7SG18 Solkor N

Numeric Differential 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

Software Revision History

Contents

Table of Figures

1 General

The relay complies with the relevant clauses in the following specifications: -

- IEC 60255 – 3
- IEC 60255 – 13

Note: References to Is refer to the current setting for the characteristic being discussed.

2 Characteristic Energizing Quantity

Rated Current (In)	1A / 5A

Rated Frequency (f_N)	Operating Range
50 Hz	47Hz to 52Hz

3 Auxiliary Energizing Quantity

3.1 DC Power Supply

Nominal Voltage (V_{aux})	Operating Range
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

Note: the status voltage need not be the same as the power supply voltage. For 110/125V or 220/250V working, use a standard 48/54V status input with a dropper resistor as follows: -

3.3 Status Input External Resistances

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

Optional versions of status input are available for direct connection of 110V and 220V dc. These do not comply with ESI 48-4 and will operate with a DC current of less than 10mA (see Section 5.6)

4 Accuracy Reference Conditions

General	IEC 60255 –3 IEC 60255 –13
Current input for IDMTL	2x to 30x Is
Current input for DTL	5x Is
Auxiliary Supply	Nominal
Frequency	50.0 Hz
Ambient Temperature	20°C

5 Accuracy & Performance

Accuracy in this section is specified at reference conditions.

5.1 Differential Element

The Magnitude and Angle of the currents are compared in separate comparators. Typical operating threshold characteristics are shown in Figure 1 and

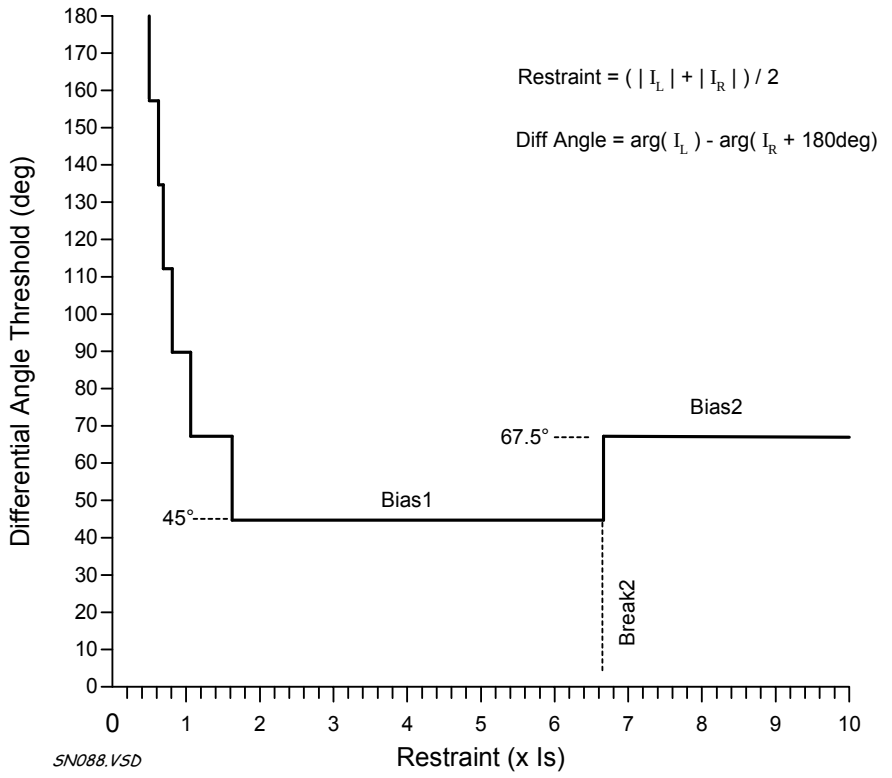

Figure 2. The error limits on these are as follows:

Operate levels	
Differential Magnitude - Initial Threshold	±10% or ±10mA
Differential Magnitude - Biased Threshold (At low levels)	Biased threshold ±(10% of Restraint) or ±10mA For Restraint <1.6Is +ve limit:- Biased threshold +10% or +10mA -ve limit:- Initial threshold -10% or -10mA
Differential Comparitor Angle Threshold	±5°

Differential and Intertrip operate times are given by:

t = t0 + td

where

t0 is the base operating time.
td is the Differential Delay time.

The base operating time depends on the communications bit rate.
Figure 3 shows typical Differential operating times at 38400.

