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ANDY100

Application Note

ANTENNA MATCHING FOR ANDY100

APN-ANTMATCHANDY100-V03

INTRODUCTION

This application note describes the RF input characteristics of the ANDY100 and discusses the different options to connect an antenna to the device. First the RF input architecture implemented in the IC is presented. Some considerations that have to be taken into account given the architecture are also included. Next, the value of the input impedance for different conditions is detailed.

Finally, several PCB reference designs are presented including a 50Ω matching board and different matched antenna layouts.

RF INPUT OF ANDY100

The ANDY100 includes a single RF port. This RF port is used for both, energy harvesting and communications.

DIFFERENTIAL INPUT

The RF port of the ANDY100 has a differential architecture. Thus, two RF pins are included in the device: RF+ and RF-. When a RF signal of power greater than the threshold RF_{SENS} is applied between these pins, the IC powers up harvesting energy from the RF signal.

When the IC is energized, a positive supply voltage between VDD and GND is generated. Given the internal architecture of the power management unit, the voltage on GND is virtually connected to an electric potential around $\frac{V_{RF+}+V_{RF-}}{2}$. Thus, even if the RF input port is differential, the grounds of the RF emitter and the ANDY100 should not be connected.

Typically, the RF link from a RFID reader to the tag is done wirelessly using RF antennas on both sides. In such a case, the grounds of the devices are isolated and no further circuitry is required. However, in case the RF link is wired, ground isolation has to be provided. This can be achieved, for example, using a UHF transformer.

Even if the RF port of ANDY100 is differential, single ended antenna topologies can also be used. This is possible because a single ended antenna, is in essence a differential antenna with one of its terminals connected to the ground plane. When using differential antennas, connect each signal RF+ and RF- of the antenna to their respective pin in the IC. When using single ended antennas, connect the ground pin of the antenna (or the ground plane of the antenna) to the RF- pin of the ANDY100. Then connect the RF signal pin of the antenna to the RF+ pin of the ANDY100. Make sure that different grounds are used for the antenna ground and the IC ground signals.

INPUT IMPEDANCE

Given that the operation frequency of the ANDY100 is in the UHF band, a proper impedance matching is needed in order to maximize power transmission. As in any RF device, power transmission is maximized when the impedance of the power source and the impedance of the load are complex conjugates. In this case, the power source will be the antenna and the load the ANDY100 IC.

Notice that both, the impedance of the antenna and the impedance of the RF port of the ADNY100 vary depending on the operation frequency. Thus, the impedance matching has to be done for a specific frequency. Depending on the characteristics of the antenna, the behavior of the tag will be correct for a wider or narrower bandwidth.

Table 1 shows the input impedance of the ANDY100 for different operation frequencies and package options.

Frequency [*MHz*]	**Re(Z_{IN}) [Ω]**	**Im(Z_{IN}) [Ω]**
QFN48		
868	8	-67j
915	8	-61j
SOIC14		
868	10	-58j
915	10	-53j

Table 1: Input impedance of ANDY100.

MKS PCB ANTENNA REFERENCE DESIGN

In this section the MKS PCB antenna reference design is presented. This antenna is a meandered $\lambda/2$ dipole antenna optimized for size and efficiency for RFID applications. A matching network is required between the IC and the antenna in order to maximize the power transfer for the impedance of the IC in a given frequency and a given package.

The reference design including the SOIC14 package and the MKS antenna is available for each ANDY100 powered Farsens design in the web. These designs include a pi shape matching network.

