Application Note AN-VTC-37

Braking resistor sizing for braking applications

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- ***General:***

In general, whenever a motor and load is decelerated to zero, energy will be transferred back into the drive. When this occurs, the internal bus voltage will increase at a rate that depends on deceleration rate and motor + load inertia.

To prevent an over-voltage trip in the drive, a braking resistor of suitable power rating can be connected to the drive brake resistor power terminals, allowing the drive to dump the energy returned from the motor as heat in the external brake resistor. The Optidrive VTC is capable of braking the same power (including overload) as it can source to the motor. Ie a 2.2kW drive can also brake 2.2kW.

The power rating of the brake resistor can be calculated from a knowledge of the maximum operational speed in RPM, the total inertia of motor and load, the deceleration time and the duty cycle.

- ***Calculation procedure***

J = total inertia of motor and load. If a gearbox is used, the reflected inertia on the motor side should be used. Units are in kg m^2

ω = angular velocity radians per second
= $2 \cdot \pi \cdot n / 60$ rad s^{-1}

where 'n' is the motor shaft speed in RPM

$M_{br} = J \cdot \alpha_{br}$

where M_{br} is the motor braking torque and α_{br} is the angular deceleration rate

If t_{br} if the deceleration time from speed ω to zero, then $\alpha_{br} = \omega / t_{br}$

For deceleration from speed ω to zero in time t_{br}, the required motor braking torque is :

$$\mathbf{M_{br} = J \cdot \frac{\pi}{30} \cdot \frac{n}{t_{br}} \quad Nm}$$

The corresponding braking power P_{br} at speed ω is given by $P_{br} = M_{br} \cdot \omega$
By taking into consideration the thermal time constant and the duty cycle of the braking requirements, an overload factor can be determined. This will reduce the required power rating of the brake resistor accordingly.

Example :

Consider a system inertia of 8 kg m^2 , with a maximum operating motor speed of 1500 rpm and a deceleration time of 10s from max speed to zero.

Braking power $P_{br} = M_{br} \cdot \omega = J \cdot \frac{\pi}{30} \cdot \frac{n}{t_{br}} \cdot \frac{\pi}{30} \cdot n$

$$= 8 \cdot \frac{\pi}{30} \cdot \frac{1500}{10s} \cdot \frac{\pi}{30} \cdot 1500 \quad \text{Watt}$$

$$= \underline{19.7\ \text{kW at } 1500\ \text{rpm}}$$

The average braking power over the deceleration cycle is therefore 19.7kW / 2 = 9.8 kW

Consider a resistor thermal time constant of 5s and a braking cycle time of 20s. This gives an overload factor of 4.

Required braking power is therefore : 9.8kW / 4 = 2.5kW, with an instantaneous power capability of 19.7kW.

Allowing for typical energy losses in the motor and load during braking, the above power ratings can be reduced by a further 10% approx.

The braking resistor power requirement is therefore : 2.2kW continuous, 18kW peak

The required ohmic brake resistance is given by :

$$R = \frac{(\text{Braking voltage})^2}{\text{Peak braking power}}$$

For 230V drives, braking voltage = 360V
For 400..480V drives, the braking voltage = 760V

Assuming a 400V drive type,

$$R = \frac{(760)^2}{18000} = 32\ \text{Ohm}$$

Note : After calculating the required resistance value, ensure that this value is greater than the minimum braking resistor ohmic value for the Optidrive rating to be used. This can be found in the rating tables at the back of the User Guide.

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