Faster to light with simpler design: A new multimode flyback LED solution

March 2016

Agenda

1. Trends and solutions
2. IRS2982S in Infineon's LED portfolio
3. IRS2982S features and benefits
4. IRS2982S value proposition
5. Summary
6. Support material

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More features, high performance/ cost IRS2982S fits perfectly



Future trend

More features, high efficiency, performance/ cost

Basic functions

Highly integrated

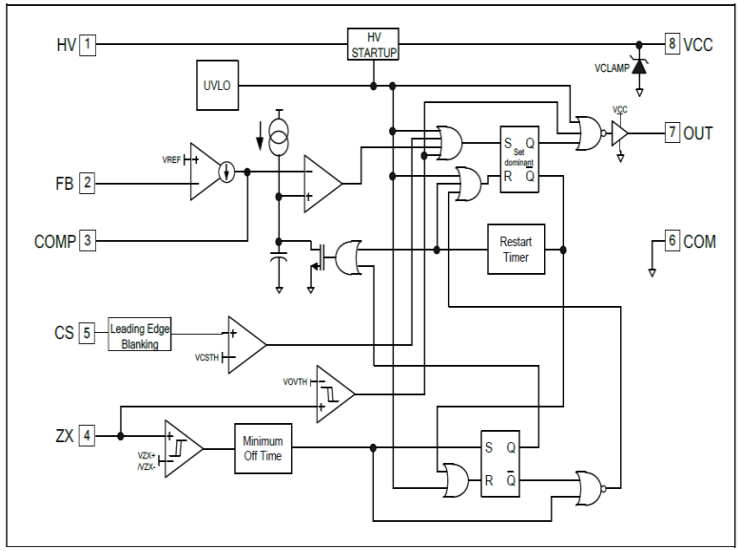
		› Configurable on the fly, simple GUI
		› 0 V- 10 V dimming capable
	› Cost effective analog solution	› High level integration for small BOM
	› Speedy startup < 0.5 s	› Speedy startup < 0.2 s
	› DCM for efficient light load	› DCM for efficient light load
	› Burst mode minimizing standby loss	› Optimizing standby loss
› CC mode with optocoupler	› CC mode with optocoupler	› Primary side output current control
› Tolerable startup time ~ 1 s		
› Flyback CrCM mode		
› Single stage PFC + flyback	√	√
› Universal AC line input		
Legacy solution	**IRS2982S**	**Digital solution**

IRS2982S solves key challenges of LED lighting: highest efficiency, low power standby, fast time-to-light

Application

- mid range, high end LED drivers for outdoor, interior, office, industrial lightings
- Wide input voltage: 85- 305 V_{AC}

Block diagram



Operation

- High power quality PF>0.95, iTHD<20% (over wide AC input at full load)
- Integrated startup cell, fast startup
- Support mode of startup cell for optimizing light load operation

Efficiency

- High efficiency from three operating modes: CrCM, DCM and burst mode

Flexibility

- IC concept supports multiple topologies
- Ideal for isolated flyback CV mode as well as non-isolated flyback with CC/CV modes

Input

- Supports universal input
- Operates with AC or DC input

Protection

- Over voltage protection
- Cycle by cycle over current protection

Cost

- Minimum external components to support small form factor designs

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IRS2982S in Infineon's LED portfolio

Power conversion

Light management
- Smart lighting -

AC-DC

DC-DC

Power

Voltage output

Current output

600 V CE CoolMOS™
ICL5101
PFC + LLC combo controller IC

600 V CE CoolMOS™
XMC1000
Multiple Topologies

800 V CE CoolMOS™
IRS2982
PFC/ flyback controller IC (CV)

600 V CE CoolMOS™
IRS2505
PFC IC

XMC1000
DC-DC buck controller + connectivity + light control

OptiMOS™
ILD2111
DC-DC buck controller

OptiMOS™
IRS25411
DC-DC buck controller

ILD6000/ ILD4000
DC-DC buck driver IC

BCR400
Linear LED driver IC

BGT 24 GHz
Radar sensor

800 V CE CoolMOS™
ICL8105
PFC/ FB controller IC (CC)

600 V CE CoolMOS™
ICL8201
Non-isolated buck converter

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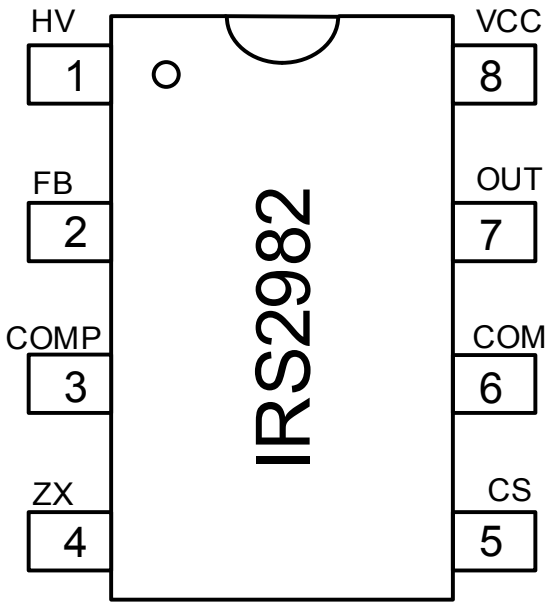
IRS2982S input/ output pins



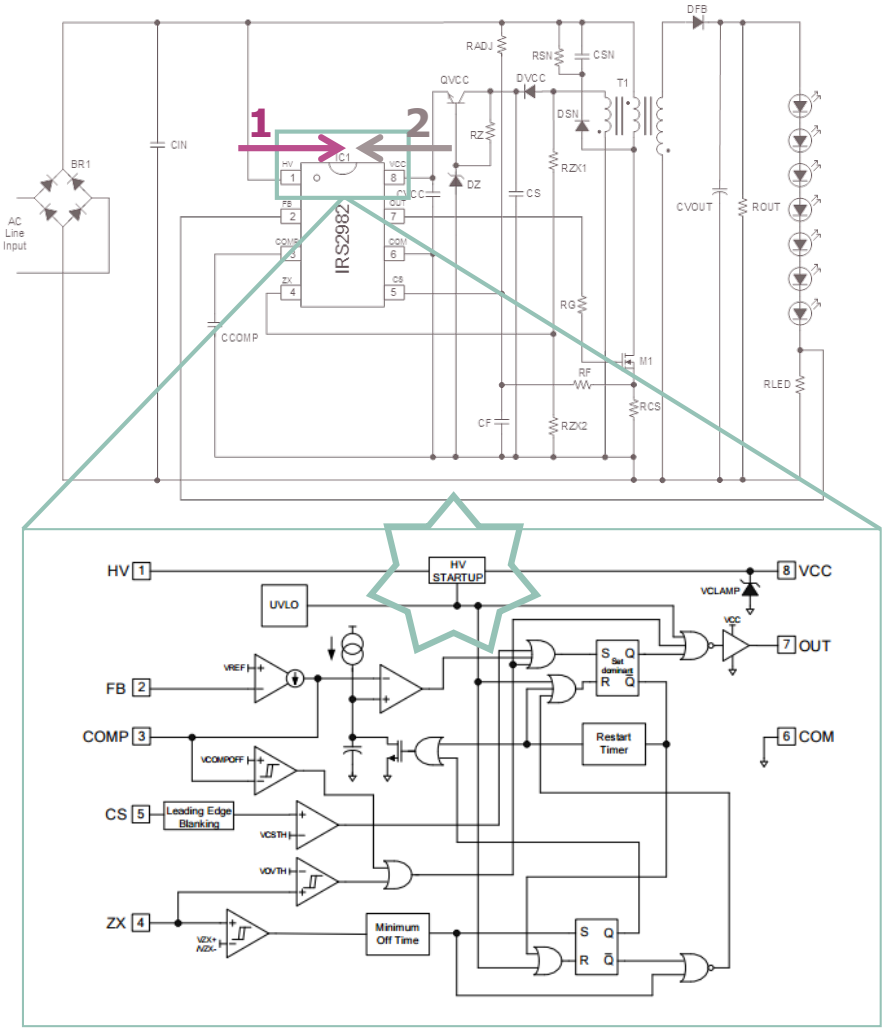
SOIC 8 package

Symbol	Description
HV	High voltage startup input
FB	Feedback input
COMP	Compensation and averaging capacitor input
ZX	Zero-crossing & over-voltage detection input
CS	Current sensing input
COM	IC power & signal ground
OUT	Gate driver output
VCC	Logic & low-side gate driver supply

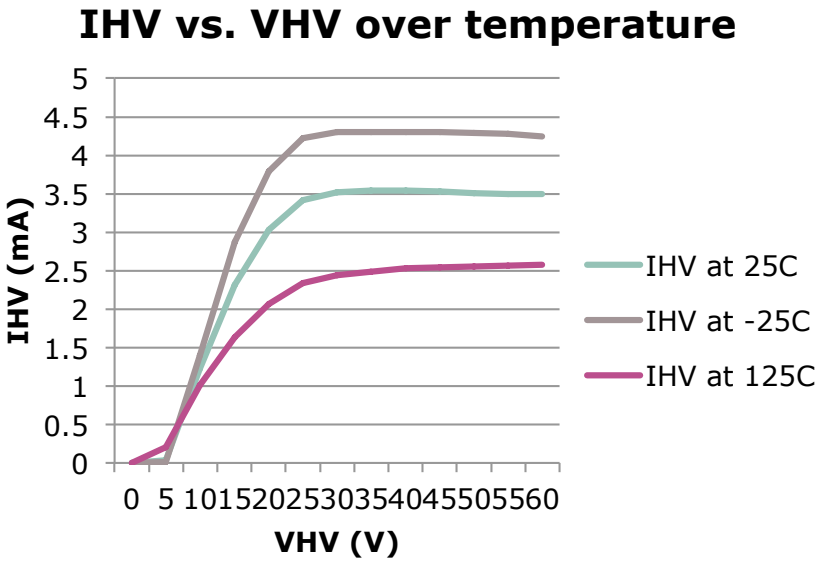
IRS2982S features and benefits

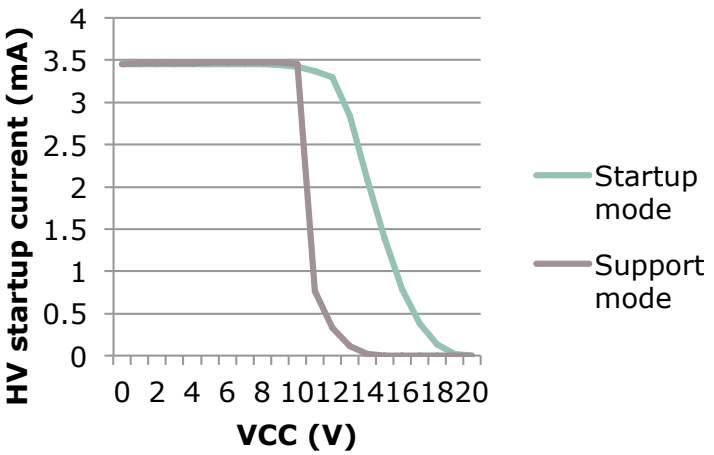
Features	Benefits
› High voltage startup cell (600 V)	› Fast time to light < 0.5 s › Eliminate external components for voltage dividing
› CrCM/ DCM operation	› Wide range applications, suitable for dimming LED converter in the current range between 1% up to 100%
› Burst mode capability	› Low standby power
› Multiple primary side control configurations	› Isolated flyback with CV mode › Non-isolated flyback with CC or CV mode
› Optimized one stage PFC+ flyback	› Low line power factor > 0.95 › Low line current THD < 20%
› Direct feedback › Stable V_{REF}, V_{CS} over temperature	› Very accurate CV or CC regulation
› Recommended dimming circuitry	› Triac dimming capable (with correctly designed converter input)
› ZX, CS pins to prevent abnormal conditions	› Over voltage and over current protection
› Wide input voltage range	› Covering 85 V_{AC} ~ 305 V_{AC}
› Multiple LED topology configuration: flyback, buck, boost and SEPIC	› Versatile in LED designs

