



Braking Resistors

*Filnor, Inc. Power Resistors are designed,
manufactured and tested for the ultimate
in safety, reliability and product life.*

Filnor, Inc.
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ISO 9001
Quality System Certified



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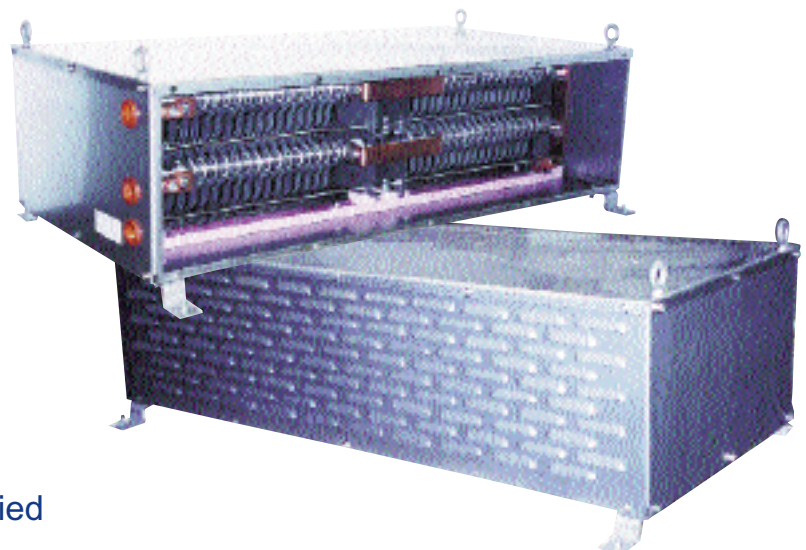
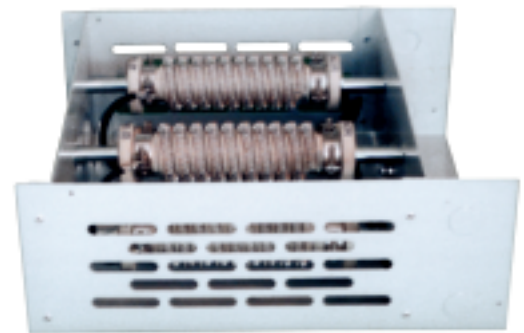
Filnor Braking Resistor Units

Filnor Braking Resistors for Variable Frequency Drives

1. Double Insulated for 1,000 Volts
2. Resistors Wired to Terminal Block with High Temperature Wire
3. Thermal Overload Available (N.C. or N.O. contacts)
4. Well Ventilated Enclosure With Durable ASA70 Gray Powder Coated Finish
5. Built-in Junction Box with Multiple Conduit Knockouts for Easy Wiring
6. Wall or Roof Mount
7. Front Mounted Nameplate with Complete Ratings
8. Quick Deliveries



Filnor offers a complete line of standard braking Resistor Packages for 230, 460, 575 Volt Drives or Braking Resistor Packages per your requirement



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Braking Resistor Calculations

Application

Regeneration of Variable Frequency Drives

When a drive unit is attempting to rapidly brake a motor "Deceleration Braking Cycle" or when an "overhauling load" condition exists, the spinning motor acts as a generator. This free-wheeling condition will force some voltage back into the drive unit (regeneration) which, depending upon the amount of regeneration, may cause an over voltage condition if the energy is not "dumped" somewhere else. Fifteen to twenty percent of this regenerated energy will be absorbed by the drive itself and natural mechanical/motor losses which leaves about eighty percent of the energy to be absorbed by some other means.

Solution: Braking Resistors

Braking resistors are used to absorb energy that is being regenerated back into a drive unit by a freewheeling motor. That energy is released in the form of heat.

Filnor Inc. Braking Resistors are sized based on the following customer supplied information:

1. Voltage: • DC Bus voltage.
2. Drive horsepower.
3. Braking Torque.
4. Duty Cycle. • On time/Off time
5. The maximum braking current or minimum ohmic value as specified by the drive manufacturer.
6. Regeneration type:
 - Deceleration braking. • Overhauling load.

