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1. General

Nexmosphere's product portfolio contains several types of LED control. This document explains the functionalities of each of these types and what considerations to make when including LED lighting into an application. In this document, the term "LED control type" is used to indicate a specific methodology to control a type of "LED strip".

2. LED control types

Each LED control type has its own set of functionalities.

Mono LED control 12V / 24V

Mono LED is the simplest type of LED control. A mono LED strip contains 1 color LEDs, for example all white or all blue LEDs.

RGB LED control 12V / 24V

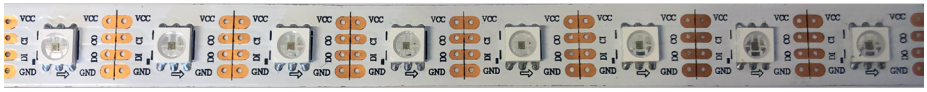
RGB LED strips can be set to different colors by mixing Red, Blue and Green LEDs.

RGBW LED control 24V

RGBW LED strips have more color options then RGB, due to an additional White LED.

Pixel LED control (X-Wave protocol)

Pixel LED strips have RGB LEDs that can be controlled individually. Nexmosphere's X-Wave protocol allows the creation of Wave animantions on Pixel LED strips.



Pixel LED control (selection LED protocol)

Nexmosphere's Selection LED protocol allows dividing a pixel LED strip into multiple segments and the control of each of those seperate segments. As this LED control type is used in very specific use cases, this LED protocol is not discussed in this document. For more information, please refer to the document "Controlling Selection Guide LEDs (API)".

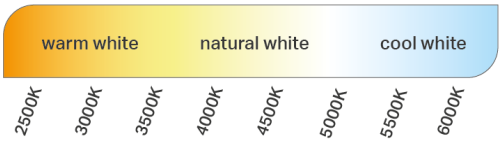
In the next section, the functionalities of each LED control type are explained.

Nexmosphere
High Tech Campus 10 (Mμ building)
5656 AE Eindhoven • The Netherlands
T +31 40 240 7070
E support@nexmosphere.com

3. Functionalities

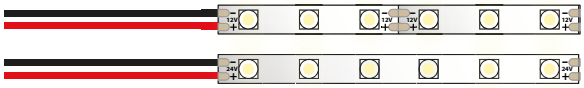
Mono LED control 12V / 24V

Mono LED strips (or single-color LED strips) contain LEDs that only provide 1 light color as output, for example white, blue or red. The brightness of the LED strips is controlled using PWM (Pulse-width modulation) and always applies to the entire LED strip. Because there only is 1 color of LED, the required current per meter is usually less than with other LED types. Single-color LED control is available in 12V and 24V DC. The 24V variant is more suitable to control longer lengths of LED strips, as it requires less current than the 12V option.



Typical use cases are:

- Illuminating shelves
- Illuminating large surfaces/lengths
- (Fashion)retail: illuminating merchandise with high-CRI LED strips to create perfect lighting conditions
- Combine a warm-white LEDstrip with a cool-white LED strip for color-temperature control



RGB LED control 12V / 24V

RGB LED strips contain LEDs with 3 color channels: Red, Green and Blue. As these channels are mixed into 1 output color, the color can be changed by individually adjusting the intensity of the channels. The brightness of the LED strips can be controlled using PWM (Pulse-width modulation) and applies to the entire LED strip. As there are 3 channels, the required current per meter is higher than with Mono LED strips. This is especially the case when setting an RGB LED strip to white - which is the combination of all 3 color channels together -, versus using a white Mono-color LED strip. RGB LED control is available in 12V and 24V DC. The 24V variant is more suitable to control longer lengths of LEDstrip as it requires less current then the 12V option.

Typical use cases are:

- Applications in which several "full" LED colors need to be implemented
- Indication lights, for example: "go" (green), "hold" (red)
- Illuminating a surface in a specific brand color (e.g. purple)

RGBW LED control 12V / 24V

RGBW LED strips are similar to RGB LED strips. The difference is that for RGBW, a dedicated channel for White LED output is added. This can either be Warm White or Cold White. This offers three main benefits compared to RGB:

1. The additional White channel offers the opportunity to create subtle pastel colors. This functionality can be compared to adjusting the saturation of a color.

2. When only using the White channel, less current is needed as opposed to setting an RGB LED to white using all 3 channels.

3. The CRI of the white light is typically better when using a dedicated White channel, as opposed to using an RGB LED and mixing the three channels (Red, Green and Blue) to create a white output.

Also for RGBW LED strips, the brightness of the LEDstrips can be controlled using PWM (Pulse-width modulation) and applies to the entire LED strip. As there are 4 channels, the required current per meter is higher than with RGB or Mono LED strips. This is especially the case when activating all 4 channels (Red, Green, Blue and White simultaneously). However, typically,

Nexmosphere
High Tech Campus 10 (Mμ building)
5656 AE Eindhoven • The Netherlands
T +31 40 240 7070
E support@nexmosphere.com

the 4 channels are not set to full brightness simultaneously. Either the White channel is used separately to create White LED output, or mixed with faded brightness of the color channels to create subtle pastel colors. RGBW LED strip control is only available in 24V DC.

