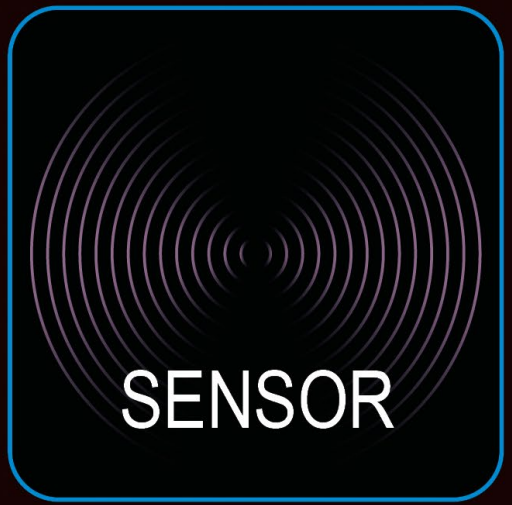
RUTRONIK TECHTALK MEETS



08.06. - 10.06.2021 | **ONLINE**

Infineon's solutions for UV-C Lighting and driving UV LEDs

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2. UV-C Disinfection: Applications and Lamps
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Our focus applications within lighting

LED drivers

- An LED driver is an electrical device which provides constant current to LED
- Applications: commercial indoor lighting, street lighting and high bay lighting

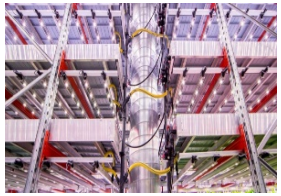
Signage & LED strips

- LED strips or signage supplied by constant voltage LED drivers usually consist of large number of parallel LED strings
- Each LED string needs a constant current source

Smart lighting

- Light control by usage of occupancy sensing
- More and more sensors being added in order to add new non-lighting related functions

Horticultural lighting



- Artificial light source traditionally HID
- Designed to stimulate plant growth by emitting light appropriate for photosynthesis
- LED based solutions are being used especially for urban farming / vertical farming

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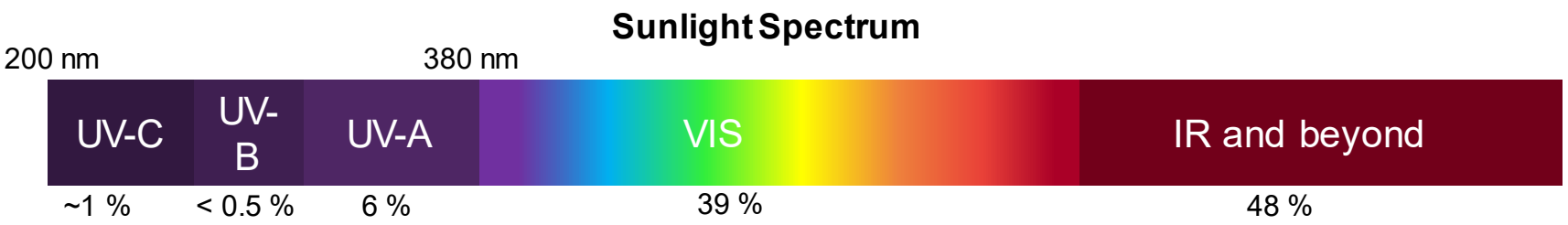
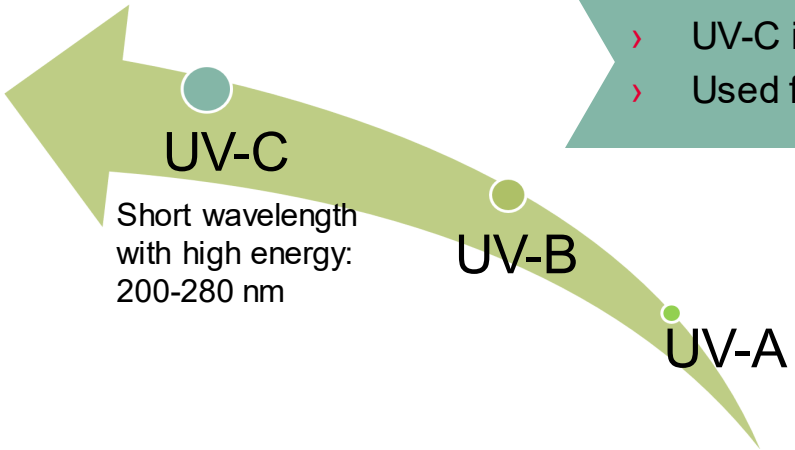
Sunlight contains some small amount of strongly germicidal UV-C





