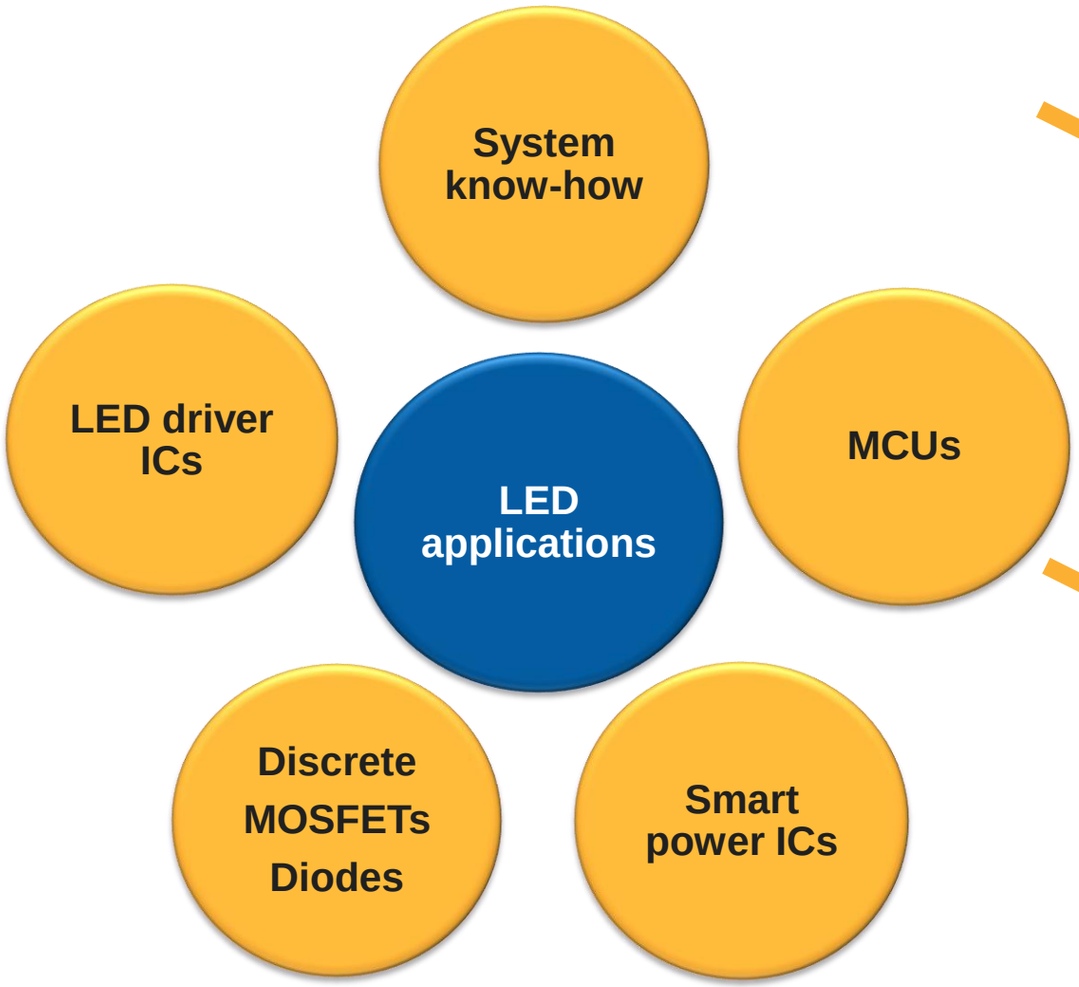
Energy-efficient solutions for offline LED lighting and general illumination

Offline LED lighting/general illumination



ST's position

- #1 in lighting segment*
- #2 in power management**

ST's expertise

- System solutions
- Technology integration and innovation
- Excellent technical support

*STMicroelectronics, Datapoint and Darnell – 2008
**iSupply - 2010

Contents

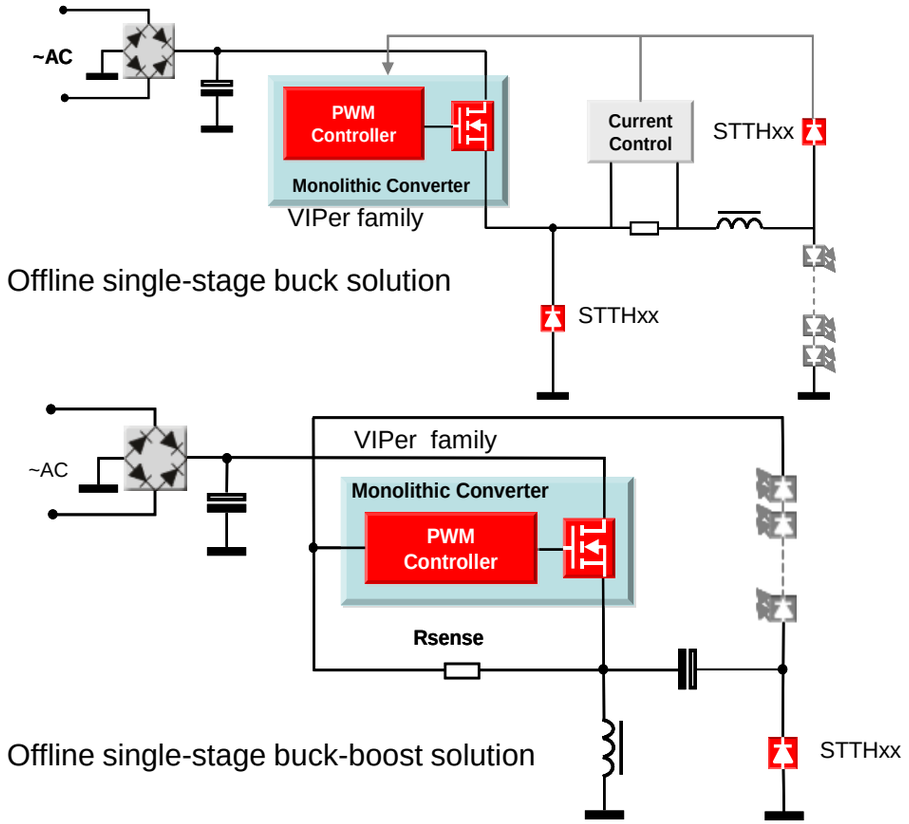
- Energy-efficient solutions for offline LED lighting
  - Offline LED driver solutions
    - Features/benefits
    - System evaluation boards and tools
  - General illumination applications
    - Residential lighting
    - Commercial lighting
    - Architectural and decorative lighting
    - Street lighting and public illumination
    - Emergency lighting
    - Machine vision

Driving LEDs using AC-DC solutions

Isolated and non-isolated topologies with high efficiencies and power factor

3 to 10 W		Single package approach, primary-side or secondary-side CC regulation	▪ Incandescent replacement ▪ Decorative bulbs
10 to 50 W		Single-stage AC-DC, single or multiple LED strings Triac dimmable or post regulation w/dimming	▪ Incandescent and fluorescent replacement ▪ Architectural and decorative lighting
50 W and above		Single-stage or double-stage AC-DC plus analog or digital CC controllers	▪ Streetlights ▪ Parking garages ▪ Warehouse high bays

Non-isolated applications: up to 10W



Applications	AC-DC solutions for LED driving
▪ Bulb replacement ▪ Lamp retrofit	Buck Buck-boost Flyback

Device	Part number/family	Benefits
Monolithic converter	VIPer family (Integrated controller + MOSFET)	▪ 800 V avalanche rugged MOSFET (VIPerPlus) ▪ Jittering for low EMI (VIPerPlus) ▪ Advanced OVP and OCP
Ultrafast diodes	STTHxx	▪ Wide selection of electrical parameters and packages

