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AN-7730

FL7730设计工具流程

概述

本文档旨在提供飞兆半导体 FL7732 设计工具的详细指南。使用该设计工具时请参考相关产品手册。



图 1. 设计流程

步骤1 — 键入输入输出参数



输入参数		
Vin最小值	90	Vac
Vin最大值	140	Vac
输出参数		
Vout	22	V
Max. Vout	28	V
Iout	380	mA
Pout	8.36	W

Vout 最大值即 OVP 电平。

步骤2 — 变压器设计

Transformer Design		
Max. Duty	39	%
Max. Ton	6.500	us
Switching freq.	60	kHz
Max. Vcs	0.5	V
Efficiency	80	%
Ae	36.6	mm ²
Bmax	0.3	
Lm	0.982	mH
Nps	3.223	
Nas	0.821	
Nap	0.255	
Np.min	75.347	T
Np	76	T
Ns	23.578	T
Na	19.368	T
Llk	10	uH

最大占空比通常为 20~50%。

较高最大占空比 ⇒ 低导通损耗，适用于低压电源应用

较低最大占空比 ⇒ Bmax余量更大，适用于高压电源应用

Ton 最大值应小于 10us。

该开关频率为额定 Vout 条件下的工作频率。
该开关频率应低于 65kHz。

Max. Vcs 为峰值 CS 电压的最大值。

输入 Max. Vcs 的值小于 0.67V，因为逐脉冲 CS 电压的限值为 0.67V。

在原边 CC 调节中，Nps 越高，Max. Vcs 越大。

因此，若设置了较高的 Max. Vcs，Nps 也会变高。

键入的 Np 取值应大于 Np.min。

如果 Np 的取值超过变压器窗口的容量，应减少最大占空比。

根据上述参数设计变压器。

然后测量 Llk（漏感），并键入表格。

步骤3 — 缓冲器设计

缓冲器设计		
Vsn	200	V
ΔV_{sn}	5	V
Rsn	242.7247	kohm
Csn	2.746596	nF

Vsn为缓冲电压。
Vsn通常设置为Nps.Vo的2~2.5倍。

ΔV_{sn} 通常设置为Vsn纹波的5%。

步骤四 — 控制电路设计

控制电路设计		
Rsense	0.593767	ohm
Rcc	100	ohm
Vin.bnk	50	V
Vf	0.5	V
Rvs1	165.2367	kohm
Rvs2	19.75502	kohm
Cvs	10	pF
Ccomi	1	uF
Cvdd	33	uF
Dvdd Vmax	73.95584	V
Rstr	155.8442	kohm

Rcc为电源CC补偿电阻。
当输入电压较高，Iout变得更高时，应该增加Rcc。
Rcc取值不得高于500ohm。
较大的Rcc会产生CS噪声，并导致Vcs峰值检测出现误差。

Vin.bnk 为COMI/VS消隐电平。
COMI消隐：开环工作时，误差幅值输入为定值。
VS消隐：禁止VS电压检测。
Vin.bnk通常设置为30~70V。

Vf为次级二极管的正向压降。

Cvs为VS滤波电容，通常设置为10~30pF。

COMI电容通常为0.68~3.3uF。
在最大Vin条件下，检测启动时输出过冲电压。
如果输出过冲电压太大，则增大Ccomi。

Vdd电容通常为10~47uF。
如果在启动时，Vdd跌落到Vdd-off附近，则增大Cvdd。



步骤5 — 功率器件设计

功率器件设计		
MOSFET Vmax	397.9899	V
MOSFET Ip _{pk}	0.842082	A
二极管Vmax	89.4245	V
二极管Ip _{pk}	2.714286	A

