TECHNICAL ACADEMY

WÜRTH ELEKTRONIK

Power to the LED

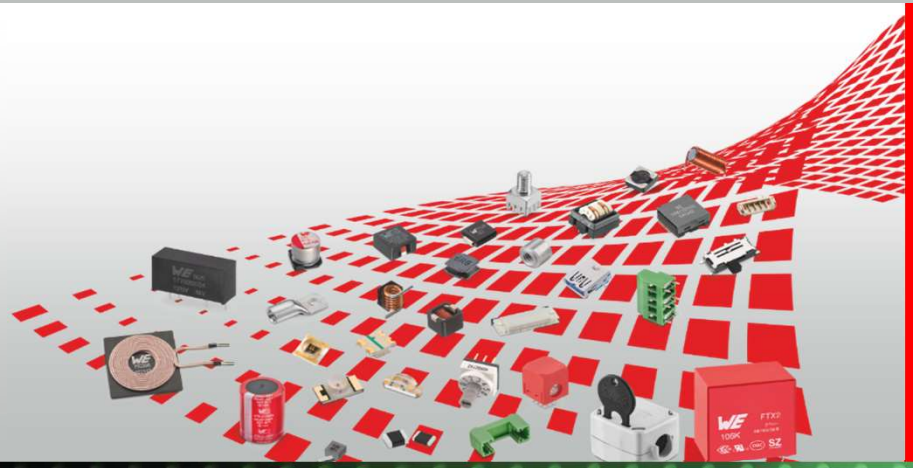
Alex Snijder

Field Application Engineer

Wurth Elektronik Nederland

Alex.snijder@we-online.com

more than you expect



LED LIGHTING & TECHNOLOGY CONFERENCE 2019

DONDERDAG
28 NOVEMBER 2019

VAN DER VALK, EINDHOVEN

Agenda

- LED driver basics
- Schematic review
- EMI considerations
- Summery

The Würth Elektronik Group

Sales: 848 million €
Employees: 8.300
* 2018

Würth Elektronik eiSos Group

Printed Circuit Boards

Intelligent Power and Control Systems

Passive Components

Power Modules & Optoelectronics

Electromechanical Components

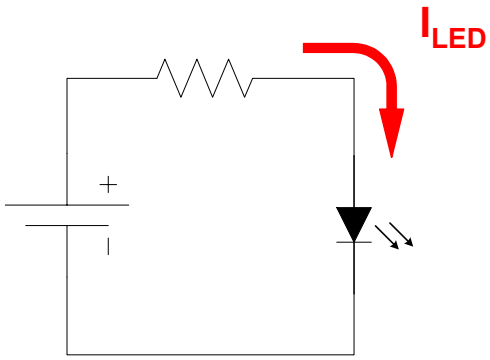
Automotive & eMobility

Wireless Connectivity & Sensors

Introduction to LED Drivers

How to switch a LED on

- **Is it enough to regulate the current flowing through the LED?**



- **Well yes, it works!!! But....**

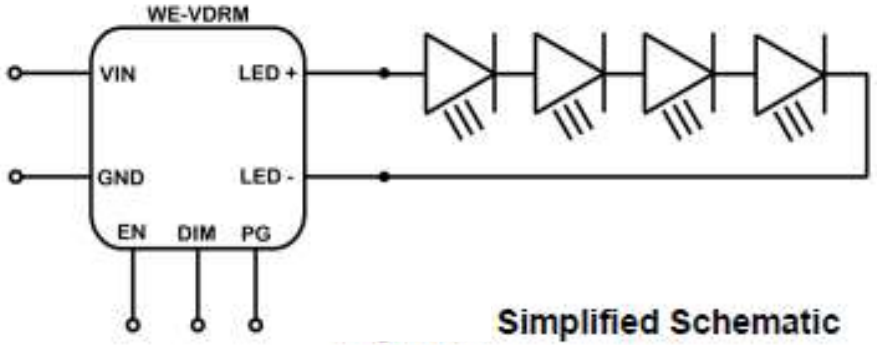
Introduction to LED Drivers

Basic operation

LED LIGHTING & TECHNOLOGY CONFERENCE 2019
28 NOV · EINDHOVEN

WÜRTH ELEKTRONIK

- **LED must be driven with current**
- **Switching regulators (buck,boost,buck-boost) offer a more efficient solution**
- **LED can be connected in series, parallel, series-parallel, etc.**
- **Brightness adjustment through Analog/PWM/PFM dimming**
- **LED fault management**



Simplified Schematic

MagI³C LED Driver

General description

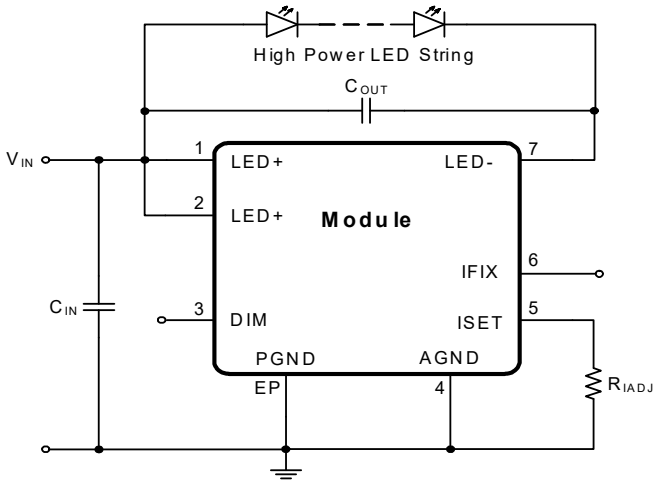
Features:

- LED Current capability: up to 450 mA
- Wide input voltage range: 4.5 V - 60 V
- Drives 1 to 16 LEDs in series up to 60 V input
- Typical LED Current Accuracy ±3.5 %
- PWM Dimming
- Analog Dimming
- High contrast ratio (min. PWM current < 16 µs)
- Integrated magnetics solution for ease of use
- Connectable in parallel for higher current operations
- Input under voltage lockout protection (UVLO)
- Temperature range: -40 °C to 125 °C

Applications:

- Indoor lighting
- Outdoor lighting
- Industrial lighting

Application Diagram:

