Working with PDF Reports

This tutorial demonstrates the usage of PDF reports. With *PowerFactory* 2023 a new reporting concept has been introduced to create PDF reports to replace the older ASCII reports.

This tutorial covers the execution of provided reports from *PowerFactory*'s DIgSILENT Library as well as simple adaptions of the reports and different export options. Reports will also be created from scratch to give an introduction to the design process.

You should be familiar with basic editing of data inside *PowerFactory*, with the user interface as well as the handling and definition of result variables.

1 Import Project

Click on the icon from the tutorial "Working with PDF Reports" of the *PowerFactory* "Reports" Tutorial window, to import and activate the project for this exercise. The tutorial can be found under the section "Base Package". The used example project is the available application example "MV Distribution Network".

2 Execute Available Reports

In this introductory section, we will familiarise ourselves with the concept and handling of the PDF reports.

Available reports can be found in the global DIgSILENT Library in the subfolders *Reports* → *Documents*. The library contains standard reports for specific calculations that can be used and adapted. In this example, we want to focus on the *Load Flow Calculation* and some of its available reports.

- To start, execute a *Load Flow Calculation* .

Note: Reports for a specific calculation, e.g. the *Load Flow Calculation* can only be executed if the results of the corresponding calculation are available.

- Open the *Report Generation* command via the corresponding *Generate reports* icon from the main toolbar.
- On the *Basic Options* page on the left side of the selection tree all available reports from the project library as well as the DIgSILENT Library are shown.
- Select the "Voltage and Loading Violations" report from the DIgSILENT library. This report lists all violations in the network for a load flow calculation considering to user-defined limits.

- After the selection of a report, it will appear on the right side. Multiple reports can be selected and executed at the same time.
- Unselect the “Grid Summary” report.
- On the bottom of the page *Document* options can be selected. Choose to *Merge selected reports into one document* and call it “MV Network Analysis”.

For every report document a dedicated *Title page* as well as *Header/Footer* can be used.

- The selection can be done on the *Page Layout* page. By default the *PowerFactory* design from the DIgSILENT Library is selected, which we will also use in the report for *Title page* and *Header/Footer*.
- The front matter allows the user to specify a *Title* and a *Project* name which are used in the report. Add a title and project name, for example:
  - *Title:* Network Violation Report
  - *Project:* Medium voltage network analysis
- Additional *Title page parameters* are available for the used templates to add more information to the title page, e.g.:
  - *Subtitle Line 1:* DIgSILENT GmbH
  - *Subtitle Line 2:* January 2023
  - *Subtitle Line 3:* Editor: Paul PowerFactory

Some reports include additional input parameters for the user which can be found on the *Parameters* page.

- On the top of the page, a drop-down list allows the user to select a report (when several reports are selected on the *Basic Options* page). All available parameters for this report are then shown.
- For the “Voltage and Loading Violations” report, define the following values to filter the reported elements:
  - *Maximum Loading of Branch Elements:* 90 %
  - *Lower Limit of Allowed Voltage:* 0.96 p.u.
  - *Upper Limit of Allowed Voltage:* 1.04 p.u.
- Then **execute** the report. The generation process can take a couple of moments. The finished report will be displayed in a new tab in *PowerFactory*.

Note: When created, reports are automatically saved in the *Graphics Board* of the active study case, meaning they are permanent objects. After *closing* the tab of the report, the report will still be available in the database and can therefore be opened again. Only *Right-Click* → *Delete Report Document* on the tab of the report will delete the report permanently.

- The generated report contains a title page, a table of contents as well as the selected “Voltage and Loading Violations” report which lists all violations in the network.
- Identify the elements in the network that violate the user-defined limits.

Hint: All names that are displayed in blue include links to the actual *PowerFactory* object and can be accessed directly in the report. With *Right-Click* → *Mark in Graphic*, the object can be highlighted in available diagrams.

- A generated report can be exported manually by using the *Export* icon .
- Afterwards, you can close or delete the report in *PowerFactory*.

In the next section, will look at different display and export options that are available for reports.

- Open the *Report Generation* command again.
- In addition to the "Voltage and Loading Violations" report, select the "Feeder Summary" report as well. The feeder summary report shall be printed out first. You can change the order of the selected reports on the right side next to the selection tree via drag&drop or the respective buttons on the bottom.
- On the *Filters* page, different filter options that are used for all selected reports can be defined, e.g. to filter voltage levels or areas.
  - Activate the grouping filter, which can be used to report only elements that are located for example in a certain area or grid.
  - Add a new row via right-click on the white area → *Append Row* and then choose to only report network elements that are within the grid "SUB_02".
  - Use the operation *Union*.

Hint: The operation mode is jointly used with the selected groupings. As an example, if a grid "Grid 1" and an area "Area A" are selected, then the operation modes have the following effect:

- *Union*: All Networks elements that are either located in "Grid 1" or in "Area A" are considered.
- *Intersection*: Only networks elements that are located in both "Grid 1" and "Area A" are considered.

- Different export options can be selected on the *Export* page. By default, a new report is created in *PowerFactory* in a new tab.
- To directly save the created pdf document on your local machine activate the option *Export generated documents*. When activated, no report will be created directly in *PowerFactory*.
- Enter a target folder and choose PDF as format.
- Activate the option *Open documents after export* as well. This will open the created report directly in the external PDF viewer (instead of in *PowerFactory*).
- **Execute** the report and inspect the reported tables. The document now contains the two selected reports in which only elements from grid "SUB_02" are listed.

3 Adapt Available Reports

So far, we have learned to execute available reports from the DIgSILENT Library. With additional input parameters the reports can be adapted, but only to a certain pre-defined degree. To change the format, such as changing certain shown parameters or adding/subtracting certain parts of the report, the built-in *Designer* can be used. In the next section we will use the *Designer* to implement specific changes to a report template.

- To start, execute a *Load Flow Calculation*.
- Similar to every other object in the DIgSILENT Library, the reports are read-only. To adapt a report, it has to be copied to the project library first.
- To do so, open the *Report Generation* command.
- In case no calculation is active, reports for calculations are not shown. Click on the *Manage* button on the right side of the dialogue. In the *Report Manager* all reports can be managed without a calculation being active.
- Adapt the following filter options in the *Report Manager* to display all reports for *Load Flow Calculations*:
  - Activate *Show filter, sorting and column options*
  - *Calculation module*: Load Flow AC
  - *Library*: DIgSILENT Library

- In the bottom, select the report “Feeder Summary AC” and press the button *Copy report to project library...* on the top of the *Report Manager*
- The *Data Manager* opens in the corresponding folder of all load flow reports. Double-click on the “Feeder Summary AC” report.
- The report opens and is copied into the project library. Now the report can be adapted.
- On the *Basic Options* the general settings of the report can be found.
  - First, change the localised name since this one will be displayed in the selection tree of the report generation command.
    - To do so, go to the *Localisation* page and enter an identifier in the localisation table.

Identifier	English	German
my_feeder_summary_report	Feeder summary report	Abgangsbericht

Table 3.1: Localisation table

Note: There are certain format rules for identifiers. Incorrect identifiers cannot be selected as localised name. The following format rules have to be met:
- Must start with lowercase character
- No spaces
- May contain English alphabet upper- and lower-case letters, and digits

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    - Go back to the *Basic Options* page and edit the *Localised name*  .
    - Choose the option *Choose localised text from localisation table* and select the earlier defined identifier.
  - The *Supported calculation modules* are shown on the *Basic Options* page as well. Here, it is defined for which calculations the report is available. This is useful when the report includes parameters that are only accessible for a certain calculation.
- On the *Variable Selection* page all variables that the report can use have to be defined. The definition is done via *IntMon* objects for each class.
- Press on the button *Show generated tables...* to get an overview of all selected parameters which are available to be used in the report.

Hint: The values of load flow parameters are only available if the results of the load flow calculation are active. If this is not the case, execute a *Load Flow Calculation* and enter the report again to see all calculation variables. If you want to enter the report again, enter the *Report Generation* command and *right-click* → *Edit* on the corresponding report.

Hint: For each object class, e.g. the feeders (ElmFeeder), two sets of parameters/tables are available to use in the report:
- ElmFeeder: contains the values/results of the defined variables
- ElmFeederMeta: contains the description and units of the defined variables

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- The options of the other pages in the report template are described in later sections of the tutorial or the User Manual.

In the following we want to adapt the feeder summary report.

- Open the *Designer...* by using the corresponding button.
- Figure 3.1 shows an overview of the report designer.

– The *Main Menu* includes all general options.

Note: Very useful is the *Preview* page which shows the end product of the report after it has been created.

