T-PRO Application in Reactor Protection Using Neutral Differential and Timed Over-Current Back-up Protection

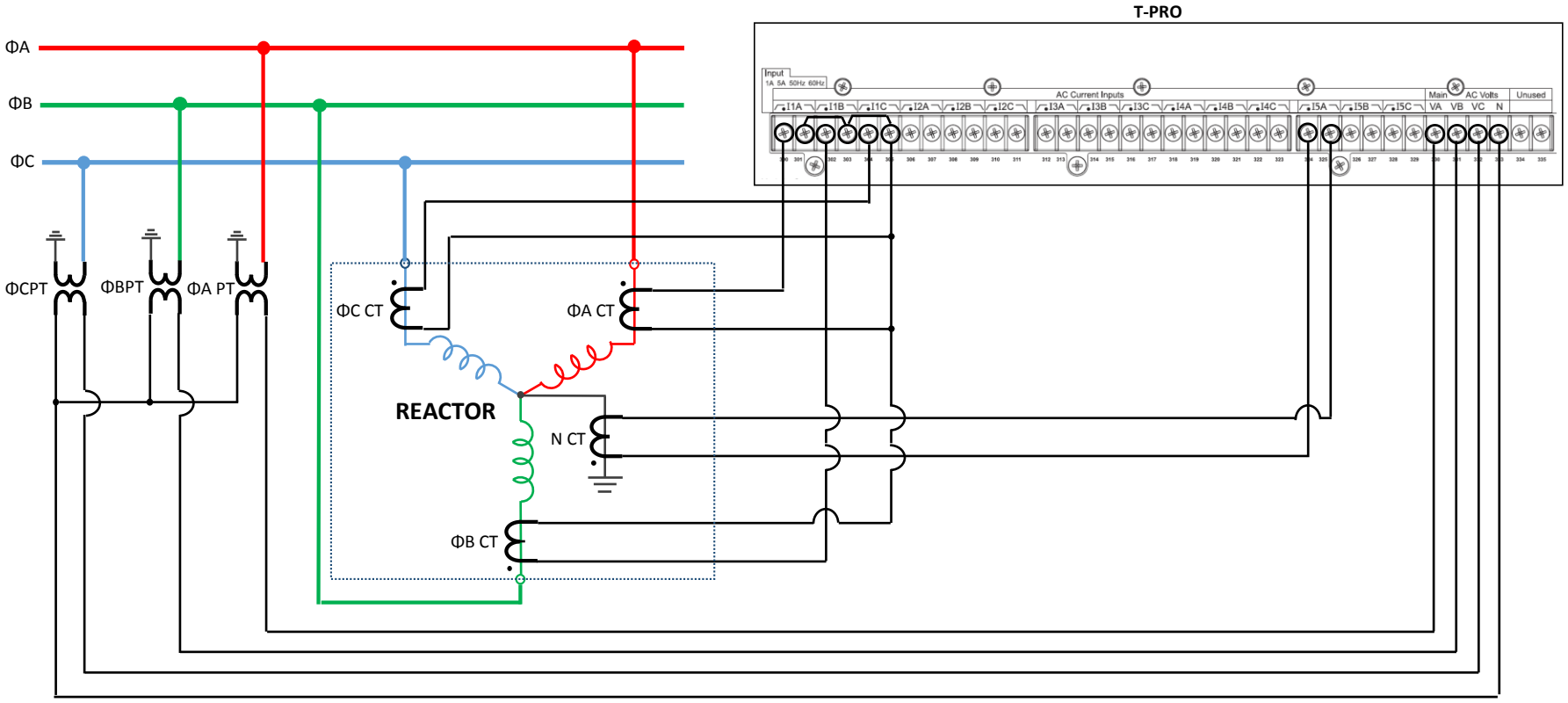
87N Neutral Differential

Neutral Differential protection (87N), which is also known as Restricted Earth Fault, provides sensitive protection to the transformer, auto-transformer or reactors for internal winding to ground faults. The function is restricted to detecting ground faults only within the zone between the CTs that define the 87N zone.

The 87N differential protection uses essentially three principles; the percentage differential slope, the delta-phase (phase angle comparison), and the rate of change of operating and restraining currents for differential trajectory tracking to increase the security of the differential protection during external or through faults.

