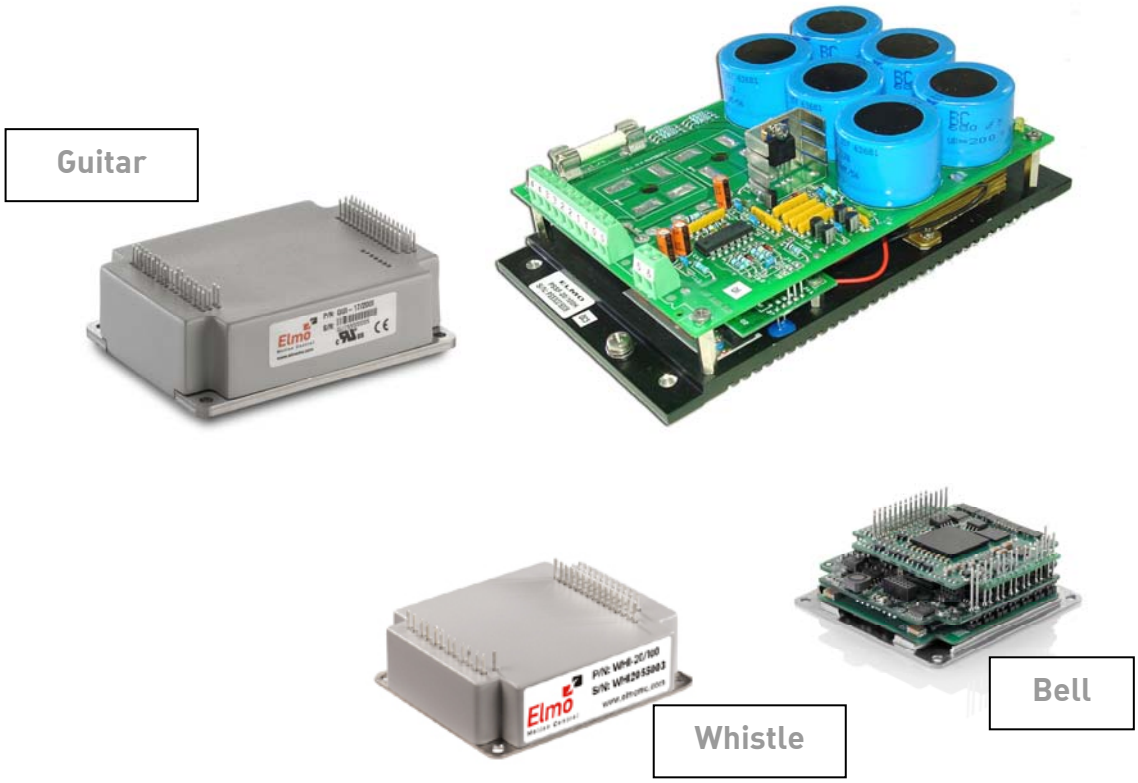

Application Note

Choosing Power Supply Wires for the Whistle, Bell & Guitar

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Introduction

The Whistle, Bell and Guitar power supply wires

Elmo's PCB mounting products are designed for straightforward implementation onto customer PCBs while ensuring very high immunity to withstand rugged environmental conditions.

The power source for these products is always a simple DC supply that has the capabilities to deliver the required power to the drive, and also to be able to absorb power from the drive's load in case it is required.

The interface between the power supply and the drives also has an important role in the overall performance of the servo system.

As power is "travelling" in both directions on the power wires between the supply and the drives, the nature of the wires must be properly considered.

There are a number of factors to consider:

1. Voltage Drops

The impedance (mainly the resistance) of the wires causes voltage drops between the power supply and the drives. However, by choosing the correct the wires the voltage drops are negligible and can be ignored.

For example, consider the AWG-16 which carries 22 Amps on the WHI-20/100:

AWG gauge	Conductor Diameter Inches	Conductor Diameter mm	Ohms per 1000 ft	Ohms per km	Maximum Amps for chassis wiring
16	0.0508	1.29032	4.016	13.17248	22

If the wire is 1 meter long on each power wire, the voltage drop at a peak of 40 A will be 0.53 V.

For a 10 meter wire the voltage drop will be 5.3 V on each wire.

Drawbacks:

- Under-voltage protection
- Common mode malfunctioning
- Common mode interferences, or even common mode failures.

Remedy: Take into consideration the actual voltage drops and minimize them to no more than 2 – 3 V. This can be accomplished by selecting the proper AWG wire.

