7PG26 DAD

High Impedance Relays

Document Release History

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

Pre release

02/2010	Document reformat due to rebrand

Software Revision History

Contents

1. REQUIRED TEST EQUIPMENT

_ AC voltage source rated for 5 x In, i.e. 1A relay, 5A source, 5A relay, 25A source.
NOTE: The test source must be capable of accurately supplying current down to 0.5% of the relay rating and also the setting voltage.
_ Time interval meter 0-100s.
_ I Voltmeter.
_ Up to 3 Ammeters.
_ I to 1000V insulation resistance test set.
_ A single phase primary injection test set 500A at 5kVA.
_ Suitable test leads.

2. PRECAUTIONS

The commissioning and future maintenance of this equipment should only be carried out by skilled personnel trained in protective relay operation and capable of observing all the necessary safety precautions and regulations appropriate to this equipment and also the associated primary plant. Equipment should be isolated from the auxiliary supplies and the circuit breaker trip circuit prior to commencing any work on an installed product. Do not open circuit the secondary winding of a current transformer while current is flowing in the primary. This can result in high voltages which may be dangerous to personnel and may damage the secondary wiring.

3. PROGRAMME OF TESTS

Apply tests in the order given below:

_ Selection of latch/non-latched output contacts, (see figure 8)
_ Check of CT secondary wiring resistance
_ Insulation resistance tests
_ Secondary injection tests
_ Primary injection tests
_ Put into service

4. CHECK OF CT SECONDARY WIRING AND PILOT RESISTANCE

Before commencing to inspect the wiring and measuring pilot resistance take the following precautions:

_ Isolate the auxiliary supplies.
_ Remove the trip and intertrip links.
_ Earth links open.
_ Changeover links of the circuits under test removed.

Check that the relay wiring is complete and that all terminal connections comply with the relevant scheme diagrams. Connect an ohmeter across the short circuiting position of each changeover link in turn, to measure the resistance of the CT secondary winding and pilot leads of each phase. The setting report for the protection should state the maximum permissible value of the d.c. resistance for the CT secondary winding and the pilot resistance. The sum of these two values should be compared with values measured above to ensure it is not exceeded. Record the results in Table 1.

5. 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:

_ CT secondary wiring connected to the a.c. input circuits.
_ D.C. wiring connected to the relay power supply.
_ D.C. wiring connected to output contacts.

Record the results in Table 2.

Insulation resistance values which may be considered satisfactory must depend upon the amount of wiring involved. Generally, where a considerable amount of multicore wiring is included, a reading of 2M∧ or 3M∧ is reasonable. For short lengths of wiring on a panel, higher readings should be expected. A reading of l M∧ or less should not normally be considered satisfactory.

6. SECONDARY INJECTION TESTS

Isolate the d.c. supplies for alarm and tripping from the relay and remove the trip and intertrip links.
Ensure the relay is powered from a suitable d.c. supply:

_ 18V to 60V d.c. or 88V to 280V d.c.

6.1. Checking the relay voltage and current settings

The CT alarm time delay should be at a minimum. Check that the required setting is applied to each pole of the relay. The CT alarm setting is a percentage of the applied setting. The voltage setting is dependant upon the value of the setting resistor. Fig. 2 shows the test circuit. Inject into each phase in turn and slowly increase the voltage, note the level of voltage and current that causes the CT alarm to operate by either observing the LED indication or monitor the operation of the alarm output contacts.

NOTE: Alarm contacts are selected latched or un-latched. When latched is selected the contacts are reset from the operation of the relay reset lever. Continue increasing the voltage until the protection operates, this can be determined by the Protection operated LED illuminating and by operation of the trip output contacts.

Record the results in Table 3.

6.2. Checking the relay operating time

Inject a current equal to three times the relay setting and record the operating time of the trip output contacts. Set the time delay for the CT alarms and inject a level of current equal to three times the relay setting and record the operating time of the alarm output contacts.

Record the results in Table 4.

7. PRIMARY INJECTION TESTS

If the CT's associated with the protection are located in power transformer bushings or gas filled circuit breakers it may not be possible to apply test connections to the busbar under test.

7.1. CT ratio and polarity tests

Since the protective system is of the current balance type it is important that the CT's should have the same ratio and be connected together with the correct polarities. To check the ratio and polarities, choose one circuit as standard, test its CT's then check those of the remaining circuits against them as described in the following sections.

7.2 Choice of standard circuit

If possible, choose a standard circuit that:

_ Will be readily available throughout the tests.
_ Will present no undue difficulty from the point of view of primary injection.
_ Is near the centre of the switchboard, in order to avoid long testing connections.