Operate Times		
Differential base operate time (Idiff > 10 Is)	≤ 40ms ≤ 55ms	(38400 baud) (19200 baud)
Differential Delay time	±1% or ±10ms	

5.2 Intertrip Element

Intertrip Element	
Intertrip base operate time	≤ 50ms (38400 baud) ≤ 65ms (19200 baud)
Intertrip Delay	±1% or ±10ms

5.3 Lowset, Highset1, Highset2 Instantaneous/DTL Elements

Lowset Element	
Pickup / Dropoff levels	
Operate Level	Setting ±5% or ±10mA
Reset Level	≥ 95% of operate level
Repeatability	±1%
Operate Time	
Operate Time See Figure 4 for operate time.	±1% or ±10ms
Repeatability	±1% or ±5ms

5.4 Overcurrent Characteristic Elements

IDMTL / DTL Characteristic	
Pickup / Dropoff levels	
Operate Level	105% of setting ±4% or ±10mA
Reset Level	≥ 95% of operate level
Repeatability	±1%
IDMTL Operate Time (NI, VI, EI, LTI)	
Starter Time See Figure 5 for starter operate time.	±5%
Operate times are calculated as follows: $t = \frac{K}{\left(\frac{I}{Is}\right)^{\alpha} - 1} \times Tm$ where I = fault current Is = current setting Tm = time multiplier and for NI K = 0.14, α = 0.02 for VI K = 13.5, α = 1.00 for EI K = 80.0, α = 2.00 for LTI K = 120.0, α = 1.00 See Figure 6 for IDMTL operate curves.	±5% or ±30ms
Reset Time	±1% or ±10ms
Repeatability	±1% or ±5ms
DTL Operate Time	
Starter Time	±5%
Operate Time	±1% or ±10ms
Reset Time	±1% or ±10ms
Repeatability	±1% or ±5ms

5.5 Circuit Breaker Fail Elements

Pickup / Dropoff levels	
Operate Level	Setting ±5% or ±10mA
Reset Level	≥ 95% of operate level
Repeatability	±1%
Operate Time	
Operate Time	±1% or ±10ms
Repeatability	±1% or ±5ms
Reset Time	
Reset Time	Typically 25ms (20 to 0.9 x setting) Accuracy ±1% or ±10ms
Repeatability	±1% or ±5ms

5.6 Status Inputs

Each status input has associated timers that can be programmed to give time delayed pick-up and time delayed drop-off. The timers have default settings of 20 ms for pick-up and 0ms for drop-off, thus providing immunity to an AC input signal.

Minimum operating current	10mA
Reset/Operate Voltage Ratio	≥ 90%
Response time (Pickup delay set to 0ms)	< 5ms

Status inputs will not respond to the following:

- 250V r.m.s. 50/60Hz applied for two seconds through a 0.1uF capacitor.
- 500V r.m.s. 50/60Hz applied between each input terminal and earth.
- 10uF capacitor discharged from maximum DC auxiliary voltage.

The inputs meet the requirements of ESI 48-4.
(Apart from the optional low current versions that operate direct from 110V and 220V.)

6 Accuracy General

Transient Overreach of Highsets and Lowset for X/R = 100	≤ -5%
Disengaging Time	< 42ms
Overshoot Time	< 40ms

Note: Output contacts can be programmed to have a minimum dwell time (the default is 100ms), after which the disengaging time is as above.

7 Accuracy Influencing Factors

For conditions other than reference conditions, the following applies.

Factor	**Range**	**Additional Error**
Temperature	-10°C to +55°C	0%
Frequency Differential setting Differential timing Overcurrent setting Overcurrent timing	47Hz to 52Hz	 ≤ 5% ≤ 1% ≤ 1% ≤ 1%
Ripple on DC supply (IEC 60255-11)	≤ 12% of DC voltage	0%
Break in DC supply (IEC 60255-11)	≤ 20 ms	0%

8 Thermal Rating

Phase & Earth Inputs

Duration	1A Tap	5A Tap
Continuous	3.0A	15A
10 min	3.5A	16.5A
5 min	4.0A	20A
3 min	5.0A	25A
2 min	6.0A	30A
3 sec	57.5A	230A
2 sec	70.7A	282A
1 sec	100A	400A
1cycle	700A	2500A

9 Burdens

Current Inputs

	AC Burden	Impedance
1A tap @ 1A	≤ 0.05VA	≤ 0.05 Ω
5A tap @ 5A	≤ 0.2VA	≤ 0.01 Ω

Note: Burdens and impedances are measured at nominal current rating.

Power Supply

	DC Burden
Quiescent (Typical)	7 Watts
Max	11 Watts

10 Output Contacts

Contact rating to IEC 60255-0-20.

