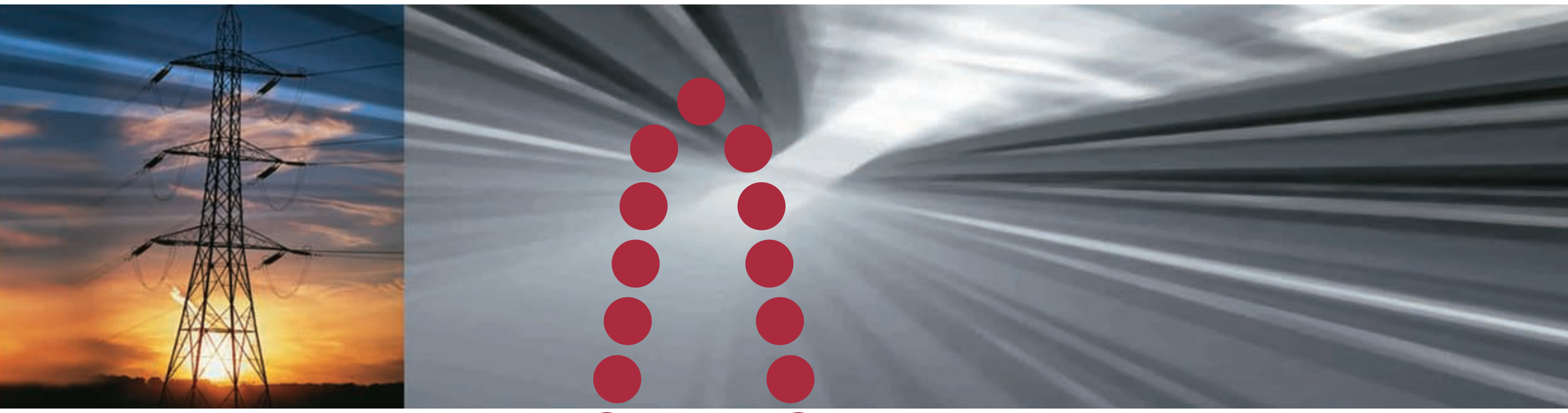


8BCD G/J

Capacitor Bank Terminal

Instructions Manual

B8BC402Gv05

License agreement for Software Embedded in Equipment

ZIV APLICACIONES Y TECNOLOGÍA, S.L.
End-User Software License Agreement

THE EQUIPMENT YOU HAVE PURCHASED INCLUDES EMBEDDED SOFTWARE PROGRAM(S). THE PROGRAM IS COPYRIGHTED AND IS BEING LICENSED TO YOU (NOT SOLD) FOR USE WITH THE EQUIPMENT.

THIS IS A LEGAL AGREEMENT BETWEEN US (AS "LICENSEE) AND ZIV APLICACIONES Y TECNOLOGIA, S.L. (AS "LICENSOR") FOR THE SOFTWARE PROGRAM INCLUDED WITH THE EQUIPMENT. PLEASE READ THE TERMS AND CONDITIONS OF THIS LICENSE AGREEMENT CAREFULLY BEFORE USING THE EQUIPMENT.

IF YOU INSTALL OR USE THE EQUIPMENT, YOU ARE ACCEPTING AND AGREEING TO THE TERMS OF THIS LICENSE AGREEMENT. IF YOU ARE NOT WILLING TO BE BOUND BY THE TERMS OF THIS LICENSE AGREEMENT, YOU SHOULD PROMPTLY RETURN THE EQUIPMENT UNUSED TO YOUR SELLER, AND YOU WILL RECEIVE A REFUND OF YOUR MONEY.

Terms and Conditions of License

1. **License Grant**. Licensor hereby grants to you, and your accept, a nonexclusive and non-transferable license to use the embedded programs and the accompanying documentation, if any (collectively referred to as the "Software"), only as authorized in this License Agreement.
2. **Restrictions.** You may not (a) use, copy, modify or transfer the Software except as expressly provided in this or another Agreement with Licensor, (b) reverse engineer, decompile or disassemble or separate the components of the Software, or (c) rent, sell or lease the Software or make the Software available to others to do any of the foregoing.
3. **No Assignment.** This License is intended for your exclusive use with the purchased equipment. You agree that you will not assign, sublicense, transfer, pledge, lease, rent or share your rights under this License Agreement.
4. **Licensor's Rights.** You acknowledge and agree that the Software is the proprietary product of Licensor protected under U.S. copyright law and international treaties.. You further acknowledge and agree that all right, title and interest in and to the Software, including associated intellectual property rights, are and shall remain with Licensor. This License Agreement does not convey to you an ownership interest in or to the Software, but only a limited right of use revocable in accordance with the terms of this License Agreement.
5. **Confidentiality**. The Software is confidential and no details or information relating to the same shall be disclosed to any third party without the prior written consent of Licensor. For the purposes of this clause, sub-contract staff, employed or retained by the Licensee to perform computer systems development work, shall not be deemed to be third parties provided such staff are subject to the disclosure restrictions set forth above. In no event, except with a prior written authorization duly signed by an officer of Licensor, may you disclose any such confidential information, even for subcontracted jobs, to persons or entities that may be considered to be direct competitors of Licensor.

6. **Term**. The License Agreement is effective upon delivery of the equipment to you and shall continue until terminated. You may terminate this License Agreement at any time by returning the equipment to Licensor, or by destroying the equipment. Licensor may terminate this License Agreement upon your breach of any term hereof. Upon such termination by Licensor, you agree to return the equipment to Licensor.
7. **Warranty and Disclaimer.** Licensor warrants, for your benefit only, that the Software, when and as delivered to you, will conform to the specifications described in the instruction manuals for the equipment purchased, or any specifications agreed to in writing by Licensor with a particular customer. This warranty does not cover any minor errors or deviations from the specifications that do not affect the proper functioning of the equipment. **EXCEPT FOR THE WARRANTIES SET FORTH ABOVE, THE SOFTWARE IS LICENSED “AS IS”, AND LICENSOR DISCLAIMS ANY AND ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**
8. **Licensee’s Remedy.** You sole and exclusive remedy for any breach of Licensor’s warranty shall be the repair or replacement, at Licensor’s sole option, of any Software that does not conform to stated specifications. Licensor shall not be responsible for any failure arising from inadequate or improper use of the Software.
9. **Limitation of Liability.** Licensor’s cumulative liability to you or any other party for any loss or damages resulting from any claims, demands, or actions arising out of or relating to this Agreement shall not exceed the purchase price paid to Licensor for the equipment. In no event shall Licensor be liable for any indirect, incidental, consequential, special, or exemplary damages or lost profits, even if licensor has been advised of the possibility of such damages.
10. **Trademark.** All ZIV trademarks (including ZIVERCOM, ZIVERLOG and ZIVERSYS) are common law trademarks of Licensor. No right, license or interest to such trademarks is granted hereunder, and you agree that no such right, license or interest shall be asserted by you with respect to such trademark.
11. **Licensee’s Indemnity.** You shall defend, indemnify and hold Licensor harmless against any loss or damage of any kind arising from a breach by you of this License Agreement, or any use or misuse of the Software by you or your employees, agents or representatives, and from any other of your conduct or from any claim or action by any of your customers in connection with the Software or this License Agreement.
12. **Governing Law.** This License Agreement shall be construed and governed in accordance with the internal laws of the State of Illinois, U.S.A.
13. **No Waiv**er. The failure of either party to enforce any rights granted hereunder or to take action against the other party in the event of any breach hereunder shall not be deemed a waiver by that party as to subsequent enforcement of rights or subsequent actions in the event of future breaches.
14. **Entire Agreement**. This License Agreement is the entire agreement between you and Licensor with respect to the use of the software and supersedes all prior understandings or agreements between the parties. This License Agreement may be amended only by a writing signed by an officer of Licensor.

ZIV Aplicaciones y Tecnología, S.L.
Parque Tecnológico, 2089
48016 Zamudio (Vizcaya)
48080 Bilbao
Spain

Table of Contents

Notes:

CHAPTER 1

Description

The **8BCD** model represents a family of integrateable microprocessor-based Terminal Units for Capacitor Bank Protection and Control.

The functions they provide can be summarized as follows:

- Primary Fault and Voltage Unbalance Protection
- Negative Sequence Protection (only for **8BCD-J** model)
- Automatic Switching Control
- Current, Voltage and Reactive Power Measurements

The **8BCD** possesses ideal characteristics for applications in transmission and distribution systems with grounded or ungrounded capacitor banks; especially in substations where protection, measuring and control are required.

1.1 General Overview

8BCD Terminal Units contain two different types of functions: Protection and Breaker Control (Automatic and Manual).

1.2 Protection Functions

- **Non-directional Overcurrent Element - Three-Phase and Ground (3X50/51 + 50N/51N)**

Included in the **8BCD** are four non-directional Overcurrent measuring elements (three for phase overcurrent protection and one for ground). Each unit is comprised of a time element, an instantaneous element and a time delay controlled by the instantaneous function.

Time elements can be selected with the following types of characteristics: **Definite Time**, **Inverse**, **Very Inverse** and **Extremely Inverse**. A **User Programmable** characteristic can be selected using the local RS232 communications port and the ZIVercom software.

Time and instantaneous overcurrent elements for phase and ground can be enabled or disabled using settings.

Three setting groups are provided for selecting alternative pre-established time and instantaneous overcurrent pickup values and time characteristics (one is active and two are in reserve).

Phase and ground, timed and instantaneous overcurrent pickup, and tripping functions can all be individually targeted.

- **Negative Sequence Unit (current unbalance protection) (46)**

The equipment has a negative sequence measuring unit that can be used with an **inverse curve** or **fixed time** characteristic. The unit can be enabled or disabled through setting.

- **Voltage Unbalance Element**

When an individual capacitor unit fails, an increase in the reactance of that series section occurs. This situation causes a voltage unbalance in the phase affected in relation to the other phases in the capacitor bank. This voltage unbalance will be measured differently, based on whether the bank is grounded or ungrounded.

According to IEEE C37.99-1990 7.2, “The unbalance due to loss of individual capacitor units is somewhat different than the calculated value because of inherent unbalance. This inherent unbalance, which exists on all capacitor bank installations, is primarily due to system voltage unbalance, capacitor manufacturing tolerance unbalance, or both. The inherent unbalance may be in a direction, such as to prevent protective relay operation, as well as to cause false operation.”

The **8BCD** Voltage Unbalance element has the sensitivity to detect the failure of individual capacitors within the grounded or ungrounded bank, but it is insensitive to routine system unbalance and switching disturbances.

The **8BCD** Terminal Unit is equipped with three independent Voltage Unbalance elements. Each has individual Pickup and Time Delay settings, and can be used as an alarm or trip function. Alarm levels on the loss of one or two capacitor units or immediate automatic removal of the bank from service can be easily set through the alphanumeric keypad and display.

Three setting groups are provided to select alternative pre-established Time Delay and Instantaneous Voltage Unbalance Pickup values (one is active and two are in reserve).

• Block Voltage Unbalance Trip Element (Blocking Unit)

An undercurrent three-phase element will block a Voltage Unbalance trip if the current flowing through the three phases is below a set level.

This element prevents a relay from tripping when the breaker is open and the inherent unbalance level on the system is above the capacitor bank Voltage Unbalance setting.

• Overvoltage Element (59)

The **8BCD** incorporates an Overvoltage protection element comprised of a Time element, an Instantaneous element and a Time Delay element controlled by the Instantaneous function. Time and instantaneous elements can be individually enabled or disabled.

There are three different user selectable time curve characteristics: **Definite Time**, **User Programmable** and **Normal Curve (Capacitor Bank Specific)**.

Three setting groups are provided for selecting alternative pre-established Time and Instantaneous Overvoltage Pickup values and Time Delay characteristics (one is active and two are in reserve).

• Instantaneous Undervoltage Element (27 Inst)

All models in this family incorporate an Undervoltage protection element comprised of an Instantaneous element that can be enabled or disabled using settings.

Three setting groups are also provided for selecting alternative pre-established Time and Instantaneous Undervoltage Pickup values and Time Delay characteristics (one is active and two are in reserve).

• Loss of Potential Detection Element

The **8BCD** Terminal Unit is provided with an element that monitors the VT secondary circuits (monitors the bus voltage), and disables any Undervoltage trip (by protection unit or by automatic control) in the event that a VT fuse blows. This element operates based on an algorithm whose inputs are current and voltage magnitudes.

• Breaker Failure Protection Element

The Terminal Unit incorporates Breaker Failure protection elements, which detects the continuation of phase or ground overcurrent and can send, through an auxiliary output, a signal to initiate backup tripping of other breakers.

• Clock/Calendar and Synchronization

The **8BCD** Terminal Units are provided with a clock/calendar system that allows events stamping with a 1ms accuracy. This system can be set through the alphanumeric keypad and display or externally through:

- **Communications protocol**
- **IRIG-B 123 signal (optional)**

When using the communications protocol, the synchronization source can be the substation central computer, if the **8BCD** is integrated into a substation automation system, or a laptop with the software application ZIVercom® installed. Both the front and rear port can be used for this synchronization.

The **8BCD-G6** Terminal Units are equipped with a BNC connector on the rear for connection to an external IRIG-B 123 synchronization system.

• Oscillography

The Terminal Unit incorporates a built in oscillographic recorder.

1.3 Control Functions

• Automatic Connection Control

The **8BCD-G** model allows the capacitor bank to be automatically connected either by time clock or by reactive power flow.

> **By time clock**: The user can program connection and disconnection time as a function of the day (weekday or holiday).
> **By reactive power flow**: Breaker open or close operation depends on the preset level of reactive power flowing through the transformer.

The Automatic Connection Control operation is blocked whenever a fault is detected.

• Breaker Control

Breaker trip and close operations can be performed either through the Terminal Unit keypad or through the communication ports via ZIVercom® communications software (provided that permission to perform operations has been enabled).

1.4 Main Breaker Monitoring Functions

• Trip and Close Coil Circuit Monitoring

The equipment incorporates elements to monitor the breakers trip and close coil circuits. Both circuits can be monitored in either the tripped or closed position. These supervision elements produce trip coil circuit failure and close coil circuit failure outputs.

• Breaker Operation Monitoring

Associated with breaker trip and close coil circuit monitoring functions are trip and close operation monitoring functions.

• Excessive Number of Trips

This function creates an event and sends a signal, which can be connected to operate one of the physical auxiliary contact outputs, if the breaker is subjected to an undesirable number of operations during a fixed period of time.

• 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.

1.5 Local Breaker Monitoring Functions (400 model)

• Excessive Number of Trips

This function creates an event and sends a signal, which can be connected to operate one of the physical auxiliary contact outputs, if the breaker is subjected to an undesirable number of operations during a fixed period of time.

• Operation Command Failure

It is verified the correct fulfillment of the Operation commands locking at the breaker open status input.

1.6 Measuring, Monitoring and Annunciation Functions

• Band Pass Filter (Model *02)

An IIR **band pass filter** is included to be applied in the phase and ground currents and bank voltage unbalance analog inputs. The filter is intended to avoid false tripping when considerable content on non-harmonic frequencies is present in these analog inputs.

• Status Contact Inputs

The Protection Subsystem of the **8BCD** has eight status contact inputs, all of them configurable. A list of available inputs is defined in Chapter 6, Table I.

• Auxiliary Contact Outputs

There are eight auxiliary contact outputs in the protection system, seven of which are configurable. Auxiliary output AUX-8, which corresponds to **Terminal Unit In Service** (powered up, self-test OK), is not programmable. A list of available outputs for Protection is defined in Chapter 6, Table II.

• LED Targets

Terminal Unit front panel indication consists of thirteen LED's. Twelve of the LED's are user definable. The other LED is assigned to indicate that the System is **Ready** (powered up, self-test OK).

1.7 Information Available Through Local Alphanumeric Display

Display of:

Protection and Control Settings

Operations:

- **Last Trip**
- **Active LED's**

Measurements:

- **Phase and Ground Currents**
- **Voltage Unbalance**
- **System Unbalance**
- **Bus Voltage**
- **Capacitor Voltage Unbalance**

1.8 Self-Test Program

A continuously running diagnostic self-test program verifies the correct operation of the Terminal Unit and alerts the user to potential problems.

1.9 Communications Protocol and System Integration

The standard protection and control protocol implemented on both ports (front and rear) and used for communications is **PROCOME** (IEC 870-5) or **DNP3.0**.

The **8BCD** Terminal Unit can be installed as a stand-alone device or combined with other similar devices to provide a complete integrated protection and control system for an entire substation. In this case, the Terminal Units are all connected to a Substation Central Unit (CPP or CPX), using either RS232 or fiber optic connecting links.

Each Terminal Unit provides stand-alone protection, control and metering functions for a specific substation device. The CPP or CPX manages data acquisition and communications with the individual Terminal Units. The CPP or CPX is also able to perform control duties at the substation level. Load transfer, frequency trip/restoration, and automatic close control are examples.

The CPP or CPX can be connected to an operations desk (PCD) by means of a local area network (LAN). The PCD is a computer interface that can be used to completely control and monitor all of the Terminal Units connected to the CPP or CPX. It is also possible to design the CPP or CPX to act as a supervisory remote control unit and interface with SCADA master units using available standard protocols.

Whenever the **8BCD** is installed as a stand-alone terminal, it can be remotely accessed through a modem connected to its rear port.

1.10 Model Selection

Model selection is determined using the following figure, according to the characteristics required:

8BCD - ☐☐☐ ☐☐☐ ☐ ☐☐☐

FUNCTIONS	
3x50/51 + 50N/51N + 27 + 59 + Voltage Unbalance + Automatic Control (Clock + Reactive Power)	G
3x50/51 + 50N/51N + 46 + 27 + 59 + Voltage Unbalance + Automatic Control (Clock + Reactive Power)	J

OPTIONS	
Analog Oscillography	2
Analog & Digital Oscillography + IRIG-B input	5
Analog Oscillography + IRIG-B input	6
Analog & Digital Oscillography	7

RATED CURRENT	
5 A + Special Voltage Unbalance Unit	C
1 A + Special Voltage Unbalance Unit	G

POWER SUPPLY	DIGITAL INPUTS	VOLTAGE SUPERV INPUTS	
24 - 48 Vdc(*)	24 - 48 Vdc(I)	24 - 48 Vdc(I)	1
110-125 Vdc(*)	24-125 Vdc(II)	125 Vdc(II)	2
220-250 Vdc(*)	48-250 Vdc(III)	250 Vdc(III)	3

(*) ± 20%

RATED VOLTAGE / FREQUENCY / LANGUAGE	
110 / 110 | 3 Vca / 50 Hz / Spanish	1
120 / 120 | 3 Vca / 60 Hz / English	3
110 / 110 | 3 Vca / 50 Hz / English	B
120 / 120 | 3 Vca / 60 Hz / Spanish	D
120 / 120 | 3 Vca / 60 Hz / Portuguese	F

COMMUNICATIONS (Front / Rear / SCADA)	
RS232 + RS232	1
RS232 + Plastic Fiber (1 mm)	2
RS232 + Glass Fiber (SMA)	3
RS232 + Glass Fiber (ST)	4
RS232 + RS485	5
RS232 + RS232 + RS232	7
RS232 + Glass Fiber (ST) + Glass Fiber (ST)	A
RS232 + Glass Fiber (ST) + RS232	B
RS232 + RS232 + RS485	C
RS232 + Plastic Fiber (1mm) + Plastic Fiber (1mm)	D

SPECIAL MODELS	
Standard	000
BCD-G Enhanced	001
BCD-G Enhanced with additional Bandpass Filter	002
BCD-J with double set of trip/close contacts and oscillography non volatile	400

TYPE OF ENCLOUSURE	
4 U x 1 19" Rack. Stainless steel enclousure. Ring Lug Connections for analog inputs	Q

COMMUNICATIONS PROTOCOL	
PROCOME	B
PROCOME and DNP3	E

FRONT PANEL	
Without Sealable Cover	A
With Sealable Cover	C

Figure 1.1: Model Selection List

CHAPTER 2

Technical Data

Power Supply Voltage

24 - 48 (±20%) Vdc	**19.2 - 57.6 Vdc**
or **110 - 125 (±20%) Vdc**	**88.0 - 150.0 Vdc**
or **220 - 250 (±20%) Vdc**	**176.0 - 300.0 Vdc**

Note: in the event of a power supply voltage failure, Terminal Units can tolerate a maximum interruption of 100 ms @110Vdc.

Power Supply Burden

Quiescent:	**7 W @ 125 Vdc**
Maximum:	**20 W @ 125 Vdc** (trip)

Current Analog Inputs

Rated ac Current (I_n)	I_n **= 5A** Nominal or I_n **= 1A** Nominal
Thermal Withstand Capability	**4** × I_n Continuously **50** × I_n for **3 s** **100** × I_n for **1 s**
Dynamic Limit (dynamic load capacity)	**240 x** I_n
Current Circuit Burden	I_n **= 5 A < 0.2VA** I_n **= 1 A < 0.05VA**

Voltage Analog Inputs

Rated ac Bus Voltage	V_n **= 110Vac** for **50 Hz** frequency **120Vac** for **60 Hz** frequency
Bus Voltage Thermal Withstand Capability	**2 x** V_n Continuously
Maximum Voltage Unbalance	**25 Vac**
Voltage Circuit Burden	V_n **= 110 Vac < 0.5 VA**

Status Contact Inputs

Eight Status Contact Inputs, all of them configurable

Status Contact Input Voltage Range

Rated Voltage Supervision Input (IN-1):

Power Supply	Rated Voltage Supervision Input Range
110 - 125 Vdc	125 Vdc (± 20%) or 110 Vdc (± 20%)

Remaining Status Contact Inputs (IN-2 to IN-8) accept the following DC voltage ranges based on the Power Supply:

Power Supply	Input Range (used as Contact Input)
24 - 125 Vdc	24 - 125 Vdc (± 20%)
110 - 250 Vdc	24 - 250 Vdc (± 20%)

Note: Status Contact Inputs (IN-5, IN-6, IN-7 and IN-8) can be connected to different, separately-fused voltages whenever they are used to supervise Trip and/or Close circuits.

Trip and/or Close Coil Circuit Supervision Inputs (IN-5 to IN-8):

Power Supply	Input Range (used for Circuit Supervision)
24 - 48 Vdc	48 Vdc (± 20%)
110 - 125 Vdc	125 Vdc (± 20%)
220 - 250 Vdc	250 Vdc (± 20%)

Current Drain:	**< 5 mA dc**
Contact Input Recognition Time (Make):	**<12 ms**
Contact Input Recognition Time (Break):	**<12 ms**

Trip & Close Outputs

Electrically separate trip and close contacts are provided with the following limits:

Continuous	**8 A**
Make and Carry (200 ms)	**30 A**
Make and Carry (4 s)	**10 A**
Connection Capability	**2500 W**
Break (Resistive)	**150W (dc) /1250VA (ac)**
Switching Voltage	**250Vdc**
Momentary Close Time	**100 ms**
Contact Operation Time	**3 ms**

Auxiliary Contact Outputs

Electrically separate auxiliary contacts are provided with the following limits:

Continuous	**3A**
Make and Carry (4s)	**8A**
Connection Capability	**2000 W**
Break (Resistive)	**75W (dc) / 1000VA (ac)**
Switching Voltage	**250 Vdc**

Measuring and Response Accuracy

Note: accuracy specified over a temperature range of -10º C to +55º C.

Time Overcurrent / Instantaneous Pickup	**< 5% @ 1.05 x pickup setting**
Time Overcurrent / Instantaneous Dropout	**< 5% @ pickup setting**
Definite and Inverse Time Characteristics	**5% or 25ms** (whichever is greater) **per IEC 255, precision class E**
***02 model**	**5% or 80ms** (whichever is greater) with Band Pass Filter active
Instantaneous Response Maximum Time	**35ms @ 2 x pickup** **25ms @ 4 x pickup and greater**
***02 model**	**85ms @ 2 x pickup** with band pass filter active **75ms @ 4 x pickup and greater** with Band Pass Filter active
Ammeter / Voltmeter	**< 5%**
Clock Accuracy	**within 1 minute per month**
Clock Backup Battery	**nickel-cadmium with 10 year life**

Repeatability

Operating Time:	**2% or 25 ms** (whichever is greater) Valid for the entire operating range

Transient Overreach

Defined as:

$$TO(\%) = \frac{(I_A - I_T)}{I_A} \times 100$$

where:

I_A = Pickup value for a current with no dc component.
I_T = Pickup value for a current with maximum dc offset.

The maximum overreach for an **8BCD** Terminal Unit is:

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

Communications

Glass Fiber Optics

Type	**Multi mode**
Wavelength	**820 nm**
Connector	**SMA / ST**
Transmitter minimum power:	
(Fiber Diameter)/(Reflective Cover Diameter): (dBm Loss)	
	50/125 μm Fiber: **-20 dBm**
	62.5/125 μm Fiber: **-17 dBm**
	100/140 μm Fiber: **-7 dBm**
Receiver Sensitivity:	**- 25.4 dBm**

Plastic Fiber Optics (1 mm)

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

Communications (cont.)

RS232C Port Signals
Terminal Unit DB-9 (9-pin) front port connector:

Pin 2 - RXD
Pin 3 - TXD
Pin 5 - GND

Terminal Unit DB-25 (25-pin) rear port connector:

Pin 2 - TXD
Pin 3 - RXD
Pin 4 - RTS
Pin 5 - CTS
Pin 7 - GND
Pin 13 - +5V, voltage for converter modules

RS485 Rear Port Signals
3 Pin Connector

Pin A driver output / receiver input
Pin B driver output / receiver input

IRIG-B 123

B: 100pps
1: Wave, amplitude modulated
2: 1kHz/1ms
3: BCD, SBS

BNC Connector

Input Impedance	**50 Ω** or **600 Ω** Default impedance = **600 Ω**
Maximum voltage input	**10 V**

CHAPTER 3

Standards and Type Tests

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

Insulation Test	IEC-255-5
Between circuits and ground:	**2 kV**, **50/60 Hz**, for 1 minute
Between independent circuits:	**2 kV**, **50/60 Hz**, for 1 minute
Impulse Voltage Test	IEC 255–5 (EN 21-136-83/ 5)
	5 kV; **1.2/50 μs**; **0.5 J**

1 MHz Burst Disturbance Test	IEC 255-22-1Class III (EN 21-136-92/22-1)
Common mode	**2.5 kV**
Differential mode	**1.0 kV**
Fast Transient Disturbance Test	IEC 255-22-4Class IV (EN 21-136-92/22-4)
	4 kV ± **10 %**
Radiated Electromagnetic Field Disturbance	IEC 1000-4-3 (ENV 50140; ENV 50204)
Amplitude modulated	**10 V/m**
Pulse modulated	**10 V/m**
Conducted Electromagnetic Field Disturbance	ENV 50141
	10 V
Electrostatic Discharge Test	IEC 255-22-2 Class III (EN 21-136-92/22-2)
	8 kV ± **10 %**

Radio Frequency Emissivity	EN 55011

Temperature	IEC 255-6
Operating range:	from **- 10 ºC** to **+ 55 ºC**
Storage range:	from **- 25 ºC** to **+ 70 ºC**
Humidity:	**95 %**(non condensing)
LCD contrast impaired for temperatures below	**- 20ºC**

Power Supply Ripple	IEC 255 - 11/EN 21-136-83(11) < **20 %**
Vibration Test (sinusoidal) **Shock and Bump Test**	IEC-255-21-1 Class I IEC-255-21-2 Class I

8BCD terminals comply with the EEC 89/336 standard of electromagnetic compatibility.

Notes:

CHAPTER 4

Physical Architecture

IV

4.1 General

The **8BCD** is supplied with three drawout printed circuit boards and a front panel. The main board provides the following functions:

- Current Analog Inputs
- CPU Module
- Trip and Close Outputs
- Contact Inputs and Outputs
- Rear Communication Port
- IRIG-B 123 Synchronization Interface
- Power Supply

The second board provides the Voltage Analog Inputs and the third board provides the Reactive Power Transducer circuitry.

