2. PRODUCT DESCRIPTION

The need for resistive braking control occurs in applications where the frequency of an AC motor at times exceeds that of the variable frequency drive controlling it. When this happens, the motor acts as a generator. The energy produced in these circumstances may cause the drive to trip on an over-voltage condition or cause the motor to build up heat. This regenerated energy must either be dissipated or returned to the power line. For applications where this condition occurs infrequently, dissipating the energy as heat through resistive braking control can be the most cost-effective solution.

The Model M3575R series of braking products is designed to provide resistive loads for braking control in applications utilizing a standard AC drive with a fixed DC bus. These modules have been designed for use as remotely mounted resistive loads for voltage controlled chopper modules such as the Model M3575T Series of Braking Control Modules or other existing resistive braking circuitry.

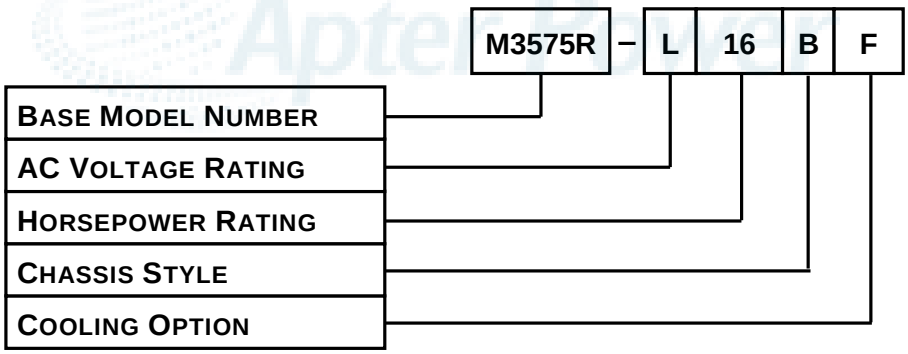
2.1. RELATED DOCS

The Model M3575T series of Resistive Braking Control modules is available in a variety of ratings and configurations for use as voltage controlled chopper modules with the M3575R Resistive Load modules or other resistive loads.

Contact the AC drive distributor for more information.

2.2. PART NUMBER BREAKDOWN

Figure 2-1: Example of Part Number Breakdown



BASE MODEL NUMBER

The Base Model Number of this unit (**M3575R**) indicates that the unit incorporates the resistive load only. An external resistive braking transistor module and its associated control circuitry are required for proper braking function.

AC VOLTAGE RATING

The AC Voltage Rating of the braking load module should match the AC line input voltage to the AC Drive being used. This rating is represented by an alpha code.

Table 2-1: AC Voltage Rating

RATING CODE	AC VOLTAGE NOMINAL AC LINE
L	230VAC Line
H	460VAC Line

HORSEPOWER RATING

The Horsepower (hp) Rating indicates the maximum horsepower level safely handled by the braking resistor module. Please see the Module Ratings Tables in Section 6.1 for the M3575R modules currently available. The Horsepower Rating is indicated by a numeric code.

Table 2-2: Example of Horsepower Rating

RATING CODE	HORSEPOWER
1	1hp
24	24hp

CHASSIS STYLE

The Chassis Style position indicates the unit enclosure. Please see the Module Ratings in Section 6.1 to determine a unit's chassis style.

Table 2-3: Chassis Styles

CHASSIS STYLE	CHASSIS CODE	DESCRIPTION	DIMENSIONS H" x W" x D"
B	B4	Type-1 Bookshelf	17.75 x 4 x 9.50
B	B7	Type-1 Bookshelf	17.75 x 7 x 9.50
B	B10	Type-1 Bookshelf	17.75 x 10 x 9.50
B	B10D	Type-1 Bookshelf	17.75 x 10 x 11.50
M	M4	Mini	12.75 x 4 x 9.50
M	M7	Mini	12.75 x 7 x 9.50
M	M10	Mini	12.75 x 10 x 9.50

COOLING OPTION

The Cooling Option position indicates whether or not the unit has an internal cooling fan which is thermostatically controlled to activate if the units internal temperature exceeds 110°F. The Cooling Fan Option is indicated by an alpha or numeric code.

