ADVANCED MOTION CONTROLS

Ferrite Recommendations

Introduction

The most cost effective way to reduce system noise is to ensure that proper grounding, shielding and cable routing practices have been observed. However, in some systems the use of ferrite suppression cores can be an excellent supplement to the above-mentioned wiring practices.

Note: When designing to meet CE requirements it may be necessary to incorporate ferrites even if proper wiring practices have been implemented. The same is true for systems that are near sensitive equipment.

			Dimensions (in.)			Impedance (Ω) at frequency		
AWG	Manuf. & Part No.	TYPE	Outer Dia.	Inner Dia.	Len.	10 MHZ	25 MHZ	100 MHZ
28-16	TDK ZCAT3035-1330	Clamp Filter	1.181	0.512	1.378	103	150	180
28-16	Fair-Rite 2631102002	Round Suppression Core	1.020	0.505	1.125	103	156	260
28-16	Fair-Rite 2643800502	Round Suppression Core	0.825	0.520	0.468	-	45	82
28-16	Fair-Rite 0443164151	Snap It	1.142	0.528	1.280	-	156	250
20-14	Fair-Rite 0431176451	Snap It	1.520	0.722	1.870	130	225	380
20-12	Fair-Rite 2643802702	Round Suppression Core	1.400	0.900	0.500	-	48	80
12-8	Fair-Rite 2643626202	Round Suppression Core	2.000	1.000	1.500	-	193	336
12-8	Fair-Rite 0431177081	Snap It	2.220	1.000	1.690	145	235	375
10-6	Fair-Rite 2643803802	Round Suppression Core	2.400	1.400	0.500	-	58	108

Table 1 – Recommended Ferrites

Note: Ferrites listed are from Fair-Rite Products Corp (www.fair-rite.com) and TDK (www.tdk.com).

Selection

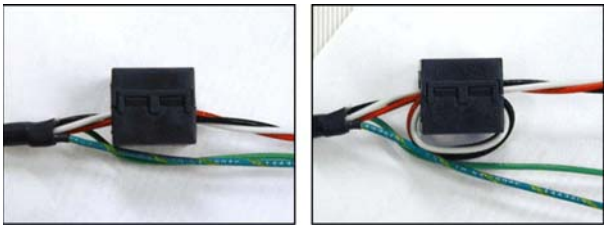
The table to the left lists ferrite suppression cores selected from Fair-Rite Products Corp (www.fair-rite.com) and TDK (www.tdk.com). Ferrites are chosen according to material type and the impedance at the frequency at which attenuation is desired. The process of choosing the correct ferrite has been simplified to just matching the gauge of the motor wire to the appropriate ferrite. Use the dimensions of the ferrite and the impedance values to further refine your selection.

Note: Higher impedance means more noise reduction. However keep in mind even the 'lowest' rated ferrite in this list has excellent performance.

Installation

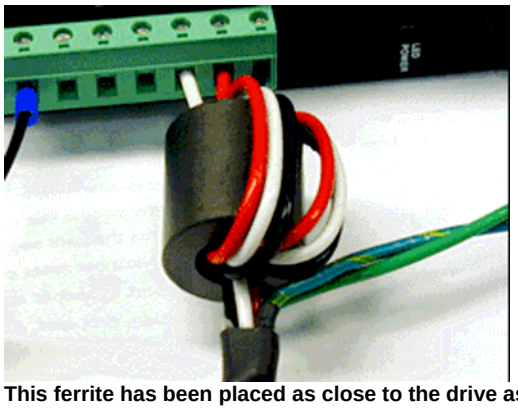
Wrap the motor wires around the ferrite 2-3 times max. The ferrite should be installed as close to the drive as possible.

One turn is defined as one pass through the ferrite.



One turn is shown on the left and two turns on the right. Notice that the ground and shield wires do not pass through the ferrite.

Although one turn will have an effect on noise levels, we recommend at least two turns.



This ferrite has been placed as close to the drive as possible. Again, the ground and shield wires do not pass through the ferrite. This image shows three turns through the ferrite.

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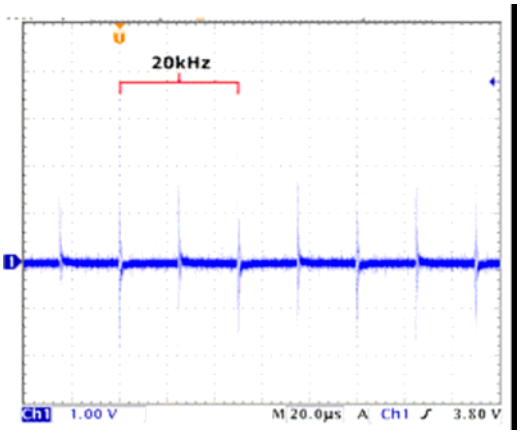
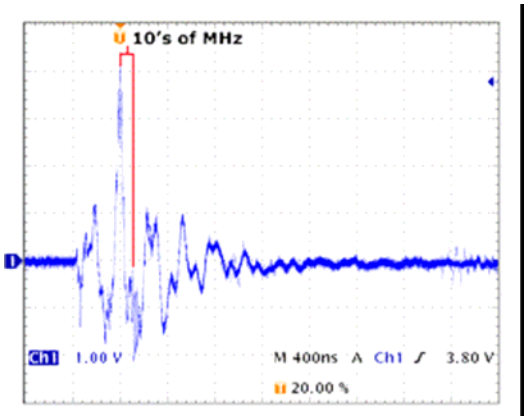
How Ferrites Help

Pulse Width Modulation (PWM) and other switching schemes such as Space Vector Modulation (SVM) are used by servo drives to efficiently control and regulate power to the motor. Switching drives are smaller, more powerful, and more reliable than drives that operate their power devices in the linear region (linear amplifiers).

Switching controls the output by turning the power devices on and off at a high frequency. The disadvantage to switching is that it generates electrical noise that disrupts other parts of the system. The output stage can transition from 0V to the full power supply voltage in nanoseconds. This fast change in voltage (dV/dt) appears as capacitively coupled noise spikes on adjacent signal lines. These noise spikes coincide with the PWM switching where there is a spike every time the power device switches ON and every time the power device switches OFF. Hence, noise appears at twice the switching frequency.

In the following oscilloscope images, noise was captured on an unshielded logic level signal that was routed next to the motor power line. The motor power line acts as the transmitter and the signal line acts as the receiver.





The drive is switching at 20kHz but the noise spikes occur at twice the switching frequency. Zoomed in on a single spike it is apparent that the frequency is in the Mega Hertz (typically 5-50MHz).

Switching noise is typically at a maximum around 30-40MHz. Therefore adding a ferrite targeted at these frequencies dramatically reduces radiated switching noise.