Texas Instruments Questions:

LDC-Tool by TI:

Spiral Inductor Designer

How does the Spiral_Inductor_Designer calculate the inductance for the LDC0851?

- Assumption: Mohan's equation:

$$L = \frac{\mu_0 * N^2 * d_{avg} * C_1}{2} * \left[\ln\left(\frac{C_2}{g}\right) + C_3 * g + C_4 * g^2\right]$$

- Depending on how many layers the circuit board has:

$$L_{TOTAL} = \sum_{i=1}^{N} L_i + 2 * \left(\sum_{j=1}^{N-1} \sum_{m=j+1}^{N} M_{j,m}\right)$$

- $M = k * \sqrt{L_1 * L_2}$
- The parameter k is a measure of the flux linkage between the coils and varies between 0 and 1. How to calculate k is still unknown to me.

Is the approach correct?

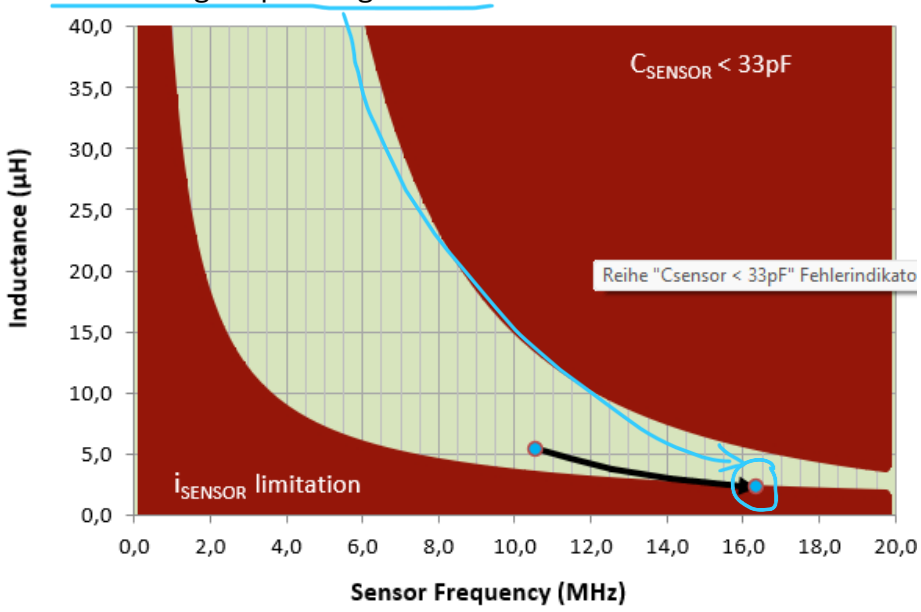
LDC0851_calc

How does the Excel tool LDC0851_calc work?

Setup:

- The values from the 20 mm coil are used. The coil is included in the LDC0851EVM.

Why is the closest target operating condition in the limited area with the 20mm coil?



Is the input parameter of the 20 mm coil correct?

For sensor inductance, I used the calculated value from the Spiral_Inductor_Designer and the values from the LDC0851 datasheet. However, the max Sensor Frequency with target does not match the value calculated by the Spiral_Inductor_Designer.
(see the table below)

Free Space Sensor Characteristics

Supply Voltage	3,3	V
Sensor Inductance	5,40	µH
External Sensor Capacitance (C_{SENSOR})	68,0	pF
Parasitic PCB capacitance (C_{BOARD})	4,0	pF
Total Capacitance (C_{TOTAL})	84,0	pF
Sensor Frequency	10,568	MHz
Conversion Latency	410	µs
Continuous Sample Rate	2,441	ksps
I_{SENSOR} without Target	1,02	mA
I_{DD} (total current) without Target	2,04	mA

Sensor Characteristics with Target Interaction

Sensor Diameter	20,00	mm
Closest Target Distance	1,00	mm
Est. Inductance with Target Interaction	2,253	µH
Max Sensor Frequency with target	16,359	MHz
$I_{DD\text{-}Max\_Target}$	2,78	mA

