



 MITSUBISHI
TRANSISTORIZED INVERTER

TECHNICAL NOTE

No. 22

CAPACITY SELECTION

DATA SECTION

MITSUBISHI

CONTENTS

CHAPTER 1 HOW TO USE THIS DATA SECTION

1.1 Using this Technical Note No. 22 with the other Capacity Selection Technical Notes	1-1
1.2 Points about the Data	1-1
(1) Combination of inverter capacity and motor capacity	1-1
(2) Torque type	1-1
(3) Torque coefficient.....	1-1
(4) Torque basis	1-1
(5) Output frequency and voltage	1-2
(6) Driving torque and how to read the data	1-2
(7) How to select the torque type in the combination lists	1-4

CHAPTER 2 DRIVING CAPABILITY DATA

2.1 Standard Motors	2-1
2.1.1 Continuous operation torque coefficient (αc)	2-1
(1) V/F control, magnetic flux vector control, general-purpose magnetic flux vector control (2.2kW, 3.7kW)	2-1
(2) Magnetic flux vector control (A200E series) (0.4kW to 1.5kW), general-purpose magnetic flux vector control (0.4kW to 1.5kW)	2-1
(3) Advanced magnetic flux vector control (0.4kW to 55kW), general-purpose magnetic flux vector control (5.5kW, 7.5kW)	2-2
(4) Vector control (standard motor with PLG: cyclic operation mode)	2-2
(5) Vector control (standard motor with PLG: continuous operation mode)	2-2
2.1.2 Short-time maximum torque coefficient torque type.....	2-3
(1) 200V series	2-3
(2) 400V series	2-6
2.2 Constant-Torque Motor [SF-JRCA]	2-9
2.2.1 Continuous operation torque coefficient (αc)	2-9
(1) Advanced magnetic flux vector control, Magnetic flux vector control	2-9
(2) General-purpose magnetic flux vector control	2-9
(3) Vector control (constant-torque motor with PLG: cyclic operation mode)	2-10
(4) Vector control (standard motor with PLG: continuous operation mode)	2-10
2.2.2 Short-time maximum torque coefficient torque type.....	2-11
2.3 Constant-Torque Motor [SF-JRC]	2-12
2.3.1 Continuous operation torque coefficient (αc)	2-12
V/F control, advanced magnetic flux vector control, magnetic flux vector control, general-purpose magnetic flux vector control	2-12
2.3.2 Short-time maximum torque coefficient torque type.....	2-13

2.4 Dedicated Motor	2-14
2.4.1 Continuous operation torque coefficient.....	2-14
Vector control	2-14
2.4.2 Short-time maximum torque coefficient torque type combination list	2-15
(1) 100V class.....	2-15
(2) 200V class.....	2-15
2.5 Data Classified by Torque Type	2-16
2.5.1 V/F control	2-16
2.5.2 Magnetic flux vector control.....	2-22
2.5.3 General-purpose magnetic flux vector control.....	2-27
2.5.4 Vector control	2-31

CHAPTER 3 BRAKING CAPABILITY DATA

3.1 Combinations of Braking Units and Inverters	3-1
3.2 Brake Torque Type.....	3-2
(1) 200V series	3-2
(2) 400V series	3-12
3.3 Brake Torque Data	3-21
3.4 Permissible Power	3-31
3.4.1 Permissible power list.....	3-31
3.4.2 Permissible power data (WRS)	3-33
3.5 Permissible Brake Duty (%ED).....	3-41
3.6 Motor-Absorbed Power.....	3-44

CHAPTER 4 MOTOR AND BRAKE CHARACTERISTICS

4.1 Load Torque Versus Motor Current Characteristics.....	4-1
(1) Standard motors, geared motors.....	4-1
(2) Constant-torque motor (SF-JRCA).....	4-3
(3) Constant-torque motor (SF-JRC)	4-4
(4) Dedicated motor	4-5
4.2 Current Compensation Coefficient	4-6
4.3 Cooling Coefficient	4-7

4.4 Characteristic List	4-9
(1) Rating plate values	4-9
(2) Load characteristics	4-10
4.5 NB Brake Characteristics	4-13

APPENDICES

1. Operating Ranges of the Standard Motors and Geared Motors.....	APP-1
2. Calculation of Required Power	APP-3
3. Formulae for Calculating Load GD^2	APP-4
4. Formulae for Calculating Load Torque	APP-5

CHAPTER 1 HOW TO USE THIS DATA SECTION

1.1 Using This Technical Note No. 22 with the Other Capacity Selection Technical Notes

This Technical Note is a collection of characteristic data used to judge whether or not a motor can be used with an inverter by making calculations about capacity for selection. This data is based on the use of our FR series inverters with our standard motors (2, 4 or 6 poles), constant-torque motors, standard motors with PLG or dedicated motors.

For the specific capacity selection procedures refer to the following technical notes:

- Technical Note No. 23 "Capacity Selection for Continuous Operation"
- Technical Note No. 24 "Capacity Selection for Cyclic Operation"
- Technical Note No. 25 "Capacity Selection for Lifting Operation"

1.2 Points about the Data

The bases and terms of the data used in Chapter 2 and subsequent chapters is described below.

(1) Combination of inverter capacity and motor capacity

The combinations of inverter and motor capacity are classified as described below:

1) Standard combination

- Combination of the same capacities
(For example, a 1.5K inverter and a 1.5kW standard motor are used together)

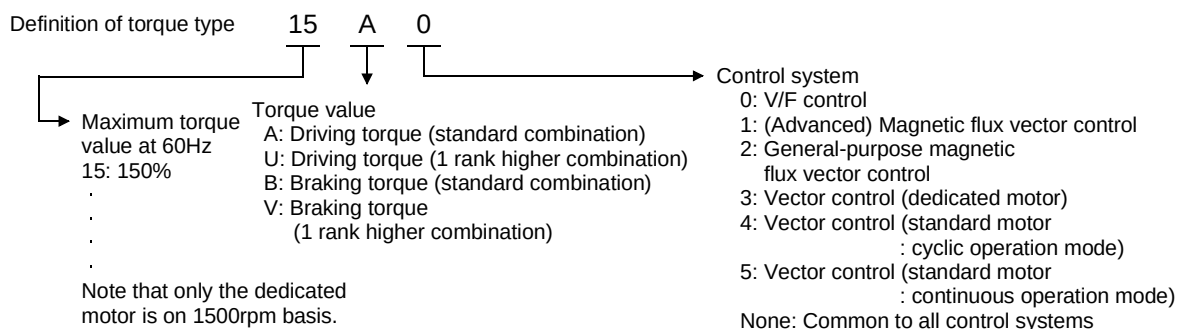
2) One rank higher combination

- The inverter capacity is one rank higher than the motor capacity.
(For example, a 2.2K inverter and a 1.5kW standard motor are used together)

(2) Torque type

Short-time maximum torque for driving or braking during operation varies according to the combination of inverter capacity and motor capacity and the inverter control system. This is represented by a symbol called torque type as indicated below:

(Example)



(3) Torque coefficient

Supposing that the rated torque of the motor at the power supply frequency of 60Hz is 1.0, the ratio of torque to that rated torque is called torque coefficient. The torque coefficient of driving torque is generically represented as α and that of braking torque as β .

(Example) Continuous operation torque coefficient : αc

Short-time maximum torque coefficient : αm

(4) Torque basis

When a machine is to be manufactured, it is designed on the basis of motor-generated torque (rated torque).

Rated motor torque is found from the rated speed at 50Hz or 60Hz. The rated torque at 50Hz is 1.2 times greater than that at 60Hz and similarly the current at 50Hz is also greater.

For this reason, the permissible continuous operation value (torque coefficient) of the motor differs between 50Hz and 60Hz and two types of data, "50Hz torque basis" and "60Hz torque basis", are provided.

- Select the data to be used according to the torque basis value used at the time of machine design. (Independent of the power supply frequency)

Also treat the maximum starting torque coefficient and acceleration/deceleration torque coefficient similarly.

- Care should be taken when an existing machine (designed on the basis of the commercial power supply frequency) is operated by an inverter.

(5) Output frequency and voltage

The characteristic data of V/F control has been prepared on the basis of the following V/F patterns. Also, this torque-basis frequency is called base frequency.

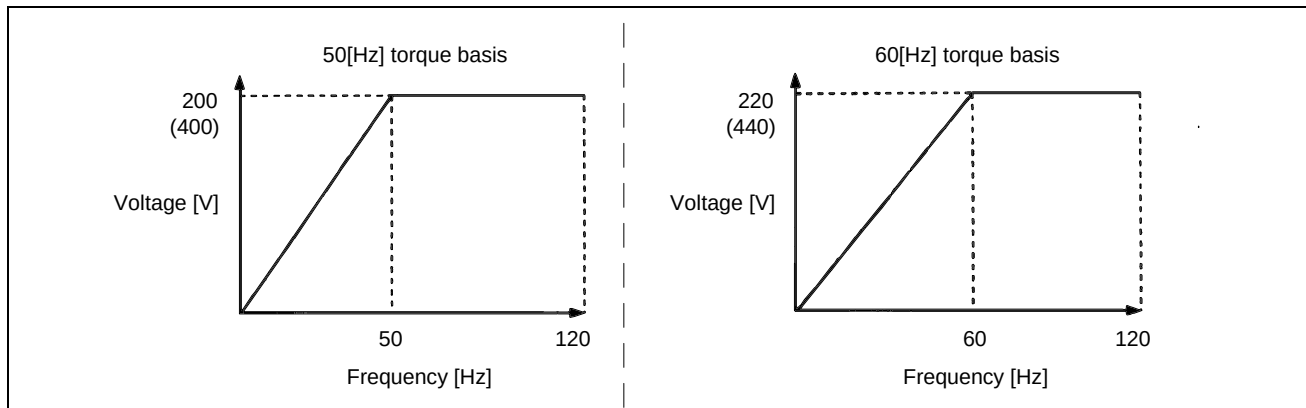


Fig. 1.1 V/F Patterns

(6) Driving torque and how to read the data

1) Continuous operation torque (continuous operation torque coefficient: α_c)

When the motor is operated continuously under load, the motor generates heat and temperature rises. The maximum value of motor-generated torque at which this temperature rise is not more than the specified value determined by the type of motor insulation is referred to as continuous operation torque. The continuous operation torque at the rated voltage and rated frequency is the rated torque. When the motor speed is reduced using an inverter, the speed of the external fan mounted to the motor shaft also reduces. As this lowers the cooling effect, the motor torque must be reduced. This continuous operation torque, which is determined by the motor capacity, remains unchanged even if the inverter capacity is increased.

2) Short-time maximum torque (short-time maximum torque coefficient: α_m)

Torque that can be generated by the motor within the overload current rating (generally 150%) of the inverter is referred to as short-time maximum torque. This torque occurs at points A and B shown in Fig. 1.2.

The short-time maximum torque coefficient is used to examine whether short-time operation can be performed or not.

Short-time maximum torque is determined by the inverter capacity.

Hence, if the inverter capacity is increased, the short-time maximum torque also increases. The time rating of the short-time maximum torque is 1 minute.

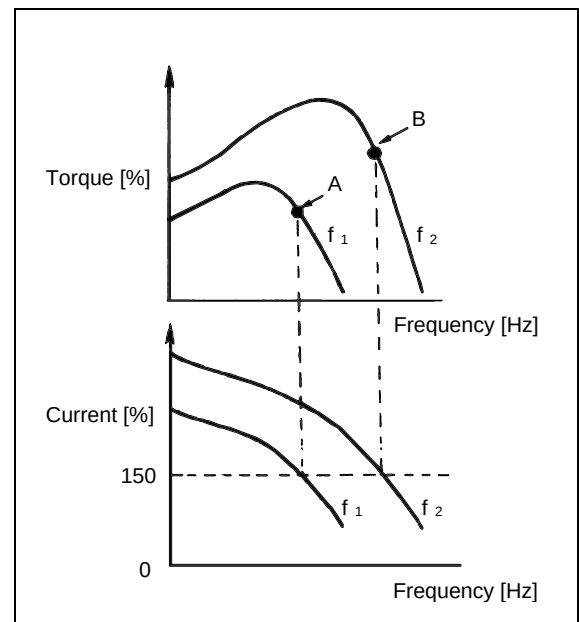


Fig. 1.2 Short-Time Maximum Torque

3) Maximum starting torque (maximum starting torque coefficient: α_s)

The maximum torque that can be generated within the overcurrent limit (generally 150%) of the inverter with a load at a stop (motor shaft locked) is called maximum starting torque.

The maximum starting torque coefficient is used to examine whether the motor can start or not.

In Fig. 1.3, the maximum output frequency within the overcurrent limit (generally 150%) of the inverter is 6Hz. Hence, the maximum torque developed at 6Hz is the maximum starting torque.

Also, at a frequency of less than 6Hz, the inverter does not trip due to overcurrent (OC1) if the motor shaft is locked. Note that if the motor shaft is locked for more than 1 minute, the inverter will trip due to overload (THM).

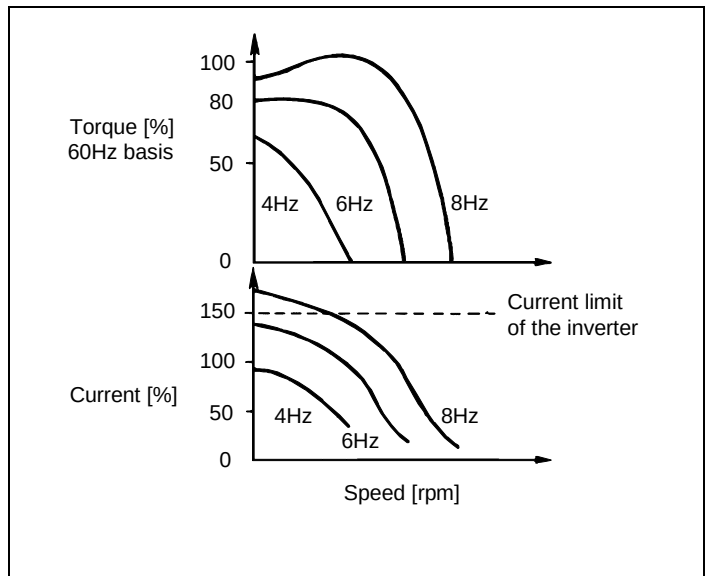


Fig. 1.3 Example of Relationships between Output Frequency, Motor Torque and Current

In Fig. 1.4, the voltage has been increased using torque boost.

(Torque boost: refer to Section 6 on the next page.)

At a frequency lower than that in Fig. 1.3 above (4Hz in this example), a current which reaches the overcurrent limit (generally 150%) flows, generating large starting torque.

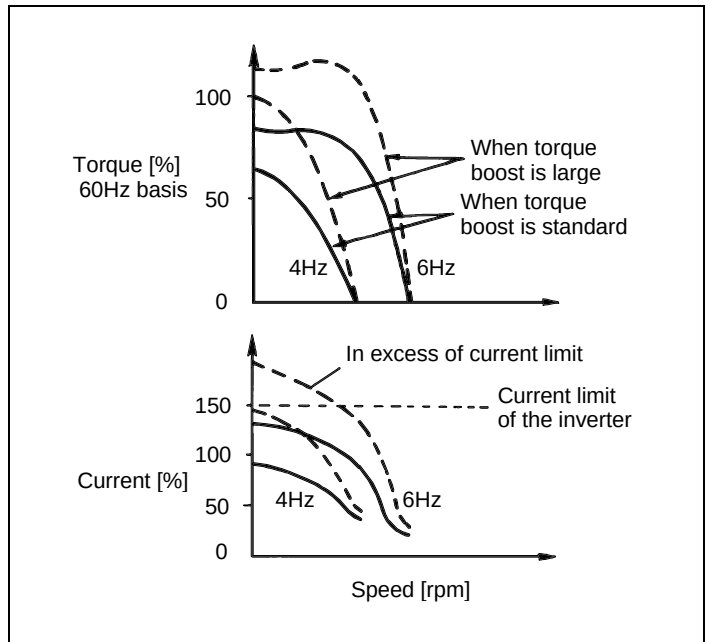


Fig. 1.4 Example of Relationships between Torque Boost, Motor Torque and Current

4) Liner acceleration torque (liner acceleration torque coefficient: α_a)

The maximum torque at which acceleration is possible without the stall prevention function of the inverter being activated during acceleration is called linear acceleration torque. When the inverter is used with a machine which requires accurate operation time, this linear acceleration torque coefficient is used to calculate acceleration time and to examine whether acceleration is possible or not.

5) Non-liner acceleration torque (non-liner acceleration torque coefficient: α_h)

The maximum torque at which acceleration is possible with the stall prevention function of the inverter being activated is called non-linear acceleration torque. When the inverter is used with a machine which has no restriction on accurate starting time, this non-linear acceleration torque coefficient is used to calculate acceleration time and to examine whether acceleration is possible or not.

6) Torque boost

When a motor is driven by an inverter, the voltage varies in proportion to the output frequency. Hence, at low frequencies, the output voltage drops, decreasing the torque generated. For this reason, the voltage can be increased in the low frequency operation range to offset the voltage drop, thereby suppressing the torque reduction. This is called torque boost.

The values for torque boost settings are listed below:

Table 1.1 Torque Boost

	Standard Motor		Constant-Torque Motor SF-JRC	
	Below 7.5 kW	11 kW and above	Below 7.5 kW	11 kW and above
Torque boost standard	6%	3%	4%	2%
Torque boost large	10%	6%	—— *	—— *

* Note that when the torque boost is increased, the current increases and the motor may overheat.

7) Heat coefficient (δ)

When the motor is hot (the winding temperature of the motor is high), torque reduces at below 20Hz. This reduction ratio is represented by the heat coefficient (δ) and used for compensation. The values are indicated below:

Table 1.2 Heat Coefficient

Inverter	Motor Capacity	δ	Application Range of δ
FR-A500	7.5kW or less	0.85	20Hz or less
FR-A200(E)	11 to 55kW	0.94	
FR-A201E			
FR-A024			
FR-Z200			
FR-E500			
FR-V200E	1.5 to 45kW	1.00	Full range

The driving torque coefficient indicated in the tables is the value when the motor is cold (the winding temperature of the motor is normal). To examine whether short-time operation at 20Hz or less can be performed and whether the motor can be started or not, the heat coefficient must be considered.

(7) How to select the torque type in the combination list

Example: Torque type for 0.75kW 4P motor driven by a FR-A540-0.75K inverter

2) 400V series

Inverter FR-A540	Motor Capacity	V/F Control			
		FR-A540 FR-A240(E) FR-A241E Refer to page	FR-Z240 Refer to page		
(In combination with standard inverter)	0.4kW	-0.4K [15A0]	[2 - 8]		
(In combination with 1 rank higher inverter)		-0.75K [20U0]	[2 - 12]		
Inverter capacity	0.75kW	-0.75K [15A0]	[2 - 8]		
		-1.5K [18U0]	[2 - 11]		
Motor 0.75kW	1.5kW	-1.5K [15A0]	[2 - 8]		
Select torque type "150A0".		-2.2K [16U0]	[2 - 9]	-2.2K [16U0]	[2 - 9]
Page containing the torque type "150A0" data	2.2kW	-2.2K [15A0]	[2 - 8]	-2.2K [15A0]	[2 - 8]
		-2.2K [15A0]	[2 - 8]	-2.2K [15A0]	[2 - 8]

Fig. 1.5 Combination List for Torque Type

CHAPTER 2 DRIVING CAPABILITY DATA

The following driving capability data is based on the combination of the FR series inverters and standard or constant-torque motors.

2.1 Standard Motors

2.1.1 Continuous operation torque coefficient (α_c)

(1) V/F control

Magnetic flux vector control (A200E series)

General-purpose magnetic flux vector control (2.2kW, 3.7kW) (A024 series, E520 series)

[60Hz torque basis]

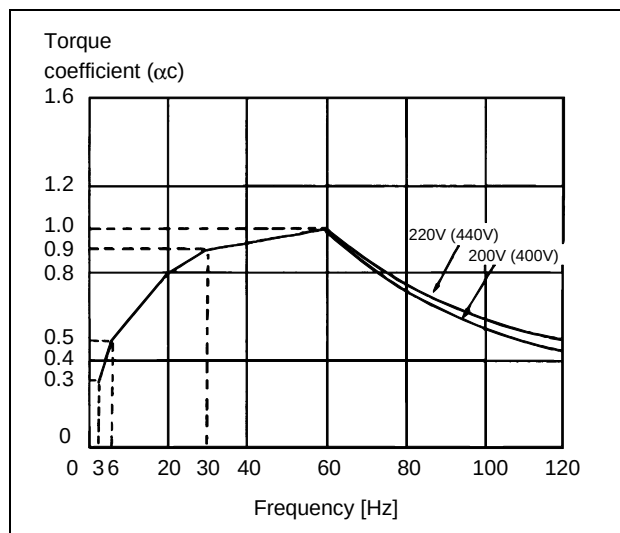


Fig. 2.1

[50Hz torque basis]

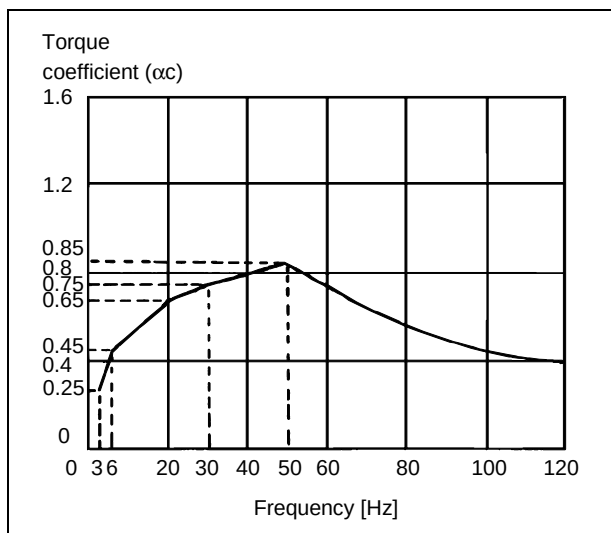


Fig. 2.2

Note: For continuous operation with large manual torque boost, use the motor at 15Hz or less.

(2) Magnetic flux vector control (A200E series) (0.4kW to 1.5kW)

General-purpose magnetic flux vector control (A024 series) (0.4kW to 1.5kW)

[60Hz torque basis]

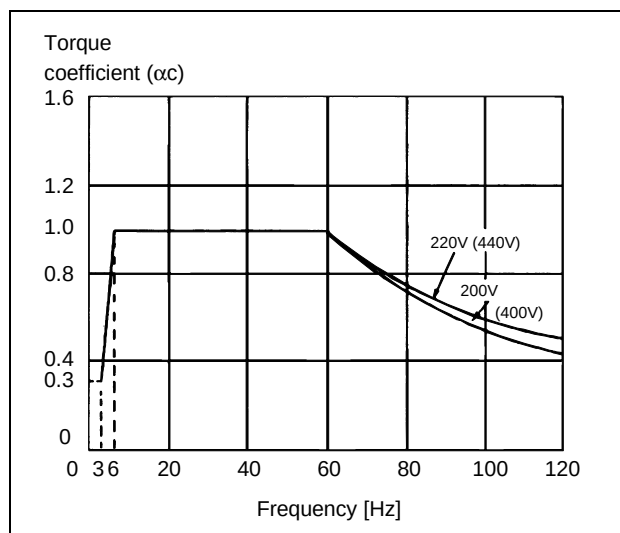


Fig. 2.3

[50Hz torque basis]

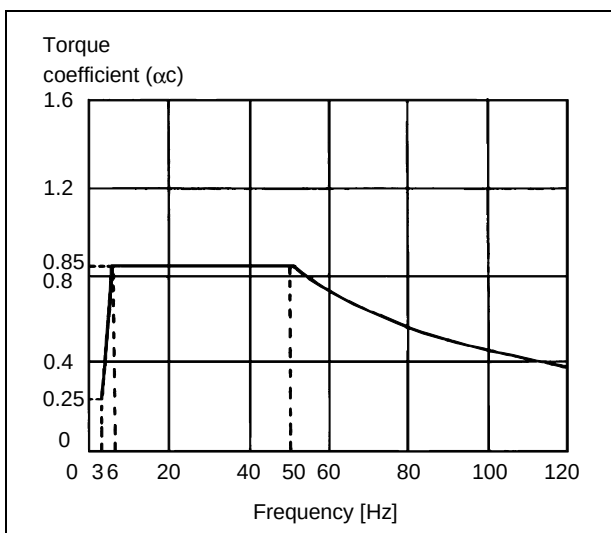


Fig. 2.4

- (3) Advanced magnetic flux vector control (0.4kW to 55kW)
General-purpose magnetic flux vector control (5.5kW, 7.5kW) E520 series only

[60Hz basis]

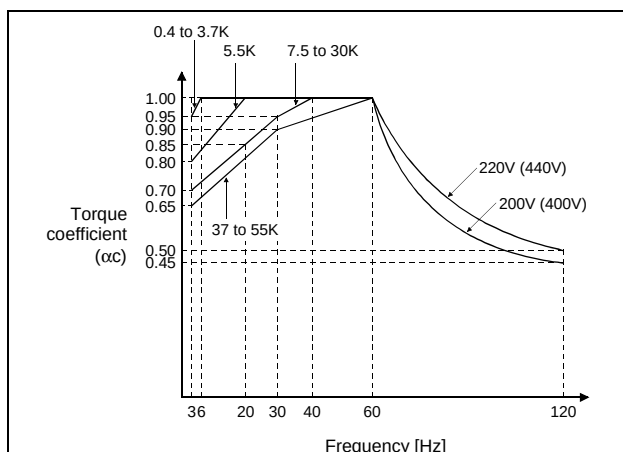


Fig. 2.5

[50Hz basis]

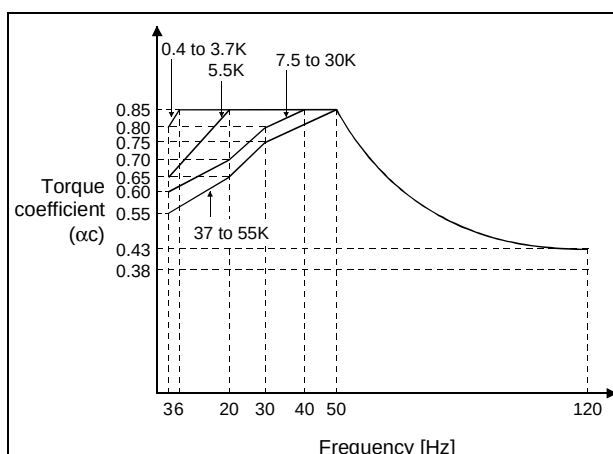


Fig. 2.6

- (4) Vector control (standard motor with PLG: cyclic operation mode)

[1800rpm basis]

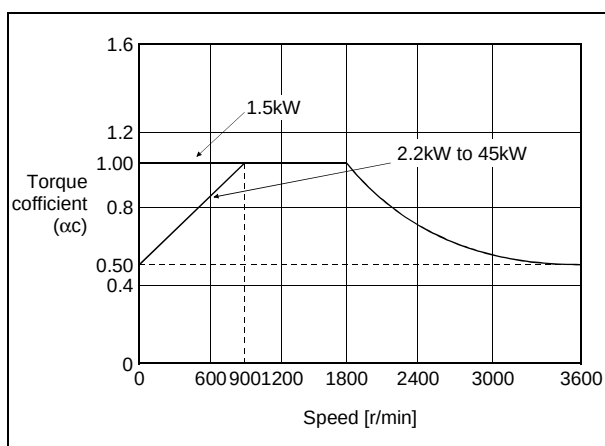


Fig. 2.7

[1500rpm basis]

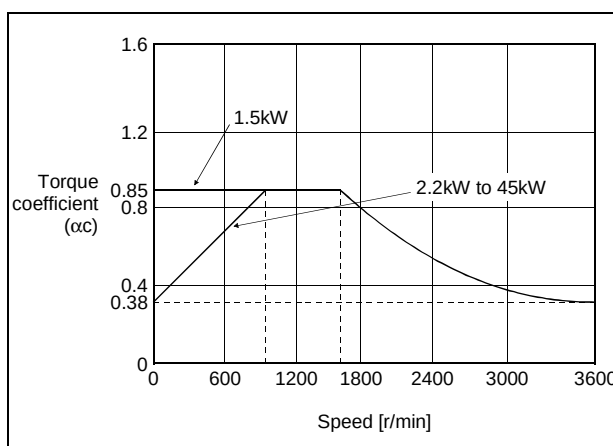


Fig. 2.8

50%ED continuous repeated operation is performed in a 10-minute cycle time.

Continuous operation is performed for a maximum of 5 minutes.

- (5) Vector control (standard motor with PLG: continuous operation mode)

[1800rpm basis]

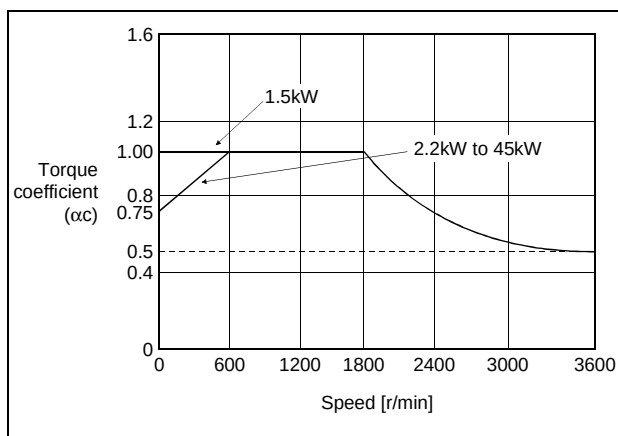


Fig. 2.9

[1500rpm basis]

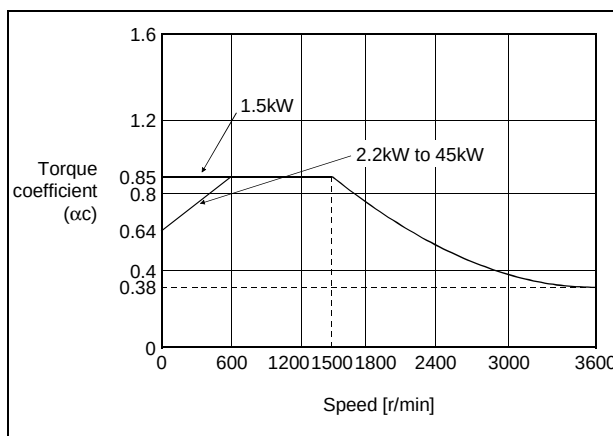
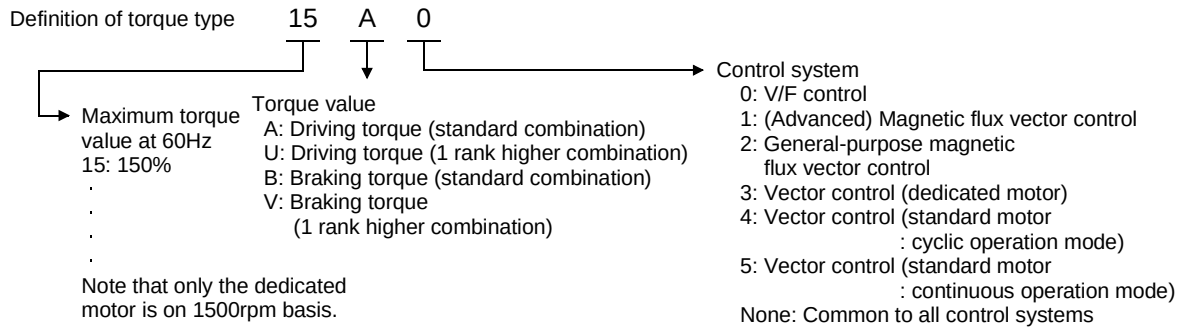


Fig. 2.10

2.1.2 Short-time maximum torque coefficient torque type

For the method of selecting the torque type from the combination list, refer to page 1-4.



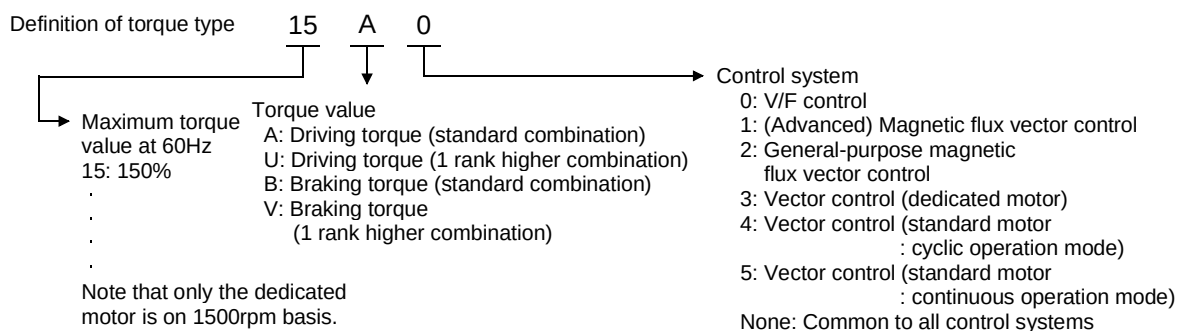
(1) 200V series

Top	Standard combination
Bottom	1 rank higher combination

Motor Capacity	V/F Control								(Advanced) Magnetic flux vector control (General-Purpose) Magnetic Flux Vector Control			
	FR-A520 FR-A220(E) FR-A221 [Refer to page]		FR-Z220 [Refer to page]		FR-A024 FR-E520 [Refer to page]		FR-Z024 [Refer to page]		FR-A520 FR-A220(E) FR-A221 [Refer to page]		FR-A024 FR-E520 [Refer to page]	
0.1kW					-0.1K [15A0]	[2 – 16]	-0.1K [15A0]	[2 – 16]			-0.1K [20A2]	[2 – 29]
					-0.2K [16U0]	[2 – 17]	-0.2K [16U0]	[2 – 17]			-0.2K [22U2]	[2 – 30]
0.2kW					-0.2K [15A0]	[2 – 16]	-0.2K [15A0]	[2 – 16]			-0.2K [20A2]	[2 – 29]
	-0.4K [16U0]	[2 – 17]	-0.4K [16U0]	[2 – 17]	-0.4K [16U0]	[2 – 17]	-0.4K [16U0]	[2 – 17]	-0.4K [16U1]	[2 – 23]	-0.4K [22U2]	[2 – 30]
0.4kW	-0.4K [15A0]	[2 – 16]	-0.4K [15A0]	[2 – 16]	-0.4K [15A0]	[2 – 16]	-0.4K [15A0]	[2 – 16]	-0.4K [15A1]	[2 – 22]	-0.4K [20A2]	[2 – 29]
	-0.75K [20U0]	[2 – 20]	-0.75K [20U0]	[2 – 20]	-0.75K [20U0]	[2 – 20]	-0.75K [20U0]	[2 – 20]	-0.75K [20U1]	[2 – 25]	-0.75K [22U2]	[2 – 30]
0.75kW	-0.75K [15A0]	[2 – 16]	-0.75K [15A0]	[2 – 16]	-0.75K [15A0]	[2 – 16]	-0.75K [15A0]	[2 – 16]	-0.75K [15A1]	[2 – 22]	-0.75K [20A2]	[2 – 29]
	-1.5K [18U0]	[2 – 19]	-1.5K [18U0]	[2 – 19]	-1.5K [18U0]	[2 – 19]	-1.5K [18U0]	[2 – 19]	-1.5K [18U1]	[2 – 24]	-1.5K [22U2]	[2 – 30]
1.5kW	-1.5K [15A0]	[2 – 16]	-1.5K [15A0]	[2 – 16]	-1.5K [15A0]	[2 – 16]	-1.5K [15A0]	[2 – 16]	-1.5K [15A1]	[2 – 22]	-1.5K [20A2]	[2 – 29]
	-2.2K [16U0]	[2 – 17]	-2.2K [16U0]	[2 – 17]	-2.2K [16U0]	[2 – 17]	-2.2K [16U0]	[2 – 17]	-2.2K [16U1]	[2 – 23]	-2.2K [22U2]	[2 – 30]
2.2kW	-2.2K [15A0]	[2 – 16]	-2.2K [15A0]	[2 – 16]	-2.2K [15A0]	[2 – 16]	-2.2K [15A0]	[2 – 16]	-2.2K [15A1]	[2 – 22]	-2.2K [20A2]	[2 – 29]
	-3.7K [18U0]	[2 – 19]	-3.7K [18U0]	[2 – 19]	-3.7K [18U0]	[2 – 19]	-3.7K [18U0]	[2 – 19]	-3.7K [18U1]	[2 – 24]	-3.7K [22U2]	[2 – 30]
3.7kW	-3.7K [15A0]	[2 – 16]	-3.7K [15A0]	[2 – 16]	-3.7K [15A0]	[2 – 16]	-3.7K [15A0]	[2 – 16]	-3.7K [15A1]	[2 – 22]	-3.7K [20A2]	[2 – 29]
	-5.5K [16U0]	[2 – 17]	-5.5K [16U0]	[2 – 17]	*1-5.5K [16U0]	[2 – 17]			-5.5K [16U1]	[2 – 23]	*1-5.5K [15A2]	[2 – 27]
5.5kW	-5.5K [15A0]	[2 – 16]	-5.5K [15A0]	[2 – 16]	*1-5.5K [15A0]	[2 – 16]			-5.5K [15A1]	[2 – 22]	*1-5.5K [18U2]	[2 – 28]
	-7.5K [16U0]	[2 – 17]	-7.5K [16U0]	[2 – 17]	*1-7.5K [16U0]	[2 – 17]			-7.5K [16U1]	[2 – 23]	*1-7.5K [15A2]	[2 – 27]
7.5kW	-7.5K [15A0]	[2 – 16]	-7.5K [15A0]	[2 – 16]					-7.5K [15A1]	[2 – 22]		
	-11K [16U0]	[2 – 17]	-11K [16U0]	[2 – 17]					-11K [16U1]	[2 – 23]		
11kW	-11K [15A0]	[2 – 16]	-11K [15A0]	[2 – 16]					-11K [15A1]	[2 – 22]		
	-15K [16U0]	[2 – 17]	-15K [16U0]	[2 – 17]					-15K [16U1]	[2 – 23]		

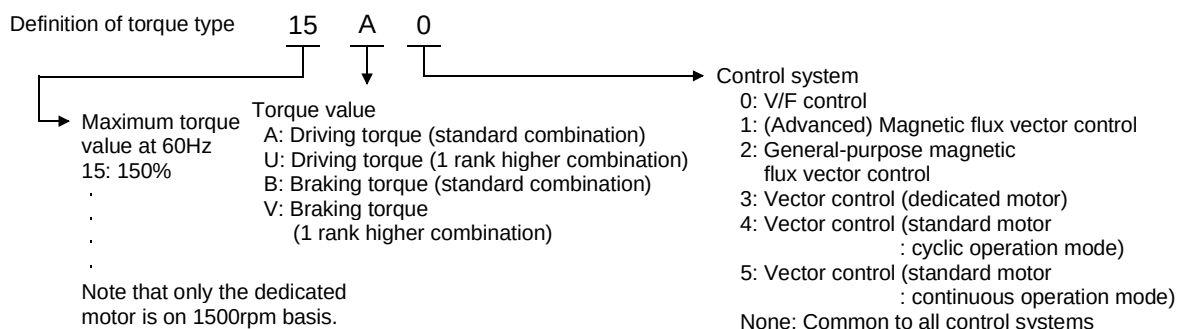
* 1: Data for 5.5K and 7.5K are those of FR-E520.

Motor Capacity	V/F Control								(Advanced) Magnetic flux vector control (General-Purpose) Magnetic Flux Vector Control			
	FR-A520 FR-A220(E) FR-A221 [Refer to page]		FR-Z220 [Refer to page]		FR-A024 FR-E520 [Refer to page]		FR-Z024 [Refer to page]		FR-A520 FR-A220(E) FR-A221 [Refer to page]		FR-A024 FR-E520 [Refer to page]	
15kW	-15K [15A0]	[2 – 16]	-15K [16U0]	[2 – 16]					-15K [15A1]	[2 – 22]		
	-18.5K [16U0]	[2 – 17]	-18.5K [16U0]	[2 – 17]					-18.5K [16U1]	[2 – 23]		
18.5kW	-18.5K [15A0]	[2 – 16]	-18.5K [15A0]	[2 – 16]					-18.5K [15A1]	[2 – 22]		
	-22K [16U0]	[2 – 17]	-22K [16U0]	[2 – 17]					-22K [16U1]	[2 – 23]		
22kW	-22K [15A0]	[2 – 16]	-22K [15A0]	[2 – 16]					-22K [15A1]	[2 – 22]		
	-30K [16U0]	[2 – 17]	-30K [16U0]	[2 – 17]					-30K [16U1]	[2 – 23]		
30kW	-30K [15A0]	[2 – 16]	-30K [15A0]	[2 – 16]					-30K [15A1]	[2 – 22]		
	-37K [16U0]	[2 – 17]	-37K [16U0]	[2 – 17]					-37K [16U1]	[2 – 23]		
37kW	-37K [15A0]	[2 – 16]	-37K [15A0]	[2 – 16]					-37K [15A1]	[2 – 22]		
	-45K [16U0]	[2 – 17]	-45K [15A0]	[2 – 17]					-45K [16U1]	[2 – 23]		
45kW	-45K [15A0]	[2 – 16]	-45K [15A0]	[2 – 16]					-45K [15A1]	[2 – 22]		
	-55K [16U0]	[2 – 17]	-55K [16U0]	[2 – 17]					-55K [16U1]	[2 – 23]		
55kW	-55K [15A0]	[2 – 16]	-55K [15A0]	[2 – 16]					-55K [15A1]	[2 – 22]		



200V series

Motor Capacity	Vector Control, Cyclic Operation Mode		Vector Control, Continuous Operation Mode	
	FR-V220E [Refer to page]		FR-V220E [Refer to page]	
1.5kW	-1.5K [15A4]	[2 – 33]	-1.5K [15A5]	[2 – 35]
2.2kW	-2.2K [15A4]	[2 – 33]	-2.2K [15A5]	[2 – 35]
3.7kW	-3.7K [15A4]	[2 – 33]	-3.7K [15A5]	[2 – 35]
5.5kW	-5.5K [15A4]	[2 – 33]	-5.5K [15A5]	[2 – 35]
7.5kW	-7.5K [15A4]	[2 – 33]	-7.5K [15A5]	[2 – 35]
11kW	-11K [15A4]	[2 – 33]	-11K [15A5]	[2 – 35]
15kW	-15K [15A4]	[2 – 33]	-15K [15A5]	[2 – 35]
18.5kW	-18.5K [15A4]	[2 – 33]	-18.5K [15A5]	[2 – 35]
22kW	-22K [15A4]	[2 – 33]	-22K [15A5]	[2 – 35]
30kW	-30K [15A4]	[2 – 33]	-30K [15A5]	[2 – 35]
37kW	-37K [15A4]	[2 – 33]	-37K [15A5]	[2 – 35]
45kW	-45K [15A4]	[2 – 33]	-45K [15A5]	[2 – 35]

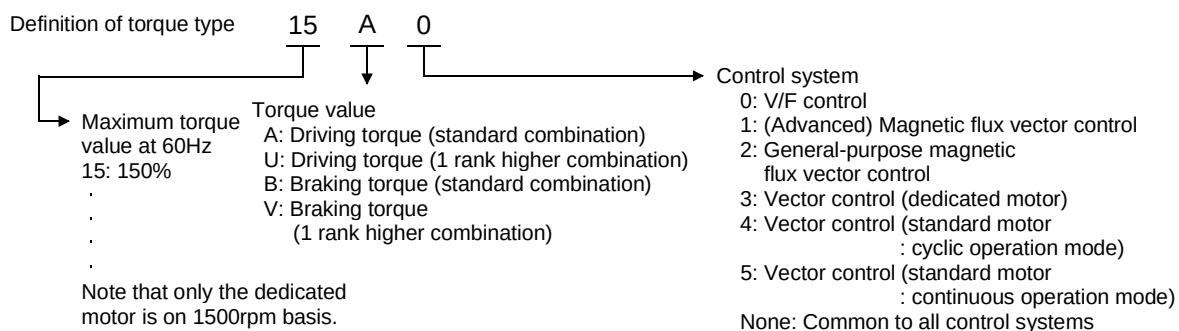


(2) 400V series

Top	Standard combination
Bottom	1 rank higher combination

Motor Capacity	V/F Control						(Advanced) Magnetic flux vector control (General-Purpose) Magnetic Flux Vector Control			
	FR-A540 FR-A240(E) FR-A241E [Refer to page]		FR-Z240 [Refer to page]		FR-A044 [Refer to page]		FR-A540 FR-A240(E) FR-A241E [Refer to page]		FR-A044 [Refer to page]	
0.4kW	-0.4K [15A0]	[2 – 16]			-0.4K [15A0]	[2 – 16]	-0.4K [15A1]	[2 – 22]	-0.4K [20A2]	[2 – 29]
	-0.75K [20U0]	[2 – 20]			-0.75K [20U0]	[2 – 20]	-0.75K [20U1]	[2 – 25]	-0.75K [22U2]	[2 – 30]
0.75kW	-0.75K [15A0]	[2 – 16]			-0.75K [15A0]	[2 – 16]	-0.75K [15A1]	[2 – 22]	-0.75K [20A2]	[2 – 29]
	-1.5K [18U0]	[2 – 19]			-1.5K [18U0]	[2 – 19]	-1.5K [18U1]	[2 – 24]	-1.5K [22U2]	[2 – 30]
1.5kW	-1.5K [15A0]	[2 – 16]			-1.5K [15A0]	[2 – 16]	-1.5K [15A1]	[2 – 22]	-1.5K [20A2]	[2 – 29]
	-2.2K [16U0]	[2 – 17]	-2.2K [16U0]	[2 – 17]	-2.2K [16U0]	[2 – 17]	-2.2K [16U1]	[2 – 23]	-2.2K [22U2]	[2 – 30]
2.2kW	-2.2K [15A0]	[2 – 16]	-2.2K [15A0]	[2 – 16]	-2.2K [15A0]	[2 – 16]	-2.2K [15A1]	[2 – 22]	-2.2K [20A2]	[2 – 29]
	-3.7K [18U0]	[2 – 19]	-3.7K [18U0]	[2 – 19]	-3.7K [18U0]	[2 – 16]	-3.7K [18U1]	[2 – 24]	-3.7K [22U2]	[2 – 30]
3.7kW	-3.7K [15A0]	[2 – 16]	-3.7K [15A0]	[2 – 16]	-3.7K [15A0]	[2 – 16]	-3.7K [15A1]	[2 – 22]	-3.7K [20A2]	[2 – 29]
	-5.5K [16U0]	[2 – 17]	-5.5K [16U0]	[2 – 17]			-5.5K [16U1]	[2 – 23]		
5.5kW	-5.5K [15A0]	[2 – 16]					-5.5K [15A1]	[2 – 22]		
	-7.5K [16U0]	[2 – 17]	-7.5K [16U0]	[2 – 17]			-7.5K [16U1]	[2 – 23]		
7.5kW	-7.5K [15A0]	[2 – 16]	-7.5K [15A0]	[2 – 16]			-7.5K [15A1]	[2 – 22]		
	-11K [16U0]	[2 – 17]	-15K [16U0]	[2 – 17]			-11K [16U1]	[2 – 23]		
11kW	-11K [16U0]	[2 – 16]					-11K [15A1]	[2 – 22]		
	-15K [15A0]	[2 – 17]	-15K [16U0]	[2 – 17]			-15K [16U1]	[2 – 23]		
15kW	-15K [16U0]	[2 – 16]	-15K [15A0]	[2 – 16]			-15K [15A1]	[2 – 22]		
	-18.5K [16U0]	[2 – 17]	-22K [18U0]	[2 – 19]			-18.5K [16U1]	[2 – 23]		
18.5kW	-18.5K [15A0]	[2 – 16]	-22K [15A0]	[2 – 16]			-18.5K [15A1]	[2 – 22]		
	-22K [16U0]	[2 – 17]	-37K [16U0]	[2 – 17]			-22K [16U1]	[2 – 23]		
22kW	-22K [15A0]	[2 – 16]	-22K [15A0]	[2 – 16]			-22K [15A1]	[2 – 22]		
	-30K [16U0]	[2 – 17]	-37K [18U0]	[2 – 19]			-30K [16U1]	[2 – 23]		

Motor Capacity	V/F Control						(Advanced) Magnetic flux vector control (General-Purpose) Magnetic Flux Vector Control			
	FR-A540 FR-A240(E) FR-A241E [Refer to page]		FR-Z240 [Refer to page]		FR-A044 [Refer to page]		FR-A540 FR-A240(E) FR-A241E [Refer to page]		FR-A044 [Refer to page]	
30kW	-30K [15A0]	[2 – 16]					-30K [15A1]	[2 – 22]		
	-37K [16U0]	[2 – 17]	-37K [16U0]	[2 – 17]			-37K [16U1]	[2 – 23]		
37kW	-37K [15A0]	[2 – 16]	-37K [15A0]	[2 – 16]			-37K [15A1]	[2 – 22]		
	-45K [16U0]	[2 – 17]	-55K [16U0]	[2 – 17]			-45K [16U1]	[2 – 23]		
45kW	-45K [15A0]	[2 – 16]					-45K [15A1]	[2 – 22]		
	-55K [16U0]	[2 – 17]	-55K [16U0]	[2 – 17]			-55K [16U1]	[2 – 23]		
55kW	-55K [15A0]	[2 – 16]	-55K [15A0]	[2 – 16]			-55K [15A1]	[2 – 22]		



400V series

Motor Capacity	Vector Control, Cyclic Operation Mode		Vector Control, Continuous Operation Mode	
	FR-V240E [Refer to page]		FR-V240E [Refer to page]	
1.5kW	-1.5K [15A4]	[2 – 33]	-1.5K [15A5]	[2 – 35]
2.2kW	-2.2K [15A4]	[2 – 33]	-2.2K [15A5]	[2 – 35]
3.7kW	-3.7K [15A4]	[2 – 33]	-3.7K [15A5]	[2 – 35]
5.5kW	-5.5K [15A4]	[2 – 33]	-5.5K [15A5]	[2 – 35]
7.5kW	-7.5K [15A4]	[2 – 33]	-7.5K [15A5]	[2 – 35]
11kW	-11K [15A4]	[2 – 33]	-11K [15A5]	[2 – 35]
15kW	-15K [15A4]	[2 – 33]	-15K [15A5]	[2 – 35]
18.5kW	-18.5K [15A4]	[2 – 33]	-18.5K [15A5]	[2 – 35]
22kW	-22K [15A4]	[2 – 33]	-22K [15A5]	[2 – 35]
30kW	-30K [15A4]	[2 – 33]	-30K [15A5]	[2 – 35]
37kW	-37K [15A4]	[2 – 33]	-37K [15A5]	[2 – 35]
45kW	-45K [15A4]	[2 – 33]	-45K [15A5]	[2 – 35]

2.2 Constant-Torque Motor [SF-JRCA]

2.2.1 Continuous operation torque coefficient (α_c)

(1) Advanced magnetic flux vector control • Magnetic flux vector control (A200E series)

[60Hz torque basis]

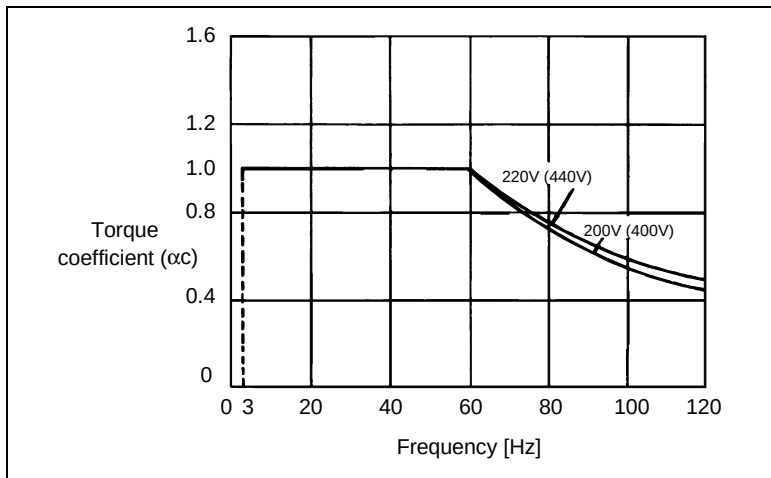


Fig. 2.11

(2) General-purpose magnetic flux vector control (A024 series)

[60Hz torque basis]

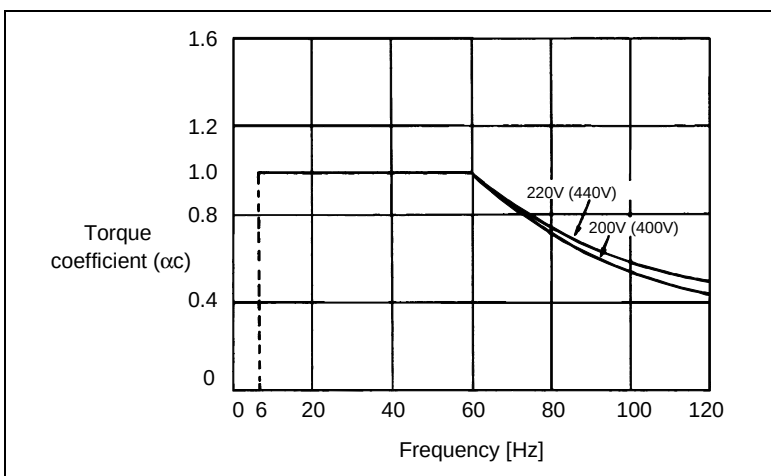


Fig. 2.12

(3) Vector control (standard motor with PLG: cyclic operation mode)

[1800rpm basis]

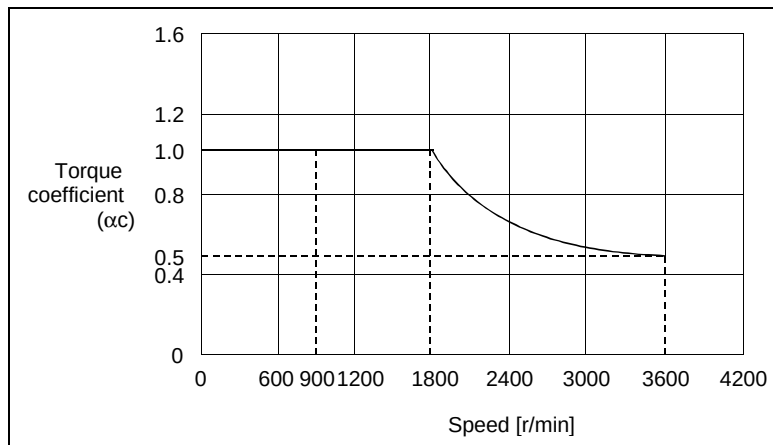


Fig. 2.13

(4) Vector control (standard motor with PLG: continuous operation mode)

[1800rpm basis]

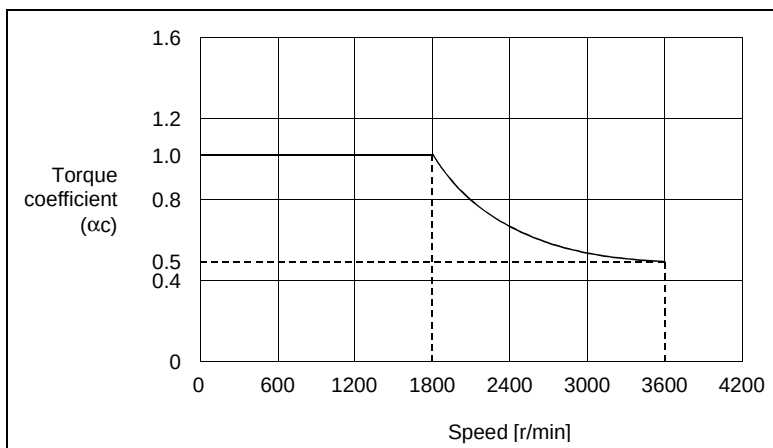
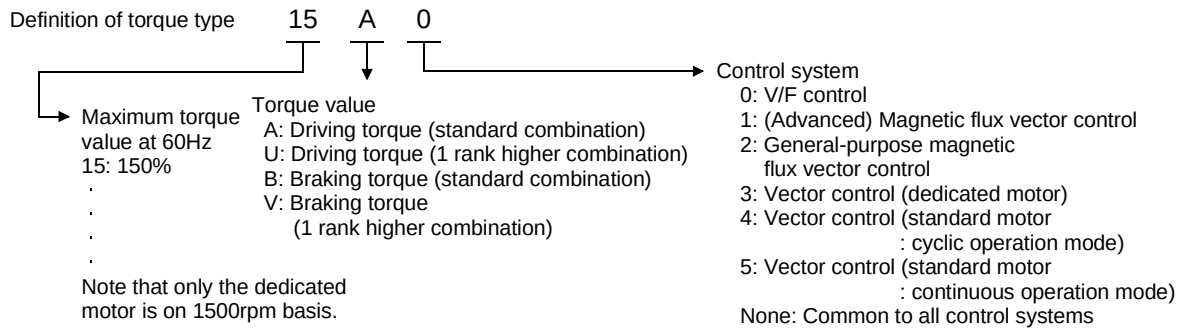


Fig. 2.14

2.2.2 Short-time maximum torque coefficient torque type

Combination list for torque type (SF-JRCA)



200V series

Motor Capacity	(Advanced) Magnetic flux vector control (General-Purpose) Magnetic Flux Vector Control				Vector Control, Cyclic Operation Mode		Vector Control, Continuous Operation Mode	
	FR-A520 FR-A220(E) FR-A221E [Refer to page]		FR-E520 FR-A024 [Refer to page]		FR-V220E [Refer to page]		FR-V220E [Refer to page]	
0.4kW	-0.4K [15A1]	[2 – 22]	-0.45K [18A2]	[2 – 28]				
0.75kW	-0.75K [15A1]	[2 – 22]	-0.75K [18A2]	[2 – 28]				
1.5kW	-1.5K [15A1]	[2 – 22]	-1.5K [18A2]	[2 – 28]	-1.5K [15A4]	[2 – 33]	-1.5K [15A5]	[2 – 35]
2.2kW	-2.2K [15A1]	[2 – 22]	-2.2K [18A2]	[2 – 28]	-2.2K [15A4]	[2 – 33]	-2.2K [15A5]	[2 – 35]
3.7kW	-3.7K [15A1]	[2 – 22]	-3.7K [18A2]	[2 – 28]	-3.7K [15A4]	[2 – 33]	-3.7K [15A5]	[2 – 35]
5.5kW	-5.5K [15A1]	[2 – 22]	*1 -5.5K [15A2]	[2 – 27]	-5.5K [15A4]	[2 – 33]	-5.5K [15A5]	[2 – 35]
7.5kW	-7.5K [15A1]	[2 – 22]	*1 -7.5K [15A2]	[2 – 27]	-7.5K [15A4]	[2 – 33]	-7.5K [15A5]	[2 – 35]
11kW	-11K [15A1]	[2 – 22]			-11K [15A4]	[2 – 33]	-11K [15A5]	[2 – 35]
15kW	-15K [15A1]	[2 – 22]			-15K [15A4]	[2 – 33]	-15K [15A5]	[2 – 35]
18.5kW	-18.5K [15A1]	[2 – 22]			-18.5K [15A4]	[2 – 33]	-18.5K [15A5]	[2 – 35]
22kW	-22K [15A1]	[2 – 22]			-22K [15A4]	[2 – 33]	-22K [15A5]	[2 – 35]
30kW	-30K [15A1]	[2 – 22]			-30K [15A4]	[2 – 33]	-30K [15A5]	[2 – 35]
37kW	-37K [15A1]	[2 – 22]			-37K [15A4]	[2 – 33]	-37K [15A5]	[2 – 35]
45kW	-45K [15A1]	[2 – 22]			-45K [15A4]	[2 – 33]	-45K [15A5]	[2 – 35]

* 1: Data for 5.5K and 7.5K are those of FR-E520.