Typical use cases are:

- Illuminating shelves or cabinets in subtle pastel colors (e.g. high-end fashion retail)
- Application in which both White LED and Colored LED output is required.
- illuminating a surface in a specific brand color (e.g. purple)

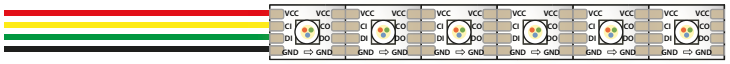
Pixel LED control

Pixel LED strips are RGB LEDs that can be controlled individually. This allows the creation of LED animations on a single LED strip, such as "waves" or "running LEDs". Pixel LED strips can ***not*** be controlled using PWM. Therefore Pixel LED strips can't be connected to controllers with only RGB or RGBW outputs. Instead, the Pixel LED strips are addressed through a digital communication method (APA102 LED), which can be utilized using Nexmosphere's X-Wave interfaces and protocol.

X-Wave offers several pre-programmed animations such as pulsing LEDs and Waves, which can be configured through API commands. For more information on the X-Wave protocol, please refer to the Manual "Controlling X-Wave LEDs with API" . Pixel LED strips operate on 5V and require a high amount of current. Therefore they are less suitable in applications where longer lengths of LED strip are required.

Typical use cases are:

- LED animations on retail shelves to attract shoppers or add an additional layer of experience
- Museum application in which lights "move" towards specific exhibition items
- High-end lighting effects
- General application in experience centers



Functionality overview

	Mono LED		RGB LED		RGBW LED	Pixel LED
	12V	24V	12V	24V	24V	5V
Brightness control	✔	✔	✔	✔	✔	✔
Color control	✖	✖	✔	✔	✔	✔
Saturation control (pastel colors)	✖	✖	✖	✖	✔	✖
True White (warm or cold)	✔	✔	✖	✖	✔	✖
Pulsing LED animations	✔	✔	✔	✔	✔	✔
X-Wave animations	✖	✖	✖	✖	✖	✔
Suitable for longer lengths	✖	✔	✖	✔	✔	✖

Nexmosphere
High Tech Campus 10 (Mμ building)
5656 AE Eindhoven • The Netherlands
T +31 40 240 7070
E support@nexmosphere.com

4. Specifications

In this section, an overview of the specifications is given for each LED control type:

Connection types - what connectors are used, specified for each controller range.
Maximum power output of the LED outputs - how much power these connectors can supply to the connected LED strip.
Control type - the technical control/communication method used to control the LED strip.
Typical power consumption LED strips - the typical power consumption for an LED strip. These values also apply to the LED strips available from our accessory portfolio. Please note that when using LED strips not provided by Nexmosphere, the power consumption values of the 3rd party LED strip need to be used for power calculation.
Max length of the LED strip on 1 output - in a full-power scenario.
Dimensions- the width of the LED strip and the length of the segments in which the LED strip can be cut.

The specifications provided are intended to provide clear and structured input for selecting the right LED type for your application. Some specifications are simplified and abstracted from the full and detailed specifications available in the datasheets of our products. Once a LED control type and the corresponding products are selected, we recommend checking the detailed specification in the datasheets (also see section 8) to confirm your final application design.

Mono LED control 12V / 24V

Connection type:

XM controllers (EM-5):	2.1mm DC connector
XC controllers:	LED connector

***Typical* power consumption**

White LED strip 60 L/m:	0.4A/meter @ 12VDC
	0.2A/meter @ 24VDC

Maximum power output of the LED outputs

XM controllers (EM-5):	1.5A @ 12VDC
XC controllers:	3.0A @ 12-24VDC

Max length of LED strip on 1 output

XM controllers (EM-5):	3.7 meter @ 12VDC
XC controllers:	7.5 meter @ 12VDC
	15 meter @ 24VDC

Control type:
PWM

Dimensions

Width LED strip:	8mm
Segment length:	50mm @ 12VDC
	100mm @ 24VDC

2.1mm DC connector

LED connector for Mono LED

Nexmosphere
High Tech Campus 10 (Mμ building)
5656 AE Eindhoven • The Netherlands
T +31 40 240 7070
E support@nexmosphere.com

RGB LED control 12V / 24V

Connection type:

XM controllers (EM-6):	Wire input - stripped end
XC controllers:	LED connector

***Typical* power consumption**

RGB LED strip 60 L/m:	1.2A/meter @ 12VDC
	0.6A/meter @ 24VDC

Maximum power output of the LED outputs

XM controllers (EM-6):	3.0A @ 12-24VDC
XC controllers:	3.0A @ 12-24VDC

Max length of LED strip on 1 output

XM controllers (EM-6):	2.5 meter @ 12VDC
XC controllers:	2.5 meter @ 12VDC
	5.0 meter @ 24VDC

Control type:

PWM

Dimensions

Width LED strip:	8mm
Segment length:	50mm @ 12VDC
	100mm @ 24VDC

RGBW LED control 24V

Connection type:

XC controllers:	RGBW connector

***Typical* power consumption**

RGBW LED strip 60 L/m:	0.8A/meter @ 24VDC

Maximum power output of the LED outputs

XC controllers:	3.0A @ 12-24VDC

Max length of LED strip on 1 output

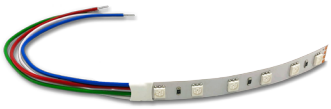
XC controllers:	3.7 meter @ 24VDC

Control type:

PWM

Dimensions

Width LED strip:	12mm
Segment length:	100mm @ 24VDC



Stripped wires for RGB LED

LED connector for RGB(W) LED

Stripped wires for RGB LED

Pixel LED control 5V

Connection type:

