7SG14 Duobias-M

Transformer Protection

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
R3 27/09/2006	CT requirements moved to application guide
R2 03/05/2005	Corrected third part bias equation.
R1 14/11/2002	Revision History Added. VT burden added

Software Revision History

Contents

1 Introduction

The following document defines the technical and performance specification of the Duobias-M-200 series of relays. Optional features are described in section 10. The relays employ a modular construction with all modules withdrawable from the front without having to disturb rear terminal wiring. Three case sizes are available E8, E12 and E16 dependent upon the number of inputs and outputs ordered. The relay utilises proven techniques with over fifty years of operational experience in transformer differential protections C21 Monobias, 2C21 & 4C21 Duobias and Duobias-M.

Performance Data to:

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

2 Technical Specification

2.1 Rated Current

1 Amp and 5 Amp current inputs are both available on the rear terminal blocks.

2.2 Rated Frequency

Two operating frequencies are available

Frequency: 50Hz or 60Hz

2.3 87 Biased Differential

The relay operates when:-

$$I_{operate} > I_{setting} \; and$$

$$I_{operate} > M \times I_{restrain} \; and$$

$$I_{operate} > \sqrt{\frac{(I_{restrain}{}^2 - K^2)}{2}} \; for \quad I_{restrain} > B$$

Where

M = bias slope

B = bias slope limit

$K^2 = B^2 - 2M^2B^2$

Two winding transformer

$$I_{operate} = \left|\vec{I}_1 + \vec{I}_2\right|$$

$$I_{restrain} = \frac{\left|\vec{I}_1\right| + \left|\vec{I}_2\right|}{2}$$

Three winding transformer

$$I_{operate} = \left|\vec{I}_1 + \vec{I}_2 + \vec{I}_3\right|$$

$$I_{restrain} = \frac{\left|\vec{I}_1\right| + \left|\vec{I}_2\right| + \left|\vec{I}_3\right|}{2}$$

Four winding transformer

$$I_{operate} = \left|\vec{I}_1 + \vec{I}_2 + \vec{I}_3 + \vec{I}_4\right|$$

$$I_{restrain} = \frac{\left|\vec{I}_1\right| + \left|\vec{I}_2\right| + \left|\vec{I}_3\right| + \left|\vec{I}_4\right|}{2}$$

Five winding transformer

$$I_{operate} = \left|\vec{I}_1 + \vec{I}_2 + \vec{I}_3 + \vec{I}_4 + \vec{I}_5\right|$$

$$I_{restrain} = \frac{\left|\vec{I}_1\right| + \left|\vec{I}_2\right| + \left|\vec{I}_3\right| + \left|\vec{I}_4\right| + \left|\vec{I}_5\right|}{2}$$

2.3.1 Stability

Under through fault conditions the protection will be stable with fault current equivalent to 50 x In and with tap change unbalance of 0% to 35% according to the differential bias slope setting in use.

2.3.2 CT Requirements

See application guide for details.

3 Indication

There are 16 red LEDs in the E8 case size. There are 32 red LEDs in the E12 and E16 case sizes. These are fully configurable to the user.

Adjacent to each column of LED's is a removable strip on which the LED function can be printed or written on to allow comprehensive fault indication. The strips are removed by opening the front fascia door, and are located at the top right hand side. It is possible to print the indicator strip in different languages other than English. The LCD provides further fault indication and can be used for programming the relay. All indications are stored in non-volatile memory without the use of an internal backup battery.

4 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.

5 Recording

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

Up to 5 waveform records each of 1-second duration may be stored within the relay. The 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.

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.

6 Communications

IEC 60870-5-103 communications is standard at no additional cost on most of Reyrolle's 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. 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. Up to 254 relays maybe connected to a Sigma network server to provide relay access over an Ethernet local area network (LAN).

7 IRIG-B Time Synchronisation

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

8 Output contacts

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

9 Status inputs

As with the indication and output contacts the status inputs are 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. These are added in-groups of eight up to a maximum of 27. A pickup timer is associated with each input. Also each input may be individually inverted where necessary.

10 Optional Features

10.1 87REF Restricted Earth Fault

High impedance restricted earth fault scheme using external stabilizing resistors. Function is insensitive to third harmonic currents.

