

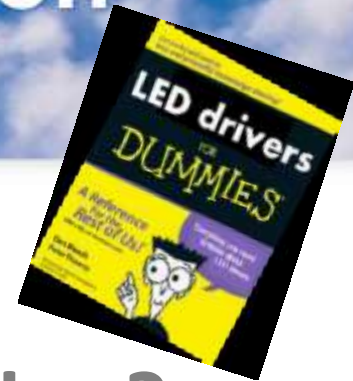
eldoLED

your product | our drive

vpt
Vereniging voor
Podiumtechnologie

Light
is our passion

How to choose the right LED driver
when it comes to perfect dimming & flicker?
and what about HD camera compatibility?



A workshop on LED drivers...? Why?

The lighting world changes – with traditional technologies the driver was a given
Now all is digital and you should know about a driver

A good driver gives a good light effect

A bad driver.....

So you'd better be informed about this important component

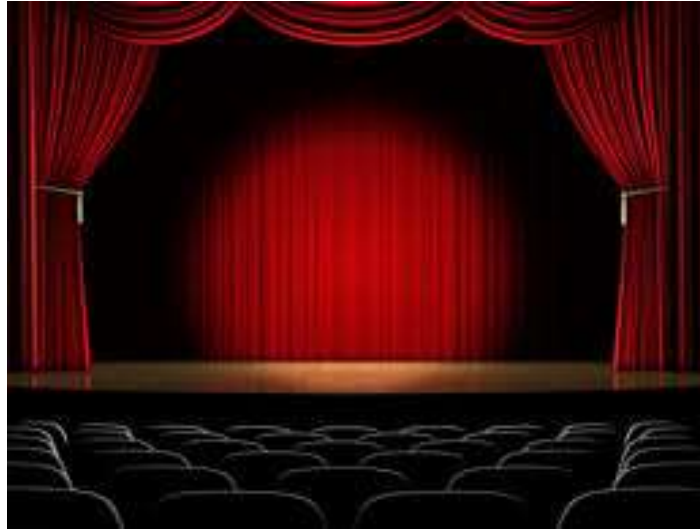
What about good **dimming**? What about **flicker**?

How to achieve good recordings with **HD cameras**?

This workshop is targetted at creative, non-technical people

'Geeky stuff' – easily explained 😊

The lighting system



LED Luminaire



LED Driver

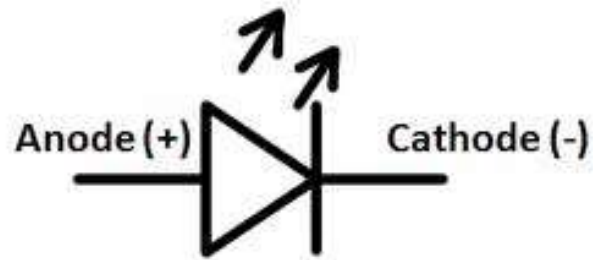


Controller

The lighting system

- **The luminaire**
- The driver
- The controller

Electrical characteristics of the led



compare electricity with water
electricity wire \approx service pipe
current \approx quantity of water
voltage \approx water pressure



energy = voltage x current

Watts = Volt x Ampere

$P = V \times I$

- The following *electrical* characteristics define the led. Below data is known when buying the led, refer to the datasheet
- Light output (Lumen)
- Drive current (Ampere, A)
- Forward voltage / Output voltage (Volt, Vf)
- Power consumption, energy (Watts, W)
- Efficacy (Lumen / Watt)

- The more current – the more light
- Colour temperature is also part of led specification
- Forward voltage is vital information when connecting any led driver

The led – some brands

XICATO

SORAA[®]
Simply Perfect Light[™]

 **LED Linear**[™]
linear lighting solutions

MEGAMAN[®]


SEOUL SEMICONDUCTOR

LED ENGIN 

 **LUMINO**

 **NICHIA**


BRIDGELUX[®]
The Magic of Light[™]

CREE 

PHILIPS
LUMILEDS

The lighting system

- The luminaire
- **The driver**
- The controller

The driver



The driver

The driver switches the light on and off

The driver arranges the dimming

The driver gives electrical current for the leds

The driver is either inside the luminaire or used externally

A.k.a. intelligent ballast, transformer, power supply (wrong name)

eldoLED drivers are programmable (current settings / dimming curve) **and dimmable** (via DALI, 1-10V or DMX)

How to program the driver ?

TOOLBOX PRO hardware (dongle)

FLUXTOOL software



LED drivers – dimming



Dimming – a trivial story?