All:	X-Wave connector

***Typical* power consumption**

Pixel LED strip 60 L/m:	3.0A/meter @ 5VDC

Maximum power output of the LED outputs

XW-D Elements:	0.5A @ 5VDC
XC controllers:	3.5A @ 5VDC
XN-135M8	1.8A @ 5VDC

Max length of LED strip on 1 output

XW-D Elements:	0.16 meter @ 5VDC (60 L/m)
XC controllers :	1.16 meter @ 5VDC (60 L/m)
XN-135M8:	0.60 meter @ 5VDC (60 L/m)

Control type:

Adressable protocol APA102

Dimensions

Width LED strip:	12mm
Segment length:	33.3mm @ 30 LEDs per meter
	16.7mm @ 60 LEDs per meter
	6.9mm @ 144 LEDs per meter

Nexmosphere
High Tech Campus 10 (Mμ building)
5656 AE Eindhoven • The Netherlands
T +31 40 240 7070
E support@nexmosphere.com

5. Power calculation

When creating a setup with LED strips, the required current of the LED strip, versus the max. current that an LED output ***and*** the Xperience controller can provide in total, should be taken into account. The max LED output current and max. system current of each Controller are listed in their datasheet. For example an Xperience controller can have the following power specifications:

- *5x LED output*
- *Max. system current: 2.0A*
- *Power consumption: 0.2A*
- *Max. output per LED output 1.5A @ 12VDC*

In this example, the max. LED output is 1.5A. However, it is not possible to draw 1.5A from each of the 5 LED outputs simultaneously, as the max. system current of the Xperience controller is 2.0A. The total current of the 5 LED outputs together can't exceed 1.8A (2.0A - 0.2A).

The required current for an LED strip can be calculated. This can be done using two different approaches:

- **Safe calculation:** only take the max. specifications of the LED strip into account, but not how it is controlled (to which colors and brightness the LED strip is set). This is the safest way of calculating the required current of the LED strip, but is typically also more restrictive than required in practice.
- **Detailed calculation (advanced):** takes both the specification of the LED strip and the control method into account, when calculating the required current. We recommend only using this method when you have a professional understanding of electricity principles such as Power, Voltage and Current.

5.1 Safe calculation

For the safe calculation, the max. power specification of the LED strip is used to calculate the required current for the total length of the LED strip. This can be done using the following formula:
(**power of LED strip** *(W/m)* **/ operating voltage LED strip** *(V)*) *** length of LED strip** *(m)* **= required current** *(A)*

Example calculations

3.0m of 12V LED strip with a required power of 4.8 W/m requires (**4.8 / 12**) *** 3** = **1.2A** of current.
2.0m of 12V LED strip with a required power of 14.4 W/m requires (**14.4 / 12**) *** 2** = **2.4A** of current.
2.5m of 24V LED strip with a required power of 19.2 W/m requires (**19.2 / 24**) *** 2.5** = **2.0A** of current.
0.5mr of 5V Pixel LED strip with a required power of 14.0 W/m requires (**14.0 / 5**) *** 0.6** = **1.4A** of current.

5.2 Detailed calculation per LED type

The detailed calculation approach is different for each LED control type. Since in using this calculation, more variables and uncertainties need to be taken into account, we advise calculating with a 2-5% safety margin (depending on what LED type you are using).

Mono LED control

When using Mono LED control, one variable is added, being the Brightness to which the LED strip will be set.
(**power of LED strip** *(W/m)* **/ operating voltage** *(V)*) *** length of LED strip** *(m)* *** brightness** *(in decimal)* **= required current** *(A)*

Example calculations

4m of 12V LED strip with a required power of 4.8 W/m at a Brightness of 50% requires (**4.8 / 12**) *** 4 * 0.5**= **0.8A** of current.
7m of 12V LED strip with a required power of 4.8 W/m at a Brightness of 80% will requires (**4.8 / 12**) *** 7 * 0.8**= **1.2A** of current.

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High Tech Campus 10 (Mμ building)
5656 AE Eindhoven • The Netherlands
T +31 40 240 7070
E support@nexmosphere.com

RGB LED control and RGBW LED control

When using RGB or RGBW LED control, we calculate the required current for each color channel separately, then add them together, and multiply this with the LED output brightness. To do so, first the required power of each color channel needs to be defined. If this is not specified in the datasheet of your LED strip, we advise dividing the total power usage (W) of the LED strip by the number of color channels to calculate the required current per channel. As in practice there can be small differences in the current draw per color channel, we advise taking a 2% margin into account.
Typically, when controlling RGB(W) LED strips, there are 2 main variables: color and brightness.