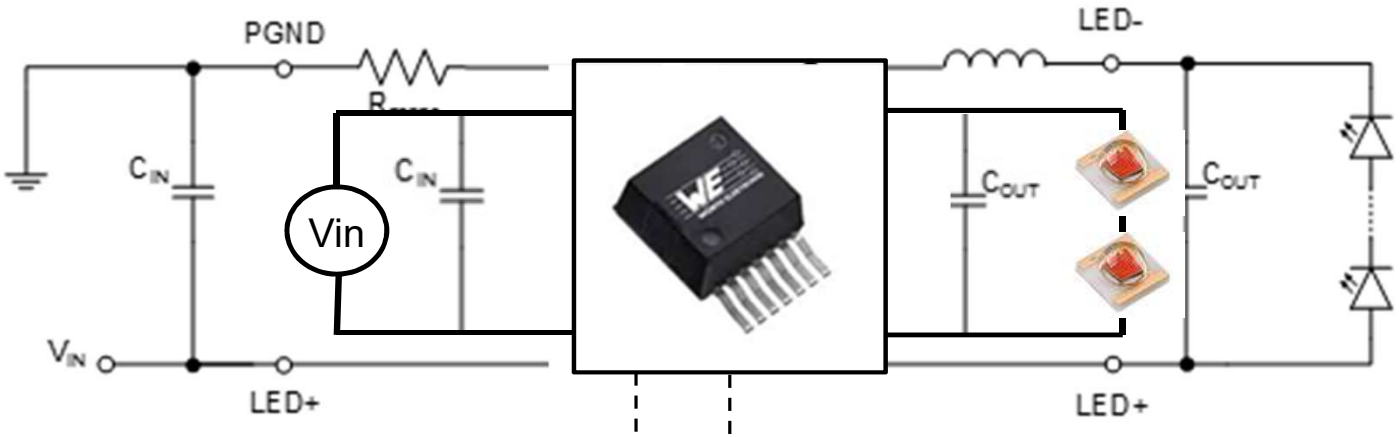


Package:

- TO-263-7
- RoHS & REACH compliant
- UL94V-0 mold material

Introduction to LED Drivers

Basic operation

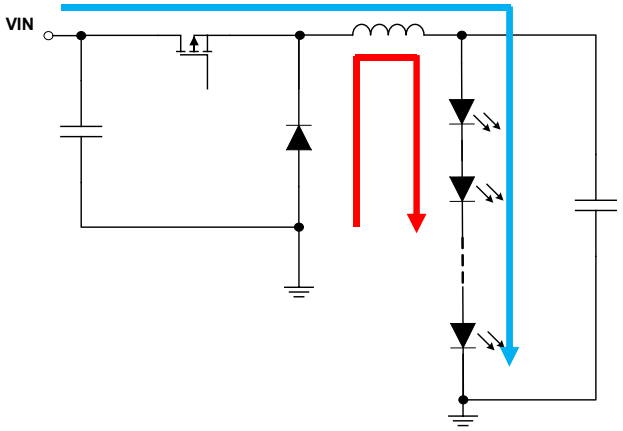


Add a resistor to adjust the current

Add an PWM or PFM signal for dimming

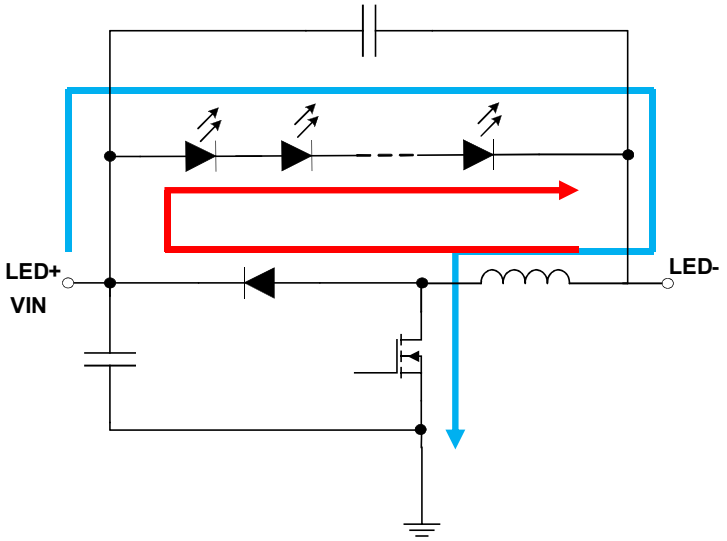
MagI³C LED Driver

Floating Buck Architecture



Traditional Buck

- High side nMOS (=>complexity) or pMOS (=>size)
- LED always connected to GND

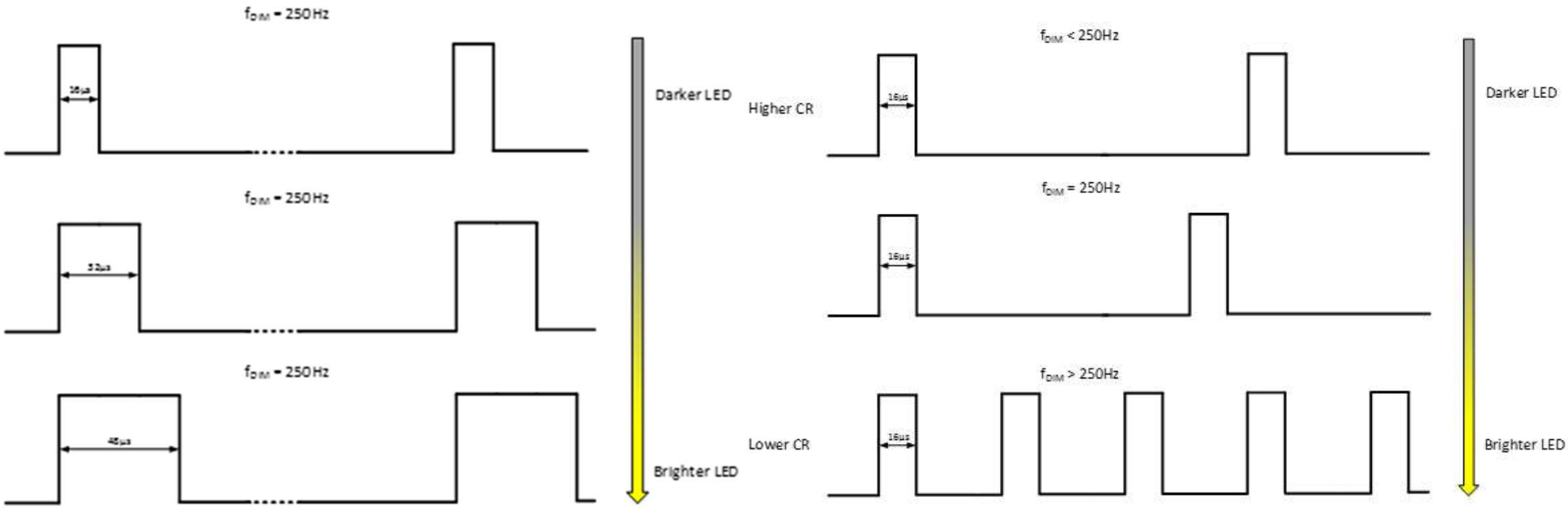


Floating Buck

- Low side nMOSFET (easier and smaller design)
- Floating LED connection
- Regulation only during CCM
- Possible extension to other topologies

