FOR HITACHI INVERTER

Dynamic Braking Unit (BRD Series)
200 V Class (BRD-E2, S2)

INSTRUCTION MANUAL

NOTE: THIS MANUAL ALSO APPLIES TO MODEL BRD-E2-N, WHICH IS IDENTICAL IN PERFORMANCE TO THE BRD-E2, BUT DOES NOT INCLUDE THE BUILT IN BRAKING RESISTOR.

Thank you very much for purchasing HITACHI DYNAMIC BRAKING UNIT. This instruction manual describes the installation, maintenance, and inspection of HITACHI DYNAMIC BRAKING UNIT.

After reading this manual, keep it at hand for future reference.

NB4881X

Hitachi, Ltd.

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1. INSPECTION UPON UNPACKING

When unpacking the dynamic braking unit, be careful not to give impact and vibration to the unit. Check the following items.

(1) Are there any components which were damaged during transportation?

(2) Are the model name and voltage on the nameplate as originally ordered?

If any faults are found, contact your distributor.

2. SPECIAL PRECAUTIONS FOR SAFETY

Pay attention to the following items in order to use the dynamic braking unit correctly and safely.

(1) To prevent the discharge resistor from overheating and burning when an error occurs in the dynamic braking unit, be sure to install a circuit for switching off the power supply on the primary side of the inverter by connecting the alarm contacts (AL1, AL2). (See the connection diagrams in Sections 4.3, 4.4, and 4.5.)

(2) The surface of each of the internal and external resistors tend to heat. Pay attention to a scald or effects of heat on other devices. (See Chapter 3, "Installation".)

(3) When many resistors are combined, the voltage is greatly increased by the inductive component in each resistor at the time of switching. Therefore, countermeasures such as thick cables or twisted wires are necessary. Use non-inductive resistors as external resistors and do not combine more than 6 resistors.

(4) Do not operate the regenerative braking unit in parallel with an old type of BRD (BRD-B, BRD-E or BRD-S). A fault may occur as the operating voltage and terminal configuration are different.

(5) When using the operating voltage setting change function or the parallel connection interlocking running function, care should be taken in the DIP switch setting and wiring. Before starting setting and wiring, be sure to turn the power off. (For these functions, see Chapter 4, "Wiring and Function Setting".)

(6) Check the wiring and connection and turn the inverter on.

(7) When the external resistor unit or individual external resistor is to be used, set the combined resistance to 17 Ω or more. Resistance 17 Ω or less may cause failure of braking unit. If the external resistor unit is connected when the internal resistors are kept connected, the internal resistors may be overheated and damaged.

When the external resistors are to be used, be sure to remove the internal resistors. Remove the internal resistors as specified below with reference to Fig. 2.1

① Remove the lead wires connected to the P and RB terminals on the PCB and the R1 and R2 terminals on the radiation fins from the internal resistors.

② Remove the internal resistors from the back.

③ Return the cables between the terminals AL1-R1 and AL2-R2 on the radiation fins to their original position.

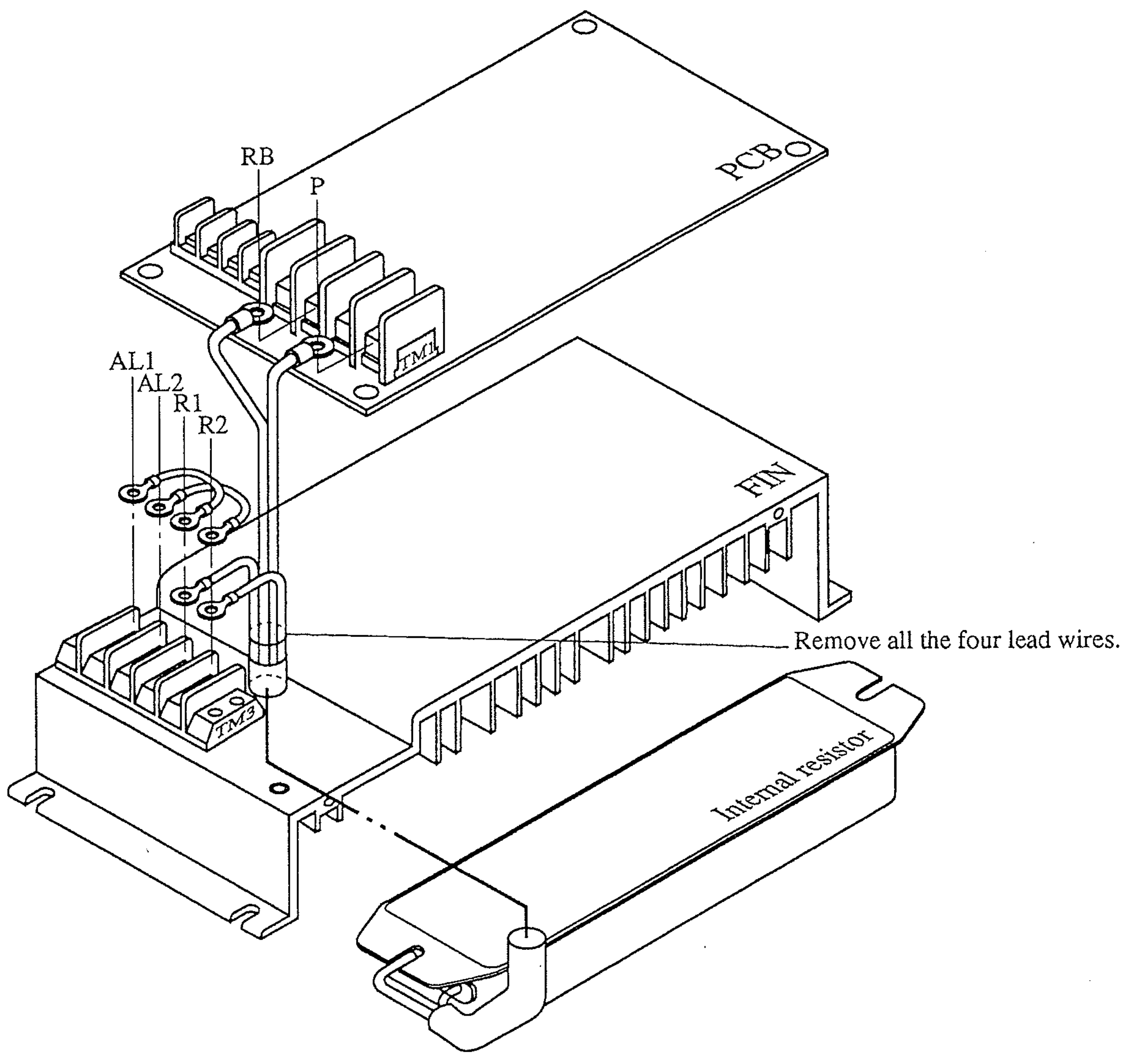
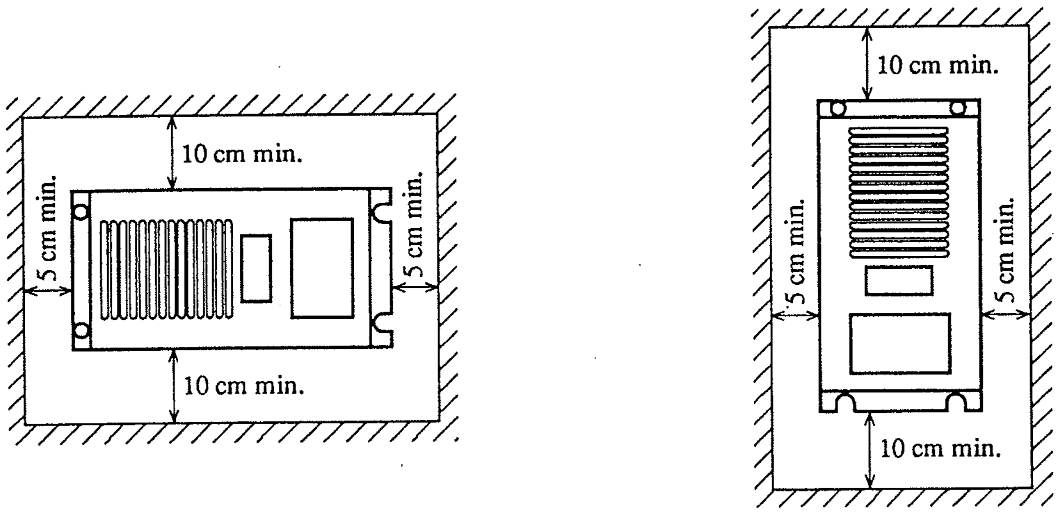


Fig. 2.1 How to Remove Internal Resistors

3. INSTALLATION

(1) Install the dynamic braking unit on a wall in the mounting state according to Figs. 3.1 (a) and (b) so that it is at a distance of at least 10 cm in the vertical direction and at least 5 cm in the horizontal direction from other devices in a well-ventilated conductors



(a) Horizontal mounting (b) Vertical mounting

Fig. 3.1 Ambient Space When the Dynamic Braking Unit is Installed

(2) If running of high frequency reoccurs when the internal resistors are used, the surface temperature of the internal resistors on the back may rise to about 200°C. Therefore, install the unit on an incombustible (metal, etc.) wall. Ensure sufficient ventilation to prevent the back from overheating exposure.