Incandescent- or halogen-like dimming

- Dimming all the way down to 0.1% or to 1% to have the best “perceived light”
- Warm dimming: dimming (less intensity) and warmer light (changing colour temperature)

Natural dimming

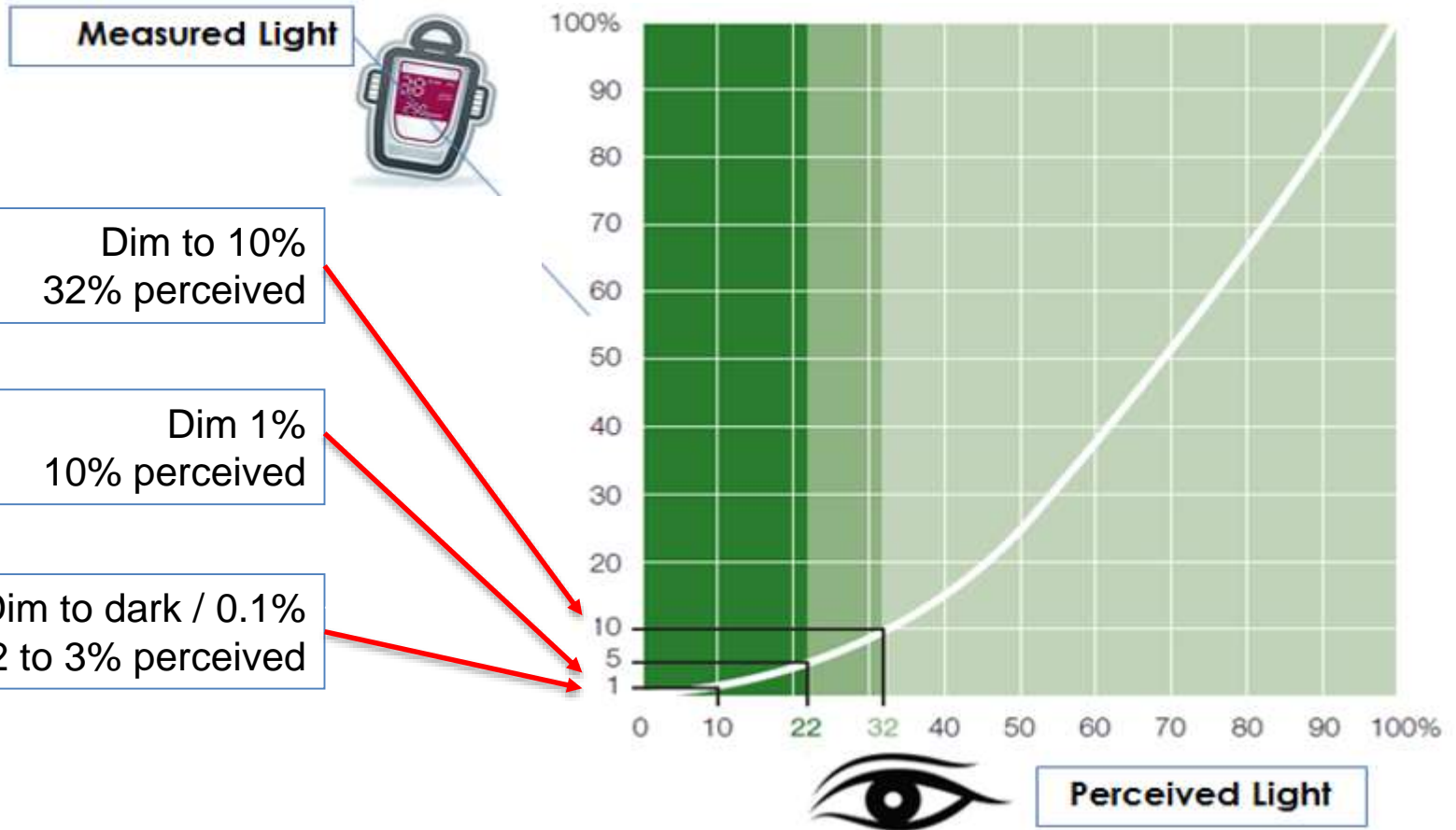
- No flicker – both no visible and no invisible flicker
- No steps – smooth and gradually from 100% down to 0.1% or 1%
- Constant brightness change over the dimmer scale
- Warm dimming (see above) & tunable white (separate control on intensity & colour temperature)

Robustness: works flawlessly with standard controls in the market

- 0..10V / 1..10V
- DALI
- DMX and DMX/RDM
- eldoLED does not support leading edge / trailing edge / phase cut / triac dimming, as this is not a standardized protocol. The use of dimmers is limited which creates loss of dimming quality

Dimming performance: measured versus perceived light

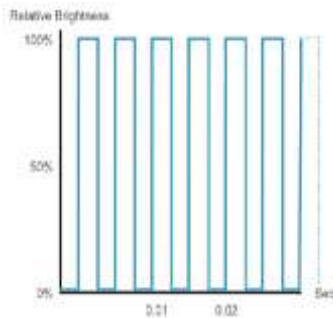
Source: IESNA Handbook, 9th edition,
measured versus perceived light



