# Realisation of a third stage for overcurrent time protection

SIPROTEC 4 7SJ6 device settings

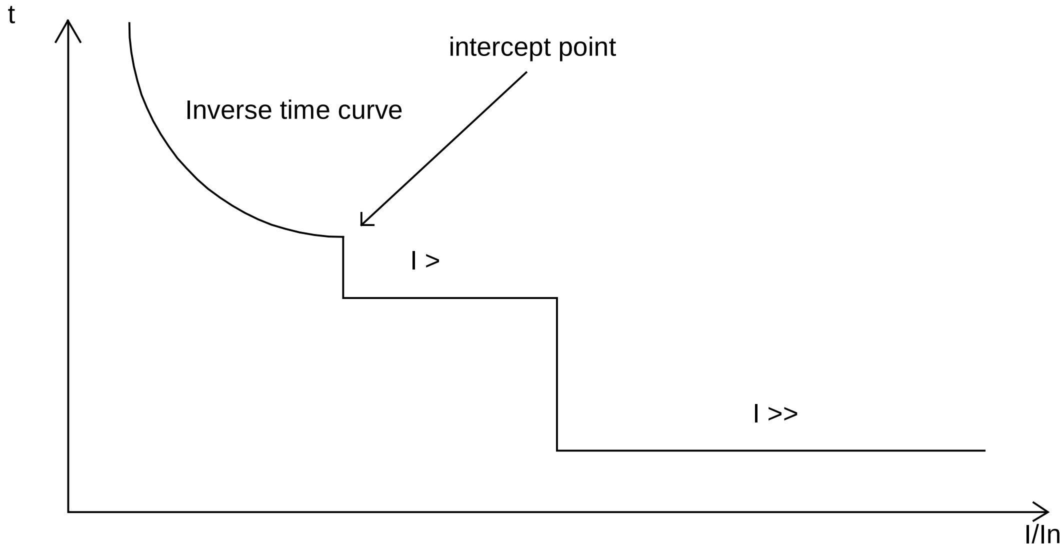
| | IEC | I > | I >> | I warn | CFC |
|---|---|---|---|---|---|
| **T / s** | 0.8 (1208) | 15 (1205) | 10 (1203) | 0 | 5 |
| **I / A** | 1 (1207) | 1.5 (1204) | 2 (1202) | 3 (4205) | 3 |

