NOTE: BRD-EZ2-110K is replaced by BRD-EZ3-110K

HITACHI DYNAMIC BRAKING UNIT (BRD SERIES)

200V Class (BRD-E2-30K/55K)
400V Class (BRD-EZ2-30K/55K/110K)

OPERATION MANUAL

CONTENTS

Read and Save this Instruction Manual.

NB4882CX

HITACHI

IMPORTANT NOTICES

Keep this manual handy for quick reference.
Read this manual carefully before installing, operating or maintaining the dynamic braking unit. Familiarize yourself with the device specifications, safety precautions, and handling and operating procedures and use this device correctly.
For maximum efficiency and safety, use this device at the specified operating rates for which it is designed. Inspect and maintain this device at specified regular intervals to insure safe and maximum performance and to prevent malfunction.

LIMITED WARRANTY

Your product is warranted against defective material or workmanship for a period of one year from the date of installation. Hitachi will repair or replace this device free of charge if any defective parts or workmanship covered within the limitations of this warranty are found.

The following are not covered by this warranty and will be charged accordingly:

(1) Abnormal handling or use of this device
(2) Failure caused by reasons unrelated to this device
(3) Improper servicing, alteration or modification by any unauthorized personnel
(4) Malfunction and failure caused by natural disasters such as fire and earthquakes

The obligation of the warrantor is solely to repair or replace the device. The warrantor is not liable for any incidental or consequential damages caused by any defects of this device.
(This warranty is valid only in Japan.)

REPAIR COST

Repairs for normal wear, accidental damage or inspection of this device outside the warranty period (one-year) will be at the owners' expense. Repairs not described in the above warranty are possible. For more information on repair cost and inspections, call your local Hitachi distributor or service center.

ORDERING REPLACEMENT PARTS AND INQUIRY

In the case of device failure, please report the following to your local Hitachi distributor or service center:

(1) Model number
(2) Date of purchase
(3) Manufacturing number (MFG. No.)
(4) Details of the malfunction

It is recommended you install a back-up device so that your work is not disrupted.

MISCELLANEOUS

- This manual is subject to change without prior notice.
- This manual is included with the device. There is no other manual. Keep this manual handy.
- Reproduction or use of any portion of this manual, without express written permission from Hitachi is prohibited.
- Every effort has been made to supply complete and accurate information. However, errors and inaccurate information may exist. Please inform us of these errors. Your comments are always welcome.
- Hitachi assumes no responsibility for any results caused by the use of this manual

History revisions

No.	Description	Date of revision	Manual No.
1	Two manuals have been combined and the contents reviewed.	'98-4-25	NB4882C

Misspellings, missing characters, ambiguous descriptions, and similar errors are corrected without notice.

SAFETY PRECAUTIONS

Carefully read this manual and other precautionary documents that came with the dynamic braking unit before installing, operating or maintaining this unit. Familiarize yourself with the device specifications, safety precautions, and handling and operating procedures and use this device correctly.
This manual uses two symbols, the first informs of malfunctions and the second indicates danger of personal injury or property damage.

Title: Creat **DANGER**	: This safety reminder indicates potentially life-threatening situations. If these instructions are not followed serious injury and in extreme cases, death could occur.
Title: Creat **CAUTION**	: This safety reminder indicates potential danger to body and property. If these instructions are not followed minor or serious injury and/or property damage could occur.

Be sure to follow these instructions carefully when you see these symbols.
Also read and follow the instructions for all "Notes" and "Remarks."

1. Installation

Title: Creat CAUTION

- Mount the dynamic braking unit on a fireproof wall (e.g. metallic wall) or a fire may occur.
(See page 2.)
- Keep the dynamic braking unit away from combustible or flammable materials or a fire may occur.
(See page 2.)
- Never hold the dynamic braking unit by the front cover when carrying it. It could fall and an injury could occur.
(See page 2.)
- Never allow any wires, dust, welding spatters, iron filings, or other materials to get into the unit or a fire may occur.
(See page 2.)
- The dynamic braking unit is very heavy. Install the unit on a solid rigid wall strong enough to support it. Otherwise, it could fall and an injury may occur.
(See page 2.)
- Do not use any inverter that is partially damaged or incomplete or an injury may occur.
(See page 2.)
- Avoid any dangerous environment
Do not place the dynamic braking unit in hot, damp, or wet locations. Don't use the dynamic braking unit in the presence of dust, corrosive gases, explosive gases, flammable gases, oil mist, or salt. Keep the dynamic braking unit out of direct sunlight.
(See page 2.)

2. Wiring

DANGER

- Always connect the grounding wire to the dynamic braking unit to prevent electric shock or fire.
  (See page 3.)
- All wiring should be done by a qualified electrician or electric shock or fire may occur.
  (See page 3.)
- Before wiring, make sure the supply power is off (or the P-N voltage is 45 V or less) to prevent electric shock or fire.
  (See page 3.)
- Always install the dynamic braking unit on the wall before wiring to prevent electric shock and personal injury.
  (See page 3.)
- Be sure to provide a thermal relay and a circuit, which shuts off primary power to the inverter. This is to prevent burning-out the external resistor due to overheating if the dynamic braking unit malfunctions.
  (See page 3.)

  For actual connections, see 4.3 and 4.4.
  (See page 3.)

CAUTION

- Make sure the voltage rating of the dynamic braking unit is equal to that of the inverter to prevent fire and personal injury.
  (See page 3.)
- Do not connect resistors directly to the D.C. terminals (P and N) or fire may occur.
  (See page 3.)
- Tighten screws at their correct specified torque (see table on right). Make sure every screw is firmly tightened or fire may occur.
  (See page 3.)
- The power cables should be MLFC flame-retardant poly-flex wire, allowing a voltage of 600 V and capable of the specified amperage or fire may occur.
  (See page 3.)

3. Control and operation

DANGER

- Be sure the front cover on the dynamic braking unit is attached before turning on the power. Never remove the cover of the dynamic braking unit or you may receive an electric shock

(See page 11.)

- Do not operate with wet hands or you may receive an electric shock.

(See page 3.)

- Never touch any terminal of the dynamic braking unit while the unit power is on (even when the unit has stopped) or you may receive an electric shock.

(See page 3.)

- Never touch any part or put anything in the dynamic braking unit while the unit's power is on or you may receive an electric shock or cause a fire.

(See page 3.)

CAUTION

- The heat radiating fins and the discharging resistors during use are hot and can cause burns. Do not touch.

(See page 3.)

4. Maintenance, inspection and part replacement

DANGER

- Be sure to turn off the supply power. (Make sure that the DC voltage between terminals P and N is 45 volts or less.) Otherwise, you may receive a serious electric shock.

(See page 24.)

- Only an authorized electrician is allowed to check, maintain, and replace parts of the dynamic braking unit.
  (Take off all metallic accessories such as watches and jewelry before operating.)
  (Use the insulated tools.)
  Otherwise, you may receive a serious electric shock or personal injury.

(See page 24.)

5. Appendix

DANGER

- Never alter or modify the dynamic braking unit.
  Improper servicing may cause serious electric shock and/or personal injury.

(See page 1.)

GENERAL NOTICES

For simplicity, some figures and illustrations in this manual are shown without the cover or peripheral parts of the device. Be sure to remount the cover and other safety features before running the dynamic braking unit.

1. UNPACKING INSPECTION

Handle the product with care when unpacking. Do not use any excessive force (impacts, vibration, etc.) on the package. Check the following:

(1) Package damage occurring during delivery
(2) Model name, voltage, etc. (order confirmation)
(3) List of accessories (including operation manual)

2. IMPORTANT NOTICES

Note the following to improve and perform safe operation of the dynamic braking unit:

DANGER
● Never alter or modify the dynamic braking unit. Improper servicing may cause serious electric shock and/or personal injury.

Note: Do not use the BRD-E2/E2Z braking unit in combination with earlier versions, (e.g. BRD-VZ or BRD-C1). The operating voltages and terminal configurations are different and may cause the dynamic braking units to malfunction.

Note: Set the DIP switches and connect the wires correctly when setting or changing the operating voltage or when running devices in a parallel connection. Be sure to turn off power to the dynamic braking unit before setting the DIP switches and the connecting wires. (For more information, see "4. Wiring and Function Setting.")

Note: Check wirings and connections carefully. If they are correct you can turn on the power to the inverter.

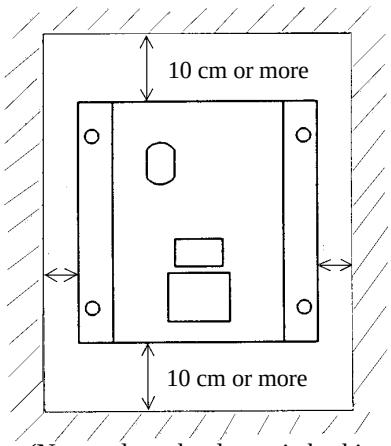
3. INSTALLATION

CAUTION

- Mount the dynamic braking unit on a fireproof wall (e.g. metallic wall) or a fire may occur.
- Keep the dynamic braking unit away from combustible or flammable materials or a fire may occur.
- Never hold the dynamic braking unit by the front cover when carrying it. It could fall and an injury could occur.
- Never allow any wires, dust, welding spatters, iron filings, or other materials to get into the unit or a fire may occur.
- The dynamic braking unit is very heavy. Install the unit on a solid rigid wall strong enough to support it. Otherwise, it could fall and an injury may occur.
- Do not use any inverter that is partially damaged or incomplete or an injury may occur.
- Avoid any dangerous environment
  Do not place the dynamic braking unit in hot, damp, or wet locations. Don't use the braking unit in the presence of dust, corrosive gases, explosive gases, flammable gases, oil mist, or salt. Keep the braking unit out of direct sunlight.

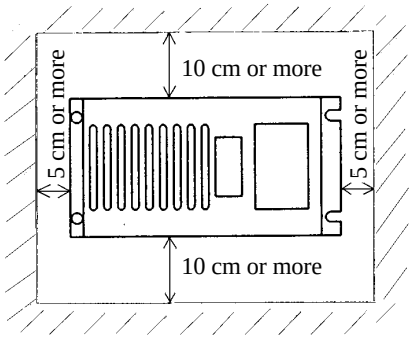
To insure ventilation, mount the dynamic braking unit on the wall with at least 10 cm clearance above and below the unit and at least 5 cm clearance on the left and right sides of the unit as shown in Figure 3.1, Figure 3.2 (a), and Figure 3.2 (b).
Do not place the dynamic braking unit with its ventilation openings facing left and right (horizontally).

Required clearance surrounding the dynamic braking unit

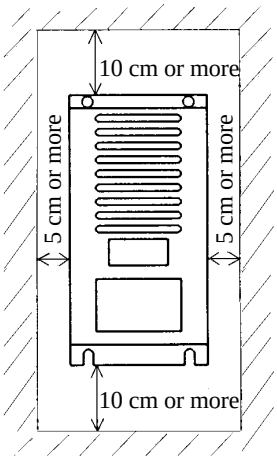


(Never place the dynamic braking unit with its ventilation openings facing left and right.)

