7SG14 Duobias-M

Transformer Protection

Document Release History

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Pre release

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Software Revision History

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1 Introduction

These commissioning recommendations apply to the testing, putting into service and subsequent maintenance of Duobias-M 200 (DU3-xxx**)** series of numerical protection relays. This range of relays is built on the **Modular II** hardware platform.

This range of relays can provide differential protection to two and three winding power transformers and other plant items such as busbars, motors and reactors. Relay models are available for connection of two to five sets (terminals) of CT's. VT's may also be connected to the relay if optional functions are required.

A separate technical manual is available for **Modular I** (DU2-XXX) Duobias M. The type of relay can be easily checked as **Modular II** relays have two pairs (Tx&Rx) of rear mounted fibre ports and Modular I relay have only one pair.

The relay can be used to protect other plant items such as reactors, busbars and motors.

A software program called Reydisp Evolution is available for download from the www.reyrolle-protection.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 all protection settings and schemes showing the D.C. status input and output relay configuration must be available.

It is recommended use is made of the Test Result Tables provided so that a comprehensive record of the protection settings, as commissioned, is available for future reference.

2 Safety

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

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 (CT) 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 CT 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 substation equipment is to be tested at the same time as the Duobias-M, 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. synchronizing 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 allow injection the current sources with a sinusoidal waveform. If the CT secondary rating is 5A the bias characteristic may be tested single phase to allow test set amplifiers to be paralleled.

Test currents of the following range are required:

The bias characteristic requires 2 sources to be applied simultaneously.

The sources must be capable of delivering at least 5 x the rated current of the relay terminal used.

If differential high-set settings greater than 4 x I_N are intended to be tested then a larger current source will be required. The basic test equipment for primary and secondary injection test is as follows:

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.

500V insulation resistance test set.

Digital Multimeter

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

500volt Variac to measure CT magnetizing characteristics and inject the Restricted Earth Fault elements.

Primary test leads and injection set.

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

When making secondary injection tests ensure that the test circuit is earthed at one point only. All trip and alarm wiring must be isolated to ensure no unexpected tripping or alarms occur.

5 Insulation resistance test

The relay terminals are factory tested to 3.5kV rms for 1 second and therefore the relay itself does not requires a pressure test. The external wiring must still be tested for any insulation breaks.

Before commencing a visual inspection of 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 earth links before conducting 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) CT secondary wiring connected to module AN 1
b) CT secondary wiring connected to module AN 2
c) Other optional CT and V.T. secondary winding connected to modules AN 3, 4 or 5.
d) 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.

e) 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. This will lead to a slight drain current of 5 to 15mA.

Record the results in Table 1.

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 2 to 3 mega-ohms is reasonable but higher readings should be expected. A reading of 1M ohm should not normally be considered satisfactory.

6 REF protection - CT and secondary wiring resistance

This test is to be applied to each of the restricted earth fault protections.

- Isolate the auxiliary supplies
- Remove the trip and intertrip links

Refer to the calculated data for the REF protection settings. This will give the maximum permissible lead resistance values.

Measure the resistance of the wiring between the relay equipment and the CTs. The readings obtained should be recorded in table 2 below. These should be approximately equal to or less than the values used in the calculated settings for the restricted earth fault function. This measurement is taken to ensure the REF calculations used suitable data and will be stable for through earth faults.

7 Relay 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 within the range of the Vx marked on the relay fascia. Ensure the polarity of the supply is correct before energising the relay. The minimum recommended fuse rating of the supply is 12 amps.

It is normal for the relay to take some time while booting up.

With the relay energised the green LED will provide a steady illumination. None of the red LED's should be illuminated after the relay has completed booting up. 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 settings, it is recommended that the laptop method be used for speed and ease of commissioning.

8.1 Setting by Laptop PC

The relay is supplied with a 25pin RS232C type communications port on the front of the fascia. This should be connected to a laptop using a 25 to 9 pin RS232 cable. Alternatively a USB connection to the laptop may be used, but this may require some Reydisp Configuration changes. Reydisp Evolution should be installed on the laptop, and this should run on any MS Windows © operating system.

To use the relay communications port the Communications Settings in the relay, must match the 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 communication address to a unique number. The address selected on the relay and the relay address selected on Reydisp Evolution must be set identically. The relay address can be changed by pressing the ⇩ or ⇧ buttons. Press ENTER to register the selected address number.