– The *Reports* show all report pages in the document.
– The *Toolbox* contains all components such as data bands, tables, graphics, etc. that can be used in the design area.
– The *Page design area* shows the different components of the report.
– The *Properties* is a detailed list of all parameters of a component when it is selected. On the bottom of this window pane the *Dictionary* with all available result parameters or a *Report Tree* overview can be shown as well.

Hint: If you need help to understand different options or parameters in the report designer, you can the user find detailed information in the help center of the Designer software by pressing F1.

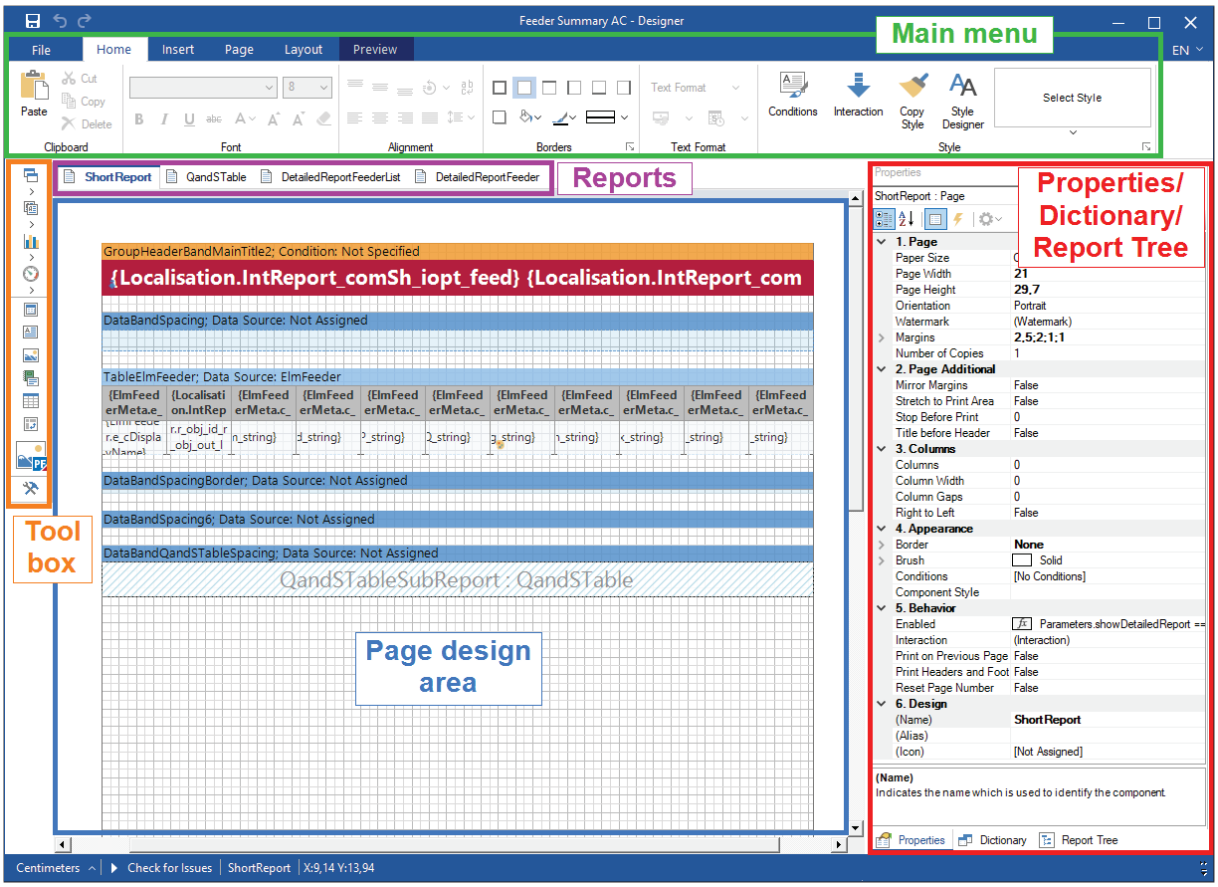

Figure 3.1: Overview of the report designer

The feeder summary report has different tabs which represent different reports that can be turned on/off by input parameters when creating the report. We want to focus on the first page “Short Report” which displays a table that lists all feeders in the network with certain result parameters. We will change a parameter in the table as well as sort and filter the table.

- The “Short Report” page includes different components which are shown in the page design area:
  - The *Group Header Band* (orange) is used as header for this part of the report.
  - *Empty Data Bands* (such as “DataBandSpacing” in dark blue) are used as spacing in between the other components.
  - The *Table* “TableElmFeeder” (light blue) provides information on the feeder. It includes result parameters of the load flow calculation.
  - The data band “DataBandQandSTableSpacing” contains the sub report *QandSTable* (different tab on top) which can optionally be printed here.
- To change input parameters of a table, double-click on the corresponding field:
  - Double click on the first cell of column two (row one, grey background) of the table “TableElmFeeder”.
  - On the *Expression* page, on the left side of the window the parameter for the description of the first branch of the feeder is displayed. Delete it.
  - On the right side, you can see a data tree where available parameters can be selected.
  - Navigate to *Data Sources* → *SQLite (SQLite)*→ *ElmFeederMeta* and select the parameter for the number of lines (*e_n_lne_desc*) with a double click. When selected, the parameter will be displayed on the left side. Remember, description and unit parameters are “Meta” parameters, which can be seen in the class name (ElmFeederMeta).
  - Close the window via **OK** and enter the second cell in the column (row two, white background) to select the actual value for the number of lines.
  - On the *Expression* page, delete the currently shown parameter, navigate to *Data Sources* → *SQLite (SQLite)*→ *ElmFeeder* and select the parameter *e_n_lne* with a double-click.
  - Close the window via **OK** and check the parameter change via the *Preview* window.
- Sorting can be defined in the options of the table component:
  - Enter the table “TableElmFeeder” with a double click.
  - On the right side, navigate to the *Sort* page.
  - Enter the first drop-down menu and select *ElmFeeder* → *c_Maxloading* to sort by the maximum loading in the feeder.
  - Choose to sort in *descending* order.
  - Click OK to close the window and observe the changes in the *Preview* window.
- Filter options can also be defined within the table component:
  - Enter the table “TableElmFeeder” again and navigate to the *Filters* page.
  - On the top left of the window, press the *Add filter* button to define a new filter for the maximum loading with the following settings:
    - *Field is*: Value
    - *Data Type*: Numeric
    - *Column* (variable): *c_Maxloading*
    - *Expression*: greater than or equal to 90
  - Define two more filters so that only feeders where the maximum voltage drop (*c_dumaxdrop*) or the maximum voltage rise (*c_dumaxrise*) is greater than or equal to 2 % are shown.
  - After defining the filters make sure that at the top the option *Filter on* is activated and the option *Or* is selected in order to combine the filters with an or condition.
  - Click OK to close the window and observe the changes in the *Preview* window.
- The resulting table should only list three remaining feeders which are sorted by their maximum loading.
- Save the changes and close the Designer. Generate a new PDF-report in *PowerFactory* after a *Load Flow Calculation* with the adapted template.

4 Modify Title Page

The topic of this exercise is to create a title page template which is customisable for a user-defined company style. The basis of the company specific title page will be the available template "PowerFactory Title Page Design" from the DIgSILENT Library.

- First, we have to find the existing template and copy it into the project library to be able to modify it.
- Open the *Report Generation* command and click on the *Manage* button on the right side of the dialog.
- In the *Report Manager*, mark the template "PowerFactory Title Page Design", press the button *Copy report to project library...* on the top of the *Report Manager* and confirm the selection in the *Data Manager*.
- The report opens and is copied into the project library. Now the report can be adapted.
- Rename the copied *Report Template* to "Company Title Page".
- On the *Localisation page*, enter a new identifier for the template according to Table 4.1.

Identifier	English	German
company_title	company title page	titelseite

Table 4.1: Localisation table (Title page)

- Then go back to the *Basic Options* page, edit the *Localised name* and select the new idientifier by selecting the option *Choose localised text from localisation table*.
- If you want to have a look at the current design of the title page, open the report via the *Designer...* button and have a look at it on the *Preview* page.

In the following sections, we will modify this template to a new design, which includes adding a company logo and additional user-defined variables.

4.1 Add images

Images can be loaded into *PowerFactory* and consequently also be used in a report template. This can be done by using a *Document* object.

