FANUC Series 30*i*/300*i*/300*i*s-MODEL A
FANUC Series 31*i*/310*i*/310*i*s-MODEL A5
FANUC Series 31*i*/310*i*/310*i*s-MODEL A
FANUC Series 32*i*/320*i*/320*i*s-MODEL A

Dual Check Safety

OPERATOR'S MANUAL

B-64004EN/02

DEFINITION OF WARNING, CAUTION, AND NOTE

This manual includes safety precautions for protecting the user and preventing damage to the machine. Precautions are classified into Warning and Caution according to their bearing on safety. Also, supplementary information is described as a Note. Read the Warning, Caution, and Note thoroughly before attempting to use the machine.

> ⚠ **WARNING**
> Applied when there is a danger of the user being injured or when there is a danger of both the user being injured and the equipment being damaged if the approved procedure is not observed.

> ⚠ **CAUTION**
> Applied when there is a danger of the equipment being damaged, if the approved procedure is not observed.

> **NOTE**
> The Note is used to indicate supplementary information other than Warning and Caution.

- Read this manual carefully, and store it in a safe place.

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1 OVERVIEW

Setup for machining, which includes attaching and detaching a workpiece to be machined, and moving it to the machining start point while viewing it, is performed with the protection door opened. The dual check safety function provides a means for ensuring a high level of safety with the protection door opened.

The simplest method of ensuring safety when the protection door is open is to shut off power to the motor drive circuit by configuring a safety circuit with a safety relay module. In this case, however, no movements can be made on a move axis (rotation axis). Moreover, since the power is shut off, some time is required before machining can be restarted. This drawback can be corrected by adding a motor speed detector to ensure safety. However, the addition of an external detector may pose a response problem, and the use of many safety relay modules results in a large and complicated power magnetic cabinet circuit.

With the dual check safety function, two independent CPUs built into the CNC monitor the speed and position of motors in dual mode. An error in speed and position is detected at high speed, and power to the motor is shut off via two independent paths. Processing and data related to safety is cross-checked by two CPUs. To prevent failures from being built up, a safety-related hardware and software test must be conducted at certain intervals time.

The dual check safety system need not have an external detector added. Instead, only a detector built into a servo motor or spindle motor is used. This configuration can be implemented only when those motors, detectors built into motors, and amplifiers that are specified by FANUC are used. When an abnormality related to safety occurs, the dual check safety function stops operation safely.

The dual check safety function ensures safety with the power turned on, so that an operator can open the protection door to work without turning off the power. A major feature of the dual check safety function is that the required time is very short from the detection of an abnormality until the power is shut off. A cost advantage of the dual check safety function is that external detectors and safety relays can be eliminated or simplified.

If a position or speed mismatch is detected by a cross-check using two CPUs, the safety function of the Dual Check Safety works the power to be shut off (MCC off) to the motor drive circuit.

IMPORTANT
The dual check safety function cannot monitor the stop state of the motors.

1.1 DIRECTIVE AND STANDARDS

1.1.1 Directives

Machine tools and their components must satisfy the EC directives listed below.
The FANUC CNC systems with the dual check safety function are compatible with all of these directives.

Directive

Directive 98/37/EC	1998 Safety of machinery
Directive 89/336/EEC	1989 Electromagnetic compatibility
Directive 73/23/EEC	1973 Low Voltage Equipment

1.1.2 Related Safety Standards

To be compatible with the directives, especially the machine directive, the international standards and European standards need to be observed.

Important safety standards

EN292-1 1991	Safety of machinery - Basic concepts, general principles for design – Part 1: Basic terminology, methodology
EN292-2 1991	Safety of machinery - Basic concepts, general principles for design – Part 2: Technical principles and specifications
EN954-1 1996	Safety of machinery - Safety-related parts of control systems – Part 1: General principles for design
EN1050 1996	Safety of machinery - Principles for risk assessment
EN60204-1 1997	Safety of machinery - Electrical equipment of machines Part 1: General requirements
DIN V VDE0801 (1990) including amendment A1(1994)	Principles for computers in safety- related systems

1.1.3 Risk Analysis and Evaluation

According to the machine directive, the manufacturer of a machine or machine components and a responsible person who supplies a machine or machine components to the market must conduct risk evaluation to identify all risks that can arise in connection with the machine or machine components. Based on such risk analysis and evaluation, a machine and machine components must be designed and manufactured. Risk evaluation must reveal all remaining risks and must be documented.

1.2 DEFINITION OF TERMS

1.2.1 General Definition of Terms

Reliability and safety
Reliability and safety are defined by EN292-1 as follows:

Term	Definition
Reliability	Capability of a machine, machine component, or equipment to perform its required function under a specified condition for a specified period
Safety	Capability of a machine to perform its function without injuring the health under a condition of use for an intended purpose specified in the operator's manual and allow its transportation, installation, adjustment, maintenance, disassembly, and disposal

1.2.2 Definition of Terms Related to the Safety Function

Safety-related I/O signal
Safety-related I/O signals are input/output signals monitored by two systems. These signals are valid for each feed axis and spindle with a built-in safety function, and are used with each monitoring system.
Example: Protection door state signal

Safety stop
When a safety stop occurs, power to the drive section is shut off. The drive section can generate neither a torque nor dangerous operation. The following are measures for incorporating the safety stop feature:
Contactor between the line and drive system (line contactor)
Contactor between the power section and drive motor (motor contactor)
If an external force is applied (such as a force applied onto a vertical axis), an additional measure (such as a mechanical brake) must be securely implemented to protect against such a force.

Safety limitation speed
When the drive system has reached a specified limitation speed, a transition is made to the safe stop state.
A measure must be implemented to prevent a set limitation speed from being changed by an unauthorized person.

Safety machine position
When the drive system has reached a specified positional limit, a transition is made to the safety stop state. When a positional limit is set, a maximum move distance traveled until a stop occurs must be considered. A measure must be implemented to prevent a set positional limit from being changed by an unauthorized person.

1.3 BASIC PRINCIPLE OF DUAL CHECK SAFETY

1.3.1 Features of Dual Check Safety

Dual Check Safety function has the following features.

- Two-channel configuration with two or more independent CPUs
- Cross-check function for detecting latent errors

Detection

A servo motor detector signal is sent via the servo amplifier and is applied to the CNC through the FSSB interface. Then, it is fed to two CPUs: a CNC CPU and a Servo CPU.

A spindle motor detector signal is sent via the spindle amplifier and is applied to the CNC connected through the serial interface. Then, it is fed to two CPUs: a CNC CPU and a CPU built into the spindle amplifier.

The safety related signal such as guard signal is sent via the independent I/O unit and is applied to the CNC through the I/O link interface. Then, it is fed to two CPUs: a CNC CPU and a PMC CPU.

Evaluation

The safety function is monitored independently by a CNC CPU and servo CPU or by a CNC CPU and spindle CPU. Each CPU cross-checks data and results at certain intervals.

Response

If the monitoring function detects an error, the CNC CPU and the servo/spindle CPU switch off the MCC via independent paths to shut off the power to the feed axis and spindle.