LDC0851 Oscilloscope evaluation

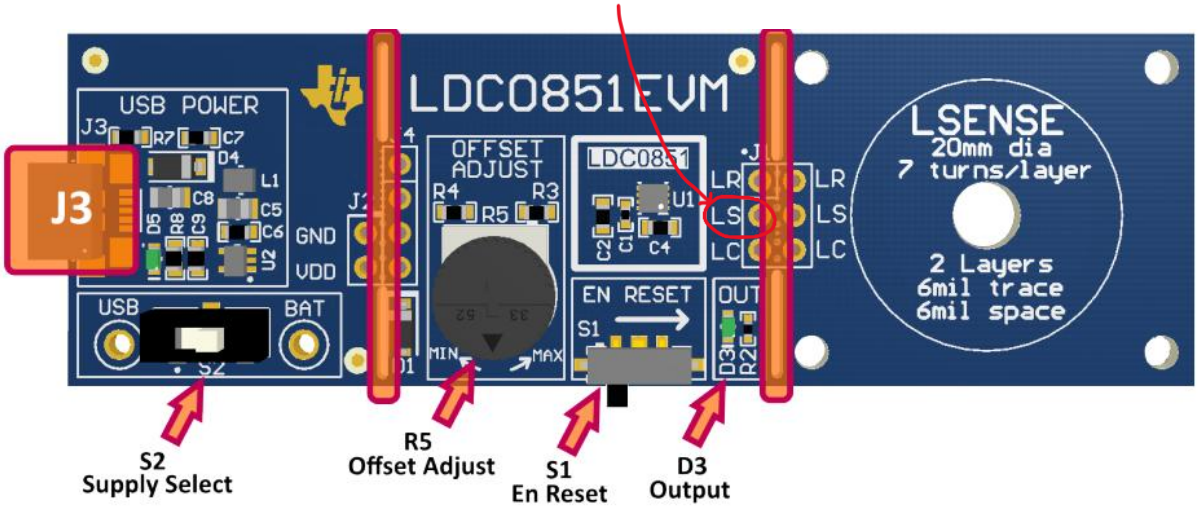
- Why does the oscilloscope show 2 sinus similar curves and?
- What do these curves represent?
- Are my Assumptions I wrote correct?

Setup:

- The 20mm coil is connected to the LDC0851EVM.
- The potentiometer of the LDC0851 is set to approximately 38.12 kOhm to reach Adjust Level 13. The equation of the switching Distance is:

$$d_{switch} = d_{coil} * 0.3 * \left(1 - \frac{ADJ_{Code}}{16}\right) = 1.1\ mm$$

- Measure with an oscilloscope on LSENS.



The following pictures shows the results of the oscillator with and without a target:

20mm Coil with no Target

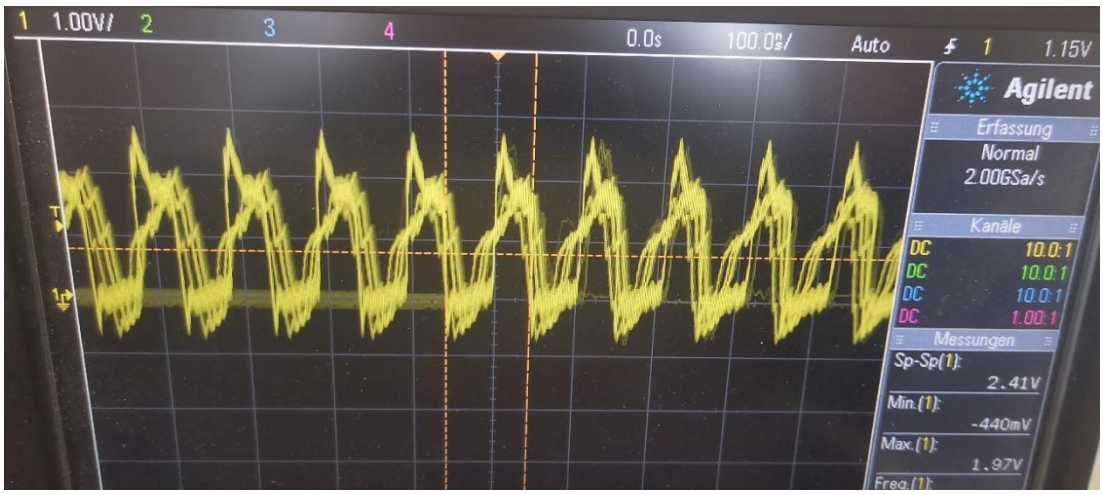


Figure 1: The oscilloscope shows two sinus similar curves (oscilloscope on run/stop)

Figure 2: focus on curves 1 (oscilloscope on single)

Figure 3 focus on curve 2 (oscilloscope on single)

