7SG17 Rho 3

Multifunction Protection Relays

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

Software Revision History

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1 GENERAL

Performance data to:
IEC60255-3 and IEC60255-8.

2 CHARACTERISTIC ENERGIZING

QUANTITY

AC Current In	1A/5A
Frequency	50/60Hz

3 AUXILIARY ENERGIZING QUANTITY

3.1 DC power supply

Nominal Operating range

	Nominal voltage	Operating range
VAUX	24,30,48V	18V to 60V dc
	110,220V	88V to 280V dc

3.2 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	175V to 280V

NB Status operating voltage need not be the same as the main energising voltage. For 110/125 volt or 220/250 volt working, a standard Rho 3 relay with 48/54 volt status will be supplied for use with external dropper resistors as follows:-

Status input external resistances

Nominal voltage	Resistor value; wattage
110/125V	2k7 ± 5% ; 2.5W
220/250V	8k2 ± 5% ; 6.0W

Status input performance

Minimum DC current for operation	10mA
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

Each status input has associated timers which can be programmed to give time delayed pick-up and time delayed drop-off. The drop-off timers have default settings of 20ms, thus providing immunity to an AC input signal. Status inputs will not respond to the following:

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

The status inputs perform according to the requirements of ESI48-4 ESI 1.

Note that alternative status inputs can be ordered, which can be driven directly from 110V or 220V, without a dropper resistor. These special low current types will operate with input currents of less than 10mA.

4 CHARACTERISTICS

4.1 Thermal protection settings

Thermal setting I_θ	0.50 to 2.00 xIn Δ 0.05xIn
NPS weighting factor 'K'	0.0 to 10.0 Δ 0.1
Heating constant τ_h	0.5 to100.0 mins Δ 0.5 min
Starting constant τ_s	0.50 to 1.50 x τ_h Δ 0.05
Cooling constant τ_c	1 to 100 x τ_h Δ 1
Hot/cold ratio	OFF, 5 to 100% Δ 5%
Thermal capacity alarm	OFF, 50 to 100% Δ 1%
Load Increase alarm	OFF, 0.5 to 1.0 x I_θ Δ 0.05 xI_θ
Thermal restart inhibit	20 to 100% Δ 1%
Operate time (cold), mins see figure 1.	$t = \tau.Ln\frac{I_{eq}^2}{I_{eq}^2 - (I_\theta)^2}$
Operate time (hot) for prior current I_p, mins	$t = \tau.Ln\frac{I_{eq}^2 - \left(I - H/C\right)I_p^2}{I_{eq}^2 - (I_\theta)^2}$
Motor start current I_{START}	1.5 to 4.0 xI_θ Δ 0.1 x I_θ
Motor stop current I_{STOP}	0.05 to 0.20 xI_θ Δ 0.05 I_θ
Stall withstand delay 1 t_{s1}	OFF, 1 to 250sec Δ 1sec
Stall withstand delay 2 t_{s2}	OFF, 1 to 250sec Δ 1sec
CB fail delay 1	OFF, 1 to 20sec Δ 0.01sec
CB fail delay 2	OFF, 1 to 20sec Δ 0.01sec

Note 1: the thermal algorithm operates on an equivalent thermal current, I_{eq}, which is a combination of the positive and negative phase sequence components, I_1 and I_2:

$$I_{eq} = \sqrt{I_1^2 + K.I_2^2}$$

Note 2: the thermal alogorithm operates using one of ( ) three time constants (τ_h, τ_s or τ_c), chosen according to the magnitude of Ieq as follows:

If $I_{eq} < I_{STOP}$ then $\tau = \tau_c$ (cooling condition)

If $I_{STOP} \le I_{eq} < I_{START}$ then $\tau = \tau_h$ (running condition)

If $I_{eq} \ge I_{START}$ then $\tau = \tau_S$ (starting condition).

Note 3: While the Hot/Cold ratio setting is entered as a percentage value, the factor H/C which appears in the equation for the Operate Time (Hot Curve) is actually a per-unit value.

Figure 1 and Figure 2 illustrate examples of cold and hot curves.

