ETIsON *Curves* user's guide

R18.0

November 2018

Index

Introduction

ETIsON *Curves* is a software application which is useful tool for the following cases:

- draw and analyse I/t curves of protection devices,
- adjust and test settings of protection devices, study influence of changing protection curve shape,
- analyse selectivity between protective devices,
- simulate load or short circuit response of protection devices,
- defining working points and limit conditions from real applications and define corresponding protection device,
- making reports for project documentation.

ETIsON Curves allows saving user's work (Figures) under special format *.FIG* . Benefit of saving file in .FIG format is saving complete user's work (project) and open it later and continue with work. Saving under .FIG format also allow exchangeability between users of ETIsON.

Overview

ETIsON's window is shown on the picture below. ETIsON is graphically oriented SW. Main window can be devided on following parts:

- axes in logarithmic measure,
- buttons and insert fields,
- icons.
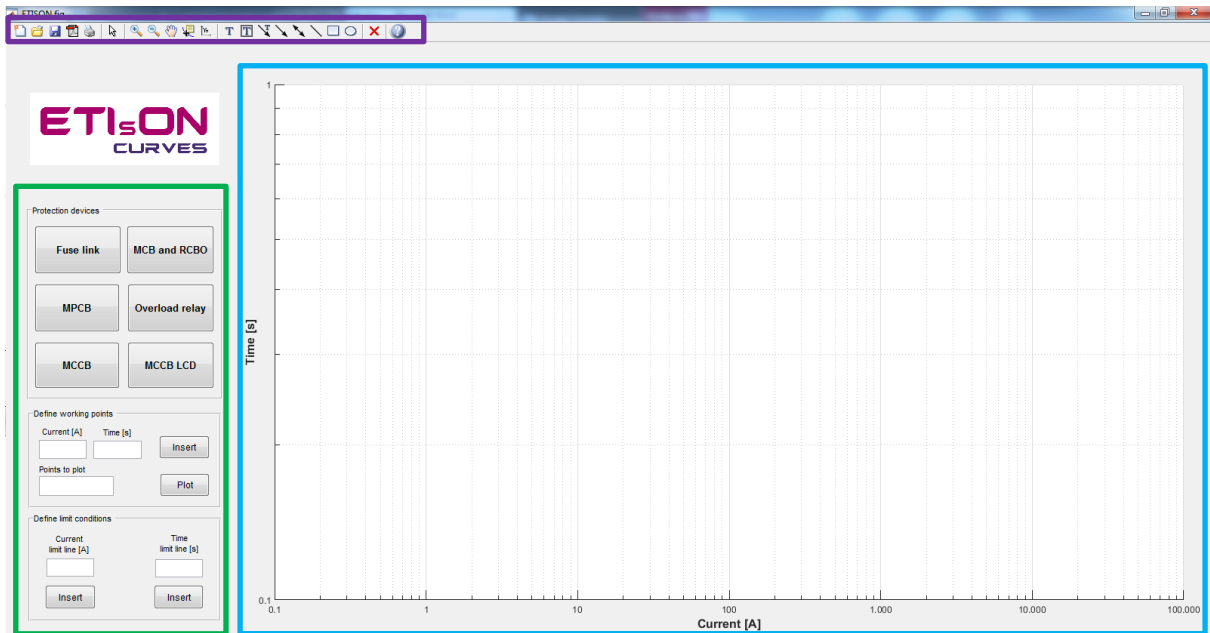
Axes

Axes area has following objects and properties:

- plot random color curves, colors are transparent in order to distinguish overlapping,
- title,
- time axis (x-axis): single unit scale [A],
- current axis (y-axis): can have single unit scale [s] or three time units [s, min, h],
- legend: links curves with correspond colors and protection device designation
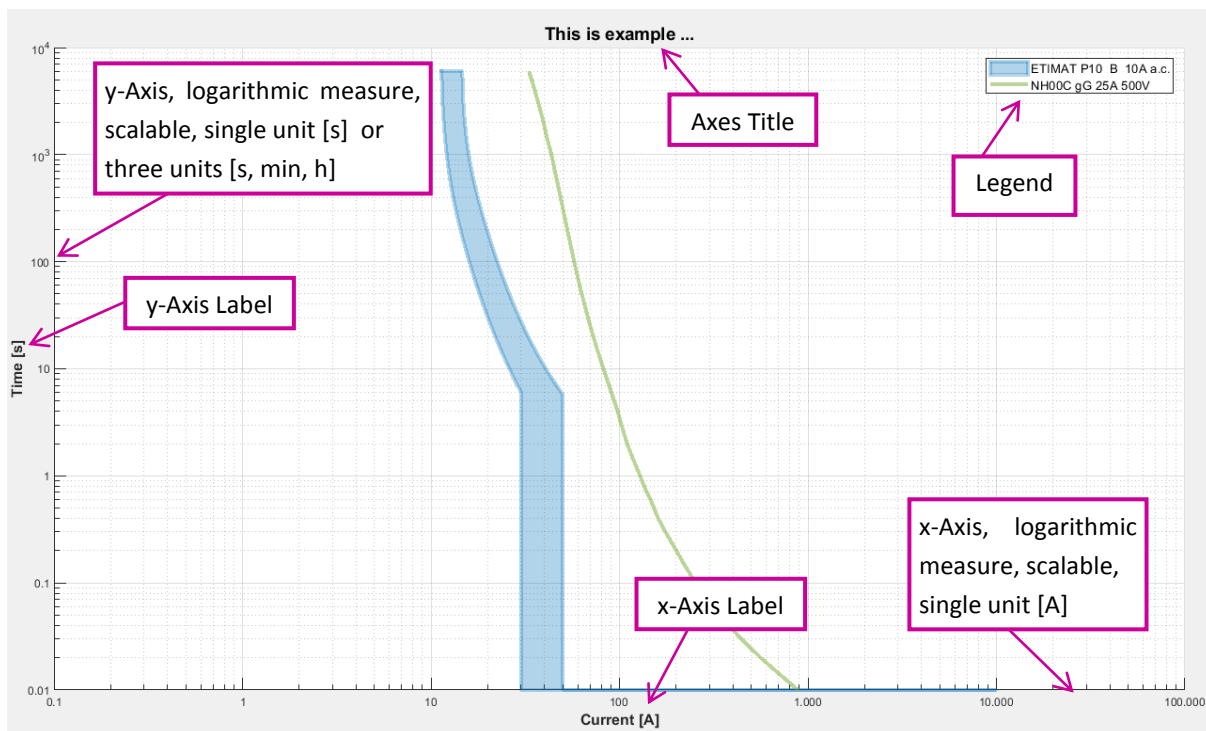
Buttons and insert fields

Buttons and insert fields with properties:

Opens graphical interface for defining Fuse-link and draw its I/t curve.

Opens graphical interface for defining & setting motor protective c.b. and draw its I/t curve.

Opens graphical interface for defining & setting MCCB and draw its I/t curve.

Working point definition inserting time & current, draw point (Insert)

Insert current limit value and draw vertical limit line.

Opens graphical interface for defining MCB and RCBO protection device and draw its I/t curve.

Opens graphical interface for defining & setting overload protection relay and draw its I/t curve.

Opens graphical interface for defining & setting LCD type of MCCB and draw its I/t curve.

Connect selected working points by line.

Insert time limit value and draw horizontal limit line.

Protection devices

Fuse link   MCB and RCBO

MPCB   Overload relay

MCCB   MCCB LCD

Define working points

Current [A]   Time [s]   Insert

Points to plot   Plot

Define limit conditions

Current limit line [A]   Time limit line [s]

Insert   Insert

Fuse-link definition

Action

Mouse click on button:

Result

Graphical interface for fuse-link definition:

Handling

In each category (column) choose a choice by mouse click. Choosing an option in current category will atomatically filter and list remain available options in next category (column). Choose a choice in each column from left to the right and finally confirm by »Draw curve«. Wrong handling is supported by screen warnings.

MCB (*Miniature Circuit Breaker*) and RCBO (*Residual current circuit breaker with Overcurrent Protection*) definition
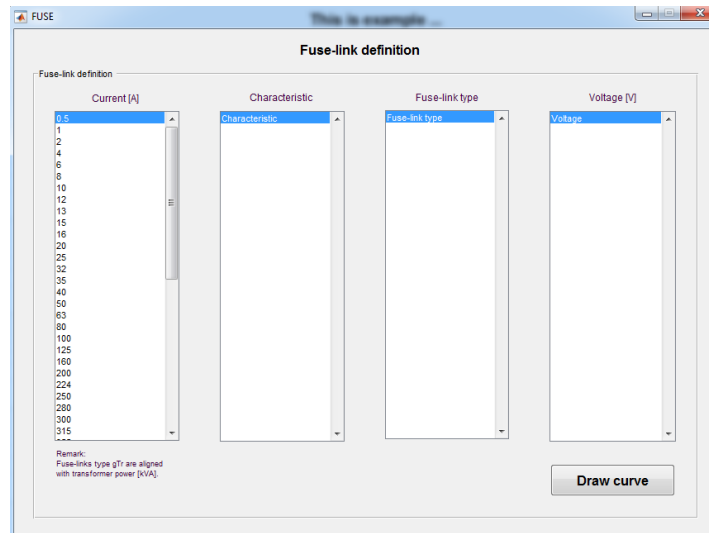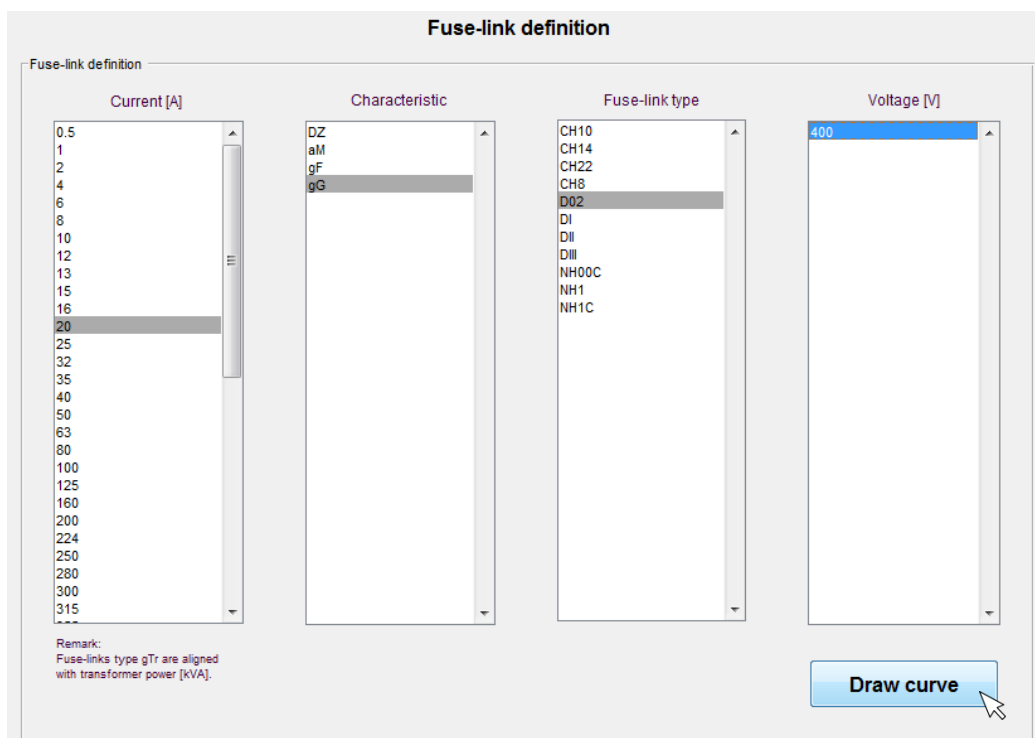
Action

Mouse click on button:
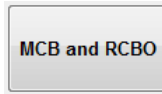
Result

Graphical interface for MCB and RCBO definition:

Handling

In each category (column) choose a choice by mouse click and finally confirm by »Draw curve«. »Checkbox« *DC curve* is automatically disabled in appropriate (visible) state if there is no option for user to choose. If »Checkbox« *DC curve* remains enabled then user is free to choose either *YES* ☑ or *NO* ☐ . D*C curve* means I/t curve in case of d.c. current.

