

Application Technique

Original Instructions

Selecting 80% or 100%-Rated Molded Case Circuit Breakers

Bulletin 140G

Topic	Page
Introduction	2
Applications in North America	3
Summary	5
Additional Resources	5



Introduction

Molded Case Circuit Breakers (MCCBs) are used as protection devices to ensure safe operation of electrical motors and electrical circuits against overload, short circuit, and ground faults. You can find MCCBs in residential applications, commercial installations, and industrial motor centers; these breakers are used as a feeder breaker or single circuit breaker that serves as the main disconnecting means for a control panel.

Rockwell Automation offers solutions of Allen-Bradley® circuit protection products from line-to-load power in many configurations, voltage ranges, and current ranges to meet your requirements. In most electrical systems, the MCCBs are rated for operation at 80% of their rated current. However, certain application use MCCBs rated for 100% operation.

This document defines certain terms applicable to circuit breakers, explains the ratings for 100% versus 80% operation, and provides cases where 100% rated MCCBs could be beneficial.

The National Electrical Manufacturers Association (NEMA) defines circuit breakers as “devices [that are] designed to open or close a circuit by nonautomatic means, and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating”. The term “molded case” refers to the construction of the circuit breaker and the fact that the circuit breaker is an assembled unit in a supporting housing of an insulating material.

UL489 defines an MCCB as “a circuit breaker which is assembled as an integral unit in a supportive and enclosed housing of Rated Current (I_n) – the marked current rating and the maximum RMS current a circuit breaker can carry continuously without tripping and the maximum current the circuit breaker will carry without changing, deleting, or adding a part or parts such as trip units and rating plugs”.

Essentially, circuit breakers are used as safety measure to protect electrical devices by combining multiple functional components, and can be used without damage when they are properly applied within their predetermined rating. [Figure 1](#) shows a selection of Allen-Bradley MCCBs. Rockwell Automation offers 100% rated MCCBs in the K-Frame (400 A), M-Frame (800 A), N-Frame (1200 A), and R-Frame (2000 A, 2500 A, and 3000 A) devices.

Figure 1 - Allen-Bradley Molded Case Circuit Breakers



Applications in North America

Most circuit breakers that are applied in North America are 80% rated, which means that they can only be used continuously at 80% of their thermal current rating.

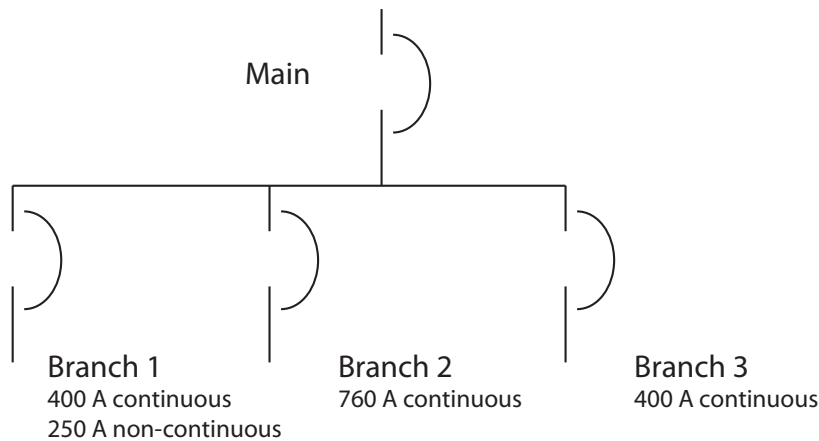
To get a clear definition on the rating, we can refer to the National Electrical Code, NEC, Article 210.20(A), which states: “Where a feeder supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than the noncontinuous load plus 125% of the continuous load.

Exception: Where the assembly that includes the overcurrent devices protecting the feeder(s) are listed for operation at 100% of their rating, neither the ampere rating of the overcurrent device nor the ampacity of the feeder conductors shall be less than the sum of the continuous load plus the noncontinuous load.”

The NEC defines a load as continuous when it is expected to run at maximum current for 3 hours or more. The rating of the conductors is important, because a load that is continuously running adds more heat to the wires than an intermittent load. Additional heat that is not accounted for can damage the conductors and other components of the system.

The following examples illustrate scenarios that compare 80% and 100%-rated breakers in the same application.

