Reyrolle
Protection
Devices

7SG12 DAD-N

Numerical High Impedance Relay with CT Supervision

Answers for energy

SIEMENS

Contents

Technical Manual Chapters

7SG12 DAD N

Numerical High Impedance Relay with CT Supervision

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:
Pre release

2010/02	Document reformat due to rebrand
R4 26/08/2005	Clarified TCS operation.
R3 20/07/2005	Second stage differential element added.
R2 24/05/2004	General update
R1 06/06/2003	First Issue for Comment.

Software Revision History

Contents

Figures

1 Introduction

The DAD-N relay represents an integration of the protection elements required to provide a complete Numerical High Impedance protection, with additional auxiliary and backup elements available to provide integrated scheme solutions. The basic relay is a single differential zone as shown below. Other models are also available which incorporate multiple zones of protection which may be used together with logic schemes to form more complex busbar protection zones with check zone capability.

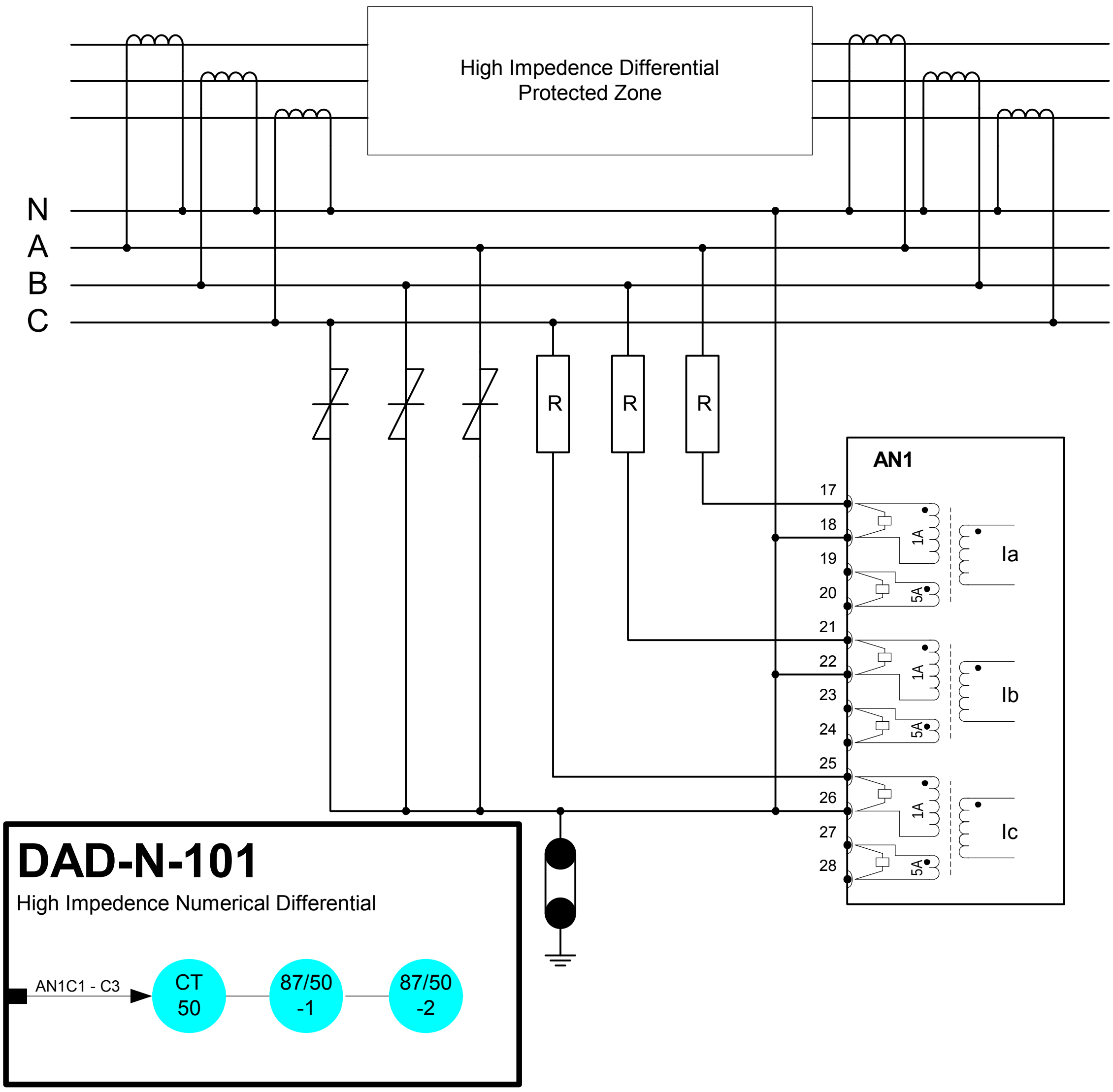


Figure 1 – DAD-N-101 Numerical High Impedance protection

2 Hardware Description

2.1 General

The structure of the relay is based upon the Modular II hardware and software platform illustrated in Figure 2 where the required cards plug in from the front after opening the front fascia. Modules are interconnected by means of ribbon cable. The basic relay is supplied in a standard Epsilon case size E8. The Modular II design provides commonality between products and spare parts across a range of protection and control relays including Duobias, Ohmega, Delta, Tau and Iota.

Configuration :

Analogue Inputs	Status Inputs	Output Relays	Case	Connections
3	11	13	E8	2621W11006

Each analogue module has up to four inputs; the first three are usually for measuring the CT secondary line currents from each of the three phases A, B and C. The fourth channel is not used.

The unit consists of the following modules:

1) Analogue Input modules (4 x I)

2) One Controller CPU module

3) One Power Supply and Basic I/O module

4) Maximum of Four Output relay/Status Input Module

5) One Front Fascia

2.2 Analogue Inputs

One analogue module is used in the E8 case of 3 channels of current.

In order to ensure high accuracy true RMS measurements and accurate phase and slip frequency calculations, the current signals are sampled at a minimum of 16 samples per cycle for both 50Hz and 60Hz system frequencies. This sampling rate also provides high accuracy and waveform storage records

2.3 Status Inputs

The relay may be fitted with up to 11 status inputs. The user can program the relay to use any status input for any function. A timer is associated with each input and a pickup time setting may be applied to each input. In addition each input may be logically inverted to allow easy integration of the relay within the user scheme. Each input may be mapped to any front Fascia LED and/or to any Output Relay contact. This allows the Relay to act as panel indication for alarms and scheme status without having to use additional external flagging elements.

2.4 Output Relays

The relay may be fitted with 13 output relays, all of which are capable of handling circuit breaker tripping duty. All relays are fully user configurable and can be programmed to operate from any or all of the control functions. There are three relays on the Power Supply/Basic I/O module which have C/O contacts and 2 with N/O contacts. Additional modules may are fitted with 8 N/O contacts.

In their normal mode of operation output relays remain energised for a minimum of 100msec and a maximum dependent on the energising condition duration. If required, however, outputs can be programmed to operate as latching relays. These latched outputs can be reset by either pressing the TEST/RESET button, or by sending an appropriate communications command.

The output relays can be used to operate the trip coils of the circuit breaker directly if the circuit breaker auxiliary contacts are used to break the trip coil current and the contact rating of the relay output contacts is not exceeded for 'make and carry' currents.

With a failed breaker condition the current 'break' may be transferred to the relay output contacts and where this level is above the break rating of the contacts an auxiliary relay with heavy-duty contacts should be utilised.

2.5 Fascia LEDS

In the E8 case there are 16 user programmable red LED flag indicators. By opening the front panel it is possible to insert a label strip into a slip in pocket, which provides legend information about the meaning of each LED. The legend may be specified when ordering the relay or alternatively the user can create a customized legend. The user can customise which LED is used for which purpose as well as being able to program each LED as being latching or self –resetting.

2.6 Self Monitoring

The relay incorporates a number of self-monitoring features. Each of these features can initiate a controlled reset recovery sequence, which can be used to generate an alarm output. In addition, the Protection Healthy LED will give visual indication.

A watchdog timer continuously monitors the microprocessor. The voltage rails are also continuously supervised and the microprocessor is reset if any of the rails falls outside of their working ranges. Any failure is detected in sufficient time so that the microprocessor can be shut down in a safe and controlled manner.

2.6.1 Protection Healthy/Defective

The normally closed contacts of relay 1 are used to signal protection defective, whilst the normally open contacts are used to signal protection healthy. When the DC supply is not applied to the relay or a problem is detected with the operation of the relay then this relay is de-energised and the normally closed contacts make to provide an external alarm. When the relay has DC supply and it has successfully passed its self-checking procedure then the Protection Healthy contacts are made and the Protection Defective contacts are opened.

3 Protection Functions

3.1 Overall Differential (87/50-1, 87/50-2)

The Overall Differential protection uses the high impedance circulating current principle, a single line diagram of such a scheme is shown in Figure 4 – High Impedance Differential Schematic. The protection consists of a DTL over-current element 87/50 per phase which is used for tripping.

Transient stability under through fault conditions is a problem with many forms of differential protection, due to variations in CT magnetising characteristics. When saturation is approached the current transformer output waveforms become increasingly distorted with a high percentage of 3rd and other harmonics. The algorithms employed in the Overall Differential protection ensure complete harmonic rejection thus improving overall protection stability.

In addition the settings for high impedance differential protection are calculated assuming that one CT is completely saturated. Using this worst case condition the voltage (determined by the value of the stabilising resistor) and current settings for the 87/50 elements can be precisely calculated with known stability margins. Intermediate conditions where the CT is only partially saturated increases the stability margin. This approach enables schemes to be engineered with relatively low knee-point voltages.

There are two stages of protection, 87/50-1 and 87/50-2 both of which are identical.

3.2 CT Supervision (CT 50)

To check for CT continuity an overcurrent element (50) is available. During healthy CT conditions the current in the differential circuit is zero. If one CT becomes open circuit the current contribution from that CT will flow through the relay. If the setting is below this level of current the relay CT alarm will operate.

3.3 Trip Circuit Supervision

Status inputs on the relay can be used to supervise the trip circuit while the associated circuit breaker (CB) is either open or closed. Each trip circuit monitored can independently be programmed to operate output contacts, LEDs and events.

To use the function set ‘Trip Cct *n* Pickup Delay’ to the required value in the Trip Circuit Supervision Menu and then map the ‘Trip Cct Fail *n*’ settings in the Status Input Menu, Output Relay Menu and LED Menu as required.

The Trip Circuit Timer(s) are inhibited whenever one or more of the status inputs selected is energised.

4 Other Features

4.1 Metering

The metering feature provides real-time data available from the relay fascia in the 'Instruments Mode' or via the communications interface.

The following displays are available:

Differential currents (Primary and secondary)

Digital input status

Output relay status

Time and Date

4.2 Data Storage

4.2.1 General

Details of relay operation are recorded in three forms, namely Waveform records, Event records and Fault Data records. All records are time and date stamped with a resolution of one millisecond.

4.2.2 Waveform Records.

The waveform record feature stores analogue and digital information for the current inputs, status inputs and output relays and LED's. Waveforms may be returned to VA TECH Reyrolle ACP Ltd for analysis.

The waveforms are stored with a sampling resolution of at least 16 samples per cycle depending upon relay model. The waveform recorder has the ability to store records for the previous four trip operations of the relay. These are labelled 1-4 with 1 being the most recent record. This however, can be altered using the 'Record Duration' setting, which offers the following selection:

- Five records of one second duration
- Two records of two seconds duration
- One record of five seconds duration

The waveform recorder will be triggered automatically when any protection element operates. It can also be triggered by any of the following means:

Via the 'Trigger Storage" status input signal.

Via the IEC870-5-103 communications interface.

The waveform recorder has a settable pre-fault triggering capability.

4.2.3 Event Records

The event recorder feature allows the time tagging of any change of state (Event) of the relay. As an event occurs, the actual event condition is logged as a record along with a time and date stamp to a resolution of 1 millisecond. There is capacity for a maximum of 500 event records that can be stored in the relay and when the event buffer is full any new record will over-write the oldest. The following events are logged:

Change of state of Output Relays.

Change of state of Status Inputs.

Change of Settings and Settings Group

Change of state of any of the control functions of the relay.

4.2.4 Fault Recording

The fault type, led flag configuration, date and time of the last five faults are recorded for display via the Fascia LCD.

Note : the real-time clock, waveform records, fault records and event records are all maintained, in the event of loss of auxiliary d.c. supply voltage, by the backup storage capacitor. This capacitor has the ability to maintain the charges on the real-time clock IC and the SRAM memory device for typically 2-3 weeks time duration.

4.3 Time Synchronisation

Time and date can be set either via the relay fascia using appropriate commands in the System Config menu, via an IRIG-B input or via the communications interface

4.3.1 IRIG-B Time Synchronisation

A BNC connector on the relay rear provides an isolated IRIG-B GPS time synchronisation port. The IRIG-B input expects a modulated 3-6 Volt signal and provides time synchronisation to the nearest millisecond.

4.3.2 IEC 60870-5-103 Time Synchronisation

Relays connected individually or in a ring or star configuration can be directly time synchronised using the IEC 60870-5-103 global time synchronisation. This can be from a dedicated substation automation system or from REYDISP EVOLUTION communications support software.

4.3.3 Real Time Clock Time Synchronisation

In the absence of IRIG-B and IEC60870 time synchronisation the relay contains a real time clock circuit which maintains real time in the absence of DC supply.

4.4 Communications

Two fibre optic communication ports, COM1 and COM 2b are provided at the rear of the relay, which give superior EMC performance. An isolated RS232 port, COM 2a, is provided at the front of the relay for local access using a PC.

Communication is compatible with the IEC870-5-103 FT 1.2 transmission and application standards. For communication with the relay via a PC (personal computer) a user-friendly software package, REYDISP EVOLUTION, is available to allow transfer of the following:

Relay Settings

Waveform Records

Event Records

Fault Data Records

Instrument and meters

Control Functions

Communications operation is described in detail in Section 4 of this manual. For information about all aspects of the communications protocol used in the Modular II range of relays see Section 4.

4.5 Settings Groups

Depending upon the relay model then up to eight alternative setting groups are provided, making it possible to edit one group while the relay protection algorithms operate using another ‘active’ group. An indication of which group is being viewed is given by the ‘Gn’ character in the top left of the display. Settings that do not indicate Gn in the top left corner of the LCD are common to all groups.

A change of group can be achieved either locally at the relay fascia or remotely via a communication interface command or via a status input change.

4.6 Password Feature

The programmable password feature enables the user to enter a 4 character alpha numeric code to secure access to the relay settings. The relay is supplied with the password set to ‘NOT ACTIVE’, which means that the password feature is disabled. The password must be entered twice as a security measure against accident changes. Once a password has been entered then it will be required thereafter to change settings. It can, however, be de-activated by using the password to gain access and by entering the password ‘NONE’. Again this must be entered twice to de-activate the security system.

As soon as the user attempts to change a setting the password is requested before any setting alterations are allowed. Once the password has been validated, the user is ‘logged on’ and any further changes can be made without re-entering the password. If no more changes are made within 1 hour then the user will automatically be 'logged off', re-enabling the password feature.

Note that the password validation screen also displays a numerical code. If the password is lost or forgotten, this code should be communicated to VA TECH Reyrolle ACP Ltd and the password can be retrieved.

5 User Interface

The user interface is designed to provide a user-friendly method of entering settings and retrieving data from the relay. The E8 relay fascia includes a 20 character by 2 line, backlit, liquid crystal display (LCD), 16 light emitting diodes (LED) and 5 push buttons.

5.1 Liquid Crystal Display

The liquid crystal display is used to present settings, instrumentation and fault data in a textual format on a 2 lines by 20-character interface.

5.2 Back Light Control

To conserve power the display backlighting is turned off if no push buttons are pressed for 5 minutes. After an hour the whole display is de-activated. A setting within the "SYSTEM CONFIG MENU" allows the timeout to be adjusted from 1 to 60 minutes and "OFF", which means the backlight is always on.

5.3 LED Indications

The following indications are provided:

Protection Healthy – Green LED.

This LED is solidly illuminated to indicate that DC volts have been applied to the relay and that the relay is operating correctly. If the internal relay watchdog detects a protection relay unhealthy condition then this LED will continuously flash.

Programmable – Red LED.

An LED MENU is provided to map any relay output or any status input to any LED.

5.4 Keypad

Five pushbuttons are used to control the functions of the relay. They are labelled **ENTER** and **CANCEL**. Note that the ► button is also labelled **TEST/RESET**.

When the relay front cover is in place only the ▼ and ► buttons are accessible. This allows read only access to all the menu displays.

5.5 Relay Identifier

The Relay Identifier setting in the SYSTEM CONFIG MENU may be used to place a circuit identifier of up to 16 alphanumeric characters onto the relay fascia. This information is also returned as part of the System Information command from Reydisp Evolution Communications Support Software.

5.6 Settings Mode

5.6.1 Settings Adjustment

The push-buttons on the fascia are used to display the relay settings, display the operating signals, e.g. currents, on the LCD and to reset the flag indication on the LCDs.

▼READ DOWN

In the Settings Display this push-button is used for scrolling down through a list of settings or signals.

In Settings Modification mode it is used for selecting the next value of (or decreasing) the displayed setting or for deselecting a bit position in a particular control setting.

▲READ UP

In Settings Display or Signal Displays this push-button is used for scrolling up through a list of settings or signals.

In Settings Modification mode it is used for selecting the previous value of (or increasing) the displayed setting or for selecting a bit position in a particular control setting.

ENTER

This push-button is used when the cover is removed to select between two modes of operation namely Settings Display or Settings Modification.

When this push-button is pressed and a relay setting is being displayed part of the display will flash to indicate that the setting being displayed can be modified by using the ▲ **READ UP** or ▼ **READ DOWN** keys on the facia.

When the required value of the setting has been established it may be entered into the relay and acted upon by pressing the **ENTER** key again.

CANCEL

This push-button is used when the cover is removed to return the relay display to its initial status. It can be used to reject any alterations to the setting being modified provided the **ENTER** key has not been pressed to accept the changes.

►TEST/RESET

This push-button is used to reset the fault indication on the LEDs on the fascia. It also acts as a lamp test button, when pressed all LEDs will momentarily light up to indicate their correct operation.

The ▼ **READ DOWN** and ▲**READ UP** push-buttons may then be used to scroll through the various signals.

5.6.2 Settings And Displays

The display menu structure is shown in Figure 5. This diagram shows the three main modes of display, which are the Settings Mode, Instruments Mode and the Fault Data Mode.

When the relay is first energised the user is presented with the following message: -

SETTINGS DEFAULTED PRESS ENTER

This shows that the relay has been set with the standard factory default settings. If this message is displayed ENTER must be pressed to acknowledge this initial condition, the display will then indicate the relay identifier. e.g.

DAD-N-XXX

Pressing the ►**TEST/RESET** key on this display initiates an LED test. Pressing ▼ **READ DOWN** at this display allows access to the three display modes, which are accessed in turn by pressing the ►**TEST/RESET** key.

The Settings Mode contains 11 setting sub-menu's. These hold all of the programmable settings of the relay in separate logical groups. The sub menus are accessed by pressing the Prices are very competitive, starting at less than £400 and peaking at around twice that► key. This enters the sub menu and presents a list of all the settings within that sub menu. Pressing the ▼ **READ DOWN** key scrolls through the settings until after the last setting in the sub menu after which the next sub menu will be shown. Access to this group is via the same method as before. If a particular sub menu is not required to be viewed then pressing ▼ **READ DOWN** will skip past that particular menu and show the next one in the list. Note that all screens can be viewed even if the password is not known. The password only protects against unauthorised changes to settings.

While viewing an editable screen pressing the **ENTER** key allows the user to change the displayed data. A flashing character(s) will indicate the editable field. Pressing ▲ **READ UP** or ▼ **READ DOWN** scrolls through the available setting values or, pressing ►**TEST/RESET** moves right through the edit fields. Note that all settings can be incremented or decremented using the ▲ **READ UP** or ▼ **READ DOWN** keys and they all wraparound so that to go from a setting minimum value to the maximum value it is quicker to press the ▼ **READ DOWN** key, rather than scroll through every setting. Also, to facilitate quicker setting changes an acceleration feature is available which if ▲ **READ UP** or ▼ **READ DOWN** are depressed and held, then the rate of scrolling through the setting values increases.

If **ESCAPE/CANCEL** is pressed during a setting change operation the original setting value is restored and the display is returned to the normal view mode.

If changes are made to the setting value then pressing **ENTER** disables the flashing character mode and displays the new setting value. This is immediately stored in non-volatile memory.

The next sections give a description of each setting in the relay. The actual setting ranges and default values can be found in the Relay Settings section of this manual.

5.7 Instruments Mode

In INSTRUMENT MODE metering points can be displayed to aid with commissioning, the following meters are available

Instrument	Description
[DIFF METERS] --> press down <--	Start of Differential current meters
Primary Currents 0.000 0.000 0.000 kA	Differential Primary currents
Secondary Currents 0.000 0.000 0.000 A	Differential Secondary currents
Nominal Currents 0.00 0.00 0.00 xIn	Differential Nominal currents
[MISC METERS] --> press down <--	Start of miscellaneous meters
Status Inputs 1-16 ---- ---- ---- ----	Displays the state of DC status inputs 1 to 16[1]
Status Inputs 17-27 ---	Displays the state of DC status inputs 17 to 27[1]
Output Relays 1-16 ---- ---- ---- ----	Displays the state of output relays 1 to 16[2]
Output Relays 17-29 ---- -	Displays the state of output relays 17 to 29[2]
Time & Date 13/08/2002 10:16:11	Time and Date

1) Display is different when fewer status inputs are fitted

2) Display is different when fewer output relays are fitted

Note that meters not designated as primary or secondary values are usually displayed as multiples of nominal

i.e. x In, 1 Amp or 5 Amp.

5.7.1 Hidden Instruments

At the “INSTRUMENTS MODE” title screen, pressing ENTER and DOWN simultaneously reveals some additional metering for calibration purposes. The reference channels as well as DC offsets may be displayed along with the RMS values in raw ADC counts. The relationship between current and ADC counts is 1 x In = 600 counts.

5.8 Fault Data Mode

In “FAULT DATA MODE”, the time and date of relay operations are recorded together with a record of the LED flag states.

5.9 Default Instruments Screens

The menu presentation of the various instruments allows the user to view a single screen at a time. However, for in service use, it is desirable that a small number of high interest, user selectable screens are presented automatically by default without user intervention. The instrument screens of interest to the user e.g. those required to be presented to a visiting engineer for record purposes can be selected by the user by pressing ENTER when viewing the required screen. On pressing ENTER a **'D'** symbol will appear at the top right of that screen. The '**D'** indicates that a screen is a 'default screen'. To de-select a default screen, simply press ENTER while on that particular screen and the **'D'** symbol will be cleared.

Time & Date	**D**
01/01/2002 01:31:39	

If no keys have been pressed for a pre-determined time the relay will jump to the default instrument display regardless of where the menu has been left by the user. It will then scroll through each of the selected default instruments and remain on each for approximately 5 seconds. The Default Screens Timer that sets the time to elapse before the relay goes into the default instruments mode is found in the SYSTEM CONFIG MENU.