Table 2-4: Cooling Options

COOLING OPTION CODE	DESCRIPTION
0	No internal cooling fan
F	115VAC internal cooling fan
FL	230VAC internal cooling fan
FD	24VDC internal cooling fan

2.3. GENERAL SPECIFICATIONS CHART

Table 2-5: General Specifications

PARAMETER	SPECIFICATION
Nominal Drive Voltage	Available for use with: 230VAC (320VDC Bus) or 460VAC (640VDC Bus) drive systems.
Braking Current	Units available for 1-47* amps DC * Loads can be combined for greater capacity.
Maximum On-Time	60 seconds for units rated for 33hp or less
Duty Cycle	20% Maximum with cooling fan option 6% Maximum without cooling fan option
Fan Voltage	230VAC, 115VAC, 24VDC
Connections	Chopper module or braking kit (from drive or add-on braking kit)
Output	Over-Temp - 125VAC, 15A resistive
Enclosure	Enclosed
Operating Temp	0°C - 40°C
Storage Temp	-20°C to +65°C

3. INSTALLATION INSTRUCTIONS

WARNING!

Installation and/or removal of this product should only be performed by a qualified electrician in accordance with National Electrical Code or local codes and regulations.

Proper installation of the Model M3575R Resistive Braking Load Module should be accomplished following the steps outlined below. Be sure to refer to the AC Drive and/or Braking Kit instruction manual as these steps are performed. Please direct all installation inquiries that may arise during the installation and startup of this braking product to the equipment supplier or system integrator.

3.1. ENVIRONMENT

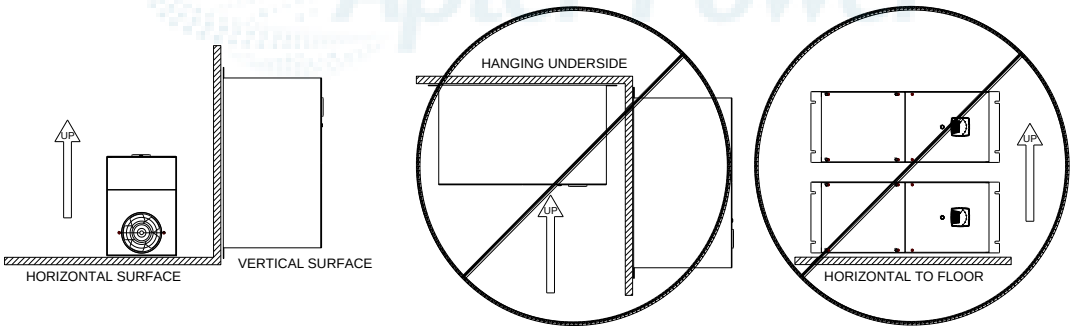
The module should be installed in an area protected from moisture and falling debris. Buildup of dust or dirt on the resistor can be a fire hazard. Operating in a wet environment can pose a shock hazard.

See Table 2-5 for the recommended temperature range for operating or storing this module.

3.2. UNPACKING

Upon receipt of this product, please verify that the product received matches the product that was ordered and that there is no obvious physical damage to the unit. If the wrong product was received or the product is damaged in any way, please contact the supplier from which the product was purchased.

Figure 3-1: M3575R Mounting Orientation



A B C

3.3. MOUNTING

The installation site for the module should be chosen with several considerations in mind:

- The mounting surface must be non-flammable, as the unit will generate high surface temperatures during typical operation.
- The unit requires a minimum clearance of two (2) inches in all directions around it when mounted near a non-heat source. When mounting near a second M3575R or other heat source, a minimum of six (6) inches of clearance MUST be allowed between the two.

