HSD7-ES STO Function Instruction

HNC Electric Limited

1. Summary of safety functions

1) What is a safety function

In order to protect operators from dangerous actions of moving parts of the machine, reduce the risk of using the machine, and improve its safety, this servo unit has built-in safety functions. Especially when the protective cover must be opened to work in a dangerous area due to mechanical maintenance, this function can prevent dangerous movements of the moving parts of the machine.

2) Safety precautions when using safety functions

⚠ Caution

- In order to confirm whether the HWBB function meets the safety requirements of the application system, a systematic risk assessment must be implemented. Otherwise it will cause personal safety due to improper use
- Even when the HWBB function is running, the servo motor may move due to external forces (gravity of the vertical axis, etc.). Please install a mechanical brake that meets the safety requirements of the system. Otherwise it will cause personal safety due to improper use.
- Even during the operation of the HWBB function, the servo motor may operate within a range of less than 180 degrees of electrical angle due to a failure of the servo unit. Please use it only in applications that can ensure that the operation will not cause danger. Otherwise it will cause personal safety due to improper use.
- The dynamic brake and brake signals are not related to safety functions. Please ensure that these faults will not cause danger when the HWBB function operates during system design. Otherwise it will cause personal safety due to improper use.
- Please connect devices that comply with safety standards to the safety function signals. Otherwise it will cause personal safety due to improper use.
- HWBB function is not used to cut off the power of the servo unit or perform electrical insulation. When performing maintenance of the servo unit, be sure to use other methods to cut off the power of the servo unit. Otherwise it may cause electric shock.

2. Hardware wire base block (HWBB) function

Hardware wire base block function HWBB: Hard Wire Base Block State (hereinafter referred to as HWBB function) refers to the safety function of cutting off motor current through hardware. Through independent loops connected to the input signals of the two channels to block the driving signal of the power module that controls the motor current, the power module can be turned off and the motor current can be cut off.

重要

Regarding the connection of signals for safety functions, the input signal is connected to the 0V common terminal, and the output signal is connected to the common emitter output terminal. This is exactly the opposite of the description of other signals in this manual.

In order not to confuse the signal status, in the description of the safety function, the signal ON/OFF is defined as the following status.

ON: The state where the contact is closed or the transistor is ON, and the current is flowing in the signal line

OFF: The state where the contact is disconnected or the transistor is OFF, and there is no current flowing in the signal line

The input signal is set 0V as common. The connection example is shown in the figure below.