6 Diagrams

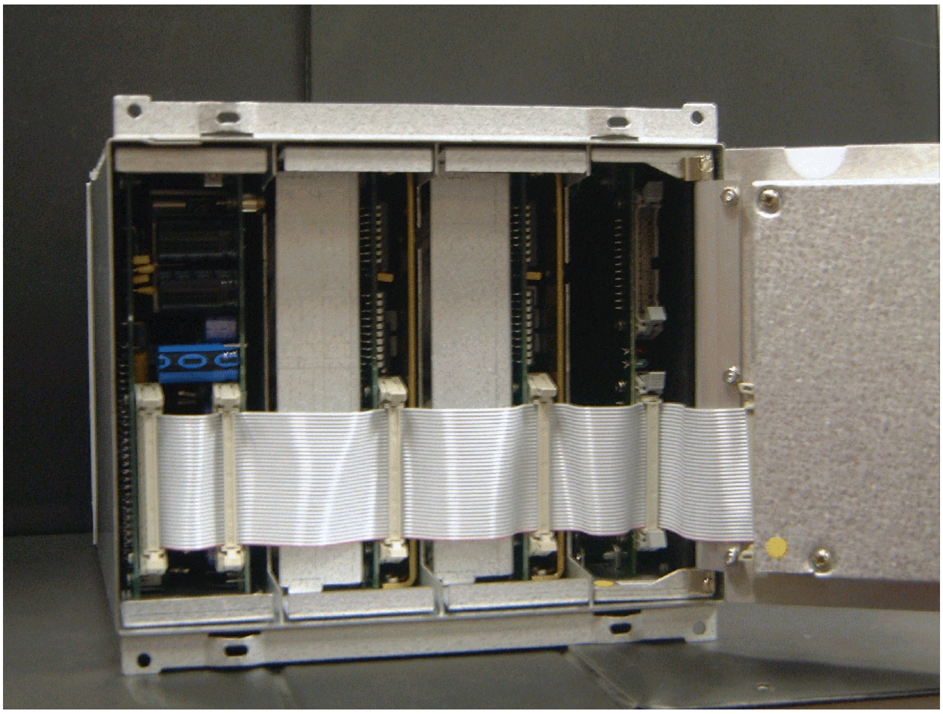


Figure 2 – DAD-N in E8 case with front panel open

Figure 3 – DAD-N Rear View

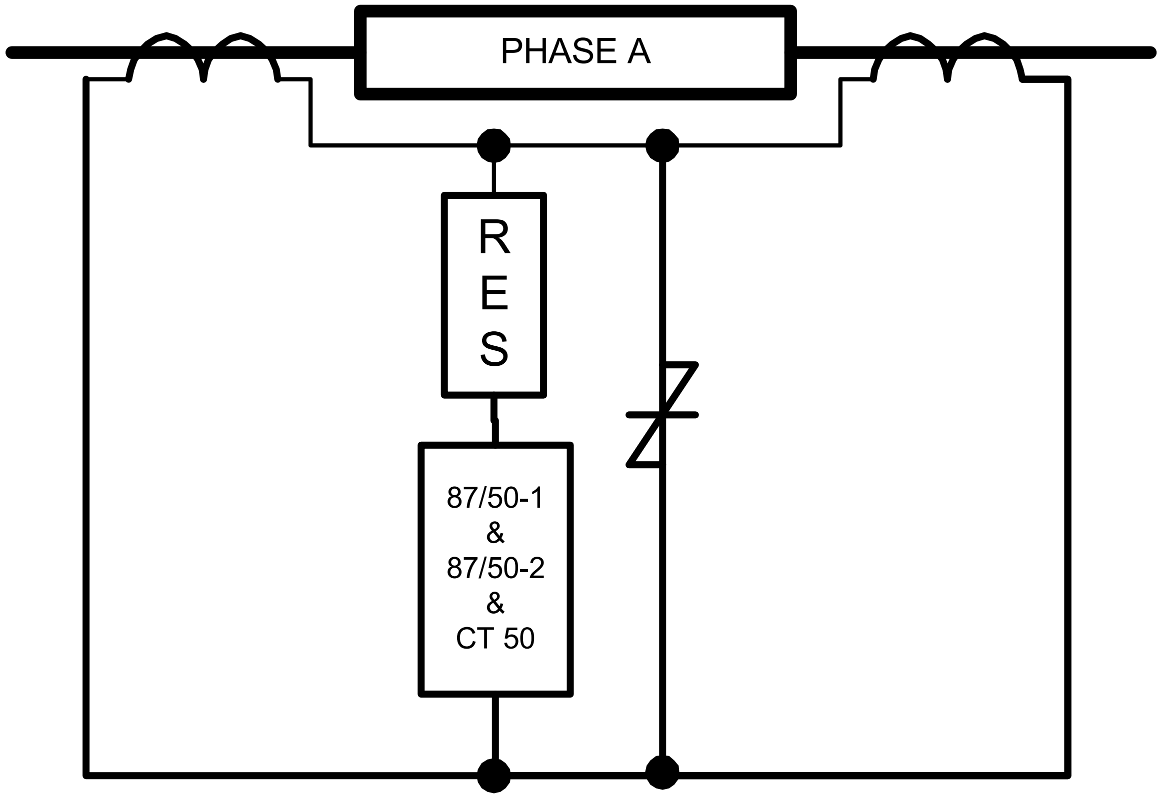


Figure 4 – High Impedance Differential Schematic

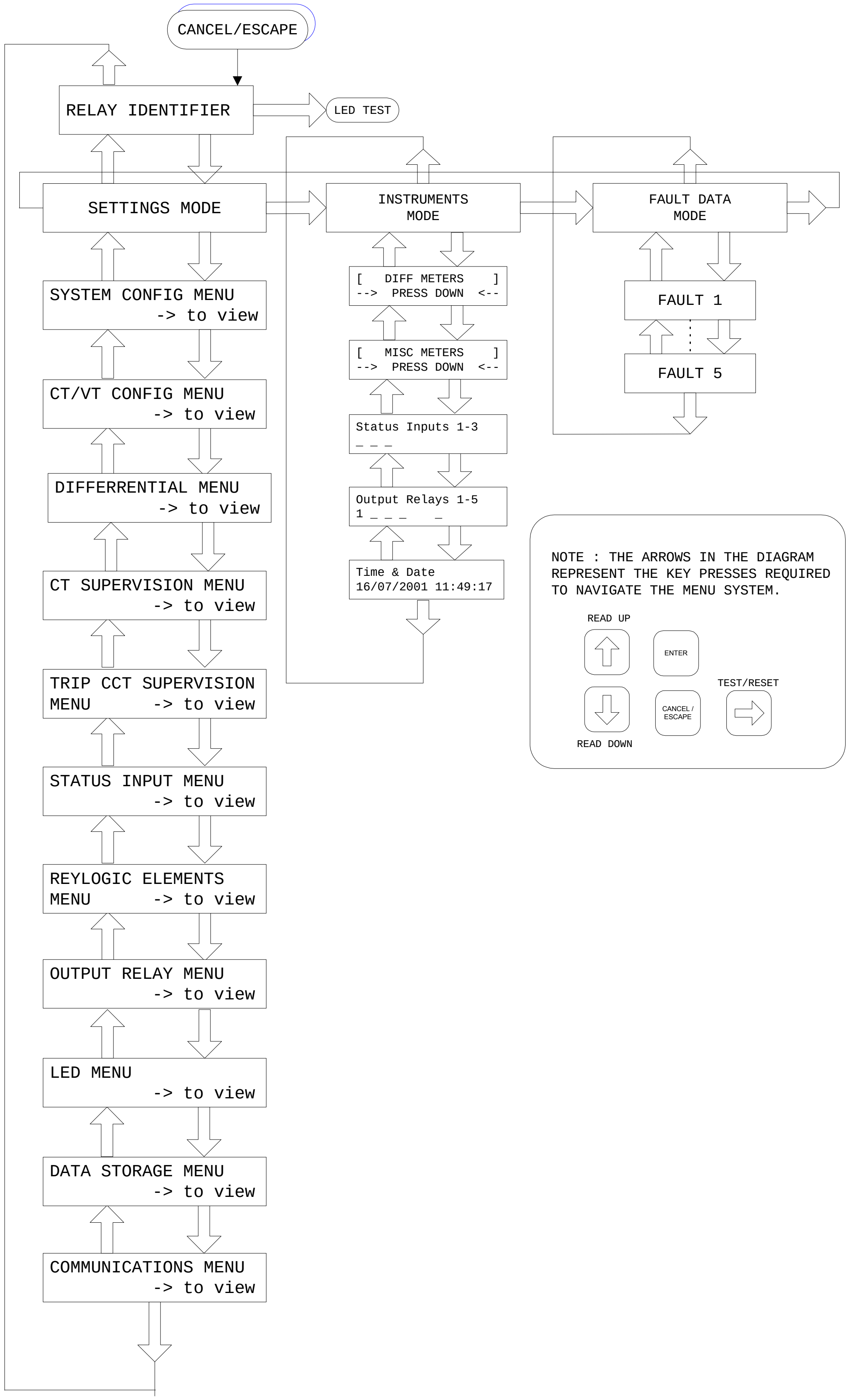


Figure 5 – DAD-N Menu Structure

7SG12 DAD N

Numerical High Impedance Relay with CT Supervision

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:
Pre release

2010/02	Document reformat due to rebrand
R6 11/10/06	CT Supervision time delay accuracy added
R5 26/08/2005	Corrected CT burden on 1A tap. Operate Time for CT Supervision added. Time Delay for TCS added.
R4 22/07/2005	Revision 15 software and SEF Current Input Module 2513H10099.
R3 18/10/2004	Corrected Status Input minimum current for operation. Corrected operating time variation over frequency.
R2 24/05/2004	Revision 12 software.
R1 24/10/2002	First Issue for comment.

Software Revision History

Contents

1. Introduction

The following document defines the technical and performance specification of the DAD-N Series relays. DAD-N relays are based upon the VATECH ACP Ltd Modular II series of protection units.

Section 3 describes performance that is common to all Modular II protections.

Section 4 describes the performance of protection elements that may be fitted to DAD-N series relays. Therefore for any one DAD-N series model, only the performance for those elements described in the Description of Operation, as available in that model will be applicable.

Performance Data to:

IEC60255-6, IEC60255-6A and IEC60255-13.

2. Accuracy Reference Conditions

General	IEC60255 Parts 6, 6A & 13
Auxiliary Supply	Nominal
Frequency	50 Hz
Ambient Temperature	20°C

3. Accuracy Influencing Factors

Temperature

Ambient range	-10°C to +55°C
Variation over range	≤ 5%

Frequency

Range 50Hz Model Range 60Hz Model	47Hz to 52Hz 57Hz to 62Hz
Setting variation	≤ 5%
Operating time variation	≤ 5%

4. Modular II Specification

4.1 Environmental Withstand

Temperature - IEC 60068-2-1/2

Operating range	-10°C to +55°C
Storage range	-25°C to +70°C

Humidity - IEC 60068-2-3

Operational test	56 days at 40°C and 95% RH

Transient Overvoltage –IEC 60255-5

Between all terminals and earth or between any two independent circuits without damage or flashover	5kV 1.2/50µs 0.5J

Insulation - IEC 60255-5

Between all terminals and earth	2.0kV rms for 1 min
Between independent circuits	2.0kV rms for 1 min
Across normally open contacts	1.0kV rms for 1 min

High Frequency Disturbance - IEC 60255-22-1 Class III

	Variation
2.5kV Common (Longitudinal) Mode	≤ 5%
1.0kV Series (Transverse) Mode	≤ 5%

Electrostatic Discharge - IEC 60255-22-2 Class IV

	Variation

8kV contact discharge	≤ 5%

Conducted & Radiated Emissions -
EN 55022 Class A (IEC 60255-25)

Conducted 0.15MHz – 30MHz Radiated 30MHz – 1GHz

Conducted Immunity -
(IEC 61000-4-6; IEC 60255-22-6)

	Variation
0.15MHz – 80MHz 10V rms 80% modulation	≤ 5%

Radiated Immunity -
IEC60255-22-3 Class III

	Variation
80MHz to 1000MHz, 10V/m 80% modulated	≤ 5%

Fast Transient – IEC 60255-22-4 Class IV

	Variation
4kV 5/50ns 2.5kHz repetitive	≤ 5%

Surge Impulse -
IEC 61000-4-5 Class IV; (IEC 60255-22-5)

	Variation
4KV Line-Earth (O/C Test voltage ±10%) 2KV Line-Line	≤ 10

Vibration (Sinusoidal) –IEC 60255-21-1 Class 1

		Variation
Vibration response	0.5gn	≤ 5%
Vibration endurance	1.0gn	≤ 5%

Shock and Bump–IEC 60255-21-2 Class 1

		Variation
Shock response	5 gn 11ms	≤ 5%
Shock withstand	15 gn 11ms	≤ 5%
Bump test	10 gn 16ms	≤ 5%

Seismic – IEC 60255-21-3 Class 1

		Variation
Seismic Response	1gn	≤ 5%

Mechanical Classification

Durability	In excess of 10^6 operations

4.2 Auxiliary Energizing Quantity

DC Power Supply

Nominal	Operating Range
24/30V	18V to 37.5V dc
50/110V	37.5V to 137.5V dc
220/250V	175V to 286V dc

Auxiliary DC Supply – IEC 60255-11

Allowable superimposed ac component	≤ 12% of DC voltage
Allowable breaks/dips in supply (collapse to zero from nominal voltage)	≤ 20ms

D.C. Burden

Quiescent (Typical)	15
Max	27

4.3 A.C Current Inputs

1 Amp and 5 Amp current inputs are both available on the rear terminal blocks for most functions except Capacitor Unbalance.

Thermal Withstand

Continuous and Limited Period Overload
AC Current Inputs

3.0 x In	Continuous
3.5 x In	for 10 minutes
4.0 x In	for 5 minutes
5.0 x In	for 3 minutes
6.0 x In	for 2 minutes
250A	for 1 second
625A peak	for 1 cycle

A.C. Burden

A.C. Burden

1A tap	≤0.2 VA
5A tap	≤0.3 VA

NB. Burdens are measured at nominal rating.

4.4 Output Contacts

Output contacts functionality is fully programmable. The basic I/O module has 5 output contacts three of which are change over. Additional modules can be added with consequential increases in case size, to provide more contacts. These are added in-groups of eight up to a maximum of 29

Output Contact Performance

Contact rating to IEC 60255-0-2.

Carry continuously 5A ac or dc

Make and Carry
(limit L/R ≤ 40ms and V ≤ 300 volts)

for 0.5 sec	20A ac or dc
for 0.2 sec	30A ac or dc

Break
(limit ≤ 5A or ≤ 300 volts)

Ac resistive	1250VA
Ac inductive	250VA @ PF ≤ 0.4
Dc resistive	75W
Dc inductive	30W @ L/R ≤ 40 ms 50W @ L/R ≤ 10 ms

Minimum number of operations	1000 at maximum load
Minimum recommended load	0.5W, limits 10mA or 5V

4.5 Status inputs

Status Inputs functionality is fully programmable. The basic I/O module has 3 status inputs these can be set to high speed for signalling. Additional modules can be added to provide more inputs. Additional inputs are added in-groups of eight up to a maximum of 27. A pickup timer is associated with each input and each input may be individually inverted where necessary.

Nominal Voltage	Operating Range
30 / 34	18V to 37.5V
48 / 54	37.5V to 60V
110 / 125	87.5V to 137.5V
220 / 250	175 to 280V

NB: the status input operating voltage does not have to be the same as the power supply voltage.

Status Input Performance

Minimum DC current for operation	48V 10mA 110V 2.25mA 220V 2.16mA
Reset/Operate Voltage Ratio	≥ 90%
Typical response time	< 5ms
Typical response time when programmed to energise an output relay contact	< 15ms
Minimum pulse duration	40ms

To meet the requirements of ESI 48-4 then 48V status inputs should be ordered together with external dropper resistors as follows:-

Status Input External Dropper Resistances

Nominal Voltage	Resistor Value (Wattage)
110 / 125V	2k7 ± 5% ; (2.5W)
220 / 250V	8k2 ± 5% ; (6.0W)

Each status input has an associated timer that can be programmed to give time-delayed pick-up. The pick-up timers can be set to 20ms to provide immunity to an AC input signal. Status inputs will then not respond to the following:

- 250V RMS 50/60Hz applied for two seconds through a 0.1μF capacitor.
- 500V RMS 50/60Hz applied between each terminal and earth.
- Discharge of a 10μF capacitor charged to maximum DC auxiliary supply voltage.

4.6 Indication

There are two types of LED indication, General and Protection Healthy.

Case Size	Number of LEDs
E8	16 General + Protection Healthy
E12/E16	32 General + Protection Healthy

All General LED indication is fully configurable by the user. All General indications are stored in non-volatile memory without the use of an internal backup battery.

4.7 Settings And Configuration

Settings changes may be done via the front panel user-friendly fascia keypad and LCD or via standard Reydisp Evolution windows software either locally or remotely. Settings changes are stored in EEPROM memory. Configuration changes may be achieved locally via the front serial port with a Windows based toolbox support package. Configuration changes and software upgrades are stored in Flash EPROM memory.

4.8 Recording

Up to 5 fault records may be stored within the relay, Fault records are accessible via the front panel showing the date and time of trips. New faults automatically overwrite the oldest fault record when they occur.

Waveform records are automatically stored whenever a trip is generated. Waveform recording can also be triggered by the status inputs. New waveform records automatically overwrite the oldest waveform record when they are triggered. The exact number and duration of waveform records, for any particular relay model, is available from the Relay Settings section of this Manual in the Data Storage Menu listing.

Up to 500 time tagged event records are stored within the relay. New events automatically overwrite the oldest event record when the 500 are used up.

4.9 Communications

IEC 60870-5-103 communications is standard on Reyrolle Modular II numerical product range. IEC 60870-5-103 has the advantage of built in time synchronisation of all devices, reduced communications overhead, high data security and compatibility with all of the major substation automation and control systems.

COM1 is a dedicated rear fibre optic serial port. COM2 can be auto-switched between rear fibre optic serial port and a front isolated RS232 serial port. IEC 60870-5-103 may be directed to use either COM1 or COM2.

All fibre optic ports can be star connected to a Sigma passive hub or simply daisy-chained in a loop-in loop-out configuration with other Reyrolle relays e.g. Argus, Delta, Ohmega, Tau.

4.10 IRIG-B Time Synchronisation

The relay incorporates an IRIG-B time synchronisation port as standard for connection to a GPS time receiver. The input accepts an a.c. modulated input signal that should be in the range 3Vp-p or 6Vp-p.

5. Protection Elements

5.1 Common Performance

Disengaging Time	30ms

Note: Output contacts have a default minimum dwell time of 100ms, which may be altered via a setting, after which the disengaging time is as above.

5.2 87/50-1, 87/50-2 Differential

Phase segregated High impedance Overall Differential scheme using external stabilizing resistors. Function is insensitive to third harmonic currents.

Pickup	± 5% of setting or ± 0.01 I_n whichever is the greater
Reset	□ 95% of I_s
Repeatability	± 2%
Transient Overreach	□5%
Operate Time 2 x Setting 4 x Setting	Operate Time 1 cycle < 1 cycle
Time Delay	± 1% or ± 5ms whichever is the greater

5.3 CT-50 CT Supervision

Pickup	± 5% of setting or ± 0.01 I_n whichever is the greater
Reset	□ 95% of I_s
Repeatability	± 2%
Transient Overreach	□5%
Operate Time 2 x Setting	Operate Time < 1.5 cycles
Time Delay	Time Delay setting +/- 5% or +/- 10 milliseconds, whichever is the greater**

**NB: - Minimum Time Delay setting is 100milliseconds

5.4 Trip Circuit Supervision

Time Delay	± 1% or +0, +20 ms whichever is the greater

7SG12 DAD N

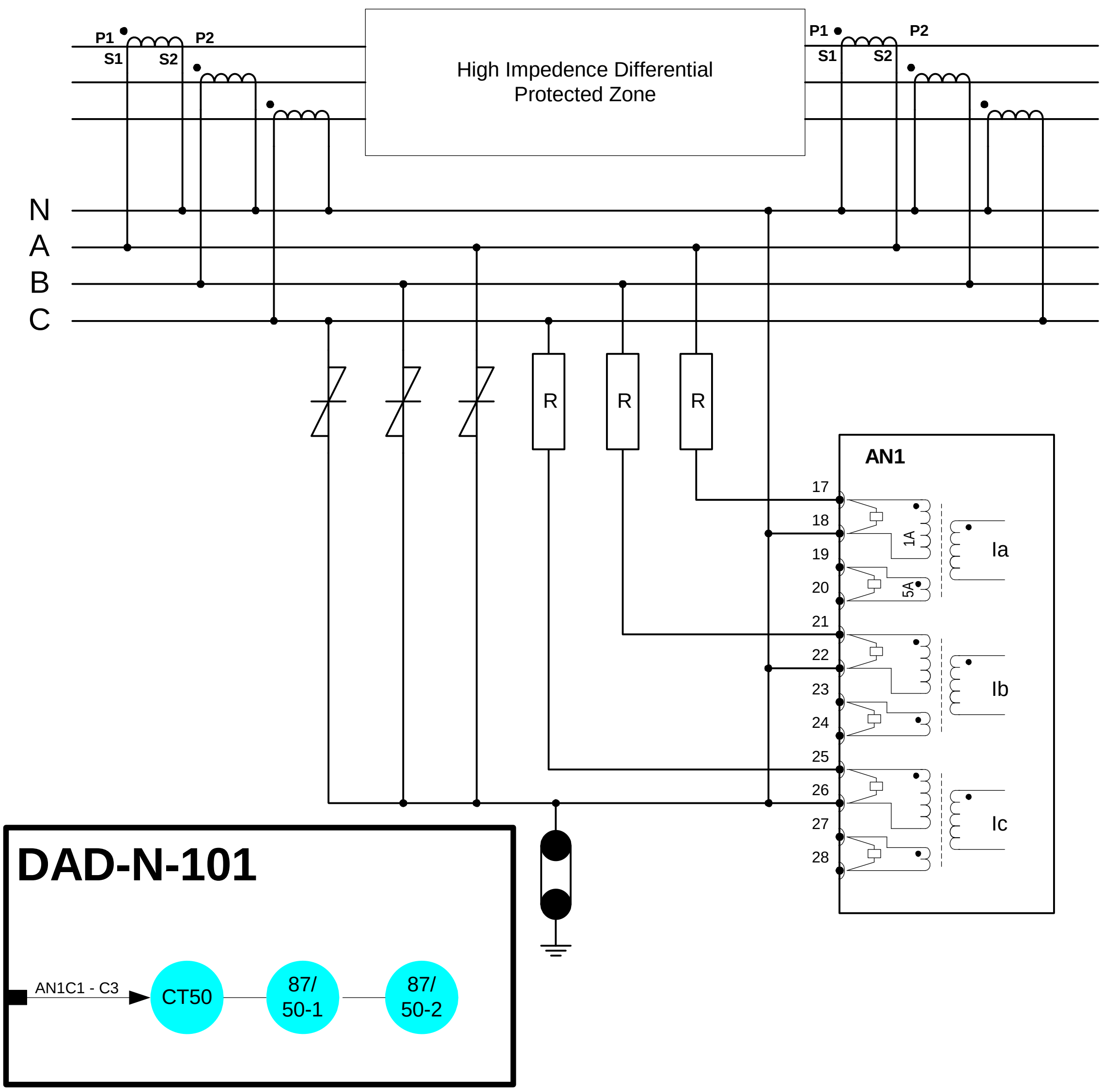
Numerical High Impedance Relay with CT Supervision

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:
Pre release

Revision	Date	Change
	2010/02	Document reformat due to rebrand
R12	26-08-2005	Corrected TCS ranges and units.
R11	15-08-2005	Added 2nd stage 87/50-2. Corrected TCS events numbers Minimum setting value reduced to 0.005xIn for 87/50 and 0.001xIn for CT 50 using 2513H10099 4xSEF analogue module. Time steps now 5ms. IEC Output relay drive added. Primary and Secondary metering resolution improved.
R10	09-02-2005	Corrected status input menu settings order
R9	08-12-2004	R14 Software version adds in Dual IEC 60870-5-103 and Modbus-RTU communications protocols, settings group change from status inputs
R8	23-09-2004	E12/E16 label added
R7	09-09-2004	CT Supervision event added, now GI. Logic diagrams updated Output Relay defaults now only for General Starter and General Trip
R6	26-01-2004	Corrected 74TC typo
R5	22/01/2004	Diagram added to front sheet Reylogic diagrams updated
R4	19/01/2004	Brought up to date with R12 binary, added in new data storage features 8 settings groups as standard
R3	18/06/2003	Phase segregated outputs added
R2	17/06/2003	Logic diagrams added, menu's adjusted
R1	30/05/2003	First Version