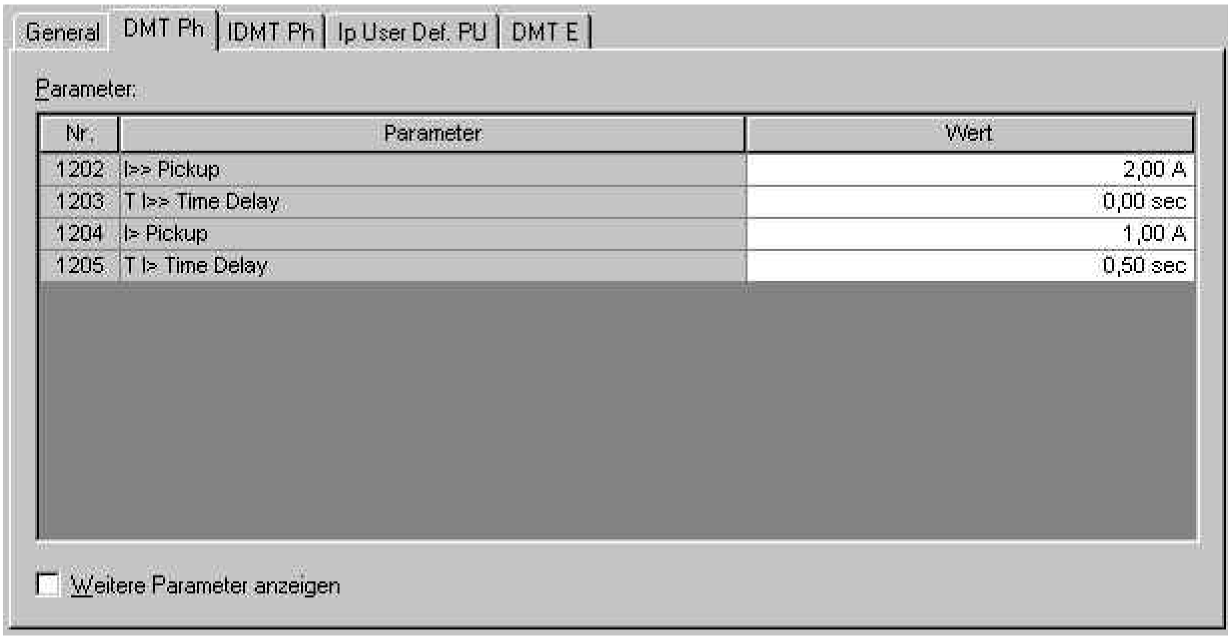
(...) = Address in the device

SIPROTEC devices offer several possibilities how to realise additional overcurrent protection. We can combine and use already existent functions, user defined curves or CFC charts.

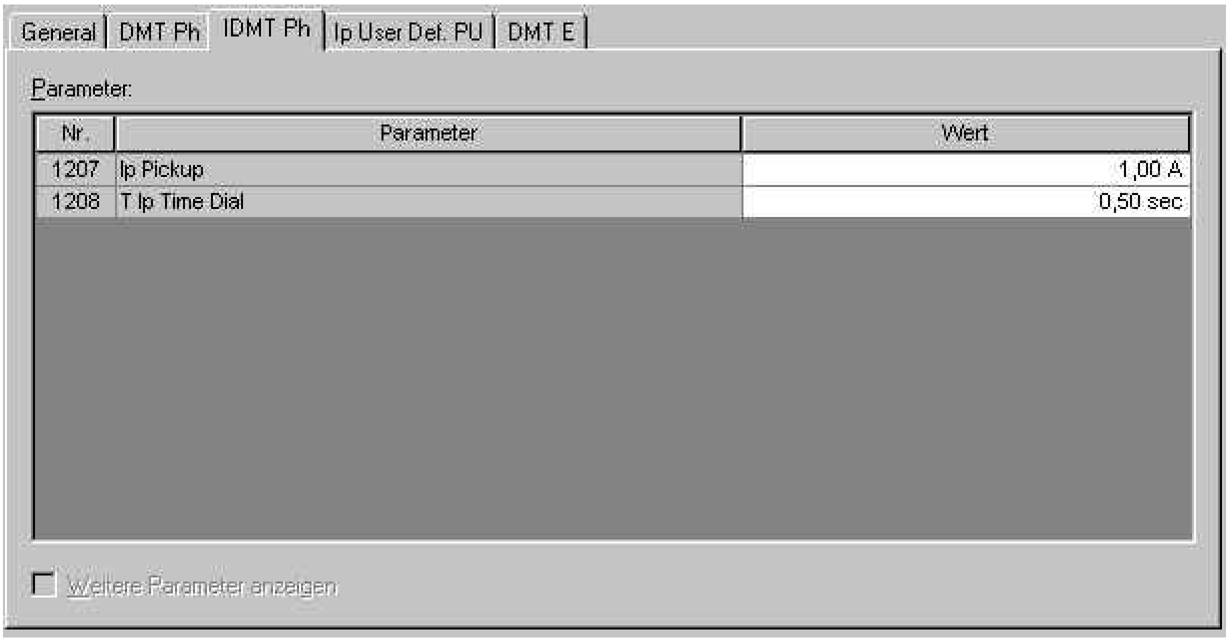
## Realisation with a combination of inverse time characteristic

The first option is the combination of the definite time stages with an inverse time characteristic curve. In this case it is possible that the trip signal of the inverse curve (e.g. IEC curve) appears in the time zone where the definite time protection is active. You must watch out not to overlay the protection zones. In order to avoid an overlay it is necessary to calculate and to connect the end points of the inverse curve with the definite time lines.



