The choice of Inductors for switching products is a critical path in any new design. Inductance values, current ratings, and DC Resistance values will alter for different applications. The mode of operation, load current, and input voltage will all impact inductor selection in some way. C&D Technologies (NCL)'s compatibility guide provides an easy-to-use reference in establishing a valid design. Providing simple cross-references between the regulator part number, the suggested C&D Technologies (NCL) family of inductors, a part number suitable for a typical application and including a worked example. Inductor selection may vary between individual application, inductors are available from C&D Technologies (NCL) in SMD, radial and axial format with current ratings from 350mA-13A and inductance ranges from 2.2µH-47mH which are suitable for most applications.

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SELECTION OF INDUCTORS FOR SWITCHING REGULATORS

Analog silicon vendors produce a wide range of switching circuits. Design notes published by these vendors provide detailed guidance on the selection of inductors for optimum performance and efficiency, and should be consulted to finalise designs.

Switching regulators have two types of operation: continuous and discontinuous modes. The difference between the two modes is directly related to the current flowing through the inductor chosen for the regulator. In discontinuous mode the current through the inductor will drop to 0A for a period of time during the switching cycle, the inductor used in continuous mode of operation will be exposed to current through out the entire switching period.

The mode of operation is dependant on individual application discontinuous mode is preferred for low load currents, and will utilise small inductor values. Continuous operation will provide greater output power however the continual flow of current will require larger values of inductance for high input voltages.

The inductance value for a switching regulator must be high enough to prevent excessive current and low enough to store sufficient energy in the core. DC Resistance should be as low as possible to reduce losses and minimise the self-heating effect of the inductor. Current ratings must be selected with care, and the core material chosen must be capable of storing the required energy without saturating.

If the maximum current rating of the inductor is exceeded the component will begin to heat up and drive the core material towards it Curie temperature causing the inductance to fall rapidly. Under specifying the current can lead to inductor saturation and the component becomes a mainly resistive element, the effect this has on the switching circuit is to increase the switch current considerably and reduce the load current.

Inductors are available in a wide range of ferrite and iron powder materials and produced in formats ranging from open wound ferrite rods to fully shielded components.

Practical inductor ranges are typically 2.2µH to 47mH however the majority of switching products are covered by the inductance ranges of 22µH to 100µH. C&D Technologies (NCL) offer a wide range of products based upon bobbin wound components, toroids and shielded products for optimum magnetic paths and low EMI radiation.

INDUCTOR SELECTION

The following equations provide a guide for a typical application, and are based on the Maxim 1636 Step Down controller for portable power.

The three key inductor parameters must be specified:

Inductance value (L), peak current (I_{PEAK}), and DC resistance (R_{DC}). The following equation includes a constant, LIR, which is the ratio of inductor peak-to-peak AC current to DC load current. A good compromise between size and losses is a 30% ripple-current to load-current ratio (LIR = 0.3), which corresponds to a peak inductor current 1.15 times higher than the DC load current. The following equation can be applied:

$$L = \frac{V_{OUT}\,(V_{IN(MAX)} - V_{OUT})}{V_{IN(MIN)} \times f \times I_{OUT} \times LIR}$$

Where: f = switching frequency, normally 200kHz or 300kHz
I_{OUT} = maximum DC load current.

The peak current can be calculated by:

$$I_{Peak} = I_{LOAD} + \frac{V_{OUT}\,(V_{IN(MAX)} - V_{OUT})}{2 \times f \times L \times V_{IN(MAX)}}$$

Using the following table of parameters the inductors performance can be calculated.

I_{IN} (A)	$V_{IN\ Min}$ (V)	V_O (V)	LIR	Operating Frequency (kHz)
1	12	5	0.3	200

The inductor calculation for this particular application shows an inductance of 69.4µH with a peak current of 1.12 Amps.

The C&D Technologies (NCL) 26S680 SMD Shielded inductor would provide a suitable solution for this example. Higher efficiency and output current are achieved with lower inductor DC resistance.

