



Is Now Part of



ON Semiconductor®

To learn more about ON Semiconductor, please visit our website at

www.onsemi.com

ON Semiconductor and the ON Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

电感L的计算

下列等式用于计算电感值(L)。它根据交流输入和直流链路电压之间的电感纹波电流而得。请参见[AN-42047](#)。

$$\Delta I_{LP-P} = \frac{V_{IN}(V_{OUTDC} - V_{IN})}{fLV_{OUTDC}} < \frac{V_{OUTDC}}{V_{IN}} = \frac{1}{1-D}, \quad (1)$$

$$\Delta I_{LP-P} = \frac{V_{IN} * D * T}{L}$$

其中:

ΔI_{LP-P} : PFC电感电流峰峰值;

V_{IN} : 输入交流电压 (V_{RMS});

V_{OUTDC} : 直流链路电压 (V);

f: 开关频率 (Hz); 和

L: PFC电感值 (H)。

$$\Delta I_{LP-P} = \frac{V_{IN}(V_{OUTDC} - V_{IN})}{fLV_{OUTDC}} \quad (2)$$

$$\therefore (\Delta I_{LP-P})_{MAX} = \frac{V_{OUTDC}}{4fL}, \therefore V_{IN} = \frac{1}{2} V_{OUTDC}$$

假设 $f=22 \text{ kHz}$, $V_{OUTDC}=390 \text{ V}_{DC}$, $\Delta I_{LP-P}=4.0 \text{ A}$, 则可按下式计算电感L:

$$L = V_{OUTDC} / (4 \times f \times \Delta I_{LP-P}) = 390V_{DC} / (4 \times 22kHz \times 4.0A) = 1.108mH \quad (3)$$

选择导线直径

在表

1的工作条件下, 额定输出功率为2.4 kW, 交流输入的额定电压为220 V_{AC} 。最大输入电流可由下式获得:

$$I_{AC_MAX} = 2.2kW / 220V_{AC} = 10.0Arms \quad (4)$$

假设每平方mm铜线的rms电流为5 [Arms/ mm^2], 则导线面积和直径可由下式计算得出:

$$Aw = I_{AC_MAX} / (5[A/mm^2]) = 10.0Arms / (5[A/mm^2]) = 2.0mm^2 \quad (5)$$

$$\begin{aligned} \text{Radius of wire} &= \text{SQRT}(Aw/3.14) \\ &= \text{SQRT}(2.0/3.14) = 0.80[mm] \end{aligned} \quad (6)$$

因此, 选择直径为2.0 mm的铜线。

磁芯选择

选择磁芯时, 需考虑很多因素:

磁芯材料、磁芯磁导率、有效横截面积 (cm^2)、磁路长度 (cm) 和标称电感 (nH/N^2)。出于性能方面的考虑, 选用 Mega Flux® 磁芯。

$$\text{Core: CK740060C} \quad (7)$$

$$\text{Magnetic Path Length } l = 18.38\text{cm} = 183.8\text{mm} \quad (8)$$

$$\text{Cross Section Area } A = 5.04\text{cm}^2 = 183.8\text{mm}^2 \quad (9)$$

$$\text{Initial permeability } \mu = 60 \times 4 \times 3.14 \times 1e-10(H/mm) \text{ at } 25\text{kHz} \quad (10)$$

材料特性

- 化学成分: 铁硅合金
- 饱和通量密度 16.000 高斯
- 居里温度: 550° C
- 初始磁导率: 60 $\mu \pm 12\%$, 测量条件: 25 kHz、1 V和0 $A_{\text{直流}}$

尺寸

磁尺寸

- 磁路长度: 18.38 cm
- 横截面积: 5.04 cm^2

物理尺寸 (壳体)

- 外径: 79.50 sm (最大值)
- 内径: 41.14 cm (最小值)
- 高度: 55.0 cm (最大值)

壳体

- 成分: PBT (POLY BUTHYLENE TERPHTALATE)
- 制造商: KOLON
- UL阻燃等级和文件编号: UL 94-V0, E88499