Figure 3.1 Clearance around dynamic braking units E2-30K/55K and EZ2-55K/110K



(a) Horizontal installation



(b) Vertical installation

Figure 3.2 Clearance around dynamic braking units EZ2-30K

4. WIRING AND FUNCTION SETTING

4.1 Wiring Notices

DANGER

- Always connect the grounding wire to the dynamic braking unit to prevent electric shock or fire.
- All wiring should be done by a qualified electrician or electric shock or fire may occur.
- Before wiring, make sure the supply power is off (or the P-N voltage is 45 V or less) to prevent electric shock or fire.
- Always install the dynamic braking unit on the wall before wiring to prevent electric shock and personal injury.
- Be sure to provide a thermal relay and a circuit, which shuts off primary power to the inverter. This is to prevent burning-out the external single resistor due to overheating if the dynamic braking unit malfunctions.

  For actual connections, see 4.3 and 4.4.

CAUTION

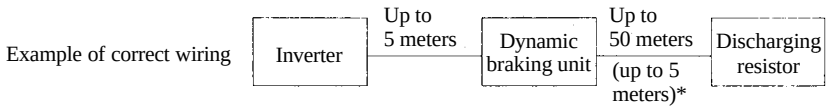
- Make sure the voltage rating of the dynamic braking unit is equal to that of the inverter to prevent fire and personal injury.
- Do not connect resistors directly to the D.C. terminals (P and N) or fire may occur.
- Tighten screws at their correct specified torque (see table on right). Make sure every screw is firmly tightened or fire may occur.
- The power cables should be MLFC flame-retardant poly-flex wire, allowing a voltage of 600 V and capable of the specified amperage or fire may occur.

Screw size	Tightening torque (N·m)
M3	0.6 to 0.9
M5	2.8 to 3.9
M8	10 to 13.5
M10	21 to 28

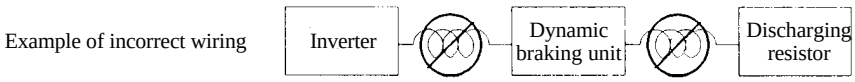
Notes:

1. Be sure to provide alarm contacts (AL1 and AL2) and a circuit, which shuts off primary power to the inverter to prevent overheating and burning if the dynamic braking unit malfunctions.

2. Use cables at their specified ratings as short as possible: up to 5 meters between the dynamic braking unit and the inverter (P, N) and up to 50 meters between the dynamic braking unit and the discharging resistor (P, RB) (or up to 5 meters for the EZ2-30K). Also make the wire connections as short as possible. Do not loop extra cable.

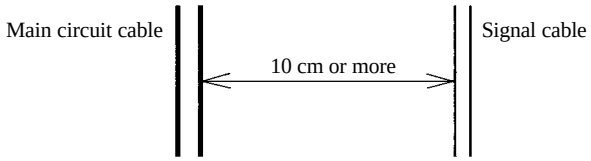


* In the EZ2-30K system, the cable between the dynamic braking unit and the discharging resistor must be 5 meters or shorter.



The cables must be tied together and supported firmly so there is no excessive load on the dynamic braking unit.

3. When the parallel connection interlocking function is used, signal cables (MA1, MA2, SL1, and SL2) between the dynamic braking units must be no more than five meters in length and no more than 0.75 mm2 in width in its section area. The signal cable must be fully separated from the main circuit cable.



4. When a combination of various resistors are used, the inductance in the resistors may raise the surge voltage during the switching operation. To prevent this, use larger cables or twist them.
   Always use up to six non-induction resistors as external resistors.
5. Use insulated crimping terminals to connect the cables to the terminal board TM1 (or TM2 of the EZ2).
6. Use closed-loop terminals with insulated caps to connect cables to the terminal board TM2 (or TM3 of the EZ2).

4.2 Functional Setting

You can select "Main unit," "Sub-unit," and an operating voltage level with the DIP switch.

Note: Be sure to turn off the dynamic braking unit when setting the DIP switch.

(1) Operating Voltage Set/Change function

The dynamic braking unit supports three operating voltage levels: Standard (factory-set), -5%, and -10%. You can select an operating voltage level by setting the DIP switch. When an overvoltage trip occurs at a certain voltage or deceleration time, this function reduces the operating voltage of the dynamic braking unit to prevent an overvoltage trip. However, at a high input voltage, only the power will be turned on braking unit. Determine the operating voltage level according to the receiving voltage.

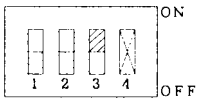
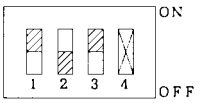
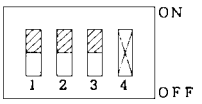
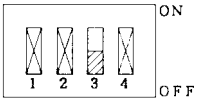
$$\text{Receiving voltage} \times 2^{a} + 20\ \text{V} < \text{Operating voltage}$$

(2) Parallel connection-interlocking function

You can run two parallel-connected dynamic braking units interlocked by connection of their signal wires (MA1, MA2, SL1,and SL2) and setting of the DIP switches. You can use one of the dynamic braking units as a sub-unit and allow it to work at the operating voltage level of the main unit by setting the dynamic braking unit as a sub-unit by the DIP switch.

Table 4.1 shows settings of the DIP switch.

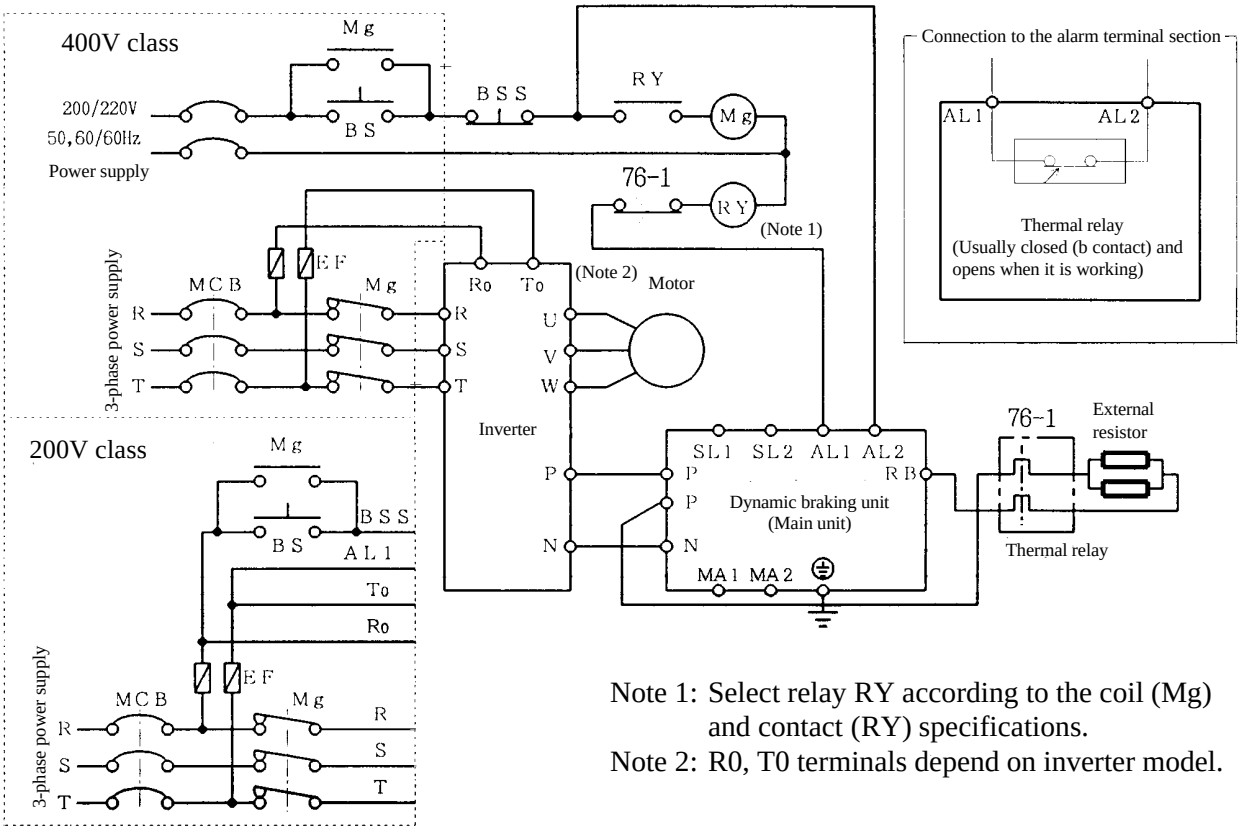
Table 4.1 DIP switch setting

	Function and operating voltage	DIP switch setting (X: Any position)	Remarks
1	Main unit Operating voltage: Standard 363V (725V)	OFF, OFF, ON, X 	Factory-set
2	Main unit Operating voltage: -5% 345V (689V)	ON, OFF, ON,X 	
3	Main unit Operating voltage: -10% 326V (653V)	ON, ON, ON, X 	
4	Sub-unit	X, X, OFF, X 	The operating voltage correspond to a main unit.

The value in parentheses indicates the operating voltage of the 400V-class dynamic braking unit.

4.3 Example of External Connection

Figure 4.1 shows an example of a connection of a motor control system containing only one dynamic braking unit.
Always use discharging resistors equal to or more than the resistance specified. If the resistance is insufficient, the dynamic braking unit may be damaged.
To prevent overheating and burning during any malfunction of the dynamic braking unit, devise a circuit to shut off the primary power of the inverter by connecting this circuit to the alarm contact terminals (AL1 and AL2).
Figure 4.2 shows the connection of a thermal relay and Table 4.2 shows a list of applicable wires.



Note 1: Select relay RY according to the coil (Mg) and contact (RY) specifications.
Note 2: R0, T0 terminals depend on inverter model.

