FAIRCHILD SEMICONDUCTOR®

Saving our world, 1mW at a time™

Fairchild Display Power Solution

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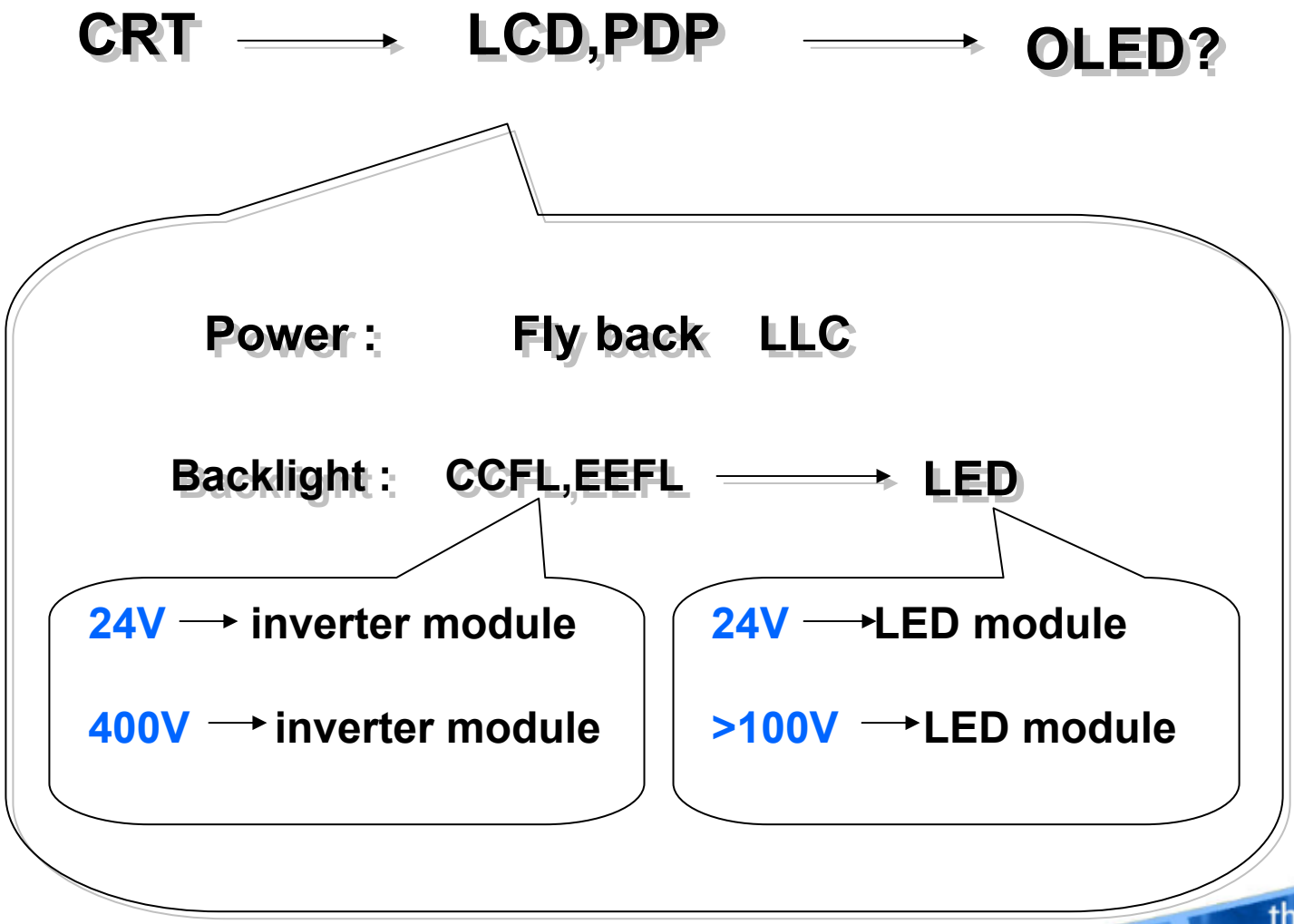
the power franchise™

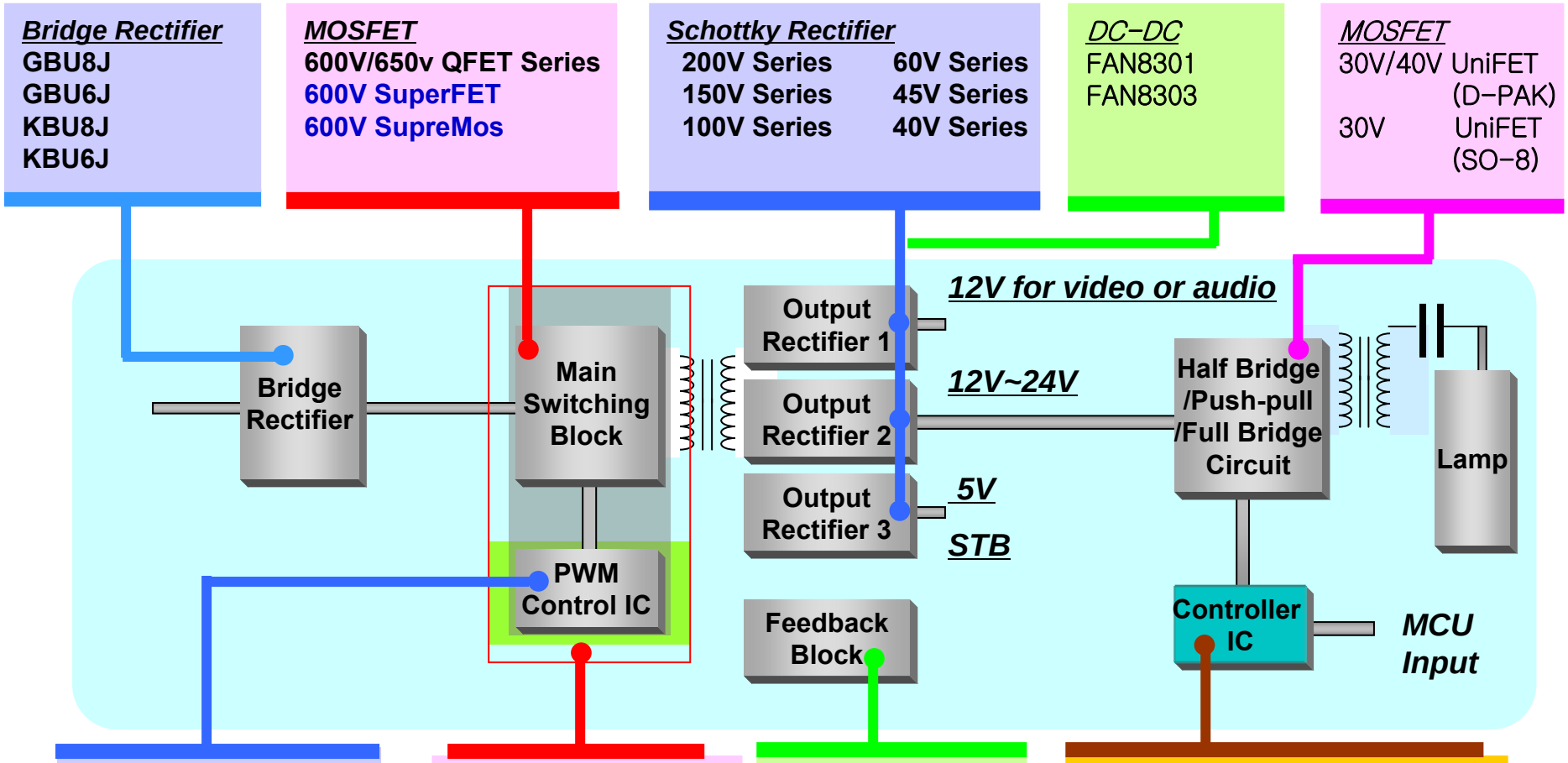
Display trend



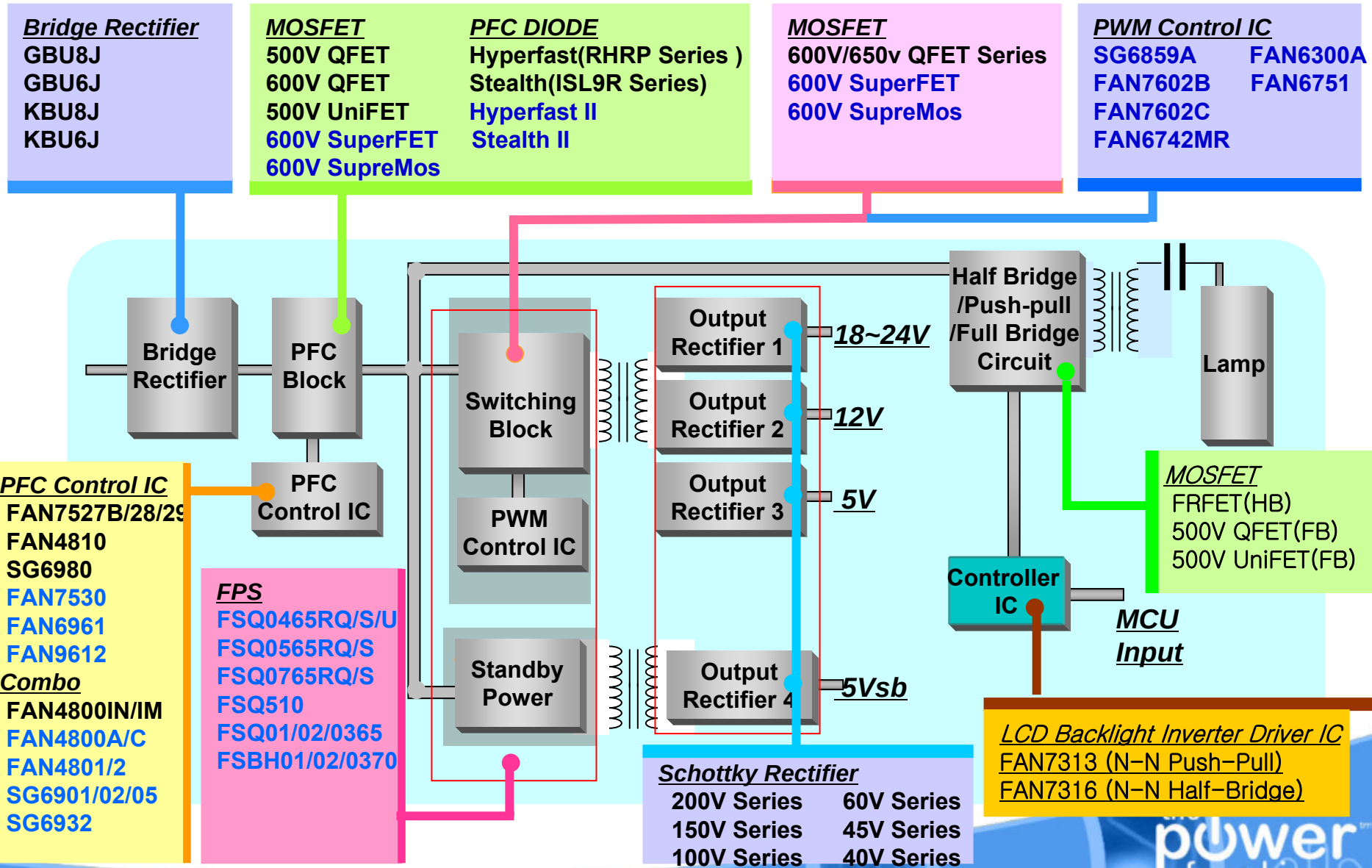
Fairchild Power Devices

PFC	DCM,CRM <300W: FAN7529/30 FAN6961(DIP/SO-8) CCM >200W: FAN4810 Inter leave >300W: FAN9612 (SSOP-16)
FPS (PWM+MOS Integrated)	FSQ0165RN,FSQ0265RN,FSQ0365RN (DIP-8) QR FSQ0465R, FSQ0565R, FSQ0765R (TO-220) QR FSQ0170RNA, FSQ0270RNA,FSQ0370RNA (DIP-8) FSFM260,FSFM300 (DIP-8) FSBH0170/FSBH0270/FSBH0370 (DIP-8)
PWM controller	SG6859A FAN7602B/C , FAN6755 SG6741 FAN6300(QR)
T-series (LLC+MOS Integrated)	FSFR1700, FSFR1800, FRFR1900/2000/2100 FSFA2100(AHB)
LLC controller	FAN7621
PFC+PWM	FAN4800/A CCM+PWM

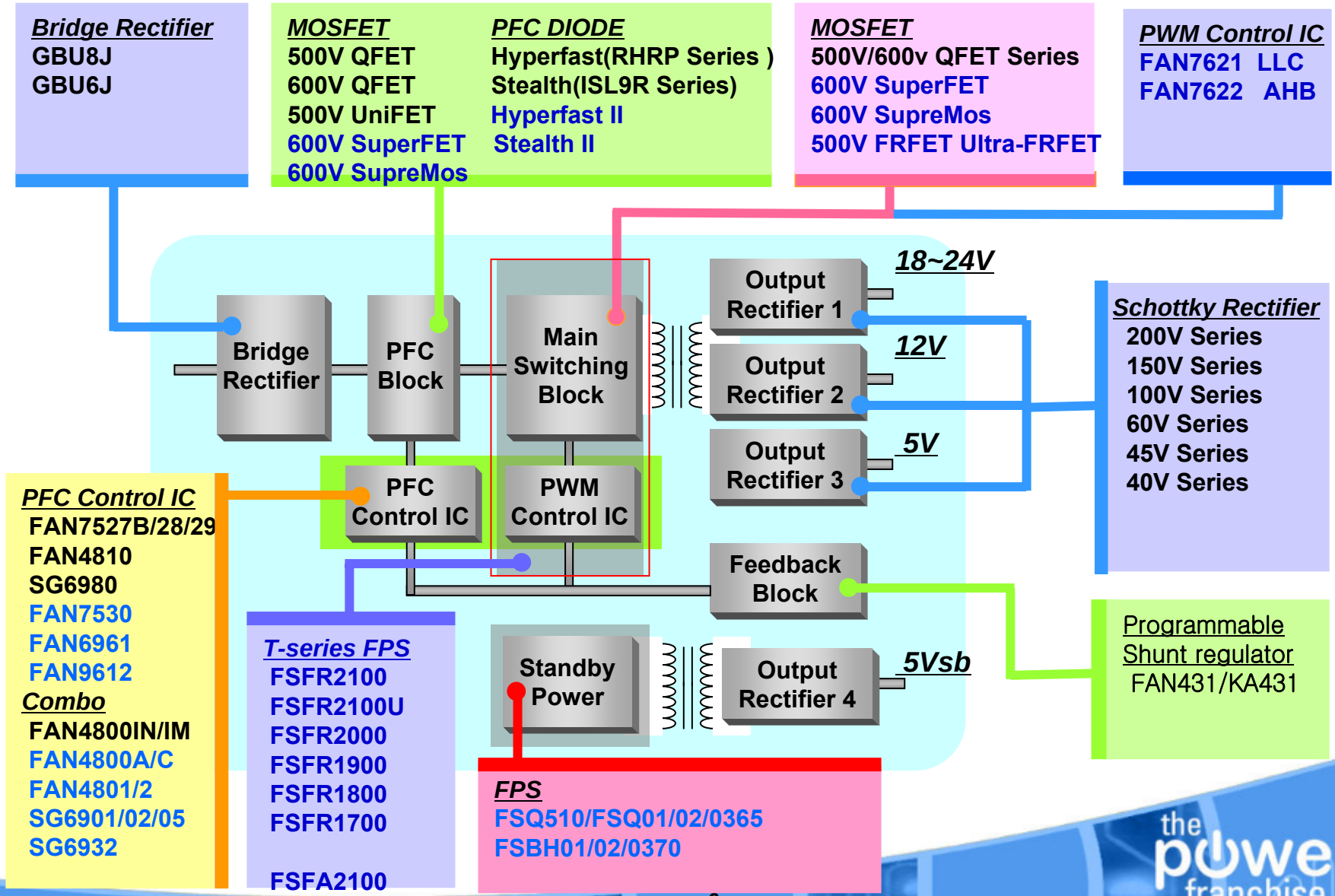
19' --- 26' LCD TV Power (Lips)



26' --- 47' LCD TV Power (SuperIP)



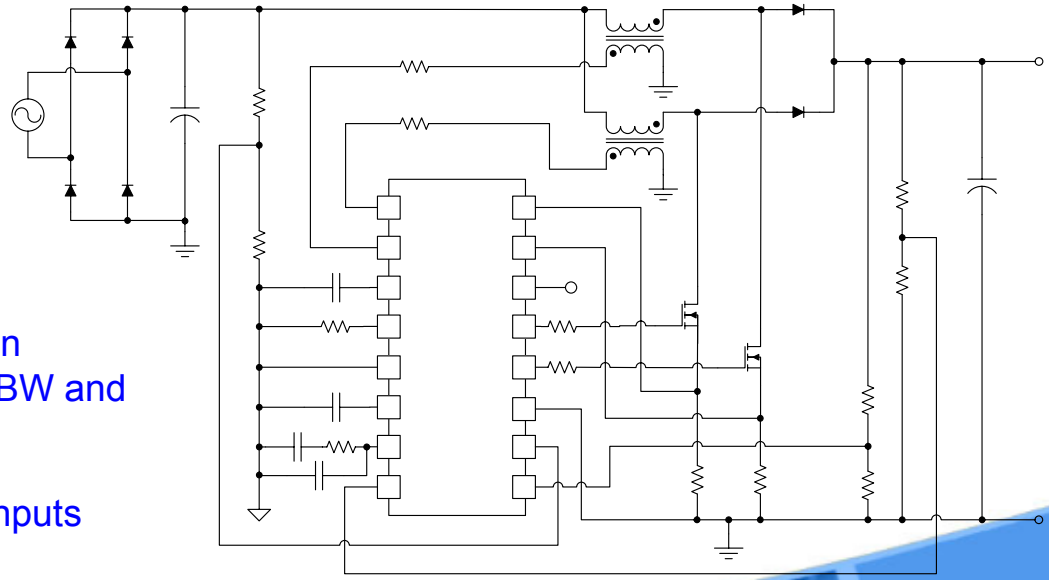
32’ --- 55’ LCD TV Power



Introduction of FAN9612
- Interleaved Dual BCM PFC Controller

❑ Efficiency
- Interleaved → Lower Turn-off Losses
- Valley Switching → Minimize C_{OSS} losses
- Strong gate drivers → reduce switching losses
- Boost-follower ("tracking boost") possible

❑ Protection
- Closed-loop soft-start w/ Prog. Ramp Time
- Power and Current Limit per Channel
- Input Voltage Feed-forward
- Secondary Latched OVP
- Input Brown-out Protection
- Line OVP
- Internal maximum f_{SW} clamp limit

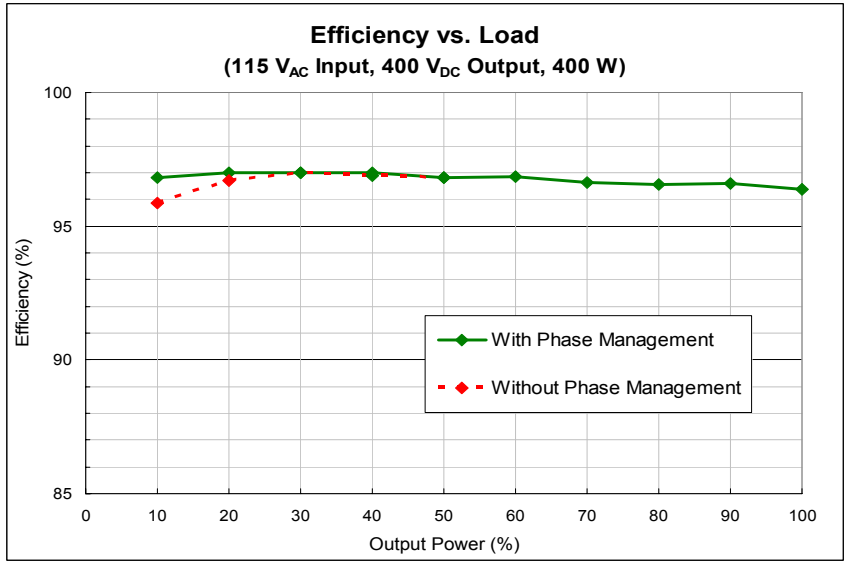


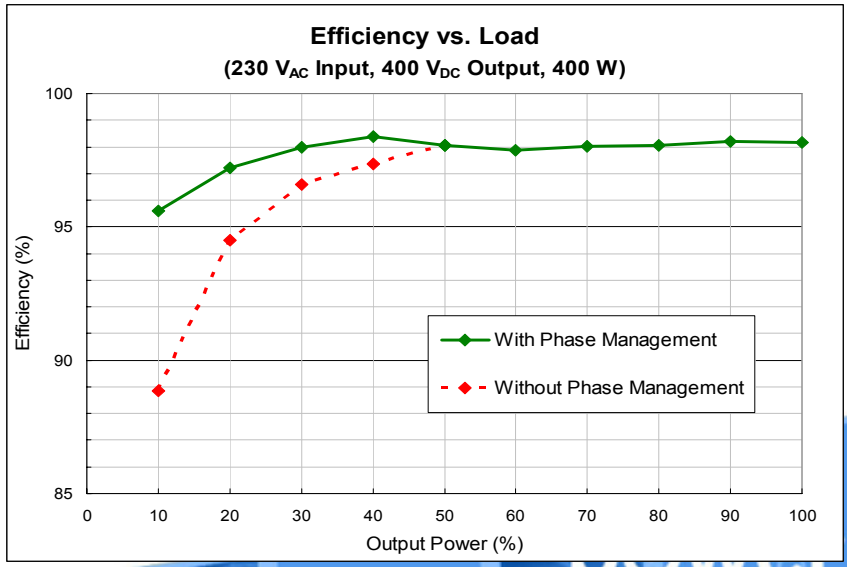
❑ Ease of Design & Solution Size
- Easy Valley Detection Implementation
- Easy Loop Compensation (constant BW and PWM Gain)
- Integrated +1.8A/-1.0A Gate Drivers
- Works with DC, 50Hz to 400Hz AC Inputs