Non-isolated eval boards: 3-10W

VIPer family: High-voltage converters in non-isolated topologies

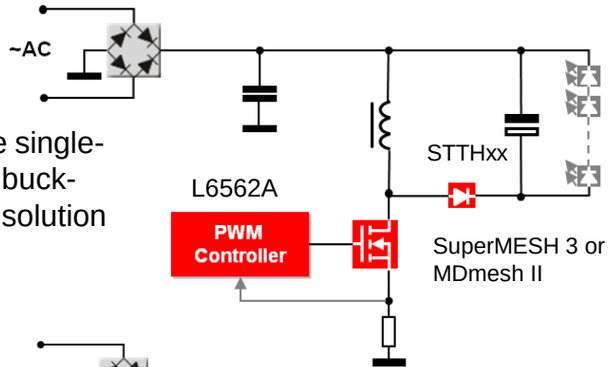
3-watt LED driver STEVAL-ILL026V1

Key features	Main benefits
▪ Single package approach: ▪ integrated ▪ robust ▪ sophisticated	▪ Miniaturized form factors ▪ Easy design
▪ High power factor > 0.7	▪ Compliant to energy saving regulations
▪ No high-voltage electrolytic cap usage	▪ High reliability (extended MTBF)

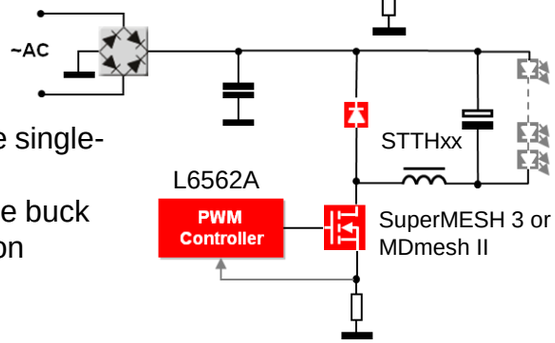
Evaluation board	Application note	Description
STEVAL-ILL026V1	AN2961	3 W non-isolated offline LED driver solution based on VIPER22AS
STEVAL-ILL017V1	AN2811	3.5 W non-isolated flyback constant-current source based on VIPER17

Non-isolated applications: up to 20W

Offline single-stage buck-boost solution



Offline single-stage inverse buck solution

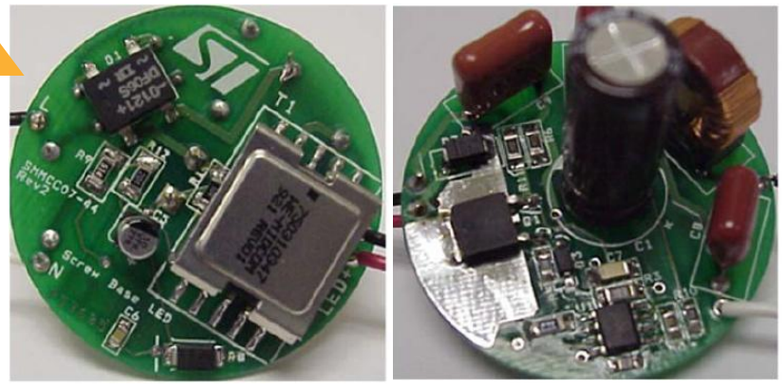


Applications	AC-DC solutions for LED Driving
▪ Neon and bulb replacement ▪ Lamp retrofit	Inverse buck Buck-boost

Device	Part number/family	Benefits
PWM controller	L6562A	▪ High power factor
Buck and buck-boost MOSFETs	SuperMESH 3*	▪ High safety margin and ruggedness ▪ High immunity to dV/dt, low conduction and switching losses
	MDmesh II* (super junction)	▪ Up to 800 V with the best RDS(on) in the market ▪ Best-in-class in dynamic dV/dt ▪ Low input capacitance and gate charge, low gate input resistance
Ultrafast diodes	STTHxx	▪ Wide selection of electrical parameters and packages

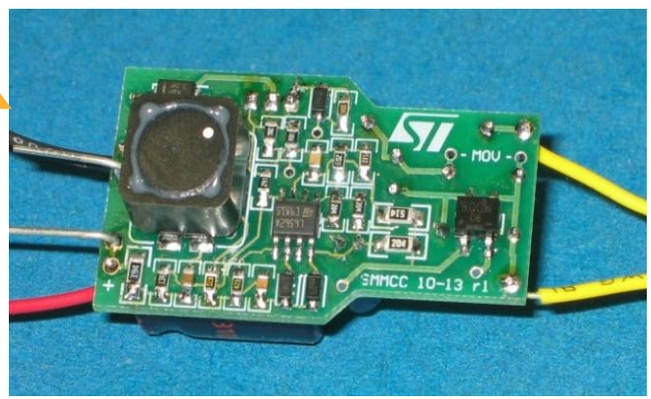
* See MOSFET selection guide in presentation, online, and in energy-efficient solutions for LED lighting brochure

L6562A PWM controller eval boards



Buck-boost STEVAL-ILL027V2

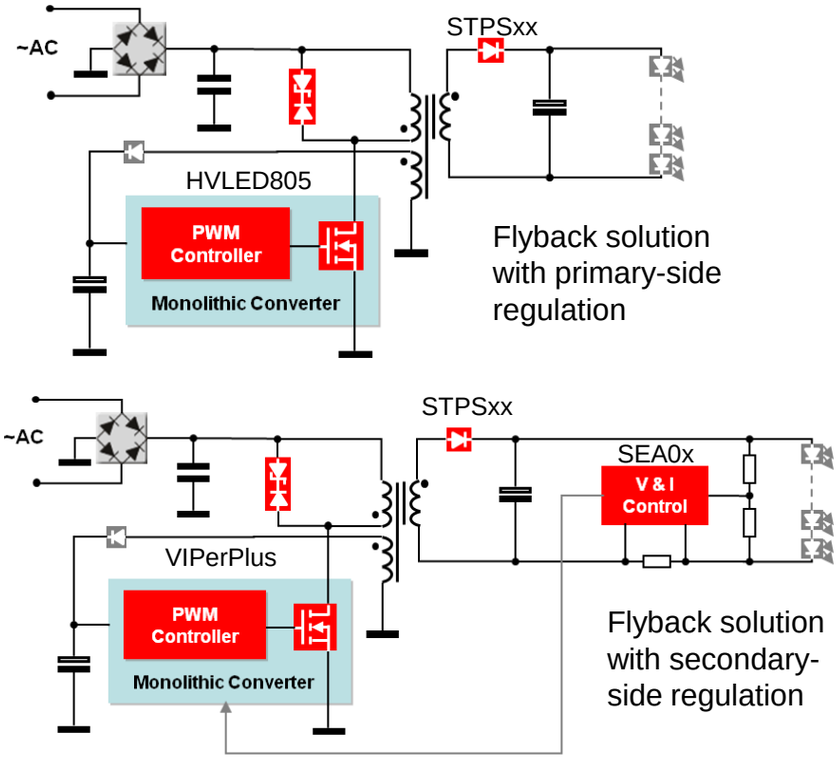
Key features	Main benefits
▪ Buck-boost topology	▪ Simple ▪ Low cost
▪ Transition mode operation	▪ Lower switching losses ▪ Spread of EMI spectrum
▪ High power factor > 0.8	▪ Compliant to energy saving regulations, suitable for residential lighting
▪ Open-load protection ▪ Short-circuit protection	▪ Robust



HPF inverse buck STEVAL-ILL034V1

Evaluation board	Application note	Description
STEVAL-ILL027V2	AN3111	18 W single-stage offline LED driver
STEVAL-ILL034V1	AN3256	Low-cost LED driver for an A19 lamp

