

FOR ENERGY EFFICIENT INNOVATIONS

THINK ON.

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适用于大输出功率级开关电源的 高性价比双开关正激拓扑方案 NCL30125

Public Information



为何采用双开关正激拓扑？

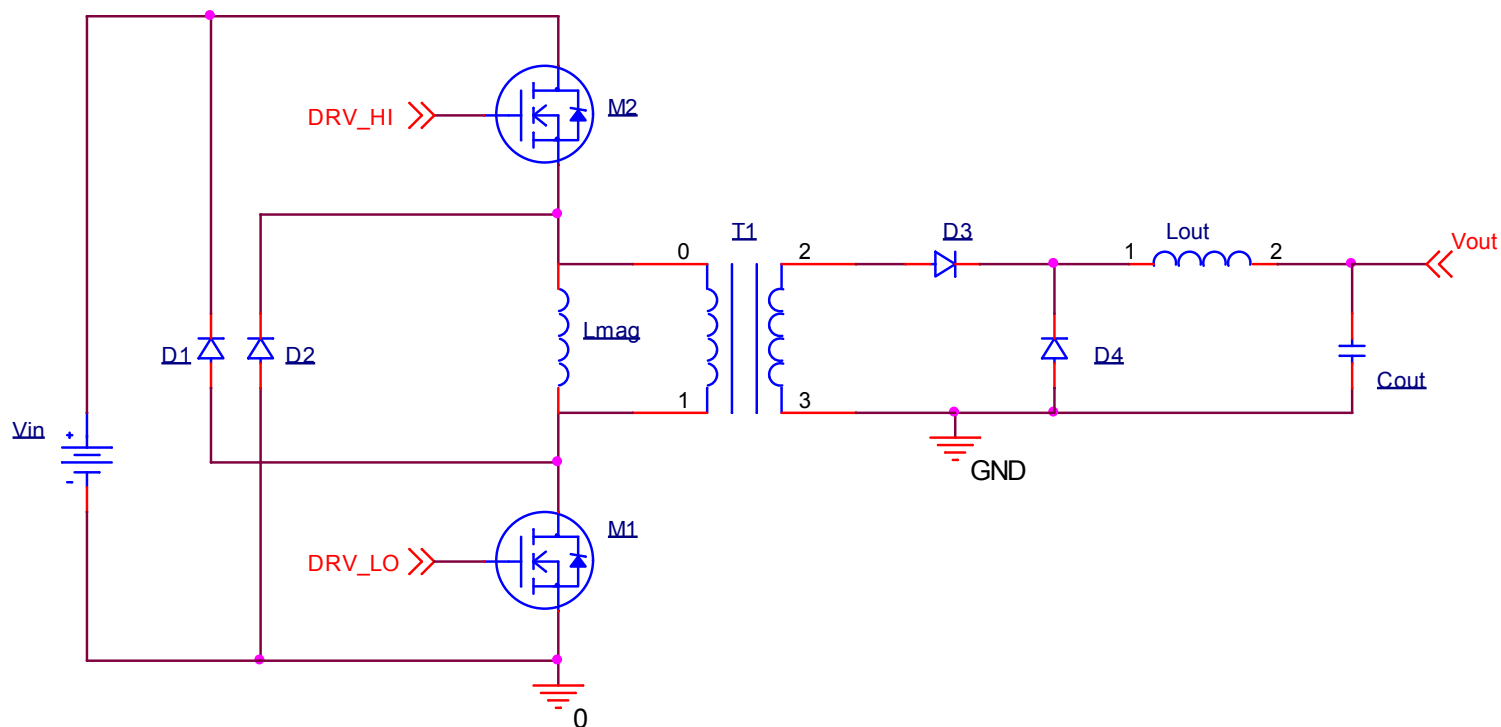
- **双开关正激拓扑**适用于许多应用领域，如**户外显示LED照明、工控电源(PSU)**等
- 双开关正激拓扑输出功率等级 → **200 – 500W**

双开关正激拓扑的优势：

- **易于设计** → 变压器仅用于能量传输;
- **极强可靠性** → 两个初级开关同时导通，无直通问题。
- 降低和钳制初级开关的电压应力 → **500V MOSFET**足够用于高压输入情况

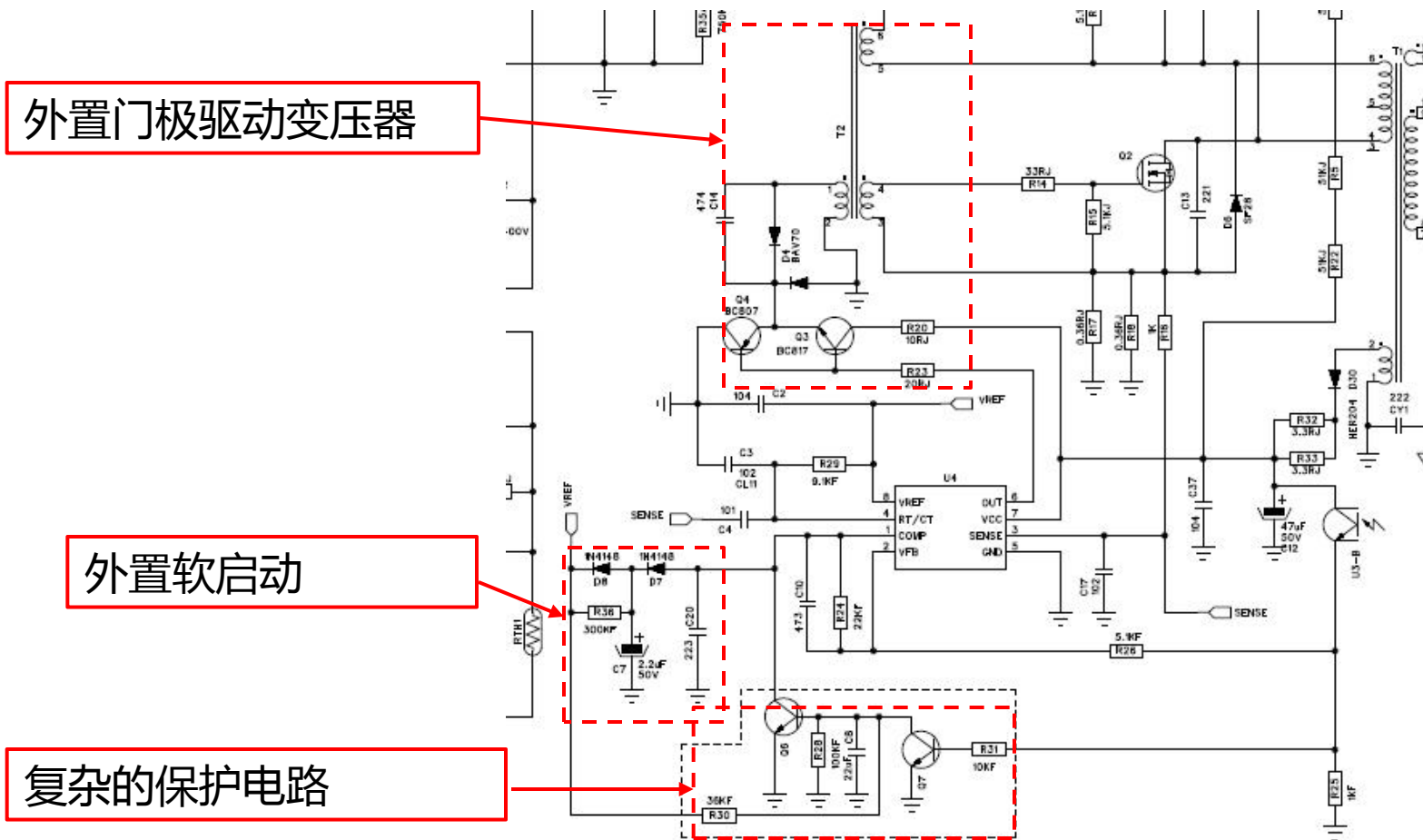
现在大多数双开关正激转换器都采用**384x系列或NCP1252**

什么是双管正激拓扑?



