

Title: Servomotor Brake Control Overview

Product(s): Sigma-5/7 SERVOPACKS and Servomotors

Doc. No. AN.SIGMA.01

Servomotor Brake Caution

The brake built into a Servomotor with a Brake is a de-energization brake. Meaning it needs to be energized to release the brake. It is used only to hold the Servomotor and cannot be used for stopping. Use the holding brake only to hold a Servomotor that is already stopped.

Overview

Servomotor brake control for Yaskawa SERVOPACKs is handled by an external relay or SSR (solid state relay) controlled by the /BK output from the SERVOPACK. The exception to this is the Sigma-7 400V SERVOPACK with holding brake option "026" which has a built in relay for controlling the brake.

The intention of this document is to provide an overview of how to design a recommend brake circuit and parameterize the SERVOPACK to use the brake effectively and reliably.

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- SERVOPACK Parameters
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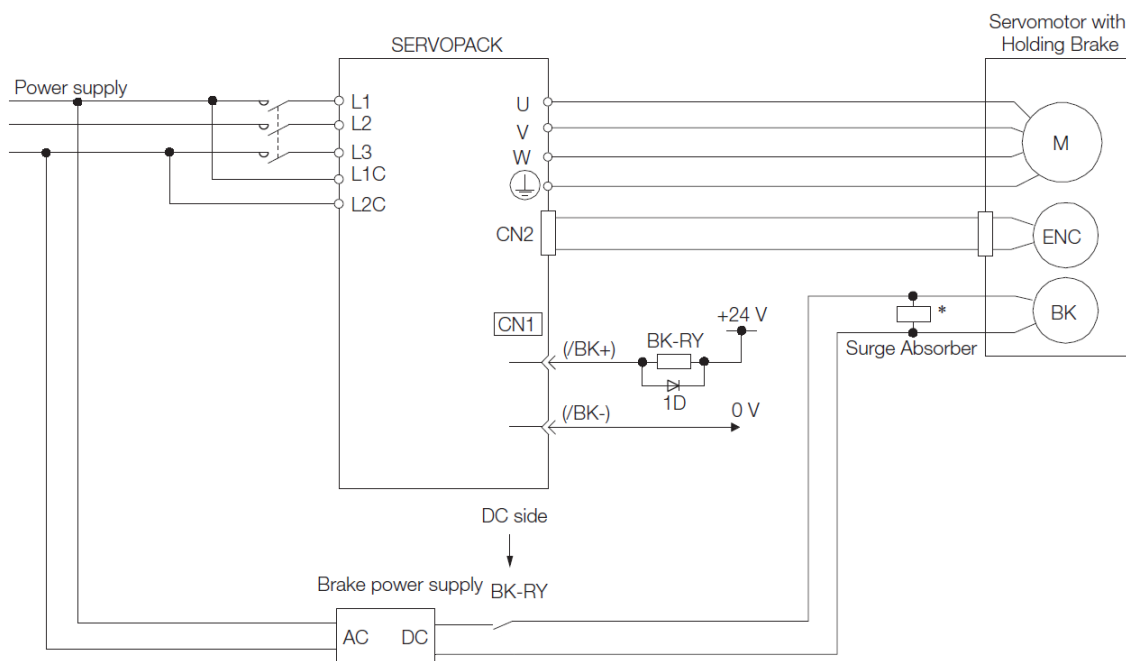
- [Confirming Brake Operation](#)

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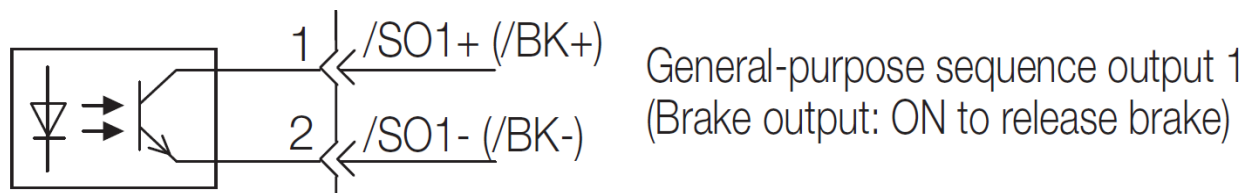
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Brake Relay Circuit



BK-RY: Brake control relay
1D: Flywheel diode

* Install the surge absorber near the brake terminals on the Servomotor.



