MSCDN – MP1

Capacitor unbalance protection

Document Release History

This document is issue 2011/10. The list of revisions up to and including this issue is:
Pre release

2011/10	References to 60Hz removed
2010/02	Document reformat due to rebrand
28/04/2005	R9 CT-X and 87/50 elements unified to 87/50-X-X Auxiliary Timer Accuracy added. 87/50-x-x 2X operating time corrected.
12/10/2004	R9 AC Voltage Input ratings added VT Supervision function added Status input minimum operate current corrected Corrected operating time variation over frequency
28/02/2003	R8 IDMTL picks up at 105% of setting. Three DTL elements are now available for Capacitor Unbalance
18/02/2003	R7 IDMTL O/C & E/F minimum operate time corrected
14/02/2003	R6 Operate time claims added for O/C and O/V elements
13/02/2003	R5 Removed incorrect references to drop-off timers on the status inputs.
10/02/2003	R4 All MP1 DO changed to ≥ 80% Cx Unbalance Accuracy changed to ± 5% of setting or ± 0.01 I_n
21/01/2003	R3 Corrected element names Added 59DT element
27/11/2002	R2 Resistor thermal overload characteristics added Resistor open circuit characteristics added
24/10/2002	R1 Revision History Added.

Software Revision History

05/05/2005	2621H80001R9a	

Contents

1 Introduction

The following document defines the technical and performance specification of the MSCDN Series relays. MSCDN relays are based upon the Siemens Modular II series of protection units.

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

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

Performance Data to:
IEC60255-6, IEC60255-6A and IEC60255-13.

Note:
Where performance is described as “X or Y”, then performance is “whichever is greater”, unless specified.

2 Accuracy Reference Conditions

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

3 Modular Ii Specification

3.1 Environmental Withstand

Temperature - IEC 60068-2-1/2

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

Humidity - IEC 60068-2-3

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

Transient Overvoltage –IEC 60255-5

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

Insulation - IEC 60255-5

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

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

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

Electrostatic Discharge - IEC 60255-22-2 Class IV

	Variation
8kV contact discharge	≤ 5%

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

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

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

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

Radiated Immunity - IEC60255-22-3 Class III

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

Fast Transient – IEC 60255-22-4 Class IV

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

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

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

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

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

Shock and Bump–IEC 60255-21-2 Class 1

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

Seismic – IEC 60255-21-3 Class 1

		Variation
Seismic Response	1gn	≤ 5%

Mechanical Classification

Durability	In excess of 10^6 operations

Auxiliary Energizing Quantity
DC Power Supply

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

Auxiliary DC Supply – IEC 60255-11

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

D.C. Burden

Quiescent (Typical)	15 Watts
Max	27 Watts

3.2 A.C Current Inputs

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

3.2.1 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

3.2.2 A.C. Burden

A.C. Burden

1A tap	≤0.1 VA
5A tap	≤0.3 VA

NB. Burdens are measured at nominal rating.

3.3 A.C Voltage Inputs

Thermal Withstand
Continuous Overload

AC Voltage	320Vrms (452Vpk)

3.3.1 A.C. Burden

A.C. Burden

110Vrms	≤0.05 VA
63.5Vrms	≤0.01 VA

3.4 Rated Frequency

Frequency: 50Hz

Frequency

Range	47Hz to 52Hz
Setting variation	≤ 5%
Operating time variation	≤ 5% or 5ms

3.5 Accuracy Influencing Factors

Temperature

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

3.6 Output Contacts

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

3.6.1 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

3.7 Status inputs

Status Inputs functionality is fully programmable. The basic I/O module has 3 status inputs, additional modules can be added to provide more inputs, these inputs are added in-groups of eight up to a maximum of 27.

A pickup timer is associated with each input and each input may be individually inverted where necessary. The pickup timer may be used to provide rejection at power system frequency.

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.

3.7.1 Status Input Performance

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

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

Status Input External Dropper Resistances

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

3.7.2 Status Input PU Timer

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

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

Accuracy

Timing	< ±1% or ±10ms

3.8 Auxiliary Timer Accuracy

Auxiliary Timers are those timers created in Reylogic, whose delay settings appear in the REYLOGIC ELEMENTS MENU

Accuracy

Setting	
0 ms	Instantaneous
> 0 ms	< +1% or +10ms

3.9 Indication

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

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

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

3.10 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.

3.11 Recording

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

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

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

3.12 Communications

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

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

All fibre optic ports can be star connected to a Sigma passive hub or simply daisy-chained in a loop-in loop-out configuration with other Reyrolle relays e.g. Argus, Delta, Ohmega, Tau. Up to 254 relays maybe connected to a Sigma network server to provide relay access over an Ethernet local area network (LAN).