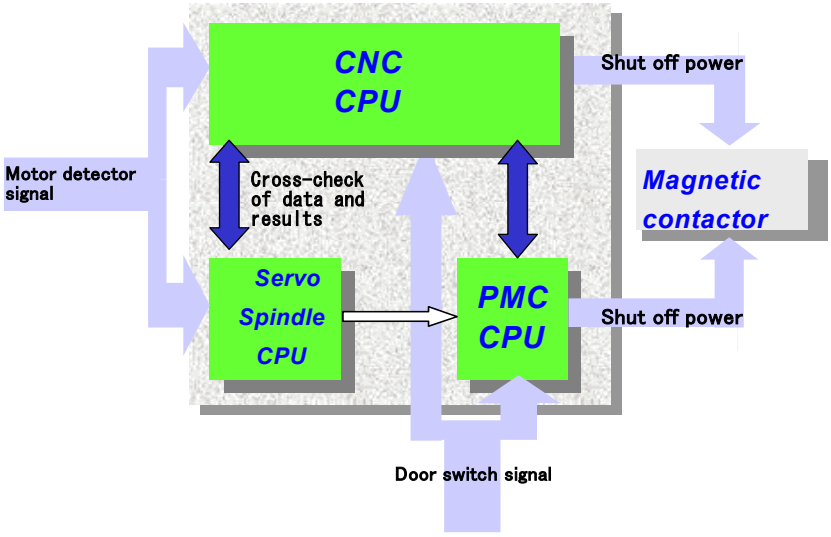
1.3.2 Compliance with the Safety Standard (EN954-1, Category 3)

The dual check safety function satisfies the requirements of Category 3 of the safety standard EN954-1.

Category 3 requires the following:

- The safety function of a safety-related portion must not degrade when a single failure occurs.
- Single errors must be detected at all times when natural execution is possible.

To satisfy these requirements, the dual check safety function is implemented using the two-channel configuration shown below.



Monitoring of servo motor and spindle motor movement

Data output from the detector built into each motor is transferred to the CNC through the amplifier. The safety of this path is ensured by using motors and amplifiers specified by FANUC.

Cross-monitoring using 2 CPUs

Two CPUs built into the CNC are used to cross-monitor the safety function. Each CPU is periodically checked for errors. If one system fails, the servo system and spindle can be stopped safely.

Power shutoff via two paths

If an error is detected, the power is shut off via two power shutoff paths. The paths need to be tested for built-up failures within a certain time.

Input signal safety

Safety-related input signals such as the protection door lock/unlock signal are monitored doubly. If a mismatch between the two occurrences of a signal is detected, the power to the motor drive circuit is shut off. This cross-check is constantly made.

Output signal safety

A signal is output (via two paths) to the relay used to shut off the power to the motor drive circuit. An error is detected by a MCC off Test. For detection of built-up failures, a MCC off Test needs to be conducted at certain intervals. This MCC off Test is not mandatory when machining is performed with the protection door closed. (The MCC off Test should be performed, before the protection door is open after the certain intervals.)

1.3.2.1 Latent error detection and cross-check

Detection of latent errors
This detection function can detect latent software and hardware errors in a system that has a two-channel configuration. So, the safety-related portions of the two channels need to be tested at least once within an allowable period of time for latent errors.
An error in one monitoring channel causes a mismatch of results, so that a cross-check detects the error.

> ⚠ **CAUTION**
> Forced detection of a latent error on the MCC shutoff path must be performed by the user through a MCC off Test (after power-on and at intervals of a specified time (within normally 24 hours)). When the system is operating in the automatic mode (when the protection door is closed), this detection processing is not requested as mandatory. But, before the protection door opens after the specified time, the detection processing is required mandatory. If this has not been performed, lock for the protection door should not be released.

Cross-check
A latent safety-related error associated with two-channel monitoring can be detected as a result of cross-checking.
For numeric data, an allowable difference between the two channels is set in a parameter. (For example, an allowable cross-checked difference is set for the actual position.)

> **NOTE**
> An error detected as the result of forced latent error detection or cross-checking leads to a safety stop state. (See Chapter 3.3.3).

1.3.2.2 Safety monitoring cycle and cross-check cycle

The safety function is subject to periodical monitoring in a monitoring cycle.
The following functions are monitored at every 8ms.
- Safe speed monitoring (servomotor)
- Safe machine position monitoring (servomotor)
- Safe position error monitoring (servomotor)

The cross-check cycle represents a cycle at which all I/O data subject to cross-checking is compared.
Cross-check cycle: 8 ms

1.3.2.3 Error analysis

Error analysis
The table below indicates the results of system error analysis controlled by the dual check safety function.

Error analysis when the protection door is open

Error	Cause	Action
Excessive speed for Spindle axis	Amplifier or control unit failure, operation error, etc.	Safety limitation speed monitoring function EN60204-1 Category 1/0 stop
Excessive speed for feed axis	Amplifier or control unit failure, operation error, etc.	Safety limitation speed monitoring function EN60204-1 Category 1/0 stop
Feed axis safety machine position error	Amplifier or control unit failure, operation error, etc.	Safety machine position monitoring function EN60204-1 Category 1/0 stop
Input/output signal error	Wiring error, control unit failure, etc.	Safe-related I/O signal monitoring function EN60204-1 Category 1/0 stop

Error analysis when the protection door is closed

Error	Cause	Action
Input/output signal error	Wiring error, control unit failure, etc.	Safe-related I/O signal monitoring function EN60204-1 Category 1/0 stop

1.3.2.4 Remaining risks

The machine tool builder is to make a failure analysis in connection with the control system and determine the remaining risks of the machine.

The dual check safety system has the following remaining risks:

a) The safety function is not active until the control system and drive system have fully powered up. The safety function cannot be activated if any one of the components of the control or drive is not powered on.
b) Interchanged phases of motor connections, reversal in the signal of encoder and reversal mounting of encoder can cause an increase in the spindle speed or acceleration of axis motion. If abnormal speed detected, system controlled to brake to zero speed, but no effective for above error. MCC off is not activated until the delay time set by parameter has expired. Electrical faults (component failure etc.) may also result in the response described above.
c) Faults in the absolute encoder can cause incorrect operation of the safety machine position monitoring function.
d) With a 1-encoder system, encoder faults are detected in a single channel, but by various HW and SW monitoring functions. The parameter related to encoder must be set carefully. Depending on the error type, a category 0 or category 1 stop function according to EN60204-1 is activated.

e) The simultaneous failure of two power transistors in the inverter may cause the axis to briefly (motion depend on number of pole pairs of motor)
Example:
An 8-pole synchronous motor can cause the axis to move by a maximum of 45 degrees. With a lead-screw that is directly driven by, e.g.16mm per revolution, this corresponds to a maximum linear motion of approximately 2.0mm.

f) When a limit value is violated, the speed may exceed the set value briefly or the axis/spindle overshoot the set point position to a greater or lesser degree during the period between error detection and system reaction depending on the dynamic response of the drive and the parameter settings (see Section Safety-Functions)

g) The category 0 stop function according to EN60204-1 (defined as STOP A in Safety Integrated) means that the spindles/axes are not braked to zero speed, but coast to a stop (this may take a very long time depending on the level of kinetic energy involved). This must be noted, for example, when the protective door locking mechanism is opened.

h) Amplifiers (drive power modules) and motors must always be replaced by the same equipment type or else the parameters will no longer match the actual configuration and cause Dual check Safety to respond incorrectly.

i) Dual check Safety is not capable of detecting errors in parameterization and programming made by the machine tool builder. The required level of safety can only be assured by thorough and careful acceptance.

j) There is a parameter that MCC off test is not to be made in the self test mode at power-on as in the case of machine adjustment. This parameter is protected, only changed by authorized person. IF MCC off test is not conducted, MCC may not be off at stop response is measured.

k) Safety machine position monitoring function does not apply to the spindle axis.

l) During machine adjustment, an exact motion may be executed incorrectly until the safety functions setup correctly and confirm test is completely.

m) Before the reference point return is performed and the MCC off test is performed, it may be dangerous because the correct operation does not be guaranteed. So, the careful operations are required when the machine is operated in the status that the protection door opens.

n) The delay timer is prepared for the cross-checking of the safety related input/output signals. When the inconsistency exists between the signal from the 2 paths, system will recognize this failure, after this time is passed. The system will start the sequence of MCC shut-off, when this time is passed after the inconsistency is detected.

