MOTION TECHNOLOGIES

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SELECTION OF THE RIGHT CHOKE FOR PWM AMPLIFIERS

Pulse Width Modulation PWM is the technique of choice these days for driving DC motors. As semiconductor technology advances PWM is getting more efficient and responsive with increasing switching frequencies.

Because of the nature of switching transistors on and off you always have the presence of a time-changing voltage (AC component, or ripple) along with the average DC voltage developed. This ripple must be reduced (filtered) to a reasonable level since it goes to produce heat in the motor. The ratio of ripple to average is known as form factor. Form factor exceeds unity except for pure DC. Values of 1.1 and below generally are acceptable. The reduction of ripple is accomplished by inductance in the circuit.

Inductance serves two purposes:

To limit current rise (di/dt) in the output transistors to a safe level.
To obtain the right form factor
To insure longer brush life by smoothing-out current variations

Most amplifier manufacturers have the recommended minimum load inductance usually in fine print. This is because the application of them to iron-core type motors usually satisfies their requirement. However this value becomes important to know when applying ironless-armature motors such as the PMI Servodisc because of the inherent low inductance. Some series inductance is usually required. The value of the series inductance then simply becomes:

$$L\ series = L\ minimum - L\ motor \qquad (1)$$

where L signifies inductance (usually in millihenries).

If you do not know the minimum inductance required you can calculate it based on a desired form factor for a specific motor. You will need to know bus voltage and switching frequency of the amplifier.

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The formula to use is:

$$Lmin. = \frac{V * FF}{4 * \sqrt{3} * f * Irms * \sqrt{(FF^2 - 1)}} \qquad (2)$$

where:L min. = minimum system inductance (henries), FF = form factor, V = amplifier bus voltage (DC Volts), f = switching frequency,(Hz), Irms = RMS current (Amps).

Let us look at an example:

Amplifier switching frequency: 15 Khz, Bus Voltage: 90V

PMI Motor: JR12M4CH — From data sheet: Irms = 8.35A (continuous current rating), L = 45 microhenries

We would like a form factor of 1.01

Substituting in the equation (2):

$$Lmin = \frac{90 * 1.01}{4 * \sqrt{3} * 15000 * 8.35 * \sqrt{(1.01^2 - 1)}}$$

L min. = .000739 henries = 0.74 millihenries

So: L minimum = 0.74 millihenries
L motor = 45 microhenries = 0.045 millihenries
From equation (1): L series = 0.74 - 0.045 = 0.69 millihenries
and this is the minimum size inductor needed to achieve the desired 1.01 form factor.

Striving for lower form factor has practical limitations. This requires greater inductance which means bigger chokes. Furthermore too much inductance although it helps form factor works against you in servo response. In high performance incremental motion requirements you take into account all aspects. This is why we always recommend PMI amplifiers for our Servodisc motors as they are optimized for best incremental performance where the Servodisc motor often finds itself.

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