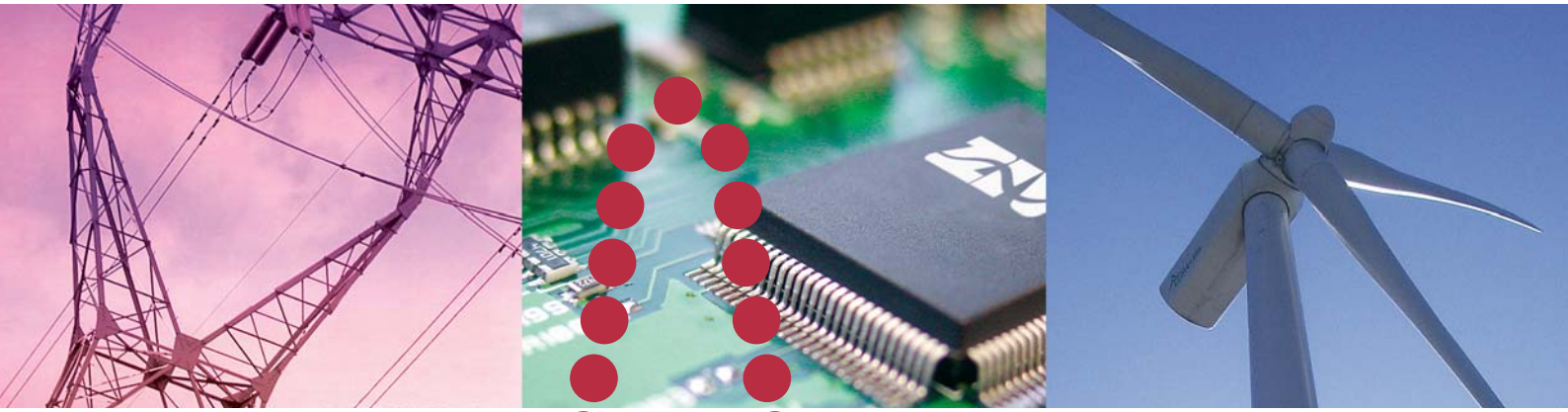
grid automation



CPI

***R/S/T

Overcurrent Protection

Instruction Manual

BCPI1012Sv01

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1. Description

The **CPI** protection relay is designed for overcurrent protection in electrical networks using state-of-the-art digital technology. Some **CPI** models can also incorporate over/undervoltage protection units and thermal unit in addition to the overcurrent units.

CPI terminals are designed for application on circuits (feeders, transformers, motors, etc.) where overcurrent protection for phase-to-phase faults, and ground faults is required. For isolated neutral systems where a high sensitivity ground protection is required, the application of directional overcurrent (**67N$_I$**) is recommended.

This instruction manual covers the models which incorporate breaker failure, open phase protection, sensitive ground overcurrent detection and breaker supervision.

1.1 Functions

- **Phase Overcurrent Protection (3x50/51). CPI-A**

Includes three phase overcurrent protection units. The three phases share the same settings. Each phase unit includes two independent protection elements; one time delayed element and one instantaneous element with a definite time setting.

The time delay elements are provided with five characteristics: inverse, very inverse, extremely inverse, definite time and user defined. Time delayed and instantaneous elements can be disabled via settings. **CPI-A** models also include information on pickup and trip for each phase instantaneous and time delayed elements.

- **Phase and Ground Overcurrent Protection (3x50/51 + 50N/51N). CPI-B**

Includes three phase and ground overcurrent protection units. The three phases share the same settings while the ground unit has independent settings. Each unit includes two independent protection elements; one time delayed element, and one instantaneous element with a definite time setting.

The time delayed elements are provided with five characteristics: inverse, very inverse, extremely inverse, definite time and user defined. Time delay and instantaneous elements can be disabled via settings. **CPI-B** models also include information on pickup and trip for each phase and ground instantaneous and time delayed elements.

- **Ground Overcurrent Protection (50N/51N). CPI-C**

Includes ground overcurrent protection unit. The ground unit includes two independent protection elements; one time delayed element and one instantaneous element with a definite time setting.

The time delayed element is provided with five characteristics: inverse, very inverse, extremely inverse, definite time and user defined. Time delayed and instantaneous elements can be disabled via setting. **CPI-C** models also include information on pickup and trip for both the instantaneous and the time delayed elements.

Note: depending on the firmware version, the phase and neutral elements may have 3 independent settings groups (one active at a time). This statement applies to models CPI-A, CPI-B and CPI-C.

- **Phase and Ground Overcurrent Protection (3x50/51 + 50N/51N) and Thermal Element (49). CPI-T**

Includes three phase and ground overcurrent protection units. The three phases share the same settings while the ground unit has independent settings. Each unit includes an instantaneous element and a time delayed element.

The time delayed elements are provided with five characteristics: Inverse, very inverse, extremely inverse, definite time and user defined. Time delay and instantaneous elements can be disabled via settings. **CPI-T** models also include information on pickup and trip for each phase and ground instantaneous and time delayed elements.

Note: For the 60, 61 and 70 Specials Models, phase units, in addition to the standard time and instantaneous elements, have two more time elements (definite time only - no time / current characteristic), and the ground unit has both an instantaneous and a time element.

In order to achieve maximum performance a power transformer should have the capacity to handle overloads for relatively short periods of time. To control these overloads and avoid the premature deterioration of the machine, the **CPI-T** has thermal protection. The thermal imaging algorithm approximates the thermal capacity of the protected device to provide a timely trip before damage occurs.

Note: The machine thermal protection element has additional settings for heat constant, cooling constant, maximum current and alarm threshold, and it also has a setting that allows the user to Enable/ Disable the unit.

1.2 Additional Functions

- **Breaker Failure Protection**

The terminal unit incorporates a breaker failure protection element (three-phase trip) that sends a trip command to initiate backup trip for other breaker(s).

- **Open Phase Protection**

This element detects open phase conditions by measuring the negative-sequence to positive-sequence current ratio. Detection of the open phase enables tripping should the setting threshold be exceeded.

- **Sensitive Ground Overcurrent Protection**

Three-phase systems where loads are not connected phase-to-ground can benefit from this function. A trip is generated if zero sequence current, which does not reach minimum phase-to-ground-fault levels, is detected for a preset period of time. The presence of such current would indicate the existence of ground overcurrent conditions.

- **Three-Phase Recloser**

Reclosing can be separately coordinated with external protection as well as with the protection contained in the terminal unit. Reclosing sequences for phase faults and ground faults can be set independently.

Reclosing is selectable up to a maximum of four attempts with independent settings for recloser timers (dead or open breaker wait times) and reset times. The reclosing sequence is controlled by the breaker position and by the reclose initiate signal, which permits reclosing based on the protective elements which operated to trip the breaker.

The trip elements and reclose attempts enabled during a fault clearing and reclosing sequence are selectable via a mask designed for that purpose.

Manual closing can be initiated from the terminal unit using its reclosing output contacts. The close command in this instance is supervised and controlled in the same way as any permissible automatic reclosing command following a trip from the protection elements.

- **Control**

Breaker trip and close operations can be performed through the terminal unit keypad (if fitted) after entering the user-defined passwords.

It is possible to select the active settings group using the keypad, via communications or via digital inputs (depending on the firmware version).

- **Breaker Maintenance Monitoring (kA^2)**

Fault interruption kA^2 values are summed and accumulated in the terminal unit each time the breaker trips. The accumulated kA^2 information is compared with an alarm setpoint intended for predicting breaker maintenance.

- **LED Targets**

Terminal unit front panel indication consists of eight LEDs. Seven of the LEDs are user definable. The eighth LED is assigned to indicate the terminal unit is "Ready" (powered up, self-test OK). A list of available LED signals is defined in Chapter 6.

- **Status Contact Inputs**

The terminal unit has two status contact inputs, both are configurable. A list of available inputs is defined in Chapter 6.

Note: The special model (2) has 8 programmable digital inputs, the first one for alternating current and the other 7 for direct current. The relay available auxiliary inputs are listed in Chapter 6.**

- **Auxiliary Contact Outputs**

There are three auxiliary contact outputs. Auxiliary output AUX - 3, which corresponds to "Terminal Unit In Service" (powered up, self-test OK), is not programmable. A list of available outputs is defined in Chapter 6.

Note: The special model (2) has 7 programmable digital outputs, one digital output for double tripping, one for breaker closure and another one for equipment "In Service". The relay available auxiliary outputs are listed in Chapter 6.**

- **Trip Contact Output**

CPI terminals have two trip contact outputs made of two normally open (NO) contacts, configurable to normally closed (NC) with internal jumpers.

- **Oscillography**

The oscillography has two separate functions: data acquisition and display.

- **Local Information (display)**

Display of:

- Events:

Last relay operation (tripped element)
Status contact input status
Auxiliary contact output status
Protection element status

- Metering:

Current
Positive Sequence
Negative Sequence
Thermal Level

- **Self-Test Program**

A continuously running diagnostic self-test program verifies the correct operation of the terminal unit and alerts the user of potential problems.

1.3 Model Selection

	CPI										
1		2	3	4	5	6	7	8	9	10	11

1	**Selection**					
	3	Vertical Format		**8**	Horizontal Format	
2	**Functions**					
	A	3x50/51		**E**	67Na	
	B	3x50/51 + 50N/51N		**S**	3x50/51 + 49	
	C	50N/51N		**T**	3x50/51 + 50N/51N + 49	
	D	67N		**W**	32	
3	**Rated Current**					
	1	If = 5A // In = 1A		**4**	If = 5A // Ins = 1A	
	2	If = 5A // In = 5A		**5**	If = 1A // In = 1A	
	3	If = 5A // In = 20A		**6**	If = 1A // Ins = 1A	
4	**Options**					
	S	Plus Model		**R**	Plus Model + Oscillography + Recloser	
	T	Plus Model + Oscillography				
5		**Power Supply**	**Status Contact Inputs**		**Power Supply**	**Status Contact Inputs**
	1	24 - 48 Vdc (*)	24 - 48 Vdc	**3**	220 - 250 Vdc (*)	178 - 264 Vdc
	2	110 - 125 Vdc (*)	24 - 125 Vdc	**4**	220 Vac	48 - 250 Vdc
6	**Frequency / Language**					
	0	50Hz, Spanish		**E**	60Hz, Portuguese	
	2	60Hz, English		**G**	50Hz, French	
	A	50Hz, English		**J**	50Hz, Portuguese	
	C	60Hz, Spanish				
7	**Communications**					
	1	RS232 + RS232		**4**	RS232 + Glass Fiber Optic (ST)	
	2	RS232 + Plastic Fiber Optic (1 mm.)		**5**	RS232 + RS485	
	3	RS232 + Glass Fiber Optic (SMA)				
8	**Remote Communications**					
	0	Standard		**2**	I/O Additional Module (8+8)	
	1	Option 0 + Remote RS232 (**)		**3**	Option 2 + Remote RS232 (**)	
9	**Special Models**					
	00	Basic Model		**60**	Overcurrent and User's Thermal Elements (2 Time Constants: Heating and Cooling): IF1>: (0.1 - 30) x In // Tmp: 0 - 300 s. IF2>: (0.1 - 30) x In // Tmp: 240 - 2100 s.	
	03	Special EDs (Activation Ranges + Detection Times)		**61**	60 Special Model + Phase & Ground Time and Instantaneous Unit Special Range: IF>>: Tmp: 0 - 300 s. IF>: (0.1 - 4) x In // Curves Rate: 0.05 - 1.5 IN>>: (0.05 - 12) x In // Tmp: 0 - 300 s. IN>: (0.04 - 3) x In // Curves Rate: 0.05 - 1.5	
	04	Special EDs (Activation Ranges)				
	10	Phase Trip		**70**	60 Special Model + 3 Setting Groups	
	15	Optional Ground Ranges: (0.1 x 1.2) x In		**71**	50 Special Model + 61 Special Model + Ground Time Overcurrent, Sensitive Ground Overcurrent And Breaker Failure Units Pickups Special Ranges.	
	20	IN>: (0.01 - 0.5) x In; IN>>: (0.01 - 6) x In				
	40	IN>: 1 - 20 A; IN>>: 0.5 - 150 A IF>: 1 - 20 A; IF>>: 0.5 - 150 A		**96**	46 Special Model + 50 Special Model	
	45	IN>: 0.5 - 20 A; IN>>: 0.5 - 150 A				
	46	IN> e IN>>: (0.01 - 6A) x In Definite Time Setting up to 150s.				
	50	3 Setting Groups				
10	**Type of Enclosure**					
	D	6 x 1/7 19" rack		**V**	19" rack, 6U	
	G	6 x 1/5 19" rack				
11	**Communication Protocols**					
	A	Protec. no PROCOME + without Control		**F**	Protec. no PROCOME + Control MODBUS and PROCOME	
	B	Protec. no PROCOME + Control PROCOME		**J**	Option E + Events PROCOME 3.0	
	D	Protec. PROCOME + Control PROCOME		**K**	Option F + Events PROCOME 3.0	
	E	Protec. no PROCOME + Control DNP3.0 and PROCOME				

(*) ±20
(**) only if COMMUNICATIONS = 1

- **Functions**

50/51	Phase Overcurrent Protection.
50N/51N	Ground Overcurrent Protection.
67N	Directional Ground Overcurrent Protection.
67NA	Zero Directional Ground Overcurrent Protection (Isolated Ground).
49	Thermal Element Protection.
32	Directional Power.

2. Technical Data

2.1 Power Supply Voltage

Selectable range depending on model:	**24 - 48Vdc (±20%)** **110 -125Vdc (±20%)** **220 - 250Vdc (±20%)**

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

2.2 Power Supply Burden

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

2.3 Current Analog Inputs

Rated Value	**In = 5 A** or **1 A** (phases / ground) **In = 0.020 A** (special ground) (selectable in the equipment)
Thermal Withstand Capability	**4 In** (continuously) **50 In** (for 3 s) **100 In** (for 1 s)
Dynamic Limit	**240 In**
Current Circuit Burden	**<0.2 VA** (In = 5 A) **<0.05 VA** (In = 1 A) **<0.002 VA** (In = 0.020 A)

2.4 Measurement Accuracy

Measured voltages	
Internal measure accuracy	**< 5 %**
Display measure accuracy	**< 5 % ±1V**
Measuring times	
Definite and Inverse Time characteristic (UNE 21-136 and IEC 255)	**<5 %** or **<25ms** (the greater)

2.5 Repeatability

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

2.6 Transient Overreach

Expressed as: $ST = \frac{I_A - I_T}{I_A} x100$

<10% for totally inductive lines
<5% for lines with an impedance angle of 70º or less

I_A = Pick up value for a current with no dc component
I_T = Pick up value for a current with maximum dc offset

2.7 Digital Inputs

Two electrically separate, user programmable digital inputs

Digital Input Voltage Range	**24 - 125 Vdc (±20%)**
(range selectable depending on model)	**48 - 250 Vdc (±20%)**
Current Drain	**<5 mA**

CPI-*-***2** Models**
8 electrically separated programmable inputs, with polarity

Digital Input Voltage Range	
IN1 Input	**110 Vac (±20%) / 125 Vdc (±20%)**
IN2 to IN8 Input (see Note)	**24 - 125 Vdc (±20%)**
(selectable for machine function)	**250 Vdc (±20%)**
Available Rated Voltages	**24 - 48 Vdc (±20%)**
	125 Vdc (±20%)
	250 Vdc (±20%)
Current Drain	**<5 mA**

Rated voltage for inputs IN2 to IN8 (depending on the model) will be selectable when they are used in trip and close circuits supervision applications.

2.8 Trip Outputs

Trip Outputs and AUX-1

2 trip contacts internally configurable as NO or NC
AUX-1 Form C switch (SPDT) internally configurable as NO and/or NC

I DC maximum limit (with resistive load)	**30 A** (1 s)
I DC continuous service (with resistive load)	**8 A**
Close	**2500 W**
Breaking capability (with resistive load)	**150 W** - max. 8 A - (48 Vdc) **55 W** (80 Vdc - 250 Vdc) **1250 VA**
Break (L/R = 0.04 s)	**60 W** at 125 Vdc
Switching voltage	**250 Vdc**
Momentary close time trip contacts remain closed	**100 ms**

Trip and Close Outputs. CPI-*-***2** Model**

4 contacts internally configurable as NO or NC

I DC maximum limit (with resistive load)	**30 A** (1 s)
I DC continuous service (with resistive load)	**8 A**
Close	**2500 W**
Breaking capability (with resistive load)	**150 W** - max. 8 A - (48 Vdc) **55 W** (80 Vdc - 250 Vdc) **1250 VA**
Break (L/R = 0.04 s)	**60 W** at 125 Vdc
Switching voltage	**250 Vdc**
Momentary close time trip contacts remain closed	**100 ms**

2.9 Auxiliary Outputs

Auxiliary Outputs AUX-2 and AUX-3
Electrically separate Form C (SPDT) auxiliary contact outputs NO or NC

I DC maximum limit (with resistive load)	**5 A** (30 s)
I DC continuous service (with resistive load)	**3 A**
Close	**2000 W**
Breaking capability (with resistive load)	**75 W** -max. 3 A- (48 Vdc) **40 W** (80 Vdc - 250 Vdc) **1000 VA**
Break (L/R = 0.04 s)	**20 W** at 125 Vdc
Switching voltage	**250 Vdc**

Auxiliary Contact Outputs (CPI-*-***2** Model)**
Electrically separate open and closed contacts and normally open contacts

I DC maximum limit (with resistive load)	**5 A** (30 s)
I DC continuous service (with resistive load)	**3 A**
Connection Capacity	**2000 W**
Breaking capability (with resistive load)	**75 W** -max. 3 A- (48 Vdc) **40 W** (80 Vdc - 250 Vdc) **1000 VA**
Break (L/R = 0.04 s)	**20 W** at 125 Vdc
Switching voltage	**250 Vdc**

2.10 Communications Link

Glass Fiber Optics	
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**

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) front and rear connectors	**Pin 5 - GND** **Pin 2 - RXD** **Pin 3 - TXD**

RS485 Port Signals	
Used signals	**A (B5)** **B (B6)**

3. Standards and Type Tests

The equipment satisfies the requirements of IEC-255 (EN 21-136) at the maximum class for the values indicated below.

3.1 Insulation

Insulation Test (Dielectric Strength)	*IEC-60255-5*
Between all circuit terminals and ground:	**2 kV, 50 Hz**, for 1 min
Between all circuit terminals:	**2 kV**, **50 Hz**, for 1 min
Voltage Impulse Test	*IEC-60255-5 (UNE 21-136-83/5)*
	5 kV; **1.2/50 μs**; **0.5 J**

3.2 Electromagnetic Compatibility

1 MHz Burst Test	*IEC-60255-22-1 Class III*
	(UNE 21-136-92/22-1)
Common mode:	**2.5 kV**
Differential mode:	**1.0 kV**
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*
Amplitude modulated *(EN 50140)*	**10 V/m**
Pulse modulated *(EN 50204)*	**10 V/m**
Conducted Electromagnetic Field Disturbance	*EN 50141*
Amplitude modulated	**10 V**
Electrostatic Discharge	*IEC-60255-22-2 Class III*
	(UNE 21-136-92/22-2) (IEC 1000-4-2)
	±8 kV ±10 %

Radio Frequency Emissivity	*EN 55011 (IEC-61000-4-6)*

3.3 Environmental Test

Temperature	*IEC-60255-6*
Operating range:	From **-10 ºC** to **+ 55 ºC**
Storage range:	From **-25 ºC** to **+ 70 ºC**
Humidity:	**95 %** (non-condensing)

3.4 Power Supply

Power Supply Ripple	*IEC-60255-11 / UNE 21-136-83 (11)* **< 20 %**

3.5 Mechanical Test

Vibration Test (sinusoidal)	*IEC-60255-21-1 Class I*
Mechanical Shock and Bump Test	*IEC-60255-21-2 Class I*

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

4. Physical Architecture

4.1 General

CPI protection terminals consist of a circuit board with the following functions:

- Power Supply
- Central Processing Unit
- Analog Input Transformers
- Contact Inputs and Outputs

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

Figures 4.1 and 4.2 show terminal unit front panels for **3CPI** series and **8CPI** series respectively. Dimensions of the front panels are specified at the end if this instruction manual.

Keypad, alphanumeric display, LED targets, and local communications port are located on the front panel.

The rear panel contains terminal connectors as shown in Figures 4.3, 4.4 and 4.5. There are two terminal connector groups, one corresponds to transformer secondary analog inputs (from 1 to 10 terminal connectors), and the other corresponds to power supply input and contact inputs and outputs (from 11 to 30 terminal connectors).

The relay is provided with communications connectors both in the front and the rear.

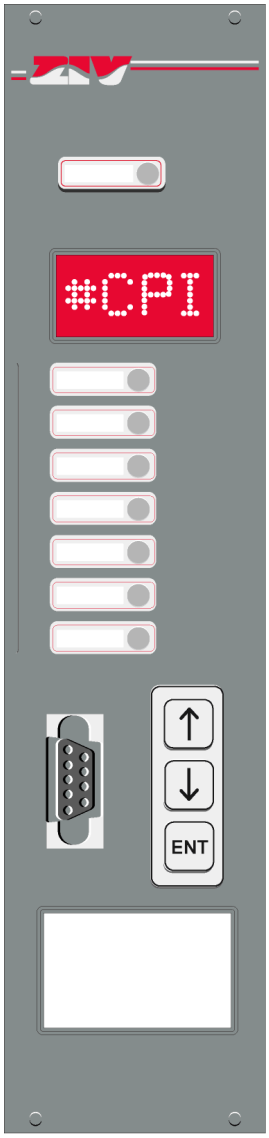


Figure 4.1: 3CPI Front View.

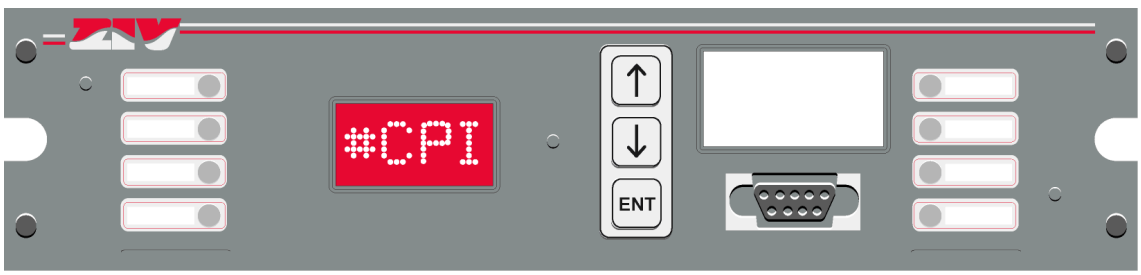


Figure 4.2: 8CPI Front View.

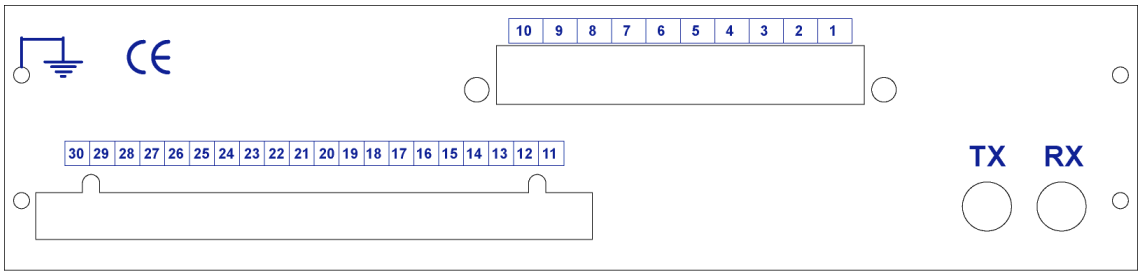


Figure 4.3: 8CPI Rear View.

4.2 Dimensions

CPI protection terminal case dimensions are 1/7 of a 19" rack wide, and 6 standard rack units high (10½"). **3CPI** terminals are vertical mount units, and **8CPI** terminals are horizontal mount units. The equipment is intended to be installed either semi-flush mounted on panels or inside a 19" rack. The **CPI** is equipped with a transparent cover which can be sealed for security purposes. The enclosure colour is graphite.

Note: 8CPI models are designed to be mounted on 1 Rack wide x 2U high adapter element. Dimension drawings for this adapter are given at the end of this instruction manual.

3CPI-*-**2** special models are designed to be mounted on 1/5 Rack wide x 6U high adapter element. 8CPI-***-**2** special models are designed to be mounted on 1 Rack wide x 3U high adapter element.**

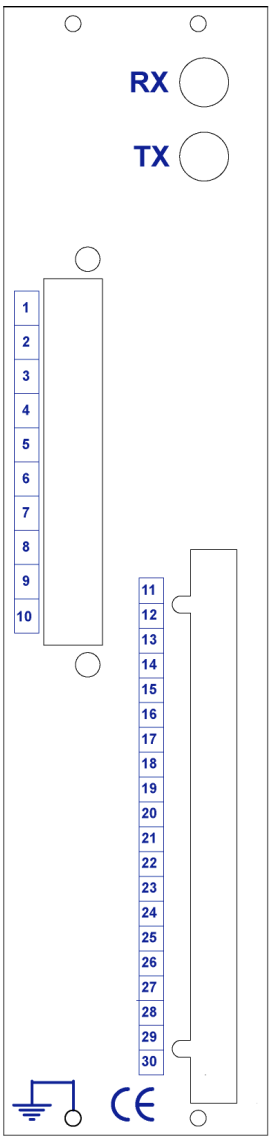


Figure 4.4: 3CPI Rear View.

4.3 Connection Elements

4.3.1 Terminal Connectors

Terminal connectors are permanently attached to the rear edge of the printed circuit board to facilitate external wiring and are arranged in rows or columns depending on the model:

- One row or column of 10 terminal connectors for transformer secondary inputs.
- One row or column of 20 terminal connectors for power supply input and contact inputs and outputs.

Voltage analog input terminals accept up to #11 AWG wire. The remaining circuit terminals permit wire up to #14 AWG. Communications connectors are provided on both front and rear equipment panels.

Note: CPI-*-***2** special models have one row or column of 18 terminal connectors (B row or column in figure 4.5) for inputs (8 digital inputs) and two row or columns for the outputs (10 digital outputs), first of them of 20 terminal connectors (D row or column in figure 4.5) and the other one of 8 terminal connectors (C row or column in figure 4.5).**

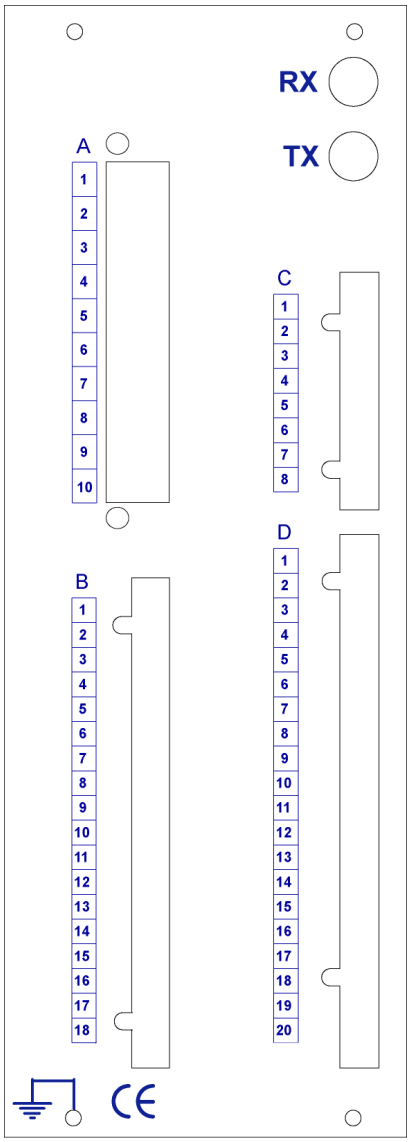


Figure 4.5: 3CPI-*-***2** Model Rear View.**

4.3.2 Removing Printed Circuit Boards (Non Self-Shorting)

The equipment has been designed to enable removal of the printed circuit board. The printed circuit board is attached to the case using self-tapping screws. These screws must be removed before the board is withdrawn. It is also necessary to remove the screws on the terminal connectors.