Note the winding 3-phase CTs must be Wye connected. Delta CT's cannot be used as they would trap the zero sequence current making it unavailable to the 87N function.

Three Line Diagram – Wiring Connection

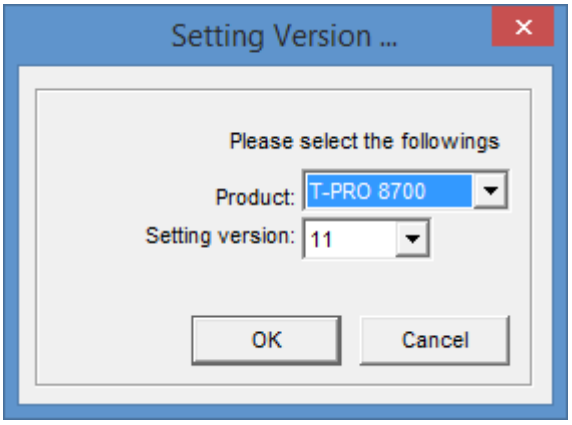


Settings

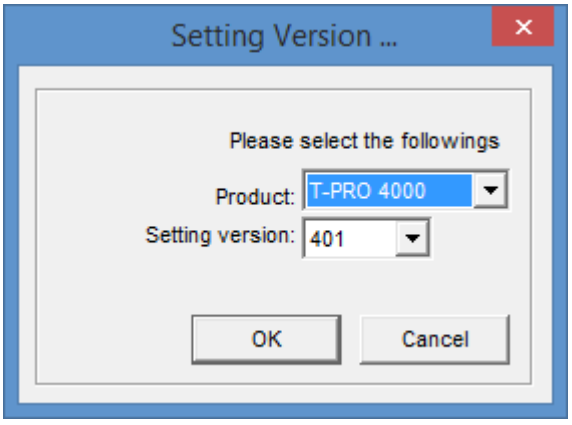
Using T-PRO Offiliner.

Creating a new setting.

