Safety Category 4 Application Note

Application:
Category 4: Safety circuit using a G9SE.

With all safety circuits a risk assessment should be performed to determine what level of safety devices and circuits should be used within the system. If the system has be classified as needing a Category 4 circuit this application note should provide some understanding of what is need to achieve this rating. For a safety circuit that is requiring category 4 rating and is needing the use of the following components the G9SE is a good alternative choice:

E-Stop (single or multiple)
Single Door switch
Single Light Curtain

With a Category 1 circuit the following functions need to apply:
1) Basic safety circuit configuration for ground faults.
2) Control circuit forced opened directly by a safety switch in positive operation (In this application: E-Stop).
3) Use of parts such as switches and relays that conform to EN and other standards (In this application: Start, Stop pushbuttons, G7SA relay).

With a Category 4 circuit then adds the following functions along with the category 1 functions above:
4) Fail-safe design will not allow the machine to restart until the circuit is satisfied.
5) Foolproof design prevents incorrect operation.

<Redundancy>
1. Input redundancy using switches: Two-channel input with limit switches SW1 and SW3 in positive operation.
2. Circuit redundancy using relays: Improves reliability with duplicate relay coil operating circuits K1 and K2.
3. Output redundancy using relays: Improves reliability with duplicate interface relay unit output circuits KM1 and KM2 connected in parallel.
4. Feedback circuit: Improves reliability by feeding back the series-connected normally closed contacts of interface relay unit output circuits KM1 and KM2 to the interface relay unit.

Below are some circuit examples using the G9SE. If you safety circuit needs more devices than what is listed below then the use of the G9SP would be the suggested controller:
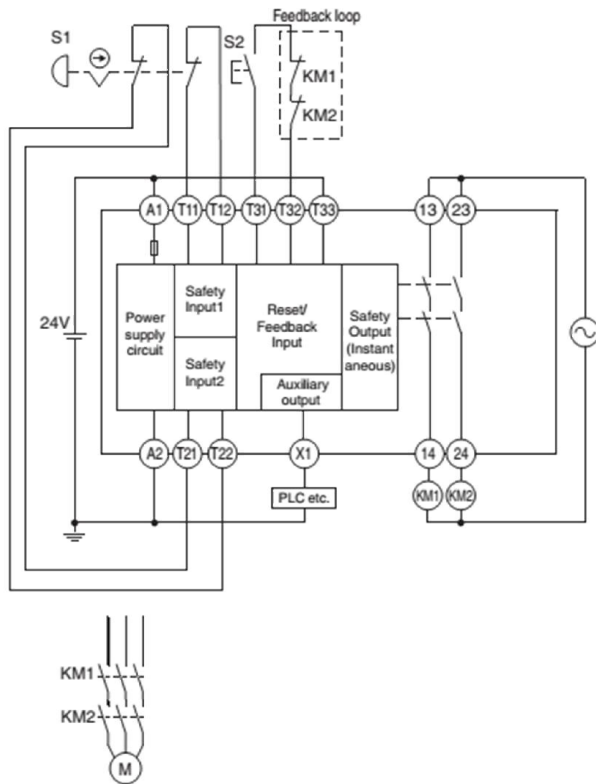
Application Overview

- Immediately removes power to Motor M when Emergency Stop Switch S1 is pressed.
- The power to Motor M is kept removed until Emergency Stop Switch S1 is released and Reset Switch S2 is pressed.

Evaluation example

PL/safety category	Model	Stop category	Reset
PLe/4 equivalent	Emergency stop pushbutton :A22E-M-02 (2NC contact) Push Button Switch (from Annex C of ISO 13849-1) Safety Relay Unit :G9SE-201 Contactor of rated load (from Annex C of ISO 13849-1)	0	Manual

Note: The above PL is only the evaluation result of the example. The PL must be evaluated in an actual application by the customer after confirming the usage conditions.

Wiring Example

Timing Chart
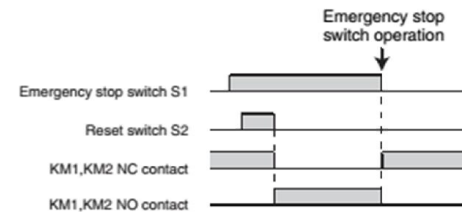
Device

S1: Emergency stop switch
S2: Reset switch
KM1, KM2: Contactor
M: 3-phase motor

The example above shows using only one E-Stop switch. It is possible to use multiple e-stops but should be wired in series.
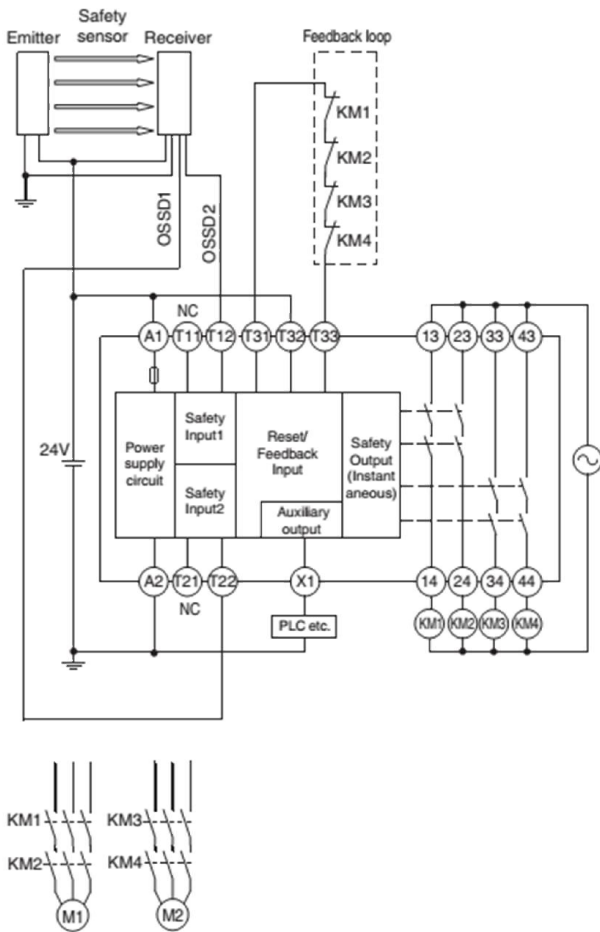
Application Overview

- The machine has the opening of the hazardous source which is small enough to prevent a person from entering.
- The Safety Light Curtain is installed at the safe distance from the hazardous source.
- Immediately removes power to Motor M when the Safety Light Curtain detects a finger entering the area.