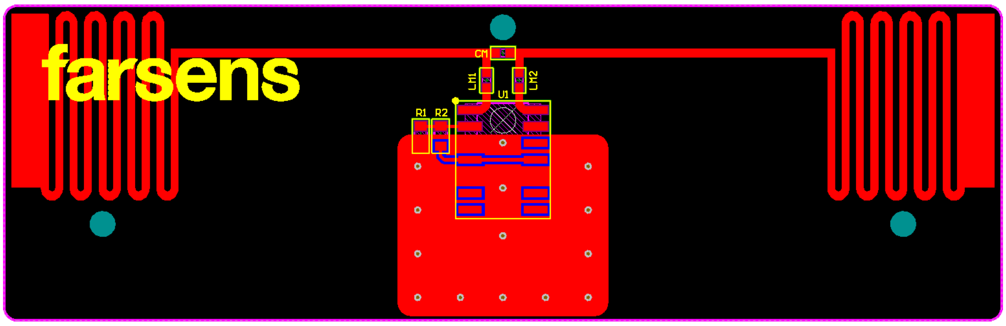

Figure 1: Layout of MKS antenna for ANDY100 with S14 package.

The following matching networks are available for different purposes:

LMx [nH]	**CM** [pF]	**Description**
5.6	4.3	Wideband operation
-	-	868MHz operation
-	-	915MHz operation
-	-	955MHz operation

Table 2: Matching network for MKS antenna with ANDY100 IC in S14 package.

SENSITIVITY OF ANDY100-S14 WITH MKS REFERENCE ANTENNA

For the provided reference antenna with the available matching networks, the performance of the tag has been measured. The average sensitivity of the tags for different operation frequencies is presented in figure 2.

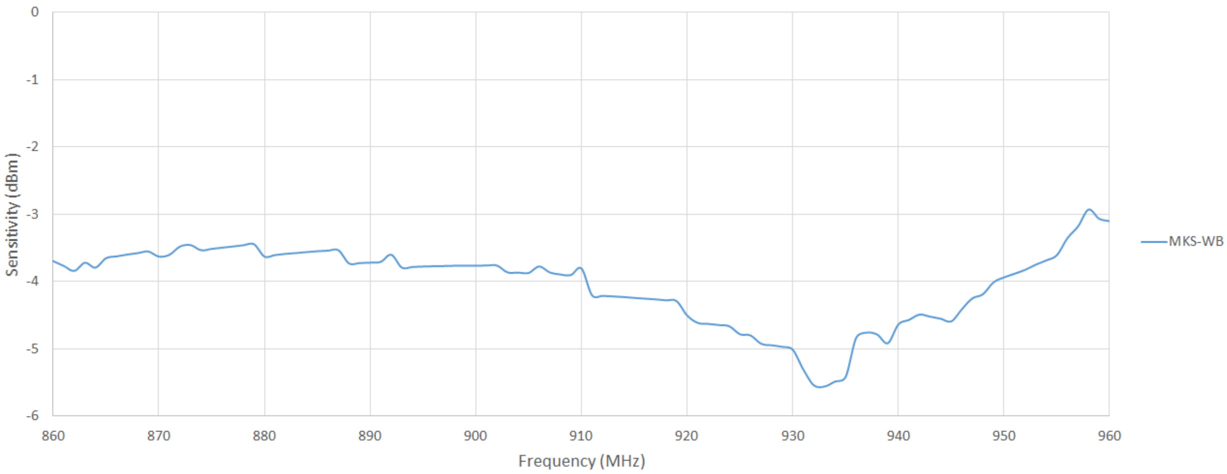

Figure 2: Sensitivity of ANDY100-S14 with MKS antenna.

COMMUNICATION RANGE OF ANDY100 TAGS

The communication range of a tag can not be easily specified as a unique numeric value, as it depends on many factors. First of all, notice that the power available at a given point depends on the environment. Different materials in the proximity of the tag can absorb or reflect RF power making the actual available power higher or lower than the expected one. Nevertheless, the most objective way to estimate the communication range of a tag is to use the free space propagation model to get the available RF power at a given distance from the reader.

Depending on the local regulations, the maximum power that can be emitted from the reader and the operation frequency differs from country to country. Figure 3 shows the available power depending on the distance between reader and tag. Several curves are presented in order to show the different regulatory conditions.

Given a sensitivity of ANDY100 tag with a specific antenna, the expected communication range can be obtained from this figure for different regulatory conditions.