Once the installation site has been selected as outlined above, the unit should be mounted in place. The M3575R must be properly oriented for proper air flow through

the units. The M3575R must **ALWAYS** be mounted with the rear surface of the unit to the mounting surface. Refer to Figure 3-1A for acceptable mounting orientation. **NEVER** mount a unit in a horizontal position with its side parallel to the mounting surface or floor as shown in Figure 3-1C. Do **not** mount the unit in an upside-down position or on the underside of a mounting surface as shown in Figure 3-1B.

Mounting dimensions and provisions vary by unit chassis size and style. Refer to Tables 6-1 thru 6-4 in Section 6.1 of this manual to determine the chassis size and style for the unit. Then refer to Section 6.5 of this manual to determine the correct mounting dimensions and provisions for the unit.

3.4. WIRING AND CUSTOMER CONNECTIONS

Connection points and terminal numbers of the AC Drive and/or Braking Kit will be found in the documentation provided with those units.

Be sure to review all pertinent AC Drive, Braking Kit and System documentation as well as the Field Connection Notes listed below before proceeding.

3.4.1. POWER WIRING

WARNING!

Only qualified electricians should perform and maintain the interconnection wiring of this product. All wiring should be done in accordance with National Electrical Code or equivalent regulations.

WARNING!

Never connect the Resistive Braking Load Module directly across the DC bus! This would exceed the maximum duty cycle rating of the load. The extreme overheating generated by the load resistors under this condition could present a fire hazard in and around the Resistive Load Module.

Table 3-1: Power Wiring Chart

CHASSIS	TERM.	CONNECTION	TORQUE
B,M (Fig 3-3)	Res1 Res2	18 - 12 AWG	3.5 – 5.3 lb-in
	7	ground	

- Please note that although the connection diagrams shown in Figures 3-3 and 3-4 depict a typical interconnection of the M3575R Resistor Module with the M3575T Braking Transistor Module, the M3575R can be used with any properly sized braking transistor module. Refer to the installation manual for the transistor module used to determine proper connection details.
- Be sure that the Resistive Load being connected meets the minimum load resistance requirements listed in the Braking Kit and/or AC Drive documentation.
- Field connection terminals used on the Bookshelf (B*) and Mini (M*) chassis units are depicted in Figure 3-3.
- Wire types and sizes should be chosen in accordance with national and/or local electrical codes as well as module termination limitations outlined in Table 3-1 to meet the voltage and RMS current ratings of the M3575R module as listed Section 6.1 of this manual.

Figure 3-4 shows typical connections for a single M3575R module.

Figure 3-5 shows parallel interconnection of two M3575R modules.

3.4.1.1. SOURCE CONSIDERATIONS

Please refer to your local codes and requirements for inline fusing between the resistor and drive. Special considerations may apply, as a blown fuse in the DC will remove the braking load, and may lead to loss of braking torque. Review the safety standards required for your application.

3.4.1.2. GROUNDING REQUIREMENTS

Using the ground lug provided, ground the chassis in accordance with local codes. Typically the wire gauge will be the same as is used to ground the attached drive.

3.4.2. I/O WIRING

The M3575R Resistive Load is equipped with an Over-Temp contact for use with existing drive or system interlock circuitry. Please refer to the system documentation for field control interlock connection details. When installing M3575R modules in parallel, it is recommended that the over-temperature contacts of these units be connected in series as shown in Figure 3-5.

Actual connection points and terminal numbers for the AC Drive module should be found in the documentation provided with the drive. Be sure to review all pertinent drive and system documentation before proceeding.

