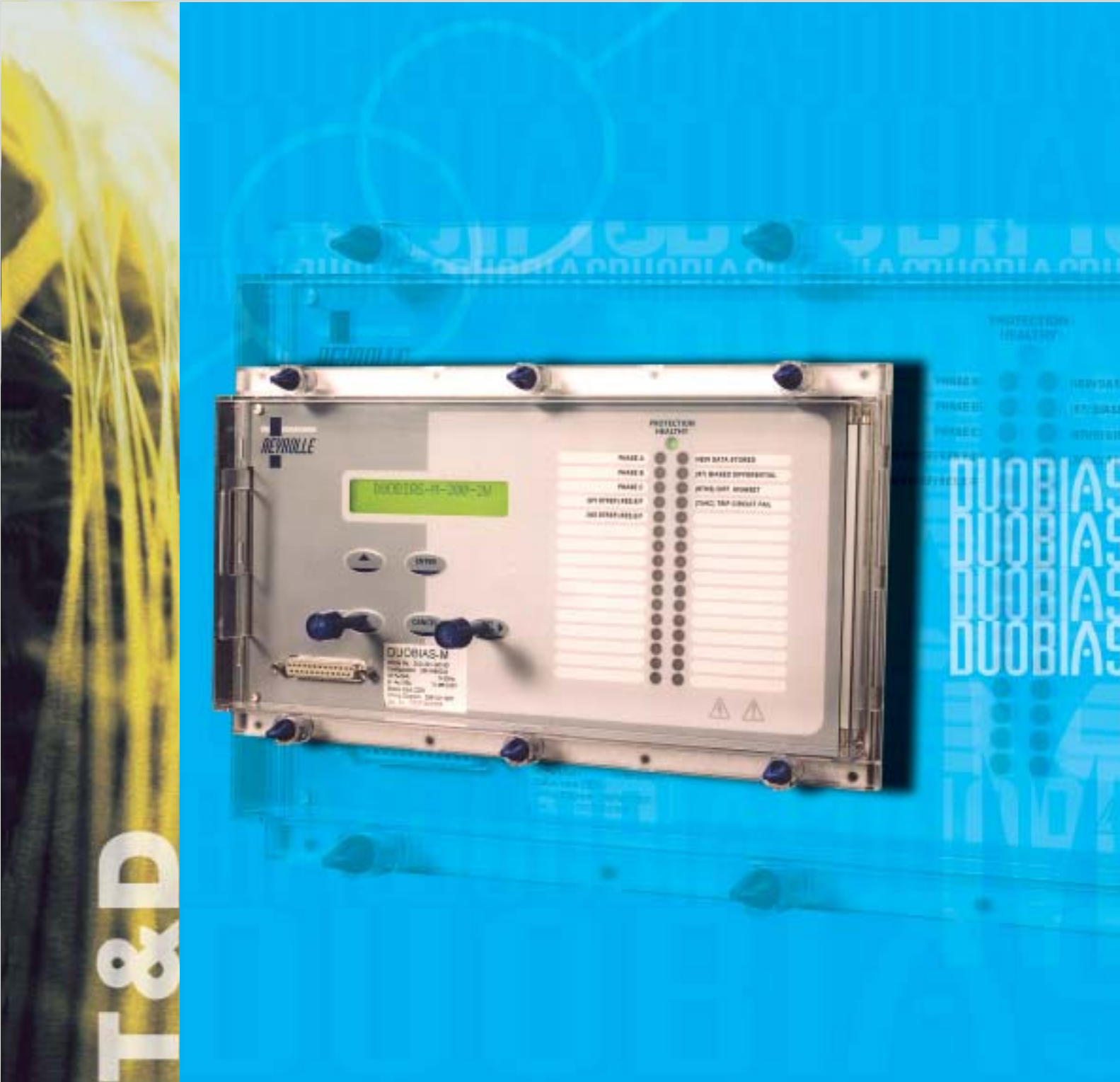


VA TECH TRANSMISSION & DISTRIBUTION

VA TECH Reyrolle ACP Ltd

Transformer protection - Duobias



T & D

DUOBIAS

Transformer protection

Introduction



The Duobias-M has an established history as a transformer protection relay, its roots going back to the fundamental development of biased differential transformer protection. It is capable of providing all the protection and alarm functions for protecting a 2 or 3 winding transformer, with upto 5 sets of CT's.

The main protection function is current differential with load bias and second harmonic restraining characteristic. This is supplemented with a number of additional functions to

Features

provide a comprehensive transformer protection management package.

Standard

- Biased current differential protection with even harmonic restraint (87) and instantaneous differential highset (87HS)
- Integral current amplitude and vector group compensation which removes the need for interposing CT's
- Variants for 2, 3, 4 or 5 sets of current transformers in case style E8, E12 or E16
- Trip circuit supervision
- LED's for alarm functions removes the need for flag repeat relays
- Programmable logic can be modified using ReylogiC schematic capture windows software
- Compatible with generic communications software Reydisp Evolution

- Metering of external and internal signals for both magnitude and phase angle aids commissioning
- Settings stored in EEPROM, logic schemes in FLASH memory
- Flash upgradeable firmware
- Flexible number of digital inputs (up to 27) and output contacts (up to 29) that can be programmed from the front panel
- Storage of 500 time-tagged event records
- Storage of 5 waveform records
- IEC60870-5-103 fibre optic communications with fibre-optic interface for superior EMC performance
- Front RS232 communication port
- IRIG-B time synchronisation input
- Continuous self monitoring

Optional

- Restricted earth fault per winding (87REF)
- Sensitive restricted earth fault per winding (87SREF)
- Circuit breaker fail per winding (50BF)
- Instantaneous / definite time overcurrent phase fault and derived earth fault per winding (50 and 50N)
- Inverse definite minimum time phase fault and derived earth fault per winding (51 and 51N)
- Instantaneous / definite time measured earth fault per winding (50G)
- Inverse definite minimum time measured earth fault per winding (51G)
- Overexcitation protection Volts/frequency (2 x DTL + 1 x IDMTL) (24)
- Transformer thermal overload (49)
- 4-stage under/overvoltage (27/59)
- 4-stage under/overfrequency (81)

Description

Protection

Duobias provides all the protection requirements of a transformer.

Vector group compensation and ratio correction

The Duobias can compensate for 13 different arrangements of transformer winding and for varying CT ratios across the transformer, without the need for secondary interposing CTs.

Biased differential (87)

A biased differential characteristic is provided which gives sensitivity for internal faults and stability for through faults and load current.

Two bias slopes are provided: the first allows for measuring inaccuracies and transformer ratio variation due to tap-changing, the second ensures stability for CT saturation on through faults.

The biased differential element restrains for second harmonic inrush currents, with a setting for restraint level. This provides stability under inrush conditions, while allowing the protection to be set more sensitively for normal operation.

The Duobias is stable for fifth harmonic currents, generated as a result of transformers operating close to, or above their kneepoint - an increasing trend as a result of the push for lower transformer costs.

Differential highset (87HS)

A differential highset is also provided, which is not subject to inrush restraint.

Restricted earth-fault (87REF)

Faults in the tap-changer windings of a transformer are common. Restricted earth-fault protection gives improved sensitivity for faults at the lower end of the transformer windings.

High impedance restricted earth-fault can be applied to each winding of the transformer.