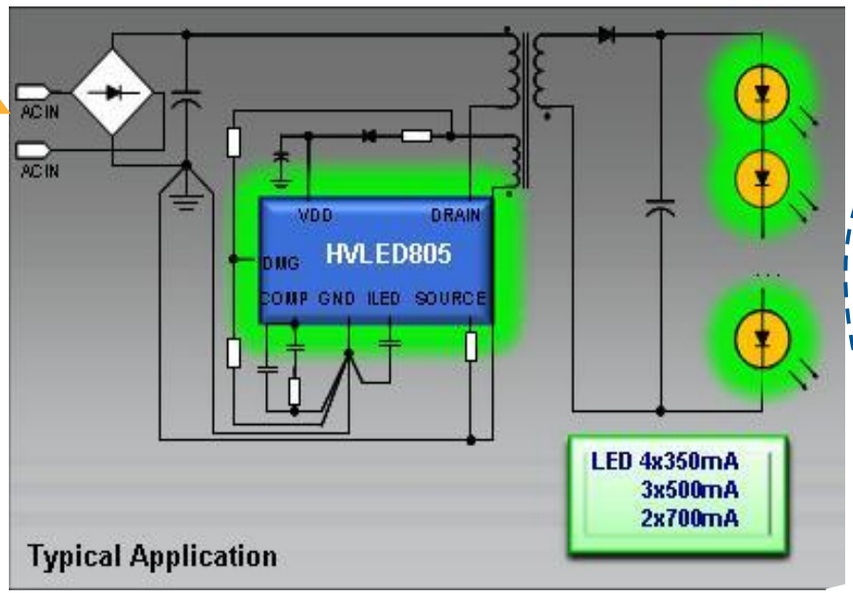
Isolated applications: Up to 10W

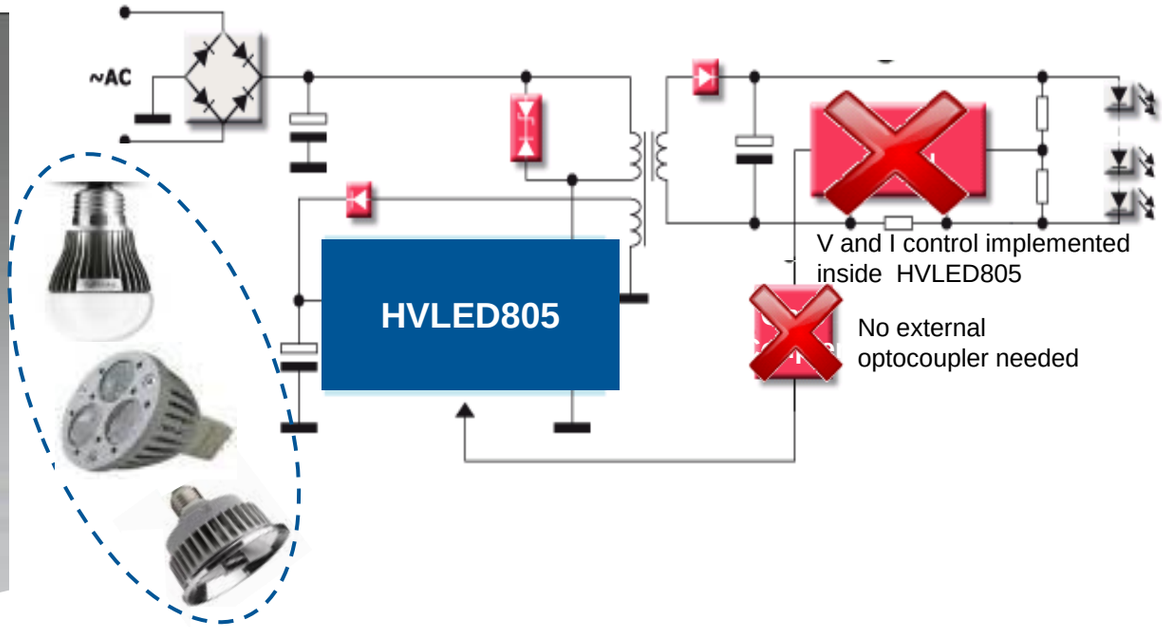


Applications	AC-DC solutions for LED driving
▪ Bulb replacement ▪ Lamp retrofit	Flyback

Device	Part number/family	Benefits
Primary IC	HVLED805 (controller + MOSFET)	▪ CC/CV primary regulation ▪ QR zero voltage switching operation ▪ 800 V avalanche rugged MOSFET
	VIPer Plus (controller + MOSFET)	▪ 800 V avalanche rugged MOSFET, high power factor ▪ Jittering for low EMI ▪ Advanced OVP and OCP
Schottky diodes	STPSxx	▪ Wide product range in Vf/Ir trade off, avalanche ruggedness
CV/CC control	SEA0x	▪ Very low current consumption, wide input voltage range

HVLED805 with primary-side regulation





Key features	Main benefits
▪ Single package approach ▪ integrated ▪ robust ▪ sophisticated	▪ Miniaturized form factors ▪ Easy design
▪ CC/CV primary regulation	▪ Reduced costs and system complexity ▪ Very small form factor to fit in LED retrofit applications
▪ No optocoupler	▪ High reliability (extended MTBF)
▪ Zero voltage switching operation and high voltage start-up	▪ High efficiency up to 85%

HVLED805 eval board solutions

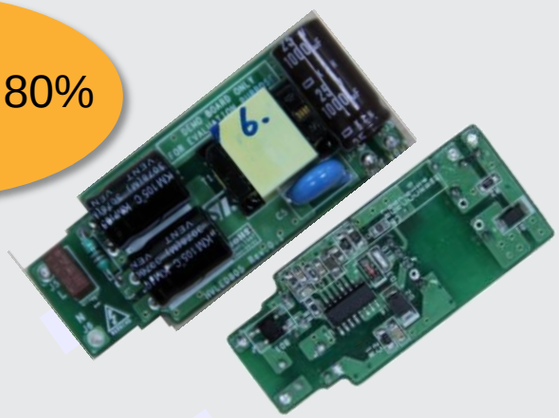
EVALHVLED805

4.2 W solution for 350 mA LED type

Evaluation board	Application note	Description
EVALHVLED805	Data brief	4.2 W offline LED driver with primary-side regulation
STEVAL-ILL037V1	AN3360	3.2 W LED power supply based on HVLED805