4.3.3 Internal Wiring

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

5. Settings

5.1 Configuration Settings

Communications (Local Port RS232C)	
Setting	**Range**
Terminal Address	Not sensitive - enter any number
Baud Rate	4800 Baud
Stop Bits	1
Parity	1 (parity) / 0 (no parity)

Communications (Remote Port)	
Setting	**Range**
Terminal Address	0 to 254
Baud Rate	300 to 19200 Bauds (1)
Maximum Baud Rate for RS232	9600 Bauds
Stop Bits	1 or 2
Parity	1 (Parity) / 0 (No parity)
Communications Timeout	0 - 100 ms
MODBUS Protocol (2)	YES / NO (3)

(1) Maximum baud rate for RS-232: 9600 bauds.
(2) Depending on the model.
(3) With NO setting answers Procome Protocol.

Communications (HMI)		
Setting	**Range**	**Default Value**
Frontal Port Parity (affects to local port)	0 or 1	1
Timeout (affects to local and remote port)	0 to 100 ms	100 ms

Language	
Setting	**Range**
Language (1)	Spanish English Portuguese

(1) Accord to software version.

Frequency	
Setting	**Range**
Frequency	50 / 60 Hz

Operation Enable	
Setting	**Range**
Breaker Operation Commands from	
Keypad	YES / NO
Local Port	YES / NO
Remote Port	YES / NO
Remote Port Settings from	
Remote Port	YES / NO
Digital Inputs	YES / NO

5.2 General Settings

General Settings		
Setting	**Range**	**Step**
Phase CT Ratio (CPI-A/B)	1 - 3000	1
Ground CT Ratio (CPI-B/C)	1 - 3000	1
Open Breaker Status	1 - 0	
Event masking	only via communications	

5.3 Protection Elements Settings

Phase Time Overcurrent Element (CPI-A/B/T)		
Setting	**Range**	**Step**
Enable	YES / NO	
Interlock Enable (only via communications)	YES / NO	
Pickup	0.2 - 2.4 In	0.01 A
Time Curve	Definite Time, Inverse, Very Inverse, Extr. Inverse	
Time Dial	0.05 - 1	0.01
Definite Time Delay	0.05 - 100 s	0.01 s

Phase Time Overcurrent Element (Special Models)		
Setting	**Range**	**Step**
Pickup 40 Special Model 61 and 71 Special Models	 0.2 - 4 In 0.1 - 4 In	 0.01 A 0.01 A
Time Dial 61 and 71 Special Models	 0.05 - 1.5	 0.01

Phase 1 Time Overcurrent Element (60, 61, 70 and 71 Special Models)		
Setting	**Range**	**Step**
Enable	YES / NO	
Pickup	0.1 - 30 In	0.01 A
Definite Time Delay	0 - 300 s	1 s

Phase 2 Time Overcurrent Element (60, 61, 70 and 71 Special Models)		
Setting	**Range**	**Step**
Enable	YES / NO	
Pickup	0.1 - 30 In	0.01 A
Definite Time Delay	240 - 2100 s	1 s

Phase Instantaneous Overcurrent Element (CPI-A/B/T)		
Setting	**Range**	**Step**
Enable	YES / NO	
Interlock Enable (only via communications)	YES / NO	
Pickup	0.1 - 30 In	0.01 A
Definite Time Delay	0 - 100 s	0.01 s

Phase Instantaneous Overcurrent Element (61 and 71 Special Models)		
Setting	**Range**	**Step**
Definite Time Delay	0 - 300 s	0.01 s

Ground Time Overcurrent Element (CPI-B/C/T)		
Setting	**Range**	**Step**
Enable	YES / NO	
Interlock Enable (only via communications)	YES / NO	
Pickup	0.04 - 0.48 In	0.01 A
Time Curve	Definite Time, Inverse, Very Inverse, Extr. Inverse	
Time Dial	0.05 - 1	0.01
Definite Time Delay	0.05 - 100 s	0.01 s
20 mA Ground Time Overcurrent Unit	0.8 -10 mA	0.01 mA
Sensitive Ground Time Overcurrent Unit	0.01 - 0.24 A	0.01 A

Ground Time Overcurrent Element (Special Models)		
Setting	**Range**	**Step**
Pickup		
40 Special Model	0.2 - 4 In	0.01 A
45 Special Model	0.1 - 4 In	0.01 A
46 and 96 Special Model	0.01 - 6 In	0.01 A
61 Special Model	0.04 - 3 In	0.01 A
71 Special Model	0.04 - 4 In	0.01 A
Time Dial		
61 and 71 Special Models	0.05 - 1.5	0.01
Definite Time Delay		
46 and 96 Special Models	0.05 - 150 s	0.01 s

Ground Instantaneous Overcurrent Element (CPI-B/C/T)		
Setting	**Range**	**Step**
Enable	YES / NO	
Interlock Enable (only via communications)	YES / NO	
Pickup	0.1 - 12 In	0.01 A
Definite Time Delay	0 - 100 s	0.01 s
20 mA Ground Time Overcurrent Unit	0.8 -24 mA	0.01 mA
Sensitive Ground Time Overcurrent Unit	0.05 - 3 A	0.01 A

Ground Instantaneous Overcurrent Element (Special Models)		
Setting	**Range**	**Step**
Pickup		
40 and 45 Special Models	0.1 - 30 In	0.01 A
46 and 96 Special Models	0.01 - 6 In	0.01 A
61 and 71 Special Models	0.05 - 12 In	0.01 A
Definite Time Delay		
46 and 96 Special Models	0 - 150 s	0.01 s
61and 71 Special Models	0 - 300 s	0.01 s

Thermal Element (CPI-T)		
Setting	**Range**	**Step**
Thermal Element Enable	YES / NO	
Heating constant (t1) (60, 61, 70 and 71 Special Models	30 - 600 min	1 min
Cooling constant (t2) (60, 61, 70 and 71 Special Models	1 - 6 times t1	1
Maximum Current Pick-up	0.2 - 2 In	0.01 A
Alarm Level Pick-up	50 - 100%	
Thermal Memory Enable	YES / NO	

Sensitive Ground Overcurrent Element		
Setting	**Range**	**Step**
Enable	YES / NO	
Pickup	0.02 - 0.48 In	0.01 A
Pickup 20mA Ground	0.4 - 10 mA	0.01 mA
Time Delay	0.05 - 300 s	0.01 s

Sensitive Ground Overcurrent Element (Special Models)		
Setting	**Range**	**Step**
Pickup		
40 Special Model	0.2 - 4 In	0.01
46 and 96 Special Models	0.01 - 0.48 In	0.01
61 Special Model	0.02 - 3 In	0.01
71 Special Model	0.02 - 4 In	0.01

Open Phase Current Element (CPI-A/B/T)		
Setting	**Range**	**Step**
Enable	YES / NO	
Pickup I_2: Negative sequence current element I_1: Positive sequence current element	0.05 - 0.40 I_2/I_1	0.05
Minimal load in the line	0.02 - 1 In	0.01 A
Time Delay	0.05 - 300 s	0.01 s

Breaker Failure Element		
Setting	**Range**	**Step**
Enable	YES / NO	
Phase Overcurrent Pickup	0.04 - 0.48 In	0.01 A
Ground Overcurrent Pickup	0.04 - 0.48 In	0.01 A
20mA Ground Overcurrent Pickup	0.8 - 10 mA	
Time Delay	0.05 - 0.7 s	0.01 s

Breaker Failure Element (Special Models)		
Setting	**Range**	**Step**
Phase Overcurrent Pickup		
61 Special Model	0.04 - 3 In	0.01 A
Ground Overcurrent Pickup		
46 and 96 Special Models	0.01 - 0.48 In	0.01 A
61 Special Model	0.04 - 0.48 In	0.01 A
71 Special Model	0.04 - 4 In	0.01 A

5.4 Recloser Settings

Recloser in Service		
Setting	**Range**	**Step**
Enable	YES / NO	

Recloser Timers		
Setting	**Range**	**Step**
Phase Reclose (1, 2, 3 and 4) Delay	0.2 - 300 s	0.01 s
Gnd Reclose (1, 2, 3 and 4) Delay	0.2 - 300 s	0.01 s

Cycle Control Timers		
Setting	**Range**	**Step**
Reference Voltage Timer	0.5 - 300 s	0.01 s
Synchrocheck Timer	0.05 - 300 s	0.01 s
Phase Fault Reset Timer	0.05 - 300 s	0.01 s
Gnd Fault Reset Timer	0.05 - 300 s	0.01 s
Manual Close Reset Timer	0.05 - 300 s	0.,01 s
Sequence Check Timer	0.05 - 0.35 s	0.01 s
Manual Close Delay	0.05 - 300 s	0.01 s

Cycle Control	
Setting	**Range**
Maximum Recloser Shots	1 - 4
Manual Close - Vref Supervision	YES / NO
Recloser - Vref Supervision	YES / NO
Manual Close - Synchrochek Supervision	YES / NO
Recloser - Synchrocheck Supervision	YES / NO
Synchrocheck Supv. Delay Enable	YES / NO

Trip Enable	
Setting	**Range**
Phase IOC	YES / NO
Phase TOC	YES / NO
Ground IOC	YES / NO
Ground TOC	YES / NO
Open Phase	YES / NO
Sensitive Ground Overcurrent	YES / NO
Breaker Failure	YES / NO
Recloser states for which these enables are defined: Recloser is reset Reclose sequence in progress 1, 2, 3 and 4 External Manual Close Reset Time Trip Manual Close Through Recloser Reset Time Trip	

Recloser Enable	
Setting	**Range**
Phase IOC	YES / NO
Phase TOC	YES / NO
Ground IOC	YES / NO
Ground TOC	YES / NO
Open Phase	YES / NO
Sensitive Ground Overcurrent	YES / NO
External Protection	YES / NO
Recloser states for which these enables are defined: Reclose for trips with recloser reset Reclose sequence in progress 1, 2, 3 and 4	

5.5 Logic Settings

Logic Settings (only via communications)		
Setting	**Range**	**Step**
Fail to Open Time (CPI-**R and CPI-T2T)	0.02 - 2 s	0.01 s
Fail to Close Time (CPI-**R and CPI-T2T)	0.02 - 2 s	0.01 s
Close Enable (CPI-**R)	YES / NO	
Trip Seal-In (CPI-T2T)	YES / NO	

Trip Masks (via communications and keypad)	
Setting	**Range**
Phase IOC	YES / NO
Phase TOC	YES / NO
Ground IOC	YES / NO
Ground TOC	YES / NO
Open Phase	YES / NO
Residual Current	YES / NO
Phase 1 Time (60, 61 and 70 Special Models)	YES / NO
Phase 2 Time (60, 61 and 70 Special Models)	YES / NO
Thermal Unit (60, 61 and 70 Special Models)	YES / NO

5.6 Breaker Monitor Settings

Trip Masks (via communications and keypad)	
Setting	**Range**
I2 Sum Alarm	0 - 99999.99 kA^2
I2 Dropout Value	0 - 99999.99 kA^2

5.7 Metering History Log Settings

Metering History Log	
Setting	**Range**
Sampling Interval	1 - 15 min
Recording Interval	from 1 min to 24.00 h.
Week Mask	Monday to Sunday
Recording Start/End Time	from 0 to 24.00 h

5.8 Oscillography Settings

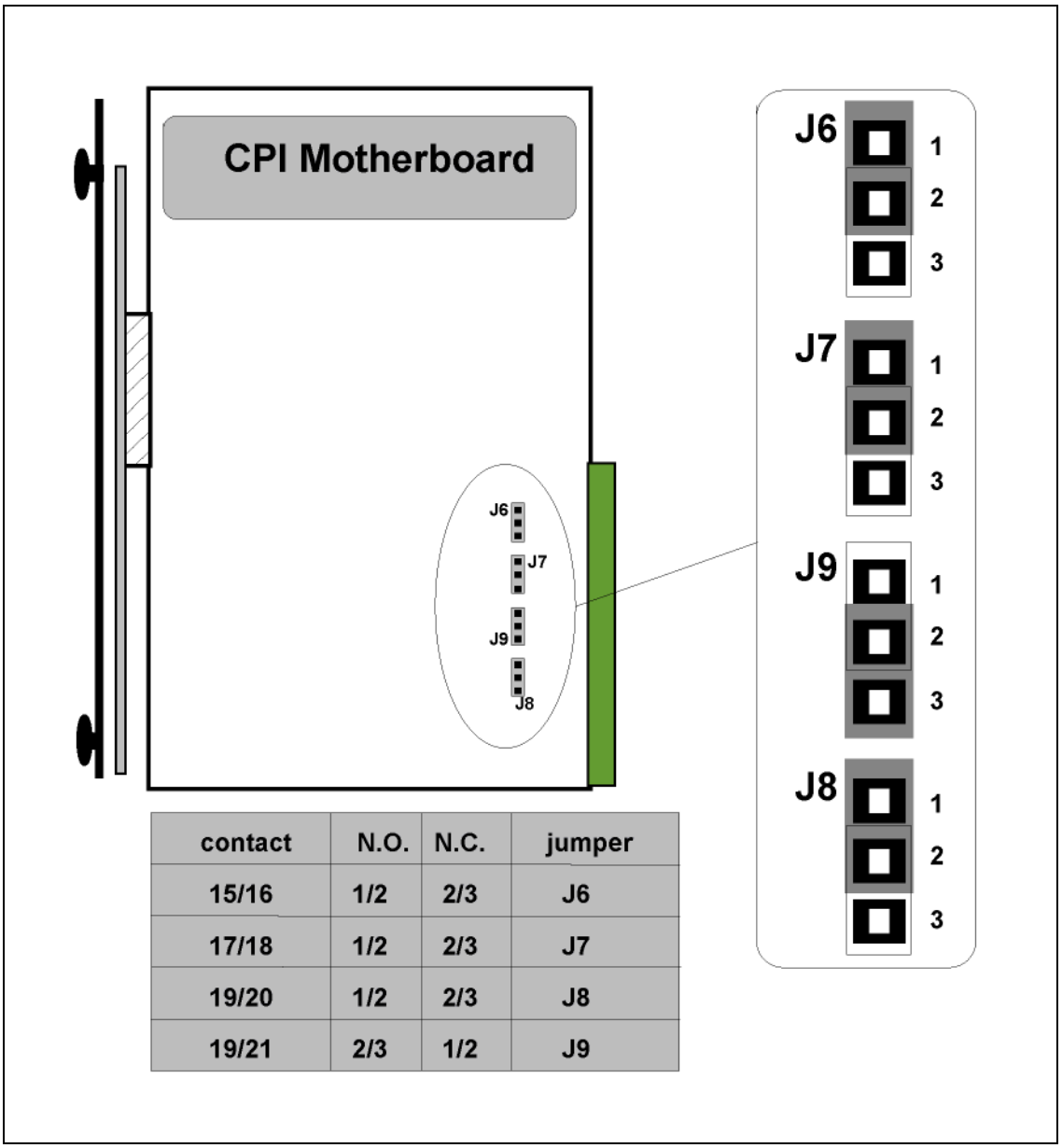
Oscillograhy		
Setting	**Range**	**Step**
Trip Required	YES / NO YES = fixed time mode NO = variable time mode	
Continuous Mode	YES / NO	
Record Storage Mode	0 = pickup 1 = trip 1 2 = trip 2	
Pre-Fault Recording Length	1 - 2 cycles	
Post-Fault Recording Length	20 - 300 cycles	1

Trigger Mask	
Setting	**Range**
Phase Time Overcurrent	YES / NO
Ground Time Overcurrent	YES / NO
Phase Instantaneous Overcurrent	YES / NO
Ground Instantaneous Overcurrent	YES / NO
Open Phase	YES / NO
Residual Current Element	YES / NO
Open Command	YES / NO
External Trigger	YES / NO
Phase 1 Time (60, 61 and 70 Special Models)	YES / NO
Phase 2 Time (60, 61 and 70 Special Models)	YES / NO

Analog Channel Mask	
Setting	**Range**
Phase A Current	YES / NO
Phase B Current	YES / NO
Phase C Current	YES / NO
Ground Current	YES / NO

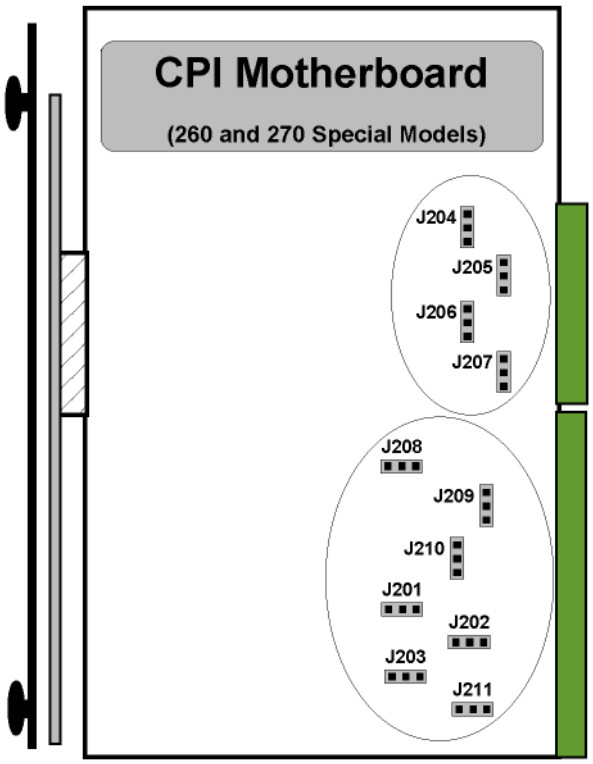
5.9 Digital Inputs, Auxiliary Outputs and LED Targets

Digital Inputs, Auxiliary Outputs and LED Targets
The ***ZIVercom***© communications program allows the user to redefine or reallocate the auxiliary outputs via the local communication port. It is also possible to configure auxiliary outputs as NO or NC contacts, by changing the internal jumpers as indicated in figure 5-1 and 5-2.



contact	N.O.	N.C.	jumper
15/16	1/2	2/3	J6
17/18	1/2	2/3	J7
19/20	1/2	2/3	J8
19/21	2/3	1/2	J9

Figure 5.1: Internal Jumpers.



contact	N.O.	N.C.	jumper	function
C1 - C2	2/3	1/2	J204	AUX-1
C3 - C4	2/3	1/2	J205	AUX-2
C5 - C6	2/3	1/2	J206	AUX-3
C7 - C8	2/3	1/2	J207	AUX-4
D1 - D2	2/3	1/2	J208	AUX-5
D3 - D4	2/3	1/2	J209	AUX-6
D5 - D6	2/3	1/2	J210	AUX-7
D7 - D8	2/3	1/2	J201	trip
D9 - D10	2/3	1/2	J202	trip
D11 - D12	2/3	1/2	J203	close
D13 - D14	2/3	1/2	J211	close

Figure 5.2: Internal Jumpers (260 and 270 Special Models).

6. Description of Operation

6.1 Overcurrent Units

CPI-A terminals provide Three-Phase Instantaneous and Time Overcurrent protection. **CPI-B** terminals provide Three-Phase and Ground Instantaneous and Time Overcurrent protection. **CPI-C** terminals provide Ground Instantaneous and Time Overcurrent protection. **CPI-T** terminals provide Three-Phase and Ground Instantaneous and Time Overcurrent protection.

Each of these overcurrent protection functions consists of an Instantaneous and a Time Overcurrent measuring element. The Instantaneous measuring element is also equipped with an adjustable timer that can be enabled or disabled. CPI-T models have a similar operation mode but settings are different for Phases and Ground. Instantaneous and Time Overcurrent element settings are made for Phase and Ground functions. Consequently, all three phases share the same Phase Instantaneous and Phase Time Overcurrent settings. The following parameters are adjustable for each of the setting groups:

- **Enable**
- **Pickup**
- **Definite Time Delay**

Note: 60, 61, 70 and 71 Specials Models has two additional time elements (definite time only – no time / current characteristic): phase time element 1 and phase time element 2. These elements operate in the same way as the other overcurrent units but have different settings.

6.1.1 Time Elements

The Time Overcurrent element continuously processes the RMS value of current analog input **I** based on averaging a full cycle of samples. Pickup takes place when the measured value exceeds 1.05 times the pickup setting, and reset occurs at the pickup setting.

The time element integrates a measured value above pickup by incrementing a counter in the integrator module using an amount proportional to the input current RMS value. When the counter reaches the operate threshold, the Time Overcurrent element initiates a trip. When the measured value drops below the pickup setting, the incrementing value is removed, causing a rapid reset of the integrator module to its initial condition with the counter at zero. Any new measured value above pickup must then start the integration interval from zero.

Three inverse time curves (Inverse, Very Inverse and Extremely Inverse), one Definite Time delay and one user defined time curve can be selected. Time-current characteristic curves have two independent settings: Curve Family, and Time Dial.

- **Time/Current Characteristics**

Figures 6.1, 6.2 and 6.3 show the pre-programmed time/current characteristic curves provided with the **CPI** Terminal Unit.

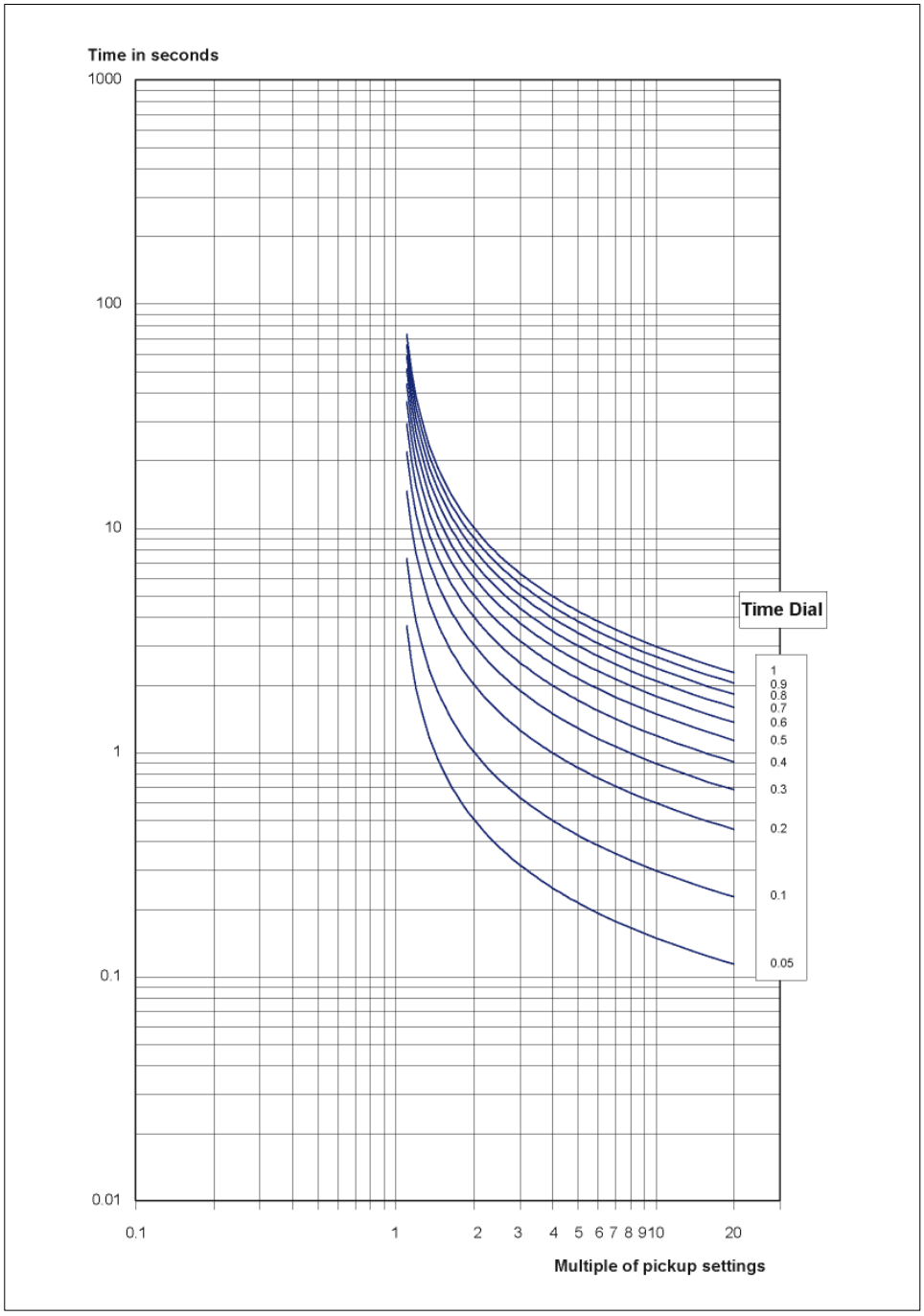


Figure 6.1: Inverse Time/Current Characteristic.

$$t = \frac{0.14}{I_s^{0.02} - 1}$$

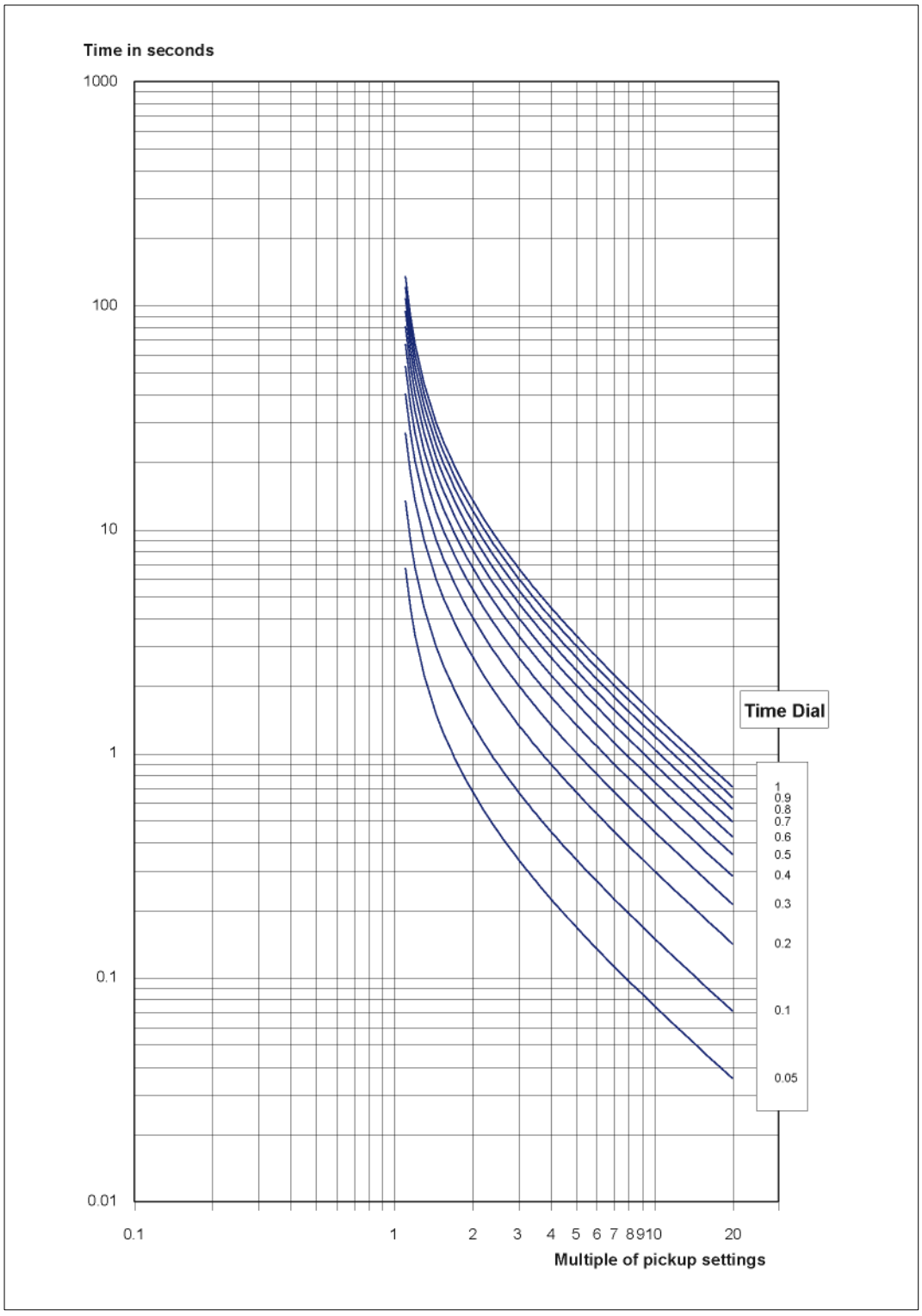


Figure 6.2: Very Inverse Time/Current Characteristic.