Key FAN9612 advantages

FAN9612 Efficiency Improvements

- **Phase Management**
  - Minimizes power losses at light load
  - Automatic phase-drop and phase-add
- **Valley Switching Technology**
  - Minimizes C_{OSS} losses at turn-on of the MOSFET switching
- **Strong Integrated Gate Drivers**
  - Reduce switching losses
- **Low Current Sense Thresholds**
  - Low Conduction Losses
- **Maximum Switching Frequency Clamp**
- **Low Start-up and Operating Currents**

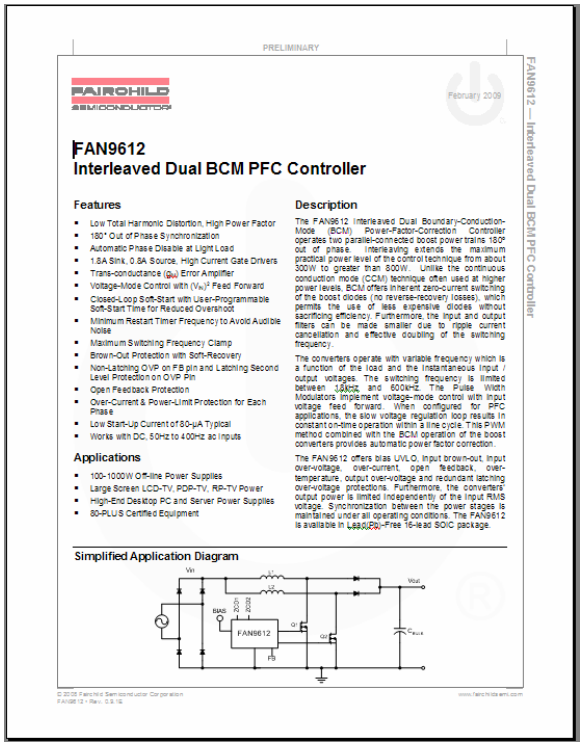




Efficiency & Cost Comparison

	Single BCM / CRM	Interleaved BCM / CRM	CCM
ZVS of MOSFET	ZVS ($V_{AC}(t) < V_O/2$) or Valley switching ($V_{AC}(t) > V_O/2$)	ZVS ($V_{AC}(t) < V_O/2$) or Valley switching ($V_{AC}(t) > V_O/2$)	NA
Diode Reverse Recovery Loss	ZCS operation → No reverse recovery loss	ZCS operation → No reverse recovery loss	Reverse recovery current → higher switching loss
Current sensing loss	Small (lower threshold just for protection)	Small (lower threshold just for protection)	Large (higher threshold for control)
Ripple Current	Higher ripple current -> larger conduction loss	Smaller Ripple currents	**Smallest Ripple Current**
Efficiency	Good (lower power levels)	**Best**	Good (higher power levels)
Inductor Size	Small	**Smallest**	Biggest
Line Filter	High peak currents → Larger line Filter	**Smallest line Filter**	Small line filter
Diode cost	Inexpensive Diodes	Inexpensive Diodes	Need SiC / Hyper FR Diode
Number of Components	**Minimal**	Needs 2 MOSFETs, 2 diodes, 2 L's & 2 CS R's	Minimal to moderate
Cost	Lower Cost (but also limited to <300W)	Low Cost solution (300W-800W)	High cost components to maintain high efficiency
Switching Freq.	Variable Frequency`	Variable Frequency	Fixed Frequency

FAN9612 reference material



PRELIMINARY

FAIRCHILD SEMICONDUCTOR

February 2009

FAN9612 — Interleaved Dual BCM PFC Controller

FAN9612
Interleaved Dual BCM PFC Controller

Features

- Low Total Harmonic Distortion, High Power Factor
- 180° Out of Phase Synchronization
- Automatic Phase Disable at Light Load
- 1.8A Sink, 0.8A Source, High Current Gate Drivers
- Trans-conductance (g_m) Error Amplifier
- Voltage-Mode Control with (V_{IN})² Feed Forward
- Closed-Loop Soft-Start with User-Programmable Soft-Start Time for Reduced Overshoot
- Minimum Restart Timer Frequency to Avoid Audible Noise
- Maximum Switching Frequency Clamp
- Brown-Out Protection with Soft-Recovery
- Non-Latching OVP on FB pin and Latching Second Level Protection on OVP Pin
- Open Feedback Protection
- Over-Current & Power-Limit Protection for Each Phase
- Low Start-Up Current of 80-µA Typical
- Works with DC, 50Hz to 400Hz ac Inputs

Applications

- 100~1000W Off-line Power Supplies
- Large Screen LCD-TV, PDP-TV, RP-TV Power
- High-End Desktop PC and Server Power Supplies
- 80-PLUS Certified Equipment

Description

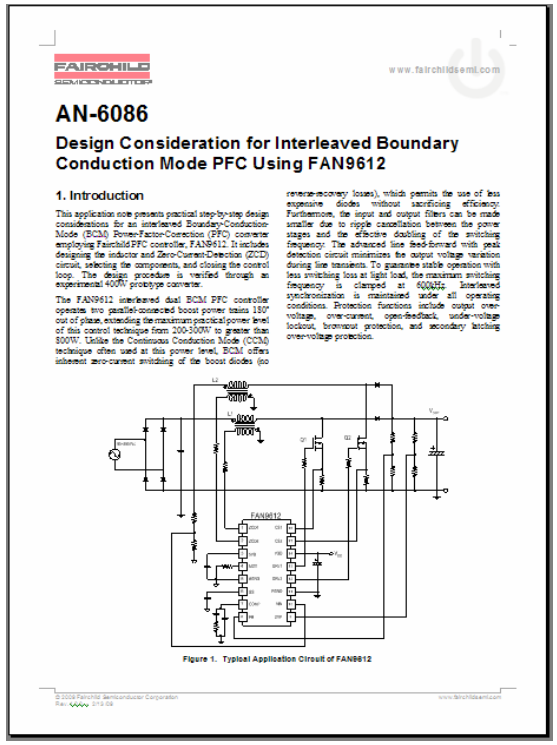
The FAN9612 Interleaved Dual Boundary-Conduction-Mode (BCM) Power-Factor-Correction Controller operates two parallel-connected boost power trains 180° out of phase. Interleaving extends the maximum practical power level of the control technique from about 300W to greater than 800W. Unlike the continuous conduction mode (CCM) technique often used at higher power levels, BCM offers inherent zero-current switching of the boost diodes (no reverse-recovery losses), which permits the use of less expensive diodes without sacrificing efficiency. Furthermore, the input and output filters can be made smaller due to ripple current cancellation and effective doubling of the switching frequency.

The converters operate with variable frequency which is a function of the load and the instantaneous input / output voltages. The switching frequency is limited between 18kHz and 600kHz. The Pulse Width Modulators implement voltage-mode control with input voltage feed forward. When configured for PFC applications, the slow voltage regulation loop results in constant on-time operation within a line cycle. This PWM method combined with the BCM operation of the boost converters provides automatic power factor correction.

The FAN9612 offers bias UVLO, input brown-out, input over-voltage, over-current, open feedback, over-temperature, output over-voltage and redundant latching over-voltage protections. Furthermore, the converters' output power is limited independently of the input RMS voltage. Synchronization between the power stages is maintained under all operating conditions. The FAN9612 is available in Lead(Pb)-Free 16-lead SOIC package.

Simplified Application Diagram

Data Sheet



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AN-6086

Design Consideration for Interleaved Boundary Conduction Mode PFC Using FAN9612

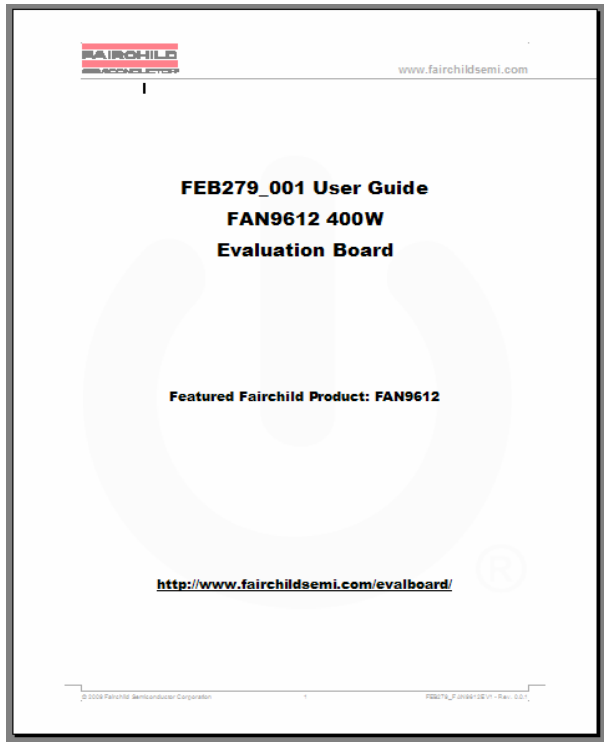
1. Introduction

This application note presents practical step-by-step design considerations for an interleaved Boundary-Conduction-Mode (BCM) Power-Factor-Correction (PFC) converter employing Fairchild PFC controller, FAN9612. It includes designing the inductor and Zero-Current-Detection (ZCD) circuit, selecting the components, and closing the control loop. The design procedure is verified through an experimental 400W prototype converter.

The FAN9612 interleaved dual BCM PFC controller operates two parallel-connected boost power trains 180° out of phase, extending the maximum practical power level of this control technique from 200-300W to greater than 500W. Unlike the Continuous Conduction Mode (CCM) technique often used at this power level, BCM offers inherent zero-current switching of the boost diodes (no reverse-recovery losses), which permits the use of less expensive diodes without sacrificing efficiency. Furthermore, the input and output filters can be made smaller due to ripple cancellation between the power stages and the effective doubling of the switching frequency. The advanced line feed-forward with peak detection circuit minimizes the output voltage variation during line transients. To guarantee stable operation with less switching loss at light load, the maximum switching frequency is clamped at 600kHz. Interleaved synchronization is maintained under all operating conditions. Protection functions include output over-voltage, over-current, open-feedback, under-voltage lockout, brownout protection, and secondary latching over-voltage protection.

Figure 1. Typical Application Circuit of FAN9612

Application Notes
- **AN-6086:** Design Considerations
- **AN-8021:** Building Variable Output Voltage Boost PFC Converters



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FEB279_001 User Guide
FAN9612 400W
Evaluation Board

Featured Fairchild Product: FAN9612

http://www.fairchildsemi.com/evalboard/

Evaluation Board User Guides (FEB279)

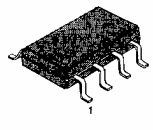
the power franchise

FAN7530 (FAN7529)
CRM PFC Controller

- Superior THD performance
- Voltage mode PWM : No input voltage sensing for power factor correction → power loss saving (80mW,2MΩ)
- Precise output over voltage protection(± 2%)
- Voltage sensing OVP → high sensing resistor can be used, power loss saving (80mW,2MΩ)
- Open feedback protection and disable function(65uA)

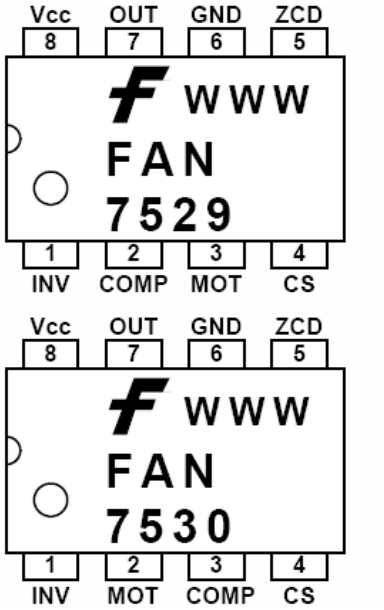
  → No Vcc shut-down circuit is necessary
- Low start-up current : Typ. 40uA
- Low operating current : Typ. 2.5mA
- +500/-800mA peak gate drive current
- Internal RC filter for current sensing
- 8-DIP and 8-SOP package

8-DIP

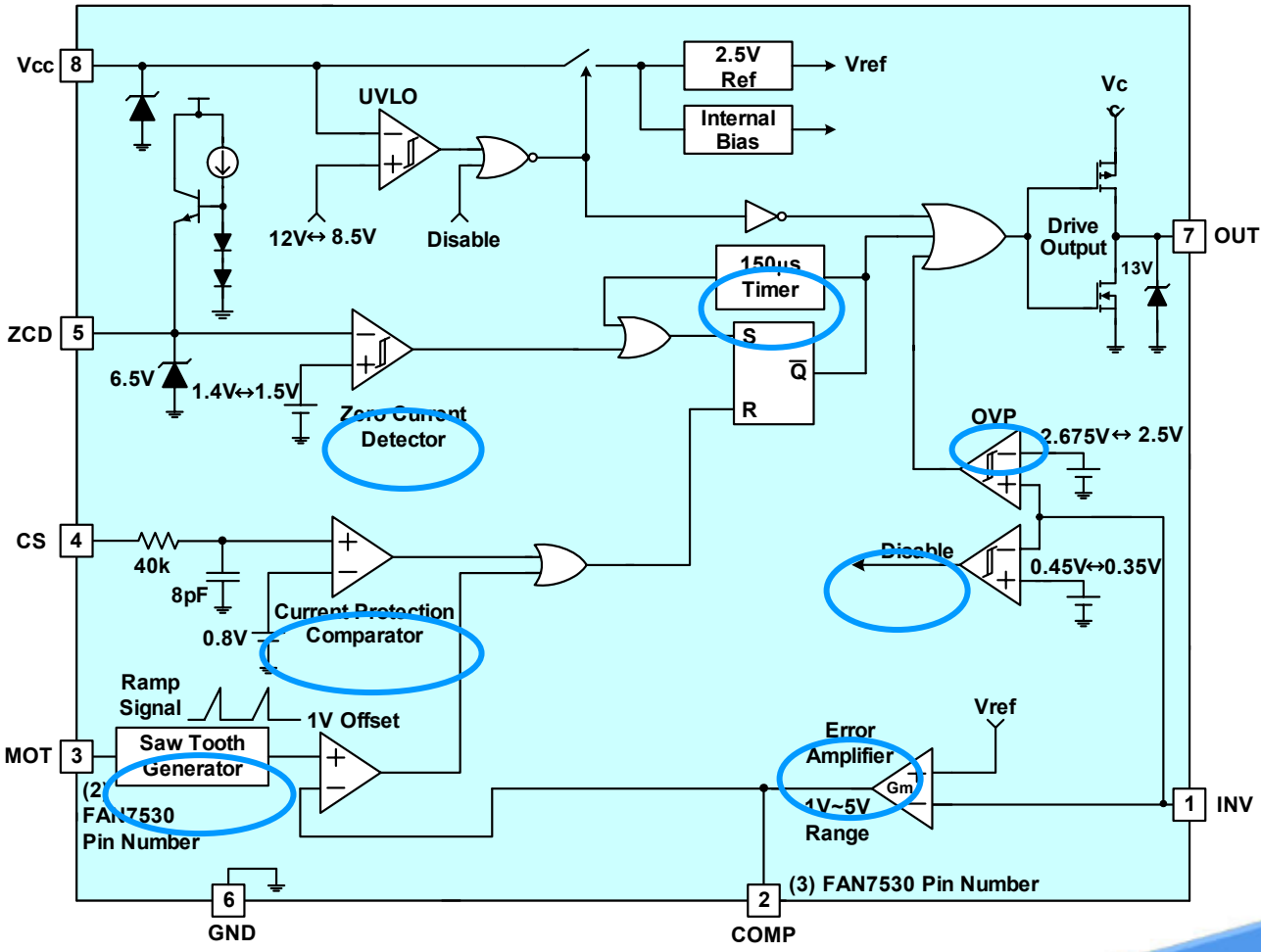


8-SOP

FAN7530(*FAN7529*) *block diagram*

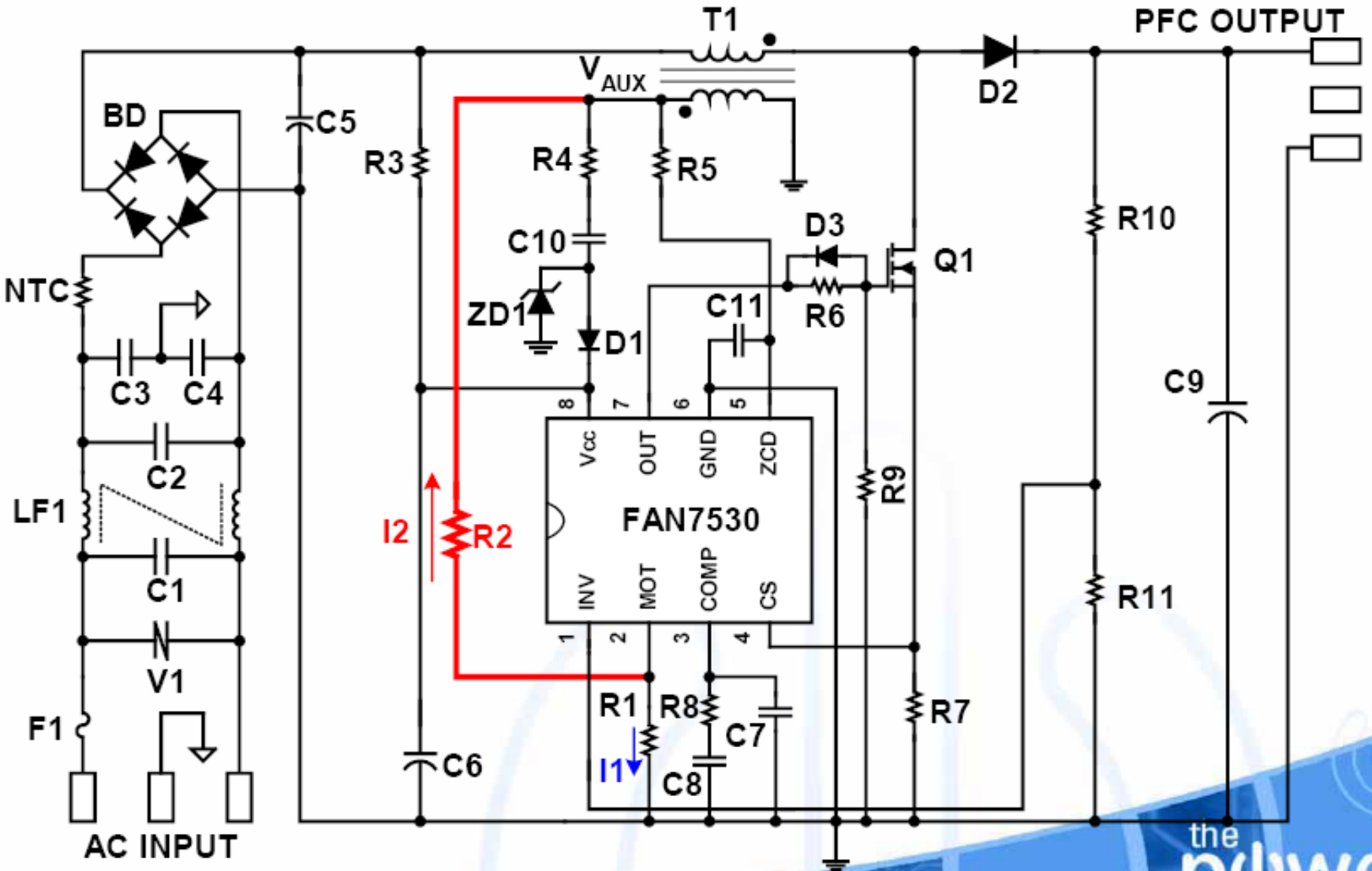


Pin Name	Function
INV	Input to Error Amp.
COMP	Output of Error Amp.
MOT	Maximum On-time Setting
CS	Current Sense Input
ZCD	Zero Current Detection Input
OUT	Gate Driver Output
VCC	Supply Voltage
GND	Ground



FAN7530(*FAN7529*)
Typical Application Circuit

Variable On-time control according to AC line voltage: FCS Patent



FAN4800A/C Features
CCM PFC +PWM

- ***Pin to pin compatible with ML4800 and FAN4800 and CM6800 and CM6800A.***
- ***PWM configurable for current mode or feedforward voltage mode operation.***
- ***Internally synchronized leading edge PFC and trailing edge PWM in one IC.***
- ***Innovative Switching-Charge® multiplier-divider.***
- ***Average-current-mode for input-current shaping.***
- ***PFC over-voltage and under-voltage protections.***
- ***PFC feedback open-loop protection.***
- ***Cycle-by-cycle current limiting for PFC/PWM.***
- ***Power on sequence control and soft-start.***
- ***Brownout protection.***
- ***Interleaved PFC/PWM switching.***

