




Notice:

OMRON products are manufactured for use according to proper procedures by a qualified operator and only for the purposes described in this manual.

The following conventions are used to indicate and classify precautions in this manual. Always heed the information provided with them. Failure to heed precautions can result in injury to people or damage to the product.

 **DANGER** Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

 **WARNING** Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

 **Caution** Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or property damage.

Visual Aids

The following headings appear in the left column of the manual to help you locate different types of information.

Note Indicates information of particular interest for efficient and convenient operation of the product.

1, 2, 3... Indicates lists of one sort or another, such as procedures, checklists, etc.

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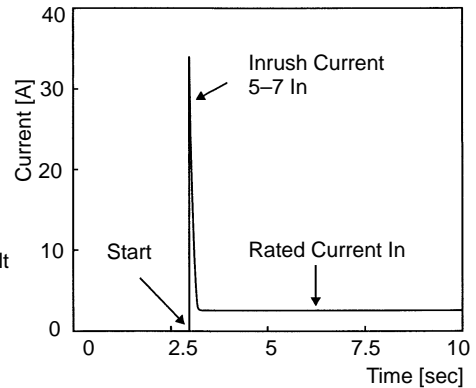
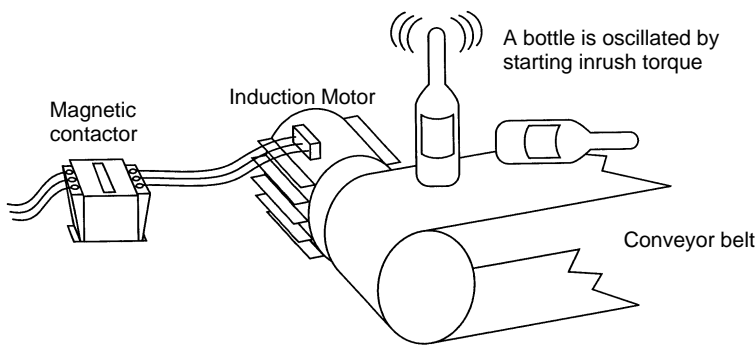
SECTION 1: Features of the G3J

1-1 Starting and Stopping the Motor

The instant a motor starts or stops, a current that is five to seven times larger than the rated current will flow in the motor and the motor will generate a high torque. Due to this high torque, the motor will cause heavy mechanical and electrical stresses that may damage the motor itself or machines or installations driven by the motor and impede the normal operation of production lines. The soft-start and soft-stop function will reduce these stresses and prevent the machines, installations, and production lines from damage and problems.

Problems Caused by a Starting Motor (Typical Examples)

Application	Problem	Result
Conveyor belt	Improper load placement, loads falling off, or damage	Decrease in productivity Gearbox fatigue or damage
Crane	Load vibration or oscillation due to shocks caused by the motor	Gearbox damage
Fan	A large current flows at startup.	Since the current is a problem only at startup, provide a large power supply or use an inverter just to suppress the inrush current.



1-2 Soft-start/stop Function

The soft-start and soft-stop function controls the inrush current and torque of motors, and starts and stops the motors more smoothly.

Principles of Operation

The G3J-S/G3J-T consists of a power module with a three triacs and a soft-start/stop control circuit. Each triac is turned ON in sequence by gate signals transmitted from the soft start/stop control circuit and then voltage is imposed on the motor.

1, 2, 3...

Soft-start Time

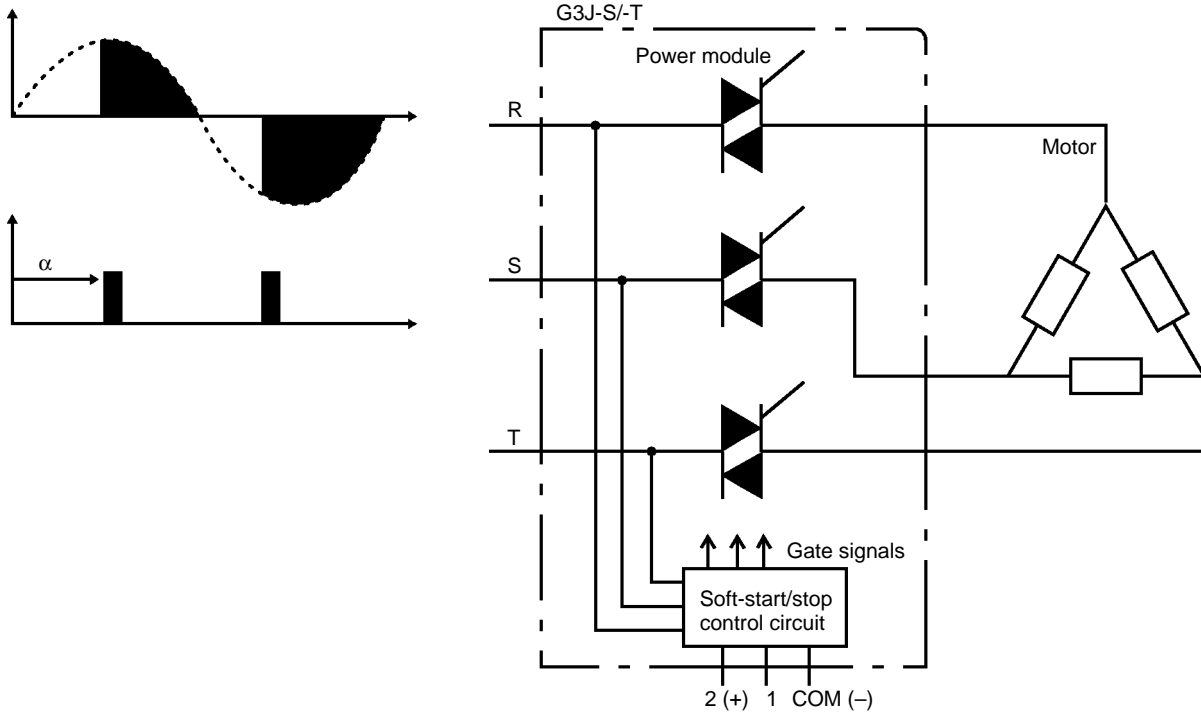
Voltage imposed on the motor increases while ignition α is gradually reduced, thus gradually increasing the rotation speed of the motor.

Ramp-up Time

Ramp-up time is a period required for ignition α to become zero degrees and a 100% voltage to be imposed on the motor.

Starting Torque

Starting torque is determined by the value of ignition α immediately after the input signal is turned ON.



Soft-stop Time

The voltage imposed on the motor decreases while ignition α is gradually increased, thus gradually decreasing the rotation speed of the motor.

Ramp-down Time

Ramp-down time is a period required for ignition α to become 180 degrees with a 0% voltage imposed on the motor.

Three Advantages

1, 2, 3...

Reduces Shock Caused by Starting Torque

Enables motors to start with the optimum starting torque, therefore protecting the motors from mechanical fatigue or damage.

Reduces Starting Currents

Reduces the starting carry currents of motors.

Starts/Stops Motors Smoothly

Smoothly starts/stops and accelerates motors, therefore preventing the products on the belt conveyors from falling off.

1-3 Approved Standards

EN60947-4-2 (IEC947-4-2)

UL508

CSA22.2 No.14

CE Marking

The G3J-S has passed the following EMC tests required by EN60947-4-2 (IEC947-4-2). These estimated results are being confirmed by KEMA.

CISPR 11; 1990	Measurement methods and electromagnetic interference limits for radio-frequency devices used in industrial, scientific, and medical applications (product standards relating to emissions)
IEC801-2; 1991	Static-electric discharge immunity test
IEC1000-4-3; 1995	Radiative radio-frequency electromagnetic field immunity test
IEC801-4; 1988	Fast transient – burst immunity test
IEC1000-4-5; 1995	Surge immunity test
IEC/DIS 1000-4-6	Conductive radio-frequency magnetic field immunity test
IEC1000-4-11; 1994	Voltage dip – momentary outage immunity test

Consequently, the CE marking on the G3J is attached to show conformance to the “EMC Directives” as well as the “Low-voltage Directives.”

EN60947-4-2 (IEC947-4-2)

The actual EN60947-4-2 (IEC947-4-2) standards are “Low-voltage switch gear and control gear, Part 4: Contactors and motor-starters, Section 2: AC semiconductor motor controllers and starters.”

These standards apply to controllers and starters intended for connection to low-voltage circuits that do not exceed 1,000 VAC. The standards include the following requirements.

1, 2, 3...

Characteristics of controllers, starters, and accessory devices

Conditions which controllers and starters must meet:

- a) Unit operation and behavior
- b) Unit insulation characteristics
- c) Degree of protection provided by the unit’s enclosure, when relevant
- d) Unit construction

Tests performed to verify that the unit satisfies these conditions as well as methods for performing these tests

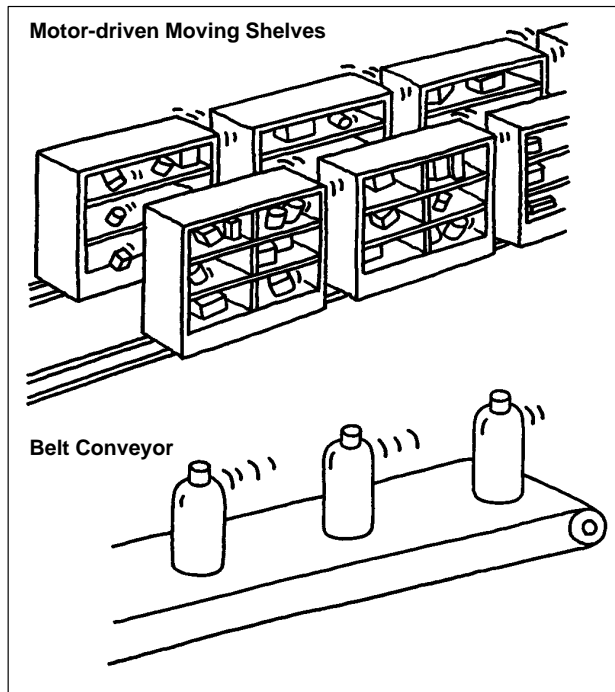
Information that must be indicated in the equipment and manufacturer documentation

1-4 Application Examples

Conveyors, machining tools with large inertia (gliding wheels), palletizers, packing machines, ventilators, pumps, compressors, electric saws, and elevator doors

Simple Acceleration Control of Motor-driven Moving Shelves and Belt Conveyor Control

The shelves use a motor that drives its wheels through a power transmission mechanism so that the shelves can move on the rails.

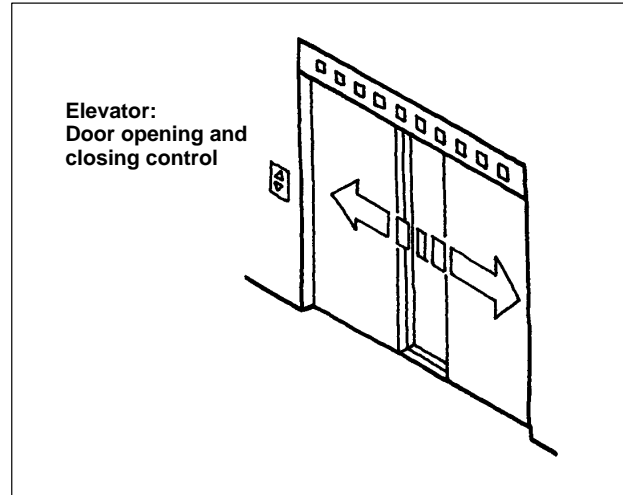


Application Point

The contactor in full-voltage startup operation will provide excessive torque to the motor to start rotation, which may vibrate or shift the items placed on the shelf or put stress on the mechanism. The starting torque control and soft-start and soft-stop function of the G3J make it possible to start or stop the motor smoothly with the appropriate torque.