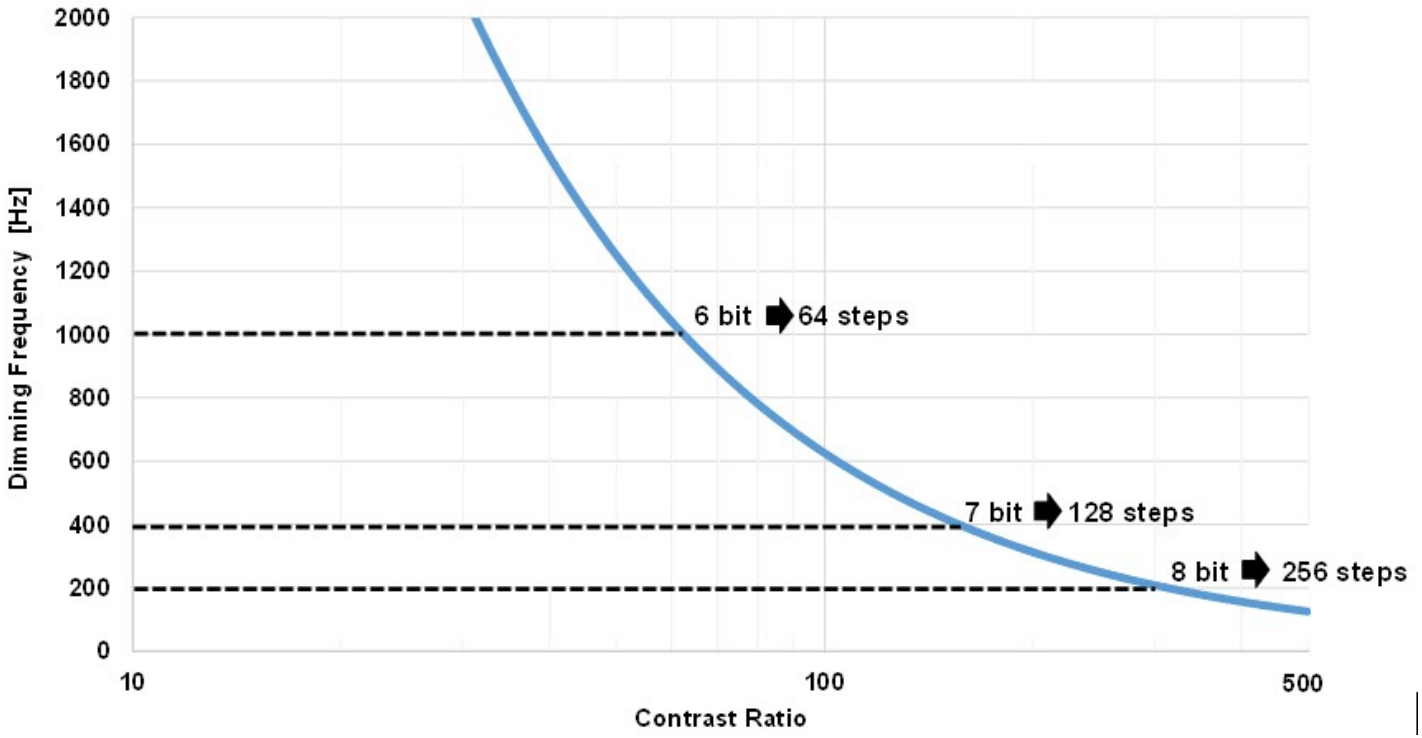
LED Drivers features

Dimming control



LED Drivers features

Dimming control



Build your own LED driver

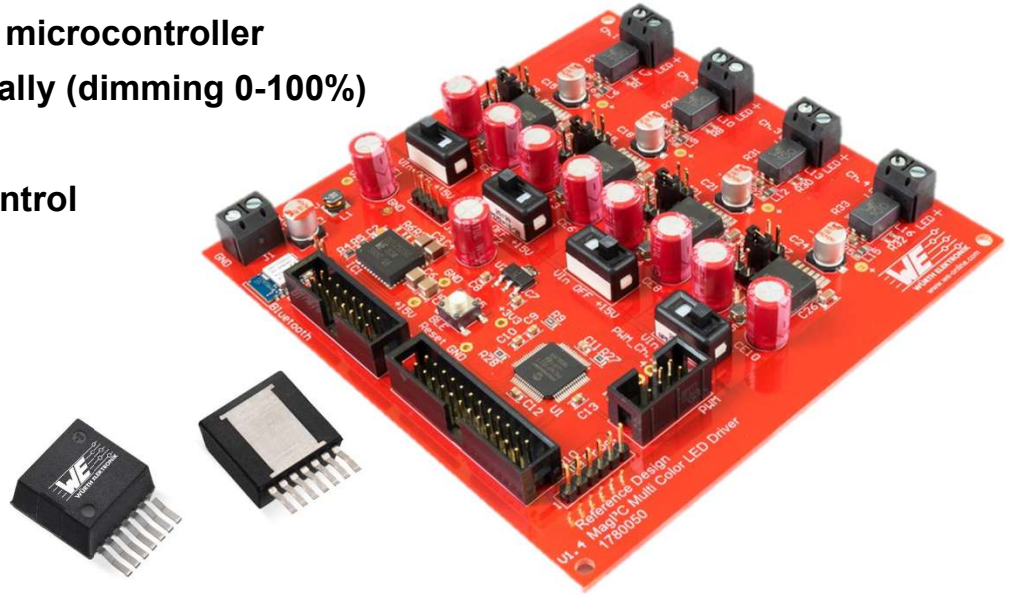
Reference Design: Multi Color LED Driver

