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## **BC90100 Module: Heatsink and Chopping Resistor Sizing Guide**

Application Note

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## 1. Application description

This application note provides guidelines for selecting and dimensioning the chopping resistor and additional heatsink for the BC90100 BX braking module, ensuring reliable thermal and electrical performance under various braking scenarios.

## 2. About BC90100 BX

- The **BC90100 BX unit does not apply PWM** to the chopping resistor.
- When the **DC bus voltage exceeds the overvoltage threshold**, the drive sends an “**ON**” signal to the BC90100 B module. This connects the chopping resistor directly across the DC bus.
- Once the **DC bus voltage drops below the overvoltage limit**, the drive sends an “**OFF**” signal to disconnect the chopping resistor.

### 2.1. BC90100 BX – Protection Features and Thermal Guidelines

#### Current Protection Mechanisms:

- **Fast Short-Circuit Protection:**
  - Triggered when the chopping current exceeds **240 A**.
  - **Response time:** 4  $\mu$ s.
- **Slow Short-Circuit Protection:**
  - Activated when current is between **105 A and 240 A**.
  - **Response time:** approximately 1 second.
- **Automatic Reset (Hiccup Mode):**
  - The short-circuit protection resets after **2 seconds**.
  - If the fault persists, the unit re-enters protection mode cyclically.

#### Thermal and Operating Limits:

- The BC90100 BX unit can **sustain 35 A continuously** at ambient temperatures up to **40°C**, **without additional heatsinking**.
- For **higher continuous currents**, an **external heatsink is required**.
- During operation **without external heatsink**, keep the **baseplate temperature below 75°C**.
- **⚠** The BC90100 BX has **no built-in thermal protection**.

#### Electrical Characteristics:

- **Internal Equivalent Resistance:** 4.5 m $\Omega$

## 3. Chopping Resistor Dimensioning

### 3.1. Known values

- **V<sub>MOT</sub>** – Nominal voltage of the DC motor bus
- **I<sub>BR</sub>** – Maximum regenerative current that the drives can feed back into the system during braking, under worst-case conditions.

**⚠ Note:** For a safe and conservative design, assume I<sub>BR</sub> equals the drive’s declared current limit. In worst-case braking, the drive limits current to the value set as **Current Limit** in EasyMotion Studio (under Protection and Limits → Drive Operation Parameters).

Drive operation parameters		
Current limit	100	A

- **I<sub>CR</sub>** – Desired current through the chopping resistor

**⚠ Note:** We recommend I<sub>CR</sub> = 1.1 × I<sub>BR</sub> to ensure proper energy dissipation

## 3.2. Calculating the Chopping Resistor Value ( $R_{CR}$ )

### 3.2.1. Theoretical Calculation

Use Ohm's law to determine the ideal resistor value:  $R_{CR} = V_{MOT} / I_{CR}$

#### Example:

- $V_{MOT} = 48 \text{ V}$
- $I_{BR} = 10 \text{ A} \rightarrow I_{CR} = 1.1 \times 10 \text{ A} = 11 \text{ A}$
- $R_{CR} = 48 \text{ V} / 11 \text{ A} = 4.36 \text{ } \Omega$

### 3.2.2. Selecting a Realistic Resistor Value

Choose the **nearest lower standard resistor value** to the theoretical result.

#### Example:

- Closest lower standard resistor:  $R_{CR(\text{real})} = 3.9 \text{ } \Omega$
- Resulting current:  $I_{CR(\text{real})} = V_{MOT} / R_{CR(\text{real})} = 48 \text{ V} / 3.9 \text{ } \Omega = 12.3 \text{ A}$

## 3.3. Determining Chopping Resistor Power Requirements

Braking behavior depends on the application type and load dynamics. Evaluate resistor power based on either **continuous** or **intermittent** braking:

### 3.3.1. Continuous Braking (e.g., Gravitational Loads)

For long-duration braking, treat the resistor's power rating as its **nominal power ( $P_{NOM}$ )**:

**Power dissipated:**  $P_{CR} = I_{CR(\text{real})}^2 \times R_{CR(\text{real})}$

#### Example:

- $P_{CR} = 12.3^2 \times 3.9 = 590.8 \text{ W}$
- Choose a resistor where  $P_{CR} < P_{NOM}$
- A suitable option:  $3.9 \text{ } \Omega$  rated at **800 W**

### 3.3.2. Short-Duration Braking (Intermittent Use)

For short braking bursts, you can use a resistor's **overload power ( $P_{OL}$ )**, as specified by the manufacturer:

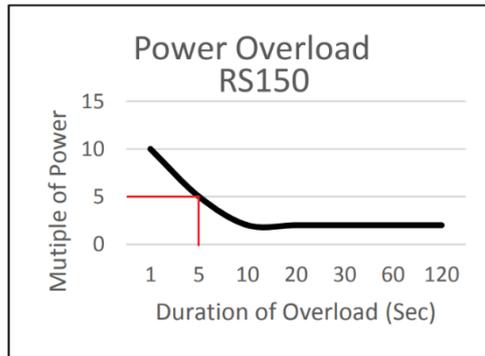
$$P_{OL} = k \times P_{NOM}$$

**Ensure:**  $P_{CR} < P_{OL}$

You must also respect **average power limits** for repeated braking cycles:

- $t_{BR}$  = Braking time
- $T_{BR}$  = Minimum interval between braking events
- $P_{CR(\text{avg})} = P_{CR} \times (t_{BR} / T_{BR})$
- Final condition:  $P_{CR(\text{avg})} < P_{NOM}$

**Example:**



- $t_{BR} = 5 \text{ s}$
- Resistor: RS150 (150 W nominal), with  $k = 5$
- $P_{OL} = 5 \times 150 \text{ W} = \mathbf{750 \text{ W}}$
- $P_{CR} = 590.8 \text{ W} < 750 \text{ W}$  ✓

Now calculate the minimum  $T_{BR}$ :

$$150 \text{ W} = (590.8 \text{ W} \times 5 \text{ s}) / T_{BR} \rightarrow T_{BR} \geq 19.7 \text{ s}$$

✓ This setup allows braking for 5 seconds every 20 seconds using a 150 W nominal chopping resistor.

#### 4. Dimensioning the Thermal Resistivity of the Heatsink for BC90100 BX (if required)

##### 4.1. Known Values

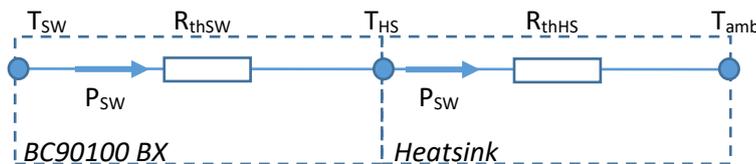
- $R_{sw}$  – Equivalent resistance of the internal chopping switch in the BC90100 BX:  
 $R_{sw} = 4.5 \text{ m}\Omega$
- $T_{sw}$  – Maximum allowable temperature of the switch case:  
 $T_{sw} = 100^\circ\text{C}$

##### 4.2. Calculating the Required Thermal Resistivity for an Additional Heatsink

###### 4.2.1. Theoretical Cooling Model

The heat transfer model is analogous to Ohm's Law:

- Voltage → Temperature difference
- Current → Thermal power
- Resistance → Thermal resistivity



**Term definitions in the model:**

- $T_{sw}$  – Temperature of the BC90100 BX switch (must remain below  $100^\circ\text{C}$ )
- $T_{hs}$  – Temperature at the baseplate of the BC90100 BX
- $T_{amb}$  – Ambient temperature
- $P_{sw}$  – Power dissipated in the internal switch

- $R_{thSW}$  – Internal thermal resistance between the switch and baseplate:  
 $R_{thSW} = 0.8^{\circ}\text{C/W}$
- $R_{thHS}$  – Thermal resistivity of the additional heatsink (this is the value to be determined)

#### 4.2.2. Calculating Power Dissipated by the Switch

**Formula:**

$$P_{SW} = I_{CR(\text{real})} \times I_{CR(\text{real})} \times R_{SW}$$

**Example:**

For  $I_{CR(\text{real})} = 100 \text{ A}$ :

$$P_{SW} = 100 \text{ A} \times 100 \text{ A} \times 4.5 \text{ m}\Omega = \mathbf{45 \text{ W}}$$

#### 4.2.3. Calculating Required Thermal Resistivity of the Additional Heatsink

**Formula:**

$$R_{thHS} = (T_{SW} - T_{amb}) / P_{SW} - R_{thSW}$$

This gives the **maximum allowed thermal resistivity** of the additional heatsink.

**Example:**

- $I_{CR(\text{real})} = 100 \text{ A}$
- $T_{amb} = 40^{\circ}\text{C}$
- $P_{SW} = 45 \text{ W}$
- $T_{SW} = 100^{\circ}\text{C}$
- $R_{thSW} = 0.8^{\circ}\text{C/W}$

$$R_{thHS} = (100^{\circ}\text{C} - 40^{\circ}\text{C}) / 45 \text{ W} - 0.8^{\circ}\text{C/W}$$

$$R_{thHS} = 60^{\circ}\text{C} / 45 \text{ W} - 0.8^{\circ}\text{C/W} = \mathbf{1.33 - 0.8 = 0.53^{\circ}\text{C/W}}$$

✅ In this example, the additional heatsink must have a thermal resistivity of **0.53°C/W or lower**.



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