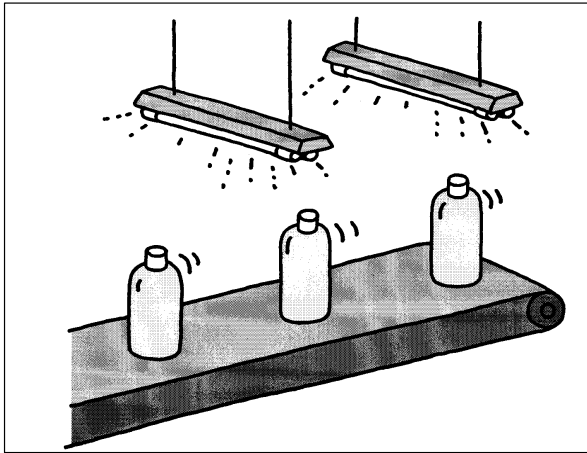
Elevator Door Control

The soft-start and soft-stop function make it possible to open and close elevator doors safely and smoothly.



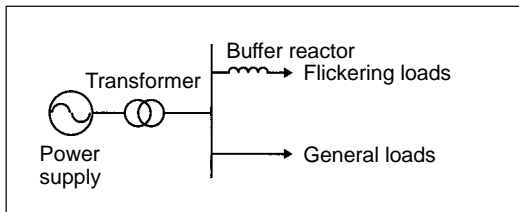
Prevention of Light Flickering

Fluorescent lamps and incandescent lamps will flicker noticeably if voltage imposed on them fluctuates frequently.



Application Point

A voltage drop of power supply will be caused by the starting currents of pump, fan, and conveyor motors that start operating, in which case fluorescent lamps and incandescent lamps connected to the same power supply will flicker. Therefore, countermeasures are usually taken to provide such flickering loads with an independent transformer, buffer reactors, or capacitors. The starting torque control function of the G3J makes it possible to suppress the starting currents, thus eliminating the installation of countermeasures or reducing the size of such installations.



Control of Water Supply Machines at Car Washes

The hydraulic pressure of the water supply hose machine at a car wash is controlled by a motor.

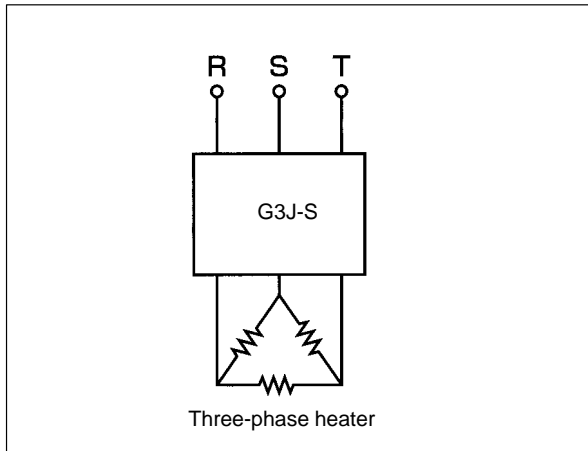


Application Point

The contactor in full-voltage startup operation will make the hose jump strongly due to the high hydraulic pressure in the hose making it necessary to hold the hose very firmly. The soft-start and soft-stop function of the G3J make it possible to start the motor smoothly and increase the hydraulic pressure gradually, thus reducing the shock caused by the water jet output from the hose.

Soft-start Control of Three-phase Heaters

Temperature control in the vicinity of 2,000°C require pure metal resistance heating elements made of kanthal super, molybdenum, and tungsten. These elements are highly heat resistive and expensive.



Type	Maximum operating temperature
Tungsten	2,400°C (in vacuum)
Molybdenum	1,800°C (in vacuum)
Platinum	1,400°C (in vacuum)
Kanthal super	1,700°C

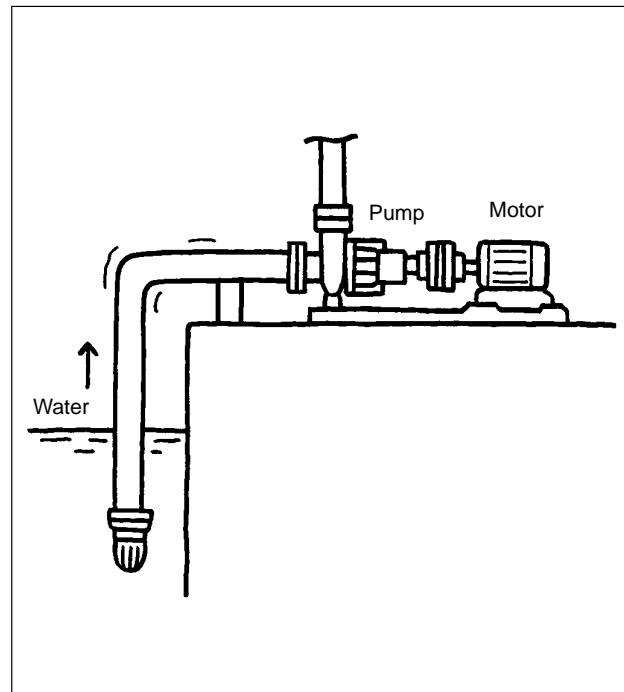
Temperature vs. Resistance	
	<p>More than 10 times as large Inrush current control required.</p>

Application Point

The resistance of a pure metal resistance heating element varies greatly with changes in temperature. The maximum resistance may be more than ten times larger than the minimum resistance within the permissible operating temperature. Therefore, an excessive inrush current will flow at the startup time of the heater system, which may result in damage to the element within a short period. The starting torque control function of the G3J-S suppresses the inrush current while the soft-start function of the G3J-S starts up the heater system smoothly.

Furthermore, the G3J-S is ideal for halogen lamp control with a large inrush current flow.

Control of Pump System to Prevent Water Pressure Vibration

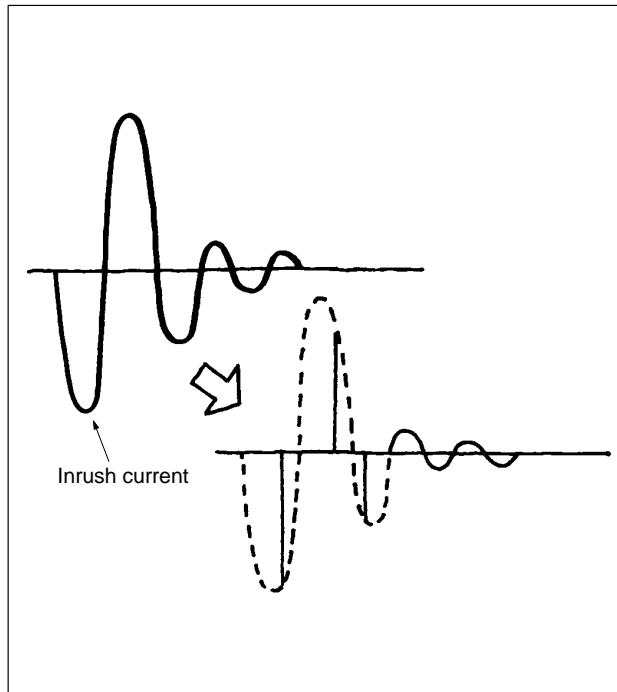


Application Point:

When a storage pump or a similar pump that pumps up a small quantity of water under high pressure is abruptly stopped, the sudden pressure change tends to result in irritating noise and structural fatigue due to vibration. The G3J-T with soft-stop function mitigates the pressure change that occurs when a pump is stopped and solves the above problem. In addition, the soft-start function controls the startup current to minimize shocks that occur when pumps are started and to extend the service life of pumps.

Saving Energy by Controlling Inrush Current

A large Inrush current flows upon startup when a motor load or pure metal (tungsten or molybdenum) heater load is used.

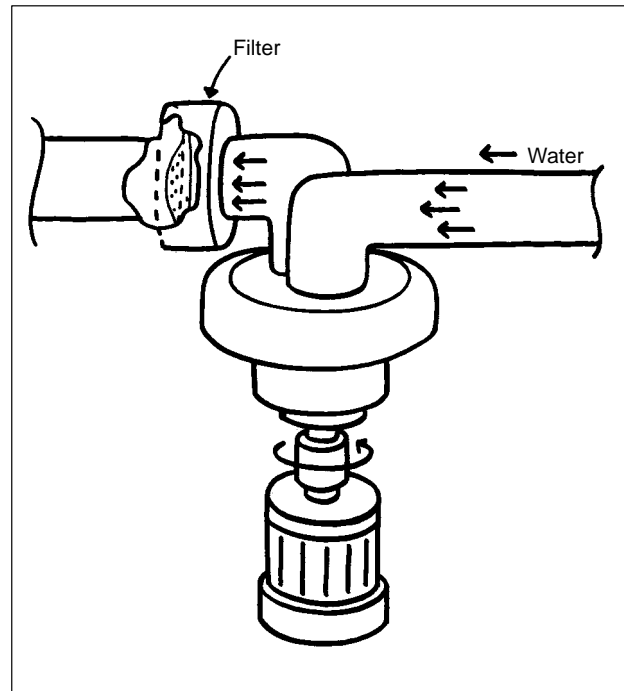


Application Point:

Since a large inrush current flows when a motor or pure metal heaters are started, a large-capacity power supply is required.

With the soft-start function of G3J , the inrush current can be controlled, allowing more compact power supplies and energy savings.

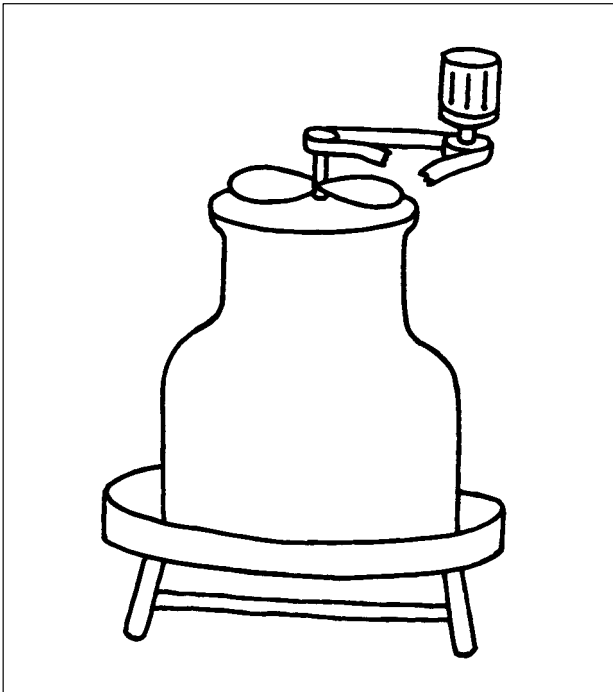
Protection of High-pressure Filters with Soft-start Function



Application Point:

When a pure water filtering device or any other device equipped with a filter is started at full voltage using capacitors, the filter may be damaged by the sudden change in water pressure. With the soft-start and soft-stop function of the G3J-T, the sudden water pressure changes can be controlled, thus extending the filter's service life.