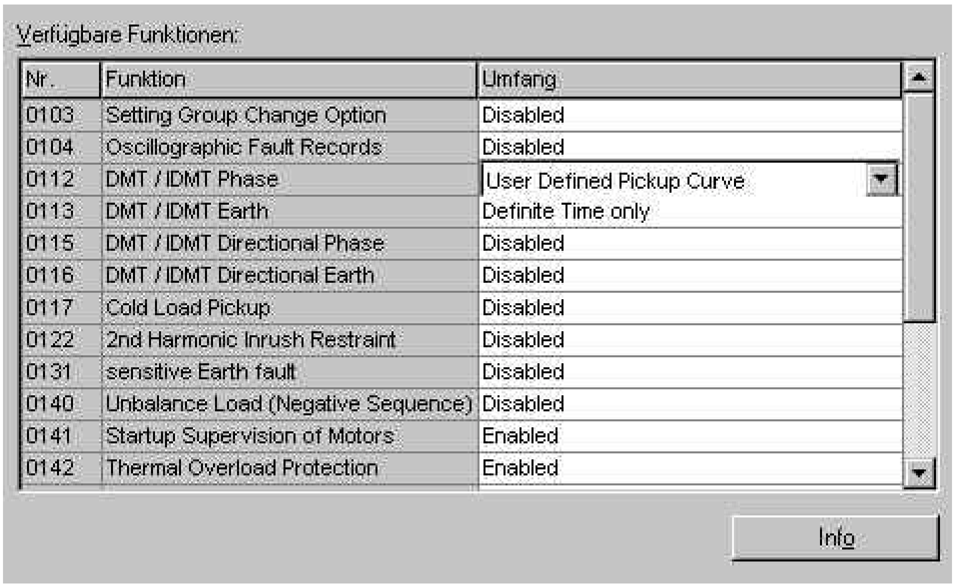

| Nr. | Parameter | Wert |
|---|---|---|
| 1202 | I>> Pickup | 2,00 A |
| 1203 | T I>> Time Delay | 0,00 sec |
| 1204 | I> Pickup | 1,00 A |
| 1205 | T I> Time Delay | 0,50 sec |