FAN4800A/C Block Driagram

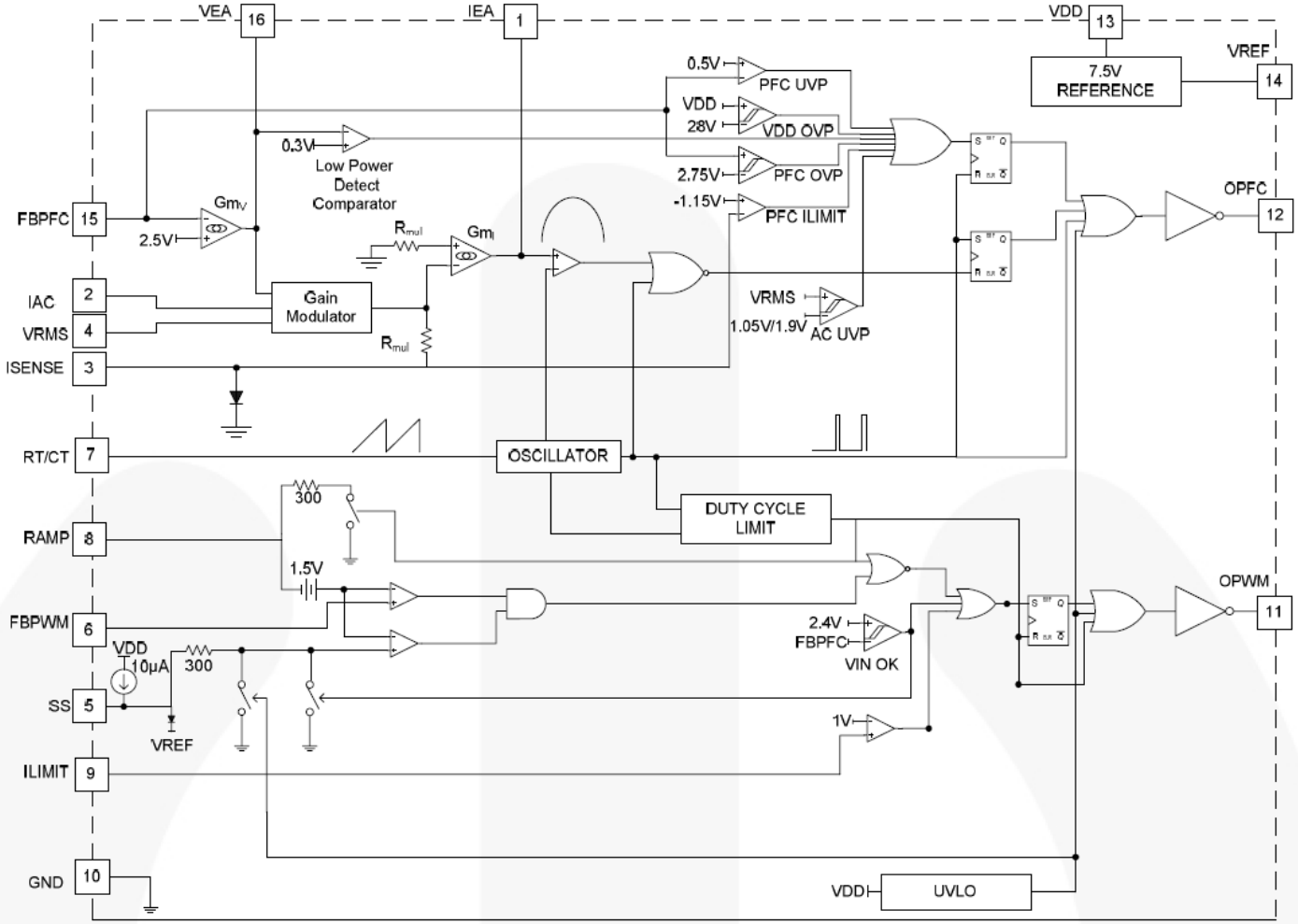
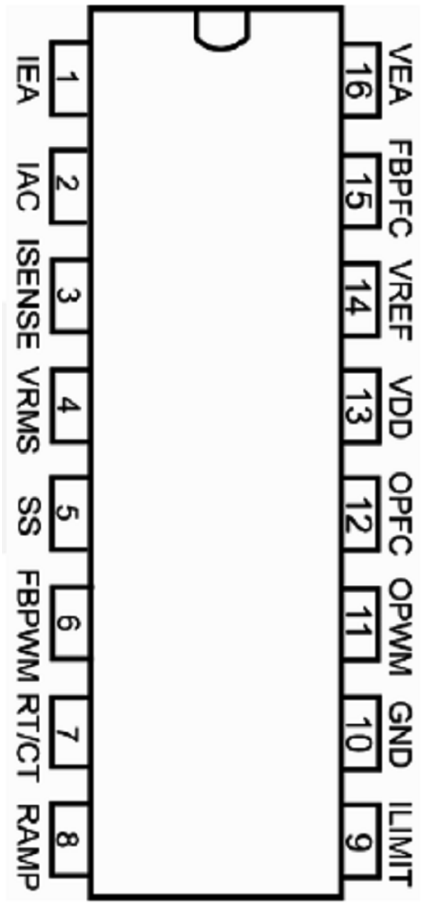


Figure 3. FAN4800A/C Function Block Diagram

FAN4800A/C Pin Definitions

Pin Definitions

Pin #	Name	Description
1	IEA	**Output of PFC Current Amplifier.** The signal from this pin is compared with an internal sawtooth to determine the pulse width for PFC gate drive.
2	IAC	**Input AC Current.** For normal operation, this input provides current reference for the multiplier. The suggested maximum IAC is 100µA.
3	ISENSE	**PFC Current Sense.** The non-inverting input of the PFC current amplifier and the output of multiplier and PFC ILIMIT comparator.
4	VRMS	**Line-Voltage Detection.** Line voltage detection. The pin is used for PFC multiplier.
5	SS	**PWM Soft-Start.** During startup, the SS pin charges an external capacitor with a 10µA constant current source. The voltage on FBPWM is clamped by SS during startup. In the event of a protection condition occurring and/or PWM disabled, the SS pin is quickly discharged.
6	FBPWM	**PWM Feedback Input.** The control input for voltage-loop feedback of PWM stage.
7	RT/CT	**Oscillator RC Timing Connection.** Oscillator timing node; timing set by R_T and C_T.
8	RAMP	**PWM RAMP Input.** In current mode, this pin functions as the current sense input; when in voltage mode, it is the feed forward sense input from PFC output 380V (feedforward ramp).
9	ILIMIT	**Peak Current Limit Setting for PWM.** The peak current limits setting for PWM.
10	GND	**Ground.**
11	OPWM	**PWM Gate Drive.** The totem-pole output drive for PWM MOSFET. This pin is internally clamped under 15V to protect the MOSFET.
12	OPFC	**PFC Gate Drive.** The totem pole output drive for PWM MOSFET. This pin is internally clamped under 15V to protect the MOSFET.
13	VDD	**Supply.** The power supply pin. The threshold voltages for startup and turn-off are 11V and 9.3V, respectively. The operating current is lower than 10mA.
14	VREF	**Reference Voltage.** Buffered output for the internal 7.5V reference.
15	FBPFC	**Voltage Feedback Input for PFC.** The feedback input for PFC voltage loop. The inverting input of PFC error amplifier. This pin is connected to the PFC output through a divider network.
16	VEA	**Output of PFC Voltage Amplifier.** The error amplifier output for PFC voltage feedback loop. A compensation network is connected between this pin and ground.



FAN4800A/C

Typical application circuit

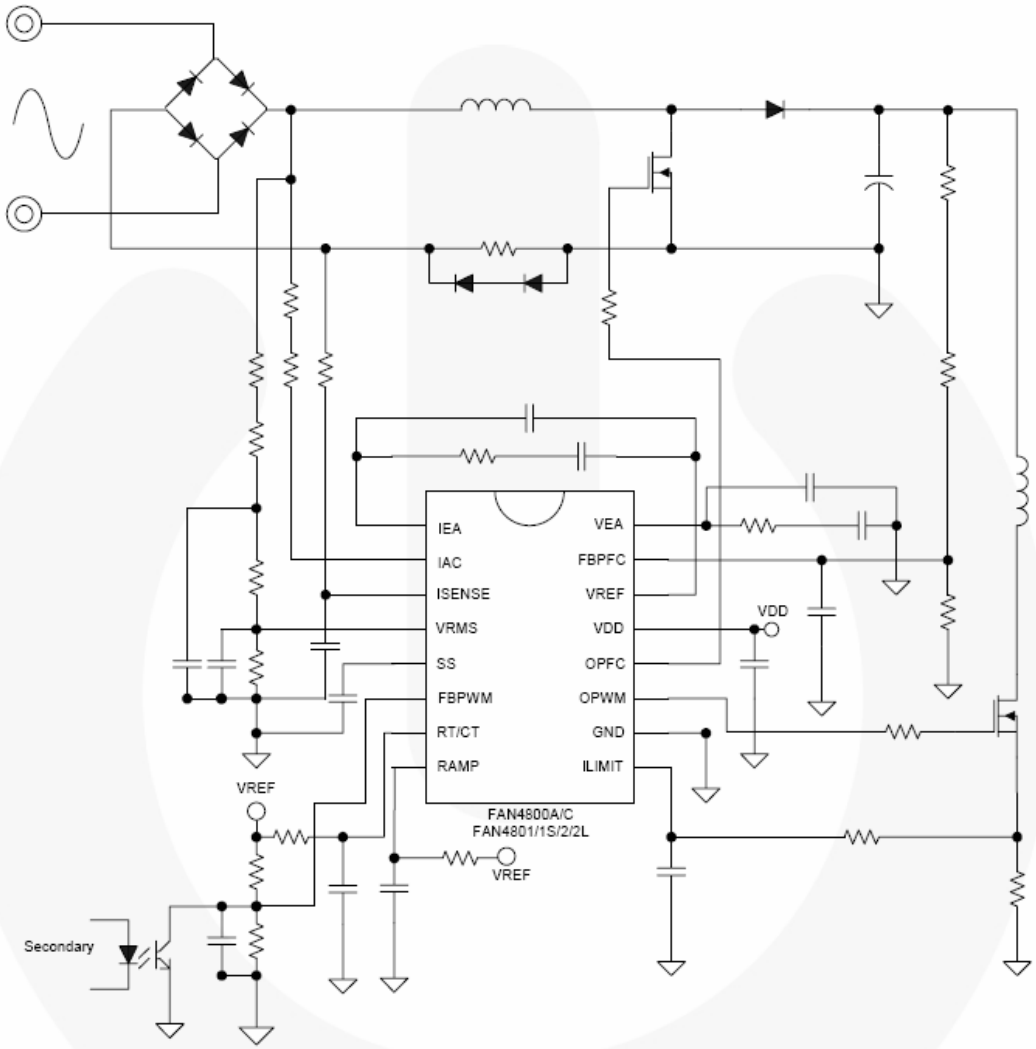
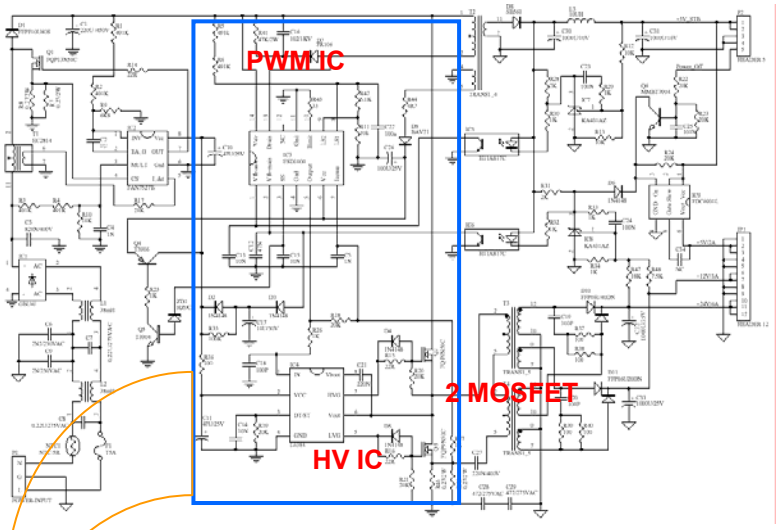


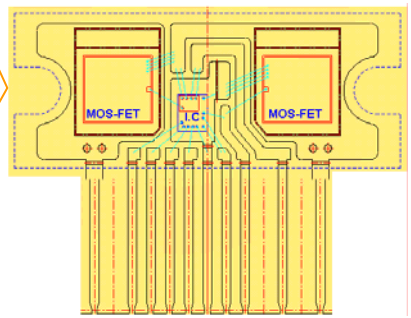
Figure 2. Typical Application Voltage Mode

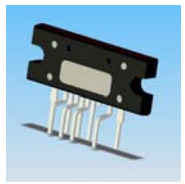
Introduction of FSFR Series



Advantages through system integration

- **High reliability & productivity**
- **BOM cost reduction**
- **Easy design**





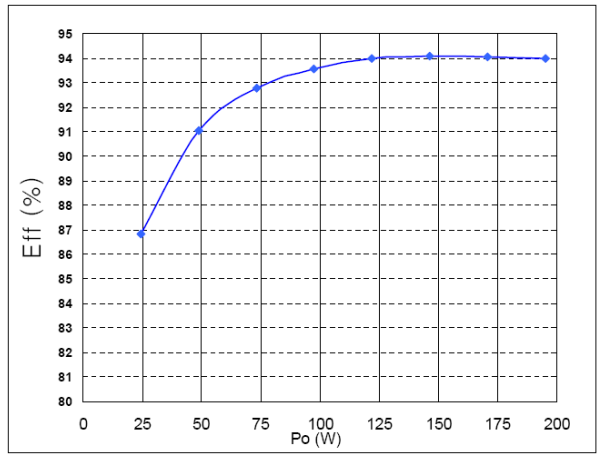
❑ **PFM Controller + High side Drive IC + 2MOSFETs in 9-SIP PKG**

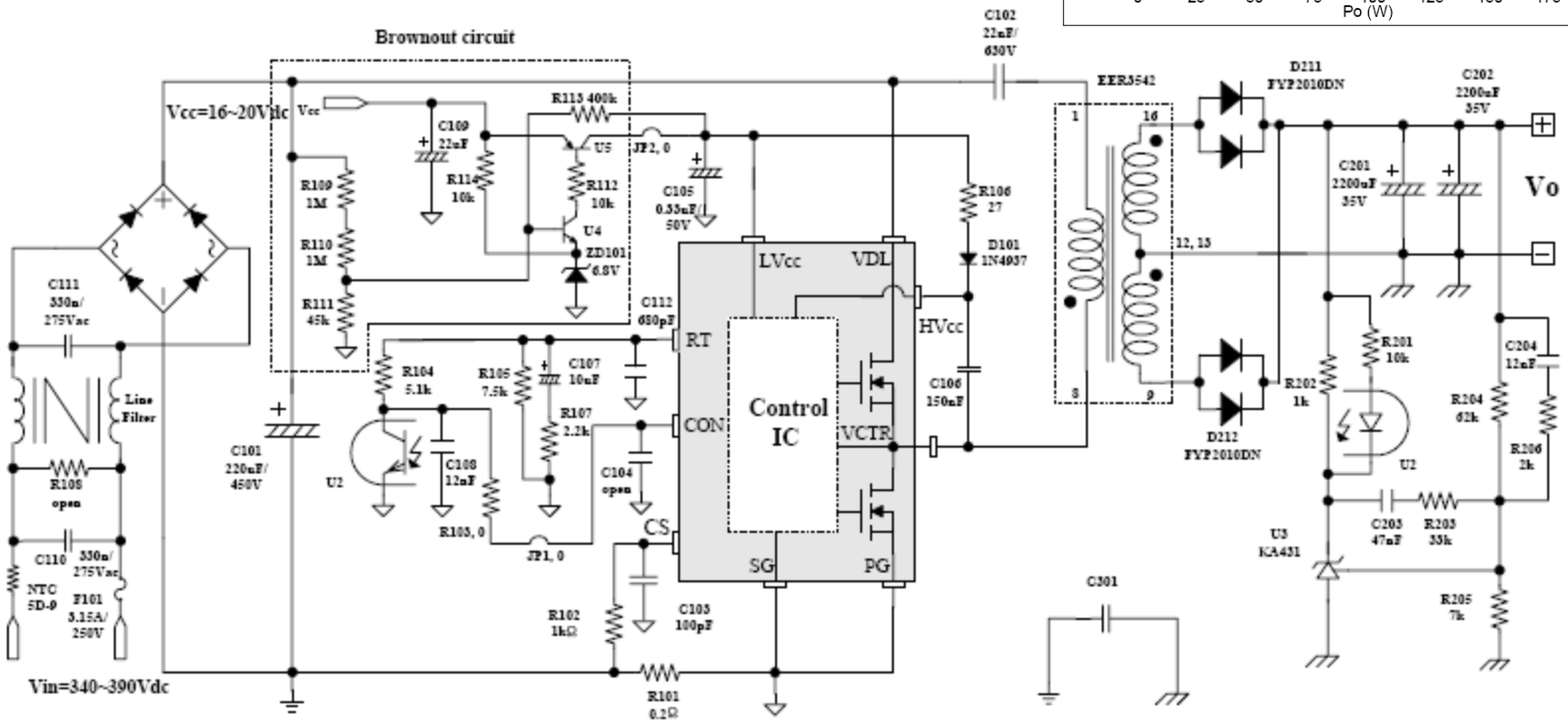
❑ **Features**

- Variable frequency control with 50% duty cycle for half-bridge resonant converter topology
- High efficiency through zero voltage switching (ZVS)
- Internal Super-FETs with Fast Recovery Type Body Diode (trr=120ns)
- Fixed dead time (350ns)
- Up to 300kHz operating frequency
- Pulse skipping for Frequency limit (programmable) at light load condition
- Simple remote ON/OFF control
- Various Protection functions: Over Voltage Protection (OVP), Over Load Protection (OLP), Over Current Protection (OCP), Abnormal Over Current Protection (AOCP), Internal Thermal Shutdown (TSD)

Typical Application Circuit

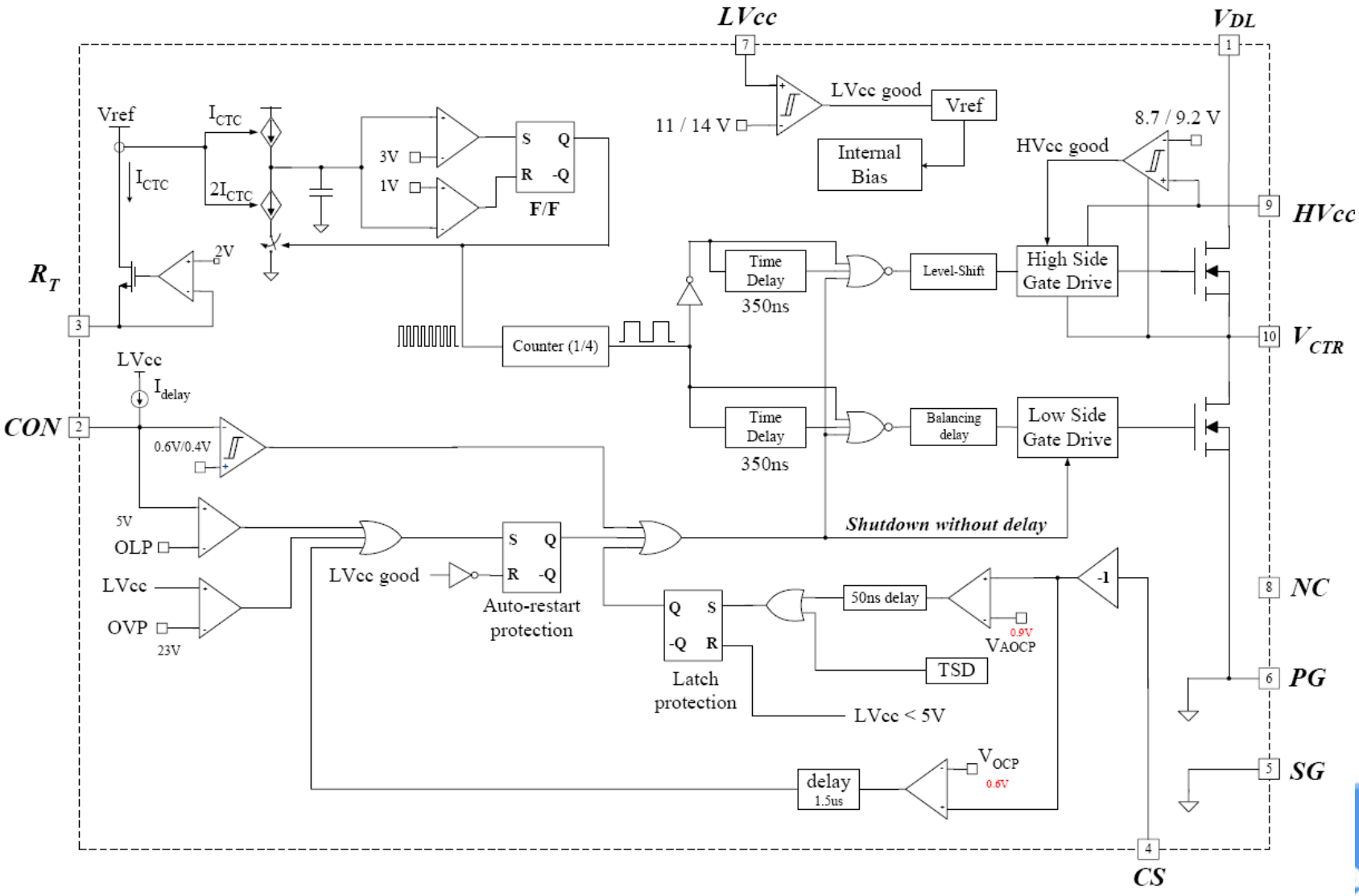
- **LLC Resonant Converter for LCD TV**
  - Vin = 340V ~ 400V, Vo = 24V, Io = 8A
  - Eff = 94% at full load condition
  - No heat sinks is required up to 200W for FSFR2100





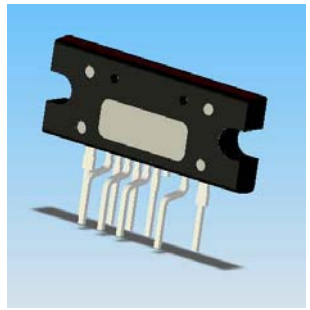
FSFR – Series FPS

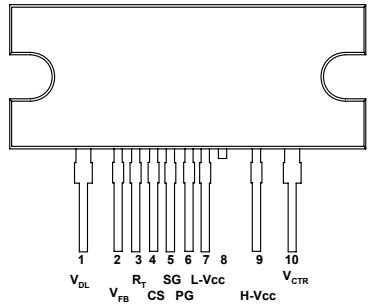
Block Diagram



FSFR – Series Pin Definitions

Pin No.	Pin Name	Pin Function Description
1	V_{DL}	This pin is the drain of the high side MOSFET. It is typically connected to the input DC link voltage.
2	CON	This pin is for enable/disable and protection. When the voltage of this pin is above 0.6V, the IC operation is enabled. Meanwhile, when the voltage of this pin drops below 0.4V, gate drive signals for both MOSFETs are disabled. When the voltage of this pin increases above 5V, protection is triggered.
3	R_T	This pin is to program the switching frequency. Typically, only a resistor is c onnected to this pin when used for constant frequency PWM mode. Meanwhile, opto-coupler is connected to this pin when used for frequency co ntrolled resonant mode configuration.
4	CS	This pin is to sense the current flowing through the low side MOSFET. Typically negative voltage is applied on this pin.
5	SG	This pin is the control ground. (Signal ground)
6	PG	This pin is connected to the source of the low side MOSFET (Power Ground)
7	L-Vcc	This pin the supply voltage of the control IC
8	NC	
9	H-Vcc	This pin the supply voltage of the high side drive circuit IC.
10	V_{CTR}	This pin is the drain of the low side MOSFET. Typically transformer is connected to this pin.