(3) The installation location should be free of high heat exposure excessive moisture, dust, corrosive gas, mist for grinding lubricant, salt damage, and vibration.

4.1 Precautions for Wiring

(1) To prevent the discharge resistor from overheating and burning when an error occurs in the dynamic braking unit, be sure to install a circuit for switching off the power supply on the primary side of the inverter by connecting the alarm contacts (AL1, AL2). For connection of the alarm contacts, see the connection diagrams in Sections 4.3, 4.4, and 4.5.

(2) Each cable between the dynamic braking unit and the inverter and external resistors (P, RB, N) should be 5 m max. in length and 3.5 mm² min. in cross section.

(3) The signal conductors (MA1, MA2, SL1, SL2) between the dynamic braking units when the parallel connection interlocking running function is used should be 5 m max. in length and 0.75 mm² min. in cross section.

(4) Crimp-style terminals with insulation must be used to connect cables to the TM1 and TM2 terminal blocks on the circuit board.

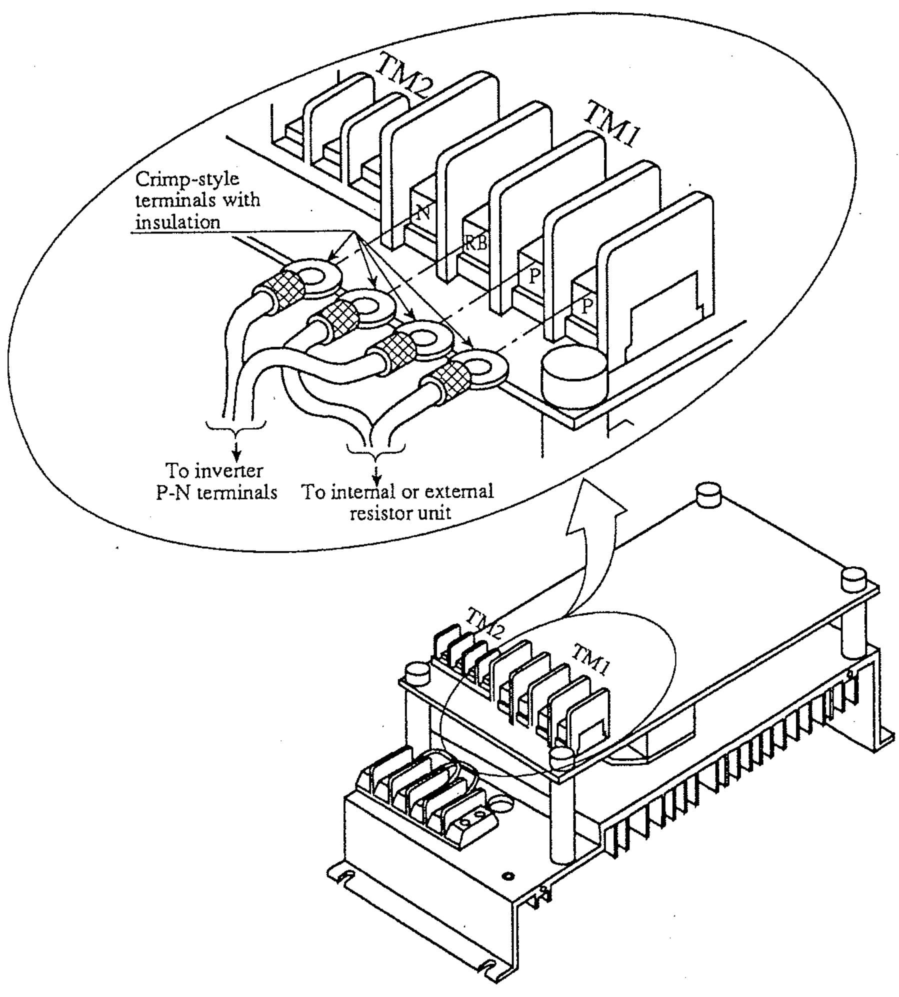


Fig. 4.1 Terminal Block Connection

4.2 Function Setting

When the DIP switch is set, "Main unit: Sub-unit" or "Operating voltage level" can be selected.

(1) Operating voltage setting change function

When the DIP switch of the dynamic braking unit is set, the operating voltage can be set in three stages such as "Standard" (set at factory before shipment), "-5%", and "-10%".

When an overvoltage trip occurs due to conditions such as input voltage or deceleration time, by decreasing the operating voltage of the dynamic braking unit, this function can be used to prevent such a trip.

A continuous operation may be performed when the power is turned on depending on the input voltage. When the setting is changed, great care should be taken in the input voltage.

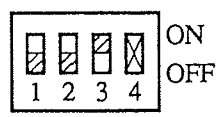
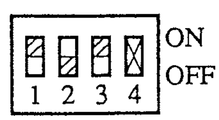
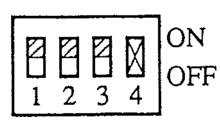
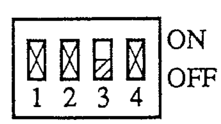
Input voltage x $\sqrt{2}$ +10V< operating voltage

(2) Parallel connection interlocking running function

Interlocking running with parallel connection of up to 5 units (main unit - sub-unit - sub-subunit) is possible by connecting the signal conductors between the units (MA1, MA2, SL1, SL2) and setting the DIP switch. When "Sub-unit" is set, the operating voltage depends on the set value of the main unit.
Table 4.1 shows DIP switch settings.

NOTE: Before starting the above setting and wiring, be sure to switch off the power.

Table 4.1 DIP Switch Settings

	Setting function (Operating voltage)	DIP switch (x: Either setting of ON and OFF is acceptable.)		Remarks
1	Main unit Operating voltage: Standard 362.5 V	OFF, OFF, ON, X		Factory setting prior to shipment
2	Main unit Operating voltage: -5% 344.5 V	ON, OFF, ON, X		
3	Main unit Operating voltage: -10% 326 V	ON, ON, ON, X		
4	Sub-unit, sub-subunit	X, X, OFF, X		The operating voltage depends on the setting of the main unit.

4.3 When Internal Resistors are Used

Connection when the parallel connection interlocking running function is used is shown in Fig. 4.3. Connect the sub-unit or sub-subunit whenever necessary.

Each internal resistor has a built-in temperature fuse. When the equipment is operated extremely frequently with no alarm contact connected, a temperature fuse may be blown out so as to prevent damage due to overheating. (When a temperature fuse is blown out, the corresponding internal resistor should be replaced.)