How LED drivers dim

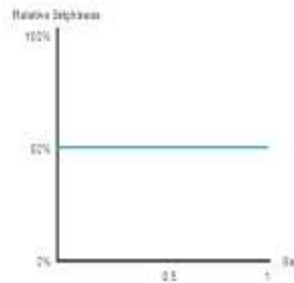
PWM dimming pulse width modulation

- Switching LED on/off in fixed frequency
- ✓ Good dimming regulations at low levels
- ✗ Potential noise generation
- ✗ Potentially undesirable flicker, depending on frequency



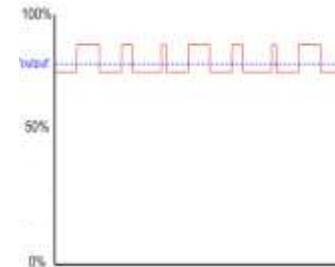
CCR dimming constant current reduction

- Varying LED current, LED always on
- ✓ No flicker
- ✓ No noise generation
- ✓ Higher LED efficacy at lower dimming levels
- ✗ Poor dimming regulation at deep dimming (low current) levels



Hybrid Hydra Drive dimming “improved” modulation

- LED are not switched off (amplitude change)
- Modulation in *variable* frequency
- Less current when possible
- ✓ Best dimming regulations at deep dimming levels
- ✓ High duty cycle frequencies
 - ✓ No flicker
 - ✓ Dimming all the way to 0.1%
- ✓ Increasing LED efficacy at dimming
- ✓ Low noise generation



Flicker. Who cares? You should!

Flicker is increasingly becoming a concern in the lighting industry

Potential flicker-induced problems like:

The human body

Headaches, fatigue, blurred vision, eyestrain

Neurological problems, including epileptic seizure

Increased autistic behaviors, especially in children

Camera recordings

'Unstable light output' in video applications



rouLED table

How to prevent flicker ?

Follow recommendation IEEE 1789

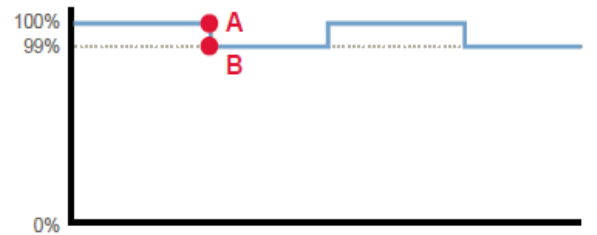
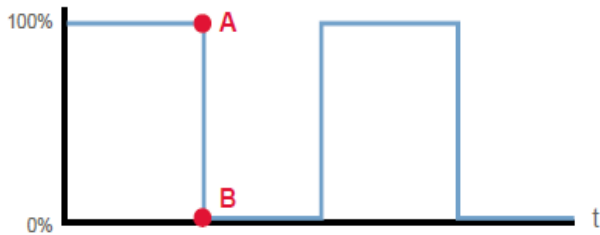


Flicker. Who cares? You should!

% Flicker: average, peak-to-peak amplitude

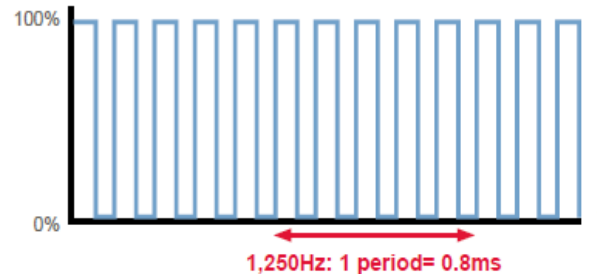
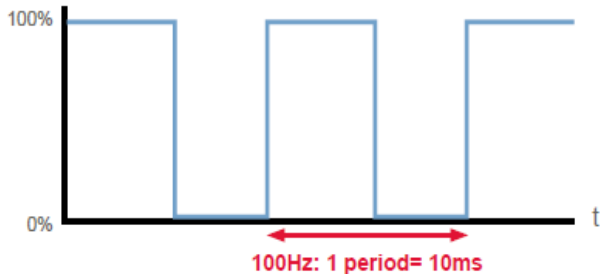
Low % flicker does not guarantee high-quality lighting, as the flicker frequency can still create low quality.