1.4 GENERAL INFORMATION

The following requirements must be fulfilled for the Dual-Check System:

- All conditions of the certification report have to be respected.
- The procedures for the changes in the System (either HW or SW) should be referred to maintenance manual (B-63945EN). When safety related components are exchanged, confirmation test regarding safety functions can be performed according to Chapter 8.
- Programming in ladder logic should be referred to PMC programming manual (B-63983EN).

Training

FANUC Training Center provides versatile training course for the person who is concerned with hardware installation, maintenance and operation. FANUC recommend studying and learning in the training center how efficiently operate FANUC products.
There are 3 CNC training course.

[CNC ELEMENTARY COURSE]
Provides basics of CNC functions, operation and programming. The course is recommended before taking more specialized training courses to gain best effects.

MAIN ITEMS OF TRAINING
- CNC functions
- Configuration of CNC
- Configuration and function of servo system
- Basic programming of CNC
- Part programming of milling machine
- Part programming of turning machine
- Introduction of Custom Macro function

[CNC MAINTENANCE COURSE]
To master maintenance technique that permits you to maintain and inspect CNC, also how to restore it promptly if a trouble should occur.

MAIN ITEMS OF TRAINING
- Function and configuration of Power Unit
- Function and configuration of CNC system
- include AC servo and AC spindle
- Self-diagnosis function
- Interface between CNC and the machine tools
- Data saving and restoring operation
- Trouble shooting

[CNC SE INTERFACE COURSE]
Training course offered to the engineers who design CNC machine tools or CNC application system for the first time. This course is also suitable for customers who provide to retrofitting, to develop an original CNC machine tools or new application of CNC.

MAIN ITEMS OF TRAINING
- Configuration of CNC system
- Interface between CNC and machine tools
- Ladder programming of machine control sequence
- Setting of parameter related to machine
- Setting of parameter related to servo and spindle

More information and course registration
Yamanakako-mura, Yamanashi Prefecture : 401-0501, JAPAN
Phone : 81-555-84-6030
Fax : 81-555-84-5540
Internet:
www.fanuc.co.jp/eschool

2 SYSTEM CONFIGURATION

The dual check safety function has the following components.

Applicable CNC
FANUC Series 30*i*/300*i*s/300*i*
FANUC Series 31*i*/310*i*s/310*i* A5
FANUC Series 31*i*/310*i*s/310*i*
FANUC Series 32*i*/320*i*s/320*i*

Number of controlled axes
- Series 30*i*/300*i*s/300*i* : 32 maximum
- Series 31*i*/310*i*s/310*i* A5 : 20 maximum
- Series 31*i*/310*i*s/310*i* : 20 maximum
- Series 32*i*/320*i*s/320*i* : 9 maximum

Number of spindle controlled axes
- Series 30*i*/300*i*s/300*i* : 8 maximum
- Series 31*i*/310*i*s/310*i* A5 : 6 maximum
- Series 31*i*/310*i*s/310*i* : 6 maximum
- Series 32*i*/320*i*s/320*i* : 2 maximum

Amplifier
- α series servo amplifier
- α series spindle amplifier
- α series power supply module

- α*i* series servo amplifier
- β*i* series servo amplifier
- α*i* series spindle amplifier
- α*i* series power supply module

Motor
- α series servo motor
- α series spindle motor
- β series servo motor
- α*i* series servo motor
- α*i* series spindle motor
- α*i*s series servo motor
- β*i*s series servo motor
- L*i*s series linear motor

I/O
- I/O unit (I/O Link)

Software
- Dual check safety software option

DETECTOR SYSTEM

The detectors below can be used.

Feed axis detector
-Pulsecoder αA1000, αA64,
- αA16000*i*, αA1000*i*, αI1000*i*, αA64*i*
- βA64B, βA32B
- βI64B, βI32B
- Separate type detector (A quard B)

Spindle detector
- M sensor
- MZ sensor
- BZ sensor

- M*i* sensor
- MZ*i* sensor
- BZ*i* sensor
- CZ*i* sensor

High Resolution Serial output circuit

3 SAFETY FUNCTIONS

3.1 APPLICATION RANGE

The dual check safety function assumes the following configuration:

A) At least, one protective door is provided.
B) If protective door is closed, safety is assured.

When the operator makes a request to open the protective door, the safety functions are enabled, and the protective door can be unlocked. While the protective door is open, the active safety functions assure safety. When the request to open the protective door is canceled, the protective door is locked, and the safety functions are disabled.

The dual check safety function provides these safety functions while the protective door is open, as described above. Some of the safety functions continue working while the protective door is closed.

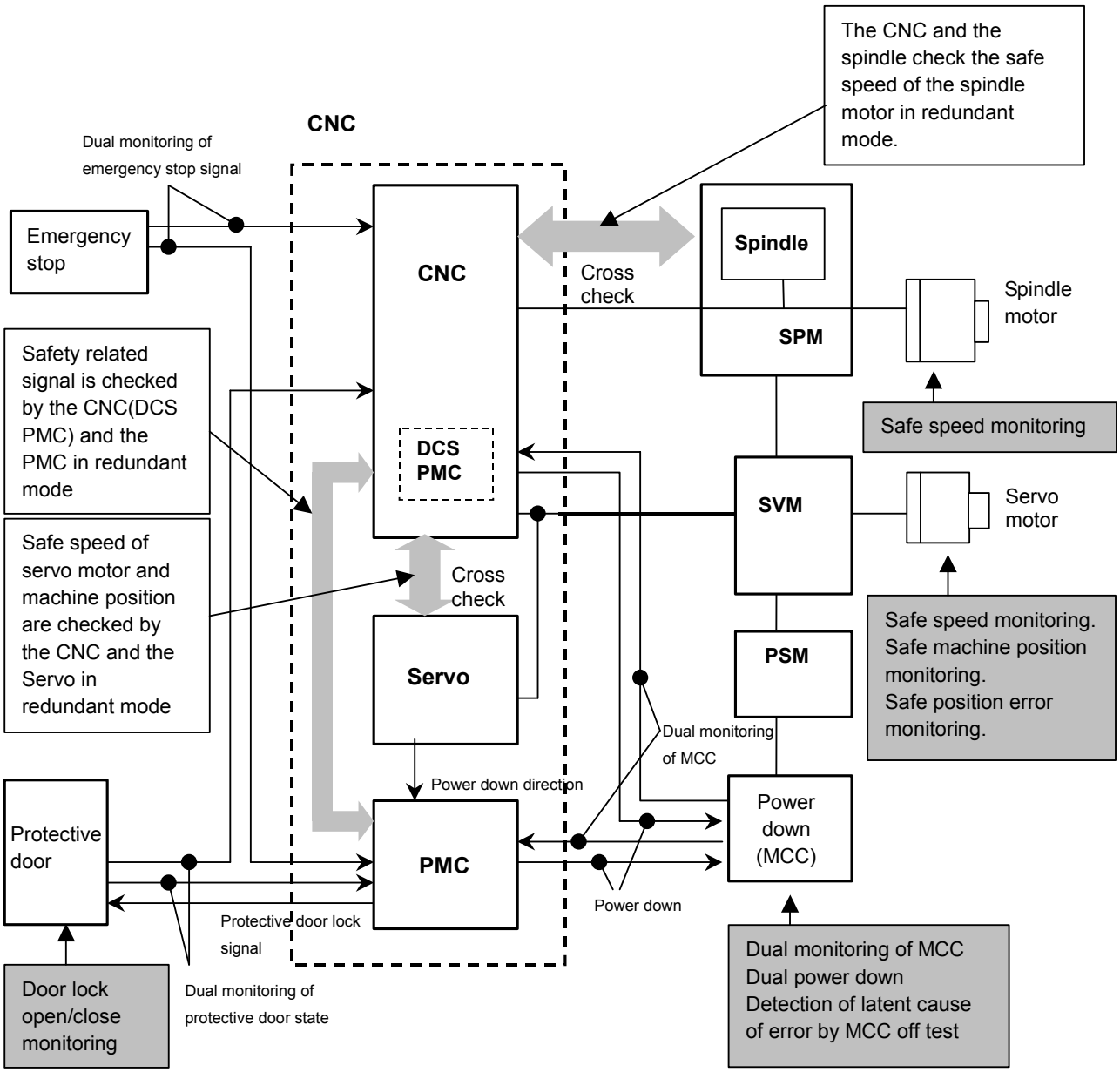
> ⚠ **WARNING**
> Each machine tool builder should take measures to assure safety while the protective door is closed and to ensure safety related to a rotation axis and travel axis. At the same time, safety measures for the FANUC servo motor or spindle motor need to be taken, while the door is open.