- 低边MOSFET像传统的单开关正激拓扑结构一样易于驱动
- 高边MOSFET源极悬空，使驱动更加复杂

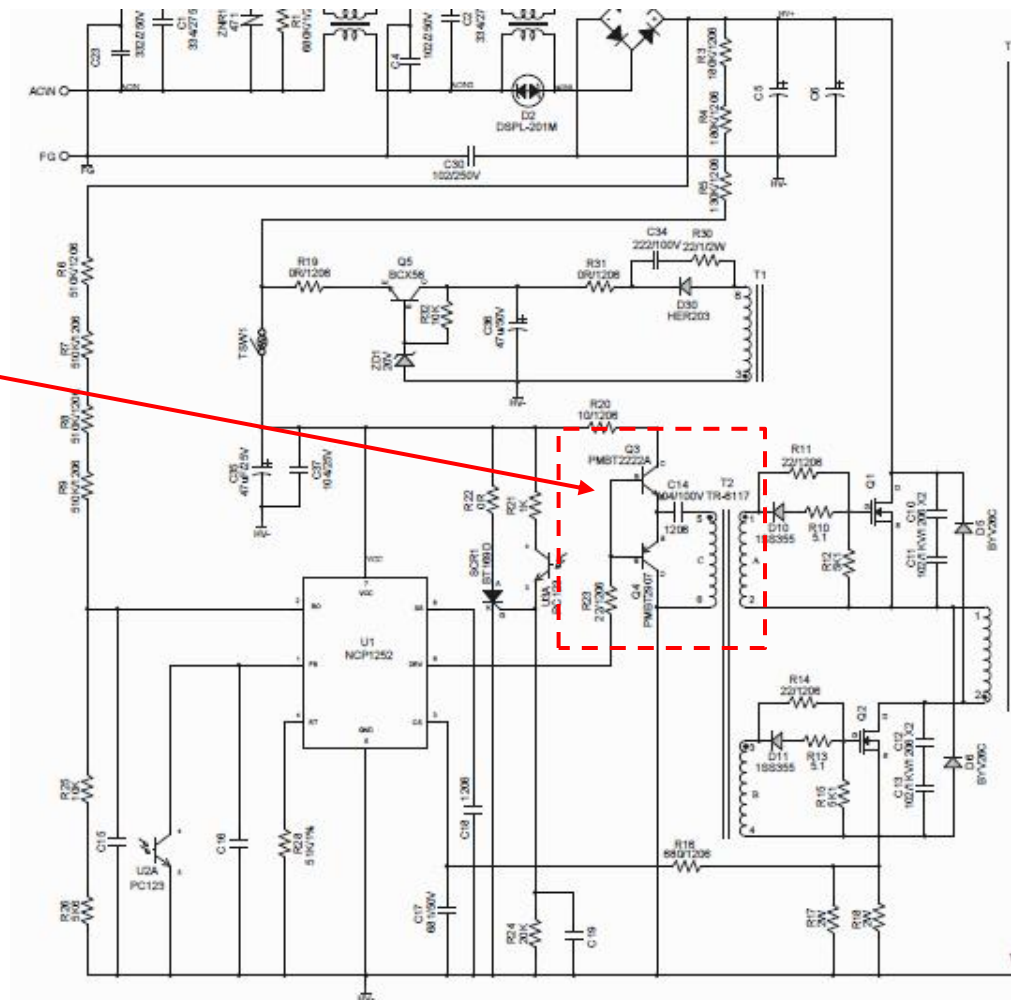
采用384x的双开关正激应用



- 384x 没有过压/欠压保护、软启动、预短路保护
- 要使用外部电路实施这些功能，需要约0.07美元的额外成本（不包括无源器件）

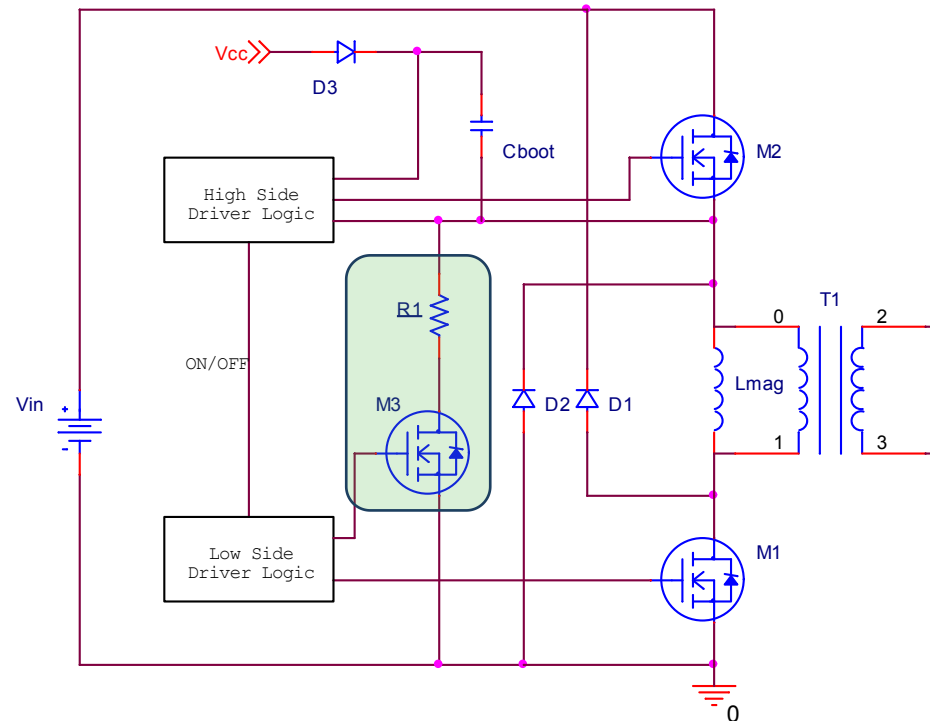
采用NCP1252的双开关正激应用

需要外部门极驱动变压器



- NCP1252 内置过压保护/欠压保护、软启动，但仍需外部启动、过压保护等电路....

我们的创新设计- 添加刷新MOSFET



- 添加额外的MOSFET M3 将自举电容器接地
- 该MOSFET 将被激活:
 - 1) 在启动时第一个DRV 脉冲前
 - 2) 在关断期间

NCL30125 – 双开关正激电流模式控制器IC

价值定位

The NCL30125 is a fixed frequency current-mode controller with integrated high voltage gate drivers. The HV pin allow a quick start-up with dynamic self supply (DSS) features. The skip cycle mode insures good efficiency in light load condition. And enable flexible & robust design with controllable soft-start time, switching frequency and various protections.

独特特性

- Adjustable frequency up to 300KHz
- Internal 700 V high side gate driver**
- +0.9/-1.2 A high & low side gate driver
- Internal 700 V HV startup current source**
- Dynamic Self Supply (DSS)
- Skip cycle mode
- Jittering function**

优势

- 2 Switch Forward optimal design
- Save external pulse transformer**
- High power driving capability
- Fast startup & Low standby power**
- Stable operation in transient & no load.
- Real no load operation
- Good EMI performance**

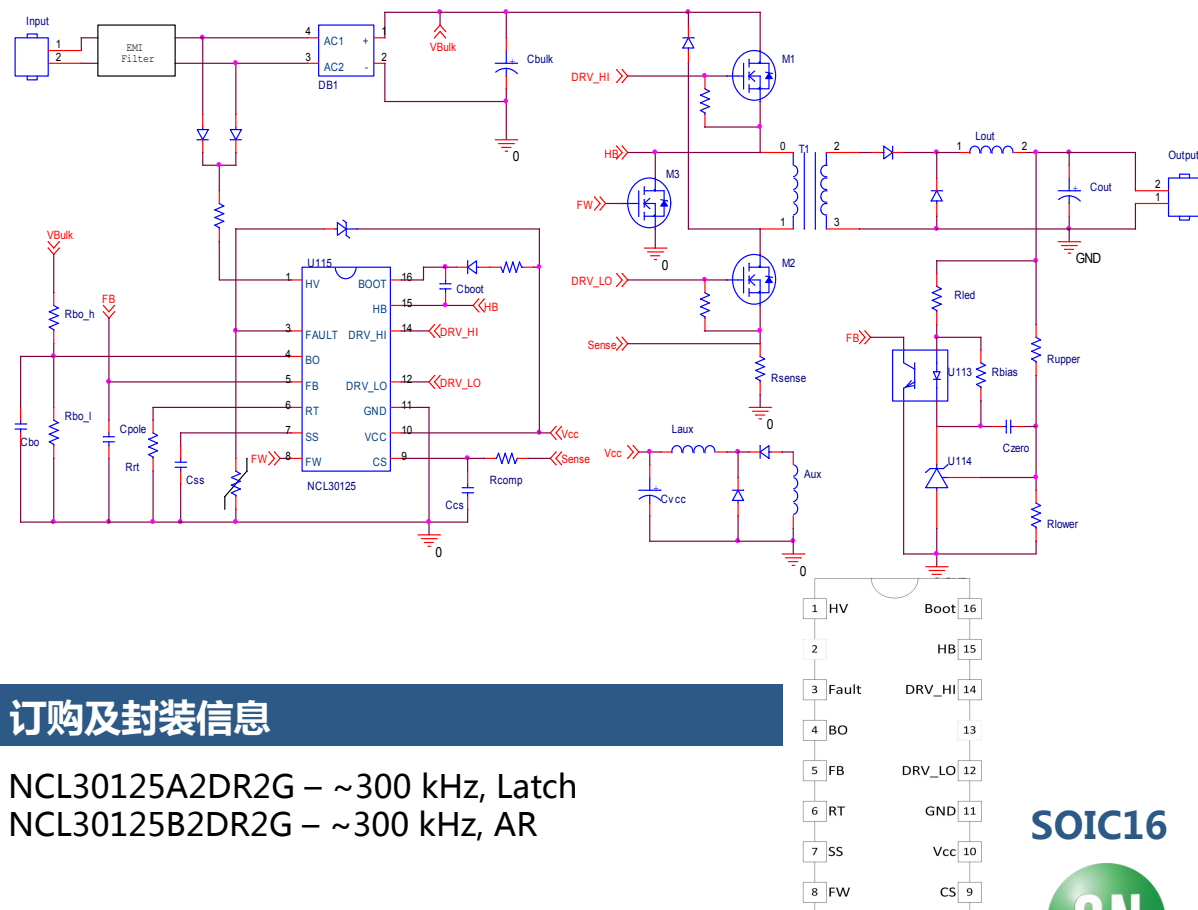
其它特性

- Design Flexibility**
 - ✓ 35 V wide V_{CC} operation
 - ✓ Adjustable operating frequency & soft start duration
 - ✓ Optional features (Skip threshold, BO level, OCP timer & etc.)
 - ✓ Auto-recovery or Latch option
- Robust system operation**
 - ✓ Brown-out, OCP(SCP/OLP), V_{CC} OVP, TSD,
 - ✓ **Dedicated Fault pin for OVP or OTP detection**

市场及应用

- Lighting Advertisement power board
- Power Supplies for Power tool charger, PC Silver Boxes, Games Adapter,