Rectangular Snip



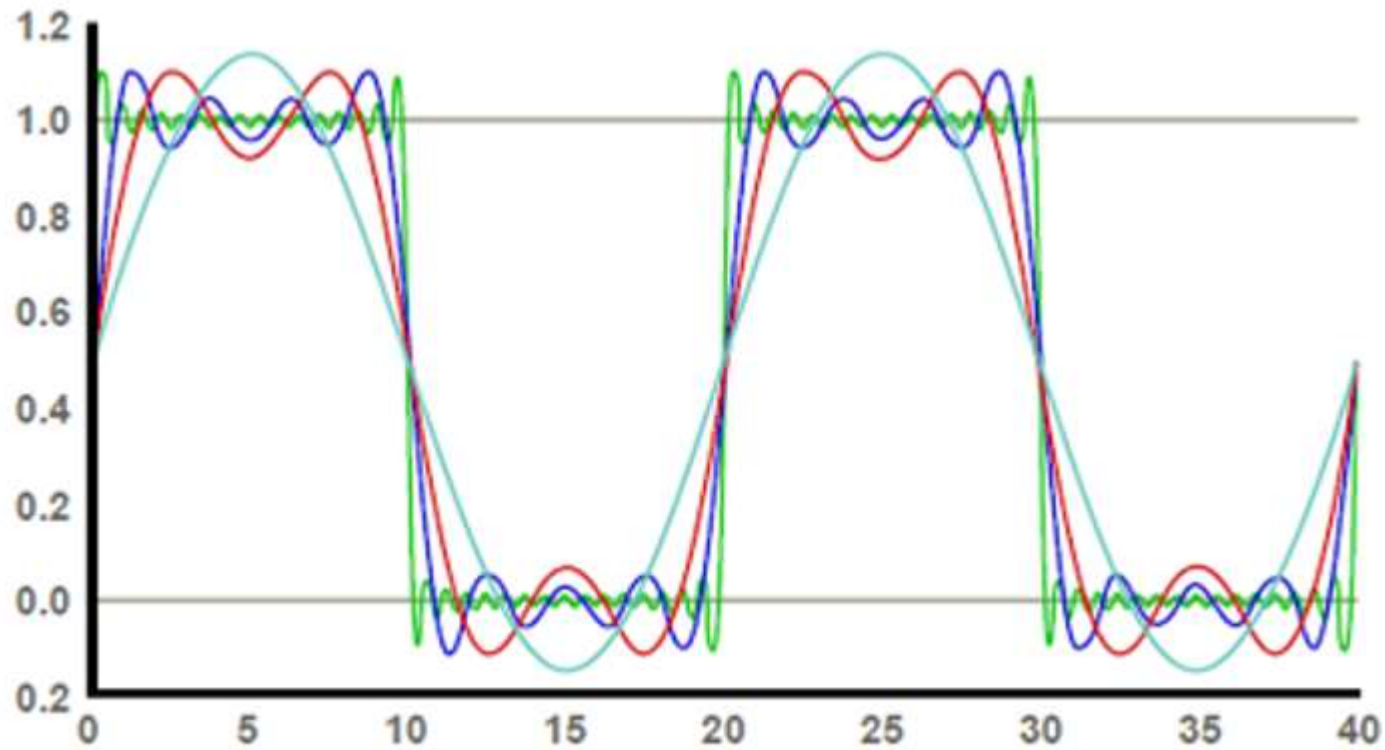
Flicker frequency: the higher, the better.

As of 1,250Hz, there are no health or performance risks for human beings.



Flicker. Who cares? You should!

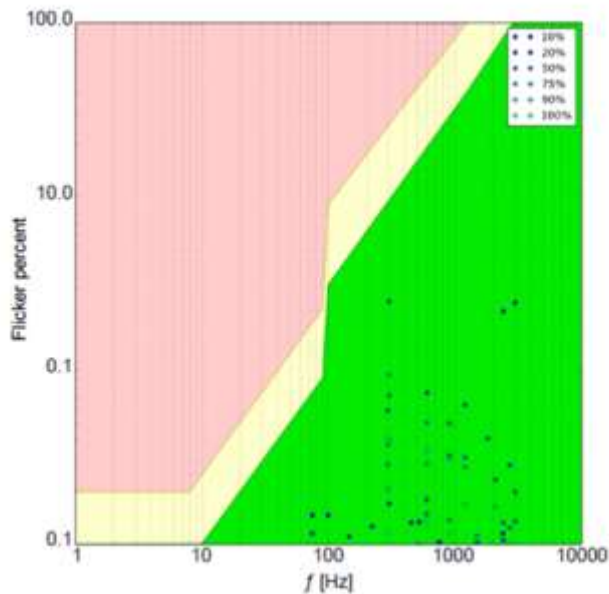
eldoLED: modulation in variable frequencies



Mapping the drivers' performance on flicker

As per IEEE 1789 recommendation

Plotting flicker percent per frequency



New eldoLED datasheet with objective flicker data

eldoLED
your product | our drive
Specification Submitted
SOLedrive 360/A

SOLedrive offers industry-best flicker: Dimming to 0% - LED dimming made beautiful. With any dimmer, in any application. Symbols ensure the LED driver works seamlessly together with LED modules, controls and intelligent luminaire elements.