$$t = \frac{13.5}{Is - 1}$$

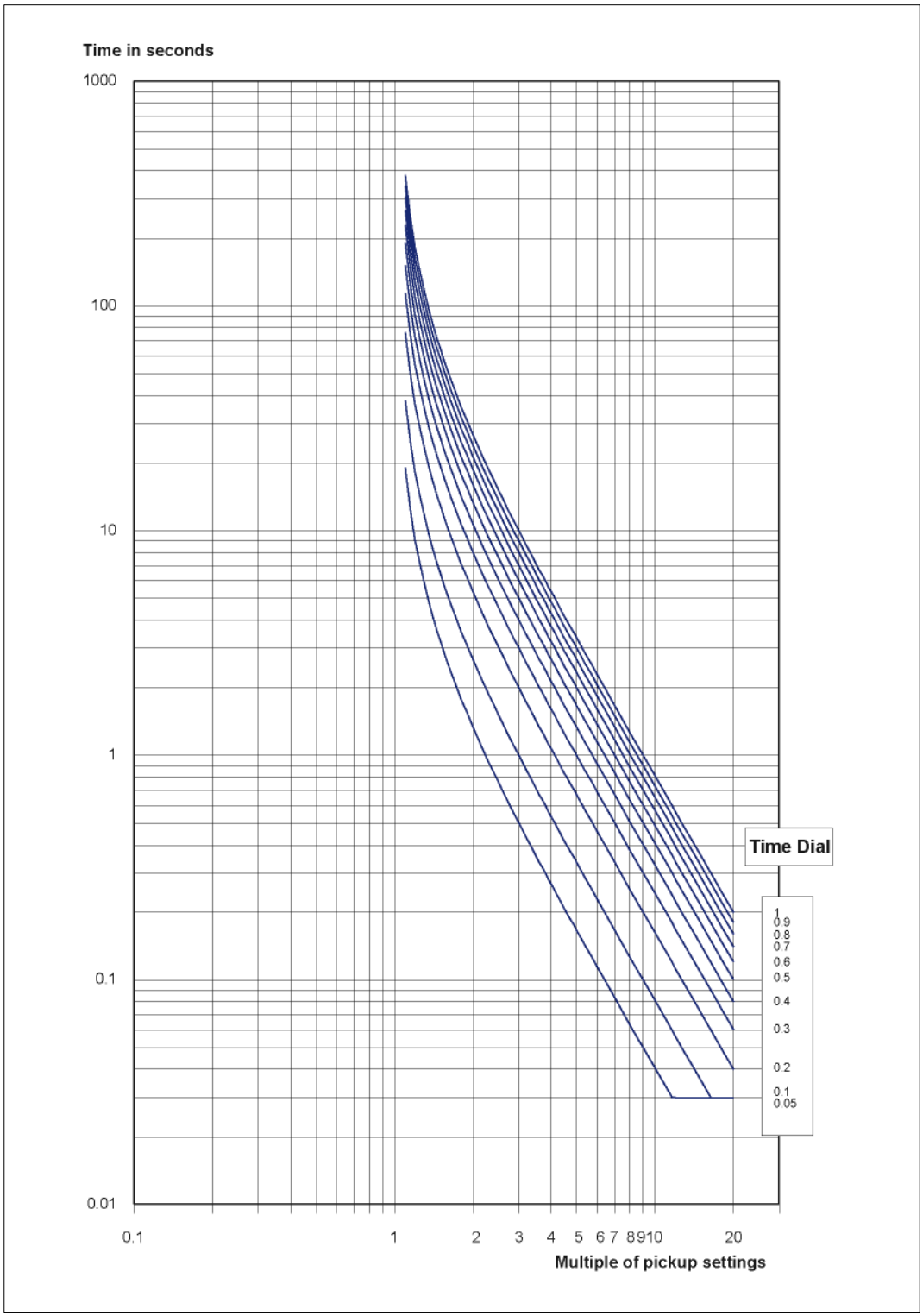


Figure 6.3: Extremely Inverse Time/Current Characteristic.

$$t = \frac{80}{I_s^{\,2} - 1}$$

6.1.2 Overcurrent Unit Block Diagrams

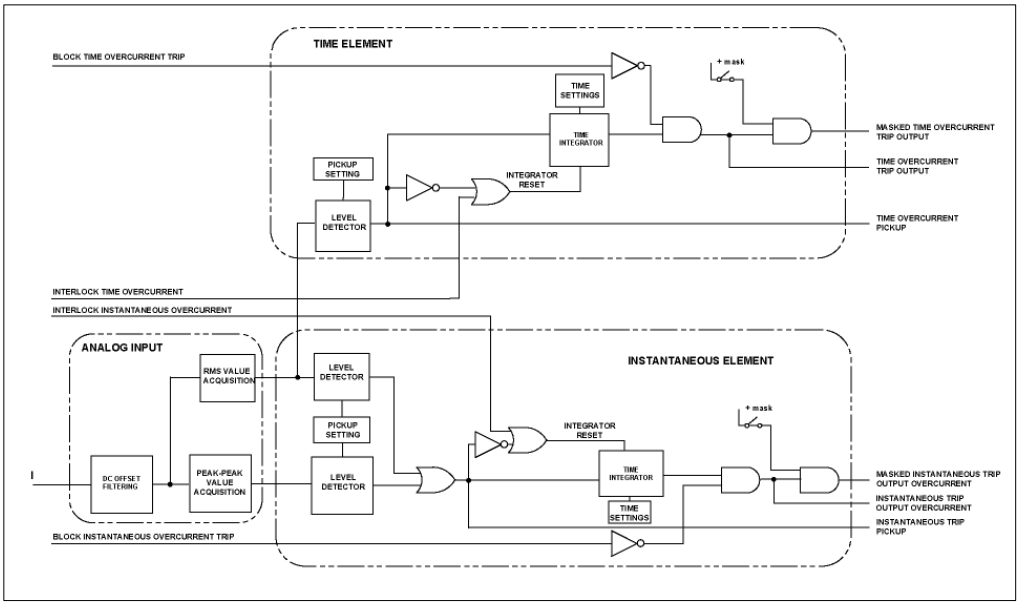


Figure 6.4: Overcurrent Unit Block Diagram.

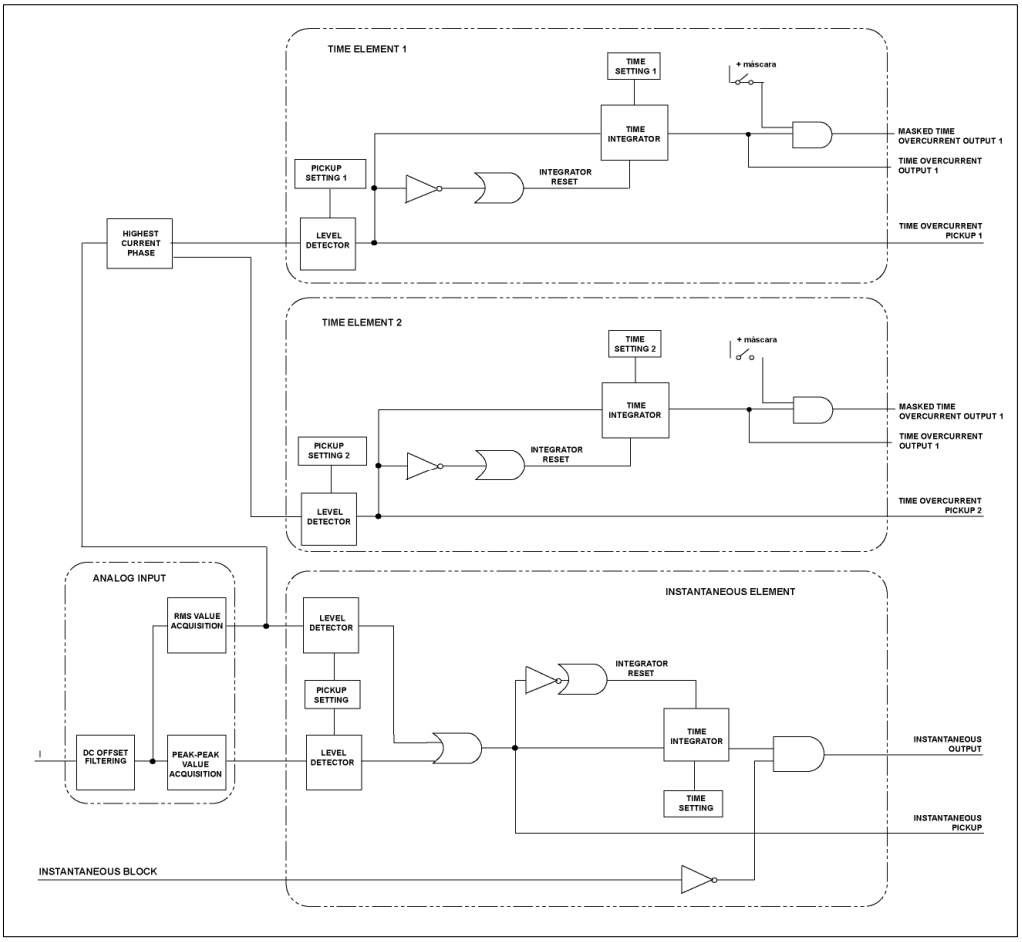


Figure 6.5: Overcurrent Unit Block Diagram [60, 61, 70 and 71 Specials Models].

6.1.3 Instantaneous Elements

The instantaneous elements respond using two different current measuring criteria, one for RMS values and the other for peak-to-peak values. For RMS current values, operation takes place whenever the measured value exceeds 1.05 times the pickup setting. For peak-to-peak current values, operation occurs whenever there are two consecutive samples, whose value exceeds 2.1 times the peak value of the pickup setting.

The RMS level detector and the peak-to-peak level detector will reset whenever the measured value is below the pickup setting.

Filtering out the DC offset component in combination with the application of these two instantaneous measurement methods results in low transient overreach without adversely affecting tripping speed.

The combined output of these measuring elements is equipped with an adjustable timer that enables delay of the instantaneous trip.

6.1.4 Interlock Control

Both the time and the instantaneous overcurrent elements have inputs referred to as Interlock Control. When the input is energized for the time overcurrent function, the operation of the time overcurrent element is blocked by resetting the Integrator module to its initial condition with the counter at zero.

To enable time overcurrent tripping, this input must remain de-energized during the entire timing process from pickup to trip. If the input is energized for the instantaneous overcurrent element, the instantaneous function is blocked via a logic gate after the level detector outputs that will hold the timer reset.

For each one of the Interlock Control inputs, there is an enable setting within each protection element menu in the display. To use these Logic Input Signals, Status Contact Inputs must be programmed for this application.

6.1.5 Block Trip and Bypass Time

Both the time and the instantaneous overcurrent elements also have inputs referred to as **Block Trip**. When the inputs are energized for the time or instantaneous overcurrent functions, the operation of the particular overcurrent element is blocked with a final logic gate after the integrator or timer. The integrator and timer, however, continue to time out. To use these Logic Input Signals, Status Contact Inputs must be programmed for this application.

Another input modifying the operation of the time overcurrent elements is called **Bypass Time**. When this input is energized, the affected element is essentially converted into an instantaneous function without any time delay. This input is available for phase and ground (depending on the model). To use these Logic Input Signals, Status Contact Inputs must be programmed for this application.

6.2 Breaker Failure Unit

The breaker failure function is designed to detect the failure of a circuit breakers response to trip commands from protection elements. It also generates a trip signal to open adjacent breakers capable of isolating the fault. The operation of this function is shown in the block diagram of Figure 6.6.

The breaker failure initiate signal (**I_BF**) is activated through a trip command generated by the terminal unit Internal Protection elements (**TRIP**) or an External Protection Trip input (**EXTR**). Once the **I_BF** signal is activated and current is still detected by the terminal unit (**C_IN** signal), the breaker failure signal (**P_BF**) starts the counter for the Breaker Failure Time Delay (**T_BF**). If **T_BF** times out before either **I_BF** resets, indicating that the conditions which initiated breaker failure are no longer present, or **C_IN** resets, indicating that there is no current detected by the terminal unit, the Breaker Failure Output (**BF**) is activated.

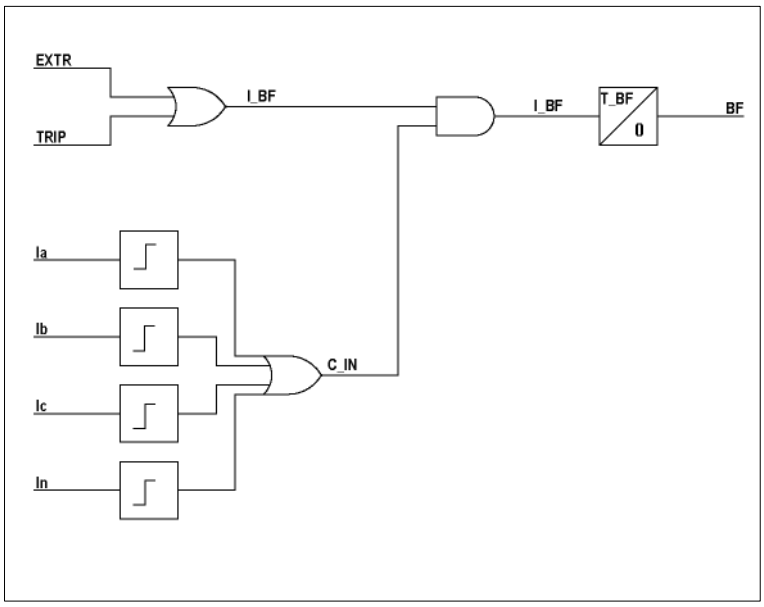


Figure 6.6: Breaker Failure Element Block Diagram.

The reset of either the **I_BF** or **C_IN** signal causes the **T_BF** timer to reset and stop the breaker failure process.

The **C_IN** signal, which indicates the presence of current, is active whenever any of the units pickup levels are exceeded. These fast reset current level detectors are intended to stop the timer as soon as the breaker is open and current has disappeared to insure that the **BF** signal is not triggered inadvertently.

In order to activate the breaker failure element from an external protection trip input, one of the terminal unit Status Contact Inputs must be configured as an External Protection Trip Input (**EXTR**). If an input is not assigned as an External Protection Trip Input, the **EXTR** signal will default to a logic “0”.

Additionally, one or more of the Auxiliary Contact Outputs must be configured as a Breaker Failure Output (**BF**) to produce a contact output for initiating backup tripping.

6.3 Open Phase Unit

- **Without Minimal Load in the Line Setting**

The Open Phase element is designed to detect an open phase in the monitored three-phase circuit by measuring the ratio of the negative to positive sequence current. Figure 6.7 shows the block diagram of this function.

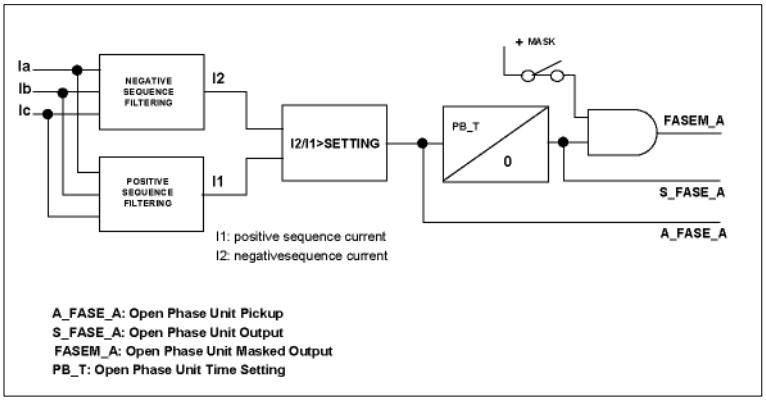


Figure 6.7: Open Phase Element Block Diagram (without Minimal Load in the Line Setting).

Open Phase Pickup is initiated when this ratio exceeds the user adjustable setting. Once the Open Phase element has picked up, output PB_P is initiated. If the PB_P signal is present for a period of time equal to or greater than the PB_T Time Delay setting, a Open Phase Trip Output occurs (PB_O).

The operation of this function is controlled by the element enable setting, the position of the breaker and the positive sequence current level. If the breaker is open or the positive sequence current level is less than 100 mA, the element is disabled. This function is also disabled when any of the phase or ground, time or instantaneous overcurrent elements are picked up.

If this function is disabled, positive and negative sequence current measurement is still provided for metering display purposes.

- **With Minimal Load in the Line Setting**

Some models have a special setting for **Minimal Load in the Line**, which is the level of direct sequence current needed for enabling unit operation. The logic of this unit is shown on the right figure.

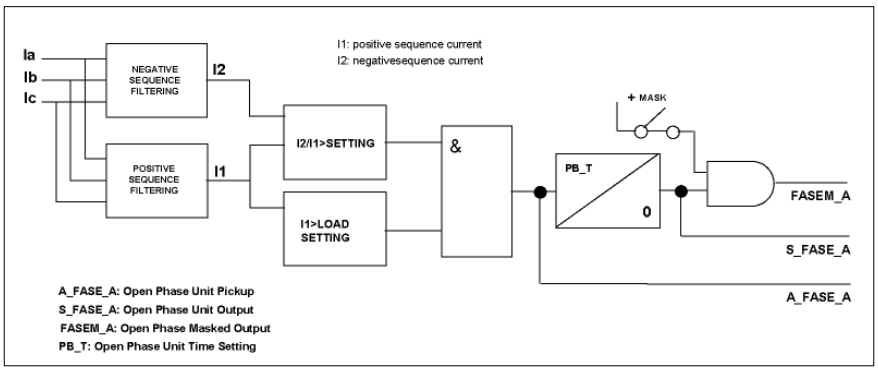


Figure 6.8: Open Phase Element Block Diagram (with Minimal Load in the Line Setting).

6.4 Sensitive Ground Overcurrent Unit

The Sensitive Ground Overcurrent Element is designed to detect situations of sensitive residual or unbalance currents by the existence of zero sequence currents which are below expected ground fault values.

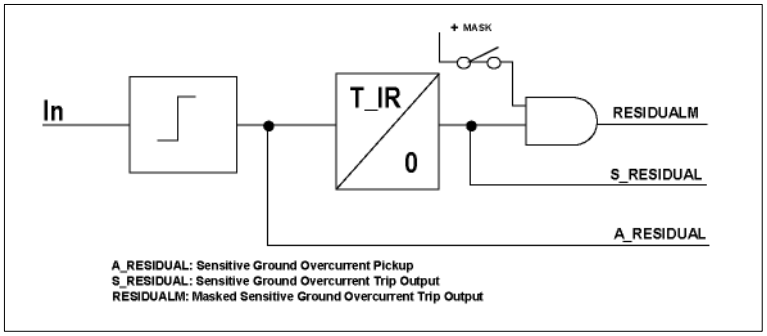


Figure 6.9: Sensitive Ground Overcurrent Block Diagram.

A trip is permitted if zero sequence current, which does not reach minimum phase to ground fault levels, is detected for a preset period of time.

The adjustable time delayed output can be used for alarm and tripping applications. Figure 6-8 shows the block diagram of this function.

The current measured by the Sensitive Ground Overcurrent Element uses the same Current Analog Input as the Ground Overcurrent Elements. Once this element has picked up, output SG_P is activated. If the SG_P signal is present for a period of time equal to or greater than the SG_T Time Delay setting, a Trip Output occurs (SG_O).

The Sensitive Ground Overcurrent Element can be disabled with the element enable setting but is automatically disabled when the Ground Time Overcurrent Element picks up.

6.5 Thermal Element

The **CPI-T** terminal incorporates a thermal protection element which utilizes thermal imaging. Thermal imaging in this case, measures the current that flows through the transformer relative to the resolution of the thermal differential equation, and estimates the thermal status of the windings, then initiates a trip when the physical integrity of the transformer's dynamic thermal capacity is reached.

The differential equation that controls any thermal phenomenon is represented by:

$$I^2 = \theta + \tau \cdot \frac{d\theta}{dt}$$

Where:

I: Is the effective value of the measured current
τ: Time constant (adjustable parameter)

The magnitude measured and used in the calculation is the current value circulating in any of the phases.

The thermal element estimates the thermal status of the transformer and initiates a trip command, when it reaches a level equivalent to the permanent flow of I_{max}.

In addition to the trip level, the thermal unit has an adjustable alarm level.

The thermal element trip time, after the application of I^2, (starting from a zero value of current), is as follows:

$$t = \tau \cdot \mathrm{Ln}\left(\frac{I^2}{I^2 - I_{max}{}^2}\right)$$

Where:

Imax: Maximum current value allowed (adjustable parameter).

If starting from a current value other than zero (I_p), the operation time is as follows:

$$t = \tau \cdot \mathrm{Ln}\left(\frac{I^2 - I_p{}^2}{I^2 - I_{max}{}^2}\right)$$

The trip reset and alarm times, well after a current decrease, either by the disappearance of the same after the opening of the breaker, are as follows.

- Where any of the three phases is higher than 50mA:

$$t = \tau 1 \cdot \mathrm{Ln}\frac{\vartheta i}{\vartheta f}$$

Where:

τ1:Time constant. Adjustable parameter.

ϑi :Initial Temperature.

ϑf :Final Temperature.

- Where any of the three phases is lower than 50mA:

$$t = \tau 2 \cdot \mathrm{Ln}\frac{\vartheta i}{\vartheta f}$$

Where:

τ2:Is time constant, times τ1. Adjustable parameter.

Note: In the 60, 61, 70 and 71 Specials Models there are two constants, one for heating (τ_1) and one for cooling (τ_2). The machine thermal protection element will use one or the other depending on whether the motor/generator is working or is off. The relay will normally use the heating constant by default, but if the higher current value in any of the three phases is lower than 50mA, the relay will consider wich is the disconnected motor/generator and will automatically switch to using the cooling constant (τ_2).

- **Thermal Memory**

The thermal memory function aims that, faced with a loss of power protection, be capable of maintaining the thermal image of the machine protected. For this it will be to remember the thermal state at the moment of the power supply loss.

- **Thermal Characteristic**

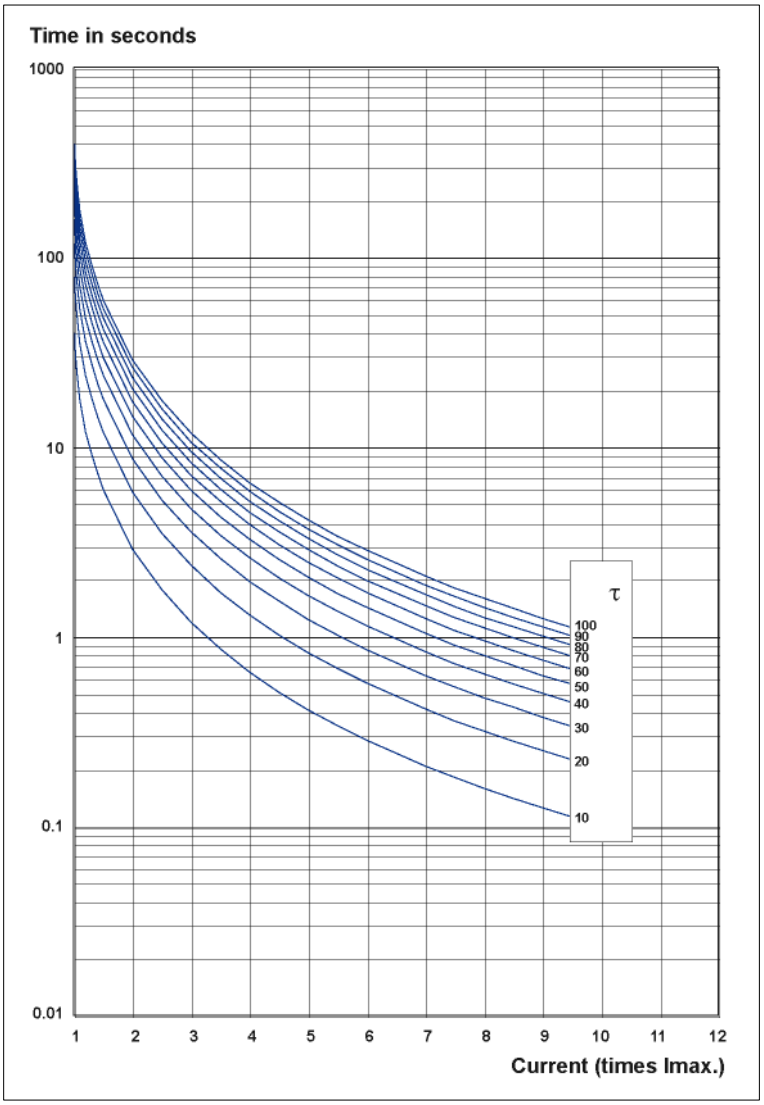


Figure 6.10: Characteristic Time Curves of Thermal Unit Operation.

6.6 General Settings

- **Transformer Ratio**

The transformer ratio settings (phase and/or ground, depending on model) only affect to the analog values displayed on the HMI. A transformer ratio setting of 1 will display the secondary values of the CTs. A setting equivalent to the CT transformation ratio will display the primary values of the system.

- **Open Breaker Status**

The function of the Open Breaker Status Input controls the state of the breaker and this input can be defined as contact normally open (with breaker open), which corresponds to the setting "0", or as contact normally (with breaker closed), which corresponds to the setting "1".

The state of the breaker is used by the recloser to define the state of Block due to Open Breaker and the beginning of the reclosing cycle. Moreover, it is linked to the breaker operation which occurs from the keyboard and via communications. Lastly, the open phase unit will not pick up if the breaker is open.

- **Event Masking**

It is possible to mask unneeded events or those events without importance for the study of protection behaviour. Event masking can be done only through ***ZIVercom***© communications software.

6.7 Recloser

The recloser function in **CPI-**R** terminals is accessible only via communications and designed to initiate up to four reclose attempts, with independent settings of the reclosing and security times.

Independent Recloser Timer settings are available for each dead time interval for both phase and ground faults.