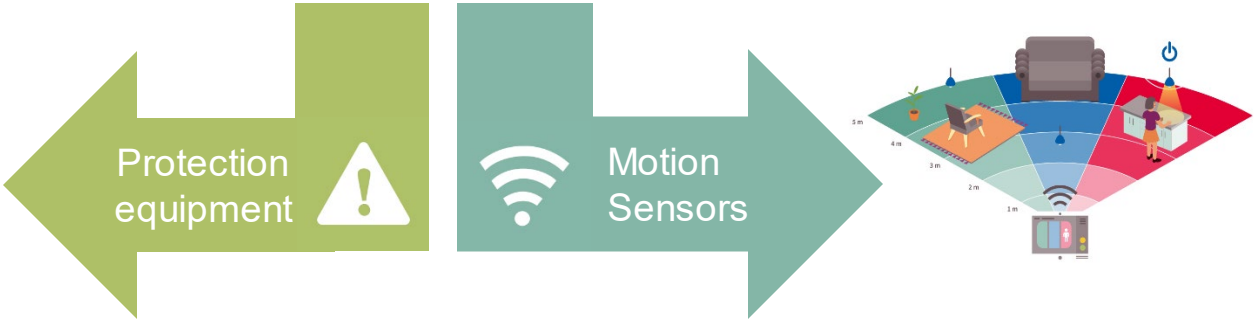
- UV-C is **most effective** killer for **virus** and **bacteria**
- Used for **germicidal disinfection**

- **UV-A** and **UV-B** do not kill viruses
- Only effective **against bacteria**

UV-C radiation - destroying DNA of germs – represents a serious health hazard for humans

- UV-C lamps mainly operating at 254 nm are harmful for skin and eyes
- To ensure safety there are following two options:

Working around **UV-C light** requires protection and shielding like glasses, protective suits and gloves



When people are not present, automatically **switch on** UV lights to sterilize the environment

UV-C Disinfection Lamps and their Applications

Medium Pressure UV-C Lamp

- Power input range: **400 W – 1 kW**
- Industrial water treatment

Amalgam Mercury Lamp

- Power input range: **140 W – 815 W**
- Industrial water and air disinfection

Low-pressure UV-C Lamp

- Power input range: **10-150 W**
- Drinking water, air purifiers

UV Surface, Air and Water Disinfection Applications

- **Medical treatment facilities** (operation rooms, hallways)
- **Transportation** (interior surfaces)
- **Air conditioning/HVAC systems**
- **Food industry** (packaging materials)
- **Water Treatment** (residential, industrial and large scale municipial applications)

Low-pressure UV-C lamps with high UV-C radiance at 254 nm **have highest germicidal effectiveness**

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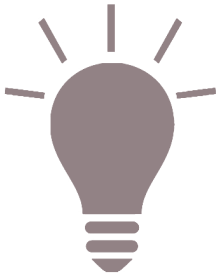
Leverage products for Fluorescent Ballasts for UV-C Ballasts