- An RGB(W) color is created by defining the brightness ratio of each color channel with a value between 0-100. For example "pink" is created by setting the red channel to 100%, green to 0% and blue to 50%. These values determine the ratio between each color, but not the actual output brightness. In the calculations below this variable will be referred to as ***color ratio***. In the calculations, the color ratio is applied as a 0.0-1.0 decimal value. To converter to 0.0-1.0 decimal value, divide the 0-100% ratio by 100. *In Appendix C (page 13), the color ratios of the default colors are provided.*
- The brightness determines how bright the light coming from the LED strip (in the color specified) will be. In the calculations below, this variable will be referred to as ***brightness.***

To calculate the required current draw for an RGB or RBW LED strip, follow the steps below:

Step 1. Power usage. Look up the power usage of each color channel in the datasheet. If not available, calculate:
(**power of LED strip** *(W/m)* **/ number of color channels**) = **power usage color channel**

Step 2. Current draw at full brightness. Calculate the required current draw for each color channel at 100% brightness:
(**power usage color channel** *(W/m)* **/ voltage***(V)*) *** length of LED strip***(m)* *** color ratio** *(in deci)* **= current draw of channel***(A)*

Step 3. Current draw at actual brightness. Add up the current draw of all color channels and multiply with the brightness (in deci) to calculate the total current draw:
(**current channel R + G + B + W) * brightness** *(in deci)* **= required current** *(A)*

Example calculations

5 meter of 12V RGB LED strip with a required power of 14.4 W/m, set to pink (R=100%, G=0%, B=50%) at 75% brightness:

1. Power usage for each color channel is (**14.4 / 3**) = **4.8 W/m per color channel**

2. Required current draw for each color channel is:

Red: (**4.8 / 12**) *** 5 * 1.0**= **2.0A**
Green: (**4.8 / 12**) *** 5 * 0.0**= **0.0A**
Blue: (**4.8 / 12**) *** 5 * 0.5**= **1.0A**

3. Total current draw is (**2.0 + 0.0 + 1.0**) *** 0.75** = **2.25A**

7 meter of 24V RGB LED strip with a required power of14.4 W/m, set to orange (R=100%, G=50%, B=0%) at 90% brightness:

1. Power usage for each color channel is (**14.4 / 3**) = **4.8 W/m per color channel**

2. Required current draw for each color channel is:

Red: (**4.8 / 24**) *** 7 * 1.0**= **1.4A**
Green: (**4.8 / 24**) *** 7 * 0.5**= **0.7A**
Blue: (**4.8 / 24**) *** 7 * 0.0**= **0.0A**

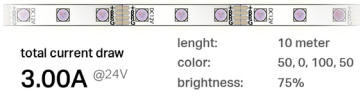
3. Total current draw is (**1.4 + 0.7 + 0.0**) *** 0.90** = **1.89A**

10 meter of 24V RGBW LED strip with a required power of19.2 W/m, set to color soft purple (R=50%, G=0%, B=100%, W=50%) at 75% brightness:

1. Power usage for each color channel is (**19.2 / 4**) = **4.8 W/m per color channel**

2. Required current draw for each color channel is:

Red: (**4.8 / 24**) *** 10 * 0.5**= **1.0A**
Green: (**4.8 / 24**) *** 10 * 0.0**= **0.0A**
Blue: (**4.8 / 24**) *** 10 * 1.0**= **2.0A**
White: (**4.8 / 24**) *** 10 * 0.5**= **1.0A**



3. Total current draw is (**1.0 + 0.0 + 2.0 + 1.0**) *** 0.75** = **3.0A**

Nexmosphere
High Tech Campus 10 (Mμ building)
5656 AE Eindhoven • The Netherlands
T +31 40 240 7070
E support@nexmosphere.com

Pixel LED control

For Pixel LEDs, each LED can be controlled separately, meaning that each LED can be set to a different color and brightness. As a result, each LED in a Pixel LED strip can also draw a different amount of current. Furthermore, Pixel LED has an IC in each LED which also draws current. For these reasons, a formula to calculate the exact required current for a Pixel LED strip at a specific color, brightness and animation would become *very* complex. As an alternative, this document provides simplified formulas of which the result approaches the required current. In these formulas, safety margins are taken into account.

Because each LED can be controlled separately, we advise to first calculate the required current for one LED (at a specific state), and secondly calculate the current draw for the complete Pixel LED strip in a specific control state. The formulas to do so are provided below.

Single LED calculation:

Step 1. Color ratios. Calculate the color ratio for each color channel.
As a color for Pixel LEDs is defined in HEX values, it first needs to be converted to an RGB color value between 0-255. This can be done using an easy online **HEX to RGB converter tool** such as https://www.color-hex.com. Secondly, the 0-255 RGB needs to be divided by 2.55 to calculate the 0-100% ratio. Once the 0-100% ratio is known, divide this by 100 to convert the ratio from 0-100% to 0.0-1.0 decimal value. *In Appendix C (page 13), the color ratios of the default colors are provided.*
Color ratio *(in deci)* = (**RGB Color Value** *(0-255)* **/ 2.55**) **/ 100**

Step 2. Current draw at full brightness. Calculate the required current draw for each color channel at 100% brightness by multiplying the color ratio with the current draw of the resepective color channel.
Current Red channel = (**Ratio Red** *(in deci)* *** 0.018A**)
Current Green channel = (**Ratio Green** *(in deci)* *** 0.014A**)
Current Blue channel = (**Ratio Blue** *(in deci)* *** 0.015A**)

Step 3. Current draw at actual brightness. Calculate the required current draw for one LED at a specific color and brightness by adding up the required currents for each color channel and multiply this with the brightness (in 0.0-1.0 deci value). Add 0.003A for the current draw of the LED IC.
(**current channel R + G + B**) *** brightness** *(in deci)* **+ 0.003A = required current per LED** *(A)*

Step 4. Total current draw of LED strip:

Calculation for "Single ramp LED output" and "Pulse LED output":
The required current draw when all LEDs in a Pixel LED strip are set at the same color and brightness (applicable for X-Wave "Single ramp LED output" and X-Wave "Pulse LED output), can be calculated by multiplying the number of LEDs in the LEDstrip with the required current per LED.
required current per LED *(A)* *** amount of LEDs = required current LED strip** *(A)*

or:

Calculation for "Wave LED output" (applicable for sinewave, animation program 00 and 01)**:**
When the Pixel LED strip is set to sinewave animations ("Wave LED output", animation program 00 and 01), the required current draw can be estimated by calculating the average required current of LED state 1 and state 2 of the X-Wave animation.
required current per LED in state 1 *(A)* *** amount of LEDs = required current LED strip** in state 1 *(A)*
required current per LED in state 2 *(A)* *** amount of LEDs = required current LED strip** in state 2 *(A)*
(req. current LED strip in state 1 *(A)* **+ req. current LED strip in** state 2 *(A)***) / 2 = current draw LED strip** set to Wave animation

Nexmosphere
High Tech Campus 10 (Mμ building)
5656 AE Eindhoven • The Netherlands
T +31 40 240 7070
E support@nexmosphere.com

Example calculations

1 meter (60 LEDs) of Pixel LED strip set to White (HEX color #FFFFFF) at 80% brightness:

1. Color ratio each color channel is:

Convert from HEX to RGB: #FFFFFF in RGB color values is **R=255**, **G=255**, **B=255**

Color ratio Red channel = (**255 / 2.55**) **/ 100** = **0.0**

Color ratio Green channel =(**255 / 2.55**) **/ 100** = **0.0**

Color ratio Blue channel = (**255 / 2.55**) **/ 100** = **0.0**

total current draw **2.46A** @5V

lenght: 1 meter
color: #FFFFFF
brightness: 80%

2. Required current draw for each color channel is:

Red= **1.0 * 0.018A** = **0.018A**

Green = **1.0 * 0.014A** = **0.014A**

Blue = **1.0 * 0.015A** = **0.015A**

3. Required current draw for one LED is ((**0.018A + 0.014A + 0.015A**) *** 0.8**) **+ 0.003 = 0.041A.**

4. Total current draw is **0.041 * 60 = 2.46A.**

3 meter (180 LEDs) of Pixel LED strip set to Sky Blue (HEX color #0080FF) pulsing from 70% brightness to 10% brightness:

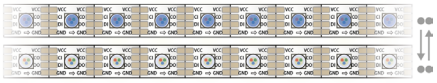
1. Color ratio each color channel is:

Convert from HEX to RGB: #0080FF in RGB color values is **R=0**, **G=128**, **B=255**

Color ratio Red channel = (**0 / 2.55**) **/ 100** = **0.0**

Color ratio Green channel =(**128 / 2.55**) **/ 100** = **0.5**

Color ratio Blue channel = (**255 / 2.55**) **/ 100** = **0.0**



total current draw **3.24A** @5V

lenght: 1 meter
color: #0080FF
brightness: 10% <-> 70%

2. Required current draw for each color channel is:

Red= **0.0 * 0.018A** = **0.000A**

Green = **0.5 * 0.014A** = **0.007A**

Blue = **1.0 * 0.015A** = **0.015A**

3. Required current draw for one LED is ((**0.000A + 0.007A + 0.015A**) *** 0.7**) **+ 0.003 = 0.018A**

4. Total current draw is **0.018 * 180 = 3.24A**

2.5 meter (150 LEDs) of Pixel LED strip set to a Wave animation with LED state 1 set to Green (HEX color #00FF00) at 90% and LED state 2 set to White (HEX color #FFFFFF) at 50% brightness:

1. Color ratio each color channel is:

LED state 1: Convert from HEX to RGB:
#00FF00 in RGB color values is **R=0**, **G=255**, **B=0**

LED state 2: Convert from HEX to RGB:
#FFFFFF in RGB color values is **R=255, G=255, B=255**

LED state 1:

Color ratio Red channel = (**0 / 2.55**) **/ 100** = **0.0**

Color ratio Green channel =(**255 / 2.55**) **/ 100** = **1.0**

Color ratio Blue channel = (**0 / 2.55**) **/ 100** = **0.0**

LED state 2

Color ratio Red channel = (**255 / 2.55**) **/ 100** = **1.0**

Color ratio Green channel =(**255 / 2.55**) **/ 100** = **1.0**

Color ratio Blue channel = (**255 / 2.55**) **/ 100** = **1.0**

2. Required current draw for each color channel:

LED state 1:

Red= **0.0 * 0.018A** = **0.000A**

Green = **1.0 * 0.014A** = **0.014A**

Blue = **0.0 * 0.015A** = **0.000A**

LED state 2:

Red= **1.0 * 0.018A** = **0.018A**

Green = **1.0 * 0.014A** = **0.014A**

Blue = **1.0 * 0.015A** = **0.015A**

3. Required current draw for one LED is:

LED state 1: ((**0.000A + 0.014A + 0.000A**) *** 0.9**) **+ 0.003 = 0.016A**

LED state 2: ((**0.018A + 0.014A + 0.015A**) *** 0.5**) **+ 0.003 = 0.024A.**

4. Total current draw is ((**0.016 * 150**) **+** (**0.024 * 150**)) **/ 2 = 3.00A**

Nexmosphere
High Tech Campus 10 (Mμ building)
5656 AE Eindhoven • The Netherlands
T +31 40 240 7070
E support@nexmosphere.com

6. Power supply

LED strips connected to an Xperience controller are powered from the power supply (PSU) of the Xperience controller. Depending on which type of LED control and Xperience controller is used, it is possible to add additional PSUs if needed. Below the options for each LED control type and Xperience controller are provided.