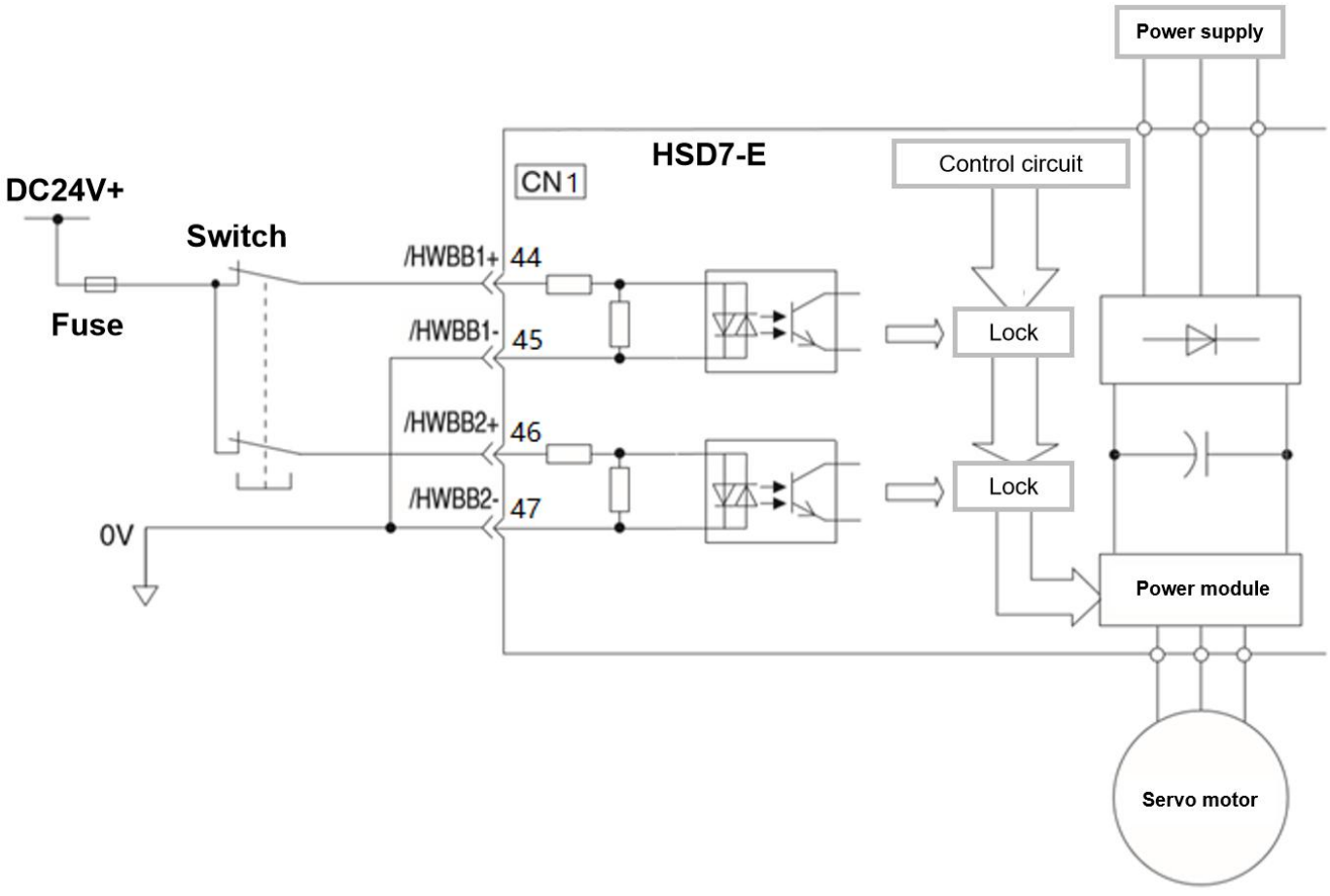
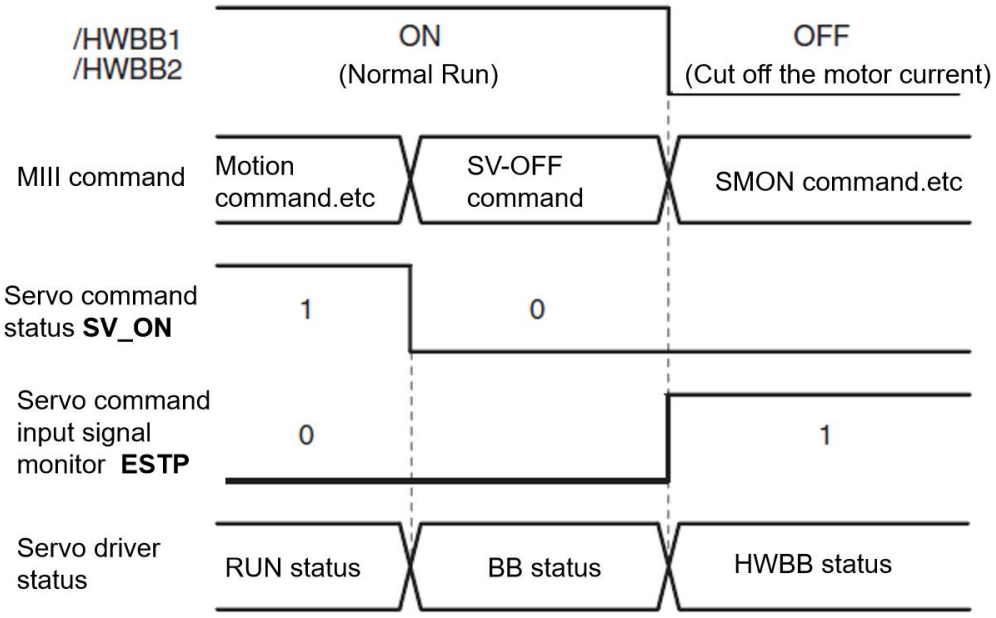