Continue to scroll down and set IEC 870 ON PORT to COM2 (front RS232 and bottom rear fibre ports are COMM 2 relay ports) and set AUTO DETECT to ON. The Auto Detect feature will automatically toggle 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 and Relay are the same. It is advisable to select the maximum baud rate on the relay and Reydisp Evolution to speeds up response times.

The communications setting can be changed in Reydisp Evolution by selecting:

OPTIONS -> COMMUNICATIONS. Note this window displays the active port of the laptop And not the relay. 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 Evolution allows off line generation of relay setting by saving the relay Settings File and then downloading it. This saves time at site as late setting changes will then be minimised.

To download a Settings File from the laptop to the relay; select Relay->Settings->Send All Settings. Confirm the action and the user will be informed whether the settings have been successfully entered into the relay. It is worth doing a few spot checks on the setting to be confident the correct settings are installed.

8.2 Setting via Relay Fascia Pushbutton

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 register 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 inter-trip links.

The recommended test set to use is an Omicron Type CMC256 (or CMC156 plus CMA156). Automatic test software can be provided to allow input of settings and automatic testing and reporting. The Omicron set should be connected in accordance with the manufacturer’s instructions.

The following settings must be selected on relay to avoid any confusion during testing: -

The initial and bias slopes settings should be set to the chosen values.

W1 Interposing CT Multiplier	1.00
W1 Interposing CT Connection	Yy0
W2 Interposing CT Multiplier	1.00
W2 Interposing CT Connections	Yy0
Bias Slope Limit	4x
Differential Highset	4x

9.1 Proving Inputs and Outputs

The number of inputs and output contacts present will vary with model.

The easiest way to prove output contact operation is to use Reydisp Evolution. The relay output contacts can be closed by selecting RELAY -> CONTROL -> CLOSE OUTPUT RELAY menus. All outputs can also be selected to “Protection Healthy” to test the contact sense.

The status inputs must be tested by application of rated voltage. The “high” (operated) or “low” (unoperated) state of each status input is most easily checked using the Instruments window of the Reydisp Evolution software.

9.2 Accuracy of Measurement

Inject all of the current inputs with nominal current (including neutral and REF inputs) in turn, and record the Relay Currents measured by the relays in Table 4 below. Tap [⇩] to select Secondary Meters: -

e.g.

W1 Sec’y Currents x I_N
1.00 1.00 1.00

Use ⇩ and ⇧ to select the current measured by each of the inputs injected: -

e.g.

W2 Sec’y Currents x I_N
1.00 1.00 1.00

If voltage inputs are provided on the relay, apply nominal voltage to the relay and record the results displayed on the relay Instruments display (Voltage Meters). The voltage input terminals may be identified by viewing the label on the rear of the fascia door. These are normally terminal 11 and 12 of one of the analogue modules.

Record the Results in Table 1 below.

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. Otherwise advice can be obtained from Customer Services Department (++00 44 (0)191 401 5190).