Sensitive restricted earth fault (87SREF)

As above but with minimum setting of $0.005 \times I_n$

Under/overvoltage (27/59)

4 stage under/overvoltage elements are provided and the undervoltage elements may be guarded with an additional undervoltage setting to prevent operation during transformer switch on.

Under/overfrequency (81)

4 stage under/overfrequency elements are provided and these may be guarded with the undervoltage guard setting defined above to prevent any unwanted operation.

Backup overcurrent & earth fault

The following backup overcurrent & earth fault elements are available for **each transformer winding**:

- Instantaneous / definite time phase fault (50)
- Inverse time / definite time phase fault (51)
- Instantaneous / definite time derived earth fault (50N)
- Inverse time / definite time derived earth fault (51N)

These elements provide backup protection for the transformer and guard against a fault outside the transformer CT zone, but within its circuit breaker zone. They can also be used to protect the transformer against damage due to uncleared external faults, grading with other time-delayed protections.

Measured earth fault

The following measured earth-fault overcurrent elements are available for **each transformer winding**:

- Instantaneous / definite time measured earth fault (50G)
- Inverse time / definite time measured earth fault (51G)

These elements are incompatible with the use of the restricted earth-fault elements, described above.

Overexcitation (24)

Overexcitation of a transformer can lead to damaging currents flowing in the transformer. This can be detected from fifth harmonic content, however this is subject to uncertainty.

The Duobias can offer a Volts/frequency (V/f) element, which provides direct measurement of excitation. The setting level of this type of element is more easily related to the transformer data. Both DTL and user defined IDMTL characteristics are available.

Thermal overload (49)

The thermal algorithm calculates the thermal state of the transformer from the measured currents.

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Circuit breaker fail (50BF)

The circuit breaker fail function operates by monitoring the current following a trip signal and issues a two stage alarm if the current does not stop within a specified time interval. These alarms can be used to retrip the circuit breaker and backtrip an upstream circuit breaker.

The circuit breaker fail function has fast reset.

Measurements and indication

Instrumentation

Analogue values can be displayed on the LCD screen. In addition most values can be obtained via the IEC60870-5-103 communications.

- Line currents for each winding
- Relay currents for each winding (after ratio and vector group compensation)
- Operate and restrain currents
- Status inputs
- Output contacts

Flag indication

Either 16 or 32 Flag LEDs are provided, which the user can assign to indicate fault and alarm status. The number of LEDs depends on the case size, see Technical Information.

Examples of their use include type of trip (biased differential, differential highset, HV overcurrent etc.), phases causing the trip, Bucholz alarm and trip, winding and oil temperature alarm and trip, and many other transformer related alarms.

System data

Sequence of event records

Up to 500 events are stored and time tagged to 1ms resolution. These are available via the communications.

Fault records

The last 10 fault records are available from the Duobias fascia with time and date of trip, measured quantities and type of fault.

Disturbance recorder

10 seconds of waveform storage is available and is user-configurable as 5 x 1s, 2 x 2s or 1 x 5s records.

Within the record the amount of pre-fault storage is also configurable. The recorder is triggered from a protection operation, or status input.

The records contain the analogue waveforms of the line currents, the relay currents after vector group correction and the digital input and output signals.

Communications

Two fibre-optic communications ports are provided on the rear of the relay. They are optimised for 62.5/125µm glass-fibre, with BFOC/2.5 (ST[®]) bayonet style connectors.

In addition users may interrogate the Duobias locally with a laptop PC and the RS232 port on the front of the relay.

The Duobias uses IEC 60870-5-103 as its communications standard.

ReyDisp Evolution

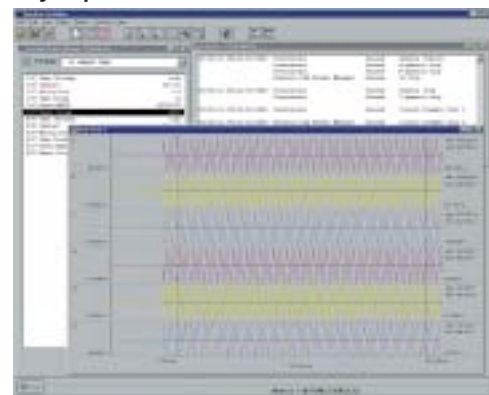


Figure 2 Disturbance records in ReyDisp Evolution

ReyDisp Evolution is common to the entire range of Reyrolle numeric products. It provides a means for the user to apply settings to the Duobias, interrogate settings and retrieve disturbance waveforms from the Duobias.

Typical applications

Transformer configurations

The Duobias can provide up to 5 sets of analogue inputs (where a set consists of 3 phase current inputs and an earth current input) which can be used on a variety of 2 and 3 winding transformer configurations.

The most common configurations of transformer are 2 and 3 winding transformers connected to single lines/busbars, as in Figure 3(a) and (b). For a 2 winding transformer 2 analogue input sets are required, while for a 3 winding transformer 3 analogue input sets are needed.

When transformers are connected to double busbars or lines, extra sets of analogue inputs may be required, if there is the possibility of a through fault on busbar CTs, as shown in the remaining diagrams of Figure 3.

Figure 4 shows the flow of fault current for an out-of-zone fault on system, with busbar connected CTs. It is important that the transformer protection is correctly biased to ensure stability for CT saturation. This cannot be done correctly if the CTs are paralleled - individual inputs to the transformer protection must be provided for correct biasing.