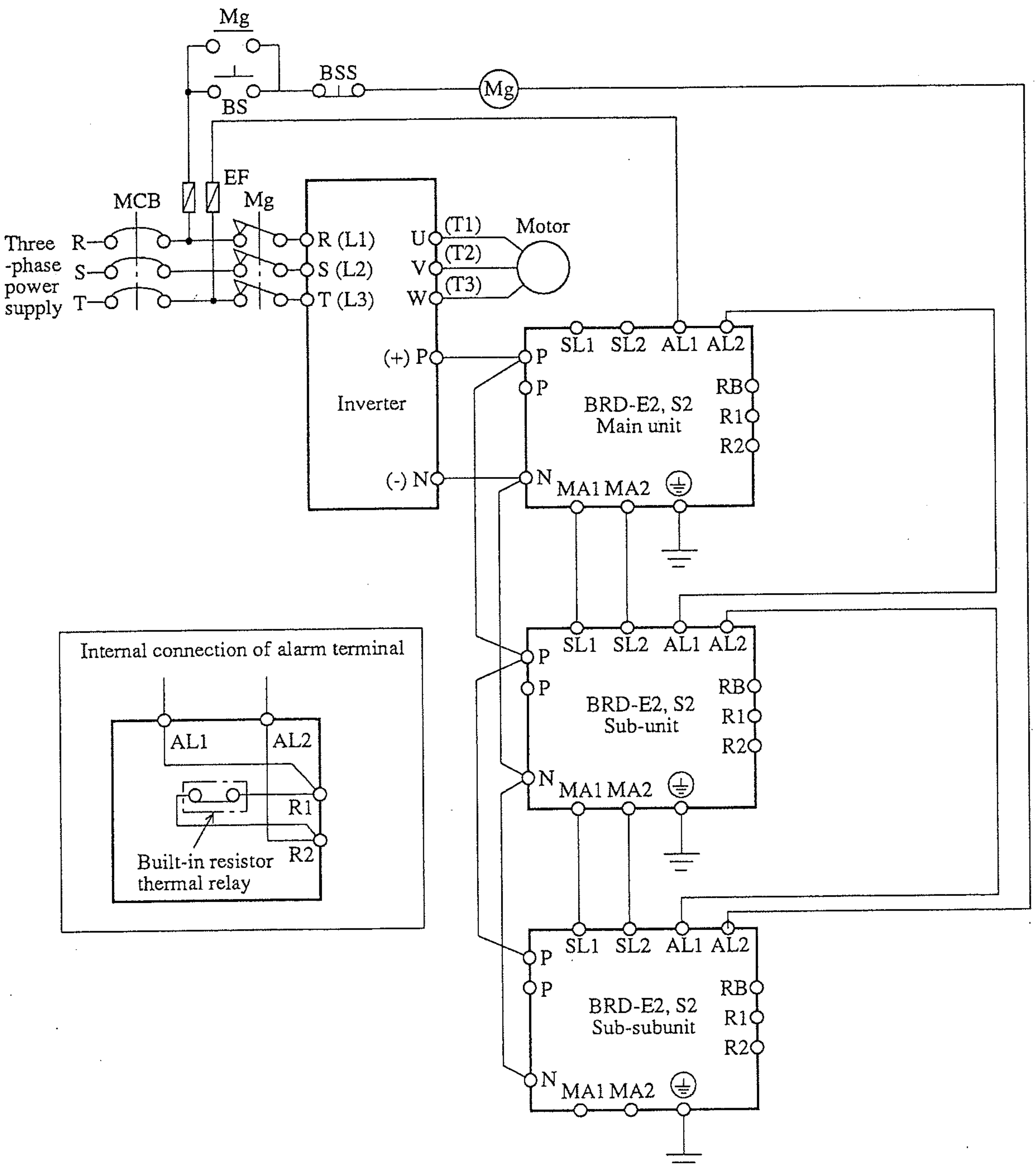


Fig. 4.3 Connection When Internal Resistors are Used

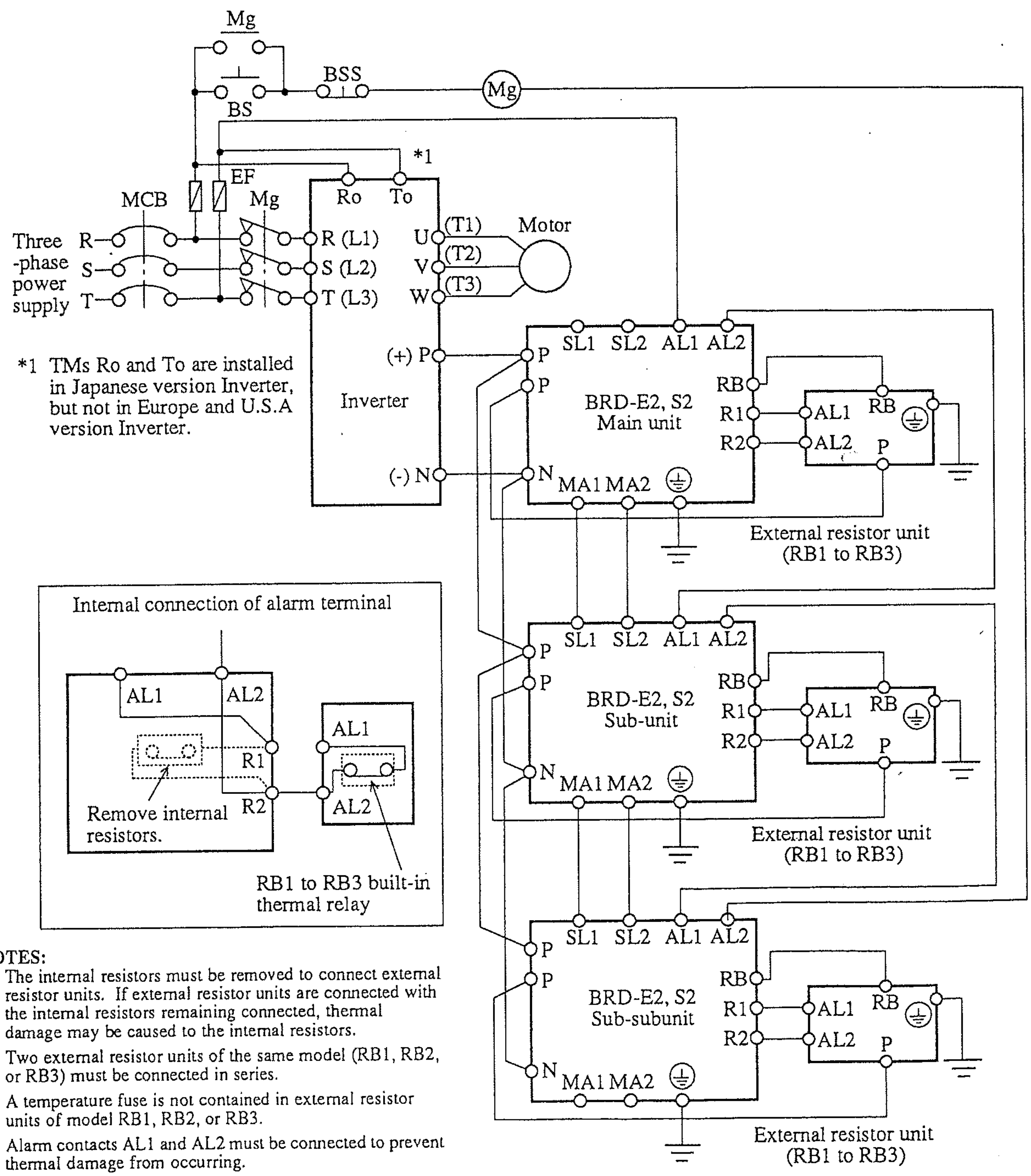
4.4 When Optional External Resistor Units RB1, RB2, and RB3 are Used

Connection when the parallel connection interlocking running function is used is shown in Fig. 4.4. Connect the sub-unit or sub-subunit whenever necessary.

When the dynamic braking unit is connected in parallel, use external resistor units of the same model (same resistance) for the main unit to sub-subunit.

If the external resistor unit is connected when the internal resistors are kept connected, the internal resistors may be overheated and damaged.

Be sure to remove the built-in resistors from the back of the dynamic braking unit. (See Fig. 2.1 shown in Chapter 2, "Special Precautions for Safety".)



NOTES:

1. The internal resistors must be removed to connect external resistor units. If external resistor units are connected with the internal resistors remaining connected, thermal damage may be caused to the internal resistors.
2. Two external resistor units of the same model (RB1, RB2, or RB3) must be connected in series.
3. A temperature fuse is not contained in external resistor units of model RB1, RB2, or RB3.
4. Alarm contacts AL1 and AL2 must be connected to prevent thermal damage from occurring.

Fig. 4.4 Connection When External Resistors are Used

4.5 When an Individual External Resistor is Used

When an individual external resistor other than the external resistor units (RB1 to RB3) is used, install a thermal relay to prevent the resistor from overheating and burning and turn the primary side power supply of the inverter off when the thermal relay is in operation.

The connection of the thermal relay is shown in Fig. 4.5 and the connection of the resistor and the thermal set value are shown in Table 4.2.

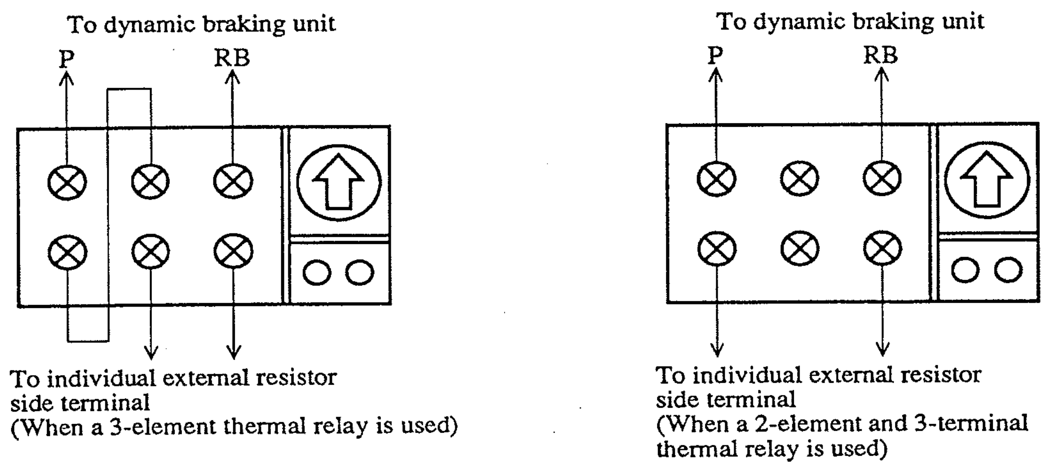
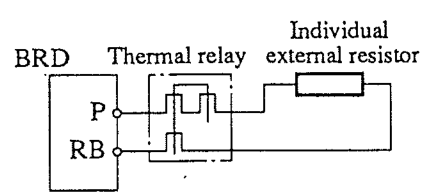
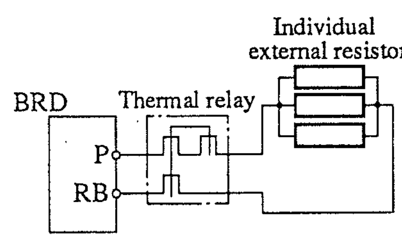


Fig. 4.5 Connection of Thermal Relay

Table 4.2 Connection of External Resistors and Thermal Set Value (Example)

Configuration of individual external resistors	One resistor of 400 W and 20 Ω	One resistors of 600 W and 20 Ω	3 resistors of 400 W and 50 Ω in parallel
Connection			
Thermal set value	2.5A	3.8A	7A

Thermal relay type: Hitachi TR20B-1E

Connection when the parallel connection interlocking running function is used is shown in Fig.4. 6. Connect the sub-unit or sub-subunit whenever necessary. In this case, use individual external resistors of the same resistance for the main unit to sub-subunit.