MPCB (*Motor Protective Circuit Breaker*) definition

Action

Mouse click on button:

Result

Graphical interface for MPCB definition:

Handling

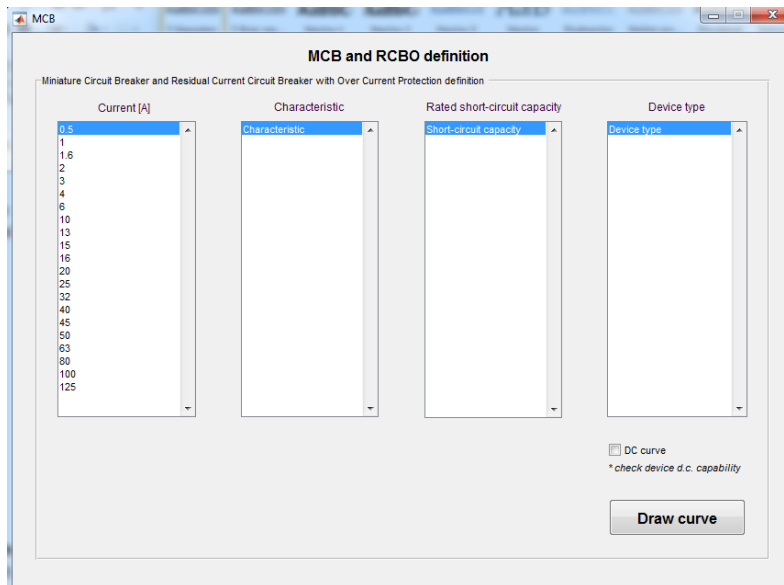In each category (column) choose a choice. Choose a choice in each column from left to the right and finally confirm by »Draw curve«. Column *Dial Settings* offers available marked dials on the real products and so I/t curve of MPCB is adjustable. Column *Protection characteristics* has option of choosing 3 phase protection curve (all phases present) or 2 phase protection curve (phase failure).
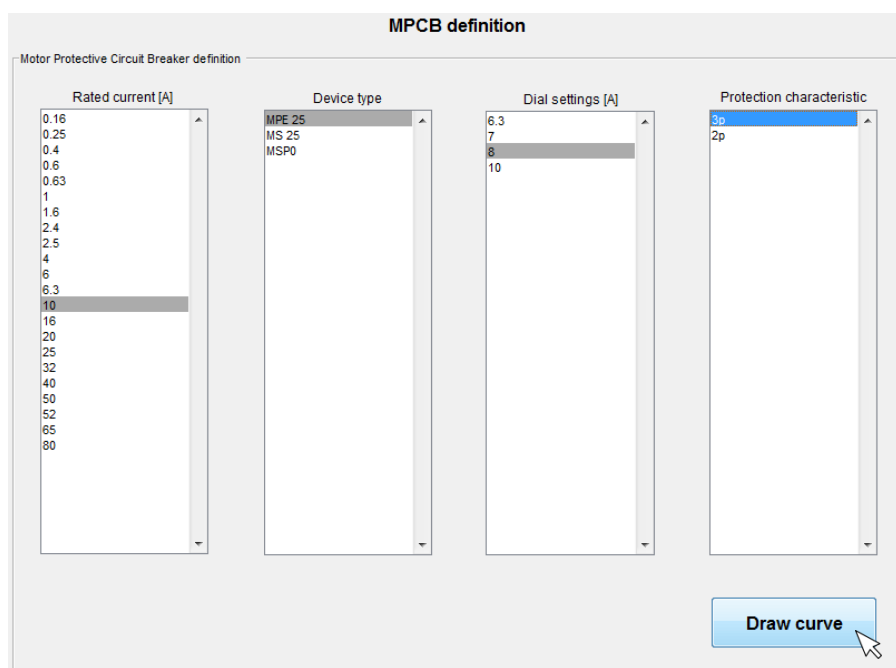
Thermal overload relay (*TOR*)

Action

Mouse click on button:

Overload relay

Result

Graphical interface for TOR definition:

Handling

In each category (column) choose a choice. Choose a choice in each column from left to the right and finally confirm by »Draw curve«. Column *Dial Settings* offers available marked dials on the real products and so I/t curve of TOR is adjustable. Column *Protection characteristics* has option of choosing 3 phase protection curve (all phases present) or 2 phase protection curve (phase failure).
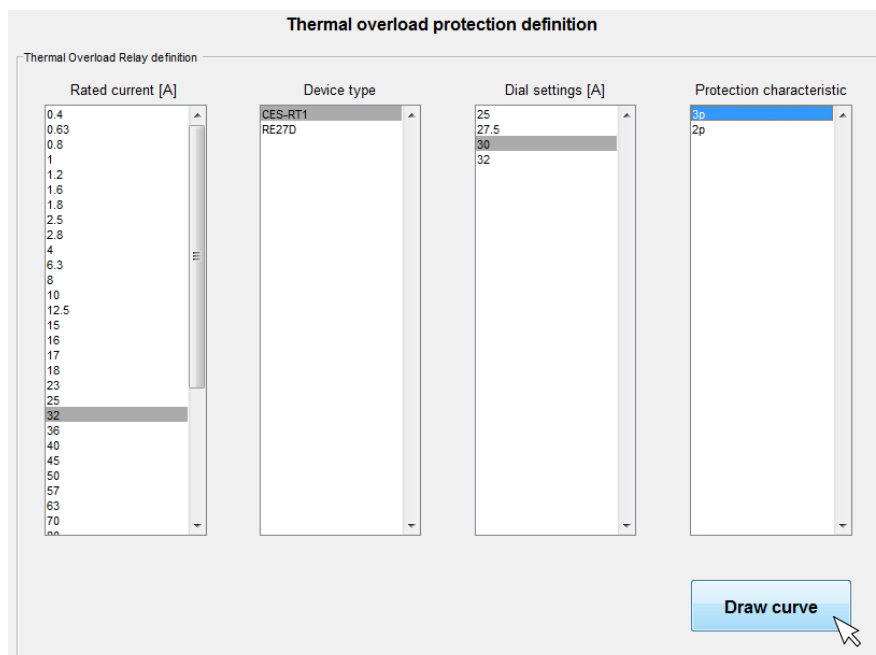
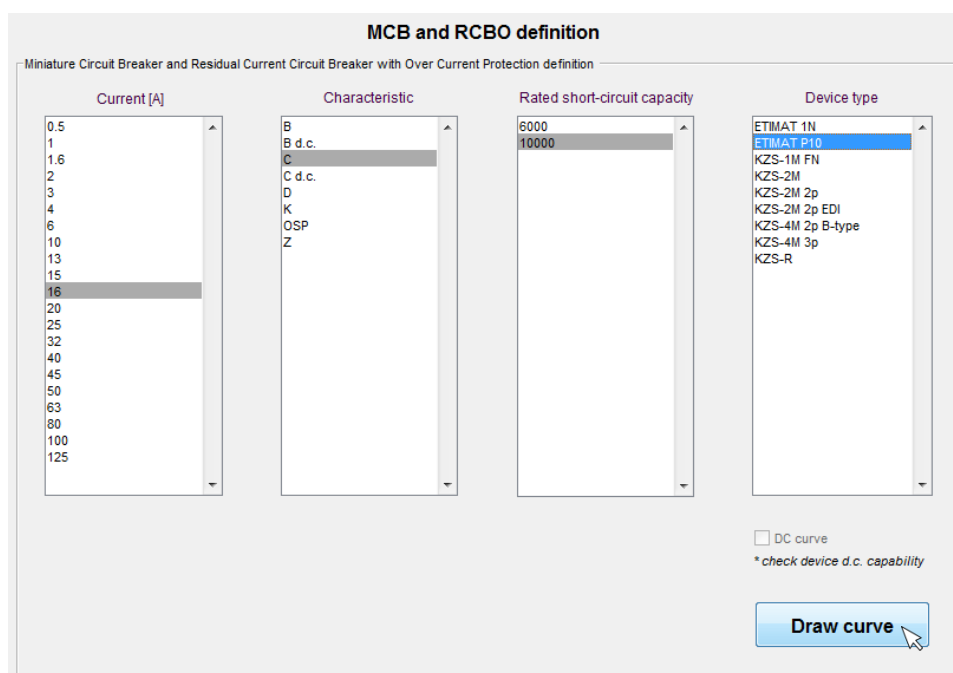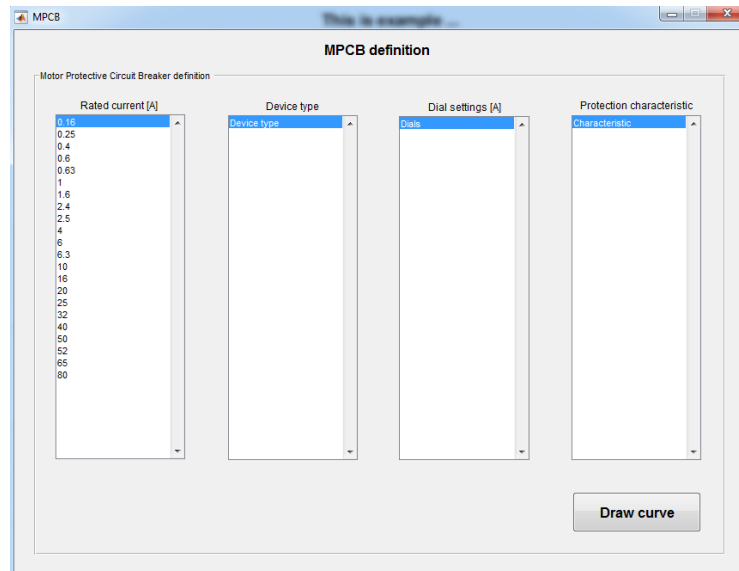# Molded Case Circuit Breaker (*MCCB*)

Action

Mouse click on button:

| MCCB |

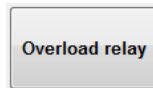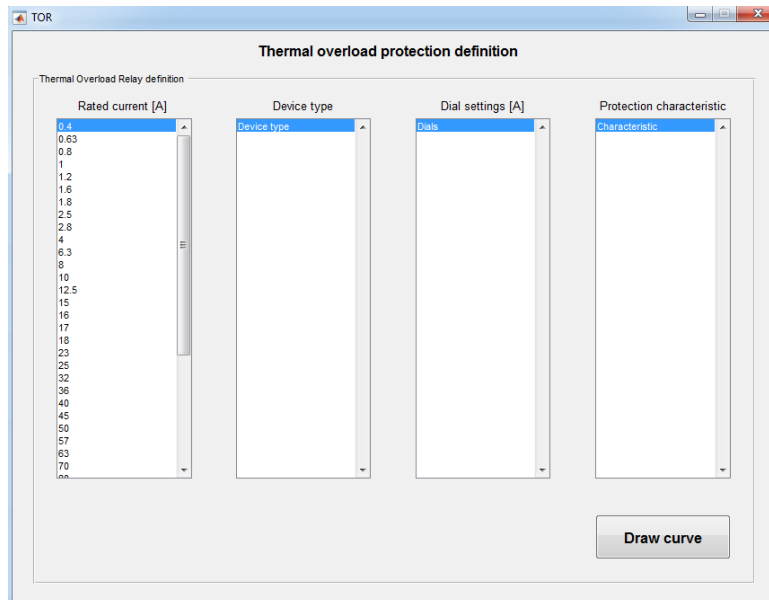**Result**