The equipment's front panel, shown in Figure 4.1, incorporates the following elements:

-Expansion Bus Cable Connection
-Alphanumeric Display
-Function Keys and Numeric Keypad
-Local Communications Port

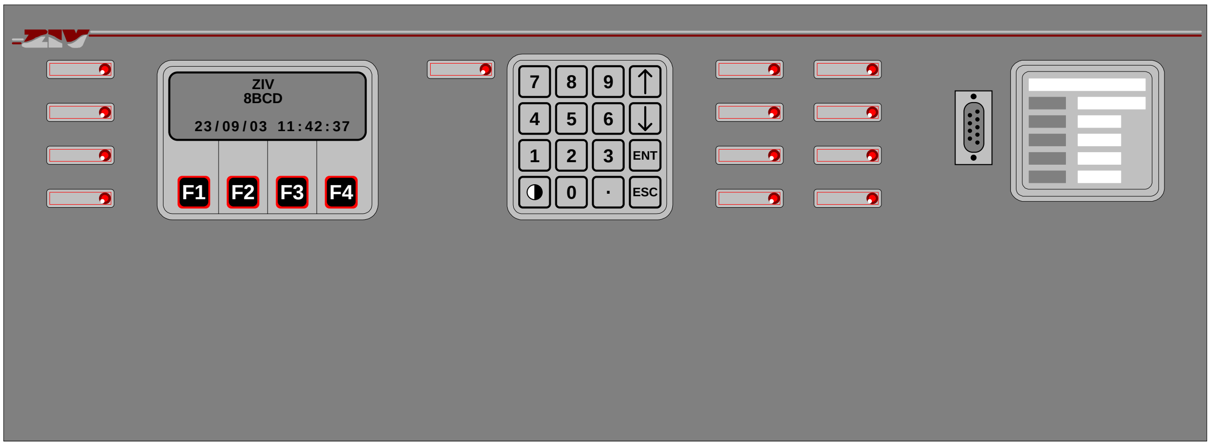


Figure 4.1: 8BCD Front View

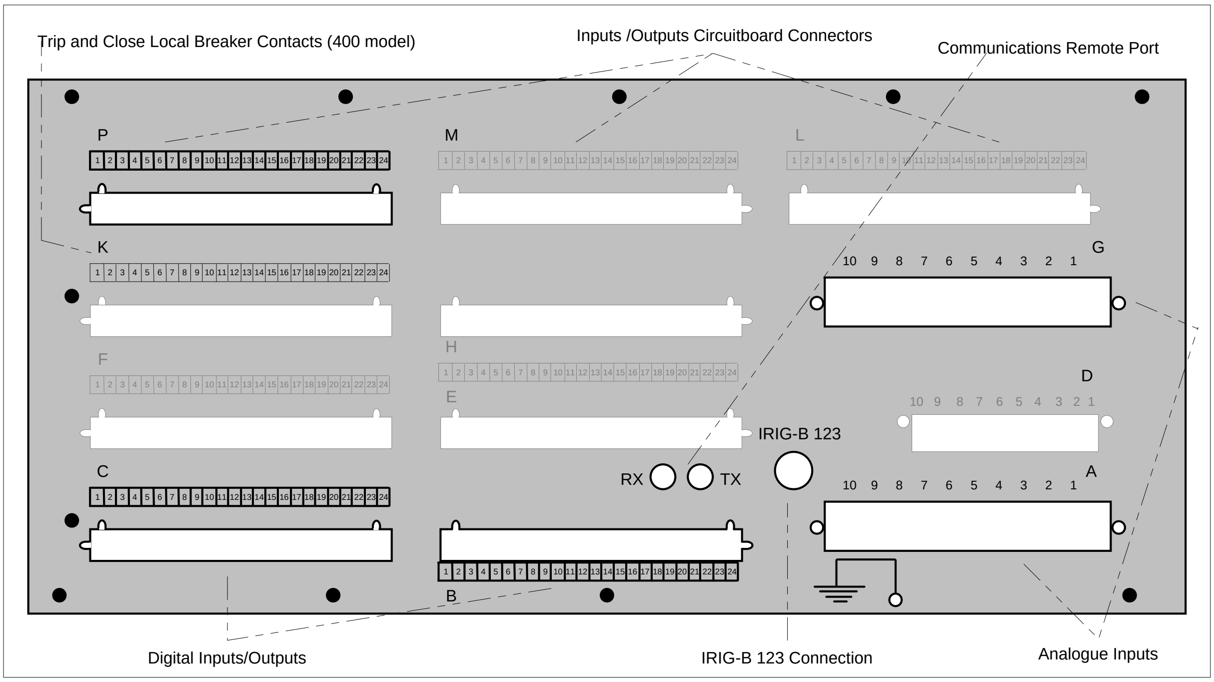


Figure 4.2: 8BCD-G-6*-****Q* Rear View**

Terminal Connector block layout for an **8BCD** equipment case is shown in Figure 4.2. This terminal connector block/case layout reflects one of the possible configurations for an **8BCD**.

4.2 Dimensions

Terminal Units have the following case dimensions according to the model specified: **8BCD** cases have a standard 19” rack width, are 4 rack units (7”) high and 10” deep.

The equipment is intended to be installed either semi-flush mounted in panels or in 19” racks. The enclosure color of the unit is graphite.

4.3 Connection Elements

4.3.1 Terminal Connectors and Connector Block (Contact Inputs and Outputs)

Terminal connectors are permanently attached to the rear edge of the printed circuit boards to facilitate external wiring, and are arranged in rows. The printed circuit board terminal connectors protrude through the rear of the equipment case and plug into terminal connector blocks to which all external wiring is landed.

4.3.2 Terminal Connectors and Connector Block (Current and Voltage Inputs)

Terminal connectors are permanently attached to the rear edge of the printed circuit boards to facilitate external wiring, and are arranged in rows. The printed circuit board terminal connectors protrude through the rear of the equipment case and plug into terminal connector blocks to which all external wiring is landed.

WARNING

The current circuit terminal connector block is not self-shorting. Consequently, current transformer (CT) secondaries must be short-circuited before proceeding with board removal.

The current and voltage analog input terminals accept ring lug connections. The remaining circuit terminals permit wire up to #14 AWG.

4.3.3 Removing Printed Circuit Boards With Current Analog Inputs

The equipment has been designed to enable removal of some drawout circuit boards.

WARNING

When doing so, caution must be exercised, since the current circuit terminal connector block is not self-shorting. Consequently, current transformer (CT) secondaries must be short-circuited before proceeding with board removal.

The Current Analog Input terminal connector block, where the external wiring is landed, is attached to both the terminal connector on the printed circuit board and the equipment case, using self-tapping screws. These screws must be removed before the board is withdrawn.

Whenever this operation is performed, the protection should be placed in the "**NOT IN SERVICE**" mode. (See Chapter 7 for this procedure.)

4.3.4 Internal Wiring

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

CHAPTER 5

Settings

• Configuration Settings

Passwords

The default **Password** that enables access to every Terminal Unit setting is **2140**. This password can be modified by the user to control access for any or all of the following functions: configuration, operation and change settings.

Operation Enable

Permits circuit breaker (or device) control from the Terminal Unit:

Permit Operation Via Local Keypad	**(YES/NO)**
Permit Operation Via Front Port	**(YES/NO)**
Permit Operation Via Remote Port	**(YES/NO)**

Permits remote change of the Terminal Unit settings

Permit Change Via Remote Port	**(YES/NO)**
Permit Change By Status Contact Inputs	**(YES/NO)**

Transducer Range

Transducer Range	±**0.1** to ±**20 Mvar**

V bus Phase Selection	**AB/BC/CA/A/B/C**

Contact Input Output Configuration

Contact inputs and outputs can be redefined or reallocated via the local RS232 communication port using the communications program ZIVercom provided with each Terminal Unit.

Communications (Remote Port)

Terminal Address	**0** to **254**
Baud Rate	**300** to **19200 Baud**
Stop Bits	**1** or **2**
Parity	**Even Parity / Odd Parity**

Communications (Local Port RS232C)

Terminal Address	(**Not sensitive** - **enter any number**)
Baud Rate	**4800 Baud**
Number Of Bits	**8**
Stop Bits	**1**
Parity	**Even Parity**

Date & Time	Keypad or via Terminal Unit connections (ZIVercom®)

Language (*)	**Spanish / English / Portuguese**
Frequency (*)	**50 / 60 Hz**

(*) depending on the software version

• General Settings

Terminal Unit In Service	**YES/NO**
CT Ratio Phase	**1 - 3000** (in steps of **1**) (**8BCD-G** model) (in steps of **0.1**) (**8BCD-J** model)
CT Ratio Ground	**1 - 3000** (in steps of **1**) (**8BCD-G** model) (in steps of **0.1**) (**8BCD-J** model)
Voltage Unbalance VT Ratio	**1 - 4000** (in steps of **1**) (**8BCD-G** model) (in steps of **0.1**) (**8BCD-J** model)
(Over/Undervoltage) VT Ratio	**1 - 4000** (in steps of **1**) (**8BCD-G** model) (in steps of **0.1**) (**8BCD-J** model)
Main Breaker Open Status	**0** or **1** (*)
Local Breaker Open Status (400 model)	**0** or **1** (*)
K (Scaling Factor)	**0.2 - 1.5** (in steps of **0.01**)
CT + R Connection	**YES/NO**

Band Pass Filter (Model *02)

Currents	**YES/NO**
Capacitor Unbalance Voltage	**YES/NO**

(*) Note: Open Breaker Status can be obtained from either a 52a contact or a 52b contact from the breaker. Open Status is indicated by a 0 when using a 52a contact or by a 1 when using a 52b contact.

• Protection Settings (Setting Group 1, 2 or 3)

The protection Terminal Unit operates based on settings from one of three settings groups (one is active, two are in reserve). The setting alternatives, which are the same for each setting group, are specified below.

Phase Time Overcurrent Element

Enable	**YES**/**NO**
Pickup	(**0.2** - **2.4**) I_n (in steps of **0.01A**)
Time Curve	**Definite time**, **Inverse** **Very Inverse**, **Extremely Inverse**
Time Dial	**0.05** - **1** (in steps of **0.01**)
Definite Time Delay	**0.05** - **100** s (in steps of **0.01** s)
Torque Control Enable	**YES**/**NO**

Ground Time Overcurrent Element	
Enable	**YES**/**NO**
Pickup	(**0.04** - **0.48**) I_n (in steps of **0.01A**)
Time Curve	**Definite Time**, **Inverse**, **Very Inverse**, **Extremely Inverse**
Time Dial	**0.05** - **1** (in steps of **0.01**)
Definite Time Delay	**0.05** - **100** s (in steps of **0.01** s)
Torque Control Enable	**YES**/**NO**

Phase Instantaneous Overcurrent Element	
Enable	**YES**/**NO**
Pickup	(**0.1** - **30**) I_n (in steps of **0.01A**)
Time Delay	**0** - **100 s** (in steps of **0.01 s**)
Torque Control Enable	**YES**/**NO**

Ground Instantaneous Overcurrent Element	
Enable	**YES**/**NO**
Pickup	(**0.1** - **12**) I_n (in steps of **0.01A**)
Time Delay	**0** - **100 s** (in steps of **0.01 s**)
Torque Control Enable	**YES**/**NO**

Breaker Failure Element	
Enable	**YES**/**NO**
Phase Overcurrent Pickup	**0.2** - **2.4 A** (in steps of **0.01A**)
Ground Overcurrent Pickup	**0.2** - **2.4 A** (in steps of **0.01A**)
Time Delay	**0.05** - **0.70 s** (in steps of **0.01 s**)

Negative Sequence Time Overcurrent Element (8BCD-J model)

Enable	**YES**/**NO**
Pickup	(**0.1** - **4**) $\mathbf{I_n}$ (in steps of **0.01A**)
Time Curve	**Definite time**, **Inverse**
Time Dial	**0.05** - **1** (in steps of **0.01**)
Definite Time Delay	**0.05** - **100** s (in steps of **0.01** s)
Torque Control Enable	**YES**/**NO**

Negative Sequence Instantaneous Overcurrent Element (8BCD-J model)

Enable	**YES**/**NO**
Pickup	(**0.04** - **20**) $\mathbf{I_n}$ (in steps of **0.01A**)
Time Delay	**0** - **100 s** (in steps of **0.01 s**)

• Voltage Protection Settings (Setting Groups 1, 2 or 3)

Voltage Unbalance (Elements 1, 2 and 3)

Enable		**YES**/**NO**
Pickup	Standard Model	**(0.5** - **15)** (in steps of **0.01 V**)
	Enhanced Model	**(0.1** - **15)** (in steps of **0.01 V**)
	8BCD-J	**(0.2** - **15)** (in steps of **0.02 V**)
Time		**0.05** - **100 s** (in steps of **0.01 s**)

Block Voltage Unbalance Element (Blocking Unit)

V_{unbal} Block Timer (enhanced model only)	**0.00 - 10.00** (in steps of **0.01**)

Undercurrent Block Voltage Unbalance Element

Enable	**YES**/**NO**
Pickup	**0.2** - **2.4 A** (in steps of **0.01 A**)

Overvoltage Time Element

Enable	**YES/NO**
Pickup	**120-150 V** (in steps of **1 V**)
Time Curve	**Definite Time** **Normal (Capacitor Bank Specific)**
Time Dial	**0.05 - 1** (in steps of **0.01**)
Definite Time Delay	**0.05 - 100 s** (in steps of **0.01 s**)

Instantaneous Overvoltage Element

Enable	**YES/NO**
Pickup	**120 - 220 V** (in steps of **1 V**)
Time Delay	**0 - 100 s** (in steps of **0.01 s**)

Instantaneous Undervoltage Element

Enable	**YES/NO**
Pickup	**21 - 119 V** (in steps of **1 V**)
Time Delay	**0 - 100 s** (in steps of **0.01 s**)

• Automatic Connection Control Settings (Setting Groups 1, 2 or 3)

In Service	**YES/NO**
Connection Method	**By time clock** **By reactive powerflow**
Operation Inhibit Time Delay	**5 - 900 s** (in steps of **1 s**) (**8BCD-G** model) **0.00 - 900s** (in steps of **0.01s**) (**8BCD-J** model)
V_{off} Threshold	**25 - 100%** (in steps of **1%**)
V_{off} Time Delay	**0.05 - 100s** (in steps of **0.01 s**)

By Time Clock

V_{add} Threshold:	**70** - **140 V** (in steps of **1 V**)
V_{add} Time Delay	**0.5** - **300 s** (in steps of **0.1 s**)
V_{remove} Threshold:	**100** - **150 V** (in steps of **1 V**)
V_{remove} Time Delay:	**0.5** - **300 s** (in steps of **0.1 s**)
$V_{hysteresis}$ Threshold:	**0** - **30** (in steps of **1 V**)
Weekday Schedule	
Enable	**YES**/**NO**
Connection Time	**00:00 - 24:00 Hours**
Disconnection Time	**00:00 - 24:00 Hours**
Weekend Schedule	
Enable	**YES**/**NO**
Saturday	**YES**/**NO**
Connection Time	**00:00** - **24:00 Hours**
Disconnection Time	**00:00** - **24:00 Hours**

By Reactive Power Flow

Connection Threshold	**-99%** to **+100%** tran-range (in steps of **1 V**)
Connection Time	**0.5** - **300 s** (in steps of **0.1 s**)
Disconnection Threshold	**-100%** to **+99%** tran-range (in steps of **1 V**)
Disconnection Time	**0.5** - **300 s** (in steps of **0.1 s**)

• Logic Settings (Settings Group 1, 2 or 3)

Operation of the Main Breaker
Operation of the Local Breaker (400 model)

Trip Output Seal-In Enable	**YES/NO**
Breaker Open Failure Time	**0.02 – 2 s** (in steps of **0.01 s**)
Breaker Close Failure Time	**0.02 – 2 s** (in steps of **0.01 s**)

Loss of Potential Detection Element

Enable	**YES/NO**
Minimum Current (I_{min})	**0.2 – 2.0 A** (in steps of **0.1 A**)
Time Delay	**0.01 – 5 s** (in steps of **0.01 s**)

Main Trip Element Enable
Local Trip Element Enable (400 model)

Phase Instantaneous Overcurrent: IOC, (PI)	**YES**/**NO**
Phase Time Overcurrent: TOC, (TI)	**YES**/**NO**
Ground Instantaneous Overcurrent: GND IOC, (GI)	**YES**/**NO**
Ground Time Overcurrent: GND TOC, (GT)	**YES**/**NO**
Voltage Unbalance Level 1: VUnb 1, (UNB1)	**YES**/**NO**
Voltage Unbalance Level 2: VUnb 2, (UNB2)	**YES**/**NO**
Voltage Unbalance Level 3: VUnb 3, (UNB3)	**YES**/**NO**
Instantaneous Overvoltage: IOV, (IOV)	**YES**/**NO**
Time Overvoltage: TOV, (TOV)	**YES**/**NO**
Instantaneous Undervoltage: IUV, (IUV)	**YES**/**NO**
Current Negative Element: I2 (I2)	**YES**/**NO**

Note: the abbreviations following the element label refer to setting choices in the ZIVercom software program and the abbreviations in parentheses refer to setting choices in the HMI Alphanumeric Display.

• Main Breaker Monitor Settings

Excessive Number Of Trips	**1** to **40**
I*I Alarm Level	**0 - 99999.99 kA²**
I*I Cumulative Present Value*	**0 - 99999.99 kA²**

*** Cumulative Present Value:** The cumulative kA^2 value the breaker (associated with the Terminal Unit) has experienced at the time the Terminal Unit is commissioned.

ΣI^2 Alarm Level and Present Value can be assigned different values to enable an alarm as the breaker reaches the level where maintenance is recommended.

Trip Coil Circuit Supervision Enable: **YES**/**NO ***

* If Trip Coil Circuit Supervision is enabled (**YES**), the position of the internal jumpers (J1 and J2) on the input/output board should be in the **SUP** position (see Figure 5.1).

* If Trip Coil Circuit Supervision is disabled (**NO**), the position of the internal jumpers (J1 and J2) on the input/output board should be in the **NO** position (see Figure 5.1).

Close Coil Circuit Supervision Enable: **YES**/**NO ***

*If Close Coil Circuit Supervision is enabled (**YES**), the position of the internal jumpers (J5 and J6) on the Input/Output Board should be in the **SUP** position (see Figure 5.1).

*If Close Coil Circuit Supervision is disabled (**NO**), the position of the internal jumpers (J5 and J6) on the Input/Output Board should be in the **NO** position (see Figure 5.1).

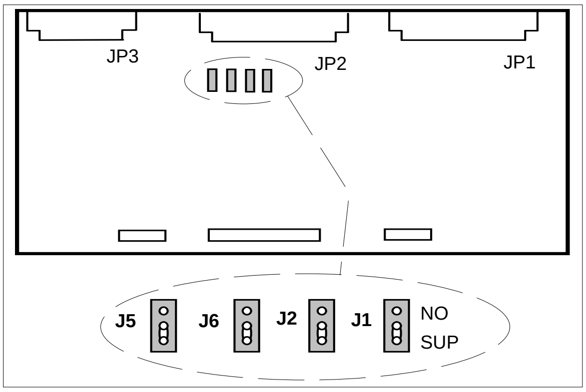


Figure 5.1: Internal Jumpers for Coil Circuit Supervision

Contact	Jumper
IN5	J1
IN6	J2
IN7	J6
IN8	J5

• Local Breaker Monitor Settings (400 model)

Excessive Number Of Trips	**1** to **40**

• Current/Voltage History Record

Average Calculation Time Interval	**1** to **15 min**
Data Record Interval	**00:01** - **24.00 Hours**
Day Calendar Mask	**Sunday** to **Saturday**
Hour Range – Historical Record Start Time	**0:00** - **24:00 Hours**
– Historical Record End Time	**0:00** - **24:00 Hours**

• Oscillography Settings

Recording Mode	**YES/NO** YES = Fixed Time Mode NO = Variable Time Mode						
Overwrite	**YES/NO**						
Trigger Mode	**Mode 0** **Mode 1** **Mode 2**						
Analog Channel mask							
Standard Model Channel Selection	1	2	3	4	5	6	
	Ia	Ib	Ic	In	Vbus	Vcap	
Enhanced and 8BCD-JModel Channel Selection	1	2	3	4	5	6	7
	Ia	Ib	Ic	In	Vbus	Vcap	Vsys
Digital Channel mask (*)	**YES/NO** (maximum 72)						
Pre-Fault Time	**1** - **2 cycles** (in steps of **1 cycle**)						
Record Length	**20** - **300 cycles** (in steps of **1 cycle**)						

(*) according to model

• Oscillography Settings (cont.)

Oscillography Trigger

The **Oscillography Trigger** initiates the oscillography function after a Pickup of selected Protection elements or a programmed External Oscillography Start logic input signal occurs.

Oscillography Trigger Elements (Initiate Elements):

Phase Instantaneous Overcurrent: IOC, (PI)	**YES/NO**
Phase Time Overcurrent: TOC, (PT)	**YES/NO**
Ground Instantaneous Overcurrent: GND IOC, (GI)	**YES/NO**
Ground Time Overcurrent: GND TOC, (GT)	**YES/NO**
Instantaneous Negative Sequence: II2 (II2) (*)	**YES/NO**
Time Negative Sequence: TI2 (TI2) (*)	**YES/NO**
Voltage Unbalance Level 1: VUnb 1, (UNB1)	**YES/NO**
Voltage Unbalance Level 2: VUnb 2, (UNB2)	**YES/NO**
Voltage Unbalance Level 3: VUnb 3, (UNB3)	**YES/NO**
Instantaneous Overvoltage: IOV, (IOV)	**YES/NO**
Time Overvoltage: TOV, (TOV)	**YES/NO**
Instantaneous Undervoltage: IUV, (IUV)	**YES/NO**
Opening: BRK Opening, (OA) (Main or Local)	**YES/NO**
External Oscillography Start: Ext. Pickup, (EP)	**YES/NO**

Note: the abbreviations following the element label refer to setting choices in the ZIVercom software program and the abbreviations in parenthesis refer to setting choices in the HMI Alphanumeric Display.

(*) 8BCD-J model

• Status and Auxiliary Contact Inputs and LED Targets

Status Contact Inputs

The Terminal Unit has eight status contact inputs, all of them configurable. A list of available inputs is defined in Chapter 6. Users can easily program different input configurations via the local RS232 communications port, using the ZIVercom® software, or request this to be done by the manufacturer.

Auxiliary Contact Outputs

The Terminal Unit has eight auxiliary contact outputs; seven of them are configurable. Auxiliary output AUX-8, which corresponds to **Terminal Unit In Service**, is not programmable.

A list of available outputs is defined in Chapter 6. Users can easily program different output configurations via the local RS232 communications port, using the ZIVercom® software, or request this to be done by the manufacturer.

LED Targets

Terminal Unit front panel indication consists of thirteen LEDs. Twelve of them are user definable. The remaining LED is assigned to indicate that the Protection Subsystems is **Ready** (powered up, self-test OK).

The signals available that can be assigned to the Protection LED targets are defined in Chapter 6, Table II. Users can easily program different LED target configurations via the local RS232 communications port, using the ZIVercom® software, or request this be done by the manufacturer.

Notes:

CHAPTER 6

Description of Operation

VI

6.1 Trip and Close Contacts

Depending on the model, the **8BCD** has two types of trip rated output contact arrangements. Standard models are equipped with a double trip contact (form a, double pole, single throw) and a double close contact. The **8BCD-J** (model 400) is equipped with two independent double trip contacts and two independent double close contacts.

Models with a single set of trip and close contacts allow operating and monitoring a single interrupting device. Every breaker function in the IED is related to this device. Models with two sets of trip and close contacts allow operating two independent interrupting devices.

- **Models with one set of trip and close contacts**

Models with a single set of trip and close contacts are used in applications where a single interrupting device is responsible for all of the protection and control switching duties. Every protection and control signal as well as the trip and close contacts are related to a single interrupting device referred to as the **Main Breaker**.

This nomenclature enables compatibility between IEDs with one set of trip and close contacts and IEDs with two sets of trip and close contacts.

- **Models with two independent sets of trip and close contacts**

These models are utilized in applications where the clearing of system faults is performed by one interrupting device and clearing of capacitor bank faults and control operations are performed by a second interrupting device. The independent operation of both interrupting devices requires a duplicate a set of functions associated to an additional set of trip and close contacts responsible for the second interrupting device.

These models include a **Main Breaker** associated to the system bus and a **Local Breaker** associated to the capacitor bank. The following figure shows an application example for models with two sets of trip and close contacts:

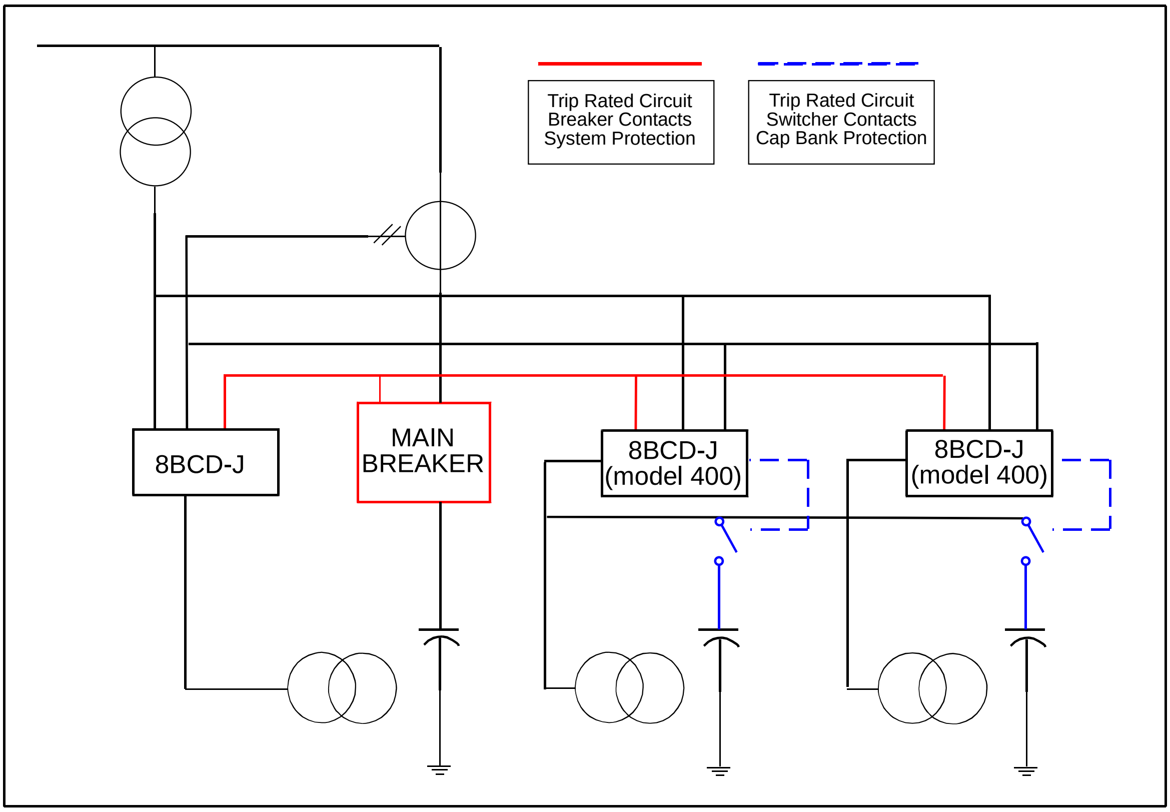


Figure 6.1: Application Example for Models with Two Sets of Trip and Close Contacts

The following functions are available for both interrupting devices:

- Trip rated output contacts with independent trip masks
- Independent breaker status monitoring
- Independent commands for trip/close operations initiated by:
  - Protection commands
  - Control commands
  - HMI commands
  - Open and Close commands via digital input
- The CURRENT DETECTED WITH OPEN BREAKER signal monitors the status of both interrupting devices, and only activates the alarm for the open breaker(s)
- The BREAKER OPEN signal associated to digital input programming is duplicated (DI17 for the Main breaker and DI 33 for the Local breaker)
- Independent counters for excessive number of trips
- Independent breaker operation monitoring of OPEN COMMAND FAILURE and CLOSE COMMAND FAILURE signals
- Independent trip seal-in settings

The following functions are only available for the **Main** interrupting device:

- Breaker failure unit
- Trip coil and close coil circuit supervision
- kA^2 sum calculation

The following functions are only available for the **Local** interrupting device:

- Connect and disconnect commands generated by the automatic control function, including trips due to low voltage

It is possible to associate the protection units included in the IED (current and voltage functions) to either, both or neither one of the **Main** or **Local** interrupting devices. These associations are done via **Trip Masks** included in the settings, assigning the trip command of each protection function to the corresponding interrupting device.

Independent settings are available for each protection unit and each interrupting device. Mask activation of a protection unit associated to the **Main** breaker, generates the operation of the **Main** breaker only. **Local** breaker operation obeys only to the activation mask of protection functions associated to the **Local** breaker.

Oscillography recording and fault report generation is activated by either one of the interrupting devices.

6.2 Band Pass Filter (*02 Model)

An IIR **band pass filter** is available to be applied in the analog inputs corresponding to phase and ground currents, and bank voltage unbalance (enable in **General Settings**). The filter is intended, to avoid false tripping with considerable content on non-harmonic frequencies in these analog inputs. This filter is not applied to the bus and system voltage inputs (Sum of Va + Vb + Vc and V_{BUS}).

The standard Fourier filter (DFT) eliminates up to the 5th harmonic, but does not filter non-harmonic frequencies. High content of non-harmonic frequencies present in the analog inputs to the relay can be a source of relay missoperation. This type of signal is usually detected in the system currents, affecting also to the voltage unbalance when derived from the neutral current of the bank through a loading resistor.

6.2.1 Filter Characteristics

- Filter measures without error fundamental frequency signals, requiring 6 cycles to adapt 100% to changes in value (while DFT requires 1 cycle). The delay is independent of the amount of change and if increases or decreases.

In any case, timer setting ranges are NOT modified. Operation of the relay with the filters disabled is not modified from other models. Filter activation implies that trip times set under 100ms cannot be guaranteed with the same precision than without the filter (see Chapter 2, **Measuring and Response Accuracy**). When filters are enabled, timers set over 100ms (in those units with the filters) will be internally corrected during the initial 100ms. This correction guarantees operation in the time set ±5% or ±25ms

- There is a light “over-shoot”. After the real value is reached, an overshoot condition appears for 6 cycles. The overshoot value is 4.29%. Both the time and the amount of overshoot are constant, independent of the input.

The filter overshoot is relevant in low current or low voltage faults, usually cleared with long time delays. The overshoot will disappear during such long delays.
Short trip time delays may coincide with the overshoot conditions. It is assumed that short time delays are applicable for major faults with large current or voltage values, were the 4.49% overshoot is considered irrelevant.

6.2.2 Affected Protection Functions

All Phase and Ground Overcurrent elements, Voltage Unbalance elements, and current detectors of Breaker Failure Unit, are affected when the band pass filter is active. Other protection functions are still working with phasors calculated by DFT using non-filtered samples.

6.3 Phase and Ground Overcurrent Elements

8BCD-G Terminal Units provide Three-Phase and Ground Instantaneous and Time Overcurrent protection functions.

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. 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**

Additionally, the Time Overcurrent settings also consist of: **Curve** and **Time Dial**.

The Terminal Unit Trip Outputs have a momentary pickup characteristic and remain picked up for a minimum of 100 ms.

6.3.1 Instantaneous Overcurrent

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 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.

6.3.2 Time Overcurrent

The basic operation for an overcurrent element is shown in the block diagram of Figure 6.2. The circuit 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 programmable time curve can be selected. The user programmable curve is loaded into the Terminal Unit front RS232 port through the ZIVercom® communications program.

