



安森美半导体
ON Semiconductor[®]

液晶电视交流-直流(AC-DC)

电源架构及LED背光

AC-DC LCD TV Power architecture
and LED backlight

液晶电视电源架构及LED背光

LCD TV Power architecture and LED backlight

- **液晶电视市场趋势 LCD-TV Market**

- 能耗降低趋势 Power Reduction Trend
- 侧光式LED液晶电视背光 Edge LED LCD TV Backlight

- **26至42英寸高压LIPS参考设计 26” to 42” H-V LIPS Reference Design**

- **46/47英寸液晶电视电源参考(PSU), 适合任何背光方案 46/47” Power Reference (PSU) for any Backlight solution**

- 采用NCP1631的交错式频率钳位CrM PFC Interleaved Frequency Clamp CrM PFC with NCP1631
- 采用NCP1379的准谐振谷底锁定反激转换器 Quasi Resonance Valley lock out Flyback Converter with NCP1379
- 采用NCP1053A的ECO待机开关电源方案 ECO Standby SMPS Solution with NCP1053A

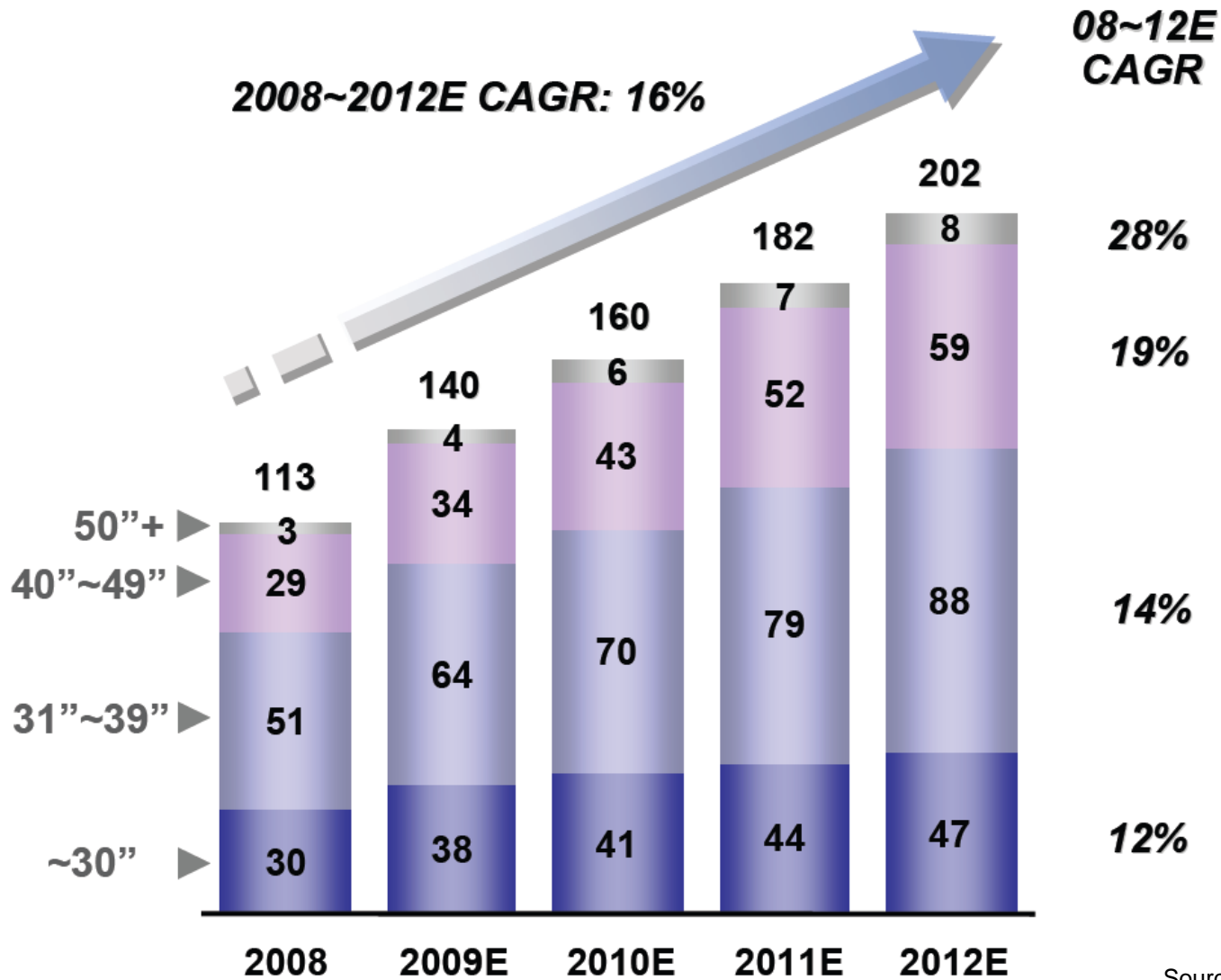
- **46/47英寸背光方案 46/47” Backlight solution**

- LIPS变换器 LIPS Inverter
- 侧光式LED驱动器 Edge LED Driver
 - 基于NCP1397的专用半桥LLC转换器 Dedicated HB LLC converter with NCP1397
 - 基于CAT4026的多通道线性驱动器 Multiple Linear Drivers with CAT4026

- **总结 Summary**

不同尺寸液晶电视付运量

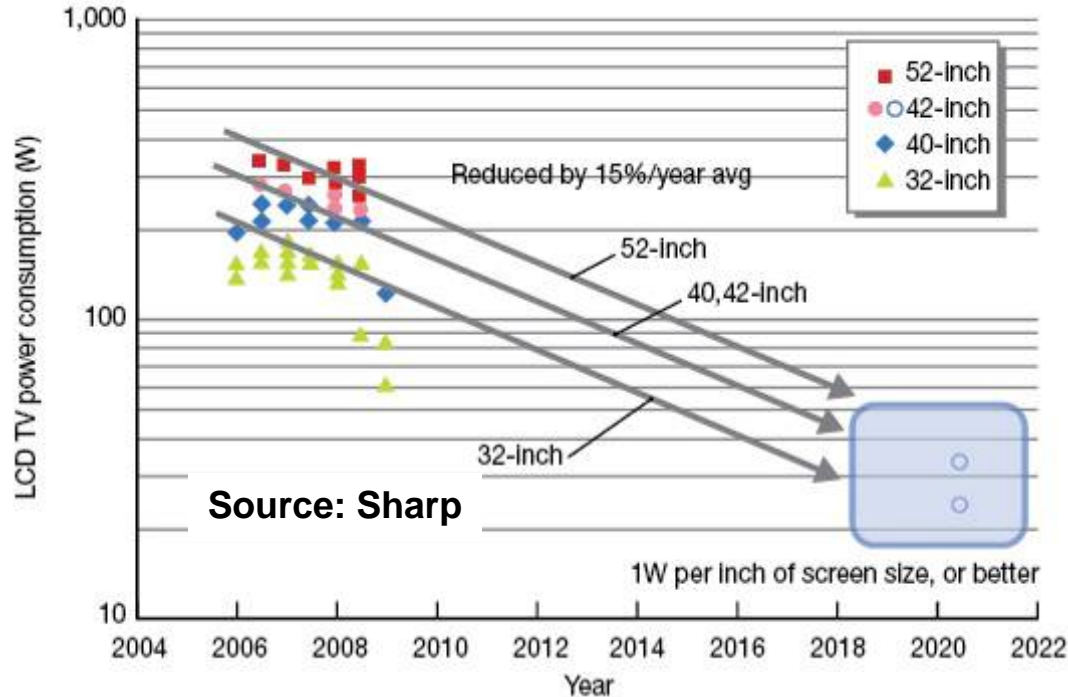
LCD-TV Shipments by Size



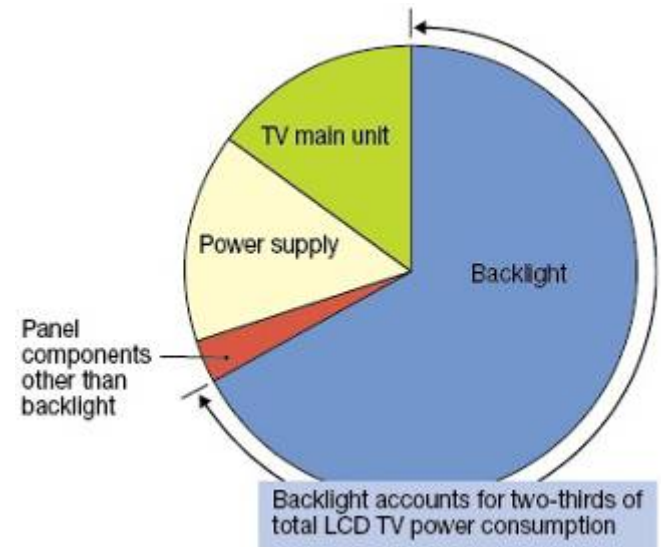
Source: Displaysearch 2Q 09

能耗降低趋势

Power Reduction Trend



- 运用规范标准压力及绿色营销来降低工作及待机模式下的能耗
Regulatory pressure and Green Marketing being applied to reduce power consumption in active and standby mode
- 新技术着重提升背光及面板能效
New technologies focused on improving backlight and panel efficiency



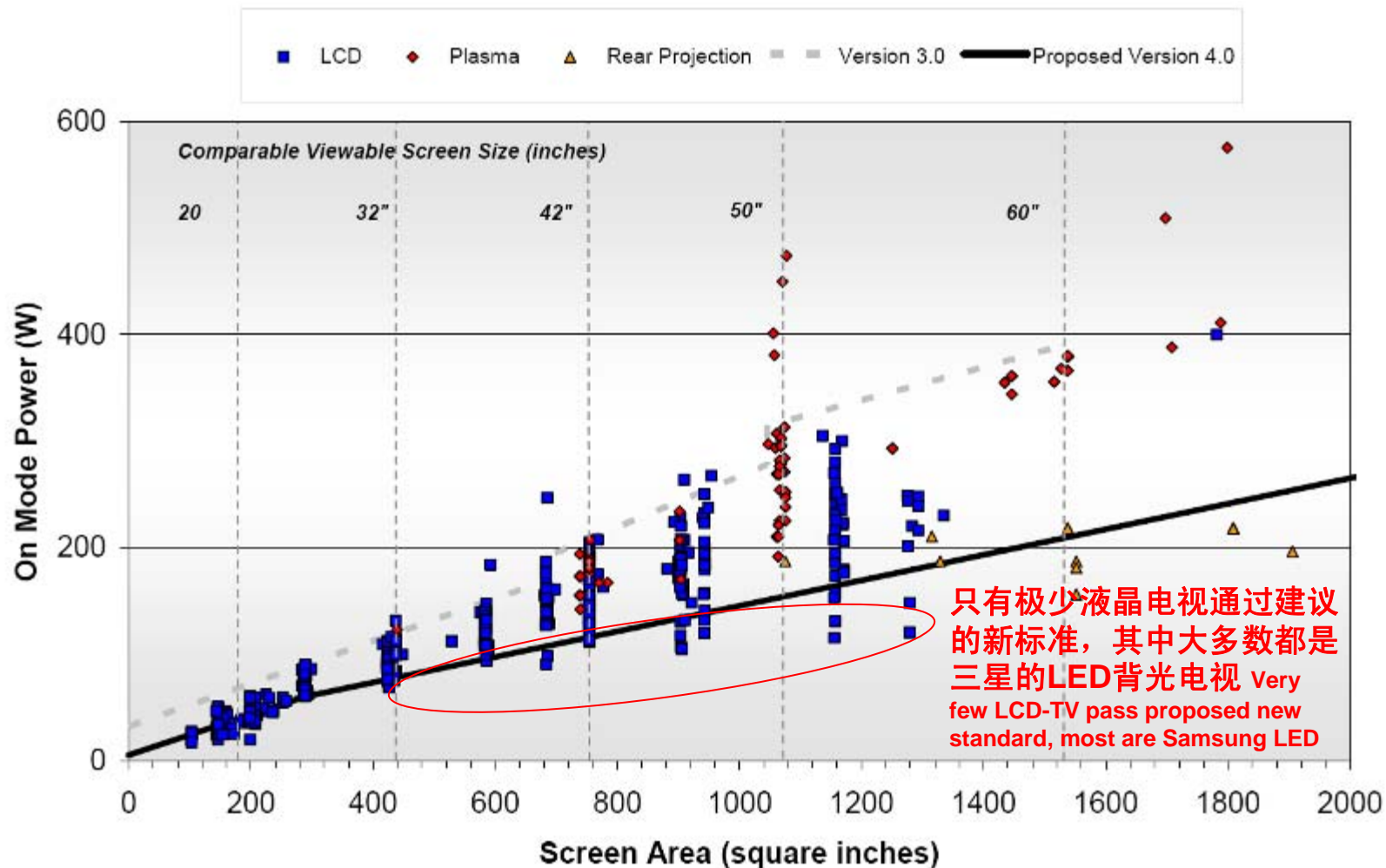
- “能源之星”4.0版电视规范修改建议稿将调低平均能耗目标
Proposed revised ENERGYSTAR TV regulations (V4.0) will lower average power targets
 - 42英寸电视从208 W降至115 W 42" TV to go from 208 W to 115 W
 - 影响所有此前轻松通过3.0版规范的小于26英寸的电视型号
Impact ALL models including <26" which easily passed V3
 - 新规范计划在2010年5月生效 New rules are planned to be effective May 2010



能耗两年降低约50% Power consumption reduction ~ - 50% over 2 years

建议版“能源之星”4.0版标准

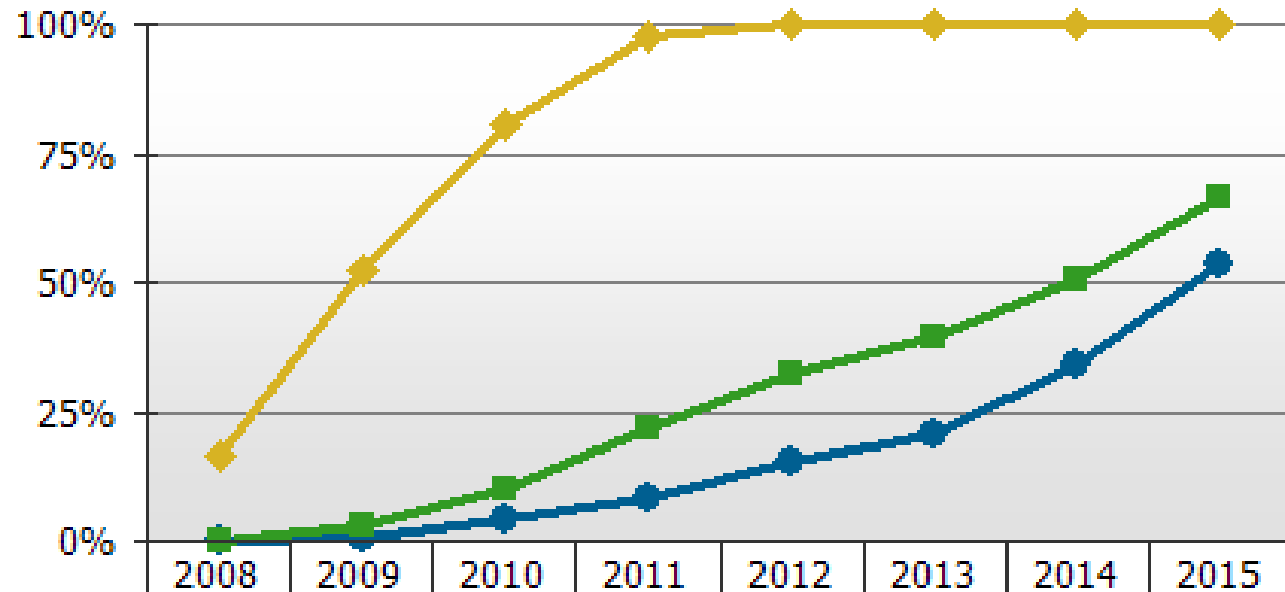
Proposed ENERGY STAR rev4.0 Standards



目标生效日期：2010年9月
Target Effective Date: May 2010

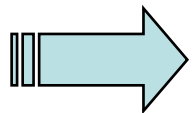
液晶电视LED背光

LCD-TV LED Backlighting



LED Backlight in Notebook	16%	52%	81%	97%	100%	100%	100%	100%
LED Backlight in Monitor	0%	1%	4%	8%	15%	21%	34%	54%
LED Backlight in LCD TV	0%	3%	10%	22%	32%	40%	50%	66%

Source: DisplaySearch July 2009



预计LED电视份额在2012年前将达到20-32%(约6,400万台)

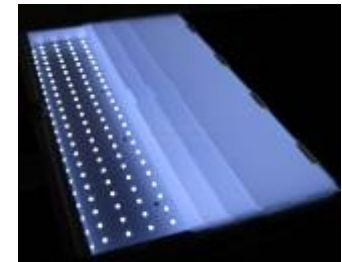
LED TVs is forecast to grow to 20-32% (~64 M#) by 2012

LED液晶电视背光选择比较

Comparison of LED LCD TV Backlight Options

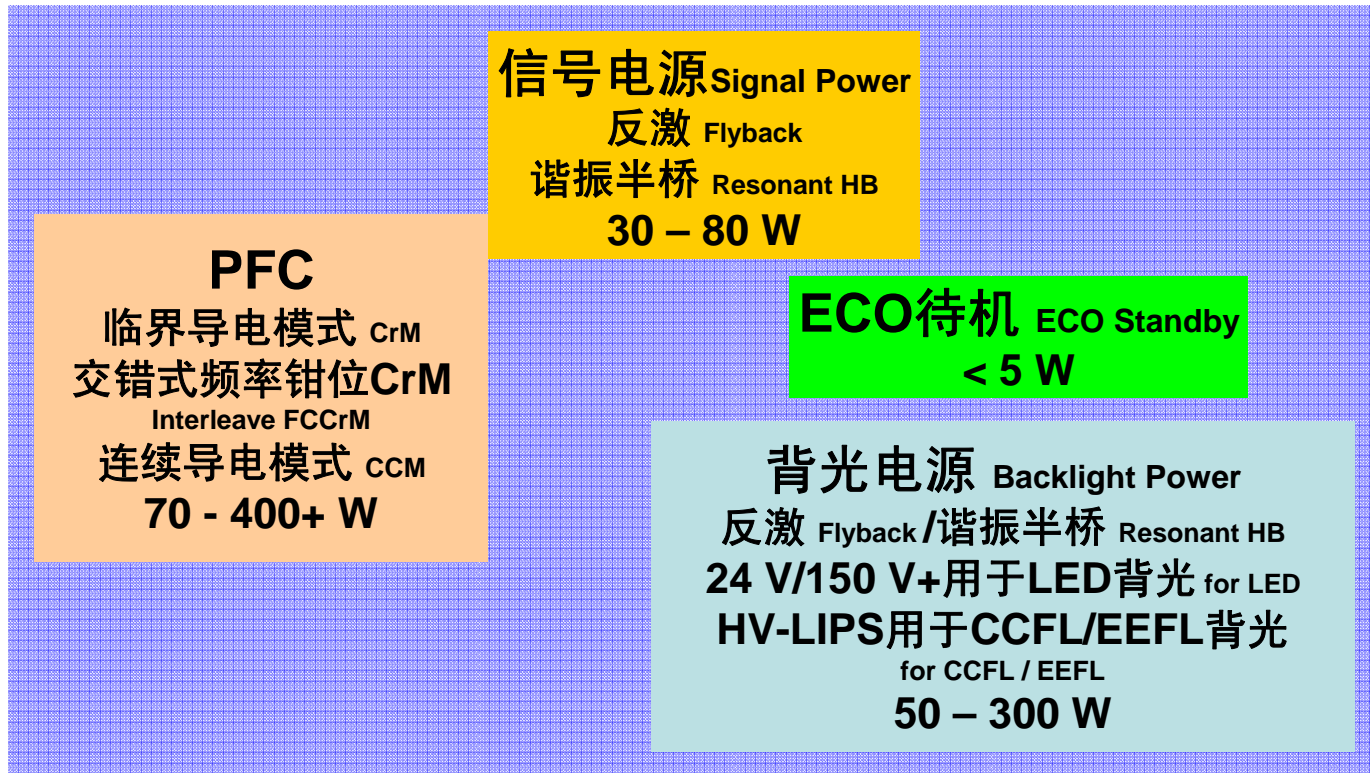
	侧光式LED背光单元 Edge-lit LED BLU	直下式LED背光单元 Direct-type LED BLU
LED驱动器 LED driver	高压升压、降压，及带正向电压可调节功能的线性结构 High voltage Boost, buck, linear with Vf adjustment	升压或降压加多通道线性 Boost or Buck plus Multi-channel linear
优势 Merit	<ul style="list-style-type: none"> • 高效 High Power Efficiency • 不依赖于系统可靠性的优异LED性能 Good system reliability independent LEDs performance. • 系统成本降低 Cost down of system • 纤薄液晶电视 Slim LCD TV 	<ul style="list-style-type: none"> • 深黑色，对比度更佳 Deep blacks, better contrast • 局域调光 Local dimming • 扫描提供更高帧率 Scanning for higher frame rate • 低能耗 Low power consumption • 复杂的信号处理 Complex signal processing
不足 Concerns	<ul style="list-style-type: none"> • 系统噪声及电磁干扰 System Noise & EMI • 使用众多外部元件(电感、电容、二极管) Using lots of external components (Inductor, capacitor, diode) 	<ul style="list-style-type: none"> • 散热限制 Thermal limitations • 系统成本高，因为LED和驱动器用量多 High system cost due to number of LEDs and # of Drivers • 图像失真 Picture artifacts

侧光式LED能效 Edge LED > 90% ?