4.2 Over/undercurrent settings

P/F alarm I_{HA}	OFF, 0.5 to 20xIn Δ 0.1xIn
P/F alarm delay tHA	0.0 to 1.0sec Δ 0.01sec 1.0 to 30.0sec Δ 0.1sec
P/F trip I_{HS}	OFF, 0.5 to 20xIn Δ 0.1xIn
P/F trip delay t_{HS}	0.0 to 1.0sec Δ 0.01sec 1.0 to 30.0sec Δ 0.1sec
E/F alarm I_{EA}	OFF, 0.005 to 1.000xIn Δ 0.005xIn
E/F alarm delay t_{EA}	0.0 to 1.0sec Δ 0.01sec 1.0 to 30.0sec Δ 0.1sec
E/F trip I_{EF}	OFF, 0.005 to 1.000xIn Δ 0.005xIn
E/F trip delay t_{EF}	0.0 to 1.0sec Δ 0.01sec 1.0 to 30.0sec Δ 0.1sec

E/F inhibit I_{EI}	OFF, 4.0 to 10.0xIn Δ 0.1xIn
U/C alarm I_{UA}	OFF, 0.10 to 1.50xIn Δ 0.05xIn
U/C alarm delay t_{UA}	0.2 to 30.0sec Δ 0.1sec
U/C trip I_{UC}	OFF, 0.10 to1.50xIn Δ 0.05xIn
U/C trip delay t_{UC}	0.2 to 30.0sec Δ 0.1sec

4.3 Phase unbalance settings

Phase difference $I_\Delta = I_{MAX} - I_{MIN}$)	0.10 to 0.40xI_θ Δ 0.05xI_θ
Negative seq. I_2	0.10 to 0.40xI_θ Δ 0.05xI_θ
Time multiplier	0.025 to 2.000x I_θ Δ0.025xI_θ
Min. Op. Time	0.1 to 2.0 sec Δ 0.1sec
Operate time - Phase difference, secs	$t = \frac{1}{\left(I_\Delta / I_\theta\right)^2} x t_m$
Operate time - Negative sequence, secs	$t = \frac{1}{\left(I_2 / I_\theta\right)^2} x t_m$

4.4 Number of starts protection

Max. starts	OFF, 1 to 20 Δ 1
Max. starts period	1 to 60 mins Δ 1 min
Start inhibit delay	1 to 60 mins Δ 1 min
Min. time between starts	OFF, 1 to 60 mins Δ 1 min

4.5 Temperature Inputs

Input Type	**Range for alarm and trip**
RTD (100Ω Pt, 100Ω Ni, 120Ω Ni, 10Ω Cu)	0 – 250^{0}C Δ 1^0
Other RTD	100 – 350Ω Δ 1 Ω
Thermistor (PTC, NTC)	100 - 1000 Ω Δ 10Ω 1100 - 30000Ω Δ 100 Ω

5 Accuracy Reference Conditions

General	IEC60255-3 IEC60255-8
Auxiliary Supply	Nominal
Frequency	50/60Hz
Ambient temperature	20^{0}C

5.1 Accuracy

Current Settings		
Thermal, stall, unbalance and phase fault overcurrent protections	Operate	± 5%
	Reset	≥ 95% of operating current
Earth fault protection	Operate	± 5% or ± 1mA
	Reset	≥ 95% of operating current (1mA)
Undercurrent protection	Operate	± 5%
	Reset	≥ 105% of operating current
All settings	Repeatability	± 1%

Time Settings		
Thermal protection	Accuracy	± 5% or ± 100ms
	Repeatability	± 100ms
Unbalance protection	Accuracy	± 5% or ± 50ms
	Repeatability	± 50ms
Independent times - ie phase fault, earth fault, undercurrent and stall protections	Accuracy	± 1% or ± 30ms
	Repeatability	± 1%

Note:

1. Where unbalance protection is configured in NPS mode, the claim assumes a period of balanced 3 phase operation prior to the unbalance occurring. In the case of the relay being switched onto an unbalanced system 'from cold', then an additional 100ms may be required for the NPS algorithm to stabilise.
2. It is advised that the unbalance protection should not be configured in phase differnence mode when operating on 60Hz systems.