Software Revision History



Model No
DAD-N-101

Cat No
DA1-101

Configuration No
2414H80001R15

Date: 24/02/2010 12:55:00

Contents

1 DAD-N-101 Relay Setting List

1.1 System Config Menu

Description	Range	Default	Setting
Active Group *Selects which settings group is currently activated*	1,2…8	1	
View/Edit Group *Selects which settings group is currently being displayed*	1,2…8	1	
Default Screens Timer *Selects the time delay after which, if no key presses have been detected, the relay will begin to poll through any screens which have been selected as default instruments screens*	OFF, 1,2,5,10,15,30,60 min	60 min	
Backlight timer *Controls when the LCD backlight turns off*	OFF, 1,2,5,10,15,30,60 min	5 Min	
Date	Date	1/1/1980	
Time	Time	00:00:00	
Select Grp Mode *Mode of operation of group change from status input. Edge triggered ignores the status input once it has changed to the relevant group, where as with Level triggered the relay will only stay in the group it has changed to whilst the status input is being driven, after which it returns to the previous group.*	Edge triggered, Level triggered	Edge triggered	
Clock Sync. From Status *Real time clock may be synchronised using a status input (See Clock Sync. in Status Input Menu)*	Disabled, Seconds,Minutes	Minutes	
Operating Mode *To allow access to change configuration files using Reylogic Toolbox the relay must be placed Out Of Service.*	Local, Remote, Local Or Remote, Out Of Service	Local Or Remote	
Change Password *Allows a 4 character alpha code to be entered as the password. Note that the display shows a password dependant encrypted code on the second line of the display*	AAAA…ZZZZ	“NONE” displayed as “NOT ACTIVE”	
Relay Identifier *An alphanumeric string shown on the LCD normally used to identify the circuit the relay is attached to or the relays purpose*	Up to 16 characters	DAD-N-101	

1.2 CT/VT Config Menu

Description	Range	Default	Setting
CT Input *Selects whether 1 or 5 Amp terminals are being used*	1,5 A	1 A	
CT Ratio *CT ratio to scale primary current instruments*	5:0.2…5000:7	2000:1	

1.3 Differential Menu

Description	Range	Default	Setting
87/50-1 Element	Disabled, Enabled	Disabled	

Description	Range	Default	Setting
Selects whether the 87/50-1 Element is enabled.			
87/50-1 Setting *Pickup level*	0.005,0.006…2.000 xIn	0.500 xIn	
87/50-1 Delay *Pickup delay*	0,0.005…60 s	0.00 s	
87/50-2 Element *Selects whether the 87/50-2 Element is enabled.*	Disabled, Enabled	Disabled	
87/50-2 Setting *Pickup level*	0.005,0.006…2.000 xIn	0.500 xIn	
87/50-2 Delay *Pickup delay*	0,0.005…60 s	0.00 s	

1.4 CT Supervision Menu

Description	Range	Default	Setting
CT 50 Element *Selects whether the CT supervision element is enabled.*	Disabled, Enabled	Disabled	
CT 50 Setting *Pickup level*	0.001,0.002…2.000 xIn	0.100 xIn	
CT 50 Delay *Pickup delay*	0.1,0.2…60 s	10.00 s	

1.5 Trip Circuit Menu

Description	Range	Default	Setting
Trip Cct Fail 1 *Selects if this trip circuit logic is enabled or disabled.*	Disabled, Enabled	Disabled	
Trip Cct Fail 1 PU Delay *Delay before trip circuit failure picks up. Use in conjunction with STATUS INPUT MENU/Trip Cct Fail 1 setting to configure which status inputs prevent this timer from operating.*	0,0.02…60 s	0.40 s	
Trip Cct Fail 2	Disabled, Enabled	Disabled	
Trip Cct Fail 2 PU Delay	0,0.02…60 s	0.40 s	

1.6 Status Input Menu

Description	Range	Default	Setting
87/50-1 Inhibit *Selects which inputs inhibit the 87/50-1 element*	NONE, 1…27[1]	NONE	
87/50-2 Inhibit *Selects which inputs inhibit the 87/50-2 element*	NONE, 1…27[1]	NONE	
CT 50 Inhibit *Selects which inputs inhibit the CT 50 element*	NONE, 1…27[1]	NONE	
Trip Cct Fail 1 *Select which inputs block Trip Cct Fail 1 timer.* *If any of the selected inputs is energised then the trip circuit timer 1 is blocked.*	NONE, 1…27[1]	NONE	
Trip Cct Fail 2 *Select which inputs block Trip Cct Fail 2 timer.*	NONE, 1…27[1]	NONE	
Trigger Wave Rec *Selects which inputs can trigger a waveform record*	NONE, 1…27[1]	NONE	
Trigger Data Rec *Selects which inputs can trigger a data*	NONE, 1…27[1]	NONE	

Description	Range	Default	Setting
record			
Select Group 1 *Switches active setting group to group 1*	NONE, 1…27[1]	NONE	
Select Group 2 *Switches active setting group to group 2*	NONE, 1…27[1]	NONE	
Select Group 3 *Switches active setting group to group 3*	NONE, 1…27[1]	NONE	
Select Group 4 *Switches active setting group to group 4*	NONE, 1…27[1]	NONE	
Select Group 5 *Switches active setting group to group 5*	NONE, 1…27[1]	NONE	
Select Group 6 *Switches active setting group to group 6*	NONE, 1…27[1]	NONE	
Select Group 7 *Switches active setting group to group 7*	NONE, 1…27[1]	NONE	
Select Group 8 *Switches active setting group to group 8*	NONE, 1…27[1]	NONE	
Clock Sync. *Selects which input is used to synchronise the real time clock*	NONE, 1…27[1]	NONE	
Inverted Inputs *Selects which inputs pickup when voltage is removed, often used when monitoring trip circuits.*	NONE, 1…27[1]	NONE	

1) 27 status inputs represents maximum configuration.

1.7 Status Input Timing Menu

Description	Range	Default	Setting
Aux I/P 1 Pickup Delay *Delay on pickup of DC Status input 1*	0.000,0.005…864000 s	0 s	
Aux I/P 1 Dropoff Delay *Delay on dropoff of DC Status input 1*	0.000,0.005…864000 s	0 s	
Aux I/P 2 Pickup Delay	0.000,0.005…864000 s	0 s	
Aux I/P 2 Dropoff Delay	0.000,0.005…864000 s	0 s	
Aux I/P 3 Pickup Delay	0.000,0.005…864000 s	0 s	
Aux I/P 3 Dropoff Delay	0.000,0.005…864000 s	0 s	
Aux I/P 4 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 4 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 5 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 5 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 6 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 6 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 7 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 7 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 8 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 8 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 9 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 9 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 10 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 10 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 11 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 11 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 12 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 12 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 13 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 13 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 14 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 14 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 15 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 15 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 16 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 16 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	

Description	Range	Default	Setting
Aux I/P 17 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 17 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 18 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 18 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 19 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 19 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 20 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 20 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 21 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 21 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 22 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 22 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 23 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 23 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 24 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 24 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 25 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 25 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 26 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 26 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 27 Pickup Delay[1]	0.000,0.005…864000 s	0 s	
Aux I/P 27 Dropoff Delay[1]	0.000,0.005…864000 s	0 s	

1) Only when fitted.

1.8 Reylogic Element Menu

Description	Range	Default	Setting
Max Data Rec Time *When a data record is triggered by a fault condition the relay stops recording information when either the triggering condition is removed or this timer expires whichever happens first.*	0,1…60000 ms	2000 ms	

1.9 Output Relay Menu

Description	Range	Default	Setting
87/50-1 Phase A *Overall Differential INST/DTL Stage 1 Phase A element has operated*	NONE, 1…29[1]	NONE	
87/50-1 Phase B	NONE, 1…29[1]	NONE	
87/50-1 Phase C	NONE, 1…29[1]	NONE	
87/50-2 Phase A *Overall Differential INST/DTL Stage 2 Phase A element has operated*	NONE, 1…29[1]	NONE	
87/50-2 Phase B	NONE, 1…29[1]	NONE	
87/50-2 Phase C	NONE, 1…29[1]	NONE	
CT 50 Phase A *Overall Differential CT Supervision INST/DTL Phase element has operated*	NONE, 1…29[1]	NONE	
CT 50 Phase B	NONE, 1…29[1]	NONE	
CT 50 Phase C	NONE, 1…29[1]	NONE	
General Starter *A starter element is picked up. Useful when testing individual functions!*	NONE, 1…29[1]	5	
General Trip *An element has operated. Useful when testing individual functions!*	NONE, 1…29[1]	4	
Trip Cct Fail 1 *Trip Circuit 1 has failed*	NONE, 1…29[1]	NONE	
Trip Cct Fail 2 *Trip Circuit 2 has failed*	NONE, 1…29[1]	NONE	
Trip Circuit Fail *A trip circuit has failed.*	NONE, 1…29[1]	NONE	

New Data Stored *The waveform recorder has stored new information Note: this is a pulsed output*	NONE, 1…29[1]	NONE	
Aux I/P 1 Operated *DC Status 1 has operated*	NONE, 1…29[1]	NONE	
Aux I/P 2 Operated	NONE, 1…29[1]	NONE	
Aux I/P 3 Operated	NONE, 1…29[1]	NONE	
Aux I/P 4 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 5 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 6 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 7 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 8 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 9 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 10 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 11 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 12 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 13 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 14 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 15 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 16 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 17 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 18 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 19 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 20 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 21 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 22 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 23 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 24 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 25 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 26 Operated[2]	NONE, 1…29[1]	NONE	
Aux I/P 27 Operated[2]	NONE, 1…29[1]	NONE	
Hand Reset Outputs *Relays selected, as Hand Reset will remain latched until manually reset from front panel or via communications link or by removing DC Supply. By default relays are Self Resetting and will reset when the driving signal is removed.*	NONE, 1…29[1]	NONE	
Protection Healthy *Relays selected are energised whilst relay self-monitoring does NOT detect any hardware or software errors and DC Supply is healthy. A changeover contact or normally closed contact may be used to generate Protection Defective from this output*	NONE, 1…29[1]	1	

1) 29 output relays represents maximum configuration.

2) Only when fitted.

1.9.1 OP Relay Timing Menu

Description	Range	Default	Setting
Min Operate Time 1	0.02, 0.04…60 s	0.1 s	
Min Operate Time 2	0.02, 0.04…60 s	0.1 s	
Min Operate Time 3	0.02, 0.04…60 s	0.1 s	
Min Operate Time 4	0.02, 0.04…60 s	0.1 s	
Min Operate Time 5	0.02, 0.04…60 s	0.1 s	
Min Operate Time 6[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 7[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 8[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 9[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 10[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 11[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 12[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 13[1]	0.02, 0.04…60 s	0.1 s	

Min Operate Time 14[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 15[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 16[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 17[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 18[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 19[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 20[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 21[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 22[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 23[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 24[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 25[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 26[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 27[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 28[1]	0.02, 0.04…60 s	0.1 s	
Min Operate Time 29[1]	0.02, 0.04…60 s	0.1 s	

1) Only when fitted.

1.10 LED Menu

Description	Range	Default	Setting
87/50-1 Phase A *Overall Differential INST/DTL Stage 1 Phase A element has operated*	NONE, 1…32	2,5	
87/50-1 Phase B	NONE, 1…32	3,5	
87/50-1 Phase C	NONE, 1…32	4,5	
87/50-2 Phase A *Overall Differential INST/DTL Stage 2 Phase A element has operated*	NONE, 1…32	2,5	
87/50-2 Phase B	NONE, 1…32	3,5	
87/50-2 Phase C	NONE, 1…32	4,5	
CT 50 Phase A *Overall Differential CT Supervision INST/DTL Phase element has operated*	NONE, 1…32	2,6	
CT 50 Phase B	NONE, 1…32	3,6	
CT 50 Phase C	NONE, 1…32	4,6	
General Starter *A starter element is picked up. Useful when testing individual functions!*	NONE, 1…32	1	
General Trip *An element has operated. Useful when testing individual functions!*	NONE, 1…32	1	
Trip Cct Fail 1 *Trip Circuit 1 has failed*	NONE, 1…32	NONE	
Trip Cct Fail 2 *Trip Circuit 2 has failed*	NONE, 1…32	NONE	
Trip Circuit Fail *A trip circuit has failed.*	NONE, 1…32	7	
New Data Stored *The waveform recorder has stored new information*	NONE, 1…32	NONE	
Aux I/P 1 Operated *DC Status 1 has operated*	NONE, 1…32	NONE	
Aux I/P 2 Operated	NONE, 1…32	NONE	
Aux I/P 3 Operated	NONE, 1…32	NONE	
Aux I/P 4 Operated[1]	NONE, 1…32	NONE	
Aux I/P 5 Operated[1]	NONE, 1…32	NONE	
Aux I/P 6 Operated[1]	NONE, 1…32	NONE	
Aux I/P 7 Operated[1]	NONE, 1…32	NONE	
Aux I/P 8 Operated[1]	NONE, 1…32	NONE	
Aux I/P 9 Operated[1]	NONE, 1…32	NONE	
Aux I/P 10 Operated[1]	NONE, 1…32	NONE	
Aux I/P 11 Operated[1]	NONE, 1…32	NONE	
Aux I/P 12 Operated[1]	NONE, 1…32	NONE	

Description	Range	Default	Setting
Aux I/P 13 Operated[1]	NONE, 1…32	NONE	
Aux I/P 14 Operated[1]	NONE, 1…32	NONE	
Aux I/P 15 Operated[1]	NONE, 1…32	NONE	
Aux I/P 16 Operated[1]	NONE, 1…32	NONE	
Aux I/P 17 Operated[1]	NONE, 1…32	NONE	
Aux I/P 18 Operated[1]	NONE, 1…32	NONE	
Aux I/P 19 Operated[1]	NONE, 1…32	NONE	
Self Reset LEDs *LEDs selected, as Self Reset will automatically reset when the driving signal is removed. By default all LEDs are Hand Reset and must be manually reset either locally via the front fascia or remotely via communications.*	NONE, 1…32	1	

1) Only when fitted.

1.11 Data Storage Menu

Description	Range	Default	Setting
Clear Faults *Clears the fault recorder*	NO, YES	NO	
Clear Events *Clears the event recorder*	NO, YES	NO	
Pre-Trigger Storage *Pre-trigger storage is that percentage of the waveform record that is recorded prior to the waveform recorder being triggered*	10…90 %	20 %	
Data Record Duration[1] *Selects the length of time for each waveform record*	5 Recs x 1 Seconds, 2 Recs x 2 Seconds, 1 Recs x 5 Seconds	5 Recs x 1 Second	
Trigger Waveform *Triggers the waveform recorder*	NO, YES	NO	
Clear Waveforms *Clears the waveform recorder*	NO, YES	NO	

1) Number of records and duration available is dependent upon relay model

1.12 Communications Menu

Description	Range	Default	Setting
Station Address *IEC 60870-5-103 Station Address*	0…254	0	
COM1 Protocol *Selects protocol to use for COM 1*	OFF, IEC60870-5-103, MODBUS-RTU	IEC60870-5-103	
COM1 Baud Rate *Sets the communications baud rate for com port 1 (Rear upper Fibre optic port)*	75, 110, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	19200	
COM1 Parity *Selects whether parity information is used*	Even, Odd, None	Even	
COM1 Line Idle *Selects the communications line idle sense*	Light Off, Light On	Light Off	
COM1 Data Echo *Enables echoing of data from RX port to TX port when operating relays in a Fibre Optic ring configuration*	Off, On	Off	
COM2 Protocol *Selects protocol to use for COM 2*	OFF, IEC60870-5-103, MODBUS-RTU, ASCII	ASCII	
COM2 Baud Rate *Sets the communications baud rate for com port 2 (Rear lower Fibre optic port AND Front Fascia RS232 port)*	75, 110, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	57600	
COM2 Parity *Selects whether parity information is*	Even, Odd, None	Even	

Description	Range	Default	Setting
used			
COM2 Line Idle *Selects the communications line idle sense*	Light Off, Light On	Light Off	
COM2 Data Echo *Enables echoing of data from RX port to TX port when operating relays in a Fibre Optic ring configuration*	Off, On	Off	
COM2 Direction *Selects how Com2 is shared between the front fascia port and the rear fibre optic port. This allows interlocking to prevent remote access whilst an engineer is attached locally on site if IEC870 is on Com2 and Auto-detect is enabled*	AUTO-DETECT, FRONT PORT, REAR PORT	AUTO-DETECT	

2 Instruments

INSTRUMENT	DESCRIPTION
[DIFF METERS] --> press down <--	Start of Differential current meters
Primary Currents 0.000 0.000 0.000 kA	Differential Primary currents
Secondary Currents 0.000 0.000 0.000 A	Differential Secondary currents
Nominal Currents 0.00 0.00 0.00 xIn	Differential Nominal currents
[MISC METERS] --> press down <--	Start of miscellaneous meters
Status Inputs 1-16 ---- ---- ---- ----	Displays the state of DC status inputs 1 to 16[1]
Status Inputs 17-27 ---	Displays the state of DC status inputs 17 to 27[1]
Output Relays 1-16 ---- ---- ---- ----	Displays the state of output relays 1 to 16[2]
Output Relays 17-29 ---- -	Displays the state of output relays 17 to 29[2]
Time & Date 13/08/2002 10:16:11	Time and Date
Fault Records 0	Number of fault data records stored
Event Records 0	Number of stored event records
Waveform Records 0	Number of disturbance waveform records

1) Display is different when fewer status inputs are fitted

2) Display is different when fewer output relays are fitted

3 IEC 60870-5-103 Communications Information

3.1 IEC 60870-5-103 Semantics in monitor direction

FUN	INF	Description	GI	TYP	COT
60	1	IEC870 Active Com1	x	1	1,9
60	2	IEC870 Active Com2	x	1	1,9
60	3	Front Port OverRide	x	1	1,9
60	4	Remote Mode	x	1	1,9
60	5	Service Mode	x	1	1,9
60	6	Local Mode	x	1	1,9
60	7	Local & Remote	x	1	1,9
60	8	Real Time Clock Set	-	1	1
60	9	Real Time Clock Drift Corrected	-	1	1
60	10	Real Time Clock Not Synchronised	-	1	1
60	11	Real Time Clock Synchronised	-	1	1
60	128	Cold Start	-	1	1
60	129	Warm Start	-	1	1
60	130	Re-Start	-	1	1
60	135	Trigger Storage	-	1	1
70	1	Status Input 1	x	1	1,9
70	2	Status Input 2	x	1	1,9
70	3	Status Input 3	x	1	1,9
70	4	Status Input 4	x	1	1,9
70	5	Status Input 5	x	1	1,9
70	6	Status Input 6	x	1	1,9
70	7	Status Input 7	x	1	1,9
70	8	Status Input 8	x	1	1,9
70	9	Status Input 9	x	1	1,9
70	10	Status Input 10	x	1	1,9
70	11	Status Input 11	x	1	1,9
70	12	Status Input 12	x	1	1,9
70	13	Status Input 13	x	1	1,9
70	14	Status Input 14	x	1	1,9
70	15	Status Input 15	x	1	1,9
70	16	Status Input 16	x	1	1,9
70	17	Status Input 17	x	1	1,9
70	18	Status Input 18	x	1	1,9
70	19	Status Input 19	x	1	1,9
70	20	Status Input 20	x	1	1,9
70	21	Status Input 21	x	1	1,9
70	22	Status Input 22	x	1	1,9
70	23	Status Input 23	x	1	1,9
70	24	Status Input 24	x	1	1,9
70	25	Status Input 25	x	1	1,9
70	26	Status Input 26	x	1	1,9
70	27	Status Input 27	x	1	1,9
80	1	Plant Control Relay 1	x	1	1,9
80	2	Plant Control Relay 2	x	1	1,9

FUN	INF	Description	GI	TYP	COT
80	3	Plant Control Relay 3	x	1	1,9
80	4	Plant Control Relay 4	x	1	1,9
80	5	Plant Control Relay 5	x	1	1,9
80	6	Plant Control Relay 6	x	1	1,9
80	7	Plant Control Relay 7	x	1	1,9
80	8	Plant Control Relay 8	x	1	1,9
80	9	Plant Control Relay 9	x	1	1,9
80	10	Plant Control Relay 10	x	1	1,9
80	11	Plant Control Relay 11	x	1	1,9
80	12	Plant Control Relay 12	x	1	1,9
80	13	Plant Control Relay 13	x	1	1,9
80	14	Plant Control Relay 14	x	1	1,9
80	15	Plant Control Relay 15	x	1	1,9
80	16	Plant Control Relay 16	x	1	1,9
80	17	Plant Control Relay 17	x	1	1,9
80	18	Plant Control Relay 18	x	1	1,9
80	19	Plant Control Relay 19	x	1	1,9
80	20	Plant Control Relay 20	x	1	1,9
80	21	Plant Control Relay 21	x	1	1,9
80	22	Plant Control Relay 22	x	1	1,9
80	23	Plant Control Relay 23	x	1	1,9
80	24	Plant Control Relay 24	x	1	1,9
80	25	Plant Control Relay 25	x	1	1,9
80	26	Plant Control Relay 26	x	1	1,9
80	27	Plant Control Relay 27	x	1	1,9
80	28	Plant Control Relay 28	x	1	1,9
80	29	Plant Control Relay 29	x	1	1,9
181	0	GI End	-	8	10
181	0	Time Synchronisation	-	6	8
181	2	Reset FCB	-	2	3
181	3	Reset CU	-	2	4
181	4	Start/Restart	-	2	5
181	22	Settings changed	-	1	1
181	23	Setting G1 selected	x	1	1,9
181	24	Setting G2 selected	x	1	1,9
181	25	Setting G3 selected	x	1	1,9
181	26	Setting G4 selected	x	1	1,9
181	36	Trip Circuit Fail	x	1	1,9
181	64	Start/Pick-up L1	x	2	1,9
181	65	Start/Pick-up L2	x	2	1,9
181	66	Start/Pick-up L3	x	2	1,9
181	67	Start/Pick-up N	x	2	1,9
181	68	General Trip	-	2	1
181	69	Trip L1	-	2	1
181	70	Trip L2	-	2	1
181	71	Trip L3	-	2	1
181	84	General Start/Pick-up	x	2	1,9
181	95	Overall Differential Stage 1	x	2	1,9

FUN	INF	Description	GI	TYP	COT
181	96	Overall Differential Stage 2	x	2	1,9
181	97	Overall Differential	x	2	1,9
181	98	CT Supervision	x	2	1,9
181	110	Setting G1 selected	x	1	1,9
181	111	Setting G2 selected	x	1	1,9
181	112	Setting G3 selected	x	1	1,9
181	113	Setting G4 selected	x	1	1,9
181	120	Trip Circuit Fail 1	x	1	1,9
181	121	Trip Circuit Fail 2	x	1	1,9
181	122	Trip Circuit Fail 3	x	1	1,9
181	123	Trip Circuit Fail 4	x	1	1,9
181	124	Trip Circuit Fail 5	x	1	1,9
181	125	Trip Circuit Fail 6	x	1	1,9
181	148	Measurand Z1 $I_{L1,2,3}$ Z1 I_{L1} (2.4 x) Z1 I_{L2} (2.4 x) Z1 I_{L3} (2.4 x)	-	9	2