The default output selection for /BK varies by the interface of the SERVOPACK. Make sure to confirm which output the /BK signal is mapped to. [Parameter for /BK Output Selection](#)

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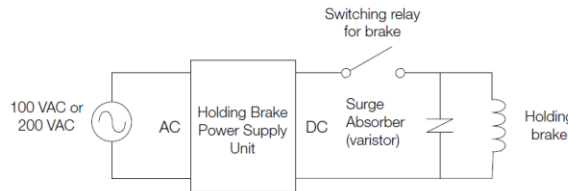
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Surge Absorbers for Relay Circuits

Surge Absorbers (varistors) and Diodes for holding brake power supplies help prevent damage to brake coils caused by voltage surges.

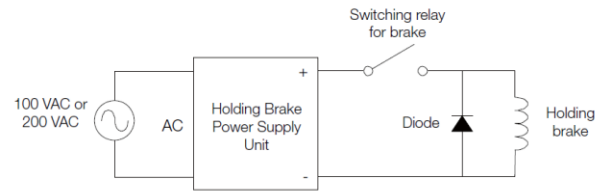
◆ Circuit for a Surge Absorber (Varistor)

A Surge Absorber (varistor) has no polarity.



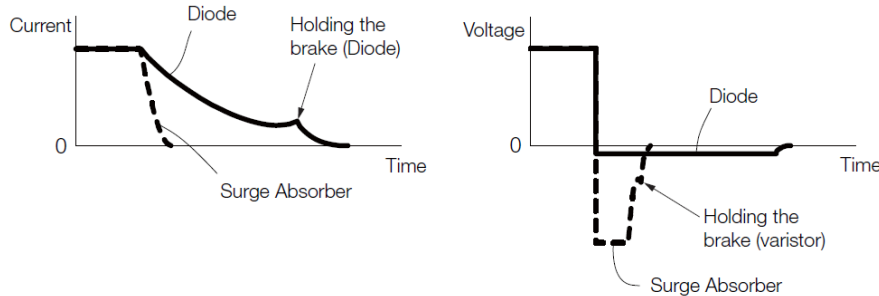
◆ Circuit for a Diode

A Diode has polarity. Refer to the following figure for connections.



Note

- When you select a Surge Absorber, varistor, or Diode for your application, consider the service life and test all operations, including the brake timing, before you use the Servomotor.
- If you connect an SSR (i.e., a semiconductor relay) to switch the brake circuit, use a Diode.
- If you connect a Diode, more time is required to brake than with a Surge Absorber. (Refer to the following figure.) If you use a diode, consider this in the application.



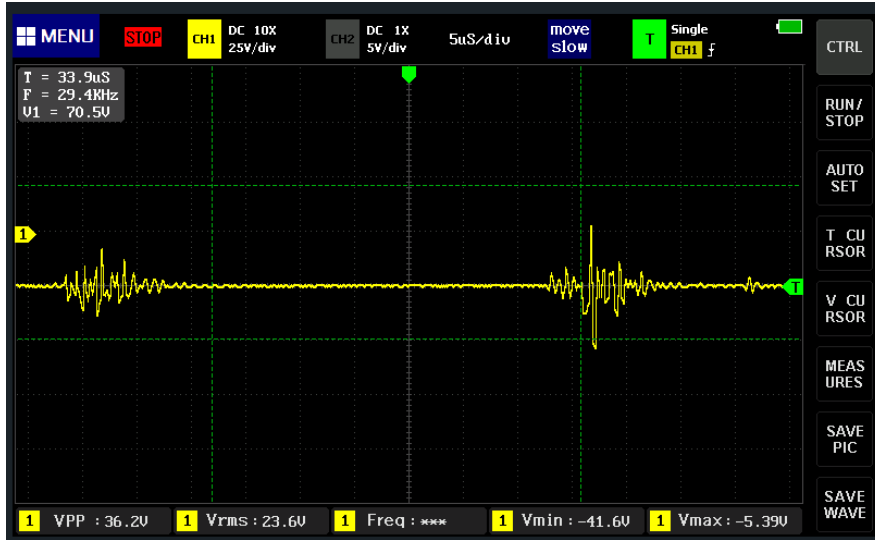
Note: Sigma-7 400V SERVOPACK with holding brake option “026”, which has a built in relay, includes a diode so no external suppression across the motor brake coil is needed.