Carry

Continuous	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

11 Protection Signalling

Transmission type	Asynchronous
Data rate	19200 bps, 38400 bps
Protocol	Asynchronous, 11bit characters including start, stop, parity.
Data Frame	10 character frame including start flag, end flag, checksum. Based on IEC 60870-5-1. Characters in a data frame are transmitted with no intentional gaps but a received gap of up to 1 bit can be tolerated
Hamming distance	4
Connection	Point to point
Max permissible jitter	<10µs at 19200 bps <5µs at 38400 bps
Max permissible delay	37.5 ms end to end

Channel propagation delay is automatically compensated for if it falls within one of the pre-selected bands in the protection settings.

Delays in each direction should be identical, or as near identical as possible. Any difference results in a phase error of 9 deg/ms on a 50Hz waveform, which must be accommodated in the protection's stability margin.

Delays in each direction must fall within the same setting band for auto compensation.

Interface Options

Interface	**TX budget**	**Max Range**
Fibre Optic 1300nm long range model	20dB	Typically from 0 to 49km using typical 9/125µm singlemode fibre*
	26dB	Typically from 5km to 15km using typical 62.5/125µm multimode fibre*
Fibre Optic 1300nm short range model	20dB	Typically from 0 to 15km using typical 62.5/125µm multimode fibre*
Electrical 4 wire RS485		< 1.2km
Metallic twisted pair pilots		< Typically 8km for 0.8mm sq pilotwire(dependant on pilot type-R&C) – see Table below.

* Based on fibre attenuations: -
62.5/125µm multimode 3.5dB/km
9/125µm single mode 0.3dB/km
Assumes no joins in the fibre, but includes a 3dB safety margin.
Actual losses for specific application should be calculated using cable manufacturers data or by direct measurement using specialised equipment. Refer to the Applications Guide section of this manual.

Typical Range Limits for Screened Twisted Pair Pilotwires

Cross Sectional Area	**Approximate Range**
0.4mm sq	4km
0.5mm sq	5km
0.6mm sq	6km
0.7mm sq	7km
0.8mm sq	8km
0.9mm sq	9km
1.0mm sq and above	10km

The combination of pilotwire resistance (R) and inter-core capacitance (C) should not exceed a RC product of 300,000 nF ohms. The value of R is the resistance for a single wire between pilotwire modems at either end of the feeder. The value of C is the inter-core capacitance a pair of pilot wires. The pilotwires should be earthed at both ends at the pilot wire terminations to limit. The relay and pilotwire modems should be earthed separately in the relay panel. This above range limits includes a suitable safety margin as the communications drop out occurs at about 340,000nF ohms.

12 Environmental Withstand

12.1 General

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

12.2 Immunity

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 III

	Variation
6kV contact discharge	≤ 5%
8kV air discharge (to fascia)	≤ 5%

Radio Frequency Interference - IEC 60255-22-3 Class III

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

Fast Transient – IEC 60255-22-4 Class IV

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

Conducted RFI – IEC 60255-22-6

	Variation
0.15 to 1000MHz - 10V	≤ 5%

12.3 Emissions

Radiated Limits – IEC 60255-25

Frequency Range	Limits at 10m Quasi-peak dB (µV/m)
30 to 230MHz	40
230 to 1000MHz	47

Conducted Limits – IEC 60255-25

Frequency Range	Limits dB (µV)	
	Quasi-peak	Average
0.15 to 0.5MHz	79	66
0.5 to 30MHz	73	60

12.4 Mechanical

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

Qualification

Product :- CE compliant to all relevant EU directives.
Quality Systems :- accredited to ISO 9001