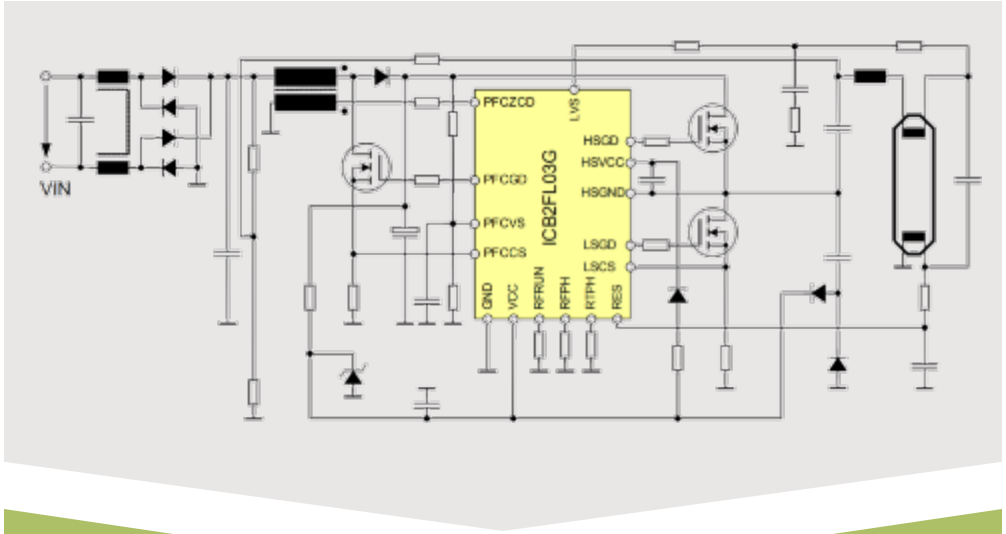
- Main stream **low pressure UV-C lamps** have a power rating between 10 W – 150 W
- They function like **fluorescent lamps** especially with regards to their **ballast**



- Infineon has a long history in Fluorescent Ballasts with **controllers** and high voltage MOSFET family → **CoolMOS™**
- Strong value proposition in **ease of design** & **efficiency**
- Over 100 mio pieces controllers sold into Fluorescent Ballasts with highest quality & **reliability** characteristics

- Controllers & MOSFETs can be used to **power UV-C lamps** as well
- Leverage quality, reliability and longstanding expertise for **UV-C market**

ICB2FL03G – Typical Application Circuit and Product Highlights
Ballast IC suited for UV-C Lamps



Digital Mixed Signal Power Control, enabling speedy and cost effective ballast designs

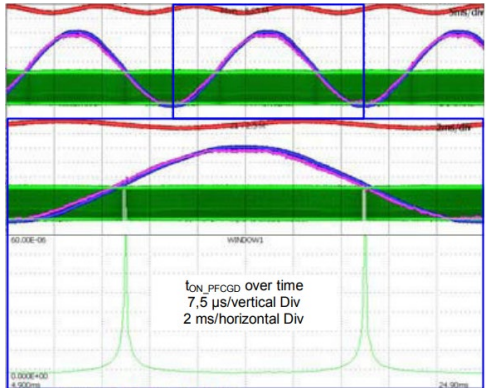
Product Highlights
Lowest count of external components
650 V half-bridge driver with Coreless Transformer Technology
Supports customer in-circuit test mode for reduced tester time
Supports multi-lamp designs (in series connection)
Integrated digital timers up to 40 seconds
Numerous monitoring and protection features for highest reliability
Very high accuracy of frequencies and timers over the whole temperature range
Very low standby losses

ICB2FL03G - Key features, benefits and values

Key features	Key benefits	Value
Able to handle lamp chokes with high saturation behavior	› Reduced BOM costs by optimized lamp choke size › Reduced system cost and improved ballast stability	Reduced system costs
Integrated high performance PFC stage	› Suitable for multi-power ballasts	
Intelligent digital/mixed signal power control	› Enables ballast compatibility with a wider range of lamp types	High compatibility for different types of UV-C lamps
Integrated high voltage half bridge driver	› Lamp can automatically restart following surge events and handle correctly EOL events	Fully integrated
All parameters set using only resistors	› Excellent dynamic PFC performance enables very low THD across wide load ranges › Halving the time for key tests (e.g. end-of-life detection and preheat/operation modes)	
Highly accurate timing and frequency control over wide temperature range	› Eases design of multi-power ballasts and reduces EMI	Customer-friendly, easy and reliable ballast design