典型应用电路图



订购及封装信息

NCL30125A2DR2G – ~300 kHz, Latch
NCL30125B2DR2G – ~300 kHz, AR

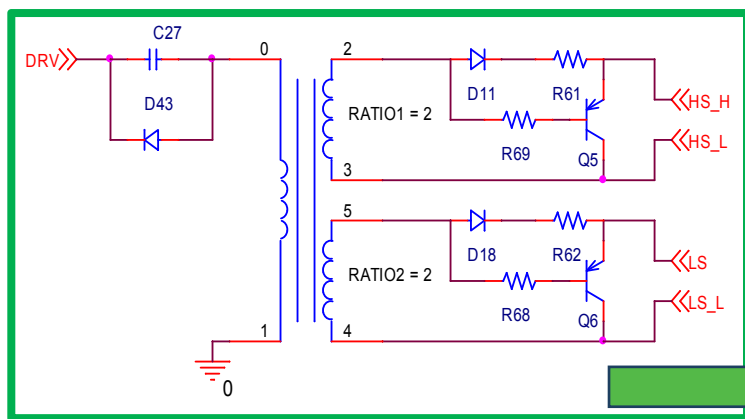
SOIC16



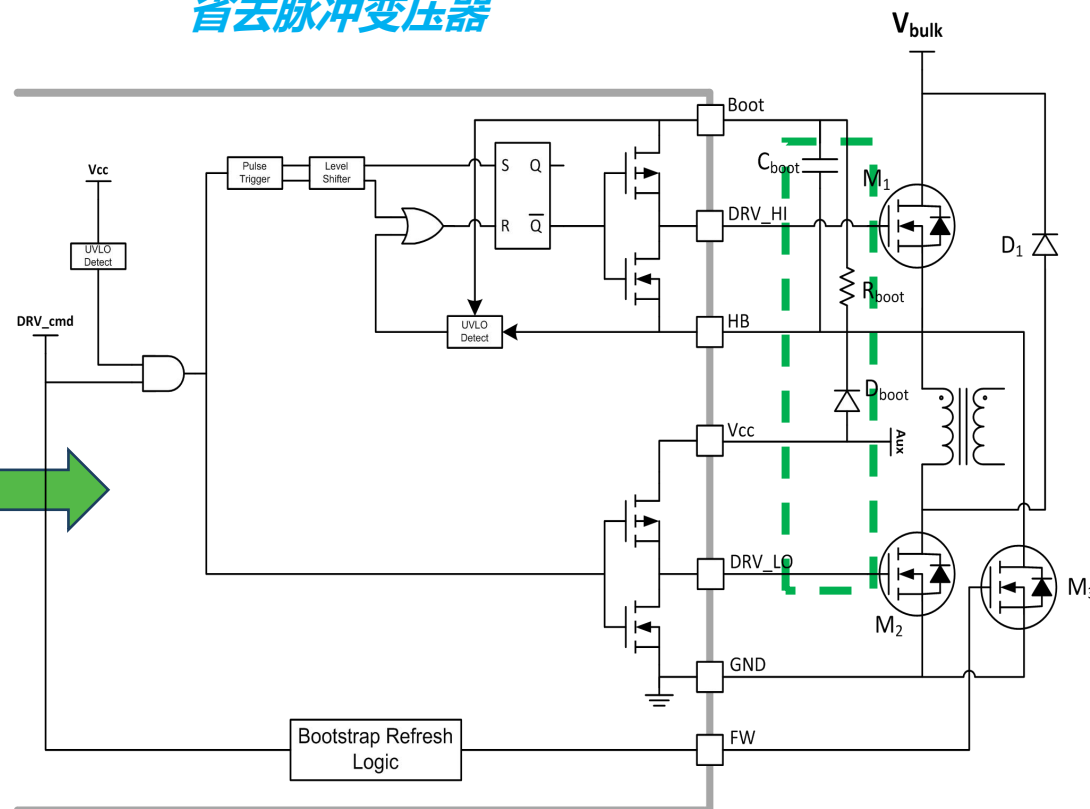
集成的高边门极驱动器

➤ +0.9/-1.2 A 高边和低边门极驱动器

→ 缩减物料单(BOM) 成本/ 空间



省去脉冲变压器



➤续流二极管由 MOSFET M₃取代

➤M₃ MOSFET 仅在启动或跳周期模式时被驱动

➤正常工作时, MOSFET 体二极管用于驱动磁化电流

➤添加M3 (1N60 - SOT223/TO251/TO252 MOSFET) 以将自举电容器接地，取代续流二极管

集成的高压启动电路

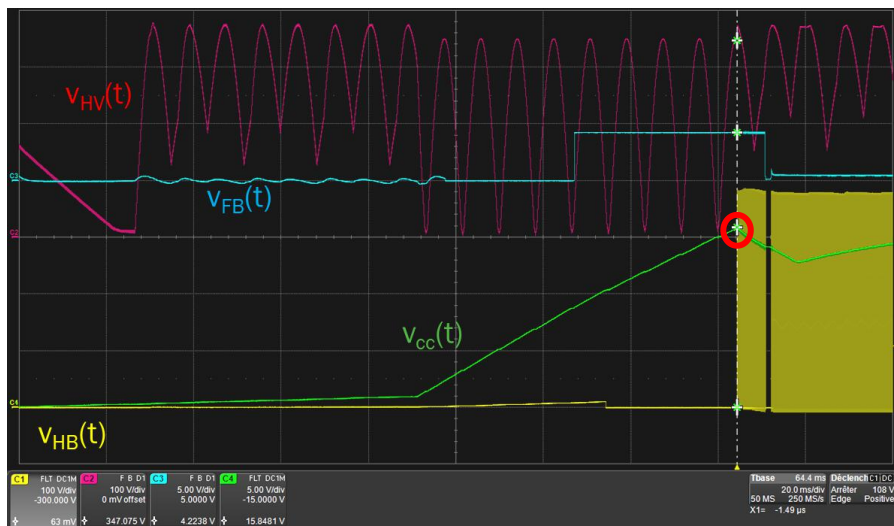
- 启动时700 V JFET 流过 V_{CC} 电容

- 快速启动时间及低待机功耗

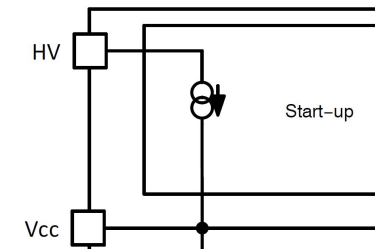
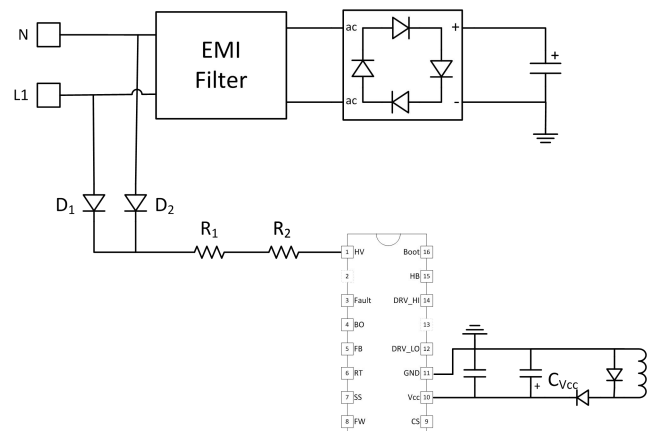
- 动态自供电

- V_{CC} 保持在 $V_{CC(OFF)}$ 阈值之上

高压启动



高压电流源停止@ V_{CC} 16 V



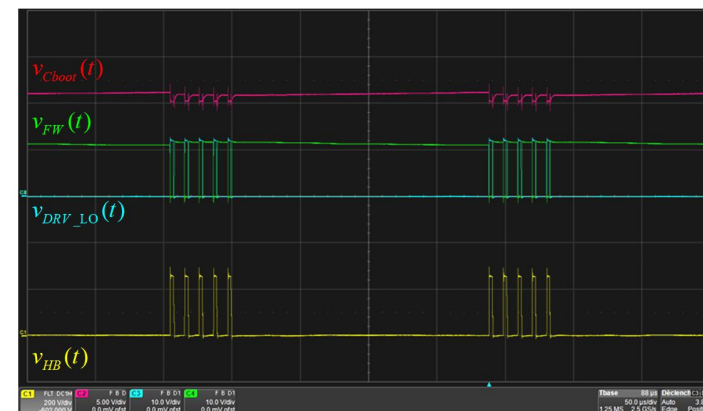
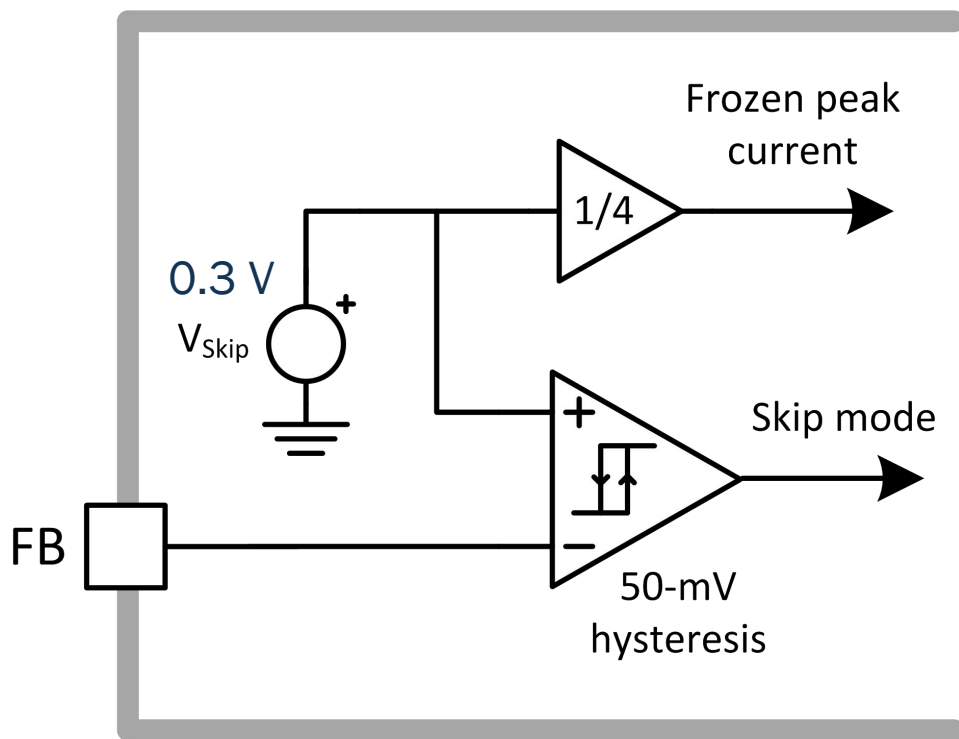
DSS – 高压电流源



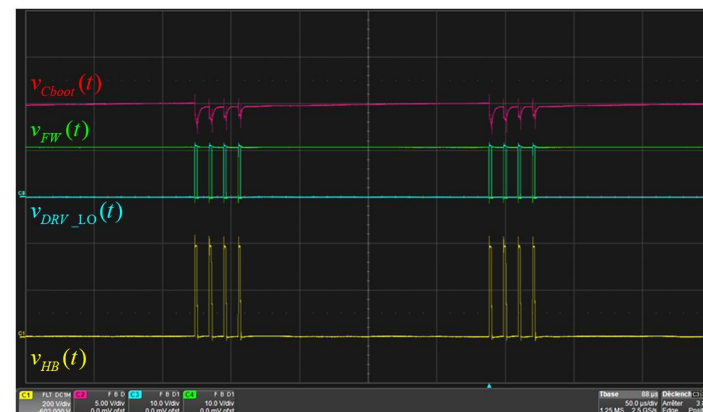
高压电流源重启@ V_{CC} 10 V

轻载跳周期模式

- 该器件在轻载条件下进入跳周期模式以保持输出稳压 (无过压保护)
 - 减小峰值电流以避免可闻噪声



$V_{in} = 176 \text{ V rms} - I_{out} = 1 \text{ A}$



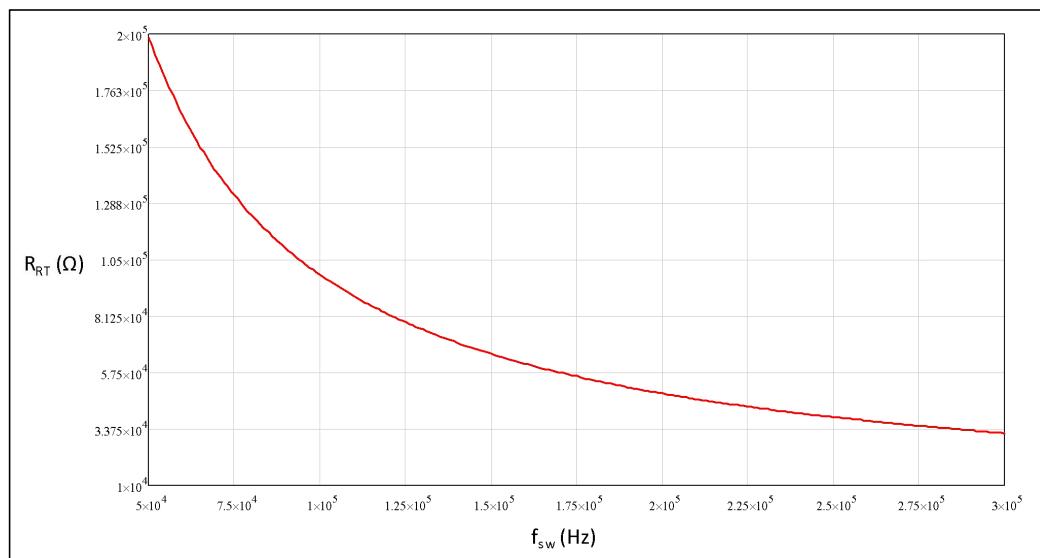
$V_{in} = 265 \text{ V rms} - I_{out} = 1 \text{ A}$

设计灵活性

可调的开关频率:

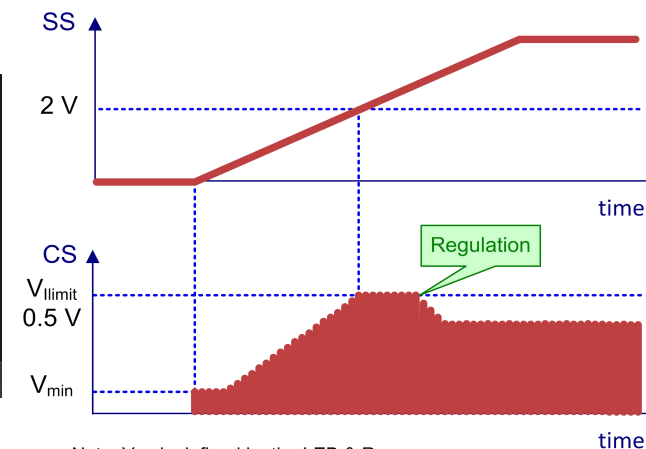
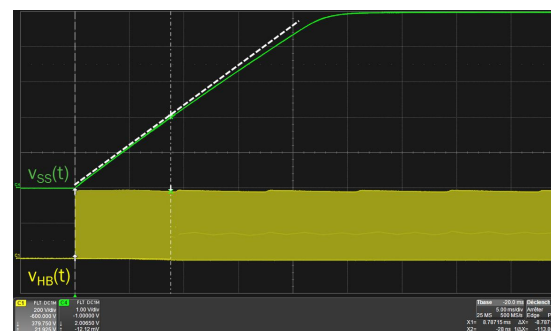
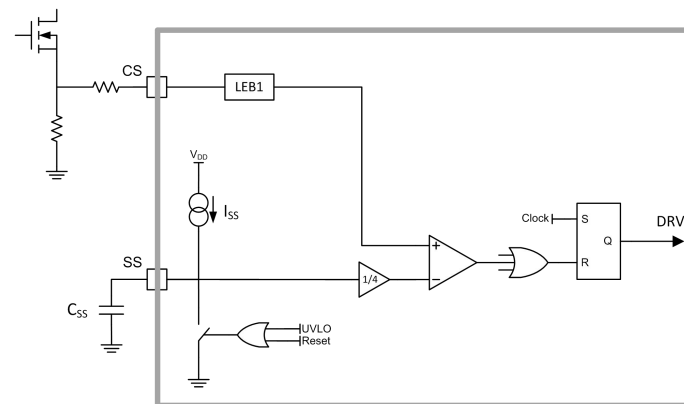
- R_{RT} 控制频率; 50 kHz ~ 300 kHz

$$R_{RT} = \left(\frac{1}{f_{sw}} - 20ns \right) \cdot 10^{10}$$



可调的软启动持续时间:

- 为了避免输出电压出现负斜率, 可以调整软启动持续时间; C_{SS}

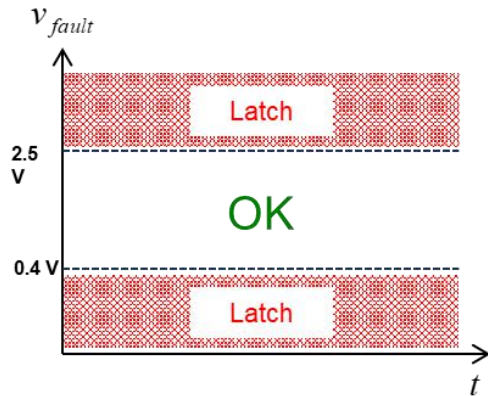
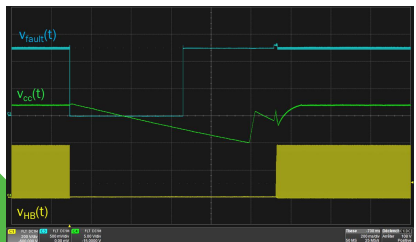
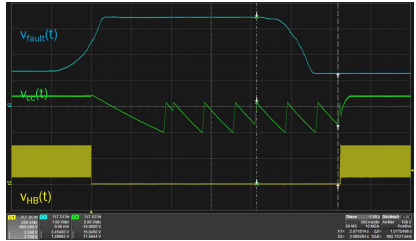
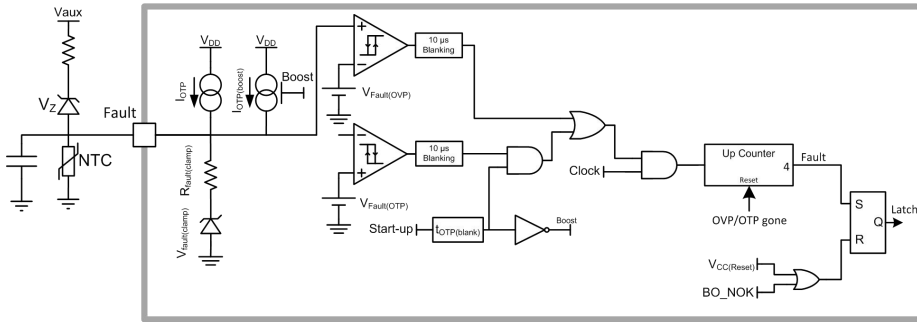


Note: V_{min} is defined by the LEB & R_{sense}

保护

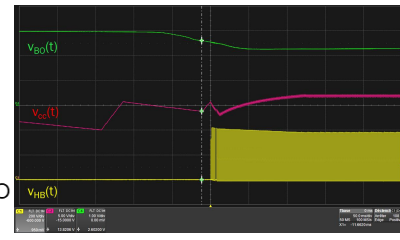
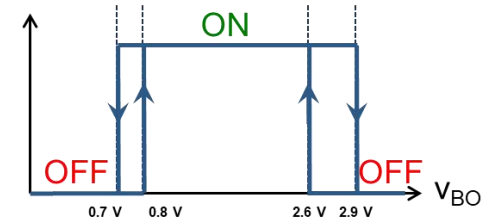
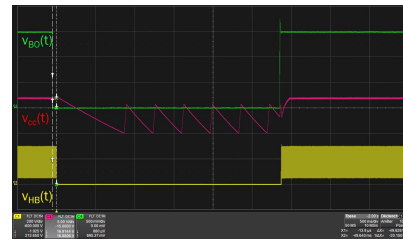
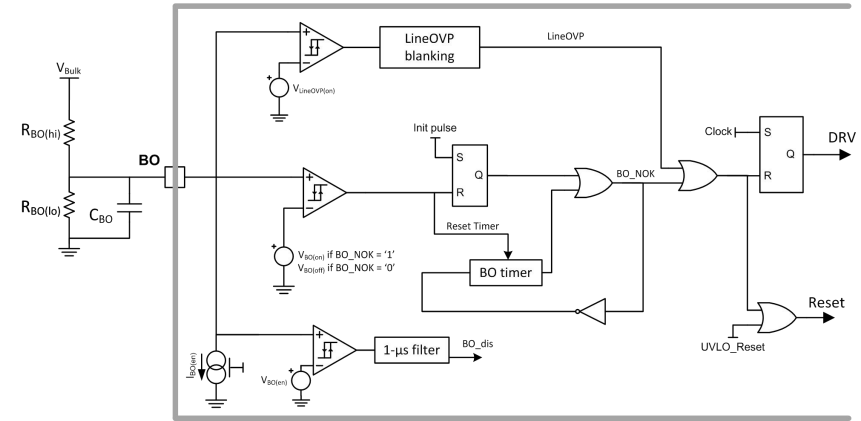
额外的故障引脚:

- 过温保护(OTP) 和过压保护(OVP)检测在故障引脚实施
- $> 2.5\text{ V}$ 或 $< 0.4\text{ V}$, IC 闪烁
- 计数4 确保好的抗扰度



欠压(BO) 或 线性过压保护(LOVP):

- 如果输入电压下降, 电源将停止工作
- 电压异常高时 (LineOVP) 的行为相同



ON → Normal operation
OFF → V_{cc} Hiccup

保护

短路(过载) 保护:

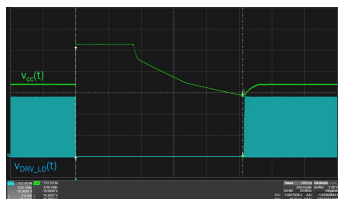
- ✓ 基于15ms计时器的CS峰值电流检测

异常过流保护

- ✓ 比过流保护(OCP) 低的LEB 和高50%的阈值
- ✓ 4 个连续脉冲提供更好的抗扰度

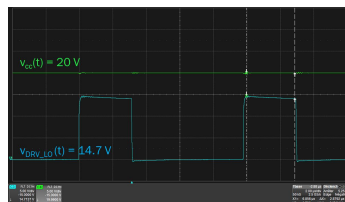
过压保护(OVP)

- ✓ Vcc 引脚



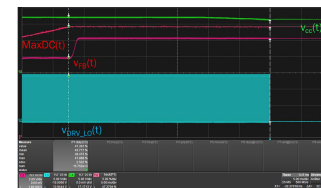
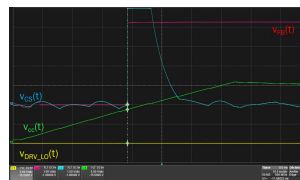
低边驱动器电压钳位

- ✓ 16 V(最大值)



