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**Application Note: AS3935-AN04 – Hardware Design Guide**

# **AS3935**

**Hardware Design Guide**

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## Revision History

Revision	Date	Owner	Description
1.0	06.06.2012	JPE	Initial release
1.1	20.02.2013	JRY	Update to corporate format
1.2	17.06.2013	JRY	Correction of Antenna values for Premo antenna; removal of Sumida antenna (antenna not in production).

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## 1 Hardware Recommendations

### 1.1 Antenna

The antenna is specified to have an inductance of 100uH since the sensitivity of the antenna needs to correlate with the statistical analysis of Lightning done by ams in cooperation with the FIT (Florida institute of technology). The following table will give an overview of recommended antennas:

**Figure 1: Recommended Antennas**

Supplier	Part number	Properties
Coilcraft	MA5532-AE	100uH, Q=34
Premo	SDTR1103-HF1-0100J	100uH, Q=45

Once the antenna has been chosen the next step is to calculate the parallel capacitor of the resonance circuit to tune it to a frequency of 500 kHz:

**Figure 2: Resonance Frequency Calculation**

Resonance frequency	Capacitance calculation	Measured inductance	Calculated capacitance	Assembled Capacitance
$f_{RES} = \frac{1}{2\pi\sqrt{L \cdot C_R}}$	$C_R = \frac{1}{(2\pi \cdot f_{RES})^2 \cdot L}$	L = 100uH	CR = 1.013nF	CA = 1013pF – 60pF = 953pF

Since the internal tuning algorithm provides in total 120pF that can be put additionally in parallel to the external capacitance, it is recommended to subtract 60pF from the calculated value. It is recommended to centre the internal capacitor array of the AS3935 to 60pF in order to allow plus/minus balancing of the resonance frequency. The resonance frequency can be balanced between 485 to 515 kHz ( $\pm 60$ pF). Therefore, a variation of  $\pm 15$ kHz of the external components can be compensated with the tuning. This feature allows assembling external components with lower precision which leads to a benefit in price. Furthermore it is possible to exclude soldering issues in production.

Finally, the Q-factor of the antenna needs to be matched to a typical value of 15. Especially for the higher Q antennas it is necessary to place a resistor in parallel to the antenna. A typical value of 10kOhm is sufficient to decrease the Q from 34 to approximately 15.

### 1.2 Layout

- Do not cross the SPI lines with the sensitive inputs of the antenna.
- Below the 500 kHz LF antenna there should not be a GND plane, to avoid Eddy currents that influence the sensitivity of the antenna.
- Long wires between the antenna and the AS3935 should be avoided, since those wires could catch up interference that can lead to disturbers or false positives.
- It is recommended to have the antenna close to the input of the AS3935 (within ~1-2cm) and to keep the parasitic capacitance as low as possible.
- Orientation of the antenna: Since lightning is not discharging straight, but in a zigzag pattern and the distance is very far away, the orientation should not matter.

- Make sure that the GND plane is routed carefully.
- Do not run SPI or any other interface on 500 kHz clock speed, in order to avoid any cross-coupling that leads to disturbers or detected noise on the antenna.
- Do not place any disturber or noise sources operating at 500 kHz close to the antenna (e.g. DCDC converters, oscillators, interfaces etc.)

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