In a single busbar installation having more than one discriminating zone, select a standard circuit for each zone. In a duplicate busbar installation in which the CT's of two or more main busbar zones may be connected in the same reserve busbar zone, check the CT's of those zones against the same standard, or against CT's that have been checked against the standard. When in doubt, study the layout of the busbars and circuits and arrange the tests so as to prove that the balance can be maintained for all possible operating arrangements of the circuit breakers and isolators.

7.3 Test of ratios of the standard circuit CT's

Test each CT of the standard circuit as described below, using the connections shown in fig. 3.

See that the links, fuses, and isolating switches are as follows:
_ Trip and intertrip links removed.
_ Supply links and fuse links removed.
_ Earth links open.
_ Trip supply isolating links/switches open.
_ Changeover links of the phase under test of the standard circuit and the test circuit removed and ammeters inserted.
_ All other changeover test links in the short circuiting position.
_ Relay test link associated with the CT under test removed and an ammeter inserted.
_ All other relay test links in the normal position.

Short circuit the relay and setting resistor associated with the CT being tested; pass a current through the primary of the CT to give about 0.5A in the secondary circuit, measure the secondary current across the normal position of the changeover test link and at the relay test link. The current at both links should be equal to:
Primary injected current / CT ratio

Record the results in Table 5.

Transfer the ammeter from the relay test block to the short circuiting position of the changeover link. If the secondary current is the same as before, for the same value of primary current, it verifies that the link will correctly short circuit the CT.

Check the labelling of the changeover links and relay test links. In duplicate busbar schemes, test in both the main and reserve busbar zones, i.e. with the busbar selector switch in each position, to check all the wiring.

7.4. Test of polarities of the standard CT's

Test the relative polarities of the CT's of the standard circuit in pairs as described below, using the connections shown in fig. 4.

See that the links and fuses are as follows:

_ Trip and intertrip links removed.
_ Supply links and fuse links removed.
_ Earth links open.
_ Changeover links of the phase under test of the standard circuit and the test circuit removed and ammeters inserted.
_ All other changeover test links in the short circuiting position
_ Relay neutral test link removed and an ammeter inserted.
_ All other relay test links in the normal position.

Short circuit the relays and setting resistors at the relay test links as shown in fig. 4; pass the same value of current as in the ratio test through the primaries of the two CT's, so as to simulate a phase to phase fault, and measure the secondary current at the relay neutral link. In a scheme that has one 3 phase main relay per zone the current at both changeover links should be: Primary injected current / CT ratio and there should be no current at the neutral link. If the current at the neutral link is equal to the sum of the currents at the relay links, one of the CT's is reversed.

7.5. Test of ratios and polarities of CTs of the remaining circuits

Compare the ratio and polarity of each CT on the remaining circuits with the corresponding CT on the standard circuit as described below, using the connections shown in fig. 5. See that the links, fuses, and isolating switches are as follows:

_ Trip and intertrip links removed.
_ Supply links and fuse links removed.
_ Earth links open.
_ Trip supply isolating switches open.
_ Changeover links of the phase under test of the standard circuit and the test circuit removed and ammeters inserted.
_ All other changeover test links in the short circuiting position.
_ Relay neutral test link removed and an ammeter inserted.
_ All other relay test links in the normal position.

Short circuit the relays and setting resistors; pass the same value of current as in the tests of the standard circuit CT's through the primaries of the two CT's being compared, measure the secondary current at the changeover links of the standard and test circuits and at the relay neutral link. The current at each changeover link should be equal to: Primary injected current / CT ratio and there should be no current at the relay neutral link. If the current at the neutral link is equal to the sum of the currents at the two changeover links, the secondary connections of the CT under test are reversed. When the ratio and polarity of the CT under test have been proved correct, transfer the ammeter from the normal to the short circuiting position of the test circuit changeover link. If the ammeter reading is the same as before, for the same value of primary current, it verifies that the changeover link will correctly short circuit the CT. Check the labelling of the changeover links and relay test links. In duplicate busbar schemes, test in both the main busbar and reverse busbar zones, i.e. with the busbar selector switches in each position, to check all the wiring.

7.6. Test of overlap of busbar section and busbar coupler current transformers

The principle of overlapping the CT's of the busbar section and busbar coupler circuits is illustrated in fig. 6. The CT's shown on the right hand side of the circuit breaker are connected to zone I current balance group and those on the left hand side to zone 2 group. Test each phase in turn as described below, using the connections shown in fig. 6.

See that the links, fuses, and isolating switches are as follows:

_ Trip and intertrip links removed.
_ Supply links and fuse links removed.
_ Earth links open.
_ Trip supply isolating links/switches open.
_ Changeover links of the busbar section or busbar coupler circuit under test in the normal position in both zones.
_ All other changeover test links in the short circuiting position.
_ Relay test links of the phase under test in both zones removed and ammeters inserted.
_ All other relay test links in the normal position.