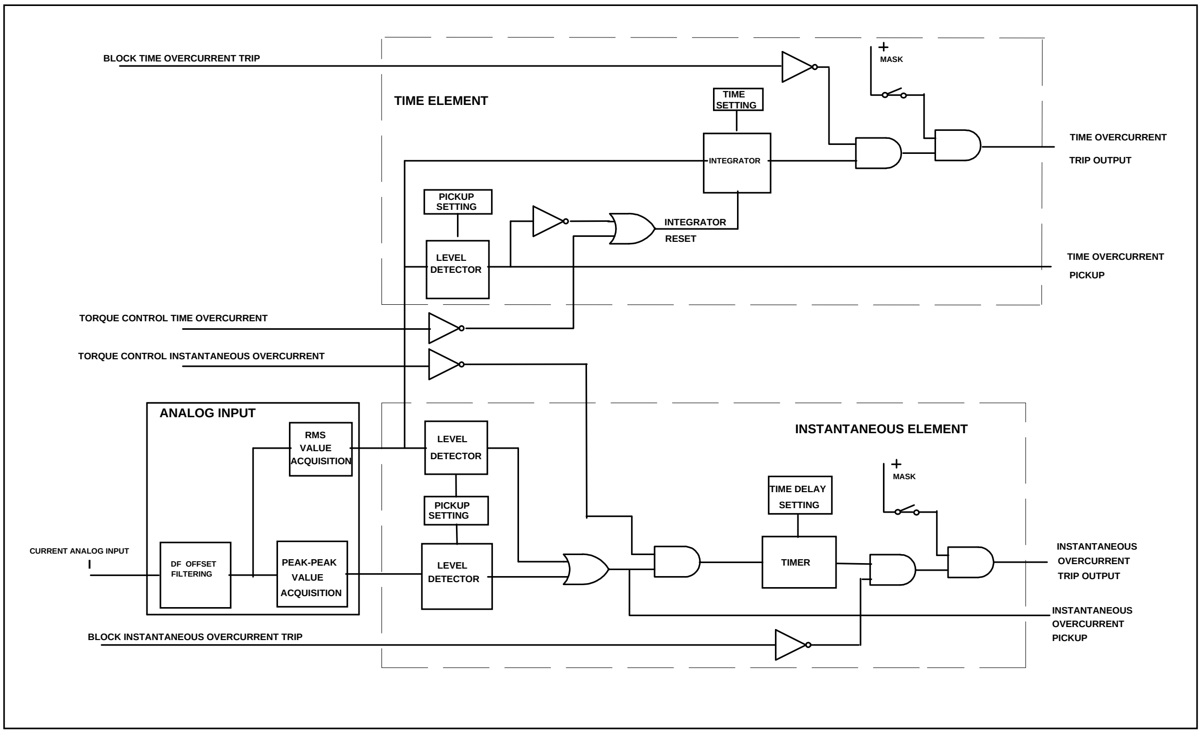


Figure 6.2: Phase and Ground Overcurrent Element Block Diagram

6.3.2.a Time/Current Characteristics

Figures 6.3, 6.4 and 6.5 show the pre-programmed time/current characteristic curves provided with the **8BCD** Terminal Unit.

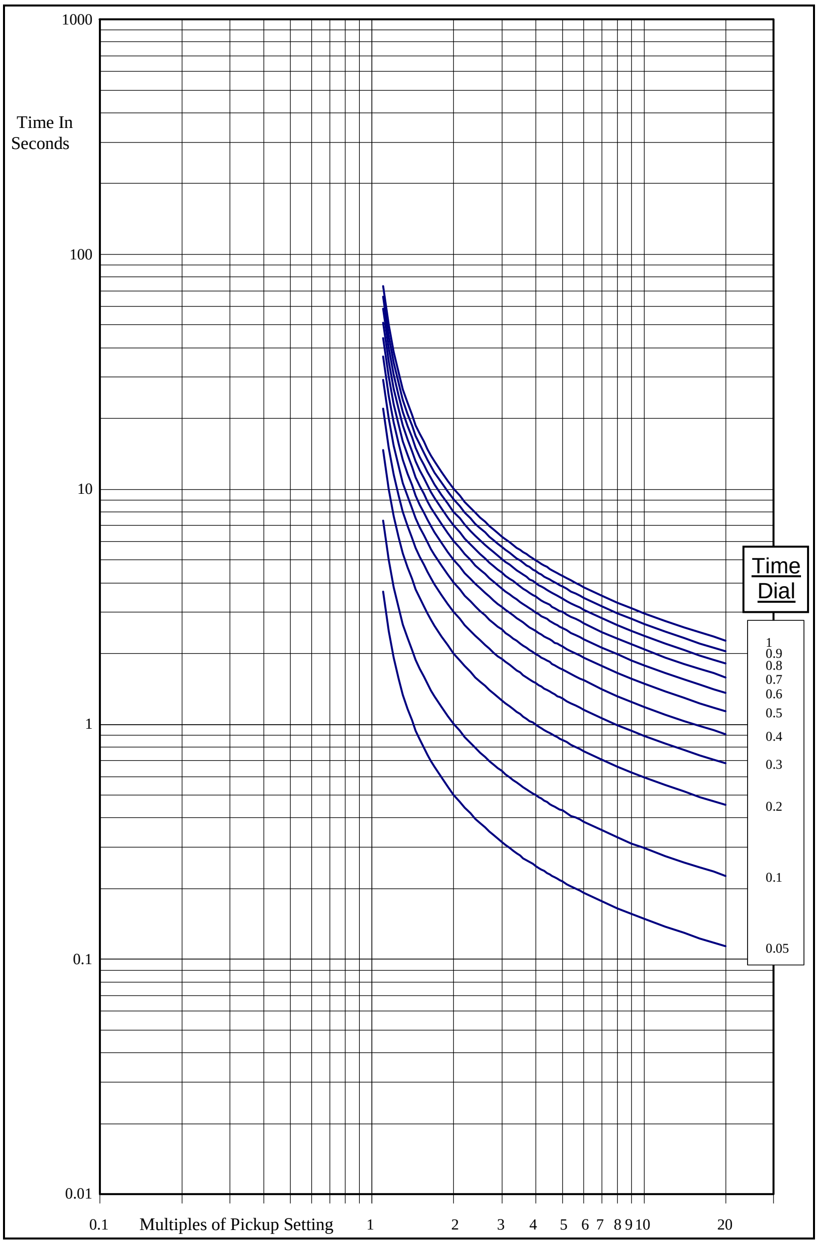


Figure 6.3: Inverse Time/Current Characteristic

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

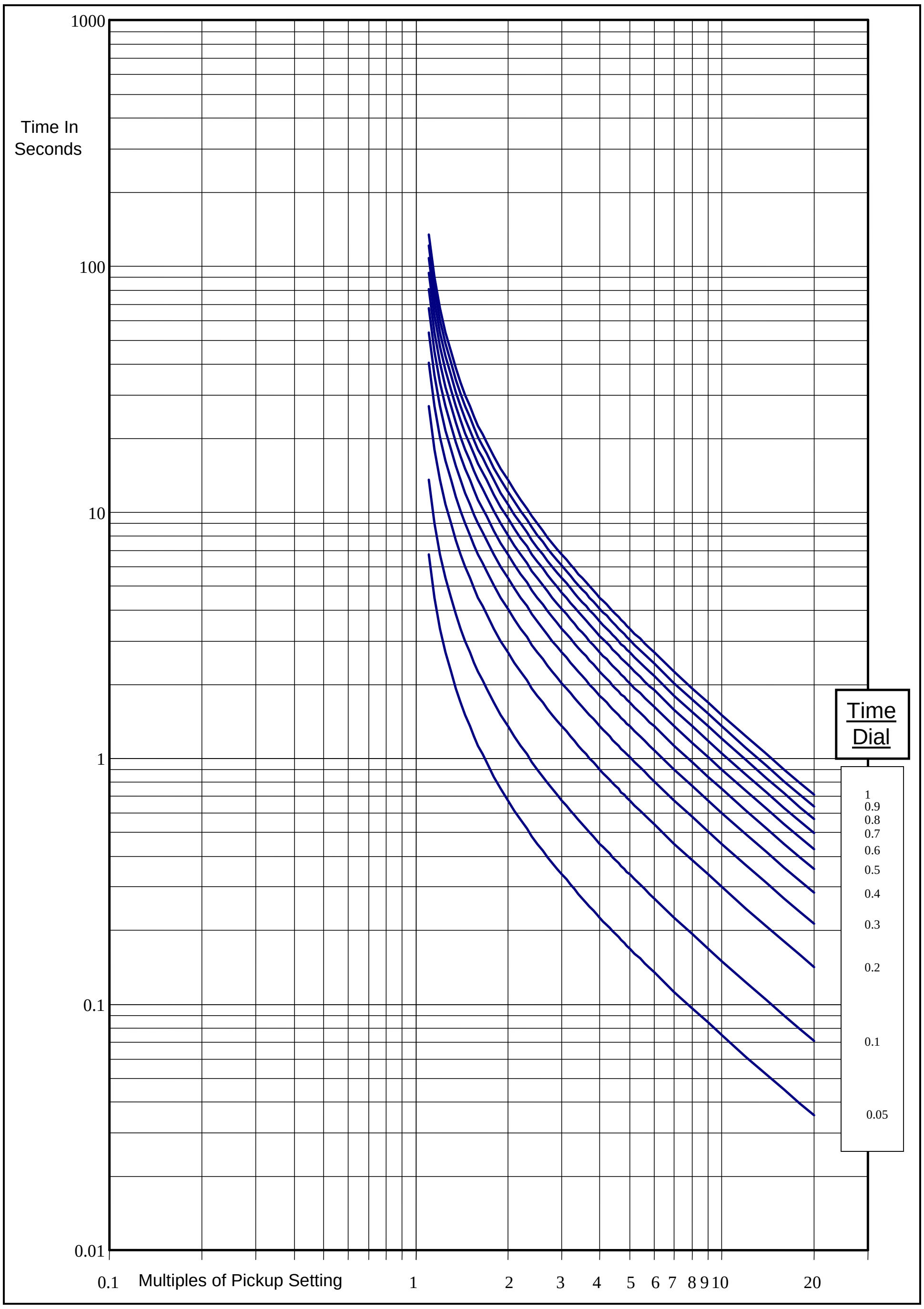


Figure 6.4: Very Inverse Time/Current Characteristic

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

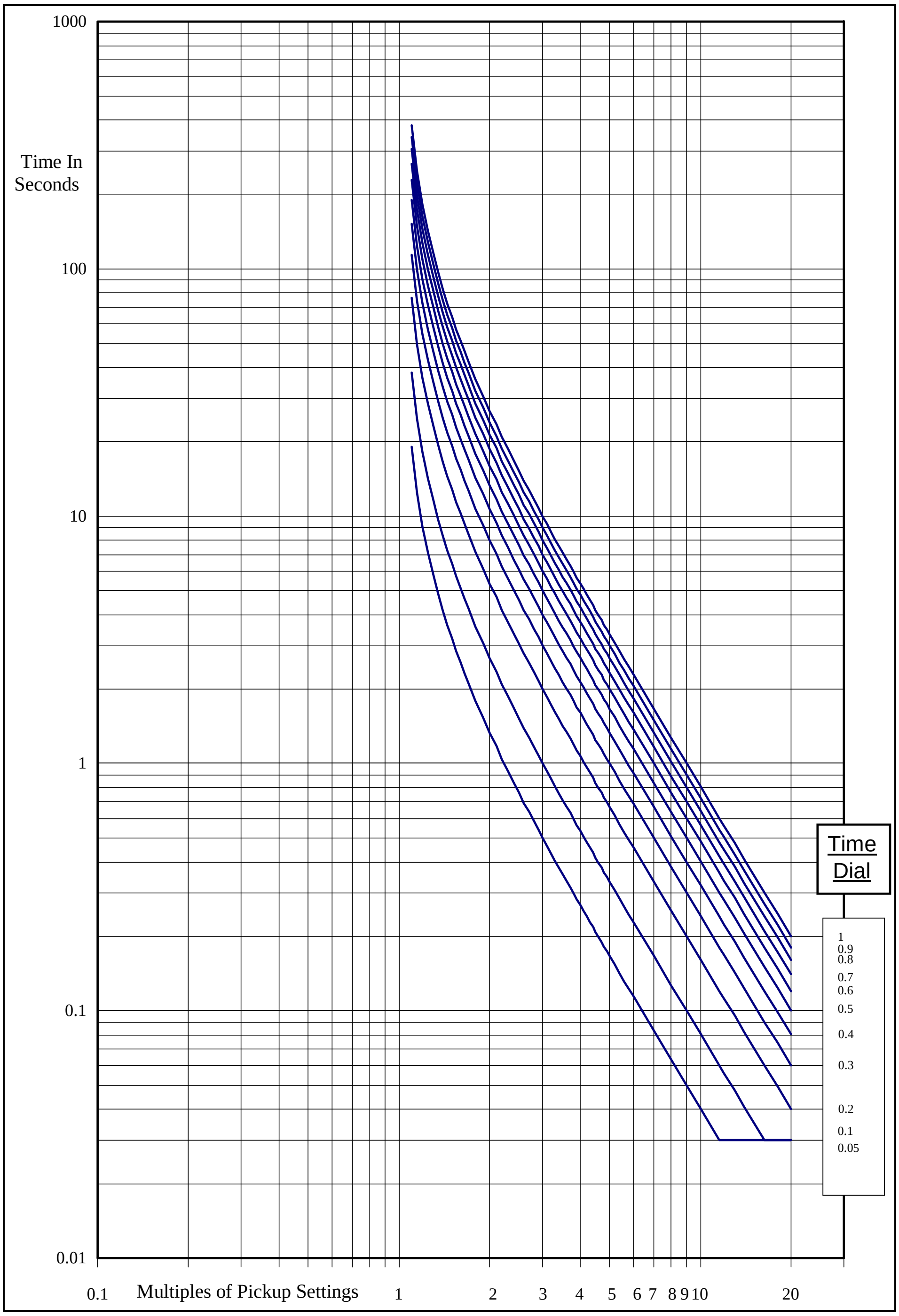


Figure 6.5: Extremely Inverse Time/Current Characteristic

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

6.3.3 Torque Control, Block Trip and Bypass Time

Both the Time and the Instantaneous Overcurrent elements have inputs referred to as **Torque Control**. When the Torque Control input for the Time Overcurrent element is energized, 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.

When the Torque Control input for the Instantaneous Overcurrent, 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 **Torque 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.

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. To use these Logic Input Signals, Status Contact Inputs must be programmed for this application.

6.4 Negative Sequence Overcurrent Elements

8BCD-J Terminal Units provide Negative Sequence Instantaneous and Time Overcurrent protection functions.

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. The following parameters are adjustable for each of the setting groups.

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

Additionally, the Time Overcurrent settings also consist of: **Curve** and **Time Dial**. Three inverse time curves (Inverse, Very Inverse and Extremely Inverse, the ones that are used for phase and ground overcurrent elements) can be selected for the Time element.

The Terminal Unit Trip Outputs remain picked up for a minimum of 100 ms.

The basic operation for those elements is shown in the block diagram of Figure 6.6. The circuit continuously processes the RMS value of calculated current analog input **I2** 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.

Both the Time and the Instantaneous elements have inputs for **Blocking** the element activation. Another input, **Bypass Time**, can modify the operation of the Time element. The explanation for the **Blocking** and **Bypass Time** functioning is the same as for the Phase and Ground Overcurrent.

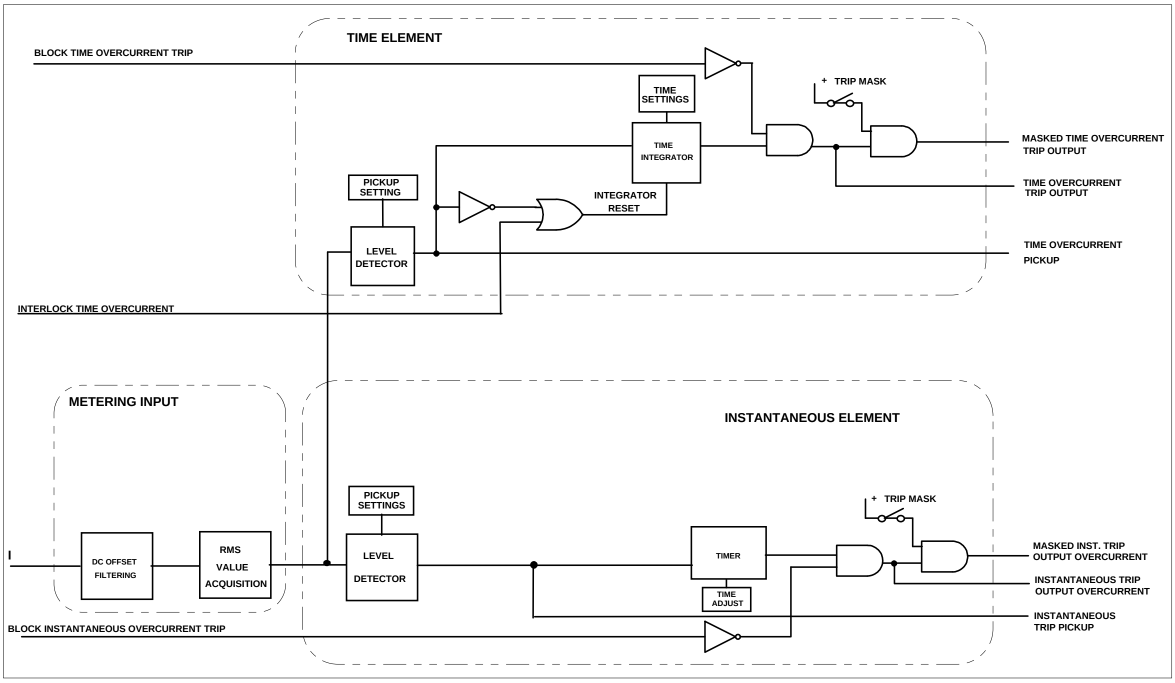


Figure 6.6: Negative Sequence Overcurrent Elements Block Diagram

6.5 Voltage Unbalance Element

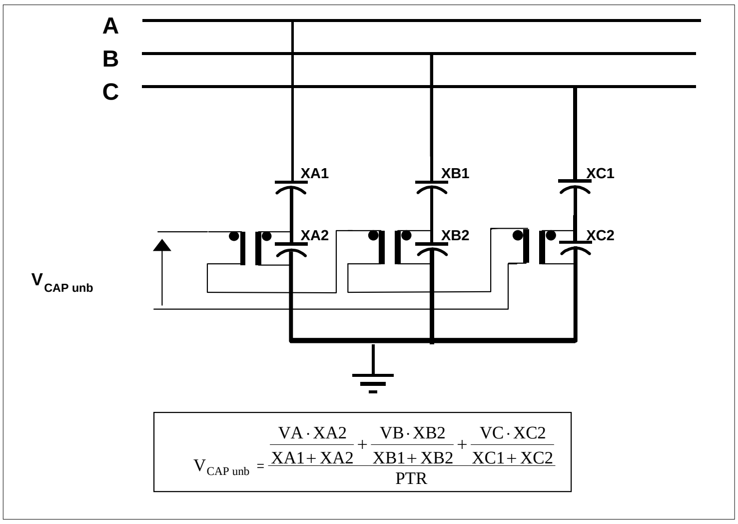
The Voltage Unbalance element included in the **8BCD** is suitable for protecting either grounded or ungrounded shunt capacitor banks. In all cases, the relay detects the per phase reactance unbalance generated when a capacitor unit fails. Depending upon the type of bank (grounded or ungrounded), the voltage/current system reacts to the failure in different ways, which should be taken into account when connecting the relay to assure that it will detect the failure. The purpose of the different connection methods described below is to convert the reactance unbalance into voltage measured by the Voltage Unbalance element of the **8BCD**.

In the case of a solid-grounded connection, the relay can be connected to the bank in two different ways, as shown in Figures 6.7 and 6.8.

6.5.1 Broken Delta Connection

In the connection shown in Figure 6.7, the **8BCD** is connected to the bank by using a set of three voltage transformers, with their secondary windings arranged as a broken delta and their primary

When both system voltage and capacitor bank are balanced, the phase current through the bank and the voltage drop across the lower sections of the capacitors (XA2, XB2 and XC2) will also be balanced, causing voltage capacitor unbalance $\mathbf{V_{CAPunb}}$ to be zero. If one capacitor unit fails in any phase, the reactance will no longer be balanced, causing an unbalance of phase currents and voltage drop. Since the $\mathbf{V_{CAPunb}}$ voltage is the summation of the latter, it will not be zero, allowing the detection of the unbalance by measuring its value.

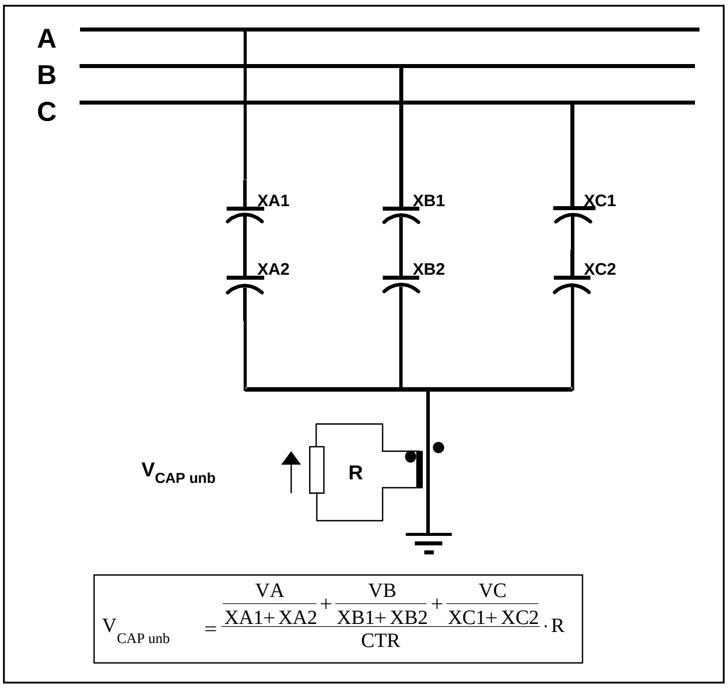


$$V_{CAP\ unb}=\frac{\frac{VA\cdot XA2}{XA1+XA2}+\frac{VB\cdot XB2}{XB1+XB2}+\frac{VC\cdot XC2}{XC1+XC2}}{PTR}$$

Figure 6.7: Grounded Capacitor Bank in Broken Delta

6.5.2 CT In Series With a Capacitor Bank Connection

In the case of Figure 6.8, the connection is through a current transformer connected in series in the ground path of the bank. A resistor in the CT secondary is used to convert the ground current to a voltage that can be measured by the Voltage Unbalance input of the **8BCD**. When both system voltage and capacitor bank are balanced, the phase currents through the bank will also be balanced, and no current will flow through the ground connection. If a capacitor unit fails in any phase, the current on that phase will change and the summation of currents at the common point will no longer be zero. The unbalanced current will flow through the ground path and be converted into a voltage by the CT and the resistor in its secondary. As measured by the **8BCD**, this voltage will be used to detect the unbalance condition.

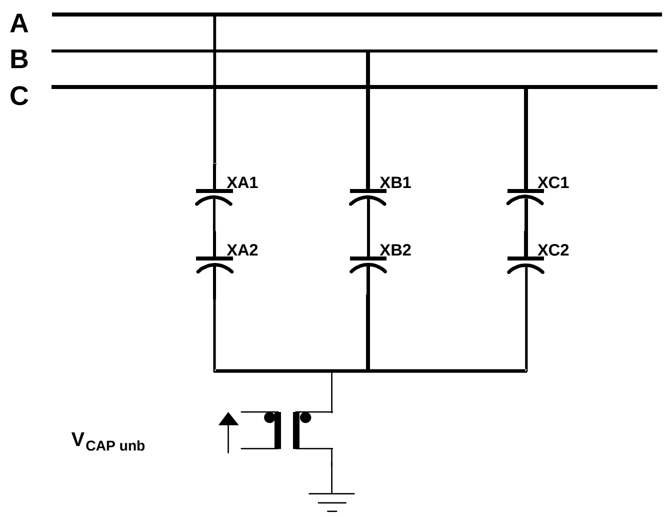


$$V_{CAP\ unb}=\frac{\frac{VA}{XA1+XA2}+\frac{VB}{XB1+XB2}+\frac{VC}{XC1+XC2}}{CTR}\cdot R$$

Figure 6.8: Current Transformer and Resistor Connected in Series with Grounded Capacitor Bank

6.5.3 Ungrounded Connection

The case of an ungrounded connection is shown in Figure 6.9. When both system voltage and capacitor bank are balanced, the voltage to ground at the capacitor bank common wye point will be zero. If a capacitor unit fails in any phase, as in the former cases, the reactance will not be balanced, causing the phase currents to be unbalanced. Since the summation of currents at the common wye point should continue to be zero, the voltages across the bank phases will be unbalanced and the voltage at the common wye point will be displaced from the ground voltage level. The voltage difference from this point to ground can be measured and used to detect the unbalanced condition.



$$V_{CAP\ unb} = \frac{1}{PTR} \cdot \frac{\frac{VA}{XA1+XA2} + \frac{VB}{XB1+XB2} + \frac{VC}{XC1+XC2}}{\frac{1}{XA1+XA2} + \frac{1}{XB1+XB2} + \frac{1}{XC1+XC2}}$$

Figure 6.9: Ungrounded Capacitor Bank

6.5.4 Compensation

A problem with all of these methods is that $\mathbf{V_{CAPunb}}$ will also be different from zero when the system voltage is unbalanced, even when the capacitor bank is healthy. One solution would be to set the Voltage Unbalance element Pickup high enough to avoid its operation due to the system unbalance. However, this would lead to a loss of sensitivity. To detect a capacitor bank failure when the system voltage is unbalanced, the voltage developed by the failure would have to be greater than that caused by the maximum system unbalance.

The **8BCD** incorporates a compensation method to overcome this problem. The Voltage Unbalance element has been developed in such a way that it subtracts the system voltage unbalance, and operates only with the unbalance generated by a capacitor bank failure. This method allows much lower Pickup settings; low enough to detect the failure of a single capacitor unit in most applications.

The design of the compensation function is shown in Figure 6.10 and 6.11. The voltage system unbalance (**V_{SYSunb}**) is obtained from the busbar line-to-neutral voltages and subtracted from the unbalance voltages measured in the capacitor bank (**V_{CAPunb}**). The result obtained it is the voltage unbalance used by the Voltage Unbalance Element (**V_{unbal}**) that only contains the unbalance due to a failed capacitor. Any inherent unbalance (V unb ERR) due to capacitor bank composition and instrument transformers is also nulled out for increased sensitivity. A description of the calibration of the V unb ERR value is found in section 6.5.5.

- **Standard Model**

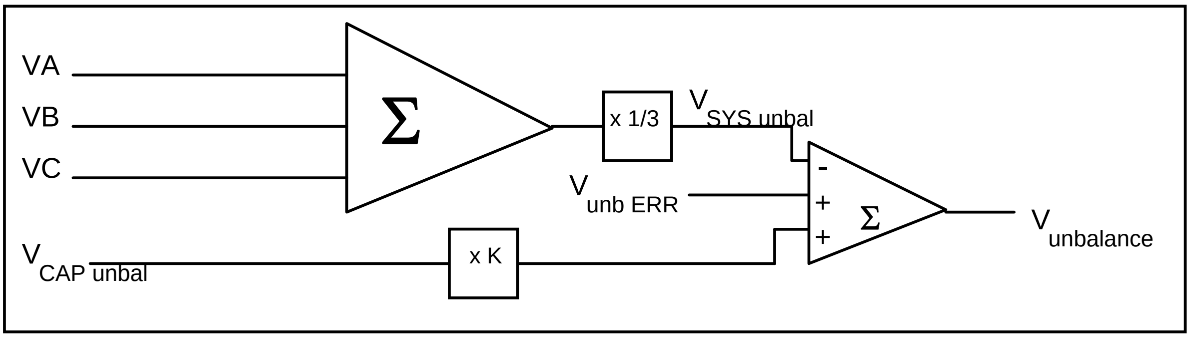


Figure 6.10: Voltage Unbalance Compensation Block Diagram (Standar Model)

- **Enhanced Model / 8BCD-J Model**

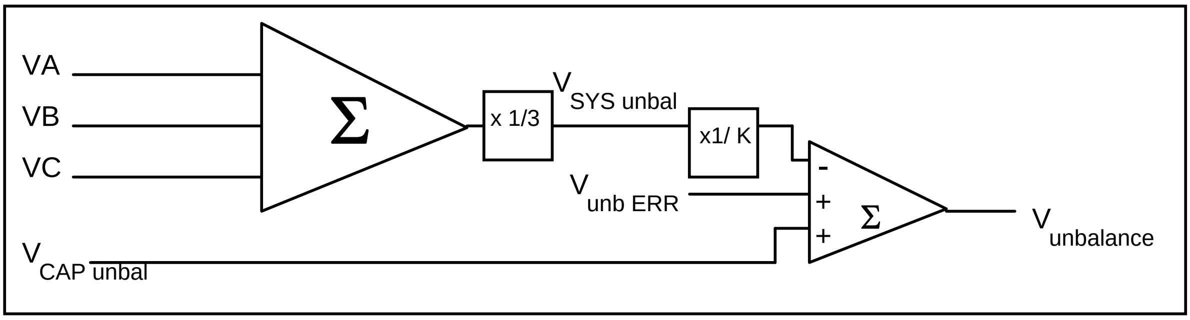


Figure 6.11: Voltage Unbalance Compensation Block Diagram (Enhanced Model)

The **K** factor is needed for scaling purposes to account for different phase and unbalance voltage transformer ratios. The values of **K** for different connection methods are shown in the following table.