Table 3-2: Terminal Block Specifications

CHASSIS	TERM.	FUNCTION	DESCRIPTION LOCATION	ELECTRICAL RATINGS (RESISTIVE)	CONN.	TORQUE
B,M *(Fig 3-3)*	3,4	Over-Temp	4.2.1.1	125VAC, 15A 250VAC, 10A 100,000 Cycles	18 - 12 AWG	3.5 – 5.3 lb-in
	5,6	Fan Power	4.2.1.2	Type FL -230VAC 0.25A Type F – 115VAC 0.5A Type FD – 24VDC 1A	14 – 12 AWG	3.5 – 5.3 lb-in

4. OPERATION

The operation of the M3575R Resistive Load Module is passive in that there are no parameters or adjustments that can be made before or during operation. Please refer to the ratings charts in Tables 6-1 thru 6-4 in Section 6 and selection criteria for proper sizing considerations.

4.1. FUNCTIONAL DESCRIPTION

Braking resistors absorb energy from drives during braking by converting excess power into heat. In order to control the drive's bus voltage level, a braking transistor must be used. This transistor may be integral to the drive, or may be connected externally. Refer to your drive manual for information on integrating the M3575R Resistive Load Module with your drive.

4.2. FEATURES

4.2.1. TERMINAL STRIP I/O

4.2.1.1. OVER-TEMP

The Over-Temp Switch is a normally closed thermostat that opens when the case temperature exceeds 71ºC. This contact can be used to indicate that the braking resistor is overheating due to excessive duty cycle.

4.2.1.2. FAN POWER

Fan power is provided for cooling when the resistor is in operation. Refer to the chart for the power requirements for your unit. Note that the fan will not run continuously. When the fan thermostat is ON, the fan will run until the thermostat cools down.

4.3. STARTUP

4.3.1. PRE-POWER CHECKS

Ensure that all connections are tight and that all wiring is of the proper size for operation. Check for exposed conductors that may lead to inadvertent contact.

4.3.2. STARTUP PROCEDURE AND CHECKS

Apply power to your drive. Ensure that the resistive load has no current flowing to it when the drive is in the idle state. If there is significant current flowing to the resistor during the idle state, this can indicate that the resistor is not properly attached to the drive. The resistor must be used with a properly sized braking transistor. Once the resistor connection is verified, run the drive through a normal acceleration and deceleration cycle. During the deceleration cycle, current may be observed through the resistive load. Refer to Section 5.3 *Troubleshooting* if the drive does not operate properly.

4.4. OPERATIONAL ADJUSTMENTS

No adjustments are necessary for this module.

5. MAINTENANCE AND TROUBLESHOOTING

Repairs or modifications to this equipment are to be performed by certified personnel only. Any repair or modification to this equipment by personnel not approved by Bonitron will void any warranty remaining on this unit.

5.1. PERIODIC TESTING

Monthly, look at surrounding surfaces for any discoloration or scorching. This would be an indication of overheating. If surrounding surfaces are discolored or scorched, increase the mounting clearances.

Ensure that debris and dust are not building up on the resistor module. The possibility of fire exists if flammable material is in contact with the resistor elements.

Ensure that the fan is operational, and free of dust and debris that might reduce the fan speed or airflow through the unit.

5.2. MAINTENANCE ITEMS

Check the fan periodically for debris, and blow out with an air hose if it has become fouled or is not running at full capacity.

5.3. TROUBLESHOOTING

If a problem occurs on start-up or during normal operation, refer to the indications detailed below. If a problem persists after following the steps below, or if the problem is not listed, please contact the equipment supplier or system integrator for assistance.

5.3.1. DRIVE TRIPS ON OVER-VOLTAGE OR SELF-LIMITS ITS DECEL RATE

Ensure that the resistor module is properly connected to the AC drive's braking control circuitry. This can be a chopper module internal to the drive or an external braking kit. Refer to the AC Drive and/or Braking Kit manuals as well as Section 3.4 of this manual for field interconnection details.

Verify the ohmic value of the resistor. The specific ohmic value for each unit can be found in Section 6.1 of this manual. Please note that the values listed have a tolerance of ±10%. If the ohmic value readings are out of tolerance, return the module for repair or replacement.