3.2 IEC 60870-5-103 Semantics in control direction

FUN	INF	Description	COM	TYP	COT
80	1	Energise Output Relay 1	ON	20	20
80	2	Energise Output Relay 2	ON	20	20
80	3	Energise Output Relay 3	ON	20	20
80	4	Energise Output Relay 4	ON	20	20
80	5	Energise Output Relay 5	ON	20	20
80	6	Energise Output Relay 6	ON	20	20
80	7	Energise Output Relay 7	ON	20	20
80	8	Energise Output Relay 8	ON	20	20
80	9	Energise Output Relay 9	ON	20	20
80	10	Energise Output Relay 10	ON	20	20
80	11	Energise Output Relay 11	ON	20	20
80	12	Energise Output Relay 12	ON	20	20
80	13	Energise Output Relay 13	ON	20	20
80	14	Energise Output Relay 14	ON	20	20
80	15	Energise Output Relay 15	ON	20	20
80	16	Energise Output Relay 16	ON	20	20
80	17	Energise Output Relay 17	ON	20	20
80	18	Energise Output Relay 18	ON	20	20
80	19	Energise Output Relay 19	ON	20	20
80	20	Energise Output Relay 20	ON	20	20
80	21	Energise Output Relay 21	ON	20	20
80	22	Energise Output Relay 22	ON	20	20
80	23	Energise Output Relay 23	ON	20	20
80	24	Energise Output Relay 24	ON	20	20
80	25	Energise Output Relay 25	ON	20	20

FUN	INF	Description	COM	TYP	COT
80	26	Energise Output Relay 26	ON	20	20
80	27	Energise Output Relay 27	ON	20	20
80	28	Energise Output Relay 28	ON	20	20
80	29	Energise Output Relay 29	ON	20	20
181	0	GI Initiation		7	9
181	0	Time Synchronisation		6	8
181	19	LED reset	ON	20	20
181	23	Settings Group 1 Select	ON	20	20
181	24	Settings Group 2 Select	ON	20	20
181	25	Settings Group 3 Select	ON	20	20
181	26	Settings Group 4 Select	ON	20	20
181	110	Settings Group 5 Select	ON	20	20
181	111	Settings Group 6 Select	ON	20	20
181	112	Settings Group 7 Select	ON	20	20
181	113	Settings Group 8 Select	ON	20	20

4 Modbus Semantics

4.1 Coils

Address	Description
00001	Energise O/P Relay 1
00002	Energise O/P Relay 2
00003	Energise O/P Relay 3
00004	Energise O/P Relay 4
00005	Energise O/P Relay 5
00006	Energise O/P Relay 6
00007	Energise O/P Relay 7
00008	Energise O/P Relay 8
00009	Energise O/P Relay 9
00010	Energise O/P Relay 10
00011	Energise O/P Relay 11
00012	Energise O/P Relay 12
00013	Energise O/P Relay 13
00014	Energise O/P Relay 14
00015	Energise O/P Relay 15
00016	Energise O/P Relay 16
00017	Energise O/P Relay 17
00018	Energise O/P Relay 18
00019	Energise O/P Relay 19
00020	Energise O/P Relay 20
00021	Energise O/P Relay 21
00022	Energise O/P Relay 22
00023	Energise O/P Relay 23
00024	Energise O/P Relay 24
00025	Energise O/P Relay 25
00026	Energise O/P Relay 26
00027	Energise O/P Relay 27
00028	Energise O/P Relay 28
00029	Energise O/P Relay 29

Address	Description
00101	Settings Group 1
00102	Settings Group 2
00103	Settings Group 3
00104	Settings Group 4
00105	Settings Group 5

Address	Description
00106	Settings Group 6
00107	Settings Group 7
00108	Settings Group 8

4.2 Inputs

Address	Description
10001	Status Input 1
10002	Status Input 2
10003	Status Input 3
10004	Status Input 4
10005	Status Input 5
10006	Status Input 6
10007	Status Input 7
10008	Status Input 8
10009	Status Input 9
10010	Status Input 10
10011	Status Input 11
10012	Status Input 12
10013	Status Input 13
10014	Status Input 14
10015	Status Input 15
10016	Status Input 16
10017	Status Input 17
10018	Status Input 18
10019	Status Input 19
10020	Status Input 20
10021	Status Input 21
10022	Status Input 22
10023	Status Input 23
10024	Status Input 24
10025	Status Input 25
10026	Status Input 26
10027	Status Input 27
10028	Status Input 28
10029	Status Input 29
10030	Status Input 30
10031	Status Input 31
10032	Status Input 32

Address	Description
10101	Front Port Override
10102	Remote mode
10103	Service mode
10104	Local mode
10105	Local & Remote
10111	Trip Circuit Fail
10112	A-Starter
10113	B-Starter
10114	C-Starter
10115	General Starter
10116	Overall Differential
10117	CT Supervision

Address	Description
10120	Overall Differential Stage 1 Phase A
10121	Overall Differential Stage 1 Phase B
10122	Overall Differential Stage 1 Phase C
10123	Overall Differential Stage 2 Phase A
10124	Overall Differential Stage 2 Phase B
10125	Overall Differential Stage 2 Phase C
10126	CT Supervision Phase A
10127	CT Supervision Phase B

Address	Description
10128	CT Supervision Phase C

4.3 Registers

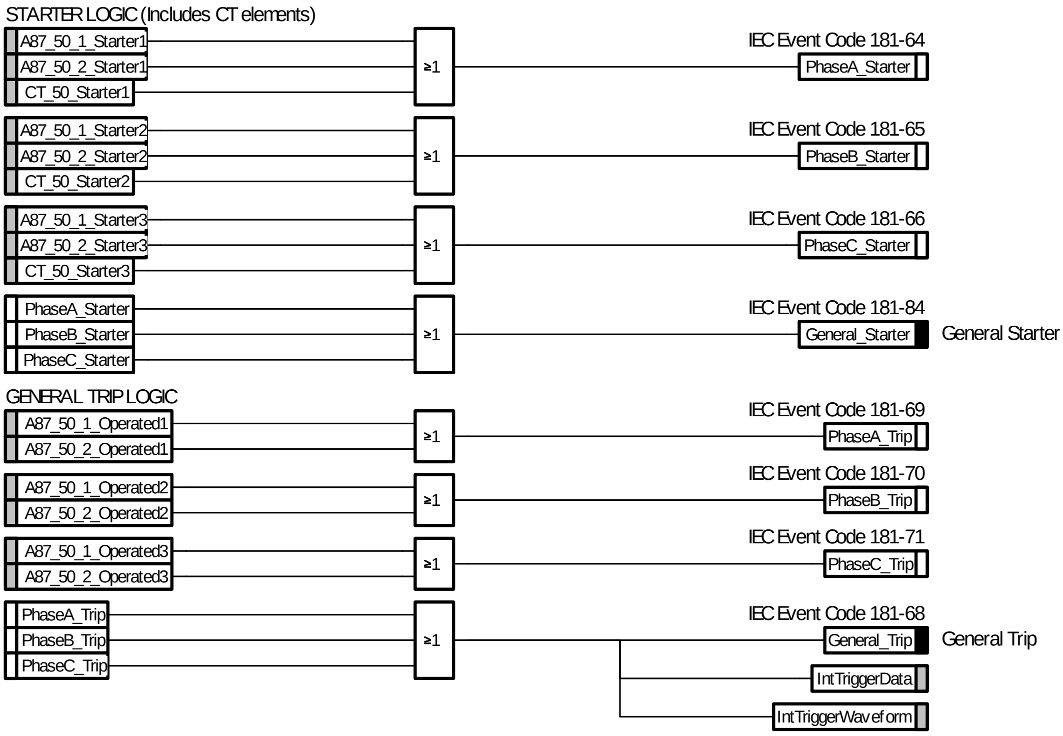
Address	Description	Format
30001	No. of Events In Store (See 434/TIR/15)	1 Register
30002	Latest Event Record (See 434/TIR/15)	8 Registers

Address	Description	Format
30010	Ia Primary	FP_32BITS_3DP[1]
30012	Ib Primary	FP_32BITS_3DP[1]
30014	Ic Primary	FP_32BITS_3DP[1]
30016	Ia Secondary	FP_32BITS_3DP[1]
30018	Ib Secondary	FP_32BITS_3DP[1]
30020	Ic Secondary	FP_32BITS_3DP[1]
30022	Ia Nominal	FP_32BITS_3DP[1]
30024	Ib Nominal	FP_32BITS_3DP[1]
30026	Ic Nominal	FP_32BITS_3DP[1]
30028	Fault Records	UINT16[2]
30029	Event Records	UINT16[2]
30030	Waveform Records	UINT16[2]

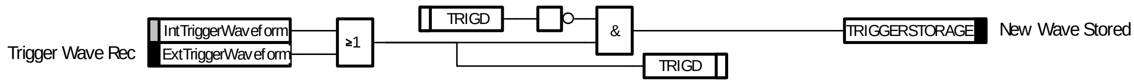
1) FP_32BITS_3DP: 2 registers - 32 bit fixed point, a 32 bit integer containing a value to 3 decimal places e.g. 50000 sent = 50.000

2) UINT16: 1 register - standard 16 bit unsigned integer

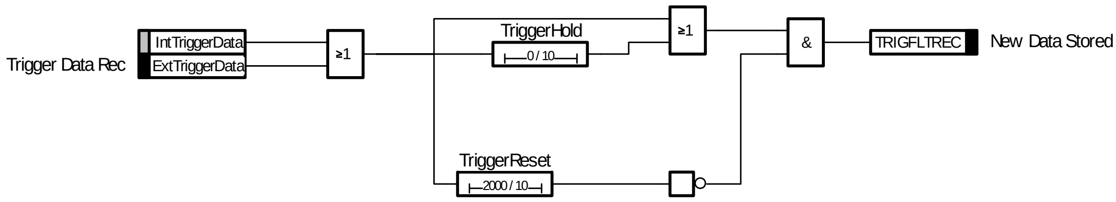
5 Reylogic Diagrams



WAVEFORM RECORDER LOGIC



DATA RECORDER LOGIC



INPUTS TO SELECT A SETTING GROUP FROM A STATUS INPUT.

6 Label Inserts

	DAD-N-101-R15
	DA1-101-**
	E8
	24/02/2010 12:55:00
1	GENERAL STARTER
2	PHASE A
3	PHASE B
4	PHASE C
5	(87/50) DIFFERENTIAL
6	(CT 50) CT SUPERVISION
7	(74TC) TRIP CIRCUIT FAIL
8	
9	
10	
11	
12	
13	
14	
15	
16	

	DA1-101-**	THIS LABEL IS	
	E12/E16 Left	DELIBERATELY BLANK	
	24/02/2010 12:55:00		
1	GENERAL STARTER		17
2	PHASE A		18
3	PHASE B		19
4	PHASE C		20
5	(87/50) DIFFERENTIAL		21
6	(CT/50) CT SUPERVISION		22
7	(74TC) TRIP CIRCUIT FAIL		23
8			24
9			25
10			26
11			27
12			28
13			29
14			30
15			31
16			32

7SG12 DAD N

Numerical High Impedance Relay with CT Supervision

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:
Pre release

2010/02.	Document reformat due to rebrand

Software Revision History

Contents

Figures

Glossary

Baud Rate	See *bits per second*.
Bit	The smallest measure of computer data.
Bits Per Second (BPS)	Measurement of data transmission speed.
Data Bits	A number of *bits* containing the data. Sent after the *start bit*.
Half-Duplex Asynchronous Communications	Communications in two directions, but only one at a time.
Hayes 'AT'	Modem command set developed by Hayes Microcomputer products, Inc.
IEC 60870-5-103	The International Electrotechnical Commission's Standard for communications with Protection Relays.
Master Station	See *primary station*.
Modem	MOdulator / DEModulator device for connecting computer equipment to a telephone line.
Parity	Method of error checking by counting the value of the bits in a sequence, and adding a parity bit to make the outcome, for example, even.
Parity Bit	*Bit* used for implementing parity checking. Sent after the *data bits*.
Primary Station	The device controlling the communication.
PSTN	Public Switched Telephone Network
RS232C	Serial Communications Standard. Electronic Industries Association Recommended Standard Number 232, Revision C.
Secondary Station	The device being communicated with.
Slave Station	See *secondary station*.
Start Bit	*Bit* (logical 0) sent to signify the start of a byte during data transmission.
Stop Bit	*Bit* (logical 1) sent to signify the end of a byte during data transmission.

1 Introduction

All Reyrolle relays utilise the International Communications Standard for Protection Relays, IEC 60870-5-103. This document describes how to connect the IEC60870-5-103 compliant communications interface to a control system or interrogating computer.

To access the interface the user will need appropriate software within the control system or on the interrogating computer such as Reydisp Evolution.

The Reyrolle Argus 1 to Argus 8 range of protection relays have a single rear communications interface. The Reyrolle Modular II relay range which includes Ohmega, Delta, Duobias, Iota, Tau and MicroTaPP have two rear communications interfaces COM1 & COM2. COM2 is multiplexed with an RS232 port mounted upon the Fascia :-

1. COM1: this port is used for IEC60870-5-103 communications to a substation SCADA or integrated control system by default.
2. COM2: this port can also be used for IEC60870-5-103 communications to a substation SCADA or integrated control system. Note however that only one port can be mapped to the IEC60870-5-103 protocol at any one time. (The COMMS INTERFACE submenu includes a setting “IEC60870 on port”, which maps the protocol to either COM1 or COM2). COM2 can also be accessed through an isolated RS232 (female 25-pin D-type) connector on the relay fascia. This provides facilities for access to the relay from a laptop or PC when commissioning or interrogating relays. A “COM2 Direction” setting is available which, when set to “AUTO-DETECT” automatically allows the front port to take control away from the rear port when a computer is plugged into the D-type connector.

2 Reydisp Evolution

Reydisp Evolution is a PC based software package providing capability for both local and remote communication to all Reyrolle Protection Relays . It provides features such as download of disturbance and event records, upload of relay settings, real-time monitoring of measurands and remote control of plant. Reydisp Evolution can be configured to connect to the relays using RS232, Fibre Optic, Modem or using Ethernet. When Ethernet is used the IEC 60870-5-103 protocol is transported using the TCP/IP protocol suite across a Local or Wide Area Network (LAN/WAN).

3 Connection Specification and Relay Settings

This section defines the connection medium as defined by IEC60870-5-103. Appendix A shows some typical communication connections.

3.1 Recommended cable

Two types of fibre-optic connectors are available with Reyrolle relays:

1. Fibres terminated with 9mm SMA connectors. With this type of connector the recommended cable is 62.5 / 125μm glass fibre. This will allow a maximum transmission distance of 1.7km between Reyrolle relays. It will also be the maximum distance between the ring network and the fibre to RS232 converter.

Alternatively, 1.0mm polymer cable may be used to reduce cost. This will provide transmission distances of up to 5m between relays. Note that the distance from the transmit output of the RS232 / fibre optic converter to the receive input of the first Reyrolle relay should not be more than 6m.

2. Fibres terminated with BFOC/2.5 (ST®) bayonet-style connectors. With this type of connector the recommended cable is also 62.5 / 125μm glass fibre. This offers superior performance over the SMA connectors in terms of better coupling to the fibre and therefore has lower losses.

No other types of cable are suitable for use with Reyrolle relays.

3.2 Connection Method

Reyrolle relays can be connected in either a Star or Ring fibre-optic communications network. If star connected then a passive fibre optic hub must be used. A lower cost option is the ring configuration where the Reyrolle relays are ‘daisy chained.’ That is, the transmit output of the first relay is connected to the receive input of the second relay, and so on until the ring is complete.

Communication to the ring may be achieved either locally in the substation or remotely via the Public Switched Telephone Network (PSTN). If remote communication is desired, then additional modem equipment must be installed.

3.3 Transmission Method

The transmission method is Half Duplex serial asynchronous transmission. In IEC 60870-5-103 the line idle state is defined as Light ON. This can alternatively be selected as Light OFF in the Communications Interface menu of the relay if required for use with alternate hardware (See Section 2.5).

3.4 Transmission Rate

Rates of 19200, 9600, 4800, 2400, 1200, 600, 300, 150, 110 and 75 bits per second (BPS) are provided. Only 19200 and 9600 BPS are standard in IEC 60870-5-103, the additional rates are provided for local or modem communications.

3.5 Line Idle Setting

The line idle setting can be set to be either ON or OFF and the setting must be compatible with the device connected to the relay. The IEC 60870-5-103 standard defines a line idle state of Light On. If the device the relay is connected to, does not have a compatible fibre-optic port then a suitable electrical to optical converter is required to connect it to a standard RS232C electrical interface. A suitable converter is the Sigma 4 type, which is available from Reyrolle Protection.

Alternative converters are the Reyrolle Dual RS232 Port (Sigma 3) or Reyrolle Passive Fibre-Optic Hub (Sigma 1).

1. The Sigma 3 Dual RS232 port provides a fibre-optic interface to a relay and two RS232 ports. The RS232 system port is typically connected to a control system while the second port is a local port. When the local port is in use the system port is automatically disabled. The Sigma 3 has an internal link to switch between line idle Light ON or Light OFF. The default configuration is Light OFF.

2. The Sigma 1 Passive Fibre-Optic Hub provides fibre-optic interfaces for up to 29 relays. It has a fibre-optic port to the control system and multiple relay connections. Each of the 30 fibre-optic ports can be configured for either Light ON or Light OFF operation. Default for all is OFF.

3.6 Parity Setting

IEC60870-5-103 defines the method of transmission as using EVEN Parity. However, in some instances an alternative may be required. This option allows the parity to be set to NONE.

3.7 Address Setting

The address of the relay must be set to a value between 1 and 254 inclusive before any communication can take place. Setting the address to zero disables communications to the relay, although if it is in an optical ring it will still obey the Data Echo setting. All relays in an optical ring must have a unique address. Address 255 is reserved as a global broadcast address.

4 Modems

The communications interface has been designed to allow data transfer via modems. However, IEC60870-5-103 defines the data transfer protocol as an 11 bit format of 1 start, 1 stop, 8 data and 1 parity bit which is a mode most commercial modems do not support. High performance modems, for example, Sonix (now 3Com), Volante and MultiTech Systems MT series will support this mode but are expensive. For this reason a parity setting (see section 2.6) to allow use of easily available and relatively inexpensive commercial modems has been provided. The downside to using no parity is that the data security will be reduced slightly and the system will not be compatible with true IEC60870 control systems.

4.1 Connecting a modem to the relay(s)

The RS232C standard defines devices as being either Data Terminal Equipment (DTE) e.g. computers, or Data Communications Equipment (DCE) e.g. modems. To connect the modem to a relay requires a fibre-optic to electrical connector and a Null Terminal connector which switches various control lines. The fibre-optic converter is then connected to the relay in the following manner :

Fibre-Optic Converter	Relay Connection
Tx	**Rx**

Rx	Tx

4.2 Setting the Remote Modem

Most modems support the basic Hayes ‘AT’ command format, though different manufacturers can use different commands for the same functions. In addition, some modems use DIP switches to set parameters while others are entirely software configured. Before applying the following settings it is necessary to return the modem to its factory default settings to ensure that it is in a known state.

The remote modem must be configured as Auto Answer, which will allow it to initiate communications with the relays. Auto answer usually requires 2 parameters to be set. One switches auto answer on and the other, the number of rings after which it will answer. The Data Terminal Ready (DTR) settings should be forced on which tells the modem that the device connected to it is ready to receive data. The parameters of the modem’s RS232C port need to be set to match those set on the relay i.e. baud rate and parity to be the same as the settings on the relay, and number of data bits to be 8 and stop bits 1.

Note: although it may be possible to communicate with the modem at e.g. 19200bps, it may not be possible to transmit at this rate over the telephone system, which may be limited to 14400. A baud rate setting needs to be chosen which is compatible with the telephone system. As 14400 is not available in the relay, the next lowest rate, 9600, would have to be used.

Since the modem needs to be transparent, simply passing on the data sent from the controller to the device and vice versa, the error correction and buffering must be turned off. In addition if possible force the Data Carrier Detect (DCD) setting to ON as this control line will be used by the fibre-optic converter.

Finally these settings should be stored in the modem’s memory for power on defaults.

4.3 Connecting to the remote modem

Once the remote modem is configured correctly it should be possible to dial into it using the standard configuration from a local PC. As the settings on the remote modem are fixed, the local modem should negotiate with it on connecting and choose suitable matching settings. If it does not, however, set the local modem to mimic the settings of the remote modem described above.

APPENDIX A - COMMUNICATION CONNECTIONS

Figures 1 to 6 illustrate a number of methods of connecting relays in communications networks.

Note that in the case of the optical ring configurations (Figure 4, Figure 6 and Figure 7), the Data Echo feature must be switched ON in the communications settings menu of the relay. In all other cases this setting should be set to OFF. In the data echo mode, everything that is received on the fibre optic receiver port is automatically (in hardware) re-transmitted from the transmitter port. This is made possible because of the communications standard IEC 60870-5-103 which operates half-duplex.

