Choosing Power Inductors for LiDAR Systems

Application Design Example

The goal to create truly safe and high-performance autonomous vehicles has captured the imagination of the automotive industry and consumers alike. The rollout of such vehicles can seem quite close at times, and many industry resources are being devoted to their development. One particular sensing system that seems certain to play a key role is LiDAR, and companies are working to perfect these systems. Every area of the LiDAR system, including efficient DC/DC power supplies, must be optimized.

A LiDAR system may contain a half dozen or so power supplies, sometimes including Boost, SEPIC, Buck-Boost and even Flyback topologies. With so many required voltage rails, there is plenty of opportunity for optimization, and inductors or transformers will play a key role in almost all systems. Finding the inductor that fits best for each topology can be a challenge, but inductor suppliers are providing new tools and guidance to help this process.

Once a power supply topology and chipset are chosen, inductor selection can begin. Many electronic systems need to convert available voltages up and down to suit subsystem needs. LiDAR in particular requires automotive battery voltages to be converted up to drive the LiDAR transducers. The LM5001 switching regulator from Texas Instruments can be used to control Flyback, SEPIC or Boost converters, making it very useful for required LiDAR power rails.

For example, in its AN-1956 application note, Texas Instruments includes a reference circuit demonstrating a boost converter using a 100 µH inductor capable of 1.8 A of current. A major step toward optimizing the power converter is selecting the correct inductor.

Making Inductor Selection Easy

Coilcraft's online Power Inductor Finder and Analyzer tool is designed to help circuit designers find the best performing inductor for their needs. Start by entering the basic parameters of 100 µH and 1.8 A into the tool (Figure 1). One click returns a list of suitable inductor choices.

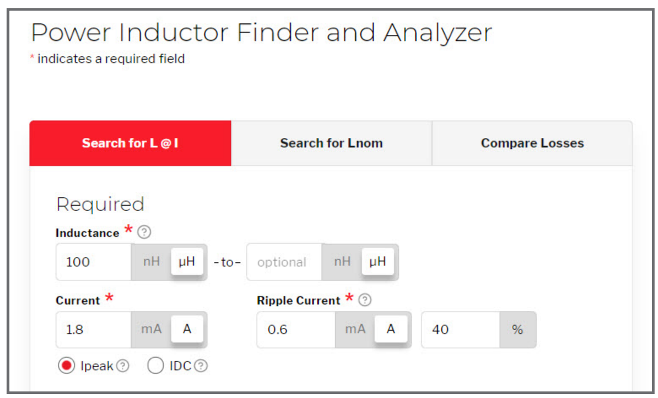


Figure 1: Power Inductor Finder and Analyzer Tool inputs

Part Number	L at 1.8 A (µH)	L nominal (µH)	Adjusted Ipeak (A)	Isat 30% drop (A)	Irms 40C rise (A)	DCR typ @ 25°C (mΩ)	Total losses (mW)	Part temp. (°C)	Temp Rating (°C)	Length (mm)	Width (mm)	Height (mm)	Mount	Shielded	Core material
Check parts below to Analyze															
MSS1246-104 Sample Buy	92	100	1.8	2.0	1.6	217	535	64°C	125°C	12.3	12.3	4.8	SM	Yes	Ferrite
RFS1113-104 Sample Buy	86	100	1.8	2.2	2.1	184	478	49°C	125°C	11.3	11.3	12.5	TH	Yes	Ferrite
MSS1246T-104 Sample Buy	91	100	1.8	2.2	1.6	217	536	61°C	165°C	12.3	12.3	4.8	SM	Yes	Ferrite
MSS1260T-104 Sample Buy	94	100	1.8	2.5	2.1	139	375	49°C	165°C	12.3	12.3	6.2	SM	Yes	Ferrite
MSS1260T-124 Sample Buy	111	120	1.8	2.3	1.9	193	488	55°C	165°C	12.3	12.3	6.2	SM	Yes	Ferrite
MSS1278T-104 Sample Buy	98	100	1.8	3.8	2.2	135	329	45°C	165°C	12.3	12.3	8.05	SM	Yes	Ferrite

Figure 2: Component options from Power Inductor Finder and Analyzer Tool

In this case, Coilcraft offers numerous inductor choices that meet the basic requirements of 100 µH and 1.8 A, and the tool provides easy ways to refine and prioritize the list according to the parameters that are most important to you. After selecting some of the most interesting components (Figure 2), more detailed performance information is provided to make a final selection.