Graphical interface for MCCB definition:
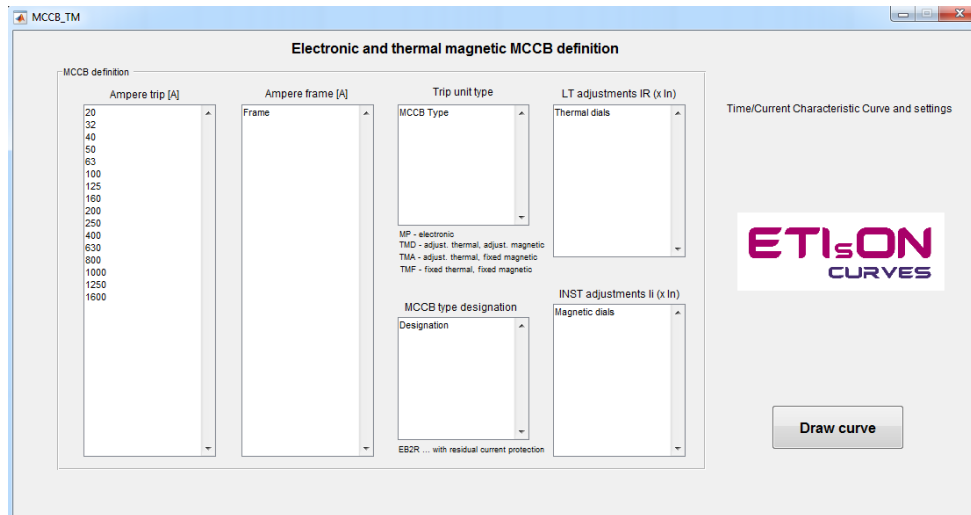
Handling

In each category (column) choose a choice and finally confirm by »Draw curve«. In Column *Trip unit type* offers available MCCBs of thermal-magnetic or electronic categories. In Column *MCCB type designation* user can choose MCCB in terms of breaking capacity. Columns *LT adjustment I_R* and *INST adjustment I_i* relate to thermal-magnetic types while electronic types get appropriate but different category to choose. In case of electronic type category *INST adjustment I_i* automatically change:

INST adjustment I_i ---> *Characteristics*. In case of thermal-magnetic or electronic type setting adjustment is supported by symbolic drawing in order to understand influence of each dial knob. Final settings of protection device are visible on legend which is shown on axes.

# Molded Case Circuit Breaker type LCD (*MCCB LCD*)
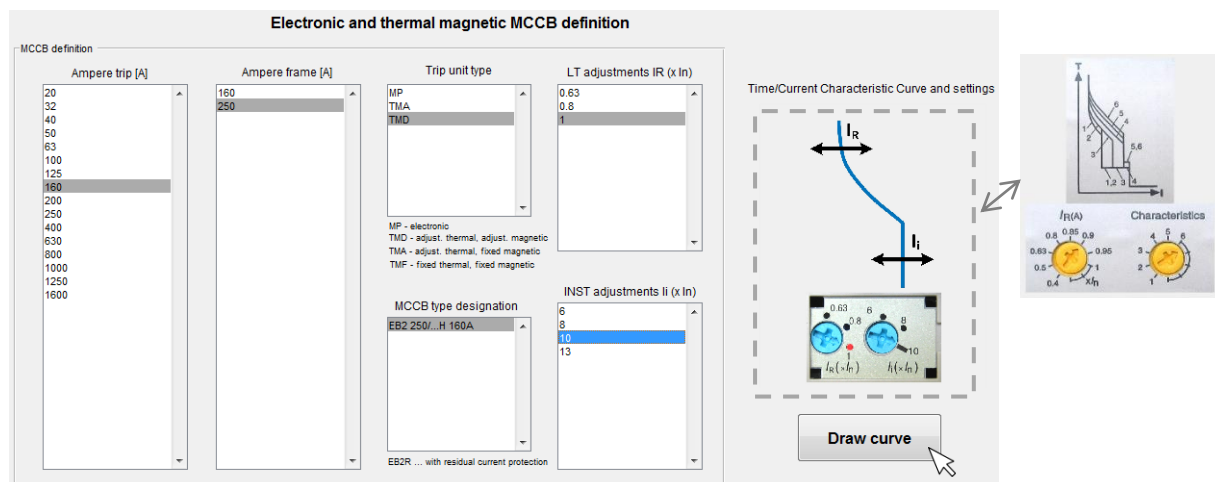
Action

Mouse click on button:

Result

Graphical interface for MCCB LCD definition:
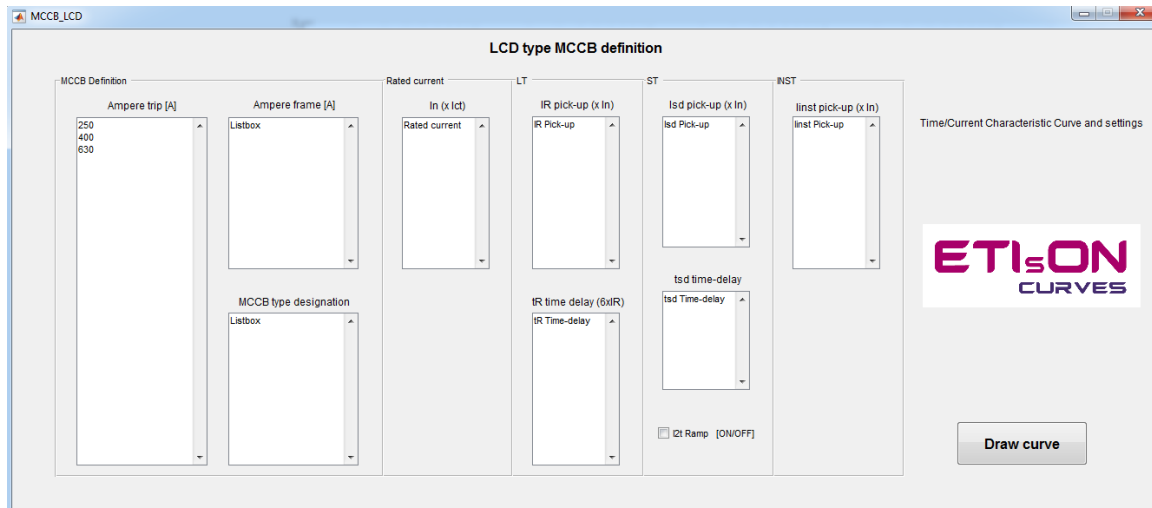
Handling

In each category (column) choose a choice and finally confirm by »Draw curve«. MCCB LCD is advanced product which demands from user deeper knowledge about protection design concepts and as well as knowledge about basics and abillities of MCCB electronic type.

Generally MCCB LCD type offers a wide range of freednom for user in terms of settings. In order to simplify setting task ETIsON include a wide range of screen warrings for the user in order to assure settings that are possible or have sense. Best way to get experiences with the product is to start using ETIsON. Setting adjustments are supported by symbolic drawing (right side of the definition window) in order to understand influence of each dial set. Final settings are visible on legend.
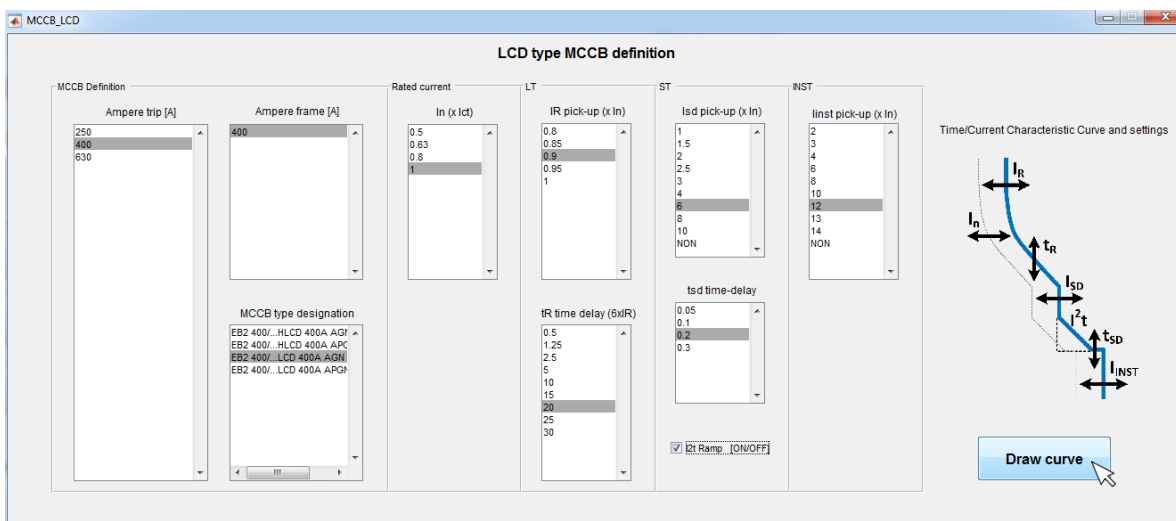
Working points

Action

1. Insert working point

Define working point coordinates by inserting values of current (edit field 'Current') and time (edit field 'Time'). Values confirm by button 'Insert'. Working point will appear on the axes (red asterix).

2. Connecting working points with line

If there are two or more points on the axes available then is possible to connect them with line. In order to connect the points is necessary to insert indexes of the points in the field 'Points to plot'. Index nr. of each plot is listed on the legend like *» x# «*. Example: if exist working points #3, #4, #6, #9 and we want to connect first two and the last one then in the field 'Points to plot' insert indexes like follows: 3,4,9 and confirm with button 'Plot'. Delimiters in the field 'Points to plot' can be »,« or ».« . Points with indexes #3, #4 and #9 will be connected with line.

Example

We want to analyse motor protective circuit braker in combination with motor load characteristics. We choose a curve of motor protective device MPE25 6.3 – 10A 3p and draw it on the axes. In addition we insert working point #1 with current 100A and time 5s. It is shown on the axes as red asterix marker. Additionally we inserted working point #3 which shows peak current of the motor in DOL start. Points #4, #5, #6 and #7 are approximation of motor current in steady state conditions. Points 4 … 7 we connect on the way as shown below in the field *'Points to plot*'. Connection between points is dark blue dotted line. Below graph is final result of this example.