SILICON SUPPORT MAGNETICS

Compatibility Guide

NATIONAL SEMICONDUCTOR

	C&D Technologies (NCL)	
Family	**Series**	**Part Number**
LM1575	26S	26S330
LM1577	1400	1410454
LM2574	24S	24S330
LM2575	26S	26S330
LM2576	1400	1410454
LM2577	1400	1410454
LM2594	24S	24S100
LM2595	26S	26S680
LM2596	1800R	18R153
LM2597	24S	24S330
LM2598	1800R	18R683
LM2599	1800R	18R153
LM2651	26S	26S220
LM2653	26S	26S220
LM2670	1800R	18R153
LM2671	24S	26S101
LM2672	26S	26S470
LM2673	1400	1433606
LM2674	26S	26S101
LM2675	26S	26S470
LM2676	1800R	18R153
LM2677	1400	1422606
LM2678	1400	1422606
LM2679	1400	1422606

MOTOROLA

	C&D Technologies (NCL)	
Family	**Series**	**Part Number**
C551411	26S	26S150
C551412	26S	26S150
C551413	26S	26S150
C551414	26S	26S150
C55171	26S	26S220
C55172	26S	26S220
C55173	26S	26S220
LM2574	24S	24S331
LM2575	26S	26S331
LM2576	1400	1415449
MC33163	1400	1415449
MC33166	1400	1415449
MC33167	1400	1415449
MC33463	2600	26S470
MC33465	2600	26S470
MC33467	2600	26S470
MC33680	2400	24330
MC34167	2600	26S221
MA78540	26S	26S221
MC33167	2600	26S331

LINEAR TECHNOLOGY

	C&D Technologies (NCL)	
Family	**Series**	**Part Number**
LT149	26S	26S470
LT1010	1400	1422514
LT1013	1400	1422514
LT1020	1400	1447448
LT1109	22R	22R473
LT1143	1800R	18R223
LT1300	26S	26S220
LT1301	1800R	18R333
LT1302	1800R	18R220
LT1303	1800R	18R473
LT1317	26S	26S100
LT1370	1800R	18R472
LT1371	24S	24S100
LT1372	22R	22R473
LT1374	1800R	18R472
LT1375	24S	24S100
LT1377	22R	22R683
LT1500	26S	26S330
LT1504	1800R	18R333
LT1576	26S	26S150
LT1578	24S	24S150
LT1610	1400	1447506
LT1611	26S	26S220
LT1613	24S	24S220
LT1617	26S	26S220
LT1624	24S	24S100
LT1777	26S	26S150
LT1930	24S	24S100
LT1504A	26S	26S470
LT1576-5	26S	26S680
LT1578-2.5	1800R	18R153

TEXAS INSTRUMENTS

	C&D Technologies (NCL)	
Family	**Series**	**Part Number**
TPS5102	1400	1410313
TPS56302	1400	1410313
TPS61000	2400	24150
TPS61001	2400	24150
TPS61002	2400	24150
TPS61003	2400	24150
TPS61004	2400	24150
TPS6734	2400	24220
TPS6735	2400	24220
UC257	1400	144738
UCC2941	26S	26S220
UCC2942	1400	1410313
UCC3941	26S	26S220
UCC39411	26S	26S220
UCC39412	26S	26S220
UCC39413	26S	26S220

MAXIM

	C&D Technologies (NCL)	
Family	**Series**	**Part Number**
MAX608	1800R	18R153
MAX629	2400	24220
MAX649	26S	26S220
MAX651	26S	26S220
MAX652	26S	26S220
MAX668	1800R	18R472
MAX742	1800R	18R104
MAX749	24S	24S470
MAX756	26S	26S220
MAX764	24S	24S470
MAX774	26S	26S220
MAX796	1400	1447423
MAX797	1400	1447423
MAX798	1400	1447423
MAX799	1400	1447423
MAX856	24S	24S470
MAX866	2200R	22R683
MAX867	2200R	22R683
MAX1626	26S	26S220
MAX1627	26S	26S220
MAX1636	1800R	18R472
MAX1652	26S	26S150
MAX1653	26S	26S150
MAX1654	26S	26S150
MAX1655	26S	26S150
MAX1664	2400	24S100
MAX1672	26S	26S100
MAX1705	1800R	18R223
MAX1706	26S	26S220
MAX1714	1800R	18R472
MAX1715	1800R	18R472
MAX1771	1800R	18R223

The information provided in this application note is believed to be accurate and reliable, but is for guidance only and should not be relied upon. The user is responsible for ensuring that the C&D Technologies (NCL) product selected is wholly suitable for its intended application and, in particular, it should be noted that the specifications of semiconductor devices change from time to time. Nothing contained in this application note is intended to imply that there is any connection between C&D Technologies (NCL) and any third party mentioned in it. C&D Technologies (NCL) does not endorse such third parties or third party products, nor should it be implied (unless otherwise stated) that such third party endorses the products of C&D Technologies (NCL).

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