# AN-P001
## A Design Guideline of Wireless Charging Module

## Introduction

In the wireless charging scheme of Qi magnetic induction mode, the power conversion efficiency between TX (power input) and RX (power output) is generally between 65% and 75%. For instance, the power loss of the 15W Qi magnetic induction wireless charging scheme during the conversion process is up to 8W max; and these power of 8W will convert into thermal energy (or heat) that emitting between PCBA and Coil.

There are 2 main aspects to be taken into consideration while designing the wireless charging transmitter pad of magnetic induction mode: First, it is necessary to follow the Qi specification design in order to pass the Qi standard certification successfully. Second, it is necessary to ensure that the heat from PCBA and Coil can be emitted to avoid the heat accumulation inside the housing.

## The factors that affect Qi certification in finished product design

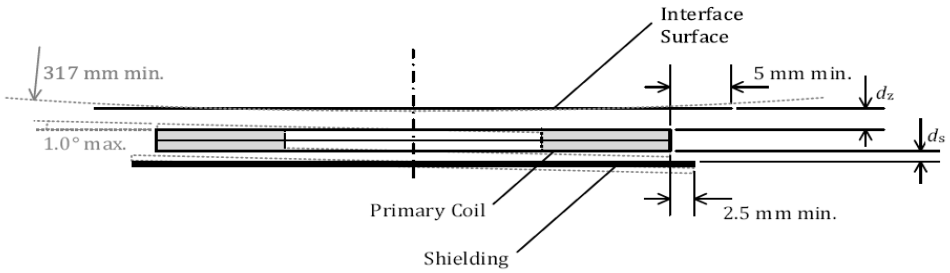



**Figure 1 – Definition for the top surface of housing**

(a) The relationship between the $d_z$ value (the distance from the surface of the coil to the surface of the top housing) and the thickness of the top housing :

(i) BPP transmitter pad, $d_z = 2^{+0.5}/_{-0.25}$ mm, where the distance from the surface of the coil to the surface of the top housing is 2.50mm max.

In order not to allow the heat which emitted from the coil to pass directly through the housing to the receiving device (such as mobile phone), a minimum of 0.5mm of distance is required to reserve for the surface of the coil and the inner surface of the housing, so the thickness of interface surface of the housing should design within 1.25~2.0mm.

(ii) EPP transmitter pad, $d_z = 3^{+0.5}/_{-0.25}$ mm, where the distance from the surface of the coil to the surface of the top housing is 3.50mm max.

EPP products produce more heat than BPP products. In order not to allow the heat which emitted from the coil to pass directly through the housing to the receiving device (such as mobile phone), a minimum of 0.8mm of distance is required to reserve for the surface of the coil and the inner surface of the housing, so the thickness of interface surface of the housing should design within 1.95~2.7mm.

(b) The effect of the components design layout towards FOD debugging :

(i) The effect of the PCBA/transmitter coil/receiver coil's design layout towards FOD debugging.

The design layout of PCBA/transmitter coil/receiver coil will directly affected the debugging of FOD. Therefore when designing a module, PCBA and coils are laid out in a "folding" manner. It is also to keep the same "folding" manner while designing a finished product.

(ii) The effect of the metal components towards FOD debugging.
During the modular design process, the appearance or shape of metal heat sink or other metal components cannot be changed at will. The relative position (distance) of metal components and coils in horizontal and vertical direction cannot be changed at will.

(iii) The effect of the housing materials towards FOD debugging.
While designing a product, the top housing cannot be made of metal. If bottom housing is made of metal, the first sample should provide to the R&D engineer of the original factory for confirmation.

(c) Main electrical components requirement for a product design :

(i) The main power conductor of the module must meet the current which above 2.0A with temperature rise (70°C or above).

(ii) The full load pressure drop from AC Adaptor's output point to the PCBA's voltage input point should be 0.5V or lesser.