LED LIGHTING & TECHNOLOGY CONFERENCE 2019
28 NOV · EINDHOVEN

WÜRTH ELEKTRONIK

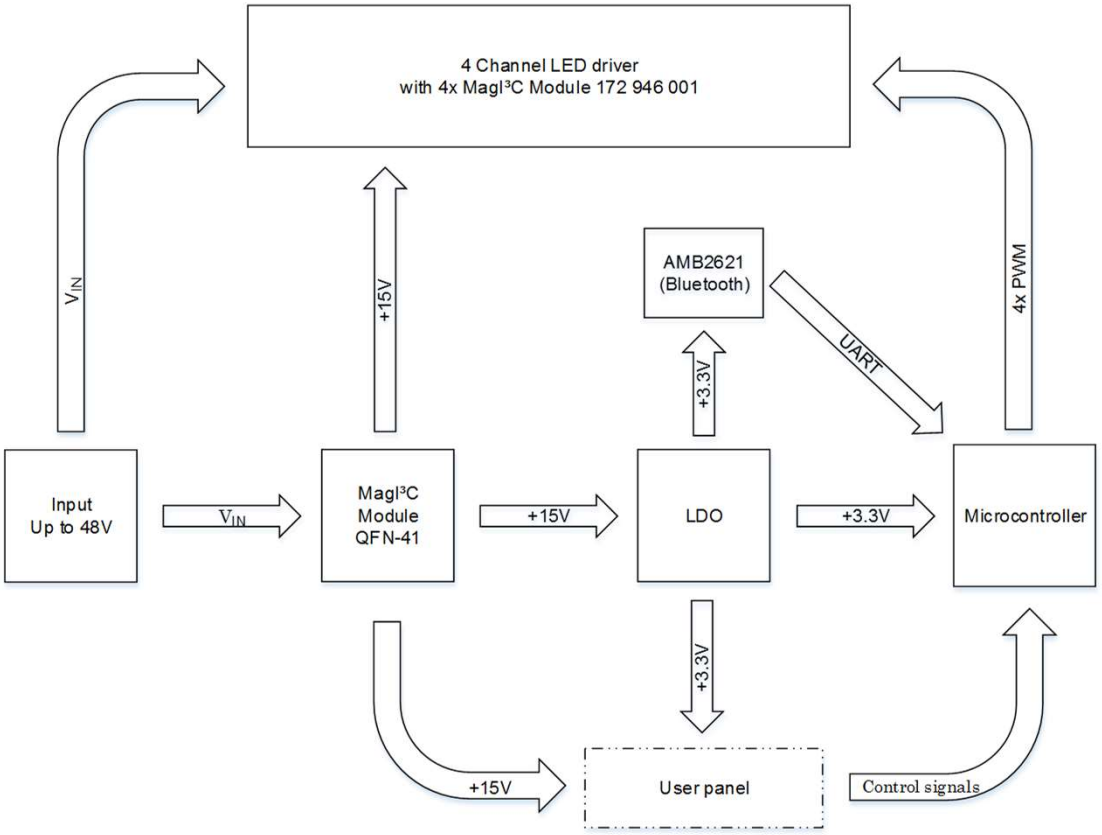
Description

- 4 Channel LED Driver (can be extended by connecting daughter board)
- 1-26 LEDs with 1,8V each in series per channel (depending on LED forward voltage)
- Upto 450mA per channel driving current
- PWM dimming method - controlled by PIC16F1527 microcontroller
- Intensity of each channel can be adjusted individually (dimming 0-100%)
- Color mixing with four channels and RGBW LEDs
- Dimming by potentiometer, button or Bluetooth control (2608011024000)
- Dimming profiles and colors can be stored
- LED Driver: MagI³C Power Module 172 946 001
- Conducted and radiated EMI compliant (EN55015)
- Good thermal behavior