If the resistor module is properly connected and the ohmic value is within tolerance, ensure that the resistor is adequately sized for the application. Most AC drives are capable of a 150-200% output surge when braking. If the resistor is insufficient to absorb and dissipate the braking energy, an over-voltage fault may occur in the AC drive.

5.3.2. THE COOLING FAN DOESN'T TURN ON

The cooling fan option is designed to switch on as needed during normal operation. This usually occurs if the resistor module temperature exceeds approximately 45°C. If normal switching does not occur, please follow the steps below to troubleshoot.

1. Does the temperature of the resistor module exceed 45°C?
   - If not, then cooling is not required and the fan will not switch on.
   - If so, proceed to step 2.

2. Verify that appropriate voltage input is present for fan power. Input voltage should be 115VAC for type “F”, 230VAC for type “FL”, or 24VDC for type “FD” cooling fan.
   - If the resistor module’s temperature exceeds 45°C and fan voltage is present, return the unit for repair or replacement.

5.3.3. OVER-TEMP CONTACT IS OPEN

If the Over-Temp Contact is OPEN and the chassis is HOT, allow the unit to cool and recheck the contact. The contact should return to its normally closed state. If the contact remains OPEN, return the unit for repair or replacement.

If the Over-Temp contact is OPEN and the chassis is COOL, return the unit for repair or replacement.

- If this occurs repeatedly, make certain that the unit is sized appropriately and that the maximum current rating is not exceeded.
- Check the wiring to make sure connections are made to the braking transistor, not across the DC bus.

5.3.4. OVER-TEMP CONTACT DOES NOT OPEN ON OVER-TEMP CONDITION

If the Over-Temp Contact remains CLOSED and the chassis temperature exceeds 71°C, immediately disconnect the resistor module and allow the unit to cool.

Allowing the resistor module’s temperature to rise excessively could present a fire hazard!

Once the chassis has COOLED, return the unit for repair or replacement.

5.4. TECHNICAL HELP – BEFORE YOU CALL

If possible, please have the following information when calling for technical help:

- Serial number of unit
- Name of original equipment supplier
- Brief description of the application
- Drive and motor Hp or kW
- The line to line voltage on all 3 phases
- The DC Bus voltage
- KVA rating of power source
- Source configuration Wye/Delta and grounding

M3575R

Table 6-3: Module Ratings – 460VAC (640VDC Bus) at 6% Duty[1]

Part Number	Peak HP	Braking Amps (RMS)	Braking Amps (peak)	Braking Watts (peak)	Braking Watts (cont.)	Load Ohms	Chassis Size
M3575R-H1M0	1hp	0.1A	1A	746	45	780Ω	M4
M3575R-H2M0	2hp	0.1A	2A	1492	90	390Ω	M4
M3575R-H3M0	3hp	0.2A	3A	2238	135	260Ω	M4
M3575R-H4M0	4hp	0.2A	4A	2984	180	195Ω	M7
M3575R-H5B0	5hp	0.3A	5A	3730	225	150Ω	B4
M3575R-H6M0	6hp	0.4A	6A	4476	270	130Ω	M7
M3575R-H8B0	8hp	0.5A	8A	5968	360	90Ω	B4
M3575R-H9M0	9hp	0.5A	9A	6714	405	87Ω	M10
M3575R-H11B0	11hp	0.7A	13A	8206	495	60Ω	B7
M3575R-H16B0	16hp	1.0A	17A	11936	720	45Ω	B7
M3575R-H24B0	24hp	1.4A	25A	17904	1080	30Ω	B10
M3575R-H27B0	28hp	0.8A	27A	20888	627	28.2Ω	B10
M3575R-H33B0	33hp	1.0A	32A	24618	739	22.5Ω	B10D

Notes:

1. Maximum on-time is 60 seconds.

Table 6-4: Module Ratings – 460VAC (640VDC Bus) at 20% Duty[1]

Part Number[2]	Peak HP	Braking Amps (RMS)	Braking Amps (peak)	Braking Watts (peak)	Braking Watts (cont.)	Load Ohms	Chassis Size
M3575R-H1MF	1hp	0.2A	1A	746	150	780Ω	M4
M3575R-H2MF	2hp	0.4A	2A	1492	300	390Ω	M4
M3575R-H3MF	3hp	0.6A	3A	2238	450	260Ω	M4
M3575R-H4MF	4hp	0.8A	4A	2984	600	195Ω	M7
M3575R-H5BF	5hp	1.0A	5A	3730	750	150Ω	B4
M3575R-H6MF	6hp	1.2A	6A	4476	900	130Ω	M7
M3575R-H8BF	8hp	1.6A	8A	5968	1200	90Ω	B4
M3575R-H9MF	9hp	1.8A	9A	6714	1350	87Ω	M10
M3575R-H11BF	11hp	2.2A	13A	8206	1650	60Ω	B7
M3575R-H16BF	16hp	3.2A	17A	11936	2400	45Ω	B7
M3575R-H24BF	24hp	4.8A	25A	17904	3600	30Ω	B10
M3575R-H27BF	28hp	8.4A	27A	20888	1800	28.2Ω	B10
M3575R-H33BF	33hp	13.4A	32A	24618	3600	22.5Ω	B10D

Notes:

1. Maximum on-time is 60 seconds.
2. Part numbers indicated represent units with the type “F” 115VAC cooling fan option. Units are also available with the type “FL” 230VAC or type “FD” 24VDC fan options. Ratings listed apply to all units with fans regardless of fan type.

6.2. WATT LOSS

Please see the Module Rating Tables in Section 6.1.

These watt ratings are subject to the duty cycle of the braking function. The continuous rating is based on a linear deceleration curve to zero speed at the rated duty cycles.

6.3. CERTIFICATIONS

The following part numbers are UL and CUL listed.

Please refer to Underwriters Laboratories file number E204386.

Table 6-5: Certifications

M3575R-L1M0	M3575R-L1MF	M3575R-H1M0	M3575R-H1MF
M3575R-L2M0	M3575R-L2MF	M3575R-H2M0	M3575R-H2MF
M3575R-L3M0	M3575R-L3MF	M3575R-H3M0	M3575R-H3MF
M3575R-L4M0	M3575R-L4MF	M3575R-H4M0	M3575R-H4MF
M3575R-L5B0	M3575R-L5BF	M3575R-H5B0	M3575R-H5BF
M3575R-L6M0	M3575R-L6MF	M3575R-H6M0	M3575R-H6MF
M3575R-L8B0	M3575R-L8BF	M3575R-H8B0	M3575R-H8BF
M3575R-L9M0	M3575R-L9MF	M3575R-H9M0	M3575R-H9MF
M3575R-L11B0	M3575R-L11BF	M3575R-H11B0	M3575R-H11BF
M3575R-L16B0	M3575R-L16BF	M3575R-H16B0	M3575R-H16BF
M3575R-L24B0	M3575R-L24BF	M3575R-H24B0	M3575R-H24BF
			M3575R-H27BF
			M3575R-H33BF
			M3575R-H17BF

6.4. FUSE/CIRCUIT BREAKER SIZING AND RATINGS

Circuit breaker and fuse sizing is dependent upon local codes and safety requirements.