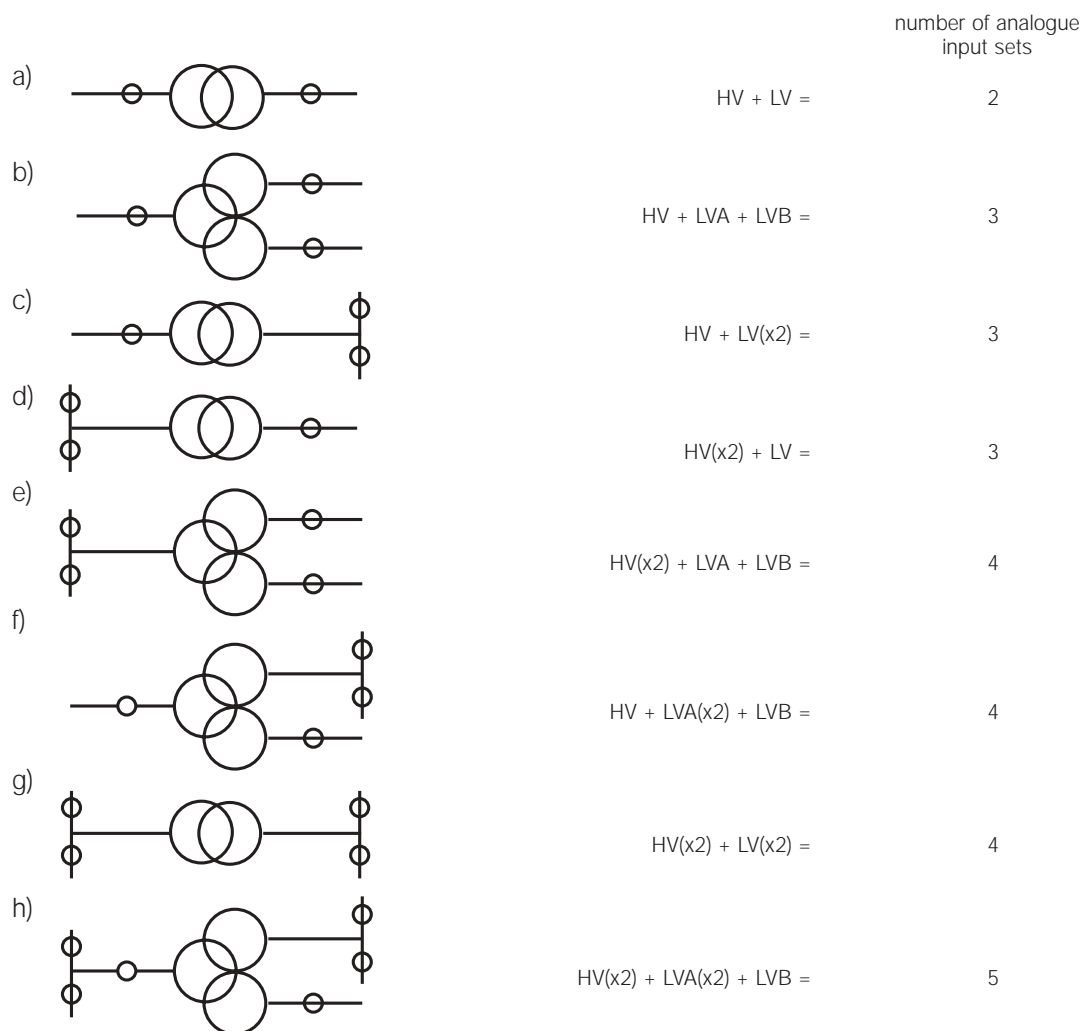


Figure 3 Transformer configurations

DUOBIAS

Transformer protection

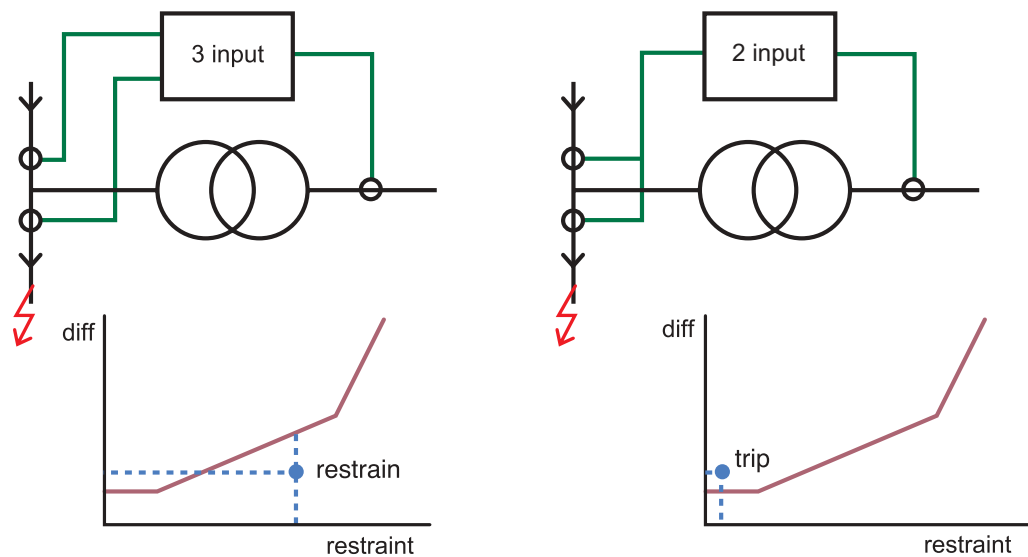


Figure 4 Out of zone fault and its effect on protection biasing

Technical information

Performance data to IEC 60255-3

Characteristic energising quantity

| | |
|------------|-----------|
| AC Current | Frequency |
| 1 A / 5 A | 50/60 Hz |

Auxiliary energising quantity

DC Power supply

| | |
|-----------------|----------------------|
| Nominal Voltage | Operating Range V dc |
| 48, 110 V | 37.5 to 137.5 |
| 220 V | 178.0 to 280.0 |

DC Status inputs

| | |
|-----------------|----------------------|
| Nominal Voltage | Operating Range V dc |
| 30, 34 V | 18.0 to 37.5 |
| 48, 54 V | 37.5 to 60.0 |
| 110, 125 V | 87.5 to 137.5 |
| 220, 250 V | 175.0 to 280.0 |

The status voltage need not be the same as the main energising voltage.

Electricity Association ESI48-4

The 30/34V and 48/54V inputs meet the requirements of ESI48-4 ESI 1. However, the 110/125V and 220/250V inputs will operate with a DC current of less than 10mA. If 110/125V or 220/250V inputs compliant with ESI48-4 ESI 1 are required, a Duobias with 48/54 V status can be supplied with external dropper resistors as follows:

| | | |
|-----------------|----------------|---------|
| Nominal Voltage | Resistor Value | Wattage |
| 110, 125 V | 2k7 ± 5% | 2.5 W |
| 220, 250 V | 8k2 ± 5% | 6.0 W |

Status input performance

| | |
|---|---------|
| Parameter | Value |
| Minimum DC current for operation (30/34V and 48/54V inputs only) | 10 mA |
| Reset/operate voltage ratio | ≥ 90 % |
| Typical response time | < 5 ms |
| Typical response time when used to energise an output relay contact | < 15 ms |
| Minimum pulse duration | 40 ms |

Each status input has an associated timer that can be programmed to give time delayed pick-up. When set to a minimum of 20ms the status inputs will provide immunity to an AC input signal and will not respond to the following:

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

Protection elements

Vector group compensation

No. of elements Per winding

Groups

Setting Yy0 0°, Yd1 -30°, Yy2 -60°,
Yd3 -90°, Yy4 -120°, Yd5 -150°,
Yy6 180°, Yd7 150°, Yy8 120°,
Yd9 90°, Yy10 60°, Yd11 30°,
Ydy0 0°

CT ratio compensation

No. of elements Per analogue input set

Multipliers

Setting 0.25 to 3.00 step 0.01

Biased differential IEC 60255-13

No. of elements 1

Level

Initial setting 10% to 200% step 10%
Bias slope 0% to 70% step 10%
Bias slope limit 1 to 20 xln step 1
Accuracy Operate: 100% of setting
 $\pm 5\%$ or $\pm 10\text{mA}$ per winding
Reset: $\geq 90\%$ of operate current
Repeatability $\pm 1\%$
Through-fault stability 50 xln

Operate time

Typically 1½ cycles

Inrush inhibit

Settings Off, 10% to 50% step 1%
Accuracy $\pm 5\%$ or $\pm 10\text{mA}$
Repeatability $\pm 1\%$

Differential highset IEC 60255-13

No. of elements 1

Level

Setting 1 to 30 x In step 1
Accuracy Operate: 100% of settings
 $\pm 5\%$ or $\pm 10\text{mA}$
Reset: $\geq 95\%$ of operate current
Repeatability $\pm 1\%$

Operate time

Typically 1 cycle

Restricted earth-fault

No. of elements 1 per winding

Level

Settings Off, 20 to 960mA step 5mA
Accuracy Operate: 100% of setting
 $\pm 5\%$ or $\pm 10\text{mA}$
Reset: $\geq 95\%$ of operate current
Repeatability $\pm 1\%$