The braking torque is usually specified as 100% or 150% which is a function of the ohmic value of the resistor. Higher braking torque means lower resistance, higher braking currents and faster motor stops. As indicated, caution should be used to not exceed the drive braking current.

The total amount of wattage actually dumped into the resistor is determined by the duty cycle and by the regeneration type. The duty cycle can be determined by dividing the "Cycle time" into the "Braking time" as shown in figure 1.

The regeneration type is a critical piece of information that was not previously mentioned. An overhauling load develops about twice the energy of a normal braking cycle.

Filnor Inc. uses the following method to calculate DB resistor requirements for normal braking loads:

1. Calculate the motor/drive wattage:

$$\text{Motor Wattage (MW)} = \text{Motor or Drive horse power (HP)} \times 746$$

2. Calculate the peak wattage:

$$\text{Peak Wattage (PW)} = \text{MW} \times \text{BT}$$

BT = Brake Torque

- Use 1.0 for 100%
- Use 1.5 for 150%

3. Calculate the required resistance:

$$\text{Resistance} = (\text{DC bus voltage})^2 / \text{PW}$$

4. Calculate the Duty Cycle (DC) as shown in Fig. 1.

$$\text{DC} = \text{Braking Time} / \text{Cycle Time}$$

5. Calculate the DB resistor wattage:

Regeneration Type: Deceleration Braking - - -

$$\text{DBrw} = (\text{PW} \times \text{DC}) / 2$$

See Figure 1.

Maximum "On Time" is 60 seconds for normal braking type.

Regeneration Type: Overhauling Load - - - DBrw = PW x DC

See Figure 2.

No maximum "On Time" for overhauling load type.

6. Calculate the DB resistor current:

$$\text{Bi (Braking Current)} = \sqrt{\text{PW} / \text{RESISTANCE}}$$

7. Calculate the Braking Current:

$$\text{DBi (DB Resistor Current)} = \sqrt{\text{DBrw} / \text{RESISTANCE}}$$

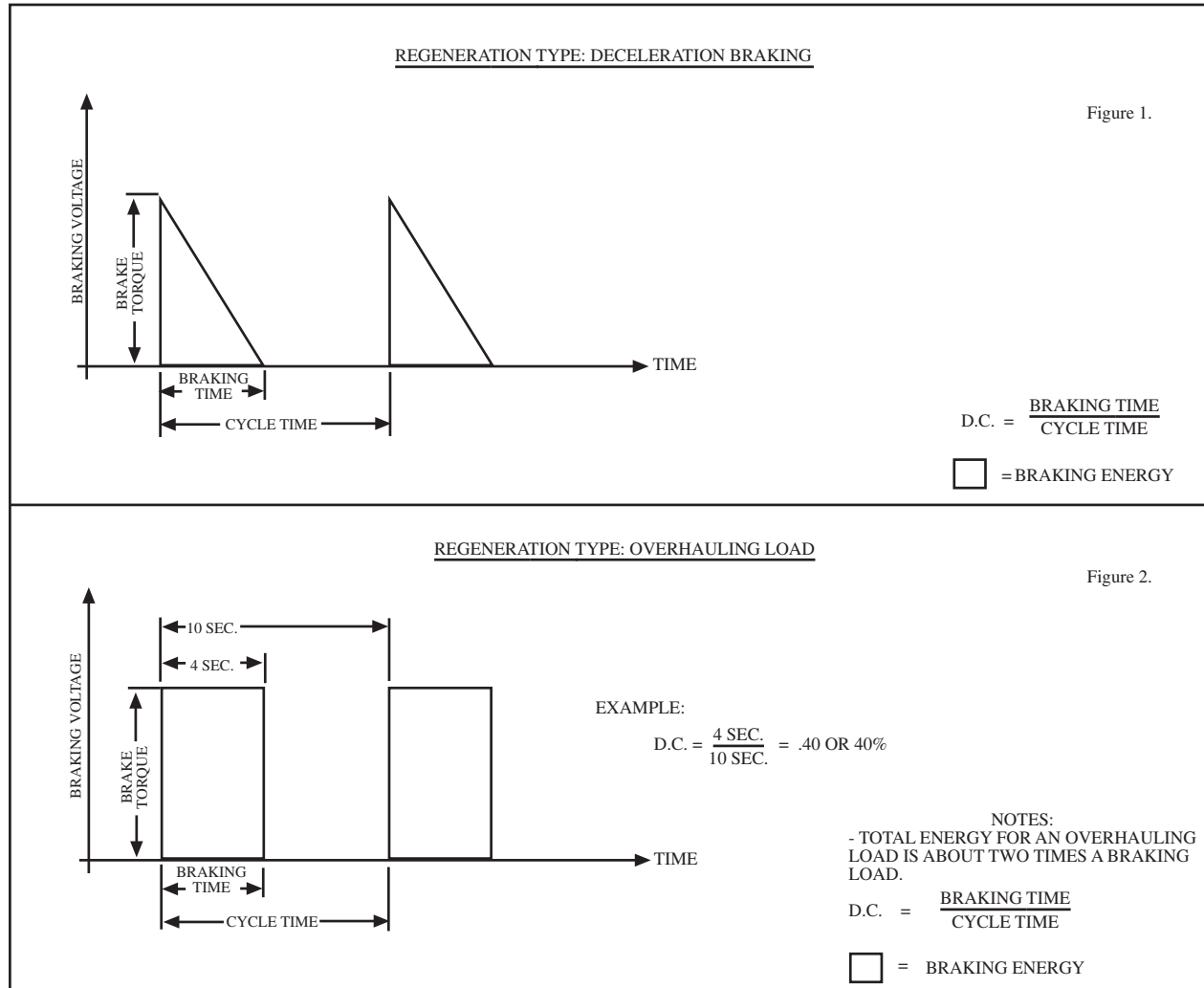
The Braking current (Bi) is the actual current that will flow through the drive's braking transistor and the DB resistor for the duty cycle time period.

