Function Code	Parameter Name	Setting Range	Unit	Function	Property	Effective Time	Default
H02-12	Delay from brake output OFF to motor de-energized in rotating state	1 to 1000	ms	Set the delay from the moment when the brake output signal (BK) becomes OFF to the moment when the S-ON signal becomes OFF at motor rotating. If the brake output function (BK) is not used, H02-12 is invalid.	During running	Immediate	500

Brake Time Sequence in Faulty State of Servo Drive

The servo faults are classified into class 1 faults (NO.1) and class 2 (NO.2). For details, refer to *Chapter 8 Troubleshooting*. The brake time sequences in faulty state of servo drive includes two conditions:

For NO. 1 faults:

The brake output signal becomes OFF when one of the following conditions is met (same as the brake time sequence at motor rotating in normal state of servo drive):

- The motor has decelerated to H02-11 when the H02-12 time is not reached.
- The motor speed is still higher than H02-11 though H02-12 time is reached.

For NO. 2 faults:

When a NO. 2 fault occurs and the brake is applied, the stop mode is forced to "Stop at zero speed, keeping de-energized state".

The servo motor stops at zero speed first. When the motor speed is smaller than 20 RPM, the brake output signal immediately becomes OFF once the preceding condition is met; but the motor is still in energized state within the time of H02-10.

5.1.7 Braking Setting

When the motor torque direction is opposite to the speed direction, the energy is transmitted from the motor back to the servo drive, causing rise of the bus voltage. When the bus voltage rises to the braking threshold, the energy is consumed by the regenerative resistor according to the braking requirements; otherwise, the servo drive will be damaged. The regenerative resistor can be built-in or external; the two must not be used together. The following table lists the specifications of the regenerative resistor.

Table 5-2 Specifications of the regenerative resistor for the servo drive

Drive Model	Built-in Regenerative Resistor			Min. Permissible Resistance of External Regenerative Resistor (Ω) (H02-21)
	Resistance (Ω)	Power Pr (W)	Processing Power P_a (W)	
IS620PS1R6I	-	-	-	50
IS620PS2R8I	-	-	-	45
IS620PS5R5I	50	50	25	40

Drive Model	Built-in Regenerative Resistor			Min. Permissible Resistance of External Regenerative Resistor (Ω) (H02-21)
	Resistance (Ω)	Power Pr (W)	Processing Power P_a (W)	
IS620PS7R6I	25	80	40	20
IS620PS012I				15
IS620PT3R5I	100	80	40	80
IS620PT5R4I	100	80	40	60
IS620PT8R4I	50	80	40	45
IS620PT012I				
IS620PT017I	40	100	50	35
IS620PT021I				25
IS620PT026I				

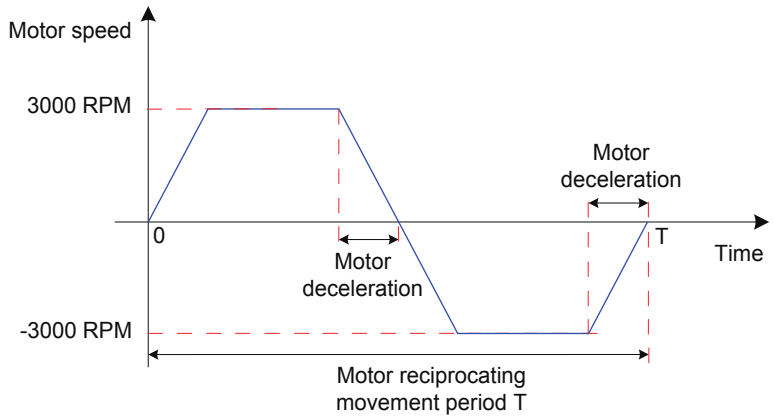
Note	The models S1R6 and S2R8 do not have the built-in regenerative resistor. Users need to prepare an external one themselves.

External Load Torque Not Existing

The energy at braking of reciprocating motor movement is converted into electric energy and fed back to the bus capacitor. When the bus voltage exceeds the braking voltage threshold, the regenerative resistor consumes the excessive feedback energy.

The following figure takes motor no-load running from 3000 RPM to static as an example to show the motor speed curve and energy data.

Figure 5-5 Motor speed curve example with external load torque not existing



■ Energy calculation

The following two tables respectively list the energy data when the motors of 220 V and 380 V decelerate from 3000 RPM under no load to 0.