Prevention of Transfer V-belt Deterioration

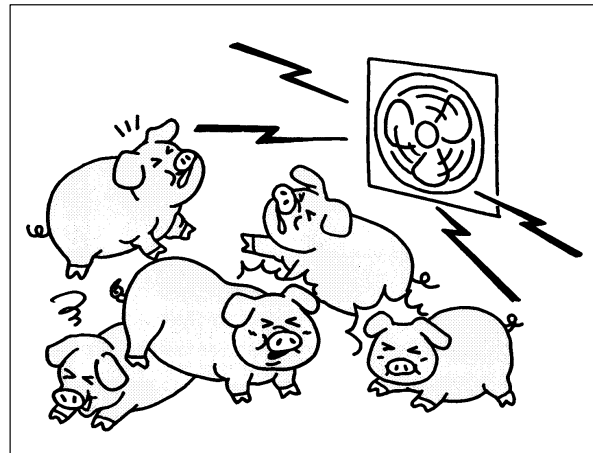


Application Point:

V-belts used for driving cooling fans of a cooling tower are subject to frequent starts and stops. These V-belts tend to deteriorate or break due to torque shocks when the cooling fans are started at a full voltage. With the soft-start function of the G3J, the V-belts' service life can be extended by the smoother starting.

ON/OFF Control of Ventilation Fans of Piggens and Hen Houses

The hog raising and poultry farming industries use high-density breeding systems to make productivity improvements in piggens and hen houses. The ventilation of such piggens and hen houses is required for the temperature control of the piggens and hen houses and the prevention of diseases and improper breeding that may be caused by the generation of gas from discharges.



Application Points

- Noise generated from ventilation fans that start suddenly may surprise the hogs or hens, which in turn may cause them to run into each other and trample each other to death. The soft-start function of the G3J-S makes it possible to suppress the starting noise of the ventilation fans.
- The contactor in full-voltage startup operation will provide excessive current to the motor to start rotation, thus requiring a power supply or transformer installation with a marginal capacity. The starting torque control function of the G3J-S makes it possible to reduce the capacity of the power supply or transformer installation, thus reducing power supply costs.

SECTION 2: Specifications of the G3J

2-1 Product

G3J-T□BL SSC with a soft-start/soft-stop function for 3-phase motors.
 G3J-S□BL SSC with a soft-start function for 3-phase motors.

2-2 Features

- A soft-start function smoothly starts motors at ideal rotation speeds. (G3J-S)
 A soft-start and soft-stop function smoothly starts and stops motors. (G3J-T)
- Keeps harmonized protection coordination with the thermal overload relay, thus withstanding overload currents.
- The thermal overload relay mounts with ease.
- Mounts with screws or to DIN tracks.
- Monoblock construction with a heat sink.
- Meets UL, CSA, IEC, and JEM requirements.
- Snubber circuit and varistor are built-in.
- Conforms to AC3 Class (IEC 947)
- Controls all three elements of the three phases.
- With an operation indicator.

2-3 Models

G3J-S

Model	Insulation method	Rated supply voltage	Input method	Applicable motor	
G3J-S405BL G3J-S403BL	Photo TRIAC	12 to 24 VDC Current consumption: 50 mA max.	No-voltage input (open and short-circuit input)	3-phase, 380 to 400 V	2.2 kW 0.75 kW
G3J-S211BL G3J-S205BL				3-phase, 200 to 220 V	2.2 kW 0.75 kW

G3J-T

Model	Number of elements	Insulation method	Rated supply voltage	Input method	Applicable motor	
G3J-T405BL G3J-T403BL	3	Photo TRIAC	12 to 24 VDC	No-voltage input (open and short-circuit input)	2.2 kW (5.5 A)	380 to 400 VAC
G3J-T217BL					0.75 kW (2.4 A)	
G3J-T211BL					3.7 kW (17.4 A)	200 to 220 VAC
G3J-T205BL					2.2 kW (11.1 A)	
					0.75 kW (4.8 A)	

2-4 Ratings (Ambient Temperature: 25°C)

Power Supply

G3J-S/-T

Rated supply voltage	12 to 24 VDC
Operating voltage range	10.2 to 26.4 VDC
Current consumption	50 mA max. (at 12 to 24 VDC)

Operation Circuit

G3J-S/-T

Input current	10 mA max. (12 to 24 VDC)	
Input method	No-voltage input (Short-circuiting and opening inputs)	Short-circuiting or opening terminals 1 and COM or 2 (+) and 1 SSR input turned ON: A maximum residual voltage of 2 V between short-circuited terminals SSR input turned OFF: A maximum current leakage of 0.15 mA Relay input: For minute signals

Main Circuit

G3J-S

Item		G3J-S405BL	G3J-S403BL	G3J-S211BL	G3J-S205BL
Rated load voltage		200 to 400 VAC (50/60 Hz)		200 to 240 VAC (50/60 Hz)	
Load voltage range		180 to 440 VAC (50/60 Hz)		180 to 264 VAC (50/60 Hz)	
Rated carry current		5.5 A (Ta = 40°C)	2.4 A (Ta = 40°C)	11.1 A (Ta = 40°C)	4.8 A (Ta = 40°C)
Min. load current		0.5 A			
Peak-value current resistance		220 A, 60 Hz, 1 cycle	96 A, 60 Hz, 1 cycle	350 A, 60 Hz, 1 cycle	150 A, 60 Hz, 1 cycle
Overload resistance		Harmonized protection coordination with the thermal overload relay is possible up to a current 7.2 times larger than the setting current (up to a current 7.2 times larger than the rated carry current).			
Close/Break current (actual values)	AC3	55A	24A	111A	48A
	AC4	66A	28.8A	133.2A	57.6A
Applicable load	3-phase inductive motor (AC3, AC53-a class)	380 to 400 VAC, 2.2 kW, 5.5 A	380 to 400 VAC, 0.75 kW, 2.4 A	200 to 240 VAC, 2.2 kW, 11.1 A	200 to 240 VAC, 0.75 kW, 4.8 A
		Motors passing the AC3-class, AC4-class, AC53-a-class switching frequency test (Ta=40°C) under conditions to be specified by OMRON.			
	Resistive load (AC1 class) (see note)	200 to 400 VAC, 5.5 A	200 to 400 VAC, 2.4 A	200 to 240 VAC, 11.1 A	200 to 240 VAC, 4.8 A

Note No single-phase load can be connected.

G3J-T

Item		G3J-T405BL	G3J-T403BL	G3J-T217BL	G3J-T211BL	G3J-T205BL
Rated load voltage		200 to 400 VAC (50/60 Hz)		200 to 240 VAC (50/60 Hz)		
Load voltage range		180 to 440 VAC (50/60 Hz)		180 to 264 VAC (50/60 Hz)		
Rated carry current		5.5 A (Ta = 40°C)	2.4 A (Ta = 40°C)	17.4 A (Ta = 40°C)	11.1 A (Ta = 40°C)	4.8 A (Ta = 40°C)
Min. load current		0.5 A				
Peak-value current resistance		220 A, 60 Hz, 1 cycle	96 A, 60 Hz, 1 cycle	500 A, 60 Hz, 1 cycle	350 A, 60 Hz, 1 cycle	150 A, 60 Hz, 1 cycle
Overload resistance		Harmonized protection coordination with the thermal overload relay is possible up to a current 7.2 times larger than the setting current (up to a current 7.2 times larger than the rated carry current).				
Close current (actual value)	AC3	55 A	24 A	174 A	111 A	48 A
	AC4	66 A	28.8 A	208.8 A	133.2 A	57.6 A
Break current (actual value)	AC3	44 A	19.2 A	139.2 A	88.8 A	38.4 A
	AC4	55 A	24 A	174 A	111 A	48 A
Applicable load	3-phase inductive motor (AC3, AC4, AC53-a class)	380 to 400 VAC, 2.2 kW, 5.5 A	380 to 400 VAC, 0.75 kW, 2.4 A	200 to 220 VAC, 3.7 kW, 17.4 A	200 to 220 VAC, 2.2 kW, 11.1 A	200 to 220 VAC, 0.75 kW, 4.8 A
	Motors passing the AC3-class, AC4-class, and AC53-a-class switching frequency test (Ta = 40°C) under conditions to be specified by OMRON.					
	Resistive load (AC1 class) (see note)	200 to 400 VAC, 5.5 A	200 to 400 VAC, 2.4 A	200 to 240 VAC, 17.4 A	200 to 240 VAC, 11.1 A	200 to 240 VAC, 4.8 A

Note No single-phase load can be connected.

2-5 Characteristics

Ambient Temperature: 25°C

G3J-S

Item	G3J-S405BL	G3J-S403BL	G3J-S211BL	G3J-S205BL
Ramp-up time	Set within a range from 1 to 25 s.			
Reset time	5 to 6 cycles+1 ms max.			
Starting torque	Set within a range from 200% to 450% In.			
Output ON-voltage drop	1.8 V _{RMS} max.		1.6 V _{RMS} max.	
Leakage current	10 mA max. at 200 to 400 VAC			
Insulation resistance	100 MΩ min. at 500 VDC			
Dielectric strength	2,500 VAC, 50/60 Hz for 1 min between inputs and outputs and between heat sink and all I/O.			
Vibration resistance	Mechanical and malfunction: 10 to 55 Hz, 0.75-mm single amplitude			
Shock resistance	Mechanical: 294 m/s ² (30G) Malfunction: 147 m/s ² (15G)			
Ambient temperature	Operating: -20°C to 60°C with no icing Storage: -30°C to 70°C with no icing			
Ambient humidity	Operating: 45% to 85% RH			
Weight	Approx. 730 g			