Grounded Banks – Measurement Through Broken Delta Connection	$K = \dfrac{V_{unb}VT}{3 \cdot \dfrac{TM \cdot VT}{N\_RACK}}$
Grounded Banks – Measurement Through a CT and Resistor	$K = \dfrac{CT \cdot X_C}{3 \cdot VT \cdot R} \cdot \dfrac{N\_RACK}{U\_RACK}$
Ungrounded Banks	$K = \dfrac{V_{unb}VT}{VT}$

V_{unb}VT:	Voltage Unbalance Transformer Ratio
VT:	System Voltage Transformer Ratio
CT:	Current Transformer Ratio
TM:	Number of Racks from the Point of Insertion of Measurement Transformers to the Common Wye Point
N_RACK:	Number of Per Phase Capacitor Racks
U_RACK:	Number of Capacitor Units Per Rack
Xc:	Nominal Reactance Phase

Vbus channel connetion type

The V_{bus} input can be derived from a variety of connections depending on the PTs selected for the application. The nominal secondary value of this input should be within 110 – 115 V in order to assure proper operation of the overvoltage and undervoltage units as well at the automatic controller and associated functions. The response of the IED will differ slightly based on the derivation of this connection as this input is used as the “reference phasor.” To select the connection type, access the Vbus Phase Selection setting from the Configuration menu in the front panel HMI and choose one of the following options: VA(A), VB(B), VC(C), VAB(AB), VBC(BC) or VCA(CA).

6.5.5 Calibrating the Voltage Unbalance Element

To improve sensitivity, the unit has been designed to subtract, from the $\mathbf{V_{CAPunb}}$, all effects other than those that appear as a consequence of a bank failure. The capacitance tolerances of the bank and the transformer ratios are an additional source of unbalance. In order to compensate for these errors, it is necessary to calibrate the **8BCD** while it is connected to the bank. Once the relay is connected and conditions are normal with no errors, other than tolerances, a procedure in the **Calibration** menu will determine that any unbalance present is an error. To compensate, the **8BCD** will calculate an **Error** phasor to make $\mathbf{V_{unbal}}$ equal to zero.

By exiting the **Calibration** menu and confirming the calibration process, the calculated value is saved in non volatile memory. From this point on, any deviation of $\mathbf{V_{unbal}}$ from zero will be considered to be caused by capacitor bank failures.

There is another important point to be considered when the unbalance condition is detected by a CT connected in the ground path. The current that flows through the ground path is capacitive and hence it leads the system unbalance voltage by 90º. Since the **8BCD** will subtract the system unbalance voltage from $\mathbf{V_{CAPunb}}$, a setting is necessary to compensate for this effect. When the CT + R Connection setting is set to YES, the angle of $\mathbf{V_{CAPunb}}$ will be retarded by 90° so that it is in phase with the system unbalance voltage.

In Chapter 8, Receiving Tests, the steps to calibrate and commission the **8BCD** will be described in detail.

6.5.6 Voltage Unbalance Element Operation

The **8BCD** has three independent unbalance elements that are connected to the $\mathbf{V_{unbal}}$ input. These are designed to be used for different capacitor bank alarm and trip levels.

The level detector operates whenever the measured value exceeds the Pickup setting and will reset whenever that value is below 0.95 times the Pickup setting. A trip or alarm is permitted if the unbalance condition is detected for a preset period of time.

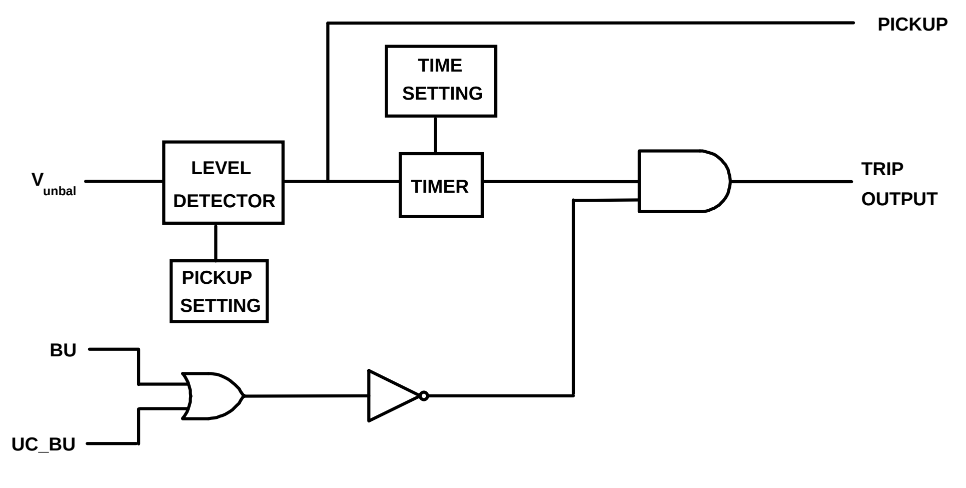
The following parameters are adjustable for each of the three Voltage Unbalance elements (Level 1, 2 and 3) for each setting group **Enable**, **Pickup** and **Time Delay**.

The following parameters are also adjustable and are common to all the Voltage Unbalance elements: **K** (**Scaling Factor**) and **CT** + **R Connection**.

The Voltage Unbalance Element will only operate when the bus voltage (terminal G1-G2) is synchronized and is above 10Vac to indicate that the bus is connected and in operation.

- **Standard Model**

The output of the Voltage Unbalance element can be blocked by the assertion of either of two logic input signals. Logic input signals BU or UC_BU are used to detect an open breaker in order to block the output of the Voltage Unbalance element during induced voltage conditions that can occur while a capacitor bank is switched out of service. BU is asserted by mapping the signal(s) "Block Voltage Unbalance Trip Level 1(2,3)" to the same input that the Open Breaker Status is hardwired to. UC_BU is asserted as a function of undercurrent (see section 6.2.7).



BU: Block Voltage Unbalance Trip Level 1 (2 or 3) Input Contact
UC_BU: Undercurrent Block Voltage Unbalance Element

Figure 6.12: Voltage Unbalance Unit Block Diagram (Standard Model)

- **Enhanced Model**

The output of the Voltage Unbalance element can be blocked by the assertion of different signals: Logic input signals BU or UC_BU are used to detect an open breaker in order to block the output of the Voltage Unbalance element during induced voltage conditions that can occur while a capacitor bank is switched out of service. BU is asserted by mapping the signal(s) "Block Voltage Unbalance Trip Level 1(2, 3)" to the same input that the Open Breaker Status is hardwired to. UC_BU is asserted as a function of undercurrent (see section 6.2.7).

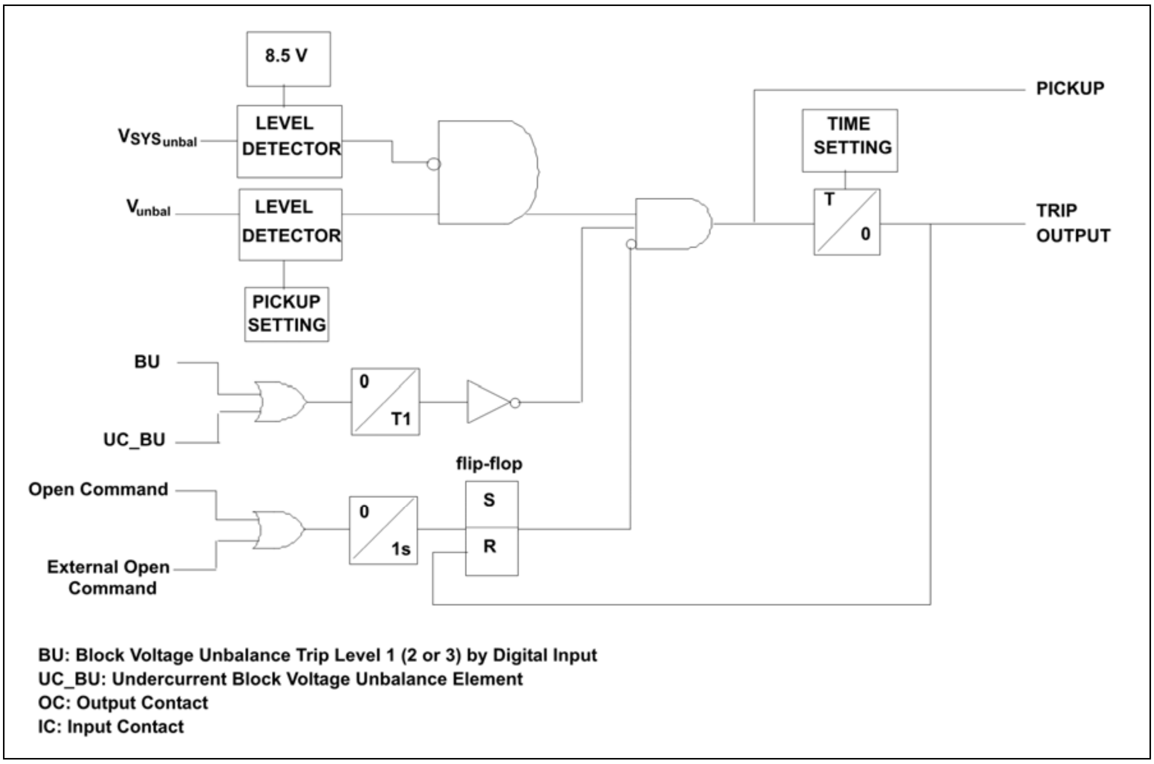


Figure 6.13: Voltage Unbalance Unit Block Diagram (Enhanced Model)

A dropout timer, T1, is used to assert the BU and/or UC_BU signals for a specified time after the signal(s) are deactivated. Setting the timer to 0 implies that the dropout timer is disabled. Additionally, the dropout timer can be used even if the Undercurrent Blocking Element is disabled for installations without CTs. This is designed to prevent nuisance tripping during routine closing.

When the **Open Command** or **External Open Command** signals are received, a 1 second pulse is sent to block the voltage unbalance tripping. This is designed to prevent nuisance tripping during routine opening. It’s recommended to enable Trip Output Seal-In function to maintain the trip command until the breaker has opened as indicated by the auxiliary contact (52b is the default), which monitors breaker position. If seal-in is not enabled the trip command will remain active for 100 ms.

- **8BCD-J Model**

The **8BCD-J** model utilizes the same blocking unit as described above and depicted in Figures 6.14 and 6.15. However, the **8BCD-J** model has one additional function not included in the **8BCD-G** enhanced model. Figure 6.15 depicts the block diagram with the additional logic that allows a user to program *latched* voltage unbalance outputs (output signals 21 – 23). The ability to latch a voltage unbalance output ensures a steady alarm signal regardless of the state of the capacitor bank interrupting device. The latched output(s) can be reset from via front panel HMI or communications.

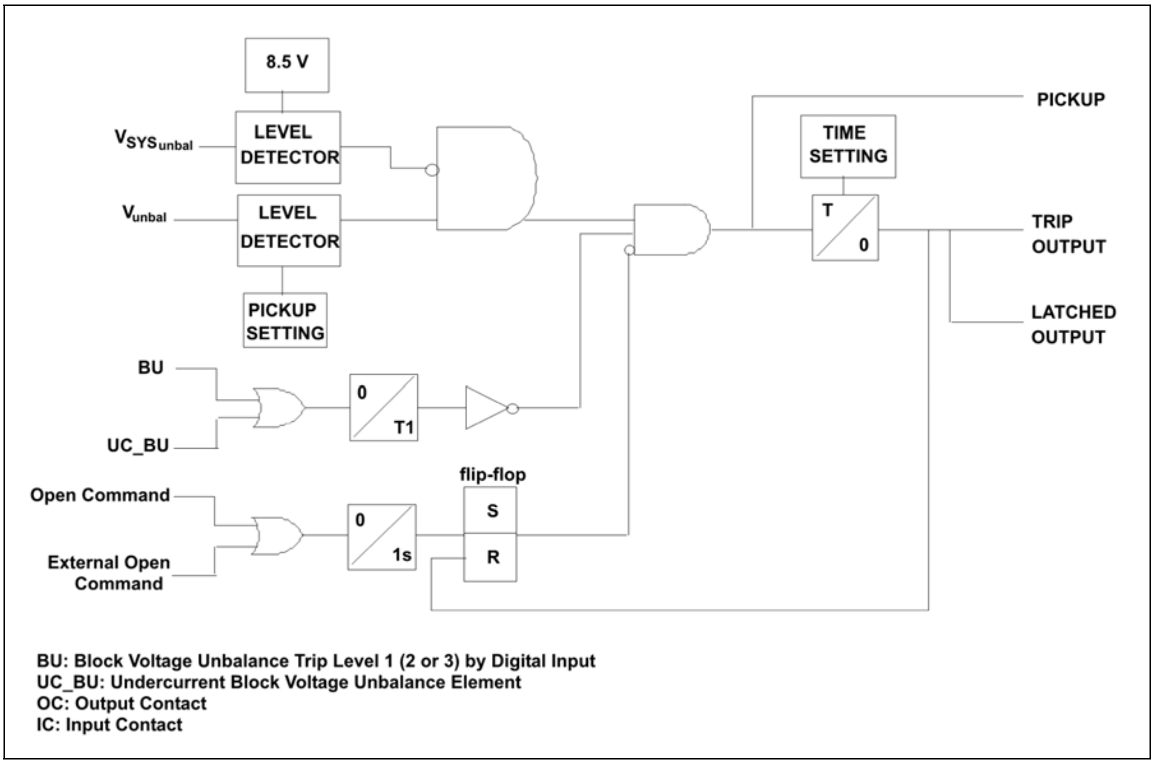


Figure 6.14: Voltage Unbalance Unit Block Diagram (8BCD-J Model)

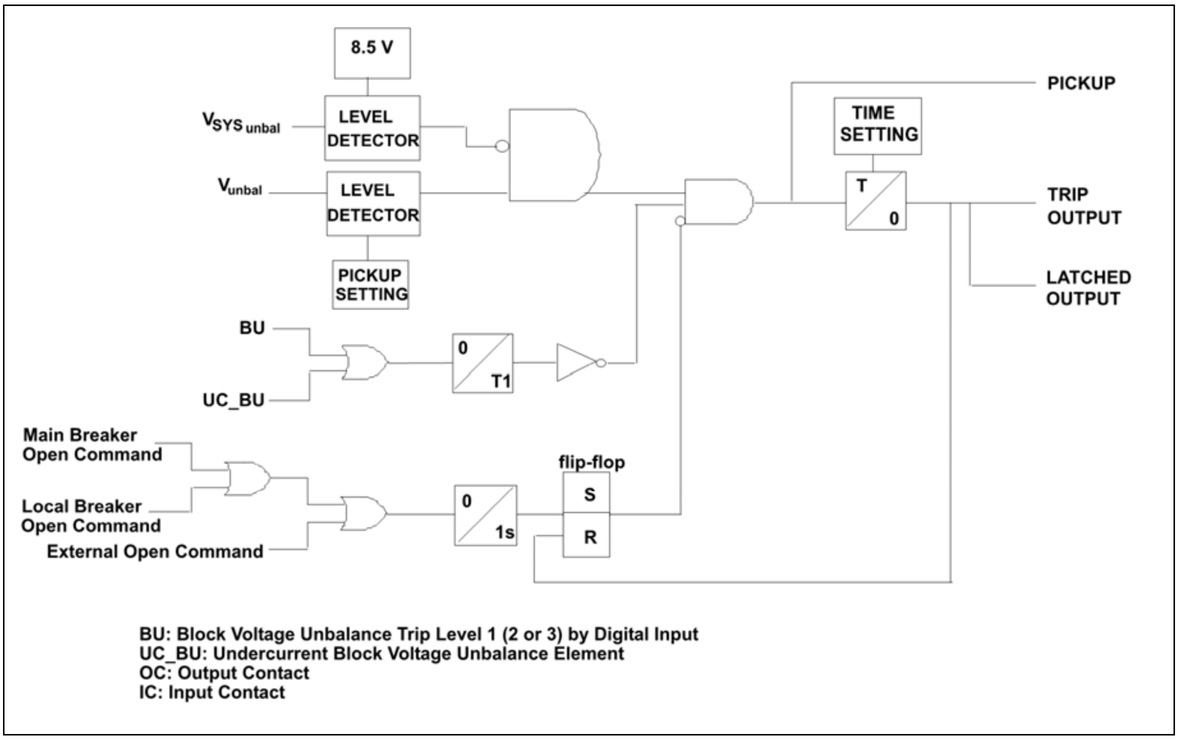


Figure 6.15: Voltage Unbalance Unit Block Diagram (8BCD-J) (400) Model)

6.5.7 Undercurrent Block Voltage Unbalance Element

The **8BCD** incorporates an Undercurrent element that can block the operation of the Voltage Unbalance element when there is not enough current flowing into the capacitor bank. The following parameters are adjustable for this function: **Enable** and **Pickup**.

Figure 6.16 shows the blocking of the Voltage Unbalance Trip caused by undercurrent. The output is activated when the current in any of the three phases is lower than the Pickup setting. The level detector operates whenever the measured value exceeds the pickup setting and it will reset whenever that value is below 0.95 times the pickup level.

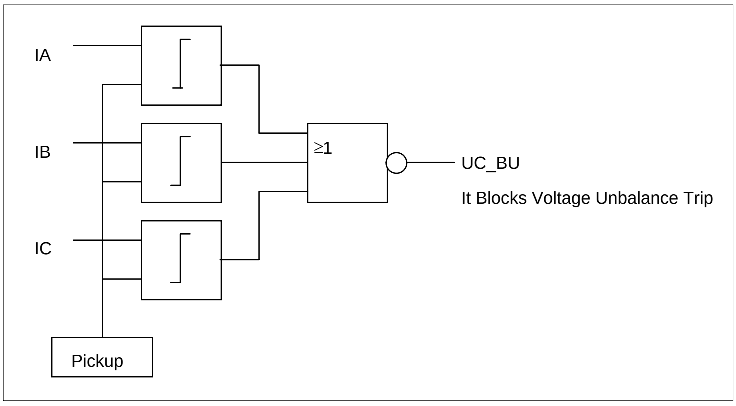


Figure 6.16: Undercurrent Block Voltage Unbalance Element Block Diagram

6.6 Overvoltage Elements

Each Overvoltage protection unit consists of an Instantaneous and a Time Overvoltage measuring element. The Instantaneous element is also equipped with an adjustable timer that can be enabled or disabled. The following parameters are adjustable for each of the setting groups **Enable**, **Pickup** and **Definite Time**.

Additionally, the Time Overvoltage element setting also consists of: **Curve** and **Time Dial**.

6.6.1 Time Overvoltage

The basic operation of the Overvoltage element is shown in the block diagram of Figure 6.16. The circuit processes the RMS input voltage V_{BUS} (bus voltage value). Pickup takes place when the measured value exceeds the reference setting value and it will reset whenever that value is below 0.95 times the pickup level.

The time element integrates a measured value above Pickup by incrementing a counter in the Integrator module using an amount proportional to the input voltage value. When the counter reaches the operate threshold, the Time Overvoltage element initiates a trip. When the measured value drops below the Pickup setting, the incrementing value is removed from the Integrator module in less than 10 ms. The measured value must remain above Pickup during the entire integration interval to produce a trip output. If the measured value drops below the Pickup setting, the Integrator module is reset to its initial condition with the counter at zero. This causes any new measured value above Pickup to start the integration interval from zero.

The curve can be selected as: **Definite Time**, **User Programmable Time** and **Normal** (Capacitor Bank Specific). The user programmable characteristic and Capacitor Bank Specific curves are loaded into the Terminal Unit front RS232 port via the ZIVercom communications program.

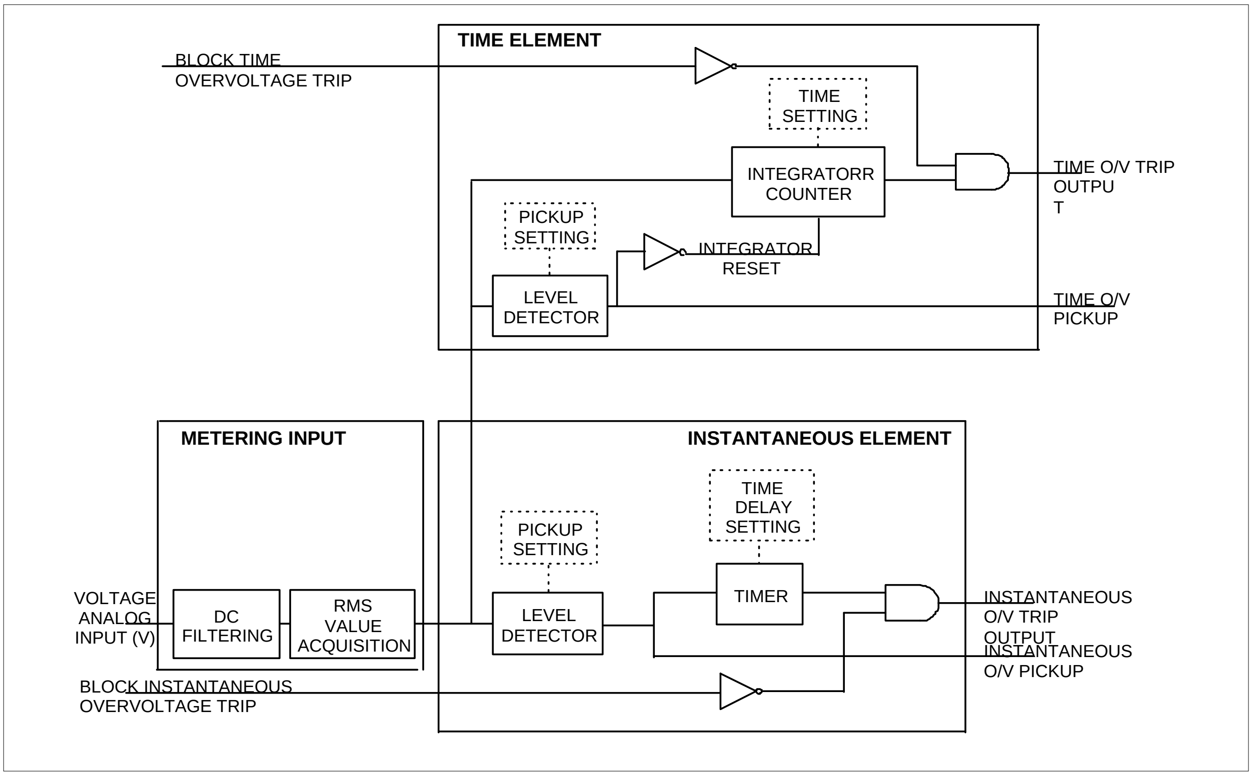


Figure 6.17: Overvoltage Element Block Diagram

6.6.1.a Time/Voltage Characteristic

Figure 6.18 shows the pre-programmed normal time/voltage characteristic curve provided with the **8BCD** Terminal Unit.

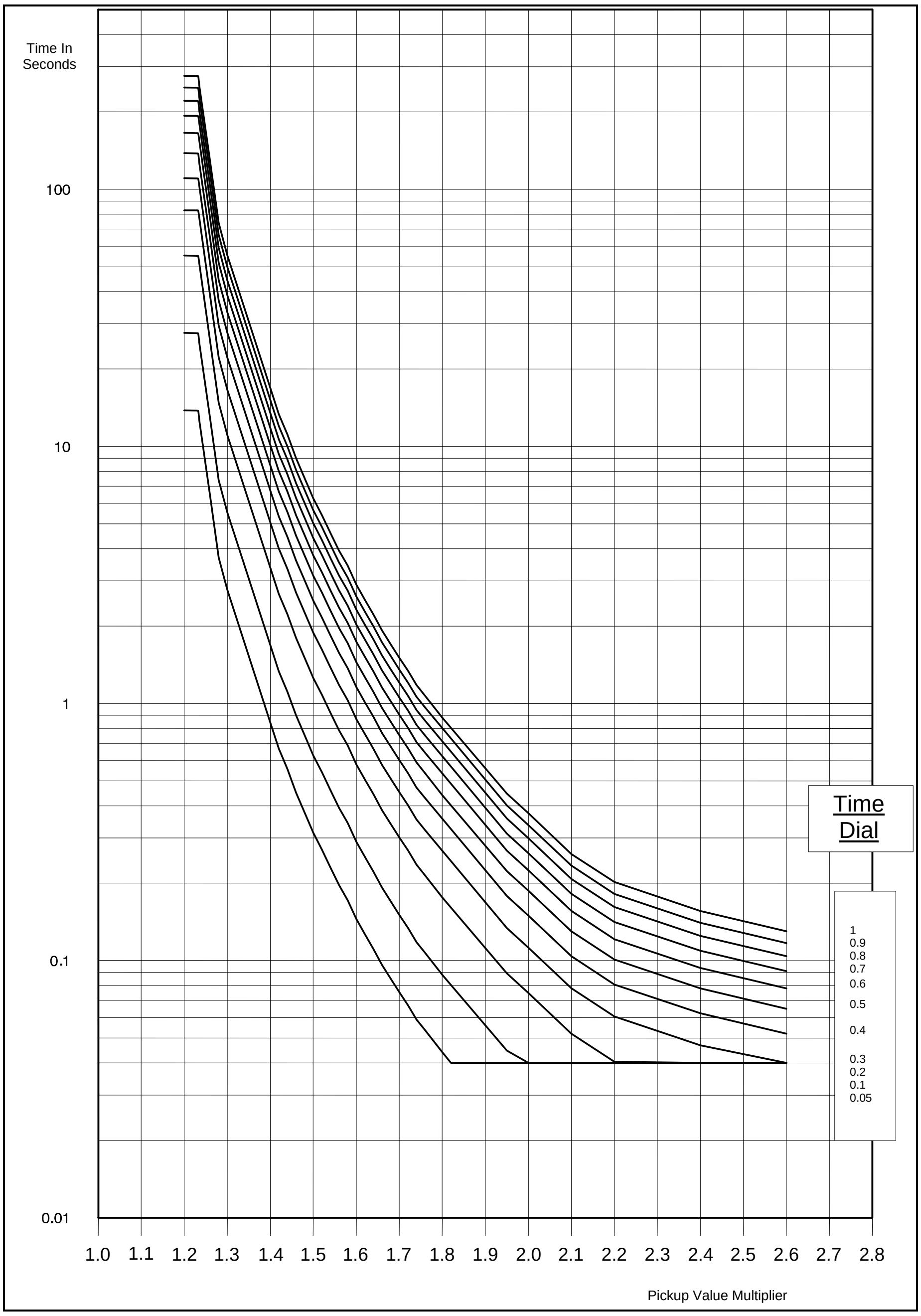


Figure 6.18: Normal Time/Voltage Characteristic

6.6.2 Instantaneous Overvoltage

As in the Time Overvoltage element, the Instantaneous Overvoltage circuit processes the RMS input value, and Pickup takes place when the measured value exceeds the reference setting value. The element is reset when measured value falls to 95% of the Pickup level.

6.7 Instantaneous Undervoltage Elements

The Undervoltage element works like the Instantaneous Overvoltage element. In this case, pickup takes place when the measured value falls below the reference setting value and it will reset whenever that value exceeds 105% of the Pickup level.

6.8 Operation Inhibit

The Automatic Connection Control will activate the Operation Inhibit signal whenever a breaker (main or local) opens, only if the other breaker is not open yet, which will prohibit any manual operations from the IED Numeric Keypad until the Operation inhibit Time expires.

6.9 Automatic Connection Control

Automatic Connection Control aims at opening and closing the capacitor bank breaker as a function of the measured value and time. In the **Automatic** mode, two different control methods are available to achieve this objective:

by Time Clock or
by Reactive Power flowing into the bus to which the capacitor bank is connected

The **Configuration**: **Operation Enable** menu allows the user to select between **Manual** and **Automatic** operation. The user can select between the two control methods by selecting options in the **Change Settings**: **Automatic Control** menu. (See Chapter 7 for further details.)

Note: if the Automatic Connection Control function is in Automatic mode and the In Service selection is set to No, the Terminal Unit will switch to Manual mode (see Chapter 7, Change Settings: General)

6.9.1 By Time Clock

Two different schedules can be set for this function: **weekdays** and **weekends**. A **Connect Time** setting and a **Disconnect Time** setting can be set for each schedule.

When the Saturday setting is set to YES it will be considered part of the weekend, otherwise it will be considered a weekday.

Three voltage settings are also available: $\mathbf{V_{add}}$, $\mathbf{V_{remove}}$ and $\mathbf{V_{off}}$; each with a time delay setting. The Connect/Disconnect commands are executed considering these three voltage settings and the bus voltage value. The interaction between the Connect/Disconnect Time settings and the voltage settings is represented in Figure 6.19.

Grid Area: When the bus voltage value is in this area, and the time is within the Disconnect Time setting, the Automatic Connection Control will send an Open Command signal to open the capacitor bank.

When the bus voltage value is in this area, and the time is within the Connect Time setting, the Automatic Connection Control will send a Close Command signal to add capacitance.

Shaded Area: Whenever the bus voltage is above the $\mathbf{V_{remove}}$ setting or below the $\mathbf{V_{off}}$ setting for the length of time set by their respective time delays, the Automatic Connection Control function sends an Open Command to remove the capacitor bank, regardless of the Connect/ Disconnect Time settings.

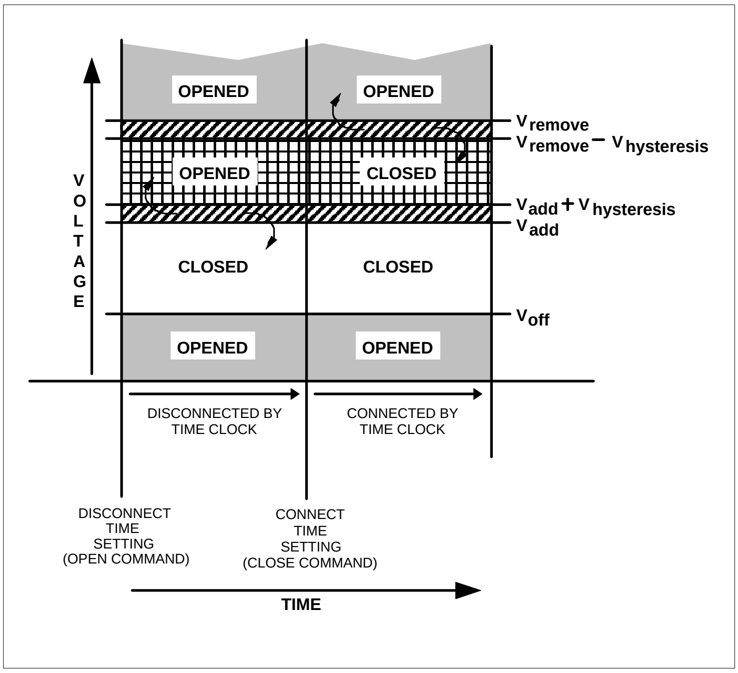


Figure 6.19: Automatic Connection Control Graphical Description

Note: Below the V_{off} setting, the Open Command will be sent both in the Manual and Automatic modes (whenever the In Service selection is set to YES)

White Area: When the voltage value is between the $\mathbf{V_{off}}$ and $\mathbf{V_{add}}$ setting, the Automatic Connection Control function sends a Close Command signal to close the breaker, regardless of the Connect/Disconnect Time settings, after the $\mathbf{V_{add}}$ Time Delay has timed out.

