adequate signal for sampling frequency adjustment, said frequency is adjusted to the corresponding nominal frequency (50/60Hz).

Angles reference for all the measurements displayed on the device corresponds to the voltage channel VPH.

2.1.7 Repeatability

Operating time	**2 %** or **25 ms** (the greater)

2.1.8 Digital Inputs

Configurable inputs with polarity:

Rated Voltage	Maximum Voltage	Burden	V on	V off
110/125 Vac	250 Vac	350 mW	90 Vac	46 Vac
24 Vdc	48 Vdc	50 mW	12 Vdc	9 Vdc
48 Vdc	90 Vdc	500 mW	30 Vdc	25 Vdc
125 Vdc	300 Vdc	800 mW	75 Vdc	60 Vdc
125 Vdc (Act. >65%)	300 Vdc	800 mW	93 Vdc	83 Vdc
250 Vdc	500 Vdc	1 W	130 Vdc	96 Vdc

Note: the activation and deactivation time of alternating current inputs is approximately 150ms.

2.1.9 Operation Outputs (Raise/Lower Tap) and Auxiliary Outputs

2 contacts normally open for each operation, one of which is configurable internally to closed, and auxiliary contacts (depends on model) normally open.

I DC maximum limit (with resistive load)	**60 A** (1 s.)
I DC continuous service (with resistive load)	**16 A**
Close	**5000 W**
Breaking capability (with resistive load)	**240 W** - max. 5 A - (48 Vdc)
	110 W (80 Vdc - 250 Vdc)
	2500 VA
Break (L/R = 0.04 s)	**120 W** at 125 Vdc
Switching voltage	**250 Vdc**
Momentary close time trip contacts remain closed	**100 ms.**
Break delay	**<150 ms.**

2.1.10 Input Transducers

0-5mA or ±2.5mA Transducers	
Input Impedance:	**511Ω**
Measurement Accuracy	**±0.2%** or **± 3μA** (the greater)
4-20mA Transducers	
Input Impedance:	**220Ω**
Measurement Accuracy	**±0.2%** or **± 3μA** (the greater)
Voltage Transducers (for 125Vdc and 250Vdc)	
Input Impedance:	**<410kΩ**
Measurement Accuracy (between 70Vdc and 350Vdc)	**±0.2%** or **±0.5 V** (the greater)
Voltage Transducers (for 24Vdc and 48Vdc)	
Input Impedance:	**<410kΩ**
Measurement Accuracy (between 10Vdc and 70Vdc)	**±0.2%** or **±0.2 V** (the greater)

2.1.11 Transducer Outputs

0.20mA Transducers	
Input impedance	**250Ω**
Measurement accuracy	**±2 %** or **± 16μA** (the greater)

2.1.12 Resistor Chain Inputs

Resistor Chain Inputs	
Input impedance	**410kΩ**

2.1.13 Accuracy of the Pickup and Reset of the Voltage Elements

Overvoltage Elements	
Pickup	**±2 %** or **±250 mV** of the theoretical value (the greater)

2.1.14 Measuring Times of the Voltage Units

Mode	Time Setting	Measuring Times	
		50Hz	60Hz
Fixed Time	0 s	32 ms	28 ms
Fixed Time	> 0 s	±1% of the setting or ±32 ms (the greater)	

2.1.15 Accuracy of the Pickup and Reset of the Frequency Elements

Overfrequency Elements
Pickup and reset — **±0.01 Hz** of the theoretical value

Underfrequency Elements
Pickup and reset — **±0.01 Hz** of the theoretical value

2.1.16 Measuring Times of the Frequency Units

Mode	Measuring Times
Fixed Time	1.5 cycles

Note: It must be added to this time the adjusted value in *Activation Half-Time* corresponding to Frequency Units.

2.1.17 Communications Link

Local Communications Port (RS232C and USB).
Remote Communications Ports (Glass F.O., Plastic F.O., RS232C, RS232-Full MODEM or RS485).
LAN Ports (RJ45).
Electric Bus.

Glass Fiber Optics (Remotes Ports)

Type	**Multimode**
Wavelength	**820 nm**
Connector	**ST**
Transmitter Minimum Power	
50/125 Fiber	**- 20 dBm**
62.5/125 Fiber	**- 17 dBm**
100/140 Fiber	**- 7 dBm**
Receiver Sensitivity	**- 25.4 dBm**

Glass Fiber Optics (LAN Ports)

Type	**Multimode**
Wavelength	**1300 nm**
Connector	**MT-RJ**
Transmitter Minimum Power	
50/125 Fiber	**- 23.5 dBm**
62.5/125 Fiber	**- 20 dBm**
Receiver Sensitivity	**- 34.5 dBm**

Plastic Fiber Optics (1 mm)

Wavelength	**660 nm**
Transmitter Minimum Power	**- 16 dBm**
Receiver Sensitivity	**- 39 dBm**

RS232C Port Signals

Terminal unit DB-9 (9-pin) connectors	**Pin 5 - GND** **Pin 2 - RXD** **Pin 3 - TXD**

RS232C Full MODEM Port Signals

Terminal unit DB-9 (9-pin) connectors	**Pin 1 - DCD** **Pin 2 - RXD** **Pin 3 - TXD** **Pin 4 - DTR** **Pin 5 - GND** **Pin 6 - DSR** **Pin 7 - RTS** **Pin 8 - CTS** **Pin 9 - RI**

RS485 Port Signals

Used signals	**Pin 4 - (A) TX+ / RX+** **Pin 6 - (B) TX- / RX-**

RJ45 Port Signals

Used signals	**Pin 1 - TX+**
	Pin 2 - TX-
	Pin 3 - RX+
	Pin 4 - N/C
	Pin 5 - N/C
	Pin 6 - RX-
	Pin 7 - N/C
	Pin 8 - N/C

Electrical Bus Port Signals

Used signals	**Pin 1 - High**
	Pin 2 - Low
	Pin 3 - GND

IRIG-B 123 and 003	B: 100pps	
	1: Amplitude modulated wave	0: By pulse width
	2: 1kHz/1ms	0: Without carrier
	3: BCD, SBS	3: BCD, SBS

Type BNC connector	
Input impedance	**41 Ω, 211 Ω** or **330 Ω (*)**
Default impedance	**211 Ω**
Maximum input voltage	**10 V**

Synchronization Precision **± 1ms.**

When the device is receiving a IRIG-B signal for synchronization both Date and Time settings will not be available through the HMI.

It is possible to configure one of the auxiliary outputs to check the IRIG-B signal status. This output will remain active as long as the IRIG-B signal reception is correct.

All the IEDs are also designed to give an indication for both the loss and recovery of such IRIG-B signal by generating the particular event.

(*) Selectable internally by the manufacturer.

2.2 Standards and Type Tests

The equipment satisfies the standards indicated below. When not specified, the standard is UNE 21-136 (IEC-60255).

2.2.1 Insulation

Insulation Test (Dielectric Strength)	*IEC-60255-5*
Between all circuit terminals and ground	**2 kV**, **50/60 Hz**, for **1 min**; or **2.5 kV**, **50/60 Hz**, for **1s**
Between all circuit terminals	**2 kV**, **50/60 Hz**, for **1min**; or **2.5 kV**, **50/60 Hz**, for **1s**
Measurement of Insulation Resistance	*IEC-60255-5*
Common mode	**R** ≥ **100 MΩ** or **5μA**
Differential mode	**R** ≥ **100 kΩ** or **5mA**
Voltage Impulse Test	*IEC-60255-5* (*UNE 21-136-83/5*)
Common mode (analog inputs, DIs, AOs and PS)	**5 kV**; **1.2/50 μs**; **0.5 J**
Differential mode (AOs)	**1 kV**; **1.2/50 μs**
Differential mode (Power Supply)	**3 kV**; **1.2/50 μs**

2.2.2 Electromagnetic Compatibility

1 MHz Burst Test	*IEC-60255-22-1 Class III* (*UNE 21-136-92/22-1*)
Common mode	**2.5kV**
Differential mode	**2.5kV**
Fast Transient Disturbance Test	*IEC-60255-22-4 Class IV* (*UNE 21-136-92/22-4*) (**IEC 61000-4-4**) **4 kV ±10 %**
Radiated Electromagnetic Field Disturbance	*IEC 61000-4-3 Class III*
Amplitude modulated (*EN 50140*)	**10 V/m**
Pulse modulated (*EN 50204*)	**10 V/m**
Conducted Electromagnetic Field Disturbance	*IEC 61000-4-6 Class III* (*EN 50141*)
Amplitude modulated	**10 V**
Electrostatic Discharge	*IEC 60255-22-2 Class IV* (*UNE 21-136-92/22-2*) (*IEC 61000-4-2*)
On contacts	**±8 kV ±10 %**
In air	**±15 kV ±10 %**

Surge Immunity Test	*IEC-61000-4-5* (*UNE 61000-4-5*)
	(1.2/50µs - 8/20µs)
Between conductors	4 kV
Between conductors and ground	4 kV

Radiated Electromagnetic Field Disturbance at Industrial Frequency (50/60 Hz)	*IEC61000-4-8*

Radio Frequency Emissivity	*EN55022* (Radiated)
	EN55011 (Conducted)

2.2.3 Environmental Test

Temperature	*IEC 60068-2*
Cold work	*IEC 60068-2-1*
	-5º C, **2 hours**
Cold work limit conditions	*IEC 60068-2-1*
	-10º C, **2 hours**
Dry heat	*IEC 60068-2-2*
	+45º C, **2 hours**
Dry heat limit conditions	*IEC 60068-2-2*
	+55º C, **2 hours**
Humid heat	*IEC 60068-2-78*
	+40º C, **93% relative humidity**, **4 days**
Quick temperature changes	*IEC 60068-2-14 / IEC 61131-2*
	IED open,
	-25º C for **3h** and
	+70º C for **3h** (**5 cycles**)
Changes in humidity	*IEC 60068-2-30 / IEC 61131-2*
	+55º C for **12h** and
	+25º C for **12h** (**6 cycles**)
Endurance test	**+55º C** for **1000 hours**

Operating range	From **-40ºC** to **+85ºC** (standard model) From **-40ºC** to **+70ºC** (model with IEC61850 communications interface)
Storage range	From **-40ºC** to **+85ºC** (standard model) From **-40ºC** to **+70ºC** (model with IEC61850 communications interface)
Humidity	**95 %** (non-condensing)

Climate Test (55º, 99% humidity, 72 hours)

Time / Current Characteristic	*ANSI C37.60 Class II*

2.2.4 Power Supply

Power Supply Interference and Ripple	*IEC 60255-11 / UNE 21-136-83 (11)* **< 20 %** and **100 ms**
Inverse Polarity of the Power Supply	*IEC 61131-2*
Resistance of Ground Connection	*IEC 61131-2* **< 0.1 Ω**
Gradual Stop / Start Test	*IEC 61131-2 (Test A)*
Surge Capacity	*IEC 60044-1*

2.2.5 Mechanical Test

Vibration (sinusoidal)	*IEC-60255-21-1 Class I*
Mechanical Shock and Bump Test	*IEC-60255-21-2 Class I*
External Protection Levels	*IEC-60529 / IEC 60068-2-75*
Front	*IP31* (without protection cover) *IP51* (with protection cover)
Rear Protection	*IP10*
Mechanical Protection	*IK07*

The models comply with the EEC 89/336 standard of electromagnetic compatibility.

2.3 Physical Architecture

2.3.1 General

The **RTV** is made up of the following boards:

- Power Supply.
- Processor module and analog inputs.
- Digital inputs, outputs and transducers input.
- Communications module.

The boards, or modules, are mounted horizontally and can be extracted by removing the front panel. External connections use plug-in terminal blocks on the rear panel of the enclosure, with ring lug connectors.

Depending on the terminal configuration, all the contact inputs / outputs may be used or some may remain as spare signals.

Figures 2.3.1 and 2.3.2 represent the external appearance of the 2-unit high models and figures 2.3.3 and 2.3.4 represent the external appearance of the 3-unit high models.

Mounted on the front are the alphanumeric keypad and display, the local communication ports (RS232C and USB), the local control buttons and the LED targets.

Figure 2.3.1: Front of a 6RTV 2-unit High.

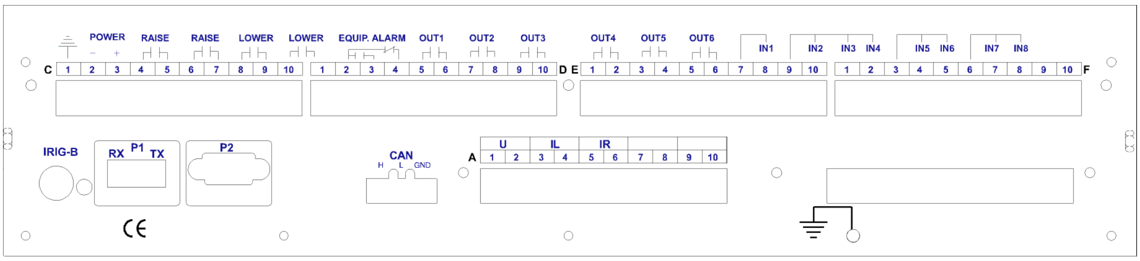


Figure 2.3.2: Rear of a 6RTV 2-unit High.

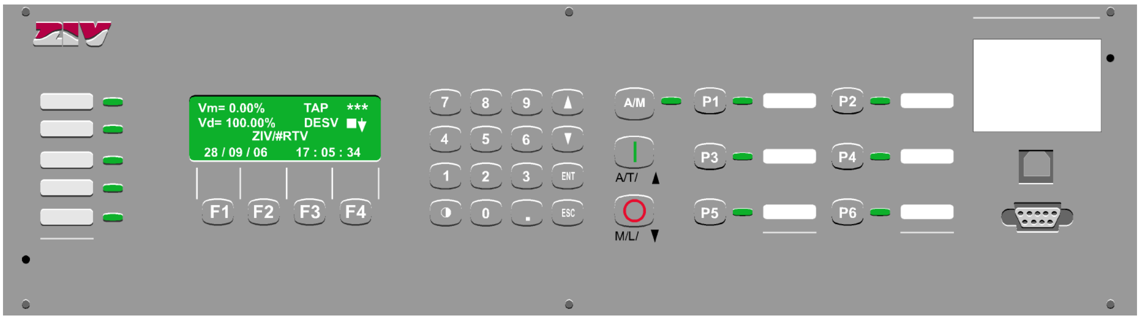


Figure 2.3.3: Front of a 6RTV 3-unit High.

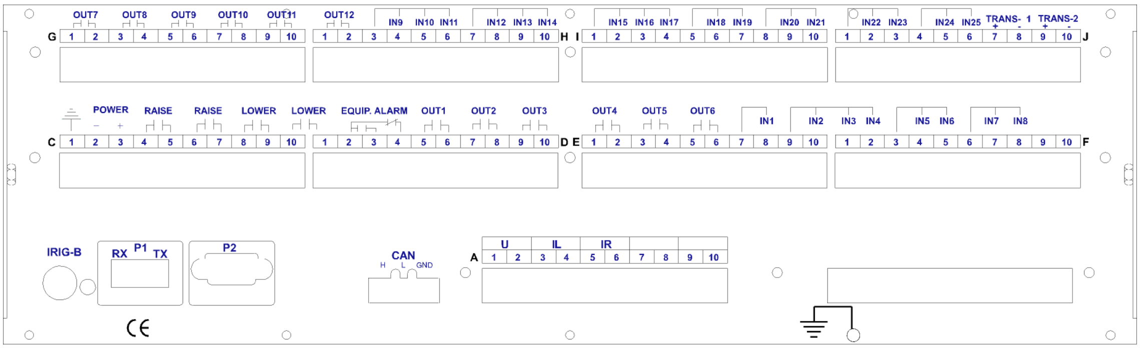


Figure 2.3.4: Rear of a 6RTV 3-unit High.

Another model are available with 4U high and 19” rack width with a front panel with that same control functions and a rear panel with additional terminals for expansion of digital inputs and outputs. This unit is depicted in figures 2.3.5 and 2.3.6.

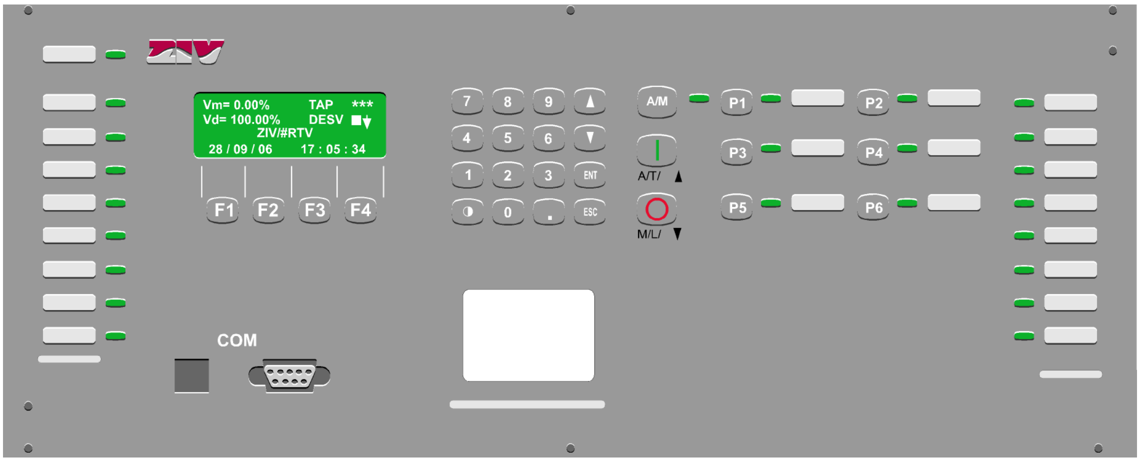


Figure 2.3.5: Front of a 6RTV 4-unit High.

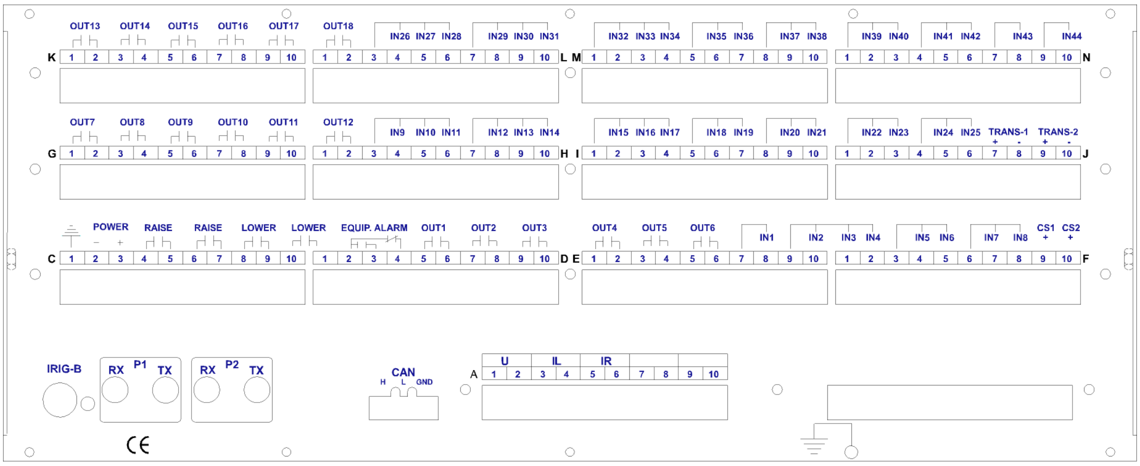


Figure 2.3.6: Rear of a 6RTV 4-unit High.

In the case of **1RTV** is a model in vertical format of 4U high and 19” rack, with a front of additional special characteristics and a rear panel with additional terminals for expansion of digital inputs and outputs. This unit is depicted in figures 2.3.7 and 2.3.8.

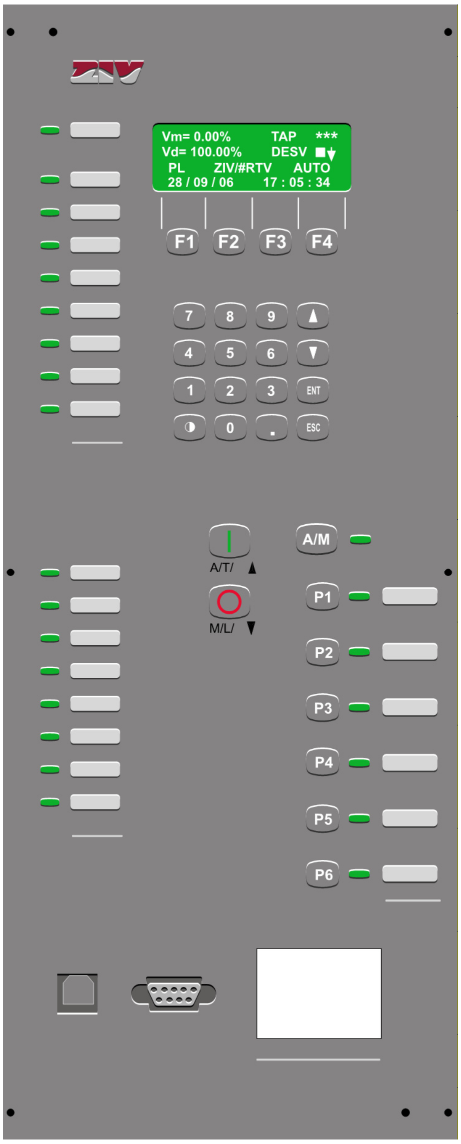


Figure 2.3.7: Front of a 1RTV 4-unit High.

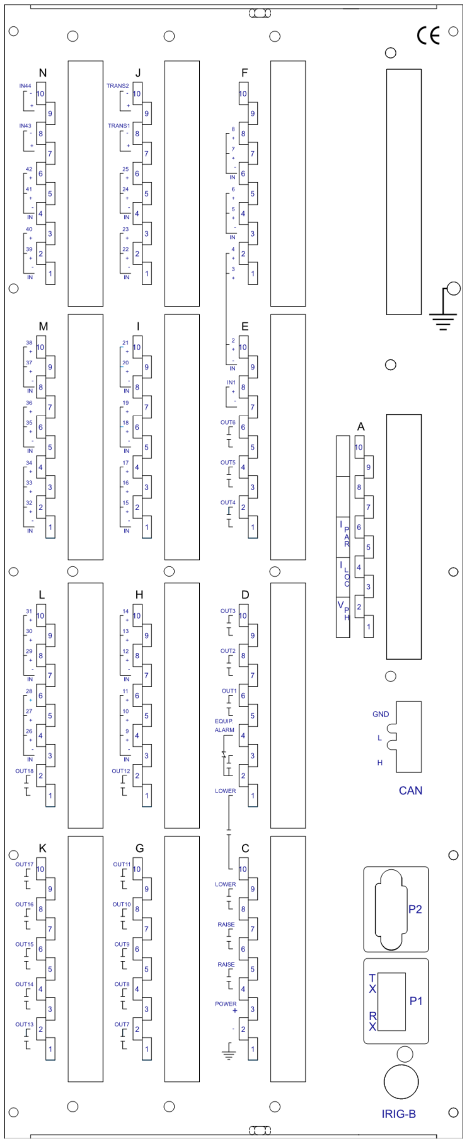


Figure 2.3.8: Rear of a 1RTV 4-unit High.

2.3.2 Dimensions

Depending on the model, **RTV** units are mounted as follows

- Models in enclosures of 1 19"-, 2 standard units high.
- Models in enclosures of 1 19"-, 4 standard units high.

The equipment is intended to be installed either semi-flush mounted on panels or inside a 19" rack. The enclosure is graphite gray.

2.3.3 Connection Elements

2.3.3.a Terminal Blocks

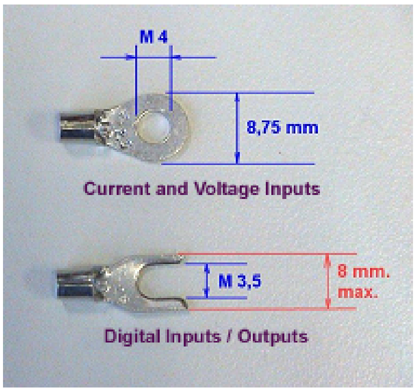
The number of connectors depends on the number of the model's contact inputs and outputs. Moreover, the terminal blocks are arranged differently depending on the model (2-units, 3-units or 4-units high).

Terminal blocks are horizontal as shown in the figures. The terminal arrangement for the 4-units high model is as follows:

- 1 row with 2 terminal blocks of 10 inputs each (20 terminals) for analog currents and voltages plus all the communication and synchronization connectors.
- 3 rows with 4 terminal blocks of 10 terminals each (40 terminals) for digital inputs, auxiliary outputs, trip and close contacts, power supply input and transducers input.

The terminals take wires up to #10 AWG (6 mm^2). We recommend ring lug terminals for these connections.

The connectors are plug-in and not self-shorting. They can be assigned to the current circuits supporting a current of 20 A continuously.



2.3.3.b Removing Printed Circuit Boards (Non Self-Shorting)

WARNING!

The IED's printed circuit board can be taken out. **WARNING: the current connector is non self-shorting. Consequently, the CT secondaries must be short-circuited externally before board removal.**

The printed circuit board is attached to the case with self-tapping screws. These screws must be removed before the board is withdrawn. This operation always requires the protection to be **not in service**.

2.3.3.c Internal Wiring

The equipment uses traditional printed circuit board connections and internal buses to minimize internal wiring.

Chapter 3.

Functions and Description of Operation

3.1 Voltage Regulator

3.1.1 Regulator Configuration

The **Regulator Configuration** includes three settings, Magnitude Display on Default Screen, Phase Angle Setting and Output Type.

3.1.1.a Magnitude Display on Default Screen

This setting refers only to the units in which the magnitudes shown on the regulator **Default Screen** are displayed.

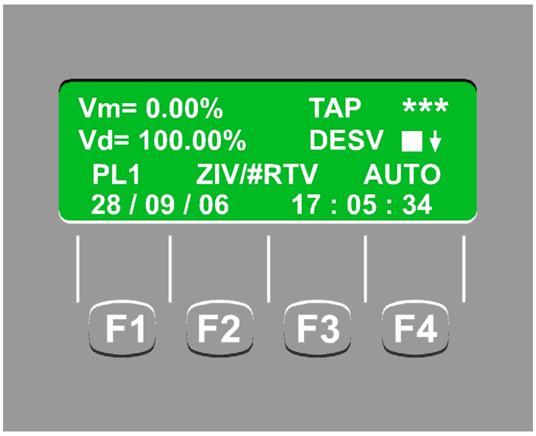


Figure 3.1.1: Magnitude Display on Default Screen.

3.1.1.b VT / CT Phase Difference Setting

Phase difference due to voltage (**VT**) and current (**CT**) transformer connections. The setting is the angle, expressed in degrees, measured counter clockwise, from V_m to I_m. Setting range is 0º to 330º (in 30º steps).

One setting for the local transformer current (I_L) and another setting for the parallel transformer current (I_P) are required.

Examples:

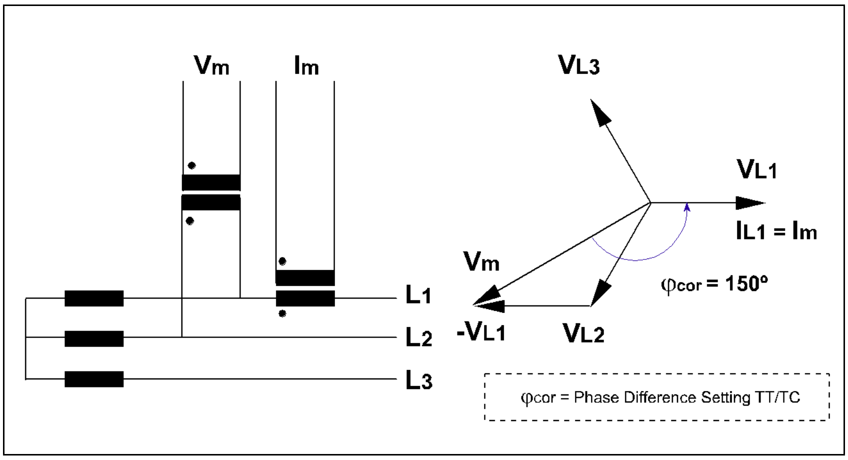


Figure 3.1.2: Example 1 for VT / CT Phase Difference Setting.

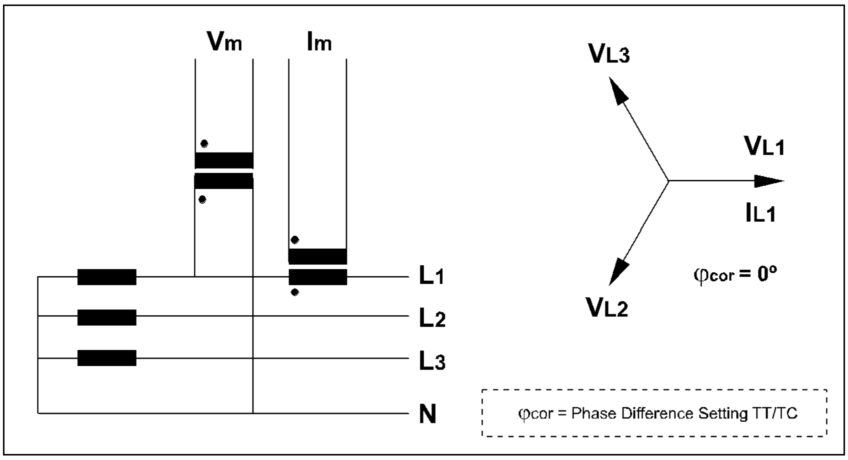


Figure 3.1.3: Example 2 for VT / CT Phase Difference Setting.

3.1.1.c Operation Output Types

Operation outputs (Raise the Tap / Lower the Tap) can be configured for the following activation types:

- **Pulse**, of adjustable duration, between 100 and 5000 msec. (see setting **Output Pulse Duration**).
- **Level** (only if **Tap Changer Monitoring** is enabled). The output resets when the target tap is reached or after Operation Fail Time times out.

Note: There exists a settings ratio check function to make sure that if the Tap Changer Supervision is disabled, the Output cannot be the Level type.

3.1.2 Voltage Set-point and Insensitivity Degree

The purpose of the **RTV** is maintaining the busbar voltage at a given V_{CON} set-point value. To this end the value of the V_{BUS} control variable must be known through a voltage measurement transformer (**TT**).

Only 3 settings are needed:

- Voltage Set-point: V_{CON}
- Insensitivity Degree: **GI**
- Delay Time: **T**

Both V_{CON} and **GI** are expressed in % of $V_{nominal}$. The **Deviation** (**DV**) is calculated at any time as:

$$DV\ (\%) = V_{CON}\ (\%) - V_{BUS}\ (\%)$$

The **GI** defines the bandwidth or dead band, within which the voltage is deemed acceptable, in view of the discontinuous and finite nature of the voltage transients. An adequate **GI** setting is normally considered equal to the voltage surge related to tap switching. These concepts are clarified in the figure below.

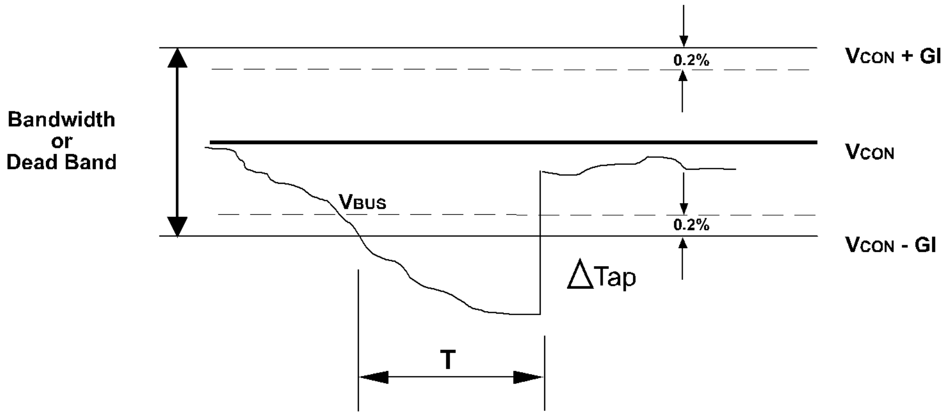


Figure 3.1.4: Insensitivity Degree.

Additionally, it can be mentioned that the dead band (not the GI) can be also defined using the following formula:

$$\text{Bandwidth} \geq 0.6 * \text{tap-change increment } [\%]$$

If the value of the Dead Band would be smaller than the tap-change increment of the transformer, the controlled system can never reach a stable condition as the voltage exceeds the bandwidth selected. If, on the other hand, a very large bandwidth is selected there will be a major control deviation and therefore the control and precision will be less.

A **Delay Time T** is introduced so as to prevent an excessive number of control operations upon short duration $\mathbf{V_{BUS}}$ voltage surges outside the dead band. Said delay can be set separately for the first control operation ($\mathbf{T_1}$) and later operations ($\mathbf{T_2}$), in case several operations are required to bring the voltage within the dead band. For more information, refer to section 3.1.3 Delay Times.

The sign of the deviation **DV** defines the type of command (Raise the Tap / Lower the Tap) to be sent to the **tap changer**.

- For a **Direct Tap / Voltage Ratio** (raise the tap is equivalent to raise the voltage):
  - If **|DV| < GI** → At rest (no action).
  - If **|DV| > GI** y $\mathbf{V_{CON}}$ (%) > $\mathbf{V_{BUS}}$ (%)→ Raise the Tap.
  - If **|DV| > GI** y $\mathbf{V_{CON}}$ (%) < $\mathbf{V_{BUS}}$ (%)→ Lower the Tap.
- For an **Indirect Tap / Voltage Ratio** (raise the tap is equivalent to lower the voltage):
  - If **|DV| < GI** → At rest (no action).
  - If **|DV| > GI** y $\mathbf{V_{CON}}$ (%) > $\mathbf{V_{BUS}}$ (%)→ Lower the Tap.
  - If **|DV| > GI** y $\mathbf{V_{CON}}$ (%) < $\mathbf{V_{BUS}}$ (%)→ Raise the Tap.

Raise the Tap or Lower the Tap commands are sent in accordance with a **Time Characteristic** that takes into account the voltage deviation **|DV|** absolute value and the settings of **Insensitivity Degree (GI)** and **Time Factor (FT)**:

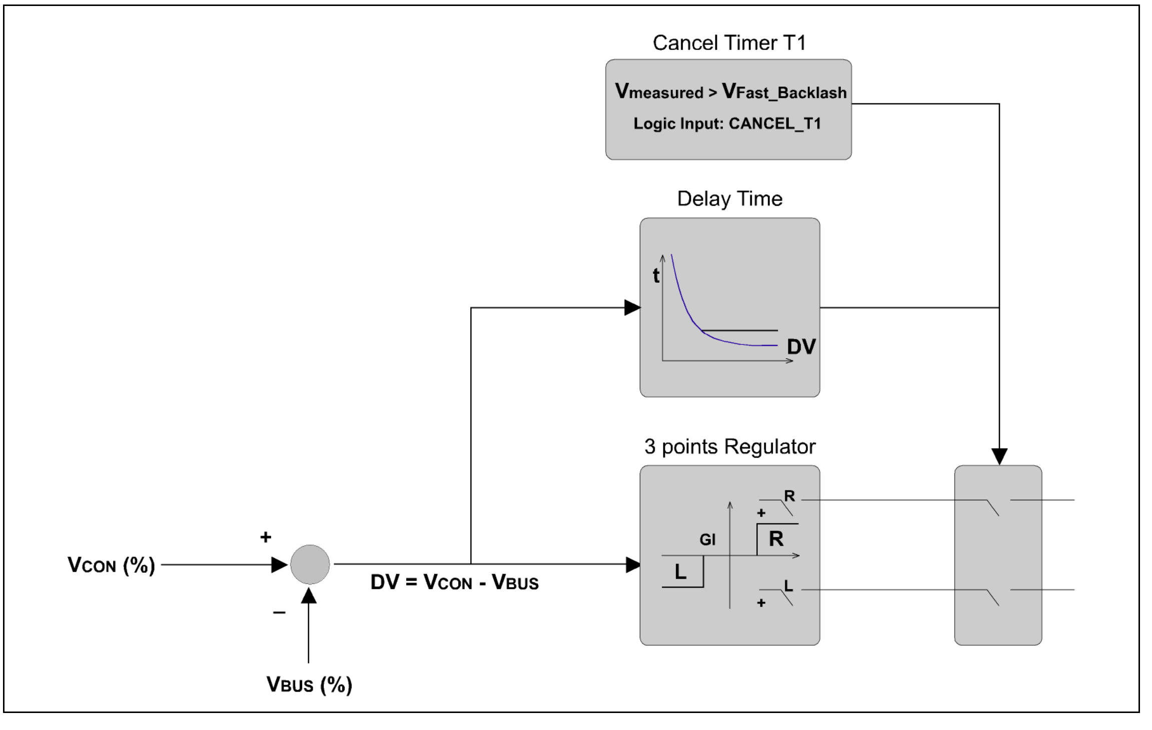


Figure 3.1.5: Schematic Representation of Raise / Lower the Tap.

The **RTV-P** with spare digit **B** or above includes, apart from the features above, a number of extra features, related to the control variable and setpoint.

The user, through the setting **Voltage source,** may select whether the controlled variable is the voltage measured through the analog voltage input or any other relay variable or magnitude, calculated in the logic or received through communications and linked through the control logic to the variable designated **EXTERNAL V**. From the moment the user sets **Voltage source** to **External**, the relay will use the value linked to the variable **EXTERNAL V** as the value to control and the angles of the local current measurement and the current measurement of the parallel transformer will be referred to this local current measurement, so the angle of **LOCC** will always be 0º in this case and, therefore, both the **LDC R-X** compensation and the current flow method cannot be enabled.

The relay includes 5 setpoint settings and a **Setpoint selection** setting to be used such that a setpoint setting may be changed to another with no need to change the settings table. The setpoint setting can be changed in two different ways:

- Using the setting **Setpoint selection**
- Using control logic input signals (**Setpoint activation command 1, Setpoint activation command 2**, etc.) that can be activated through digital inputs, signals calculated in the control logic, commands or signals received through communications, etc. The setpoint will be activated when one of the corresponding signals activates, taking into account internally a signal leading edge such that, if a signal is already active, a second signal is activated, the setpoint will change to this second signal, always remaining the last setpoint the leading edge of which was activated in case all signals are switched to a deactivated status.

Also, the setpoint could be changed through up and down commands, the percentage of the settable change being between 1 and 6%.

3.1.3 Delay Times

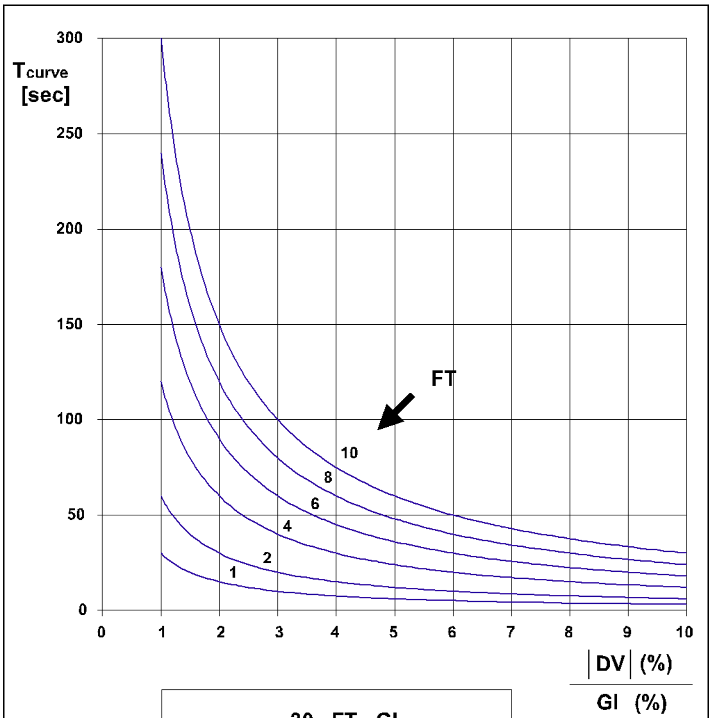
3.1.3.a Delay Time for the First Control Operation: T_1

A **Delay time for the first control operation: T1** is implemented so as to prevent an excessive number of operations upon short duration voltage surges outside the dead band. The settings involved are:

- **Curve type**: Inverse or Definite Time Curve.
- **Time Factor**: From 1 to 10 sec.
- **Definite Time T_1 ($T_{definite1}$)**: From 1 to 600 sec.

Where:

GI: Insensitivity Degree Setting Value (in %).
|DV|: Voltage Deviation absolute value (in %).



$$T_{curve} = \frac{30 \cdot FT \cdot GI}{|DV|} \text{ (sec)}$$

Figure 3.1.6: Time Curve for the First Control Operation: T_1.

If **Inverse Curve** is selected, if T_{curve} values obtained from the equation in the above figure are below $T_{definite1}$, $T_{definite1}$ is used. Refer to the summary table in the next page.

3.1.3.b Delay Time for Following Control Operations: T_2

Should more than one tap change be required to bring the V_{BUS} voltage back within the dead band **(V_{CON} ± GI)**, the second and following operations will take place after the **Definite Time T_2**.

This is because after the first tap change, if an **inverse curve** is used, taking into account that the delay is inversely proportional to the deviation **|DV|**, the next tap change commands can be delayed too much (time delay greater than **T_1**).

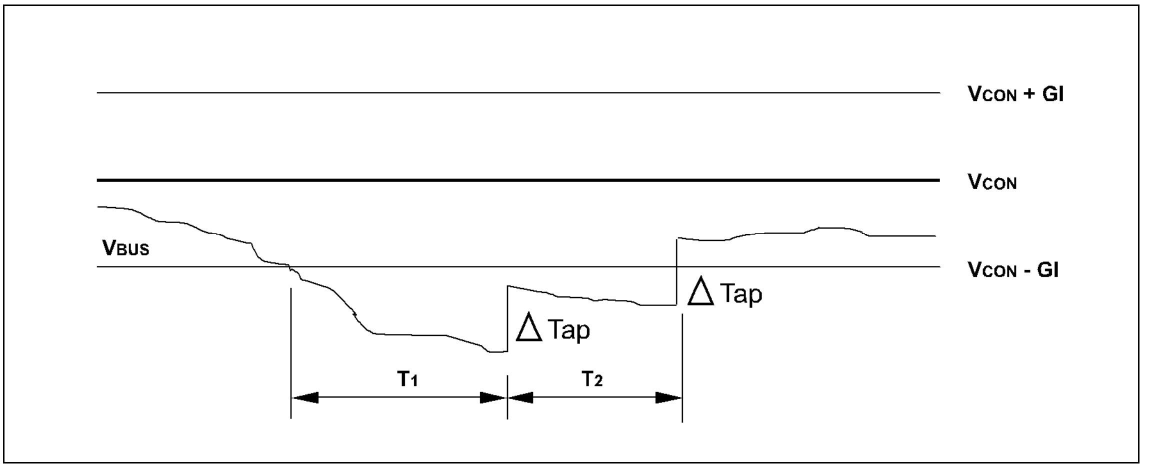


Figure 3.1.7: Delay Time for Following Control Operations: T_2.

Table 3.1-1: Delay Time Summary Table			
		1º Tap Switching (T_1)	Following Tap Switching
Curve Type	Inverse Curve	$T_{curve} > T_{definite1} \rightarrow T_1 = T_{curve}$	T_2
		$T_{curve} < T_{definite1} \rightarrow T_1 = T_{definite1}$	
	Definite Time	$T_1 = T_{definite1}$	T_2

3.1.3.c Cancel Timer T_1

Timer **T_1** can be cancelled in two ways as represented in the upper part of figure 3.1.4 (Cancel Timer T_1):

- The measured voltage goes above **Runback Voltage** setting.
- Logic input **CANCEL_T1** is activated (Cancel Timer T1).

In both cases, the first tap change command will occur in a maximum time of 0.5 to 1.5 seconds, and the following commands, if required, are sent after **T_2**.

3.1.4 Line Drop Compensation (LDC)

The main purpose of the **RTV** is keeping the busbar voltage **V_{BUS}** supplied by the transformer at a given level **V_{CON}**. The final target is keeping constant the load voltage **V_{LOAD}** the voltage drop between the transformer and the load is a function of the current supplied by the transformer, the **RTV** must take into account said current and compensate for the line voltage drop.

Commonly known as **LDC** (Line Drop Compensation), it is also known as **Current Compensation** as it comes to compensate for current flow effects.

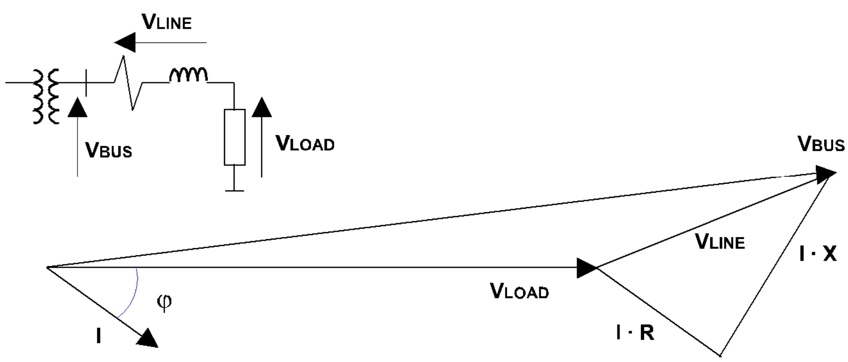


Figure 3.1.8: Line Drop Compensation (LDC).

Two **Line Drop Compensation** (**LDC**) methods are available

- **LDC-Z**: Magnitude sum compensation, which depends only on the magnitude of the current. This compensation method is adequate when the busbar feeds a number of lines, networks or with small cosφ variation. LDC-Z setting in % (slope ΔU/I) (from 0% to 10%).
- **LDC-R&X**: Vector sum compensation, as it depends on line impedance, current and cosφ. This compensation method is appropriate when the load concentrates at the line end, and line parameters are known. Required settings: LDC-R and LDC-X in Volts (0 to 30 V).

Two logic inputs exist associated with this function:

- **ENABLE_LDC**: Line Drop Compensation Enabled Input.
- **DOUBLE_LDC**: In hard wire regulation of two transformers in parallel, the activation of this input doubles line voltage drop compensation because of the parallel connection, since the current is approximately equal in both transformers, half the current flowing through each of them with respect to the current that would flow with only one transformer. When transformers are regulated through communications, the activation of this input will multiply the line voltage drop compensation depending on the number of transformers operating in parallel at that time (the relay will calculate it as a function of the number of active signals **EXIST_TRF_PARAL_X**).

3.1.4.a Line Drop Compensation: LDC-Z

LDC-Z setting, also known simply as K_C, and expressed in **%** of $V_{nominal}$, represents the line voltage drop when the circulating current is $I_{nominal}$. It is a magnitude sum compensation, i.e. depends only on the magnitude of the current. Said compensation is added to the voltage set-point V_{CON}, resulting into V_{COMP}.

$$V_{COMP}\ (\%) = V_{CON}\ (\%) + K_C\ (\%) \cdot I_{pu}$$

Where:

V_{COMP}: Compensated voltage, in % of $V_{nominal}$.
V_{CON}: Set-point voltage, in % of $V_{nominal}$.
K_C: Current compensation or **LDC-Z** setting, in % of $V_{nominal}$.
I_{pu}: Local current per unit, i.e., $I_{LOCAL} / I_{nominal}$.

For this to have any effect, the following setting values are required:

- Line Drop Compensation (LDC) enable: **YES**
- Line Drop Compensation (LDC) type: **LDC-Z**

Once the **compensated voltage** V_{COMP} has been obtained, the **deviation DV** is calculated taking into account the latter value, in place of **set-point voltage** V_{CON}.

$$DV\ (\%) = V_{COMP}\ (\%) - V_{BUS}\ (\%)$$

Example:

Kc = 2% → A voltage drop 2% of $V_{nominal}$ is produced when the circulating current is $I_{nominal}$.

3.1.4.b Line Drop Compensation: LDC-R&X

LDC-R and **LDC-X** settings represent the voltage drop (in volts, not in ohms), based on $\mathbf{V_{nominal}}$, when the circulating current is $\mathbf{I_{nominal}}$. For this to have any effect, the line drop compensation must be enabled and the **Line Drop Compensation Type** must be **LDC-R&X**.

$$\mathbf{LDC\text{-}R = I_n \cdot (RT_{CT}/RT_{VT}) \cdot r \cdot L \quad (V)}$$

$$\mathbf{LDC\text{-}X = I_n \cdot (RT_{CT}/RT_{VT}) \cdot x \cdot L \quad (V)}$$

Where,

- $\mathbf{I_n}$: Rated current (1 or 5 A).
- **r** : Line resistance in Ω/Km per phase.
- **x** : Line reactance in Ω/Km per phase.
- **L** : Line length in Km.

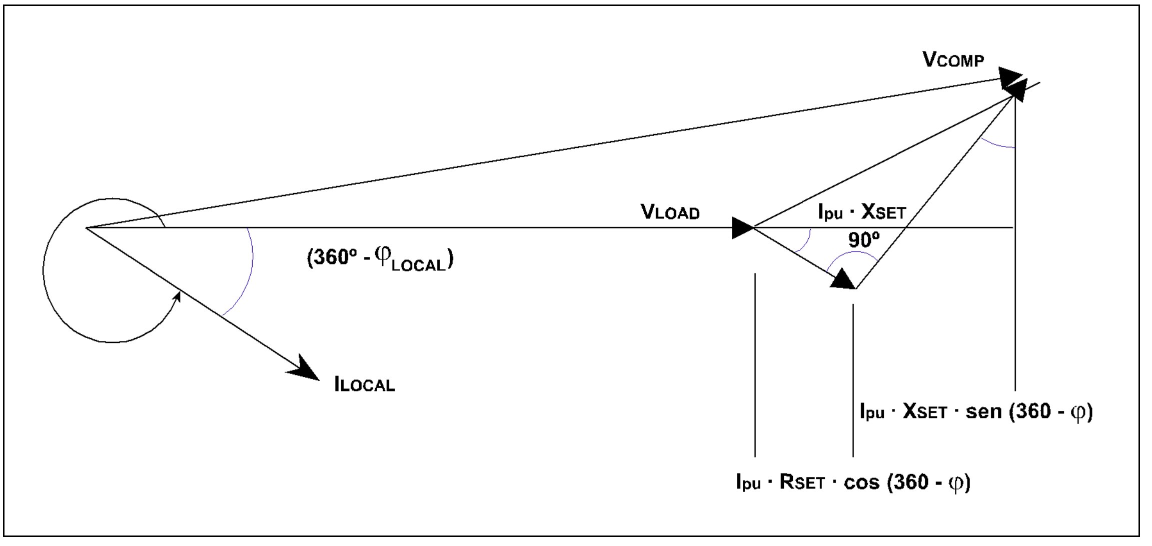


Figure 3.1.9: Line Drop Compensation: LDC-R&X.

$$\mathbf{V_{COMP} = V_{CON} + Setting_{LDC\text{-}R} \cdot I_{pu} \cdot Cos\,(360 - \Phi_c) + Setting_{LDC\text{-}X} \cdot I_{pu} \cdot Sen\,(360 - \Phi_c)}$$

Where $\Phi_c = \varphi_{LOC} - \varphi_{\text{phase displacement TT/TC LOC}}$

Example:

LDC-R = 6 V ; LDC-X = 0V ; φ=0º ; V_n = 120 V ; I_n = 5 A ; I_{LOCAL} = 2 A
V_{COM} = 120 + (2/5) · 6 = 122.4 V

3.1.5 Voltage Regulation of Parallel Transformers

Transformers are connected in parallel to increase transformer power when a single transformer cannot supply the load power demand.

Both single phase and three phase transformers can be connected in parallel. In order to operate in parallel, transformer electrical characteristics must comply with a number of conditions.

- Conditions for the **connection of single phase transformers**:
  - Similar transformer ratio (secondary voltage).
  - Connected with correct polarity.
  - Similar impedance.
  - Similar power.
- Conditions for the **connection of three phase transformers**:
  - Similar transformer ratio (secondary phase to phase voltage).
  - Similar phase difference between primary and secondary (compatible vector group and clock hour figure).
  - Similar tap/voltage ratio.
  - Similar impedance.
  - Similar power.

In such cases there are a number of regulation strategies, two of them being highlighted in view of their broad use:

- **Master / Slave**:
  - Rather used method.
  - It is intended to maintain the same tap for all parallel regulators.
  - One master controls the rest.
  - It requires knowing the taps of all LTC (Load Tap Changer).
- **Reactive Circulating Current (Reactive Compensation)**:
  - Most used method.
  - The **Circulating Current** is considered to be reactive, and can be calculated from transformer impedances (X_{1T} and X_{2T} in %).
  - This requires the use of a CT to measure the current of the other transformer (parallel) or to receive data from the other transformers through communications.
  - Knowing the taps is not required.
- **Negative reactance:**
  - This could be the least used method.
  - This uses LDC R-X as compensation and regulation method but with negative value of the reactance factor.
  - Communications between equipment not required.
  - Knowledge of the taps not required.

3.1.5.a Reactive Compensation

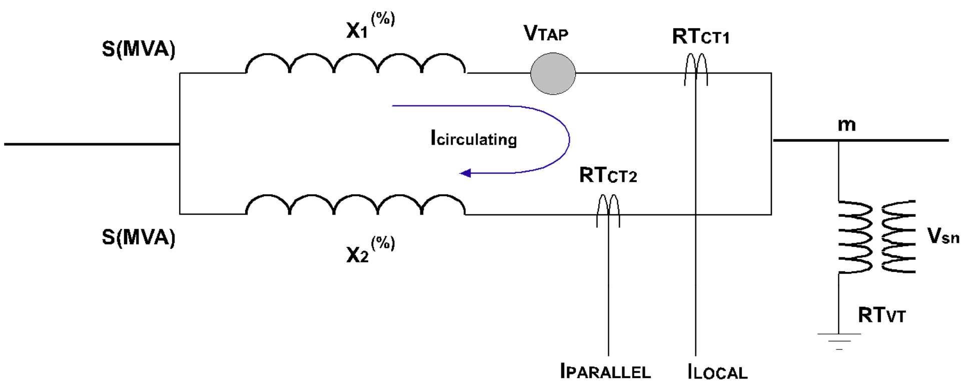
Even with transformers of same design and construction, there exist small differences between electrical characteristics. When secondary windings are connected in parallel, both are forced to have the same voltage, thus, a reactive power flow could be established between both transformers, which only serves to increase losses and temperature.

The meaning of the reactive power flow is that one transformer is forced to generate more reactive power than the load consumption and is absorbed by the other transformer. The purpose of **reactive compensation** is minimizing tap difference between both transformers, thus reducing the reactive power flow generated.

Reactive compensation can be used:

- Only for **two** transformers complying with the similarity conditions.
- If **Reactive Compensation Enable** setting is activated.
- If logic input **ENABLE_CREAC** is activated.

The following table shows a diagram of two transformers **T1** and **T2** of different impedances expressed in % working in parallel. As the transformer short circuit impedances are mainly reactive, they are represented by $\mathbf{X_1^{(\%)}}$ and $\mathbf{X_2^{(\%)}}$.



LEGENDE:

$X_1^{(\%)}$ & $X_2^{(\%)}$	Power transformers reactances, expressed in %
RT_{CT1} & RT_{CT2}	CT1 & CT2 Measurement Transformer Ratio (local and parallel respectively)
RT_{VT}	Voltage m Measurement Transformer Ratio

Figure 3.1.10: Diagram of two Transformers with Different Impedances Working in Parallel.

3.1.5.b Calculation of the Reactive Current Flowing through two Transformers in Parallel with Current Wiring

For calculating the **Reactive Circulating Current** through the secondary winding of both power transformers **T1** and **T2** connected in parallel, the regulator has the following data:

$\mathbf{I_1^m}$: current through **T1**, measured by the regulator (I_Local)
$\mathbf{I_2^m}$: current through **T2**, measured by the regulator (I_Parallel)
φ_1: phase angle between $\mathbf{I_1^m}$ and voltage
φ_2: phase angle between $\mathbf{I_2^m}$ and voltage

Where $\mathbf{I_1}$ and $\mathbf{I_2}$ are actual currents through the secondary windings of power transformers **T1** and **T2**:

$$I_1 = I_1^m \cdot RT_{CT1}$$
$$I_2 = I_2^m \cdot RT_{CT2}$$

The **circulating current** through the **secondary** of both transformers, $\mathbf{I_{circulating}}$, expressed in Amps, is calculated by the regulator thus:

$$I_{circulating} = I_1^m \cdot RT_{CT1} \cdot sen\,\varphi_1 - I_2^m \cdot RT_{CT2} \cdot sen\,\varphi_2$$

Where:

$\varphi_1 = \varphi_{LOC} - \varphi_{PHASE\text{-}DIFFERENCE\ TT/TI\ LOC}$

$\varphi_2 = \varphi_{PAR} - \varphi_{PHASE\text{-}DIFFERENCE\ TT/TI\ PAR}$

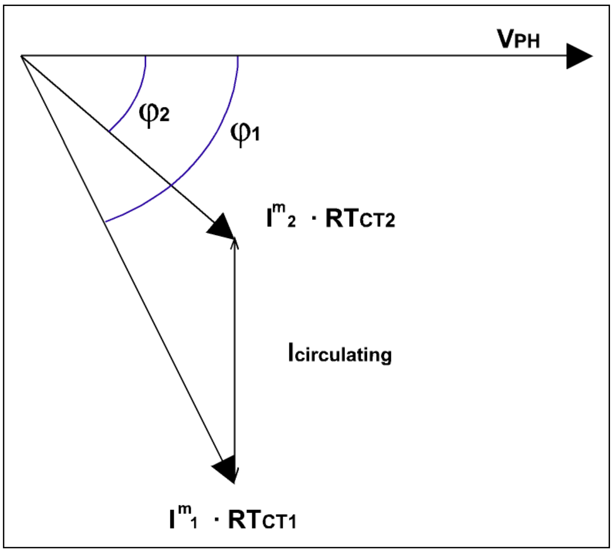


Figure 3.1.11: Diagram Representing the Reactive Circulating Current.

3.1.5.c Calculation of Reactive Current for RTV-P Model

Following the need for a voltage regulator with the capacity to work with more than two transformers in parallel, the **RTV-P** model comes into existence, with a capacity to regulate systems with a maximum of 5 transformers in parallel.

Apart of being able to work the same as for other models, namely, only with two transformers and calculating the circulating reactive current from the wired currents (I_Local and I_Parallel), it has the capacity to exchange measurements through communications, which allows the regulation of up to 5 transformers.

The maximum number of transformers to be regulated is a function of the method used for relay communications:

- Three if communications is through **Virtual Inputs/Outputs** (see section 3.12.6)
- Five if communications is through **GOOSE** messages (refer to section 3.12.5.i)

In both cases, regulators will exchange the measurement of their own Reactive Power, such that each relay will receive a maximum of 2 magnitudes (Virtual Inputs/Outputs) or 4 magnitudes (GOOSE), the so called Q_x^m. In this way, taking into account that all transformers in parallel must be at the same voltage, the circulating Current will be calculated through the formula below:

$$I_{circ} = I_1^m \cdot RT_{CT1} \cdot sen\,\varphi_L + \left(\frac{Q_2^m + Q_3^m + Q_4^m + Q_5^m}{3 \cdot V_1^m \cdot RT_{VT1} \cdot N_{trf}} \right)$$

where **Ntrf** is the number of transformers operating in parallel, calculated by the **RTV** as a function of the number of active signals **EXIST_TRF_PARAL_X**.

In case GOOSE is used for communications, apart from the reactive power, the regulators could exchange more data, resulting in the possibility of implementing Master/Slave regulation or reducing the need for wiring if required.

The process for receiving the reactive power from another regulator through GOOSE is as follows:

- Subscription to 4 possible Gooses. For this, GIGGIO node InRef data will be configured with the communications parameters that appear in the Gooses sent by the rest of the regulators and the equipment data in which they will be saved (intAddr) will be indicated. E.g.:

  ```
  InRef ->MAC:01-0C-CD-01-00-
  C1;APPID:1001;GCBREF:PTRTV01LD1/LLN0$GO$gcb01;GOID:GOOSE_PTRTV01;POS:13
  intAddr -> GIGGIO1.AnIn01.mag.f[MX]
  ```

- Create a control configuration where static magnitudes representing the reactive powers of regulators are mapped to data of GIGGIO node where subscriptions have previously been configured in the CID.
- Set the regulator to use reactive power compensation through communications.
- Enable the **Reactive Compensation Enable** setting
- Activate **Parallel Transformer Input** (the logic must be modified to send this signal to a digital Input or command).

In this way, if the equipment receives a GOOSE message with the data required or via Virtual Inputs/Outputs, the regulator will take into account the reactive power of the other transformer in parallel for the calculation of the circulating current and the subsequent compensation of the set point voltage.

3.1.5.d Calculation of Reactive Compensation Setting

As a general rule, power transformer manufacturers specify the impedance in **percentage** (**%**) or **per unit** (**pu**) of nameplate rated values.

Per unit impedance values of same type machines are all within a very close margin of each other, even if actual ohmic values are very different, for different values of voltage and power ratings.

Bearing in mind the above, in case of working with two parallel transformers, KR (%) is defined as the **Reactive Compensation** setting, expressed in %, as:

$$K_R^{(\%)} = \frac{X_1^{(\%)} + X_2^{(\%)}}{10}$$

Thus, the voltage drop caused by one tap difference (subscript Tap), as seen by the regulator (superscript Reg), expressed in % of rated voltage, will be:

$$V_{Tap}^{Reg}(\%) = K_R^{(\%)} \cdot \frac{1}{0.1 \cdot I_{sn}^m} \cdot (I_1^m \cdot sen\,\varphi_1 - I_2^m \cdot \frac{RT_{CT2}}{RT_{CT1}} \cdot sen\,\varphi_2),$$

Where all terms are known to the regulator, whether by setting or measurement.

In case of working with more than two transformers in parallel conditions, the reactive compensation factor is calculated as follows:

$$K_R^{(\%)} = \frac{X_1^{(\%)} + X_{PAR}^{(\%)}}{10}$$

$$\frac{1}{X_{PAR}^{(\%)}} = \frac{1}{X_2^{(\%)}} + \frac{1}{X_3^{(\%)}} + \frac{1}{X_4^{(\%)}} + \frac{1}{X_5^{(\%)}}$$

Example:

- Transformer T1 data: 15 MVA; 69 kV / 13.8 - 11.9 KV; 12.95%;
- Transformer T2 data: 15 MVA; 69 kV / 13.8 - 11.9 KV; 13.00%;

- Voltage measurement transformer ratio (VT):

  V_{sn} = 120 V ;→RT_{VT} = 13800/120

- Tap voltage variation (17 taps):

  ΔV_{tap} = 862.5 V (referred to primary)
  ΔV_{tap} = 862.5 * (13.8/69) = 172.5 V (referred to secondary)

- Power transformer rated secondary current:

  I_{sn} = 627.55 A ;→RT_{CT1} = RT_{CT2} = 800/5

- Calculation of circulating current due to ΔV_{tap} :

ΔI_{circ} = 172.5 / 3.295 = 52.358 A

- Calculation of loop impedance Z_{loop} (Ω) :

$Z_{base1} = Z_{base2} = U_{sn}^2 / S = 13.8^2 / 15 = 12.696\ \Omega$
$Z_{loop} = (Z_{pu1} + Z_{pu2}) \cdot Z_{base} = (0.1295 + 0.13) \cdot 12.696 \approx 3.295\ \Omega$

- Simplified calculation of reactive compensation setting $K_R^{(\%)}$:

$K_R^{(\%)} = (X_1^{(\%)} + X_2^{(\%)}) / 10 = (12.95 + 13)/10 = 2.59\%$

- Exact calculation of reactive compensation setting $K_R^{(\%)}$:

$$K_R^{(\%)} = \frac{X_1^{(\%)} + X_2^{(\%)}}{10} \cdot \frac{V_{s\,LN}^T}{V_{pn}^m} \cdot \frac{I_{pn}^{m1}}{I_{sn}^T}$$

$K_R^{(\%)} = 2.59\% \cdot (13800/13800) \cdot (800/627.55) = 3.30\ \%$

3.1.5.e Calculation of Reactive Current and Reactive Current Compensation Setting for the Relay RTV-P with Spare Digit B or Above

As in the previous case, regulators will interchange with each other their own Reactive Power, such that each relay will receive a maximum of 2 magnitudes (Virtual Inputs/Outputs) or 4 magnitudes (GOOSE), the so called Q_x^m. In this way, taking into account that transformers in parallel must be at the same voltage, the calculation of the current flow will be carried out through the following formulas:

$$I_{circ12} = \frac{I_1^m \cdot RT_{CT1} \cdot sen\ \varphi_1 - \left(\dfrac{Q_2^m}{3 \cdot V_1^m \cdot RT_{VT1}} \right)}{2}$$

$$I_{circ13} = \frac{I_1^m \cdot RT_{CT1} \cdot sen\ \varphi_1 - \left(\dfrac{Q_3^m}{3 \cdot V_1^m \cdot RT_{VT1}} \right)}{2}$$

$$I_{circ14} = \frac{I_1^m \cdot RT_{CT1} \cdot sen\ \varphi_1 - \left(\dfrac{Q_4^m}{3 \cdot V_1^m \cdot RT_{VT1}} \right)}{2}$$

$$I_{circ15} = \frac{I_1^m \cdot RT_{CT1} \cdot sen\ \varphi_1 - \left(\dfrac{Q_5^m}{3 \cdot V_1^m \cdot RT_{VT1}} \right)}{2}$$

Where V_1^m is the measured voltage that will be a function of the voltage type setting such that it will be divided by √3 for phase to phase voltage.

Then the relay will calculate the final current flow:

$$I_{circ} = I_{circ12} + I_{circ13} + I_{circ14} + I_{circ15}$$

Thus, compensating the setpoint as follows:

$$V_{COMP}(\%) = V_{CON}(\%) + K_R(\%) \cdot (I_{circ} / 0.1 \cdot I_n)$$

The relay includes 5 settings to indicate the impedance of the transformers in the scheme and the value K_R will be calculated automatically in dynamic form as a function of the signal indicating that the transformer is connected in parallel:

- With two transformers in parallel

$$K_R = \frac{X_1(\%) + X_x(\%)}{10}$$

- With more than two transformers in parallel:

$$K_R = \frac{X_1(\%) + X_{PAR}(\%)}{10}$$

$$\frac{1}{X_{PAR}(\%)} = \frac{1}{X_2(\%)} + \frac{1}{X_3(\%)} + \frac{1}{X_4(\%)} + \frac{1}{X_5(\%)}$$

3.1.6 Combined Compensation and Maximum Compensation

The two types of **set-point voltage V_{CON}** setting compensation used by the **RTV** to obtain the **compensated voltage V_{COMP}** have been described separately. In case both compensation methods were applied simultaneously, the calculation of the **compensated voltage V_{COMP}** would be made as follows:

$$V_{COMP}\,(\%) = V_{CON}\,(\%) + K_C\,(\%) \cdot I_{pu} + K_R\,(\%) \cdot (I_{circulating} \;/\; 0.1 \cdot I_n),$$

where each term has the above described meaning.

