CoreCompact24

Excel-based calculation tool

User manual

Ein Bild, das Text, Screenshot, Zahl, parallel enthält.

Automatisch generierte Beschreibung

Ein Bild, das Text, Screenshot, Software, Zahl enthält.

Automatisch generierte Beschreibung

Version 1.x beta, Stand: 18.09.2024 - MEi

Subject to technical and editorial changes

Contents

[1 Introduction 2](#_Toc178590066)

[2 Simplified calculator 3](#_Toc178590067)

[2.1 Calculation parameters 3](#_Toc178590068)

[2.2 Wiring specifications 4](#_Toc178590069)

[2.2.1 What exactly does the calculator do? 4](#_Toc178590070)

[2.3 Calculation results 5](#_Toc178590071)

[2.4 Example 6](#_Toc178590072)

[3 Detailed calculator 7](#_Toc178590073)

[3.1 System settings 7](#_Toc178590074)

[3.2 Luminaire circuit simulation 8](#_Toc178590075)

[3.2.1 Luminaire selection 8](#_Toc178590076)

[3.2.2 Wiring modeling 9](#_Toc178590077)

[3.3 Calculation results 12](#_Toc178590078)

[3.3.1 Evaluation of the single circuits 12](#_Toc178590079)

[3.3.2 Evaluation of the overall system 13](#_Toc178590080)

[4 Revision history 14](#_Toc178590081)

Introduction

24V emergency lighting systems work with significantly lower voltages than a 230V system. For the emergency luminaires operated in this way to have the same electrical and lighting performance, around 9 times more current is required at 24V than in a 230V system. The result is that with the same cable cross-section, 9 times more voltage drops over a given length. If the voltage available to a luminaire falls below a certain level, the luminaire will no longer work (a minimum operating voltage is always required for the electronics built into the luminaires, especially due to LEDs and processors). For this reason, when planning a 24V system, care must be taken to ensure that the cables are not too long. The calculator described here will help you with this. Two different calculation tools are available:

1. Simplified calculator: Shows the maximum cable lengths for a preselected wiring type.
   * A detailed luminaire selection is not required (maximum luminaire output is assumed).
   * Simultaneous display of the maximum cable length for a circuit with 1, 2, 3, …, 20 luminaires.
2. Detailed calculator: Models the actual wiring of up to four circuits with all details.
   * Requires prior knowledge of the luminaires used and their spatial arrangement in the building.
   * Shows which luminaires have sufficient electrical supply and which do not.
   * Checks compliance with other system-wide constraints (e.g., total output power).

**Note:** Macros must be enabled. The calculator requires **Microsoft Excel under Microsoft Windows.**

**Note:** The calculator supports multiple languages, select your language on the "System" page, cell M7.

Simplified calculator

The so-called “simplified calculator” is located on the “Simplified” page:

Ein Bild, das Text, Screenshot, Software, parallel enthält.

Automatisch generierte Beschreibung

**Simplified calculator**

The calculator essentially consists of a table **(1)** which shows the maximum cable length for a circuit for each possible number of luminaires **(2)**. For each column of the table **(1)**, certain specifications for the main string wire(s) and luminaire taps can be specified column-wise **(3)** so that different wiring variants can be compared. In addition, commonly used general parameters for the circuit and luminaires apply to all calculations **(4)**. If you click on a field in the table **(1)**,the correspondingwiring is shown graphically in the “Visualisation” section on the right **(5)**.

If desired, general information about the project can be displayed in the header area **(6)**. This information is entered/edited on the "System" page and is adopted from there.

## Calculation parameters

All calculations in the “Simplified Calculator” use the following preset values (see “General” section **(4)**):

Ein Bild, das Text, Screenshot, Schrift, Zahl enthält.

Automatisch generierte Beschreibung

* **Terminal voltage:** Fixed at 18.0V, the circuit voltage reached at the end of battery discharge.
* **Max. current of all strings:** Fixed to the maximum current supplied by the system per circuit.
* **Circuit fuse rating:** Current at which the circuit fuse blows.
* **Max. luminaire power:** Expected maximum power of the luminaires used.
* **Luminaire power factor:** Average power factor (cos φ) of the luminaires.
* **Lamp shutdown voltage:** Smallest voltage at which all lamps operate.