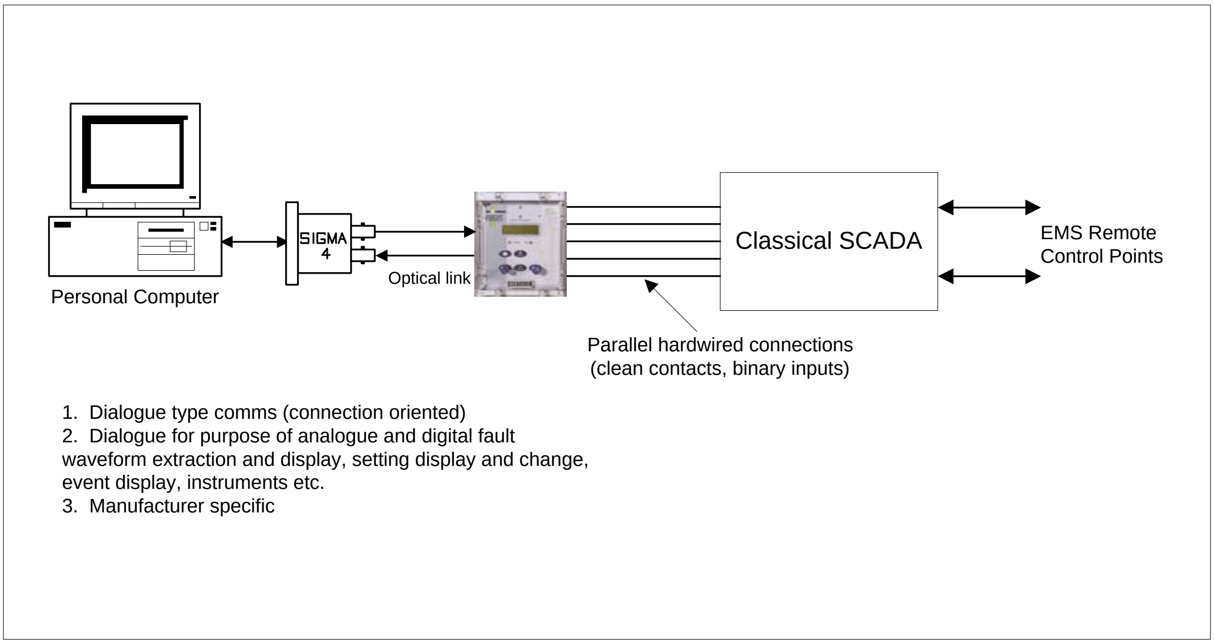
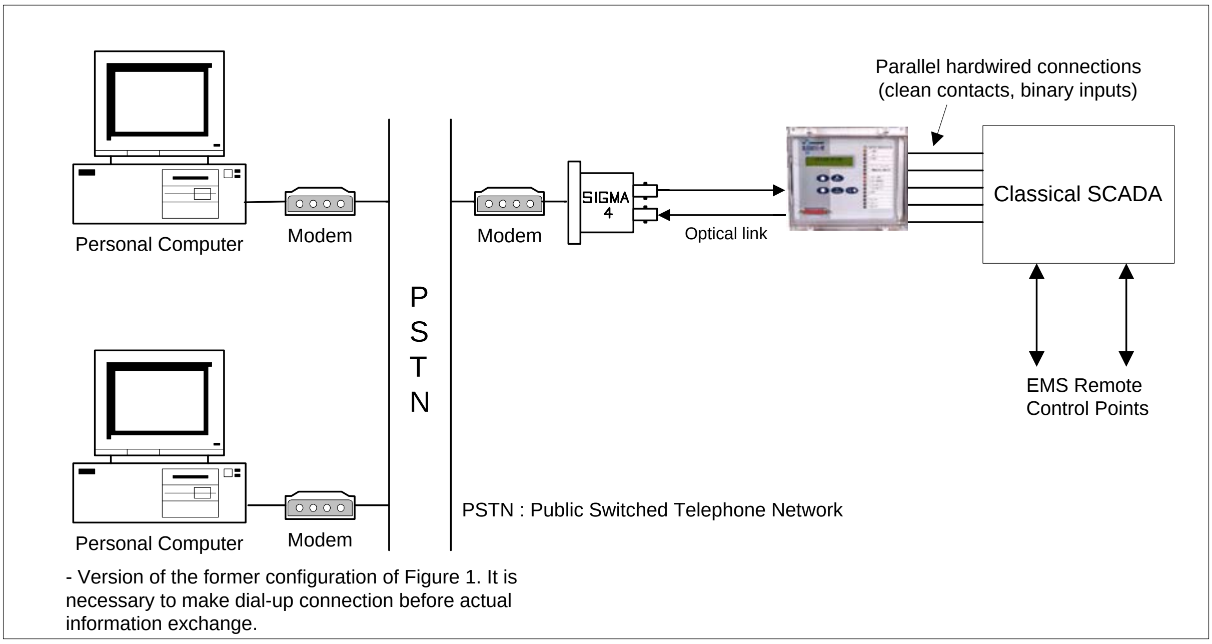


Figure 1 - Basic Communications Configuration



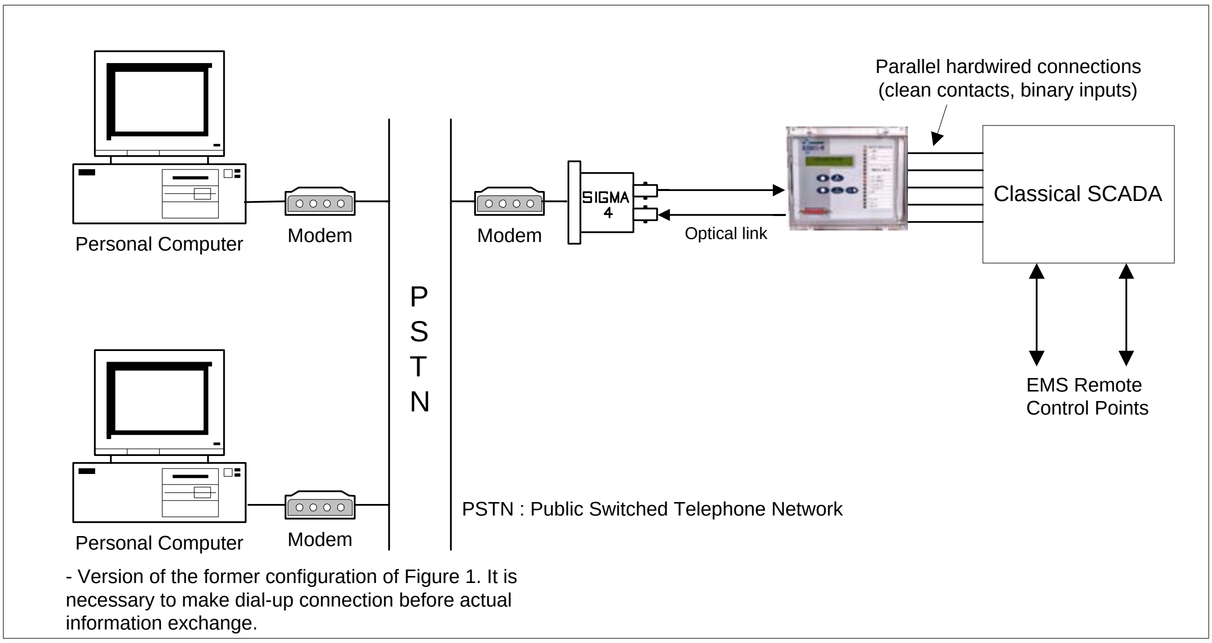
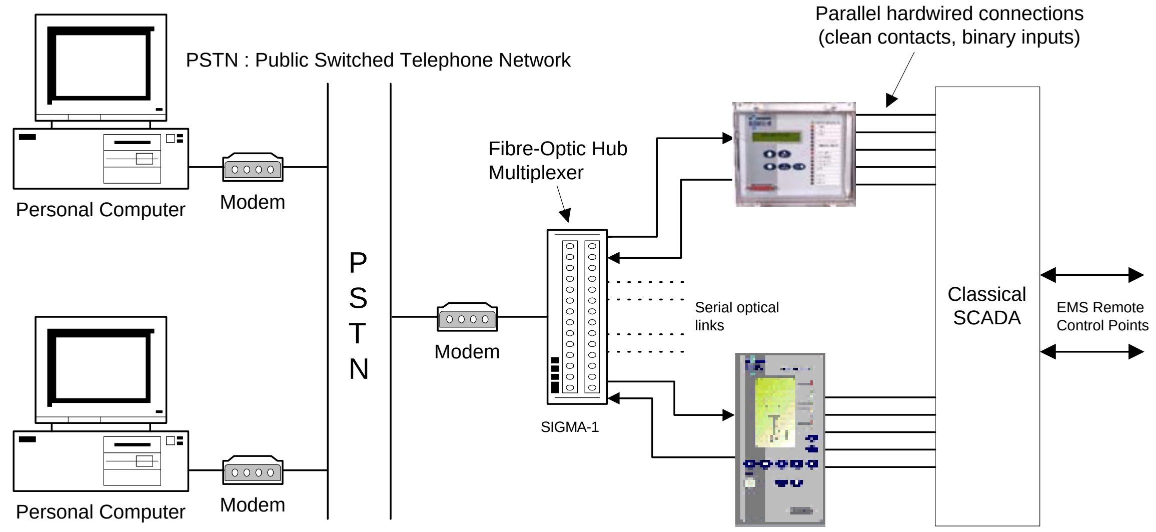


Figure 2 - Basic Communications Configuration (Remote)



- A more sophisticated version of the former configuration of Figure 2. Several relays within the substation can be accessed via one modem but only one can be communicated with at a time.

Figure 3 - Star Type Configuration (Using SIGMA-1 Multiplexer)

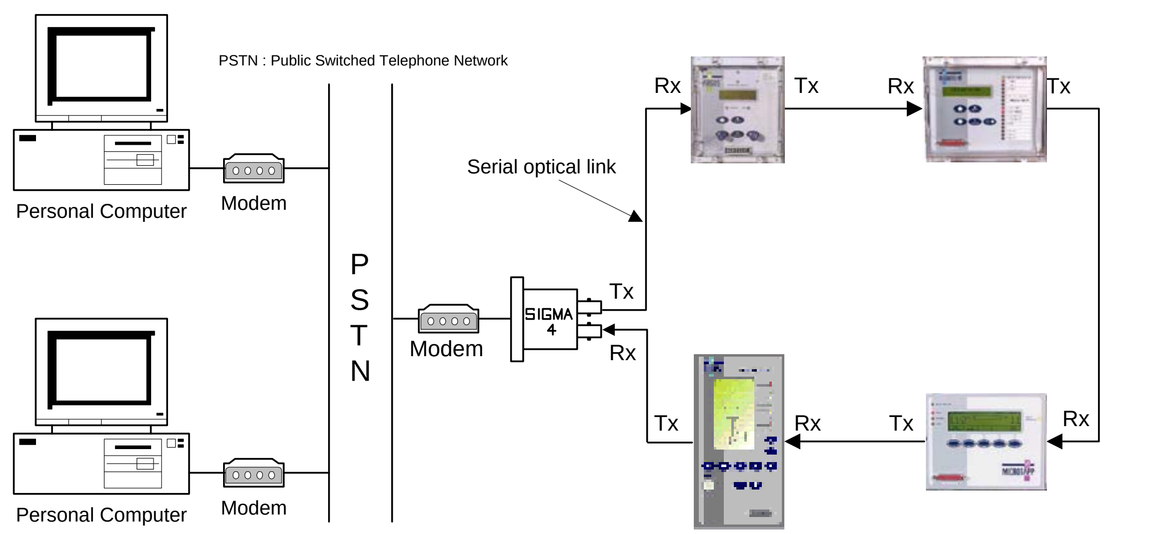


Figure 4 - Optical Ring Configuration (Using SIGMA-4 Fibre/RS232 Convertor)

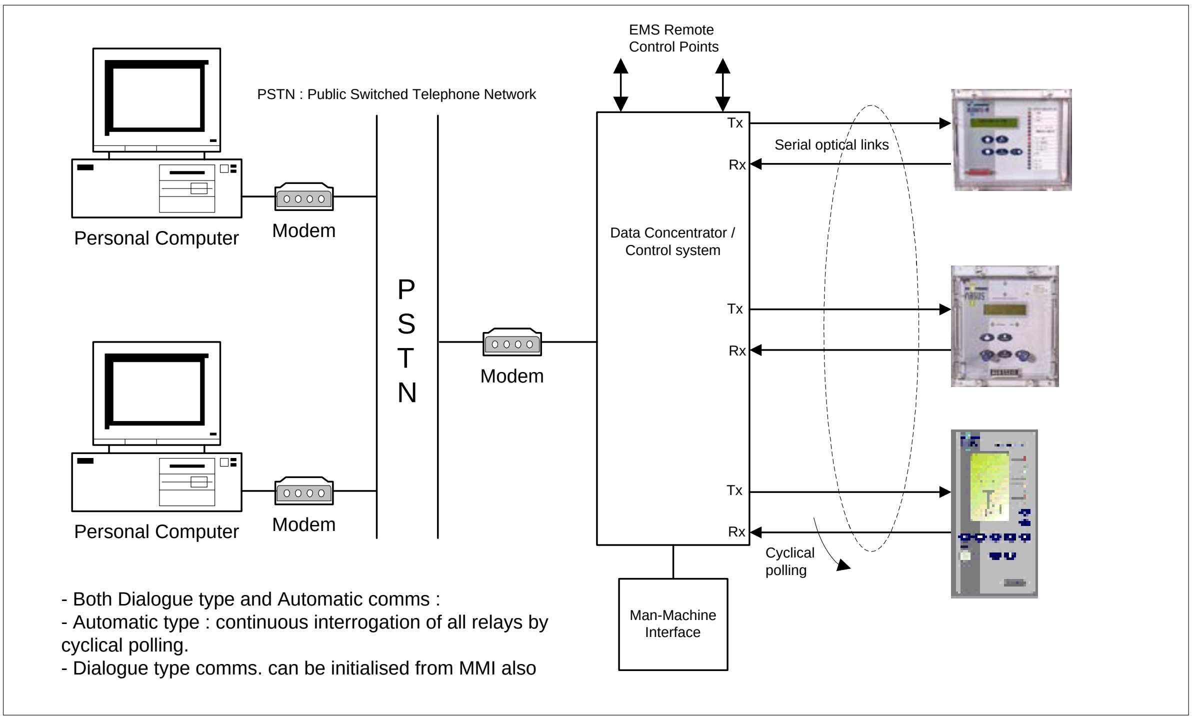


Figure 5 – Direct Control System/Data Concentrator Configuration

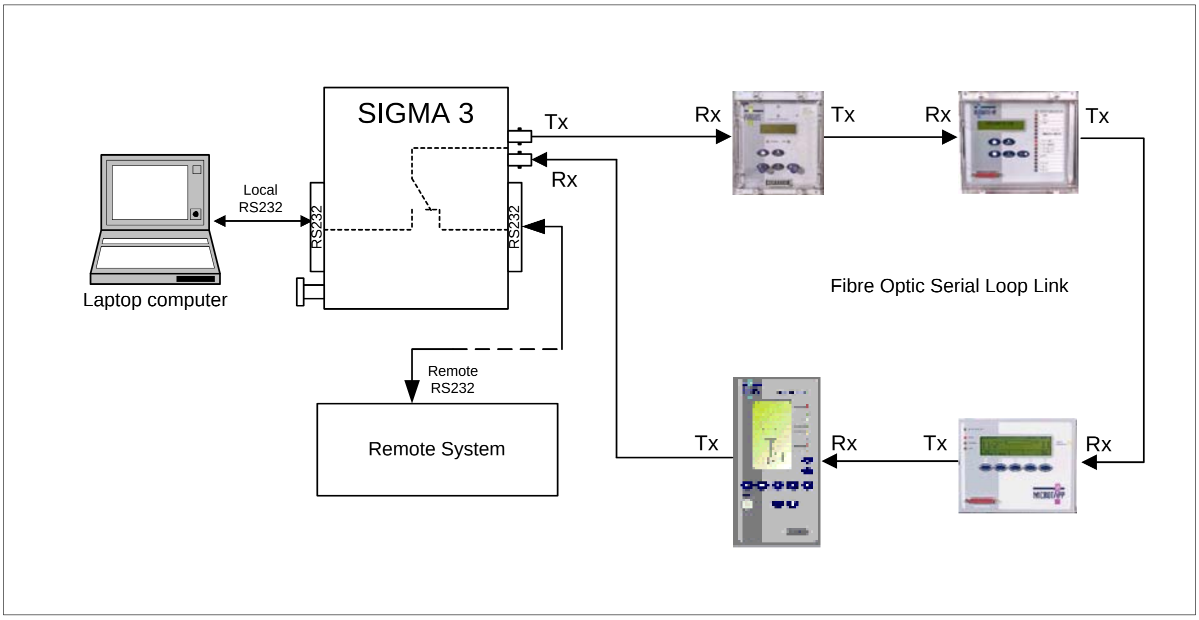


Figure 6 – Automatic switchover remote to local control using the SIGMA-3

When a portable PC is plugged into the front port of a SIGMA-3 then the remote system is automatically disconnected to ensure local control only. Alternatively on Modular II relays the portable PC may be plugged directly into the front fascia RS232 connection.

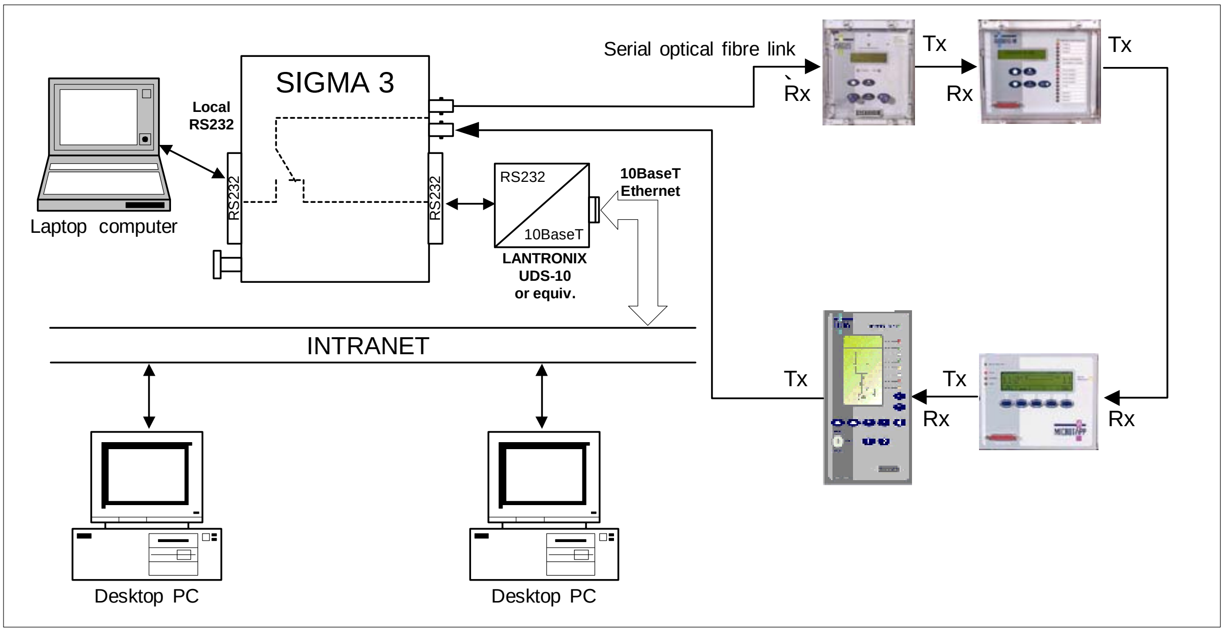


Figure 7 – LAN Network connectivity using a SIGMA-3 + Lantronix UDS-10 or equivalent

A SIGMA-3 unit may be used to as shown in Figure 7 to connect Argus and Modular II protection relays to a local area network via an Ethernet to RS232 convertor such as the Lantronix UDS-10 or similar device. SIGMA-3 units may be used on a per bay or per substation basis. They provide a single point of contact to the protection relays for monitoring and diagnostic purposes.

7SG12 DAD N

Numerical High Impedance Relay with CT Supervision

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:
Pre release

2010/02.	Document reformat due to rebrand

Software Revision History

Contents

Figures

1. Introduction

These notes give guidance on the application of the DAD-N. Reference should also be made to the Commissioning section, which provides detailed set-up instructions.

2. Differential Protection

A Busbar is a zero impedance connection joining several items such as lines, loads etc. Therefore at busbar stations the switchgear is stressed, at times of fault, to levels higher than occur elsewhere on the system. It is therefore important that faults are detected and cleared as quickly as possible. In addition, since Busbars act as connection points in an electrical system, it is important that good fault discrimination is achieved with only the minimum amount of plant necessary to clear the fault being disconnected.

Differential unit protection is the most obvious solution to these requirements.

Differential protection works on the basic premise that the currents which enter a protection zone should be equal to the currents leaving it. Any discrepancy, allowing for measuring errors, etc. indicates an in-zone fault. By contrast an external fault will produce no discrepancy in the measured currents.

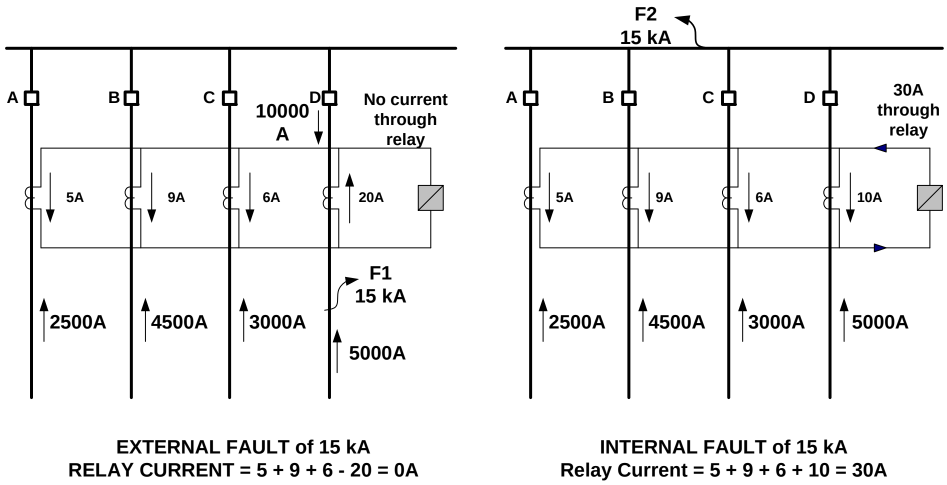


Figure 1 – Current Differential Protection

Good fault discrimination is achieved, therefore. In addition, because the protection is based on simple current level detection it is extremely fast. Typical operate time for a high impedance scheme is <20ms.

Busbar faults are almost always permanent faults and are therefore not suitable for Auto-reclosure. Instead every source connection to the Busbar must be broken and isolated.

3. High Impedance Differential Protection

In a High Impedance current differential scheme, the secondary winding of the CTs positioned at all entry and exit points of a protected zone are summated external to the protection relay. These entry and exit points must include all incomers, sections, couplers and outgoing feeders. The principle is therefore that one protection Relay must be provided for each protected zone.

The principles of such a scheme can easily be extended to a 3-phase system. In effect three separate protection circuits, each covering one phase, are installed. Each phase system is joined together at the star point of each set of CTs with the star point always connected away from the protected zone. These will provide both phase-phase and phase-earth coverage.

The High Impedance Busbar protection must satisfy 2 criteria:

- It must be **stable** so that operation does not occur for any faults external to the protected zone.
- It must be sufficiently **sensitive** so that any faults in the protected zone are detected.

To achieve **stability**, the protection must be designed so that it is tolerant to any current imbalances due to CT saturation effects resulting from external (through) faults. Transient stability under through fault conditions is a problem with many forms of differential protection due to variations in CT magnetising characteristics. As saturation is approached, the CT output current waveforms become increasingly distorted with a high percentage of 3rd and other higher odd harmonics. These variations can lead to unbalanced currents causing mal-operations.

3.1 Stabilising Resistor

Consider a simple 4 CT protection:

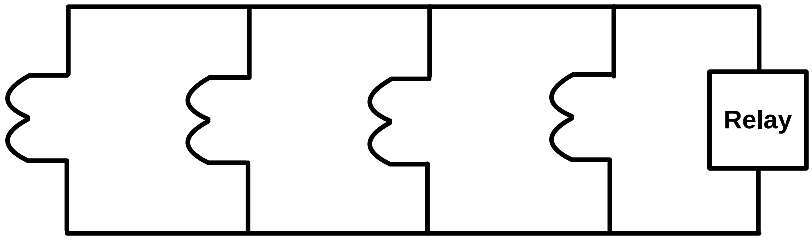


Figure 2 – Simple 4 CT Protection

It is a proven design principle that the worst case for current unbalance due to CT saturation occurs when one of the paralleled CTs becomes completely saturated while all the other CTs continue to function linearly. This situation would never occur in reality, but by making the protection tolerant to it we can be confident that it will remain stable for all through fault conditions.

When a CT becomes total saturated, its secondary winding can be considered as a resistance rather than a current source. The value of this resistance is equal to the CT secondary resistance, R_{ct}, and will be considerably larger than the resistance of the Relay analogue inputs. This means that most of the unbalanced currents from the other CTs will flow through the Relay and these may be of sufficient magnitude to operate the protection.

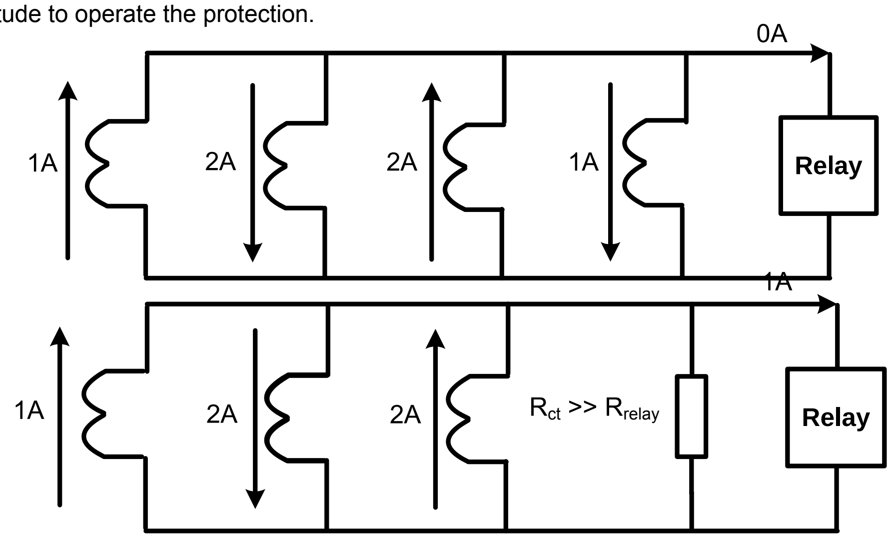


Figure 3 – Current Distribution with one CT totally saturated

The solution is to load the Relay circuit by adding a series resistor such that most of the unbalance current due to the CT becoming saturated will instead flow through the saturated CT secondary. Since this resistor will make the protection stable for all through faults, it is termed the Stabilising Resistor, Rstab. Similarly, it is this additional resistance which makes the Relay a “High Impedance” path.