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Example scenario where a 24V power supply has voltage fluctuations that may benefit from a Surge Absorber (Varistor), also known as a “snubber”.



Surge Absorbers (Varistors) for Holding Brake Power Supplies

Use the following table as reference in selecting a Surge Absorber. Elements were selected for a Surge Absorber surrounding air temperature range of -20°C to 60°C and an ON/OFF switching frequency of 10 times or less per minute. The information in this table is for reference only, and does not ensure operation in combination with the holding brake.

Surge Absorbers are not provided by Yaskawa.

Holding Brake Power Supply Voltage		24 VDC		
Manufacturer		Nippon Chemi-Con Corporation	Semitec Corporation	Panasonic
		Order Number		
Brake Rated Current	1 A max.	TNR5V121K	Z5D121	ERZV05D121
	2 A max.	TNR7V121K	Z7D121	ERZV07D121
	4 A max.	TNR10V121K	Z10D121	ERZV10D121
	8 A max.	TNR14V121K	Z15D121	ERZV14D121

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Diodes for Holding Brake Power Supplies

Select a Diode for the holding brake power supply with a rated current that is greater than that of the holding brake and with the recommended withstand voltage given in the following table.

Diodes are not provided by Yaskawa.

Brake Voltage	Withstand Voltage
24 VDC	100 to 200 V

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Brake Specification

Confirm the brake specifications for the Servomotor being used in the application.

All given brake specifications are for 24 VDC Servomotor brakes. Use a dedicated 24 VDC power supply just for energizing the Servomotor brake coil. I/O signals might malfunction if they use the same 24 VDC power supply as the Servomotor brake coil.

- Rated Current – sizing external relay or SSR
- Brake Release and Close Times - important to the motion controller program and setting SERVOPACK parameters

Sigma-5 SGMMV

Servomotor		Holding Brake Specifications				
Model	Rated Output W	Capacity W	Holding Torque N·m	Rated Current A(at 20°C)	Brake Release Time ms	Brake Close Time ms
SGMMV-A1E SGMMV-A1A	10	2.0	0.0318	0.075	40	100
SGMMV-A2E SGMMV-A2A	20	2.6	0.0637	0.108	40	100
SGMMV-A3E SGMMV-A3A	30	2.6	0.0955	0.108	40	100

Sigma-5 SGMJV

Servomotor		Holding Brake Specifications				
Model	Rated Output W	Capacity W	Holding Torque N·m	Rated Current A(at 20°C)	Brake Release Time ms	Brake Close Time ms
SGMJV-A5A	50	5.5	0.159	0.23	60	100
SGMJV-01A	100	5.5	0.318	0.23	60	100
SGMJV-C2A	150	5.5	0.477	0.23	60	100
SGMJV-02A	200	6	0.637	0.25	60	100
SGMJV-04A	400	6	1.27	0.25	60	100
SGMJV-06A	600	6.5	1.91	0.27	80	100
SGMJV-08A	750	6.5	2.39	0.27	80	100

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Sigma-5 SGMVA

Servomotor		Holding Brake Specifications				
Model	Rated Output W	Capacity W	Holding Torque N·m	Rated Current A(at 20°C)	Brake Release Time ms	Brake Close Time ms
SGMAV-A5A	50	5.5	0.159	0.23	60	100
SGMAV-01A	100	5.5	0.318	0.23	60	100
SGMAV-C2A	150	5.1	0.477	0.21	60	100
SGMAV-02A	200	6	0.637	0.25	60	100
SGMAV-04A	400	6	1.27	0.25	60	100
SGMAV-06A	550	8	1.75	0.32	80	100
SGMAV-08A	750	6.5	2.39	0.27	80	100
SGMAV-10A	1000	7	3.18	0.29	80	100

Sigma-5 SGMGV

Servomotor		Holding Brake Specifications				
Model	Rated Output kW	Capacity W	Holding Torque N·m	Rated Current A(at 20°C)	Brake Release Time ms	Brake Close Time ms
SGMGV-03	0.3	10.0	4.5	0.42	100	80
SGMGV-05	0.45	10.0	4.5	0.42	100	80
SGMGV-09	0.85	10.0	12.7	0.41	100	80
SGMGV-13	1.30	10.0	19.6	0.41	100	80
SGMGV-20	1.80	10.0	19.6	0.41	100	80
SGMGV-30	2.90	18.5	43.1	0.77	170	100
SGMGV-44	4.4	18.5	43.1	0.77	170	100
SGMGV-55	5.5	25.0	72.6	1.05	170	80
SGMGV-75	7.5	25.0	72.6	1.05	170	80
SGMGV-1A	11	32.0	84.3	1.33	170	80
SGMGV-1E	15	35.0	114.6	1.46	250	80