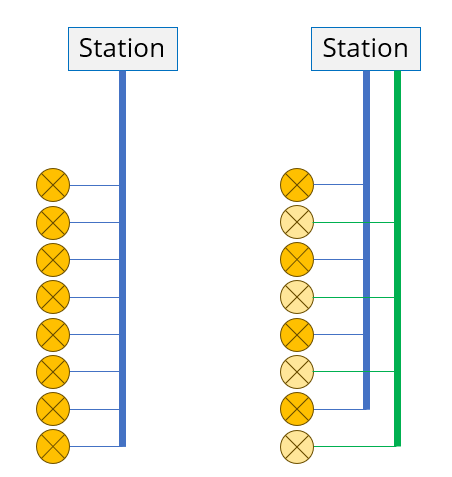
**Here is how it is done:**

* Check the “Max. luminaire power” value and, if necessary, adjust it to the largest power value of the luminaires that you are going to use.

## Wiring specifications

What exactly does the calculator do?

The "Simplified Calculator" considers wiring variants where one or more cable strings are routed from the system through the fire compartment. Each luminaire is connected to a string using a tap wire. If there are more than one strings, the connection is made alternatingly, as shown in the following picture:



**Wiring examples. Thick lines = strings, thin lines = taps.**

Such a wiring variant is determined by the six parameters in area **(3)** set:

Ein Bild, das Text, Diagramm, Screenshot, Reihe enthält.

Automatisch generierte BeschreibungEin Bild, das Text, Screenshot, Schrift, Zahl enthält.

Automatisch generierte Beschreibung

* Distance between system and first luminaire: Minimum cable length **L0** between the system terminal and the first tap for the first luminaire. This value is typically determined by the installation location of the system (station).
* Distance between the luminaires: Mutual distance **DL** of the luminaire taps along the strings if all luminaires were connected to one string. Enter the smallest distance that will probably occur.
* String wire cross-section: This value is assumed as the wire cross-section for all strings,
* Number of strings (count): 1, 2, 3 or 4 strings can be selected.
* Luminaire taps’ cross-section: This value is assumed as the wire cross-section for all luminaire taps.
* Luminaire taps’ maximum length: Largest expected length **LA** of the luminaire tap wires.   
  **Tip:** Set this value to zero to calculate through-wiring.

**Here is how it is done:**

* Adapt the parameters in columns A, B, C, D, E, F, G, and/or H to the specifications resulting from the spatial conditions (floor plan, estimated cable lengths) of the project.
* Check the box at the left of the column letter to activate the calculation of the cable lengths for the selected parameters:



## Calculation results

In accordance with the specifications of the general parameters and the wiring, the calculator in table **(1)** showsthe results for each number of luminaires (1 to 20) in the column below the wiring specifications. The calculation result looks like this:

Ein Bild, das Text, Schrift, Screenshot, Reihe enthält.

Automatisch generierte Beschreibung

There are three numbers with the following meaning:

* **L1** (first number): Maximum distance at which, measured from the system and along the string, the **tap** for the **first** luminaire from the string may be made.
* **LN** (second number): Maximum distance at which, measured from the system and along the string, the **tap** for the **last** luminaire on the string may be made.
* **Itotal** (third number): Current that flows through **all luminaires** (= terminal current on the system).

**Here is how it is done:**

* Read the three values above for the number of luminaires you are interested in.
* The second number **LN** tells you the maximum length of the longest string wire. If the layout requires a longer string wire, try more strings or a larger wire cross-section.
* The first number **L1** tells you the maximum distance the first luminaire can be from the system.
* The luminaire taps must not be closer together than specified in the wiring specifications.

**Note:** If an asterisk (\*) is displayed to the right of the result (see section 2.4 for an example), the cable length is limited by the condition that a short circuit on a single luminaire (no matter which one) should trigger the circuit fuse. A longer maximum string length can then only be achieved by using a larger conductor cross-section, not by using additional strings.

**Note:** The total current of all strings in a circuit is limited to 3.8A.

**Exceptions:** It may happen that no result is displayed for certain configurations. Such configurations are not feasible because they violate one or more of the system's boundary conditions. The letters displayed provide information:

* **A:** The configuration would result in undersupply (too low voltage) to one or more luminaires due to the voltage drop along the cable.
* **B:** The configuration would require a higher total current than allowed.
* **C:** The length of the wire would be so large that a short circuit in at least one of the luminaires would, due to the resistance of the wire, not trigger circuit fuse.

