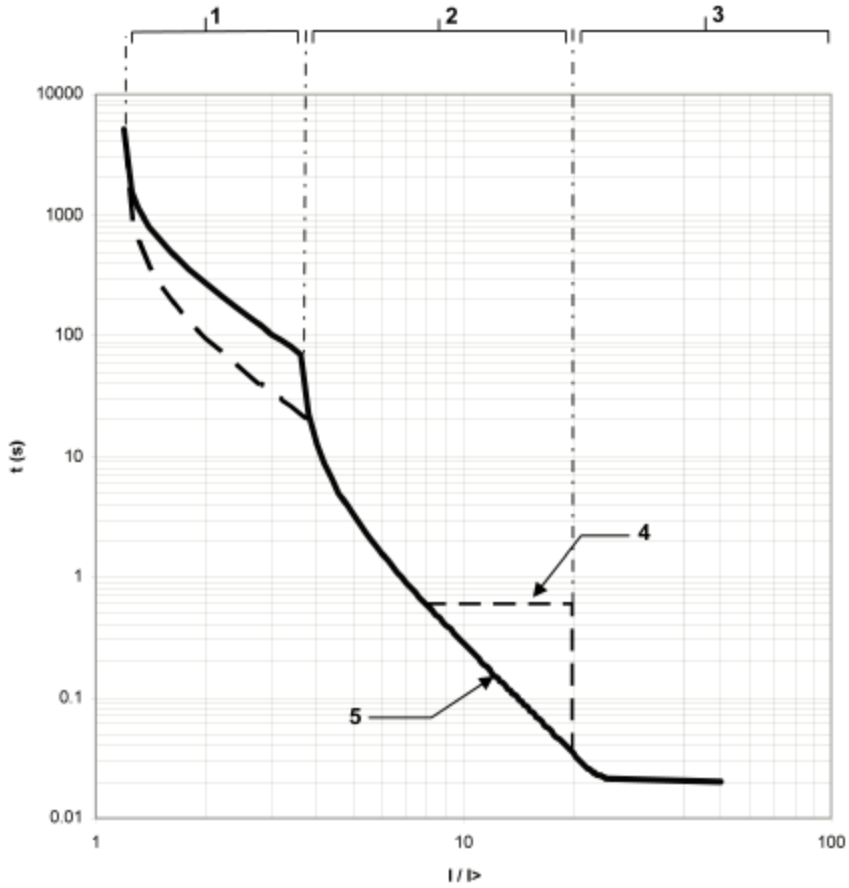
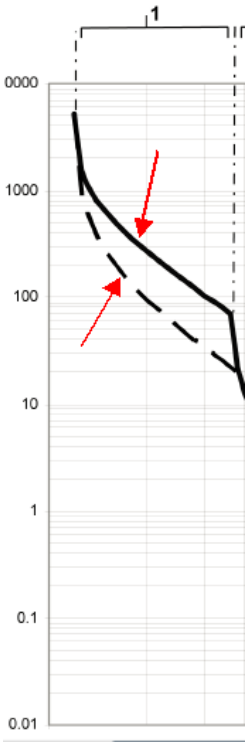
In reference to Phase Overcurrent Protection (ANSI 50-51), the overall protection graph is presented as follows:



Calculation of tripping time in terms of settings for each curve/segment can be summarized as follows:

Curve (1) overload pickup between 1.2 and 3.5 I>:



Calculating the Tripping Time

For a continuous current higher than the tripping set point, it is possible to calculate the tripping time using the equation below:

$$Td(I) = \tau \bullet \ln\left(\frac{I^2 - Ito^2}{I^2 - (1.2 \cdot I>)^2}\right)$$

where:

- I: Overload current (maximum of the 3 phase currents)
- I>: ANSI 50-51 protection setting set point
- τ: Heating/cooling time constant (10 min = 600 s)
- Ito: Equivalent thermal current before application of the overload
- ln(): Natural logarithm function

The equivalent thermal current Ito corresponds to the continuous current which would have resulted in the same thermal capacity used before application of the overload.
The tripping curve shown in the figure above is given for a zero initial thermal current Ito.

This curve, called "cold curve", is defined by the equation below:

$$Td(I) = 600 \bullet \ln\left(\frac{I^2}{I^2 - (1.2 \cdot I>)^2}\right)$$

The dotted-line curve in the overload zone corresponds to the tripping time for an initial thermal capacity used equal to the I> setting set point.