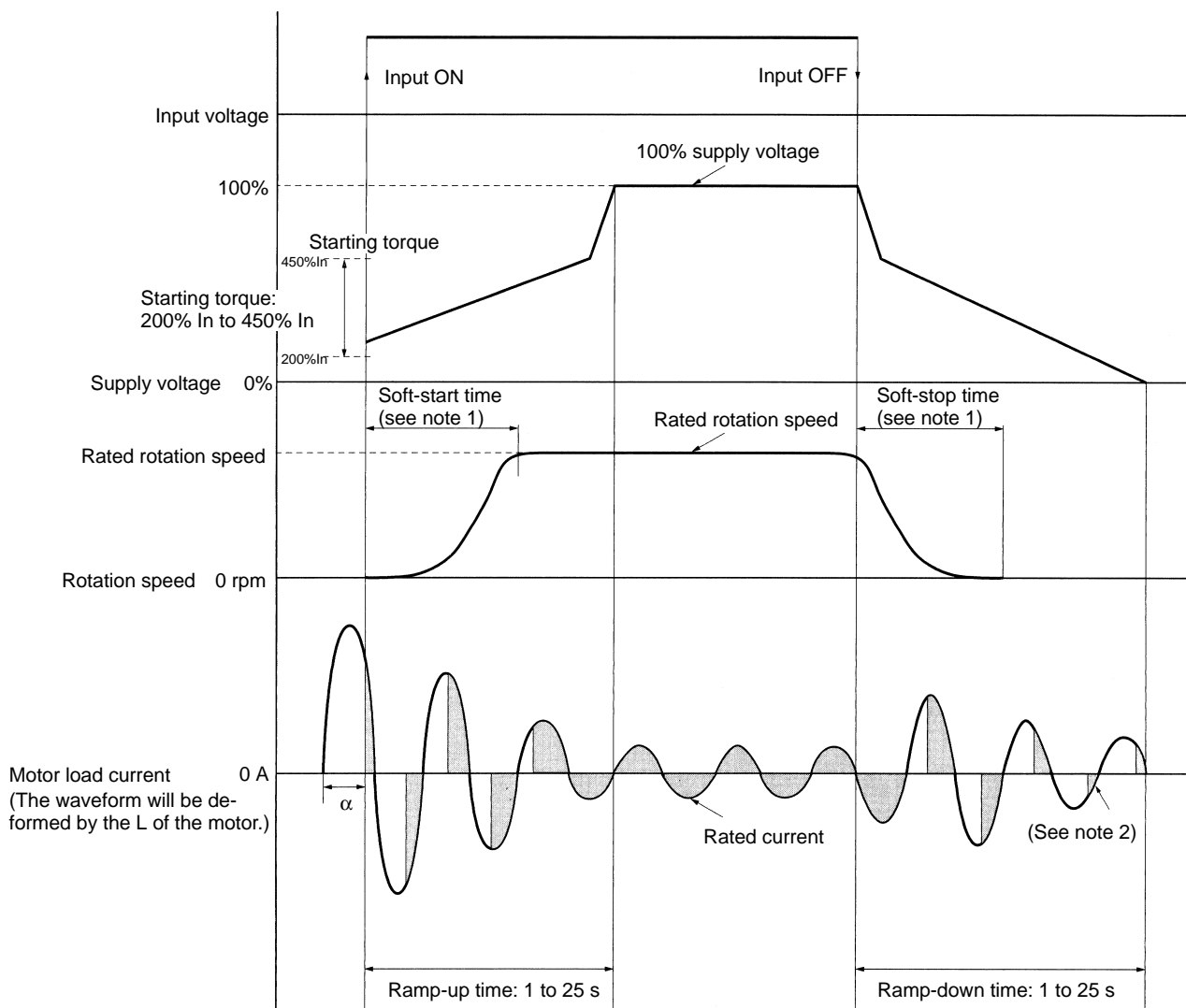
G3J-T

Item	G3J-T405BL	G3J-T403BL	G3J-T217BL	G3J-T211BL	G3J-T205BL
Ramp-up time	Set within a range from 1 to 25 s.				
Ramp-down time	Set within a range from 1 to 25 s.				
Starting torque	Set within a range from 200% to 450% In.				
Output ON-voltage drop	1.8 V _{RMS} max.		1.6 V _{RMS} max.		
Leakage current	10 mA max. (at 400 VAC)		10 mA max. (at 200 VAC)		
Insulation resistance	100 MΩ min. (at 500 VDC)				
Dielectric strength	2,500 VAC, 50/60 Hz for 1 min				
Vibration resistance	Destruction: 10 to 55 Hz, 0.75-mm single amplitude Malfunction: 10 to 55 Hz, 0.75-mm single amplitude				
Shock resistance	Destruction: 294 m/s ² (30G) Malfunction: 147 m/s ² (15G)				
Ambient temperature	Operating: -20°C to 60°C (with no icing or condensation) Storage: -30°C to 70°C (with no icing or condensation)				
Ambient humidity	Operating: 45% to 85%				
Weight	730 g max.		800 g max.	730 g max.	

Soft Start/Stop

The G3J-T is a solid-state contactor that smoothly starts and stops machines and equipment connected to power supplies without damaging the machines, equipment, or power supplies.

Soft-start/stop Characteristics



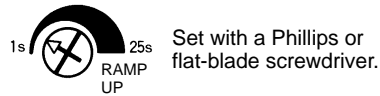
- Note**
1. In addition to starting torque, ramp-up time, and ramp-down time, the soft-start time and soft-stop time vary with the load characteristics such as the inertia and friction factor of the load. Therefore, the soft-start time or soft-stop time will not increase beyond a certain point.
 2. Due to the soft-stop control characteristics, the load current continues flowing even after the motor stops. Set to the optimum value according to the adjustment steps.

Soft-start/stop Setting Method

Adjuster

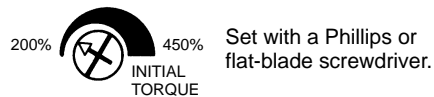
Ramp-up Time Setting with the Ramp-up Adjuster

The ramp-up time of a motor can be set within a range from 1 to 25 s, with which the soft-start time of the motor is adjusted until the motor rotates at full speed.



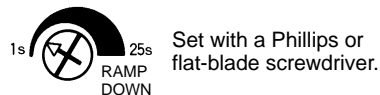
Starting Torque Setting with the Starting Torque Adjuster

The starting torque of a motor can be set within a range from 200% to 450% In provided that the starting torque is 600% In when the motor is started at full voltage, which allows optimum motor control without any time lag at the time the motor starts.



Ramp-down Time Setting with the Ramp-down Adjuster

The ramp-down time of a motor can be set within a range from 1 to 25 s, with which the soft-stop time of the motor is adjusted until the motor decelerates to a stop.



Adjustment Steps

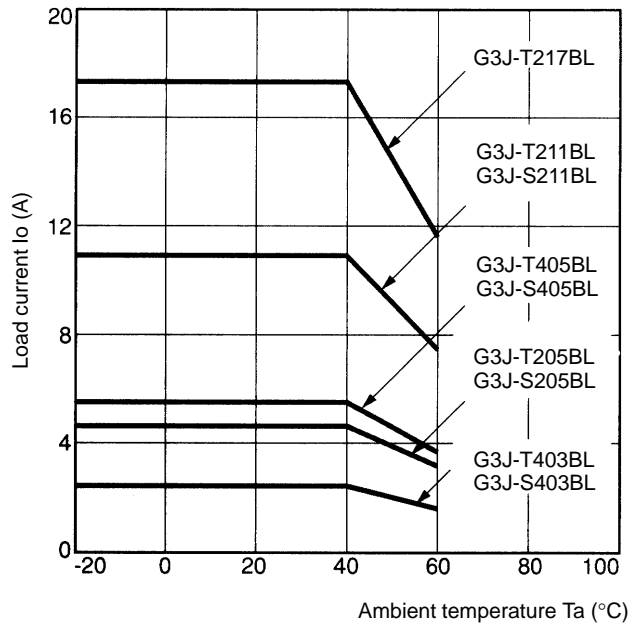
1. Start and stop the motor with the factory settings.
Ramp-up adjuster: 1 s
Starting torque adjuster: 200% In
Ramp-down adjuster: 1 s
2. If the motor does not rotate smoothly, increase the starting torque.
3. Gradually increase the ramp-up time to adjust the start time.
4. Gradually increase the ramp-down time to adjust the stop time.
5. The soft-start time or soft-stop time will not increase beyond a certain point (depend on load). Do not set the ramp-up time or ramp-down time beyond this point.

Further Adjustment or Arrangement

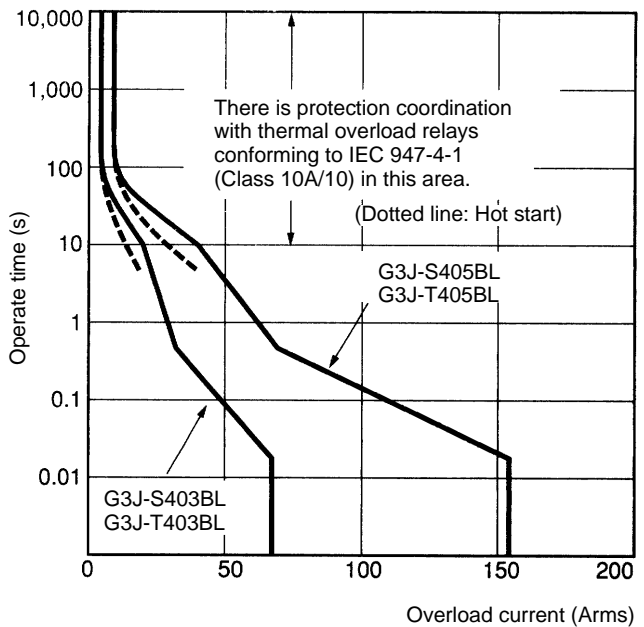
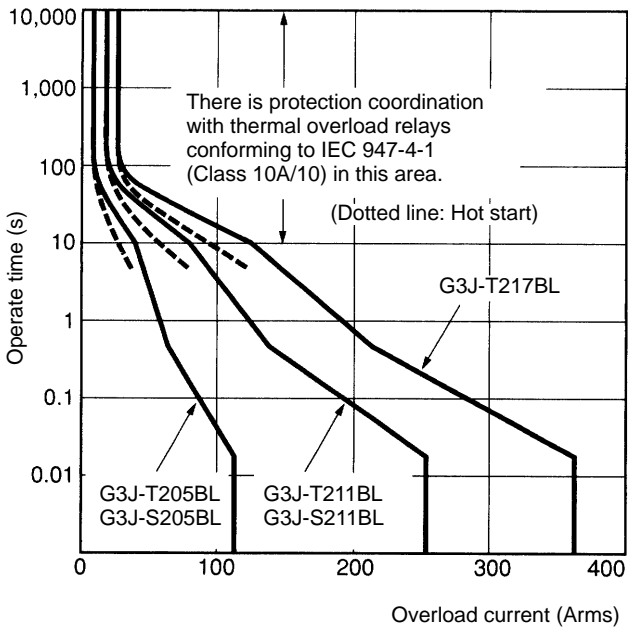
Increase the starting torque if the motor does not start with a long soft-start time.

2-6 Reference Data

2-6-1 Load Current vs. Ambient Temperature (Continuous Current)

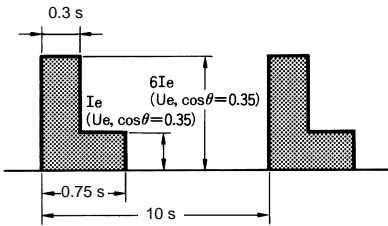


2-6-2 Overload Current Resistance (60 Hz, Ta of 25°C, and Non-repetitive (1/2 for Repetitive))



2-6-3 Switching Frequency Test Conditions (AC3/AC4/AC53-a)

AC3 Class (Immediate Start)



Ie: Rated carry current
Ue: Rated load voltage (200/400 V)

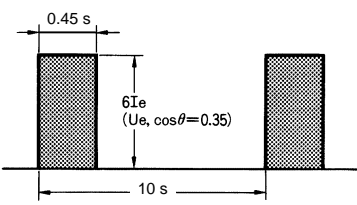
The following Soft-start conditions apply.

Ramp-up time: 1 s
Starting torque: 450% In

The following Soft-start/stop conditions apply:

Ramp-up time: 1 s
Ramp-down time: 1 s
Starting torque: 450% In

AC4 Class (Inching)



Ie: Rated carry current
Ue: Rated load voltage (200/400 V)

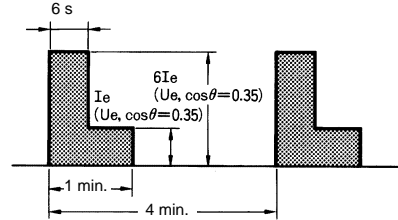
The following Soft-start conditions apply.

Ramp-up time: 1 s
Starting torque: 450% In

The following Soft-start/stop conditions apply:

Ramp-up time: 1 s
Ramp-down time: 1 s
Starting torque: 450% In

AC53-a: 6-6: 25-15



Ie: Rated carry current
Ue: Rated load voltage (200/400 V)

The following Soft-start conditions apply.