## Example

The following example compares three wiring variants (columns A, B and C) with 1 and 2 strings, where the 5m long luminaire taps are to be located at a mutual distance of 10m. Parameters in which the columns differ are marked in color (red/green).

Ein Bild, das Text, Screenshot, Zahl, parallel enthält.

Automatisch generierte Beschreibung

**Column A:** Wiring with one string of 1.5mm². Due to the short-circuit condition, only 11 luminaires are possible, and the string can only be 117.4m long; additional strings would not change this (note the asterisk \* in the result).

**Column B:** Due to the findings in column A, the string wire is changed to a cross-section of 2.5mm². Now, up to 16 luminaires are possible with a string length of up to 162.7m.

**Column C:** A second string allows a maximum string length of 195.7m to be used with up to 19 luminaires, which according to column B would only be usable with up to 8 luminaires with a single string.

Ein Bild, das Text, Design enthält.

Automatisch generierte Beschreibung

**“Worst-case” consideration:**

In **column D,** the mutual distance between the luminaire taps was set to zero. This wiring variant assumes that all luminaire taps are connected to the very end of the string; it thus represents a "worst case" consideration for the voltage drop along the string, since the total current of all luminaires flows through the entire length of the string, see image on the right.

Itotal

**Note:** The results in column D show that this calculation only produces small string lengths and thus pessimistic results (compare the values for 16 luminaires in columns B, C and D). In practice, as the example shows, much larger string lengths are feasible due to the finite distances between the luminaires. However, calculating these realistic string lengths requires an iterative simulation of the complete wiring harness, as is implemented in the calculator.

# Detailed calculator

The “Detailed Calculator” consists of the pages “System”, “Circuit 1”, “Circuit 2”, “Circuit 3” and “Circuit 4”.

Ein Bild, das Text, Screenshot, Software, Zahl enthält.

Automatisch generierte Beschreibung

**“System” page**

The **“System”** page is used to enter general project information (area **(1)**) and general settings for the overall system **(2)**. The battery capacity, the ageing factor and the planned autonomy time are set here. The calculation results are later displayed in the results area **(3)** to display an evaluation of the simulated circuits. The language of the calculator can be selected using the selection list at the top right **(4)**.

## System settings

**Here is how it is done:**

* On the “System” page, set the desired battery capacity and autonomy time **(2)**.
* Due to regulatory requirements, the ageing factor should remain set at 80%.
* Enter general information about your project in the header area **(1)**. The entries will be shown on all other pages of the calculator as well.

## Luminaire circuit simulation

Each of the pages "Circuit 1", "Circuit 2", "Circuit 3" and "Circuit 4" serves to simulate *one* circuit, i.e., to calculate current and voltage distribution with an explicit selection of luminaires for a specific wiring.

Ein Bild, das Text, Screenshot, Software, Webseite enthält.

Automatisch generierte Beschreibung

**Page “Circuit 1”**

For this purpose, in section **(1)** the luminaires of the circuit are selected. There are a total of twenty rows, one line for each luminaire. The luminaires are counted and arranged from the central station. In the area **(2)** The exact wiring is then modelled. Each cable is described by a grey field with the corresponding length and a white field with the wire cross-section:



From the wiring and the performance data of all lamps, the calculator calculates the voltage and the flowing current at each luminaire. These values are displayed in the range **(3)** for mains operation (circuit terminal voltage 24V) and battery operation shortly before shutdown (end of discharge, terminal voltage 18V). Area **(4)** shows the sum of the currents and an overall evaluation of the circuit configuration. Fields with problematic values are colored red. The comment field **(5)** gives further information.