Figure 1 HWBB wiring diagram

2.1 Hardware wire base block state (HWBB state)

The status of the servo unit when the hardware base lock function is running is as follows. When the /HWBB1 or /HWBB2 signal is OFF, the HWBB function of the servo unit operates and enters the hardware base lock state (hereinafter referred to as the HWBB state).

- When the HWBB function is activated after SV-OFF (the motor is not energized)



- Active the HWBB function when the motor is energized

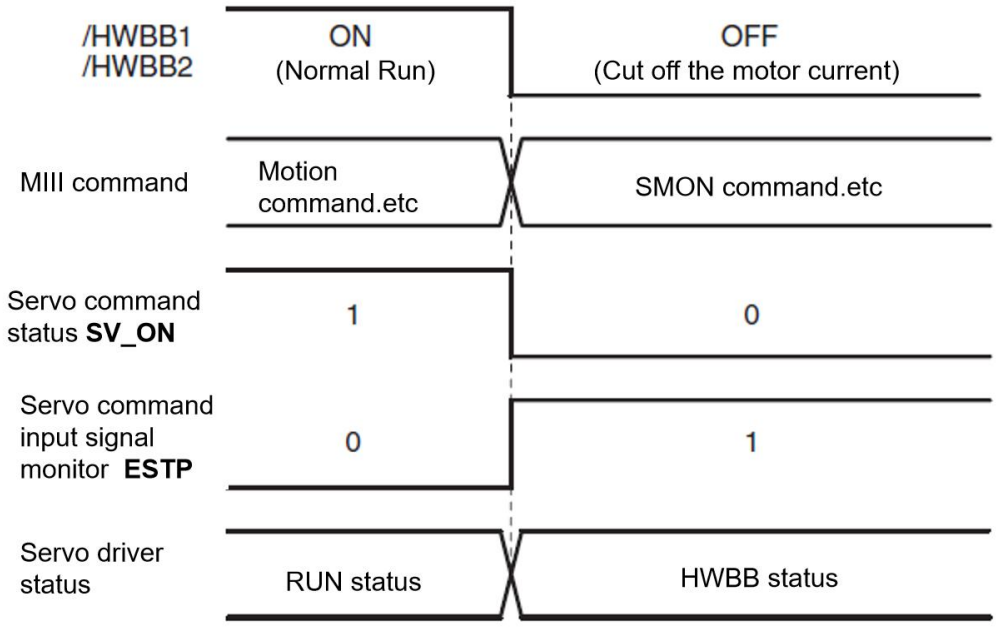


Figure 2 HWBB timing diagram

2.2 Recovery method from HWBB state

Normally, turn off the servo ON input (/S-ON) signal and set the servo motor to be de-energized, and then turn off the /HWBB1 and /HWBB2 signals to switch to the HWBB state. When the /HWBB1 and /HWBB2 signals are set to ON in this state, it will become the base block state (hereinafter referred to as the BB state), and the /S-ON signal can be received.