Ramp-up time: 1 s
Starting torque: 450% In

The following Soft-start/stop conditions apply:

Ramp-up time: 1 s
Ramp-down time: 1 s
Starting torque: 450% In

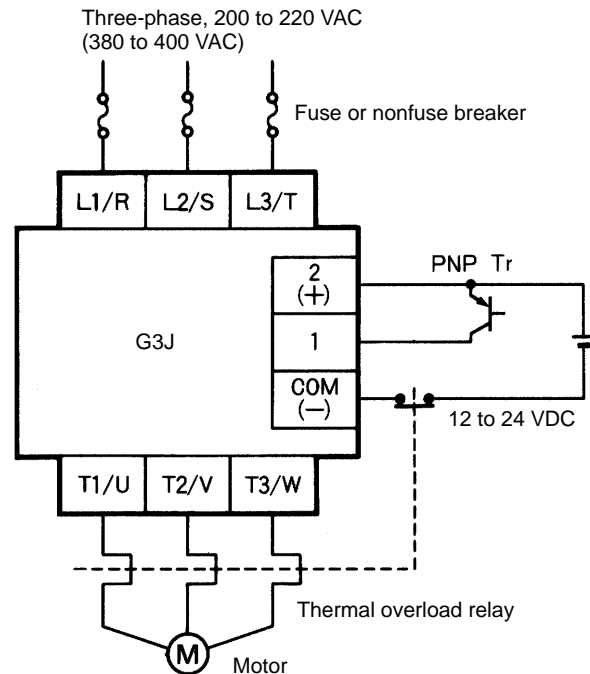
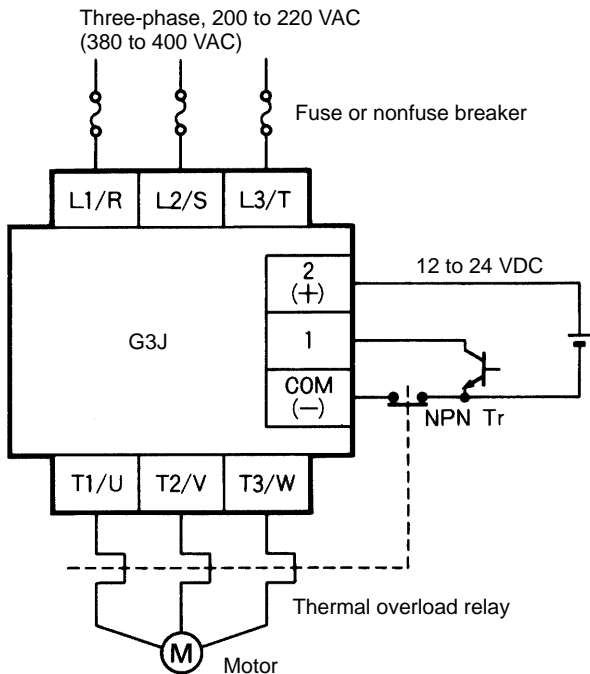
2-7 Connection Examples

Protection coordination is ensured for motor overcurrents.

Be sure to supply power to the G3J through a fuse or nonfuse breaker to protect the G3J from damage due to short-circuiting.

Soft-start / Soft-start/stop Models

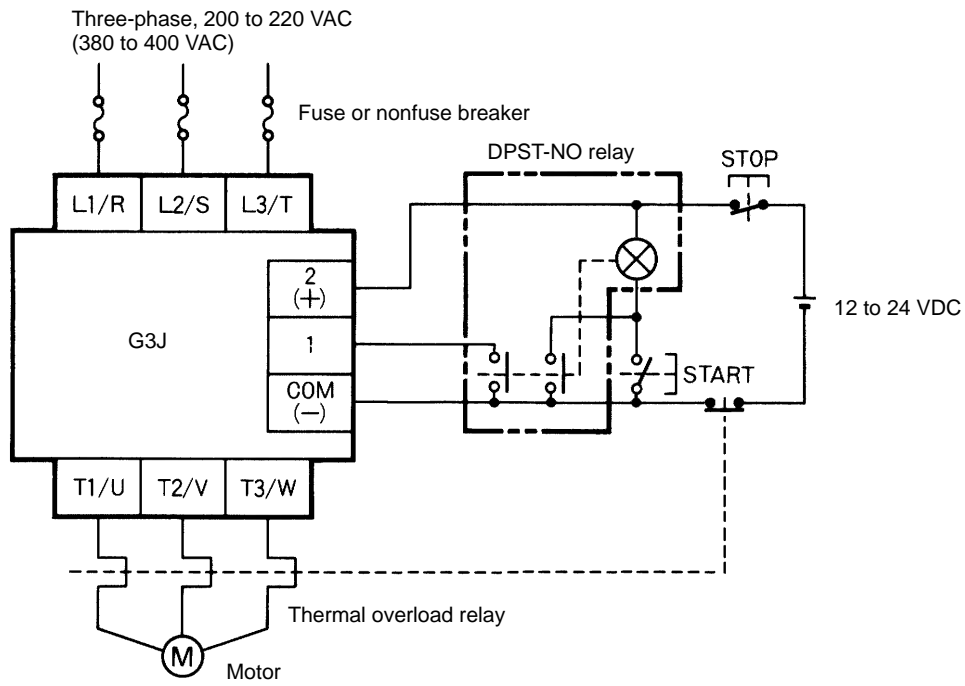
G3J-S□BL, G3J-T□BL



- Note**
1. When the minimum applicable load of the thermal relay auxiliary contacts becomes smaller than the input current of the G3J, insert a bleeder resistance.
 2. Connect the thermal relay b contact to the 2 (+) or COM (-) line. Connecting the thermal relay b contact to the 1 input will cause contact failure.

Self-hold Circuit

G3J-S□BL, G3J-T□BL



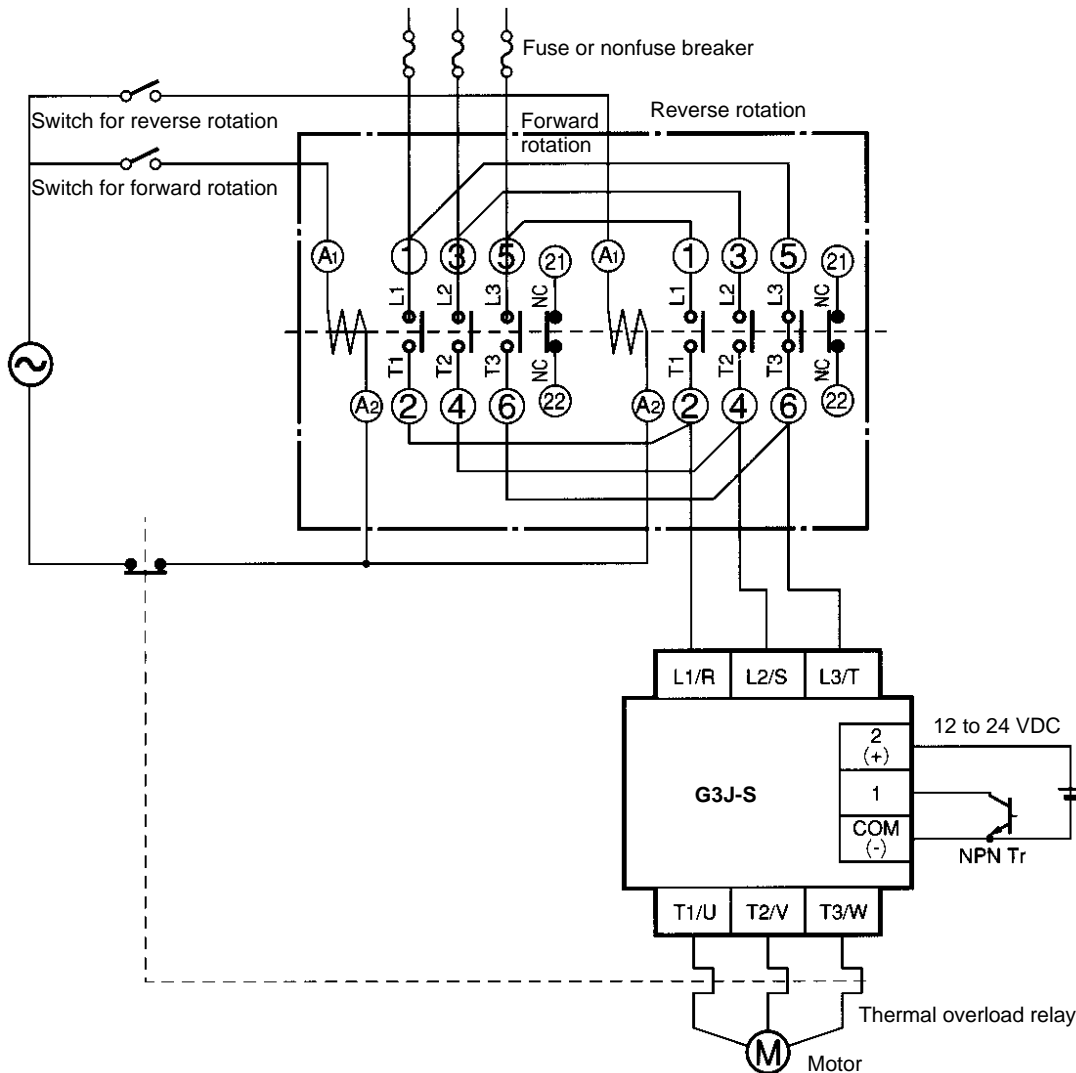
Note Be sure to use a fuse or nonfuse breaker to protect the G3J.

Reverse Rotation: Example

G3J-S or G3J-T with a Reversible Contactor with Built-in Mechanical Interlock Function