2.3 Constant-Torque Motor [SF-JRC]

2.3.1 Continuous operation torque coefficient (α_c)

V/F control

Advanced Magnetic flux vector control (A500 series)

Magnetic flux vector control (A200E series)

General-purpose magnetic flux vector control (A024 series, E520 series)

[60Hz torque basis]

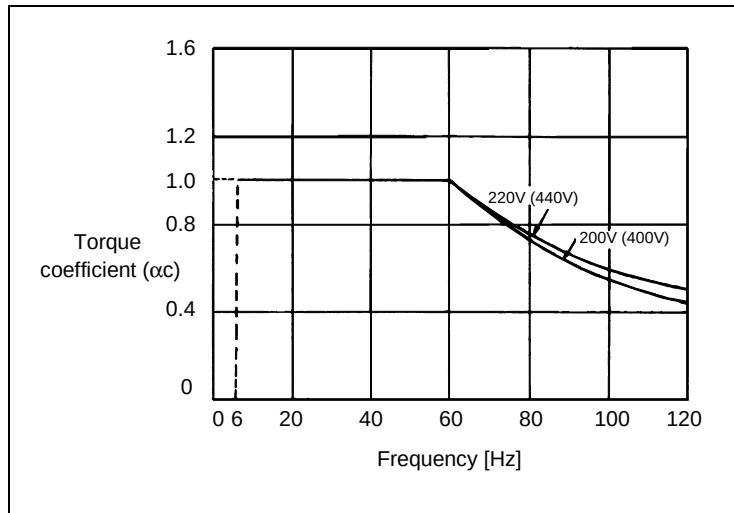
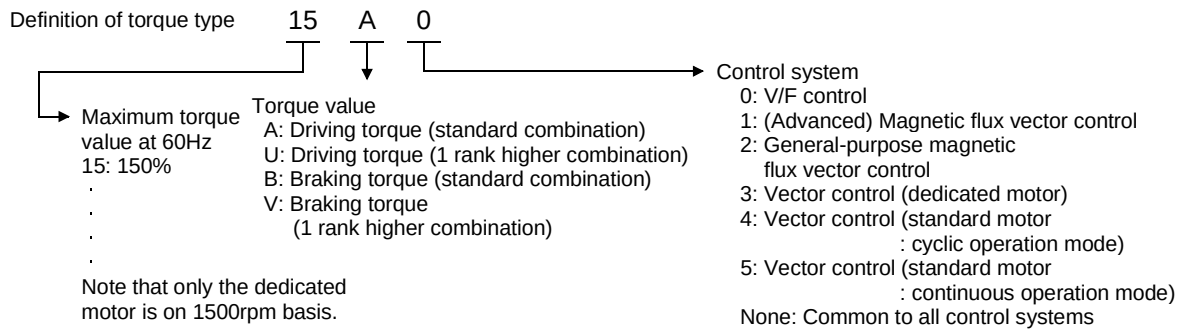


Fig. 2.15

2.3.2 Short-time maximum torque coefficient torque type

Combination list for torque type (SF-JRC)



200V series

Motor Capacity	V/F Control						Advanced Magnetic flux vector control (General-Purpose) Magnetic Flux Vector Control			
	FR-A520 FR-A220(E) FR-A221E [Refer to page]		FR-Z220 [Refer to page]		FR-E520 FR-A024 [Refer to page]		FR-A520 FR-A220(E) FR-A221E [Refer to page]		FR-E520 FR-A024 [Refer to page]	
0.4kW	-0.4K [15A0]	[2 – 16]	-0.4K [15A0]	[2 – 16]	-0.45K [15A0]	[2 – 16]	-0.4K [15A1]	[2 – 22]	-0.45K [18A2]	[2 – 28]
0.75kW	-0.75K [15A0]	[2 – 16]	-0.75K [15A0]	[2 – 16]	-0.75K [15A0]	[2 – 16]	-0.75K [15A1]	[2 – 22]	-0.75K [18A2]	[2 – 28]
1.5kW	-1.5K [15A0]	[2 – 16]	-1.5K [15A0]	[2 – 16]	-1.5K [15A0]	[2 – 16]	-1.5K [15A1]	[2 – 22]	-1.5K [18A2]	[2 – 28]
2.2kW	-2.2K [15A0]	[2 – 16]	-2.2K [15A0]	[2 – 16]	-2.2K [15A0]	[2 – 16]	-2.2K [15A1]	[2 – 22]	-2.2K [18A2]	[2 – 28]
3.7kW	-3.7K [15A0]	[2 – 16]	-3.7K [15A0]	[2 – 16]	-3.7K [15A0]	[2 – 16]	-3.7K [15A1]	[2 – 22]	-3.7K [18A2]	[2 – 28]
5.5kW	-5.5K [15A0]	[2 – 16]	-5.5K [15A0]	[2 – 16]	*1-5.5K [15A0]	[2 – 16]	-5.5K [15A1]	[2 – 22]	*1-5.5K [15A2]	[2 – 27]
7.5kW	-7.5K [15A0]	[2 – 16]	-7.5K [15A0]	[2 – 16]	*1-7.5K [15A0]	[2 – 16]	-7.5K [15A1]	[2 – 22]	*1-7.5K [15A2]	[2 – 27]
11kW	-11K [15A0]	[2 – 16]	-11K [15A0]	[2 – 16]			-11K [15A1]	[2 – 22]		
15kW	-15K [15A0]	[2 – 16]	-18.5K [15A0]	[2 – 16]			-15K [15A1]	[2 – 22]		
18.5kW	-18.5K [15A0]	[2 – 16]	-22K [15A0]	[2 – 16]			-18.5K [15A1]	[2 – 22]		
22kW	-22K [15A0]	[2 – 16]	-30K [15A0]	[2 – 16]			-22K [15A1]	[2 – 22]		
30kW	-30K [15A0]	[2 – 16]	-37K [15A0]	[2 – 16]			-30K [15A1]	[2 – 22]		
37kW	-37K [15A0]	[2 – 16]	-45K [15A0]	[2 – 16]			-37K [15A1]	[2 – 22]		
45kW	-45K [15A0]	[2 – 16]	-55K [15A0]	[2 – 16]			-45K [15A1]	[2 – 22]		

* 1: Data for 5.5K and 7.5K are those of FR-E520.

2.4 Dedicated Motor

2.4.1 Continuous operation torque coefficient (α_c)
Vector control (V200 series)

[1500rpm basis]

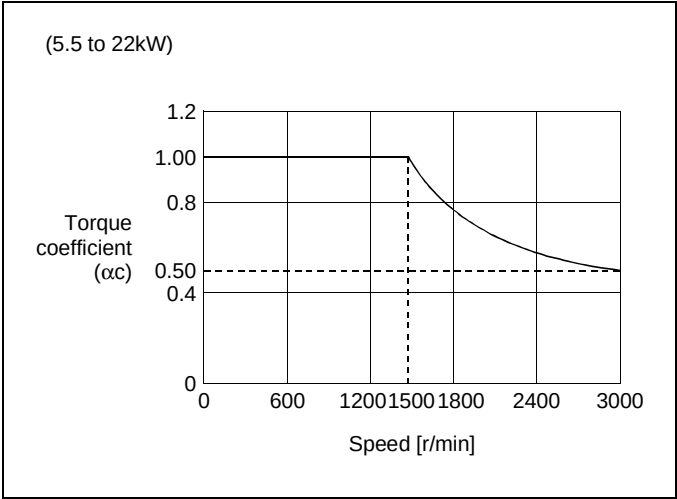


Fig. 2.16

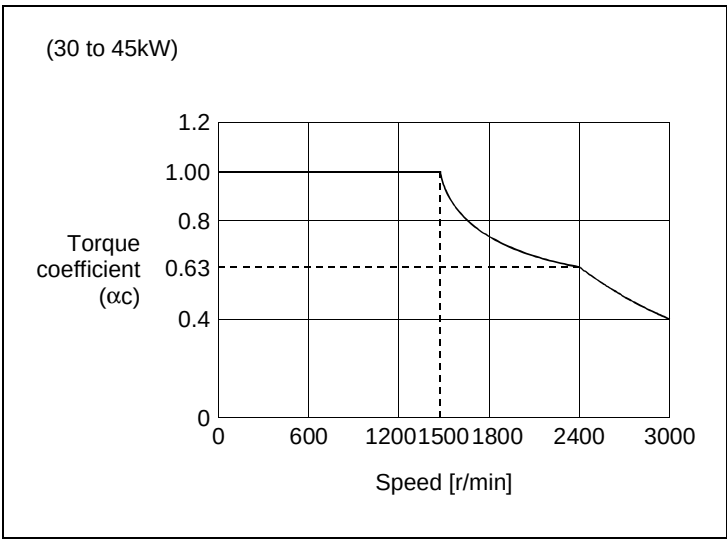
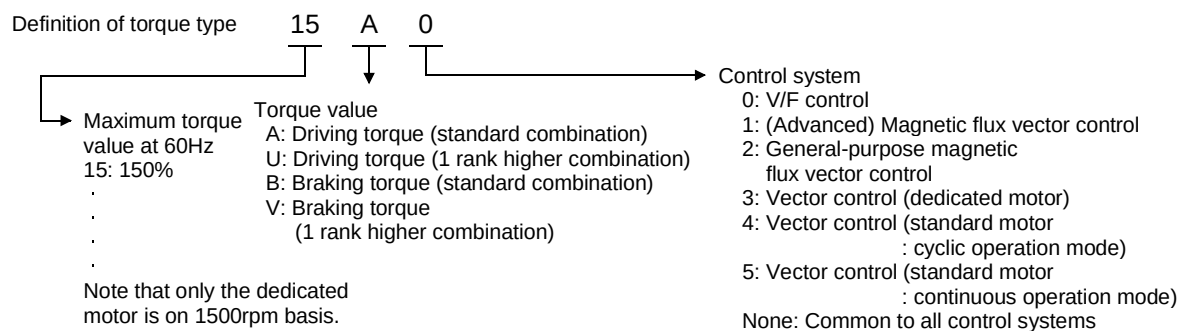


Fig. 2.17

2.4.2 Short-time maximum torque coefficient torque type (dedicated motor)



(1) 200V class

Motor Capacity	Vector Control	
	FR-V220E [Refer to page]	
5.5kW	-5.5K [15A3]	[2 – 31]
7.5kW	-7.5K [15A3]	[2 – 31]
11kW	-11K [15A3]	[2 – 31]
15kW	-15K [15A3]	[2 – 31]
18.5kW	-18.5K [15A3]	[2 – 31]
22kW	-22K [15A3]	[2 – 31]
30kW	-30K [15A3]	[2 – 31]
37kW	-37K [15A3]	[2 – 31]
45kW	-45K [15A3]	[2 – 31]

(2) 400V class

Motor Capacity	Vector Control	
	FR-V240E [Refer to page]	
5.5kW	-5.5K [15A3]	[2 – 31]
7.5kW	-7.5K [15A3]	[2 – 31]
11kW	-11K [15A3]	[2 – 31]
15kW	-15K [15A3]	[2 – 31]
18.5kW	-18.5K [15A3]	[2 – 31]
22kW	-22K [15A3]	[2 – 31]
30kW	-30K [15A3]	[2 – 31]
37kW	-37K [15A3]	[2 – 31]
45kW	-45K [15A3]	[2 – 31]

Top	Standard combination
Bottom	1 rank higher combination

2.5 Data Classified by Torque Type

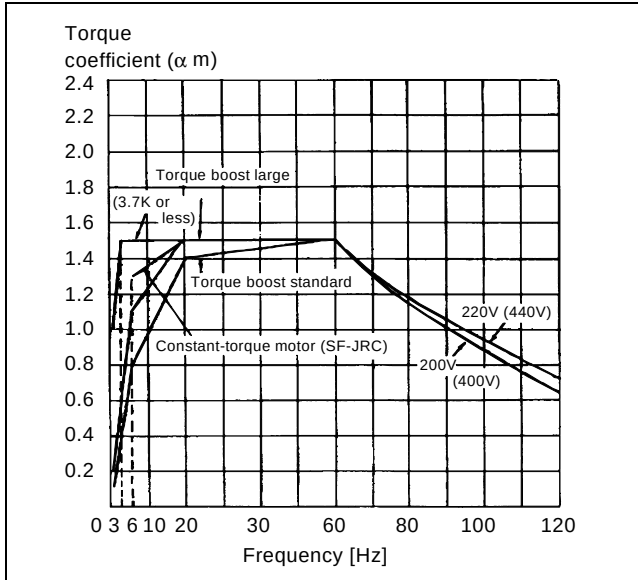
2.5.1 V/F control

Torque type **15A0**

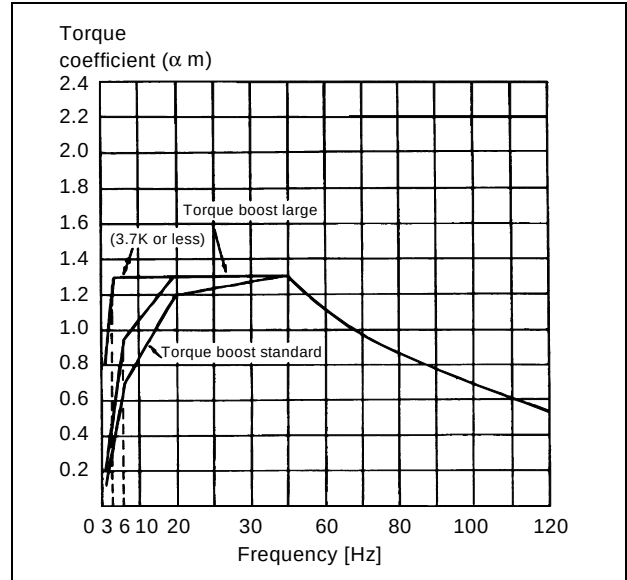
15A0

1) Short-time maximum torque (α_m)

[60Hz torque basis]



[50Hz torque basis]



2) Maximum starting torque (α_s)

Frequency	Manual Torque Boost	Motor Capacity					Maximum Frequency (Hz) 0.1 to 55kW
		0.1 to 1.5kW	2.2 to 3.7kW	5.5 to 7.5kW	11 to 30kW	37 to 55kW	
60Hz	Torque boost standard	0.80	0.80	0.90	0.75	0.75	6
	Torque boost large	1.15	1.15	1.10	0.90	0.90	5
50Hz	Torque boost standard	0.70	0.70	0.75	0.65	0.65	6
	Torque boost large	1.00	1.00	0.95	0.75	0.75	5
Constant-torque motor SF-JRC 60Hz		1.30	1.30	1.30	1.30	1.30	6

3) Linear acceleration torque (α_a) (For any frequency that exceeds 60Hz, use the above graph to find the coefficient.)

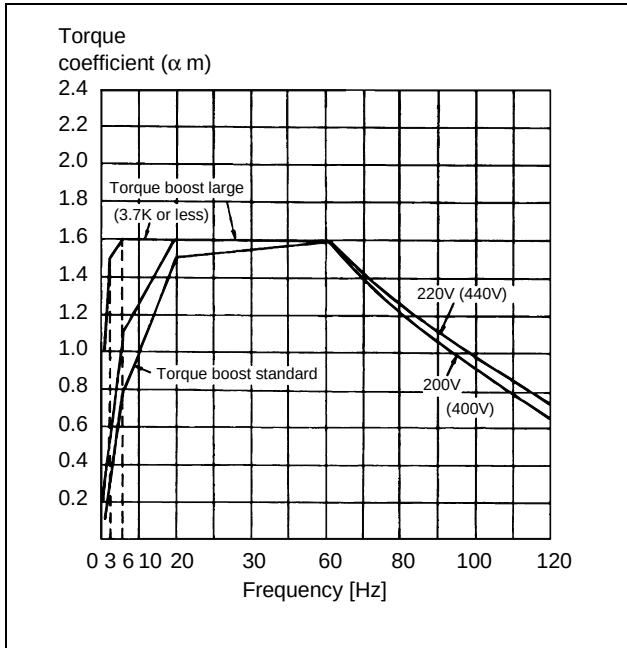
Frequency	Manual Torque Boost	Motor Capacity [kW], Frequency Range [Hz]														
		0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
		0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	Torque boost standard	0.80	0.63	0.63	0.80	0.63	0.63	0.90	0.63	0.63	0.75	0.75	0.80	0.75	—	—
	Torque boost large	1.15	0.63	0.63	1.15	0.63	0.63	1.10	0.63	0.63	0.90	0.80	0.80	0.90	—	—
50Hz	Torque boost standard	0.70	0.50	0.50	0.70	0.50	0.50	0.75	0.50	0.50	0.65	0.60	0.60	0.65	—	—
	Torque boost large	1.00	0.50	0.50	1.00	0.50	0.50	0.95	0.50	0.50	0.75	0.60	0.60	0.75	—	—
Constant-torque motor SF-JRC 60Hz		1.30	0.60	0.60	1.30	0.60	0.60	1.30	0.60	0.60	1.30	0.70	0.70	1.30	—	—

4) Non-linear acceleration torque (α_h)

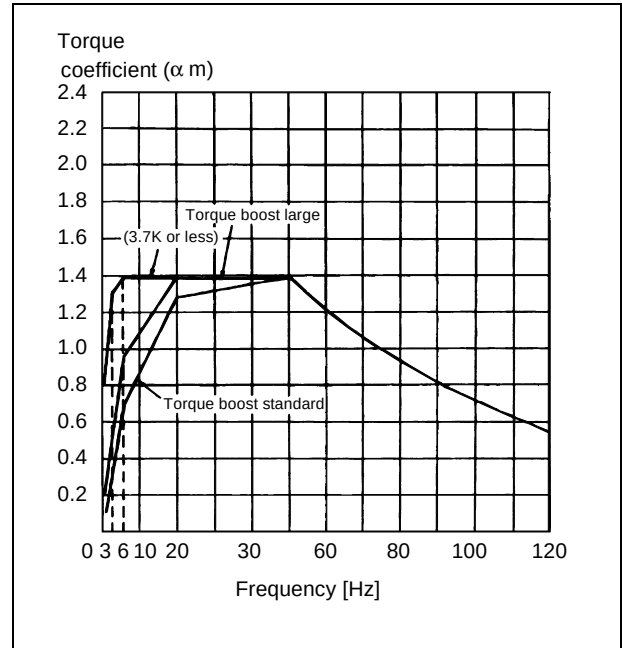
Frequency	Manual Torque Boost	Motor Capacity [kW], Frequency Range [Hz]														
		0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
		0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	Torque boost standard	1.25	1.10	1.00	1.25	1.10	1.00	1.25	1.10	1.00	1.25	1.10	1.00	1.25	—	—
	Torque boost large	1.45	1.20	1.00	1.45	1.20	1.00	1.35	1.15	1.00	1.35	1.15	1.00	1.35	—	—
50Hz	Torque boost standard	1.05	0.90	0.75	1.05	0.90	0.75	1.05	0.90	0.75	1.05	0.90	0.75	1.05	—	—
	Torque boost large	1.25	1.00	0.75	1.25	1.00	0.75	1.15	0.95	0.75	1.15	0.95	0.75	1.15	—	—
Constant-torque motor SF-JRC 60Hz		1.25	0.90	0.60	1.25	0.90	0.60	1.25	0.90	0.60	1.25	1.00	0.70	1.25	—	—

1) Short-time maximum torque (α_m)

[60Hz torque basis]



[50Hz torque basis]

2) Maximum starting torque (α_s)

Frequency	Manual Torque Boost	Motor Capacity					Maximum Frequency (Hz)
		0.1 to 1.5kW	2.2 to 3.7kW	5.5 to 7.5kW	11 to 30kW	37 to 55kW	
60Hz	Torque boost standard	1.05	1.05	1.15	0.95	0.95	15
	Torque boost large	1.35	1.35	1.30	1.05	1.05	12
50Hz	Torque boost standard	0.95	0.95	1.00	0.85	0.85	15
	Torque boost large	1.20	1.20	1.15	0.90	0.90	12

3) Linear acceleration torque (α_a) (For any frequency that exceeds 60Hz, use the above graph to find the coefficient.)

Frequency	Manual Torque Boost	Motor Capacity [kW], Frequency Range [Hz]														
		0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
		0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	Torque boost standard	1.05	0.63	0.63	1.05	0.63	0.63	1.15	0.63	0.63	0.95	0.80	0.80	0.95	—	—
	Torque boost large	1.35	0.63	0.63	1.35	0.63	0.63	1.30	0.63	0.63	1.05	0.80	0.80	1.05	—	—
50Hz	Torque boost standard	0.95	0.50	0.50	0.95	0.50	0.50	1.00	0.50	0.50	0.85	0.60	0.60	0.85	—	—
	Torque boost large	1.20	0.50	0.50	1.20	0.50	0.50	1.15	0.50	0.50	0.90	0.60	0.60	0.90	—	—

4) Non-linear acceleration torque (α_h)

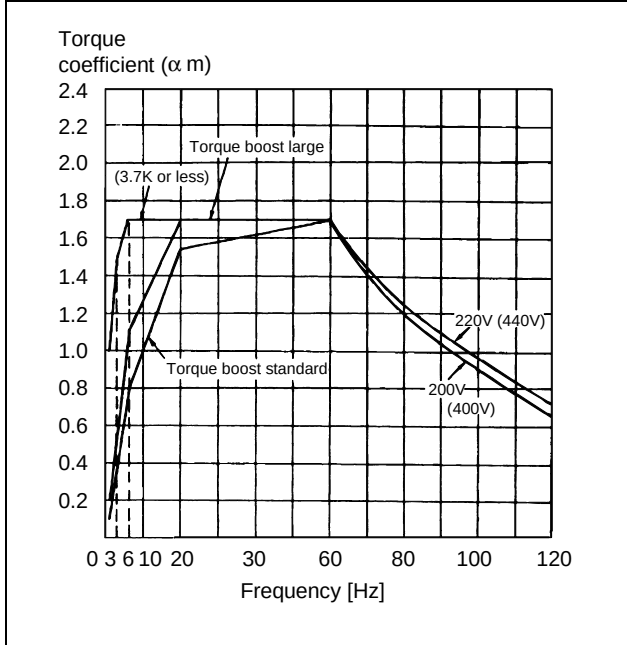
Frequency	Manual Torque Boost	Motor Capacity [kW], Frequency Range [Hz]														
		0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
		0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	Torque boost standard	1.30	1.20	1.05	1.30	1.20	1.05	1.30	1.20	1.05	1.30	1.20	1.05	1.30	—	—
	Torque boost large	1.55	1.30	1.05	1.55	1.30	1.05	1.40	1.25	1.05	1.40	1.25	1.05	1.40	—	—
50Hz	Torque boost standard	1.15	1.00	0.85	1.15	1.00	0.85	1.15	1.00	0.85	1.15	1.00	0.85	1.15	—	—
	Torque boost large	1.30	1.05	0.85	1.30	1.05	0.85	1.20	1.00	0.85	1.20	1.00	0.85	1.20	—	—

Torque type 17U0

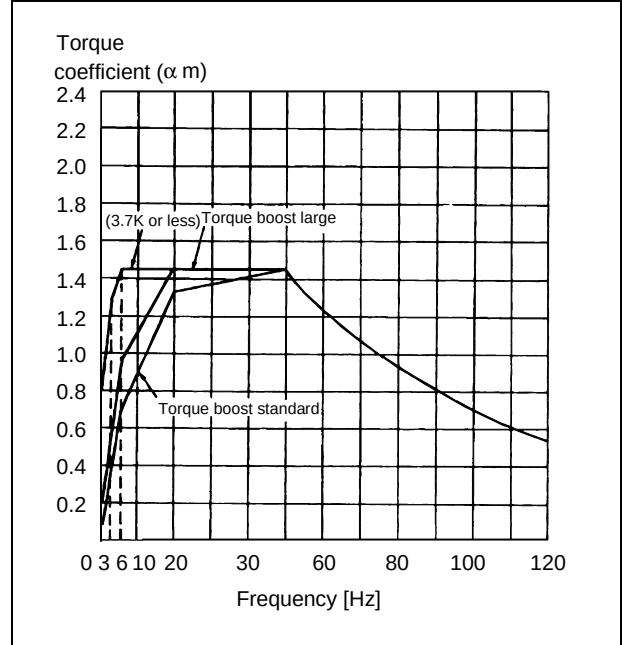
17U0

1) Short-time maximum torque (α_m)

[60Hz torque basis]



[50Hz torque basis]

2) Maximum starting torque (α_s)

Frequency	Manual Torque Boost	Motor Capacity					Maximum Frequency (Hz)
		0.1 to 1.5kW	2.2 to 3.7kW	5.5 to 7.5kW	11 to 30kW	37 to 55kW	
60Hz	Torque boost standard	1.10	1.10	1.20	1.00	1.00	15
	Torque boost large	1.40	1.40	1.35	1.10	1.10	12
50Hz	Torque boost standard	0.95	0.95	1.00	0.90	0.90	15
	Torque boost large	1.20	1.20	1.15	0.90	0.90	12

3) Linear acceleration torque (α_a) (For any frequency that exceeds 60Hz, use the above graph to find the coefficient.)

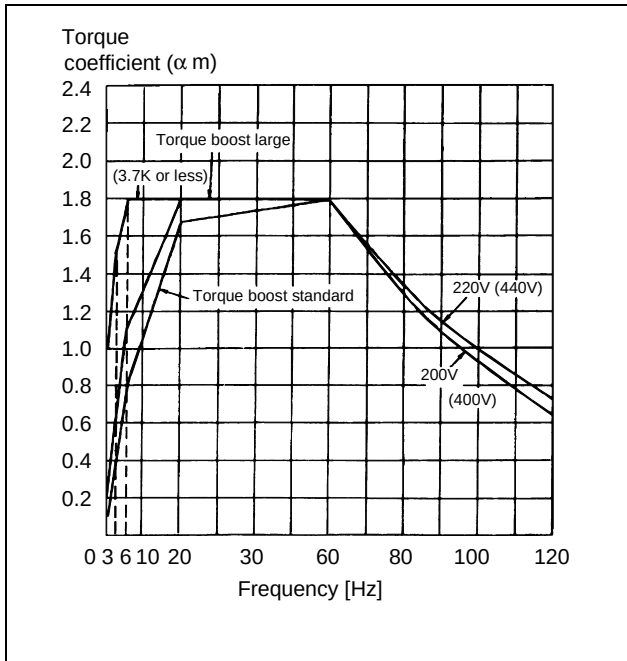
Frequency	Manual Torque Boost	Motor Capacity [kW], Frequency Range [Hz]														
		0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
		0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	Torque boost standard	1.10	0.63	0.63	1.10	0.63	0.63	1.20	0.63	0.63	1.00	0.85	0.85	1.00	—	—
	Torque boost large	1.40	0.63	0.63	1.40	0.63	0.63	1.35	0.63	0.63	1.00	0.85	0.85	1.10	—	—
50Hz	Torque boost standard	0.95	0.50	0.50	0.95	0.50	0.50	1.00	0.50	0.50	0.90	0.65	0.65	0.90	—	—
	Torque boost large	1.20	0.50	0.50	1.20	0.50	0.50	1.15	0.50	0.50	0.90	0.65	0.65	0.90	—	—

4) Non-linear acceleration torque (α_h)

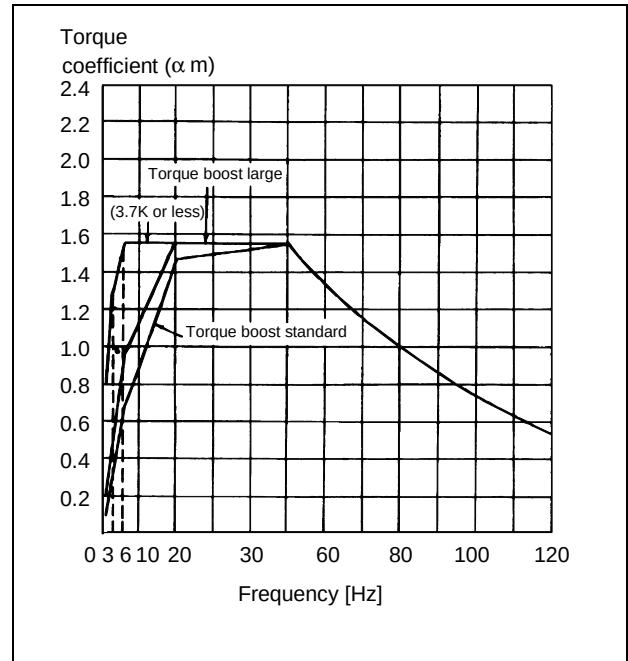
Frequency	Manual Torque Boost	Motor Capacity [kW], Frequency Range [Hz]														
		0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
		0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	Torque boost standard	1.35	1.25	1.10	1.35	1.25	1.10	1.35	1.25	1.10	1.35	1.25	1.10	1.35	—	—
	Torque boost large	1.60	1.35	1.10	1.60	1.35	1.10	1.45	1.30	1.10	1.45	1.30	1.10	1.45	—	—
50Hz	Torque boost standard	1.20	1.05	0.85	1.20	1.05	0.85	1.20	1.05	0.85	1.20	1.05	0.85	1.20	—	—
	Torque boost large	1.40	1.10	0.85	1.40	1.10	0.85	1.25	1.05	0.85	1.25	1.05	0.85	1.25	—	—

1) Short-time maximum torque (αm)

[60Hz torque basis]



[50Hz torque basis]

2) Maximum starting torque (αs)

Frequency	Manual Torque Boost	Motor Capacity					Maximum Frequency (Hz)
		0.1 to 1.5kW	2.2 to 3.7kW	5.5 to 7.5kW	11 to 30kW	37 to 55kW	
60Hz	Torque boost standard	1.15	1.15	1.25	1.05	1.05	15
	Torque boost large	1.45	1.45	1.40	1.15	1.15	12
50Hz	Torque boost standard	1.00	1.00	1.05	0.90	0.90	15
	Torque boost large	1.25	1.25	1.20	0.95	0.95	12

3) Linear acceleration torque (αa) (For any frequency that exceeds 60Hz, use the above graph to find the coefficient.)

Frequency	Manual Torque Boost	Motor Capacity [kW], Frequency Range [Hz]														
		0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
		0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	Torque boost standard	1.15	0.63	0.63	1.15	0.63	0.63	1.25	0.63	0.63	1.05	0.85	0.85	1.05	—	—
	Torque boost large	1.45	0.63	0.63	1.45	0.63	0.63	1.40	0.63	0.63	1.15	0.85	0.85	1.15	—	—
50Hz	Torque boost standard	1.00	0.50	0.50	1.00	0.50	0.50	1.05	0.50	0.50	0.90	0.65	0.65	0.90	—	—
	Torque boost large	1.25	0.50	0.50	1.25	0.50	0.50	1.20	0.50	0.50	0.95	0.65	0.65	0.95	—	—

4) Non-linear acceleration torque (αh)

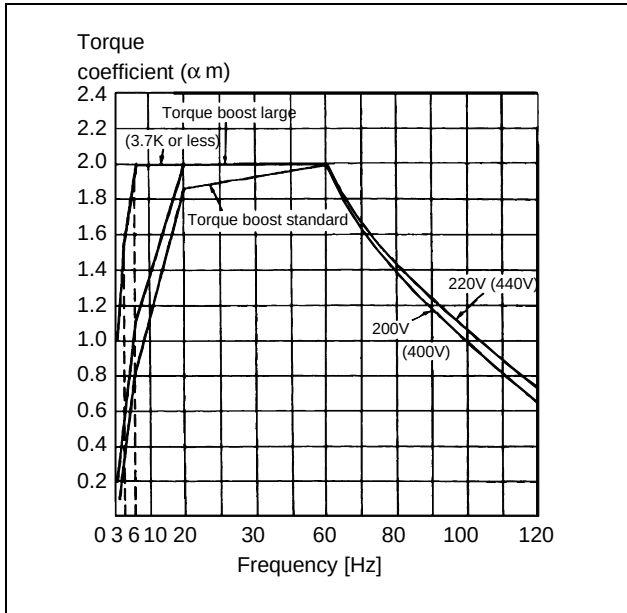
Frequency	Manual Torque Boost	Motor Capacity [kW], Frequency Range [Hz]														
		0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
		0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	Torque boost standard	1.45	1.30	1.20	1.45	1.30	1.20	1.45	1.30	1.20	1.45	1.30	1.20	1.45	—	—
	Torque boost large	1.70	1.45	1.20	1.70	1.45	1.20	1.55	1.35	1.20	1.55	1.35	1.20	1.55	—	—
50Hz	Torque boost standard	1.25	1.10	0.90	1.25	1.10	0.90	1.25	1.10	0.90	1.25	1.10	0.90	1.25	—	—
	Torque boost large	1.50	1.20	0.90	1.50	1.20	0.90	1.35	1.15	0.90	1.35	1.15	0.90	1.35	—	—

Torque type 20U0

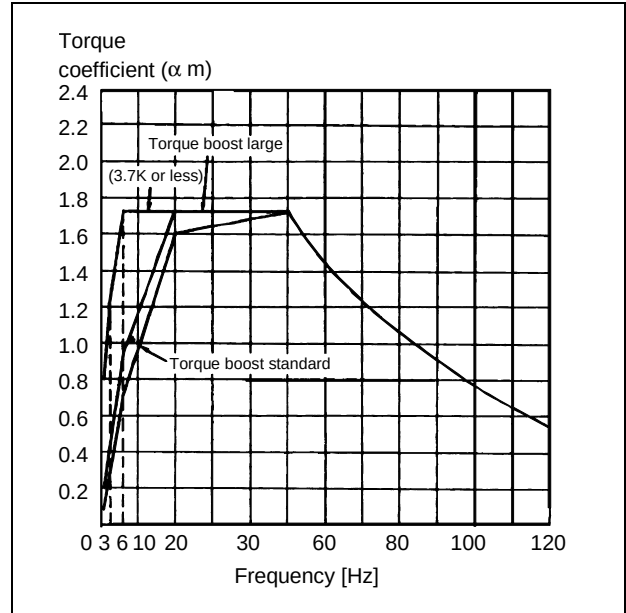
20U0

1) Short-time maximum torque (α_m)

[60Hz torque basis]



[50Hz torque basis]

2) Maximum starting torque (α_s)

Frequency	Manual Torque Boost	Motor Capacity					Maximum Frequency (Hz)
		0.1 to 1.5kW	2.2 to 3.7kW	5.5 to 7.5kW	11 to 30kW	37 to 55kW	
60Hz	Torque boost standard	1.25	1.25	1.40	1.15	1.15	15
	Torque boost large	1.55	1.55	1.50	1.20	1.20	12
50Hz	Torque boost standard	1.05	1.05	1.10	0.95	0.95	15
	Torque boost large	1.35	1.35	1.30	1.00	1.00	12

3) Linear acceleration torque (α_a) (For any frequency that exceeds 60Hz, use the above graph to find the coefficient.)

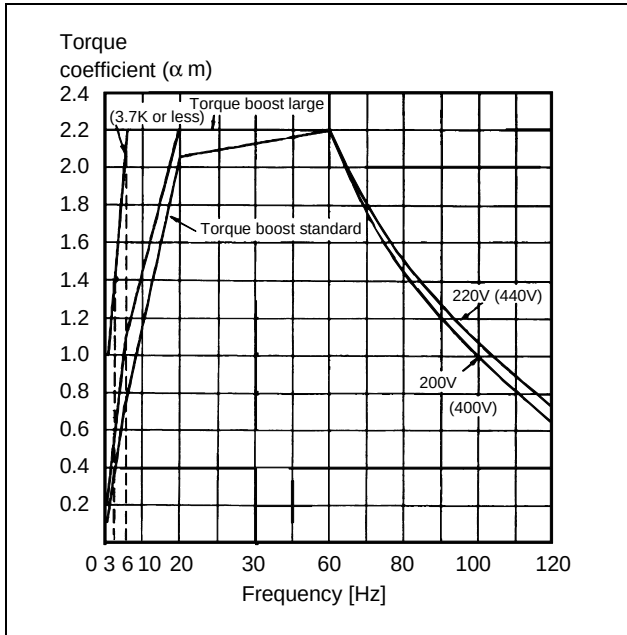
Frequency	Manual Torque Boost	Motor Capacity [kW], Frequency Range [Hz]														
		0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
		0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	Torque boost standard	1.25	0.63	0.63	1.25	0.63	0.63	1.40	0.63	0.63	1.15	0.90	0.90	1.15	—	—
	Torque boost large	1.55	0.63	0.63	1.55	0.63	0.63	1.50	0.63	0.63	1.20	0.90	0.90	1.20	—	—
50Hz	Torque boost standard	1.05	0.50	0.50	1.05	0.50	0.50	1.10	0.50	0.50	0.95	0.70	0.70	0.95	—	—
	Torque boost large	1.35	0.50	0.50	1.35	0.50	0.50	1.30	0.50	0.50	1.00	0.70	0.70	1.00	—	—

4) Non-linear acceleration torque (α_h)

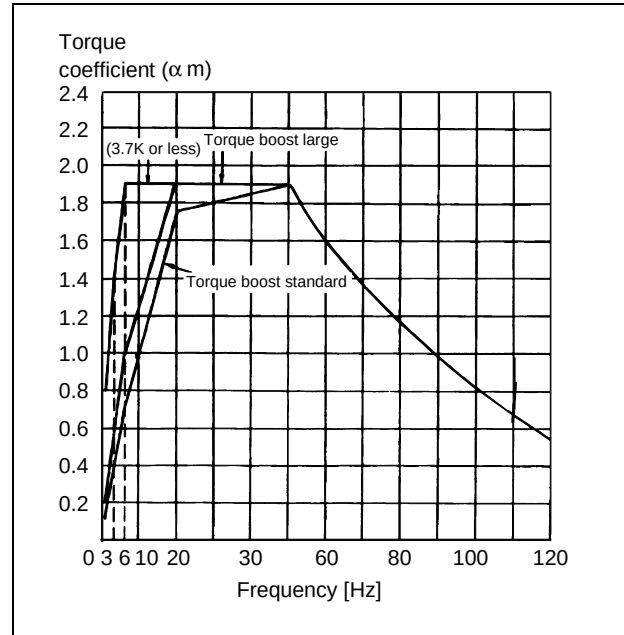
Frequency	Manual Torque Boost	Motor Capacity [kW], Frequency Range [Hz]														
		0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
		0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	Torque boost standard	1.60	1.45	1.30	1.60	1.45	1.30	1.60	1.45	1.30	1.60	1.45	1.30	1.60	—	—
	Torque boost large	1.90	1.60	1.30	1.90	1.60	1.30	1.75	1.50	1.30	1.75	1.50	1.30	1.75	—	—
50Hz	Torque boost standard	1.40	1.20	1.00	1.40	1.20	1.00	1.40	1.20	1.00	1.40	1.20	1.00	1.40	—	—
	Torque boost large	1.65	1.30	1.00	1.65	1.30	1.00	1.50	1.25	1.00	1.50	1.25	1.00	1.50	—	—

1) Short-time maximum torque (αm)

[60Hz torque basis]



[50Hz torque basis]

2) Maximum starting torque (αs)

Frequency	Manual Torque Boost	Motor Capacity					Maximum Frequency (Hz)
		0.1 to 1.5kW	2.2 to 3.7kW	5.5 to 7.5kW	11 to 30kW	37 to 55kW	
60Hz	Torque boost standard	1.30	1.30	1.45	1.20	1.20	15
	Torque boost large	1.65	1.65	1.60	1.30	1.30	12
50Hz	Torque boost standard	1.10	1.10	1.15	1.00	1.00	15
	Torque boost large	1.40	1.40	1.35	1.05	1.05	12

3) Linear acceleration torque (αa) (For any frequency that exceeds 60Hz, use the above graph to find the coefficient.)

Frequency	Manual Torque Boost	Motor Capacity [kW], Frequency Range [Hz]														
		0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
		0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	Torque boost standard	1.30	0.63	0.63	1.30	0.63	0.63	1.45	0.63	0.63	1.20	0.90	0.90	1.20	—	—
	Torque boost large	1.65	0.63	0.63	1.65	0.63	0.63	1.60	0.63	0.63	1.30	0.90	0.90	1.30	—	—
50Hz	Torque boost standard	1.10	0.50	0.50	1.10	0.50	0.50	1.15	0.50	0.50	1.00	0.70	0.70	1.00	—	—
	Torque boost large	1.40	0.50	0.50	1.40	0.50	0.50	1.35	0.50	0.50	1.05	0.70	0.70	1.05	—	—

4) Non-linear acceleration torque (αh)

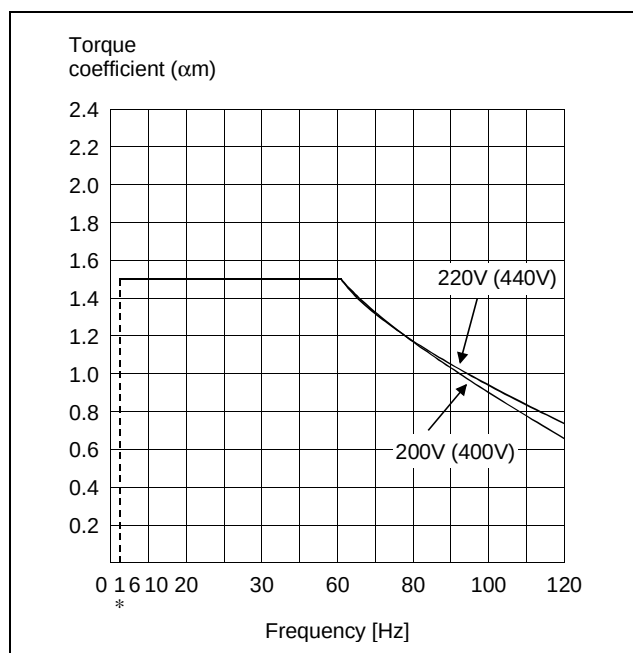
Frequency	Manual Torque Boost	Motor Capacity [kW], Frequency Range [Hz]														
		0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
		0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	Torque boost standard	1.75	1.55	1.35	1.75	1.55	1.35	1.75	1.55	1.35	1.75	1.55	1.35	1.75	—	—
	Torque boost large	2.10	1.75	1.35	2.10	1.75	1.35	1.90	1.65	1.35	1.90	1.65	1.35	1.90	—	—
50Hz	Torque boost standard	1.50	1.30	1.10	1.50	1.30	1.10	1.50	1.30	1.10	1.50	1.30	1.10	1.50	—	—
	Torque boost large	1.80	1.45	1.10	1.80	1.45	1.10	1.65	1.35	1.10	1.65	1.35	1.10	1.65	—	—

2.5.2 Advanced magnetic flux vector control • Magnetic flux vector control (A200E series)

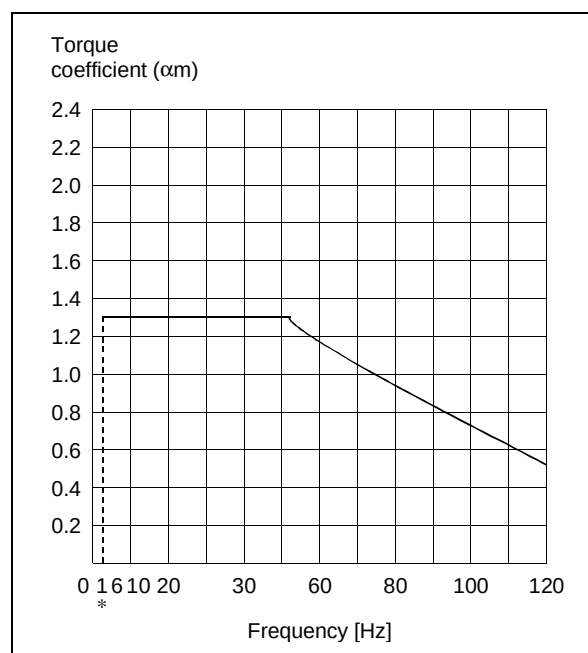
Torque type **15A1**

15A1

1) Short-time maximum torque α_m
[60Hz torque basis]



[50Hz torque basis]



* 0.5Hz for the FR A500 (advanced magnetic flux vector control).

2) Maximum starting torque (α_s)

Frequency	Motor Capacity					Maximum Frequency (Hz)
	0.1 to 1.5kW	2.2 to 3.7kW	5.5 to 7.5kW	11 to 30kW	37 to 55kW	
60Hz	1.50	1.50	1.50	1.50	1.50	1
50Hz	1.30	1.30	1.30	1.30	1.30	1

3) Linear acceleration torque (α_a) (For any frequency that exceeds 60Hz, use the above graph to find the coefficient.)

