AN1000 APPLICATION NOTE

(AN1000 应用手册)

NU1680-based Wireless Power Receiver Design

(基于 NU1680 的无线功率接收器设计手册)

1 Introduction(简介)

- BPP 5W Wireless Power Receive
  5W BPP 无线功率接收 Rx
- Ultra-simple solution with 1 coil + 1 NU1680 + 12pcs components
  极简的电路设计解决方案：1 个线圈+1 片 NU1680 + 12 颗外围器件
- None of firmware to save the resource of developing and manufacture
  无固件烧入，可节省研发和生产时间和资源
- Remove Bootstrap Capacitor of Synchronous rectifier bridge for low cost
  去除了同步整流桥上的自举电容，使成本更低
- I^2C available, FOD parameter configurable
  具备 I^2C 功能，可通过它配置 FOD 等寄存器参数
- Small Size with 16-QFN 3.0mm x 3.0mm, 0.5mm pitch
  小尺寸，16 脚 QFN 封装，3.0mm x 3.0mm，脚间距 0.5mm

2 Applications (应用)

- WPC 5W BPP Compliant Receiver with Maximum 5W Received Power
  最大接收功率 5W，符合 WPC 5W BPP 规范
- Wireless Power Receiver for TWS, Electric Toothbrush, Electric Shaver, E-Cigarette and others Consumer Equipment
  无线充电场合：TWS, 电动牙刷，电动剃须刀，电子烟和其他消费类产品