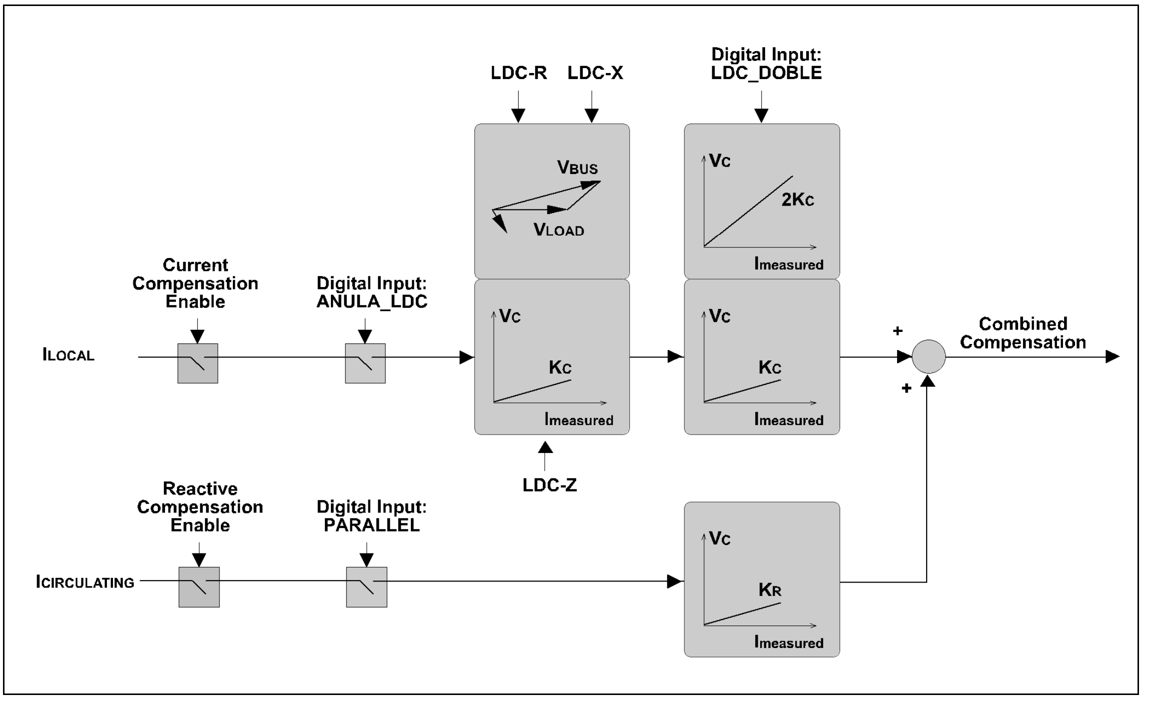


Figure 3.1.12: Combined Compensation and Maximum Compensation.

The **Maximum Compensation** setting limits the voltage compensation to a given value, such that if the sum of both current and reactive compensation values or each of said compensation values separately, exceeds said setting, this latter setting is used for the calculation of the voltage value.

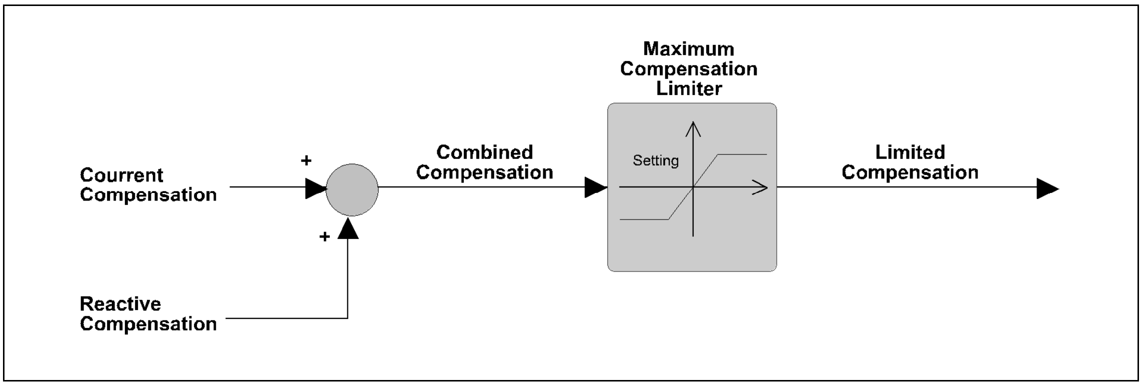
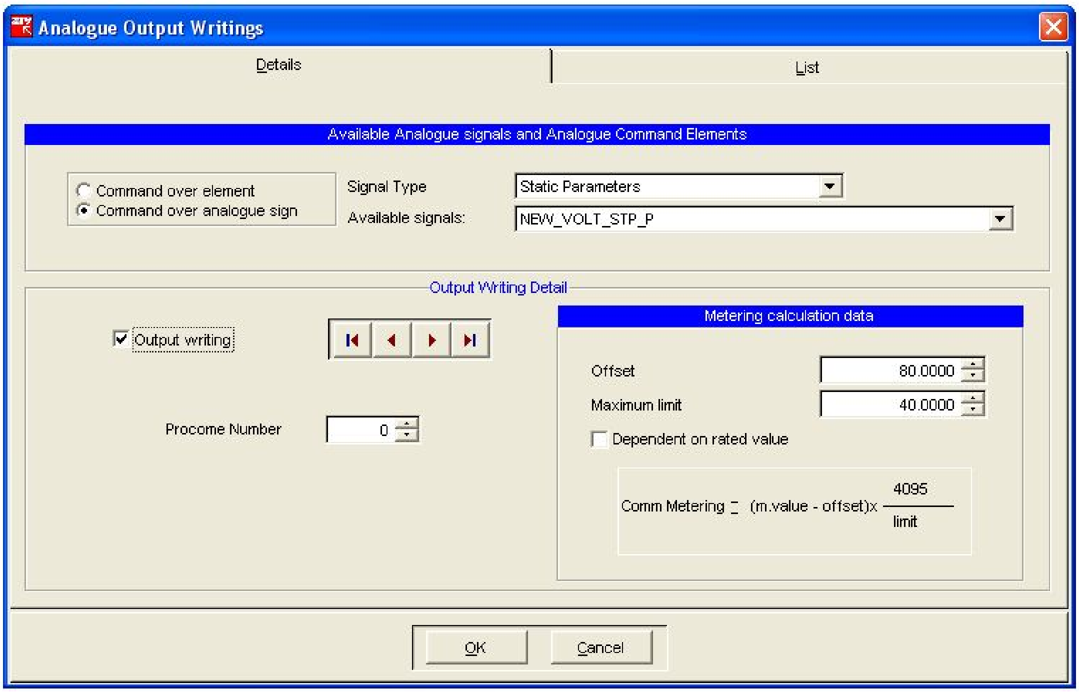


Figure 3.1.13: Maximum Compensation Setting.

3.1.7 Voltage Set-point Change

The **Voltage Set-point** can be changed in a number of ways:

- Accessing the **Settings Data Base**, either from the HMI or communications. There exists only a factory programmed interlock, which prevents changing the **Voltage Set-point** setting from the HMI, when the Control Mode is from the Control Panel or Remote Control.
- Through **Set-point Raise and Lower Commands**. These commands can be activated through the user logic (hard wired to front pushbuttons or physical digital inputs) or through communications.
- The activation of **Raise setpoint command** increases the setpoint 1%.
  - **Set-point Raise Command** activation increases the set-point in 1% or the set increment in case of the **RTV-P** with spare digit B or above (1-6%).
  - **Set-point Lower Command** activation decreases the set-point in 1% or the set increment in case of the **RTV-P** with spare digit B or above (1-6%).
- Through communications protocols (PROCOME, MODBUS, DNP3, etc.), which support **Write Analog Outputs**. There exist two options, which are described below, and are configured with the help of ***ZivercomPlus***®:
  - **Command on Magnitude**: on the static magnitude NEW_VOLT_STP_P (in percentage) and on the static magnitude NEW_VOLT_STP if the model is IEC 61850 compatible (in primary values). This method renders the use of the other two methods for set-point change (settings and commands) impossible.
  - **Command on Element**: selecting the Analog Command previously declared in the Resource Declaration. This way “Analog Pulses” are obtained and the use of the other two set-point change methods (settings and commands) is made possible.
- In case of the **RTV-P** with spare digit B or above, through the setting **Setpoint Selection**, to use one of the 5 setpoints available in the relay or through the activation of the signals corresponding to each of them (**Setpoint Activation Command 1, Setpoint Activation Command 2**, etc.).



When the set-point, entered by any of the above methods, reaches any of the range threshold values, the **Set-Point Threshold** signal is activated.

3.1.8 Operation Modes

3.1.8.a Equipment in Service / Out of Service

Through the **Equipment in Service** setting, in section **General Settings**:

- **Equipment In Service**: involves the normal execution of all functions integrated into the relay (dependant on functions settings).
- **Equipment Out of Service**: relay functions are limited exclusively to metering operations.

Important: With the relay Out of Service, user programmed logic is prevented, so that the RTV will not execute any action that might be configured in said logic.

3.1.8.b Control Modes: Local, Control Panel and Remote Control

The **RTV** can be operated in the following Control Modes, (or combination of):

- Local Control
- Control Panel
- Remote Control

Switching between Control Modes is made through the user logic.

The Control Mode can be used for interlocking, through the user logic. There only exists one factory programmed interlock, preventing changing the **Voltage Set-Point** setting from the HMI, when the Control Mode is from the Control Panel or Remote Control.

3.1.8.c Regulation Modes: Automatic / Manual

The **RTV** can operate on the following **Regulation Modes**:

- **Automatic Mode**: enables the main regulator control loop **DV** deviation signal input to the regulator, which calculates the **Raise / Lower the Tap commands**.
- **Manual Mode**: the regulator does not calculate the **Raise / Lower the Tap commands**. Refer to the following section on how to carry out manual tap change operations.

Methods can be switched through **Switch to Automatic Command / Switch to Manual Command** commands, either through front pushbuttons, digital inputs or communications system.

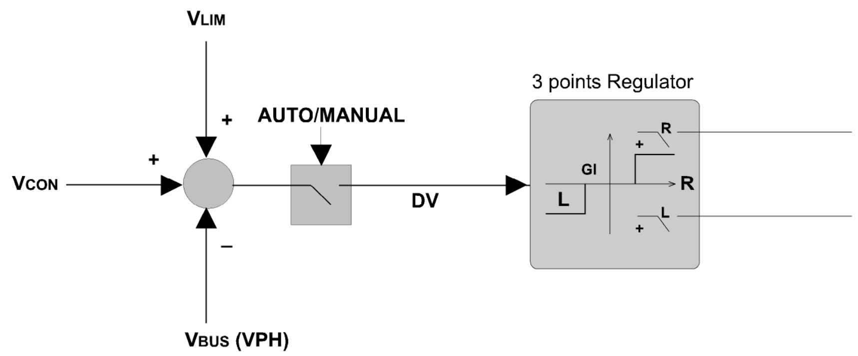


Figure 3.1.14: Main Regulator Control Loop (Automatic Mode).

There exists a specific situation when the regulator will switch spontaneously from **Automatic Mode** to **Manual Mode**. Refer to section 3.1.12.b Blockings Independent of Tap monitoring, **Internal Anomaly Blocking**.

3.1.9 Manual Commands

The **RTV** can execute manual **Raise and Lower the Tap** commands through:

- Raise the Tap Command
- Lower the Tap Command

These commands can be configured using the ***ZivercomPlus®*** program, connecting to:

- Front keypad pushbuttons
- Digital inputs
- Communications system

To this end, the relay must be in **Manual Mode.**

3.1.10 Tap Control

3.1.10.a Tap Coding

RTV relays are provided with 40 logic inputs to the protection (INXX_TAP) for detecting the **Active Tap** (Refer to section 3.1.15 Voltage Regulator Digital Inputs).

The coding can be **Direct** in **BCD Code** (Binary Coded Decimal) or by **Resistor Chain**.

- **Direct** coding: every input represents a Tap value, which must be configured through the communications program ***ZivercomPlus***®. That is to say, IN01_TAP input activation will result in the **Active Tap** being equal to the **Minimum Tap** setting value.
- **BCD Code**: using up to a maximum of 7 (seven) digital inputs associated with the first seven inputs of protection logic used to assign the taps (IN01_TAP to IN07_TAP) configured using the ***ZivercomPlus***® communications program. Assuming that the **Minimum Tap** setting is set to 1, the **Active Tap** is coded as specified in the following table:

Active Tap	IN07_TAP	IN06_TAP	IN05_TAP	IN04_TAP	IN03_TAP	IN02_TAP	IN01_TAP	Active Tap	IN07_TAP	IN06_TAP	IN05_TAP	IN04_TAP	IN03_TAP	IN02_TAP	IN01_TAP
1							X	**21**		X					X
2						X		**22**		X				X	
3						X	X	**23**		X				X	X
4					X			**24**		X			X		
5					X		X	**25**		X			X		X
6					X	X		**26**		X			X	X	
7					X	X	X	**27**		X			X	X	X
8				X				**28**		X		X			
9				X			X	**29**		X		X			X
10			X					**30**		X	X				
11			X				X	**31**		X	X				X
12			X			X		**32**		X	X			X	
13			X			X	X	**33**		X	X			X	X
14			X		X			**34**		X	X		X		
15			X		X		X	**35**		X	X		X		X
16			X		X	X		**36**		X	X		X	X	
17			X		X	X	X	**37**		X	X		X	X	X
18			X	X				**38**		X	X	X			
19			X	X			X	**39**		X	X	X			X
20		X						**40**	X						

- **Resistor Chain**: relays featuring inputs to capture the tap value through **Resistor Chain** will provide three contacts: minimum value, maximum and position/pointer, such that the relay will calculate the number of the present tap as a function of the measured voltage drop related to the present resistance and the setting of the number of taps. For a proper operation of the system, the resistance at minimum value must be equal to the jump of resistance for tap indication, an external resistor being provided for this purpose if necessary. The relay is able to operate and manage the present tap with no need to provide an external resistor, but the voltage drop in the minimum tap must be equal or above 0.2V.

In order to be able to work with or without an external resistance equal to the jump of resistance for tap indication, the relay is provided with a setting **External Resistance** (**Resistor Chain**) by which the user will instruct the relay whether an external resistor has been placed or not so that the relay may take this into account for internal calculations.

The relay will issue an alarm when detecting disconnected cables, overload or when the relay does not detected any resistance between maximum and minimum values.

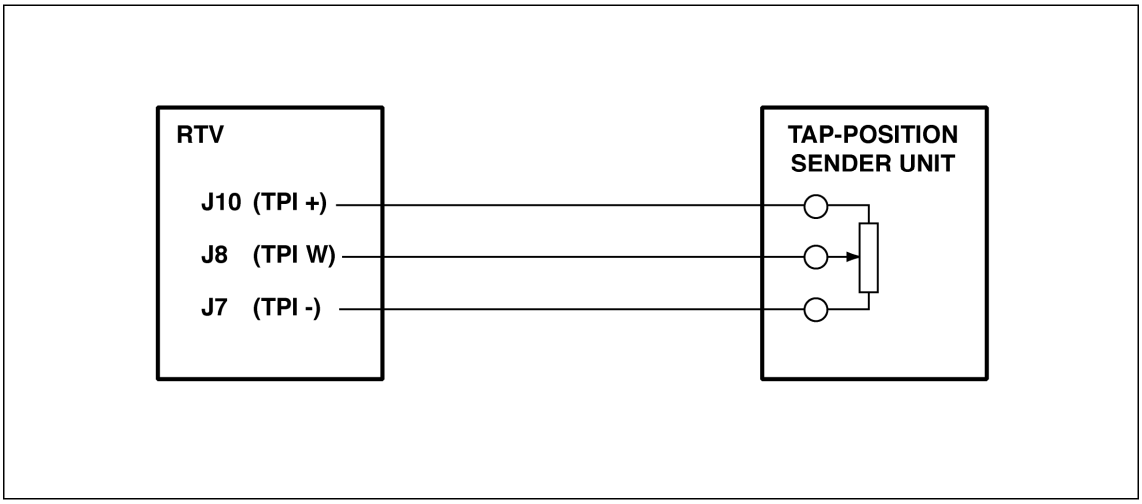


Figure 3.1.15: RTV Connection with the Tap Module.

3.1.10.b Number of Taps, Minimum Tap, Upper Limit and Lower Limit

Number of Taps, Minimum Tap, Upper and Lower Limits are the settings related to **Tap Control**.

The **Maximum Tap** is calculated as a function of the Minimum Tap and the Number of Taps, according to the formula:

Maximum Tap = Minimum Tap + Number of Taps - 1

Example 1:Minimum Tap = -3 ; Number of Taps = 7 → Maximum Tap = +3
Example 2:Minimum Tap = 0 ; Number of Taps = 16 → Maximum Tap = +15
Example 3:Minimum Tap = 40 ; Number of Taps = 40 → Maximum Tap = +79

3.1.10.c Tap Indication

Tap Indication stands for the fact of having a number of digital inputs configured and hard wired for this purpose. No settings are therefore involved and is independent of whether there is monitoring or not.

The **Active Tap** indication will be a function of the **Minimum Tap** and **Maximum Tap** settings:

- Active Tap value: (Minimum Tap< = Tap< = Maximum Tap), or
- invalid value, for the display to show "***".

3.1.10.d Tap Monitoring

Tap Monitoring stands for the fact of alarm or blocking generation upon special conditions. It involves a setting.

With the **Tap Monitoring** setting enabled, when the tap reaches any of the Minimum Tap, Maximum Tap, Lower Limit and Upper Limit, the corresponding logic outputs are activated, and can be used for regulator blocking.

Alarms are **Logic Outputs**:

- Invalid tap alarm (no tap, simultaneous, etc.).
- Upper tap limit alarm.
- Lower tap limit alarm.
- Maximum tap alarm.
- Minimum tap alarm.
- Command failure alarm.
- Runaway alarm (**RTV-P** with spare code B or higher).

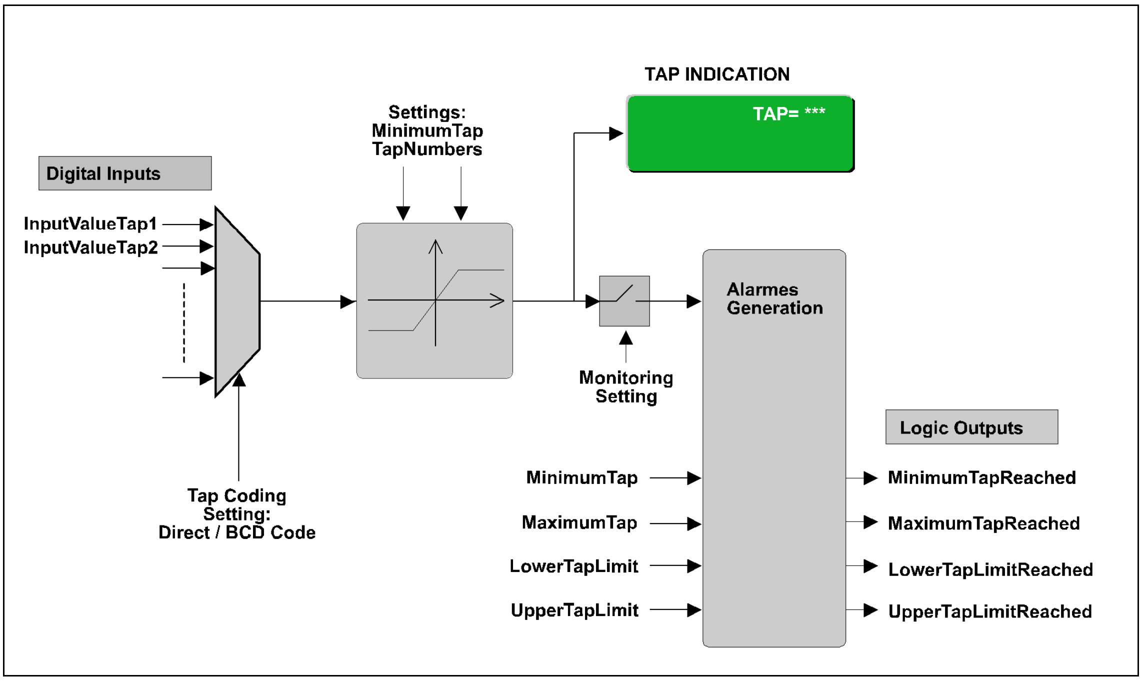


Figure 3.1.16: Tap Monitoring Setting Diagram.

3.1.10.e Tap Change Operation Monitoring

When **Tap Monitoring** is enabled, three settings are available to monitor the tap change operation after a command. Said settings are **Command Failure Time**, **Maximum Simultaneous Tap Time and Maximum No Active Tap Time**.

- **Command Failure Time**: waiting time for tap change command execution. If no tap change occurs before the timer times out, a new command is sent. If this second command fails, the **Raise / Lower Tap Command Fail** outputs activate. The tap must change to the next up or down tap, respectively, in order to be acknowledged as correct. This time is also used in the RTV-P with spare digit B or above, to generate runaway alarm such that if after a raise/lower tap command the relay detects two tap changes, going through both taps, within the operation failure time setting, then the relay generates a runaway alarm.
- **Maximum Simultaneous Tap Time**: time elapsed from the time the relay detects various **Active Taps** until **Blocking on Simultaneous Tap** state is reached.
- **Maximum No Active Tap Time**: time elapsed from the time the relay detects no **Active Tap** until the **Blocking on No Active Tap** state is reached.

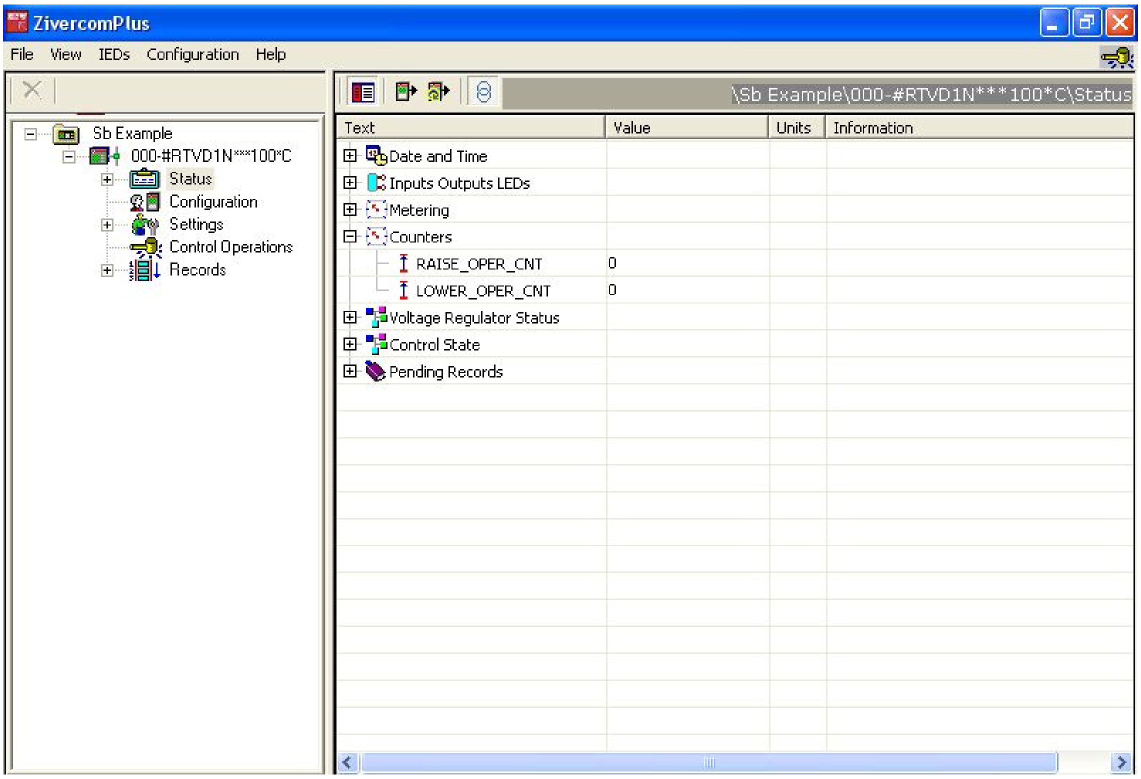
Refer to section 3.1.11 **Blockings** to check activation and reset conditions.

3.1.10.f Tap Change Operation Counters

In order to make tap changer maintenance operations easier, 2 (two) counters are provided:

- **Number of Raise the Tap Operations** (RAISE_OPER_CNT)
- **Number of Lower the Tap Operations** (LOWER_OPER_CNT)

Counters can be reset through the digital input **Tap Changer Operation Counter Reset**.



3.1.11 Blockings

The regulator must remain blocked on a number of circumstances. Some blockings only affect the **Automatic Mode** and other blockings only the **Manual Mode**. Also, some blockings are a function of **Tap Monitoring**.

- **Blocking Limits**

Minimum Voltage Blocking

The regulator is blocked when the measured voltage is below the **Minimum Voltage** setting value (refer to **Blocking Limits** settings). The blocking condition resets when the measured voltage is above said setting. In the RTV-P with spare digit B or above the blocking could be delayed through the setting **Minimum Voltage Timer**.

Maximum Switched Current Blocking

The regulator is blocked when the measured current is above **Maximum Switched Current** setting value (refer to **Blocking Limits** settings). This protects the tap changer contacts from excessive wear.

Blocking by voltage out of range (only RTV-P models)

The regulator blocks when the measured voltage is out of the regulation range for a time exceeding the **Time for Voltage out of Range** setting. The blocked condition resets when the measured voltage is again within the regulation range. This blocking affects the Automatic mode. In the **RTV-P** with spare digit **B** or above, the blocking could be disabled or reset from the control logic by using the signals **Voltage out of Range Blocking Enable** and **Voltage out of Range Timer Reset**.

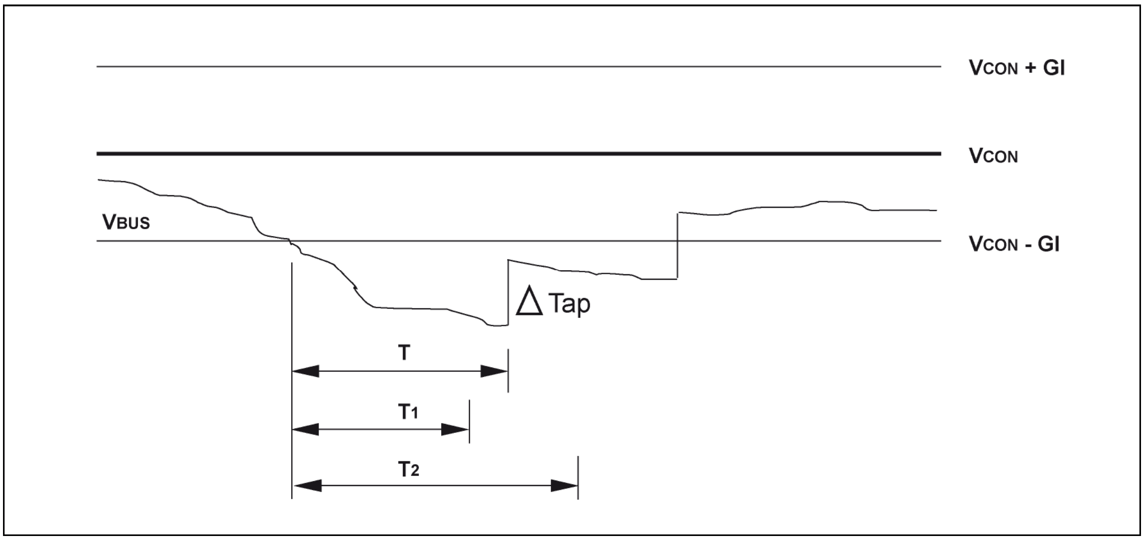


Figure 3.1.17: Blocking by Voltage out of Range.

Example:

Case 1: T1 (Blocking by voltage out of range) < T (Time for changing tap). The regulator blocks after T1
Case 2: T2 (Blocking by voltage out of range) > T (Time for changing tap). The regulator changes tap and blocks after T2.

- **Blockings Dependent on Tap Monitoring**

These blockings only operate when the **Tap Monitoring** feature is enabled.

No Active Tap or Simultaneous Tap Blocking

The relay remains blocked if after an adjustable time setting (**Maximum Time with No Active Tap** setting), no active tap exists or if after another adjustable time setting (**Maximum Time with Simultaneous Taps** setting), more than one tap are active simultaneously.

To exit the blocked condition simply activate one tap if the blocking occurred by no active tap, or else deactivate all taps but one if the blocking occurred by excess of taps.

Tap Runaway Blocking

If voltage varies when the transformer is at the lowest or highest tap position so that lower tap or raise tap commands are expected respectively (direct tap / voltage ratio), the regulator will not execute said commands as it will go into tap runaway blocking state. The only way to exit the blocked condition is by a reverse command (raise the tap command if at minimum tap and lower tap command if at maximum tap). Furthermore, unblocking and tap change command will take place simultaneously.

Internal Anomaly Blocking

If **Tap Monitoring** is enabled, commands are monitored so that commands are executed two consecutive times; that is, if the corresponding tap change does not occur before the fail tap change timer times out after the first tap change command, a new command is sent, and if the corresponding tap change does not occur before the tap change fail timer times out again, the **Internal Anomaly Blocking** activates.

Under these circumstances, the relay switches to **Manual Mode**. The relay can be unblocked by switching again to **Automatic Mode**.

Tap change must be step by step; that is, the relay waits for the tap to change to the next step up if it is a raise the tap command, or to the next step down if it is a lower the tap command. If tap changes are not produced in this way, the tap change is not acknowledged and the **Internal Anomaly** contact is equally activated.

In the **RTV-P** with spare digit **B** this **Internal Anomaly Blocking** signal is renamed **Block by Tap Failure Command**.

Runaway blocking

In the **RTV-P** with spare digit **B**, with the tap supervision enabled, commands are supervised, such that if after a command the relay detects two consecutive tap changes within the command failure time setting, namely, the relay goes to the next tap, the target tap, and from this to another, the relay switches to **Block by Runaway**.

- **Logic Blocking Inputs**

The following logic inputs can be allocated to physical inputs or configured in logic cards through the ***ZivercomPlus***® program. Inputs will remain deactivated if not allocated or configured.

- **External Blocking**
- **Automatic Raise Tap Operation Blocking**
- **Automatic Lower Tap Operation Blocking**
- **Manual Raise Tap Operation Blocking**
- **Manual Lower Tap Operation Blocking**

The two figures below show the positions of all blockings within the regulator control loop.

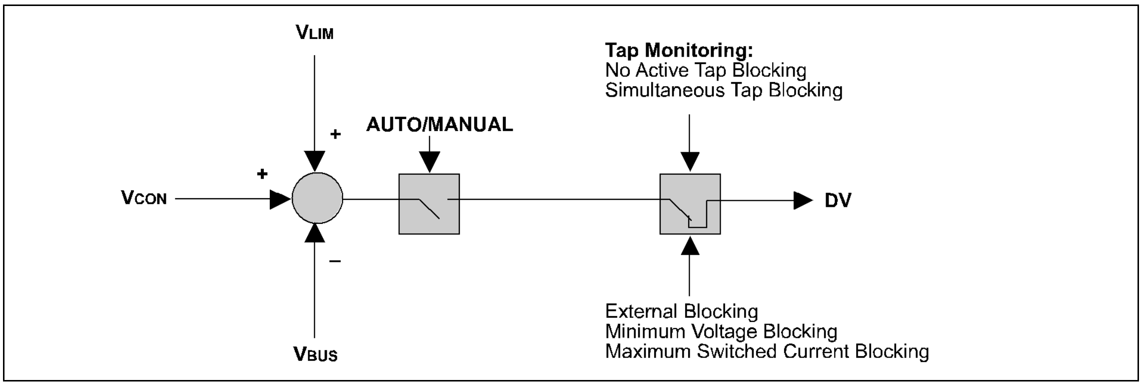


Figure 3.1.18: Blockings within the Main Regulator Control Loop (Automatic Mode).

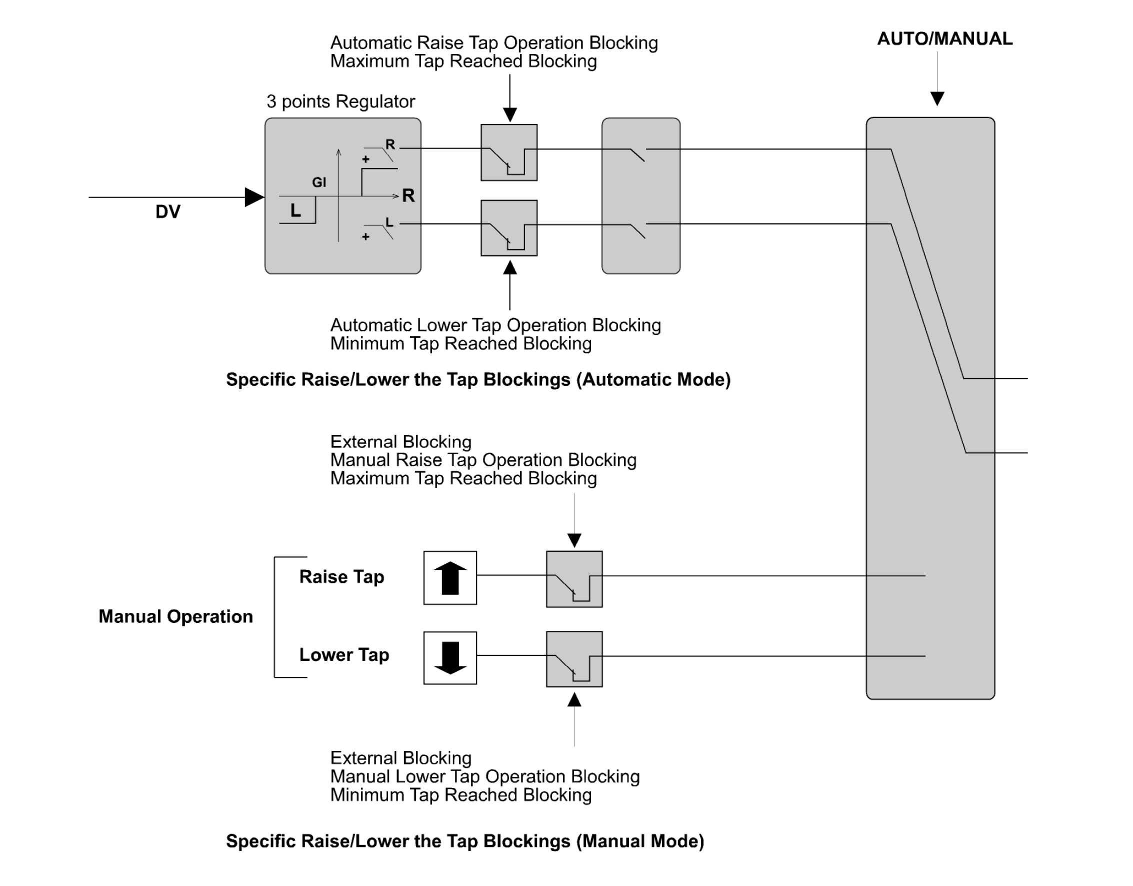


Figure 3.1.19: Specific Raise / Lower the Tap Blockings (Automatic and Manual Modes).

3.1.12 Power Flow Reversal

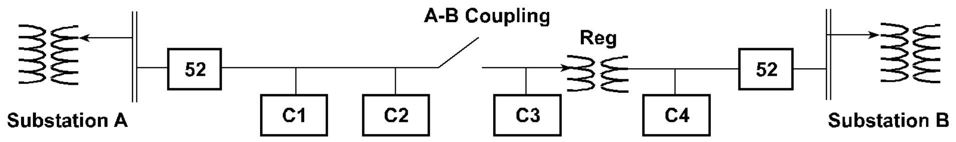


Figure 3.1.20: Power Flow Reversal Diagram.

Normally, the **A-B Coupling** is open and loads are supplied radially from their respective substations. If Substation B is put out of service, C3 and C4 loads could be supplied from Substation A, simply closing the **A-B Coupling**. The power flow through **Reg Regulator** would be reversed.

To regulate the voltage under this situation, the regulator should be provided with a VT on the original power supply side (Substation B side), or calculate said voltage from known data. Another valid option could be blocking the regulator on **power reversal** detection.

The **RTV** activates the logic **Detected Power Reversal** output when the angle between V_{PH} and I_{LOCAL}, once corrected by the setting **Local VT/CT Phase Difference** is:

$$90º < \varphi < 270º$$

and resets said output when:

$$85º > \varphi > 275º$$

This logic output can be configured through logic to block the regulator or to position it at an intermediate tap (e.g. neutral tap).

3.1.13 Settings Recommendation

Nominal Values	
Voltage	Set the nominal voltage the relay is going to measure and control in secondary values (taking into account if it is a phase to phase or phase to ground voltage). This way the default setpoint setting will be 100%
Local CT	Nominal current of the local CT in secondary values (1A or 5A).
Parallel CT	Nominal current of the parallel CT in secondary values (1A or 5A).

General Settings	
VT and CT ratios	Set the ratios (primary divided by secondary) for the VT and CT. The relay will use this just to show the measurements in the display in primary values multiplying the setting by the value measured and to send them by communications.
Voltage input type	Define if the wired voltage is phase to phase or phase to ground. This setting is used to calculate the power values.
Voltage source	VPH

Voltage Regulator Configuration	
Tap Changer Supervisory Control	Yes, but just if the tap value is received.
Tap Codification Type	It depends on how the tap value is received. BCD if BCD code is wired, Resistor when connecting a resistor chain and Direct in any other case.
Units in Main Display	Primary.
VT/CT Phase correction	this setting is used to define the phase difference between the VT and CT connection. The setting is the angle, expressed in degrees, measured counterclockwise, from the voltage measured (VT connection) to the current (CT connection).
Selectable outputs type	Pulsed with 500ms. When activating the supervisory control, it is recommended using the Continuous mode and so the output will reset when reaching to the expected tap value or after the failure time.

Voltage Regulator Control	
Voltage Setpoint (Bandcenter) 1	100%
Voltage Setpoint (Bandcenter) 2 to 5	As required.
Voltage Setpoint Selection	1
Voltage Setpoint Increment	1%
Dead Band (bandwith/2)	Normally is set with the value of one tap, this is the voltage difference between two taps is percentage. If the value of the Bandwith (2 times the setting) is smaller than the tap-change increment of the transformer, the controlled system can never reach a stable condition as the voltage exceeds the bandwidth selected. If, on the other hand, a very large bandwidth is selected there will be a major control deviation and therefore the control and precision will be less. It must be ensured that. It must be ensured that: Bandwidth ≥ 0.6 * tap-change increment [%]
Tap/voltage Relation	It depends on the tapchanger type and where the voltage is measured/control. The default value is Direct, this is reducing the voltage means tapping down.

Voltage Regulator Control (continue)	
Runback Voltage	115%. Normally transformers regulate between 100 ± 10% so it should be set above the maximum voltage. This way the relay will detect great variations of the voltage and will skip the first delay time.
Time Delay Type	Inverse or Definite for the first delay time.
Time Factor for Inverse Curve	Just necessary when defining Inverse in the previous setting.
Definite Time T1	10 to 15 seconds.
Definite Time T2	10 to 15 seconds.

Compensations	
Line Drop Compensation	Enable it when required.
Line Drop Compensation Type Selector	It depends on the electrical system where the equipment is installed. Normally LDC R-X is used when line parameters are known and the load is concentrated at the end of one line and LDC-Z is used when many lines are involved or the line parameters are not known.
Z	100*Vline/VN.
R	Resistance voltage drop in the line.
X	Reactance voltage drop in the line.
Circulating Current Compensation	Enabled when required.
Parallel Transformer Data Source	Communications or wired depending on the system design. In case of selecting Communications, the equipments can exchange the information by GOOSE message (LAN port) or Virtual Inputs/Outputs (Remote serial port 1 and 2).

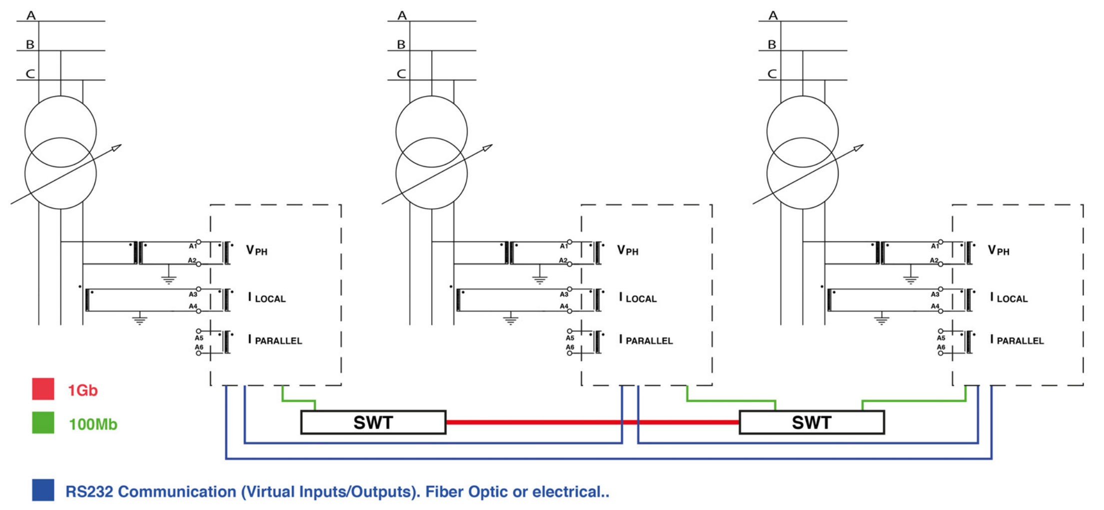


Figure 3.1.21: Communications for Parallel Transformers.

Maximum Voltage Compensation Limit	10%.
Circulating current compensation ratio	(X1+X2)/10 or (X1+XPAR)/10 where I/XPAR=1/X1+1/X2+1/X3+1/X4+1/X5
Transformer Impedances	X1, X2, X3, X4 and X5 of each transformer.

Lockout Limits	
Under Voltage	80%.
Under Voltage Timer	Set a time if required.
Maximum Switching Current	120%.
Time for Out of Voltage	Greater than T1 + T2 x (maximum number of taps -1).

Tap Control	
Number of Taps	Depending on the system/design. It is not necessary.
Minimum Value	Minimum value of the tap.
Low Limit Value	Value of the tap that will generate the low tap value reached alarm and block.
Upper Limit Value	Value of the tap that will generate the high tap value reached alarm and block.
Operation Failure Time	Greater than time to send the command + time passed till the tapchager receives the command + mechanical time that takes the tapchanger to change the tap. It has to be equal or less than the T2 delay time.
Maximum Simultaneous Time	10 to 15 seconds.
Maximum Time without Active Tap	10 to 15 seconds.

3.1.14 Settings Calculation Example

- **Example 1**

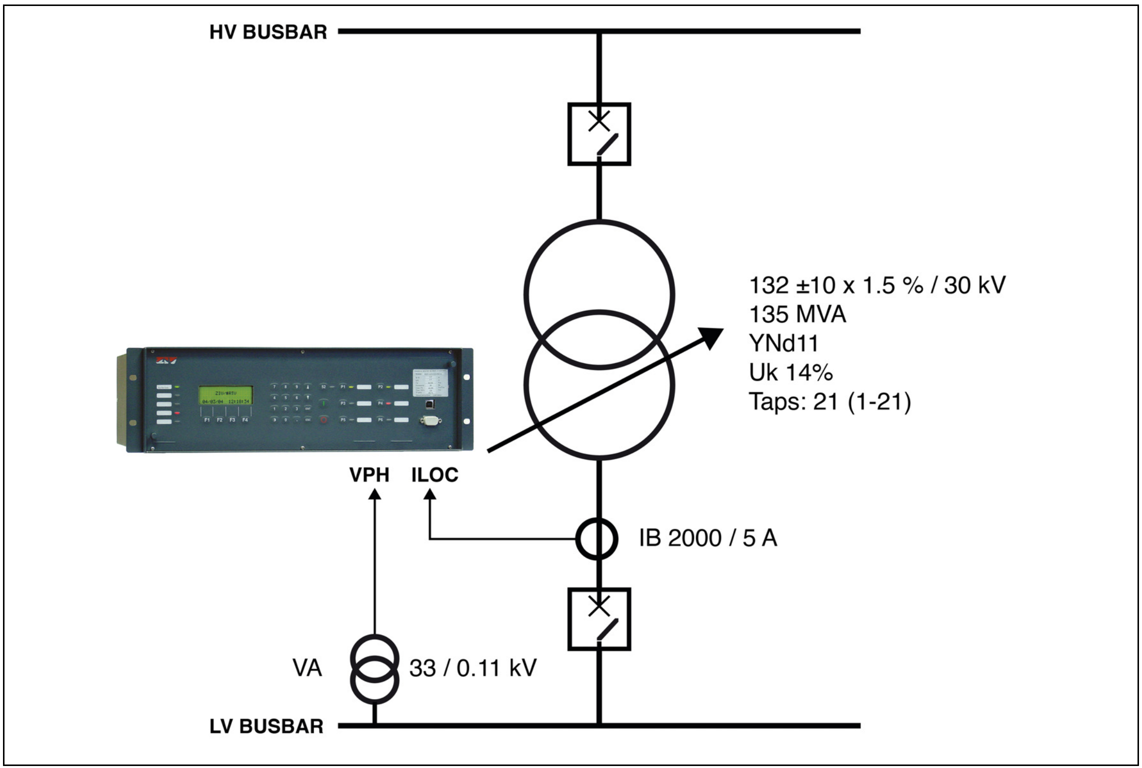


Figure 3.1.22: Example 1 Information.

Table 3.1-2: Example 1 for Settings Calculation

Voltage wired to the relay	Phase A → VA → 57.73V in secondary values.
Nominal values	ILOC: 5A
	V: 57.73V
	Frequency: 50 or 60Hz
General	TT Ratio: 300
	CT Ratio: 400
	Type of voltage: phase to ground => Phase Voltage
	Voltage source: VPH (wired)
Voltage Regulator Configuration	TapChanger Supervisory Control: Yes.
	Tap Codification type: Direct.
	Units in Main Display: Primary Values.
	VT/CT Phase Correction for ILOCAL: 240º
	VT/CT Phase Correction for IPAR: N/A
	Selectable Output Type: continuous.
Voltage Regulator Control	Voltage Setpoint (Bandcenter) 1: 100 % (57.73V in secondary values, this is 30kV in primary side).
	Voltage Setpoint (Bandcenter) 2, 3, 4, 5: N/A.
	Voltage Setpoint Selection: 1
	Voltage Setpoint Increment: 1
	Dead Band (Bandwith/2): 2.6% Δtap = 1980V HV side → 450V LV side. This voltage referred to the secondary of the VT is: 450 / 300 = 1.5V. Referring this voltage to the nominal voltage of the device: 100 x 1.5 / 57.73 = 2.6 %.
	Tap/Voltage Relation: Direct.
	Runback Voltage *: > 151.8/132 = 1.15 → 115%
	Time Delay Time: Definite Time.
	Time Factor for Inverse Curve: N/A.
	Definite Time T1: 10 s.
	Definite Time T2: 10 s.
Compensations	As required
Lockout Limits	Under Voltage: < 112.2/ 132 (= 85%) → 75%
	Under Voltage Timer: 0s.
	Maximum Switching Current: 115%
	Time for Out of Voltage: 10s + 10s x 22 taps (three tap change at central tap) = 230s.
Tap Control	Number of Taps: 21
	Minimum Tap: 1
	Low Limit Tap Value: 1
	Upper Limit Tap Value: 21
	Operation Failure Time: 15s.
	Maximum Simultaneous Time: 10s.
	Maximum Time without Active Tap: 10s.
	External Resistor Chain: N/A.
Voltage Bands	115%, 110%, 105%, 100%, 95%, 90%

(*) Over the maximum regulation voltage, even though the Overvoltage Unit (59) will not allow reaching to this voltage level unless it is set to trip with values over 115 % Un.

- **Example 2**

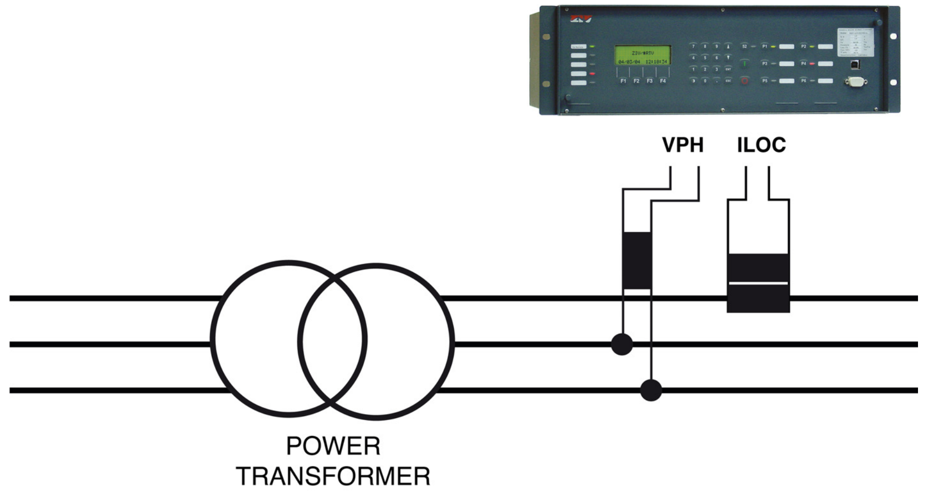


Figure 3.1.23: Example 2 Information (Modifying the VT/CT Connection).

Table 3.1-3: Example 2 for Settings Calculation	
Nominal values	ILOC: 5A
	V: 110V
General	TT Ratio: 300
	CT Ratio: 400
	Type of voltage: phase to phase => Line Voltage
Voltage Regulator Configuration	VT/CT Phase Correction for ILOCAL: 90º

3.1.15 Voltage Regulator Setting Range

Regulator Configuration			
Setting	**Range**	**Step**	**By Default**
Tap Monitoring (**)	YES / NO		NO
Tap Coding	0: Direct 1: BCD Code 2: Resistor Chain (*)		Direct
Magnitude Display (Default Screen)	0: Primary 1: Secondary 2: Percentage		Percentage
Local VT/CT Phase Difference	0 - 330º	30º	0º
Parallel VT/CT Phase Difference	0 - 330º	30º	0º
Output Type (**)	0: Pulse 1: Level		Pulse
Output Pulse Duration	0.1 - 5 s	0.01 s	3 s (1s for IEC 61850 models)

(*) RTV-P****B*** Models.**
(**) There is a settings ratio check function to make sure that if Tap Monitoring is disabled, the Output Type may not be on Level.

Regulation Control			
Setting	**Range**	**Step**	**By Default**
Voltage Setpoint	80 - 120 %	0.01%	100%
Voltage Setpoint 2 (*)	80 - 120 %	0.01%	100%
Voltage Setpoint 3 (*)	80 - 120 %	0.01%	100%
Voltage Setpoint 4 (*)	80 - 120 %	0.01%	100%
Voltage Setpoint 5 (*)	80 - 120 %	0.01%	100%
Voltage Setpoint selection (*)	1 - 5	1	1
Voltage Setpoint Increment (*)	1 - 6 %	1	1%
Insensitivity Degree (GI)	0.4 - 5.0 %	0.01%	3%
Tap / Voltage Ratios	0: Direct 1: Inverse		Direct
Runback Voltage	100 - 130%	0.01%	110%
First Operation Time Curve	0: Inverse 1: Definite time		Inverse
Time Factor	1 - 10 s	0.01 s	10 s
Definite Time T1	1 - 600 s	1 s	10 s
Definite Time T2	1 - 600 s	1 s	10 s

(*) RTV-P****B*** Models.**

Compensation			
Setting	**Range**	**Step**	**By Default**
Line Drop Compensation (LDC)			
Line Drop Compensation Enable	YES / NO		NO
Line Drop Compensation Type	0: LDC-Z 1: LDC-R&X		LDC-Z
Line Drop Compensation Z: LDC-Z	 0 - 10 %	 0.01%	 0 %
Line Drop Compensation R&X : LDC-R LDC-X	 0 - 30 V 0 - 30 V	 0.01 V 0.01 V	 0 V 0 V
Line drop compensation R&X (RTV-P) LDC-R LDC-X	 -30 - 30 V -30 - 30 V	 0.01 V 0.01 V	 0 V 0 V
Reactive Circulating Current Compensation			
Reactive Compensation Enable	YES / NO		NO
Reactive Compensation (no for RTV-P******B*** models)	1.0 - 5.0 % 1.0 - 15 % (RTV-P*N****A***)	0.01 %	1 %
Data Source Parallel Transformers (only RTV-P model)	0: Wired 1: Communications		Wired
Maximum Compensation	0.1 - 15.0 %	0.01 %	10 %
X1 (*)	1 - 25 %	0.01 %	10 %
X2 (*)	1 - 25 %	0.01 %	10 %
X3 (*)	1 - 25 %	0.01 %	10 %
X4 (*)	1 - 25 %	0.01 %	10 %
X5 (*)	1 - 25 %	0.01 %	10 %

(*) RTV-P****B*** Models.**

Blocking Limits			
Setting	**Range**	**Step**	**By Default**
Minimum Voltage	0.1 - 100.0 %	0.01%	70 %
Minimum Voltage Timer	0 - 600 s	0.01s	0s
Maximum Switched Current	0.1 - 120.0 % 0.1 - 135.0% (RTV-P*N****A***)	0.01%	100 %
Time for Voltage Out of Range (only RTV-P model)	1 - 1200 s	0.01 s	120 s

Tap Control			
Setting	**Range**	**Step**	**By Default**
Number of Taps	0 - +40	1	2
Minimum Tap	-40 - +40	1	1
Lower Tap Limit	-40 - +79	1	1
Upper Tap Limit	-40 - +79	1	1
Tap Change Fail Time	5 - 20 s	0.01 s	10 s
Maximum Simultaneous Tap Time	5 - 20 s	0.01 s	10 s
Maximum No Active Tap Time	5 - 20 s	0.01 s	10 s
Resistor Chain	YES / NO		NO

Notes:

1. Maximum Tap is calculated as:

Maximum Tap = Minimum Tap + Number of Taps – 1

2. A settings check function exists to make sure that:

Minimum Tap <= Lower Tap Limit <= Upper Tap Limit <= Maximum Tap

3. To introduce a minus sign from the HMI, press key

- ## Voltage Regulator: HMI access

0 - CONFIGURATION	0 - GENERAL	**0 - VR CONFIGURATION**
1 - OPERATIONS	**1 - VOLTAGE REGULATOR**	**1 - VR CONTROL**
2 - CHANGE SETTINGS	2 - METERING	**2 - COMPENSATION**
3 - INFORMATION	...	**3 - LOCKOUT LIMITS**
		4 - TAPCHANGE CONTROL
		5 - VOLTAGE BANDS

Regulator Configuration (VR Configuration)

0 - VR CONFIGURATION	**0 - ENABLE TAP SUPERV.**
1 - VR CONTROL	**1 - TAP CODE**
2 - COMPENSATION	**2 - DISPLAY UNITS**
3 - LOCKOUT LIMITS	**3 - VT/CT PHASE COR. L**
4 - TAPCHANGE CONTROL	**4 - VT/CT PHASE COR. P**
5 - VOLTAGE BANDS	**5 - OUTPUTS TYPE**
	6 - PULSED OUTPUT TIME

Regulator Control (VR Control)

0 - VR CONFIGURATION	**0 - VOLT. SETPOINT**
1 - VR CONTROL	**1 - BANDWIDTH/2**
2 - COMPENSATION	**2 - TAP/VOLT RELATION**
3 - LOCKOUT LIMITS	**3 - RUNBACK VOLTAGE**
4 - TAPCHANGE CONTROL	**4 - TIME DELAY TYPE**
5 - VOLTAGE BANDS	**5 - TIME FACTOR**
	6 - DEFINITE TIME T1
	7 - DEFINITE TIME T1

Compensation

0 - VR CONFIGURATION	**0 - ENABLE LDC**
1 - VR CONTROL	**1 - LDC TYPE**
2 - COMPENSATION	**2 - LDC-Z PARAMETER**
3 - LOCKOUT LIMITS	**3 - LDC-R PARAMETER**
4 - TAPCHANGE CONTROL	**4 - LDC-X PARAMETER**
5 - VOLTAGE BANDS	**5 - ENABLE CIRC. CURR.**
	6 - CIR.CUR.COMP.RATIO
	7 - MAX COMPENSATION

Compensation (RTV-P Model)

0 - VR CONFIGURATION	**0 - ENABLE LDC**
1 - VR CONTROL	**1 - LDC TYPE**
2 - COMPENSATION	**2 - LDC-Z PARAMETER**
3 - LOCKOUT LIMITS	**3 - LDC-R PARAMETER**
4 - TAPCHANGE CONTROL	**4 - LDC-X PARAMETER**
5 - VOLTAGE BANDS	**5 - ENABLE CIRC. CURR.**
	6 - CIR.CUR.COMP.RATIO
	7 - EXT TRAFOS SOURCE
	8 - MAX COMPENSATION

Lockout Limits

0 - VR CONFIGURATION	**0 - MIN. VOLTAGE**
1 - VR CONTROL	**1 - MAX. CURRENT**
2 - COMPENSATION	
3 - LOCKOUT LIMITS	
4 - TAPCHANGE CONTROL	
5 - VOLTAGE BANDS	

Lockout Limits (RTV-P Model)

0 - VR CONFIGURATION	**0 - MIN. VOLTAGE**
1 - VR CONTROL	**1 - MAX. CURRENT**
2 - COMPENSATION	**2 - OUT OF VOLTAGE**
3 - LOCKOUT LIMITS	
4 - TAPCHANGE CONTROL	
5 - VOLTAGE BANDS	

Tap Change Control

0 - VR CONFIGURATION	**0 - NUMBER OF TAPS**
1 - VR CONTROL	**1 - MINIMUM TAP VALUE**
2 - COMPENSATION	**2 - LOW LIMIT TAP**
3 - LOCKOUT LIMITS	**3 - UPPER LIMIT TAP**
4 - TAPCHANGE CONTROL	**4 - OPER.FAILURE TIME**
5 - VOLTAGE BANDS	**5 - MAX.SIMUL. TIME**
	6 - MAX. TIME W/O TAP

Voltage Bands

0 - VR CONFIGURATION	**0 - Band Limit S3**
1 - VR CONTROL	**1 - Band Limit S2**
2 - COMPENSATION	**2 - Band Limit S1**
3 - LOCKOUT LIMITS	**3 - Band Limit I1**
4 - TAPCHANGE CONTROL	**4 - Band Limit I2**
5 - VOLTAGE BANDS	**5 - Band Limit I3**

3.1.16 Voltage Regulator Digital Inputs

Table 3.1-4: Voltage Regulator Digital Inputs

Name	Description	Function
IN01_TAP	Input Value Tap 01	Logic inputs for Active Tap detection.
IN02_TAP	Input Value Tap 02	
IN03_TAP	Input Value Tap 03	
...	...	
IN38_TAP	Input Value Tap 38	
IN39_TAP	Input Value Tap 39	
IN40_TAP	Input Value Tap 40	
ENABLE_LDC	Line Drop Compensation Enabled Input	
DOUBLE_LDC	Line Drop Compensation with double slope	Doubles Line Drop Compensation (LDC)
ENABLE_CREAC	Reactive Compensation Enabled Input	
CANCEL_T1	Cancels Timer T1	
BLK_EXT_REG	Regulator External Blocking	Blocking Inputs.
BLK_MAN_RAISE	Manual Raise the Tap Operation Blocking	
BLK_MAN_LOWER	Manual Lower the Tap Operation Blocking	
BLK_AUT_RAISE	Automatic Raise the Tap Operation Blocking	
BLK_AUT_LOWER	Automatic Lower the Tap Operation Blocking	
CMD_RAISE_STP	Raise the Voltage Set-point Command	Increases the voltage set-point V_{CON} in 1%.
CMD_LOWER_STP	Lower the Voltage Set-point Command	Decreases the voltage set-point V_{CON} in 1%.
CMD_RAISE_TAP	Raise the Tap Command	
CMD_LOWER_TAP	Lower the Tap Command	
CMD_MANUAL	Switch to Manual State Command	
CMD_AUTO	Switch to Automatic State Command	
RST_TAP_CNT	Tap Change Operation Counter Reset	

Table 3.1-5: Voltage Regulator Digital Inputs (RTV-P Model)

Name	Description	Function
EXIST_TRF_PARAL_1	Input Parallel transformer 1	Logic inputs for parallel transformer regulation through communications.
EXIST_TRF_PARAL_2	Input Parallel transformer 2	
EXIST_TRF_PARAL_3	Input Parallel transformer 3	
EXIST_TRF_PARAL_4	Input Parallel transformer 4	

Table 3.1-6:Voltage Regulator Digital Inputs (RTV-P with spare code B)

Name	Description	Function
ENABLE_TIME_OUT_V	Out of Voltage Block Enable Input	
RESET_TIME_OUT_V	Reset Out of Voltage Timer	

3.1.17 Voltage Regulator Analog Inputs

Table 3.1-7: Voltage Regulator Analog Inputs (RTV-P model)

Name	Description	Function
VAR T1 PARALELO	Reactive power input of parallel transformer 1	Analog inputs for parallel transformer regulation through communications.
VAR T2 PARALELO	Reactive power input of parallel transformer 2	
VAR T3 PARALELO	Reactive power input of parallel transformer 3	
VAR T4 PARALELO	Reactive power input of parallel transformer 4	
NUE_CONSIG_PRI	Set point input in primary values	Analog inputs to change set point
NUE_CONSIG_TEN_P	Set point input in percentage	

Table 3.1-8:Voltage Regulator Analog Inputs (RTV-P with spare code B)

Name	Description	Function
V EXTERNA	Input of controlled magnitude instead of VPH	Analog input for regulation.

3.1.18 Digital Outputs and Voltage Regulator Events

Table 3.1-9: Digital Outputs and Voltage Regulator Events		
Name	**Description**	**Function**
ST_AUTO	Regulator Status: Automatic Mode (1) or Manual Mode (0)	Automatic Mode (1) or Manual Mode (0)
RAISE_OUTPUT	Raise the Tap Physical Output	RAISE operation output.
LOWER_OUTPUT	Lower the Tap Physical Output	LOWER operation output.
BLK_MIN_VOLT	Minimum Voltage Blocking	Measured voltage is below Minimum Voltage setting.
BLK_MAX_CURR	Maximum Switched Current Blocking	Measured local current is above Maximum Switched Current setting.
BLK_SEV_TAPS	Simultaneous Tap Blocking	
BLK_NO_TAP	No Tap Blocking	
BLK_LIMIT_TAP	Limit Tap	
BLK_INT_FAIL	Regulator Internal Anomaly Blocking	
EXTREME_STP	Extreme set-point	
FAIL_RAISE	Raise the Tap Command Fail	
FAIL_LOWER	Lower the Tap Command Fail	
MAX_TAP_REACH	Maximum Tap reached	The active tap equals the Minimum Tap Setting. + Tap Number - 1
MIN_TAP_REACH	Minimum Tap reached	The active tap equals the Minimum Tap setting.
SUP_TAP_REACH	Upper Tap Limit reached	The active Tap equals the Upper Tap Limit setting.
INF_TAP_REACH	Lower Tap Limit reached	The active Tap equals the Lower Tap Limit setting.
REVERSE_POWER	Power Reversal detected	
VOLT_OUT_BAND	Voltage out of Dead Band	$\|DV\| > GI$
VM_GT_VD	Voltage over Dead Band	$\|DV\| > GI$ & $V_M < V_D$ (*)
VM_LT_VD	Voltage under Dead Band	$\|DV\| > GI$ & $V_M > V_D$ (*)

(*) V_M (measured voltage) = V_{PH} // V_D (*wished* voltage) = V_{COMP}

Table 3.1-10:Digital Outputs and Voltage Regulator Events (RTV-P with spare code B)		
Name	**Description**	**Function**
BLK_RUNAWAY	Block by Runaway	
RC_NO_CONN	Resistor Chain Not Connected or Broken Wire	
RC_NO_DISP	Resistor Chain Not Available	
RC_SOBREC	Resistor Chain Overloaded	

3.1.19 Voltage Regulator Testing

- **Metering Test**

Measurements are shown in engineering units (V or A) and in percentage (%) of the rated value and are displayed in:

- The default screen.
- The Cyclic Menu (pressing the front F2 key).
- The information menu >> Measurements.
- The ***ZivercomPlus®*** (State >> Measurements).

The steps to carry out the metering test are:

- Set **Rated Voltage**, **Frequency** and **Rated Currents** (Settings>> Rated Values):
  - Rated VABC: 115 V
  - Rated Freq: 50 Hz
  - Rated Local I.: 5 A
  - Rated Parallel I.: 5 A

- Set **Turns Ratios** (Settings>> General):
  - Turns Ratio V.T. Phase: 1
  - Turns Ratio C.T. Local: 1
  - Turns Ratio C.T. Parallel: 1

- Set **VT / CT phase difference** (Settings>> Voltage Regulator>> Regulator Configuration):
  - Local VT / CT phase difference: 0º
  - Parallel VT / CT phase difference: 0º

- Apply a voltage, close to the rated voltage, between terminals A1-A2 (marked as U), for angle reference.
- Apply a current, close to the rated current, between terminals A3-A4 (marked as IL).
- Apply a current, close to the rated current, between terminals A5-A6 (marked as IR).

Voltage Measurement

Apply the voltage shown in following table between terminals A1-A2 (marked as U) and check the following measurements:

Table 3.1-11: Voltage Measurement Test

Applied Voltage	Measured value (%)	Measured value (secondary)
x Vac	$(\frac{x}{V_n} \cdot 100 \pm \frac{x}{V_n} \cdot 0.5)\%$	**x** ± 0.005**x** Vac

Local and Parallel Current Measurement

Apply the current shown in following table between terminals A3-A4 (marked as IL) and check measurements. Repeat the test applying current between terminals A5-A6 (marked as IR) and check measurements.

Table 3.1-12: Local and Parallel Current Measurement Test		
Applied Current	**Measured Value (%)**	**Measured value (secondary)**
x Aac	$(\frac{x}{I_n} \cdot 100 \pm \frac{x}{I_n} \cdot 0.5)\%$	**x** ± 0.005**x** Aac

Angle Measurement

The angles shown in the HMI and the ***ZivercomPlus***® are the angles of phase difference between current and the voltage phasor, which is taken as reference for angles, measured **counterclockwise**, without applying **Local VT / CT Phase Difference** or **Parallel VT / CT Phase Difference** setting corrections.

If the voltage does not exceed a certain threshold (around 1 V), a reference for angles will not exist, and these will appear as invalid values.

Circulating Current Measurement

- Apply voltage between terminals A1-A2 (marked as U), in order to have a reference for angles.
- Apply a current between terminals A3-A4 (marked as IL).
- Apply a current between terminals A5-A6 (marked as IR).
- Formula for calculating $\mathbf{I_{circulating}}$

$$I_{Circulating} = I_{Local} \cdot RT_{Local} \cdot sen\,\varphi_L - I_{Parallel} \cdot RT_{Parallel} \cdot sen\,\varphi_P$$

In the calculation of $\mathbf{I_{Circulating}}$ Turns Ratios (RT_{Local} and $RT_{Parallel}$) are involved, so that units are **Primary Amps**. As can be seen in the above formula, the sign of the circulating current $\mathbf{I_{Circulating}}$ can be either positive or negative.

The angles in the following table appear in the ***ZivercomPlus***® or the HMI.

Table 3.1-13: Circulating Current Measurement Test				
$\mathbf{I_{Local}}$	$\mathbf{\varphi_L}$ **(º)**	$\mathbf{I_{Parallel}}$	$\mathbf{\varphi_P}$ **(º)**	$I_{Circulating}$ (A)
5	30º	0	0	

- **Regulator Operation Test**

Although there is no need for applying any current or voltage during this test, loading an adequate configuration is needed though.

The following steps are needed for testing the relay operation:

- Apply a pulse (>200 ms) to an input configured as **Switch to Automatic** and check that the relay switches to **Automatic Mode**, that is, the corresponding outputs and LEDs activate.
- Apply a pulse (>200 ms) to the input configured as **Switch to Manual** and check that the relay switches to **Manual Mode**, that is, the corresponding outputs and LEDs activate.
- Repeat the test by sending **Switch to Automatic** and **Switch to Manual** commands through the communications system.

  Repeat the test by sending **Switch to Local** and **Switch to Remote** commands.

  Leave the regulator in **Manual Mode** for the rest of the test.