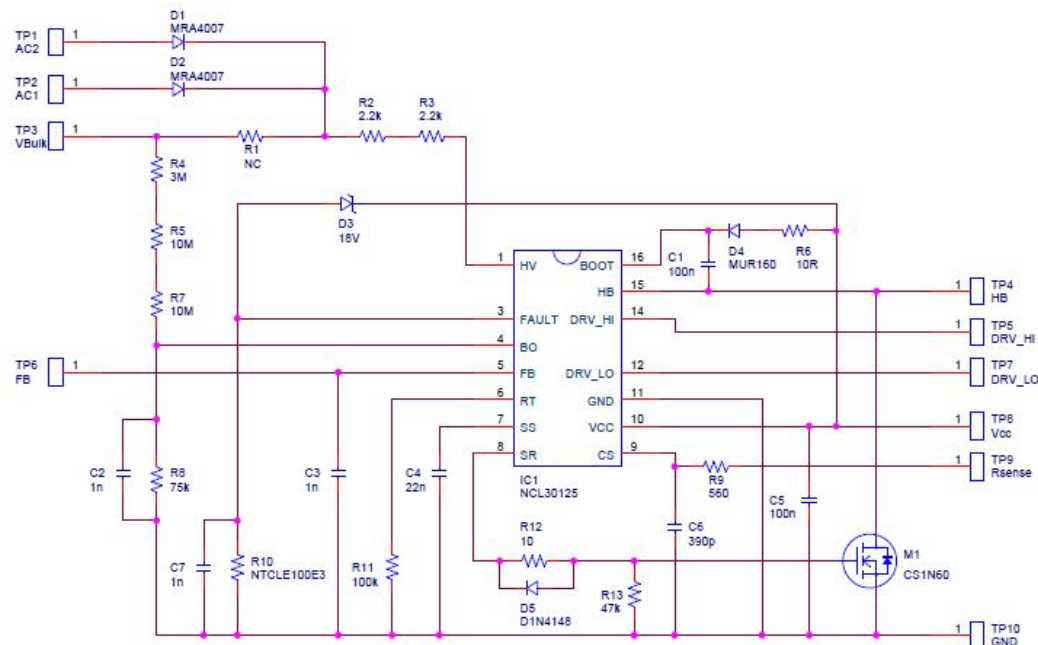
R_{CS} 短路/ 开路保护

- ✓ 启动前测试引脚 (引脚保持开路状态)
- ✓ 如果引脚为GND , 则最大的DC比较器将激活OCP保护

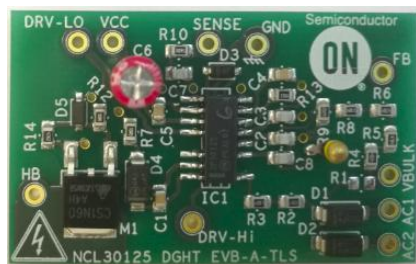


NCL30125 子板替换竞争对手

在200 W (24 V/ 8A) 对量产的/现有的双开关正激电源的直接替换测试



- 输出功率~200W, 满载24V/8A
- 工作开关频率~ 85KHz
- NCL30125 子板替换竞争对手 + 外部门极驱动变压器

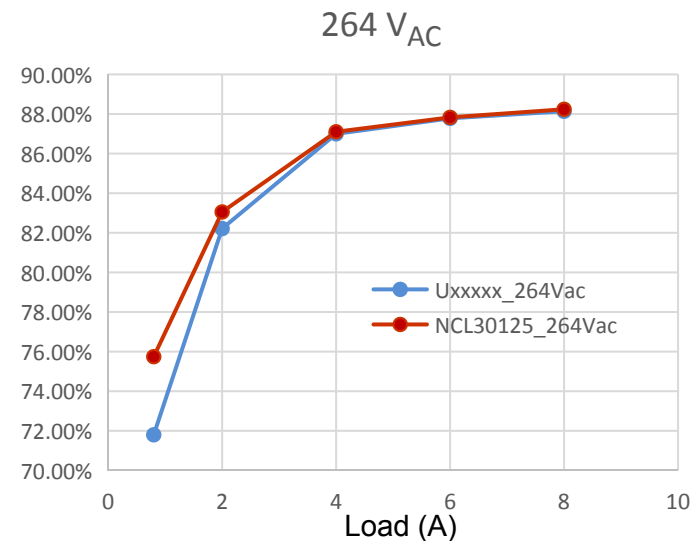
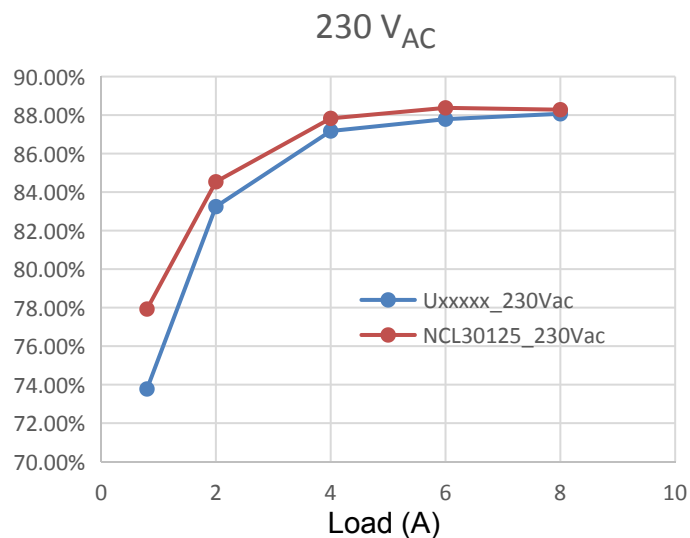
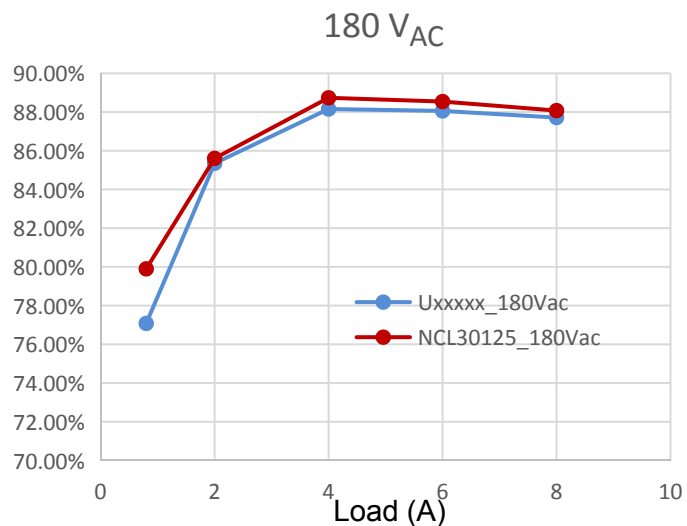


特性比较 – NCL30125 对比竞争对手

特性		NCL30125	竞争对手
Start up	700 V HV startup	Yes	No
Vcc	UVLO on/off	16 / 8.8 V	8.4 / 7.6 V
	max. rating	38 V	36 V
	Start up current	500 uA / 11 mA	500 uA / 17 mA
Driver	Source / Sink	0.9 / 1.2 A	1.0 / 1.0 A
	High & Low Side Gate Driver	Yes	No
	Clamp	13.5 V	No
CS	CS limit	0.5 V	1 V
	Propogation delay	40 ns	150 ns
	LEB	285 ns	No
	Internal Ramp compensation	Adjustable	No
Freq.	Freq. setting	Adjustable	Adjustable
	Freq. jittering	300 Hz, +/-5%	No
Soft Start		Adjustable	No
Skip Cycle Mode		Yes	No
Dynamic Self bias		Yes	No
Protections	BO, Output short, Fault	Yes	No
Packages		SO16	DIP8/SO8

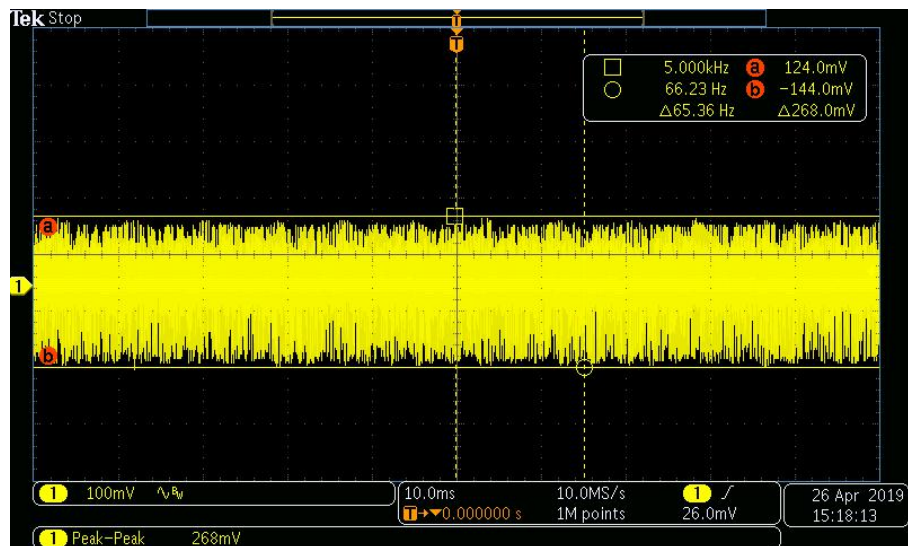
测试2SW 正激的量产/现有板

能效比较



轻载能效更高; NCL30125 跳周期模式

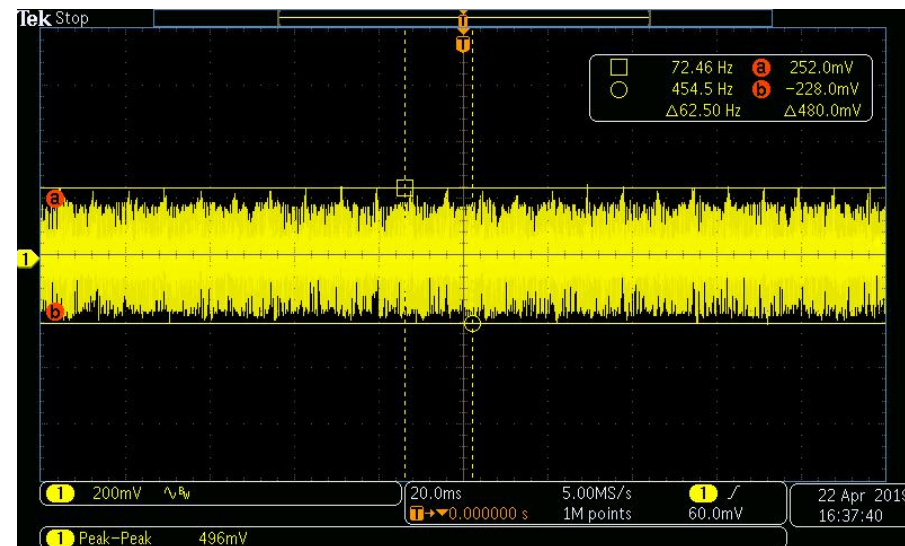
测试2SW 正激的量产/现有板 输出电压纹波比较



NCL30125

负载= 8A @230V 输入

电压纹波: 268mVp-p



Uxxxxx

负载= 8A @230V input

电压纹波: 496mVp-p

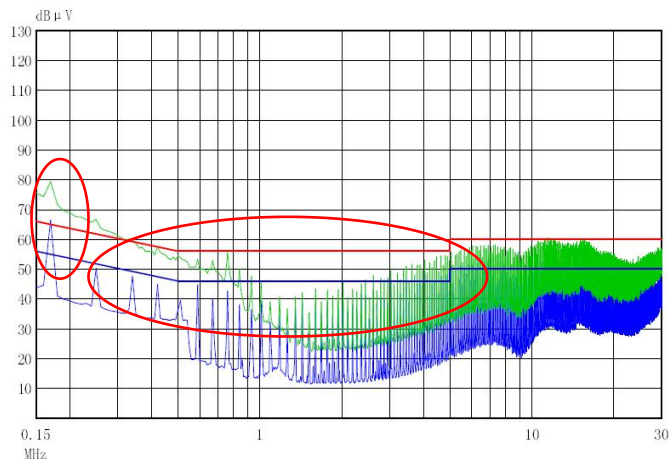
在将竞争对手电路更换为NCL30125 电路后表现出**好的输出电压纹波性能**