9.3 Checking the Bias Characteristic (87BD)

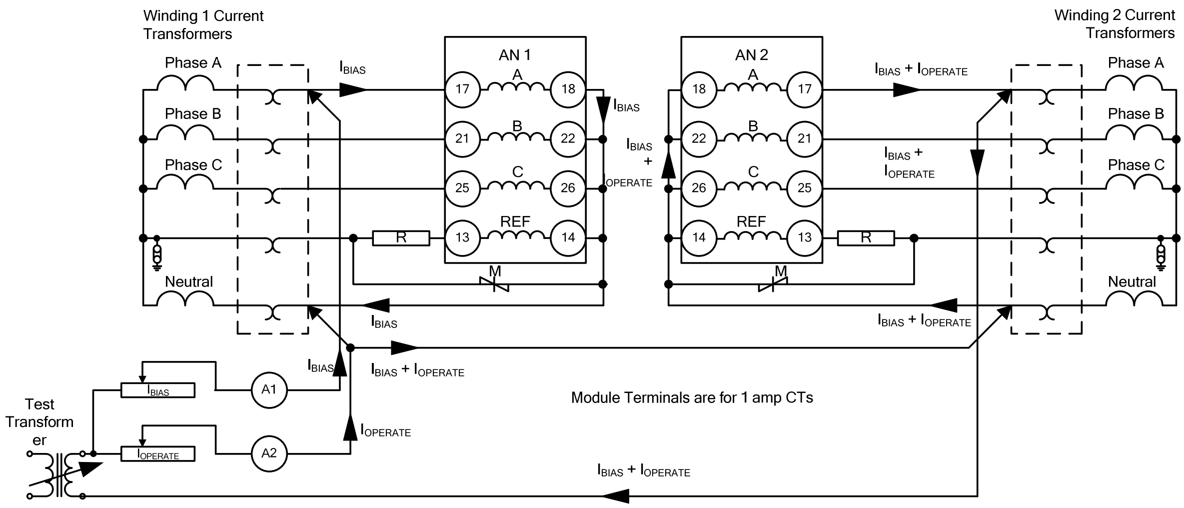

Figure 1 - Biased Differential Test Circuit using Variacs

When testing the bias characteristic, the Relay Currents can be displayed on the LCD by changing to the INSTRUMENTS mode and scrolling down to [BIAS DIFF METERS]. The Instruments to view to help check the relay bias characteristics are the Relay Currents, the Operate (differential) currents and the Restrain (bias) currents.

Inject nominal current into W1 Red and W2 Red Phase current inputs. If the test set has the facilities it can also be done three-phase.

While testing the bias slope, select the Instrument display: -

W1 Relay Currents x I_N
0.00 0.00 0.00

The Differential Operate and Restrain Current Meters should also be checked.

Repeat the tests with increasing bias currents up to 2.5 times the relay rating.

Record the results and check for accuracy in Table 5

Repeat the tests for the other phases if necessary.

Check that the Bias Currents on the Instruments Display are as expected. The upper bias characteristic may also be checked if required. Some of the more common bias characteristics used are displayed in Section 2 of this manual.

The Biased Differential may also be conveniently tested using an Omicron Test Unit. Please contact Siemens Protection Devices Ltd for an Omicron test object template (.occ) for the Duobias-M Biased Differential Test Characteristics.

9.4 Inrush Inhibit

The relay has an anti-aliasing filter that does attenuate the even harmonic content slightly. The attenuation differs depending upon whether the relay is used on a 50 or 60Hz power system. Software revisions R15 onwards include an automatic adjustment for this filter loss.

The relay has a built feature to avoid a false operation when energising a transformer. This uses the presence of even harmonic in the operate signals to distinguish between an inrush and an internal fault. Three different methods are included in the relay.

The test method will depend upon the Inrush Restraint Method selected. As previously mentioned the SUM method has an advantage over the CROSS method in terms of operating speed if an internal fault occurs on energising the transformer.

Only the Inrush Restraint method selected need be tested.

Sum - Restraint Method

This method uses one Inrush Sum some with which to compare the operate current in each phase. The square roots of the even harmonic content in each phase differential current is summed and then divided by the Inrush Setting to arrive at an overall threshold.

Cross – Inhibit Method

The magnetising inrush restraint feature can be checked by injecting the relay with 2nd harmonic current into one set of inputs while fundamental is injected into another set of inputs. If possible the test should be done three phase as all phases are blocked if one phase exceeds the Inrush Inhibit Setting.

Check the **87 Inrush Inhibit** setting is set to [Enabled].

Inject W1 inputs with a balanced three phase current of nominal amplitude and frequency. This will operate all three phases of the biased differential function. The 87BD and phase LED's will be lit.

Inject about 5% of nominal 2nd harmonic current into W2 inputs. Slowly raise the 2nd Harmonic Current until the biased differential resets. The approximate levels of 2nd harmonic to block operation are set out in the table below. Digital Test sets such a Omicron 256-6 use a ratio injection to test the relay inhibit, the Duobias M does not work like this as its setting is a percentage of the operate current.

INRUSH SETTING (FRACTION OF I_{OP})	2ND HARMONIC CURRENT INTO W2 REQUIRED TO BLOCK 87BD FOR NOMINAL FUNDAMENTAL CURRENT INJECTION OF W1 INPUTS		SETTING AT RECOMMENDED TEST POINT IN TERMS OF 2ND / OPERATE	
	50 Hz Relay(x I_n)	60 Hz Relay(x I_n)	50Hz Relay(x I_n)	60Hz Relay(x I_n)
0.10	0.108	0.120	0.100	0.132
0.12	0.128	0.144	0.121	0.159
0.14	0.150	0.168	0.141	0.186
0.16	0.172	0.192	0.161	0.213
0.18	0.194	0.219	0.181	0.241
0.20	0.216	0.245	0.200	0.268
0.22	0.239	0.268	0.220	0.296
0.24	0.262	0.293	0.240	0.325

The relay will filter out some of the second harmonic content in currents due to the anti-aliasing filter roll off.