Defining point #1:

Points we want to connect:

MPCB and motor I/t response
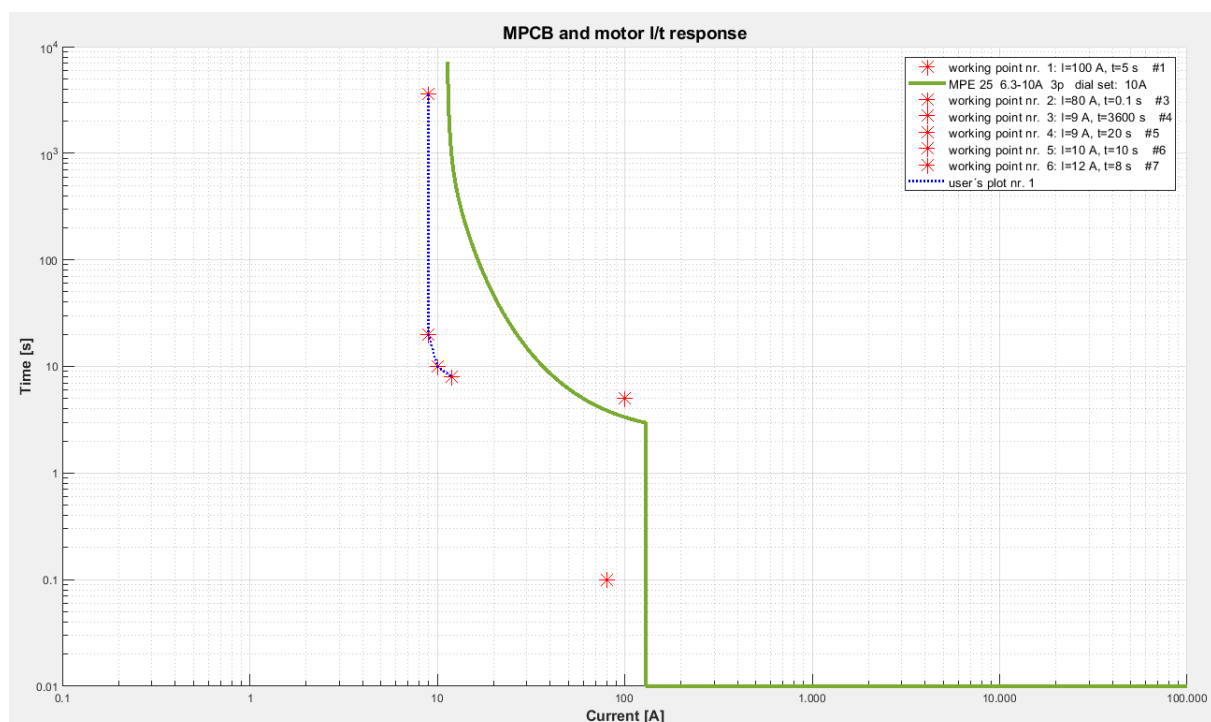
Limit conditions

Action

1. Insert Current limit condition

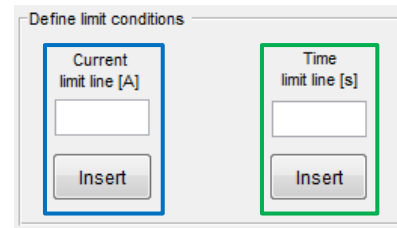Define current limit condition by inserting value of current »Current limit line«. Value confirm by button »Insert«. Current limit line will appear on the axes (dashed magenda vertical line).

2. Insert Time limit condition

Define time limit condition by inserting values of time »Time limit line«. Value confirm by button »Insert«. Time limit line will appear on the axes (light blue horizontal line).

Example

We have a bunch of curves on the graph and we want to set limit conditions of our application in order to make sure we are within limit conditions (on the safe side).

Current limit nr. 1 we set for max. short circuit current value can happen in the system (8000 A) and this value is the limit for breaking capacity of protection devices.
Current limit nr. 2 we set as peak starting current of the load (50 A). Instantaneous part of RCBO must not trip during starting the load (instantaneous part has to be on the right side of the vetical line)
Time limit nr. 1 we set on 5 s. We have to make sure protection devices trip earlier or up to 5 s max. in case of installation failure downstream protection device location in the installation (additional measurements of the installation or calculations must be done to define failure currents of the circuits …).
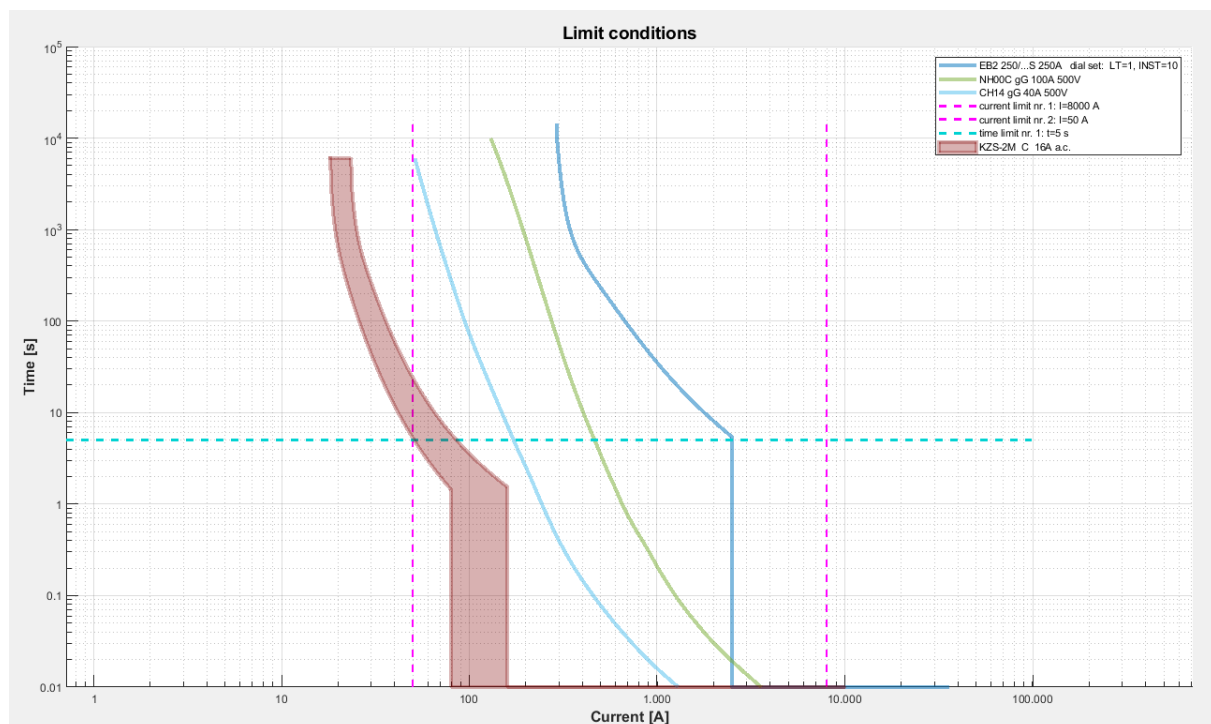
Icons

Icons are located on the top left side of the ETIsON Curve window. Icons are following:

Tip

If cursor is placed and stand still on the icon then 'Tooltip text' apper and explain meaning of the icon.
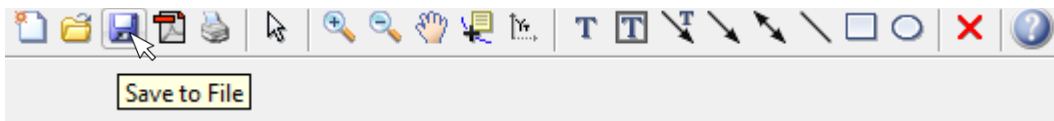
New Figure

Appearance of the icon:

Meaning

Make new empty figure (new window with empty axes).

If figure exist already by pressing icon 'new' user is first asked about saving existed project. Upon user's choice afterwards open a new figure (empty axes).

Use

- in case of cleaning all curves or objects from the axes at once,
- open new project.

Example

Window with question about saving current figure before open new blank one.

Open

Appearance of the icon:

Meaning

Open figure from file with ending **.FIG** .

OPEN function in ETIsON is valid only for files type *.fig* .

By pressing icon OPEN user is warned about saving existed project in order not to loose it.

Pressing icon OPEN and choosing file ending with .fig ETIsON will open the choosen file and allow to the user to change it (add curves of objects, delete, save again).

ETIsON does not support openning graphic files like: .JPG, .PNG, .BMP, .TIF, etc.

Remark

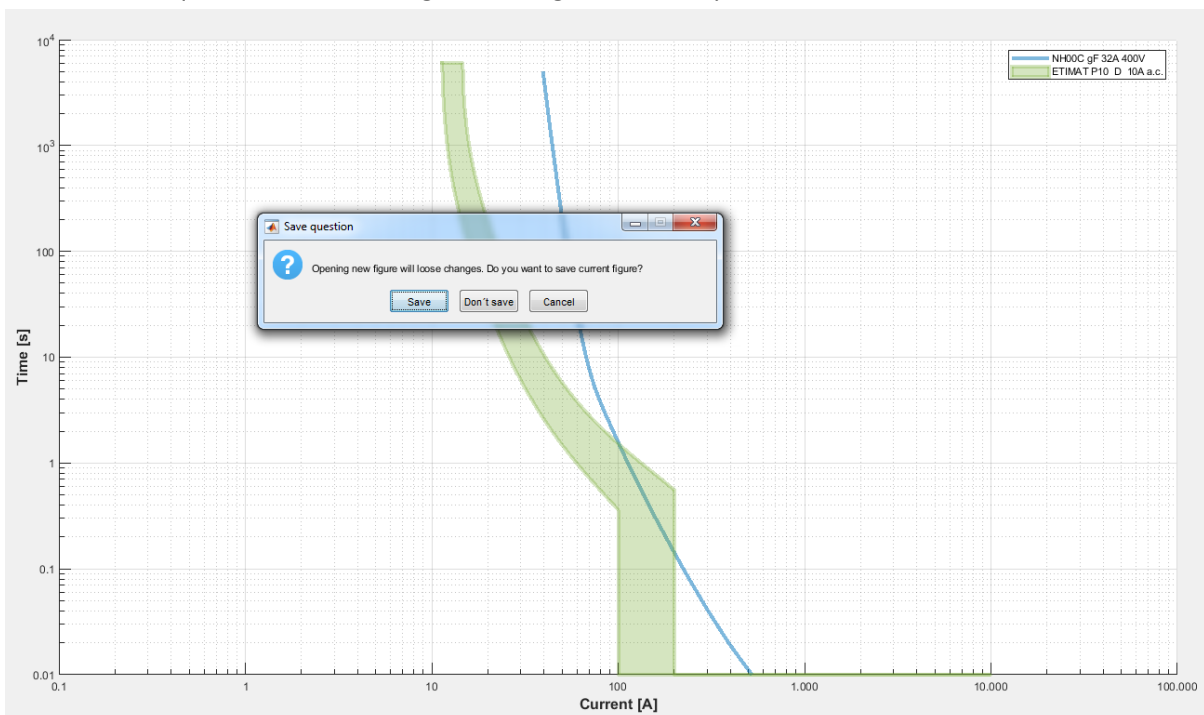*Default folder for saving/opening projects in ETISON is folder with name 'Projects' and is located one level lower than ETISON.EXE file. Pay attention during ETIsON installation.*

In any case user is free to choose other target folder for opening or saving.

Use

- opening the project again with full functionallities by adding, deleting or changing,
- exchangeability between users of ETIsON (sharing and openning between users).

Save

Appearance of the icon:

Meaning

Save to a file.

Suported formats:

- Graphical formats: .jpg, .png, .bmp, .tif
- Figure format (ETIsON format): .fig

By pressing icone SAVE menu for saving appear. User can choose target folder for saving, file format and the name of the file.