Key differentiator
High voltage start-up cell



Startup mode

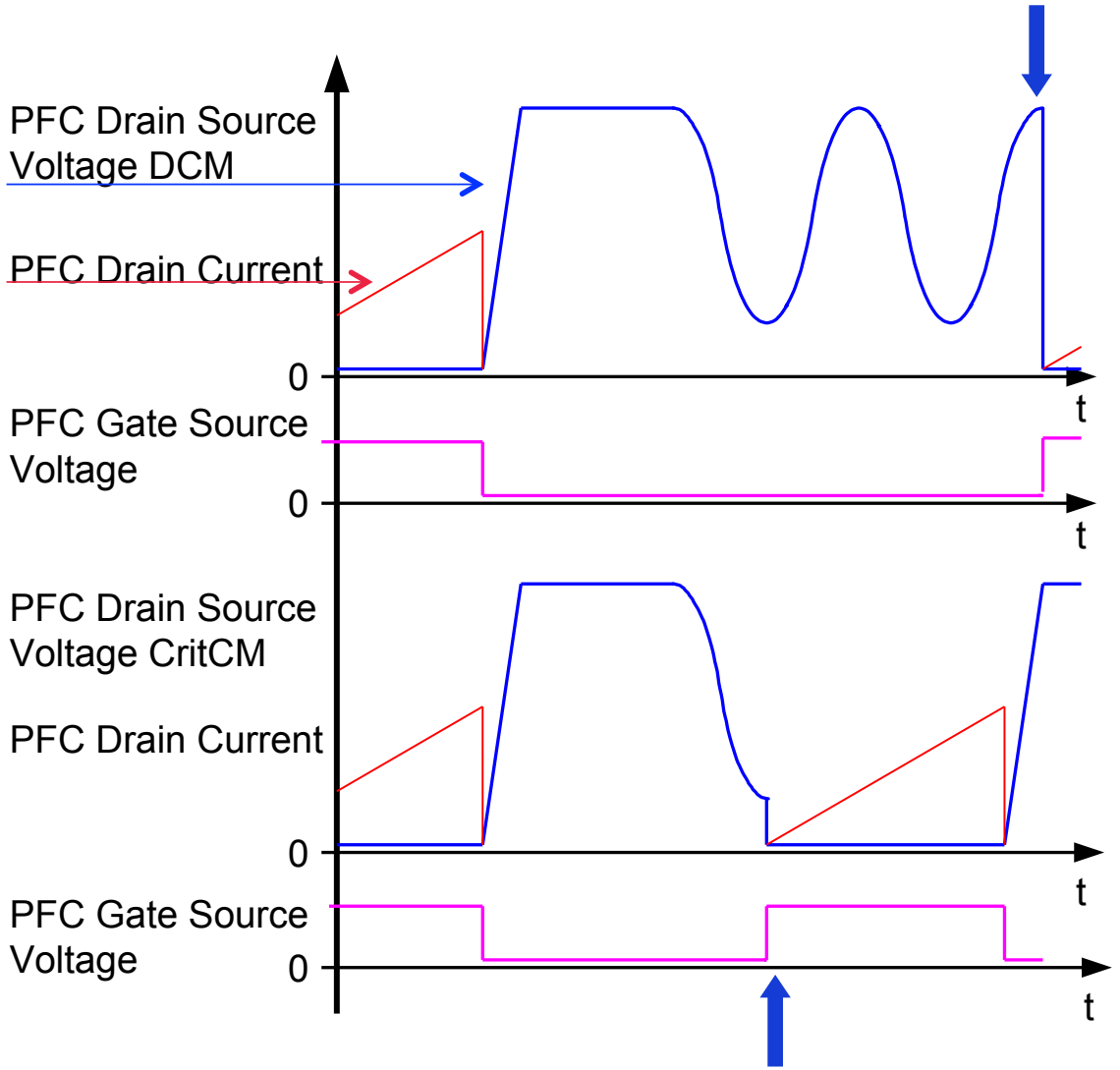




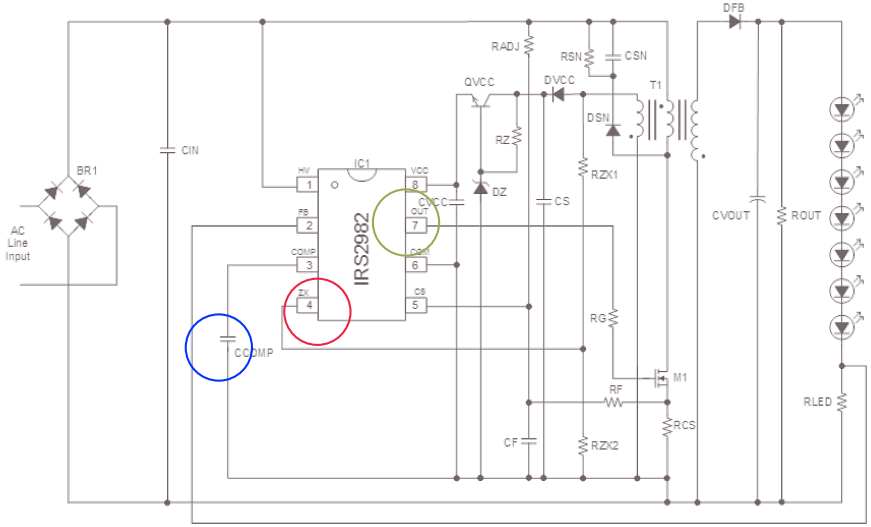
CrCM: Standard to most LED controller
DCM: IRS2982S key feature for light load

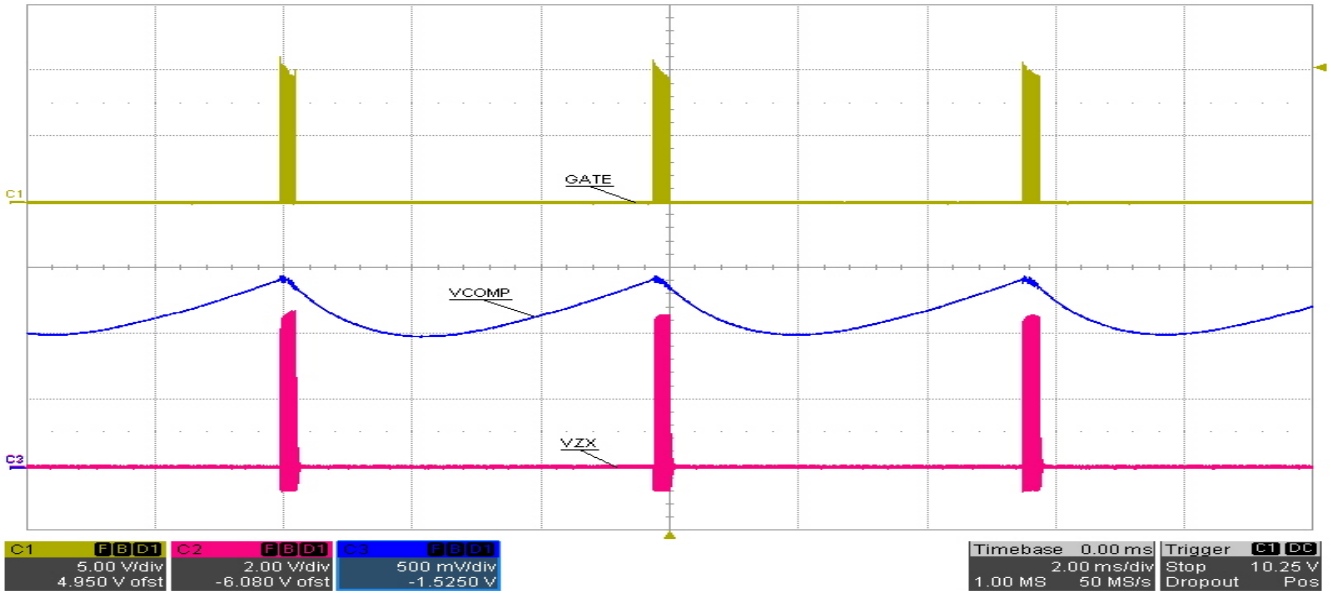
The IRS2982S normally operates in critical conduction mode (CrCM), also known as transition or boundary mode. The IRS2982S includes a minimum off time limit (tOFFMIN) of ~ 3 µs so that if the ZX pin input transitions high and then low before tOFFMIN expires, the gate drive output will not transition high again until the end of this period (DCM mode).

This function extends the operating range of the converter allowing operation down to **very low duty cycles**. This thereby enables **dimming designs to be implemented as well as limiting operating frequency to prevent overheating of the circuit inductor**, MOSFET and snubber components.