The types of controlled recloser signals are:

- Recloser starts for phase-to-ground faults tripped by the time unit (Ground Time)
- Recloser starts for phase-to-ground faults tripped by the instantaneous unit (Ground instantaneous)
- Recloser starts for phase-to-phase faults tripped by the time units (Phase Time)
- Recloser starts for phase-to-phase faults tripped by the instantaneous units (Phase instantaneous)
- Recloser starts for open phase unit trip
- Recloser starts for sensitive ground or zero sequence current unit trip
- Recloser starts for external protection unit trip

Figure 6-11 and 6-12 are flow diagrams which describe the operation of the recloser. The Reclose Initiate (RI) signal shown in these diagrams is the logic sum of the following signals:

RI-P (Recloser starts for phase-to-phase faults)
RI-N (Recloser starts for phase-to-ground faults)

Therefore RI = RI-P + RI-N

RI is activated when either RI-P or RI-N is initiated. RI is reset when both RI-P and RI-N are reset.

6.7.1 Reclose Sequence

Up to four reclose attempts can be programmed in the reclose sequence. A sequence of operations takes place during each of these close attempts which is controlled by the recloser settings, external inputs, and inputs from the protection elements of the **CPI** terminal. Please refer to the block diagrams of Figures 6-11 and 6-12.

- **Sequence Start**

When the recloser function is in the Recloser Reset state, reclosing can be initiated by internal protection elements or an External Protection Trip input (**EXTR**).

When the Reclose Initiate (**RI**) signal is activated, the recloser switches from the Reset state to the Sequence Check Time state. The Sequence Check Time timer begins timing at this point. If this timing is completed before the fault is cleared (RI de-activated) and the breaker opens (**OB**), the recloser switches to **Recloser Lockout Due To Breaker Failure**. Manually closing the breaker will reset the recloser provided the breaker remains closed for the recloser Reset Time After Manual Close set by the user.

If the fault has been successfully cleared, the reclose sequence continues with the activation of the Reclose Sequence In Progress (**RSP**) signal.

- **Reclose Supervision by Rated Voltage**

If the recloser Reclose Supervision by Rated Voltage setting is YES, the next step in the reclose logic process is a Rated Voltage Timer (RV Timer) for detecting rated voltage at the Rated Voltage input. If voltage is detected during the user predetermined time interval, the recloser switches to the Reclose Timer (Dead Time) state prior to the first reclose attempt. If rated voltage at the Rated Voltage input is not detected during the user predetermined time interval, the recloser switches to Recloser Lockout Due To Lack of Rated Voltage.

If the recloser Rated Voltage setting is NO, the RV Timer logic is bypassed and the Recloser Timer (Dead Time) state is achieved immediately.

- **Recloser Timer**

The Recloser Time (Dead Time) is the time the breaker is allowed to remain open before a reclose is attempted. This time delay starts when the Recloser Timer (Dead Time) state is achieved. The Recloser Timer (Dead Time) time delay setting can be different for each reclose attempt. When this timer has timed out, the Reclose Inhibit (INHR) input status is verified. If an INHR input signal is not present, the Reclose Command (RC) is activated and the Closing Time state is achieved.

If an INHR signal is present, the Supervision by Reclose Inhibit setting status is checked. If Supervision by Reclose Inhibit is disabled, the Reclose Command (RC) is activated and the Closing Time state is achieved. If Supervision by Reclose Inhibit is enabled, the Reclose Inhibit Timer starts. If the Reclose Inhibit (INHR) input is removed before the timing is completed, the Reclose Command (RC) is activated and the Closing Time state is achieved. If the Reclose Inhibit Timer times out and the Reclose Inhibit (INHR) input is present, the recloser state changes to Recloser Lockout Due To Unsatisfied Reclosing Conditions.

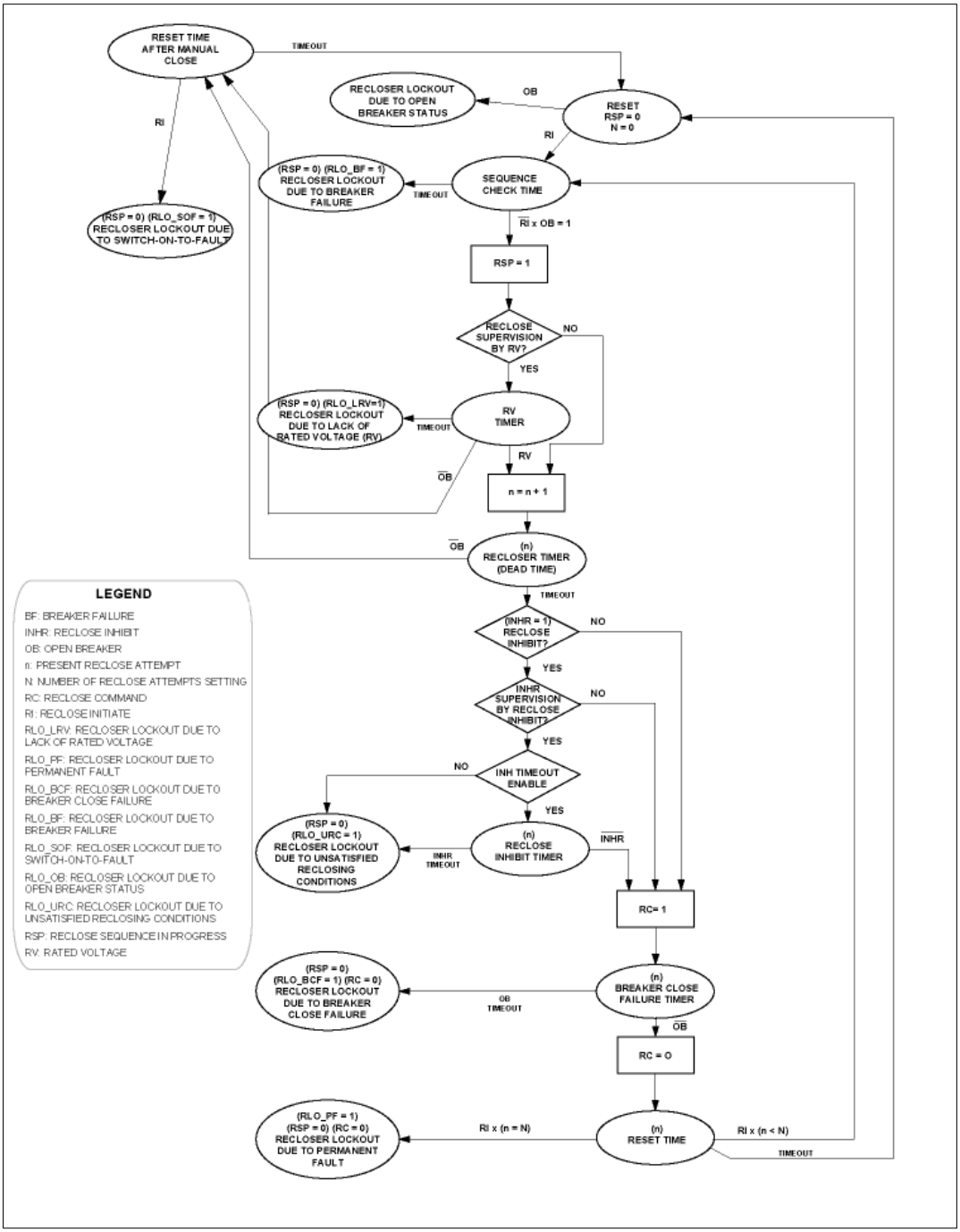


Figure 6.11: Recloser Flow Diagram (I).

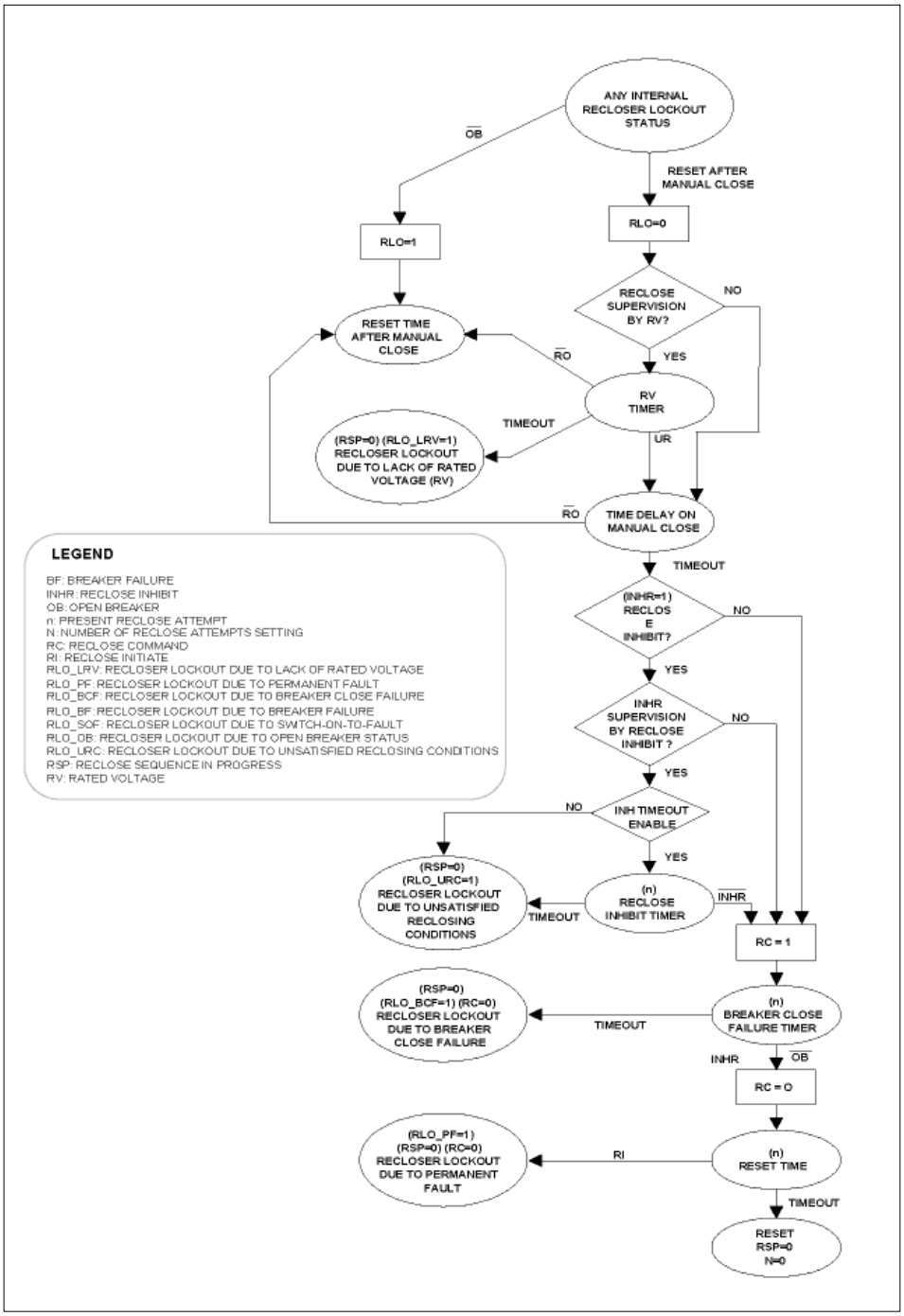


Figure 6.12: Recloser Flow Diagram (II).

- **Closing Time**

When the recloser Closing Time state is achieved, the Reclose Command (RC) output is activated to send a close command to the breaker and an adjustable Breaker Close Failure Timer is started. If the breaker closes before the Breaker Close Failure Time is completed, the recloser Reset Time state is achieved. If the time is completed and the breaker remains open, the recloser state switches to Recloser Lockout Due To Breaker Close Failure. In either case the Reclose Command (RC) output is subsequently de-activated.

- **Reset Time**

When the recloser Reset Time state is achieved, an adjustable Reset Time timer is started. The Reset Time setting corresponds to the closing attempt the recloser is currently executing and the type of prior fault. If the Reset Time is completed without a trip being initiated, the recloser switches to the Recloser Reset state and the reclose attempt is completed successfully.

If a trip occurs and Reclose Initiate (RI) is activated before the Reset Time is completed, the next step in the reclose sequence is determined by the Number of Reclose Attempts setting. If a trip (RI active) occurs after the last reclose attempt permitted by this setting, the recloser switches to Recloser Lockout Due To Permanent Fault, and the reclose sequence ends. If the recloser has not reached the last permitted reclose attempt, the trip (RI active) which occurs before the Reset Time is completed initiates a new reclose attempt and the recloser switches to the Sequence Check Time state.

6.7.2 Recloser Lockout

The previous sections in this chapter have described how the Recloser Lockout state is achieved where the recloser cannot initiate a breaker closing attempt in response to fault conditions and corresponding trip operations.

Another condition will produce Recloser Lockout. Recloser Lockout is also achieved when the breaker is opened without a fault associated with the breaker operation. Under this circumstance, the recloser switches to Recloser Lockout Due To Open Breaker Status and reclosing is disabled.

The recloser will remain in the Recloser Lockout state until a closed breaker is detected or a Manual Close Command is initiated through the terminal unit. The recloser will then reset only if the breaker remains closed for the Reset Time After Manual Close set by the user.

6.7.3 Manual Close

There are two **manual close** operations that affect the status of the recloser:

- **External Manual Close**

External manual closing is identified when the recloser detects, by way of the Open Breaker (OB) Status Contact Input, that the breaker has closed and that a closing command has not been issued by the terminal unit through the recloser.

When this condition is detected, the recloser leaves the Recloser Lockout state and switches to the Reset Time after Manual Close state. When this state is achieved the timer for the Reset Time after Manual Close starts. If timing is completed without a trip initiation, the recloser switches to the Recloser Reset state. If there is a trip before timing is completed, the recloser switches to the Recloser Lockout Due To Switch-On-To-Fault state.

- **Recloser Manual Close**

If the Recloser Manual Close Enable setting is YES in the Logic Settings, then reclosing is initiated when the recloser receives a Manual Close Command (MC) signal from a Status Contact Input. The subsequent closing sequence is similar to a final programmed reclose attempt except there is no Sequence Check Time. Also, the following Reclose Sequence settings supersede those associated with a final programmed reclose attempt:

- Manual Close Supervision By Rated Voltage
- Manual Close Supervision By Reclose Inhibit
- Time Delay On Manual Close. Equivalent To Recloser Timer (Dead Time)
- Reset Time After Manual Close
- Trip Mask Elements at Recloser Manual Close

Near the end of the Recloser Manual Close sequence, at breaker closure, the Reset Time after Manual Close timer is started. Recloser Lockout results if a mask enabled trip output occurs during this period of time. If no trip occurs, the recloser returns to the Recloser Reset state.

6.7.4 Block Reclosing and Recloser External Lockout

There are two types of block signals, manual and external. Priority is given to the block commands received first. To remove the block the corresponding opposite command should be issued.

- **Block Reclosing**

The recloser can be manually blocked with the Recloser Block command via the operator interface keyboard on the terminal unit. If the recloser is in a reclose sequence when the block reclosing command is received, further operations are suspended. No reclose attempts are initiated after a breaker trip.

A Recloser Unblock command must be entered from the operator interface to exit the Blocked status. If the breaker is open when this command is received, the recloser changes to the Recloser Lockout state. If the breaker is closed when the Unblock command is received, the Reset Time after Manual Close timer is started.

- **Recloser External Lockout**

The Recloser External Lockout feature operates the same as Block Reclosing, except that commands are executed through Status Contact Inputs instead of the operator interface.

The Recloser External Lockout state can be controlled by the status of one single status contact input or by two separate contact inputs, depending on the model.

Block Reclosing commands override Recloser External Lockout commands. If the recloser receives a Recloser Block command while in the Recloser External Lockout state, the recloser changes to the Recloser Blocked state which can only be reset by a Recloser Unblock command.

6.7.5 Definitive Trip

A Definitive Trip signal will be generated in the recloser if, after the reclosing attempt sequence the fault persists. Then, the trip will occur.

It is possible too to configure an auxiliary output (DD + DISP*BLQ), also as a definitive trip, so that when a trip occurs the recloser will get internally blocked.

This definitive trip signal will remain active as long as the unit performing that trip does not reset. It usually happens when after a trip no reclosing attempt takes place.

6.7.6 Recloser Not in Service

The recloser is placed in the Not in Service state whenever the Recloser In Service Enable setting is NO.

6.7.7 Recloser and Trip Control Masks

The Reclose Sequence Trip Mask controls which protective elements can operate based on recloser status, and the Reclose Sequence Reclose Mask controls which protective elements can initiate reclosing after operating.

- **Trip enable**

Tripping can be controlled by recloser status for the following elements:

Phase Instantaneous Overcurrent
Phase Time Overcurrent
Ground Instantaneous Overcurrent
Ground Time Overcurrent
Open Phase
Sensitive Ground Overcurrent

Enabling or disabling of these units for trip generation is subjected to the following status:

Recloser at rest
Recloser counting security time following closure #1, 2, 3 or 4
Recloser counting security time following external manual close
Recloser counting security time following manual closure through block reclosing

The action of the trip masks can only take place if the corresponding unit has been activated, within its own protection settings, given that if the unit has been deactivated, its pickup process does not initiate.

Trip mask, which corresponds to the NO setting, makes the physical output of the trip contact, or of an output configured as masked, but it realizes the whole process of the unit from start to the decision of generating a trip.

- **Reclose Enable**

Reclosing can be enabled or disabled for the followings faults:

Phase to Ground Faults tripped by the time elements (Ground Time Overcurrent)
Phase to Phase Faults tripped by the time elements (Phase Time Overcurrent)
Phase to Ground Faults tripped by the instantaneous elements (Ground Instantaneous Overcurrent)
Phase to Phase Faults tripped by the instantaneous elements (Phase Instantaneous Overcurrent)
Unbalance between phase tripped by the open phase element
Ground unbalance tripped by the Sensitive Ground current element
External tripping of the protection (received through a configurable digital entry as an external protection pickup)

The masks are defined for the following recloser status:

- Recloser after tripping following rest status
- Recloser after tripping while at rest #1, 2, 3 or 4

If the recloser is out of service or blocked, the masks are not operative and all trips are by default in active status.

Warning: Caution should be exercised when disabling protective trip elements that are expected to respond to faults, as each of the above settings are independent. Masking of all the units makes it impossible for the protection to trip. No masking is YES in the setting. Therefore, you have to make sure that at least one measurement unit is not masked and is in an enable status.

6.8 Logic

The logic settings include the following functions: trip seal, time delay for breaker opening and closing failure and closing through the recloser (model dependant).

6.8.1 Trip Output Seal-In

The Trip Output Seal-In function is enabled by setting the Seal-In Enable to YES. Once a protective trip and subsequent breaker operation command have been generated, the command is maintained until the breaker has opened as indicated by the 52b auxiliary contact which monitors breaker position.

If the Seal-In Enable is set to NO, the trip command resets when the protection trip elements reset. If the breaker fails to open, and the fault has been cleared by an upstream breaker, the Trip Output contact will be destroyed attempting to interrupt the breaker trip coil current.

6.8.2 Breaker Opening and Closure Failure Time

For manual operations as for those generated by the protection or reclose units, the non reception of the breaker change of status, after the operation order has been emitted, within the time of operation failure (adjustable independently for the opening and the closure), induces the activation of the opening order failure or closing order failure signals. If the closing order failure signal is generated before breaker closure during a reclose cycle, it will cause the recloser to block.

The equipment will maintain the closing or opening order for the time indicated in this setting if the operation is not executed before that time has elapsed.

6.8.3 Manual Close via Recloser Sequence

As it has already been mentioned in paragraph 6.7.3 about the recloser, there is a possibility to close the breaker through the recloser logic, so that it is this logic that decides the closure. For this to occur, it is necessary to set the closure setting through the recloser on YES (box ticked).

It is reminded that the recloser is only accessible via communications through the ***Zivercom®*** communication program.

6.8.4 Trips Masks

A specific Settings Group allows the user to enable/disable relay trip by selecting the status of the corresponding mask.

- **Trip Enable**

Tripping can be controlled by this setting for the following elements:

CPI-B and CPI-T** Models**
Phase and Ground Instantaneous
Phase and Ground Time
Time Phase 1 (*)
Time Phase 2(*)
Thermal Element (**)
Open Phase
Residual Current

CPI-C Models**
Ground Instantaneous
Ground Time
Residual Current

(*) 60, 61, 70 and 71 Specials Models
(**) CPI-T Models

6.9 Breaker Monitoring

CPI terminal units record the interrupting current for each trip of the associated breaker and accumulate it as amperes squared (I^2). This number is proportional to the accumulated power actually interrupted by the breaker.

When a trip is initiated, the largest of the three phase primary currents is recorded and then stored as I^2. The current measurement period is between trip initiation and breaker opening. When the breaker is opened manually, either through the terminal unit or by external means, the value accumulated is equivalent to the square of the time overcurrent pickup setting.

Once the value established for the Alarm Level of I^2 is reached, the function activates the ΣI^2 Alarm Level signal that can be used to activate a programmable Auxiliary Contact Output. When activated, this output is captured by the sequence of events recorder.

Two settings of this function can be controlled and displayed:

- ΣI^2 Alarm Level
- ΣI^2 Cumulative Present Value

The Cumulative Present Value is updated each time a breaker opening operation takes place. It represents a base to which successive interruption values are added. This setting can be modified by the user to set an initial value into a newly installed terminal unit to match the history of an existing breaker. The value may also be reset to zero after major breaker maintenance has been completed.

6.10 Setting Group Change

Protection, Logic and Trip Masks Settings are stored in three groups (Group 1, Group 2 and Group 3) which can be activated or deactivated from the keypad or communications port, or by using external Status Contact Inputs.

The Setting Group Control function allows the user to modify the active Setting Group by means of Status Contact Inputs. This feature enables quick modification of the protection settings when circumstances require a change. Use of this function requires that the protection setting groups be pre-programmed.

Change of setting group using the HMI will be explained in Chapter 7, Keypad and Alphanumeric Display. Using local communications this change is carried out with the setting Activate table (Settings Menu).

Change of setting group using the communications port or digital input need of a specific enabling by an option in the configuration menu of HMI. Both options are simultaneously incompatible.

The value of E_DIG should be set to “1” (YES) to enable group setting changes to be made from the status contact inputs. If E_DIG is set to “0”, the terminal unit will remain in the last setting group selected, independent of the activity of the Status Contact Inputs. When Setting Group Control by status contact is enabled, no setting changes can be made from the keypad of the local RS232 communications port. If the Change Settings option on the Main Menu is selected from the keypad, the displays indicates ACCESS DENIED.

To use this function, three status contact inputs must be programmed to activate the three setting group.

Control setting group by status contact inputs (E_DIG set to “1”) and by remote communications port (P_REM set to “1”) cannot be enabled simultaneously.

Note: Only you can change group, activating T1, T2 and T3, if the display is in default screen.

6.11 Event Recording

Protection functions that are monitored by the Sequence of Events feature are listed in Table 6-1. Each equipment model will have only the signals indicated with a check mark ✓.

Table 6-1: Event Recording

Function	Event	CPI-A	CPI-B	CPI-C	CPI-T
Overcurrent Elements Activation	Phase A Time Overcurrent Pickup	✓	✓	✓	✓
	Phase B Time Overcurrent Pickup	✓	✓	✓	✓
	Phase C Time Overcurrent Pickup	✓	✓	✓	✓
	Ground Time Overcurrent Pickup		✓	✓	✓
	Phase A Instantaneous Overcurrent Pickup	✓	✓	✓	✓
	Phase B Instantaneous Overcurrent Pickup	✓	✓	✓	✓
	Phase C Instantaneous Overcurrent Pickup	✓	✓	✓	✓
	Ground Instantaneous Overcurrent Pickup		✓	✓	✓
	Phase 1 Time Overcurrent Pickup				✓
	Phase 2 Time Overcurrent Pickup				✓
	Phase A Time Overcurrent Trip Output Active	✓	✓		✓
	Phase B Time Overcurrent Trip Output Active	✓	✓		✓
	Phase C Time Overcurrent Trip Output Active	✓	✓		✓
	Ground Time Overcurrent Trip Output Active		✓	✓	✓
	Phase A Instantaneous Trip Output Active	✓	✓		✓
	Phase B Instantaneous Trip Output Active	✓	✓		✓
	Phase C Instantaneous Trip Output Active	✓	✓		✓
	Ground Instantaneous Trip Output Active		✓	✓	
	Phase 1 Time Overcurrent Trip Output Active				✓
	Phase 2 Time Overcurrent Trip Output Active				✓
Overcurrent Elements Reset and Deactivation	Phase A Time Overcurrent Reset	✓	✓		✓
	Phase B Time Overcurrent Reset	✓	✓		✓
	Phase C Time Overcurrent Reset	✓	✓		✓
	Ground Time Overcurrent Reset		✓	✓	✓
	Phase A Instantaneous Overcurrent Reset	✓	✓		✓
	Phase B Instantaneous Overcurrent Reset	✓	✓		✓
	Phase C Instantaneous Overcurrent Reset	✓	✓		✓
	Ground Instantaneous Overcurrent Reset		✓	✓	✓
	Phase 1 Time Overcurrent Reset				✓
	Phase 2 Time Overcurrent Reset				✓
	Phase A Time Overcurrent Trip Output Deactivated	✓	✓		
	Phase B Time Overcurrent Trip Output Deactivated	✓	✓		
	Phase C Time Overcurrent Trip Output Deactivated	✓	✓		
	Ground Time Overcurrent Trip Output Deactivated		✓	✓	

Table 6-1: Event Recording					
Function	**Event**	**CPI-A**	**CPI-B**	**CPI-C**	**CPI-T**
Overcurrent Elements Reset and Deactivation	Phase A Inst. Trip Output Deactivated	✓	✓		
	Phase B Inst. Trip Output Deactivated	✓	✓		
	Phase C Inst. Trip Output Deactivated	✓	✓		
	Ground Inst. Trip Output Deactivated		✓	✓	
	Phase 1 Time Overcurrent Trip Output Deactivated				✓
	Phase 2 Time Overcurrent Trip Output Deactivated				✓
Sensitive Ground Overcurrent, Phase Open Phase, Breaker Failure, Coil Monitoring and Oscillography Activation	Sensitive Ground Overcurrent Pickup	✓	✓	✓	✓
	Sensitive Ground Overcurrent Trip Output Active	✓	✓	✓	✓
	Open Phase Pickup	✓	✓	✓	✓
	Open Phase	✓	✓	✓	✓
	Breaker Failure Trip Output Active	✓	✓	✓	✓
	Breaker Monitor I*I Cumulative Alarm Level	✓	✓	✓	
	Breaker Monitor I*I Cumulative Alarm Overflow	✓	✓	✓	
	Oscillography Pickup (optional) (CPI-**R/T)	✓	✓	✓	
Residual Overcurrent and Open Phase Elements Reset and Deactivation	Residual Overcurrent Reset	✓	✓	✓	✓
	Residual Overcurrent Output Deactivation	✓	✓	✓	✓
	Open Phase Reset	✓	✓		✓
	Open Phase Output Deactivation	✓	✓		✓
Initialization	Power up	✓	✓	✓	✓
	Change of Settings Initialization	✓	✓	✓	✓
Inputs	Status Contact Input IN-1 Active	✓	✓	✓	✓
	Status Contact Input IN-2 Active	✓	✓	✓	✓
	Status Contact Input IN-3 Active				✓
	Status Contact Input IN-4 Active				✓
	Status Contact Input IN-5 Active				✓
	Status Contact Input IN-6 Active				✓
	Status Contact Input IN-7 Active				✓
	Status Contact Input IN-8 Active				✓
	Status Contact Input IN-1 Deactivated	✓	✓	✓	✓
	Status Contact Input IN-2 Deactivated	✓	✓	✓	✓
	Status Contact Input IN-3 Deactivated				✓
	Status Contact Input IN-4 Deactivated				✓
	Status Contact Input IN-5 Deactivated				✓
	Status Contact Input IN-6 Deactivated				✓
	Status Contact Input IN-7 Deactivated				✓
	Status Contact Input IN-8 Deactivated				✓

Table 6-1: Event Recording					
Function	**Event**	**CPI-A**	**CPI-B**	**CPI-C**	**CPI-T**
Inputs	Status Contact Input IN-1 Disabled	✓	✓	✓	✓
	Status Contact Input IN-2 Disabled	✓	✓	✓	✓
	Status Contact Input IN-3 Disabled				✓
	Status Contact Input IN-4 Disabled				✓
	Status Contact Input IN-5 Disabled				✓
	Status Contact Input IN-6 Disabled				✓
	Status Contact Input IN-7 Disabled				✓
	Status Contact Input IN-8 Disabled				✓
Recloser (CPI-**R)	Recloser External Lockout Reset	✓	✓	✓	
	Recloser External Lockout	✓	✓	✓	
	Recloser Manual Lockout Reset	✓	✓	✓	
	Recloser Manual Lockout	✓	✓	✓	
	Recloser Lockout due to switch-on-to-fault	✓	✓	✓	
	Recloser Lockout due to lack of Rated Voltage	✓	✓	✓	
	Recloser Lockout Due To Breaker Failure	✓	✓	✓	
	Recloser Lockout due to Permanent Fault	✓	✓	✓	
	Recloser Lockout due to Open breaker Status	✓	✓	✓	
	Recloser Lockout due to Unsatisfied Reclosing Conditions	✓	✓	✓	
	Recloser Lockout Due To Sequence Check Failure	✓	✓	✓	
	Recloser Command	✓	✓	✓	
	Recloser at rest	✓	✓	✓	
	Reclose Sequence in Progress	✓	✓	✓	
Breaker and recloser	Breaker Open	✓	✓		
	Breaker Closed	✓	✓		
	Breaker Manual Closing Command Failure	✓	✓		
	Breaker Manual Opening Command Failure	✓	✓		
	Breaker Closing Manual Command	✓	✓		
	Breaker Opening Manual Command	✓	✓		
Commands	Trip Blocked Due to Setting Disagreement	✓	✓	✓	✓
	Breaker Open Command	✓	✓	✓	✓
	Breaker Closed Command				✓
	Breaker Open Command Failure				✓
	Breaker Closed Command Failure				✓
	Thermal Alarm				✓
	Thermal Element Trip				✓
	Low Battery Thermal Memory Alarm Reset				✓
	Alarm Reset				✓
	Thermal Element Reset				✓
HMI	Local Mode (Keypad and Display)	✓	✓	✓	✓
	Remote Mode (Rear Port)	✓	✓	✓	✓
	Local Mode (Front Port)	✓	✓	✓	✓

Table 6-1: Event Recording					
Function	**Event**	**CPI-A**	**CPI-B**	**CPI-C**	**CPI-T**
Group Change	Group 1 Activation from Digital Input		✓		✓
	Group 2 Activation from Digital Input		✓		✓
	Group 3 Activation from Digital Input		✓		✓
	Group 1 Activation from Control Command		✓		✓
	Group 2 Activation from Control Command		✓		✓
	Group 3 Activation from Control Command		✓		✓

- **Event Recorder Management**

The event record capacity is one hundred (100) events. The Event Recorder structure is a FIFO stack. Once the full capacity is reached, a new event overwrites the oldest event.