电源架构仍然多种多样

Power Architectures Remain Varied



传统24 V背光与HV-LIPS方案并存

Traditional 24 V Backlight and HV-LIPS approach

纤薄电视设计也影响电源方案的选择

Thin TV design impacts solutions choices as well

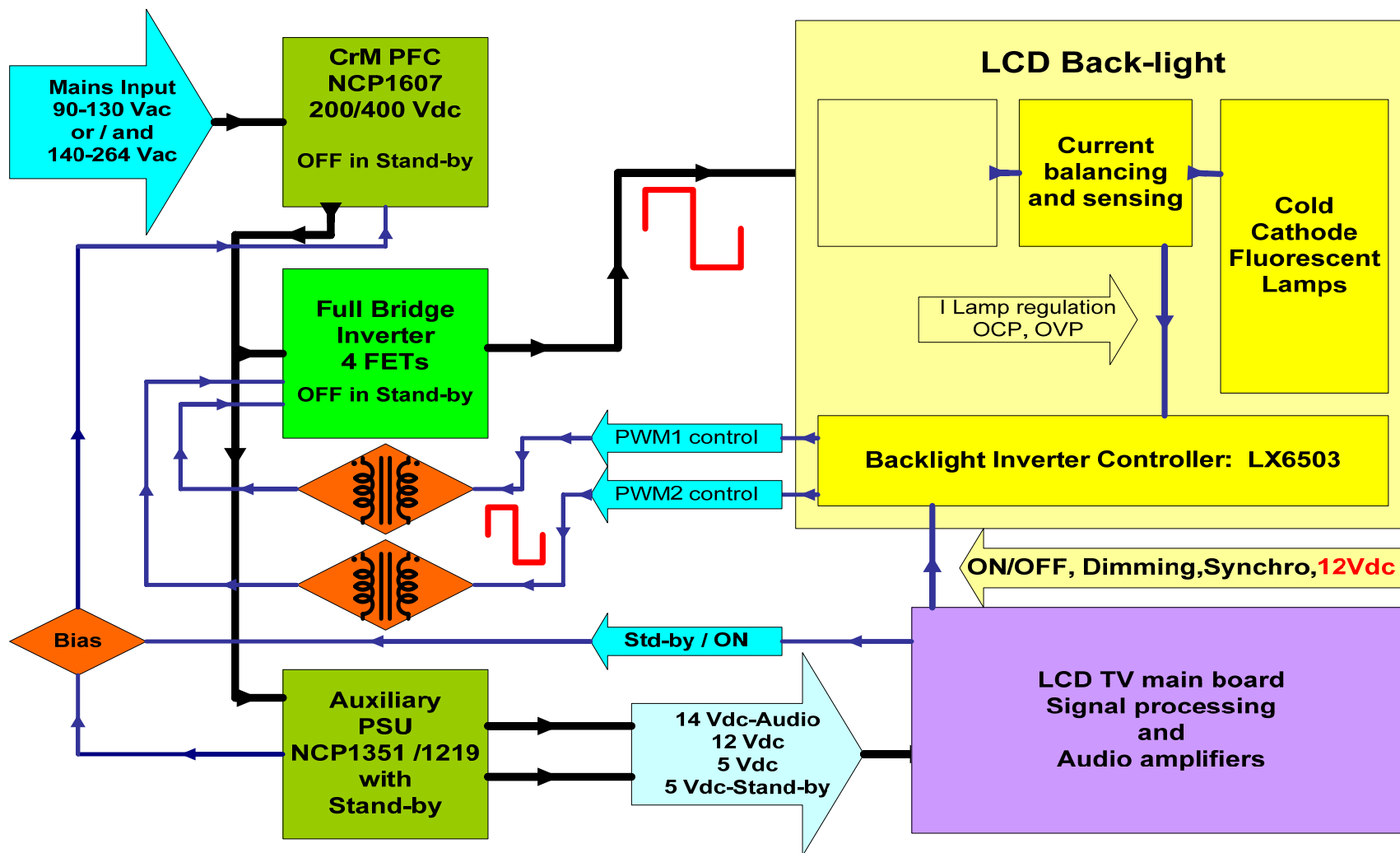


32英寸高压LIPS参考设计 32" HV-LIPS Reference Design

- **32英寸(市场销量最大)参考设计能扩展至支持26/42英寸** For 32" (highest volume size) with possible extension to 26/42"
 - 2009年3月上市 Available since March 2009
 - 针对CCFL背光(份额超过95%), 能扩展至支持EEFL背光 For CCFL (>> 95% of backlight) with possible extension to EEFL
 - 单电路板, 采用液晶显示及逆变器集成电源(LIPS) Single PCB with LCD and Inverter Power Supply
- **性价比极佳的方案** Very Cost effective solution
 - 无额外待机开关电源 No extra Standby SMPS
 - 简单直接的CrM功率因数校正段 Straightforward CrM PFC
- **所用的关键安森美半导体IC** Key ONSEMI ICs
 - **NCP1607 CrM PFC控制器** as CrM PFC controller
 - **NCP1351 或 NCP1219 带低待机能耗模式的反激转换控制器** as Flyback with low power standby mode
- **LX6503 Microsemi背光控制器** Microsemi Backlight controller
 - 全桥高压逆变器, 无高端驱动器(分立电路) Full Bridge High Voltage Inverter without High Side Driver (discrete circuit)
 - Jin平衡方案 Jin balance solution

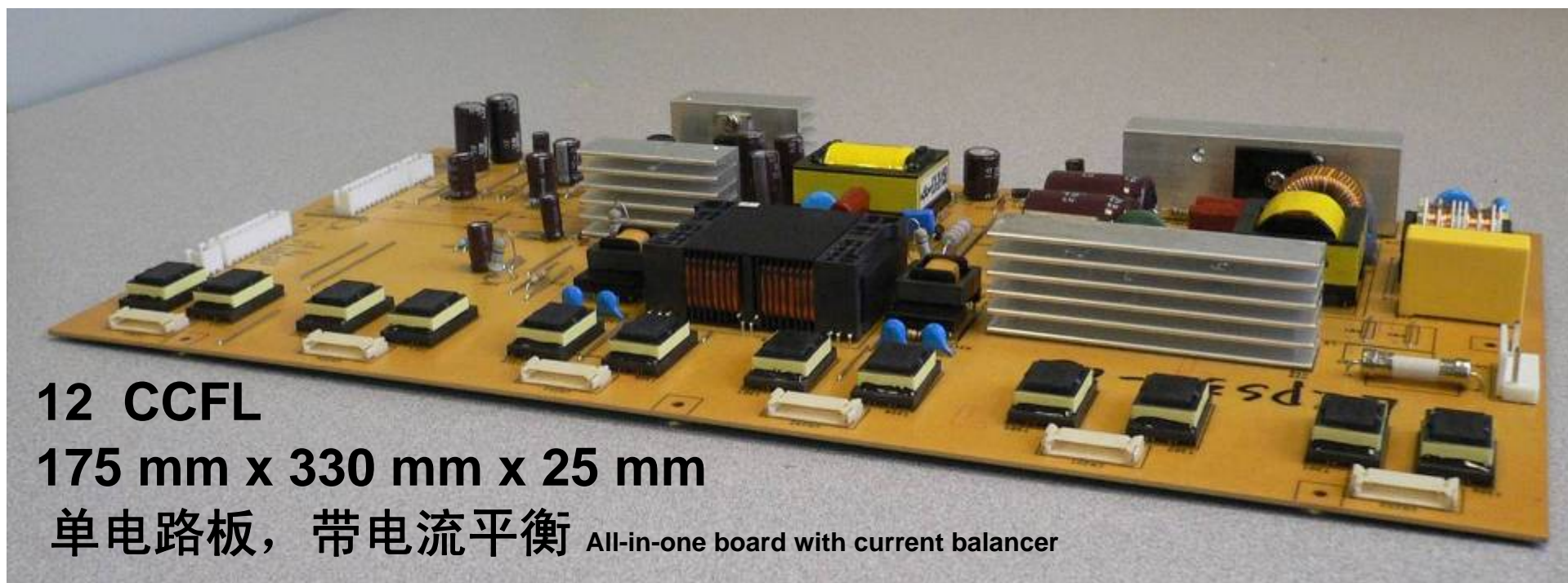
32英寸液晶电视功能框图

32" HV-LIPS LCD TV block diagram



高压LIPS液晶电视电源完整方案

HV-LIPS LCD TV Complete Solution



12 CCFL

175 mm x 330 mm x 25 mm

单电路板，带电流平衡 All-in-one board with current balancer

GreenPoint®参考设计文档 GreenPoint® Reference design documentation:

http://www.onsemi.com/pub_link/Collateral/TND360-D.PDF

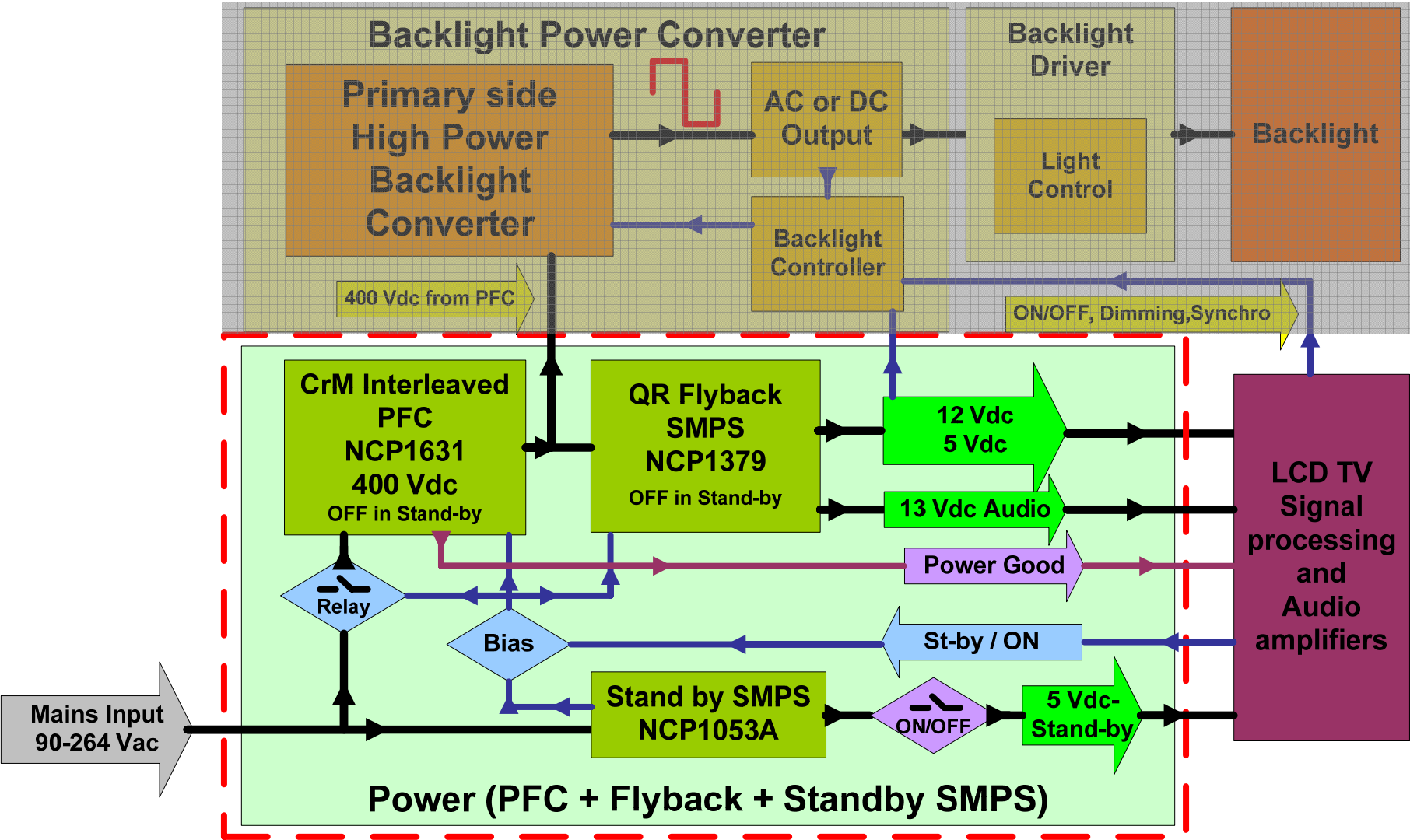
46/47英寸电源参考(PSU)

46/47" Power Reference (PSU)

- 针对更高功率的液晶电视，能扩展支持40/42英寸或52/55英寸 Higher power LCD-TVs with extension to 40/42" or 52"/55"
- 用于仅关注电源段的性能主导型项目 Performance driven project focusing on power stage only
 - 低于90 mW的极低待机能耗，带ECO“关闭模式” Very low standby < 90 mW with ECO “OFF mode”
 - 交错式频率钳位CrM PFC提高能效 Interleaved frequency clamp CrM PFC for higher efficiency
 - 高达70 W反激转换器用于总体信号处理及音频电源 Up to 70 W Flyback converter for the overall Signal Processing and Audio
 - 提供高达200 W/400 V用于背光 Up to 200 W / 400 V available for backlight
- 所用的关键安森美半导体IC Key ONSEMI ICs
 - 新的**NCP1631**交错式 FCCrM PFC控制器 New **NCP1631** Interleaved FCCrM PFC controller
 - 带谷底锁定功能的新**NCP1379**准谐振反激转换器控制器或**NCP1252**固定频率脉宽调制(PWM)控制器 New **NCP1379** QR Flyback with valley lock-out or **NCP1252** fixed frequency PWM controller
 - **NCP1053A**高能效、低待机能耗开关电源 **NCP1053A** high efficiency low power Standby SMPS
- 低厚度设计 Low profile design
 - 第一阶段：电路板上高度低于13 mm(总高度低于17.5 mm) 1st phase: < 13 mm on top of PCB (< 17.5 mm total)
 - 第二阶段：电路板上高度低于8 mm(总高度低于12.5 mm) 2nd phase: < 8 mm on top of PCB (< 12.5 mm total)