Figure 4.1 External connection example

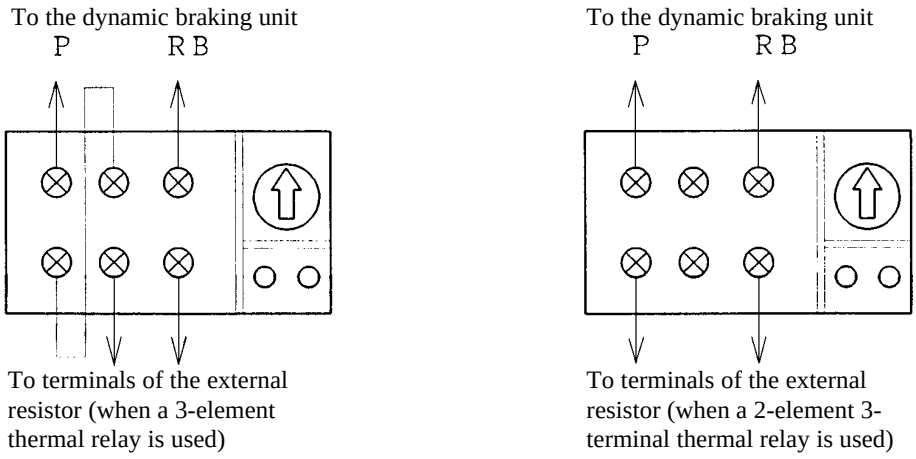
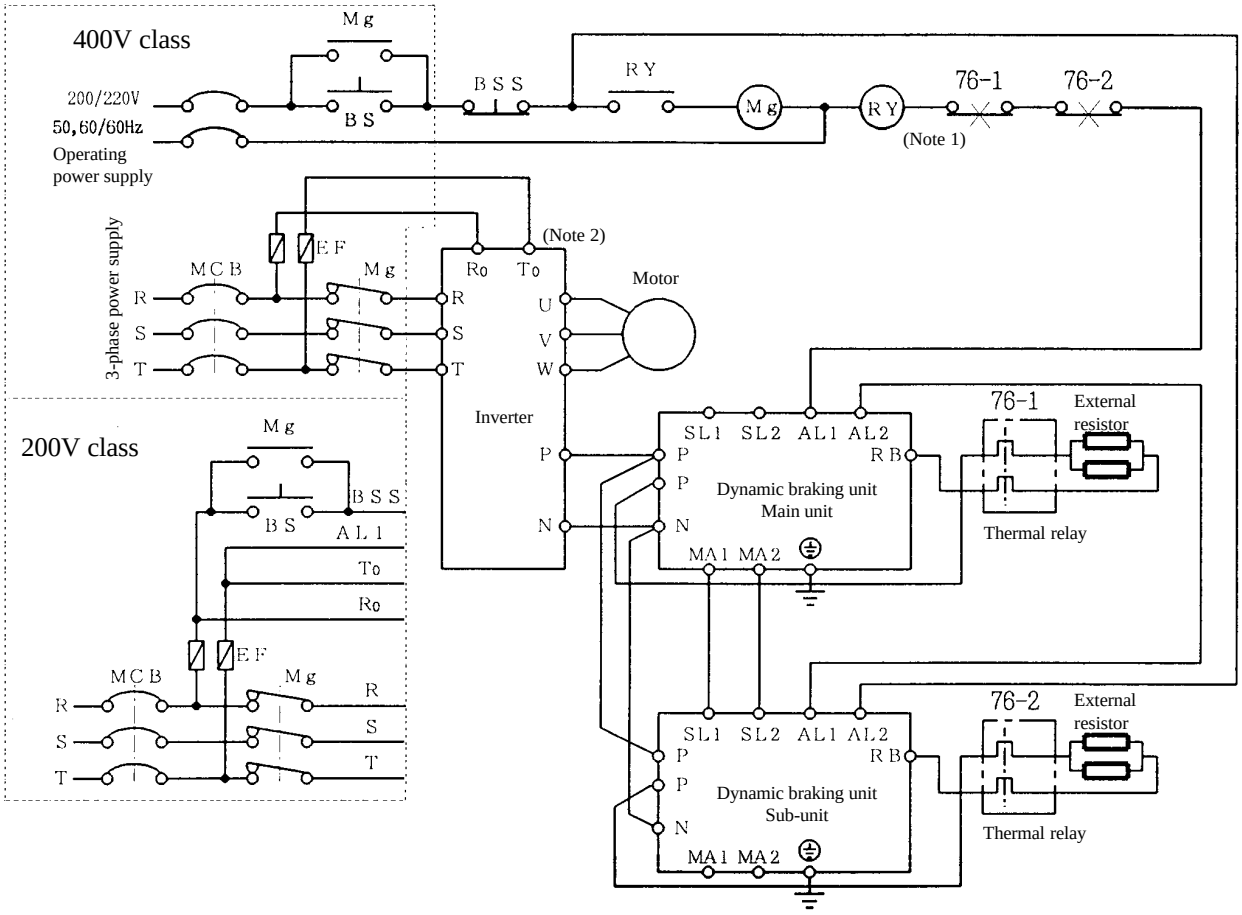


Figure 4.2 Connection of a Thermal Relay

4.4 Example of External Connection (Parallel Connection Operation)

Figure 4.3 shows a connection example of a motor control system, which uses the parallel connection interlocking function.
In this case, both the main unit and the sub-unit must use external resistors of the same resistance.
To prevent overheating and burning if the dynamic braking unit malfunctions, provide a thermal relay to shut off the primary power of the inverter when the thermal relay is operating.
Figure 4.3 shows the connection of a thermal relay and Table 4.3 shows a list of applicable wires.



Note 1: Select relay RY according to the coil (Mg) specifications and the contact (RY) specifications.
Note 2: R0, T0 terminals depend on inverter model.

Figure 4.3 External connection example for the parallel connection operation

Table 4.2 Applicable wires

Model		Connection resistance	Wire for P, RB, and N connections (Note1)	SL1, SL2, MA1, MA2	Grounding wire
200V class	E2-30K	8Ω or more	5.5mm^2 or more	0.75mm^2 or more	5.5mm^2 or more
		5Ω to 7.9Ω	8mm^2 or more		
		4Ω to 4.9Ω	14mm^2 or more		
	E2-55K	4Ω or more	14mm^2 or more		
		3Ω to 3.9Ω	22mm^2 or more		
		2Ω to 2.9Ω	38mm^2 or more		
400V class	EZ2-30K	17Ω or more	3.5mm^2 or more		
		13Ω to 16.9Ω	5.5mm^2 or more		
		10Ω to 12.9Ω	8mm^2 or more		
	EZ2-55K	10Ω or more	8mm^2 or more		
		7.5Ω to 9.9Ω	14mm^2 or more		
		6Ω to 7.4Ω	22mm^2 or more		
	EZ2-110K	6Ω or more	22mm^2 or more		
		4Ω to 5.9Ω	38mm^2 or more		
		3Ω to 3.9Ω	60mm^2 or more		

Note 1:

The wire for P, RB, and N connections should be MLFC wire (flame-retardant poly-flex wire, able to withstand voltage of 600 V).

If the distance between the dynamic braking unit and a discharging resistor is 10 meters or more, use a cable thicker than the specified wire size. Table 4.2 shows sizes of MLFC wire.

-1) If the distance is between 10 m (not including 10 m) and 25 m, use a wire size one rank larger.

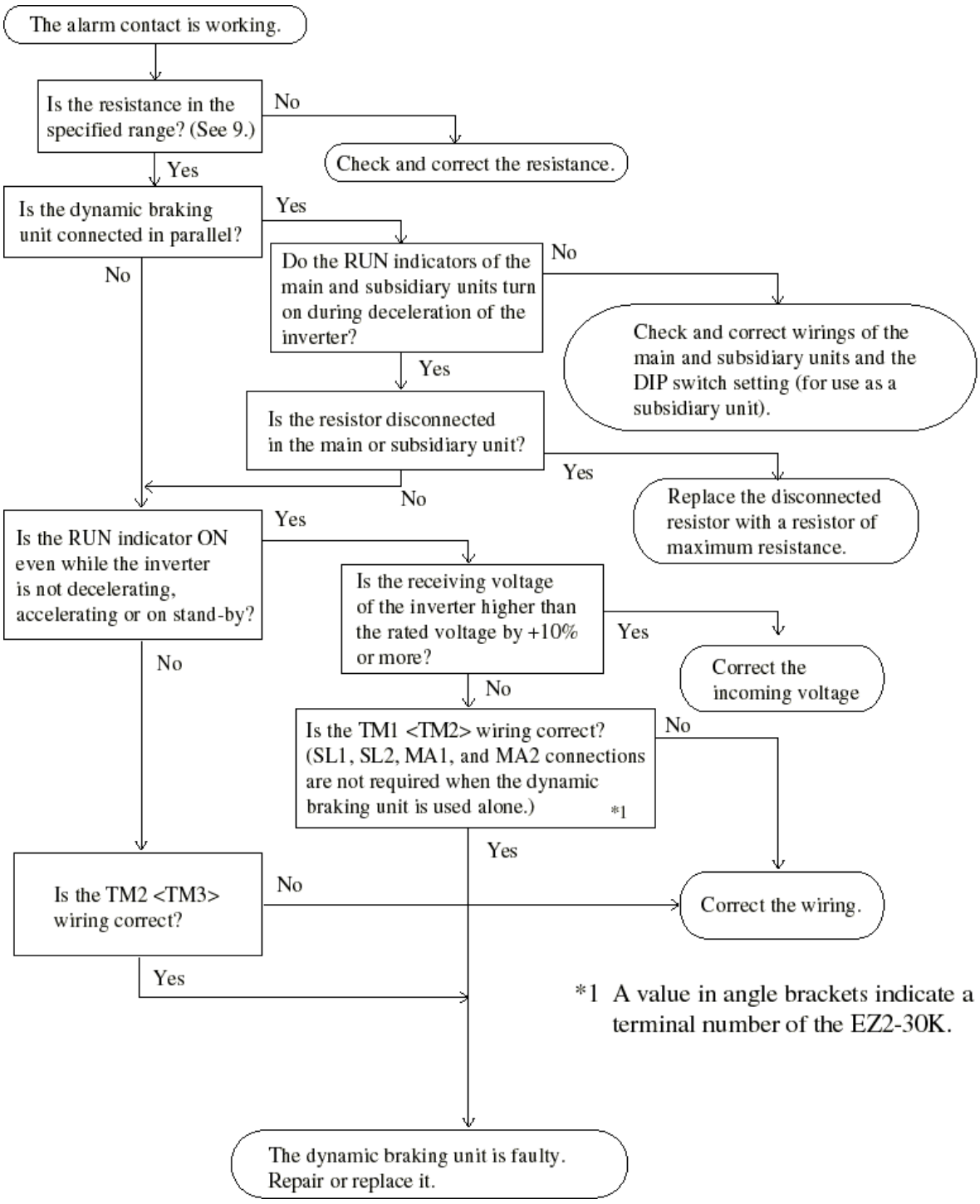
-2) If the distance is between 25 m (not including 25 m) and 50 m, use a wire size two ranks larger.

However, the cable should be up to 5 m between the braking unit and the discharging resistor.