On T-PRO 8700



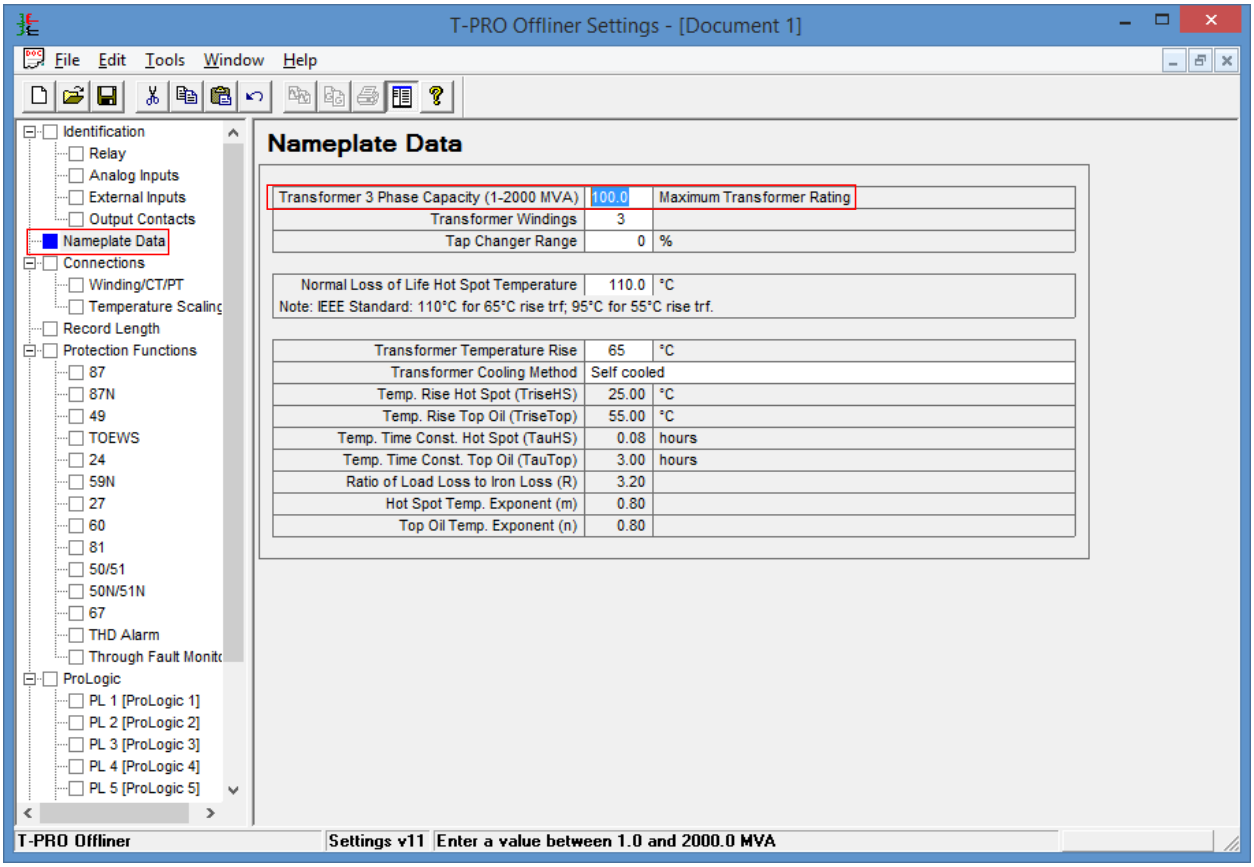
On T-PRO 4000



Nameplate Data

Enter the power of the reactor in MVA.

On T-PRO 8700 & 4000



Connections > Winding/CT/PT

Enter the Reactor Voltage in kV being the HV side voltage level and its connection in 'Y'.

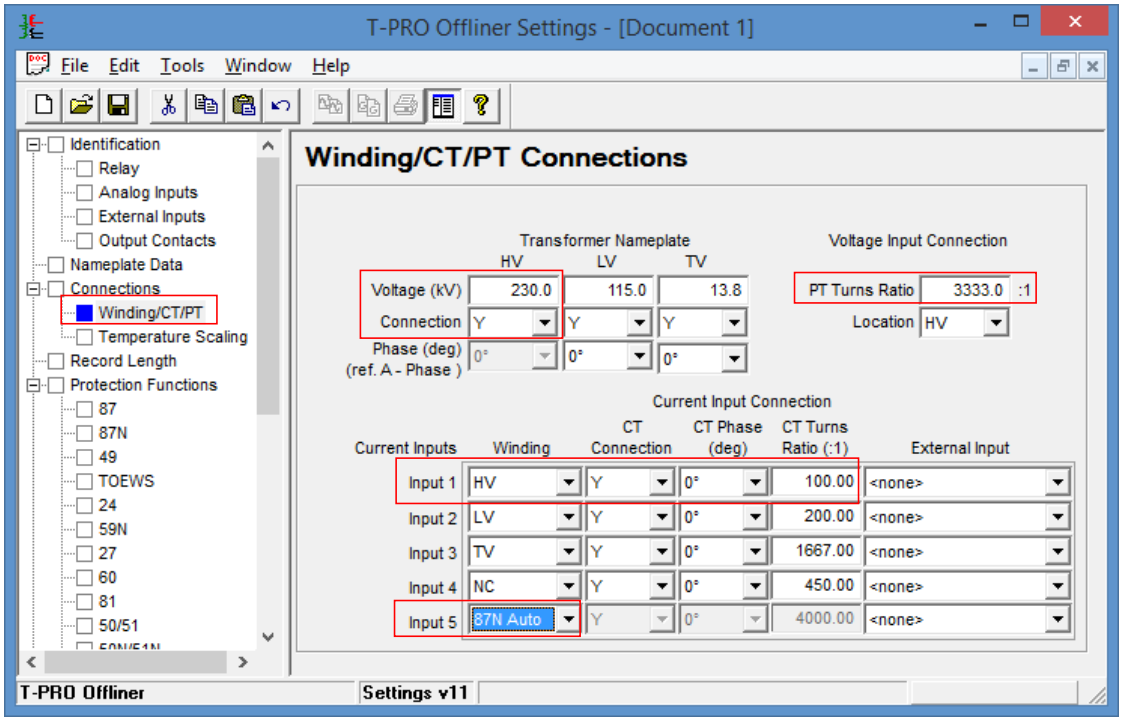
Enter the PT Turns Ratio and its location being 'HV'.