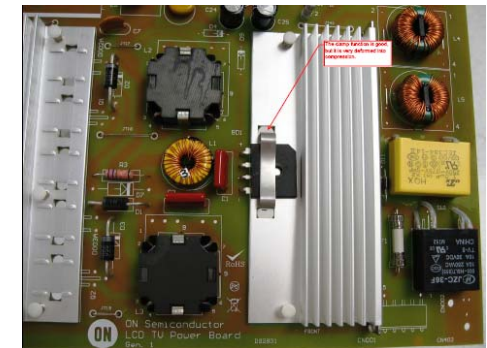
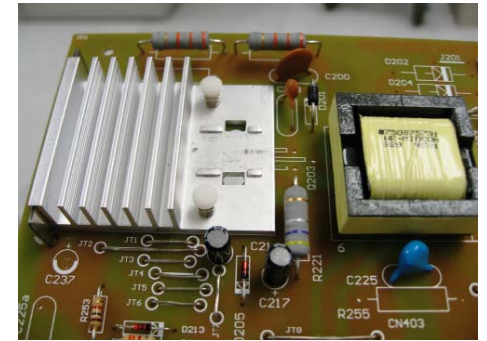
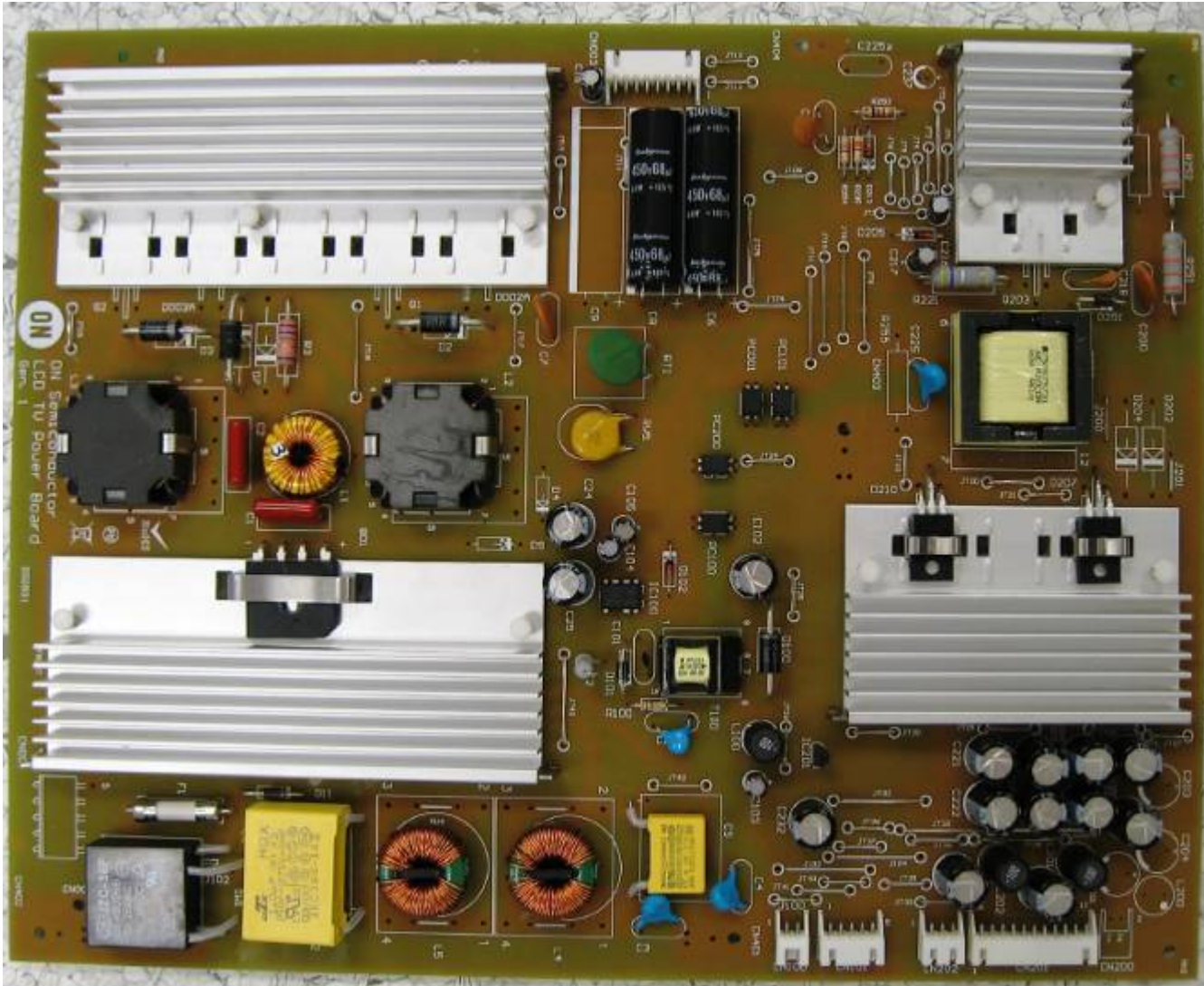
46英寸液晶电视电源功能框图

46" LCD TV Power Block Diagram



46英寸液晶电视电源方案(PSU)

46" LCD TV Power Solution Unit (PSU)



46英寸液晶电视PFC方案

46" LCD TV PFC Solution

• 高达300 W交错式频率钳位CrM PFC Up to 300 W Interleaved Frequency Clamp CrM PFC

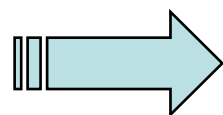
- 电磁干扰性能优于CrM(与CCM相当), 电磁兼容性能优于CCM(与CrM相当) Better EMI than CrM (= CCM), Better EMC than CCM (= CrM),
- 更低的 I_{rms} 用于输出电容: 优于CrM及CCM Lower I_{rms} for output C: better than CrM and CCM
- 更小的线圈尺寸, 设计适合提供一半功率: 更适合于纤薄设计 Smaller coils size designed for 1/2 of power: better for SLIM design
- 功率MOSFET、线圈及二极管采用2个较小的标准组件(与32英寸CrM PFC所用组件相当)规范1个较大的组件 Power MOS, coils and diodes split in 2 smaller standard parts (= 32"CrM)

• 新控制器NCP1631 New controller NCP1631

- 频率钳位利于 Frequency clamp to
 - 改善电磁干扰及提升能效 Improve EMI and efficiency
 - 采用更小/更低成本的PFC线圈 Smaller / lower cost PFC coils
- 以“PFC-OK”提供输出电压信息 Output voltage information with “PFC-OK”
 - Improve reliability and avoid under supply working conditions

• 提供简单的纤薄窄电压范围版本方案 Easy SLIM narrow range version








- 简单的FCCrM(1/2交错式)用于140至264 V的窄电压范围 Simple FCCrM (1/2 Interleave) for narrow range 140-264 V
- 采用与32英寸宽电压范围版本类似的元件 Similar parts as 32" Wide Range



交错式FCCrM PFC用于功率大于200 W及纤薄设计 Interleaved
FCCrM PFC for > 200W & SLIM design



PFC方案小结 PFC Summary

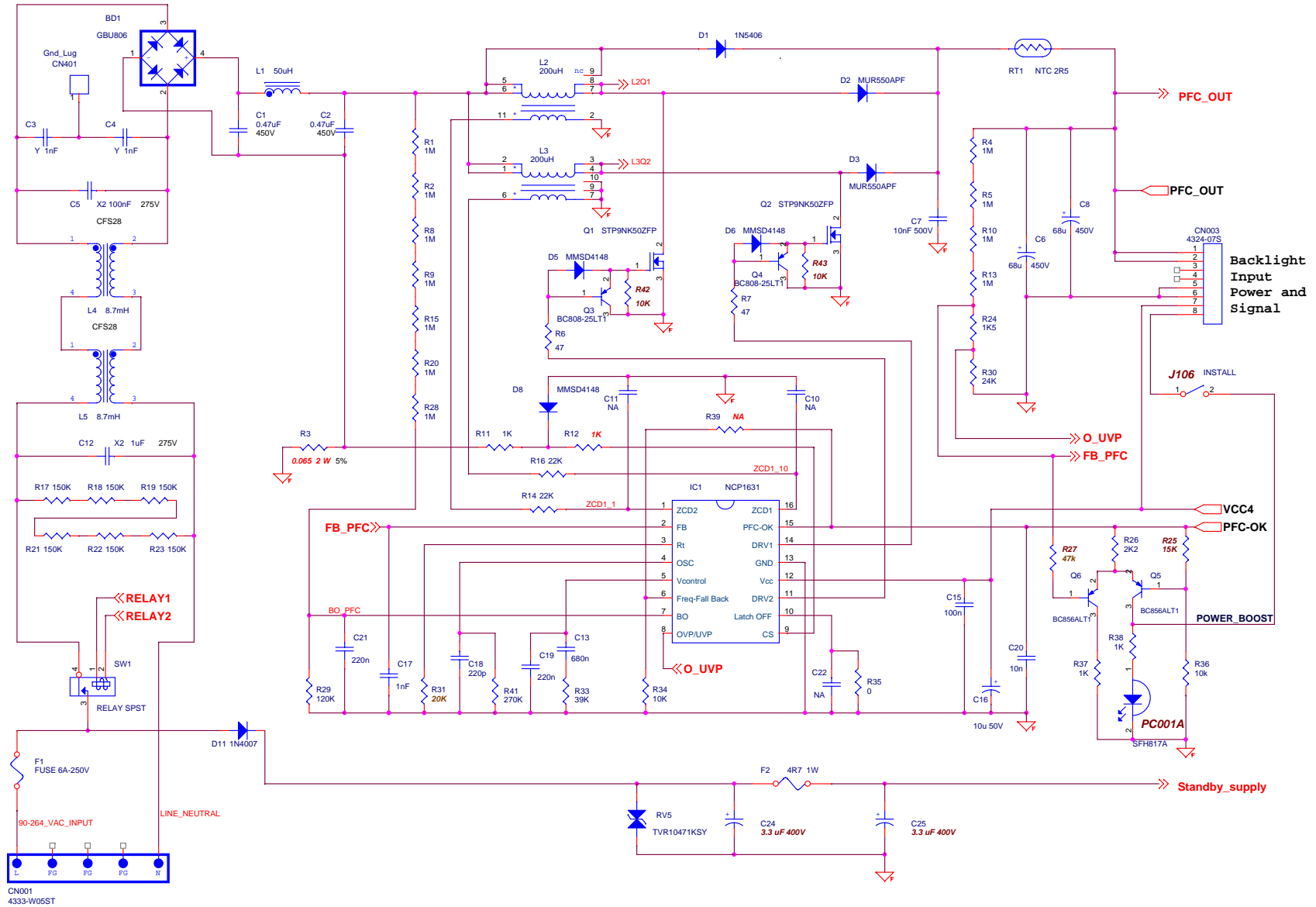
	Single FCCrM stage		Interleaved FCCrM stage		Single CCM stage	
	General	300-W, wide mains	General	300-W, wide mains	General	300-W, wide mains
$\Delta I_{in(max)}$ (A)	Independent on L	10.0 A	Independent on L	2.6 A	Depends on L	2.6 A (at 90 V _{in} , full load if L = 250 μ H)
Inductor	1 coil 	75 μ H	2 coils  	150 μ H	1 coil 	250 μ H
		$I_{Lpk(max)} = 10$ A		$I_{Lpk(max)} = 5.0$ A		$I_{Lpk(max)} = 6.3$ A
		$I_{Lrms(max)} = 4.1$ A		$I_{Lrms(max)} = 2.0$ A		$I_{Lrms(max)} = 3.5$ A
		$L \cdot I_{pk}^2 = 7.5$ mJ		$L \cdot I_{pk}^2 = 3.7$ mJ		$L \cdot I_{pk}^2 = 9.9$ mJ
Total MOSFET conduction losses (with below MOSFETs)	$\frac{4R_{DS(on)}}{3} \left(\frac{P_{i(ng)}}{V_{i(ms)}} \right)^2 \cdot \left(1 - \left(\frac{8\sqrt{2} \cdot V_{i(ms)}}{3\pi V_{out}} \right) \right)$	4.6 W	$\frac{2R_{DS(on)}}{3} \left(\frac{P_{i(ng)}}{V_{i(ms)}} \right)^2 \cdot \left(1 - \left(\frac{8\sqrt{2} \cdot V_{i(ms)}}{3\pi V_{out}} \right) \right)$	4.6 W	$R_{DS(on)} \left(\frac{P_{i(ng)}}{V_{i(ms)}} \right)^2 \cdot \left(1 - \left(\frac{8\sqrt{2} \cdot V_{i(ms)}}{3\pi V_{out}} \right) \right)$	3.5 W
MOSFETs		1 * SPP20N60 or 2* SPP11N60		2 * SPP11N60		1 * SPP20N60 or 2* SPP11N60
Diode	Ultrafast	MUR550 (TO220) 	2 * Ultrafast	2 * MUR550 (axial) 	Low t _r diode	High speed diode (SiC..) 
$I_{Cirms(max)}$ (A)	$\sqrt{\frac{32 \cdot I \cdot \left(\frac{P_{out}}{\eta} \right)^2}{8\pi \cdot V_{in(max)} \cdot V_{out}} - \left(\frac{P_{out}}{V_{out}} \right)^2}$	2.0	$\sqrt{\frac{16 \cdot \sqrt{2} \cdot \left(\frac{P_{out}}{\eta} \right)^2}{8\pi \cdot V_{in(max)} \cdot V_{out}} - \left(\frac{P_{out}}{V_{out}} \right)^2}$	1.3	$\sqrt{\frac{8 \cdot \sqrt{2} \cdot \left(\frac{P_{out}}{\eta} \right)^2}{3\pi \cdot V_{in(max)} \cdot V_{out}} - \left(\frac{P_{out}}{V_{out}} \right)^2}$	1.7
EMI complexity	DM: high CM: moderate		DM: moderate CM: moderate		DM: moderate CM: high	
Characteristics	Compact design		Low profile designs		Compact design	

Compared to CrM, FCCrM allows the use of smaller inductances (due to frequency clamp)

The inductance for the single and interleaved FCCrM stages is based on a 130 kHz frequency clamp (high frequency design).

The switching frequency is also supposed to be 130 kHz for the CCM stage.

46英寸液晶电视PFC电路图 46" LCD TV PFC Schematic



46英寸液晶电视准谐振反激方案

46" LCD TV QR Flyback Solution

• 反激转换器 Flyback converter

- 最大功率达70 W(32英寸设计为50 W) Up to 70 W max (50 W for 32" design)
- 最多3路输出电压能力(与32英寸相当), 最大输出电流能力为4 A Up to 3 output voltages capability (= 32") with 4 A Max by output

• 准谐振反激转换器 Quasi Resonance Flyback Converter

- 以最低电压开关, 降低电磁干扰 Reduced EMI with minimum voltage switching
- 极佳的安全特性, 过载/短路时频率降低 Best safety behaviors with frequency going down for overload / short circuit

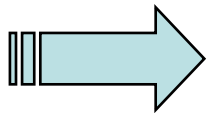
• 新的NCP1379控制器 New NCP1379 controller

- 谷底锁定系统保持极低电压开关(低至4阶谷底), 避免轻载时高开关频率 Valley-lockout system to keep minimum voltage switching down to the 4th valley and avoid high switching frequency at light load
- 可变频率模式用于超低功率模式, 在宽功率范围内保持高能效 Variable frequency mode for ultra low power mode to keep high efficiency over wide power range
- 过流保护, 带闩锁或自动复位100 ms内部定时器 Over current protection with latch or auto recovery 100 ms internal timer

46英寸液晶电视PWM固定频率反激方案

46" LCD TV PWM Fixed F Flyback Solution

- **PWM固定频率反激转换器** PWM Fixed Frequency Flyback converter
 - 50 kHz固定频率脉宽调制 50 kHz Fixed frequency Pulse Wide Modulation
 - 支持自然的CCM，为多输出方案改善电流因数及变压器耦合/交叉稳压 Allow natural CCM to improve current form factor and transformer coupling / cross regulation for multiple outputs solution
- **新的NCP1252控制器** New NCP1252 controller
 - 可调节开关频率，支持轻载条件下跳周期模式 Adjustable switching frequency with skip mode for light load conditions
 - 可调节软启动 Adjustable soft start
 - 过流保护，带100 ms内部定时器 Over current protection with 100 ms internal timer
- **前述准谐振模式的可选替代方案** Alternative solution to previous QR mode
 - 用于相同电路板设计(控制器位置相同) Both designs on the same PCB (position for each controller)
 - 开关频率相同 Both with the same switching frequency
 - 关键元件相同(变压器、功率MOSFET、二极管及电容) Both with the same key parts (transformer, Power MOS, diodes and capacitors)

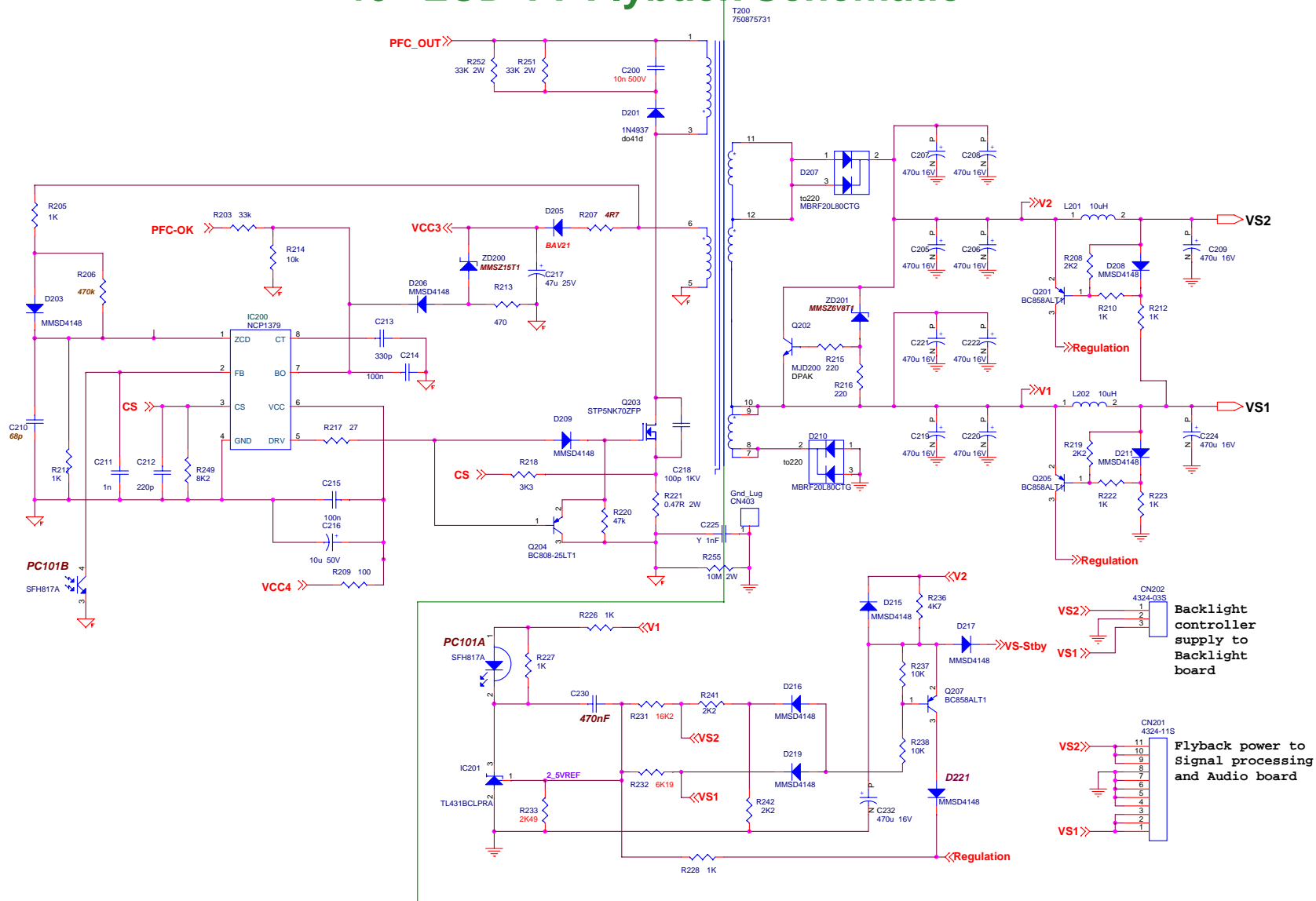


用于功率达70 W的准谐振谷底锁定或PWM反激开关电源
QR Valley lock-out or PWM Flyback SMPS up to 70W



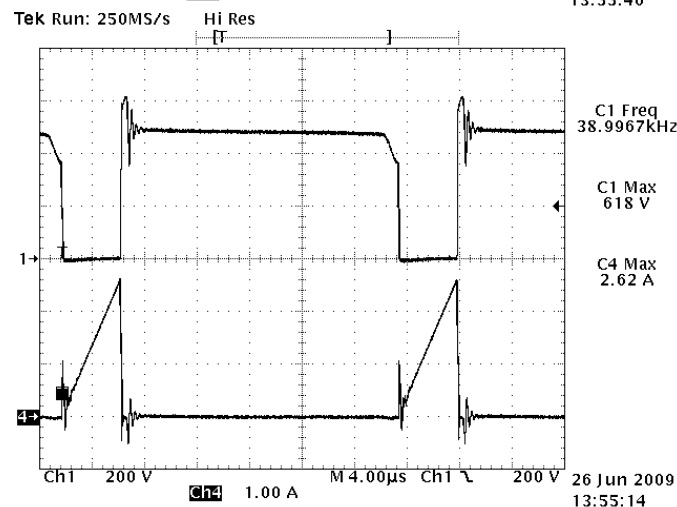
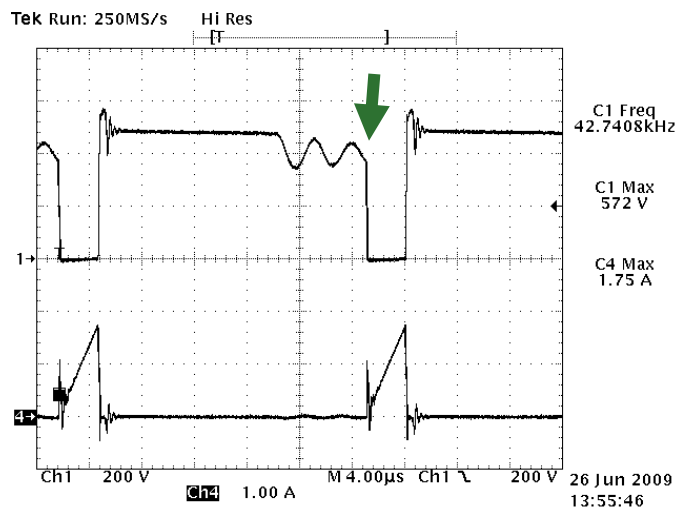
46英寸液晶电视反激电源电路图

