



Innovative LED technologies for industrial image processing

Made in GERMANY

What must LED lightings do in automation systems today?

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Funded by:



The evotron GmbH & Co. KG



Line Lights



Four Side Lights



Area Lights



Ring Lights



Spot Lights



Telecentric Lights



Digital LED-Controller



Robot Capture Tool

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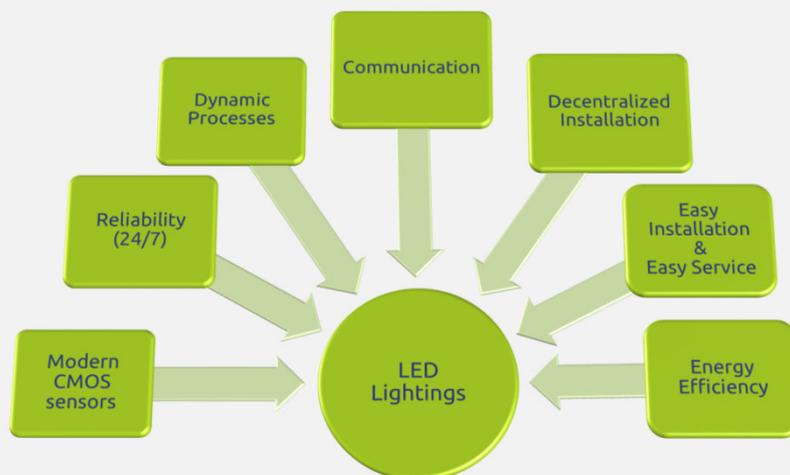
What must LED lightings do in automation systems today?



- Requirements of automation
- Importance of light in machine vision
- The LED as a light source
- Controlling a LED
- lumiSENS® Technology

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Requirements for LED lightings



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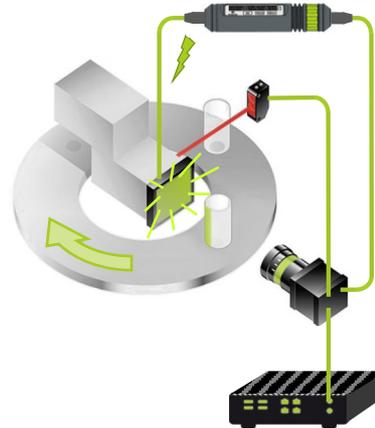
Importance of light in machine vision



- Light is the sensor signal in machine vision
- Only precisely controlled light ensures constant measuring conditions
- Light influences image quality the most
- The light thus influences the:
 - Reliability,
 - Speed and
 - Process stabilityof image processing solutions

Fig. Industry-estimated influence on image quality

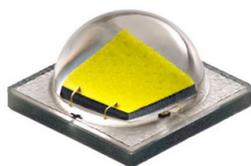
Lighting: 60% - 95%



Lens: 10% - 50% | Camera: 10% - 50%

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The LED as a light source



Narrow-band, monochrome light

Equal brightness at the same control

High efficiency (> 50%)

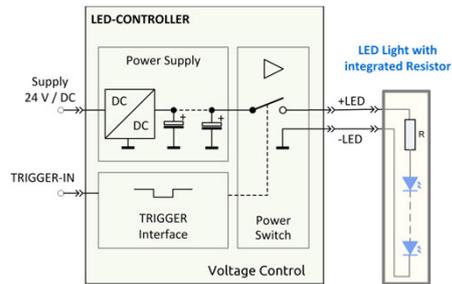
Switch-on and switch-off time in the ns-range

Long life

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Controlling a LED

Voltage control



- Widespread
- Easy to use
- No stable light
- Poor efficiency

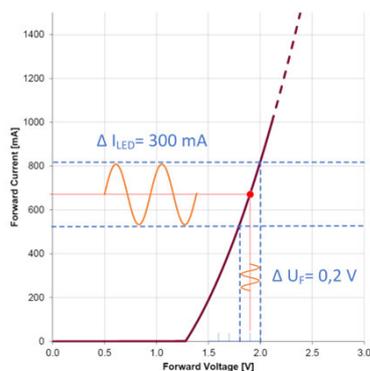
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Controlling a LED

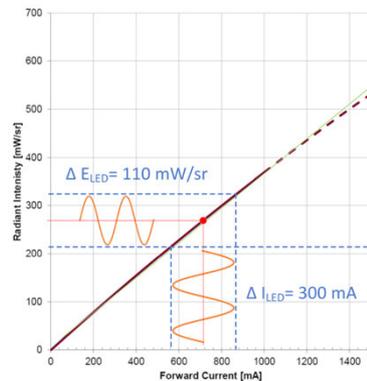
Voltage control – Stability of the light