3 Typical <=5W Rx Design （<=5W 的典型 Rx 设计）

Typical schematic and eBOM as below,
典型应用的原理图和电子物料清单如下

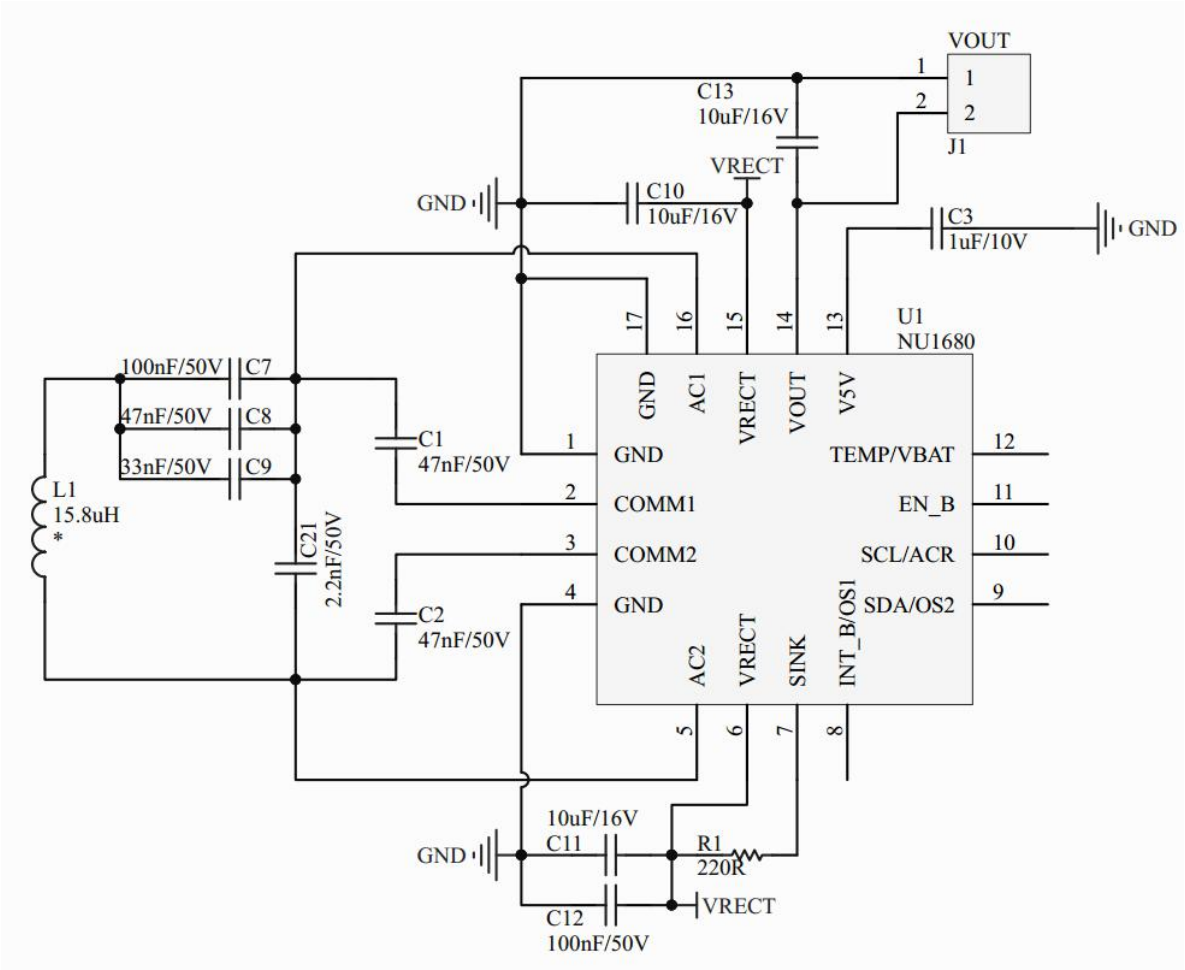


Figure 1. Typical Schematic
图 1 .典型应用原理图

NU1680 Typcial Design Bill of Materials

Project Name		NU1680		Creation date	2019.9.21			
The Version Of PCB				The Version Of BOM	Ver 1.0			
No.	Footprint	Comment	Designator	Description (5W/1A)	Description (3.5W/0.7A)	Description (<=3W/0.6A)	Quantity	Alternative
1	0402	Capacitor	C1, C2, C8	Capacitor/47nF/50V/0402/X5R/10%	Capacitor/47nF/50V/0402/X5R/10%	Capacitor/47nF/50V/0402/X5R/10%	3	
2	0402	Capacitor	C21	Capacitor/2.2nF/50V/0402/X5R/10%	Capacitor/2.2nF/50V/0402/X5R/10%	Capacitor/2.2nF/50V/0402/X5R/10%	1	
3	0402	Capacitor	C7, C12	Capacitor/100nF/50V/0402/X5R/10%	Capacitor/100nF/50V/0402/X5R/10%	Capacitor/100nF/50V/0402/X5R/10%	2	
4	0402	Capacitor	C9	Capacitor/33nF/50V/0402/X5R/10%	Capacitor/33nF/50V/0402/X5R/10%	Capacitor/33nF/50V/0402/X5R/10%	1	
5	0603	Capacitor	C10, C11	Capacitor/10uF/16V/0603/X5R/10%	Capacitor/10uF/16V/0603/X5R/10%	Capacitor/4.7uF/16V/0603/X5R/10%	2	
6	0603	Capacitor	C13	Capacitor/10uF/16V/0603/X5R/10%	Capacitor/4.7uF/16V/0603/X5R/10%	Capacitor/4.7uF/16V/0603/X5R/10%	1	
7	0402	Capacitor	C3	Capacitor/1uF/10V/0402/X5R/10%	Capacitor/1uF/10V/0402/X5R/10%	Capacitor/1uF/10V/0402/X5R/10%	1	
8	0805	Resistor	R1	Resistor/220R/5%/0805	Resistor/220R/5%/0805	Resistor/220R/5%/0805	1	
9	QFN	IC	U1	NU1680	NU1680	NU1680	1	
10	32mm*24mm*1.0mm	Inductor	L1	Inductor/15.8uH/Q>=23	Inductor/15.8uH/Q>=23	Inductor/15.8uH/Q>=23	1	
11		PCB		2Layer, FR4, OSP, 1OZ	2Layer, FR4, OSP, 1OZ	2Layer, FR4, OSP, 1OZ	1	