13 Characteristics

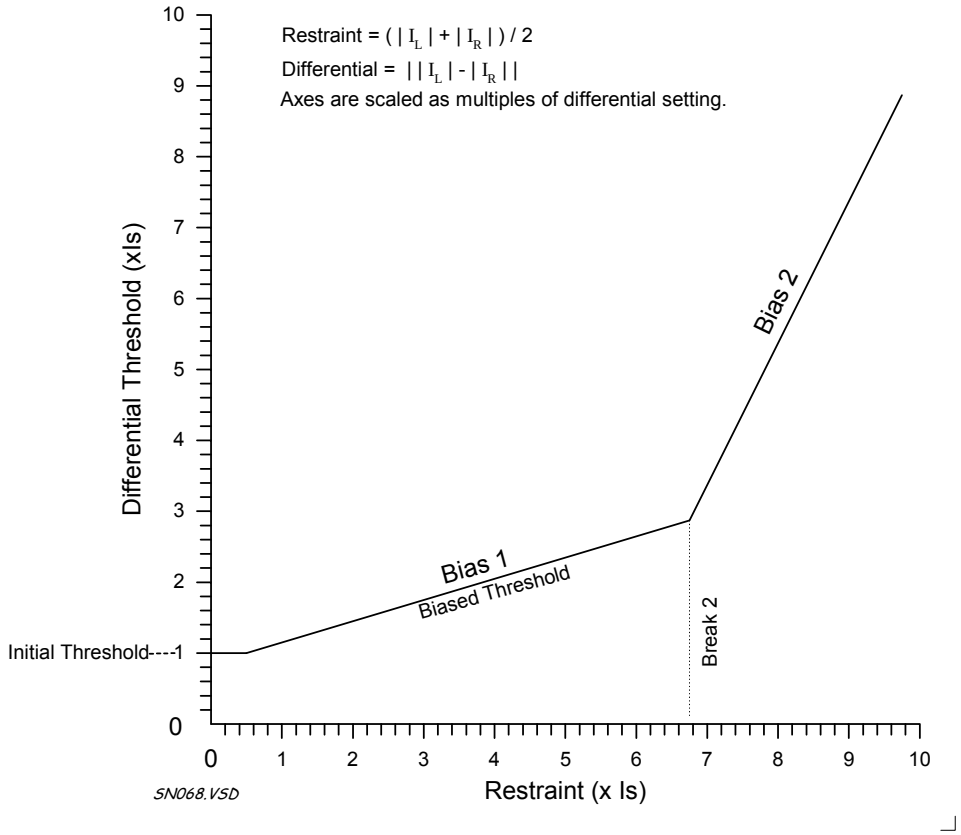

Figure 1 – Differential Threshold (Magnitude)

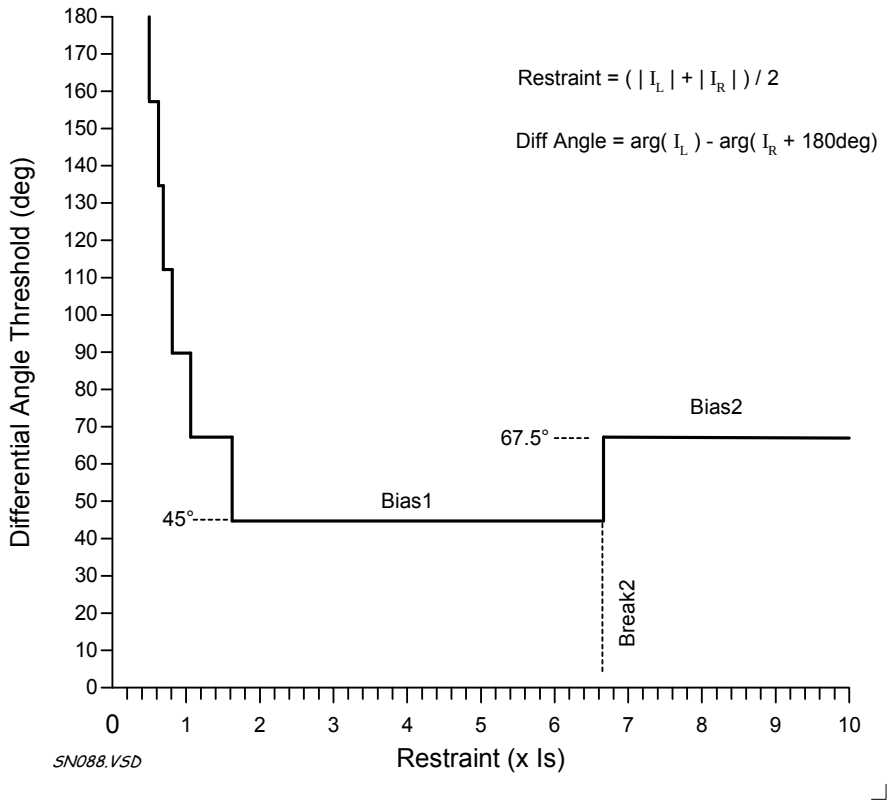

Figure 2 – Differential Threshold (Angle)