Voltage variations affect the LED current



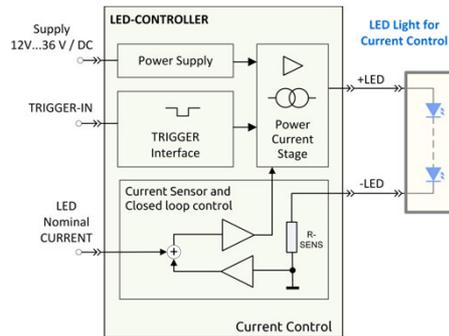
Current variations affect the brightness



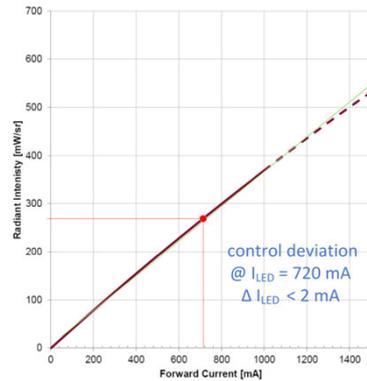
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Controlling a LED

Current control



Constant current guarantees stable light

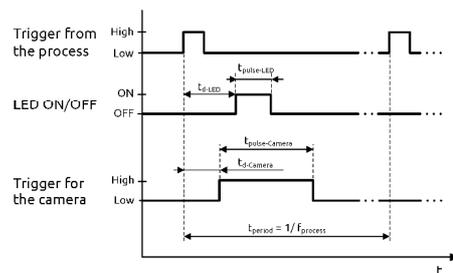


Controlling a LED

Flash operation

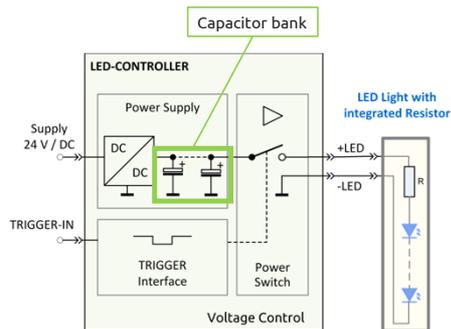
- Energy efficient – Light, when it is needed
- Overdriving the LED – Ultra bright light
- Synchronisation with the process & camera

Precise timing to synchronise lights and camera with the process

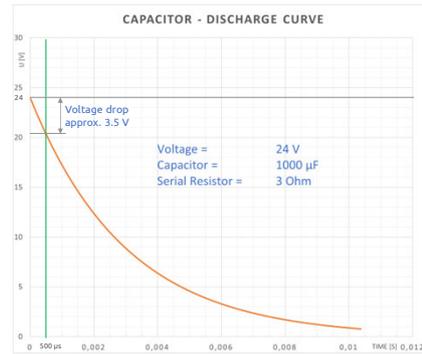


Controlling a LED

Flash operation – Voltage controlled



Capacitor banks cannot supply a constant LED pulse current



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The lumiSENS® technology

Features

- Integrated Light-Sensor-Processor LSP
- Real-time access to all lighting and controller data
- LED temperature and brightness monitoring
- Reproducible and long-term stable parameters
- Patent pending



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The lumiSENS® technology

The digital LED controller DCC2404-1WS



- Fully digital in-cable LED controller with lumiSENS® technology
- Universally applicable – suitable for many LED lightings
- Operation modes: Continuous, Flash and Sequence
- Secure industrial WLAN interface
- {JSON} REST API for the integration into the process control

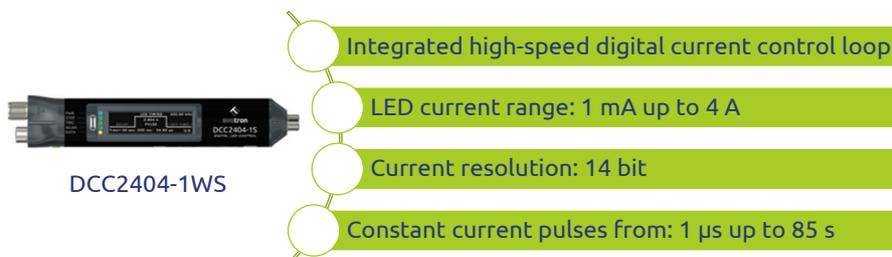
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The lumiSENS® technology

Constant brightness



- Current control is the basic prerequisite for constant brightness
- The dynamic of modern CMOS image sensors requires a high current resolution and stability



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Current control – Signal quality

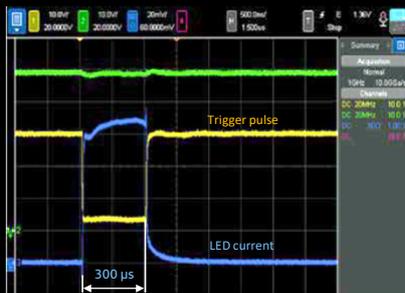


Image source: Newsletter 10_2018 ATI GmbH

Fig. Market companion – 300 µs LED current pulse



Fig. evotron DCC2404-1WS – 300 µs LED current pulse, time division: 100 µs
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Timing