Operate time

Typically <1 cycle

Sensitive Restricted earth fault

No. of elements 1 per winding

Level

Settings Off, 5 to 960mA step 5mA
Accuracy Operate: 100% of setting
 $\pm 5\%$ or $\pm 10\text{mA}$
Reset: $\geq 95\%$ of operate current
Repeatability $\pm 1\%$

Operate time

Typically <1 cycle

Phase-fault overcurrent protection

Characteristic Instantaneous/DTL

No. of elements Up to 2 per winding

Level

Settings 10% to 2500% step 2%
Accuracy Operate: 100% of setting
 $\pm 5\%$ or $\pm 10\text{mA}$
Reset: $\geq 95\%$ of operate current
Repeatability $\pm 1\%$

Delay

Settings 0.0 to 864000s
Accuracy $\pm 5\text{ms}$
Repeatability $\pm 1\%$

Characteristic

IEC IDMTL
Normal Inverse (NI),
Very Inverse (VI),
Extremely Inverse (EI),
Long Time Inverse (LTI),
IEEE Moderately Inverse (MI),
Very Inverse (VI),
Extremely Inverse (EI)

No. of elements 1 per winding

Level

Settings 0.10 to 2.50 step 0.05 In
Accuracy Operate: 105% of setting
 $\pm 5\%$ or $\pm 10\text{mA}$
Reset: $\geq 95\%$ of operate current
Repeatability $\pm 1\%$

IDMTL delay

Time multiplier 0.025x to 1.600x
Accuracy $\pm 5\%$ or $\pm 30\text{ms}$
Repeatability $\pm 1\%$

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Transformer protection

Earth-fault overcurrent protection

| | |
|------------------------|---|
| Characteristic | Instantaneous/DTL |
| No. of elements | Up to 2 per winding |
| Level | |
| Settings | 25% to 2500% step 2% |
| Accuracy | Operate: 100% of setting ± 5% or ±10mA |
| | Reset ≥ 95% of operate current |
| Repeatability | ±1% |

| | |
|---------------|-----------------|
| Delay | |
| Settings | 0.00 to 864000s |
| Accuracy | ± 5 ms |
| Repeatability | ± 1% |

| | |
|------------------------|--|
| Characteristic | |
| IDMTL (IEC) | Normal Inverse (NI), Very Inverse (VI), Extremely Inverse (EI), Long Time Inverse (LTI), Moderately Inverse (MI), Very Inverse (VI), Extremely Inverse (EI), User-defined curve |
| IDMTL | |
| No. of elements | 1 per winding |
| Level | |
| Settings | 0.25 to 2.5xIn step 0.05In |
| Accuracy | Operate: 105% of setting ± 5% or ± 10mA |
| | Reset: ≥ 95% of operate current |
| Repeatability | ±1% |

| | |
|--------------------|------------------|
| IDMTL delay | |
| Time multiplier | 0.025x to 1.600x |
| Accuracy | ± 5% or ± 30 ms |
| Repeatability | ± 1% |

Under/overvoltage

| | |
|------------------------|-----------------------------|
| No. of elements | 4 |
| Level | |
| Settings | 0.01 to 2.5 x Vn step 0.01 |
| Hysteresis | 0 to 80% step 0.1 |
| Delay | 0 to 864000s |
| Pickup | ± 0.1% of setting or ± 0.1V |
| Reset | ≥ 95% of Is |
| Repeatability | ± 2% |
| Transient overreach | ≤ 5% |

Under/overfrequency

| | |
|------------------------|---------------------------------|
| No. of elements | 4 |
| Level | |
| Settings | 40 to 70Hz step 0.01 |
| Hysteresis | 0 to 80% step 0.1 |
| Delay | 0 to 864000s |
| Pickup | ± 0.1% of settings or ± 0.010Hz |
| Reset | ≥ 95% of Is |
| Repeatability | ± 2% |

Overexcitation

| | |
|------------------------|----------------------------------|
| Characteristic | DTL |
| No. of elements | 2 |
| Level | |
| Settings | 0.1 to 2.00 step 0.01 |
| Hysteresis | 0 to 80% step 0.1 |
| Delay | 0.1 to 864000s |
| Pickup | ± 0.1% of settings or ± 0.01 V/f |
| Reset | ≥ 95% of Is |
| Repeatability | ± 2% |

| | |
|------------------------|------------------------------------|
| Characteristic | IDMTL |
| No. of elements | 1 |
| Level | |
| Settings | 1 to 2 step 0.01 |
| Point settings | Wide range to create curve profile |
| Pickup | ± 0.1% of settings or ± 0.01 V/f |
| Reset | ≥ 95% of Is |
| Repeatability | ± 2% |

Thermal overload

| | |
|------------------------|------------------------------|
| No. of elements | 1 |
| Level | |
| Settings | 1 to 3 xIn step 0.01 |
| Time constant | 1 to 1000 min step 0.1 |
| Pickup | ± 5% of setting or ± 0.01 In |
| Reset | ≥ 95% of Is |
| Repeatability | ± 2% |

Circuit breaker failure

| | |
|------------------------|-----------------|
| Characteristic | DTL |
| No. of elements | 2 |
| Level | |
| Settings | 0.05 to 2.00 In |

Delay

| | |
|---------------|--|
| Settings | Re-trip 0 to 60 sec Back-trip 0 to 60 sec |
| Accuracy | ± 5 ms |
| Repeatability | ± 1% |
| Reset time | 20 ms |

LED's indication

| | |
|--------------------|----|
| No. of LEDs | |
| Size 8 case | 16 |
| Size 12 case | 32 |
| Size 16 case | 32 |

General Accuracy

Reference conditions

| | |
|-----------------------|--------------------|
| Parameter | Reference or Value |
| General | IEC 60255-3 |
| Current settings | 100% of In |
| Time multiplier | 1.0 |
| Current input (IDMTL) | 2x to 30x Is |
| Auxiliary supply | Nominal |
| Frequency | 50 Hz |
| Ambient temperature | 20°C |

General settings

| | |
|---------------------------------|---------|
| Parameter | Value |
| Transient overreach of | ≤ -5% |
| Highest/lowest (X/R = 100) | |
| Disengaging time ⁽¹⁾ | < 42 ms |

Output contacts have a minimum dwell time of 100ms, after which the disengagement time is as above.

Accuracy influencing factors

Temperature

-10 °C to +55 °C ≤ 5% variation

Frequency

47 Hz to 52 Hz Settings: ≤ 5% variation
Operate Time: ≤ 5% variation

Thermal withstand

Continuous/limited period
3.0 x I_n continuous
3.5 x I_n 10 minutes
4.0 x I_n 5 minutes
5.0 x I_n 3 minutes
6.0 x I_n 2 minutes

Short term overload

Maximum current (A) for:
Input 1 cycle 1 sec 2 sec 3 sec
5A 2500 400 282 230
1A 700 100 70.7 57.7

Burdens

Current inputs

5A ≤ 0.2 VA < 0.01 Ω
1A ≤ 0.05 VA ≤ 0.05 Ω

Note: Burdens and impedances are measured at nominal current rating.