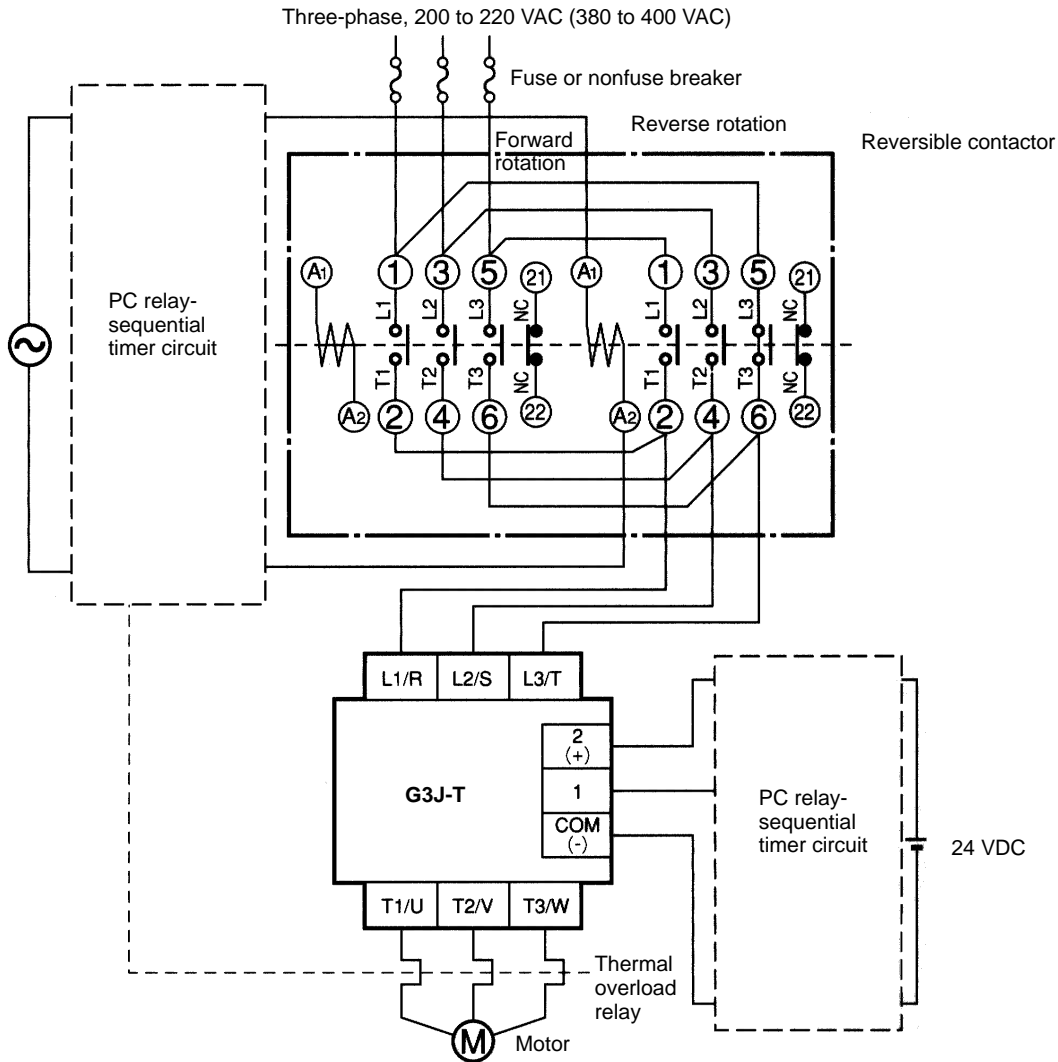
G3J-S□BL, G3J-T□BL

Three-phase, 200 to 220 VAC (380 to 400 VAC)

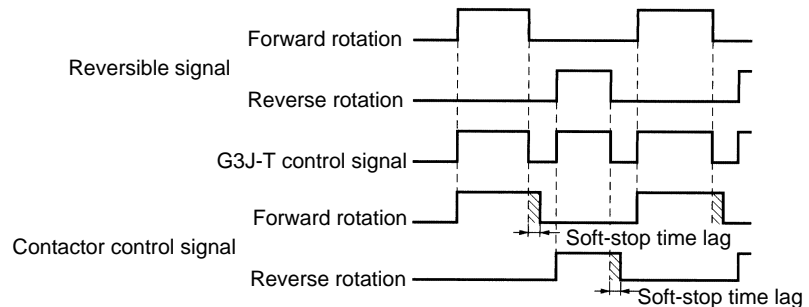


- Note**
1. Be sure to use a fuse or nonfuse breaker to protect the G3J.
 2. Be sure that the interval between forward and reverse operations is at least 100 ms.
 3. Be sure to apply the input signal of the G3J-S after the reversible contactor starts operating. If the input signal is applied before the contactor starts operating, the soft-start function may not operate.

G3J-SG3J-T



For soft-stop control, the G3J-T has enough load current to continue rotating the motor during ramp-down time setting even after the control signal of the G3J-T is turned OFF. Therefore, a time lag is required between the time when the G3J-T stops operating up to the time when the reversible contactor is turned OFF. The ramp-down time of the G3J-T is adjustable up to approximately 25 s max. Therefore, set the time lag to 25 s in the initial sequence during the adjustment stage. Adjust the time lag of the sequential circuit according to the application.



- Note**
1. Be sure that the interval between forward and reverse operations is at least 100 ms. If the G3J is turned ON by noise input, short-circuiting between phases will result. In order to prevent this, insert the protective resistor.
 2. Two G3J-S or G3J-T Units cannot be used together in reversible operation.

2-8 Fuse Selection

The following table shows the I^2t (60 Hz half-wave 1 cyc) values for G3J models.

Model	I^2t
G3J-T217BL	970A ² S
G3J-S211BL G3J-T211BL	260A ² S
G3J-S205BL G3J-T205BL	121A ² S
G3J-S405BL G3J-T405BL	260A ² S
G3J-S403BL G3J-T403BL	260A ² S

When selecting a fuse to protect a G3J, use a quick-breaking fuse for semiconductor protection that satisfies the following condition: fuse's $I^2t < G3J$'s I^2t .

Protecting the Motor

As shown in Figure A, the motor system is protected by a power fuse and circuit breaker while the motor itself is protected by a thermal relay. Table A shows the type of protection provided by each of these protective devices.

Circuit breaker	Applicable circuit	Arc-suppression media	Activation time
Power fuse (PF)	1,000 VAC min.	Ordinary	1 Hz max.
Air circuit breaker (ACB)	1,000 VAC max.	Air	5 Hz max.
Oil circuit breaker (OCB)	1,000 VAC min.	Oil	8.5 Hz max.
Vacuum circuit breaker (VCB)	1,000 VAC min.	Vacuum	3 Hz max.
Gas-filled circuit breaker	1,000 VAC min.	Gas such as SF ₆	3 Hz max.
Molded-case circuit breaker (MCCB)	600 VAC or 750 VDC max.	Air	20 to 40 ms

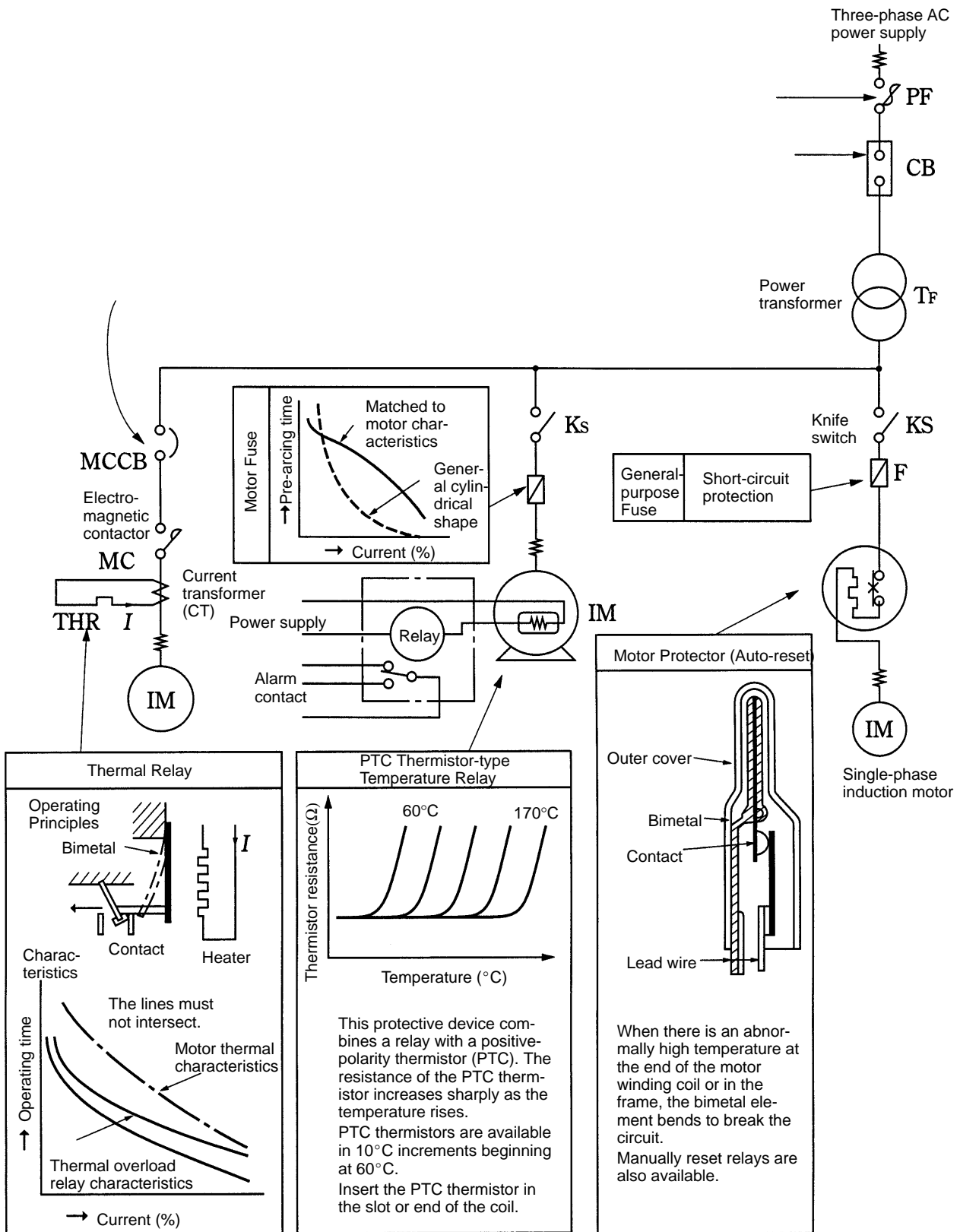


Fig. A: Protection Example

Table A: Protection Summary

		Protection Device Summary													
		Short-circuit	Overcurrent Overload	Rotor lockup	Open-phase operation	Overheating	Ground	Overspeed	Step-out	Overvoltage	Insufficient voltage	Negative phase	Reverse power	Bearing/Rotor	
Protection device	Installed within motor	Thermal stabilizer (motor protector)			△	△	⊕								
		Temperature relay (TR)	<ul style="list-style-type: none"> — Bimetal-type — Thermistor-type — Resistor-type 			△	△	⊕							
				Vibrating relay				△							
	Overcurrent relay (OCR)			<ul style="list-style-type: none"> — Inductive — Thermal (Thermal relay – THR)		⊕	△	△			△				
		Circuit breaker (CB)	<ul style="list-style-type: none"> — Fuse (PF) — Air (ACB) — Oil (OCB) — Vacuum (VCB) — Molded case (MCCB) 			⊕									
	Thermal-type			Electro-magnetic-type		⊕	⊕	⊕	⊕						
	Installed outside motor			Motor fuse (F)	⊕	⊕	⊕	△							
	3E relay		⊕		⊕				△			⊕			
	4E relay		⊕		⊕		⊕		△			⊕			
	Ground relay (leakage relay)						⊕								
	Overvoltage relay (OVR or UVR)		△					△		⊕	⊕		△		
	Overspeed relay (OSR)							⊕							
	Differential relay (DfR)		⊕				⊕								
Reverse-power relay (RPR)								△				⊕			
Step-out relay (SOR)								⊕							

2-9 Future SSC Development for Motor Applications

Soft Start and Stop

G3J	Keyword	Abstract	Application	Development
Currently available	Voltage ramp-up	The applied motor voltage is increased at a steady rate.	Low-inertia systems	---
---	Current ramp-up	The applied motor current is increased at a steady rate.	All kinds of equipment such as hoists	Not set yet.
---	Fixed torque	A fixed torque is output at startup.	High-inertia systems such as large fans, conveyors, and crushing machines	Not set yet.
---	Boost at start	A large current is applied only at startup.	Mixers, plastic molding machines, concrete mixers	Not set yet.
Currently available	Freewheel stop	The motor stops of its own accord after the applied power is stopped.	All kinds of equipment	---
Currently available	Voltage ramp-down	The speed is reduced gradually by gradually decreasing the applied voltage. The soft-stop stopping time cannot be shorter than the freewheel stopping time.	Can be used to eliminate the hammer effect in pumps.	---
---	DC braking	DC is applied after the AC power is cut. The braking effect is extremely large, so DC braking can be used only at low rotational speeds.	---	Under development
---	Forward/Reverse rotation	Forward/Reverse rotation can be controlled safely with an electric interlock function that prevents the forward and reverse rotation elements from turning ON simultaneously.	---	Under development

SECTION 3: Questions and Answers

- Q1** What types of motors does the G3J control?
A1 The G3J mainly controls induction motors.
- Q2** What is the difference between the G3J-T and other manufacturers' soft-start/stop SSCs?
A2 **1) Performance:**
 The dispersion of the ramp-up time, ramp-down time, and starting torque of a motor controlled by the G3J-T is much less than those of motors controlled by other manufacturers' soft-start/stop SSCs. Therefore, the G3J-T can control motors more smoothly than any other soft-start/stop SSC. Refer to Figure 1 below.