Reference Design: Multi Color LED Driver

Block Diagram

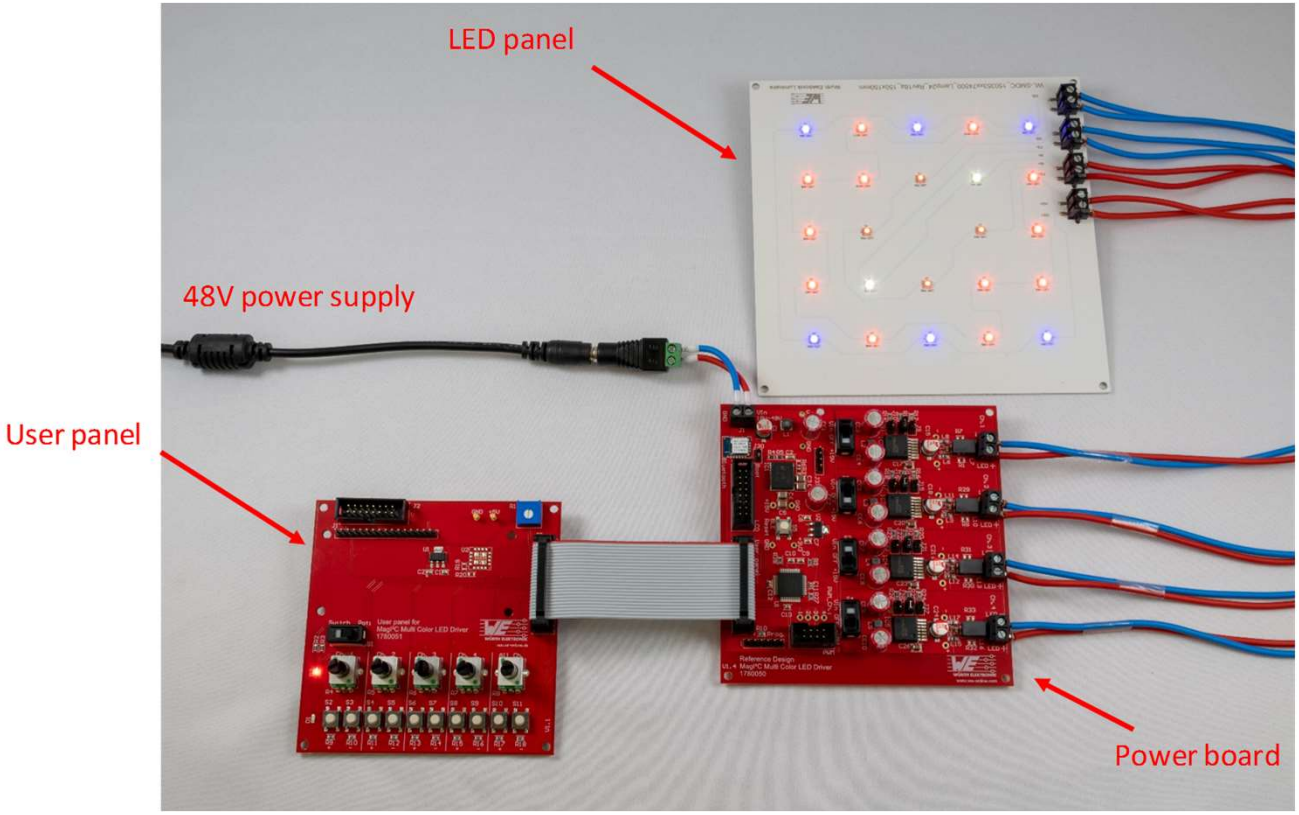


Reference Design: Multi Color LED Driver

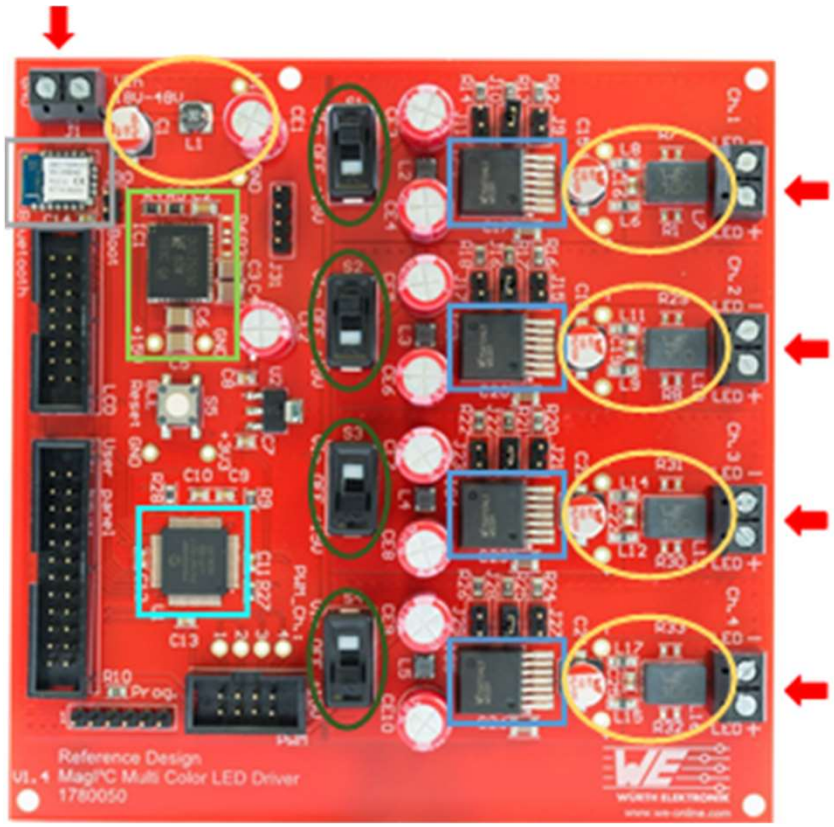
Power Board, User Panel and LED Panel

LED LIGHTING & TECHNOLOGY CONFERENCE 2019
28 NOV · EINDHOVEN

WÜRTH ELEKTRONIK



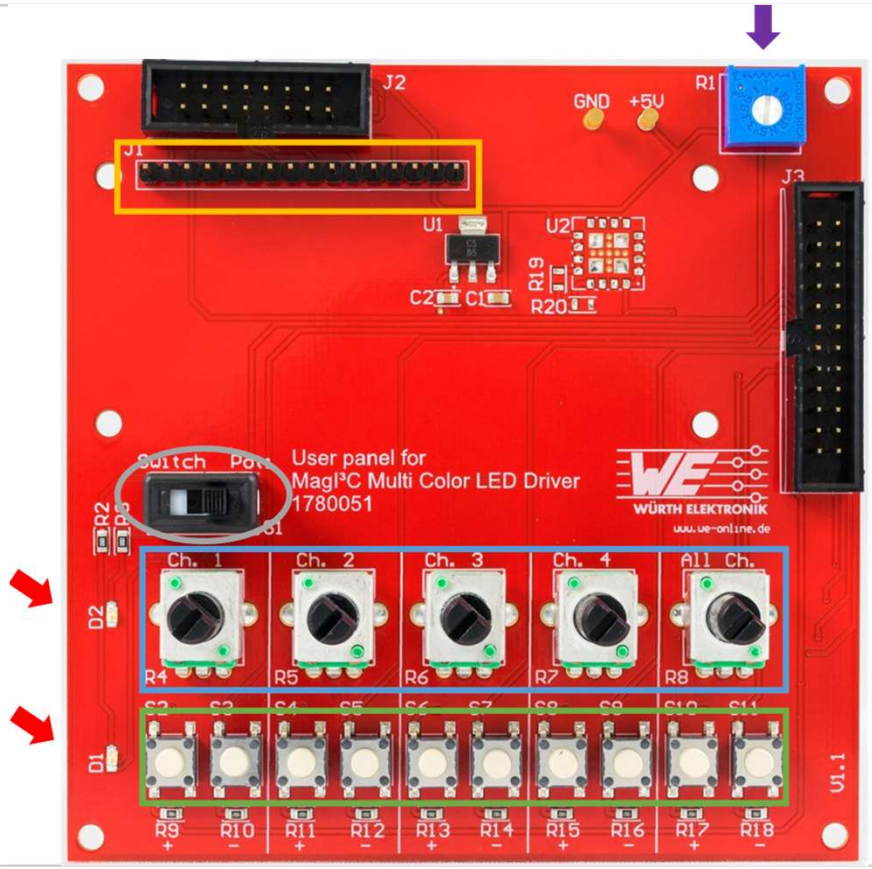
LED driver reference design



- 18-48V_{In} ; 1,8-V_{in} V_{out} ; up to 450mA
- LDHM LED Step Down High Current Module 172946001
- VDRM Variable Step Down Regulator Module QFN-41 171021501
- PIC16F1527 Microcontroller
- Bluetooth 4.2 Smart Module (260811024000)
- Switch between V_{In}, Off and +15V
- Input and Output Filter
- Robust screw terminal for V_{In} and V_{Out}