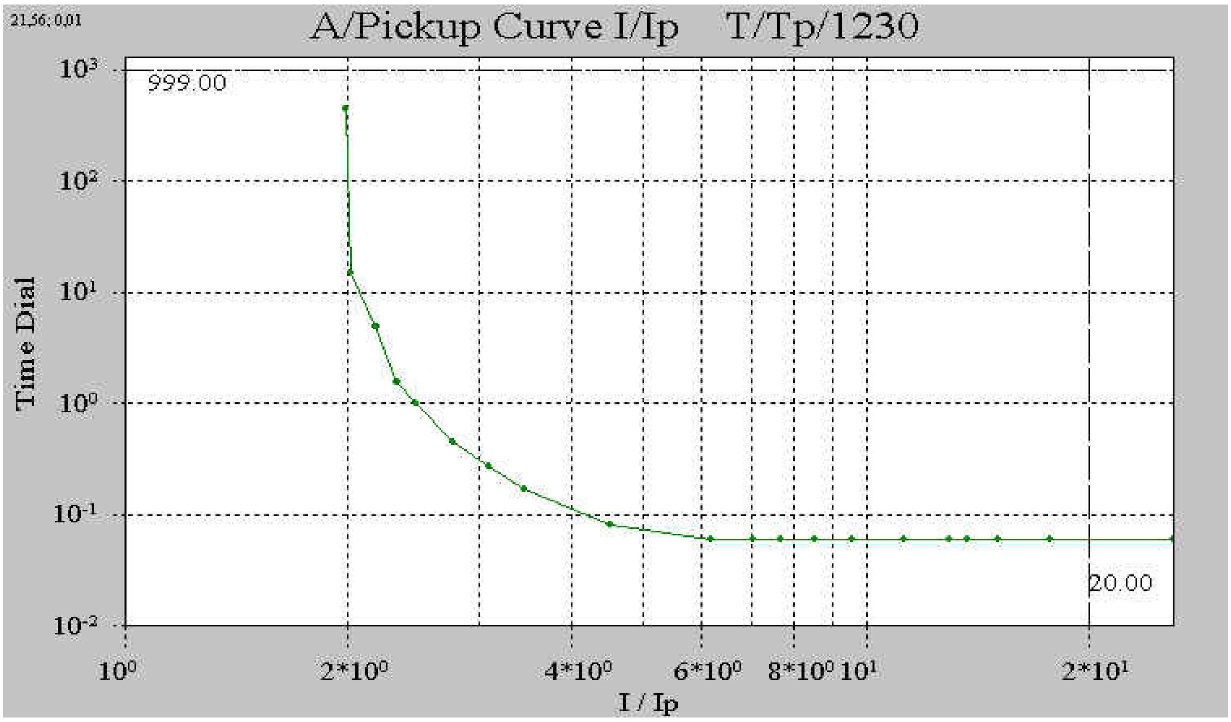

It will be defined an inverse curve with three parameters ($I_n$,$T_p$, type of curve). The inverse curve stage generates a trip signal throughout the whole current area, but with the beginning from the intercept point the definite time (I>, I>>) protection trip times are shorter and the definite time stages will lead to a final trip first.

## Realisation with an user defined curve

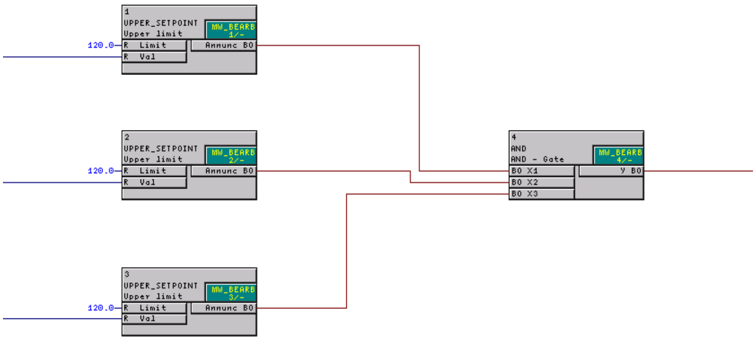
The second option is to combine the definite time protection with an user defined curve. You can define your own curve, but must pay attention again that the tripping areas do not cover and disturb each other. To solve this it can be easily drawn in DIGSI.
It is also possible to draw an user defined curve like a definite time (I>,I>>) protection line.




| Nr. | Funktion | Umfang |
|---|---|---|
| 0103 | Setting Group Change Option | Disabled |
| 0104 | Oscillographic Fault Records | Disabled |
| 0112 | DMT / IDMT Phase | User Defined Pickup Curve |
| 0113 | DMT / IDMT Earth | Definite Time only |
| 0115 | DMT / IDMT Directional Phase | Disabled |
| 0116 | DMT / IDMT Directional Earth | Disabled |
| 0117 | Cold Load Pickup | Disabled |
| 0122 | 2nd Harmonic Inrush Restraint | Disabled |
| 0131 | sensitive Earth fault | Disabled |
| 0140 | Unbalance Load (Negative Sequence) | Disabled |
| 0141 | Startup Supervision of Motors | Enabled |
| 0142 | Thermal Overload Protection | Enabled |

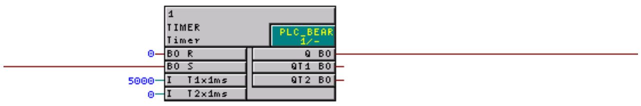


## Realisation with CFC




The third option is that you define your own overcurrent stage inside CFC. You must open a new CFC chart and insert three upper setpoint gates which can detect currents higher than the pre-set threshold. If one of the three phase currents should be higher than this threshold, a signal will go through the OR gate in direction to the timer which starts counting. After this timer delay (time delay settable) the trip signal will appear. You can use this stage in combination with two definite time stages. As explained before you must pay attention that the trip time zones are not covering each other. You connect the UPPER_SETPOINT gate inputs to all three phase currents and the timer output will be connected directly to binary output.