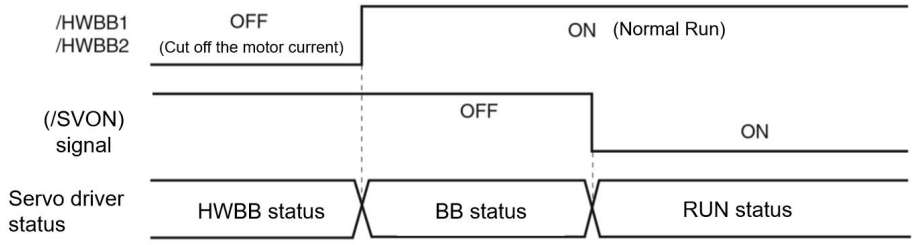


Figure 3 S-ON_OFF to ON

If the servo ON input (/S-ON) signal is received when the /HWBB1 and /HWBB2 signals are OFF, the HWBB state will remain unchanged even if the /HWBB1 and /HWBB2 signals are set to ON. Once the /S-ON signal is OFF and enter the BB state, please input the /S-ON signal again.

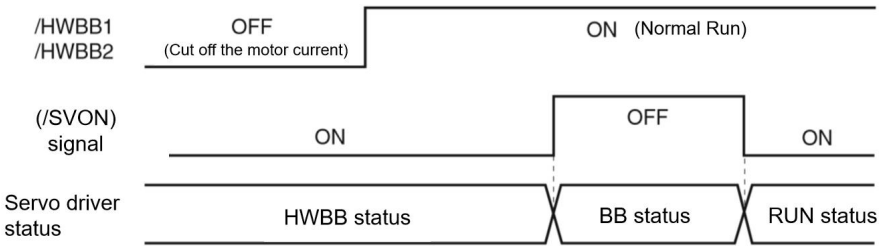


Figure 4 S-ON_ON to OFF

(Note)

1. The base is blocked by cutting off the main circuit power supply in time, and the HWBB state will be maintained before the servo ON input (/SON) signal is turned off.
2. When the servo ON input (/SON) signal is set to always "valid" (Pn50A=n.8), it cannot be restored. When using the HWBB function, do not make this setting.

2.3 HWBB signal fault detection

After inputting either of the /HWBB1 or /HWBB2 signals, if the other signal is not input within 10 seconds, "A.Eb1 (safety function signal input time failure alarm)" will occur. This function can detect faults such as HWBB signal disconnection.

⚠ Caution

- "A.Eb1 (Safety function signal input time failure alarm)" has nothing to do with safety functions. Please pay attention to this when designing the system.

2.4 Input signal (HWBB signal) specifications

After requesting the HWBB function by setting the 2-channel input signals /HWBB1 and /HWBB2 to OFF, the power to the servo motor will be cut off within 8ms.

(Note) 1. When the OFF time of /HWBB1 and /HWBB2 signals is less than 0.5ms, it will not be judged as OFF.

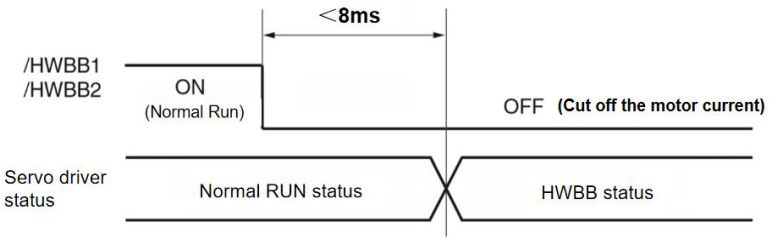


Figure 5 Servo status

2.5 Regarding the operation without the upper device

The HWBB function is also effective when the host device is not used for operation.
However, when the HWBB function is running in the following functions, please exit the function execution mode first, and then enter the function execution mode again to restart the operation. Directly turn on the /HWBB1 and /HWBB2 signals, and operation cannot be restarted.