The filter response attenuates the 2nd (100Hz) harmonic current by approximately x 0.94 for a 50Hz Relay, and by x 0.84 for a 60Hz relay.

The root mean square value of operate current must be calculated, as this is what is used to set the Inrush Inhibit level. Typically digital test sets such as the Omicron uses 2nd Harmonic / Fundamental to check the relay accuracy. However the relay uses the percentage of second harmonic to the root mean square of operate current. As the operate current includes the injected 2nd harmonic as well as the fundamental this must be taken into account.

9.5 Checking the Differential Highset (87HS)

Connect the test current source to relay or test plug. The test can be done single phase or three phase. This tests requires the injection of current in excess of the relay rating, so ensure that the duration of the test does not exceed the relay overload withstand rating.

Use the LCD display to check that the LV input settings are as follows:

LV Interposing CT Multiplier 1.00

LV Interposing CT Connection Yy0

These ensure a 1:1 ratio between the injected phase and the relay setting.

Note, the LV interposing CT multiplier could be set to 3.0 for test purposes to reduce the test current requirements if the test set has limited range.

Select Instruments Mode and select the following display.

W1 Relay Currents

0.00 0.00 0.00 x In

Switch on and increase the value of the test current until the highset relay operates, record the value in Table 2.

Operation of the Differential Highset on phase A is indicated by illumination of the appropriate LED. Check that the contacts operate on all the output relays selected for this function, both trip and alarm. (Note that the differential will also operate). Repeat the test for other phases if required and record the results.

9.6 Restricted Earth Fault (87REF)

Refer to the calculated setting data and check that the relay has the correct settings for each of REF protections. Measure the resistance of the REF series setting resistors and adjust each one to match the REF setting data. Record the values in Table 6.

This should be done in two stages: A by current injection or B - By application voltage.

A - Current Injection by test set

Inject the REF inputs with the CT's disconnected and record the pickup values in Table 6. The setting resistor should be temporarily be shorted out to allow injection from digital test set.

B – Applied Voltage using Variac

Follow safety procedure to ensure no other personnel can come into contact with secondary wiring during this test. Tests are carried out with the current transformers connected in idle shunt to the REF parallel leg. Apply voltage across the REF parallel leg input via the test block or lead and connect an a.c. voltmeter to verify the voltage applied. Slowly increase the applied voltage and note the voltage required for the REF protection to operate on the voltmeter. Ensure that appropriate LED's illuminate and selected output relays operate.

9.7 Over Fluxing or Volts per Hertz Protection (24)

The testing of over fluxing element requires a variable voltage source.

The settings are set in terms of nominal voltage and frequency. Application of a voltage of nominal voltage and frequency represents 100% or 1 per unit. Apply the required settings prior to testing.

24IT – inverse time

The inverse V/f element is best tested at the settings selected that constitute the overall inverse characteristics. The seven setting points require the voltage to be calculated to check for pickup with nominal frequency applied. The voltage may be raised or the frequency dropped to determine the pickup of the Volts per Hertz settings applied. Usually it is easier to increase the voltage while applying h nominal frequency.

Record the results in Table 6

24 DTL – definite time

The voltage required for operation should be calculated and tested. The pickup and operate time should be recorded for each stage used.

9.8 Thermal Overload (49)

The thermal pickup and operating time should be checked. The thermal overload equations for calculating the operate time are:

Time to trip $t(mins) = \tau \times \ln\left\{\frac{I^2}{I^2 - (I_\theta)^2}\right\}$

where,

t – operate time in minutes
I - applied current in terms of x In
I_Θ - thermal pick-up setting x In

The steady state % thermal capacity used can be calculated from:

$$\%\ thermal\ capacity\ used = \left(\frac{I^2}{(I_\theta)^2}\right) \times 100$$

The pickup value and accuracy of timing should be within 5% of setting.

A typical operate time with 2 x pickup applied and a time constant of 1 minute would result in a calculated operate time of 17.26 seconds.

9.9 Over Current and Earth Fault (51, 51N, 50, 50N, 50G, 51G)

The pickup and timing should be tested for each element. Earth Fault elements may be measured (51N) from a neutral CT's or derived for line CT inputs (51G). This will affect where the injection must be made to allow testing.