Enter HV CT Connection being 'Y', CT Phase degree being '0' and its Turns Ratio. Leave the default settings on the other inputs.

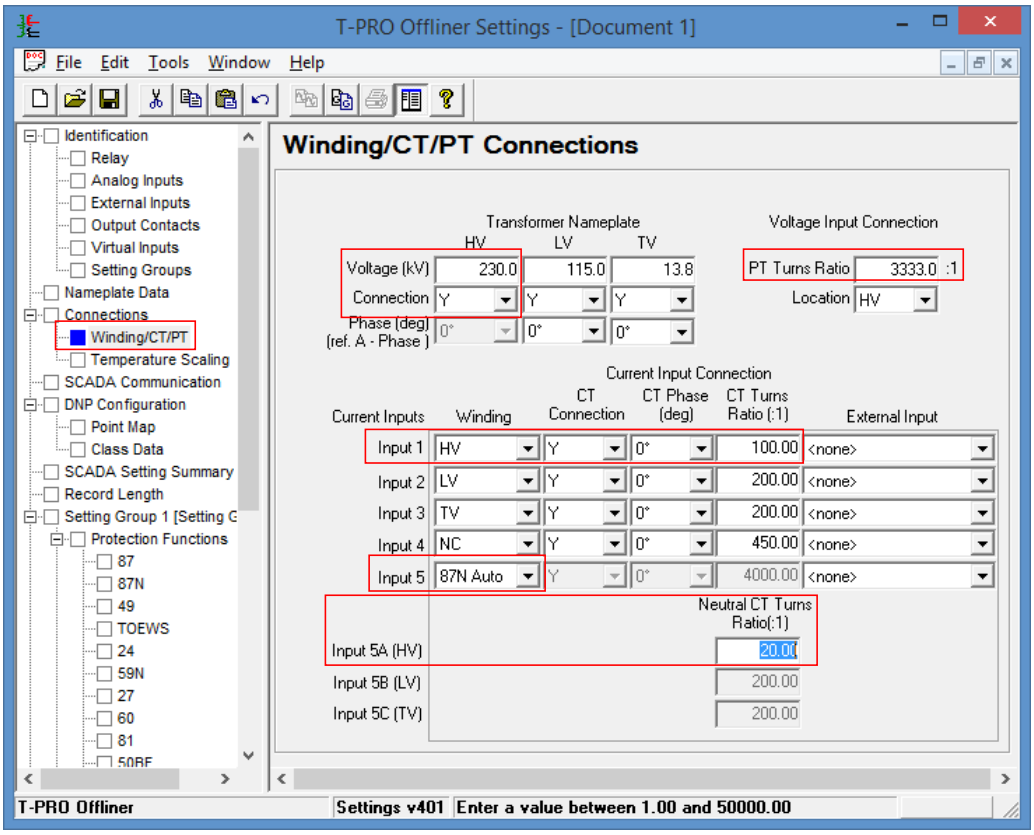
To enable 87N-HV, Input 5 must be set to '87N Auto'.

For T-PRO 4000 only, enter the HV Neutral CT Turns Ratio.

On T-PRO 8700



On T-PRO 4000



Protection Functions > 87N

IOmin

Per unit minimum level that operates the device 87N.

The setting value should consider CT errors.

IRs

Per unit point on the restraint axis of the differential characteristic where Slope 1 and Slope 2 intersect.

S1

Slope of first part of characteristic meeting IOmin and Slope 2.

The setting value should account for tap-changers, inrush current, CT mismatch.