Energise the primary injection test equipment and see that the relay of the correct zone is energised.

7.7. Test of fault setting by primary injection

See that the links, fuses, and isolating switches are as follows:

_ Trip and intertrip links removed.
_ Supply links and fuse links removed.
_ Earth links open.
_ Trip supply isolating links/switches open.
_ All other changeover links in the normal position.

_ Relay test link associated with the CT energised in the test removed and an ammeter inserted.
_ All other relay test links in the normal position.

Measure the phase fault and earth fault settings (for each phase) in each zone. Use the connections shown in fig. 7.

7.8. CT supervision alarm setting

The requirements for this test are identical with those described above and it will normally be possible to make the two tests at the same time.
Measure the settings in terms of the injected primary current.
Measure the secondary voltage and current at which operation occurs and record in Table 6.

8. PUTTING INTO SERVICE

To put the protective system into service proceed as follows:
_ Put all changeover links, relay test links, and earth links in their normal position.
_ Check all relays and flags are reset.
_ Insert all trip supply links and fuses.
_ Insert all trip and intertrip links.

	Resistance (Rp + Rn + Rs) Ohms	Resistance (Rp^{I} + Rn^{I} + Rs^{I}) Ohms	Setting Report Max. Permissible Value Ohms		
Phase A					
Phase B					
Phase C					
Neutral					

Table 1 - Wiring Resistance

Wiring Section	Resistance Megaohms
CT Secondary Circuits	
DC Power Supply Wiring	
DC Wiring	

Table 2 - Wiring Insulation Resistance

	Alarm Setting	Measured Value	Relay Setting	Measured Value
Phase A				
Phase B				
Phase C				

Table 3 - Relay Fault Settings

	Alarm Timer Setting	Alarm Measured Time	Relay Opening Time
Phase A			
Phase B			
Phase C			

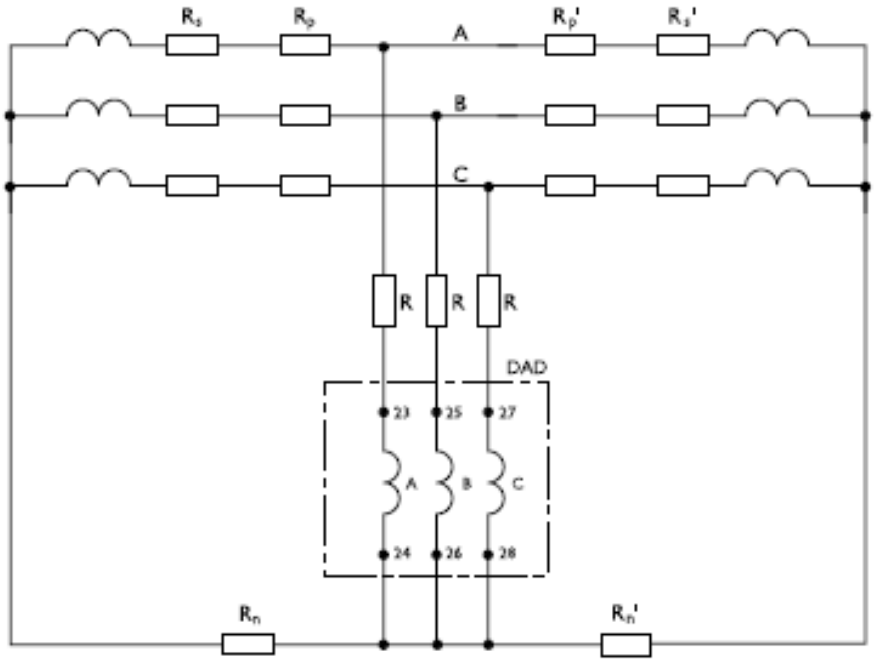
Table 4 - Relay Operating Times

	Primary Current Amps	Secondary Current Amps	Calculated Secondary Current Amps
Phase A			
Phase B			
Phase C			

Table 5 - Current Transformer Ratios

Circuit												
	A1 Amps	A2 Amps	V Volts	A1 Amps	A2 Amps	V Volts	A1 Amps	A2 Amps	V Volts	A1 Amps	A2 Amps	V Volts
Phase A												
Phase B												
Phase C												

Table 6 - Fault Settings



R_s & R_s' = Resistance of C.T. secondary of circuit 1 (R_s) and circuit 2 (R_s')
R_p & R_p' = Resistance of phase wiring of circuit 1 (R_p) and circuit 2 (R_p')
R_n & R_n' = Resistance of neutral wiring of circuit 1 (R_n) and circuit 2 (R_n')
R = Stabilising resistance