The pickup level, operate and reset time should be recorded in Table 10. The ANSI overcurrent elements also have inverse reset curves that may be tested. The IEC curves may have a DTL reset applied. The reset delays are used to ensure grading between differing types of relays, if "pecking" or intermittent type of faults earth occurs. These are quite common on power cables particularly XLPE.

The 50G/51G elements require current to be applied to the phase inputs as the earth fault current is derived from the residual (sum) of the three phase current inputs. The 50N/51N elements are measured directly from the single Aux I/P input.

NOTE

All (51) elements have a minimum pickup of 1.05 xI_s, all (50) elements have a minimum pickup of 1.00 xI_s.

9.10 Negative Phase Sequence Over Current (46DTL, 46ITL)

The negative sequence current is measured from the phase inputs. Pure negative phase sequence current can be injected by swapping the phase relationship of two of the phase currents. This can be achieved by swapping over two leads or changing the set phase angle of two of the three currents.

The NPS current then equals the value of the phase current injected.

The pickup level and operate times can be recorded in Table 13.

10 Primary injection tests

Primary injection is recommended to prove the relay connections, CT polarity and settings before putting the protection scheme into service. To prove the connections of REF protection a primary injection must be done. The differential protection can also be proven using load current if a risk of trip is permitted and step 10.1 is then not necessary.

WARNING!

It is important before carrying out any primary injection to ensure appropriate CTs are shorted to avoid operation of mesh corner or busbar type unit protection. If the injected primary current is large enough, the bus zones protection may trip out unnecessarily!

10.1 Biased Differential Protection

Sufficient primary current to prove the connections and settings is required so that a minimum secondary current of about 10mA rms circulates in the relay inputs.

An external three-phase primary short is required on one side of the transformer, ideally the HV side. Apply 415 LVAC to the other side ensuring the primary current is injected through all of the biased differential CT's. The following procedure should be followed to check the a.c. scheme and settings are correct.

i Use Reydisp Evolution software to trigger a Waveform Record of the currents.
ii Retrieve the waveform record from the relay.
iii View the Waveform Record in Reydisp Evolution.
iv Check the W1 and W2 Relay Currents are in anti-phase by placing the cursors on the peak relay currents. Check each phase in turn.

If the current transformers associated with the protection are located in power transformer bushings it may not be possible to apply test connections between the current transformer and the power transformer windings. Primary injection is needed however to verify the secondary connection of a neutral CT relative to the phase CTs and the relay. In these circumstances primary current must be injected through the associated power transformer winding. It may be necessary to short-circuit another winding in order to allow sufficient current to flow.

If difficulty is experience due to physical restraints, the differential may be proven using load current.

10.2 Restricted Earth Fault

The CT polarities forming the Restricted Earth Fault (REF) protection must be proved, and the recommended way to achieve this is by primary injection. Inject single phase or three phase current from a suitable primary test set through earth and primary conductors. The results of these tests may be recorded in Table

During these primary injection tests the injected current may be limited due to the impedance of the neutral connection. Temporary shorts must be added to allow a definite result to be established. Place a temporary short across the setting resistor to allow the secondary current to be measured.

Insert the test block with necessary shorts across from CT to relay side. Inject primary current sufficient to allow measurement. Measure and record the REF spill current displayed by the appropriate relay Instrument. This spill current should be very small e.g. a few mA's.

Reverse the connections to the secondary winding of the neutral CT the spill current should become larger. Repeat for other phases if necessary.

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

The differential protection should be operated by secondary injection to check that correct tripping (or intertripping) and indication occurs.

Simulate the operation of each external contact that initiates a Duobias M status input. This can be done by temporarily shorting across the operating contact. In each case check the appropriate LED illuminates and that the correct tripping, intertripping and alarm initiation occurs.

Disconnect the d.c. power supply to the Duobias-M relay and check the correct PROTECTION UNHEALTHY alarm contact operates. If this alarm is wired to a remote indication point e.g. a control centre, the operation of the alarm at this point should also be checked.

Operate the differential protection and the REF protections in turn by primary or secondary injection and check that the correct tripping and indication occurs.

11 Tests using load currents

Re – insert all the d.c. fuse and links for all supply, trip and alarm functions.

Connect the laptop and check communications is established with the relay by downloading all settings. Ensure that the Duobias-M relay is set with the correct setting for the specific application of the relay. Select INSTRUMENTS MODE.

Under steady load conditions record in to Table 15 the readings displayed on the instruments. If the secondary connections and the matching of the differential protection to the transformer ratio and vector group connections are correct the readings "OPERATE A, B, C" should be negligible for all three phases.