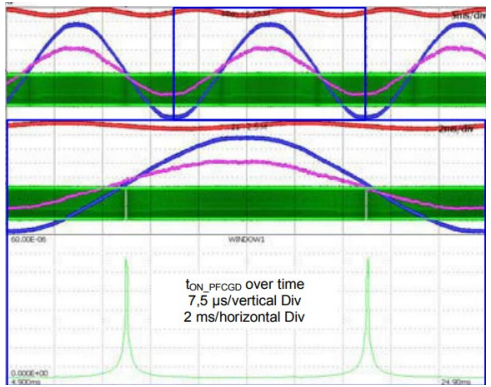
Excellent dynamic PFC performance – enabling low THD
Waveform of input current shows THD optimization

V_{in} = 180 V_{AC}



- V_{BUS}
- V_{IN}
- V_{PFCGD_pin5}
- I_{IN} (200mA/Div)

V_{in} = 230 V_{AC}

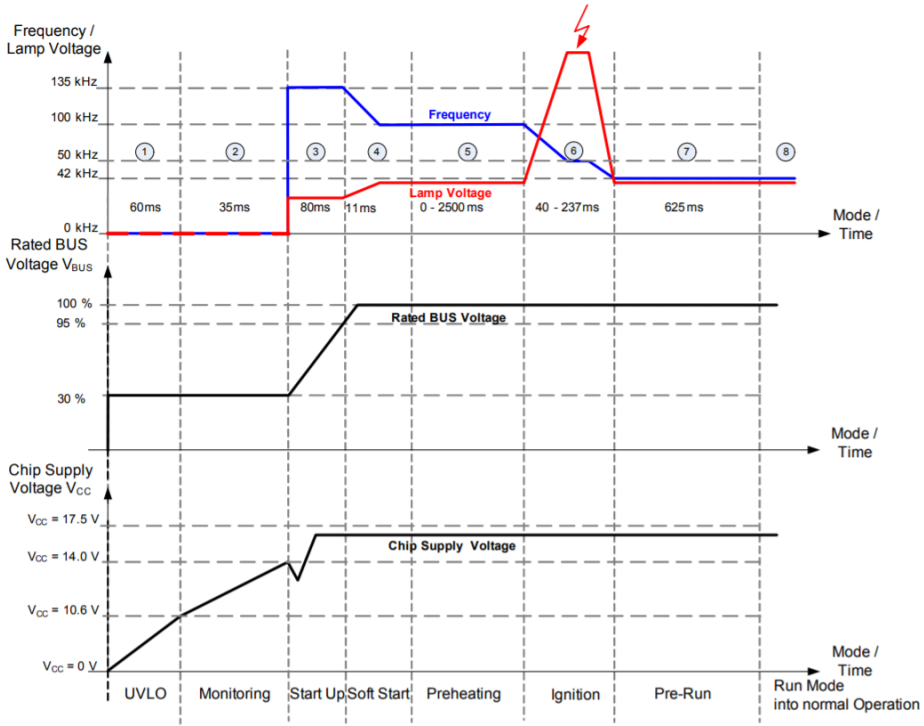


- Discontinuous mode PFC for load range 0 to 100 %
- Integrated digital compensation of PFC control loop
- Improved compensation of AC input current, also in DCM operation
- Adjustable PFC current limitation

- Excellent performance of the PFC stage
- THD < 4 % with gapless input current I_{IN}
- Very low THD across wide load ranges
  → ICB2FL03G suitable for multi-power ballasts

ICB2FL03G – normal start-up procedure diagram of how IC Ballast works and powers up lamps

Normal Operation



- 8 different phases during typical start from UVLO (Under Voltage Lock Out, phase 1) to run mode (phase 8) and into normal operation
- The current consumption of the IC depends on the voltage at the RES pin
- Pre-run mode is a saftey mode in order to prevent a malfunction of the IC due to an instable system
- In run mode all protection functions are alive

Reference solution for 54 W UV-C Ballast incl. ICB2FL03G and 600 V CoolMOS™ PFD7 in SOT223 package