6.5. DIMENSIONS AND MECHANICAL DRAWINGS

Figure 6-1: Bookshelf and Mini Chassis Dimensional Outline Drawing

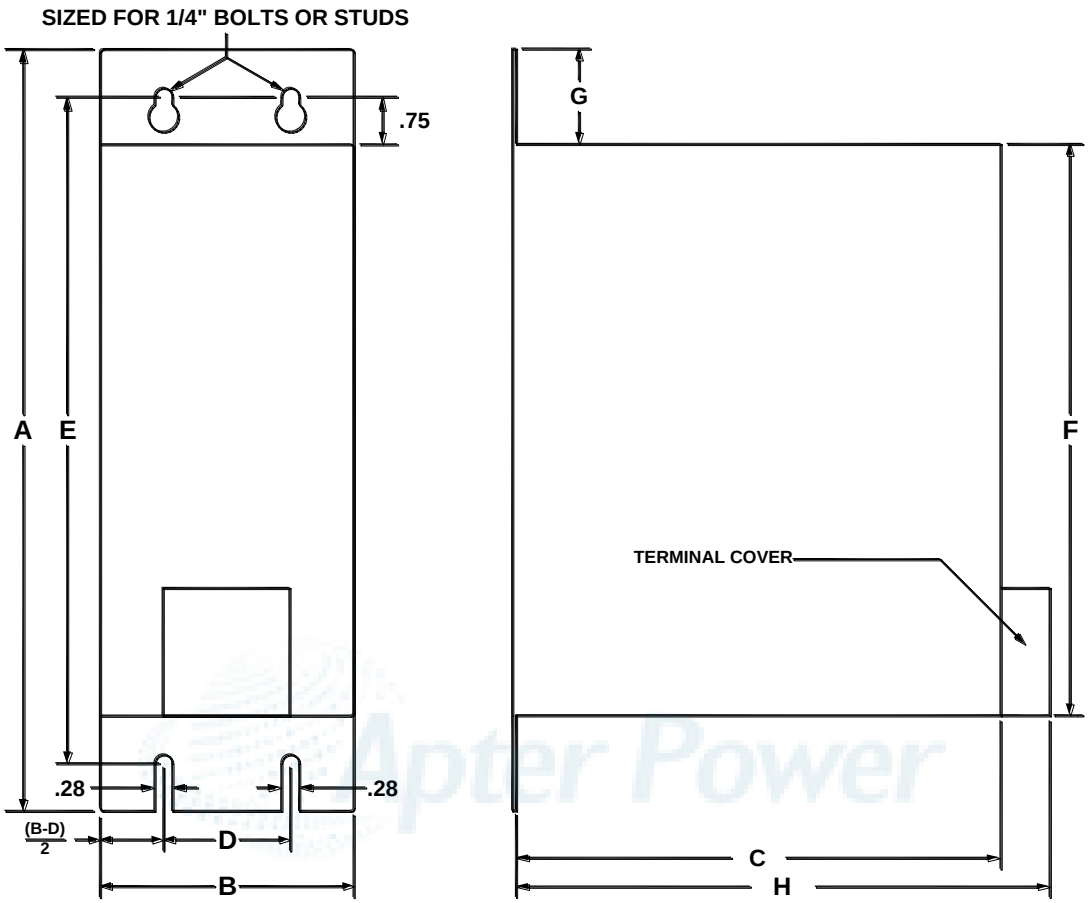


Table 6-6: Bookshelf and Mini Chassis Dimensions

CHASSIS	DIM.A	DIM.B	DIM.C	DIM.D	DIM.E	DIM.F	DIM.G	DIM.H	
								w/o cover	w/cover
B4	17.75	4.00	8.0	1.75	16.75	15.00	1.38	8.0	9.50
B7	17.75	7.00	8.0	5.00	16.75	15.00	1.38	8.0	9.50
B10	17.75	10.00	8.0	8.00	16.75	15.00	1.38	8.0	9.50
B10D	17.75	10.00	10.0	8.00	16.75	15.00	1.38	10.0	11.50
M4	12.75	4.00	8.0	1.75	12.00	10.50	1.13	8.0	9.50
M7	12.75	7.00	8.0	5.00	12.00	10.50	1.13	8.0	9.50
M10	12.75	10.00	8.0	8.00	12.00	10.50	1.13	8.0	9.50

7. APPENDICES

7.1. APPLICATION NOTES

Resistive load banks are selected based on the application. In order to calculate the model needed, please use the following guidelines.