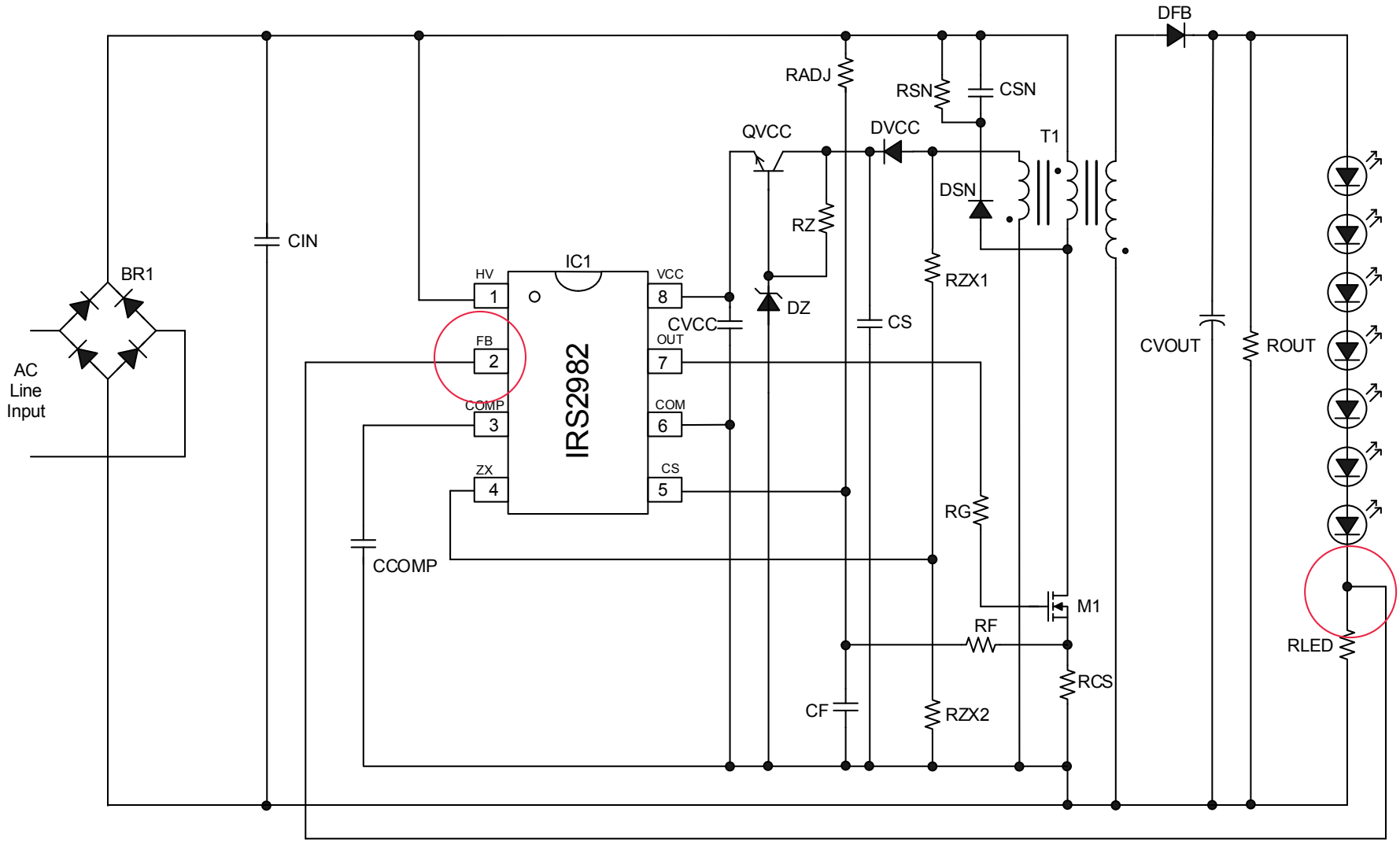
Burst mode to minimize standby power





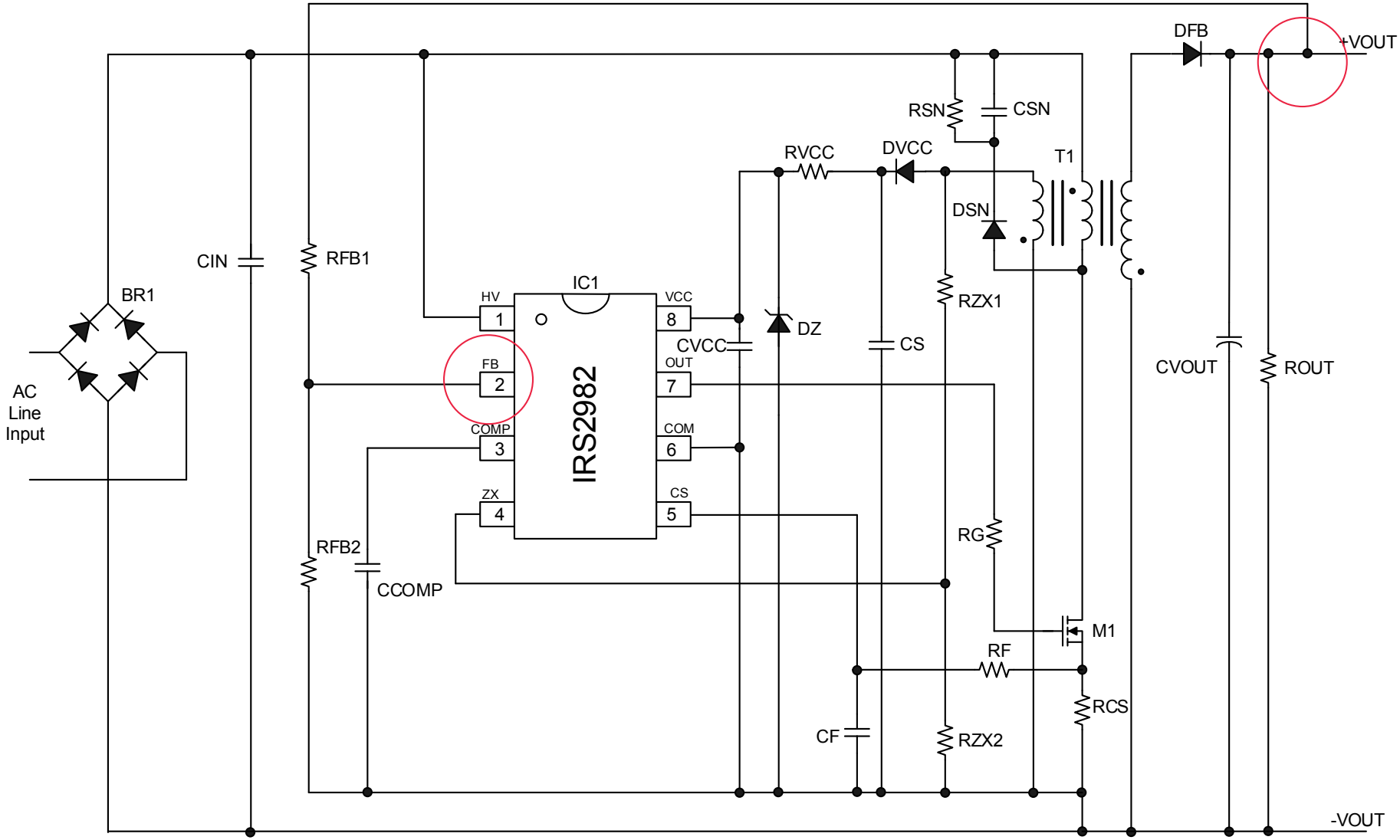
Gate drive (yellow), VCOMP (blue), VZX (red)

Non-isolated flyback
Constant current regulation

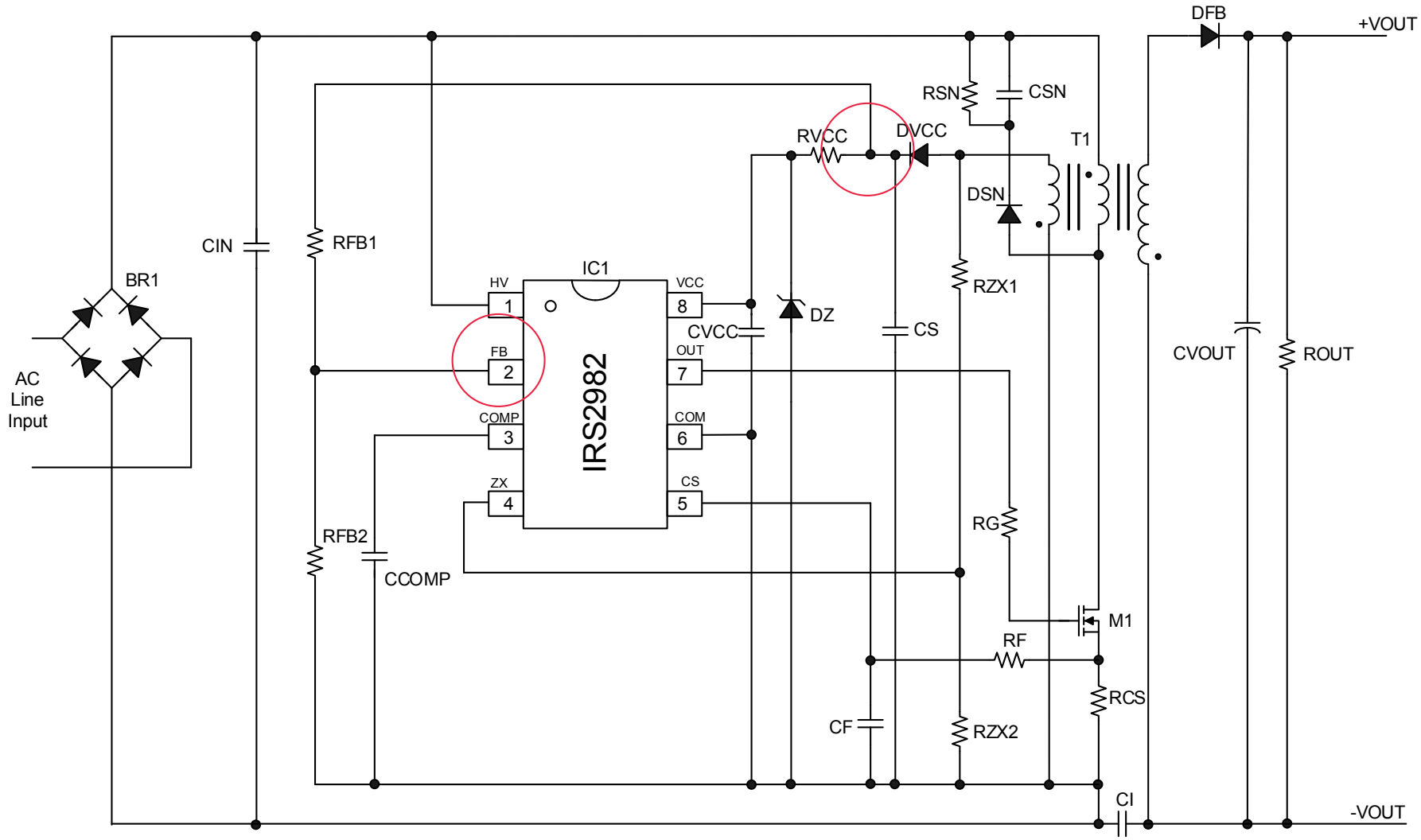


- Can be used in some non-isolated LED lamps/ bulbs needing high PF and accurate current
- Triac dimming is also possible with bleed and damper network