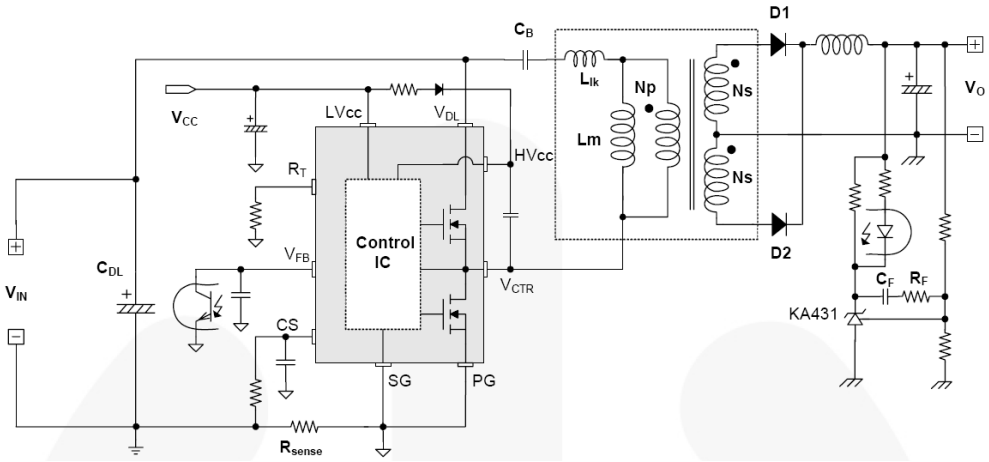




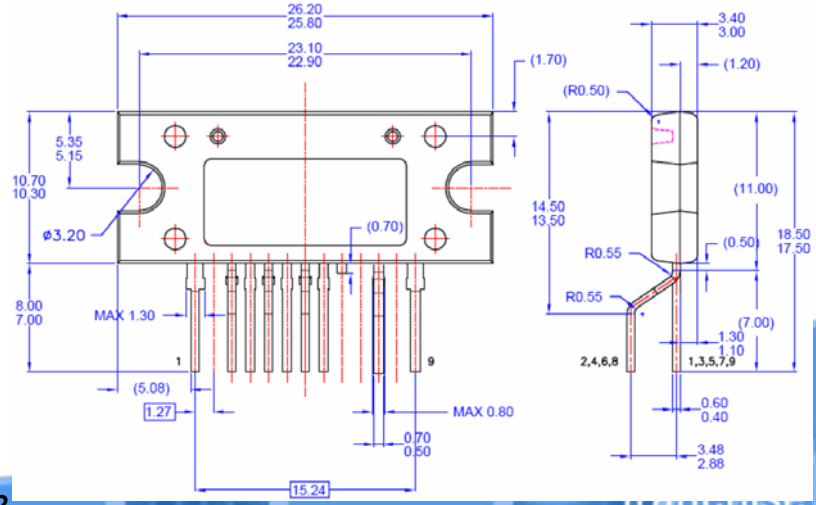
FSFA-series
Integrated solution for AHB

- **General Features**
  - **Integrated solution using FAN7622**
  - **9-SIP with enough creepage**
  - **Internal SuperFET™ with fast-recovery type body diode (t_{rr}<120ns)**
  - **Optimized dead time (200ns) for ZVS operation**
- **Design Resources**
  - **AHB design tool Ver 0.9 is now developing**
  - ***AN4153 – Designing Asymmetric PWM Half-Bridge Converters with Current Doubler and Synchronous Rectifier using FSFA-series FPS™***
- **Lineup**
  - **Up to now, the biggest one (FSFA2100, 0.38 Ω) is released.**

- **Typical Application Circuit**



- **Package Information**



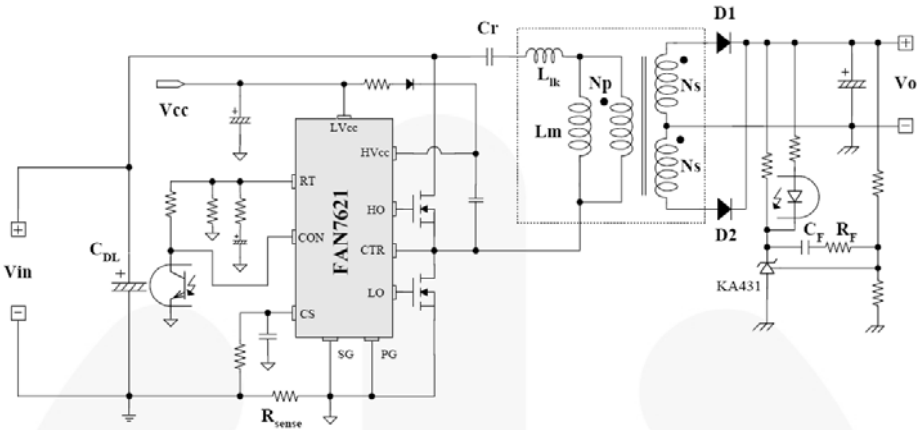
FAN7621

PFM controller for LLC

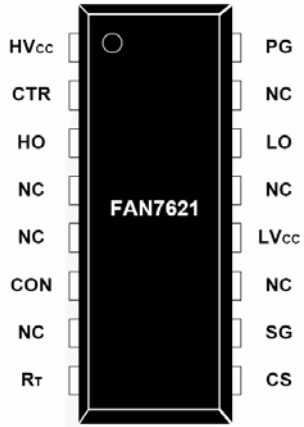
- **Motivations**
  - To cover larger power applications
  - To meet a height specification (less than 10 mm) for some customers

- **General Features**
  - 16-DIP and 16-SOP stand alone controller
  - Variable frequency control with 50% duty cycle for half-bridge resonant topology
  - High efficiency through zero voltage switching (ZVS)
  - High-side gate driver included
  - I_{source} is typically 360mA
  - I_{sink} is typically 600mA
  - Optimized dead time (350ns)
  - Up to 300kHz operating frequency
  - Pulse skipping for frequency limit (programmable) at light load condition
  - Simple remote ON/OFF control
  - Various Protection functions such as OVP, OLP, OCP, AOCP, and TSD

- **Typical Application Circuit**



- **Pin Configurations**



Pin #	Name	Description
1	HV_{CC}	This is the supply voltage of the high-side gate-drive circuit IC.
2	CTR	This is the drain of the low-side MOSFET. Typically, a transformer is connected to this pin.
3	HO	This is the high side gate driving signal.
4	NC	No connection.
5	NC	No connection.
6	CON	This pin is for enable/disable and protection. When the voltage of this pin is above 0.6V, the IC operation is enabled. When the voltage of this pin drops below 0.4V, gate drive signals for both MOSFETs are disabled. When the voltage of this pin increases above 5V, protection is triggered.
7	NC	No connection.
8	R_T	This pin programs the switching frequency. Typically, an opto-coupler is connected to control the switching frequency for the output voltage regulation.
9	CS	This pin senses the current flowing through the low-side MOSFET. Typically, negative voltage is applied on this pin.
10	SG	This pin is the control ground.
11	NC	No connection.
12	LV_{CC}	This pin is the supply voltage of the control IC.
13	NC	No connection.
14	LO	This is the low side gate driving signal.
15	NC	No connection.
16	PG	This pin is the power ground. This pin is connected to the source of the low-side MOSFET.

Selection Guide : T-series

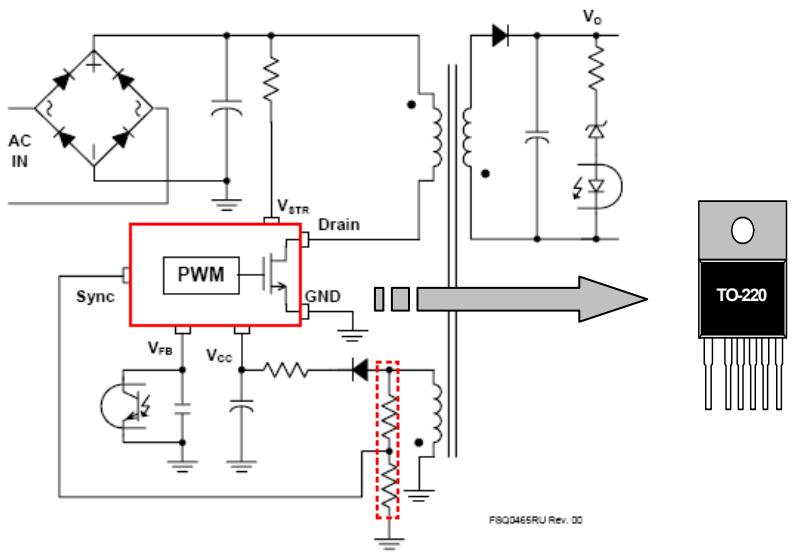
- **Full lineup products “100W~600W” with a proper heat sink will be prepared so that an appropriate power solution can be taken**

Device	Device		Pout		MosFET		Working sample	Code S	Ref.
	Type	Part No.	without H/S	with H/S	Rds(on)_max	BV			
3Chips in One PKG	Resonant	FSFR2100	200W	450W	0.38Ω	600V	Now	Now	Fully released
		FSFR2100U	180W	400W	0.51Ω	500V	Now	P02	Need to pass Rel. test
		FSFR2000	160W	350W	0.67Ω	500V	Now	Now	Fully released
		FSFR1900	140W	300W	0.85Ω	500V	Now	Now	Fully released
		FSFR1800	120W	260W	0.95Ω	500V	Now	Now	Fully released
		FSFR1700	100W	200W	1.25Ω	500V	Now	Now	Fully released
	Asy.	FSFA2100	200W	450W	0.38Ω	600V	Now	P8	Fully released
Controller	Resonant	FAN7621	-		External MosFETs are needed		Now	P12	Need to pass Rel. test
	Asy.	FAN7622	-		External MosFETs are needed		P01	P02	

Introduction of e-Series II

Features

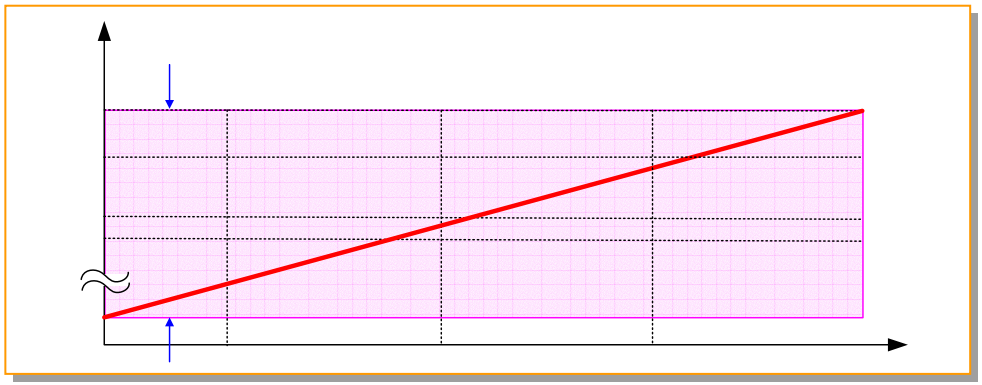
- **Enhanced surge characteristics with a specific layout**
- Avalanche rugged internal current sensing sense-FET
- Simple sync detection circuit – only 2 resistors are needed
- Better efficiency through valley switching and *hybrid control* – *patent pending*
- Extremely narrow frequency range owing to hybrid control
- Low EMI through valley switching, *inherent frequency modulation* and *AVS(Alternating Valley Switching)* – 2 *patents pending*
- Low standby power comsumption
- Reduced IC temperature
- High reliability by reinforced protections (*OSP*, AOCP, TSD with hysteresis,…) – *patent pending*



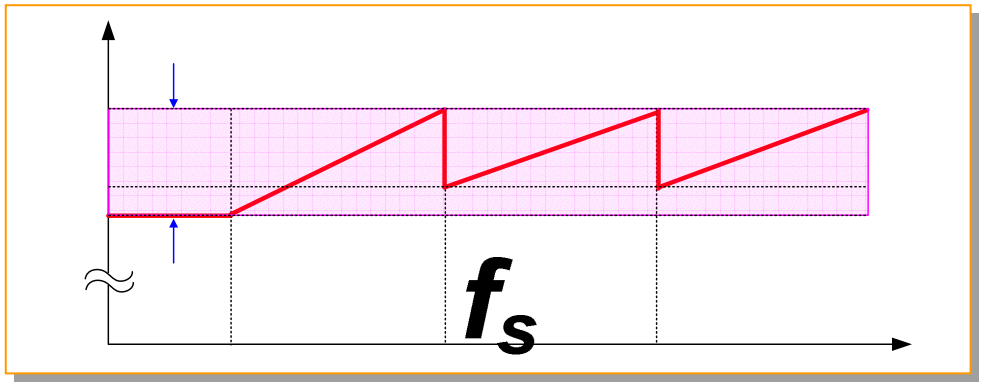
Product ID	I_{LIM}	R_{DS} (ON) MAX.	Maximum output power			
			230Vac±15%		85~265Vac	
			Adapter	Open frame	Adapter	Open frame
FSQ0465R	2.5	2.6	60W	70W	33W	48W
FSQ0565R	3.0	2.2	70W	80W	41W	60W
FSQ0765R	3.5	1.6	80W	90W	48W	70W

What is the benefit using e-Series II?

- Extremely narrow frequency range



Conventional QRC



e-Series I

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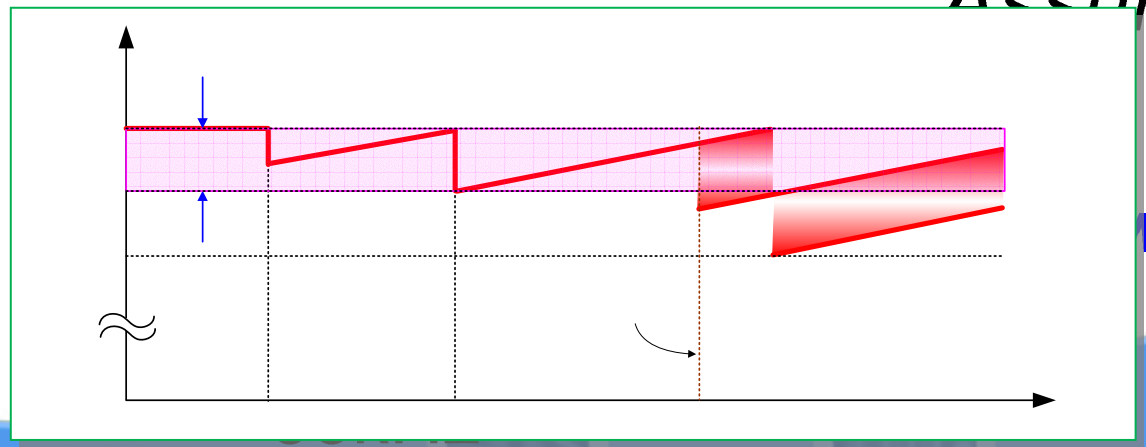

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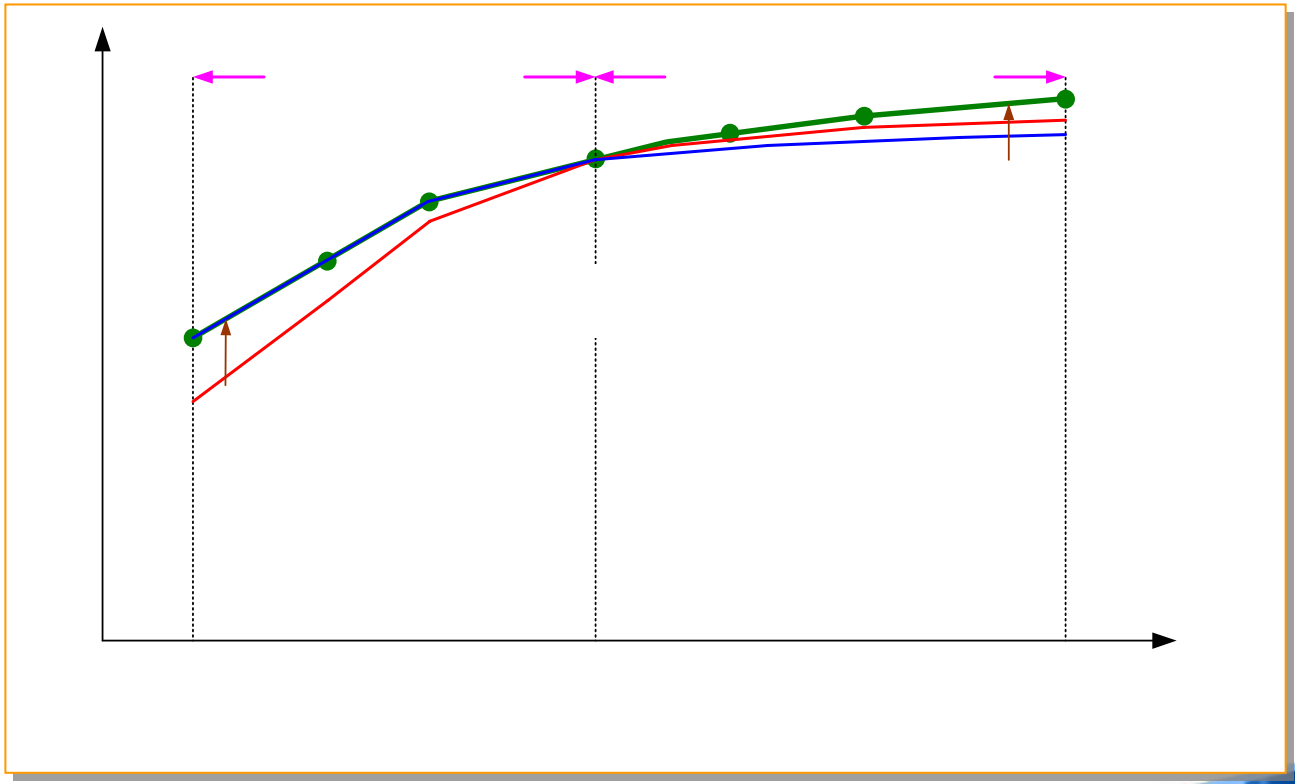
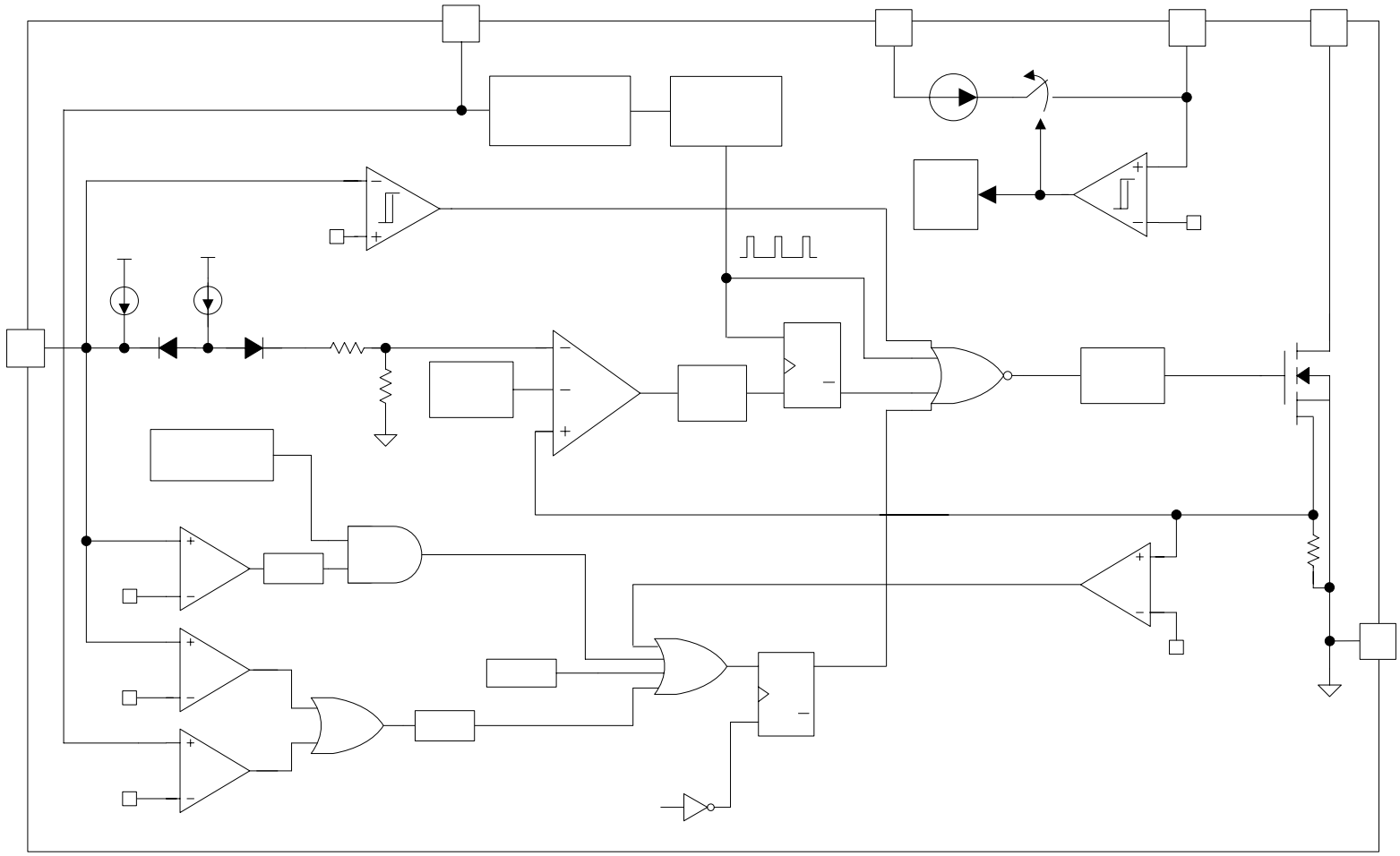
What is the benefit using e-Series II?

