MSC-3

Dynamic Braking Option
Instruction Manual

ZENER

ZENER TECHNOLOGY AND QUALITY ASSURANCE

Since 1976 Zener Electric has supplied many thousands of drives to industry. These drives have been installed into numerous applications resulting in a wealth of in house experience. The Zener MSC-3 AC variable speed controller is the culmination of this experience, modern technology and industrial application requirements. The Zener Quality Assurance program ensures that every MSC-3 manufactured has proven to operate correctly in the production test bay before dispatch.

SAFETY

Your MSC-3 must be applied, installed and operated in a safe manner. It is the responsibility of the user to ensure compliance with all regulations and practices covering the installation and wiring of your MSC-3. The instruction manual should be completely read and understood before attempting to connect or operate the MSC-3. Only skilled personnel should install this equipment.

This equipment contains a number of components that are designated by their various manufacturers as “not for use in life support appliances, devices or systems where malfunction of the components can reasonably be expected to result in personal injury or death”. Customers using or selling Zener products for use in such applications do so at their own risk and agree to indemnify Zener for any damage resulting from improper use or sale.

THE CONTENTS OF THIS MANUAL ARE SUBJECT TO CHANGE WITHOUT NOTICE

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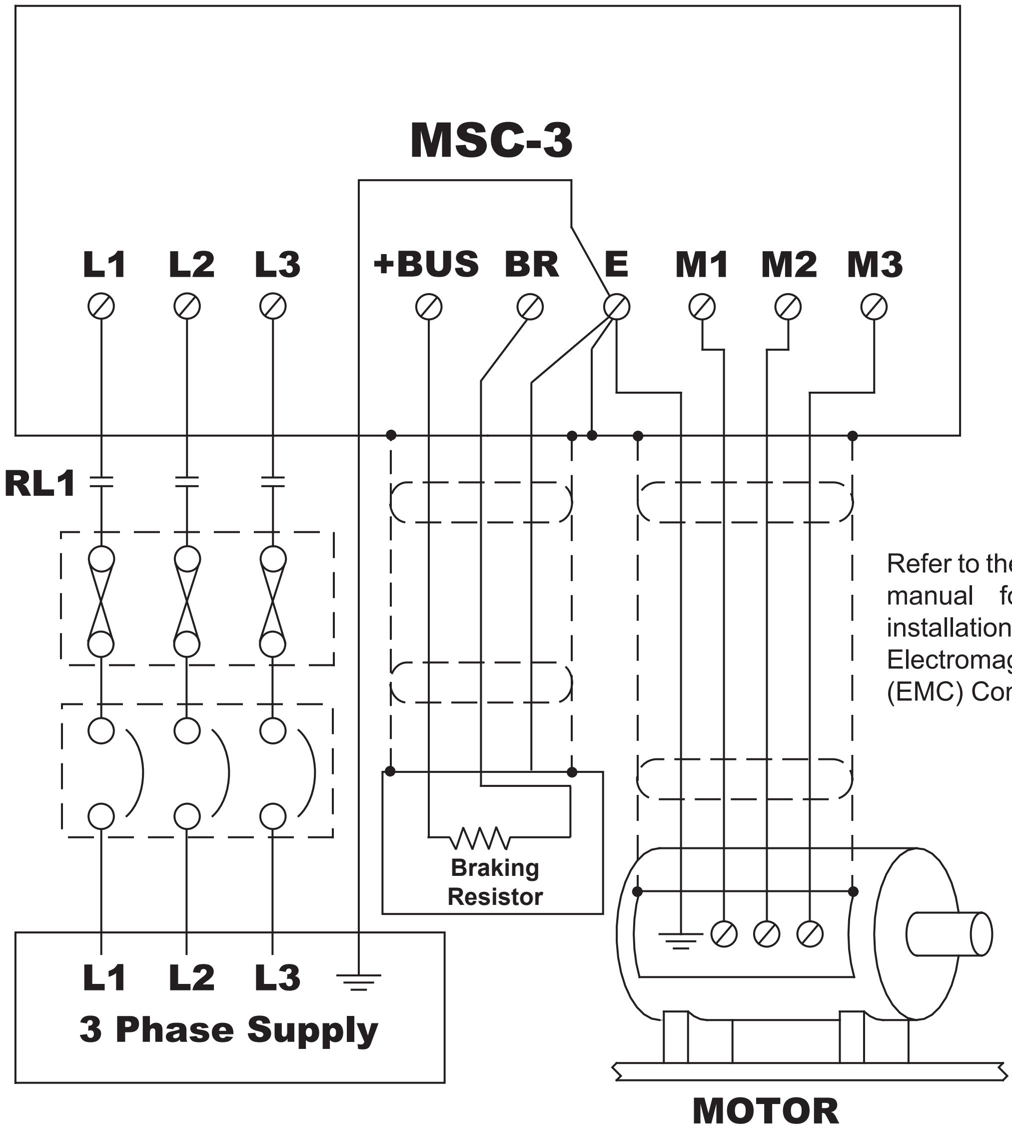
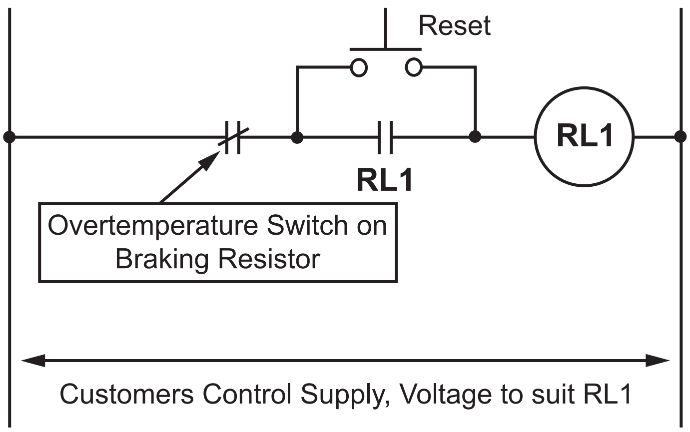
Contents