Created graphical files (.jpg, .png, .bmp, .tif) cannot be open in ETIsON (use viewers for graphical files already installed on computer). OPEN function in ETIsON is valid only for files type .fig .
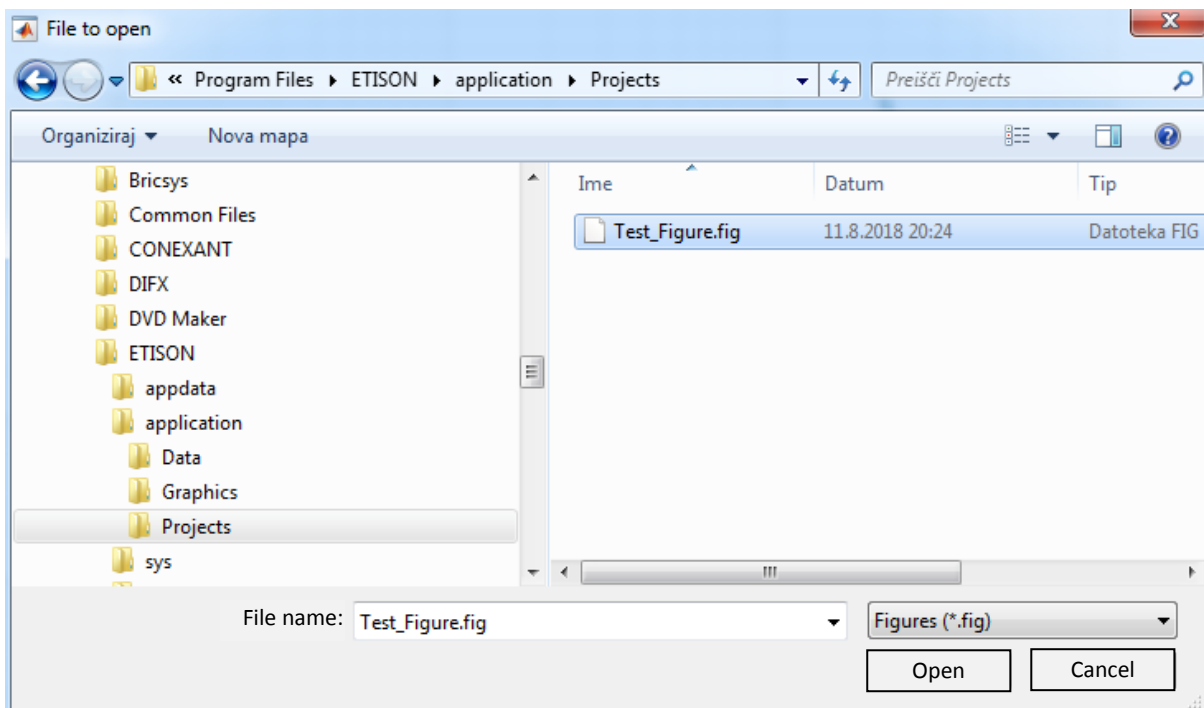
Remark

Default folder for saving/opening projects in ETISON is folder with name 'Projects' and is located one level lower than ETISON.EXE file. Pay attention during ETIsON installation.

In any case user is free to choose other target folder for opening or saving.

Use

- Saving for creating reports, analyses, for the project documentation and later re-load again with full functionallities by adding, deleting or cahanging,
- exchangeability between users of ETIsON (sharing and openning between users).

Create PDF, Print Axes

Appearance of the icons:

Meaning

Create PDF: create a PDF format and save it to a file.

Print Axes: send current axes to the printer.

By pressing icon *Create PDF* a menu for write to a file appear. User can choose target folder for saving and name of the file.

By pressing icon *Print Axes* a menu for printing appear. User can choose printer for printing current axes.

Pointer (figure pointer)

Appearance of the icon:

Meaning

Pointer icon is used for selecting and marking objects on the axes.

When pointer is enabled then Axes go into *Edit mode*.

Pointer icon is toggle icon (by pressing it stays in ON (enabled) or OFF (disabled) position).

Pointer by itself has no deeper function but is frequently supported by another icon with additional function.

Pointer tool is typically used with one of the

following icons (or its object in case of annotations):

Action:

1. Activate *Pointer tool* and mark object on the axes

2. Object and be cleared (use icon 'X') or changed (annotations)

Active pointer tool can be used also to edit legend (see chapter Legend).

Zoom In, Zoom out

Appearance of the icons:
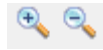
Meaning

Zoom In: zoom (magnify) the selected detail on the axes

Zoom Out: opposite as Zoom In

Use

Zoom In and *Zoom out* are toggle icons (by presing it stays in ON (enabled) or OFF (disabled) position).

When Zoom function is enabled then cursor on the axes change to 'cross'.

Case for Zoom In:

1. activate *Zoom In* icon,
2. click on left mouse button and hold (inside axes area),
3. move mouse and make a rectangle which has to be Zoomed (magnified),
4. release left button,
5. if more zoom is needed just repeat above steps 2, 3 and 4.

Tip

Doubble click on mouse left button while Zoom is enabled revert drawings to the original screen size.

Example

Enable *Zoom In* icone.

Mark area with rectangle. The area will influence Zoom In tool.

Final drawing on the axes.
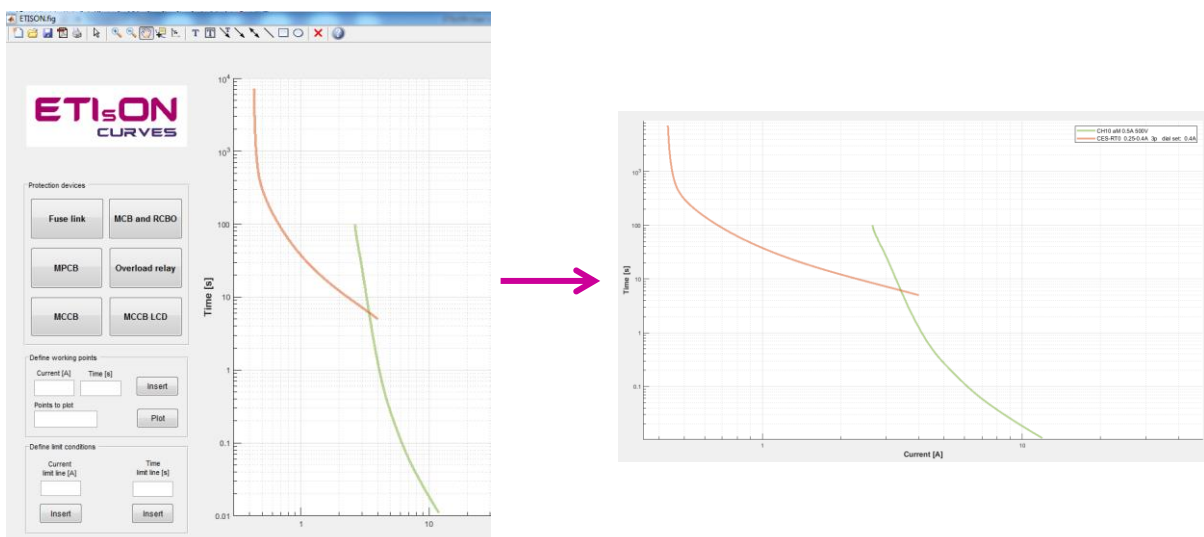
Pan

Appearance of the icon:

Meaning
Grab axes and move it in all directions.

Use
*Pan tool* is used in cases if user want to change positon of the drawings on the axes.
Pan tool is a toggle icon (by pressing it stays in ON (enabled) or OFF (disabled) position).
When Pan function is enabled then cursor on the axes change to 'hand'.

Case for *Pan tool*:
1. enable *Pan tool* then click on left mouse button and hold (hand will grab the axes),
2. move mouse and same time axes area will follow to the mouse moving on the screen,
3. find appropriate position of the dawing and release left mouse button.

Example
Move drawings in the center of the axes.

Data Cursor

Appearance of the icon:

Meaning

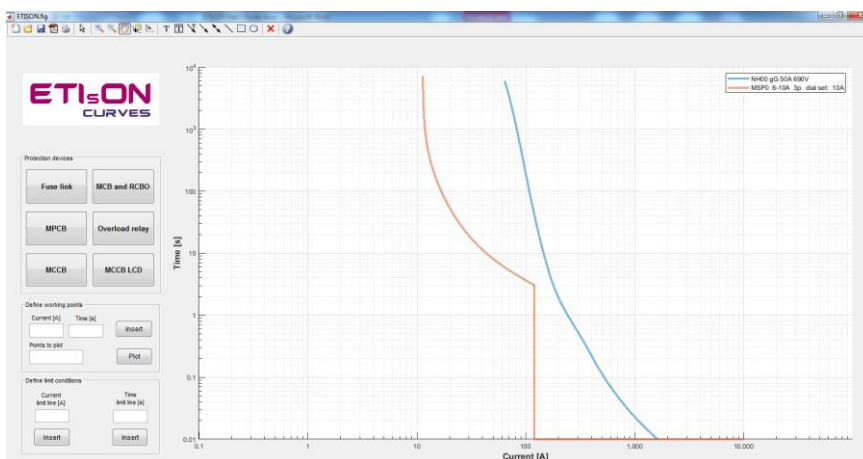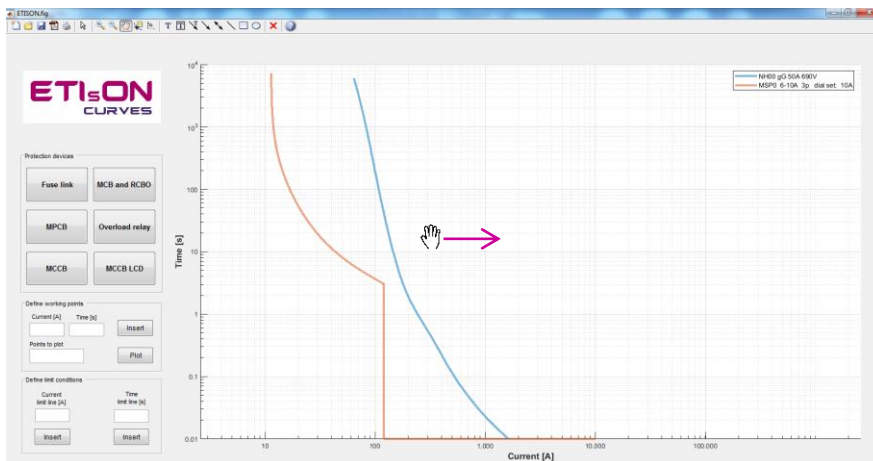Get coordinates (current and time) of the current postion on the curve.

Use

Data Cursor tool is used in cases if user want to get values of current and time of certain point on the curve. *Data Cursor* tool is a toggle icon (by pressing it stays in ON (enabled) or OFF (disabled) position). When *Data Cursor* tool is enabled then cursor on the axes change to 'thick cross'.

Case for *Data Cursor* tool:

1. Enable *Data Cursor* tool then set cursor on desired positon on the curve and make short click on left mouse button. A black square marker will appear on the curve together with light yellow textbox containing values of the coordinates (current and time).
2. Right click on the black square marker offer an option »Selection Style« which additional offer »Mouse Position« and »Snap to Nearest Data Vertex« options. For finding precise position on the curve choose »Mouse Position« which automatically enable precise interpolation between data vertex. Combining *Zoom In* tool + »Mouse Position« offer extremely precise positioning of the desired point on the curve.
3. If more Datatips have to be placed make right click and choose »Create New Datatip« to add more.
4. If certain Datatip has to be deleted make right click on the Datatip which has to be deleted and choose »Delete Current Datatip«.