Be sure to remove the built-in resistors from the back of the dynamic braking unit in the same way as the external resistor units are used and connect R1 and R2. (See Fig. 2.1 shown in Chapter 2, "Special Precautions for Safety".)

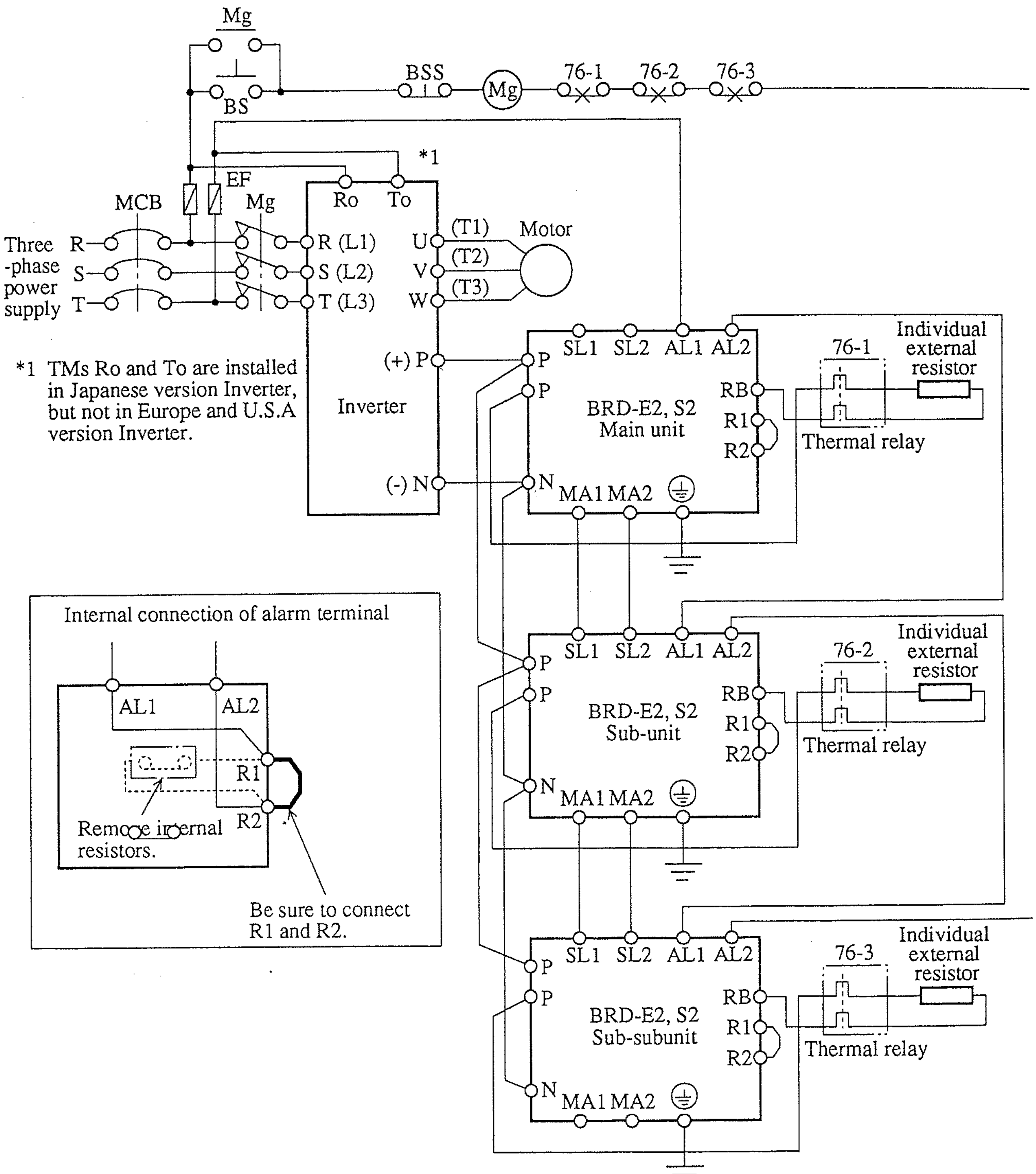
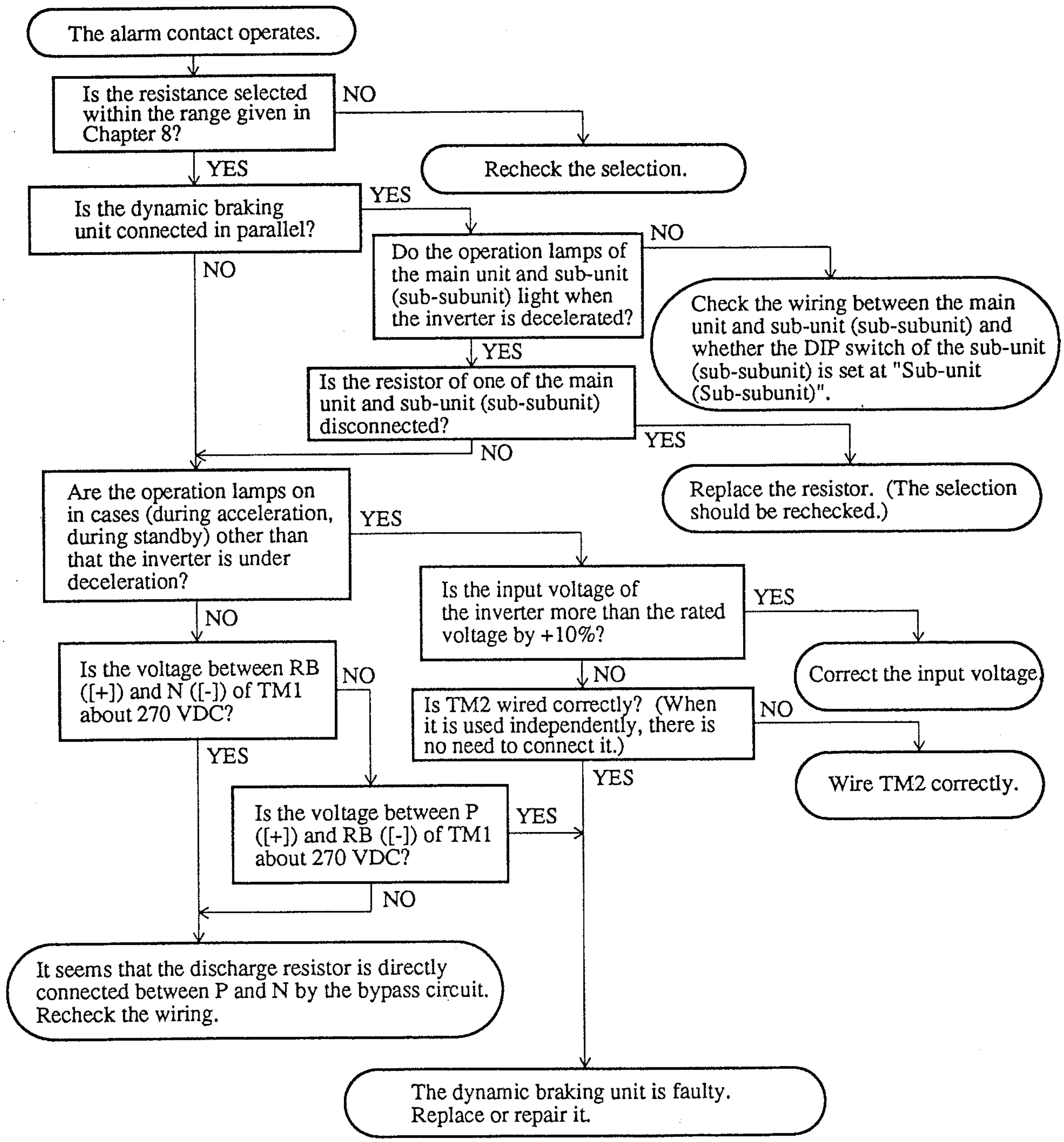