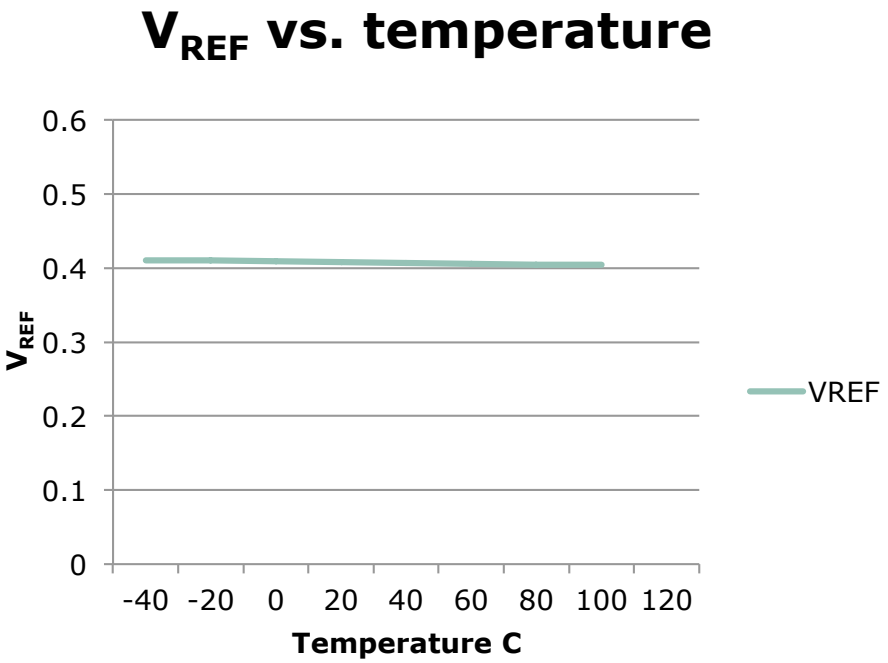
Non-isolated flyback
Constant voltage regulation

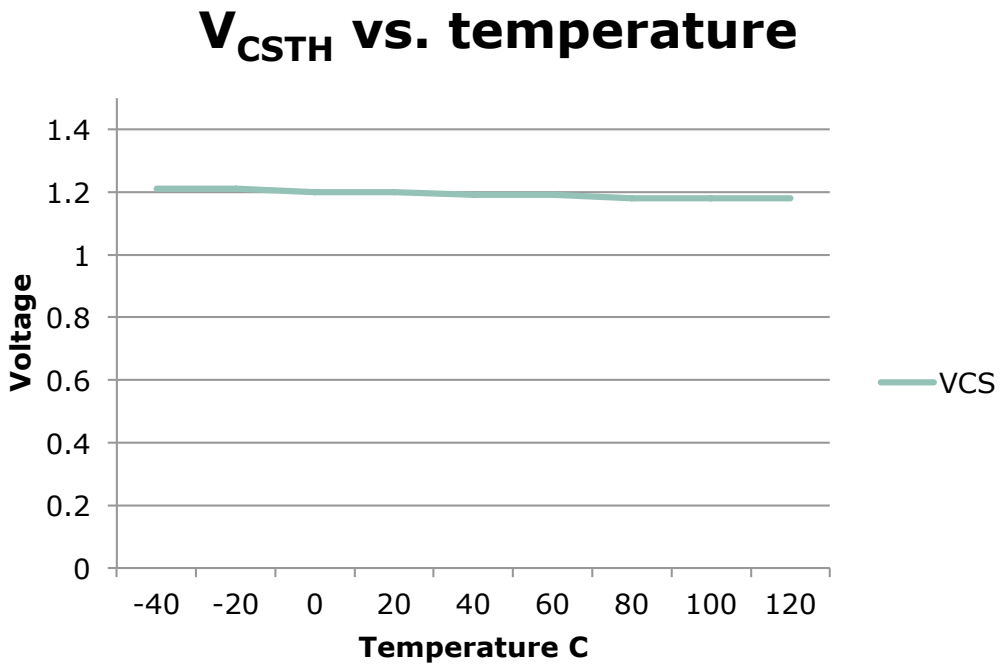


Isolated flyback key application
Constant voltage regulation



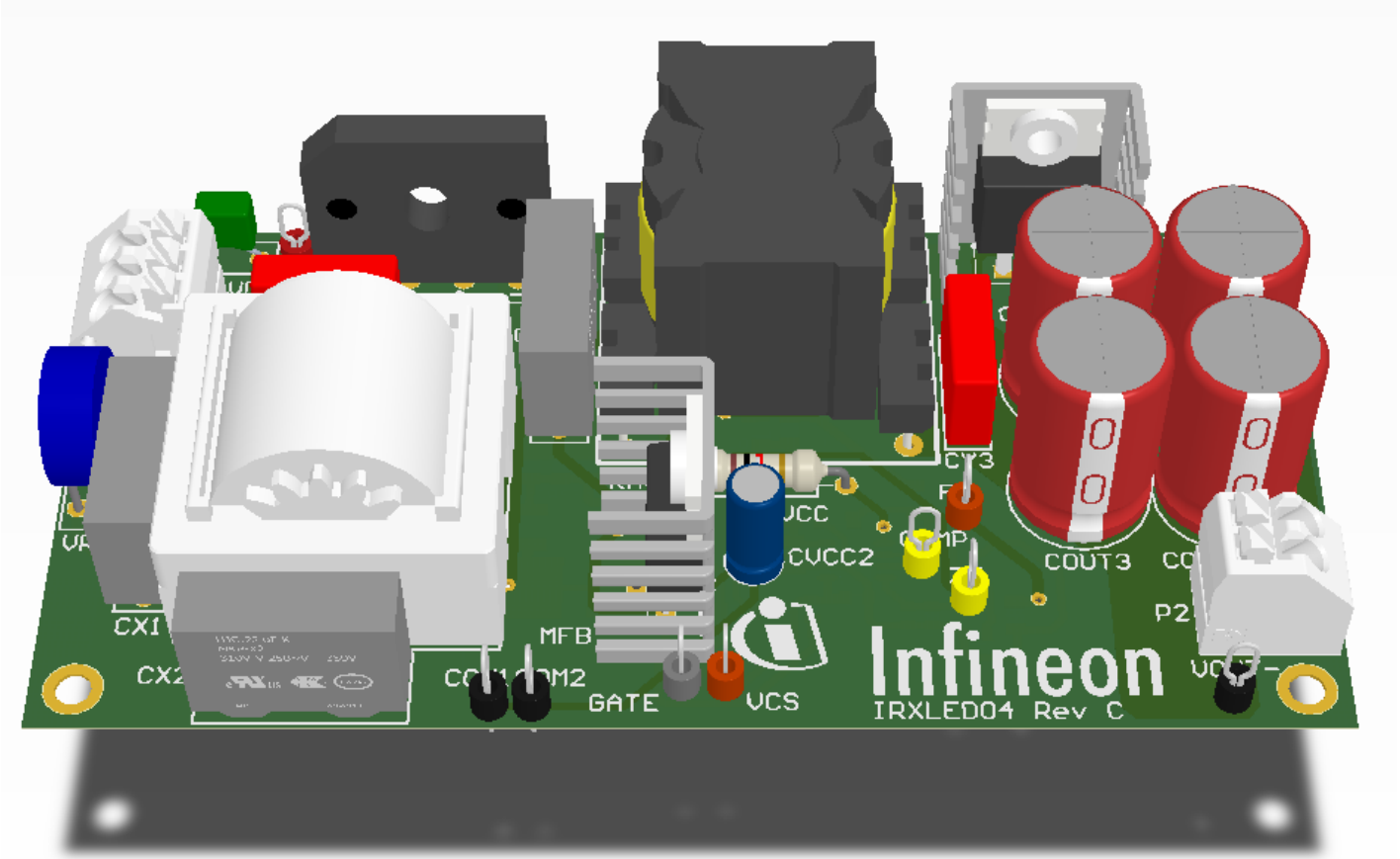
V_{REF} and V_{CS} over temperature for accurate CV and CC regulation





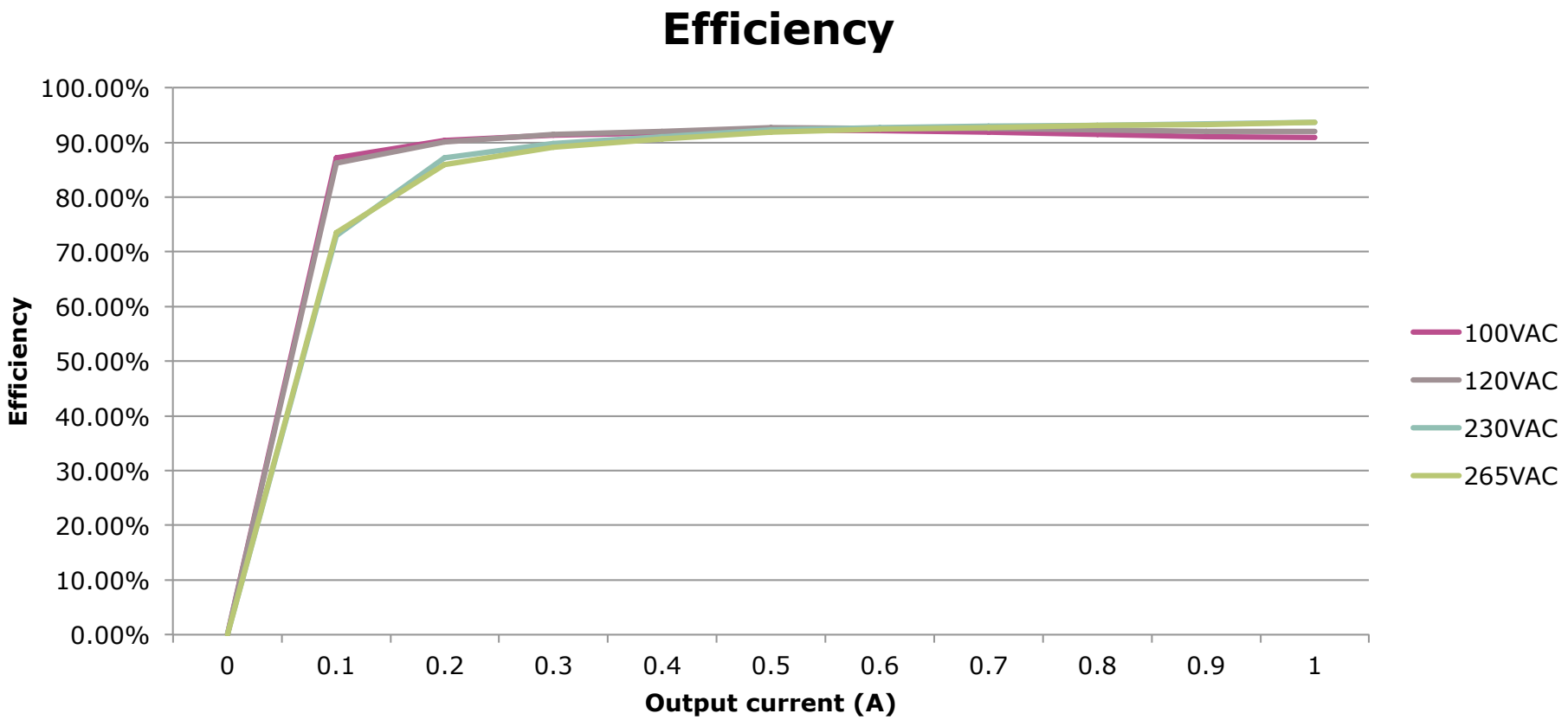
- V_{REF} tolerance +/- 2%
- V_{CSTH} tolerance +/- 5%