Electrical Installation Diagram



Refer to the MSC-3 Instruction manual for the necessary installation practices to ensure Electromagnetic Compatibility (EMC) Compliance.



Installation Considerations

Additional information

This manual is intended to be read in conjunction with the MSC-3 Instruction manual, which contains important installation and operation information.

Either fuses or a circuit breaker can be used in the AC supply. Please refer to the MSC-3 Instruction manual for recommended sizing

Braking resistor over temperature protection

The braking resistor may get quite hot during normal operation. This will depend on the resistor selected and the application braking duty cycle. To prevent fire and other hazards that may arise from excessive braking resistor temperature or a failure of the dynamic brake switching device within the inverter, a thermal cut out switch should be wired as shown. This switch should act to remove line power from the inverter. Safety issues should be carefully considered before adopting alternative arrangements.

Emergency stop

Many codes and safety standards require that emergency stop circuits use only electro-mechanical components to ensure continued functionality of safety functions in the event of a failure within a complex electronic device such as an inverter. Safety stop circuits and safety critical interlocks should not rely on functionality of the inverter or it's dynamic braking functions for safe operation.

Dynamic Braking

Dynamic Braking provides the means for dissipating the motor regenerative energy into an external resistor. Dynamic Braking (when fitted) operates anytime the MSC-3 experiences regenerative currents from an overhauling load, that is, any motor with a high inertia or a motor that is required to decelerate rapidly. An MSC-3 with Dynamic Braking option fitted, needs only the external braking resistor connected to it and the function enabled.

Selecting the Braking Resistor

The resistance value and the power rating must be calculated from the motor or shaft power. For a 480V rated MSC-3, i.e. a drive with the following model number MSC-3Rxx, the dc bus voltage to use in calculations is 800V. (This is the DC bus overvoltage trip point, which represents the highest possible braking resistor voltage in normal operation.) For 240 and 600V models substitute a DC bus voltage of 400 and 1000 respectively. Firstly, determine the current:

$$I_{res} = \frac{P_{motor} \times \eta}{800}$$

η = motor efficiency + 0.90 to 0.95 for most large motors (>10kW) and 0.85 to 0.90 for smaller.

