Selecting additional inductors for small BL-Motors (< 15mm)

Summary

Operating a small BL motor with a MCBL3002 can lead to control loop instabilities under certain conditions listed below.
Adding additional inductances to the motor phases will resolve this issue. This application note describes how to estimate a suitable inductance value.
The Adapter 6500.00321 can be used for applying the inductance to the system.

Applies To

MCBL3002

Description

The instabilities may occur to combinations matching all of the conditions below:

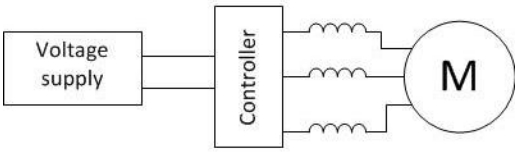
- Motor winding type of 6V
- Supply voltage of about 24V or bigger
- Electrical time constant L/R < 50 µs

The following table shows the motors and additional Inductance values, which should resolve the issues of control loop instabilities.

Motor	**Winding in Volts**	**Additional recommended Inductance in µH (at 24 V)**		**Additional recommended Inductance in µH (at 30 V)**	
		$I_{lim} = I_n$	I_{lim} = 2A	$I_{lim} = I_n$	I_{lim} = 2A
0620	006	470	0	470	10
0824	006	180	33	220	47
1028	006	100	47	120	68
1218	006	180	22	220	47
1226	006	100	33	150	47

In case the values need to be calculated with other values than given in the Table above, the following Formula is presented.

$$L_{add} = \frac{\frac{U_{supply}}{I_{lim}} - R_{mot}}{2 * f_{PWM}} - L_{mot}$$



Important: There is no need for additional Inductances when the Formula returns values smaller or equal to 0.

Example usage

1. Given Parameters

Motor 1226 S 006 B K1155

Parameter	Value	Comment
Motor supply voltage	$U_{supply} = 12\,V$	Depends on the application
Motor resistance	$R = R_{mot} = 2.2\,\Omega$	
Motor inductance	$L = L_{mot} = 0{,}000036\,H$	= 36µH
Controller PWM frequency	$f_{pwm} = 78120\ Hz$	= 78,120 kHz
Controller Continuous Current	$I_{cont} = 2\,A$	Typically chosen as I_{lim}
Controller Peak Current	$I_{max} = 3\,A$	Only for S2 mode

2. Choose $I_{lim} = I_{max}$
3. Insert the values and calculate:
   a. $L_{add} = \frac{\frac{12\,V}{3\,A} - 2{,}2\,\Omega}{2 * 78{,}12\text{e}{+}3\ \text{Hz}} - 0{,}000036\,H = -0{,}0000245\,H = -24{,}5\mu\text{H}$
   b. The Result with $12\,V$ is smaller than 0, so no additional Inductance is necessary.
4. In case the supply voltage is $30\,V$:
   a. $L_{add} = \frac{\frac{30\,V}{3\,A} - 2{,}2\,\Omega}{2 * 78{,}12\text{e}{+}3\ \text{Hz}} - 0{,}000036\,H = 0{,}0000139\text{H} = 13{,}9\mu\text{H}$
   b. The Result indicates an Inductance value of approx $13{,}9\ \mu H$. For economic reasons, a value of the E6- or E12-series should be selected. In this case it would be $15\ \mu H$.

Example Inductors:

(selected with >2A continuous and >3A peak)

Value	Manufacturer	Full name
2,2 µH	Taiyo Yuden	NR6028T2R2N
10 µH	Bourns Inc.	SRN6045-100M
15 µH	Bourns Inc.	SRN6045TA-150M
22 µH	Murata	DD1217AS-H-220M=P3
33 µH	Bourns Inc.	SRR1208-330YL
47 µH	Bourns Inc.	SRR1208-470YL
68 µH	Bourns Inc.	SRR1208-680YL

The selection of the inductor greatly depends on the continuous current, the peak current, the dimensions and the technology.

Inductance Adapter for the 0620-Motor

If you want to rely on a ready-to-use solution, you can try the Adapter 6500.00321.
It adds 470 µH to the system and is specially developed for situations where space is a crucial factor. It is pin-compatible to the MCBL3002 S and adds around 20mm of length to the Controller.
In some cases the Sample-Rate reduction of the velocity control loop (by Increasing the SR-value) is necessary too. See the Communication / Function Manuals for an explanation.

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