Safety function

The dual check safety function has the following safety functions:

- Safe-related I/O signal dual monitoring
  Emergency stop input, protective door open/close state,
  relay state for turning off the MCC
  Output signal for shutting off the power (turning the MCC off)
  To detect the latent cause of an abnormal state of this output, a MCC off Test must be made.
- Spindle motor
  Safe speed monitoring
- Servo motor
  Safe speed monitoring
  Safe machine position monitoring
  Safe position error monitoring

> ⚠ **CAUTION**
> This safety function is enabled while the protective door is open after a request to open the protective door is made. If the request to open the protective door is canceled and if the protective door is closed, this safety function is disabled. The dual input check of the safe-related I/O signal monitoring function and the emergency stop function are always active, regardless of whether the protective door is opened or closed.



3.2 BEFORE USING THE SAFETY FUNCTION

3.2.1 Important Items to Check Before Using the Safety Function

When using the safety function for the first time upon assembly of the machine, replacing a part, or changing a safety parameter (such as a safe speed limit or safe range as described in Chapter 6), the user must check that all safety parameters are correct and that all safety functions are working normally. A return reference position must be made on each axis. The user must also check the absolute position of the machine. For details, see Chapter 7, “START UP.”

3.2.2 MCC off Test of the Safe Stop Function

An MCC off Test of the safe stop function monitors the contact state of the electromagnetic contactor (MCC), compares the state with a command to the electromagnetic contactor, and checks that the safe stop function works normally. The user of the machine must carry out the test. This test must be carried out when the CNC is turned on or when 24 hours have elapsed after the previous test is completed. If the CNC is turned on or if 24 hours have elapsed after the previous test is completed, a guard open request (protective door open request) should not be accepted until the test is performed. A machine tool builder must make the ladder program to realize this sequence.

3.3 STOP

3.3.1 Stopping the Spindle Motor

Because the spindle motor is an induction type motor, power-down during rotation causes the motor to continue rotating for a certain amount of time. From a safety standpoint, the motor may have to be stopped immediately. If an error is detected and the spindle is judged to be controlled, it is possible to stop spindle motor by the ladder program. In case of emergency stop and abnormal condition of safety related I/O, it is necessary to design the ladder program to shut off the power after waiting the specified time elapses.

To speed down and stop the spindle, the PMC must input the spindle Emergency Stop signals (*ESPA(G71.1), *ESPB(G75.1), and so on). When this signal is input, the spindle slows down and stops. (A Ladder program for inputting this signal in case of alarm must be created.) The emergency stop input (connector CX4) of the PSM has the same effect. If the Emergency Stop signal is connected to emergency stop input (connector CX4) of the PSM, the spindle slows down and stops in the emergency stop state. If the spindle does not stop in spite of the stop command, the MCC is shut off.

If this processing is not performed, power-down causes the spindle motor to continue rotating at the speed prior to power-down (and eventually stopping in the end).

> ⚠ **CAUTION**
> When the servo alarm related to the communication error or position detector is caused, MCC off signal corresponding to the spindle is output. Shut off the MCC after executing appropriate procedure such as spindle stop operation. According to the setting value of the parameter, MCC off signals of all axes, which belong to the same path of the spindle that causes an alarm, are output. Shut off the MCC after executing appropriate procedure such as spindle stop operation.

3.3.2 Stopping the Servo Motor

Because the servo motor is a synchronous motor, power-down results in a dynamic brake stop. The dynamic brake stop is electric braking in which the excited rotor is isolated from the power source and the generated electric energy is used up in the winding. An internal resistor provides additional braking. Unlike an induction motor, the servo motor does not coast because of this function.

If the input of the Emergency Stop signal or an error of a safe-related signal or speed monitoring is detected, the CNC automatically specifies a command to zero the speed and reduces the speed to zero (controlled stop). After the motor slows down and stops, the power is turned off, and the motor is brought into the dynamic brake stop state. To slow down and stop the motor, some parameters must be specified in the CNC. If those parameters are not specified, the motor is immediately brought into the dynamic brake stop state.
When abnormal state is detected in monitoring safety speed or so on, a dynamic brake stop is made.

3.3.3 Stop States

The following stop states are possible.

Safe stop state

The power to the motor is shut off (MCC off state) in this state. If the spindle motor can be controlled, the ladder program must shut off the power after the spindle motor is slowed down to a stop. If the spindle motor cannot be controlled, the power is immediately shut off.

If the servo motor can be controlled, the motor is slowed down to a stop and then brought into the dynamic brake stop state. If the motor cannot be controlled, the motor is immediately brought into the dynamic brake stop state.
If the power is shut off immediately, the spindle motor continues at the same speed prior to the abnormal event and eventually comes to a stop. If the spindle motor can be slowed down to a stop, the operation is performed as instructed by the PMC and then the power is shut off.

Controlled stop state

The power to the motor is not shut off. The servo motor and the spindle motor are controlled to stop.
In the controlled stop state of either motor, the safety function is active if the condition for enabling the safety function is satisfied (the door is open). If a further abnormal event occurs, the motor is brought into the safe stop state by the ladder program.

> ⚠ **WARNING**
> 1 The machine tool builder must design the machine so that the machine is kept in the stop state if the power to the servo motor driving circuit is shut off.
> Example) Brake mechanism that would not drop the vertical axis after the power is shut off
> 2 If the power to the spindle motor driving circuit is shut off, the spindle motor continues rotating at the speed before the power-down and eventually comes to a stop. A measure must be taken so that this coasting does not affect safety.

3.4 SAFE-RELATED I/O SIGNAL MONITORING

A set of safe-related I/O signals are connected to the two channels of the I/O respectively. As for safe-related I/O signals, a pair of signals are prepared and connected to each I/O through different paths. The two independent CPUs individually check the input signals. If a mismatch between two corresponding signals is found, the system enters the safe stop state. The following safe-related I/O signals are monitored or output in redundant mode:

- Emergency stop input signal
- Protective door state input signal (Request to monitor for each axis)
- Input signal for selecting safety speed monitoring and safety position monitoring
- Input signal for monitoring the MCC contact state
- Output signal for turning off the MCC (power-down)
- Output signal for position switch
- Output signal for brake control
- User defined safe-related I/O signals

In order to setup double monitoring system, machine tool builder must connect safety signals to both I/O Link #1, #2 and I/O Link#3, #4, Profibus-DP.

IMPORTANT
If the safety input signals, except for Emergency Stop input signals, are connected to the I/O module, a Ladder program must be created to establish a one-to-one relationship between the actual input (X) and the input to the CNC (G).