Figure 1 Circuit Resistances

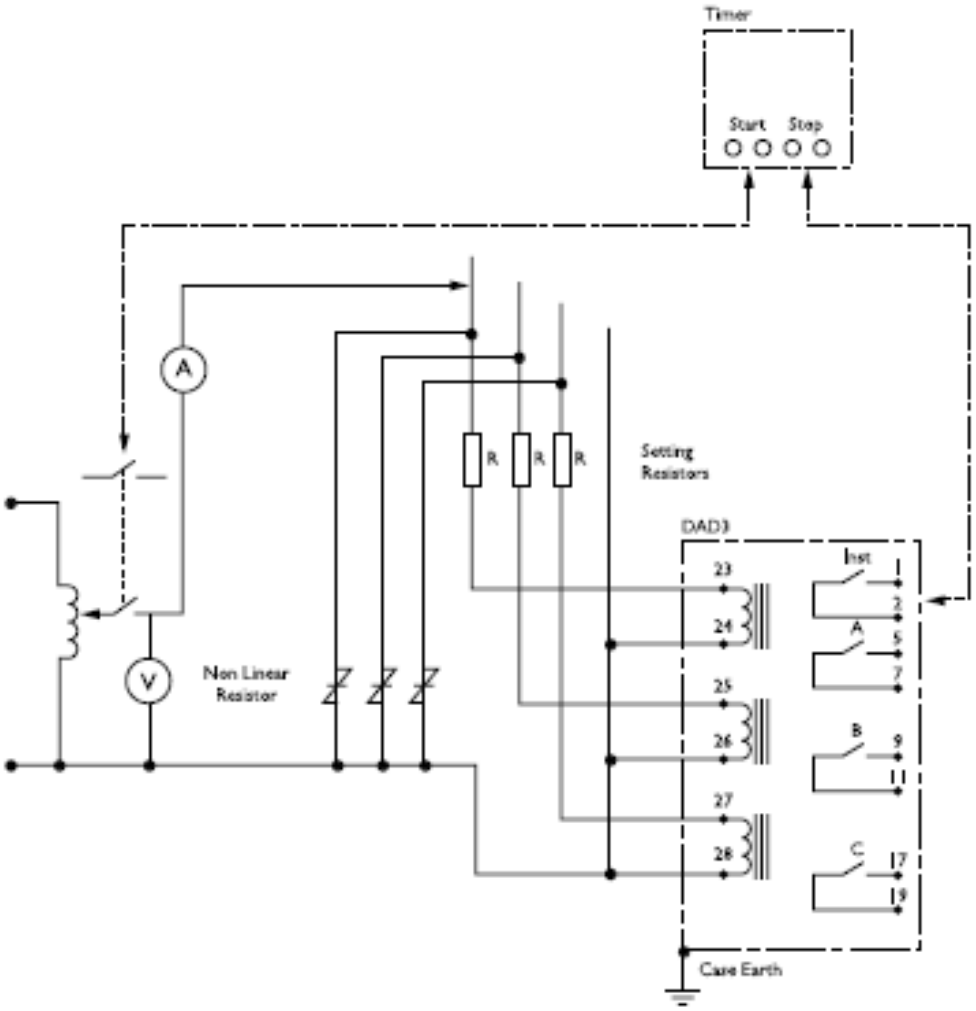


Figure 2 Checking Relay Current and Voltage Settings

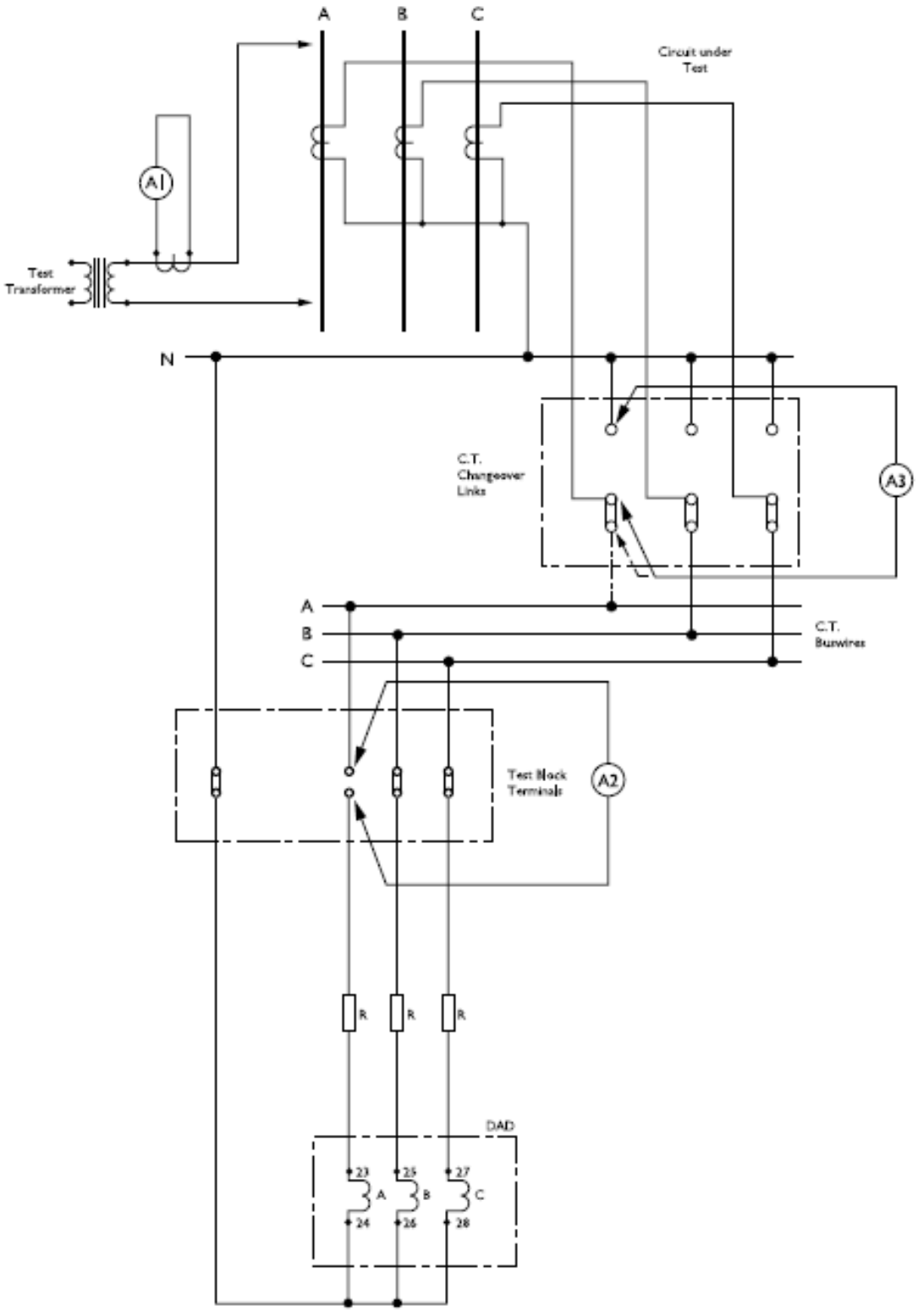