Example 1:



Using the definitions in NEC Article 220, the load is continuous if it is expected to run for 3 hours or longer.

Circuit Protection Requirements, 80% vs 100%-Rated MCCBs

		80% Rated Design (Noncontinuous load + 125% of continuous load)				100% Rated Design (Noncontinuous load + continuous load)			
		Branch 1	Branch 2	Branch 3	Main	Branch 1	Branch 2	Branch 3	Main
Load Type	Continuous	400 A	760 A	400 A	-	400 A	760 A	400 A	-
	Noncontinuous	250 A	-	-		250 A	-	-	
Total Load	Calculation	250 + 400 (1.25)	760 (1.25)	400 (1.25)	750 + 950 + 500	400 + 250	760	400	650 + 800 + 400
	Sum	750 A	950 A	500 A	2200 A	650 A	760 A	400 A	1810 A
Min. Trip		750 A	950 A	500 A	2200 A	650 A	760 A	400 A	2000 A
Recommended MCCB		800 A, M-Frame	1200 A, N-Frame	800 A, M-Frame	2500 A, R-Frame	800 A, M-Frame	800 A, M-Frame	400 A, K-Frame	2000 A, R-Frame

Now that we have our recommended MCCBs, we can review the bill of material (BOM) for each design and see how the designs affect the cost of the solution. Using the BOMs that are shown in [Figure 2](#), we can see that the 100%-rated MCCB solution saves approximately 10%.

Figure 2 - 80% and 100%-rated MCCB BOM comparison

Equipment List | Discount Level: None | Price Agreement: None | 9% Preferred Availability Parts | \$100,496.07

Item	Description	Unit	Price	Cost	Margin	Qty	Ext. Price	Ext. Cost	Ext. Margin
1	140G-M0F3-D80 1400 - Molded Case Circuit Breaker, M frame, 100 kA Interrupt Rating, T/M - Thermal Magnetic, 3 Poles, Rated Current 800 A (80% Rated)	EA	\$10,740.38	\$7,156.78	0.00 %	1	\$10,740.38	\$7,156.78	0.00 %
2	140G-N6H3-E12 1400 - Molded Case Circuit Breaker, N frame, 65 kA Interrupt Rating, LS (electronic), 3 Poles, Rated Current 1200 A (80% Rated)	EA	\$14,139.98	\$10,103.98	0.00 %	1	\$14,139.98	\$10,103.98	0.00 %
3	140G-R12K3-E25 1400 - Molded Case Circuit Breaker, R frame, 125 kA Interrupt Rating, LS0-M (electronic), 3 Poles, Rated Current 2500 A (80% Rated), with Door Interlock	EA	\$64,875.33	\$48,235.33	0.00 %	1	\$64,875.33	\$48,235.33	0.00 %

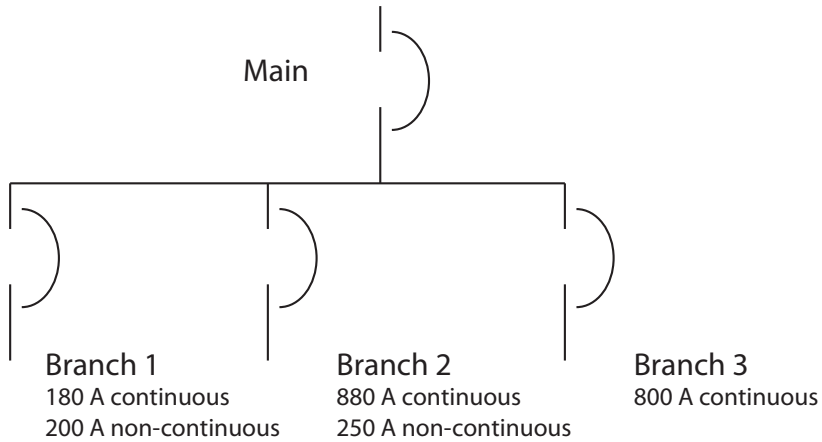
80% rated MCCBs

Equipment List | Discount Level: None | Price Agreement: None | 9% Preferred Availability Parts | \$91,248.61