Using this information, you are now able to balance the tradeoffs between the physical size of the inductors and their various performance parameters.

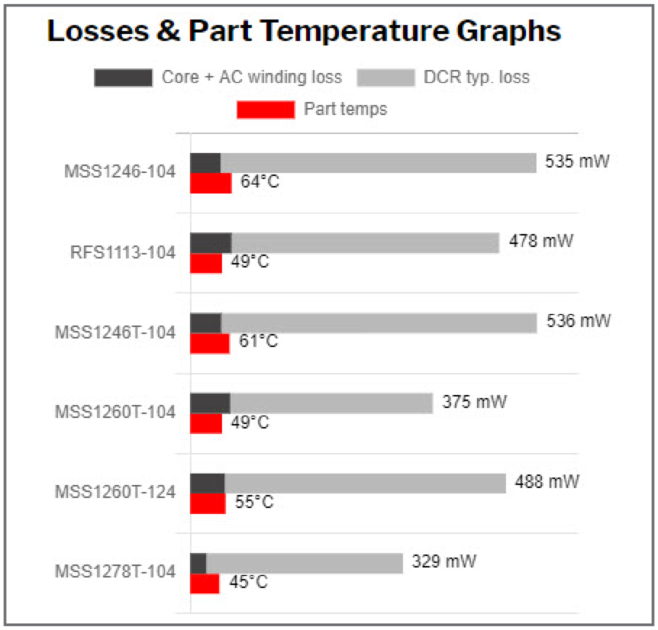


Figure 3: Losses and part temperature analysis

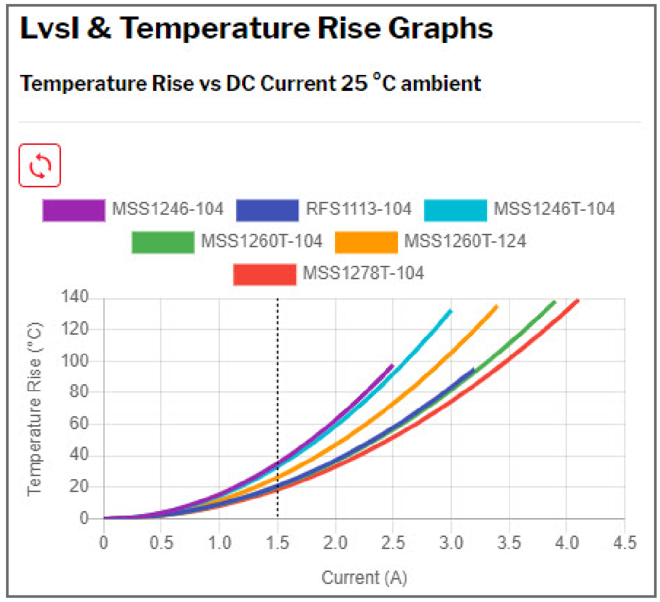
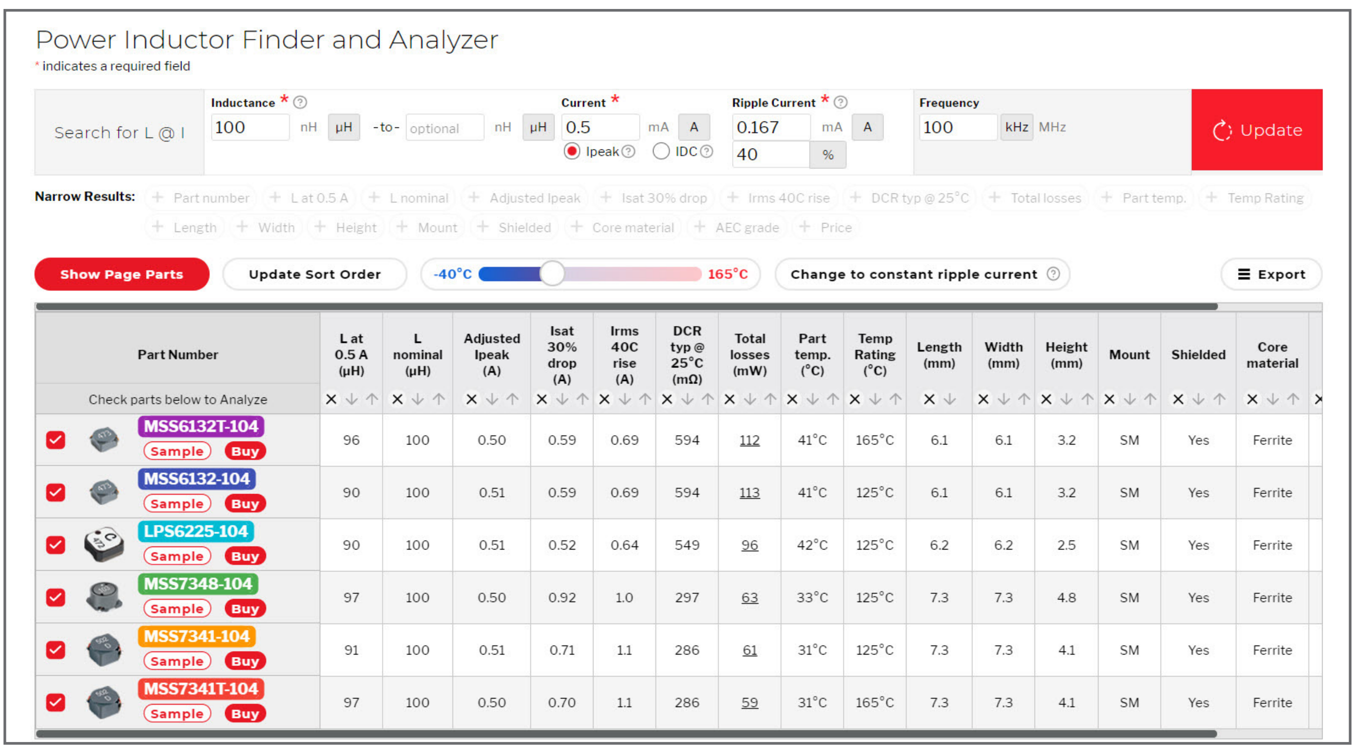


Figure 4: L vs I and Temperature Rise

In this example, the MSS1260T-104, measuring 12 x 12 x 6 mm, provides a nice balance of performance and physical size based upon the given parameters and the fact it works well for the reference design board.

Since overall solutions size is certainly important for LiDAR systems, you will probably want to select as small an inductor as possible. In this example, the inductor is more than enough for a 0.5 A requirement. This means a much smaller inductor can be considered (Figures 5-7).