Frequency	Motor Capacity [kW], Frequency Range [Hz]														
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	1.40	0.63	0.63	1.40	0.63	0.63	1.40	0.63	0.63	1.40	0.80	0.80	1.40	—	—
50Hz	1.20	0.50	0.50	1.20	0.50	0.50	1.20	0.50	0.50	1.20	0.60	0.60	1.20	—	—

4) Non-linear acceleration torque (α_h)

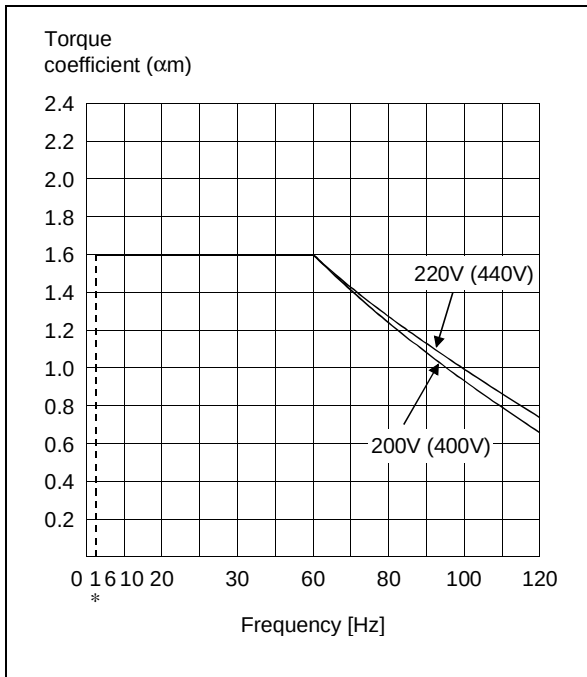
Frequency	Motor Capacity [kW], Frequency Range [Hz]														
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	1.40	1.20	1.00	1.40	1.25	1.10	1.40	1.25	1.10	1.40	1.25	1.10	1.40	—	—
50Hz	1.20	1.00	0.85	1.20	1.05	0.90	1.20	1.05	0.90	1.20	1.05	0.90	1.20	—	—

Torque type 16U1

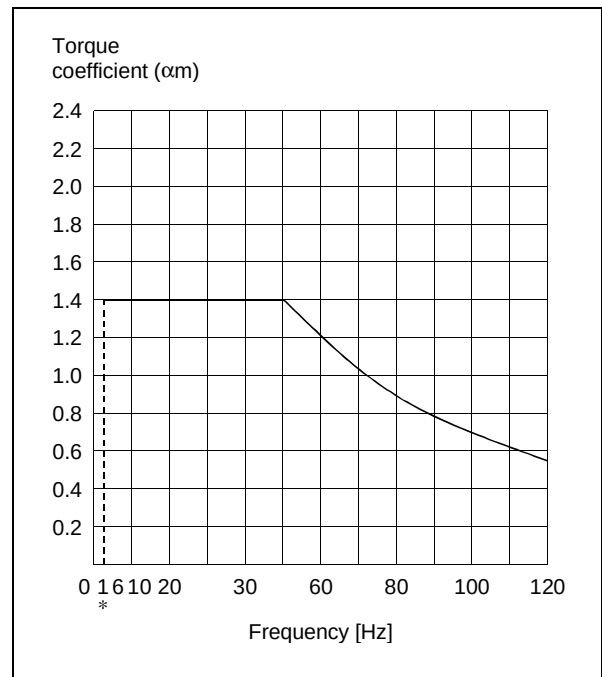
16U1

1) Short-time maximum torque (α_m)

[60Hz torque basis]



[50Hz torque basis]



* 0.5Hz for the FR-A500 (advanced magnetic flux vector control).

2) Maximum starting torque (α_s)

Frequency	Motor Capacity					Maximum Frequency (Hz)
	0.1 to 1.5kW	2.2 to 3.7kW	5.5 to 7.5kW	11 to 30kW	37 to 55kW	0.1 to 55kW
60Hz	1.60	1.60	1.60	1.60	1.60	1
50Hz	1.35	1.35	1.35	1.35	1.35	1

3) Linear acceleration torque (α_a) (For any frequency that exceeds 60Hz, use the above graph to find the coefficient.)

Frequency	Motor Capacity [kW], Frequency Range [Hz]														
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	1.50	0.63	0.63	1.50	0.63	0.63	1.50	0.63	0.63	1.50	0.80	0.80	1.50	—	—
50Hz	1.25	0.50	0.50	1.25	0.50	0.50	1.25	0.50	0.50	1.25	0.60	0.60	1.25	—	—

4) Non-linear acceleration torque (α_h)

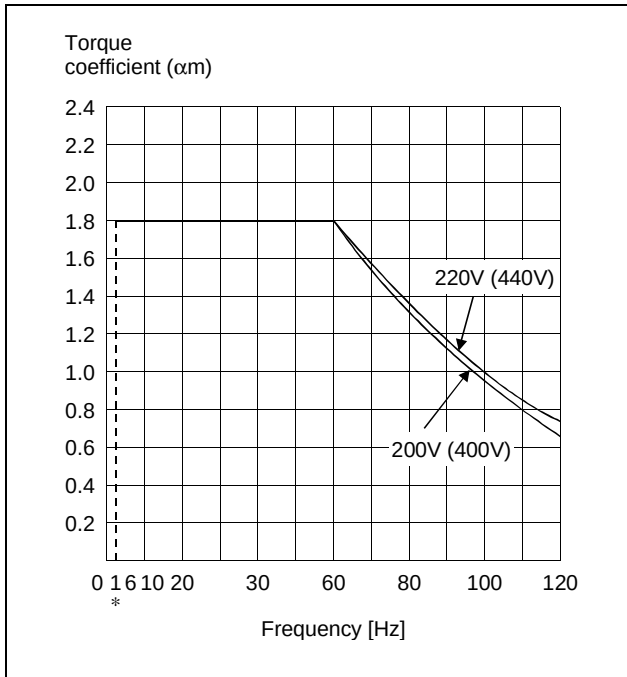
Frequency	Motor Capacity [kW], Frequency Range [Hz]														
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	1.50	1.25	1.05	1.50	1.30	1.10	1.50	1.30	1.10	1.50	1.30	1.10	1.50	—	—
50Hz	1.25	1.00	0.85	1.25	1.05	0.90	1.25	1.05	0.90	1.25	1.05	0.90	1.25	—	—

Torque type **18U1**

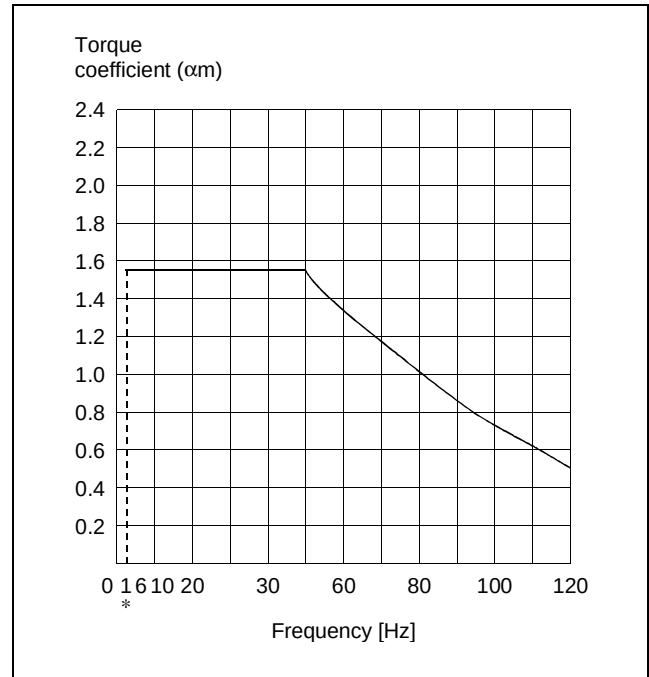
18U1

1) Short-time maximum torque (α_m)

[60Hz torque basis]



[50Hz torque basis]



* 0.5Hz for the FR-A500 (advanced magnetic flux vector control).

2) Maximum starting torque (α_s)

Frequency	Motor Capacity					Maximum Frequency (Hz)
	0.1 to 1.5kW	2.2 to 3.7kW	5.5 to 7.5kW	11 to 30kW	37 to 55kW	
60Hz	1.80	1.80	1.80	1.80	1.80	1
50Hz	1.50	1.50	1.50	1.50	1.50	1

3) Linear acceleration torque (α_a) (For any frequency that exceeds 60Hz, use the above graph to find the coefficient.)

Frequency	Motor Capacity [kW], Frequency Range [Hz]														
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	1.65	0.60	0.60	1.65	0.63	0.63	1.65	0.63	0.63	1.65	0.85	0.85	1.65	—	—
50Hz	1.40	0.50	0.50	1.40	0.50	0.50	1.40	0.50	0.50	1.40	0.65	0.65	1.40	—	—

4) Non-linear acceleration torque (α_h)

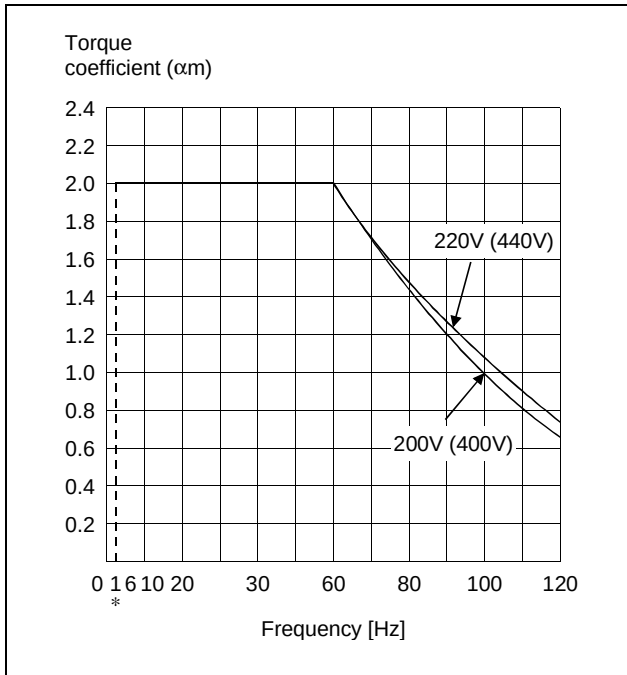
Frequency	Motor Capacity [kW], Frequency Range [Hz]														
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	1.70	1.35	1.15	1.70	1.40	1.20	1.70	1.40	1.20	1.70	1.40	1.20	1.70	—	—
50Hz	1.40	1.10	0.90	1.40	1.15	1.00	1.40	1.15	1.00	1.40	1.15	1.00	1.40	—	—

Torque type **20U1**

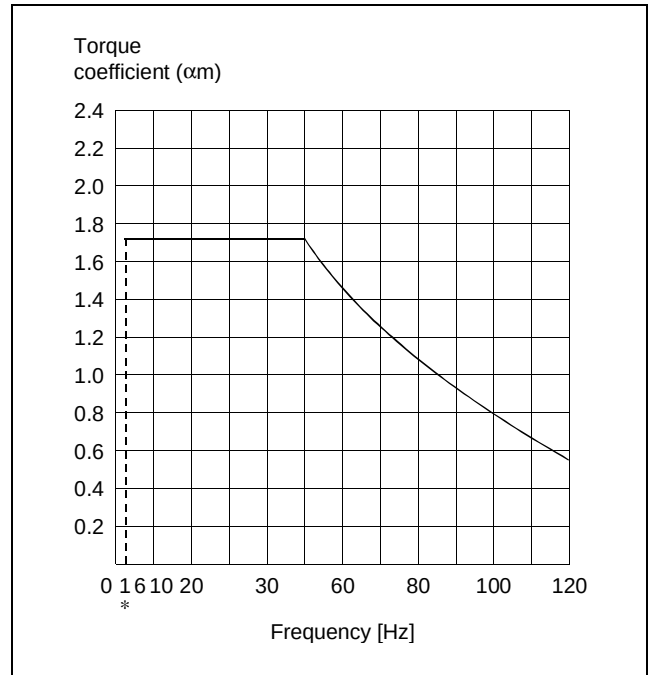
20U1

1) Short-time maximum torque (α_m)

[60Hz torque basis]



[50Hz torque basis]



* 0.5Hz for the FR-A500 (advanced magnetic flux vector control).

2) Maximum starting torque (α_s)

Frequency	Motor Capacity					Maximum Frequency (Hz)
	0.1 to 1.5kW	2.2 to 3.7kW	5.5 to 7.5kW	11 to 30kW	37 to 55kW	0.1 to 55kW
60Hz	2.00	2.00	2.00	2.00	2.00	1
50Hz	1.70	1.70	1.70	1.70	1.70	1

3) Linear acceleration torque (α_a) (For any frequency that exceeds 60Hz, use the above graph to find the coefficient.)

Frequency	Motor Capacity [kW], Frequency Range [Hz]														
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	1.85	0.63	0.63	1.85	0.63	0.63	1.85	0.63	0.63	1.85	0.90	0.90	1.85	—	—
50Hz	1.55	0.50	0.50	1.55	0.50	0.50	1.55	0.50	0.50	1.55	0.70	0.70	1.55	—	—

4) Non-linear acceleration torque (α_h)

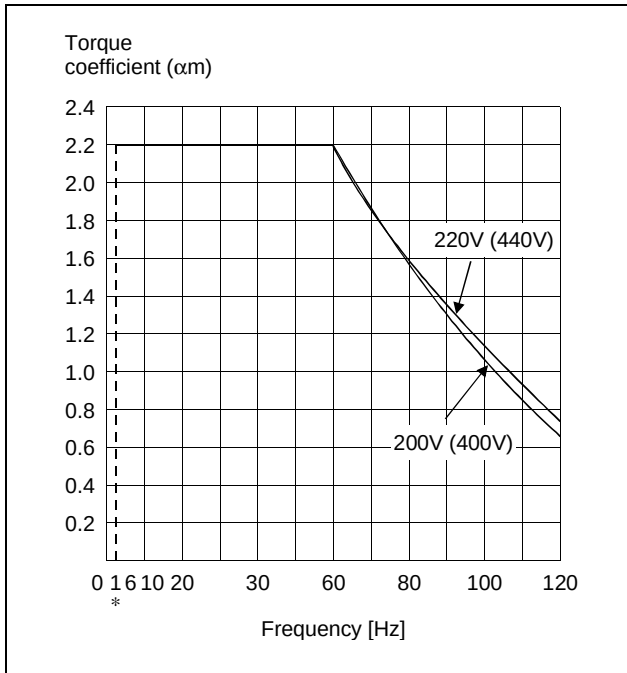
Frequency	Motor Capacity [kW], Frequency Range [Hz]														
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	1.90	1.45	1.20	1.90	1.55	1.30	1.90	1.55	1.30	1.90	1.55	1.30	1.90	—	—
50Hz	1.60	1.25	1.00	1.60	1.30	1.10	1.60	1.30	1.10	1.60	1.30	1.10	1.60	—	—

Torque type **22U1**

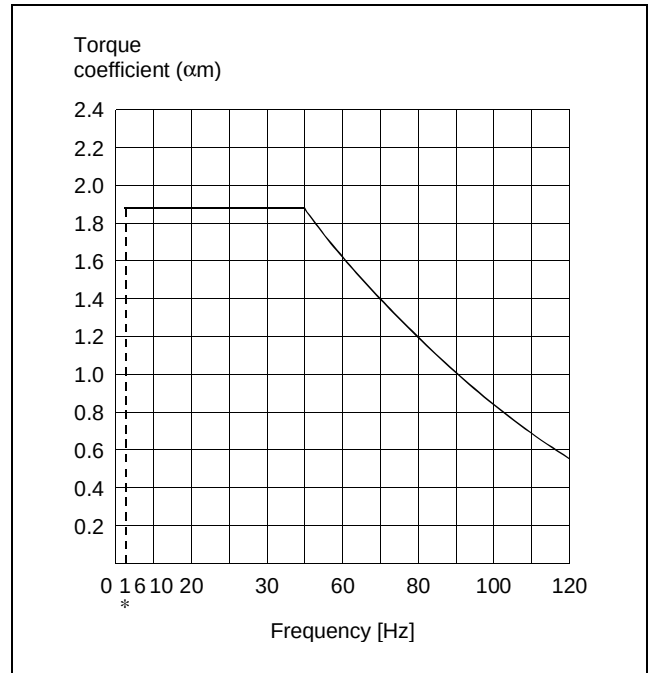
22U1

1) Short-time maximum torque (α_m)

[60Hz torque basis]



[50Hz torque basis]



* 0.5Hz for the FR-A500 (advanced magnetic flux vector control).

2) Maximum starting torque (α_s)

Frequency	Motor Capacity					Maximum Frequency (Hz)
	0.1 to 1.5kW	2.2 to 3.7kW	5.5 to 7.5kW	11 to 30kW	37 to 55kW	0.1 to 55kW
60Hz	2.20	2.20	2.20	2.20	2.20	1
50Hz	1.85	1.85	1.85	1.85	1.85	1

3) Linear acceleration torque (α_a) (For any frequency that exceeds 60Hz, use the above graph to find the coefficient.)

Frequency	Motor Capacity [kW], Frequency Range [Hz]														
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	2.05	0.63	0.63	2.05	0.63	0.63	2.05	0.63	0.63	2.05	0.90	0.90	2.05	—	—
50Hz	1.70	0.50	0.50	1.70	0.50	0.50	1.70	0.50	0.50	1.70	0.70	0.70	1.70	—	—

4) Non-linear acceleration torque (α_h)

Frequency	Motor Capacity [kW], Frequency Range [Hz]														
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW			11 to 30kW			37 to 55kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 100	60 to 100	0 to 60	0 to 100	60 to 100
60Hz	2.10	1.60	1.30	2.10	1.70	1.40	2.10	1.70	1.40	2.10	1.70	1.40	2.10	—	—
50Hz	1.75	1.35	1.05	1.75	1.35	1.10	1.75	1.35	1.10	1.75	1.35	1.10	1.75	—	—

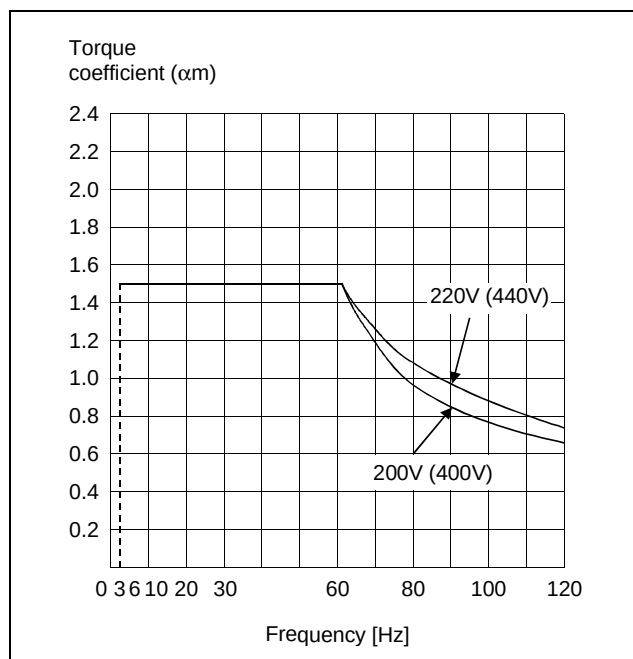
2.5.3 General-purpose magnetic flux vector control (E520 series, A024 series)

Torque type **15A2**

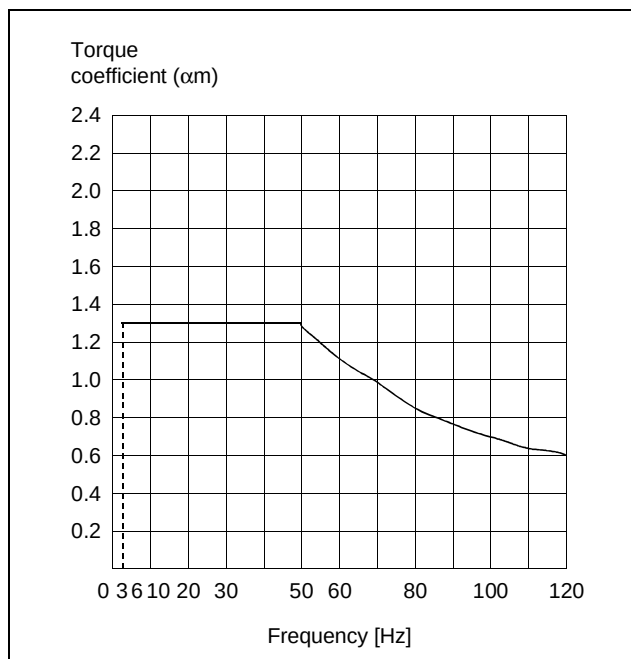
15A2

1) Short-time maximum torque (α_m)

[60Hz torque basis]



[50Hz torque basis]



2) Maximum starting torque (α_s)

Frequency	Motor Capacity			Maximum Frequency (Hz)
	0.1 to 1.5kW	2.2 to 3.7kW	5.5 to 7.5kW	0.1 to 55kW
60Hz	1.50	1.50	1.50	6
50Hz	1.30	1.30	1.30	6

3) Linear acceleration torque (α_a) (For any frequency that exceeds 60Hz, use the above graph to find the coefficient.)

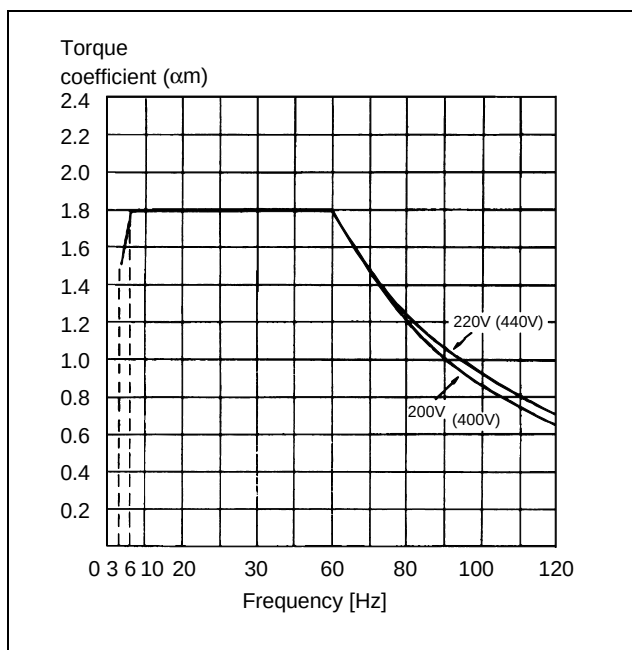
Frequency	Motor Capacity [kW], Frequency Range [Hz]								
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120
60Hz	1.40	0.63	0.63	1.40	0.63	0.63	1.40	0.63	0.63
50Hz	1.20	0.50	0.50	1.20	0.50	0.50	1.20	0.50	0.50

4) Non-linear acceleration torque (α_h)

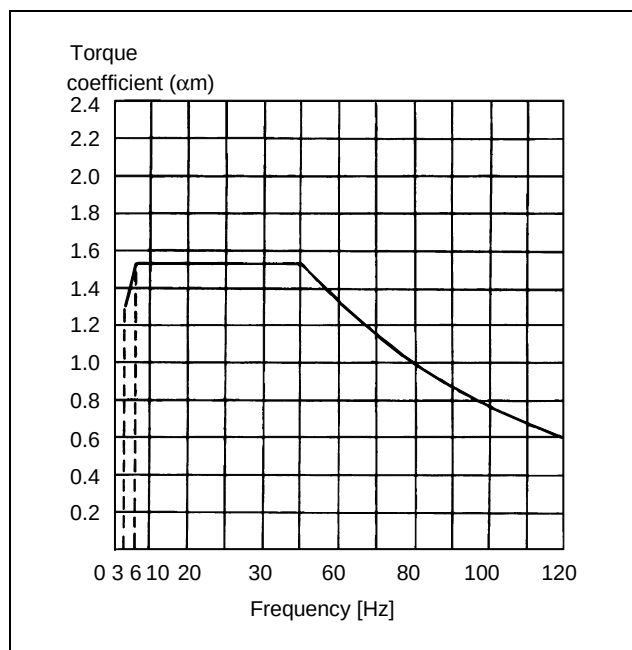
Frequency	Motor Capacity [kW], Frequency Range [Hz]								
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120
60Hz	1.40	1.20	1.00	1.40	1.25	1.10	1.40	1.25	1.10
50Hz	1.20	1.00	0.85	1.20	1.05	0.90	1.20	1.05	0.90

Torque type **18A2****18A2**

1) Short-time maximum torque (α_m)
[60Hz torque basis]



[50Hz torque basis]



2) Maximum starting torque (α_s)

Frequency	Motor Capacity			Maximum Frequency (Hz)
	0.1 to 1.5kW	2.2 to 3.7kW	5.5 to 7.5kW	0.1 to 55kW
60Hz	1.80	1.80	1.80	6
50Hz	1.50	1.50	1.50	6

3) Linear acceleration torque (α_a) (For any frequency that exceeds 60Hz, use the above graph to find the coefficient.)

Frequency	Motor Capacity [kW], Frequency Range [Hz]								
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120
60Hz	1.70	0.63	0.63	1.70	0.63	0.63	1.70	0.63	0.63
50Hz	1.40	0.50	0.50	1.40	0.50	0.50	1.40	0.50	0.50

4) Non-linear acceleration torque (α_h)

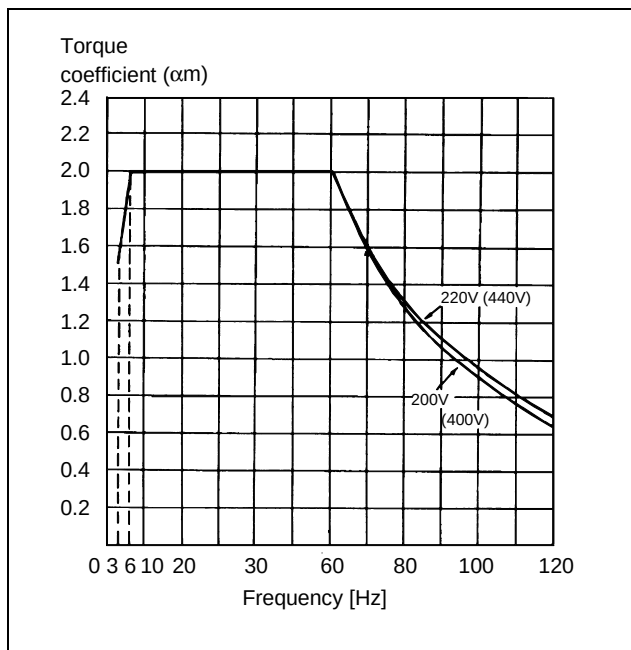
Frequency	Motor Capacity [kW], Frequency Range [Hz]								
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120
60Hz	1.70	1.35	1.15	1.70	1.40	1.20	1.70	1.40	1.20
50Hz	1.40	1.10	0.90	1.40	1.15	1.00	1.40	1.15	1.00

Torque type 20A2 20U2

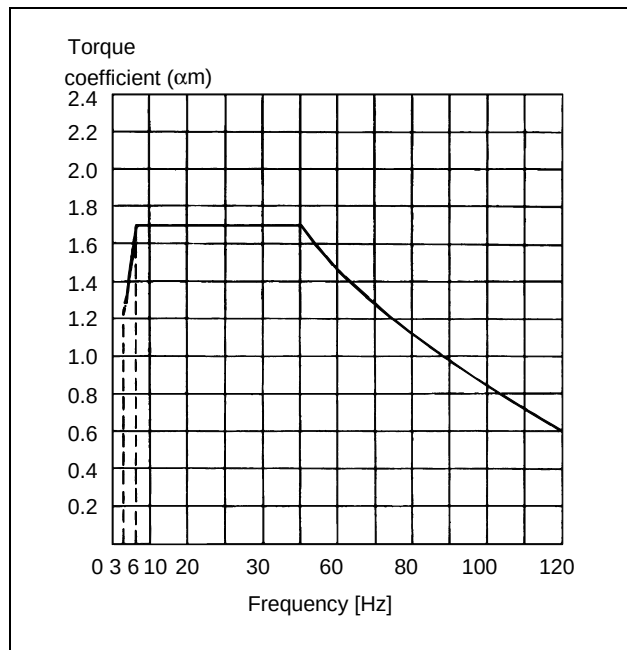
20A2

20U2

1) Short-time maximum torque (α_m)
[60Hz torque basis]



[50Hz torque basis]



2) Maximum starting torque (α_s)

Frequency	Motor Capacity			Maximum Frequency (Hz)
	0.1 to 1.5kW	2.2 to 3.7kW	5.5 to 7.5kW	
60Hz	2.00	2.00	2.00	6
50Hz	1.70	1.70	1.70	6

3) Linear acceleration torque (α_a) (For any frequency that exceeds 60Hz, use the above graph to find the coefficient.)

Frequency	Motor Capacity [kW], Frequency Range [Hz]								
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5 kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120
60Hz	1.85	0.63	0.63	1.85	0.63	0.63	1.85	0.63	0.63
50Hz	1.55	0.50	0.50	1.55	0.50	0.50	1.55	0.50	0.50

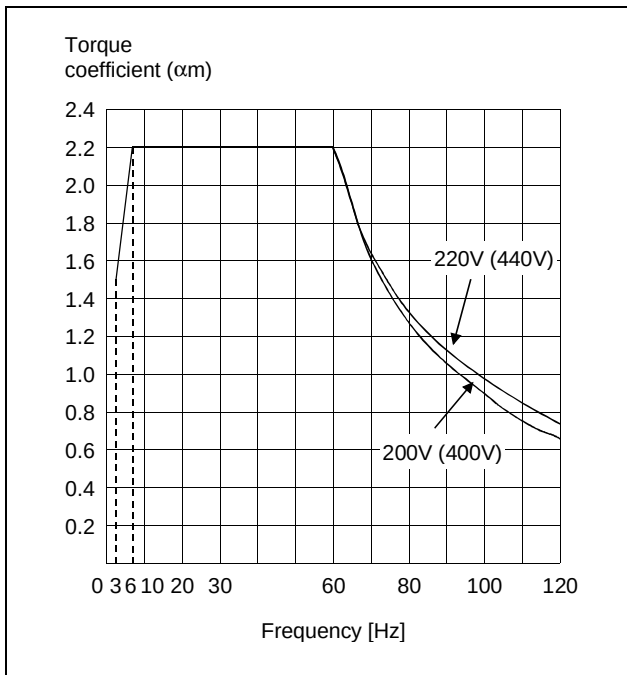
4) Non-linear acceleration torque (α_h)

Frequency	Motor Capacity [kW], Frequency Range [Hz]								
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5 kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120
60Hz	1.90	1.45	1.20	1.90	1.55	1.30	1.90	1.55	1.30
50Hz	1.60	1.25	1.00	1.60	1.30	1.10	1.60	1.30	1.10

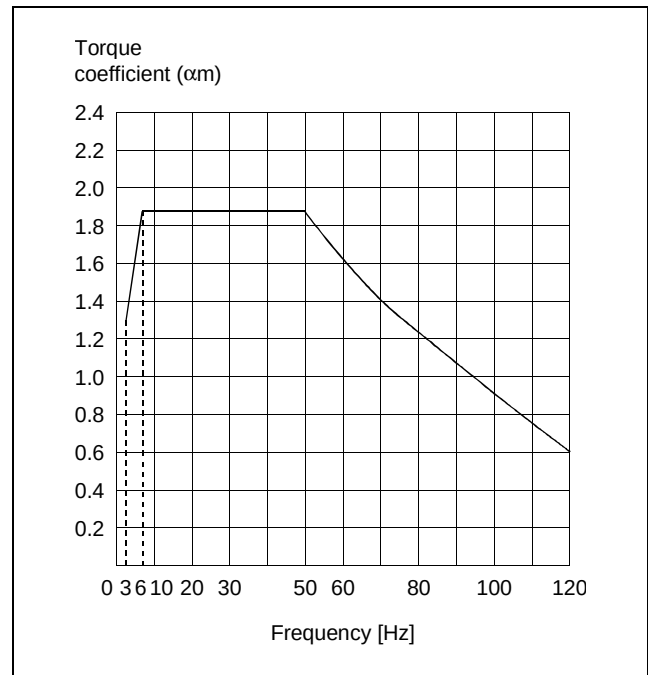
Torque type 22U2

22U2

1) Short-time maximum torque (α_m)
[60Hz torque basis]



[50Hz torque basis]



2) Maximum starting torque (α_s)

Frequency	Motor Capacity			Maximum Frequency (Hz)
	0.1 to 1.5kW	2.2 to 3.7kW	5.5 to 7.5kW	0.1 to 55kW
60Hz	2.20	2.20	2.20	6
50Hz	1.85	1.85	1.85	6

3) Linear acceleration torque (α_a) (For any frequency that exceeds 60Hz, use the above graph to find the coefficient.)

Frequency	Motor Capacity [kW], Frequency Range [Hz]								
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120
60Hz	2.05	0.63	0.63	2.05	0.63	0.63	2.05	0.63	0.63
50Hz	1.70	0.50	0.50	1.70	0.50	0.50	1.70	0.50	0.50

4) Non-linear acceleration torque (α_h)

Frequency	Motor Capacity [kW], Frequency Range [Hz]								
	0.1 to 1.5kW			2.2 to 3.7kW			5.5 to 7.5kW		
	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120	0 to 60	0 to 120	60 to 120
60Hz	2.10	1.60	1.30	2.10	1.70	1.40	2.10	1.70	1.40
50Hz	1.75	1.35	1.05	1.75	1.35	1.10	1.75	1.35	1.10

2.5.4 Vector control

(1) Dedicated Motor

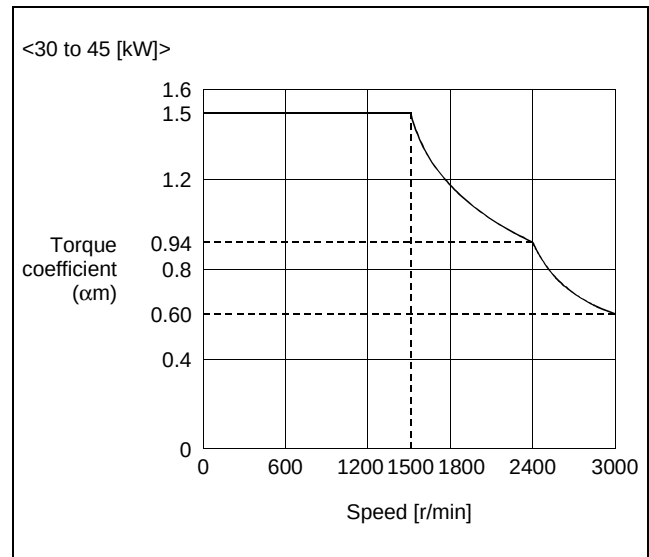
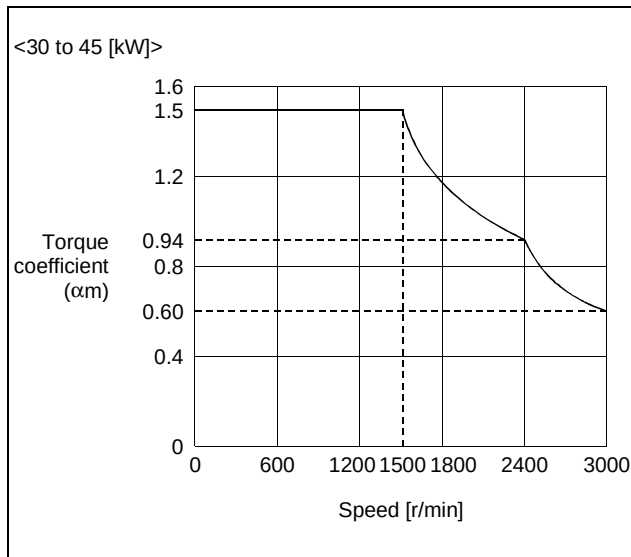
Torque type 15A3 15U3

15A3

15U3

1) Short-time maximum torque (α_m)

[1500r/min torque basis]



2) Maximum starting torque (α_s)

Rated Speed	Motor Capacity	Maximum Speed (r/min)
	5.5 to 45kW	5.5 to 45kW
1500r/min	1.50	1

3) Linear acceleration torque (α_a) (For any speed that exceeds 1500r/min, use the above graph to find the coefficient.)

Rated Speed	Motor Capacity [kW], Speed Range [r/min]					
	5.5 to 22kW			30 to 45kW		
	0 to 1500	0 to 3000	1500 to 3000	0 to 1500	0 to 3000	1500 to 3000
1500r/min	1.50	0.75	0.75	1.50	0.60	0.60

4) Non-linear acceleration torque (α_h)

Rated Speed	Motor Capacity [kW], Speed Range [r/min]					
	5.5 to 22kW			30 to 45kW		
	0 to 1500	0 to 3000	1500 to 3000	0 to 1500	0 to 3000	1500 to 3000
1500r/min	1.50	1.30	1.10	1.50	1.25	1.00

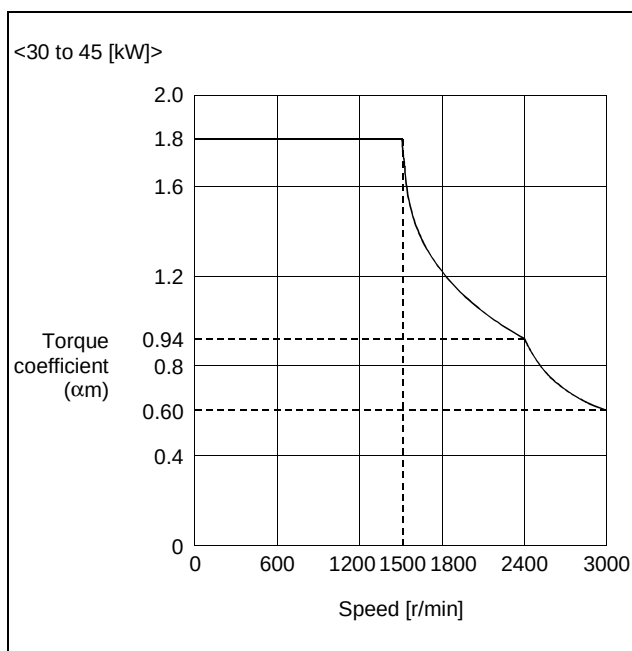
(1) Dedicated Motor

Torque type 18A3 18U3

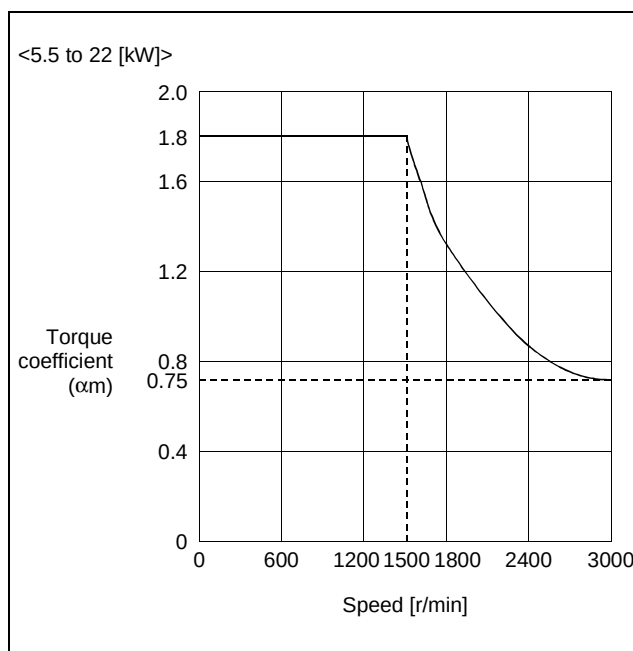
18A3

18U3

1) Short-time maximum torque (α_m)
[1500r/min torque basis]



[50Hz torque basis]



2) Maximum starting torque (α_s)

Rated Speed	Motor Capacity	Maximum Speed (r/min)
	5.5 to 45kW	5.5 to 45kW
1500r/min	1.80	1

3) Linear acceleration torque (α_a) (For any speed that exceeds 1500r/min, use the above graph to find the coefficient.)

Rated Speed	Motor Capacity [kW], Speed Range [r/min]					
	5.5 to 22kW			30 to 45kW		
	0 to 1500	0 to 3000	1500 to 3000	0 to 1500	0 to 3000	1500 to 3000
1500r/min	1.70	0.75	0.75	1.70	0.60	0.60

4) Non-linear acceleration torque (α_h)

Rated Speed	Motor Capacity [kW], Speed Range [r/min]					
	5.5 to 22kW			30 to 45kW		
	0 to 1500	0 to 3000	1500 to 3000	0 to 1500	0 to 3000	1500 to 3000
1500r/min	1.70	1.46	1.23	1.70	1.43	1.15

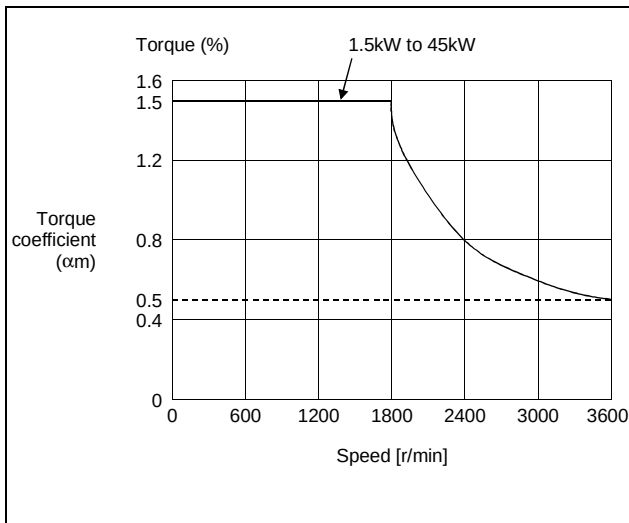
(2) Standard motor with PLG: cyclic operation mode

Torque type 15A4

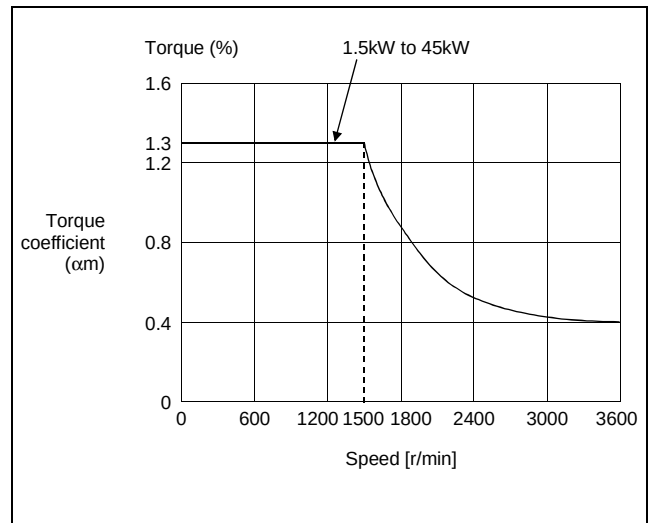
15A4

1) Short-time maximum torque (α_m)

[1800r/min torque basis]



[1500r/min torque basis]



2) Maximum starting torque (α_s)

Rated Speed	Motor Capacity	Maximum Speed (r/min)
	1.5 to 45kW	1.5 to 45kW
1800r/min	1.50	1
1500r/min	1.30	1

3) Linear acceleration torque (α_a) (For any speed that exceeds 1800r/min, use the above graph to find the coefficient.)

Rated Speed	Motor Capacity [kW], Speed Range [r/min]								
	1.5 to 7.5kW			11 to 30kW			37 to 45kW		
	0 to 1800	0 to 3600	1800 to 3600	0 to 1800	0 to 3000	1800 to 3000	0 to 1800	0 to 1950	1800 to 1950
1800r/min	1.50	0.50	0.50	1.50	0.60	0.60	1.50	1.20	1.20
1500r/min	1.30	0.40	0.40	1.30	0.45	0.45	1.30	0.75	0.75

4) Non-linear acceleration torque (α_h)

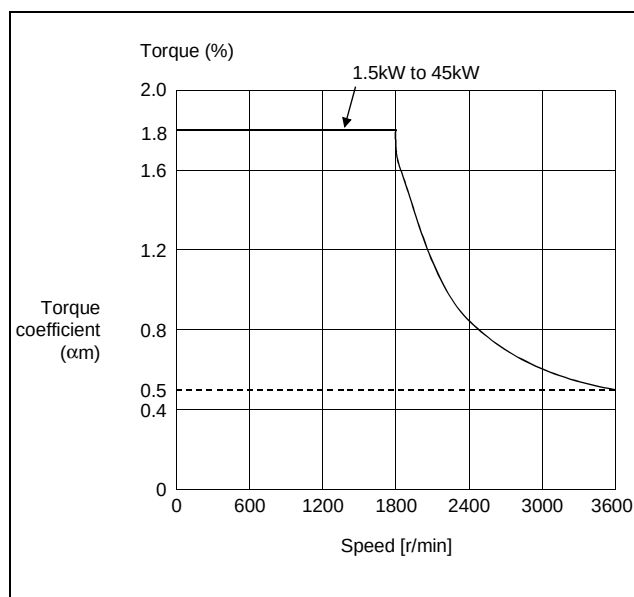
Rated Speed	Motor Capacity [kW], Speed Range [r/min]								
	1.5 to 7.5kW			11 to 30kW			37 to 45kW		
	0 to 1800	0 to 3600	1800 to 3600	0 to 1800	0 to 3000	1800 to 3000	0 to 1800	0 to 1950	1800 to 1950
1800r/min	1.50	1.25	1.00	1.50	1.32	1.05	1.50	1.49	1.35
1500r/min	1.30	1.04	0.85	1.30	1.09	0.88	1.30	1.24	1.03

18A4

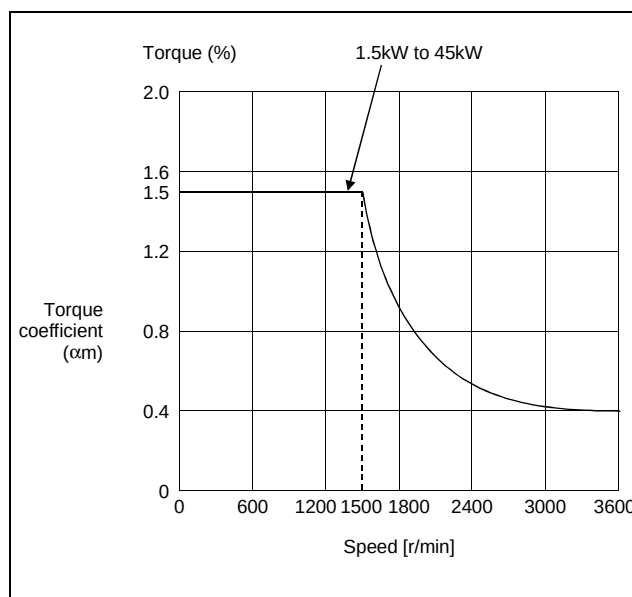
Torque type 18A4 18U4

18U4

1) Short-time maximum torque (α_m)
[1800r/min torque basis]



[1500r/min torque basis]



2) Maximum starting torque (α_s)

Rated Speed	Motor Capacity	Maximum Speed (r/min)
	1.5 to 45kW	1.5 to 45kW
1800r/min	1.80	1
1500r/min	1.70	1

3) Linear acceleration torque (α_a) (For any speed that exceeds 1500r/min, use the above graph to find the coefficient.)

Rated Speed	Motor Capacity [kW], Speed Range [r/min]								
	1.5 to 7.5kW			11 to 30kW			37 to 45kW		
	0 to 1800	0 to 3600	1800 to 3600	0 to 1800	0 to 3000	1800 to 3000	0 to 1800	0 to 1950	1800 to 1950
1800r/min	1.70	0.50	0.50	1.70	0.60	0.60	1.70	1.30	1.30
1500r/min	1.40	0.40	0.40	1.40	0.43	0.43	1.40	0.80	0.80

4) Non-linear acceleration torque (α_h)

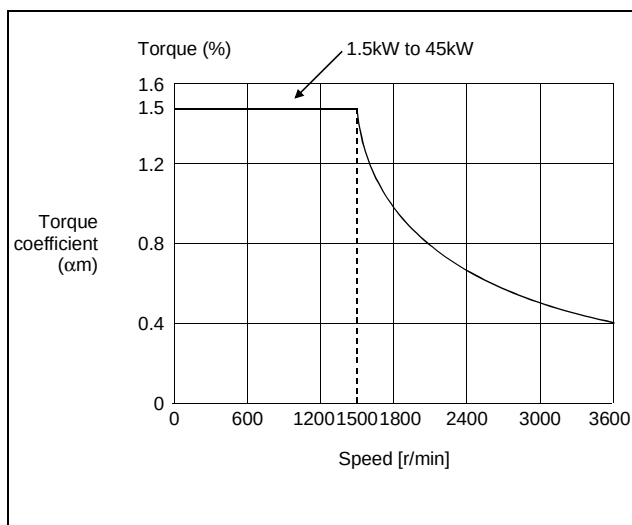
Rated Speed	Motor Capacity [kW], Speed Range [r/min]								
	1.5 to 7.5kW			11 to 30kW			37 to 45kW		
	0 to 1800	0 to 3600	1800 to 3600	0 to 1800	0 to 3000	1800 to 3000	0 to 1800	0 to 1950	1800 to 1950
1800r/min	1.70	1.40	1.10	1.70	1.48	1.15	1.70	1.68	1.50
1500r/min	1.40	1.11	0.90	1.40	1.16	0.92	1.40	1.33	1.10

(3) Standard motor with PLG: Continuous operation mode

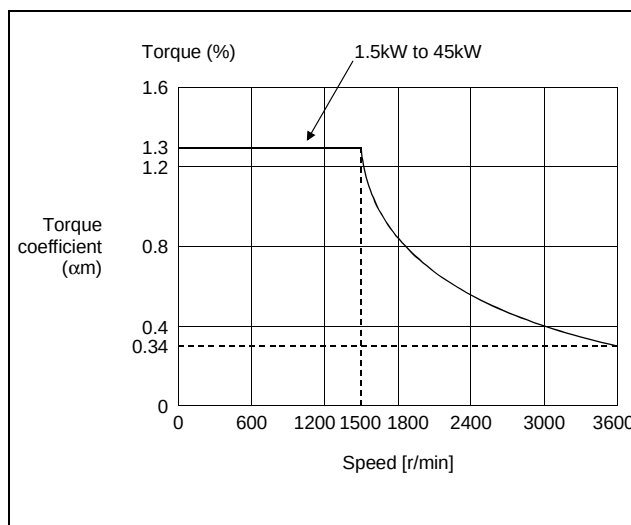
Torque type 15A5

15A5

1) Short-time maximum torque (α_m)
[1800r/min torque basis]



[1500r/min torque basis]



2) Maximum starting torque (α_s)

Rated Speed	Motor Capacity	Maximum Speed (r/min)
	1.5 to 45kW	1.5 to 45kW
1800r/min	1.50	1
1500r/min	1.30	1

3) Linear acceleration torque (α_a) (For any speed that exceeds 1500r/min, use the above graph to find the coefficient.)

Rated Speed	Motor Capacity [kW], Speed Range [r/min]								
	1.5 to 7.5kW			11 to 30kW			37 to 45kW		
	0 to 1500	0 to 3600	1500 to 3600	0 to 1500	0 to 3000	1500 to 3000	0 to 1500	0 to 1950	1500 to 1950
1800r/min	1.50	0.40	0.40	1.50	0.47	0.47	1.50	1.00	1.00
1500r/min	1.30	0.34	0.34	1.30	0.40	0.40	1.30	0.82	0.82

4) Non-linear acceleration torque (α_h)

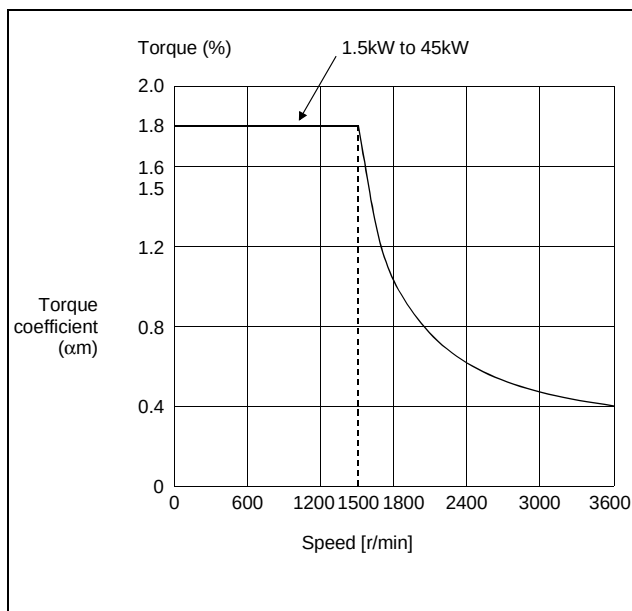
Rated Speed	Motor Capacity [kW], Speed Range [r/min]								
	1.5 to 7.5kW			11 to 30kW			37 to 45kW		
	0 to 1500	0 to 3600	1500 to 3600	0 to 1500	0 to 3000	1500 to 3000	0 to 1500	0 to 1950	1500 to 1950
1800r/min	1.50	1.18	0.95	1.50	1.24	0.99	1.50	1.44	1.25
1500r/min	1.30	1.02	0.82	1.30	1.08	0.85	1.30	1.24	1.06

18A5

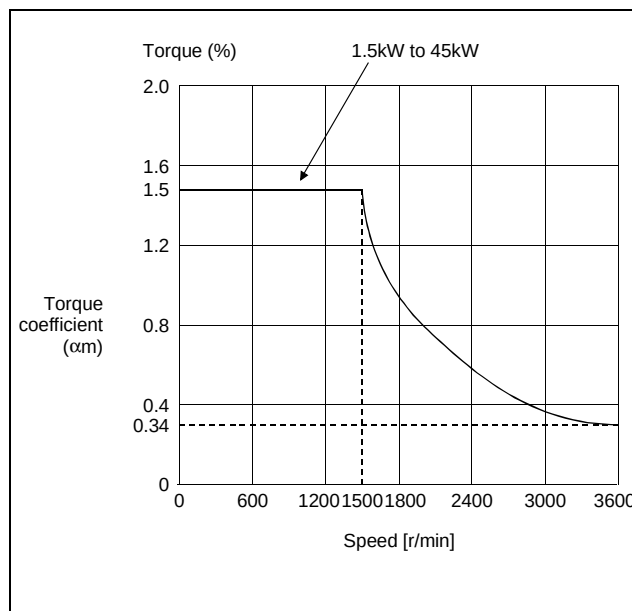
Torque type 18A5 18U5

18U5

1) Short-time maximum torque (α_m)
[1800r/min torque basis]



[1500r/min torque basis]



2) Maximum starting torque (α_s)

Rated Speed	Motor Capacity 1.5 to 45kW	Maximum Speed (r/min) 1.5 to 45kW
1800r/min	1.80	1
1500r/min	1.50	1

3) Linear acceleration torque (α_a) (For any speed that exceeds 1500r/min, use the above graph to find the coefficient.)