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Sigma-5 SGMSV

Servomotor		Holding Brake Specifications				
Model	Rated Output kW	Capacity W	Holding Torque N·m	Rated Current A(at 20°C)	Brake Release Time ms	Brake Close Time ms
SGMSV-10	1.0	12	7.84	0.50	170	80
SGMSV-15	1.5	12	7.84	0.50	170	80
SGMSV-20	2.0	12	7.84	0.50	170	80
SGMSV-25	2.5	12	10.00	0.50	170	80
SGMSV-30	3.0	10	20.00	0.41	100	80
SGMSV-40	4.0	10	20.00	0.41	100	80
SGMSV-50	5.0	10	20.00	0.41	100	80

Sigma-7 SGM7J

Servomotor		Holding Brake Specifications				
Model	Rated Output W	Capacity W	Holding Torque N·m	Rated Current A(at 20°C)	Brake Release Time ms	Brake Close Time ms
SGM7J-A5A	50	5.5	0.159	0.23	60	100
SGM7J-01A	100	5.5	0.318	0.23	60	100
SGM7J-C2A	150	5.5	0.477	0.23	60	100
SGM7J-02	200	6.0	0.637	0.25	60	100
SGM7J-04	400	6.0	1.270	0.25	60	100
SGM7J-06A	600	6.5	1.910	0.27	80	100
SGM7J-08	750	6.5	2.390	0.27	80	100
SGM7J-15D	1500	7.5	4.770	0.31	80	100

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Sigma-7 SGM7A

Servomotor		Holding Brake Specifications				
Model	Rated Output W	Capacity W	Holding Torque N·m	Rated Current A(at 20°C)	Brake Release Time ms	Brake Close Time ms
SGM7A-A5A	50	5.5	0.159	0.23	60	100
SGM7A-01A	100	5.5	0.318	0.23	60	100
SGM7A-C2A	150	5.1	0.477	0.21	60	100
SGM7A-02	200	6	0.637	0.25	60	100
SGM7A-04	400	6	1.27	0.25	60	100
SGM7A-06A	550	8	1.75	0.32	80	100
SGM7A-08	750	6.5	2.39	0.27	80	100
SGM7A-10	1000	7	3.18	0.29	80	100
SGM7A-15	1500	12	7.84	0.5	170	80
SGM7A-20	2000	12	7.84	0.5	170	80
SGM7A-25	2500	12	10.00	0.5	170	80
SGM7A-30	3000	10	20.00	0.41	100	80
SGM7A-40	4000	10	20.00	0.41	100	80
SGM7A-50	5000	10	20.00	0.41	100	80
SGM7A-70	7000	NA	NA	NA	NA	NA

Sigma-7 SGM7P

Servomotor		Holding Brake Specifications				
Model	Rated Output W	Capacity W	Holding Torque N·m	Rated Current A(at 20°C)	Brake Release Time ms	Brake Close Time ms
SGM7P-01A	100	6.0	0.318	0.25	80	100
SGM7P-02A	200	7.4	0.637	0.31	80	100
SGM7P-04A	400	7.4	1.27	0.31	80	100
SGM7P-08A	750	7.5	2.39	0.31	80	100
SGM7P-15A	1500	7.5	4.77	0.31	80	100

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Sigma-7 SGM7G

Servomotor		Holding Brake Specifications				
Model	Rated Output kW	Capacity W	Holding Torque N·m	Rated Current A(at 20°C)	Brake Release Time ms	Brake Close Time ms
SGM7G-03A	0.3	10	4.5	0.43	100	80
SGM7G-05	0.45	10	4.5	0.43	100	80
SGM7G-09	0.85	10	12.7	0.41	100	80
SGM7G-13	1.3	10	19.6	0.41	100	80
SGM7G-20	1.8	10	19.6	0.41	100	80
SGM7G-30	2.9	18.5	43.1	0.77	170	100
SGM7G-44	4.4	18.5	43.1	0.77	170	100
SGM7G-55	5.5	25	72.6	1.05	170	80
SGM7G-75	7.5	25	72.6	1.05	170	80
SGM7G-1A	11	32	84.3	1.33	170	80
SGM7G-1E	15	35	114.6	1.46	250	80