Auxiliary supply

Quiescent (Typically) 15 W
Maximum 27 W

Output contacts

Contact rating to IEC 60255-0-2.

Carry continuously 5 A AC or DC

Make and carry

(limits: L/R ≤ 40ms and V ≤ 300 volts)

0.5 sec 20 A AC or DC
0.2 sec 30 A AC or DC

Break

(limits: ≤ 5A or ≤ 300 volts)

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

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

Environmental

Temperature IEC 68-2-1/2

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

Humidity IEC 68-2-3

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

Transient overvoltage IEC 60255-5

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

Insulation IEC 60255-5

RMS levels for 1 minute
Between all terminals and earth 2.0 kV
Between independent circuits 2.0 kV
Across normally open contacts 1.0 kV

Immunity

Auxiliary DC supply IEC 60255-11

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

High frequency disturbance IEC 60255-22-1

Class III

2.5kV, Longitudinal mode ≤ 3 % variation
1.0kV, Transverse mode

Electrostatic discharge IEC 60255-22-2 Class III

8kV, Contact discharge ≤ 5% variation

Radio frequency interference IEC 60255-22-3

10 V/m, 80 to 1000 MHz ≤ 5% variation

Fast transient IEC 60255-22-4 Class IV

4kV, 5/50ns, 2.5kHz, repetitive ≤ 3% variation

Conducted RFI IEC 60255-22-6

10 V, 0.15 to 80 MHz ≤ 5% variation

Emissions

Conducted limits IEC 60255-25

| Frequency Range | Limits dB(μV) | |
|-----------------|---------------|---------|
| | Quasi-peak | Average |
| 0.15 to 0.5 MHz | 79 | 66 |
| 0.5 to 30 MHz | 73 | 60 |

Radiated limits IEC 60255-25

| Frequency Range | Limits 10 m Quasi-peak, dB (μV/m) | |
|------------------|--------------------------------------|--|
| | | |
| 30 to 230 MHz | 40 | |
| 230 to 10000 MHz | 47 | |