Rated Speed	Motor Capacity [kW], Speed Range [r/min]								
	1.5 to 7.5kW			11 to 30kW			37 to 45kW		
	0 to 1500	0 to 3600	1500 to 3600	0 to 1500	0 to 3000	1500 to 3000	0 to 1500	0 to 1950	1500 to 1950
1800r/min	1.70	0.40	0.40	1.70	0.45	0.45	1.70	1.00	1.00
1500r/min	1.40	0.34	0.34	1.40	0.39	0.39	1.40	0.90	0.90

4) Non-linear acceleration torque (α_h)

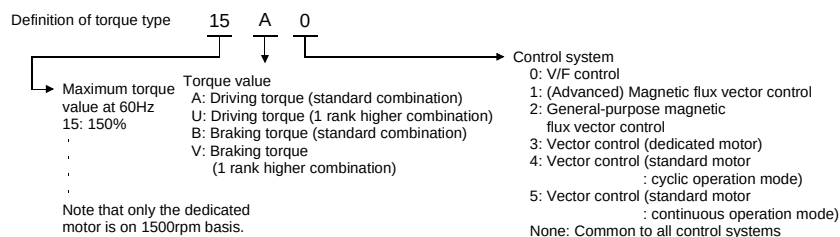
Rated Speed	Motor Capacity [kW], Speed Range [r/min]								
	1.5 to 7.5kW			11 to 30kW			37 to 45kW		
	0 to 1500	0 to 3600	1500 to 3600	0 to 1500	0 to 3000	1500 to 3000	0 to 1500	0 to 1950	1500 to 1950
1800r/min	1.70	1.32	1.05	1.70	1.39	1.08	1.70	1.62	1.35
1500r/min	1.40	1.09	0.87	1.40	1.15	0.90	1.40	1.34	1.15

CHAPTER 3 BRAKING CAPABILITY DATA

3.1 Combinations of Braking Units and Inverters

Voltage	Braking Unit	Inverter Model							
	Type	Model	FR-A520 FR-A540 FR-A220(E) FR-A240(E)	FR-E520	FR-A024 FR-A044	FR-Z220 FR-Z240	FR-Z024	FR-A221E FR-A241E	FR-V220 FR-V240
200V	Built-in brake	—	0.4 to 7.5K are built-in type.	Capacitor-regenerative	Capacitor-regenerative	0.4 to 7.5K are built-in type.	Capacitor-regenerative	—	1.5 to 5.5K are built-in type
			11 to 55K are capacitor-regenerative.			11 to 55K are capacitor-regenerative.			7.5 to 45K are capacitor-regenerative.
	External resistor	MYS	0.4 to 7.5K	0.4 to 3.7K	0.4 to 3.7K	0.4 to 7.5K	0.4 to 3.7K	—	1.5 to 5.5K
		MRS	0.4 to 3.7K	0.4 to 3.7K	0.4 to 3.7K	0.4 to 3.7K	0.4 to 3.7K	—	1.5 to 2.2K
		ABR	0.4 to 7.5K	0.4 to 7.5K	0.4 to 3.7K	0.4 to 7.5K	0.4 to 3.7K	—	1.5 to 5.5K
	Brake unit	BU type	0.4 to 55K	0.1 to 3.7K	0.1 to 3.7K	0.4 to 55K	—	—	1.5 to 45K
		FR-BU/GRG type	0.4 to 3.7K	0.1 to 3.7K	0.1 to 3.7K	0.4 to 3.7K	—	—	1.5 to 2.2K
		FR-BU/FR-BR	5.5 to 55K	5.5 to 7.5K	—	5.5 to 55K	—	—	3.7 to 45K
	Power return converter	FR-RC	7.5 to 55K	—	—	7.5 to 55K	—	—	5.5 to 45K
	High power factor converter	FR-HC	0.4 to 55K	0.1 to 7.5K	0.1 to 3.7K	—	—	—	1.5 to 45K
400V	Built-in brake	—	0.4 to 7.5K are built-in type.		Capacitor-regenerative	2.2 to 7.5K are built-in type.		—	1.5 to 5.5K are built-in type
			11 to 55K are capacitor-regenerative.			15 to 55K are capacitor-regenerative.			7.5 to 45K are capacitor-regenerative.
	External resistor	MYS	2.2 to 7.5K		2.2 to 3.7K	2.2 to 7.5K		—	1.5 to 5.5K
		MRS	—		—	—		—	—
		ABR-H	0.4 to 7.5K		0.4 to 3.7K	2.2 to 7.5K		—	1.5 to 5.5K
	Brake unit	BU-H Type	0.4 to 55K		0.4 to 3.7K	2.2 to 55K		—	1.5 to 5.5K
		FR-BU-H/GRG type	0.4 to 3.7K		0.4 to 3.7K	2.2 to 3.7K		—	1.5 to 2.2K
		FR-BU-H/FR-BR-H	5.5 to 55K		—	7.5 to 55K		—	3.7 to 45K
	Power return converter	FR-RC-H	7.5 to 55K		—	7.5 to 55K		—	5.5 to 45K
	High power factor converter	FR-HC-H	0.4 to 55K		0.1 to 3.7K	—		—	1.5 to 45K

3.2 Brake Torque Type



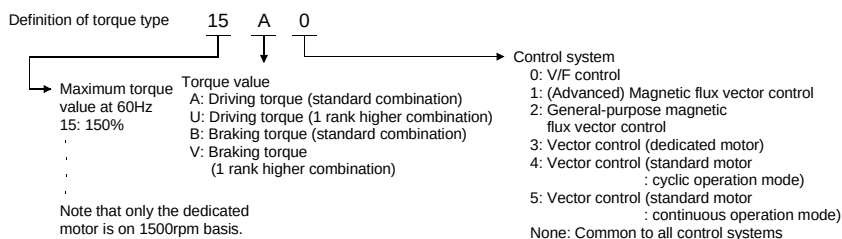
(1) 200V series

1) FR-A520 series (200V class) (1/2)

FR-A220(E) series (200V class) (1/2)

Top	Standard combination
Bottom	1 rank higher combination

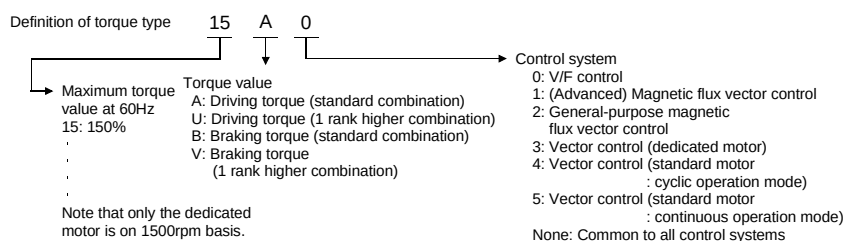
Motor Capacity	Inverter Capacity	Braking Unit							Torque type	Refer to page
		Built-in brake	MYS	FR-ABR	BU type	FR-BU	FR-RC	FR-HC		
0.4kW	0.4K	120W 220 [15B]	220W 200 [15B]	0.4K [15B]	BU-1500 [15B]	FR-BU-15K GGZ300W 50 Ω [15B]		7.5K [15B]	02B 02V	3-21
	0.75K	120W 100 [20V]	220W 100 [20V]	0.75K [20V]	BU-1500 [28V]	FR-BU-15K GGZ300W 50 Ω [28V]		7.5K [28V]	05B 09V	3-22
0.75kW	0.75K	120W 100 [15B]	220W 100 [15B]	0.75K [15B]	BU-1500 [15B]	FR-BU-15K GGZ300W 50 Ω [15B]		7.5K [15B]	07B	3-23
	1.5K	120W 60 [20V]	220W 60 [20V]	2.2K [20V]	BU-3700 [28V]	FR-BU-15K GRGZ300-5Ω 4 in series [28V]		7.5K [28V]	09B 09V	3-24
1.5kW	1.5K	120W 60 [15B]	220W 60 [15B]	2.2K [15B]	BU-1500 [15B]	FR-BU-15K GRGZ300-5Ω 4 in series [15B]		7.5K [15B]	10B 10V	3-25
	2.2K	120W 60 [15V]	220W 60 [15V]	2.2K [15V]	BU-3700 [20V]	FR-BU-15K GRGZ300-5Ω 4 in series [20V]		7.5K [20V]	12B 12V	3-26
2.2kW	2.2K	120W 60 [10B]	220W 60 [10B]	2.2K [10B]	BU-3700 [15B]	FR-BU-15K GRGZ300-5Ω 4 in series [15B]		7.5K [15B]	15B 15V	3-27
	3.7K	120W 40 [15V]	220W 40 [15V]	3.7K [15V]	BU-3700 [15V]	FR-BU-15K GRGZ300-5Ω 4 in series [20V]		7.5K [20V]	18B 18V	3-28
3.7kW	3.7K	120W 40 [10B]	220W 40 [10B]	3.7K [10B]	BU-3700 [10B]	FR-BU-15K GRGZ300-5Ω 4 in series [15B]		7.5K [15B]	20B 20V	3-29
	5.5K	220W 25 [15V]	220W 50 2 in parallel [15V]	5.5K [15V]	7.5K [20V]	FR-BU-15K FR-BR-15K [20V]		7.5K [20V]	28B 28V	3-30
5.5kW	5.5K	220W 25 [10B]	220W 50 2 in parallel [10B]	5.5K [10B]	7.5K [15B]	FR-BU-15K FR-BR-15K [15B]		7.5K [15B]		
	7.5K	220W 20 [12V]	220W 40 2 in parallel [12V]	7.5K [12V]	7.5K [20V]	FR-BU-15K FR-BR-15K [20V]	15K [20V]	7.5K [20V]		
7.5kW	7.5K	220W 20 [10B]	220W 40 2 in parallel [10B]	7.5K [10B]	7.5K [15B]	FR-BU-15K FR-BR-15K [15B]	15K [15B]	7.5K [15B]		
	11K	Capacitor-regenerative [02V]			15K [15V]	FR-BU-15K FR-BR-15K [20V]	15K [20V]	15K [20V]		
11kW	11K	Capacitor-regenerative [02B]			15K [10B]	FR-BU-15K FR-BR-15K [15B]	15K [15B]	15K [15B]		
	15K	Capacitor-regenerative [02V]			15K [10V]	FR-BU-15K FR-BR-15K [15V]	15K [20V]	15K [20V]		



FR-A520 series (200V class) (2/2)
FR-A220 (E) series (200V class) (2/2)

Top	Standard combination
Bottom	1 rank higher combination

Motor Capacity	Inverter Capacity	Braking Unit					Torque type	Refer to page
		Built-in brake	BU Type	FR-BU	FR-RC	FR-HC		
15kW	15K	Capacitor-regenerative [02B]	15K [05B]	FR-BU-15K FR-BR-15K [10B]	15K [15B]	15K [15B]	02B 02V	3-21
	18.5K	Capacitor-regenerative [02V]	2×15K [15V]	FR-BU-30K FR-BR-30K [18V]	30K [18V]	30K [18V]	05B 07B	3-22 3-23
18.5kW	18.5K	Capacitor-regenerative [02B]	2×15K [10B]	FR-BU-30K FR-BR-30K [15B]	30K [15B]	30K [15B]	09B 09V	3-24
	22K	Capacitor-regenerative [02V]	2×15K [10V]	FR-BU-30K FR-BR-30K [18V]	30K [18V]	30K [18V]	10B 10V	3-25
22kW	22K	Capacitor-regenerative [02B]	2×15K [10B]	FR-BU-30K FR-BR-30K [12B]	30K [15B]	30K [15B]	12B 12V	3-26
	30K	Capacitor-regenerative [02V]	2×15K [10V]	FR-BU-30K FR-BR-30K [12V]	30K [20V]	30K [20V]	15B 15V	3-27
30kW	30K	Capacitor-regenerative [02B]	2×15K [07B]	FR-BU-30K FR-BR-30K [10B]	30K [15B]	30K [15B]	18B 18V	3-28
	37K	Capacitor-regenerative [02V]	3×15K [12V]	FR-BU-55K FR-BR-55K [18V]	55K [18V]	55K [18V]	20B 20V	3-29
37kW	37K	Capacitor-regenerative [02B]	3×15K [09B]	FR-BU-55K FR-BR-55K [15B]	55K [15B]	55K [15B]	28B 28V	3-30
	45K	Capacitor-regenerative [02V]	3×15K [09V]	FR-BU-55K FR-BR-55K [15V]	55K [18V]	55K [18V]		
45kW	45K	Capacitor-regenerative [02B]	3×15K [05B]	FR-BU-55K FR-BR-55K [12B]	55K [15B]	55K [15B]		
	55K	Capacitor-regenerative [02V]	4×15K [10V]	FR-BU-55K FR-BR-55K [12V]	55K [18V]	55K [18V]		
55kW	55K	Capacitor-regenerative [02B]	4×15K [07B]	FR-BU-55K FR-BR-55K [10B]	55K [12B]	55K [15B]		

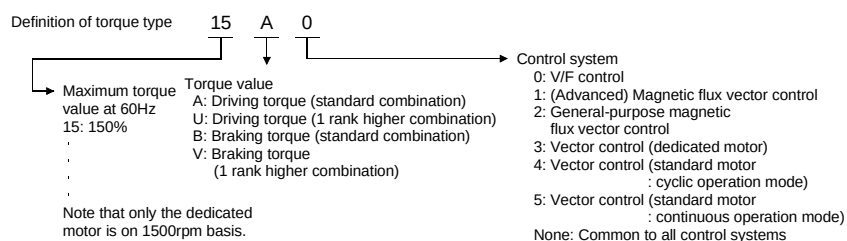


2) FR-E520 series (200V class)
FR-A024 series (200V class)

Top	Standard combination
Bottom	1 rank higher combination

Motor Capacity	Inverter Capacity	Braking Unit							Torque type	Refer to page
		Built-in brake	MRS	FR-ABR	FR-ABR	BU Type	FR-BU	FR-HC		
0.1kW	0.1K	Capacitor-regenerative [02B]				BU-1500 [15B]	FR-BU-15K GGZ300W 50Ω [15B]	7.5K [15B]	02B 02V	3-21
	0.2K	Capacitor-regenerative [02V]				BU-1500 [28V]	FR-BU-15K GGZ300W 50Ω [28V]	7.5K [28V]	05B 09V	3-22
0.2kW	0.2K	Capacitor-regenerative [02B]				BU-1500 [15B]	FR-BU-15K GGZ300W 50Ω [15B]	7.5K [15B]	07B 10B	3-23
	0.4K	Capacitor-regenerative [02V]	120W 200Ω [20V]	0.4K [20V]		BU-1500 [28V]	FR-BU-15K GGZ300W 50Ω [28V]	7.5K [28V]	09B 10V	3-24
0.4kW	0.4K	Capacitor-regenerative [02B]	120W 200Ω [15B]	0.4K [15B]		BU-1500 [15B]	FR-BU-15K GGZ300W 50Ω [15B]	7.5K [15B]	12B 15B	3-25
	0.75K	Capacitor-regenerative [02V]	120W 100Ω [20V]	0.75K [20V]		BU-1500 [28V]	FR-BU-15K GGZ300W 50Ω [28V]	7.5K [28V]	12B 15V	3-26
0.75kW	0.75K	Capacitor-regenerative [02B]	120W 100Ω [15B]	0.75K [15B]		BU-1500 [15B]	FR-BU-15K GGZ300W 50Ω [15B]	7.5K [15B]	18B 20B	3-27
	1.5K	Capacitor-regenerative [02V]	120W 60Ω [20V]	2.2K [20V]		BU-1500 [28V]	FR-BU-15K GRGZ300-5Ω 4 in series [28V]	7.5K [28V]	18B 20V	3-28
1.5kW	1.5K	Capacitor-regenerative [02B]	120W 60Ω [15B]	2.2K [15B]		BU-1500 [15B]	FR-BU-15K GRGZ300-5Ω 4 in series [15B]	7.5K [15B]	28B 28V	3-29
	2.2K	Capacitor-regenerative [02V]	120W 60Ω [15V]	2.2K [15V]	3.7K [20V]	BU-3700 [20V]	FR-BU-15K GRGZ300-5Ω 4 in series [20V]	7.5K [20V]		3-30
2.2kW	2.2K	Capacitor-regenerative [02B]	120W 60Ω [150]	2.2K [10B]	3.7K [15B]	BU-3700 [15B]	FR-BU-15K GRGZ300-5Ω 4 in series [15B]	7.5K [15B]		
	3.7K	Capacitor-regenerative [02V]	120W 40Ω [15V]	3.7K [15V]	5.5K [20V]	BU-3700 [15V]	FR-BU-15K GRGZ300-5Ω 4 in series [20V]	7.5K [20V]		
3.7kW	3.7K	Capacitor-regenerative [02B]	120W 40Ω [10B]	3.7K [10B]	5.5K [15B]	BU-3700 [10B]	FR-BU-15K GRGZ300-5Ω 4 in series [15B]	7.5K [15B]		
	*1 5.5K	Capacitor-regenerative [02V]		5.5K [15V]		7.5K [20V]	FR-BU-15K FR-BR-15K [20V]	7.5K [20V]		
5.5kW	*1 5.5K	Capacitor-regenerative [02B]		5.5K [10B]		7.5K [15B]	FR-BU-15K FR-BR-15K [15B]	7.5K [15B]		
	*1 7.5K	Capacitor-regenerative [02V]		7.5K [12V]		7.5K [20V]	FR-BU-15K FR-BR-15K [20V]	7.5K [20V]		
7.5kW	*1 7.5K	Capacitor-regenerative [02B]		7.5K [10B]		7.5K [15B]	FR-BU-15K FR-BR-15K [15B]	7.5K [15B]		

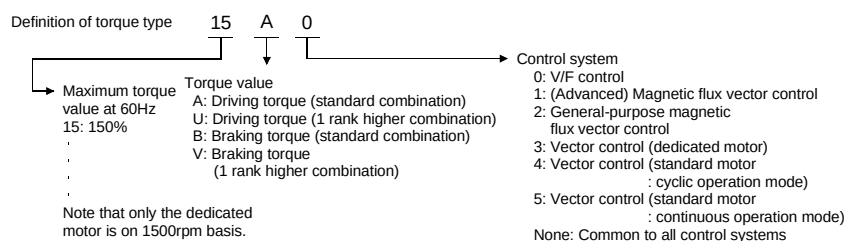
*1: Data of 5.5K and 7.5K are those of FR-E520.



3) FR-Z220 series (200V class) (1/2)

Top	Standard combination
Bottom	1 rank higher combination

Motor Capacity	Inverter Capacity	Braking Unit						Torque type	Refer to page
		Built-in brake	MYS	FR-ABR	BU Type	FR-BU	FR-RC		
0.4kW	0.4K	120W 200 [15B]	220W 200 [15B]	0.4K [15B]	BU-1500 [15B]	FR-BU-15K GGZ300W 50Ω [15B]		02B 02V	3-21
	0.75K	120W 100 [20V]	220W 100 [20V]	0.75K [20V]	BU-1500 [28V]	FR-BU-15K GGZ300W 50 Ω [28V]		05B 07B	3-22 3-23
0.75kW	0.75K	120W 100 [15B]	220W 100 [15B]	0.75K [15B]	BU-1500 [15B]	FR-BU-15K GGZ300W 50 Ω [15B]		09B 09V	3-24
	1.5K	120W 60 [20V]	220W 60 [20V]	2.2K [20V]	BU-3700 [28V]	FR-BU-15K GRGZ300-5Ω 4 in series [28V]		10B 10V	3-25
1.5kW	1.5K	120W 60 [15B]	220W 60 [15B]	2.2K [15B]	BU-1500 [15B]	FR-BU-15K GRGZ300-5Ω 4 in series [15B]		12B 12V	3-26
	2.2K	120W 60 [15V]	220W 60 [15V]	2.2K [15V]	BU-3700 [20V]	FR-BU-15K GRGZ300-5Ω 4 in series [20V]		15B 15V	3-27
2.2kW	2.2K	120W 60 [10B]	220W 60 [10B]	2.2K [10B]	BU-3700 [15B]	FR-BU-15K GRGZ300-5Ω 4 in series [15B]		18B 18V	3-28
	3.7K	120W 40 [15V]	220W 40 [15V]	3.7K [15V]	BU-3700 [15V]	FR-BU-15K GRGZ300-5Ω 4 in series [20V]		20B 20V	3-29
3.7kW	3.7K	120W 40 [10B]	220W 40 [10B]	3.7K [10B]	BU-3700 [10B]	FR-BU-15K GRGZ300-5Ω 4 in series [15B]		28B 28V	3-30
	5.5K	220W 25 [15V]	220W 50 2 in parallel [15V]	5.5K [15V]	7.5K [20V]	FR-BU-15K FR-BR-15K [20V]			
5.5kW	5.5K	220W 25 [10B]	220W 50 2 in parallel [10B]	5.5K [10B]	7.5K [15B]	FR-BU-15K FR-BR-15K [15B]			
	7.5K	220W 20 [15V]	220W 40 2 in parallel [15V]	7.5K [15V]	7.5K [20V]	FR-BU-15K FR-BR-15K [20V]	15K [20V]		
7.5kW	7.5K	220W 20 [10B]	220W 40 2 in parallel [10B]	7.5K [10B]	7.5K [15B]	FR-BU-15K FR-BR-15K [15B]	15K [15B]		
	11K	Capacitor-regenerative [02V]			15K [15V]	FR-BU-15K FR-BR-15K [20V]	15K [20V]		
11kW	11K	Capacitor-regenerative [02B]			15K [10B]	FR-BU-15K FR-BR-15K [15B]	15K [15B]		
	15K	Capacitor-regenerative [02V]			15K [10V]	FR-BU-15K FR-BR-15K [15V]	15K [20V]		

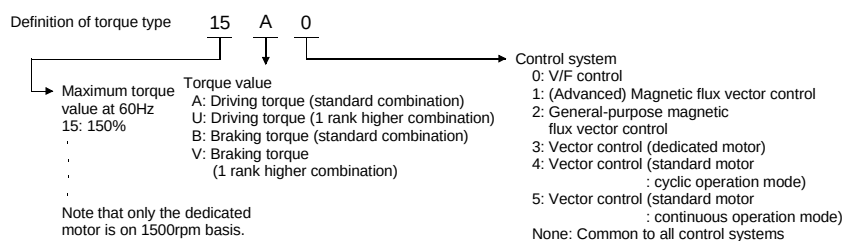


4) FR-Z024 series (200V class)

Top	Standard combination
Bottom	1 rank higher combination

Motor Capacity	Inverter Capacity	Braking Unit	
		Built-in brake	MRS
0.1kW	0.1K	Capacitor-regenerative [02B]	
	0.2K	Capacitor-regenerative [02V]	
0.2kW	0.2K	Capacitor-regenerative [02B]	
	0.4K	Capacitor-regenerative [02V]	120W 200Ω [20V]
0.4kW	0.4K	Capacitor-regenerative [02B]	120W 200Ω [15B]
	0.75K	Capacitor-regenerative [02V]	120W 100Ω [20V]
0.75kW	0.75K	Capacitor-regenerative [02B]	120W 100Ω [15B]
	1.5K	Capacitor-regenerative [02V]	120W 60Ω [20V]
1.5kW	1.5K	Capacitor-regenerative [02B]	120W 60Ω [15B]
	2.2K	Capacitor-regenerative [02V]	120W 60Ω [15V]
2.2kW	2.2K	Capacitor-regenerative [02B]	120W 60Ω [10B]
	3.7K	Capacitor-regenerative [02V]	120W 40Ω [15V]
3.7kW	3.7K	Capacitor-regenerative [02B]	120W 40Ω [10B]

Torque type	Refer to page
02B	3-21
02V	3-21
05B	3-22
07B	3-23
09B	3-24
09V	3-24
10B	3-25
10V	3-25
12B	3-26
12V	3-26
15B	3-27
15V	3-27
18B	3-28
18V	3-28
20B	3-29
20V	3-29
28B	3-30
28V	3-30

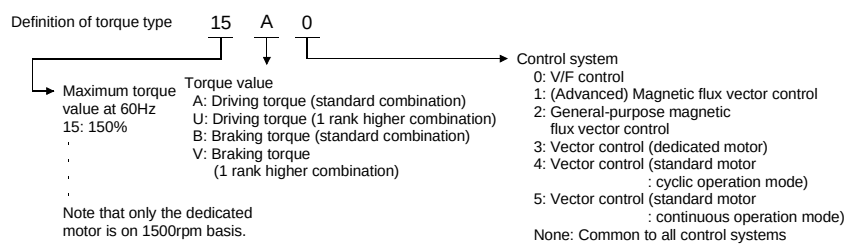


5) FR-A221E series (200V class) (1/2)

Top	Standard combination
Bottom	1 rank higher combination

Motor Capacity	Inverter Capacity	Inverter with Built-In Power Return Function
3.7kW	5.5K	FR-A221E-5.5K [20V]
5.5kW	5.5K	FR-A221E-5.5K [15B]
	7.5K	FR-A221E-7.5K [20V]
7.5kW	7.5K	FR-A221E-7.5K [15B]
	11K	FR-A221E-11K [20V]
11kW	11K	FR-A221E-11K [15B]
	15K	FR-A221E-15K [20V]
15kW	15K	FR-A221E-15K [15B]
	18.5K	FR-A221E-18.5K [18V]
18.5kW	18.5K	FR-A221E-18.5K [15B]
	22K	FR-A221E-22K [18V]
22kW	22K	FR-A221E-22K [15B]
	30K	FR-A221E-30K [20V]
30kW	30K	FR-A221E-30K [15B]
	37K	FR-A221E-37K [18V]

Torque type	Refer to page
02B	3-19
02V	
05B	3-20
07B	3-21
09B	3-22
09V	
10B	3-23
10V	
12B	3-24
12V	3-25
15B	
15V	3-26
18B	
18V	3-27
20B	
20V	3-28
28B	
28V	

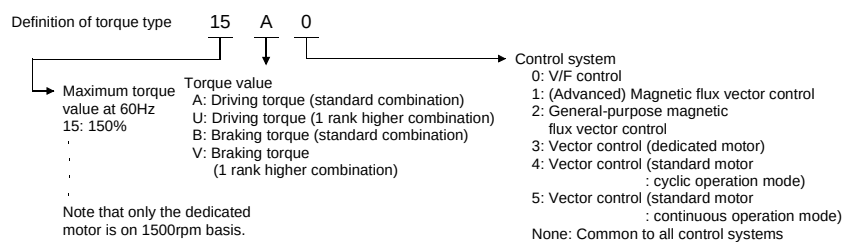


FR-A221E series (200V class) (2/2)

Top	Standard combination
Bottom	1 rank higher combination

Motor Capacity	Inverter Capacity	Inverter with Built-In Power Return Function
37kW	37K	FR-A221E-37k [15B]
	45K	FR-A221E-45k [18V]
45kW	45K	FR-A221E-45k [15B]
	55K	FR-A221E-55k [18V]
55kW	55K	FR-A221E-55K [15B]

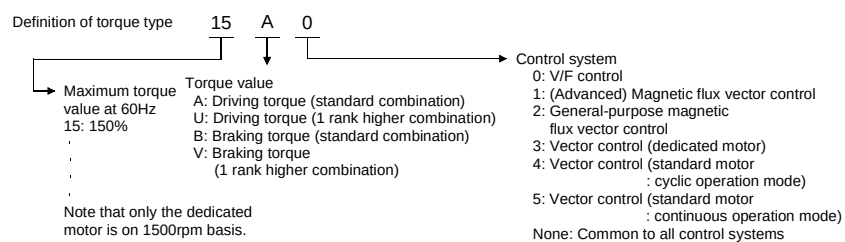
Torque type	Refer to page
02B	3-19
02V	
05B	3-20
07B	3-21
09B	3-22
09V	
10B	3-23
10V	
12B	3-24
12V	
15B	3-25
15V	
18B	3-26
18V	
20B	3-27
20V	
28B	3-28
28V	



6) FR-V220E series (200V class) (1/2)

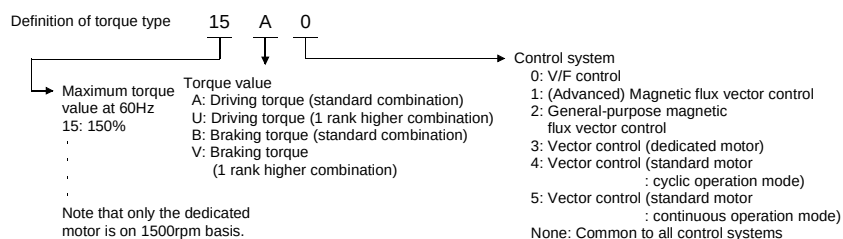
Top	Standard combination
Bottom	1 rank higher combination

Motor Capacity	Inverter Capacity	Braking Unit								Torque type	Refer to page
		Built-in brake	MYS	FR-ABR	BU Type	FR-BU	FR-RC	FR-HC	FR-HC		
0.4kW	0.4K									02B 02V	3-21
	0.75K									05B 07B	3-22 3-23
0.75kW	0.75K									09B 09V	3-24
	1.5K									10B 10V	3-25
1.5kW	1.5K	120W 60 [15B]	220W 60 [15B]	2.2K [15B]	BU-1500 [15B]	FR-BU-15K GRZG300-5Ω 4 in series [15B]		7.5K [15B]	7.5K [15B]	12B 12V	3-26
	2.2K	120W 60 [15V]	220W 60 [15V]	2.2K [15V]	BU-3700 [15V]	FR-BU-15K GRZG300-5Ω 4 in series [15V]		7.5K [15V]	7.5K [15V]	15B 15V	3-27
	2.2K	120W 60 [10B]	220W 60 [10B]	2.2K [10B]	BU-3700 [15B]	FR-BU-15K GRZG300-5Ω 4 in series [15B]		7.5K [15B]	7.5K [15B]	18B 18V	3-28
	3.7K	120W 40 [15V]	220W 40 [15V]	3.7K [15V]	BU-3700 [15V]	FR-BU-15K GRZG300-5Ω 4 in series [15V]		7.5K [15V]	7.5K [15V]	20B 20V	3-29
2.2kW	2.2K	120W 40 [10B]	220W 40 [10B]	3.7K [10B]	BU-3700 [10B]	FR-BU-15K GRZG300-5Ω 4 in series [15B]		7.5K [15B]	7.5K [15B]	28B 28V	3-30
	5.5K	220W 25 [15V]	220W 50 2 in parallel [15V]	5.5K [15V]	7.5K [15V]	FR-BU-15K FR-BR-15K [15V]	15K [15V]	7.5K [15V]	7.5K [15V]		
	5.5K	220W 25 [10B]	220W 50 2 in parallel [10B]	5.5K [10B]	7.5K [15B]	FR-BU-15K FR-BR-15K [15B]	15K [15B]	7.5K [15B]	7.5K [15B]		
	7.5K	Capacitor-regenerative [02V]			7.5K [15V]	FR-BU-15K FR-BR-15K [15V]	15K [15V]	7.5K [15V]	7.5K [15V]		
7.5kW	7.5K	Capacitor-regenerative [02B]			7.5K [15B]	FR-BU-15K FR-BR-15K [15B]	15K [15B]	7.5K [15B]	7.5K [15B]		
	11K	Capacitor-regenerative [02V]			15K [15V]	FR-BU-15K FR-BR-15K [15V]	15K [15V]	15K [15V]	15K [15V]		
11kW	11K	Capacitor-regenerative [02B]			15K [10B]	FR-BU-15K FR-BR-15K [10B]	15K [15B]	15K [15B]	15K [15B]		
	15K	Capacitor-regenerative [02V]			15K [10V]	FR-BU-15K FR-BR-15K [15V]	15K [15V]	15K [15V]	15K [15V]		

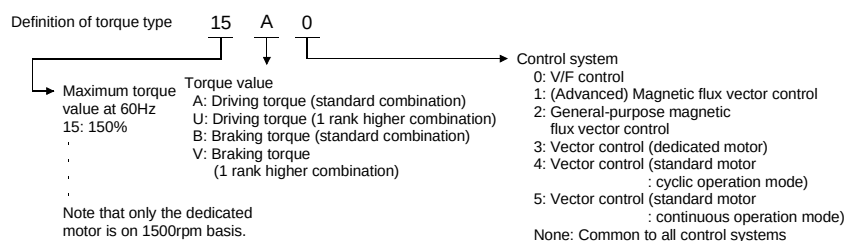


Top	Standard combination
Bottom	1 rank higher combination

Torque type	Refer to page
02B 02V	3-21
05B	3-22
07B	3-23
09B 09V	3-24
10B 10V	3-25
12B 12V	3-26
15B 15V	3-27
18B 18V	3-28
20B 20V	3-29
28B 28V	3-30



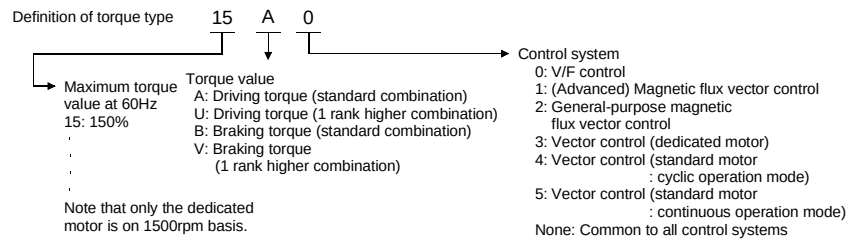
Top	Standard combination
Bottom	1 rank higher combination



3) FR-Z240(E) series (400V class) (1/2)

Top	Standard combination
Bottom	1 rank higher combination

Motor Capacity	Inverter Capacity	Braking Unit						Torque type	Refer to page
		Built-in brake	MYS	FR-ABR	BU Type	FR-BU	FR-RC		
2.2kW	2.2K	120W 250 [10B]	220W 250 [10B]	H2.2K [10B]	H7.5K [15B]	GRGZ300-20Ω 4 in series [15B]		02B 02V	3-21
	3.7K	220W 150 [15V]	220W 150 [15V]	H3.7K [15V]	H7.5K [20V]	GRGZ300-20Ω 4 in series [20V]		05B 07B	3-22 3-23
3.7kW	3.7K	220W 150 [10B]	220W 150 [10B]	H3.7K [10B]	H7.5K [15B]	GRGZ300-20Ω 4 in series [15B]		09B 09V	3-24
	7.5K	300W 75 [20V]	220W 150 2 in parallel [20V]	H7.5K [20V]	H7.5K [20V]	FR-BU-H15K FR-BR-H15K [28V]	H15K [28V]	10B 10V 12B 12V	3-25 3-26
5.5kW	7.5K	300W 75 [15B]	220W 150 2 in parallel [15B]	H7.5K [15B]	H7.5K [15B]	FR-BU-H15K FR-BR-H15K [20B]	H15K [20B]	15B 15V 18B 18V	3-27 3-28
	15K	Capacitor-regenerative [02V]			H15K [20V]	FR-BU-H15K FR-BR-H15K [20V]	H15K [20V]	20B 20V	3-29
7.5kW	7.5K	300W 75 [10B]	220W 150 2 in parallel [10B]	H7.5K [10B]	H7.5K [10B]	FR-BU-H15K FR-BR-H15K [15B]	H15K [15B]	28B 28V	3-30
	15K	Capacitor-regenerative [02V]			H15K [15V]	FR-BU-H15K FR-BR-H15K [20V]	H15K [28V]		
11kW	15K	Capacitor-regenerative [02B]			H15K [10B]	FR-BU-H15K FR-BR-H15K [15B]	H15K [20B]		
	22K	Capacitor-regenerative [02V]			H30K [20V]	FR-BU-H30K FR-BR-H30K [20V]	H30K [28V]		
15kW	15K	Capacitor-regenerative [02B]			H15K [09B]	FR-BU-H30K FR-BR-H30K [10B]	H15K [15B]		
	22K	Capacitor-regenerative [02V]			H30K [15V]	FR-BU-H30K FR-BR-H30K [20V]	H30K [20V]		
18.5kW	22K	Capacitor-regenerative [02B]			H30K [10B]	FR-BU-H30K FR-BR-H30K [15B]	H30K [15B]		
	37K	Capacitor-regenerative [02V]			2×H30K [20V]	FR-BU-H55K FR-BR-H55K [20V]	H55K [20V]		
22kW	22K	Capacitor-regenerative [02B]			H30K [10B]	FR-BU-H30K FR-BR-H30K [15B]	H30K [15B]		
	37K	Capacitor-regenerative [02V]			2×H30K [18V]	FR-BU-H55K FR-BR-H55K [20V]	H55K [20V]		

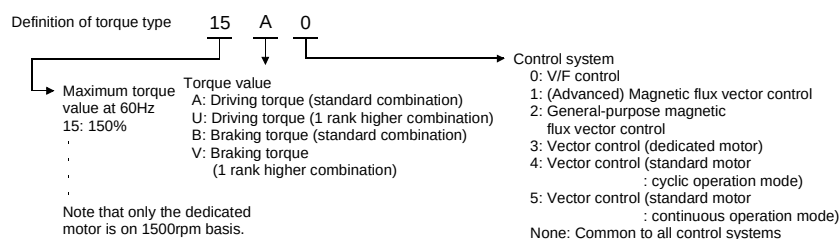


FR-A241E series (400V class) (2/2)

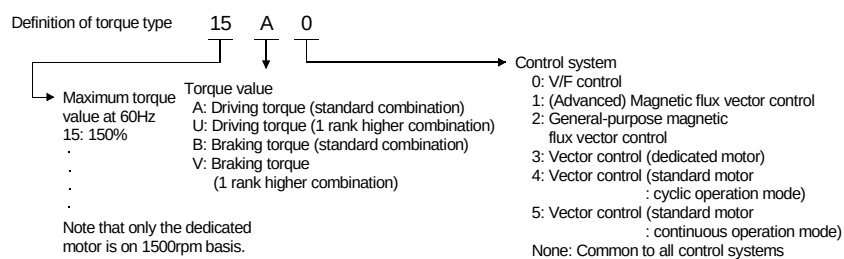
Top	Standard combination
Bottom	1 rank higher combination

Motor Capacity	Inverter Capacity	Inverter with Built-In Power Return Function
37kW	37K	FR-A241E-37K [15B]
	45K	FR-A241E-45K [18V]
45kW	45K	FR-A241E-45K [15B]
	55K	FR-A241E-55K [18V]
55kW	55K	FR-A241E-55K [15B]

Torque type	Refer to page
02B	3-21
02V	
05B	3-22
07B	3-23
09B	3-24
09V	
10B	3-25
10V	
12B	3-26
12V	
15B	3-27
15V	
18B	3-28
18V	
20B	3-29
20V	
28B	3-30
28V	



Top	Standard combination
Bottom	1 rank higher combination



FR-V240E series (400V class) (2/2)

Top	Standard combination
Bottom	1 rank higher combination

Motor Capacity	Inverter Capacity	Braking Unit					
		Built-in brake	BU Type	FR-BU	FR-RC	FR-HC	FR-HC
15kW	15K	Capacitor-regenerative [02B]	H15K [09B]	FR-BU-15K FR-BR-15K [10B]	H15K [15B]	H15K [15B]	15K [15B]
	18.5K	Capacitor-regenerative [02V]	H30K [12V]	FR-BU-30K FR-BR-30K [15V]	H30K [15V]	H30K [15V]	30K [15V]
18.5kW	18.5K	Capacitor-regenerative [02B]	H30K [10B]	FR-BU-30K FR-BR-30K [15B]	H30K [15B]	H30K [15B]	30K [15B]
	22K	Capacitor-regenerative [02V]	H30K [10V]	FR-BU-30K FR-BR-30K [15V]	H30K [15V]	H30K [15V]	30K [15V]
22kW	22K	Capacitor-regenerative [02B]	H30K [10B]	FR-BU-30K FR-BR-30K [15B]	H30K [15B]	H30K [15B]	30K [15B]
	30K	Capacitor-regenerative [02V]	H30K [10V]	FR-BU-30K FR-BR-30K [15V]	H30K [15V]	H30K [15V]	30K [15V]
30kW	30K	Capacitor-regenerative [02B]	H30K [07B]	FR-BU-30K FR-BR-30K [15B]	H30K [15B]	H30K [15B]	30K [15B]
	37K	Capacitor-regenerative [02V]	2 × H30K [15V]	FR-BU-55K FR-BR-55K [15V]	H55K [15V]	H55K [15V]	55K [15V]
37kW	37K	Capacitor-regenerative [02B]	2 × H30K [10B]	FR-BU-55K FR-BR-55K [15B]	H55K [15B]	H55K [15B]	55K [15B]
	45K	Capacitor-regenerative [02V]	2 × H30K [10V]	FR-BU-55K FR-BR-55K [15V]	H55K [15V]	H55K [15V]	55K [15V]
45kW	45K	Capacitor-regenerative [02B]	2 × H30K [09B]	FR-BU-55K FR-BR-55K [12B]	H55K [15B]	H55K [15B]	55K [15B]
	55K						
55kW	55K						

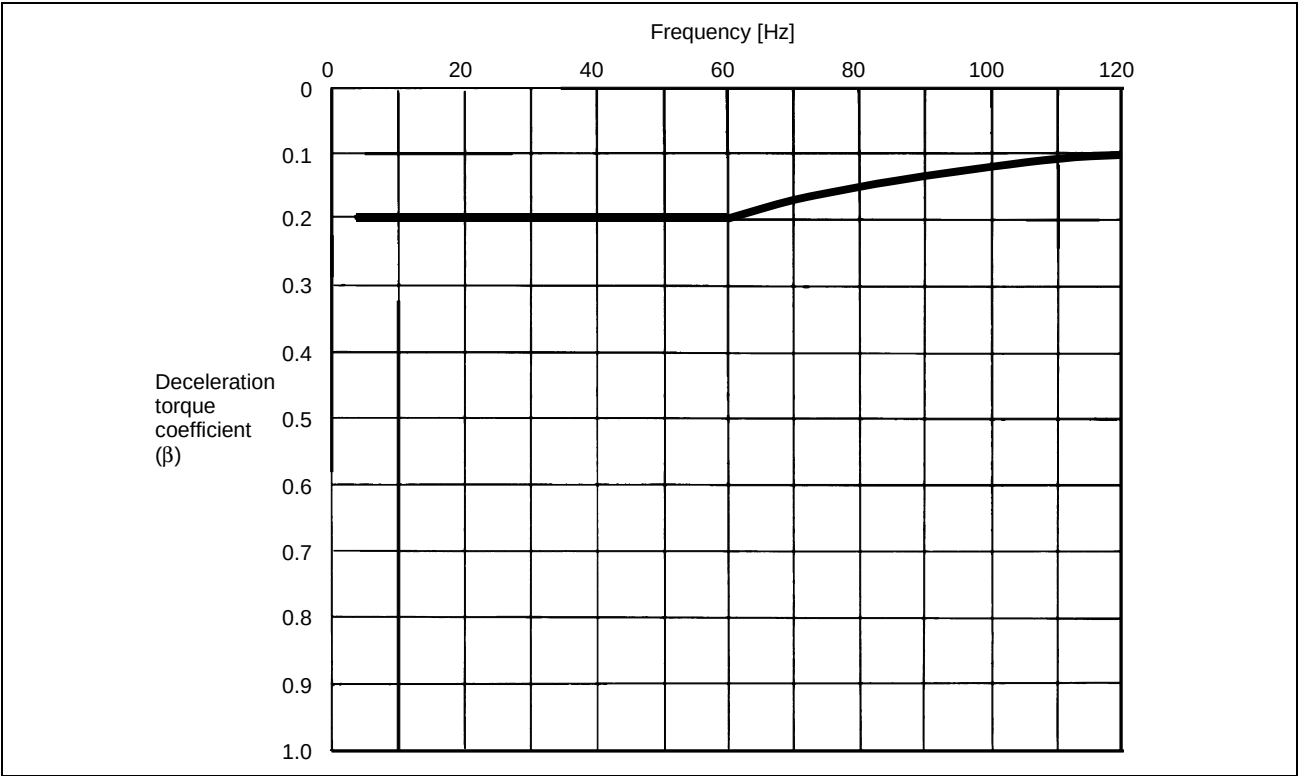
Torque type	Refer to page
02B	3-21
02V	3-22
05B	3-23
07B	3-24
09B	3-25
09V	3-26
10B	3-27
10V	3-28
12B	3-29
12V	3-30
15B	3-27
15V	3-28
18B	3-29
18V	3-30
20B	3-29
20V	3-30
28B	3-30
28V	3-30