The Capacity or Rated Current of the brake coil is used to size the relay or SSR that will control 24VDC to the brake coil. Other factors to consider when sizing the relay or SSR:

- /BK output can only supply 50mA
- Brake coil is an inductive load
- Duty cycle of the application
 - A relay would not be recommended if the brake is cycled every 10 seconds
 - In this case, an SSR would need to be used

Below are examples of external devices that could be used to control the brake coil for the largest listed motors in this document.

Manufacturer		Wago	Phoenix Contact
		Order Number	
External Device Type	Relay	788-384	2966171
	SSR	788-700	2900364

SSRs are convenient in that they typically include suppression hardware where on the other hand it is recommended to add external suppression hardware when using relays.

[Surge Absorbers for Relay Circuits](#)

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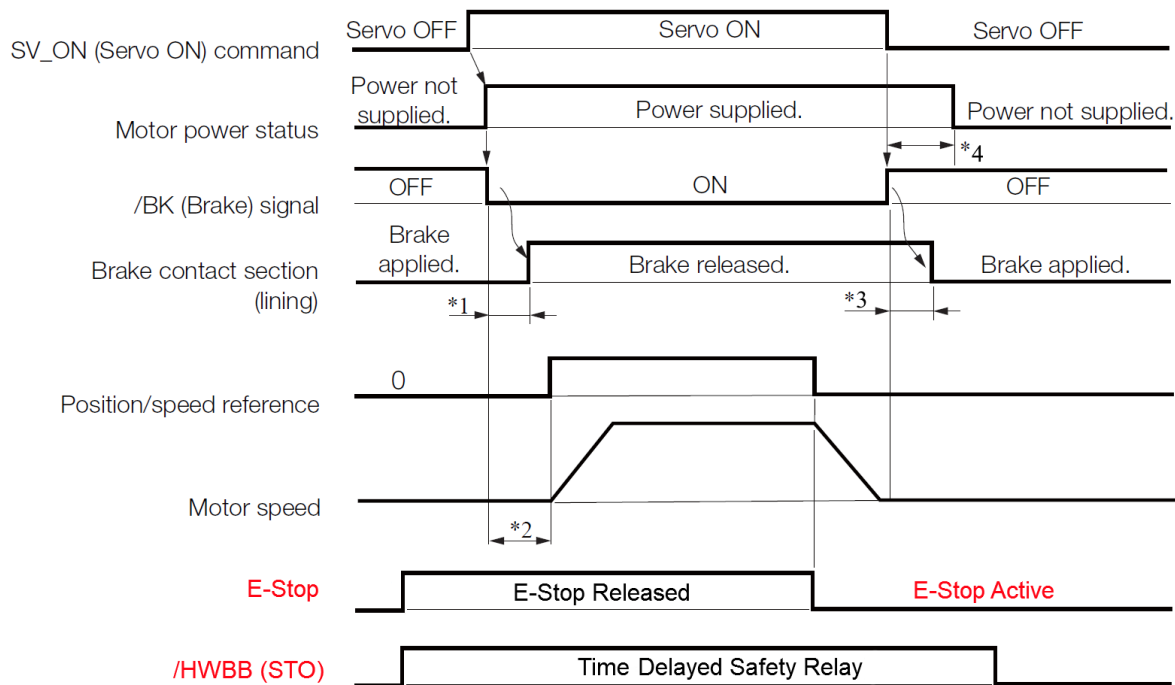
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The Brake Release Time will be used in the user's motion controller program to delay motion until the brake has been fully released. The /BK output turns ON as soon as the SERVOPACK enables the Servomotor. This time is how long it takes to fully release the brake. It is recommended to wait for at least 50 ms plus the brake release time before commanding motion.

The Brake Close Time will be used to set Pn506 (Brake Reference-Servo OFF Delay Time). Pn506 sets the time for how long the motor stays enabled after the servo off command. This is used for applications in which the load might fall with the motor disabled and the brake released. Set this to the time it takes for the brake to close, plus 50 ms to account for delays.

