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Drum HV Thermal Management

Application Note

February 2016 (Ver. 1.402)

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Introduction

Figure 1: Drum HV Digital Servo Drive

Typical Servo Drive operation is characterized by high power peaks with relatively low average power consumption. In most cases, the average power is less than 15% - 25% of the consumed peak power.
When delivering power to the motor, the Servo Drive creates heat that must be carefully controlled to enable smooth and reliable enduring operation.
Proper selection of the heat dissipation device can contribute significantly to the efficiency of the overall application, space and costs savings.

Power Dissipation

The integral heat sink of the DRU- HV can dissipate around 18W – 22W, depending on the mounting method. Due to the nature of servo drive operation, whose high power peaks with very low average power consumption, mounting the Drum on an external heat dissipating device can be very efficient and beneficial. This “No Fan” approach can be advantageous up to an average current of 20A -25A with the 800V types, and 35A- 40A with the 400V types.

Mounting the Drum to an External Heat Sink

When installing the Drum to an external heat-sink:

1. Any external heat-sink should have N5 surface treatment
2. **“No Thermal Compound Smearing”**
   The direct attachment of the Drum to an External N5 heat-sink results in a thermal resistance of approx. 0.07 °C/W between the Drum and the external Heat Sink. This method is sufficient for up to 300W – 350W dissipation.
   “With Thermal Compound Smearing”
   For Heat dissipation that is higher than 350W, it is highly recommended to improve the thermal resistance between the Drum and the external heat-sink using a thermal foil, or smearing a thermal conductive compound. With a thermal foil, the thermal resistance can be as low as 0.03 °C/W.

Disassembling the Drum from the External Heat Sink

When disassembling the Drum from the external heat sink:

1. Remove the Thermal Foil and discard.
2. Use Ethyl/Isopropyl Alcohol and a clean lintless cloth to remove the foil material remnants from the Drum and Heat Sink contact surfaces.
3. If reinstalling the Drum to the Heat Sink, mount a new replacement Thermal Foil
   (Elmo P/N: ACC-FOIL-DRU-HV).