3.3 Brake Torque Data

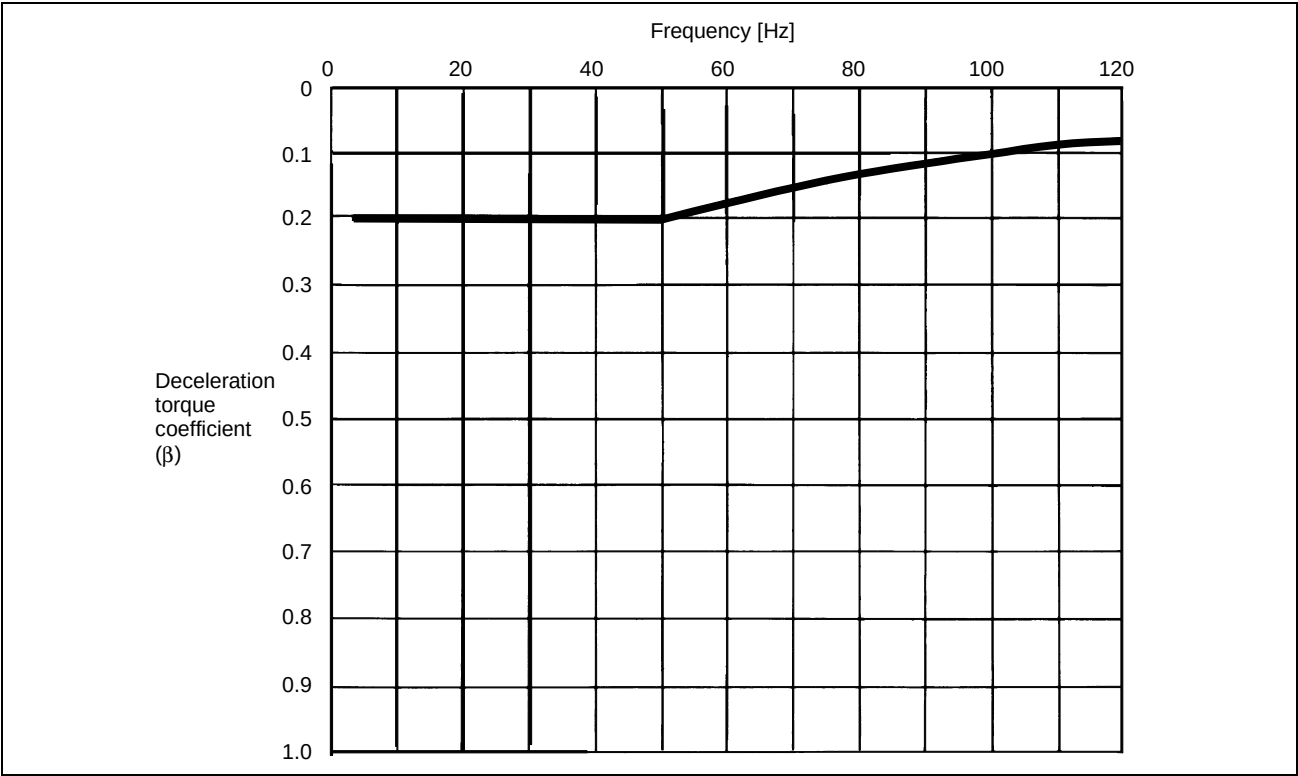
(1) Torque type 02B 02V

02B
02V

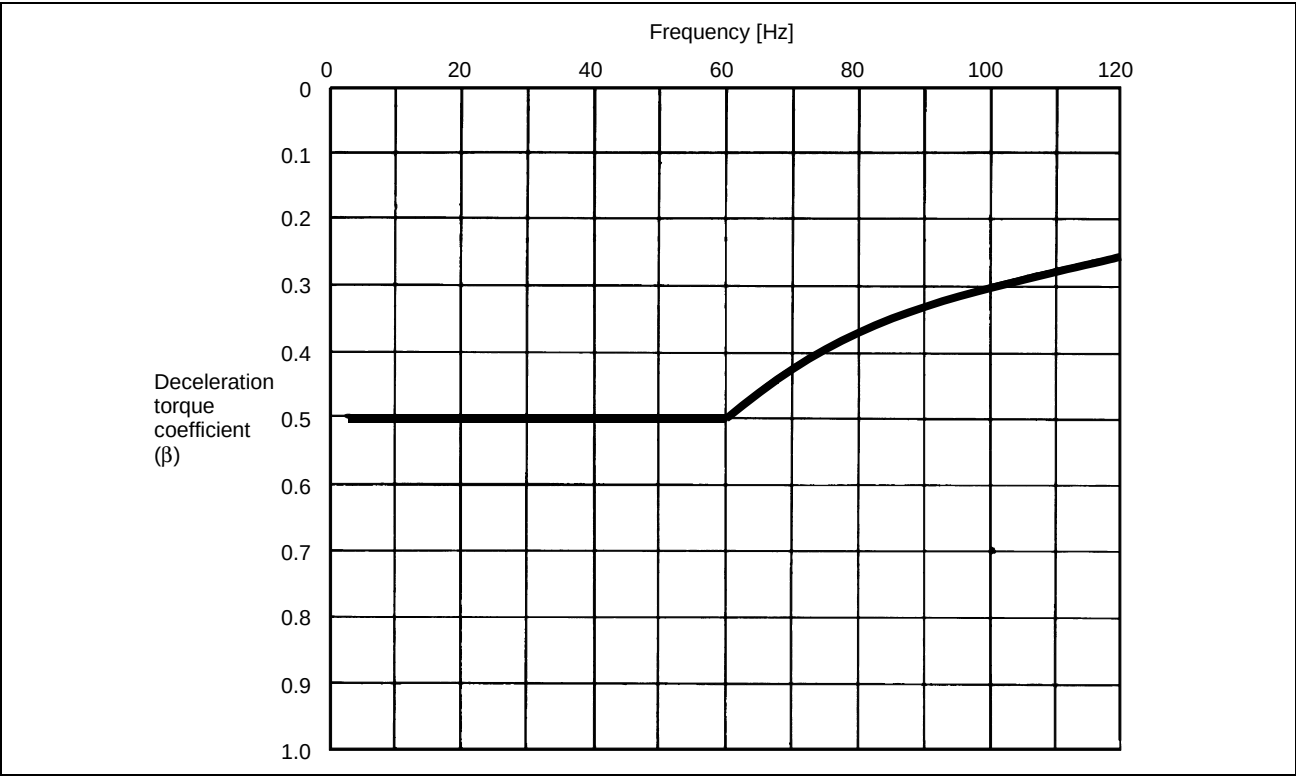
1) 60Hz torque basis



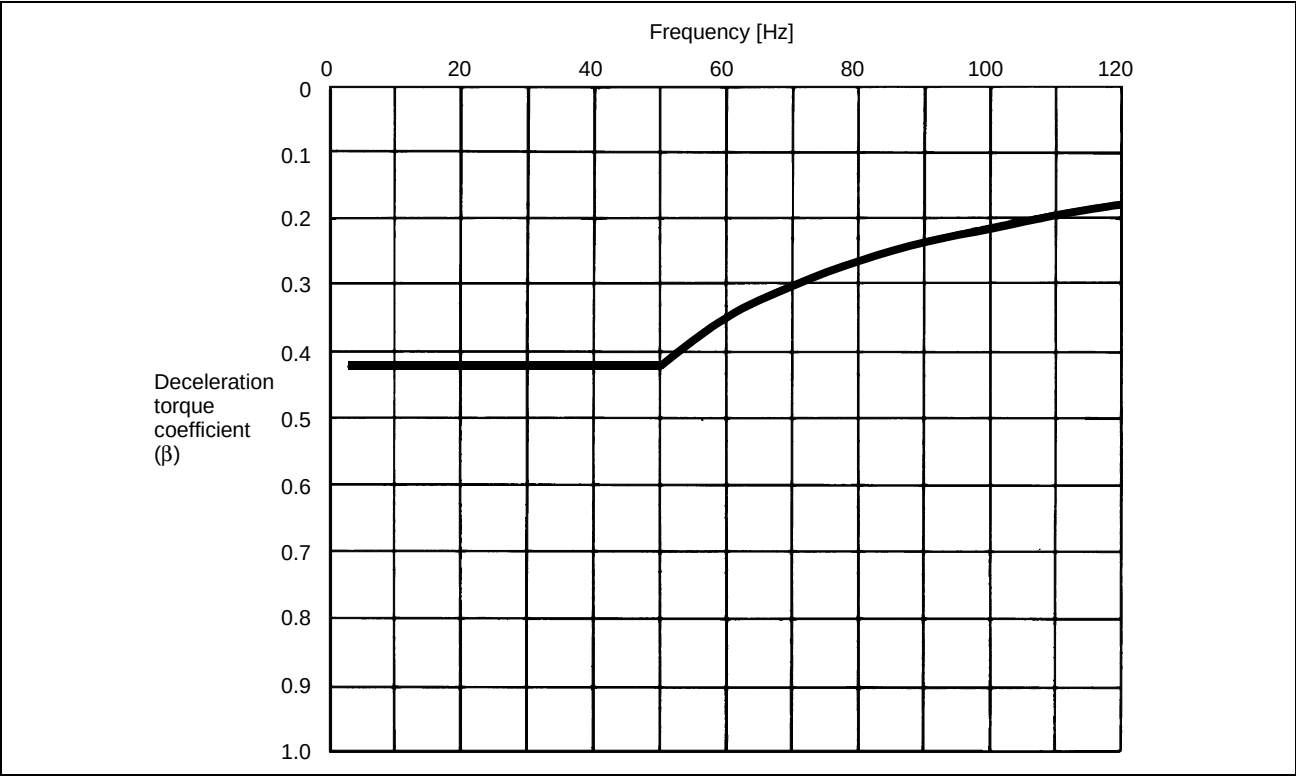
2) 50Hz torque basis



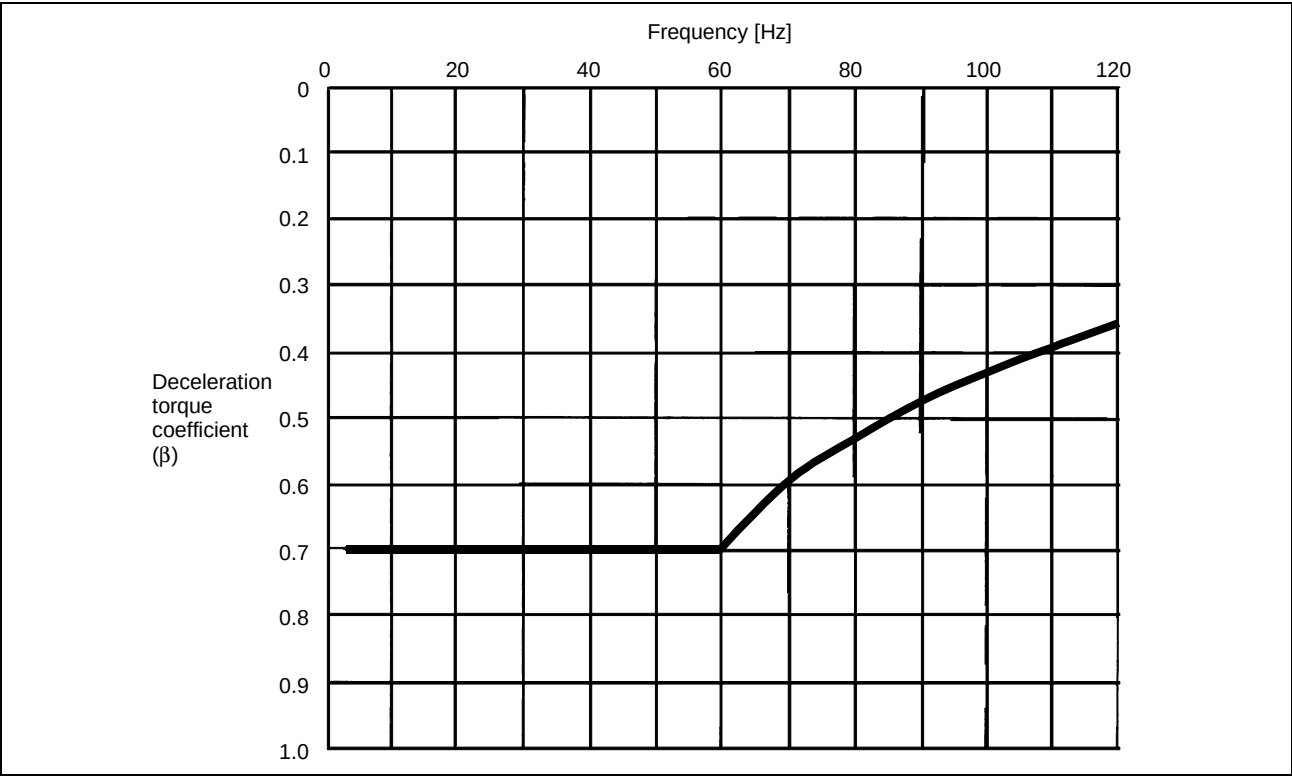
1) 60Hz torque basis



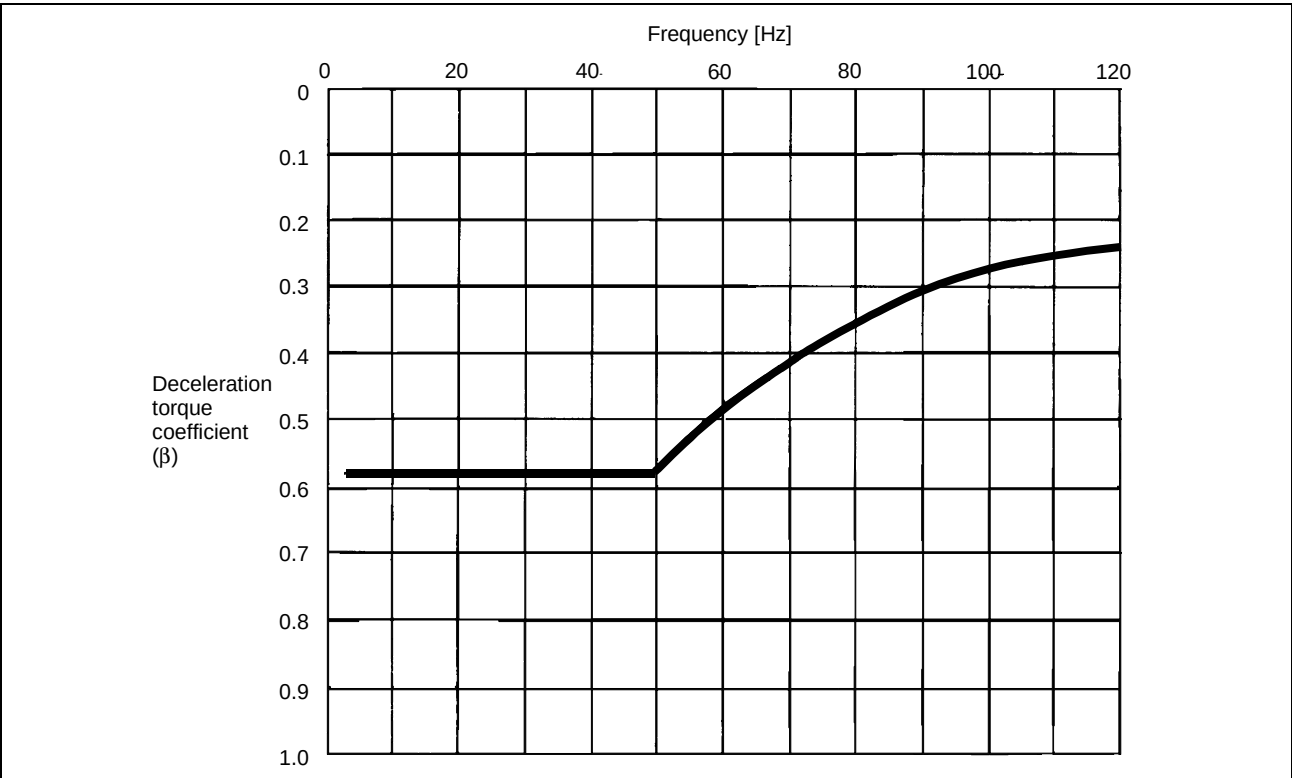
2) 50Hz torque basis



1) 60Hz torque basis



2) 50Hz torque basis

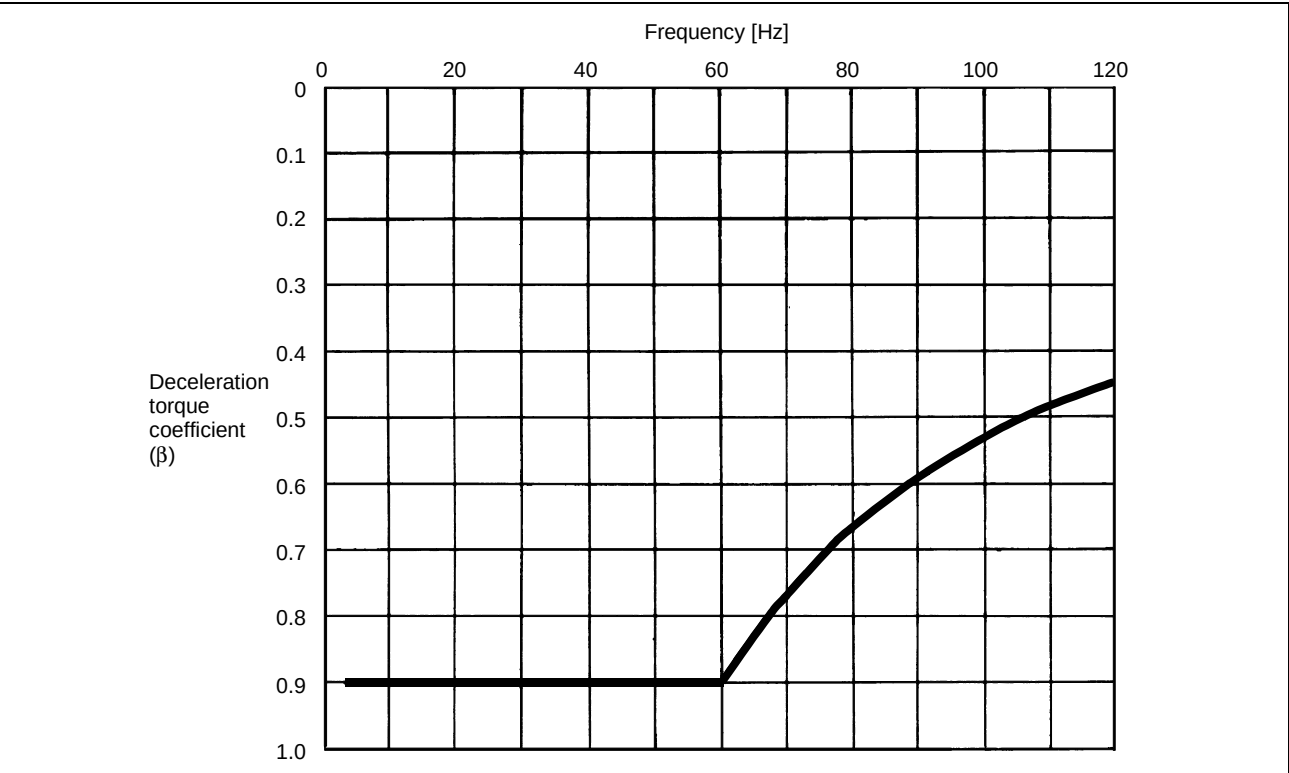


(4) Torque type 09B 09V

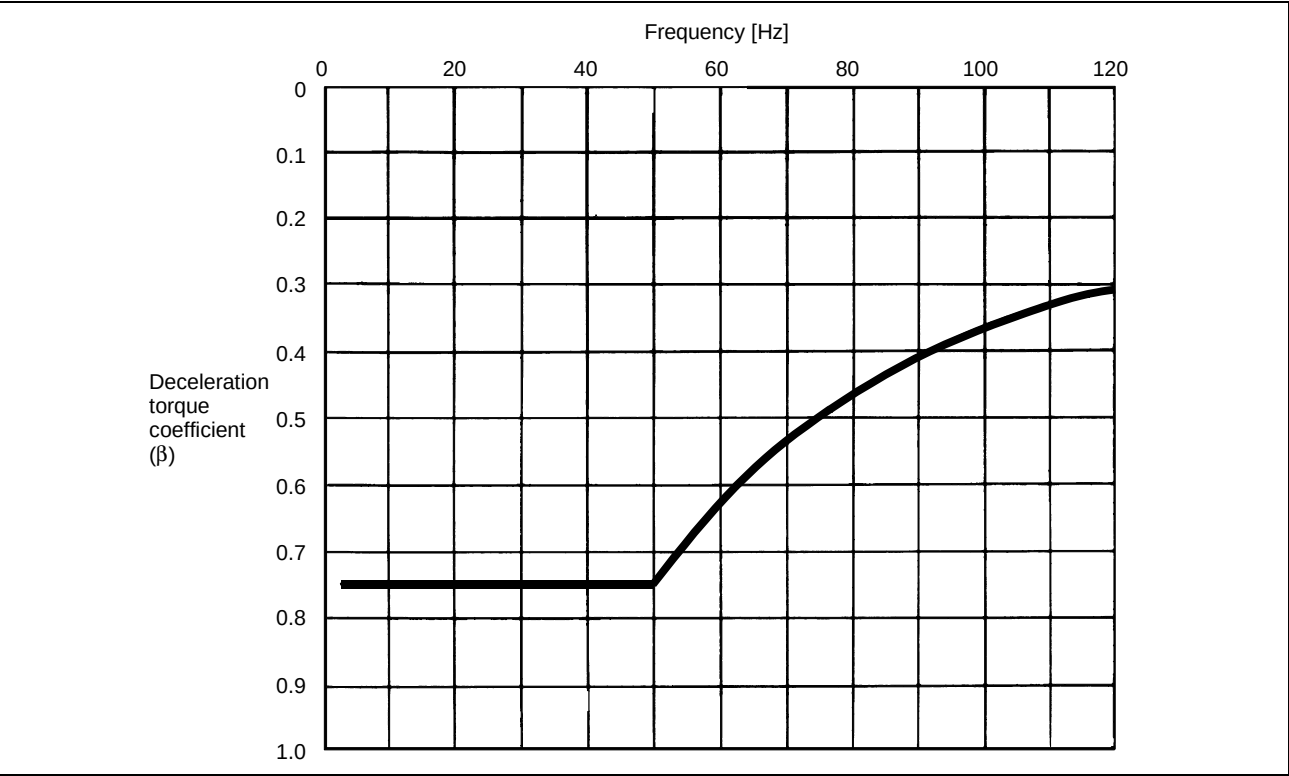
09B

09V

1) 60Hz torque basis



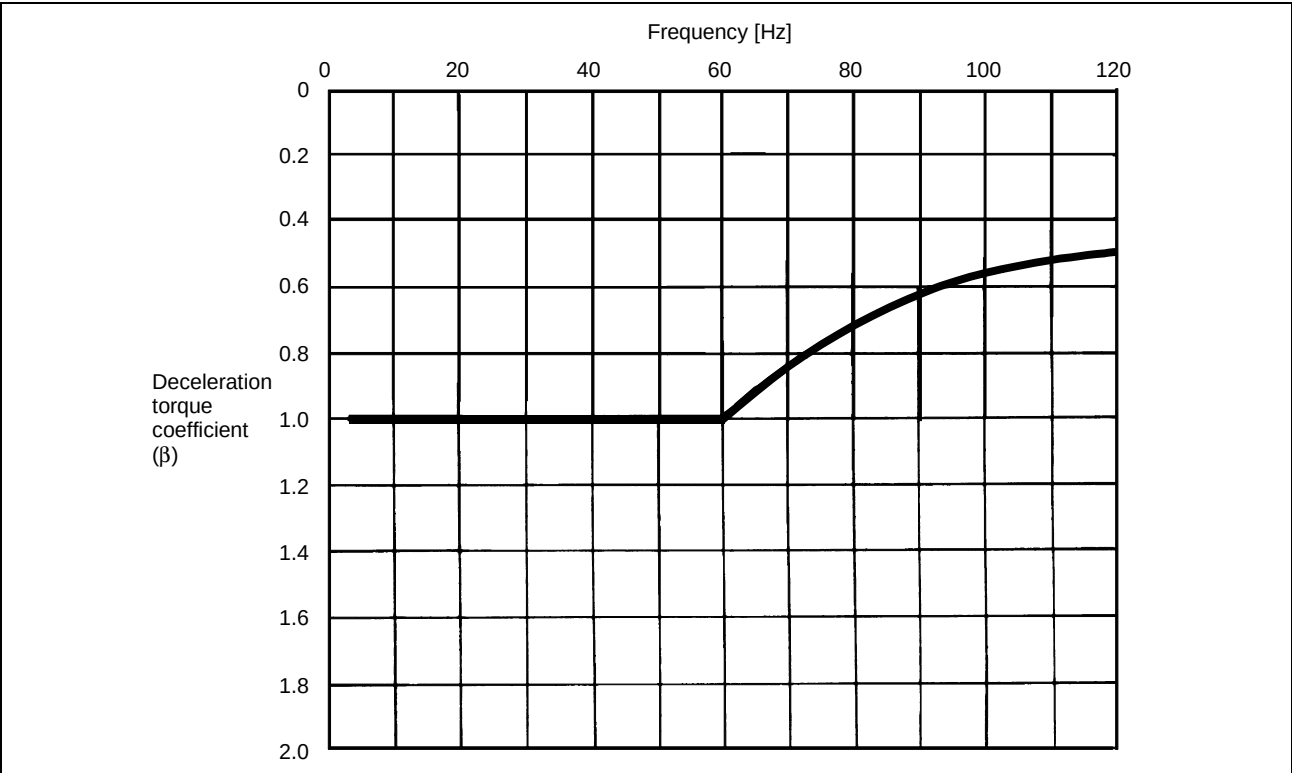
2) 50Hz torque basis



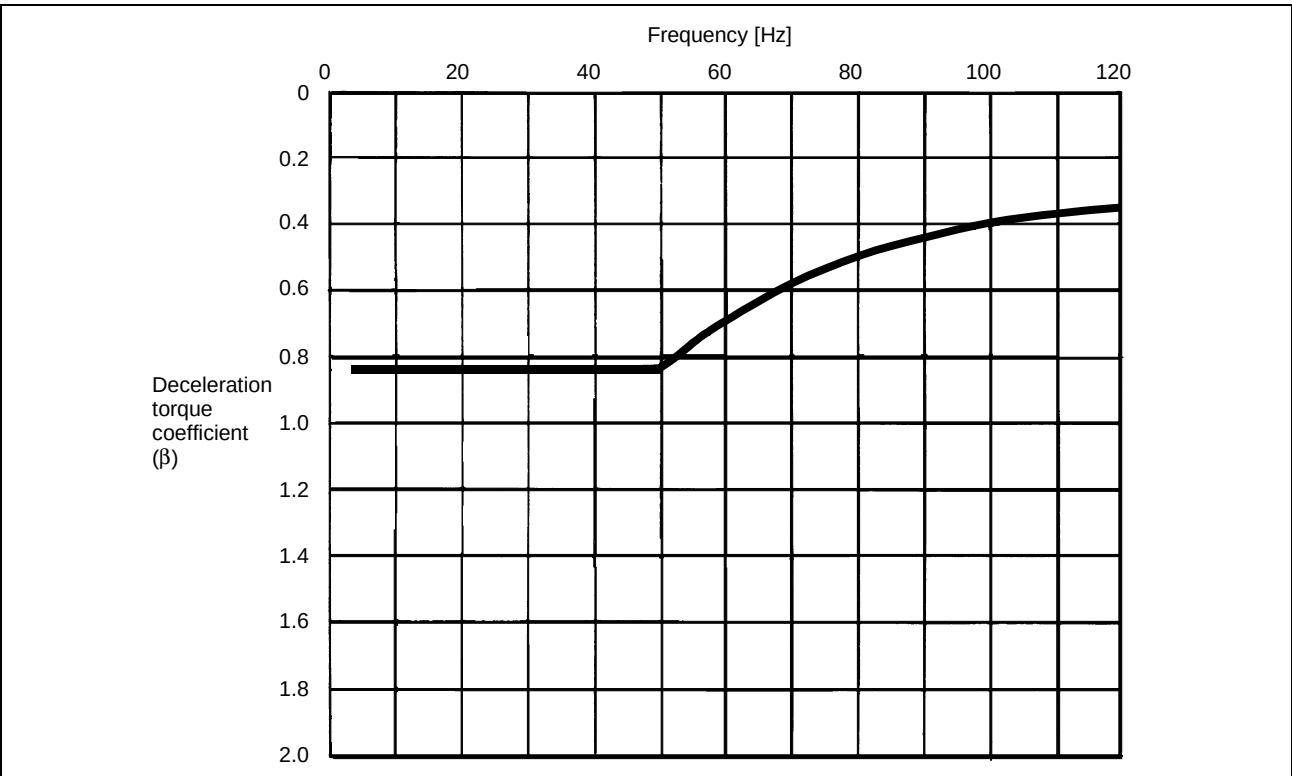
(5) Torque type 10B 10V

10B
10V

1) 60Hz torque basis



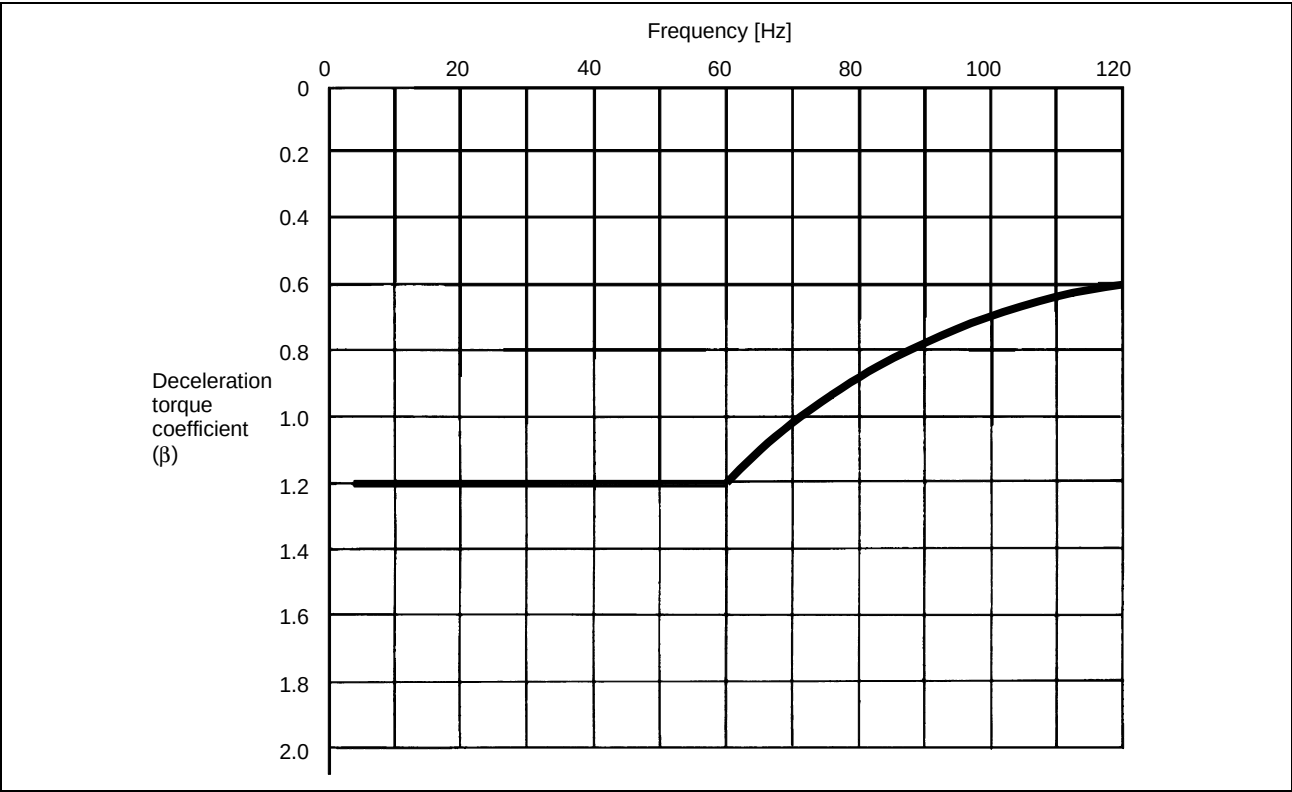
2) 50Hz torque basis



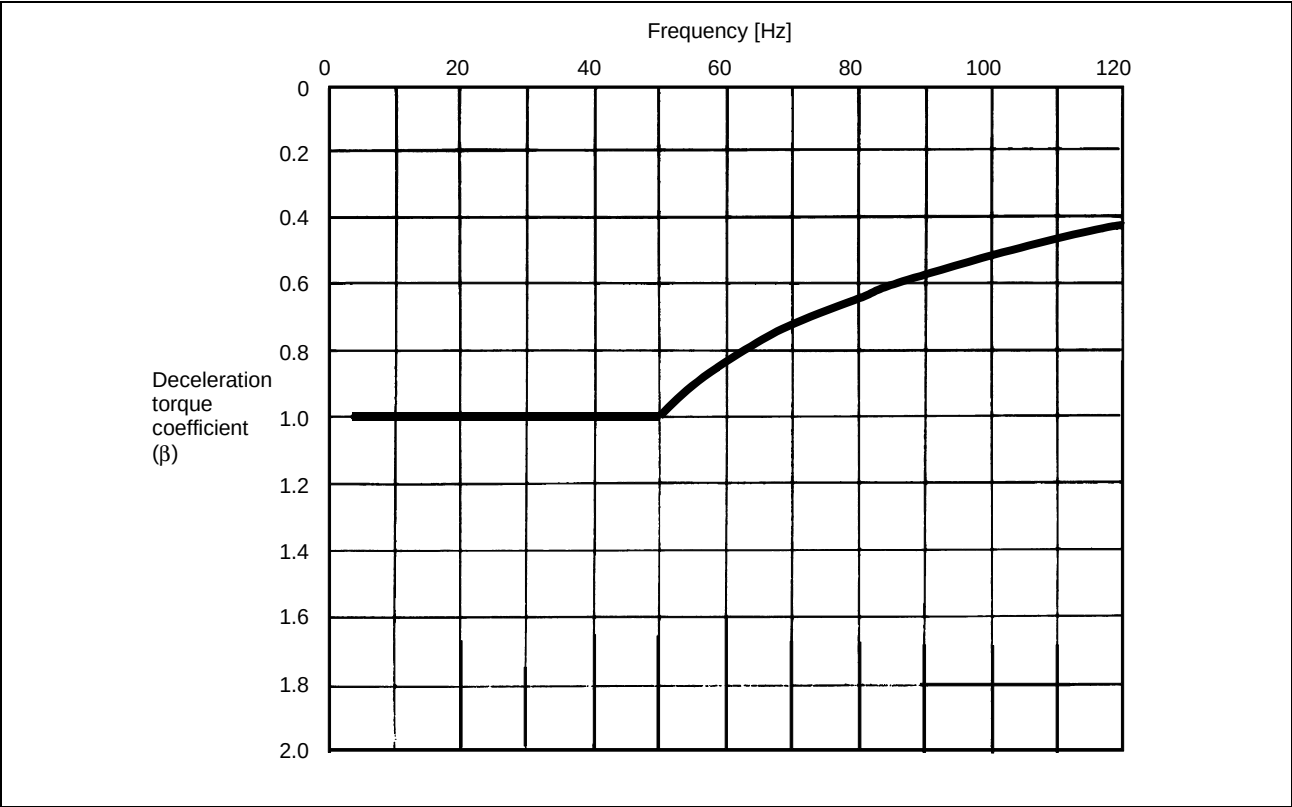
(6) Torque type 12B 12V

12B
12V

1) 60Hz torque basis



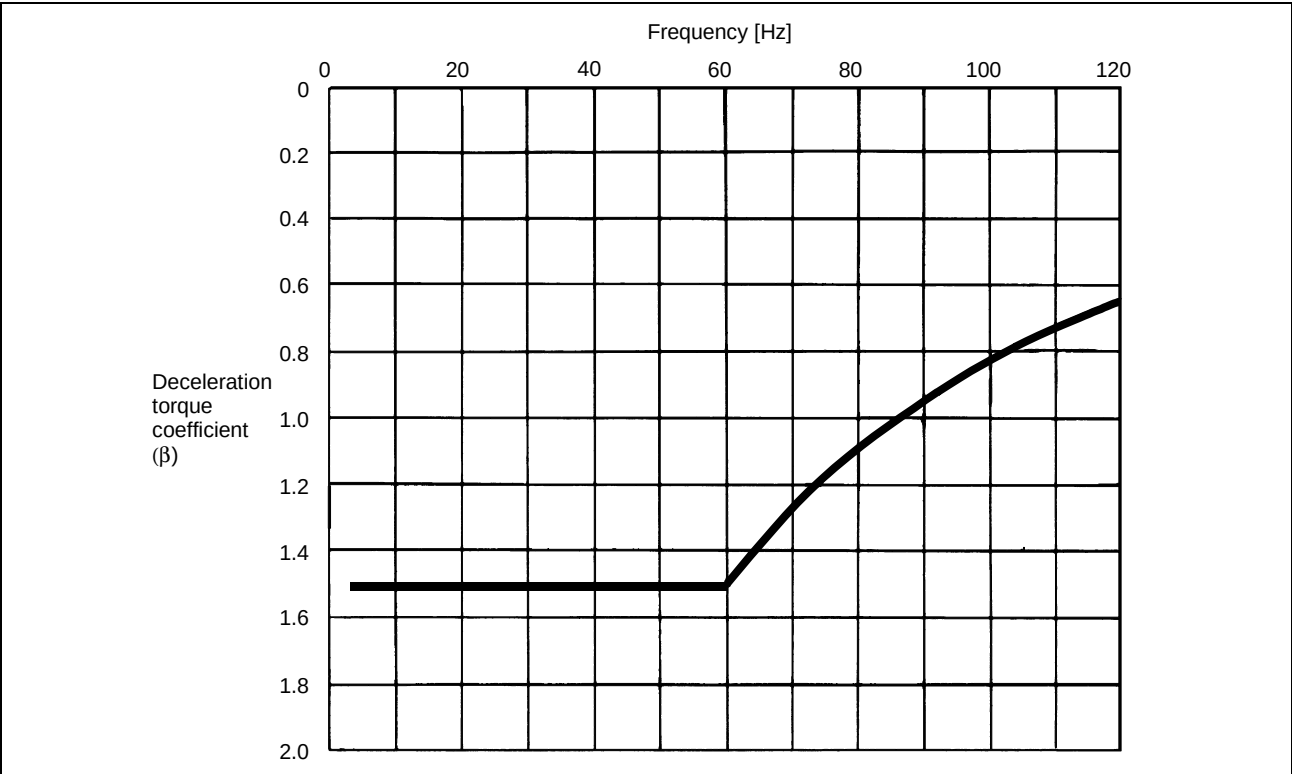
2) 50Hz torque basis



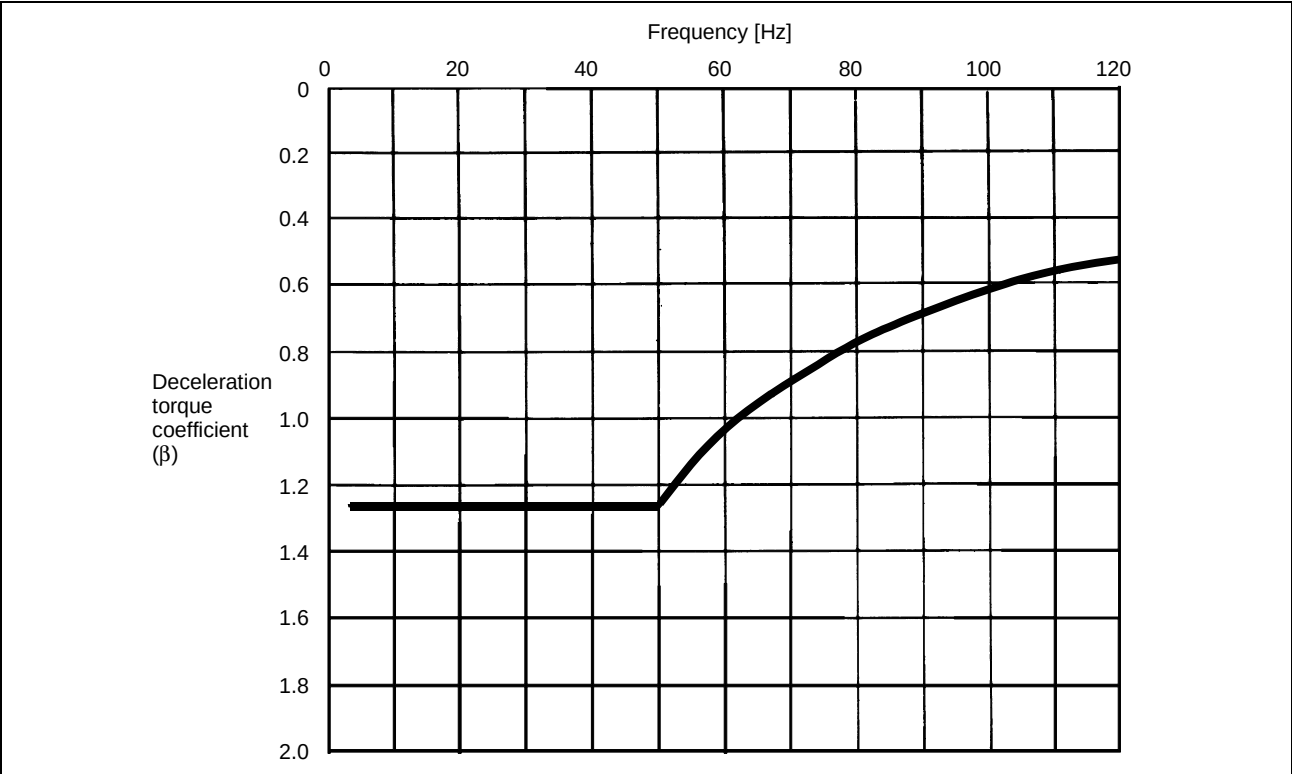
(7) Torque type 15B 15V

15B
15V

1) 60Hz torque basis



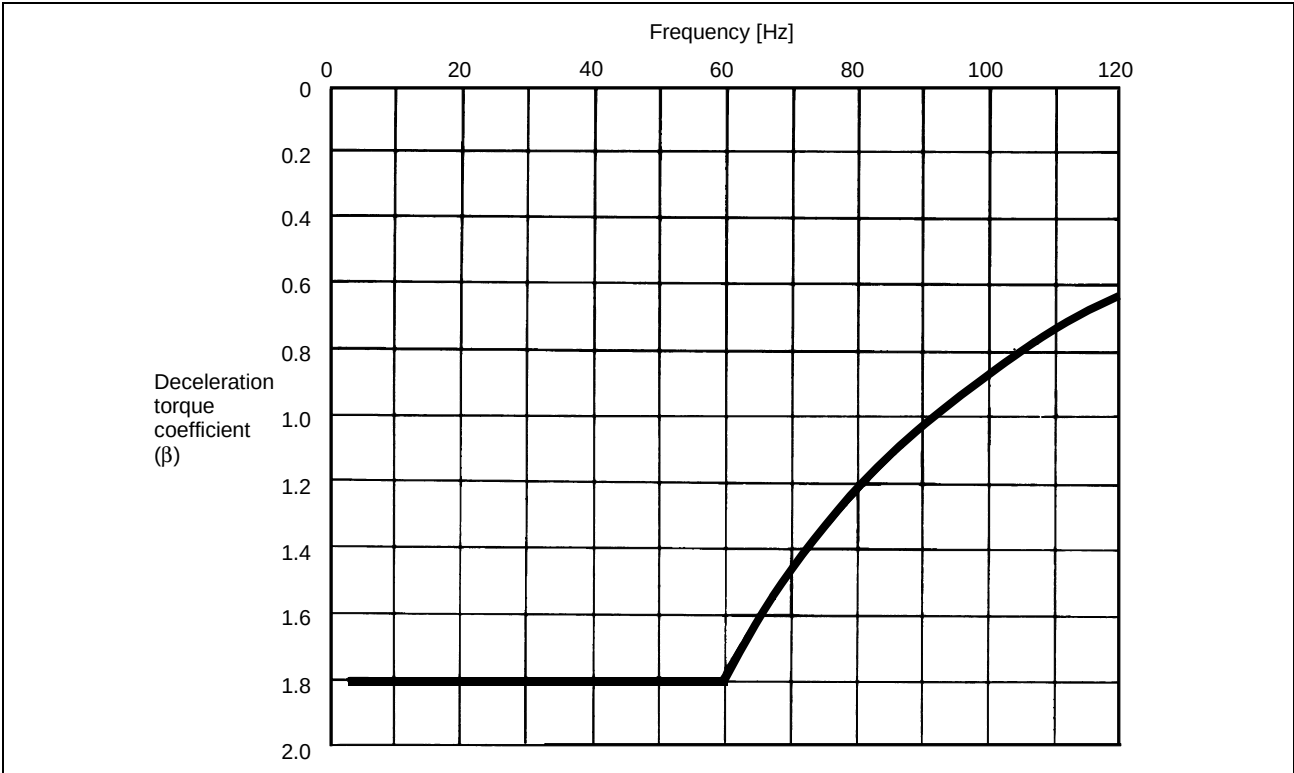
2) 50Hz torque basis



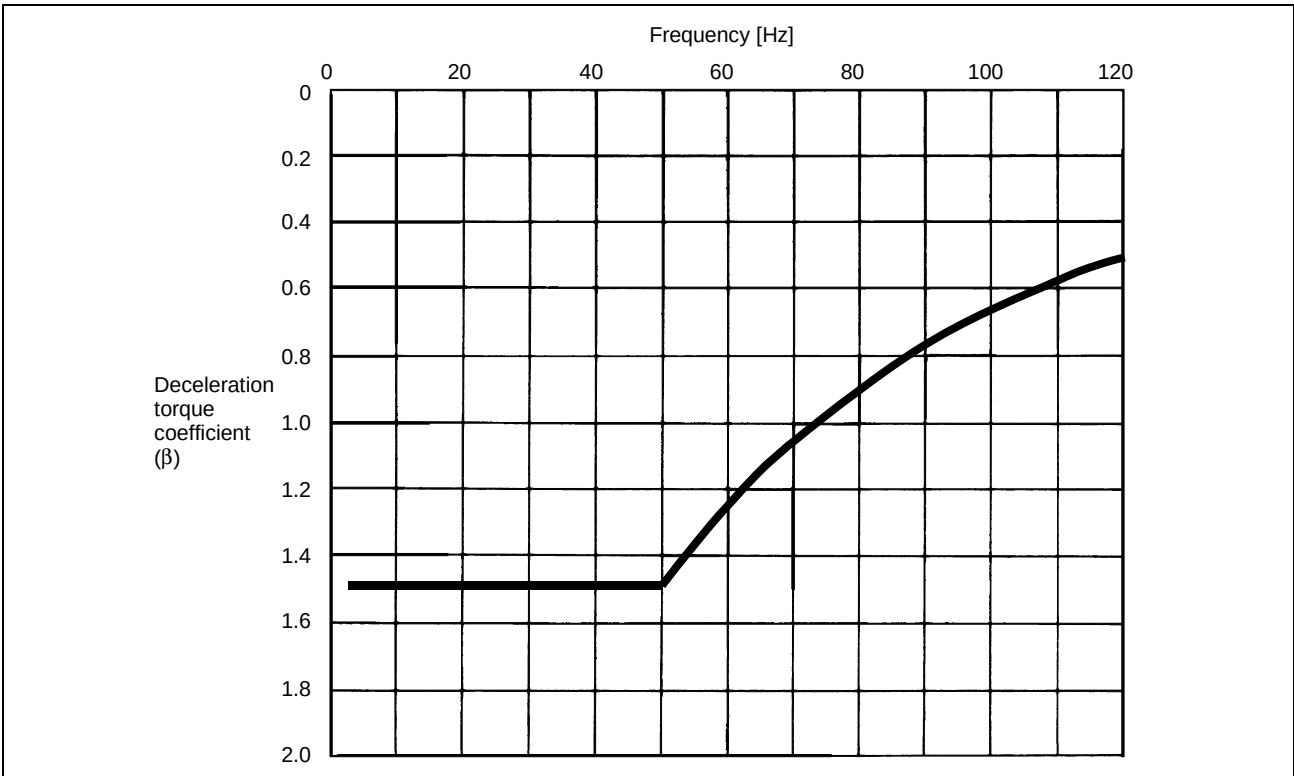
(8) Torque type 18B 18V

18B
18V

1) 60Hz torque basis



2) 50Hz torque basis

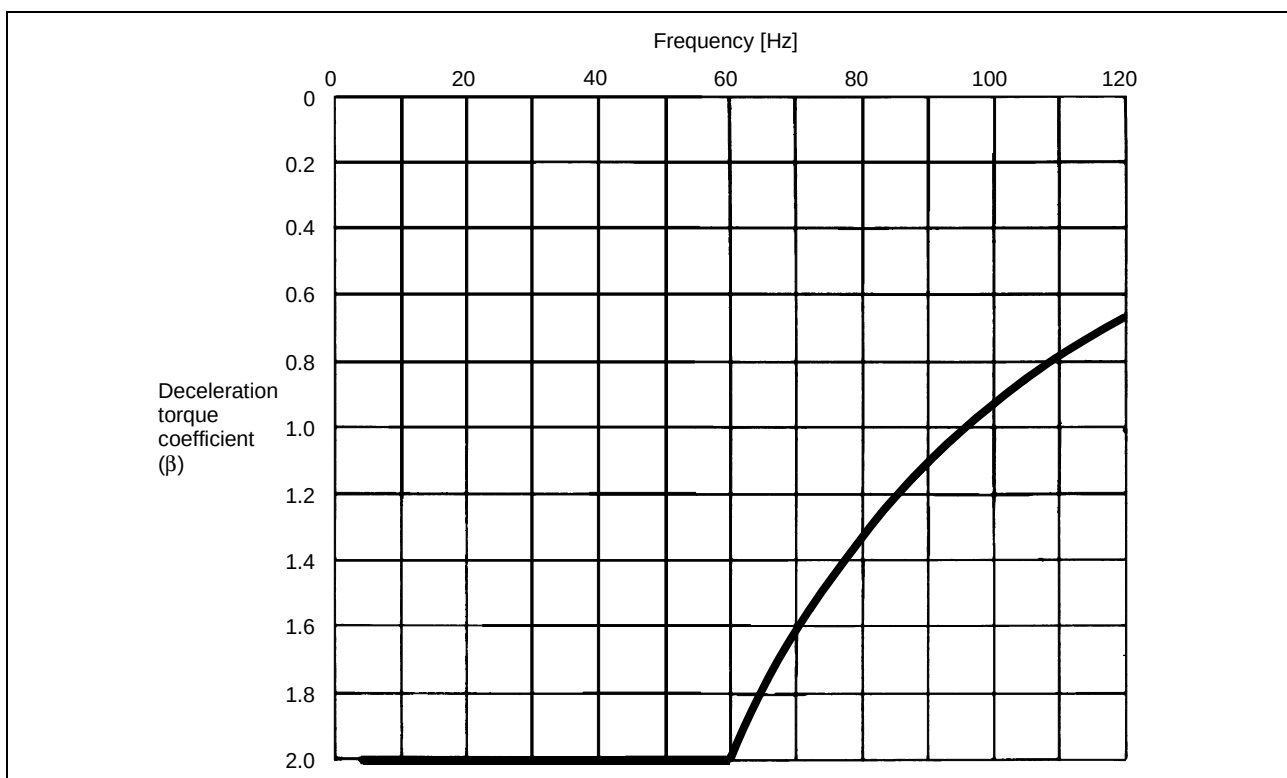


(9) Torque type 20B 20V

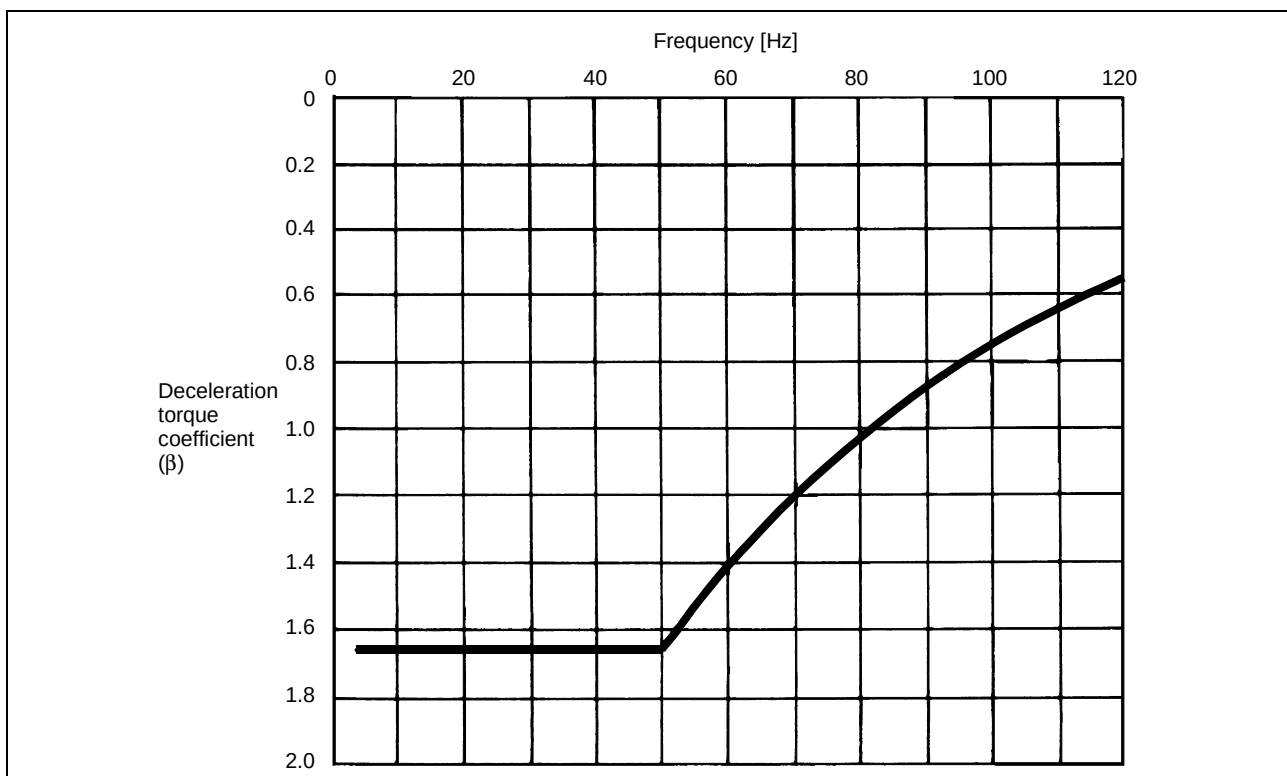
20B

20V

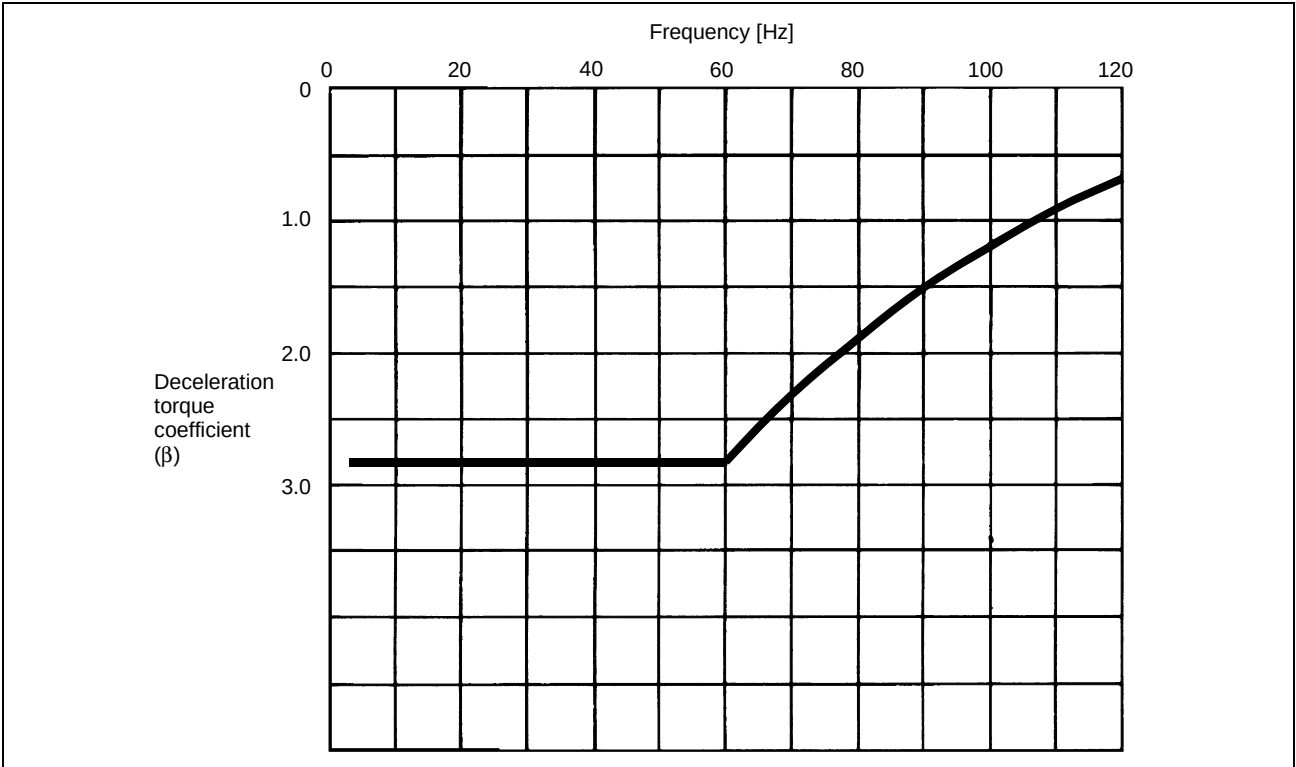
1) 60Hz torque basis



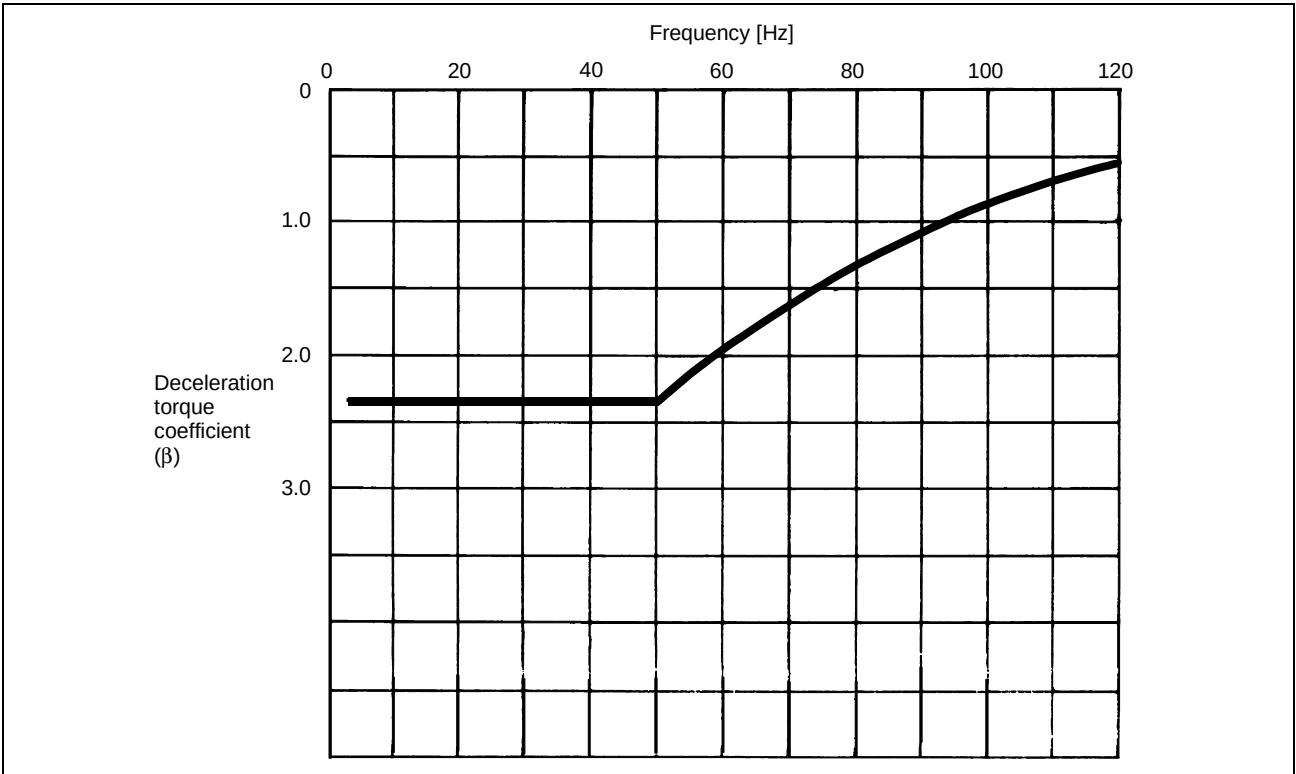
2) 50Hz torque basis



1) 60Hz torque basis



2) 50Hz torque basis



3.4 Permissible Power

3.4.1 Permissible power list

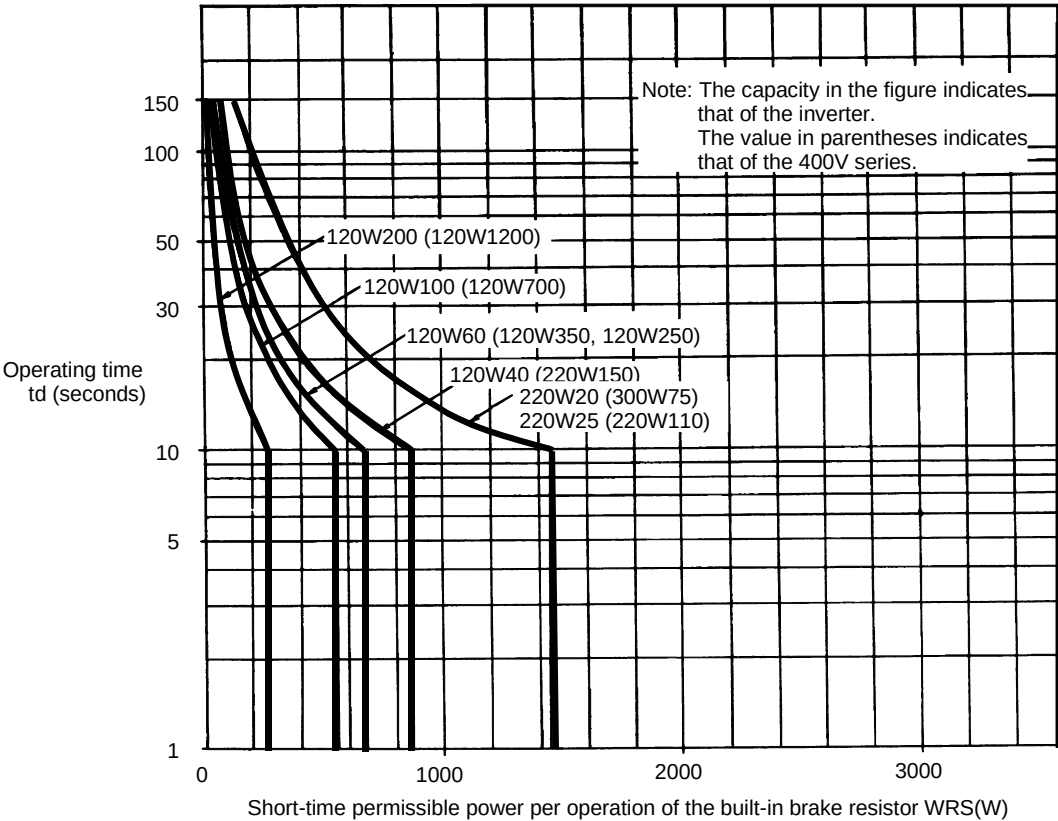
200V Series					400V Series				
Braking unit		Short-time permissible power WRS (W)	Continuous permissible power WRC (W)		Braking unit		Short-time permissible power WRS (W)	Continuous permissible power WRC (W)	
Type	Capacity				Type	Capacity			
Built-in brake (A520 A220 V220 Z220)	0.4K	260	15		Built-in brake (A540 A240 V240 Z240)	0.4K	260		
	0.75K	560	30			0.75K	560	30	
	1.5K	660	55			1.5K	660	55	
	2.2K	660	55			2.2K	660	55	
	3.7K	860	80			3.7K	860	80	
	5.5K	1430	130			5.5K	1430	130	
	7.5K (Not provided for V220)	1430	130			7.5K (Not provided for V240)	1430	130	
MRS	120W 200Ω	260	15						
	120W 100Ω	560	30						
	120W 60Ω	660	55						
	120W 40Ω	860	80						
MYS	220W 200	800	65		MYS	220W 250	1300	110	
	220W 100	1100	90			220W 150	1430	130	
	220W 60	1300	110			220W 150,2 in parallel	2720	200	
	220W 40	1430	130						
	220W 25	1430	130						
	220W 20	1430	130						
	220W 50, 2 in parallel	2260	160						
	220W 40, 2 in parallel	2720	200						
FR-ABR	0.4K (200Ω)	600	60		FR-ABR	H0.4K (1200Ω)	400	45	
	0.75K (100Ω)	1300	80			H0.75K (700Ω)	700	76	
	2.2K (60Ω)	2100	120			H1.5K (350Ω)	1400	115	
	3.7K (40Ω)	3100	155			H2.2K (250Ω)	2000	120	
	5.5K (25Ω)	5000	185			H3.7K (150Ω)	3200	155	
	7.5K (20Ω)	6000	340			H5.5K (110Ω)	4500	185	
						H7.5K (75Ω)	6500	340	
BU type	1500 (300W 50Ω)	1250	100		BU type	H7.5K (300W 10Ω×6 in series)	4440	600	
	3700 (300W 10Ω×3 in series)	2200	300			H15K (450W 5Ω×8 in series)	6800	1200	
	7.5K (450W 5Ω×4 in series)	3200	600			H30K (600W 2Ω×12 in series)	11500	2400	
	15K (600W 2Ω×6 in series)	5400	1200			2×H30K	22750	4400	
	2×15K	10800	2200			3×H30K	34250	6200	
	3×15K	16200	3100			4×H30K	45500	8000	
	4×15K	21600	4000						
	5×15K	27000	4800						
	6×15K	32400	5600						
	7×15K	37600	6300						
FR-BU	15K	GGZ300W 50Ω	1250	100	FR-BU	H15K	GGZ300W 200Ω	1250	100
		GRGZ300-5Ω 4 in series	3200	600			GRGZ300-20Ω 4 in series	3200	600
		FR-BR-15K	16500	990			FR-BR-15K	16500	990
	30K	FR-BR-30K	33000	1990		H30K	FR-BR-30K	33000	1990
	55K	FR-BR-55K	65000	3910		H55K	FR-BR-55K	65000	3910
FR-RC	15K	22500	11000		FR-RC	H15K	22500	11000	
	30K	45000	15000			H30K	45000	22000	
	55K	82500	30000			H55K	82500	45000	