Fig. 4.6 Connection When Individual External Resistors are Used

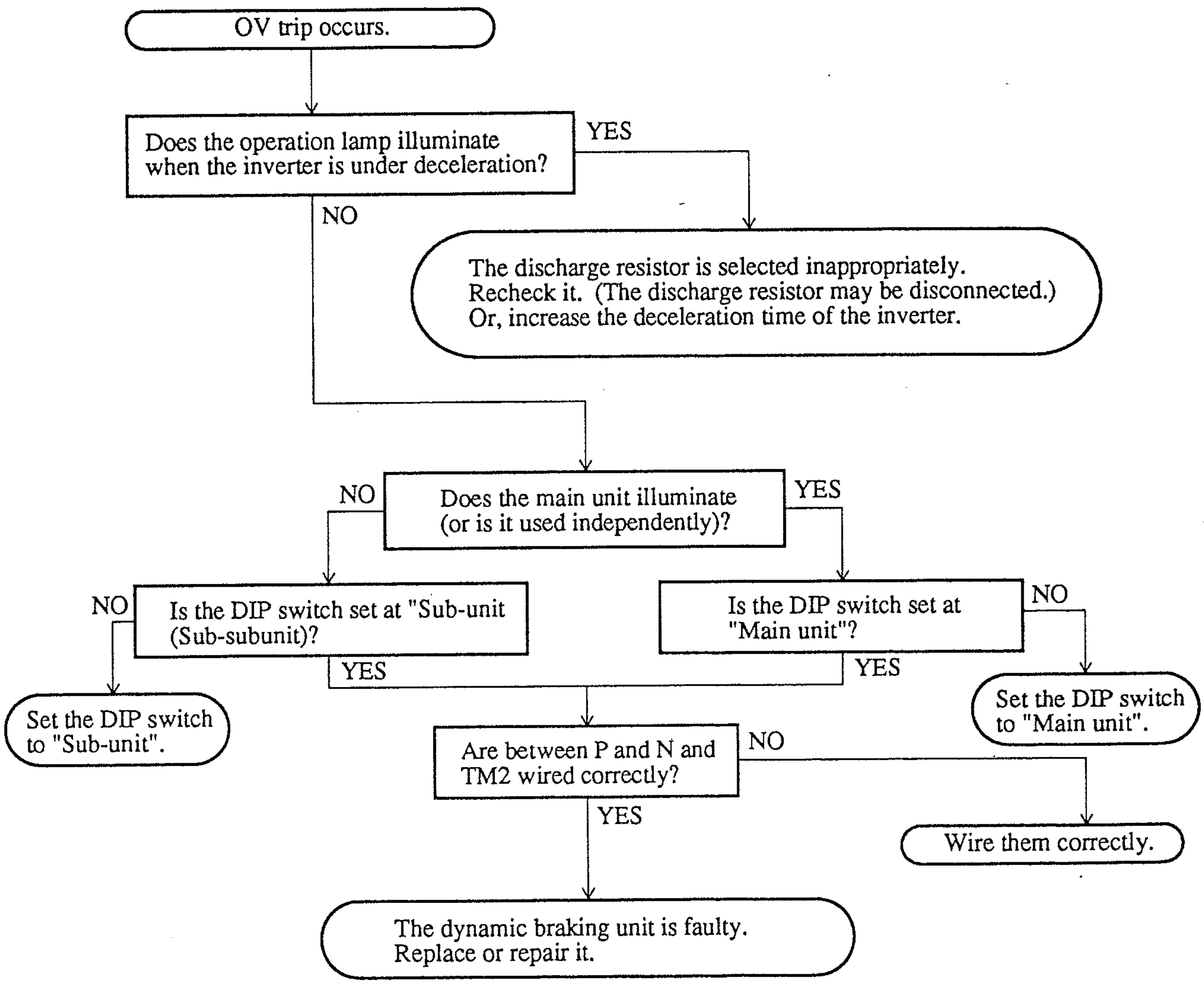
5.1 The Inverter Stopped Due to an Operation of the Alarm Contact.

This fault basically occurs when the discharge resistor is abnormally overheated due to large regenerative energy or frequent braking. An effective countermeasure is to recheck the resistance of the discharge resistor, the number of dynamic braking units to be installed, and the deceleration time. In addition to these, incorrect wiring and an inappropriate input voltage are considered to be possible causes. Therefore, use the following flow chart for checking and implementing countermeasures.



5.2 The inverter is Tripped to OV When it is Under Deceleration.

This fault basically occurs when the regenerative energy is too high and the increased voltage cannot be fully absorbed. An effective countermeasure is to recheck the resistance of the discharge resistor, the number of dynamic braking units to be installed, and the deceleration time. In addition to these, disconnection of the discharge resistor and incorrect setting of various cables and the DIP switch are considered to be possible causes. Therefore, use the following flow chart for checking and implementing countermeasures.



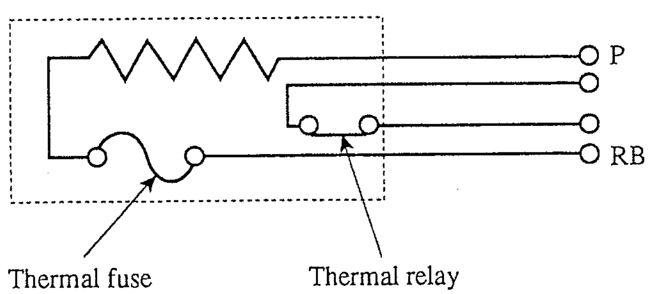
6.1 Standard Specification

When there are customer-rated requirements, the rated requirements and the specification on the nameplate take precedence over this standard specification.

Table 6.1 Standard Specification

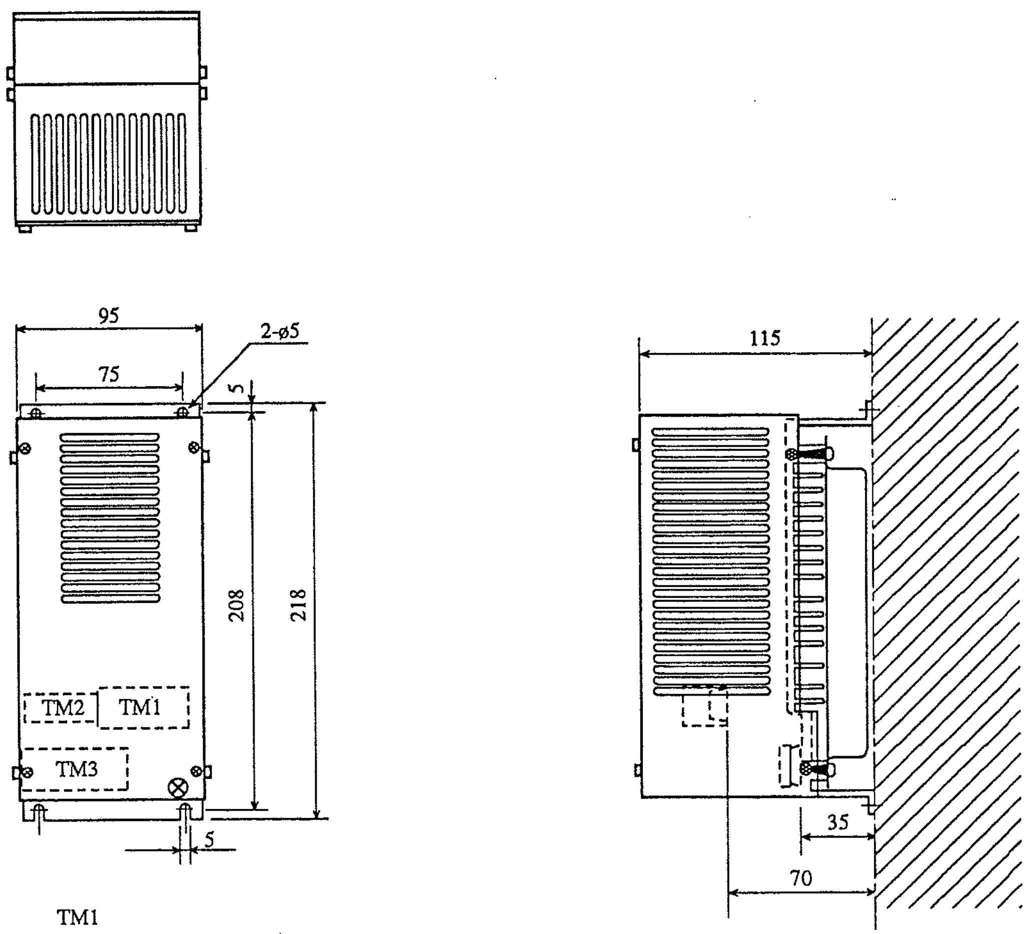
Model abbreviation		BRD-E2	BRD-S2
Protective structure		Open type	
Voltage class		200 to 220 V/50 Hz, 200 to 230 V/60 Hz	
Discharge current of braking unit		Rated 2 A (built-in resistors used), max. 21.6 A (external resistor used: 17 Ω min. *1)	
Operating voltage (ON/OFF)		362.5 ±5 V/355 ±5 V (Operating voltage setting change: -5%, -10% function *2)	
Operation indication		LED ON	
Built-in resistor	Resistance	180 Ω (2.1A)	20 Ω (21.6A)
	Allowable continuously ON time	10 s. max.	0.5 s. max.
	Allowable running cycle	1/10 (on for 10 s., off for 90 s.)	1/80 (on for 0.5 s., off for 40 s.)
	Power consumption	Instantaneous 0.37 kW, rating 120 W	Instantaneous 6 kW, rating 120 W
Protective function		(a) The thermal relay operates at a built-in resistor temperature of 200 °C and returns at about 170 °C (contact b). Contact rating: 240 VAC, 3 A (load R), 0.2 A (load L) 36 VDC, 2 A (load R) (b) The built-in resistor contains a fuse. (Cannot be returned)	
General specification	Ambient temperature	-10 to 40 °C, -10 to 50 °C when the front cover is removed	
	Storage temperature	-10 to 60 °C	
	Humidity	20 to 90%, no dew condensation	
	Vibration	2.0 m/s² (0.2 G max.) 10 to 55 Hz *5	
	Use location	A height of 1000 m max., indoors (free of corrosive gas and dust)	
Others		Interlocking setting function in the case of parallel connection (Operation of the main unit and sub-unit) *2, *3	

