APPLICATION NOTE

I•CODE1 Label IC

Guidelines on the use of I•CODE1 label ICs concerning the different input capacitances (23.5 pF vs. 97pF)

Preliminary
Revision 1.1
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1 Contents

2 Definitions

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics section of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

2.1 Life Support Applications

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so on their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

3 Introduction

Together with the label coil the I•CODE1 label IC's input capacitance forms a resonance circuit of a certain resonance frequency. The target of label coil design is to meet with this resonance frequency the operating frequency of 13.56 MHz of the I•CODE1 system.
Therefore a label IC input capacitance of 23.5 pF leads to an inductance of the label coil of approximately 5.5 µH. This inductance is not attainable for small label sizes. Thus, the label IC with the higher input capacitance of 97 pF, which leads to a coil inductance of approximately 1.5 µH, has to be taken. The label size (area) where the higher capacitance becomes the better choice depends mainly on the coil manufacturing technology, but there exists no well defined quantity which leads in each case to a clear decision. Therefore for each technology a region exists where both possibilities have to be investigated. This paper gives guidance for different coil manufacturing technologies in this matter.

4 Coil Manufacturing Technologies

Three different technologies are currently in use to manufacture label coils.

- Etched, one layer:
  The turns are etched from one thin layer of metal (copper). Since there exists only one conducting layer all turns have to pass through the connecting pads of the label IC which show a distance of 1.3 mm. This fact limits the number of turns.

- Etched, one layer with additional bridge:
  The IC is positioned beside the turns. The turns are etched from one thin layer of metal (copper). The second layer is used as the return path (bridge) to the label IC. The number of turns is limited by the area of the label only.

- Printed:
  The turns are printed onto a substrate. Since the specific conductivity of the printed material is small in comparison to pure copper, printed turns have to be much wider than etched turns to meet the same quality factor. Thus, printed labels always use a second layer as return path (bridge) to the label IC. The number of turns is limited by the area of the label only.

5 Guideline

Amongst the resonance frequency, the number of turns and the average area surrounded by the turns are important quantities regarding the performance of the label. The higher the number of turns and the higher the average area the lower is the minimal threshold field strength of the label.
For given outer dimensions of a label a 5.5 µH coil shows in general more turns and therefore a lower average area than an 1.5 µH coil. For big labels the positive effect of the higher number of turns predominates. With decreasing label size the effect of the higher average area of the 1.5 µH coil shows an increasing influence until the 1.5 µH coil shows the better performance. The exact borderline depends on the minimal track width of the turns, the minimal distance between the turns, the ratio of the lateral lengths of the label and other parameters. Thus, the borderline is not derivable from the label area only.

Nevertheless, to meet a resonance frequency of 13.56 MHz (proper inductance) is the primary goal.

Figure 1 shows the suitability of the 23.5 pF label IC and the 97 pF label IC as a function of the label area for the different manufacturing technologies. As mentioned above no accurate borderline exists. Each technology shows a transition or borderline region. In this borderline region it is recommended to calculate and test both possibilities.
The area of the label limits the number of turns for 5.5 µH coils as well as for 1.5 µH coils . Thus for very small labels even an inductance of 1.5 µH is not attainable. The limit for 1.5 µH coils correlates with the hatched region at the left end of bars. The exact limit depends on the minimal track width and track distance.

- Etched, one layer with additional bridge:
  The borderline region is at approximately 4 cm². The check of the attainability of an inductance of 5.5 µH is the first step for label sizes in the borderline region. If 5.5 µH are attainable the calculation of the minimum threshold field strength of both designs gives additional indication. If no clear decision is possible a series of tests should be performed.
- Etched, one layer:
  The borderline is between 4 cm² and 14 cm². For this technology the limiting factor for the 5.5 µH coil is simply the number of turns a manufacturer is able to place between the connection pads of the label IC. Since this number varies heavily with different manufacturer's capabilities the borderline region is extended. If the maximum number of turns between the connection pads is sufficient for 5.5 µH is shown by the calculation of the inductance. In this case the 23.5 pF label IC should be taken.
- Printed:
  Since printed coils need much wider tracks than etched coils to reach the same conductivity the borderline region is at approximately 16 cm². The check of the attainability of an inductance of 5.5 µH is the first step for label sizes in the borderline region. If 5.5 µH are attainable the calculation of the minimum threshold field strength of both designs gives additional indication. Attention should be paid on the parallel equivalent resistance of the coil when calculating the minimal threshold field strength. If no clear decision is possible a series of tests should be performed.