Part Number	L at 0.5 A (µH)	L nominal (µH)	Adjusted Ipeak (A)	Isat 30% drop (A)	Irms 40C rise (A)	DCR typ @ 25°C (mΩ)	Total losses (mW)	Part temp. (°C)	Temp Rating (°C)	Length (mm)	Width (mm)	Height (mm)	Mount	Shielded	Core material
MSS6132T-104	96	100	0.50	0.59	0.69	594	112	41°C	165°C	6.1	6.1	3.2	SM	Yes	Ferrite
MSS6132-104	90	100	0.51	0.59	0.69	594	113	41°C	125°C	6.1	6.1	3.2	SM	Yes	Ferrite
LPS6225-104	90	100	0.51	0.52	0.64	549	96	42°C	125°C	6.2	6.2	2.5	SM	Yes	Ferrite
MSS7348-104	97	100	0.50	0.92	1.0	297	63	33°C	125°C	7.3	7.3	4.8	SM	Yes	Ferrite
MSS7341-104	91	100	0.51	0.71	1.1	286	61	31°C	125°C	7.3	7.3	4.1	SM	Yes	Ferrite
MSS7341T-104	97	100	0.50	0.70	1.1	286	59	31°C	165°C	7.3	7.3	4.1	SM	Yes	Ferrite