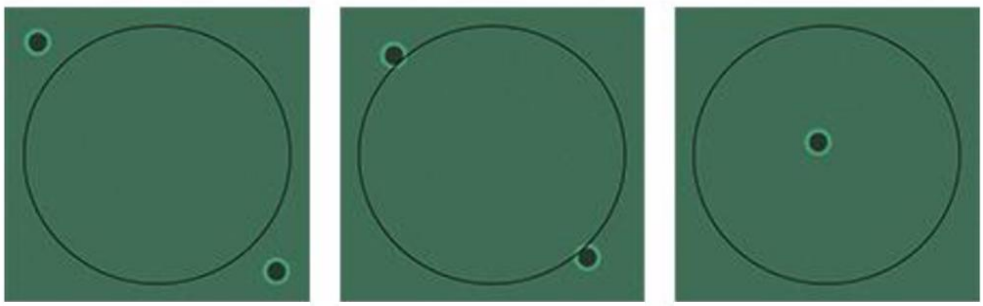
(iii) When collocates with AC Adaptor, the ripple wave of the AC Adaptor should be 2.5% or lesser.

(iv) If the main power PWM of the transmitter module resonates with the PWM of AC Adaptor, It is necessary to increase the common mode inductance isolation, or replace the AC Adaptor with different primary frequencies.

## Requirements for the placement of magnets in product design

Draw a circle with a diameter of 70mm in the center of the transmitting coil, and the field of influence of the magnet (note: the influence's field of the magnet, not the diameter of the magnet) must be outside the circle. As shown in Figure 2:

**Figure 2 – Standard of the placement of magnet**



| **Correct** | **No recommend** | **Incorrect** |
|---|---|---|
| The magnetic field is outside the circle | The magnetic field is close to the circle | The magnetic field is in the circle |

Note: If a product with multiple coils, each coil should have the same influence sphere of verification.

## Passive cooling in structural design

(a) Passive heat dissipation refers to the housing and structure design of the Qi wireless charging transmitter pad of magnetic induction mode, from where it must ensure good internal air circulation so that the heat generated from the PCBA and TX Coil during working condition can be diffused via heat radiation and convection.

(b) The distance from the surface of the highest component on the PCBA to the inner surface of the housing: ≥1.0mm

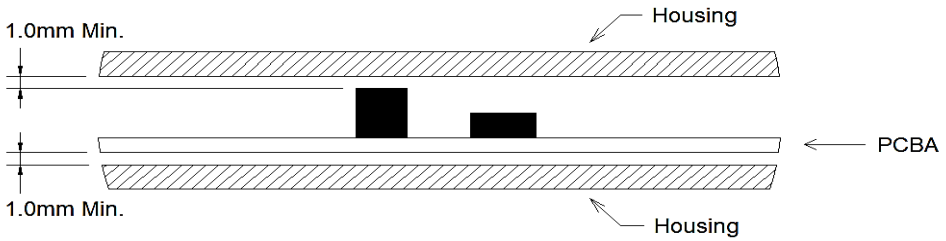



**Figure 3 – The minimum distance between PCB, components and housing**

(c) TX Coil surface cannot be too close to the inner surface of the housing. It is to avoid the heat generated from TX Coil will direct transfer to the receiving devise through the inner surface of housing during the working condition. Together with the heat from the receiving device itself, both heats superimposed and cause the protection of receiving equipment from overheating.

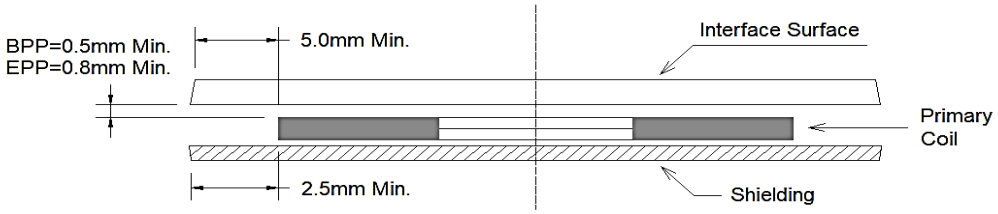



**Figure 4 – The distance between the surface of the coil and the housing of the product**

(d) The distance from the surface of the TX Coil to the inner surface of the housing cannot be less than 0.5mm.The surface of the coil should fix by the "special framework structure" instead of the entire plastic material.

(e) The "special framework structure" of the plastic material which uses to fix the TX Coil cannot be a ring like surrounded the TX Coil. It must ensure that the air can flow smoothly within the surface of TX Coil.

(f) The design of the housing of the transmitter pad is recommended to design the heat dissipation hole at the bottom and the side wall so that the cold/hot air can form the convection through the bottom and side vents. The rubber stop pad at the bottom of the housing is suggested as a point shape, which is also one of the structural designs that ensure the air flows smoothly under the housing.