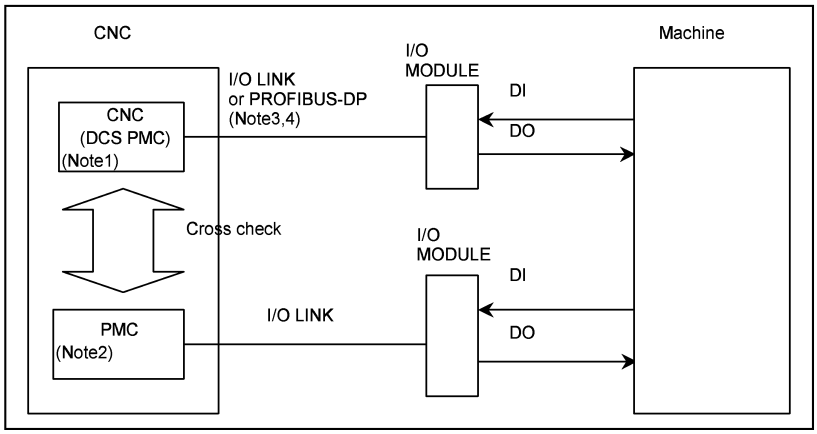
The duplicated input/output signals are always checked for a mismatch, regardless of whether the safety function is active or not. When a signal state changes, the pair of signals may not match for some period because of a difference in response. The dual check safety function checks whether a mismatch between the two signals continues for a certain period of time, so that an error resulting from the difference in response can be avoided. The check period must be specified as a safety parameter.

Parameter number	Name
1945	Safe-related input/output signal check timer

The following signals are not defined as safe-related I/O signals and are not duplicated. The signals, however, are necessary for the system.

- Input signal for making a protective door open request
- Input signal for starting the test mode
- Output signal for requesting a MCC off Test

This section briefly describes the signals. For details, see Chapter 5, “OPERATION.” For specific connections, see the sample system configuration in Chapter 10.



NOTE
1 Dual Check Safety PMC (DCS PMC)
2 First path PMC, Second path PMC, Third path PMC
Please refer to “FANUC Series 30*i*/300*i*/300*i*s-MODEL A PMC PROGRAMMING MANUAL (B-63983EN)”
3 When I/O Link and PROFIBUS-DP are connected to DCS PMC at the same time, the X/Y signals cannot be allocated to PROFIBUS-DP.
4 Please activate “Broken wire detection” of the slave, which connect with PROFIBUS network as Safety-related I/O. As for detail, please refer to “6.6. PROFIBUS-DP parameter settings”.

⚠ **CAUTION**
Ladder functional instruction MOVB, MOVD and MOVW cannot be used with ladder for Dual Check Safety PMC. Use MOVN instead of them.

I/O related with Dual Check Safety Function
PMC(n=path(0-9)) DCS PMC (m=path(0-9) x20)

	Symbol	Signal name	I/O address	
1	*ESP	Emergency Stop signal	<X008#4,0,1> (PMC) <X008#4,0,1>(DCS PMC)	Dual input monitoring
2	*SGOPN	Guard State signal	Machine side signal	Dual input
3	*VLDVx	Safety Check Request signal (Servo)	<Gn750#0-#7> (PMC) <G(002+m)#0-#7>(DCS PMC)	Dual input monitoring
	*VLDPs	Safety Check Request signal (Spindle)	<Gn751#0-#3>(PMC) <G(003+m)#0-#3>(DCS PMC)	Dual input monitoring
4	SVAn/ SVBn	Safety Speed / Safety Position Selection signal (Servo)	<Gn752/Gn753>(PMC) <G(004+m)/G(005+m)>(DCS PMC)	Dual input monitoring
	SPAn/ SPBn	Safety Speed Selection signal (Spindle)	<Gn754>(PMC) <G(006+m)>(DCS PMC)	Dual input monitoring
5	*SMC	MCC Contact State signal	<Gn748#6>(PMC) <G(000+m)#6>(DCS PMC)	Dual input monitoring
6	*DCALM	MCC Off signal (for all system)	<F0748#7>(PMC) <F000#7>(DCS PMC)	Dual output
	*MCF	MCC Off signal (for each machine group)	<Fn748#1>(PMC) <F(000+m)#1>(DCS PMC)	Dual output
	*MCFVx	MCC Off signal (for each servo axis)	<Fn752#0-#7>(PMC) <F(004+m)#0-#7>(DCS PMC)	Dual output
	*MCFPs	MCC Off signal (for each spindle)	<Fn753#0-#3>(PMC) <F(005+m)#0-#3>(DCS PMC)	Dual output
7	BRKx	Safety Brake signal	<Fn754#0-#7>(PMC) <F(006+m)#0-#7>(DCS PMC)	Dual output
8	SPS	Safety Position Switch signal	<Fn755-Fn758>(PMC) <F(007+m)-F(010+m)>(DCS PMC)	Dual output
9		Programmable Safety I/O signals		Dual input monitoring
				Dual output
10	ORQ	Guard Open Request signal	<Gn191#3>(PMC)	Input
11	OPT	Test Mode signal	<Fn191#2>(PMC)	Input
12	*OPIHB	Guard Open Inhibit signal	<Fn191#0>(PMC) <F(019+m)#0>(DCS PMC)	Dual output
13	RSVx	Monitoring result signal (Servo)	<Fn750#0-#7>(PMC) <F(002+m)#0-#7>(DCS PMC)	Dual output
	RSPs	Monitoring result signal (Spindle)	<Fn751#0-#3>(PMC) <F(003+m)#0-#3>(DCS PMC)	Dual output
14	RQT	MCC Off Test Execution Request signal	<Fn191#2>(PMC)	Output
15	POSEx	Position Information Effect signal	<Fn766#0-#7>(PMC) <F(018+m)#0-#7>(DCS PMC)	Dual output

Safe-related I/O

1. *ESP Emergency Stop signal (input)

This signal is Emergency Stop signal and is monitored in redundant mode.

The signal is connected to the *ESP input of the servo amplifier as well.

2. *SGOPN Guard State signal (Machine side input signal)

The signal is provided for double monitoring of the protective door state. The signal is connected so that it is normally set to 1 while the protective door is closed and locked (door closed) and set to 0 otherwise (door opened). These states are implemented by the combination of the safety door and safety relays. The PMC ladder for safety check must check the state of axes by asserting the Safety Request signal, when a protective door is open.

3. *VLDVx, *VLDPs Safety Check Request signal (input)

These signals are monitored in redundant mode. These signals request safety check when a protective door is open. These signals are prepared for each axis and each spindle.
CNC monitors these signals. If safe speed range of a servo motor is exceeded in the door open state, the system enters the controlled stop state. If an axis is still not stopped, the system enters the safe stop state.
If safe speed range of a spindle motor is exceeded in the door open state, the spindle motor enters free run state. If the spindle motor is not decelerated, the system enters the safe stop state.

4. SVAx/SVBx,SPAs/SPBs Safety Speed / Safety Position Selection signal (input)

These signals are monitored in redundant mode. SVA/SVB are the signals to select safety speed / safety position for each servo axis.
SPA/SPB are the signals to select safety speed for each spindle.
(The values of safety speed / safety position are given by the parameters.)

5. *SMC MCC Contact State signal (input)

The MCC contact state is monitored in redundant mode. In normal operation, the MCC is closed, therefore whether the contact of a relay is in an abnormally closed state cannot be detected. In the test mode, it can be detected whether the contact of relay is abnormally closed.

6. *DCALM, *MCF, *MCFVx, *MCFPs MCC Off signal (output)

With these signals, the MCC is shut off by 2 channels I/O when either one of these signals state is “0”.
*DCALM is to allow turning off MCC of all system when I/O cross check alarm or some problems of safety check function are found.
*MCF is to allow turning on MCC of each machine group according to emergency stop or MCC off Test.
*MCFVx is to allow turning on MCC of each axis according to monitor safety speed of servo axis or so on. *MCFPs is to allow turning on MCC of each spindle according to the result of monitoring safety speed of spindle.
These signals are assigned on both PMC and DCS PMC. Machine tool builder must output the signal to shut off MCC when either one of these signal is “0”.

7. BRKx Safety Brake signal (output)

These signals are output to control the brake of each servo axis.