Features

- Instant dimming, contribution to dark/lighting cycles
- Symbols add value with sensing, connecting, protecting, loading, communicating, shading and lighting dynamic features
- Programmable to fit application

Electrical specifications

Driver type	constant current
LED output	1 (A, Class 2)
LED output power	30W max
LED output current range	100-1.250mA, Settable
LED output current resolution	programmable in 1mA steps
LED output voltage range	2-28V
Standby power	<0.5W
Input voltage AC	120-270V (EMC approved) 120-277V (UL approved)
Input voltage DC	120-280V
Input current	0.35A max
Inrush current	negligible: 30mA @ 277V
Surge protection	2kV 25k 2kV CM
Efficiency @ full load	94%
Efficiency @ 2/3 load	92%
Power factor @ full load	>0.9C
THD @ full load	<20%
Dimming protocol	0-10V
Control channels	1
Temperature range	-20°C / -40°C to +40°C / +122°F
Turn-on	80°C / 180°F
Turn-off	80°C / 170°F
Warranty	5 years

Dimensions, weight, packaging

Label	210x40x33.5mm 8.27x1.59x1.33in
Weight	22g ± 7.84oz
Drivers per carton	50 pcs

Wiring

100-120V AC
 120-277V AC
 120-280V DC

SOLedrive AC, 20W, 0-10V, constant current, 1x20V output, side led, 2845: 57g

Features

- Independent driver
- Low total THD
- High power factor and efficiency

Certifications & standards

EN 61347-0-2-1, EN 62384, EN 60914, EN 9832, EN 61000-3-2, EN 61047
 UL 120, UL 8750 (Class 2 output)

Flicker percent per frequency

According to IEEE Standard P1789

Order number configuration

100-120V AC
 120-277V AC
 120-280V DC
 100-120V AC
 120-277V AC
 120-280V DC

LED output current in mA steps, e.g. "1000" "1000" etc.
 Dimming curve, either "100V" for a hyperbolic, "LSP" for a linear, "SLM" for a soft-linear, or "SQV" for a square dimming curve.

Minimum dimming level, sets to one decimal place, e.g. "100.0" for 0%, "101.0" for 7.5%, "101.5" for 10.1%, etc. Leave blank if default minimum dimming level (0.1%) is required.

Product name	Model name
Product code	

Active lead driver	Active lead driver
Active lead driver	Active lead driver
Active lead driver	Active lead driver
Active lead driver	Active lead driver

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3 supported lighting protocols

DALI

Digital protocol for white light or for dynamic white light
Bi directional communication

1-10V or 0-10V

Analogue protocol for white light
One directional communication

DMX or DMX/RDM

Digital protocol for coloured light, RGB(W)
DMX – mono directional communication
RDM – bi directional communication

DMX & DMX/RDM



eldoLED was founded 8 years ago – started with DMX drivers

A lot of installations in theatres, mostly in general lighting

Mariinsky Theatre – Sint Petersburg - Russia

The Royal Opera House – London - UK

Landestheater – Linz – Austria

....

eldoLED joins the yearly DMX / RDM Plugfest

Interpolation is a feature to remove visible light steps generated by DMX controller