Tip

Yellow textbox can have different positions. Left click and hold the button on the textbox + moving the mouse will show possible 4 positions (see example below).

Example

Define point of intersection between the curves and mark it with Datatip.
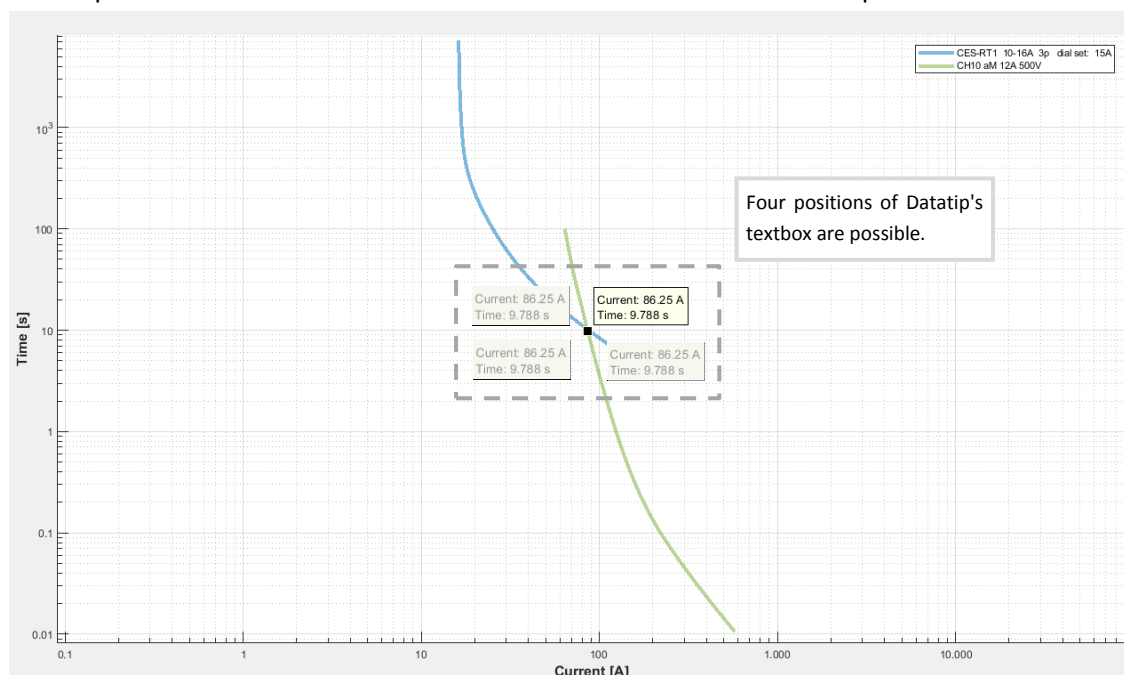
Y-axis Unit

Appearance of the icon:

Meaning

Switch between time units: *one time unit [s]* OR *three time units [s, min, h]*

Use

Y-axis Unit tool is used in cases if user want to switch time axis units. In some cases more appropriate unit is second [s] while in some cases user is more familiar with minutes or hours.

Action

Click on *Y-axis Unit* icon and a question dialog will apper.
Choose one of the available options.
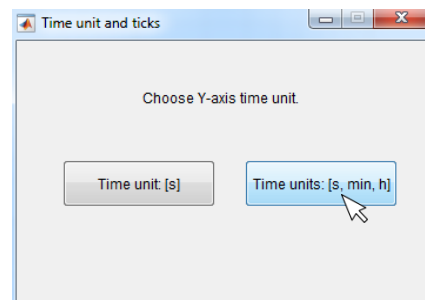
Example

Switch between time units.
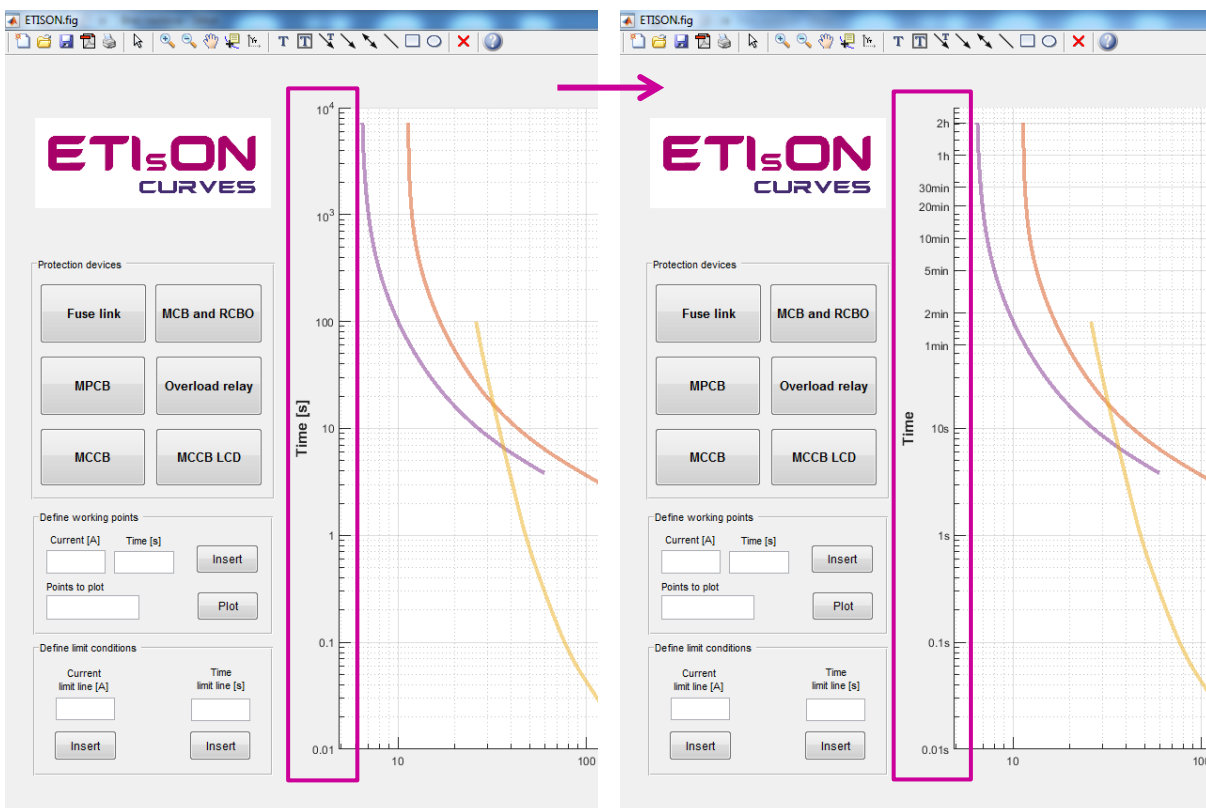
Add Title

Appearance of the icon: T

Meaning

Add title to the axes.

Use

Add Title tool is used for adding title to the axes.

Action

Click on *Add Title* icon and a insert dialog will apper. Type text for title and confirm with OK.

Example

Add title to the axes.

Annotation tools

Appearance of the icons:

Meaning

Objects to be added in order to coment, mark or stress properties.

Use

Add annotations to clarify, stress, emphasize certain properties about curves or relations between curves.

Action

Click on above shown icons and appropriate annotation tool will automatically appear on the axes. To move or orient annotation toll in appropriate position Pointer tool must be enabled (edit mode).
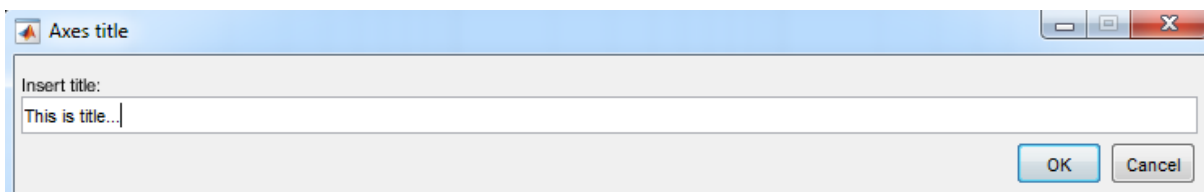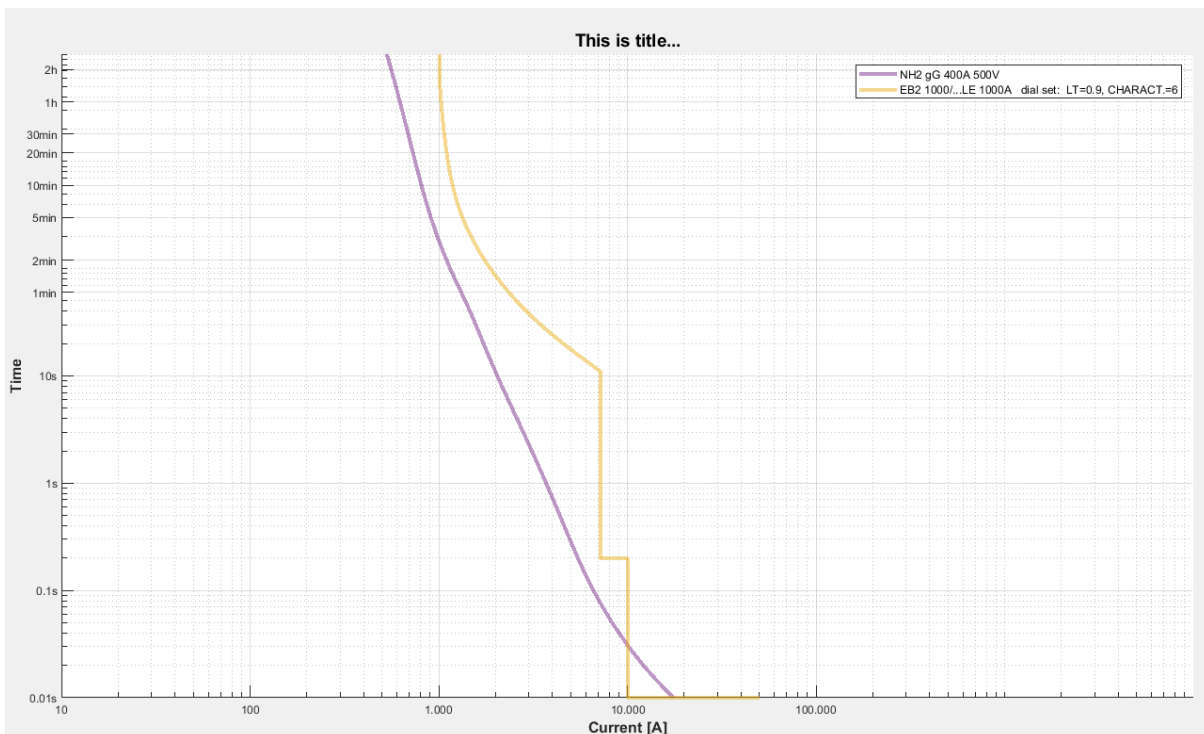
Tips

When editing annotations *Pointer tool* must be enabled.

To insert text in *Textbox* for comments make double click on yellow area to enter edit text mode.

To insert text in *Arrow with text* annotation make double click on text area (Text to add …)

To move annotations: enable Pointer tool + click left button and hold button upon annotation tool + move (orient) to wanted position.