5. TROUBLESHOOTING

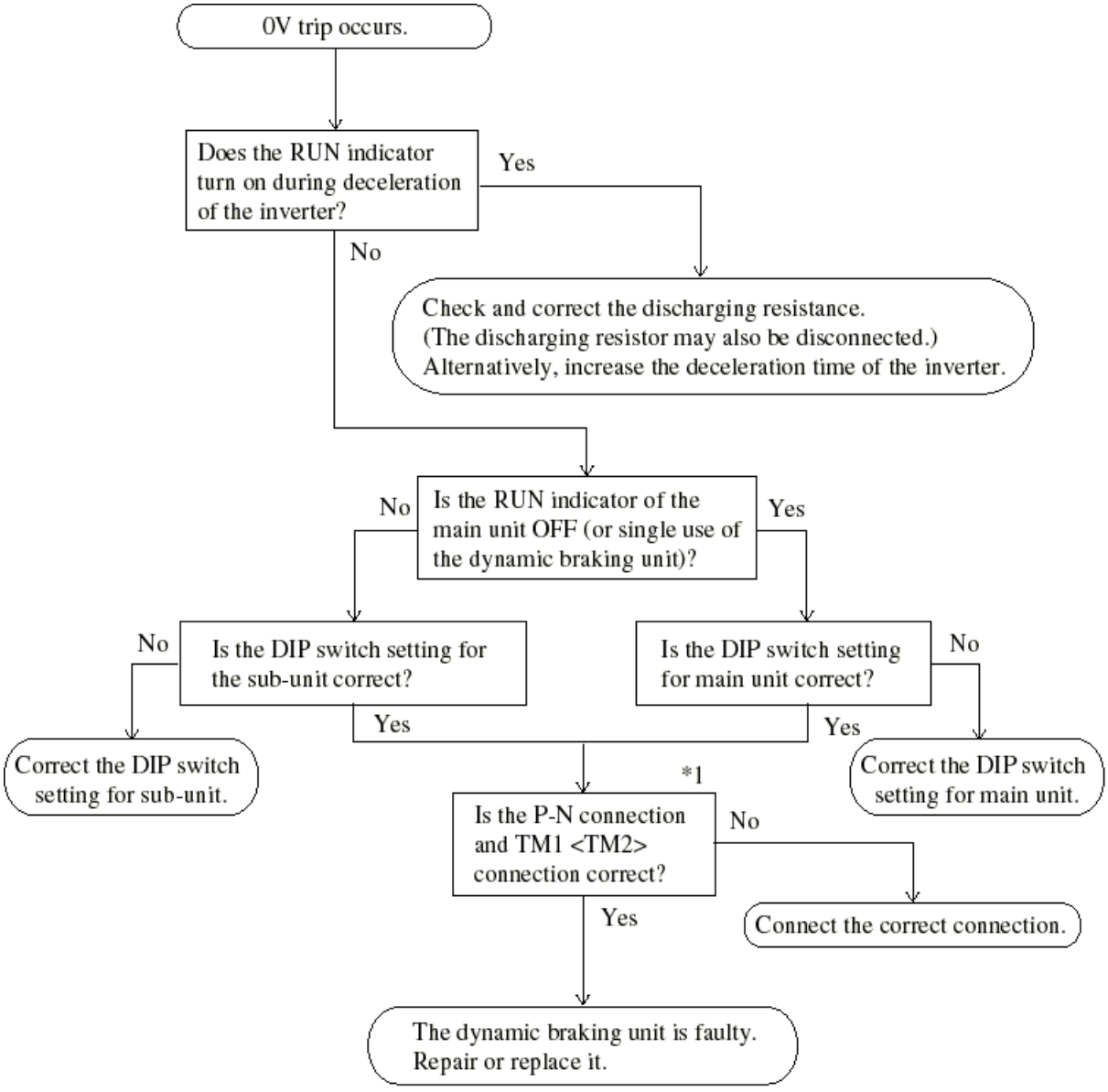
5.1 Alarm contact is activated and the inverter stops

This event may be caused by a large amount of regeneration energy or a frequently breaking that result in the overheating of the discharging resistor. To prevent this event, check and correct resistances of the discharging resistors, the number of dynamic braking units in use, and the deceleration time. This event also occurs when incorrect connections are made or when the voltage is inappropriate. Follow the instructions below to check and repair.



5.2 When the inverter is tripped by overvoltage during inverter deceleration

This event may be caused by too much regeneration energy, which is unable to handle the increase in voltage.
To prevent this problem, check and correct the resistances of the discharging resistors, the number of dynamic braking units in use, and the deceleration time. This problem occurs also when the discharging resistor is disconnected, when wrong connections are made or when the DIP switch setting is improper. Follow the instructions below to inspect and repair.



*1 A value in angle brackets indicate a terminal number of the EZ2-30K.

6. PRE-START CHECKS

Follow the safety instructions below before operating this device.

DANGER

- Be sure the front cover on the dynamic braking unit is attached before turning on the power. Never remove the cover of the braking unit or you may receive an electric shock.
- Do not operate with wet hands or you may receive an electric shock.
- Never touch any terminal of the dynamic braking unit while the braking unit power is on (even when the braking unit has stopped) or you may receive an electric shock.
- Never touch any part or put anything in the dynamic braking unit while the braking unit's power is on or you may receive an electric shock or cause a fire.

CAUTION

- The heat radiating fins and the discharging resistors during use are hot and can cause burns. Do not touch.

Notes:

(1) Check the wiring and connections.

Wrong wiring or incorrect connection may cause the dynamic braking unit to malfunction or cause damage.

(2) Check whether a non-grounding terminal has been used.

Grounding of a non-grounding terminal may cause the dynamic braking unit to malfunction.

(3) Check whether there is any foreign material (wire, dust, crimping terminal, tool etc.) in the dynamic braking unit.

Foreign materials in the dynamic braking unit may short-circuit the unit causing a malfunction or damage.

(4) Check for short-circuiting and inspect the ground fault or the dynamic braking unit may malfunction or cause damage.

7. SPECIFICATIONS

7.1 Standard Specifications

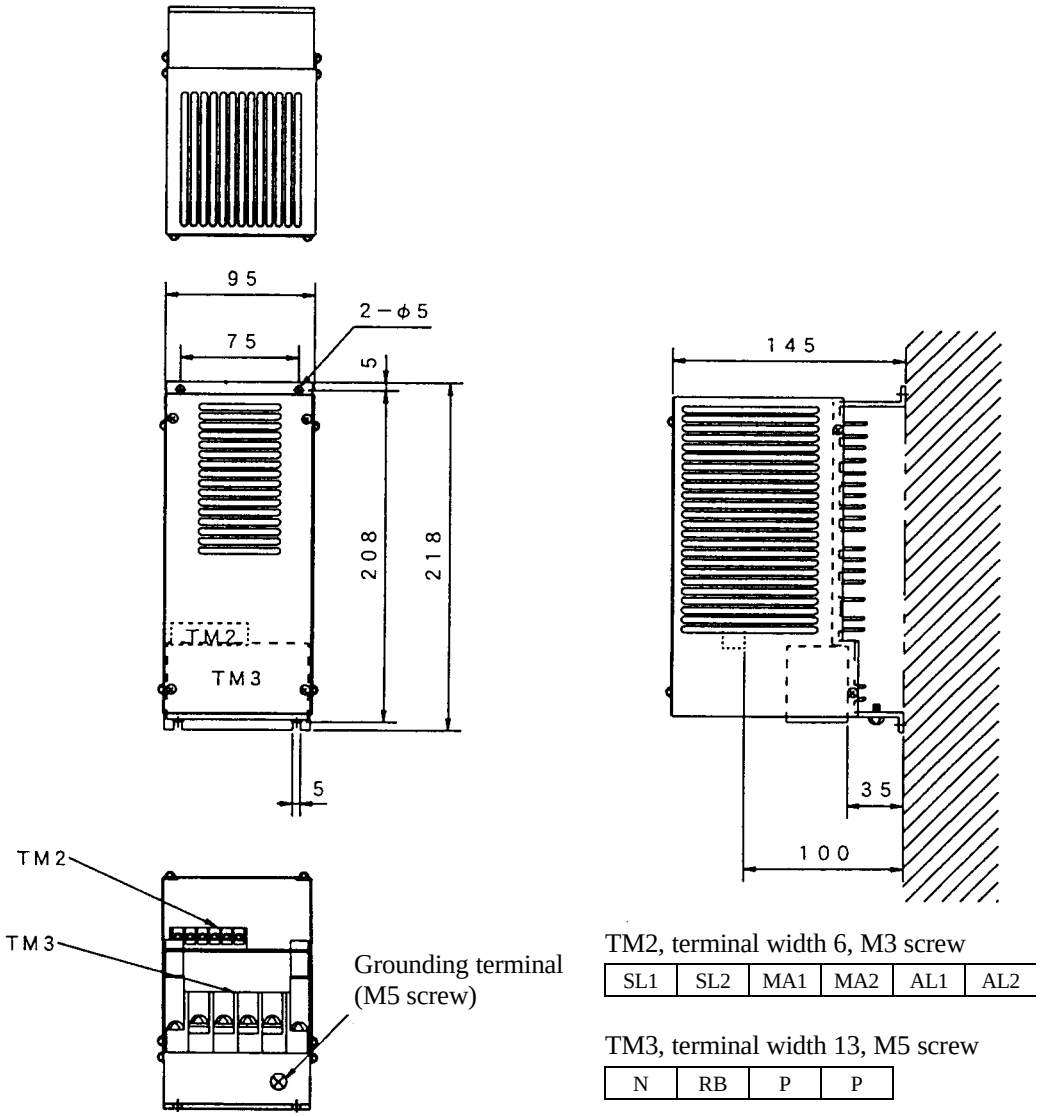
Table 7.1 shows the standard specifications of the dynamic braking unit. However, user's specifications (if any) should be used preferentially.

Table 7.1 Standard Specifications

Model		E2-30K	E2-55K	EZ2-30K	EZ2-55K	EZ2-110K
Enclosure		Open type				
Voltage class applicable		200V-class		400V-class		
Operating voltage (ON/OFF)		362.5±5V/355±5V[*1]		725±5V/710±5V[*1]		
Service status indication		LED ON				
Discharging resistance I		4 ohms or more	2 ohms or more	10 ohms or more	6 ohms or more	3 ohms or more
Allowable operation cycle		1/5[*2]		1/10[*3]	1/5[*2]	
Continuous ON time		2 minutes maximum		10 seconds maximum	2 minutes maximum	
Discharging resistance II		6 ohms or more	4 ohms or more	24 ohms or more	12 ohms or more	6 ohms or more
Allowable operation cycle		Continuous				
Protective function		Protection of power modules against overheating Thermal relay for protection Operates at a cooling fin temperature of 100 °C. Usually closed (b contact) Contact rating: 240 VAC, 3A (R load), 0.2A (L load) 36 VDC, 2A (R load) Minimum load: 15 VDC, 50 mA (R load)				
General specifications	Ambient temperature	–10 to 50°C				
	Storage temperature	–10 to 60°C				
	Relative humidity	20 to 90% (Non-condensing)				
	Vibration [*5]	4.9m/s^2 (0.5G) 10 to 55Hz		2.0m/s^2 (0.2G) 10 to 55Hz	4.9m/s^2 (0.5G) 10 to 55Hz	
	Installation site	Up to 1000 meters above sea level, indoor (free from corrosive gases and dust)				
	Coating color	Munsell color system 5Y7/1 (The aluminum-cooling fin is not coated.)				
Others		Equipped with a parallel connection interlocking function (for main or subsidiary unit)[*4]				

*1 Operating voltage set/change: -5% and -10% (set by the DIP switch)
*2 Allowable operation cycle: 2 minutes ON and 8 minutes OFF
*3 Allowable operation cycle: 10 seconds ON and 90 seconds OFF
*4 Parallel connection operation: set by the DIP switch
*5 Conforms to the JIS C0911 (1984) test methods