The following information is stored in each event register:

- Phase and ground currents (depending on model) measured at the moment the event was generated
- Event date and time
- Event description

The management of the event recorder 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 the Ground Time Overcurrent Pickups are recorded in the same memory position. However, if the occurrences were not simultaneous, two separate events would be generated.

Simultaneous events are defined as those operations that occur within a 1 ms interval, which is the resolution time of the recorder.

Important: There is the option of masking those events that the user considers unnecessary for the analysis of relay operations. Since the capacity of the relay is 100 events, the recording of unnecessary data may erase important information. In the case of the open phase element, when the current burden in the line is small, pickups and resets can be generated continuously.

- **Records Retrieval**

ZIVercom® communications software allows the user to retrieve the information recorded by the unit. Information is decoded for user friendly presentation. Information is presented in table format with a record per table entry.

Note: with options D, J and K in communications protocol, "All" is about all the events that the unit have. In the other options, there is the option "All Pendants" to take the events.

6.12 Fault Reports

The equipment also incorporates Fault Reports where relevant fault information is stored. The register stores Fault Reports for the last fifteen (15) trips in non-volatile memory. When the register is full, a new report replaces the oldest report.

The information stored in each Fault Report is listed below:

Fault Initiation Time Tag - indicates the date and time of pick up of the first element involved in the fault. It also displays:

- Pre-Fault Currents - Three phase and ground current values two cycles before the fault started.
- Elements Picked Up For Full Fault Duration.

Open Command Time Tag - indicates the date and time of the trip command. It also displays:

- Currents at Open Command Initiation (depending on the model): currents at the moment the trip command was generated.
- Tripped Elements

Fault End Time Tag - indicates the date and time of reset of the last element involved in the fault. It also displays:

- Current Interrupted By Breaker - Maximum phase current registered between the moment the trip command was initiated and the end of the fault (determined by Open Breaker Status (52b contact) or Open Command Failure).

- **Report Access**

The ***ZIVercom***® communications and remote management software program is the user-friendly interface used for reading detailed fault reports information.

Depending on the firmware version, the fault report will indicate the active settings group at the moment of the trip command.

6.13 Current History Record

The current history record function can only be accessed with the ***ZIVercom®*** communication software to display records or modify settings.

This function is designed to record the evolution of the electric burden that flows through the point where it is located. It records periodic values of current. The terminal unit samples all three phase currents every second and then calculates an average value for each phase over the interval defined as the Sample Interval. This time interval is adjustable between 1 and 15 minutes. Each interval provides two values of current that corresponds to the highest and the lowest of the three measures carried out on the phases.

At the end of the recording period called the Data Record Interval, adjustable between 1 minute and 24 hours, the maximum value retained from each Sample Interval is entered in the Current History Record. Figure 6-13 illustrates an example of a Current History Record.

TM: Sample Interval. The figure shows a value of TM equal to one minute.

TR: Data Record Interval. The figure shows a value of equal to 15 minutes.

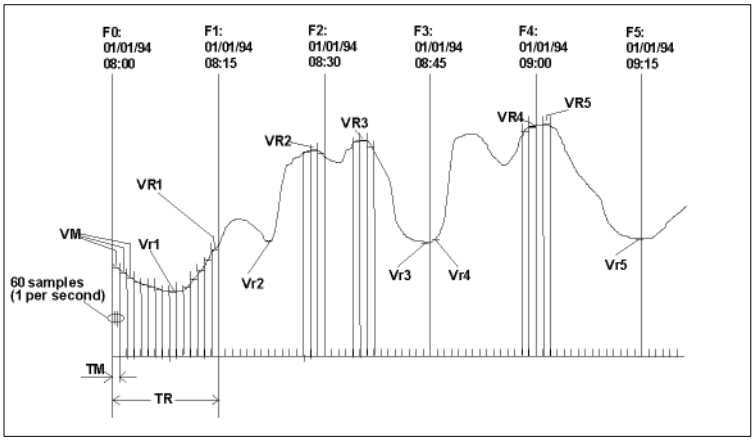


Figure 6.13: Example of Current History Record.

Two VM values, corresponding to the maximum and minimum average considering the three phase currents are retained for each TM time interval. The maximum and minimum of all computed VM values is recorded in each TR interval. The current profile of the record in Figure 6.13 contains the following data: VR1 - Vr1; VR2 - Vr2; VR3 - Vr3; VR4 - Vr4 and VR5 - Vr5.

Note: if during the sample interval, phase or ground units pick up, the recorded value is the average of the measures taken during the time in which the units have not been picked up. On the contrary, if the units remain picked up during all the interval, the recorded value is: 0A.

The available RAM for current history corresponds to 168 record values (equivalent to seven days with Data Record Intervals of one hour). Hour Range and Day Calendar Mask settings are available to manage memory space. The Hour Range, which applies to all days, determines the time period of the day when values are entered in the Current History Record. Data entry by days of the week is controlled by using the Day Calendar Mask.

6.14 Oscillography

The oscillography is composed of two different functions: Capture and View. The first refers to the capture and storage of protection data in the terminal unit. Capture is a part of the relay software. View refers to the collection and graphical display of the stored data. This is performed by one or more software programs run by a PC connected to the terminal unit.

- **Capture Function**

An analog record is stored each time a sample is taken. Status Contact Input signals are only stored by the Event Record function.

- **Stored Data**

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

- Analog values of the samples selected for recording
- Starting time of the oscillography record

- **Number of Channels**

Depending on the model, up to nine new channels can be used, with the ability to activate or de-activate the channels as required with the relevant setting.

Some models have the possibility to used digital channels (the number will be depending on the number of configurable logic outputs).

Once a range has been stored in the relay, a collection can be set for a maximum of 72 digital channels. There is the possibility of recollecting the same range as many times as desired by setting each times the collection of different digital channels. In this case, the communications program ***ZIVercom®*** sends a message to the user indicating that this range was already collected. This way, the user is aware that in their range list, there will be various ranges with the same time stamp, corresponding to the moment of the range pickup.

- **Recording Mode**

The following Recording Modes are selectable: Fixed Time Mode and Variable Time Mode.

In the Fixed Time Mode, recording begins when the Start function is activated. Recording stops when the pre-determined Record Length set by the user is reached.

In the Variable Time Mode, recording begins when the Start Function is activated. Recording stops when the Start Function is de-activated.

- **Start Function**

The Start Function consists of a programmable mask which can be applied to permit recording to start after selected internal logic output signals or the External Oscillography Start Logic Input Signal. The External Oscillography Start signal can be assigned to any of the physical Status Contact Inputs.

This Start Function Control Mask is connected to each protection element within the relay. Only connections that are enabled by the mask settings will activate the oscillography Start Function. The activation occurs when any of the selected protection elements pick up, and de-activation occurs when all selected elements are reset.

- **Start Time (Pre-Fault Time)**

Pre-Fault is the storage time before the activation of the Start Function.

- **Oscillography Record Length**

Oscillography Record Length is defined as the fault record duration time when the Fixed Time mode is selected and is adjustable from 20 to 300 cycles.

- **Number of Records**

The number of records stored in memory varies and depends on the number of channels recorded and on the length of the fault records.

Once the recording memory is full, the Overwrite setting determines whether or not the next event that occurs is stored over the oldest stored record (s). If the Overwrite setting has been set to YES and as the new records vary in length, old records will get cancelled depending on the space required by the new record.

- **Record Storage Mode depending on Start Types**

Start Mode: Fixed Time Mode [Fixed Time (Yes)] - Recorded data is stored whenever the Start Function is activated and continues for a time determined by the Record Length setting. Variable Time Mode [Fixed Time (No)] - Recorded data is stored while the Start Function is activated. Pre-Fault Data is stored in both cases.

Trip Mode 1: Fixed Time Mode [Fixed Time (Yes)] - Recorded data, plus pre-fault data, is stored in memory only if a trip occurs within the time set for the Record Length. If a trip occurs after this time has expired, no record is stored. Variable Time Mode [Fixed Time (No)] - Recorded data is stored whenever the Start Function is active in addition to the pre-fault data.

Trip Mode 2: Fixed Time Mode [Fixed Time (Yes)] - Recorded data, plus pre-fault data, is stored in memory only if a trip occurs within the time set for the Record Length. If no trip occurs within the time set for the Record Length, only 4 cycles of recorded data will be stored after the Start Function is activated. Variable Time Mode [Fixed Time (No)] - If no trip occurs while the Start Function remains active, only 4 cycles of recorded data will be stored after the Start Function is activated. If a trip occurs while the Start Function is active, recorded data will be stored during the whole time the Start Function remains active in addition to the pre-fault data.

Note: For the elements in which reset time can be long, it is recommended to set Fixed Time on YES.

It is reminded that information recorded during the time set as pre-fault time is always stored.

- **Overwrite**

If the Overwrite setting has been set to NO, no more records will be stored once the oscillography memory is full. In that situation, set overwrite on YES so that new records can get stored.

If the Overwrite setting has been set to YES, once the memory is full, the next record will replace the oldest record that is erased.

6.15 Contact Inputs, Outputs & LED Targets

CPI terminal units are provided with programmable inputs and outputs enabling user configuration of flexible logic designs. The following paragraphs contain a description of the programming structure to configure protection inputs, outputs and signalling. Factory default settings may be modified using the ***ZIVercom*** ® software program.

6.15.1 Status Contact Inputs

The terminal unit metering elements, and logic functions use the Logic Input Signals listed in Table 6-2 below (each equipment model will have only the signals indicated with a check mark ✓). Any of these Logic Input Signals can be assigned to one of the two Status Contact Inputs of the terminal unit. The closure of a contact will thereby activate those Logic Input Signals assigned to it. Several different Logic Input Signals can be assigned to one Status Contact Input, but a given Logic Input Signal can only be assigned to one Status Contact Input.

Table 6-2: Status Contact Inputs

Num.	Name	Function	Description	CPI-A	CPI-B	CPI-C	CPI-T
5	APE	External Protection Trip	Collect and use the signal of an external trip for the breaker failure function and the *start* of the recloser operation.	✓	✓	✓	✓
6	CED	Block Trip	Block all trips if activated before any trip occurs.	✓	✓	✓	✓
7	ATUT_F	Bypass Time Phase Time Overcurrent	Convert a time setting of a particular element into an instantaneous one.	✓	✓		✓
8	ATUT_N	Bypass Time Ground Time Overcurrent			✓	✓	✓
9	BDI_F	Block Phase Instantaneous Overcurrent Trip	Activation of the input before a trip is generated prevent tripping of the unit. If it is activated after the trip, the trip is reset.	✓	✓		✓
10	BDI_N	Block Ground Instantaneous Overcurrent Trip			✓	✓	✓
11	BDT_F	Block Ground Time Overcurrent Trip		✓	✓		✓
12	BDT_N	Block Ground Time Overcurrent Trip			✓	✓	✓
13	API_F	Interlock Control Phase Instantaneous O/C	Reset the time functions included in the units and maintain them at 0 while it is active.	✓	✓		✓
14	API_N	Interlock Control Ground Instantaneous O/C			✓	✓	✓
15	APT_F	Interlock Control Phase Time O/C		✓	✓		✓
16	APT_N	Interlock Control Ground Time O/C			✓	✓	✓

Table 6-2: Status Contact Inputs							
Num.	**Name**	**Function**	**Description**	**CPI-A**	**CPI-B**	**CPI-C**	**CPI-T**
17	IA	Open Breaker Status (52b contact)	Controls the status of the breaker. Can be defined either as normally open or as normally closed contact.	✓	✓	✓	✓
18	BE	Recloser External Lockout (CPI-**R)	The activation leaves the recloser in a Lockout status.	✓	✓	✓	✓
19	DBE	Recloser External Lockout Reset (CPI-**R)	The activation leaves the recloser in a Lockout Reset status.	✓	✓	✓	✓
21	INR	Reclose inhibit (CPI-**R)	Causes the verification by the recloser of the Supervision by Reclose Inhibition setting (if the setting is enabled).	✓	✓	✓	✓
22	VR	Rated voltage (CPI-**R)	Receives the voltage signal used by the recloser in the Recloses by Rated Voltage supervision function.	✓	✓	✓	✓
25	INH_C_ED	Setting Group Control Inhibition (CPI-***-***050** and CPI-***-***096**)	They activate the corresponding Settings Group (1, 2, or 3). This function depends on the operation.		✓		✓
26	T_AJ_1	Table 1 active (CPI-***-***050** and CPI-***-***096**)	Enable Setting (Configuration). The Inhibit Group Selection input disables Group changes.		✓		✓
27	T_AJ_2	Table 2 active (CPI-***-***050** and CPI-***-***096**)			✓		✓
28	T_AJ_3	Table 3 active (CPI-***-***050** and CPI-***-***096**)			✓		✓
31	I_EX	Oscillography pickup (optional) (CPI-**R/T)	Activate the oscillography (depending on mask status).	✓	✓	✓	✓

Users can easily program different input settings using the local RS232 communications port and the ***ZIVercom***® software.

6.15.2 Auxiliary Contact and Trip Outputs

- **Auxiliary Contact Outputs**

Models **CPI** feature 3 auxiliary contacts. In models with recloser, only AUX-2 is programmable. In models without recloser, both AUX-1 and AUX-2 are programmable. AUX-3 indicates Unit in Service and is not programmable.

CPI models with recloser include a virtual output (last output in ***ZIVercom***®). This virtual output allows to send a signal via communications.

AUX-1 output has two contacts internally configurable to normally open (NO) or normally closed (NC), that correspond to the connectors 19/20 and 19/21. The location of these contacts and how to configure them is described in Chapter 5 of this manual.

CPI-T model has eight output auxiliary contacts (AUX-1 to AUX-8), internally configurable to normally open (NO) or normally closed (NC). AUX-8 non programmable auxiliary contact is assigned to indicate the terminal unit is **"Ready"** (powered up, self-test OK). The location of these contacts and how to configure them is described in Chapter 5 of this manual.

Operation

The terminal unit protection, reclosing and monitoring functions generate a series of Logic Output Signals during terminal unit operation. Each of these signals has either a “True” or “False” value and this status (or its negation by using the “not” input (s) to the “OR” and “AND” logic gates) can be used as an input to either of the combinational logic gates shown in Figure 6-13.

The desired final “AND” or “OR” output from the logic cell can then be connected to any one of the two programmable Auxiliary Contact Outputs (AUX-1 and AUX 2) available in the terminal unit.

CPI terminal units are provided with two blocks, each one with eight possible input signals. One of them is assigned to the OR (any signal activates the output) logic operation and the other to the AND (all signals have to be activated to activate the output) logic operation. In turn, an OR or AND operation can be carried out between these two blocks. To the result of this operation, can be applied the option to produce a pulse signal or not, in the following manner:

- **without pulse**: Setting the pulse timing at “0”, the auxiliary contact output is active while the signal that has activated it lasts.
- **with pulses**: Once the auxiliary contact output has been activated, it maintains itself the set time independently from the fact that the signal which generated it becomes not longer active or stay active during a longer period.

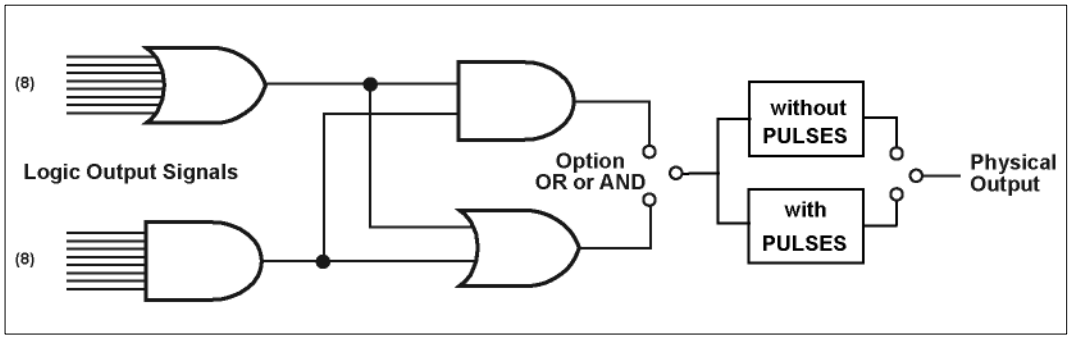


Figure 6.14: Auxiliary Contact Output Logic Cell Block Diagram.

Table 6-3: Auxiliary Contact Outputs							
Num.	**Name**	**Description**	**Function**	**CPI-A**	**CPI-B**	**CPI-C**	**CPI-T**
1	SUT_A	Phase A Time Ov. Trip Output Active	Overcurrent Elements Trips. They are affected by their respective trip mask.	✓	✓		✓
2	SUT_B	Phase B Time Ov. Trip Output Active		✓	✓		✓
3	SUT_C	Phase C Time Ov. Trip Output Active		✓	✓		✓
4	SUT_N	Ground Time Ov. Trip Output Active			✓	✓	✓
5	SUI_A	Phase A Inst. Ov. Trip Output Active		✓	✓		✓
6	SUI_B	Phase B Inst. Ov. Trip Output Active		✓	✓		✓
7	SUI_C	Phase C Inst. Ov. Trip Output Active		✓	✓		✓
8	SUI_N	Ground Inst.Ov. Trip Output Active			✓	✓	✓
39	SUT_1	Phase 1 Time Ov. Trip Output Active					✓
40	SUT_2	Phase 2 Time Ov. Trip Output Active					✓
9	AUT_A	Phase A Time Ov. Pickup	Overcurrent Elements Pickups.	✓	✓		✓
10	AUT_B	Phase B Time Ov. Pickup		✓	✓		✓
11	AUT_C	Phase C Time Ov. Pickup		✓	✓		✓
12	AUT_N	Ground Time Ov. Pickup			✓	✓	✓
13	AUI_A	Phase A Inst. Ov. Pickup		✓	✓		✓
14	AUI_B	Phase B Inst. Ov. Pickup		✓	✓		✓
15	AUI_C	Phase C Inst. Ov. Pickup		✓	✓		✓
16	AUI_N	Ground Inst. Ov Pickup			✓	✓	✓
31	AUT_1	Phase 1 Inst. Ov. Pickup					✓
32	AUT_2	Phase 2 Inst. Ov. Pickup					✓
34	A_FASE_A	Open Phase Pickup.	Open Phase and Sensitive Ground Elements Pickups.	✓	✓		✓
35	A_RESIDUAL	Sensitive Ground Ov. Pickup		✓	✓	✓	✓

Table 6-3: Auxiliary Contact Outputs							
Num.	**Name**	**Description**	**Function**	**CPI-A**	**CPI-B**	**CPI-C**	**CPI-T**
36	**S_FASE_A**	Open Phase Trip Output	Open Phase and Sensitive Ground Elements Trips.	✓	✓		✓
37	**S_RESIDUAL**	Sensitive Ground Ov. Trip Output		✓	✓	✓	✓
43	**FI**	Breaker Failure Output	Signal for alarm or to initiate tripping of others breakers.	✓	✓	✓	✓
44	**ALARMA_PR**	Protection Module Alarm		✓	✓	✓	✓
45	**A_SINT**	ΣI^2 Alarm Level	Alarm signal for accumulated power open by the breaker.	✓	✓		✓
54	**APERTURA**	Open Command	Send the order for opening / closing of the breaker.	✓	✓	✓	✓
55	**CIERRE**	Close Command		✓	✓		✓
56	**DISP**	Internal Protection Trip Output	OR Logic in all units.	✓	✓	✓	✓
57	**FOA**	Open or Trip Command Failure	In the case of manual operations as well as for those generated by the protection or reclose units, these outputs signals the non reception of the breaker change of state following the operation order and within the operation failure time (this time can be set independently for opening and closure).	✓	✓		✓
58	**FOC**	Close Command Failure		✓	✓		✓
60	**DBAI**	Trip Blocked for Incorrect Settings		✓	✓	✓	✓
61	**IR**	Reclose Initiate (CPI-**R)	Collocate the recloser in the start time state (from a rest situation of the recloser).	✓	✓	✓	✓
62	**SUTM_A**	Phase A Time Ov. Mask Enabled Trip Output	Trip of the Open Phase and Sensitive Ground Units non affected by their respective trip mask.	✓	✓		✓
63	**SUTM_B**	Phase B Time Ov. Mask Enabled Trip Output		✓	✓		✓
64	**SUTM_C**	Phase C Time Ov. Mask Enabled Trip Output		✓	✓		✓
65	**SUTM_N**	Ground Time Ov. Mask Enabled Trip Output			✓	✓	✓

Table 6-3: Auxiliary Contact Outputs							
Num.	**Name**	**Description**	**Function**	**CPI-A**	**CPI-B**	**CPI-C**	**CPI-T**
66	**SUIM_A**	Phase A Instantaneous Ov. Mask Enabled Trip Output	Trip of the Open Phase and Sensitive Ground Units non affected by their respective trip mask.	✓	✓		✓
67	**SUIM_B**	Phase B Instantaneous Ov. Mask Enabled Trip Output		✓	✓		✓
68	**SUIM_C**	Phase C Instantaneous Ov. Mask Enabled Trip Output		✓	✓		✓
69	**SUIM_N**	Ground Instantaneous Ov. Mask Enabled Trip Output			✓	✓	✓
70	**FASEM_A**	Open Phase Mask Enabled Trip Output		✓	✓		✓
71	**RESIDUALM**	Sensitive Ground Mask Enabled Trip Output		✓	✓	✓	✓
72	**SUTM_1**	Phase 1 Time Overcurrent Mask Enabled Trip Output					✓
73	**SUTM_2**	Phase 2 Time Overcurrent Mask Enabled Trip Output					✓
74	**BI**	Recloser Lockout For Whatever Reason (CPI-**R)	Any of the internal blocks described below.	✓	✓	✓	✓
75	**SBI_NTR**	Recloser Lockout Due To Lack Of Rated Voltage (CPI-**R)	The voltage reference input is not active before the waiting time of the reference voltage (if the recloser supervision by reference voltage setting is enabled).	✓	✓	✓	✓
76	**SBI_DD**	Recloser Lockout Due To Permanent Fault (CPI-**R)	This signal is activated when all the recloses take place and the fault is still there.	✓	✓	✓	✓

Table 6-3: Auxiliary Contact Outputs							
Num.	**Name**	**Description**	**Function**	**CPI-A**	**CPI-B**	**CPI-C**	**CPI-T**
77	**SBI_FC**	Recloser Lockout Due To Breaker Close Failure (CPI-**R)	The breaker has not closed during the time of the closure failure (logic setting – time of breaker closure failure)	✓	✓	✓	✓
78	**SBI_FI**	Recloser Lockout Due To Breaker Failure (CPI-**R)	End of the starting time without resetting of the fault and breaker opening.	✓	✓	✓	✓
79	**SBI_FL**	Recloser Lockout Due To Switch-On-To-Fault (CPI-**R)	If following a manual close or a change of setting, there is a trip before the security time has elapsed after manual close.	✓	✓	✓	✓
80	**SBI_IA**	Recloser Lockout Due To Open Breaker Status (CPI-**R)	Breaker opening non related to a fault.	✓	✓	✓	✓
81	**SBI_NCR**	Recloser Lockout Due To Unsatisfied Reclosing Conditions (CPI-**R)	Signal related to the operation inhibition input.	✓	✓	✓	✓
82	**RCC_1**	Reclose Attempt 1 (CPI-**R)	Signal the sequence in which the recloser is.	✓	✓	✓	✓
83	**RCC_2**	Reclose Attempt 2 (CPI-**R)		✓	✓	✓	✓
84	**RCC_3**	Reclose Attempt 3 (CPI-**R)		✓	✓	✓	✓
85	**RCC_4**	Reclose Attempt 4 (CPI-**R)		✓	✓	✓	✓
86	**DD**	BI DD + BI FL (CPI-**R)	The fault persists at the end of the reclose sequences or internal block of the recloser due to a fault when energizing the line.	✓	✓	✓	✓
87	**BLQ**	RBM + RBE (CPI-**R)	Recloser blocked manually or externally.	✓	✓	✓	✓
88	**OR**	Reclose Command (CPI-**R)	Command module close signal sending.	✓	✓	✓	✓
89	**CC**	Reclose Sequence In Progress (CPI-**R)	OR Logic of the recloses sequences.	✓	✓	✓	✓
90	**RBM**	Recloser Blocked (CPI-**R)	Signals generated through the MMI, communications, or through an external status input.	✓	✓	✓	✓

Table 6-3: Auxiliary Contact Outputs							
Num.	**Name**	**Description**	**Function**	**CPI-A**	**CPI-B**	**CPI-C**	**CPI-T**
91	RBE	Recloser External Lockout (CPI-**R)		✓	✓	✓	✓
93	SRP	Recloser Reset (CPI-**R)	Recloser at rest after a security period following a fault, or a security period following an external close when a fault did not occur.	✓	✓	✓	✓
94	SRES	Recloser In Service (CPI-**R)	Signal corresponding to the Recloser In Service setting.	✓	✓	✓	✓
98	ALARMAERR	Error Module Detected Alarm					✓
99	IN_1	Physical Input 1	Outputs activated depending on the corresponding input.	✓	✓	✓	✓
100	IN_2	Physical Input 2		✓	✓	✓	✓
101	IN_3	Physical Input 3					✓
102	IN_4	Physical Input 4					✓
103	IN_5	Physical Input 5					✓
104	IN_6	Physical Input 6					✓
105	IN_7	Physical Input 7					✓
106	IN_8	Physical Input 8					✓
107	A_TERM	Thermal Alarm	Outputs activated depending on the corresponding input..				✓
108	S_TERM	Thermal Output					✓
109	M_TERM	Thermal Masked Output					✓
110	T_AJ_1	Group 1 activated (depending on software model)	Activated outputs depending on the setting groups selected.		✓		✓
111	T_AJ_2	Group 2 activated (depending on software model)			✓		✓
112	T_AJ_3	Group 3 activated (depending on software model)			✓		✓

- **Trip and Close Output**

CPI models are provided with one trip output relay with two contacts. These contacts are internally configurable to NO or NC. Trip contacts correspond to terminal connectors 15-16 and 17-18. Trip outputs location and configuration procedure is outlined in chapter 5 of this manual. **CPI-T** models are provided with two trip and closed outputs, internally configurable to NO or NC.