Item	Description	Unit	Price	Cost	Margin	Qty	Ext. Price	Ext. Cost	Ext. Margin
1	140G-M6F3-D80-Z1 1400 - Molded Case Circuit Breaker, M frame, 65 kA Interrupt Rating, T/M - Thermal Magnetic, 3 Poles, Rated Current 800 A (100% Rated)	EA	\$10,087.24	\$7,265.42	0.00 %	1	\$10,087.24	\$7,265.42	0.00 %
2	140G-K6F3-D40-Z1 1400 - Molded Case Circuit Breaker, K frame, 65 kA Interrupt Rating, T/M - Thermal Magnetic, 3 Poles, Rated Current 400 A (100% Rated)	EA	\$6,198.80	\$4,547.36	0.00 %	1	\$6,198.80	\$4,547.36	0.00 %
3	140G-R12K3-E20-Z1 1400 - Molded Case Circuit Breaker, R frame, 125 kA Interrupt Rating, LS0-M (electronic), 3 Poles, Rated Current 2000 A (100% Rated), with Door Interlock	EA	\$64,875.33	\$48,435.83	0.00 %	1	\$64,875.33	\$48,435.83	0.00 %

100% rated MCCBs

Example 2:



Using the definitions in NEC Article 220, the load is continuous if it is expected to run for 3 hours or longer.

Circuit Protection Requirements, 80% vs 100%-Rated MCCBs

		80% Rated Design (Noncontinuous load + 125% of continuous load)				100% Rated Design (Noncontinuous load + continuous load)			
		Branch 1	Branch 2	Branch 3	Main	Branch 1	Branch 2	Branch 3	Main
Load Type	Continuous	180 A	880 A	800 A	-	180 A	880 A	800 A	-
	Noncontinuous	200 A	250 A	-		200 A	250 A	-	
Total Load	Calculation	200 + 180 (1.25)	250 + 880 (1.25)	800 (1.25)	425 + 1350 + 1000	200 + 180	250 + 880	800	380 + 1130 + 800
	Sum	425 A	1350 A	1000 A	2775 A	380 A	1130 A	800 A	2310 A
Min. Trip		425 A	1350 A	1000 A	2775 A	380 A	1130 A	800 A	2310 A
Recommended MCCB		800 A, M-Frame	2500 A, R-Frame	1200 A, N-Frame	3000 A, R-Frame	400 A, K-Frame	1200 A N-Frame	800 A, M-Frame	2500 A, R-Frame

Now that we have our recommended MCCBs, we can review the bill of material (BOM) for each design and see how the designs affect the cost of the solution. Using the BOMs that are shown in Figure 3, we can see that the 100%-rated MCCB solution saves approximately 34%. In this scenario, the 100%-rated solution also saves panel space, because you are using physically smaller MCCBs.

Figure 3 - 80% and 100%-rated MCCB BOM comparison

Equipment List		Discount Level: None	Price Agreement: None	0% Preferred Availability Parts		\$167,625.97	
1	140G-M0F3-D80 140G - Molded Case Circuit Breaker, M frame, 100 kA Interrupt Rating, T/M - Thermal Magnetic, 3 Poles, Rated Current 800 A (80% Rated)	\$10,740.38 \$7 / 15F	Sell 1,0000 M 10740.38 Ea. \$10,740.38 Cost 1,0000 M 10740.38 Ea. \$10,740.38 Margin 0.00 % 0.00 Ea. \$0.00				
2	140G-N6H3-E12 140G - Molded Case Circuit Breaker, N frame, 65 kA Interrupt Rating, LSI (electronic), 3 Poles, Rated Current 1200 A (80% Rated)	\$14,139.98 \$7 / 17F	Sell 1,0000 M 14139.98 Ea. \$14,139.98 Cost 1,0000 M 14139.98 Ea. \$14,139.98 Margin 0.00 % 0.00 Ea. \$0.00				
3	140G-R12K3-E25 140G - Molded Case Circuit Breaker, K frame, 125 kA Interrupt Rating, LSI-M (electronic), 3 Poles, Rated Current 2500 A (80% Rated), with Door Interlock	\$64,875.33 \$7 / 18F	Sell 1,0000 M 64875.33 Ea. \$64,875.33 Cost 1,0000 M 64875.33 Ea. \$64,875.33 Margin 0.00 % 0.00 Ea. \$0.00				
4	140G-R12K3-E30 140G - Molded Case Circuit Breaker, K frame, 125 kA Interrupt Rating, LSI-M (electronic), 3 Poles, Rated Current 3000 A (80% Rated), with Door Interlock	\$77,870.28 \$7 / 18F	Sell 1,0000 M 77870.28 Ea. \$77,870.28 Cost 1,0000 M 77870.28 Ea. \$77,870.28 Margin 0.00 % 0.00 Ea. \$0.00				