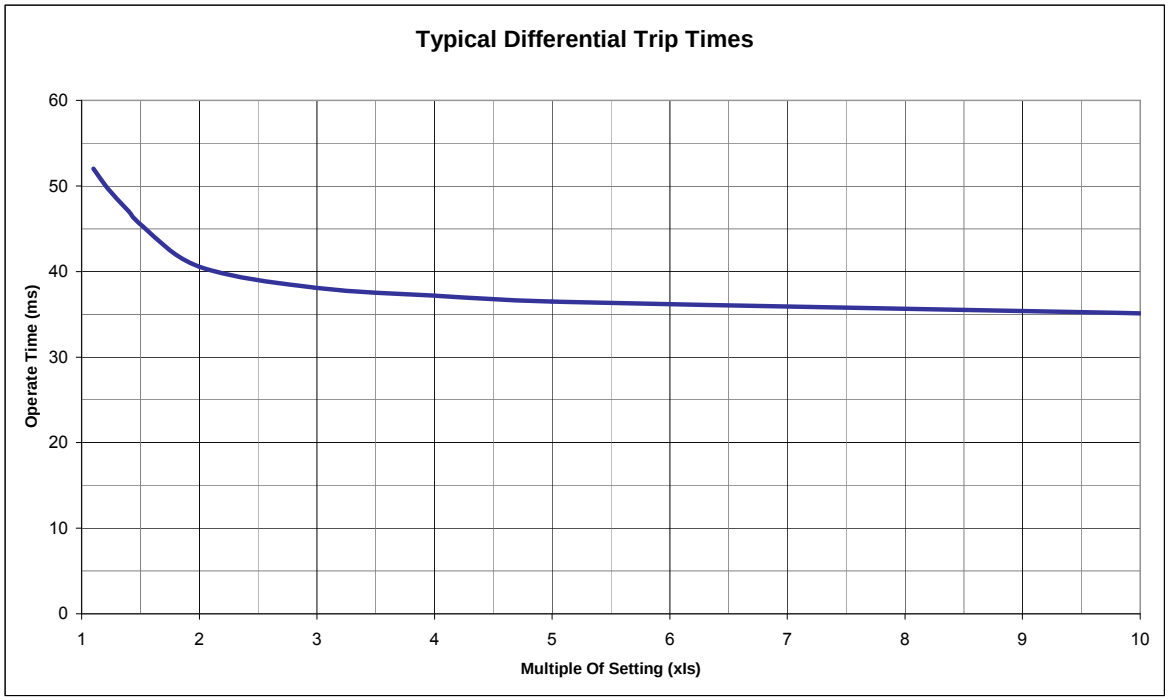

Figure 3 – Typical Differential Trip Times @ 38400 baud

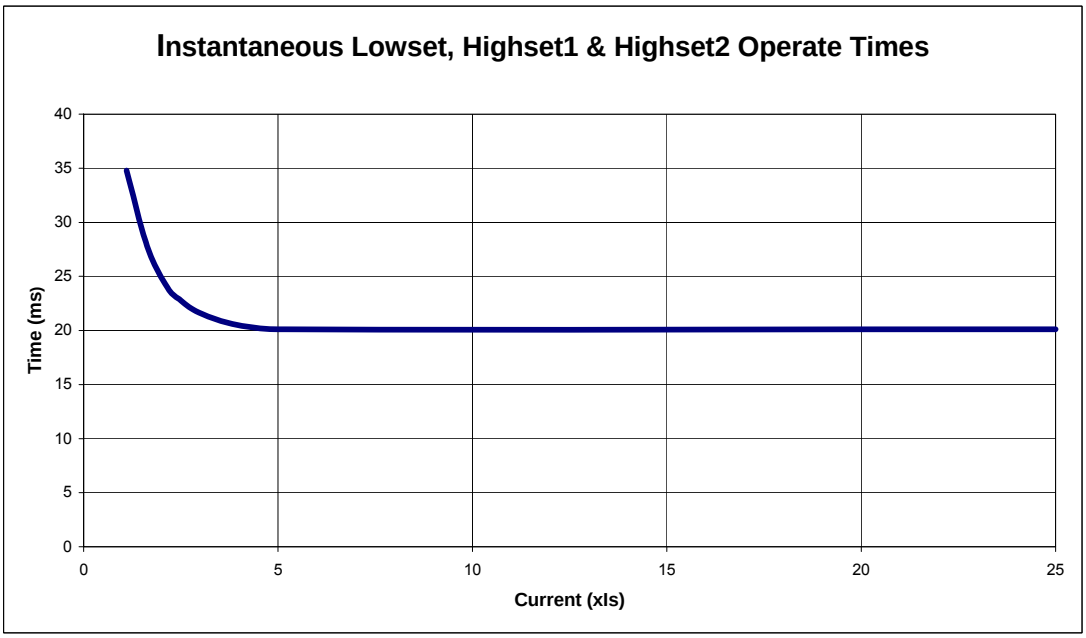

Figure 4 – Instantaneous Lowset, Highset1 & Highset2 Operate Times