Slashed Area: The purpose of the $\mathbf{V_{hysteresis}}$ setting is to prevent the capacitor bank from entering a repetitive open-close sequencing. The setting value must be greater than the maximum step change in bus voltage that occurs when the capacitor bank is either switched ON or OFF. Assume, for example, the capacitor bank is switched off by the time clock. If the system voltage level drops below $\mathbf{V_{add}}$, the capacitor bank will be switched back on to the system. The resulting increase in voltage level must be less than the $\mathbf{V_{hysteresis}}$ setting to prevent the bank from being deenergized again. A similar situation occurs when the capacitor bank is energized and the system voltage exceeds the Vremove setting.

The Automatic Connection Control is dependent on the “Current” day, hour and minute data which is checked every 5 ms;

- The algorithm analyzes the type of day (determines the day of the week from Sunday to Saturday).
- Then verifies whether connection and disconnection periods are enabled for that day. If disabled, no operation is done if voltage is between V_{REMOVE} and V_{ADD}. If enabled, the Automatic Control operates according to Connect Time settings or Disconnect Time settings.
- Note that “minute” is the unit which determines when a time period finishes. If disconnection time starts at 24:00, at 23:59 the Automatic Control is still in connection time. If set at 23:59, the Automatic Control is in connection time until 23:58.995, and at 23:59.000 is in disconnection time.

Note that if a connection or disconnection operation timer is running and the Automatic Control enters in a time period not set, the timer will stop and no operation will be executed.

6.9.2 By Reactive Power Flow

8BCD terminals include an analog input for direct current measurement. This input can be connected to a metering transducer output that provides the value of the reactive power flowing through the transformer(s) in the ±1 mA range (depending on the model). This input can be adjusted by the Transducer full scale setting (available through the **Configuration** menu). The full scale value defines the conversion scale from mA to reactive power.

Automatic Connection Control by Reactive Power will send a Close Command when the measured reactive power exceeds the **Connection Threshold** setting; and will send an Open Command when the power level is below the value of the **Disconnection Threshold** setting. For power measurement values between these settings, the Automatic Connection Control will not send any order.

As in the case of Automatic Connection Control by time clock, an Open Command will be sent in both **Automatic** and **Manual** modes (whenever the **In Service** selection is set to **YES**) if the measured voltage is below the $\mathbf{V_{off}}$ setting, regardless of the reactive power settings.

6.9.3 Open Command Due to Lack of Voltage

As stated previously, the Automatic Connection Control function will send an Open Command in both **Automatic** and **Manual** modes (whenever the **In Service** selection is set to **YES**) if the voltage drops below the $\mathbf{V_{off}}$ setting for the time set on the $\mathbf{V_{off}}$ **Time Delay** setting, regardless of the reactive power or time clock Connection/Disconnection settings.

6.9.4 Lockout Due to Trip

When a trip is performed (for any of both breakers, main or local) by any of the overcurrent elements or by any of the voltage unbalance elements, the Automatic Connection Control function will switch to the “Block Due to Protection Trip” (blocktrip) status. In this case, no operation command will be sent, and the Automatic Connection Control function will switch to the **Blocktrip** mode. This situation will remain until a Reset command from the Terminal Unit keypad is executed (refer to Chapter 7 for this procedure) or by the Automatic Connection Control Reset logic input signal (to use this logic input signal, a status contact input must be programmed for this application). After this Reset, the Automatic Connection Control will switch to the **Manual** mode.

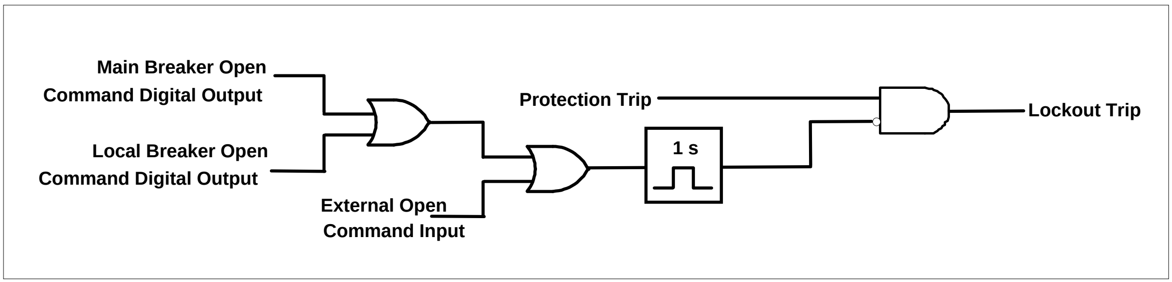


Figure 6.20: Lockout Due to Trip Diagram

6.9.5 Operation Command Failure

The **8BCD** verifies the correct fulfillment of the Operation commands by means of one of the status contact inputs connected to one of the auxiliary contacts (52b is the default) of the capacitor bank breaker. If any of the commands sent were not successfully performed, the Operation Command Failure signal will be recognized and the Automatic Connection Control will switch to **Manual** (if it was in **Automatic**).

6.9.6 Models with Two Sets of Trip and Close Contacts (model 400)

For models with two sets of trip and close contacts (model 400), the automatic control function only actuates the **local** set of trip and close contacts. The **main** breaker trip and close contacts are not affected by any command generated from the Automatic Control logic.

6.10 Loss of Potential Detection

This function distinguishes between a loss of voltage due to failure of the voltage transformer providing the bus reference voltage to the **8BCD** and other causes for loss of voltage, such as occurs when opening the breaker that is feeding the bus where the capacitor bank is connected.

The **8BCD** monitors the VT secondary circuit, and disables the Undervoltage protection trip in the event that a VT fuses blows. This element operates based on an algorithm whose inputs are current and voltage magnitudes as shown in Figure 6.21.

The parameters adjustable for this function are: **Enable**, **Minimum Current** and **Time Delay**.

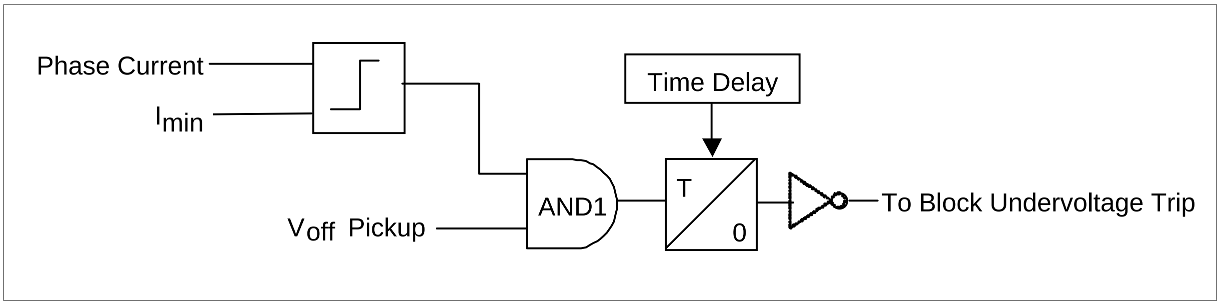


Figure 6.21: Loss of Voltage Detection Block Diagram

The Automatic Connection Control must be **In Service** to enable the loss of potential detection.

Let us suppose the **8BCD** loses voltage because there is a problem in the secondary circuit of the voltage transformer. Under this circumstance:

- The voltage decays instantaneously
- The phase current continues flowing into the capacitor bank

The current detector output (logic 1) does not change state. The V_{off} Pickup will become a logic 1, activating the timer. After Time Delay T, the output of the loss of Voltage element will change state, blocking the Instantaneous Undervoltage element (27 Inst), used for protection, and the V_{off} function used for control.

If the voltage is lost due to opening of the breaker that feeds the bus where the capacitor bank is connected, both the current and voltage measured by the relay will decay slowly. Normally the V_{off} function picks up before the Loss of Voltage Detection (I_{min}) function does Taking this into account, the settings (Pickup and Time Delay) should be selected in such a way that:

- The Loss of Potential Detection Time Delay is less than the Time Delay settings of either the V_{off} function setting or the Instantaneous Undervoltage (27 Inst) element setting.
- The Loss of Potential Detection Time Delay is greater than the time difference between the loss of Voltage detection and the loss of current detection by the I_{min} function.

Figure 6.22 shows the change in bus voltage and capacitor bank current when the bus and capacitor bank are de-energized. In this Figure, the Loss of Voltage Detection Time Delay is set for 500 msec, and the V_{off} Time Delay is set for 1000 ms.

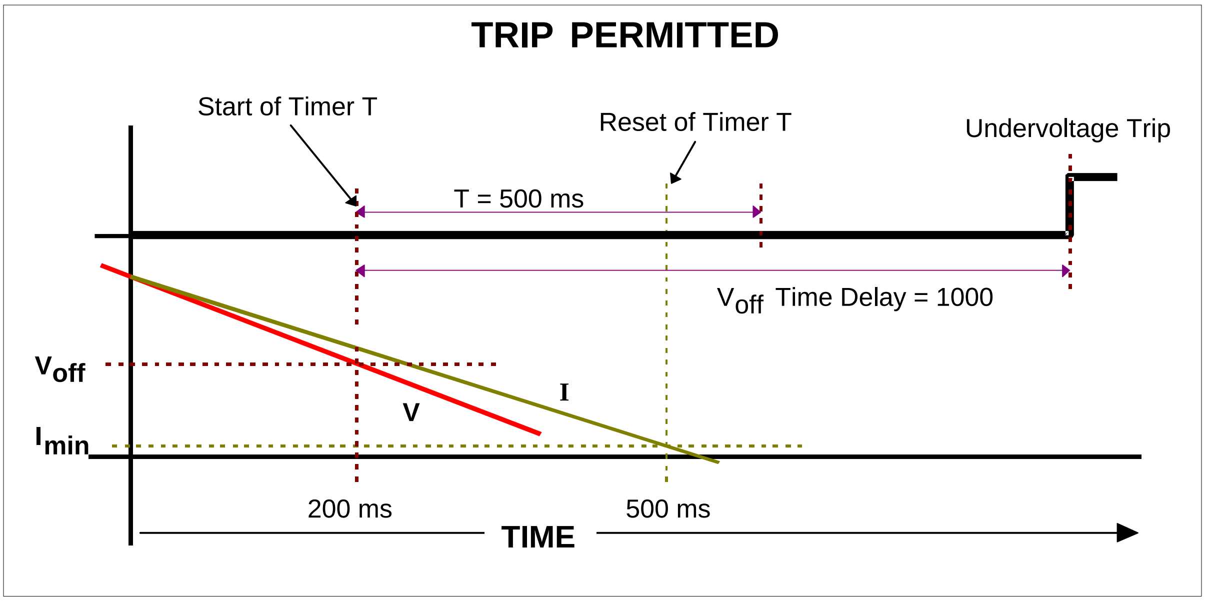


Figure 6.22: Graphical Representation of the Loss of Potential Detection Function

6.11 Breaker Failure

The breaker failure function is designed to detect the failure of a circuit breaker's response to trip commands from protection elements. This function also generates a signal that could be used to trip adjacent breakers capable of isolating the fault.

The operation of this function is shown in the block diagram of Figure 6.23. 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. 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 unit's 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.

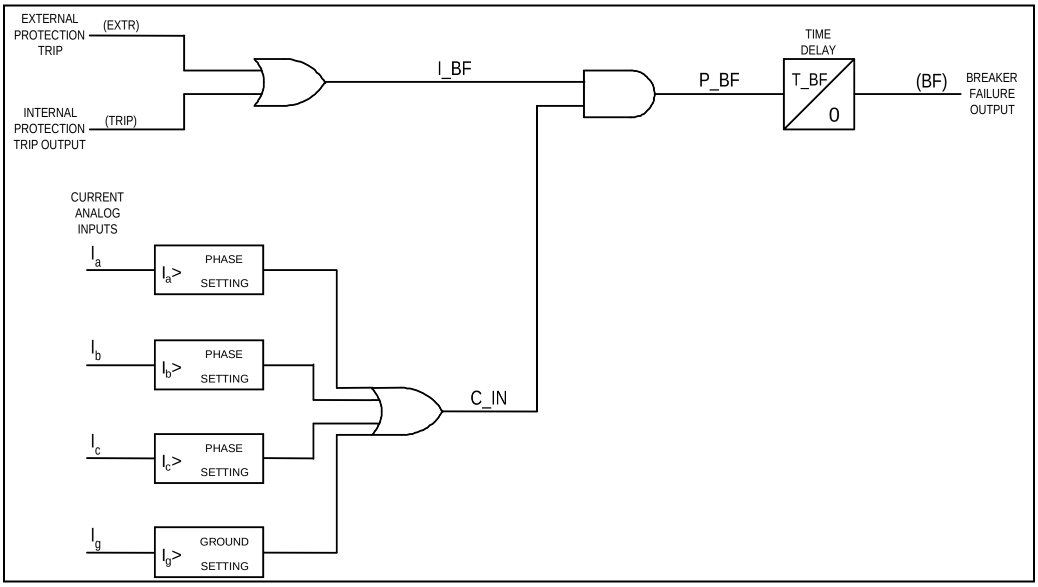


Figure 6.23: Breaker Failure Element Block Diagram

6.12 Trip Elements (Masks)

Protection trip signals are generated by any of the 10 protection elements included in the IED. The user can select which of these trip signals will activate the trip contacts of the Terminal Unit. Trip Element selection is controlled by settings (YES/NO) for the following elements:

Phase Instantaneous Overcurrent	**Instantaneous Overvoltage**
Phase Time Overcurrent	**Undervoltage**
Ground Instantaneous Overcurrent	**Voltage Unbalance Level 1**
Ground Time Overcurrent	**Voltage Unbalance Level 2**
Time Overvoltage	**Voltage Unbalance Level 3**

A specific protection element will be able to produce an Internal Protection Trip Output when both the Protection Element and the Trip Element are enabled.

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. In other words, the protection would be disabled for tripping.

6.13 Trip and Close Coil Circuit Supervision

This function includes two independent elements:

Close Coil Circuit Supervision

Trip Coil Circuit Supervision

The IED will initiate an alarm if either the trip or close coil circuits are open circuited or there is a loss of DC Control Voltage. Supervision is achieved in both the open and closed positions of the circuit breaker. The supervision function generates two outputs, Trip Coil Circuit Supervision Failure (TCF) and Close Coil Circuit Supervision Failure (CCF). These two outputs can be assigned to any of the programmable Auxiliary Contact Outputs.

It is possible to independently disable each Circuit Supervision function.

The block diagram depicting this feature (in the open breaker condition) is shown in figure 6.24.

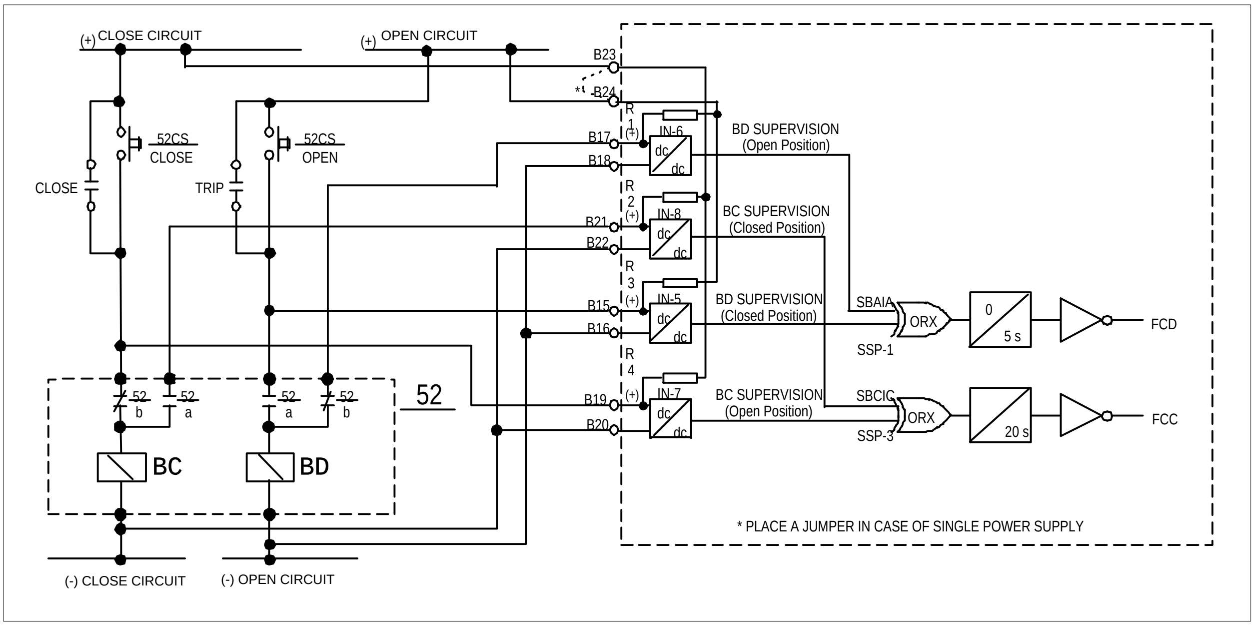


Figure 6.24: Trip/Close Coil Circuit Supervision Block Diagram

6.13.1 Trip Coil Circuit

In Figure 6.24 (breaker open), input IN-5 is energized through the internal resistor R3. Input IN-6 is not energized since the voltage at terminal B17 is less than pickup because the resistance of R1 is larger than that of the trip coil. In this situation Trip Coil Circuit Supervision With 52 Closed (TCS-A) is active and Trip Coil Circuit Supervision With 52 Open (TCS-B) is inactive, causing Trip Coil Circuit Supervision Failure (FCD) to be inactive.

If the trip coil opens, the input IN-6 is energized and the TCS-B signal is activated, causing deactivation of the output of the exclusive OR gate and 5 seconds later the activation of the Trip Coil Circuit Supervision Failure (TCF) signal.

When the circuit breaker is closed, the status of the 52a and 52b contacts will change and consequently (assuming the trip coil is not open circuited) inputs IN-6 and IN-5 will be inverted as well as the TCS-A and TCS-B signals. However, the TCF output will remain deactivated since both inputs at the exclusive OR gate have different logic values.

The purpose of the 5-second time delay is to compensate for the time gap between the closing of the 52a and opening of the 52b contacts. In general, TCS-A and TCS-B signals will not change their states simultaneously and a transient logic “0” will appear at the output of the exclusive OR. When this disagreement lasts less than 5 seconds this “0” will not modify the state of TCF.

If the trip coil circuit is opened while the breaker is closed, input IN-5 is energized and TCS-A is activated initiating the deactivation of the output of the exclusive OR gate and 5 seconds later, activation of the Trip Coil Circuit Supervision Failure (TCF) signal.

If a trip occurs while the breaker is closed and the breaker opens reversing the status of the 52a and 52b contacts, the TCF signal will not be activated regardless of the time duration of the trip command. If the breaker did not execute the command, the TCF signal is activated in 5 seconds.

If the DC Control Voltage disappears, the inputs that are energized reverse their state. Consequently, the inputs of both exclusive OR gates become inactive, initiating activation of both trip and Close Coil Circuit Supervision Failure outputs (TCF and CCF).

When the supervision function detects an open circuit in the trip coil circuit, and therefore the inability to initiate a trip, Manual Close breaker operations processed through the Terminal Unit are not permitted.

6.13.2 Close Coil Circuit

The explanation given for the trip coil circuit also applies to the close coil circuit, but taking into account that the time delay is 20 s.

6.13.3 Trip/Close Coil Circuit Supervision Inputs

The characteristics of the Status Contact Inputs (IN-5, IN-6, IN-7, IN-8) used for Trip and Close Coil Circuit Supervision functions are different from standard Status Contact Inputs.

These characteristics are determined by the four jumpers located on the Protection board, as shown in Figure 5.1. Jumpers J1 and J2 are used for Trip Coil Supervision, and jumpers J5 and J6 are used for Close Coil Supervision. These are associated with the IN-5, IN-6, IN-7 and IN-8 inputs, respectively. If the Terminal Unit is provided with an additional printed circuit board for the Protection Subsystem, the jumpers are placed on the printed circuit board that contains the power supply. To use the inputs for the supervision functions described in Sections 6.13.1 and 6.13.2, connect the jumper links in the SUP position.

6.13.4 Trip/Close Coil Circuit Supervision Input Programming

The Status Contact Inputs associated with the Trip and Close Coil Circuit Supervision functions are made using the programmable inputs software menu. The programmable inputs software menu enables the assignment of IN-5, IN-6, IN-7 and IN-8 to TCS-A, TCS-B, CCS-B and CCS-A signals respectively. The association made in Figure 6.24 is:

IN-5	TCS-A (Trip Coil Circuit Supervision With 52 Closed)
IN-6	TCS-B (Trip Coil Circuit Supervision With 52 Open)
IN-7	CCS-B (Close Coil Circuit Supervision With 52 Open)
IN-8	CCS-A (Close Coil Circuit Supervision With 52 Closed)

The Trip and Close Coil Circuit Supervision functions operate separately. If only one coil is monitored, the other Status Contact Inputs can be used for other functions if the printed circuit board jumper links are modified.

6.13.5 Trip/Close Output Supervision

The Trip and Close Coil CircuitSupervision functions described in Sections 6.13.1 and 6.13.2 are also used to monitor the Auxiliary Contact Outputsused for the trip and close signals:

Trip Coil Circuit Supervision ⇒ Trip OutputSupervision
Close Coil CircuitSupervision ⇒ Close Output Supervision

These functions are shown in the block diagram of Figure 6.25 Signal TOF_1 (Trip Output Failure-Supply Power 1) indicates that the Terminal Unit trip output contact failed to operate properly. This is determined by monitoring the logic “trip” command generated within the microprocessor and the status change of input IN-5 (SSP-1). A 50 msec time delay is provided to allow for pickupof the tripping contacts. The close output is monitored in a similar manner. Signal COF_3 (Close Output Failure-Supply Power 3) indicates an improper close operation.

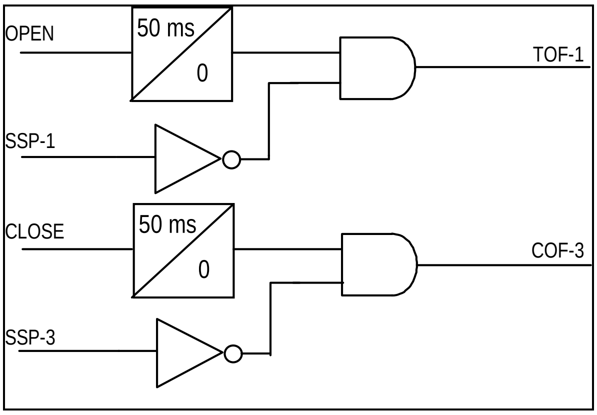


Figure 6.25: Trip/Close Output Supervision Logic Block Diagram

6.14 Breaker Monitoring

6.14.1 Contact Wear Indication

8BCD Terminal Units record the interrupting current for each trip of the associated breaker and accumulates 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 **I*I** Alarm signal that can be used to activate a programmable Auxiliary Contact Output. When activated, this output is captured by the sequence of events recorder.

This function has two settings:

- **I*I Alarm (Alarm $\sum kA^2$)**
- **I*I Cumulative (Actual Value of $\sum kA^2$)**

The Cumulative 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.

6.14.2 Excessive Number Of Trips

The Excessive Number Of Trips function is intended to interrupt an uncontrolled sequence of openings and closings that could damage the breaker. When a certain number of trips have occurred, adjustable between 1 and 40 in a definite time period (30 minutes), an output signal is generated that can be connected to operate one of the physical Auxiliary Contact Outputs.

Excessive Number of Trips output will be deactivated every time that **8BCD** relay detects a falling edge of the digital input corresponding to the CB open status; that is when the CB is closed.

6.15 Setting Group Control By Status Contact Inputs

This 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.

The following categories can have different settings for the three independent Setting Groups:

Configuration Settings	**Automatic Control Settings**
Oscillography Settings	**Logic Settings**
General Settings	**Historical Settings**
Protection Settings	**Breaker Monitoring Settings**

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

The Terminal Unit must be programmed from the keypad to enable setting group control by the Status Contact Inputs. This programming change is made from the **Configuration** option on the Main Menu, by selecting **Operation Enable** and then **Remote Settings**. The value of DIG_IN should be set to “Y” (YES) to enable Group Setting changes from Status Contact Inputs (refer to Section 7.4.1.b).

When Setting Group Control by Status Contact Inputs is enabled, no setting changes can be made from the keypad or the local RS232 port. If the **Active Group** option on the Main Menu is selected from the keypad, the display indicates **Access Denied** (refer to Section 7.4.3).

It is not permitted to simultaneously enable Setting Group Control by Status Contact Inputs (DIG_IN set to “Y”) and by Remote Communications Port (REM_P set to “Y”).

Three Status Contact Inputs to activate the three setting groups must be programmed to use this function.

6.15.1 Operation

The Status Contact Setting Group Control logic will recognize a single input only. If Group 2 settings are being used and the Activate Setting Group 2 Status Contact Input is energized, a Status Contact Input to Activate Setting Group 1 or Group 3 will not produce a change until the Group 2 Input is de-energized. If all three inputs are de-energized, the equipment will remain in the last setting group activated. The Inhibit Setting Group Control (INH_SGC) signal, if assigned to a Status Contact Input, and if that input is energized, will prevent Setting Group Control By Status Contact Inputs.

Note: setting groups can only be changed using external Status Contact inputs if the display is in the default screen state.

6.16 Event Record

Protection functions that are monitored by the sequence of events portion of the Terminal Unit are listed in **Table 6-1**.

Table 6-1: Event List

Function	Events
Overcurrent Elements Activation [12]	Phase A TOC Pickup
	Phase B TOC Pickup
	Phase C TOC Pickup
	Ground TOC Pickup
	Phase A Instantaneous Overcurrent Pickup
	Phase B Instantaneous Overcurrent Pickup
	Phase C Instantaneous Overcurrent Pickup
	Ground Instantaneous Overcurrent Pickup
	Phase A TOC Trip Output Active
	Phase B TOC Trip Output Active
	Phase C TOC Trip Output Active
	Ground TOC 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
Voltage Elements Activation [12]	Level 3 Voltage Unbalance Pickup
	Level 2 Voltage Unbalance Pickup
	Level 1 Voltage Unbalance Pickup
	Instantaneous Undervoltage Unit Pickup
	Time Overvoltage Pickup
	Instantaneous Overvoltage Pickup
	Loss of Potential Detection Output Active
	Level 3 Voltage Unbalance Output Active
	Level 2 Voltage Unbalance Output Active
	Level 1 Voltage Unbalance Output Active
	Instantaneous Undervoltage Output Active
	Time Overvoltage Output Active
	Instantaneous Overvoltage Output Active
Block Activation [12]	Blocking Unit Output Active
Overcurrent Elements Deactivation [16]	Phase A Time OC Reset Phase B Time OC Reset Phase C Time OC Reset Ground Time OC Reset Phase A Instantaneous OC Reset Phase B Instantaneous OC Reset Phase C Instantaneous OC Reset Ground Instantaneous OC Reset

Table 6-1: Event List (continued)	
Function	**Events**
Overcurrent Elements Deactivation Cont.) [16]	Phase A TOC Trip Output Deactivated
	Phase B TOC Trip Output Deactivated
	Phase C TOC Trip Output Deactivated
	Ground TOC Trip Output Deactivated
	Phase A Instantaneous Trip Output Deactivated
	Phase B Instantaneous Trip Output Deactivated
	Phase C Instantaneous Trip Output Deactivated
	Ground Instantaneous Trip Output Deactivated
Voltage Elements Deactivation [16]	Level 3 Voltage Unbalance Reset
	Level 2 Voltage Unbalance Reset
	Level 1 Voltage Unbalance Reset
	Instantaneous Undervoltage Unit Output Reset
	Time Overvoltage Unit Reset
	Instantaneous Overvoltage Unit Reset
	Loss of Potential Detection Output Deactivated
	Level 3 Voltage Unbalance Output Deactivated
	Level 2 Voltage Unbalance Output Deactivated
	Level 1 Voltage Unbalance Output Deactivated
	Instantaneous Undervoltage Output Deactivated
	Time Overvoltage Output Deactivated
	Instantaneous Overvoltage Output Deactivated
Block Deactivation [16]	Blocking Unit Output Deactivated
Breaker Failure & Monitor [17]	Breaker Failure Output Active
	Trip Coil Circuit Supervision Failure Output Active
	Close Coil Circuit Supervision Failure Output Active
	Protection Not In Service Alarm Active
	Breaker Monitoring 2 Cumulative Alarm Level
	Breaker Monitoring 2 Cumulative Alarm Level Overflow
	Trip Coil Circuit Supervision Power Output #1 Failure Output active
	Close Coil Circuit Supervision Power Output #3 Failure Output active
	Oscillography Start (optional)
Overcurrent Element Deactivation [17]	Negative Sequence Instantaneous Overcurrent Pickup (8BCD-J model)
	Negative Sequence Instantaneous Overcurrent Output Active (8BCD-J model)
	Negative Sequence Time Overcurrent Pickup (8BCD-J model)
	Negative Sequence Time Overcurrent Output Active (8BCD-J model)
Alarm Reset [18]	Protection Not In Service Alarm Reset
Overcurrent Element Activation [18]	Negative Sequence Instantaneous OC Reset (8BCD-J model) Negative Sequence Instantaneous Overcurrent Trip Output Desactivated (8BCD-J model) Negative Sequence Time OC Reset (8BCD-J model) Negative Sequence Time Overcurrent Trip Output Desactived (8BCD-J model)
Initialization [19]	Power up Change Of Settings Initialization

Table 6-1: Event List (continued)	
Function	**Events**
Inputs [6]	Status Contact Input IN-8 Activated
	Status Contact Input IN-7 Activated
	Status Contact Input IN-6 Activated
	Status Contact Input IN-5 Activated
	Status Contact Input IN-4 Activated
	Status Contact Input IN-3 Activated
	Status Contact Input IN-2 Activated
	Status Contact Input IN-1 Activated
	Status Contact Input IN-8 Deactivated
	Status Contact Input IN-7 Deactivated
	Status Contact Input IN-6 Deactivated
	Status Contact Input IN-5 Deactivated
	Status Contact Input IN-4 Deactivated
	Status Contact Input IN-3 Deactivated
	Status Contact Input IN-2 Deactivated
	Status Contact Input IN-1 Deactivated
	Status Contact Input IN-8 Disabled
	Status Contact Input IN-7 Disabled
	Status Contact Input IN-6 Disabled
	Status Contact Input IN-5 Disabled
	Status Contact Input IN-4 Disabled
	Status Contact Input IN-3 Disabled
	Status Contact Input IN-2 Disabled
	Status Contact Input IN-1 Disabled
Commands [5]	Main Breaker Close Command Failure
	Main Breaker Open Command Failure
	Main Breaker close Command
	Main Breaker open Command
	Main Breaker Excessive number of trips
	Current detected with Local Breaker Open Status (400 model)
	Local Breaker Close Command Failure (400 model)
	Local Breaker Open Command Failure 400 model)
	Local Breaker close Command (400 model)
	Local Breaker open Command (400 model)
	Local Breaker Excessive number of trips (400 model)
Operator Interface HMI [9]	Setting Group 1 Activated By Status Contact Input Setting Group 2 Activated By Status Contact Input Setting Group 3 Activated By Status Contact Input Local Mode (Keypad and Display) Remote Mode (Rear Port) Local Mode (Front Port)

Table 6-1: Event List (continued)	
Function	**Events**
Automatic Connection Control [10]	Reset After Block Due to Protection Trip
	Reactive Power Automatic Control Select
	Clock/Calendar Automatic Control Select
	Switch to Automatic Mode
	Switch to Manual Mode
	Operation Inhibit
	End of Operation Inhibit
	Calendar Automatic Control Disconnected Due to Lack of Synchronization
	Disconnection Command (open) Sent by Equipment
	Connection Command (close) Sent by Equipment
	Block Due to Protection Trip
IRIG-B 123 [9]	IRIG-B 123 Time Code Recovery (optional)
	IRIG-B 123 Time Code Loss (optional)

The following information is stored in each event register:

- **Phase and ground current, bus voltage (Vbus) and calculated unbalance voltage (Unbal), measured at the moment the event was generated. Additionally, the measured voltage unbalance of the capacitor bank neutral (Vcap unb) and system voltage (Vsys unb) are provided in the enhanced model.**

- **Event date and time**

The event record capacity is one hundred (100) events. When the record is full, a new event displaces the oldest event.