Next unbalance the differential protection by 180° reversing a vector group compensation setting. e.g.

Yd1 would become yD7

Yy0 would become Yy6

Repeat the tests and record the currents inTable 15.

The operate currents "OPERATE A, B, C" should now be comparatively large.

Reset the vector group compensation setting back to the correct setting, re-check that the "OPERATE A, B, C" currents are negligible.

12 Putting into service

Ensure that: The trip supply is connected.

Press the CANCEL button several times on the front of the relay to move back to the top of the menu structure

Press the TEST/RESET pushbutton

None of the RED LEDs should be illuminated.

Check the Protection Healthy GREEN LED has continuous illumination.

Ensure that all earth links, trip links and inter-trip links are in their normal operational positions.

Operate the Cancel PUSH BUTTON

Replace the cover.

13 Site test sheet

See following pages

.

SITE TEST SHEET

CUSTOMER ______________________________

CUSTOMER CONTRACT NUMBER ______________________________

SIEMENS CONTRACT NUMBER ______________________________

SITE/CIRCUIT REF. ______________________________

RELAY SERIAL NUMBER ______________________________

RELAY MODEL **DUOBIAS-M-2______**

RELAY ARTICLE NUMBER ______________________________

Signatures and Date:

Test Engineer **Customers Representative**

……………………………….. ………………………………..

1 Site tests

1.1 Insulation Resistance

CIRCUIT TEST	FITTED	INSULATION RESISTANCE (MEGOHMS)
AN 1	√	
AN 2	√	
AN 3	□	
AN 4	□	
AN 5	□	
I/O 1	□	
I/O 2	□	
I/O 3	□	
PSU I/O	√	
PSU DC SUPPLY	√	

Table 1 - Insulation Resistance

1.2 Hardware Tests

1.2.1 Status Inputs

STATUS INPUT (MODULE)	TERMINAL NO.S		USAGE BY PROTECTION SCHEME	CHECKED
	+	-		
Status 1 (PSU)	21	23	□ *e.g. Buchholz*	□ OK
Status 2 (PSU)	25	27	□	□ OK
Status 3 (PSU)	26	28	□	□ OK
Status 4 (I/O 1)	1	3	□	□ OK
Status 5 (I/O 1)	5	7	□	□ OK
Status 6 (I/O 1)	9	11	□	□ OK
Status 7 (I/O 1)	13	15	□	□ OK
Status 8 (I/O 1)	17	21	□	□ OK
Status 9 (I/O 1)	19	21	□	□ OK
Status 10 (I/O 1)	23	27	□	□ OK
Status 11 (I/O 1)	25	27	□	□ OK
Status 12 (I/O 2)	1	3	□	□ OK
Status 13 (I/O 2)	5	7	□	□ OK
Status 14 (I/O 2)	9	11	□	□ OK
Status 15 (I/O 2)	13	15	□	□ OK
Status 16 (I/O 2)	17	21	□	□ OK
Status 17 (I/O 2)	19	21	□	□ OK
Status 18 (I/O 2)	23	27	□	□ OK
Status 19 (I/O 2)	25	27	□	□ OK
Status 20 (I/O 3)	1	3	□	□ OK
Status 21 (I/O 3)	5	7	□	□ OK
Status 22 (I/O 3)	9	11	□	□ OK
Status 23 (I/O 3)	13	15	□	□ OK
Status 24 (I/O 3)	17	21	□	□ OK
Status 25 (I/O 3)	19	21	□	□ OK
Status 26 (I/O 3)	23	27	□	□ OK
Status 27 (I/O 3)	25	27	□	□ OK