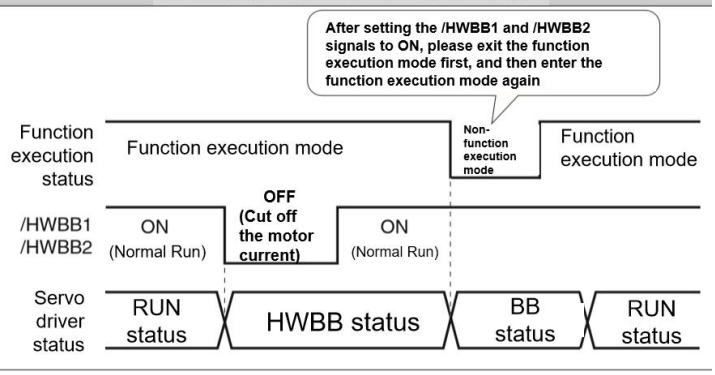
Object function	Method to recover from HWBB state
* JOG RUN * Origin search * Program JOG RUN * Automatic adjustment (no external command) * EasyFFT * Motor current detection signal offset adjustment	

Figure 6 Operation without the upper device

2.6 Regarding servo ready output (/S-RDY) signal

Since the servo ON input (/S-ON) signal cannot be received in the HWBB state, the servo ready output is OFF. When the /HWBB1 and /HWBB2 signals are ON at the same time, and the servo ON input (/S-ON) signal is OFF (BB status), the servo ready output is ON. The following is an example when the main circuit power supply is ON and no servo alarm occurs.

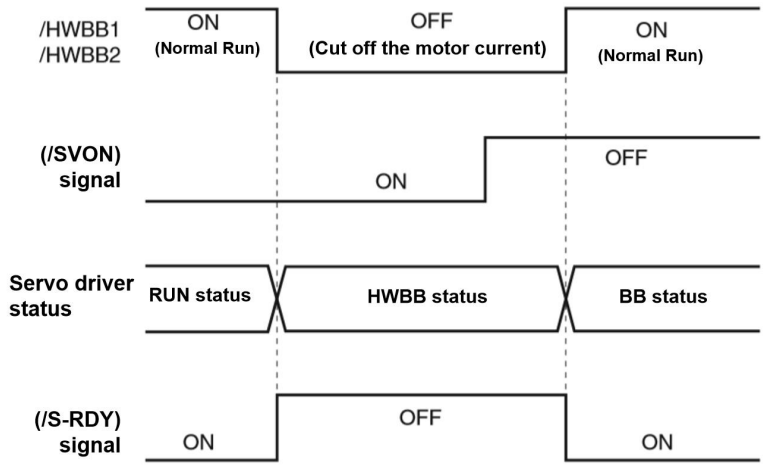


Figure 7 Servo ready output (/S-RDY) signal

2.7 Regarding brake control output signal (/BK)

When the /HWBB1 or /HWBB2 signal is OFF and the HWBB function is running, the brake control output (/BK) signal is OFF. At this time, "Brake command-Servo OFF delay time (Pn506)" is invalid, so after the brake control output (/BK) signal is OFF, the motor may act due to external force before the brake actually acts.

⚠ Caution

- Since the dynamic brake has nothing to do with the safety function, please ensure that in the HWBB state, there will be no danger even if it enters the free running state. Generally, it is recommended to adopt the sequential control that enters the HWBB state after the instruction is stopped.
- In applications where the HWBB function is frequently used, if the motor is stopped by a dynamic brake, the internal components of the servo unit may deteriorate. To prevent aging of components, please design a sequence control loop that enters the HWBB state after stopping.

2.8 Regarding the setting of position deviation clearing action

The position deviation clearance in the HWBB state is implemented according to the setting of the clear operation (Pn200 = n. X). When position control is set to not clear the position deviation (Pn200 = n. 1), in the HWBB state, if the position command from the upper device is not stopped, the position deviation will continue to accumulate, resulting in the following situations.

d00 (excessive position deviation alarm) occurs.

When switching from the HWBB state to the BB state to turn on the servo, the servo motor will only run the accumulated position deviation.

Therefore, in the HWBB state, stop the position command from the host device. In addition, if it is set to not clear the position deviation (Pn200 = n. 1), in the HWBB state or the BB state, please input the clear (CLR) signal to clear the position deviation.