To change size of annotation: short click on annotation to select it and cursor will change to four arrows. Move cursor on the selection marker (small blue square) and cursor will change into double (diagonal) arrow then click and hold button and mouse move will change annotation size.

Example

Show available annotation tools (on left side in magenda rectangle) and annotations in practical use (in the middle of axes).
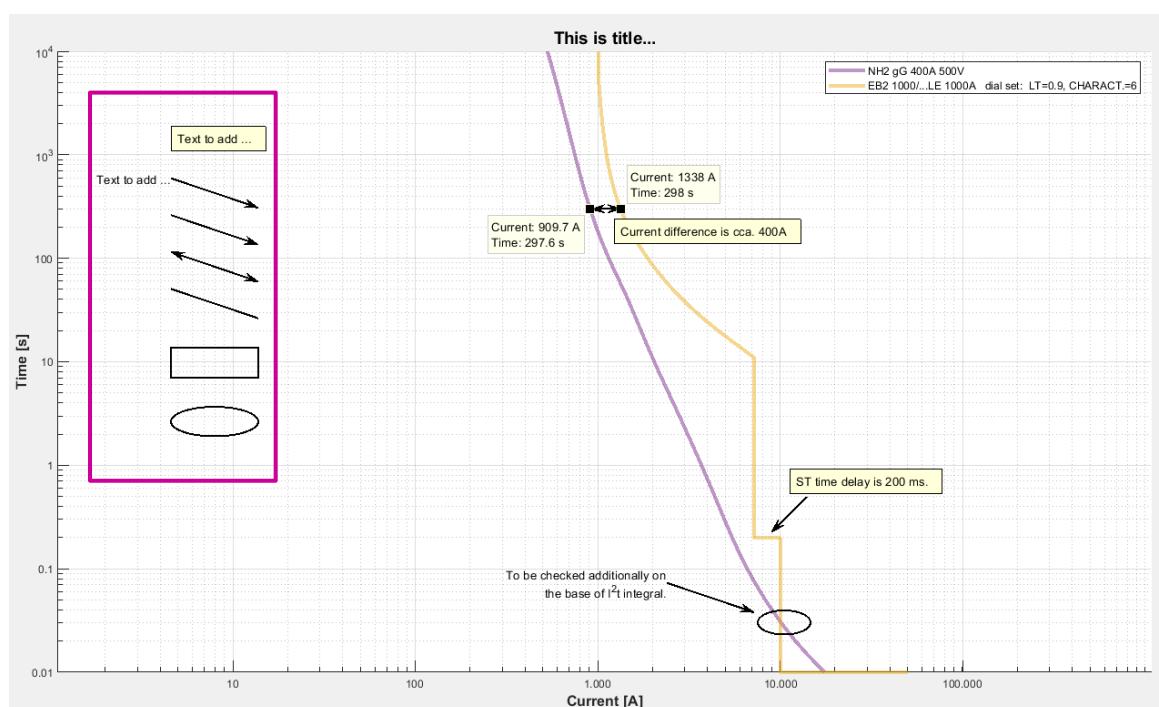
Clear object

Appearance of the icon:

Meaning
Clear selected object from the axes.

Use
Used to clear objects from Axes. Objects can be: curves, working points, line between working points, limit line, annotations.

Action
Enable *Pointer tool* and click on object on the axes to select it. Click on the *Clear object* icone and object will be cleared.

Case for *Clear object* tool:
1. enable *Pointer tool* then click on object that has to be cleared. Object will be selected.
2. Press icon *Clear object* and selected object will be cleared.

Tip
Datatip cannot be cleared by using *Clear object* tool but only with option related to Datatip (enable icone Data Cursor and press right button on the mouse and option for clearing will appear).

Example
Fuse-link curve is selected (blue square markers) to be cleared.
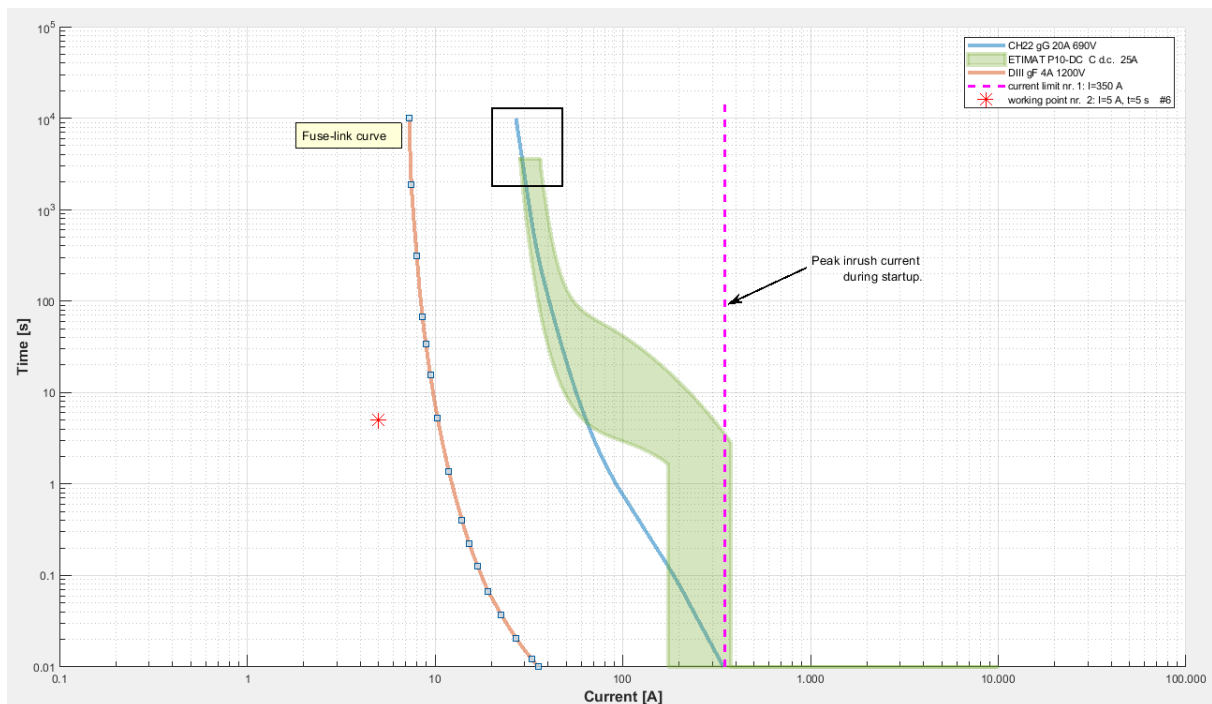
About ETIsON

Appearance of the icon:

Meaning
Get information about ETIsON version and check for updates.

Use
Additonal information about owner of the software and checking for updates.

Action
Click of icon *About ETIsON* will open dialog window with two options to choose.

Example
Check if update is available.

Legend

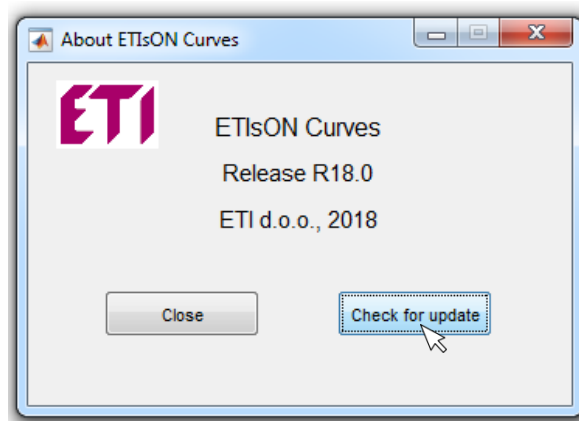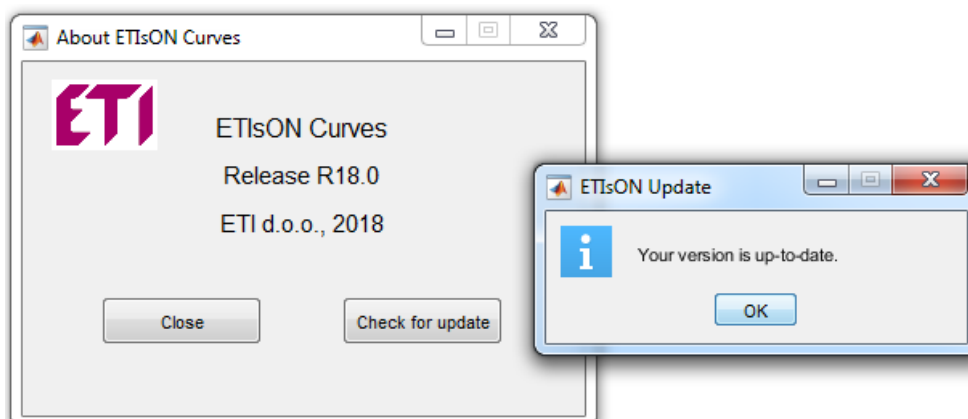Legend is inserted and updated automatically. Legend link curves with correspond colors and supplement with protection device designation.

Legend is fundamental part for understanding curves. In case of protection device with adjusting possibilities legend show dial settings of curve which is drawn on the axes. If protection curve is optimised by iterations then previous settings shown on the legend will be most wellcome.

Beside protection devices' designation legend show also user's working points, line with connected working points, lines showing limit conditions. To distinguish these objects on legend they are shown with rising unique indexes.

If object which is shown on the legend is cleared from the axes legend will be automatically updated (indexes as well) when first next object will be drawn on the axes.

Right button click on the legend offer additional options in relation with legend (see below example). **Left button click** and hold enable an option to move and set the legend anywhere on the axes. Default legend position is 'north-west'.

Double click on certain item inside the legend activate 'Edit legend' mode. Once this Edit legend mode is activated then user can edit text inside the legend (clear or add text).

Example

Data shown on legend, right click on legend show available options
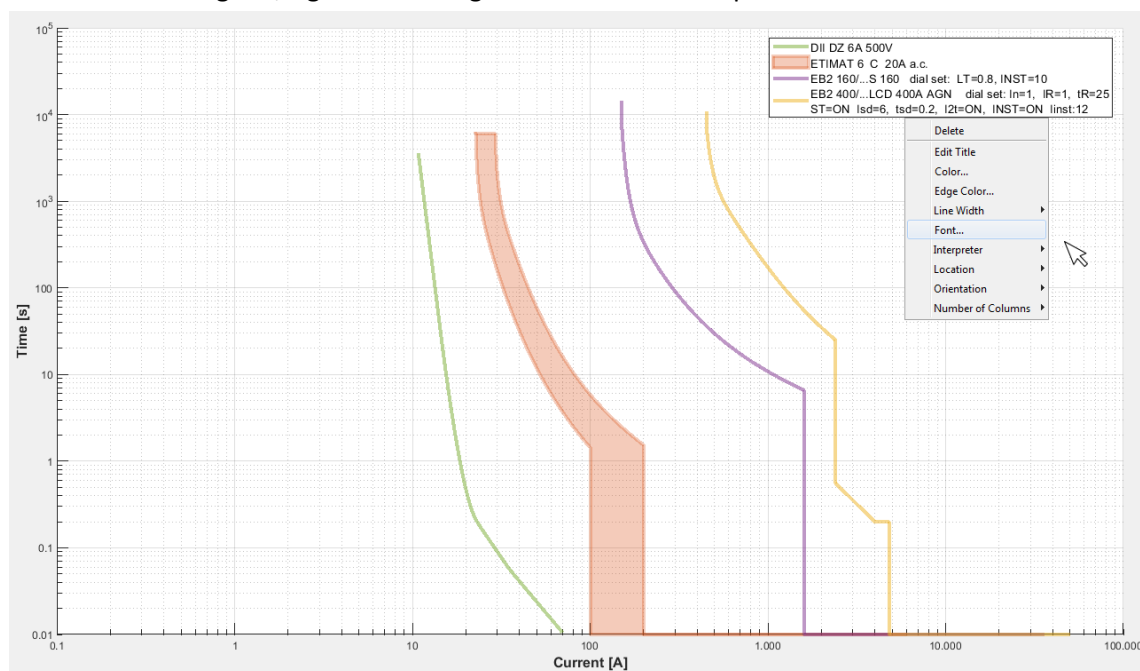
TIP: If legend is deleted (unwanted) it can be fully restored by inserting next plot on the axes.