10.2 50 Overcurrent, N-Derived Earth Fault, G-Measured Earth Fault

Basic instantaneous overcurrent element with following time delay. May be applied to phase currents, derived earth fault or measured earth fault currents. Some models allow this element to be applied to the sum of the currents from two sets of current transformers where overcurrent is required for a transformer winding but the current transformers are not ideally placed.

10.3 51 IDMTL Overcurrent, N-Derived Earth Fault, G-Measured Earth Fault

Inverse time overcurrent element. May be applied to phase currents, derived earth fault or measured earth fault currents. Some models allow this element to be applied to the sum of the currents from two sets of current transformers where overcurrent is required for a transformer winding but the current transformers are not ideally placed.

CHARACTERISTIC	RANGES
IEC IDMTL CURVES	Operate times are calculated from: $t = Tm \times \left[\frac{K}{\left[\frac{I}{I_s}\right]^{\alpha} - 1} \right]$ I = fault current I_s = current setting Tm = time multiplier NI: K = 0.14, □= 0.02 VI: K = 13.5, □ = 1.0 EI: K = 80.0, □ = 2.0 LTI: K = 120.0, □ = 1.0
Time Multiplier	0.025 to 1.600 Δ 0.025 sec
Reset	0.0 to 60.0 Δ 1.0 sec
ANSI IDMTL CURVES	Operate times are calculated from: $t = M \times \left[\frac{A}{\left[\frac{I}{I_s}\right]^{P} - 1} + B \right]$ I = fault current I_s = current setting M = time multiplier MI: A = 0.0515, B = 0.114, P = 0.02 VI: A = 19.61, B = 0.491, P = 2.0 EI: A = 28.2, B = 0.1217, P = 2.0
ANSI RESET CURVES	Operate times are calculated from: $t = M \times \left[\frac{R}{\left[\frac{I}{I_s}\right]^{2} - 1} \right]$ I = fault current I_s = current setting M = time multiplier MI: R = 4.85 VI: R = 21.6 EI: R = 29.1

10.4 49T Thermal Overload

CHARACTERISTIC	RANGES
THERMAL IEC 60255-8	Operate times are calculated from: $t = \tau \times \ln\left\{ \frac{I^2 - I_p^2}{I^2 - (K.I_n)^2} \right\}$ □ = thermal time constant I = measured current I_P = prior current I_n = current rating K = constant
K Factor	0.1 to 10.0 Δ 0.1 x In
□ Factor	1.0 to 1000.0 Δ 0.5 mins

10.5 27/59 Under/Over Voltage

Instantaneous element with following time delay. Some models have a single voltage input with an option for three phase voltage measurment. Upto 4 stages may be included, each of which can be set to over or under voltage operation. Each of which may be selectively blocked from operating by a separately set under voltage element to prevent operation when CB opens.

10.6 24DT Definite Time Overfluxing (V/f)

Instantaneous element with following time delay. Some models have a single voltage input with an option for three phase voltage measurment.

10.7 24IT Inverse Time Overfluxing (V/f)

Inverse time element specified using seven user defined points on a curve. Some models have a single voltage input with an option for three phase voltage measurement.

10.8 81 Under/Over Frequency

Instantaneous element with following time delay. Some models have upto 4 stages, each of which can be set to over or under frequency. Each of which may be selectively blocked from operating by a separately set under voltage element to prevent operation when CB opens.

11 Performance Specification

Throughout the performance specification accuracy statements are made at reference conditions. These reference conditions are as follows:

11.1 Accuracy Reference Conditions

GENERAL	IEC60255 PARTS 6, 6A & 13
Auxiliary Supply	Nominal
Frequency	50/60Hz
Ambient Temperature	20°C
Initial Setting	Any Setting
Bias Slope	Any Setting
High Set	Any Setting
Restricted Earth Fault	Any Setting
Magnetizing Inrush	Any Setting
Current Amplitude Correction	1.00
Vector Group Compensation	Yy0,0°

11.2 Accuracy

11.2.1 87 Biased Differential

INITIAL SETTING	± 5% OF SETTING OR ± 0.01 I_N
Bias Slope	± 10% of bias slope setting
Reset	□ 90% of I_s
Repeatability	± 2%
Transient Overreach	□ 5%

11.2.2 87HS Differential Highset

PICKUP	± 5% OF SETTING
Reset	□ 95% of I_s
Repeatability	± 2%
Transient Overreach	□5%

11.2.3 87REF Restricted Earth Fault

PICKUP	± 5% OF SETTING OR ± 0.01 I_N
Reset	□ 95% of I_s
Repeatability	± 2%
Transient Overreach	□5%