8. SPS1 to SPS32 (SPS33 to SPS64 in case of 2 or more path) Safety Position Switch (output)

These signals show whether the machine position of each axis is stayed within the range specified by the parameters or not.

9. Programmable Safety I/O signals (input/output)

The 8 bytes (64 bit) programmable safe I/Os can be freely defined as the different address from the above basic safe signals. Each byte of 8 byte programmable safe I/Os can be assigned on either address of X/Y or R or D by parameter. Each byte of the programmable safe I/O between the PMC and DCS PMC is cross-checked by the CNC and PMC. The combinations of cross-checking these signals are defined by using Safety parameters as follows.

Signal type	Combination No.	DCS PMC	PMC
input	1	No.11950	No.11970
	2	No.11951	No.11971
	3	No.11952	No.11972
	4	No.11953	No.11973
	5	No.11954	No.11974
	6	No.11955	No.11975
	7	No.11956	No.11976
	8	No.11957	No.11977
output	1	No.11960	No.11980
	2	No.11961	No.11981
	3	No.11962	No.11982
	4	No.11963	No.11983
	5	No.11964	No.11984
	6	No.11965	No.11985
	7	No.11966	No.11986
	8	No.11967	No.11987

Signals other than safe-related I/O

The following signals are not safe-related signals (are not checked in redundant mode) but are important signals in the dual check safety system. The machine tool builder must create an appropriate Ladder program with these signals.

IMPORTANT
The error of ladder program cannot be checked by safety function itself. Please make sure to check safety function (see Chapter 7).

10. ORQ Guard Open Request signal (input)

When this signal is input, the CNC set the Guard Open Inhibit signal (*OPIHB) to “1” (Guard open accept). The PMC ladder program of a machine tool builder confirms the safety machine position and the safety speed. If both machine position and speed are judged within safe range according to the result of confirmation, the guard unlock signal is set to 1 (guard unlock enabled). The machine tool builder

must provide an output signal that opens the actual protective door through the PMC.

11. OPT Test Mode signal (input)

When the signal is input, a MCC off Test is executed. The MCC off Test checks whether the contact of the MCC is abnormally closed. When carrying out the MCC off Test manually, input this signal after the preparation of a MCC off Test is completed by the PMC.

12. *OPIHB Guard Open Inhibit signal (output)

When the Guard Open Request signal (ORQ) is input, the CNC sets this signal to "1". The machine tool builder must design the PMC ladder logic by this signal.
If this signal is set to "1", the PMC confirms safety machine position and safety speed. If the result of confirmation is judged safe, PMC turns on the signal to release guard lock and outputs the signal to open the actual protective door.
If the protective door is unlocked (*SGOPN becomes "0") while the signal is set to 0, PMC will notify alarm occurrence to an operator by lighting a lamp or so on and bring the motor into the safe stop state.

NOTE
This signal is not output while MCC off Test is carried out.

13. RSVx, RSPs Monitoring Result signal (output)

These signals show the result of monitoring safety machine position and safety speed of each axis and the result of monitoring safety speed of each spindle. When Guard Open Inhibit signal (*OPIHB) is set to "1", a machine tool builder can judge whether the machine is in the safety state or not according to these signals. If safety is confirmed as a result, turn on the signal to unlock the guard lock and output the signal to open the actual protective door.

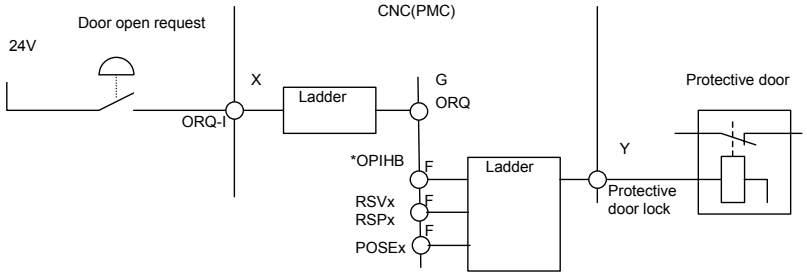
14. RQT MCC Off Test Execution Request signal (output)

If the execution of a MCC off Test is required, this signal is output. At power-on, this signal is always output. If this signal is output, a MCC off Test must be executed.

15. POSEx Position Informaion Effect signal (output)

This signal is output when Dual Check Safety Function is effective and the reference point is established. When the reference point is not established, the machine system is in danger state because Safety Machine Position Monitoring and Safety Position Error Monitoring are not active. If this signal is "0", Machine Tool Builder has to control not to open the protective door.

Guard Open Request signal and Guard Unlock signal



The figure shows a sample connection of the protective door open request switch and the guard unlock signal. In the normal state, the door lock state is changed as follows before the safety monitoring state is established.

Door lock state transition

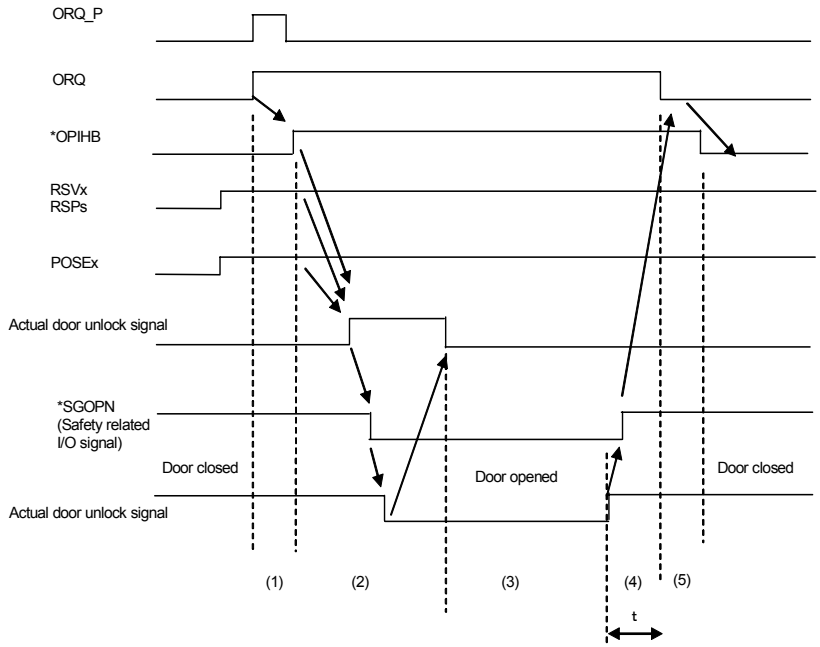
	ORQ-I	ORQ	*OPIHB	RSVx RSPs	POSEx	Protective door lock (*SGOPN)		
A	0	0	0			Locked	A protective door open request is not made, and the door is locked.	Normal operating state
B	1	0	0			Locked	A guard open request is made.	
C1	1	1	0			Locked	The request is transferred to the CNC.	
C2	1	1	1			Locked	The CNC receives the request.	
D	1	1	1	1	1	Locked	Reference point is established and a safe speed check, a machine position check and a position error check prove that there is no failure and that the CNC can enter the safe state.	
E	1	1	1	1	1	Unlocked (*SGOPN=0)	The actual safety door is unlocked. Operations can be performed with the door open.	Safety function is enabled.
D	1	1	1	1	1	Locked	The door is closed and locked again.	
F	0	1	1	1	1	Locked	The guard open request is canceled.	
G	0	0	1	1	1	Locked	The request is transferred to the CNC.	
A	0	0	0			Locked	The CNC receives the request and exits from the safe state.	

IMPORTANT

The PMC ladder must be designed to monitor whether the protective door is open (*SGOPN is set to 0) while ORQ is set to 0. If the door open is detected, the PMC ladder judges that an abnormal event has occurred and enters the safe stop state. This can occur, for instance, when the door happens to open (or to be unlocked) while machining is in progress with the protective door closed.