220 V:

Capacity (W)	Servo Motor Model ISMH*-*******-*****		Rotor Inertia J (10^{-4} kgm^2)	Braking Energy EO(J) from 3000 RPM to Static with No Load	Max. Braking Energy Absorbed by Capacitor EC(J)
100	H1 (low inertia, 40/60/80 cm flange)	10B30CB	0.048	0.237	9
200		20B30CB	0.163	0.806	9
400		40B30CB	0.25	1.237	18
750		75B30CB	1.3	6.435	26
1000	H2 (low inertia, 100/130 cm flange)	10C30CB	3.12	15.44	26
1500		15C30CB	3.71	18.364	47
850	H3 (medium inertia, 130/180 cm flange)	85B15CB	15.5	76.725	26
1300		13C15CB	21.8	107.91	47
400	H4 (low inertia, 60/80 cm flange)	40B30CB	0.667	3.301	18
750		75B30CB	2.033	10.063	26

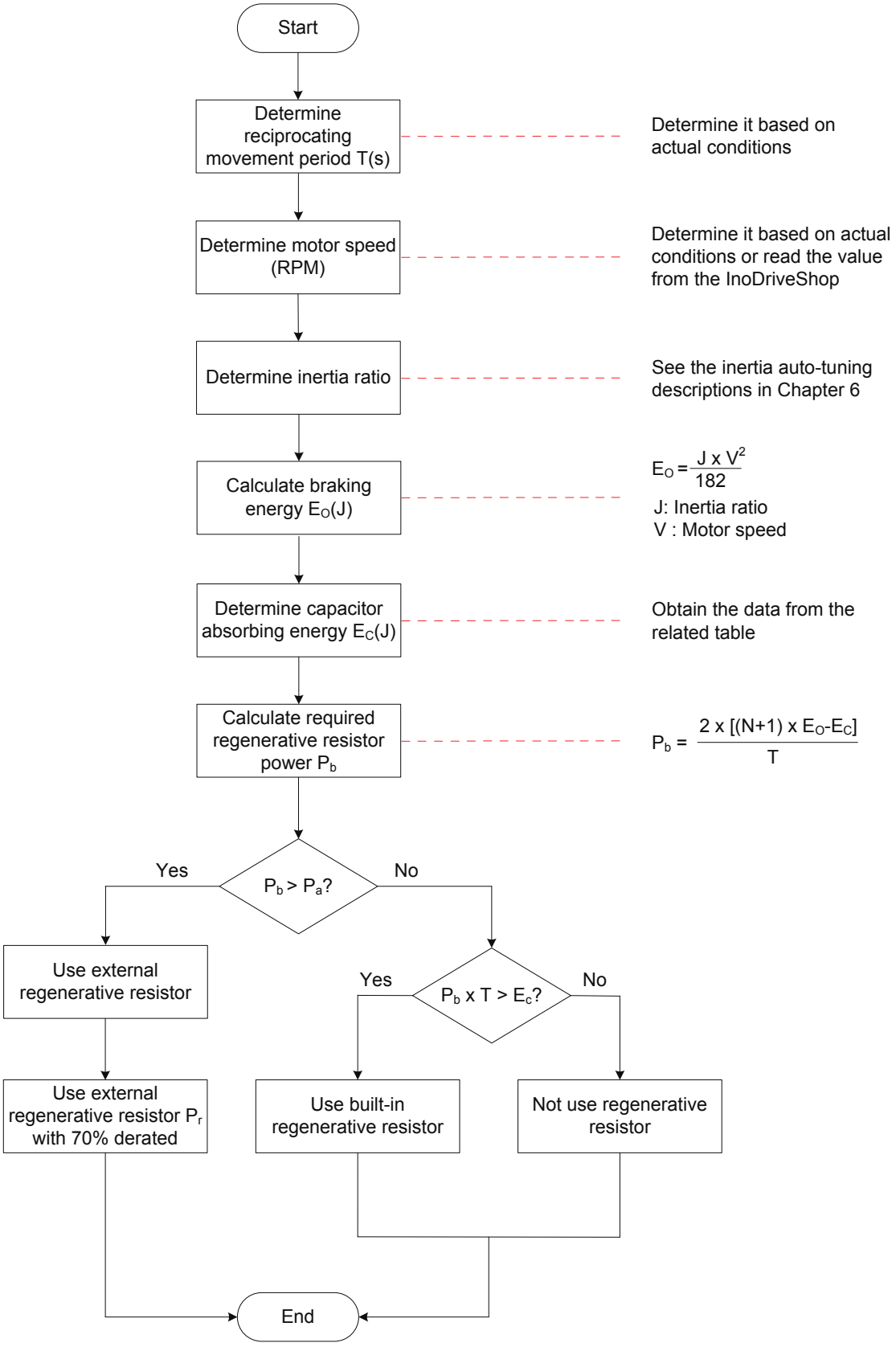
380 V:

Capacity (W)	Servo Motor Model ISMH*-*******-*****		Rotor Inertia J (10^{-4} kgm^2)	Braking Energy EO(J) from 3000 RPM to Static with No Load	Max. Braking Energy Absorbed by Capacitor EC(J)
1000	H2 (low inertia, 100/130 cm flange)	10C30CD	3.12	15.444	28
1500		15C30CD	3.71	18.3645	34
2000		20C30CD	3.06	15.147	50
2500		25C30CD	3.65	18.0675	50
3000		30C30CD	7.72	38.214	50
4000		40C30CD	12.1	59.895	81
5000		50C30CD	15.4	76.23	81
850	H3 (medium inertia, 130/180 cm flange)	85B15CD	15.5	76.725	28
1300		13C15CD	21.8	107.91	34
1800		18C15CD	28	138.6	50
2900		29C15CD	57.2	283.14	50
4400		44C15CD	90.8	449.46	81
5500		55C15CD	109.5	542.025	122
7500		75C15CD	143.1	708.345	122

If the total braking time T is known, whether an external regenerative resistor is required and the power of the resistor can be calculated based on the flowchart and formula.

■ Regenerative resistor selection

Figure 5-6 Regenerative resistor selection flowchart



The following part describes the process when the motor decelerates from 3000 RPM to 0 as an example.

Assume that the load inertia is N times of the motor inertia, the braking energy is (N+1) x E_O when the motor decelerates from 3000 RPM to 0. The capacitor absorbs energy E_C, and the remaining energy to be consumed by the regenerative resistor is (N+1) x E_O – E_C. Assume that the reciprocating movement period is T, the required regenerative resistor power is 2 x [(N+1) x E_O-E_C]/T.

Determine whether to use the regenerative resistor and select the built-in or external one. Then, set H02-25 accordingly.

The resistor with aluminum case is recommended.

Relevant parameters:

Function Code	Parameter Name	Setting Range	Function	Property	Effective Time	Default
H02-25	Regenerative resistor type	0: Built-in 1: External, natural cooling 2: External, forced air cooling 3: No resistor, using only capacitor	Set the regenerative resistor type and the mode of absorbing and releasing the braking energy.	At stop	Immediate	0

Take the H1 series 750 W model as an example. Assume that the reciprocating movement period T = 2s, maximum speed = 3000 RPM, inertia ratio = 4, the required regenerative resistor power is:

$$P_b = \frac{2 \times [(N+1) \times E_O - E_C]}{T} = \frac{2 \times [(4+1) \times 6.4 - 9]}{2} = 23\ W$$

The calculated value is smaller than the capacity (P_a = 25 W) of the built-in regenerative resistor, and a built-in regenerative resistor is sufficient to meet the requirements.

If the inertia ratio is 10 and other conditions are the same, the required regenerative resistor power is:

$$P_b = \frac{2 \times [(N+1) \times E_O - E_C]}{T} = \frac{2 \times [(10+1) \times 6.4 - 9]}{2} = 61$$

The calculated value is larger than the capacity (P_a = 25 W) of the built-in regenerative resistor, and an external regenerative resistor is required. The recommended power is E_O/(1 – 70%) = 204.6 W.

■ Connection and setting of regenerative resistor

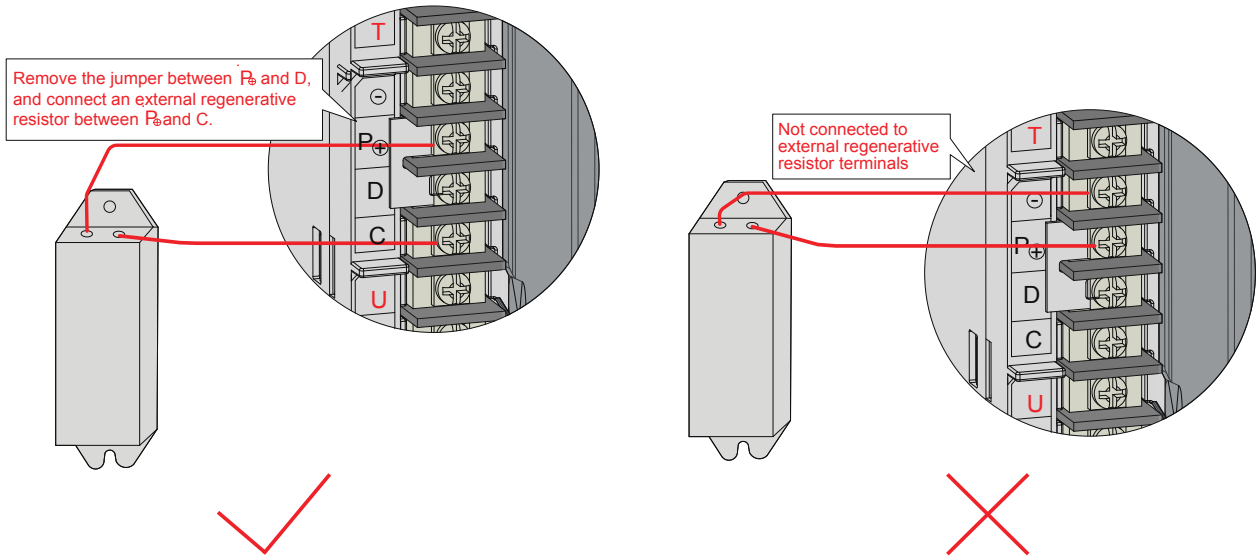
a. Using external regenerative resistor:

When P_b > P_a, an external regenerative resistor needs to be connected. Based on the cooling mode of the regenerative resistor, set H02-25 to 1 or 2.

Use the external regenerative resistor with 70% derated, that is, $P_r = P_b/(1 – 70\%)$, and ensure the power is larger than the permissible minimum resistance of the servo drive.

Remove the jumper between $P_\oplus$ and D, and connect two ends of the resistor respectively to terminals $P_\oplus$ and C.

Figure 5-7 Connection diagram of external regenerative resistor



For the wire size, refer to *Chapter 3 Wiring*.

Based on the cooling mode of the regenerative resistor, set H02-25 to 1 or 2, and set the following parameters.

Relevant parameters:

Function Code	Parameter Name	Setting Range	Unit	Function	Property	Effective Time	Default
H02-21	Permissible minimum resistance of regenerative resistor	Model dependent	-	Display the permissible minimum resistance of the external regenerative resistor.	At display	-	Model dependent
H02-26	Power of external regenerative resistor	1 to 65535	W	Set the power of the actually used external regenerative resistor. Note: The power of the actually used external regenerative resistor must not be smaller than the calculated value.	At stop	Immediate	Model dependent

Function Code	Parameter Name	Setting Range	Unit	Function	Property	Effective Time	Default
H02-27	Resistance of external regenerative resistor	1 to 1000	Ω	Set the resistance of the actually used external regenerative resistor. Note: The resistance of the actually used external regenerative resistor must not be smaller than the permissible minimum resistance of regenerative resistor in H02-21. Otherwise, fault Err.922 will occur.	At stop	Immediate	Model dependent

CAUTION

Set the power and resistance of the external regenerative resistor in H02-26 and H02-27 correctly.

Ensure the resistance of the external regenerative resistor is larger than the permissible minimum resistance.

In natural environment, when the regenerative resistor is used at its rated power rather than the processing power (average), the temperature of the resistor will rise to above 120°C under continuous braking. To ensure safety, reduce the temperature with force air cooling, or use a resistor with a thermal switch. For the load characteristics of the regenerative resistor, consult the manufacturer.

5

Set the heat dissipation coefficient based on the heat dissipation condition of the external regenerative resistor.

Relevant parameters:

Function Code	Parameter Name	Setting Range	Unit	Function	Property	Effective Time	Default
H02-24	Resistor heat dissipation coefficient	10 to 100	%	Set the heat dissipation coefficient for the external regenerative resistor. The value is not larger than 30% when natural ventilation is used. The value is not larger than 50% when forcible air cooling is used.	At stop	Immediate	30

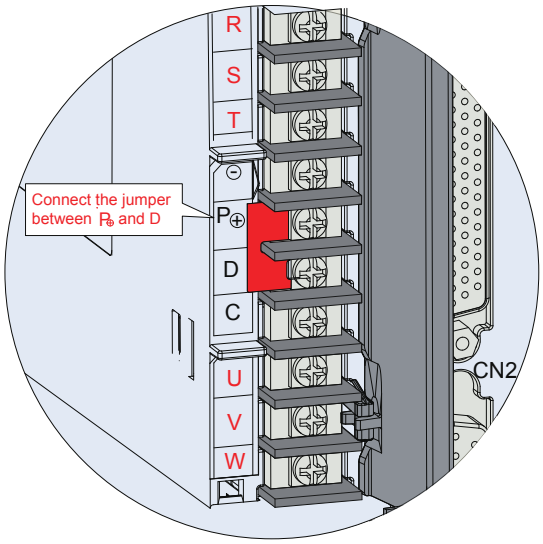
Note	A larger resistor heat dissipation coefficient means better braking efficiency.

b. Using built-in regenerative resistor:

When Pb < Pa and Pb x T > EC, the built-in regenerative resistor is used. Set H02-25 to 0.