- Machine vision of dynamically moving objects requires a precise timing
- Pulse width = 1 µs @ v = 4 m/s → Motion blur = 4 µm
- Pulse generation by software causes jitter → Jitter is the problem



DCC2404-1WS

- FPGA based pulse and trigger generation unit
- Capabilities to sync LED pulse and camera shutter
- In-cable controller ⇒ Short cables – Low delay
- Pulse frequency: 0,01 Hz up to 500 kHz
- Pulse timing: 1 µs up to 85 s
- Time resolution: 20 ns, Jitter: < 7 ns

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Timing accuracy



- Current: 2 A
- Pulse width: 5 μ s
- Cable length: 200 mm
- Delay time $t_{dLED-ON}$: 420 ns
- Jitter: 5,13 ns



Fig. evotron DCC2404-1WS – 2 A LED current pulse, time division: 2 μ s

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The lumiSENS® technology

Communication



- Industry 4.0 requires communication with all process control components
- LED lightings and LED controller are process control components



DCC2404-1WS

- Secure industrial WLAN interface
- Standard communication protocol
- {JSON} REST API for integration in process control
- Online access to all lighting and controller data
- Easy configuration and reconfiguration

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Installation & Service



- Today 24/7 production processes require:
 - Easy installation / quick replacement of control components (digital twin)
 - Predictive maintenance
 - Precise error identification in case of malfunction



DCC2404-1WS

- Plug & Play installation of new lightings
- Easy back-up of configuration data
- Restoring of configuration data ⇒ Digital twin
- Realtime monitoring of the LED lifetime
- Error messages ⇒ IWLAN, OLED display and I/O

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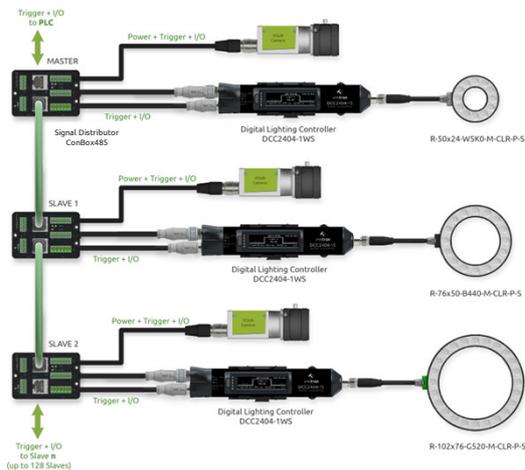
Decentralised installation – Example 1



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Decentralised installation – Example 2



- Highly synchronized array of 3 camera lighting units
- Signal distributor ConBox485:
 - Interference-free trigger signal distribution over long distances
 - Power supply, trigger and I/O signal distribution for 1 camera and max. 2 LED controllers
- Up to 256 slave units

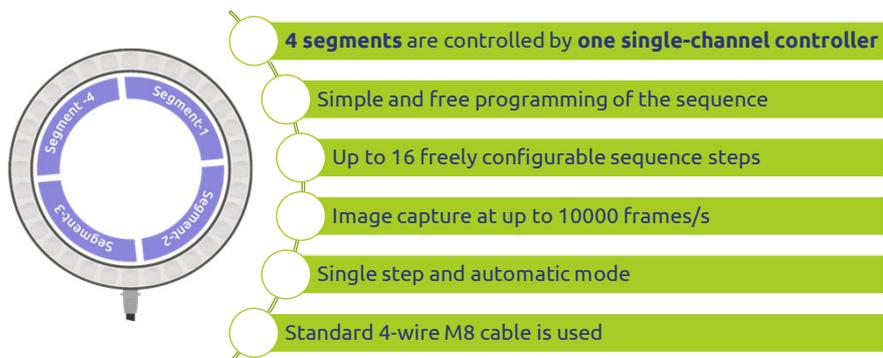
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Segmented ring lights - Sequence Mode



- Sequence mode is a special flash operation mode for segmented LED lightings with lumiSENS® technology



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The lumiSENS® technology

Segmented ring lights - Sequence Mode



- Sequence mode is a special flash operation mode for segmented LED lightings with lumiSENS® technology



Segmented Ringlight
R-76x50-G520-M-CLR-P-S

- 4 segments are controlled by one single-channel controller
- Simple and free programming of the sequence
- Up to 16 freely configurable sequence steps
- Image capture at up to 10000 frames/s
- Single step and automatic mode
- Standard 4-wire M8 cable is used

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Robot Image Capture Tool



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Robot Image Capture Tool

- CMOS camera
- LED controller
- 4 segment light



New

Flexibility and high precision
Fast and easy installation

evotron lumiSENS® Technology

for all robots with standard ISO 9409-1 flange

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