3.13 Irig-B Time Synchronisation

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

4 Protection Elements

4.1 Common Performance

Disengaging Time

Disengaging Time	30ms

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

4.2 87/50-x-x Overall Differential

Phase segregated High impedance Overall Differential scheme using external stabilizing resistors. Function is insensitive to third harmonic currents. Each element with individual Inhibit DO Delay timer (Auxiliary Timer) and following time delay.

Accuracy

Pickup	100% of setting ± 5% or ± 0.01 I_n
Reset	≥ 80% of I_s
Repeatability	± 2%
Transient Overreach	≤5%
Operate Time	± 1% or ± 10ms

Operating Time

Current Applied	Typical
2 x setting	≤ 1.5 cycle
4 x setting	≤ 1 cycle

4.3 C1/2 50-x Capacitor Unbalance

Phase segregated Capacitor Unbalance element, whose operate quantity is calculated from the ratio of capacitor load current and the measured spill current, followed by three identical instantaneous Overcurrent elements with following time delay

Accuracy

Pickup	100% of setting ± 5% or ± 0.02 I_n
Reset	≥ 80% of I_s
Repeatability	± 2%
Operate Time	± 1% or ± 10ms

Operating Time

Current Applied	Typical
2 x setting	1.5 cycles
4 x setting	1 cycle

4.4 50N Cap Bank Phase Unbalance

Derived phase unbalance quantity, from the sum of phase currents, applied to an instantaneous overcurrent element with following time delay.

Accuracy

Pickup	100% of setting ± 5% or ± 0.01 I_n
Reset	≥ 80% of I_s
Repeatability	± 2%
Operate Time	± 1% or ± 10ms

Operating Time

Current Applied	Typical
2 x setting	1.5 cycles
4 x setting	1 cycle

4.5 R1/2 49 Resistor Thermal Overload

Thermal overload element applied to each phase of each resistor independently.

Accuracy

Pickup	100% of setting ± 5% or ± 0.02 I_n
Reset	≥ 95% of I_s
Repeatability	± 2%
Operate Time	± 5% or ± 0.1s
Frequency Range	1st, 2nd …15th Harmonic

Operating Time

Characteristic	**Ranges**
THERMAL IEC 60255-8	Operate times are calculated from: $t = \tau \times \ln\left\{\frac{I^2 - I_P^2}{I^2 - (k \times I_B)^2}\right\}$ τ = thermal time constant I = measured current I_P = prior current I_B = basic current k = constant
□ Factor	1 to 10000 Δ 0.5 seconds

4.6 50 Resistor Open Circuit

An instantaneous/delayed overcurrent element measures the difference in currents on each resistor on a phase-by-phase basis.

Accuracy

Pickup	100% of setting ± 5% or ± 0.02 I_n
Reset	≥ 95% of I_s
Repeatability	± 2%
Operate Time	± 1% or ± 10ms

Operating Time

Current Applied	Typical
2 x setting	2 cycles
4 x setting	1.5 cycle

4.7 49 Reactor Thermal Overload

Thermal overload element applied to each phase of the reactor independently.

Accuracy

Pickup	100% of setting ± 5% or ± 0.02 I_n
Reset	≥ 95% of I_s
Repeatability	± 2%
Operate Time	± 5%
Frequency Range	1st, 2nd …15th Harmonic

Operating Time

Characteristic	**Ranges**
THERMAL IEC 60255-8	Operate times are calculated from: $t = \tau \times \ln\left\{\frac{I^2 - I_P^2}{I^2 - (k \times I_B)^2}\right\}$ τ = thermal time constant I = measured current I_P = prior current I_B = basic current k = constant
□ Factor	1 to 1000 Δ 0.5 minutes

4.8 50 Backup Overcurrent

Three phase definite time overcurrent element.

Accuracy

Pickup	100% of setting ± 5% or ± 0.02 I_n
Reset	≥ 95% of I_s
Repeatability	± 2%
Operate Time	± 1% or ± 10ms
Frequency Range	1st, 2nd …15th Harmonic

Operating Time

Current Applied	Typical
2 x setting	2 cycles
4 x setting	1.5 cycle

4.9 50N Backup Earth Fault

Definite time derived earth fault element.

Accuracy

Pickup	100% of setting ± 5% or ± 0.02 I_n
Reset	≥ 95% of I_s
Repeatability	± 2%
Operate Time	± 1% or ± 10ms
Frequency Range	1st, 2nd …15th Harmonic

Operating Time

Current Applied	Typical
2 x setting	2 cycles
4 x setting	1.5 cycle

4.10 51 Backup Overcurrent,

Three phase inverse time overcurrent element.