Figure 1:
Difference in Performance Among Models

Item	Judgment	G3J-T		Celduc	Electromatic
		Value in catalog	Actual value		
Ramp-up time setting	Good	1 to 25 s	1 s: 1 s \pm 20% 25 s: 25 s \pm 25%	1 to 25 s (25 s: 0.3 to 4 s)	1 to 20 s (20 s: 70%/_20%)
Soft-start time lag	Good	Not listed	10 ms max.	(100 ms max., n = 1)	(10 ms max., n = 1)
Starting torque setting	Good	200% to 450%	200%: 100 to 300 450%: 400 to 500	100 to 450% (200%: 280 to 340; 450%: 420 to 450)	0 to 450% (0%: 430 to 470; 450%: 460 to 480)
Ramp-down time setting	Good	1 to 25 s	1 s: 1 s \pm 20% 25 s: 25 s \pm 25%	Varies in synchronization with ramp-up time.	1 to 20 s Set with an independent adjuster.
Current consumption	Fair	50 mA max.	Approx. 30 mA	55 mA	230 mA

Note The value in parentheses is an actual value obtained from measuring one product from each manufacturer.

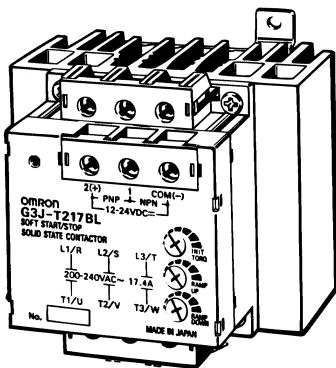
2) Appearance:

As shown in Figure 2, the G3J-T is a compact, monoblock contactor with a heat sink.

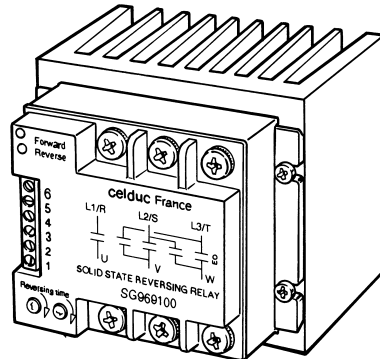
Figure 2:
Difference in Appearance Among Models

2.2-kW Output at 400 V (AC3 Class) with DC Input

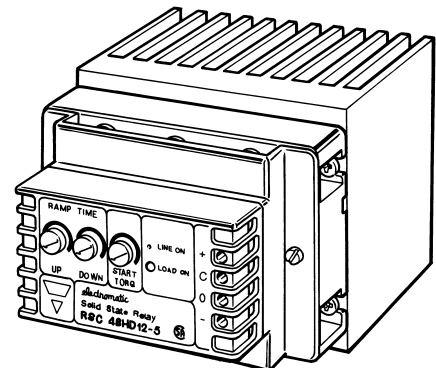
OMRON
 G3J-T



Celduc
 SMC93500



Electromatic
 RSC40HD12-5



- Q3** The starting torque of other manufacturers' soft-start SSC models can be set from 0% I_n while that of the G3J-S can be set from only 200% I_n . Does this not cause a problem?
- A3** No. A motor will not start smoothly unless the starting torque of the motor is 200% I_n or more. It seems that only a few users practically start motors with less than 200% I_n .
- Q4** What thermal overload relays can be used with the G3J?
- A4** There is harmonized protection coordination between the G3J and all thermal overload relays conforming to IEC 947-4-1 (Class 10A/10) including OMRON's easy-to-mount J7TM (motor elements = 2) or J7TY (motor elements = 3).

Reference: What is harmonized protection coordination?

Figure 3a shows the operating characteristics of a thermal overload relay required by IEC 947-4-1. The thermal overload relay is designed so that it will operate within periods shorter than the those specified in the table when it is overloaded.

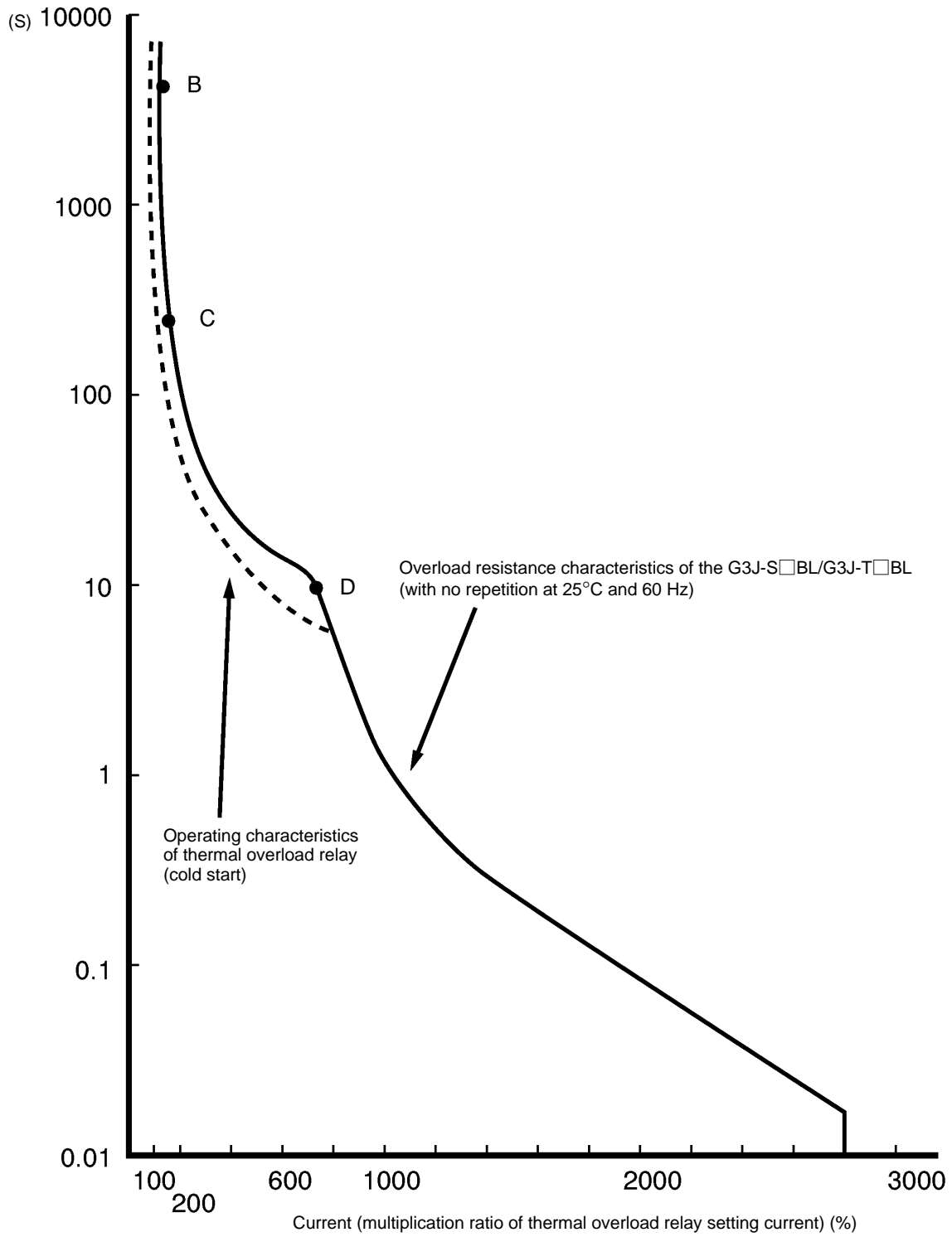
Figure 3b shows the comparison between the overload resistance characteristics of the G3J and the operating characteristics of a thermal overload relay.

According to the figure, the curve of the overload resistance characteristics of the G3J is above the curve of the operating characteristics of the thermal overload relay. This means that the G3J can withstand overloads until the thermal overload relay shuts OFF the overload currents. In this case, it can be said that there is harmonized protection coordination between the G3J and the thermal overload relay.

**Figure 3a:
Operating Characteristics
of Thermal Overload Relays
(Required by IEC 947-4-1
Class 10)**

Item	A	B	C	D
Setting current set value	1.05 I_n	1.2 I_n	1.5 I_n	7.2 I_n
Operating status	Not operating	Operation within 2 h after hot start	Operation within 4 min after hot start	Operation between 4 and 10 s after cold start

Figure 3-b:
Overload Resistance Characteristics of G3J-S□BL/G3J-T□BL
vs. Operating Characteristics of Thermal Overload Relay

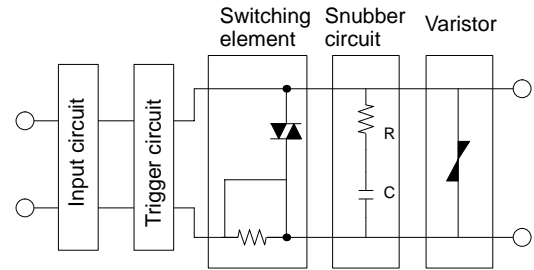
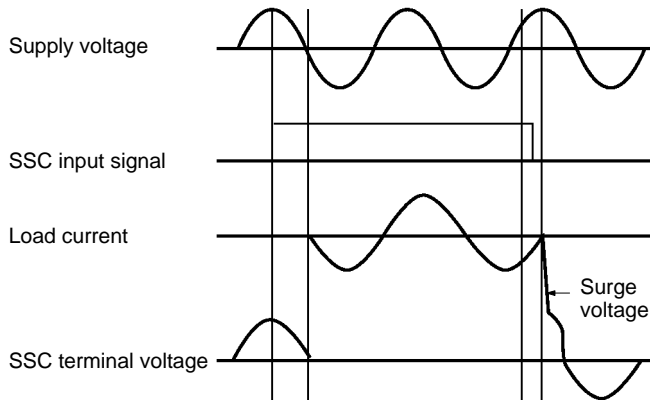


Q5 What is a snubber circuit?

A5 An SSC cannot turn OFF a motor current if there is a sudden rising voltage imposed on the output terminals of the SSC. The snubber circuit of an SSC will suppress such rising voltages and protects the SSC.

On the other hand, if the AC power supply line connected to an SSC generates a comparatively high surge voltage, a varistor usually will be used to suppress the surge voltage.

The G3J-S has both a snubber circuit and varistor.