- On the *Images* page of the *Report Template*, images can be connected to the report.
- The template currently contains the image of the *PowerFactory Logo*.
- First, we want to add new images to the report. Append a new row to the *Images* table and add an *Identifier* name, for example "company_logo".
- The image is connected via a *Document (IntDocument)* object. Double-click on the corresponding field (second column) to select a new document. In the *Data Manager*, navigate to *Library* → *Reports*→ *Logos/Pictures* which contains images we will use in the report.
- Select the "DIgSILENT Logo". Via *right-click* → *Edit* the document can be edited and inspected via "View".
- Feel free to upload your own company logo.

Hint: To import a new picture into *PowerFactory* follow the following steps:

- Create a new *Document (IntDocument)* object in a location selected via the Data Manager.

- Change the name of the document and select the picture be imported into PowerFactory using the ellipsis (. . .) to the right of the *Filename* field.
- You can show the picture with the button *View*.
- With the button *Import* the picture is embedded into the document object and can be used in the report afterwards.

- Next to a company logo an additional picture shall be displayed on the title page. Add another row to the *Images* table, name the identifier “company_picture” and select the document “Company Picture” under *Library* → *Reports*→ *Logos/Pictures*.
- Both images are now connected to the report and can be used in the designer. This will be further explained in section 4.3.1 and 4.3.4.

4.2 Add external parameters

Additional user-defined parameters such as date, name and company name can be added to the report so each user can adapt them.

- First new identifiers for each parameter have to be defined on the *Localisation* page. Add identifiers for the following parameters:
  - editor
  - department
  - date
  - company
- Then navigate to the *Parameters* page. Delete the existing parameters and add new rows for the new parameters corresponding to the newly added identifiers. An example is shown in table 4.2.

Identifier	Data type	Initial value	Localised name
editor	String	Editor	editor
department	String	Dep. X	department
date	String	01.01.2023	date
company	String	DIgSILENT GmbH	company

Table 4.2: Parameters table (Title page)

- The *Data type* of all parameters is *String*. Initial values are optional, but are usually good to have.
- These parameters can be set in the report template and before executing the report.

4.3 Data bands

In the following, we will look at the report in the *Designer* and will discuss the structure as well as how to modify the report.

- Open the *Report Template* via the *Designer. . .* button.
- In general, reports consist of various data bands with different functionalities. On the very top of the toolbox on the left side of the designer (see Figure 3.1), data bands can be added. Holding the cursor over a data band shows a more detailed explanation.
- All data that is to be displayed in the report must be structured in data bands. The basic data bands are discussed in the following sections.

4.3.1 Report Title and Logo

The *Report Title* band is usually used at the beginning of the report and is printed only once.

- In the report template, the report title band (green) contains of a logo and the company name which we want to modify.
- Currently the *PowerFactory* logo is displayed on the left side of the band. Delete it.
- In the toolbox, select the PowerFactory *Images* icon (second last icon on the bottom) and click on the location where the logo shall be placed.
- Select the company logo and place the logo to the wanted location in the report data band.
  - The logo can be draged to the wanted position.
  - The size can be changed by using the mouse or via the *Properties* page (section *3. Position*), which is shown on the right side of the designer (when logo is selected).
  - Make sure that width of the logo is 1.8 cm and the height is 1.7 cm. It shall be placed on the top left of the report title band.
  - The borders of the logo shall also be displayed in black. This can be done in section *4. Appearance* of the *Properties* under the option *Border*.
- Next to the logo, the company name shall be displayed.
  - Double click on the text in the data band and delete the currently displayed name.
  - A text can be inserted here. We want to add one of the external parameters we defined in section 4.2 to display the company name the user enters.
  - On the right side, navigate to *Data Sources* → *SQ Lite {SQ Lite}*→ *Parameters* and select the parameter “company” with a double-click. The external parameter is now displayed in the text on the left side.
  - Close the window with **OK**.

Hint: When a data band is selected, e.g. the data band with the company name (here in dark red), the style can be changed on the very right side of the *Main Menu* (see Figure 3.1). Different DIgSILENT styles are available and can be selected. For a user-defined style, select the style “No”. This unlocks further options to make changes (font, background colour etc.) in the *Main Menu*.

- Use the *Preview* page to check the changes. The default values are displayed for external parameters.
- An example of the report title band with the applied changes is shown in Figure 4.1.

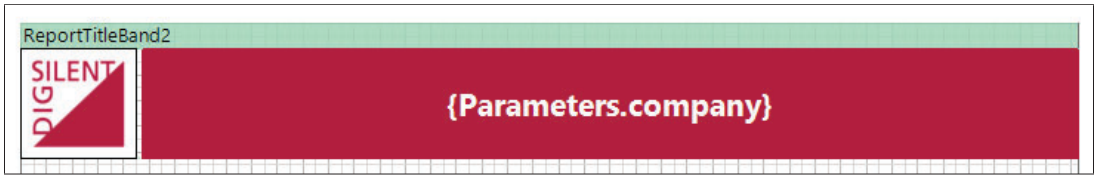

Figure 4.1: Report Title Band in the designer

4.3.2 Data spacing

Empty data bands can be placed in between other data bands in order to create space. This is done throughout the report. The data source type is for this purpose not important.

- The empty group header bands (orange) “GroupHeaderBand2” and “GroupHeaderBand1” are not needed and can be deleted via *Right-Click* → *Delete*.

- Furthermore, the group header band that shows the front cover title from the localisation (big font) as well as the bands that show the external parameters “firstLine”, “secondLine” and “thirdLine” can be deleted.
  - “GroupHeaderBandFrontCoverMain”
  - “GroupHeaderBandTitle1”, “GroupHeaderBand3”, “GroupHeaderBand4”
- After the report title band a certain space shall be created.
- The height of the empty data band “DataBandSpacing” in between report title band and the first group header band shall be 2.8 cm (*Properties* → *4. Position*→ *Height*).

4.3.3 Group Header

Group Header bands can be used to divide the report into groups. The group header band is output once at the beginning of the group. Here, on the title page, the group header bands are used more for a visual grouping.

- We want to display the title and project name.

Note: The “Title” parameters are added by the user in the *Report Generation* command .

- The style of the two remaining group header bands shall be adapted:
  - “GroupHeaderBandFrontCover2”: Content: Title.name, Height: 1.6 cm, Style: No, Font Size: 24, bold
  - “GroupHeaderBandFrontCover2_2”: Content: Title.project, Height: 1 cm, Style: No, Font Size: 20

Hint: When defining properties, e.g. the height of a data band, it is important to be aware of the object one is defining a parameter for. For example “GroupHeaderBandFrontCover2” consists of the data band itself and an additional text box which is placed in the data band. When selecting the text box, under *5. Behaviour* the *Dock Style* “Fill” is defined. So a text box that fills a data band always has the size of the data band. Therefore, the size should be defined in the data band and not in the text box itself. For the *Dock Style* “None”, data band and text box can have different heights.

- Below the group header bands after “GroupHeaderBandFrontCover2_2” a space of 1.8 cm shall be added with an empty data band.
- Rename the data bands according to Figure 4.2. The name can be changed under *Properties* → *6. Design*.