Mechanical

Vibration (sinusoidal) IEC 60255-21-1 Class 1

0.5 gn, Vibration response ≤ 5% variation
1.0 gn, Vibration endurance

Shock and bump IEC 60255-21-2 Class 1

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

Seismic IEC 60255-21-3 Class 1

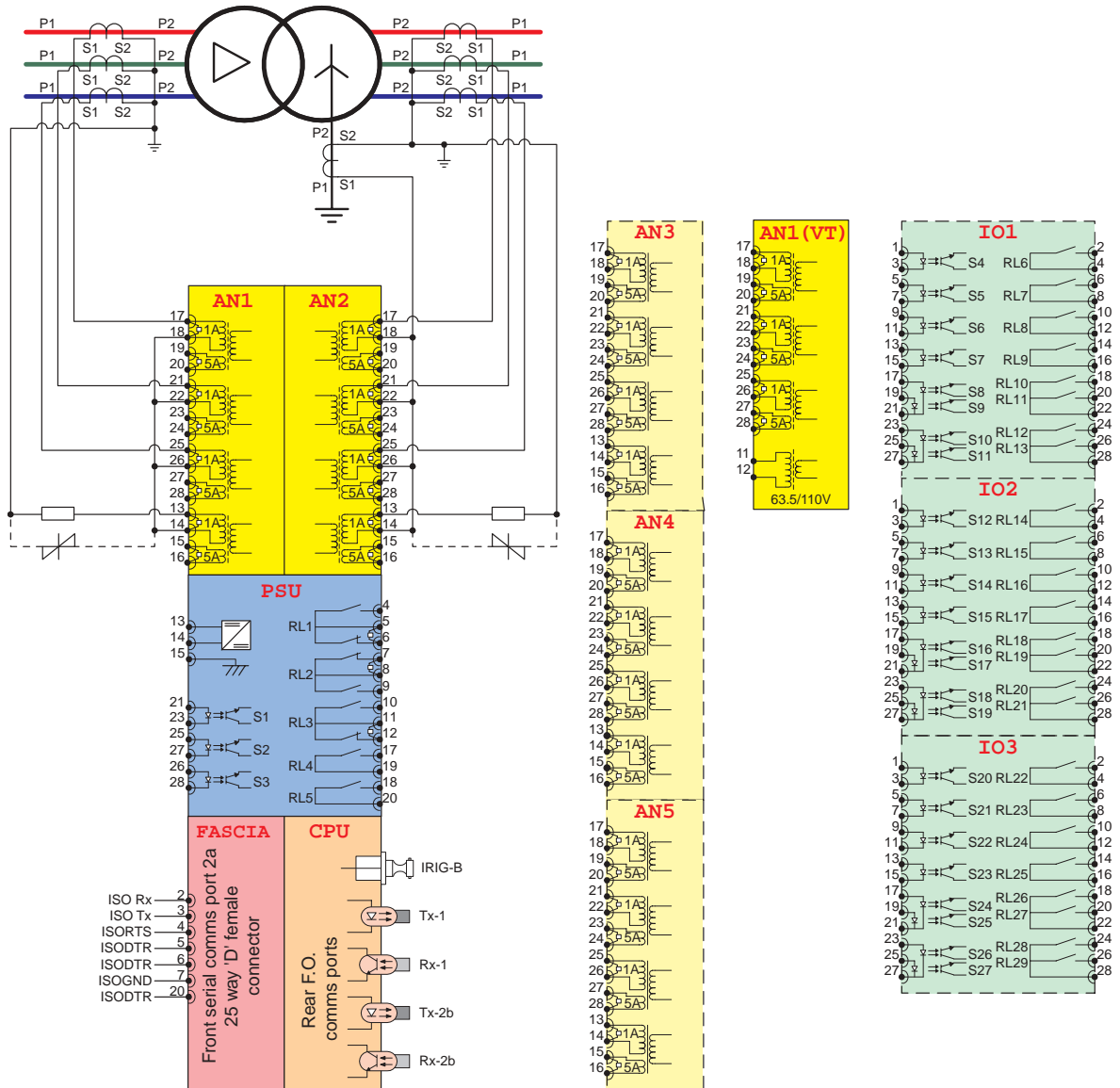
1 gn, Seismic response ≤ 5% variation

Mechanical classification

Durability In excess of 10⁶ operations

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Transformer protection

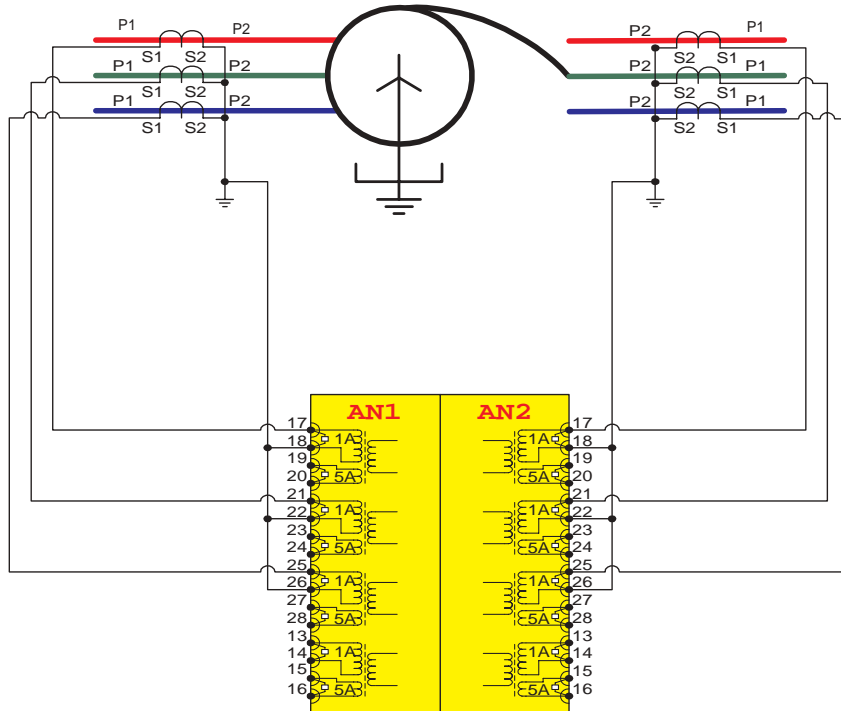


Notes

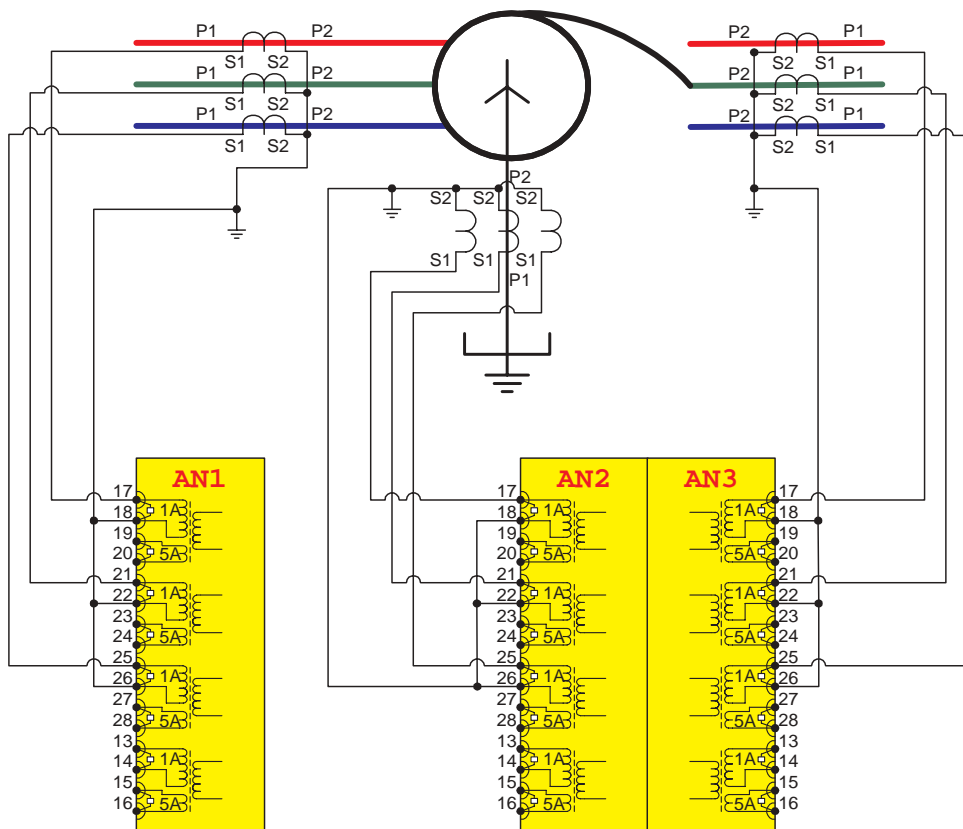
1. CT circuits shown connected to 1A inputs, 5A rated CTs use alternative inputs.
2. NLR and stabilising resistor (to be ordered separately) required for high impedance REF.
3. Spare slots may be occupied by either additional I/O modules (IO2, IO3), or additional CT sets (AN3, AN4, AN5) upto a maximum of 29o, 27i and 5 CT sets.

Module Positions

| | | case size | | |
|-----------------|---|-----------|-------|-----|
| | | E16 | E12 | E8 |
| module position | A | PSU | PSU | PSU |
| | B | IO1 | IO1 | AN2 |
| | C | spare | spare | AN1 |
| | D | spare | AN2 | CPU |
| | E | spare | AN1 | |
| | F | AN2 | CPU | |
| | G | AN1 | | |
| | H | CPU | | |



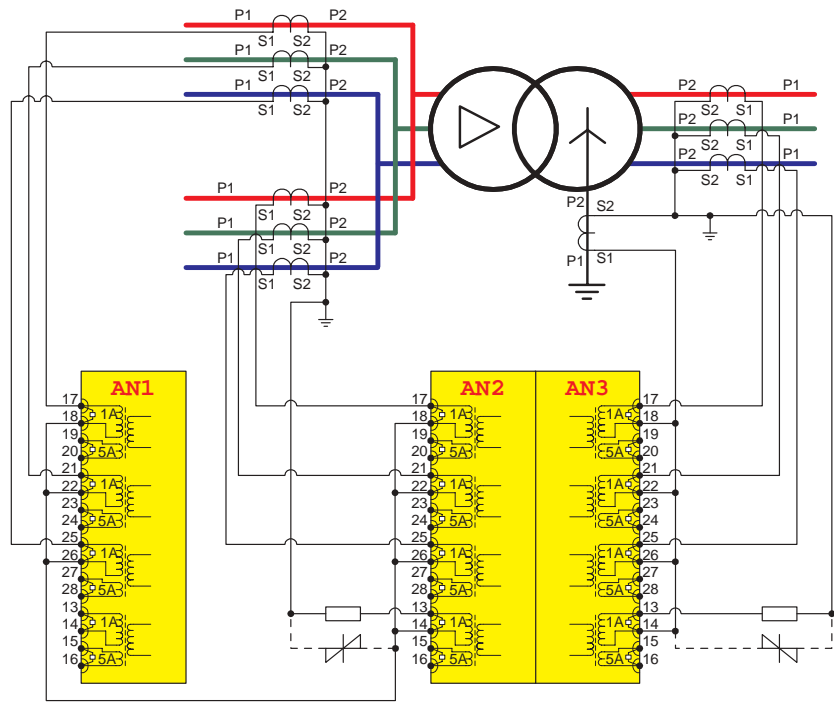
Example connection showing use for autotransformer with 2 CT sets