IRXLED04
50 W flyback evaluation board



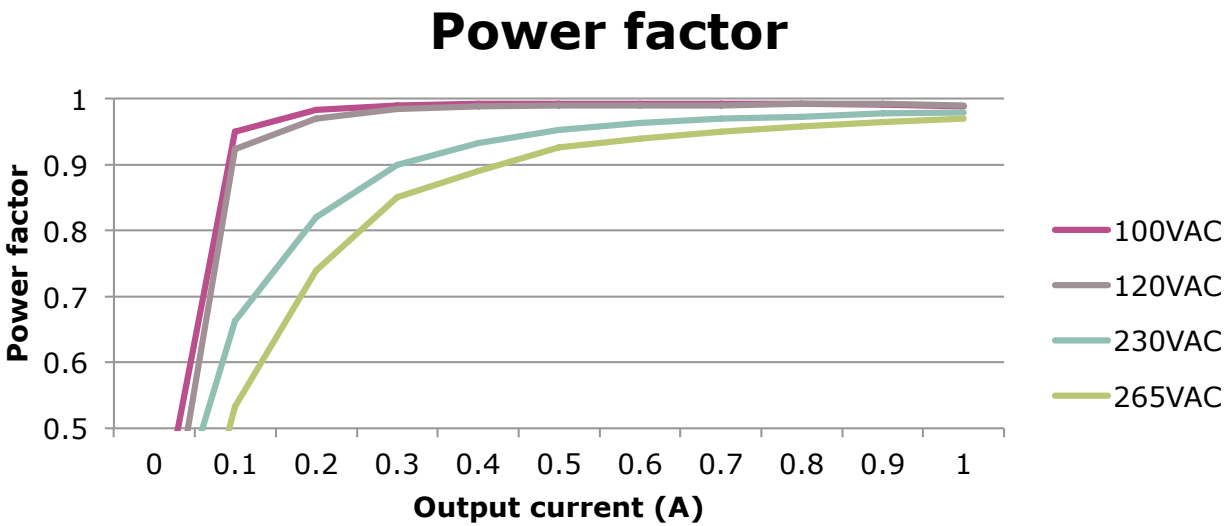
- Isolated flyback with CV
- 100 to 265 V_{AC} input, 55 V nominal output up to 1 A
- High power factor, low iTHD over wide line/load range
- Board size 4.4” (112 mm) x 2.2” (56 mm)

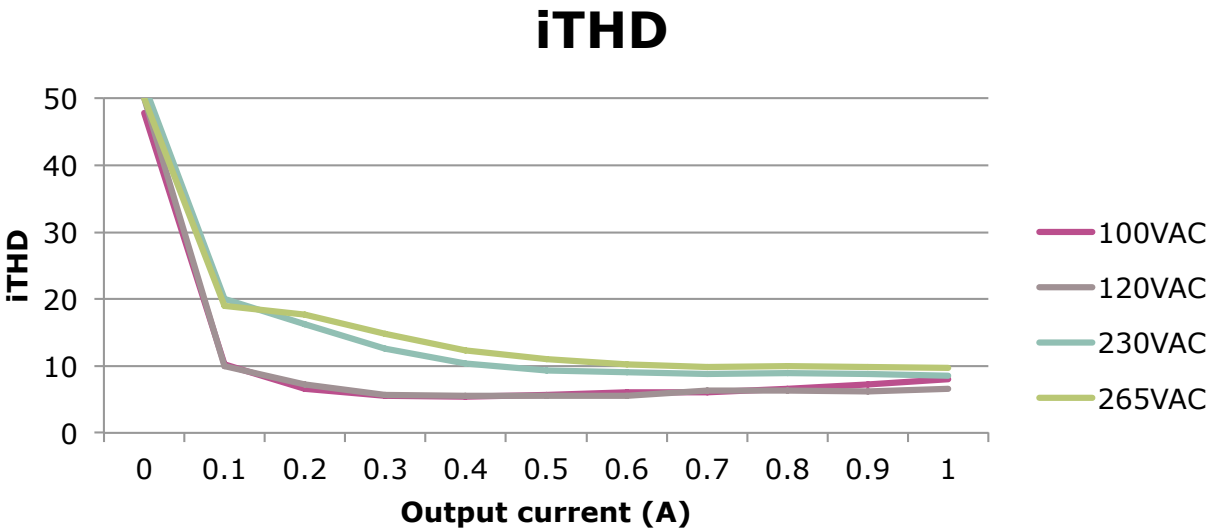
IRS2982S efficiency (50 V_{OUT}, 55 W)



- Low line efficiency > 90% starting 20% load
- High line efficiency > 90% starting 40% load

> 0.9 PF and < 20% iTHD for low line

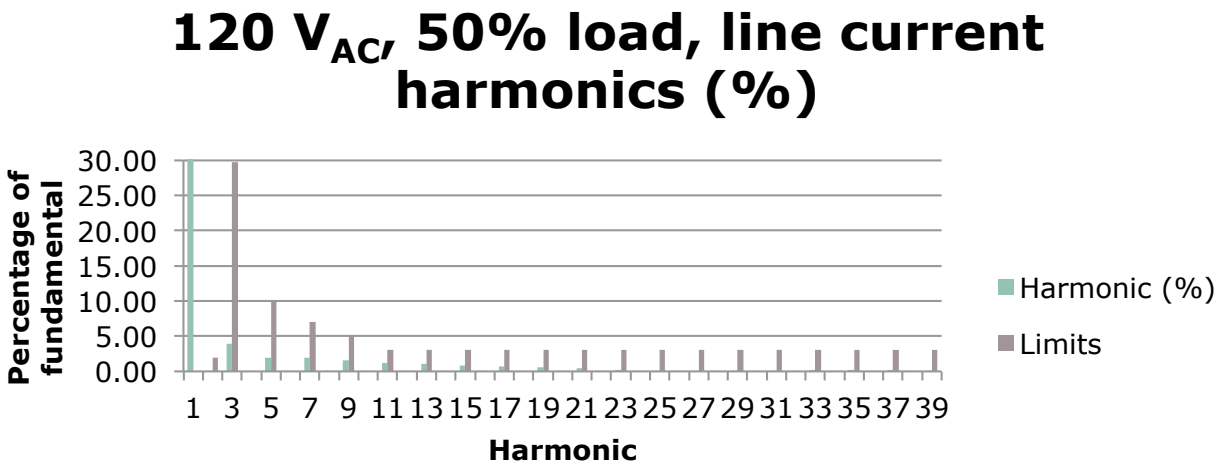


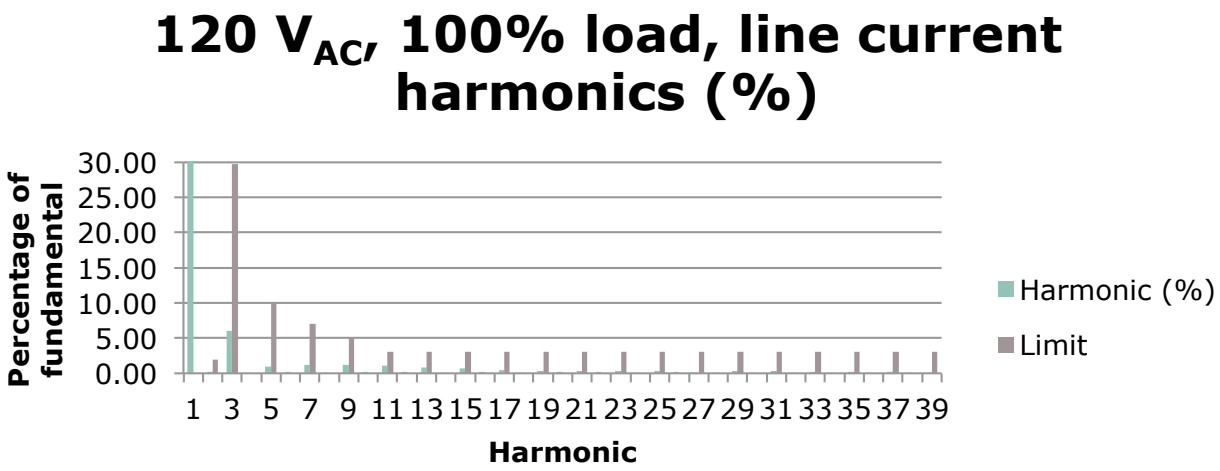


Harmonic limits EN61000-3-2 Class C (Lighting)

Requirements	Harmonics Limits Class C according EN 61000-3-2 for System Power > 25W	
	Harmonics order n	Maximum value expressed as a percentage of the fundamental input current
	2	<2%
	3	<30 λ %
	5	10%
	7	<7%
	9	<5%
	11 ≤ n ≤ 39	<3%
		λ = power factor

