AC and DC Drives: Drive Heat Dissipation and Enclosure Sizing

RELIANCE ELECTRIC

Application Solution

This is an upgrade of the Application Notes Binder Article 1B. This upgrade reflects the latest product offerings from Reliance Electric Standard Drives.

Introduction

AC and DC drives are very efficient devices. AC drive efficiencies are >= 95%, while DC drive conversion efficiency is often over 98%.

Even with these high conversion efficiencies, drive losses (heat dissipation) must be considered when sizing the enclosure that will house one or more AC or DC drives

In this application note, we will provide AC and DC drives watts losses and the standard enclosure heat dissipation capabilities. This provides for an appropriate cabinet selection for installation purposes.

Drive Heat Dissipation

Because AC and DC drives operate at less than 100% efficiency, heat is generated by the drive and expressed in terms of watts loss. Tables 1 through 6 provide values for a wide range of AC and DC drives.

Table 1. SP120 Drive Heat Dissipation*

HP	100-115 V	200-240 V 1 phase	200-240 V 3 phase
1/4	17	17	17
1/2	29	29	29
3/4	-	33	33
1	41	41	41
1 1/2	-	53	53
2	-	70	70
3	-	101	101
5	-	-	169

Table 2. SP200 Drive Dissipation*

HP	100-115 V	200-240 V 1 phase	200-240 V 3 phase	200-240 V 3 phase
1/2	30	30	30	30
1	52	52	47	50
1 1/2	80	80	-	-
2	-	90	85	85

* Assumes 8 kHz carrier frequency (worst case)

Table 3. SP500 Drive Heat Dissipation

HP	115 V	200-240 V	380-460 V	575 V
1/4-1	80	70	60	50
2	-	120	100	90
3	-	210	140	120
5	-	250	180	180
7 1/2	-	-	210	220
10	-	-	250	-
15	-	-	375	-
20	-	-	600	-

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Table 4. NEMA GV3000/SE Drive Heat Dissipation

HP	200-230V	380-460V
1	60	60
2	100	100
3	140	140
5	180	180
7 /2	210	210
10	250	250
15	375	375
20	600	600
25*	-	600
25	-	750
30	660	800
40	900	960
50	1100	1200
50***	-	1420
60*	1350	1200
75	1650	1350
75**	-	1780
100**	2250	1650
125	-	3200
125**	-	2250
150**	-	2700
200**	-	3300
200	-	3290
250	-	4160
300	-	5100
350	-	6150
400	-	7350

* V/Hz models only
** Chassis style units
*** Derikon model only

Table 4a. Bookshelf GV3000/SE Drive Heat Dissipation

Model No.	Watts Loss
31ER4060	60
31ET4060	
38ER4060	70
38ET4060	
55ER4060	100
55ET4060	
85ER4060	150
85ET4060	
126ER4060	210
126ET4060	
150ER4060	250
150ET4060	
240ER4060	380
240ET4060	
300ER4060	470
300ET4060	
430ER4060	600
430ET4060	

Table 5. Single Phase DC Drive Heat Dissipation (Watts Loss)

	Minpak Plus/Flexpak Plus		DC2	
HP	115 VAC	230 VAC	115 VAC	230 VAC
1/4	25	-	18	-
1/3	30	-	22	-
1/2	35	25	25	-
3/4	40	-	33	-
1	-	35	40	25
1½	-	40	-	3
2	-	50	-	40
3	-	70	-	-
5	-	110	-	-
DC3 60 Watts at full load (all models)				

Table 6. Three Phase DC Drive Heat Dissipation (Watts Loss)

	MaxPakIII/FlexPak 3000		MinPak Plus/FlexPak Plus	
HP	230 V	460 V	230 V	460 V
5	360	403	150	275
7½	369	409	170	285
10	420	424	180	295
15	474	432	236	315
20	523	520	290	335
25	582	547	430	370
30	635	581	480	400
40	831	626	585	450
50	1016	659	-	-
60	1090	699	-	-
75	1266	995	-	-
100	1625	1138	-	-
125	1915	1232	-	-
150	2151	1375	-	-
200	-	1922	-	-
250	-	2245	-	-
300	-	2479	-	-
400	-	4087	-	-
500	-	4463	-	-
600	-	4634	-	-

Choosing An Appropriate Cabinet

The data in table 7 provides the heat dissipating capabilities for all standard wall and floor-mounted cabinets.

NEMA 1 vs Totally-Enclosed Cabinet Heat Dissipation

NEMA 1 cabinets (with louvered or slotted openings) have considerably more heat dissipating capabilities than totally enclosed types. In NEMA 1 enclosures, hot air rises with the cabinet, drawing cooler air in through the openings in the lower sections and exhausting hot air from the openings at the cabinet's top. Totally enclosed cabinets must count primarily on radiation and conduction as their means of dissipating heat and therefore must be sized based on their conduction and radiation capacities.

A cabinet will dissipate most of its heat through exposed vertical surfaces due to convection air currents; therefore the vertical surface area of the cabinet becomes the determining factor in sizing totally-enclosed cabinets for heat dissipation. Horizontal surfaces do not dissipate heat well and therefore are not considered as a factor. Since the back of the cabinet is usually against a wall, heat dissipation from this area should not be considered either.

The resulting calculation can be based on the front and two sides of the cabinet as long as there is at least six inches of unrestricted air space between the cabinet and adjacent structures. If a cabinet side is against a wall, then that side cannot be considered in the heat dissipation calculation.

An internal circulating air increases the amount of heat transferred to the walls of the cabinet and hence to the outside air.