Table 2 - Status Inputs

1.2.2 Output Relays

OUTPUT RELAY(LOCATION)	TYPE	TERMINAL NO.	USED IN SCHEME	CHECKED
Relay 1(PSU)	C/O	4 (NO) 5 (COM) 6 (NC)	□ □ □	□ OK
Relay 2(PSU)	C/O	9 (NO) 8 (COM) 7 (NC)	□ □ □	□ OK
Relay 3(PSU)	C/O	10 (NO) 11 (COM) 12 (NC)	□ □ □	□ OK
Relay 4 (PSU)	N/O	17 –19	□	□ OK
Relay 5 (PSU)	N/O	18 – 20	□	□ OK
Relay 6 (I/O 1)	N/O	2-4	□	□ OK
Relay 7 (I/O 1)	N/O	6-8	□	□ OK
Relay 8 (I/O 1)	N/O	10-12	□	□ OK
Relay 9 (I/O 1)	N/O	14-16	□	□ OK
Relay 10 (I/O 1)	N/O	18-22	□	□ OK
Relay 11 (I/O 1)	N/O	20-22	□	□ OK
Relay 12 (I/O 1)	N/O	24-28	□	□ OK
Relay 13 (I/O 1)	N/O	26-28	□	□ OK
Relay 14 (I/O 2)	N/O	2-4	□	□ OK
Relay 15 (I/O 2)	N/O	6-8	□	□ OK
Relay 16 (I/O 2)	N/O	10-12	□	□ OK
Relay 17 (I/O 2)	N/O	14-16	□	□ OK
Relay 18 (I/O 2)	N/O	18-22	□	□ OK
Relay 19 (I/O 2)	N/O	20-22	□	□ OK
Relay 20 (I/O 2)	N/O	24-28	□	□ OK
Relay 21 (I/O 2)	N/O	26-28	□	□ OK
Relay 22 (I/O 3)	N/O	2-4	□	□ OK
Relay 23 (I/O 3)	N/O	6-8	□	□ OK
Relay 24 (I/O 3)	N/O	10-12	□	□ OK
Relay 25 (I/O 3)	N/O	14-16	□	□ OK
Relay 26 (I/O 3)	N/O	18-22	□	□ OK
Relay 27 (I/O 3)	N/O	20-22	□	□ OK
Relay 28 (I/O 3)	N/O	24-28	□	□ OK
Relay 29 (I/O 2)	N/O	26-28	□	□ OK

Table 3 - Output Relay Contacts

1.3 Secondary Injection

1.3.1 Accuracy of Measurement

TEST	AVAILABLE	APPLIED VALUE	RELAY INSTRUMENTS DISPLAY (±5%)
Winding 1 Line Currents	√	1.00 xI_n	(I_A, I_B, I_C)
Winding 2 Line Currents	√	1.00 xI_n	(I_A, I_B, I_C)
Winding 3 Line Currents	□	1.00 xI_n	(I_A, I_B, I_C)
Winding 4 Line Currents	□	1.00 xI_n	(I_A, I_B, I_C)
Winding 5 Line Currents	□	1.00 xI_n	(I_A, I_B, I_C)
W1 EF/REF	□	0.200 xI_n	
W2 EF/REF	□	0.200 xI_n	
W3 EF/REF	□	0.200 xI_n	
Voltage Input	□	1.00 xV_n	

Table 4 - Measurement Accuracy

1.3.2 Biased Differential Characteristics

87BD Initial Setting	87BD Bias Slope Setting	Bias Current (x I_N) Measured on Ammeter A1				
		0.00	1.00	1.50	2.00	2.50
		Operate Current Measured on Ammeter A2				
0.10	**0.10**	0.10	0.11	0.16	0.21	0.26
0.20	**0.20**	0.20	0.22	0.33	0.44	0.56
0.30	**0.30**	0.30	0.35	0.53	0.71	0.88
0.40	**0.40**	0.40	0.50	0.75	1.00	1.25
0.50	**0.50**	0.50	0.67	1.00	1.33	1.67
0.50	**0.60**	0.50	0.86	1.29	1.71	2.14
0.50	**0.70**	0.50	1.08	1.62	2.15	2.69
Selected Settings		**Test Results**				
		0.00	**1.00**	**1.50**	**2.00**	**2.50**
Phase A Pickup						
Phase B Pickup						
Phase C Pickup						

Table 5 - Biased Differential Characteristics

1.3.3 Inrush Inhibit Pickup

87 Inrush Setting (xI_D)	Actual Blocking Level (xI_D)

Table 6 - Inrush Inhibit

The tolerance for the Inrush Setting is ±10% of setting.