- Better efficiency thru valley switching and hybrid control

- Quasi-resonant operation requires DCM design, which results in increased conduction loss especially at low line.
- E-series II FPS operates in ***CCM at low line*** and in ***valley switching & AVS at high line***
  → Efficiency is not deteriorated at low line.



e-SeriesII FPS - Block diagram



e-SeriesII FPS – Pin definition

Pin #	Name	Description
1	Drain	**SenseFET drain.** High-voltage power SenseFET drain connection.
2	GND	**Ground.** This pin is the control ground and the SenseFET source.
3	Vcc	**Power Supply.** This pin is the positive supply input. This pin provides internal operating current for both start-up and steady-state operation.
4	FB	**Feedback.** This pin is internally connected to the inverting input of the PWM comparator. The collector of an opto-couple is typically tied to this pin. For stable operation, a capacitor should be placed between this pin and GND. If the voltage of this pin reaches 6V, the overload protection triggers, which shuts down the FPS.
5	Sync	**Sync.** This pin is internally connected to the sync-detect comparator for quasi-resonant switching. In normal quasi-resonant operation, the threshold of the sync comparator is 1.2V/1.0V.
6	Vstr	**Start-up.** This pin is connected directly, or through a resistor, to the high-voltage DC link. At start-up, the internal high-voltage current source supplies internal bias and charges the external capacitor connected to the Vcc pin. Once Vcc reached 12V, the internal current source is disabled. It is recommended to connect Vstr and Drain together.

Information of e-SeriesII FPS

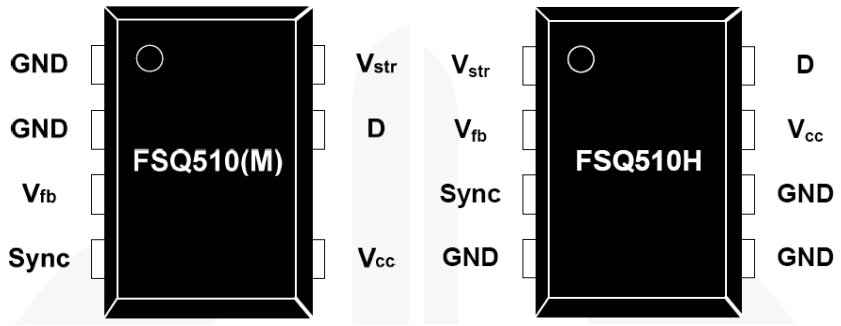
Product number	PKG(5)	Operating temp	I_{LIM}	$R_{DS(ON)MAX.}$	Maximum output power(1)			
					230Vac±15%(2)		85~265Vac	
					Adapter(3)	Open frame	Adapter	Open frame(4)
FSQ0465RB	TO-220F-6L	-25~85°C	2.5A	2.6Ω	60W	70W	33W	48W
FSQ0465RS			1.8A	2.6 Ω	60W	70W	33W	48W
FSQ0465RU			1.8A	4.0 Ω	50W	60W	28W	40W
FSQ0565RQ			2.25A	2.2Ω	70W	80W	41W	60W
FSQ0565RS			3.0A	2.2Ω	70W	80W	41W	60W
FSQ0765RQ			2.5A	1.6Ω	80W	90W	48W	70W
FSQ0765RS			3.5A	1.6Ω	80W	90W	48W	70W

(1) The junction temperature can limit the maximum output power.
(2) 230Vac or 110/115Vac with doubler.
(3) Typical continuous power in a non-ventilated enclosed adapter measured 50°C ambient temperature.
(4) Maximum practical continuous power in an open-frame deign at 50°C ambient.
(5) PB-free package per JEDEC J-STD-020B.

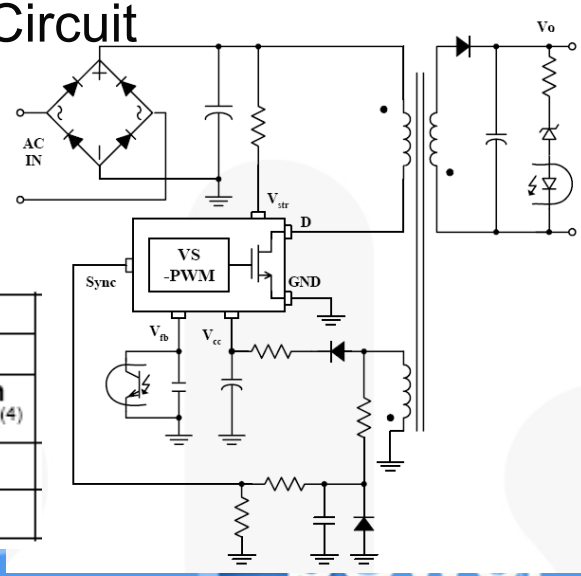
FSQ510 – Standby PSU Solution

- **General Features**
  - Uses an LDMOS (700V) integrated power switch
  - Optimized for Valley Switching Converter
  - Inherent Frequency Modulation
  - Small frequency variation for wide load ranges
  - Burst mode for low standby power consumption
  - Pulse-by-pulse current limit
  - Protections: OLP and TSD with hysteresis
  - Internal Startup circuit
  - Soft-start (5ms) is included

- **Pin Configurations**



- **Typical Application Circuit**



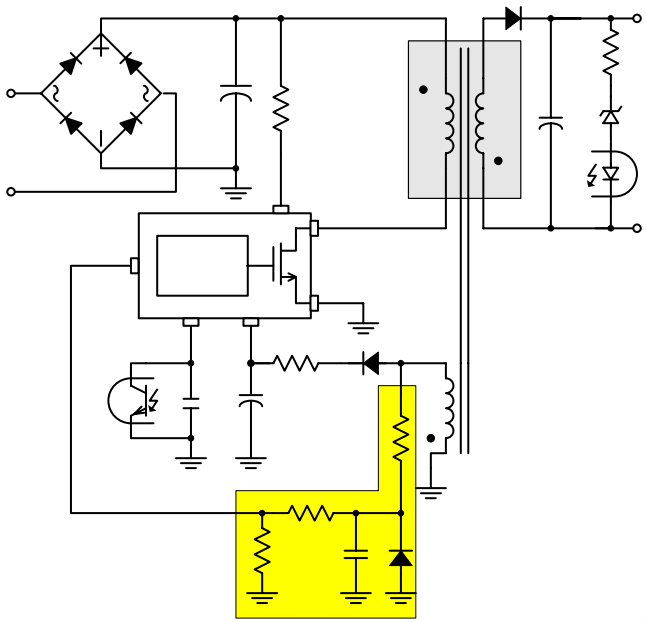
- **Lineup**

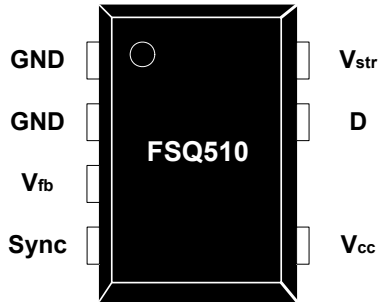
Part Number	Package	Pb-Free	Operating Temperature Range	Current Limit	$R_{DS(ON)}$ (MAX)	Output Power Table (1)			
						230VAC ± 15% (2)		85-265VAC	
						Adapter (3)	Open Frame (4)	Adapter (3)	Open Frame (4)
FSQ510	7-DIP	Yes	-40°C to +85°C	320mA	32Ω	5.5W	9W	4W	6W
FSQ510H	8-DIP	Yes	-40°C to +85°C	320mA	32Ω	5.5W	9W	4W	6W

Introduction of FSQ510

New Green FPS e-Series™ supports environment friendly systems through

- Hybrid PWM Controller allows both fixed frequency PWM and QR-PWM
- Low standby power consumption less than 60mW for FSQ510
- Better efficiency by soft switching technology (QRC)
- Low EMI by inherent frequency modulation and minimum voltage switching
- Enhanced thermal performance by minimized switching loss
- High reliability by strong protections

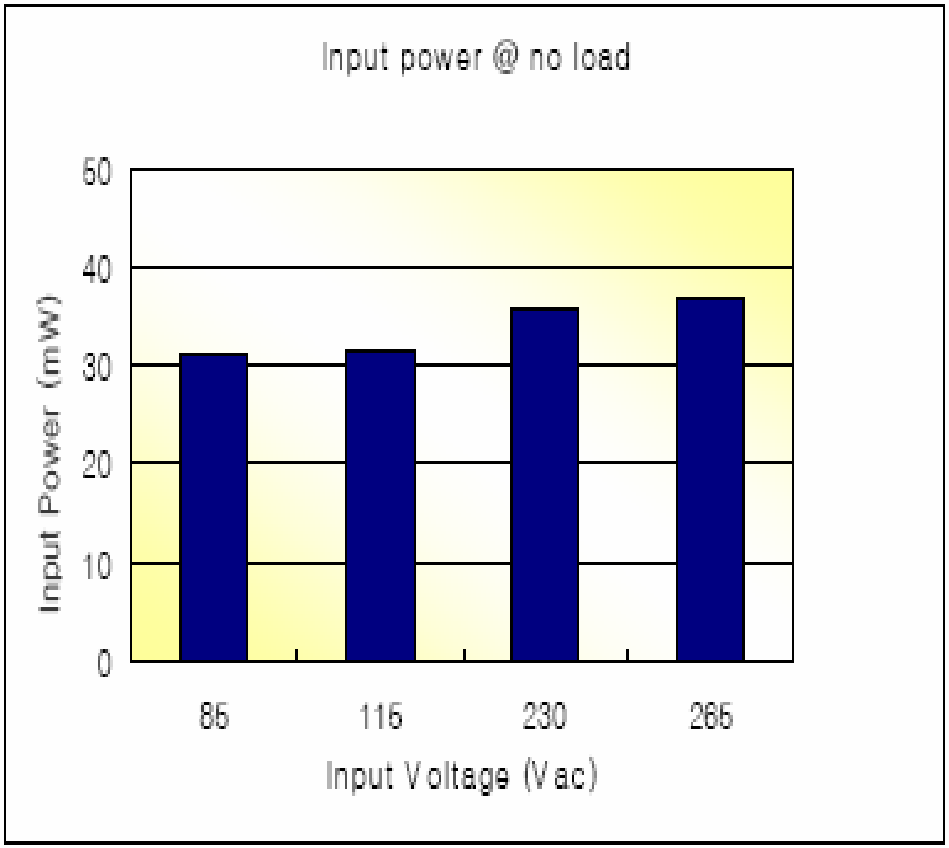


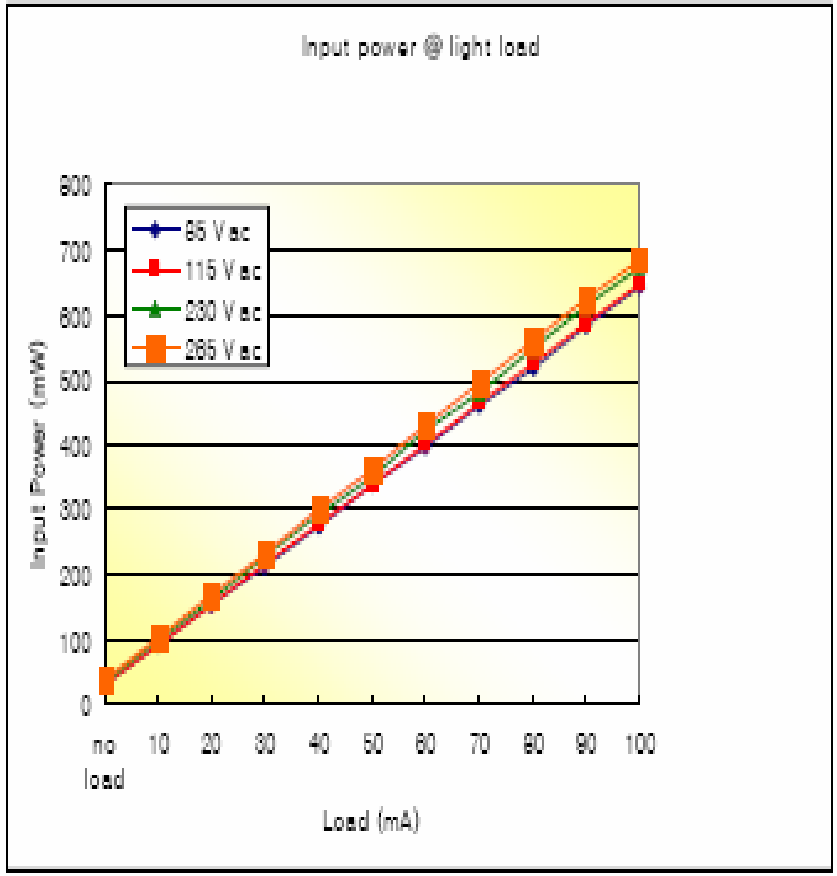


7 DIP

FSQ510 for Standby Power

- Power consumption at the condition, Vout = 5.2V & 0.8A

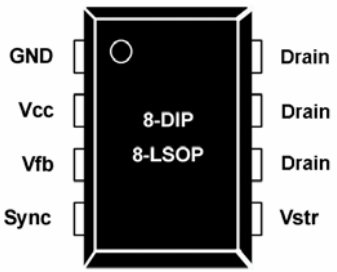


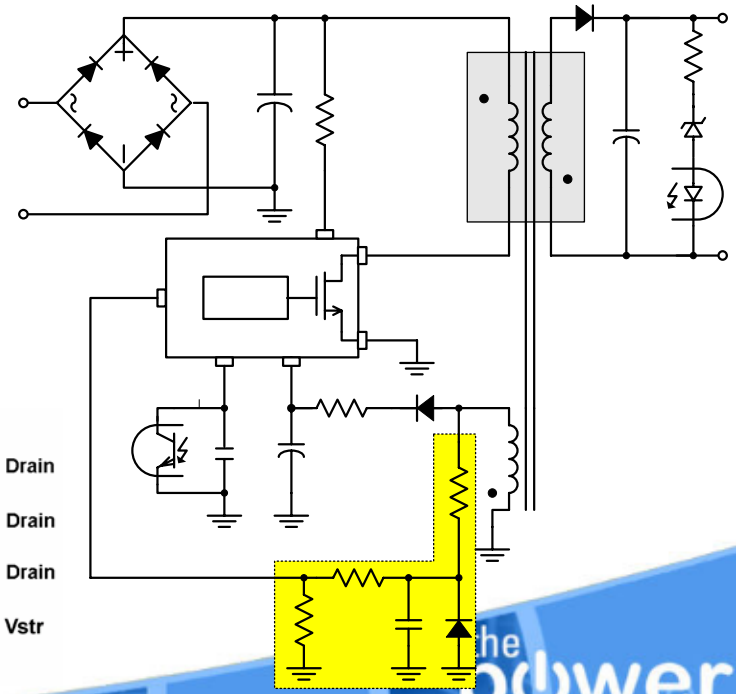


E-Series I FPS (FSQ0365/0265/0165/321/311)

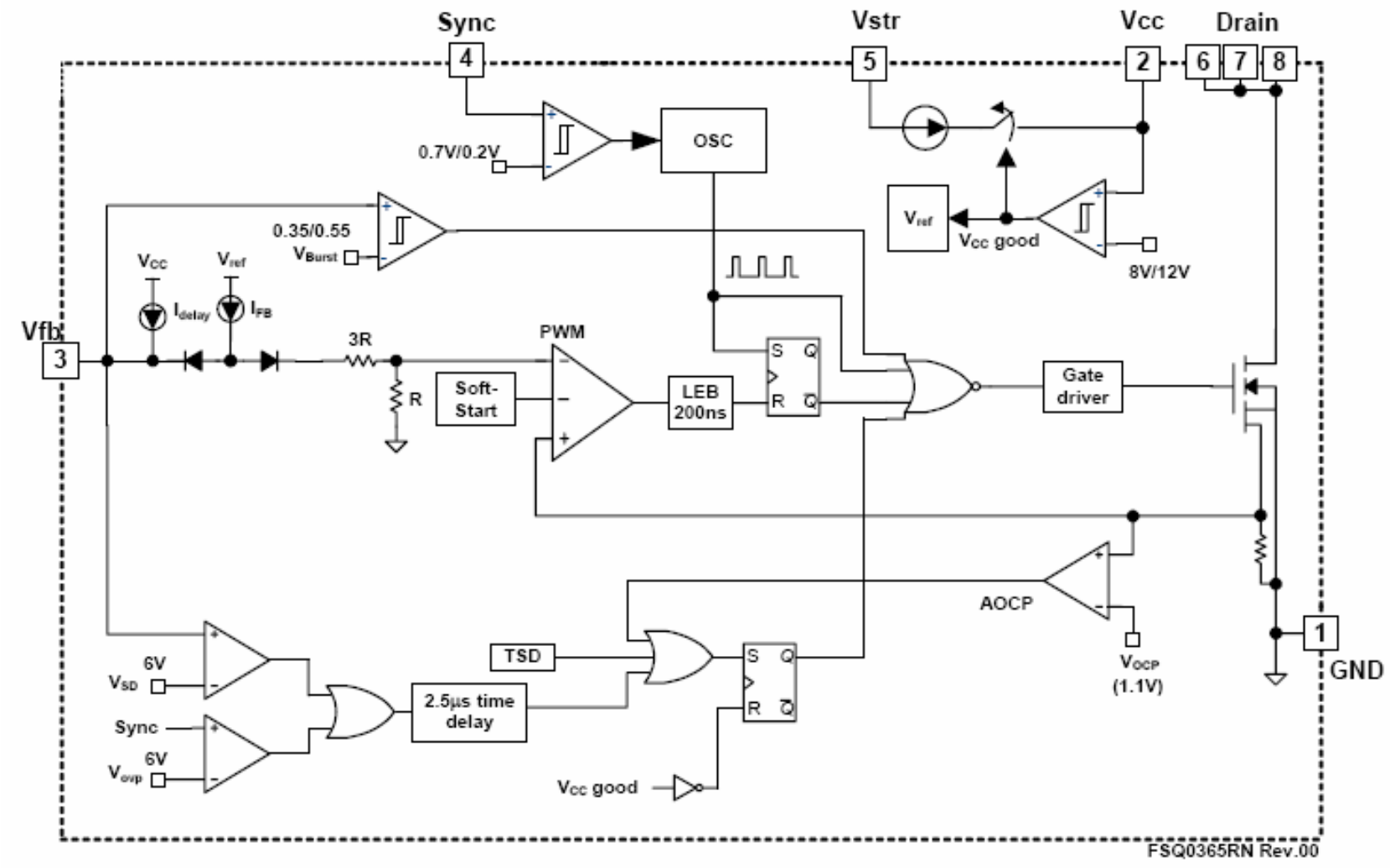
❑ Features

- **Optimized for Quasi-Resonant Converter (QRC)**
- **Low EMI through Variable Frequency Control and Inherent Frequency Modulation**
- **High Efficiency through Minimum Voltage Switching**
- **Narrow frequency variation range over Wide Load and Input Voltage Variation**
- **Advanced Burst-Mode Operation for Low Standby Power Consumption and minimized audible noise (standby power consumption less than 1 W for 0.5W load)**
- **Pulse-by-Pulse Current Limit**
- **Various Protection functions: OLP, OVP, AOCP, TSD**
- **Under Voltage Lock Out (UVLO) with Hysteresis**
- **Internal startup circuit**
- **Internal High Voltage Sense FET (650V)**
- **Built-in Soft Start (15ms)**
- **Code S: Now**





e-Series I FPS Block Diagram



Lineup of *e-Series I FPS*

Ordering Information

Product Number[5]	PKG.	Operating Temp.	Current Limit	$R_{DS(ON)}$ Max.	Maximum Output Power[1]				Replaces Devices
					230VAC±15%[2]		85-265VAC		
					Adapter[3]	Open-Frame[4]	Adapter[3]	Open-Frame[4]	
FSQ311	8-DIP	-25 to +85°C	0.6A	19 Ω	7W	10W	6W	8W	FSDL321 FSDM311
FSQ311L	8-LSOP								
FSQ321	8-DIP	-25 to +85°C	0.6A	19 Ω	8W	12W	7W	10W	FSDL321 FSDM311
FSQ321L	8-LSOP								
FSQ0165RN	8-DIP	-25 to +85°C	0.9A	10 Ω	10W	15W	9W	13W	FSDL0165RN
FSQ0165RL	8-LSOP								
FSQ0265RN	8-DIP	-25 to +85°C	1.2A	6 Ω	14W	20W	11W	16W	FSDM0265RN FSDM0265RNB
FSQ0265RL	8-LSOP								
FSQ0365RN	8-DIP	-25 to +85°C	1.5A	4.5 Ω	17.5W	25W	13W	19W	FSDM0365RN FSDM0365RNB
FSQ0365RL	8-LSOP								

Notes:

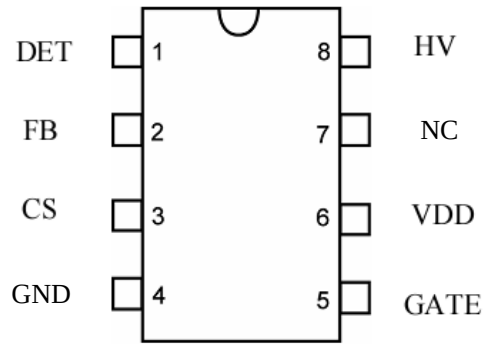
1. The junction temperature can limit the maximum output power.
2. 230VAC or 100/115VAC with doubler. The maximum power with CCM operation.
3. Typical continuous power in a non-ventilated enclosed adapter measured at 50°C ambient temperature.
4. Maximum practical continuous power in an open-frame design at 50°C ambient.
5. PB-free package per JEDEC J-STD-020B.