Power Dissipation Data

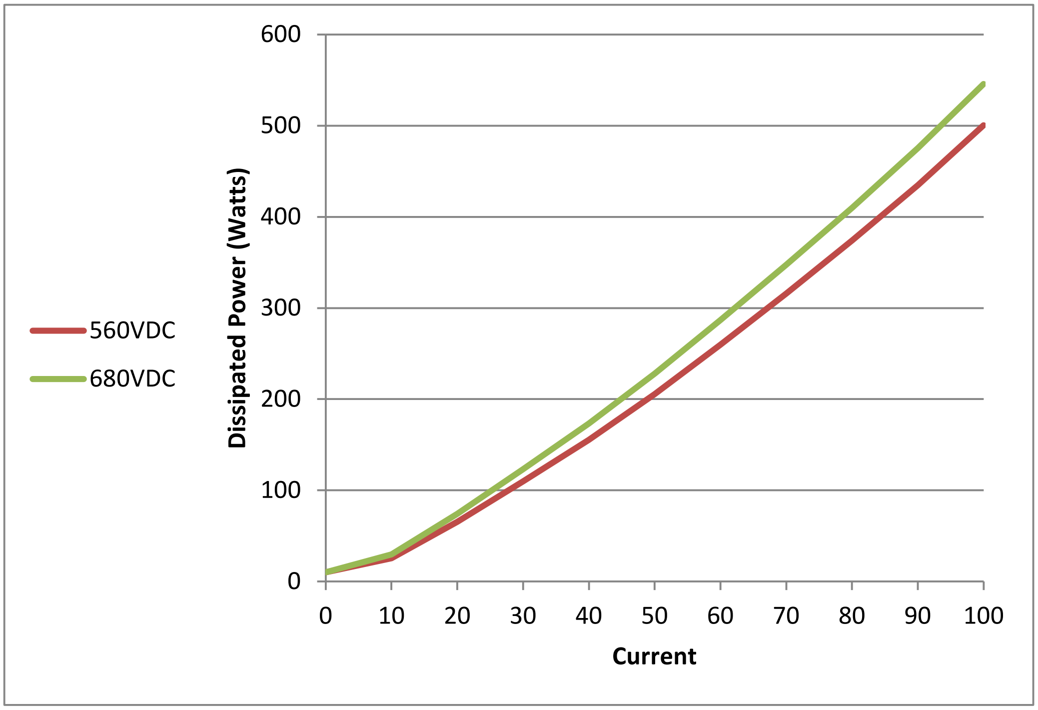

Figure 2: Power Dissipation for “800V” types

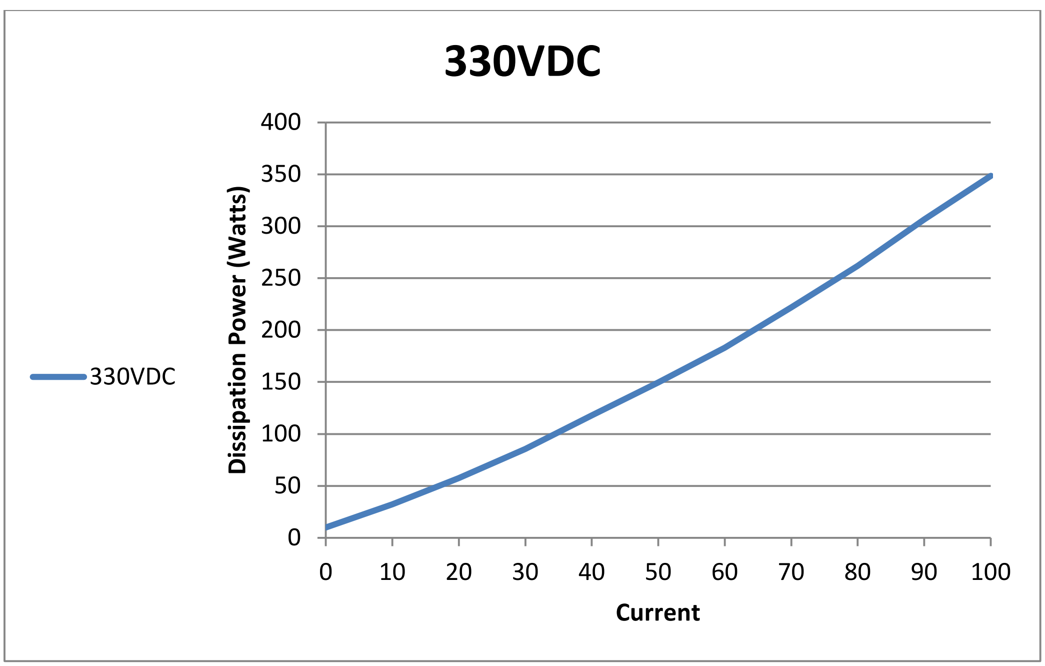

Figure 3: Power Dissipation for “400V” types

Regarding Figure 2 and Figure 3, the following should be noted:

DC Bus Voltage (VDC)	Rectified Voltage (VAC)
560	3X400
680	3X480
330	3X230

The power dissipation in the chart includes the losses of the rectifying bridge.

The DRU-HV (400V and 800V types) dissipate around 8W -10W with 0 Amperes output.

Selecting an External Heat Sink

The calculation is simply determined by the thermal resistance of the external heat sink, where the external heat sink Thermal Resistance will depend on whether a Thermal Foil is inserted or not:

Without thermal foil/ smearing:

$$T_{Heat-Sink} = T_{Ambient} + P_{Dissipation(W)} * \left(0.07\, {}^{\circ C}/_{W} + R_{\theta(Thermal\ Resistance\_External\_HS}\, {}^{\circ C}/_{W}\right) < 87^{\circ}C$$

$$R_{\theta(Thermal\ Resistance\_External\_HS}\, {}^{\circ C}/_{W} = \frac{87^{\circ}C - T_{Ambient} - 0.07 * P_{Dissipation(W)}}{P_{Dissipation(W)}}$$

With thermal foil or smearing

$$R_{\theta(Thermal\ Resistance\_External\_HS}\, {}^{\circ C}/_{W} = \frac{87^{\circ}C - T_{Ambient} - 0.03 * P_{Dissipation(W)}}{P_{Dissipation(W)}}$$

The $P_{Dissipation(W)}$ is derive from the heat dissipation chart

Example

An application with the following data:

VDC= 600V (rectified 480VAC)

Average current consumption of 60A

Using the “650V” curve at 60A the power dissipation is ≈300W.