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, the resolution time of the recorder.

The ZIVercom communications and remote management software program is used for reading event record information.

Note: when using the band pass filter implementes in this model, note that a compensation time of 60 ms is included for models of 60Hz, and 70 ms for models of 50 Hz. This compensation time wil be reflected in the event recorded, being subtracted from the desired operating time. Other characteristic of the filter is that the operating time will decrease as the difference between the pickup setting and the applied input increases. All operating times are within the published accuracy. The best time accuracy is achieved for pickup values 3 times the pickup setting.

6.16.1 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, and is available in the General settings menu.

6.17 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 displaces the oldest report. The information stored in each Fault Report is listed below:

- Fault Initiation Time Tag - **Corresponds with the time when the first element involved in the fault picked up**.
- Open Command Time Tag.
- Fault End Time Tag - **Corresponds to the time when the last element involved in the fault resets**.
- Element Initiating Trip.
- Elements Picked Up for Full Fault Duration.
- Pre-Fault Currents - **Three phase and ground current values one cycle before the fault started**.
- Pre-Fault Voltages (Standard Model) – Vbus and Vsys unbal.
- Pre-Fault Voltages (Enhanced Model) – Vbus, Vcap unbal, Vunbalance and Vsys unbal.
- 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 is the default) **or Open Command Failure**.
- Currents and Voltages at Open Command Initiation.
- Setting Group Active at Time of Trip.

All of the above information is stored in memory and available through both communications.

6.18 Current/Voltage History Record

This function records periodic values of line current, and bus voltage. 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** (Calc Time Interval). The Terminal Unit samples bus Voltage every second and then calculates an average value over the interval defined as the **Sample Interval**. The **Sample Interval** is adjustable between 1 and 15 minutes. At the end of the interval, the phase with the highest value is retained.

The **Data Record Interval** is adjustable between 1 minute and 24 hours. At the end of the recording period, the maximum value retained from all **Sample Intervals** is entered in the historical record.

The available RAM for current and voltage history corresponds to 168 record values (equivalent to seven days of recording with data record intervals of one hour).

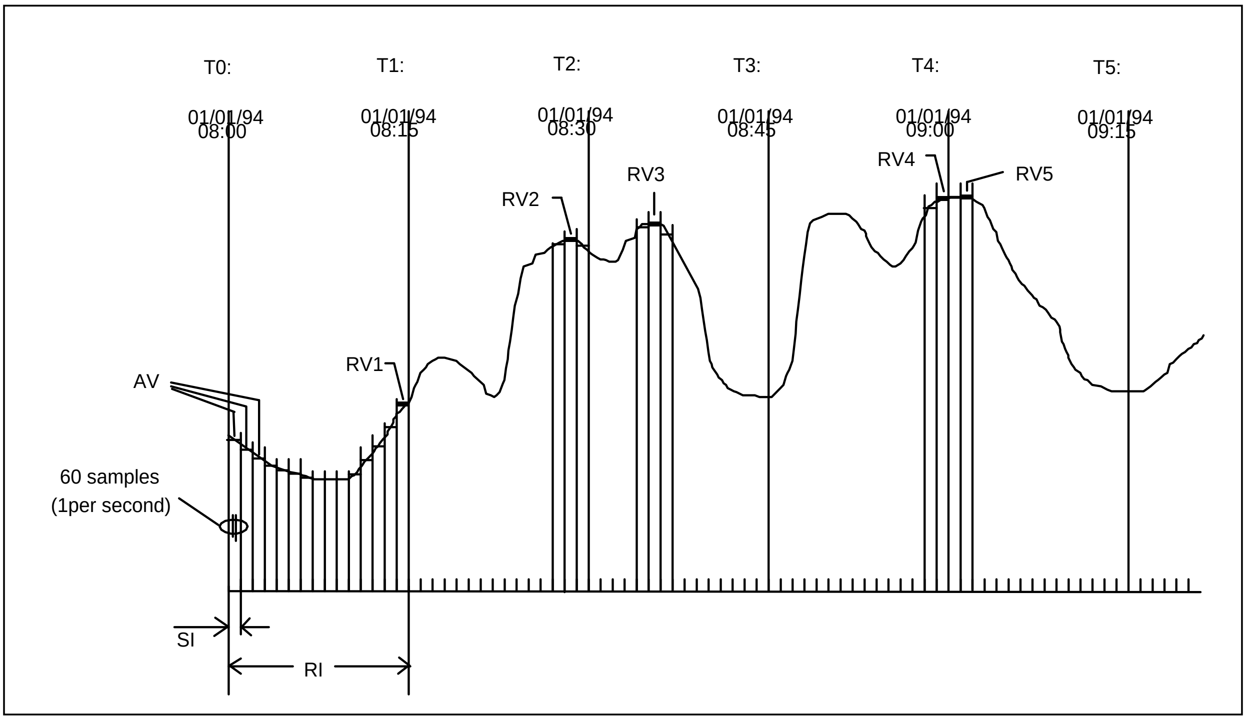


Figure 6.26: Current History Record (example)

AV: **Average Value of 1 sample per second over SI for highest phase current.**
SI: **Sample Interval. The figure shows a value of SI equal to one minute.**
RI: **Data Record Interval. The figure shows a value of RI equal to 15 minutes.**

It is possible to select Recording Hours and Days, to manage memory space. The Hours Range, which applies to all days, determines the time interval of the day when values are entered in the historical record. Data entry for days of the week is selected using the Day mask.

The values recorded for the Historical Current/Voltage Record are determined by samples taken during the Sample Interval. Figure 6.26 illustrates an example of an historical current record.

An AV value, the average of one sample per second for the highest phase current or voltage, is retained for each Sample Interval. The maximum value of all the computed AV values is recorded in each RI interval. The current profile of the record in Figure 6.26 contains the Recorded Value data shown in the table at the right.

VALUE	TIME
RV1	T1
RV2	T2
RV3	T3
RV4	T4
RV5	T5

Associated with the Phase Current/Bus Voltage History Record is a **Maximum Demand** function that stores the maximum value recorded since the last reset. This information can be accessed from the keypad by selecting: **Information: Metering: Imax** and **Information: Metering: Vmax**. The display provides an option to reset this value to zero by using the function keys F1 (YES) and F4 (NO).

6.19 Oscillography

The oscillography function is composed of two different sub functions: **Capture** and **View**. The **Capture** function refers to the capture and storage of protection data in the Terminal Unit. **Capture** is part of the IED software. The **View** function refers to the collection and graphical display of the stored data. **View** is performed by one or more software programs run on a PC connected to the Terminal Unit.

Note: when a oscillographic register is generated by the band pass filter, keep in mind the pass-band filter's characteristic curve because the fault duration will depend of this curve.

• Capture Function

An analog record is stored each time a sample is taken. Status Contact Input activation and deactivation 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**
- **Selected digital signal sample values. The digital signal table is the same as the Logic Output Signals (table 6-3) (*)**
- **Starting time of the oscillography record**

(*) Only in model with oscillography with digital tops

• Recording Mode

Two recording modes are selectable: **Fixed Time Mode** and **Variable Time Mode**. In the Fixed Time Mode, recording begins when the Oscillography Trigger 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 Oscillography Trigger is activated. Recording stops when the Oscillography Trigger is deactivated.

• Oscillography Trigger (Initiate)

The Oscillography Trigger consists of selectable verification boxes, which can be applied to trigger oscillography recording after detecting 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 Oscillography Trigger is connected to each protection element within the relay. Only connections that are enabled in the trigger settings will activate the Oscillography. The activation occurs when any of the selected protection elements pick up, and deactivation occurs when all selected elements are reset.

• Pre-Pickup Time (Pre-Fault Time)

Pre-Pickup Time is defined as the length of data stored before the Oscillography Trigger initiates a record. This time can be adjusted for either 1 or 2 cycles.

• 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 the length of the fault records. Once recording memory is full, the Overwrite setting determines whether or not the next event that occurs will be stored over the oldest stored record(s).

• Trigger Modes

Trigger Mode 0:

Fixed Time Mode [Fixed Time (Yes)] - Recorded data is stored whenever the Oscillography Trigger is activated and continues for a time determined by the Record Length setting.
Variable Time Mode [Fixed Time (No)] - Recorded data is stored whenever the Oscillography Trigger is activated.

Pre-Pickup Data is stored in both cases.

Trigger Mode 1:

Fixed Time Mode [Fixed Time (Yes)] - Recorded data, plus pre-pickup 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, plus pre-pickup data, is stored only if a trip occurs within the time while the Oscillography Trigger is active. If a trip occurs after this time has expired, no record is stored.

Trigger Mode 2:

Fixed Time Mode [Fixed Time (Yes)] – If a trip occurs while the time set for the Record Length, recorded data will be stored (after the Oscillography Trigger is activated) up to the time the trip occurs, plus 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 Oscillography Trigger is activated. Pre-pickup data is stored in both cases.

Variable Time Mode [Fixed Time (No)] - If no trip occurs while the Oscillography Trigger remains active, only 4 cycles of recorded data will be stored after the Oscillography Trigger is activated. If a trip occurs while the Oscillography Trigger is active, recorded data will be stored during the whole time the Oscillography Trigger remains active in addition to the pre-pickup data.

• Overwrite

If the Overwrite setting has been set to NO, once the oscillography memory is full, no more records will be stored.

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

6.20 Contact Inputs, Outputs and LED Targets

8BCD Terminal Units are provided with programmable inputs, outputs and LED targets enabling user configuration of flexible logic designs. Logic equations can be created and modified using the ZIVercom software program.

6.20.1 Status Contact Inputs

The Terminal Unit protection, reclosing and monitoring functions can be controlled by the **Logic Input Signals** listed in **Table 6-2** below. Any of these Logic Input Signals can be assigned to the eight 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: Logic Input Signals

No.	Name	Description
1	SSP_1	Trip Coil Circuit Supervision with 52 Closed
2	SSP_3	Close Coil Circuit Supervision with 52 Open
3	SBAIA	Trip Coil Circuit Supervision With 52 Open
4	SBCIC	Close Coil Circuit Supervision With 52 Closed
5	APE	External Protection Trip
7	ATUT_F	Bypass Time Phase Time Overcurrent
8	ATUT_N	Bypass Time Ground Time Overcurrent
9	BDI_F	Block Phase Instantaneous Trip
10	BDI_N	Block Ground Instantaneous Overcurrent Trip
11	BDT_F	Block Phase Time Overcurrent Trip
12	BDT_N	Block Ground Time Overcurrent Trip
13	API_F	Torque Control Phase Instantaneous O/C
14	API_N	Torque Control Ground Instantaneous O/C
15	APT_F	Torque Control Phase Time Overcurrent
16	APT_N	Torque Control Ground Time Overcurrent
17	IA	Main Breaker Open Status (52b contact is default)
18	MANUAL	Change to Manual Mode
19	AUTO	Change to Automatic Mode
20	REP_BLQ	Automatic Control Reset
21	CEXT	Main Breaker External Closing Command
22	52TRAFOS	Transformer Breaker
23	52AB	Bus Bar Jumper Breaker
24	EX	External Oscillography Start
25	INH_C_ED	Inhibit Setting Group Control
26	T_AJ_1	Activate Setting Group 1
27	T_AJ_2	Activate Setting Group 2
28	T_AJ_3	Activate Setting Group 3
29	BDT_SOT	Block Time Overvoltage Trip
30	BDI_SOT	Block Instantaneous Overvoltage Trip
31	BDI_SUT	Block Instantaneous Undervoltage Trip
32	BDI_DT	Block Voltage Unbalance Trip Level 1
33	IA	Local Breaker Open Status (400 model)

Table 6-2: Logic Input Signals		
No.	**Name**	**Description**
34	CEXT	Local Breaker External Closing Command (400 model)
35	BDI_DT2	Block Voltage Unbalance Trip Level 2
36	BDI_DT3	Block Voltage Unbalance Trip Level 3
37	BDI-SN	Block Negative Sequence Instantaneous Overcurrent Trip (8BCD-J model)
38	BDT-SN	Block Negative Sequence Time Overcurrent Trip
39	APT-SN	Bypass Time Negative sequence Time Overcurrent (8BCD-J model)
40	APE	External Open Command (Enhanced Model)

Users can easily program different input settings using the local RS232 communications port and the ZIVercom software program. The user may also provide the settings to the manufacturer to be pre-loaded onto the Terminal Unit prior to delivery.

6.20.2 Auxiliary Contact Outputs

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 "**Inv**" 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 6.27. The desired final "**AND**" or "**OR**" output from the logic cell can then be connected to any one of the seven programmable Auxiliary Contact Outputs (AUX-1 through AUX-7) available in the Terminal Unit. Auxiliary Contact Output (AUX-8), which corresponds to **Relay In Service**, is not programmable.

To permit the user to create combinational logic equations for the Auxiliary Contact Outputs, Terminal Units are provided with the logic cell structure shown in Figure 6.27. To configure Auxiliary Contact Outputs, Logic Output Signals are assigned to these logic cells. The desired Logic Cell Output can then be assigned to an Auxiliary Contact Output. The logic cells also contain a timing function that can be configured to produce a continuous signal or a definite time pulse signal for the associated Auxiliary Contact Output.

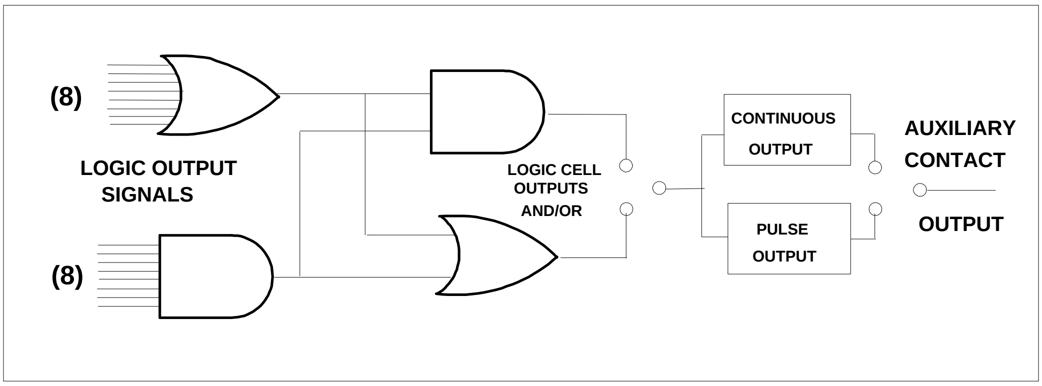


Figure 6.27: Auxiliary Contact Output Logic Cell Block Diagram

The value entered for a continuous output signal or a pulse output signal varies between 0 and 200 and is adjusted through the ZIVercom software program.

- 0 corresponds to a **continuous output signal** when the logic is satisfied.
- T corresponds to a **pulse output signal** with a duration of T X 0.1 seconds ±10% when the logic is satisfied.

Pulse duration = T x 0.1 (±10%),
where T varies from 1 to 200

The available Logic Output Signals are described in **Table 6-3**.

Table 6-3: Logic Output Signals

No.	Name	Description
1	SUT_A	Phase A Time Overcurrent Trip Output
2	SUT_B	Phase B Time Overcurrent Trip Output
3	SUT_C	Phase C Time Overcurrent Trip Output
4	SUT_N	Ground Time Overcurrent Trip Output
5	SUI_A	Phase A Instantaneous Overcurrent Trip Output
6	SUI_B	Phase B Instantaneous Overcurrent Trip Output
7	SUI_C	Phase C Instantaneous Overcurrent Trip Output
8	SUI_N	Ground Instantaneous Overcurrent Trip Output
9	AUT_A	Phase A Time Overcurrent Pickup
10	AUT_B	Phase B Time Overcurrent Pickup
11	AUT_C	Phase C Time Overcurrent Pickup
12	AUT_N	Ground Time Overcurrent Pickup
13	AUI_A	Phase A Instantaneous Overcurrent Pickup
14	AUI_B	Phase B Instantaneous Overcurrent Pickup
15	AUI_C	Phase C Instantaneous Overcurrent Pickup
16	AUI_N	Ground Instantaneous Overcurrent Pickup
17	SUI-SN	Negative Sequence Instantaneous Overcurrent Trip Output (8BCD-J model)
18	AUI-SN	Negative Sequence Instantaneous Overcurrent Pickup (8BCD-J model)
19	SUT-SN	Negative Sequence Time Overcurrent Trip Output (8BCD-J model)
20	AUT-SN	Negative Sequence Time Overcurrent Pickup (8BCD-J model)
21	SU-DT1	Level 1 Voltage Unbalance Trip Output Latched (8BCD-J model)
22	SU-DT2	Level 2 Voltage Unbalance Trip Output Latched (8BCD-J model)
23	SU-DT3	Level 3 Voltage Unbalance Trip Output Latched (8BCD-J model)
27	SUT_SOT	Time Overvoltage Trip Output
28	SUI_SOT	Instantaneous Overvoltage Trip Output
29	SUSI_SUT	Instantaneous Undervoltage Trip Output
30	SUI_DT	Level 1 Voltage Unbalance Trip Output
33	AUT_SOT	Time Overvoltage Pickup
34	AUI_SOT	Instantaneous Overvoltage Pickup
35	AUSI_SUT	Instantaneous Undervoltage Pickup
36	AUI_DT	Level 1 Voltage Unbalance Pickup
37	SUIM-SN	Negative Sequence Inst. OC Main Mask Enabled Trip Output 8BCD-J model)
38	SUTM-SN	Negative Sequence Temp OC Main Mask Enabled Trip Output (8BCD-J model)
39	IL	Line Current
40	FSP_1	Trip Output Failure-Supply Power 1

Table 6-3: Logic Output Signals (cont.)		
No.	**Name**	**Description**
41	FSP_3	Close Output Failure-Supply Power 3
42	FCD	Trip Coil Circuit Failure
43	FCC	Close Coil Circuit Failure
44	FI	Breaker Failure Output
45	ALARMA_PR	Protection Not In Service Alarm
46	A_SINT	I*I Cumulative Alarm Level
47	APERTURA	Main Breaker Open Command
48	CIERRE	Main Breaker Close Command
49	DISP	Internal Protection Trip Output
50	FOA	Main Breaker Open or Trip Command Failure
51	FOC	Main Breaker Manual Close Failure
52	IIA	Current detected with Main Breaker Open Status (52b contact)
53	IILA	Current detected with Local Breaker Open Status (52b contact) (400 model)
54	SUTM_A	Phase A Time Overcurrent Main Mask Enabled Trip Output
55	SUTM_B	Phase B Time Overcurrent Main Mask Enabled Trip Output
56	SUTM_C	Phase C Time Overcurrent Main Mask Enabled Trip Output
57	SUTM_N	Ground Time Overcurrent Main Mask Enabled Trip Output
58	SUIM_A	Phase A Instantaneous Overcurrent Main Mask Enabled Trip Output
59	SUIM_B	Phase B Instantaneous Overcurrent Main Mask Enabled Trip Output
60	SUIM_C	Phase C Instantaneous Overcurrent Main Mask Enabled Trip Output
61	SUIM_N	Ground Instantaneous Overcurrent Main Mask Enabled Trip Output
63	SUTM_SOT	Time Overvoltage Main Mask Enabled Trip Output
65	SUIM_SOT	Instantaneous Overvoltage Main Mask Enabled Trip Output
66	SUIM_SUT	Instantaneous Undervoltage Main Mask Enabled Trip Output
67	SUIM_DT	Level 1 Voltage Unbalance Main Mask Enabled Trip Output
68	ERROR_RTC	Automatic Connection Control Disconnected Due to Lack of Synchronization
69	INH_MANI	Maneuver Inhibit
70	MODOAUTO	Automatic Mode
71	BCD_REPON	BCD Reset Signal
73	BI_FP_SECC	Circuit Switcher Blocked
74	BI_INT	Breaker 52C Blocked
75	BD_DISPARO	Automatic Control Lockout Due to Permanent Fault
76	CERRAR_BAT	Automatic Control Connection Command
77	ABRIR_BAT	Automatic Control Disconnection Command
78	BATCERRADO	Capacitor Bank Connected
79	BATABIERTO	Capacitor Bank Disconnected
80	DISP	Local Breaker Open Command (400 model)
81	CIERRE	Local Breaker Close Command (400 model)
82	ALARM_ENT	Alarm Detected in the Environment Module
83		Local Breaker Excessive Number of Trips (400 model)
84	SUTM-A	Phase A Time Overcurrent Local Mask Enable Trip Output (400 model)
85	SUTM-B	Phase B Time Overcurrent Local Mask Enable Trip Output (400 model)
86	SUTM-C	Phase C Time Overcurrent Local Mask Enable Trip Output (400 model)

Table 6-3: Logic Output Signals (cont.)		
No.	**Name**	**Description**
87	SUTM-N	Ground Time Overcurrent Local Mask Enable Trip Output (400 model)
88	SUIM-A	Phase A Inst. Overcurrent Local Mask Enable Trip Output (400 model)
89	SUIM-B	Phase B Inst. Overcurrent Local Mask Enable Trip Output (400 model)
90	SUIM-C	Phase C Inst. Overcurrent Local Mask Enable Trip Output (400 model)
91	SUIM-N	Ground Inst. Overcurrent Local Mask Enable Trip Output (400 model)
92	SUTM-SOT	Time Overvoltage Local Mask Enable Trip Output (400 model)
93	SUIM-SOT	Inst. Overvoltage Local Mask Enable Trip Output (400 model)
94	SUIM-SUT	Inst. Undervoltage Local Mask Enable Trip Output (400 model)
95	SUM-DT1	Level 1 Voltage Unbalance Local Mask Enable Trip Output (400 model)
96	SUM-DT2	Level 2 Voltage Unbalance Local Mask Enable Trip Output (400 model)
97	SUM-DT3	Level 3 Voltage Unbalance Local Mask Enable Trip Output (400 model)
98	SUIM-SN	Negative Sequence Inst. OC Local Mask Enabled Trip Output (400 model)
99	SUTM-SN	Negative Sequence Temp OC Local Mask Enabled Trip Output (400 model)
100	FOA	Local Breaker Open or Trip command Failure (400 model)
101	FOC	Local breaker Manual close Failure (400 model)
102	E1T1	Physical Input 1 (Board 1)
103	E2T1	Physical Input 2 (Board 1)
104	E3T1	Physical Input 3 (Board 1)
105	E4T1	Physical Input 4 (Board 1)
106	E5T1	Physical Input 5 (Board 1)
107	E6T1	Physical Input 6 (Board 1)
108	E7T1	Physical Input 7 (Board 1)
109	E8T1	Physical Input 8 (Board 1)
110	E1T2	Physical Input 1 (Board 2)
111	E2T2	Physical Input 2 (Board 2)
112	E3T2	Physical Input 3 (Board 2)
113	E4T2	Physical Input 4 (Board 2)
114	E5T2	Physical Input 5 (Board 2)
115	E6T2	Physical Input 6 (Board 2)
116	E7T2	Physical Input 7 (Board 2)
117	E8T2	Physical Input 8 (Board 2)
119	ENUM_DISP	Main Breaker Excessive Number of Trips
120	SUI_DT2	Level 2 Voltage Unbalance Trip Output
121	SUI_DT3	Level 3 Voltage Unbalance Trip Output
122	AUI_DT2	Level 2 Voltage Unbalance Pickup
123	AUI_DT3	Level 3 Voltage Unbalance Pickup
124	BUDT	Voltage Unbalance Units Blocked
125	SUIM_DT2	Level 2 Voltage Unbalance Main Mask Enabled Trip Output
126	SUIM_DT3	Level 3 Voltage Unbalance Mask Main Enabled Trip Output
127	IRIGB_OK	IRIG-B 123 Ok (optional)

6.20.3 Breaker Trip and Close Outputs

8BCD Terminal Units are provided with two output relays, each with two normally open contacts rated for breaker trip and close operations. The Trip Output relay is assigned the logic output signal **Open**. This output is activated both when the relay generates an Internal Protection Trip Output signal and when a command is received to trip the breaker from the operator interface keypad on the Terminal Unit.

The Close Output relay is assigned to the logic output signal **Close**. This output is activated when the Terminal Unit generates a Close Command, when a Manual Close Command is received from a status contact input, and when a command is received to close the breaker from the operator interface Keypad on the Terminal Unit.

• General

Manual trip and close operations can be performed through the **8BCD** Terminal Units using the same Trip and Close Output contacts described above. These operations can be enabled using the Keypad (see Chapter 7 Alphanumeric Keypad and Display).

Manual operation is designed to require confirmation before trip or close commands are completed. The Terminal Unit is designed to confirm that the breaker has changed state. A Breaker Open and a Breaker Close Failure Time can be programmed for trip and close operations. Open Command Failure or Close Command Failure alarms are generated if the breaker response is too slow.

• 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 auxiliary contact (52b is the default), which monitors breaker position.

If the Seal-In Enable is set to NO, the trip command resets when the protection trip elements reset or, in the case of Voltage Unbalance elements in **8BCD-G** Enhanced model and **8BCD-J**, 100ms after any open command and during 1s. 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.

6.20.4 LED Targets

8BCD Terminal Units are provided with 13 optical indicators (LED’s) located on the front panel. The logic cell structure, shown in the block diagram of Figure 6.28, permits the user to create combinational logic equations for the LED Target Outputs. To configure LED Target Outputs, Logic Output Signals are assigned to these logic cells. The desired Logic Cell Output can then be assigned to an LED Target Output. The available Logic Output Signals are shown in **Table 6-3**.

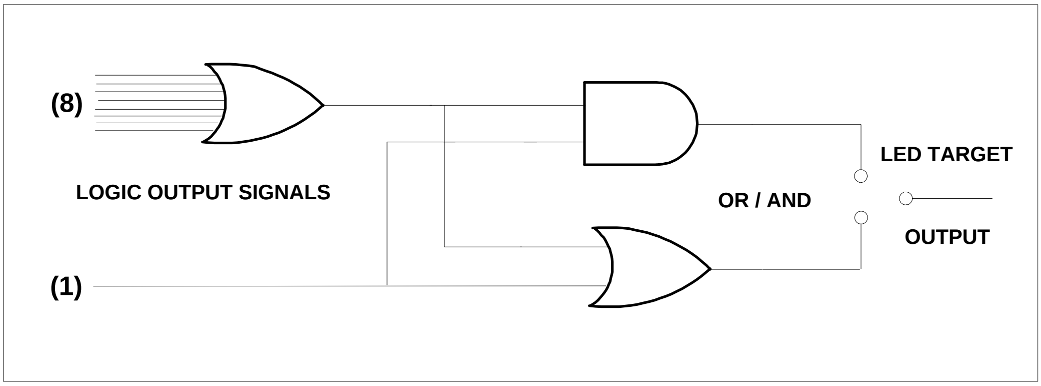


Figure 6.28: LED Target Output Logic Block Diagram

Each LED can be defined as latched or unlatched. If an LED is latched, it will remain illuminated until reset. This is accomplished via the Terminal Unit 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 reset.