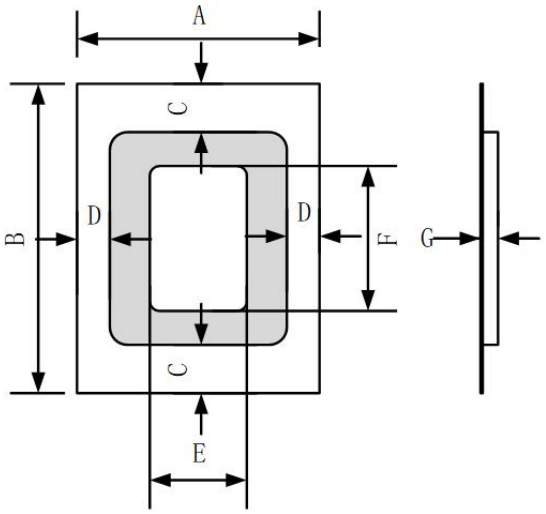
Figure 2. eBOM for Typical Design of 5W/3.5W/<=3W

图 2. 5W/3.5W/<=3W 典型应用下的电子物料清单

The Coil Specification is as below,

谐振电感线圈的规格书，

SHAPE AND DIMENSIONS



A:24±0.5mm
B:32±0.5mm
C:2.4±0.3mm
D:1.4±0.3mm
E:10.5±0.3mm
F:16±0.3mm
G:1mm Max.

Winding specification

Coil Number	Wire	Turns
1	0.32mm, AWG28	18

SPECIFICATION

Core: Ferrite	Inductance	DC Resistance	Q
Test condition	100kHz	25±10℃	100kHz/1V
Units	uH	mΩ	/
Part Number:	15.8±5%	430 Max	23 MIN

The following testing is using NU1620+NU1513 wireless transmitter EVM with MPA2 Tx Coil.