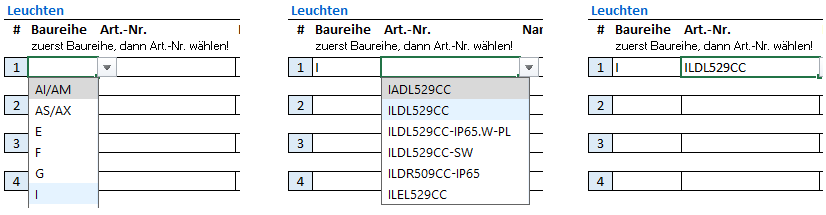
### Luminaire selection

The calculator contains the data for all available luminaires for the CoreCompact24 system. Since the range is extensive, the luminaires are sorted by "series". To select a specific luminaire, you must first select the series. You can then select the desired luminaire from the list of items in this series.

There is a separate row for each of the maximum twenty luminaires in a circuit; the rows are numbered from 1 to 20. Select all the luminaires for the circuit you want to model. In general, luminaire number 1 will be the one closest to the central station, and the distance to the control panel increases as the number increases.

**Here is how it is done:**

1. In the “Series” column (Excel column C), select the series of the desired luminaire.
2. In the “Article no.” column (Article number, Excel column D), select the article number of the desired lamp.
3. Optional: Enter additional information in the Name/Comment field (Excel column E) as needed.



The minimum supply voltage of the luminaire and its power consumption are shown in the "Umin" and "Power" columns. For a correct configuration, the minimum supply voltage must not be underrun at any luminaire; the greater the power consumption of a luminaire, the more current it will require and the more it will contribute to the voltage drop along the cables supplying it.

**Tip:** Use a luminaire selection multiple times by selecting the series and item number of a luminaire and pressing Ctrl-C. Then select only the series field in one or more other luminaire rows and press Ctrl-V.

### Wiring modeling

The calculator allows you to specify a wide variety of wiring options. The following image shows two examples:

Ein Bild, das Text, Screenshot, Zahl, Schrift enthält.

Automatisch generierte Beschreibung

**Wiring examples. Left: through wiring; right: cable harness with taps for each luminaire.**

Electrical connections are represented by black lines (━━━). Branching points (━┫) represent branches at terminals. The pairs of boxes  with a gray length value in meters and a white cross-section in square millimeters represent a cable or a cable section with the respective length and wire cross-section. In the modeling diagram, connections can run through these "cables" either vertically (perpendicular) or horizontally (horizontally):

**Ein Bild, das Text, Schrift, Screenshot, Reihe enthält.

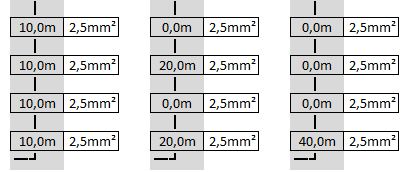
Automatisch generierte Beschreibung**

**Vertical (left) and horizontal (right) cable sections.**

This means that we can read the above wiring examples as follows:

* The example on the left simulates through-wiring, where a cable coming from the system (“**Station**”) with a length of 10m and a conductor cross-section of 1.5mm² is inserted into the first luminaire. From there, another similar cable runs to the second luminaire, etc. The branching points (━┫) between the cable sections correspond to the terminals in the luminaire (⊗) to which the two cables (incoming + outgoing) are connected.
* In the example on the right, a wire string with a cross-section of 2.5mm² is simulated from which short tapping cables having a cross-section of 1.5mm² branch off at regular intervals to supply the individual luminaires. The string first runs for 135m from the system, then there is a tap every 10m. The branching points (━┫) here therefore represent terminals in the string where the string sections meet, and the taps are connected (direct connection). Note the last string section with 2.5mm² and the tap wire to the last luminaire with 1.5mm². A terminal would be required to connect these two; alternatively, one could choose the same cross-section for both cable sections.

Consecutive cable sections without branches and with the same cross-section represent a single cable with the corresponding total length. The following three examples therefore describe the same 40m cable in different ways:



**Unbranched, consecutive cable sections with the same cross-section.**

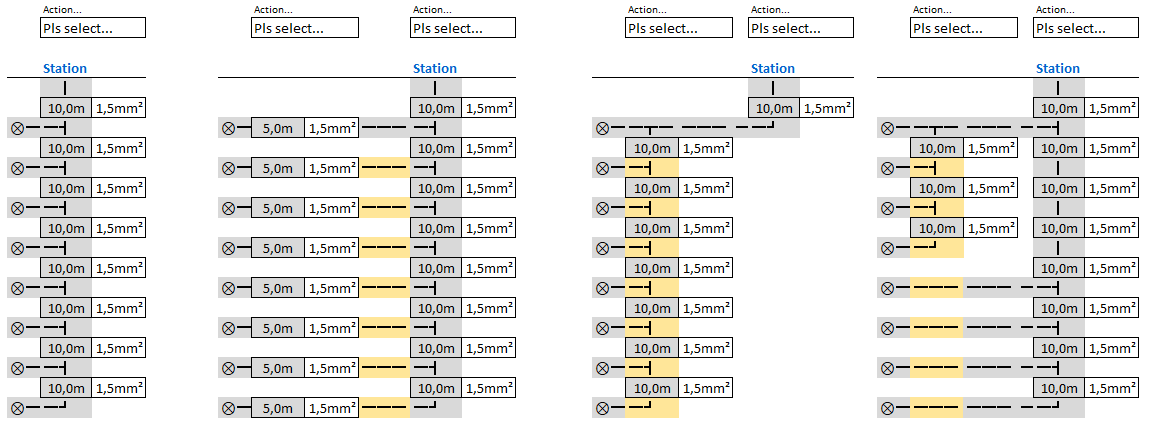
Depending on the complexity of the desired wiring type, one or more "columns" with horizontal or vertical cable runs are required in the calculator's circuit diagram. Above each column with cable settings, you will see a drop-down selection list ("Action..."):



This allows the selection of the following actions:

* “Insert wires |” This action inserts a column with vertical cables on the left.
* “Insert wires –” This action inserts a column with horizontal cables on the left.
* “Delete wires...” With this action you can delete a column.

**Examples:**



**A) B) C) D)**

**Additional wiring columns (AC); change the cable routing by double-clicking on the yellow fields (D)**

**A)** Without additional columns, there is only one vertical (main) string wire coming from the control center, which represents a through-wiring (see above).

**B)** Starting from A, adding a column of horizontal cables (“Insert wires –”). This creates cables running to the individual luminaires, which branch off as tap wires from the main string.

**C)** Starting from A, adding a column of vertical cables (“Insert wires |”). These initially will form another vertical string.

**Important:** Added columns with cables contain a couple of yellow fields (see **B)** and **C)**). The cable routing in these fields can be switched by double-clicking, as shown here by double-clicking on the red-bordered field:



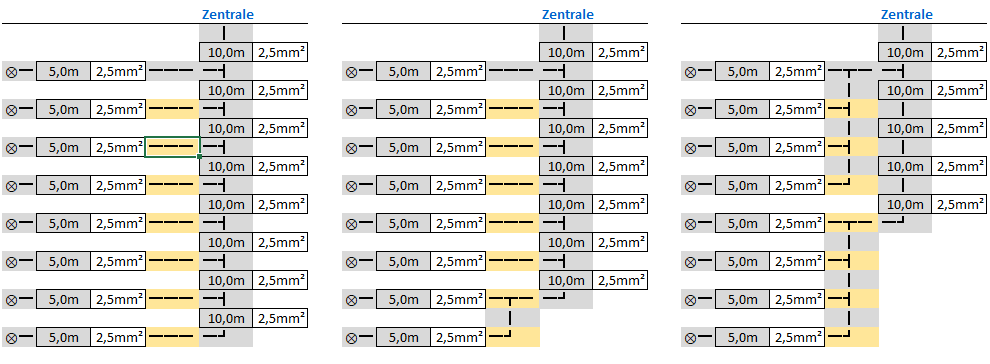
is shown above under **D)**:

**D)** Refinement, starting from C. By clicking on the last four yellow fields, the last four luminaires are directly connected to the main string (through wiring). The first four luminaires are also supplied by through wiring, but with their own line which, coming from the system, branches off from the main string after 10m.

Another example of simulating star-shaped wiring:



**E) F) G)**



Here in **E)** the cable routing is changed by double-clicking on the bottom yellow field so that the taps of the last two luminaires tap at the same point on the line (**F)**). If you repeat the double-click on the other marked fields, the connection can be changed to the star wiring shown in **G)** : Here the taps of the first four and the last four luminaires each branch off the main string in a star shape from a common point at 10m and 50m.