Reference Design: Multi Color LED Driver

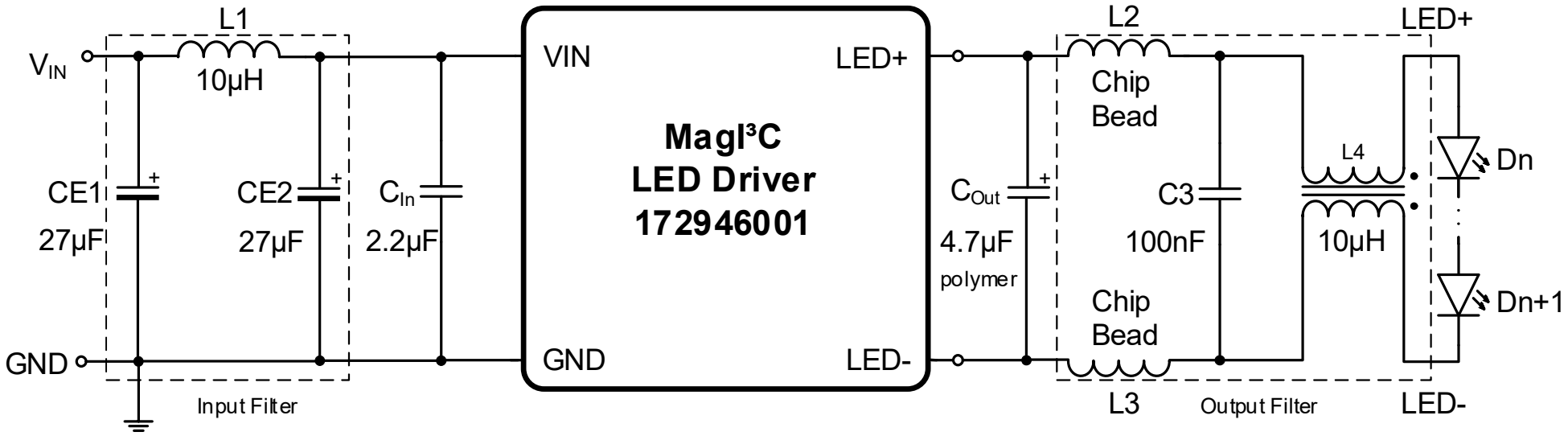
User Panel



- Potentiometer for LCD contrast
- Possibility for an LCD to show dimming-ratio per channel
- Switch between potentiometer or button operation
- LED for indicating potentiometer or button operation
- Potentiometer for LED dimming
- Buttons for LED dimming