- Apply a pulse (>200 ms) to an input configured as **Raise the Tap Command** and check that the relay activates the corresponding outputs and LEDs during the set time.
- Apply a pulse (>200 ms) to an input configured as **Lower the Tap Command** and check that the relay activates the corresponding outputs and LEDs during the set time.

For models with tap monitoring and signaling, this operation can be executed two times, that is, if after the tap change command the tap change fail timer times out with no tap change, the Raise/Lower the Tap LED lights again for three seconds. If the tap change fail timer times out (from the time when the LED is lit) again with no tap change, the relay switches to internal anomaly blocking and to manual state.

For models with no tap monitoring, the Raise / Lower the Tap command can be given an indefinite number of times until the voltage is within the range. The time lapse between commands is the delay time when the Runback Voltage has not been exceeded. In case said voltage is exceeded, the first command would be given immediately and the time between consecutive commands is 12 seconds.

- **Insensitivity Degree (GI)**

No configuration is needed for this test.

The steps to be followed are:

- Set **Rated Voltage** to 115 V (Settings>> Rated Values>> Rated Voltage ABC).
- Apply a voltage **V_{BUS}** (close to rated voltage) between terminals A1-A2 (marked as U). No current is needed to be applied, but in case there is any current applied, set **Line Drop Compensation Enable** and **Reactive Compensation Enable** to **NO**.
- Set **Voltage Set-point** to 100% (Settings>> Voltage Regulator >> Regulation Control >> Set-point).
- Set **Insensitivity Degree** to 1% (Settings>> Voltage Regulator >> Regulation Control >> Insensitivity).
- Set **Tap/Voltage Ratio** to Direct (Settings>> Voltage Regulator >> Regulation Control >> Tap/Voltage ratio).
- Check the deviation value by means of the formula below, where V_{CON} is the set **Voltage Set-point** value:

$$DV\ (\%) = V_{CON}\ (\%) - V_{BUS}\ (\%)$$

Check that:

- If the absolute value of the calculated deviation **|DV|** is smaller than the set insensitivity degree **GI**, the voltage is **within the range**, and the default screen shows: **DESV** □ .
- If, on the contrary, the absolute value of the deviation **|DV|** is greater than the insensitivity degree **GI**, the voltage is **outside the range**, and the default screen shows **DESV** ■ .
- Check that the sign of the deviation generates adequate tap change commands, that is, if the measured voltage is greater than the voltage set-point value, the **Lower the Tap** (**LOWER contacts**) output is activated. On the contrary, if the measured voltage is smaller than the voltage set-point value, the **Raise the Tap** (**RAISE contacts**) output is activated. This can be seen on the default screen: **DESV** ■↑ o **DESV** ■↓ .
- Repeat the test switching the **Tap / Voltage Ratio** setting to Inverse, checking that the sign of the deviation generates adequate tap change commands, that is, if the measured voltage is greater than the voltage set-point value, the **Raise the Tap** (**RAISE contacts**) output is activated. On the contrary, if the measured voltage is smaller than the voltage set-point value, the **Lower the Tap** (**LOWER contacts**) output is activated
- Check the default screen and the generated events

Bear in mind that the accuracy of voltage measurement is ±0.1%.

- **Line Drop Compensation LDC-Z**

No configuration is needed for this test.

The steps to be followed are:

- Set **Rated Voltage** to 115 V (Settings>> Rated Values>> Rated Voltage ABC).
- Set **Local Rated Current** to 5 A (Settings>> Rated Values >> Local Rated I).
- Apply a voltage (close to rated voltage) between terminals A1-A2 (marked as U), in order to have a reference for angles (115 ⌊ 0º).
- Apply a local current between terminals A3-A4 (marked as IL).
- Set **Line Drop Compensation Enable** setting to: YES.
- Set **Line Drop Compensation Type** to*:* Z Type.
- Set **Voltage Set-point V_{CON}** to 100% (Settings>> Voltage Regulator >> Regulation Control>> Set-point).
- Set **Maximum Compensation** to 15%.
- Disable any other type of compensation (**Reactive Compensation**).
- Set **Line Drop Compensation Z** (LDC-Z *)* to 10%.

Calculate the **Compensated Voltage V_{COMP}** through the formula:

$$V_{COMP}\,(\%) = V_{CON}\,(\%) + K_C\,(\%) \cdot I_{pu}\,,$$

where I_{pu} = Per unit Current (that is, $I_{LOCAL} / I_{nominal}$).

Table 3.1-14: Line Drop Compensation LDC-Z Test

V_{CON} (%)	LDC-Z o K_C (%)	I_{LOCAL} (A)	I_{pu}	V_{COMP} (%)
100 %	10 %	1 A	0,2	102 %
100 %	10 %	2 A	0,4	104 %
100 %	10 %	3 A	0,6	106 %
100 %	10 %	4 A	0,8	108 %
100 %	10 %	5 A	1,0	110 %

- Check **Deviation Value** through the following formula, where **V_{COMP}** is the value calculated above:

$$DV\,(\%) = V_{COMP}\,(\%) - V_{BUS}\,(\%)$$

- To check the following **Logic Inputs**, a configuration must be loaded:

  ENABLE_LDC: Enable Line Drop Compensation.
  DOUBLE_LDC: Double Line Drop Compensation.

- **Reactive Compensation with Wired Currents**

The steps to be followed for the **Reactive Compensation** test are:

- Load a configuration that includes logic input ENABLE_CREAC (**Reactive Compensation Enable**).
- Apply voltage, close to rated voltage, between terminals A1-A2 (marked as U), in order to have a reference for angles.
- Apply a current between terminals A3-A4 (marked as IL): I_{LOCAL}.
- Apply a current between terminals A5-A6 (marked as IR): $I_{PARALLEL}$.
- Set following settings (Voltage Regulator >> Compensation):

Reactive Compensation Enable: YES
Reactive Compensation K_R (%): 5%
Maximum Compensation: 15%

All other settings must remain at default values.

- Calculate **Circulating Reactive Current $I_{circulating}$** through the formula:

$$I_{circulating} = I_{LOCAL} \cdot RT_{LOCAL} \cdot \text{sen}\, \varphi_L - I_{PARALLEL} \cdot RT_{PARALLEL} \cdot \text{sen}\, \varphi_P$$

- Calculate **Compensated Voltage V_{COMP}** through the formula:

$$V_{COMP}(\%) = V_{CON}(\%) + K_R(\%) \cdot (I_{CIRC} / 0{,}1 \cdot I_n)$$

- Calculate **Deviation DV** through the formula:

$$DV(\%) = V_{COMP}(\%) - V_{BUS}(\%)$$

- Check that if the calculated deviation is below the set insensitivity degree, the voltage is **within the range**. If, on the contrary, the deviation is above the insensitivity degree, the voltage is **outside the range**.
- Check that if ENABLE_CREAC input is deactivated, the **Reactive Compensation** effect disappears, that is: $V_{COMP}(\%) = V_{CON}(\%)$
- Check that as long as $I_{LOCAL}\angle\varphi_L = I_{PARALLEL}\angle\varphi_P$, then $V_{COMP}(\%) = V_{CON}(\%)$ also.

Table 3.1-15: R Reactive Compensation Test through Wiring

V_{CON} (%)	$I_{LOCAL}\angle\varphi_L$	$I_{PARALLEL}\angle\varphi_P$	$I_{circulating}$	V_{COMP} (%)
100 %	1 ∠330º	1 ∠0º	- 0.5	95 %
100 %	1 ∠0º	1 ∠330º	0.5	105 %
100 %	1 ∠330º	1 ∠330º	0	100 %
100 %	5 ∠330º	5 ∠330º	0	100 %
100 %	1 ∠330º	1 ∠120º	- 1.366	86.34 %
100 %	1 ∠330º	1 ∠90º	- 1.5	85 %

- **Reactive compensation with hard wired currents (RTV-P with spare digit B or above)**

The steps to follow for **Reactive Compensation** are:

- Load a configuration that includes the logic input **ENABLE_CREAC** (**Reactive Compensation Enable**).
- Apply voltage close to the rated voltage, between terminals A1-A2 (marked U), in order to have angle reference.
- Apply current between terminals A3-A4 (marked IL): $\mathbf{I_{LOCAL}}$.
- Apply current between terminals A5-A6 (marked IR): $\mathbf{I_{PARALELO}}$.
- Set the following settings (Voltage Regulator>> Compensation):

Reactive compensation enable:	YES
X1:	25%
X2:	25%
Maximum compensation:	15%

Other settings must remain with their default values.

- Calculate **Reactive current flow** $\mathbf{I_{CIRC}}$ according to formula:

$$I_{circ} = \frac{I_1^m \cdot RT_{CT1} \cdot \operatorname{sen}\varphi_1 - I_2^m \cdot RT_{CT2} \cdot \operatorname{sen}\varphi_2}{2}$$

$$K_R^{(\%)} = \frac{X_1^{(\%)} + X_2^{(\%)}}{10}$$

- Calculate **Compensated voltage** $\mathbf{V_{COMP}}$ according to formula:

$$V_{COMP}(\%) = V_{CON}(\%) + K_R(\%) \cdot (I_{CIRC} / 0{,}1 \cdot I_n)$$

- Calculate **Deviation DV** according to formula:

$$DV(\%) = V_{COMP}(\%) - V_{BUS}(\%)$$

- Check that if the calculated deviation is less than the set insensitivity degree, the voltage is **within range**. If, otherwise, the deviation is greater than the insensitivity degree, the voltage is **out of range**.
- Check that when deactivating the input **ENABLE_CREAC** the **Reactive compensation** effect disappears, namely: $V_{COMP}(\%) = V_{CON}(\%)$
- Check that whenever $I_{LOCAL}\angle\varphi_L = I_{PARALELO}\angle\varphi_P$, also $V_{COMP}(\%) = V_{CON}(\%)$.

Table 3.1-16: Reactive Compensation Test through Wiring

V_{CON} (%)	$I_{LOCAL}\angle\varphi_L$	$I_{PARALLEL}\angle\varphi_P$	$I_{circulating}$	V_{COMP} (%)
100 %	1 ∠330º	1 ∠0º	- 0.25	97.5
100 %	1 ∠0º	1 ∠330º	0.25	102.5
100 %	1 ∠330º	1 ∠330º	0	100
100 %	5 ∠330º	5 ∠330º	0	100
100 %	1 ∠330º	1 ∠120º	- 0.683	93.17
100 %	1 ∠330º	1 ∠90º	- 0.75	92.5
100 %	2 ∠0º	2 ∠30º	-0.5	95
100 %	2 ∠30º	2 ∠0º	0.5	105
100 %	1.3 ∠20º	2.8 ∠25º	-0.36935	96.3065
100 %	3.6 ∠70º	2.1 ∠40º	1.0165	110.165
100 %	2.25 ∠160º	2.31 ∠173º	0.244	102.44

- **Reactive Compensation through Communications (only RTV-P Model)**

Below are the steps to be followed for the **Reactive compensation** test:

- Load a CID or a configuration to each relay that include the logic inputs **ENABLE_CREAC (Compensation enable), EXIST_TRF_PARAL_1 (Parallel transformer 1) and the analog input VAR T1 PARALELO (receipt of the reactive power measured by the other RTV).**
- Link both equipment, either through GOOSE messages, or virtual Inputs/Outputs.
- Apply voltage, close to the nominal value, between terminals A1-A2 (marked as U), in order to have angle reference.
- Apply current between terminals A3-A4 (marked as IL): **I_{LOCAL}.**
- Set the following settings (Voltage regulator >> Compensation):

Reactive compensation enable:	YES
Reactive compensation K_R (%):	5%
Maximum compensation:	15%
Parallel transformer data source	Communications

All other settings must remain at default values.

- The **Circulating reactive current I_{CIRC}** is calculated by the formula:

$$I_{circ} = I_1^m \cdot RT_{CT1} \cdot sen\ \varphi_L + \left(\frac{Q_2^m + Q_3^m + Q_4^m + Q_5^m}{3 \cdot V_1^m \cdot RT_{VT1}} \right)$$

It being two transformers in parallel, it becomes:

$$I_{circ} = I_1^m \cdot RT_{CT1} \cdot sen\ \varphi_L + \left(\frac{Q_2^m}{3 \cdot V_1^m \cdot RT_{VT1}} \right)$$

- The **Compensated voltage V_{COMP}** is calculated by the formula:

$$V_{COMP}(\%) = V_{CON}(\%) + K_R(\%) \cdot (I_{CIRC} / 0{,}1 \cdot I_n)$$

Table 3.1-17: Reactive Compensation Test through Communications (RTV-P)

$I_{RTV1}\angle\varphi_L$	$I_{RTV2}\angle\varphi_P$	Q_{RTV1}	Q_{RTV2}	I_{CIRC}1	I_{CIRC}2	V_{COMP} (%)1	V_{COMP} (%)2
1 ∠330º	1 ∠0º	172VAR	-0.7VAR	-0.502	0.497	95.02%	104.92%
1 ∠0º	1 ∠330º	-0.25VAR	172.4VAR	0.5	-0.5	104.94%	95.05%
1 ∠330º	1 ∠330º	171.8VAR	172.1VAR	0.002	-0.004	100.02%	100%
5 ∠330º	5 ∠330º	858.7VAR	861.3VAR	0.005	-0.009	100.07%	99.89%
1 ∠330º	1 ∠120º	171.46VAR	-298.9	-1.362	1.358	86.51%	113.43%
1 ∠330º	1 ∠90º	171.3VAR	-345VAR	-1.489	1.490	85.26%	114.76%

- **Reactive Compensation through Communications (RTV-P with spare digit B or above)**

The steps to follow for the **Reactive Compensation** test are:

- Load a CID or configuration to the relays provided with logic inputs **ENABLE_CREAC** (**Compensation enable), EXIST_TRF_PARAL_1 (Parallel transformer 1)** and analog input **VAR T1 PARALLEL (receiving the reactive power measured by the other RTV)**.
- Link both relays, whether through GOOSE messages, or virtual Inputs/Outputs.
- Apply voltage, close to rated voltage, between terminals A1-A2 (marked U), for angle reference.
- Apply current between terminals A3-A4 (marked IL): **I_{LOCAL}**.
- Set the following settings (Voltage regulator >> Compensation):

Reactive compensation enable:	YES
X1:	4,03%
X2:	3,85%
Maximum compensation:	15%
Parallel transformer data source	Communications

Other settings must remain with their default values.

- Calculate **Reactive current flow I_{CIRC}** according to formula:

$$I_{circ12} = \frac{I_1^m \cdot RT_{CT1} \cdot sen\,\varphi_1 + \left(\dfrac{Q_2^m}{3 \cdot V_1^m \cdot \boldsymbol{RT}_{VT\,1}} \right)}{2}$$

$$I_{circ} = I_{circ12}$$

$$K_R = \frac{X_1(\%) + X_2(\%)}{10} = 0{,}788$$

- Calculate **Compensated voltage V_{COMP}** according to formula:

$$V_{COMP}\,(\%) = V_{CON}\,(\%) + K_R\,(\%) \cdot (\,I_{CIRC}\ / 0{,}1 \cdot I_n)$$

Table 3.1-18:Reactive Compensation Test through Communications (RTV-P)

$I_{RTV1}\angle\varphi_L$	$I_{RTV2}\angle\varphi_P$	Q_{RTV1}	Q_{RTV2}	$I_{CIRC}1$	$I_{CIRC}2$	V_{COMP} (%)1	V_{COMP} (%)2
1 ∠330º	1 ∠0º	172.5	0	-0.25	0.25	99.606	100.394%
1 ∠0º	1 ∠330º	0	172.5	0.25	-0.25	100.394	99.606%
1 ∠330º	1 ∠330º	172.5	172.5	0	0	100	100%
5 ∠330º	5 ∠330º	862.5	862.5	0	0	100	100%
1 ∠330º	1 ∠120º	172.5	-298.77	- 0.683	0.683	98.9236	100.076%
1 ∠330º	1 ∠90º	172.5	-345	- 0.75	0.75	98.818	101.182%

- **Delay Time**

In order to carry out this test, a configuration must be loaded both to switch the relay to **Automatic Mode** and to configure **CANCEL_T1** input (Cancel Timer T_1).

Apart from loading said configuration the steps below must be followed:

- Apply voltage (between terminals A1-A2) close to rated voltage.
- No current must be applied.
- Set all settings to default values.

  In this test, the time elapsed from the time the voltage comes out of the regulation range until the Raise/Lower the Tap command is given is measured, checking the operation of the contacts marked on the backside sticker as **RAISE** and **LOWER**.

  Calculate the **Delay Time**, according to the inverse curve, through the following expression:

$$T_{curve} = \frac{FT \cdot 30 \cdot GI}{|DV|}$$

  For example, if default settings are considered:

  V_{CON} = 100%   GI = 3%   FT = 10 s   Runback Voltage = 110%

- Starting from a situation where the voltage is **within the range**, 90% voltage is applied. The theoretical time obtained through the above formula is 90 seconds, after which the operation of the **RAISE** contacts is checked. In this situation, the next commands must be activated after the **Definite Time T_2** setting value (10 seconds).
- Starting from a situation where the voltage is **within the range**, 110% voltage is applied. The theoretical time obtained through the above formula is 90 seconds, after which the operation of the **LOWER** contacts is checked. In this situation, the next commands must be activated after the **Definite Time T_2** setting value (10 seconds).
- Repeat the test for FT = 1s and bear in mind that for the T_{curve} values obtained from the above formula smaller than $T_{definido1}$, $T_{definido1}$ shall be used. Refer to summary table in section 3.1.3.b Time for following operations: T_2.
- Repeat the test for **First Operation Curve Type** setting: Definite Time.
- Starting from a situation where the voltage is **within the range**, activate the input configured as **Cancel Timer** and apply a voltage **outside the range**. Check that the operation time is between 0.5 s and 1.5 s.
- Similarly, starting from a situation where the voltage is **within the range** apply a voltage above the **Runback Voltage** setting value and measure the time elapsed until the tap change command is given. This time must be between 0.5 s and 1.5 s.

In both cases, **Cancel Timer** and **Runback Voltage**, the first tap change command is sent immediately, and following commands, if required, are sent after **T_2**, no matter the calculated **Delay Time**.

3.2 Voltage Unit

3.2.1 Phase Overvoltage Element

RTV-P*N-**A****** relays feature a phase overvoltage element.

3.2.1.a Phase overvoltage element

RTV's phase overvoltage elements are associated to the only analog voltage input of the relay. Activation is produced when the RMS value of the measured voltage reaches a given settable value.

The overvoltage element picks up when the measured value equals or exceeds the setting value (1), and resets when it reaches a settable percentage (below 100) of the setting value.

The pickup of the overvoltage element enables the timing function. This is carried out by applying increments to a counter that operates the time element when the counter times out. The timer can be set to a fixed time through the time setting included.

A quick reset of the integrator takes place when the measured RMS value drops below the pickup setting value. In order for the output to activate, the pickup must be on throughout the integration time. Any reset drives the integrator to the initial conditions, so that a new activation starts the counter from zero.

A physical input can be assigned to the logic block signal of the **Phase Overvoltage Element Trip Output**, in order to deactivate the output if this is activated.

3.2.2 Voltage Element Block Diagram

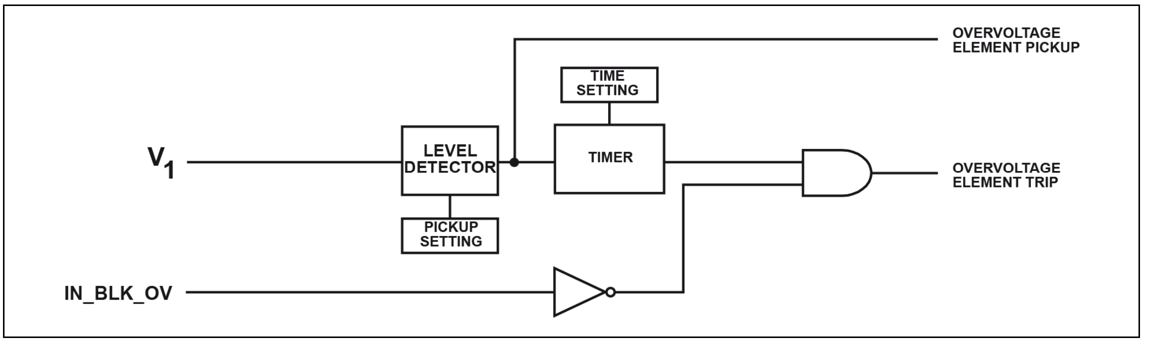


Figure 3.2.1: Voltage Element Block Diagram.

3.2.3 Voltage Element Settings

Voltage Element Reset Range			
Setting	**Range**	**Step**	**By Default**
Phase Overvoltage Element Reset	50 - 99% of the setting	1	95 %

Phase Overvoltage			
Setting	**Range**	**Step**	**By Default**
Enable	YES / NO		NO
Pickup	20 - 300 V	0.01 V	70 V
Time Delay	0 - 300 s	0.01 s	0 s

- **Voltage Protection: HMI Access**

0 - CONFIGURATION	0 - GENERAL	
1 - OPERATIONS	1 - VOLTAGE REGULATOR	**0 - VOLTAGE**
2 - CHANGE SETTINGS	**2 - METERING**	1 - FREQUENCY
3 - INFORMATION	...	

0 - VOLTAGE	**0 - VOLTAGE RESET**
1 - FREQUENCY	**1 - PHASE OVERVOLTAGE**

Voltage Reset

0 - VOLTAGE RESET	**0 - PH OV RESET**
1 - PHASE OVERVOLTAGE	

Phase Overvoltage

0 - VOLTAGE RESET	**0 - UNIT 1**	**0 - PH. OV ENABLE**
1 - PHASE OVERVOLTAGE		**1 - PH. OV PICKUP**
		2 - PH. OV DELAY

3.2.4 Digital Inputs to the Voltage Module

Table 3.2-1: Digital Inputs to the Voltage Module		
Name	**Description**	**Function**
IN_BLK_OV_PH1	Phase overvoltage element 1block input	Activating this input prior to trip generation inhibits the operation of the element. If it is activated after tripping, this resets.
ENBL_OV_PH1	Phase overvoltage element 1 enable input	Activating this input enables the element. This can be assigned to a level digital input or a command from the communications protocol or from the HMI. The default value of this logic input is “1”.

3.2.5 Voltage Module Digital Outputs and Events

Table 3.2-2: Voltage Module Digital Outputs and Events		
Name	**Description**	**Function**
PU_OV1_A	Phase overvoltage element 1 pickup	Overvoltage element pickup and start of the time count.
TRIP_OV1_A	Phase overvoltage element 1 trip signal	Overvoltage element trip signal.

3.2.6 Voltage Element Test

- **Pickup and Reset**

Set the element pickup value and check the activation through an output configured to that end. Also, it can be checked through the pickup flags of the **Information - Status - Elements - Voltage - Phase Overvoltage** menu. Similarly, it can be checked that if the element trips, the trip flag of the mentioned menu activates.

Table 3.2-3: Overvoltage Element Pickup and Reset				
Setting of the unit	Pickup		Reset	
X	Maximum	Minimum	Maximum	Minimum
	1,03 x X	0,97 x X	(RST setting+ 0,03) x X	(RST setting- 0,03) x X

Where the “Reset setting” value corresponds to the Reset per-unit setting value of the overvoltage element.

- **Operating Time**

This will be checked through user outputs configured for that purpose.

Fixed or Instantaneous Time

Apply a voltage 20% above the selected pickup setting value. The operating time must correspond to 1% or ±32 ms (for 50Hz) of the selected time setting value. Note that the operating time for a setting of 0 ms is approximately between 20 and 32 ms (for 50Hz) or between 15 and 28 ms (for 60Hz).

3.3 Frequency Element

3.3.1 Introduction

RTV-P*N-**B**** IEDs have one underfrequency element with the following settings:

- **Inhibition Voltage**. This setting checks that the voltage is above a set value. If so, it allows the frequency elements to meter and to operate. Otherwise, it gives a frequency value of zero and the frequency elements are inhibited.
- **Activation Half-Waves**. This is the number of half-waves that must meet the fault conditions for the frequency elements to pick up.
- **Reset Cycles**. This is the number of cycles during which there may not exist fault conditions so that the frequency elements already picked up will reset. When the frequency elements have been picked up and have not yet operated, the fault conditions may disappear during a brief instant. This setting indicates how long these conditions may disappear without resetting the element. For example, if the rate of change should be falling below -0.5 Hz/s and during an instant it only goes down to -0.45 Hz/s; it may not be desirable that the protection function reset if the time the fault condition disappears is very short.

All the elements have a disabling counter. This counter, of approximately 50 milliseconds, operates when, while the element is tripped, the function is deactivated either by the inhibition voltage.

All the elements have a time module that can be set to instantaneous. It has the following settings:

- Pickup
- Time

Figure 3.3.1 is the block diagram of one of the frequency elements.

Associated with the level detection block, there is a setting for the pickup value: the Underfrequency element picks up whether or not the value measured is less than the setting value a given quantity.

Activation of the pickup enables the timing function. This is done by applying increments on a meter that picks up the element when it times out.

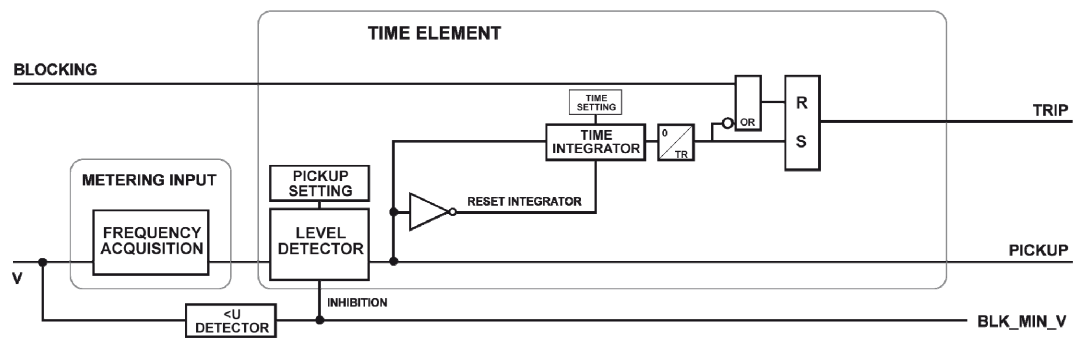


Figure 3.3.1: Block Diagram of a Frequency Element.

3.3.2 Underfrequency Element

Pickup occurs when the value measured coincides with or is below the pickup value (100% of the setting) during a number of half-waves equal to or greater than the setting of **Activation Half-Waves**, and resets when the frequency goes up above 10mHz of this setting for a time equal to or greater than the **Reset Time** setting. This **Reset Time** setting indicates how long the fault conditions must disappear after a fault for the trip to reset.

3.3.3 Elements Blocking Logic

Underfrequency element has a **Blocking Logic Input**. Activating this input prevents the activation of the output of the corresponding Frequency element, as shown in figure 3.3.1.

These logic input signals can be associated to the relay's status contact inputs by configuring the input settings.

3.3.4 Undervoltage Element for Blocking

This element supervises the functioning of the Underfrequency element, impeding the operation of this unit for measured voltages below the set value.

The element picks up when the measured voltage value coincides with or is less than the pickup value (100% of the setting), and resets with a value greater than or equal to 105% of the setting, provided this condition is maintained for at least 10 consecutive cycles. These 10 verification cycles provide assurance that the voltage is stable.

In any case, the relay cannot measure frequency for voltage less than 2 volts. Therefore, in these conditions, the Underfrequency element does not work.

3.3.5 Voltage Element Settings

Common Settings			
Setting	**Range**	**Step**	**By Default**
Inhibit Voltage	2 - 150 V	1 V	2 V
Pickup Activation Timer	3 - 30 half cycles	1 half cycles	6 half cycles
Reset Time	0 - 10 cycles	1 cycle	0 cycle

Underfrequency Elements 1, 2, 3 and 4			
Setting	**Range**	**Step**	**By Default**
Enable	YES / NO		NO
Pickup	40 - 70 Hz	0.01 Hz	40 Hz
Time Delay	0.00 - 300 s	0.01 s	0 s
Reset Time	0.00 - 300 s	0.01 s	2 s

- **Voltage Protection: HMI Access**

0 - CONFIGURATION	0 - GENERAL	
1 - OPERATIONS	**1 - PROTECTION**	0 - VOLTAGE
2 - CHANGE SETTINGS	2 - RECLOSER	**1 - FREQUENCY**
3 - INFORMATION	3 - LOGIC	
	...	

0 - OVERCURRENT	**0 - INHIBIT VOLTAGE**
1 - VOLTAGE	**1 - PICK UP TIME**
2 - FREQUENCY	**2 - DROPOUT TIME**
3 - BREAKER FAILURE	**3 - UNDERFREQUENCY**
...	

Underfrequency

0 - INHIBIT VOLTAGE	**0 - UNIT 1**	**0 - UNDERFREQ. ENABLE**
1 - PICK UP TIME	**1 - UNIT 2**	**1 - UNDERFREQ. PICKUP**
2 - DROPOUT TIME	**2 - UNIT 3**	**2 - UNDERFREQ. DELAY**
3 - LOAD SHEDD. 1 ENA.	**3 - UNIT 4**	**3 - DROPOUT TIME**
4 - LOAD SHEDDNG TYPE		
5 - OVERFREQUENCY		
6 - UNDERFREQUENCY		
7 - RATE OF CHANGE F.		

3.3.6 Digital Inputs to the Voltage Modules

Table 3.3-1: Digital Inputs of the Frequency Modules		
Name	**Description**	**Function**
IN_BLK_UF1	Underfrequency element 1 block input	Activation of the input before the trip is generated prevents the element from operating. If activated after the trip, it resets.
ENBL_UF1	Underfrequency element 1 enable input	Activation of this input puts the element into service. It can be assigned to status contact inputs by level or to a command from the communications protocol or from the HMI. The default value of this logic input signal is a “1.”

3.3.7 Auxiliary Outputs and Events of the Voltage Modules

Table 3.3-2: Auxiliary Outputs and Events of the Frequency Modules		
Name	**Description**	**Function**
PU_UF1	Underfrequency element 1 pickup	Pickup of the Frequency Elements and start of the time count.
TRIP_UF1	Underfrequency element 1 trip	Trip of the Frequency Element.
UF1_ENBLD	Underfrequency element 1 enabled	Enable or disable status indication of the frequency element.
BLK_MIN_V	Minimum voltage block	Blocking of Frequency and element.

3.3.8 Underfrequency Element Test

Before testing the element, the voltage elements that are not being tested must be disabled.

- **Pickup and Reset of the Underfrequency Element**

Depending on the settings of the Underfrequency element, the pickups and resets must be within the margins indicated in table 3.4-3.

Table 3.3-3:Pickup and Reset of the Underfrequency Elements				
Setting	Pickup		Reset	
XHz	ΦA_MIN	ΦA_MAX	ΦR_MIN	ΦR_MAX
	X + 0.005Hz	X - 0.005Hz	(X + 0.01Hz) - 0.005Hz	(X + 0.01Hz) + 0.005Hz

- **Voltage Reset**

The Frequency elements must reset within the margin indicated in table 3.3-4 for set voltage value X.

Table 3.3-4: Voltage Reset				
Setting	Pickup		Reset	
X	MAX	MIN	MAX	MIN
	1.03 x X	0.97 x X	1.08 x X	1.02 x X

- **Operating Times**

They are verified with trip outputs configured as unit trip output.

To measure times, the voltage generator must be able to generate an up or down frequency ramp depending on the element to be tested as well as to provide an output to initiate a chronometer when it gets to the pickup frequency.

Operating times for a setting of Xs, must comply with 1.5 cycles + **Activation Half Cycles** setting. If the setting value is 0, the operating time will also be close to 1.5 cycles + **Activation Half Cycles** setting.

In operating times, it is important how the frequency ramp is generated and when the chronometer starts. The frequency value of the signal generated should be very close to the threshold to test and generate the broadest step possible.

Without a frequency ramp generator, only the Overfrequency element can be tested. Going from no voltage applied to applying voltage above the disable and the Overfrequency settings will yield a time value somewhat greater than with a frequency ramp.

3.4 Voltage Measurement Circuit Supervision

3.4.1 Introduction

In order to avoid incorrect operations issued by the units that use voltage measurements, a function is incorporated into models **RTV-P** with spare code **B** to check if a drop in the measurement is produced by a failure in the analog voltage measurement reception circuit.

3.4.2 Detection of Voltage Circuit Failure

This supervision unit blocks inputs from protection elements when the protection magnetic-thermal circuit breaker of the voltage measuring transformer has previously tripped. The logic related to the detection of the thermal-magnetic circuit breaker trip conditions must be carried out before the functions it blocks. The logic associated to the element is indicated in the following figure.

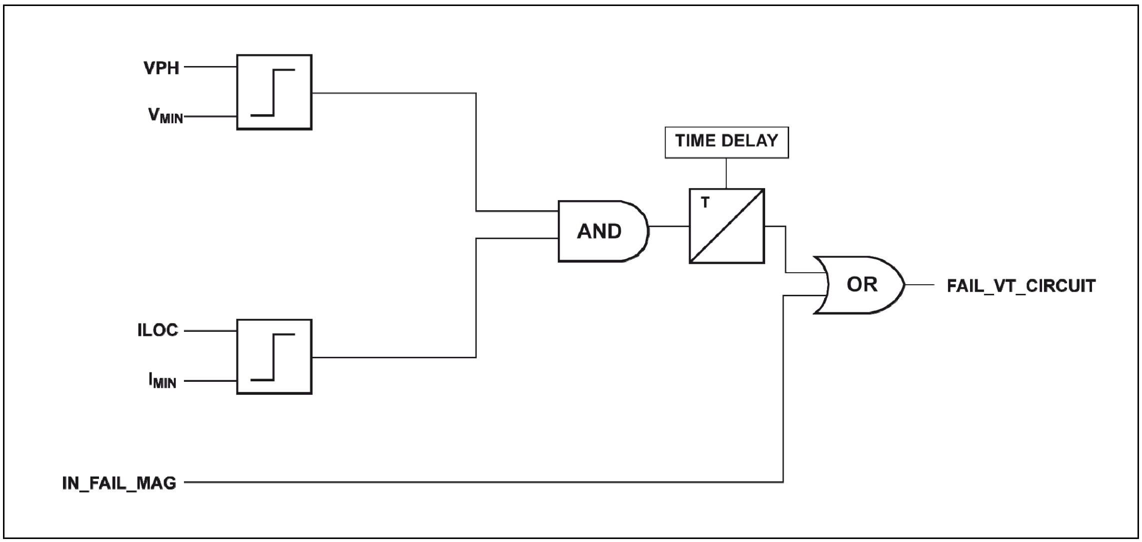


Figure 3.4.1: Voltage Circuit Failure Detection Element Scheme.

Current **ILOC** is compared with the setting value **Imin**. If **ILOC** is higher, **VPH** voltage will be compared with the corresponding setting value **Vmin**. In this case, if **VPH** voltages are lower than **Vmin** the relay will activate the signal **Failure on voltage measuring circuit** after a certain time delay **T1**. The blocking of those protection units affected by the voltage unbalance will have to be duly programmed in the logic module through the communication program ***ZivercomPlus***®.

3.4.3 Voltage Circuit Supervision Settings

Voltage Circuit Supervision Settings			
Setting	**Range**	**Step**	**By Default**
Voltage Circuit Supervision Enable	YES / NO		
Current Pickup	0.2 - 2 A	0.01	0.5 A
Voltage Pickup	2 - 100 V	0.01	30 V
Voltage Circuit Supervision Time	0.01 - 5.00 s	0.01	0.4 s

- **Voltage Circuit Supervision: HMI Access**

0 - CONFIGURATION	0 - GENERAL	
1 - OPERATIONS	1 - PROTECTION	
2 - CHANGE SETTINGS	...	**0 - V CIRCUIT SUPV EN**
3 - INFORMATION	**5 - V CIRCUIT SUPERV**	**1 - V CIRCUIT SUPV PU**
	...	**2 - V CIRCUIT SUPV TMP**

3.4.4 Digital Inputs of the Voltage Circuit Supervision Module

Table 3.4-1: Digital Inputs of the Voltage Circuit Supervision Module		
Name	**Description**	**Function**
IN_FAIL_MAG	Circuit Breaker Failure Input	The activation of this input means direct activation of voltage circuit failure Detector signal.

3.4.5 Digital Outputs and Events of the Voltage Circuit Supervision Module

Table 3.4-2: Digital Outputs and Events of the Voltage Circuit Supervision Module		
Name	**Description**	**Function**
IN_FAIL_MAG	Circuit Breaker Failure Input	The activation of this input means direct activation of voltage circuit failure Detector signal.
FAIL_VT_CIRCUIT	Voltage circuit failure detector	It shows that although voltage measurement does not reach the equipment, there actually is voltage. So that no trip on lack of voltage shall be performed.

3.5 Configuration Settings

3.5.1 Introduction

The **Configuration Settings** group has the following groups of settings: Nominal Values, Passwords, Communications, Date and time, Contrast and Control Buttons Enabled.

3.5.2 Nominal Values

The **Nominal Values** settings serve to select the rated operating values for:

- **Voltage**: Nominal voltage to be controlled by the regulator is set. This is the reference for all settings expressed in times or % of the nominal voltage.
- **Nominal Frequency**: permits choosing the rated frequency of the network, independently of whether or not the system for adapting to the frequency can later adapt to the changes that occur in this magnitude.
- **Local Current**: Nominal current of the local transformer is set.
- **Parallel Current**: Nominal current of the transformer in parallel is set. This is only needed when there is a possibility of both transformers working in parallel.

After modifying any of these settings, which are only accessible from the HMI display, the relay restarts the same way as if its power supply were turned off and then back on; no setting or information is lost.

3.5.3 Passwords

The Passwords option allows changing the access password for the options: **Configuration**, **Operations** and **Settings**.

Selecting the Configuration option allows varying the access password for the options of the **Configuration** group. Likewise, it is possible to configure different passwords for the **Operations** options and for modifying **Settings**.

3.5.4 Communications

See section 3.15 of Communications.

3.5.5 Date and Time

Selecting **Date and Time** from the **Configuration** menu provides access to this setting to configure the date and the time.

3.5.5.a Local Time Zone Setting

If **Time Zone IRIG-B** is set to **UTC**, a time correction must be introduced to adapt the relay to the local time zone. Setting **Local Time Zone** allows putting UTC time forward or back as required.

3.5.5.b Summer Time / Winter Time Change

Relay allows configuring the dates when summer time / winter time change takes place. In the first case the relay clock is put one hour forward (+1 Hour). In the second case the relay clock is put one hour back (-1 Hour) for the winter season.

To configure a change of season the following must be specified:

- **Begin Time**: time when change of season takes place. Range 0 to 23 h.
- **Begin Day Type**: type of day when change of season takes place. It can take the following values **First Sunday**, **Second Sunday**, **Third Sunday**, **Fourth Sunday**, **Last Sunday** of the month and **Specific Day**.
- **Begin Day**: in case **Specific Day** is selected, state in which specific day of the month the change of season takes place.
- **Begin Month**: state the month in which the change of season takes place.

These settings are independent for the summer and winter seasons.

Note: if the Begin Day setting value is higher than the number of days of a given month, the last valid day of said month is taken as the day for the change of season.

The change of season function can be activated or deactivated through **Summer Time / Winter Time Change Enable** setting.

3.5.6 Contrast Setting

This setting serves to modify the contrast value of the display (higher value = greater contrast).

3.5.7 Command Buttons

Enables or disables front pushbuttons for performing operations associated to them through the relay programmable logic.

3.5.8 Configuration Settings

Nominal Values			
Setting	**Range**	**Step**	**By Default**
Nominal VABC	50 V / 230 V	0.1	110 V
Nominal Frequency	50 Hz / 60 Hz	10	50 Hz
Nominal I. Local	1 A / 5 A	1	5 A
Nominal I. Parallel	1 A / 5 A	1	5 A

Passwords
The factory-specified access password (full access) is 2140. Nevertheless, you can change the password to access the following options with the keypad: **Configuration**, **Operations** and **Settings**.

Communications
See section 3.15

Contrast
Adjustable from keypad by ◑ key.

Date and Time			
Setting	**Range**	**Step**	**By Default**
Local Time Zone	GMT+(0, 1, 2, 3, 3:30, 4, 4:30, 5, 5:30, 5:45, 6, 6:30, 7, 8, 9, 9:30, 10, 11, 12) GMT-(1, 2, 3, 3:30, 4, 5, 6, 7, 8, 9, 10 ,11)		GMT+ 01:00
Summer Time / Winter Time Change Enable	YES / NO		NO
Summer Begin Time	0 - 23 Hours	1	2
Summer Begin Day Type	0 = Specific Day 1 = First Sunday of the month 2 = Second Sunday of the month 3 = Third Sunday of the month 4 = Fifth Sunday of the month 5 = Last Sunday of the month		Last Sunday of the month
Summer Begin Day	1 - 31	1	1
Summer Begin Day	January, February, March, ...		March
Winter Begin Day	0 - 23 Hours	1	3
Winter Begin Day Type	0 = Specific Day 1 = First Sunday of the month 2 = Second Sunday of the month 3 = Third Sunday of the month 4 = Fifth Sunday of the month 5 = Last Sunday of the month		Last Sunday of the month
Winter Begin Day	1 – 31	1	1
Winter Begin Month	January, February, March, ...		October

- **Configuration Settings: HMI Access**

0 - CONFIGURATION	**0 - NOMINAL VALUES**	**0 - NOMINAL ILOC**
1 - OPERATIONS	1 - PASSWORDS	**1 - NOMINAL IPAR**
2 - CHANGE SETTINGS	2 - COMMUNICATIONS	**2 - NOMINAL VABC**
3 - INFORMATION	3 - TIME AND DATE	**3 - NOMINAL FREQ.**
	4 - CONTRAST	
	5 - COMMAND BUTTONS	

0 - CONFIGURATION	0 - NOMINAL VALUES	**0 - CONFIGURATION**
1 - OPERATIONS	**1 - PASSWORDS**	**1 - OPERATIONS**
2 - CHANGE SETTINGS	2 - COMMUNICATIONS	**2 - SETTINGS**
3 - INFORMATION	3 - TIME AND DATE	
	4 - CONTRAST	
	5 - COMMAND BUTTONS	

0 - CONFIGURATION	0 - NOMINAL VALUES	**0 - PORTS**
1 - OPERATIONS	1 - PASSWORDS	**1 - PROTOCOLS**
2 - CHANGE SETTINGS	**2 - COMMUNICATIONS**	
3 - INFORMATION	3 - TIME AND DATE	
	4 - CONTRAST	
	5 - COMMAND BUTTONS	

0 - CONFIGURATION	0 - NOMINAL VALUES	**0 - TIME AND DATE**
1 - OPERATIONS	1 - PASSWORDS	**1 - LOCAL TIME ZONE**
2 - CHANGE SETTINGS	2 - COMMUNICATIONS	**2 - SUMMER/WINTER ENAB**
3 - INFORMATION	**3 - TIME AND DATE**	**3 - SUMMER START HOUR**
	4 - CONTRAST	**4 - TYPE OF SUMMER DAY**
	5 - COMMAND BUTTONS	**5 - SUMMER STARTINGDAY**
		6 - SUMMER START MONTH
		7 - WINTER START HOUR
		8 - TYPE OF WINTER DAY
		9 - WINTER STARTINGDAY
		10 - WINTER START MONTH

0 - CONFIGURATION	0 - NOMINAL VALUES
1 - OPERATIONS	1 - PASSWORDS
2 - CHANGE SETTINGS	2 - COMMUNICATIONS
3 - INFORMATION	3 - TIME AND DATE
	4 - CONTRAST
	5 - COMMAND BUTTONS

3.6 General Settings

3.6.1 Introduction

General Settings comprise the following settings groups: relay In Service, Transformer Ratios and Transducer Inputs (as per model).

3.6.2 In Service

Relay enabled (set to **YES**), allows all the functions integrated into the relay to be executed normally (as per programmed function settings).

Relay disabled (set to **NO**), restricts relay functions only to metering operations. Said measurements are viewed in the display and through local and remote communications systems.

3.6.2.a Digital Outputs and Events (Protection In Service)

Table 3.6-1: Digital Outputs and Events (Protection In Service)

Name	Description	Function
PROT_INSRV	Protection in Service	Shows that the relay is working with all the functions available.

3.6.3 Transformer Ratio

The **Transformer Ratio** defines the mode in which analog values are viewed in the protection display. If the **Transformer Ratio** is set to 1, the display presents secondary values. If, on the contrary, the **Transformer Ratio** corresponding to the analog input matching transformers is selected, the display presents primary values. The following **Transformer Ratios** can be set:

- Phase Voltage
- Local Current
- Parallel Current

All relay settings refer to secondary values. The analog settings defined in the programmable logic can refer both to secondary and primary values.

All magnitudes of the ***ZivercomPlus®*** **Event** logs and **History** records are presented in secondary values, except for energy and circulating current I_CIRCULATING, which are always given in primary values. Also, all the measurements that can be sent through communications using the Virtual Input / Output protocol will follow this same criterion.

In the ***ZivercomPlus®*** **State** section, magnitudes can be shown in primary or secondary values through the **Transformer Ratio** button (represented by a transformer symbol), again excluding energy, which is always represented in primary values. If the **Transformer Ratio** button is pressed, magnitudes are represented in primary values.

3.6.4 Voltage Type

The type of voltage measured through the phase voltage (VPH) input can be configured by a setting.

In order to adequately calculate power magnitudes (P, Q, S and CosFI) the only requirement is to determine whether a phase-to-neutral or phase-to-phase voltage is involved.

3.6.5 Voltage Source (RTV-P with Spare Digit B or Above)

The variable to be controlled by the relay control function can be configured through a setting, the options being the voltage analog input VPH or any other relay controlled variable or magnitude, calculated by the logic, or received through communications and linked by the control logic to the variable designated V EXTERNAL.

From the moment the user sets the voltage source to External, the relay will use the value linked to the variable V EXTERNAL as the measurement to be controlled and the angles of the local measured current and the parallel transformer measured current will be referred to this local measured current, so that the ILOC angle will always be 0º in this case so that both LDC R-X compensation and the flowing current method may not be enabled.

3.6.6 Transducer Inputs

Depending on the relay model, input current or voltage transducers are included. For the same HW, the following converter options can be selected: 0 to 5mA and –2.5 to +2.5 mA. However, converters from 4 to 20 mA have specific HW.

In the programmable logic they can be assigned a unit and a multiplier to represent the real magnitude reading (current, voltage, etc.) and their transformer ratio. The display shows the reading in mA converted to the metered magnitude (V, A, W, etc.).

NOTE: In case the –2.5 to +2.5mA range is selected, the transducer input measurement reaches +/-3mA. For a 0 to 5mA setting the measurement reaches +5.587mA. For a 4 to 20mA setting it measures up to 24mA.

3.6.7 Transducer Output

Depending on the relay model, an output converter ranging from 0 to 20mA can be included. This range can be configured through a maximum and minimum value. Also, maximum and minimum values of the measurement related to the converter must be set through the control logic. In this way, the relay output value will be linear, following the formula below:

$$\frac{x - Min\_Var\_Assigned}{Max\_Var\_Assigned - Min\_Var\_Assigned} = \frac{y - Min\_Val\_Convert}{Max\_Val\_Convert - Min\_Val\_Convert}$$

Any relay measurement or calculated measurement may be linked to the output converter through the control logic using the magnitude **Conv Output 1**.

3.6.7.a Models with Power Supply Voltage Monitoring

For models incorporating the **Power Supply Voltage Monitoring** function, the relay includes a specific input to measure direct voltage. There are two types of transducers as a function of the rated voltage of the digital inputs:

- For equipment with 24Vdc and 48Vdc digital inputs.
- For equipment with 125Vdc and 250Vdc digital inputs.

The measured magnitude is available for display and recording in any function using "user magnitudes" (HMI, ***ZivercomPlus®***, oscillos, events, logs, programmable logic, protocols, etc.).

3.6.8 General Settings

In Service			
Setting	**Range**	**Step**	**By Default**
In Service	YES / NO		YES

Transformer Ratios			
Setting	**Range**	**Step**	**By Default**
Phase Voltage Transformer Ratio	1 - 4000 1 - 11000 (RTV-P*N****A***)	1	1
Local Current Transformer Ratio	1 - 3000 1 - 10000 (RTV-P*N****A***)	1	1
Parallel Current Transformer Ratio	1 - 3000 1 - 10000 (RTV-P*N****A***)	1	1

Voltage Type			
Setting	**Range**	**Step**	**By Default**
Voltage Type	0: Phase to Ground 1: Phase to Phase		0: Phase to Ground

Voltage Source (RTV-P with Spare Digit B or Above)			
Setting	**Range**	**Step**	**By Default**
Voltage Source	0: VPH 1: EXTERNAL V		0: VPH

Transducers Input			
Setting	**Range**	**Step**	**By Default**
Transducer Type I1	0: -2.5 ÷ +2.5 mA 1: 0.0 ÷ +5.0 mA		0

Transducer Output			
Setting	**Range**	**Step**	**By Default**
Upper Limit Output Transducer	0 - 20	0,01	20
Lower Limit Output Transducer	0 - 20	0,01	0
Upper Limit Assigned Variable	-9999 - 9999		
Lower Limit Assigned Variable	-9999 - 9999		

Event Masks (only via communications)	
Setting	**Range**
Event Masks	YES / NO

- **General Settings: HMI access**

0 - CONFIGURATION	**0 - GENERAL**	**0 - UNIT IN SERVICE**
1 - OPERATIONS	1 - VOLTAGE REGULATOR	**1 - ILOCAL CT RATIO**
3 - CHANGE SETTINGS	...	**2 - IPARAL CT RATIO**
4 - INFORMATION		**3 - PHASE VT RATIO**
		4 - INPUT VOLTAGE
		5 - CONVERTERS

Transducers

0 - UNIT IN SERVICE	**0 - I1 CONVERTER TYPE**
1 - ILOCAL CT RATIO	
2 - IPARAL CT RATIO	
3 - PHASE VT RATIO	
4 - INPUT VOLTAGE	
5 - CONVERTERS	

3.7 Power Supply Voltage Monitoring

3.7.1 Introduction

Models where the Input / Output digit for Model Selection shows that the relay is provided with an voltage transducer input (Sup. VDC), feature a DC Voltage Monitoring function for substation batteries.

Overvoltage and undervoltage condition alarms can be generated through said monitoring function, also allowing recording the evolution of said voltage when trips, closing and other control operations requiring power supply from the monitored batteries take place.

3.7.2 Description of Operation

As the measured battery voltage is relay power supply voltage, measurement is obtained through hard connection of said supply voltage to the transducer input arranged for voltage measurement, in parallel with the relay power supply voltage.

Two measurement elements are available, one overvoltage and the other undervoltage, which compare voltage measured through the transducer with pickup settings.

Elements pickup at 100% of setting and reset at 95% in case of overvoltage and 105% in case of undervoltage.

These elements are not provided with output timers; their activation / deactivation log the events and activate / deactivate the signals shown in table 3.5-1.

Output timers can be incorporated through the *programmable logic* in order to get the necessary logic function, such as obtaining a new signal as a result of gates AND or OR.

Signals obtained through this logic functions can generate their own events and trigger new actions (LED activation, oscillograph starting, etc.).

When measured voltage is below 10Vdc, transducer power supply is considered unconnected and the oscillograph will not start on undervoltage nor will the event and signal activation corresponding to this undervoltage be generated.

No matter the model (power supply and digital input voltage range), overvoltage and undervoltage elements have only one setting (15Vdc to 300Vdc). Nevertheless, 24 Vdc and 48Vdc models will have a common measurement range and 125Vdc and 250Vdc models will have another. Measurement ranges for each of them are shown in Chapter 2.

A Log of said voltages can be saved into oscillographic records attached to each relay operation, logged into the events record, visualized locally or through communications channel and used for the generation of user logic functions in the “programmable logic”.

Note: this monitoring is only valid for direct current power supply, and if the relay works with alternating current power supply, the transducer shall not be connected to said power supply.

3.7.3 Power Supply Voltage Monitoring Settings

DC Power Monitoring			
Setting	**Range**	**Step**	**By Default**
DC_OV Pickup	15 - 300 Vdc	0.1 V	300 V
DC_UV Pickup	15 - 300 Vdc	0.1 V	15 V

- **Power Supply Voltage Monitoring: HMI access**

0 - CONFIGURATION	0 - GENERAL	**0 - DC_OV PICKUP**
1 - OPERATIONS	1 - VOLTAGE REGULATOR	**1 - DC_UV PICKUP**
2 - CHANGE SETTINGS	...	
3 - INFORMATION	**6 - DC POWER LIMIT**	
	...	

3.7.4 Auxiliary Outputs and Events of the Power Supply Voltage Monitoring

Table 3.7-1: Auxiliary Outputs and Events of the Power Supply Voltage Monitoring

Name	Description	Function
OVDC	Power supply overvoltage	These signals activate when relay power supply voltage exceeds battery voltage monitoring overvoltage or undervoltage element settings respectively.
UVDC	Power supply undervoltage	

3.8 Change Settings Groups

3.8.1 Description

The Protection, Logic and Recloser settings include four alternative groups (GROUP 1, GROUP 2, GROUP 3 and GROUP 4), which can be activated or deactivated from the keypad, through the communication ports, by using digital inputs or with signals generated in the programmable logic.

This function permits modifying the active setting groups and, thereby, the response of the protection. This way, the behavior of the IED can adapt to changes in the external circumstances.

Two logic input signals can block changes in the active group from the HMI as well as via communications. When inputs **INH_CGRP_COM** and **INH_CGRP_HMI** are active, groups can not be changed with commands via communications nor through the HMI.

If the digital inputs are used to change groups, up to four digital inputs may need to be configured through the programmable digital inputs:

- Command to activate Settings Group 1 by digital input (**CMD_GRP1_DI**)
- Command to activate Settings Group 2 by digital input (**CMD_GRP2_DI**)
- Command to activate Settings Group 3 by digital input (**CMD_GRP3_DI**)
- Command to activate Settings Group 4 by digital input (**CMD_GRP4_DI**)

Activating inputs **CMD_GRP1_DI**, **CMD_GRP2_DI**, **CMD_GRP3_DI** and **CMD_GRP4_DI** will activate GROUP 1, GROUP 2, GROUP 3 and GROUP 4 respectively.

If, while one of the inputs is active, either of the other three or several of them are activated, no group change will take place. The status contact settings group control logic will recognize a single input only. If all four inputs are deactivated, however, the IED will remain in the last active settings group.

Note: Groups can be changed by activating Digital Inputs only if the display is in the default screen.

3.8.2 Digital Inputs to Change Settings Groups

Table 3.8-1: Digital Inputs to Change Settings Groups

Name	Description	Function
INH_CGRP_COM	Inhibit group change via communications	It blocks any change of the active group by the PROCOME procedure.
INH_CGRP_HMI	Inhibit group change via HMI	It blocks any change of the active group through the HMI menu.
CMD_GRP1_COM	Command to activate Settings Group 1 via communications	Commands to change the active group via communications.
CMD_GRP2_COM	Command to activate Settings Group 2 via communications	
CMD_GRP3_COM	Command to activate Settings Group 3 via communications	
CMD_GRP4_COM	Command to activate Settings Group 4 via communications	
CMD_GRP1_DI	Command to activate Settings Group 1 via DI	Commands to change the active group via digital input.
CMD_GRP2_DI	Command to activate Settings Group 2 via DI	
CMD_GRP3_DI	Command to activate Settings Group 3 via DI	
CMD_GRP4_DI	Command to activate Settings Group 4 via DI	
CMD_GRP1_HMI	Command to activate Settings Group 1 via HMI	Commands to change the active group via HMI.
CMD_GRP2_HMI	Command to activate Settings Group 2 via HMI	
CMD_GRP3_HMI	Command to activate Settings Group 3 via HMI	
CMD_GRP4_HMI	Command to activate Settings Group 4 via HMI	

3.8.3 Auxiliary Outputs and Events to Change Settings Groups

Table 3.8-2: Auxiliary Outputs and Events to Change Settings Groups

Name	Description	Function
INH_CGRP_COM	Inhibit group change via communications	The same as for the digital input.
INH_CGRP_HMI	Inhibit group change via HMI	
CMD_GRP1_COM	Command to activate Settings Group 1 via communications	
CMD_GRP2_COM	Command to activate Settings Group 2 via communications	
CMD_GRP3_COM	Command to activate Settings Group 3 via communications	
CMD_GRP4_COM	Command to activate Settings Group 4 via communications	
CMD_GRP1_DI	Command to activate Settings Group 1 via DI	
CMD_GRP2_DI	Command to activate Settings Group 2 via DI	
CMD_GRP3_DI	Command to activate Settings Group 3 via DI	
CMD_GRP4_DI	Command to activate Settings Group 4 via DI	
CMD_GRP1_HMI	Command to activate Settings Group 1 via HMI	
CMD_GRP2_HMI	Command to activate Settings Group 2 via HMI	
CMD_GRP3_HMI	Command to activate Settings Group 3 via HMI	
CMD_GRP4_HMI	Command to activate Settings Group 4 via HMI	
T1_ACTIVATED	Settings Group 1 activated	Indication of the active group.
T2_ACTIVATED	Settings Group 2 activated	
T3_ACTIVATED	Settings Group 1 activated	
T4_ACTIVATED	Settings Group 1 activated	

3.9 Event Record

3.9.1 Description

The capacity of the recorder is 400 notations in non-volatile memory. The signals that generate the events are user-selectable and are recorded with a resolution of 1 ms together with a maximum of 12 values also selectable from all the available metering values measured or calculated by the IED ("user defined values", including VDC in models with power supply voltage monitoring).

Each of the functions that the system uses records an event in the **Event Record** when any of the situations listed in the tables nested in the description of each function occur. Moreover, the events listed in Table 3.9-1 -the IED's general services- are also recorded. The tables mentioned above only list the events available with the default configuration. The list of signals can be expanded with those that the user configures in the programmable logic (any signal existing in the programmable logic can be configured to generate an event with the description that the user defines).

Table 3.9-1: Event Records

Name	Description
HMI access	See the description in Auxiliary Outputs.
Clock synchronization	
IRIG-B Active	
External oscillography trigger	
Oscillography picked up	
Deletion of oscillographs	
Automatic Mode Change Button	
Open Button P1	
Open Button P2	
Open Button P3	
Open Button P4	
Open Button P5	
Open Button P6	
Manual Mode Change Button	
Close Button P1	
Close Button P2	
Close Button P3	
Close Button P4	
Close Button P5	
Close Button P6	
Digital Input 1	
...	
Digital Input 44 (depends on model)	
Validity of Digital Input 1	
...	
Validity of Digital Input 44 (depends on model)	
Enabled Command of Digital Input 1	
...	
Enabled Command of Digital Input 44 (depends on model)	
Unable Command of Digital Input 1	
...	
Unable Command of Digital Input 44 (depends on model)	

Table 3-9.1: Event Records	
Name	**Description**
Auxiliary Output 1	See the description in Auxiliary Outputs.
...	
Auxiliary Output 18 (depends on model)	
LEDs Reset Input	
Equipment warm start up	
Equipment cold start up	
Remote	
Local control	
Panel-controlled	
Change of settings initialization	
Critical system error	
Non-critical system error	
Port 0 communication failure	
Port 1 communication failure	
Port 2 communication failure	
Port 3 communication failure	
Maximeters reset input	
Reset pending reconfiguration (*)	
Write to flash in progress (*)	
SNTP not synchronized (*)	
Status of communications port LAN1 (*)	
Status of communications port LAN2 (*)	
Communications port LAN active (bonding) (*)	
Network congestion detected in LAN1 (*)	
Network congestion detected in LAN2 (*)	

(*) RTV-*-****06*** Models.**

All the configured events as well as the pre-existing ones in the default configuration can be masked.

The text indicated in the events tables is expanded with the message **Activation of...** when the event is generated by activation of any of the signals or **Deactivation of...** when the event is generated by deactivation of the signal.

3.9.2 Organization of the Event Record

The event record capacity is two hundred and fifty-six events. When the record is full, a new event displaces the oldest one. The following information is stored in each event register:

- Values of the 12 magnitudes selected at the time the event is generated
- Event date and time

Event recorder management is optimized so that simultaneous operations generated by the same event occupy a single position in the event memory. For example, the simultaneous occurrence of the phase A and neutral time overcurrent pickups are recorded in the same memory position. However, if the occurrences are not simultaneous, two separate events are generated. Simultaneous events are those operations occurring within a 1 ms interval, the resolution time of the recorder.

3.9.3 Event Mask

Use the **General** settings in communications to mask unneeded or unused events for system behavior analysis. Events are masked by communications within the **General** settings.

Important: Events that can be generated in excess should be masked since they could fill the memory (400 events) and erase more important previous events.

3.9.4 Consulting the Record

The communications and remote management program, ***ZivercomPlus®***, has a completely decoded system for consulting the Event Record.

3.9.5 Event Record Settings (via communications)

Event Masks
IED events may be masked separately.

Event Magnitudes				
Null	P	RAISE_OPER_CNT	ENERG.A.P.	IMAX
CNVI1	Q	LOWER_OPER_CNT	ENERG.A.N.	IMIN
CNVI2	S	NEW_VOLT_STP_P	ENERG.R.I.	VMAX
I_LOCAL	FP		ENERG.R.C.	VMIN
I_LOCAL_P	V_CON		TACTIVE	PMAX
I_PARALLEL	V_CON_P		TAP	PMIN
I_PARALLEL_P	V_COMP		ALARMES	QMAX
I_CIRCULATING	V_COMP_P		FREQ	QMIN
VPH	VDC			SMAX
VPH_P				SMIN

Note: all magnitudes for each event are stored in secondary values; therefore not affected by any primary-to-secondary transformer ratios except for energy and I_CIRCULATING that are always recorded in primary values.

3.10 Metering History Log

3.10.1 Operation

This function records the evolution of the values monitored at the point where the IED is installed. It samples (per second) each of the values programmed for this purpose and calculates their average over the interval defined as **Sampling Interval**. This time interval is adjustable between 1 and 15 minutes.

The **Recording Interval** is an adjustable period of time between 1 minute and 24 hours. The maximum and minimum averages recorded in the whole interval are recorded with their final time stamp. Figure 3.10.1 shows how the Metering History Log works.

-**SI**: Sampling Interval; the figure shows an SI value of one minute.

-**RI**: Recording Interval; the figure shows a RI of 15 minutes.

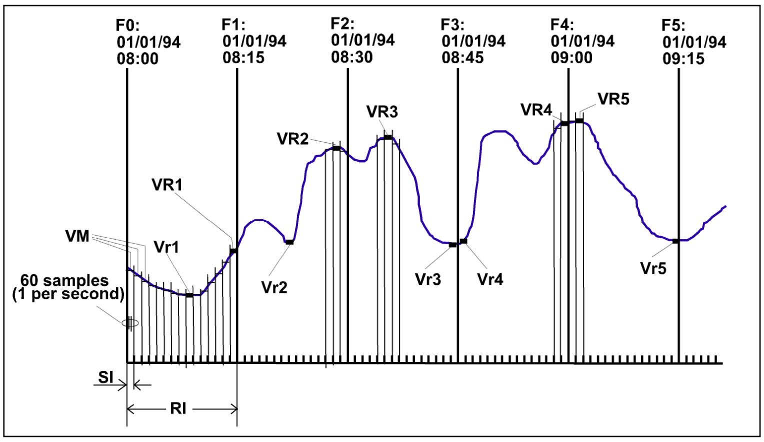


Figure 3.10.1: Diagram of the Metering Log.

There are 12 Log Groups. Up to 4 different magnitudes may be defined within each group for historical record calculations.

For each period **TM** there are 2 values **VM** recorded: the maximum and minimum average values considered among all magnitudes within the same group. If only one magnitude is considered in a group, then the average values will be the same as the maxim um and minimum values respectively (see Figure 3.10.1).

For each period **TR** there are 2 other values recorded and displayed: the maximum and minimum values among all **VM** values recorded for each group. The profile of Figure 3.10.1 yields the following values: VR1 - Vr1; VR2 - Vr2; VR3 - Vr3; VR4 - Vr4 and VR5 - Vr5.

Note: if phase or ground elements pick up during the Sampling Interval, the average of the measurements made while the elements were not picked up is recorded. Otherwise, if the elements remain picked up throughout the SI, the value recorded is: 0A / 0V.

As already indicated, twelve (12) values can be configured among all the direct or calculated metering values ("user defined values", including VDC in models with Power Supply Voltage Monitoring) available in the IED (M_i). Up to four different magnitudes can be selected for each group. An average value will be calculated for each magnitude during the period **Sampling Interval**. See Figure 3.10.2.

The average value is calculated as from the maximum and minimum values for each magnitude.

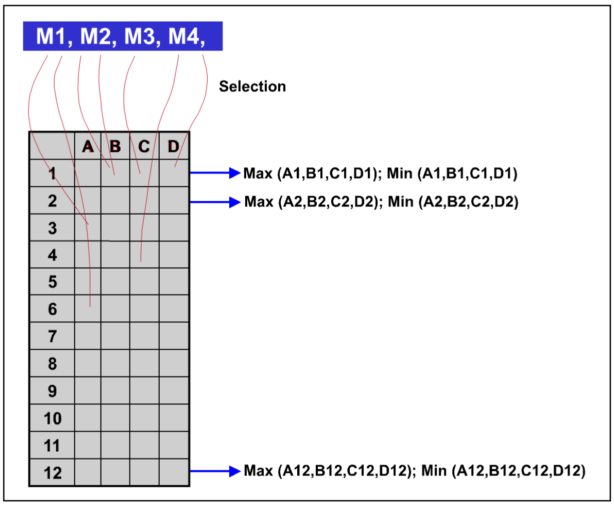


Figure 3.10.2: Metering History Log Logic.

The maximum and minimum values from among all maximum and minimum measures within each group are recorded per period.

Likewise, the phase currents and voltages as well as the powers are constantly sampled. The sampled values are compared with those already stored. This keeps a maximum/minimum demand metering of the phase currents and voltages and of the active, reactive and apparent powers up to date.

These maximum and minimum values are stored in non-volatile memory, so they are reset by the logic input signal, **Maximum Demand Element Reset**.

All this information is only available via communications through the communications and remote management program ***ZivercomPlus***®.

3.10.2 Metering History Log Settings

Metering History Log			
Setting	**Range**	**Step**	**By Default**
Sampling Interval	1 - 15 min		
Recording Interval	00.01 to 24.00 h.		
Week Mask	Monday to Sunday	YES / NO	
Recording Time	00.00 to 24.00 h		

Log Groups				
There are 12 Log Groups. Up to 4 different magnitudes may be defined within each group for historical record calculations. Said magnitudes are:				
Null	P	RAISE_OPER_CNT	ENERG.A.P.	IMAX
CNVI1	Q	LOWER_OPER_CNT	ENERG.A.N.	IMIN
CNVI2	S	NEW_VOLT_STP_P	ENERG.R.I.	VMAX
I_LOCAL	FP		ENERG.R.C.	VMIN
I_LOCAL_P	V_CON		TACTIVE	PMAX
I_PARALLEL	V_CON_P		TAP	PMIN
I_PARALLEL_P	V_COMP		ALARMES	QMAX
I_CIRCULATING	V_COMP_P		FREQ	QMIN
VPH	VDC			SMAX
VPH_P				SMIN

Note: all magnitudes for each event are stored in secondary values; therefore not affected by any primary-to-secondary transformer ratio except for energy and I_CIRCULATING that are always recorded in primary values.

- **Metering History Log: HMI Access**

0 - CONFIGURATION	0 - GENERAL	**0 - SAMPLE INTERVAL**
1 - OPERATIONS	1 - VOLTAGE REGULATOR	**1 - LOG REC. INTERVAL**
3 - CHANGE SETTING	2 - METERING	**2 - HIST. START TIME**
4 - INFORMATION	**3 - HISTORY**	**3 - HIST. END TIME**
	...	