80% rated MCCBs

Equipment List		Discount Level: None	Price Agreement: None	0% Preferred Availability Parts		\$110,999.14	
1	140G-M6F3-D80-Z1 140G - Molded Case Circuit Breaker, M frame, 65 kA Interrupt Rating, T/M - Thermal Magnetic, 3 Poles, Rated Current 800 A (100% Rated)	\$10,087.24 \$7 / 15F	Sell 1,0000 M 10087.24 Ea. \$10,087.24 Cost 1,0000 M 10087.24 Ea. \$10,087.24 Margin 0.00 % 0.00 Ea. \$0.00				
2	140G-K6F3-D40-Z1 140G - Molded Case Circuit Breaker, K frame, 65 kA Interrupt Rating, T/M - Thermal Magnetic, 3 Poles, Rated Current 400 A (100% Rated)	\$6,198.80 \$7 / 15F	Sell 1,0000 M 6198.80 Ea. \$6,198.80 Cost 1,0000 M 6198.80 Ea. \$6,198.80 Margin 0.00 % 0.00 Ea. \$0.00				
3	140G-N6H3-E12-Z1 140G - Molded Case Circuit Breaker, N frame, 65 kA Interrupt Rating, LSI (electronic), 3 Poles, Rated Current 1200 A (100% Rated)	\$16,842.82 \$7 / 17F	Sell 1,0000 M 16842.82 Ea. \$16,842.82 Cost 1,0000 M 16842.82 Ea. \$16,842.82 Margin 0.00 % 0.00 Ea. \$0.00				
4	140G-R12K3-E25-Z1 140G - Molded Case Circuit Breaker, K frame, 125 kA Interrupt Rating, LSI-M (electronic), 3 Poles, Rated Current 2500 A (100% Rated), with Door Interlock	\$77,870.28 \$7 / 18F	Sell 1,0000 M 77870.28 Ea. \$77,870.28 Cost 1,0000 M 77870.28 Ea. \$77,870.28 Margin 0.00 % 0.00 Ea. \$0.00				

100% rated MCCBs

Summary

When you perform a system analysis done from branch to main feed, the results can provide a guide to whether your application is best suited for an 80% or 100%-rated MCCB that conforms to guidelines set out in NEC Section 210.20(A). It is also important that you understand the exception to NEC Section 210.20(A) concerning the rules about applying 100%-rated MCCBs to an entire system—the entire system, including the conductors, must be listed for 100% operation.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
Molded Case Circuit Breaker Selection Guide, publication 140G-S6001	Provides complete product selection information and specifications for MCCBs.
Short-circuit Current Ratings and Your Industrial Control Panel Application Techniques, publication SCCR-AT002	Provides examples for short-circuit current ratings of panels based on the methods stated in UL 508A Supplement B.
Molded Case Circuit Breaker Selectivity Guide Technical Data, publication 140G-TD050	Assists designers of a control system in choosing an Allen-Bradley Molded Case Circuit Breaker (MCCB) or Miniature Circuit Breaker (MCB) for proper coordination in main (primary) and branch circuits.
Circuit Protection Methods White Paper, publication 1492-WP001	Provides information that helps differentiate between Supplementary Protection, Branch Circuit Protection, and Self-Protected Devices.
Control Circuit and Load Protection Selection Guide, publication 1492-S6122	Provides complete product selection information and specifications for miniature circuit breakers, residual current devices, supplementary protectors, etc. for load-side use with MCCBs.
Low Voltage Motor Protection White Paper, publication 193-WP008	Addresses many issues related to the proper understanding of short-circuit and overload protection devices and how to select them.
Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication IC-TD002	Provides a quick reference tool for Allen-Bradley industrial automation controls and assemblies.
Safety Guidelines for the Application, Installation, and Maintenance of Solid-state Control, publication SG1-1.1	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications .	Provides declarations of conformity, certificates, and other certification details.

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Knowledgebase	Access Knowledgebase articles.	rok.auto/knowledgebase
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc





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