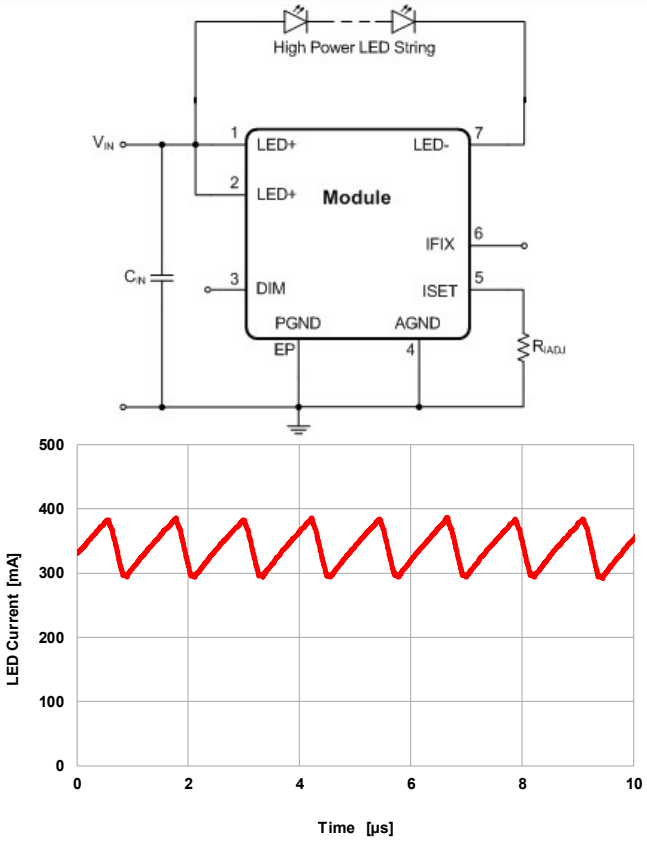
Multi Color LED Driver

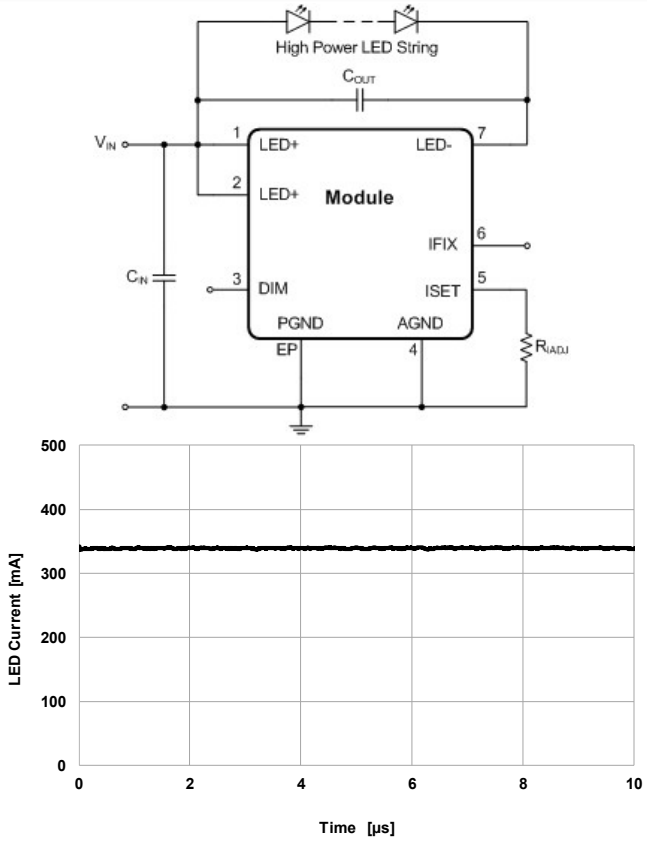
Single LED Channel EMI Filter



Multi Color LED Driver

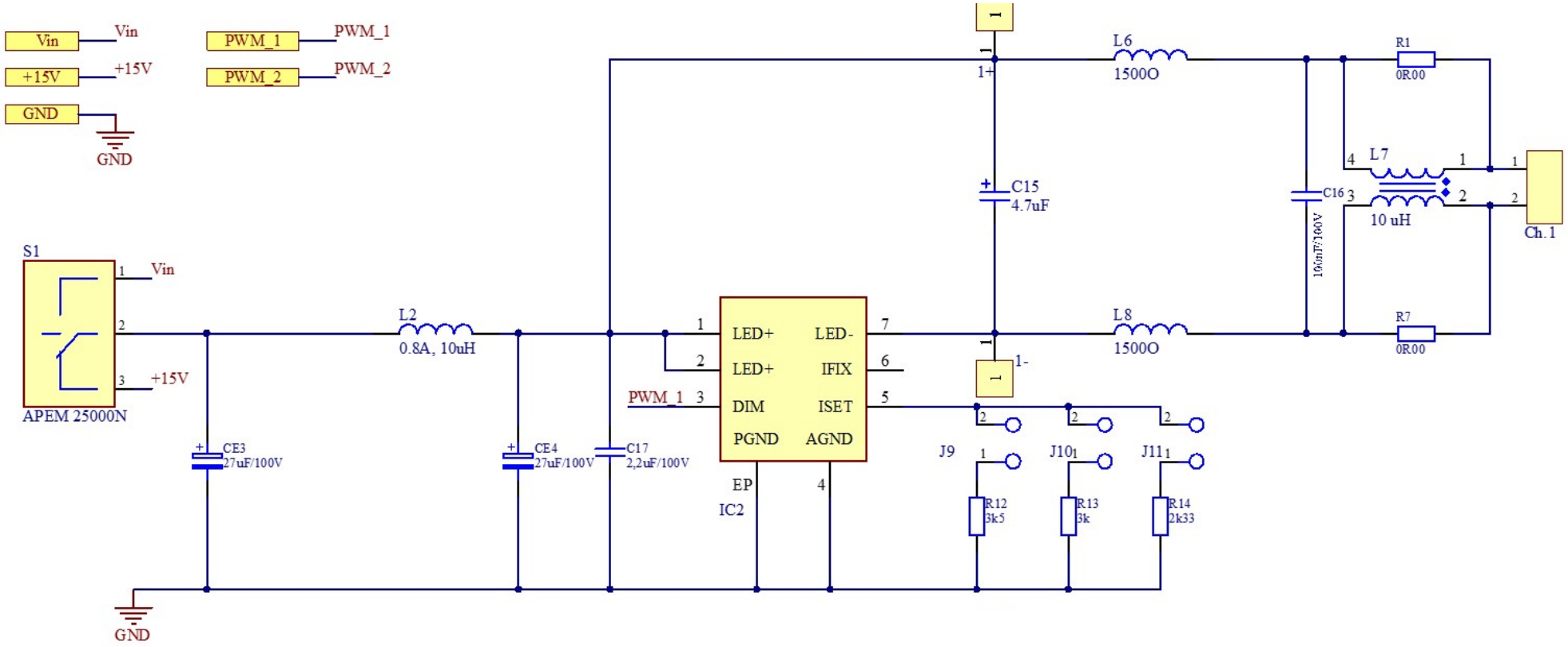
Single LED Channel EMI Filter





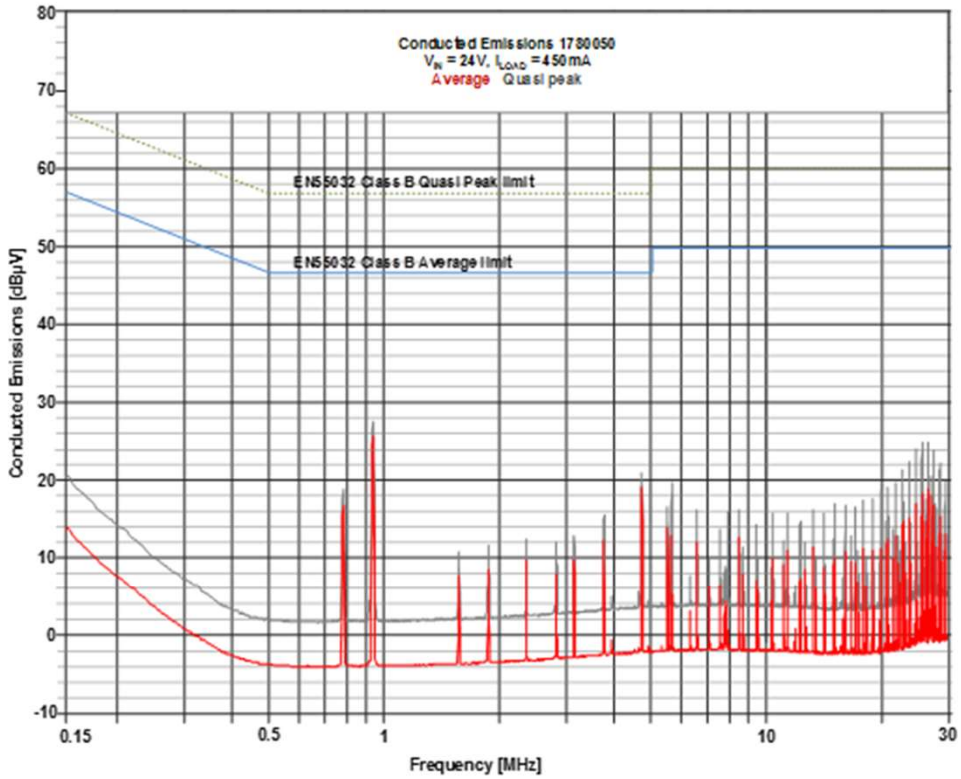
Multi Color LED Driver

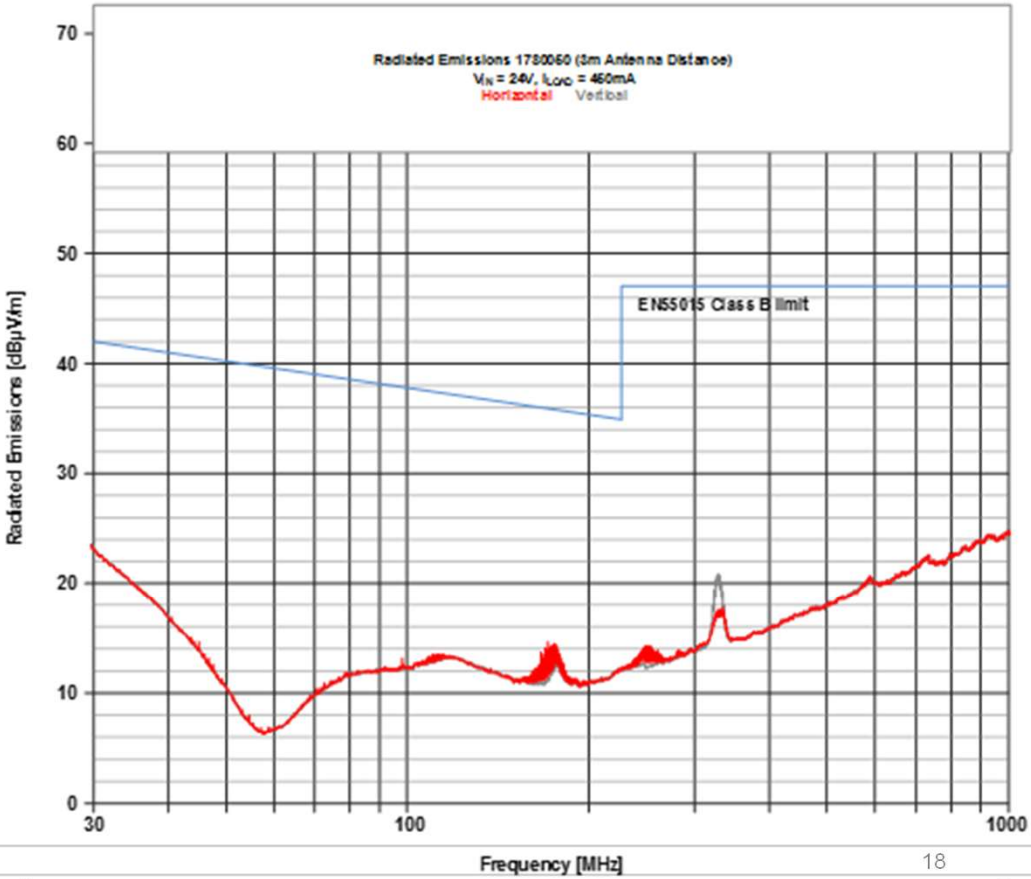
Single LED Channel schematic



Multi Color LED Driver

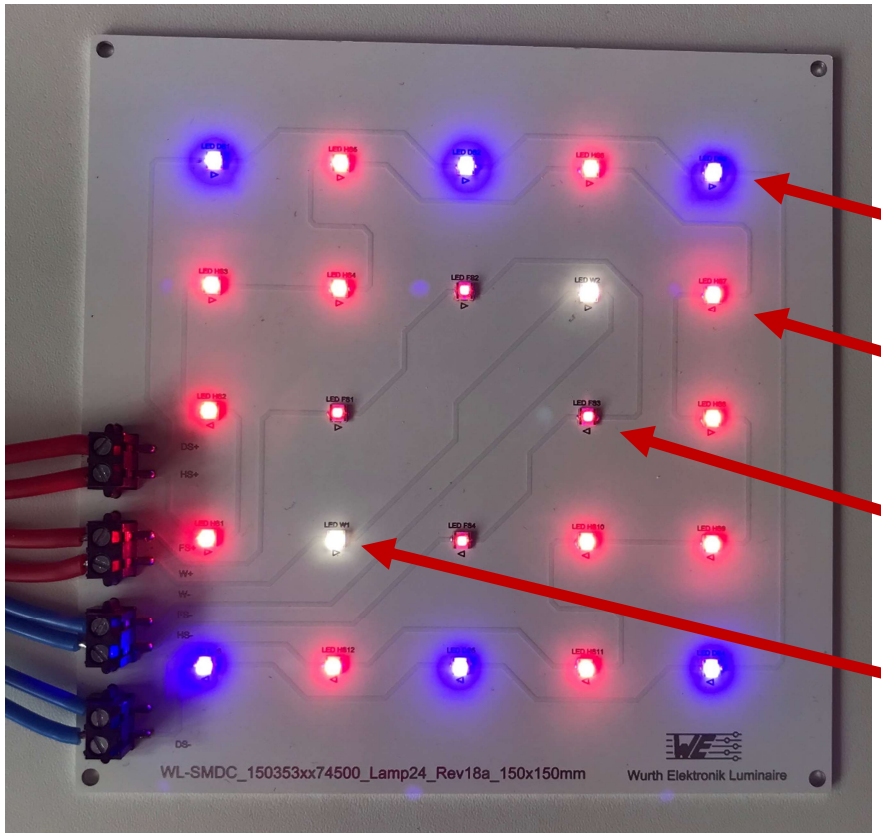
Single LED Channel EMI Filter





Reference Design: Multi Color LED Driver

LED Panel



	No. of LEDs	Photosynthetic Photon Flux[1] (µmol · s^{-1})	Photon Flux[1] (µmol · s^{-1})
WL-SMDC Deep Blue 450 nm (150353DS74500)	6	13.84	14.16
WL-SMDC Hyper Red 660 nm (150353HS74500)	12	21.66	23.64
WL-SMDC Far Red 730 nm (150353FS74500)	4	0.52	7.16
WL-SMTC Warm White 3000 K (158353030)	2	2.92	3.42

LED Selection

REDEXPERT® - *Horticulator*

LED LIGHTING & TECHNOLOGY CONFERENCE 2019
28 NOV · EINDHOVEN

WÜRTH ELEKTRONIK

- **Design custom light spectra**
- **See electrical parameters**
- **See quantum output parameters**
- **Quick access to data sheets**
- **Order free samples**

Summery

- **To drive LED an LED driver is preferred**
  - Enables dimming control
  - Higher efficiency
- **EMC challenges around an LED driver design**
  - Differential mode noise – LC or PI filters
  - Common mode noise – Common mode chokes
- **Typical applications**
  - Horticulture
  - General lighting applications
  - Street signs

LED LIGHTING & TECHNOLOGY CONFERENCE 2019
28 NOV · EINDHOVEN

WÜRTH ELEKTRONIK