下图是基于 NU1620+NU1513（MPA2 线圈）的 Tx 评估板的测试结果。

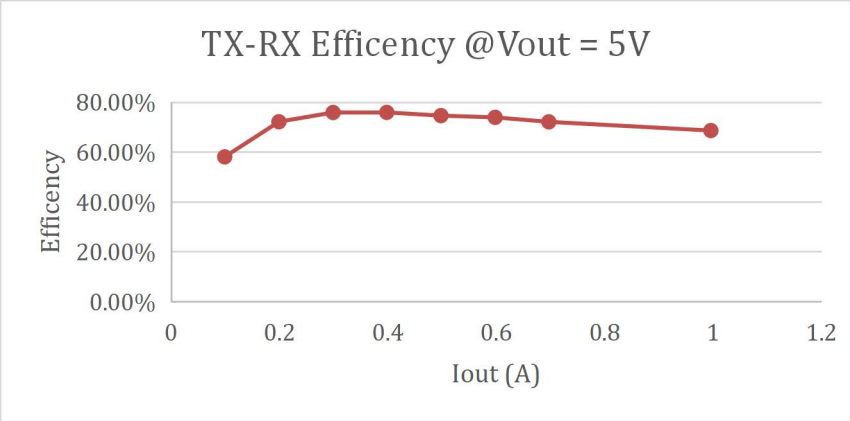


Figure 3. Efficiency: VOUT=5V

图 3. VOUT = 5V 时，效率 曲线

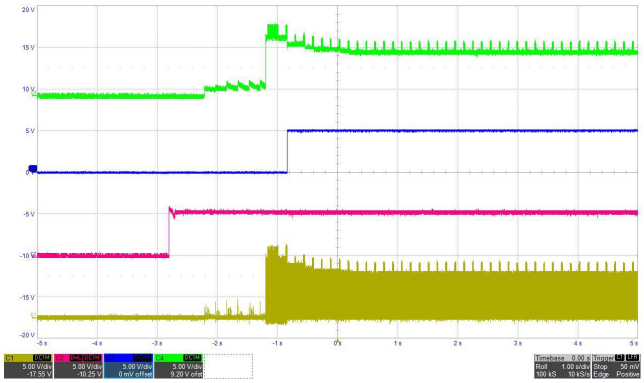


Figure 4. Start up by Adapter: VOUT=5V, IOUT=0.5A

图 4.适配器启动

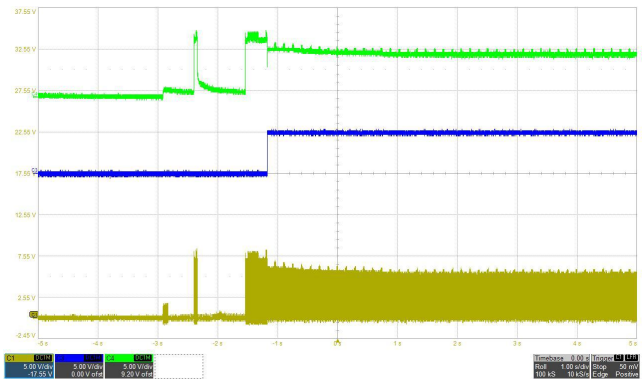


Figure 5. Start up by Rx: VOUT=5V, IOUT=0.5A

图 5.接收器启动

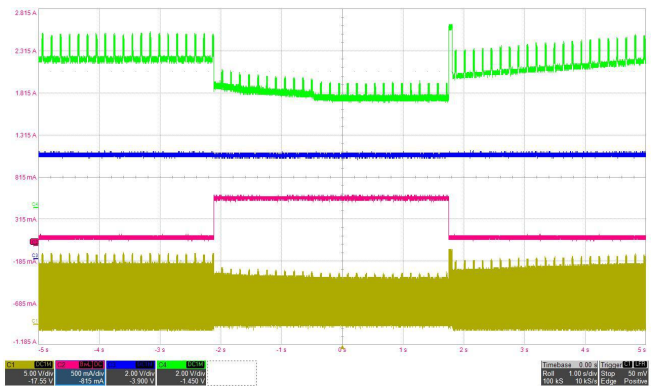


Figure 6. Transient Response: VOUT=5V, IOUT=0A to 0.5A; 0.5A to 0A

图 6.输出瞬变响应

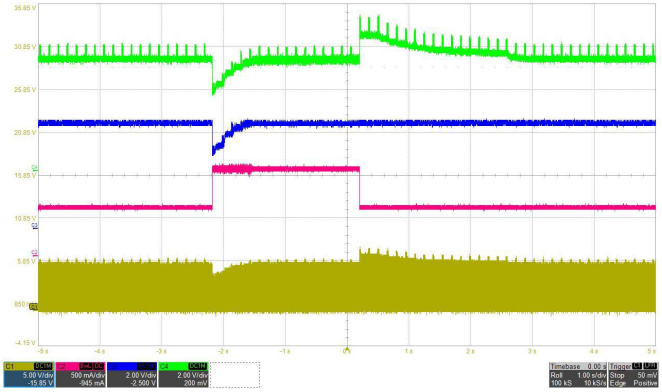


Figure 7. Transient Response: VOUT=5V, IOUT=0.5A to 1A; 1A to 0.5A

图 7.输出瞬变响应

Note: (1) Figure 4: CH1-AC1; CH2-VIN_Adapter; CH3-V_{out}; CH4-V_{rect}
(2) Figure 5: CH1-AC1; CH2-N/A; CH3-V_{out}; CH4-V_{rect}
(3) Figure 6~7: CH1-AC1; CH2-I_{out}; CH3- V_{out}; CH4-V_{rect}
(4) The typical characteristics were tested at TA = 25°C, unless otherwise noted

Top Layer shown as Figure 8,
PCB 设计顶层电路如图 8 所示

- Resonant capacitor C7/C8/C9/C21, COMM capacitor C1/C2 should be placed on the left side of IC, more close more better.
  C7/C8/C9/C21 是谐振电容，C1/C2 是 COMM 电容并应将它们放置在 IC 芯片的左边，同时越接近芯片越好
- The trace to coil L1 should be large width.
  L1 线圈走线应为宽铜线
- Two VRECT capacitors should be placed on each side respectively.
  VRECT 引脚端需分别各接一个电容（10uF/16V 或 4.7uF/16V）
- Place some Via on IC thermal pad pin for good thermal conduction.
  在 IC 芯片底部散热焊盘上放置一些通孔，以获得良好的热传导