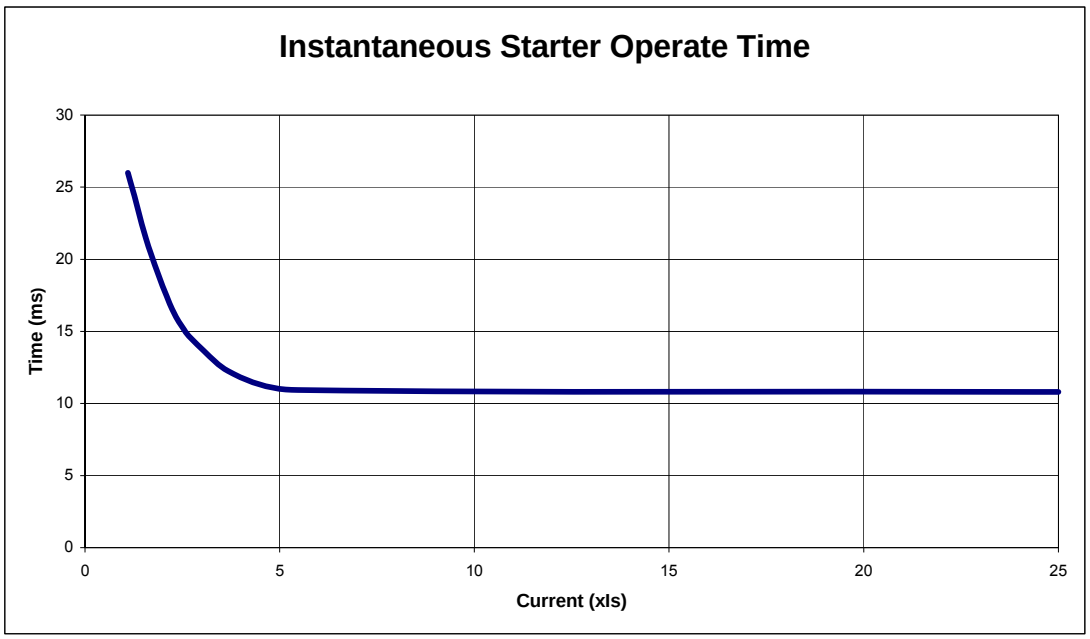

Figure 5 – Overcurrent Starter Operate Time

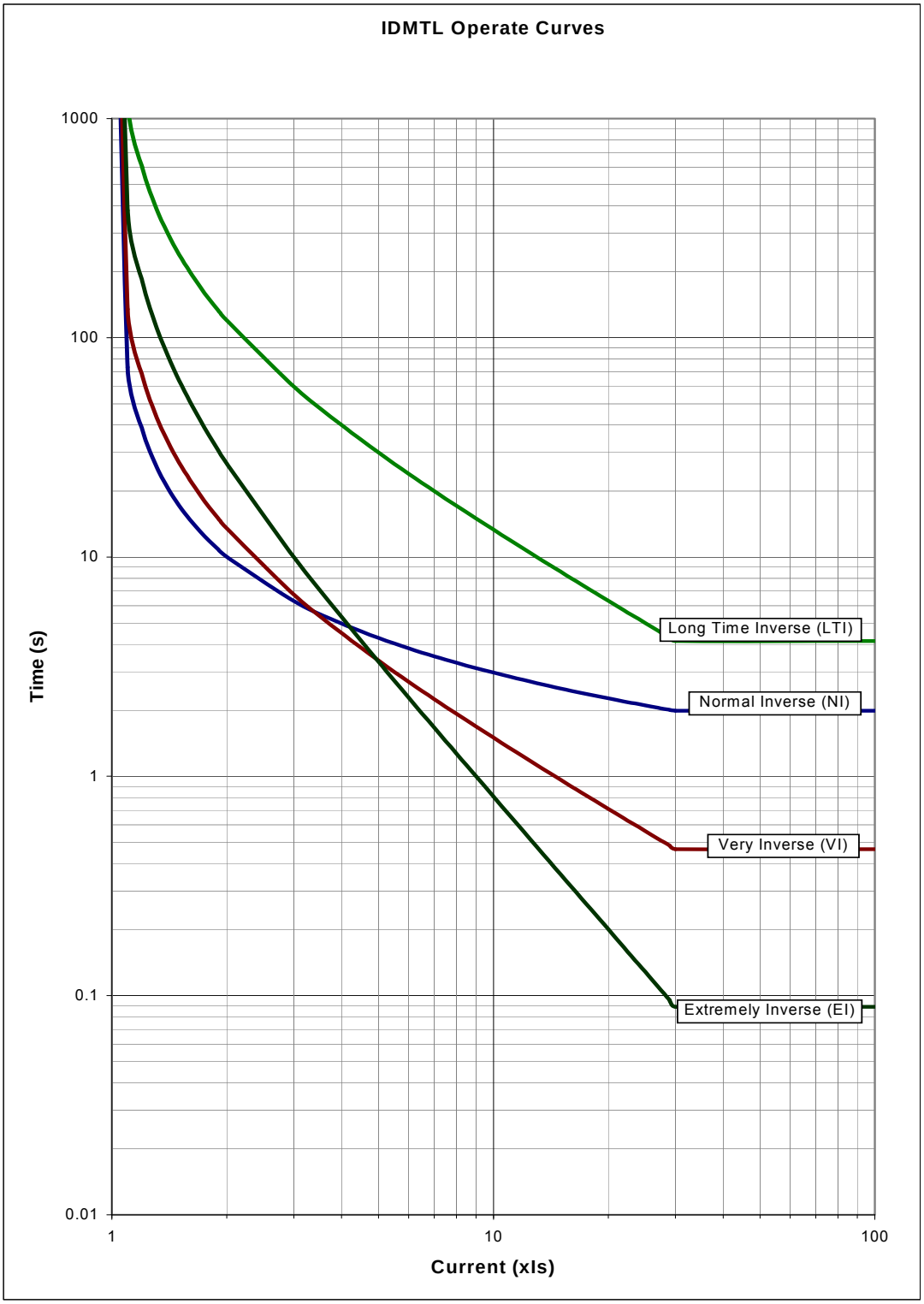

Figure 6 – IDMTL Overcurrent Characteristic (Time Multiplier = 1)