3.11 Voltage Band Recording

3.11.1 Operation

Voltage Band settings define a set of limits to compare the voltage (in % of $V_{nominal}$). This way a reference band is available, three upper level bands and another three lower level bands.

Bands can be represented as in the following diagram:

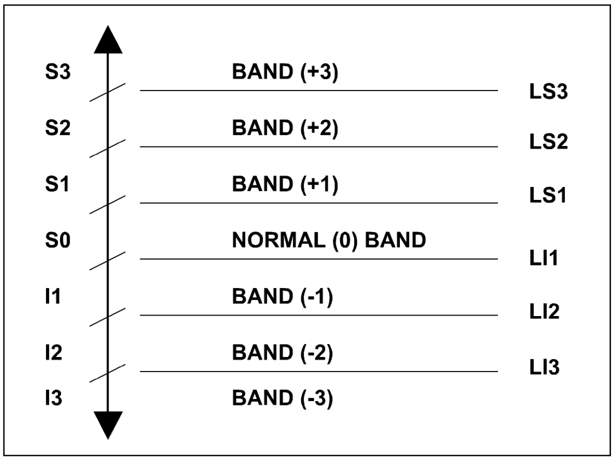


Figure 3.11.1: Band Diagram.

Voltage Band Records are cumulative monthly periodical records, that is, there is a record every month (12 months). The following information is written:

- Number of Raise the Tap Operations (NRaiseTapOperations), in the month.
- Number of Lower the Tap Operations (NLowerTapOperations), in the month.
- Permanence time (in seconds) of the voltage within each band, in a month.
- Number of times the voltage has been within each band, in a month.

3.11.2 Voltage Band Settings

Voltage Band Settings Range			
Setting	**Range**	**Step**	**By Default**
Band Limit S3	0 -130 %	0.01%	115 %
Band Limit S2	0 - 130 %	0.01%	110 %
Band Limit S1	0 - 130 %	0.01%	105 %
Band Limit I1	0 - 130 %	0.01%	100 %
Band Limit I2	0 - 130 %	0.01%	95 %
Band Limit I3	0 - 130 %	0.01%	90 %

Note: There exists a settings ratio check function to make sure that:

```
S3 > S2 > S1 > I1 > I2 > I3
```

- **Voltage Band: HMI Access**

0 - CONFIGURATION	0 - GENERAL	0 - VR CONFIGURATION
1 - OPERATIONS	**1 - VOLTAGE REGULATOR**	1 - VR CONTROL
3 - CHANGE SETTING	2 - METERING	2 - COMPENSATION
4 - INFORMATION	...	3 - LOCKOUT LIMITS
		4 - TAPCHANGE CONTROL
		5 - VOLTAGE BANDS

0 - VR CONFIGURATION	**0 - BAND LIMIT S3**
1 - VR CONTROL	**1 - BAND LIMIT S2**
2 - COMPENSATION	**2 - BAND LIMIT S1**
3 - LOCKOUT LIMITS	**3 - BAND LIMIT I1**
4 - TAPCHANGE CONTROL	**4 - BAND LIMIT I2**
5 - VOLTAGE BANDS	**5 - BAND LIMIT I3**

3.11.3 Voltage Band Module Outputs and Events

Table 3.11-1: Voltage Band Module Outputs and Events

Name	Description	Function
IN_BAND_S3	Voltage in Upper Band 3	
IN_BAND_S2	Voltage in Upper Band 2	
IN_BAND_S1	Voltage in Upper Band 1	
IN_BAND_REF	Voltage in Reference Band	
IN_BAND_I1	Voltage in Lower Band 1	
IN_BAND_I2	Voltage in Lower Band 2	
IN_BAND_I3	Voltage in Lower Band 3	

3.12 Oscillographic Recording

3.12.1 Introduction

The oscillography function is composed of two different sub functions: **Capture** and **Display**. The first captures and stores protection data inside the IED and is part of the relay's software; the second retrieves and presents the stored data graphically with one or more programs running on a PC connected to the protection.

The sampling and storage frequency is 32 samples per cycle with 15 seconds of total storage. Permanence of the information, with the IED disconnected from the power supply, is guaranteed during 27 days.

The IEDs come with a display and analysis program, because the waveform records are in binary COMTRADE format according to IEEE standard C37.111-1999. The COMTRADE file generated considers the changes in frequency that can occur in the system, so that the analog magnitudes are stored with complete fidelity to how they have evolved on the system.

3.12.2 Capture Function

It is possible to record measured analog values, user defined values, digital inputs to the IED, internal logic signals generated by the protection and the programmable logic up to a total of 64 oscillographs in cyclical memory.

3.12.3 Stored Data

The following data are stored with a resolution time equal to the sampling rate:

- Value of the samples of the selected parameters (measured and user defined) and of the digital and analogical signals programmed for this purpose.
- Time stamp of the oscillography startup.

3.12.4 Number of Channels and Digital Signals

It is possible to record up to 15 analog values, enabling or disabling them via independent settings.

It is possible to include up to 5 **User Defined Values**. User defined values are every calculated value including those values calculated by the programmable logic via ***ZivercomPlus®*** software.

Models with Power Supply Voltage Monitoring measure the voltage via a transducer input. This value is considered an user-defined value.

User defined values include any type of parameters. If sine waves are recorded the oscillography records the changes of the RMS value.

Values are stored in the COMTRADE oscillography format with the label assigned in the programmable logic. The power supply voltage is stored with the label VDC.

It is also possible to assign direct metering from the analog channels as an user-defined value. Being waveforms the RMS value is stored. COMTRADE label is VALUE_u (ie. VA_u).

The maximum number of recorded digital signals is 80. Each user-defined value configured in the oscillography counts as 16 digital signals.

3.12.5 Start Function

The Start Function is determined to an **External Pickup Signal** (which, if it is to be used, must be connected to any of the physical status contact inputs, to a programmable button of the HMI, to a command via communications or to a signal configured for this purpose in the programmable logic).

If the start function mask setting is **YES**, this signal activates the oscillography startup. This signal will not start the oscillography function if its mask setting is **NO**.

3.12.6 Oscillograph Deletion Function

Since the oscillograph records are stored in non-volatile memory, there is a mechanism that allows deleting all the content of this memory externally.

The oscillograph deletion function can operate by activating the **Deletion of Oscillographs** signal, which can be assigned by the programmable logic to any of the physical inputs, to a programmable button of the HMI, to a command via communications, etc.).

3.12.7 Pre-Fault Time

This is the length of pre-fault data that must be stored before the start function initiates a record. The setting range is from 0 to 25 pre-fault cycles.

3.12.8 Length of the Oscillograph

It is the fault record duration. The number of records stored in memory varies and depends on the number of channels recorded and the length of the fault records. Once the recording memory is full, the next event will overwrite the oldest one stored.

The maximum number of waveform records is 64, and the maximum number of cycles that can be stored in memory is 725. Depending on the length selected, the maximum number varies

Table 3.12-1: Number of oscillographs

Set number of cycles	Maximum number of oscillographs
725	1
350	2
175	3
...	...
22	32
11	64

Note 1: When selecting the length of each oscillograph, it is important to take into account that if, for example, an oscillography record length greater than 350 cycles is selected, only one oscillograph can be stored.

Note 2: modifying settings belonging to the oscillography recording or loading a programmable logic configuration will erase all the oscillography files recorded in the IED.

3.12.9 Oscillographic Recording Settings

Oscillographic Recording			
Setting	**Range**	**Step**	**By Default**
Pre-trigger Length	0 - 25 cycles	1	5 cycles
Length	5 - 725 cycles	1	5 cycles

Start Function		
Setting	**Step**	**By Default**
Overvoltage Element 1 (RTV-P*N****A***)	YES / NO	NO
External Pickup	YES / NO	YES
DC_OV Pickup (Models with TI Sup. VDC)	YES / NO	NO
DC_UV Pickup (Models with TI Sup. VDC)	YES / NO	NO

Analog Channels Masks (up to 10 channels)	
1 - Phase Voltage (VPH)	
2 - Local Current (I_LOCAL)	
3 - Parallel Current (I_PARALLEL)	

User Defines Magnitudes (up to 5 magnitudes)				
Null	P	RAISE_OPER_CNT	ENERG.A.P.	IMAX
CNVI1	Q	LOWER_OPER_CNT	ENERG.A.N.	IMIN
CNVI2	S	NEW_VOLT_STP_P	ENERG.R.I.	VMAX
I_LOCAL	FP		ENERG.R.C.	VMIN
I_LOCAL_P	V_CON		TACTIVE	PMAX
I_PARALLEL	V_CON_P		TAP	PMIN
I_PARALLEL_P	V_COMP		ALARMES	QMAX
I_CIRCULATING	V_COMP_P		FREQ	QMIN
VPH	VDC			SMAX
VPH_P				SMIN

Note: each User Defined value configured in the Oscillography counts as 16 digital signals.

Digital Channel Selection (up to 80)
Selectable from all configurable Digital Inputs and Digital Signals

- **Oscillographic Recording: HMI Access**

0 - CONFIGURATION	0 - GENERAL	**0 - PRETRIG. LENGTH**
1 - OPERATIONS	...	**1 - LENGTH**
2 - CHANGE SETTINGS	**4 - OSCILLOGRAPHY**	**2 - OSCILLO CHANN. MASK**
3 - INFORMATION	...	

3.12.10 Digital Inputs of the Oscillographic Recording

Table 3.12-2: Digital Inputs of the Oscillographic Recording		
Name	**Description**	**Function**
TRIG_EXT_OSC	External Oscillography Trigger	Input intended for external triggering.
DEL_OSC	Deletion of Oscillographs Command	The activation of this input deletes all the oscillographs stored.

3.12.11 Digital Outputs and Events of the Oscillographic Recording

Table 3.12-3: Digital Outputs and Events of the Oscillographic Recording		
Name	**Description**	**Function**
TRIG_EXT_OSC	External Oscillography Trigger	The same as for the Digital Input.
PU_OSC	Oscillography Picked Up	This output indicates that the oscillographic recording is on process.
DEL_OSC	Deletion of Oscillographs Command	The same as for the Digital Input.

3.13 Inputs, Outputs & LED Targets

3.13.1 Introduction

The **RTV** has a flexible, user-definable structure of **Inputs / Outputs / LEDs**. It is described in the following sections. Factory programming included default values. Settings can be changed using the software package ***ZivercomPlus***®.

3.13.2 Digital Inputs

The **RTV** has a flexible structure of physical digital inputs depending on the model. All these inputs can be configured with any input signal to the pre-existing protection and control modules or defined by the user in the programmable logic

The **Filtering** of the digital inputs can be configured with the following options:

- **Time Between Samplings Filter 1** (**2-10 ms**): to establish the periodicity with which samples of the state of a digital input are taken.
- **Number of Samples with the same Value to Validate a Filter-1 Input** (**1-10**): the number of samples that must be detected consecutively to consider an input deactivated or activated can be set to logical "0" or "1" respectively.
- **Time Between Samplings Filter 2** (**2-10 ms**): to establish the periodicity with which samples of the state of a digital input are taken.
- **Number of Samples with the same Value to Validate a Filter-2 Input** (**2-10**): The number of samples that must be detected consecutively to consider an input deactivated or activated can be set to logical "0" or "1" respectively.
- **Filter Assignation** (**Filter 1 / Filter 2**): Each configurable digital input can be assigned to "filter 1" or to "filter 2." The settings previously defined allow constructing filters 1 and 2 to create fast and slow detection inputs.
- **Number of Changes to Deactivate an Input and its Time Slot** (**2-60/1-30s**): an adjustable time slot is established to keep a digital input in which there is an external or internal malfunction to the relay from generating problems. This time slot monitors the number of times that this digital input changes condition. If this number of changes in state exceeds a set value, it disables and input is frozen into last state. Once an input is disabled, it will be enabled again when the enabling conditions are met or by an enabling command.
- **Number of Changes to Enable an Input and its Time Slot**: as for disabling, to enable an input again, there is also a time slot and a user-definable number of changes within that slot.

Depending on model, the following settings related to Digital Inputs also exist:

- **Digital Input Supply Voltage Control** (YES / NO): Allows Digital Input validation control enable as a function of relay Supply voltage.
- **Digital Input Supply Voltage Level** (**24 / 48 / 125 / 125(>65%Vn) / 250 Vdc**): States relay Rated Supply Voltage. When latter setting is set to YES, and relay supply voltage drops below DIs activation threshold, all validation signals are deactivated and the DIs disabled. Validation is reset when relay supply voltage exceeds DIs activation threshold. The supply voltage level is obtained through an input Vdc converter connected in parallel with the relay supply voltage. For DIs activation and deactivation thresholds as appropriate refer to chapter 2.1.
- **Automatic Digital Input disable** (YES / NO): There is a separate setting for each Digital Input. If set to YES, allows for Automatic ED Disable on excessive number of changes (see in this same chapter the settings **Number of Changes for Disable** an input and **Time Window**).

The IED's metering elements and logic functions use **Logic Input Signals** in their operation. They are enumerated in the tables nested in the description of each of them. Those corresponding to the IED's general services are listed in Table 3.13-1 and can be assigned to the **Physical Digital Inputs** or to logic output signals of opcodes configured in the programmable logic. More than one **Logic Input Signal** can be assigned to a **Single Status Contact Input**, but the same logic input signal can not be assigned to more than one status contact input.

The tables mentioned above only list the inputs available with the default configuration. The list of inputs can be expanded with those that are configured in the programmable logic (any logic input signal created in the programmable logic can be used with the description that the user creates).

3.13.2.a Enable Input

The protection element module of each **RTV** family IED has a special “logic input signal” to put it “into service” or “out of service” from the HMI (buttons on the front), with a digital input by level and with the communications protocol configured in each port (control command).

This logic input signal is called **Enable Input ….** It combines with the **In Service** setting in this algorithm.

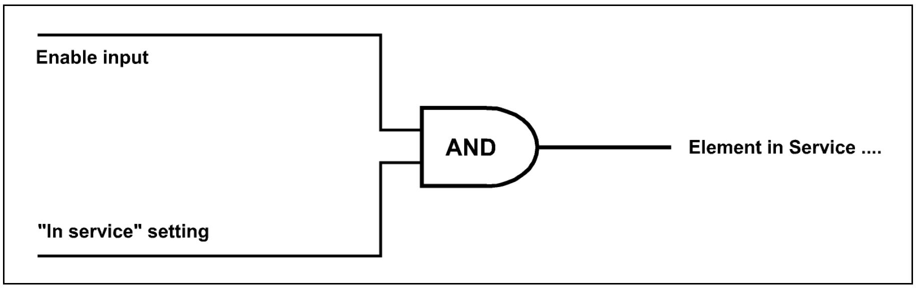


Figure 3.13.1: Unit Enabling Logic.

The default value of the logic input signal **Enable input IED...** is a “1.” Therefore, when you do not configure the programmable logic at all, putting the protection elements into service depends only on the value of the **In Service** setting of each of them. The logic configuration to activate or switch off the enabling logic input signal will be as complicated or simple as you wish, from assigning it to a status contact input to building logical schemas with the various logic gates available (flip-flop’s, etc.).

Those protection functions that are put “out of service” by any of these methods will not generate or activate any of their associated logic signals, not even those that may be configured in the programmable logic and are directly related to these functions.

3.13.2.b Digital Inputs Settings

Digital Input Filtering			
Setting	**Range**	**Step**	**By Default**
Time between samples. Filter 1	2 - 10 ms.	2	6 ms.
Time between samples. Filter 2	2 - 10 ms.	2	6 ms.
No. of same value samples for filter 1 validation	1 - 10 samples	1	2
No. of same value samples for filter 2 validation	1 - 10 samples	1	2
Filters Assignation: (Independent Setting for each relay DI)	0 = Filter 1 1 = Filter 2		Filter 1
No. of changes for input disabling	2 - 60 changes	1	60
Disabling time	1 - 30 s.	1	2 s.
No. of changes for input enabling	2 - 60 changes	1	5
Enabling time	1 - 30 s.	1	2 s.
Digital Input Supply Voltage Control	0: NO 1: YES	1	0: NO
Digital Input Supply Voltage Level	0: 24 1: 48 2: 125 3: 125(>65%) 4: 250	1	24
Automatic Digital Input Disable (Independent Setting for each relay DI)	0: NO 1: YES	1	1: YES

3.13.2.c Digital Inputs Table

Table 3.13-1: Digital Inputs

Name	Description	Function
ENBL_PLL	Digital PLL Enable Input	Enables the operation of the automatic system to adapt to the frequency. By default, when not configured, it is a logic "1."
IN_RST_MAX	Maximeters Reset Input	Its activation sets the content of the current, voltage and power demand elements to zero.
IN_PMTR_RST	Power Meters Reset Input	Its activation sets the content of the power meters to zero.
LED_1	LED 1	They activate their corresponding LEDs.
LED_2	LED 2	
...	(*)	
LED_P1R	LED P1 Red	
LED_P1G	LED P1 Green	
LED_P2R	LED P2 Red	
LED_P2G	LED P2 Green	
LED_P3R	LED P3 Red	
LED_P3G	LED P3 Green	
LED_P4R	LED P4 Red	
LED_P4G	LED P4 Green	
LED_P5R	LED P5 Red	
LED_P5G	LED P6 Green	
LED_P6R	LED P6 Red	
LED_P6G	LED P7 Green	
LED_AMR	LED A/M Red	
LED_AMG	LED A/M Green	
CMD_ENBL_DI1	Command to Enable Digital Input 1	Inputs to the module of digital inputs that activate and deactivate each of the digital inputs.
CMD_ENBL_DI2	Command to Enable Digital Input 2	
...	(*)	
CMD_DIS_DI1	Command to Disable Digital Input 1	
CMD_DIS_DI2	Command to Disable Digital Input 2	
...	(*)	
REMOTE	Remote	Sets the relay in remote mode. Must be activated to enable DNP 3.0 commands.
LOCAL	Local Control	Means 'Local Commands' enabled, whose performance is defined in user's logic module.
CONTROL_PANEL	Operation Desk Control	Means 'Operation Desk Commands' enabled, whose performance is defined in user's logic module.
IN_1	Digital Input 1	They activate their corresponding inputs.
IN_2	Digital Input 2	
IN_3	Digital Input 3	
...	(*)	

(*) The number of digital inputs and digital outputs available will depend on each particular model.

3.13.3 Auxiliary Outputs

The IED has **6** auxiliary output contacts (all of them configurable). These outputs can be extended up to 18 contacts by including the expansion module.

They can all be configured with any input or output signal of the pre-existing protection and control modules or defined by the user in the programmable logic.

The IED's metering elements and logic functions generate a series of logic output signals. Each of these signals has either a “true” or “false” value and this status can be used as an input to either of the combinational logic gates shown in Figure 3.13.2. The use of the combinational logic gates described in figure is optional. Its purpose is to facilitate the simplest configurations. To develop more complex algorithms and be able to assign the resulting outputs to auxiliary contact outputs, the necessary opcodes must be programmed in the programmable logic.

The outputs from the blocks described in Figure 3.13.2 can be connected to one of the programmable auxiliary contact outputs in the IED. There is an additional, non-programmable auxiliary output contact corresponding to relay In Service (**“Ready”**).

Two blocks of eight inputs are available. One of the blocks performs an **OR** operation with the selected signals (any signal activates the logic gate output). The other block performs an **AND** operation with the selected signals (all signals need to be active to activate the logic gate output). The result of these two blocks is then operated through either an **AND** or an **OR** gate. The pulse option can be added to the result of this operation. It works as follows:

- **Without Pulses**: by adjusting the pulse timer to 0, the output signal remains active as long as the signal that activated it lasts.
- **With Pulses**: once the output signal is activated, it remains the set time whether or not the signal that generated it is deactivated before or remains active.

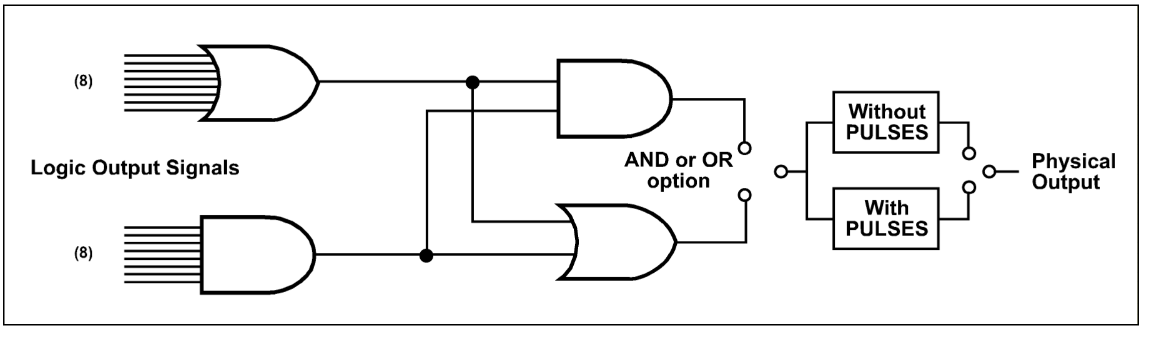


Figure 3.13.2: Auxiliary Contact Output Logic Cell Block Diagram

All the logic output signals listed in the tables nested in the description of each of the elements are user-definable. Moreover, the signals indicated in Table 3.13-2, all corresponding to the IED's general services, can also be assigned.

The tables mentioned only list the logical outputs available with the default configuration. The list of signals can be expanded with those configured in the programmable logic (any logic signal created in the programmable logic can be used with the description that the user creates).

3.13.3.a Auxiliary Outputs Table

Table 3.13-2: Auxiliary Outputs

Name	Description	Function
ACCESS_HMI	HMI Access	Indication that the HMI has been accessed.
SYNC_CLK	Clock Synchronization	Indication of having received a date / time change.
B_OPEN_P1	Open Button P1	They indicate that the corresponding button has been pressed.
B_OPEN_P2	Open Button P2	
B_OPEN_P3	Open Button P3	
B_OPEN_P4	Open Button P4	
B_OPEN_P5	Open Button P5	
B_OPEN_P6	Open Button P6	
B_OPEN_AM	Open Button A/M	
B_CLS_P1	Close Button P1	
B_CLS_P2	Close Button P2	
B_CLS_P3	Close Button P3	
B_CLS_P4	Close Button P4	
B_CLS_P5	Close Button P5	
B_CLS_P6	Close Button P6	
B_CLS_AM	Close Button A/M	
IN_1	Digital Input 1	They indicate that the corresponding input has been activated.
IN_2	Digital Input 2	
IN_3	Digital Input 3	
...	(*)	
VAL_DI_1	Validity of Digital Input 1	They indicate whether the input has been enabled or disabled.
VAL_DI_2	Validity of Digital Input 2	
VAL_DI_3	Validity of Digital Input 3	
...	(*)	
CMD_ENBL_DI1	Command to Enable Digital Input 1	The same as for the digital inputs.
CMD_ENBL_DI2	Command to Enable Digital Input 2	
CMD_ENBL_DI3	Command to Enable Digital Input 3	
...	(*)	
CMD_DIS_DI1	Command to Disable Digital Input 1	
CMD_DIS_DI2	Command to Disable Digital Input 2	
CMD_DIS_DI3	Command to Disable Digital Input 3	
...	(*)	
DO_1	Digital Output 1	
DO_2	Digital Output 2	
DO_3	Digital Output 3	
...	(*)	
LED_1	LED 1	
LED_2	LED 2	
LED_3	LED 3	
...	(*)	

(*) The number of digital inputs and digital outputs available will depend on each particular model.

Table 3.13.2: Auxiliary Outputs

Name	Description	Function
LED_P1R	LED P1 Red	The same as for the digital inputs.
LED_P1G	LED P1 Green	
LED_P2R	LED P2 Red	
LED_P2G	LED P2 Green	
LED_P3R	LED P3 Red	
LED_P3G	LED P3 Green	
LED_P4R	LED P4 Red	
LED_P4G	LED P4 Green	
LED_P5R	LED P5 Red	
LED_P5G	LED P5 Green	
LED_P6R	LED P6 Red	
LED_P6G	LED P6 Green	
LED_AMR	LED A/M Red	
LED_AMG	LED A/M Green	
IN_RST_LED	LEDs Reset Input	Resets the LEDs that are active because they are memorized.
IN_PMTR_RST	Power Meters Reset Input	The same as for the digital inputs.
IN_RST_MAX	Maximeters Reset	Its activation sets the content of the current, voltage and power demand elements to zero.
RST_MAN	Manual Reinitialization of The Relay	It is marked whenever the IED is reset manually.
PU_CLPU	Cold Load Pickup of Relay	It is marked whenever the IED is energized.
PU_WLPU	Warm Pickup of Relay	It is activated after any reset (configuration loading, manual reset,…), while remaining de device powered-up.
INIT_CH_SET	Change of Settings Initialization	It is indicated when some setting is modified.
FAIL_COM_L	Port 0 Communication Failure	They activate when no communication port activity is detected during the set time.
FAIL_COM_R1	Port 1 Communication Failure	
FAIL_COM_R2	Port 2 Communication Failure	
FAIL_COM_R3	Port 3 Communication Failure	
FAIL_COM_CAN	Port CAN Communication Failure	
REMOTE	Remote	Sets the relay in remote mode. Must be activated to enable DNP 3.0 commands.
LOCAL	Local Control	Means 'Local Commands' enabled, whose performance is defined in user's logic module.
CONTROL_PANEL	Operation Desk Control	Means 'Operation Desk Commands' enabled, whose performance is defined in user's logic module.

Table 3.13.2: Auxiliary Outputs		
Name	**Description**	**Function**
ERR_CRIT	Critical System Error	They note that some technical problem has cropped up in the IED.
ERR_NONCRIT	Non-Critical System Error	
EVENT_SYS	System Event	Indicates the reset of SW in the IED.

(*) The number of digital inputs and digital outputs available will depend on each particular model.

Configuration for outputs can be loaded at the factory. Users can easily program different output configurations using the ***ZivercomPlus®*** software via the local communication ports that have the PROCOME protocol configured (the local port is always assigned this protocol).

3.13.4 Operation Outputs: RAISE/LOWER the Tap

The **RTV** IED has four switching output signals, two of them normally open (N/O) and the other two definable by jumper as N/O or N/C. Two of these switching outputs are assigned to the logic output called **RAISE** and the other two, to the logic output called **LOWER**. These outputs are activated both when the relay generates the operations automatically and when the operations are manually. In all cases, they remain active for and adjustable time (3s. by default).

3.13.5 LED Targets

The **RTV** IED has optical indicators (LEDs) on the front panel. All of them are user-definable except one, that indicates whether the IED is **Ready**.

Each of the user-definable optical indicators is associated to a combinatorial function. These are diagrammed in figure 3.13.3. They way they function and are configured is similar to the auxiliary contact outputs. One of the two blocks has eight inputs that perform an OR operation (any signal activates the output). The other block has one input. The two blocks together can perform an OR or an AND operation without the subsequent possibility of using pulses.

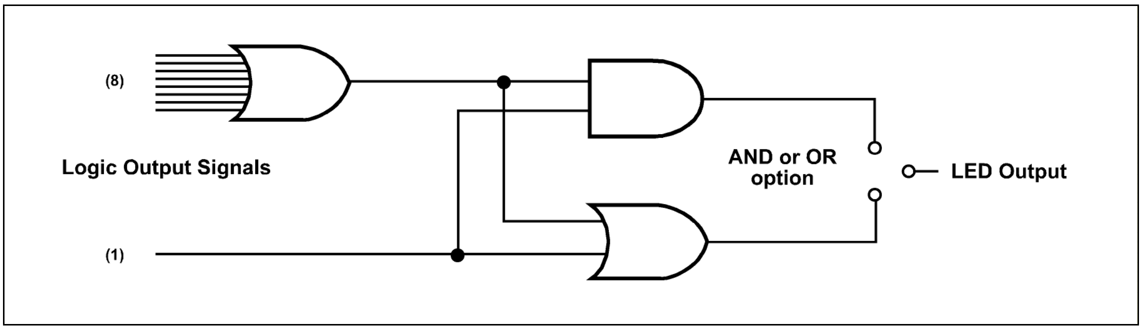


Figure 3.13.3: Target Output Logic Cell Block Diagram.

Each LED can be latched or unlatched. If an LED is latched, it will remain illuminated until reset. It is possible to program one of the programmable buttons, communications command, or digital input with the **Reset LEDs** digital input. Since it is defined as a command it will be available in the operations display menu. The latching function resides in the volatile memory section of the microprocessor. A power supply loss will cause any latched LED to reset.

The LEDs can be associated to any of the available logic output signals indicated in table 3.13-2. Logic equations can be created and modified with the ***ZivercomPlus®*** program via the local communication ports that have the PROCOME protocol configured (the local port is always assigned this protocol).

To develop more complex algorithms and be able to assign the resulting outputs to the LEDs, the necessary opcodes must be programmed in the programmable logic. This, for example, allows configuring latched LEDs that do not lose memory after an auxiliary power supply voltage failure. This requires the use of latched bistable circuits.

The IED has another 7 LEDs associated with each of the operating buttons available on the front of the IED. These indicators show the current state of the element governed by each button by its color (user-configurable). In the process of selecting an element and confirming / executing a command, the associated LED blinks. These LEDs must be configured through the programmable logic.

3.13.6 Digital Inputs, Auxiliary Outputs and LED's Test

Apply rated voltage, appropriate for the model. At this time, the **In Service** LED should be lit.

- **Digital Inputs**

For the inputs test, the rated voltage is applied between the terminals corresponding to the inputs (marked in the external connections diagram), always taking the polarity of the contacts into account.

From the inputs screen of the **Information** menu, it is verified that the inputs are activated ("1"). The voltage is removed and the contact inputs must reset ("0").

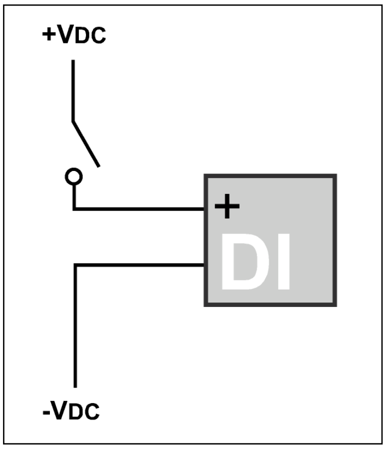


Figure 3.13.4: Digital Inputs Test.

- **Auxiliary Outputs**

To test the auxiliary contact outputs, their operation is provoked according to how they are configured. If they are not configured, they can be configured as activation of the status contact inputs. Part of the inputs test consists in verifying the operation of auxiliary output contacts OUT1 to OUT6.

- **Selection and Command Buttons and Associated LEDs**

To test the definable selection and command buttons on the front of the IED, they are assigned a configuration such that, once they have been selected and the command given, the corresponding auxiliary contact outputs (indicated in the external connections diagram) are activated and deactivated.

Pressing the **A/M** causes the associated LED to blink; then pressing the **I** or **O** key enables the **Automatic Mode** or **Manual Mode** as long as the mode is in the position contrary to the selected one.

Pressing the **P1** to **P6** keys after the configuration indicated above has been made, causes the LEDs corresponding to each of them to blink. Then, pressing the **I** or **O** key enables the contacts corresponding to the auxiliary contact outputs OUT1 to OUT6.

- **LED Targets**

To check the LED targets, the **F2** key must be pressed from the stand-by screen until the Resetting LEDs screen appears. It is held down until all the LEDs light up. When the push-button is released, they must all go off.

3.14 Programmable Logic

3.14.1 Description

One of the functions of these models is a fully configurable one called programmable logic. The user can freely interconnect this logic digitally and analogically by using the ***ZivercomPlus®***. program.

All the signals generated by the equipment will be available to the events, fault reports, oscillograph records, digital inputs and outputs, HMI and communications according to how their programmable logic has been configured.

The inputs to the logic functions can be any of the signals or readings generated by the following functions:

- Protection units.
- Digital inputs.
- Communications.
- Command functions.
- Analog inputs.

The user can define a logical operation using primitive logic functions (AND, OR, XOR, NOT, etc.), bistable circuits (latched or not), timers, comparators, constants, values, etc.

The programming function allows definition of the trip logic, control logic, interlocks, functional modules, local and remote states and control hierarchy required for complete protection and operation of a bay.

Priorities may also be selected in the programmable logic. There are three run cycles, of 2, 10 and 20 milliseconds, and priorities may be allocated placing the logics in either cycle. In this way, control logic can be carried out and use them as protection functions as they can be run with a priority similar to the functions implemented into the equipment firmware itself. For more information, please refer to the ***ZivercomPlus®*** manual.

The processing of the input signals produces logical outputs that can be assigned to existing connections between the IED and the exterior: auxiliary output contacts, display, LEDs, communications, HMI, etc.

The maximum capacity of the programmable logic is up to 64 KB, this is, approximately, 1000 primitives functions (opcodes).

3.14.2 Functional Characteristics

The IEDs can execute local programmable control functions associated with the bay as well as the logic associated with internal and external interlockings, treatment and generation of alarms and processing of signals. They are all programmable.

The execution of interlockings towards the external circuits implies being able to execute continuously active outputs depending on the combination of the state of various input signals through logic gates. These interlocking outputs are used for interrupting / continuing an exterior command circuit. These interlockings are the consequence of the logic capacity pointed out in the following sections.

The execution of internal interlockings implies being able to obtain logic outputs of permission / blocking of commands towards the external circuits according to the combination of the state of various input signals through logic gates. These processed logic signals affect the permissions / lockouts of commands generated both from the unit's local control module and from the Central Unit originating in the control display, central programmable control functions and/or remote control.

Logical alarms can be generated with data from the combination of the state of various input signals through logic gates as well as from "timers" of presence / absence of a given signal, either physical or logic.

The processing of analog signals offers the possibility of comparing analog inputs with set points and of generating digital ON/OFF signals as a result of this comparison as well as the possibility of adding and multiplying analog signals. Analog values can be used in primary or secondary values.

Logic configurations can also generate **user defined values** such as counters. This values are the result of the user defined logic algorithms. **User defined values** can be displayed on the HMI, sent via communications and retrieved using ***ZivercomPlus*®**.

Likewise, it is also possible to define new user settings in the IED associated with the algorithm. These settings can be consulted afterwards from the HMI or communications.

In addition, the algorithms can disable protection elements of the IED. The disabling of an element allows it to be replaced by another that operates under user-defined algorithms.

Basically, the system takes input signals from various sources, both external to the IED (communications or HMI) and internal; processes these signals according to the configuration that has been loaded and the pre-established settings and activates certain output signals that will be used for sending information messages or measurements to the central unit as well as commands to relays, LEDs and protection.

The **Programmable Logic** and its **Configuration** comprise the engine of this whole system. The logic has a set of *blocks* that encompass a series of logic operations. Each of these blocks determines an *outcome* (state of one or more signals) depending on the state of the inputs of that *block*. The **Configuration** determines the use of one or another block.

The operation chosen to obtain a given output determines the input signals to the *blocks*. The **Input Connection** process is the software process that connects the inputs of the *blocks* with the appropriate inputs to the control subsystem according to the **Configuration**.

Likewise, the output signals from the blocks are associated with the appropriate outputs. This is done in the **Output Connecting** process according to the **Configuration**.

If the required input signals are signals that arrive through communications, they arrive encoded according to the PROCOME, MODBUS or DNP 3.0 communications protocol, which forces associating each necessary signal with its corresponding protocol. This process is performed in **Input Tagging** and the associations are made in one form or another according to the configuration. The same happens with the signals sent through communications; the software process is carried out in **Output Tagging** and is also determined by the **Configuration**.

New logic-generated values can be redirected to the IED's different communication protocols as well as to the HMI.

The **Programmable Logic** can be used to generate events with any available digital signal that the IED can capture with the PROCOME communications protocol and the program. It doesn't matter if this signal is a digital input or a signal received via communications from the central unit or, on the contrary, is the outcome of internal operations included in the programmed algorithm itself. Moreover, there is the option of recording the event by the rising edge of the chosen signal, by the falling edge or by both.

Once the event is generated, it can be captured the same as the rest of the events generated by the IED (as, for example, trip events) with the ***ZivercomPlus®*** communications program.

There is an exclusive option to simplify the task of configuring the Digital Inputs, Digital Outputs and LEDs. This voids the need to work with complex algorithms that would make the task unnecessarily difficult.

3.14.3 Primitive Functions (Opcodes)

The following logic operations can be used in the algorithm.

AND	Pulse	Adder	BCD/Analog Converter
OR	Timer A	Subtracter	Binary/Analog Converter
XOR	Timer B	Multiplier	Analog/BCD Converter
NOT	DFF	Divisor	Analog/Binary Converter
Cable	RSFF	Comparator	Pulse train
Multifiber Cable	Analog Cable	Level Comparator	Rising edge
Multiplexer	Counter	Digital/Analog Converter	Valid Value

- **AND**

Performs an AND operation between digital signals.

Operands:

From 2 to 16 digital input signals.

Results:

Digital output signal, the outcome of the operation.

- **OR**

Performs an OR operation between digital signals.

Operands:

From 2 to 16 digital input signals.

Results:

Digital output signal, the outcome of the operation.

- **XOR**

Performs an XOR operation between two digital signals.

Operands:

Two digital input signals.

Results:

Digital output signal, the outcome of the operation.

- **NOT**

Moves to a digital signal the outcome of negating another.

Operands:

Digital input signal.

Results:

Digital input signal.

- **Cable**

Moves to a digital signal the value of another.

Operands:

Digital input signal.

Results:

Digital output signal.

- **Multifiber Cable**

Moves to a digital signal the value of another.

Operands:

Digital input signal.

Results:

From 1 to 16 digital output signals.

- **Multiplexer**

Based on a selector, it establishes the value of an output signal with the value of one of the two inputs.

Operands:

Digital input selector signal.
2 digital input signals.

Results:

Digital output signal.

- **Analog Selector**

Based on a selector, it establishes the value of an analog output magnitude with the value of one of the two analog input magnitudes.

Operands:

Digital input selector signal.
2 analog input magnitudes.

Results:

Analog output magnitude.

- **Pulse**

When the input signal goes from 0 to 1, the output signal is activated during the time specified as parameter.

Operands:

Digital input signal.
Setting or pulse time constant in seconds.

Results:

Digital output signal.

Limits:

The maximum time must be set between 0.0 and 2147483.648 seconds (24 days).

- **Timer A**

When the time set since the input signal went from 0 to 1 is up, the output goes to one until the input resets.

Operands:

Digital input signal.
Setting or delay time constant in seconds.

Results:

Digital output signal.

Limits:

The maximum time must be set between 0.0 and 2147483.648 seconds (24 days).

- **Timer B**

The output is activated as long as the input is active or has been deactivated after a time no greater than the time set.

Operands:

Digital input signal.
Setting or delay time constant in seconds.

Results:

Digital output signal.

Limits:

The maximum time must be set between 0.0 and 2147483.648 seconds (24 days).

- **DFF**

Type D bistable. Whenever a rising edge occurs in the clock signal, the bistable takes the value of the input.

Operands:

Digital clock signal.
Digital input signal.

Results:

Digital output signal

- **RSFF**

Type RS bistable. As long as the S signal is active, the bistable takes the value of the input. When the R input is activated, the bistable takes value 0.

Operands:

Digital signal R.
Digital signal S.

Results:

Digital output signal.

- **Analog Cable**

Moves to an analog magnitude the value of another.

Operands:

Input magnitude.

Results:

Output magnitude.

- **Counter**

It manages a counter that increases with each rising edge of the clock signal. When the reset input is activated, the counter resets to 0.

Operands:

Digital reset signal.
Digital clock signal.

Results:

Magnitude of counter value.

Limits:

The counter has a saturation value of 65535. Subsequent increments do not modify the output value of the counter.

- **Adder**

It establishes the value of the output magnitude with the result of the sum of the input values.

Operands:

2 input values, settings or constants.

Results:

Output magnitude.

- **Subtracter**

It establishes the value of the output magnitude with the result of the subtraction of the input values.

Operands:

2 input values, settings or constants.

Results:

Output magnitude.

- **Multiplier**

It establishes the value of the output magnitude with the result of the product of the input values.

Operands:

2 input values, settings or constants.

Results:

Output magnitude.

- **Divisor**

It establishes the value of the output magnitude with the result of the division of the input values.

Operands:

2 input values, settings or constants.

Results:

Output magnitude.

- **Comparator**

Compares two input values and establishes the value of the digital output signal according to the outcome of the comparison.

Operands:

2 input values, settings or constants.
Type of comparison as a constant value inserted in the opcode:
Greater than.
Less than.
Equal to.
Not equal to.
Greater than or equal to.
Less than or equal to.

Results:

Digital output signal.

- **Level Comparator**

It compares the input magnitude with respect to a minimum and maximum reference value and establishes the output according to it. Thus:
The output is 1 if the input is greater than the maximum reference value.
The output is 0 if the input is less than the minimum reference value.
Otherwise, the output keeps the same value.

Operands:

Input magnitude (magnitude, setting or constant).
Minimum reference value (magnitude, setting or constant).
Maximum reference value (magnitude, setting or constant).

Results:

Digital output signal.

- **Digital / Analog Converter**

It converts a digital signal to an analog magnitude with value 0 or 1.

Operands:

Digital input signal.

Results:

Analog output magnitude.

- **BCD / Analog Converter**

With 16 digital inputs, it generates an analog magnitude using BCD code.

Operands:

16 digital input signals.

Results:

Analog output magnitude.

- **Binary / Analog Converter**

With 16 digital inputs, it generates an analog magnitude using binary code.

Operands:

16 digital input signals.

Results:

Analog output magnitude.

- **Analog / BCD Converter**

It converts an analog magnitude into 16 digital signals by converting to BCD code.

Operands:

Analog input magnitude.

Results:

16 digital output signals.

- **Analog / Binary Converter**

It converts an analog magnitude into 16 digital signals by converting to binary code.

Operands:

Analog input magnitude.

Results:

16 digital output signals.

- **Pulse Train**

Logic block produced by a pulse train while the digital input signal is active.

Operands:

Digital signal enabling pulse train.
Magnitude, setting or time constant of active pulse in seconds.
Magnitude, setting or time constant of inactive pulse in seconds.

Results:

Digital output signal.

- **Rising Edge**

The output is activated when a change from 0 to 1 is detected in the input.

Operands:

Digital input signal.

Results:

Digital output signal.

- **Valid Value**

Determines if an analog value is within the limits of the possible valid finite values.

Operands:

Magnitude the value of which must be checked.

Results:

Digital output set to 1 when the input value is a valid finite number.
Digital output set to 0 when the input value is not finite or is invalid.

3.14.3.a Logic Operations with Memory

Certain logical functions can be configured to preserve the internal state of the function after a shut down. Not all the logical functions have internal states that require this treatment:

Table 3.14-1: Logic Operations with Memory

Logical function	Can be memorized
AND	-
OR	-
XOR	-
NOT	-
Cable	-
Multifiber Cable	-
Pulse	Y
Timer A	Y
Timer B	Y
DFF	Y
RSFF	Y
Analog cable	-
Counter	Y
Adder	-
Subtracter	-
Multiplier	-
Divisor	-
Comparator	-
Level comparator	Y
Digital to analog	-
RSFF with timed reset	Y
Pulse train	Y

Memorization mode is selected by means of a memory field inserted in the opcode when configuring with the ***ZivercomPlus***® program.

3.15 Communications

3.15.1 Communications Ports

RTV relays are provided with different types of communications ports as a function of the selected model:

- **1** front **Local Port** type RS232C and USB.
- Up to **3 Remote Ports** with following configurations:
  - Remote Port 1: optical fiber interface (glass ST or plastic 1mm), electrical interface RS232 / RS232 FULL MODEM and RJ45 connector for ETHERNET communications.
  - Remote Port 2: optical fiber interface (glass ST or plastic 1mm), electrical interface RS232 / RS485 and RJ45 connector for ETHERNET communications.
  - Remote Port 3: optical fiber interface (glass ST or plastic 1mm), electrical interface RS232 / RS485 and RJ45 connector for ETHERNET communications.
- **2 LAN Ports** with following configurations (ETHERNET type communications):

	LAN 1	**LAN 2**
1st Combination	RJ45	RJ45
2nd Combination	FOC ST	FOC ST

- **1 Remote Port** with CAN protocol BUS connection.

Technical data for these communications links can be found in Chapter 2.1 (Technical Data). Information on model ports can be found in chapter 1.5 (Model selection).

3.15.2 Communication with *ZivercomPlus*®

Protection, loading or reading programmable logic configuration and reading out protection data (events, fault reports, oscillograms, ...) can be configured through communications ports set for PROCOME protocol. The local port is always assigned this protocol, whereas for remote ports it depends on settings.

Communications are established through ***ZivercomPlus***® communications program, which allows dialog between the **RTV** family and other relays, whether locally (via a PC connected to front port) or remotely (via rear serial ports with PROCOME protocol), covering all needs regarding programming, settings, recording, reports, etc.

Local and remote communications ports are configured through HMI.

RTV model features three controllers, one for each communications port, so that communications can be established through all of them at the same time.

The ***ZivercomPlus***® communications program that involves the application of the model involved is protected against non-authorized users through access passwords. The ***ZivercomPlus***®, that runs in WINDOWS™ environment is easy to operate and uses buttons or keys to display the different submenus.

3.15.3 Synchronization by IRIG-B 123 and 003

RTV relays are provided with a BNC type input for IRIG-B 123 or 003 standard time synchronization signals. Said input is located at the relay rear panel. Synchronization accuracy is ±1ms.

In case the relay is receiving an IRIG-B synchronization signal, access from HMI to **Date and Time** settings is denied.

An output can be configured to show IRIG-B signal received status. This output remains active while the relay receives correctly said signal.

Relays are also prepared for indication of both the loss and recovery of IRIG-B signal by generating events associated to each of these circumstances.

3.15.3.a UTC / Local Time Configuration

Discerning whether the time received through BNC connector corresponds to **UTC Time** or a given **Time Zone (Local)** is possible through **IRIG-B Time Zone** setting.

In the first case, a correction must be introduced to adapt the UTC time to the time zone of the relay site. The **Local Time Zone** setting within the **Date and Time** settings group is used for this purpose, which allows putting UTC time forward or back as required.

In the second case, the relay receives the time signal already adapted to the local time zone and no correction is needed. In this case local **Local Time Zone** has no effect.

3.15.3.b IRIG-B Function Settings

IRIG-B Function Settings			
Setting	**Range**	**Step**	**By Default**
IRIG-B Time Zone	0 = Local Time 1 = UTC Time	1	0 = Local Time

3.15.3.c Auxiliary Outputs of the IRIG-B Function

Table 3.15-1: Auxiliary Outputs of the IRIG-B Function

Name	Description	Function
SIGNAL_IRIGB	IRIGB Active	Signal indicates that IRIG-B signal is being received.

3.15.4 Communications Protocol

All **RTV** relays are provided with rear communications ports for remote access and one front port for local access. Depending on model, rear ports feature several communications protocols:

- **Remote Ports 1** and **2**: options PROCOME, DNP3.0, MODBUS and Virtual Inputs / Outputs are available.
- **Remote Port 3**: options PROCOME, DNP3.0 and MODBUS are available.
- **Remote Port 4**: options CAN and CAN MULTI-MAESTRO are available.
- **Ports LAN 1** and **2**: can communicate through IEC61850.

It is worth mentioning that communications through all ports can be maintained simultaneously.

PROCOME protocol complies with IEC-870-5 standards and is used, the same as for IEC61850, for both protection and control information management. On the other hand, protocols DNP 3.0, CAN and MODBUS are used for control information management.

For more details on protocols refer to the applicable protocol paragraph.

3.15.4.a Control Change Recording

Depending on signals configured into the programmable logic through the ***ZivercomPlus***® program, the different system events make changed-state signals to be written.

Different signal lists for PROCOME 3.0 and DNP 3.0 protocols can be configured through the programmable logic, saving changes into different and separate **RTV** relay files for each of the communications ports. This implies that although the tail of changes of one port is emptied after collecting said information, the same information is available at the other port for collection through the allocated protocol, whether it is the same as for the first port or not.

Also, from the signals configured in PROCOME, DNP 3.0 or both, signals to be displayed through the HMI can be selected. They are also saved into separate files, so that even if tails of control changes of communications ports are emptied, the information is still available through HMI. Between 100 and 115 records are saved depending on their simultaneity.

Information on the Control Change Record is displayed from the HMI or pressing F1 key through **Information** option, the changes list view or delete options being available. If the view option is selected, the last change generated is always displayed (the most recent). Information is presented as follows:

```
AA/MM/DD|HH:MM:SS
000   text1     □ or ■
001   text2     □ or ■

AA/MM/DD|HH:MM:SS
000   text3     □ or ■
001   text4     □ or ■
```

Namely, events are grouped by “date” and “time”. Then, in the following line, the milliseconds corresponding to each control change and the label defined through the ***ZivercomPlus***® (maximum of 13 characters) are shown. And at the end of the line, a filled or blank square indicates ACTIVATION-ON (■) or DEACTIVATION-OFF (□) respectively. Default signal text labels are defined in input and output tables; in case of new signals generated into the programmable logic, said text must be defined. In any case, in order to use the names required by each user, the creation of a logic record card allocating a personalized name to every signal to be displayed is recommended.

The date and time stamp will be generated every time a new event occurs in it.

The MODBUS allows to display the actual value of the configured digital signals but do not record their changes.

3.15.5 Communications Settings

As the below described settings are independent for each port, they are grouped as follows: **Local Port**, **Remote Port 1**, **Remote Port 2**, **Remote Port 3**, **LAN1**, **LAN2** and **CAN**. Finally, specific settings for each protocol are described.

Whenever communication is established through one of these ports, the following codes are displayed on relay alphanumeric HMI:

- **Local port**: **[PL]** code.
- **Remote port 1**, **Remote port 2**, **Remote port 3**: **[P1]**, **[P2]** and **[P3]** codes.
- **Remote ports LAN1** and **LAN 2**: no display on MMI.
- **Remote port CAN**: **[P4]** code.

These codes, in case of PROCOME 3.0 protocol, remain displayed during **Communications Password TimeOut** setting indicated in paragraph 3.40.5.f after the last communication carried out; in case of MODBUS, DNP V3.00 and CAN protocols, the message remains displayed for one minute after the last communication.

There are three timer settings, one for each communications port (**Communication Failure Time Indication**), which, no matter the assigned protocol, allow configuring the period without communication activity before generating the alarms (digital signals and events) **Communication Failure Port 0**, **1**, **2**, **3** and **CAN**.

3.15.5.a Local Port

The setting options of the local communications port are:

- **Baud Rate**: a value from 300 bauds to 38400 bauds can be chosen, default value being 38400 bauds.
- **Stop Bits**: one of two stop bits can be selected.
- **Parity**: even, odd or no parity (None) can be selected. No parity is configured by default.
- **Character Reception Time** (0-60000 ms): maximum time between characters allowed during the receiving of a message. The current message will be considered cancelled if it exceeds the set time between the reception of two characters.
- **Communication Failure Indication Time** (0-600 s.): maximum time between messages without indication of communication channel blocking.

3.15.5.b Remote Port 1

Remote port 1 has fiber optic and electrical access RS232 / RS232 FULL MODEM. Access through RS232 FULL MODEM has all the MODEM lines in format DB9. The settings available for configuring this port are:

- **Baud Rate, Stop Bits, Parity** and **Character Reception Time**, the same as the local port.
- **Protocol**: depending on model, PROCOME 3.0, DNP 3.0, MODBUS Protocols and Virtual Inputs Outputs can be selected. The default protocol is PROCOME.
- ·**Advanced settings**:

  1. Flow Control

  CTS Flow (NO / YES): It specifies whether the **Clear to Send** signal is monitored to control the data transmission flow. If the setting is YES and the CTS signal falls to "0", the transmission is suspended until the CTS signal resets.

  DSR Flow (NO / YES): It specifies whether the **Data Set Ready** signal is monitored to control the data transmission flow. If the setting is YES and the DSR signal falls to "0", the transmission is suspended until the DSR signal resets.

  DSR Sensitive (NO / YES): It specifies whether the communications port is sensitive to the state of the DSR signal. If the setting is YES, the communications driver ignores any byte received unless the DSR line is active.

  DTR Control (INACTIVE / ACTIVE / ENABLE SEND):

  Inactive: It sets the DTR control signal to permanently inactive.

  Active: It sets the DTR control signal to permanently active.

  Enable Send: The DTR signal remains active as long as the receiving of new characters is allowed.

  RTS Control (INACTIVE / ACTIVE / ENABLE SEND / SOL. SEND):

  Inactive: It sets the RTS control signal to permanently inactive.

  Active: It sets the RTS control signal to permanently active.

  Enable Send: The RTS signal remains active as long as the receiving of new characters is allowed.

  Solicit Send: The RTS signal remains active as long as there are characters pending transmission.

  2. Time

  Transmission Time Factor (0-100 characters): Per-character time factor, which determines when the transmission ends by time-out.

  TRANSMISSION TIME CONSTANT (0-60000 ms): Fixed time in seconds that is added to the per-character time factor, and that determines when the transmission ends by time-out.

  3. Message modification

  Number of Zeros (0-255): Number of zeros to insert as preamble to each message.

  4. Collisions

  Type of Collision (NO / ECHO / DCD):

  NO: Collision detection disabled.

  ECHO: A collision is considered to have occurred when the characters received do not coincide with the characters transmitted.

  DCD: A collision is considered to have occurred when the DCD line is activated.

  Number of Retries (0-3): Maximum number of retries in the transmission when collisions are detected.

  Minimum Time Between Retries (0-60000 ms): Minimum time between retransmissions on collision detection.

  Maximum Time Between Retries (0-60000 ms): Maximum time between retries on collision detection.

3.15.5.c Remote Ports 2 and 3

Remote ports 2 and 3 have fiber optic and electrical access RS232 / RS485. Available configuration settings for these ports are similar to the local port settings, and it is possible to select the communications protocol and a specific parameter for RS485 application. Thus, settings are:

- **Baud Rate, Stop Bits, Parity** and **Character Reception Time**.
- **Protocol**: Depending on model, PROCOME 3.0, DNP 3.0, MODBUS protocols and Virtual Inputs / Outputs (this last option is only available for remote port 2) can be selected. The default protocol is PROCOME.
- **·Advanced settings**:

  1. Operation Mode (RS232 / RS485): This setting allows selecting the operation mode of DB9 interface of remote port 2 or 3 as a RS232 port or RS485 port.

  2. Time

  Transmission Time Factor (0-100 characters): Per-character time factor which determines when the transmission ends by time-out.

  Transmission Time Constant (0-60000 ms): Fixed time in seconds that is added to the per-character time factor, and that determines when the transmission ends by time-out.

  Number of 485 Stop Bytes (0-4 bytes): It specifies the number of stop bytes between transmit and receive when the port is configured as RS485.

  3. Message modification

  Number of Zeros (0-255): Number of zeros to insert as preamble to each message.

  4. Collisions

  Type of Collision (NO / ECHO / DCE):

  NO: Collision detection disabled.

  ECHO: A collision is considered to have occurred when the characters received do not coincide with the characters transmitted.

  Number of Retries (0-3): Maximum number of retries in the transmission when collisions are detected.

  Minimum Time between Retries (0-60000 ms): Minimum time between retransmissions on collision detection.

  Maximum Time between Retries (0-60000 ms): Maximum time between retries on collision detection.

3.15.5.d Ethernet Remote Ports 1, 2 and 3

- **Protocol**: Depending on model, PROCOME 3.0, DNP 3.0, MODBUS protocols and Virtual Inputs / Outputs (this last option is only available for remote port 2) can be selected. The default protocol is PROCOME.
- **Ethernet**
  1. Enabling the Ethernet Port (YES-NO): enables (YES) or disables (NO) the Ethernet Port.
  2. IP Address (ddd.ddd.ddd.ddd): Ethernet device ID number.
  3. Net mask (128.000.000.000 – 255.255.255.254): number that indicates to the device what part of the IP address is the network number, and what part of the IP address corresponds to the device.
  4. Port Number (0 - 65535): number used to indicate the delivery route of the data received, to the destination device.
  5. Max. Time between Messages TCP (0-65 sec.): number of seconds between Keepalive packages - if zero then Keepalive packages were not sent. These Packages inform the server if a client is still present on the Ethernet Network.
  6. RX Car Time (0-60000 milliseconds): maximum time between characters allowed while receiving a message through the Ethernet. The message is timed out if the set time is exceeded between the receipt of two characters.
  7. Communication Fault Indication Time (0-600 sec.): maximum time between messages via the Ethernet port before an indication that communications have stopped.

3.15.5.e Remote Port 4

Remote port 4 of BUS CAN has the following configuration settings available:

- **Baud Rate** (100, 125, 250, 500 and 100 Kbaud).
- **Trip Indication Time** (1 - 10sg).

3.15.5.f PROCOME 3.0 Protocol Settings

The configuration settings of the PROCOME 3.0 protocol are:

- **Relay Number** (0-254): it specifies the address of the **RTV** relay (acting as RTU or Remote Terminal Unit) in relation to the rest of equipment that communicate with the same master station (MTU or Master Terminal Unit).
- **Communications Password Enable** (YES-NO): this setting allows to enable the access password function to establish communication with the relay through the rear port: YES means enabling the permission and NO, disabling.
- **Communications Password TimeOut** (1-10 minutes): this setting allows establishing a period of time for activating a communication blocking with the relay (whenever communication is via the rear port): if the set time expires with no activity taking place in the communications program, the system blocks, and the communication must be reinitiated.
- **Communications Password**: the communications password allows establishing a specific password to access communications with the relay through the rear port. This password must have 8 characters, which will be entered using the numerical keys and the key corresponding to a dot.

3.15.5.g DNP 3.0 Protocol Settings

The DNP 3.0 protocol configuration settings include the definition of:

- **Relay Number** (0-65519): it specifies the address of the **RTV** relay (acting as RTU or Remote Terminal Unit) in relation to the rest of equipment that communicate with the same master station (MTU or Master Terminal Unit). The 0xFFF0 to 0xFFFF addresses are reserved for the Broadcast addresses.
- **T. Confirm TimeOut** (100-65535): it specifies the time lapse (in milliseconds) from the time the **RTV** sends a message requesting the master to confirm the Application layer (Level 7), until this confirmation is considered lost. The **RTV** requests confirmation of the Application Layer when it sends spontaneous (Unsolicited) messages or in response to requests for Class 1 or Class 2 Data. When this time expires, the message is retransmitted the number of times specified in the N. Retries parameter.
- **N. Retries** (0-65535): number of retries of the Application Layer (N7). The default value is 0 (zero), indicating that no retransmission will be attempted.
- **Master Number Unsolicited** (0-65535): it specifies the address of the master station (MTU or Master Terminal Unit) to which the **RTV** relay will send spontaneous (Unsolicited) messages. It is used in combination with Enable Unsolicited parameter. Addresses 0xFFF0 to 0xFFFF are reserved for Broadcast addresses.
- **Enable Unsolicited** (YESI/NO): enables (YES) or disables (NO) sending spontaneous messages (Unsolicited); it is used in combination with the MTU Number parameter. For the **RTV** relay to begin sending spontaneous messages the master must also enable them with the Function Code FC = 20.
- **Unsolicited Start Enable** (YES/NO): enables (YES) or disables (NO) sending spontaneous start messages (Unsolicited after Restart); it is used in combination with the MTU Number parameter. For the **RTV** relay to begin sending spontaneous start messages there is not need for the master to enable them.
- **Time Grouping Unsolicited** (100-65535): it specifies the time interval between the generation of a first event for an unsolicited message and the transmission of the message, with the purpose of grouping several events that may occur within this time interval in a single transmission message, in order not to saturate the communications line with multiple messages.
- **Sync. Interval** (0-120 minutes): it specifies the maximum time interval between two synchronizations. If no synchronization occurs within the interval, the need for synchronization is set in Internal Indication (IIN1-4 NEED TIME). This setting has no effect if the Sync. Interval is 0.
- **Unsolicited Start Activation** (YES/NO): enables (YES) or disables (NO) sending Forced Unsolicited messages (for compatibility with versions pre DNP3-1998). When Unsolicited Start is activated, the **RTV** relay begins to transmit the existing spontaneous messages without additional enabling by the level 2. For this setting to have effect Enable Unsolicited Start must be enabled.
- **DNP3 Revision** (STANDARD ZIV/2003): indicates the DNP3 certification revision to use. STANDARD ZIV or 2003 (DNP3-2003 Intelligent Electronic Device (IED) Certification Procedure Subset Level 2 Version 2.3 29-Sept-03).
- **Measurement Transmission as Class 1** (YES/NO): enables (YES) or disables (NO) measurement transmission as Class 1.
- **Compression of Multiple Reading Response Messages** (YES/NO): enables (YES) or disables (NO) same fragment multiple object response to multiple request message.

Up to 64 measurements or analog magnitudes can be set for DNP3 transmission. Among them, up to 16 measurements can be set for transmission upon a change request.

To select the measurements to transmit upon a change request, enable the **DNP3 Measurement Change** control configuration option using ***Ziverlog***®.

The measurement change transmission is set through two parameters for each measurement: **Upper Limit** (in profile I relays) or **Maximum Value** (in profile II relays) setting values and the **Band** setting value set for that measurement. Up to 16 band values may be configured through ***ZivercomPlus***®, which will be associated to the measurements enabled for change transmission in the same sequence as they are ordered in ***Ziverlog***®. Namely: band value 000 will be assigned to the first measurement enabled for change transmission, 001 to the second, and so on up to the last measurement enabled, with the limit of 16. The band represents a percentage of the **Maximum Value**, so that when a measurement change exceeds that band, the measurement value is annotated to be sent as change. When the relay receives a measurement change request, it will send all changes annotated.

Analog changes will not be annotated for measurements with option **DNP3 Measurement Change** enabled but with the band set to 100%, or measurements with option **DNP3 Measurement Change** not enabled, they being deemed disabled for change transmission.

Additionally, these are other settings defined for the **DNP3 Profile II and Profile II Ethernet Protocols**:

- **Class for Binary Changes** (CLASS..., NONE). Assigns the class to the binary changes.
- **Class for Analog Changes** (CLASS..., NONE). Assigns the class to the analog changes.
- **Class for Counter Changes** (CLASS..., NONE). Assigns the class to the counter changes.
- **"Status" Type Binary Inputs** (YES-NO). Binary inputs used are according to "status" type inputs (YES) or binary inputs used are not sent according to "status" type inputs (NO).
- **32 bits Analog Inputs** (YES-NO). Analog inputs used are 32 bits resolution (YES) or analog inputs used are 16 bits resolution (NO).
- **Change in DNP3 Counter (1 to 32767**). The setting value shows the minimum increase of counts needed to send a new DNP3 message stating a new change in the counter. 20 counters can be configured as maximum under the DNP3 Profile II and Profile II Ethernet Protocols.

3.15.5.h MODBUS Protocol Setting

The only configuration setting of the MODBUS protocol is the **Relay Number** (0-254), which the same as for the other protocols specifies the **RTV** relay address (acting as RTU or Remote Terminal Unit) with reference to the rest of relays communicating with the same master station (MTU or Master Terminal Unit).

3.15.5.i TCP/IP Protocol Settings

TCP/IP protocol configuration settings include the definition of:

- **Ethernet Channel 0** (**LAN 1**). The following settings are available within the channel:
  - IP Address (ddd.ddd.ddd.ddd).
  - DHCP Enable (YES/ NO).
  - Default Gateway (ddd.ddd.ddd.ddd).
  - Network Mask (ddd.ddd.ddd.ddd).
  - DNS Address (ddd.ddd.ddd.ddd).
- **Ethernet Channel 1** (**LAN 2**). The following settings are available within the channel:
  - IP Address (ddd.ddd.ddd.ddd).
  - DHCP Enable (YES/ NO).
  - Default Gateway (ddd.ddd.ddd.ddd).
  - Network Mask (ddd.ddd.ddd.ddd).
  - DNS Address (ddd.ddd.ddd.ddd).
- **SNTP** The following settings are available within SNTP:
  - SNTP enable (YES / NO).
  - Broadcast Synchronization Enable (YES / NO).
  - Unicast Synchronization Enable (YES / NO).
  - IP address of Primary SNTP Server (ddd.ddd.ddd.ddd).
  - IP address of Slave SNTP Server (ddd.ddd.ddd.ddd).
  - Unicast Validity Timer (10 - 1000000).
  - Unicast Error Timer (10 - 1000000).
  - Number of Connection Retries (1 - 10).
  - Tuning period (1 - 1000000).
  - Retry Period (1 - 1000000).
  - Broadcast validity Timer (0 - 1000000).
  - Broadcast Error Timer (0 - 1000000).
  - Maximum Synchronism Time Delay (0 - 1000000).
  - Ignore Synchronization Leap Indicator (YES / NO).
  - Synchronism State Calculation (Timing / Leap Indicator).

Settings related to the Ethernet Redundancy (depending on the model):

- **Redundancy mode** (No Redundancy / Bondng Redundancy / PRP Redundancy / RSTP Redundancy).
- **Channel status time** (1 - 60).
- **Bonding Redundancy**
  - Link check interval (25 - 500).
- **PRP Redundancy**
  - Transmission time of supervision frames (0 - 30000).
  - LSB of supervision frame destination MAC address (0 - 255).
- **RSTP Redundancy**: settings are found in the web server. Refer to section Communications Protocol IEC61850.

3.15.6 IEC61850 Communications Protocol

3.15.6.a Introduction

IEC61850 communications equipment of the ‘V’ family is provided with functions additional to those provided by protection and control equipment.

This equipment may become independent from communications, performing their protection or control functions independently or may be used for data reports, set or receive specific data.

IEC61850 communications provide the following additional services:

- Report device-generated data (Starting, tripping, blocking, etc.) to higher level equipment (Central unit, remote control, HMI, etc.).
- Report prompt data (GOOSE) to other same level equipment (protections, control equipment, auxiliary services) or even to other higher level equipment.
- MMS communications that allows any MMS browser to receive the model of equipment data and be able to operate with it to edit settings and parameters and execute commands to the equipment.
- Handle a single configuration file (CID) that allows having a backup of all parameters whether they are protection, control and communications.
- Web server to provide data about equipment status, errors and state and measurement values.

3.15.6.b Starting Communications

Unlike protection and control functions that start in less than 3 seconds, **IEC61850** communications start in a variable time as a function of the data configured. In a reboot, the main **IEC61850** communications screens are as follows:

Initial moment in which the basic data of the operating system are loaded.	**Starting IEC61850** **06/08/11 02:98:36**
Autorun screen that manages the IP and allows to stop booting or carry out other maintenance tasks.	**AUTORUN 1.35 E(3.8)** **LN1:192.168.1.81**
Screens to create the **IEC61850** model and read **CID**.	**READ CID** **_RTVP4N403B.CID**
Equipment home screen that indicates the equipment is fully booted and ready for communications.	**ZIV/RTV** **17/04/10 22:49:02**

3.15.6.c Information Screens

Equipment with **IEC61850** communications include a data Menu, access of which is gained pressing the key combination: Up Scroll Arrow and Dot from the HMI default screen.

This screen displays in the first line the equipment software model, in the second line, versions of the active **IEC61850** application, the third, the equipment IP (if no network cable were connected, it will show 0.0.0.0) and the last line, the MAC of the network adapter.

RTVP4N*403*B20FC**
V(0.7) [02] [6.0R]
192.168.1.81
00:E0:AB:02:98:36

From this screen more data can be displayed through the function keys F2, F3 and F4.

Pressing F2 displays a screen with Goose message data. This screen displays information on whether Goose message transmission is activated: [ON]GO, if receive is configured [ON]GI, and if so, the message that is not being received: 01??
The arrow → indicates the moment when a Goose message is sent.

[ON]GIe:0000 0000
01?? GIv:0000 0000
[ON]GOe:0000 0000→
GOv:0000 0000

Pressing F3 displays a screen with expanded data.