Model	Type		Operating voltage	Weight (kg)
	TYPE	FORM		
BRD-EZ2-30K	HP	DM	725±5	2



TM2, terminal width 6, M3 screw

SL1	SL2	MA1	MA2	AL1	AL2

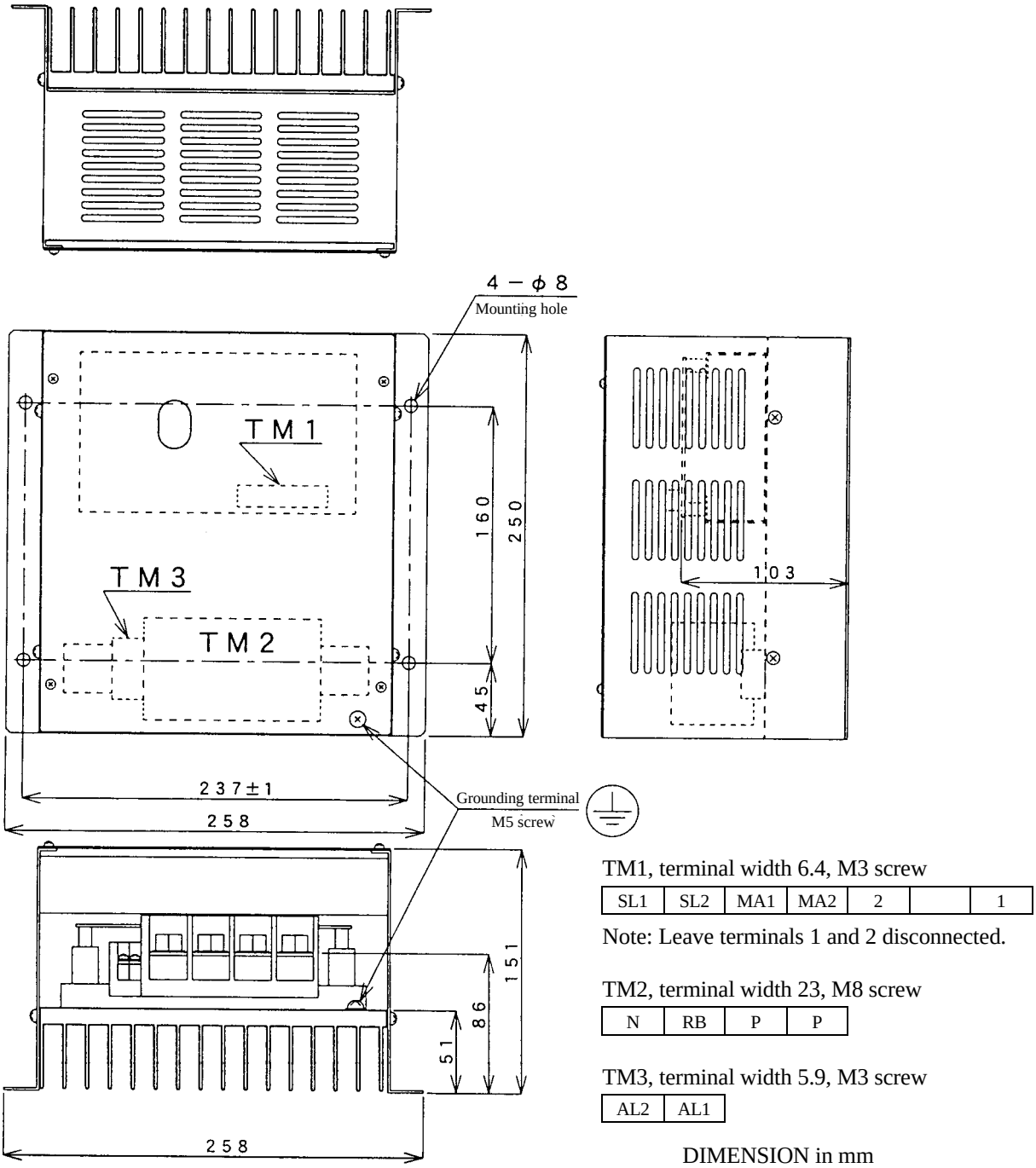
TM3, terminal width 13, M5 screw

N	RB	P	P

DIMENSION in mm

Figure 7.1 Dimensions

Model	Type		Operating voltage	Weight (kg)
	TYPE	FORM		
BRD-E2-30K	HP	DM	362.5±5	6
BRD-EZ2-55K	HP	DM	725±5	6



TM1, terminal width 6.4, M3 screw

SL1	SL2	MA1	MA2	2		1

Note: Leave terminals 1 and 2 disconnected.

TM2, terminal width 23, M8 screw

N	RB	P	P

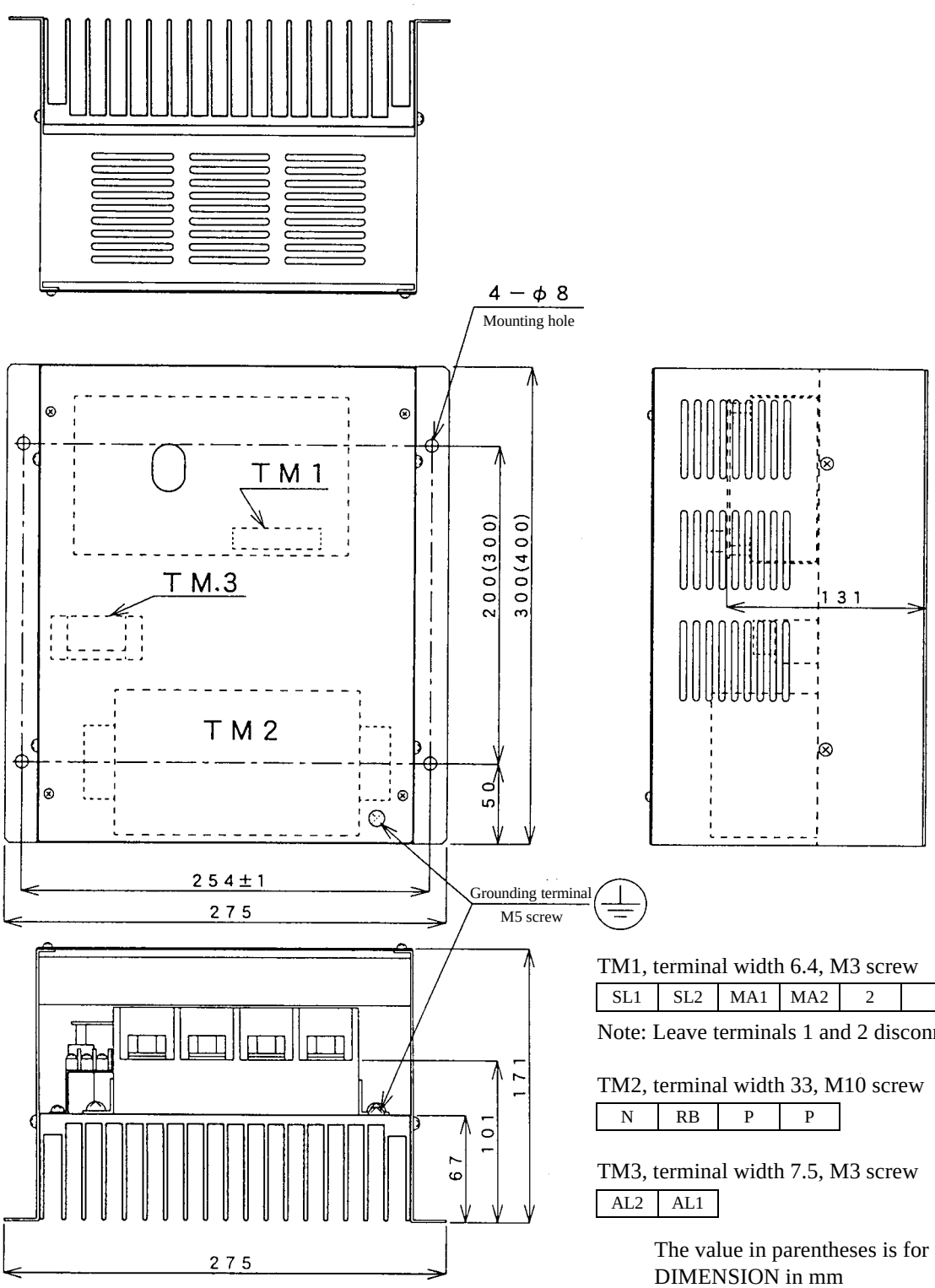
TM3, terminal width 5.9, M3 screw

AL2	AL1

DIMENSION in mm

Figure 7.2 Dimensions

Model	Type		Operating voltage (V)	Weight (kg)
	TYPE	FORM		
BRD-E2-55K	HP	DM	362.5±5	8
BRD-EZ2-110K	HP	DM	725±5	10



TM1, terminal width 6.4, M3 screw

SL1	SL2	MA1	MA2	2		1

Note: Leave terminals 1 and 2 disconnected.

TM2, terminal width 33, M10 screw

N	RB	P	P

TM3, terminal width 7.5, M3 screw

AL2	AL1

The value in parentheses is for EZ2-110K.
DIMENSION in mm

Figure 7.3 Dimensions

8. INTERNAL CIRCUITS

Internal circuits of the dynamic braking units E2-30K/55K, EZ2-30K, and EZ2-55K/110K are shown respectively in Figures 8.1 to 8.3. See 4.3 and 4.4 on how to connect the terminals.

1. Terminals of the E2-30K/55K and EZ2-55K/110K
   (1) TM1
   MA1, MA2, SL1, and SL2: Control signals for parallel interlocking connection

   (2) TM2
   P: DC voltage (+)
   P, RB: Resistance
   N: DC voltage (-)

   (3) TM3
   AL1, AL2: Alarm contacts

2. Terminals of the EZ2-30K
   (1) TM2
   MA1, MA2, SL1, and SL2: Control signals for parallel interlocking connection
   AL1, AL2: Alarm contacts

   (2) TM3
   P: DC voltage (+)
   P, RB: Resistance
   N: DC voltage (-)

For actual terminal layouts and screw sizes, see Figures 7.1 to 7.3.