46" LCD TV Flyback Schematic



46英寸液晶电视准谐振反激电源波形

46" LCD TV QR Flyback Waveform



- 准谐振模式，带谷底锁定 QR mode with valley lock-out

- 带谷底锁定，用于低功率模式 With valley lock-out for low P
- 以最大功率提供较低频率 With lower frequency by P Max

- 顶部迹线 Top Trace

- $V_{in} = 400 \text{ Vdc}$ **$P_{out} = 34 \text{ W}$**
- 1.75 A at 42.7 kHz
- $V_{max} = 572 \text{ V}$

- 底部迹线 Bottom Trace

- $V_{in} = 400 \text{ Vdc}$ **$P_{out} = 70 \text{ W}$**
- 2.62 A at 39 kHz
- $V_{max} = 618 \text{ V}$



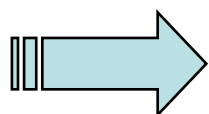
谷底锁定是准谐振模式的一项关键改进

Valley lock-out is a Key improvement of QR mode

ECO待机开关电源方案(1)

ECO Standby SMPS Solution (1)

- **最大功率达5 W的专用ECO开关电源** Dedicated up to 5W max ECO Power Standby SMPS
 - **$P_{in} < 90 \text{ mW}$ for $P_{out} = 40 \text{ mW}$ @ 230 Vac**
 - 非常适合最大功率小于5 W的小型专用待机电视微处理器 Ideal for small dedicated Standby TV μP with $P_{Max} < 5\text{W}$
 - **集成高压开关稳压器NCP1053A** Integrated High Voltage switcher NCP1053A (400 mA / 40 kHz Max)
 - **磁滞模式提升ECO性能，开关频率及IC功率消耗更低** Hysteretic mode improves ECO performance with lower switching frequency and lower IC power consumption
 - **低频模式支持不连续导电模式(DCM)，降低开关损耗，以有限的反射电压避免电压钳位的功率损耗** Low frequency mode allows DCM to reduce switching losses with limited reflected voltage to avoid power dissipation of voltage clamp
 - **电流受限，减免可能的噪声问题** Limited current reduces possible noise issues



磁滞、低频及DCM用于ECO待机开关电源
Hysteretic, Low Freq & DCM for ECO Standby SMPS



ECO待机开关电源方案(2)

ECO Standby SMPS Solution (2)

• 待机继电器 Standby relay

- 断开所有“寄生”待机负载连接(带X2电容及放电电阻的主电源滤波器，连接至主电源电压的PFC输入欠压(BO)及反馈(FB)功能等) Disconnect all “parasitic” standby load (Mains filter with X2 capacitors and discharge Resistance, BO and FB of PFC connected on mains voltage...)
- 在230 Vac时节省约100至150 mW的功率 Provides savings of ~100-150 mW @ 230 Vac
- 由电视机微处理器直接控制(待机/导通)，由5 V待机电源供电 Directly controlled by TV μ P (Standby / ON) and supplied by 5V Standby

• 可选ECO“导通/关闭开关” Optional ECO “ON / OFF switch”

- 低成本2 A/10 V非隔离开关(次级)断开微处理器电源连接 Low cost 2A / 10V non-isolated switch (secondary) to disconnect μ P supply
- 关闭模式定义：不能以遥控或其它任何信号启动 OFF mode definition: Will not start with remote control or any other signal
- **230 Vac条件下空载输入能耗低于20 mW** $P_{in} < 20 \text{ mW}$ by no load @ 230 Vac



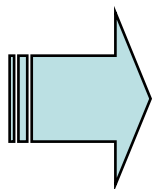
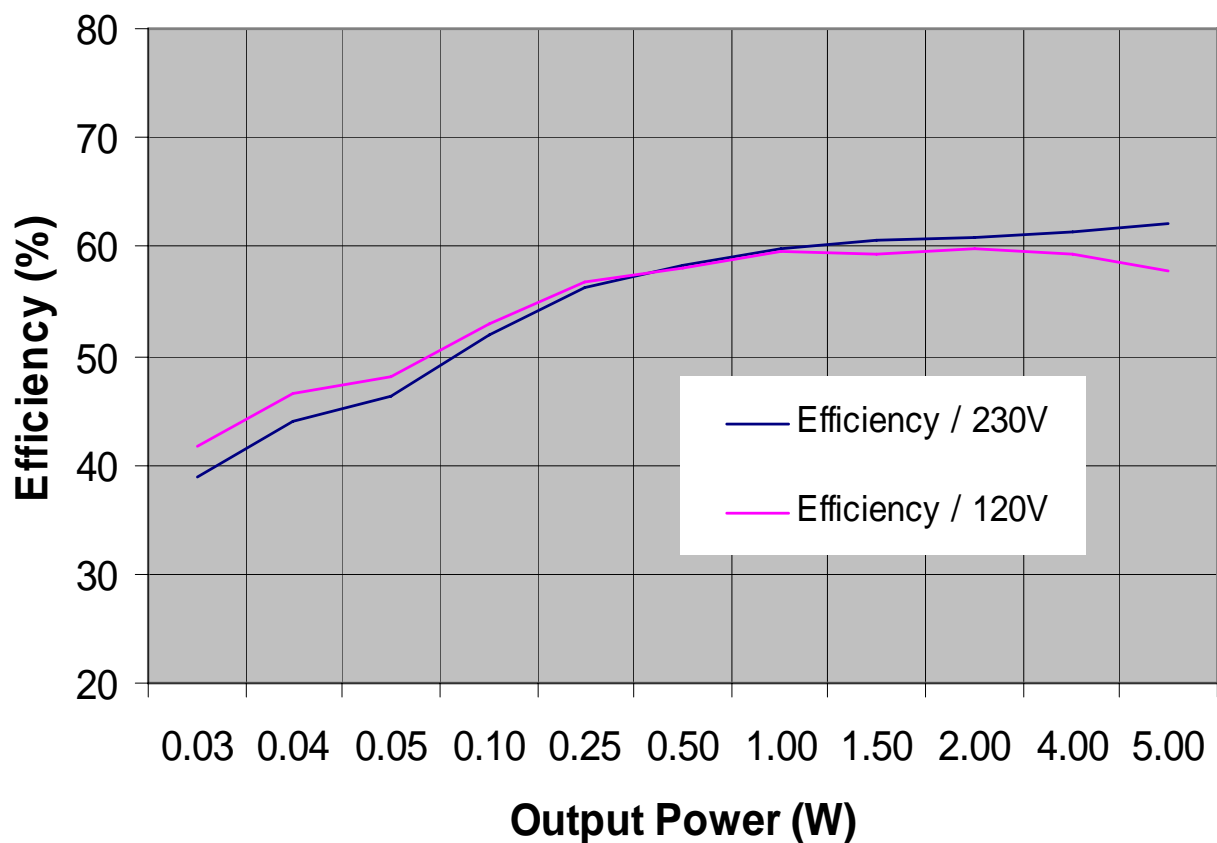
ECO开关提供“导通/关闭”功能，无需使用主电源开关

ECO switch provides “ON/OFF” without Mains switch



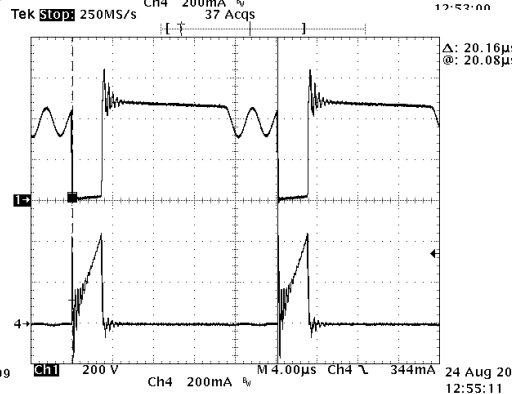
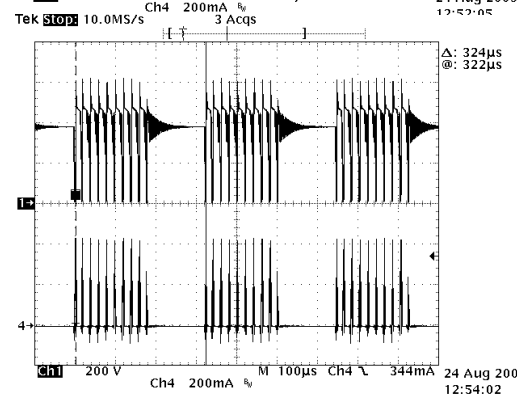
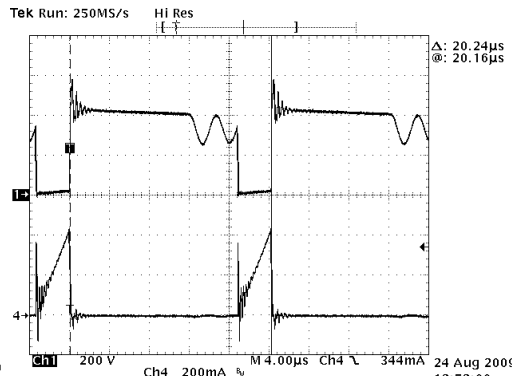
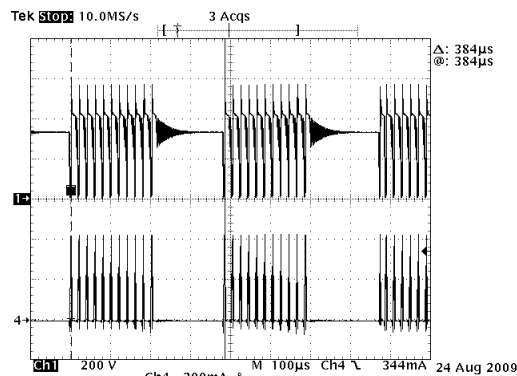
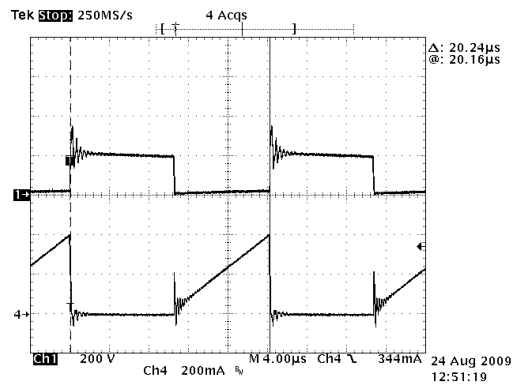
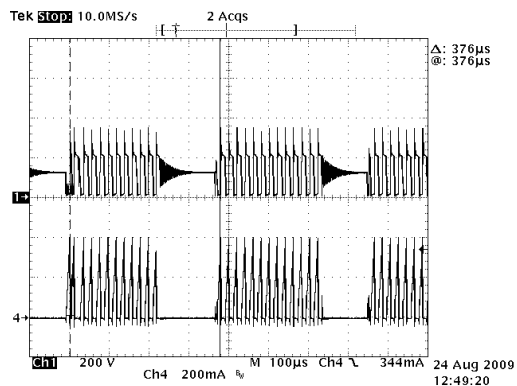
ECO待机开关电源能效

ECO Standby SMPS efficiency



关闭模式/空载 OFF mode / no load: $P_{in} < 20 \text{ mW @ 230 Vac}$ (15 @ 120 Vac)
 待机/40 mW输出 Standby / 40 mW Out: $P_{in} < 90 \text{ mW @ 230 Vac}$ (86 @ 120 Vac)

ECO待机开关电源波形图 ECO Standby SMPS Waveforms



• NCP1053A开关稳压器漏电压及电流 Drain Voltage and Current of NCP1053A Switcher

–200 V/div & 200 mA/div

• 针对 5 V及1 A=5 W输出 For 5V & 1A = 5W Output

• 左图：磁滞突发模式 Left: Hysteretic Burst mode

–(100 μs/div)

• 右图：详细周期 Right: Detailed cycle

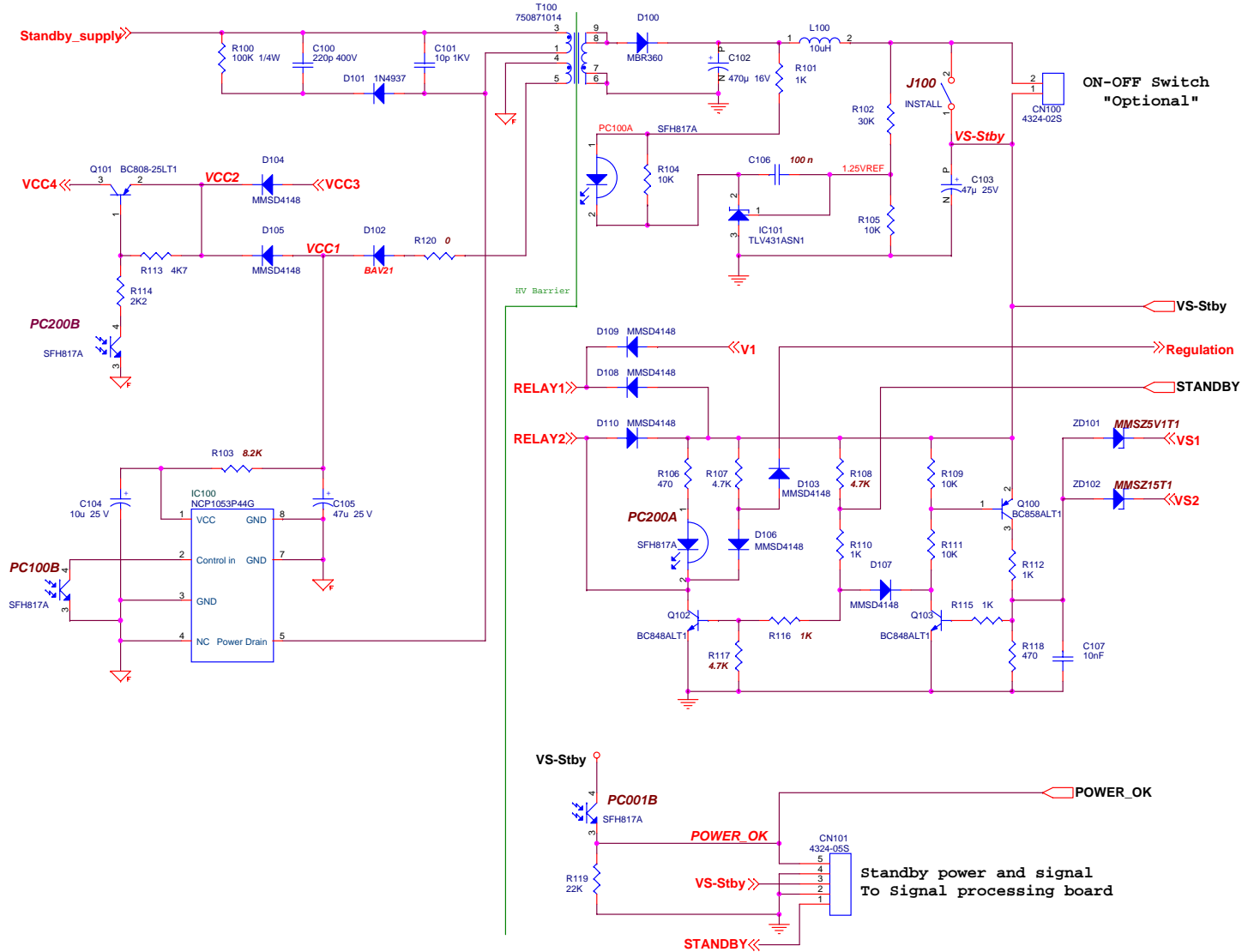
–(4 μs/div)

• 顶部迹线 Top Trace: 90 Vac

• 中间迹线 Middle Trace: 230 Vac

• 底部迹线 Bottom Trace: 264 Vac

ECO待机开关电路电路图 ECO Standby SMPS Schematic



46英寸平板电视电源-背光接口

46" Flat TV PSU - Backlight Interface

- **连接电源至任何背光方案** Interconnection on Power to any Backlight solutions
 - 400 Vdc PFC输出提供高达200 W功率能力 400 Vdc PFC Output supply up to 200 W capability
 - 提供“PFC OK”信号(若PFC电压高于300 Vdc则显示高电平) PFC OK signal (High level if $V_{PFC} > 300 \text{ Vdc}$)
 - 次级电压电源(5 V及12 V) Secondary voltages supply (5V and 12V)
 - 提供“电源良好”(PG)信号给电视微处理器及背光控制器 Power Good signal to inform both TV μP and Backlight controller
- **单独及专用背光方案** Separated & Dedicated Backlight solutions
 - 高压LIPS用于CCFL/EEFL背光 High Voltage LIPS for CCFL / EEFL
 - 带2个高端驱动器NCP5111及Microsemi背光控制器 With 2 High Side Drivers NCP5111 and Microsemi Backlight controller
 - 高直流输出电压半桥LLC(100-300 V), 用于LED驱动器 High DC Output Voltage HB LLC (100-300 V) for LED Driver
 - 采用新的NCP1397及侧光式LED驱动器 With new NCP1397 and Edge LED Drivers
 - 传统24 Vdc半桥LLC Classical 24 Vdc HB LLC
 - 已获市场证实的NCP1392/93设计用于传统24 V逆变器 Proven NCP1392 / 93 design from classical 24 V Inverter
 - 等离子显示器(PDP)专用电源转换器, 带双输出半桥LLC方案 PDP dedicated Power converter with dual outputs HB LLC solution
 - 采用新的NCP1397控制器, 并增加降压或升压转换器 With new NCP1397 and added Buck or Boost converter