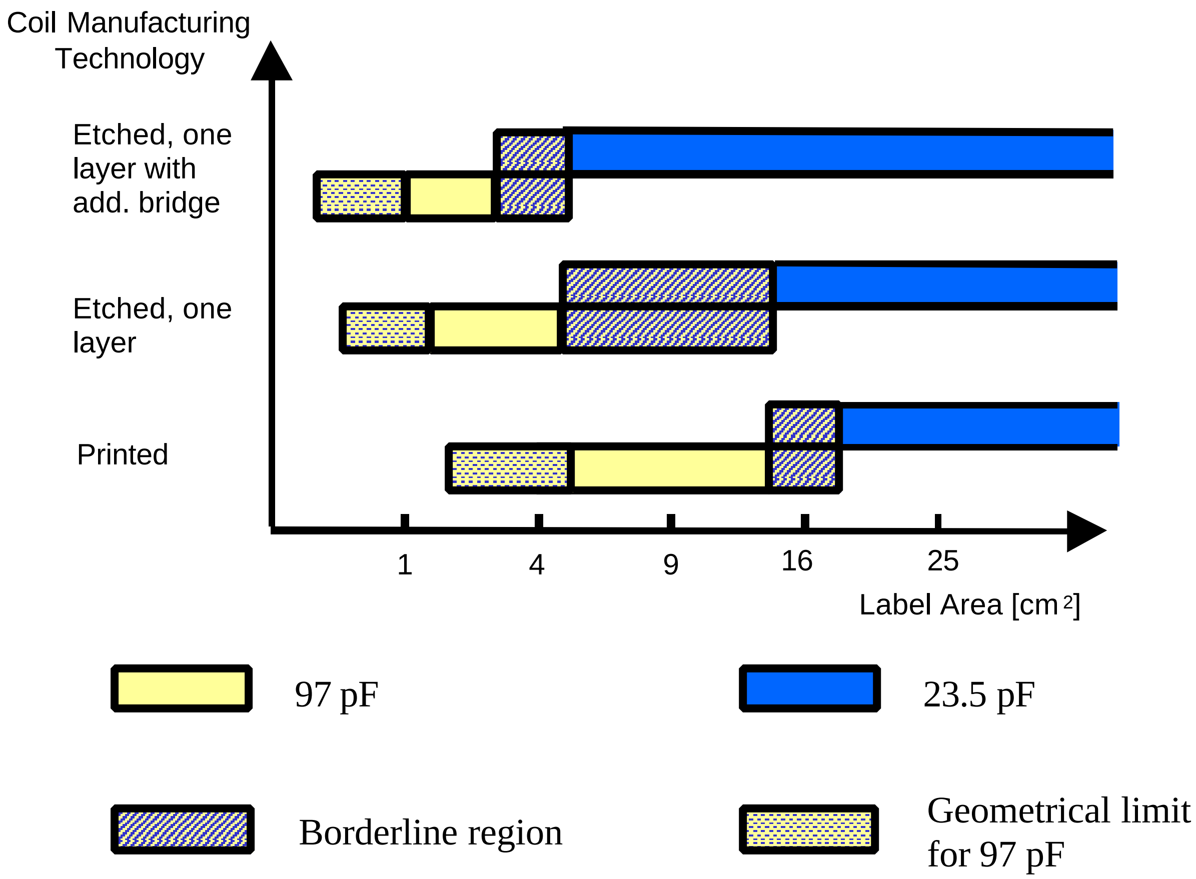
Coil Manufacturing Technology
Etched, one layer with add. bridge
Etched, one layer
Printed
1
4
9
16
25
Label Area [cm 2]
97 pF
23.5 pF
Borderline region
Geometrical limit for 97 pF

Figure 1

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