2.9 Peripheral device monitoring (EDM1)

Peripheral device monitoring (EDM1) is a function to monitor the failure of the HWBB function. Please connect with feedback from safety devices.

(Note) In order to satisfy PL e in EN ISO 13849-1 and SIL3 in IEC61508, the EDM1 signal must be monitored by the host device. When the EDM1 signal is not monitored by the host device, it becomes PLd.

• Fault detection signal of EDM1 signal

The relationship between EDM1 and /HWBB1 and /HWBB2 signals is shown below. The fault of the EDM1 signal circuit itself can be detected by confirming the status of the /HWBB1, /HWBB2, and EDM1 signals in the table. If it can be confirmed when the power is turned on, etc., the fault can be detected.

Signal	Logic			
/HWBB1	ON	ON	OFF	OFF
/HWBB2	ON	OFF	ON	OFF
EDM1	OFF	OFF	OFF	ON

⚠ Caution

- The EDM1 signal is not a safety output. Do not use it for purposes other than the fault monitoring function.

2.10 EDM1 output signal specifications

After the HWBB function is requested by setting the 2-channel input signals /HWBB1 and /HWBB2 to OFF, the EDM1 output signal will be ON within 8ms when the safety function operates normally.

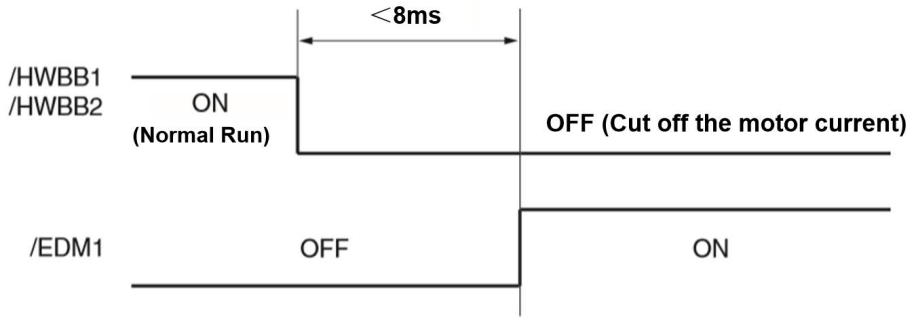


Figure 8 EDM1 output signal

3. 3. Examples of the use of safety functions

The following is an example of using the safety function.

3.1 Connection example

The following shows a connection example that uses a safety device to activate the HWBB function when the protective cover is opened.