LED lighting & TV studio camera / stage camera compatibility



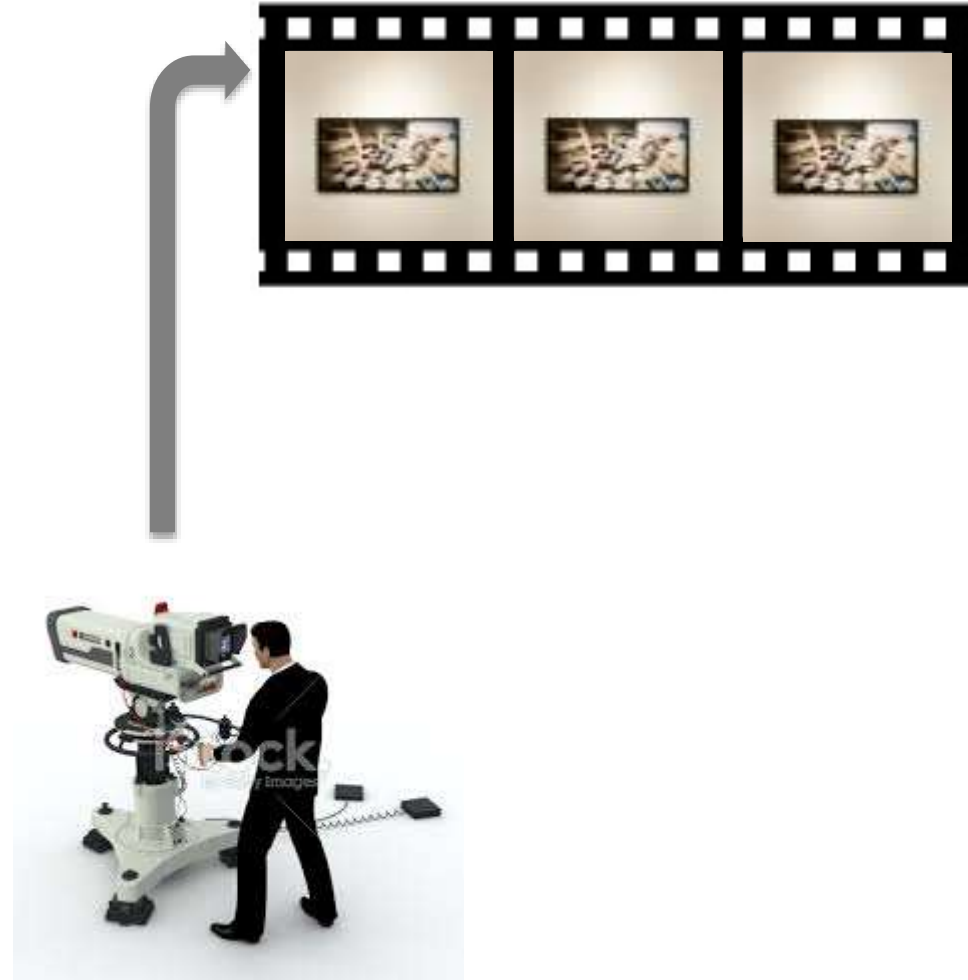
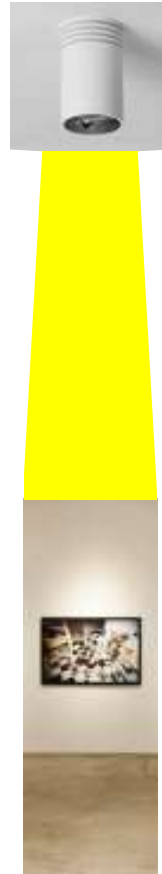
What is TV studio camera compatibility?



- TV studio cameras are based on a fixed shutter time of 50/60Hz
- Other portable cameras / mobile phones etc. are 25Hz / 30Hz with automatic adjustable shutter time. The adjustable shutter time acts on the amount of light



- In general (PWM) LED drivers have a fixed dimming frequency in the range of 250Hz - 2kHz
- If the LED driver dimming frequencies are not duplicates of the camera frequency (shutter time), this will result in visible horizontal shadow lines



Differences in LED dimming methods

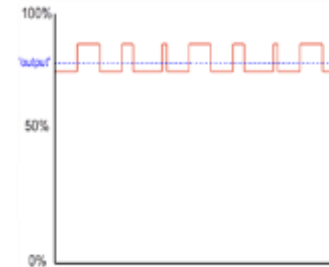
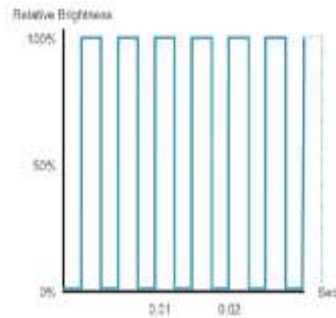
3rd party PWM dimming

vs.

eldoLED Hybrid HydraDrive dimming

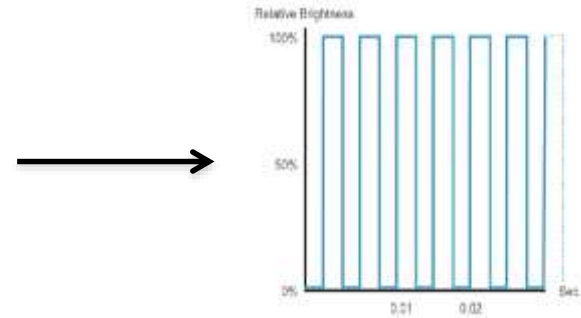
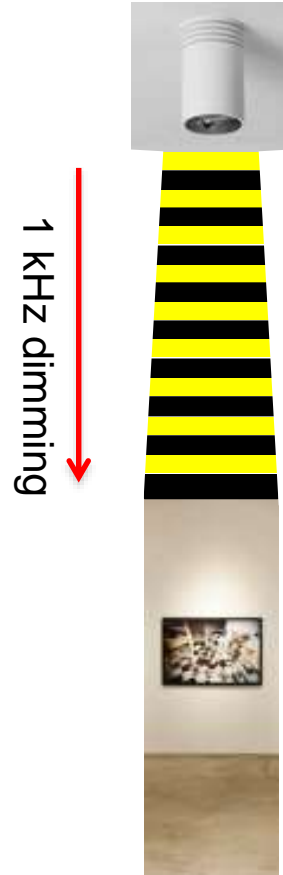
- ✗ In general PWM dimming frequencies can not be divided by 50 / 60Hz
- ✗ Noticeable rainbow effect with TV studio cameras
 - Mixed colours will be separated into red, green and blue