Accuracy

Pickup	105% of setting ± 5% or ± 0.02 I_n
Reset	≥ 95% of I_s
Repeatability	± 2%
Operate Time	± 5% or ± 40ms
Frequency Range	1st, 2nd …15th Harmonic

Operating Time

Characteristic	Ranges
IEC IDMTL CURVES	Operate times are calculated from: $t = Tm \times \left[\frac{K}{\left[\frac{I}{Is}\right]^{\alpha} - 1} \right]$ I = fault current Is = current setting Tm = time multiplier NI: K = 0.14, α = 0.02 VI: K = 13.5, α = 1.0 EI: K = 80.0, α = 2.0 LTI: K = 120.0, α = 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: $t = M \times \left[\frac{A}{\left[\frac{I}{Is}\right]^{P} - 1} + B \right]$ I = fault current Is = 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: $t = M \times \left[\frac{R}{\left[\frac{I}{Is}\right]^{2} - 1} \right]$ I = fault current Is = current setting M = time multiplier MI: R = 4.85 VI: R = 21.6 EI: R = 29.1

4.11 51N Derived Earth Fault

Inverse time derived earth fault element.

Accuracy

Pickup	105% of setting ± 5% or ± 0.02 I_n
Reset	≥ 95% of I_s
Repeatability	± 2%
Operate Time	± 5% or ± 40ms
Frequency Range	1st, 2nd …15th Harmonic

Operating Time

Characteristic	Ranges
IEC IDMTL CURVES	Operate times are calculated from: $t = Tm \times \left[\frac{K}{\left[\frac{I}{Is}\right]^{\alpha} - 1} \right]$ I = fault current Is = current setting Tm = time multiplier NI: K = 0.14, α= 0.02 VI: K = 13.5, α = 1.0 EI: K = 80.0, α = 2.0 LTI: K = 120.0, α = 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: $t = M \times \left[\frac{A}{\left[\frac{I}{Is}\right]^{P} - 1} + B \right]$ I = fault current Is = 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: $t = M \times \left[\frac{R}{\left[\frac{I}{Is}\right]^{2} - 1} \right]$ I = fault current Is = current setting M = time multiplier MI: R = 4.85 VI: R = 21.6 EI: R = 29.1

4.12 27 Undervoltage

Single phase definite time undervoltage element. An under voltage guard element may be used to block this elements operation.

Accuracy

Pickup	100% of setting ± 0.1% or ± 0.1 V
Reset	≤ 100.5% of V_s (Adjustable)
Repeatability	± 0.1%
Operate Time	± 1% or ± 20ms
Frequency Range	1st, 2nd …15th Harmonic

Operating Time

Operate Time	< 3 cycles

4.13 59DT Definite Time Overvoltage

Three phase definite time overvoltage element

Accuracy

Pickup	100% of setting ± 0.1% or ± 0.1 V
Reset	≥ 99.5% of V_s
Repeatability	± 0.1%
Frequency Range	1st, 2nd …15th Harmonic

Operating Time

Operate Time	< 4 cycles

4.14 59IT Inverse Time Overvoltage

Three phase inverse time overvoltage element specified using seven user defined points on a curve.

Accuracy

Pickup	± 0.1% of setting or ± 0.1 V
Reset	≥ 99.5% of V_s
Repeatability	± 0.1%
Operate Time	± 5% or ± 0.1s
Frequency Range	1^{st}, 2^{nd} …15^{th} Harmonic

Operating Time

Characteristic	**Ranges**
CURVE	7 Point user defined inverse curve X_0, Y_0 : X_6, Y_6 X_i:=1.00xVn … 2.00xVn Y_i:=0.1 … 20000s

4.15 VT Supervision

The VT supervision element operates when the 27 VTS and the 50 VTS element operate to indicate that the capacitor bank is energised but rated voltage has not been applied to the relay on a phase by phase basis.

4.15.1 27 VTS Undervoltage

Three phase definite time undervoltage element

Accuracy

Pickup	100% of setting ± 0.1% or ± 0.1 V
Reset	≥ 99.5% of V_s
Repeatability	± 0.1%

Operating Time

Operate Time	< 4 cycles

4.15.2 50 VTS Current Check

Three phase definite time overcurrent check element

Accuracy

Pickup	100% of setting ± 5% or ± 0.02 I_n
Reset	≥ 95% of I_s
Repeatability	± 2%
Operate Time	± 1% or ± 10ms

Operating Time

Current Applied	Typical
2 x setting	2 cycles
4 x setting	1.5 cycle