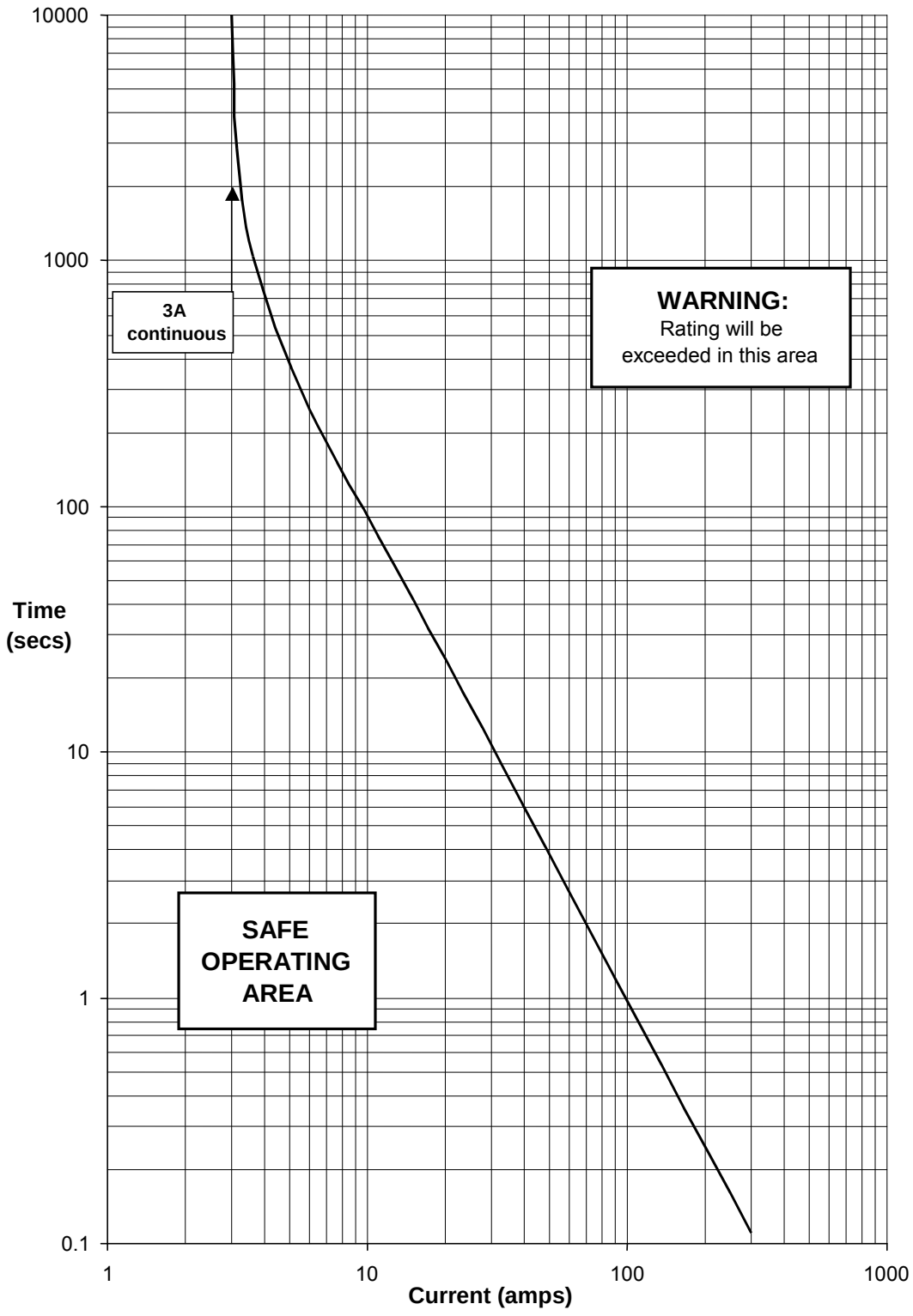

Figure 7 – Thermal Rating for 1A Relay