- ✓ Frequencies are multiples of camera frequency 25 / 30 / 50 / 60Hz
- ✓ Reduced rainbow effect with TV studio cameras



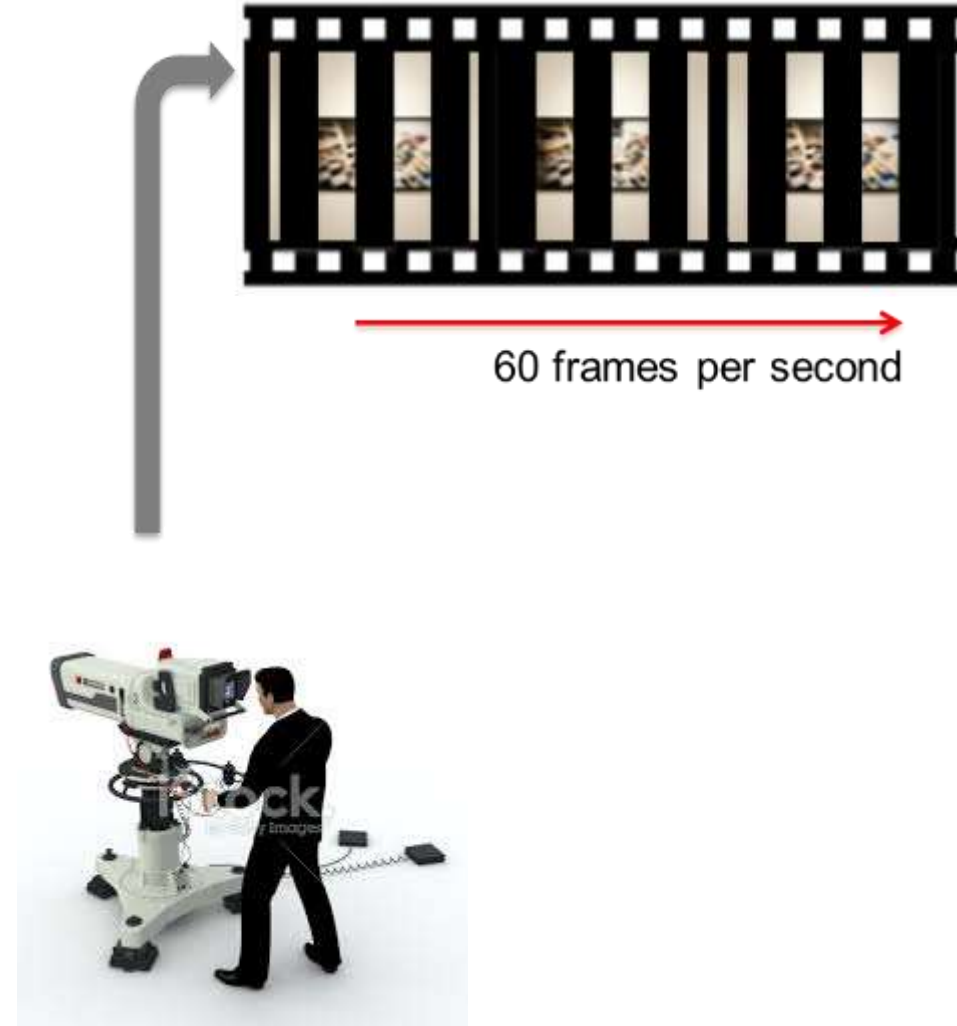
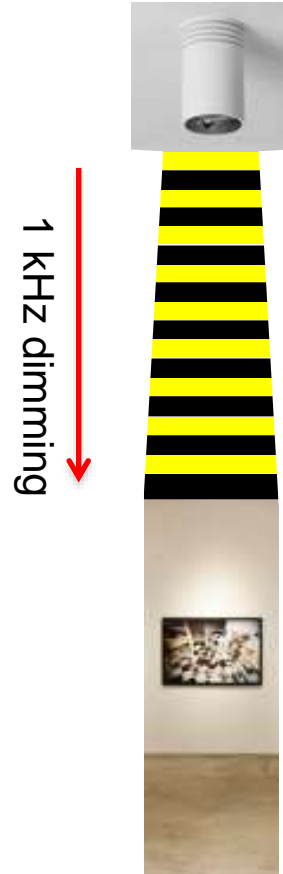
PWM dimming