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Braking Resistor Calculations



Caution:

Check the drive manufacturer's specification for "Braking Current" or "Peak Current" for the braking module. This value should not exceed the calculated braking current!

Example Deceleration Braking

An example of the proceeding would be as follows:
Customer information:

- Motor Horse Power: **75 HP**
- Drive Input Voltage: **460Vac**
- Braking Torque: **150%**
- Duty Cycle
 - On Time: **3 Seconds**
 - Off Time: **15 Seconds**

- Minimum DB Ohmic Value (Per Manufacturer's Specifications): **5 Ohms**
- Maximum Braking Current Value (Per Manufacturer's Specifications): **130 Amps**
- Regeneration Type: **Deceleration Braking**
- 1. Motor Wattage (MW) = 75 HP x 746 = **55950 Watts**
- 2. Peak Wattage (PW) = 55950 Watts x 150% Brake Torque (Use 1.5) = **83925 Watts**
- 3. Resistance = (750Vdc)² / 83925 Watts = **6.7 Ohms**
- 4. Duty Cycle (DC) = 3 Seconds on / 15 Second off = **.2 or 20%**
- 5. DB Resistor Wattage (DBrw) = (83925 Watts x .2 Duty



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Braking Resistor Calculations

$$\text{Cycle}/2 = 8392.5 \text{ Watts}$$

6. DB Resistor Current (DBi) = SquareRoot (8392.5 Watts / 6.7 Ohms) = **35.4 Amps**

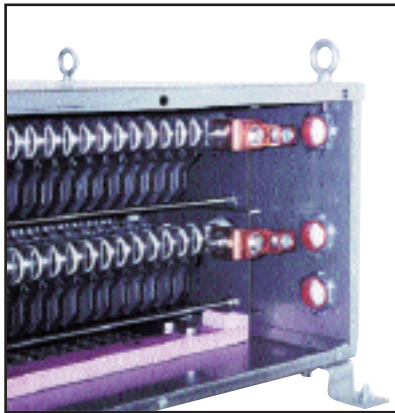
7. Braking Current (Bi) = SquareRoot (83925 Watts / 6.7 Ohms) = **112 Amps**

4. Duty Cycle (DC) = 3 Seconds on / 15 Second off = .2 or 20%

5. DB Resistor Wattage (DBrw) = 83925 Watts x .2 Duty Cycle = **16785 Watts**

6. DB Resistor Current (DBi) = SquareRoot (16785 Watts / 6.7 Ohms) = **50.0 Amps**

7. Braking Current (Bi) = SquareRoot (83925 Watts / 6.7 Ohms) = **112 Amps**



Duty cycle 50% or Higher/Deceleration Braking

If a Deceleration Braking load is specified with a duty cycle higher than 50%, the overhauling load form of the calculation is used. This is because the braking waveform no longer looks like a right triangle but begins to look more like the rectangular pattern of the overhauling load.