200V Class				400V Class		
Braking unit		Short-time permissible power WRS (W)	Continuous permissible power WRC (W)	Braking unit	Short-time permissible power WRS (W)	Continuous permissible power WRC (W)
Type	Capacity			Capacity		
Inverter with built-in power return function	FR-A221E-5.5K	8250	5500	FR-A241E-5.5K	8250	5500
	FR-A221E-7.5K	11250	7500	FR-A241E-7.5K	11250	7500
	FR-A221E-11K	16500	11000	FR-A241E-11K	16500	11000
	FR-A221E-15K	22500	15000	FR-A241E-15K	22500	15000
	FR-A221E-18.5K	27750	18500	FR-A241E-18.5K	27750	18500
	FR-A221E-22K	33000	22000	FR-A241E-22K	33000	22000
	FR-A221E-30K	45000	30000	FR-A241E-30K	45000	30000
	FR-A221E-37K	55500	37000	FR-A241E-37K	55500	37000
	FR-A221E-45K	67500	45000	FR-A241E-45K	67500	45000
	FR-A221E-55K	82500	55000	FR-A241E-55K	82500	55000
High power factor converter	FR-HC-7.5K	11250	7500	FR-HC-H7.5K	11250	7500
	FR-HC-15K	22500	15000	FR-HC-H15K	22500	15000
	FR-HC-30K	45000	30000	FR-HC-H30K	45000	30000
	FR-HC-55K	82500	55000	FR-HC-H55K	82500	55000

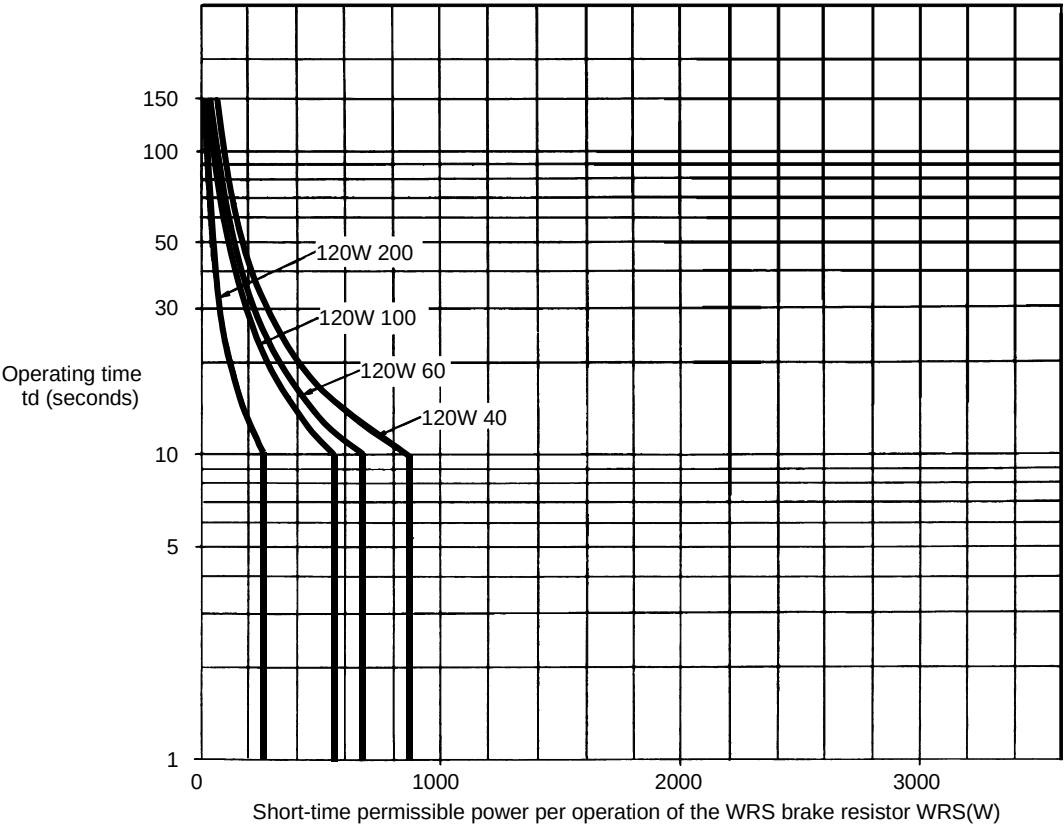
3.4.2 Permissible power data (WRS)

(1) Built-in brake resistor

Common to 200V and 400V

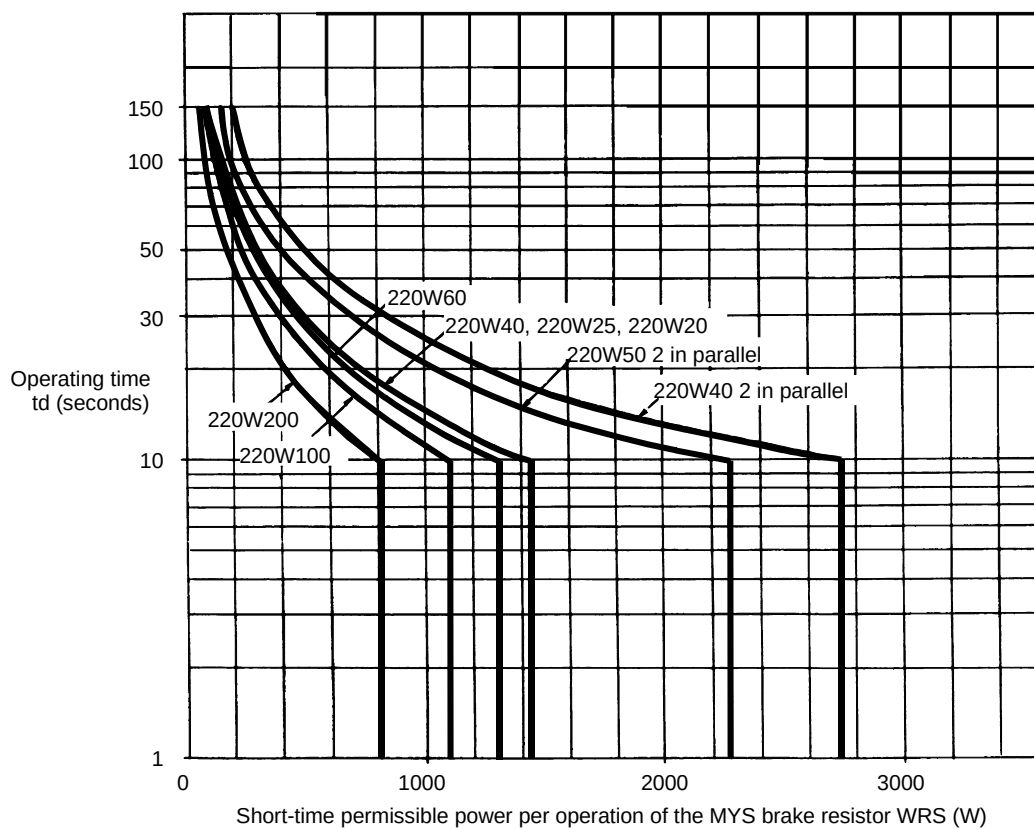


(2) MRS resistor

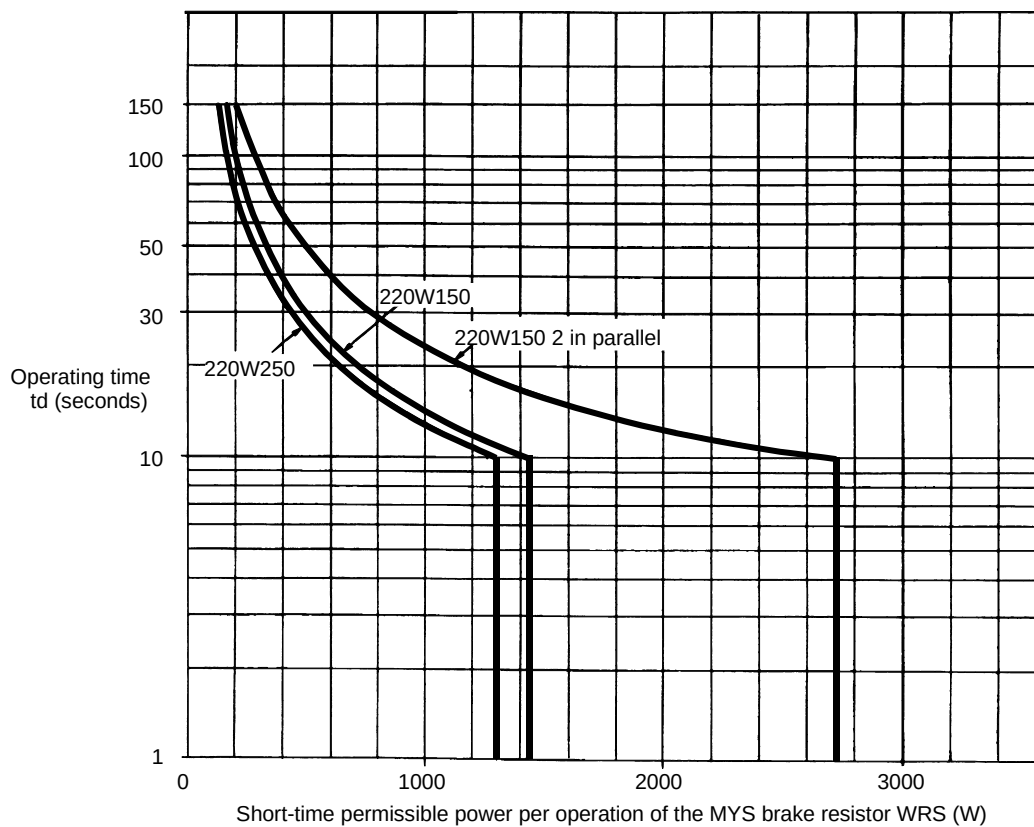


(3) MYS brake resistor

200V series

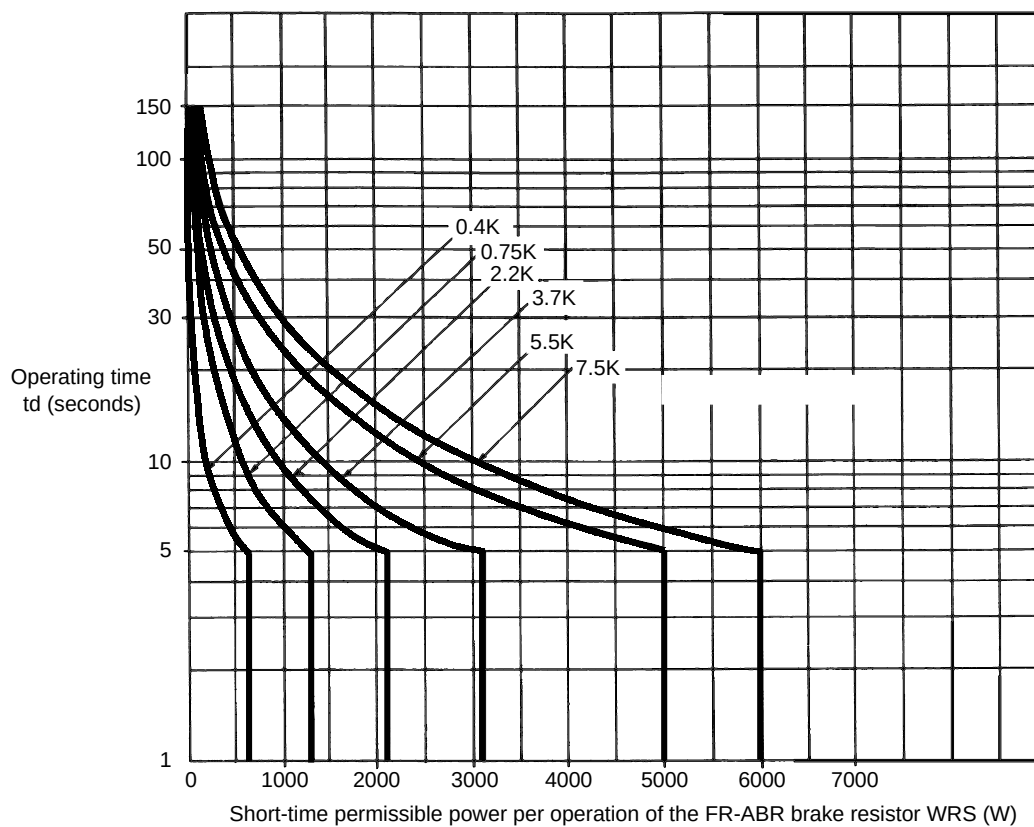


400V series

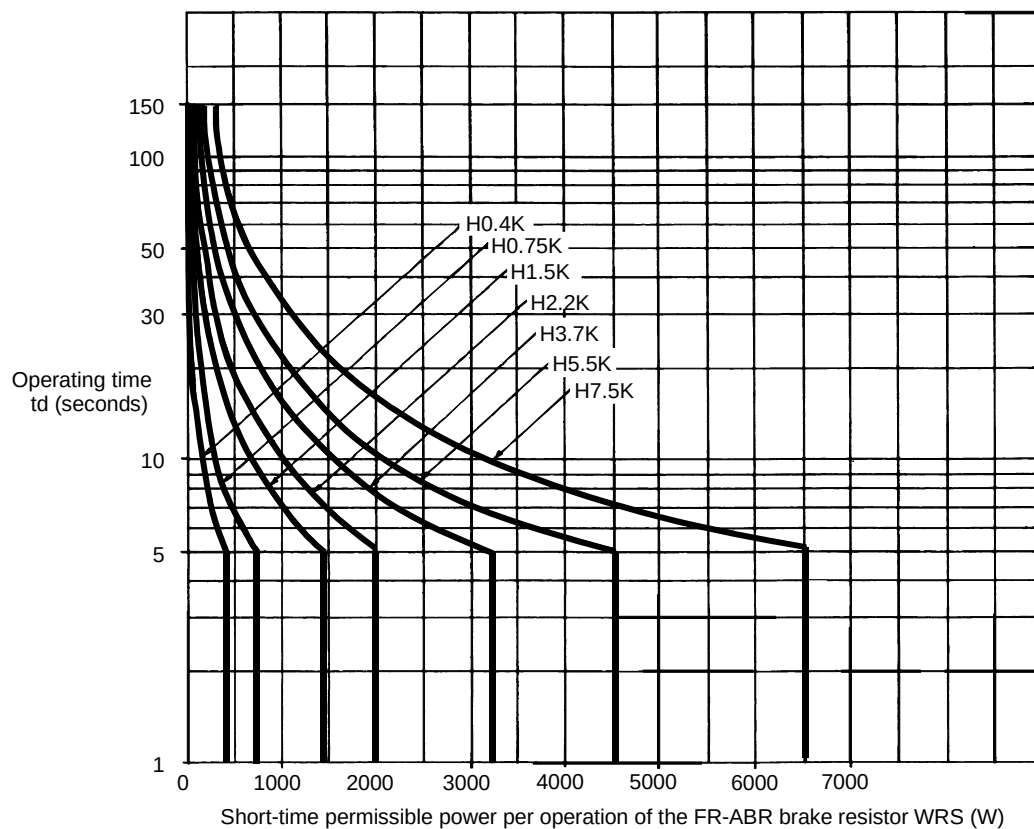


(4) FR-ABR resistor

200V series

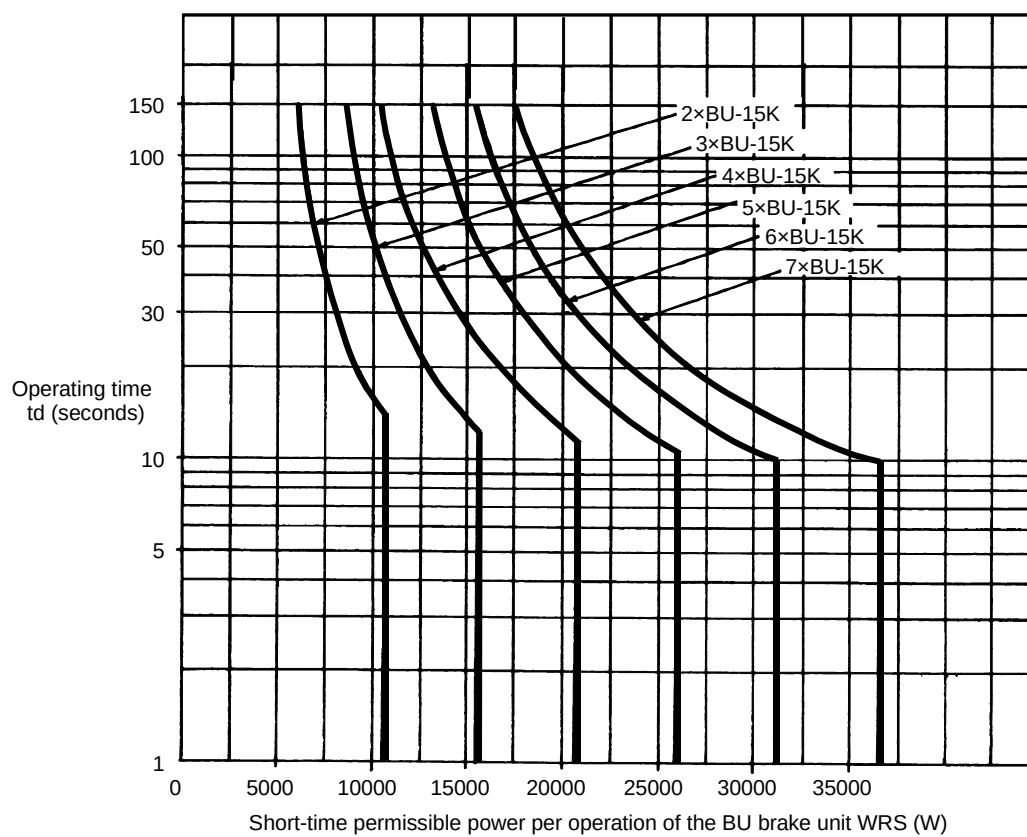
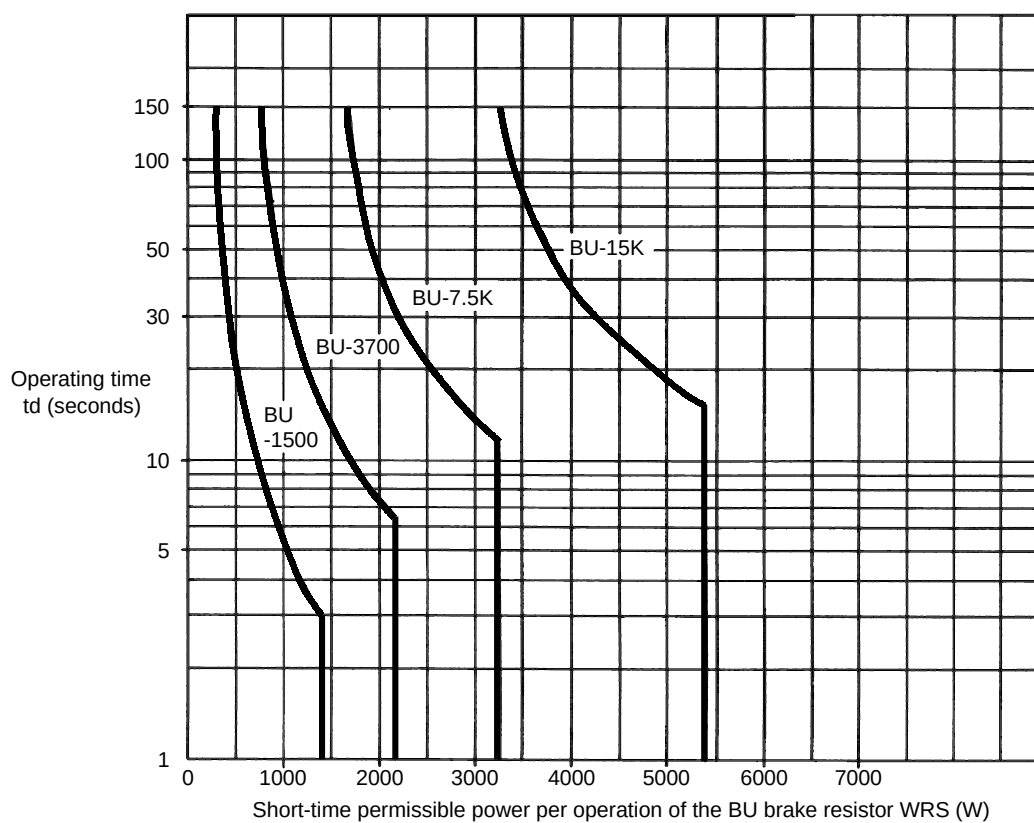


400V series

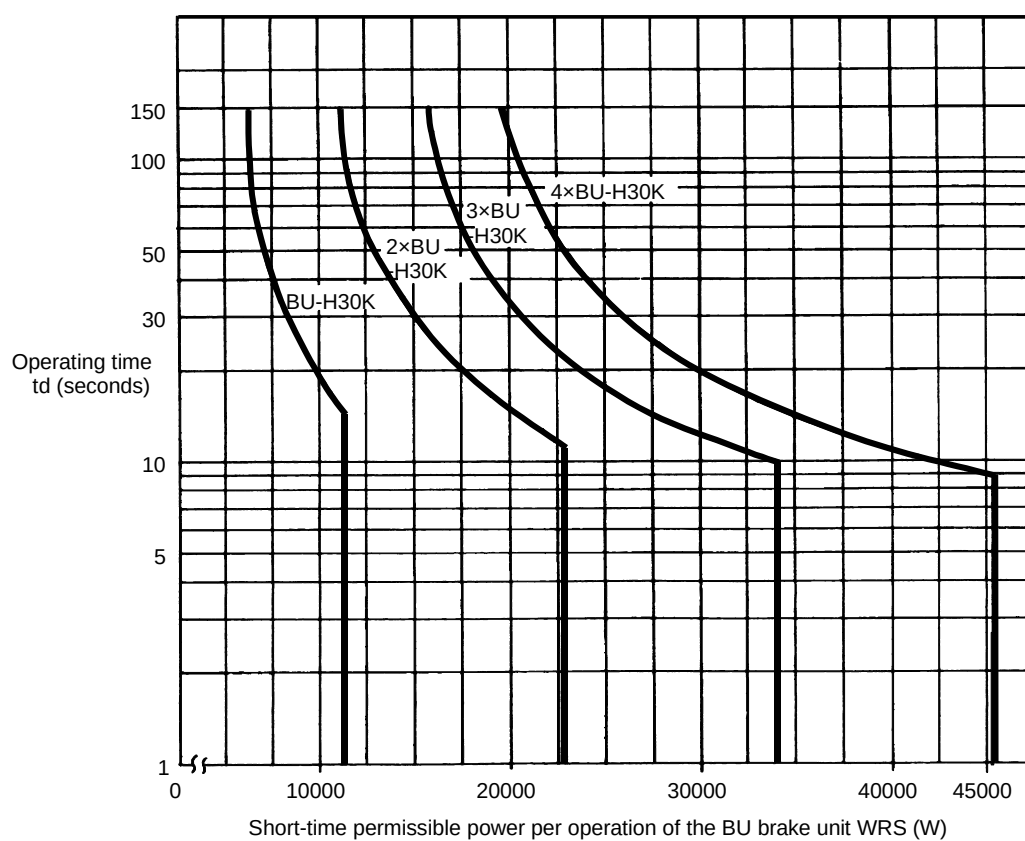
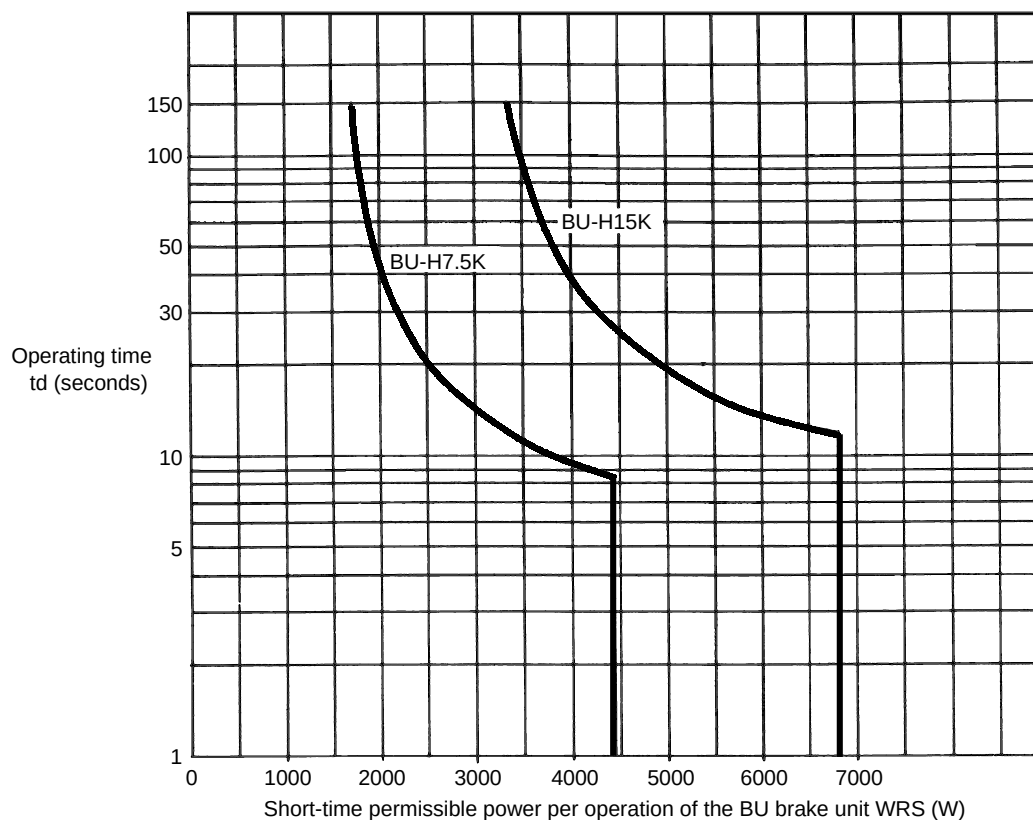


(5) BU brake unit

200V series

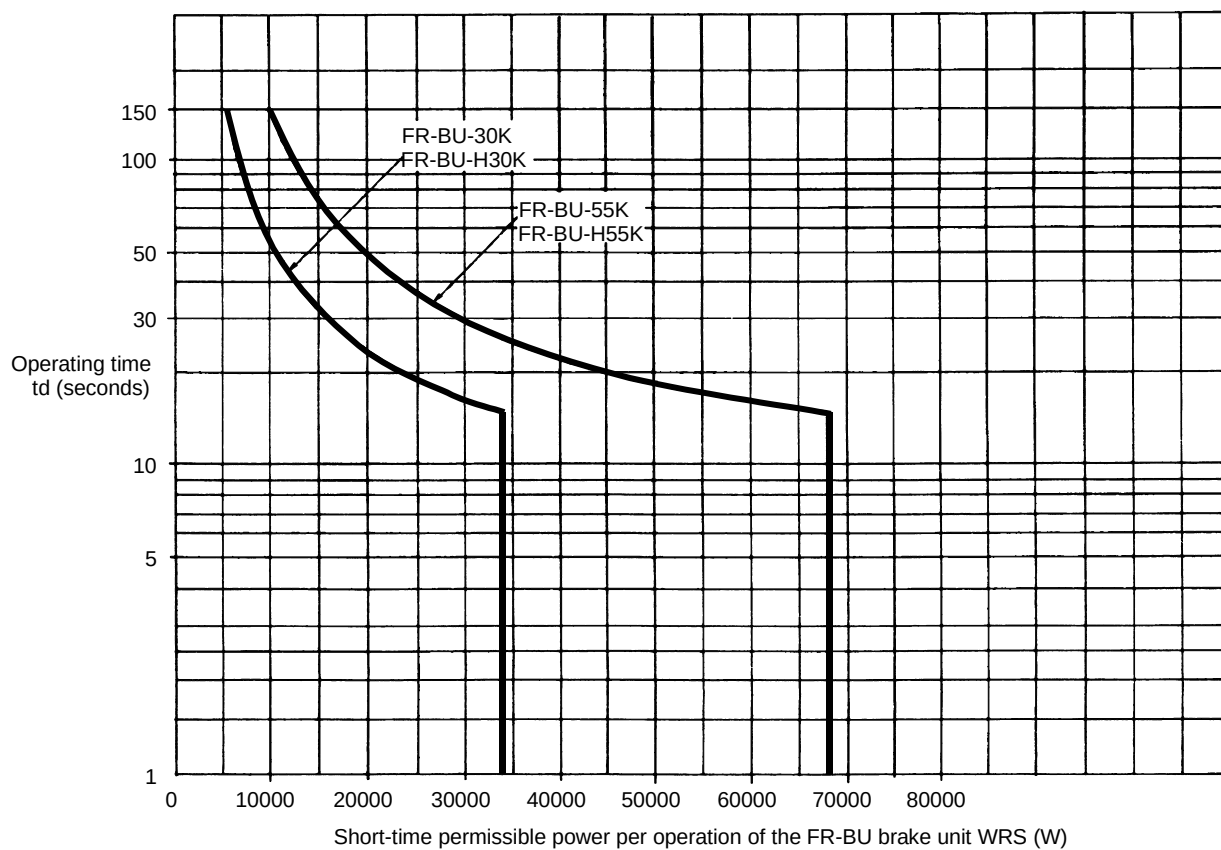
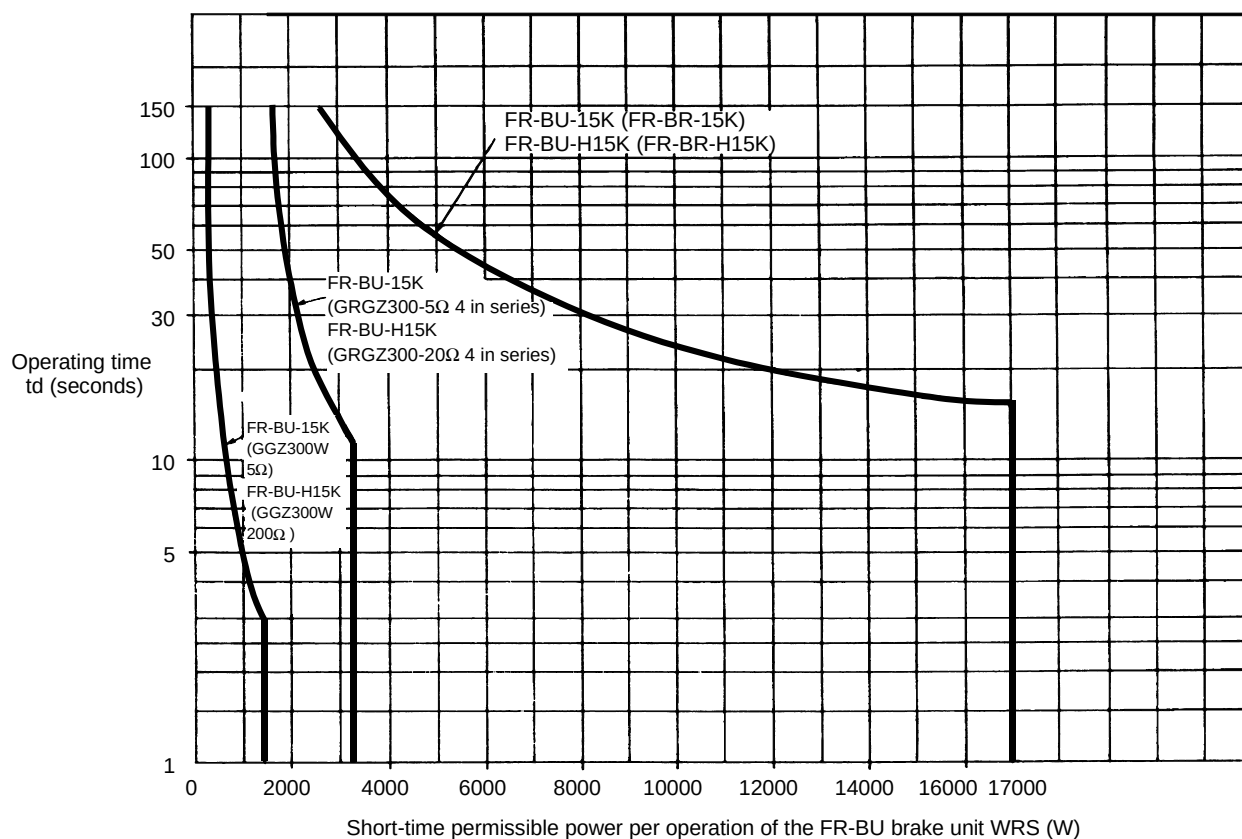


400V series



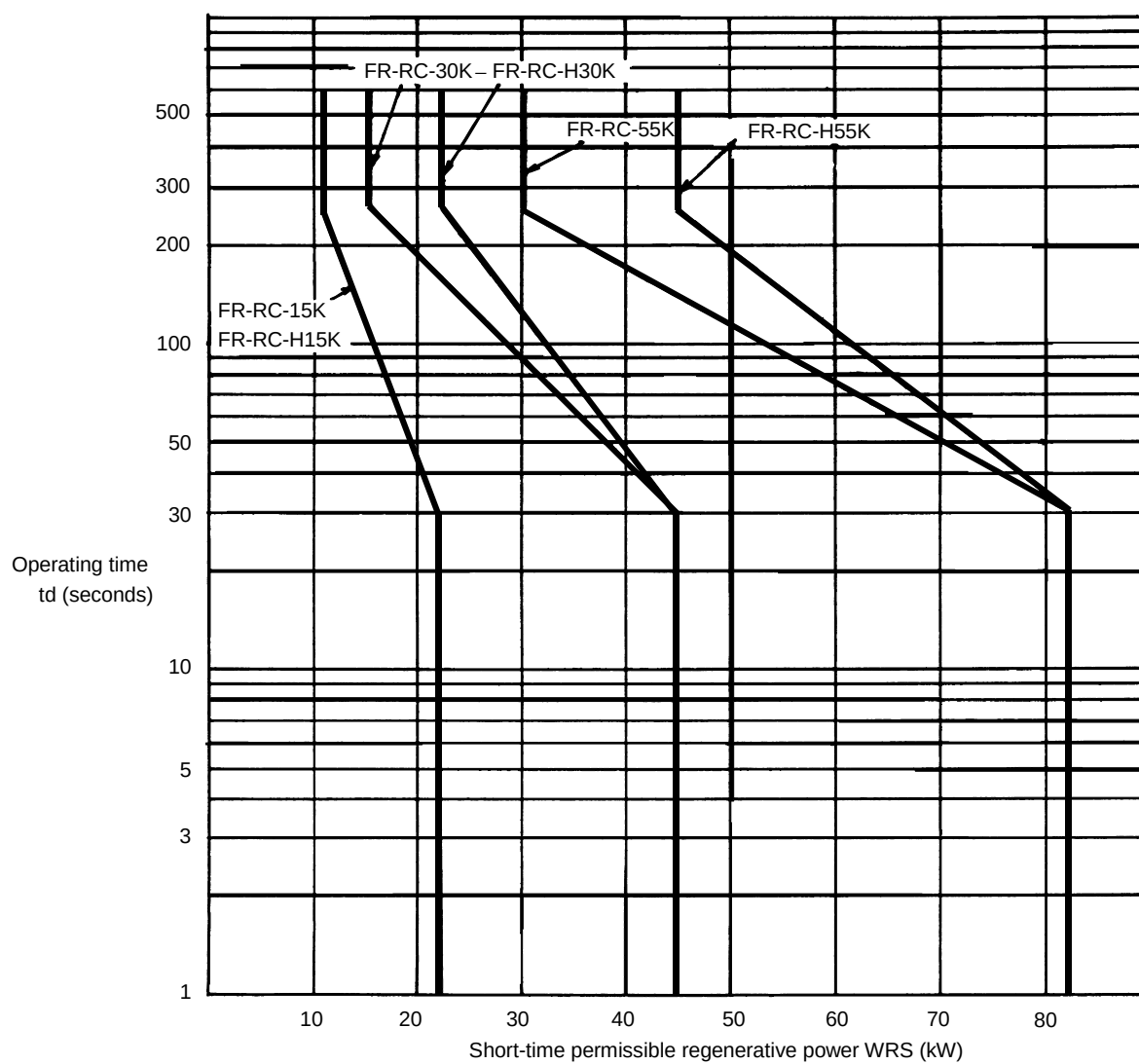
(6) FR-BU brake unit

200V and 400V series



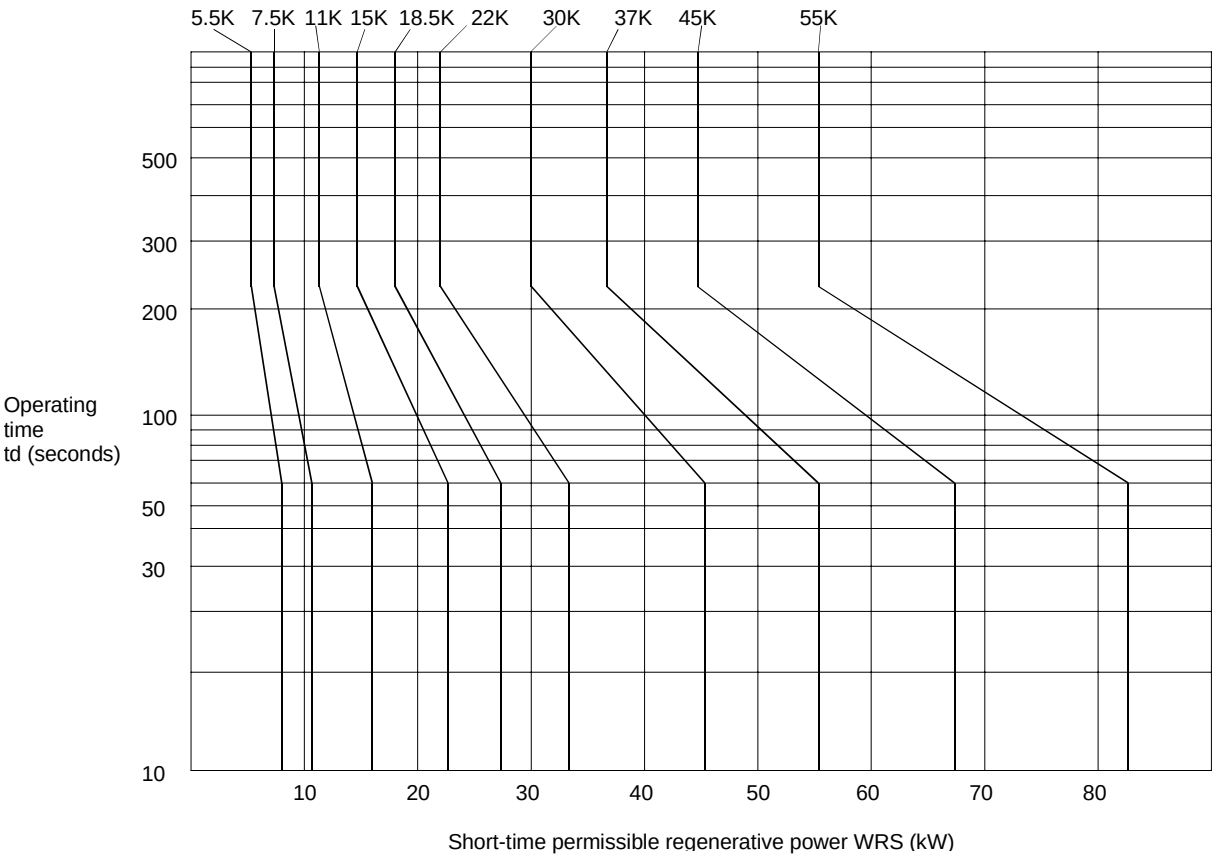
(7) FR-RC power return converter

200V and 400V series



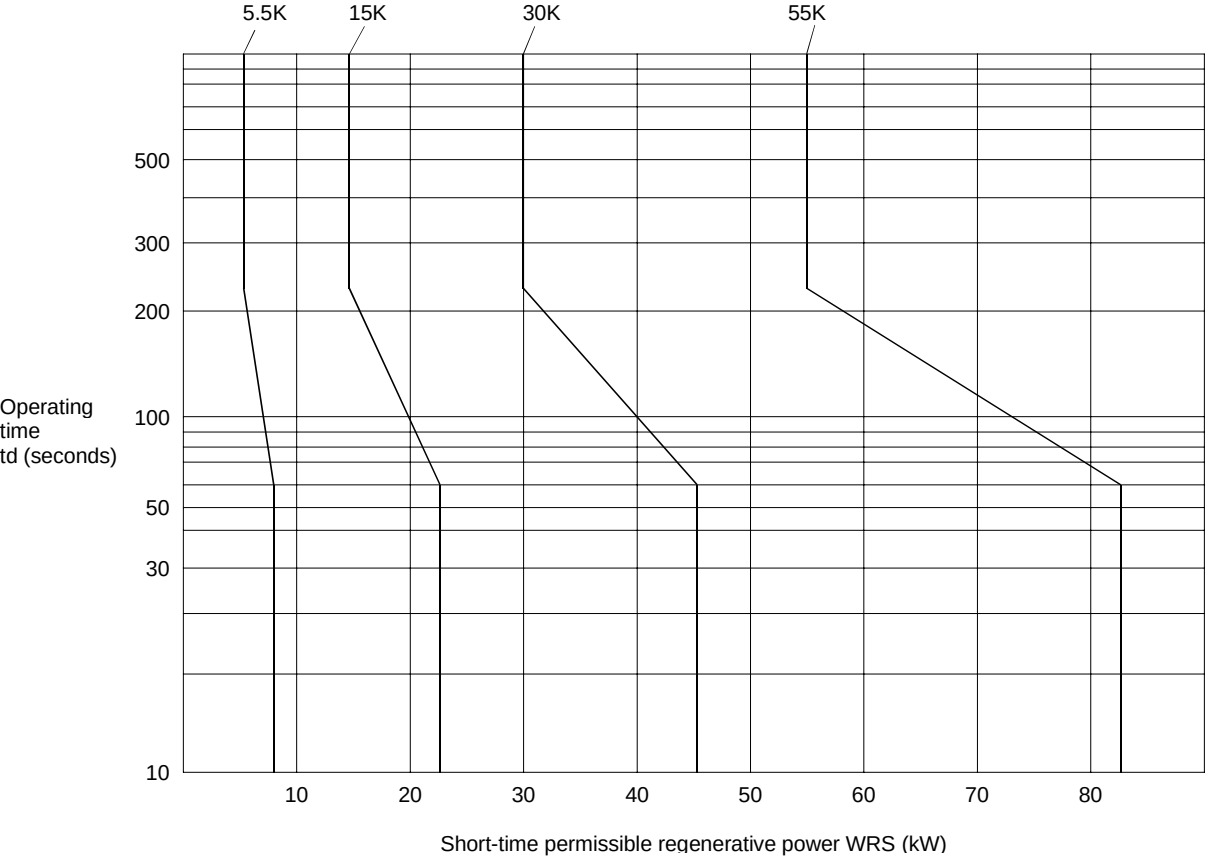
(8) Inverter with built-in power return function

FR-A221E (200V class), FR-A241E (400V class)



(9) High power factor converter

FR-HC (200V class), FR-HC-H (400V class)



3.5 Permissible Brake Duty (%ED)

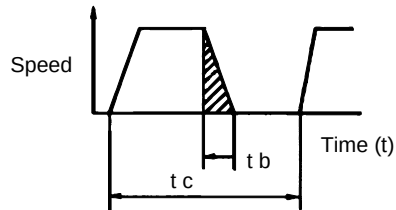
(1) Definition of duty (%ED)

Duty (%ED) represents the ratio of actual operating time to total time during repeated intermittent operation. There is a simple brake selection method based on this value.

When continuous operating time (t_b) is more than 5 seconds, check the continuous permissible power (WRC).