S2

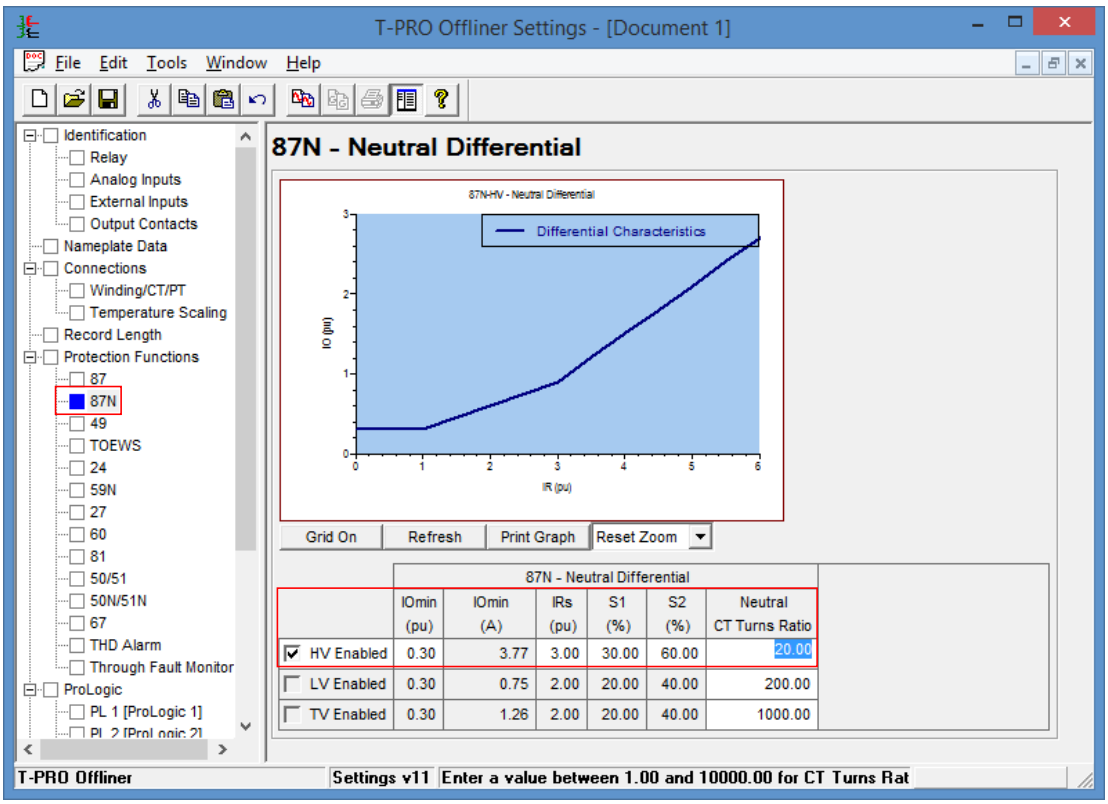
Slope of second part of characteristic meeting Slope 1.

The setting value should account for CT saturation for high magnitude currents. However, for the Reactor Neutral Differential application, it is not critical.

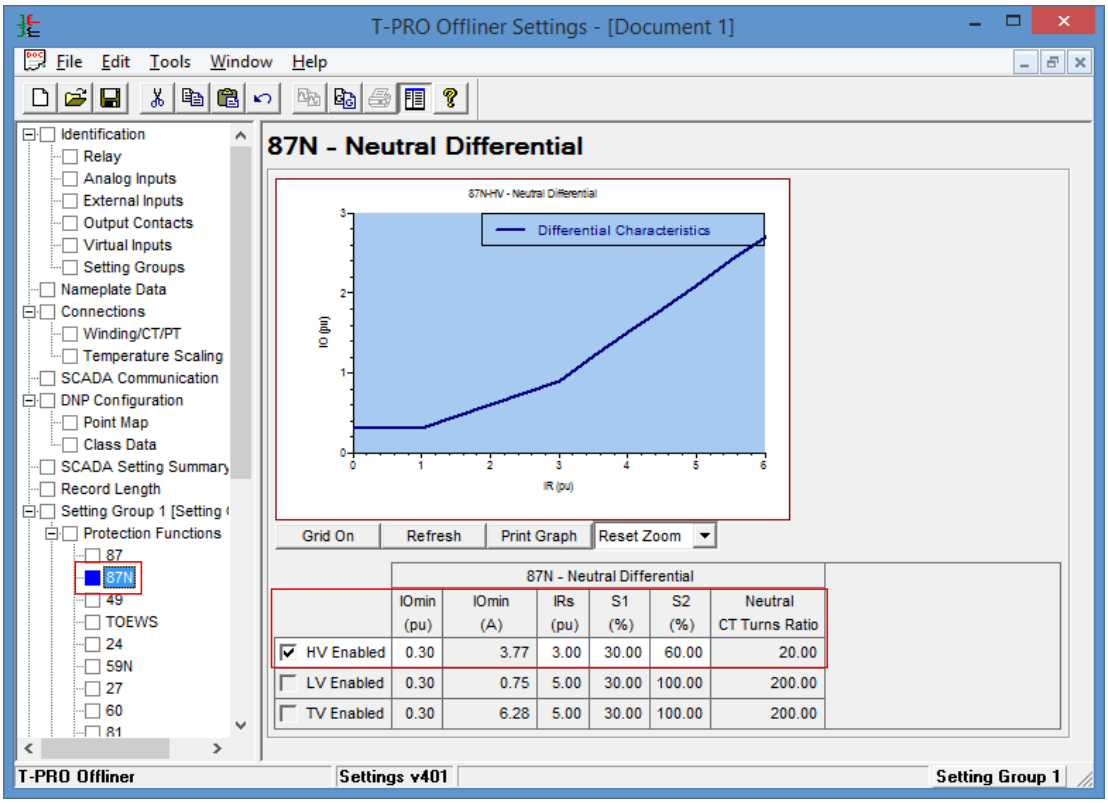
Neutral CT Turns Ratio (*for T-PRO 8700 only*)