11.2.4 50 DTL Overcurrent

PICKUP	± 5% OF SETTING OR ± 0.01 I_N
Reset	□ 95% of I_s
Repeatability	± 2%
Operate Time	± 1% or ± 10ms

11.2.5 50N DTL Derived Earth Fault

PICKUP	± 5% OF SETTING OR ± 0.02 I_N
Reset	□ 95% of I_s
Repeatability	± 2%
Transient Overreach	□5%

11.2.6 50G DTL Measured Earth Fault

PICKUP	± 5% OF SETTING OR ± 0.01 I_N
Reset	□ 95% of I_s
Repeatability	± 2%
Transient Overreach	□5%

11.2.7 51 IDMTL Overcurrent

PICKUP	± 5% OF SETTING OR ± 0.01 I_N
Reset	□ 95% of I_s
Repeatability	± 2%
Transient Overreach	□ 5%

11.2.8 51N IDMTL Derived Earth Fault

PICKUP	± 5% OF SETTING OR ± 0.02 I_N
Reset	□ 95% of I_s
Repeatability	± 2%
Transient Overreach	□ 5%

11.2.9 51G IDMTL Measured Earth Fault

PICKUP	± 5% OF SETTING OR ± 0.01 I_N
Reset	□ 95% of I_s
Repeatability	± 2%
Transient Overreach	□ 5%

11.2.10 27/59 Under/Over Voltage

PICKUP	± 0.1% OF SETTING OR ± 0.1 V
Reset	□ 95% of I_s
Repeatability	± 2%
Transient Overreach	□ 5%

11.2.11 81 Under/Over Frequency

PICKUP	± 0.1% OF SETTING OR ± 0.010 HZ
Reset	□ 95% of I_s
Repeatability	± 2%
Transient Overreach	□ 5%

11.2.12 24DT Definite Time Overfluxing (V/f)

PICKUP	± 0.1% OF SETTING OR ± 0.01 V/F
Reset	□ 95% of I_s
Repeatability	± 2%
Transient Overreach	□ 5%

11.2.13 24IT Inverse Time Overfluxing (V/f)

PICKUP	± 0.1% OF SETTING OR ± 0.01 V/F
Reset	□ 95% of I_s
Repeatability	± 2%
Transient Overreach	□ 5%

11.2.14 49 Thermal Overload

PICKUP	± 5% OF SETTING OR ± 0.01 I_N
Reset	□ 95% of I_s
Repeatability	± 2%
Transient Overreach	□ 5%

11.3 Accuracy General

DISENGAGING TIME	30MS

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

11.4 Accuracy Influencing Factors

Temperature

AMBIENT RANGE	-10°C TO +55°C
Variation over range	≤ 5%

Frequency

RANGE	47HZ TO 52HZ 57HZ TO 62HZ
Setting variation	≤ 5%
Operating time variation	≤ 5%

11.5 Operate Times

11.5.1 87 Biased Differential

CURRENT APPLIED	TYPICAL
3 x setting	1.5 cycles

11.5.2 87HS Differential Highset

CURRENT APPLIED	TYPICAL
2 x setting	1 cycle
4 x setting	≤ 1 cycle

11.5.3 87REF Restricted Earth Fault

CURRENT APPLIED	TYPICAL
2 x setting	1 cycle
4 x setting	≤ 1 cycle

11.5.4 50 DTL Overcurrent

CURRENT APPLIED	TYPICAL
2 x setting	1.5 cycles
4 x setting	1 cycle

11.5.5 50N DTL Derived Earth Fault

CURRENT APPLIED	TYPICAL
2 x setting	1.5 cycles
4 x setting	1 cycle

11.5.6 50G DTL Measured Earth Fault

CURRENT APPLIED	TYPICAL
2 x setting	1.5 cycles
4 x setting	1 cycle

11.6 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

11.7 Burdens

A.C. Burden

CURRENT 1A I/P	□ 0.1 VA
Current 5A I/P	□ 0.3 VA
Voltage I/P	□ 0.01 VA

NB. Burdens are measured at nominal rating.

D.C. Burden

QUIESCENT (TYPICAL)	15
Max	27

12 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

13 Auxiliary Energising Quantity

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

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

Status Inputs

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 1MA 220V 2MA
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 associated timers that can be programmed to give time-delayed pick-up and time delayed drop-off. 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.

14 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