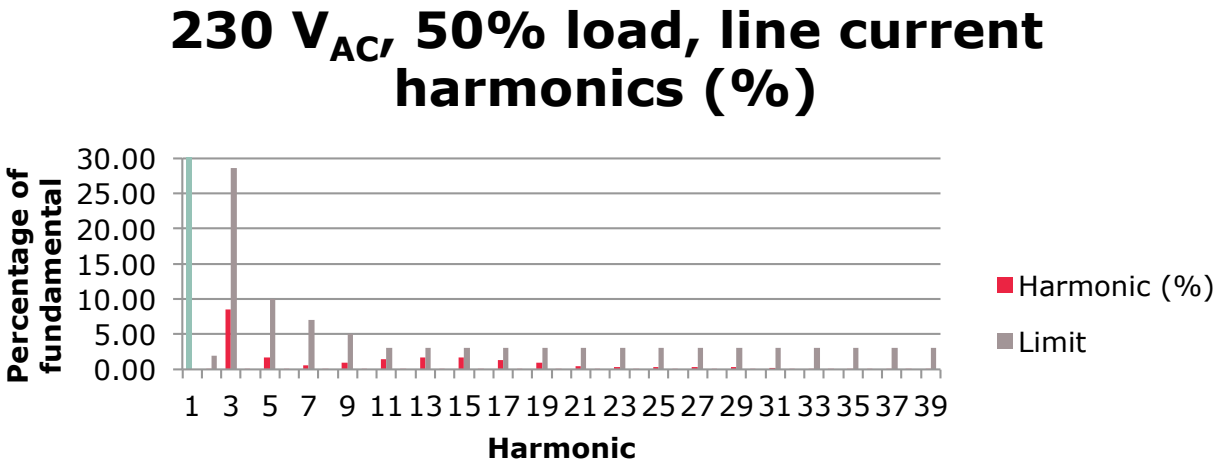
Harmonics at 120 V_{AC}

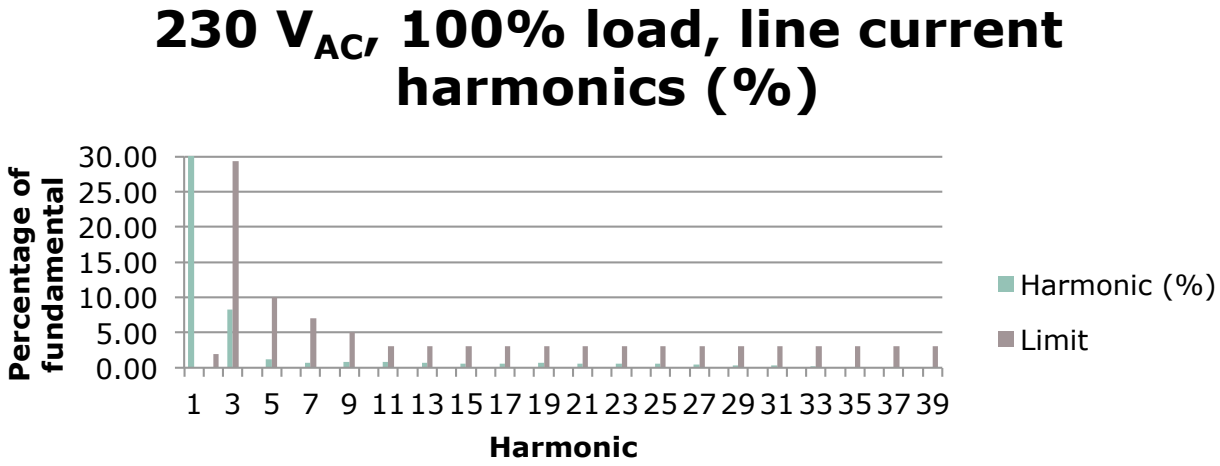




› Tested using an electronic pure sine wave AC source, IRS2982S easily meets the standard

Harmonics at 230 V_{AC}

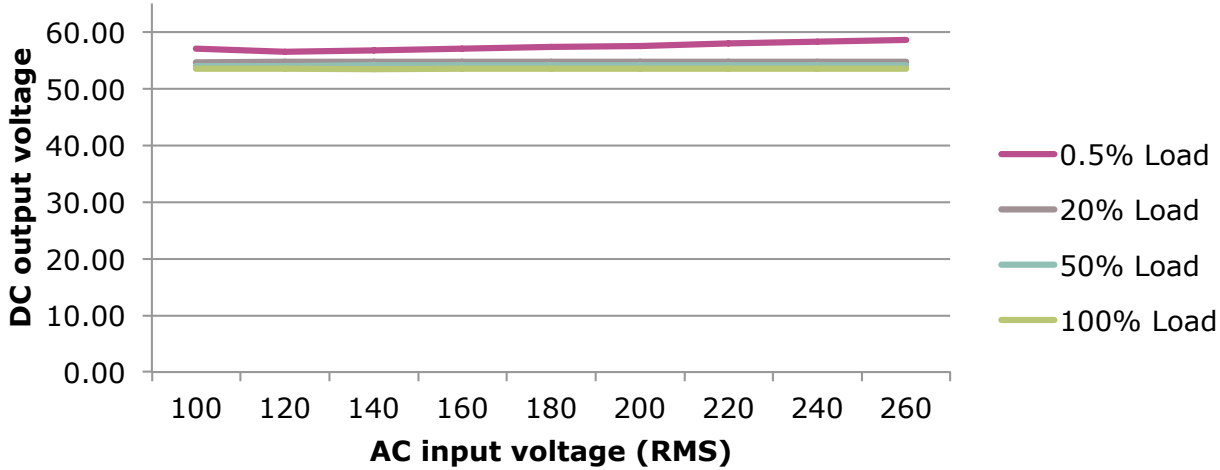




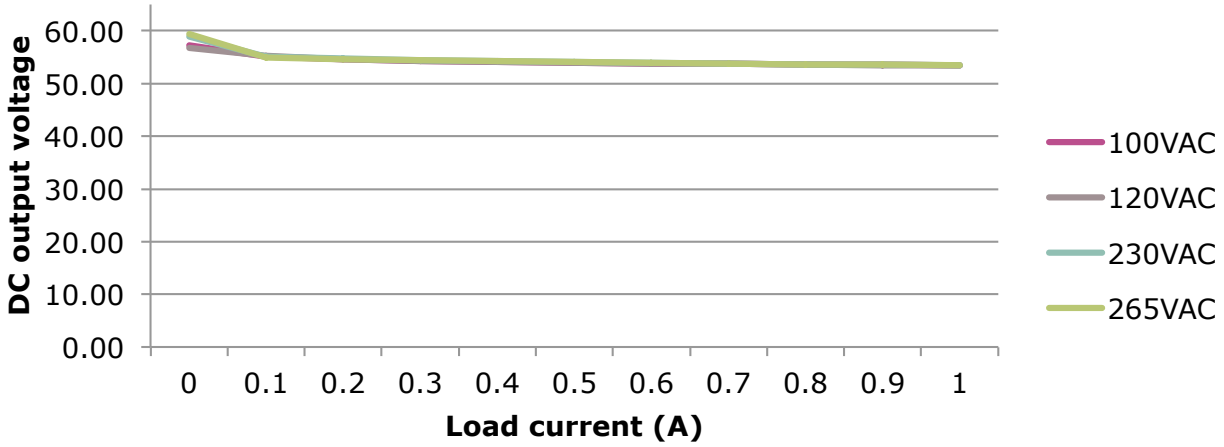
› Tested using an electronic pure sine wave AC source, IRS2982S easily meets the standard

Stable line and load regulation

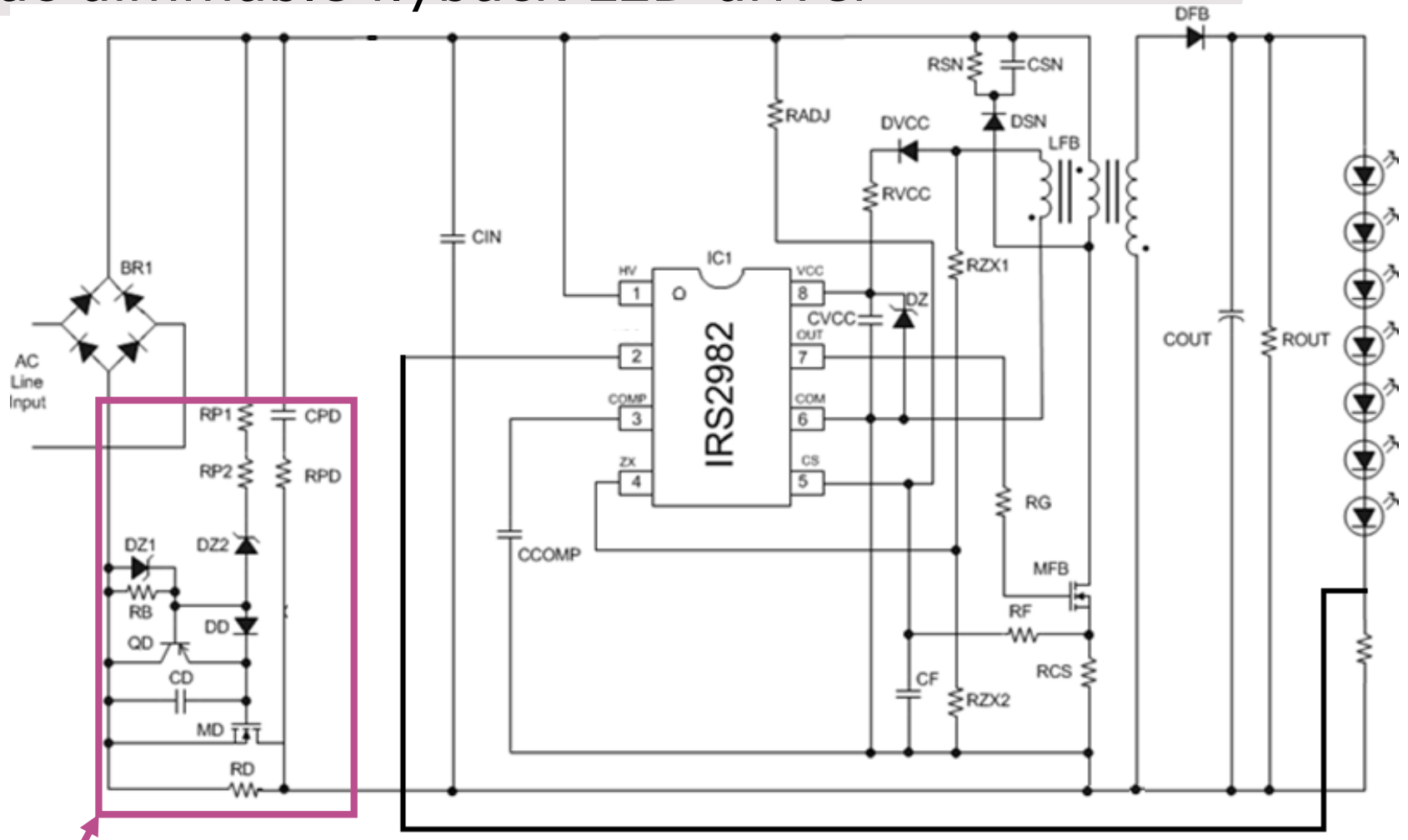
Line regulation



Load regulation

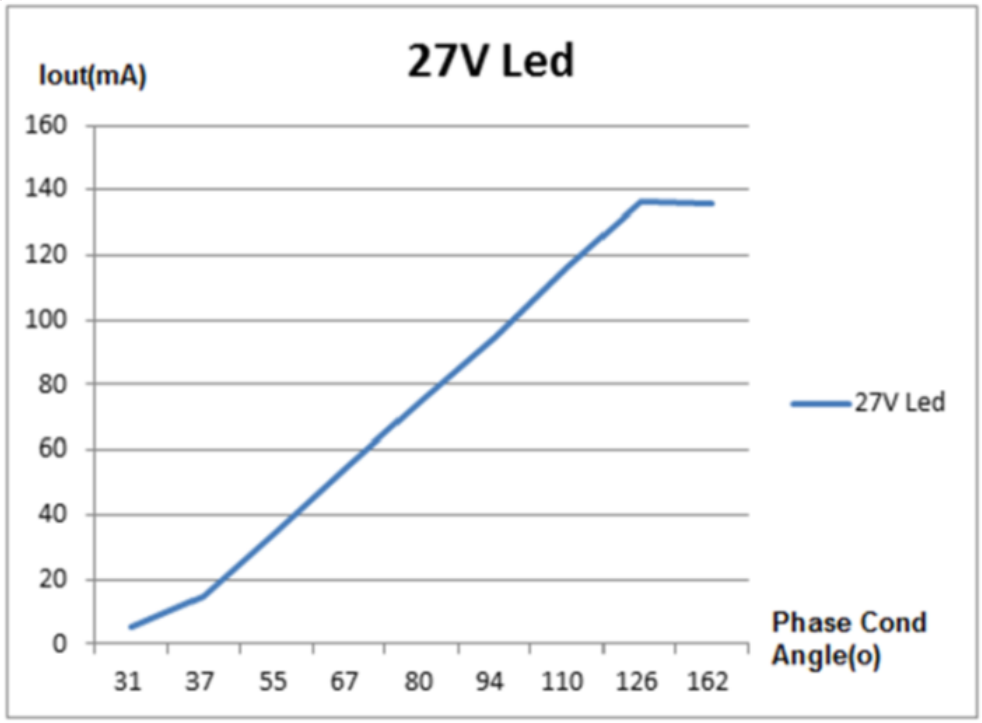


IRS2982
Triac dimmable flyback LED driver



Active damper and passive bleed circuits enables triac dimming!