子板

测试2SW 正激的量产/现有板

导通EMI 比较

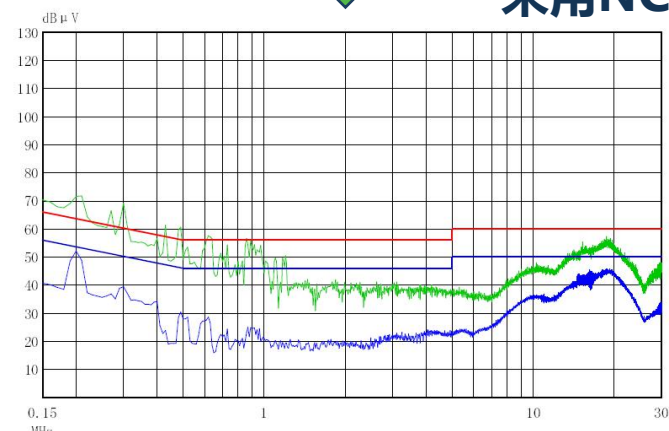
L-Line 在 230V/50Hz 满载



采用竞争对手

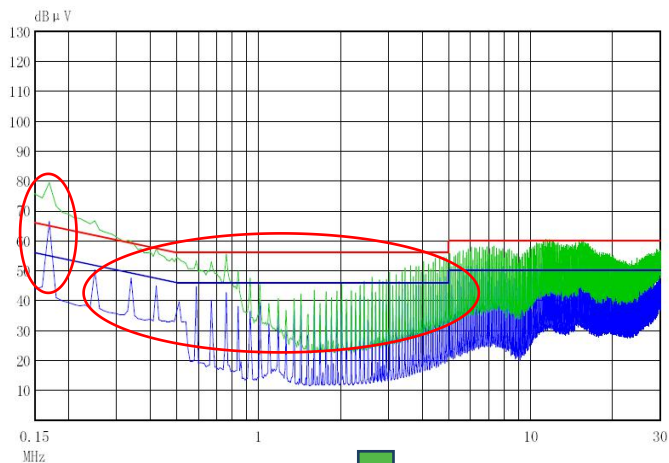


采用NCL30125后



显著改进:
仅更换NCL30125控制电路,
CE测试的峰值即可满足要求。

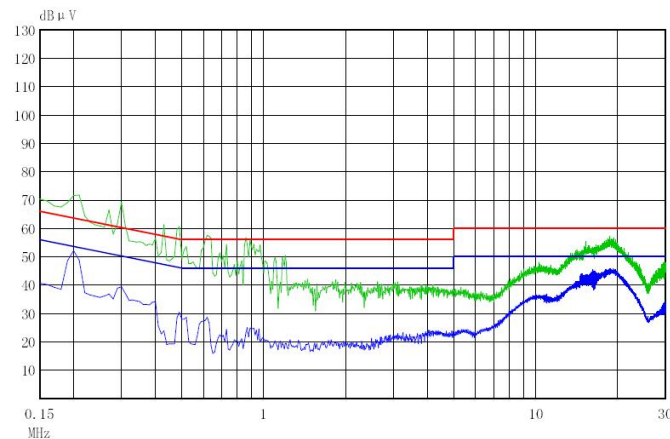
N-Line 在 230V/50Hz 满载



采用竞争对手



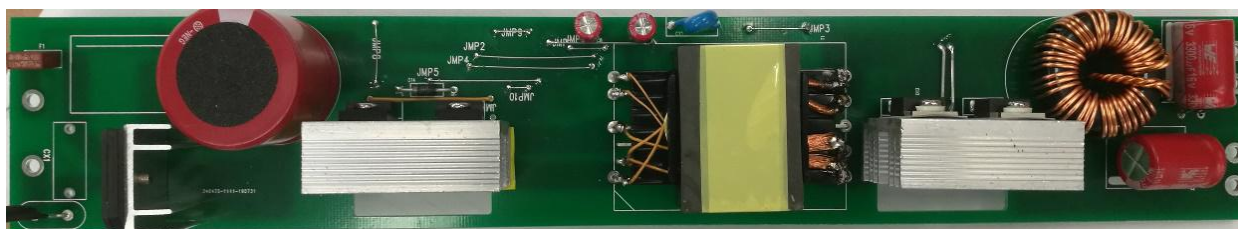
采用NCL30125后



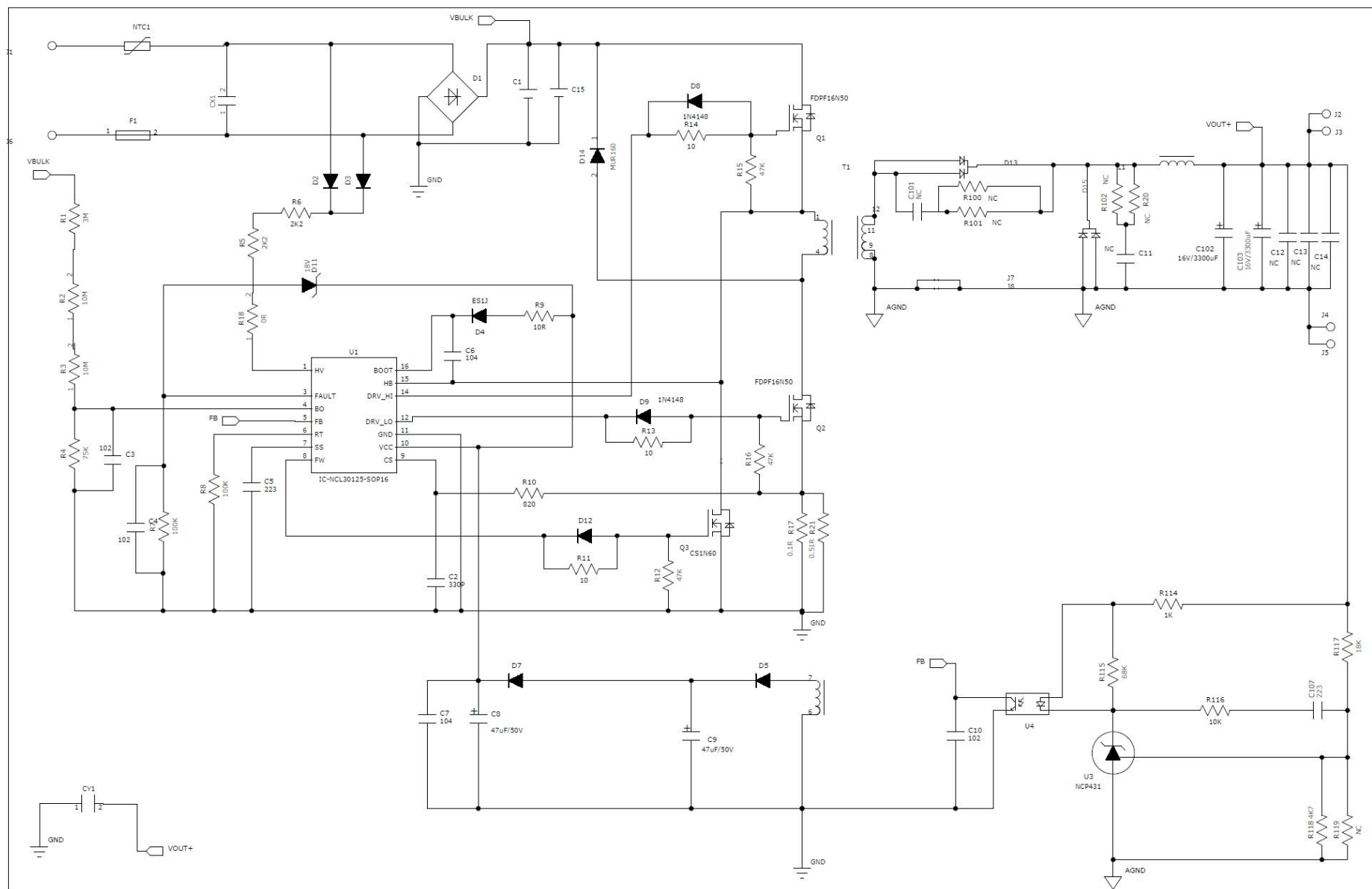
300 W (12 V/25 A) 参考设计

设计规格

No.	Description	Symbol	Min	Typ	Max	Unit	Test condition
1	Input Voltage Range	Vin(min/max)	180	230	264	Vac	
2	Input Current	Irms			2	A	180Vac and full load
3	Rated Input Frequency	f _{in}	50		60	Hz	
4	Input Frequency Range	F _{in} (min/max)	47		63	Hz	
5	Rated Output Power	P _{out}		300		W	
6	Efficiency At Full Load	η	88.5			%	Tested at board end, 230Vac
7	Output Voltage and Current.(CC mode)	V _{out} /I _{out}		12V/25A		V/A	180Vac-264Vac
8	No load power	P _{standby}			<0.3	W	230Vac input