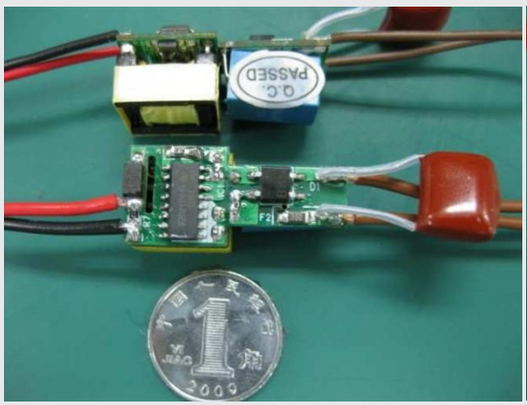
STEVAL-ILL037V1

Efficiency > 80%

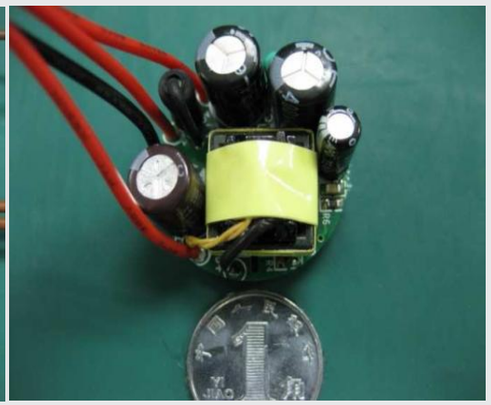


3.2 W solution for 200 mA LED type

3 W solution for 300 mA LED type

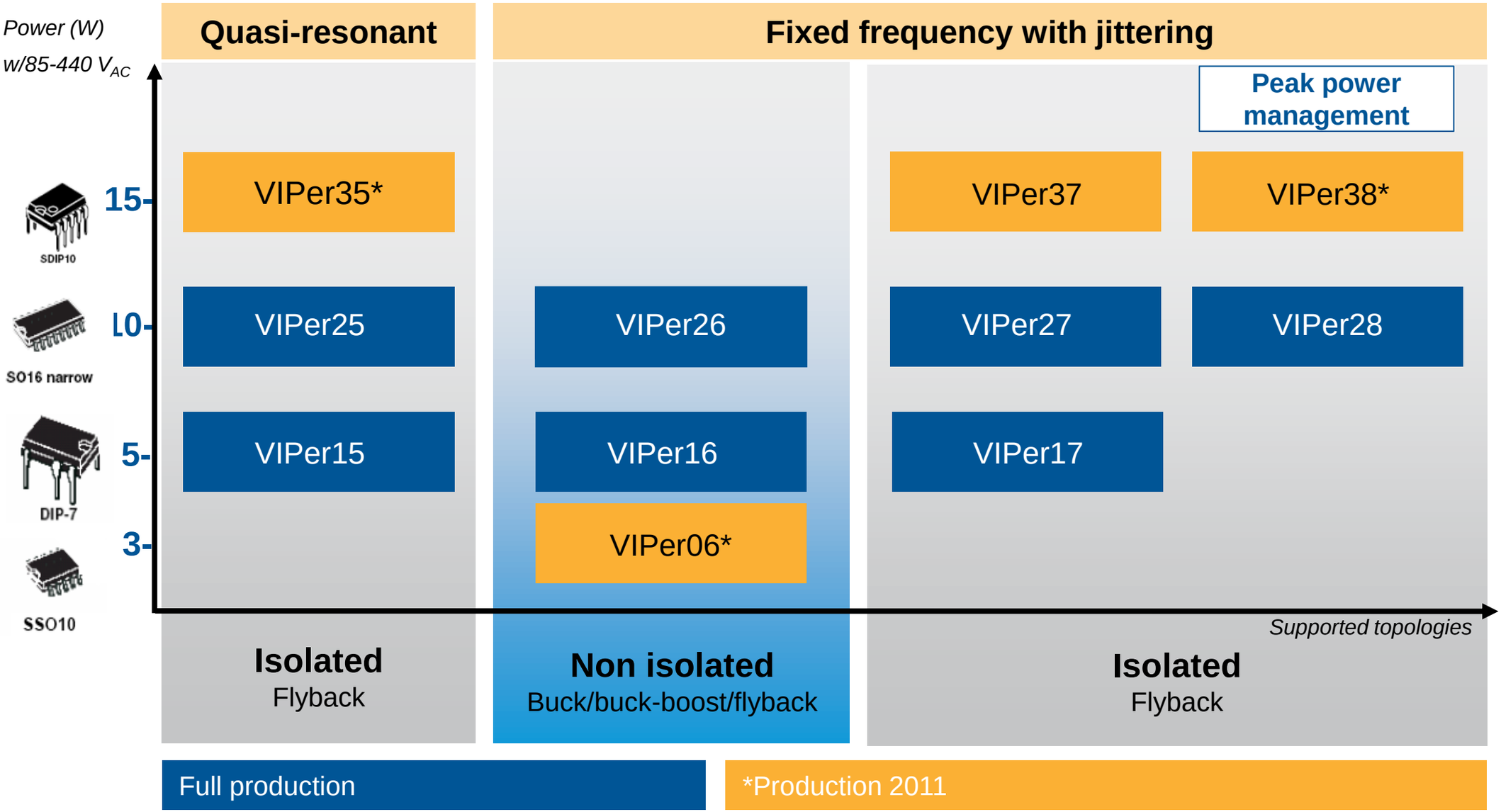


No e-cap solution



Solution with e-cap

VIPerPlus family overview

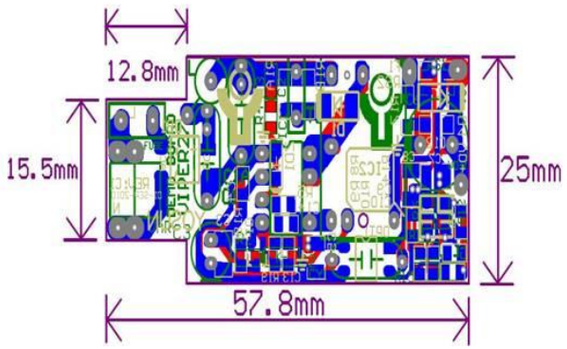


VIPerPlus HPF LED driver eval board

High-voltage converters in high power factor flyback

EVLVIP27-7WLED *
VIPer27 LED driver module

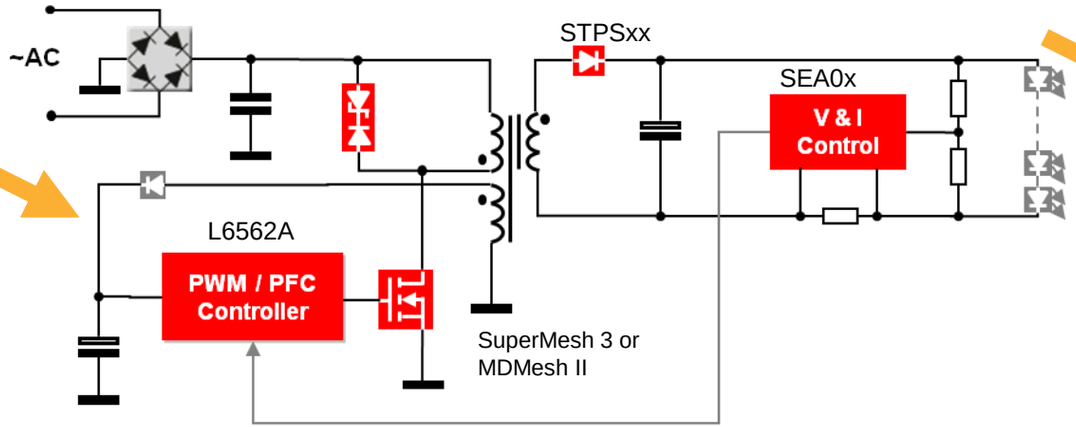
Key features	Main benefits
▪ Single package approach ▪ integrated ▪ robust ▪ sophisticated ▪ High-frequency operation	▪ Miniaturized form factors ▪ Easy design
▪ High power factor > 0.9	▪ Compliant to energy saving regulations, suitable for commercial lighting
▪ No electrolytic output capacitor if current ripple is accepted	▪ High reliability (extended MTBF)



Evaluation board	Application note	Description
EVLVIP27-7WLED *	AN3212	3.5 W to 7 W high power factor offline LED driver based on VIPer devices

* Please contact local sales support to order this board

Isolated applications: from 10 to 75W



Offline single-stage HPF flyback solution

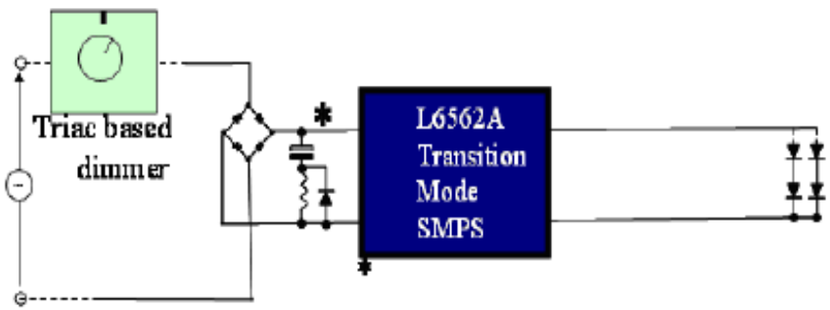
Applications	AC-DC solutions for LED driving
▪ Tube lamp and bulb replacement	Flyback
▪ Architectural and decorative lighting	Flyback
▪ Street lighting	Flyback

Device	Part number/family	Benefits
Primary IC	L6562A / AT (PFC controller)	▪ High power factor flyback ▪ Triac dimmable ▪ Extended temperature range (AT version)
Flyback MOSFET	SuperMESH 3*	▪ High safety margin and ruggedness ▪ High immunity to dV/dt, low conduction and switching losses
	MDmesh II* (super junction)	▪ Up to 800 V with best $R_{DS(on)}$ in the market ▪ Best-in-class in dynamic dV/dt ▪ Low input capacitance and gate charge, low gate input resistance
Schottky diodes	STPSxx	▪ Wide product range in Vf/Ir trade-off, avalanche ruggedness
CV/CC control	SEA0x	▪ Very low current consumption, wide input voltage range

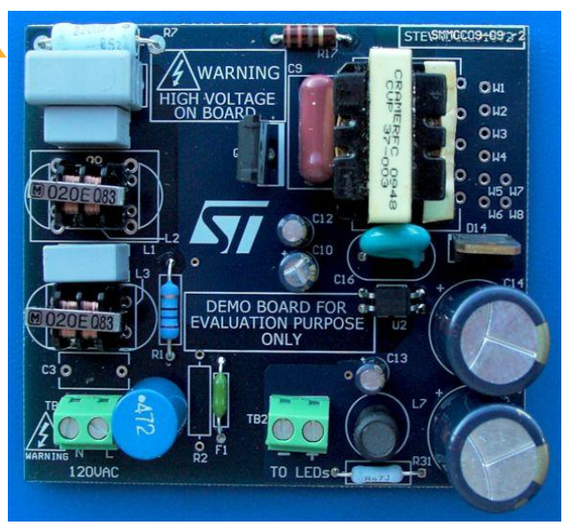
* See MOSFET selection guide in presentation, online, and in energy-efficient solutions for LED lighting brochure