Figure 5: Comparison results of smaller components with 0.5 A (min) current ratings

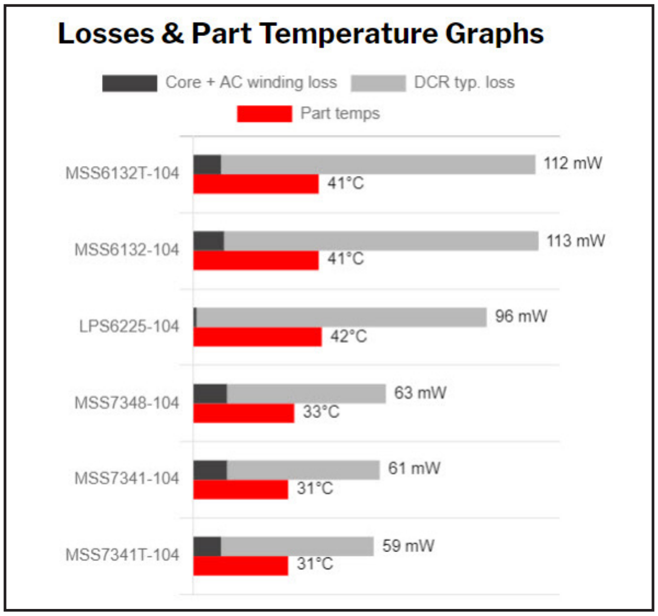


Figure 6: Losses and part temperature analysis (0.5 A)

From this data, you see that the part with the lowest losses, the MSS7341T-104 (measuring 7.3 x 7.3 x 4.1 mm), is significantly smaller than the MSS1260T-104.

Reviewing the boost circuit more closely by using the Coilcraft [DC-DC Optimizer], we can optimize the inductor selection even further.

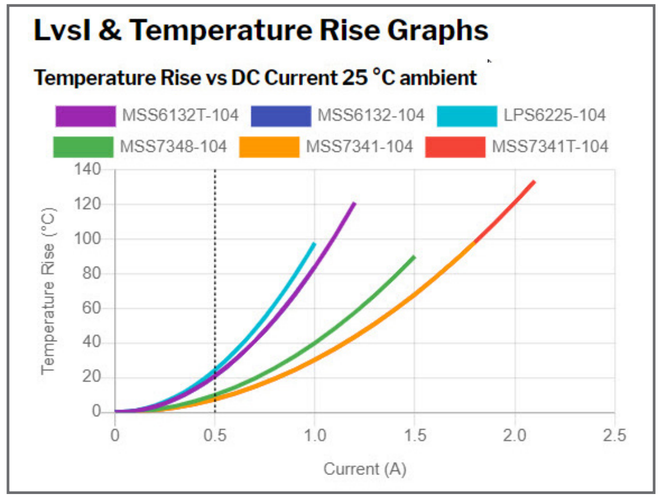
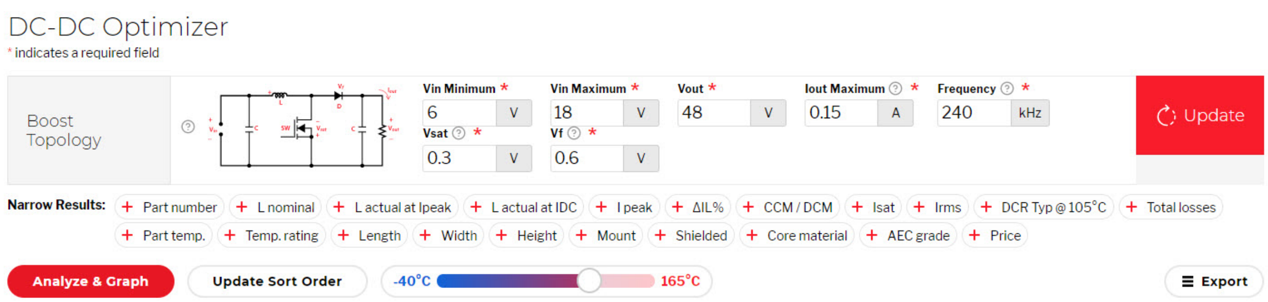