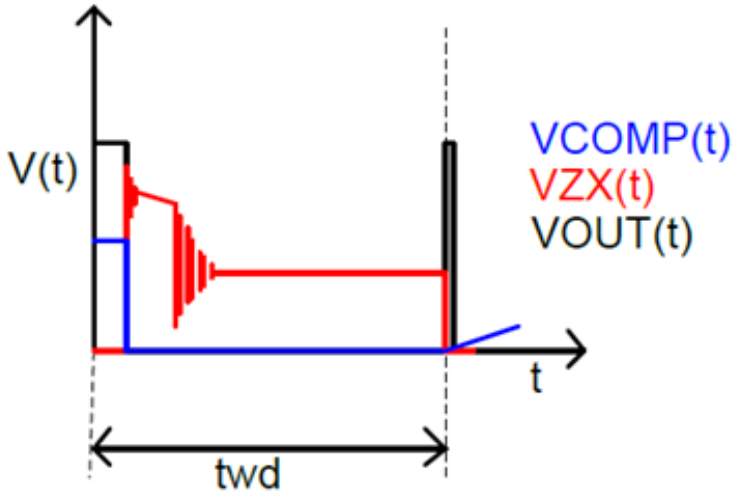
IRS2982
Stable and flicker free dimming

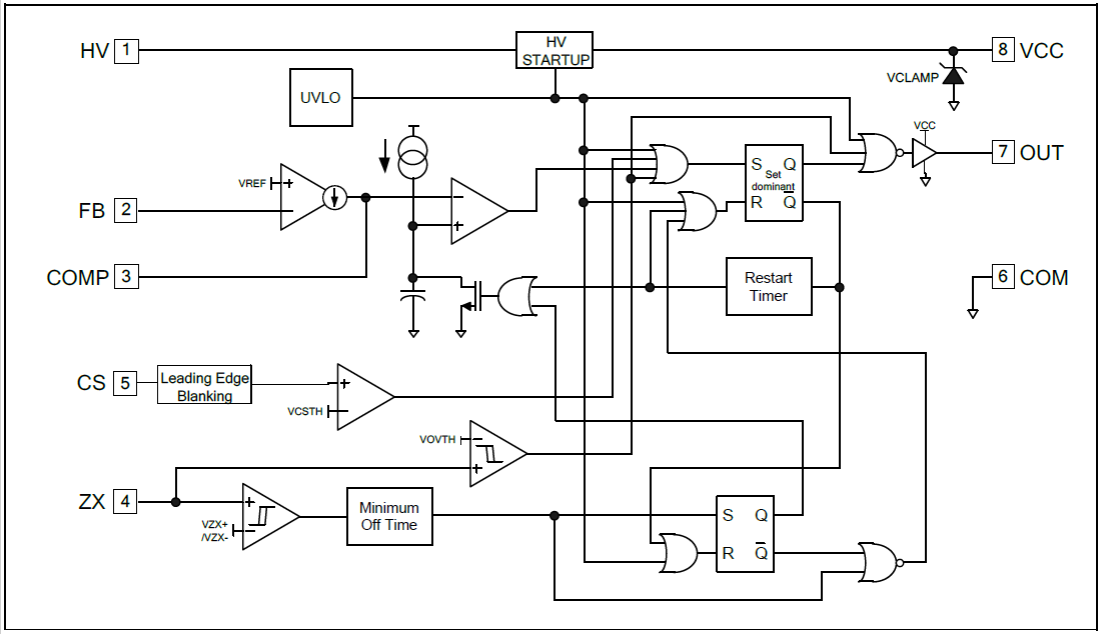


Dimming curve

Load	Vin(V)	Pin(W)	PF	THD(%)	Vout (V)	Iout (mA)	Pout (W)	Eff(%)
27V LED	200	4.507	0.959	15.3	27	134.1	3.62	80.34
	220	4.6	0.949	17	27.01	136.5	3.69	80.15
	242	4.713	0.937	19	27.04	139.2	3.76	79.86
	265	4.846	0.923	21	27.07	142.2	3.85	79.43
	220				32	no load		

Over voltage protection through ZX input





The ZX input is a multi-functional, used for zero crossing detection and output over voltage limiting. If the load becomes disconnected in a flyback or boost converter the output voltage can become very high causing damage to components as well as presenting an electrical hazard. In order to protect against this the IRS2982 senses the output voltage indirectly through the ZX input connected to the auxiliary winding, which is proportional to the output voltage. If the ZX input voltage exceeds VOVTH when the MOSFET switches off, the gate drive remains switched off for a period tWD (~ 100 µs) before starting the next cycle regardless of when the ZX voltage transitions low. The IRS2982 also **discharges the COMP capacitor to so that the next cycle will begin at minimum duty cycle and ramp up slowly**. **This protection scheme allows the load to be "hot" connected and disconnected from the converter output without risk of damaging the circuit by high voltages appearing at the output**. Care should be taken however to avoid damage to LED loads due to output capacitor discharge.

Over current protection through CS input

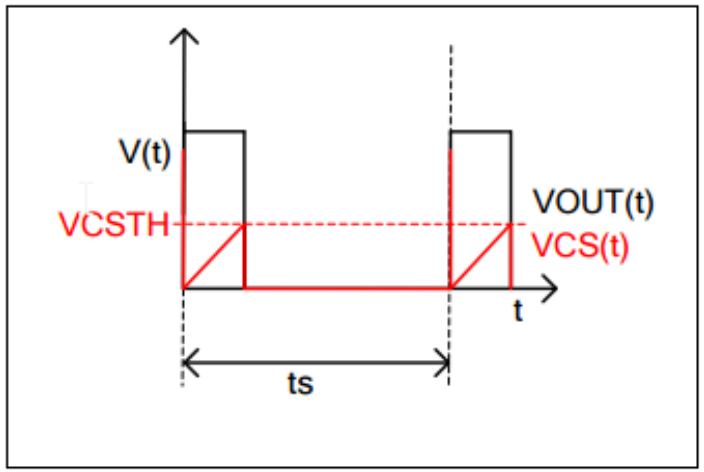
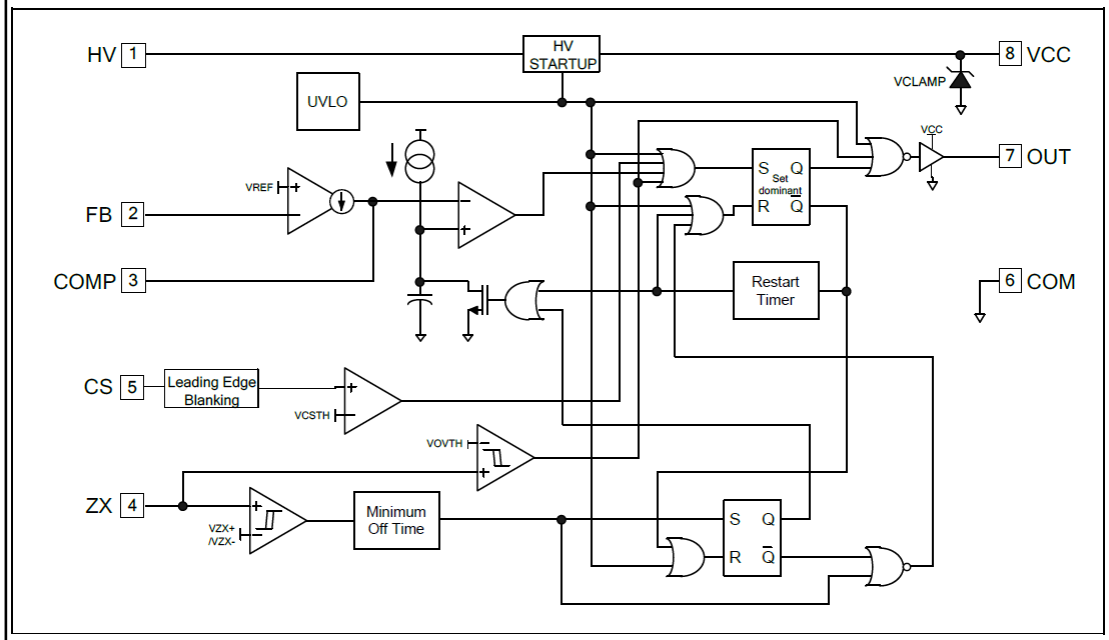


Figure 3: Cycle by cycle current limiting



Primary MOSFET current is sensed through a shunt resistor (RCS) connected from the source of the flyback MOSFET switch to the DC bus return. This current waveform is a high frequency ramp rising from zero at the beginning of each switching cycle to reach a peak level at the point the MOSFET is switched off and remaining at zero during the off time. At very low input voltages the voltage or current regulation loop would demand a very high peak current, which may exceed the maximum rating of the transformer. To prevent saturation from occurring, the IRS2982 provides cycle by cycle primary current limiting with a threshold VCSTH at the CS pin input. Under low line or fault conditions where the MOSFET current is abnormally high the gate drive is switched off after the blanking time tBLANK. Leading edge blanking is necessary to avoid false triggering due to the fast high current switch on transient that occurs at switch on of the MOSFET resulting from discharge of parasitic capacitances.