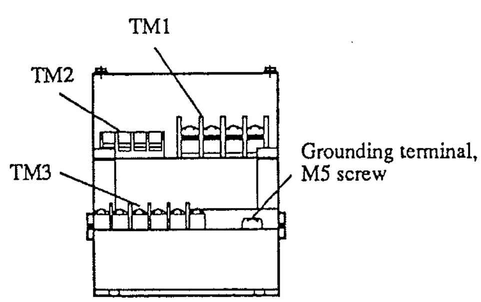
*1: There are optional external resistor units (RB1, RB2, RB3) available.
*2: The function is set by the DIP switch.
*3: The function should be connected externally. (See Chapter 4, "Wiring and function setting".)
*4: The internal resistors contain a fuse.
Highly frequent operation without alarm contacts being connected may cause the fuses to blow out for the prevention of thermal damage. If the fuses blow out, then the internal resistors must be replaced.



Dynamic Braking Unit (class 200 V)

Model	Type		Operating voltage (V)	Weight (kg)
	TYPE	FORM		
BRD-E2	HP	DM	362.5 ±5.0	1.3
BRD-S2	HP	DM	362.5 ±5.0	1.3





TM2, terminal width 6, M3 screw

SL1	SL2	MA1	MA2

TM1, terminal width 9, M4 screw

N	RB	P	P

TM3, terminal width 7, M3 screw

AL1	AL2	R1	R2

DIMENSION in mm

Fig. 6.1 Dimensional Drawing

6.2 Option

When the built-in resistors are removed and the external resistor units are used, the braking torque can be increased.

Table 6.2 shows the specifications of the external resistor units.

Take the following precautions when operating the equipment.

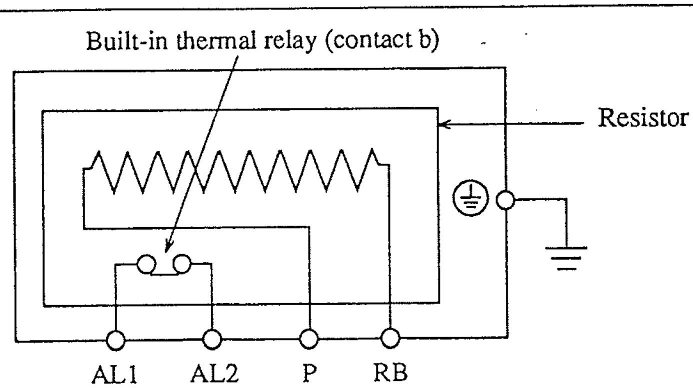
(1) Install each external resistor unit on a wall in the mounting state so that it is at a distance of at least 10 cm in the vertical direction and at least 5 cm in the horizontal direction from other devices in a well-ventilated state in the same way as with the dynamic braking unit.

(2) When running of high frequency is repeated, the surface temperature of the resistors may rise to about 200°C. Therefore, install the units on an incombustible (metal, etc.) wall.

(3) The installation location should be free of high heat exposure excessive moisture, dust, corrosive gas, mist from grinding lubricant, salt damage, and vibration.

(4) Each of the external resistor units (RB1 to RB3) has no built-in temperature fuse. Be sure to connect the alarm contacts (AL1, AL2) so as to prevent damage due to overheating.

Table 6.2 Specifications of External Resistor Units

Model abbreviation	RB1	RB2	RB3
Resistance	50 Ω	35 Ω	17 Ω
Allowable continuous ON time	10 s. max.		
Power consumption Instantaneous Rating	2.6 kW 400 W	3.8 kW 600 W	7.7 kW 1200 W
Protective function	Thermal relay (contact b) contained Operation (contact open) temperature: 200°C ± 10°C Return (contact close) temperature: 160°C± 10°C Contact rating: 240 VAC, 3 A (load R), 0.2 A (load L) 36 VDC, 2 A (load R)		
Internal connection diagram			

7. INTERNAL CIRCUIT

The internal circuit is shown in Fig. 7.1 and the configuration of the terminals of the terminal block are shown below. For connection of each terminal, see Sections 4-3 to 4-5.

(1) TM1

P: Plus side of DC voltage

P, RB: Resistors (built-in or external)

N: Minus side of DC voltage

(2) TM2

MA1, MA2, SL1, SL2: Control signals during parallel connection interlocking running

(3) TM3

AL1, AL2, R1, R2: Alarm contacts

For the actual layout and screw diameters, see Fig. 6.1, "Dimensional Drawing" in Section 6.1.

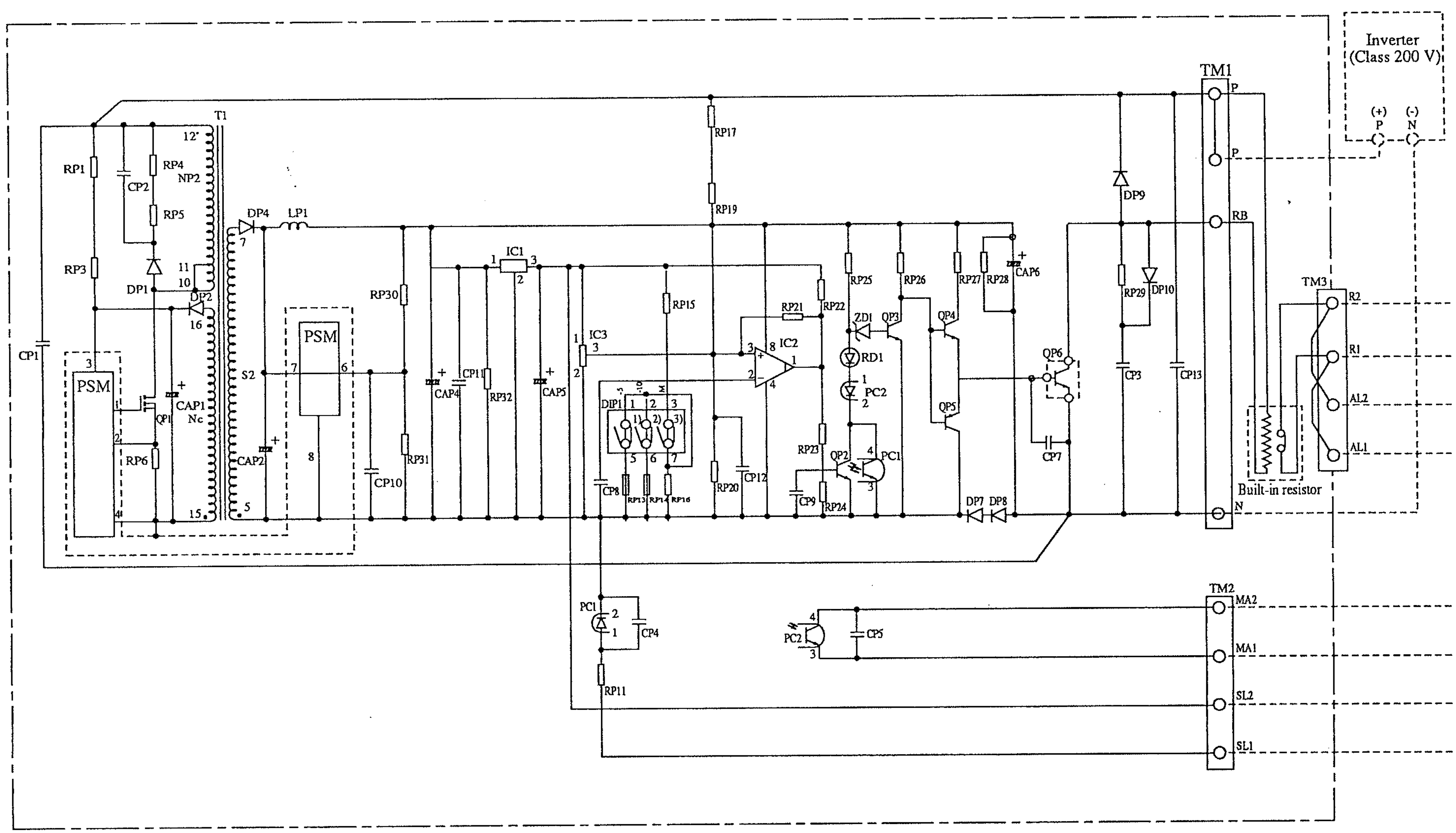


Fig. 7.1 Internal Circuit

8. HOW TO SELECT DYNAMIC BRAKING UNITS AND DISCHARGE RESISTORS

When the set frequency is decreased, the synchronous speed of the motor is reduced simultaneously.