Now calculate the value of resistance to achieve I_{res};

$$R_{\max} = \frac{800}{I_{res}}$$

A minimum resistance value must also be calculated so as to not exceed the braking transistor (IGBT) current rating. Use the table below to determine R_{min} for the 480V case. , R_{min} was calculated using the same formula as for R_{max}, replacing I_{res} with I_{IGBT} and DC bus voltage with 400, 800 and 1000 for 240, 480 and 600V drives respectively.

MSC-3	Nominal Supply Voltage	Braking IGBT Amp	**R_{min}**
L3 -L23	240	15	**26.7**
L30, L40	240	25	**16**
L55	240	90	**4.5**
L82	240	110	**3.7**
L109	240	180	**2.5**
L140	240	220	**1.9**
L170	240	330	**1.3**
R3 - R23	480	15	**53.3**
R30, R40	480	25	**32**
R55	480	90	**8.9**
R82	480	110	**7.3**
R109	480	180	**4.5**
R140	480	220	**3.7**
R170	480	330	**2.5**
J3 - J23	600	15	**66.7**
J30, J40	600	25	**40**

The Braking transistor IGBT can operate continuously (i.e. Duty cycle, D = 1) provided Rmin or greater is used. Now the power rating of the resistor can be calculated from the motor duty cycle. The duty cycle should be determined as:

$$D = \frac{time\_in\_braking}{cycle\_time}$$

It is a number between 0 and 1. If D is less than 0.2 (or 20%) then make it 0.2. This is to ensure that the minimum power rating of the resistor is adequate to handle a full braking load, without catastrophic failure. The duration of the braking period determines the temperature rise of the resistor as determined by the thermal time constant of the resistor. If the ‘braking’ is prolonged, as might be the case with an over-hauling load such as a conveyor belt heavily loaded, going downhill, then the dynamic brake will be working continuously and the resistor will heat up accordingly.

In typical applications braking is intermittent (D <<1), therefore the resistor rating does not need to be for continuous operation but rather could be sized according to an average value of the power dissipation over the cycle time. Even though the instantaneous intermittent power may exceed this rating, if the resistor thermal time constant is longer than the braking period, the resulting resistor temperature rise over the cycle time may still be acceptable and the resistor will handle the load.

For 240V models $$P_{res} = \frac{400^2 \times D}{R}$$

For 480V models $$P_{res} = \frac{800^2 \times D}{R}$$

For 600V models $$P_{res} = \frac{1000^2 \times D}{R}$$

Installing the Braking Resistor

Wire the resistor to the two terminals labeled +BUS and BR in the MSC-3. Also fit a thermal protection device to the resistor so that the resistor is protected from excessive loading / over-heating. The thermal protection device should open an isolation contactor fitted in series with the supply input to the MSC-3. Locate the braking resistor away from the drive in an area with sufficient cooling for the resistor. Cooling fans may be useful.

Enabling Dynamic Braking

Before running the motor, select the E00 STOP/START menu. Scroll down () until E06 DYNAMIC BRK appears. Press ENTER. Select ENABLED. The MSC-3 is now ready to run with dynamic braking. Check that the ramp times have been set to the desired values.

Dynamic braking performance

How much torque is available?

The maximum braking power can be found from:

$$Power = \frac{(V_{brake})^2}{R}$$

V_{brake} is the DC bus voltage during braking (see table below)

R is the braking resistor value, in ohms

This can be translated into braking torque by:

$$Torque_{braking} = \frac{Power}{RPM \bullet \frac{2\pi}{60}}$$

This represents the electrical braking torque. The mechanical braking torque will be slightly higher, due to friction and other losses. Torque is in Newton-metres

These equations can be combined to give:

$$Torque_{braking}\,(Nm) = \frac{k}{RPM \bullet R}$$

k varies with drive rated voltage. See table below

Rated drive voltage (AC)	Braking voltage (DC)	*k*
240	375	1342909
480	750	5371637
600	950	8618494

Please note that the **braking torque cannot exceed the limit imposed by inverter output current** (motor current). A conservative approach to this is to say that at x% overload, the maximum braking torque available is x% more than the rated torque. This is reasonable up to around 1.5 - 2 times motor rated torque. Beyond this point there is considerable divergence in the performance of different motors.

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