Enter the HV Neutral CT Turns Ratio.

On T-PRO 8700



On T-PRO 4000



Protection Functions > 50N/51N (Back-up)

51N Pickup

Minimum level that operates device 51N.

Curve Type

Sets the type of curve.

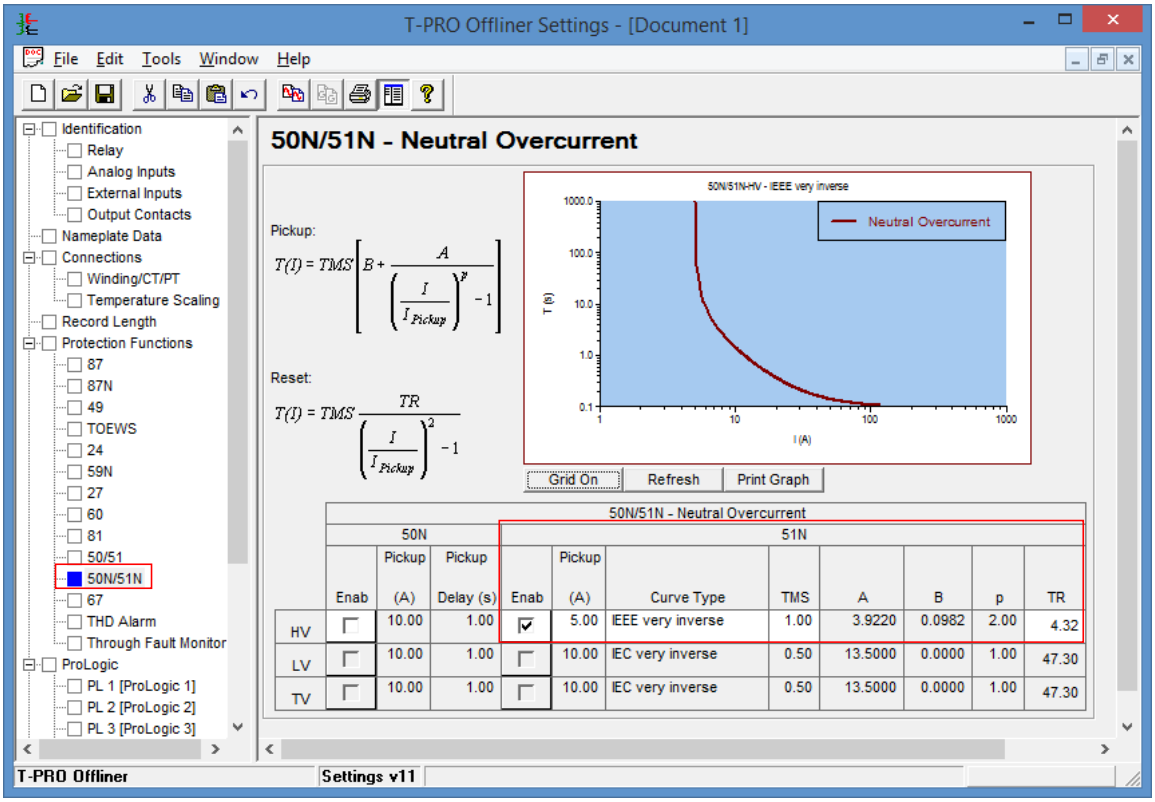
TMS

Factor for altering inverse time curve.