EBOOT (3.8)
[RTV-9836]
Ver SO(2.99)
IEC [6.0R][RUN]

It is a screen that can be scrolled down using the scroll arrows, the complete data being: Data on the Eboot, Operating System, application, checksums versions and network adapter data, etc.

```
EBOOT (3.8)
[RTV -9836]
Ver SO(2.99)
IEC [6.0R][RUN]
CRC:[4720E6D0]
BLD[Sep 28 2011]
BLD[08:46:05]
MMS<->IEC<->RTV
RTVP4N***403*K20FC
(0.7)[02]
[BOND_ETHBOND]
192.168.1.81
00:E0:AB:02:98:36
DHCP[0]
Type[6]
GWY[192.168.1.10]
CONNECTIONS 0

[BOND:ETHBOND]
RxERR:[0]
TxERR:[0]

FiFoE:0 Use:1
FiFoM:0 Use:68
NmRtr:0 Mxmed:4
```

Pressing F4 displays the SNTP client data screen. The screen shows the version of the Operating System, the version of the SNTP client, whether the client is switched off, switched on or in Error and the receive time and whether is valid (v) or invalid (i).

Ver S.O.(2.99)
Ver SNTP(2.250)
Sinc SNTP [ON]
10/04/17 22:49:02v

Press ESC to return to the default screen from any screen.

3.15.6.d Web Server

Through the web server access can be gained to firmware versions, boot status and useful relay data. Write the equipment IP address in a web browser for access:

The following data are displayed:

(C) ZIV http://www.ziv.es	
EBOOT	See (3.8) ID[RTV-9836]
Version NK	2.99
Version IEC	[6.2R][RUN]
Build EXE	[Sep 28 2011][4720E6D0]
Model RTV	RTVP4N***403*B20FC
Version API	(0.6)[01]
HTML	APPLICATION
HTML	EXECUTION
HTML	MAPPING
HTML	CIDLOAD
	CONNECTIONS
	LIST DIGITALS
	LIST ANALOGS
	LIST OSCILOS
TXT	APLERROR.LOG
TXT	MAPERROR.LOG
TXT	EXECERROR.LOG
TXT	CIDERROR.LOG
CID ACTIVE	_DBCC1A612P.CID

ETHERNET ADAPTERS						
LAN2	**BOND_ETHBOND**	128.127.50.152	00:E0:AB:02:98:36	DHCP ON	Type[6]	GATEWAY:[128.127.0.102]

That corresponds to firmware versions, network adapter data, boot data, which can be displayed in web page (HTML) format or in downloadable text file (TXT) format.

Also, information on the active MMS connections (MMS clients), a list of internal signals and their value in IEC61850 standard format with their actual description is provided.

Generated oscillograms (DAT and CFG files) can be displayed and downloaded from the link.

Also, the active CID will be available, which can be downloaded from the link.

3.15.6.e Communications Port Configuration

Relays with IEC61850 communications use Ethernet network, using TCP/IP protocol for MMS communications (used to pack network data). Therefore, regardless of the physical medium and the connection (fiber, copper, etc.) the IP used by the relay in the network must be configured. For this, knowing the type of Ethernet redundancy implemented in each relay is vital, there being currently three possibilities:

- **No redundancy**

The relay is provided with 2 separate network adapters with different MAC address and different IP address. Both adapters are independent, it being possible to access the MMS data through both adapters. GOOSE messages will be sent and received only through one of the two adapters.

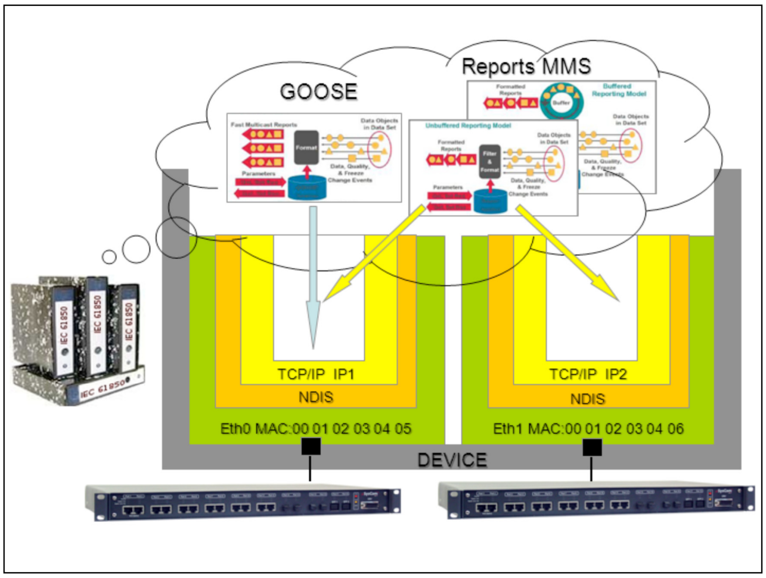


Figure 3.15.1 Configuration of Communications Ports for Relays without Ethernet Redundancy.

- **Bonding Type Redundancy**

The relay is provided with 2 network adapters both operating with the same MAC address and the same IP address, only one of them being active as a function of the medium detection (a broken connection to the adapter results in switching to the other adapter that has a good connection). Both MMS data and GOOSE messages will be sent and received only by the active adapter.

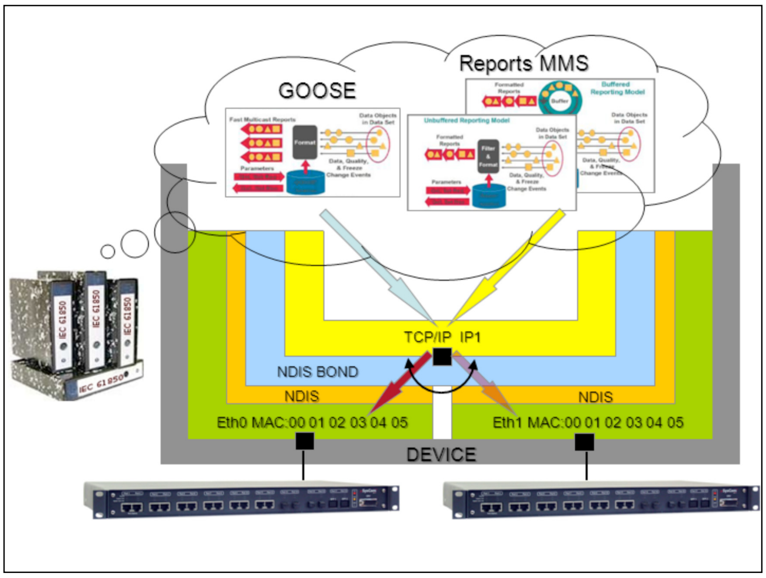


Figure 3.15.2 Configuration of Communications Ports for Relays with Bonding Type Redundancy.

- **PRP Type Redundancy**

The relay is provided with 2 network adapters both operating with the same MAC address and the same IP address, both adapters being active at any time and sending the same data through both adapters using the IEC 62439-3 protocol Parallel Redundancy Protocol (PRP).

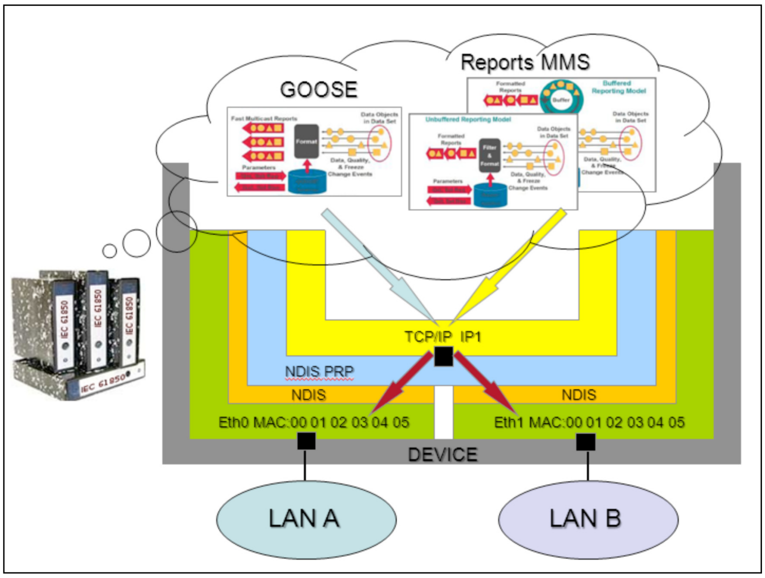


Figure 3.15.3 Configuration of Communications Ports for the Relay with PRP Type Redundancy.

This protocol is based on connecting the relays to two separate Ethernet networks (LAN), not connected to each other. The same data are sent through both adapters at the same time, adding 6 bytes to each Ethernet frame for the PRP protocol. These bytes enable discarding duplicate data, as the same data are received through both adapters and the idea is discarding the duplicate packet at the lowest possible level within the communications stack. The relay will send PRP supervision frames periodically (multicast) to enable system monitoring. Both MMS data and GOOSE messages will be sent through both adapters at the same time.

- **RSTP Type Redundancy**

The relay includes 2 network adapters, both operating with the same MAC address and the same IP address, and both adapters are active at all times. Relays define, together, the optimal path to send messages opening the ring to prevent loop formation. Also, they reconfigure the path when some type of relay or link failure occurs.

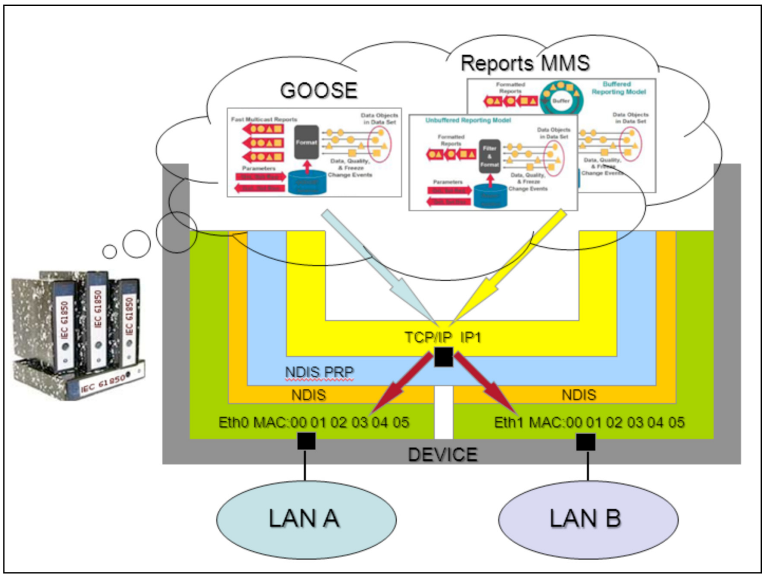


Figure 3.15.4 Configuration of Communications Ports for Relays with RSTP Type Redundancy

RSTP type redundancy is based on connecting relays with each other with single ring, star or star-ring instead of using switches. The relays themselves are in charge of defining and opening the ring, as well as deleting messages from the same preventing their indefinite recirculation.

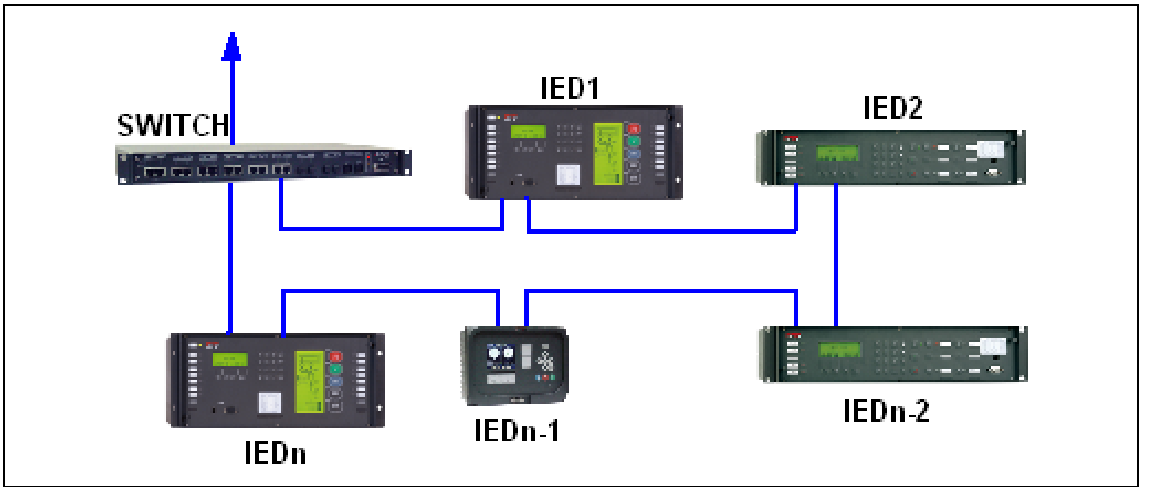


Figure 3.15.5 Example of Connecting Relays with RSTP Redundancy with Simple Ring

Relays **RTV-***-*****1*****, **RTV-***-*****2***** and **RTV-***-*****3***** have no Ethernet redundancy, so they are provided with 2 physical ports with separate IPs, thus separate configuration settings. They will have the following settings per adapter:

- IP Address.
- DHCP Enable.
- Default Gateway.
- Network Mask.
- DNS Address.

RTV-*-*****0***** Model settings are described below.

- **Goose Channel** (**Ethernet Channel 1** - **Ethernet Channel 2**): it selects the Goose message transmission / reception channel in IEC-61850.
- **Input Gooses**. The following settings are available within each IED:
  - **Subscription data**:
    Input Goose (from **1** to **32**):
    - Goose ID (Up to 65 characters): Input Goose identifier.
    - Goose CB ref (Up to 64 characters).
    - MAC Address (00.00.00.00.00.00 - FF.FF.FF.FF.FF.FF): Ethernet card address.
    - AppID (0 – 16383).
  - **Connections with Logic Inputs**:
    Logic Input Goose (from **1** to **32**):
    - Associated Goose: Input Goose from 1 to 32.
    - Object number (0 - 1024).
  - **Output Goose**.
    Goose Out Enable (YES / NO): it enables output Gooses.
    Goose Out ID (up to 65 characters): output Goose identifier.
    MAC Address (01.0C.CD.01.00.00 - 01.0C.CD.01.01.FF).
    Priority (0 -1).
    VID (0 - 4095).
    App. ID (0 - 16383).
    Revision (0 - 999999999).
    First Retry Timer (1 - 100 ms).
    Retry Time Multiplier (1 - 100).
    Maximum Retry Time (0.1 - 30 s).

RTV-*-*****2***** and **RTV-***-*****3***** relays do not include most of these settings, as they are used for Gooses configuration, configuration file IEC 61850 (**CID**).

The following settings can still be defined:

- **Goose Channel** (**Channel Ethernet 1** - **Channel Ethernet 2**): selects Goose message transmission / reception channel according to IEC-61850.
- **Output Goose**.
  - **Goose Out Enable**(YES / NO): enables output Gooses.

Relays **RTV-***-*****4***** count on Bonding type redundancy, whereby they have 2 physical ports with only one IP with only one set of setting:

- IP Address.
- DHCP Enable.
- Default Gateway.
- Network Mask.
- DNS Address.

Since there is no setting to configure the GOOSE send / receive channel, as it always occurs through the active adapter, it incorporates only the following setting:

- **Output Goose**.
  - **Goose Out Enable** (YES / NO): it enables output Gooses.

It also includes a setting to configure the medium switching time (from 25 to 1000 ms).

Models **RTV-***-*****6** or higher implement different types of redundancy. They will have a setting to configure this mode of redundancy:

- If no redundancy is selected (**No Redundancy**), they will have 2 physical ports with separate IPs, thus, separate configuration settings. They will have the following settings per adapter:

○ IP Address.	○ Network Mask.
○ DHCP Enable.	○ DNS Address.
○ Default Gateway.	

The following settings can also be defined:

- ○ **Goose Channel** (**Channel Ethernet 1** - **Channel Ethernet 2**): selects Goose message transmission / reception channel according to IEC-61850.
- ○ **Output Goose**.
  - ▪ **Goose Out Enable**(YES / NO): enables output Gooses.

- If Bonding type redundancy is selected (**Bonding Redund.**), they will have 2 physical ports with only one IP and only one set of settings:

○ IP Address.	○ Network Mask.
○ DHCP Enable.	○ DNS Address.
○ Default Gateway.	

As there is no setting to configure the GOOSE send / receive channel, as it always is produced through the active adapter, they incorporate the following settings:

- ○ **Output Goose**.
  - ▪ **Goose Out Enable**(YES / NO): enables output Gooses.
- ○ **Channel Status Time Delay** (1 – 60 s): time without medium detection to indicate the channel is down.
- ○ **Link Check Interval** (25 – 500 ms): time to determine that no medium is available switching to the other adapter.

- If PRP type redundancy is selected (**PRP Redund.**), it will have 2 physical ports with only one IP and only one set of settings:

○ IP Address.	○ Network Mask.
○ DHCP Enable.	○ DNS Address.
○ Default Gateway.	

As there is no setting to configure the GOOSE send / receive channel, as it is always produced through both adapters, they have the following settings:

- ○ **Output Goose**.
  - ▪ **Goose Out Enable**(YES / NO): enables output Gooses.
- ○ **Channel Status Time Delay** (1 - 60 s): time without receiving frames to indicate that the channel is down.
- ○ **Transmission Time of Supervision Frames** (0 - 30000): send interval of PRP supervision frames.
- ○ **LSB of Supervision Frame Destination MAC Address** (0 - 255): last octet of the PRP supervision frame destination MAC (destination MAC address will be 01-15-4E-00-01-XX).

- In case of **RTSP** type redundancy, the relay will be provided with 2 physical ports with only one IP and with only one set of settings as for Bonding type redundancy. All settings related to the switch, VLANes, priorities, etc., will be available through the web server from the moment when the relay setting is selected as **RSTP** and the relay has been booted. In this way, access can be gained to the settings below through the web server:

    - ***Version***: operation with protocol RSTP or STP.
    - ***Bridge Priority***: node priority.
    - ***Max Age***, ***Hello Time***, ***Forward Delay***: timers of the protocol RSTP itself (seconds).
    - ***Tx Hold Count***: maximum burst of messages sent per second.
    - For each port:
        - ***Priority***: priority.
        - ***Cost***: link cost.
        - ***Edge*** (On, Off, Auto): port with a host connected to it.
        - ***PtP*** (On, Off, Auto): point to point.
        - ***Edge Tx Filter***: deletion of Tx in case of an Edge port.

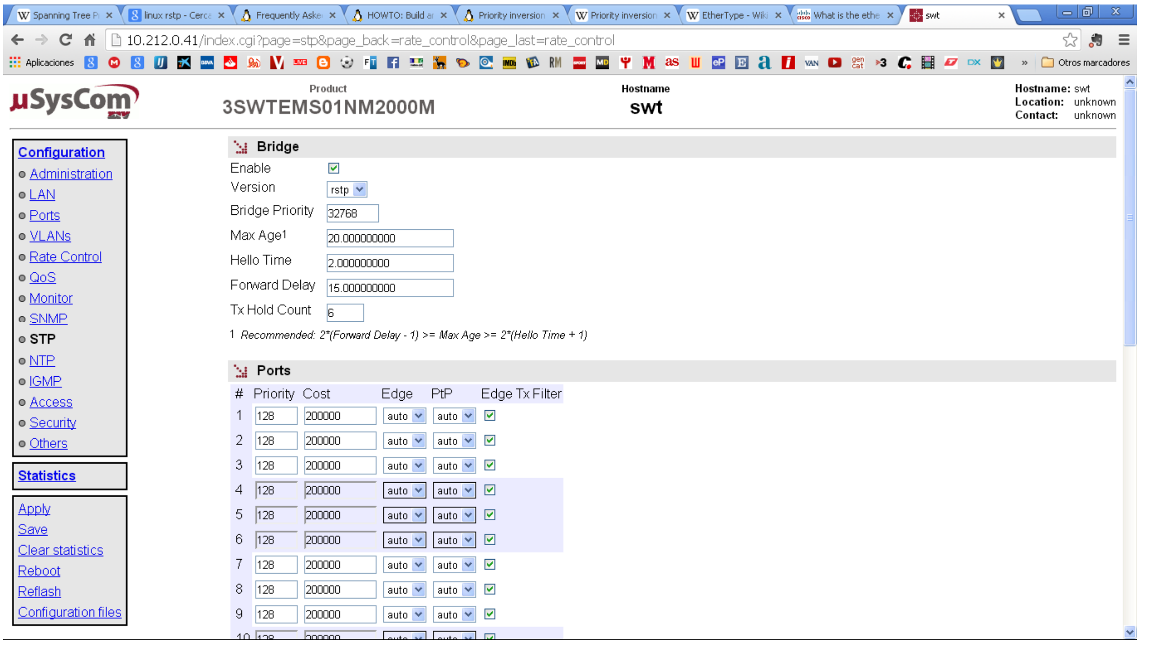


Figure 3.15.6 Image of the RSTP Settings available in the Web Server.

3.15.6.f FTP Access

The FTP access will allow having a number of equipment folders available. There will be different folders as a function of the user and password:

For IEC61850 versions previous tan the 7.7R, logging in as user: *info* and password: *info*, a directory structure similar to the one on the right will be displayed.

For IEC61850 versions equals or higher than the 7.7R the level of security has increased and a username and password to perform the loading of a CID and thus to change the control settings and protection settings will be necessary. In the same way, with the appropriate username and password, you can access to a directory in which you will only be able to copy a new CID (see Changing CID Configuration File section). For the user and password, please contact the manufacturer.

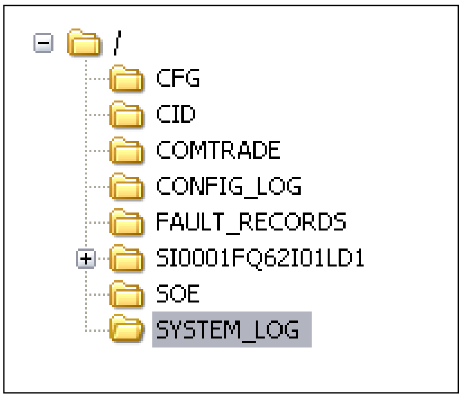


Figure 3.15.7 Directory Structure.

These are read-only folders and the information can be downloaded.

Directories will contain the same data provided by the web server: Boot data, active CID, oscillogram files, etc.

3.15.6.g CID Configuration File

The equipment includes a file (**CID**) in **IEC61850** standard format according to part 6 (SCL). This file allows knowing the equipment data model in node, data and attribute format.

Also, it allows to configure GOOSE message parameters, receive other GOOSES, create datasets and assign them to Reports, edit settings, change the control logic, descriptions, parameters, etc.

This file can be edited through a SCL file editing program, the ***ZiverCID***®.

This program allows configuring this file to be sent later to the equipment through FTP or USB port.

- **Loading the CID trough FTP**

In order to gain access to the equipment through FTP an FTP client program is required. The Windows browser itself allows making an FTP to the equipment address. For this, enter the equipment IP address in the Address bar in the following way:

For IEC61850 versions previous tan the 7.7R, the **CID** configured can be copied to the FTP root directory without entering user and password, as write access is gained only to the directory NotValidated. For IEC61850 versions higher than the 7.7R, the level of security has increased and a username and password to perform the action.

The equipment will validate the **CID**, that is, checks it is a correct SCL and the CID IP coincide with the IP configured in the equipment). After a certain version IEC61850 also checks that the IED matches the relay model that is within the CID.

Once it has been validated, the equipment carries out a backup and reboot process, rebooting communications and using a new **CID**. If the **CID** fails validation it will be rejected and deleted from the directory, and it will continue to operate in the normal way with the already loaded **CID** without ever losing communications.

If problems arise during loading the new **CID** (control reconfiguration process or loading protection settings), the relay will display a screen that will allow recovering the previous **CID** (refer to the errors section).

- **Loading the CID through USB by means of a Pendrive**

To load a new **CID** to the equipment through the HMI USB, an empty Pendrive is needed to copy the new CID to the root directory.

With the equipment fully booted and from the home screen, insert the Pendrive and wait for it to be detected.

Then confirmation to copy is requested.

COPY CID
_RTVP4N104K.cid
CONFIRM COPY
YES NO

Confirm by pressing F1.

REMOVE PENDRIVE
COPY OK

When removing the Pendrive, the equipment will copy the **CID** to a temporary directory (NotValidated directory) where it will be validated (it will check it is a correct SCL and **CID** IP matches that of the equipment).

VALID CID
VALIDATE CID

For versions higher than the 7.7R the level of security has increased and a password to perform the loading of a new CID will be necessary.

Once it has been validated, the equipment carries out a backup and reboot process, rebooting communications and using the new **CID**. If the **CID** fails validation it will be rejected and deleted from the directory, and it will continue to operate in the normal way with the already loaded **CID** without ever losing communications.

If problems arise during loading the new **CID** (control reconfiguration process or loading protection settings), the relay will display a screen that will allow recovering the previous **CID** (refer to the errors section).

If the USB contains more files or directories apart from the **CID,** the relay will display the message below, refusing to load:

REMOVE PENDRIVE
ONLY ONE FILE IN

- **Backup**

For a backup protection of the relay data, namely, obtaining the CID, logs, oscillograms and other data, the methods below can be used

- FTP with access as user: *info* and password: **info** (refer to FTP access section)
- Web server (refer to section)
- USB. With the relay booted and with no error messages displayed on the screen, insert an empty USB in the relay to automatically copy the active CID. Then, three screens will be displayed giving the user the option to download the rest of the data:

COPY OSCILOS
CONFIRM COPY
YES NO

COPY REPORTS
CONFIRM COPY
YES NO

COPY SYSLOGS
CONFIRM COPY
YES NO

- **CID Load by Frontal Port**

CID file can be also loaded by the frontal serial port of the IED using the configuration tool ***ZIV e-NET TOOL*** (available depending on model selection).

- **Errors**

During equipment configuration, actions may be carried out resulting in errors that can be identified and corrected.

- **Switching the equipment off during the process of CID write to a Flash memory**: during operation, the equipment writes the CID to Flash type non volatile memory.

!WRITING CID!
DO NOT POWER OFF

  If during this process, the equipment is switched off, it is likely that the CID copied to the Flash is lost. In this case, in the next boot up the type of message below will be displayed on the screen, **_RTVP4N104K.CID** being the active **CID** file.

IEC [6.0R]
!ERROR!:[0100]
_RTVP4N104K.CID
YES RESTORE CID? NO

  For a few seconds, it will be possible to recover the backup copy of the **CID** available in the equipment just before the settings were last changed. The equipment will offer the same option after an incomplete attempt to load a new **CID**.

  If F1 is pressed to recover the **CID**, the equipment will use this backup copy to boot up. If F4 or no key is pressed, the equipment will remain waiting for a new CID through any of the **CID** loading methods (FTP or USB).

- **In case of multiple undue shutdowns** (e.g. shutdown after CID recovery), the backup copy of the CID could also be lost. In this case the message on the right will be displayed, waiting for a new **CID** to be introduced by any of the **CID** loading methods (FTP or USB).

IEC [6.0R]
!ERROR!:[0100]
-------.CID

- **100000 Alarm**. This means there is a problem with IEC61850 communications that does not affect the protection and control function.
  In this case, please contact the technical service to identify the nature of the failure.

ZIV/RTV
[ALARMS:00100000]
17/04/10 22:49:02

3.15.6.h Code Errors

- **HMI of the relay**

ERROR CODE	DESCRIPTION
0x00003010	General error generated while loading the Data Model of the relay. Reasons: the CID file does not match the relay model, the CID version does not match the FW version of the relay…
0x00003020	IDS does not match the relay model. Reason: the IEC 61850 FW relay model and version does not match the protection FW relay model and version.
0x00003060	Error in the GOOSE subscription configuration. Reason: there is any kind of error in the GIGGIO logical node (setRef or intAddr). Check the webser log, it indicates exactly where the problem is.
0x00003070	Error in RFC1006.CFG file. Reason: IEC 61850 FW error, this file belongs to the set of files of the FW and it is loaded to the relay when updating the FW.
0x00003080	Error in the interface version of the relay. Reason: IEC 61850 FW error.
0x00003011	Error when loading a new CID file. Reason: the control logic inside the CID file has any kind of error.
0x00003200	Error in IRQs of DPRAM. Reason: IEC 61850 and/or protection FW error.

- **Webserver**

TEXT	DESCRIPTION
ERROR_SUSGOOSE	Error in the GOOSE subscription configuration.
ERROR_CFGPERFIL	Error while loading the Data Model of the relay.
ERROR_CFGLOG	Error when asking for the information of the control logic which is loaded in the relay.
ERROR_MEMCFGLOG	Error when reserving memory for the control logic configuration.
ERROR_CFGLOGREAD	Error when reading the control logic nodes loaded.
ERROR_VER_PERFIL	Error in the compatibility of the profiles loaded.
ERROR_DB_REFNVL	Error in the generation of Data Sets.
ERROR_CFGERROR	Error while mapping the Data Model.
ERROR_CRC_PERFIL	Error in the CRC.
ERROR_OPENPERFIL	Error when opening the profile.
ERROR_RUN_SRVCOMPRESS	Error when executing the compression server.
ERROR_OPEN_CID	Error when opening or Reading the CID file.
ERROR_HEAD_CID	Error when reading the head of the CID file.
ERROR_IED_NAME_CID	Error when reading the IED name in the CID file.
ERROR_DATASET_ITEM_CID	Error when reading elements of a Data Set.
ERROR_RCB_CID	Error when reading the list of RCBs.
ERROR_GOOSE_ID_CID	Error when reading the elements of a GOOSE.
ERROR_READ_SP_CID	Error when reading the data of a SP.
ERROR_WRITE_SP_CID	Error when writing data of a SP.
ERROR_WRITE_PRM_REV_CID	Error when writing the ParamRev in the CID.
ERROR_RTV_RD_CID	Error when reading protection settings.
ERROR_RTV_WR_CID	Error when writing protection settings.
ERROR_HEAD_LOGICA	Error when reading data of the control logic from the CID.

TEXT	DESCRIPTION
ERROR_READ_CF_CID	Error when reading the CF values from CID.
ERROR_CACHE_CID	Error when generating the copy in RAM of the CID once uncompressed.
ERROR_CONNECT_AP_IP	Error when read in the IP address from CID.
ERROR_ATTR_IN_CID	There is one (or more) elements in one Data Set whose reference does not exist (it is located in no logical node).
ERROR_LCB_CID	Error when Reading data of LCB.
ERROR_CREATE_MAPLOG	Error when generating the MAPLOG.BIN file.
ERROR_READ_PRM_REV_CID	Error when Reading the ParamRev of the CID.
ERROR_GEN_LOG_CID	Error when generating the control logic.
ERROR_EXTRACT_LOG_CID	Error when extracting the files of the control logic.
ERROR_CONF_LOG_CID	Error in the control configuration loaded to the relay.
ERROR_APIXML_INIT	Error when initialization the XML library

3.15.6.i PROCOME, DNP3 and MODBUS Protocols on IEC-61850 Ports

RTV--*******N** relays can communicate through LAN1 and LAN2 ports with IEC61850, PROCOME, MODBUS and DNP v3.0. TCP/IP ports for these communications links are allocated to the following values and cannot be configured:

- PROCOME: port 32001.
- MODBUS: port 502.
- DNP v3.0: port 20000.

This does not affect to the port selection for other physical ports (local port, remote ports 1-3).

RTV--*******P** relays include five communications instances for other than IEC61850 protocols through LAN IEC61850 ports. One instance is always PROCOME (proprietary protocol) and the other four can be configured to communicate with DNP3.0 or MODBUS simultaneously (the same protocol can be selected for the four instances).

TCP/IP ports for these communications links will be configurable, except the proprietary protocol, PROCOME, which will have fixed TCP/IP port (32001).

This does not affect to the port selection for other physical ports (local port, remote ports 1-3).

3.15.7 CAN Communications Protocol

3.15.7.a Introduction

In view of the large number of signals acquired and controlled in power substations, remote real time device inputs and outputs must be connected via high speed serial communication protocols, so as to reduce the cost and simplify the hard wiring in the power substation environment.

The above is achieved through the communication of **ZIV** Master Relays with other Slave Relays using the CAN protocol, this way increasing the number of inputs and outputs available in **ZIV** Master Relays, said signals behaving as if they were internal to **ZIV** Master Relay.

3.15.7.b General Data

- **Physical Level**

Description	Value
Can Version	2.0b
Baud Rate	125 kbits
Bit Time	8 micro s
Maximum Distance	500 meters
Id Size	11 bits

When CAN 2.0b with 16 bit ID messages are transmitted the following bits corresponding to the extended CAN are sent:

- RTR to 1 (recessive).
- r0 to 1(recessive).
- r1 1 0(dominant).

All transmitted messages are acknowledged by writing one dominant bit of the first of the two recessive bits sent by the transmitter in the acknowledge field.

NRZ bits coding (Non-Return-to-Zero).

In data frames with 5 consecutive bits, a sixth bit with opposite sign is inserted.

CAN bus electrical characteristics are defined in ISO 11898.

- **Link Level**

It uses media access CSMA/CD+CR (Carrier Sense Multiple Access Collision Resolution).

- In Ethernet (CSMA), upon a collision, all messages are lost.
- In CAN (CSMA/CD+CR), upon a collision, the highest priority message survives (defined by dominant bits).

The state of a node can be Active, Passive or Cancelled as a function of errors detected.

- **Application Level**

The Application Layer uses an optimized protocol for power substation Protection and Control applications, with messages of 1 to 8 bytes.

Implemented protocol messages are used to achieve the following functions:

- **LOGIN Message**. Allows the **ZIV** Master Relay to know the availability of Slave Relays.
- **CHANGE Message**. Allows the **ZIV** Master Relay to receive spontaneously the state of Slave Relay inputs and outputs.
- **READ Message**. Allows the **ZIV** Master Relay to request the state of Slave Relay inputs and outputs.
- **TICK Message**. Allows the **ZIV** Master Relay to synchronize with Slave Relays.
- **DIGITAL OUTPUT WRITE Message**. Allows the **ZIV** Master Relay to send the state of digital outputs to Slave Relays.
- **SETTINGS WRITE Message**. Allows the **ZIV** Master Relay to send the Settings value to Slave Relays.

3.15.7.c Digital Inputs of the CAN Function

Table 3.15-2: Digital Inputs of the CAN Function

Name	Description	Function
RDO_1	Remote digital output 1	Activates said remote digital output in the CAN port.
RDO_2	Remote digital output 2	
RDO_3	Remote digital output 3	
RDO_4	Remote digital output 4	
RDO_5	Remote digital output 5	
RDO_6	Remote digital output 6	
RDO_7	Remote digital output 7	
RDO_8	Remote digital output 8	
RDO_9	Remote digital output 9	
RDO_10	Remote digital output 10	
RDO_11	Remote digital output 11	
RDO_12	Remote digital output 12	
RDO_13	Remote digital output 13	
RDO_14	Remote digital output 14	
RDO_15	Remote digital output 15	
RDO_16	Remote digital output 16	

3.15.7.d Auxiliary Outputs of the CAN Function

Table 3.15-3: Auxiliary Outputs of the CAN Function

Name	Description	Function
RIN_1	Remote digital input 1	Activates said remote digital input in the CAN port.
RIN_2	Remote digital input 2	
RIN_3	Remote digital input 3	
RIN_4	Remote digital input 4	
RIN_5	Remote digital input 5	
RIN_6	Remote digital input 6	
RIN_7	Remote digital input 7	
RIN_8	Remote digital input 8	
RIN_9	Remote digital input 9	
RIN_10	Remote digital input 10	
RIN_11	Remote digital input 11	
RIN_12	Remote digital input 12	
RIN_13	Remote digital input 13	
RIN_14	Remote digital input 14	
RIN_15	Remote digital input 15	
RIN_16	Remote digital input 16	
RIN_17	Remote digital input 17	
RIN_18	Remote digital input 18	
RIN_19	Remote digital input 19	
RIN_20	Remote digital input 20	
RIN_21	Remote digital input 21	
RIN_22	Remote digital input 22	
RIN_23	Remote digital input 23	

Table 3.15-3: Auxiliary Outputs of the CAN Function		
Name	**Description**	**Function**
RIN_24	Remote digital input 24	Activates said remote digital input in the CAN port.
RIN_25	Remote digital input 25	
RIN_26	Remote digital input 26	
RIN_27	Remote digital input 27	
RIN_28	Remote digital input 28	
RIN_29	Remote digital input 29	
RIN_30	Remote digital input 30	
RIN_31	Remote digital input 31	
RIN_32	Remote digital input 32	
VAL_RIN_1	Validity of remote digital input 1	Activates said validity of remote digital input.
VAL_RIN_2	Validity of remote digital input 2	
VAL_RIN_3	Validity of remote digital input 3	
VAL_RIN_4	Validity of remote digital input 4	
VAL_RIN_5	Validity of remote digital input 5	
VAL_RIN_6	Validity of remote digital input 6	
VAL_RIN_7	Validity of remote digital input 7	
VAL_RIN_8	Validity of remote digital input 8	
VAL_RIN_9	Validity of remote digital input 9	
VAL_RIN_10	Validity of remote digital input 10	
VAL_RIN_11	Validity of remote digital input 11	
VAL_RIN_12	Validity of remote digital input 12	
VAL_RIN_13	Validity of remote digital input 13	
VAL_RIN_14	Validity of remote digital input 14	
VAL_RIN_15	Validity of remote digital input 15	
VAL_RIN_16	Validity of remote digital input 16	
VAL_RIN_17	Validity of remote digital input 17	
VAL_RIN_18	Validity of remote digital input 18	
VAL_RIN_19	Validity of remote digital input 19	
VAL_RIN_20	Validity of remote digital input 20	
VAL_RIN_21	Validity of remote digital input 21	
VAL_RIN_22	Validity of remote digital input 22	
VAL_RIN_23	Validity of remote digital input 23	
VAL_RIN_24	Validity of remote digital input 24	
VAL_RIN_25	Validity of remote digital input 25	
VAL_RIN_26	Validity of remote digital input 26	
VAL_RIN_27	Validity of remote digital input 27	
VAL_RIN_28	Validity of remote digital input 28	
VAL_RIN_29	Validity of remote digital input 29	
VAL_RIN_30	Validity of remote digital input 30	
VAL_RIN_31	Validity of remote digital input 31	
VAL_RIN_32	Validity of remote digital input 32	

Table 3.15-3: Auxiliary Outputs of the CAN Function

Name	Description	Function
RDO_1	Remote digital output 1	Activates said remote digital output in the CAN port.
RDO_2	Remote digital output 2	
RDO_3	Remote digital output 3	
RDO_4	Remote digital output 4	
RDO_5	Remote digital output 5	
RDO_6	Remote digital output 6	
RDO_7	Remote digital output 7	
RDO_8	Remote digital output 8	
RDO_9	Remote digital output 9	
RDO_10	Remote digital output 10	
RDO_11	Remote digital output 11	
RDO_12	Remote digital output 12	
RDO_13	Remote digital output 13	
RDO_14	Remote digital output 14	
RDO_15	Remote digital output 15	
RDO_16	Remote digital output 16	

3.15.8 Virtual Inputs / Outputs

Virtual inputs / outputs function allows the bidirectional transmission of up to 16 digital signals and 16 analog magnitudes between two **RTV** relays connected through a digital communications system. Said function allows programming logic functions of local and remote information whether analog or digital.

Among the main applications of virtual inputs / outputs is the optimizing of teleprotection schemes: they reduce digital signal transfer time between terminals, give more security in said transfer, allow exchanging a greater number of signals, etc.

The exchange of information between relays is made through frames sent every 2 ms, which include 16 digital signals and ½ analog magnitude. It is apparent that the transmission speed of the 16 digital signals is very high, as they are considered high priority signals; so that they can be used within teleprotection schemes.

The virtual inputs / outputs function allows detecting communication failure that generate errors in the frame contents (some of which are corrected by using a redundancy code) or errors in the frame reception sequence. The number of errors detected is recorded by a counter that resets after the **Error Detection Period** time setting. There is an input exists to reset this counter.

Depending on the model, relay rear ports Remote 1 and Remote 2 can be configured as virtual inputs / outputs ports. To this end, **Protocol Selection** setting of this port must be set to Virtual Inputs / Outputs.

Once the protocol Virtual Inputs / Outputs has been selected for one of the ports, the relay ignores all settings associated to said port shown in the Communications field, and only the settings introduced into the Inputs / Outputs field are considered as settings of the port selected as virtual.

Virtual inputs and outputs are configured exactly the same as for digital inputs and outputs, through the programmable logic incorporated into the ***ZivercomPlus***® program.

3.15.8.a Virtual Port 1

Virtual Port 1 settings:

- **Enable**: enables virtual inputs / outputs function for this port.
- **Baud Rate**: a value from 9600 to 115200 bauds can be selected, default value being 9600 bauds.
- **Error detection period**: time after which the communications error counter is reset.
- **Time Out**: time without receiving a complete frame before a communications error is generated.
- **CTS flow** (NO / YES): it specifies whether the Clear to Send signal is monitored for data transmission flow control. If it set to YES and the CTS signal falls to “0”, the transmission is interrupted until the CTS signal is reset.
- **DSR flow** (NO / YES): it specifies whether the Data Set Ready signal is monitored for data transmission flow control. If it set to YES and the DSR signal falls to “0”, the transmission is interrupted until the DSR signal is reset.
- **DSR Sensitive** (NO / YES): it specifies whether the communications port is sensitive to DSR signal state. If it is set to YES, the communications driver ignores any bit received unless the DSR line is active.
- **DTR Control** (Inactive/ Active/ Enable Send):
  Inactive: sets DTR control signal to permanent inactive state.
  Active: sets DTR control signal to permanent active state.
  Enable Send: DTR signal remains enabled while receiving new characters is allowed.
- **DTR Control** (INACTIVE / ACTIVE / ENABLE SEND):
  Inactive: It sets the DTR control signal to permanently inactive.
  Active: It sets the DTR control signal to permanently active.
  Enable Send: The DTR signal remains active as long as the receiving of new characters is allowed.
- **RTS Control** (INACTIVE / ACTIVE / ENABLE SEND / SOL. SEND):
  Inactive: It sets the RTS control signal to permanently inactive.
  Active: It sets the RTS control signal to permanently active.
  Enable Send: The RTS signal remains active as long as the receiving of new characters is allowed.
  Solicit Send: The RTS signal remains active as long as there are characters pending transmission.

3.15.8.b Virtual Port 2

Virtual port 2 settings:

- **Enable**: enables virtual inputs / outputs function for this port.
- **Baud Rate**: a value from 9600 to 115200 bauds can be selected, default value being 9600 bauds.
- **Error Detection Period**: time after which the communications error counter is reset.
- **Time Out**: time without receiving a complete frame before a communications error is generated.

3.15.8.c Virtual Measurements

Virtual magnitudes corresponding to rear ports Remote 1 and Remote 2 can also be configured in the Inputs / Outputs field, and any of the magnitudes calculated by the relay can be selected, including the magnitudes calculated into the programmable logic through the ***ZivercomPlus***® program.

3.15.8.d Digital Inputs of the Virtual Inputs / Outputs Function

Table 3.15-4: Digital Inputs of the Virtual Inputs / Outputs Function		
Name	**Description**	**Function**
RST_CO_ERR1	Error counter 1 reset	Activation of this input resets the communications error counter associated to port 1.
RST_CO_ERR2	Error counter 2 reset	Activation of this input resets the communications error counter associated to port 2.
OUT_VIR1_1	Virtual digital output_1 1	Activates said virtual digital output of port 1.
OUT_VIR1_2	Virtual digital output_1 2	
OUT_VIR1_3	Virtual digital output_1 3	
OUT_VIR1_4	Virtual digital output_1 4	
OUT_VIR1_5	Virtual digital output_1 5	
OUT_VIR1_6	Virtual digital output_1 6	
OUT_VIR1_7	Virtual digital output_1 7	
OUT_VIR1_8	Virtual digital output_1 8	
OUT_VIR1_9	Virtual digital output_1 9	
OUT_VIR1_10	Virtual digital output_1 10	
OUT_VIR1_11	Virtual digital output_1 11	
OUT_VIR1_12	Virtual digital output_1 12	
OUT_VIR1_13	Virtual digital output_1 13	
OUT_VIR1_14	Virtual digital output_1 14	
OUT_VIR1_15	Virtual digital output_1 15	
OUT_VIR1_16	Virtual digital output_1 16	
OUT_VIR2_1	Virtual digital output_2 1	Activates said virtual digital output of port 2.
OUT_VIR2_2	Virtual digital output_2 2	
OUT_VIR2_3	Virtual digital output_2 3	
OUT_VIR2_4	Virtual digital output_2 4	
OUT_VIR2_5	Virtual digital output_2 5	
OUT_VIR2_6	Virtual digital output_2 6	
OUT_VIR2_7	Virtual digital output_2 7	
OUT_VIR2_8	Virtual digital output_2 8	
OUT_VIR2_9	Virtual digital output_2 9	
OUT_VIR2_10	Virtual digital output_2 10	
OUT_VIR2_11	Virtual digital output_2 11	
OUT_VIR2_12	Virtual digital output_2 12	
OUT_VIR2_13	Virtual digital output_2 13	
OUT_VIR2_14	Virtual digital output_2 14	
OUT_VIR2_15	Virtual digital output_2 15	
OUT_VIR2_16	Virtual digital output_2 16	

3.15.8.e Auxiliary Outputs of the Virtual Inputs / Outputs Function

Table 3.15-5: Auxiliary Outputs of the Virtual Inputs / Outputs Function

Name	Description	Function
VAL_DI1	Validity of virtual digital inputs 1	
VAL_AI1	Validity of virtual analog inputs 1	
VAL_DI2	Validity of virtual digital inputs 2	
VAL_AI2	Validity of virtual analog inputs 2	
IN_VIR1_1	Virtual Digital Input_1 1	Shows that said virtual input of port 1 is activated.
IN_VIR1_2	Virtual Digital Input_1 2	
IN_VIR1_3	Virtual Digital Input_1 3	
IN_VIR1_4	Virtual Digital Input_1 4	
IN_VIR1_5	Virtual Digital Input_1 5	
IN_VIR1_6	Virtual Digital Input_1 6	
IN_VIR1_7	Virtual Digital Input_1 7	
IN_VIR1_8	Virtual Digital Input_1 8	
IN_VIR1_9	Virtual Digital Input_1 9	
IN_VIR1_10	Virtual Digital Input_1 10	
IN_VIR1_11	Virtual Digital Input_1 11	
IN_VIR1_12	Virtual Digital Input_1 12	
IN_VIR1_13	Virtual Digital Input_1 13	
IN_VIR1_14	Virtual Digital Input_1 14	
IN_VIR1_15	Virtual Digital Input_1 15	
IN_VIR1_16	Virtual Digital Input_1 16	
IN_VIR2_1	Virtual Digital Input_2 1	Shows that said virtual input of port 2 is activated.
IN_VIR2_2	Virtual Digital Input_2 2	
IN_VIR2_3	Virtual Digital Input_2 3	
IN_VIR2_4	Virtual Digital Input_2 4	
IN_VIR2_5	Virtual Digital Input_2 5	
IN_VIR2_6	Virtual Digital Input_2 6	
IN_VIR2_7	Virtual Digital Input_2 7	
IN_VIR2_8	Virtual Digital Input_2 8	
IN_VIR2_9	Virtual Digital Input_2 9	
IN_VIR2_10	Virtual Digital Input_2 10	
IN_VIR2_11	Virtual Digital Input_2 11	
IN_VIR2_12	Virtual Digital Input_2 12	
IN_VIR2_13	Virtual Digital Input_2 13	
IN_VIR2_14	Virtual Digital Input_2 14	
IN_VIR2_15	Virtual Digital Input_2 15	
IN_VIR2_16	Virtual Digital Input_2 16	

Table 3.15-5: Auxiliary Outputs of the Virtual Inputs / Outputs Function		
Name	**Description**	**Function**
OUT_VIR1_1	Virtual digital output_1 1	Activates said virtual digital output of port 1.
OUT_VIR1_2	Virtual digital output_1 2	
OUT_VIR1_3	Virtual digital output_1 3	
OUT_VIR1_4	Virtual digital output_1 4	
OUT_VIR1_5	Virtual digital output_1 5	
OUT_VIR1_6	Virtual digital output_1 6	
OUT_VIR1_7	Virtual digital output_1 7	
OUT_VIR1_8	Virtual digital output_1 8	
OUT_VIR1_9	Virtual digital output_1 9	
OUT_VIR1_10	Virtual digital output_1 10	
OUT_VIR1_11	Virtual digital output_1 11	
OUT_VIR1_12	Virtual digital output_1 12	
OUT_VIR1_13	Virtual digital output_1 13	
OUT_VIR1_14	Virtual digital output_1 14	
OUT_VIR1_15	Virtual digital output_1 15	
OUT_VIR1_16	Virtual digital output_1 16	
OUT_VIR2_1	Virtual digital output_2 1	Activates said virtual digital output of port 2.
OUT_VIR2_2	Virtual digital output_2 2	
OUT_VIR2_3	Virtual digital output_2 3	
OUT_VIR2_4	Virtual digital output_2 4	
OUT_VIR2_5	Virtual digital output_2 5	
OUT_VIR2_6	Virtual digital output_2 6	
OUT_VIR2_7	Virtual digital output_2 7	
OUT_VIR2_8	Virtual digital output_2 8	
OUT_VIR2_9	Virtual digital output_2 9	
OUT_VIR2_10	Virtual digital output_2 10	
OUT_VIR2_11	Virtual digital output_2 11	
OUT_VIR2_12	Virtual digital output_2 12	
OUT_VIR2_13	Virtual digital output_2 13	
OUT_VIR2_14	Virtual digital output_2 14	
OUT_VIR2_15	Virtual digital output_2 15	
OUT_VIR2_16	Virtual digital output_2 16	

3.15.8.f Magnitudes of the Virtual Inputs / Outputs Function

Table 3.15-6: Magnitudes of the Virtual Inputs / Outputs Function		
Name	**Description**	**Units**
MV1 01	Virtual Quantity 1 for communication channel 1	Depend on the magnitude configurated
MV2 01	Virtual Quantity 2 for communication channel 1	Depend on the magnitude configurated
MV1 03	Virtual Quantity for communication channel 1	Depend on the magnitude configurated
MV1 04	Virtual Quantity 4 for communication channel 1	Depend on the magnitude configurated
MV1 05	Virtual Quantity 5 for communication channel 1	Depend on the magnitude configurated
MV1 06	Virtual Quantity 6 for communication channel 1	Depend on the magnitude configurated
MV1 07	Virtual Quantity 7 for communication channel 1	Depend on the magnitude configurated
MV1 08	Virtual Quantity for communication channel 1	Depend on the magnitude configurated
MV1 09	Virtual Quantity 9 for communication channel 1	Depend on the magnitude configurated
MV1 10	Virtual Quantity 10 for communication channel 1	Depend on the magnitude configurated
MV1 11	Virtual Quantity 11 for communication channel 1	Depend on the magnitude configurated
MV1 12	Virtual Quantity 12 for communication channel 1	Depend on the magnitude configurated
MV1 13	Virtual Quantity 13 for communication channel 1	Depend on the magnitude configurated
MV1 14	Virtual Quantity 14 for communication channel 1	Depend on the magnitude configurated
MV1 15	Virtual Quantity 15 for communication channel 1	Depend on the magnitude configurated
MV1 16	Virtual Quantity 16 for communication channel 1	Depend on the magnitude configurated
MV2 01	Virtual Quantity 1 for communication channel 2	Depend on the magnitude configurated
MV2 01	Virtual Quantity 2 for communication channel 2	Depend on the magnitude configurated
MV2 03	Virtual Quantity 3 for communication channel 2	Depend on the magnitude configurated
MV2 04	Virtual Quantity 4 for communication channel 2	Depend on the magnitude configurated
MV2 05	Virtual Quantity 5 for communication channel 2	Depend on the magnitude configurated
MV2 06	Virtual Quantity 6 for communication channel 2	Depend on the magnitude configurated
MV2 07	Virtual Quantity 7 for communication channel 2	Depend on the magnitude configurated
MV2 08	Virtual Quantity 8 for communication channel 2	Depend on the magnitude configurated
MV2 09	Virtual Quantity 9 for communication channel 2	Depend on the magnitude configurated

Table 3.15-6: Magnitudes of the Virtual Inputs / Outputs Function		
Name	**Description**	**Units**
MV2 10	Virtual Quantity 10 for communication channel 2	Depend on the magnitude configurated
MV2 11	Virtual Quantity 11 for communication channel 2	Depend on the magnitude configurated
MV2 12	Virtual Quantity 12 for communication channel 2	Depend on the magnitude configurated
MV2 13	Virtual Quantity 13 for communication channel 2	Depend on the magnitude configurated
MV2 14	Virtual Quantity 14 for communication channel 2	Depend on the magnitude configurated
MV2 15	Virtual Quantity 15 for communication channel 2	Depend on the magnitude configurated
MV2 16	Virtual Quantity 16 for communication channel 2	Depend on the magnitude configurated
N E FA 1	Cumulative number of fatal errors detected in analog frame in communication channel 1	
N E FA 2	Cumulative number of fatal errors detected in analog frame in communication channel 2	
N E FD 1	Cumulative number of fatal errors in communication channel 1	
N E FD 2	Cumulative number of fatal errors in communication channel 2	
N ERR C 1	Cumulative number of fatal errors detected and repaired in communication channel 1	
N ERR C 2	Cumulative number of fatal errors detected and repaired in communication channel 2	
ACUM ERR 1	Cumulative number of fatal errors detected in the last N seconds in communication channel 1	
ACUM ERR 2	Cumulative number of fatal errors detected in the last N seconds in communication channel 2	
T SIN ACT 1	Time without activity in communication channel 1	
T SIN ACT 2	Time without activity in communication channel 2	

3.15.9 Communications Settings

Local Port Communications			
Setting	**Range**	**Step**	**Default**
Baud Rate	300 - 38400 Baud		38400
Stop Bits	1 - 2		1
Parity	0: None 1: Even		0: None
RX Time Between Character	1 - 60000 ms	0.5 ms	40 ms
Communication Failure Indication Time	0 - 600 s	0.1 s	60 s

Remote Communications Port 1			
Setting	**Range**	**Step**	**Default**
Protocol Selection	0: PROCOME 1: DNP 3.0 2: MODBUS		0: PROCOME
Baud Rate	300 - 38400 Baud		38400 Baud
Stop Bits	1 - 2		1
Parity	0: None 1: Even 2: Odd		0: None
RX Time between Character	1 - 60000 ms	0.5 ms	40 ms
Communication Failure Indication Time	0 - 600 s	0.1 s	60 s
Advanced Settings			
Flow Control			
CTS Flow	0 (NO) - 1 (YES)		NO
DSR Flow	0 (NO) - 1 (YES)		NO
DSR Sensitive	0 (NO) - 1 (YES)		NO
DTR Control	0: Inactive 1: Active 2: Permit send		0: Inactive
RTS Control	0: Inactive 1: Active 2: Permit send 3: Solicit send		0: Inactive
Time			
Tx Time Factor	0 -100 characters	0.5	1
Tx Time Constant	0 - 60000 ms	1 ms	0 ms
Message Modification			
Number of Zeros	0 - 255	1	0
Collisions			
Type of Collision	0: NO 1: DCD 2: ECO		NO
Number of Retries	0 - 3	1	0
Minimum Retry Time	0 - 60000 ms	1 ms	0 ms
Maximum Retry Time	0 - 60000 ms	1 ms	0 ms

Remote Communications Port 2			
Setting	**Range**	**Step**	**Default**
Protocol Selection	0: Procome 1: DNP V3.0 2: Modbus		0: Procome
Baud Rate	300 - 38400 Baud		38400 Baud
Stop Bits	1 - 2		1
Parity	0: None 1: Even 2: Odd		0: None
RX Time Between Character	1 - 60000 ms	0.5 ms	40 ms
Communication Failure Indication Time	0 - 600 s	0.1 s	60 s
Advanced Settings			
Operation Mode	0: RS232 1: RS485		0: RS232
Time			
Tx Time Factor	0 -100 characters	0.5	1
Tx Time Constant	0 - 60000 ms	1 ms	0 ms
Number of 485 Stop Bytes	0 - 4 bytes	1 byte	0 bytes
Message Modification			
Number of Zeros	0 - 255	1	0
Collisions			
Type of Collision	0: NO 1: ECO		0: NO
Number of Retries	0 - 3	1	0
Minimum Retry Time	0 - 60000 ms	1 ms	0 ms
Maximum Retry Time	0 - 60000 ms	1 ms	0 ms

Remote Communications Ports 1, 2 and 3 Ethernet			
Setting	**Range**	**Step**	**Default**
Protocol Selection	PROCOME DNP 3.0 MODBUS Virtual Inputs / Outputs (*)		PROCOME
Enabling the Ethernet Port	NO / YES		YES
IP Address	ddd. ddd. ddd. ddd		192.168.1.151(PR1) 192.168.1.61(PR2) 192.168.1.71(PR3)
Net Mask	128.000.000.000 - 255.255.255.254		255.255.255.0
Port Number	0 - 65535	1	20000
Max. Time between Messages TCP	0 - 65 s	1	30
RX Car. Time	0 - 60000 ms	0.5 ms	1 ms
Communication fault indication time	0 - 600 s	0.1 s	60 s

(*) The Virtual Inputs / Outputs function is only for the Remote Port 2.

Communications Protocols			
Setting	**Range**	**Step**	**Default**
PROCOME Protocol			
IED Address	0 - 254	1	0
Communications Password Enable	YES / NO		NO
Communications Password Timeout	1 - 10 min	1	10 min
Communications Password	8 characters		
DNP 3.0 Protocol			
IED Address	0 - 65519	1	1
T. Confirm Timeout	100 - 65535 ms	1	1000 ms
Max. Retries	0 - 65535	1	0
Enable Unsolicited	YES / NO		NO
Unsolicited Start Enable	YES / NO		
Unsolic. Master No.	0 - 65519	1	1
Unsolic. Grouping Time.	100 - 65535 ms	1	1000 ms
Sync Interval	0 - 120 min	1	0 min
Unsolicited Start Activation	YES / NO		
DNP 3.0 Revision	Standard ZIV / 2003		
DNP 3.0 Protocol: Measurements (16 Deadband Measurements Change)	0.01 - 100	0.01	100
DNP 3.0 Profile II Protocol: Measurements (16 Deadband Measurements Change)	0.0001 - 100	0.0001	100
Digital Changes Class (DNP 3.0 Profile II and Profile II Ethernet)	CLASS 1 CLASS 2 CLASS 3 NONE		CLASS 1
Analog Changes Class (DNP 3.0 Profile II and Profile II Ethernet)	CLASS 1 CLASS 2 CLASS 3 NONE		CLASS 2
Counters Changes Class (DNP 3.0 Profile II and Profile II Ethernet)	CLASS 1 CLASS 2 CLASS 3 NONE		CLASS 3
Validity Status for Digital Inputs (DNP 3.0 Profile II and Profile II Ethernet)	YES / NO		YES
32 Bits Measurements (DNP 3.0 Profile II and Profile II Ethernet)	YES / NO		YES
Counters (max. 20) (DNP 3.0 Profile II and Profile II Ethernet)	1 - 32767	1	1
MODBUS Protocol			
IED Address	0 - 247	1	1

Communications Protocols			
Setting	**Range**	**Step**	**Default**
IEC-61850 Protocol			
Goose Channel	Ethernet Channel 1 Ethernet Channel 2		Ethernet Channel 1
Input Gooses			
Subscription data			
Input Goose (from 1 to 32)			
Goose ID	Up to 65 characters		
Goose CB ref	Up to 64 characters		
MAC Address	00.00.00.00.00.00 – FF.FF.FF.FF.FF.FF		00.00.00.00.00.00
AppID	0 - 16383	1	0
Connections with Virtual Input Gooses			
Virtual Input Goose (from 1 to 32):			
Associated Goose	Input Goose from 1 to 32		
Object number	0 - 1024	1	0
Output Goose			
Goose Out Enable	YES / NO		
Goose Out ID	Up to 65 characters		
MAC Address	01.0C.CD.01.00.00 - 01.0C.CD.01.01.FF		01.0C.CD.01.00.C1
Priority	0 - 1	1	0
VID	0 - 4095	1	0
App. D	0 - 16383	1	0
Revision	0 - 999999999	1	0
First Retry Timer	1 - 100 ms	1	4
Retry Time Multiplier	1 - 100	1	2
Maximum Retry Time	0.1 - 30 sc	0.01	10
IP			
IP Address	ddd.ddd.ddd.ddd		
DHCP Enable	YES / NO		YES
Default Gateway	ddd.ddd.ddd.ddd		
Network Mask	ddd.ddd.ddd.ddd		
DNS Address	ddd.ddd.ddd.ddd		

Communications Protocols			
Setting	**Range**	**Step**	**Default**
IEC-61850 Protocol			
SNTP			
SNTP enable	YES / NO		NO
Broadcast Synchronizing Enable	YES / NO		NO
Unicast Synchronizing Enable	YES / NO		NO
IP Address of Main SNTP Server	Ddd.Ddd.Ddd.Ddd		
IP Address of Secondary SNTP Server	Ddd.Ddd.Ddd.Ddd		
Time Delay of Unicast Validation	10 - 1000000 S	1 S	30 S
Time Delay of Unicast Error	10 - 1000000 S	1 S	30 S
Number of Connection Retries	1 - 10	1	3
Synchronizing Period	10 - 1000000 S	1 S	10 S
Period between Retries	10 - 1000000 S	1 S	10 S
Time Delay of Broadcast Validation	0 - 1000000 S	1 S	0 S
Time Delay of Broadcast Error	0 - 1000000 S	1 S	0 S
Maximum Synchronizing Time Difference	0 - 1000000 S	1 S	0 S
Ignore Synchronizing Leap Indicator	YES / NO		NO
Calculation of Synchronizing Status	Time delay Leap Indicator		Time delay
Ethernet			
Redundancy Mode	No Redundancy Bondng Redund. PRP Redund. RSTP Redund.		No Redundancy
Channel Status Time	1 - 60 s	1 s	5 s
Bonding			
Link Check Interval	25 - 500 ms	25 ms	100 ms
PRP			
Supervision Frame Send Interval	0 - 30000 ms	500 ms	2000 ms
LSB of Destination MAC for Supervision Frames	0 - 255	1	0

- **Communications: HMI Access**

0 - CONFIGURATION	0 - NOMINAL VALUES	**0 - PORTS**
1 - OPERATIONS	1 - PASSWORDS	**1 - PROTOCOLS**
2 - CHANGE SETTINGS	**2 - COMMUNICATIONS**	
3 - INFORMATION	3 - TIME AND DATE	
	4 - CONTRAST	
	5 - HMI DIAGRAM CONF.	