**Here is how it is done:**

1. After selecting the luminaires (see previous chapter), use the drop-down list "Action..." to add the columns with vertical and horizontal cables required for the wiring. The examples above will give you hints on the options:
   1. For strings to which one or more taps are connected, at least one column of vertical cables is required (one such column is always already present at the beginning, example **A**).
   2. For through-wiring, connect luminaires directly to the branching points in the string as shown in examples **A)**, **C)** and **D)**.
   3. To connect luminaires with taps instead of through-wiring, you need at least one column with horizontal cables for the tap wires (see example **E**). This also applies, for example, to star-shaped wiring as in example **G)**.
   4. Horizontal cables are also used for tapping lines from a line (Example **B)**).
2. Specify the individual cables: For each cable section, the length in m can be entered directly into the grey field (double-click); the cross-section can be set in the white field (click and select the desired value from the selection list).

**Tip:** Set the length of any cable (partial) sections that are not required to zero (0m). They will then act like a direct electrical connection.

**Tip:** Copy-and-paste cable specifications by (1.) selecting the gray and white fields of a cable, (2.) pressing Ctrl-C, (3.) selecting only the gray fields of one or more other cables, and (4.) pressing Ctrl-V.

## Calculation results

The calculator recalculates the entire circuit model every time you enter data (luminaires, cables, connections), so you don't have to start the calculation manually by yourself. This way, you always see the result of the simulation that matches your input, and you can see the effect of any changes immediately.

### Evaluation of the single circuits

A separate simulation is calculated on each of the pages “Circuit 1”, “Circuit 2”, “Circuit 3” and “Circuit 4” to verify whether each individual luminaire is sufficiently supplied with electricity during mains and emergency operation over the autonomy time.

Ein Bild, das Text, Screenshot, Software, Zahl enthält.

Automatisch generierte Beschreibung

**Example of a faulty circuit configuration.**

Luminaires for which this is not the case are marked red in the "Status" column, as are calculated values that are causing this **(1)**. The overall evaluation of the circuit **(2)** is then also marked as faulty; in the output field **(3)**,a textual summary of the errors found then appears instead of the comment "Working configuration". The total current of all luminaires is also compared with the maximum output current per circuit; exceeding this also leads to an error. The circuit tab and the "System" tab turn red in the event of an error.

Typical causes of circuit configuration errors:

* Cables that are too long and have a small cross-section cause too great a voltage drop, meaning that individual luminaires receive too little voltage.
* Too many luminaires require too much electric current.

Tips for remedying these problems: Use larger wire cross-sections and/or parallel wire strings to increase the voltage at the luminaires (which also reduces the current consumed). If necessary, redistribute luminaires to more circuits.

### Evaluation of the overall system

The calculator simulates a maximum of four complete circuit configurations corresponding to the four circuits of the CoreCompact24 system. On the "System" page, the results of the four circuits are summarized and further criteria are checked.

Ein Bild, das Text, Screenshot, Software, Webseite enthält.

Automatisch generierte Beschreibung

**Example of a faulty overall configuration**

The "Circuit Summary" lists the results of each circuit. Circuits with at least one luminaire are evaluated and are either "OK" (green) or faulty, symbolized by a white "🞬" on a red background **(1)**. Unused circuits (i.e., those without luminaires) are not evaluated **(2)**. On the far right, the "Total" column shows the total values (sums) of all circuits. The overall rating is "OK" (green) if all evaluated circuits are "OK" (green) too **(3)**.

Furthermore, the total current consumption of all luminaires is compared to a limit value that results from the choice of battery, its estimated battery aging, and the autonomy time of the system **(4)**. If this value is exceeded, an error is displayed. In the event of an error, the output field **(5)** shows a textual summary of all findings and the "System" tab turns red.

Typical causes and remedies for errors:

* A circuit is incorrectly configured 🡪see possible causes and remedies in the previous section.
* The circuits and all “OK” but the total current is too high. This means:
  + The battery capacity selected is too small or the autonomy time is too long. Try a different choice.
  + If no other choice can be made that resolves the problem, the luminaires must be split across multiple systems.

# Revision history

|  |  |  |  |
| --- | --- | --- | --- |
| version | Date​ | **author** | **Remark/major changes** |
| 1.x beta | 24.09.2024 | Martin Eichler | First version |
|  |  |  |  |
|  |  |  |  |