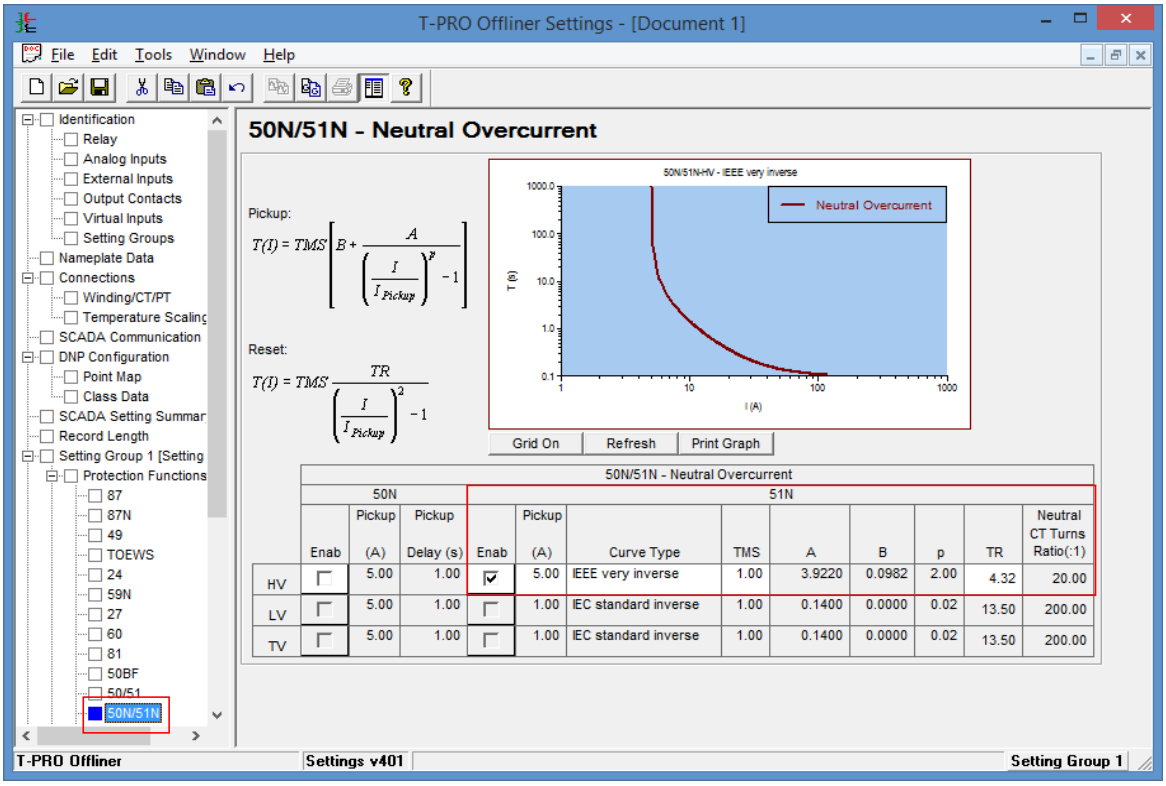
TR

Factor for altering the reset time.

On T-PRO 8700



On T-PRO 4000



Calculation Example (87N IOmin)

Assuming the following data:

System

Reactor Power = 100 MVA

HV Voltage = 230 kV

Phase CT Ratio = 100:1

Neutral CT Ration = 20:1

Setting

IOmin = 0.3 pu

Calculating the minimum pickup current

$$IOmin(A) = \frac{kVA}{\sqrt{3} * kV} * \frac{1}{Phase\ CTR} * IOmin(pu) = \frac{100 * 10^3}{\sqrt{3} * 230} * \frac{1}{100} * 0.3 = 0.75A$$

$$Magnitude\ Correction\ Factor\ (MCF) = \frac{Phase\ CTR}{Neutral\ CTR} = \frac{100}{20} = 5$$

$$IOmin(A) referred\ to\ Neutral = 0.75 * 5 = 3.75A$$

So, if a current equal or greater than 3.75A is seen by the Neutral CT, T-PRO picks up.