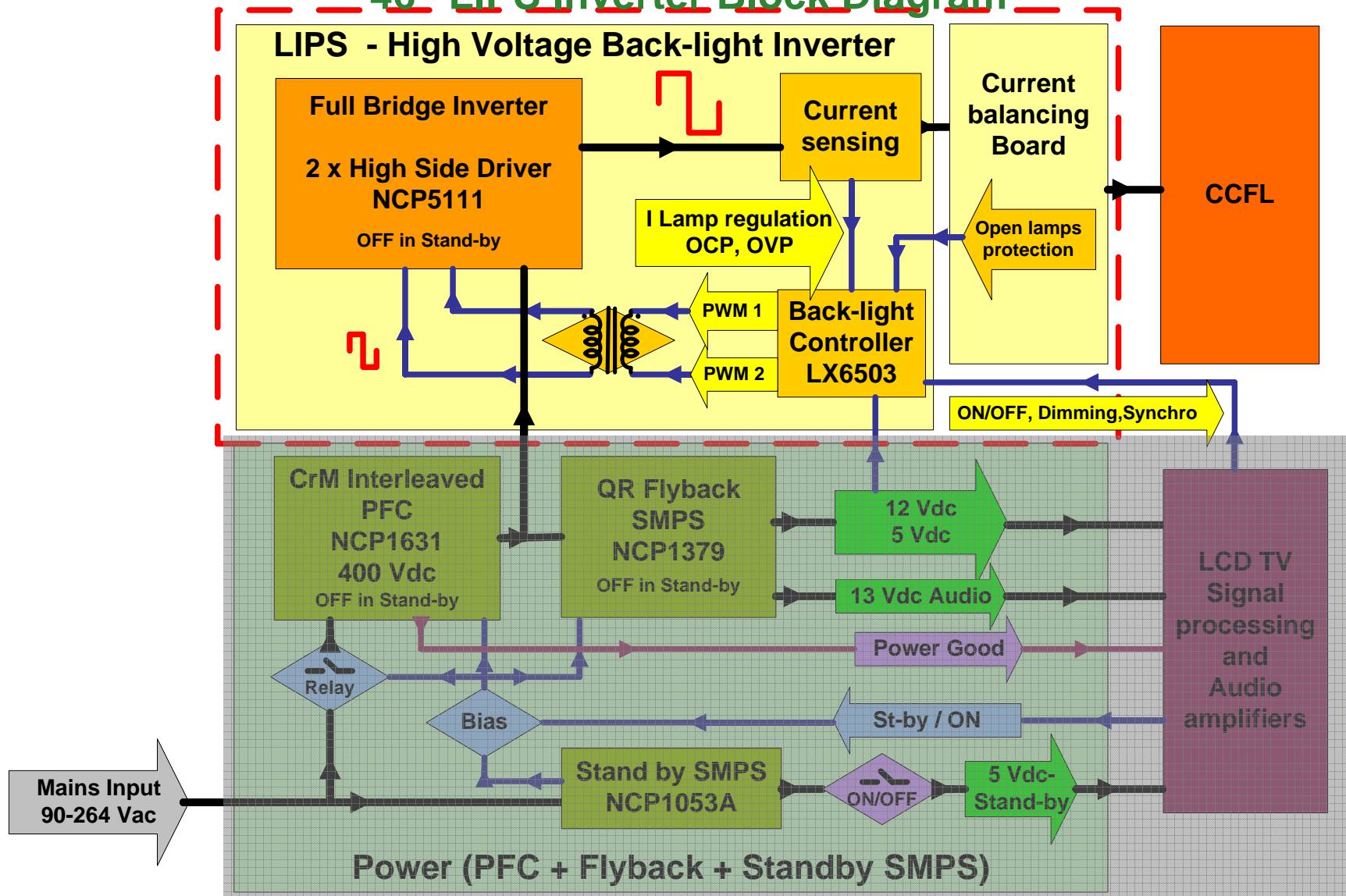
46英寸LIPS逆变器

46" LIPS Inverter

- **针对更高功率的液晶电视** Higher power LCD-TVs
 - 能扩展至40/42英寸或52/55英寸设计, 适合CCFL或EEFL背光 With extension to 40/42" or 52"/55" for both CCFL or EEFL
 - 遵从**32英寸LIPS参考设计** Follow on of *32" LIPS Reference Design*
 - 全桥固定频率ZVS, 可能带同步能力 Full Bridge fixed frequency ZVS with possible synchronization
 - 高能效、低电磁干扰及正弦灯电流 High efficiency, low EMI and sinusoidal lamp current
- **专用LIPS模块** Dedicated LIPS module
 - 互连至46英寸电源参考设计(第一阶段, 高度低于13 mm) To be interconnected with *46" Power Reference Design Step 1 < 13 mm*
 - 采用Microsemi背光控制器LX6503 Microsemi Backlight controller LX6503
 - 大尺寸液晶电视中标准的单独电流平衡电路板 Separate balancer board standard in large format LCD-TVs
- **所用安森美半导体IC** ON Semi IC's
 - **2颗**高端驱动器**NCP5111**, 提升能效及减小全桥500 V功率MOSFET的尺寸 **2** High Side Drivers **NCP5111** to improve efficiency and reduce size of full bridge 500V Power MOS-FETs
 - 1个信号驱动器变压器, 提供PWM信号给初级侧 1 single signal driver transformer to provide both PWM signal to primary side
- **用于低厚度设计** Low profile design
 - 修改高压变压器设计条件下电路板上高度低于13 mm(总高度低于17.5 mm) < 13 mm on top of PCB (< 17.5 mm total) with modified HV Transformers

46英寸逆变器功能框图

46" LIPS Inverter Block Diagram



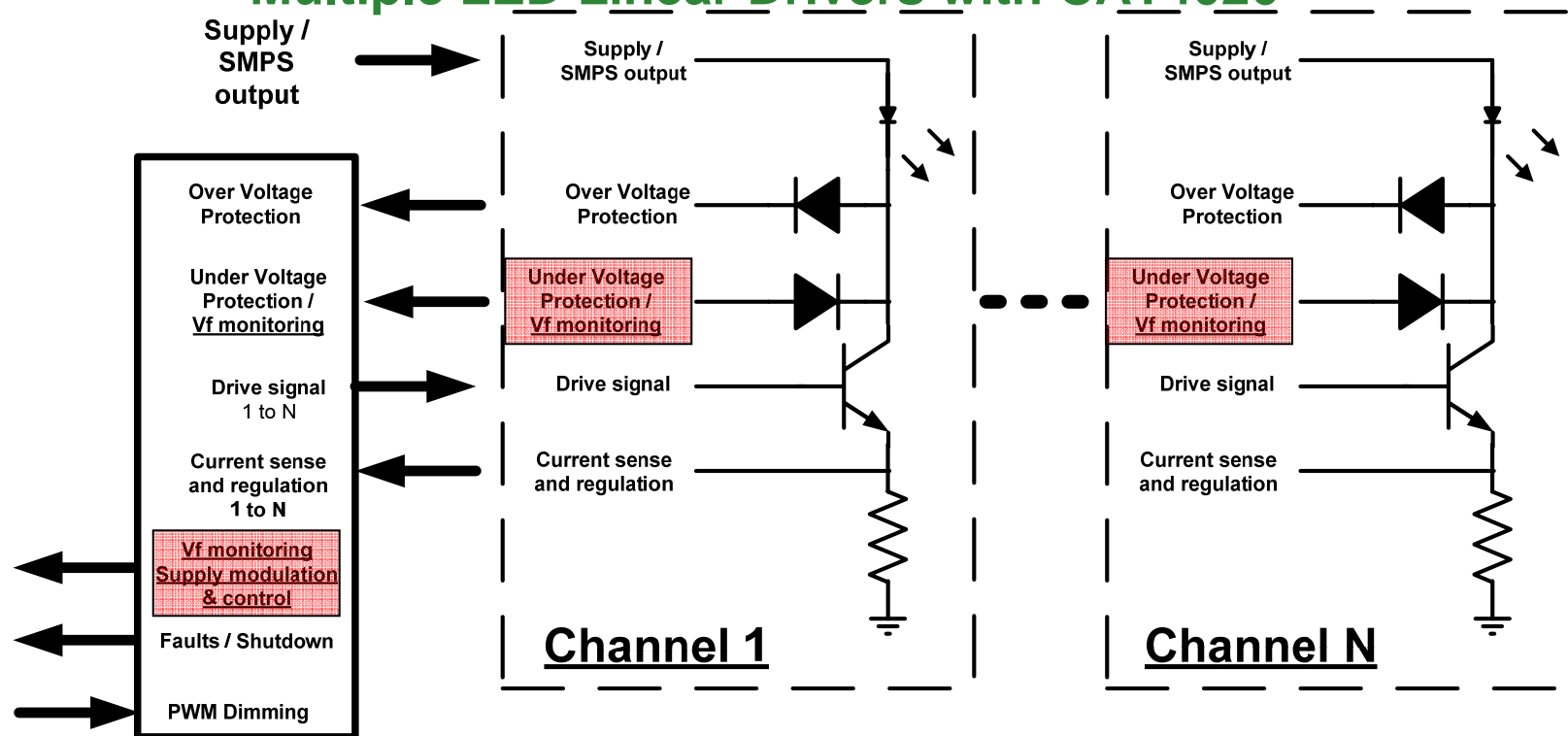
46英寸LED背光源

46" LED Backlight Power

- **针对更高功率的液晶电视** Higher power LCD-TVs
 - 可扩展至支持40/42英寸或52/55英寸设计 With extension to 40/42" or 52"/55"
 - 专用于背光源的半桥LLC转换器 HB LLC dedicated to Backlight power
 - 功率小于100 /120 W的应用可以考虑采用NCP1379的准谐振反激转换器 QR
Flyback with NCP1379 could be considered < 100 / 120 W
 - 高直流输出电压直接为LED驱动器供电 High DC output voltage to power directly LED drivers
- **单独/专用LED电源模块** Separate / Dedicated LED Power module
 - 可连接至46英寸电源参考设计(第二阶段, 高度小于8 mm) To be connected with 46" Power Reference Design step 2 < 8 mm
 - 带嵌入式侧光式LED驱动器 With embedded Edge LED Drivers
- **所用安森美半导体IC** ON Semi IC's
 - 带高端驱动器的新**NCP1397**初级侧控制器 New **NCP1397** primary side controller with high side drivers
 - 新的6通道线性LED驱动器控制器CAT4026, 带正向电压(V_f)监测功能 New 6 channel linear LED driver controller CAT4026 with V_f monitoring
- **低厚度设计** Low profile design
 - 电路板上高度低于8 mm(总高度低于12.5 mm) < 8 mm on top of PCB (< 12.5 mm total)

采用CAT4026的多通道LED线性驱动器

Multiple LED Linear Drivers with CAT4026



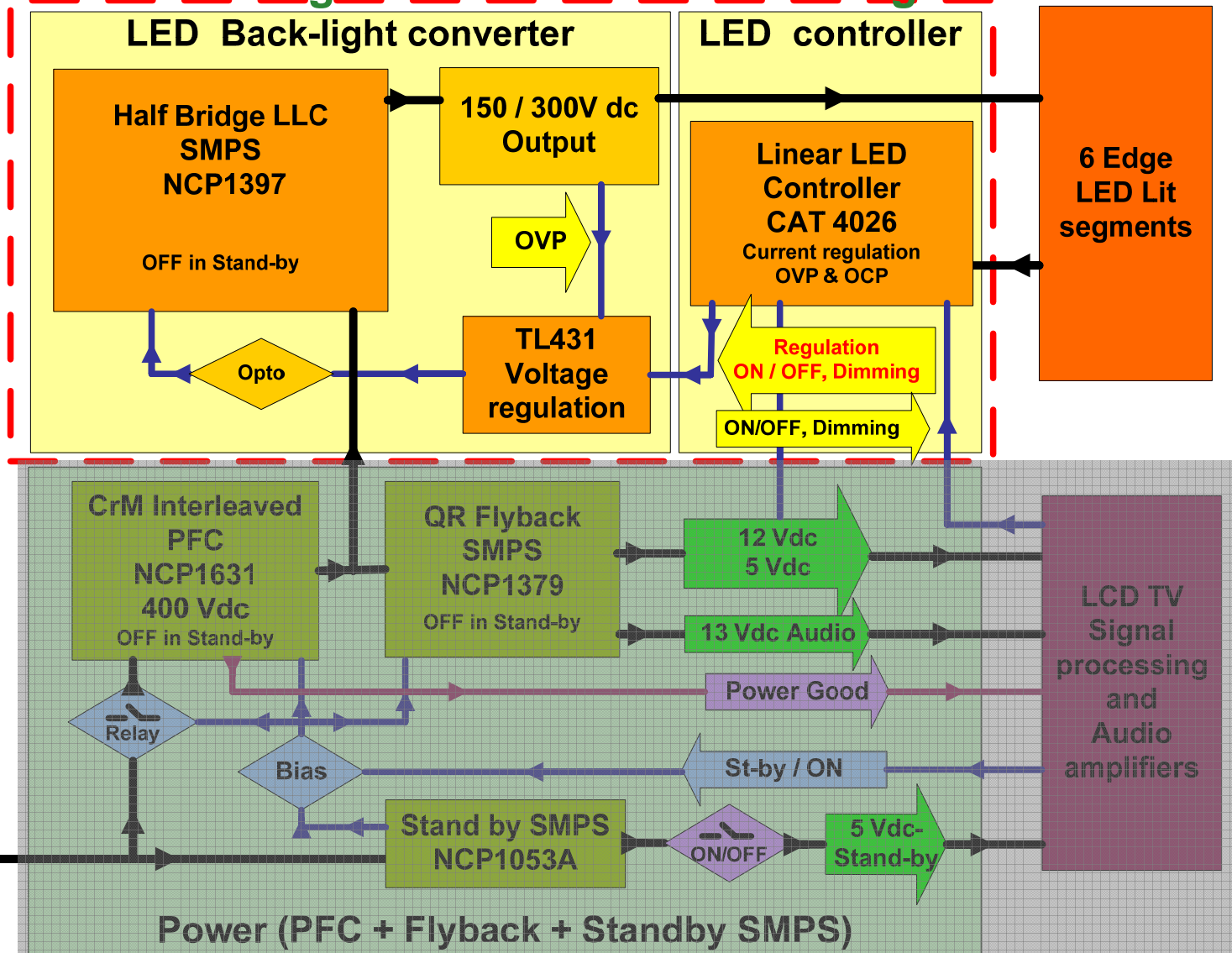
- 单控制器驱动多达6个通道，使用线性双极晶体管来提升稳流及平衡功能 Single controller to drive up to 6 channels with linear bipolar transistors used to provide current regulation and balancing
- 线性：无电磁干扰并降低方案成本(无额外线圈、二极管及电容) Linear: No EMI and reduce solution cost (not extra coils, diodes and capacitors)
- 低耗散得益于“正向电压监测及电源调制和控制” Limited dissipation thanks to “ V_f monitoring and supply modulation & control”

➡ 专用开关电源支持输出电压调制
Dedicated SMPS to support output voltage modulation

46英寸侧光式LED驱动器电视功能框图

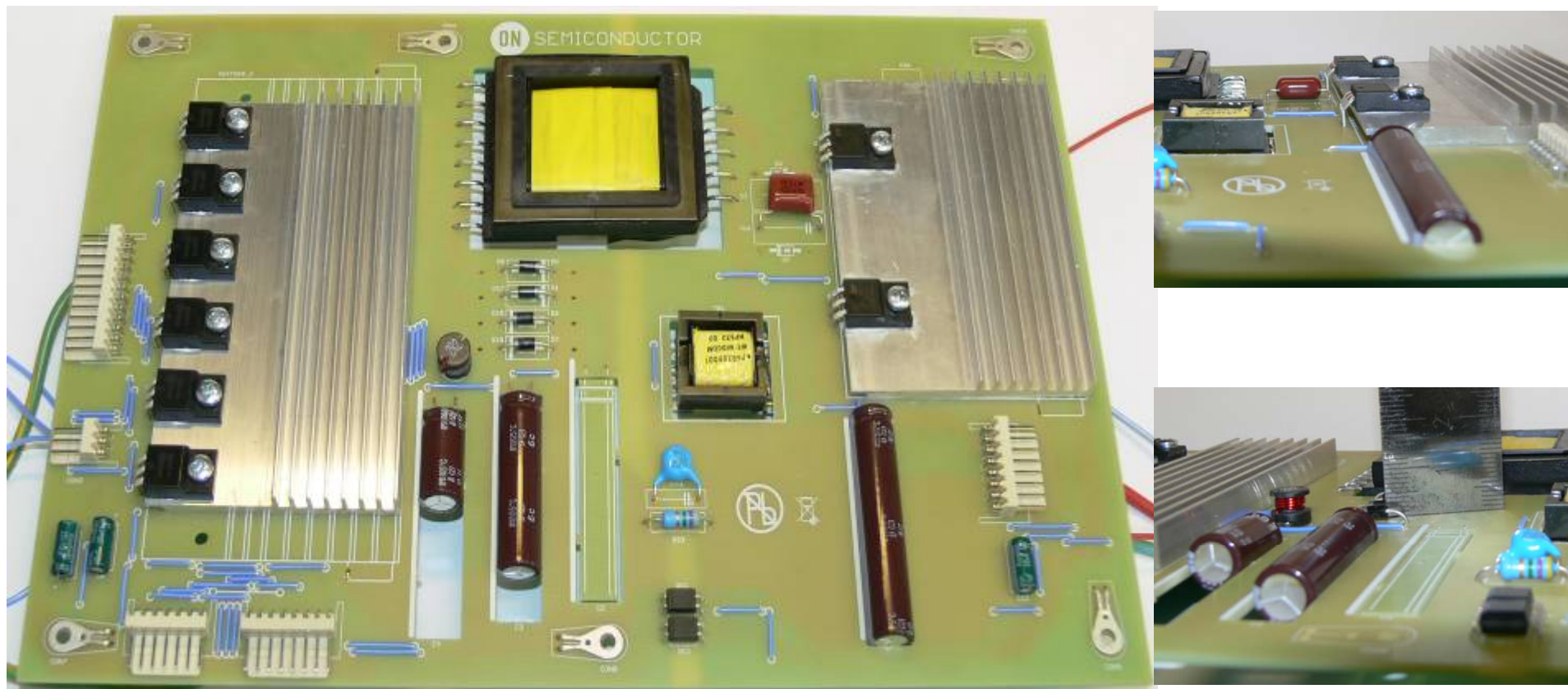
46" Linear Edge LED Driver TV Block Diagram

专用开关电源
用于背光，带
调制输出电压
Dedicated SMPS for
Backlight with
Modulated output
voltage



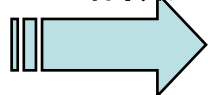
46英寸线性LED驱动器背光方案

46" Linear LED Driver Backlight Solution



•采用特殊技术，电路板中增加通孔，降低高度 Special technologies with added through holes in PCB to reduce the height

•电路板尺寸 PCB size: 250 mm x 165 mm



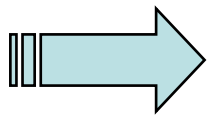
超薄设计：高度低于8 mm/总高度低于12.5 mm

Ultra SLIM design < 8 mm / 12.5 mm total

超薄开关电源用半桥LLC

HB LLC for ultra slim SMPS

- 元器件数量有限 Limited number of components
 - 不需要次级稳压线圈 No secondary regulation coil needed,
 - 小尺寸谐振电感部分或全部集成在变压器中 Small size resonant inductance partially or fully integrated in transformer
- 零电压开关(ZVS)条件在所有负载条件下用于初级开关稳压器 Zero Voltage Switching (ZVS) condition for primary switches under all load conditions
- 零电流开关(ZCS)在所有负载条件下用于次级二极管 Zero Current Switching (ZCS) for secondary diodes under all load conditions
- 功率密度比其它拓扑结构更高：更适合纤薄设计 Higher power density than other topologies: Better for SLIM design



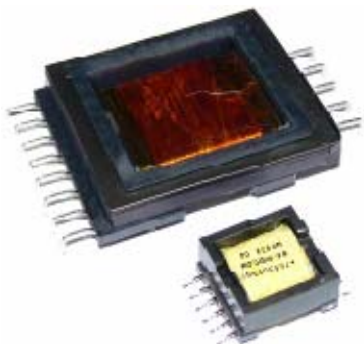
高能效、优异电磁干扰性能适合低高度开关电源

High efficiency and EMI friendly for low profile SMPS

谐振电感位置?