- In general LED drivers have fixed dimming frequency in the range of 250Hz - 2kHz



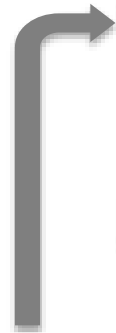
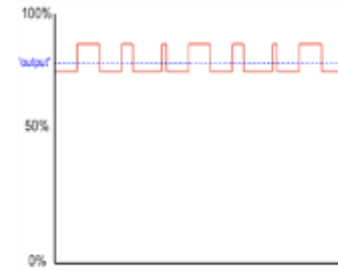
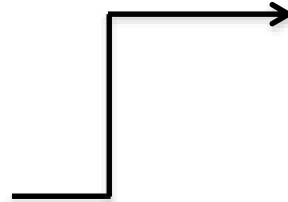
PWM dimming

- In general LED drivers have fixed dimming frequency in the range of 250Hz - 2kHz
- In general PWM dimming frequencies can not be divided by 50 / 60Hz
- Each frame receives different amount of LED light. This will result in visible horizontal shadow lines



Hybrid HydraDrive dimming

- Hybrid Hydra Drive works with variable frequencies

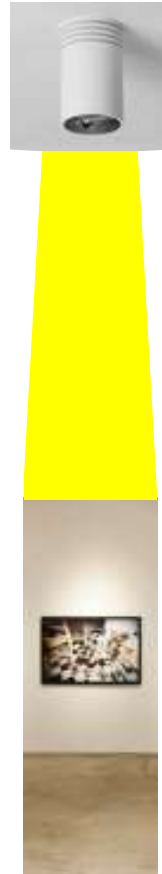


60 frames per second



Hybrid HydraDrive dimming

- Hybrid Hydra Drive works with variable frequencies
- All dimming frequencies can be divided by 50 / 60Hz
- Each frame receives the same amount of LED light



The lighting system

- The luminaire
- The driver
- **The controller**

The controller



The controller is the brains of the lighting network

It sends out a signal over the lighting network

The signal is picked up by drivers and translated into a light effect

eldoLED supports 3 lighting network interfaces

- 0-10V & 1-10V : white functional lighting or warm dimming
- DALI: white functional- or dynamic white lighting
- DMX & DMX/RDM: coloured RGB(W) or dynamic white lighting

(eldoLED does not support leading edge / trailing edge / phase cut / triac)

Integration with building management systems / domotica like KNX

Via KNX gateways to DALI, 0-10V/1-10V or DMX

The controller – some brands



0-10V
1-10V



Specifier conclusions

The driver arranges the dimming – so the choice of the driver is crucial to get the light effect that your customer needs. A driver can always be specified separately - you are in control ;)

1. Choose a driver that dims to the level that your customer needs
(dim to dark 0.1% versus dim to 1% versus dim to a higher level)
2. Choose a driver that delivers non-harmful flicker, when dimming
(follow the independent IEEE 1789 recommendation)
3. Choose a driver that gives you good HD camera compatibility
(without visible interference)

eldoLED

your product | *our drive*



Light
is our **passion**

eldoLED driver range

	dimming	AC energy usage	DC energy usage	Controls			# control channels ("addresses")
				DALI	0-10V 1-10V	DMX RDM	
<i>constant current</i>							
SOLO	dark / 0.1%	20, 30, 50, 100W		✓	✓		1
ECO	to 1%	20, 30, 50, 100W		✓	✓		1
DUAL	dark / 0.1%	50, 100W		✓			2
POWER	dark / 0.1%	50W, 100W		✓		✓	1 to 4
<i>constant voltage</i>							
LINEAR	dark / 0.1%	100W	150, 200, 1150W	✓	✓	✓	1 to 4

eldoLED driver range

AC drivers	# output groups	# control channels
20W ECO	1	1
20W SOLO	1	1
30W ECO	1	1
30W SOLO	1	1
50W ECO	1	1
50W SOLO	2	1
50W DUAL	2	2
50W POWER	3 or 4	1 to 4
100W SOLO	4	1
100W DUAL	4	2
100W POWER	4	1 to 4
100W LINEAR	4	1 to 4

DC drivers	Max Energy	# output groups	# control channels
LIN720 DMX, DALI	24A X 48V = 1152W	4	1 to 4
LIN180 DMX	6A X 24V = 144W	4	1 to 4
LIN210 DALI	8A X 24V = 192W	2	1
LIN220 DALI	8A X 24V = 192W	2	2
LIN211 0-10v	8A X 24V = 192W	2	1
LIN212 DMX	8A X 24V = 192W	2	1
LIN222 DMX	8A X 24V = 192W	2	2