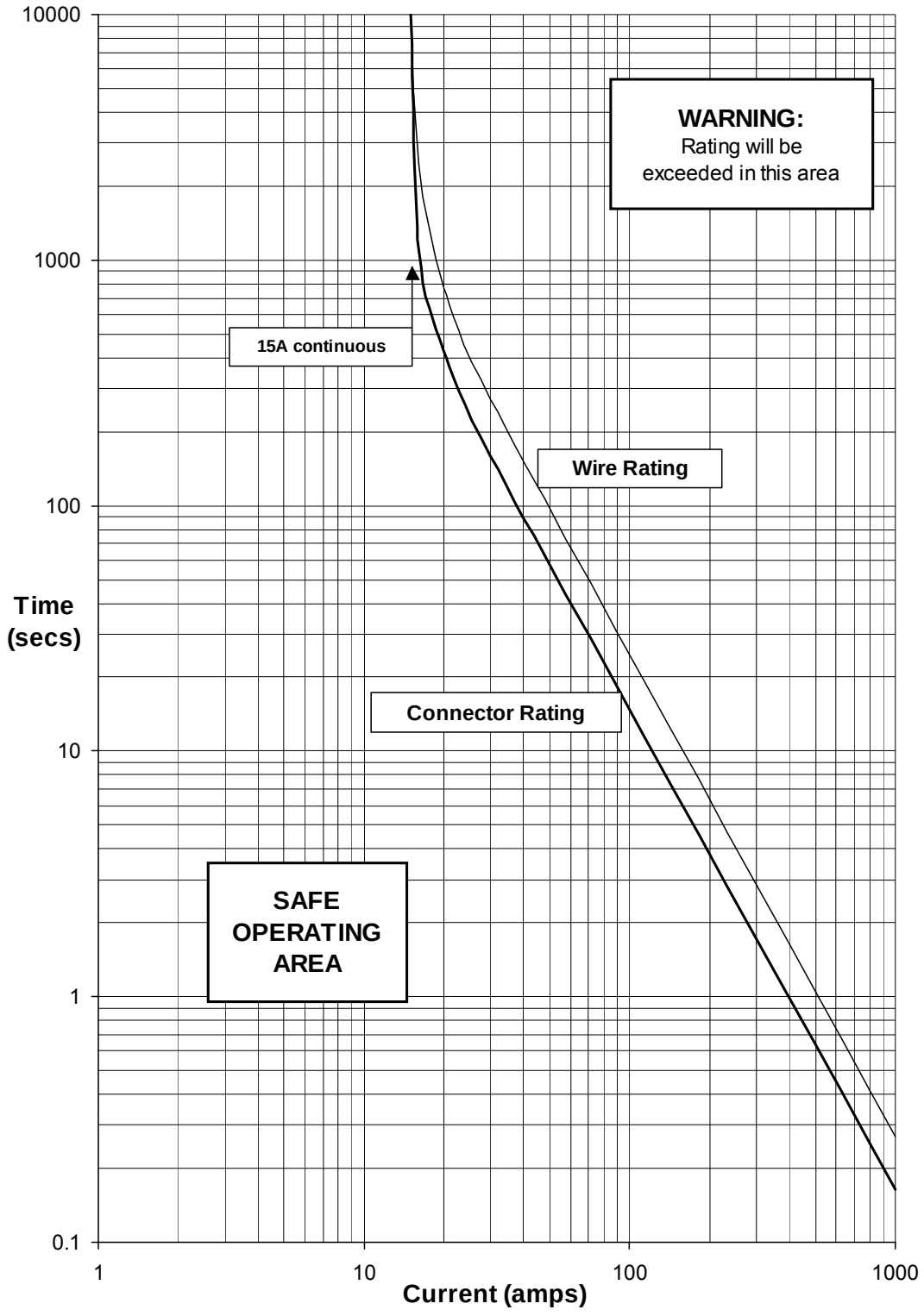

Figure 8 – Thermal Rating for 5A Relay