Timing diagram from door close state to door open state

The following diagram shows the timings at which the door is opened and closed again.



(1) When the Guard Open Request signal (ORQ) is input, the CNC returns the answer signal (*OPIHB) to PMC.
(2) The PMC ladder program checks that the machine position, speed and position error are within safe ranges by the Monitoring Result signal (RSVx/RSPs) and the reference point is established by the Position Information Effect signal (POSEx). Then, it turns on the guard unlock signal. This example assumes that the protective door has an electromagnetic lock mechanism. While the door is open, the unlock signal is turned off.
(3) The door is open.
(4) The protective door is closed and locked. After this, the Guard Open Request signal (ORQ) must be turned off.
(5) When the Guard Open Request signal (ORQ) is turned off, the CNC turned off the answer signal (*OPIHB).

> ⚠ **CAUTION**
> Ensure a time of 100 ms or longer (“t” in the figure) from when the door is closed (locked) until the Guard Open Request signal (ORQ) goes off. If this time requirement is not satisfied, an alarm may be raised when the door is closed (locked).
> Design an operator panel to inform an operator that Guard Open Request signal (ORQ) is turned on by lighting a lamp.

3.5 EMERGENCY STOP

The Emergency Stop signal is monitored in redundant mode. When the emergency stop is input, the servo motor slows down to a stop (*see the below caution) and enters the dynamic brake stop. The spindle slows down to a stop (*see the below caution) as instructed by the PMC (Ladder program), and then the power is shut off.

⚠ CAUTION
To enable the function to slow down and stop the servo motor, the corresponding parameter must be specified. If the parameter is not specified, the motor immediately enters the dynamic brake stop state. The spindle motor slows down and stops as instructed by the PMC (Ladder program). If the PMC does not instruct this, the motor maintains the high speed prior to the power-down and coasts. If an illegal speed is specified because of a failure on the PMC side while the safety function is active (the protective door is open), the CNC enters the safe stop state.

⚠ WARNING
In the emergency stop state, the processing to open or close the protective door depends on the Ladder program created by the machine tool builder. For instance, if the protective door should not be opened in the emergency stop state, a Ladder program of the processing must be created.

IMPORTANT
Emergency Stop Button must fulfill the Standard IEC60947-5-1. This is mandatory.

3.6 SAFE SPEED MONITORING

If the safe speed range is exceeded while the protective door is open, the dual check safety function immediately enters the stop state. If each axis or spindle is not stopped, the dual check safety function enters the safety stop state. For each feed axis and spindle, up to four safe speed ranges can be specified in safety parameters.

Both the CNC and the SV/SP monitor whether a safe speed is kept on each feed axis and spindle. Limit speed can be changed by the Safety Speed / Safety Position Selection signals (SVAn/SVBn for feed axis, SPAn/SPBn for spindle).

Name	Safety Speed/Safety Position Selection signal		Safety speed parameter	
	SVAn/ SPAn	SVBn/ SPBn	Feedaxis	Spindle
Safety speed 1	0	0	No.13821	No.4372
Safety speed 2	1	0	No.13822	No.4438
Safety speed 3	0	1	No.13823	No.4440
Safety speed4	1	1	No.13824	No.4442

When excess limit error is detected, Monitoring Result signal (RSVx/RSPs) is set to “0”. In this situation, if Safety Check Request signal (*VLDVx/ *VLDPs) is “0” and safety monitor is executed, an alarm is generated.

Error detected CPU	Alarm
CNC	SV0494/SP0757
SV	SV0476
SP	SP9069(SPINDLE ALARM 69)

⚠ CAUTION

1 When an illegal speed is detected for the servo axis, if the axis is not stopped after the time specified in the parameter, the MCC Off signal (*MCFVx) is turned to “0”.
2 When an illegal speed is detected for the spindle axis, CNC checks whether the spindle speed decelerates continuously or not. If acceleration is detected, the MCC Off signal (*MCFPs) is turned to “0”.

IMPORTANT

1 A gear ratio, ball screw, and the like must be carefully selected so that a safe speed can be kept on the feed axis.

2 Before inputting the Guard Open Request signal (ORQ), reduce each axial speed and spindle speed to a safe speed range or below. If a speed exceeds the limit, do not unlock the protective door. The PMC ladder must be designed that the power to the driving circuit is shut off (safe stop state) if the door is forced open.

⚠ **WARNING**

The safe speed monitoring function monitors whether the traveling speed exceeds a specified limit. The function cannot monitor the stop state (zero speed). If an error causes a movement on the feed axis at a speed lower than the safe speed range while the protective door is open, for instance, the function cannot detect this state. The machine must be designed so that this state does not affect the safety of the machine system.

3.7 SAFE MACHINE POSITION MONITORING

While the door is open, the dual check safety function checks whether the position on each feed axis is within the safe machine position range defined by safety parameters. If it detects a machine position beyond the safety range, the dual check safety function immediately enters the stop state. If each axis is not stopped, the dual check safety function enters the safety stop state.
For each feed axis, up to four safe positions can be specified in safety parameters.

Both the CNC and the Servo monitor whether each axis is within the safety position. The range of the safety machine position can be changed by the Safety Speed / Safety Position Selection signals (SVAn/SVBn for feed axis).

Name	Safety Speed/Safety Position Selection signal		Safety machine position parameter	
	SVAn	SVBn	+ direction	- direction
Safety machine position 1	0	0	No.13831	No.13832
Safety machine position 2	1	0	No.13833	No.13834
Safety machine position 3	0	1	No.13835	No.13836
Safety machine position 4	1	1	No.13837	No.13838

When “out of position error” is detected, Monitoring Result signal (RSVx) is set to “0”. In this situation, if Safety Check Request signal (*VLDVx) is “0” and safety monitor is executed, an alarm is generated.

Error detected CPU	Alarm
CNC	SV0495
SV	SV0477

⚠ CAUTION

1 The safe machine position monitoring function does not keep monitoring the specified range. Only after the function detects that a position on a feed axis exceeds the range, the system enters the stop state. Accordingly, in the stop state, an over travel has occurred on the feed axis. The travel distance depends on the traveling speed and other conditions.
2 When an “out of position error” is detected, if the axis is not stopped after the time specified in the parameter, the MCC Off signal (*MCFVx) is turned to “0”.

The user of the machine must first carry out a reference position return in order to obtain the initial position. If the reference position return is not carried out, the check function is disabled. This check function is enabled after the reference position is established. (The function cannot be disabled by any means after the reference position is established.) A safe machine position limit on each feed axis is specified in a safety parameter.

> ⚠ **CAUTION**
> A machine operator must confirm whether the machine reference position is established correctly by checking the actual machine position and position display of the CNC.

At power-on, the safety function does not work. After power-on, the CNC checks whether a reference position return is completed. If the reference position return is completed and if the protective door is open, safe machine position monitoring, safe speed monitoring and safety position error monitoring are performed. Then, the safety functions start working. If the reference position return is not completed, safe machine position monitoring cannot be performed because the coordinates are not established. In this state, the machine position monitoring function is disabled. After a reference position return is made, this function is enabled. Depending on the safety parameter setting, however, an alarm may be raised. To avoid this alarm, specify the safe machine position parameters before making a reference position return.

> ⚠ **CAUTION**
> 1 The machine coordinate of the safety function is based on position feed back. So it does not always indicate the same value as the machine coordinate based on the summation of the command value.
> 2 This function is activated only in position control mode. This function is not activated in torque control mode.