When using the built-in regenerative resistor, connect terminals $P_{\oplus}$ and D with a jumper.

Figure 5-8 Connection of the built-in regenerative resistor



Check that the following parameters are set according to *1.1.4 Specifications of Regenerative Resistor*.

Relevant parameters:

Function Code	Parameter Name	Setting Range	Function	Property	Effective Time	Default
H02-22	Power of built-in regenerative resistor	Model dependent	Display the power of the built-in regenerative resistor.	At display	-	Model dependent
H02-23	Resistance of built-in regenerative resistor	Model dependent	Display the resistance of the built-in regenerative resistor.	At display	-	Model dependent

c. Not using regenerative resistor:

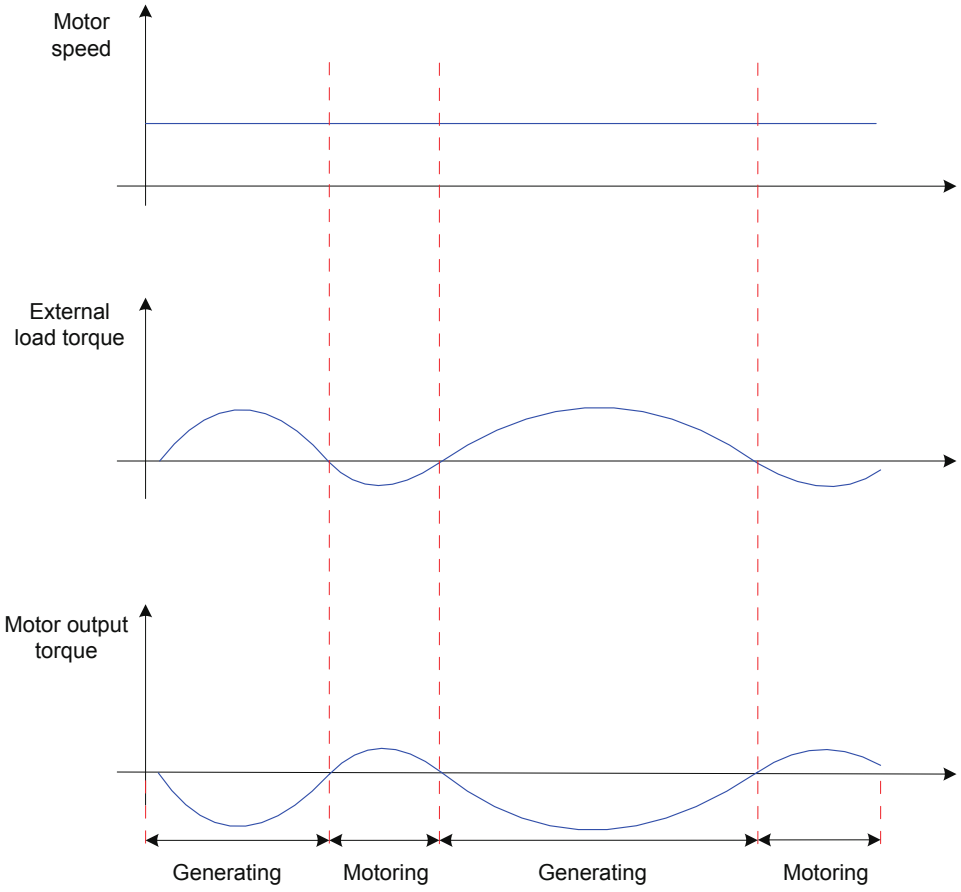
When Pb x T < EC, no regenerative resistor is required, as the bus capacitor is sufficient to absorb the braking energy. In this case, set H02-25 to 3.

External Load Torque Existing, Making the Motor in Generating State

When the motor torque direction is the same as the rotating direction, the motor produces energy externally. In some special applications where the motor torque direction is opposite to the rotating direction, the motor is in generating state, and pumps the electric energy back to the servo drive.

When the load is in continuous generating state, the common DC bus is recommended.

Figure 5-9 Example of curve for external load torque existing



Take the H1 series 750 W model (rated torque 2.39 Nm) as an example. When the external load torque is 60% of the rated torque and the motor speed is 1500 RPM, the power pumped back to the drive is:

(60% x 2.39) x (1500 x 2π/60) = 225 W

As the regenerative resistor is derated by 70%, and therefore, the power of the external regenerative resistor is:

225/(1 – 70%) = 750 W, with resistance 50 Ω