QRC Controller:FAN6300

- **FEATURES**
  - Quasi-Resonant Operation
  - Over Power Compensation (DET Pin)
  - Internal 4mS Soft-Start
  - Internal Minimum Toff 8uS
  - Internal Leading Edge Blanking
  - Cycle-by-cycle current limiting
  - Peak current mode control
  - High Efficiency

QRC, High Average Eff.
High Cost-Efficient

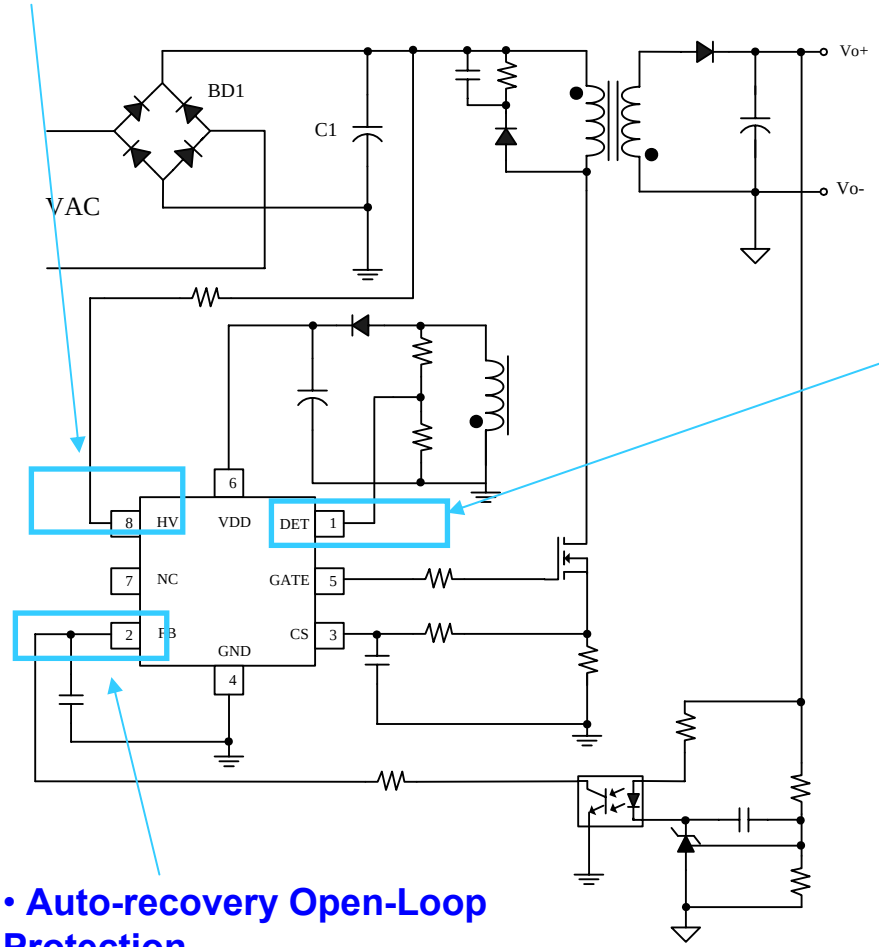
- **PROTECTION**
  - Auto-Recovery- FB pin Open-Loop Protection for Output Over Load & SCP
  - VDD Pin OVP & DET Pin for Output Voltage OVP (Latched)



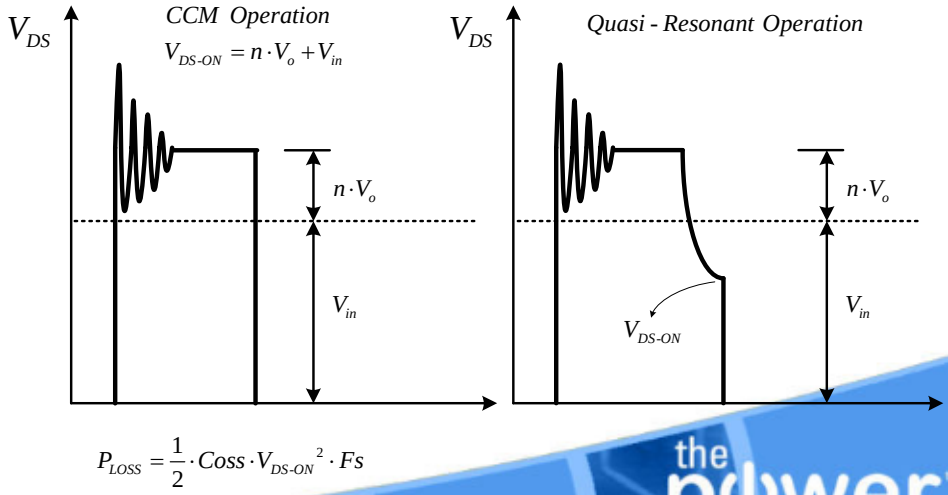
FAN6300

QRC Controller:FAN6300 Typical Application Circuit

HV Startup



- Valley Detect for QR Operation
- H/L line Over Power Compensation
- Output Voltage OVP (Latched)

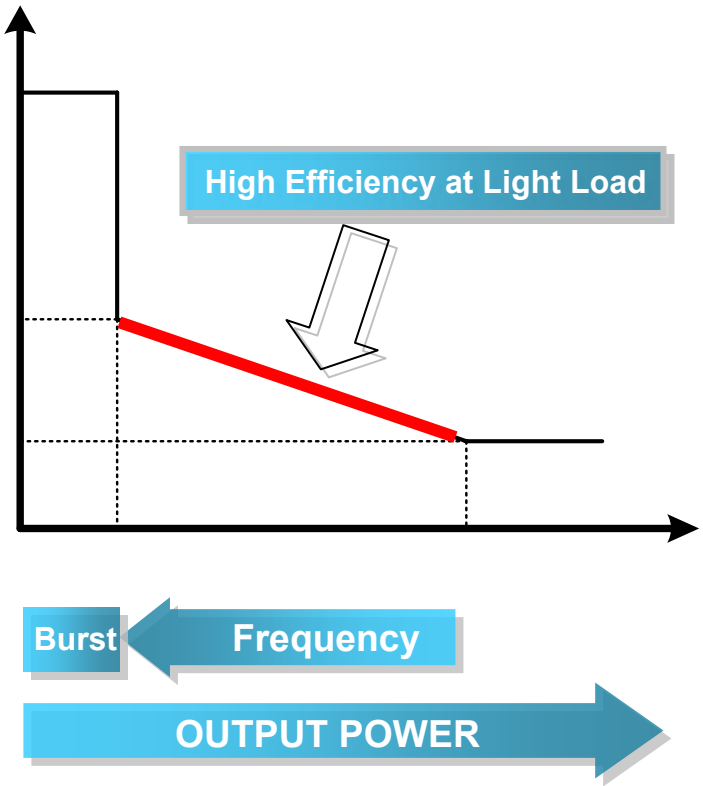


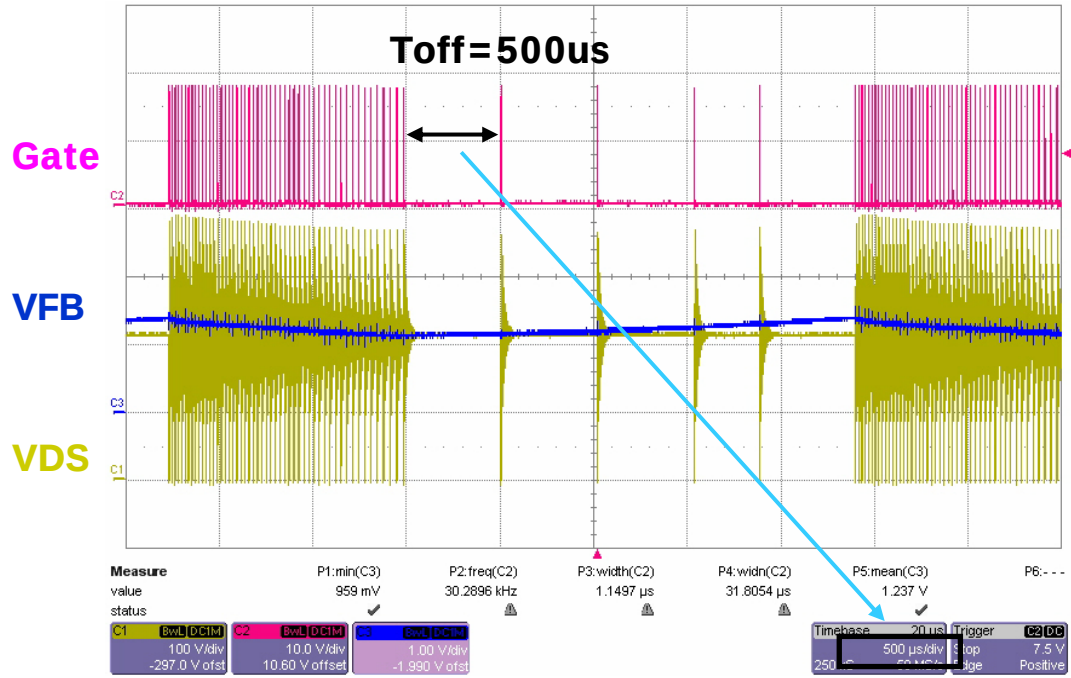
$$P_{LOSS} = \frac{1}{2} \cdot Coss \cdot V_{DS-ON}^{\ 2} \cdot Fs$$

- Auto-recovery Open-Loop Protection

QRC Controller:
FAN6300 - Green Mode Operation

- Green Mode Operation
  - OFF-Time modulation
  - Maximum On-Time Fixed





QRC Controller:

FAN6300 - No load & Light load & Efficiency test result

QRC, High Average Eff.
High Cost-Efficient

Test Board: NB 90W 19V

(PFC:FAN6961+QRC:FAN6300)

Input Voltage	Input wattage(W)	Output voltage(V)	Spec.
90V/60Hz	0.182	19.304	240Vac < 0.3W
115V/60Hz	0.186	19.306	
230V/50Hz	0.233	19.310	
240V/50Hz	0.239	19.314	
264V/50Hz	0.252	19.316	

Output Watt		Actual Output Watt	Input Watt	Spec.
0.5W	115Vac	0.517	0.713	Input Watt <1W
	230Vac	0.517	0.823	
1W	115Vac	1.013	1.268	Input Watt <1.7W
	230Vac	1.013	1.345	
1.15W	115Vac	1.158	1.440	Input Watt <2.16W
	230Vac	1.158	1.513	
1.5W	115Vac	1.505	1.849	Input Watt <2.4W
	230Vac	1.505	1.893	
1.7W	115Vac	1.710	2.076	Input Watt <2.4W
	230Vac	1.711	2.173	

Output Watt	22.5W	45W	67.5W	90W	avg
90V/60Hz	89.12	90.31	89.93	88.84	89.55
115V/60Hz	89.57	90.96	90.87	90.08	90.37
230V/50Hz	87.83	90.15	90.84	91.40	90.06
264V/50Hz	88.13	90.79	91.38	91.34	90.41

Introduction of FAN6755

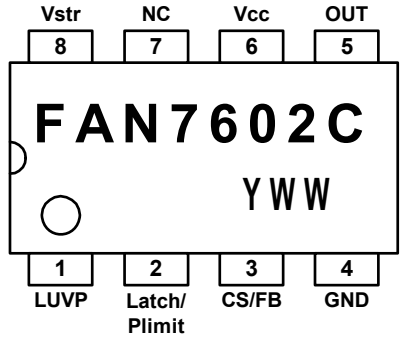
- Fixed frequency PWM IC, FAN6755
  - 700V JFET
  - Power saving < 80mW
  - 25% load improvement, average efficiency >84% to meet EPS 2.0 level 5
  - Internal soft-start

- Input Power at NO LOAD

	SG6742ML	FAN6754	FAN6755
90V/60Hz	0.0710	0.0385	0.0384
115V/60Hz	0.0738	0.0436	0.0391
230V/50Hz	0.1020	0.0790	0.0640
240V/50Hz	0.1050	0.0830	0.0660
264V/50Hz	0.1200	0.0880	0.0780

FAN7602C
- Green Function Current Mode PWM IC

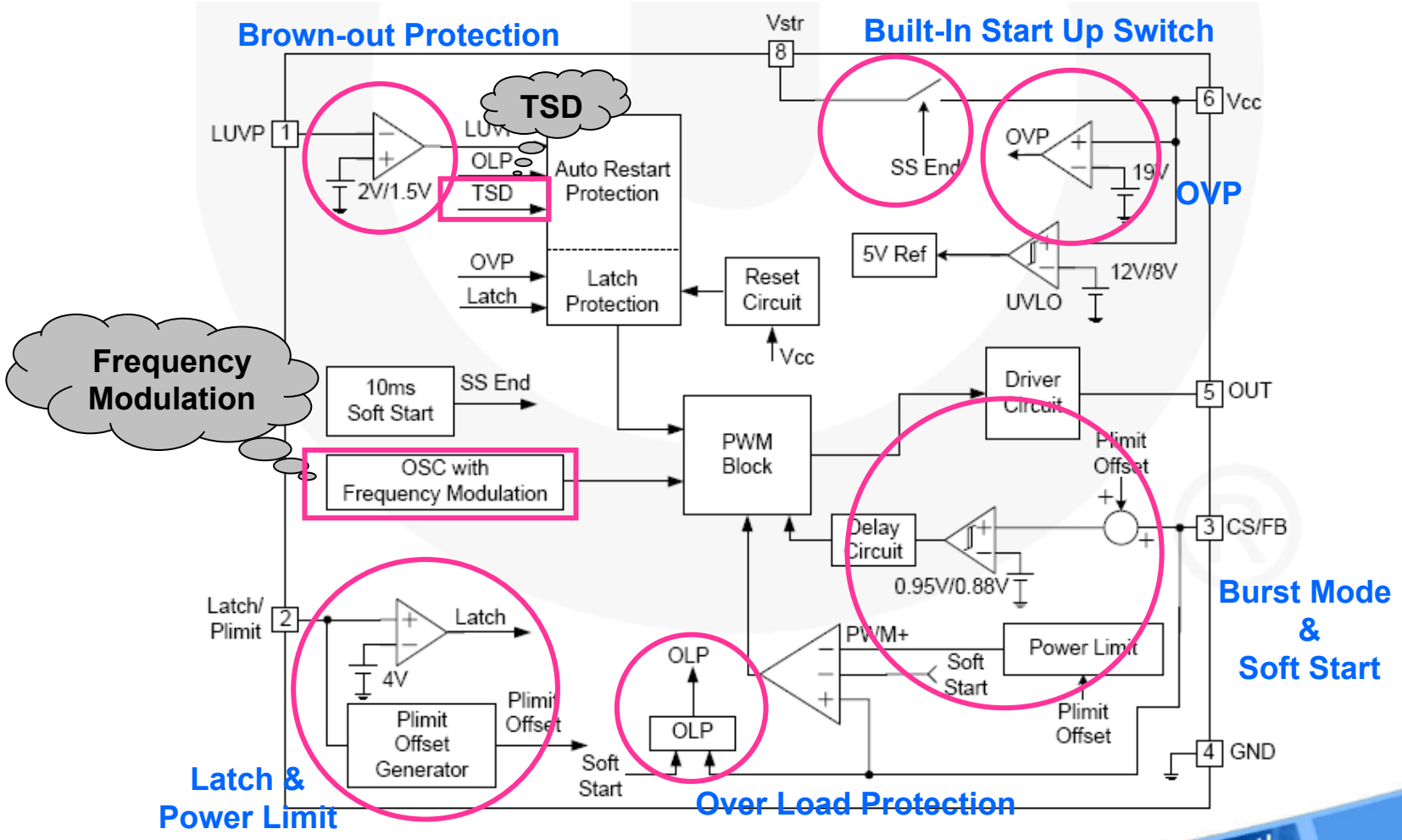
- **Features**



- **Green Function Control**
- **Oscillator with Frequency Modulation**
- **Built-In Start_Up Switch**
- **Burst Mode Operation**
- **Internal Soft Start (14ms)**
- **Input Power Limit Function**
- **Under Voltage Lock Out (UVLO): 12V / 8V**
- **Over Voltage Protection (OVP): 19V**
- **Over Load Protection**
- **Line Under Voltage Protection (Brown Out Protection)**
- **TSD**
- **Output Current : +500mA/-650mA**
- **8DIP/8SOP**

FAN7602C
- Green Function Current Mode PWM IC

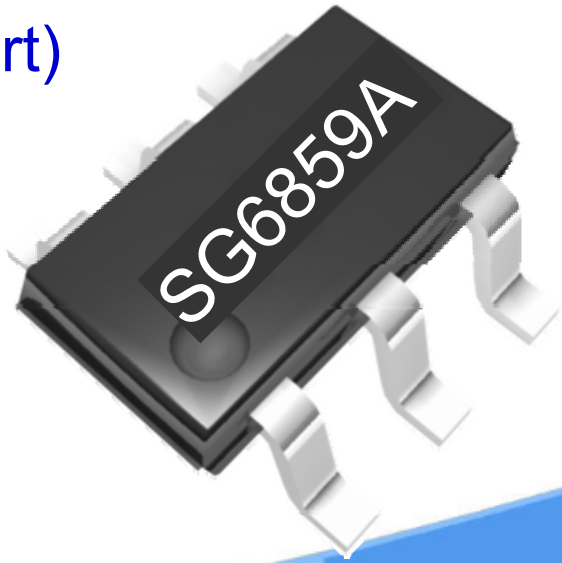
- **Block Diagram**



6PIN PWM Controller : SG6859A

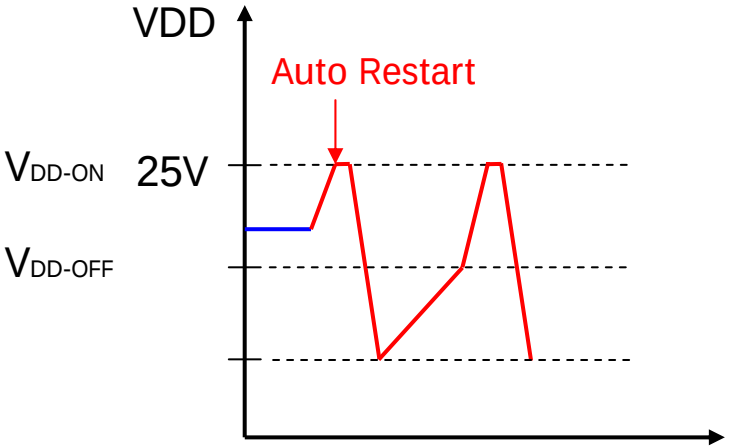
Low Cost
SOT23 Package

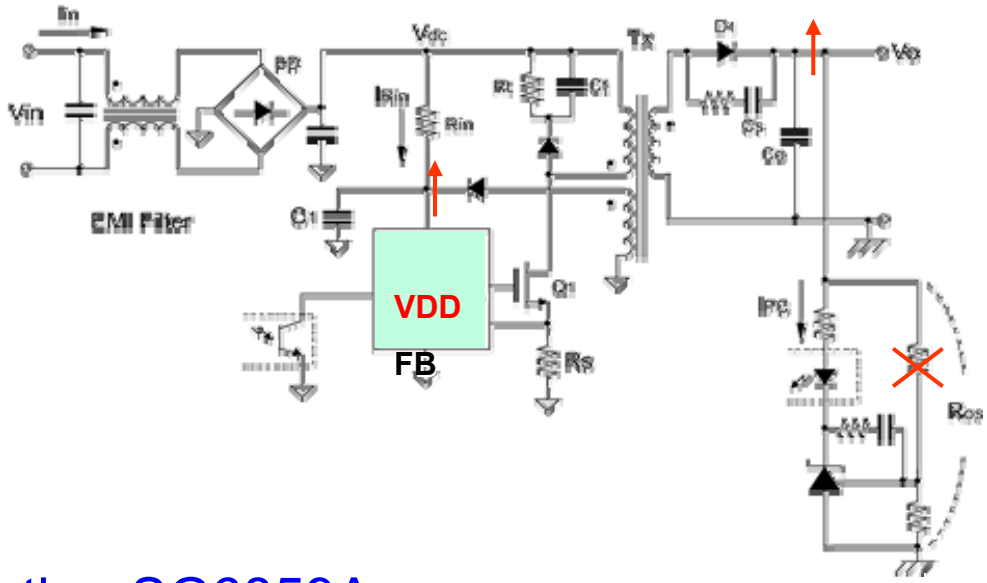
- **Features**
  - Programmable PWM frequency by RI Pin
  - Green-mode operation for power saving
  - Sense pin Built-in Saw Limit for Line compensation
  - Built-in Leading Edge Blanking
  - VDD Over Voltage Protection(Auto Restart)
  - Built-in Slope Compensation
  - Frequency hopping
  - Open-loop protection