1.3.4 Differential Highset Pickup

Phase Setting (xI_N)	A Phase Pickup	B Phase Pickup	C Phase Pickup

Table 7 - Highset Differential Pickup

1.3.5 Restricted Earth Fault

Test	Fitted	Value/Setting	Measured / Pickup	Units
W1 REF Resistor	☐			ohms
W1 REF Current Setting				xIn
W1 Voltage Setting				volts
W2 REF Resistor	☐			ohms
W2 REF Current Setting				xIn
W2 Voltage Setting				volts
W3 REF Resistor	☐			ohms
W3 REF Current Setting				xIn
W3 Voltage Setting				volts

Table 8 - Restricted Earth Fault

1.3.6 Overfluxing

Test	Setting X (Volts)	Setting Y (Seconds)	Pickup X (Volts)	Pickup Y (Seconds)
X0, Y0				
X1, Y1				
X2, Y2				
X3, Y3				
X4 ,Y4				
X5, Y5				
X6, Y6				

Table 9 - Over Fluxing Inverse Curve 24IT

Test	Setting (Volts)	Actual Pickup (Volts)	Time Delay Setting (Seconds)
24DT-1			
24DT-2			

Table 10 - Over Fluxing Dual Definite Time 24DT

1.3.7 Thermal Overload

Pickup Setting (X In)	Actual Pickup (X In)	Calculated Time (Seconds)	Actual Operate Time (Seconds)

Table 11 - Thermal Overload

1.3.8 Backup Over current and Earth Fault

Element Ansi No. (E.G. 51N)	Pickup Setting	Actual Pickup	Calculated Operate Time (S) At Multiple Of Pu.		Actual Operate Time Delay (S)	Reset Time Applied	Reset Time Recorded
			(s)	(x PU)			

Table 12 - Backup Overcurrent and Earth Fault

1.3.9 Negative Phase Sequence Over current

Element Ansi No. (E.G. 46DTL)	Pickup Setting	Actual Pickup	Calculated Operate Time (S) At Multiple Of PU		Actual Operate Time Delay (S)	Reset Time Applied	Reset Time Recorded
			(s)	(x PU)			

Table 13 - Negative Phase Sequence Over current

1.4 Primary Injection / On Load Tests

1.4.1 Differential Protection

1.4.1.1 Line And Relay Magnitude Checks From Relay Instruments

INSTRUMENT	PRIMARY CURRENTS (kA)	SECONDARY CURRENTS (A) [BEFORE ICT]	ICT RELAY CURRENTS (xI_N) [AFTER ICT]
W1 Phase A			
W1 Phase B			
W1 Phase C			
W2 Phase A			
W2 Phase B			
W2 Phase C			

Table 14 - Primary Inject Magnitude Check

1.4.1.2 Operate and Restrain Magnitude Checks From Relay Instruments

INSTRUMENT	ACUAL SETTINGS	180° UNBALANCED SETTINGS
Operate Phase A		
Operate Phase B		
Operate Phase C		
Restrain Phase A		
Restrain Phase B		
Restrain Phase C		

Table 15 - Operate Currents Check

1.4.1.3 Phase Checks

PHASE DIFFERENCE OF WINDING ICT CURRENTS	ANTI PHASE CHECK
A Phase	☐ OK
B Phase	☐ OK
C Phase	☐ OK

Table 16 - Primary Injection Phase Difference Check

The Winding (W1,W2 etc) ICT Currents for each phase should be in anti-phase. For a two winding transformer the W1 ICT A phase current should be in anti-phase (180 degrees apart) with the W2 ICT A phase current. All phases should be checked to ensure wiring errors are not present.

1.4.2 Restricted Earth Fault

TEST	PRIMARY CURRENT INJECTED (A)	REF SECONDARY CURRENT (mA)	CHECK
W1 Neutral CT Normal Polarity			☐ OK (no spill current)
W1 Neutral CT Reversed			☐ OK (significant spill current)
W2 Neutral CT Normal Polarity			☐ OK (no significant spill current)
W2 Neutral Neutral CT Reverse			☐ OK (significant spill current)

Table 17 - REF Primary Injection Tests

1.5 Trip, Alarm and Indication Tests

TEST	ACTION	RESULT
Trip/Intertrip	Local and Remote CB Trip Operation Confirmed	□ OK
Remote Alarms	All external Alarms confirmed	□ OK
LED Indication for operation of external protection	All LED's correctly indicate for the operation of each device	□ OK
Protection Healthy Alarm	Local (and Remote) indication and alarm confirmed	□ OK

Table 18 - Trip, Alarm and Indication Test

1.6 Communication

TEST	ACTION	RESULT
Local Relay Port	Download Settings Confirmed	□ OK
Saved Settings File	Record the name of the As Installed Settings File(s) and storage location	
Remote Relay Access(if used)	Relay Access Confirmed	□ OK
Relay Password	Enter Password(NONE is entered if not used)	□ OK
Numeric Password Code	_ _ _ _ _ _ _ _ _ _ _ _	□ Record Password Code

Table 19 - Communication