NCL30125 – 电路图

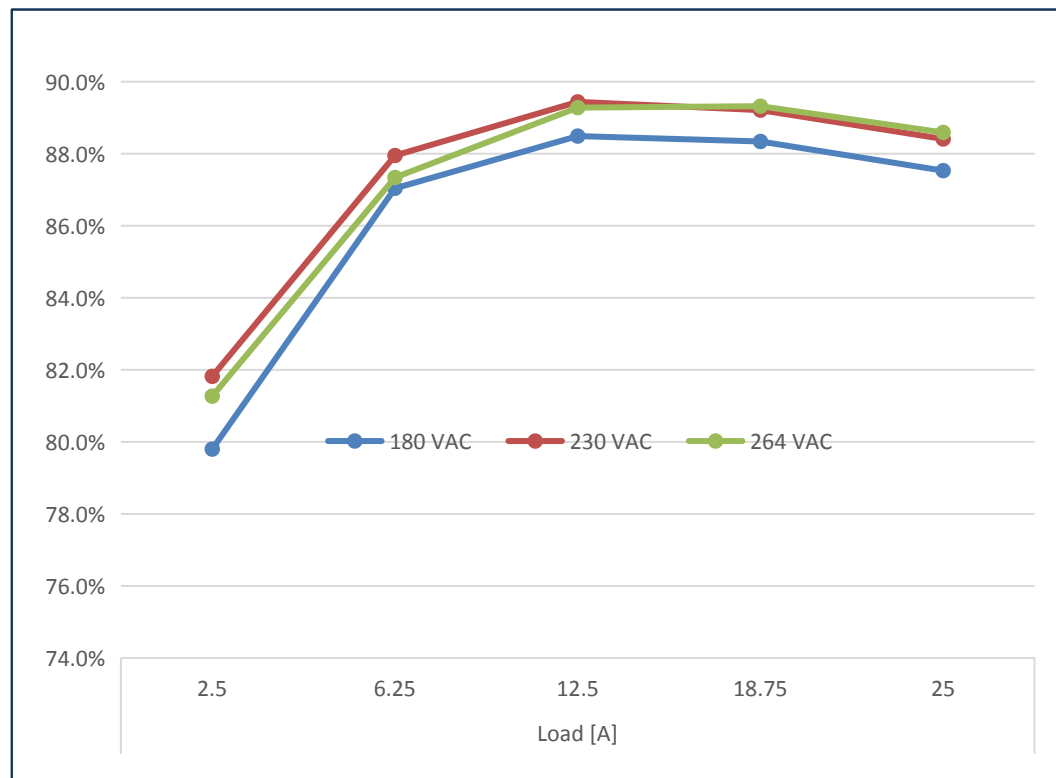


Public Information

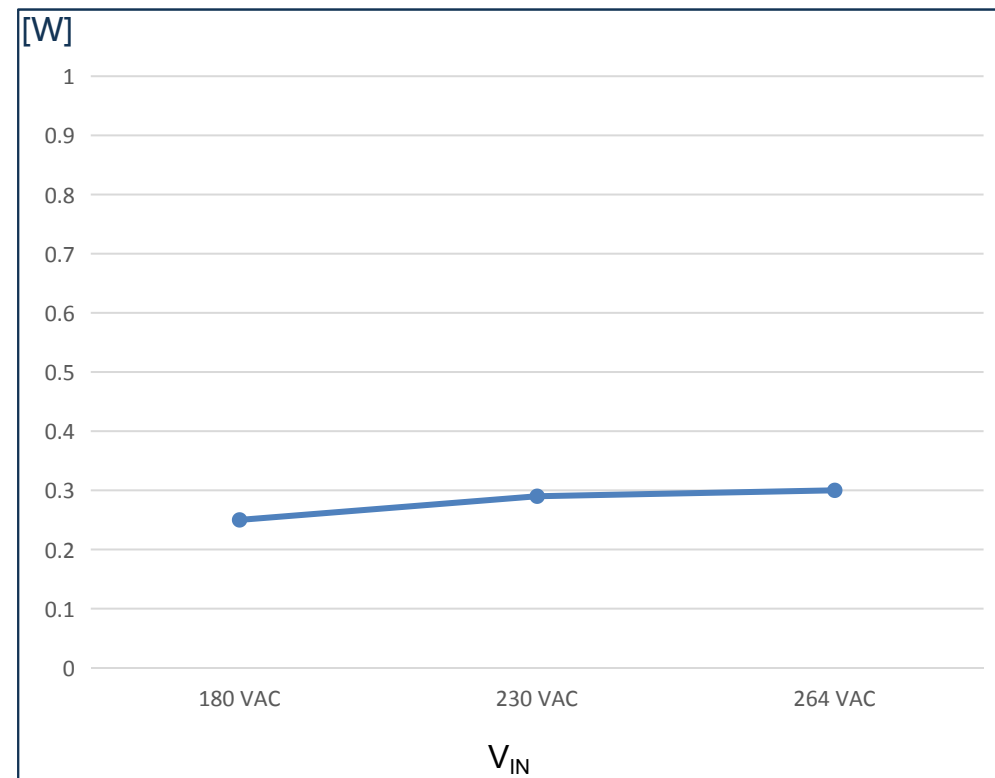


300 W (12 V/25 A) 板

能效

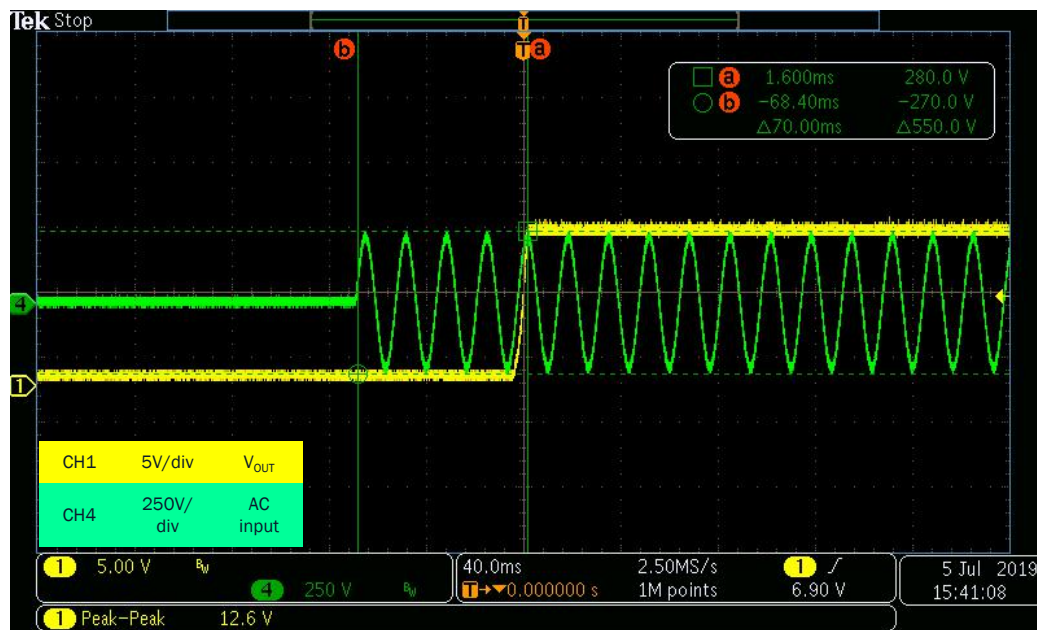


空载输入功率



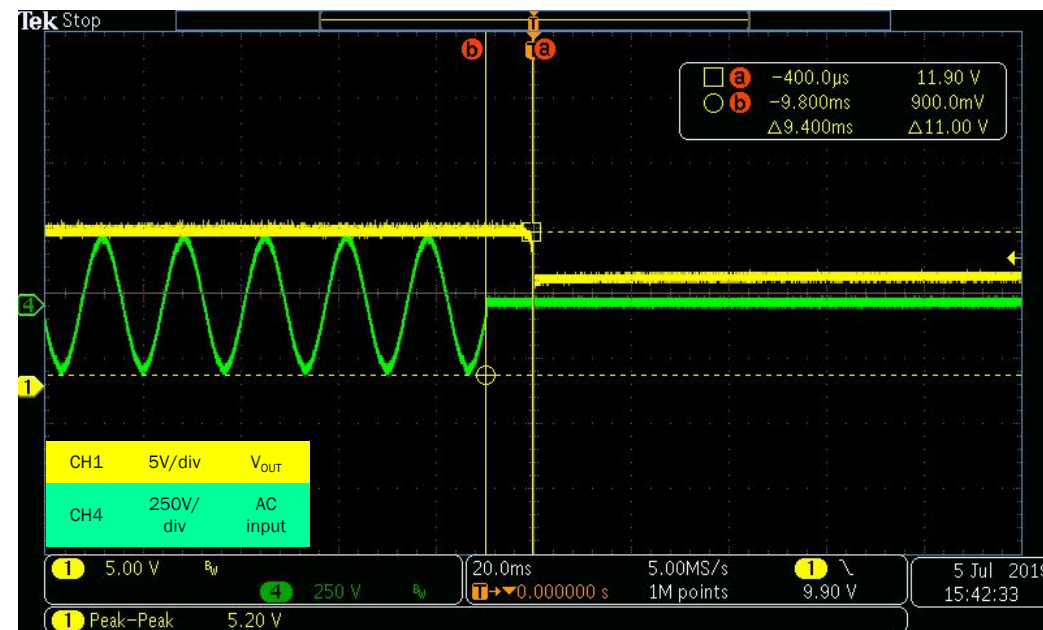
300 W (12 V/25 A) 板- 波形

启动



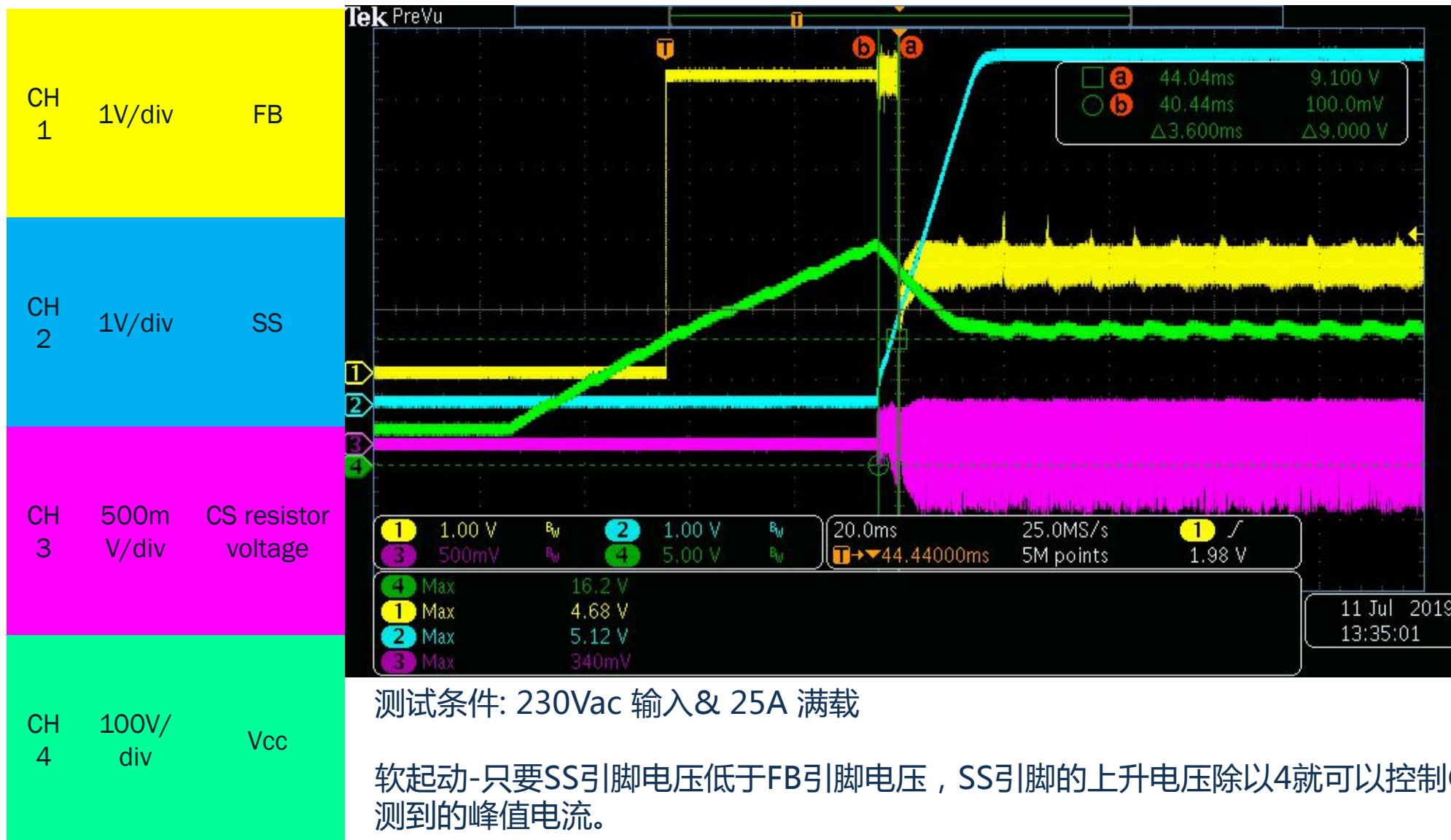
180 V_{AC} 输入 & 25 A 满载

AC 关断



180 V_{AC} 输入 & 25 A 满载

NCL30125 – 启动



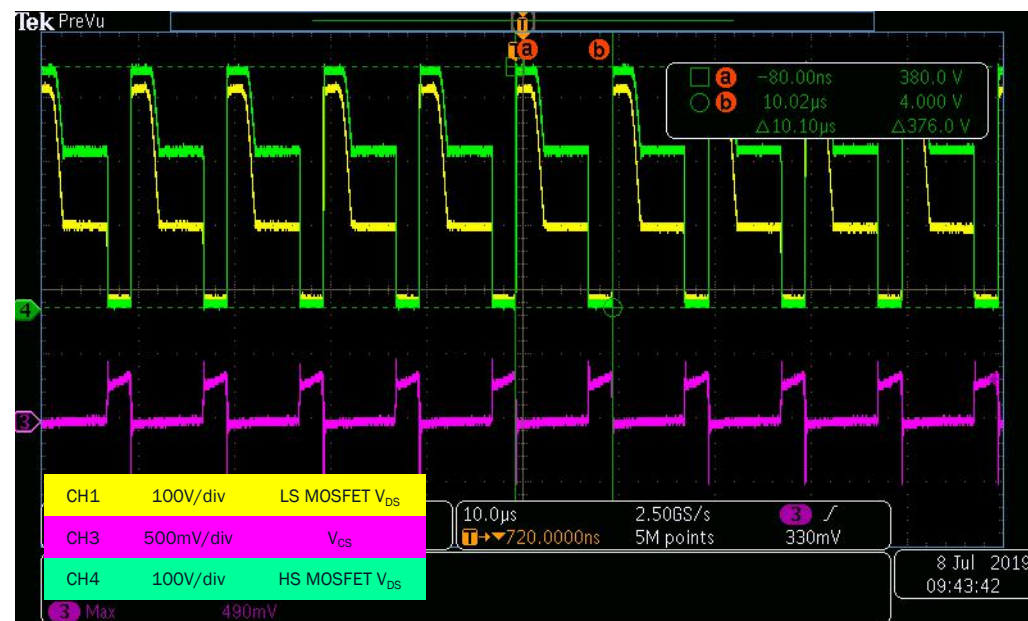
300 W (12 V/25 A) 板 – 波形

正常工作



230 V_{AC} 输入 & 25 A 满载

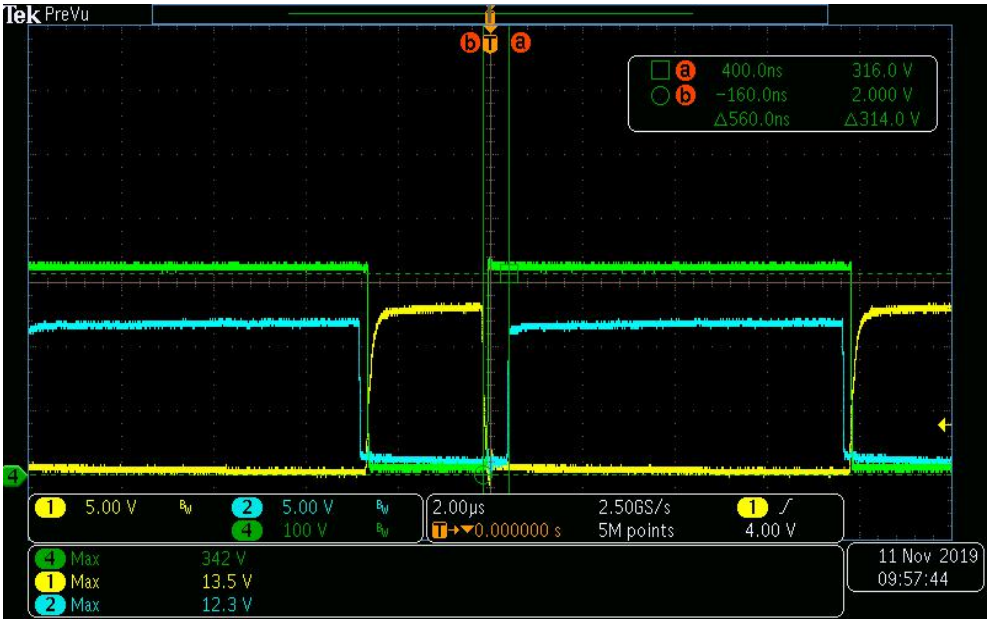
正常工作



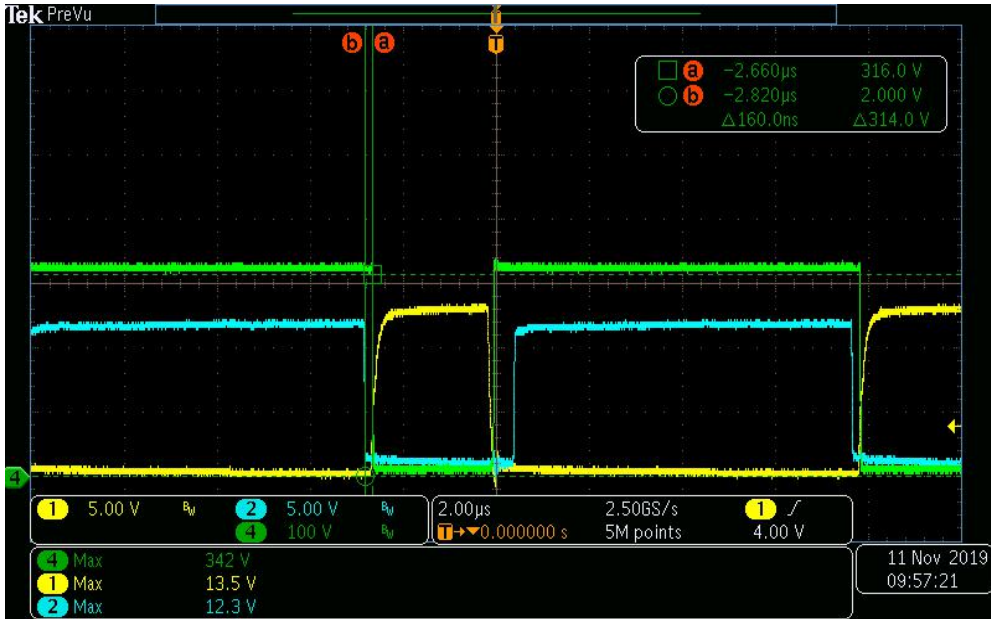
264 V_{AC} 输入 & 25 A 满载

NCL30125 – 正常工作条件下的FW 和D-S

CH1	100V/div	Low side driver
CH2	5V/div	FW
CH3	N/A	N/A
CH4	100V/div	High side Mosfet D-S



tdelay1



tdelay2



NCL30125 – 输出过压保护

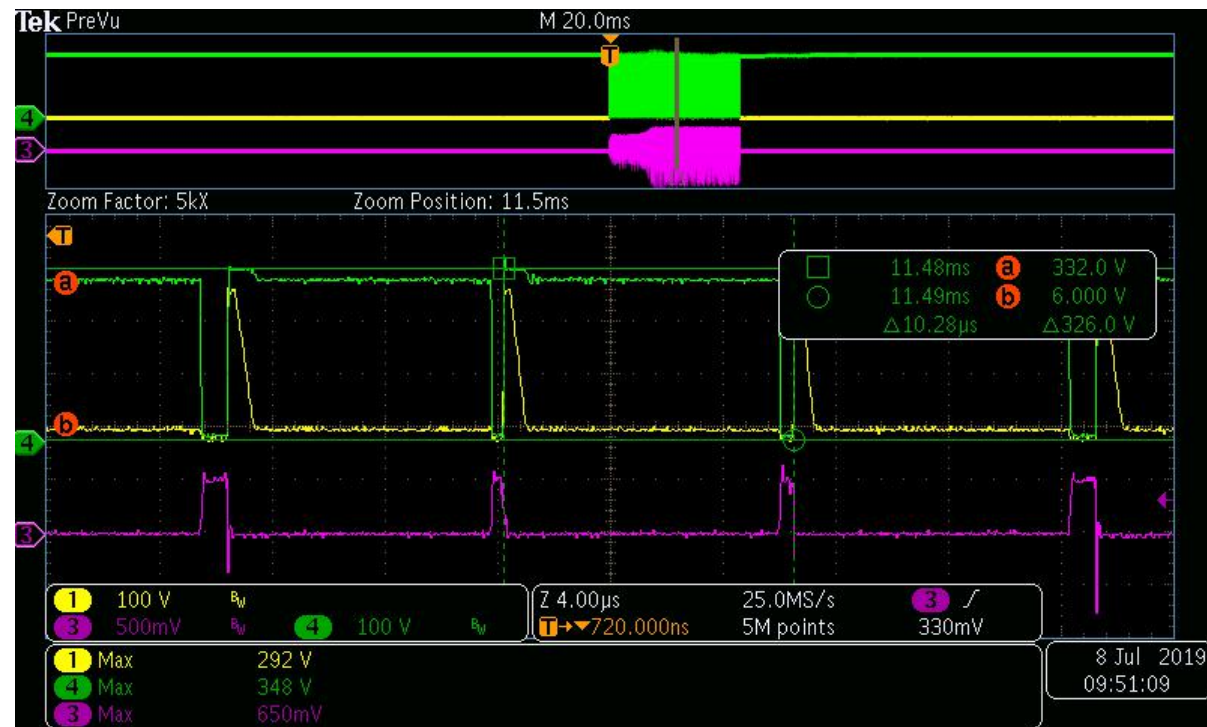
CH1	100V/div v	HB point Voltage
CH2	5V/div	Vcc
CH3	N/A	N/A
CH4	5V/div	Output Voltage



@ 230Vac
输入& 输出OVP 保护

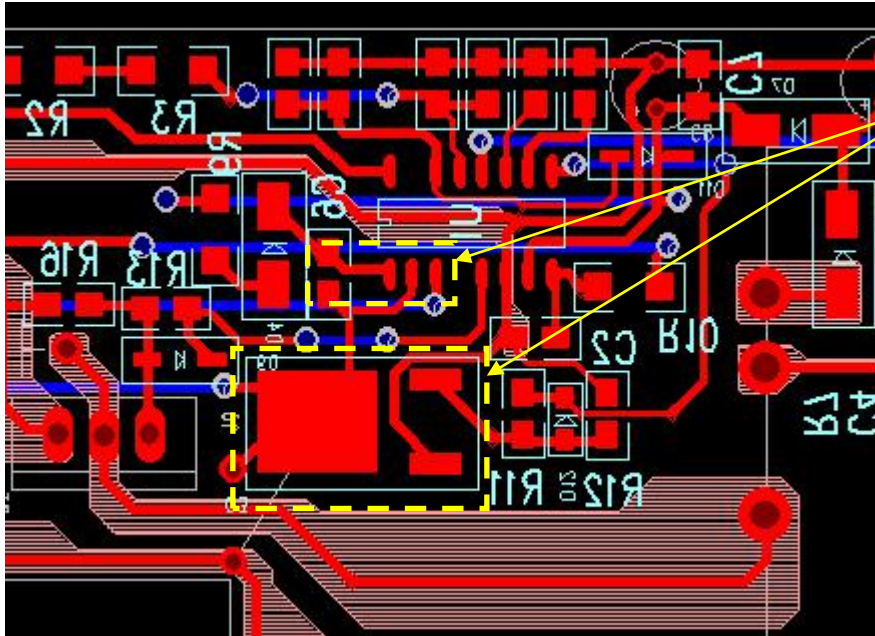
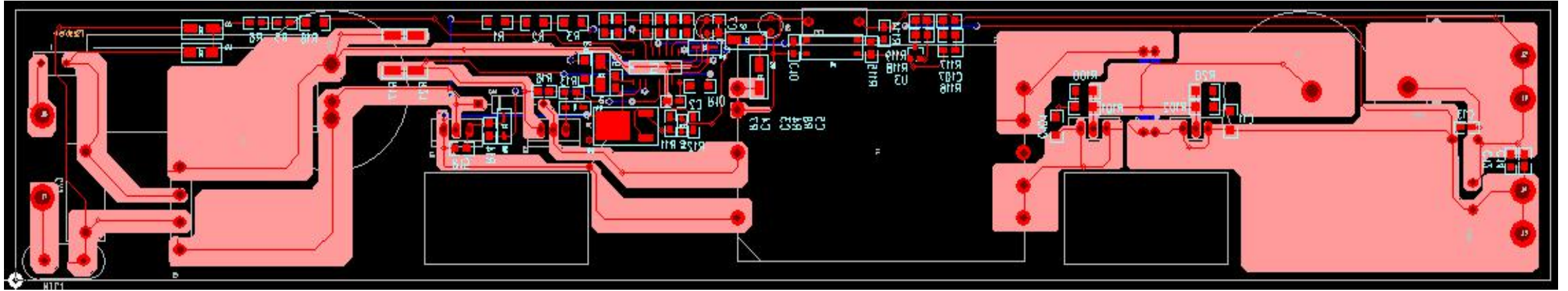
NCL30125 – 过流保护和短路保护

CH1	100V/div	Low side Mosfet D-S
CH2	N/A	
CH3	500mV/div	CS resistor voltage
CH4	100V/div	High side Mosfet D-S



@ 230Vac 输入
短路保护 → 输入功率约2.2W

NCL30125 – PCB 布板指南



The MOSFET Q3 应靠近
IC 高边门极驱动器部分

系统成本比较

特性	NCL30125	竞争对手	预估成本