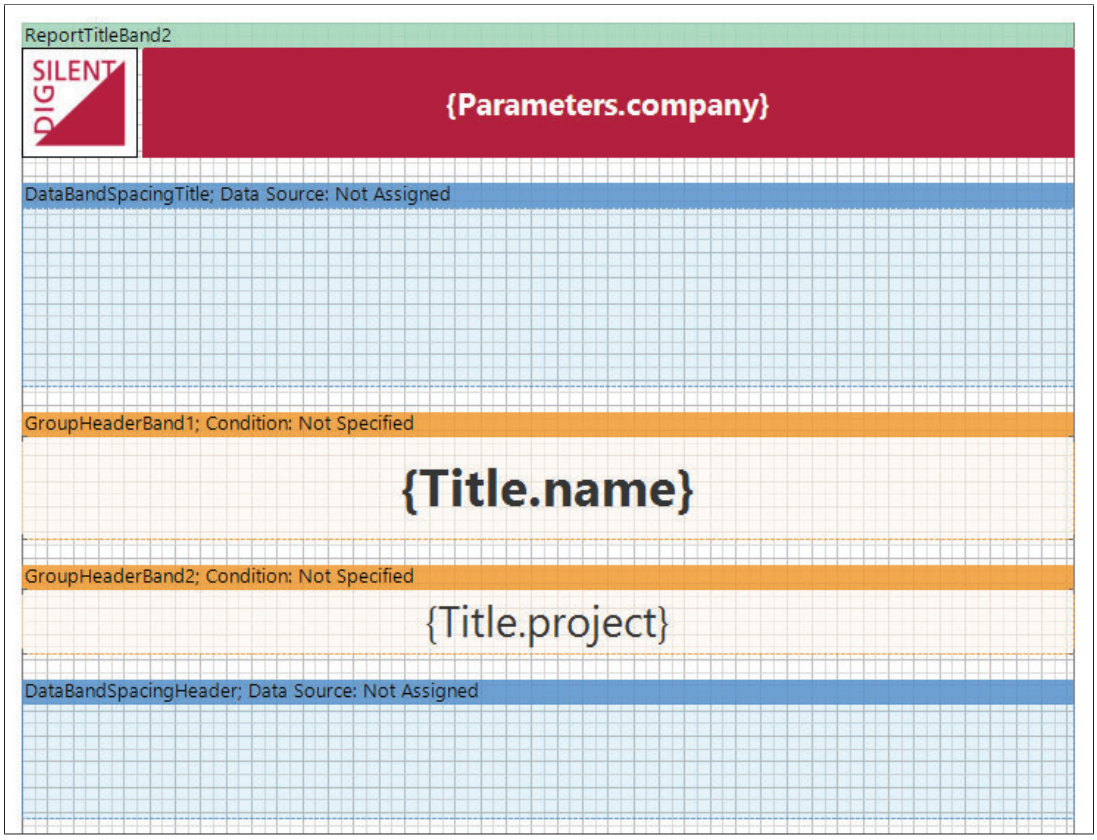

Figure 4.2: Report “Company Title Page” - Part 1

4.3.4 Picture

An additional company picture, which we added earlier to the report template, shall be inserted to the title page in the designer.

- In the toolbox on the left of the designer, go to the bands icon, select *Data* and move the band via drag&drop into the designer.
- If drag&drop was not used to insert the band, a dialog pops up after the placement, in which the data source of the data band can be selected. Select *not assigned* as data source since we only want to place a picture within the data band and press **OK**.
- If the band does not appear at the location, it is inserted at the end of the report. Move it up to the wanted position under the data spacing of the title information.
- Change the height of the data band to 6 cm.
- Select the PowerFactory *Images* icon, click within the created data band and select the “Company Picture”.
- After it is placed, select the picture and change the *Dock Style* under *Properties* → *5. Behavior* to “Fill”. The picture should now fill out the whole data band.

In addition to the company picture, we want to add two lines, one above and one under the picture, to create a frame.

- To do so, add two data bands (one above and one under the pictute) with the following attributes (in the *Properties* under *5. Appearance*):
  - *Data Source:* Not assigned
  - *Height:* 0.4 cm
  - *Border:* Top/Bottom
  - *Border Color:* Black
  - *Border Size:* 1
  - *Border Style:* Solid
- An example for the report format is shown in Figure 4.3.

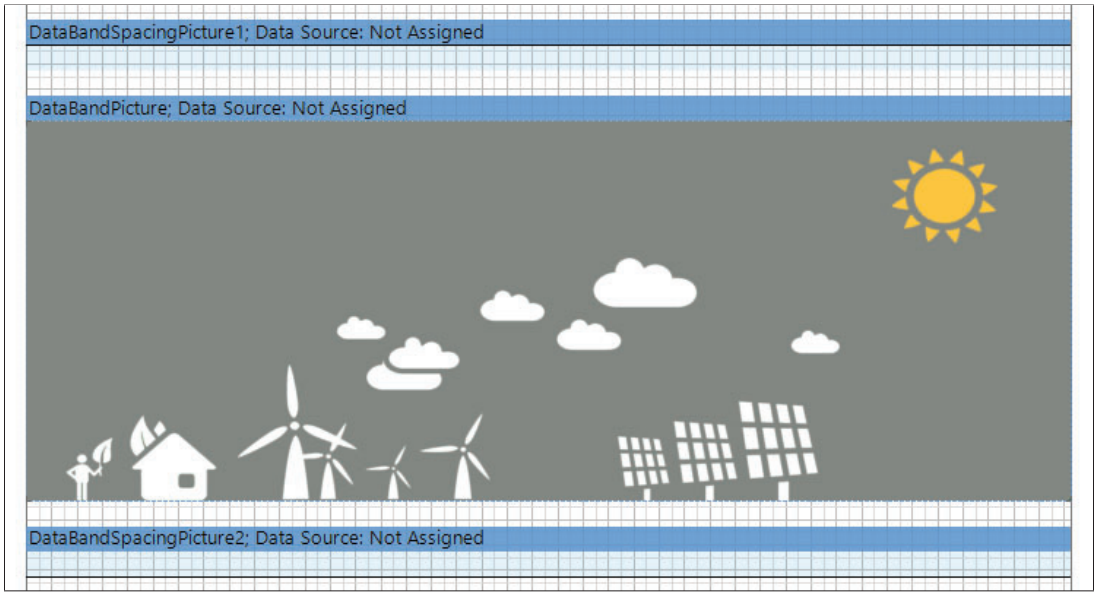

Figure 4.3: Report “Company Title Page” - Part 2

4.3.5 Table

Lastly a table with general information shall be displayed on the title page. The table should include the external parameters that were defined in section 4.2.

- Select the *Table* icon from the toolbox and insert it in the report.

Note: A table does not have to be placed within a data band.

- Place the table under the company picture below the data spacing band.
- The table shall have 2 columns and 3 rows which can be defined in the under *Properties* → *2. Table*.
- In the first column add the description (simple text) of the external parameters and in the second column add the external parameters themselves.
- Adapt the format of the table to your needs. For each cell, the format can be changed via the main menu or under *Properties* → *4. Appearance*.
- Add empty data bands above (height: 1.8 cm) and below (height: 3.3 cm) the table to add spacing.

- On the bottom of the report two tables still exist from the original template. They include information of the study case, the *PowerFactory* project etc. Keep them on your title page.
- An example for the report format is shown in Figure 4.4.

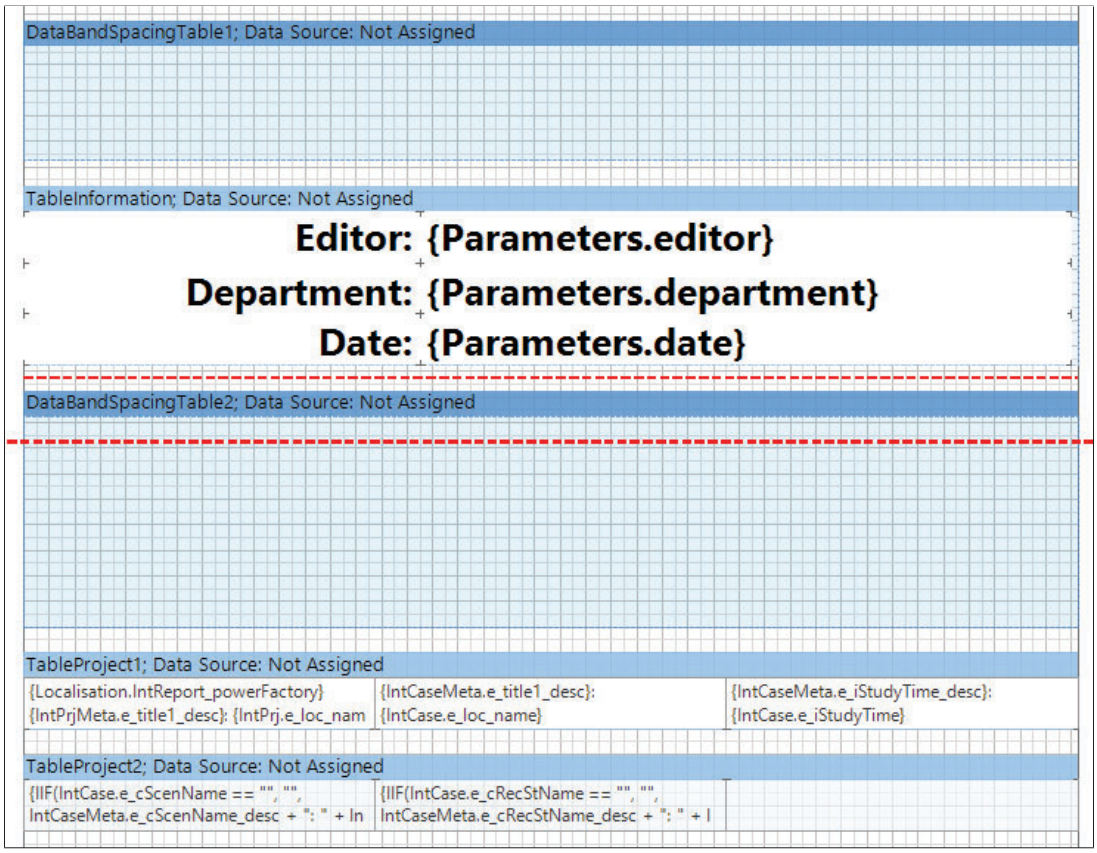

Figure 4.4: Report “Company Title Page” - Part 3

Note: The red lines in the report as can be seen in Figure 4.4 indicates the end of a page. With flexible input fields (as defined in this report) the red lines might not match with the actual size of the report. Therefore, always check the size of the generated report on the *Preview* page.