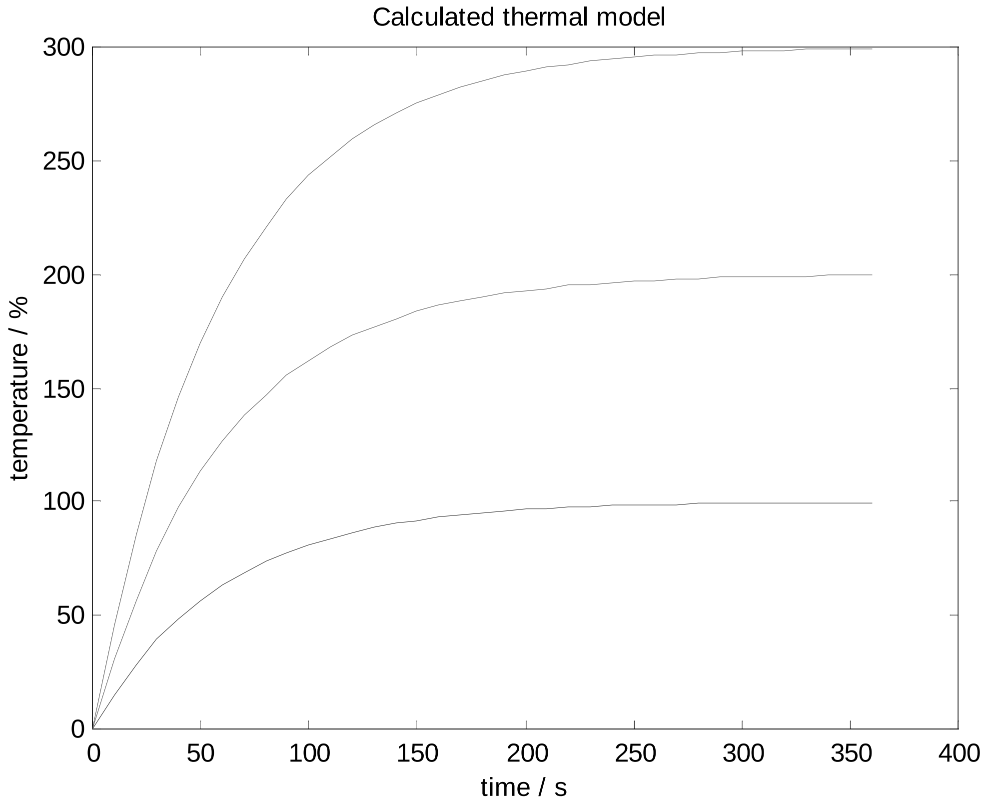
Notice: For using the CFC chart solution the timer gate has to be inserted not
in the layer for the measurement supervision, but to be used in
the fast PLC task processing (priority class PLC BEARB) or
slow PLC task processing (priority class PLC1 BEARB).