Note: **The motor must be stopped before the servo off command.** A time delayed safety relay should be used so that the motion controller can decelerate a moving servomotor before the SERVOPACK is given a controlled servo off command.



*1. Brake Release Time

*2. Brake Release Time + 50ms

*3. Brake Close Time

*4. Brake Close Time + 50ms = Pn506 (Brake Reference-Servo OFF Delay Time)

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Parameter for /BK Output Selection

Parameter Pn50F.2 determines the SERVOPACK output used for the /BK signal.

- Make sure there is no other functions for that output
- If you allocate more than one signal to the same output connector pin, a logical OR of the signals is output. Allocate the /BK signal to its own output connector pin, i.e., do not use the same output terminal for another signal.
- For example, never allocate the /TGON (Rotation Detection) signal and /BK signal to the same output connector pin. If you did so, the /TGON signal would be turned ON by the falling speed on a vertical axis, and the brake would not operate.

The default setting for Pn50F.2 varies by the interface of the SERVOPACK

- SGD7S
 - Analog voltage/pulse train reference
 - /BK signal is disabled by default
 - CN1-25 and CN1-26 is the first output, but has two default signals that need to be disabled or moved before /BK can be allocated.
 - /COIN (Positioning Completion Output) Pn50E.0 = 0 to disable
 - /V-CMP (Speed Coincidence Output) Pn50E.1 = 0 to disable
 - /BK (Brake Output) Pn50F.2 = 1 for CN1-25 and CN1-26
 - MECHATROLINK-II/MECHATROLINK-III/EtherCAT/Option
 - CN1-1 and CN1-2
- SGD7W
 - 200V (MECHATROLINK-III)
 - Axis A: CN1-23 and CN1-24
 - Axis B: CN1-25 and CN1-26
 - 400V (MECHATROLINK-III/EtherCAT)
 - Axis A: CN1-1 and CN1-2
 - Axis B: CN1-23 and CN1-24

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- SGD7 with DC Power Input
 - Analog voltage/pulse train reference
 - /BK signal is disabled by default
 - CN1-7 and CN1-11 is the first output, but has two default signals that need to be disabled or moved before /BK can be allocated.
 - /COIN (Positioning Completion Output) Pn50E.0 = 0 to disable
 - /V-CMP (Speed Coincidence Output) Pn50E.1 = 0 to disable
 - /BK (Brake Output) Pn50F.2 = 1 for CN1-7 and CN1-11
 - MECHATROLINK-II/MECHATROLINK-III
 - CN1-11 and CN1-5

SGD7 400V Hardware Option "026" adds a built-in brake relay to the SERVOPACK

- Pn023.0 = 0 (Use the built-in brake relays.)
- SGD7W with built-in brake relay only supports Axis A
- Built-in Brake Relay Specifications
 - Service life (number of operations): 30,000 operations
 - Allowable number of operations: 30 operations per minute max.
 - No external suppression is needed as it is already built-in

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If an alarm occurs while the Servomotor is operating, the Servomotor will start stopping and the /BK signal will be turned OFF. The timing of /BK signal output can be adjusted by setting the brake reference output speed level (Rotary Servomotors: Pn507, Linear Servomotors: Pn583) and the Servo OFF-Brake Command Waiting Time (Pn508).

Note: If zero-speed stopping is set as the stopping method for alarms, the setting of Pn506 (Brake Reference-Servo OFF Delay Time) is used after the motor stops. Zero-speed stopping is only available for Group 2 alarms. See the SERVOPACK manual for designation of which group an alarm belongs to.

Alarms are not the only way that unexpected stopping can occur. The other examples would be if the servo off command occurs before the servomotor has come to a stop or main power is removed.