Example Overhauling Load:

The same calculation for an **overhauling load** would be as follows:

1. Motor Wattage (MW) = 75 HP x 746 = **55950 Watts**

2. Peak Wattage (PW) = 55950 Watts x 150% Brake Torque (Use 1.5) = **83925 Watts**

3. Resistance = $(750\text{Vdc})^2 / 83925 \text{ Watts}$ = **6.7 Ohms**



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Terms To Know

Variable Frequency Drive (AKA Drive or VFD):

An electronic unit that takes a constant voltage/frequency input and delivers a variable voltage/frequency output to a motor. This output will turn the motor at a RPM less than its natural synchronous speed.

Overhauling Load:

A condition that exists when a motor is being dragged by the load coupled to its output faster than the speed set by the drive. This condition causes voltage to be regenerated back into the drive and is different from that of the braking cycle because the energy being dissipated by the DB resistors is essentially constant during this period of time. This means that the DB resistors must absorb approximately twice the energy during an overhauling load period versus the same braking time period.

DC Bus:

The "DC bus" is the DC voltage section of the drive that is after the input rectifiers and before the output transistor section. The output transistors take the DC bus voltage and "chop" it to an approximated three phase sine wave (with a variable voltage and frequency) to drive the output motor. Maximum DC bus voltage for various voltage drives are as follows:

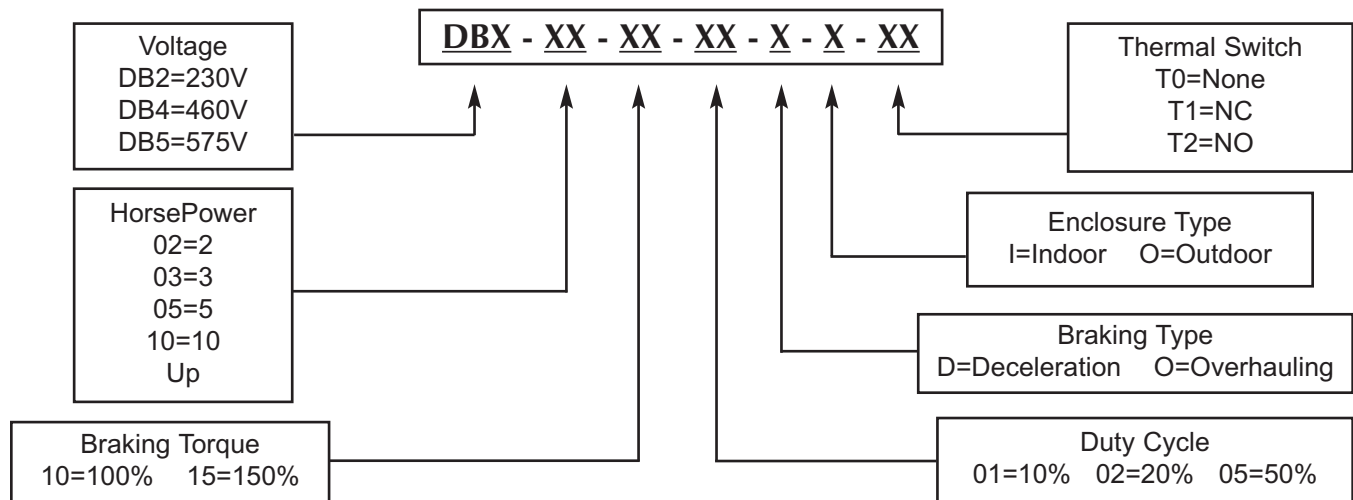
- 230 Vac drive = 350 to 400Vdc
- 460 Vac drive = 750 to 800Vdc
- 575 Vac drive = 925 to 975Vdc

If the DC bus voltage rises above the allowable level, a transistor in the drive turns on and dumps the excess voltage into the DB resistor.