Each LED is pre-programmed with default logic. This logic can be modified by using the local RS232 communications port and the ZIVercom software. The user may also provide the settings to the manufacturer to be pre-loaded onto the Terminal Unit prior to delivery.

6.21 Communications

6.21.1 Communications Settings

Communications settings are listed in Chapter 5 (Settings) and include **Terminal Unit Address**, **Baud Rate**, **Stop Bits**, and **Parity**.

6.21.2 Communications Types

8BCD Terminal Units contain two communication ports. The local port allocated on the front panel is an RS232 with fixed settings. The remote port is optional and it can be glass fiber optics (SMA or ST), 1mm plastic fiber optics, RS485, or RS232. Technical data relative to these ports is listed in Chapter 2.

6.21.3 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 **8BCD** family, enabling operations such as programming, settings configuration, event recording, activity reports, etc.

ZIVercom contains passwords to provide access only to authorized personnel. ZIVercom is a user friendly software tool running under **Windows™**. It is possible to navigate and perform all the available actions in a series of submenus via graphical data boxes and buttons.

To establish communications, the settings and Terminal Unit address in the IED and ZIVercom software must match.

8BCD models use the same controller for both remote and local ports. Therefore, only one port can be used at once. The local port has priority over the remote port.

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

- **Metering Data**
- **Settings**
- **Contact Inputs Status**
- **Auxiliary Outputs & LED Targets**
- **Event Records**
- **Oscillography**

Note: the ZIVercom used for models 002 is the same as for the model 001. In the emulation mode login isung 8BCD->G (ENHANCED).

CHAPTER 7

Alphanumeric Keypad and Display

VII

7.1 Alphanumeric Display

The liquid crystal alphanumeric display has a 4 row by 20 character matrix. It provides information on Terminal Unit alarms, settings, metering, status, etc. Four function keys are mounted below the display. The function of each of these keys appears in the last line of the display, where appropriate.

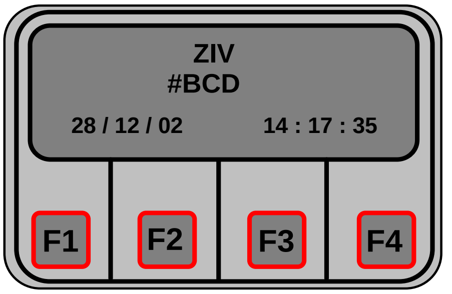


Figure 7.1: Alphanumeric Display and Function Keys

7.2 Alphanumeric Keypad

The equipad consists of 16 keys arranged in a 4 x 4 matrix and is used to scroll through menus and enter setpoints. Please refer to Figure 7.2.

The display selection keys (↑ ↓) provide access to any of the options shown in the display, and scroll the screen up or down to display other options.

Menu options can also be accessed by pressing the corresponding number displayed next to the option.

Figure 7.2: Keypad Layout

The **ENT** key is used to confirm an action after a selection has been made, store a new setting after a setting has been entered and move forward through the list of records. After an operation has been performed (selection, change of settings, information viewing, etc.), this key is pressed to move to previous levels in the menu. When modifying a setting, the delete key (**ESC**) can be used to delete an incorrect entry.

• Function Keys

F1 is used to confirm changes that have been made using the keypad. **F2** is used to sequentially display relay status and information, and to reset: targets, counters and LED's. If a cover has been installed on the Terminal Unit, only the **F2** key is accessible. **F4** is used to cancel changed settings that have been made using the keypad.

• Operation Modes

The Operator Interface has two possible operation modes. One mode operates using only a single key, **F2**, when the cover is installed, and the other mode takes advantage of the complete keypad.

7.3 Access Using Function Key F2

The Function Key **F2** is pressed for less than two seconds to sequence through the display screens. Pressing **F2** for more than two seconds changes status and resets: last trip indication, LEDs, and automatic connection control. The display indicates which operation is required to change status or reset functions.

The following information (depending on options specified) can be sequentially displayed by pressing Function Key **F2**:

- **Last Trip Indication**
- **Primary Phase and Ground Currents (I_A, I_B, I_C, I_G)**
- **Negative Sequence Current (I2) (8BCD-J model only)**
- **Bus Voltage (V_{BUS})**
- **Primary Voltage Unbalance (V_{UNBAL})**
- **Primary Capacitor Voltage Unbalance ($V_{CAP\ U}$)**
- **Primary System Unbalance ($V_{SYS\ U}$)**
- **Automatic Connection Control Status and Reset**
- **Reset Trip Indication**
- **Reset LED's**

The number of screens appearing in this operating mode depends on the **8BCD** model. Not all options are shown in the following example.

• Last Trip Indication

If a trip has occurred, the Trip/Close screen displays the associated protection elements. The first row is reserved for the Instantaneous Overcurrent and Overvoltage elements. The second line is reserved for the Time Overcurrent and Overvoltage elements. The third line shows the Voltage Unbalance and the Undervoltage elements.

```
TR:         ########
            ########
            ########
@@@@           XXXXX
```

Phase and Ground Instantaneous Overcurrent Trip: IOC_**

**** is replaced by the phase or ground elements that have generated the trip. For example, a two-phase-to-ground fault (A to B to Ground) produces IOC_ABG if all three Instantaneous Overcurrent elements (A, B and G) responded.

A: Overcurrent Element - Phase A
B: Overcurrent Element - Phase B
C: Overcurrent Element - Phase C
G: Neutral Overcurrent Element

Phase and Ground Time Overcurrent Trip: TOC_****

**** is replaced by the phase or ground elements that have generated the trip. For example, a trip due to an A phase-to-ground fault produces TOC_AG if both the A phase and ground time overcurrent elements responded.

Instantaneous Overvoltage Trip: IOV

Time Overvoltage Trip: TOV

Instantaneous Negative Sequence Overcurrent Trip: II2 (8BCD-J model only)
Time Negative Sequence Overcurrent Trip: TI2 (8BCD-J model only)
Instantaneous Voltage Unbalance Trip (Level 1): VU1
Instantaneous Voltage Unbalance Trip (Level 2): VU2
Instantaneous Voltage Unbalance Trip (Level 3): VU3
Instantaneous Undervoltage Trip: UV

The trip section is blank if no trip operations have occurred since the last time the Terminal Unit was reset.

The fourth row is reserved for the capacitor bank Automatic Connection Control function. @ indicates the connection method in use:

By Time Clock: **CLOCK**
By Reactive Power: **KVAR**

X indicates the Automatic Connection Control mode:

Manual Control: **MANUAL**
Automatic Connection Control: **AUTO**
Block Trip **BLCKTRIP**

- **Primary Phase Currents and Ground Current**

F2 ➔

```
IA    0.00 A
IB    0.00 A
IC    0.00 A
IG    0.00 A
```

- **Primary Bus Voltage, Measured Voltage Unbalance, Calculated Voltage Unbalance and System Voltage**

F2 ➔

```
V   BUS     X.XX   V
V   UNBAL   X.XX   V
V   CAP   U
V   SYS   U
```

- **Automatic Connection Control Status**

X = present automatic connection control status: **Manual**, **Automatic**, **Blocktrip**. # = new status. If the automatic connection control is in Blocktrip, the new status will be **Reset**. If the automatic connection control is in Manual mode, the new status will be **Auto**. If the automatic connection control is in Automatic mode, the new status will be **Manual**.

```
STATUS          XXXXXXX

########  ➔   PRESS 2 s
CONTINUE ➔   PRESS
```

For example, if the automatic connection control is in Blocktrip and **F2** key is pressed for two seconds, the blocktrip is reset. The following screen is briefly displayed.

```
BLOCKING   RESET
```

- **Reset Trip Indication**

```
RST   TRIP      INDICATORS

CONFIRM    ➔  PRESS 2 s
CONTINUE   ➔  PRESS
```

F2 ➔ **(2 s)**

```
TRIP INDICATION RESET
```

- **Reset LED's**

```
RESET   LEDS

CONFIRM   ➔   PRESS 2 s
CONTINUE  ➔   PRESS
```

F2 ➔ **(2 s)**

```
LEDS   RESET
```

The LED's will all illuminate momentarily and will reset. If **F2** is pressed now, the system presents the default screen. From here, the cycle can be repeated.

Note: the system automatically returns to the default screen if no key entries are made after 20 seconds.

7.4 Access Using the Keypad

From the default screen or the trip/close screen, pressing any key on the keypad displays the Main Menu.

```
0. CONFIGURATION
1. Operation
2. Active Group
3. Change Settings ↓
4. Information
```

The main menu has a series of sub-menus associated with it. These are displayed in a circular window arrangement. The arrows ↓ ↑ in the display indicate that additional options not displayed on the screen can be viewed by scrolling up or down. Scrolling and option selection is accomplished from the main screen by using the arrow keys ↑ ↓.

When the selected option switches to UPPERCASE, the option can be chosen by pressing **ENT**. Selection can also be made by pressing the corresponding option selection number. Pressing 1, for example, selects **Operation**. If an error is made when entering numbers, press ↓. To move from sub-menus back to main menus, press **ESC**.

Whenever any setting has been changed, and the **ESC** key is used to move back to main menus, a Confirmation screen will appear. Function Keys **F1** and **F4** are used to accept or reject changes.

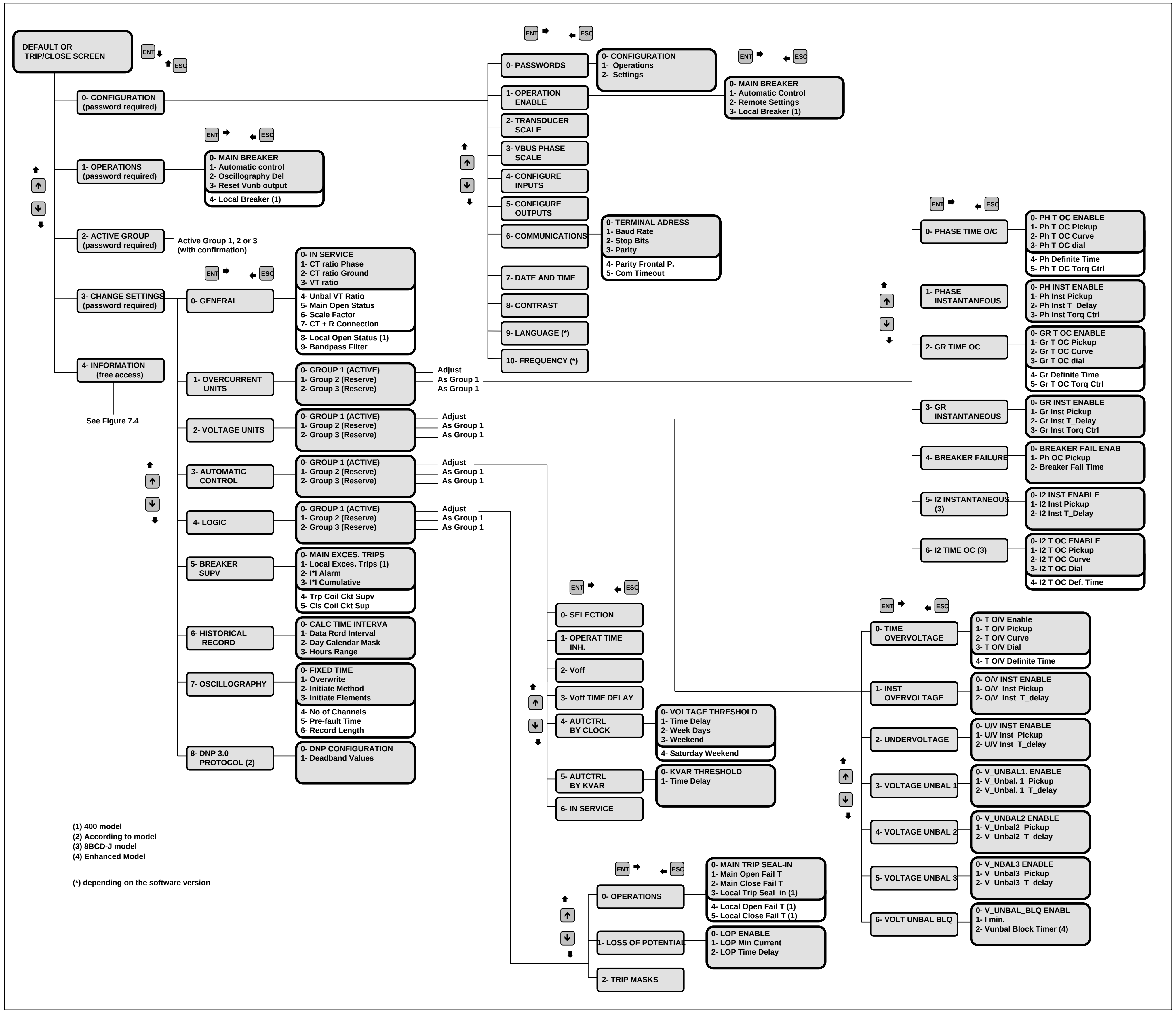


Figure 7.3: Operator Interface Menu Map (Configuration, Operation and Settings)

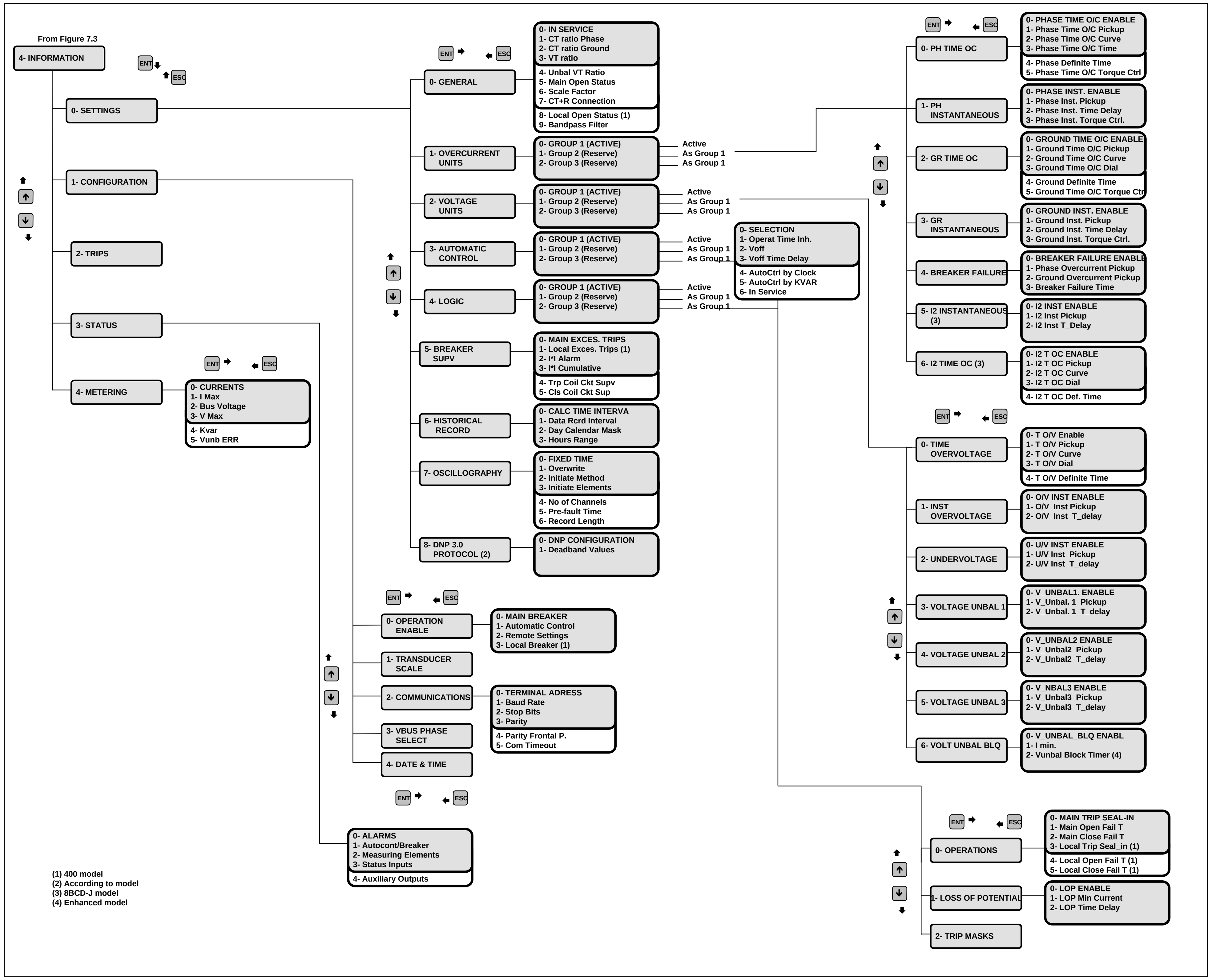


Figure 7.4: Operator Interface Menu Map (Information)

CHAPTER 8

Receiving Tests

VIII

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 metering circuits **even after equipment has been disconnected**.
- Equipment should be solidly grounded before handling or operating.
- Under no circumstances should the operating limits of the equipment be exceeded (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 model-dependent and are detailed in the following table.

8BCD	**PROTECTION**	Preliminary Inspection
		Insulation Test
		In Service Test
		Voltage V SySunb Calibration
		Current Metering Test
		Capacitor Voltage Unbalance Metering Test
		System Voltage Unbalance Metering Test
		Bus Voltage Metering Test
		Reactive Power Metering Test
		Instantaneous Overvoltage Element Test
		Phase Instantaneous Overcurrent Element Test
		Ground Instantaneous Overcurrent Element Test
		Time Overvoltage Element Test
		Phase Time-Overcurrent Element Test
		Ground Time-Overcurrent Element Test
		Negative Sequence Overcurrent Element Test (8BCD-J model)
		Undervoltage Element Test
		Voltage Unbalance Elements Test
		Breaker Failure Detection Test
		Trip/Close Coil Circuit Supervision Input Test
		Capacitors Bank Automatic Control Test

Protection units testing can trip either the local breaker and/or the general breaker (in models 400). Other tests indicate the corresponding breaker depending on the function.

8.1.1 Accuracy

The results obtained in electrical testing greatly depend on the accuracy of the measuring instruments and test source signals (auxiliary power supply voltage, AC currents and AC voltages). It is extremely important that there is little or no distortion (<2%) present in the test source signals as harmonics can affect measuring element precision when levels are above reference conditions used to certify the performance accuracy of equipment.

Therefore, verification of the information specified in Chapter 2, Technical Data, can only reasonably be achieved using test equipment under nominal reference conditions with tolerances as indicated in national and international testing standards. Unless there is absolute compliance with these standards and practices, acceptance tests performed on equipment should only focus on operation verification and not on measurement 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

Before proceeding with this test, set the trip and close coil circuit supervision digital (status) input jumpers on the power supply module **J1**, **J2**, **J5** and **J6** to **NO**.

• Common Mode

Wire all the rear connection terminals together except C1, C2, C3 (power supply) and P17, P18, P19, P20 (transducer inputs) and any other already wired (connections to external units or internal drivers). Then, apply 2000 V_{ac} for 1 minute between interconnected terminals and metal case.

Wire P17, P18, P19, P20 terminals together and apply 800 Vac, for 1 minute between that group of terminals and the metal case.

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.

Important note: before installing equipment, remove wiring used to perform Common Mode Insulation Test.

8.4 In Service/Out of Service Contact Test

Verify the **In Service/Out of Service** contact closes when the auxiliary power supply voltage is removed from the equipment and opens when the auxiliary power supply voltage is restored.

With auxiliary power applied, change the **In Service** setting to **NO** and verify the contact is closed. Return the **In Service** setting to **YES**.

8.5 Receiving Tests

To avoid undesirable tripping operations, enable only the individual elements that are being tested.

Monitor the Measuring Elements Pickup indicator in the Alphanumeric Display (select **Information: Status: Measuring Elements**) and the Trip output contact to establish that the timing elements are picking up.

Confirm that the Measuring Elements Trip indicator in the Alphanumeric Display (select **Information: Status: Measuring Elements**) and the Trip output contact are operating.

8.5.1 Current Metering Test

Apply the currents listed in Table 10-1 to the Phase A Current Analog input and verify that the phase metering values in the Alphanumeric Display (select **Information**: **Metering** are within the ranges specified for Measured Value. The 20A ac current should not be applied for longer than 8 seconds. Repeat this procedure for phases B and C and ground current.

Table 10-1		
Applied Current	**Measured Value $I_n \pm$ 5%**	
	-5%	**+5%**
$0.2 \times I_n$	$0.2\ I_n \times 0.95$	$0.2\ I_n \times 1.05$
I_n	$I_n \times 0.95$	$I_n \times 1.05$
$5 \times I_n$	$5\ I_n \times 0.95$	$5\ I_n \times 1.05$

8.5.2 Bus Voltage Metering Test

Apply the voltages listed in Table 10-2 to the Bus Inputs, and verify that the ground metering values in the Alphanumeric Display are within the ranges specified for Measured Value.

Table 10-2		
Applied Current	**Measured Value $V_{n\ \pm}$ 5%**	
	+5%	**-5%**
$0.5\ V_n$	$0.5\ V_n \times 0.95$	$0.5\ V_n \times 1.05$
V_n	$V_{n\ \times}\ 0.95$	$V_n \times 1.05$
$1.5\ v_n$	$1.5\ V_n \times 0.95$	$1.5\ V_n \times 1.05$

8.5.3 Capacitor Voltage Unbalance Metering Test

Apply V_n to the Bus Voltage input (required to correctly read the phase angle of voltages). Apply the voltages listed in Table 10-3 to the Capacitor Voltage Unbalance Element Input and verify that the voltage metering values in the Alphanumeric Display are within the ranges specified for Measured Value.

Table 10-3	
Applied Voltage	**Measured Value**
1 Vac / 0º	0.95 - 1.05 Vac
5 Vac / 45º	4.75 - 5.25 Vac
15 Vac / 90º	14.2 - 15.8 Vac

8.5.4 System Voltage Unbalance Metering Test

Apply 120 Vac to the Bus Voltage input (required to correctly read the phase angle of voltages). Apply the voltages listed in Table 10-4 to the System Voltage Phase A input, and verify that the voltage metering values of the **System Voltage Unbalance**, shown in the Alphanumeric Display, are within the ranges specified for Measured Value.

Table 10-4	
Applied Voltage	**Measured Value**
1 Vac / 0º	0.32 - 0.35 Vac
5 Vac / 45º	1.58 - 1.75 Vac
15 Vac / 90º	4.74 - 5.25 Vac

8.5.5 Reactive Power Metering Test

Select the **By Reactive Power** option in the **Automatic Connection Control** mode. Set the full scale to 10 MVAR (Transducer Scale setting). Connect a DC Current Power Supply to the mA input channel [P17 (+), P18 (-)]. Apply the currents listed in Table 10-5 between the terminals, and verify that the current metering values in the Alphanumeric Display are within the ranges specified for Measured Value.

Table 10-5	
Applied Current	**Measured Value**
+1 mA dc	9.8 / 10.2 MVAR
0.5 mA dc	4.9 / 5.1 MVAR
-0.5 mA dc	-4.9 / -5.1 MVAR
-1 mA dc	-9.8 / -10.2 MVAR

8.5.6 Overvoltage Instantaneous Element Test

Enable only the Overvoltage Instantaneous elements.

• Pickup

Based on the settings and voltage ranges listed in Table 10-6, apply voltage to the corresponding voltage input.

Table 10-6				
SETTING	PL_MIN	PL_MAX	RL_MIN	RL_MAX
120	114 Vac	126 Vac	108.3 Vac	119.7 Vac
175	166.25Vac	183.75Vac	157.9 Vac	174.6 Vac
220	209 Vac	231 Vac	198.5 Vac	219.5 Vac
X	X - 5%	X + 5%	X × 0.95- 5%	X × 0.95+5%

Check that the Pickup indication for the Instantaneous Overvoltage element in the Alphanumeric Display is a steady "1" when the Voltage is between PL_MIN and PL_MAX (Pickup Level: Minimum and Maximum). Check that the Alphanumeric Display Pickup indication resets for values of voltage (exceeding 95% of the Pickup values) between RL_MIN and RL_MAX (Reset level: minimum and maximum).

• Time Delays

Set the Time Delay to 0 seconds and the Pickup of the Overvoltage Instantaneous elements to 120 Vac. Apply the voltages listed in Table 10-7 to the Overvoltage Instantaneous Input, and verify that the operating times are within the ranges specified.

Table 10-7		
VOLTAGE	T_MIN	T_MAX
144 Vac	---	60 ms
240 Vac	---	55 ms

Set Time Delay to 10 seconds. Apply the previous voltages again, and verify that the new values are within the ranges specified in Table 10-8.

Table 10-8		
VOLTAGE	T_MIN	T_MAX
144 Vac	9.5 s	10.5 s
240 Vac	9.5 s	10.5 s

8.5.7 Overvoltage Time Element Test

Enable only the Overvoltage Time elements.

• Pickup

Based on the settings and voltage ranges listed in Table 10-9, apply voltage to the corresponding voltage input.

Table 10-9				
SETTING	PL_MIN	PL_MAX	RL_MIN	RL_MAX
120	114 Vac	126 Vac	108.3 Vac	119.7 Vac
X	X - 5%	X + 5%	X × 0.95-5%	X × 0.95+5%

Check that the Pickup indication for the Time Overvoltage element in the Alphanumeric Display is a steady "1" when the Voltage is between PL_MIN and PL_MAX (Pickup Level: Minimum and Maximum). Check that the Alphanumeric Display Pickup indication resets for values of voltage (exceeding 95% of the Pickup values) between RL_MIN and RL_MAX (Reset level: minimum and maximum).

• Time Delays

Inverse Time Curve

Set the Pickup of the Time Overvoltage element to 120V ac. Apply the voltages listed in Table 10-10A, Table 10-10B, and Table 10-10C; and verify that the times are within the ranges specified.

Table 10-10A (INDEX = 0.05)		
VOLTAGE	**T_MIN**	**T_MAX**
165 Vac	0.247s	0.405 s
176 Vac	0.116 s	0.182 s

Table 10-10B (INDEX = 0.5)		
VOLTAGE	**T_MIN**	**T_MAX**
165 Vac	2.474 s	4.054 s
176 Vac	1.166 s	1.821 s

Table 10-10C (INDEX= 1)		
VOLTAGE	**T_MIN**	**T_MAX**
165 Vac	4.949 s	8.108 s
176 Vac	2.332 s	3.643 s

Definite Time Curve

Repeat the test choosing the Definite Time Curve and setting the Time Delay to 10 seconds. Verify that the times are within the ranges specified.

Table 10-11		
VOLTAGE	**T_MIN**	**T_MAX**
180 Vac	9.5 s	10.5 s
192 Vac	9.5 s	10.5 s

8.5.8 Instantaneous Undervoltage Element Test

Enable only the Instantaneous Undervoltage elements.

• Pickup

Based on the settings and voltage ranges listed in Table 10-12, apply voltage to the corresponding voltage input.

Table 10-12				
SETTING	**PL_MIN**	**PL_MAX**	**RL_MIN**	**RL_MAX**
75	71.25 Vac	78.75 Vac	74.81 Vac	82.69 Vac
X	X - 5%	X + 5%	X × 1.05-5%	X × 1.05+5%

Check that the Pickup indication for the Instantaneous Undervoltage element in the alphanumeric display is a steady "1" when the Voltage is between PL_MIN and PL_MAX (Pickup Level: Minimum and Maximum).

Note: to verify the Undervoltage Element Pickup, the initial voltage value must be higher than the voltage value to be measured.

Check that the Alphanumeric Display Pickup indication resets for values of voltage (under 105% of the Pickup Values) between RL_MIN and RL_MAX (Reset level: minimum and maximum).

• Time Delays

Applying 120 Vac to the Bus Voltage Input, verify that, when the Voltage Supply is disabled, the Undervoltage Element Time Delays are within the ranges specified in Table 10-13.

Table 10-13		
VOLTAGE	T_MIN	T_MAX
75 Vac	---	60 ms

Repeat the test with the Time Delay set to 10 seconds, and check that the times are within the ranges specified in Table 10-14.

Table 10-14		
VOLTAGE	T_MIN	T_MAX
75 Vac	9.5 s	10.5 s

8.5.9 Voltage Unbalance Elements 1, 2 and 3 Test

Enable only the Voltage Unbalance element 1.

• Pickup

Apply 120 Vac to the Bus Voltage input. Based on the settings and voltage ranges listed in Table 10-15, apply voltage listed to the Capacitor Voltage Unbalance input.

Table 10-15				
SETTING	PL_MIN	PL_MAX	RL_MIN	RL_MAX
0.5	0.475 Vac	0.525 Vac	0.451 Vac	0.498 Vac
10	9.5 Vac	10.5 Vac	9.975 Vac	9.025 Vac
X	X - 0.5%	X + 5%	X × 0.95-5%	X × 0.95 + 5%

Check that the Pickup indication for the Voltage Unbalance element (1) in the Alphanumeric Display is a steady "1" when the Voltage is between PL_MIN and PL_MAX (Pickup Level: Minimum and Maximum). Check that the Alphanumeric Display pickup indication resets for values of voltage between RL_MIN and RL_MAX (Reset level: Minimum and Maximum).

• Time Delays

Apply 120 Vac to the Bus Voltage Input. Set the time delay to 0.05 seconds and the pickup of the Voltage Unbalance element (1) to 15 V. Apply the voltages listed in table 10-16 to Capacitor Voltage Unbalance input, and verify that the operating times are within the ranges specified.

Table 10-16		
VOLTAGE	T_MIN	T_MAX
20 Vac	0.025 s	0.075 s

Set the time delay to 10 seconds. Apply the previous voltages again, and verify that the new values are within the ranges specified in table 10-17.

Table 10-17		
VOLTAGE	T_MIN	T_MAX
20 Vac	9.5 s	10.5 s

The process is the same for Voltage Unbalance Element 2 and 3.