A logic signal “close breaker” is available to program an auxiliary contact. In models with recloser such logic signal is fixed in contact AUX-1.

Breaker operation

Manual control of the breaker is possible via the trip and close contacts in the **CPI** models, provided that it has been programmed if required. Breaker control can be disabled in the Configuration menu (refer to Chapter 7). Manual control operation always request confirmation for the commands issued for added security.

After breaker operation by manual or protection commands the relay checks for change of breaker status. Breaker status change has to be received before timeout of the Command Failure Timer. Timeout of the Command Failure Timer will generate the signals Breaker Opening Command failure or Breaker Close Command failure. Open and Close Command Failure Timers have independent settings.

6.15.3 LED Targets

CPI terminals are provided with eight optical indicators (**LEDs**) located on the front panel. Seven of the **LEDs** are user definable. The eighth **LED** is always assigned to indicate the terminal unit is **"Ready"** (powered up, self-test OK).

The logic cell structure, shown in the block diagram of Figure 6.15, permits the user to create combinational logic equations for the **LED** Target Outputs. To configure **LED** Target Outputs, Logic Output Signals are assigned to a **LED** Target Output. The available Logic Output Signals are shown in Table 6-3.

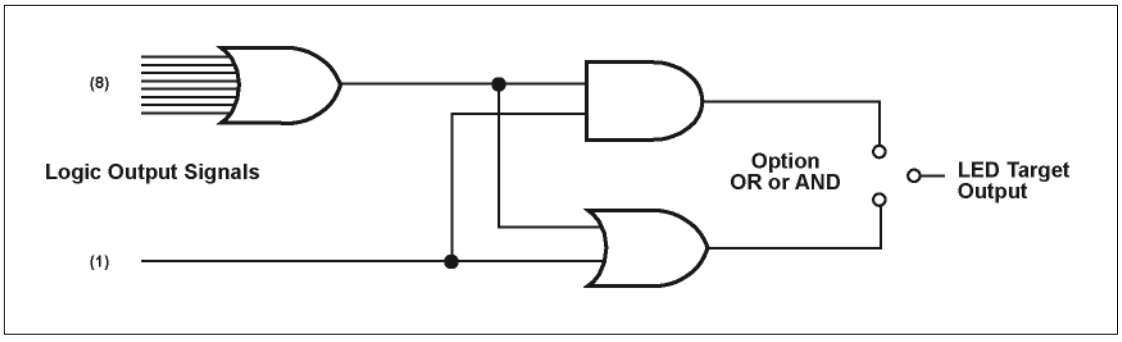


Figure 6.15: LED Target Output Logic Cell Block Diagram.

Each **LED** can be defined as latched or unlatched. If a **LED** is latched it will remain illuminated until reset, even after a condition has disappeared. The **LED** reset function is accomplished via the keypad 🡻 (see Chapter 7: Alphanumeric Keypad and Display).

The latching function resides in the volatile memory section of the microprocessor. A power supply loss will cause any latched **LED** to be reset.

Each **LED** can be assigned to any Logic Output Signal listed in Table 6-3.

6.16 Communications

6.16.1 Communications Settings

Communications settings are listed in Chapter 5 (Settings) and include terminal unit address, baud rate, stop bits, and parity.

6.16.2 Communications Types

CPI Terminals contain two communications ports. The local port located on the front panel is an RS232 DB-9 port with fixed settings. The remote port is optional, and can be glass fiber optics, 1mm plastic fiber optics, RS232 or RS485 type. Technical data relative to these ports is listed in Chapter 2 (Technical Data).

6.16.3 Communicating with the Unit

Communications with the unit through the communication ports is achieved using the ***ZIVercom***© software application. This software is designed to connect with units of the **CPI** family, allowing operations such as programming, settings configuration, event recording, activity reports, etc.

Remote port communication settings can be modified only via the HMI. Local port communication settings are fixed to 4800 baud, 1 stop bit, even parity, as listed in Chapter 5.

CPI models are provided with two communication controllers. This enable simultaneous communications via both ports.

ZIVercom© is password protected to provide access only to authorized personnel. ***ZIVercom***© is a user-friendly, Windows™ based software tool. The software allows easy navigation of and access to available settings and actions through a series of intuitive menus and graphical user interfaces.

Terminal unit status information can be accessed either in local or remote mode. The following data can be retrieved:

- Metering Data
- Contact Inputs/Outputs Status
- Settings
- Protection Element Status
- Contact Inputs
- Last Trip Information
- Auxiliary Outputs & LED Targets
- Time and Date
- Event Records
- Fault Report
- Current History Record

7. Alphanumeric Keypad and Display

7.1 Alphanumeric Display and Keypad

The dot matrix display has four characters, each one being a 7 x 5 dot matrix. It provides information on terminal unit alarms, settings, metering, status, etc. The default screen displays model identification (**#CPI**) as shown in figure 7.1.

Figure 7.1: Alphanumeric Display.

The **CPI** keypad consists of 3 keys (see figure 7.2). This keypad is associated with the information on the Alphanumeric Display. Only one key is accessible (the ↓ key) when the cover is installed on the equipment.

Starting from the default screen, the Local Interface has two possible operation modes. One mode operates using only a single key (when the cover is installed), and the other takes advantage of the complete keypad.

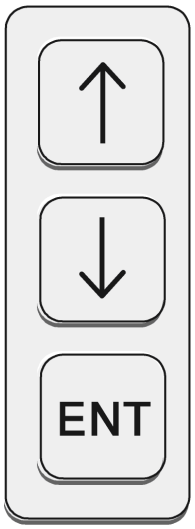


Figure 7.2: Keypad.

7.2 Keys, Functions and Operation Modes

- **Option Selection**

Using the selection keys (↑ ↓), it is possible to scroll through the different options on the display. The **ENT** key is used to confirm a selection.

To scroll through different settings use the ↓ key. Once the desired setting is found, use the **ENT** key to select it. The setting value will be displayed. If these setting value needs to be changed, press the **ENT** key a second time and the setting value will blink.

- **Change of Settings (Range)**

For settings with a numeric value (inside a range) the procedure is as follows: The first digit in the setting will blink. Pressing the ↑ key is possible to scroll through the different values for that digit. Once the selection is made, press the ↓ key to set it and the next digit will blink. Repeat the procedure until the setting value is completed.

For digits where no changes are desired, press the ↓ key to skip to the next digit. Once every digit has been adjusted press the **ENT** key to set the value and the screen will show the setting identifier. Proceed to the next setting by pressing the ↓ key.

The system does not allow to exceed the range for a given setting. When setting a value out of range, the value resets to zero and the blinking cursor is placed on the first digit.

- **Change of Settings (Options)**

For settings with preset options, it is possible to scroll through the different values using the ↑ and ↓ keys. Once the selection is displayed, press the **ENT** key to set the value and the screen will show the setting identifier. Proceed to the next setting by pressing the ↓ key.

- **Exit Menus or Settings**

After an operation has been performed (selection, change of settings, viewing information, etc.) move to the previous level in the menu by pressing the ↑ key.

7.3 Screen Sequence Using a Single Key

From the default screen, press the ↓ key to access the following screen sequence:

- Phase and neutral current metering (depending on model)
- Positive sequence and negative sequence metering
- Recloser status (can be change between blocked and unblocked)
- Last relay trips since last reset
- Reset trip information
- Reset LEDs

The following figures show the screen sequence which cycles using the ↓ key. Figure 7.3 shows the sequence after a trip has occurred. Figure 7.4 sequence starts without trip indication. The white areas shown in both figures depict screen groups dependent on the **CPI** model, with different content for each model. The shaded areas depict screen common for each model. The screen mnemonics will change depending on the selected language (English, Spanish or Portuguese) and are explained in the following paragraphs.

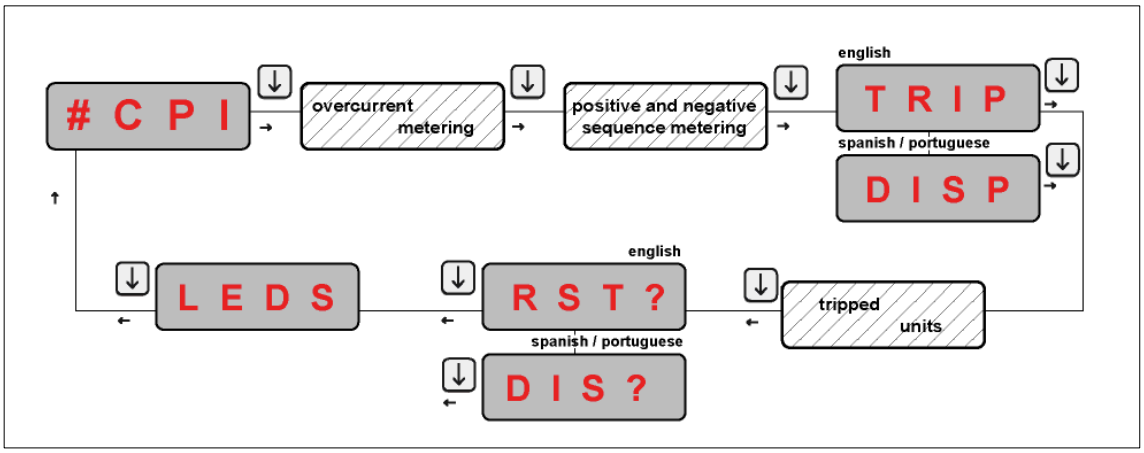


Figure 7.3: General Screen Sequence using the ↓ key (with Trip Indication).

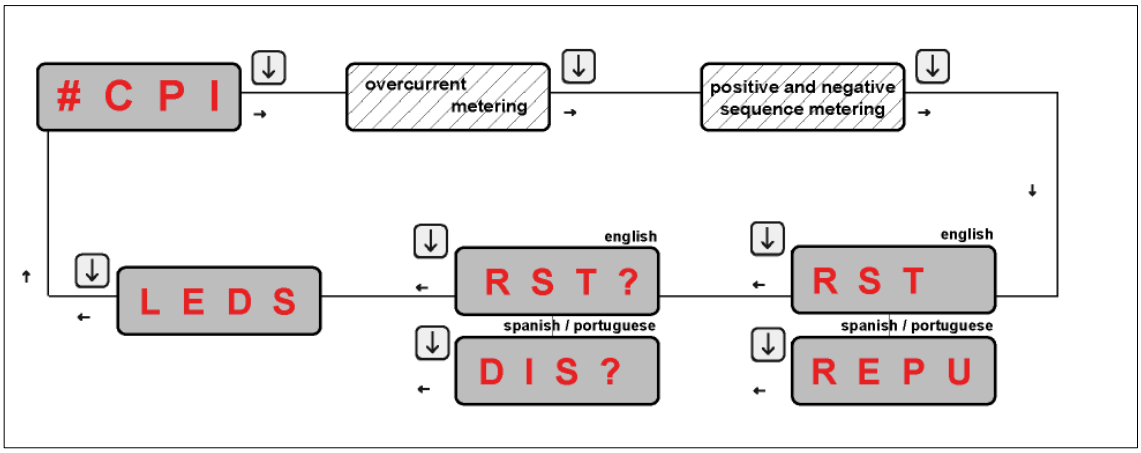


Figure 7.4: General Screen Sequence using the ↓ key (without Trip Indication).

The mnemonics used are.

TRIP DISP	Screen indicating a protection trip.
RST? DIS?	Trip Indication Reset. Once the trip conditions have been removed, it is possible to reset the trip indication by pressing and holding the ↓ key for more than two (2) seconds.
RST REPU	Message displayed after resetting the tripped units.
LEDS	It is possible to reset the trip indication by pressing and holding the ↓ key for more than two (2) seconds.

The following figures depict the screen groups including metering and trip indications. These sequences are model dependent, corresponding to the white areas in figure 7.3.

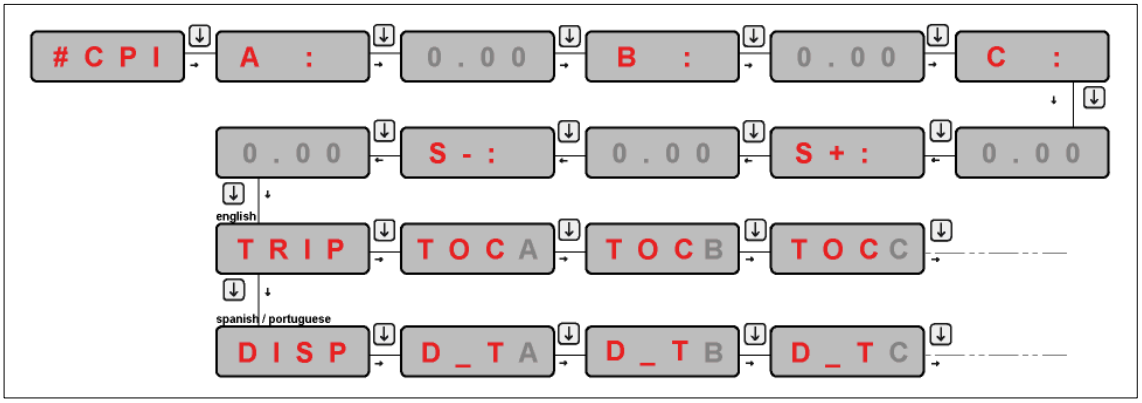


Figure 7.5: Metering Elements and Trip Information Screen Sequence. CPI-A Model.

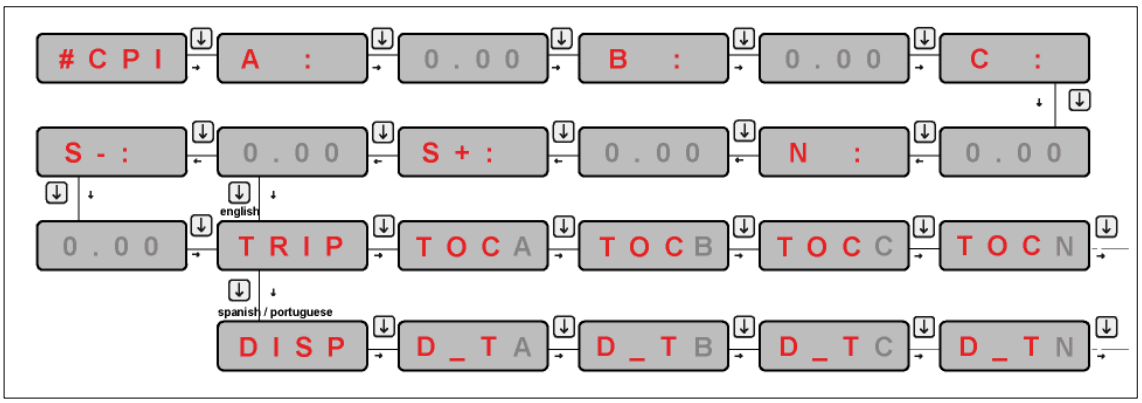


Figure 7.6: Metering Elements and Trip Information Screen Sequence. CPI-B Model.

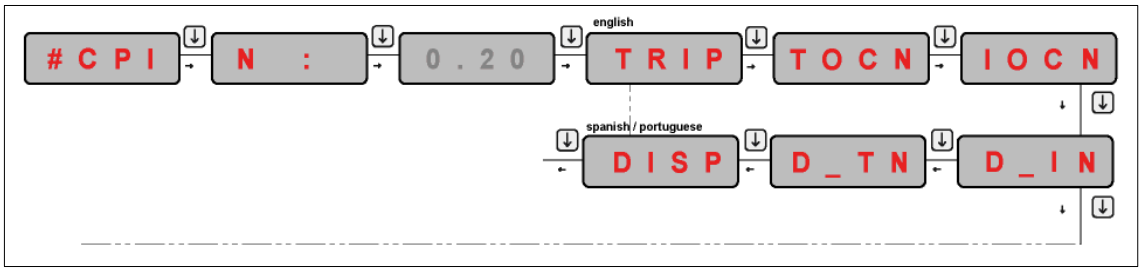


Figure 7.7: Metering Elements and Trip Information Screen Sequence. CPI-C Model.

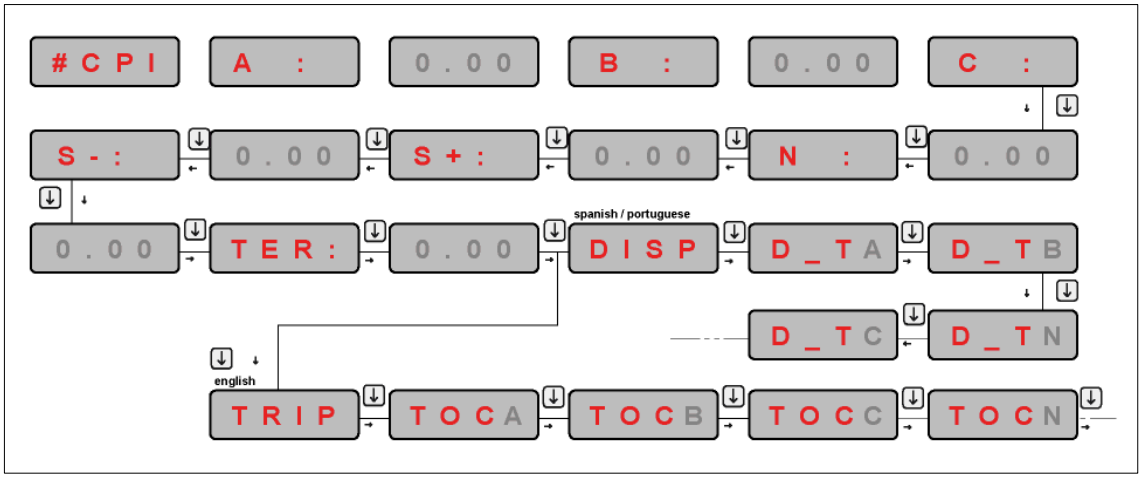


Figure 7.8: Metering Elements and Trip Information Screen Sequence. CPI-T Model.

The screen mnemonics included are.

A :	Indicates that the value displayed in the next screen corresponds to the real time measurement of the current circulating on Phase A.
B :	Indicates that the value displayed in the next screen corresponds to the real time measurement of the current circulating on Phase B.
C :	Indicates that the value displayed in the next screen corresponds to the real time measurement of the current circulating on Phase C.
N :	Indicates that the value displayed in the next screen corresponds to the real time measurement of the neutral current.
S + : **S - :**	Indicates that the value displayed in the next screen corresponds to the real time measurement of the positive (+) or negative (-) sequence current.

TER:	Indicates that the value displayed in the next screen corresponds to the thermal image measure.
0.00	Measured value in Amps, indicating primary values (according to the CT ratio set in the relay). The value corresponds to the phase or neutral, positive or negative sequence current indicated in the previous screen.
TRIP DISP	Indicates that a protection trip has occurred, and has not been acknowledged. Following to these screen are the indication of the elements issuing the trip command.
TOCX DT_X	Indicates a Time Overcurrent trip by element X. Depending on the **CPI** model, X can take the value A, B, C, or N.
IOCX DI_X	Indicates an Instantaneous Overcurrent trip by element X. Depending on the **CPI** model, X can take the value A, B, C, or N.

Always that a protection trip command is issued, the relay will display the TRIP (or DISP) indication, followed by the tripped elements. If more than an element is under trip conditions, the screens shown will not be in chronological sequence.

These screens will be displayed always that a protection trip command is issued. Once the trip conditions are eliminated, the screens will remain until reset from the RST? (or DIS?) screen. Once the indications are reset, screens TRIP (or DISP), TOCX (or D_TX), and IOCX (or D_IX) are replaced by RST (or REPU).

7.4 Screen Sequence Using the Complete Keypad

From the default screen (see Figure 7.1), there are a series of screen sequences. Using the selection keys (↑ ↓) and the **ENT** key is possible to access the following options.

- **Measures and last trip**
- **Settings**
  - generals
  - protection
  - logic
  - supervision
  - oscillographic
- **Information**
  - inputs status
  - outputs status
  - units status
  - selected language
  - selected frequency
- **Configuration**
  - communications
  - enables
  - language
  - frequency
- **Operations**
  - on the breaker
  - on the recloser
  - change group enable

For a global display of the screen sequence and the keys used to move forward in the sequence, below there is a table describing the process.

- **General Settings: HMI Access**

SETT	GNRL	PCT
INFO	PRO	NCT
CNFG	LOGI	I_AB
OPER	SUPV	
	OSCI	

- **Protection Settings: HMI Access**

SETT	GNRL	TOCP	ENBL
INFO	PRO	TOCN	PKUP
CNFG	LOGI	IOCP	CURV
OPER	SUPV	IOCN	DIAL
	OSCI	RESD	TIME
		PH_U	
		BF	
		TIM1	
		TIM2	
		THE	

SETT	GNRL	TOCP	
INFO	**PRO**	**TOCN**	**ENBL**
CNFG	LOGI	IOCP	**PKUP**
OPER	SUPV	IOCN	**CURV**
	OSCI	RESD	**DIAL**
		PH_U	**TIME**
		BF	
		TIM1	
		TIM2	
		THE	

SETT	GNRL	TOCP	
INFO	**PRO**	TOCN	
CNFG	LOGI	**IOCP**	**ENBL**
OPER	SUPV	IOCN	**PKUP**
	OSCI	RESD	**TIME**
		PH_U	
		BF	
		TIM1	
		TIM2	
		THE	

SETT	GNRL	TOCP	
INFO	**PRO**	TOCN	
CNFG	LOGI	IOCP	
OPER	SUPV	**IOCN**	**ENBL**
	OSCI	RESD	**PKUP**
		PH_U	**TIME**
		BF	
		TIM1	
		TIM2	
		THE	

SETT	GNRL	TOCP	
INFO	**PRO**	TOCN	
CNFG	LOGI	IOCP	
OPER	SUPV	IOCN	
	OSCI	**RESD**	**ENBL**
		PH_U	**PKUP**
		BF	**TIME**
		TIM1	
		TIM2	
		THE	

SETT	GNRL	TOCP	
INFO	**PRO**	TOCN	
CNFG	LOGI	IOCP	
OPER	SUPV	IOCN	
	OSCI	RESD	
		PH_U	**ENBL**
		BF	**PKUP**
		TIM1	**LOAD**
		TIM2	**TIME**
		THE	

SETT	GNRL	TOCP	
INFO	**PRO**	TOCN	
CNFG	LOGI	IOCP	
OPER	SUPV	IOCN	
	OSCI	RESD	
		PH_U	
		BF	**ENBL**
		TIM1	**RSTP**
		TIM2	**RSTN**
		THE	**TIME**

SETT	GNRL	TOCP	
INFO	**PRO**	TOCN	
CNFG	LOGI	IOCP	
OPER	SUPV	IOCN	
	OSCI	RESD	
		PH_U	
		BF	
		TIM1	**ENBL**
		TIM2	**PKUP**
		THE	**TIME**

SETT	GNRL	TOCP	
INFO	**PRO**	TOCN	
CNFG	LOGI	IOCP	
OPER	SUPV	IOCN	
	OSCI	RESD	
		PH_U	
		BF	
		TIM1	**ENBL**
		TIM2	**PKUP**
		THE	**TIME**

SETT	GNRL	TOCP	
INFO	**PRO**	TOCN	
CNFG	LOGI	IOCP	
OPER	SUPV	IOCN	
	OSCI	RESD	**ENBL**
		PH_U	**HC**
		BF	**CC**
		TIM1	**IMAX**
		TIM2	**%ALR**
		THE	**MEM**

- **Logic Settings: HMI Access**

SETT	GNRL	
INFO	PRO	**OPTF**
CNFG	**LOGI**	**CLTF**
OPER	SUPV	**MODE**
	OSCI	**MASK**

- **Supervision Settings: HMI Access**

SETT	GNRL	
INFO	PRO	
CNFG	LOGI	
OPER	**SUPV**	**A_I2**
	OSCI	**V_I2**

- **Oscillographic Settings: HMI Access**

SETT	GNRL	**FIXT**	**YES**
INFO	PRO	**DEL**	**NO**
CNFG	LOGI	TRIG	
OPER	SUPV	MASK	
	OSCI	CHAN	
		PREP	
		LONG	

SETT	GNRL	FIXT	**TP:**
INFO	PRO	DEL	**TN:**
CNFG	LOGI	TRIG	**IP:**
OPER	SUPV	**MASK**	**IN:**
	OSCI	CHAN	**PU:**
		PREP	**SG:**
		LONG	**BO:**
			EX:
			TP1:
			TP2:
			SAVE

SETT	GNRL	FIXT	
INFO	PRO	DEL	
CNFG	LOGI	TRIG	**IA:**
OPER	SUPV	MASK	**IB:**
	OSCI	**CHAN**	**IC:**
		PREP	**IN:**
		LONG	**SAVE**

- **Information Menu: HMI Access**

SETT	**D_IN**
INFO	**DOUT**
CNFG	**PKUP**
OPER	**LANG**
	FREQ

- **Communications Configuration: HMI Access**

SETT	**COMM**	**ADDR**
INFO	PERM	**RATE**
CNFG	LANG	**STOP**
OPER	FREQ	**PARI**
		MODB
		FPAR
		TOUT

- **Enables Configuration: HMI Access**

SETT	COMM	**BREA**	**KEYB**
INFO	**PERM**	GROU	**P_LO**
CNFG	LANG		**P_RE**
OPER	FREQ		

SETT	COMM	BREA	
INFO	**PERM**	**GROU**	**IN**
CNFG	LANG		**REM**
OPER	FREQ		

- **Language Configuration: HMI Access**

SETT	COMM	
INFO	PERM	**ENGL**
CNFG	**LANG**	**PORT**
OPER	FREQ	**SPAN**

- **Frequency Configuration: HMI Access**

SETT	COMM	
INFO	PERM	
CNFG	LANG	**50Hz**
OPER	**FREQ**	**60Hz**

- **Breaker Operations: HMI Access**

SETT		**OPEN**
INFO	**BREA**	**CLOS**
CNFG	RECL	**OK?**
OPER	GROU	**EXEC**
		NOEX
		ACKN

- **Recloser Operations: HMI Access**

SETT		
INFO	BREA	**BLOQ**
CNFG	**RECL**	**DESQ**
OPER	GROU	**RCLC**

- **Group Change Operations: HMI Access**

SETT		
INFO	BREA	**GRO1**
CNFG	RECL	**GRO2**
OPER	**GROU**	**GRO3**

8. Receiving Tests

8.1 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 auxiliary supply and measuring 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 (auxiliary voltage, current, etc.).**
- **The auxiliary supply voltage (AC or DC) should be disconnected from the equipment before extracting or inserting any module, otherwise damage may result.**

The number, the type and the specific characteristics of the acceptance tests are detailed in the following table.