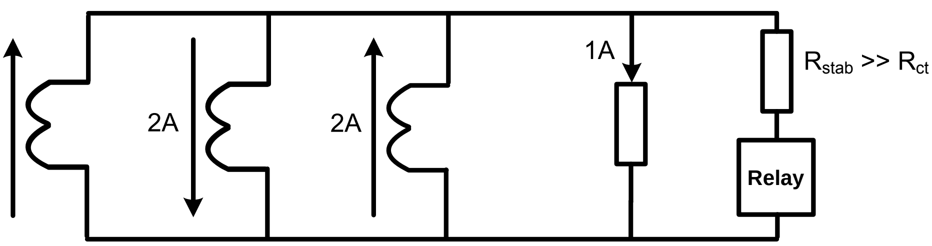


Figure 4 – Stabilising Resistor

The maximum voltage which can appear across the Relay for a through fault coincident with CT saturation is:

$$V_{max}\,(V) = I_{MaxSecExtFault} \text{ x } (R_{ct} + (2 \text{ x } R_{lead}))$$

Where:

$I_{MaxSecExtFault}$ = Maximum secondary external (through) fault current = $I_{MaxPriExtFaul}$ x CT Ratio

R_{ct} = CT secondary winding resistance

R_{lead} = Maximum lead resistance in parallel with the Relay circuit

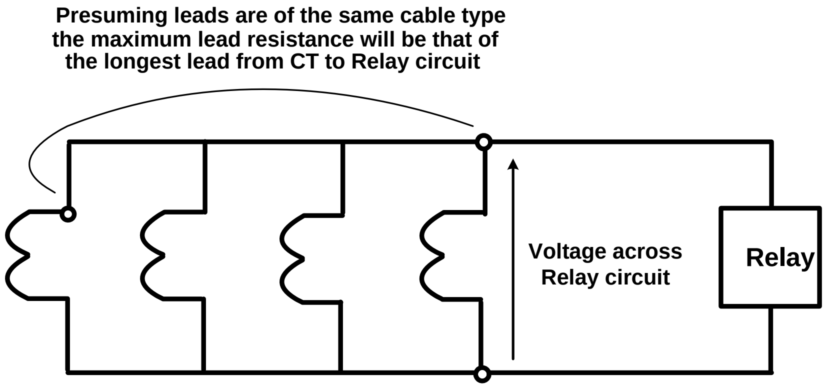


Figure 5 – Measuring Lead Resistance

So that R_{lead} + R_{ct} + R_{lead} is the total resistance in parallel with the Relay.

There will be some lead resistance between the Relay and the closest CT, but this is generally ignored to give the most onerous operating conditions.

If $I_{MaxPriExtFault}$ is not known, the breaking capacity current of the Circuit Breaker can be used.

The value of R_{stab} must be such that the current flowing through the Relay at this voltage is less than the protection pick-up setting, I_s.

I_s must be chosen so that the protection will operate for all internal fault currents. **Sensitivity** is achieved by ensuring that I_s is such that the protection will operate at the correct level of primary fault current. See Section 3.3 “Fault Setting”.

Therefore, for stability:

$$\frac{V_k}{2} \text{ x } \frac{1}{I_s} \geq R_{stab}\,(\Omega) \geq \frac{V_{max} - V_{relay}}{I_s}$$

Where:

V_{relay} = The burden of the Relay analogue inputs (VA) / nominal current (A)

For the DAD-N, this will be so small that it can be ignored

Usually the value of R_{stab} is chosen at the higher end of the range, so that:

$$\frac{V_k}{2} \text{ x } \frac{1}{I_s} \geq R_{stab}\,(\Omega) \geq \frac{V_k}{4} \text{ x } \frac{1}{I_s}$$

The Voltage across the Relay and Stabilising Resistor at the Relay operating current, I_s, is termed the setting voltage, V_s. So that:

$$V_s = I_s \text{ x } R_{stab}$$

Note that where high quality CTs are being used, with a high V_k, the value of V_s chosen must not be so low that the CT will be operating at the very low, non-linear part of its magnetising curve.

It is important that R_{stab} is suitably rated to withstand the current levels expected during an internal (in-zone) fault. The continuous rating of R_{stab} should be:

$$\text{Continuous Rating of } R_{stab}\,(W) \geq (I_s)^2 \times R_{stab}$$

Similarly, R_{stab} must have a short time rating large enough to withstand the fault current levels before the fault is cleared. This is usually for 0.5 seconds to allow for a failure in the main protection system or switchgear and so considers longer fault clearance times through operation of the back-up protection.

$$\text{Short Time Rating of } R_{stab}\,(W) \geq \frac{V_{MaxSecIntFault}{}^2}{R_{stab}}$$

$$V_{MaxSecIntFault}\,(V) \geq (V_K{}^3 \times R_{stab} \times I_{MaxSecIntFault})^{1/4} \times 1.3$$

Where:

V_k = Kneepoint voltage of the CT

$V_{MaxSecIntFault}$ = Maximum secondary internal fault voltage

$I_{MaxSecIntFault}$ = Maximum secondary internal fault current = $I_{MaxPriIntFault}$ x CT Ratio

Once again, if $I_{MaxPriIntFault}$ is not known, the breaking capacity current of the Circuit Breaker can be used.

Note that the stabilising resistor will have no effect until CT saturation occurs. The CT secondaries act as current sources and any imbalance must go through the relay circuit despite the presence of R_{stab}.

3.2 Non-Linear Resistor

For safety reasons, overvoltages within a protection panel must not be allowed to go above 3kV. For the protection system:

$$\mathbf{V_{Peak}\,(V) = 2 \times \sqrt{2 \times V_K \times ((I_{MaxSecIntFault} \times R_{stab}) - V_K)}}$$

If V_{peak} can go above 3kV, a Metrosil (non-linear resistor) must be fitted in parallel with the Relay circuit to limit its maximum level. However, it is considered good practice to fit a Metrosil for all installations.

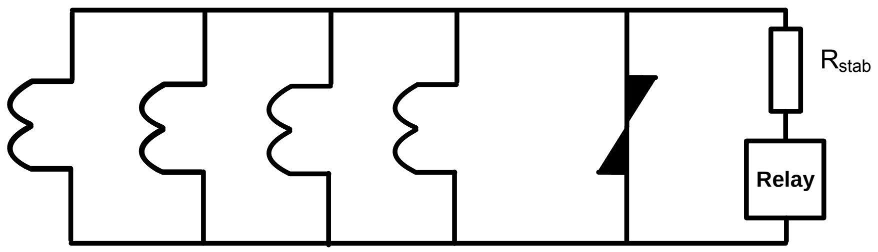


Figure 6 – Non-Linear Resistor

Metrosils are specified by 3 figures – their diameter and the fixed, device-specific constants C (thickness) and β (chemical composition). The diameter relates to the Power Rating of the device, C and B to the current which will flow through the Metrosil for a given voltage:

$$V = C \times I^{\beta}$$

The voltage characteristic of the Metrosil must be;

Large enough so that negligible current flows through the Metosil at the relay operating voltage.

$$C \times I_s{}^{\beta} \gg R_{stab} \times I_s$$

Small enough so that dangerous over-voltages do not occur.

$$C \times I_{MaxSecIntFault}^{\beta} < 3kV$$

The Metrosil must be rated sufficiently to dissipate the heat created by the flow of maximum secondary internal fault current:

$$\text{Required Continuous Rating of Metrosil (W)} \geq (4 / \pi) \times I_{MaxSecIntFault} \times V_K$$

This will usually give a massive power rating requiring a Metrosil of unrealistic size. For this reason the Metrosil is chosen so that it can withstand $I_{MaxSecIntFault}$ for only the maximum fault clearance time. Generally using the Metrosil's one second rating is sufficient.

3.3 Fault Setting

To achieve correct sensitivity to in-zone faults, the protection scheme must typically operate for a primary current of 10-30% of the minimum primary fault current, $I_{MaxPriIntFault}$.

$I_{MinPriIntFault}$ is a complex figure which must be calculated from a detailed system study.

In addition, allowance must be made for the magnetising current of the paralleled CTs. In effect, these act as losses in the secondary circuit and so reduce the secondary current available to operate the protection.

$$\text{Primary Operate Current} = [(\text{Number of CTs} \times \text{Magnetising Current at } I_s) + I_s] \times \text{CT Ratio}$$

This assumes there is little or no current leakage through the Metrosil or any other current paths.

If this is greater than the maximum allowable Primary operate current of $I_{MinPriIntFault}$ x 30%, then I_s must be reduced to bring it back within specification. This, of course, would entail re-calculating the value of R_{stab}. The process is thus iterative until a suitable primary operate level is achieved.

As the number of paralleled CTs increases, the losses through magnetising current become so large that it becomes impossible to set I_s low enough. At this point the scheme becomes unworkable. As a very rough guideline, the maximum number of paralleled CTs is about 20.

Similarly, if the Primary Operate Current is smaller than the minimum allowable Primary operate current of $I_{MaxPriIntFault}$ x 10%, then I_s must be increased to bring it back within specification.

If it is not possible to increase I_s then a Shunt Resistor, R_{shunt}, can be placed in parallel with the relay. This has the effect of modifying the above equation to:

$$\text{Primary Operate Current} = [(\text{Number of CTs} \times \text{Magnetising Current at } I_s) + I_s + I_{shunt}] \times \text{CT Ratio}$$

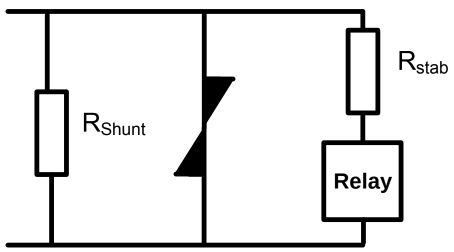


Figure 7 – Shunt Resistor

The value of R_{shunt} can then be calculated:

$$I_{shunt} \geq (\text{Primary Operate Current} / \text{CT Ratio}) - [(\text{Number of CTs} \times \text{Magnetising Current at } I_s) + I_s]$$

$$R_{shunt} \leq (I_s \times R_{stab}) / I_{shunt}$$

For solidly earthed systems, where the fault current will be very high, it is acceptable practice to use a primary fault setting of 50% of the Busbar full load current.

3.4 Check Zone

On double busbar systems, where there will be a significant number of switching operations, it is usual to provide an extra level of tripping security by fitting a Check Zone relay. This monitors the current of every incomer and outgoing feeder on the Busbar, but not the internal Busbar Sections and Couplers.

A Check Zone relay is also sometimes installed on single busbar systems of high importance.

The outputs of the relays protecting each Busbar zone are then connected in series with the Check Zone relay's outputs. Only when both operate will a trip be issued.

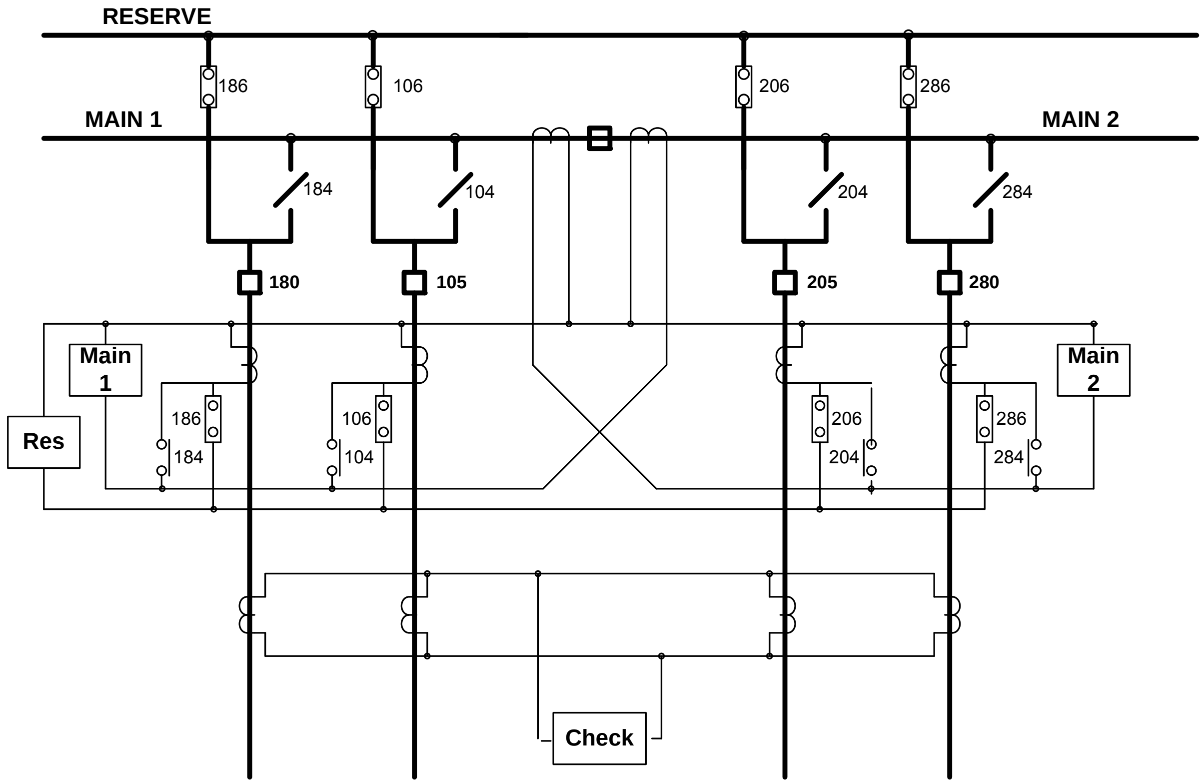


Figure 8 – Check Zone Relay

4. Current Transformer Requirements

The CTs used in a High-Impedance Differential scheme must follow some simple rules:

- They must be of the high-accuracy type in accordance with Class 'PX' to IEC 60044.
- They must have the same turns ratio.
- The knee point voltage of each CT should be at least 2 x Vs.

  The knee point voltage is expressed as the voltage applied to the secondary circuit with the primary open circuit which when increased by 10% causes the magnetising current to increase by 50%.

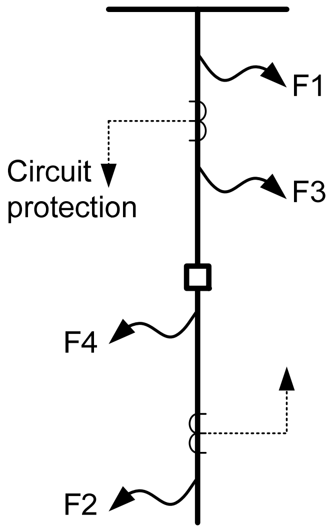
It is permissible for the CTs to have different magnetizing characteristics since under load (or through-fault) conditions the secondary currents will substantially balance. For an in-zone fault, there will be high levels of secondary current and so any unbalance in the magnetizing characteristics will actually aid correct tripping.

5. Current Transformer Location

The mounting position of CTs for busbar protection varies according to the type of switchgear. In many cases, the CTs are built into the Circuit Breakers. In others, they are separate devices located as close to the Breakers as possible.

5.1 CTs overlapping the Circuit Breaker

This arrangement is common in outdoor bulk oil types. The performance of the protection is considered for the faults F1 to F4.



A fault at F1 is a busbar fault which should be cleared by the busbar protection.

Fault F2 is a circuit fault and should be cleared by the circuit protection.

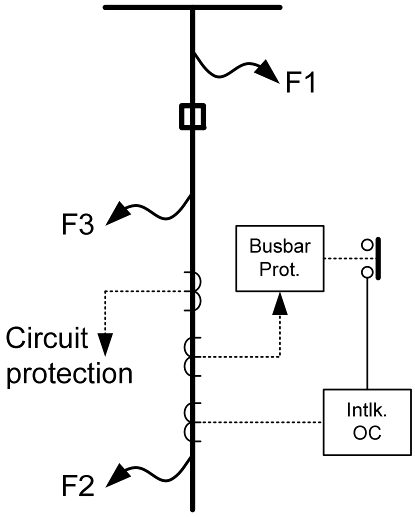
F3 is a busbar fault but because of its position should cause both busbar and circuit protection to operate and the fault will be cleared, although the circuit breaker at the remote end of the circuit may also be tripped.

Although F4 is a circuit fault, it may be detected by both circuit and busbar protection depending on their relative operating times. Thus, circuit breakers selected to the busbar may be opened unnecessarily for a circuit fault.

For F3 and F4, the disadvantage may be acceptable in view of the low incidence of such faults.

Figure 9 – CTs Overlapping the CB

5.2 CTs on the circuit side of the Circuit Breaker



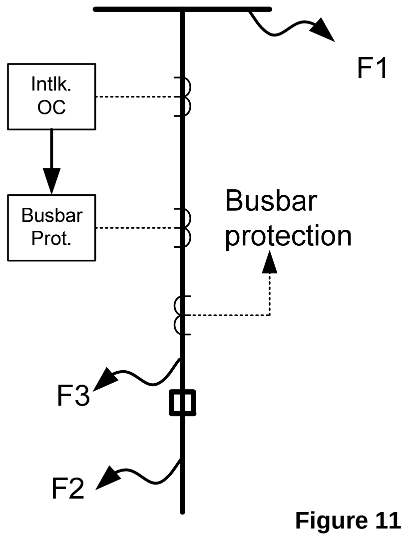
Faults F1 and F2 should be correctly cleared as before, but F3 will only cause operation of the busbar protection because the fault is outside the circuit protection zone. Thus the fault may remain fed from the remote end of the circuit. Arrangements must therefore be made to cause the CB at the remote end of the line to be tripped under these circumstances.

This can be affected by a direct intertrip or CB fail scheme. Another method, as shown, uses an interlocked overcurrent relay. This is arranged to detect any power infeed at F3 after the circuit breaker is opened.

This relay is a three pole over current type with a time setting of about 0.3 second. Its operation is inhibited until the busbar protection operates and so if the fault persists at F3 after the circuit breaker opens, the busbar protection remains operated, so permitting the interlocked overcurrent relay to function and unstabilise the circuit unit protection or send an intertripping signal to the remote end of the circuit.

Figure 10 – CTs on other side of CB

5.3 CTs on the Busbar side of the Circuit Breaker



The faults at F1 and F2 will be correctly cleared.

A fault at F3 will cause the circuit protection to trip the circuit breaker, but the fault will remain fed from the busbars. The busbar protection will not operate as F3 is outside its zone.

Again an interlocked Over current relay is used, but in this case, since it is the circuit protection which remains operated for the fault at F3, it is this protection which is used to initiate operation of the interlocked overcurrent relay. If F3 persists for about 0.3 seconds, the interlocked overcurrent relay then operates the tripping relays of the protection of the section of busbar to which the circuit is selected.

Figure 11 – CTs on Busbar side of CB

5.4 Bus Section and Bus Couplers

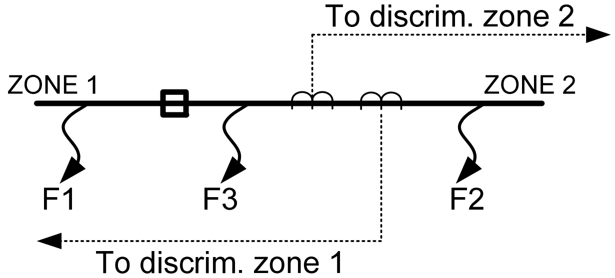


Figure 12 – CTs on Bus Section and Bus Coupler

For these, the ideal arrangement is to have a set of CTs on each side of the circuit breaker. The CTs associated with a discriminating zone should be mounted on the side of the breaker away from the zone with which they are associated.

If the two sets of CTs are mounted on one side as shown, then faults F1 and F2 will be correctly cleared by the operation of the appropriate discrimination zone relays plus the overall check relay. A fault at F3 will cause the operation of zone discrimination relay plus the check relay to clear the left hand busbar. However, F3 will continue to be fed from the circuits selected to zone 2 busbar, since the zone 2 busbar protection will not operate as this fault is just outside its zone. For such a fault at F3, the zone 1 relay will clear the busbar and reset, so de-energising relay TD before it has time to operate the zone 2 trip relay. Relay TD must therefore have a setting time of about 0.4 seconds. Similar considerations apply in the case of Bus Couplers.

6. CT Supervision

If a CT secondary becomes open-circuit, or if the wiring to the CT is broken, a current unbalance will be created in the Relay circuit. This may exceed the operating level in which case the protection has no option but to cause a trip.

If the resulting unbalance is lower than the operate level, however, it is important that the condition is detected since a resulting through fault may be sufficient to raise the unbalanced current above the operate level. A simple current pick-up is therefore provided, CT Supervision, which should be set higher than normal unbalance levels due to measuring errors, etc. but lower than the Differential operate level. Generally a setting of 10% of the Differential operate level is acceptable.

Once a CT Supervision condition has been detected, the relay can be programmed to issue an alarm via one of the output contacts. Where a mal-operation is preferred to missing a real fault, this alarm is used to simply alert the system operator to the condition. It should then be rectified as soon as possible.

Where a mal-operation is unacceptable, however, this alarm can be used to disable the protection until the CT is repaired. Traditionally this has been done by using the alarm to short-circuit the secondaries of all the CTs for a given phase, since there is no way of telling which is faulty. This method has been used where an open-circuited CT may cause damage to plant. Care must be taken, however, to ensure that the rating of the relay output contacts is sufficient to make and break the high current transients involved. If not, the alarm output must be used to operate a dedicated shorting relay with higher-rated contacts.

With modern numeric relays like the DAD-N, it has become possible to simply disable the Differential protection rather than short out the CT secondaries. To do this, the CT Supervision alarm output contact should be externally connected to a status input used to inhibit the relay’s Differential protection elements.

Note that the CT Supervision delay must be set carefully. Since the CT Supervision element will still pick-up for a genuine fault condition, the delay should be set long enough so that it does not issue an alarm before the protection has correctly cleared the fault. Setting the delay too low (less than a few seconds) may cause confusion where the CT Supervision condition is used as an alarm, and an unacceptable race condition where the CT Supervision alarm is used to disable the protection (will the protection operate to clear the genuine fault before the CT Supervision alarm disables it ?) Typically a setting of 2 to 10 seconds is applied.