Vmax为MOSFET的最大漏源电压。
Ip_{pk}为MOSFET峰值电流。

Vmax为次级二极管的最大反向电压。
Ip_{pk}为次级二极管的峰值电流。

步骤6 — DIM检测电路设计

DIM检测电路设计		
ZDdim	11	V
Rdim1	1	Mohm
Rdim2	75	kohm
Rdim3	62	kohm
Cdim	3.3	uF

ZDdim的齐纳电压通常为10~40V。

通常，Rdim1的取值约为1Mohm。

如果Rdim1过小，

- 效率降低。
- 当电源电压变化时，Dim管脚电压会有较大变化。

如果Rdim1过大，

- ZDdim偏置电流会变得很小。
- 引起调光角检测误差。

TRIAC调光器具有不同的最大调光角。

因此，Rdim2/3不能通过调光器测试进行计算与获取。

Rdim为几十~几百kohm。

Rdim决定了调光的控制范围。

为了获得更宽的调光控制范围，可以减少Rdim2与Rdim3。

（但是，随着调光控制范围的扩大，闪烁的可能性也会更高），尤其是在电源电压较高和输出功率较低时）

滤波电容Cdim为Dim管脚提供直流电压，其取值为0.1~0.5uF。如果Cdim太大，在启动时，Dim管脚电压上升缓慢，并会影响上电速度。

步骤7 — 无源泄放器设计

无源泄放器设计		
Cbleeder	330	nF
Rbleeder	0.5	kohm

Cbleeder通常为47~470nF。

如果增加Cbleeder，

- 闪烁现象会减轻。
- 效率与功率因数会变得更糟。

选择Cbleeder后，Rbleeder可随后确定。

Rbleeder通常为0.1~10kohm。

过大的Rbleeder限制了泄放电流，会引起闪烁。

过小的Rbleeder会引起调光启动时输入电流振荡，也会引起闪烁。

因此，应该根据触发时检测到的输入电流来调整Rbleeder。

确定最小Rbleeder时，应该满足以下条件：

- 触发时的输入电流相对于调光器维持电流要足够高。
- 在触发后，不出现误触发。

为消除闪烁并获得高效率，应该选取合适的最小Rbleeder值。

步骤8 — 有源阻尼器设计

有源阻尼器设计		
Rdamp	100	ohm
SWdamp Vmax	300	V
Ddelay Vmax	300	V
Cdelay	100	nF
Rdelay	20	kohm

Rdamp通常为10~1kohm。

Rdamp是用来限制启动过程输入尖峰电流，并由此消除闪烁。虽然较大的Rdamp可以显著地降低尖峰电流，并消除闪烁，但是也会降低效率。

因此，在不采用有源阻尼电路时，应该寻找满足以下条件的最小Rdamp：

- 在调光角90°时，输入尖峰电流小于标准规定。
- Rdamp电流振荡不引起闪烁。
(同时检测输入电流与Rdamp电流。判断输入电流振荡是否受Rdamp电流影响。)

在找到最小Rdamp后，检查此时Rdamp的温度。如果温度过高，且效率过低，就需要采用有源阻尼器，着手有源阻尼器设计。

有源阻尼器设计		
Rdamp	100	ohm
SWdamp Vmax	300	V
Ddelay Vmax	300	V
Cdelay	100	nF
Rdelay	20	kohm

检测调光角90°启动时Rdamp电压。
这是SWdamp最大电压。

提示！低阈值电压时SWdamp可以减小功率损耗。（因为Rdamp电压是按照阈值电压进行调节的。）

延迟最大电压与SWdamp最大电压相同。

通常，Cdelay的取值约为100nF。

Rdelay取值范围为几十~几百kohm。
较大的Rdelay会延长调光器触发至SWdamp开通之间的延时时间。

寻找最小Rdelay，并满足以下条件：
在调光角90°时，当输入电流得到Rdamp抑制后，SWdamp应该导通。（在SWdamp开通前，应校验输入电流振荡是否已经结束。）
选择比较合适最小Rdelay可以获得高的效率。

相关资料

查阅设计工具:

http://www.fairchildsemi.com/design_tools/led-driver-design-tool/

查阅产品数据手册

[*FL7730—可调光单级 PFC PSR 离线 LED 驱动器*](#)

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