Instructions for sizing Cabinets

1. Locate the watts loss value for the type of drive being used and its horsepower rating from tables 1-6.

2. Based on the type of enclosure required for the application, locate the minimum enclosure size from table 7 that will dissipate the watts loss of the drive selected in step 1. (Note that NEMA 1 is vented enclosure whereas NEMA 3, 3R, 4, 4X, and 12 are not vented.)[1]

3. Ensure that the selected enclosure is large enough to house not only the drive (with adequate clearance for air ventilation per associated instruction manual) but also any additional control items that may require cabinet mounting. Examples of additional items are input-line fuses, circuit breakers, contactors, relays, timers, etc. Table 9 shows watts loss values for these items. These additional devices can result in sizing a larger enclosure depending on the required mounting space.

[1]For a further discussion of NEMA and its definitions, see "Does this Nema Rating Match Your Required IP Rating?" (D-7745)

Table 7. Enclosure Heat Dissipation Capacity

HxWxD (inches)	Cabinet Type	Vertical sq. in.	WATTS NEMA 1		WATTS NEMA 12		WATTS Positive pressure
			No. P.U. fan	P.U. Fan	P.U. Fan Only	P.U. Fan Only	
24x24x16	Wall-mount	1,344	525	700	305	350	NA
30x24x16	Wall-mount	1,680	615	820	340	390	NA
36x30x16	Wall-mount	2,232	810	1,080	385	440	NA
48x36x16	Wall-mount	3,264	990	1,320	575	600	NA
86x34x24	1-bay floor-mount	7,039	1,620	2,120	760	880	4,141
86x64x24	2-bay floor-mount	9,641	2,220	2,940	1,000	1,140	8,100
86x94x24	3-bay floor-mount	12,244	2,840	3,760	1,230	1,410	12,000

P.U.=Power Unit

Applications with Multiple Drives

For multiple drives in one cabinet, add the watts loss values of all drives to obtain the total watts loss that the enclosure will be required to dissipate. Use this value for steps 2 and 3 above.

Other Cabinet and Heat-Related Issues

Type "1A" and other Enclosure Definitions

Slots and louvers provide ventilation in NEMA 1enclosures. Type "1A" is not defined by NEMA and carries different meanings to different people. Some people believe that "1A" means a pressurized cabinet, while others believe that it means door gaskets are added to a NEMA 1 cabinet. Pressurized cabinets are sometimes considered to be dust-tight as the positive pressure prevents the ingress of airborne particles. The definition of "1A" varies from customer to customer, so get a clear definition from them before specifying NEMA "1A".

Sizing Cabinets Purchased Externally

Reliance Electric Standard Drives provides NEMA 1 and NEMA 12 cabinets as per the selections shown in the D-406 catalog. However, there are requirements for other cabinet types such as NEMA 3, 3R, 3S, 4, 4X, and 13 which must be externally purchased through a third party. To establish heat dissipation capacities for these cabinets, determine the total vertical square inches of the sides, front of the enclosure. Again, since the assumption is that the cabinet sits against a wall, the back area cannot be used to dissipate heat.

Then, apply this formula for a close estimation of the watts dissipation:

Watts dissipation = 0.125 (watts/in2) X Vertical sq. in.

Check the value calculated against the watts loss of all drives and accessories to be mounted in the cabinet to see if the size is sufficient.

De-rating for High Ambient Conditions

The watts loss values provided in the tables above and the formula are based on a 40°C ambient and allow for a 15°C rise to 55°C (internal). If the application conditions require the enclosure mounted in an area where the ambient exceeds 40°C, table 8 should be used to de-rate cabinet heat dissipation capability.

Table 8. High Ambient De-rating factors

Ambient Temperature	De-Rating Factor
40° C (104° F)	Cabinet Heat Capacity X 1
45° C (113° F)	Cabinet Heat Capacity X .602
50° C (122° F)	Cabinet Heat Capacity X .253
55° C (131°F)	Use seperate ventilation

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De-Rating for High Altitude

Altitude is also a factor in enclosure heat dissipation capability. All heat dissipation capacities in the tables are based on an altitude of 3300 feet (1000 meters) or less. At higher altitudes, air density, fan efficiencies, and heat transfer efficiencies all decrease. De-rate heat dissipation capacity of the enclosure by 3% for each additional 1000 feet (305 meters) above the 3300 feet (1000 meters).

Air Conditioning

An alternative to relying on heat dissipation solely through radiation and conduction in totally enclosed cabinets is to cool the cabinet via air conditioning. Since air conditioners are rated in terms of BTU/HR., controller watts loss must be converted to BTU/Hr as follows:

BTU/HR = Watts X 3.413

Please note that not all drives cabinets can be air-conditioned nor are all air conditioners UL®-listed. Please contact Reliance Electric Drives group for application assistance when considering the use of air conditioning.

Table 9. Component Heat Loss Values

Component	Heat Loss
1-phase transformer	0.07 X VA rating
3-phase transformer	0.03 X VA rating
Contacors: Size 1 & 2	10W
Size 3, 4, 4½	20W
Size 5,6	40W
Starters: Size 00, 0, 1	12W
Relays: #00 - 4 pole	12W
#00 - 8 pole	24W
Standard 115 (KUP)	2W
Reference Relays (Ice Cube)	1W
Resistors	I^2R value
Add an extra 10% for miscellaneous components	

For further assistance, please contact you local sales office or Regional Drives Center.

U.S. Drives Technical Support
Tel: (1) 262.512.8176, Fax: (1) 262.512.2222, Email: support@drives.ra.rockwell.com, Online: www.ab.com/support/abdrives

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation, Vorstlaan/Boulevard du Souverain 36, 1170 Brussels, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

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