Products	SP Number	Package	Description	Link
ICB2FL03G	SP001228884	PG-DSO-16	Intelligent Ballast IC for UV-C Disinfection lamps	https://www.infineon.com/cms/en/product/power/lighting-ics/fluorescent-ballast-ics/icb2fl03g/
Reference board with ICB2FL03G EVAL_ICB2FL03G	SP000992690	PCB	Demo board for the 54W T5 Design with voltage mode preheating	https://www.infineon.com/cms/en/product/power/lighting-ics/fluorescent-ballast-ics/icb2fl03g/#!boards
IPN60R1K5PFD7S	SP004748876	PG-SOT223-3-1	600 V CoolMOS™ PFD7 high efficiency superjunction MOSFET	https://www.infineon.com/cms/en/product/power/mosfet/500v-900v-coolmos-n-channel-power-mosfet/600v-coolmos-n-channel-power-mosfet/ipn60r1k5pfd7s/

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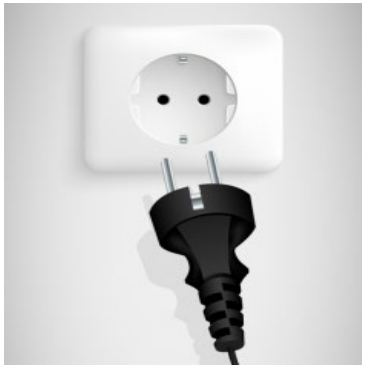
DC/DC Lighting ICs
Best choice to control current for UV LEDs

Input	AC / DC	DC / DC	Where to use



Constant voltage power supply

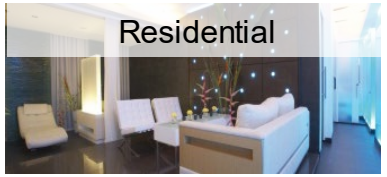
Suitable products

- **Linear regulators BCRs**
- **Switch mode LED driver**
  - **ILD8150E**

- Power discretes
- Schottky diodes
- Microcontroller

Channel letters, signage

Residential



Architectural

Fridge, white goods, disinfection appliances

BCR Drivers and Controllers - Linear current regulator portfolio

	BCR401W BCR402W	BCR401U BCR402U BCR405U	BCR420U/ BCR320U	BCR450	BCR430U	BCR431U	BCR601	BCR602
Description	Linear LED driver IC	Linear LED driver IC	Linear LED driver IC	Linear LED controller IC	Linear LED driver IC	Linear LED driver IC	Linear LED **controller IC**	Linear LED **controller IC**
Adjustable current range	10 – 60 mA	10 – 65 mA	10 -250 mA	50 mA – 1A	20-100 mA	8-37 mA	Bipolar or NMOS transistor up to xA	Bipolar or NMOS transistor up to xA
Voltage drop	1.2 V	1.4 V	1.4 V	0.5 V	**0.135 V at 50 mA**	**0.105 mV at 15 mA**	0.345 V at pin Vdrop	Depending on Vin, system configurable
Breakdown voltage	**18 V**	**40 V**	**25 V / 40 V**	**27 V**	**42 V**	**42 V**	**60 V**	**60 V**
Protections	Negative thermal coefficient	Negative thermal coefficient	Negative thermal coefficient	Thermal shut down at 120°C	Smart temperature controlling circuit	Smart temperature controlling circuit	**Voltage feedback to primary side, OVP, OTP, Hotplug**	OTP
Package total power dissipation	500 mW	750 mW	1000 mW	Depends on transistor	600 mW	600 mW	360 mW	360 mW
Dimming	Ext. digital transistor required, bus voltage	Ext. digital transistor required, bus voltage	PWM dimming via enable pin, bus voltage	PWM dimming via EN pin	PWM dimming via Rset pin, bus voltage	PWM dimming via Rset pin, bus voltage	Analog down to 3%	Analog down to 3% and PWM dimming down to 1%
Qualification	AEC Qualified	AEC Qualified	AEC Qualified	Industrial	Industrial	Industrial	Industrial	Industrial
Target application	LED strip	LED strip	LED strip	LED strip/module	LED strip/signage	LED strip/signage	LED driver	LED module, strip
Size	SOT-343	SC-74	SC-74	SC-74	SOT-23-6	SOT-23-6	DSO-8	SOT-23-6