Ports / Local Port

0 - PORTS	**0 - LOCAL PORT**	**0 - BAUDRATE**
1 - PROTOCOLS	1 - REMOTE PORT 1	**1 - STOP BITS**
	2 - REMOTE PORT 2	**2 - PARITY**
	3 - REMOTE PORT 3	**3 - RX TIME BTW. CHAR**
	4 - IRIG-B	**4 - COMMS FAIL IND. TIME**

Ports / Remote Port 1

0 - PORTS	0 - LOCAL PORT	**0 - PROTOCOL SELECT.**
1 - PROTOCOLS	**1 - REMOTE PORT 1**	**1 - BAUDRATE**
	2 - REMOTE PORT 2	**2 - STOP BITS**
	3 - REMOTE PORT 3	**3 - PARITY**
	4 - IRIG-B	**4 - RX TIME BTW. CHAR**
		5 - COMMS FAIL IND. TIME
		6 - ADVANCED SETTINGS

0 - PROTOCOL SELECT.	
1 - BAUDRATE	
2 - STOP BITS	
3 - PARITY	**0 - FLOW CONTROL**
4 - RX TIME BTW. CHAR	**1 - TIME**
5 - COMMS FAIL IND. TIME	**2 - MESSAGE MODIF.**
6 - ADVANCED SETTINGS	**3 - COLLITIONS**

Remote Port 2

0 - PORTS	0 - LOCAL PORT	**0 - PROTOCOL SELECT.**
1 - PROTOCOLS	1 - REMOTE PORT 1	**1 - BAUDRATE**
	2 - REMOTE PORT 2	**2 - STOP BITS**
		3 - PARITY
		4 - RX TIME BTW. CHAR
		5 - COMMS FAIL IND. TIME
		6 - STOP BYTES 485
		7 - ADVANCED SETTINGS

0 - PROTOCOL SELECT.	
1 - BAUDRATE	
2 - STOP BITS	
3 - PARITY	**0- FLOW CONTROL**
4 - RX TIME BTW. CHAR	**1 - OPERATING MOD**
5 - COMMS FAIL IND. TIME	**2 - TIME**
6 - STOP BYTES 485	**3 - MESSAGE MODIF.**
7 - ADVANCED SETTINGS	**4 - COLLITIONS**

Ports / Remotes Ports 1, 2 and 3 Ethernet

0 - PORTS	0 - LOCAL PORT	**0 - PROTOCOL SELECT.**
1 - PROTOCOLS	**1 - REMOTE PORT 1**	**1 - UART**
	2 - REMOTE PORT 2	**2 - ETHERNET**
	3 - REMOTE PORT 3	
	4 - IRIG-B	

0 - PROTOCOL SELECT.	**0 - BAUDRATE**
1 - UART	**1 - STOP BITS**
2 - ETHERNET	**2 - PARITY**
	3 - RX TIME BTW. CHAR
	4 - COMMS FAIL IND. TIME
	5 - ADVANCED SETTINGS

0 - BAUDRATE	
1 - STOP BITS	
2 - PARITY	**0 - FLOW CONTROL**
3 - RX TIME BTW CHAR	**1 - TIME**
4 - COMMS FAIL IND. TIME	**2 - MESSAGE MODIF.**
5 - ADVANCED SETTINGS	**3 - COLLITIONS**

0 - PROTOCOL SELECT.	**0 - ENAB. ETHERNET PORT**
1 - UART	**1 - IP ADDRESS**
2 - ETHERNET	**2 - NET MASK**
	3 - PORT NUMBER
	4 - MAX. TIME TCP MESSAG
	5 - RX CAR. TIME
	6 - TPO. IND. FALLO COMS

Protocols / Procome Protocol

0 - PORTS	**0 - PROCOME PROTOCOL**	**0 - UNIT NUMBER**
1 - PROTOCOLS	1 - DNP 3.0 PROTOCOL	**1 - COMMS PASSW. ENABLE**
	2 - MODBUS PROTOCOL	**2 - COMMS PASSW. TIMEOUT**
	3 - IEC 61850	**3 - COMMS PASSW.**
	4 - TCP/IP	

Protocols / DNP 3.0 Protocol

0 - PORTS	0 - PROCOME PROTOCOL	**0 - RELAY NUMBER**
1 - PROTOCOLS	**1 - DNP 3.0 PROTOCOL**	**1 - T. CONFIRM TIMEOUT**
	2 - MODBUS PROTOCOL	**2 - MAX RETRIES**
	3 - IEC 61850	**3 - HAB. UNSOLICITED**
	4 - TCP/IP	**4 - UNSOL. PICKUP ACT.**
		5 - UNSOLIC. MASTER NO.
		6 - UNSOL. GROUPING TIME
		7 - SYNCR. INTERVAL
		8 - REV DNP 3.0
		9 - MEASURES

Protocols / DNP 3.0 Protocol (Profile II and Profile II Ethernet)

0 - PORTS	0 - PROCOME PROTOCOL	**0 - RELAY NUMBER**
1 - PROTOCOLS	**1 - DNP 3.0 PROTOCOL**	**1 - T. CONFIRM TIMEOUT**
	2 - MODBUS PROTOCOL	**2 - MAX RETRIES**
	3 - IEC 61850	**3 - HAB. UNSOLICITED**
	4 - TCP/IP	**4 - UNSOL. PICKUP ACT.**
		5 - UNSOLIC. MASTER NO.
		6 - UNSOL. GROUPING TIME
		7 - SYNCR. INTERVAL
		8 - REV DNP 3.0
		9 - DIGITAL CHANGES CLASS
		10 - ANAL. CHANGES CLASS
		11 - COUN. CHANGES CLASS
		12 - STATUS VALIDEZ ED
		13 - MEASURES 32 BITS
		14 - MEASURES
		15 - COUNTERS

Protocols / Modbus Protocol

0 - PORTS	0 - PROCOME PROTOCOL	
1 - PROTOCOLS	1 - DNP 3.0 PROTOCOL	
	2 - MODBUS PROTOCOL	**0 - UNIT NUMBER**
	3 - IEC 61850	
	4 - TCP/IP	

Protocols / IEC 61850 Protocol

0 - PORTS	0 - PROCOME PROTOCOL	
1 - PROTOCOLS	1 - DNP 3.0 PROTOCOL	
	2 - MODBUS PROTOCOL	**0 - GOOSE CHANNEL**
	3 - IEC 61850	**1 - ENBLGOOSEOUT**
	4 - TCP/IP	

Protocols / TCP/IP Protocol

0 - PORTS	0 - PROCOME PROTOCOL	
1 - PROTOCOLS	1 - DNP 3.0 PROTOCOL	
	2 - MODBUS PROTOCOL	**0 - LAN 1**
	3 - IEC 61850	**1 - LAN 2**
	4 - TCP/IP	**2 - SNTP**

0 - PROCOME PROTOCOL		**0 - IP ADDRESS**
1 - DNP 3.0 PROTOCOL		**1 - ENABLE DHCP**
2 - MODBUS PROTOCOL	**0 - LAN 1**	**2 - DEFAULT GATEWAY**
3 - IEC 61850	**1 - LAN 2**	**3 - NETWORK MASK**
4 - TCP/IP	2 - SNTP	**4 - DNS ADDRESS**

0 - PROCOME PROTOCOL		**0 - ENABLESNTP**
1 - DNP 3.0 PROTOCOL		**1 - ENBL_BROADCASTSNTP**
2 - MODBUS PROTOCOL	0 - LAN 1	**2 - ENBL_UNICASTSNTP**
3 - IEC 61850	1 - LAN 2	**3 - MAINSNTPSRV**
4 - TCP/IP	**2 - SNTP**	**4 - BACKUPSNTPSRV**
		5 - UNICAST VALID TIME
		6 - UNICAST ERROR TIME
		7 - RETRY ATTEMPTS
		8 - SYNC PERIOD
		9 - RETRY PERIOD
		10 - BRDCST VALID TIME
		11 - BRDCST ERROR TIME
		12 - MAX TIME DIF
		13 - SNTP_IGNORELEAPIND
		14 - SNTP_SYNCSTATECALC

Protocols / IEC 61850 Protocol (RTV-***-*****6)

0 - PORTS	0 - PROCOME PROTOCOL	**0 - ETHERNET**
1 - PROTOCOLS	1 - DNP 3.0 PROTOCOL	**1 - IP**
	2 - MODBUS PROTOCOL	**2 - GOOSE**
	3 - IEC 61850	**3 - SNTP**

0 - ETHERNET	**0 - REDUNDANCY MODE**
1 - IP	**1 - CHANNEL LIVE TIME**
2 - GOOSE	**2 - BONDING**
3 - SNTP	**3 - PRP**

0 - ETHERNET	0 - REDUNDANCY MODE	
1 - IP	1 - CHANNEL LIVE TIME	
2 - GOOSE	**2 - BONDING**	**0 - LINK CHK INTERVAL**
3 - SNTP	3 - PRP	

0 - ETHERNET	0 - REDUNDANCY MODE	
1 - IP	1 - CHANNEL LIVE TIME	
2 - GOOSE	2 - BONDING	**0 - SUPERV TX INTERVAL**
3 - SNTP	**3 - PRP**	**1 - SUP LSB DEST MAC**

0 - ETHERNET		**0 - IP ADDRESS**
1 - IP	**0 - LAN 1**	**1 - ENABLE DHCP**
2 - GOOSE	**1 - LAN 2**	**2 - DEFAULT GATEWAY**
3 - SNTP		**3 - NETWORK MASK**
		4 - DNS ADDRESS

0 - ETHERNET	
1 - IP	**0 - GOOSE CHANNEL**
2 - GOOSE	**1 - ENBLGOOSEOUT**
3 - SNTP	

0 - ETHERNET	**0 - ENABLESNTP**
1 - IP	**1 - ENBL_BROADCASTSNTP**
2 - GOOSE	**2 - ENBL_UNICASTSNTP**
3 - SNTP	**3 - MAINSNTPSRV**
	4 - BACKUPSNTPSRV
	5 - UNICAST VALID TIME
	6 - UNICAST ERROR TIME
	7 - RETRY ATTEMPTS
	8 - SYNC PERIOD
	9 - RETRY PERIOD
	10 - BRDCST VALID TIME
	11 - BRDCST ERROR TIME
	12 - MAX TIME DIF
	13 - SNTP_IGNORELEAPIND
	14 - SNTP_SYNCSTATECALC

3.15.10 Outputs and Events of the Communications Module (RTV-***-*****6)

Table 3.15-7: Outputs and Events of the Communications Module (RTV-*-*****6)**

Name	Description	Function
RESET REQ	Reset Required for Reconfiguration	Indicates that it is necessary to reset the relay in order for the configuration changes to take effect.
WRITING FLASH	Writing to Flash in Progress	Indicates that a write to FLASH is in progress (ON: In progress / OFF: End).
SNTP NO SYNC	SNTP Not Synchronized	Indicates the synchronizing status of the SNTP module. (ON: Not Synchronized / OFF: Synchronized).
LAN1 STATUS	LAN1 Communications Port Status	Indicates the status of the applicable communications port LAN. It is only used when the relay is redundancy configured, whether bonding or PRP (if there is no redundancy, the value is always OFF): - Bonding: Indicates whether LAN detects medium during a settable time. If medium is not detected during this time, it takes the value OFF. As soon as it detects medium, it switches to ON. - PRP: Indicates whether LAN receives frames during a settable time. If it receives any frame, it takes the value ON. If no frames are received during this time, it takes the value OFF.
LAN2 STATUS	LAN2 Communications Port Status	
BOND ACT LAN	Active LAN Communications Port (bonding)	Indicates the active LAN when the configured redundancy is bonding (OFF: LAN1 active / ON: LAN2 active).
LAN1 NET OVFL	Network Congestion Detected on LAN1	Indicates whether a network congestion is taking place (abnormal network avalanche) in the corresponding LAN (ON: Congestion present / OFF: No congestion present).
LAN2 NET OVFL	Network Congestion Detected on LAN2	

3.15.11 Communications Test

In order to proceed with the communications testing the relay must be supplied with the nominal voltage. Then the “In Service” LED must light up.

3.15.11.a PROCOME Protocol Test

The testing shall be performed through the three communications ports (one front and two rear [P1 and P2] ports), which must be set as follows:

Baud rate	**38,400 bauds**
Stop bits	**1**
Parity	**1** (even)

All ports shall be assigned the PROCOME protocol in order to use the ***ZivercomPlus***® communications program in all of them.

Connect with the relay through the front port via a male DB9 cable. Synchronize the time through the ***ZivercomPlus***® program. Disconnect the relay and wait for two minutes. Then, supply power to the relay again and connect with the relay through both rear ports. Finally set the ***ZivercomPlus***® program to cyclic and check that the time updates properly with both P1 and P2 connected.

3.15.11.b DNP v3.0 Protocol Tests

The main objects to test are:

1	0	Binary Input – All variations
1	1	Binary Input

The relay is asked about the state in that instant of the IED's status contact input signals (digital inputs, digital outputs, logic signals) configured to be sent via DNP v3.0.

2	0	Binary Input Change – All variations
2	1	Binary Input Change without Time
2	2	Binary Input Change with Time
2	3	Binary Input Change with Relative Time

The relay is asked about the control changes generated by the status contact input signals configured to be sent via DNP v3.0. They can be all the changes, without time, with time or with relative time.

10	0	Binary Outputs – All variations

The relay is asked about the state of the writings of outputs configured in the relay.

12	1	Control Relay Output Block

The operations sent through communications are tested on the IED.

20	0	Binary Counter – All variations
20	1	32-bit Binary Counter
21	0	Frozen Counter – All variations
21	1	32-bit Frozen Counter
22	0	Counter Change Event – All variations

A request is made for the value of the counters included in the IED's logic. These counters can be 32-bits binary or frozen counters. A request is also made for the changes generated by the value of these counters.

30	0	Analog Input – All variations
30	2	16-Bit Analog Input

A request is made for the value of the IED's analog inputs at that precise moment.

32	0	Analog Change Event – All variations
32	4	16-Bit Analog Change Event with Time

A request is made for the control changes generated by the variation in the value of the IED's analog channels.

40	0	Analog Output Status – All variations

The relay is asked about the state at that precise moment of the value of the IED's analog outputs.

41	2	16-Bit Analog Output Block

The relay is asked about the state at that precise moment of the value of the IED's 16-bit analog outputs.

50	1	Time and Date

The IED's date and time are synchronized.

52	2	Time Delay Fine

The relay is asked about the communications delay time. It is measured from the time the relay receives the first bit of the first byte of the question until the transmission of the first bit of the first byte of the IED's response.

60	1	Class 0 Data
60	2	Class 1 Data
60	3	Class 2 Data
60	4	Class 3 Data

The relay is asked about the various data defined in the relay as Class 0, Class 1, Class 2 and Class 3.

Within these requests, the IED's generation and sending of Unsolicited Messages for each of the different kinds of data is tested.

80	1	Internal Indications

The IED's Internal Indication bit (IIN1-7 bit Device Restart) is reset.

--	--	No Object (Cold Start)

When the IED receives a “Cold Load Pickup” object, it must answer with a message object “Time Delay Fine” and with a reset of the internal indication bit IIN1-7 (Device Restart).

--	--	No Object (Warm Start)

When the IED receives a “Warm Load Pickup” object, it must answer with a message object “Time Delay Fine” and with a reset of the internal indication bit IIN1-7 (Device Restart).

--	--	No Object (Delay Measurement)

The IED must answer with a communications object “Time Delay Fine.”

The Broadcast addresses are tested and the indications corresponding to “All Stations” with each of them.

Chapter 4.

Maintenance and Troubleshooting

4.1 Alarm Codes

4.1.1 Introduction

IED models notify the occurrence of alarms by 3 routes:

- Activation of an Alarm Generation Signal and Event
- Update of the Alarm Status Magnitude
- Indication on the HMI Stand-by Screen

Model **RTV-xxx-xxxx01xxx** is also provided with a fourth route:

- General alarm counter

4.1.2 Activation of an Alarm Generation Signal and Event

The IED has 2 status contact input signals to indicate critical and non-critical level alarms:

- Non-critical system error: **ERR_NONCRIT**
- Critical system error: **ERR_CRIT**

The activation of any of these signals generates its associated event. These signals can be used as inputs to be processed by the user-developed algorithms. Likewise, these signals can be connected to any of the communications protocols for their remote notification.

4.1.3 Update of the Alarm Status Magnitude

The IED has a magnitude whose value is determined by the combination of active alarms in the IED. This magnitude can be used as input to be processed by the user-developed algorithms. Likewise, a user-developed algorithm can connect this magnitude or the outcome of its processing to any of the communications protocols for transmission.

Next Table shows the possible causes of alarm coded by alarm magnitude, together with their level of severity.

Table 4.1-1: Alarm Status Magnitude and Severity Level

Alarm	Value	Severity
Error reading settings	0x00000001	CRITICAL
Protection operation error	0x00000020	CRITICAL
Error writing settings	0x00000040	CRITICAL
Non-critical error in A/D converter	0x00000080	NON-CRITICAL
Critical error in A/D converter	0x00000100	CRITICAL
Loss of content in non-volatile RAM	0x00000200	NON-CRITICAL
Error in internal clock operation	0x00000400	NON-CRITICAL
Error read/write from FLASH	0x00008000	CRITICAL
Error lack of VCC	0x00080000	CRITICAL
Error IEC 61850	0x00100000	NON-CRITICAL
Error signals	0x00200000	CRITICAL
Error in configuration	0x00800000	NON-CRITICAL
Program error	0x01000000	CRITICAL

In the case of more than one alarm at once, the sum of the codes of these alarms is seen in hexadecimal form.

4.1.4 Indication on the HMI Stand-By Screen

The activation of the **Critical System Error** signal produces the display of the current magnitude of the status of alarms of the IED in hexadecimal format on the stand-by display of the HMI.

4.1.5 General Alarm Counter

The relay is provided with three counters on the HMI to inform on the number of starts, re-starts and Traps:

- **Number of starts** (NARRANQS). Informs on the number of times the relay has been cold restarted (relay power supply failure).
- **Number of restarts** (NREARRAQS). Informs on the number of times the relay has been hot restarted (manually through change in configuration, or change of any nominal setting or relay reset).
- **Number of Traps** (NTRAPS). Number of exceptions produced in the relay followed by a reset.

Warning: contact the manufacturer if the unit displays any of these alarms codes.

4.2 Troubleshooting

4.2.1 Introduction

The purpose of this Chapter is to allow identifying error conditions in the device so that the user can carry out the appropriate corrective action in each case.

4.2.2 Software with Self-Checking

The relay performs continuous monitoring and self-checking its hardware and software. If any problem is detected, the device will show an alarm message in the HMI as it is explained in the Chapter 4.1, Alarm Codes.

The alarms generated by the self-checking module are divided in two levels, critical and non-critical alarms (table located in Chapter 4.1, Alarm Codes). When there is a non-critical alarm, the corresponding alarm message is displayed in the HMI and the device keeps on working due to the fact that the error level detected does not prevent the basic protection functionality, while when there is a critical alarm along with the error message in the HMI the alarm or watchdog contact of the relay changes its position because the protection goes out of service.

4.2.3 Power Up

If the relay does not appear to power up, verify the following points in order to determine if the error is located in the external wiring, in the power supply module or in the display.

Table 4.2-1: Power Up

Test	Check	Actions
1	Measure the auxiliary voltage on terminals of the relay, verifying that the voltage level and polarity is the one defined on the front label. Verify the positive and negative terminal in the external connection drawing.	If the auxiliary voltage is correct, proceed to test 2. If the auxiliary voltage is not the expected one, verify the wiring, fuses and/or minicircuit breakers should be checked.
2	Verify the alarm/watchdog contact of the relay taking into account the external connection drawing of the device	In the device is in service status and the "ready" LED and display are not switched on, the problem is located in the frontal card of the relay or in the internal cables. If the device is in alarm status the problem is located in the power supply module or in the internal cables. In both situations contact your supplier and the Quality Department of ZIV.

4.2.4 In Service / Alarm Contact

Table 4.2-2: In Service / Alarm Contact		
Test	**Check**	**Actions**
1	Access through the MMI or with the communication program (*Zivercomplus*®) to the setting called as “Unit In Service” which is inside General. If it is enabled proceed to test 2.	If the setting is disabled, enable it and verify that the alarm/watchdog contact switched from alarm status to in service status. If it does not change, proceed to test 2.
2	Check if there is any alarm message in the MMI and verify if it is a critical alarm taking into account the table located in the Chapter 4.1, Alarm Codes.	Contact your supplier and the Quality Department of ZIV.

4.2.5 Error Messages during Power Up

If the device, once the power up process has finished, is not showing the default screen (model, date and time) verify the following points.

- **IEC61850 Devices**

Table 4.2-3: Error Messages during Power Up - IEC61850 Devices		
Test	**Check**	**Actions**
1	IEC61850 power up stops showing the following message: ---------------.CID	Protection is operating but communications cannot run because the device has no CID file. Load a correct CID file to the relay.
2	IEC61850 power up stops showing the 3010 error	Protection is operating but communications cannot run because there is a problem while loading the IEC61850 profile. Contact your supplier of the Quality Department of ZIV.
3	IEC61850 power up stops showing the 3011 error	Protection is operating but communications cannot run because there is a problem while loading the CID file. Verify in the logs (web server or FTP) the error reason, modify the CID file and load the corrected file.
4	IEC61850 power up stops showing the 3020 error	Protection is operating but communications cannot run because the FW version of the protection and the IEC61850 FW are not matching. Contact your supplier of the Quality Department of ZIV.
5	IEC61850 power up stops showing the 3030 error	Protection is operating but communications cannot run because there is a mistake in the external control logic configuration of the CID (InRefs, LOGGAPC). Verify in the logs (web server or FTP) the error reason, modify the CID file and load the corrected file.

Table 4.2-3: Error Messages during Power Up - IEC61850 Devices		
Test	**Check**	**Actions**
6	IEC61850 power up stops showing the 3060 error	Protection is operating but communications cannot run because there is a mistake in the GOOSE subscription configuration. Verify in the logs (web server or FTP) the error reason, modify the CID file and load the corrected file.
7	IEC61850 power up stops showing the 3070 error	Protection is operating but communications cannot run because there is an error in the internal file that manages the Ethernet connection. Contact your supplier of the Quality Department of ZIV.
8	IEC61850 power up stops showing the 3080 error	Protection is operating but communications cannot run because there is a problem in the interfaces. Contact your supplier of the Quality Department of ZIV.
9	IEC61850 power up stops showing the 3200 error	Protection is operating but communications cannot run because there is a problem with the interruptions of the DPRAM. Contact your supplier of the Quality Department of ZIV.
	If there is a generic non IEC61850 error message in the HMI, check which kind of error it is according to the table that appears in Chapter 4.1, Alarm Codes.	Contact your supplier of the Quality Department of ZIV.

- **Non IEC61850 Devices**

Table 4.2-4: Error Messages during Power Up – Non IEC61850 Devices		
Test	**Check**	**Actions**
1	If there is an error message in the HMI, check which kind of error it is according to the table that appears in Chapter 4.1, Alarm Codes.	Contact your supplier of the Quality Department of ZIV.

4.2.6 Error Messages when the Relay is in Normal Operation

Table 4.2-5: Error Messages when the Relay is in Normal Operation		
Test	**Check**	**Actions**
1	If there is an error message in the MMI, check which kind of error it is according to the table that appears in Chapter 4.1, Alarm Codes.	Contact your supplier of the Quality Department of ZIV.

4.2.7 Errors while Communicating

Table 4.2-6: Errors while Communicating		
Test	**Check**	**Actions**
1	If a communication error takes place when trying to communicate with *Zivercomplus®* program through the frontal port with the following message: Doesn't communicate. Cannot get identifier.	Verify: - That you are using a crossed cable (5-5, 2-3). - That you are using a USB cable and you have all the drivers installed. - That the communication parameters of the device and the ones set in *Zivercomplus®* fit. Click two times in the screen of *Zivercomplus®* and scan the PC port used for the connection with the relay to obtain automatically the suitable parameters. If even with those parameters the message is still appearing, contact your supplier and the Quality Department of ZIV.
2	If a communication error takes place when trying to communicate with *Zivercomplus®* program through the frontal port with the following message: Cannot locate the identifier corresponding profile: XXXX.	Close *Zivercomplus®* program, update the database and run again *Zivercomplus®* in order to communicate with the relay.
3	If a communication error takes place when trying to communicate with *Zivercomplus®* program through the serial rear ports of the relay.	Verify: - That you are using a crossed cable (5-5, 2-3). - That the communication parameters of the device and the ones set in *Zivercomplus®* fit. - That the protocol of the rear port has been set to PROCOME. Click two times in the screen of *Zivercomplus®* and scan the PC port used for the connection with the relay to obtain automatically the suitable parameters. If even with those parameters the message is still appearing, contact your supplier and the Quality Department of ZIV.
4	If a communication error takes place when trying to communicate with *Zivercomplus®* program through the Ethernet serial rear ports or the LAN ports of the relay.	Verify: - The IP address of the relay is the same one set in *Zivercomplus®*. - That the TCP port set in *Zivercomplus®* is 32001. - That the LAN parameter selected in *Zivercomplus®* is transparent. - That the IP address of the PC belongs to the same family address of the one set in the relay and the network masks are correct. If the error is still appearing, contact your supplier and the Quality Department of ZIV.

Table 4.2-6: Errors while Communicating

Test	Check	Actions
5	Errors when communicating in Modbus and DNP3 through the serial remote ports.	Verify: - That you are using a crossed cable. - That the communication parameters of the device and the ones set in Zivercomplus fit. - That the rear port in the relay has been set with the appropriate protocol. - That the control configuration of the relay has the addresses requested by the client. If you cannot communicate, verify the correct behavior of the port trying to communicate in PROCOME with *Zivercomplus*®. If it works, check again the initial points. If it does not work, contact your supplier and the Quality Department of ZIV.
6	Errors when communicating in Modbus and DNP3 through the serial Ethernet ports.	Verify: - The IP address of the relay is the same one set in *Zivercomplus*®. - That the TCP port fits. - The rear port is set with the appropriate protocol. - That the control configuration of the relay has the addresses requested by the client. - That the IP address of the PC/client belongs to the same family address of the one set in the relay and the network masks are correct. If you cannot communicate, verify the correct behavior of the port trying to communicate in PROCOME with *Zivercomplus*®. If it works, check again the initial points. If it does not work, contact your supplier and the Quality Department of ZIV.
7	Errors when communicating in Modbus and DNP3 through the IEC61850 LAN ports.	Verify: - That the model supports DNP3 and MODBUS through the LAN IEC61850 ports as defined in the model selection. - The IP address of the relay is the same one set in the PC/client. - That the TCP port fits. - The rear port is set with the appropriate protocol. - That the control configuration of the relay has the addresses requested by the client. - That the IP address of the PC/client belongs to the same family address of the one set in the relay and the network masks are correct. - That the number of instances of each protocol have not been exceeded. - That there is no IEC61850 error in HMI of the relay (press ↑•). If you cannot communicate, verify the correct behavior of the port trying to communicate in PROCOME with *Zivercomplus*®. If it works, check again the initial points. If it does not work, contact your supplier and the Quality Department of ZIV.

4.2.8 Error in Digital Inputs

Table 4.2-7: Error in Digital Inputs		
Test	**Check**	**Actions**
1	Verify with a multimeter that the DI is energized (positive and negative as external connection wiring diagram) checking the voltage level and polarity taking into account the indications of the front label of the relay.	If the voltage supply of the DI is correct (positive and negative) skip to step 2. If the auxiliary voltage is not the expected one, check the external wiring, fuses and/or mini circuit breakers of the circuit.
2	If you are using a DI that can be configured for coil supervision, check that the corresponding setting has been set to NO.	Access through HMI or *Zivercomplus®* to the coil supervision settings and disable them. If they were enabled go to step 3.
3	Check the activation/deactivation voltage levels as the table that appears in Digital Inputs inside Chapter 2.1, Technical Data.	If the voltage is located inside the activation margin and the DI is not activating, verify that the FW of the relay matches with the model of the front label of the relay. In any case contact your supplier and the Quality Department of ZIV.

4.2.9 Error in Digital Outputs

Table 4.2-8: Error in Digital Outputs		
Test	**Check**	**Actions**
1	If the output contacts are not operating.	Verify the control logic and the signals that activate the outputs. If it is correct, make the necessary actions in order to execute the control logic and give the closing command. Verify if the output is changing the status in the HMI of the relay. If any of the outputs are not operating contact your supplier or the Quality Department of ZIV. If you are seeing the DO changing in the HMI, verify the activation of the output contact a multimeter, taking into account the external connection wiring diagram. If the physical output is not activating, contact your supplier and the Quality Department of ZIV.
2	If the TRIP contacts are not operating when there is a trip condition indicated in the HMI.	Verify that the protection unit is not taking into account the status of the breaker or other kind of factors. If the tripping condition is being complied but the trip contacts are not closed after verifying them with a multimeter and the external connection wiring diagram, contact your supplier and the Quality Department of ZIV.
3	If the CLOSE contacts are not operating when the relay gives a reclosing command.	Repeat the action to generate a new reclosing command, verifying that the command is generated in the events of the relay and the close contact is not closing (with a multimeter and the external connection wiring diagram). If the DO is not activating, contact your supplier and the Quality Department of ZIV.

4.2.10 Error in Input Transducers

Table 4.2-9: Error in Input Transducers

Test	Check	Actions
1	Verify that the input transducer has a suitable input signal taking into account the type of input transducer of the relay (front label of the relay and model selection).	If the input signal is not the expected one, check the external wiring, intermediate devices, etc. If the input signal is the correct one, contact your supplier and the Quality Department of ZIV.

4.2.11 Error in Measurements

- Compare the measurements shown in the HMI of the relay with the magnitudes metered with a multimeter in the terminals of the relay.
- Check that the transformation ratios of the CTs and VTs are the correct ones.
- Check that the terminals wired in the relay are the correct ones (external connection wiring diagram).
- Check the angle shift in order to confirm that the inputs are correctly wired.

If all the verifications are correct (external wiring, polarity and measurements in terminals of the relay), contact your supplier and the Quality Department of ZIV.

4.2.12 Fatal Errors

The device can reset itself in order to escape from transient anomalies, whose cause could be internal or external to the relay and which do not imply a damage of the relay itself. When there is an evidence of a malfunctionality of the device and/or a spontaneous reset, access through the HMI to the FW information screen (ENT / Information / Relay Information / Software/) and check if it is appearing a numerical code inside brackets [xx] in the line which is located between the firmware model and the version and checksum. If so, collect the available information of the relay (events, logs, fault reports, disturbance recorder files, etc.) and contact your supplier and the Quality Department of ZIV.

A. PROCOME 3.0 Protocol

A.1 Control Application Layer

- **Application Functions**

☑ **Initialization of the secondary station**
☑ **Clock synchronization**
☑ **Control functions**
  ☑ Control interrogation
  ☑ Refreshing of digital control signals
  ☑ Write outputs
  ☑ Enabling and disabling of inputs
  ☑ Overflow
  ☑ Force single coil

- **Compatible ASDUs in Secondary-to-Primary Direction**

☑ **<5> Identification**
☑ **<6> Clock synchronization**
☑ **<100> Transmission of metering values and digital control signal changes**
☑ **<101> Transmission of counters**
☑ **<103> Transmission of digital control states**
☑ **<110> Write binary outputs**
☑ **<111> Write analog outputs**
☑ **<121> Force single coil**

- **Compatible ASDUs in Primary to Secondary Direction**

☑ **<6> Clock synchronization**
☑ **<100> Control data request (Metering values and control changes INF=200)**
☑ **<100> Control data request (Capture of counters INF=202)**
☑ **<100> Control data request (Request for counters INF=201)**
☑ **<103> Request for digital control states**
☑ **<110> Write binary outputs**
☑ **<111> Write analog outputs**
☑ **<112> Enable/disable binary inputs**
☑ **<121> Force single coil**

A.2 Control Data

- **Control Metering (MEA-s)**

Configurable through the *ZivercomPlus*®: any value measured or calculated by the protection or generated by the programmable logic. It is possible to select between primary and secondary values, taking into account the corresponding transformation ratios.

All the full scale values of the magnitudes are definable, and these magnitudes can be used to create **user values**. Some typical values are:

- Phase currents: **Rated Value I_{PHASE} + 20%** sends 4095 counts
- Voltages: **Rated Value V + 20%** sends 4095 counts
- Powers: **3 x 1.4 x rated value I_{PHASE} x rated value / √3** sends 4095 counts.
- Power Factor: from **- 1 to 1** sends from - 4095 to 4095 counts

With the ***ZivercomPlus***® program, it is possible to define the **full-scale** value to be used to transmit this magnitude in counts, the unit that all the protocols use. There are three definable parameters that determine the range of distance covered:

- **Offset value**: the minimum value of the magnitude for which 0 counts are sent.
- **Limit**: the length of the range of the magnitude on which it is interpolated to calculate the number of counts to send. If the offset value is 0, it coincides with the value of the magnitude for which the defined maximum of counts (4095) is sent.
- **Nominal flag**: this flag allows determining whether the limit set is proportional to the rated value of the magnitude or not. The rated value of the new magnitudes defined by the user in the programmable logic can be configured, while the rest of the existing magnitudes are fixed.

The expression that allows defining this full-scale value is the following:

- When the Nominal flag is enabled,

$$CommunicationsMeasurement = \frac{Measurement - Offset}{Nominal} \times \frac{4095}{Limit}$$

- When the Nominal flag is NOT enabled,

$$CommunicationsMeasurement = (Measurement - Offset) \times \frac{4095}{Limit}$$

- **Counters**

Configurable through the *ZivercomPlus*®: Counters can be created with any signal configured in the Programmable Logic or from the Protection modules. The default counters are those of the real energies (positive and negative) and the reactive energies (capacitive and inductive).

The metering range of energies in primary values is from 100wh/varh to 99999 MWh/Mvarh. The magnitude transmitted via communications is this same primary value; that is, one (1) count represents 100 wh/varh.

- **Force Single Coil (ISE-s)**

Configurable through the *ZivercomPlus*®: A command can be made on any input from the Protection modules and on any signal configured in the Programmable Logic.

- **Write Control Outputs (ISS-s)**

Configurable through the *ZivercomPlus*®: A writing can be made on any input from the Protection modules and on any signal configured in the Programmable Logic.

- **Digital Control Signals (ISC-s)**

Configurable through the *ZivercomPlus*®: Any input or output logic signal from the Protection modules or generated by the Programmable Logic.

- **Write Analog Outputs (ISA-s)**

Configurable through the *ZivercomPlus*®: A writing can be made on any input from the Protection modules and on any signal configured in the Programmable Logic.

B. DNP V3.00 Device Profiles Document

Dnp3 Basic Profile

(Version 02.44.00 is the last Software Version that supports this Profile)

DNP V3.00 Basic Profile

DEVICE PROFILE DOCUMENT

This document must be accompanied by: Implementation Table and Point List.

Vendor Name: ZIV Aplicaciones y Tecnología S.A.

Device Name: RTV

Highest DNP Level Supported: For Requests 2 For Responses 2	Device Function: ☐ Master ☒ Slave

Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):

1) **Supports Enable/Disable Unsolicited Responses (FC=20 and 21), for classes 1 and 2.**
2) **Supports Write operations (FC=2) on Time and Date objects.**
3) **Supports Delay measurement Fine (FC=23).**
4) **Supports Warm Start command (FC=14).**
5) **Supports** Unsolicited after Restart (for compatibility with terminals whose revision is before DNP3-1998)
6) **Supports selection of DNP3 Revision.**
7) **Supports indication of no** synchronization in time.
8) **Supports simultaneous communications with two different Master devices**

Maximum Data Link Frame Size (octets): Transmitted **292** Received **292**	Maximum Application Fragment Size (octets): Transmitted **2048** (if >2048, must be configurable) Received **249** (must be <= 249)
Maximum Data Link Re-tries: ☒ None ☐ Fixed at ______ ☐ Configurable, range ___ to ______	Maximum Application Layer Re-tries: ☐ None ☒ Configurable, range **0** to **3** (Fixed is not permitted)

Requires Data Link Layer Confirmation:

☒ Never
☐ Always
☐ Sometimes. If 'Sometimes', when? ______________________
☐ Configurable. If 'Configurable', how? ______________________

Requires Application Layer Confirmation:

- ☐ Never
- ☐ Always (not recommended)
- ☒ When reporting Event Data (Slave devices only) **For unsolicited, Class 1 and Class 2 responses that contain Event Data. (If there is no Event Data reported into a Class 1 or 2 response, Application Layer Confirmation is not requested)**
- ☐ When sending multi-fragment responses (Slave devices only)
- ☐ Sometimes. If 'Sometimes', when?
- ☐ Configurable. If 'Configurable', how?

Timeouts while waiting for:

Data Link Confirm	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable
Complete Appl. Fragment	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable
Application Confirm	☐ None	☐ Fixed at ____	☐ Variable	☒ Configurable
Complete Appl. Response	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable

Others ____

Attach explanation if 'Variable' or 'Configurable' was checked for any timeout

Application Confirm timeout setting (*MMI*): Range 50 ms. 65.535 ms.

Sends/Executes Control Operations:

- Maximum number of CROB (obj. 12, var. 1) objects supported in a single message **1**
- Maximum number of Analog Output (obj. 41, any var.) supported in a single message **0**

☐ Pattern Control Block and Pattern Mask (obj. 12, var. 2 and 3 respectively) supported.
☐ CROB (obj. 12) and Analog Output (obj. 41) permitted together in a single message.

WRITE Binary Outputs	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
SELECT (3) / OPERATE (4)	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE (5)	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE - NO ACK (6)	☐ Never	☒Always	☐ Sometimes	☐ Configurable

Count > 1	☐ Never	☐ Always	☒ Sometimes	☐ Configurable
Pulse On	☐ Never	☒Always	☐ Sometimes	☐ Configurable
Pulse Off	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Latch On	☐ Never	☒Always	☐ Sometimes	☐ Configurable
Latch Off	☐ Never	☒Always	☐ Sometimes	☐ Configurable

Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable

Attach explanation:

- **All points support the same Function Codes: (3) Select, (4) Operate, (5) Direct Operate and (6) Direct Operate - No ACK.**
- **Maximum Select/Operate Delay Time: 60 seconds.**
- **Count can be >1 only for PULSE ON and PULSE OFF**

FILL OUT THE FOLLOWING ITEMS FOR SLAVE DEVICES ONLY:	
Reports Binary Input Change Events when no specific variation requested: ☐ Never ☒ Only time-tagged ☐ Only non-time-tagged ☐ Configurable to send both, one or the other (attach explanation)	Reports time-tagged Binary Input Change Events when no specific variation requested: ☐ Never ☒ Binary Input Change With Time ☐ Binary Input Change With Relative Time ☐ Configurable (attach explanation)
Sends Unsolicited Responses: ☐ Never ☒ Configurable (**See Note D**) ☒ Only certain objects **(Class 1 and 2)** ☐ Sometimes (attach explanation) ☒ ENABLE/DISABLE UNSOLICITED Function codes supported	Sends Static Data in Unsolicited Responses: ☒ Never ☐ When Device Restarts ☐ When Status Flags Change No other options are permitted.
Default Counter Object/Variation: ☐ No Counters Reported ☐ Configurable (attach explanation) ☒ Default Object 20,21 Default Variation 1 ☐ Point-by-point list attached	Counters Roll Over at: ☐ No Counters Reported ☐ Configurable (attach explanation) ☐ 16 Bits ☐ 32 Bits ☒ Other Value 31 Bits ☐ Point-by-point list attached
Sends Multi-Fragment Responses: ☒ Yes ☐ No	

QUICK REFERENCE FOR DNP3.0 LEVEL 2 FUNCTION CODES & QUALIFIERS		
Function Codes 1 Read 2 Write 3 Select 4 Operate 5 Direct Operate 6 Direct Operate-No ACK 7 Immediate Freeze 8 Immediate Freeze no ACK 13 Cold Start 14 Warm Start 20 Enable Unsol. Messages 21 Disable Unsol. Messages 23 Delay Measurement 129 Response 130 Unsolicited Message	7 6 5 4 3 2 1 0 [ ] Index Size | Qualifier Code **Index Size** 0- No Index, Packed 1- 1 byte Index 2- 2 byte Index 3- 4 byte Index 4- 1 byte Object Size 5- 2 byte Object Size 6- 4 byte Object Size	 **Qualifier Code** 0- 8-Bit Start and Stop Indices 1- 16-Bit Start and Stop Indices 2- 32-Bit Start and Stop Indices 3- 8-Bit Absolute address Ident. 4- 16-Bit Absolute address Ident. 5- 32-Bit Absolute address Ident. 6- No Range Field (all) 7- 8-Bit Quantity 8- 16-Bit Quantity 9- 32-Bit Quantity 11-(0xB) Variable array

IMPLEMENTATION TABLE

OBJECT			REQUEST (RTV will parse)		RESPONSE (RTV will respond)		
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes (dec)	Qual Codes (hex)	Notes
1	0	Binary Input – All variations	1	6			
1	1	Binary Input			129	1	Assigned to Class 0.
2	0	Binary Input Change – All variations	1	6,7,8			
2	1	Binary Input Change without Time	1	6,7,8	129		B
2	2	Binary Input Change with Time	1	6,7,8	129,130	28	Assigned to Class 1.
2	3	Binary Input Change with Relative Time	1	6,7,8	129		B
10	0	Binary Outputs – All variations	1	6	129		A
12	1	Control Relay Output Block	3,4,5,6	17,28	129	17,28	
20	0	Binary Counter – All variations	1	6	129		~~A~~
20	1	32 Bits Binary Counter			129	1	
21	0	Frozen Counter – All variations	1	6	129		~~A~~
21	1	32 Bits Frozen Counter			129	1	
22	0	Counter Change Event – All variations	1	6,7,8	129		B
30	0	Analog Input – All variations	1	6			
30	2	16-Bit Analog Input			129	1	Assigned to Class 0.
32	0	Analog Change Event – All variations	1	6,7,8			
32	4	16-Bit Analog Change Event with Time			129,130	28	Assigned to Class 2.
40	0	Analog Output Status – All variations	1	6	129		A
41	2	16-Bit Analog Output Block	3,4,5,6	17,28	129		A
50	1	Time and Date	2	7 count=1	129		C
52	2	Time Delay Fine	23		129	1	F,G

OBJECT			REQUEST (RTV will parse)		RESPONSE (RTV will respond)		
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes (dec)	Qual Codes (hex)	Notes
60	1	Class 0 Data	1	6	129	1	
60	2	Class 1 Data	1 20,21	6,7,8 6	129,130	28	D
60	3	Class 2 Data	1 20,21	6,7,8 6	129,130	28	D
60	4	Class 3 Data	1 20,21	6,7,8 6	N/A		B
80	1	Internal Indications	2	0 index=7			E
--	--	No Object (Cold Start)	13				F
--	--	No Object (Warm Start)	14				F
--	--	No Object (Delay Measurement)	23				G

NOTES

A: Device implementation level does not support this group and variation of object or, for static objects, it has no objects with this group and variation. OBJECT UNKNOWN response (IIN2 bit 1 set).

B: No point range was specified, and device has no objects of this type. NULL response (no IIN bits set, but no objects of the specified type returned).

C: Device supports write operations on Time and Date objects. Time Synchronization-Required Internal Indication bit (IIN1-4) will be cleared on the response.

D: The device can be configured to send or not, unsolicited responses depending on a configuration option by means of *MMI* (Man-Machine Interface or front-panel user interface). Then, the Master can Enable or Disable Unsolicited messages (for Classes 1 and 2) by means of requests (FC 20 and 21).
If the unsolicited response mode is configured "on", then upon device restart, the device will transmit an initial Null unsolicited response, requesting an application layer confirmation. While waiting for that application layer confirmation, the device will respond to all function requests, including READ requests.

E: Restart Internal Indication bit (IIN1-7) can be cleared explicitly by the master.

F: The outstation, upon receiving a *Cold or Warm Start* request, will respond sending a Time Delay Fine object message (which specifies a time interval until the outstation will be ready for further communications), restarting the DNP process, clearing events stored in its local buffers and setting IIN1-7 bit (Device Restart).

G: Device supports Delay Measurement requests (FC = 23). It responds with the Time Delay Fine object (52-2). This object states the number of milliseconds elapsed between Outstation receiving the first bit of the first byte of the request and the time of transmission of the first bit of the first byte of the response.

DEVICE SPECIFIC FEATURES

- Internal Indication IIN1-6 (Device trouble): Set to indicate a change in the current DNP configuration in the outstation. Cleared in the next response. Used to let the master station know that DNP settings have changed at the outstation. Note that some erroneous configurations could make impossible to communicate this condition to a master station.

  This document also states the DNP3.0 settings currently available in the device. If the user changes whatever of these settings, it will set the *Device Trouble Internal Indication* bit on the next response sent.
- Event buffers: device can hold as much as 50 Binary Input Changes and 50 Analog Input Changes. If these limits are reached the device will set the *Event Buffers Overflow Internal Indication* bit on the next response sent. It will be cleared when the master reads the changes, making room for new ones.
- Configuration ➔ Operation Enable menu: the device can enable or disable permissions for the operations over al Control Relay Output Block. In case permissions are configured off (disabled) the response to a command (issued as Control Relay Output Block) will have the Status code NOT_AUTHORIZED. In case the equipment is blocked the commands allowed are the configured when permitted. While blocked, the relay will accept commands over the configured signal. If the equipment is in operation inhibited state, the response to all commands over the configured signal will have the Status code NOT_AUTHORIZED.
- Configuration ➔ Binary Inputs/Outputs menu: contains the default configuration (as shipped from factory or after a reset by means of F4 key), but customers can configure Inputs/Outputs to suit their needs, by means of *ZIVercomPlus®* software.

POINT LIST

BINARY INPUT (OBJECT 1) -> Assigned to Class 0. BINARY INPUT CHANGE (OBJECT 2) -> Assigned to Class 1.		
Index	Description	
0	*Configure by ZIVercomPlus®* 2048 points	
1	*Configure by ZIVercomPlus®* 2048 points	
2	*Configure by ZIVercomPlus®* 2048 points	
3	*Configure by ZIVercomPlus®* 2048 points	
4	*Configure by ZIVercomPlus®* 2048 points	
5	*Configure by ZIVercomPlus®* 2048 points	
6	*Configure by ZIVercomPlus®* 2048 points	
7	*Configure by ZIVercomPlus®* 2048 points	
8	*Configure by ZIVercomPlus®* 2048 points	
9	*Configure by ZIVercomPlus®* 2048 points	
10	*Configure by ZIVercomPlus®* 2048 points	
11	*Configure by ZIVercomPlus®* 2048 points	
12	*Configure by ZIVercomPlus®* 2048 points	
13	*Configure by ZIVercomPlus®* 2048 points	
14	*Configure by ZIVercomPlus®* 2048 points	
15	*Configure by ZIVercomPlus®* 2048 points	
16	*Configure by ZIVercomPlus®* 2048 points	
17	*Configure by ZIVercomPlus®* 2048 points	
...	*Configure by ZIVercomPlus®* 2048 points	
253	*Configure by ZIVercomPlus®* 2048 points	
254	*Configure by ZIVercomPlus®* 2048 points	
255	*Configure by ZIVercomPlus®* 2048 points	

CONTROL RELAY OUTPUT BLOCK (OBJECT 12)		
Index	Description	
0	*Configure by ZIVercomPlus®* 256 points	
1	*Configure by ZIVercomPlus®* 256 points	
2	*Configure by ZIVercomPlus®* 256 points	
3	*Configure by ZIVercomPlus®* 256 points	
4	*Configure by ZIVercomPlus®* 256 points	
5	*Configure by ZIVercomPlus®* 256 points	
6	*Configure by ZIVercomPlus®* 256 points	
7	*Configure by ZIVercomPlus®* 256 points	
8	*Configure by ZIVercomPlus®* 256 points	
9	*Configure by ZIVercomPlus®* 256 points	
10	*Configure by ZIVercomPlus®* 256 points	
11	*Configure by ZIVercomPlus®* 256 points	
12	*Configure by ZIVercomPlus®* 256 points	
13	*Configure by ZIVercomPlus®* 256 points	
14	*Configure by ZIVercomPlus®* 256 points	
15	*Configure by ZIVercomPlus®* 256 points	
16	*Configure by ZIVercomPlus®* 256 points	
17	*Configure by ZIVercomPlus®* 256 points	
...	*Configure by ZIVercomPlus®* 256 points	
253	*Configure by ZIVercomPlus®* 256 points	
254	*Configure by ZIVercomPlus®* 256 points	
255	*Configure by ZIVercomPlus®* 256 points	

ANALOG INPUT (OBJECT 30) -> Assigned to Class 0. ANALOG INPUT CHANGE (OBJECT 32) -> Assigned to Class 2.		
Index	Description	Deadband
0	*Configure by ZIVercomPlus®* 512 points	Deadband_1.
1	*Configure by ZIVercomPlus®* 512 points	Deadband_2.
2	*Configure by ZIVercomPlus®* 512 points	Deadband_3.
3	*Configure by ZIVercomPlus®* 512 points	Deadband_4.
4	*Configure by ZIVercomPlus®* 512 points	Deadband_5.
5	*Configure by ZIVercomPlus®* 512 points	Deadband_6.
6	*Configure by ZIVercomPlus®* 512 points	Deadband_7.
7	*Configure by ZIVercomPlus®* 512 points	Deadband_8.
8	*Configure by ZIVercomPlus®* 512 points	Deadband_9.
9	*Configure by ZIVercomPlus®* 512 points	Deadband_10.
10	*Configure by ZIVercomPlus®* 512 points	Deadband_11.
11	*Configure by ZIVercomPlus®* 512 points	Deadband_12.
12	*Configure by ZIVercomPlus®* 512 points	Deadband_13.
13	*Configure by ZIVercomPlus®* 512 points	Deadband_14.
14	*Configure by ZIVercomPlus®* 512 points	Deadband_15.
15	*Configure by ZIVercomPlus®* 512 points	Deadband_16.

Additional assign with *ZIVercomPlus*®:

ANALOG INPUT (OBJECT 30) -> Assigned to Class 0.	
Index	Description
16	*Configure by ZIVercomPlus® 512 points*
17	*Configure by ZIVercomPlus® 512 points*
18	*Configure by ZIVercomPlus® 512 points*
19	*Configure by ZIVercomPlus® 512 points*
20	*Configure by ZIVercomPlus® 512 points*
21	*Configure by ZIVercomPlus® 512 points*
22	*Configure by ZIVercomPlus® 512 points*
23	*Configure by ZIVercomPlus® 512 points*
24	*Configure by ZIVercomPlus® 512 points*
25	*Configure by ZIVercomPlus® 512 points*
26	*Configure by ZIVercomPlus® 512 points*
27	*Configure by ZIVercomPlus® 512 points*
....	*Configure by ZIVercomPlus® 512 points*
254	*Configure by ZIVercomPlus® 512 points*
255	*Configure by ZIVercomPlus® 512 points*

The full scale ranges are adjustable and user's magnitudes can be created. It's possible to choose between primary and secondary values, considering CT and PT ratios. Typical ranges in secondary values are:

Description	Full Scale Range		
	Engineering units	Counts	
Currents (Local & Remote)	0 to 1,2 x In_{PHASE} A	0 to 32767	◊ Deadband
Voltage	0 to 1,2 x Vn V	0 to 32767	◊ Deadband
Power (Real, reactive, apparent)	0 to 3 x 1,4 x In_{PHASE} x Vn/√3 W	-32768 to 32767	◊ Deadband
Power factor	-1 to 1	-32768 to 32767	◊ Deadband

With *ZIVercomPlus®* program it's possible to define the ***Full Scale Range*** that is desired to transmit each magnitude in *counts*, which is the unit used by the protocol. There are three parameters to determine the distance range covered:

- **Offset:** minimum value of each magnitude to transmit 0 counts.
- **Limit:** it's the length of the magnitude range used to calculate the number of counts to transmit. If **offset** is 0, it's the same as the value of the magnitude for which the maximum number of counts defined by the protocol is sent (32767 counts).
- **Nominal Flag:** this *flag* defines if the **limit** is proportional to the rated value of the magnitude or not. The rated value of the new magnitudes defined by the user is a setting, while for the pre-defined magnitudes is a fix value.

Mathematical expression to describe the ***Full Scale Range*** is:

- When **Nominal Flag** is actived,

$$MeasureComm = \frac{Measure - Offset}{RatedValue} \times \frac{32767}{Limit}$$

- When **Nominal Flag** is NOT actived,

$$MeasureComm = (Measure - Offset) \times \frac{32767}{Limit}$$

Deadbands

- Deadbands are used for configuring *Analog Input Change* objects (Object 32).
- A Deadband is defined as a percentage over the **Full Scale Range** (FSR).
- The Deadband can be adjusted to the device by means of *MMI* (Man-Machine Interface or front-panel user interface), between 0.00% and 100.00%, in steps of 0.01%. Default value is 100.00%, meaning that generation of Analog Change Events is **DISABLED** for that input. There is an independent setting for each Analog Input.

Energy counters

The range for the energy counters in primary values is from 100wh/varh to 99999Mwh/Mvarh, and these are the values transmitted by protocol.

DNP3 PROTOCOL SETTINGS

DNP3 Protocol Settings						
DNP Protocol Configuration						
Setting Name	**Type**	**Minimum Value**	**Maximum Value**	**Default Value**	**Step/ Select**	**Unit**
Relay Number	Integer	0	65519	1	1	
T Confirm Timeout	Integer	1000	65535	1000	1	msec.
Max Retries	Integer	0	65535	0	1	
Enable Unsolicited.	Boolean	0 (No)	1 (Yes)	0 (No)	1	
Enable Unsol. after Restart	Boolean	0 (No)	1 (Yes)	0 (No)	1	
Unsolic. Master No.	Integer	0	65519	1	1	
Unsol. Grouping Time	Integer	100	65535	1000	1	msec.
Synchronization Interval	Integer	0	120	0	1	min.
DNP 3.0 Rev.	Integer	2003 ST.ZIV	2003 ST.ZIV	2003	2003 ST.ZIV	
DNP Port 1 Configuration						
Setting Name	**Type**	**Minimum Value**	**Maximum Value**	**Default Value**	**Step/ Select**	**Unit**
Protocol Select	**Uinteger**	**Procome Dnp3 Modbus**	**Procome Dnp3 Modbus**	**Procome**	**Procome Dnp3 Modbus**	
Baud rate	**Integer**	**300**	**38400**	**38400**	**300 600 1200 2400 4800 9600 19200 38400**	**baud**
Stop Bits	**Integer**	**1**	**2**	**1**	**1**	
Parity	**Integer**	**None Odd Even**	**None Odd Even**	**None**	**None Odd Even**	
Rx Time btw. Char	**Float**	**1**	**60000**	**0.5**	**40**	**msec.**
Comms Fail Ind. Time	**Float**	**0**	**600**	**0.1**	**60**	**s**

Advaced settings						
Flow control						
CTS Flow	Bool	No Yes	No Yes	No	No Yes	
DSR Flow	Bool	No Yes	No Yes	No	No Yes	
DSR Sensitive	Bool	No Yes	No Yes	No	No Yes	
DTR Control	Integer	Inactive Active Rec. Req.	Inactive Active Rec. Req.	Inactive	Inactive Active Rec. Req.	
RTS Control	Integer	Inactive Active Rec. Req. Sen. Req.	Inactive Active Rec. Req. Sen. Req.	Inactive	Inactive Active Rec. Req. Sen. Req.	
Times						
Tx Time Factor	Float	0	100	1	0.5	
Tx Timeout Const	Uinteger	0	60000	0	1	
Message modification						
Number of Zeros	Integer	0	255	0	1	
collision						
Collision Type	Integer	NO ECHO DCD	NO ECHO DCD	NO	NO ECHO DCD	
Max Retries	Integer	0	3	0	1	
Min Retry Time	Uinteger	0	60000	0	1	msec.
Max Retry Time	Uinteger	0	60000	0	1	msec.

DNP Port 2 Configuration

Setting Name	Type	Minimum Value	Maximum Value	Default Value	Step/ Select	Unit
Protocol Select	Uinteger	Procome Dnp3 Modbus	Procome Dnp3 Modbus	Procome	Procome Dnp3 Modbus	
Baud rate	Integer	300	38400	38400	300 600 1200 2400 4800 9600 19200 38400	baud
Stop Bits	Integer	1	2	1	1	
Parity	Integer	None Odd Even	None Odd Even	None	None Odd Even	
Rx Time btw. Char	Float	1	60000	0.5	40	msec.
Comms Fail Ind. Time	Float	0	600	0.1	60	s

Advaced settings						
Operating Mode	**Integer**	**RS-232 RS-485**	**RS-232 RS-485**	**RS-232**	**RS-232 RS-485**	
Times						
Tx Time Factor	**Float**	**0**	**100**	**1**	**0.5**	
Tx Timeout Const	**Uinteger**	**0**	**60000**	**0**	**1**	
Wait N Bytes 485	**Integer**	**0**	**4**	**0**	**1**	
Message modification						
Number of Zeros	**Integer**	**0**	**255**	**0**	**1**	
collision						
Collision Type	**Integer**	**NO ECHO**	**NO ECHO**	**NO**	**NO ECHO**	
Max Retries	**Integer**	**0**	**3**	**0**	**1**	
Min Retry Time	**Uinteger**	**0**	**60000**	**0**	**1**	**msec.**
Max Retry Time	**Uinteger**	**0**	**60000**	**0**	**1**	**msec.**
Analog Inputs (Deadbands)						
Setting Name	**Type**	**Minimum Value**	**Maximum Value**	**Default Value**	**Step**	**Unit**
Deadband AI#0	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#1	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#2	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#3	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#4	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#5	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#6	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#7	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#8	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#9	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#10	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#11	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#12	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#13	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#14	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#15	Float	0 %	100 %	100 %	0.01 %	

- ✓ All settings remain unchanged after a power loss.

DNP Protocol Configuration

- **Relay Number** (RTU Address):
  Remote Terminal Unit Address. Addresses 0xFFF0 to 0xFFFF are reserved as *Broadcast Addresses*.
- **T Confirm Timeout** (N7 Confirm Timeout) :
  Timeout while waiting for Application Layer Confirmation. It applies to Unsolicited messages and Class 1 and Class 2 responses with event data.
- **Max Retries** (N7 Retries) :
  Number of retries of the Application Layer after timeout while waiting for Confirmation.
- **Enable Unsolicited** (Enable Unsolicited Reporting) :
  Enables or disables Unsolicited reporting.
- **Enable Unsol. after Restart** :
  Enables or disables Unsolicited after Restart (for compatibility with terminals whose revision is before DNP3-1998). It has effect only if **Enable Unsolicited after Restart is set.**

- **Unsolic. Master No.** (MTU Address) :
  Destination address of the Master device to which the unsolicited responses are to be sent. Addresses 0xFFF0 to 0xFFFF are reserved as *Broadcast Addresses*. It is useful only when Unsolicited Reporting is enabled.
- **Unsol. Grouping Time** (Unsolicited Delay Reporting) :
  Delay between an event being generated and the subsequent transmission of the unsolicited message, in order to group several events in one message and to save bandwidth.
- **Synchronization Interval**
  Max interval time between two synchronization. If no synchronizing inside interval, indication IIN1-4 (NEED TIME). This setting has no effect if **Synchronization Interval is zero.**
- **DNP 3.0 Rev**.
  Certification revision **STANDARD ZIV** or **2003** (DNP3-2003 Intelligent Electronic Device (IED) Certification Procedure Subset Level 2 Version 2.3 29-Sept-03)

DNP Port 1 and Port 2 Configuration

- **Number of Zeros** (Advice_Time) :
  Number of zeros before the message.
- **Max Retries** (N1 Retries) :
  Number of retries of the Physical Layer after collision detection.
- **Min Retry Time** (Fixed_delay) :
  Minimum time to retry of the Physical Layer after collision detection.
- **Max Retry Time** :
  Maximum time to retry of the Physical Layer after collision detection.
- **Collision Type** :

  Port 1:

  NO

  ECHO based on detection of transmitted data (monitoring all data transmitted on the link).

  Port 2:

  NO

  ECHO based on detection of transmitted data (monitoring all data transmitted on the link.

  DCD (Data Carrier Detect) based on detecting out-of-band carrier.

  If the device prepares to transmit and finds the link busy, it waits until is no longer busy, and then waits a backoff_time as follows:

  backoff_time = Min Retry Time + random(Max Retry Time - Max Retry Time)

  and transmit. If the device has a collision in transmission the device tries again,up to a configurable number of retries (Max Retries) if has news collision.

- **Wait N Bytes 485**:

Number of wait bytes between Reception and transmission Use Port 2 Operate Mode RS-485.

Dnp3 Basic Extended Profile

(Version 02.45.00 is the first Software Version that supports this Profile)

DNP V3.00 Basic Extended Profile

DEVICE PROFILE DOCUMENT

This document must be accompanied by: Implementation Table and Point List.

Vendor Name: ZIV Aplicaciones y Tecnología S.A.

Device Name: RTV

Highest DNP Level Supported:	Device Function:
For Requests 2 For Responses 2	☐ Master ☒ Slave

Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):

1) **Supports Enable/Disable Unsolicited Responses (FC=20 and 21), for classes 1 and 2.**
2) **Supports Write operations (FC=2) on Time and Date objects.**
3) **Supports Delay measurement Fine (FC=23).**
4) **Supports Warm Start command (FC=14).**
5) **Supports** Unsolicited after Restart (for compatibility with terminals whose revision is before DNP3-1998)
6) **Supports selection of DNP3 Revision.**
7) **Supports indication of no** synchronization in time.
8) **Supports simultaneous communications with two different Master devices**
9) **Supports respond to Multiple Read Request with multiple object types in the same Application Fragment .**

Maximum Data Link Frame Size (octets):	Maximum Application Fragment Size (octets):
Transmitted ____**292**____ Received ____**292**____	Transmitted __**2048**__ (if >2048, must be configurable) Received___**249**__(must be <= 249)

Maximum Data Link Re-tries:	Maximum Application Layer Re-tries:
☒ None ☐ Fixed at ____________________ ☐ Configurable, range ___ to ______	☐ None ☒ Configurable, range __**0**__ to __**3**__ (Fixed is not permitted)

Requires Data Link Layer Confirmation:

☒ Never
☐ Always
☐ Sometimes. If 'Sometimes', when? ____________________
☐ Configurable. If 'Configurable', how? ____________________

Requires Application Layer Confirmation: ☐ Never ☐ Always (not recommended) ☒ When reporting Event Data (Slave devices only) **For unsolicited, Class 1 and Class 2 responses that contain Event Data. (If there is no Event Data reported into a Class 1 or 2 response, Application Layer Confirmation is not requested)** ☐ When sending multi-fragment responses (Slave devices only) ☐ Sometimes. If 'Sometimes', when? ☐ Configurable. If 'Configurable', how?
Timeouts while waiting for: Data Link Confirm ☒ None ☐ Fixed at ____ ☐ Variable ☐ Configurable Complete Appl. Fragment ☒ None ☐ Fixed at ____ ☐ Variable ☐ Configurable Application Confirm ☐ None ☐ Fixed at ____ ☐ Variable ☒ Configurable Complete Appl. Response ☒ None ☐ Fixed at ____ ☐ Variable ☐ Configurable Others ____ Attach explanation if 'Variable' or 'Configurable' was checked for any timeout **Application Confirm timeout setting (*MMI*): Range 50 ms. 65.535 ms.**

Sends/Executes Control Operations:

- Maximum number of CROB (obj. 12, var. 1) objects supported in a single message **1**
- Maximum number of Analog Output (obj. 41, any var.) supported in a single message **0**

☐ Pattern Control Block and Pattern Mask (obj. 12, var. 2 and 3 respectively) supported.
☐ CROB (obj. 12) and Analog Output (obj. 41) permitted together in a single message.

WRITE Binary Outputs	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
SELECT (3) / OPERATE (4)	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE (5)	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE - NO ACK (6)	☐ Never	☒ Always	☐ Sometimes	☐ Configurable

Count > 1	☐ Never	☐ Always	☒ Sometimes	☐ Configurable
Pulse On	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Pulse Off	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Latch On	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Latch Off	☐ Never	☒ Always	☐ Sometimes	☐ Configurable

Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable

Attach explanation:

- **All points support the same Function Codes: (3) Select, (4) Operate, (5) Direct Operate and (6) Direct Operate - No ACK.**
- **Maximum Select/Operate Delay Time: 60 seconds.**
- **Count can be >1 only for PULSE ON and PULSE OFF**

FILL OUT THE FOLLOWING ITEMS FOR SLAVE DEVICES ONLY:	
Reports Binary Input Change Events when no specific variation requested: ☐ Never ☒ Only time-tagged ☐ Only non-time-tagged ☐ Configurable to send both, one or the other (attach explanation)	Reports time-tagged Binary Input Change Events when no specific variation requested: ☐ Never ☒ Binary Input Change With Time ☐ Binary Input Change With Relative Time ☐ Configurable (attach explanation)
Sends Unsolicited Responses: ☐ Never ☒ Configurable (**See Note D**) ☒ Only certain objects **(Class 1 and 2)** ☐ Sometimes (attach explanation) ☒ ENABLE/DISABLE UNSOLICITED Function codes supported	Sends Static Data in Unsolicited Responses: ☒ Never ☐ When Device Restarts ☐ When Status Flags Change No other options are permitted.
Default Counter Object/Variation: ☐ No Counters Reported ☐ Configurable (attach explanation) ☒ Default Object _20,21____ Default Variation _______1_____ ☐ Point-by-point list attached	Counters Roll Over at: ☐ No Counters Reported ☐ Configurable (attach explanation) ☐ 16 Bits ☐ 32 Bits ☒ Other Value ____31 Bits____ ☐ Point-by-point list attached
Sends Multi-Fragment Responses: ☒ Yes ☐ No	

QUICK REFERENCE FOR DNP3.0 LEVEL 2 FUNCTION CODES & QUALIFIERS

Function Codes

1	Read
2	Write
3	Select
4	Operate
5	Direct Operate
9	Direct Operate-No ACK
10	Immediate Freeze
11	Immediate Freeze no ACK
13	Cold Start
14	Warm Start
20	Enable Unsol. Messages
21	Disable Unsol. Messages
23	Delay Measurement
129	Response
130	Unsolicited Message

7	6	5	4	3	2	1	0
	Index Size			Qualifier Code			

Index Size

0- No Index, Packed
1- 1 byte Index
2- 2 byte Index
3- 4 byte Index
4- 1 byte Object Size
5- 2 byte Object Size
6- 4 byte Object Size

Qualifier Code

0- 8-Bit Start and Stop Indices
1- 16-Bit Start and Stop Indices
2- 32-Bit Start and Stop Indices
3- 8-Bit Absolute address Ident.
4- 16-Bit Absolute address Ident.
5- 32-Bit Absolute address Ident.
6- No Range Field (all)
7- 8-Bit Quantity
8- 16-Bit Quantity
9- 32-Bit Quantity
11-(0xB) Variable array

IMPLEMENTATION TABLE

OBJECT			REQUEST (RTV will parse)		RESPONSE (RTV will respond)		
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes (dec)	Qual Codes (hex)	Notes
1	0	Binary Input – All variations	1	6			
1	1	Binary Input			129	1	Assigned to Class 0.
2	0	Binary Input Change – All variations	1	6,7,8			
2	1	Binary Input Change without Time	1	6,7,8	129		B
2	2	Binary Input Change with Time	1	6,7,8	129,130	28	Assigned to Class 1.
2	3	Binary Input Change with Relative Time	1	6,7,8	129		B
10	0	Binary Outputs – All variations	1	6	129		A
12	1	Control Relay Output Block	3,4,5,6	17,28	129	17,28	
20	0	Binary Counter – All variations	1	6	129		~~A~~
20	1	32 Bits Binary Counter			129	1	
21	0	Frozen Counter – All variations	1	6	129		~~A~~
21	1	32 Bits Frozen Counter			129	1	
22	0	Counter Change Event – All variations	1	6,7,8	129		B
30	0	Analog Input – All variations	1	6			
30	2	16-Bit Analog Input			129	1	Assigned to Class 0.
32	0	Analog Change Event – All variations	1	6,7,8			
32	4	16-Bit Analog Change Event with Time			129,130	28	Assigned to Class 2.
40	0	Analog Output Status – All variations	1	6	129		A
41	2	16-Bit Analog Output Block	3,4,5,6	17,28	129		A
50	1	Time and Date	2	7 count=1	129		C
52	2	Time Delay Fine	23		129	1	F,G

OBJECT			REQUEST (RTV will parse)		RESPONSE (RTV will respond)		
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes (dec)	Qual Codes (hex)	Notes
60	1	Class 0 Data	1	6	129	1	
60	2	Class 1 Data	1 20,21	6,7,8 6	129,130	28	D
60	3	Class 2 Data	1 20,21	6,7,8 6	129,130	28	D
60	4	Class 3 Data	1 20,21	6,7,8 6	N/A		B
80	1	Internal Indications	2	0 index=7			E
--	--	No Object (Cold Start)	13				F
--	--	No Object (Warm Start)	14				F
--	--	No Object (Delay Measurement)	23				G

NOTES

A: Device implementation level does not support this group and variation of object or, for static objects, it has no objects with this group and variation. OBJECT UNKNOWN response (IIN2 bit 1 set).

B: No point range was specified, and device has no objects of this type. NULL response (no IIN bits set, but no objects of the specified type returned).

C: Device supports write operations on Time and Date objects. Time Synchronization-Required Internal Indication bit (IIN1-4) will be cleared on the response.

D: The device can be configured to send or not, unsolicited responses depending on a configuration option by means of *MMI* (Man-Machine Interface or front-panel user interface). Then, the Master can Enable or Disable Unsolicited messages (for Classes 1 and 2) by means of requests (FC 20 and 21).
If the unsolicited response mode is configured "on", then upon device restart, the device will transmit an initial Null unsolicited response, requesting an application layer confirmation. While waiting for that application layer confirmation, the device will respond to all function requests, including READ requests.

E: Restart Internal Indication bit (IIN1-7) can be cleared explicitly by the master.

F: The outstation, upon receiving a *Cold or Warm Start* request, will respond sending a Time Delay Fine object message (which specifies a time interval until the outstation will be ready for further communications), restarting the DNP process, clearing events stored in its local buffers and setting IIN1-7 bit (Device Restart).

G: Device supports Delay Measurement requests (FC = 23). It responds with the Time Delay Fine object (52-2). This object states the number of milliseconds elapsed between Outstation receiving the first bit of the first byte of the request and the time of transmission of the first bit of the first byte of the response.

DEVICE SPECIFIC FEATURES

- Internal Indication IIN1-6 (Device trouble): Set to indicate a change in the current DNP configuration in the outstation. Cleared in the next response. Used to let the master station know that DNP settings have changed at the outstation. Note that some erroneous configurations could make impossible to communicate this condition to a master station.

  This document also states the DNP3.0 settings currently available in the device. If the user changes whatever of these settings, it will set the *Device Trouble Internal Indication* bit on the next response sent.
- Event buffers: device can hold as much as 50 Binary Input Changes and 50 Analog Input Changes. If these limits are reached the device will set the *Event Buffers Overflow Internal Indication* bit on the next response sent. It will be cleared when the master reads the changes, making room for new ones.
- Configuration ➔ Operation Enable menu: the device can enable or disable permissions for the operations over al Control Relay Output Block. In case permissions are configured off (disabled) the response to a command (issued as Control Relay Output Block) will have the Status code NOT_AUTHORIZED. In case the equipment is blocked the commands allowed are the configured when permitted. While blocked, the relay will accept commands over the configured signal. If the equipment is in operation inhibited state, the response to all commands over the configured signal will have the Status code NOT_AUTHORIZED.
- Configuration ➔ Binary Inputs/Outputs menu: contains the default configuration (as shipped from factory or after a reset by means of F4 key), but customers can configure Inputs/Outputs to suit their needs, by means of *ZIVercomPlus®* software.