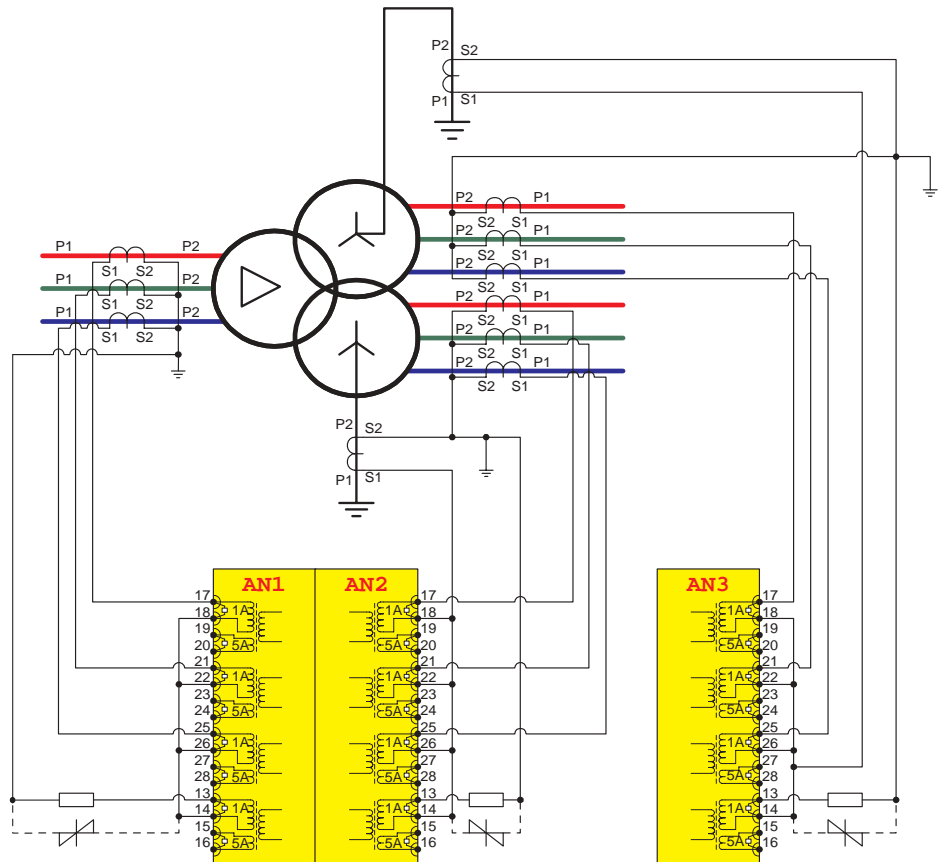
Example connection showing use for autotransformer with 3 CT sets

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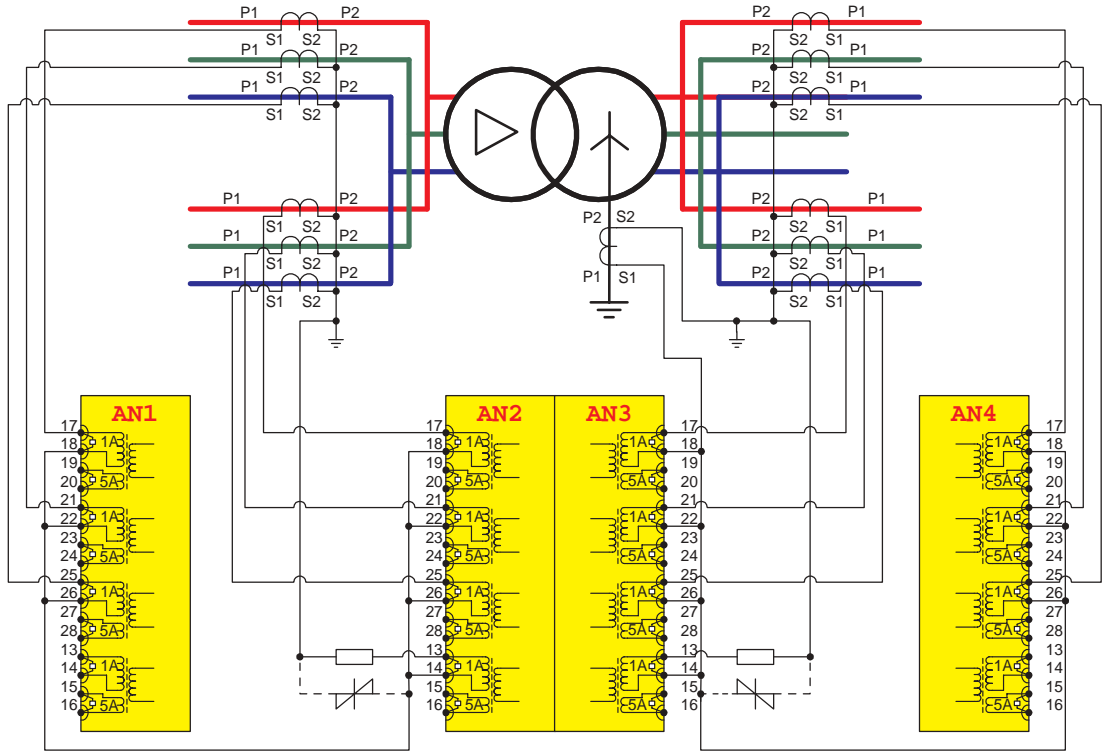
Transformer protection



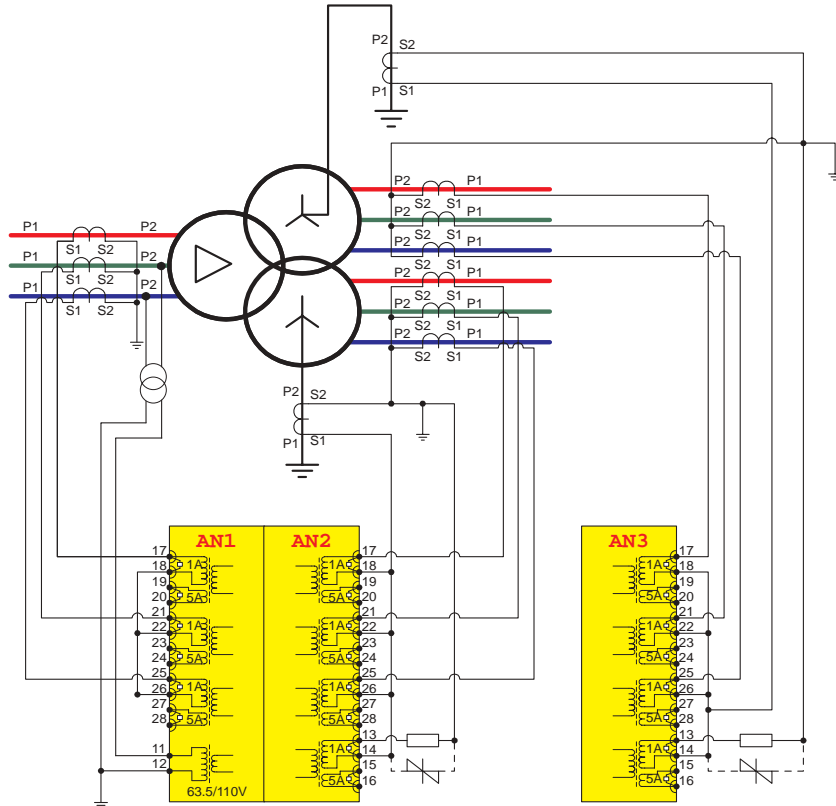
Example connection showing use with dual-bus connections CTs