CPI	Preliminary inspection
	Insulation test
	Current measuring test
	Phase and Neutral Units Test
	Phase Time Overcurrent Test
	Sensitive Ground Overcurrent Test
	Breaker Failure Test
	Thermal Element Test [#CPI-T2T(60) Special Models]
	Recloser Test
	Status contact inputs & LED targets Test
	Communications Test

8.1.1 Accuracy

The results obtained in electrical testing greatly depend on the accuracy of the measuring instruments and test source signals (auxiliary voltage, and measurement voltages). Therefore, verification of the information specified in the Technical Data section of this manual can only reasonably be achieved using 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 no distortion (<2%) in the test source signals as harmonics can affect internal measuring of the equipment. For example, distortions will affect this unit, 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.

8.2 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.

8.3 Insulation Test

While testing for insulation of switchgear and external wiring, it is recommended to disconnect the terminal unit to avoid damage, since insulation testing has been performed by the manufacturer. The following paragraphs describe common mode and transverse mode insulation tests:

- **Common Mode**

With no wires connected to the unit, wire all the rear connection terminals together except for number 10, number 30, and the ground terminal. With external wiring connected, disconnect terminals 28, 29, 30, and the ground terminal located on the metal case (see drawings and connection diagrams). Apply 2,000 Vac for 1 minute between interconnected terminals and metal case.

In **CPI-***-***2**** special model, wire all the rear connection terminals together except for number D20 and those that have any connected wiring. Apply 2,000 Vac for 1 minute between interconnected terminals and metal case.

- **Transverse Mode**

Divide the terminals into terminal groups according to table 8-1. Apply 2000 VAC for 1 minute between pairs of terminal groups:

Table 8-1: Insulation Test (Transverse Mode)

CPI-A	CPI-B / CPI-T	CPI-C	CPI-***-***2** Special Model
1-2	1-2	---	A1 - A2
3-4	3-4	---	A3 - A4
5-6	5-6	---	A5 - A6
---	7-8	7-8	A7 - A8
11-12-13-14	11-12-13-14	11-12-13-14	D7 - D8 - D9 - D10
15-16-17-18	15-16-17-18	15-16-17-18	D11 - D12 - D13 - D14
19-20-21-22-23-24-25-26-27	19-20-21-22-23-24-25-26-27	19-20-21-22-23-24-25-26-27	B1 – B2 – B3 – B4 – B5 – B6 – B7 – B8 – B9 - B10 - B11 - B12 - B13 – B14 – B15 – B16 – B17 – B18
28-29	28-29	28-29	D1 - D2 - D3 - D4 - D5 - D6 – D15 – D16 – D17 – C1 – C2 – C3 – C4- C5 – C6 – C7 – C8

Note: High voltage may be present after testing due to internal capacitors. Gradually, reduce test voltage to zero, before removing the test probes.

8.4 Current Measuring Test

To avoid trips while performing this test, protection elements must be disabled and the test current should not be interrupted by the breaker. Apply the a.c. current values indicated in table 8-2 to the Phase and Neutral Current Analog Inputs – terminal connectors are model dependent.

Table 8-2: Current Measuring Test	
Applied Current	Measured Value
X Aac	X ± 5% Aac

Note: For high current values, apply test current for the shortest time possible. Do not exceed 8 seconds for 20 A input current.

8.5 Phase and Neutral Units Test

It is recommended to test each unit individually. Disable every unit but the unit to be tested.

- **Pickup and Reset**

Adjust the desired settings in the terminal unit, and apply current to the corresponding analog input. To verify pickup and reset values, set the display to the Information - Pickup menu- Auxiliary outputs can also be programmed to verify element pickup and reset.

Table 8-3: Phase and Neutral Units Test				
Setting	**Pickup**		**Reset**	
	Maximum	Minimum	Maximum	Minimum
X	1.10 x X	1 x X	1.05 x X	0.95 x X

- **Operating Times**

Operating times can be verified monitoring the trip outputs (terminals 15-16 and 17-18).

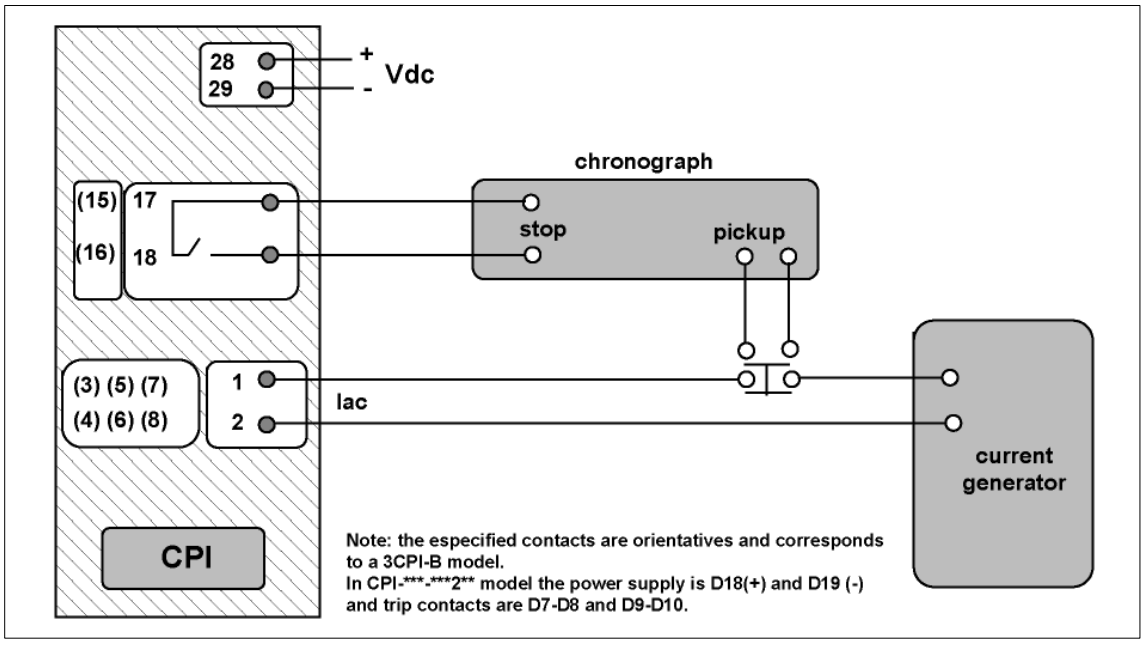


Figure 8.1: Operating Time Test Setup.

Fixed Time or Instantaneous

Apply a current value 20% over the pickup setting. Operating time should be the time setting ±5% or ±25 ms (whichever is greater). Note that minimum operating speed for instantaneous operation averages 30 ms.

Inverse Time

For a given curve, operation time depends on the time dial setting and the applied current (refer to Chapter 6 for Time/Current Characteristic Curves). Tolerance is ±5% of the current value.

8.6 Open Phase Element Test

Enable only the Open Phase Element and apply the following two phase currents to the Phase A and Phase B Current Analog Inputs:

Ia = 1/0º and Ib = 1/60º (inductive angles).

Check that the Open Phase element has not picked up. Increase the Phase B current and confirm that the Pickup indication for the Open Phase element in the alphanumeric display is a steady "1" when the current is between 1.35A ac and 1.49A ac. Increase the Phase B current to 2A ac and check that a trip occurs in 9.5 s to 10.5 s. Verify that the Trip Output Contacts close.

In models with Minimum load in the line, the unit is set to 0.2 I2/I1 and the Minimum load in the line to 1.2 A. Applying Ia = 1/0º and Ib = 2/60º, the unit should not operate. If, under the same conditions, the Minimum Load in the Line is set to 0.8 A, the unit should pick up.

8.7 Sensitive Ground Overcurrent Element Test

Apply current to the Ground Current Analog Input and check that the Pickup indication for the Sensitive Ground Overcurrent element in the alphanumeric display is a steady "1" when the current is between 100mA and 110mA ac. Increase the current to 150 mA ac and verify that a trip occurs between 9.5 s and 10.5 s.

8.8 Breaker Failure Element Test

To test this element, assign the logic output signal, Breaker Failure Output (BF) to one of the Auxiliary Contact Outputs. Disable all elements except for Phase and Ground Instantaneous Overcurrent and Breaker Failure.

Set the Phase and Ground Instantaneous Overcurrent Pickup to 0.5A and set their Time Delay to zero. Set Breaker Failure Time Delay to 0.5 s and the Breaker Failure Phase and Ground Overcurrent Pickup levels to 0.7A. Produce a trip by applying 1A ac phase to ground to the Phase A and Ground Current Analog Inputs and maintain the current after the phase and ground elements trip. The breaker failure element will operate in a time 0.475 s to 0.525 s. The operation of the Breaker Failure element will activate the Auxiliary Contact Output.

Gradually reduce the current until the breaker failure element reaches a stable reset. Verify that this occurs between 0.735A ac and 0.665A ac. Restore the Breaker Failure Auxiliary Contact Output to its previous configuration.

8.9 Thermal Element Test

Before beginning this test in **CPI-T** models, it is advisable to turn off and on the protection so reset the thermal level. Apply a current greater than the maximum current (I_{max}) setting and verify that the trip time is:

$$t = \tau \cdot \mathrm{Ln} \frac{(I \pm 5\%)^2}{(I \pm 5\%)^2 - I_{max}{}^2}$$

where τ represents the set time constant.

For example, if we consider a time constant without ventilation of 0.5 minutes and a maximum current of 5 A, and apply to Phase A of the first winding, a current of 6 A, the trip time of the element must be between 29.81s and 44.02s.

Note: For the 60 and 70 Specials Models, carry out the test both with τ_1 and τ_2, the latter being x times τ_1.

8.10 Recloser Test

In order to test the recloser in the **CPI-**R** model, the following points are reminded:

- After manual closing, you must wait for the duration of the security time. If you do not wait for that time before generating the trip, the recloser will lockout.
- For the reclose sequence to start, the protection has to detect that the breaker is open, and that no current flows through the phases before the starting time has concluded (setting in the group of recloser – time sequence control).
- If the equipment is giving a fault in the breaker opening circuit, it will not carry out the reclose, and will lockout.
- For the recloser to carry out the complete sequence until its permanent fault status, the trips have to be generated.
- It has to be taken into account if the rated voltage options and inhibition inputs, are being used. Same remark for the unit's inhibitors and the trip and reclose masks.

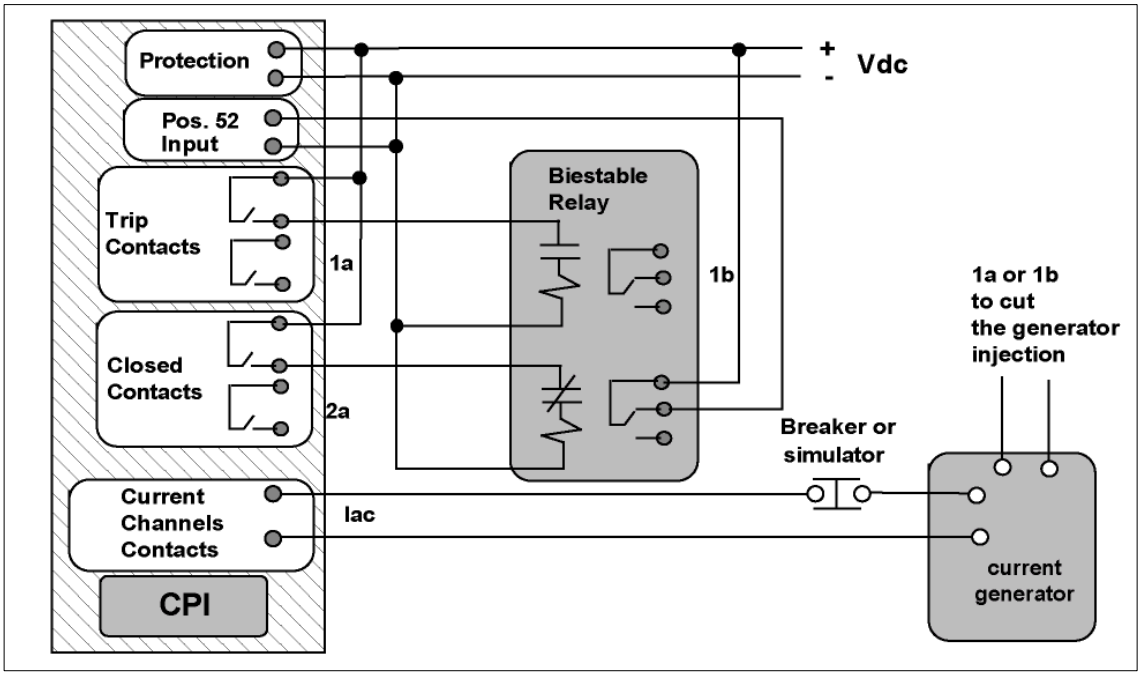


Figure 8.2: Recloser Test Setup.

Figure 8.2 shows how to carry out the recloser test. If the current generator did not cut the injection before the starting time, the test can be carried out by opening the current circuit (by opening the breaker itself o by simulating it), or by generating an instantaneous trip, using a simple pulse. This way of action could be sufficient to cause the instantaneous element to trip, and at the same time, to stop it from seeing the current circulating before starting time.

8.11 Contact Inputs, Auxiliary Outputs, and LED Targets Test

Connect the equipment to a suitable power supply (rated Vdc) through terminal connectors 28 (+) and 29 (-). Ready LED will illuminate.

Apply rated voltage to the contact input connectors 11(+) – 12(-) and 13(+) – 14(-). Select from the information menu the inputs status screens (refer to Chapter 7 Operator Interface) and verify that both signals are ON. Disconnect the test probes and verify that both signals are OFF.

To test auxiliary outputs, the forcing function to activate the output depends on how the outputs are configured. A straight forward test is to program the outputs to activate when the physical inputs are energized. In this fashion the inputs test doubles as the output operation test.

Press the 🡻 key to scroll through the screen sequence until the screen LEDS is reached. Then, press the 🡻 key for 2 seconds and verify that all the LEDs illuminate. Release the 🡻 key and verify that all the LEDs turn off

Note: be carefully with CPI-*-***2** special model and its 8 inputs (IN-1 to IN-8), 8 physically outputs (AUX-1 to AUX-8) and 8 virtually outputs [AUX-1 (virtual) to AUX-8 (virtual)].**

8.12 Communication Test

Connect the equipment to a suitable power supply (rated Vdc) through terminal connectors 28 (+) and 29 (-). Ready LED will illuminate. Test will be performed through local communications port, allocated on front panel. This port has fixed settings as follows:

Baud Rate	4800 bauds
Stop Bits	1
Parity	0 (no parity) - 1 (even parity)

Connect to the terminal unit through the local communications port using a DB9 (9-pin) serial connection wire. Synchronize time using the ***ZIVercom***© software program. Disconnect the communications wire and disconnect the terminal unit power supply and wait for two minutes. Afterwards, connect the power supply and connect to the terminal unit through the remote communications port. Activate the cyclical mode in the ***ZIVercom***© software program and verify that time actualizes properly.

8.13 Installation

8.13.1 Location

The location where the terminal unit is to be installed should meet the following minimum conditions to ensure correct operation, long service life, and ease of installation and maintenance:

- Absence of dust
- Absence of dampness
- Absence of vibration
- Adequate lighting
- Easy access
- Horizontal or vertical mounting

Mounting should be in accordance with the external connections scheme.

8.13.2 Connection

Terminal number 30 should be solidly grounded to ensure disturbance filtering circuits operate properly. The wire used for grounding these terminals should be stranded 14 AWG. Ground wire length should be minimized and should not exceed 12”. The ground connector of the enclosure, located at the rear of the equipment should also be grounded.

A. Communications Protocol PROCOME 3.0

Model-specific documentation with protection communications protocol PROCOME 3.0

A.1 Settings

A.1.1 Configuration Settings

Communications (HMI)	
Setting	**Range**
Communications password enable	YES / NO
Communications password timeout	1 - 1440 min
Communications password	8 characters

These settings are establishing communication through the remote port. Only can be modified through ***ZIVercom***© communication program.

A.2 Description of Operation

A.2.1 Event Record

Table A-1:Event Record			
Function	**Event**	**Oct.**	**Byte**
33750	Measurement annotation	1	1

A.2.2 Inputs

There exists the possibility of the physical inputs functioning with inverse logic, assigning one or a set of them to a digital input or to its negated.

A.2.3 Communicating with the Unit

Using the PROCOME profile, it is possible to communicate with the unit to request control changes and to execute orders. In this case, the distance to the fault calculated by the locator is transmitted as one more measurement.

A.3 Alphanumeric Keypad and Display

A.3.1 Communications

Selecting the communications option brings up a menu composed of the settings: **Terminal Address, Baud Rate, Stop Bits, Parity, Frontal Port Parity, Communications Timeout, Communications Password Enable** and **Communications Password Timeout**.

- **Communications Password Enable, Communications Password Timeout and Communications Password**

P_CL The setting of Communications Password Enable makes it possible to enable the password access function to establish communication with the unit via the rear port: YES means enabling the permission and NO, disabling.

T_CL The setting of communications password timeout allows establishing a period of time for activating a lockout of communication with the unit (whenever communication is via the rear port): if the set time elapses with no activity taking place in the communications program, the system locks itself in this state. Consequently, it will be necessary to restart the communication.

The last setting of the communications group, **Communications Password**, makes it possible to establish a specific password to access communication with the unit through the rear port (only through ***ZIVercom***©, communications program. This password must have 8 characters, which will be entered using the numerical keys and the key corresponding to a dot.

A.3.2 Accessing the Information

The variations in the settings menus described in the preceding sections are reflected in the information menus, with the same layout shown. Note that the information menu only allows viewing the established settings and does not allow modifying them.

B. MODBUS RTU Documentation. Address Map

Documentation specific to the models with the MODBUS RTU communication profile

B.1 Preliminary Information

This document is intended as a reference on the implementation of the MODBUS RTU protocol in the **CPI-**R/S/T**.

This document describes the MODBUS map of addresses (inputs, outputs, metering registers and commands) and their equivalent in the **CPI-**R/S/T**.

The functions implemented are as follows:

ModBus Function	Description
01	Reading of Outputs (Read Coil Status)
02	Reading of Inputs (Read Input Status)
04	Reading of Metering Registers (Read Input Registers)
05	Commands (Force Single Coil)

Any other function non-included in the table above will be considered illegal and the exception code 01 (Illegal function) will be returned as a reply.

The following maps of addresses are outlines and will depend on the model.

B.2 Reading of Outputs (Read Coil Status)

- **Range of Modbus Addresses for CPI-**R/S/T**

The Output Modbus addresses assigned to **CPI-**R/S/T** are as follows:

Addresses	Description
0200H..02FFH	Outputs Status

- **Map of Modbus Addresses for CPI-**R/S/T**

The Output Modbus addresses assigned to **CPI-**R/S/T** are as follows:

Addresses	Description
0200H (*)	Breaker Status
0201H (*)	Internal Recloser Lockout (see note)
0202H (*)	Manually Recloser Lockout (see note)
0203H (*)	Externally Recloser Lockout (see note)
0204H (*)	Recloser Sequence in Progress (see note)
0205H (*)	Recloser Reset (see note)
0206H (*)	Recloser in Service (see note)
0207H	Aux-1 Status
0208H	Aux-2 Status
0209H	Aux-3 Status
020AH	Aux-4 Status
020BH	Aux-5 Status
020CH	Aux-6 Status
020DH	Aux-7 Status
020EH	Aux-1 Status (Virtual)
020FH	Aux-2 Status (Virtual)
0210H	Aux-3 Status (Virtual)
0211H	Aux-4 Status (Virtual)
0212H	Aux-5 Status (Virtual)
0213H	Aux-6 Status (Virtual)
0214H	Aux-7 Status (Virtual)
0215H	Group 1 Active (see note)
0216H	Group 2 Active (see note)
0217H	Group 3 Active (see note)
0218H	Ground Overcurrent Units Status

Note: Each direction functional is variable depending on the model.

Assigned addresses are fixed and their content is variable (it depends on the configuration selected by the end-user for each relay).

The remaining addresses of the range will be considered as illegal and the exception code 02 (Illegal Data Address) will be returned as a reply.

B.3 Reading of Inputs (Read Input Status)

- **Range of Modbus Addresses for CPI-**R/S/T**

The Input Modbus addresses assigned to **CPI-**R/S/T** are as follows:

Addresses	Description
0000..00FFH	Inputs Stauts

- **Map of Modbus Addresses for CPI-**R/S/T**

The Input Modbus addresses assigned to **CPI-**R/S/T** are as follows:

Addresses	Description
0000H	INPUT-1 Status
0001H	INPUT-2 Status
0002H	INPUT-3 Status
0003H	INPUT-4 Status
0004H	INPUT-5 Status
0005H	INPUT-6 Status
0006H	INPUT-7 Status
0007H	INPUT-8 Status
0008H	INPUT-9 Status
0009H	INPUT-10 Status
000AH	INPUT-11 Status
000BH	INPUT-12 Status
000CH	INPUT-13 Status
000DH	INPUT-14 Status
000EH	INPUT-15 Status
000FH	INPUT-16 Status

Assigned addresses are fixed, their content being variable (it depends on the configuration selected by the end-user for each relay).

The remaining addresses of the range will be considered as illegal and the exception code 02 (Illegal Data Address) will be returned as a reply.

B.4 Reading of Metering Register (Read Input Registers)

- **Range of Modbus Addresses for CPI-**R/S/T**

The Modbus addresses for the Metering Input Registers assigned to **CPI-**R/S/T** are as follows:

Addresses	Description
2000H..201FH	Metering Value

- **Map of Modbus Addresses for CPI-**R/S/T**

The Modbus addresses for the Metering Input Registers assigned to **CPI-**R/S/T** are as follows:

Addresses	Description
2000H	Phase A Overcurrent Metering Ground Overcurrent Metering (#CPI-C2S models)
2001H	Phase B Overcurrent Metering
2002H	Phase C Overcurrent Metering
2003H	Phase A Voltage Metering Thermal Element Percentage (see note)

Note: Thermal Percentage Maximum Range is 32760 or 7FF8 for 240% (CPI-T2T Model).

The rest of addresses of the range will be considered as illegal and the exception code 02 (Illegal Data Address) will be returned as a reply.

B.5 Commands (Force Single Coil)

- **Range of Modbus Addresses for CPI-**R/S/T**

The range of Modbus addresses for commands in the **CPI-**R/S/T** is as follows:

Addresses	Description
00200..02FFH	Commands

- **Map of Modbus Addresses for CPI-**R/S/T**

The range of Modbus addresses for commands in the **CPI-**R/S/T** is as follows:

Direction	Value	Function
0200H	0000H-OFF	Breaker Open
0200H	FF00H-ON	Breaker Close
0201H	0000H-OFF	Recloser Lockout
0201H	FF00H-ON	Recloser Lock
0202H	FF00H-ON	Distance Reset
0203H	FF00H-ON	Settings Group1 Activation
0204H	FF00H-ON	Settings Group2 Activation
0205H	FF00H-ON	Settings Group3 Activation
0206H	0000H-OFF	Unblock ground overcurrent units
0206H	FF00H-ON	Block ground overcurrent units

The rest of addresses of the range will be considered as illegal and the exception code 02 (Illegal Data Address) will be returned as a reply.

Any other value different from 00H or FHH will be considered as illegal and the exception code 03 (Illegal Data Value) will be returned as a reply.

C. Schemes and Drawings

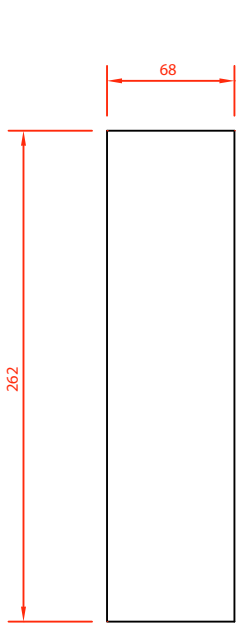
Dimension and Drill Hole Schemes

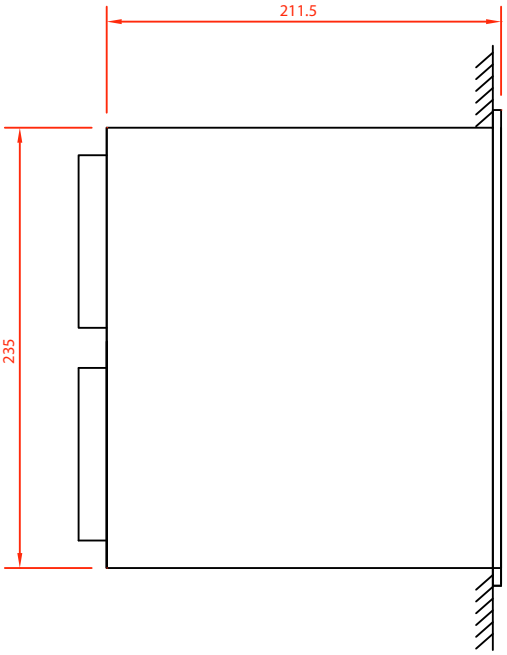
3CPI	>>4BF0100/0016
8CPI	>>4BF0100/0026
3CPI-***-***2**G*	>>4BF0100/0035

External Connection Schemes

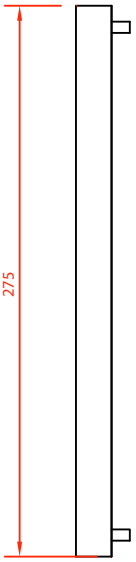
CPI-A	>>3RX0131/0034
CPI-B	>>3RX0131/0035
CPI-C	>>3RX0131/0036
CPI-T2T	>>3RX0131/0041

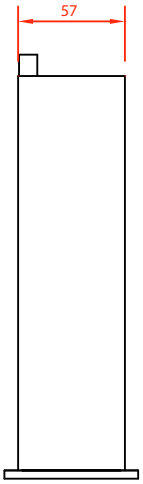
CAJA TIPO "D"
CAIXA TIPO "D"
BOîTIER TYPE "D"
ENCLOSURE TYPE "D"

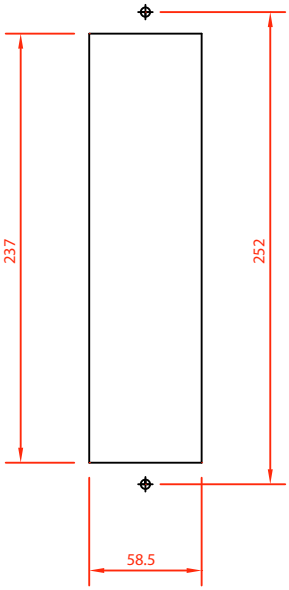




TAPA
TAMPA
COUVERCLE
FRONT COVER







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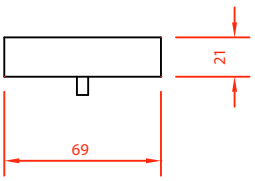
FUROS 5mm Ø
PERÇAGES 5mm Ø
5mm Ø DRILLING



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TAMPA
COUVERCLE
FRONT COVER

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8		9		10	
11		12		13	
14		15		16	

Z I V Aplicaciones y Tecnología S.L.