Figure 3 Connections for the Test of Current Transformers Ratios

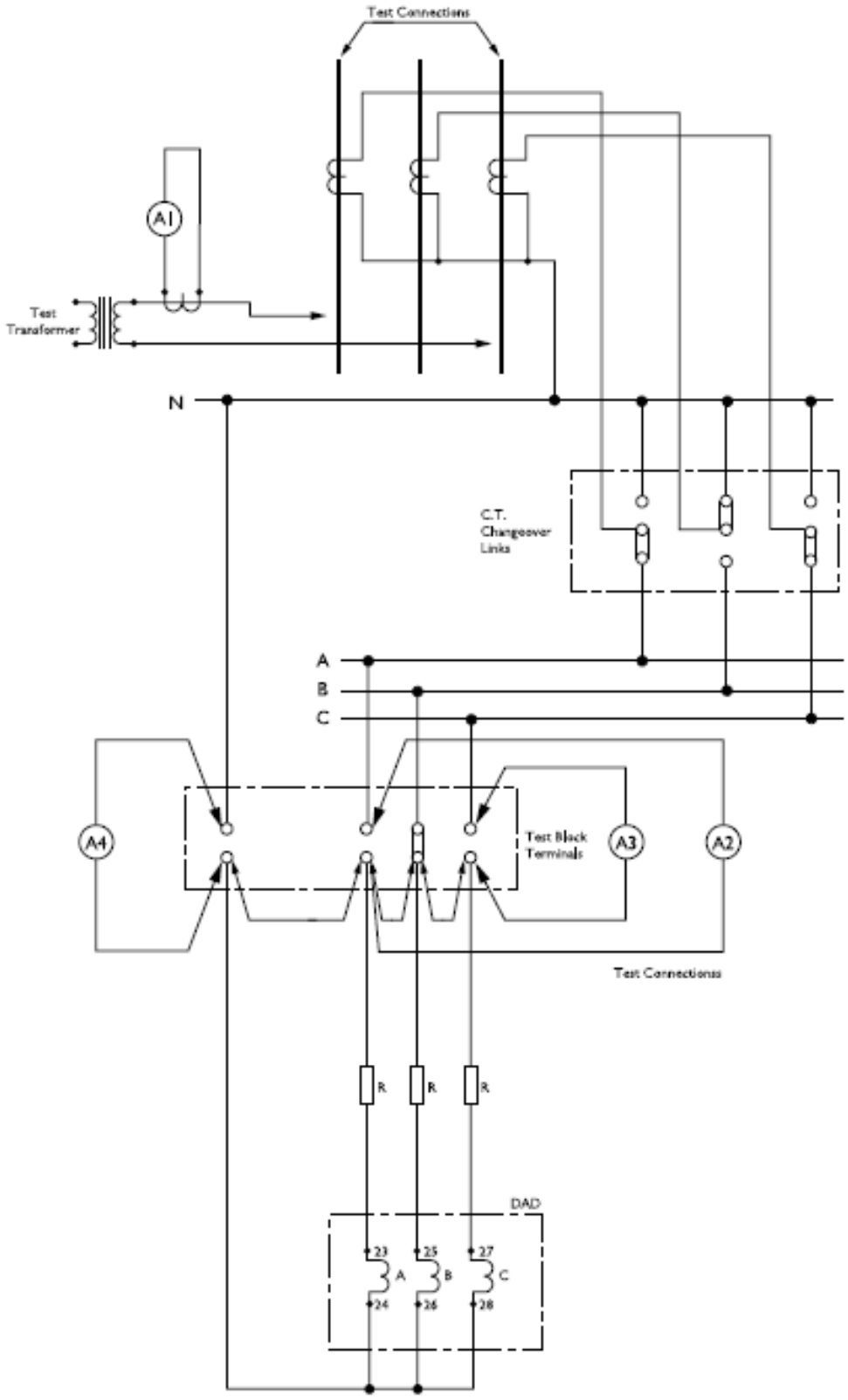