Q6 Can the G3J switch the rotation direction of the motor controlled by the G3J?

A6 Refer to *Reverse Rotation: Example* on page 18.

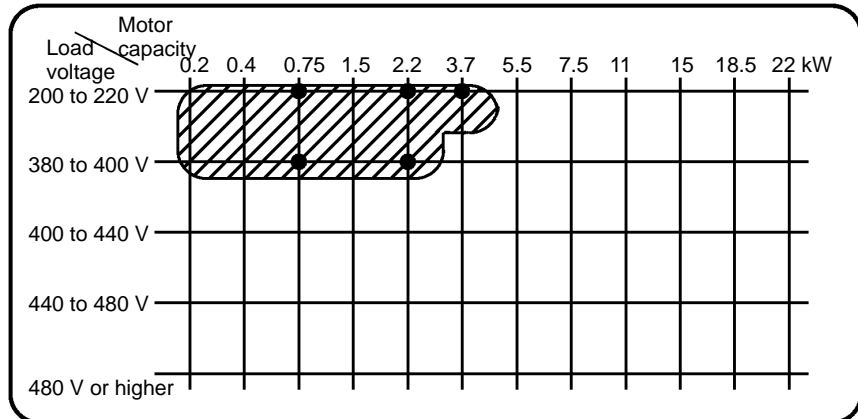
Q7 Is it possible to connect a motor with a capacity of more than 3.7 kW to the G3J?

A7 According to OMRON's survey, the majority of all motors fall within the capacity range of 3.7 kW or less. Therefore, OMRON will try to increase the market share of the G3J in this capacity range. However, we will also review the possibility of providing larger capacity models because our competitors are already offering larger capacity models as shown in Figure 4.

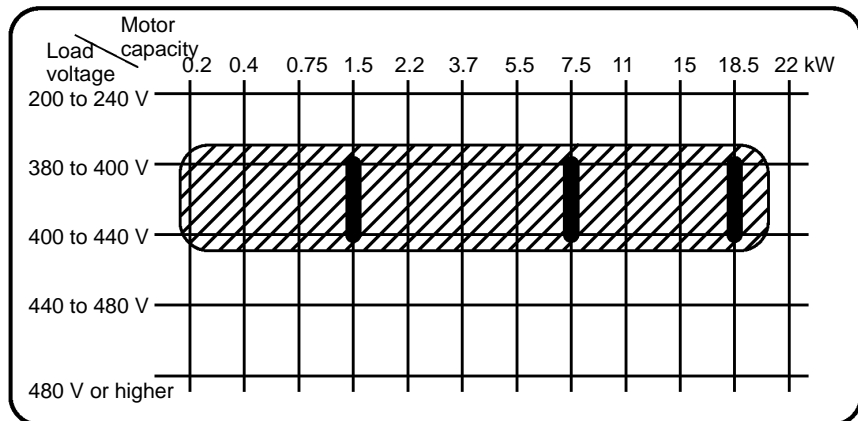
Figure 4:
Difference in Product
Availability Among
Companies

AC3 Class with DC Input

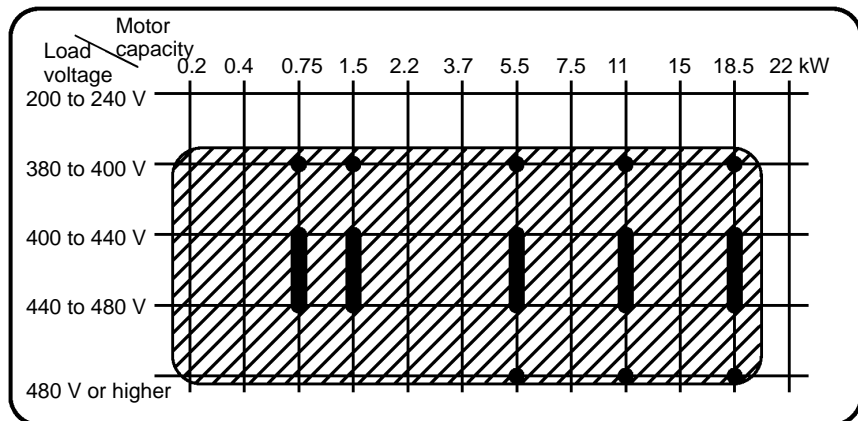
OMRON G3J Series



Celduc SMC Series



Electromatic RSC Series



- Q8** The inverter used for a motor in soft-start control generates noise, by which peripheral equipment malfunctions. Doesn't the G3J have the same problem?
- A8** The inverter is in frequency control while the G3J is in phase control when it is used for a motor in soft-start/soft-stop control, thus the G3J will suppress much more noise than the inverter.
 Furthermore, a G3J-S4□□B meeting EMC Directives is available.

- Q9** What is the big difference between the G3J and inverter?
- A9** The speed of the motor will be controlled by the inverter in frequency control. On the other hand, the phase of the commercial power supply frequency will be controlled by the G3J used for a motor in soft-start/soft-stop control. The use of the G3J is recommended for starting/stopping the motor smoothly and the speed control of the motor will not be required once the motor starts running at rated speed.
- Q10** An on-site motor insulation test is conducted regularly by turning off the power with a magnetic relay instead of the main switch of the site. The G3J cannot, however, turn off the power completely. Are there any countermeasures against this?
- A10** It will be necessary to conduct an on-site motor insulation test after turning off the main switch, which is applicable to any type of SSR. Considering the relay contact weld, it is recommended that the main switch be turned off for safety's sake in any case when conducting on-site motor insulation tests.
- Q11** The SSR is vulnerable to inrush currents. Is there any method for using a contactor to turn on the power and the G3J just to turn off the power?
- A11** Inrush currents will not cause particular problems if the G3J is used because the soft-start function of the G3J can suppress inrush currents. The G3J was designed by taking motor inrush currents into consideration and the applicable capacity of each motor available is provided in the datasheet.
- Q12** Can the G3J soft-start/soft-stop a single-phase motor?
- A12** No. The G3J obtains signals from the difference in phase caused by the three-phase power supply and sends the signals to the control circuit through the R, S, and T terminals.
- Q13** Are there fail-safe methods that suppress noise and prevent motor malfunction for the G3J used for a motor in forward and reverse rotation control?
- A13** The G3J can withstand 1- μ s noise at a peak voltage of 1,500 V. There is a fail-safe method for preventing power supply short-circuiting while the motor is in forward and reverse rotation control in which a contactor is located on the previous stage to receive thermal signals connected to the G3J. There is another fail-safe method for preventing power supply short-circuiting in which two contacts are located on the previous stage for the motor in forward and reverse rotation control followed by the G3J for the motor in soft-start/soft-stop control. Refer to *Reverse Rotation: Example* on page 18.
- Q14** What is the switching timing of the R, S, and T phases?
- A14** The G3J turns ON all outputs the moment the corresponding inputs are ON. Due to the difference in characteristics among the elements used, there will be a difference of few μ s in timing between any two phases, which however, will not cause a practical problem. The outputs are turned OFF with a phase shift of 120° each between R and S, S and T, and T and R phases.
- Q15** Can the G3J connect to a motor that has a capacity of less than 0.75 kW or a capacity of 1.5 kW?
- A15** The datasheet describes the minimum load current as being 0.5 A. When connecting a motor with an input of less than 0.75 kW, be sure that the input current of the motor is at least 0.5 A. Connect the 2.2-kW model to a motor with an input of 1.5 kW.
- Q16** If the G3J is connected to a general-purpose motor, can the motor rotate without changing the starting torque setting of the G3J?
- A16** No. The torque required by the motor will vary with the capacity of the motor and the load of the motor. Therefore, torque adjustment will be necessary according to the actual operating conditions.

- Q17** Doesn't the G3J incorporate an operation indicator?
- A17** Yes. The G3J incorporates an operation indicator that will be lit when a signal is input to the G3J.
- Q18** A standard motor must withstand a current 1.4 to 1.6 times larger than the maximum instantaneous current input to the motor. Can the SSC withstand this value?
- A18** Yes, as long as the capacity of the motor is within the permissible range. An in-rush current of approximately 33 A is expected to flow to a motor that has a capacity of 2.2 kW at 400 V.
In fact, the G3J-S(T)405BL can withstand an overload current of approximately 220 A, which is quite sufficient.
- Q19** Is it possible to use the soft-start function of the G3J for a heater to prolong the life of the heater?
- A19** It is possible to use the G3J with three-phase heaters in soft-start control, in which case, the three-phase heaters will be in soft-start control with the input signals turned ON and OFF.
- Q20** Is there any way to eliminate the leakage current of the G3J?
- A20** It is very difficult to eliminate the leakage current because of the necessity of the semiconductor elements and a snubber circuit. If a load need to be physically separated from power supply, it is recommended that a contactor be located on the previous stage and the soft-start/soft-stop function of the G3J be used.
- Q21** Is it possible to make use of a Fuji or Mitsubishi thermal relay mounted to a magnetic contactor as is?
- A21** It is difficult to make use of the thermal relay, although the difference is in mounting position only. It will be necessary to check the terminal pitch and hook position. If a supporting stand (e.g., the LA71064) is available for the thermal relay, use the supporting stand. Then, external wiring will be required for the thermal relay and stabilizing current adjustments will be necessary.
- Q22** Doesn't external noise shorten the life of the G3J?
- A22** There will be no particular noise problem. As a result of inching and other ON and OFF tests using motors, the G3J proved that it can withstand 1,000,000 operations.
The G3J can withstand 1- μ s noise at a peak voltage of 1,500 V.
- Q23** Is there a method that uses the G3J for constructing a system for a motor in reversible rotation control that is less expensive than a method that uses an inverter for the same purpose?
- A23** Yes. There is a method in which a contactor is located on the previous stage for a motor in forward and reverse rotation control followed by the G3J for the motor in soft-start/soft-stop control.
- Q24** Is there a pre-wired G3J model that can replace an existing contactor?
- A24** If it is a reversible contactor, for example, there is no pre-wired G3J model that can replace it.
- Q25** The G3J has leakage current. Is it possible to check the insulation resistance of the G3J load like a mechanical contactor?
- A25** It will be impossible to check the insulation resistance of the load without turning the power off. Therefore, the main switch will need to be turned off.
The G3J itself has an insulation resistance of 100 M Ω min. as described in the datasheet.

- Q26** Isn't the G3J damaged if 500 to 1,000 V is imposed?
- A26** Tests proved that there will be no problem when imposing a withstand impulse voltage of 2 kV (1.2 x 50 μ s) on the output terminals of the G3J five times. If the imposed voltage is, however, excessive, the built-in varistors may be damaged. The G3J incorporates the following varistors.
200-V type with a dielectric strength of 470 V
400-V type with a dielectric strength of 940 V
The dielectric strength of the G3J between the input and output terminals is 2,500 VAC for one minute.
- Q27** The G3J to be used in place of a contactor will require auxiliary contacts. Are there any countermeasures?
- A27** There are no countermeasures so far. As for interlock, there is an external relay method. (Refer to the datasheet.)
- Q28** What noise standards do the G3J-S satisfy?
- A28** EMC No. 62268-KRQ/EMC96-4710
- Q29** Are there any measures against surge occurrence when switching ON or OFF? Any countermeasures against noise?
- A29** Conforms to the EMC Directive.
- Q30** Is it possible to use the G3J in place of a star/delta timer?
- A30** Yes, provided that a power of 3.7 kW min. is applicable in star/delta operation.