Examples

Hereinafter we are presenting two illustrative examples which show possible use of ETIsON by simplifying and solving everyday's problems designes are faced with.
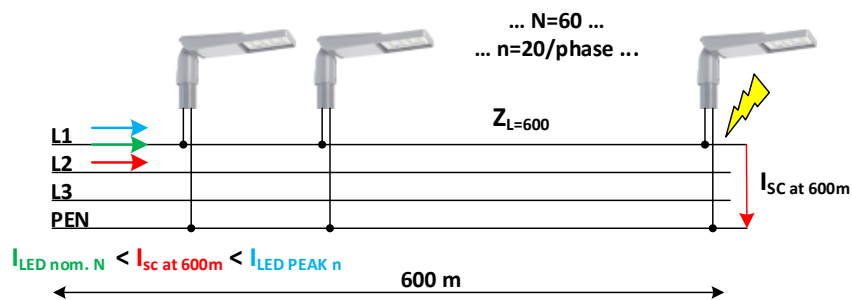
Example 1: **LED light protection design**
Example 2: **DOL motor starter in combination with induction motor having high inrush current**
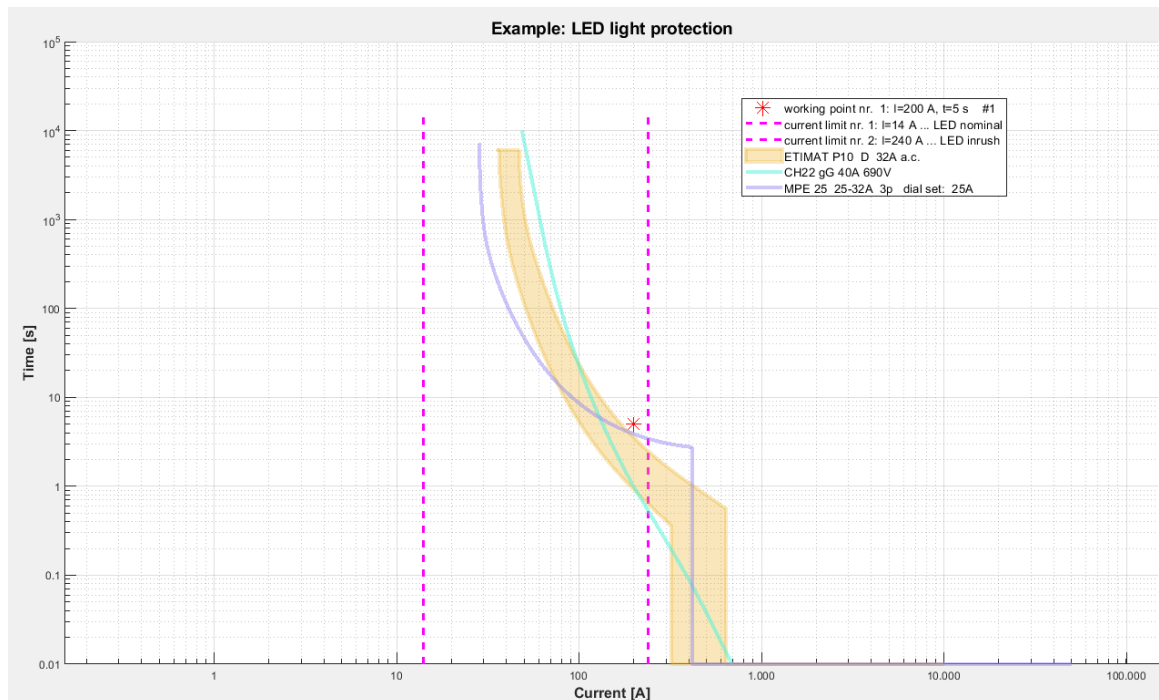
Example 1: LED light protection design

Presume there is line of 60 street lights (LED lights) connected on three-phase system (20 lights per phase equally distributed all over the distance). Total line distance is 600 m. The task is to find appropriate protection device.

Data 1: Line

Line length: 600m

$I_{sc\ at\ 600m}$ = **200A** (max. short circuit current at the end of line)

$T_{max\ OFF}$ = **5s** (max. switch off time of protection device)

Data 2: LED nominal current

Single light power: P=150W

Supply: 230V

$I_{LED\ single}$ = 0,7A

N = 20 lights/phase

$I_{LED\ nom.\ N}$ = **0,7*20 = 14A**

Data 3: LED inrush current

$I_{LED\ PEAK\ inrush}$ = **12A / LED light**

N = 20 lights/phase

$I_{LED\ PEAK\ n}$ = **240A**

... N=60 ...
... n=20/phase ...

$Z_{L=600}$

L1
L2
L3
PEN

$I_{SC\ at\ 600m}$

$I_{LED\ nom.\ N}$ < $I_{sc\ at\ 600m}$ < $I_{LED\ PEAK\ n}$

600 m

Finding solution with ETsON:

Example: LED light protection

working point nr. 1: I=200 A, t=5 s   #1
current limit nr. 1: I=14 A ... LED nominal
current limit nr. 2: I=240 A ... LED inrush
ETIMAT P10 D 32A a.c.
CH22 gG 40A 690V
MPE 25 25-32A 3p   dial set: 25A

Working point is set on worst case condition (end of the line is s.c. current the lowest) and trip time must meet the condition T <= 5 s. This means appropriate curve has to trip faster (to be »below« the working point). **LED nominal current limit line** indicate protection curve must be more to the righ (protection device must not trip under nominal conditions). Finally **LED inrush limit line** indicate current at the moment of switching ON the LED lights. Protection device must not trip during switch ON the lights which means instantaneous part of the curves must be over inrush limit current (be on the right side of the limt line). Alternatively fuse-links trip time must be still long enough (if inrust transient take 100ms then fuse trip time at the same condition should be few times longer for instance 5-times). Above picture show three possible protection devices which meet criteria. Remark: Cable cross section in real application is important but in this example it was not our scope.

Example 2:   DOL motor starter in combination with induction motor having high inrush current

Presume there is a three phase induction motor with very high inrush current. We want to use direct on-line starter (DOL). Task is to find appropiate Motor Protection Circuit Breaker or combiantion fuse – thermal relay. We want to have instatntaneous trip set at least at 14-times motor rated current. **Data:** *Induction motor IE3; P = 11 kW, 4-pole, 50Hz, 400V; I$_{r\,400V\,50\,Hz}$ = 19,6 A; Starting current ratio: 11*

I_{INST} = 14*19,6 = 274,4 A

I_{rM} = 19,6 A

Finding solution with ETsON:
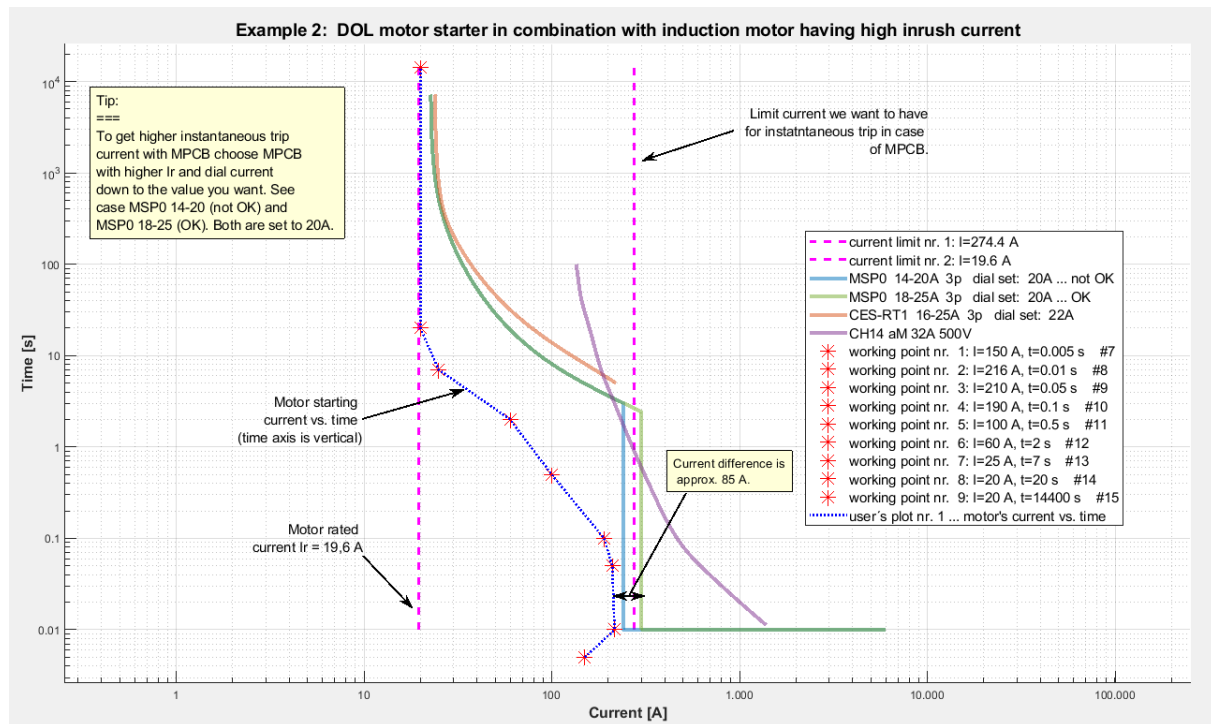
Curent limit nr. 1 is set to desired multiplication of motor rated current. This value is important for motor protective circuit breakers as their instantaneous trip must be on the right side of this limit value.
Curent limit nr. 2 show motor rated current. Protective device curve must be on the right side of this vertical line as this current value is normal working condition for the motor. However in long steady state condition protection curve my not be too far away as in this case overload protection may not be good enough.

Working points (#7 … #15) represent motor I/t starting characteristics under load (normally is hard to get it but in this example we have it). Remember here we have axis *x* and *y* upsidedow as normally we consider time axis (*x*) as hotizontal. We used working points and connected them with line and finally we got motor starting curve (**user's polt nr. 1**). If we want to avoid protection will trip during startup then peak of the inrush (starting) current of the motor must be lower as instatntaneous (magnetic) trip of MPCB.

Combination of **fuse-link characteristic aM** + **thermal overload relay** could also be acceptable. At desired current (14 x I$_r$) expected trip time of this combination is about 1 s (fuse-link blow) while MPCB is about 3 s. In this case fuse-link + thermal overload relay protection combination is more convenient in case of easy loads and not very frequent staring of the motor.

Author:
M. Sc. Franc Jenko

Izlake, November 2018