POINT LIST

BINARY INPUT (OBJECT 1) -> Assigned to Class 0. BINARY INPUT CHANGE (OBJECT 2) -> Assigned to Class 1.		
Index	Description	
0	*Configure by ZIVercomPlus*® 2048 points	
1	*Configure by ZIVercomPlus*® 2048 points	
2	*Configure by ZIVercomPlus*® 2048 points	
3	*Configure by ZIVercomPlus*® 2048 points	
4	*Configure by ZIVercomPlus*® 2048 points	
5	*Configure by ZIVercomPlus*® 2048 points	
6	*Configure by ZIVercomPlus*® 2048 points	
7	*Configure by ZIVercomPlus*® 2048 points	
8	*Configure by ZIVercomPlus*® 2048 points	
9	*Configure by ZIVercomPlus*® 2048 points	
10	*Configure by ZIVercomPlus*® 2048 points	
11	*Configure by ZIVercomPlus*® 2048 points	
12	*Configure by ZIVercomPlus*® 2048 points	
13	*Configure by ZIVercomPlus*® 2048 points	
14	*Configure by ZIVercomPlus*® 2048 points	
15	*Configure by ZIVercomPlus*® 2048 points	
16	*Configure by ZIVercomPlus*® 2048 points	
17	*Configure by ZIVercomPlus*® 2048 points	
...	*Configure by ZIVercomPlus*® 2048 points	
253	*Configure by ZIVercomPlus*® 2048 points	
254	*Configure by ZIVercomPlus*® 2048 points	
255	*Configure by ZIVercomPlus*® 2048 points	

CONTROL RELAY OUTPUT BLOCK (OBJECT 12)		
Index	Description	
0	*Configure by ZIVercomPlus⑧* 256 points	
1	*Configure by ZIVercomPlus⑧* 256 points	
2	*Configure by ZIVercomPlus⑧* 256 points	
3	*Configure by ZIVercomPlus⑧* 256 points	
4	*Configure by ZIVercomPlus⑧* 256 points	
5	*Configure by ZIVercomPlus⑧* 256 points	
6	*Configure by ZIVercomPlus⑧* 256 points	
7	*Configure by ZIVercomPlus⑧* 256 points	
8	*Configure by ZIVercomPlus⑧* 256 points	
9	*Configure by ZIVercomPlus⑧* 256 points	
10	*Configure by ZIVercomPlus⑧* 256 points	
11	*Configure by ZIVercomPlus⑧* 256 points	
12	*Configure by ZIVercomPlus⑧* 256 points	
13	*Configure by ZIVercomPlus⑧* 256 points	
14	*Configure by ZIVercomPlus⑧* 256 points	
15	*Configure by ZIVercomPlus⑧* 256 points	
16	*Configure by ZIVercomPlus⑧* 256 points	
17	*Configure by ZIVercomPlus⑧* 256 points	
...	*Configure by ZIVercomPlus⑧* 256 points	
253	*Configure by ZIVercomPlus⑧* 256 points	
254	*Configure by ZIVercomPlus⑧* 256 points	
255	*Configure by ZIVercomPlus⑧* 256 points	

ANALOG INPUT (OBJECT 30) -> Assigned to Class 0. ANALOG INPUT CHANGE (OBJECT 32) -> Assigned to Class 2.		
Index	Description	Deadband
0	*Configure by ZIVercomPlus®* 512 points	Deadband_1.
1	*Configure by ZIVercomPlus®* 512 points	Deadband_2.
2	*Configure by ZIVercomPlus®* 512 points	Deadband_3.
3	*Configure by ZIVercomPlus®* 512 points	Deadband_4.
4	*Configure by ZIVercomPlus®* 512 points	Deadband_5.
5	*Configure by ZIVercomPlus®* 512 points	Deadband_6.
6	*Configure by ZIVercomPlus®* 512 points	Deadband_7.
7	*Configure by ZIVercomPlus®* 512 points	Deadband_8.
8	*Configure by ZIVercomPlus®* 512 points	Deadband_9.
9	*Configure by ZIVercomPlus®* 512 points	Deadband_10.
10	*Configure by ZIVercomPlus®* 512 points	Deadband_11.
11	*Configure by ZIVercomPlus®* 512 points	Deadband_12.
12	*Configure by ZIVercomPlus®* 512 points	Deadband_13.
13	*Configure by ZIVercomPlus®* 512 points	Deadband_14.
14	*Configure by ZIVercomPlus®* 512 points	Deadband_15.
15	*Configure by ZIVercomPlus®* 512 points	Deadband_16.

Additional assign with *ZIVercomPlus®*:

ANALOG INPUT (OBJECT 30) -> Assigned to Class 0.	
Index	Description
16	*Configure by ZIVercomPlus® 512 points*
17	*Configure by ZIVercomPlus® 512 points*
18	*Configure by ZIVercomPlus® 512 points*
19	*Configure by ZIVercomPlus® 512 points*
20	*Configure by ZIVercomPlus® 512 points*
21	*Configure by ZIVercomPlus® 512 points*
22	*Configure by ZIVercomPlus® 512 points*
23	*Configure by ZIVercomPlus® 512 points*
24	*Configure by ZIVercomPlus® 512 points*
25	*Configure by ZIVercomPlus® 512 points*
26	*Configure by ZIVercomPlus® 512 points*
27	*Configure by ZIVercomPlus® 512 points*
....	*Configure by ZIVercomPlus® 512 points*
254	*Configure by ZIVercomPlus® 512 points*
255	*Configure by ZIVercomPlus® 512 points*

The full scale ranges are adjustable and user's magnitudes can be created. It's possible to choose between primary and secondary values, considering CT and PT ratios. Typical ranges in secondary values are:

Description	Full Scale Range		
	Engineering units	Counts	
Currents (Local & Remote)	0 to 1,2 x In_{PHASE} A	0 to 32767	↔ Deadband
Voltage	0 to 1,2 x Vn V	0 to 32767	↔ Deadband
Power (Real, reactive, apparent)	0 to 3 x 1,4 x In_{PHASE} x Vn/√3 W	-32768 to 32767	↔ Deadband
Power factor	-1 to 1	-32768 to 32767	↔ Deadband

With *ZIVercomPlus®* program it's possible to define the ***Full Scale Range*** that is desired to transmit each magnitude in *counts*, which is the unit used by the protocol. There are three parameters to determine the distance range covered:

- **Offset:** minimum value of each magnitude to transmit 0 counts.
- **Limit:** it's the length of the magnitude range used to calculate the number of counts to transmit. If **offset** is 0, it's the same as the value of the magnitude for which the maximum number of counts defined by the protocol is sent (32767 counts).
- **Nominal Flag:** this *flag* defines if the **limit** is proportional to the rated value of the magnitude or not. The rated value of the new magnitudes defined by the user is a setting, while for the pre-defined magnitudes is a fix value.

Mathematical expression to describe the ***Full Scale Range*** is:

- When **Nominal Flag** is actived,

$$MeasureComm = \frac{Measure - Offset}{RatedValue} \times \frac{32767}{Limit}$$

- When **Nominal Flag** is NOT actived,

$$MeasureComm = (Measure - Offset) \times \frac{32767}{Limit}$$

Deadbands

- Deadbands are used for configuring *Analog Input Change* objects (Object 32).
- A Deadband is defined as a percentage over the **Full Scale Range** (FSR).
- The Deadband can be adjusted to the device by means of *MMI* (Man-Machine Interface or front-panel user interface), between 0.00% and 100.00%, in steps of 0.01%. Default value is 100.00%, meaning that generation of Analog Change Events is **DISABLED** for that input. There is an independent setting for each Analog Input.

Energy counters

The range for the energy counters in primary values is from 100wh/varh to 99999Mwh/Mvarh, and these are the values transmitted by protocol.

DNP3 PROTOCOL SETTINGS

DNP3 Protocol Settings						
DNP Protocol Configuration						
Setting Name	**Type**	**Minimum Value**	**Maximum Value**	**Default Value**	**Step/ Select**	**Unit**
Relay Number	Integer	0	65519	1	1	
T Confirm Timeout	Integer	1000	65535	1000	1	msec.
Max Retries	Integer	0	65535	0	1	
Enable Unsolicited.	Boolean	0 (No)	1 (Yes)	0 (No)	1	
Enable Unsol. after Restart	Boolean	0 (No)	1 (Yes)	0 (No)	1	
Unsolic. Master No.	Integer	0	65519	1	1	
Unsol. Grouping Time	Integer	100	65535	1000	1	msec.
Synchronization Interval	Integer	0	120	0	1	min.
DNP 3.0 Rev.	Integer	2003 ST.ZIV	2003 ST.ZIV	2003	2003 ST.ZIV	
DNP Port 1 Configuration						
Setting Name	**Type**	**Minimum Value**	**Maximum Value**	**Default Value**	**Step/ Select**	**Unit**
Protocol Select	**Uinteger**	**Procome Dnp3 Modbus**	**Procome Dnp3 Modbus**	**Procome**	**Procome Dnp3 Modbus**	
Baud rate	**Integer**	**300**	**38400**	**38400**	**300 600 1200 2400 4800 9600 19200 38400**	**baud**
Stop Bits	**Integer**	**1**	**2**	**1**	**1**	
Parity	**Integer**	**None Odd Even**	**None Odd Even**	**None**	**None Odd Even**	
Rx Time btw. Char	**Float**	**1**	**60000**	**0.5**	**40**	**msec.**
Comms Fail Ind. Time	**Float**	**0**	**600**	**0.1**	**60**	**s**

Advaced settings						
Flow control						
CTS Flow	Bool	No Yes	No Yes	No	No Yes	
DSR Flow	Bool	No Yes	No Yes	No	No Yes	
DSR Sensitive	Bool	No Yes	No Yes	No	No Yes	
DTR Control	Integer	Inactive Active Rec. Req.	Inactive Active Rec. Req.	Inactive	Inactive Active Rec. Req.	
RTS Control	Integer	Inactive Active Rec. Req. Sen. Req.	Inactive Active Rec. Req. Sen. Req.	Inactive	Inactive Active Rec. Req. Sen. Req.	
Times						
Tx Time Factor	Float	0	100	1	0.5	
Tx Timeout Const	Uinteger	0	60000	0	1	
Message modification						
Number of Zeros	Integer	0	255	0	1	
collision						
Collision Type	Integer	NO ECHO DCD	NO ECHO DCD	NO	NO ECHO DCD	
Max Retries	Integer	0	3	0	1	
Min Retry Time	Uinteger	0	60000	0	1	msec.
Max Retry Time	Uinteger	0	60000	0	1	msec.

DNP Port 2 Configuration

Setting Name	Type	Minimum Value	Maximum Value	Default Value	Step/ Select	Unit
Protocol Select	Uinteger	Procome Dnp3 Modbus	Procome Dnp3 Modbus	Procome	Procome Dnp3 Modbus	
Baud rate	Integer	300	38400	38400	300 600 1200 2400 4800 9600 19200 38400	baud
Stop Bits	Integer	1	2	1	1	
Parity	Integer	None Odd Even	None Odd Even	None	None Odd Even	
Rx Time btw. Char	Float	1	60000	0.5	40	msec.
Comms Fail Ind. Time	Float	0	600	0.1	60	s

Advaced settings						
Operating Mode	**Integer**	**RS-232 RS-485**	**RS-232 RS-485**	**RS-232**	**RS-232 RS-485**	
Times						
Tx Time Factor	**Float**	**0**	**100**	**1**	**0.5**	
Tx Timeout Const	**Uinteger**	**0**	**60000**	**0**	**1**	
Wait N Bytes 485	**Integer**	**0**	**4**	**0**	**1**	
Message modification						
Number of Zeros	**Integer**	**0**	**255**	**0**	**1**	
collision						
Collision Type	**Integer**	**NO ECHO**	**NO ECHO**	**NO**	**NO ECHO**	
Max Retries	**Integer**	**0**	**3**	**0**	**1**	
Min Retry Time	**Uinteger**	**0**	**60000**	**0**	**1**	**msec.**
Max Retry Time	**Uinteger**	**0**	**60000**	**0**	**1**	**msec.**

Analog Inputs (Deadbands)						
Setting Name	**Type**	**Minimum Value**	**Maximum Value**	**Default Value**	**Step**	**Unit**
Deadband AI#0	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#1	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#2	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#3	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#4	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#5	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#6	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#7	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#8	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#9	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#10	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#11	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#12	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#13	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#14	Float	0 %	100 %	100 %	0.01 %	
Deadband AI#15	Float	0 %	100 %	100 %	0.01 %	

- ✓ All settings remain unchanged after a power loss.

DNP Protocol Configuration

- **Relay Number** (RTU Address):
  Remote Terminal Unit Address. Addresses 0xFFF0 to 0xFFFF are reserved as *Broadcast Addresses*.
- **T Confirm Timeout** (N7 Confirm Timeout) :
  Timeout while waiting for Application Layer Confirmation. It applies to Unsolicited messages and Class 1 and Class 2 responses with event data.
- **Max Retries** (N7 Retries) :
  Number of retries of the Application Layer after timeout while waiting for Confirmation.
- **Enable Unsolicited** (Enable Unsolicited Reporting) :
  Enables or disables Unsolicited reporting.
- **Enable Unsol. after Restart** :
  Enables or disables Unsolicited after Restart (for compatibility with terminals whose revision is before DNP3-1998). It has effect only if **Enable Unsolicited after Restart is set.**
- **Unsolic. Master No**. (MTU Address) :
  Destination address of the Master device to which the unsolicited responses are to be sent. Addresses 0xFFF0 to 0xFFFF are reserved as *Broadcast Addresses*. It is useful only when Unsolicited Reporting is enabled.
- **Unsol. Grouping Time** (Unsolicited Delay Reporting) :
  Delay between an event being generated and the subsequent transmission of the unsolicited message, in order to group several events in one message and to save bandwidth.
- **Synchronization Interval**
  Max interval time between two synchronization. If no synchronizing inside interval, indication IIN1-4 (NEED TIME). This setting has no effect if **Synchronization Interval is zero.**
- **DNP 3.0 Rev**.
  Certification revision **STANDARD ZIV** or **2003** (DNP3-2003 Intelligent Electronic Device (IED) Certification Procedure Subset Level 2 Version 2.3 29-Sept-03)

DNP Port 1 and Port 2 Configuration

- **Number of Zeros** (Advice_Time) :
  Number of zeros before the message.
- **Max Retries** (N1 Retries) :
  Number of retries of the Physical Layer after collision detection.
- **Min Retry Time** (Fixed_delay) :
  Minimum time to retry of the Physical Layer after collision detection.
- **Max Retry Time** :
  Maximum time to retry of the Physical Layer after collision detection.
- **Collision Type** :
  Port 1:
  NO
  ECHO based on detection of transmitted data (monitoring all data transmitted on the link).

  Port 2:
  NO
  ECHO based on detection of transmitted data (monitoring all data transmitted on the link.
  DCD (Data Carrier Detect) based on detecting out-of-band carrier.

  If the device prepares to transmit and finds the link busy, it waits until is no longer busy, and then waits a backoff_time as follows:
  backoff_time = Min Retry Time + random(Max Retry Time - Max Retry Time)
  and transmit. If the device has a collision in transmission the device tries again,up to a configurable number of retries (Max Retries) if has news collision.

- **Wait N Bytes 485**:
  Number of wait bytes between Reception and transmission Use Port 2 Operate Mode RS-485.

Dnp3 Profile II

(Version 02.46.00 is the first Software Version that supports this Profile)

DNP V3.00 Profile II

DEVICE PROFILE DOCUMENT

This document must be accompanied by: Implementation Table and Point List.

Vendor Name: ZIV Aplicaciones y Tecnología S.A.

Device Name: RTV

Highest DNP Level Supported: For Requests **2** For Responses **2**	Device Function: ☐ Master ☒ Slave

Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):

1) **Supports Enable/Disable Unsolicited Responses (FC=20 and 21), for classes 1 and 2.**
2) **Supports Write operations (FC=2) on Time and Date objects.**
3) **Supports Delay measurement Fine (FC=23).**
4) **Supports Warm Start command (FC=14).**
5) **Supports** Unsolicited after Restart (for compatibility with terminals whose revision is before DNP3-1998)
6) **Supports selection of DNP3 Revision.**
7) **Supports indication of no** synchronization in time.
8) **Supports simultaneous communications with two different Master devices**
9) **Supports assign event Class for Binary, Analog and Counter events:**
   Class 1 , Class 2, Class 3, None
10) **Supports respond to Multiple Read Request with multiple object types in the same Application Fragment .**

Maximum Data Link Frame Size (octets): Transmitted ____**292**____ Received ____**292**____	Maximum Application Fragment Size (octets): Transmitted _**2048**_ (if >2048, must be configurable) Received___**249**__(must be <= 249)
Maximum Data Link Re-tries: ☒ None ☐ Fixed at ____________ ☐ Configurable, range ___ to ______	Maximum Application Layer Re-tries: ☐ None ☒ Configurable, range __**0**__ to __**3**__ (Fixed is not permitted)

Requires Data Link Layer Confirmation:

☒ Never
☐ Always
☐ Sometimes. If 'Sometimes', when?
____
☐ Configurable. If 'Configurable', how?
____

Requires Application Layer Confirmation:

- ☐ Never
- ☐ Always (not recommended)
- ☒ When reporting Event Data (Slave devices only) **For unsolicited, Class 1 Class 2 and Class 3 responses that contain Event Data. (If there is no Event Data reported into a Class 1 2 or 3 response, Application Layer Confirmation is not requested)**
- ☐ When sending multi-fragment responses (Slave devices only)
- ☐ Sometimes. If 'Sometimes', when?
- ☐ Configurable. If 'Configurable', how?

Timeouts while waiting for:

Data Link Confirm	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable
Complete Appl. Fragment	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable
Application Confirm	☐ None	☐ Fixed at ____	☐ Variable	☒ Configurable
Complete Appl. Response	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable

Others

Attach explanation if 'Variable' or 'Configurable' was checked for any timeout

Application Confirm timeout setting (*MMI*): Range 50 ms. 65.535 ms.

Sends/Executes Control Operations:

- Maximum number of CROB (obj. 12, var. 1) objects supported in a single message **1**
- Maximum number of Analog Output (obj. 41, any var.) supported in a single message **0**

☐ Pattern Control Block and Pattern Mask (obj. 12, var. 2 and 3 respectively) supported.
☐ CROB (obj. 12) and Analog Output (obj. 41) permitted together in a single message.

WRITE Binary Outputs	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
SELECT (3) / OPERATE (4)	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE (5)	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE - NO ACK (6)	☐ Never	☒ Always	☐ Sometimes	☐ Configurable

Count > 1	☐ Never	☐ Always	☒ Sometimes	☐ Configurable
Pulse On	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Pulse Off	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Latch On	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Latch Off	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable

Attach explanation:

- **All points support the same Function Codes: (3) Select, (4) Operate, (5) Direct Operate and (6) Direct Operate - No ACK.**
- **Maximum Select/Operate Delay Time: 60 seconds.**
- **Count can be >1 only for PULSE ON and PULSE OFF**

FILL OUT THE FOLLOWING ITEMS FOR SLAVE DEVICES ONLY:	
Reports Binary Input Change Events when no specific variation requested: ☐ Never ☒ Only time-tagged ☐ Only non-time-tagged ☐ Configurable to send both, one or the other (attach explanation)	Reports time-tagged Binary Input Change Events when no specific variation requested: ☐ Never ☒ Binary Input Change With Time ☐ Binary Input Change With Relative Time ☐ Configurable (attach explanation)
Sends Unsolicited Responses: ☐ Never ☒ Configurable (**See Note D**) ☒ Only certain objects **(Class 1 2 and 3)** ☐ Sometimes (attach explanation) ☒ ENABLE/DISABLE UNSOLICITED Function codes supported	Sends Static Data in Unsolicited Responses: ☒ Never ☐ When Device Restarts ☐ When Status Flags Change No other options are permitted.
Default Counter Object/Variation: ☐ No Counters Reported ☐ Configurable (attach explanation) ☒ Default Object 20,21 Default Variation 1 ☐ Point-by-point list attached	Counters Roll Over at: ☐ No Counters Reported ☐ Configurable (attach explanation) ☐ 16 Bits ☐ 32 Bits ☒ Other Value 31 Bits ☐ Point-by-point list attached
Sends Multi-Fragment Responses: ☒ Yes ☐ No	

QUICK REFERENCE FOR DNP3.0 LEVEL 2 FUNCTION CODES & QUALIFIERS

Function Codes

1	Read
2	Write
3	Select
4	Operate
5	Direct Operate
6	Direct Operate-No ACK
7	Immediate Freeze
8	Immediate Freeze no ACK
13	Cold Start
14	Warm Start
20	Enable Unsol. Messages
21	Disable Unsol. Messages
23	Delay Measurement
129	Response
130	Unsolicited Message

7	6	5	4	3	2	1	0
	Index Size			Qualifier Code			

Index Size

0- No Index, Packed
1- 1 byte Index
2- 2 byte Index
3- 4 byte Index
4- 1 byte Object Size
5- 2 byte Object Size
6- 4 byte Object Size

Qualifier Code

0- 8-Bit Start and Stop Indices
1- 16-Bit Start and Stop Indices
2- 32-Bit Start and Stop Indices
3- 8-Bit Absolute address Ident.
4- 16-Bit Absolute address Ident.
5- 32-Bit Absolute address Ident.
6- No Range Field (all)
7- 8-Bit Quantity
8- 16-Bit Quantity
9- 32-Bit Quantity
11-(0xB) Variable array

IMPLEMENTATION TABLE

OBJECT			REQUEST (RTV parse)		RESPONSE (RTV respond)		
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes (dec)	Qual Codes (hex)	Notes
1	0	Binary Input – All variations	1	0,1,6,7,8			Assigned to Class 0.
1	1	Binary Input	1	0,1,6,7,8	129	0,1	
2	0	Binary Input with Status	1	0,1,6,7,8	129	0,1	
2	0	Binary Input Change – All variations	1	6,7,8			
2	2	Binary Input Change with Time	1	6,7,8	129,130	17,,28	Assign to Event Class
12	1	Control Relay Output Block	3,4,5,6	17,28	129	17,28	Echo of request
20	0	Binary Counter – All variations	1	0,1,6,7,8			Assigned to Class 0.
20	1	32 Bits Binary Counter			129	0,1	
21	0	Frozen Counter – All variations	1	0,1,6,7,8			
21	1	32 Bits Frozen Counter			129	0,1	
22	0	Counter Change Event – All variations	1	6,7,8			
22	5	32 Bits Counter Change Event With Time			129,130	17,,28	Assign to Event Class
30	0	Analog Input – All variations	1	0,1,6,7,8			Assigned to Class 0.
30	1	32-Bit Analog Input	1	0,1,6,7,8	129	1	
30	2	16-Bit Analog Input	1	0,1,6,7,8	129	1	
32	0	Analog Change Event – All variations	1	6,7,8			
32	3	32-Bit Analog Change Event with Time	1	6,7,8	129,130	28	Assign to Event Class
32	4	16-Bit Analog Change Event with Time	1	6,7,8	129,130	28	Assign to Event Class
50	1	Time and Date	2	7 count=1	129		C
52	2	Time Delay Fine	23		129	1	F,G

OBJECT			REQUEST (RTV parse)		RESPONSE (RTV respond)		
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes (dec)	Qual Codes (hex)	Notes
60	1	Class 0 Data	1	6	129	1	
60	2	Class 1 Data	1 20,21	6,7,8 6	129,130	28	D
60	3	Class 2 Data	1 20,21	6,7,8 6	129,130	28	D
60	4	Class 3 Data	1 20,21	6,7,8 6	129,130	28	D
80	1	Internal Indications	2	0 index=7			E
--	--	No Object (Cold Start)	13				F
--	--	No Object (Warm Start)	14				F
--	--	No Object (Delay Measurement)	23				G

NOTES

C: Device supports write operations on Time and Date objects. Time Synchronization-Required Internal Indication bit (IIN1-4) will be cleared on the response.

D: The device can be configured to send or not, unsolicited responses depending on a configuration option by means of *MMI* (Man-Machine Interface or front-panel user interface *ZIVercomPlus*). Then, the Master can Enable or Disable Unsolicited messages (for Classes 1, 2 and 3) by means of requests (FC 20 and 21).
If the unsolicited response mode is configured “on”, then upon device restart, the device will transmit an initial Null unsolicited response, requesting an application layer confirmation. While waiting for that application layer confirmation, the device will respond to all function requests, including READ requests.

E: Restart Internal Indication bit (IIN1-7) can be cleared explicitly by the master.

F: The outstation, upon receiving a *Cold or Warm Start* request, will respond sending a Time Delay Fine object message (which specifies a time interval until the outstation will be ready for further communications), restarting the DNP process, clearing events stored in its local buffers and setting IIN1-7 bit (Device Restart).

G: Device supports Delay Measurement requests (FC = 23). It responds with the Time Delay Fine object (52-2). This object states the number of milliseconds elapsed between Outstation receiving the first bit of the first byte of the request and the time of transmission of the first bit of the first byte of the response.

DEVICE SPECIFIC FEATURES

- Internal Indication IIN1-6 (Device trouble): Set to indicate a change in the current DNP configuration in the outstation. Cleared in the next response. Used to let the master station know that DNP settings have changed at the outstation. Note that some erroneous configurations could make impossible to communicate this condition to a master station.

  This document also states the DNP3.0 settings currently available in the device. If the user changes whatever of these settings, it will set the *Device Trouble Internal Indication* bit on the next response sent.
- Event buffers: device can hold as much as 128 Binary Input Changes, 64 Analog Input Changes and 64 Counter Input Change. If these limits are reached the device will set the *Event Buffers Overflow Internal Indication* bit on the next response sent. It will be cleared when the master reads the changes, making room for new ones.
- Configuration ➔ Operation Enable menu: the device can enable or disable permissions for the operations over al Control Relay Output Block. In case permissions are configured off (disabled) the response to a command (issued as Control Relay Output Block) will have the Status code NOT_AUTHORIZED. In case the equipment is blocked the commands allowed are the configured when permitted. While blocked, the relay will accept commands over the configured signal. If the equipment is in operation inhibited state, the response to all commands over the configured signal will have the Status code NOT_AUTHORIZED.
- Customers can configure Inputs/Outputs to suit their needs, by means of *ZIVercomPlus®* software.

POINT LIST

BINARY INPUT (OBJECT 1) -> Assigned to Class 0. BINARY INPUT CHANGE (OBJECT 2) -> Assign to Class.		
Index	Description	
0	*Configure by ZIVercomPlus®* 2048 points	
1	*Configure by ZIVercomPlus®* 2048 points	
2	*Configure by ZIVercomPlus®* 2048 points	
3	*Configure by ZIVercomPlus®* 2048 points	
4	*Configure by ZIVercomPlus®* 2048 points	
5	*Configure by ZIVercomPlus®* 2048 points	
6	*Configure by ZIVercomPlus®* 2048 points	
7	*Configure by ZIVercomPlus®* 2048 points	
8	*Configure by ZIVercomPlus®* 2048 points	
9	*Configure by ZIVercomPlus®* 2048 points	
10	*Configure by ZIVercomPlus®* 2048 points	
11	*Configure by ZIVercomPlus®* 2048 points	
12	*Configure by ZIVercomPlus®* 2048 points	
13	*Configure by ZIVercomPlus®* 2048 points	
14	*Configure by ZIVercomPlus®* 2048 points	
15	*Configure by ZIVercomPlus®* 2048 points	
16	*Configure by ZIVercomPlus®* 2048 points	
17	*Configure by ZIVercomPlus®* 2048 points	
...	*Configure by ZIVercomPlus®* 2048 points	
253	*Configure by ZIVercomPlus®* 2048 points	
254	*Configure by ZIVercomPlus®* 2048 points	
255	*Configure by ZIVercomPlus®* 2048 points	

CONTROL RELAY OUTPUT BLOCK (OBJECT 12)		
Index	Description	
0	*Configure by ZIVercomPlus®* 256 points	
1	*Configure by ZIVercomPlus®* 256 points	
2	*Configure by ZIVercomPlus®* 256 points	
3	*Configure by ZIVercomPlus®* 256 points	
4	*Configure by ZIVercomPlus®* 256 points	
5	*Configure by ZIVercomPlus®* 256 points	
6	*Configure by ZIVercomPlus®* 256 points	
7	*Configure by ZIVercomPlus®* 256 points	
8	*Configure by ZIVercomPlus®* 256 points	
9	*Configure by ZIVercomPlus®* 256 points	
10	*Configure by ZIVercomPlus®* 256 points	
11	*Configure by ZIVercomPlus®* 256 points	
12	*Configure by ZIVercomPlus®* 256 points	
13	*Configure by ZIVercomPlus®* 256 points	

CONTROL RELAY OUTPUT BLOCK (OBJECT 12)		
Index	Description	
14	*Configure by ZIVercomPlus®* 256 points	
15	*Configure by ZIVercomPlus®* 256 points	
16	*Configure by ZIVercomPlus®* 256 points	
17	*Configure by ZIVercomPlus®* 256 points	
...	*Configure by ZIVercomPlus®* 256 points	
253	*Configure by ZIVercomPlus®* 256 points	
254	*Configure by ZIVercomPlus®* 256 points	
255	*Configure by ZIVercomPlus®* 256 points	

ANALOG INPUT (OBJECT 30) -> Assigned to Class 0. ANALOG INPUT CHANGE (OBJECT 32) -> Assign to Class		
Index	Description	Deadband
0	*Configure by ZIVercomPlus®* 256 points	() Deadband_1.
1	*Configure by ZIVercomPlus®* 256 points	() Deadband_2.
2	*Configure by ZIVercomPlus®* 256 points	() Deadband_3.
3	*Configure by ZIVercomPlus®* 256 points	() Deadband_4.
4	*Configure by ZIVercomPlus®* 256 points	() Deadband_5.
5	*Configure by ZIVercomPlus®* 256 points	() Deadband_6.
6	*Configure by ZIVercomPlus®* 256 points	() Deadband_7.
7	*Configure by ZIVercomPlus®* 256 points	() Deadband_8.
8	*Configure by ZIVercomPlus®* 256 points	() Deadband_9.
9	*Configure by ZIVercomPlus®* 256 points	() Deadband_10.
10	*Configure by ZIVercomPlus®* 256 points	() Deadband_11.
11	*Configure by ZIVercomPlus®* 256 points	() Deadband_12.
12	*Configure by ZIVercomPlus®* 256 points	() Deadband_13.
13	*Configure by ZIVercomPlus®* 256 points	() Deadband_14.
14	*Configure by ZIVercomPlus®* 256 points	() Deadband_15.
15	*Configure by ZIVercomPlus®* 256 points	() Deadband_16.

Additional assign with *ZIVercomPlus*⑧:

Index	Description
16	*Configure by ZIVercomPlus⑧* 256 *points*
17	*Configure by ZIVercomPlus⑧* 256 *points*
18	*Configure by ZIVercomPlus⑧* 256 *points*
19	*Configure by ZIVercomPlus⑧* 256 *points*
20	*Configure by ZIVercomPlus⑧* 256 *points*
21	*Configure by ZIVercomPlus⑧* 256 *points*
22	*Configure by ZIVercomPlus⑧* 256 *points*
23	*Configure by ZIVercomPlus⑧* 256 *points*
24	*Configure by ZIVercomPlus⑧* 256 *points*
25	*Configure by ZIVercomPlus⑧* 256 *points*
26	*Configure by ZIVercomPlus⑧* 256 *points*
27	*Configure by ZIVercomPlus⑧* 256 *points*
....	*Configure by ZIVercomPlus⑧* 256 *points*
62	*Configure by ZIVercomPlus⑧* 256 *points*
63	*Configure by ZIVercomPlus⑧* 256 *points*

The full scale ranges are adjustable and user's magnitudes can be created. It's possible to choose between primary and secondary values, considering CT and PT ratios. Typical ranges in secondary values are:

Description	Full Scale Range		
	Engineering units	Counts	
Currents (Local & Remote)	0 to 1,2 x In_{PHASE} A	0 to 32767	↻ Deadband
Voltage	0 to 1,2 x Vn V	0 to 32767	↻ Deadband
Power (Real, reactive, apparent)	0 to 3 x 1,4 x In_{PHASE} x Vn/√3 W	-32768 to 32767	↻ Deadband
Power factor	-1 to 1	-32768 to 32767	↻ Deadband

Communication Measure in Counts

With *ZIVercomPlus* program is possible to define the *Full Scale Range* that is desired to transmit each magnitude in *counts*. Parameters necessary to configure the Mathematical expression are:

- **Offset:** A number indicating the compensation of de Magnitude.
- **Limit:** it's the Maximum value of magnitude range.
- **Max Communication:** it's a constant that depend of the Number Bits of Analog Input.
  Max Communication=2**(Number Bits Analog Input - 1)
  For 16-Bit Analog Input (Obj 30 Var. 2) 2**(15) = 32.767 counts
  For 32-Bit Analog Input (Obj 30 Var. 1) 2**(31) = 2.147.483.647 counts
- **Rated value:** Nominal Value of the magnitude.
- **Nominal Flag:** This *flag* defines if the **limit** is proportional to the **rated value** of the magnitude.
- **TR:** Secondary to Primary Transformation Ratio.

Mathematical expression to describe the *Full Scale Range* is:

- When **Nominal Flag** is actived,

$$MeasureCom = TR \times \frac{Measure - Offset}{RatedValue} \times \frac{MaxComunication}{Limit}$$

- When **Nominal Flag** is NOT actived,

$$MeasureCom = TR \times (Measure - Offset) \times \frac{MaxComunication}{Limit}$$

Communication Measure in Engineering Units

With *ZIVercomPlus* program **also** it's possible to transmit each magnitude in Engineering Units. Parameters necessary to configure the Mathematical expression are:

- **Offset:** A number indicating the compensation of de magnitude.
- **Limit:** it's the Maximum value of magnitude range.
- **Rated value:** Nominal Value of the magnitude.
- **Nominal Flag:** this *flag* defines if the **limit** is proportional to the **rated value** of the magnitude or not. The rated value of the new magnitudes defined by the user is a setting, while for the pre-defined magnitudes is a fix value.
- **TR:** Secondary to Primary Transformation Ratio.
- **Scaling Factor:** Multiply Factor of magnitude.

Mathematical expression to obtain **Measure in Engineering Units** is:

- When **Nominal Flag** is actived,

$$MeasureCom = TR \times \frac{Measure - Offset}{RatedValue} \times ScalingFactor$$

- When **Nominal Flag** is NOT actived,

$$MeasureCom = TR \times (Measure - Offset) \times ScalingFactor$$

DeadBands

- Deadband is an area of a magnitude range or band where no generate magnitude change (the magnitude is dead). Meaning that no generation of Analogical Change Events if difference with value of generation of previous change is not equal or greater that DeadBand calculated. There is an independent setting for each 16 Measures with change.
- A Deadband is calculated as a percentage defined in DeadBand Setting over value of **parameter Limit**.
- The Deadband can be adjusted to the device by means of *MMI* (Man-Machine Interface or front-panel user interface *ZIVercomPlus*), between 0.0000% and 100.00%, in steps of 0.0001%. Default value is 100.00%, meaning that generation of Analog Change Events is **DISABLED** for that input. There is an independent setting for each Magnitude with change.

BINARY COUNTER (OBJECT 20) -> Assigned to Class 0. FROZEN COUNTER (OBJECT 21) 32 BIT COUNTER CHANGE EVENT (OBJECT 22) -> Assign to Class		
Index	Description	Deadband
0	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_1.
1	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_2.
2	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_3.
3	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_4.
4	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_5.
5	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_6
6	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_7.
7	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_8.
8	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_9.
9	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_10.
10	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_11.
11	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_12.
12	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_13.
13	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_14.
14	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_15.
15	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_16.
16	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_17.
17	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_18.
18	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_19.
19	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_20.

◊ CounterDeadBands

- CounterDeadband is an area of a counter magnitude range or band, where no generate counter magnitude change (the communication counter magnitude is dead).Meaning that no generation of Counter Change Events if difference with value of generation of previous change is not equal or greater that CounterDeadBand setting. There is an independent setting for each Counter.

- The CounterDeadband can be adjusted to the device by means of *MMI* (Man-Machine Interface or front-panel user interface *ZIVercomPlus*), between 1 and 32767, in steps of 1, default value is 1.

DNP3 PROTOCOL SETTINGS

DNP3 Protocol Settings						
DNP Protocol Configuration						
Setting Name	**Type**	**Minimum Value**	**Maximum Value**	**Default Value**	**Step/ Select**	**Unit**
Relay Number	Integer	0	65519	1	1	
T Confirm Timeout	Integer	1000	65535	1000	1	msec.
Max Retries	Integer	0	65535	0	1	
Enable Unsolicited.	Boolean	0 (No)	1 (Yes)	0 (No)	1	
Enable Unsol. after Restart	Boolean	0 (No)	1 (Yes)	0 (No)	1	
Unsolic. Master No.	Integer	0	65519	1	1	
Unsol. Grouping Time	Integer	100	65535	1000	1	msec.
Synchronization Interval	Integer	0	120	0	1	min.
DNP 3.0 Rev.	Integer	2003 ST.ZIV	2003 ST.ZIV	2003	2003 ST.ZIV	
Binary Changes CLASS	Integer	None Class 1 Class 2 Class 3	None Class 1 Class 2 Class 3	Class 1	None Class 1 Class 2 Class 3	
Analog Changes CLASS	Integer	None Class 1 Class 2 Class 3	None Class 1 Class 2 Class 3	Class 2	None Class 1 Class 2 Class 3	
Counter Changes CLASS	Integer	None Class 1 Class 2 Class 3	None Class 1 Class 2 Class 3	Class 3	None Class 1 Class 2 Class 3	
Binary Status Change	Boolean	0 (No)	1 (Yes)	1 (Yes)	1	
32 Bits Analog Input	Boolean	0 (No)	1 (Yes)	1 (Yes)	1	
Analog Inputs (Deadbands)						
Setting Name	**Type**	**Minimum Value**	**Maximum Value**	**Default Value**	**Step**	**Unit**
Deadband AI#0	Float	0 %	100 %	100 %	0.0001 %	
Deadband AI#1	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#2	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#3	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#4	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#5	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#6	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#7	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#8	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#9	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#10	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#11	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#12	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#13	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#14	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#15	Float	0 %	100 %	100 %	0. 0001 %	

Counter Inputs (CounterDeadbands)						
Setting Name	**Type**	**Minimum Value**	**Maximum Value**	**Default Value**	**Step**	**Unit**
Deadband Cont.I#0	Integer	1	32767	1	1	
Deadband Cont.I#1	Integer	1	32767	1	1	
Deadband Cont.I#2	Integer	1	32767	1	1	
Deadband Cont.I#3	Integer	1	32767	1	1	
Deadband Cont.I#4	Integer	1	32767	1	1	
Deadband Cont.I#5	Integer	1	32767	1	1	
Deadband Cont.I#6	Integer	1	32767	1	1	
Deadband Cont.I#7	Integer	1	32767	1	1	
Deadband Cont.I#8	Integer	1	32767	1	1	
Deadband Cont.I#9	Integer	1	32767	1	1	
Deadband Cont.I#10	Integer	1	32767	1	1	
Deadband Cont.I#11	Integer	1	32767	1	1	
Deadband Cont.I#12	Integer	1	32767	1	1	
Deadband Cont.I#13	Integer	1	32767	1	1	
Deadband Cont.I#14	Integer	1	32767	1	1	
Deadband Cont.I#15	Integer	1	32767	1	1	
Deadband Cont.I#16	Integer	1	32767	1	1	
Deadband Cont.I#17	Integer	1	32767	1	1	
Deadband Cont.I#18	Integer	1	32767	1	1	
Deadband Cont.I#19	Integer	1	32767	1	1	

DNP Port 1 Configuration						
Setting Name	**Type**	**Minimum Value**	**Maximum Value**	**Default Value**	**Step/ Select**	**Unit**
Protocol Select	**Uinteger**	**Procome Dnp3 Modbus**	**Procome Dnp3 Modbus**	**Procome**	**Procome Dnp3 Modbus**	
Baud rate	**Integer**	**300**	**38400**	**38400**	**300 600 1200 2400 4800 9600 19200 38400**	**baud**
Stop Bits	**Integer**	**1**	**2**	**1**	**1**	
Parity	**Integer**	**None Odd Even**	**None Odd Even**	**None**	**None Odd Even**	
Rx Time btw. Char	**Float**	**1**	**60000**	**0.5**	**40**	**msec.**
Comms Fail Ind. Time	**Float**	**0**	**600**	**0.1**	**60**	**s**

Advanced Settings						
Flow control						
CTS Flow	Bool	No Yes	No Yes	No	No Yes	
DSR Flow	Bool	No Yes	No Yes	No	No Yes	
DSR Sensitive	Bool	No Yes	No Yes	No	No Yes	
DTR Control	Integer	Inactive Active Rec. Req.	Inactive Active Rec. Req.	Inactive	Inactive Active Rec. Req.	
RTS Control	Integer	Inactive Active Rec. Req. Sen. Req.	Inactive Active Rec. Req. Sen. Req.	Inactive	Inactive Active Rec. Req. Sen. Req.	
Times						
Tx Time Factor	Float	0	100	1	0.5	
Tx Timeout Const	Uinteger	0	60000	0	1	
Message modification						
Number of Zeros	Integer	0	255	0	1	
collision						
Collision Type	Integer	NO ECHO DCD	NO ECHO DCD	NO	NO ECHO DCD	
Max Retries	Integer	0	3	0	1	
Min Retry Time	Uinteger	0	60000	0	1	msec.
Max Retry Time	Uinteger	0	60000	0	1	msec.

DNP Port 2 and 3 Configuration

Setting Name	Type	Minimum Value	Maximum Value	Default Value	Step/ Select	Unit
Protocol Select	Uinteger	Procome Dnp3 Modbus	Procome Dnp3 Modbus	Procome	Procome Dnp3 Modbus	
Baud rate	Integer	300	38400	38400	300 600 1200 2400 4800 9600 19200 38400	baud
Stop Bits	Integer	1	2	1	1	
Parity	Integer	None Odd Even	None Odd Even	None	None Odd Even	
Rx Time btw. Char	Float	1	60000	0.5	40	msec.
Comms Fail Ind. Time	Float	0	600	0.1	60	s

Advanced Settings						
Operating Mode	Integer	RS-232 RS-485	RS-232 RS-485	RS-232	RS-232 RS-485	
Times						
Tx Time Factor	Float	0	100	1	0.5	
Tx Timeout Const	Uinteger	0	60000	0	1	
Wait N Bytes 485	Integer	0	4	0	1	
Message modification						
Number of Zeros	Integer	0	255	0	1	
collision						
Collision Type	Integer	NO ECHO	NO ECHO	NO	NO ECHO	
Max Retries	Integer	0	3	0	1	
Min Retry Time	Uinteger	0	60000	0	1	msec.
Max Retry Time	Uinteger	0	60000	0	1	msec.

✓ All settings remain unchanged after a power loss. F4

DNP Protocol Configuration

- **Relay Number** (RTU Address):
  Remote Terminal Unit Address. Addresses 0xFFF0 to 0xFFFF are reserved as *Broadcast Addresses*.
- **T Confirm Timeout** (N7 Confirm Timeout) :
  Timeout while waiting for Application Layer Confirmation. It applies to Unsolicited messages and Class 1 and Class 2 responses with event data.
- **Max Retries** (N7 Retries) :
  Number of retries of the Application Layer after timeout while waiting for Confirmation.
- **Enable Unsolicited** (Enable Unsolicited Reporting) :
  Enables or disables Unsolicited reporting.
- **Enable Unsol. after Restart** :
  Enables or disables Unsolicited after Restart (for compatibility with terminals whose revision is before DNP3-1998). It has effect only if **Enable Unsolicited after Restart is set.**
- **Unsolic. Master No**. (MTU Address) :
  Destination address of the Master device to which the unsolicited responses are to be sent. Addresses 0xFFF0 to 0xFFFF are reserved as *Broadcast Addresses*. It is useful only when Unsolicited Reporting is enabled.
- **Unsol. Grouping Time** (Unsolicited Delay Reporting) :
  Delay between an event being generated and the subsequent transmission of the unsolicited message, in order to group several events in one message and to save bandwidth.
- **Synchronization Interval**
  Max interval time between two synchronization. If no synchronizing inside interval, indication IIN1-4 (NEED TIME). This setting has no effect if **Synchronization Interval is zero.**
- **DNP 3.0 Rev**.
  Certification revision **STANDARD ZIV** or **2003** (DNP3-2003 Intelligent Electronic Device (IED) Certification Procedure Subset Level 2 Version 2.3 29-Sept-03)
- **Binary Changes CLASS**.
  Selection to send Binary Changes as CLASS 1 CLASS 2 CLASS 3 or None.
- **Analog Changes CLASS**.
  Selection to send Analog Changes as CLASS 1 CLASS 2 CLASS 3 or None.
- **Counter Changes CLASS**.
  Selection to send Counter Changes as CLASS 1 CLASS 2 CLASS 3 or None.
- **Binary Status** .
  Send Binary with status otherwise without status
- **32 Bits Analog Input** .
  Send Analog All Variations and Analog Change Event Binary Changes with 32 bits otherwise with 16 bits

DNP Port 1 Port 2 and Port 3 Configuration

- **Number of Zeros** (Advice_Time) :
  Number of zeros before the message.
- **Max Retries** (N1 Retries) :
  Number of retries of the Physical Layer after **collision** detection.
- **Min Retry Time** (Fixed_delay) :
  Minimum time to retry of the Physical Layer after **collision** detection.
- **Max Retry Time** :
  Maximum time to retry of the Physical Layer after **collision** detection.
- **Collision Type** :

  Port 1:
  NO
  ECHO based on detection of transmitted data (monitoring all data transmitted on the link).

  Port 2:
  NO
  ECHO based on detection of transmitted data (monitoring all data transmitted on the link.
  DCD (Data Carrier Detect) based on detecting out-of-band carrier.

  If the device prepares to transmit and finds the link busy, it waits until is no longer busy, and then waits a backoff_time as follows:

  backoff_time = Min Retry Time + random(Max Retry Time - Max Retry Time)

  and transmit. If the device has a collision in transmission the device tries again ,up to a configurable number of retries (Max Retries) if has news collision.

- **Wait N Bytes 485**:
  Number of wait bytes between Reception and transmission Use Port 2 Operate Mode RS-485 .

Dnp3 Profile II Ethernet

(Version 02.60.00 is the first Software Version that supports this Profile)

DNP V3.00 Dnp3 Profile II Ethernet

DEVICE PROFILE DOCUMENT

This document must be accompanied by: Implementation Table and Point List.

Vendor Name: ZIV Aplicaciones y Tecnología S.A.

Device Name: RTV

Highest DNP Level Supported:	Device Function:
For Requests **2** For Responses **2**	☐ Master ☒ Slave

Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):

1) **Supports Enable/Disable Unsolicited Responses (FC=20 and 21), for classes 1 and 2.**
2) **Supports Write operations (FC=2) on Time and Date objects.**
3) **Supports Delay measurement Fine (FC=23).**
4) **Supports Warm Start command (FC=14).**
5) **Supports** Unsolicited after Restart (for compatibility with terminals whose revision is before DNP3-1998)
6) **Supports selection of DNP3 Revision.**
7) **Supports indication of no** synchronization in time.
8) **Supports simultaneous communications with two different Master devices**
9) **Supports assign event Class for Binary, Analog and Counter events:**
   Class 1 , Class 2, Class 3, None
10) **Supports respond to Multiple Read Request with multiple object types in the same Application Fragment .**

Maximum Data Link Frame Size (octets):	Maximum Application Fragment Size (octets):
Transmitted **292** Received **292**	Transmitted **2048** (if >2048, must be configurable) Received **249** (must be <= 249)
Maximum Data Link Re-tries:	Maximum Application Layer Re-tries:
☒ None ☐ Fixed at ____________ ☐ Configurable, range ___ to ______	☐ None ☒ Configurable, range **0** to **3** (Fixed is not permitted)

Requires Data Link Layer Confirmation:

☒ Never
☐ Always
☐ Sometimes. If 'Sometimes', when? ____________________________
☐ Configurable. If 'Configurable', how? ____________________________

Requires Application Layer Confirmation:

- ☐ Never
- ☐ Always (not recommended)
- ☒ When reporting Event Data (Slave devices only) **For unsolicited, Class 1 Class 2 and Class 2 responses that contain Event Data. (If there is no Event Data reported into a Class 1 2 or 3 response, Application Layer Confirmation is not requested)**
- ☐ When sending multi-fragment responses (Slave devices only)
- ☐ Sometimes. If 'Sometimes', when?
- ☐ Configurable. If 'Configurable', how?

Timeouts while waiting for:

Data Link Confirm	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable
Complete Appl. Fragment	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable
Application Confirm	☐ None	☐ Fixed at ____	☐ Variable	☒ Configurable
Complete Appl. Response	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable

Others

Attach explanation if 'Variable' or 'Configurable' was checked for any timeout

Application Confirm timeout setting (*MMI*): Range 50 ms. 65.535 ms.

Sends/Executes Control Operations:

- Maximum number of CROB (obj. 12, var. 1) objects supported in a single message **1**
- Maximum number of Analog Output (obj. 41, any var.) supported in a single message **0**

☐ Pattern Control Block and Pattern Mask (obj. 12, var. 2 and 3 respectively) supported.
☐ CROB (obj. 12) and Analog Output (obj. 41) permitted together in a single message.

WRITE Binary Outputs	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
SELECT (3) / OPERATE (4)	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE (5)	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE - NO ACK (6)	☐ Never	☒Always	☐ Sometimes	☐ Configurable

Count > 1	☐ Never	☐ Always	☒ Sometimes	☐ Configurable
Pulse On	☐ Never	☒Always	☐ Sometimes	☐ Configurable
Pulse Off	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Latch On	☐ Never	☒Always	☐ Sometimes	☐ Configurable
Latch Off	☐ Never	☒Always	☐ Sometimes	☐ Configurable

Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable

Attach explanation:

- **All points support the same Function Codes: (3) Select, (4) Operate, (5) Direct Operate and (6) Direct Operate - No ACK.**
- **Maximum Select/Operate Delay Time: 60 seconds.**
- **Count can be >1 only for PULSE ON and PULSE OFF**

<table>
<tr><th colspan="2">FILL OUT THE FOLLOWING ITEMS FOR SLAVE DEVICES ONLY:</th></tr>
<tr><td>Reports Binary Input Change Events when no specific variation requested:

☐ Never
☒ Only time-tagged
☐ Only non-time-tagged
☐ Configurable to send both, one or the other (attach explanation)</td><td>Reports time-tagged Binary Input Change Events when no specific variation requested:

☐ Never
☒ Binary Input Change With Time
☐ Binary Input Change With Relative Time
☐ Configurable (attach explanation)</td></tr>
<tr><td>Sends Unsolicited Responses:

☐ Never
☒ Configurable (See Note D)
☒ Only certain objects (Class 1 2 and 3)
☐ Sometimes (attach explanation)

☒ ENABLE/DISABLE UNSOLICITED Function codes supported</td><td>Sends Static Data in Unsolicited Responses:

☒ Never
☐ When Device Restarts
☐ When Status Flags Change

No other options are permitted.</td></tr>
<tr><td>Default Counter Object/Variation:

☐ No Counters Reported
☐ Configurable (attach explanation)
☒ Default Object 20,21
Default Variation 1
☐ Point-by-point list attached</td><td>Counters Roll Over at:

☐ No Counters Reported
☐ Configurable (attach explanation)
☐ 16 Bits
☐ 32 Bits
☒ Other Value 31 Bits
☐ Point-by-point list attached</td></tr>
<tr><td colspan="2">Sends Multi-Fragment Responses: ☒ Yes ☐ No</td></tr>
</table>

QUICK REFERENCE FOR DNP3.0 LEVEL 2 FUNCTION CODES & QUALIFIERS

Function Codes

Code	Function
1	Read
2	Write
3	Select
4	Operate
5	Direct Operate
9	Direct Operate-No ACK
10	Immediate Freeze
11	Immediate Freeze no ACK
13	Cold Start
14	Warm Start
20	Enable Unsol. Messages
21	Disable Unsol. Messages
23	Delay Measurement
24	Record Current Time
129	Response
130	Unsolicited Message

7	6	5	4	3	2	1	0
	Index Size			Qualifier Code			

Index Size

0- No Index, Packed
1- 1 byte Index
2- 2 byte Index
3- 4 byte Index
4- 1 byte Object Size
5- 2 byte Object Size
6- 4 byte Object Size

Qualifier Code

0- 8-Bit Start and Stop Indices
1- 16-Bit Start and Stop Indices
2- 32-Bit Start and Stop Indices
3- 8-Bit Absolute address Ident.
4- 16-Bit Absolute address Ident.
5- 32-Bit Absolute address Ident.
6- No Range Field (all)
7- 8-Bit Quantity
8- 16-Bit Quantity
9- 32-Bit Quantity
11-(0xB) Variable array

IMPLEMENTATION TABLE

OBJECT			REQUEST (RTV parse)		RESPONSE (RTV respond)		
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes (dec)	Qual Codes (hex)	Notes
1	0	Binary Input – All variations	1	0,1,6,7,8			Assigned to Class 0.
1	1	Binary Input	1	0,1,6,7,8	129	0,1	
2	0	Binary Input with Status	1	0,1,6,7,8	129	0,1	
2	0	Binary Input Change – All variations	1	6,7,8			
2	2	Binary Input Change with Time	1	6,7,8	129,130	17,,28	Assign to Event Class
12	1	Control Relay Output Block	3,4,5,6	17,28	129	17,28	Echo of request
20	0	Binary Counter – All variations	1	0,1,6,7,8			Assigned to Class 0.
20	1	32 Bits Binary Counter			129	0,1	
21	0	Frozen Counter – All variations	1	0,1,6,7,8			
21	1	32 Bits Frozen Counter			129	0,1	
22	0	Counter Change Event – All variations	1	6,7,8			
22	5	32 Bits Counter Change Event With Time			129,130	17,,28	Assign to Event Class
30	0	Analog Input – All variations	1	0,1,6,7,8			Assigned to Class 0.
30	1	32-Bit Analog Input	1	0,1,6,7,8	129	1	
30	2	16-Bit Analog Input	1	0,1,6,7,8	129	1	
32	0	Analog Change Event – All variations	1	6,7,8			
32	3	32-Bit Analog Change Event with Time	1	6,7,8	129,130	28	Assign to Event Class
32	4	16-Bit Analog Change Event with Time	1	6,7,8	129,130	28	Assign to Event Class
50	1	Time and Date	2	7 count=1	129		C
50	3	Time and Date at Last Recorded Time	2	7 count=1	129		C
52	2	Time Delay Fine	23		129	1	F,G

<table>
<tr><th colspan="3">OBJECT</th><th colspan="2">REQUEST
(RTV parse)</th><th colspan="2">RESPONSE
(RTV respond)</th><th></th></tr>
<tr><th>Obj</th><th>Var</th><th>Description</th><th>Func Codes (dec)</th><th>Qual Codes (hex)</th><th>Func Codes (dec)</th><th>Qual Codes (hex)</th><th>Notes</th></tr>
<tr><td>60</td><td>1</td><td>Class 0 Data</td><td>1</td><td>6</td><td>129</td><td>1</td><td></td></tr>
<tr><td rowspan="2">60</td><td rowspan="2">2</td><td rowspan="2">Class 1 Data</td><td>1</td><td>6,7,8</td><td rowspan="2">129,130</td><td rowspan="2">28</td><td rowspan="2">D</td></tr>
<tr><td>20,21</td><td>6</td></tr>
<tr><td rowspan="2">60</td><td rowspan="2">3</td><td rowspan="2">Class 2 Data</td><td>1</td><td>6,7,8</td><td rowspan="2">129,130</td><td rowspan="2">28</td><td rowspan="2">D</td></tr>
<tr><td>20,21</td><td>6</td></tr>
<tr><td rowspan="2">60</td><td rowspan="2">4</td><td rowspan="2">Class 3 Data</td><td>1</td><td>6,7,8</td><td rowspan="2">129,130</td><td rowspan="2">28</td><td rowspan="2">D</td></tr>
<tr><td>20,21</td><td>6</td></tr>
<tr><td>80</td><td>1</td><td>Internal Indications</td><td>2</td><td>0
index=7</td><td></td><td></td><td>E</td></tr>
<tr><td>--</td><td>--</td><td>No Object (Cold Start)</td><td>13</td><td></td><td></td><td></td><td>F</td></tr>
<tr><td>--</td><td>--</td><td>No Object (Warm Start)</td><td>14</td><td></td><td></td><td></td><td>F</td></tr>
<tr><td>--</td><td>--</td><td>No Object (Delay Measurement)</td><td>23</td><td></td><td></td><td></td><td>G</td></tr>
</table>

NOTES

C: Device supports write operations on Time and Date objects. Time Synchronization-Required Internal Indication bit (IIN1-4) will be cleared on the response.

D: The device can be configured to send or not, unsolicited responses depending on a configuration option by means of *MMI* (Man-Machine Interface or front-panel user interface *ZIVercomPlus*). Then, the Master can Enable or Disable Unsolicited messages (for Classes 1, 2 and 3) by means of requests (FC 20 and 21).
If the unsolicited response mode is configured "on", then upon device restart, the device will transmit an initial Null unsolicited response, requesting an application layer confirmation. While waiting for that application layer confirmation, the device will respond to all function requests, including READ requests.

E: Restart Internal Indication bit (IIN1-7) can be cleared explicitly by the master.

F: The outstation, upon receiving a *Cold or Warm Start* request, will respond sending a Time Delay Fine object message (which specifies a time interval until the outstation will be ready for further communications), restarting the DNP process, clearing events stored in its local buffers and setting IIN1-7 bit (Device Restart).

G: Device supports Delay Measurement requests (FC = 23). It responds with the Time Delay Fine object (52-2). This object states the number of milliseconds elapsed between Outstation receiving the first bit of the first byte of the request and the time of transmission of the first bit of the first byte of the response.

DEVICE SPECIFIC FEATURES

- Internal Indication IIN1-6 (Device trouble): Set to indicate a change in the current DNP configuration in the outstation. Cleared in the next response. Used to let the master station know that DNP settings have changed at the outstation. Note that some erroneous configurations could make impossible to communicate this condition to a master station.

  This document also states the DNP3.0 settings currently available in the device. If the user changes whatever of these settings, it will set the *Device Trouble Internal Indication* bit on the next response sent.
- Event buffers: device can hold as much as 128 Binary Input Changes, 64 Analog Input Changes and 64 Counter Input Change. If these limits are reached the device will set the *Event Buffers Overflow Internal Indication* bit on the next response sent. It will be cleared when the master reads the changes, making room for new ones.
- Configuration ➔ Operation Enable menu: the device can enable or disable permissions for the operations over al Control Relay Output Block. In case permissions are configured off (disabled) the response to a command (issued as Control Relay Output Block) will have the Status code NOT_AUTHORIZED. In case the equipment is blocked the commands allowed are the configured when permitted. While blocked, the relay will accept commands over the configured signal. If the equipment is in operation inhibited state, the response to all commands over the configured signal will have the Status code NOT_AUTHORIZED.
- Customers can configure Inputs/Outputs to suit their needs, by means of *ZIVercomPlus®* software.

POINT LIST

BINARY INPUT (OBJECT 1) -> Assigned to Class 0. BINARY INPUT CHANGE (OBJECT 2) -> Assign to Class.		
Index	Description	
0	*Configure by ZIVercomPlus*® 2048 points	
1	*Configure by ZIVercomPlus*® 2048 points	
2	*Configure by ZIVercomPlus*® 2048 points	
3	*Configure by ZIVercomPlus*® 2048 points	
4	*Configure by ZIVercomPlus*® 2048 points	
5	*Configure by ZIVercomPlus*® 2048 points	
6	*Configure by ZIVercomPlus*® 2048 points	
7	*Configure by ZIVercomPlus*® 2048 points	
8	*Configure by ZIVercomPlus*® 2048 points	
9	*Configure by ZIVercomPlus*® 2048 points	
10	*Configure by ZIVercomPlus*® 2048 points	
11	*Configure by ZIVercomPlus*® 2048 points	
12	*Configure by ZIVercomPlus*® 2048 points	
13	*Configure by ZIVercomPlus*® 2048 points	
14	*Configure by ZIVercomPlus*® 2048 points	
15	*Configure by ZIVercomPlus*® 2048 points	
16	*Configure by ZIVercomPlus*® 2048 points	
17	*Configure by ZIVercomPlus*® 2048 points	
...	*Configure by ZIVercomPlus*® 2048 points	
253	*Configure by ZIVercomPlus*® 2048 points	
254	*Configure by ZIVercomPlus*® 2048 points	
255	*Configure by ZIVercomPlus*® 2048 points	

CONTROL RELAY OUTPUT BLOCK (OBJECT 12)		
Index	Description	
0	*Configure by ZIVercomPlus*® 256 points	
1	*Configure by ZIVercomPlus*® 256 points	
2	*Configure by ZIVercomPlus*® 256 points	
3	*Configure by ZIVercomPlus*® 256 points	
4	*Configure by ZIVercomPlus*® 256 points	
5	*Configure by ZIVercomPlus*® 256 points	
6	*Configure by ZIVercomPlus*® 256 points	
7	*Configure by ZIVercomPlus*® 256 points	
8	*Configure by ZIVercomPlus*® 256 points	
9	*Configure by ZIVercomPlus*® 256 points	
10	*Configure by ZIVercomPlus*® 256 points	
11	*Configure by ZIVercomPlus*® 256 points	
12	*Configure by ZIVercomPlus*® 256 points	
13	*Configure by ZIVercomPlus*® 256 points	

CONTROL RELAY OUTPUT BLOCK (OBJECT 12)		
Index	Description	
14	*Configure by ZIVercomPlus®* 256 points	
15	*Configure by ZIVercomPlus®* 256 points	
16	*Configure by ZIVercomPlus®* 256 points	
17	*Configure by ZIVercomPlus®* 256 points	
...	*Configure by ZIVercomPlus®* 256 points	
253	*Configure by ZIVercomPlus®* 256 points	
254	*Configure by ZIVercomPlus®* 256 points	
255	*Configure by ZIVercomPlus®* 256 points	

ANALOG INPUT (OBJECT 30) -> Assigned to Class 0. ANALOG INPUT CHANGE (OBJECT 32) -> Assign to Class		
Index	Description	Deadband
0	*Configure by ZIVercomPlus®* 256 points	() Deadband_1.
1	*Configure by ZIVercomPlus®* 256 points	() Deadband_2.
2	*Configure by ZIVercomPlus®* 256 points	() Deadband_3.
3	*Configure by ZIVercomPlus®* 256 points	() Deadband_4.
4	*Configure by ZIVercomPlus®* 256 points	() Deadband_5.
5	*Configure by ZIVercomPlus®* 256 points	() Deadband_6.
6	*Configure by ZIVercomPlus®* 256 points	() Deadband_7.
7	*Configure by ZIVercomPlus®* 256 points	() Deadband_8.
8	*Configure by ZIVercomPlus®* 256 points	() Deadband_9.
9	*Configure by ZIVercomPlus®* 256 points	() Deadband_10.
10	*Configure by ZIVercomPlus®* 256 points	() Deadband_11.
11	*Configure by ZIVercomPlus®* 256 points	() Deadband_12.
12	*Configure by ZIVercomPlus®* 256 points	() Deadband_13.
13	*Configure by ZIVercomPlus®* 256 points	() Deadband_14.
14	*Configure by ZIVercomPlus®* 256 points	() Deadband_15.
15	*Configure by ZIVercomPlus®* 256 points	() Deadband_16.

Additional assign with *ZIVercomPlus®*:

Index	Description
16	*Configure by ZIVercomPlus®* 256 *points*
17	*Configure by ZIVercomPlus®* 256 *points*
18	*Configure by ZIVercomPlus®* 256 *points*
19	*Configure by ZIVercomPlus®* 256 *points*
20	*Configure by ZIVercomPlus®* 256 *points*
21	*Configure by ZIVercomPlus®* 256 *points*
22	*Configure by ZIVercomPlus®* 256 *points*
23	*Configure by ZIVercomPlus®* 256 *points*
24	*Configure by ZIVercomPlus®* 256 *points*
25	*Configure by ZIVercomPlus®* 256 *points*
26	*Configure by ZIVercomPlus®* 256 *points*
27	*Configure by ZIVercomPlus®* 256 *points*
....	*Configure by ZIVercomPlus®* 256 *points*
62	*Configure by ZIVercomPlus®* 256 *points*
63	*Configure by ZIVercomPlus®* 256 *points*

The full scale ranges are adjustable and user's magnitudes can be created. It's possible to choose between primary and secondary values, considering CT and PT ratios. Typical ranges in secondary values are:

Description	Full Scale Range		
	Engineering units	Counts	
Currents (Local & Remote)	0 to 1,2 x In_{PHASE} A	0 to 32767	↻ Deadband
Voltage	0 to 1,2 x Vn V	0 to 32767	↻ Deadband
Power (Real, reactive, apparent)	0 to 3 x 1,4 x In_{PHASE} x Vn/√3 W	-32768 to 32767	↻ Deadband
Power factor	-1 to 1	-32768 to 32767	↻ Deadband

Communication Measure in Counts

With *ZIVercomPlus* program is possible to define the *Full Scale Range* that is desired to transmit each magnitude in *counts*. Parameters necessary to configure the Mathematical expression are:

- **Offset:** A number indicating the compensation of de Magnitude.
- **Limit:** it's the Maximum value of magnitude range.
- **Max Communication:** it's a constant that depend of the Number Bits of Analog Input.
  Max Communication=2**(Number Bits Analog Input - 1)
  For 16-Bit Analog Input (Obj. 30 Var. 2) 2**(15) = 32.767 counts
  For 32-Bit Analog Input (Obj. 30 Var. 1) 2**(31) = 2.147.483.647 counts
- **Rated value:** Nominal Value of the magnitude.
- **Nominal Flag:** This *flag* defines if the **limit** is proportional to the **rated value** of the magnitude.
- **TR:** Secondary to Primary Transformation Ratio.

Mathematical expression to describe the *Full Scale Range* is:

- When **Nominal Flag** is actived,

$$MeasureCom = TR \times \frac{Measure - Offset}{RatedValue} \times \frac{MaxComunication}{Limit}$$

- When **Nominal Flag** is NOT actived,

$$MeasureCom = TR \times (Measure - Offset) \times \frac{MaxComunication}{Limit}$$

Communication Measure in Engineering Units

With *ZIVercomPlus* program **also** it's possible to transmit each magnitude in Engineering Units. Parameters necessary to configure the Mathematical expression are:

- **Offset:** A number indicating the compensation of de magnitude.
- **Limit:** it's the Maximum value of magnitude range.
- **Rated value:** Nominal Value of the magnitude.
- **Nominal Flag:** this *flag* defines if the **limit** is proportional to the **rated value** of the magnitude or not. The rated value of the new magnitudes defined by the user is a setting, while for the pre-defined magnitudes is a fix value.
- **TR:** Secondary to Primary Transformation Ratio.
- **Scaling Factor:** Multiply Factor of magnitude.

Mathematical expression to obtain **Measure in Engineering Units** is:

- When **Nominal Flag** is actived,

$$MeasureCom = TR \times \frac{Measure - Offset}{RatedValue} \times ScalingFactor$$

- When **Nominal Flag** is NOT actived,

$$MeasureCom = TR \times (Measure - Offset) \times ScalingFactor$$

◊ DeadBands

- Deadband is an area of a magnitude range or band where no generate magnitude change (the magnitude is dead). Meaning that no generation of Analogical Change Events if difference with value of generation of previous change is not equal or greater that DeadBand calculated. There is an independent setting for each 16 Measures with change.
- A Deadband is calculated as a percentage defined in DeadBand Setting over value of **parameter Limit**.
- The Deadband can be adjusted to the device by means of *MMI* (Man-Machine Interface or front-panel user interface *ZIVercomPlus*), between 0.0000% and 100.00%, in steps of 0.0001%. Default value is 100.00%, meaning that generation of Analog Change Events is DISABLED for that input. There is an independent setting for each Magnitude with change.

BINARY COUNTER (OBJECT 20) -> Assigned to Class 0.
FROZEN COUNTER (OBJECT 21)

32 BIT COUNTER CHANGE EVENT (OBJECT 22) -> Assign to Class

Index	Description	Deadband
0	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_1.
1	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_2.
2	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_3.
3	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_4.
4	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_5.
5	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_6
6	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_7.
7	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_8.
8	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_9.
9	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_10.
10	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_11.
11	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_12.
12	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_13.
13	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_14.
14	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_15.
15	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_16.
16	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_17.
17	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_18.
18	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_19.
19	*Configure by ZIVercomPlus®* 256 points	◊ CounterDeadBand_20.

CounterDeadBands

- CounterDeadband is an area of a counter magnitude range or band, where no generate counter magnitude change (the communication counter magnitude is dead).Meaning that no generation of Counter Change Events if difference with value of generation of previous change is not equal or greater that CounterDeadBand setting. There is an independent setting for each Counter.

- The CounterDeadband can be adjusted to the device by means of *MMI* (Man-Machine Interface or front-panel user interface *ZIVercomPlus*), between 1 and 32767, in steps of 1, default value is 1.