Brown-out Protects against drops in input voltage.Soft-Start upon recovery.	Embedded	- External components needed - Turn-off can only be done via the Vcc pin:not preferred solution - Additional cost - Consumes PCB area - Reliability issues	\$0.03
SCP When the inside comparator senses the primary current is higher than 0.75V for more15ms, the PWM IC will trigger the protection.	Embedded	- External components needed - Accuracy & effectiveness - Additional cost - Consumes PCB area - Reliability issues	\$0.03
Soft Start Duty ratio modulates slowly to prevent transient stress	1 external capacitor	- 4 External components needed - Additional cost - Consumes PCB area - Reliability issues	\$0.01
Gate Drive Clamp Protects against over voltage on MOSFET gate	integrated	- External diode needed - Additional cost - Consumes PCB area	\$0.005
Ramp Compensation Stable operation for =>50% duty cycle	1 resistor	- 5 components	\$0.02
OVP protection	1 zener	- 5 components	\$0.01

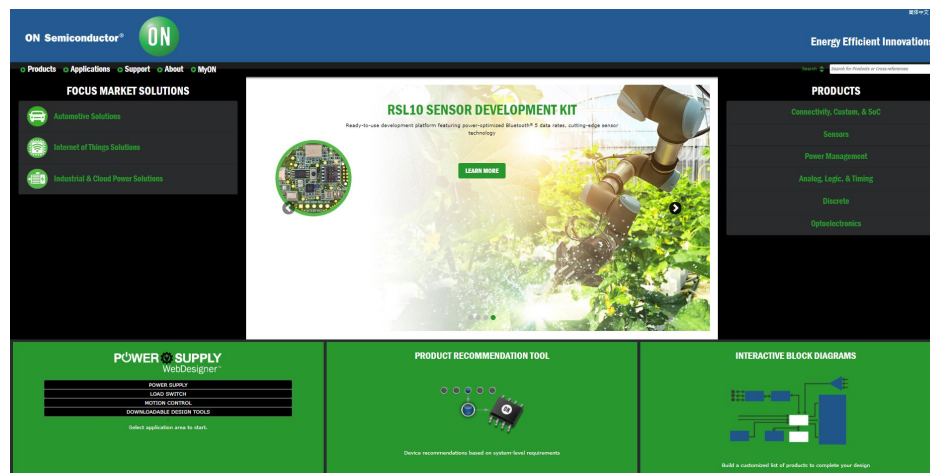
总结

采用NCL30125的双开关正激的主要价值：

- **减少元器件数**
- **高可靠性**
- **更强固的保护**
- **更好的轻载和待机性能**
- **减轻EMI**
- **估计采用NCP30125可省下的成本: \$0.105**

更多信息

- 安森美半导体网站
www.onsemi.cn



- 安森美半导体官方微信
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