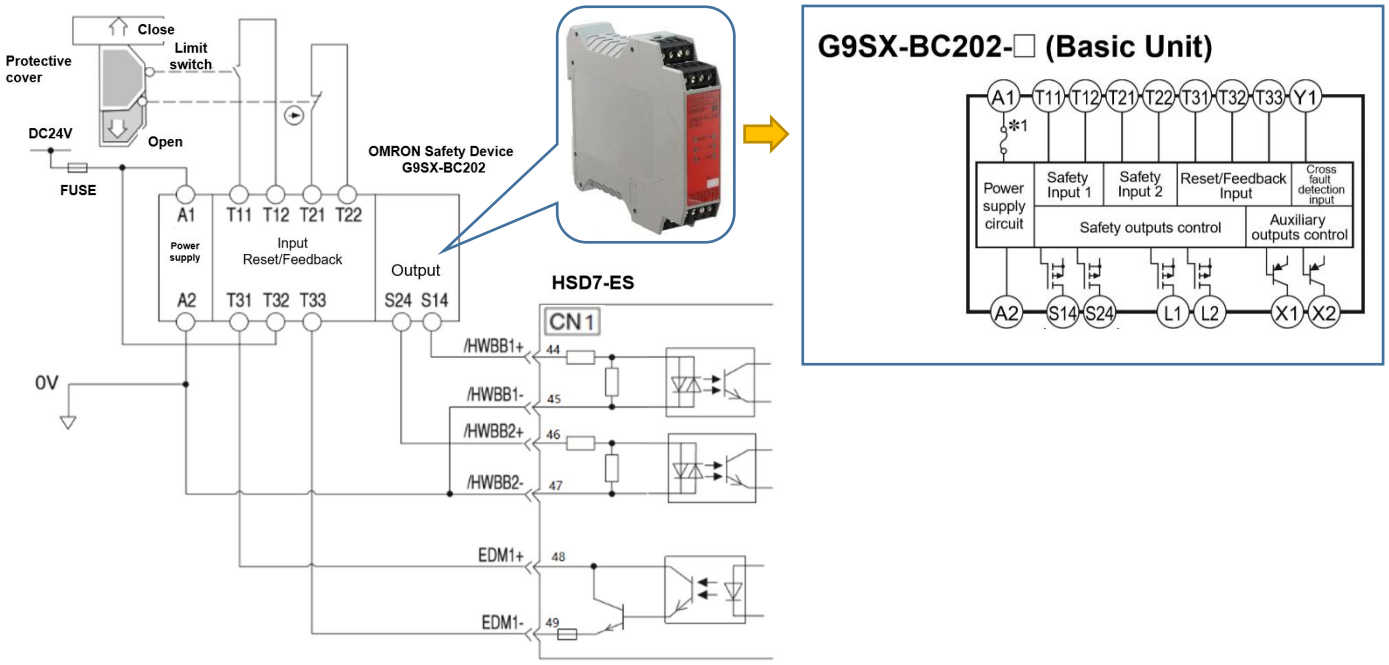


Figure 9 Recommended wiring method

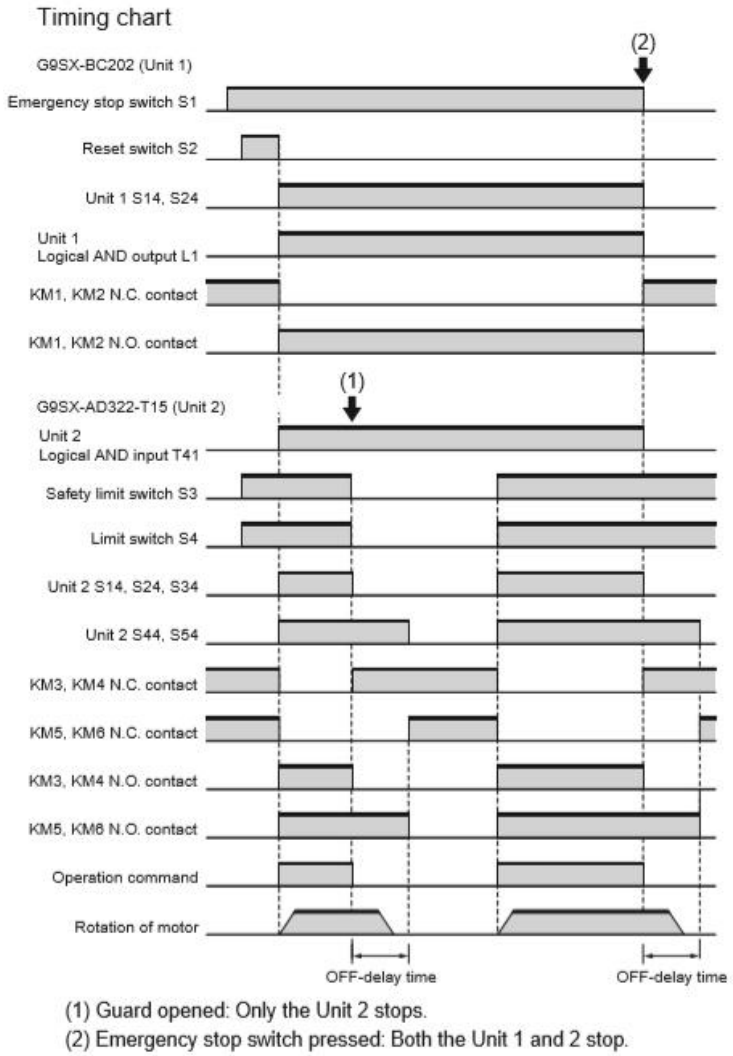


Figure 10 Omron G9SX-BC202 safety relay sequence diagram

The above safety relays are recommended to use Omron G9SX-BC202. For more detailed information, please refer to the official website:

https://automation.omron.com/en/us/products/family/G9SX/g9sx-bc202-rt%20dc24

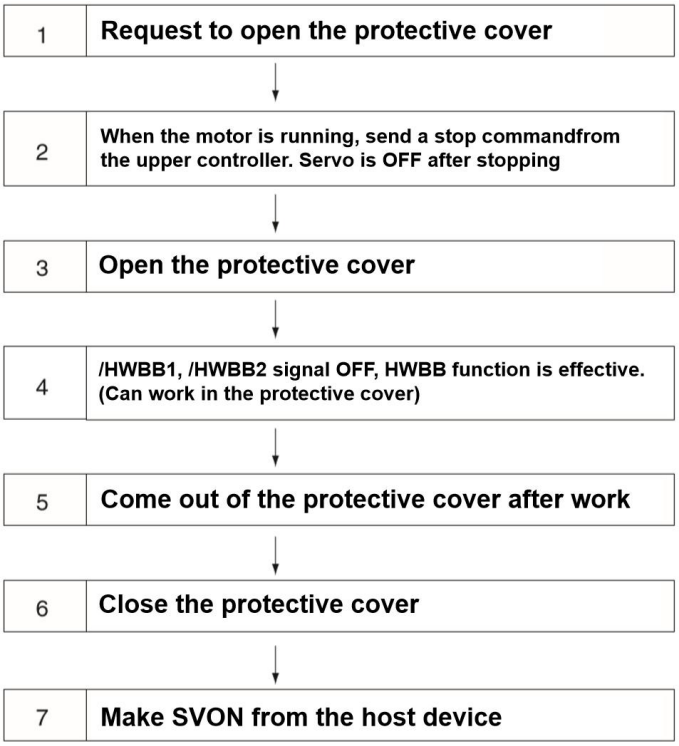
Under normal circumstances, when the protective cover is opened, the /HWBB1 and /HWBB2 signals are both OFF, and the EDM1 signal is ON. If the protective cover is closed at this time, it will be reset due to the ON of the feedback loop, and the /HWBB1 and /HWBB2 signals will enter the operable state after ON.

(Note) The EDM1 signal is used for common emitter output. When wiring, make sure that the current flows from EDM1+ to EDM1-.

3.2 Fault detection method

When a fault occurs in which the /HWBB1 or /HWBB2 signal remains ON, the EDM1 signal will not turn ON, and even if the protective cover is closed, it cannot be reset, causing the machine to fail to start, and the fault can be detected at this time. This situation may be caused by a malfunction of peripheral equipment, a broken/short-circuited external wiring, or a malfunction of the servo unit. Please find out the reason and take corresponding measures.

3.3 Steps for usage



3.4 Safety function validity confirmation test

When the device is started, when the servo unit is replaced during maintenance, or after wiring, be sure to perform the following HWBB function validation test. (It is recommended to keep the confirmation result as a record.)

• Make sure that when the /HWBB1 and /HWBB2 signals are turned off, the display of the panel operator or digital operator changes to "Hbb" and the servo motor stops operating.

• Monitor the ON/OFF status of /HWBB1 and /HWBB2 signals. If it does not match the signal's ON/OFF display, it may be that the peripheral equipment is malfunctioning, the external wiring is broken/short-circuited, or the servo unit is malfunctioning. Please find out the reason and deal with it accordingly