Evaluation example

PL/safety category	Model	Stop category	Reset
PLe/4 equivalent	Safety Light Curtain :F3SJ-B Safety Relay Unit :G9SE-401 Contactor of rated load (from Annex C of ISO 13849-1)	0	Auto

Note: The above PL is only the evaluation result of the example. The PL must be evaluated in an actual application by the customer after confirming the usage conditions.

Wiring Example

Timing Chart
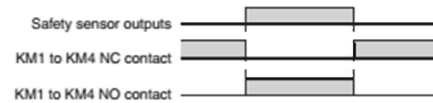
Device

Safety sensor
KM1 to KM4: Contactor
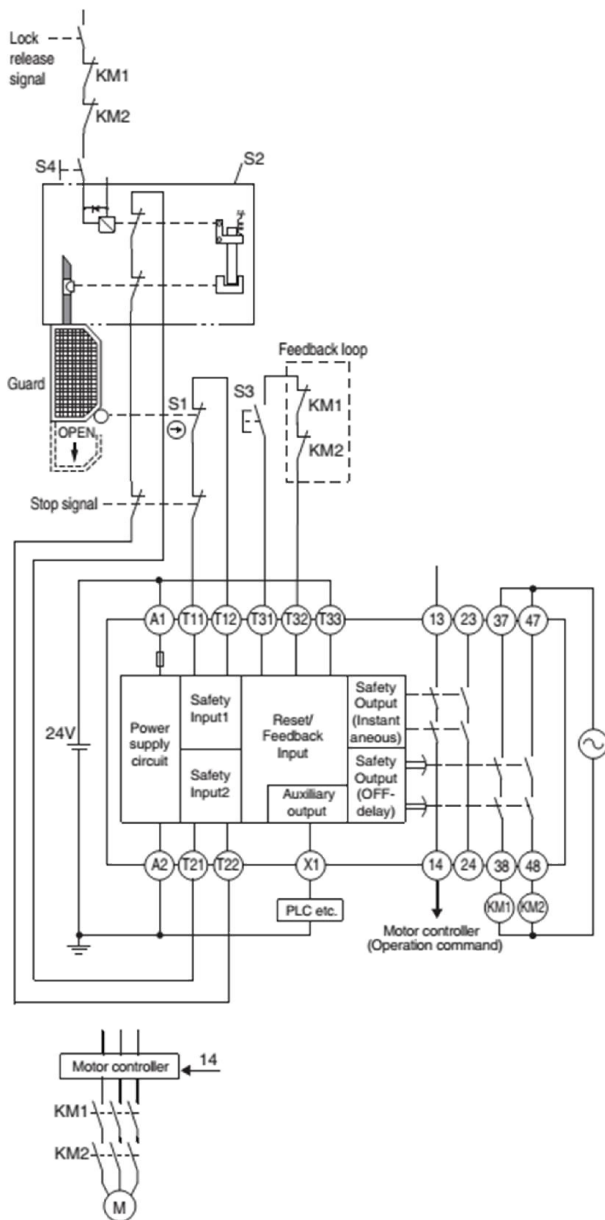M1, M2: 3-phase motor

Application Overview

- Immediately removes power to Motor M when Limit Switch S1 and Guard Lock Safety Door Switch S2 detect the opening of the Guard.
- The power to Motor M is kept removed until Reset Switch S3 is pressed.
- When the NC contacts on both KM1 and KM2 are closed and the lock release signal is input, the Guard can be opened while Lock Release Switch S4 is pressed.
- The power to Motor M is kept removed until the Guard is closed and locked and Reset Switch S3 is pressed.

Evaluation example

PL/safety category	Model	Stop category	Reset
PLe/4 equivalent	Safety Limit Switch :D4N-□□20 Guard Lock Safety Door Switch:D4SL-N□□□A-□(Mechanical lock) Push Button Switch(from Annex C of ISO 13849-1) Safety Relay Unit :G9SE-221-T05 Contactor of rated load (from Annex C of ISO 13849-1)	1	Manual

Note: The above PL is only the evaluation result of the example. The PL must be evaluated in an actual application by the customer after confirming the usage conditions.

Wiring Example

Timing Chart
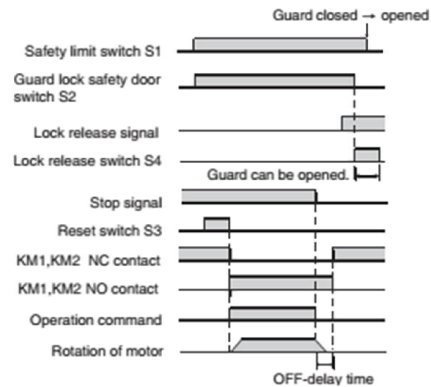
Device

S1: Safety limit switch
S2: Guard lock safety door switch(Mechanical Lock)
S3: Reset switch
KM1, KM2: Contactor
M: 3-phase motor