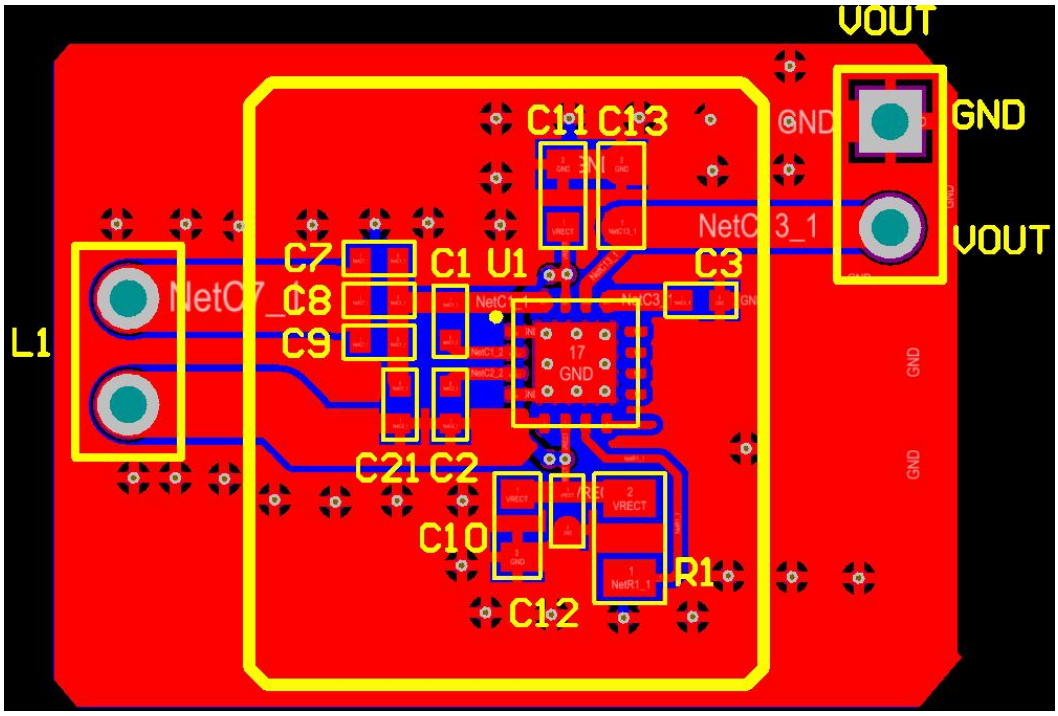


Figure 8: Top layer

Bottom Layer partly shown as Figure 9, Only one consideration needs to be taken care of that at least >=0.3mm width copper connect two VRECT Pins and place at least two Via on each side.
底层部分如图 9 所示，这里只需考虑一个因素，即连接两个 VRECT 引脚的铜线线宽至少>=0.3mm，同时每侧最少放置两个通孔。

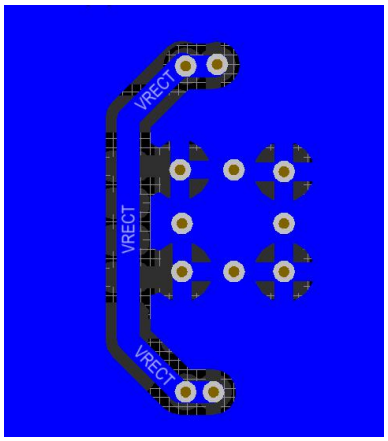


Figure 9: Bottom layer

Note: Make the resonant power routing loop as small as possible and keep away from another signal circuit.
注意：尽可能减小谐振环路，同时将其远离其他信号电路。

4 Advanced Design

The typical design can cover most application requirement. If you want to get the advanced design, such like VOUT setting, FOD parameter configuration and some protection modification, please use the NU1680 End-use GUI tool which can support I^2C program by OnEasy USB to I^2C driver (安易博科技). Further if you would like to develop the resonant coil or capacitor for different application, please use NU1680 System Parameter Design Tool.
以上典型设计基本可以满足绝大部分应用需求。如果你想进行较复杂的高阶设计，比如设置 VOUT 幅值，FOD 参数配置和修改一些保护特性，可使用 NU1680 的图形用户界面工具，该工具可以通过安易博电子科技公司的 OnEasy USB-I^2C 驱动器来支持 I^2C 编程。此外，如果您想进一步开发不同用途的谐振线圈或电容器，请使用 NU1680 系统参数设计工具来设计。

5 Revision Histories

	Date	Changes
V0.1	Sep/24/2019	First release.