Figure 4 Connections for the Ratio Test of C.T.'s

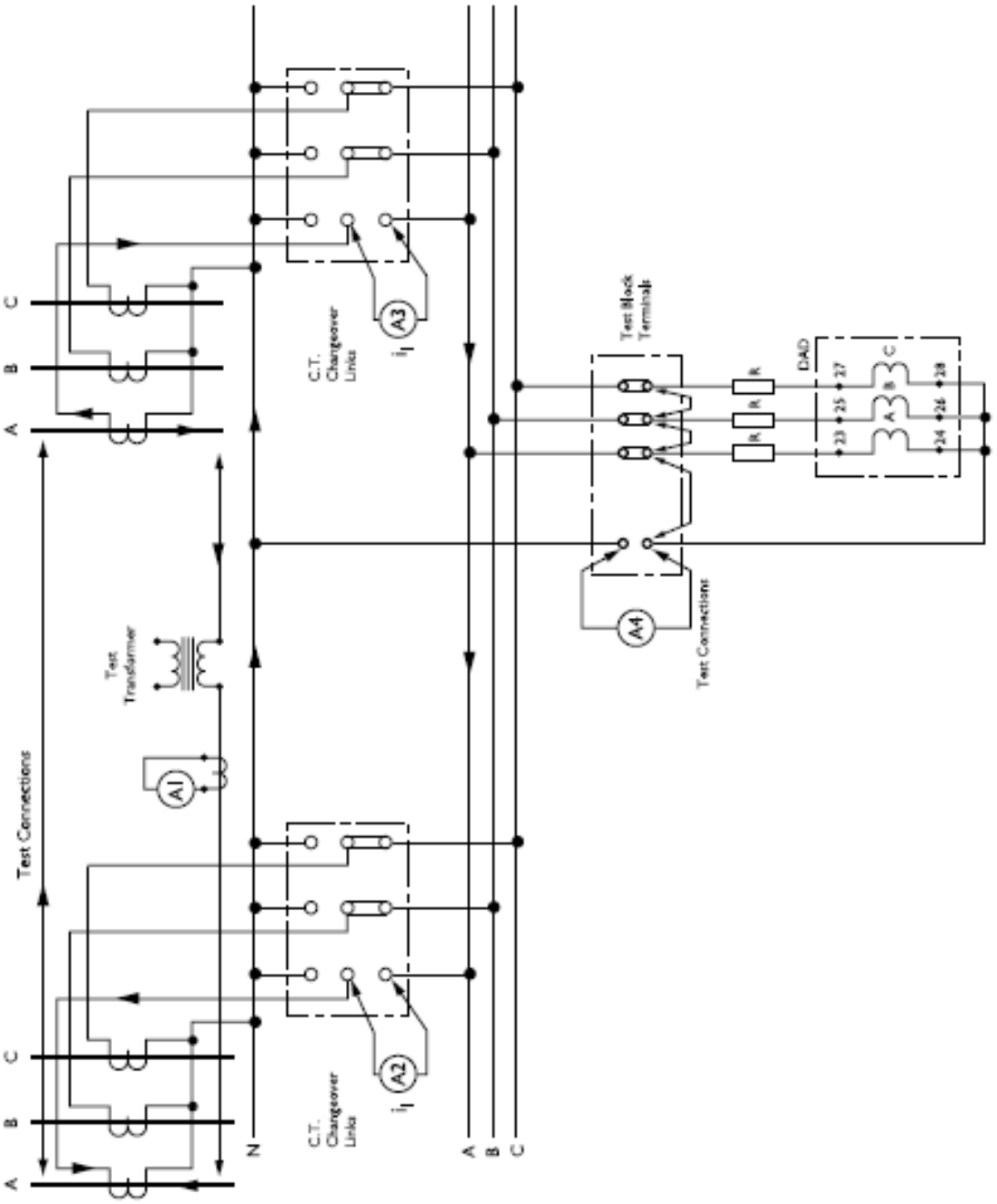


Figure 5 Connections for the Test of a C.T. against a Standard Circuit C.T.