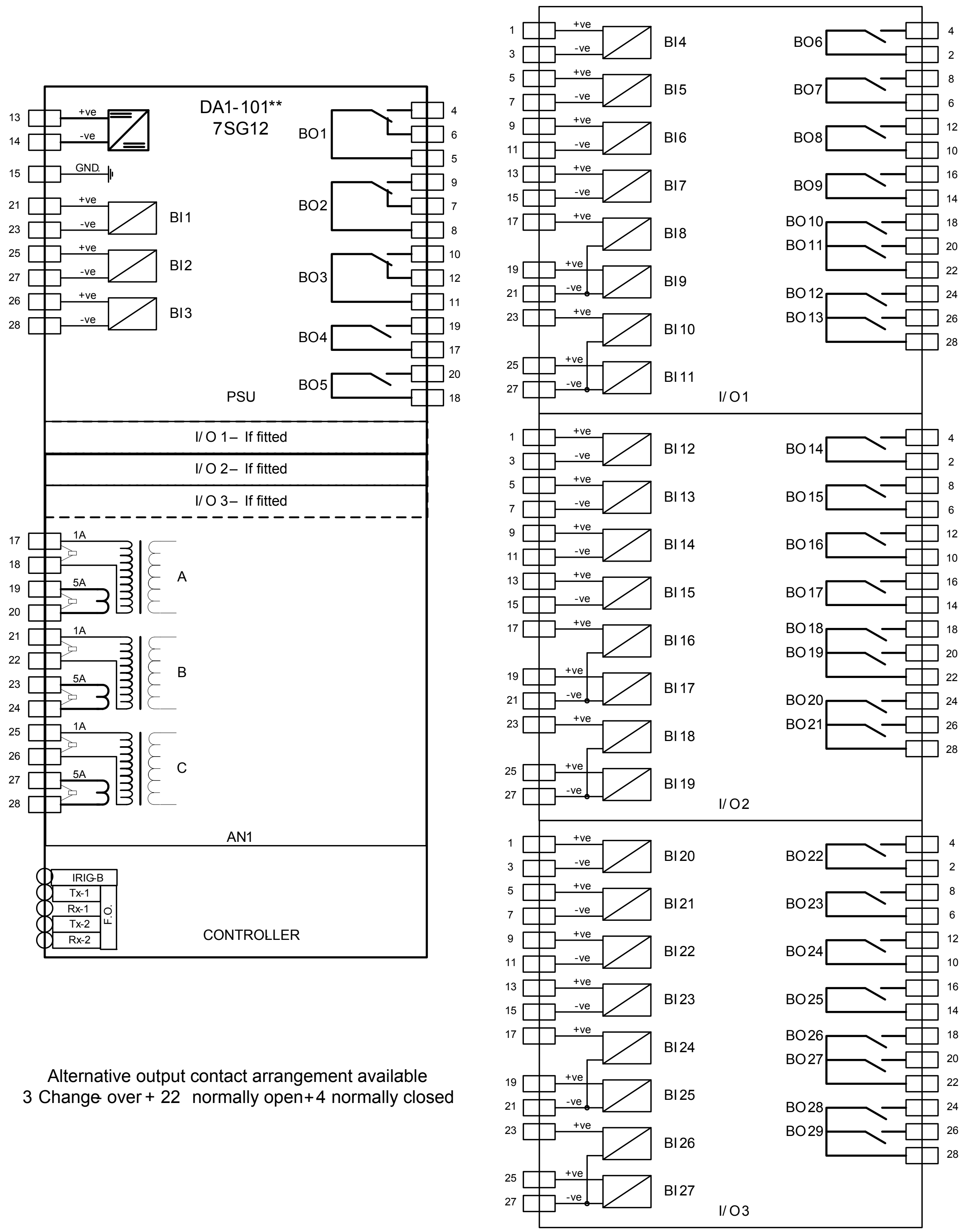


Figure 13 – DAD-N Connection Diagram

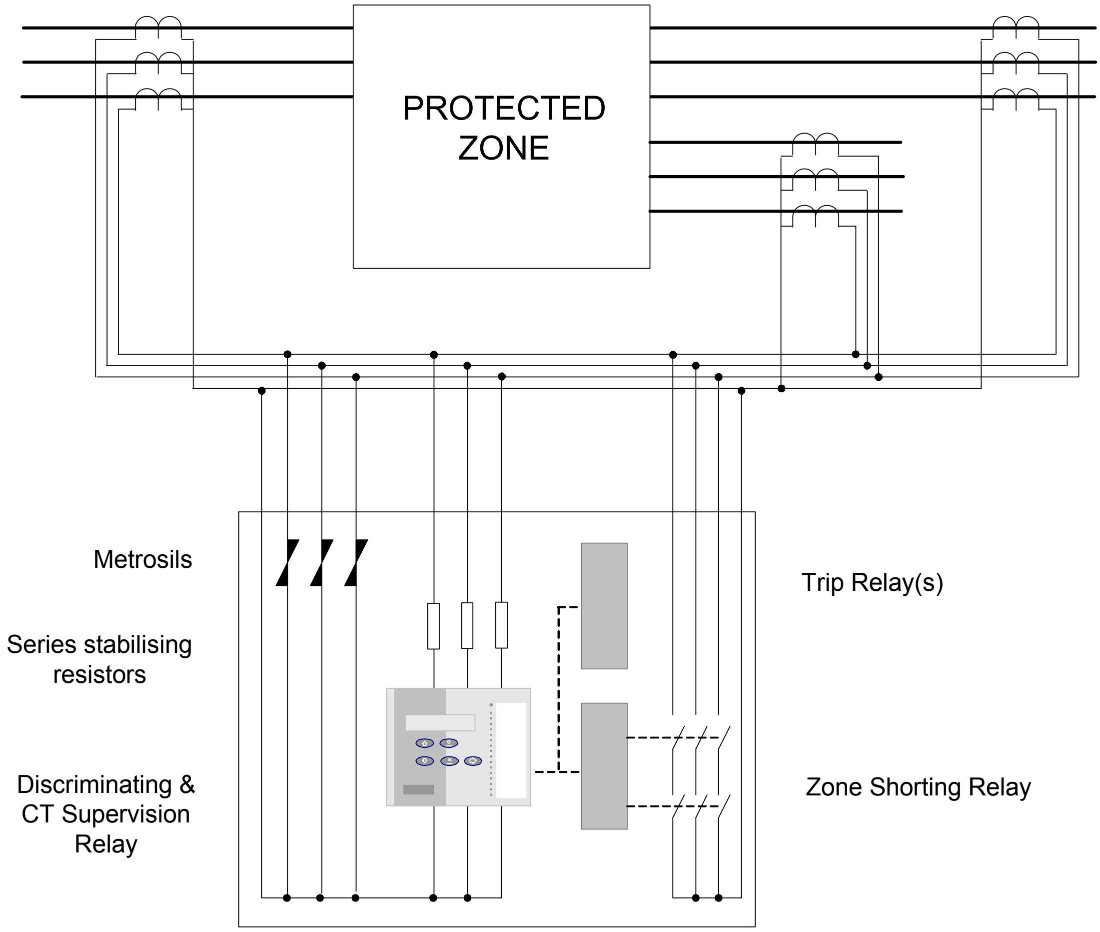


Figure 14 – Typical High Impedance Protection Components

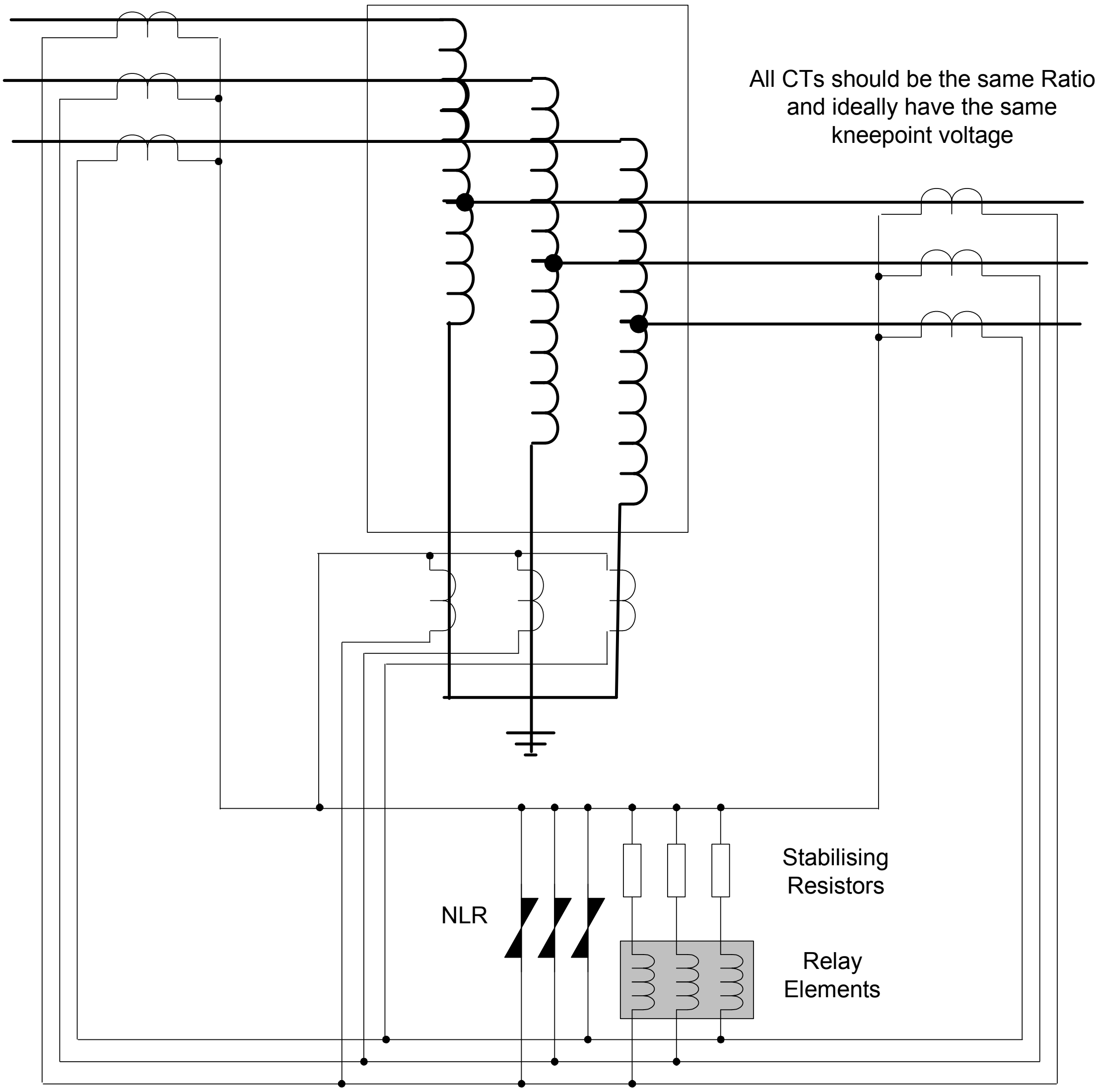


Figure 15 – High Impedance Protection of Auto-transformer

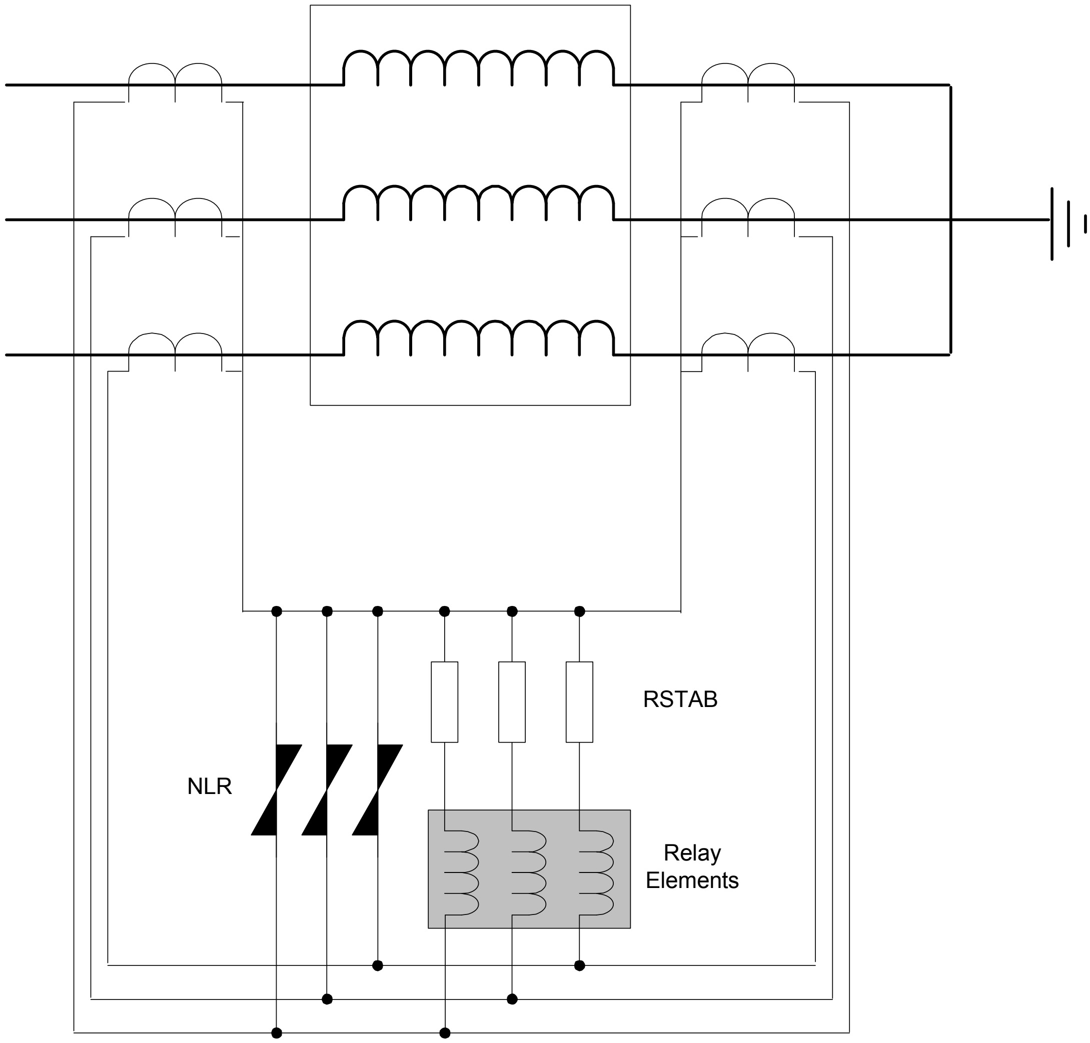


Figure 16 – High Impedance Protection of Motor, Generator or Reactors

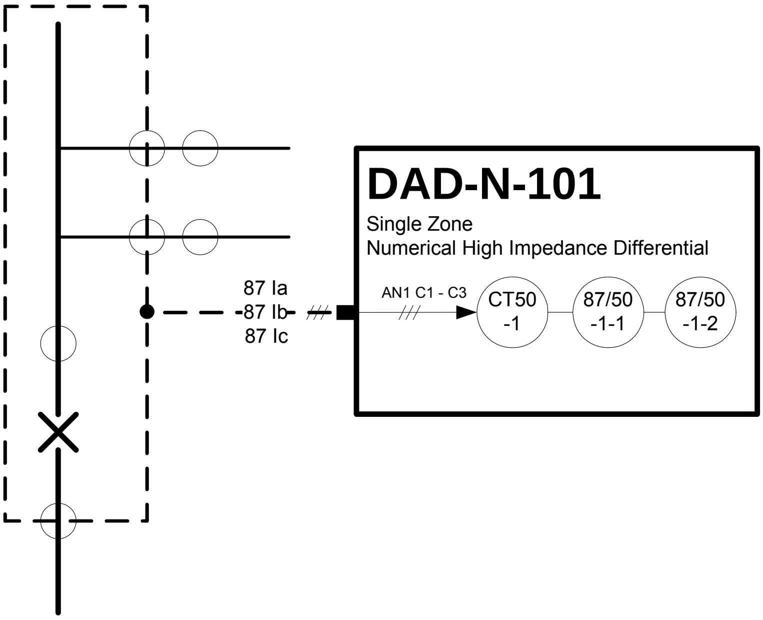


Figure 17 – DAD-N-101 Differential Protection Elements

7SG12 DAD N

Numerical High Impedance Relay with CT Supervision

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:
Pre release

2010/02	Document reformat due to rebrand

Software Revision History

Contents

1 Unpacking, Storage & Handling

On receipt, remove the relay from the carton and inspect it for obvious damage. It is recommended that the relay modules are not removed from the case. To prevent the possible ingress of dirt, the sealed polythene bag should not be opened until the relay is to be used.

If damage has been sustained a claim should immediately be made against the carrier, also inform Reyrolle Protection and the nearest Reyrolle agent.

When not required for immediate use, the relay should be returned to its original carton and stored in a clean, dry place.

The relay contains static sensitive devices, these devices are susceptible to damage due to static discharge and for this reason it is essential that the correct handling procedure is followed.

The relay's electronic circuits are protected from damage by static discharge when the relay is housed in its case. When individual modules are withdrawn from the case, static handling procedures should be observed.

- Before removing the module from its case the operator must first ensure that he is at the same potential as the relay by touching the case.
- The module must not be handled by any of the module terminals on the rear of the chassis.
- Modules must be packed for transport in an anti-static container.
- Ensure that anyone else handling the modules is at the same potential.

As there are no user serviceable parts in any module, there should be no requirement to remove any component parts.

If any component parts have been removed or tampered with, then the guarantee will be invalidated. Reyrolle Protection reserves the right to charge for any subsequent repairs.

2 Recommended Mounting Position

The relay uses a liquid display (LCD) which is used in programming and or operation. The LCD has a viewing angle of ± 45º and is back lit. However, the best viewing position is at eye level, and this is particularly important when using the built-in instrumentation features.

The relay should be mounted to allow the operator the best access to the relay functions.

3 Relay Dimensions

The relay is supplied in an Epsilon case E8.

4 Fixings

4.1 Crimps

4mm Ring crimp terminals suitable for the appropriate wire gauge are recommended.

4.2 Panel Fixing Screws

2-Kits – 2995G10046 each comprising:

- Screw M4 X10
  2106F14010 – 4 off
- Lock Washes
  2104F70040 – 4 off

- Nut M4
  2103F11040 – 4 off

4.3 Communications

9mm ST fibre optic connections rear port connections and RS232 front port connection. (Refer to section 4 – Communications Interface).

5 Ancillary Equipment

The relay can be interrogated locally or remotely by making connection to the fibre optic terminals on the rear of the relay or the RS232 port on the relay fascia. For local interrogation a portable PC is required. The PC must be capable of running Microsoft Windows Ver 3.1 or greater, and it must have a standard RS232 port. A standard data cable is required to connect from the PC to the 25 pin female D type connector on the front of the relay. For remote communications more specialised equipment is required. See the section on Communications for further information, and also see Report No. 690/0/01 on Relay Communications.

6 Precautions

When running fibre optic cable, the bending radius must not be more than 50mm.

If the fibre optic cables are anchored using cable ties, these ties must be hand tightened – under no circumstances should cable tie tension tools or cable tie pliers be used.

7SG12 DAD N

Numerical High Impedance Relay with CT Supervision

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:
Pre release

2010/02	Document reformat due to rebrand

Software Revision History

Contents

List of Tables

1. Introduction

These commissioning recommendations apply to the testing, putting into service and subsequent maintenance of DAD-N (**Modular II)** series integrated High Impedance protection relay.

A software program called Reydisp Evolution is available for download from the www.siemens.com website. This allows access to settings, waveform records and event records via relay communications with an IBM PC compatible computer.

Before starting the test procedures, the protection settings, the D.C. inputs, output relay configuration details must be available. This requires the following information: Plant current rating and the C.T. ratios. The Differential protections setting must also have been determined using the calculated performance for stability and sensitivity.

It is recommended that use is made of all the tables provided so that a comprehensive record of the protection settings, as commissioned, is available for reference.

2. Safety

The commissioning and maintenance of this equipment should only be carried out by skilled personnel trained in protective relay maintenance and capable of observing all the safety precautions and Regulations appropriate to this type of equipment and also the associated primary plant.

Ensure that all test equipment and leads have been correctly maintained and are in good condition. It is recommended that all power supplies to test equipment be connected via a Residual Current Device (RCD) which should be located as close to the supply source as possible.

The choice of test instrument and test leads must be appropriate to the application. Fused instrument leads should be used when measurements of power sources are involved, since the selection of an inappropriate range on a multi-range instrument could lead to a dangerous flashover. Fused test leads should not be used where the measurement of a current transformer (C.T.) secondary current is involved, the failure or blowing of an instrument fuse or the operation of an instrument cut-out could cause the secondary winding of the C.T. to become an open circuit.

Open circuit secondary windings on energised current transformers are a hazard that can produce high voltages dangerous to personnel and damaging to equipment, test procedures must be devised so as to eliminate this risk.

3. Sequence of Tests

If other equipment is to be tested at the same time as the relay, then such testing must be co-ordinated to avoid danger to personnel and equipment.

When cabling and wiring is complete, a comprehensive check of all terminations for tightness and compliance with the approved diagrams must be carried out. This can then be followed by the insulation resistance tests, which if satisfactory allows the wiring to be energised by either the appropriate supply or test supplies. When injection tests are completed satisfactorily, all remaining systems can be functionally tested before the primary circuit is energised. Some circuits may require further tests, e.g synchronising before being put on load.

4. Test Equipment Required

Various test sets designed for protection testing can be used to test the relay providing these provide the required current source with sinusoidal waveform within practical limits.

Test currents of the following range are required:

Differential up to 2.5 xI_N

Where I_N is the relay nominal current rating.

The basic test equipment for primary and secondary injection test is as follows:

a) A digital test set capable of at least 2 x three phase current injection. The set must be capable of injecting at least 4 x the rated current on any of the relay inputs. For relay models with voltage inputs the amplifiers need to be reconfigured for voltage output.

b) 1 - 500V insulation resistance test set.

c) 1 – Digital Multimeter

d) Laptop PC to drive the test set and the Reydisp Evolution relay software.

e) 500volt Variac to measure CT magnetizing characteristics.

f) Primary test leads and injection set.

Suitable primary injection connectors and secondary injection test plugs and leads and a suitable a.c supply may be required and must be suitable for the site concerned.

When making secondary injection tests ensure that the test circuit is earthed at one point only.

5. Insulation Resistance Test

Before commencing to inspect the wiring take the following precautions:

Isolate the auxiliary supplies.

Remove the trip and inter-trip links.

Check that the relay wiring is complete and that all terminal connections are tight and remove the C.T. earth link for the insulation resistance tests.

Measure the insulation resistance between each section of the wiring and the other sections connected together and to earth.

The sections comprise:

a) C.T. secondary wiring connected to module AN1 (Analogue 1 module)

b) D.C. wiring connected to PSU and I/O modules, excluding power supply wiring to the PSU Module.

Before testing the D.C. wiring to earth, apply test connections between suitable points to short circuit each status input and series resistor to avoid possible damage to the opto-coupler should the wiring be earthed.

c) Test the power supply wiring to module PSU separately. Note that the D.C. +ve and D.C. -ve are each connected to earth by surge capacitors.

Record the results in Table 1 - Insulation Resistance Values.

Wiring Section	Resistance MegaOhms
AN1 C.T.'s to earth and other circuits	
D.C. Wiring to Earth and other circuits	
Power Supply wiring to earth	

Table 1 - Insulation Resistance Values

Insulation resistance values that are considered satisfactory must depend upon the amount of wiring involved. Generally, where a considerable amount of multi-core wiring is included, a reading of 2M ohms to 3M ohms is reasonable, for short lengths of wiring on a panel, higher readings should be expected. A reading of 1M ohm would not normally be considered satisfactory.

6. Check of C.T and Secondary Wiring Resistance

This test is to be applied to each of the Overall Differential protections.

Isolate the auxiliary supplies.

Remove the trip and inter-trip links.

Refer to the calculated performance data for the Overall Differential. This will give the maximum permissible lead resistance values.

Measure the resistance of the wiring between the relay equipment and the C.T.'s. The readings obtained should be recorded. These should be approximately equal to or less than the values used in the calculated settings for the Overall Differential elements.

Wiring Section	Resistance Ohms
AN1C1 (Differential Phase A)	
AN1C2 (Differential Phase B)	
AN1C3 (Differential Phase C)	

Table 2 – Lead Resistance Values

7. Power Supply

Remove the relay front cover to give access to all the fascia push buttons. Relays are provided with a power supply suitable for one of the standard auxiliary supply ratings of 24V, 30V, 48V, 110V, 220V D.C. Ensure that the actual supply is the same as the relay rating as marked on the fascia. Ensure the polarity of the supply is correct before energising the relay. Note, the minimum recommended fuse rating of the supply is 6 A slow-blow or 12 A HRC fuse. Note that the relay D.C. status inputs are current rated.