Hint: If a table does not look to be 100 % aligned with the background grid of the design area, right-click on the table and select *Align* → *Align to grid*.

4.3.6 Table of Contents and Header/Footer

In addition to the front page itself, the header and footer of the first pages can also be defined here.

- The footer is located on the very bottom of the report in the designer. Changes can be made here directly.
- The header and the table of contents are located on a second report page. At the top, the tab “Page 1” can be selected to change the respective formats.
- For example, exchange the *PowerFactory* logo, which is displayed on the top left in the header, with your own company logo.

4.3.7 Execution

After all changes are done in the designer, save the file and close the designer as well as the report template. The title page template can now be used to generate reports.

- First, execute a *Load Flow Calculation*.
- Open the *Report Generation* command via the corresponding *Generate reports* icon from the main toolbar.
- On the *Page Layout* select the customised company title page as *Title page*.
- All external title page parameters that are used are shown below and can be adapted here.
- Execute the *Report Generation* command and inspect the title page.

Note: The Header/Footer for the complete report is also linked on the *Page Layout* page. The template to be used can be customised as well.

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5 Create Simple New Report

In this section of the tutorial we will create a new report with basic functionalities from scratch. We will focus on the *Load Flow Calculation*. The new report shall include summary results of feeders in the network as well as lines that violate a user-defined loading limit.

- First, execute a *Load Flow Calculation*, so that we are able to use the results in the report.
- Open the *Report Generation* command via the corresponding *Generate reports* icon from the main toolbar.
- Under the list of *Available Reports*, select the button *Create new report...* to create a new report template.

5.1 General settings

Before using the designer to draft the report, some general settings in the *Report Template* have to be configured.

- Rename the report template to “Load flow analysis report”.
- Define the usage *Report*.
- Via the button *Restrict to specific calculation modules* it can be specified for which calculations the report template can be used. Define the following modules:
  - Load Flow AC, balanced
  - Load Flow DC, balanced
  - Low Voltage Load Flow, balanced
- Change the *Localised name* which will be displayed in the report generation command.
  - To do so, go to the *Localisation* page first, enter an identifier in the localisation table and select it afterwards as *Localised name*. An example is shown in Table 5.1.

Identifier	English	German
ldf_analysis_report	Load Flow Analysis	Lastflussanalyse

Table 5.1: Localisation table

- On the *Variable Selection* page, the variables of all element classes that shall be used in the report must be defined. *Add* variables for the *Load Flow Calculation* for the following classes:
  - Line (ElmLne)
    - *c:loading* (Loading in %)
  - Feeder (ElmFeeder)
    - *c:Maxloading* (Maximum Loading in %)
    - *c:umin* (Minimum voltage of all terminals in p.u.)
    - *c:umax* (Maximum voltage of all terminals in p.u.)

Hint: The button *Show generated tables...* shows an overview about all selected parameters which are available to be used in the report. Note that the values of load flow parameters are only available if the results of the load flow calculation are active.

- On the *Parameters* page, add an input parameter for the loading limit to report feeders and lines. Remember to add an identifier on the *Localisation* page for the external parameter.
  - *Identifier:* limit_loading
  - *Data type:* Double
  - *Initial value:* 80

5.2 Feeder Summary

After the general definitions in the *Report Template* are done, the report can be drafted in the designer. The first part of the report shall list all feeders along with basic parameters that exceed the user-defined loading limit.

- Open the *Designer...* via the corresponding button.
- In the toolbox on the left side (see Figure 3.1), select the icon on the top *Bands* → *Report Title* and place it in the page design area.
- Select the *Text* icon from the toolbox and place it within the *Report Title Band*.
  - Double click in the text field to add a report header, e.g. “Load Flow Analysis Report”.
  - Select the text field to set the *Dock Style* under *Properties* → *5. Behavior* to “Fill”.
  - Select a style for the text field.
  - Increase the height of the report title band (not the text field within) if needed under *Properties* → *1. Position*.
- Via *Bands* → *Data* in the toolbox, add another data band to the report. It should have no data source and be left empty in order to act as spacing in between the report title and the next data band.
  - Change the name of the data band under *Properties* → *7. Design* to “DataSpacing”.
- Add a new *Group Header* band to the report, add a text field to it and enter “Feeder summary” as caption.
  - Change the *Dock Style* to “Fill” again.
  - Adapt the font, font size and font stlye according to your own ideas.
- An example for the report design till this point is shown in Figure 5.1.

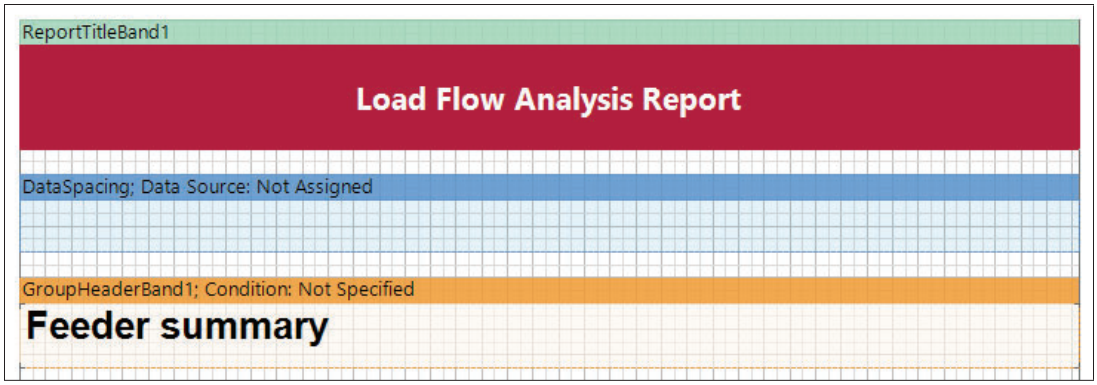


Figure 5.1: Report “Load Flow Analysis” - Part 1

- Below the group header a small introductory text for the section shall be entered.
  - Insert a new data band and place a text field within (*Dock Style:* Fill).
  - For the text field make the additional setting of *2. Text Additional* → *Word Wrap*→ *True*, so that the text is wrapped within the field.
  - Write an introduction and use the following parameters to describe the limits:
    - *ElmFeederMeta.c_Maxloading_desc*: Description of the feeder parameter *c:Maxloading*
    - *ElmFeederMeta.c_Maxloading_unit*: Unit of the feeder parameter *c:Maxloading*
    - *Parameters.limit_loading*: Value of the user-defined loading limit, which we earlier defined as external parameter
  - An example for the introductory text in the designer is shown in Figure 5.2.

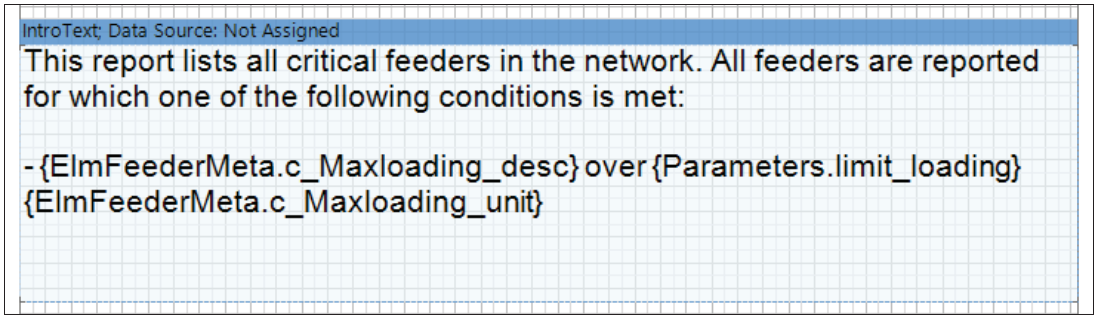


Figure 5.2: Report “Load Flow Analysis” - Part 2

Below the introduction a table shall be placed that lists all feeders which violate the user-defined loading limit. In the report, we will use two separate tables. One that contains the description of the shown variables and a second one which lists the the actual values.

- Add a *Table* from the toolbox and place it in the report. This is our “Description Table”.
- Select the data source *ElmFeederMeta* which contains the description and units of the feeder variables.
- The table shall have one row and four columns with parameter descriptions. Use the internal parameters within the data source *ElmFeederMeta* to add the following descriptions:
  - Column 1: Feeder name
  - Column 2: Max. Loading in %
  - Column 3: umin in p.u.
  - Column 4: umax in p.u.