Example connection showing use with 2 LV windings



Example connection showing use with HV and LV dual-bus connection CTs



Example connection showing use with 2 LV windings & HV VT connection

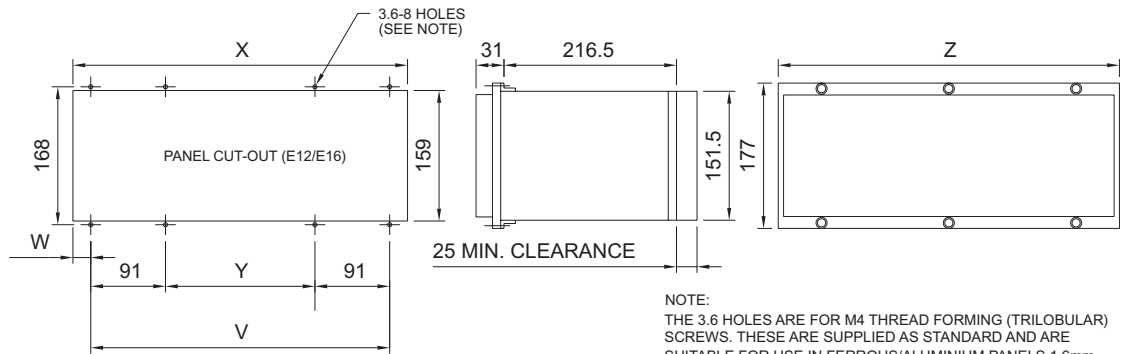
DUOBIAS

Transformer protection

Case

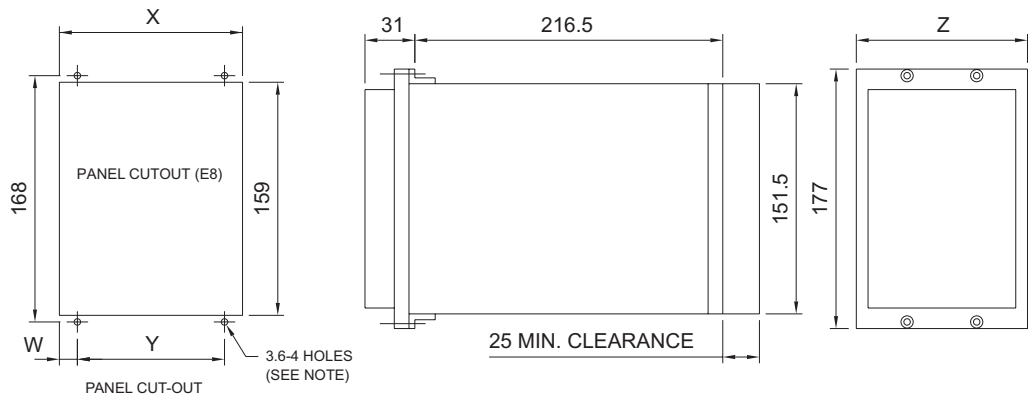
The Duobias is supplied in either a size 8, size 12 or size 16 case, depending on the number of analogue input sets, and the status input and output relay requirement, see the table below.

| Digital I/O provision | Number of analogue input sets | | | |
|-------------------------------------|-------------------------------|---------|---------|---------|
| | 2 | 3 | 4 | 5 |
| 3 status inputs, 5 output relays | Size 8 | Size 12 | Size 12 | Size 16 |
| 11 status inputs, 13 output relays | Size 12 | Size 12 | Size 16 | Size 16 |
| 19 status inputs, 21 outputs relays | Size 12 | Size 16 | Size 16 | - |
| 27 status inputs, 29 output relays | Size 16 | Size 16 | - | - |



Overall Dimensions and panel drilling for Epsilon E12 and E16 cases

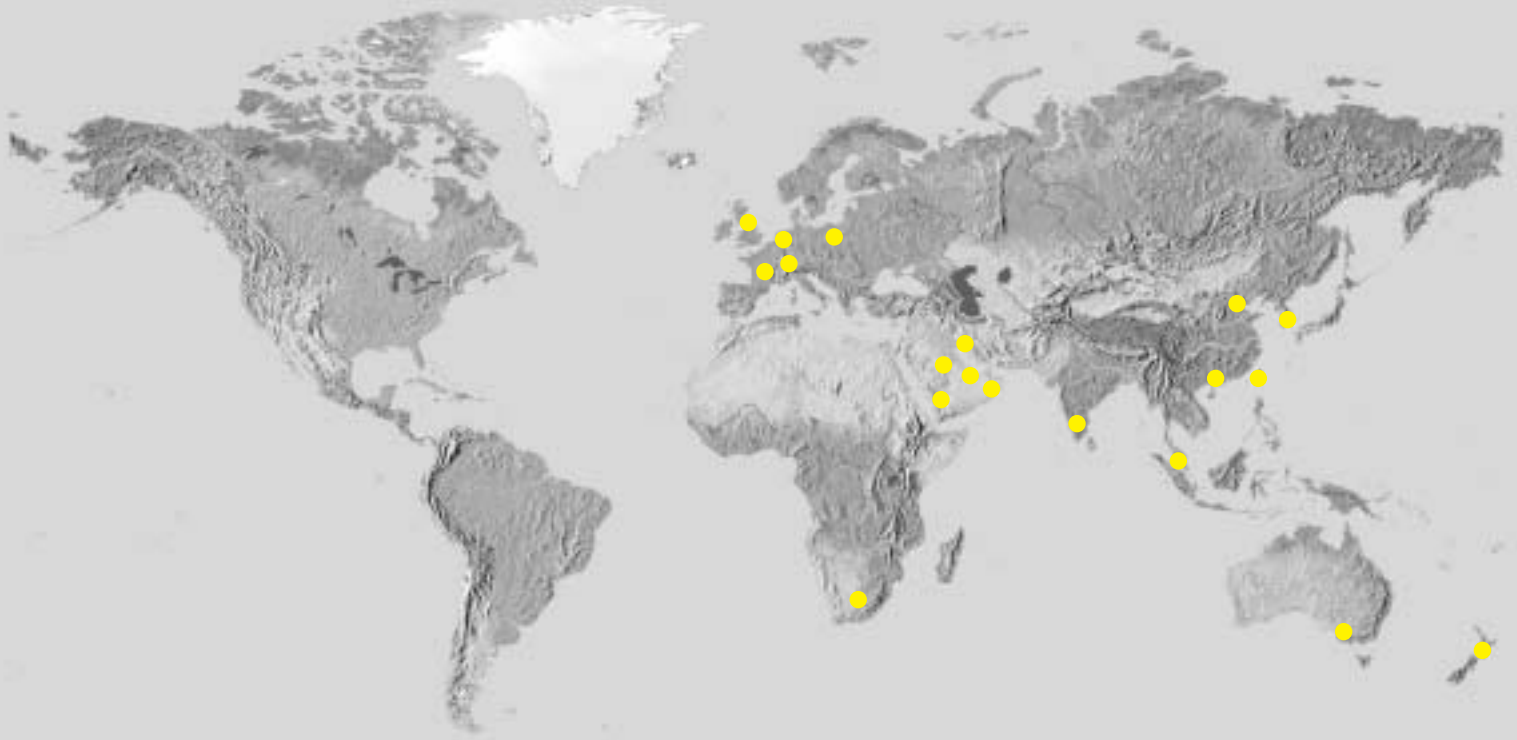
NOTE:
THE 3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS/ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY 4.5) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).



Overall Dimensions and panel drilling for Epsilon E8 case

| | E8 | E12 | E16 |
|---|-------|-------|-------|
| V | - | 286 | 364 |
| W | 9.75 | 9.25 | 21.75 |
| X | 201.5 | 304.5 | 407.5 |
| Y | 182 | 104 | 182 |
| Z | 207.5 | 311.5 | 415.5 |

All dimensions are in Millimetres



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