(g) The surface of the housing is suggested to be convex or striated. It is to avoid the surface of the housing surface and the mobile phone (or other receiving device) has close contact, also to prevent the heats from both surfaces to be superimposed.

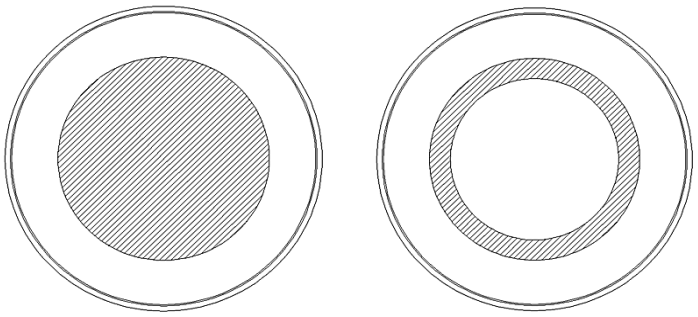


**Figure 5 – "Surface of a Top Housing" showing the whole or round silicone rubber are not suitable for the heat dissipation of the cell phone**

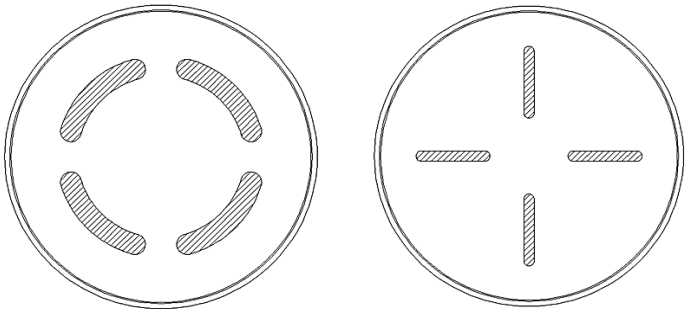


**Figure 6 – "Surface of a Top Housing" showing the spacer ring or spokes shape are good for the heat dissipation of the cell phone**

## Active heat dissipation in structural design

(a) In the design of PCBA and main chip, overheating protection and automatic fan control circuit are designed for heat dissipation.

(b) When the transmitter structural is designed, it is recommended to reserve the position of the cooling fan. If the passive heat dissipation in the second item is still remaining too high, a pre-designed cooling fan will be installed in the housing.

(c) Generally the cooling fan adopts the side vent style (a CPU cooling fan similar to a laptop.); the optimal design for the side vent air stream is, where the air stream flow from the opposite side vent of the air exhaust outlet, then takes the heat away from the PCBA and coil.

(d) It is not recommended to set the air intake vent at the both opposition sides of the air exhaust outlet. This is to avoid the heats again drawing in to the housing by negative pressure drainage and generate a heat cycle.

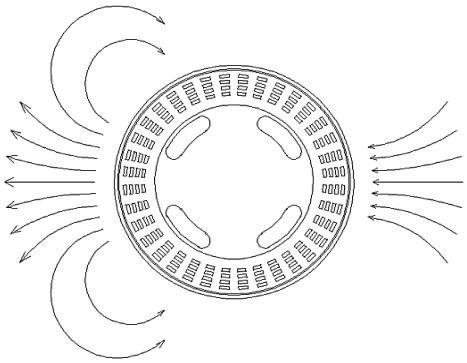


**Figure 7 – When the heat is dissipation at the side vents, the hot air must be avoided to be drawn into the cavity again**

(e) Experimental proof of aerodynamics: When air is compressed and released, it consumes the thermal energy (or heat) in the air (the most typical example is: the airflow is hot when one open his/her mouth and blows; while one close his/her mouth and blows, the air is cold.) Based on this principle, when designing the active heat dissipation, the air inlet should be slightly smaller than the exhaust air outlet. In addition, once the air flows into the housing it should be rapidly diffused through the airway to the entire cavity.

(f) When designing the side air vent, and the active heat dissipation of the bottom inlet, the air inlet should also be designed in the opposite side of the exhaust air vents. The principle is the same as (c). Design of the bottom inlet must ensure the bottom surface of the housing is 1.5mm (or above) above the desktop. Furthermore, the ring like bottom rubber stop pad is not suitable; air should flow smoothly through the bottom of cavity.