This curve, called "warm or Hot curve", is defined by the equation below:

$$Td(I) = 600 \bullet \ln\left(\frac{I^2 - I>^2}{I^2 - (1.2 \cdot I>)^2}\right)$$

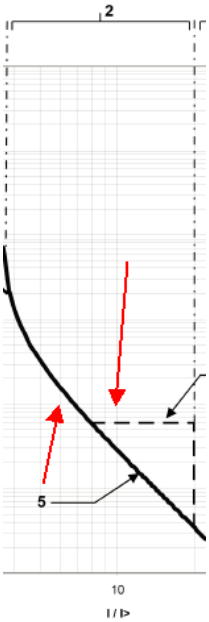
The below table gives some examples of trip times in relation to set current I> & the initial thermal status before any occurrence of overloading; this is determined by relay calculation according to above formulas.

Examples of Tripping Times (Rounded Up or Down to the Nearest 0.1 s):

Current	Td (Where Ito = 0)	Td (Where Ito = I>)
1.5 I>	613.0 s	260.3 s
2 I>	267.8 s	95.2 s
2.5 I>	157.1 s	52.5 s
3 I>	104.6 s	33.9 s
3.5 I>	75.0 s	23.9 s

Depending on the initial thermal capacity used caused by changes in the load current, the tripping time in the event of an overload will be in the range of times indicated above.
The current thermal capacity used is not saved in the event of loss of the VIP power supply, or when the phase currents fall below the value of the VIP pick-up current.
Each time the VIP wakes up, the equivalent thermal current Ito is reset to zero.

Curve (2) - "Secondary Fault" Pick-up Curve (Between 3.5 and 20 I>)



The "secondary fault" pick-up curve is IDMT type, with a tripping time that depends on the current value. It allows the phase-to-phase fault at the MV/LV transformer secondary to be eliminated, while ensuring coordination with the downstream fuses or LV circuit breakers.

Calculating the Tripping Time
This curve, called FUSE, is defined by the special equation below:

$$Td(I) = \frac{6.3}{\left(\frac{I}{3.5 \cdot I>}\right)^{3} - 1}$$

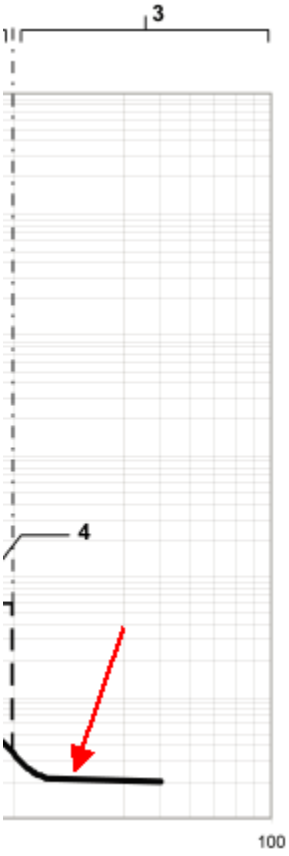
where:
- I: Measured fault current (maximum of the 3 phase currents)
- I>: 50-51 protection setting set point

The main characteristics of the FUSE curve are:
- An asymptote defined at 3.5 I>
- A "1/I3" slope to obtain a slope comparable with the LV or MV blown fuse curves This similarity simplifies coordination with downstream LV fuses or upstream MV fuses.

This IDMT curve is managed in accordance with the recommendations of standard CEI 60255-151, which defines the standardized IDMT curves (IEC or IEEE curves). In particular, this curve applies the concept of integration if the current amplitude changes during the fault (open-ended fault). This concept can ensure discrimination between the VIP curve and an upstream protection relay that uses standardized IDMT curves.

FUSE/CB Curve Selection (option you choose according to downstream LV device):
By default, the VIP uses the FUSE curve over the whole range 3.5 I> to 20 I>. This curve simplifies coordination with downstream LV fuses.
If the VIP is upstream of an LV circuit breaker, it is advisable to activate the CB curve via the setting on the front panel.
The **CB curve** activates a minimum time delay of 600 ms, which is applied between 8 I> and 20 I> (dotted line curve in the above figure). This time delay ensures coordination with the short time set point of the downstream LV trip unit. This short time set point is usually set with a DT time delay of 0.2 s to 0.4 s, which could overlap with the FUSE curve and make both protection stages non-discriminating. If necessary, activation of the CB curve can ensure discrimination with the LV circuit breaker.

Curve (3) - “Primary Fault” Pick-Up Curve (Above 20 I>)



The “primary fault” pick-up curve is DT type, with an instantaneous tripping time delay for a current higher than 20 I>. It allows a phase-to-phase fault at the MV/LV transformer primary to be eliminated quickly.
If the I> set point is set to a value higher than or equal to the rated current for the protected MV/LV transformer, this high set point, above 20 In, does not see faults at the secondary. This current discrimination ensures coordination with LV protection functions.
The VIP tripping time in this range is **less than 20 ms** (VIP already supplied with power) for short-circuit currents higher than 40 I>.
Minimum tripping time:
Depending on the device used, a minimum tripping time can be activated to comply with the circuit breaker breaking capacities.