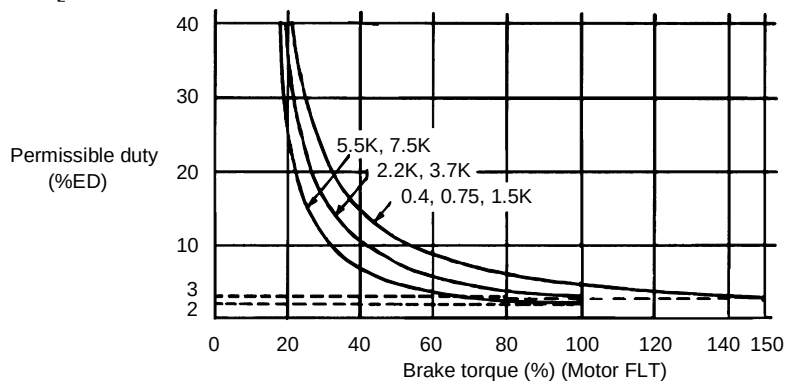
$$\%ED = \frac{t_b}{t_c} \times 100$$

$t_b < 5$ seconds (continuous operating time)



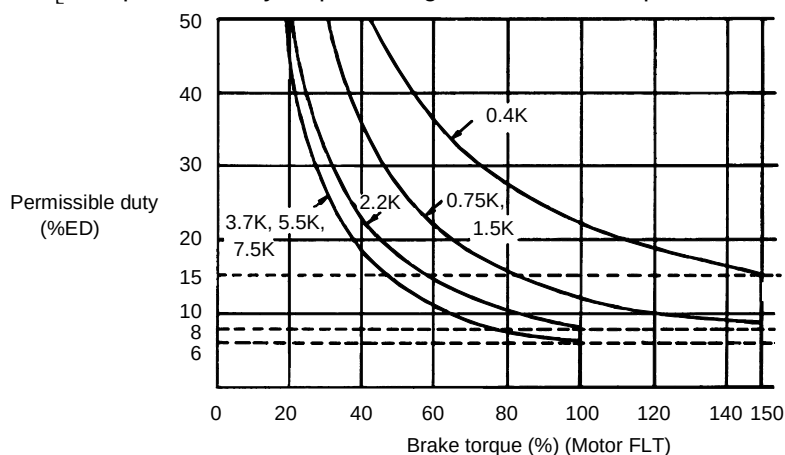
(2) MRS brake resistor

In the figure, kW indicates the output of the applied motor and brake torque is represented by its percentage to the rated torque of that motor



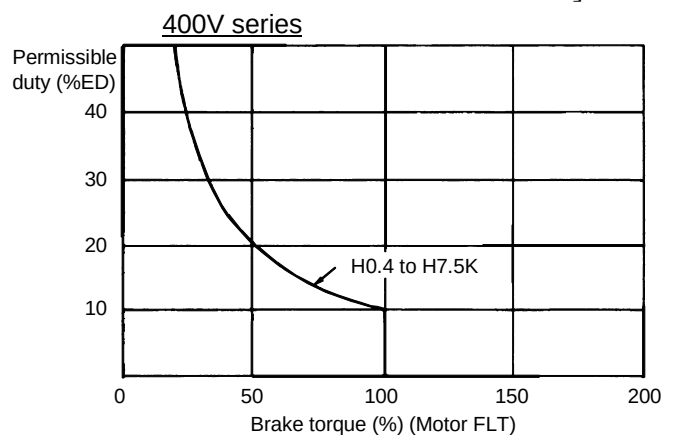
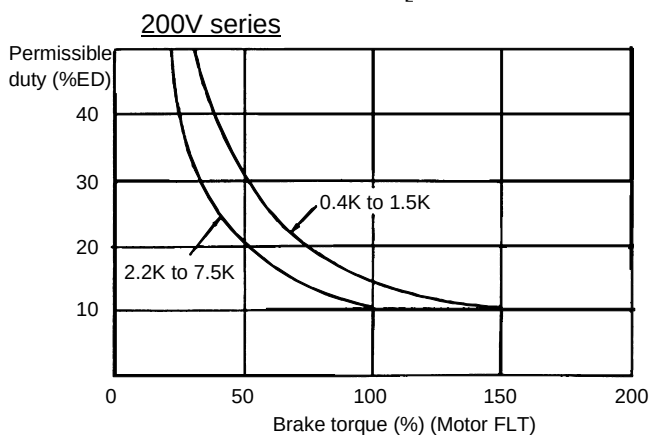
(3) MYS brake resistor

In the figure, kW indicates the output of the applied motor and brake torque is represented by its percentage to the rated torque of that motor



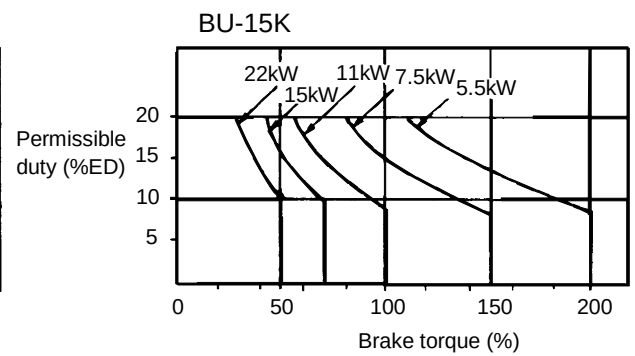
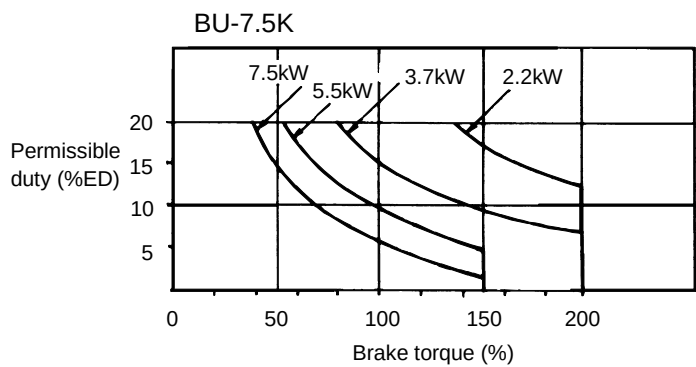
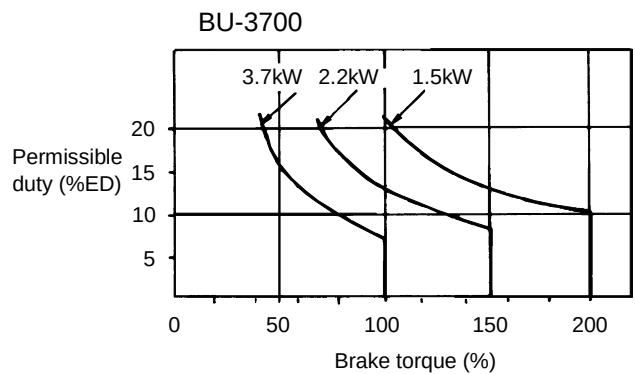
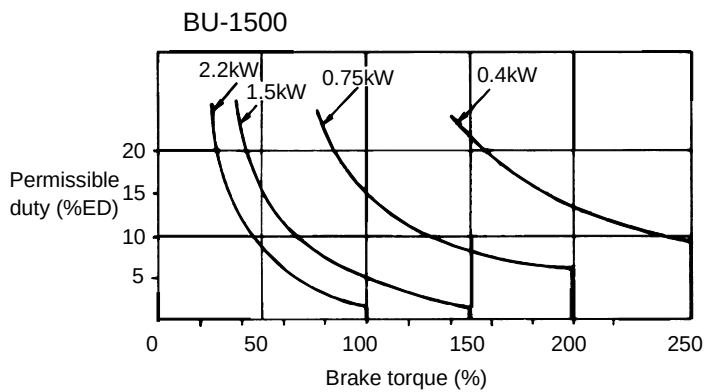
(4) FR-ABR brake resistor

In the figure, kW indicates the output of the applied motor and brake torque is represented by its percentage to the rated torque of that motor

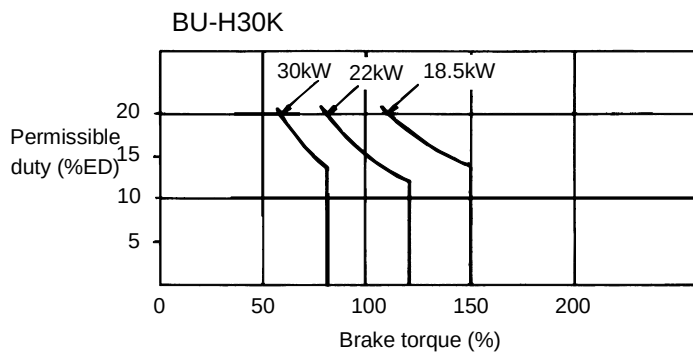
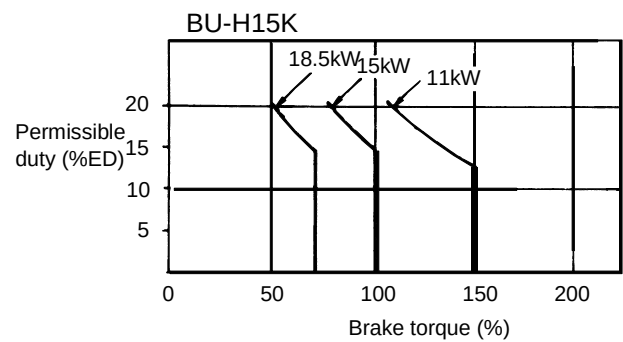
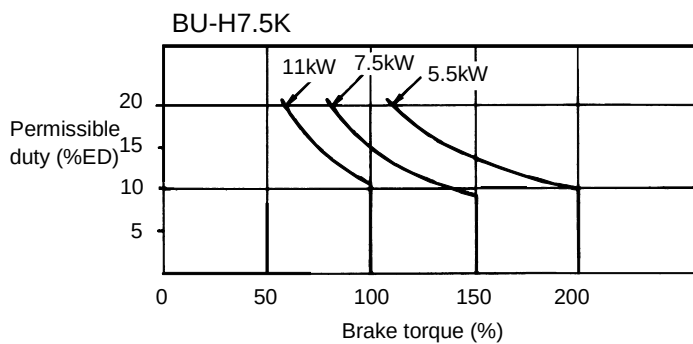


- (5) BU brake unit [In the figure, kW indicates the output of the applied motor and brake torque is represented by its percentage to the rated torque of that motor]

200V series



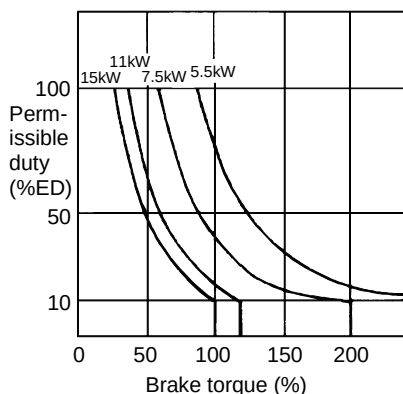
400V series



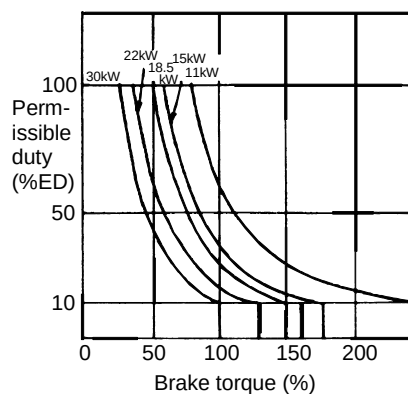
- (6) FR-BU/BR brake unit [In the figure, kW indicates the output of the applied motor and brake torque is represented by its percentage to the rated torque of that motor]

200V series

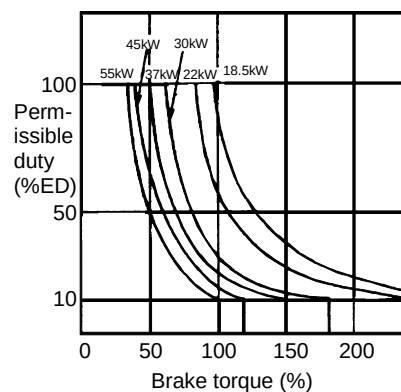
FR-BU-15K/FR-BR-15K



FR-BU-30K/FR-BR-30K

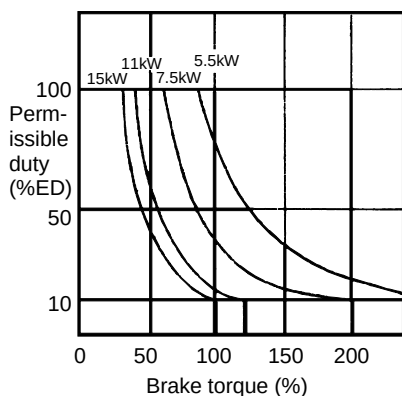


FR-BU-55K/FR-BR-55K

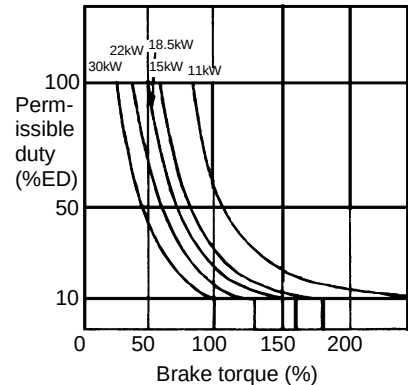


400V series

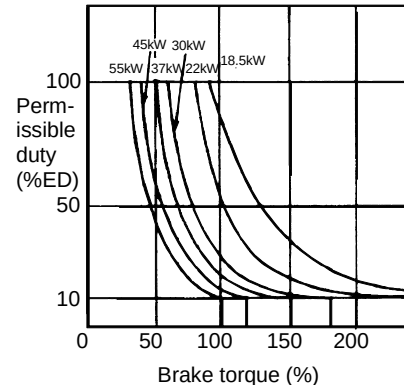
FR-BU-H15K/FR-BR-H15K



FR-BU-H30K/FR-BR-H30K



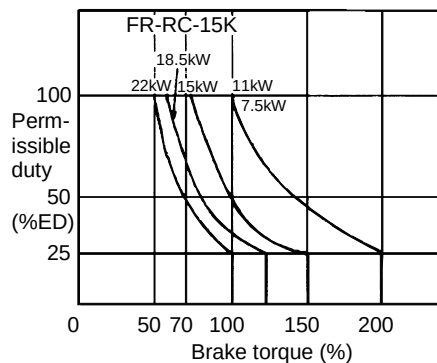
FR-BU-H55K/FR-BR-H55K



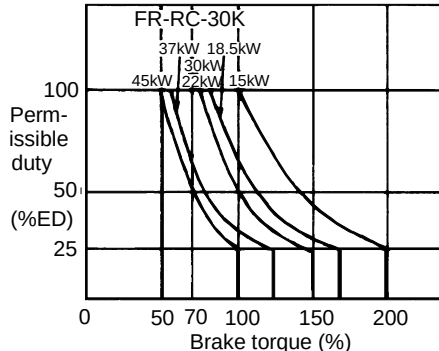
- (7) FR-RC power return converter [In the figure, kW indicates the output of the applied motor and brake torque is represented by its percentage to the rated torque of that motor]

200V series

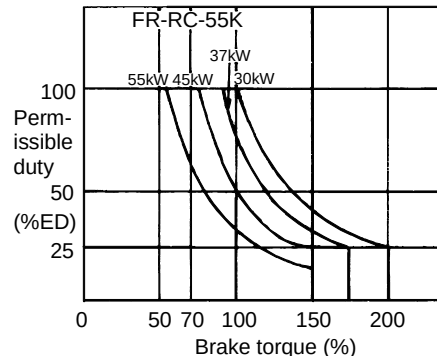
FR-RC-15K



FR-RC-30K

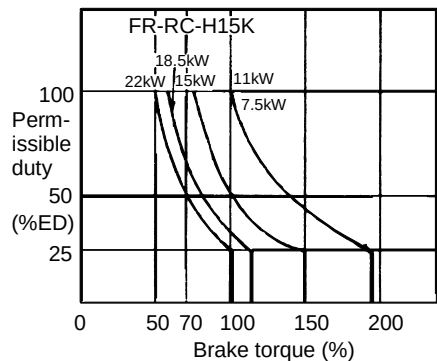


FR-RC-55K

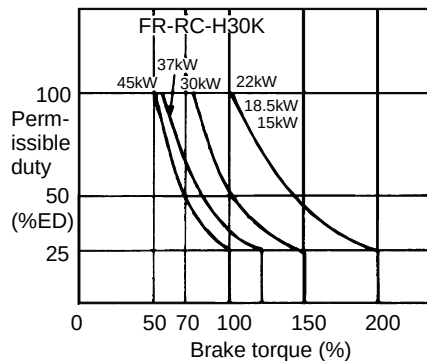


400V serie

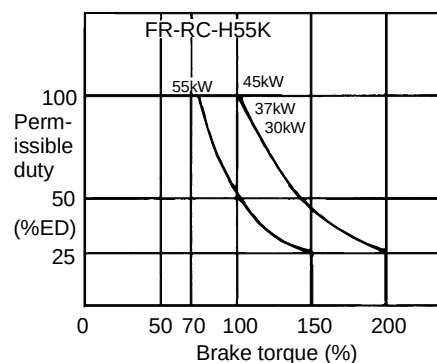
FR-RC-H15K



FR-RC-H30K

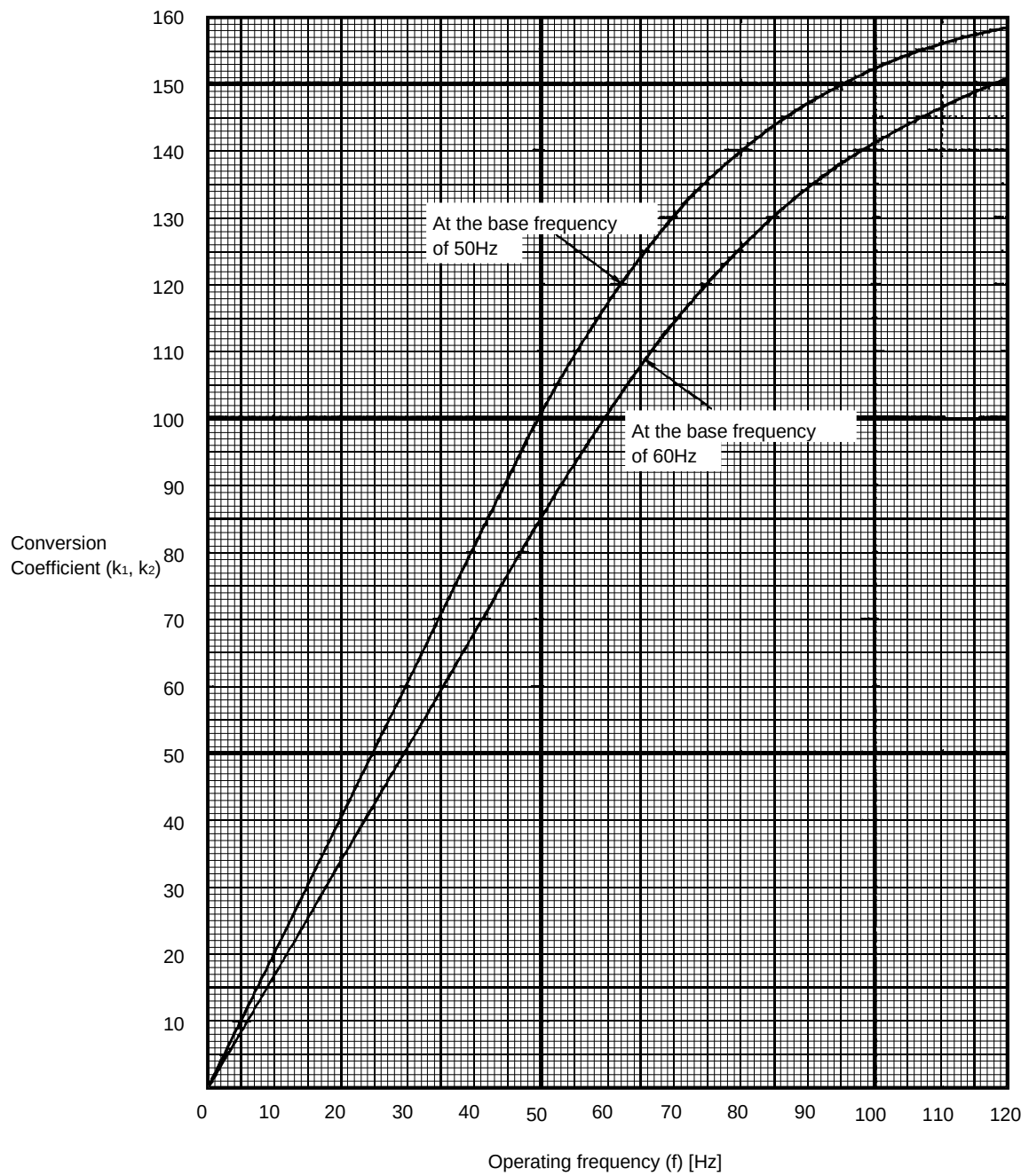


FR-RC-H55K



3.6 Motor-Absorbed Power

The following graph indicates the conversion coefficient for the power absorbed (consumed) in the motor.



CHAPTER 4 MOTOR AND BRAKE CHARACTERISTICS

This chapter gives the electrical characteristics of the standard motors and constant-torque motors and the characteristics of the NB brake when the motors are operated with a commercial power supply.

4.1 Load Torque Versus Motor Current Characteristics

(1) Standard motors, geared motors

The load torque versus current characteristics of standard motors are shown in Fig. 4.1 (for 2 pole and 4 pole) and Fig. 4.2 (for 6 pole). The load torque versus current characteristics of geared motors are shown in Fig. 4.1 (for 2 pole and 4 pole). Note that the figures are based on standard torque boost.

Symbol	Standard Motor	Geared Motor
————	0.4 to 0.75 kW	—
-----	1.5 to 2.2 kW	0.4 to 0.75 kW
-.-.-.-.-	3.7 to 7.5 kW	1.5kW, 3.7kW, 7.5 kW
.....	11 to 22 kW	2.2kW, 5.5kW, 11kW to 22 kW
— — — — —	30 to 55 kW	—

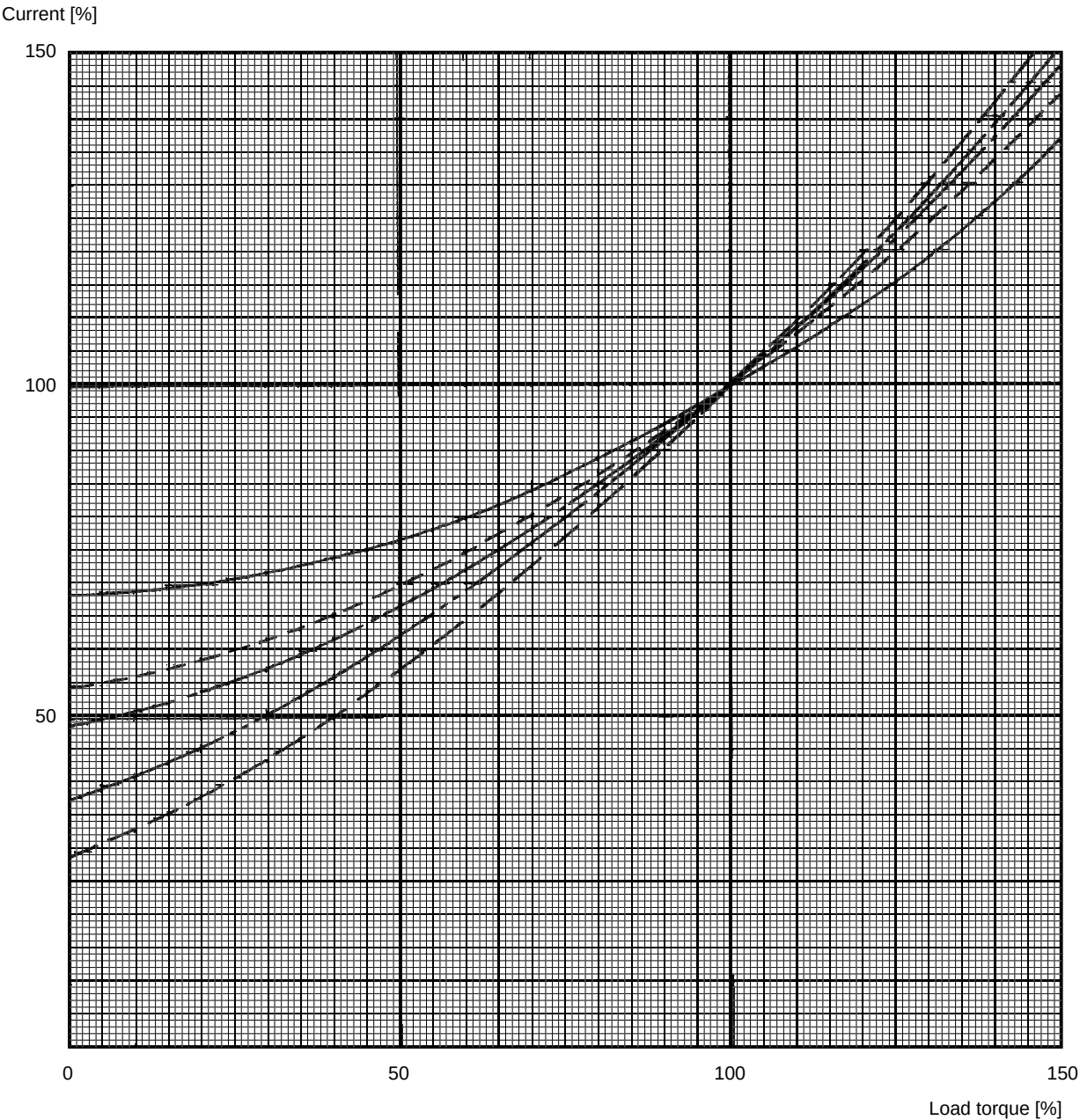


Fig. 4.1 Load Torque Versus Current Characteristics (2 pole, 4 pole)

Symbol	General-Purpose Motor
—————	0.4 to 0.75 kW
-----	1.5 to 2.2 kW
- · - · - · - · - · -	3.7 to 7.5 kW
- · · · · · - · · · · ·	11 to 22 kW
— · — · — · — · — · —	30 to 55 kW

Current [%]

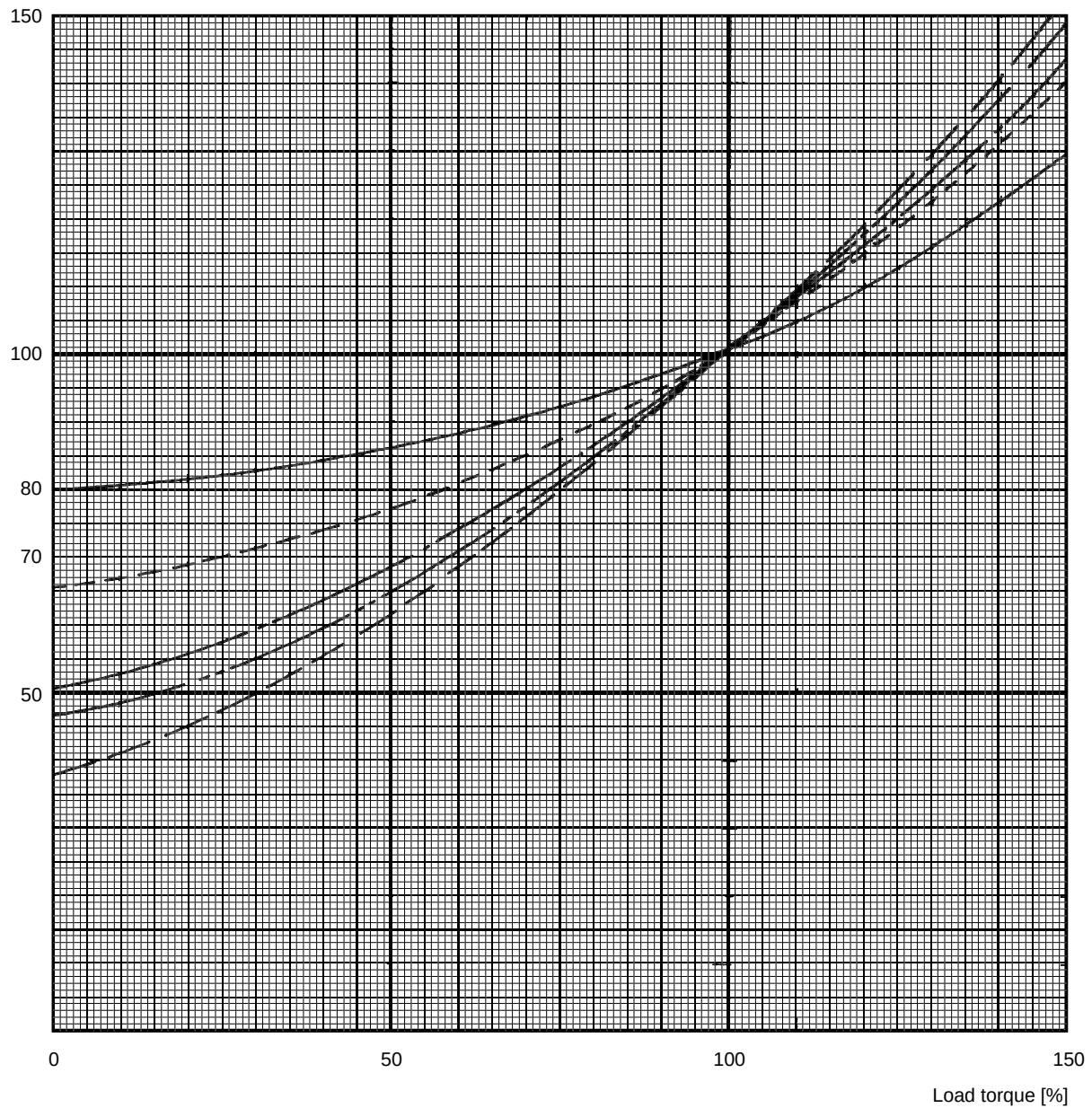


Fig. 4.2 Load Torque Versus Current Characteristics (6 pole)

(2) Constant-torque motor (SF-JRCA)

Symbol	Constant-Torque Motor
—————	0.4 kW, 0.75 kW, 2.2kW to 7.5 kW
-----	1.5 kW
-----	11 kW, 15 kW, 37 kW, 45 kW
-----	18.5 kW, 22 kW, 30 kW, 55 kW

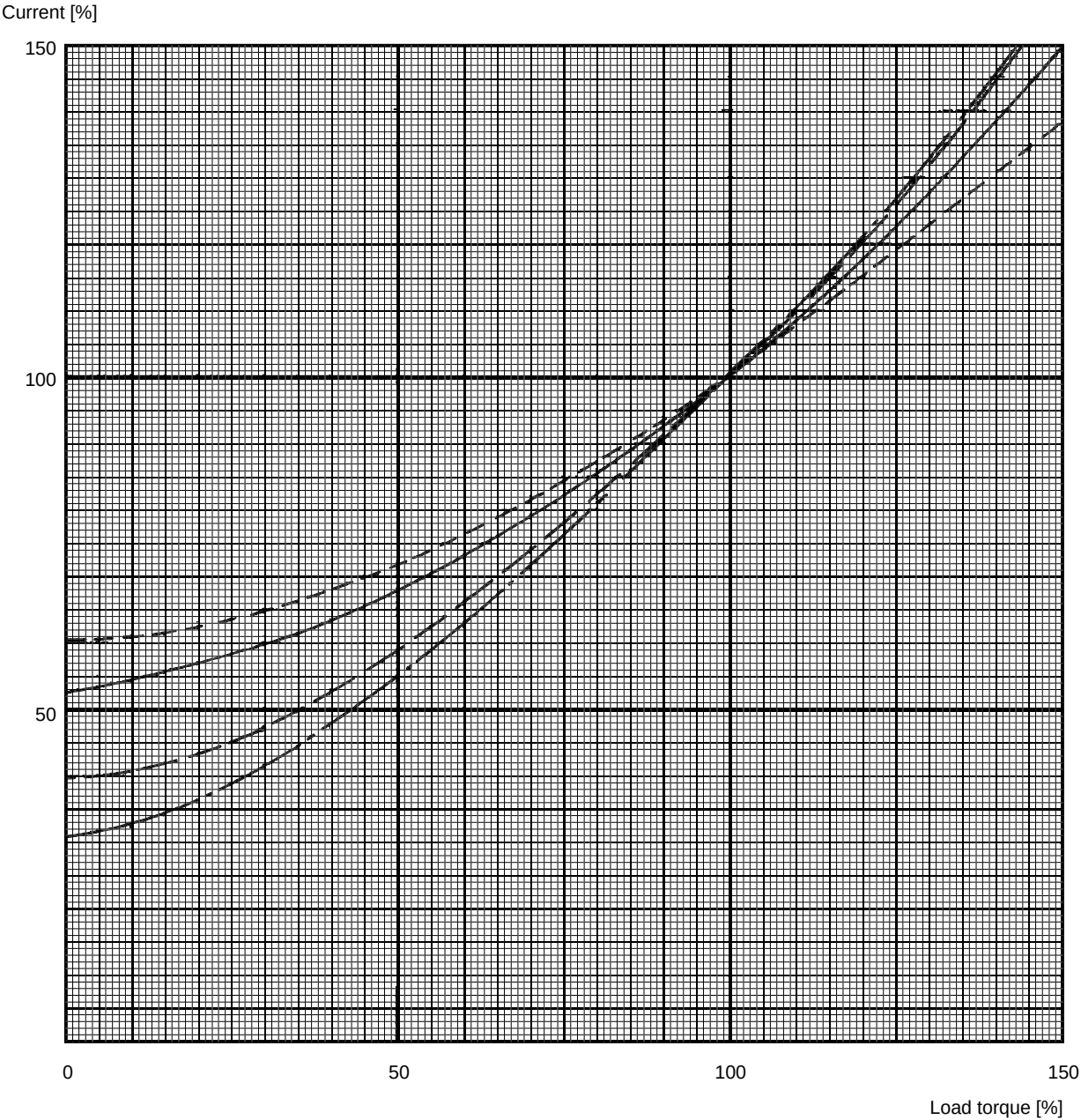


Fig. 4.3 Load Torque Versus Current Characteristics

(3) Constant-torque motor (SF-JRC)

Symbol	Constant-Torque Motor
—————	0.4 kW, 0.75 kW
-----	1.5 kW, 2.2kW
—————	3.5 kW, 5.5 kW, 7.5 kW, 37 kW
-----	11 kW, 15 kW, 22 kW
-----	18.5 kW, 30 kW, 45 kW

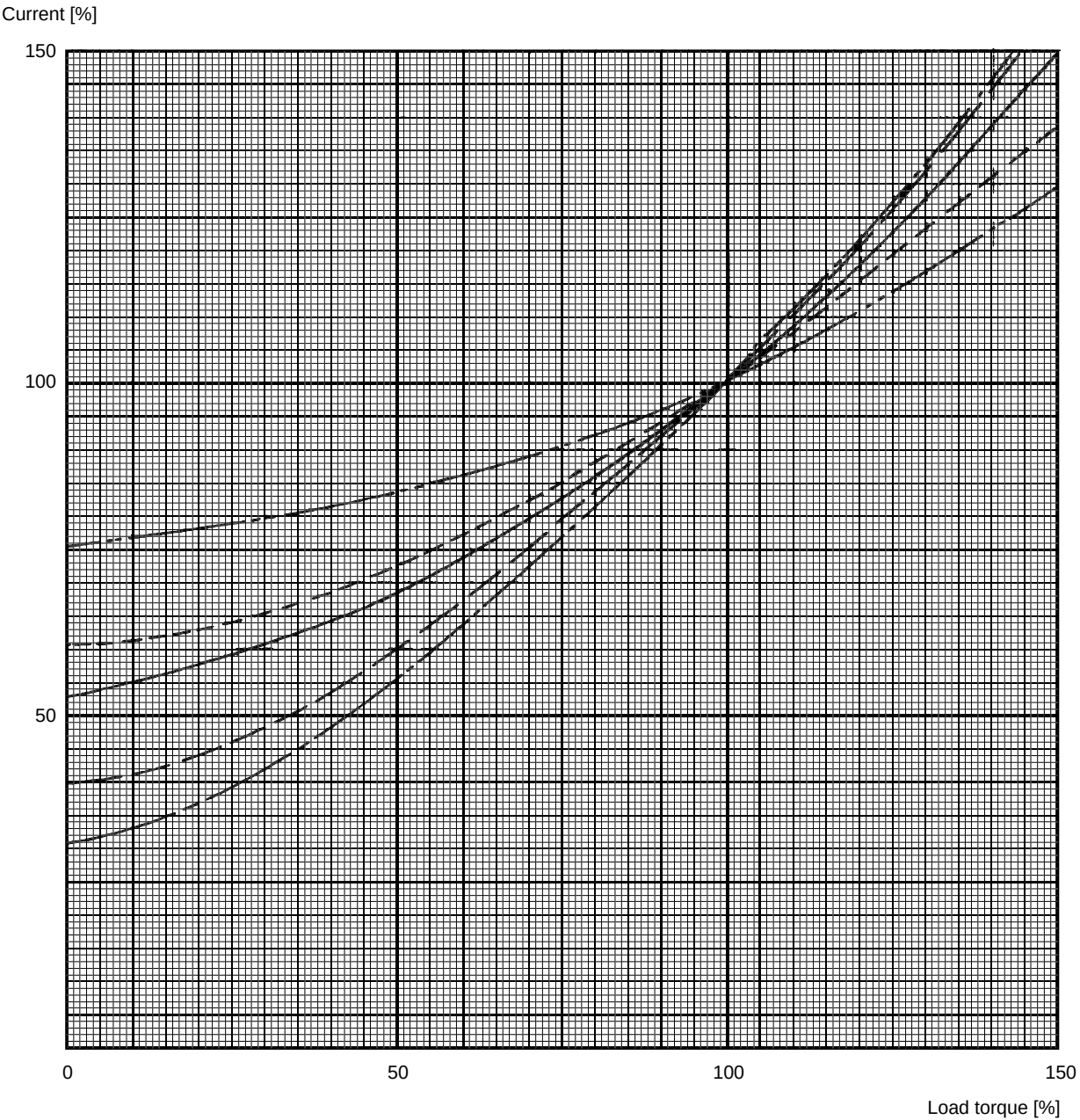


Fig. 4.4 Load Torque Versus Current Characteristics

(4) Dedicated motor (SF-VR)

Symbol	Constant-Torque Motor
—————	5.5 to 7.5kW
-----	11 to 22kW
- - - - -	30 to 45kW

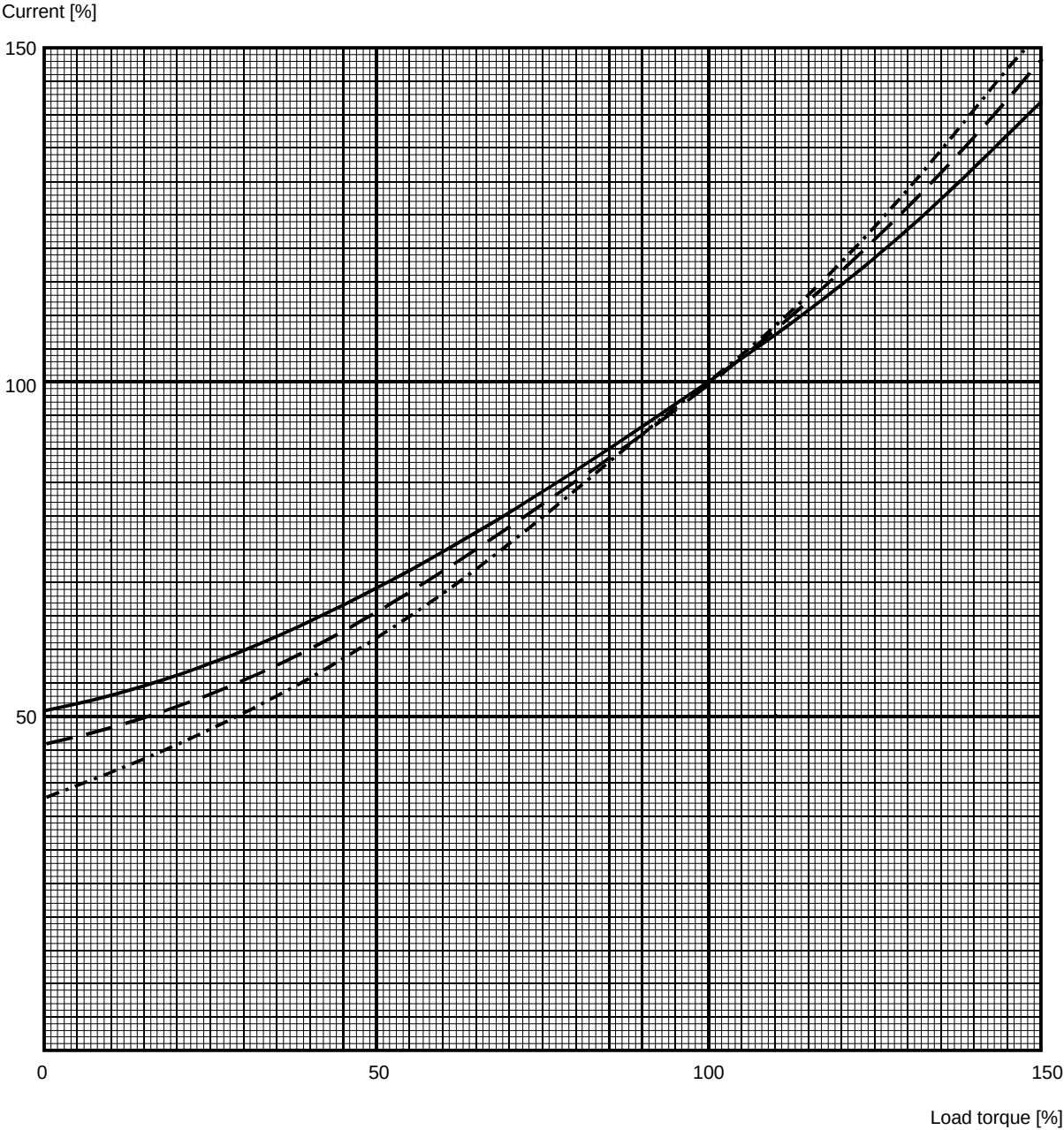
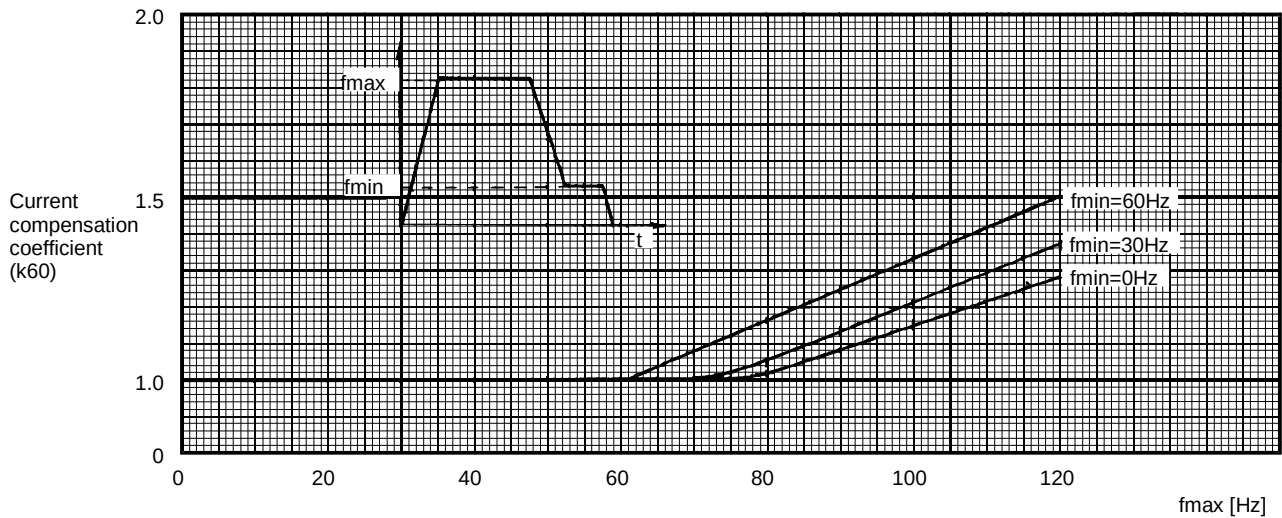


Fig.4.5 Load Torque Versus Current Characteristics

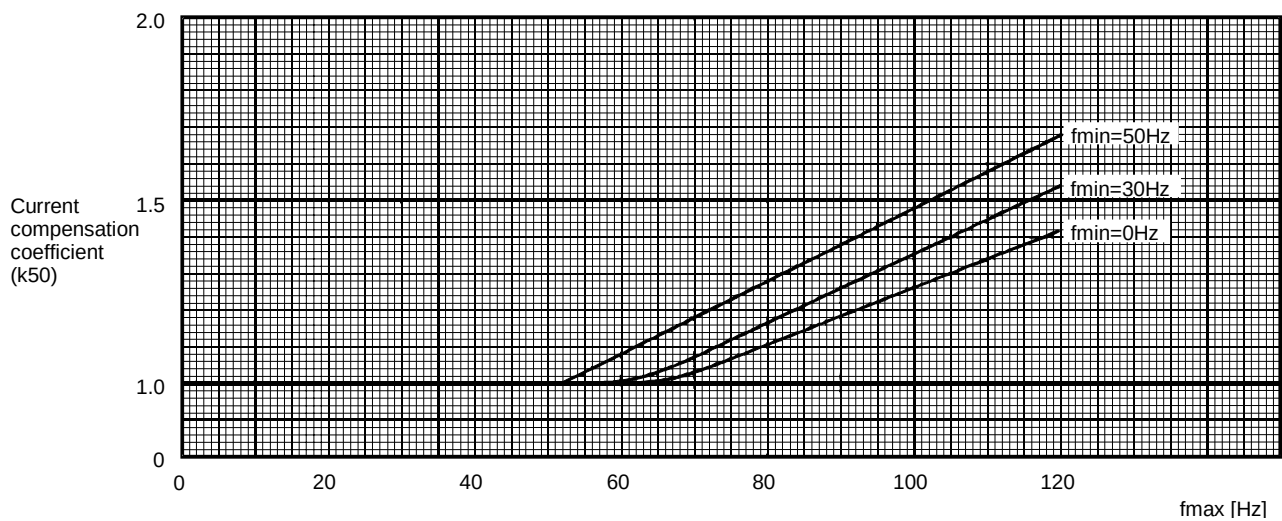
4.2 Current Compensation Coefficient

If the maximum frequency (f_{max}) is higher than the base frequency of the motor during acceleration/deceleration, the motor current value must be compensated as described for the following:

- 1) When the base frequency is 60Hz
Find k_{60} from Fig. 4.6(a) according to f_{max} and f_{min} .
- 2) When the base frequency is 50Hz
Find k_{50} from Fig. 4.6(b) according to f_{max} and f_{min} .



(a) When the base frequency is 60Hz



(b) When the base frequency is 50Hz

Fig. 4.6 Current Compensation Coefficient during Acceleration/Deceleration

4.3 Cooling Coefficient (C)

Since the shaft of the standard motor is equipped with a cooling fan, reduction in motor speed decreases cooling air flow, reducing the cooling effect. This reduction is compensated for by the cooling coefficient. How to find the cooling coefficient (C) in each operation zone

- 1) At a stop
Cooling coefficient (C) = 0.4
- 2) At constant speed
Found from Fig. 4.7 according to the running frequency (f).
- 3) During acceleration/deceleration
 - (a) If the maximum frequency (fmax) is not more than the base frequency of the motor, find the average value of output frequencies of the inverter before and after acceleration or before and after deceleration, and find the cooling coefficient from Fig. 4.7.
 - (b) If the maximum frequency (fmax) is higher than the base frequency of the motor, find the cooling coefficient from Fig. 4.8 according to fmax and fmin.

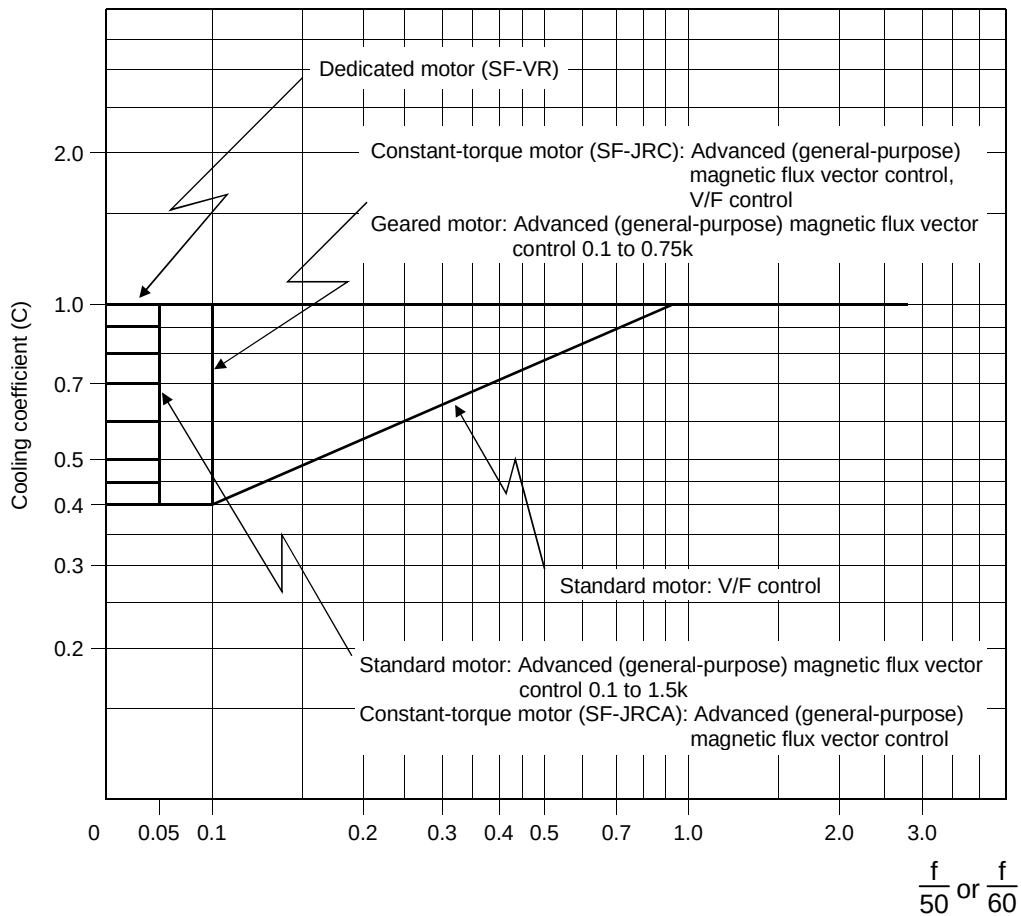


Fig. 4.7 Cooling Coefficient

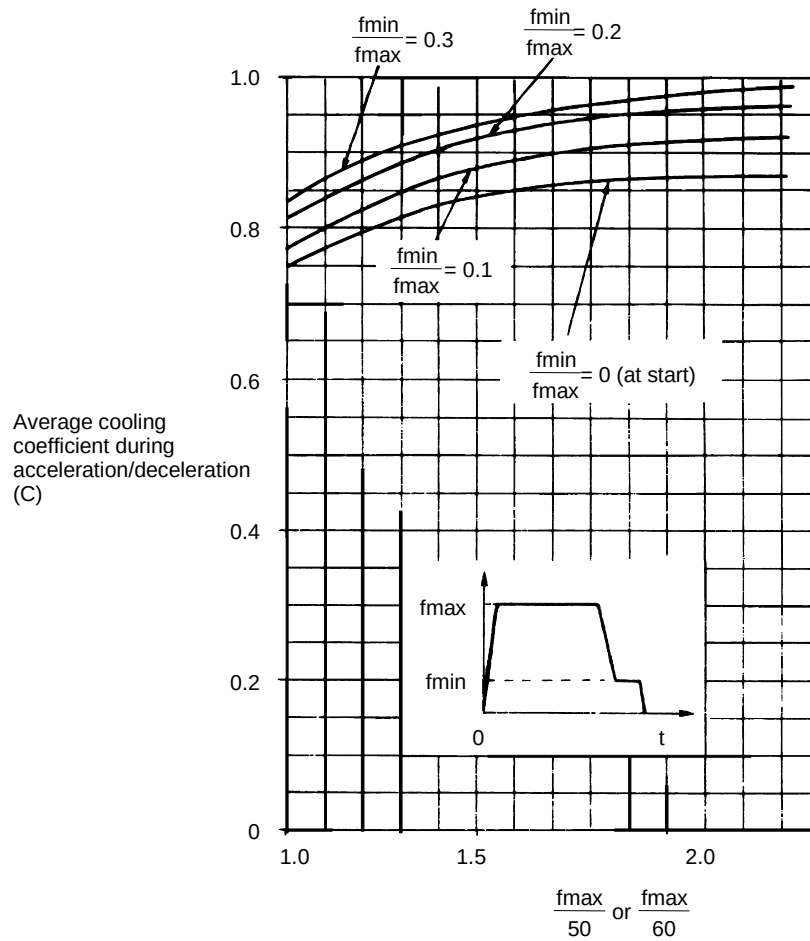


Fig. 4.8 Average Cooling Coefficient during Acceleration/Deceleration
(If f_{max} exceeds the base frequency of the motor)

[Supplementary explanation for Fig. 4.7]

Use the following formulas for calculation of the cooling efficiency:

- When the base frequency is 60Hz

$$\text{When } 6\text{Hz} \leq f < 60\text{Hz}, \quad C = \left(\frac{f}{60} \right)^{0.4}$$

$$\text{When } 60\text{Hz} \leq f \leq 120\text{Hz}, \quad C=1$$

- When the base frequency is 50Hz

$$\text{When } 6\text{Hz} \leq f < 50\text{Hz}, \quad C = \left(\frac{f}{50} \right)^{0.4}$$

$$\text{When } 50\text{Hz} \leq f \leq 120\text{Hz}, \quad C=1$$

4.4 Characteristic List

(1) Rating plate values

The rating plate values of the totally enclosed, fan cooled type standard motors are given in Table 4.1 and their characteristics relative to %load are given in Table 4.2. When a drip-proof protection type is to be used, refer to the other data.