## Realisation with overload protection

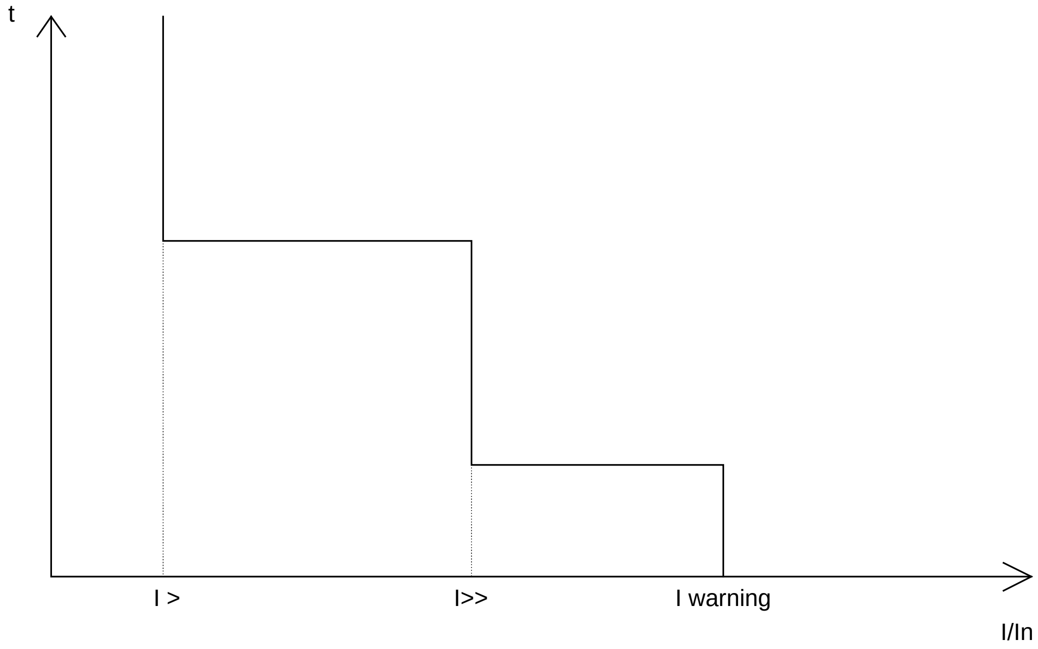
There is also a fourth option how you can realise the third overcurrent stage. In the protection device mostly the overload protection is available. This function calculates the thermal conditions of a single body model of the protected element. The model calculates on base of incoming currents with differential equation. When the 100% temperature threshold of the internal model is exceeded the function initiates a trip signal. 100% temperature can not be exceeded if the currents are lower than k • $I_n$. This is an indirect way to recognise overcurrent conditions.

$$\frac{d\Theta}{dt} + \frac{1}{\tau} \cdot \Theta = \frac{1}{\tau} \cdot I^2$$




The upper diagram shows us the temperature behaviour in case of three different incoming currents. Higher currents reach the 100% temperature faster. In the first part the temperature rise is similar to a simple linear equation y = k • x.

Another possibility is the usage of the current warning stage of the overload protection function which is also offered in this function. This stage actually initiates a trip signal when the pre-set current is exceeded. It has no delay time. Together with the definite time protection it represents a three stage definite time protection. This option is also very accurate, simply definable and transparent as the first realisation with an additional curve. Only now we actually design a third definite time stage.



**Summary**

All four offered solutions have their advantages and disadvantages.

- The first solution with an inverse time characteristic curve is very useful. If you calculate the trip zones and set them properly, this option offers a very accurate, simply definable and transparent tripping time. You can choose between two standards, IEC and ANSI (already defined in the device). Detailed description is found in the SIPROTEC device user manual.

- The second solution recommends a combination of user defined curve and definite time protection function. If IEC or ANSI curves are not suitable, any user can define his own protection curve (UDC) in a special defined table or diagram. UDC offers a very comfortable way of defining protective zones, simply adjustable with other protection demands. The advantage of this curve is that it can be also drawn as a definite time line. As result it can not only offer a third, but also many further overcurrent stages.

- The CFC chart overcurrent stage is very useful because of large possibility of processing and further usage of obtained measured data. But in this case you have the disadvantage of the time accuracy for measured values in CFC. The average processing time in the CFC chart is about 0.5 s. This can be a problem only when fast trip times are requested. The advantage of the CFC overcurrent stage is a very simple further processing of measurement values. You can simply design and create a variety of internal functions (energy counters, logic functions, switching commands,... ) in order to design selective and reliable protective functions.

- The overload protection can also be used for the third overcurrent stage. This solution is enabling an indirect detection of high incoming currents by the thermal model of the protected device. This stage offers several options for initiating a trip signal. You can use the main trip signal which appears when the thermal model has exceeded the 100 % temperature. This protection can not detect pulsing short time currents. It is possible that incoming currents are extremely high for very short time periods and the thermal picture will not exceed the 100% level and not lead to a trip because of the step-by-step increasing slow temperature. Then you have to use the current warning stage of the overload function, which runs without time delay.