2. Absorbing Energy

When power is being pumped back from the load to the supply it happens in a relatively high frequency occurrence. As the power wires exhibit not only pure resistance but an impedance of R+L, the result is a delay and voltage drop of the energy flow from the drive back to the power supply.

Drawback: The "reverse" energy mainly charges the internal capacitance of the drive and the drive might be exposed to high DC voltages on its power bus.

Remedy: For long wires add capacitance close to the drive side; use thick wires as much as possible.

Recommendations

1. Always use suitable AWG gauge wires. It is highly recommended to use thicker wires in order to reduce bus impedances, voltage drops and interferences. For reference please use the following table:

AWG gauge	Conductor Diameter Inches	Conductor Diameter mm	Ohms per 1000 ft.	Ohms per km	Maximum amps for chassis wiring
0	0.3249	8.25246	0.0983	0.322424	245
1	0.2893	7.34822	0.1239	0.406392	211
2	0.2576	6.54304	0.1563	0.512664	181
3	0.2294	5.82676	0.197	0.64616	158
4	0.2043	5.18922	0.2485	0.81508	135
5	0.1819	4.62026	0.3133	1.027624	118
6	0.162	4.1148	0.3951	1.295928	101
7	0.1443	3.66522	0.4982	1.634096	89
8	0.1285	3.2639	0.6282	2.060496	73
9	0.1144	2.90576	0.7921	2.598088	64
10	0.1019	2.58826	0.9989	3.276392	55
11	0.0907	2.30378	1.26	4.1328	47
12	0.0808	2.05232	1.588	5.20864	41
13	0.072	1.8288	2.003	6.56984	35
14	0.0641	1.62814	2.525	8.282	32
15	0.0571	1.45034	3.184	10.44352	28
16	0.0508	1.29032	4.016	13.17248	22
17	0.0453	1.15062	5.064	16.60992	19
18	0.0403	1.02362	6.385	20.9428	16
19	0.0359	0.91186	8.051	26.40728	14
20	0.032	0.8128	10.15	33.292	11
21	0.0285	0.7239	12.8	41.984	9
22	0.0254	0.64516	16.14	52.9392	7
23	0.0226	0.57404	20.36	66.7808	4.7
24	0.0201	0.51054	25.67	84.1976	3.5
25	0.0179	0.45466	32.37	106.1736	2.7
26	0.0159	0.40386	40.81	133.8568	2.2
27	0.0142	0.36068	51.47	168.8216	1.7
28	0.0126	0.32004	64.9	212.872	1.4
29	0.0113	0.28702	81.83	268.4024	1.2
30	0.01	0.254	103.2	338.496	0.86
31	0.0089	0.22606	130.1	426.728	0.7
32	0.008	0.2032	164.1	538.248	0.53

Table 1: AWG gauge wires vs. current carrying capacity

2. For drives that are up to **10 A cont/20 A peak**, the internal capacitance is always sufficient and adequate.

3. For wires up to **1.5 – 2 meters** long (the actual length depends on the size of the wires), the internal capacitance of the **15 A cont/ 30 A peak** and **20 A cont/40 A peak** drives is always sufficient.

4. For drives that are **higher** than **10 A cont/20 A peak** with wires that are longer than **1.5 – 2 meters**, additional capacitance must be added to the DC power bus as follows:

    a. **PCB Mounting and the Electrolytic capacitor.** In most of the applications an electrolytic capacitance greater than 100 μF is sufficient. The electrolytic capacitors should be high current ripple capacitors.

    b. **PCB mounting and Ceramic Capacitors.** If a dedicated PCB has been designed, it is recommended to add ceramic capacitance on the DC power bus. Using ceramic capacitors saves space and provides the best high frequency performance. A sufficient capacitance is greater than 30 μF. The best way to achieve this capacitance is by connecting a few ceramic capacitors in parallel.

    c. **PCB Mounting and Combination Electrolytic and Ceramic Capacitors.** A more reasonable design approach is a combination of ceramic capacitance of a few microFaradays (1 μF – 10 μF) and an electrolytic capacitance greater than 100 μF. The electrolytic capacitors should be high current ripple capacitors.

    d. **Solo Wiring.** For Solo applications, an electrolytic capacitor greater than 100 μF must be connected to the DC power wires at a distance that is less than 1.5 – 2 meters from the Solo. The electrolytic capacitors should be high current ripple capacitors.

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