Temperature protection	
RTD (100Ω Pt, 100Ω Ni, 120Ω Ni)	± 2^0C
RTD (10 Ω Cu)	± 5^0C
Other RTD	± 1Ω
Thermistor (PTC, NTC)	± 5%

5.2 Accuracy general

Transient overreach of phase fault protection for X/R = 100	≤ -5%
Disengaging time	< 42ms
Overshoot time	< 40ms

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

5.3 Accuracy influencing factors

Temperature

Ambient range	-10^0C to +55^0C
Variation over range	≤ 5%

Frequency

Range	47Hz to 52Hz 57Hz to 62Hz
Setting variation	≤ 5%
Operating time variation	≤ 5%

Harmonic content

Harmonic content of waveforms	Frequencies to 550Hz
Operating time variation	≤ 5%

High frequency disturbance – IEC60255-22-1 Class III

	Variation
2.5kV common (longitudinal) mode	≤ 3%
1.0kV series (transverse) mode	≤ 3%

Electrostatic frequency interference – IEC60255-22-2 Class III

	Variation
8kV common discharge	≤ 5%

Radio frequency interference – IEC60255-22-3 Class III

	Variation
20MHz to 1000MHz, 10 V/m	≤ 5%

Fast transient – IEC60255-22-4 Class IV

	Variation
4kV 5/50ns 2.5Hz repetitive	≤ 3%

Vibration (sinusoidal) – IEC60255-21-1 Class I

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

Shock and bump – IEC60255-21-2 Class I

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

Seismic – IEC60255-21-3 Class I

		Variation
Seismic response	1gn	≤ 5%

Mechanical Classification

Durability	In excess of 10^6 operations

Auxiliary DC Supply – IEC60255-11

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

6. Thermal Withstand

Continuous and limited period overload

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

Short term overload

5A Phase / earth	400A for 1 sec
	282A for 2 sec
	230A for 3 sec
	2500A for 1 cycle
1A Phase / Earth	100A for 1 sec

	70.7A for 2 sec
	57.7A for 3 sec
	700A for 1 cycle

7. Burdens

	AC burden	**Impedance**
5A Phase	≤ 0.2VA	≤ 0.01Ω
1A Phase	≤ 0.05VA	≤ 0.05VA
5A Earth	≤ 0.4VA	≤ 0.02VA
1A Earth	≤ 0.2VA	≤ 0.2VA

NB: Burdens and impedances are measured at nominal current rating

	DC burden
Quiescent (typical)	3 Watts
Max	10 Watts

8. Output Contact Performance

Contact rating to IEC60255-0-2

Carry continuously 5A ac of 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 ≤ 40ms 50W @ L/R ≤ 10ms