SSR Controller: SG6859A

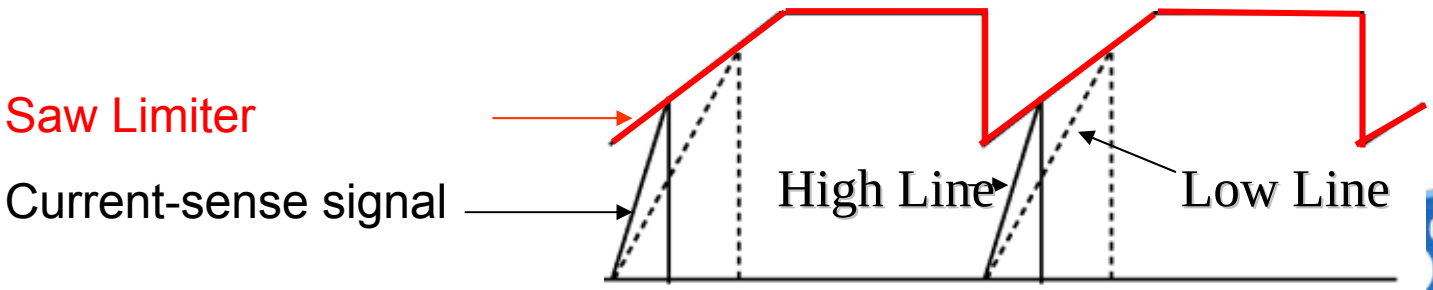
VDD Over Voltage Protection-SG6859A





Saw Limiter for Line Compensation-SG6859A

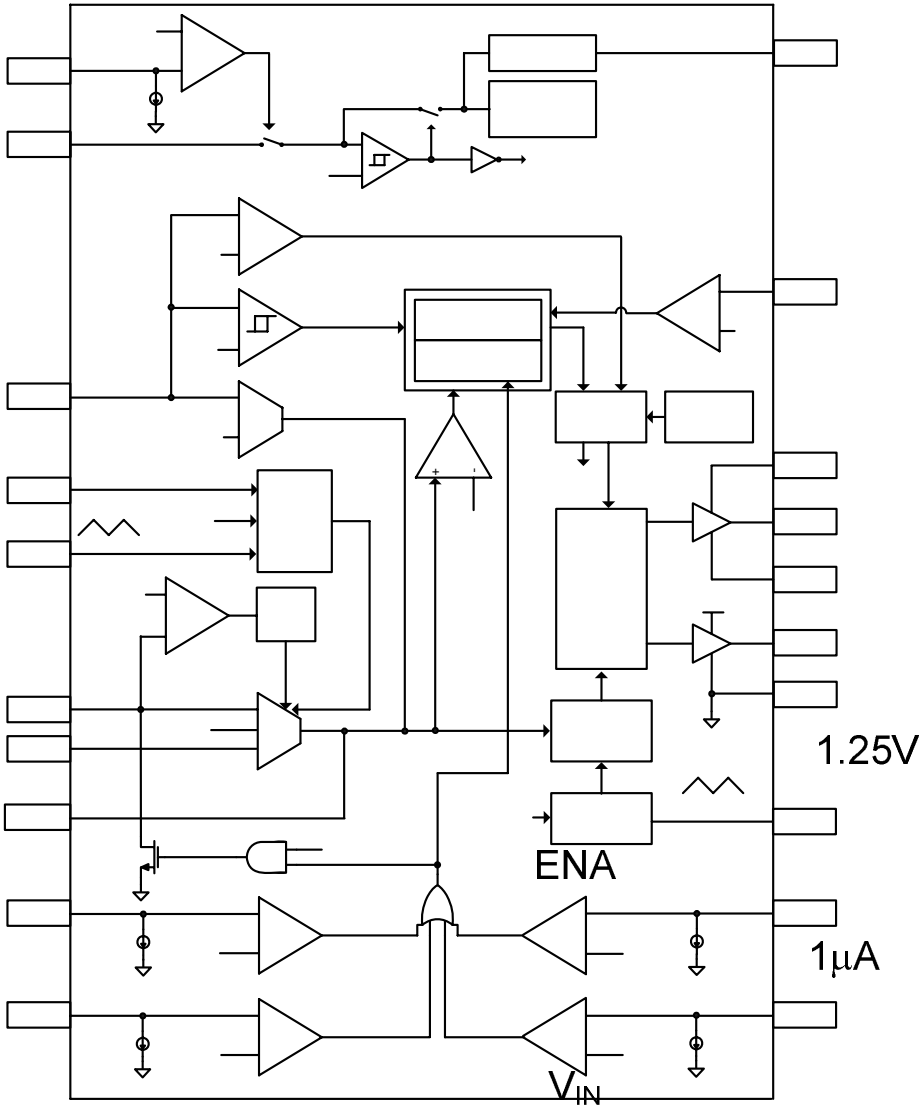
Constant Output Power under Universal AC input



FSC Inverter Product Line - up

Generation	Products	Description	Features								Status
			Vcc (V)	Dimming	Soft Start	OLP	OLR(=OVP)	SCP	Vout(Max)	Iout(Max)	
0 G	FAN7547A	1Ch. Buck-Royer	6 ~ 30	Analog, Burst	O	O	O	X	Vcc	0.2A	S
	FAN7548	2Ch. Buck-Royer	9 ~ 30	Analog, Burst	O	O	O	X	13.5V	0.2A	S
1st G	FAN7311/A/B	P-N Full Bridge	5 ~ 25.5	Analog, Burst	O	O	O	X	8.5V	0.2A	S
	FAN7314/A	P-N Half Bridge	5 ~ 25.5	Analog, Burst	O	O	O	X	8.5V	0.2A	S
2nd G	FAN7313	Push-Pull	4.5 ~ 25.5	Analog, Burst	O	Internal (4)	O	O	6V	0.5A	S
	FAN7316	N-N Half Bridge	4.5 ~ 24	Analog, Burst	O	Internal (4)	O	O	6V	0.5A	S
	FAN7317	P-N Full Bridge	6 ~ 24	Burst	O	Internal (4)	Internal (4)	SLP	6V	0.2/0.3A	S
	FAN7318	P-N Half Bridge	6 ~ 30	Analog, Burst	O	Internal (4)	Internal (4)	SLP	8V	0.3/0.4A	D (P12)
3rd G	FAN7320	H/B Switch Integration	9 ~ 25.5	Analog, Burst	O	Internal (4)	Internal (4)	SLP	Ron=30mΩ		S

FAN7313
Block Diagram & Features

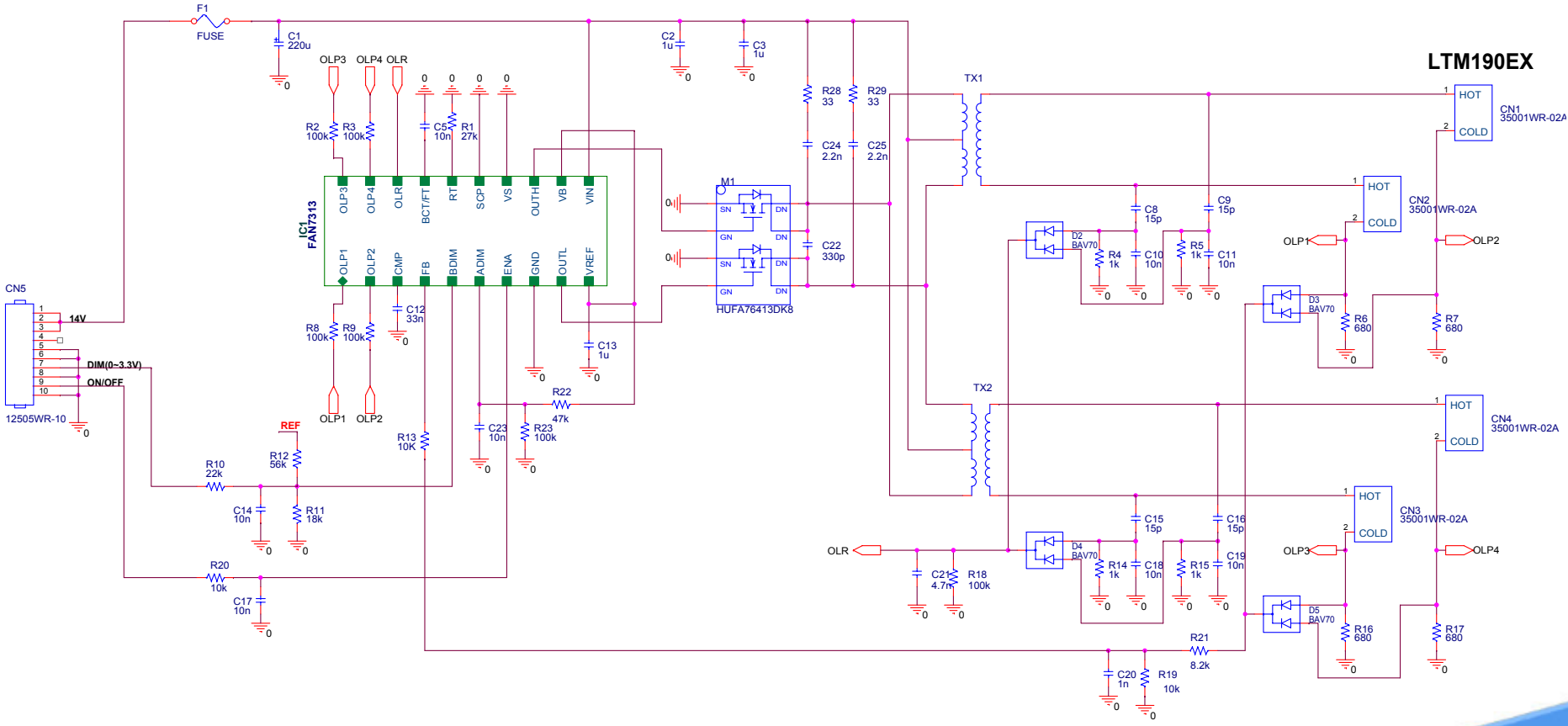


Features

- High Efficiency Single Stage Power Conversion
- Wide Input Voltage Range : 4.5~25.5V
- Precision Voltage Reference : 2%
- Reduces Number of Required External Components
- Push-Pull Topology
- Soft Start
- PWM Control at Fixed Frequency
- Analog and Burst Dimming
- Striking Frequency (=1.3* F_{normal})
- Open Lamp Protection
- Open Lamp Regulation
- Short Circuit Protection
- 20 Pin SOIC

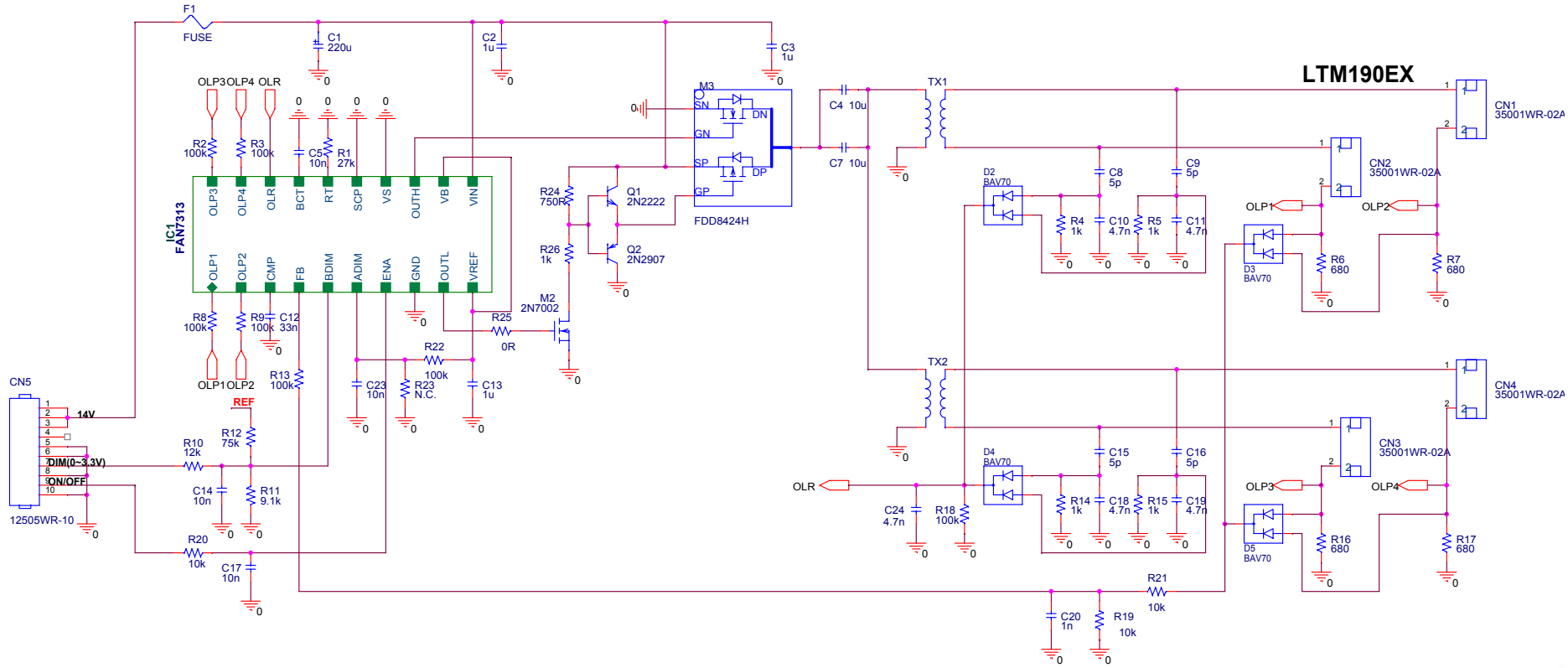
FAN7313

Push-Pull Application Circuit

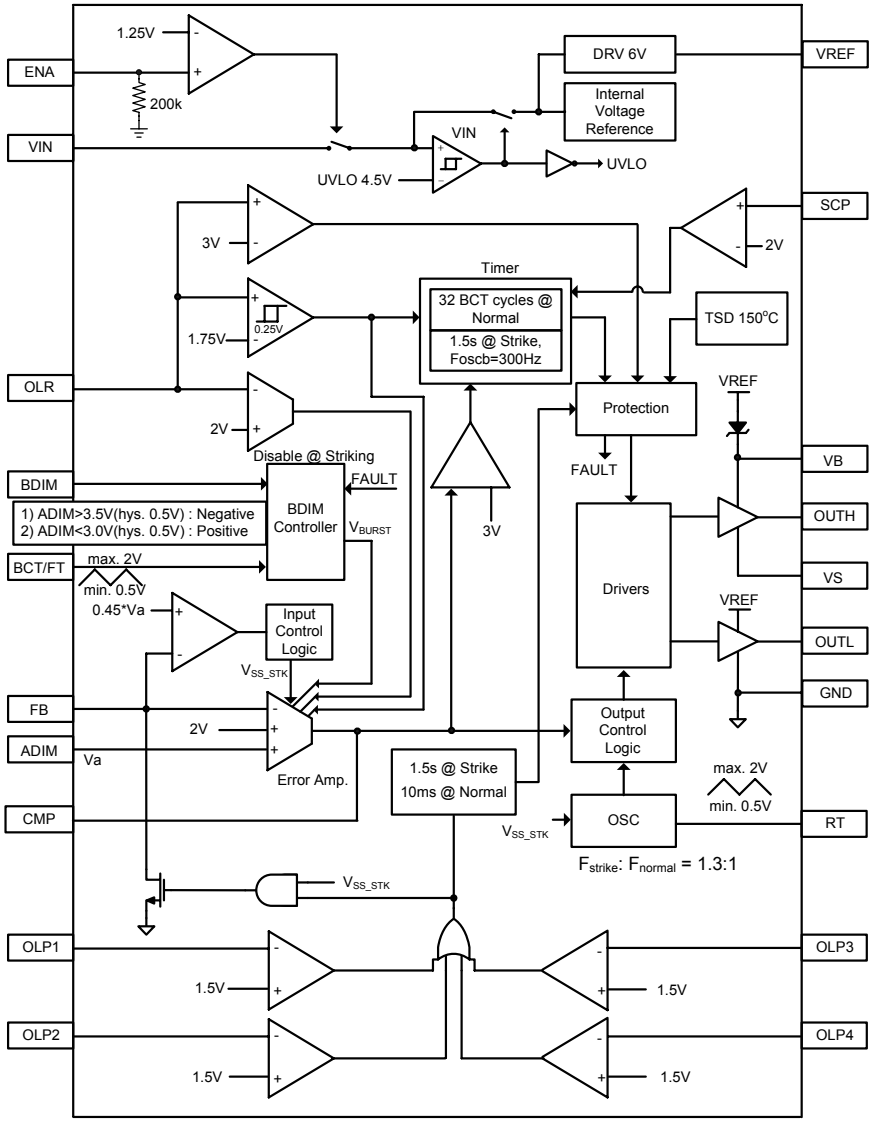


FAN7313

P-N Half-Bridge Application Circuit



FAN7316
Block Diagram & Features

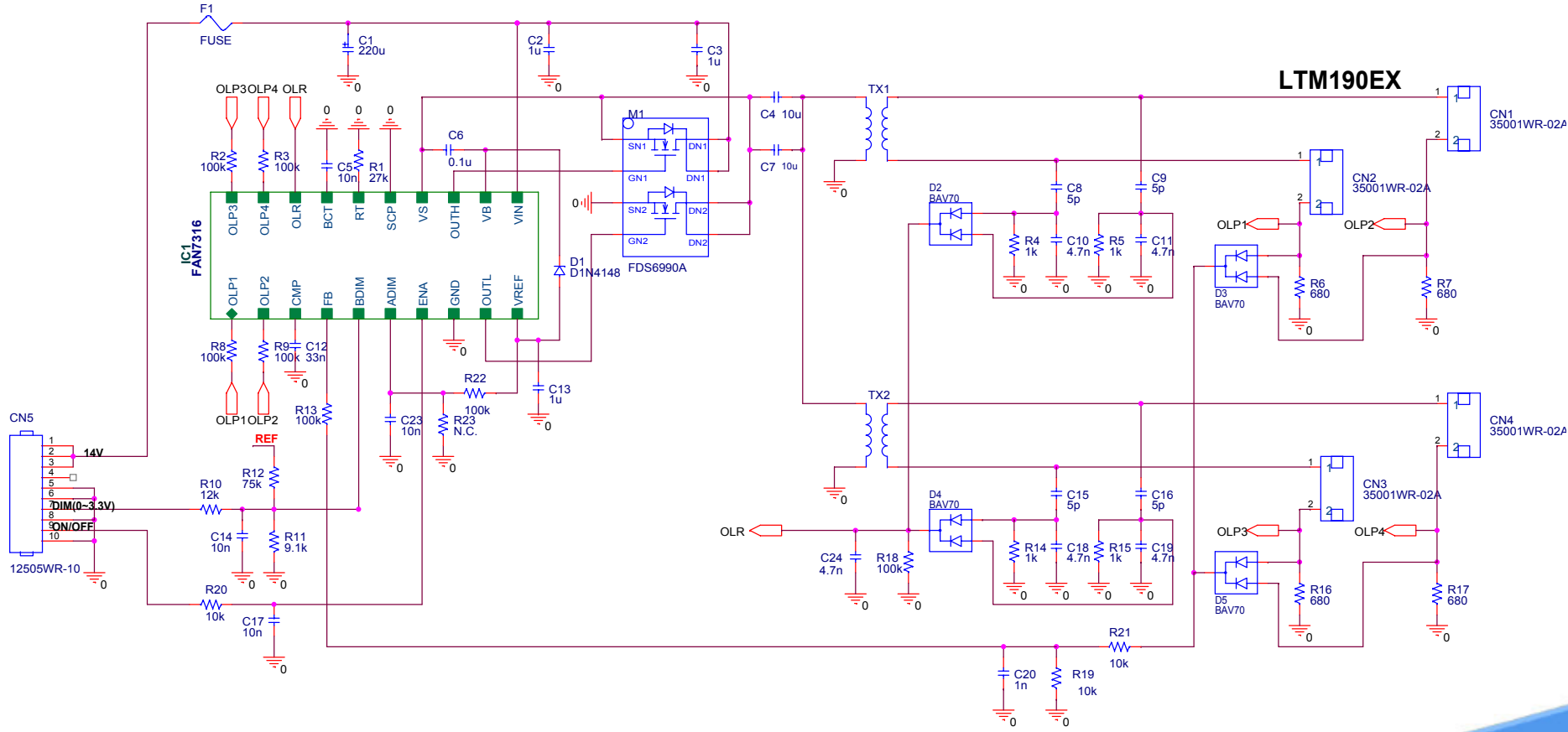


Features

- High Efficiency Single Stage Power Conversion
- Wide Input Voltage Range : 4.5~24V
- Precision Voltage Reference : 2%
- Reduces Number of Required External Components
- N-N Half-Bridge & Push-Pull Topology
- Soft Start
- PWM Control at Fixed Frequency
- Analog and Burst Dimming
- Striking Frequency (=1.3* F_{normal})
- Open Lamp Protection
- Open Lamp Regulation
- Short Circuit Protection
- 20 Pin SOIC