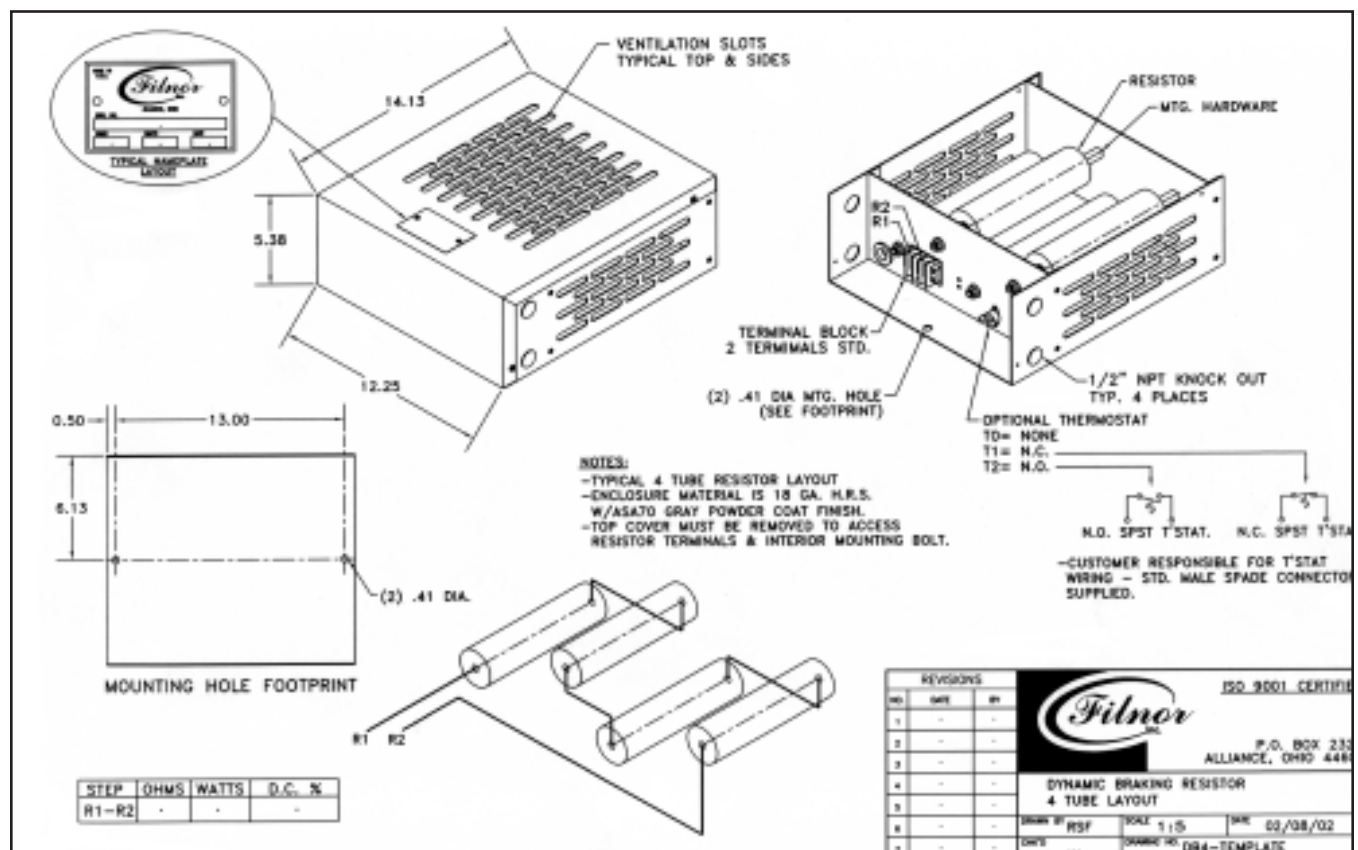


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Filnor Inc. Standard Braking Resistor Part Numbering Scheme



A Typical Drawing



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