L6562A

15W Triac dimmable eval board



Key features	Main benefits
▪ High power factor flyback topology supported > 0.9	▪ Compliant to energy saving regulations
▪ Control and power section separated	▪ Suitable for high power ▪ Design flexibility
▪ Triac dimmable	▪ Commonly available dimming option for home fixtures
▪ High output voltage	▪ No limitation to the number of LEDs within a string
▪ Based on low-cost controller and MOSFETs	▪ Cost-effective solution

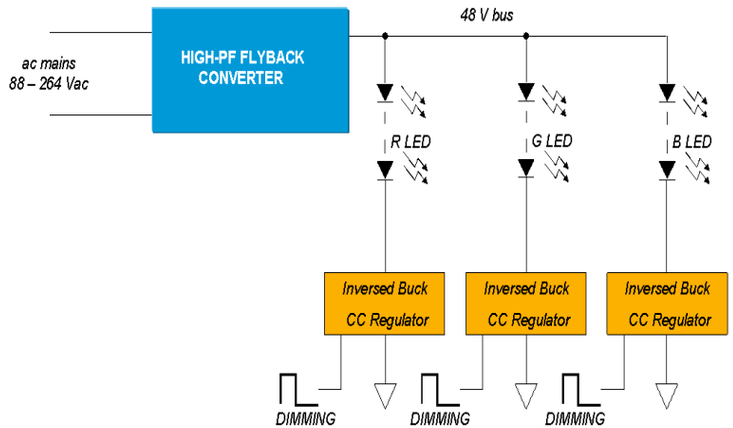


STEVAL-ILL016V2

Evaluation board	Application note	Description
STEVAL-ILL016V2	AN2711	15 W offline Triac dimmable LED driver from 96 to 32 V_{AC}

L6562A

HPF flyback + inverse buck eval boards



Key features	Main benefits
▪ High efficiency (> 90%), high power factor (> 0.9), flyback topology supported	▪ Compliant to energy saving regulations
▪ Control and power section separated	▪ Suitable for high power ▪ Design flexibility
▪ CC regulator in inverse buck working in fixed off time	▪ Constant ripple current, when input/output voltages change
▪ High output voltage	▪ No limit to number of LEDs on string

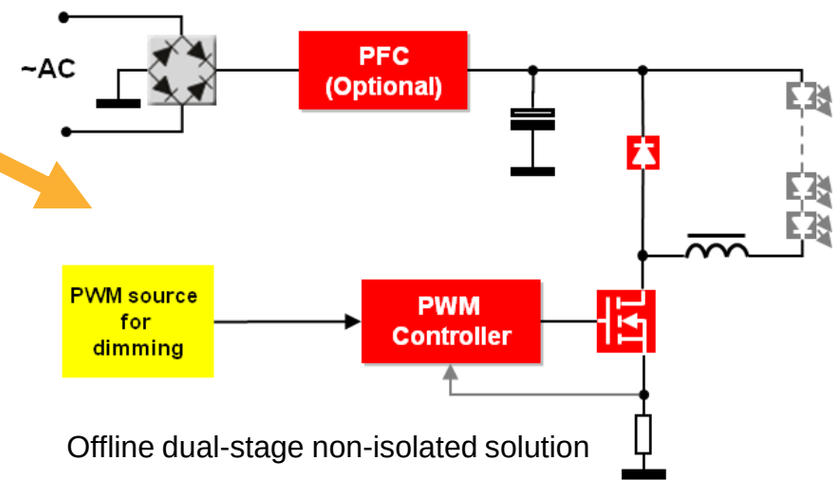
STEVAL-ILL019V1

Evaluation board	Application note	Description
STEVAL-ILL019V1	UM0926	35 W offline RGGB LED driver with individual channel brightness regulation
EVL6562A-35WFLB *	AN2838	35 W wide-range HPF flyback converter with L6562A
EVL6562A-LED	AN2928 AN2983	Modified buck converter for LED applications

* Please contact local sales support to order this board

Non-isolated: 80W and higher eval board

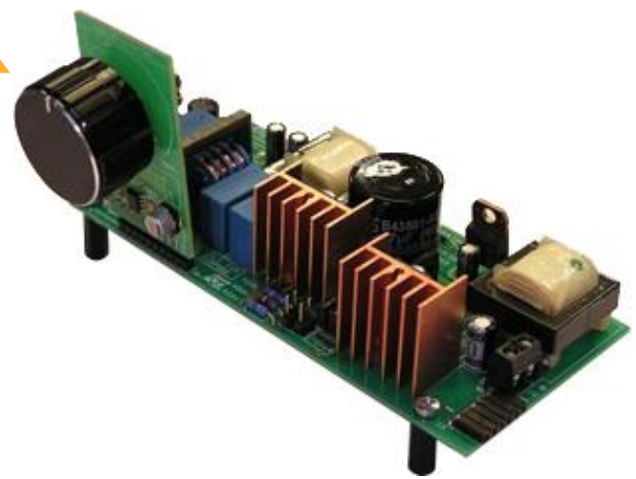
PFC boost + inverse buck



Offline dual-stage non-isolated solution

Applications	AC-DC stage	DC-DC stage
▪ Street lighting	PFC boost	Inverse buck

Key features	Main benefits
▪ LED current setting to 350 mA, 700 mA and 1 A	▪ High flexibility
▪ High efficiency (~90%), high power factor, very low THD	▪ High performances
▪ High output voltage	▪ No limitation to the number of LEDs within a string
▪ EN55015 and EN61000-3-2 compliant	▪ Satisfies the relevant lighting regulations

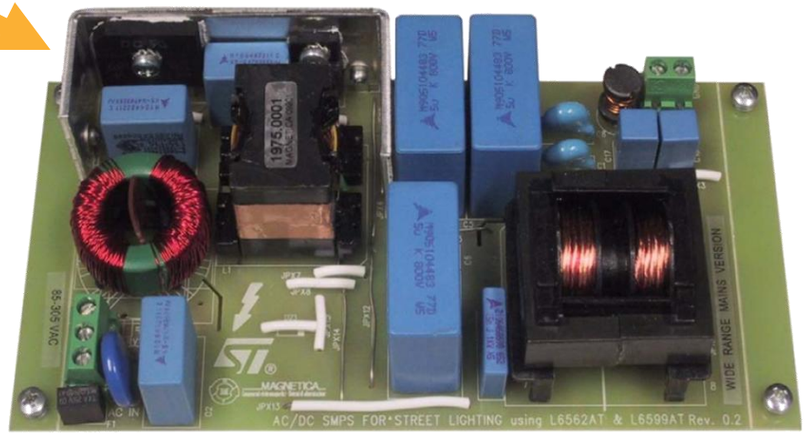


STEVAL-ILL013V1

Evaluation board	Application note	Description
STEVAL-ILL013V1	AN2928 UM0670	80 W offline LED driver with dimming based on L6562A

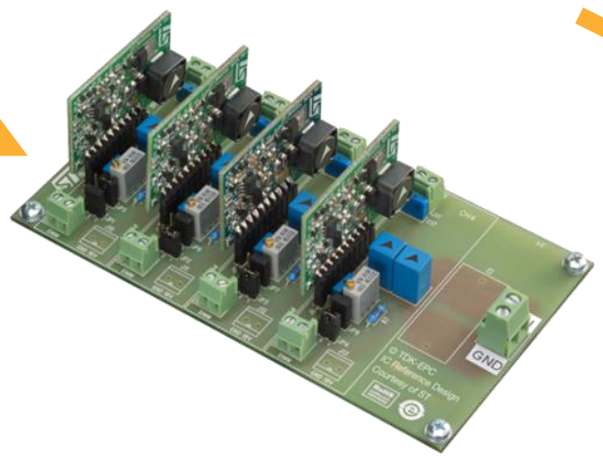
Isolated: >70W resonant LED eval boards

PFC (L6562AT) + resonant converter (L6599AT) + inverse buck (L6562AT) with MOSFETs*