Figure 7: L vs I and Temperature Rise (0.5 A)

Using the TI LM5001 switching regulator with the following assumptions yields the list of parts shown in Figure 8.

Vin: 6 to 18V
Vout: 48V
Iout: 150mA
Freq: 240kHz

Note this time we are also assuming a temperature of 105° C (ambient).



Part Number	L nominal (µH)	L actual at Ipeak (µH)	L actual at IDC (µH)	I peak (A)	ΔIL%	CCM / DCM	Isat (A)	Irms (A)	DCR Typ @ 105°C (mΩ)	Total losses (mW)	Part temp. (°C)	Temp. rating	Length (mm)	Width (mm)	Height (mm)	Mount
Check parts below to Analyze																
XGL4030-103 Sample Buy	10	8.0	9.2	2.3	184%	CCM	3.1	3.9	82.4	1294	159°C	165°C	4.3	4.3	3.1	SM
XGL4030-123 Sample Buy	12	9.4	11	2.1	154%	CCM	2.7	3.4	103	1882	188°C	165°C	4.3	4.3	3.1	SM
XAL4040-103 Sample Buy	10	8.0	9.3	2.3	182%	CCM	3.0	3.1	110	640	137°C	165°C	4.3	4.3	4.1	SM
XAL4040-153 Sample Buy	15	13	14	2.0	121%	CCM	2.8	2.8	143	463	127°C	165°C	4.3	4.3	4.1	SM
XGL5050-103 Sample Buy	10	9.1	9.8	2.3	175%	CCM	4.9	6.2	39.9	471	121°C	165°C	5.28	5.48	5.1	SM
XGL5050-123 Sample Buy	12	11	12	2.1	147%	CCM	4.3	5.1	51.1	424	122°C	165°C	5.28	5.48	5.1	SM
XGL5050-153 Sample Buy	15	14	14	1.9	118%	CCM	3.9	4.6	65.1	384	120°C	165°C	5.28	5.48	5.1	SM
XGL5050-183 Sample Buy	18	16	17	1.8	99%	CCM	3.7	4.5	73.9	325	116°C	165°C	5.28	5.48	5.1	SM

Figure 8: Coilcraft DC-DC Optimizer tool results

Next, let's use the DC-DC Optimizer Tool to compare the XGL4030-103, XAL4040-103 and XGL5050-103.

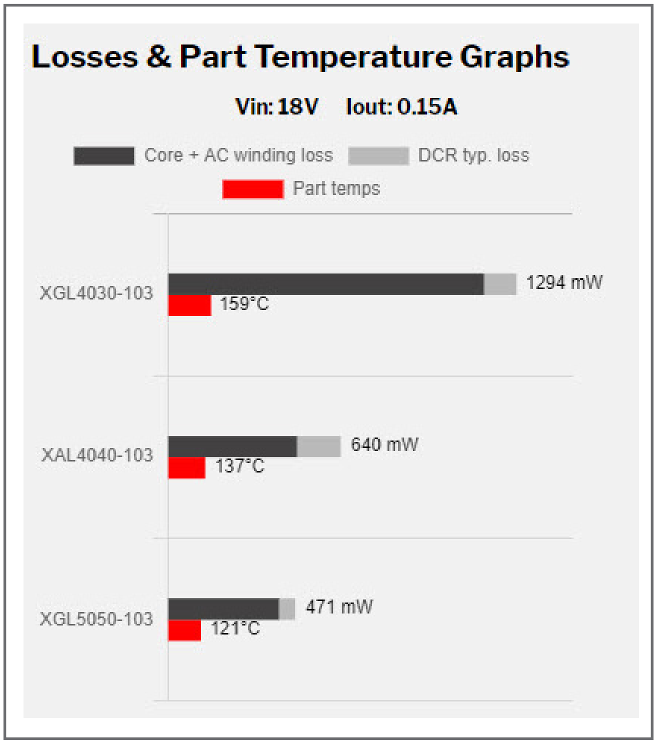


Figure 9: Losses and part temperature analysis (105° C)