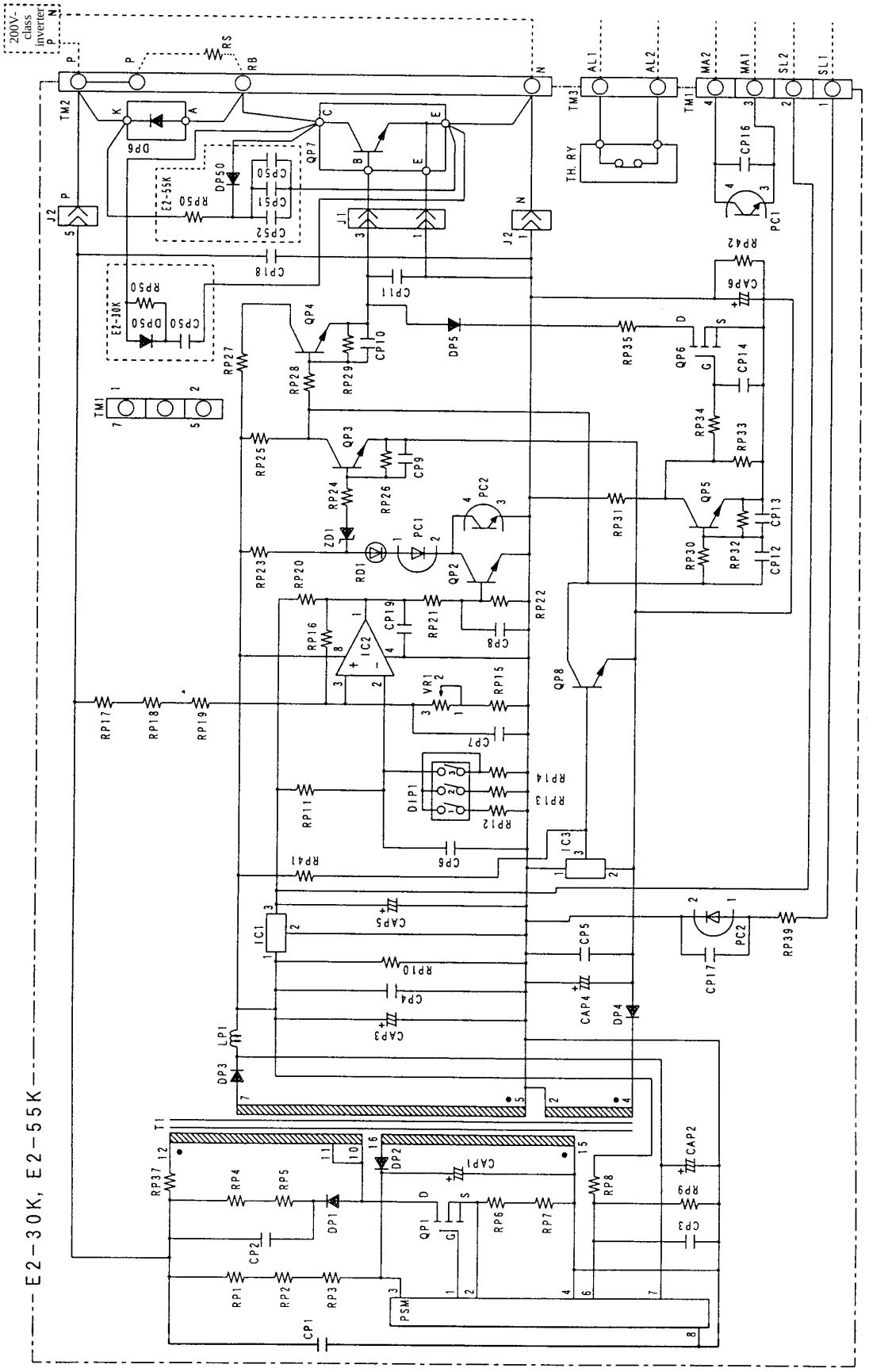


Figure 8.1 Internal circuit

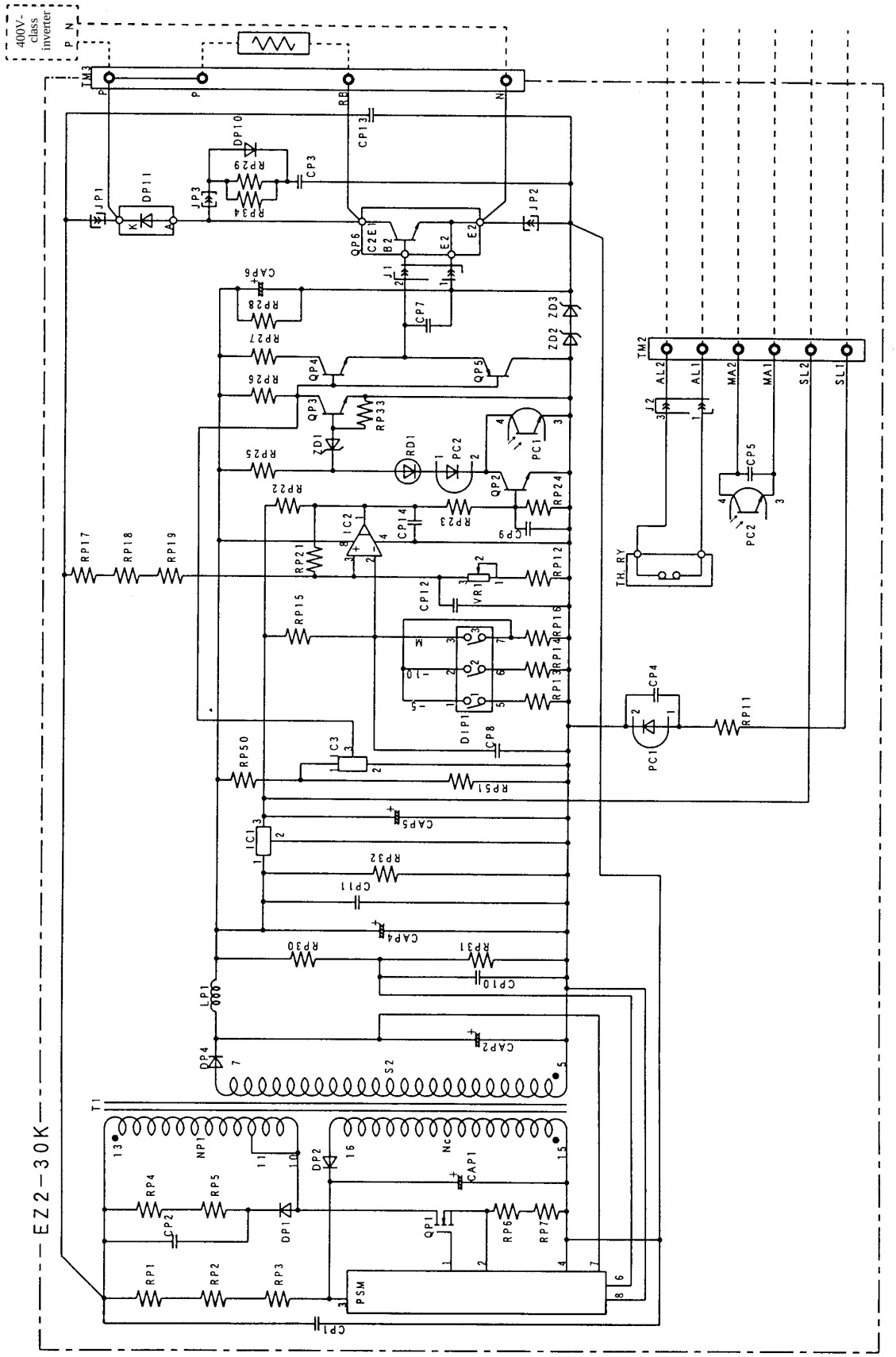


Figure 8.2 Internal circuit

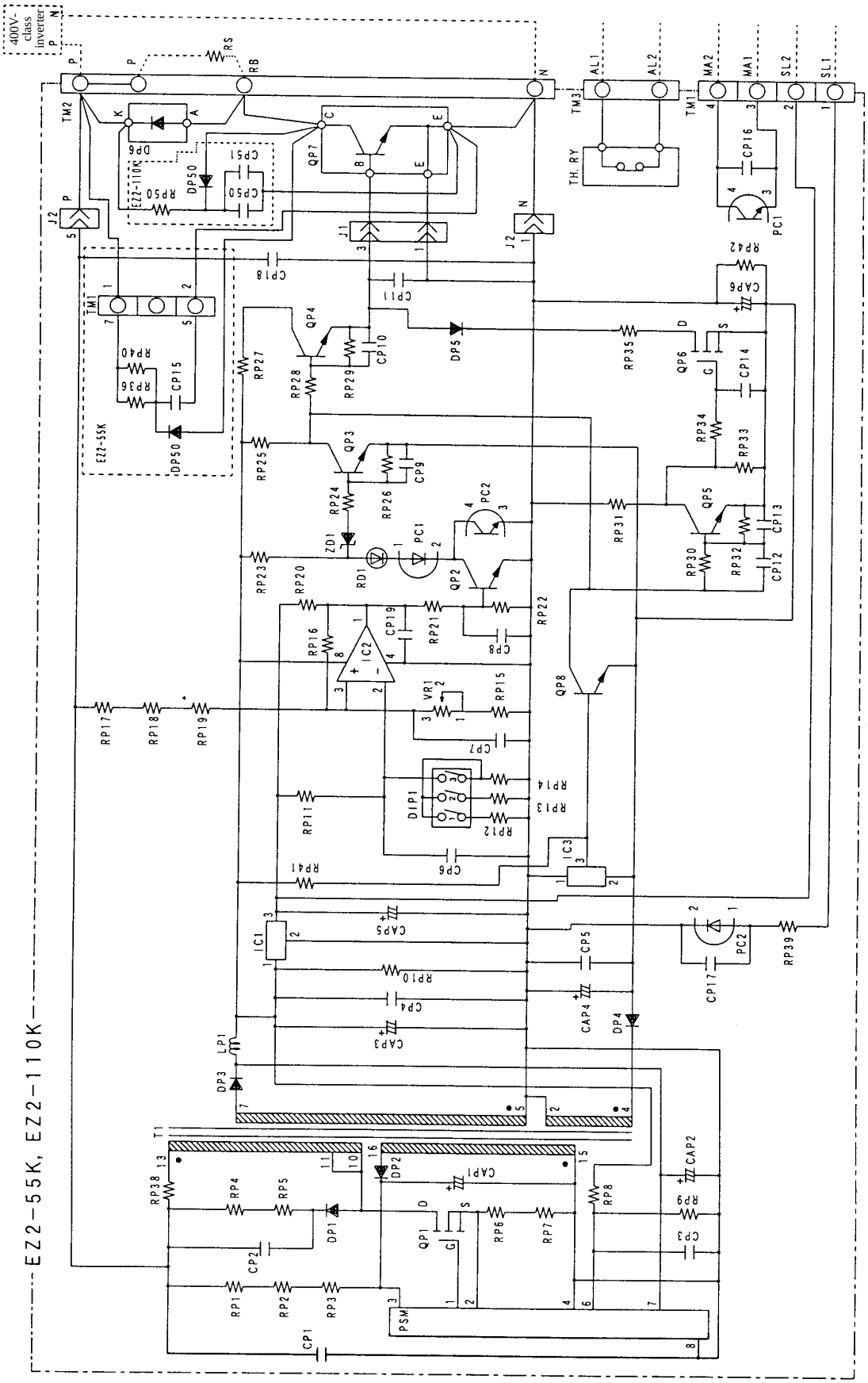


Figure 8.3 Internal circuit

9. SELECTION OF DYNAMIC BRAKING UNITS AND DISCHARGING RESISTORS

The synchronous speed of the motor decreases relative to a decrease in set frequency. When this happens, the synchronous speed of the motor is less than the rotational speed of the rotor and the slip becomes negative. Consequently, the torque generated by the motor operates as a braking touque. See Figure 9.1.
This braking torque is a function of voltage verses frequency. For example, the difference between the torque at frequency f1 and the torque at frequency f3 in Figure 9.2 is caused by the difference between their voltage-vs-frequency ratios.