PFC + resonant converter

Key features	Main benefits
▪ PFC + resonant controller, with extended temperature range	▪ Suitable for outdoor applications
▪ No el-cap usage	▪ High rel (extended MTBF)
▪ Zero voltage switching and symmetrical topology	▪ Very high efficiency > 92%
▪ Post-regulation with dimming solution	▪ Dimmable solutions
▪ EN55015 and EN61000-3-2 compliant	▪ Satisfies the relevant lighting regulations



Inverse buck – EVL6562A-LED

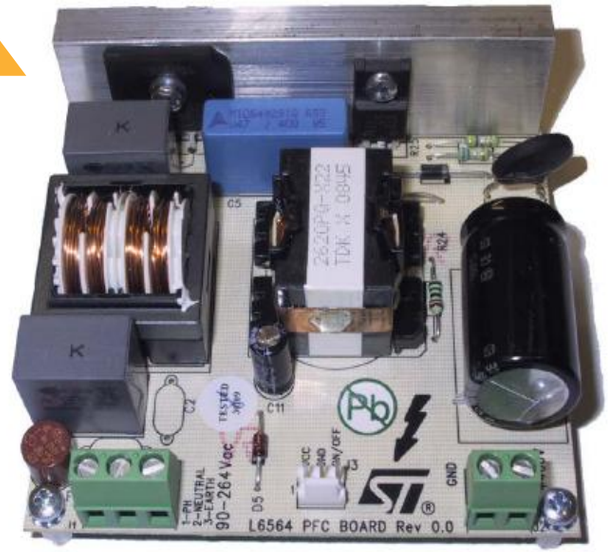
Evaluation board	Application note	Description
EVL130W-SL-EU	AN3105	48 V, 130 W LED street lighting SMPS based on L6562AT and L6599AT for European input mains range
EVL130W-STRLIG	AN3106	48 V, 130 W LED street lighting SMPS based on L6562AT and L6599AT for wide input mains range
EVL6562A-LED	AN2983 AN2928 for ref	Modified buck converter for LED applications

* See MOSFET selection guide earlier in presentation, online, and in energy-efficient solutions for LED lighting brochure

Isolated LED supply: >75W eval board

L6564: current mode PFC controller

Key features	Main benefits
Fast bidirectional input voltage feedforward	Fast reaction to ▪ load change ▪ input voltage change
Protection ▪ for inductor saturation ▪ adjustable overvoltage ▪ against feedback loop disconnection	▪ Very robust design
Low start-up current	▪ High efficiency



Device	Part number/family	Benefits
PFC controller	L6562AT L6563S, L6564	▪ Flexibility: 8 pins (L6562A) to 10 pins (L6564) up to 14 pins (L6563S) with different levels of protection ▪ T version for extended temperature range (-40 to 150 ˚C)

Ideal for
▪ PFC preregulator ▪ SMPS for LED luminaries

Evaluation board	Application note	Description
EVL6564-100W	AN3022	100 W transition mode PFC preregulator with L6564

L6585DE: SMPS eval board for LEDs

Front-end one-chip SMPS solution

Description and purpose

- Highly-efficient and compact power supply for high-brightness LED applications such as street lighting

Key features

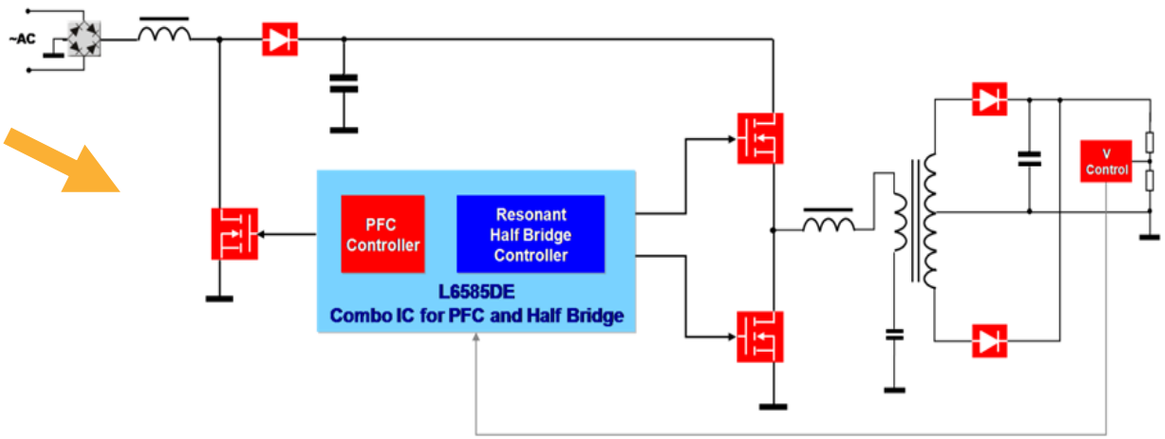
- Input voltage 90 to 264 V_{AC}
- Output current: 2 7 A
- Output voltage: 48 V
- No el cap (extended MTBF)
- Efficiency: 91% (115 VAC), 93% (230 VAC)
- System power: 130 W
- OCP, SC protection

Key products

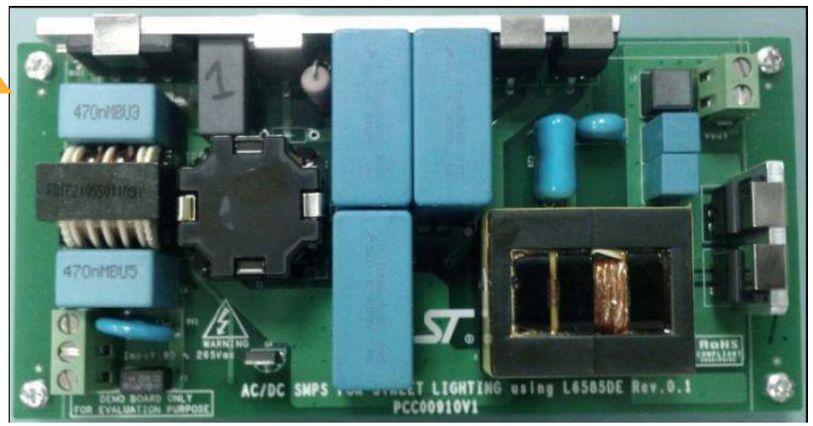
- L6585DE, STF9NM60N, STF21NM60N, STPS10150C, STTH3L06

Typical applications

- Street lighting SMPS, adapters (with 19 V, 4.7 A output)



PFC stage + series-resonant half-bridge topology



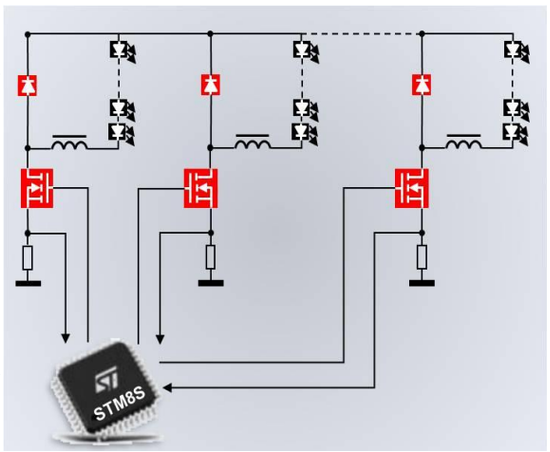
STEVAL-ILL038V1

Digital current controller eval board

Multi-string LED driving based on STM8S microcontroller

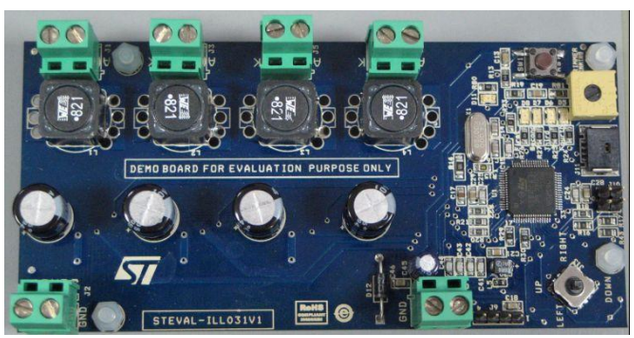
Main PSU

ZigBee module



STM8S

Key features	Main benefits
▪ Inverse buck topology in CCM	▪ Ground referred circuit, no need for gate drivers ▪ Logic level MOSFET driven directly by microcontroller ▪ Low-voltage sensing circuit ▪ High efficiency up to 98% ▪ Works w/o output capacitor
▪ Accurate average-current control	▪ Long lifetime for LED ▪ Able to compensate for Vf variation due to thermal issue
▪ Global dimming from 2% to 100% at 225 Hz (PWM dimming)	▪ No flicker
▪ Independent analog dimming	▪ Suitable for RGBW luminaries