Mono LED control

XC controllers: mono LED strips connected to an XC controller are powered from the PSU of the Xperience controller. Please make sure that the voltage of the power supply matches the voltage of the LED strip (12V or 24V).
XM controllers (EM-5 Module): mono LED strips connected to an EM-5 module of an XM controller are powered from the PSU of the EM-5 Module. A 12V PSU can be connected to each EM-5 module. On one XM controller, a max. of 2 EM-5 modules can be powered simultaneously by direct connection of the PSU onto the EM-5 module.

RGB LED control

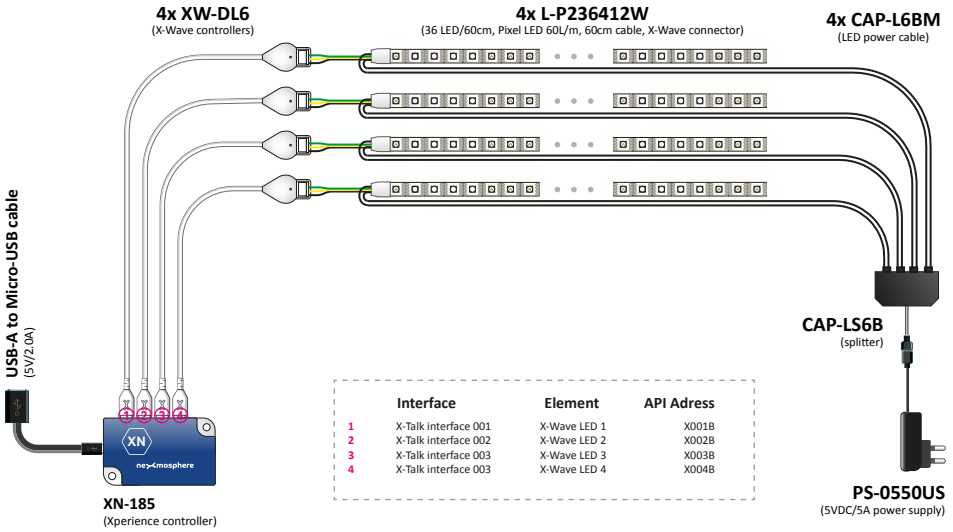
XC controllers: RGB LED strips connected to an XC controller are powered from the PSU of the Xperience controller. Please make sure that the voltage of the power supply matches the voltage of the LED strip (12V or 24V).
XM controllers (EM-6 Module): RGB LED strips connected to an EM-6 module of an XM controller are powered from the PSU of the EM-6 Module. A 12V or 24V PSU can be connected to each EM-6 module. On one XM controller, no more than 1 EM-6 module can be powered. In case more then 1 PSU would be required, the EM-6 modules can be adjusted by Nexmosphere during assembly to allow for each EM-6 module to be powered separately. Alternatively, a ShopModule with RGB LED control can also be connected to the XM controller.

RGBW LED control

XC controllers: RGBW LED strips connected to an XC controller can only be powered from the power supply of the Xperience controller. Please make sure that the voltage of the power supply matches the voltage of the LED strip (24V).

Pixel LED control

XC controllers: Pixel LED strips connected to an XC controller are powered from the PSU of the Xperience controller. The XC controller requires a PSU of 12V or 24V. As the Pixel LED strips need a 5V supply, the Xperience controller converts the voltage level internally.
XN controllers: Pixel LED strips connected to an XN-135M8 controller are powered from the 5V USB power supply of the Xperience controller.
Elements: the XW-DL X-Wave Elements are powered from the controller via the X-Talk interface and can only provide 0.5A to the Pixel LED strip. In case the power consumption of the Pixel LED strip exceeds this value, an additional LED power cable can be mounted onto the Pixel LED strip. This cable is pre-mounted at Nexmosphere and can provide an additional 3A of power. A 2-way and 6-way splitter are available to connect multiple LED power cables to an additional 5V PSU. Below, an example schematic for a setup with additional LED power supply cables is provided.



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E support@nexmosphere.com

7. How to select the right LED products for your application

When creating an application which includes LED, we suggest to follow the steps below to select the most suitable products for your setup:

Step 1. Define the functional requirements of your application and prioritize them

Questions to define the functional requirements are:

- Do you need one color LED or multiple colors?
- Is a high CRI required?
- Are you going to use short lengths of LED strip or long lengths?
- Do you need wave animations or just single ramps and/or pulsing LEDs?

Step 2. Select the LED control type that fits your functional requirements best

Once you've listed the functional requirements, check in section 3 (page 2-3) which LED control type fits these requirements best. For an overview of the functionalities see page 3 of this document.

Step 3. Check the technical specifications of the selected LED control type

Check the specifications of the selected LED control type in section 4 (page 4-5). Typically, the max. length of LED strip that can be controlled from one output is a critical spec. The max. length specification in section 4 is based on max power scenarios. In practice, the exact power requirements can be lower depending on how the LED strips are controlled.