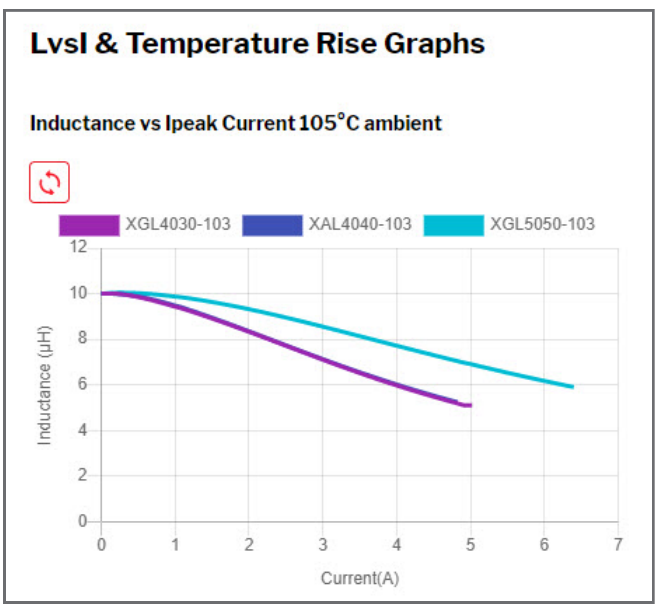


Figure 10: L vs I and Temperature Rise (105° C)

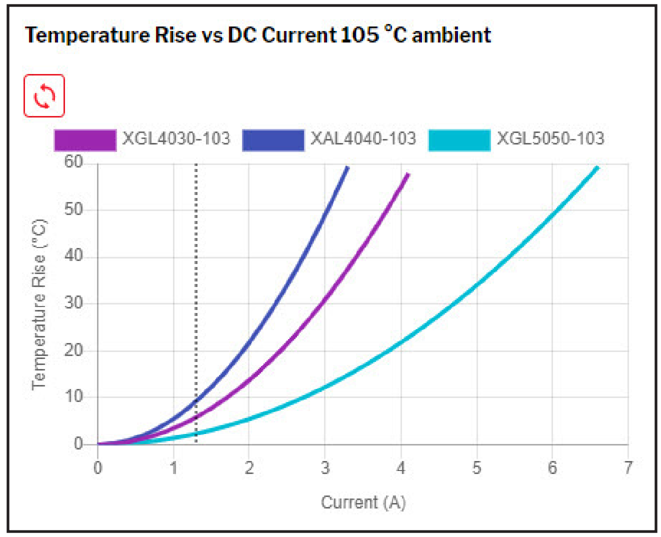


Figure 11: Temperature rise vs. DC current (105° C)

Based on the information in Figure 9, XGL5050-103 has the lowest losses. If the 5 mm x 5 mm size is too large for the circuit, the XAL4040-103 becomes the best choice.

As these examples demonstrate, Coilcraft has both the online tools and extensive product portfolio to help optimize your SMPS needs. For more information about the online tools or if you have any technical questions please contact us at 847-639-6400 or visit www.coilcraft.com/AEC.

References:

AN-1956 LM5001 Boost Evaluation Board, Texas Instruments User's Guide, SNVA393B – March 2009 – Revised April 2013

Additional Coilcraft Resources:

1. Application Note: Selecting the Best Inductor for Your DC-DC Converter
2. Application Note: Choosing Inductors for Energy Efficient Power Applications
3. Application Note: Selecting Coupled Inductors for SEPIC Applications