Resonant inductance location?

外部电感 External inductance



优势 Benefits:

- 设计灵活性更高 Greater design flexibility
- EMI辐射更低 Lower radiated EMI emission
- 利用变压器绕组 Transformer winding utilization
- 有可能使用谐振线圈上的辅助绕组来感测初级电流，用于过流保护 Possibility to use aux. winding on resonant coil to sense primary current for OCP

不足 Drawbacks:

- 绕组冷却条件较差 Worse windings cooling
- 初级至次级绝缘的实现更复杂 Primary to secondary insulation is more complex to achieve

内部泄漏电感 Internal leakage inductance

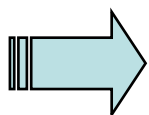


优势 Benefits:

- 初级至次级绝缘易于实现 Primary to secondary insulation is easy to achieve
- 绕组冷却条件更佳 Better cooling for windings
- 仅一颗元件 One component only

不足 Drawbacks:

- 设计灵活性较低 Less design flexibility
- 存在EMI辐射问题 EMI radiation
- 漂移磁通导致开关电源金属表面涡流问题 Eddy currents in SMPS metal cover due to stray flux
- 绕组窗口利用率较低 Poor winding window utilization

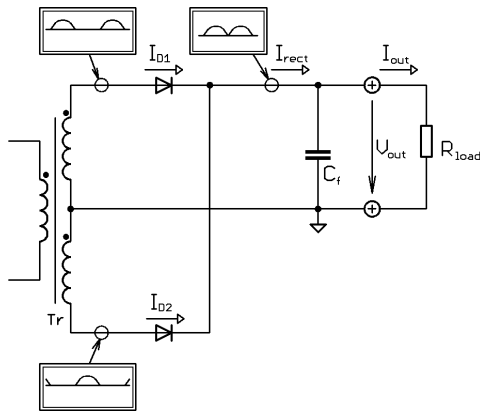


外部谐振线圈更适合超薄设计 External resonant coil is better for ultra slim design

次级整流

Secondary rectification

推挽式配置 Push-pull configuration



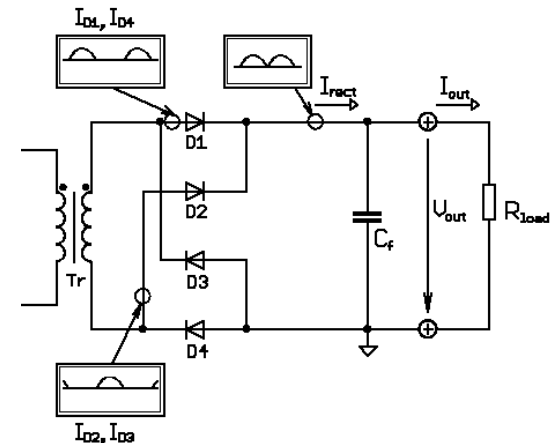
优势 Benefits:

- 压降较低 Less voltage drop
- 二极管单封装 Single package for diodes

不足 Drawbacks:

- 需要额外次级绕组 Need additional secondary winding
- 需要次级绕组间的良好匹配 Need good matching between both secondary windings
- 变压器窗口利用率 Transformer window utilization
- 整流器击穿电压更高 Higher breakdown voltage for rectifiers

桥整流器 Bridge rectifier

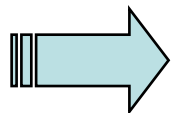


优势 Benefits:

- 仅需一个绕组，节省变压器窗口面积 Needs only one winding thus saves transformer window area
- 二极管额定电压更低 Lower voltage ratings for diodes
- 次级绕组间不要求匹配 Doesn't requires matching between sec. windings

不足 Drawbacks:

- 损耗更高-不太适合高输出电压和低输出电流应用 Higher losses – not big deal for high output voltage and low output current applications



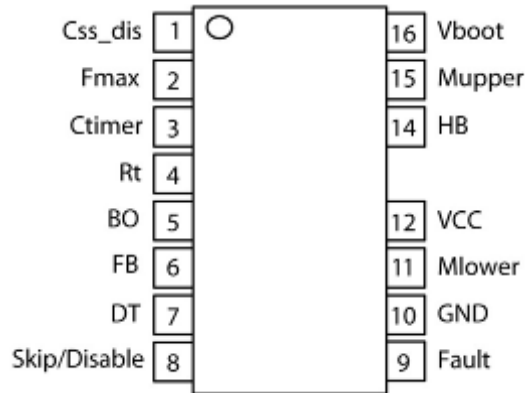
桥整流器更适合高压输出应用 Bridge rectifier is better for HV output applications



NCP1397 – LLC段控制器 LLC stage controller

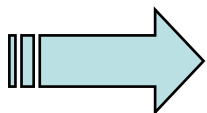
特性 Features:

- 50至500 kHz的高频工作 High-frequency operation from 50 kHz up to 500 kHz
- 600 V高压浮动驱动器 600 V high-voltage floating driver
- 可调节最小开关频率($\pm 3\%$ 精度) Adjustable minimum switching frequency ($\pm 3\%$ accuracy)
- 100 ns至2 μ s的可调节死区时间 Adjustable deadtime from 100 ns to 2 μ s.
- 藉外部可调节软启动实现的启动序列 Startup sequence via an externally adjustable soft-start
- 输入欠压保护, 结合门锁输入 Brown-out protection combined with latch input
- 基于定时器的自恢复或立即门锁OCP Timer-based auto-recovery or immediate latched OCP
- 关闭输入用于导通/关闭控制(跳周期模式) Disable input for ON/OFF control (skip mode)
- 300 μ A的低启动电流 Low startup current of 300 μ A
- 1 A/0.5 A峰值电流汲/源极驱动能力 1 A / 0.5 A peak current sink / source drive capability
- 共用集电极或射极光耦合器连接 Common collector or emitter optocoupler connections



在背光应用中的优势 Benefits for backlight application:

- 不需要驱动器变压器=>成本及安装优势 No driver transformer needed => cost and insulation advantages
- 简单应用跳周期模式=>适合调光所需 Simple skip mode implementation => needed for dimming
- 简单应用过流保护=>节省成本 Simple OCP implementation => cost impact

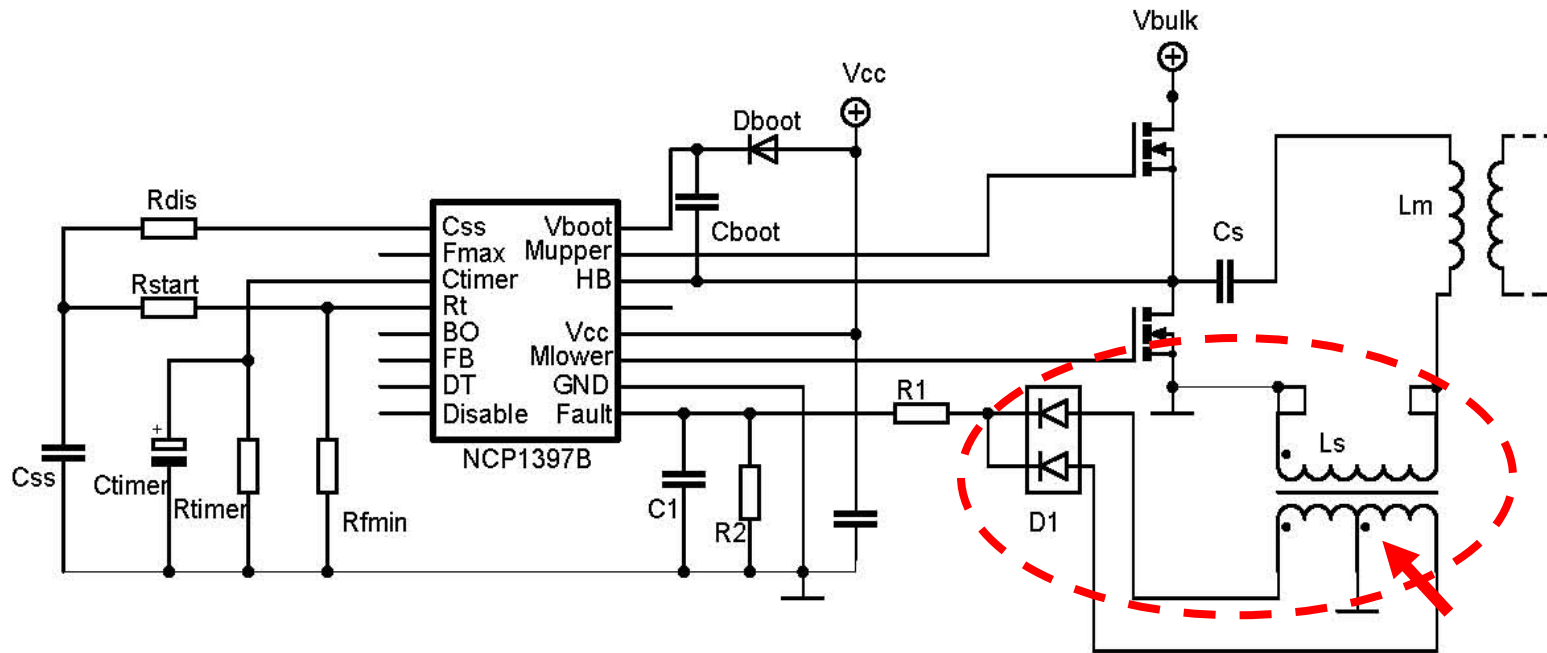


NCP1397是高性价比及高安全性的方案

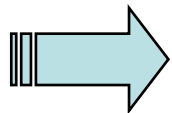
NCP1397 is cost effective and highly safe solution



新的过流保护应用 New OCP implementation



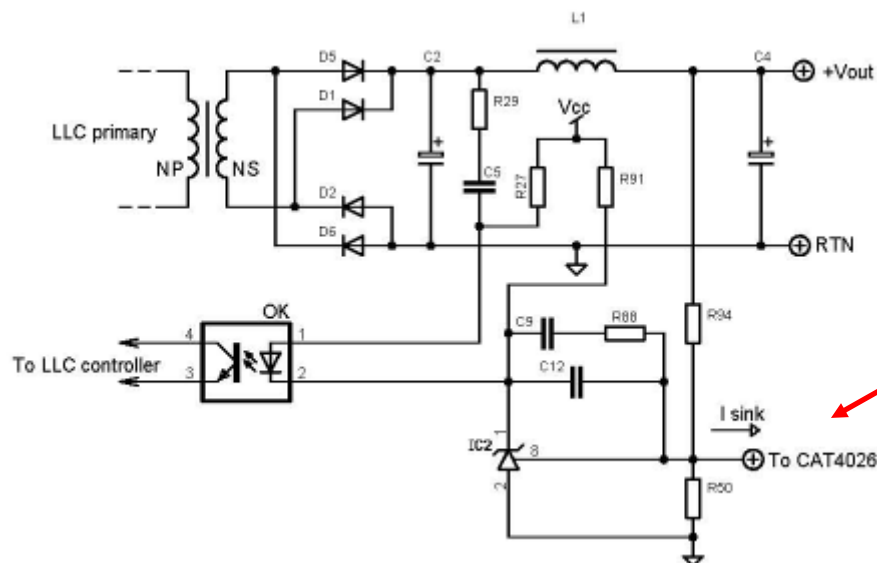
- 使用C定时器及R定时器实现可调节延迟故障检测 Adjustable delayed fault detection using C timer and R timer
- 短路保护，藉C_{ss}引脚提供频率转换 Short circuit protection with frequency shift via C_{ss} pin
- 新的谐振线圈辅助绕组双相电流信息 New Double phase current information from auxiliary winding of resonance coil
 - 极精确及快速的初级电流信息 Very accurate and fast primary current information
 - 低元件数量，不需要高压电容 Low component count without the need of High Voltage capacitor



谐振线圈辅助绕组提供精确及快速的过流保护

Res. Coil aux. winding provides accurate and fast OCP

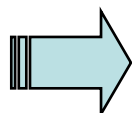
输出电压调制 Output Voltage modulation



CAT4026从反馈分频器汲取电流，提高输出电压
 CAT4026 sinks current from FB divider to increase output voltage

• 线性LED驱动器优势 Linear LED Drivers impact

- 专用开关电源支持输出电压调制 Dedicated SMPS to support output voltage modulation
 - 出现LED串较大程度不匹配时，LLC输出电压必须宽范围(约±20%)稳压 LLC output voltage has to be regulated in wide range (~ ± 20%) in case of big mismatch between LED strings
 - => LLC段工作频率范围优势 LLC stage operating frequency range impact
 - => 极小调光占空比条件下使用跳周期模式 Skip mode to be used under very small dimming duty cycles
- 不允许增加辅助电压用于音频及信号处理 Does not allow to get added auxiliary voltages for Audio & Signal processing
 - 由正向电压监测导致太多变化(约±20%) Too much variation due to Vf monitoring (~ ± 20%)
 - 由背光调光导致太多低频纹波(<1% by 100 Hz) Too much low frequency ripple due to backlight dimming

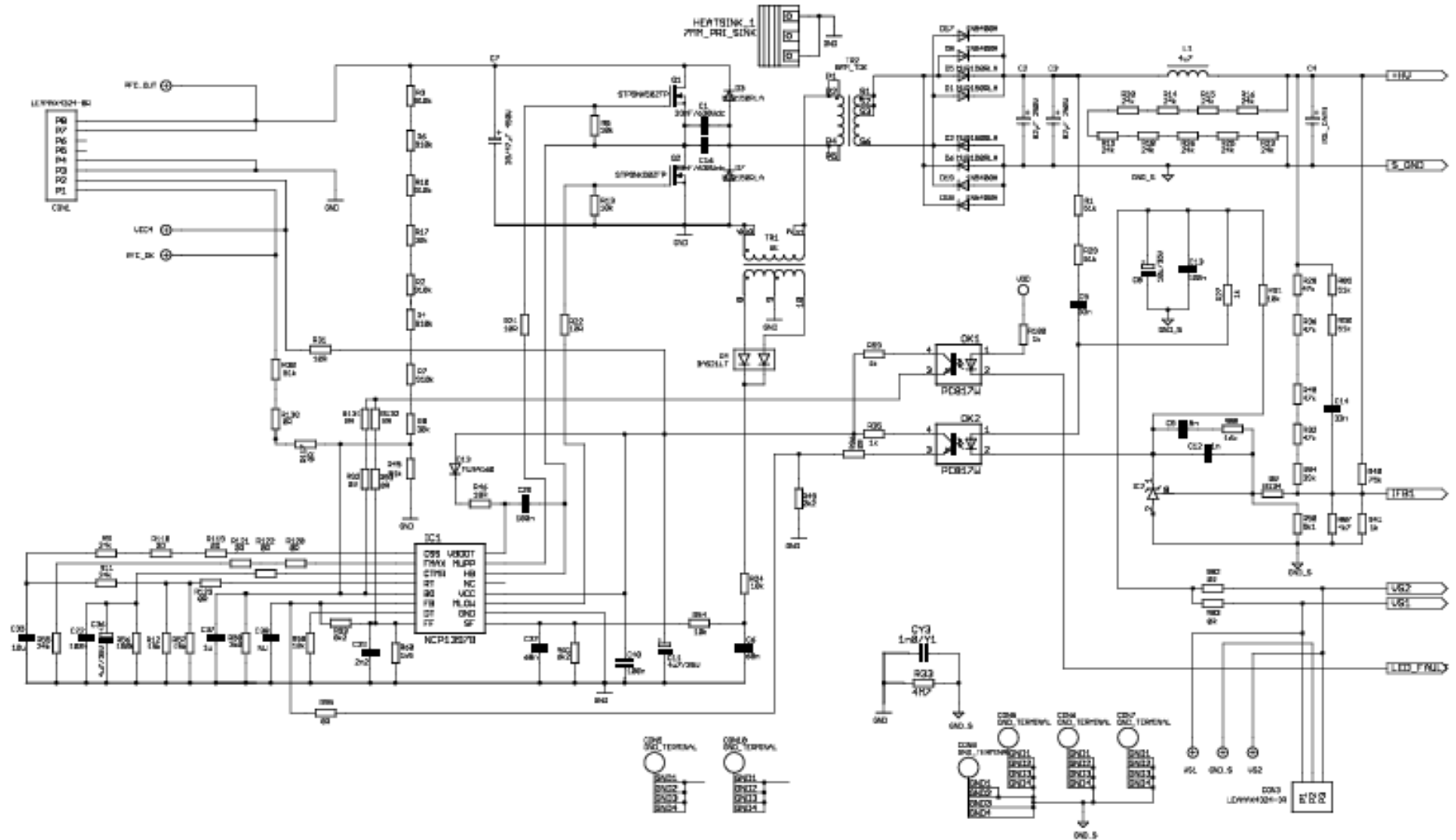


线性驱动器使用单输出电压调制 Single Output Voltage modulated for Linear Driver

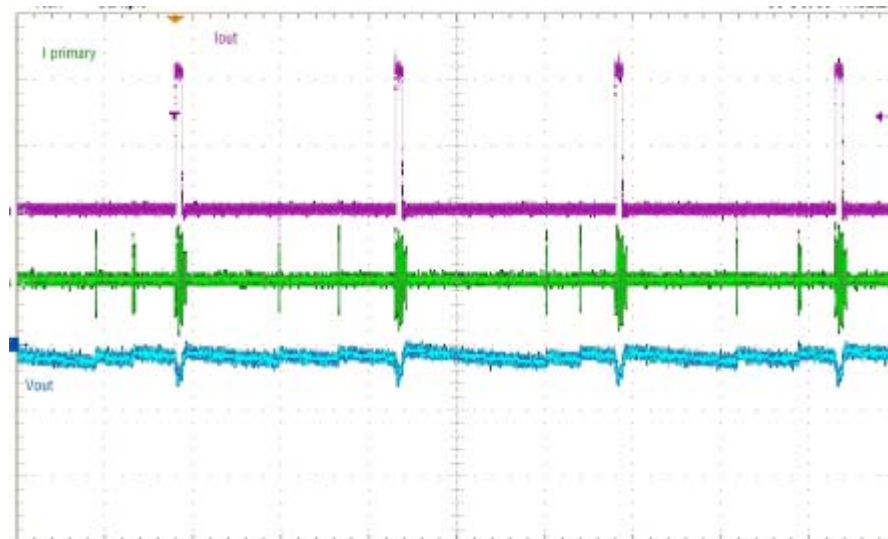
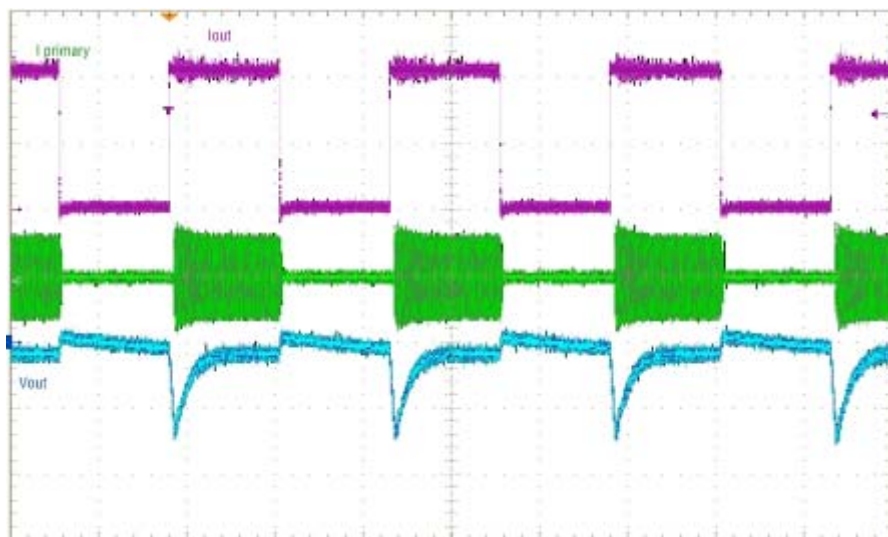