STEVAL-ILL031V1

Evaluation board	Application note	Description
STEVAL-ILL031V1	AN3151	Digital constant-current controller for multi-string LED applications based on STM8S208x

Solar-LED streetlight controller w/STM32

25 W LED lamp driver and 80 W battery charger

Description and purpose

- Cost-optimized and fully-protected solution to control solar energy storage and to manage LED streetlights

Key features

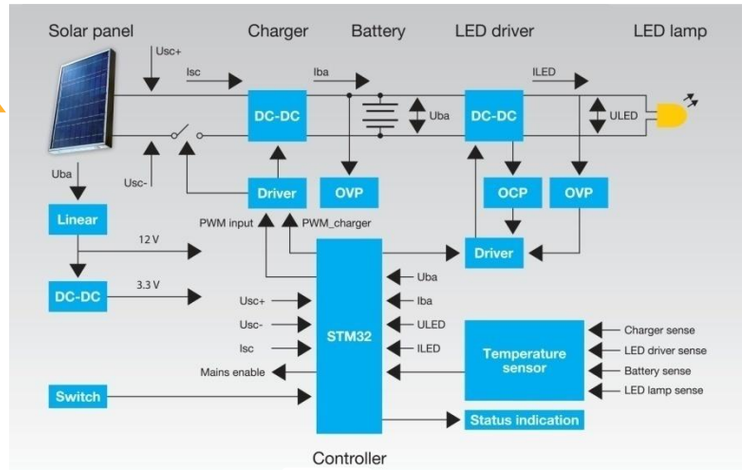
- Maximum power point tracker (MPPT) for more efficient energy use
- Automatic day/night detection
- Automatic battery/mains switchover
- Constant-current control for LED lamps
- Battery charge control with temperature monitoring
- Easy system monitoring via debug
- Full protection function for battery, LED lamp and solar panel

Key products

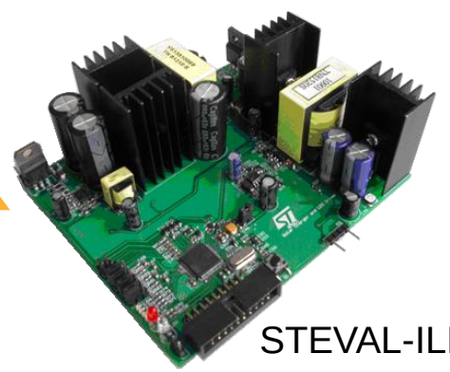
- STP40NF10, STP75NF75, STPS20H100, STPS1L60, STPS2045

Typical applications

- LED street lighting, solar LED applications



STM32 MCU



STEVAL-ILL022V1

Evaluation board	Application note	Description
STEVAL-ILL022V1	**UM0512**	STEVAL-ILL022V1 solar-LED streetlight controller with 25 W LED lamp driver and 80 W battery charger based on the STM32F101Rx

Smart street lighting

Intelligent LED cities – ST solutions

Lamp driver and controller

Power Supply
L6562AT
L6599AT

LED Driving
STM8S

Lamp communication module: wireless network solution

STM32W

M24LR64-R

Lamp communication module: wired network solution

STM32F

ST7540

M24LR64-R

District data concentrator

GPRS Module

M24128-Bxx

STM32F

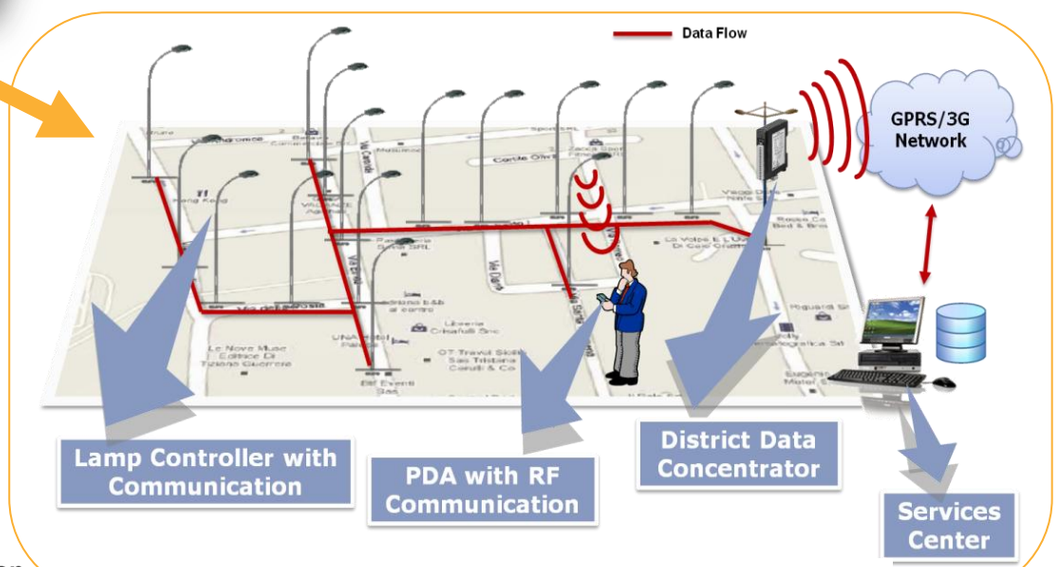
ST7540

PLM option

STM32W

ZigBee® option

M24LR64-R



Lightens street lighting energy load

Power MOSFET overview

P/N	BVDss (V)	$R_{DS(on)}$ (max) (Ω)	Package	Technology
ST*90N4F3	40	0.0065	DPAK, TO-220, IPAK	STripFET™ III
ST*200N4F3	40	0.004	D²PAK, TO-220	STripFET™ III
ST*270N4F3	40	0.0025	D²PAK, TO-220	STripFET™ III
STL70N4LLF5	40	0.0065	PowerFLAT 5x6	STripFET™ V
STL80N4LLF3	40	0.005	PowerFLAT 5x6	STripFET™ III
STL140N4LLF5	40	0.00275	PowerFLAT 5x6	STripFET™ V
ST*3NF06L	60	0.1	SOT-223	STripFET™ II
STS5NF60L	60	0.055	SO-8	STripFET™ II
STS4DNF60L	40	0.055	SO-8 DUAL	STripFET™ II
STL28N8F3 *	80	0.034	PowerFLAT 3.3 x 3.3	STripFET™ III
STS4NF100	100	0.06	SO-8	STripFET™ II
ST*19NF20	200	0.16	TO-220, TO-220FP, D2PAK	STripFET™ II
ST*20NF20	200	0.125	TO-220, TO-220FP, DPAK	STripFET™ II
ST*16NF25	250	0.235	TO-220, TO-220FP, DPAK	STripFET™ II
ST*50NF25	250	0.069	TO-220, D2PAK	STripFET™ II
STQ3N45K3-AP	450	3.8	IPAK, SOT-223, TO92	SuperMESH 3™
ST*8NM50N	500	0.79	DPAK, TO-220, TO-220FP	MDmesh™ II
ST*10NM50N	500	0.63	DPAK, TO-220, TO-220FP	MDmesh™ II
ST*11NM50N	500	0.47	DPAK, TO-220, TO-220FP	MDmesh™ II
ST*14NM50N	500	0.32	DPAK, D2PAK	MDmesh™ II
ST*19NM50N	500	0.25	TO-220, TO-220FP	MDmesh™ II
ST*23NM50N	500	0.19	D2PAK, TO-247, TO-220/FP	MDmesh™ II
ST*28NM50N	500	0.158	D2PAK, TO-247, TO-220/FP	MDmesh™ II
ST*5N52K3	525	1.5	D²PAK, DPAK, TO-220FP, TO-220, IPAK	SuperMESH 3™
ST*6N52K3	525	1.2	DPAK, TO-220FP	SuperMESH 3™
ST*7N52DK3	525	1.15	DPAK, TO-220FP, TO-220	SuperFREDmesh 3™