Hint: To get the wanted output, the input of Column 2 could look like this:
- *{ElmFeederMeta.c_Maxloading_short_desc} in {ElmFeederMeta.c_Maxloading_unit}*

- Select a style for each column as well.
- Insert a second table from the toolbox to list the corresponding values to the description table.
- Select the data source *ElmFeeder*.

Hint: Selecting a data source of a *PowerFactory* element class for a table creates a "for-loop" in the report. The corresponding table will be printed for each element that can be found. In this case, the table will be printed for each feeder element in the network.

- The second table shall have one row and four columns. The cells of each column shall contain the actual value of the parameters from the description table.
  - Input column 2: *{ElmFeeder.c_Maxloading_string}*

Hint: Data sources of element classes, e.g. ElmFeeder, contain two different data types for each variable:
- Double: variable of the type double, e.g. *ElmFeeder.c_Maxloading*
- String: variable of the type string, e.g.*ElmFeeder.c_Maxloading_string*

Both can be used in the report. The string variable retains the format that is set in *PowerFactory*, for example the number of digits or the separator. The format of the double variable can be processed in the designer.

- Since the table is printed out for each element that can be found, the actual number of rows is dynamic. In this case a dedicated style for the odd and even number of rows can be defined.
- In the table itself, navigate to *Properties* → *6. Appearance* where odd and even styles can be selected. Define the following styles:
  - Odd Style: *DigsiStyle_Data1_Odd_Style*
  - Even Style: *DigsiStyle_Data1_Even_Style*
- To apply the selected styles to the cells, enter each of the four cells, navigate to *Properties* → *4. Appearance* and set *Use Parent Styles* to "True".
- Verify the resulting output on the *Preview* page.

Since the report currently lists all feeders in the network, we want to filter it to only show the feeders for which the maximum loading exceeds the user-defined limit.

- Enter the table and navigate to the page *Filters*.
- Select the button *Add Filters* and define a new filter with the following settings:
  - *Field is:* Expression
  - *Expression:* ElmFeeder.c_Maxloading > Parameters.limit_loading

Hint: The parameters within the expression field can be selected via the *Edit* button on the right side of the field.

- In addition to the filter, go to the *Sort* page and define to sort by the maximum loading in *descending* order.

5.3 Detailed Results

This section of the report shall contain more detailed results. In this simplified version of the report, a table with all lines in the network that exceed the user-defined loading limit shall be listed.

- First, add a new *Data* band to the report without any source or information in it so that it acts as spacing.
- Then add a *Group Header* band and insert a text field with the caption “Detailed results” into it.
- Insert a table with the data source *ElmLneMeta* which contains the description of the variables that are to be printed.
  - This table has one row and one column and shall act as a header for the following table.
  - Add a description to indicate that lines with a loading over the user-defined limit are displayed.
- Insert another table with the data source *ElmLne* to list all lines in the network along with their loading.
  - This table has one row and two columns.
  - The first column shows the name of a line.
  - The second column shows the value of the line loading along with its unit.
- In addition, add a filter to the second table to only show lines which violate the user-defined loading limit and sort the lines in *descending* order of their loading.
- An example for the detailed results section in the designer is shown in Figure 5.3.

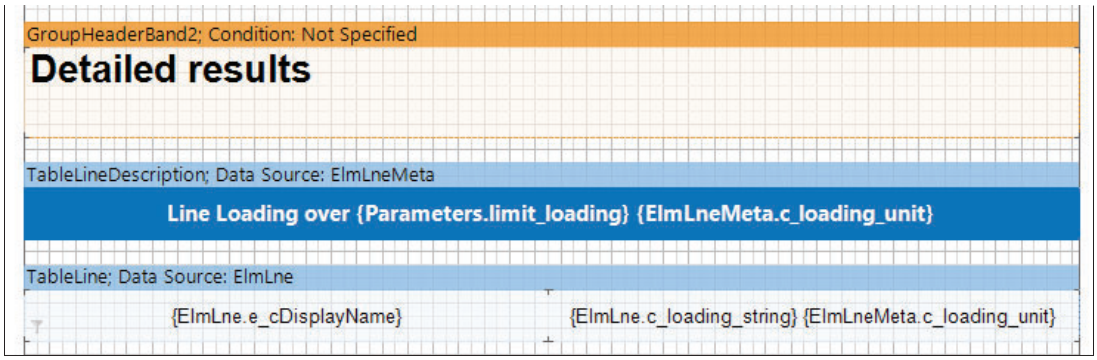


Figure 5.3: Report “Load Flow Analysis” - Part 3

6 Advanced Functionalities of Reports

The load flow analysis report that we started to create in section 5 shall be further extended, using advanced functionalities.

- First, make sure that the results of the *Load Flow Calculation* are active in order to display the results in the report.
- Open the *Report Generation* command via the corresponding *Generate reports* icon from the main toolbar.
- Under the list of *Available Reports* and select the “Load Flow Analysis” report in the project library via *Right-Click* → *Edit...*.

6.1 Report extension

In the first part, the report is to be extended by additional variables and external parameters to include voltage results. Detailed explanations of these steps are done in previous exercises of this tutorial.

- To add new variables to the report, enter the *Variable Selection* page of the report template.
- *Add* a new variable selection for *Terminals (ElmTerm)* and *Edit* the existing selection to add the parameters listed below.

Hint: Some of the parameters, like the *Reference Parameters (r:)* can't be selected directly in the *Variable Selection*. To add these, enter the *Editor* page in the variable selection and type in the corresponding parameters.

  - Feeder (ElmFeeder)
    - *e:loc_name* (Name)
    - *c:dumaxdrop* (Max. voltage rise in %)
    - *c:dumaxrise* (Max. voltage drop in %)
  - Line (ElmLne)
    - *r:cpFeed:e:loc_name* (Feeder reference)
  - Terminal (ElmTerm)
    - *m:u* (Voltage in p.u.)
    - *r:cpFeed:e:loc_name* (Feeder reference)
    - *b:dist* (Distace to feeder start in km)
    - *e:iUsage* (Usage)

Note: The feeder name in the selection of *ElmFeeder* and the reference parameters in the other variable selection are needed to determine elements within the feeder in the report.

- Go to the *Parameters* page and add additional external parameters:
  - Minimum voltage limit "limit_umin": *Data Type:* Double, *Initial value:* 0.95
  - Maximum voltage limit "limit_umax": *Data Type:* Double, *Initial value:* 1.05
- Don't forget to add identifiers on the *Localisation* page in order to use it as *Localised name* in the parameter definition.
- Enter the *Designer...* via the button to the right.
- Add the description (data band "IntroText") of the new voltage limits to the introduction text in similar style to the loading limit.
- Enter the table "TableFeeder" which displays the feeder results and add additional filters to the table.
  - Filter for feeders with the minimum voltage below the user-defined input parameter "limit_umin".
  - Filter as well for feeders with the maximum voltage higher than the user-defined input parameter "limit_umax".
  - All filters shall operate in an OR condition, so that a feeder is displayed if one of the filter conditions is true.
- Add a page break to data band "DataSpacing2" in front of the second group header.
  - To do so, navigate to *Properties* → *2. Page and Column Break*→ *a*nd set the option *New Page After* to "True".

6.2 Conditional colouring of cells

Every data band or text field can be assigned to different conditions. In this part we will look at a style condition to colour a cell in a table depending on a condition.

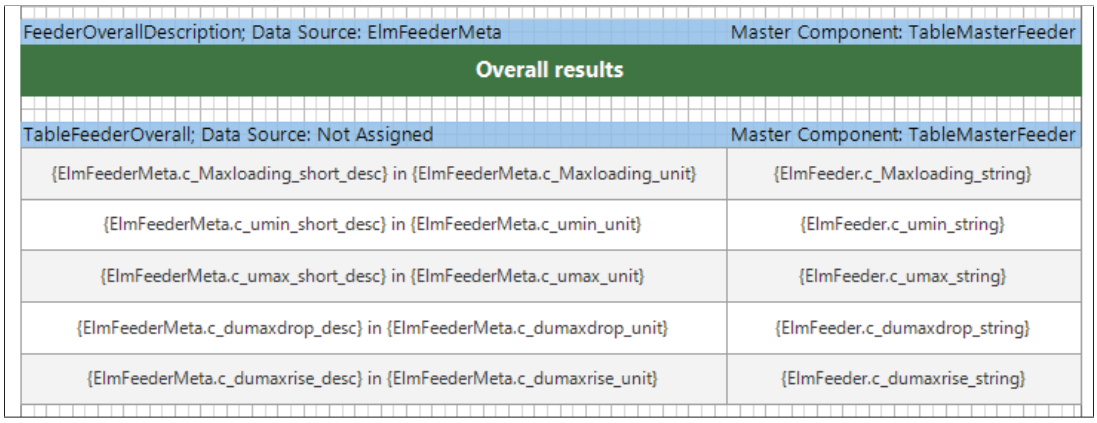
- Find the table “TableFeeder” which displays the feeder results.
- Select the second column, where the maximum loading of the feeder is displayed, with a simple left mouse click.
- Then select the *Conditions* icon in the style section of the main menu.
- Press the *Add conditions* button to add a new *Highlight Condition* with the following settings to the cell.
  - *Field is:* Expression
  - *Expression:* ElmFeeder.c_Maxloading > Parameters.limit_loading
  - *Colour:* red
- Also add highlight conditions to the other two feeder results (minimum/maximum voltage) when their corresponding user-defined limis are violated.