If this occurs, the synchronous speed becomes lower than speed of the rotor, a negative slip is caused, and the generated torque of the motor becomes braking torque. The status thereof is shown in Fig. 8.1.

The generated braking torque varies with the V/f characteristic. For example, the reason that the torque at f_1 and torque at f_3 shown in Fig. 8.2 are switched to those shown in Fig. 8.1 is that the ratio of V/f is different.

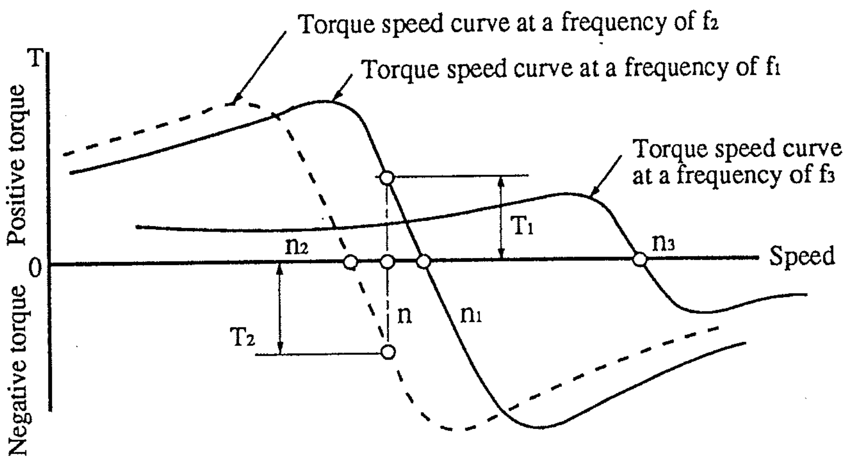


Fig. 8.1 Frequency Change and Motor Torque

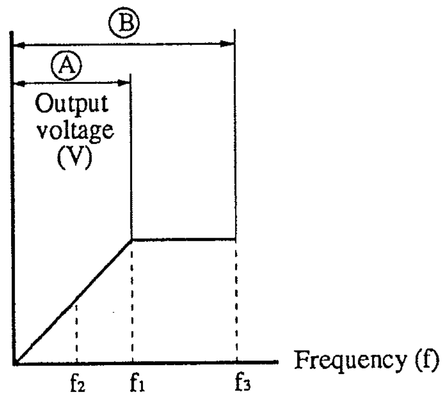


Fig. 8.2 V/f Characteristic

The motor performs dynamic running in this state and the rotational energy of the motor is switched to electric energy and regenerated in the inverter circuit. The status thereof is shown in Fig. 8.3.

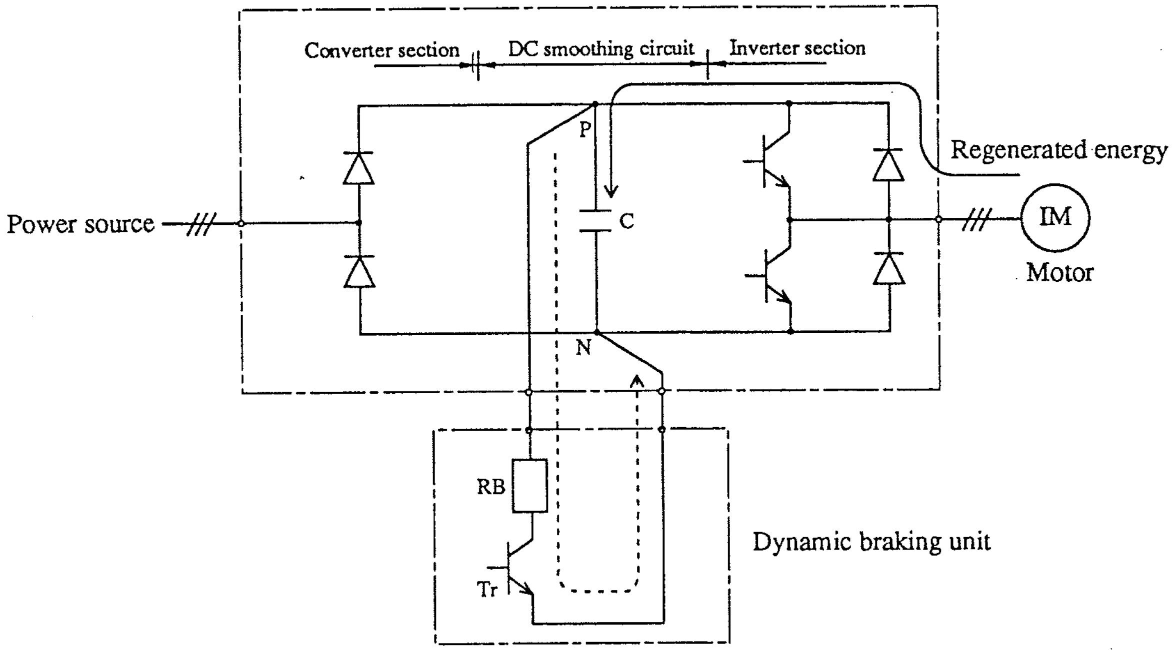


Fig. 8.3 Dynamic Braking by the Inverter

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

8.1 Braking Energy When no Dynamic Braking Unit is Installed

"Braking energy = Loss on the motor side including mechanical loss + loss on the inverter side" is caused.

The overall efficiency during inverter running varies with the motor capacity and loss. The overall efficiency is generally range from 65% to 90% and the braking energy ranges from about 10% to 35%. (at 50 Hz to 60 Hz)

The braking torque of up to about 11 kW is generally equivalent to about 20% of the rated torque of the motor.

When regenerative energy higher than this braking energy is required, the DC voltage increases by charging the capacitor of the DC smoothing circuit, the overvoltage protective circuit is operated, and the inverter interrupts output. (The motor enters the free running state.)

8.2 When Dynamic Braking Units are Used

When the moment of inertia of a load (load J) is high or the motor is decelerated suddenly, the regenerative energy increases. Therefore, a dynamic braking unit (BRD) is necessary for absorbing the regenerative energy.

When the DC circuit voltage reaches the specified value in Fig. 8.3, the transistor (Tr) is switched ON and the regenerative energy is consumed as heat by the resistor (RB). The braking torque in this state is determined by the V/f characteristic of the inverter, the allowable current of the dynamic braking unit (determined by the resistor RB), and the RB capacitor as the generated torque of the motor relates to the current flowing through the transistor (Tr) and resistor (RB).

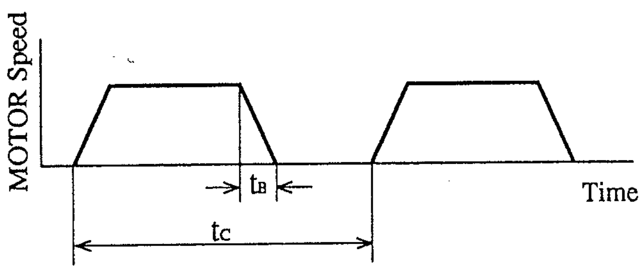
The braking torque (motor torque ratio %) when BRD-EZ2 is used is shown below.

A combination of blank columns shown in Tables 8.1 to 8.3 cannot be used.

(1) When one dynamic braking unit is used

Common conditions:

The motor is a Hitachi standard 3-phase squirrel-cage totally-enclosed-fan-cooled type motor, 4 poles



- BRD operation frequency $\frac{t_B}{t_C} \leq 0.1$
- BRD continuous operation time $t_B \leq 10$ seconds
- T_B Ⓐ : Mean braking torque at 3 to 60 (50) Hz
- T_B Ⓑ : Mean braking torque at 3 to 120 (100) Hz

(For Ⓐ and Ⓑ , see Fig. 8.2.)

Table 8.1 When one BRD-EZ2 Unit is Used Independently

Motor (kW)	Inverter (kVA)	Individual motor Moment of inertia kg•m²	Rated torque of motor To:N•m		Torque ratio of motor (%)					
					Built-in resistor		RB1		RB3	
			50 Hz	60 Hz	T_B Ⓐ	T_B Ⓑ	T_B Ⓐ	T_B Ⓑ	T_B Ⓐ	T_B Ⓑ
0.40	1.0	0.0011	2.69	2.25	150	120				
0.75	1.5	0.0023	5.04	4.21	100	80	150	120		
1.50	2.5	0.0043	10.00	8.33	60	60	100	80		
2.20	3.5	0.0080	14.70	12.20	50	50	100	80		
3.70	5.5	0.0150	24.50	20.50	40	40	60	60	150	120
5.50	8.0	0.0220	36.50	30.40	30	30	50	50	100	80
7.50	11.0	0.0300	49.70	41.40	-	-	40	40	80	80
11.00	16.0	0.0780	72.40	60.40	-	-	30	30	70	70
15.00	22.0	0.0980	98.80	82.30	-	-	-	-	50	50

8.3 General Calculation Formula for Study

An example of the travel device for obtaining the braking torque and discharge resistance will be shown below.

(1) Rated torque of the motor 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 motor speed (r/min)

(2) Braking torque T_B (N•m): Torque necessary for deceleration

* When this value is negative, braking can be performed only by the inverter. (BRD is not necessary.)