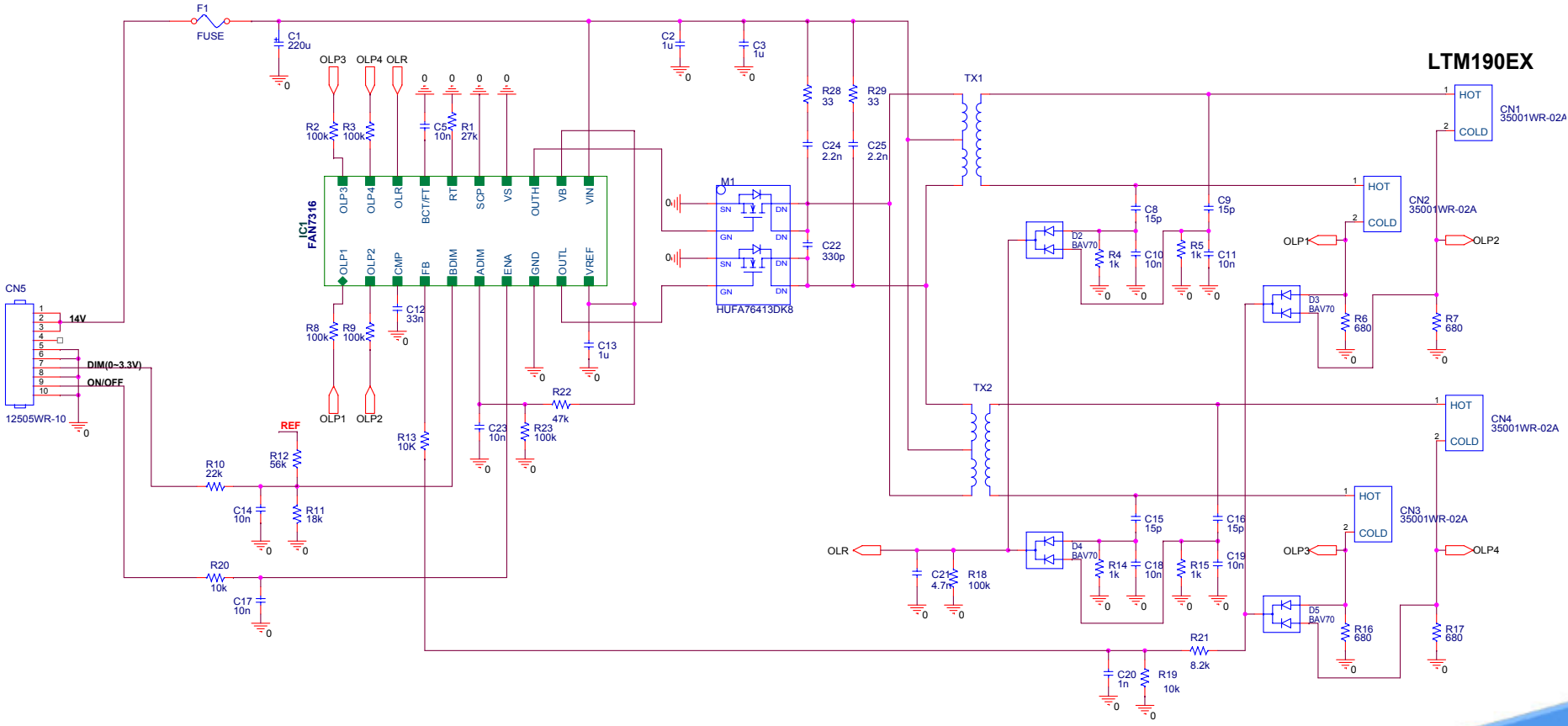
FAN7316

N-N Half-Bridge Application Circuit

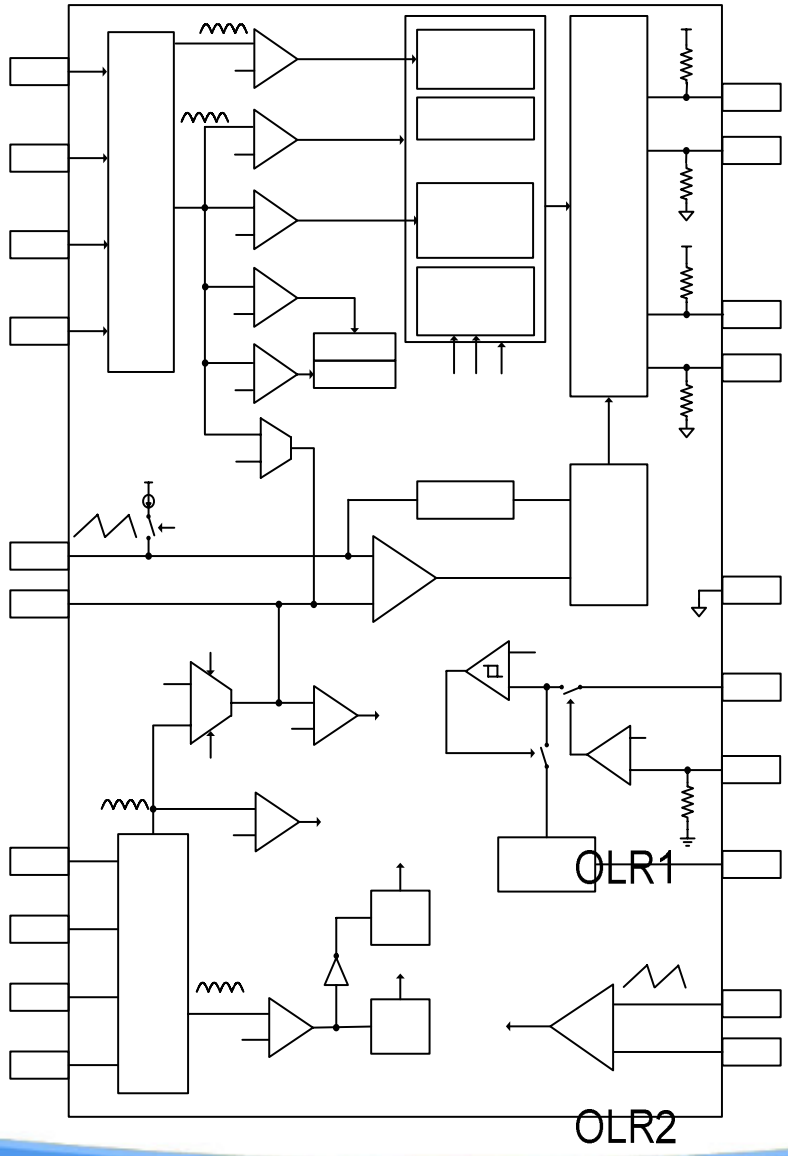


FAN7316

Push-Pull Application Circuit



FAN7317
Block Diagram & Features



Features

- High Efficiency Single Stage Power Conversion
- Wide Input Voltage Range : 6~24V
- Precision Voltage Reference : 2%
- **Reduces Number of Required External Components**
- ZVS P-N Full-Bridge Topology
- Soft Start
- PWM Control at Fixed Frequency
- Burst Dimming
- Programmable Striking Frequency
- Open Lamp Protection
- Open Lamp Regulation
- Short Lamp Protection
- 20 Pin SOIC

0.3V +

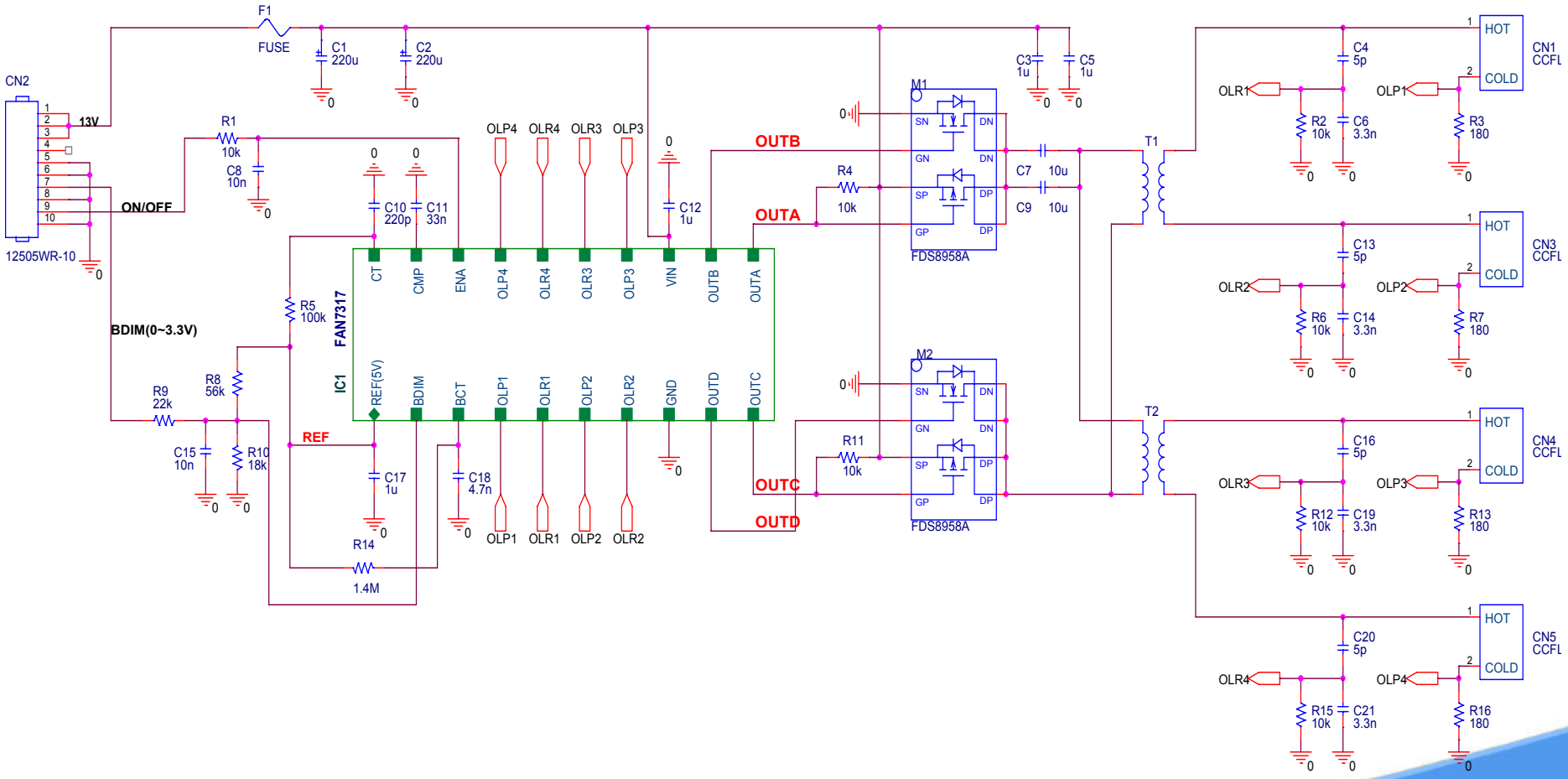
Arc protection / no delay

+

3V -

FAN7317

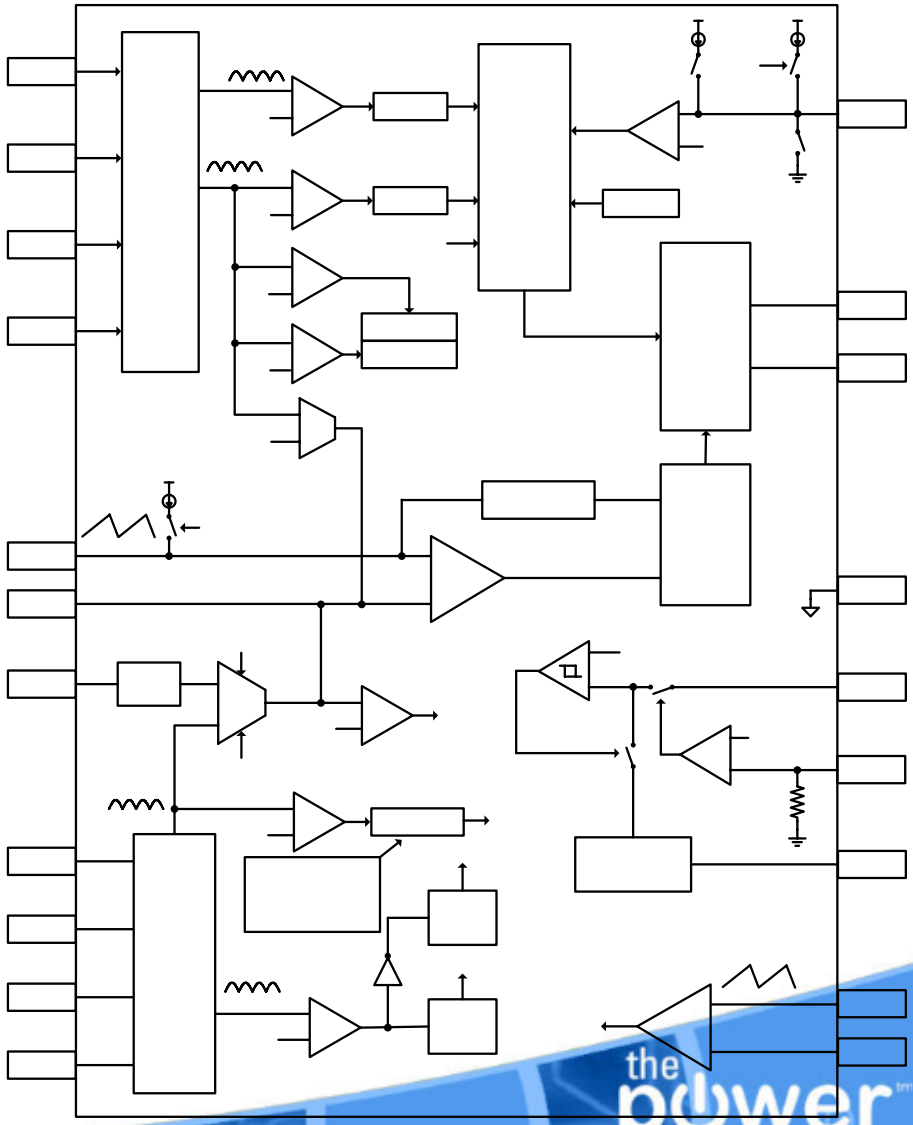
P-N Full-Bridge Application Circuit



FAN7318
Block Diagram & Features

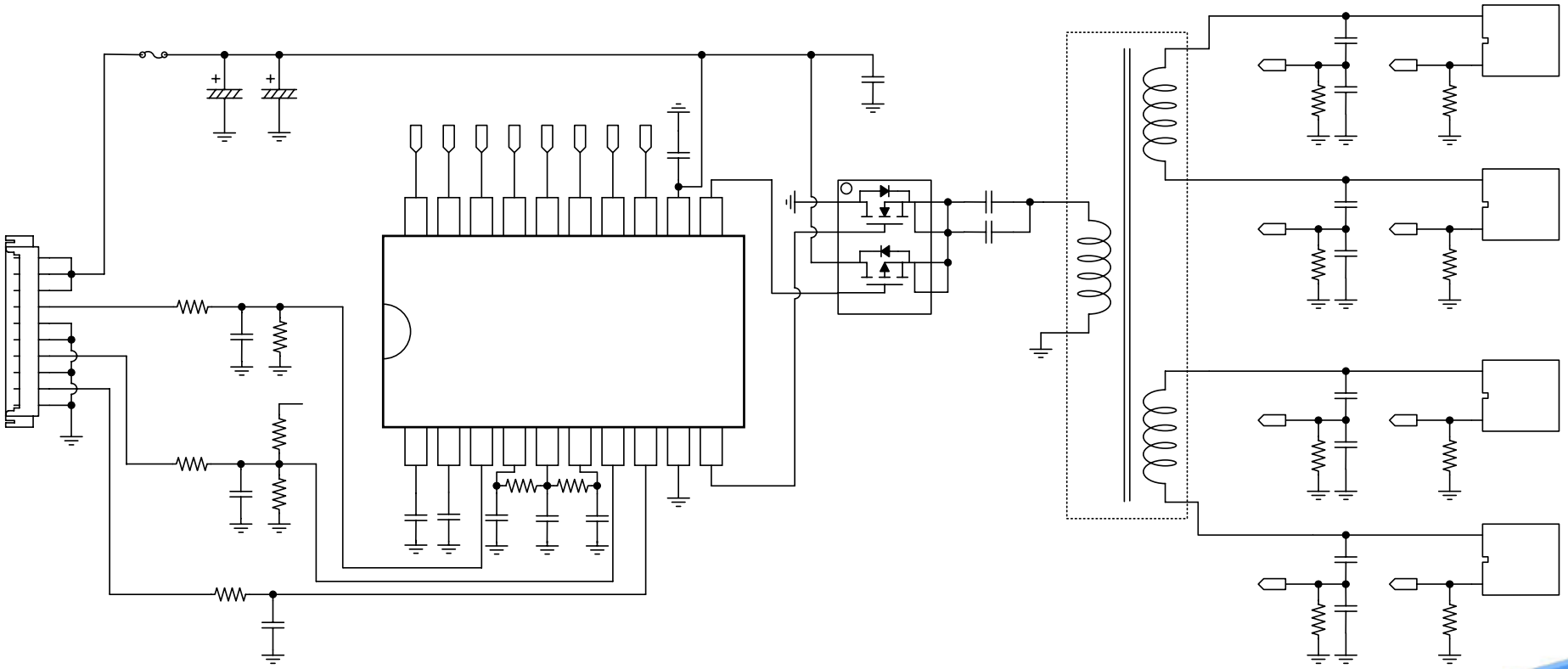
Features

- High-Efficiency Single-Stage Power Conversion
- Wide Input Voltage Range: 6V to 30V
- Backlight Lamp Ballast and Soft Dimming
- Minimal Required External Components
- Precision Voltage Reference Trimmed to 2%
- P-N Half-Bridge Topology
- Direct PMOS Drive Circuit
- Soft-Start
- PWM Control at Fixed Frequency
- Negative Analog Dimming Function
- Negative Burst Dimming Function
- Programmable Striking Frequency
- Open-Lamp Regulation
- Open-Lamp Protection (disabled by ENA voltage)
- Short-Lamp Protection (disabled by ENA voltage)
- CMP-High Protection (disabled by a pull-down resistor)
- High-FB Protection
- Thermal Shutdown
- 20-Pin SOIC



FAN7318

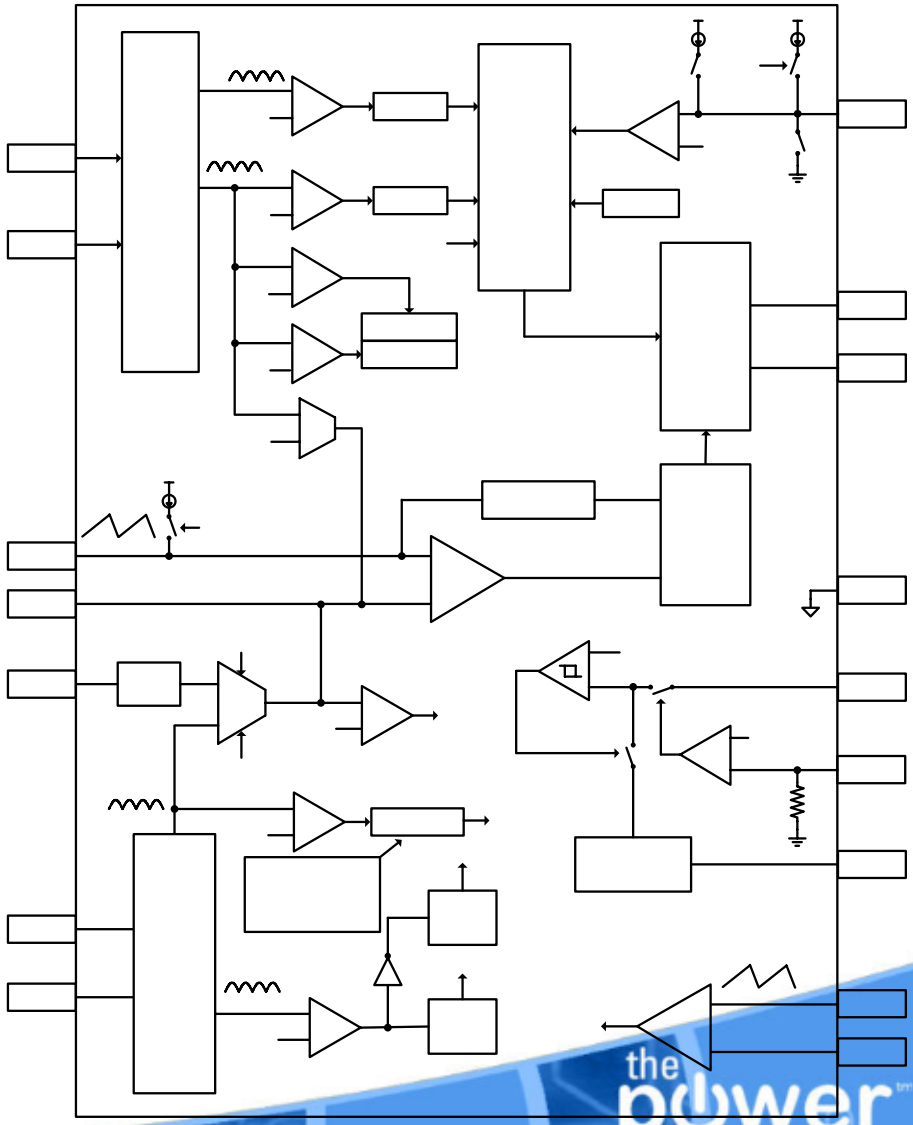
4 lamps application circuit



FAN7318A
Block Diagram & Features

Features

- High-Efficiency Single-Stage Power Conversion
- Wide Input Voltage Range: 6V to 30V
- Backlight Lamp Ballast and Soft Dimming
- Minimal Required External Components
- Precision Voltage Reference Trimmed to 2%
- P-N Half-Bridge Topology
- Direct PMOS Drive Circuit
- Soft-Start
- PWM Control at Fixed Frequency
- Negative Analog Dimming Function
- Negative Burst Dimming Function
- Programmable Striking Frequency
- Open-Lamp Regulation
- Open-Lamp Protection (disabled by ENA voltage)
- Short-Lamp Protection (disabled by ENA voltage)
- CMP-High Protection (disabled by a pull-down resistor)
- High-FB Protection
- Thermal Shutdown
- 16-Pin SOIC



FAN7318A

2 lamps application circuit