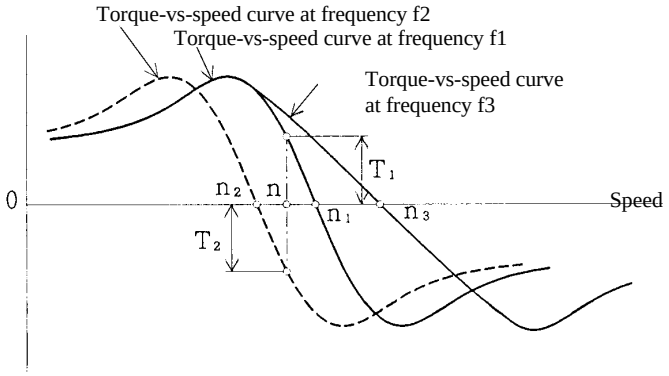


Figure 9.1 Frequency change and motor torque

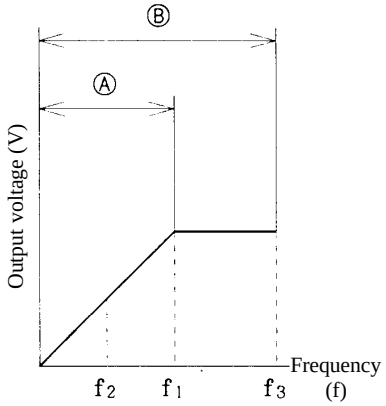


Figure 9.2 Voltage-vs-frequency characteristics

In this status, the motor operates as a generator. The rotational energy of the motor is converted into electrical energy and feed back into the inverter circuit. See Figure 9.3.

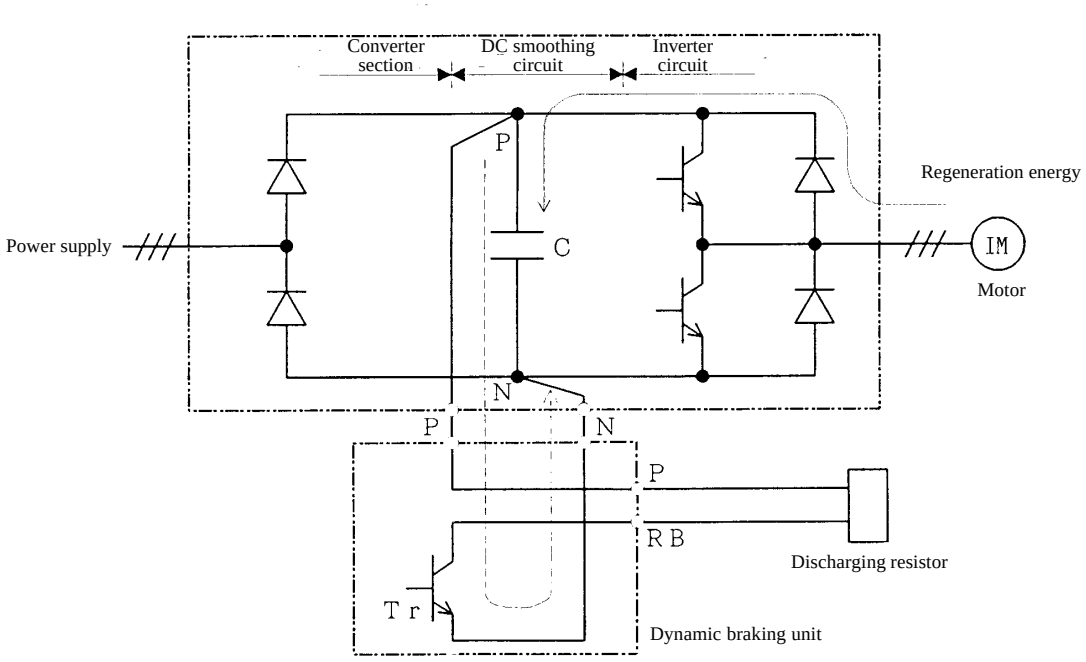


Figure 9.3 Dynamic braking by the inverter

The regenerated energy is stored in the DC bus circuit of the inverter.
(Capacitor feedback type)

9.1 Braking Energy without a Dynamic Braking Unit

Usually, the braking energy of a motor is the sum of the motor loss (including mechanical loss) and inverter loss.
The overall efficiency of an inverter-controlled motor is 65% to 90% depending upon the motor capacity and power loss, and the braking energy which fluctuates around 10% to 35% when at frequency of 50 Hz to 60 Hz).
Generally, the braking torque of up to about 11 KW is about 20% of the rated torque of the motor.
If regeneration energy is greater than the braking energy, the capacitor in the DC bus circuit will be charged, thus increasing the DC voltage. This may cause the over-voltage protecting circuit to shut off the output of the inverter. (The motor runs freely.)

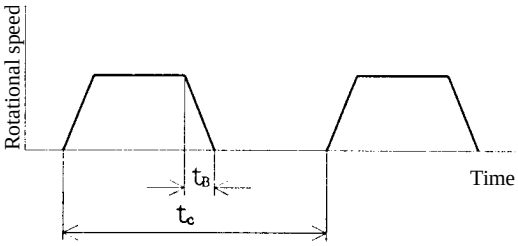
9.2 Using the Dynamic Braking Unit

For a load with high inertia, the motor must be decelerated immediately, and the dynamic braking unit (BRD) will need to absorb the resulting regeneration energy.
In Figure 9.3, when the voltage of the D.C. circuit reaches a preset value, the transistor Tr switches on and the resistor RB consumes the regeneration energy as heat. In this status, the V/F characteristics of the inverter, the permissive current (determined by the resistance of RB), and the capacitance of RB in the dynamic braking unit will determine the braking torque.
This is because the torque generated by the motor is dependent upon the current passing through Tr (and RB).
Do not combine any items which are blank in Table 9.1 to Table 9.3.

(1) For use in one dynamic braking unit

Table 9.1 For use in a single dynamic braking unit

(Common conditions) Motor: Hitachi standard 3-phase squirrel-cage (4 poles)
totally-enclosed fan-cooled motor



- BRD operation frequency $\frac{t_B}{t_C}$ 0.2
  (or 0.1 for the EZ2-30K)
- BRD continuous operation time t_B 2 minutes
  (or 10 seconds for the EZ2-30K)
- T_B Ⓐ: Mean braking torque at 3 Hz to 60 (or 50) Hz
  (For meanings of Ⓐ, see Figure 9.2.)

Motor (kW)	Inverter (kW)	Moment of inertia J for one motor (GD^2) kg·m^2 (kgf·m^2)	Rated torque of the motor To: N·m (kgf·m)		Motor torque ratio %				
					E2		EZ2		
					30K	55K	30K	55K	110K
					4 Ω	2 Ω	10 Ω	6 Ω	3 Ω
			50Hz	60Hz	T_B Ⓐ	T_B Ⓐ	T_B Ⓐ	T_B Ⓐ	T_B Ⓐ
18.5	22.0	0.16 (0.64)	122 (12.4)	101 (10.3)	170				
22.0	22.0	0.19 (0.76)	144 (14.7)	120 (12.2)	150				
30.0	30.0	0.30 (1.20)	197 (20.0)	164 (16.7)	110		175		
37.0	37.0	0.35 (1.40)	243 (24.7)	202 (20.6)	85	170	142		
45.0	45.0	0.40 (1.60)	295 (30.1)	245 (25.0)	75	140	116	195	
55.0	55.0	0.55 (2.20)	361 (36.8)	300 (30.6)	60	120	95	160	
75.0	75.0	1.03 (4.12)	492 (50.2)	407 (41.5)	—	—	70	115	
90.0	90.0	1.23 (4.92)	588 (60.0)	487 (49.6)	—	—	58	95	190
110.0	110.0	1.83 (7.32)	719 (73.3)	595 (60.7)	—	—	—	80	150

(2) For use in two dynamic braking units

Table 9.2 For use in two dynamic braking units

Motor (kW)	Inverter (kW)	Moment of inertia J for one motor (GD^2) kg·m^2 (kgf·m^2)	Rated torque of the motor To: N·m (kgf·m)		Motor torque ratio %				
					E2		EZ2		
					30K	55K	30K	55K	110K
					4 Ω	2 Ω	10 Ω	6 Ω	3 Ω
			50Hz	60Hz	T_B Ⓐ	T_B Ⓐ	T_B Ⓐ	T_B Ⓐ	T_B Ⓐ
18.5	22.0	0.16 (0.64)	122 (12.4)	101 (10.3)					
22.0	22.0	0.19 (0.76)	144 (14.7)	120 (12.2)					
30.0	30.0	0.30 (1.20)	197 (20.0)	164 (16.7)					
37.0	37.0	0.35 (1.40)	243 (24.7)	202 (20.6)	170				
45.0	45.0	0.40 (1.60)	295 (30.1)	245 (25.0)	140		230		
55.0	55.0	0.55 (2.20)	361 (36.8)	300 (30.6)	120		190		
75.0	75.0	1.03 (4.12)	492 (50.2)	407 (41.5)	—	—	140	230	
90.0	90.0	1.23 (4.92)	588 (60.0)	487 (49.6)	—	—	110	195	
110.0	110.0	1.83 (7.32)	719 (73.3)	595 (60.7)	—	—	95	159	

(3) Mean braking torque with one size bigger capacity
In a standard combination of a motor and an inverter, the braking torque is limited by the overcurrent strength of the inverter. However, by increasing the rank of the inverter, you can use the maximum torque of the motor.
Table 9.3 shows the braking torques of the inverters whose capacity is increased by one.
The motor capacity must be raised when 135% or more braking is required.

Table 9.3 Requirements for maximizing the braking torque of motor (when the inverter capacity is increased by one)

Requirement:

Ⓐ Mean braking torque 135% (To × 1.35)
Ⓑ T_B Ⓑ = 0.5 × T_B Ⓐ

Ⓐ Increasing the inverter capacity by one
Ⓒ The operation frequency and other conditions are the same as those in Table 9.1 and Table 9.2.

Motor (kW)	Inverter (kW)	Moment of inertia J for one motor (GD^2) kg·m^2 (kgf·m^2)	Rated torque of the motor To: N·m (kgf·m)		Number of sets of dynamic braking units and resistors required				
					E2		EZ2		
					30K	55K	30K	55K	110K
					4 Ω	2 Ω	10 Ω	6 Ω	3 Ω
			50Hz	60Hz	T_B Ⓐ	T_B Ⓐ	T_B Ⓐ	T_B Ⓐ	T_B Ⓐ
18.5	22.0	0.16 (0.64)	122 (12.4)	101 (10.3)	1				
22.0	22.0	0.19 (0.76)	144 (14.7)	120 (12.2)	1				
30.0	30.0	0.30 (1.20)	197 (20.0)	164 (16.7)	2	1	1		
37.0	37.0	0.35 (1.40)	243 (24.7)	202 (20.6)	2	1	1		
45.0	45.0	0.40 (1.60)	295 (30.1)	245 (25.0)	2	1	2	1	
55.0	55.0	0.55 (2.20)	361 (36.8)	300 (30.6)	—	2	2	1	
75.0	75.0	1.03 (4.12)	492 (50.2)	407 (41.5)	—	—	2	2	1
90.0	90.0	1.23 (4.92)	588 (60.0)	487 (49.6)	—	—	—	2	1
110.0	110.0	1.83 (7.32)	719 (73.3)	595 (60.7)	—	—	—	2	1

9.3 General Formulas Use for Estimation

The example below calculates the braking torque and the discharging resistance of a motor for traveling machine.