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

where J...........Moment of inertial of the "motor + load (motor shaft conversion)" ($kg{\bullet}m^2$)
N_1, N_2 .....Motor speed before and after deceleration (r/min)
T_L ....Motor shaft conversion load torque (N•m)
t_B ....Deceleration time (s)

(3) Discharge resistance R (Ω): Resistance viewed from the inverter

* When this value is less than 17 Ω (minimum value for each BRD unit), a plurality of BRD units are necessary.

$$R = \frac{362.5^2}{0.105 \times T_B \times N_1} \times \frac{1}{1.2}$$

(4) Mean discharge capacity P_L (W)

* Set the capacity of the discharge resistor to 2.5 to 3 times of the following value (W).

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

where t_C ....Running cycle (s)

(2) When two dynamic braking units are used

Table 8.2 When Two BRD-EZ2 Units are Used in Parallel

Motor (kW)	Inverter (kVA)	Individual motor Moment of inertia $kg \cdot m^2$	Rated torque of motor To:N•m		Torque ratio of motor (%)					
					Built-in resistor		RB1		RB3	
			50 Hz	60 Hz	T_B Ⓐ	T_B Ⓑ	T_B Ⓐ	T_B Ⓑ	T_B Ⓐ	T_B Ⓑ
0.40	1.0	0.0011	2.69	2.25	-	-	-	-	-	-
0.75	1.5	0.0023	5.04	4.21	150	120	-	-	-	-
1.50	2.5	0.0043	10.00	8.33	100	80	-	-	-	-
2.20	3.5	0.0080	14.70	12.20	70	70	150	120	-	-
3.70	5.5	0.0150	24.50	20.50	50	50	110	90	-	-
5.50	8.0	0.0220	36.50	30.40	30	30	80	80	100	100
7.50	11.0	0.0300	49.70	41.40	30	30	60	60	100	100
11.00	16.0	0.0780	72.40	60.40	-	-	50	50	100	100
15.00	22.0	0.0980	98.80	82.30	-	-	40	40	100	100

(3) Mean braking torque when the inverter frame moves up by one size

In the case of a standard combination of the motor and inverter, the braking torque is limited due to the resistant overcurrent of the inverter. However, when the frame of the inverter moves up, the torque of the motor can be increased up to the limit. The braking torque when the inverter frame is moved up by one size is shown in Table 8.3. When braking torque of 135% or more is necessary, it is necessary to move up the motor frame.

Table 8.3 Conditions for Maximizing the Braking Torque of the Motor (When the inverter is moved up by one size)

Conditions: ① The mean braking torque is set to 135% (To x 1.35).
② The inverter frame moves up by one size.
③ T_B Ⓑ $= 0.8 \times T_B \times$ Ⓐ
④ The running frequency is the same as the one shown in Tables 8.1 and 8.2.

Motor (kW)	Inverter (kVA)	Individual motor Moment of inertia $kg \cdot m^2$	Rated torque of motor To:N•m		Torque ratio of motor (%)		
					Built-in resistor	RB1	RB3
			50 Hz	60 Hz	T_B Ⓐ	T_B Ⓐ	T_B Ⓐ
0.40	1.0	0.0011	2.69	2.25	BRD-E2 ••• 1	-	-
0.75	1.5	0.0023	5.04	4.21	BRD-E2 ••• 2	BRD-E2 ••• 1	-
1.50	2.5	0.0043	10.00	8.33	BRD-E2 ••• 3	RB1 •••••••• 1	-
2.20	3.5	0.0080	14.70	12.20	-	BRD-E2 ••• 2 RB1 •••••••• 2	BRD-E2 ••• 1 RB3 •••••••• 1
3.70	5.5	0.0150	24.50	20.50	-	BRD-E2 ••• 3 RB1 •••••••• 3	
5.50	8.0	0.0220	36.50	30.40	-	-	BRD-E2 ••• 2
7.50	11.0	0.0300	49.70	41.40	-	-	RB3 •••••••• 2
11.00	16.0	0.0780	72.40	60.40	-	-	BRD-E2 ••• 3
15.00	22.0	0.0980	98.80	82.30	-	-	RB3 •••••••• 3

9. PARTS ORDERING AND INQUIRIES

When contacting your distributor for replacing faulty parts or inquiries, report the following items.

(1) Model

(2) Serial manufacturing number (MFG. No.)

(3) Details of fault

If the nameplate is illegible, report only the items you can identify together with simple sketches of the required parts.
To minimize the idle time of the unit, it is recommended that one set of the main unit be in stock.

Warranty

The warranty period under normal installation and handling conditions shall be one year after the date of delivery. The warranty shall cover the repair of only the main unit delivered.

1. This warranty is effective only in Japan.
2. The repair in the following cases shall be charged to the user.

   (a) Fault or damage caused by maloperation or inappropriate modification or repair

   (b) Fault or damage caused by falling or transportation

   (c) Fault or damage caused by fire, earthquake, flooding, lightning, natural disaster, environmental pollution, or too excessive voltage

3. When repair is required for the unit at the user's site, all expenses associated with the on site repair shall be charged to the user.
4. This manual will not be reissued. Keep it carefully.

(5) Duty cycle $\frac{t_B}{t_C}$

① When the BRD built-in resistors are used, $\frac{t_B}{t_C} \leq \frac{1}{10}$.

When $\frac{t_B}{t_C} > \frac{1}{10}$ is required, use the external resistors.

② When the built-in resistors are removed, $\frac{t_B}{t_C} \leq \frac{1}{2}$.

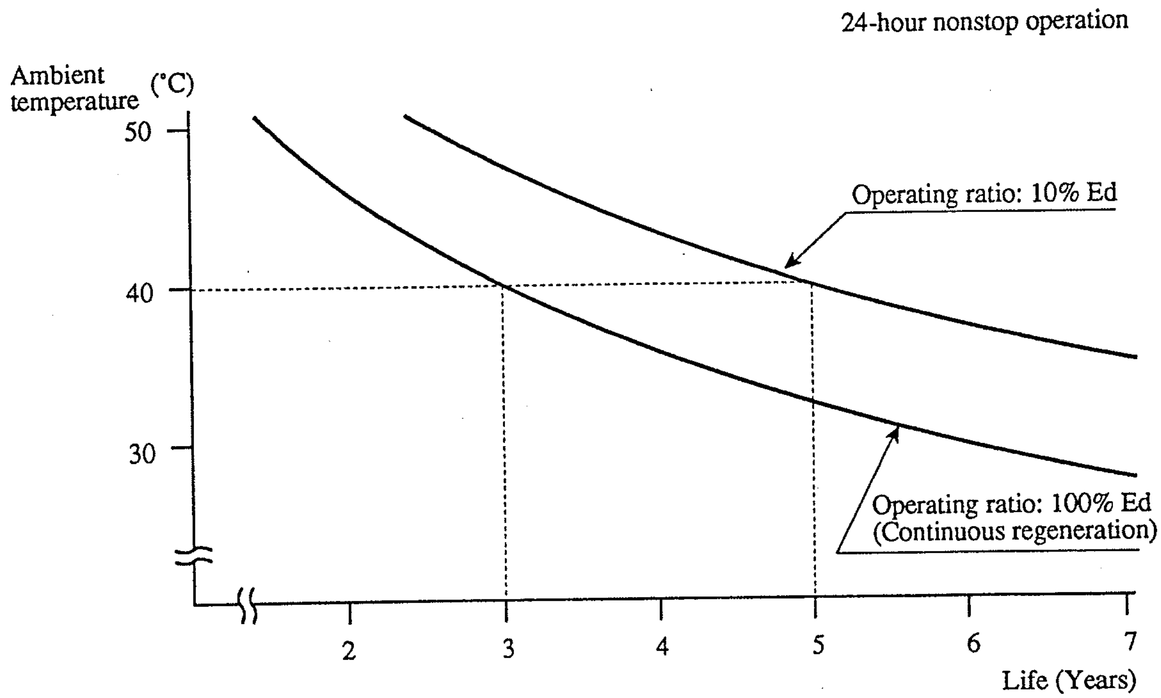
③ When the optional external resistor units RB1, RB2, and RB3 are used

When $\frac{1}{2} \geq \frac{t_B}{t_C} > \frac{1}{10}$ is required, the resistor capacity should be reduced as shown below.

$\frac{t_B}{t_C}$	$\frac{1}{10}$	$\frac{1}{5}$	$\frac{1}{3}$	$\frac{1}{2}$
Reduction rate (%)	100	60	40	30

Example: If RB3 is used when $\frac{t_B}{t_C} = \frac{1}{5}$, the resistor may be considered as a resistor of 720 W. (1200 W x 0.6 = 720 W)

Appendix 1 Capacitor Life



A.1 Capacitor life curves

The lives of the aluminum electrolytic capacitors differ according to the particular ambient temperature. See Fig. A.1 above.

Check the capacitors at fixed periods to see that they are free from liquid leakage, deformation, or other abnormalities.

Be extra careful that operation at high ambient temperatures or high frequency, in particular, causes the capacitors to deteriorate and thus the life of the regenerative braking unit to decrease.