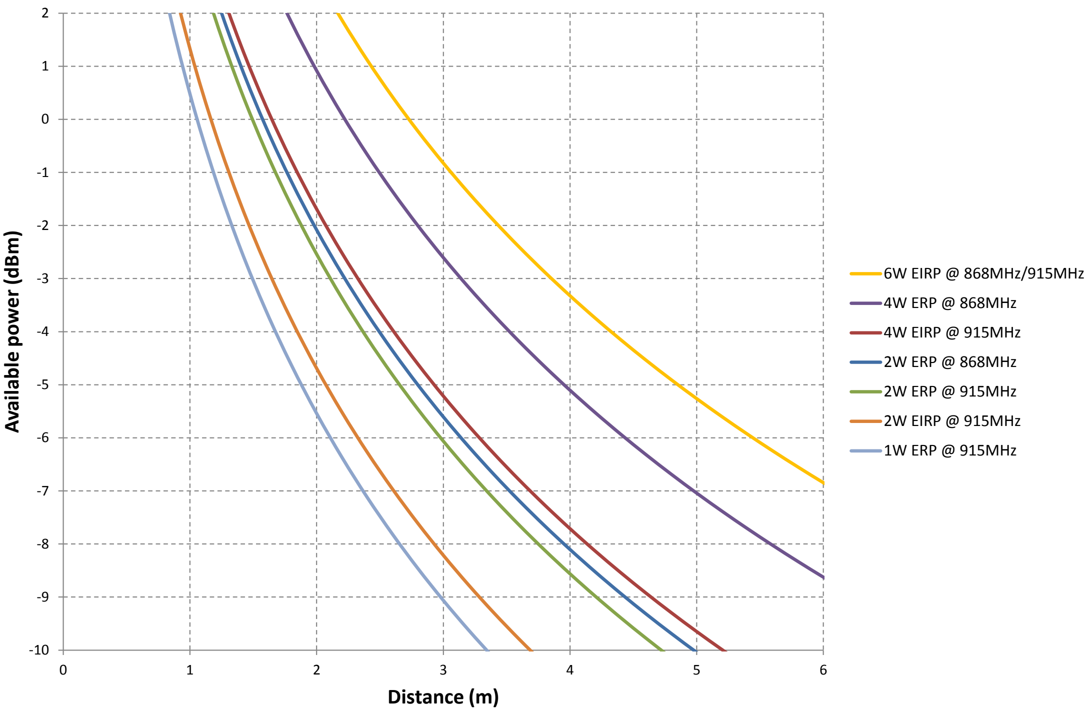

Figure 3: Available power for different regulatory conditions.

As of 31 May 2013, this is the distribution of GS1 member countries [1]:

- **4W EIRP @ 915MHz:** Argentina, Australia, Brazil, Canada, Chile, Colombia, Costa Rica, Dominican Republic, Hong Kong, Japan, Korea, Mexico, Panama, Peru, South Africa, Thailand, United States, Uruguay, Venezuela
- **2W ERP @ 868MHz:** Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, Iran, Ireland, Italy, ordan, Latvia, Lithuania, Luxembourg, Macedonia, Malta, Moldova, Netherlands, Norway, Oman, Poland, Portugal, Romania, Russia, Saudi Arabia, Serbia, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Tunisia, Turkey, United Arab Emirates, United Kingdom
- **2W ERP @ 915MHz:** Brunei Darussalam, China, Indonesia, Malaysia, Singapore, Vietnam
- **4W ERP @ 868MHz:** India
- **6W EIRP @ 868/915MHz:** New Zealand
- **2W EIRP @ 915MHz:** Israel
- **1W ERP @ 915MHz:** Taiwan

[1] The operation frequency bands have been simplified to 868MHz or 915MHz. For countries with different operation frequencies the closest band has been used. Data extracted from GS1 document *Regulatory status for using RFID in the EPC Gen 2 band (860 to 960 MHz) of the UHF spectrum*, 31 May 2013