(1) Rated motor torque T_M (N·m)

$$T_M = 9550 \times \frac{P_M}{N_M}$$

where
P_M: Rated capacity of the motor (kW)
N_M: Rated revolutions per minutes of the motor (r.p.m.)

(2) Braking torque (required to decelerate) T_B (N·m)
* While this value is negative, only the inverter can brake the motor. (The BRD is not required.)

$$T_B = \frac{J \times (N_1 - N_2)}{9.55 \times t_B} - T_L$$

where
J: Moment of inertia of the motor and the load (converted to motor shaft) ($kg \cdot m^2$)
N_1, N_2: Rotational speed (r.p.m.) before deceleration and rotational speed (r.p.m.) after deceleration
T_L: Load torque (converted to motor shaft) (N·m)
t_B: Deceleration time (seconds)

(3) Discharging resistance R (ohms): Resistance relative to the inverter
* If this value is under the minimum value of a BRD, two or more BRDs are required.

$$R = \frac{V_{on}^2}{0.105 \times T_B \times N1} \times \frac{1}{1.2}$$

where
V_{on}: BRD operating voltage (362.5 V for the 200V class or 725V for the 400V class)

(4) Mean discharging capacity PL (W)
* The capacity of the discharging resistor should be 2.5 to 3 times the result of the formula below.

$$P_L = \frac{0.105 \times (T_B - 0.2 \times T_M) \times (N_1 + N_2)}{2} \times \frac{t_B}{t_C}$$

where
t_C: Operation cycle(s)

(5) Duty cycle t_B/t_C

@he duty cycle (t_B/t_C) for the discharging resistor I is as follow:

$$\frac{t_B}{t_C} \quad \frac{1}{5} \left(\text{EZ2-30K: } \frac{t_B}{t_C} \quad \frac{1}{10} \right)$$

A he dynamic braking unit can be used continuously for the use of the discharging resistor II.
* See 9.3 (4) for capacities of the discharging resistors.
* See Table 7.1 for details of the discharging resistors I and II.

(6) Thermal set value

$$\text{Thermal set value (A)} \quad \sqrt{\frac{\text{Rated capacity of the discharging resistor (W)}}{2} \div \text{Resistance of the discharging resistor } (\Omega) \div 1.2}$$

* This is a reference value for enameled and ribbon resistors.

10. MAINTENANCE AND CHECKS

10.1 Notices on Maintenance and Checks

DANGER

- Be sure to turn off the supply power. (Make sure that the DC voltage between terminals P and N is 45 volts or less.) Otherwise, you may receive a serious electric shock.
- Only an authorized electrician is allowed to check, maintain, and replace parts of the dynamic braking unit.
  (Take off all metallic accessories such as watches and jewelry before operating.)
  (Use the insulated tools.)
  Otherwise, you may receive a serious electric shock or personal injury.

Notes:

(1) Always keep the inside and outside of the dynamic braking unit clean. Always connect cables correctly. Missing and wrong connections are prohibited. Tighten the terminals and connectors firmly.

(2) Keep this device away from wet, oily, or dusty locations. Metallic filings in the product can easily cause short-circuits, damage the unit or start a fire.

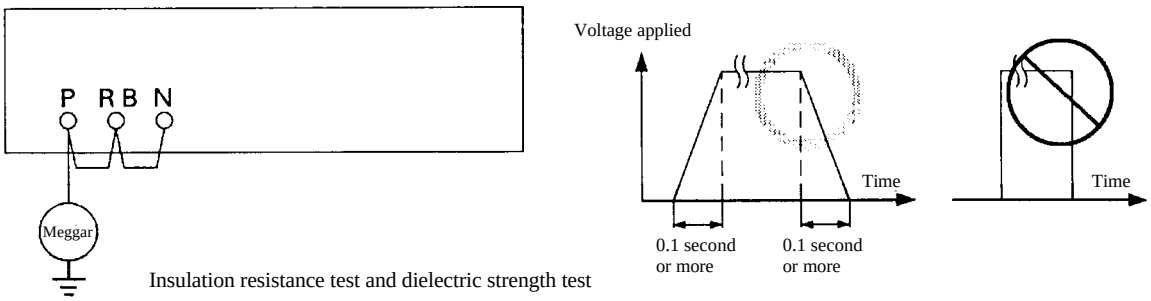
10.2 Check Items

(1) Daily checks
(2) Periodic checks (every one year)
(3) Insulation resistance test and dielectric strength test

See Page 25.

Connect the terminals as shown below and test under the following conditions:

- Insulation resistance test
  Measure the resistance between the ground and the interconnected terminals with a meggar and make sure it is 5 megohms or more.
- Do not perform the dielectric strength test.
  When required, apply a voltage of 2000 VAC between the ground and the interconnected terminals for one minute and check for problems.
- Do not use any other terminals for the dielectric strength test.
- Be sure to increase and decrease the test voltage slowly.



Insulation resistance test and dielectric strength test

Table 10.1 Daily and Periodic Checks

Check point	Check item		Checking	Check cycle		Checking method	Requirement	Typical part replacement timing	Testing tools
				Daily	Periodic				
General	Environment		Check ambient temperature, relative humidity, and concentration of dust, toxic gases, and oil mist.			Visually and audibly	The ambient temperature should be -10°C to +50°C (not freezing). The ambient relative humidity should be 20% to 90% (non-condensing). No abnormal vibration and noise should be detected.	–	Thermometer, hygrometer, and multi-meter
	Device status Supply voltage		Check for abnormal vibration and noise from the device.						
Main circuit	General		(1) Insulation resistance test (between main circuit terminal and the grounding terminal) (2) Check for loose screws (terminal bases, etc.). (3) Check for overheated or burnt parts. (4) Cleaning			(1) Tighten the screws firmly.	(1) (2): No problem should be detected. Tightening torques (in N.m) M3: 0.6 to 0.9 M8: 10 to 13.5 M4: 1.5 to 2.1 M10: 21 to 28 M5: 2.8 to 3.9 M6: 4.1 to 5.3	–	500V meggar
	Terminal board		Check for damages and breaks.			Visually	No problem should be detected.	–	–
	Smoothing capacitor on the PC board		(1) Check for electrolyte leaks. (2) Check whether the capacitor is swollen.			(1) (2) Visually	(1) (2) No problem should be detected.	5 years (Note)	–
	Resistor		(1) Check for cracks and discoloration.			(1) Visually	(1) No problem should be detected.	–	–
Control circuit	Operation check		Carry out the sequence protector test to check the operation of the protective and display circuits.			Simulate the output of the inverter protection circuit.	The circuits should work normally.	–	–
Protective circuit	Component check (including PC board)	General	(1) Check for burnt smell and discoloration. (2) Check for rust and corrosion.			Visually	No problem should be detected.	5 years (Note)	–
		Capacitor	(1) Check for electrolyte leaks and casing deformation.			Visually			

Note: The ambient temperature affects the service life of the capacitor. See Ambient Temperature vs. Capacitor Life (Appendix).

11. PARTS ORDERING AND INQUIRY

When inquiring or ordering replacement parts, please provide the following information to your local Hitachi distributor or service office:

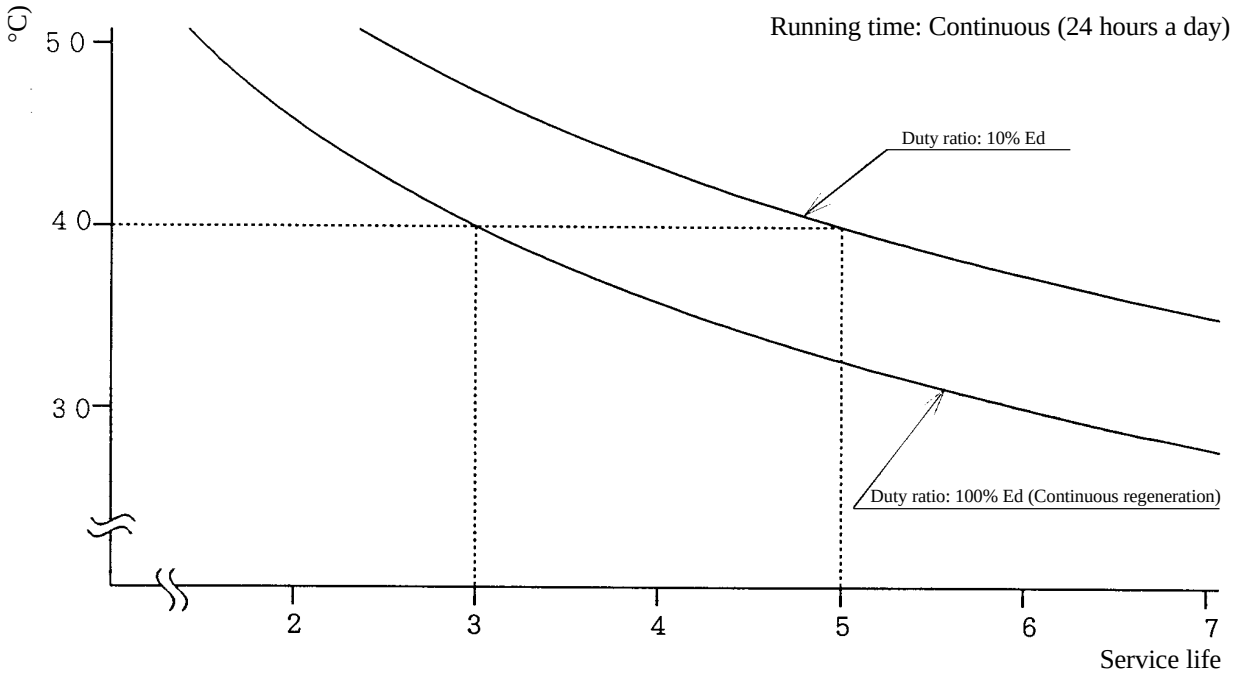
(1) Model number
(2) Manufacturing number (MFG. No.)
(3) Symptom or details of the trouble (in detail)

If the label is hard to be read, report the external view or appearance of the replacement part and a short explanation of the trouble, together with the ordering sheet.

It is recommended for you to have another product as an auxiliary device your work will not be disrupted.

APPENDIX

Service life of capacitor



Appendix Figure 1 Ambient Temperature vs. Capacitor Life characteristics

The ambient temperature affects the service life of the aluminum electrolytic capacitor. (See Appendix Figure 1.)
Periodically check the capacitor and make sure it is free from leaks, deformations, etc.
If the dynamic braking unit is frequently used in a hot location, the capacitor will quickly deteriorate and consequently the service life of the dynamic braking unit may be shortened.