With the relay energised the green LED will provide a steady illumination, all the red LEDs should be out. Operate the TEST/RESET button and check that all the red LEDs are illuminated while the push is depressed.

8. Programming the Relay

The relay can either be set using the fascia buttons or from a laptop PC running Reydisp Evolution. Due to the number of possible settings, it is recommended that the laptop method be used for speed and ease of commissioning.

8.1 Setting by laptop

The relay is supplied with an RS232 port on the front of the fascia. This should be connected to a laptop using a 25 to 9 way RS232 cable. Reydisp Evolution should be installed – this will run on any MS Windows © operating system.

To access the relay communications port the Communications Settings in the relays must match the settings Communications settings selected in the Reydisp Evolution software.

To change the communications settings on the relay use the following procedure. On the relay fascia, keep tapping the ⇩ key until the COMMUNICATIONS MENU is displayed on the relay LCD. Press the TEST/RESET ⇨ once to bring up the STATION ADDRESS on the LCD. Press the ENTER button to alter the address to any desired number between 1 and 254. Set each relay to a unique number in the substation. The relays address and the relay address must be set identically. The relay address can be changed by tapping the ⇩ or ⇧ buttons. Press ENTER to register the selected number.

Continue to scroll down and set IEC 870 ON PORT to COM2 (front RS232 and lower rear fibre ports are COMM 3 relay ports) and set AUTO DETECT to ON. The Auto Detect feature will automatically switch the active port to the front RS232 from the bottom rear fibre port when connection is made.

Ensure that the Communications baud rate and parity check settings on the Reydisp Evolution software running on laptop and Relay are the same. It is advisable to select the maximum baud rate on the relay and Reydisp Evolution, as this speeds up response times.

The communications setting can be changed in Reydisp Evolution by selecting:
OPTIONS -> COMMUNICATIONS. This window displays the active part of the laptop. Select "OK" when changes are complete. Set the address on Reydisp Evolution to be the same as the relay station address.

Check the communications link by retrieving the relay settings (Relay->Settings->Get Settings)

Reydisp Evolutions allows off line generation of relay setting by saving the relay Settings File and then downloading it. This saves time and possibly sore fingers if the relay type is a more advance model with many protection functions.

To download a Settings File on the laptop, select Relay->Settings->Send All Settings. Confirm the action and the program will inform whether the settings have been successfully entered into the relay. It is worth doing a few spot checks on the settings to be confidant the correct settings are installed.

8.2 Setting via relay fascia

The relay can be set from the fascia by utilising the ⇧, ⇩, ⇨ and ENTER buttons. Settings can be selected with the arrow buttons. Pressing ENTER when the setting to change is found will make the setting flash. This allows the ⇧ and ⇩ buttons to be used to alter the setting. Once the desired setting is selected the ENTER pushbutton MUST be pressed for the relay to active the selected setting. The setting will now stop flashing indicating this value will be utilised by the relay software.

The menu structure is shown in the "Description of Operation" section of this manual.

9. Secondary Injection Tests

Isolate the auxiliary D.C. supplies for alarm and tripping from the relay and remove the trip and intertrip links.

We recommend the use of an Omicron Test Set Type CMA156. The Omicron set should be connected in accordance with the manufacturer's instructions.

By default all protection elements are disabled, however if this is not the case, then disable all protection and alarm elements.

9.1 Accuracy of Measurement

Inject all of the current inputs with nominal current in turn, and record the following currents measured by the relay in Table 3 – Accuracy of Measurement.

Tap ⇩ to select: -
e.g. Diff Currents
0.00 0.00 0.00 x I_n

If the relay measurement is within tolerance proceed to 9.2 below. If any of the measurements are outside the stated tolerance (±5%) the relay must be sent back to the Quality Assurance Department for investigation.

Meter	A	B	C
Diff1 Currents	A xIn	B xIn	C xIn

Table 3 – Accuracy of Measurement

9.2 Checking the Differential Element

When testing the Differential Element the Differential Currents can be displayed on the LCD by changing to INSTRUMENTS mode and scrolling down to [Diff1 Currents].

Connect a single phase current source to Phase A, see Table below :-

		Connection	
Phase	**Unit**	**Start**	**Finish**
A	AN1C1	17	18
B	AN1C2	21	22
C	AN1C3	25	26

Modify the following settings :-

Setting Description	Setting Value
87/50 Element	Enable
87/50 Delay	0.1

Modify the operate setting and determine the PU and DO at each setting :-

Setting Description	Setting Value	PU	DO
87/50 Setting	0.05		

87/50 Setting	0.10		
87/50 Setting	0.50		
87/50 Setting	0.90		

Table 4 – Differential Element PU/DO

Record the results and verify the accuracy complies with performance stated in the Performance Specification.

Verify the correct operation of the Trip Relays RL4, RL5 and the LED indication.

Repeat Tests for connections to Phase B and C.

10. Primary Injection Tests

Primary injection tests are required to prove the CT ratio and secondary connections to the relay.

Differential Currents	A xIn	B xIn	C xIn

Table 5 – Primary Injection Test Results

Inject using a primary injection test set and record and verify the expected levels on the instruments on the relay, the Reference Currents and corresponding Spill current will be in phase when the Spill Angle is zero.

11. Fault Setting Tests

Fault setting tests use primary injection testing to verify the protection settings; they can conveniently be combined with the current transformer ratio and polarity tests in section 10.1.
Isolate the auxiliary d.c. supplies for trip and alarm, remove the Trip and Intertrip links. Use the test circuit shown in Fig 8. Inject primary current and record the values at which the relay operates. Relay operation is indicated by LEDs . Check the operation of all the output relays selected for each protection function.

11.1 Differential protections

Isolate the auxiliary d.c. supplies for trip and alarm and remove the Trip and Intertrip links.

Check that the setting resistor is the correct ohmic value, also that the correct Differential settings are selected.

Measure the primary current for operation of the CT and 87/50 elements and record the value obtained.

12. Tripping and Intertripping Tests

Re-connect the auxiliary d.c. supplies for trip and alarm operations and insert the Trip and Inter-Trip links.

Simulate the operation of each external contact that initiates a status input and in each case check that appropriate LED illuminates and that the correct tripping, intertripping and alarm initiation occurs.

Disconnect the d.c. power supply to the relay and check for correct PROTECTION INOPERATIVE alarm. Operate all protection and alarm elements in turn by primary or secondary injection and check that the correct tripping and indication occurs.

13. Tests Using Load Currents

Isolate the auxiliary d.c. supplies for the trip and alarm functions.

Ensure that the relay is set the assigned settings for the capacitor bank installation.

Energise the Capacitor Bank.

Utilising the INSTRUMENT Display verifies the correct meter readings for each of the instruments, noting the following:-

- Ensure all primary current displays are correct, thus verifying CT Ratio settings are correct.
- Ensure all secondary current displays are correct, thus verifying CT input settings are correct.

- Verify that there is minimal Diff Currents displayed, thus verifying that the Differential circuit is balanced.

14. Putting into Service

Ensure that:
The trip supply is connected.
All the RED LEDs are off.
The GREEN LED is ON steady.
All earth links, trip links and inter-trip links are in their normal operational positions.

Operate the Cancel PUSH BUTTON

Check that the LCD displays the screen below, or the ‘Relay Identifier’ set in the SYSTEM CONFIG MENU.

DAD-N

Replace the cover. The above reading will remain for approximately 1 hour then the display will go blank.

7SG12 DAD N

Numerical High Impedance Relay with CT Supervision

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:
Pre release

2010/02	Document reformat due to rebrand

Software Revision History

1 Maintenance Instructions

The Argus 7 is a maintenance free relay, with no user serviceable parts. During the life of the relay it should be checked for operation during the normal maintenance period for the site on which the product is installed. It is recommended the following tests are carried out :

1 Visual inspection of the metering display (every year)

2 Operation of output contacts (every 2 years)

3 Secondary injection of each element (every 5 years)

2 Defect Report Form

Form sheet for repairs and returned goods (fields marked with * are mandatory fields)

Sender:

*** Name, first name:**	Complete phone number (incl. country code):	Complete fax number (incl. country code):
Email address:	*** Org-ID and GBK reference:**	*** AWV:**

*** Order-/ reference-no (choosing at least 1 option):**

Order-no for repair:	order-/ delivery note-no for return of commission failure:	Beginning order-no for credit note demand:

Information concerning the product and its use:

*** Order Code (MLFB):**	Firmware version: V	*** Serial number:**	
* Customer:	Product was in use approximately since:	Station/project:	Hotline Input no.:
Customer original purchase order number:	Delivery note number with position number:	Manufacturer:	

*** Type of order (choosing at least 1 option):**

- ☐ Repair
- ☐ Upgrade / Modification to ...
- ☐ Return of commission failure
- ☐ Warranty repair
- ☐ For collection
- ☐ Credit Note
- ☐ Quotation (not repair V4 and current products! See prices in PMD)

Type of failure:

- ☐ Device or module does not start up
- ☐ Sporadic failure
- ☐ Permanent failure
- ☐ Repeated breakdown
- ☐ Mechanical problem
- ☐ Knock sensitive
- ☐ Temperature caused failure
- ☐ Failure after firmware update
- ☐ Overload
- ☐ Transport damage
- ☐ Failure after ca ☐ hrs in use

Error description:

- ☐ Display message:
  (use separated sheet for more info)
- ☐ Active LED messages:
- ☐ Faulty Interface(s), which?
- ☐ Wrong measured value(s), which?
- ☐ Faulty input(s)/output(s), which?

***Detailed error description** (please refer to other error reports or documentation if possible):

*** Shall a firmware update be made during repair or mechanical upgrade of protective relays? (choosing at least 1 option)**

- ☐ Yes, to most recent version
- ☐ No
- ☐ Yes, actual parameters must be reusable

repair report:

- ☐ Yes, standard report (free of charge)
- ☐ Yes, detailed report (charge: 400EUR)

Shipping address of the repaired/upgraded product:

Company, department

Name, first name

Street, number

Postcode, city, country

Date, Signature

Please contact the Siemens representative office in your country to obtain return instructions.

E D EA MF TCC 6 release from 11/2009

7SG12 DAD N

Numerical High Impedance Relay with CT Supervision

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:
Pre release

2010/02	Document reformat due to rebrand

Software Revision History

Figures

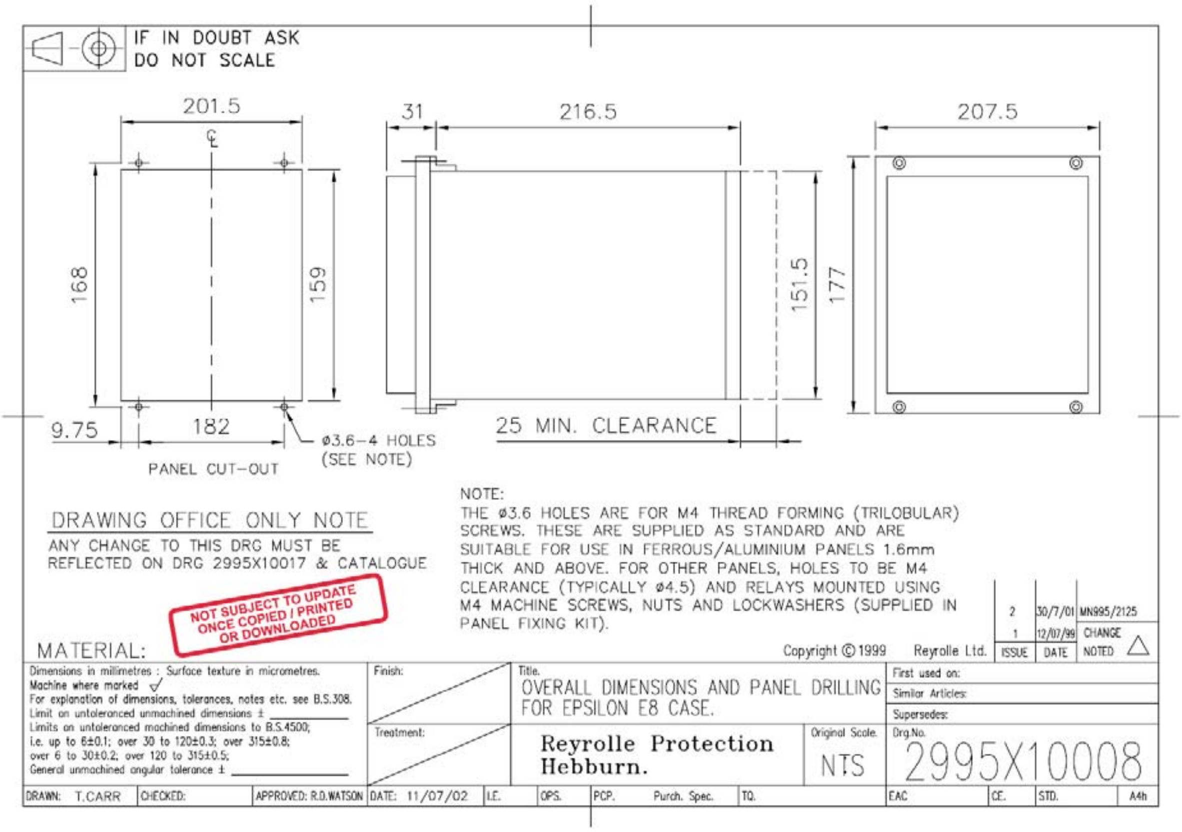


Figure 1 – E8 Case Style Panel Cut-out

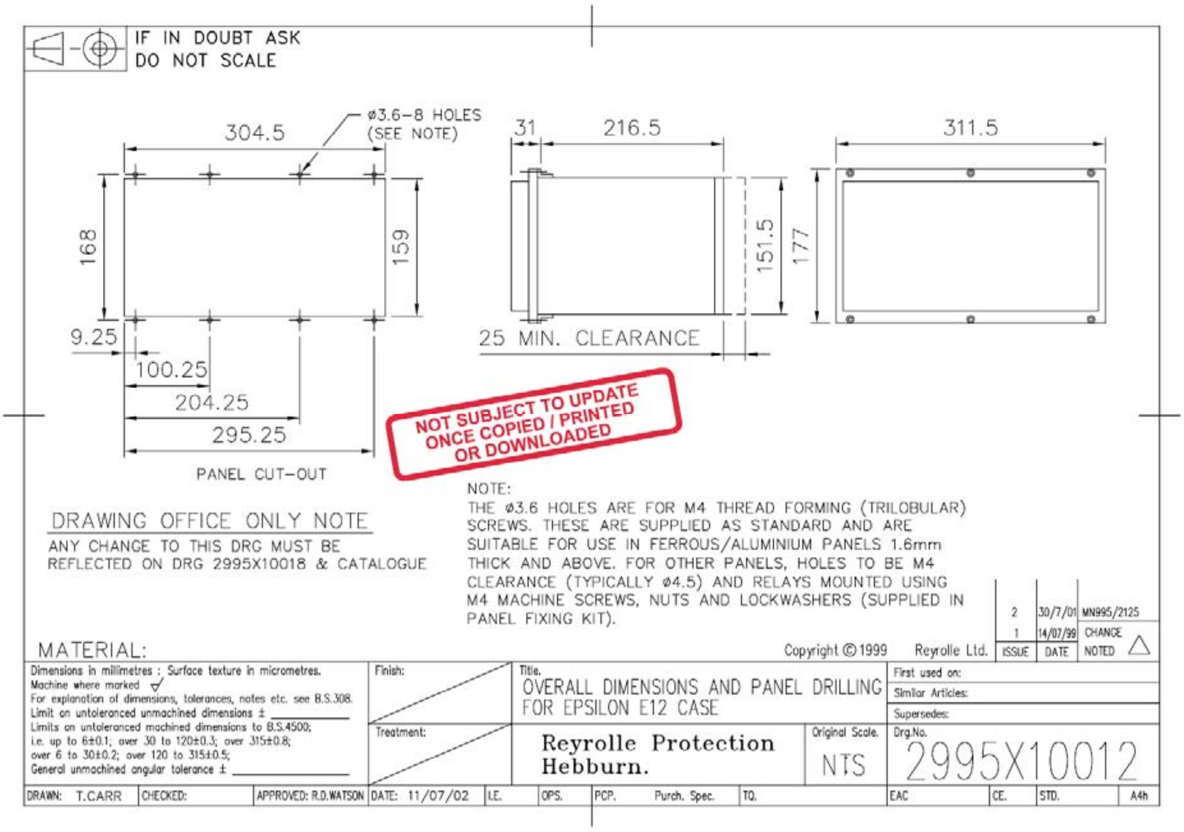


Figure 2 – E12 Case Style Panel Cut-out

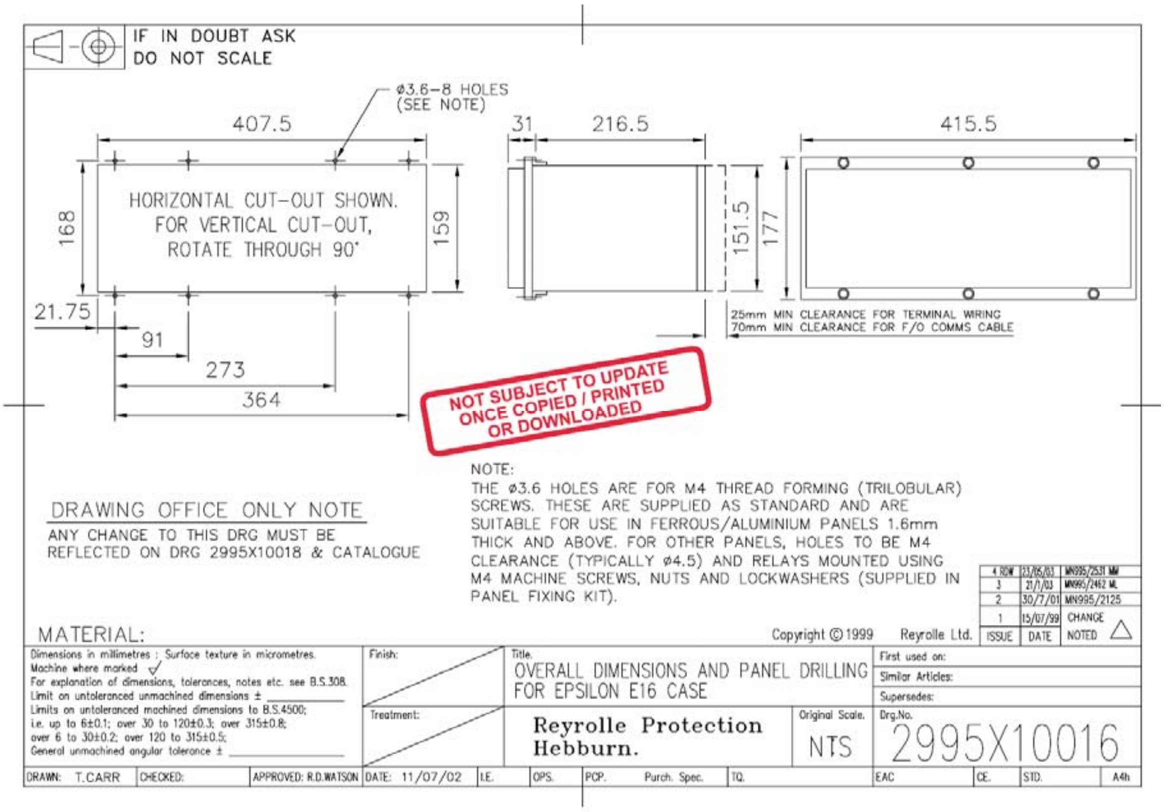
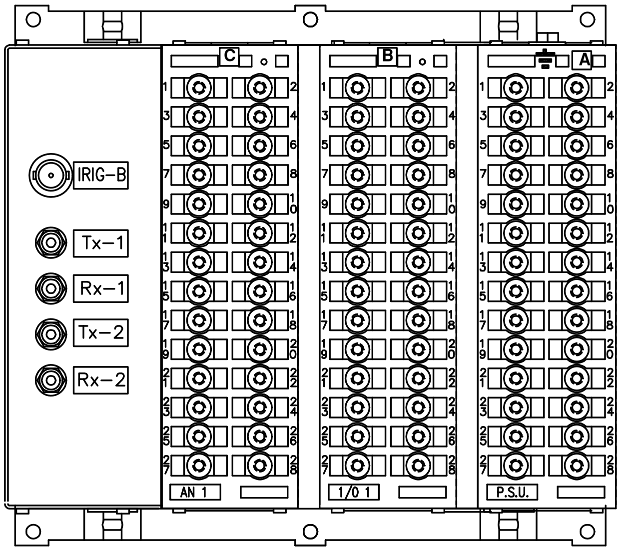
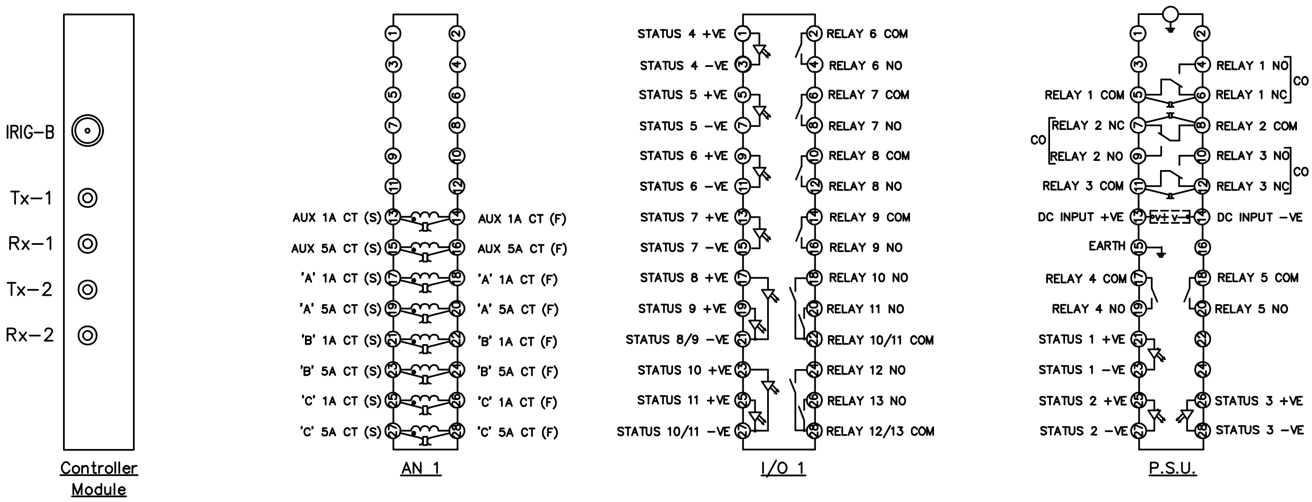


Figure 3 – E16 Case Style Panel Cut-out



RELAY VIEWED FROM REAR



MODULE LABEL KEY	
ANALOGUE MODULE	AN 1 etc
INPUT/OUTPUT MODULE	I/O 1 etc
P.S.U. & BASIC I/O MODULE	P.S.U.

Figure 4 – Rear Terminal View

Published by and copyright © 2010:
Siemens AG
Energy Sector
Freyeslebenstrasse 1
91058 Erlangen, Germany

Siemens Protection Devices Limited
P.O. Box 8
North Farm Road
Hebburn
Tyne & Wear
NE31 1TZ
United Kingdom
Phone: +44 (0)191 401 7901
Fax: +44 (0)191 401 5575
www.siemens.com/energy

For more information, please contact our
Customer Support Center.
Phone: +49 180/524 70 00
Fax: +49 180/524 24 71(Charges depending on provider)
E-mail: support.energy@siemens.com

Power Distribution Division Order No. C53000-G7076-C15-1
Printed in Fürth

Printed on elementary chlorine-free bleached paper.