P/N	BVDss (V)	$R_{DS(on)}$ (max) (Ω)	Package	Technology
ST*7NM60N	600	0.9	DPAK, TO-220, TO-220FP	MDmesh™ II
ST*9NM60N	600	0.7	DPAK, TO-220, TO-220FP	MDmesh™ II
ST*10NM60N	600	0.55	DPAK, TO-220, TO-220FP	MDmesh™ II
ST*13NM60N	600	0.36	DPAK, TO-220, TO-220F	MDmesh™ II
ST*18NM60N	600	0.285	D2PAK, TO-247, TO-220/FP	MDmesh™ II
ST*22NM60N	600	0.22	D2PAK, TO-247, TO-220/FP	MDmesh™ II
ST*24NM60N	600	0.19	D2PAK, TO-247, TO-220/FP	MDmesh™ II
ST*26NM60N	600	0.165	D2PAK, TO-247, TO-220/FP	MDmesh™ II
ST*2N62K3	620	3.5	DPAK, TO-220, TO-220FP	SuperMESH 3™
ST*3N62K3	620	2.5	D2PAK, DPAK, TO-220FP, TO-220, IPAK	SuperMESH 3™
ST*4N62K3	620	1.95	DPAK, D²PAK,TO-220FP, IPAK, TO-220, I²PAK	SuperMESH 3™
ST*5N62K3	620	1.6	D²PAK, DPAK,TO-220FP, TO-220, IPAK	SuperMESH 3™
ST*6N62K3	620	1.2	IPAK, DPAK, TO-220,TO-220FP	SuperMESH 3™
ST*10N65K3	650	1	TO-220FP	SuperMESH 3™
ST*3NK80Z	800	4.5	TO-220, TO-220FP, DPAK, IPAK	SuperMESH™
ST*5NK80Z	800	2.4	TO-220, TO-220FP	SuperMESH™
ST*7NM80	800	1.05	TO-220, TO-220FP, DPAK, IPAK	MDmesh™ II
ST*11NM80	800	0.4	D2PAK, TO-220, TO-220FP, TO-247	MDmesh™ II
STS3N95K3	925	6.3	TO-220, TO-220FP, DPAK, IPAK	SuperMESH 3™
ST*5N95K3	925	3.5	TO-220, TO-220FP	SuperMESH 3™
ST*7N95K3	925	1.35	TO-220, TO-220FP, DPAK, IPAK	SuperMESH 3™
ST*13N95K3	925	0.85	D2PAK, TO-220, TO-220FP, TO-247	SuperMESH 3™

MDmesh II – ST's 2nd generation super junction, high-voltage power MOSFET technology

SuperMESH 3 – Covers high-voltage breakdown class for

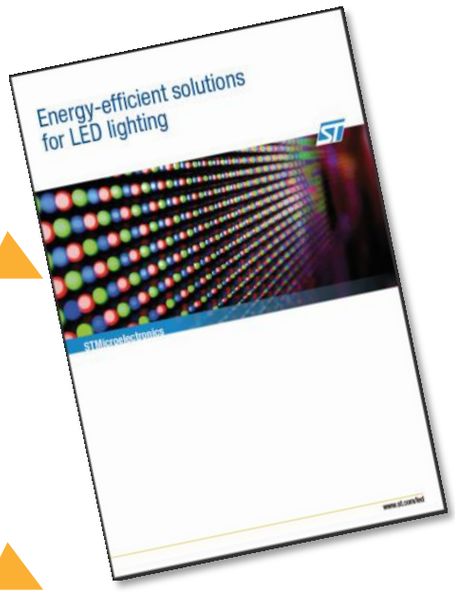
- improved avalanche ruggedness
- lower on-resistance
- enhanced dynamic performance
- improved diode reverse recovery characteristics

* Under development. Available in Q3/2012

Energy-efficient solutions on st.com

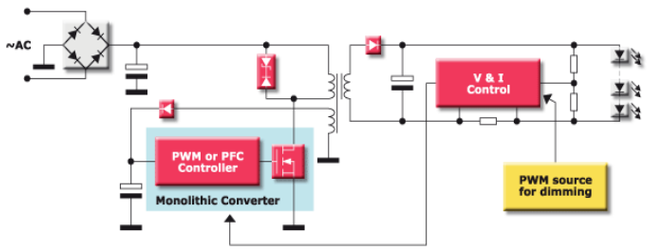
Offline LED lighting and general illumination

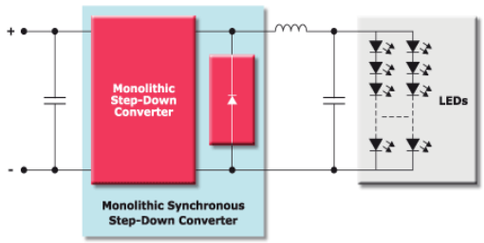
LED lighting brochure

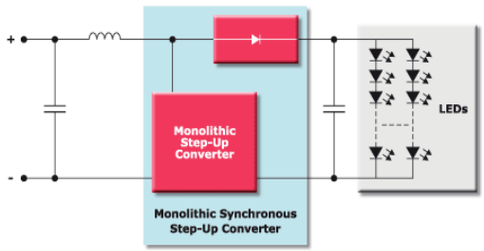


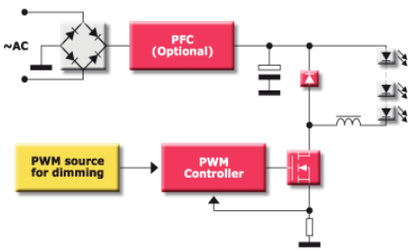
LED application web pages

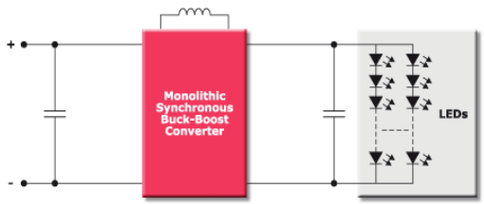
STMicroelectronics offers a full range of components and evaluation boards for offline LED driver applications. The most common topologies are presented. The major applications covered are residential, commercial, architectural and street lighting.



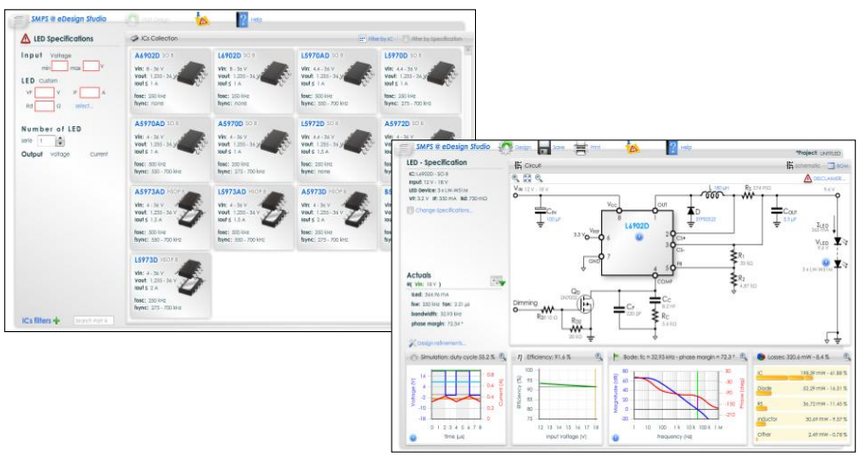








eDesign Studio www.st.com/edesignstudio



ST products and solutions

For more information, visit:

www.st.com > home > support > tools & resources
www.st.com/LED > off-line LED drivers

Thank you