Table 4.1 Rating Plate Values of the Totally Enclosed, Fan Cooled Type Motors, Squirrel-Cage Type 200/200/220V 50/60/60Hz

Number of Poles	Model	Output (kW)	Frame Number	Insulation class	200V Class						400V Class					
					Rated current (A)			Rated speed (r/min)			Rated current (A)			Rated speed (r/min)		
					200V	200V	220V	200V	200V	220V	400V	400V	440V	400V	400V	440V
					50Hz	60Hz	60Hz	50Hz	60Hz	60Hz	50Hz	60Hz	60Hz	50Hz	60Hz	60Hz
2 pole	SF-JR	0.2	63	E	1.1	1.0	1.0	2800	3340	3400	0.58	0.54	0.53	2820	3370	3400
		0.4	71		2.1	1.9	1.8	2850	3420	3450	1.0	0.90	0.90	2850	3430	3440
		0.75	80		3.4	3.3	3.1	2810	3400	3410	1.7	1.65	1.55	2810	3400	3410
		1.5	90L		6.2	6.0	5.6	2870	3440	3450	3.1	3.0	2.8	2870	3440	3450
		2.2	90L		8.6	8.4	7.8	2860	3430	3460	4.3	4.2	3.9	2860	3430	3460
		3.7	112M		14.2	13.8	12.8	2910	3480	3490	7.1	6.9	6.4	2910	3480	3490
		5.5	132S	B	22.4	20.8	19.8	2910	3490	3500	11.2	10.4	9.9	2910	3490	3500
		7.5	132S		27.6	26.6	24.6	2920	3500	3510	13.8	13.3	12.3	2920	3500	3510
		11	160M		40	39	36	2920	3500	3510	20	19.5	18	2920	3500	3510
		15	160M		53	52	48	2920	3500	3510	26.5	26	24	2920	3500	3510
		18.5	160L		64	63	58	2920	3500	3510	32	31.5	29	2920	3500	3510
	SF-LH	22	180M	F	78	76	70	2920	3500	3510	39	38	35	2920	3500	3510
		30	180L		104	104	94	2930	3500	3520	52	52	47	2930	3500	3520
		37	200L		134	128	120	2930	3520	3530	67	64	60	2930	3520	3530
		45	200L		162	154	144	2930	3520	3530	81	77	72	2930	3520	3530
		55	225S		198	192	176	2940	3530	3540	99	96	88	2940	3530	3540
		75	250S		263	251	234	2970	3560	3570	—	—	—	—	—	—
		90	250M		320	310	286	2960	3550	3560	—	—	—	—	—	—
		110	280S		—	—	—	—	—	—	191	—	172	2950	—	3560
		132	280M		—	—	—	—	—	—	243	—	215	2940	—	3540
		160	315S		—	—	—	—	—	—	274	—	248	2940	—	3540
		200	315M		—	—	—	—	—	—	340	—	308	2940	—	3540
4 pole	SF-JR	0.2	63	E	1.26	1.1	1.1	1430	1730	1740	0.63	0.55	0.55	1430	1730	1740
		0.4	71		2.2	2.0	2.0	1410	1690	1700	1.1	1.0	1.0	1410	1690	1700
		0.75	80		3.7	3.4	3.3	1400	1690	1700	1.8	1.7	1.65	1400	1690	1700
		1.5	90L		6.6	6.2	6.0	1420	1710	1720	3.3	3.1	3.0	1420	1710	1720
		2.2	100L		9.2	9.0	8.6	1430	1710	1720	4.6	4.5	4.3	1430	1710	1720
		3.7	112M		14.6	14.2	13.4	1420	1710	1730	7.3	7.1	6.7	1420	1710	1730
		5.5	132S	B	22	21	19.8	1430	1720	1730	11.0	10.5	9.9	1430	1720	1730
		7.5	132M		29	28	26.4	1440	1730	1740	14.5	14	13.2	1440	1730	1740
		11	160M		42.5	41	38	1430	1720	1740	21.5	20.5	19	1430	1720	1740
		15	160L		56	54	50	1440	1730	1740	28	27	25	1440	1730	1740
		18.5	180M		68	66	62	1460	1750	1760	34	33	31	1460	1750	1760
	SF-LH	22	180M	F	81	78	72	1460	1750	1760	40.5	39	36	1460	1750	1760
		30	180L		110	106	98	1460	1750	1760	55	53	49	1460	1750	1760
		37	200L		131	130	118	1460	1760	1770	65.5	65	59	1460	1760	1770
		45	200L		162	156	144	1460	1760	1770	81	78	72	1460	1760	1770
		55	225S		202	192	178	1470	1760	1770	101	96	89	1470	1760	1770
		75	250S		271	265	242	1470	1760	1770	136	133	121	1470	1760	1770
		90	250M		320	312	286	1470	1760	1770	160	156	143	1470	1760	1770
		110	280S		—	—	—	—	—	—	190	—	170	1470	—	1770
		132	280M		—	—	—	—	—	—	242	—	210	1460	—	1760
		160	315S		—	—	—	—	—	—	283	—	257	1470	—	1770
		200	315M		—	—	—	—	—	—	353	—	319	1470	—	1770
6 pole	SF-JR	0.2	71	E	1.4	1.3	1.3	930	1110	1120	0.7	0.65	0.65	930	1110	1120
		0.4	80		2.7	2.5	2.5	920	1100	1110	1.3	1.2	1.2	920	1100	1110
		0.75	90L		4.2	4.0	4.0	950	1140	1150	2.1	2.0	2.0	950	1140	1150
		1.5	100L		7.4	7.0	6.8	930	1110	1120	3.7	3.5	3.4	930	1110	1120
		2.2	112M		10.4	10	9.8	940	1120	1140	5.2	5.0	4.9	940	1120	1140
		3.7	132S	B	17.2	16	15.2	950	1140	1150	8.6	8.0	7.6	950	1140	1150
		5.5	132M		24.6	23	22	950	1140	1150	12.3	11.5	11.0	950	1140	1150
		7.5	160M		32	30	29	960	1140	1150	16	15	14.5	960	1140	1150
		11	160L		46	43	41	970	1150	1160	23	21.5	20.5	970	1150	1160
		15	180M		62	58	56	970	1160	1170	31	29	28	970	1160	1170
	SF-LH	18.5	180L	F	72	70	65	970	1160	1170	36	35	32.5	970	1160	1170
		22	180L		85	82	76	970	1160	1170	42.5	41	38	970	1160	1170
		30	200L		117	110	102	970	1160	1170	58.5	55	51	970	1160	1170
		37	200L		145	136	128	970	1160	1170	72.5	68	64	970	1160	1170
		45	225S		174	164	152	970	1160	1170	87	82	76	970	1160	1170
		55	250S		218	198	186	970	1160	1170	109	99	93	970	1160	1170
		75	250M		288	266	248	970	1160	1170	144	133	129	970	1160	1170
		90	280S		344	324	300	980	1170	1180	172	162	150	980	1170	1180
		110	280M		—	—	—	—	—	—	207	—	180	970	—	1170
		132	315S		—	—	—	—	—	—	249	—	223	980	—	1180
		160	315M		—	—	—	—	—	—	299	—	268	980	—	1180

(2) Load characteristics

Table 4.2 Characteristic List of the Totally Enclosed, Fan Cooled Type Motors,
Squirrel-Cage Type 200/200/220V 50/60/60Hz

Out-put (kW)	Number of Poles	Frame Number	Motor GD ² (kgf•m ²)	Voltage (V)	Frequen- cy (Hz)	Load Characteristics											Speed (r/min)	Starting current (A)
						50% load			75% load			100% load						
						Cur- rent (A)	Effi- ciency (%)	Power factor (%)	Cur- rent (A)	Effi- ciency (%)	Power factor (%)	Cur- rent (A)	Effi- ciency (%)	Power factor (%)				
0.4	2	71M	0.003	200	50	1.43	70.0	57.6	1.64	75.3	70.1	1.91	77.2	78.4	2850	12.0		
				200	60	1.18	72.4	67.8	1.43	77.0	78.7	1.74	78.4	84.8	3420	10.8		
				220	60	1.26	70.1	59.6	1.45	75.8	71.5	1.70	78.2	79.2	3450	11.9		
	4	71M	0.007	200	50	1.62	67.4	52.8	1.82	72.9	65.4	2.08	74.7	74.3	1410	10.6		
				200	60	1.32	72.6	60.4	1.56	76.7	72.6	1.86	77.5	80.1	1690	9.80		
				220	60	1.42	68.9	53.5	1.61	74.5	65.8	1.84	76.7	74.3	1700	10.8		
	6	80M	0.011	200	50	2.29	61.7	40.8	2.44	68.7	51.7	2.65	71.8	60.8	920	12.4		
				200	60	1.87	66.9	46.2	2.06	72.6	57.9	2.31	74.8	66.8	1100	11.2		
				220	60	2.06	63.1	40.4	2.20	70.1	51.2	2.39	73.4	59.9	1110	12.3		
	8	90L	0.022	200	50	2.54	56.2	40.5	2.67	63.9	50.7	2.87	67.7	59.3	715	12.2		
				200	60	2.13	61.7	43.9	2.31	68.3	55.0	2.56	70.9	63.6	855	10.8		
				220	60	2.32	57.6	39.2	2.45	65.4	49.1	2.64	69.3	57.4	860	11.9		
0.75	2	80M	0.005	200	50	2.19	73.3	67.4	2.65	77.7	78.8	3.21	79.0	85.4	2810	21.6		
				200	60	1.95	74.3	74.6	2.46	78.4	84.1	3.06	79.4	88.9	3400	20.0		
				220	60	2.01	72.0	68.0	2.42	77.3	78.9	2.92	79.3	85.1	3410	22.0		
	4	80M	0.012	200	50	2.76	70.9	55.3	3.16	75.9	67.8	3.66	77.6	76.1	1400	22.8		
				200	60	2.25	74.9	64.2	2.72	78.9	75.7	3.30	79.8	82.2	1690	20.4		
				220	60	2.42	71.9	56.6	2.78	77.2	68.7	3.24	79.2	76.7	1700	22.4		
	6	90L	0.026	200	50	3.31	69.5	47.0	3.67	74.7	59.1	4.16	76.5	68.0	950	21.6		
				200	60	2.84	72.6	52.5	3.27	76.9	64.7	3.83	77.9	72.6	1140	18.4		
				220	60	3.02	69.8	46.6	3.35	75.3	58.4	3.79	77.5	67.0	1150	20.2		
	8	100L	0.034	200	50	4.11	63.1	41.7	4.43	69.5	52.7	4.89	72.1	61.4	705	19.0		
				200	60	3.47	67.2	46.4	3.88	72.4	57.9	4.45	73.5	65.9	840	16.0		
				220	60	3.76	63.7	41.1	4.07	70.2	51.7	4.49	73.0	60.0	850	17.6		
1.5	2	90L	0.010	200	50	3.94	78.6	69.9	4.90	82.4	80.5	6.01	83.6	86.1	2870	48.2		
				200	60	3.52	78.4	78.5	4.58	82.2	86.3	5.78	83.4	89.9	3440	42.0		
				220	60	3.56	76.7	72.0	4.44	81.4	81.7	5.45	83.3	86.8	3450	46.2		
	4	90L	0.027	200	50	4.43	76.4	63.9	5.34	80.7	75.4	6.43	82.1	82.0	1420	50.6		
				200	60	3.86	78.9	71.1	4.87	82.4	80.8	6.06	83.4	85.7	1710	44.0		
				220	60	4.00	76.4	64.4	4.83	81.0	75.5	5.81	82.8	81.8	1720	48.4		
	6	100L	0.037	200	50	5.38	74.3	54.2	6.24	78.0	66.7	7.37	78.7	74.6	930	40.0		
				200	60	4.60	76.9	61.2	5.61	79.8	72.6	6.90	79.7	78.8	1110	35.0		
				220	60	4.83	74.6	54.6	5.62	78.8	66.7	6.63	79.9	74.3	1120	38.5		
	8	112M	0.065	200	50	6.94	75.7	41.2	7.78	79.2	52.7	8.99	79.5	60.7	695	34.0		
				200	60	5.39	80.7	49.7	6.36	83.2	61.4	7.65	83.0	68.2	835	29.2		
				220	60	5.97	78.0	42.3	6.69	81.8	53.9	7.68	82.8	62.0	845	32.1		
2.2	2	90L	0.020	200	50	5.23	81.1	74.8	6.72	84.4	84.0	8.41	85.3	88.5	2860	75.4		
				200	60	4.80	81.1	81.6	6.40	84.3	88.3	8.19	85.1	91.1	3430	64.8		
				220	60	4.76	79.5	76.2	6.12	83.6	84.7	7.64	85.1	88.8	3460	71.3		
	4	100L	0.032	200	50	5.98	82.5	64.5	7.38	84.2	76.7	9.12	83.7	83.3	1430	59.6		
				200	60	5.08	84.4	74.0	6.68	85.5	83.4	8.57	84.7	87.6	1710	52.2		
				220	60	5.26	83.3	65.9	6.54	85.5	77.5	8.08	85.5	83.6	1720	57.4		
	6	112M	0.088	200	50	7.25	80.8	54.2	8.50	83.1	67.4	10.1	83.0	75.6	940	62.0		
				200	60	6.21	83.3	61.4	7.66	84.6	73.5	9.49	83.8	79.9	1120	53.0		
				220	60	6.53	81.7	54.1	7.67	84.2	67.1	9.12	84.4	75.1	1140	58.3		
	8	132S	0.15	200	50	8.71	79.5	45.9	9.84	82.3	58.8	11.4	82.6	67.7	715	56.0		
				200	60	7.13	82.2	54.1	8.51	84.0	66.6	10.3	83.5	73.7	850	47.0		
				220	60	7.69	80.2	46.8	8.75	83.2	59.5	10.1	83.8	68.0	860	51.7		
3.7	2	112M	0.029	200	50	8.43	85.2	74.4	10.9	87.1	84.1	13.8	87.1	88.7	2910	110		
				200	60	7.51	85.4	83.2	10.3	87.1	89.5	13.3	87.0	92.0	3480	93.4		
				220	60	7.47	84.1	77.3	9.79	86.7	85.8	12.4	87.3	89.7	3490	103		
	4	112M	0.065	200	50	9.00	85.3	69.6	11.4	86.8	80.8	14.3	86.5	86.5	1420	112		
				200	60	7.96	86.9	77.2	10.6	87.9	85.8	13.7	87.2	89.5	1710	96.0		
				220	60	8.01	85.7	70.7	10.2	87.6	81.4	12.8	87.8	86.7	1730	106		
	6	132S	0.14	200	50	10.5	84.9	59.7	12.9	86.4	71.9	15.9	85.9	78.4	950	96.0		
				200	60	8.92	87.0	68.9	11.6	87.6	78.6	14.9	86.6	82.7	1140	80.0		
				220	60	9.24	85.8	61.3	11.4	87.4	73.0	14.1	87.3	79.1	1150	88.0		
	8	132M	0.45	200	50	13.9	80.8	47.4	16.0	83.1	60.3	18.8	82.2	68.6	705	92.4		
				200	60	11.4	83.9	56.0	13.9	84.9	68.1	17.1	83.3	74.4	845	75.6		
				220	60	12.2	82.2	48.5	14.1	84.5	61.1	16.6	84.5	61.9	855	83.2		

The above characteristics are represented by typical values calculated by the circle diagram method.

**Table 4.2 Characteristic List of the Totally Enclosed, Fan Cooled Type Motors,
Squirrel-Cage Type 200/200/220V 50/60/60Hz**

Out- put (kW)	Number of Poles	Frame Number	Motor GD ² (kgf•m ²)	Voltage (V)	Frequen- cy (Hz)	Load Characteristics										Speed (r/min)	Starting current (A)
						50% load			75% load			100% load					
						Cur- rent (A)	Effi- ciency (%)	Power factor (%)	Cur- rent (A)	Effi- ciency (%)	Power factor (%)	Cur- rent (A)	Effi- ciency (%)	Power factor (%)			
5.5	2	132S	0.045	200	50	14.2	83.4	66.9	17.9	86.3	77.3	22.1	87.1	82.5	2910	146	
				200	60	11.4	85.5	81.6	15.5	87.9	87.6	20.0	88.5	89.8	3490	124	
				220	60	11.8	83.8	73.0	15.2	87.1	81.9	19.0	88.2	86.0	3500	136	
	4	132S	0.11	200	50	13.6	86.2	67.9	17.4	87.6	78.2	21.9	87.1	83.1	1430	130	
				200	60	11.8	87.0	77.5	16.0	88.1	84.6	20.8	87.6	87.1	1720	110	
				220	60	11.9	85.9	70.7	15.4	88.0	80.1	19.4	88.2	84.4	1730	121	
	6	132M	0.20	200	50	16.6	84.7	56.6	20.0	87.0	68.4	24.3	87.3	74.9	950	159	
				200	60	13.3	87.8	68.0	17.2	89.2	77.5	21.9	89.0	81.6	1140	131	
				220	60	14.0	86.2	59.9	17.1	88.5	71.3	21.0	89.0	77.4	1150	144	
	8	160M	0.45	200	50	19.7	83.6	48.3	22.9	86.2	60.2	27.2	86.6	67.4	725	134	
				200	60	16.0	86.6	57.3	19.9	88.3	67.9	24.8	88.1	72.7	870	115	
				220	60	17.0	84.9	50.0	20.0	87.6	61.7	23.9	88.2	68.5	875	126	
7.5	2	132S	0.063	200	50	16.0	87.8	77.1	21.3	89.4	85.2	27.3	89.4	88.6	2920	210	
				200	60	14.5	87.1	85.8	20.2	89.0	90.3	26.4	89.2	91.8	3500	179	
				220	60	14.1	86.2	80.7	19.0	88.7	87.4	24.4	89.5	90.2	3510	197	
	4	132M	0.16	200	50	17.6	88.4	69.7	22.8	89.3	79.8	28.9	88.8	84.4	1440	199	
				200	60	15.5	89.3	78.0	21.2	90.0	85.2	27.6	89.4	87.8	1730	172	
				220	60	15.5	88.8	71.3	20.2	90.2	80.9	25.6	90.1	85.2	1740	189	
	6	160M	0.42	200	50	21.0	86.3	59.7	25.9	88.2	71.2	31.8	88.3	77.1	960	180	
				200	60	17.4	88.7	70.4	22.9	89.6	79.3	29.3	89.1	82.8	1140	155	
				220	60	17.9	87.3	63.0	22.4	89.1	73.9	27.8	89.3	79.4	1150	171	
	8	160L	0.70	200	50	25.8	86.3	48.7	29.9	89.0	60.8	35.4	89.6	68.3	730	203	
				200	60	21.0	89.4	57.8	26.0	91.2	68.6	32.3	91.2	73.7	870	170	
				220	60	22.3	87.7	50.5	26.1	90.5	62.4	31.1	91.3	69.5	875	187	
11	2	160M	0.15	200	50	23.2	87.6	78.0	30.9	89.9	85.8	39.3	90.6	89.2	2920	338	
				200	60	21.2	86.8	86.2	29.3	89.3	90.9	38.1	90.1	92.6	3500	288	
				220	60	20.6	85.9	81.5	27.6	88.9	88.2	35.2	90.1	91.0	3510	317	
	4	160M	0.28	200	50	26.0	89.2	68.4	33.4	90.6	78.6	42.0	90.5	83.5	1430	290	
				200	60	22.2	90.1	79.4	30.4	91.0	86.0	39.7	90.6	88.4	1720	250	
				220	60	22.3	89.1	72.6	29.2	90.7	81.8	37.0	90.8	85.8	1740	275	
	6	160L	0.55	200	50	29.6	88.1	60.9	36.8	89.7	72.0	45.5	89.9	77.6	970	264	
				200	60	24.6	90.2	71.5	32.6	91.3	79.9	41.9	91.2	83.2	1150	230	
				220	60	25.4	89.0	63.8	32.0	90.9	74.5	39.7	91.3	79.8	1160	253	
	8	180M	1.4	200	50	40.1	86.7	45.7	46.1	88.9	58.4	53.6	89.3	66.3	725	333	
				200	60	33.4	88.7	53.6	40.3	90.2	65.6	48.8	90.1	72.2	870	294	
				220	60	35.4	87.5	46.6	40.9	89.7	59.1	47.7	90.3	67.1	875	324	
15	2	160M	0.19	200	50	29.3	91.3	81.1	40.0	92.6	87.8	51.6	92.9	90.4	2920	456	
				200	60	27.8	89.6	86.9	39.0	91.4	91.1	51.0	91.9	92.4	3500	384	
				220	60	26.9	89.0	82.2	36.6	91.2	88.5	47.0	92.0	91.0	3510	422	
	4	160L	0.40	200	50	34.4	89.8	70.2	44.2	91.3	80.5	55.5	91.4	85.4	1440	456	
				200	60	29.9	90.3	80.2	40.8	91.5	87.1	52.8	91.5	89.7	1730	398	
				220	60	29.9	89.6	73.6	39.0	91.3	82.8	49.3	91.8	87.1	1740	438	
	6	180M	1.3	200	50	41.3	88.7	59.1	50.4	90.5	71.2	61.3	90.8	77.8	970	440	
				200	60	34.2	90.5	69.9	44.5	91.7	79.5	56.4	91.6	83.7	1160	380	
				220	60	35.5	89.3	62.2	43.9	91.2	73.8	53.8	91.6	79.8	1170	418	
	8	180L	1.9	200	50	42.2	89.4	57.3	52.2	90.3	68.9	64.4	89.9	74.8	725	340	
				200	60	37.2	90.3	64.6	48.4	90.4	74.2	62.4	89.1	77.8	870	300	
				220	60	38.0	89.4	58.0	47.2	90.4	69.4	58.4	89.9	75.0	875	330	
18.5	2	160L	0.24	200	50	34.8	91.3	84.2	48.1	92.6	90.0	62.4	92.8	92.2	2920	570	
				200	60	33.0	90.4	89.5	46.9	92.0	92.9	61.6	92.3	94.0	3500	492	
				220	60	31.4	89.9	85.9	43.5	91.9	91.1	56.4	92.6	93.0	3510	541	
	4	180M	0.69	200	50	39.3	90.7	74.9	52.3	91.7	83.5	67.0	91.5	87.0	1460	484	
				200	60	35.4	90.8	83.1	49.3	91.8	88.5	64.6	91.6	90.3	1750	418	
				220	60	34.6	90.2	77.9	46.4	91.7	85.6	59.6	91.9	88.7	1760	460	
	6	180L	1.6	200	50	43.7	90.3	67.7	56.4	91.3	77.8	71.1	91.1	82.4	970	458	
				200	60	39.1	90.9	75.1	53.1	91.1	82.8	69.3	90.2	85.4	1160	402	
				220	60	39.0	90.4	68.9	50.6	91.3	78.8	64.1	91.0	83.2	1170	442	
	8	200L	2.1	200	50	58.0	88.6	51.9	68.8	89.8	64.8	82.5	89.4	72.4	730	466	
				200	60	48.2	89.9	61.6	60.8	90.4	72.9	76.3	89.5	78.2	875	410	
				220	60	50.8	89.2	53.6	60.7	90.4	66.3	73.2	90.2	73.6	880	451	

The above characteristics are represented by typical value calculated by the circle diagram method.

**Table 4.2 Characteristic List of the Totally Enclosed, Fan Cooled Type Motors,
Squirrel-Cage Type 200/200/220V 50/60/60Hz**

Out- put (kW)	Number of Poles	Frame Number	Motor GD ² (kgf•m ²)	Voltage (V)	Frequen- cy (Hz)	Load Characteristics										Speed (r/min)	Starting current (A)
						50% load			75% load			100% load					
						Cur- rent (A)	Effi- ciency (%)	Power factor (%)	Cur- rent (A)	Effi- ciency (%)	Power factor (%)	Cur- rent (A)	Effi- ciency (%)	Power factor (%)			
22	2	180M	0.35	200	50	42.8	90.9	81.5	58.7	92.2	88.0	76.1	92.3	90.4	2920	588	
				200	60	40.3	90.1	87.4	57.0	91.6	91.3	74.9	91.8	92.3	3500	504	
				220	60	38.6	89.7	83.3	53.1	91.6	89.1	68.7	92.2	91.2	3510	554	
	4	180M	0.83	200	50	46.8	90.3	75.2	62.3	91.5	83.6	79.8	91.4	87.1	1460	600	
				200	60	42.2	90.5	83.2	58.7	91.7	88.5	76.9	91.6	90.2	1750	522	
				220	60	41.1	89.8	78.2	55.3	91.5	85.7	70.9	91.8	88.7	1760	574	
	6	180L	1.9	200	50	51.8	90.2	68.0	66.8	91.1	78.3	84.3	90.7	83.0	970	580	
				200	60	46.0	91.0	75.8	62.5	91.4	83.4	81.5	90.6	86.1	1160	506	
				220	60	45.1	90.3	69.4	59.8	91.4	79.3	75.6	91.2	83.7	1170	557	
	8	200L	2.4	200	50	67.2	89.2	53.0	79.6	90.6	66.0	95.2	90.6	73.6	725	568	
				200	60	56.4	90.1	62.6	71.0	90.8	73.9	88.8	90.3	79.3	865	458	
				220	60	58.6	89.4	55.1	70.4	90.8	67.8	84.8	90.8	75.0	870	504	
30	2	180L	0.45	200	50	58.4	90.6	81.9	80.3	91.7	88.1	104	91.6	90.5	2930	824	
				200	60	54.7	89.8	88.2	77.7	91.2	91.6	103	91.2	92.5	3500	730	
				220	60	52.2	89.5	84.3	72.1	91.3	89.7	93.8	91.7	91.6	3520	803	
	4	180L	1.1	200	50	63.3	90.6	75.5	84.5	91.7	83.8	108	91.5	87.2	1460	884	
				200	60	56.3	90.9	84.5	79.2	91.8	89.3	104	91.5	90.7	1750	750	
				220	60	55.1	90.3	79.1	74.6	91.7	86.3	96.2	91.9	89.1	1760	825	
	6	200L	2.2	200	50	71.9	90.7	66.4	92.3	91.5	76.9	116	91.1	81.8	970	730	
				200	60	60.2	32.2	78.0	83.0	92.3	84.7	109	91.5	86.9	1160	640	
				220	60	60.9	91.4	70.7	79.8	92.3	80.2	102	92.0	84.2	1170	704	
	8	225S	4.8	200	50	79.6	91.5	59.4	99.2	92.3	71.0	123	92.0	76.7	730	828	
				200	60	66.1	92.8	70.7	88.1	93.1	79.2	114	92.5	82.3	870	717	
				220	60	67.5	92.3	63.2	85.6	93.2	74.1	107	93.0	79.2	880	789	
37	2	200L	0.70	200	50	77.5	91.4	75.5	103	92.8	83.5	132	93.0	86.8	2930	874	
				200	60	68.3	90.2	86.8	96.4	91.9	90.4	127	92.3	91.1	3520	760	
				220	60	66.9	89.7	80.8	91.1	91.8	87.0	117	92.5	89.3	3530	836	
	4	200L	1.5	200	50	72.0	92.1	80.5	99.1	92.7	87.1	129	92.3	89.6	1460	1000	
				200	60	66.5	91.8	87.4	95.2	92.4	91.1	126	92.0	91.8	1760	880	
				220	60	63.9	91.4	83.1	88.6	92.5	88.8	116	92.5	90.8	1770	968	
	6	200L	2.7	200	50	91.9	90.8	64.0	116	91.7	75.3	144	91.5	80.9	970	950	
				200	60	75.4	92.1	76.9	103	92.5	84.4	133	91.9	87.1	1160	822	
				220	60	76.8	91.5	69.1	99.4	92.5	79.3	125	92.3	84.0	1170	904	
	8	250S	6.7	200	50	106	90.3	56.0	128	90.9	68.5	157	90.2	75.4	735	958	
				200	60	87.1	91.5	67.0	113	91.8	76.9	144	91.1	81.0	880	804	
				220	60	88.6	91.1	59.1	111	92.0	71.1	136	91.8	77.2	885	884	
45	2	200L	0.80	200	50	94.3	91.3	75.5	126	92.7	83.6	161	93.0	86.9	2930	1130	
				200	60	81.6	91.0	87.4	116	92.5	91.0	153	92.8	91.8	3520	976	
				220	60	80.9	90.4	80.8	110	92.3	87.2	142	92.9	89.6	3530	1070	
	4	200L	1.8	200	50	95.2	92.1	74.0	126	93.0	83.0	161	92.8	86.9	1460	1380	
				200	60	81.7	92.8	85.6	115	93.5	90.3	152	93.2	91.7	1760	1200	
				220	60	80.4	92.2	79.7	109	93.3	86.9	141	93.4	89.8	1770	1320	
	6	225S	4.3	200	50	104	91.6	68.5	134	92.2	78.8	169	91.8	83.5	970	1150	
				200	60	86.6	92.6	81.0	121	92.7	87.1	159	91.9	89.1	1160	1040	
				220	60	86.8	92.1	73.8	115	92.8	82.7	148	92.5	86.5	1170	1140	
	8	250M	7.6	200	50	122	88.6	60.0	152	89.7	71.6	187	89.4	77.6	730	1000	
				200	60	101	90.1	71.0	136	90.7	78.9	175	90.0	83.4	875	1000	
				220	60	106	89.2	62.5	132	90.5	74.0	165	90.5	79.7	880	1080	
55	2	225S	1.2	200	50	116	90.9	75.1	154	92.5	83.7	196	92.9	87.4	2940	1400	
				200	60	101	90.2	86.9	142	92.0	91.0	186	92.5	92.2	3530	1250	
				220	60	99.7	89.5	80.8	135	91.7	87.5	173	92.5	90.2	3540	1370	
	4	225S	2.5	200	50	115	92.7	74.5	153	93.3	83.5	196	93.0	87.3	1470	1490	
				200	60	101	93.2	84.6	142	93.6	89.6	187	93.2	91.2	1760	1250	
				220	60	98.4	92.8	79.0	134	93.7	86.5	172	93.6	89.5	1770	1370	
	6	250S	6.3	200	50	138	90.3	63.9	173	91.7	75.3	214	91.8	81.0	970	1400	
				200	60	108	92.5	79.6	148	93.1	86.4	193	92.8	88.8	1160	1300	
				220	60	112	91.4	70.3	146	92.7	80.3	183	92.8	84.9	1170	1400	
	8	280S	9.5	200	50	139	91.4	62.3	175	92.1	73.8	218	91.6	79.5	730	1333	
				200	60	114	91.9	75.5	155	92.3	83.0	202	91.6	85.6	880	1168	
				220	60	117	91.3	67.3	151	92.3	77.7	190	92.1	82.4	885	1284	

The above characteristics are represented by typical values calculated by the circle diagram method.

4.5 NB Brake Characteristics

(1) Manufactured models

Table 4.3 Manufactured Models

Motor			NB Brake	
Output (kW)		Frame number		
4 pole	6 pole		150% torque	80% torque
0.2	—	63	NB-0.2	NB-0.2
0.4	0.2	71	NB-0.4	NB-0.4
0.75	0.4	80	NB-0.8C	NB-0.4
1.5	0.75	90L	NB-1.5C	NB-0.8C
2.2	1.5	100L	NB-2.2C	NB-1.5C
3.7	2.2	112M	NB-4C	NB-2.2C
5.5	3.7	132S	NB-7.5C	NB-4C
7.5	5.5	132M		
11	7.5	160M	NB-15C	NB-7.5C
15	11	160L		

(2) Brake characteristics

Model	Rated Braking Torque (kgf•m)	Permissible Braking Work Load of Lining (kgf•m/m)	Permissible Wear (mm)	Electromagnet Characteristic		Electromagnet Stroke		Delay Time Independent off (second)	Power Supply	Single Brake Weight (kgf)	Brake GD ² (kgf•m ²)
				Input (W)	Current (A)	Initial (mm)	Adjustment limit (mm)				
NB-0.2	0.2 (1.96 N•m)	80	2	9.5	0.32	0.6	1.5	0.025	Single-phase	5	0.00098
				7.5	0.25			0.025			
NB-0.4	0.4 (3.92 N•m)	80	2	10	0.55	0.6	1.5	0.025	Single-phase	5	0.0018
				8.5	0.40			0.025			
NB-0.8C	0.8 (7.84 N•m)	220	3	25	0.4	0.5	1.5	0.026	Three-phase	7	0.0019
				18	0.2			0.026			
NB-1.5C	1.5 (14.7 N•m)	350	6	25	0.4	0.5	1.5	0.026	Three-phase	8	0.0034
				18	0.2			0.026			
NB-2.2C	2.2 (21.6 N•m)	600	6	30	0.5	0.5	1.5	0.027	Three-phase	13	0.012
				24	0.32			0.027			
NB-4C	4 (39.2 N•m)	850	6	35	0.82	0.5	1.5	0.027	Three-phase	18	0.018
				26	0.54			0.027			
NB-7.5C	7.5 (73.5 N•m)	1100	7	45	0.84	0.5	1.5	0.036	Three-phase	28	0.062
				35	0.56			0.036			
NB-15C	15 (147 N•m)	1300	7	98	1.3	0.5	1.5	0.025	Three-phase	55	0.15
				84	0.8			0.025			

Note: 1. 200V 50Hz on top, 200V 60Hz on the bottom.

2. The rated braking torque is dynamic friction torque developed at slow speed (immediately before a stop) in accordance with JEM-1240(1970)6.6-(2).

• Braking torque

The rated braking torque is represented by dynamic friction torque and the value of the NB brake model indicates the rated braking torque.

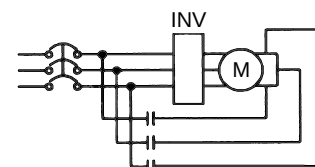
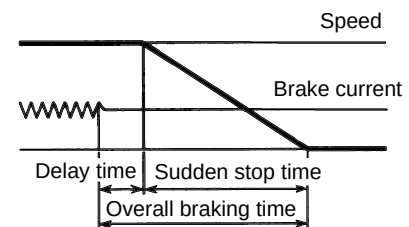
The standard ratio of the braking torque to the rated torque of the motor is 150%.

Also, since the brake is operated smoothly at 85% (~15%) of the rated voltage with the rated braking torque maintained, there is sufficient allowance of power supply voltage fluctuations.

• Power supply connection method and brake operation characteristic

Connect the brake coil to the input side (commercial power supply) of the inverter as shown in Fig. 4.9.

The operation characteristic is as shown in Fig. 4.9.



(Externally connected power switched off independently)

Fig. 4.9 Operation Characteristic

APPENDICES

1. Operating Ranges of Standard Motors and Geared Motors

The operating frequency ranges of standard motors and geared motors are given below.

- (1) Operating frequency ranges of standard motors (this also applies to the constant-torque motors)
The operating frequency ranges of the inverter-driven standard motors are as listed below:

Table Appendix-1 Operating Frequency Ranges of Standard Motors

SB-J(F, V), SB-JR(F, V), SF-JR(F, V), SF-J(F, V), SF-JRC, SF-JRCA
SB-KH(KF, KV), SF-KH(KF, KV)

Number of Poles Frame Number	2 Pole	4 Pole	6 Pole		
63	120Hz or less	120Hz or less	120Hz or less		
71					
80					
90					
100					
112	90Hz or less	100Hz or less			
132	75Hz or less				
160					
180	65Hz or less	65Hz or less	65Hz or less		
200	60Hz or less				
225					
250	60Hz or less	60Hz or less			

Note: The operating frequency ranges of outdoor, water-proof, and brake motors are given in Table Appendix-2.

Table Appendix-2 Operating Frequency Ranges of the Outdoor, Water-Proof, and Motors with NB Brake

Number of Poles \ Model/Frame Number		2 Pole	4 Pole	6 Pole
With NB brake		There are no relevant models.	30 to 65Hz (with the exception of vertical types)	45 to 90Hz (with the exception of vertical types)
Outdoor type Water-proof type	63 to 132	65Hz or less	120Hz or less	120Hz or less
	160		100Hz or less	
	180		60Hz or less	65Hz or less
	200	65Hz or less		
	225	60Hz or less		
	250	60Hz or less		

Note: When a motor with an NB brake is operated continuously at less than 900r/min, noise is produced due to the play of the brake disc, this is not a fault.

(2) Operating frequency ranges of geared motors

The operating frequency ranges of inverter-driven geared motors are listed below:

Table Appendix-3 Operating Frequency Ranges of Geared Motors

Motor Capacity (kW)	Operating Frequency Range (Hz)					
	Grease lubricated			Oil lubricated		
	4P	6P	8P	4P	6P	8P
0.1 0.2 0.3 0.4 0.75	0 to 120Hz					
1.5						
2.2	0 to 90 Hz					
3.7	0 to 85 Hz	0 to 120 Hz	0 to 120 Hz	25 to 120 Hz	35 to 120 Hz	50 to 120 Hz
5.5	0 to 75 Hz	0 to 110 Hz		25 to 115 Hz		
7.5	0 to 70 Hz	0 to 100 Hz		25 to 105 Hz		
11				25 to 105 Hz	35 to 70 Hz	50 to 70 Hz
15				25 to 95 Hz		
22				25 to 90 Hz		
30				25 to 70 Hz		
37				25 to 65 Hz	35 to 65 Hz	
45						
55						
75						

Note: (1) The above table applies to the Mitsubishi geared motors.

(2) The standard model of the GM-EJB mini-geared motor with brake cannot be used as standard. The 'current type' brake must be modified into a 'voltage type'.

(3) When a motor with brake is operated continuously at the speed of less than 900r/min (4P 30Hz), noise is produced due to the play of the brake disc, this is not a fault.

Note that the brake supply should be 60Hz or less.

2. Calculation of Required Power

The formulas used to calculate the required powers of various machines and apparatuses are given below:

(1) General formula

Required power P [kW]

$$P = \frac{T \cdot N}{974} \dots\dots\dots(2-1)$$

T : Required torque [kgf • m]
N : Speed [r/min]

(2) General industrial machines

1) Pump

$$P = \frac{Q \cdot H}{6.12\eta} \text{ [kW]} \dots\dots\dots(2-2)$$

Q : Pump discharge [m³/min]
H : Head [m]
η : Pump efficiency (0.55 to 0.85 depending on the type)

2) Fan, blower

$$P = \frac{Q \cdot H}{6120\eta} \text{ [kW]} \dots\dots\dots(2-3)$$

Q : Wind flow [m³/min]
H : Wind pressure [mm water column]
η : Fan/blower efficiency (0.5 to 0.8 depending on the type)

3) Compressor

$$P = \frac{5.83Q(P^{0.286} - 1)}{\eta} \text{ [kW]} \dots\dots\dots(2-4)$$

Q : Discharge air flow [m³/min]
p : Discharge absolute pressure [kg/cm²]
η : Compressor efficiency (0.5 to 0.8)

(3) Cargo-handling machines

1) For winding

$$P = \frac{(Q + g_0) V}{6120\eta} \text{ [kW]} \dots\dots\dots(2-5)$$

Q : Load [kgf]
g₀ : Hanger weight [kgf]
V₁ : Winding velocity [m/min]
η : Machine efficiency (0.7 to 0.85)

2) For traversing

$$P = \frac{(Q + g_0 + G_0) W_{2r} \cdot V_2}{6120\eta} \text{ [kW]} \dots\dots\dots(2-6)$$

G₀ : Grab's own weight [kgf]
W_{2r} : Running resistance [kgf/kgf]
V₂ : Traversing velocity [m/min]

3) For running

$$P = \frac{(Q + G) W_{3r} \cdot V_3}{6120\eta} \text{ [kW]} \dots\dots\dots(2-7)$$

W_{3r} : Running resistance [kgf/kgf]
V₃ : Running velocity [m/min]
G : Crane's own weight [kgf]

4) For swiveling

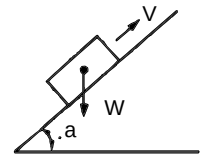
$$P = \frac{(Q + G_1) W_{4r} \cdot V_4}{6120\eta} \text{ [kW]} \dots\dots\dots(2-8)$$

W_{4r} : Running resistance [kgf/kgf]
V₄ : Running velocity [m/min]
G₁ : Crane swivel section weight [kgf]

5) Pulling up an object along the slant of angle α relative to the horizontal surface

$$P = \frac{W(\sin \alpha + \mu \cdot \cos \alpha) V}{6120\eta} \text{ [kW]} \dots\dots\dots(2-9)$$

W : Weight [kgf]
μ : Friction coefficient
η : Winding machine efficiency
V₁ : Winding velocity [m/min]



(4) Machine tools

1) Table feeding work

$$P = \frac{(W + T) \mu \cdot V}{6120\eta} \text{ [kW]} \dots\dots\dots(2-10)$$

W : Workpiece weight [kgf]
T : Table weight [kgf]
μ : Friction coefficient of table/bed
V : Table feedrate [m/min]

2) Press

$$P = \frac{K \cdot E \cdot N}{6120\eta} \text{ [kW]} \dots\dots\dots(2-11)$$

E : Press work load [kgf • m]

$$E = \frac{GD^2}{8g} \cdot \left(\frac{\pi}{60} \right)^2 \cdot (N_1^2 - N_2^2) \text{ [kgf • m]} \dots\dots(2-12)$$

GD² : GD² of load [kgf • m²]
g : 9.8 [m/sec²]
N₁ : No-load speed [r/min]
N₂ : Pressing speed [r/min]
N : Number of strokes [times/min]
η : Press efficiency (0.75 to 0.8)
K : Constant determined by the following specifications (normally 1.5 to 2)

- (1) Work load and time of single pressoperation
- (2) Cycle time
- (3) GD² of flywheel
- (4) Flywheel speed

(5) Others

1) Driving an inertia object

$$P = \frac{1}{974} \cdot \frac{GD^2}{375} \cdot \frac{N^2}{t} \text{ [kW]} \dots\dots\dots(2-13)$$

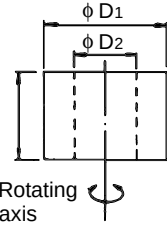
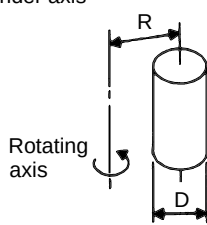
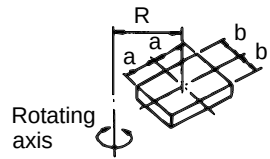
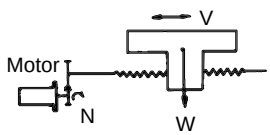
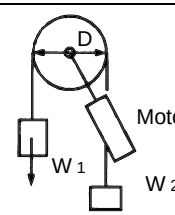
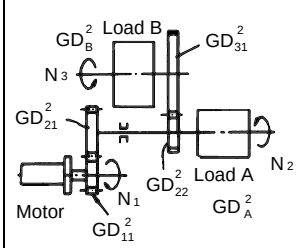
N : Speed [r/min]
GD² : Flywheel effect [kgf • m²]
t : Acceleration time [sec]

3. Formulae for Calculating Load GD^2

Typical GD^2 calculation formulae are indicated in Table Appendix-4.

Note: When load inertia J ($\text{kg} \cdot \text{cm}^2$) is used, the conversion formula between J and GD^2 is $GD^2 = 4J$.

Table Appendix-4 Calculation of Load GD^2

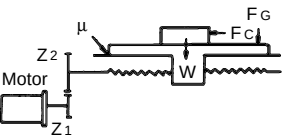
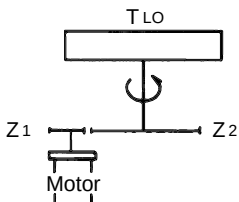
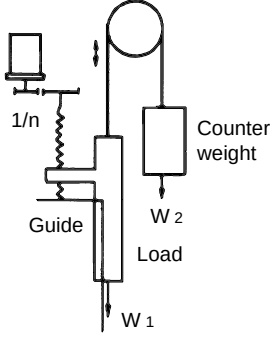
Type	Mechanism	Formula
Cylinder	Rotating axis is the center of a cylinder. 	$GD_L^2 = \frac{\pi \cdot \rho \cdot L}{8} (D_1^4 - D_2^4) \times 10^{-4} = \frac{W}{2} (D_1^2 + D_2^2) \times 10^{-4} \dots\dots\dots(3-1)$ GD_L^2 : Load GD^2 [kgf $\cdot$ m²] ρ : Specific gravity of cylinder material [kgf/cm³] L : Length of cylinder [cm] D_1 : OD of cylinder [cm] D_2 : ID of cylinder [cm] W : Weight of cylinder [kgf] Reference data : Specific gravities of materials Iron 7.8×10^3 [kgf $\cdot$ cm³] Aluminum..... 2.7×10^3 [kgf $\cdot$ cm³] Copper..... 8.96×10^3 [kgf $\cdot$ cm³]
	Misaligned rotating axis and cylinder axis 	$GD_L^2 = \frac{W}{2} (D^2 + 8R^2) \times 10^{-4} \dots\dots\dots(3-2)$ GD_L^2 : Load GD^2 [kgf $\cdot$ m²] D, R : As shown in the diagram [cm]
Square pillar		$GD_L^2 = 4W \left(\frac{a^2 + b^2}{3} + R^2 \right) \times 10^{-4} \dots\dots\dots(3-3)$ GD_L^2 : Load GD^2 [kgf $\cdot$ m²] a, b, R : As shown on the left [cm]
Object that moves linearly		$GD_L^2 = \left(\frac{V}{2\pi N} \right)^2 = 4W \cdot \left(\frac{\Delta S}{20\pi} \right)^2 \times 10^{-4} \dots\dots\dots(3-4)$ GD_L^2 : Load GD^2 converted into equivalent value at motor shaft [kgf $\cdot$ m²] V : Velocity of object that moves linearly [m/min] N : Motor speed [r/min] ΔS : Moving distance of linearly moving object per motor revolution [mm/rev] W : Weight of object that moves linearly [kgf]
Object hung		$GD_L^2 = W \cdot D^2 \times 10^{-4} + GD_P^2 \dots\dots\dots(3-5)$ W : Overall weight ($W_1 + W_2$) [kgf] GD_P^2 : GD^2 of pulley [kgf $\cdot$ cm²] D : Diameter of pulley [m]
Load varied in speed		$GD_L^2 = GD_{11}^2 + (GD_{21}^2 + GD_{22}^2 + GD_A^2) \cdot \left(\frac{N_2}{N_1} \right)^2 + (GD_{31}^2 + GD_B^2) \cdot \left(\frac{N_3}{N_1} \right)^2 \dots\dots\dots(3-6)$ GD_A^2, GD_B^2 : GD^2 of loads A, B [kgf $\cdot$ cm²] GD_{11}^2 to GD_{31}^2 : GD^2 of gears [kgf $\cdot$ cm²] N_1 to N_3 : Shaft speeds [r/min]

4. Formulae for Calculating Load Torque

Typical load torque calculation formulae are given in Tables Appendix-5 and -6.

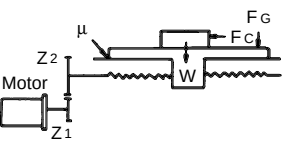
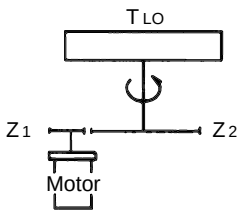
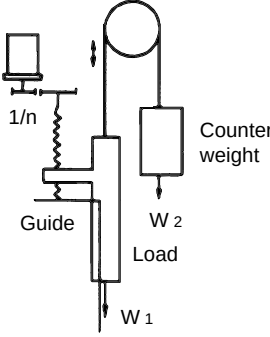
(1) Load torque calculation formulae [kgf • m]

Table Appendix-5 Load Torque Calculation Formulae [kgf • m]

Type	Mechanism	Formula
Linear motion		$T_L = \frac{F}{20 \pi \eta} \cdot \left(\frac{V}{N} \right) \times 10^{-2} = \frac{F \cdot \Delta S}{20 \pi \eta} \times 10^{-2} \text{ [kgf • m]} \dots\dots\dots(4-1)$ F : Axial force of machine which moves linearly [kgf] η : Drive system efficiency V : Moving velocity [mm/min] N : Motor speed [r/min] ΔS : Moving distance per motor revolution [mm/rev] When the table is moved, e.g. as shown on the left, F in the above formula can be found by the following formula (4-2): $F = F_c + \mu (W + F_g) \text{ [kgf • m]} \dots\dots\dots(4-2)$ F_c : Axially moving force of moving part [kgf] F_g : Tightening force of table guide surface [kgf] W : Overall weight of moving part [kgf] μ : Rotary motion
Rotary motion		$T_L = \frac{1}{n} \cdot \frac{1}{\eta} \cdot T_{LO} + T_F \text{ [kgf • m]} \dots\dots\dots(4-3)$ T_{LO} : Load torque on load axis [kgf • m] T_F : Friction load torque converted into equivalent value at motor shaft $\frac{1}{n}$: Reduction ratio $\left(\frac{Z_1}{Z_2} \right)$ η : Drive system efficiency
Vertical motion		Lifting $T_L = T_U + T_F \text{ [kgf • m]} \dots\dots\dots(4-4)$ Lowering $T_L = -T_U \cdot \eta^2 + T_F \text{ [kgf • m]} \dots\dots\dots(4-5)$ T_U : Unbalance torque [kgf • m] T_F : Friction torque of moving part [kgf • m] $T_U = \frac{(W_1 - W_2)}{20 \pi \eta} \cdot \left(\frac{V}{N} \right) = \frac{(W_1 - W_2) \cdot \Delta S}{20 \pi \eta} \times 10^{-2} \dots\dots\dots(4-6)$ $T_F = \frac{\mu \cdot (W_1 + W_2) \cdot \Delta S}{20 \pi \eta} \times 10^{-2} \dots\dots\dots(4-7)$ W₁ : Weight of load [kgf] W₂ : Weight of counterweight [kgf] η : Drive system efficiency μ : Friction coefficient

(2) Load torque calculation formulae [N • m]

Table Appendix-6 Load Torque Calculation Formulae [N • m]

Type	Mechanism	Formula
Linear motion		$T_L = \frac{F}{2 \times 10^3 \pi \eta} \cdot \left(\frac{V}{N} \right) = \frac{F \cdot \Delta S}{2 \times 10^3 \pi \eta} \text{ [N} \cdot \text{m]} \dots\dots\dots(4-8)$ F : Axial force of machine which moves linearly [N] η : Drive system efficiency V : Moving velocity [mm/min] N : Motor speed [r/min] ΔS : Moving distance per motor revolution [mm/rev] When the table is moved, e.g. as shown on the left, F in the above formula can be found by the following formula (4-9): $F = F_c + \mu (W \cdot g + F_G) \text{ [kg]} \dots\dots\dots(4-9)$ F_c : Axially moving force of moving part [N] F_G : Tightening force of table guide surface [N] W : Overall weight of moving part [kg] g : Friction coefficient [9.8m/s²] μ : Rotary motion
Rotary motion		$T_L = \frac{1}{n} \cdot \frac{1}{\eta} \cdot T_{LO} + T_F \text{ [N} \cdot \text{m]} \dots\dots\dots(4-10)$ T_{LO} : Load torque on load axis [N • m] T_F : Friction load torque converted into equivalent value at motor shaft [N • m] $\frac{1}{n}$: Reduction ratio $\left(\frac{Z_1}{Z_2} \right)$ η : Drive system efficiency
Vertical motion		Lifting $T_L = T_U + T_F \text{ [N} \cdot \text{m]} \dots\dots\dots(4-11)$ Lowering $T_L = -T_U \cdot \eta^2 + T_F \text{ [N} \cdot \text{m]} \dots\dots\dots(4-12)$ T_U : Unbalance torque [N • m] T_F : Friction torque of moving part [N • m] $T_U = \frac{(W_1 - W_2) \cdot g}{2 \times 10^3 \pi \mu} \cdot \left(\frac{V}{N} \right) = \frac{(W_1 - W_2) \cdot g \cdot \Delta S}{2 \times 10^3 \pi \mu} \dots\dots\dots(4-13)$ $T_F = \frac{\mu \cdot (W_1 + W_2) \cdot g \cdot \Delta S}{2 \times 10^3 \pi \eta} \dots\dots\dots(4-14)$ W₁ : Weight of load [kg] W₂ : Weight of counterweight [kg] η : Drive system efficiency μ : Friction coefficient