For proper servo operation, the integral heat-sink of the Drum should be maintained at “not higher than 80°C - 82°C”

For ambient temperature of 40°C the required thermal resistance is

$$R_{\theta} = \frac{80^{\circ}C - 40^{\circ}C - 0.03 * 300W}{300W} \cong 0.1\, {}^{\circ C}/_{W}$$

Summary

This application note can be summarized by the following:

- For up to 5KW - 10KW output power (approx. 100W losses), no fan cooling is required. Installing the Drum to an adequate external heat-sink and allowing "Natural Air Convection" is sufficient.
  The "No Fan" solution can easily be extended to higher heat dissipation not limited to 100W, by using the correct thermal resistance of the external heat-sink.
- For High power losses, it is recommended to use a cooling fan.
- Elmo offers the comprehensive Cooling Fan Assembly (P/N ACC-HS-DRU-HV) that can dissipate up to 600W at ambient temperature of 40°C.

Figure 4: Elmo's Cooling Fan Assembly (P/N ACC-HS-DRU-HV)

Figure 5: Thermal Foil (P/N ACC-FOIL-DRU-HV)

Elmo provides a thermal foil suitable for the assembly of the G-DRU-HV to an external heat-sink (Figure 5).

Figure 6: Elmo's Drum and Cooling Fan Assembly

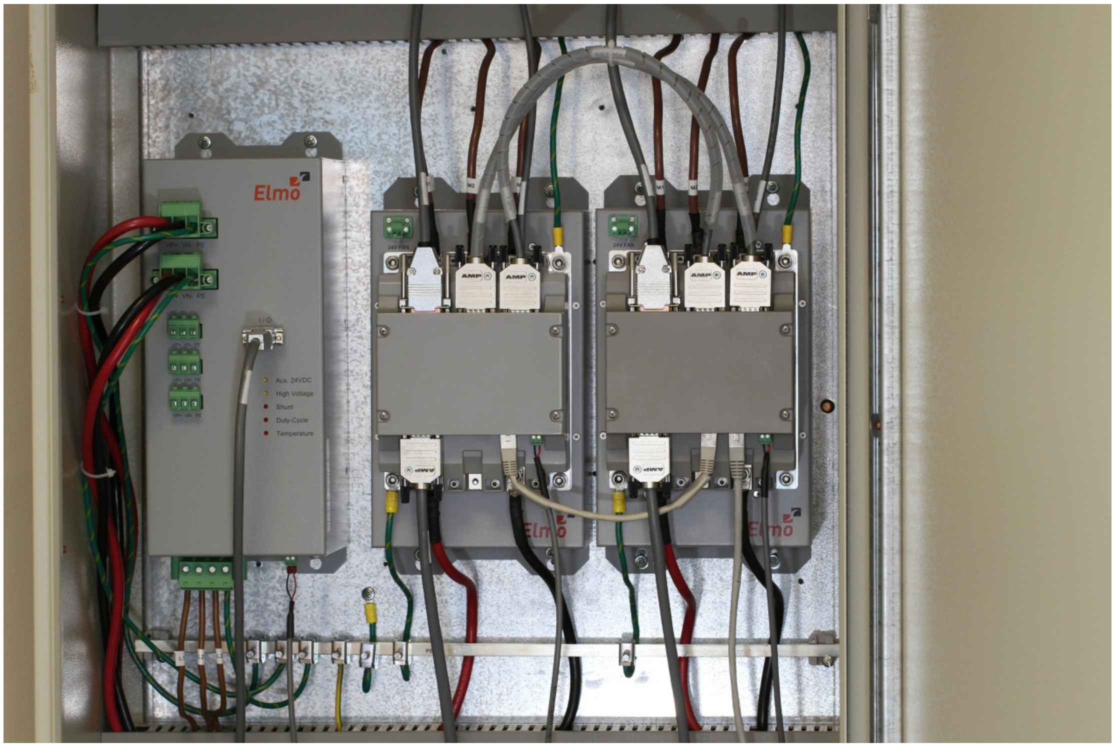

Figure 7: Typical Two 60kW Gold-Drum Servo Drives, Powered by Elmo TAM-100/480 (Power Supply for Servo Applications), in the Elmo Gantry Configuration

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