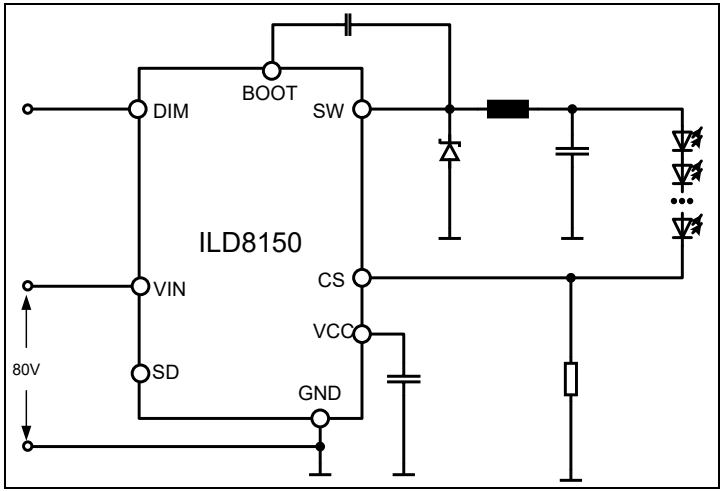
New ILD8150/E
Complete features and application overview

Features

- Supply voltage 8 V to 80 V
- Integrated HS MOSFET switch, up to 1.5 A average output current
- Efficiency up to 97%
- LED current precision ± 3%
- Up to 2 MHz switching frequency
- Low typical $R_{DS(on)}$ of 275 mΩ
- Soft-start to protect primary side
- External shunt resistor connected to GND to set LED target current
- Low power shutdown pin
- Overtemperature protection, UVLO

Dimming features

- PWM Dimming Input, with 250 Hz to 20 kHz PWM dimming frequency
- Analog dimming 100% - 12.5%
- PWM dimming 12.5% down to 0.5 % with 3.4 kHz flicker-free modulation
- Dim-to-off
- Pull-down transistor to avoid LED glowing in dim-to-off



Applications

- LED driver
- Multi-channel lighting
- Tunable white

Package versions

- DSO-8
- DSO-8 exposed pad (ILD8150E)

IFX's portfolio for modular plug & play reference solutions

AC / DC Conversion

Up to 4 channels for power scaling

Dual-stage half-bridge LLC (320W)

REF_LLC_BUCK_4CH_320W

constant-voltage (CV) output of 54V, low stand-by

Flyback converter with constant voltage output (40W)

REF-XDPL8219-U40W

DC/DC Conversion

60V linear controller

80V high-side buck

one channel 700 mA, 36W

DEMO_BCR601_60V_IVCTRL

REF_TW_BCR601_55V_0.5A

tunable white, 27W

REF_ILD8150_DC_1.5A — with through hole inductor

REF_ILD8150_DC_1.5A_SMD — with SMD inductor

REF_ILD8150_DC_1.5A — with through hole inductor

REF_ILD8150_DC_1.5A_SMD — with SMD inductor

REF_TW_ILD8150E_60V_1A — tunable white, 60W

Further boards upcoming, pls always check:

www.infineon.com/leddriver-reference-solutions

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Summary and key take-aways

- **UV-C** lighting is proven and effective for **disinfection against virus and bacteria**
- Main stream UV-C lamps have a power rating between 10 W – 150 W and function like fluorescent lamps especially with regards to their ballast
- UV-C LEDs have higher voltage requirements than conventional LEDs, besides from that no difference in power control

Ballast controller ICB2FL03G enables easy design combined with proven reliability

- Fully integrated, customer-friendly and reliable
- Speedy and cost effective ballast design with the minimum of external components

DC/DC LED Driver ICs for keeping the current at UV-LEDs reliably under control

- Vast portfolio of different drivers and controllers available
- Selection according to supply voltage and driving current needed

Part of your life. Part of tomorrow.