- In case the max. length spec. in section 4 fits your technical requirements - **proceed to step 6**
- In case the max. length spec. in section 4 doesn't fit your technical requirements - **proceed to step 4**
- In case you are planning on using your own LED strips, check the specifications which you can usually find on their datasheets, to make sure these match with the selected LED control type - **proceed to step 4**

Step 4. Calculate the required current draw of the LED strips in your application

In section 5 (page 6-9), step-by-step instructions are provided on how to calculate the exact current draw of an LED strip. Execute these calculations for each LED strip in your application and add up the results to calculate the total required current draw of the LED strips in your application.

Step 5. Check if the total required current draw is within the max specifications of the selected LED control type

Check the max current draw of the selected LED control type in section 4 (page 4-5) and check whether the required current draw of your application is within this specification. If the required current draw is higher then the max. specification, either a different control type needs to be selected or the total required current draw needs to be decreased by either decreasing the number of LEDs or the output brightness.

Step 6. Select the most suitable Controller and/or Element for your LED application

Appendix A (page 12) provides an overview of all available Controllers and Elements for each LED control type. Select the most suitables ones for your LED application. Typically, the number of LED strips that need to be controlled is the most critical specification. Secondly, check if the number of required X-talk interfaces is available on the selected controller (see datasheet of the Controller).

Step 7. Select the right accessories for your application

Appendix B (page 13) provides an overview of the available Accessories for each LED control type. The most critical accessory is the LED strip. To select:

- First check if there is an LED strip available with the right connection cable for the selected Controller. Not all combinations of LED strip + connectors are available as a pre-assembled accessory.
- If the required combination of LED strip +connector is not available as a pre-assembled accessory, select the cable with the connector for the selected controller. You should solder this cable onto your LED strip, that can be purchased at a 3rd party.

In case you'd like help in selecting the right products, please contact applications@nexmosphere.com.

Nexmosphere
High Tech Campus 10 (Mμ building)
5656 AE Eindhoven • The Netherlands
T +31 40 240 7070
E support@nexmosphere.com

APPENDIX A - Product overview

Below, an overview of the available products for each LED control type is provided. In appendix B, an overview of the available accessories for these products is provided.

Mono LED control

Product code	LED outputs	LED accessory	Other
EM-5	5 channel mono LED output	L-W or L-C LED strips	expandable with other EM modules
XC-820	2x RGBW LED output	CAL-S cable	add your own LED strip. 12V or 24V
XC-841	4x RGBW LED output	CAL-S cable	add your own LED strip. 12V or 24V
XC-847	4x RGBW LED output, 2x X-Wave	CAL-S cable	add your own LED strip. 12V or 24V
XC-860	6x RGBW LED output	CAL-S cable	add your own LED strip. 12V or 24V

RGB LED control

Product code	LED outputs	LED accessory	Other
EM-2	1 channel RGB LED output	L-X.....S LED strips	expandable with other EM modules
EM-6	2x RGBW LED output	L-X.....S LED strips	expandable with other EM modules
XC-820	2x RGBW LED output	L-X.....L LED strips	24V LED strips
XC-841	4x RGBW LED output	L-X.....L LED strips	24V LED strips
XC-847	4x RGBW LED output, 2x X-Wave	L-X.....L LED strips	24V LED strips
XC-860	6x RGBW LED output	L-X.....L LED strips	24V LED strips

RGBW LED control

Product code	LED outputs	LED accessory	Other
XC-820	2x RGBW LED output	L-X.....L LED strips	24V LED strips
XC-841	4x RGBW LED output	L-X.....L LED strips	24V LED strips
XC-847	4x RGBW LED output, 2x X-Wave	L-X.....L LED strips	24V LED strips
XC-860	6x RGBW LED output	L-X.....L LED strips	24V LED strips

Pixel LED control (X-Wave)

Product code	LED outputs	LED accessory	other
XC-720	2x X-Wave interface	L-P LED strips	Pixel LED strips (APA-102)
XC-741	4x X-Wave interface	L-P LED strips	Pixel LED strips (APA-102)
XC-747	4x X-Wave interface, 2x RGBW	L-P LED strips	Pixel LED strips (APA-102)
XC-760	6x X-Wave interface	L-P LED strips	Pixel LED strips (APA-102)
XN-135M8L	1x X-Wave interface	L-P LED strips	Pixel LED strips (APA-102)
Elements (can be connected to any X-talk interface)			
XW-DL	1x X-Wave interface	L-P LED strips	CAP-L6BM powercable required
XW-L	1x X-Wave, rigid 5 or 9 LEDs	N/A	Rigid linear LED board with 5 or 9 LEDs

Nexmosphere
High Tech Campus 10 (Mμ building)
5656 AE Eindhoven • The Netherlands
T +31 40 240 7070
E support@nexmosphere.com

APPENDIX B - Accessory overview

Below, an overview of the available accessories for each LED control type is provided. There are 3 different accessories:

LED strips - LED strips with pre-assembled cable and connectors, ready to be plugged into one of the LED outputs
LED cables - LED cables with connectors, to be soldered onto 3rd party LED strips
Power supplies and cables - to power the LED strips

Mono LED control

LED strips	**Product code**	**Compatible with**
12V Cold white LED strip (60L/m) with 2.1mm DC connector	L-C.....D	EM-5
12V Warm white LED strip with 2.1mm DC connector	L-W.....D	EM-5
LED cables	**Productcode**	**Compatible with**
Cable with "LED connector"	CAL-S . C	XC controllers
Power supplies and cables	**Productcode**	**Compatible with**
12V power supply	PS-12....	EM-5 and XC controllers
24V power supply	PS-24....	XC controller