9. Environmental Withstand

Temperature – IEC6068-2-1/2

Operating range	-10^0C to $+55^0$C
Storage range	-25^0C to $+70^0$C

Humidity – IEC6068-2-3

Operational test	56 days at 40^0C and 95% RH

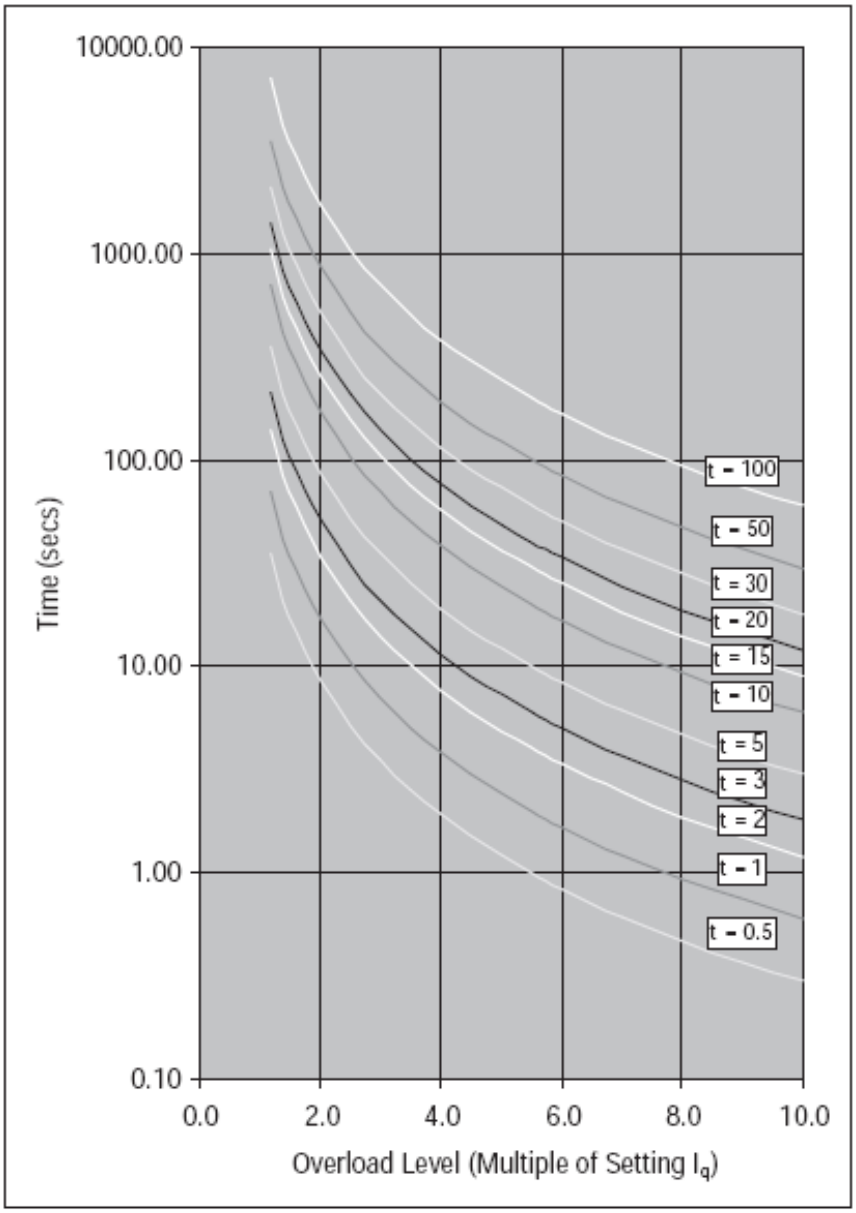
Transient overvoltage

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

Insulation – IEC60255-5

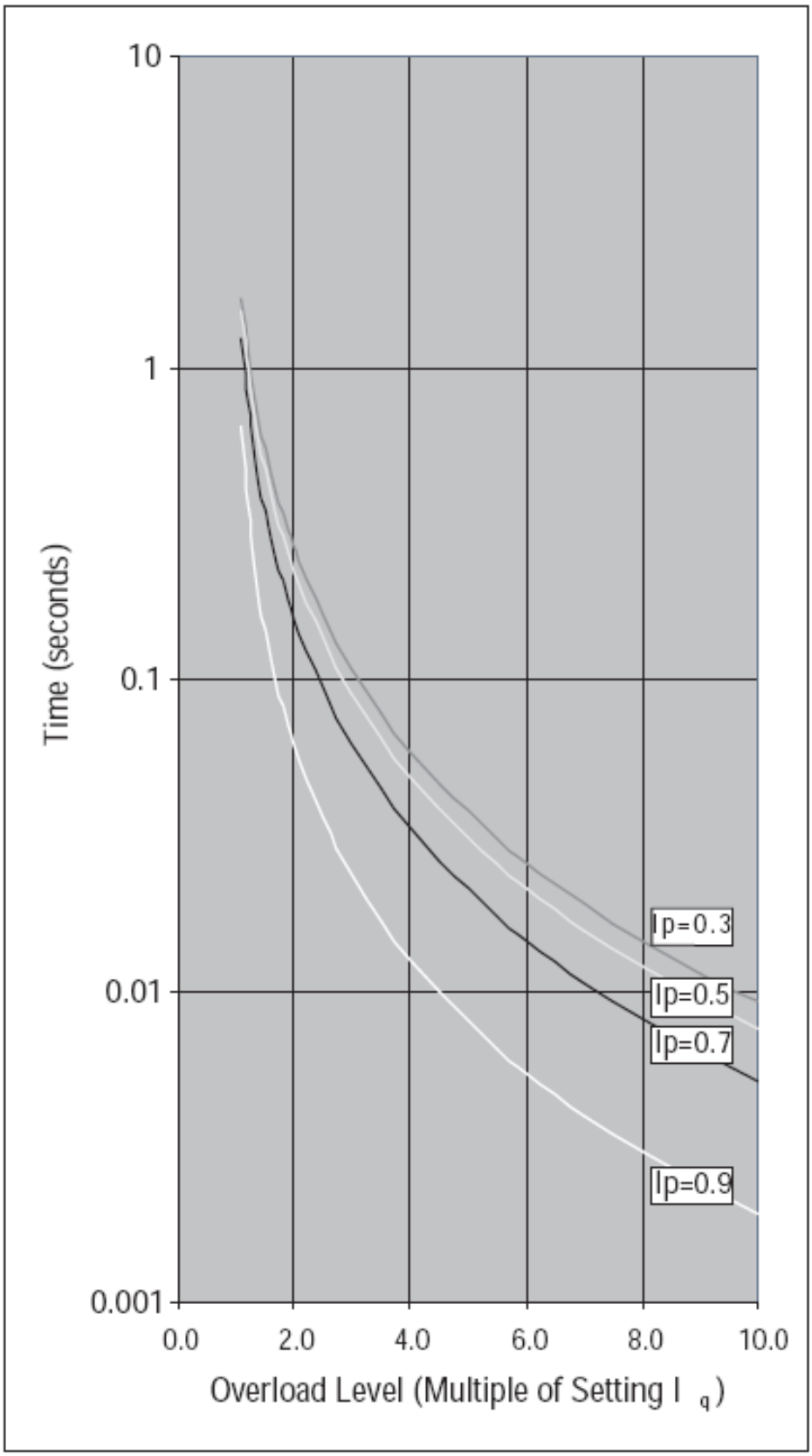
Between all terminals and earth	2.0kV ms for 1 min
Between independent circuits	2.0kV ms for 1 min
Across normally open contacts	1.0kV ms for 1 min