6.3 Master components

The concept of master components allows the creation of dependencies between different bands, so that a certain data band is only printed if another data band is also printed. In this part of the exercise we want to introduce detailed feeder results which shall only be displayed if the corresponding feeder violates the user-defined limits.

- Under the second group header “Detailed results” add a new table which displays the feeder name for which results shall be listed.
  - The data source is the class *ElmFeeder*, meaning the data band is printed out for each feeder that can be found.
  - Introduce three filters with the following conditions, so a feeder is displayed if one of the conditions is true:
    - Maximum loading > limit_loading
    - Minimum voltage < limit_umin
    - Maximum voltage > limit_umax
  - The cell shall contain the name of the feeder, e.g. *Feeder {ElmFeeder.e_cDisplayName}*.
  - Rename the table to “TableMasterFeeder” under *Properties* $\rightarrow$ *8. Design*
- This table will be our “Master Table” acting as a “Master Component”. The idea is to print this table and additionally all of the following components for each feeder that fulfils the filter conditions if this table is printed.
- Enter the line loading tables “TableLineDescription” and “TableLine”, go to the page *Master Component* and select the table “TableMasterFeeder” so that the table acts as master for these components.
- Verify the results on the *Preview* page.One can see that the line loading table is now printed whenever its master component is displayed.
- Under the master table and above the line loading tables, add a new table that displays general feeder results along with a new data band that adds a description. An example is shown in Figure 6.1. The table in this example contains the following results:
  - Maximum loading in %
  - Minimum voltage in p.u.
  - Maximum voltage in p.u.

  - Maximum voltage drop in %
  - Maximum voltage rise in %



FeederOverallDescription; Data Source: ElmFeederMeta	Master Component: TableMasterFeeder
Overall results	
TableFeederOverall; Data Source: Not Assigned	Master Component: TableMasterFeeder
{ElmFeederMeta.c_Maxloading_short_desc} in {ElmFeederMeta.c_Maxloading_unit}	{ElmFeeder.c_Maxloading_string}
{ElmFeederMeta.c_umin_short_desc} in {ElmFeederMeta.c_umin_unit}	{ElmFeeder.c_umin_string}
{ElmFeederMeta.c_umax_short_desc} in {ElmFeederMeta.c_umax_unit}	{ElmFeeder.c_umax_string}
{ElmFeederMeta.c_dumaxdrop_desc} in {ElmFeederMeta.c_dumaxdrop_unit}	{ElmFeeder.c_dumaxdrop_string}
{ElmFeederMeta.c_dumaxrise_desc} in {ElmFeederMeta.c_dumaxrise_unit}	{ElmFeeder.c_dumaxrise_string}

Figure 6.1: Report “Load Flow Analysis” - Part 4

- After creating the tables, it is important to add a master component to them so that the tables are always printed out when the master table is printed out.
  - Enter the tables and navigate to the *Master Component* page.
  - Select the table “TableMasterFeeder” as master component.

6.4 Relations

In section 6.3 it was shown how to use master components for the line loading tables. Currently all lines within the network are printed whenever the table for one feeder is printed. This is not the ideal outcome since we might only want to see the lines within the respective feeder. For this, the relationships between element classes can be used.

- Enter the line loading table “TableLine”, go to the page *Relation* and click the button *New Relation*.
- We want to define a relation between the lines (ElmLne) and feeders (ElmFeeder) so that lines are only found if they are located within the feeder.
- In *PowerFactory* this works via reference parameters, which were recorded earlier in the variable definition.
- The relation in the designer collects all child objects if the parent and child variable match. In our case, the feeder name must be equal to the feeder that is referenced in a line.
- Define the following relation:
  - *Name in Source:* LineFeeder
  - *Name:* Line in Feeder
  - *Alias:* LineFeeder
  - *Parent:* ElmFeeder
  - *Parent parameter:* e_c$Display$Name (name of the feeder)
  - *Child:* ElmLne
  - *Child parameter:* r_cp$Feed_e_loc_name (feeder reference parameter of the line)
  - *Active Relation:* Yes
- A new relation is created in the *Dictionary*. Assign the relation in the line loading table “TableLine” on the page *Relation*.
- Verify the results on the *Preview* page. Now only lines within the corresponding feeder are displayed.

6.5 Voltage profile diagram

Several different charts and diagrams are available in the *Designer* to visualise the results from *PowerFactory*. As an example, we want to implement a voltage profile diagram of a feeder (voltage over feeder length) in the load flow analysis report.

- To visualise diagrams or charts in the designer, one generally has to implement two components:
  1. A data band that contains the data which is used in a chart
  2. The chart itself displaying the data
- First, add a data band with a text field saying “Voltage profile”. Define the table “TableMasterFeeder” as master component.
- Add another data band that provides the data for the upcoming chart with the following settings:
  - *Data source:* ElmTerm
  - *Relation:* Define a relation between the terminals and feeders with the following settings as shown in section 6.4:
    - *Name in Source:* TermFeeder
    - *Name:* Terminals in Feeder
    - *Alias:* TermFeeder
    - *Parent:* ElmFeeder
    - *Parent parameter:* e_c$Display$Name (name of the feeder)
    - *Child:* ElmTerm
    - *Child parameter:* r_cp$Feed_e_loc_name (feeder reference parameter of the terminal)
    - *Active Relation:* Yes
  - *Master Component:* TableMasterFeeder
  - Sort by the parameter *b_dist* (distance from terminal to feeder start) in ascending order
  - *6. Behaviour - Enabled:* False
- Add a new band for the chart with the following settings:
  - No data source
  - *Master component:* TableMasterFeeder
  - *Height:* 4.8 cm
- Add a chart via the corresponding icon in the toolbox *Scatter* → *Scatter Line* and place it within the just placed data band.
- A window with the *Chart* definition opens up along with the *Dictionary* window on the right.
  - In the *Dictionary*, navigate to the data source *ElmTerm* and drag&drop the variable *m_u* (voltage in p.u.) into the *Chart* definition. It will appear under *Values* and will later be displayed in the chart.
  - Into *Arguments*, drag&drop the variable *b_dist* (distance from terminal to feeder start) from the data source *ElmTerm*.
- In the *Properties* of the newly placed chart, do the following settings under *6. Behaviour*:
  - Set the *Dock Style* to “Fill”.
  - Set the option *Grow to Height* to “True”.
- This part of the report could look like Figure 6.2 in the designer.