- Rotary Servomotors

Pn507	Brake Reference Output Speed Level				
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 min-1	100	Immediately	Setup
Pn508	Servo OFF-Brake Command Waiting Time				
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 100	10 ms	50	Immediately	Setup

- Linear Servomotor

Pn583	Brake Reference Output Speed Level				
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	0 to 10,000	1 mm/s	10	Immediately	Setup
Pn508	Servo OFF-Brake Command Waiting Time				
	Setting Range	Setting Unit	Default Setting	When Enabled	Classification
	10 to 100	10 ms	50	Immediately	Setup

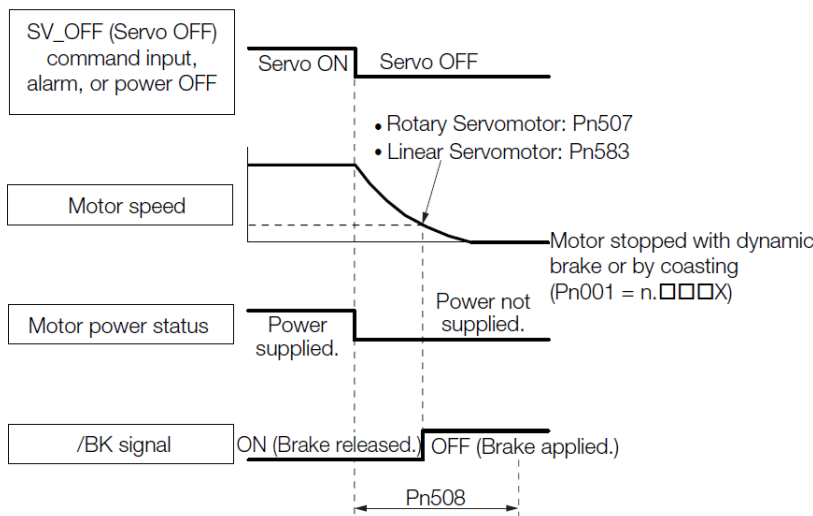
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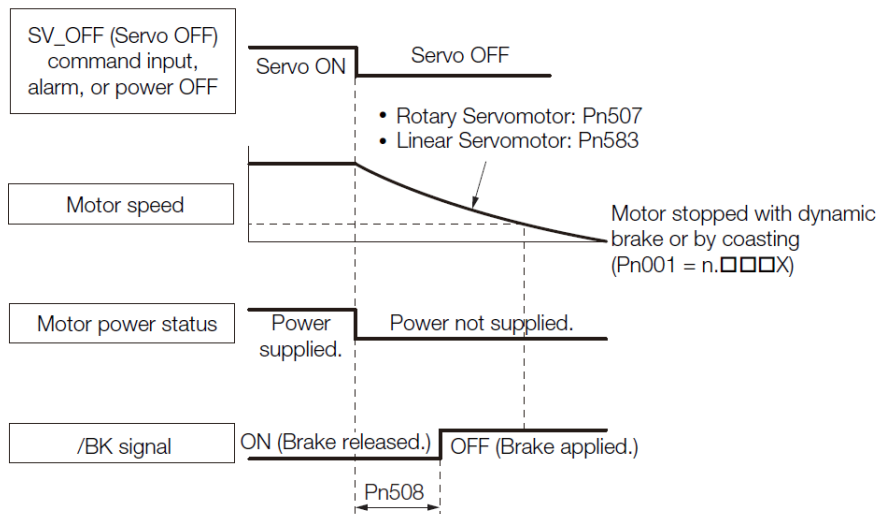
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During unexpected stopping, the /BK signal will be turned OFF by the first condition that is satisfied. See the two possible conditions below.

- 1.) The Servo OFF-Brake Command Waiting Time has not elapsed, but the motor speed has dropped below the Brake Reference Output Speed Level.



- 2.) The Motor speed is above the Brake Reference Output Speed Level, but the Servo OFF-Brake Command Waiting Time has elapsed.



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Confirming Brake Operation

There is no built-in feedback device to confirm that the servomotor brake is released. A multi-meter can be used measure that the brake coil is getting power supplied to it and that it is being energized. Measuring 24 VDC across the brake coil confirms that the relay or SSR is in proper operation. After voltage is confirmed, a measurement of current through the brake coil will confirm that it is getting that voltage.

The servomotor brake will also make an audible click when it releases and engages, but this doesn't guarantee the brake is fully released.

A sign that the brake is not being released during machine operation is that the torque demand is higher than expected. Yaskawa servomotor brakes have, at a minimum, the same holding torque as the servomotor's rated torque. This means the motor can drive through the brake. Unexpected SERVOPACK alarms can be an indication that the brake is not fully released while motion is being commanded.

- A.710 - Instantaneous Overload
- A.720 - Continuous Overload
 - A.910 – Overload Warning (Occurs Before A.720)
- A.d00 - Position Deviation Overflow
- A.860 - Encoder Overheated