Current (multiples of setting)	Operate time t for various time constraints (seconds)										
	0.5 (mins)	1 (mins)	2 (mins)	3 (mins)	5 (mins)	10 (mins)	15 (mins)	20 (mins)	30 (mins)	50 (mins)	100 (mins)
1.2	35.57	71.14	142.27	213.41	355.69	711.37	1067.06	1422.75	2134.12	3556.87	7113.74
1.5	17.63	35.27	70.53	105.80	176.34	352.67	529.01	705.34	1058.02	176..36	3526.72
2.0	8.63	17.26	34.52	51.78	86.30	172.61	258.91	345.22	517.83	863.05	1726.09
2.5	5.23	10.46	20.92	31.38	52.31	104.61	156.92	209.22	313.84	523.06	1046.12
3.0	3.53	7.07	14.13	21.20	35.33	70.67	106.00	141.34	212.01	353.35	706.70
3.5	2.55	5.11	10.22	15.33	25.55	51.09	76.64	102.19	153.28	255.47	510.95
4.0	1.94	3.87	7.74	11.62	19.36	38.72	58.08	77.45	116.17	193.62	387.23
4.5	1.52	3.04	6.08	9.12	15.19	30.39	45.58	60.77	91.16	151.93	303.86
5.0	1.22	2.45	4.90	7.35	12.25	24.49	36.74	48.99	73.48	122.47	244.93
5.5	1.01	2.02	4.03	6.05	10.08	20.17	30.25	40.34	60.51	100.85	201.70
6.0	0.85	1.69	3.38	5.07	8.45	16.90	25.35	33.81	50.71	84.51	169.03
7.0	0.62	1.24	2.47	3.71	6.19	12.37	18.56	24.74	37.11	67.86	123.72
8.0	0.47	0.94	1.89	2.83	4.72	9.45	14.17	18.90	28.35	47.25	94.49
9.0	0.37	0.75	1.49	2.24	3.73	7.45	11.18	14.91	22.36	37.27	74.54
10.0	0.30	0.60	1.21	1.81	3.02	6.03	9.05	12.06	18.09	30.15	60.30



Figue 1 IEC60255-8 cold curve operate times for varying time constants

NB. operate times are in seconds, time constants are set in minutes



Figue 2 IEC60255-8 hot curves for varying levels of prior load current
NB. operate times are in seconds, time constants are set in minutes