DNP3 PROTOCOL SETTINGS

DNP3 Protocol Settings						
DNP Protocol Configuration						
Setting Name	**Type**	**Minimum Value**	**Maximum Value**	**Default Value**	**Step/ Select**	**Unit**
Relay Number	Integer	0	65519	1	1	
T Confirm Timeout	Integer	1000	65535	1000	1	msec.
Max Retries	Integer	0	65535	0	1	
Enable Unsolicited.	Boolean	0 (No)	1 (Yes)	0 (No)	1	
Enable Unsol. after Restart	Boolean	0 (No)	1 (Yes)	0 (No)	1	
Unsolic. Master No.	Integer	0	65519	1	1	
Unsol. Grouping Time	Integer	100	65535	1000	1	msec.
Synchronization Interval	Integer	0	120	0	1	min.
DNP 3.0 Rev.	Integer	2003 ST.ZIV	2003 ST.ZIV	2003	2003 ST.ZIV	
Binary Changes CLASS	Integer	None Class 1 Class 2 Class 3	None Class 1 Class 2 Class 3	Class 1	None Class 1 Class 2 Class 3	
Analog Changes CLASS	Integer	None Class 1 Class 2 Class 3	None Class 1 Class 2 Class 3	Class 2	None Class 1 Class 2 Class 3	
Counter Changes CLASS	Integer	None Class 1 Class 2 Class 3	None Class 1 Class 2 Class 3	Class 3	None Class 1 Class 2 Class 3	
Binary Status Change	Boolean	0 (No)	1 (Yes)	1 (Yes)	1	
32 Bits Analog Input	Boolean	0 (No)	1 (Yes)	1 (Yes)	1	
Analog Inputs (Deadbands)						
Setting Name	**Type**	**Minimum Value**	**Maximum Value**	**Default Value**	**Step**	**Unit**
Deadband AI#0	Float	0 %	100 %	100 %	0.0001 %	
Deadband AI#1	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#2	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#3	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#4	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#5	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#6	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#7	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#8	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#9	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#10	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#11	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#12	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#13	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#14	Float	0 %	100 %	100 %	0. 0001 %	
Deadband AI#15	Float	0 %	100 %	100 %	0. 0001 %	

Counter Inputs (CounterDeadbands)						
Setting Name	**Type**	**Minimum Value**	**Maximum Value**	**Default Value**	**Step**	**Unit**
Deadband Cont.I#0	Integer	1	32767	1	1	
Deadband Cont.I#1	Integer	1	32767	1	1	
Deadband Cont.I#2	Integer	1	32767	1	1	
Deadband Cont.I#3	Integer	1	32767	1	1	
Deadband Cont.I#4	Integer	1	32767	1	1	
Deadband Cont.I#5	Integer	1	32767	1	1	
Deadband Cont.I#6	Integer	1	32767	1	1	
Deadband Cont.I#7	Integer	1	32767	1	1	
Deadband Cont.I#8	Integer	1	32767	1	1	
Deadband Cont.I#9	Integer	1	32767	1	1	
Deadband Cont.I#10	Integer	1	32767	1	1	
Deadband Cont.I#11	Integer	1	32767	1	1	
Deadband Cont.I#12	Integer	1	32767	1	1	
Deadband Cont.I#13	Integer	1	32767	1	1	
Deadband Cont.I#14	Integer	1	32767	1	1	
Deadband Cont.I#15	Integer	1	32767	1	1	
Deadband Cont.I#16	Integer	1	32767	1	1	
Deadband Cont.I#17	Integer	1	32767	1	1	
Deadband Cont.I#18	Integer	1	32767	1	1	
Deadband Cont.I#19	Integer	1	32767	1	1	
DNP Port 1 Port 2 and 3 DNP 3 Profile II Ethernet Configuration						
Setting Name	**Type**	**Minimum Value**	**Maximum Value**	**Default Value**	**Step**	**Unit**
Protocol Select	**Uinteger**	**Procome Dnp3 Modbus**	**Procome Dnp3 Modbus**	**Procome**	**Procome Dnp3 Modbus**	
Enable Ethernet Port	**Boolean**	**0 (No)**	**1 (Yes)**	**1 (Yes)**	**1**	
IP Address Port 1	**Byte[4]**	**ddd.ddd.ddd.ddd**	**ddd.ddd.ddd.ddd**	**192.168.1.51**	**1**	
IP Address Port 2	**Byte[4]**	**ddd.ddd.ddd.ddd**	**ddd.ddd.ddd.ddd**	**192.168.1.61**	**1**	
IP Address Port 3	**Byte[4]**	**ddd.ddd.ddd.ddd**	**ddd.ddd.ddd.ddd**	**192.168.1.71**	**1**	
Subnet Mask	**Byte[4]**	**128.0.0.0**	**255.255.255.254**	**255.255.255.0**	**1**	
Port Number	**Uinteger**	**0**	**65535**	**20000**	**1**	
Keepalive Time	**Float**	**0**	**65**	**30**	**60**	**s.**
Rx Time Characters	**Float**	**1**	**60000**	**1**	**0.5**	**ms.**
Comms Fail Timer	**Float**	**0**	**600**	**60**	**0.1**	**s.**

✓ All settings remain unchanged after a power loss.

DNP Protocol Configuration

- **Relay Number** (RTU Address):
  Remote Terminal Unit Address. Addresses 0xFFF0 to 0xFFFF are reserved as *Broadcast Addresses*.
- **T Confirm Timeout** (N7 Confirm Timeout) :
  Timeout while waiting for Application Layer Confirmation. It applies to Unsolicited messages and Class 1 and Class 2 responses with event data.
- **Max Retries** (N7 Retries) :
  Number of retries of the Application Layer after timeout while waiting for Confirmation.
- **Enable Unsolicited** (Enable Unsolicited Reporting) :
  Enables or disables Unsolicited reporting.
- **Enable Unsol. after Restart** :
  Enables or disables Unsolicited after Restart (for compatibility with terminals whose revision is before DNP3-1998). It has effect only if **Enable Unsolicited after Restart is set.**
- **Unsolic. Master No**. (MTU Address) :
  Destination address of the Master device to which the unsolicited responses are to be sent. Addresses 0xFFF0 to 0xFFFF are reserved as *Broadcast Addresses*. It is useful only when Unsolicited Reporting is enabled.
- **Unsol. Grouping Time** (Unsolicited Delay Reporting) :
  Delay between an event being generated and the subsequent transmission of the unsolicited message, in order to group several events in one message and to save bandwidth.
- **Synchronization Interval**
  Max interval time between two synchronization. If no synchronizing inside interval, indication IIN1-4 (NEED TIME). This setting has no effect if **Synchronization Interval is zero.**
- **DNP 3.0 Rev**.
  Certification revision **STANDARD ZIV** or **2003** (DNP3-2003 Intelligent Electronic Device (IED) Certification Procedure Subset Level 2 Version 2.3 29-Sept-03)
- **Binary Changes CLASS**.
  Selection to send Binary Changes as CLASS 1 CLASS 2 CLASS 3 or None.
- **Analog Changes CLASS**.
  Selection to send Analog Changes as CLASS 1 CLASS 2 CLASS 3 or None.
- **Counter Changes CLASS**.
  Selection to send Counter Changes as CLASS 1 CLASS 2 CLASS 3 or None.
- **Binary Status** .
  Send Binary with status otherwise without status
- **32 Bits Analog Input** .
  Send Analog All Variations and Analog Change Event Binary Changes with 32 bits otherwise with 16 bits

DNP PROFILE II ETHERNET Port 1 Port 2 and Port 3 Configuration

- **Enable Ethernet Port** :
  Enables or disables Ethernet Port.

- **IP Address** :
  Identification Number of Ethernet device.

- **Subnet Mask** :
  Indicate the part of IP Address is the Net Address and the part of IP Address is the Device Number.

- **Port Number** :
  Indicate to Destinatión Device the path to send the recived data.

- **Keepalive Time** :
  Number of second between Keepalive paquets, if zero no send packages Keepalive. These packages allow to Server know if a Client is present in the Net.

- **Rx Time Between Characters** :
  Maximum time between Characters.

- **Comm Fail Timer** :
  Maximum time between Messages without indicate Communication Fail.

C. MODBUS RTU Documentation. Address Map

C.1 Preliminary Information

This a reference document for implementing the MODBUS RTU protocol in the **RTV** IED.

This document provides a detailed MODBUS address map (input status, coil status, input registers and force single coil) and their equivalent in the **RTV** relay.

The functions that will be implemented are:

MODBUS Function	Meaning
01	Read Coil Status
02	Read Input Status
04	Read Input Registers
05	Force Single Coil
06	Force Single Register

Any other function not among those indicated will be considered illegal and will return exception code 01 (Illegal function).

C.2 Function 01: Read Coil Status

C.2.1 Modbus Address Map for RTV

The MODBUS coil status address map for the **RTV** relay will be:

Address	Description
Configurable through the *ZivercomPlus*®	Any input or output logic signal from the protection modules or generated by the programmable logic.

The content of the addresses is variable (reflection of each relay's configuration). The range of addresses is from 0 to 1023 and they are assigned automatically by the ***ZivercomPlus***® program.

Non-configured addresses will be considered illegal and will return exception code 02 (Illegal data address).

C.3 Function 02: Read Input Status

C.3.1 Modbus Address Map for RTV

The MODBUS input status address map for the **RTV** relay will be:

Address	Description
Configurable through the *ZivercomPlus*®	Any input or output logic signal from the protection modules or generated by the programmable logic.

The content of the addresses is variable (reflection of each relay's configuration). The range of addresses is from 0 to 1023 and they are assigned automatically by the ***ZivercomPlus***® program.

Non-configured addresses will be considered illegal and will return exception code 02 (Illegal data address).

C.4 Function 03: Read Holding Registers

C.4.1 Modbus Address Map for RTV

The MODBUS read holding registers address map for the **RTV** relay will be:

Address	Description
Configurable through the *ZivercomPlus*®	Any input or output logic signal from the protection modules or generated by the programmable logic whose number of changes is to be measured.

Configurable through the *ZivercomPlus*®: Counters can be created with any signal configured in the Programmable Logic or from the Protection modules. The default counters are those of the real energies (positive and negative) and the reactive energies (capacitive and inductive).

The metering range of energies in primary values is from 100wh/varh to 6553.5 kWh/kVArh. This is the magnitude transmitted via communications. That is, one (1) count represents 100 wh/varh.

To obtain an energy counter with a higher maximum value, a “user magnitude” must be created using this counter. For example, dividing the value of the counter by 1000 and making the output of the divider the new magnitude yields an energy counter with a range from 100 kWh/kVArh to 6553.5 MWh/Mvarh; that is, one (1) count represents 100 kWh/varh.

The content of the addresses is variable (reflection of each relay's configuration). The range of addresses is from 0 to 255 and they are assigned automatically by the ***ZivercomPlus***® program.

Non-configured addresses will be considered illegal and will return exception code 02 (Illegal data address).

C.5 Function 04: Read Input Registers

C.5.1 Modbus Address Map for RTV

The MODBUS read input registers address map for the **RTV** relay will be:

Address	Description
Configurable through the *ZivercomPlus*®	Any magnitude measured or calculated by the protection or generated by the programmable logic. It is possible to select between primary and secondary values, taking into account the corresponding transformation ratios.

All the full scale values of the magnitudes are definable, and these magnitudes can be used to create **user values**. Some typical values are:

- **Phase currents**: Rated value I_{PHASE} + 20% sends 32767 counts.
- **Voltages**: Rated value **V + 20%** sends 32767 counts.
- **Powers**: 3 x 1.4 x rated value I_{PHASE} x rated value / √3 sends 32767 counts.
- **Power factor**: from -1 to 1 sends from -32767 to 32767 counts.

With the ***ZivercomPlus***® program, it is possible to define the **full-scale value** to be used to transmit this magnitude in counts, the unit that all the protocols use. There are three definable parameters that determine the range of distance covered:

- **Offset value**: the minimum value of the magnitude for which 0 counts are sent.
- **Limit**: the length of the range of the magnitude on which it is interpolated to calculate the number of counts to send. If the offset value is 0, it coincides with the value of the magnitude for which the defined maximum of counts (32767) is sent.
- **Nominal flag**: this flag allows determining whether the limit set is proportional to the rated value of the magnitude or not. The rated value of the new magnitudes defined by the user in the programmable logic can be configured, while the rest of the existing magnitudes are fixed.

The expression that allows defining this full-scale value is the following:

- -When the Nominal flag is enabled,

$$CommunicationsMeasurement = \frac{Measurement - Offset}{Nominal} \times \frac{32767}{Limit}$$

- -When the Nominal flag is NOT enabled,

$$CommunicationsMeasurement = (Measurement - Offset) \times \frac{32767}{Limit}$$

The content of the addresses is variable (reflection of each relay's configuration). The range of addresses is from 0 to 255 and they are assigned automatically by the ***ZivercomPlus***® program.

Non-configured addresses will be considered illegal and will return exception code 02 (Illegal data address).

C.6 Function 05: Force Single Coil

C.6.1 Modbus Address Map for RTV

The MODBUS force single coil address map of the **RTV** relay will be:

Address	Description
Configurable through the *ZivercomPlus*®	A command can be made on any input from the protection modules and on any signal configured in the programmable logic.

The content of the addresses is variable (reflection of each relay's configuration). The range of addresses is from 0 to 255 and they are assigned automatically by the ***ZivercomPlus***® program.

Non-configured addresses will be considered illegal and will return exception code 02 (Illegal data address).

Any value other than 00H or FFH will be considered illegal and will return exception code 03 (Illegal data value).

D. Schemes and Drawings

Dimension and drill hole schemes

RTV (2U x 1 19” rack)	>>	4BF0100/0040
RTV (3U x 1 19” rack)	>>	4BF0100/0041
RTV (4U x 1 19” rack)	>>	4BF0100/0037

External connection schemes

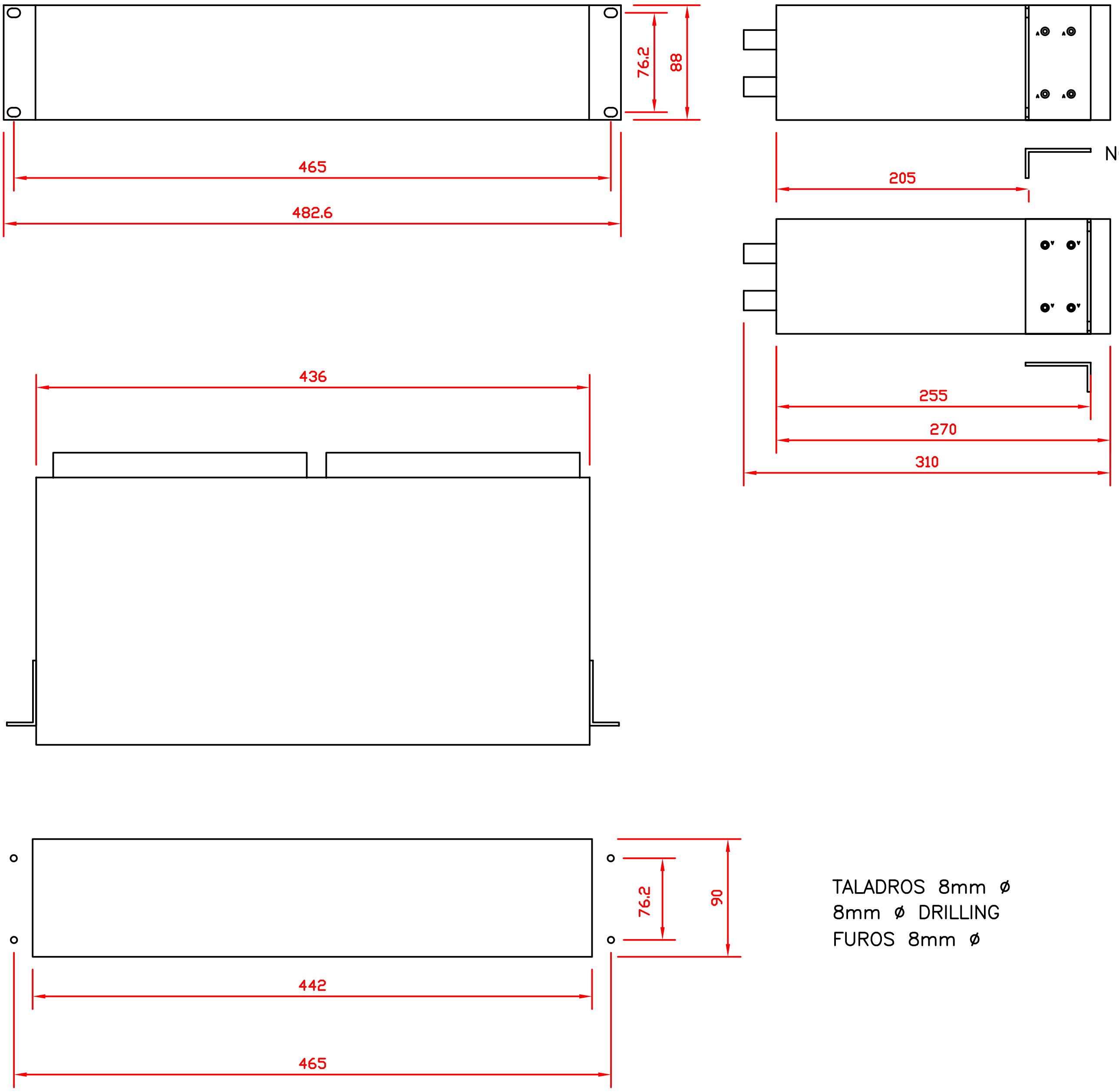
RTV-D	>>	3RX0190/0004 (generic)
RTV-D	>>	3RX0190/0005 (generic)
RTV-P	>>	3RX0190/0017 (generic)
RTV-P	>>	3RX0190/0019 (generic)
RTV-P	>>	3RX0190/0023 (generic)

CAJA TIPO "M"

BOÎTIER TYPE "M"

ENCLOSURE TYPE "M"

CAIXA TIPO "M"



TALADROS 8mm ø
8mm ø DRILLING
FUROS 8mm ø

NOTA 1:
LA PIEZA ADMITE LAS 2 POSICIONES MOSTRADAS PARA FACILITAR UN MONTAJE DEL EQUIPO MÁS Ó MENOS SALIENTE

REVISIONES		0	CD0504145	1	
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11		12		13	
14		15		16	

Z I V Aplicaciones y Tecnologia S.A.

TITULO: DIMENSIONES Y TALADRADO

PROYECTO: CAJA TIPO "M" 2U 1RACK

Rev.0

NUMERO: 4BF0100/0040

	Fecha	Nombre
Dibujado	28/04/05	U.G.
Aprobado	28/04/05	C.G.G.

Hoja: 1

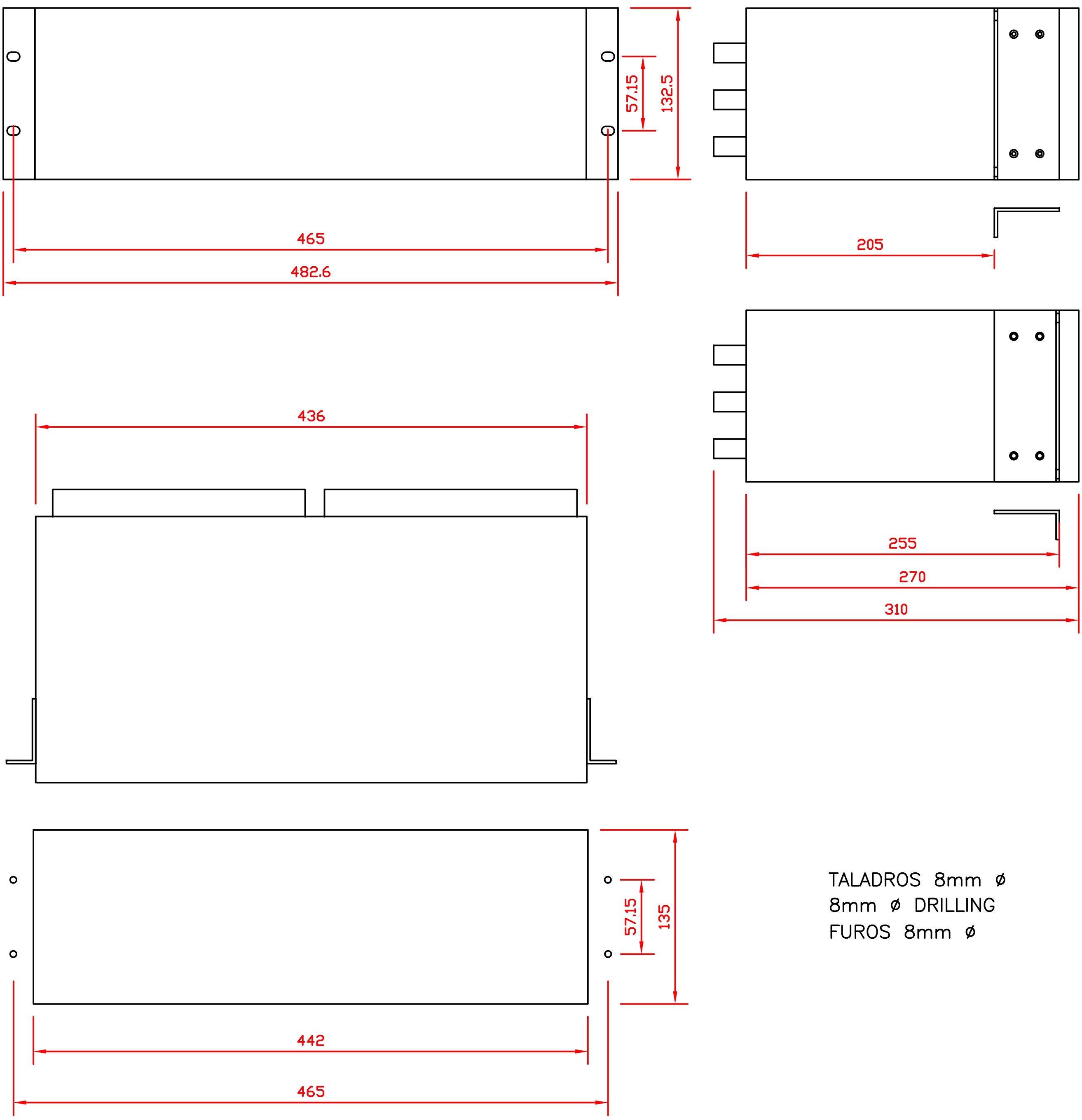
Continua en Hoja:

CAJA TIPO "S"

BOÎTIER TYPE "S"

ENCLOSURE TYPE "S"

CAIXA TIPO "S"



NOTA 1:
LA PIEZA ADMITE LAS 2 POSICIONES MOSTRADAS PARA FACILITAR UN MONTAJE DEL EQUIPO MÁS Ó MENOS SALIENTE

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8		9		10	
11		12		13	
14		15		16	

Z I V Aplicaciones y Tecnologia S.A.

TITULO: DIMENSIONES Y TALADRADO

PROYECTO: CAJA TIPO "S" 3U 1RACK

Rev.0

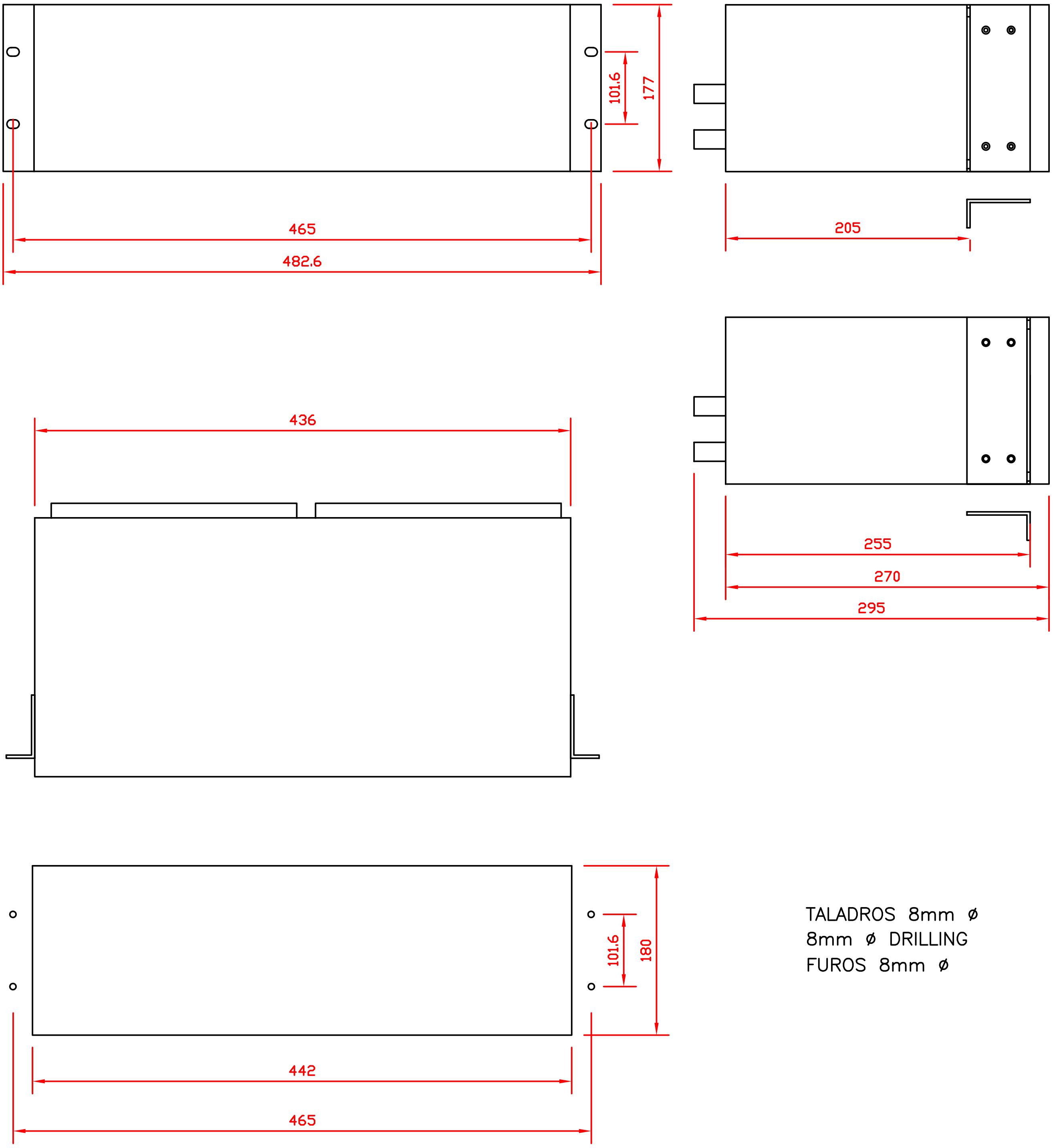
NUMERO: 4BF0100/0041

	Fecha	Nombre
Dibujado	28/04/05	U.G.
Aprobado	28/04/05	C.G.G.

Hoja: 1

Continua en Hoja:

CAJA TIPO "Q"
ENCLOSURE TYPE "Q"
CAIXA TIPO "Q"



NOTA 1:
LA PIEZA ADMITE LAS 2 POSICIONES MOSTRADAS PARA FACILITAR UN MONTAJE DEL EQUIPO MÁS Ó MENOS SALIENTE

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8	9		10	
11	12		13	
14	15		16	

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TITULO: DIMENSIONES Y TALADRADO

PROYECTO: CAJA TIPO "Q" 4U 1RACK (IDV)

Rev.0
Rev.1 12/4/05

NUMERO: 4BF0100/0037

	Fecha	Nombre
Dibujado	07/09/04	J.C.S.
Aprobado	07/09/04	J.M.Y.

Hoja: 1
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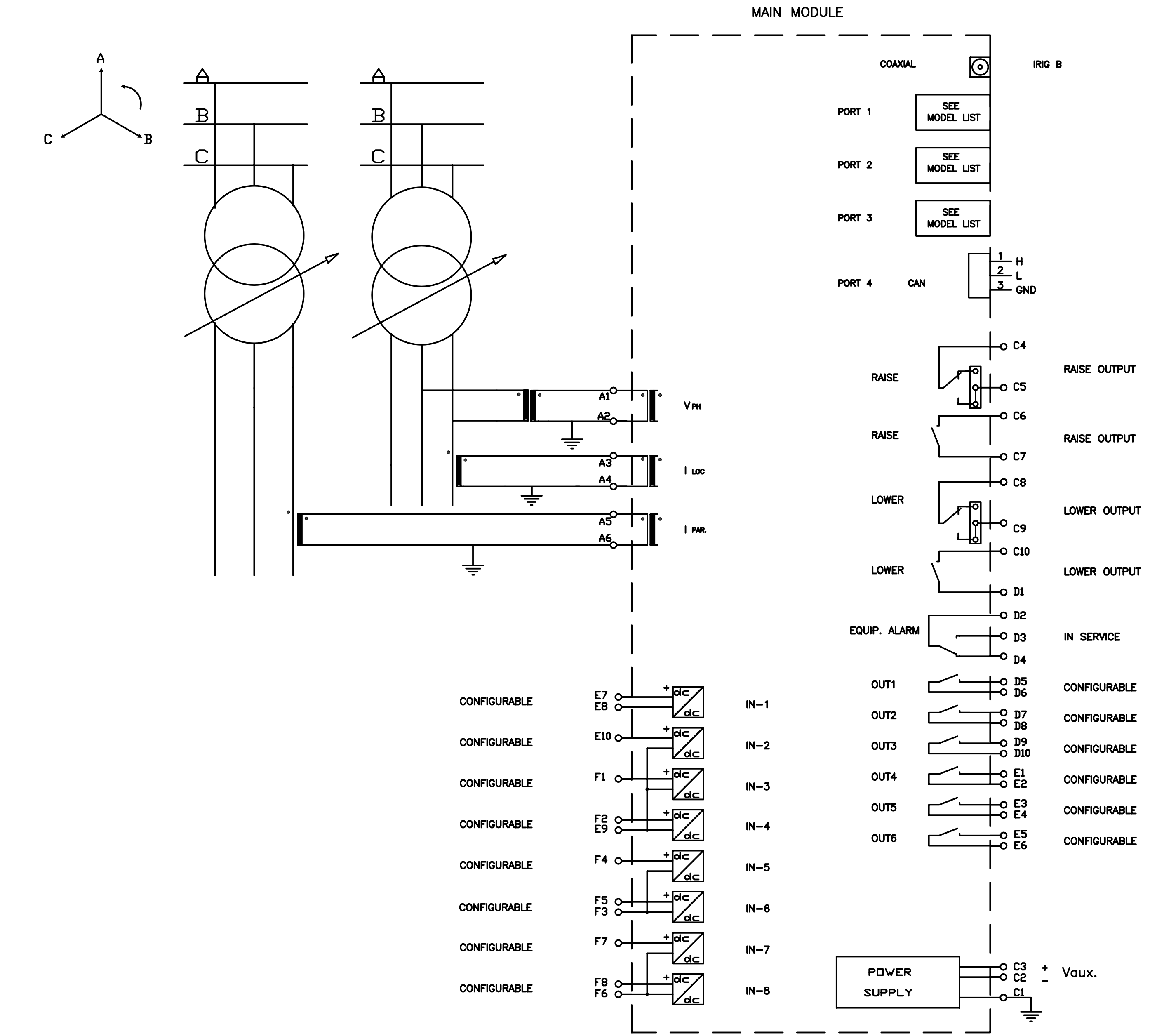

LEDS

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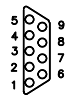
18. – CONFIGURABLE
19. – CONFIGURABLE
20. – CONFIGURABLE
21. – CONFIGURABLE
22. – CONFIGURABLE

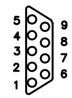
SERIAL PORT RS-232 FULL MODEM

PIN	SIGNAL
1	DCD
2	RX
3	TX
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI



SERIAL PORT RS-232 / RS-485

PIN	SIGNAL
1	FREE
2	RX
3	TX
4	RS485+
5	GND
6	RS485-
7	FREE
8	FREE
9	FREE



SERIAL PORT CAN

PIN	SIGNAL
1	H
2	L
3	GND

NOTE : THIS CONNECTION IS ONLY A EXAMPLE OF APPLICATION. VPH, ILOC AND IPAR MAY BE CONNECTED TO ANY PHASE, IN A PHASE-PHASE CONFIGURATION OR IN A PHASE-GROUND CONFIGURATION.

REVISIONS	0	CD0609102	1		2		3		4	
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TITLE: EXTERNAL CONNECTION RTV-D (300)

PROJECT: RTV

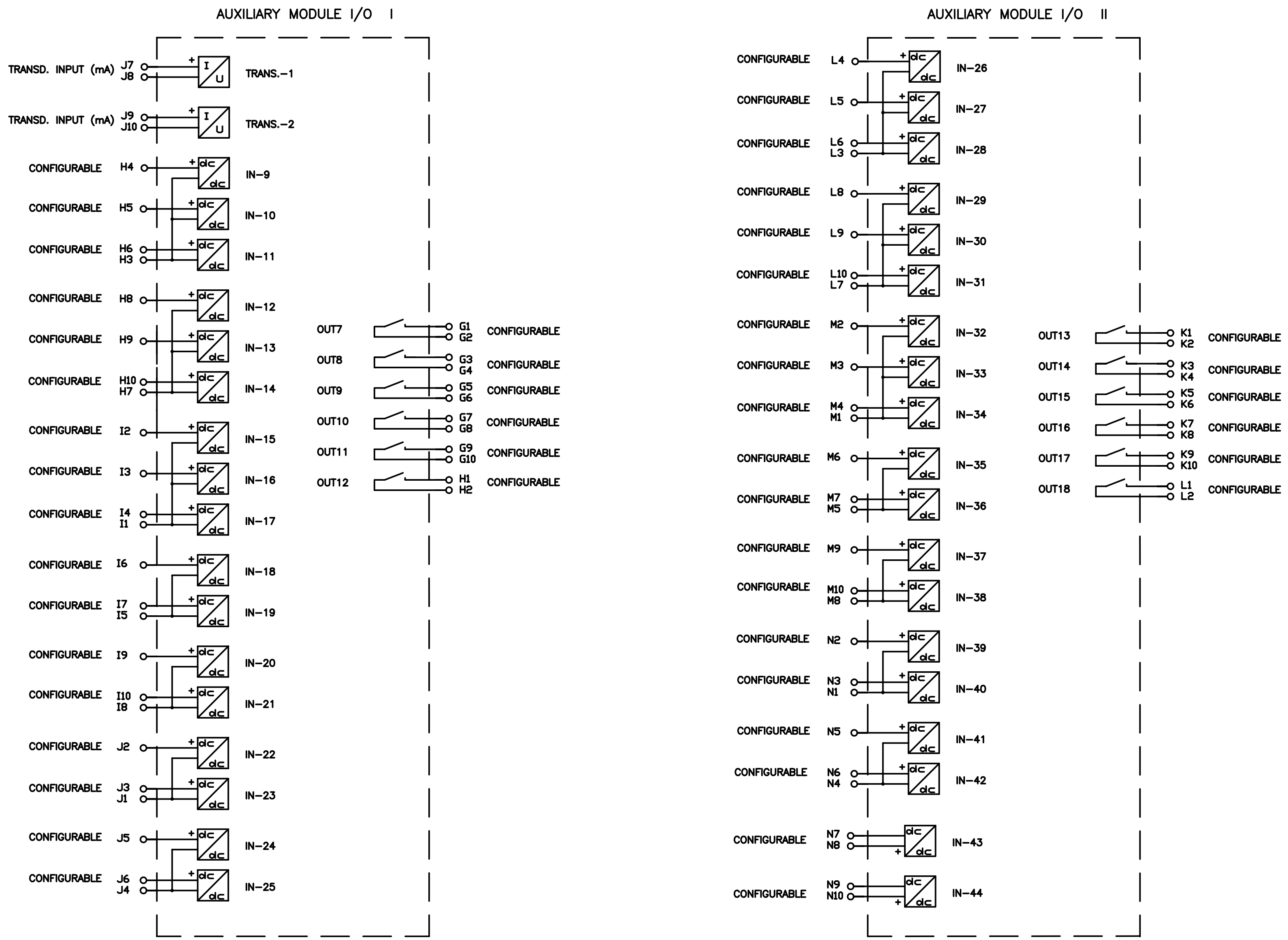
Rev.0

NUMBER: 3RX0190/0004

	Date	Name
Drawn	19/10/06	J.C.S.
Approved	19/10/06	P.A.

Sheet: 1

Continued on Sheed: 2



"WARNING"
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Unauthorized disclosure is strictly prohibited and may result in serious legal consequences.

REVISIONS	0	CD0609102	1		2		3		4	
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Z I V Aplicaciones y Tecnologia S.A.

TITLE: EXTERNAL CONNECTION RTV-D (300)

PROJECT: RTV

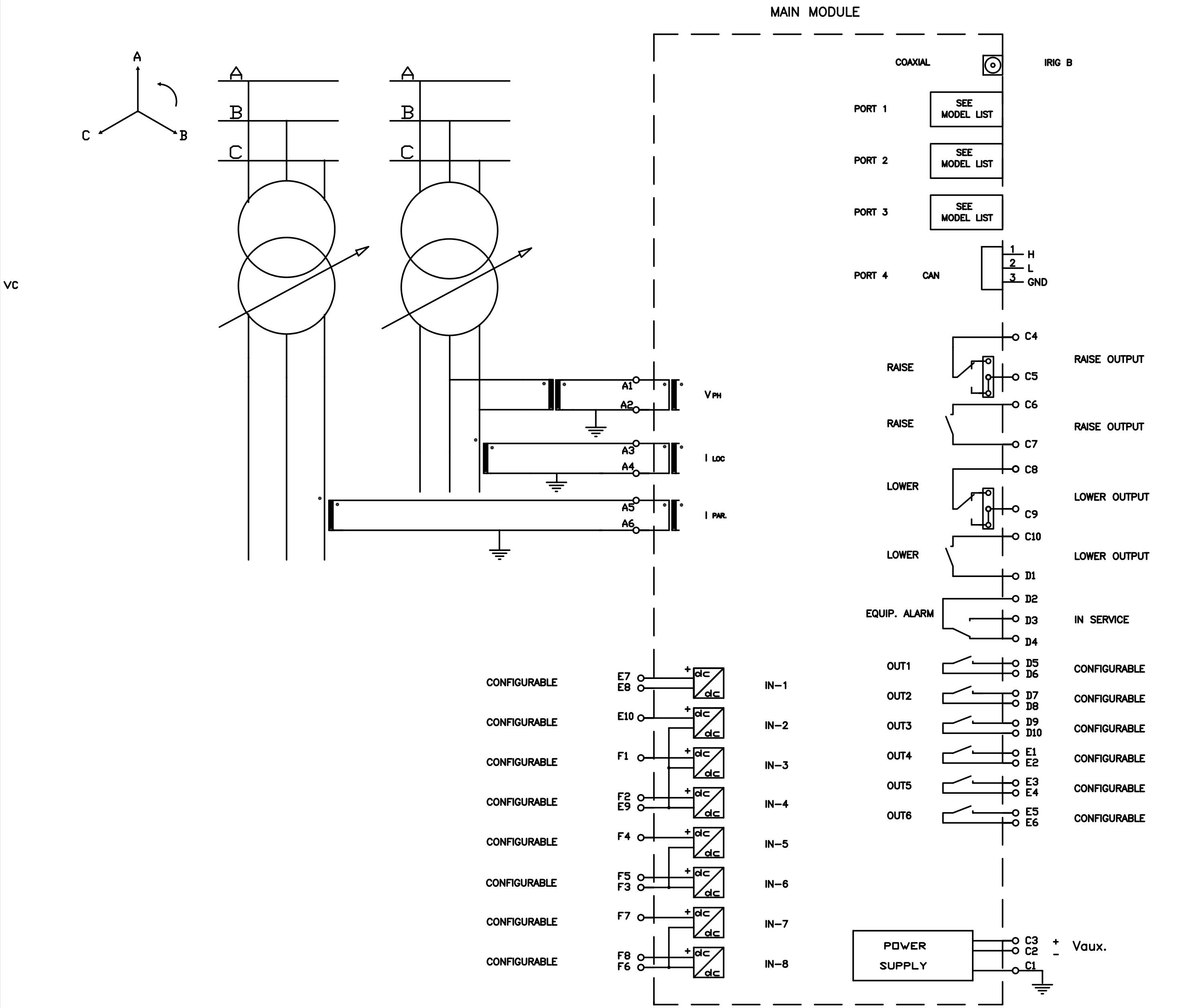
Rev.0

NUMBER: 3RX0190/0004

	Date	Name
Drawn	18/03/05	J.C.S.
Approved	18/03/05	P.A.

Sheet: 2

Continued on Sheed: -



LEDS

1. – CONFIGURABLE
2. – CONFIGURABLE
3. – CONFIGURABLE
4. – CONFIGURABLE
5. – CONFIGURABLE
6. – CONFIGURABLE
7. – CONFIGURABLE
8. – CONFIGURABLE
9. – CONFIGURABLE
10. – CONFIGURABLE

SERIAL PORT RS-232 FULL MODEM

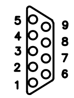
PIN	SIGNAL
1	DCD
2	RX
3	TX
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI

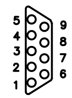
SERIAL PORT RS-232 / RS-485

PIN	SIGNAL
1	FREE
2	RX
3	TX
4	RS485+
5	GND
6	RS485-
7	FREE
8	FREE
9	FREE

SERIAL PORT CAN

PIN	SIGNAL
1	H
2	L
3	GND





NOTE : THIS CONNECTION IS ONLY A EXAMPLE OF APPLICATION. VPH, ILOC AND IPAR MAY BE CONNECTED TO ANY PHASE, IN A PHASE-PHASE CONFIGURATION OR IN A PHASE-GROUND CONFIGURATION.

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TITLE: EXTERNAL CONNECTION RTV-D (100)

PROJECT: RTV

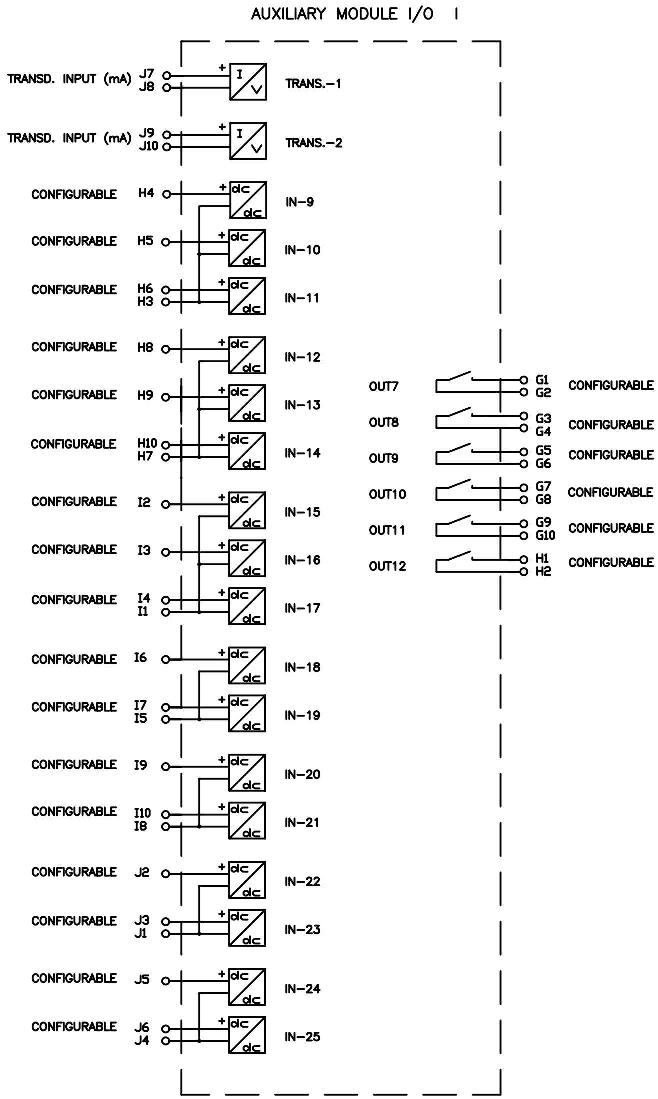
Rev.0

NUMBER: 3RX0190/0005

	Date	Name
Drawn	19/10/06	J.C.S.
Approved	19/10/06	P.A.

Sheet: 1

Continued on Sheed: 2



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in serious legal consequences.

REVISIONS	0	CD0609102	1		2		3		4	
5	6		7		8		9		10	
11	12		13		14		15		16	

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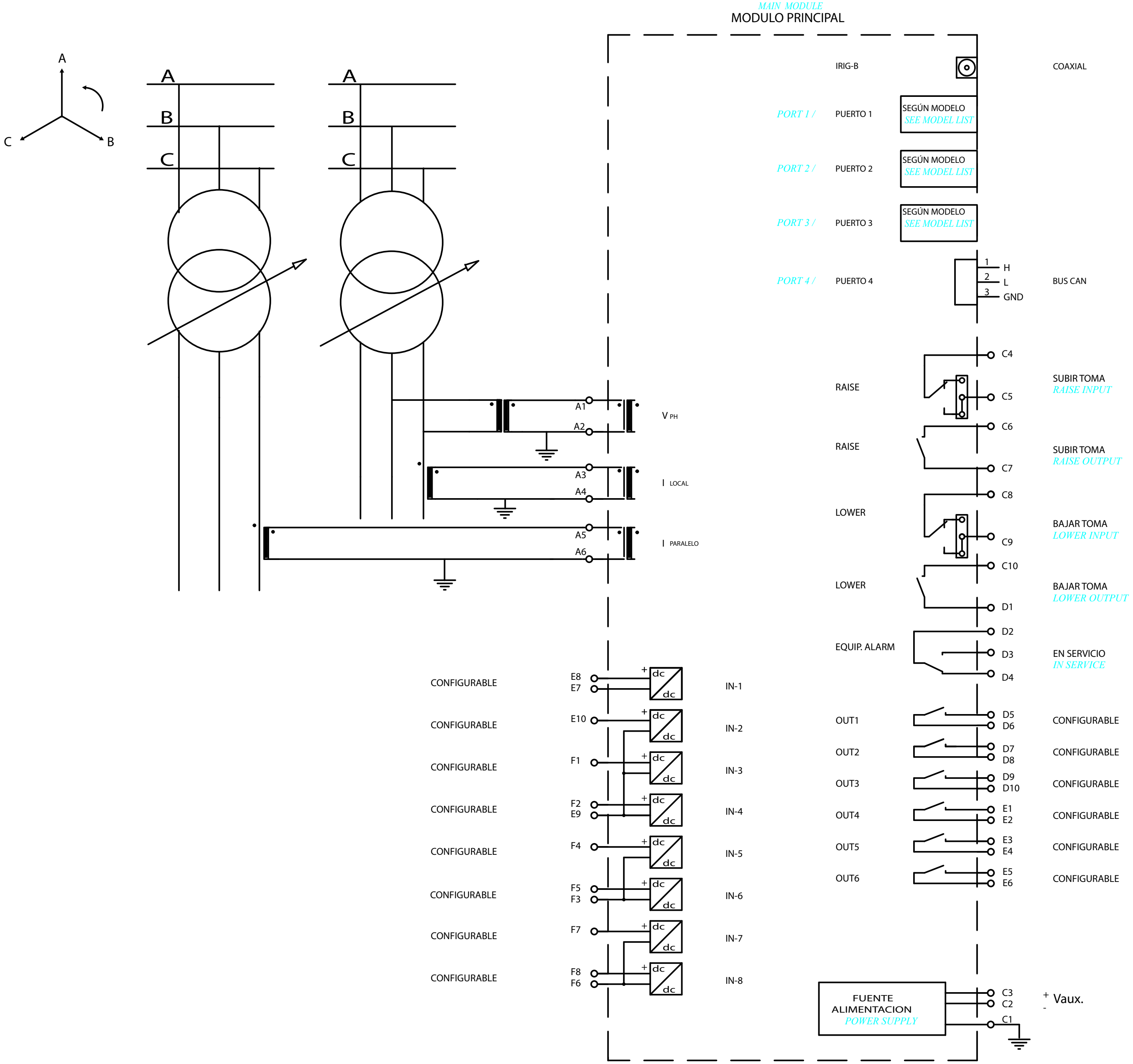
TITLE: EXTERNAL CONNECTION RTV-D (100)

PROJECT: RTV

Rev.0

NUMBER: 3RX0190/0005

	Date	Name	
Drawn	19/10/06	J.C.S.	Sheet: 2
Approved	19/10/06	P.A.	Continued on Sheed: -



LEDS

1. - CONFIGURABLE
2. - CONFIGURABLE
3. - CONFIGURABLE
4. - CONFIGURABLE
5. - CONFIGURABLE
6. - CONFIGURABLE
7. - CONFIGURABLE
8. - CONFIGURABLE
9. - CONFIGURABLE
10. - CONFIGURABLE

SERIAL PORT
PUERTO SERIE
RS-232 FULL MODEM

PIN	SIGNAL SEÑAL
1	DCD
2	RX
3	TX
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI

SERIAL PORT
PUERTO SERIE
RS-232 / RS-485

PIN	SIGNAL SEÑAL
1	LIBRE / FREE
2	RX
3	TX
4	RS485+
5	GND
6	RS485-
7	LIBRE / FREE
8	LIBRE / FREE
9	LIBRE / FREE

SERIAL PORT
PUERTO SERIE
CAN

PIN	SIGNAL SEÑAL
1	H
2	L
3	GND

NOTA : LA CONEXIÓN REPRESENTADA ES ÚNICAMENTE UN EJEMPLO DE APLICACIÓN. V PH, I LOCAL, I PARALELO PUEDEN CONECTARSE A CUALQUIER FASE, TANTO EN CONFIGURACIÓN FASE-FASE, COMO FASE-TIERRA.

NOTE : THIS CONNECTION IS ONLY A EXAMPLE OF APPLICATION. VPH, ILOC AND IPAR MAY BE CONNECTED TO ANY PHASE IN A PHASE-PHASE CONFIGURATION OR IN A PHASE-GROUND CONFIGURATION.

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11		12		13		14		15		16

Z I V Aplicaciones y Tecnologia

TITULO: CONEXIONES EXTERNAS RTV-P (000)
TITLE: EXTERNAL CONNECTION RTV-P (000)

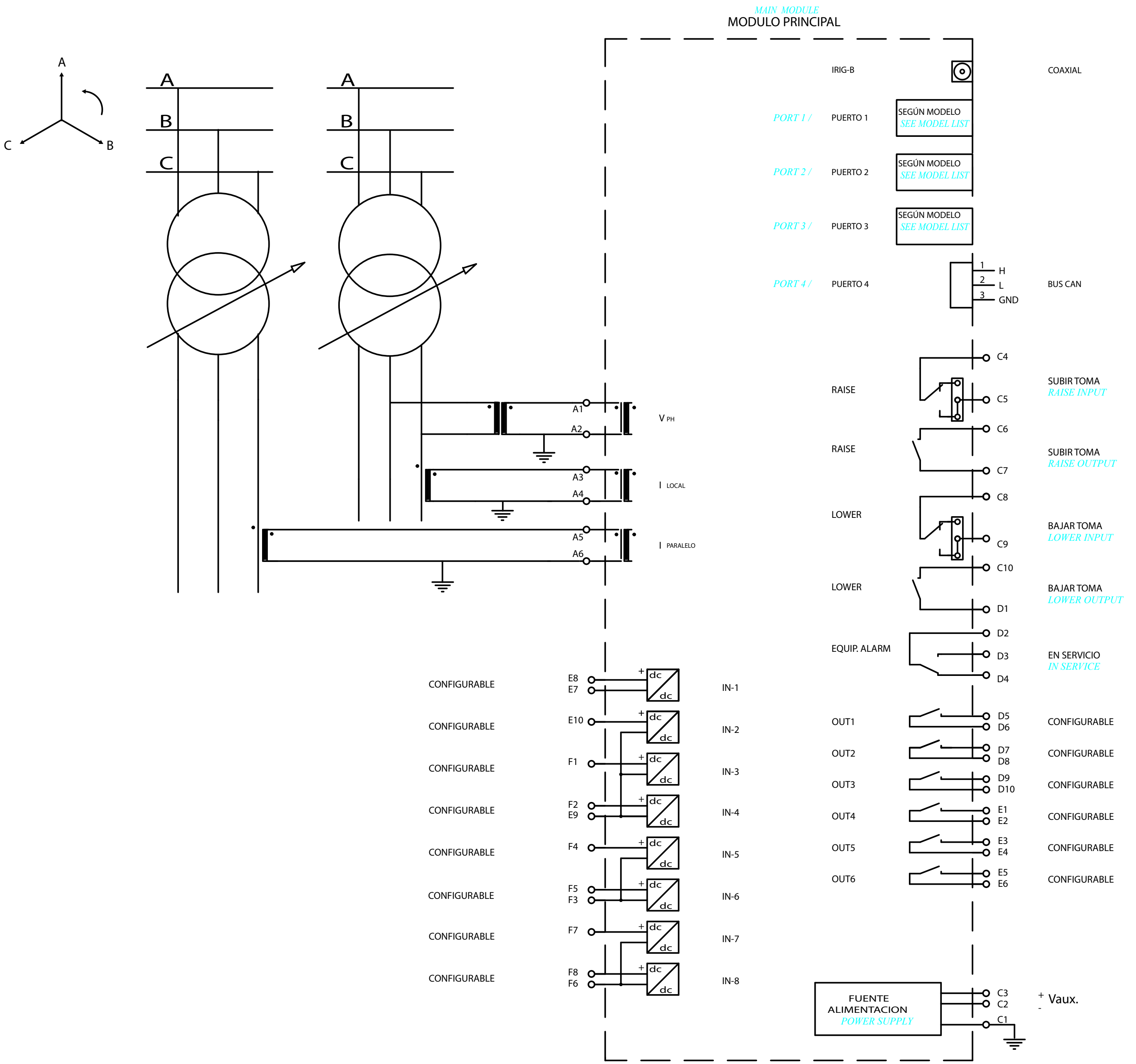
PROYECTO / *PROJECT:* RTV / RTV

Rev. 0

NUM.: 3RX0190/0017

	Fecha / *Date*	Nombre / *Name*
Dibujado / *Drawn*	21/12/12	J.M.S.
Aprobado / *Approved*	21/12/12	P.A.

Hoja / *Sheet:* 1
Continua en Hoja: / *Continued on sheet:* -



LEDS

1. - CONFIGURABLE
2. - CONFIGURABLE
3. - CONFIGURABLE
4. - CONFIGURABLE
5. - CONFIGURABLE
6. - CONFIGURABLE
7. - CONFIGURABLE
8. - CONFIGURABLE
9. - CONFIGURABLE
10. - CONFIGURABLE

SERIAL PORT
PUERTO SERIE
RS-232 FULL MODEM

PIN	*SIGNAL* SEÑAL
1	DCD
2	RX
3	TX
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI

SERIAL PORT
PUERTO SERIE
RS-232 / RS-485

PIN	*SIGNAL* SEÑAL
1	LIBRE / *FREE*
2	RX
3	TX
4	RS485+
5	GND
6	RS485-
7	LIBRE / *FREE*
8	LIBRE / *FREE*
9	LIBRE / *FREE*

SERIAL PORT
PUERTO SERIE
CAN

PIN	*SIGNAL* SEÑAL
1	H
2	L
3	GND

NOTA : LA CONEXIÓN REPRESENTADA ES ÚNICAMENTE UN EJEMPLO DE APLICACIÓN. V PH, I LOCAL, I PARALELO PUEDEN CONECTARSE A CUALQUIER FASE, TANTO EN CONFIGURACIÓN FASE-FASE, COMO FASE-TIERRA.

NOTE : THIS CONNECTION IS ONLY A EXAMPLE OF APPLICATION. VPH, ILOC AND IPAR WAY BE CONNECTED TO ANY PHASE IN A PHASE-PHASE CONFIGURATION OR IN A PHASE-GROUND CONFIGURATION.

REV.	0	CD1212119	1		2		3		4	
5		6		7		8		9		10
11		12		13		14		15		16

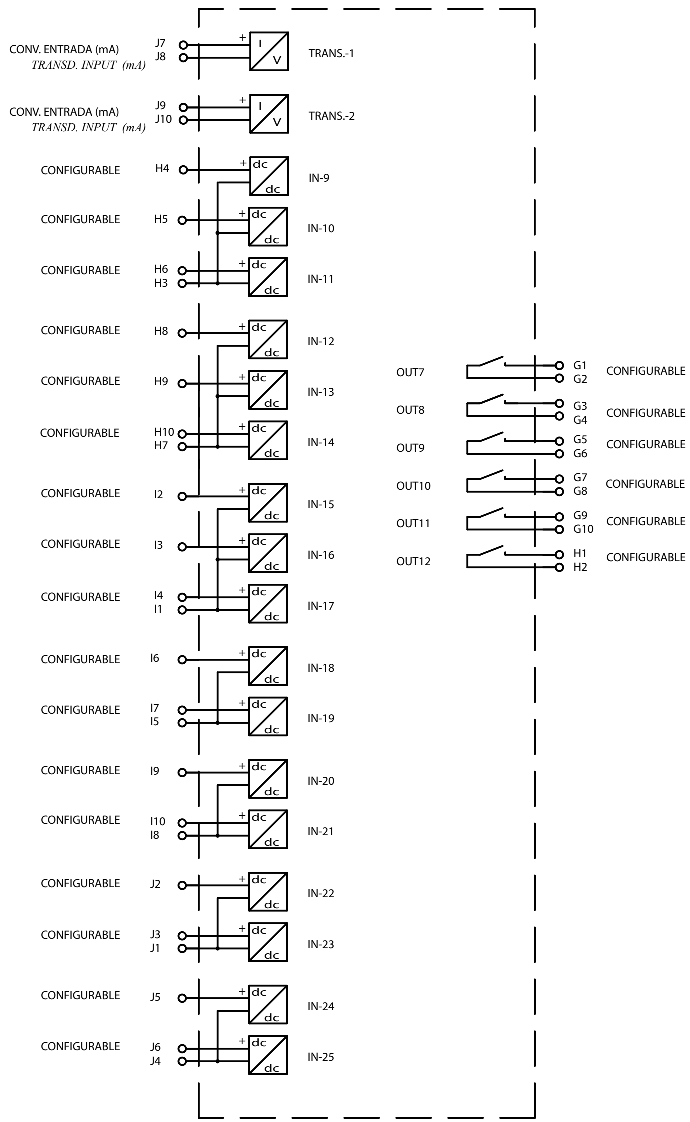
Z I V Aplicaciones y Tecnologia

TITULO: CONEXIONES EXTERNAS RTV-P (100)
TITLE: EXTERNAL CONNECTION RTV-P (100)
PROYECTO / *PROJECT:* RTV / RTV
Rev. 0
NUM.: 3RX0190/0019

	Fecha / *Date*	Nombre / *Name*
Dibujado / *Drawn*	21/12/12	J.M.S.
Aprobado / *Approved*	21/12/12	P.A.

Hoja / *Sheet:* 1
Continua en Hoja: *Continued on sheet:* 2

AUXILIARY MODULE E/S I
MÓDULO AUXILIAR E/S I



REV.	0	CD1212119	1		2		3	4
5	6		7		8		9	10
11	12		13		14		15	16

Z I V Aplicaciones y Tecnologia

TITULO: CONEXIONES EXTERNAS RTV-P (100)
TITLE: EXTERNAL CONNECTION RTV-P (100)

PROYECTO / *PROJECT:* RTV / RTV

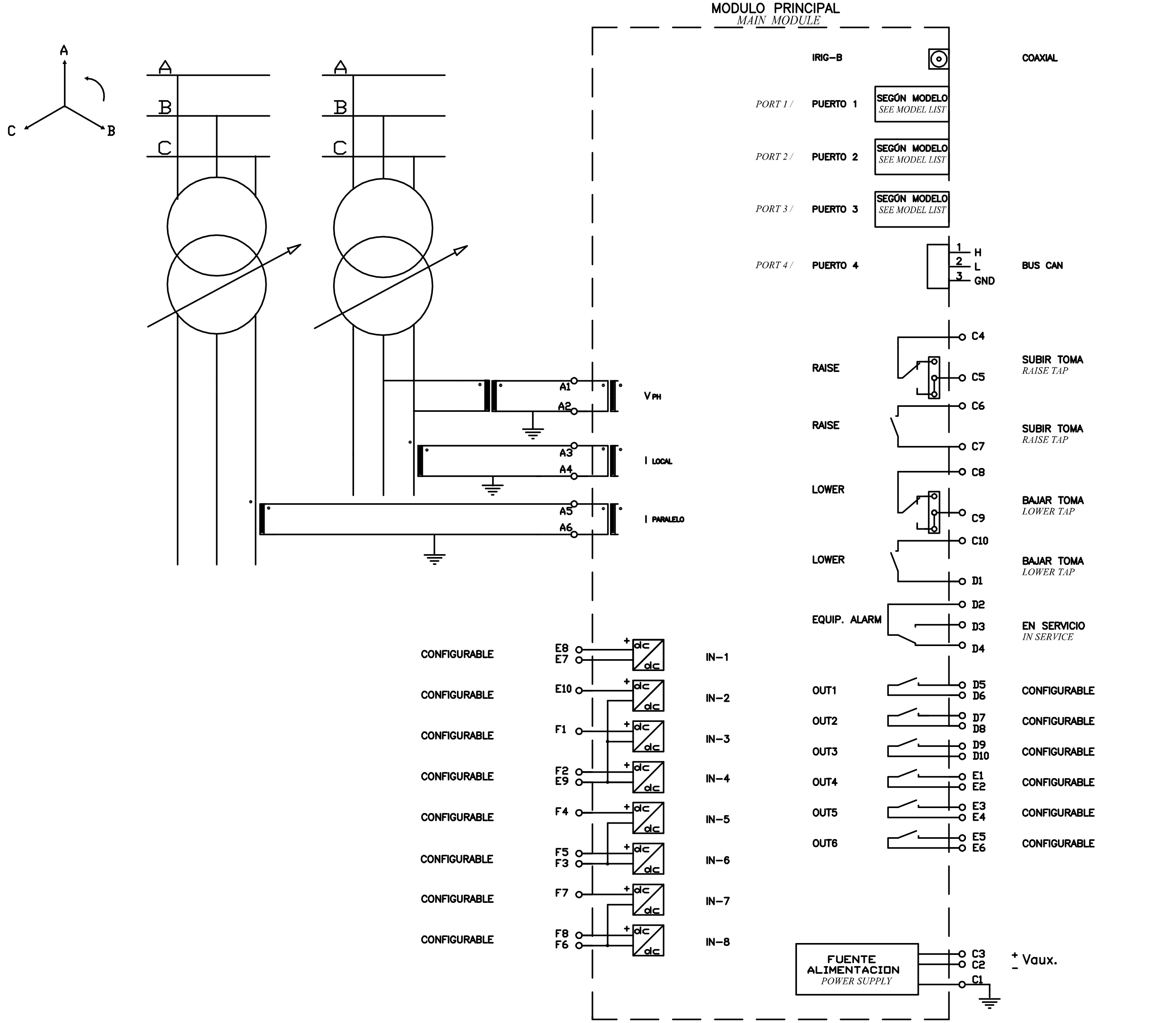
Rev. 0

NUM.: 3RX0190/0019

	Fecha / *Date*	Nombre / *Name*
Dibujado / *Drawn*	21/12/12	J.M.S.
Aprobado / *Approved*	21/12/12	P.A.

Hoja / *Sheet:* 2

Continua en Hoja: -
Continued on sheet:



LEDS

1. – CONFIGURABLE
2. – CONFIGURABLE
3. – CONFIGURABLE
4. – CONFIGURABLE
5. – CONFIGURABLE
6. – CONFIGURABLE
7. – CONFIGURABLE
8. – CONFIGURABLE
9. – CONFIGURABLE
10. – CONFIGURABLE

SERIAL PORT
PUERTO SERIE
RS-232 FULL MODEM

PIN	SEÑAL *SIGNAL*
1	DCD
2	RX
3	TX
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI

SERIAL PORT
PUERTO SERIE
RS-232 / RS-485

PIN	SEÑAL *SIGNAL*
1	LIBRE / *FREE*
2	RX
3	TX
4	RS485+
5	GND
6	RS485-
7	LIBRE / *FREE*
8	LIBRE / *FREE*
9	LIBRE / *FREE*

SERIAL PORT
PUERTO SERIE
CAN

PIN	SEÑAL *SIGNAL*
1	H
2	L
3	GND

NOTA : LA CONEXIÓN REPRESENTADA ES ÚNICAMENTE UN EJEMPLO DE APLICACIÓN. V PH, I LOCAL, I PARALELO PUEDEN CONECTARSE A CUALQUIER FASE, TANTO EN CONFIGURACIÓN FASE-FASE, COMO FASE-TIERRA.

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REV.	0	CD500001899	1	2	3	4
5	6		7	8	9	10
11	12		13	14	15	16

Z I V Aplicaciones y Tecnologia

TITULO: CONEXIONES EXTERNAS RTV-P (6##)
TITLE: EXTERNAL CONNECTION RTV-P (6##)

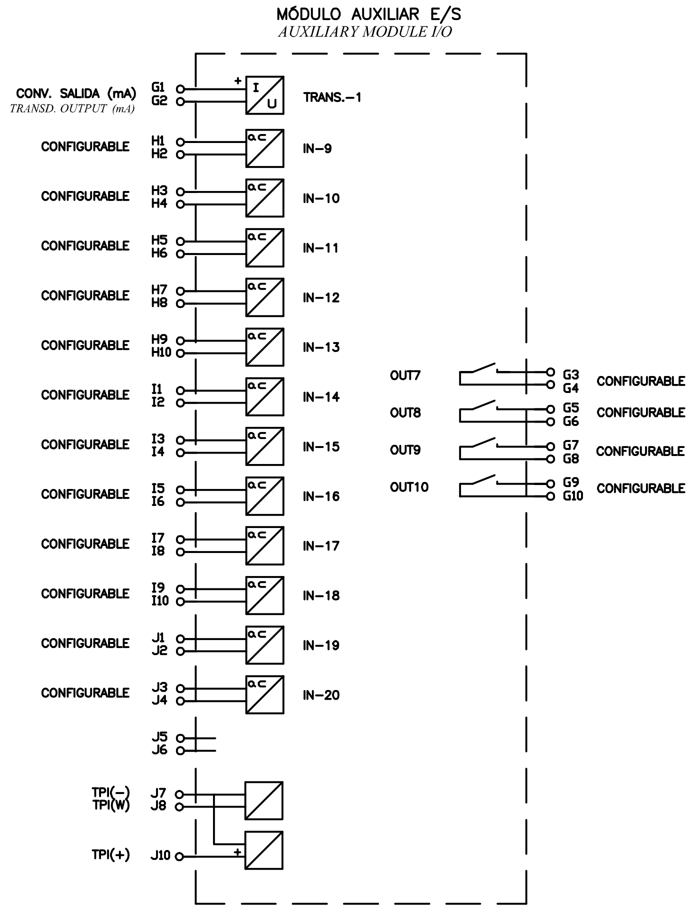
PROYECTO / *PROJECT:* RTV / RTV

Rev.0

NUM.: 3RX0190/0023

	Fecha / *Date*	Nombre / *Name*
Dibujado / *Drawn*	23/05/16	J.M.S.
Aprobado / *Approved*	23/05/16	P.A.

Hoja / *Sheet:* 1
Continua en Hoja: / *Continued on sheet:* 2



REV.	0	CD500001899	1		2		3		4	
5			6		7		8		9	10
11			12		13		14		15	16

Z I V Aplicaciones y Tecnologia

TITULO: CONEXIONES EXTERNAS RTV-P (6##)
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PROYECTO / *PROJECT:* RTV / RTV

Rev.0

NUM.: 3RX0190/0023

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Dibujado / *Drawn*	23/05/16	J.M.S.
Aprobado / *Approved*	23/05/16	P.A.

Hoja / *Sheet:* 2

Continua en Hoja: / *Continued on sheet:* -

E. List of Illustrations and Tables

E.1 List of Figures

E.2 List of Tables

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