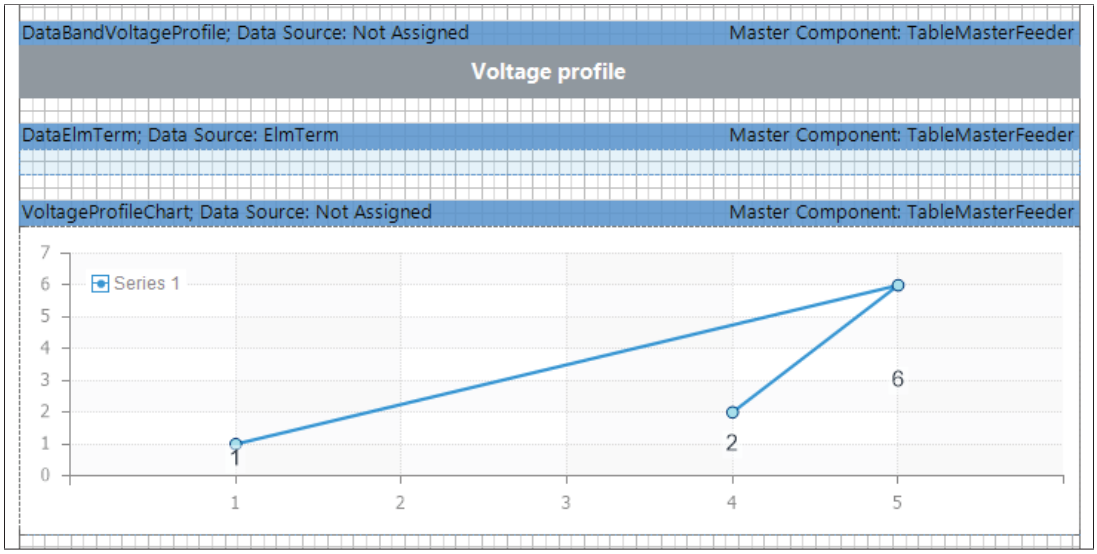


Figure 6.2: Report “Load Flow Analysis” - Part 5

- To visualise the chart properly, different settings regarding the axis and labels have to be made.
- Enter the chart via a double click. In the *Chart Editor* various different display settings can be selected. Enter the editor via *More options*.
- In the *Chart Editor* different sections can be entered, while most of the settings will appear on the *Properties* page in the background to the right.
  - Since feeders can contain a lot of terminals, additional labels might overflow the diagram. To avoid this select the option *None* on the *Labels* tab.
  - Navigate to *Chart* → *Legend*, go to the *Properties* page and set the option *Visible* to “False”.
  - Navigate to *Area* → *X Axis* and enter the *Properties* page to change the settings for the x-axis.
    - Labels - *Format:* N2 (numeric, 2 digits), *Placement:* Auto Rotation
    - Range - *Auto:* True
    - Ticks - *Visible:* False
    - Title - *Position:* Outside, *Text:* feeder length in km
    - *Start From Zero:* True
  - Navigate to *Area* → *Y Axis* and enter the *Properties* page to make different settings for the y-axis.
    - Labels - *Format:* N3, *Placement:* Auto Rotation
    - Range - *Auto:* True
    - Ticks - *Visible:* False
    - Title - *Direction:* Bottom to Top, *Position:* Outside, *Text:* voltage in p.u.
    - *Start From Zero:* False
  - In addition, navigate to *Series* → *Marker* and set the option *Size* in the *Properties* to 0.
- Close the *Chart Editor* and verify the voltage profile diagram on the *Preview* page.

6.6 Table of contents

- Save all changes and leave the designer.
- When executing the *Report Generation* command with the newly designed “Load flow analysis report” and the title page created in section 4, an empty table of contents will be shown on page 2 of the report.

A table of contents can be included in the reports if two conditions are met:

1. The title page has to contain a table of contents. This condition is met here.
2. The report(s) have to be initialised in order to be included in the table of contents.

The initialisation of a report for the table of contents can be done within the designer.

- Open the “Load flow analysis report” again and enter the *Designer...*
- In the toolbox, select *Bands* → *Table of Contents* and place it somewhere in the report.
- Enter the table of contents. Each data band that is to be displayed in the table of contents has to be selected here.
  - The title band as well as the group headers shall be shown in the table of contents.
  - Check the text component within the title band “ReportTitleBand1”.
  - When checked this band will be part of the table of contents. The displayed text can be seen on the bottom of the dialog under *Expression*.
  - The expression can be edited via the edit icon .
  - If the text is not updated correctly, the available text within the field can be selected in the expression via the corresponding icon .
  - In addition to the title band, also choose to show the text components within the group headers in the table of contents.
  - Before closing the table of contents again, verify that the check boxes next to the band which are to be displayed are checked.
- Verify the output of the table of contents on the *Preview* page.
- With the placement of the table of contents into a report, it is initialised with its settings.
- Before leaving the designer, the table of contents has to be deleted again. Otherwise there are problems with the report generation. The settings for the table of contents will still be active in the background.
- Save the changes, leave the designer and execute the *Report Generation* command again.
- The selected data bands are now listed in the table of contents.

6.7 Use events - chapter number

Chapter numbers are not automatically created within the report but can be inserted manually. This can be done by creating events. Events can be defined for the report itself as well as for each band in the report and with their help, additional actions actions can be scripted into the report. The scripting language in the designer is based on C#.

In this section, events are used to define chapter numbers that can be displayed within the report.

- Enter the *Designer...* of the “Load flow analysis report”.
- Click on the grey area in the page design area to select the report itself. In the *Properties* to the right, switch to the events tab as shown in Figure 6.3.

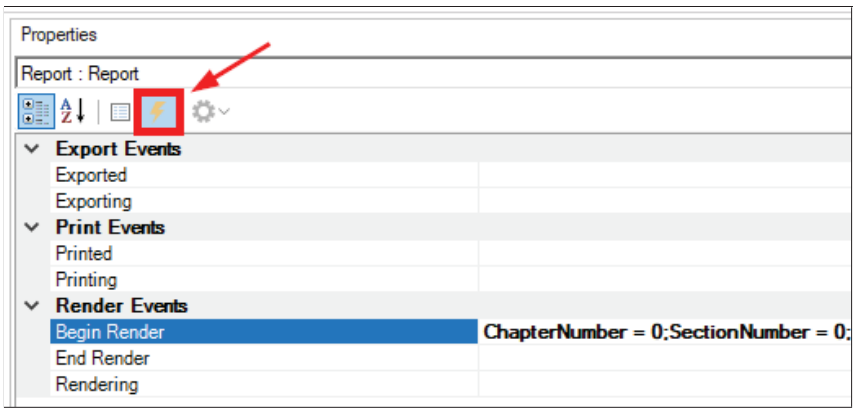


Figure 6.3: Event definition

- Different events can be created on this page. Under *Render Events*, it can be seen that certain parameters such as “ChapterNumber” are already defined in the report.

Hint: The variables which are defined in events can be found in the *Dictionary* under *Variables*.

- The defined variables can be further processed in the event sections of each data band.
- Select the first group header band and navigate to *Properties* → *Events*.
- Under *Render Events* → *Begin Render* define to increase the variable “ChapterNumber” by one.
  - *ChapterNumber += 1;*
- Each time this band is used in the report, the chapter number will now be increased by one.
- Define the same event for the other group header in the report.
- To display the chapter number, enter the text field of the group header bands and add the chapter number (under *Variables*) to the text.
  - *{ChapterNumber} Feeder summary*
- Verify the output on the *Preview* page.
- Increase the variable {SectionNumber} for each time the table “TableMasterFeeder” is printed. Add the variable to the text field of its cell as well.
- Add the table of contents to the report again and verify if the *Expression* of the text components shown also include the chapter number. If not, update the shown text via the select icon . Afterwards, the table of contents can be deleted again.
- When executing the *Report Generation* command again, the chapter numbers should now also be displayed in the table of contents.

7 Summary

This concludes the exercise. Now it should be clear how to carry out the following tasks:

- ☐ Execute available reports from the DIgSILENT Library.
- ☐ Adapt available reports.
- ☐ Modify and create a new title page.
- ☐ Create new reports in the designer.

8 Additional *PowerFactory* Documentation

There is additional information available, depending on what you are looking for; the following documents can be accessed either directly from *PowerFactory* or from the *DIgSILENT* download area (`https://www.digsilent.de/en/downloads.html`).

- **Tutorials:** step by step description of several tasks in *PowerFactory*. *Help* → *Tutorial...*
- **Examples:** the window *PowerFactory* Examples provides a list of application examples of *PowerFactory* calculation functions. Every example comes with an explanatory document. Additionally, videos demonstrate the software handling and its functionalities. *File* → *Examples...*
- **User Manual:** all the functions, objects and settings of *PowerFactory* are described in the User Manual. Pressing the key **F1** while working with *PowerFactory* will lead directly to the related topic inside the User Manual. *Help* → *User Manual*
- **Technical References:** description of the models implemented in *PowerFactory* for the different power systems components. *Help* → *Technical References*
- **What's New:** document and video provided with every annual release. *Help* → *What's New*
- **Release Notes:** for all new versions and updates of the program *Release Notes* are provided, which document the implemented changes. *Help* → *Release Notes*
- **Knowledge base:** a database of information, based on an FAQ format, available for any users (whether registered or not) in `https://www.digsilent.de/en/faq-powerfactory.html`
- **Scripting References:** description and examples of DPL and Python commands. *Help* → *Scripting References*
- **Additional Packages:** documents with additional description and /or examples of the *PowerFactory* Interfaces. *Help* → *Additional Packages*

Apart from the mentioned documentation, *DIgSILENT* provides **Direct Technical Support**, where *PowerFactory* experts offer direct assistance to registered users with valid guarantee/maintenance. The Support Centre is located on the website `https://www.digsilent.de/en/support.html`.