TITULO> DIMENSIONES Y TALADRADO

PROYECTO> CAJA TIPO "D" 6U 1/7RACK

Rev.0
Rev. 1 14/9/98
Rev. 2 14/2/02
Rev. 3 6/2/09
Rev. 4 27/7/10

NUMERO> 4BF0100/0016

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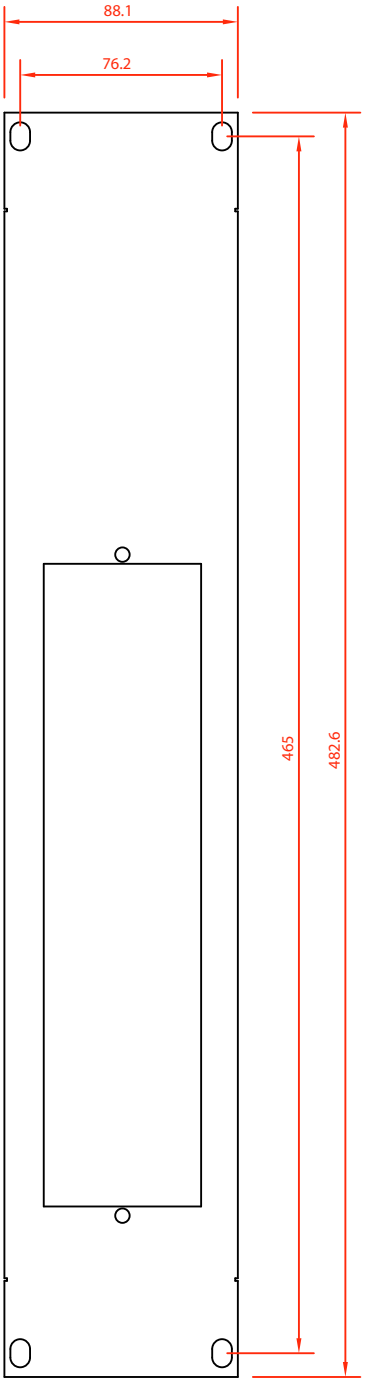
Dibujado	3/5/96	J.C.S.
Aprobado	3/5/96	R.O.



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Z I V Aplicaciones y Tecnología S.L.

TITULO> PLACA ADAPTACION A 19''X 2U

PROYECTO> RELE INDUSTRIAL

Rev.0
Rev. 1 14/2/02
Rev. 2 6/2/09

NUMERO> 4BF0100/0026

	Fecha	Nombre
Dibujado	29/4/99	J.C.S.
Aprobado	29/4/99	R.O.

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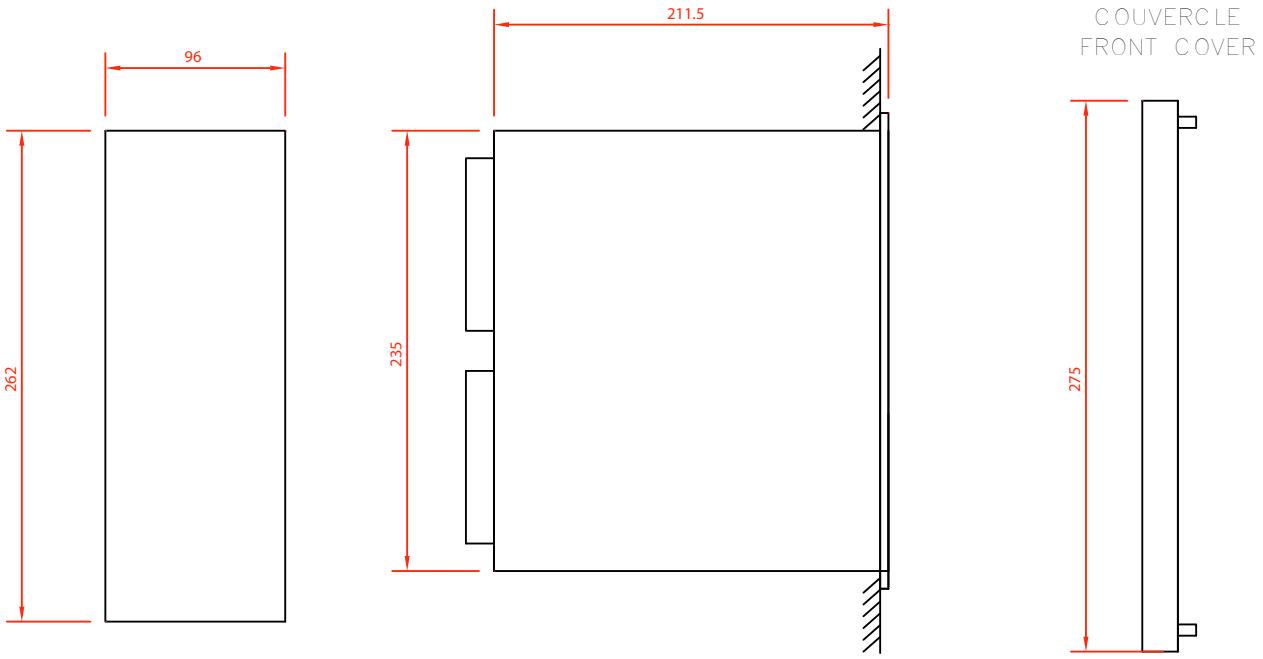
CAIXA TIPO "G"
BOîTIER TYPE "G"
ENCLOSURE TYPE "G"



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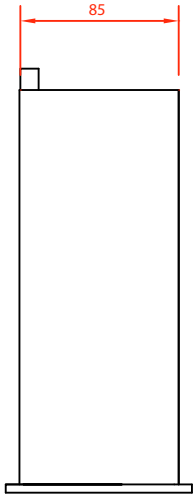
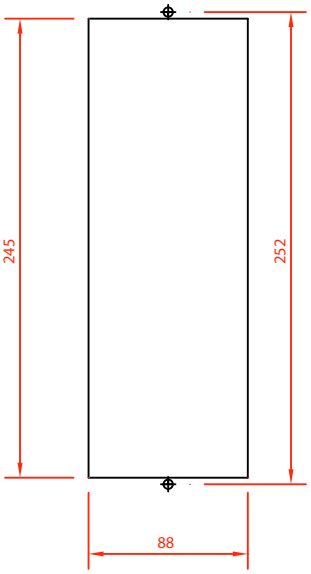
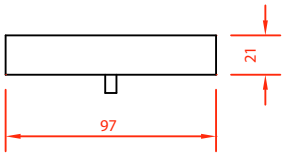
TAMPA
COUVERCLE
FRONT COVER





TALADROS 8mm Ø
FUROS 8mm Ø
PERÇAGES 8mm Ø
8mm Ø DRILLING



TAPA
TAMPA
COUVERCLE
FRONT COVER

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14	15		16	

ZIV Aplicaciones y Tecnología S.L.

TITULO> DIMENSIONES Y TALADRADO

PROYECTO> CAJA TIPO "G" 6U 1/5RACK

Rev.0
Rev. 1 9/2/09

NUMERO> 4BF0100/0035

	Fecha	Nombre
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Aprobado	30/03/04	P.A.

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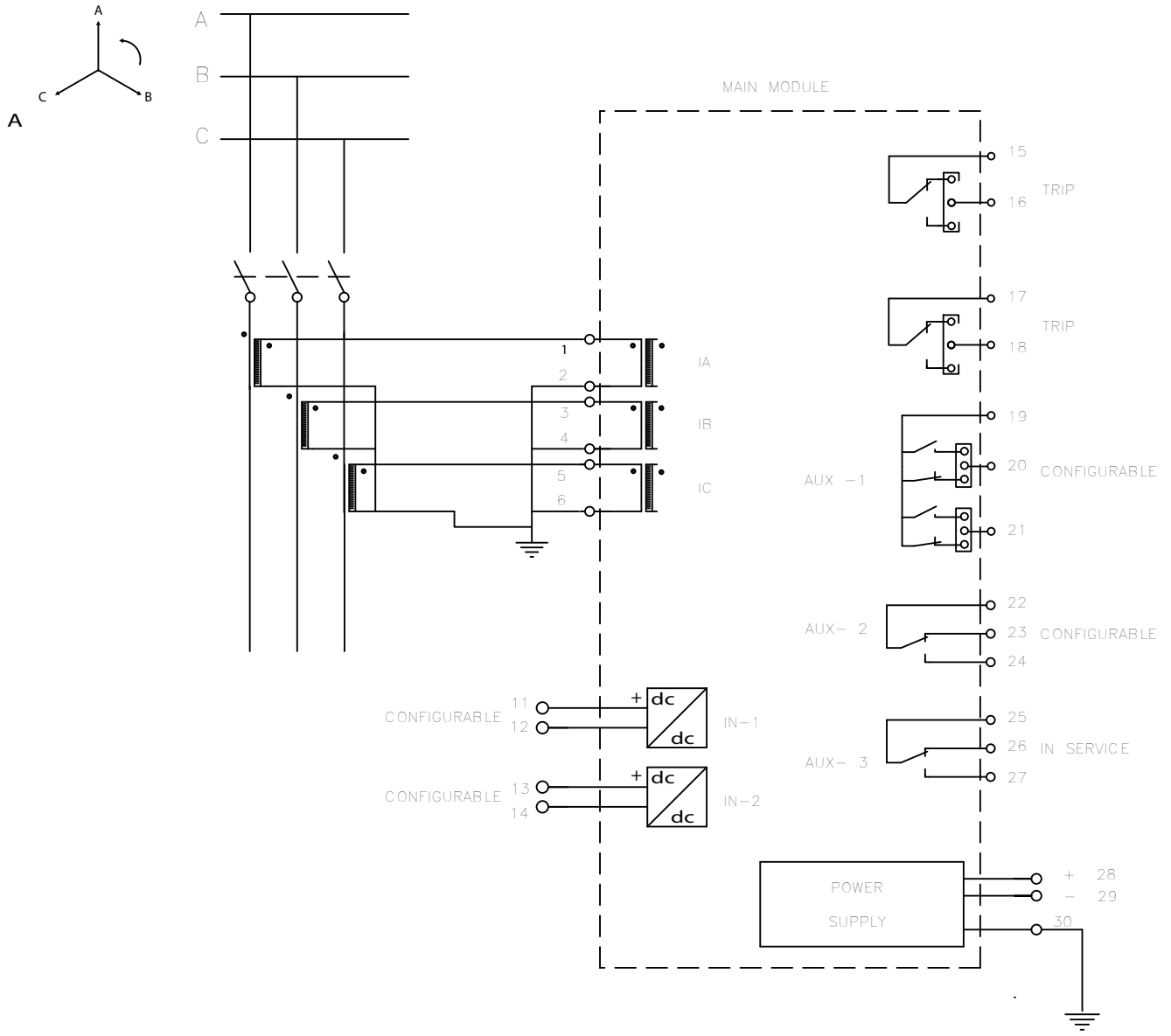

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ZIV Aplicaciones y Tecnología, S.L.

TITLE> EXTERNAL CONNECTIONS 3/8CPI−A

PROJECT> OVERCURRENT PROTECTION

Rev.0

NUMBER> 3RX0131/0034

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Approved	15/04/03	J.M.Y.

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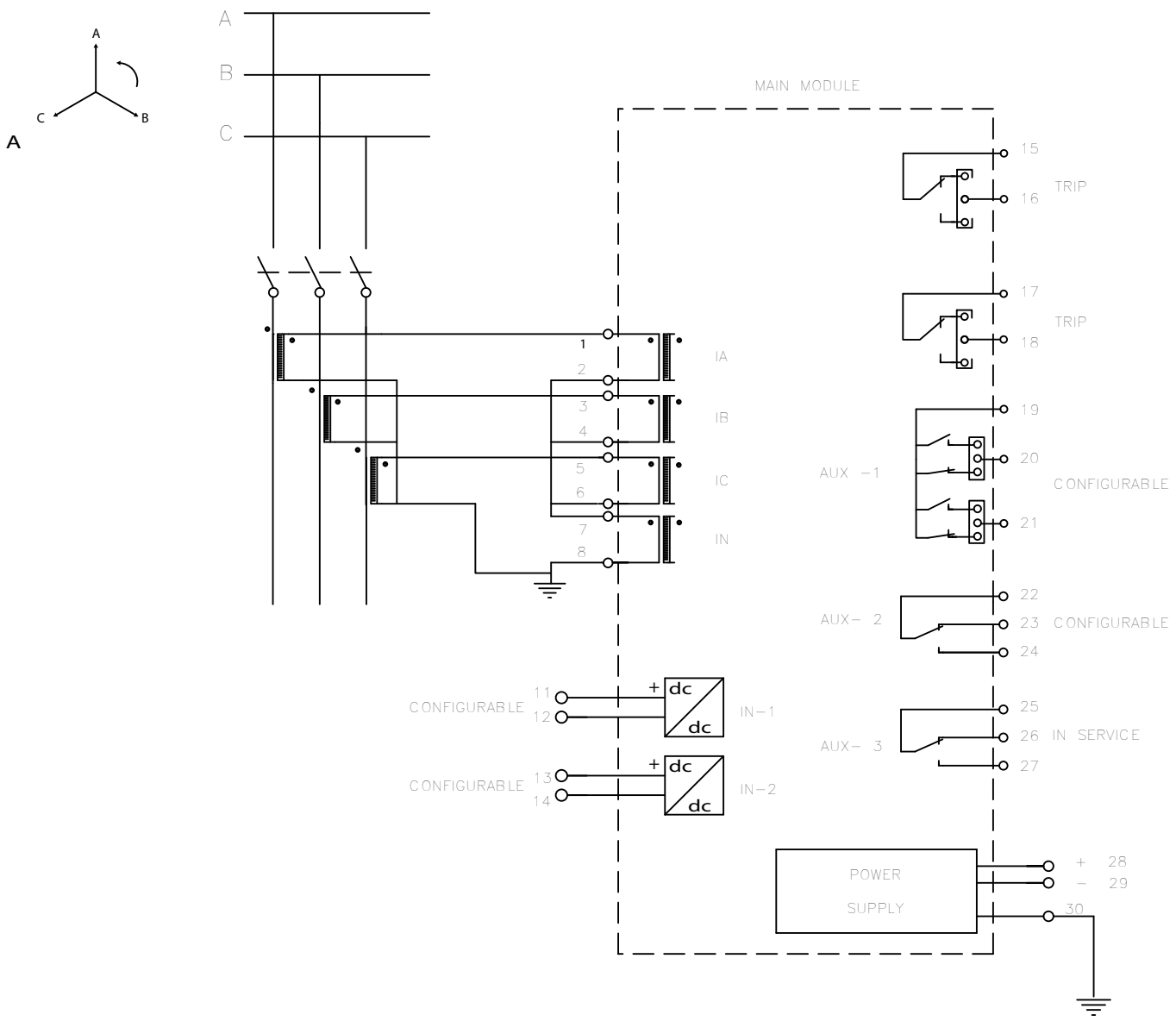

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ZIV Aplicaciones y Tecnología, S.L.

TITLE> EXTERNAL CONNECTIONS 3/8CPI−B

PROJECT> OVERCURRENT PROTECTION

Rev. 0

NUMBER> 3RX0131/0035

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Approved	15/04/05	J.M.Y.

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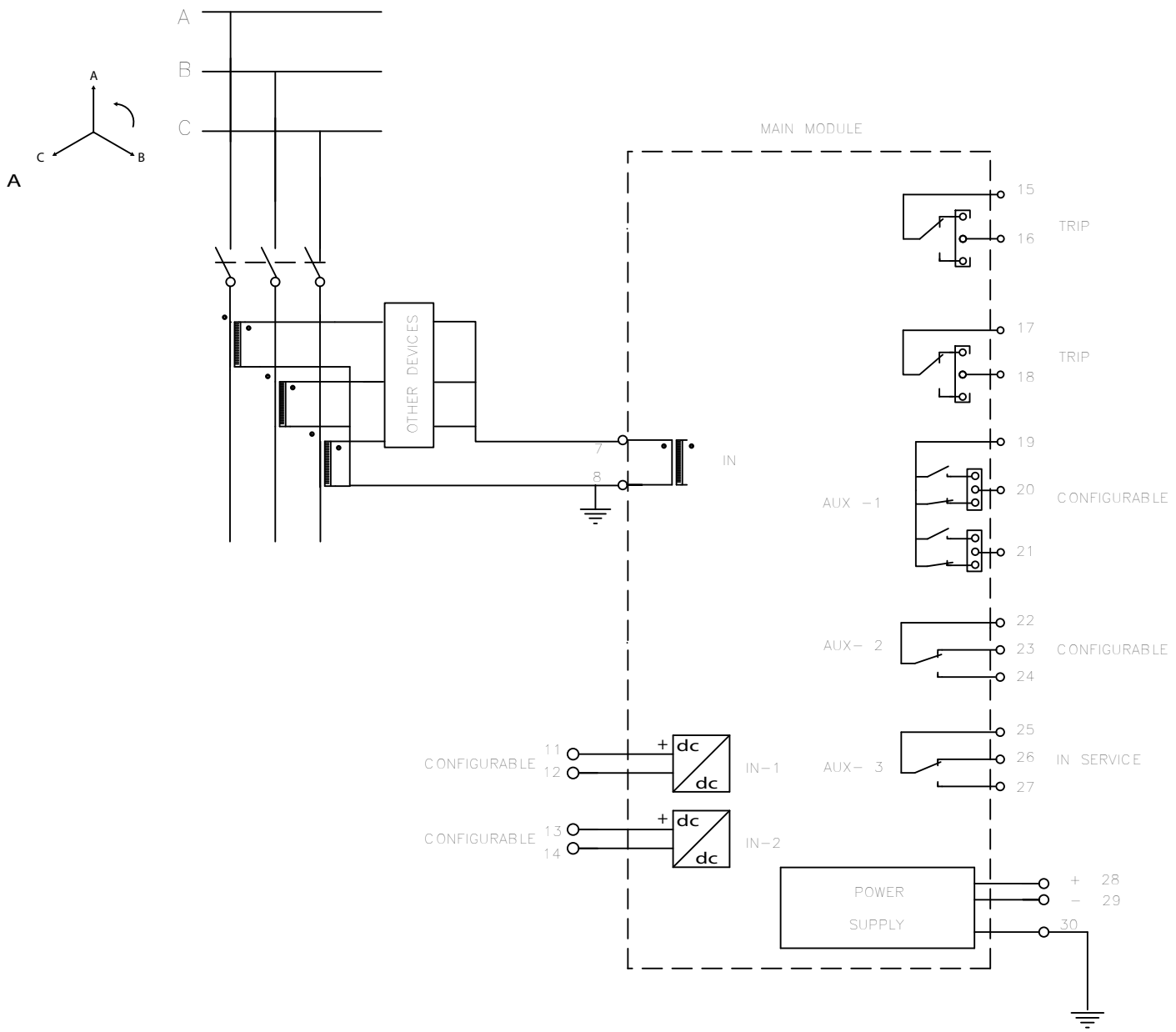

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ZIV Aplicaciones y Tecnología, S.L.

TITLE> EXTERNAL CONNECTIONS 3/8CPI–C

PROJECT> OVERCURRENT PROTECTION

Rev.0

NUMBER> 3RX0131/0036

	Date	Name
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Approved	15/04/03	J.M.Y.

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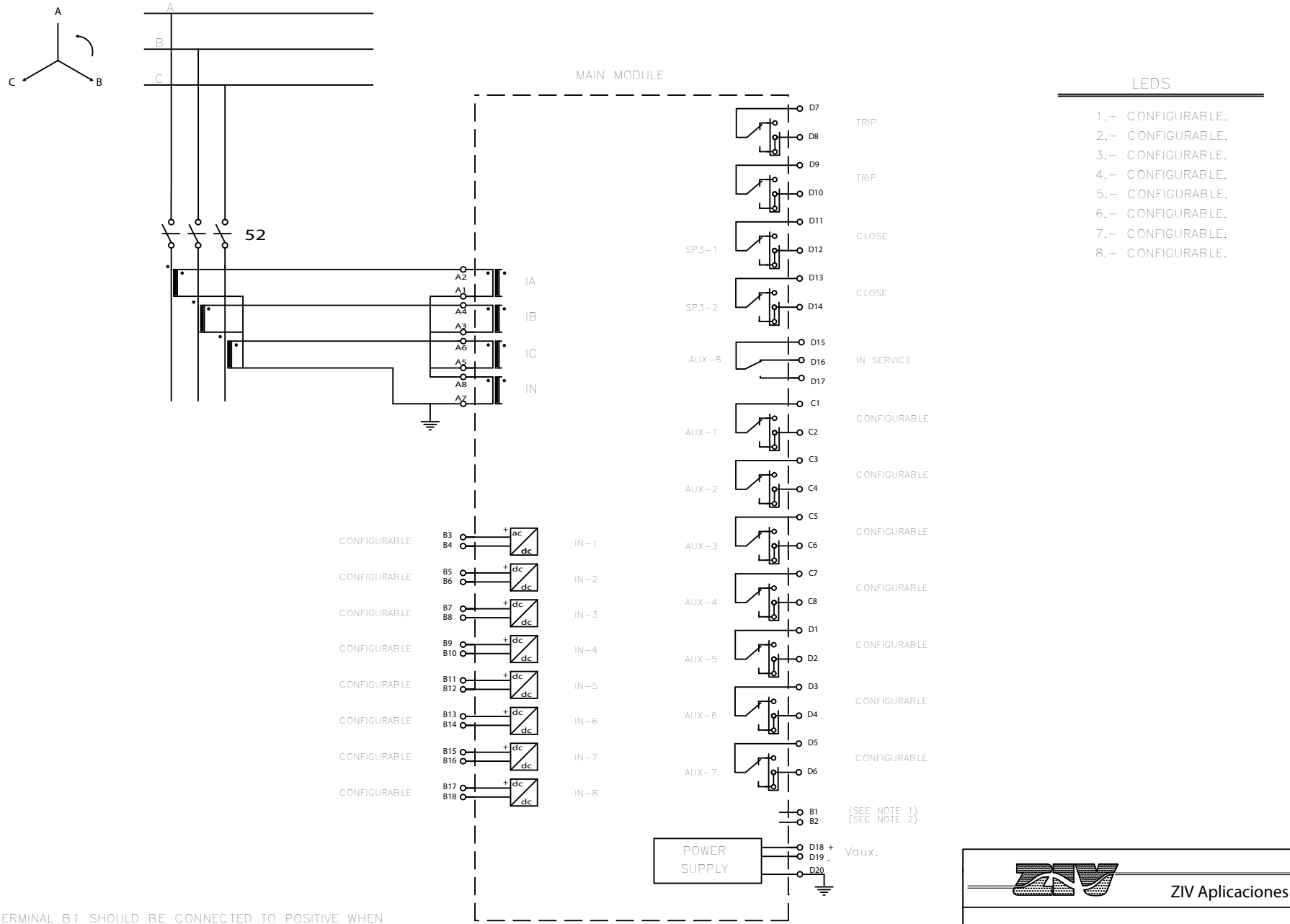

LEDS

1.- CONFIGURABLE.
2.- CONFIGURABLE.
3.- CONFIGURABLE.
4.- CONFIGURABLE.
5.- CONFIGURABLE.
6.- CONFIGURABLE.
7.- CONFIGURABLE.
8.- CONFIGURABLE.

NOTE 1: TERMINAL B1 SHOULD BE CONNECTED TO POSITIVE WHEN ANY OF THE INPUTS (IN7,IN8) ARE BEING USED FOR THE BREAKER COIL SUPERVISION FUNCTION.

NOTE 2: TERMINAL B2 SHOULD BE CONNECTED TO POSITIVE WHEN ANY OF THE INPUTS (IN5,IN6) ARE BEING USED FOR THE BREAKER COIL SUPERVISION FUNCTION.

REVISIONS	0	CD0510151	1	CD0604105	2	CD0608111	3		4	
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ZIV Aplicaciones y Tecnología, S.L.

TITLE> EXTERNAL CONNECTIONS 3/8CPI

PROJECT> OVERCURRENT PROTECTION (1/5 RACK)

Rev.0
Rev.1 30/05/06
Rev.2 04/08/06

NUMBER> 3RX0131/0041

	Date	Name
Drawn	04/08/06	J.C.S.
Approved	04/08/06	P.A.

Sheet:1

Continued on Sheed:

D. List of Illustrations and Tables

D.1 List of Figures

D.2 List of Tables

Annex D. List of Illustrations and Tables

E. Warranty

ZIV GRID AUTOMATION, S.L.
Standard Product Warranty

All new products sold to customers are warranted against defects in design, materials, and workmanship for a period of ten (**10**) years from the time of delivery (at the moment the product leaves ZIV GRID AUTOMATION premises, as indicated in the shipping documents). Customer is responsible of notifying ZIV GRID AUTOMATION of any faulty conditions as soon as they are detected. If it is determined that the new product defect is covered by the warranty, ZIV GRID AUTOMATION will repair, or substitute the product at its own discretion to the customer at no charge.

ZIV GRID AUTOMATION may, at its own discretion, require the customer to ship the unit back to the factory for diagnosis before making a determination as to whether it is covered by this warranty. Shipping costs to the ZIV GRID AUTOMATION factory (including but not limited to, freight, insurance, customs fees and taxes, and any other expenses) will be the responsibility of the customer. All expenses related to the shipment of the repaired or replacement units back to the customer will be borne by ZIV GRID AUTOMATION.

Customers are responsible for all expenses related to the shipment of defective units back to ZIV GRID AUTOMATION when it is determined that such units are not covered under this warranty or that the fault is not ZIV GRID AUTOMATION´s responsibility. Units repaired by ZIV GRID AUTOMATION are warranted against defects in materials, and manufacturing for a period of one (1) year from the time of delivery (at the moment the product leaves ZIV GRID AUTOMATION premises, as indicated by the shipping documents), or for the remaining of the original warranty, whichever is greater.

ZIV GRID AUTOMATION warranty does not cover: 1) improper installation, connection, operation, maintenance, and/or storage, 2) minor defects not interfering with the operation of the product, possible indemnities, misuse or improper usage, 3) abnormal or unusual operating conditions or application outside the specifications for the product, 4) application in any way different from that for which the products were designed, 5) repairs or alterations performed by individuals other than ZIV GRID AUTOMATION employees or an authorised representative.

Limitations:

1) Equipment or products provided but not manufactured by ZIV GRID AUTOMATION. Such products may be covered by a warranty issued by the corresponding manufacturer.
2) Software: ZIV GRID AUTOMATION warrants that the licensed Software corresponds with the specifications included in the instruction manuals provided with the units, or with the specifications agreed with the end-customer. ZIV GRID AUTOMATION sole and entire liability, and customer exclusive remedy, with respect to any claims relating to the Software shall be to provide a new set of diskettes free of charge.
3) In the case that a bank guarantee or similar instrument be required to back up the warranty period, such warranty period, and only for these purposes, will be of a maximum of twelve (12) months from the time of delivery (at the moment the product leaves ZIV GRID AUTOMATION premises, as indicated in the shipping documents).

THIS WARRANTY IS IN LIEU OF ANY OTHER WARRANTIES AND ZIV GRID AUTOMATION HEREBY DISCLAIMS ANY OTHER WARRANTY, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL ZIV GRID AUTOMATION BE LIABLE FOR ANY INDIRECT, INCIDENTAL, CONSEQUENTIAL, OR SPECIAL DAMAGES OR FOR ANY OTHER LOSS, INJURY, DAMAGE, OR EXPENSE OF ANY KIND INCLUDING LOST PROFITS OR ANY OTHER PECUNIARY LOSS ARISING FROM ANY SOURCE.

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