20mm Coil with Target

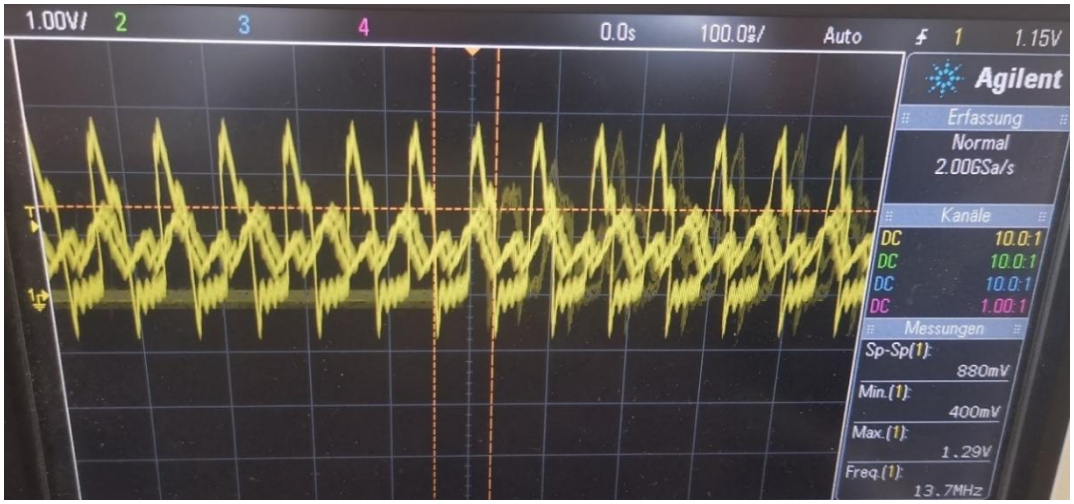


Figure 4: The oscilloscope shows two sinus similar curves (oscilloscope on run/stop)

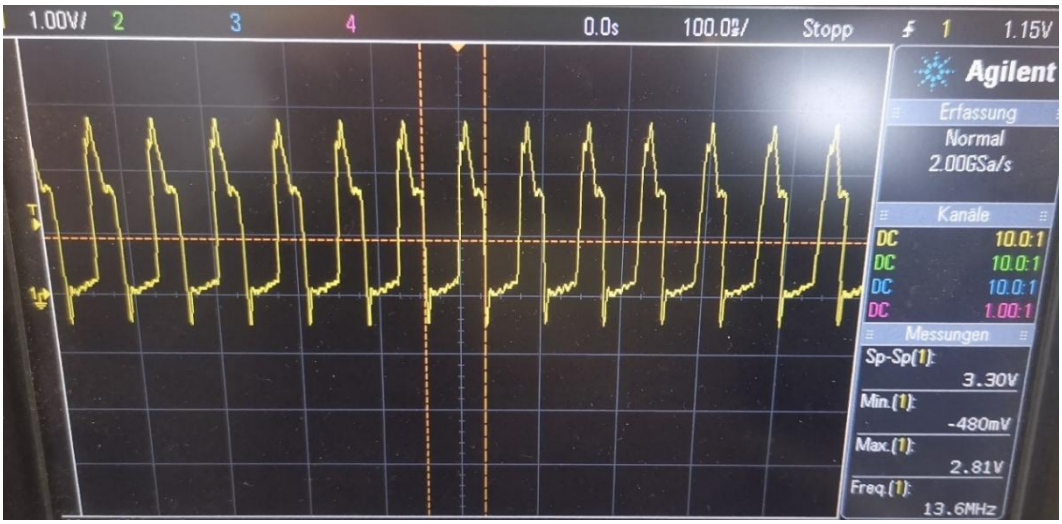


Figure 5: focus on curves 1 (oscilloscope on single)

Figure 6: focus on curves 2 (oscilloscope on single)

Assumption:

Without Target:

- The inductance of the LSENS coil is higher than with a target, which leads to a lower frequency.
- Figure 2 represents the oscillation of the LSENS coil
- Figure 3: an additional harmonic oscillation by the LDC0851 (don't know what exactly the curve represents

With Target:

- The inductance of the LSENS coil is lower than without a target, which leads to a higher frequency.
- Figure 5 represents the oscillation of the LSENS coil
- Figure 6: an additional harmonic oscillation by the LDC0851 (don't know what exactly the curve represents -> the amplitudes of this figures changes after ½ period

Therefore, the amplitude changes because the energy transfer between the coil and the target is different.