Verify the amount of peak power needed for braking. VFD's are rated for braking power as well as peak braking capacity. This information is available in the drive manual.

7.1.1. WATTAGE

For example: A drive rated for 10 horsepower of output may be rated for 150% braking. This means that there is 15hp of braking required. In this case the peak power required would be:

$$P_{brake} = hp._{Braking} * 746 \qquad P_{brake} = 15hp * 746 = 11190Watts$$

7.1.2. OHMIC VALUE

The ohmic value of the resistor can usually be determined from the drive manual under the "minimum ohmic value". This ohmic value indicates the rating of the chopper or braking transistor, and may not be directly related to the horsepower of the drive. In order to calculate the required ohmic value for the braking load, use the following formula:

$$R_{brake} = (V_{DCbus})^2 \Big/ P_{brake}$$

The DC bus voltage for the equation is determined by the level that the drive begins braking. For 460/480VAC systems, this is typically 750VDC, for 230VAC systems, it is typically 375VDC. Refer to your drive manual for specifics.

For the above example, the ohmic value would be:

$$R_{brake} = (750VDC)^2 \Big/ 11190Watts = 50.3ohms$$

This value must be verified with the drive manual that it is not less than the "minimum ohmic value" for that drive manual. If so, the braking requirements may be more than the drive can absorb, and a larger drive or external braking transistor may be required.

If it is greater, it is possible to select a resistor value lower than the calculated value.

7.1.3. DUTY CYCLE

The duty cycle is based on the amount of time the drive is actually braking as opposed to accelerating, running at constant speed, or idle. For instance, if a pick and place operation requires 3 seconds to accelerate, traverses for 44 seconds and then decelerates for 3 seconds, the total cycle time is:

$$T_{cycle} = T_{acc} + T_{run} + T_{dec} = 3 + 44 + 3 = 50\text{sec}$$

The duty cycle for braking is:

$$\%_{duty} = {T_{dec}}/{T_{cycle}} = .06 = 6\%$$

This rating assumes the application load will be linearly decreasing from peak braking power to zero braking as the process comes to a stop.

Check this rating against the module's duty cycle rating, and if it is higher than rated, select the next higher rated module. If a duty cycle is required over 20%, please call for assistance with your application.

7.1.4. CONTINUOUS RATING

The continuous rating is listed for long term heating calculations should the unit be installed in an area where heat dissipation is an issue. The rating is based on a triangular cycle that starts at peak value and reduces to zero within the rated duty cycle. Therefore, the average braking power during the deceleration cycle is ½ the power required if full power were required during the entire braking cycle. This value is:

$$P_{continuous} = P_{peak} * \%_{duty} / 2$$

For the above example, the

$$P_{continuous} = 11190 * 6\% / 2 = 336W$$

7.2. COMPETITIVE CROSS REFERENCE

Table 7-1: AB-To-Bonitron Shunt Cross-Reference

AB SHUNT P/N	WATTAGE (PEAK / CONT)	DUTY (MAX)	LOAD RES. (MIN / MAX)	BONITRON P/N
2090-SR020-36	32000 / 3600	11%	20Ω / 25Ω	M3575R-H33BF
2090-SR025-09	25600 / 900	3.5%	25Ω / 31Ω	M3575R-H27B0
2090-SR025-18	25600 / 1800	7%	25Ω / 31Ω	M3575R-H27BF
2090-SR040-09	16000 / 1800	5.5%	40Ω / 50Ω	M3575R-H16BF
2090-SR040-18	16000 / 1800	11%	40Ω / 50Ω	M3575R-H16BF
2090-SR120-09	5333 / 900	16%	117Ω / 143Ω	M3575R-H6MF