图 2. 所选环形芯的规格: CK740060C

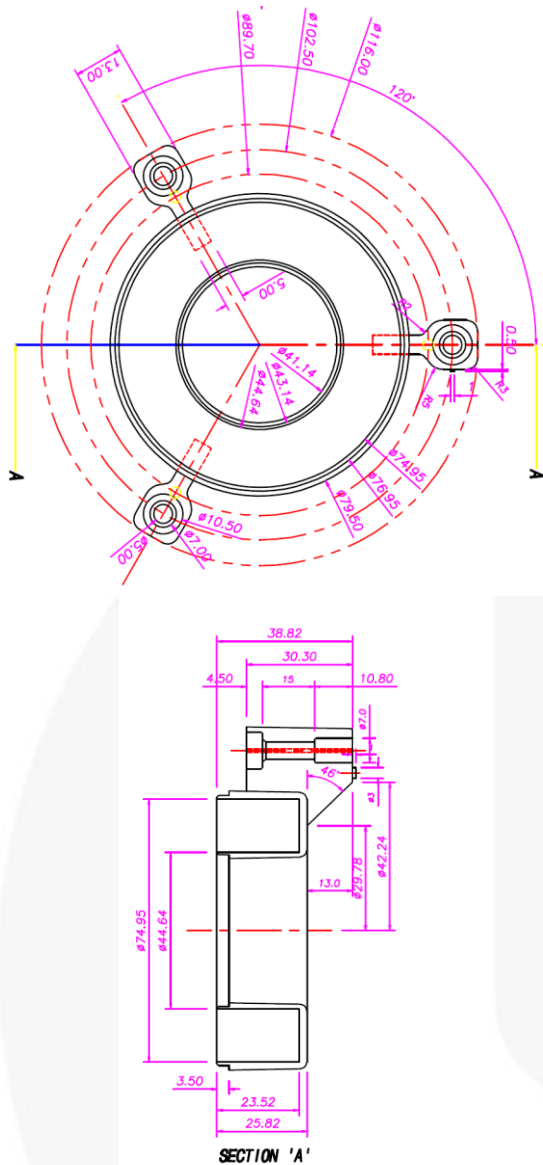


图 3. 磁芯壳体尺寸

线路匝数计算

图 4显示带环形芯的升压PFC电感及其走线。

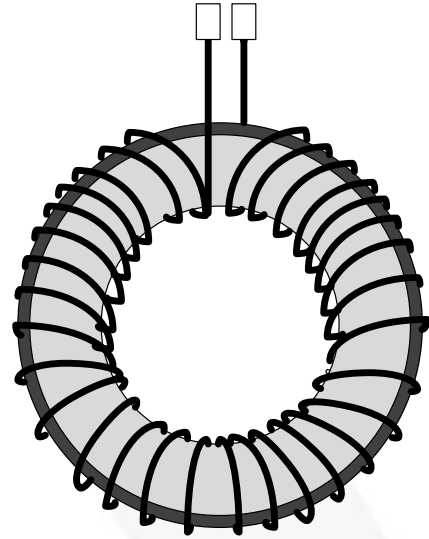


图 4. 带环形芯的升压PFC SPM电感走线

对于电感而言，可通过下式计算其每条导线的匝数(N)，参考网站：<http://www.changsung.com>:

$$L = \frac{0.4\pi\mu N^2 A * 10^{-2}}{1} \quad (11)$$

根据等式(8)

(10)和(11)中的磁芯参数，可如下计算N:

$$N = \text{SQRT}(1.108\text{mH} \times 183.9 / (60 \times 4 \times 3.14 \times 1e-10 / H \times 504)) = 74\text{turn} \quad (12)$$

因此，所选匝数应大于计算得到的74匝。选择导线的74匝作为升压PFC SPM®电感的最终匝数。

PFC电感的实施



图 5. 电感俯视图



图 6. 铜线宽度 (2.01 mm)



图 7. 电感值 (0.98 mH)

根据计算，选定的铜线宽2.0 mm，电感值为1.1 mH。实际值为：铜线宽2.01 mm，电感0.98 mH。

通过测试验证设计

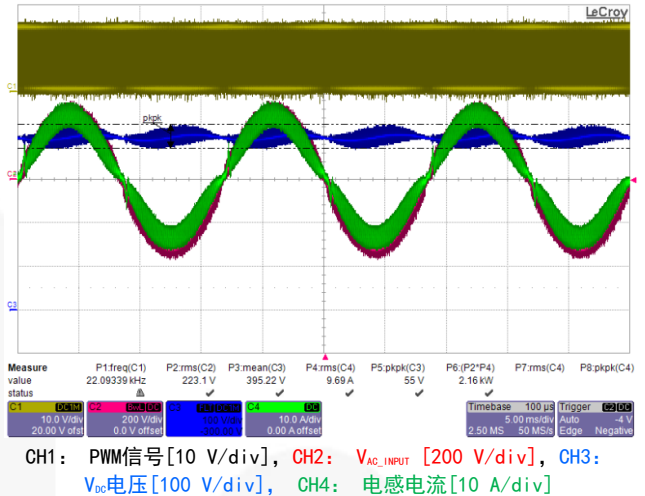


图 8. 满载测试结果 (9.69 Arms)

经验证，电感电流的最大纹波电流大于4A PK_{PK} ，与等式中 ΔI_{LP_P} (3) 的假设值相近。

参考文献

[AN-42047 — 功率因数校正 \(PFC\) 基础知识](#)

[AN-6982 — 采用FAN6982的功率因数校正转换器设计](#)

[磁粉芯: http://www.changsung.com/](http://www.changsung.com/)

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION.

As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA
Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada
Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800-282-9855 Toll Free
USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81-3-5817-1050

ON Semiconductor Website: www.onsemi.com
Order Literature: <http://www.onsemi.com/orderlit>
For additional information, please contact your local
Sales Representative