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IRS2982S value arguments

Benefits		IFX LED flyback controller IRS2982S
Strong arguments	Fast light delivery and simpler design	› High voltage regulator enables time to light within 0.5 second › High voltage startup cell, DCM modes eliminates 5~ 10 external components
	Low standby power	› Burst mode capability reduce standby power to less than 500 mW
	Low light load loss	› DCM operation enables wider operation range from 1 to 100%
Medium arguments	Versatile in LED designs	› IRS2982S is suitable for multiple topologies including: flyback, buck, boost and sepic
Soft arguments	Capacity	› Infineon has the biggest power semiconductor capacity within the industry and is by far the biggest investor in capacity for power semiconductors
	Product portfolio	› Infineon provides both LED controllers, high voltage MOSFET, sensors as well as microcontrollers
	Robustness	› Infineon offers highly ruggedized performance and proven reliability

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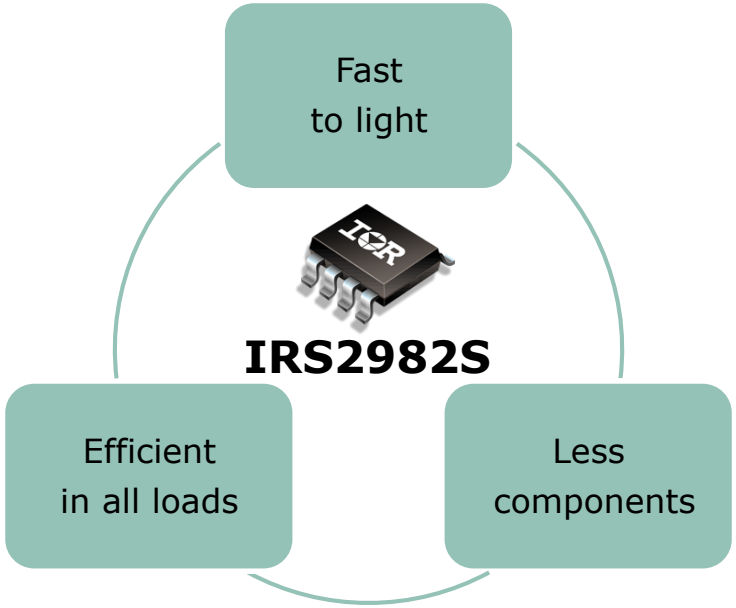
Summary

- LED driver customers are demanding more features, low power loss at light load and standby, while trying to maintain system cost
- IRS2982S's HV startup, CrCM/ DCM/ Burst mode, versatile configurations enables fast to light with less component counts as well as better efficiency overall



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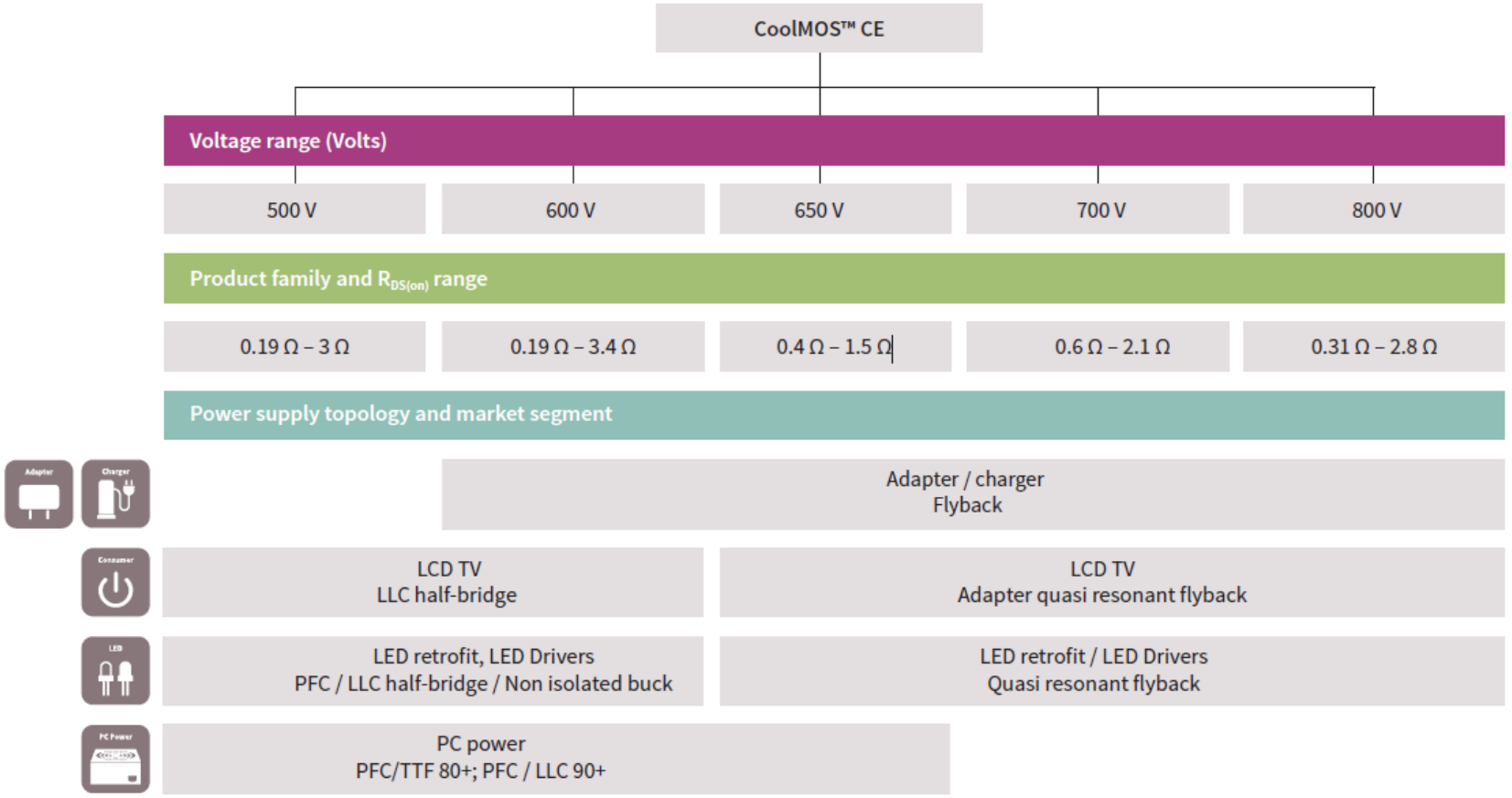
IRS2982S pairs with CoolMOS™ CE for price-driven applications



Superjunction technology at the price of a planar MOSFET

Why CoolMOS™ CE ?

- **Superjunction device** (SJ): as such it delivers low conduction and switching losses, improves efficiency and ultimately reduces power consumption
- **Broad portfolio**: 500 V, 600 V, 650 V, 700 V and 800 V devices available, best fitting LED lighting
- **Attractive price position:** with no compromise on proven CoolMOS™ quality
- **Flexibility:** suitable for hard and soft switching applications
- **Fast design-in:** ease of use enables customers to reduce the design in cycle and compete in dynamic markets

Top 7 reasons for choosing Infineon beyond product performance

Benefits	Provided by our CE solution…
1 Product portfolio	› We own a broad portfolio covering 5 voltage classes in both TH and SMD packages and exceed by > **3 times** our closest competitor
2 Capacity	› We own the world's largest capacity for power devices, with **3** dedicated frontends and **4** backends › We secure supply during market upswing
3 Lead times	› We understand **lighting** market's dynamics and offer **≤ 6 weeks** lead time
4 Delivery performance	› Our delivery performance is constantly **≥ 95%**
5 Quality	› Our field failure rates are on average < **0.2 PPM***
6 Price competitiveness	› With full implementation in 300 mm we gained economy of scale and improved our cost structure
7 Design-in support	› We have a large field application engineering team to provide professional & flexible support for your design

Note: *1 PPM = 1 failure per 1 Million pcs shipped

Recommendations for mid & low power QR flyback topologies

	$R_{DS(ON)}$ [mΩ]	 TO-220 FullPAK	 TO-252 DPAK	 TO-251 IPAK
800 V	**2800**		IPD80R2K8CE	IPU80R2K8CE
	1400	IPA80R1K4CE	IPD80R1K4CE	IPU80R1K4CE
	1000	IPA80R1K0CE	IPD80R1K0CE	IPU80R1K0CE
	650	IPA80R650CE		
	460	IPA80R460CE		
	310	IPA80R310CE		

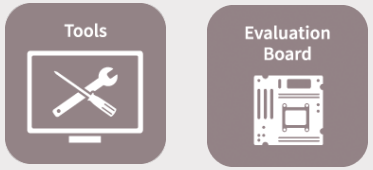
Support material

Collaterals and brochures

- Presentations

- PMM DCDC PL16 sharepoint site
- PMM pool presentations

Technical material



- Application notes
- Datasheets
- Eval boards IRXLED04

- IRS2982S datasheet
- ANEVAL_201602_PL16_017_IRXLED04

Videos

Contact

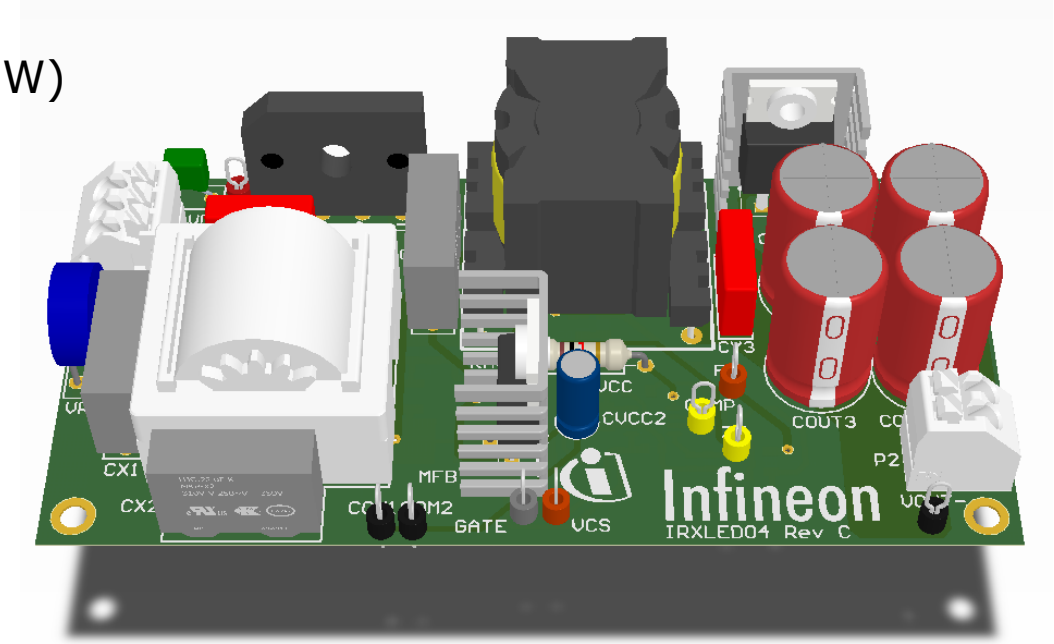
- Product manager
- Application manager

- Josh.feng@infineon.com
- Peter.Green@infineon.com

IRXLED04
50 W flyback evaluation board

Features

- Input voltage range: 85–265 V_{AC}
- Input voltage frequency: 47–63 Hz
- Regulated main output voltage: 55 V_{DC} / 0.9 A
- Harmonics: according to EN61000-3-2 Class-C
- EMI: according to EN55015
- Safety : according to EN61347-2-13
- Replaces IRXLED03
- Board dimensions: 4.4” (L) x 2.2” (W)
- Available in April 2016



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