线性LED驱动器半桥LLC电路图

HB LLC schematic for Linear LED Driver



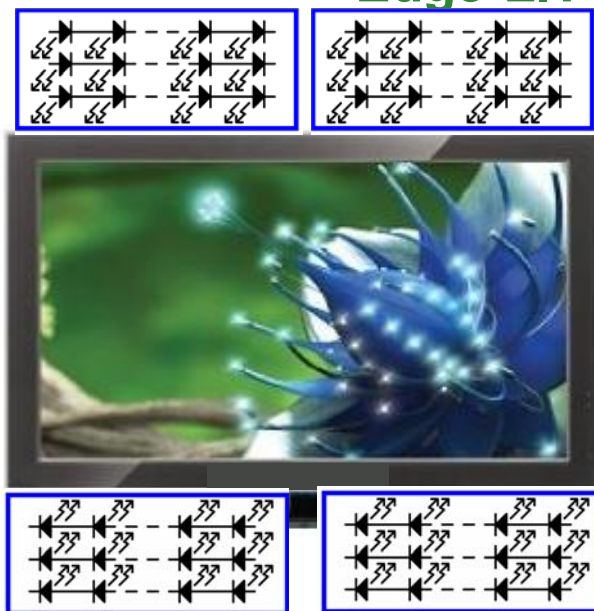
半桥LLC波形 HB LLC waveforms



- 100 Hz调光时半桥LLC上会有剧烈的负载变化(0到100%) Strong load variation (0 to 100%) on HB LLC with 100 Hz dimming
- 迹线 Traces:
 - 顶部: 输出电流从0到1 A (0.5 A/div)
Top: Output current from 0 to 1A (0.5 A/div)
 - 中间: 初级电流2 A/div
Middle: Primary current 2 A/div
 - 底部: 输出电压纹波2 V/div (120 Vdc)
Bottom: Output voltage ripple 2 V/div (120 Vdc)
- 顶部图片: 50%调光 Top picture: 50% dimming
 - 半桥LLC工作在突发模式 HB LLC works in Burst
 - 输出电压上高达3V 峰值纹波 Up to 3 Vpeak ripple on Vout
- 底部图片: 5%调光 Bottom picture: 5% dimming
 - 半桥LLC工作在突发模式 HB LLC works in Burst
 - 输出电压上峰值电压纹波小于0.5 V < 0.5 Vpeak ripple on Vout

侧光式LED背光趋势

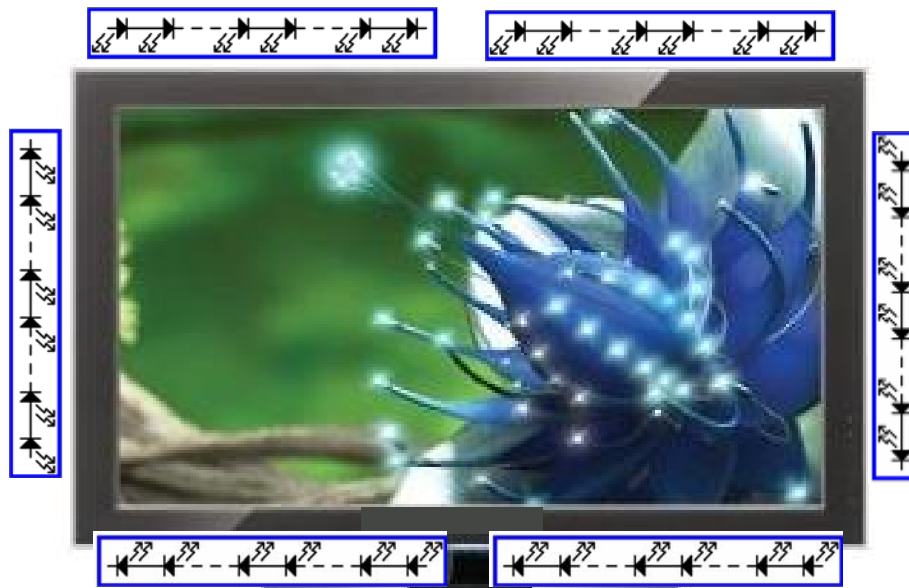
Edge-LIT LED Backlighting trends



中等尺寸面板LED电视 'Mid-Size' Panel LED TV

4个LED光条(各3串) 4 LED Light Bars (each 3 strings)

LED串 LED String : 100 V+ , 50 mA+

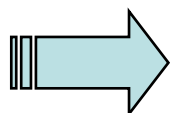


大尺寸面板LED电视 Large Panel LED TV

6个LED光条(单串) 6 LED Light Bars (single strings)

LED串 LED String : 200 V+ , 100 mA+

- “LED光条”因配置(LED串的数量)不同而不同 ‘LED Light bars’ vary in configuration (number of LED strings)
 - 单串大功率LED Single LED Strings of High Power (~ 200 V+ , 100 mA+)
 - 多串(达4串)较低功率LED Multiple LED Strings (up to 4) of Lower Power (~ 100 V+ , 50 mA+)



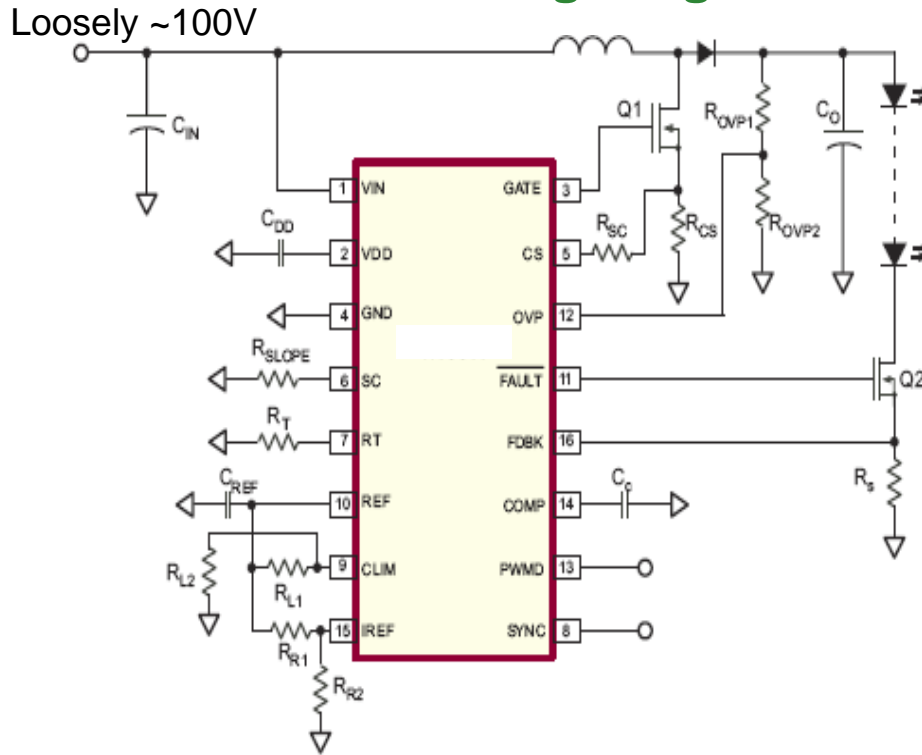
LED驱动器方案必须处理4到16个通道

LED Driver solutions must handle from 4 to 16 channels



现有大面板背光方案

Existing Large Panel Backlight Solution



各个LED通道使用 Every / each LED channels uses

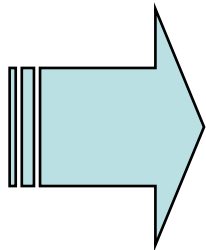
- 专用DC/DC驱动器IC A dedicated DC/DC Driver IC
- 升压用功率MOSFET A Power MOS for the Boost
- 带高Irms的大电感 A large inductor with high Irms
- 大肖特基二极管 A large schottky diode
- 大输出电容 A large output capacitor
- 增加功率MOSFET以提供调光及短路保护功能 A added Power MOS to provide dimming and short circuit protection

优势 Advantage: 独立通道 Independent Channel

高效及LED故障处理 Efficiency and LED-Fault handling

宽输入电压调整 Loosely regulated input supply

不足 Drawback: 高的成本及复杂度 Cost and Complexity

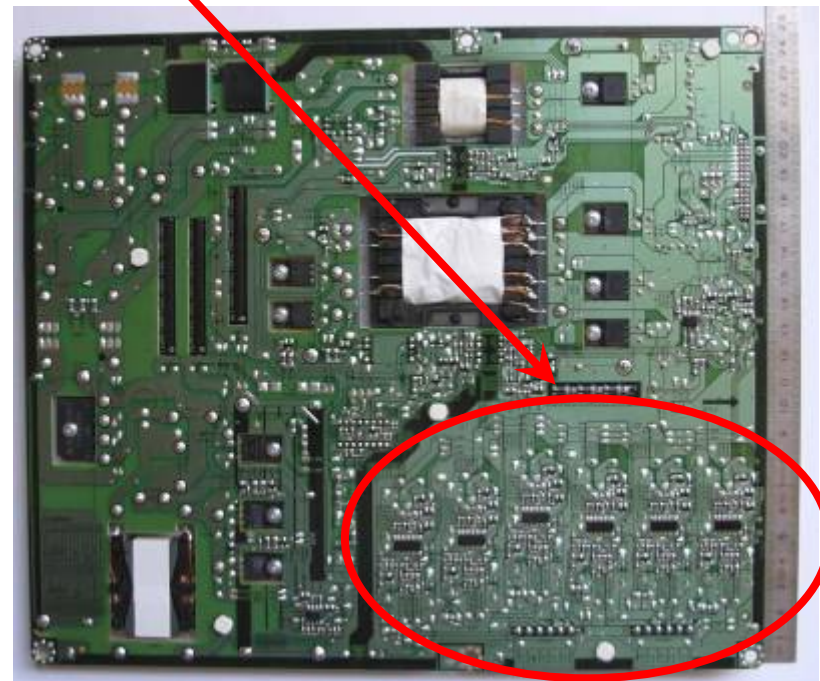
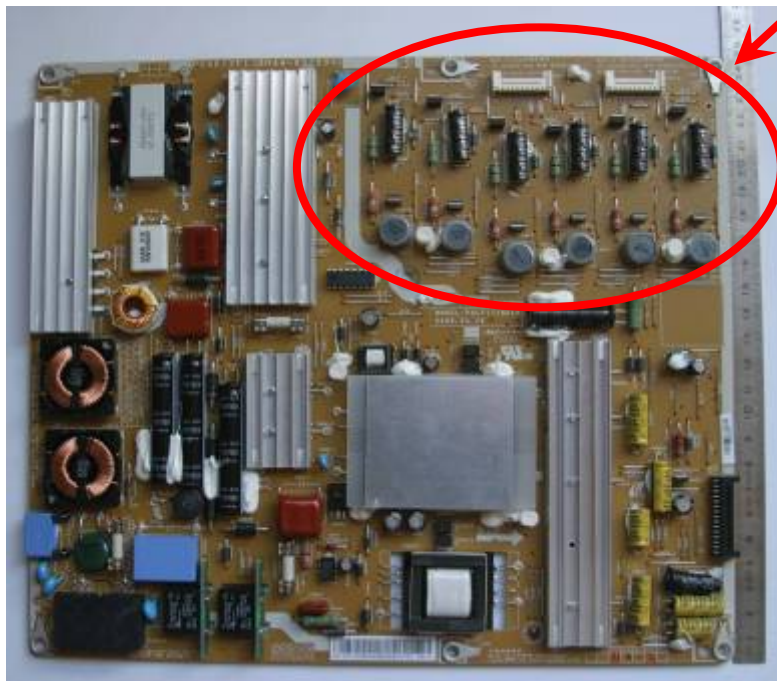


现有LED驱动器背光方案

Existing LED Driver Backlight Solution

- 6通道侧光式LED电视使用的大尺寸面板电源模块 Large-size panel power Module used for 6 Channel Edge-LIT LED TV
- 各通道均含有专用驱动器IC+电感型DC/DC升压+开关 Each channel has a Dedicated Driver IC + inductive DC/DC boost + switch

6通道=6 x (DC/DC升压+额外开关)
6 Ch = 6 x (DC/DC Boost + add. switch)

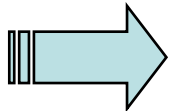


6通道=6 x 驱动器IC 6 Ch = 6 x Driver IC

多通道“线性”LED侧光方案

Multi-channel “Linear” Edge-Lit solution

- 高性价比方案，支持高数量的通道 Cost effective solution to address a wide number of channels
 - 易于分级为多达12或18个通道(2或3个控制器) Easily cascaded for up to 12 or 18 channels (2 or 3 controllers)
- 正向电压监测功能动态调节阳极电压 VF Monitoring to dynamically adjusts Anode voltage
 - 反馈将 V_{Fmax} LED串阴极稳压至3 V Feedback regulates V_{Fmax} LED string cathode to 3V
 - 提供线性控制 Provide linear control
 - 限制总体功率耗散 Limit the overall power dissipation
- 能效目标范围高于90%，典型值94%(视LED不匹配程度而定) Efficiency target range >90%, 94% typ. (varies with LED mismatch)
- 由外部功率双极结晶体管(BJT)提供散热 Thermal dissipation addressed by external Power BJT's
 - DPAK或TO-220封装，并增加散热片 DPAK or TO-220 with added heat sink
- 应对不同LED串故障 Address various LED string faults
 - LED开路 Open-LED
 - 过多LED短路 Excessive Shorted LED



“线性LED驱动器”：用于多通道的高性价比方案

“Linear LED Driver”: A cost effective solution for multiple channels

多通道“线性”侧光方案

Multi-channel “Linear” Edge-Lit solution

- 6通道配置如下所示 6 channel configuration shown

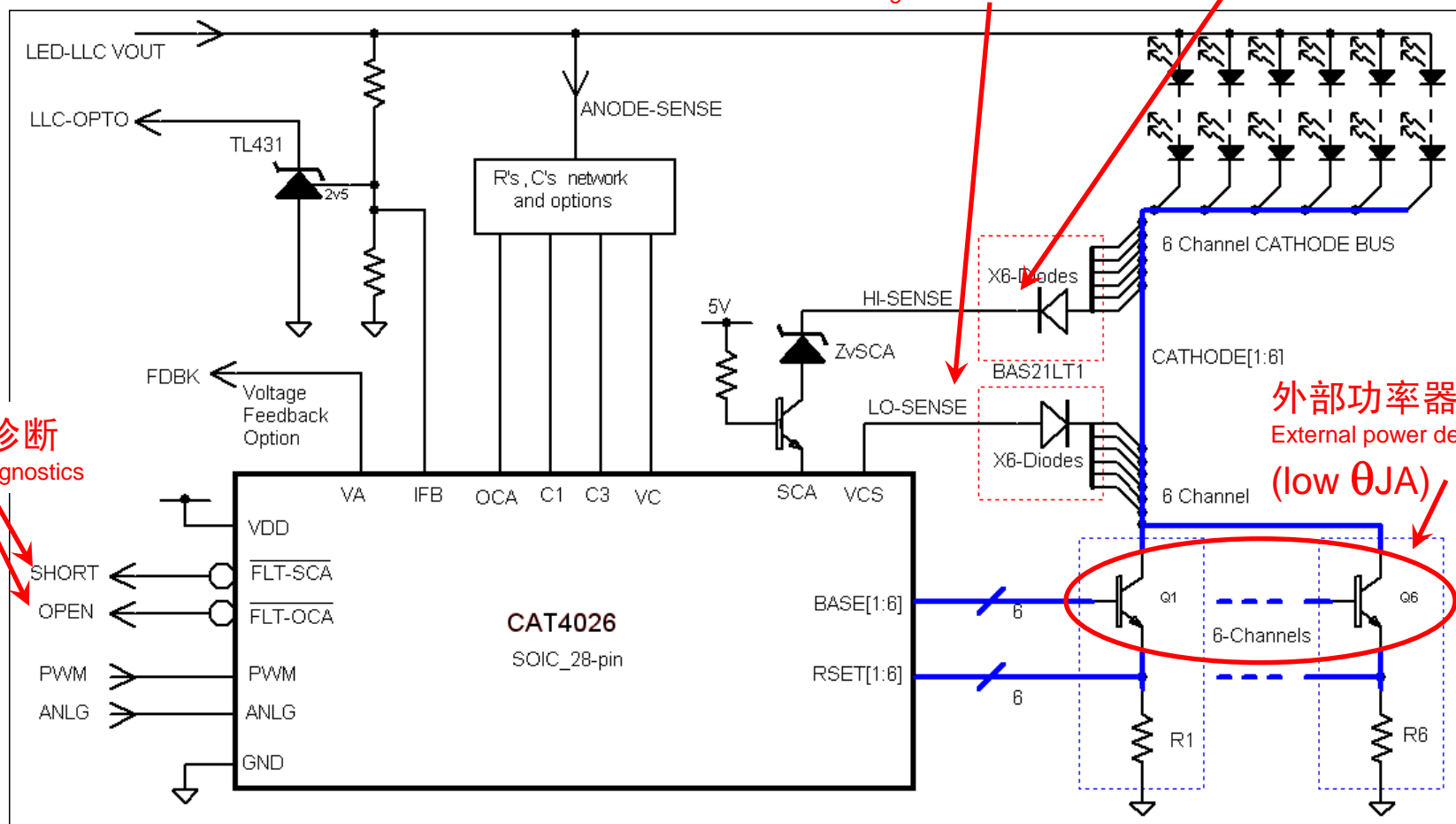
LED阳极：动态调节
LED-Anode : dynamic adjustment