RGB LED control

LED strips	**Product code**	**Compatible with**
12V RGB LED strip (60L/m) with stripped end wire cable	L-X1.....S	EM-6
24V RGB LED strip (60L/m) with stripped end wire cable	L-X5.....S	EM-6
LED cables	**Product code**	**Compatible with**
RGB connection cable (easy-click)	CAR-...	EM-6
Cable with "RGBW connector"	CA5-S . C	XC controllers
Power supplies and cables	**Product code**	**Compatible with**
12V power supply	PS-12....	EM-5 and XC controllers
24V power supply	PS-24....	EM-6 and XC controllers

RGBW LED control

LED strips	**Product code**	**Compatible with**
24V RGBW LED strip (60L/m) with RGBW LED connector	L-X5.....L	XC controllers
LED cables	**Product code**	**Compatible with**
Cable with "RGBW connector"	CA5-S . C	XC controllers
Power supplies and cables	**Product code**	**Compatible with**
24V power supply	PS-24....	XC controller

Pixel LED control (X-Wave)

LED strips	**Product code**	**Compatible with**
Pixel LED strip (30L/m) with X-Wave connector	L-P1.....W	all X-Wave interfaces
Pixel LED strip (60L/m) with X-Wave connector	L-P2.....W	all X-Wave interfaces
Pixel LED strip (144L/m) with X-Wave connector	L-P3.....W	all X-Wave interfaces
LED cables	**Product code**	**Compatible with**
Cable with "X-Wave connector"	CAW-S . C	all X-Wave interfaces
Power supplies, cables and splitters	**Product code**	**Compatible with**
Separate power supply cable	CAP-L6BM	all L-P.....W LED strips
Splitter for separate power supply cable	CAP-LS..B	CAP-L6BM and 5V PSU's
5V power supply	PS-05....	XM controllers and CAP-...
24V power supply	PS-24....	XC controller

Nexmosphere
High Tech Campus 10 (Mμ building)
5656 AE Eindhoven • The Netherlands
T +31 40 240 7070
E support@nexmosphere.com

APPENDIX C - Default color ratios

Default color ratios Pixel LEDs

Default color nr		HEX 00-FF	RGB 0-255	Ratio 0-100%	Ratio 0.0-1.0
0	R	FF	255	100	1.0
	G	FF	255	100	1.0
	B	FF	255	100	1.0
1	R	FF	255	100	1.0
	G	00	0	0	0.0
	B	00	0	0	0.0
2	R	00	0	0	0.0
	G	FF	255	100	1.0
	B	00	0	0	0.0
3	R	00	0	0	0.0
	G	00	0	0	0.0
	B	FF	255	100	1.0
4	R	FF	255	100	1.0
	G	FF	255	100	1..0
	B	00	0	0	0.0
5	R	FF	255	100	1.0
	G	00	0	0	0.0
	B	FF	255	100	1.0
6	R	00	0	0	0.0
	G	FF	255	100	1.0
	B	FF	255	100	1.0
7	R	FF	255	100	1.0
	G	80	128	50	0.5
	B	00	0	0	0.0
8	R	FF	255	100	1.0
	G	00	0	0	0.0
	B	80	128	50	0.5
9	R	80	128	50	0.5
	G	FF	255	100	1.0
	B	00	0	0	0.0
A	R	00	0	0	0.0
	G	FF	255	100	1.0
	B	80	128	50	0.5
B	R	80	128	50	0.5
	G	00	0	0	0
	B	FF	255	100	1.0
C	R	00	0	0	0.0
	G	80	128	50	0.5
	B	FF	255	100	1.0
D	R	FF	255	100	1.0
	G	B3	179	70	0.7
	B	B3	179	70	0.7
E	R	B3	179	70	0.7
	G	FF	255	100	1.0
	B	B3	179	70	0.7
F	R	B3	179	70	0.7
	G	B3	179	70	0.7
	B	FF	255	100	1.0

Default color ratios RGB(W) LED

Default color nr		Ratio 0-100%	Ratio 0.0-1.0
0	R	100	1.0
	G	100	1.0
	B	100	1.0
0	R	0	0.0
	G	0	0.0
	B	0	0.0
	w	100	1.0
1	R	100	1.0
	G	0	0.0
	B	0	0.0
	w	0	0.0
2	R	0	0.0
	G	100	1.0
	B	0	0.0
	w	0	0.0
3	R	0	0.0
	G	0	0.0
	B	100	1.0
	w	0	0.0
4	R	100	1.0
	G	75	0.75
	B	0	0.0
	w	0	0.0
5	R	100	1.0
	G	0	0.0
	B	100	1.0
	w	0	0.0
6	R	0	0.0
	G	100	1.0
	B	100	1.0
	w	0	0.0
7	R	100	1.0
	G	25	0.25
	B	0	0.0
	w	0	0.0
8	R	100	1.0
	G	0	0.0
	B	50	0.5
	w	0	0.0
9	R	50	0.5
	G	100	1.0
	B	0	0.0
	w	0	0.0

Nexmosphere
High Tech Campus 10 (Mμ building)
5656 AE Eindhoven • The Netherlands
T +31 40 240 7070
E support@nexmosphere.com