8.5.10 Automatic Connection Control Test

• Connections and Settings

Voltage should be applied between the terminal connectors corresponding to the Bus Voltage input. DC current should be applied to the mA input channel terminal connectors. The following tests should be performed:

Disable all the Voltage elements. Then, implement the following Automatic Connection Control settings.

Automatic Connection Control	In Service (YES)
V_{off} Threshold:	60 Vac (50%)
V_{off} Time Delay	5 s
Operation Inhibit Time Delay:	10 s
Time Clock Settings:	
V_{add} Voltage:	70 Vac
V_{remove} Voltage:	100 Vac
V_{add} Time Delay:	3 s
V_{remove} Time Delay:	3 s
$V_{hysteresis}$ Threshold	5 Vac
Connection Time:	00:00 - 12:00
Disconnection Time:	12:00 - 00:00
Reactive Power Settings	
Connection Threshold:	+10%
Disconnection Threshold:	-10%
Connection Time Delay	5 s
Disconnection Time Delay	5 s

Time measured values should be within +/-5% or 50 ms (whichever is greater).

• Automatic/Manual Test

Before this test is performed, the Terminal Unit must be changed from the blocked status in which it remains after any protection trip (Blocktrip). To do so, the corresponding command (**Blocking Reset**) must be sent using the F2 Function Key (see Section 7.3 for this procedure).

Next, a “Change to Automatic Mode” command must be sent to the Terminal Unit (**Operation**: **Automatic Connection Control**: **Automatic**). The Automatic Connection Control element should change to **Automatic**.

• Automatic Connection Control by Time Clock Test

Using the Alphanumeric Keypad and Display, select **Change Settings**: **Automatic Connection Control**: **Selection Mode**: **By Time Clock**. Apply a 65 Vac voltage. The breaker closes.

Set a specific time within the Connection Threshold range. To do so, input:

Connection Threshold (**HH:MM:SS**):	00:01:00
Disconnection Threshold (**HH:MM:SS**):	00:00:00

Raise the voltage up to 110 Vac. After 3 seconds, the Automatic Connection Control element should send a signal to open the capacitor bank.

After 5 seconds (half of the Operation Inhibit Time Delay), lower the voltage to 85 Vac. The Automatic Connection Control element should send a signal to close the capacitor bank after a 5 second time delay (the remaining 5 seconds of the Operation Inhibit Time Delay).

Lower the voltage to 40 Vac. The Automatic Connection Control element should send a signal to open the capacitor bank after a 5 second time delay. Wait 7 seconds, then change the hours of the Connection and Disconnection Thresholds. To do so, set the Terminal Unit in the following way:

Connection Hours (**HH:MM:SS**):	00:00:00
Disconnection Hours (**HH:MM:SS**):	00:01:00

Raise the voltage up to 65 Vac. The Automatic Connection Control element should send a signal to close the capacitor bank after 3 seconds.

Raise the voltage to 80 Vac. The Automatic Connection Control element should send a signal to open the capacitor bank after 3 seconds.

• Automatic Connection Control by Reactive Power Test

Set the voltage to a steady 65 Vac value. Using the Alphanumeric Keypad and Display, select **Automatic Connection Control**: **Selection**: **By Reactive Power**.

Supply 0.5 mA via the mA input channel. The Automatic Connection Control element should close the capacitor bank after 5 seconds. Supply –0.5 mA. The Automatic Connection Control element should open the capacitor bank after 5 seconds.

8.5.11 Instantaneous Negative Sequence Overcurrent Element Test (8BCD-J Model)

Enable only the Phase Instantaneous overcurrent elements.

- **Pickup**

Based on the settings and current ranges listed in Table 10-18, apply current to the Phase A Current Analog Input and check that the Pickup indication for the Phase A Instantaneous Over-current element in the alpha-numeric display is a steady "1" when the current is between PL_MIN and PL_MAX (Pickup Level: Minimum and Maximum).

Table 10-18				
SETTING	PL_MIN	PL_MAX	RL_MIN	RL_MAX
1.5A ac	0.5A ac	0.55A ac	0.47A ac	0.53A ac
6A ac	2A ac	2.21A ac	1.9A ac	2.1A ac
30A ac	10A ac	11.03A ac	9.5A ac	10.5A ac
X	(X × 1.05)-5%	(X × 1.05)+5%	X - 5%	X + 5%

Eventually, the Alphanumeric Display indication corresponding to the Trip Output of the Instantaneous Negative Sequence Overcurrent element should also activate, as well as the Trip Output Contacts.

Check that the Alphanumeric Display Pickup indication resets for values of current between RL_MIN and RL_MAX (Reset Level: Minimum and Maximum). When the Pickup indication resets, the Trip Output indication should also reset.

- **Time Delay**

Set the Pickup of the Phase Instantaneous Overcurrent elements to 0.5A ac. Apply the currents listed in Table 10-19 to the Phase A Current Analog Input, and verify that the operating times are within the ranges specified.

Table 10-19		
CURRENT	T_MIN	T_MAX
0.6A ac	---	45 ms
2A ac	---	35 ms
10A ac	---	30 ms

Set the Phase Instantaneous Overcurrent Time Delay to 10 s. Apply 2A ac, and verify that tripping occurs within 9.5 s and 10.5 s.

8.5.12 Ground Instantaneous Overcurrent Element Test

Enable only the Ground Instantaneous Overcurrent element.

• Pickup

Based on the settings and current ranges listed in Table 10-20, apply current to the Ground Current Analog Input. Check that the Pickup indication for the Ground Instantaneous Overcurrent element in the Alphanumeric Display is a steady "1" when the current is between PL_MIN and PL_MAX.

Table 10-20				
SETTING	**PL_MIN**	**PL_MAX**	**RL_MIN**	**RL_MAX**
0.5A ac	0.5A ac	0.55ª ac	0.47A ac	0.53A ac
2A ac	2A ac	2.21ª ac	1.9A ac	2.1A ac
10A ac	10A ac	11.03A ac	9.5A ac	10.5A ac
X	(X × 1.05)-5%	(X × 1.05)+5%	X - 5%	X + 5%

Eventually, the alphanumeric indication corresponding to the Trip Output of the Ground Instantaneous Overcurrent element should also activate, as well as the Trip Output Contacts.

Check that the Alphanumeric Display Pickup indication resets for values of current between RL_MIN and RL_MAX. When the Pickup indication resets, the Trip Output indication should reset, as well.

• Time Delay

Set the Pickup setting of the Ground Instantaneous Overcurrent element to 0.5A ac. Apply the currents indicated in Table 10-21 to the Ground Current Analog Input, and verify that the times are within the ranges specified.

Table 10-21		
CURRENT	**T_MIN**	**T_MAX**
0.6A ac		45 ms
2A ac		35 ms
10A ac		30 ms

Adjust the Ground Instantaneous Overcurrent Time Delay to 10 s. Apply 2A ac, and verify that tripping occurs between 9.5 s and 10.5 s.

8.5.13 Time Negative Sequence Overcurrent Element Test (8BCD-J Model)

• Pickup

Based on the settings and current ranges listed in Table 10-22, apply current to the Phase A Current Analog Input. Check that the Pickup indication for the Phase Time Overcurrent element in the Alphanumeric Display is a steady "1" when the current is between PL_MIN and PL_MAX.

Table 10-22				
SETTING	**PL_MIN**	**PL_MAX**	**RL_MIN**	**RL_MAX**
3A ac	1A ac	1.1ª ac	0.95A ac	1.05A ac
15A ac	5A ac	5.51A ac	4.75A ac	5.25A ac
36A ac	12A ac	13.23A ac	11.40A ac	12.60A ac
X	(X × 1.05)-0.5%	(X × 1.05) +5%	X - 5%	X + 5%

Eventually, the Alphanumeric Display indication corresponding to the Trip Output of the Time Negative Sequence Overcurrent element should also activate, as well as the Trip Output Contacts.

Check that the Alphanumeric Display Pickup indication resets for values of current between RL_MIN and RL_MAX. When the Pickup indication resets, the Trip Output indication should reset, as well.

• Time Delay

Inverse Time Curves

Set the Pickup of the Phase Time Overcurrent element to 1.0A ac and the Time Dial to 0.5. Apply the currents listed in Table 10-23 to the Phase A Current Analog Input, and verify that the times for the Inverse, Very Inverse and Extremely Inverse Time Curves are within the ranges specified.

Table 10-23 (TIME IN SECONDS)						
PHASE CURRENT (A ac)	**TIME DIAL = 0.5**					
	INVERSE		**VERY INVERSE**		**EXT. INVERSE**	
	T_MIN	**T_MAX**	**T_MIN**	**T_MAX**	**T_MIN**	**T_MAX**
2	4.4585	5.5705	5.9583	7.5417	11.7030	14.9636
5	2.0195	2.2603	1.1585	1.7935	1.5431	1.7902
20	1.0770	1.1904	0.3303	0.3803	0.0753	0.1253

Definite Time Curve

Select the Definite Time curve. Set the Pickup of the Phase Time Overcurrent elements to 1A ac. Apply 2A ac to the Phase A Current Analog Input for each Time Dial setting listed in Table 10-24, verifying that the corresponding operating times are within the ranges specified. Repeat this process for phases B and C.

Table 10-24		
TIME DIAL SETTING	**T_MIN (s)**	**T_MAX (s)**
0.05	0.025	0.075
0.1	0.075	0.125
1	0.95	1.05
10	9.5	10.5

8.5.14 Ground Time Overcurrent Test

Enable only the Ground Time Overcurrent element.

- **Pickup**

Based on the settings and current ranges listed in Table 10-25, apply current to the Ground Current Analog Input. Check that the Pickup indication for the Ground Time Overcurrent element in the Alphanumeric Display is a steady "1" when the current is between PL_MIN and PL_MAX.

Table 10-25				
SETTING	**PL_MIN**	**PL_MAX**	**RL_MIN**	**RL_MAX**
0.2A ac	0.2A ac	0.22A ac	0.19A ac	0.21A ac
1A ac	1A ac	1.1A ac	0.95A ac	1.05A ac
2.4A ac	2.4A ac	2.64A ac	2.28A ac	2.52A ac

Eventually, the Alphanumeric Display indication corresponding to the Trip Output of the Ground Time Overcurrent element should also activate, as well as the Trip Output Contacts.

Check that the Alphanumeric Display Pickup indication resets for values of current between RL_MIN and RL_MAX. When the Pickup indication resets, the Trip Output indication should reset, as well.

- **Time Delay**

Inverse Time Curves

Set the Pickup of the Ground Time Overcurrent element to 0.2A ac and the Time Dial to 0.5. Apply the currents listed in Table 10-26 to the Ground Current Analog Input; and verify that the times for the Inverse, Very Inverse and Extremely Inverse Time Curves are within the ranges specified.

Table 10-26 (TIME IN SECONDS)						
PHASE CURRENT (A ac)	**TIME DIAL = 0.5**					
	INVERSE		**VERY INVERSE**		**EXT. INVERSE**	
	T_MIN	**T_MAX**	**T_MIN**	**T_MAX**	**T_MIN**	**T_MAX**
0.4	4.4585	5.5705	5.9583	7.5417	11.7030	14.9636
1	2.0195	2.2603	1.1585	1.7935	1.5431	1.7902
4	1.0770	1.1904	0.3303	0.3803	0.0753	0.1253

Definite TimeCurve

Select the Definite Time curve. Set the pickup of the Ground Time Overcurrent element to 0.2A ac. Apply 0.4A ac to the Ground Current Analog Input for each Time Dial setting listed in Table 10-27, verifying that the corresponding operating times are within the ranges specified.

Table 10-27		
TIME DIAL SETTING	T_MIN (s)	T_MAX (s)
0.05	0.025	0.075
0.1	0.075	0.125
1	0.95	1.05
10	9.5	10.5

8.5.15 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 the 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 should operate in 0.475 s to 0.525 s. The operation of the Breaker Failure element should 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.

8.5.16 Trip/Close Coil Circuit Supervision Input Test

Disconnect the auxiliary power supply from the Terminal Unit. Remove the power supply of the protection printed circuit board from the unit, and set the jumpers on this board to SUP. Re-establish the power supply voltage. Set the Alphanumeric Display to **Information: Status: Status Inputs**. Verify that IN-5, IN-.6, IN-7 and IN-11 are active with no voltage applied to their respective input terminals.

Disconnect the power supply voltage from Terminal Unit again, and restore the jumpers on the power supply printed circuit board to their previous positions.

8.5.17 Instantaneous Elements in Maximum Range Mode Test

Set all the instantaneous elements to their maximum operating range values.

Verify for every metering channel:

1. The terminal unit performs a trip for a current equal to 110% of the setting value.
2. The terminal unit does not perform a trip for a current equal to 95% of the setting value.

8.5.18 Default and User Settings

Settings must remain in their default values for the three available Setting Groups. The Power Supply jumpers should be set following the specific requirements of each purchase order.

The desired configuration should be loaded via the Communications Front Port, following the code specified in the purchase order, verifying that the loading process has been correctly performed.

8.6 Communication Test

Test will be performed through local communications port, allocated on front panel. This port has fixed settings as follows:

Baud Rate	**4800**
Stop Bits	**1**
Parity	**Even parity (1)**

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.

8.7 Installation

8.7.1 Location

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

- **Absence of dust**
- **Absence of dampness**
- **Absence of vibration**
- **Adequate lighting**
- **Easy access**
- **Front panel in an upright and vertical position**

8.7.2 Connection

Terminals C1 and F1 (or K1, X1 depending on the model) 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”.

8.7.3 Calibration Procedure

The **8BCD-G** has been designed to increase the measurement sensitivity of the Voltage Unbalance element. Therefore, it is necessary to take into account, during commissioning, the errors and tolerances of the whole system to which the **8BCD-G** is connected (capacitor bank, transformer ratios, etc.) that can influence the measurement process. Without calibration, the errors present when the **8BCD-G** is connected will appear as an unbalanced voltage. The Calibration Procedure allows these errors to be memorized by the relay and considered as a deviation (magnitude and phase) from the theoretical zero, which will then be subtracted from the measured voltage unbalance.

The procedure to calibrate the relay is as follows:

Push the Function Key F4. The Alphanumeric Display will show a screen asking for the password. Input the Calibration password 1798. The relay will then display a screen showing the word: **Calibrating**. It is now calculating the offset.

Once the calculations are finished, the **8BCD-G** will show a screen with the most significant values used by the Voltage Unbalance element, including the calculated error (ERR). At this time the calculated error is not yet used by the measuring element.

Depress the ESC key. The **8BCD-G** will ask for **Confirmation** of the Calibration procedure. If the Function Key F4 is pressed (NO), the relay will go back to the idle (default) screen, discarding the calculated error (ERR). If Function Key F1 is pressed (YES), the relay will also go back to the idle screen, but with the calculated error memorized (ERR) and being considered in the measuring process, as explained in Chapter 6.

If the **8BCD-G** is not calibrated when initially installed, it will work properly, but with less sensitivity. The initial error due to the errors and tolerances of the whole system will always be present, and the Pickup setting of the Voltage Unbalance element will need to be set to a higher voltage value to avoid a false operation.

CHAPTER 9

Figures

Chapter 9

Figure		Page

Schemes and Drawings

The following plans are attached

Dimension and drill hole schemes

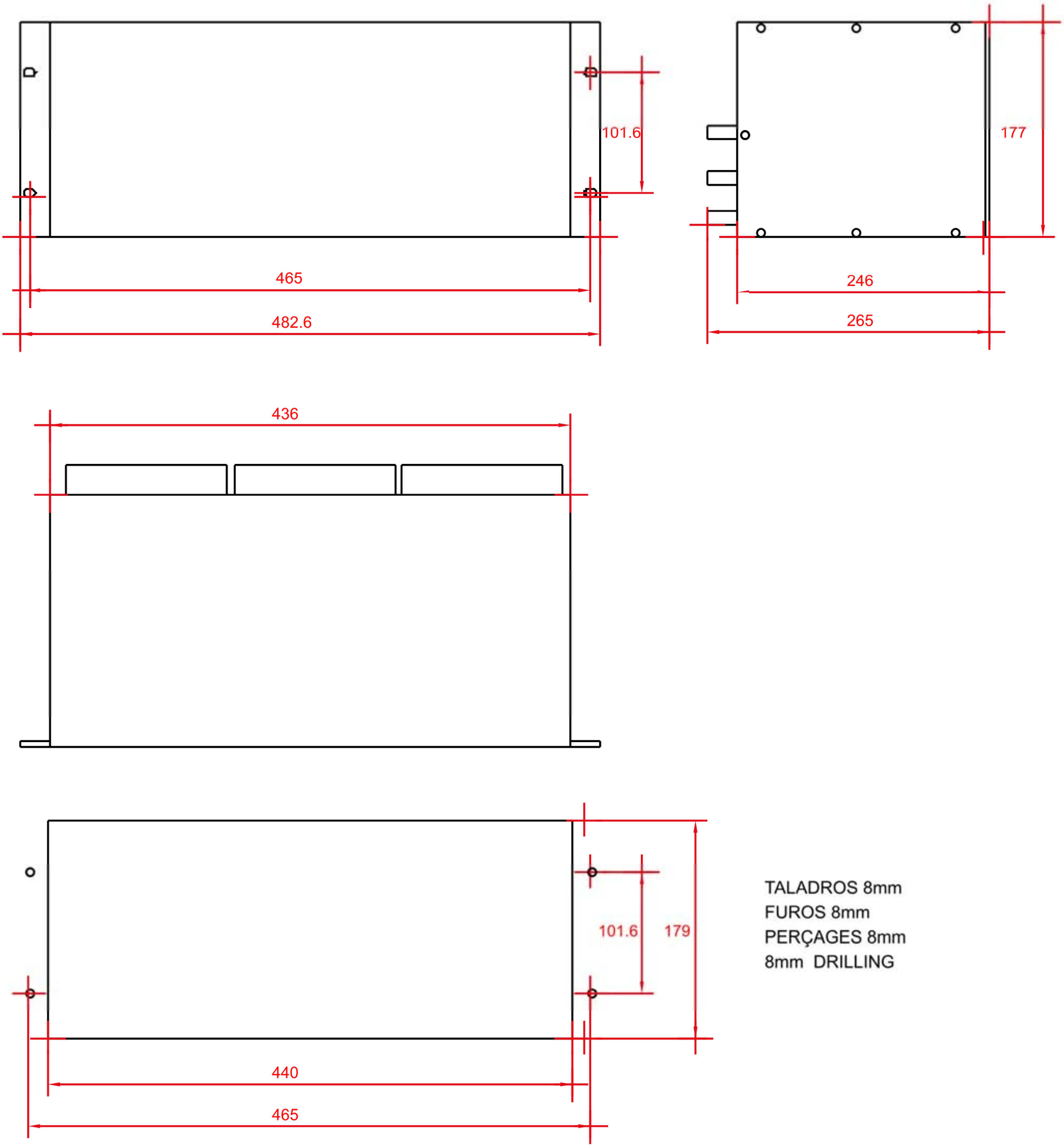
8BCD	>>	4BF0100/0012

External connection scheme

8BCD-G	>>	3RX0140/0016
8BCD-J	>>	3RX0140/0017

Note: The following external connection plan is an example of a possible configuration for the unit.

CAJA TIPO "K" Y "Q"
CAIXA TIPO "K" Y "Q"
BOîTIER TYPE "K" ET "Q"
ENCLOSURE TYPE "K" AND "Q"



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

REVISIONES		0		1	CDN9506107
2	CDR9510101	3	CDR9710100	4	CDR9809104
5	CD9911149	6	CD0202125	7	CD0411139
8	CD0901130	9		10	
11		12		13	
14		15		16	

Z I V Aplicaciones y Tecnología S.L.

TÍTULO: DIMENSIONES Y TALADRADO

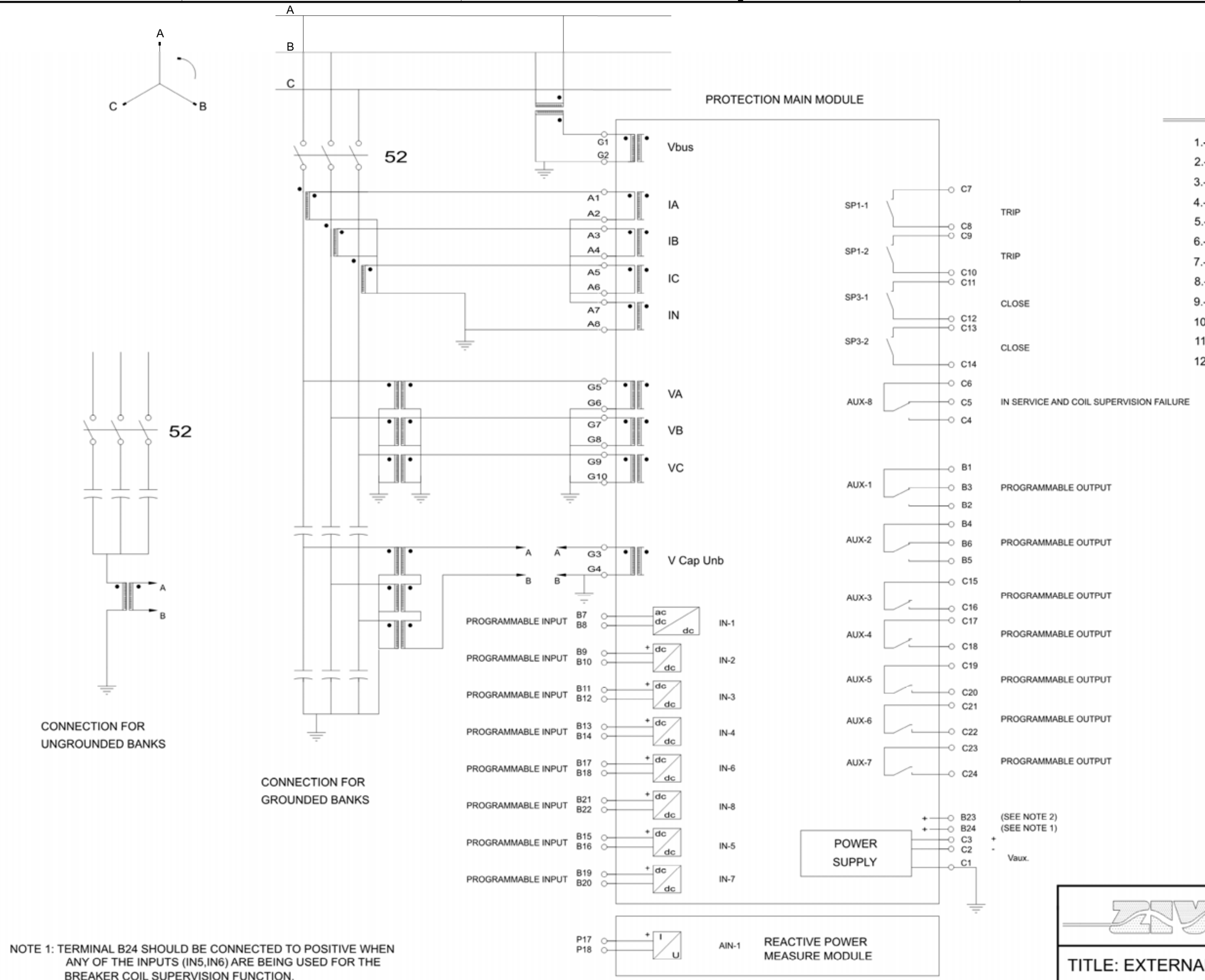
PROYECTO: CAJA TIPO "K" Y "Q" 4U 1RACK

Rev. 0
Rev. 2 2/10/95
Rev. 3 2/10/97
Rev. 4 10/9/98
Rev. 5 19/11/99
Rev. 6 14/2/02
Rev. 7 19/11/04
Rev. 8 6/2/09

NÚMERO: 4BF0100/0012

	Fecha	Nombre
Dibujado	27/6/95	R.O.
Aprobado	27/6/95	R.O.

Hoja: 1
Continua en Hoja:



LEDS

1.- PROGRAMMABLE.
2.- PROGRAMMABLE.
3.- PROGRAMMABLE.
4.- PROGRAMMABLE
5.- PROGRAMMABLE.
6.- PROGRAMMABLE.
7.- PROGRAMMABLE
8.- PROGRAMMABLE.
9.- PROGRAMMABLE.
10.- PROGRAMMABLE
11.- PROGRAMMABLE.
12.- PROGRAMMABLE.

NOTE 1: TERMINAL B24 SHOULD BE CONNECTED TO POSITIVE WHEN ANY OF THE INPUTS (IN5,IN6) ARE BEING USED FOR THE BREAKER COIL SUPERVISION FUNCTION.

NOTE 2: TERMINAL B23 SHOULD BE CONNECTED TO POSITIVE WHEN ANY OF THE INPUTS (IN7,IN8) ARE BEING USED FOR THE BREAKER COIL SUPERVISION FUNCTION.

REVISIONS	0	CD0310133	1		2		3		4	
5	6		7		8		9		10	
11	12		13		14		15		16	

Z I V Aplicaciones y Tecnología S.L.

TITLE: EXTERNAL CONNECTIONS 8BCD

PROJECT: CAP. BANK PROTECTION

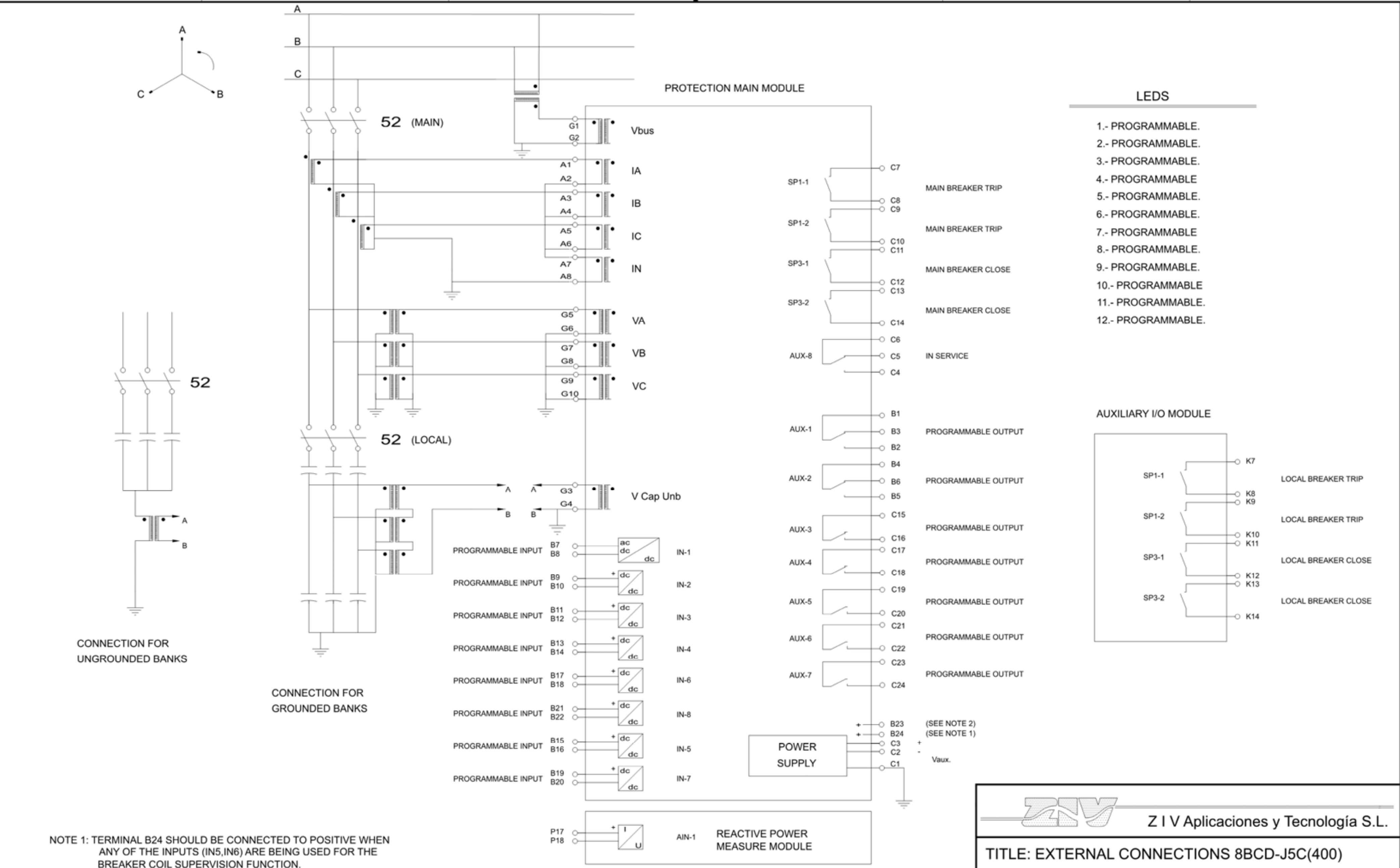
Rev. 0

NUMBER: 3RX0140/0016

	Date	Name
Drawn	10/10/03	J.C.S.
Approved	10/10/03	J.M.Y.

Sheet: 1

Continued on Sheed:



NOTE 1: TERMINAL B24 SHOULD BE CONNECTED TO POSITIVE WHEN ANY OF THE INPUTS (IN5,IN6) ARE BEING USED FOR THE BREAKER COIL SUPERVISION FUNCTION.

NOTE 2: TERMINAL B23 SHOULD BE CONNECTED TO POSITIVE WHEN ANY OF THE INPUTS (IN7,IN8) ARE BEING USED FOR THE BREAKER COIL SUPERVISION FUNCTION.

REVISIONS	0	CD0402139	1	CD0612115	2		3		4	
5	6		7		8		9		10	
11	12		13		14		15		16	

Z I V Aplicaciones y Tecnología S.L.

TITLE: EXTERNAL CONNECTIONS 8BCD-J5C(400)

PROJECT: CAP. BANK PROTECTION

Rev. 0
Rev. 1 18/12/05

NUMBER: 3RX0140/0017

	Date	Name	Sheet: 1
Drawn	17/02/04	J.C.S.	Continued on Sheed:
Approved	17/02/04	J.M.Y.	