LED阴极稳压为约3 V
LED Cathode regulation ~3 V

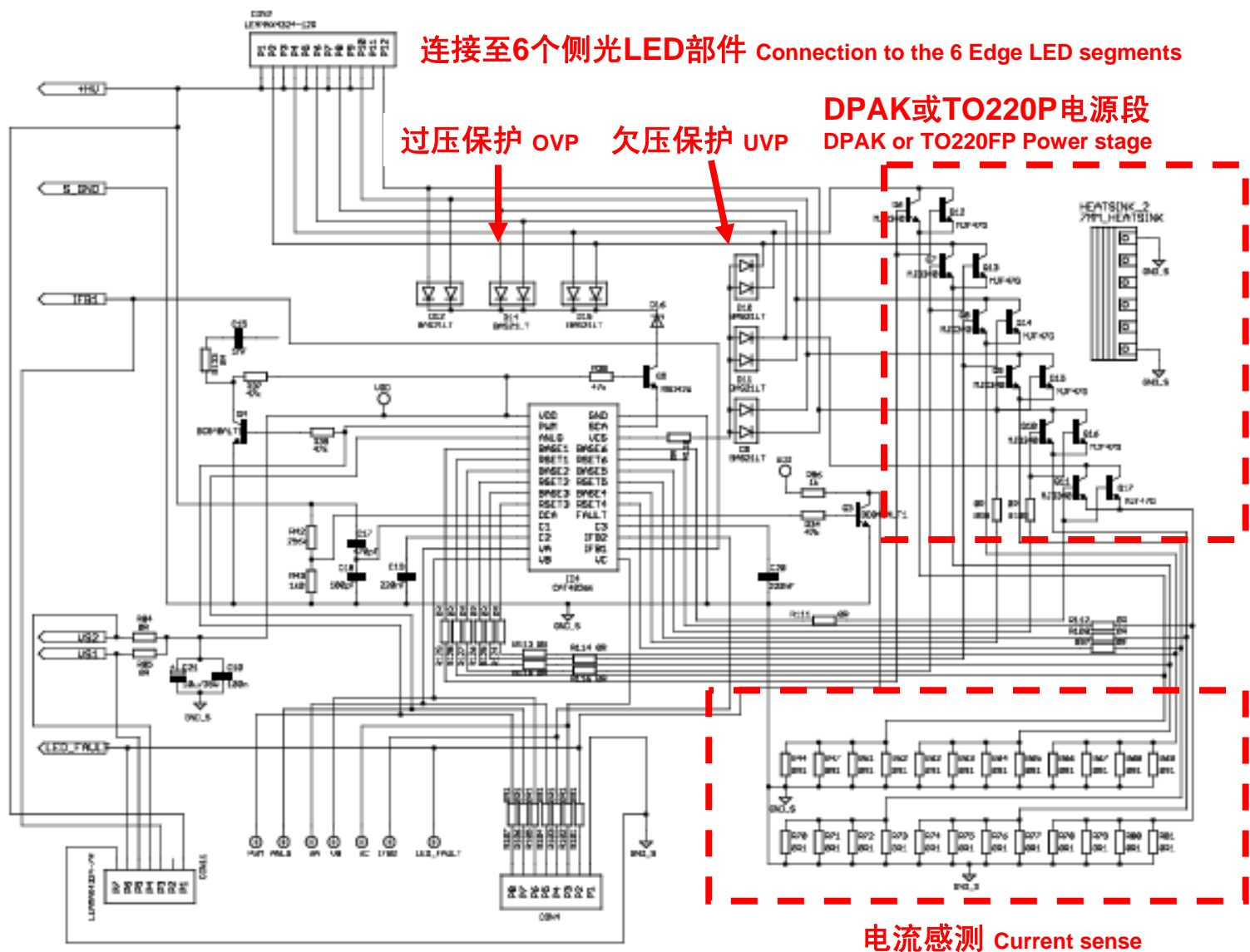
LED阴极过压保护
LED Cathode OVP

故障诊断
Fault Diagnostics

外部功率器件
External power devices
(low θ_{JA})

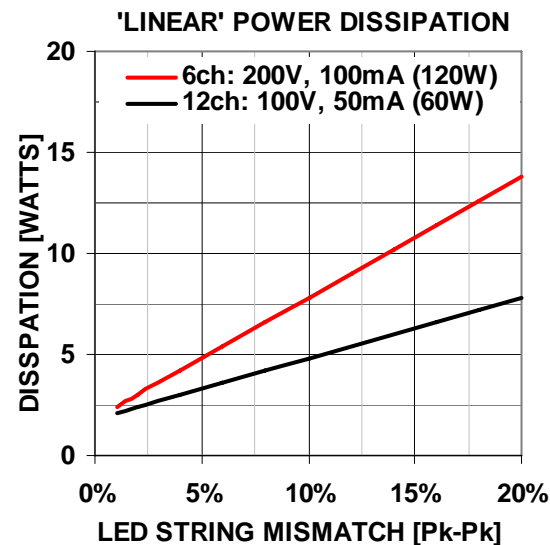
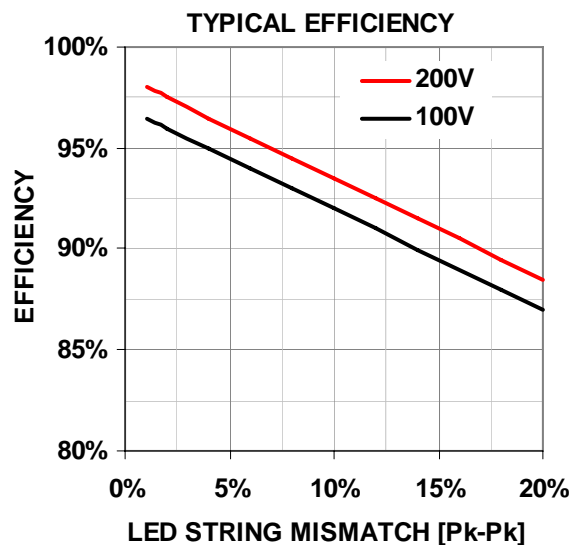
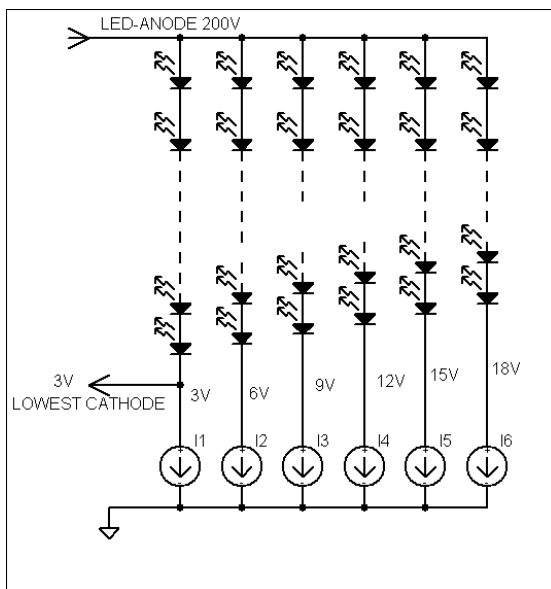


多通道“线性”侧光驱动器电路图 Multi-channel “Linear” Edge Driver schematic

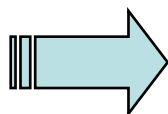


优化动态LED阳极控制

Optimized Dynamic LED-Anode control



- 能效取决于LED串的匹配度 Efficiency depends on LED string matching
- 200 V LED串(不匹配度为10%)提供约94%的能效 200 V LED strings (with 10% mismatch) delivers ~ 94% efficiency
- 热功率耗散等级: 约5至10 W范围 Thermal power dissipation levels : ~ 5 to 10 watt range

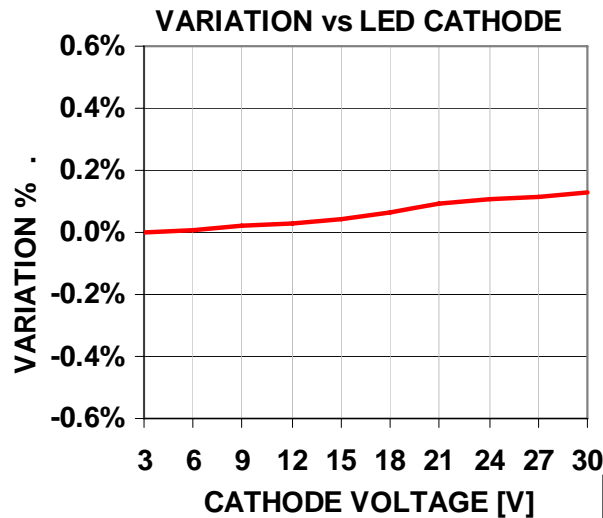
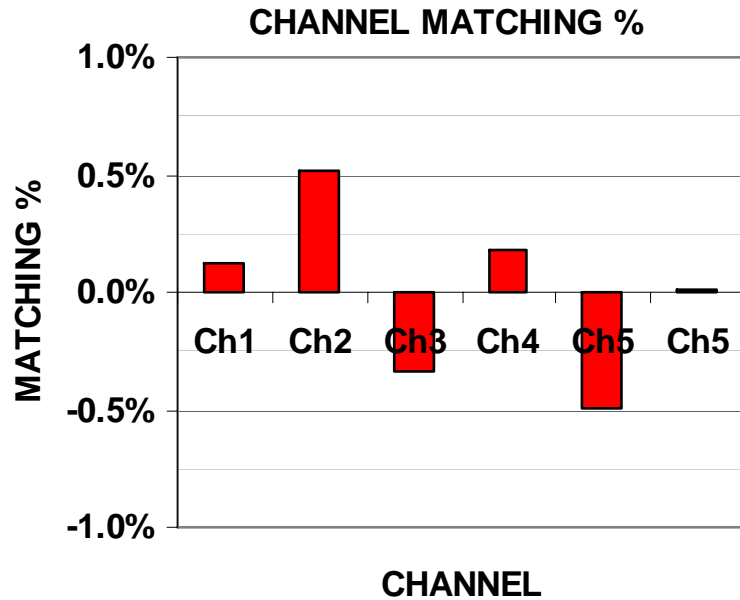
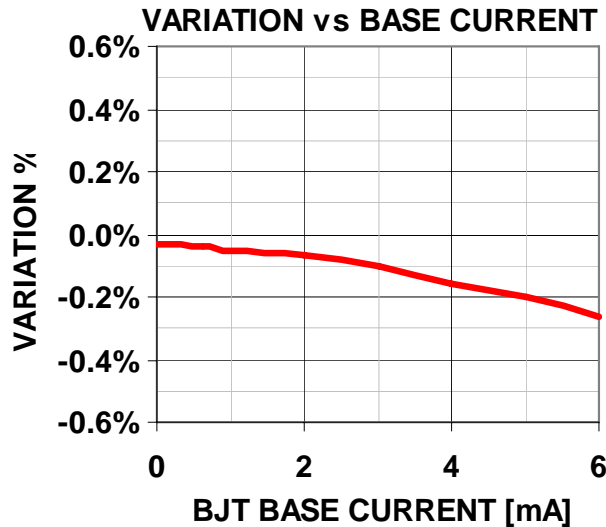


电压调制及控制功能旨在限制总体功率损耗

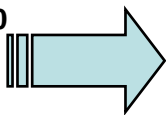
V modulation & control to limit overall Power dissipation

LED通道电流匹配

LED Channel Current Matching



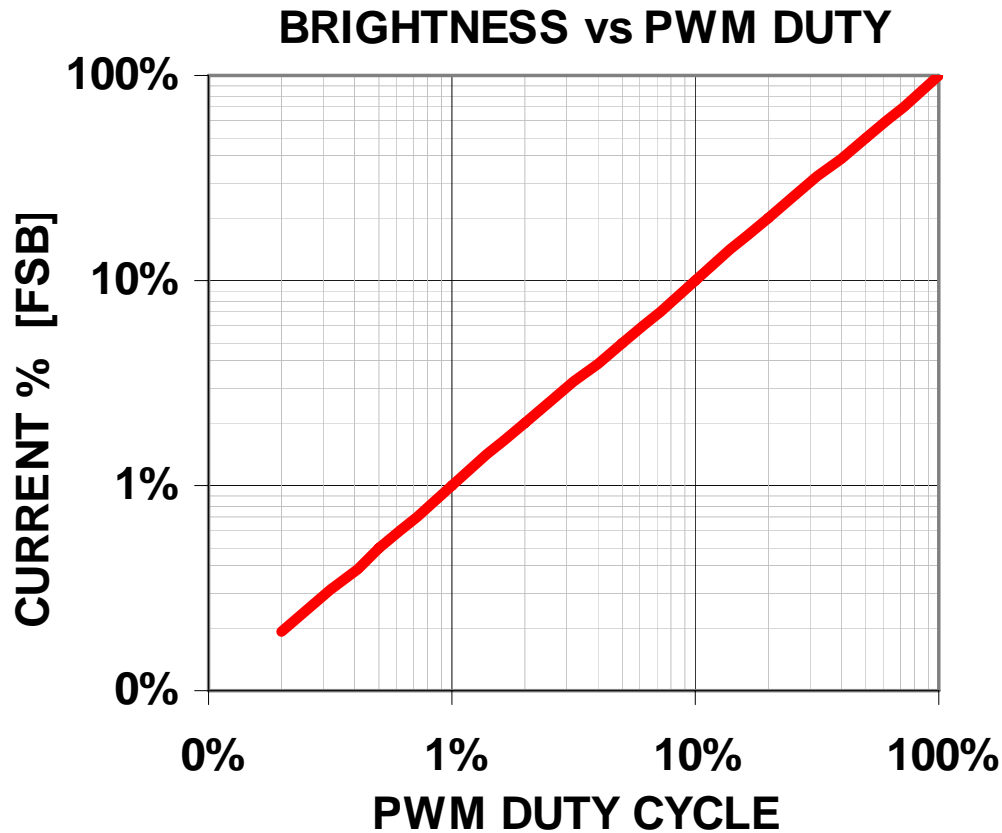
- 初级通道匹配容限 Initial channel matching tolerance $\sim \pm 0.5\%$
- BJT基极电流变化 Variation with BJT Base current : $< 0.25\%$
- 阴极至30 V变化 Variation with Cathode to 30V : $< 0.15\%$
- 总体通道匹配精度优于 Overall Channel matching less than $\pm 2\%$



极佳的电流匹配精度 $< \pm 2\%$
 Very good current matching $< \pm 2\%$

优化宽PWM调光范围

Optimized Wide PWM dimming range

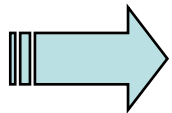


线性方案在极短“导通”时间方面没有概念限制 No concept limitation for Linear solution for very short “ON” time

CAT4026线性驱动器优化用于PWM调光，带直接引脚控制

CAT4026 Linear Driver is optimized for PWM dimming with direct pin control

开关电源及大输出电容直接管理较强的功率变化 Strong power variation managed directly by SMPS and large output capacitor



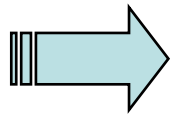
400 Hz PWM调光最低<1% Down < 1% for 400 Hz PWM dimming



侧光式LED线性背光小结

Edge LED Linear Backlighting summary

- 提供另一适合的方案，降低了总方案成本 Provides a suitable alternative with reduced total solution cost.
- 正向电压(VF)监测功能尽可能减小并优化功率耗散 VF monitoring minimizes & optimizes power dissipation
- 散热考虑要求外部功率器件(低成本型) Thermal considerations require external power devices (low cost type)
- 将电磁干扰降至最低(无电感，无独立通道直流-直流转换) Minimizes EMI (No inductors, No individual channel DC/DC)
- 提供有竞争力的通道至通道LED匹配 Offers competitive Channel to Channel LED matching
- 提供有竞争力的宽范围PWM调光，且具备优异的线性度 Offers competitive wide range PWM dimming with good linearity
- 支持故障诊断，防止LED开路及LED短路模式 Supports Fault diagnostics against Open-LED and Short-LED modes



线性是易于设计及高性价比的方案

The Linear is a easy to design and cost effective solution



总结 Summary

- **完整的液晶电视电源方案路线图 Complete roadmap of LCD TV solutions**
 - **32英寸LIPS参考设计提供 32" LIPS reference design provides**
 - 针对CCFL的成本优化方案 A cost optimized solution for CCFL
 - 方案可扩展，优化电路后支持26至42英寸设计 Scalable to cover from 26" up to 42" with circuit optimization
 - **46英寸电源参考设计提供 46" Power reference design provides**
 - 适合任何背光类型的电源(PFC、反激转换及待机电源) Power (PFC, Flyback and Standby) for any type of Backlight
 - 对大尺寸(40到55英寸)设计而言，实现小于13或8 mm厚度 For large screen sizes (from 40" up to 55") < 13 or 8 mm
 - **46英寸LIPS，高度低于13 mm，带单独LIPS参考设计，为大CCFL/EEFL面板提供高端/高性能方案 46" LIPS < 13 mm with separate LIPS reference design provides a high end / high performance solution for larger CCFL / EEFL panels**
 - **46英寸侧光LED方案，纤薄，高度低于8 mm，带单独LED驱动器参考设计，提供低厚度的下一代产品，为高端LED电视提供高能效的线性侧光式LED驱动器方案 46" Edge LED SLIM < 8 mm with separate LED Drivers reference design provides a low profile next generation for high end products with very efficient Linear Edge LED driver solution**
- **途径 Approach**
 - 提供极大的协同优势，便于复用方案，因此加速设计过程，并加快新方案上市，保持与市场同步发展 Allow maximum synergy by re-use solutions, thus speeding up the design process and allow faster time to market of new solutions thus keeping up with market evolution

For More Information

- View the extensive portfolio of power management products from ON Semiconductor at www.onsemi.com
- View reference designs, design notes, and other material supporting the design of highly efficient power supplies at www.onsemi.com/powersupplies