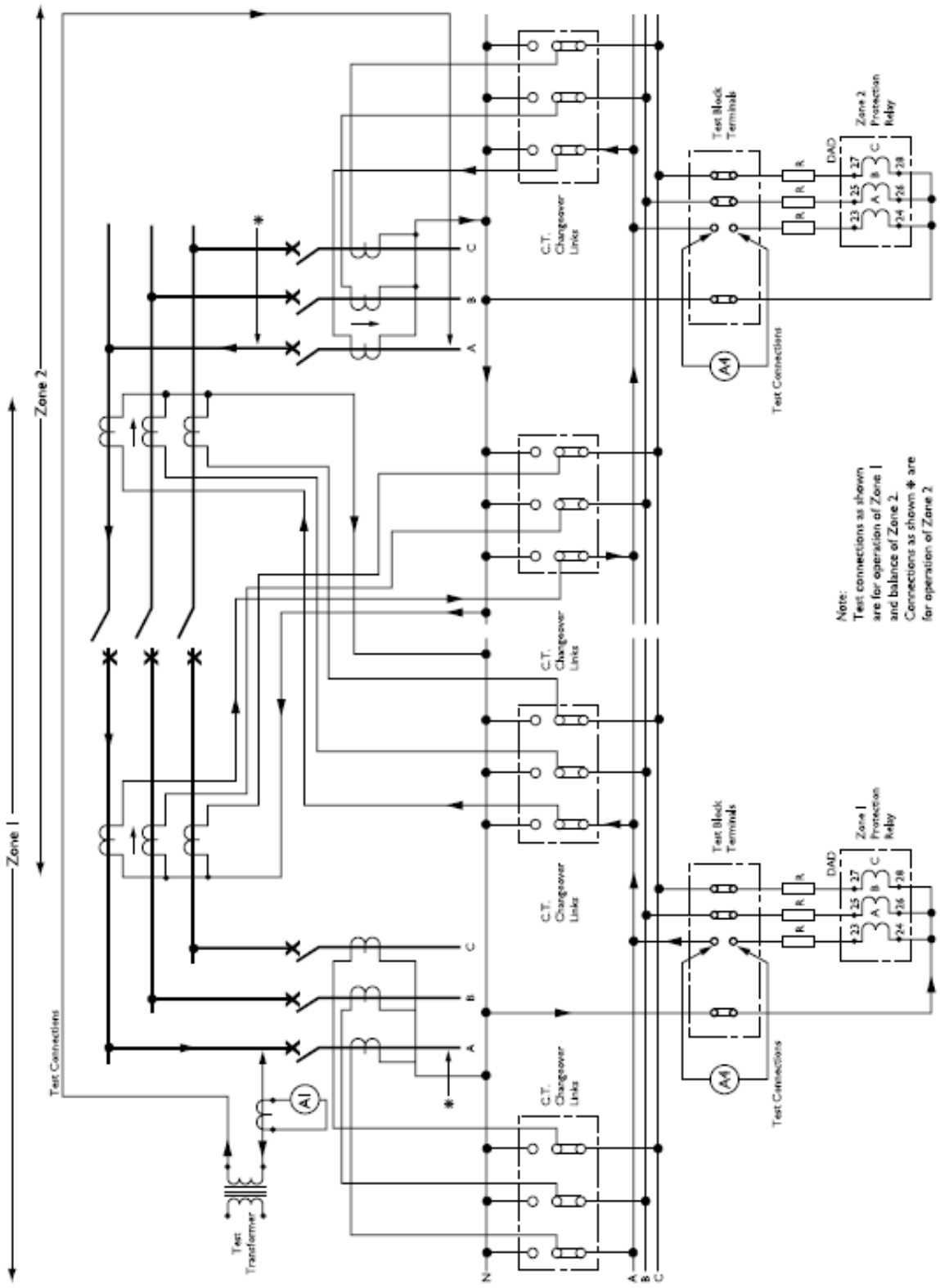


Figure 6 Connections for C.T. Test of Overlap by Primary Injection

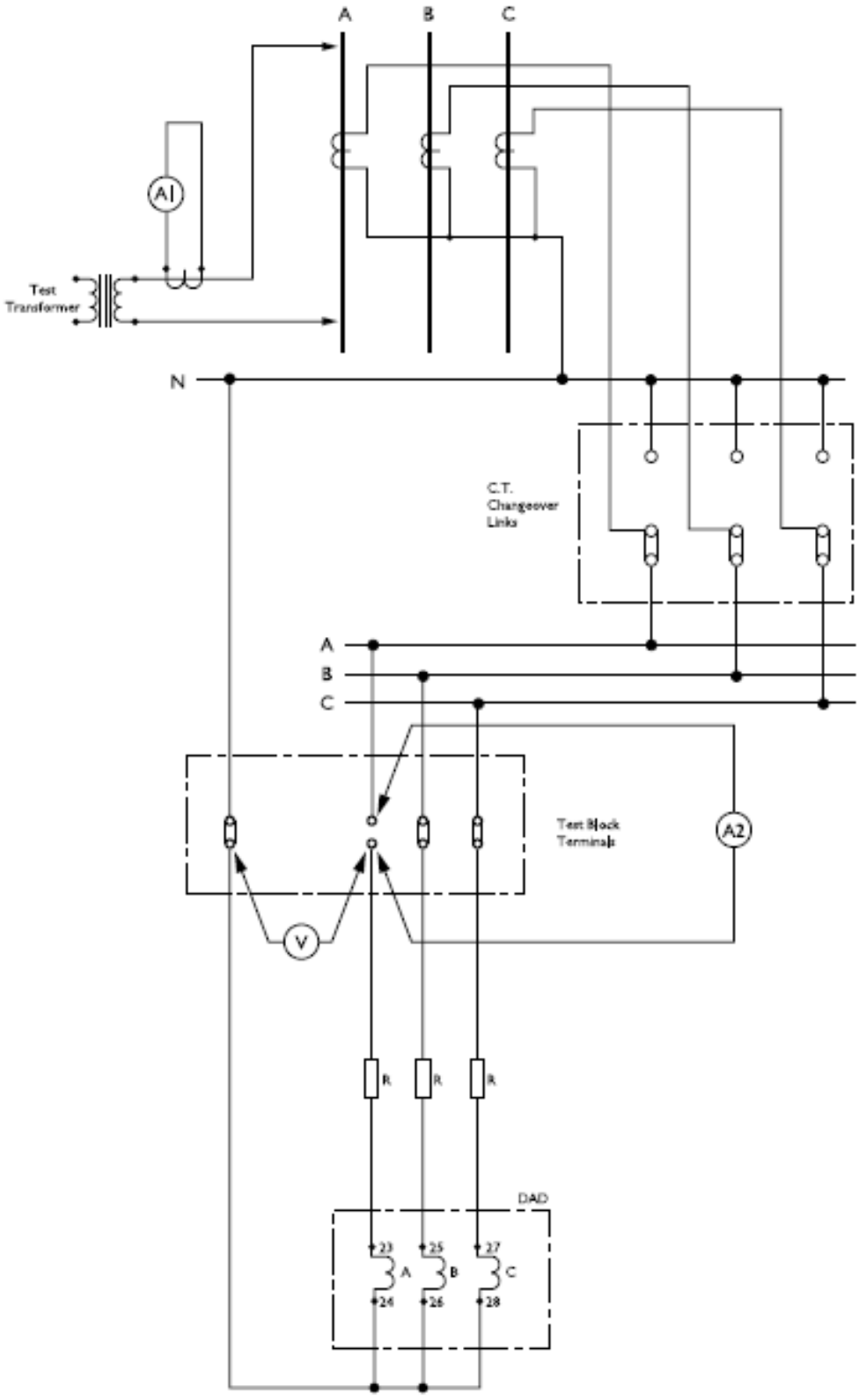
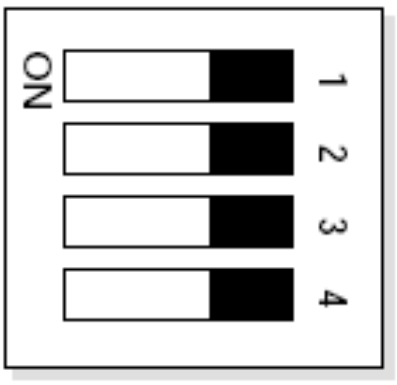


Figure 7 Test Circuit for the Determination of Fault Settings

The DIL switches shown are located on the bottom face of the withdrawable relay chassis. Function is as shown in the diagram



FUNCTION
RL2
RL3
RL4
Not used

With the switches in the ON position, the relevant relay is latched

Figure 8. Selection of Latched/Non-Latched Output Contacts