3.8 MCC OFF TEST

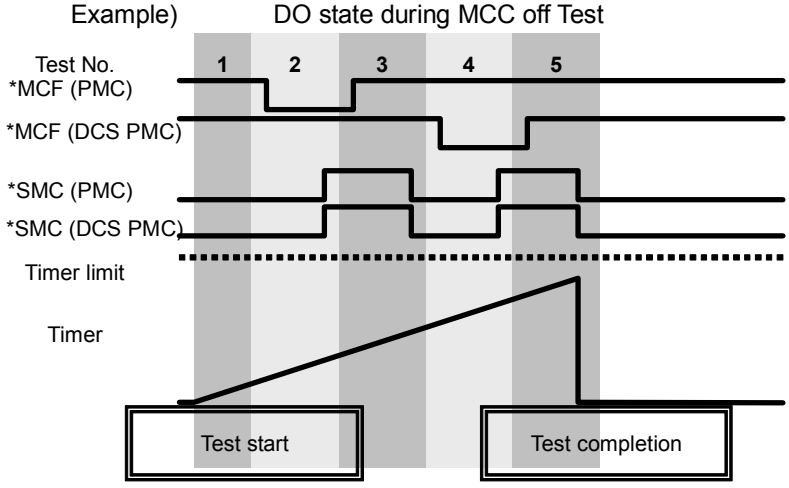
A MCC off Test must be carried out in intervals of 24 hours, so that the safety functions would not be damaged by a possible cause of failure. A message telling that the MCC off Test must be carried out is displayed at power-on or when 24 hours have elapsed after the previous MCC off Test. The machine tool builder must set up the machine not to open the protective door before a MCC off Test is not completed.
The protective door can be opened only after the MCC off Test is carried out accordingly.

A MCC off Test performs the test to turn on and off MCC by controlling *SMC signal in order to confirm whether the circuit to shut off MCC is normal. The MCC off Test is performed both on PMC and DCS PMC. If the MCC off Test is not completed within the time specified by the parameter No.1946 (MCC off Test timer), servo alarm SV0488 is generated. It is necessary to carry out the MCC off Test before the protective door is open, when power is on or 24 hours have elapsed after previous MCC off Test.

The PMC ladder program must be designed to carry out the following control.

<1> When MCC off Test request signal (RQT) is set to "1" at power-on or in case 24 hours are elapsed after the previous MCC off Test, the protective door is locked till the MCC off Test is performed. But the operator can operate the machine while the protective door is closed.

<2> When the MCC off Test request signal (RQT) is turned to "0", the protective door can be unlocked.



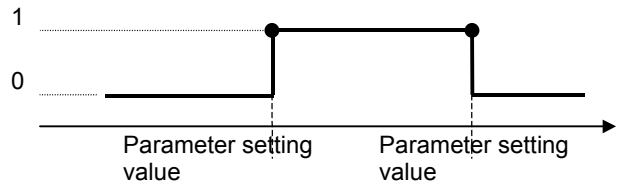
IMPORTANT

Carry out the MCC off Test with the protective door closed. As the test shuts off the MCC, prepare the system for mechanical MCC shut-off before starting the MCC off Test.

3.9 SAFETY POSITION SWITCH FUNCTION

It is checked whether the machine position is within the range of safety position switch. The checked result is outputted to the Safety Position Switch signal. The correspondence between axes and each signal is specified by the parameters. In case of 1 path system, up to 32 points can be specified. And in case of 2 or more paths, up to 64 points can be specified.

When a machine position of controlled axis is within a range, which is specified by the safety parameters, this signal is output.



The signals are output after establishment of the reference position. The signal is not output before the completion of return to reference position.
The “machine position” is the actual machine position (which is calculated using feedback of position detector), not the commanded position.
The comparison of position for safe position switch is executed in detection unit.
If the machine position equals parameter setting value, the safe position switch signal is output.
The safe position switch signal is not output for axis which the Dual Check Safety (No.1904#6(DCN=1)) is not applied to.

Safety Position switch can be assigned up to 16 points per 1 group to the output signal (F area) and totally up to 4 groups can be used in the CNC system.
Two areas per a path are provided to assign. It is possible to assign the signal to an appropriate area.
Safe position switch signals can be assigned to arbitrary controlled axes. (All points can be also assigned to one axis.) The assignment of controlled axes is set by the safety parameters (No.13880 to No.13911, No.10501 to No.10532).
And the signals can be also assigned to the rotary axes.

When inconsistency between the position switch on PMC and that on DCS PMC is lasted for the time that is specified by the parameter No.1945, the safety function sets MCC Off signal (*DCALM) to “0” and generates the alarm “safe I/O cross check error” (PW0010/PW0011) .

NOTE
The machine coordinate of the safety function is based on position feed back. So it does not always indicate the same value as the machine coordinate based on the summation of the command value. Two machine coordinates that are calculated by two CPU independently are not always the same because the position feedback is continuously changed a little. As there is a possibility that the condition of two signals is different from each other near the boundary, do not stop an axis near the boundary.

⚠ CAUTION
This function is activated only in position control mode. This function is not activated in velocity control mode and torque control mode.

- **Hysteresis**

  Position switch sometimes turns on and off repeatedly near the boundary of position switch area by very small vibration of a servo motor. According to this problem, position switch is inconvenient to use. So "hysteresis" described below is applied.

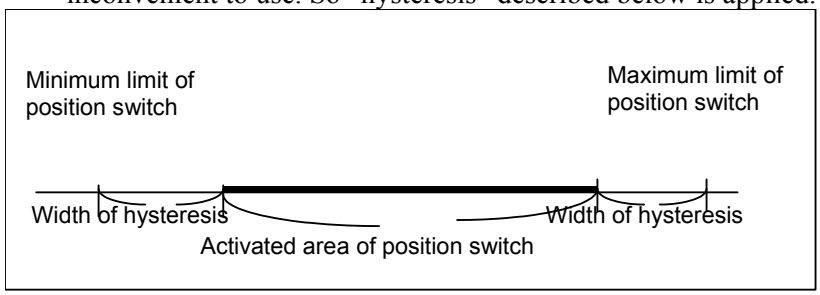


Fig.3.9(a) Measuring area of position switch in case state of switch is "0"

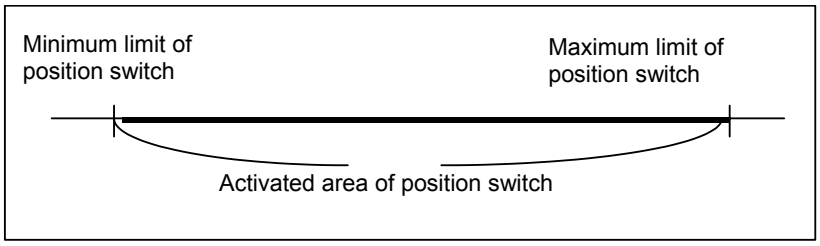


Fig.3.9(b) Measuring area of position switch in case state of switch is "1"

The position switch is checked at every sampling period. When the minimum and maximum limit of position switch are given like above figure, activated area is checked by the area shown in the figure 3.9(a) considering hysteresis if the state of position switch measured at last time is "0". And activated area is checked by the area shown in the figure 3.9(b) not considering hysteresis if the state of position switch measured at last time is "1". According to this, it is possible to suppress frequent changing of position switch.

3.10 SAFETY RELATED PARAMETERS CHECK FUNCTION

At every power-on, the CNC checks whether the safety related parameters are destroyed and are transferred to the SV, the SP and the PMC normally or not. The SV, the SP and the PMC also check whether the safety related parameters are transferred from the CNC normally or not.
If some problem is found in this check, an alarm is generated and the MCC is shut off. (*DCALM=0)

3.11 PARAMETER LOCK FUNCTION

It is possible to lock the rewriting of the safety related parameters.
The parameter No.3225 and No.3226 unlock these parameters. The following parameters are locked.

No.980, No.981, No.982, No.1023, No.1240, No.1838, No.1839, No.1840, No.1841,No.1842, No.1902, No1904, No.1945, No.1946, No.1948, No.1950, No.3021,No.3022, No.3225, No.3717, ,No.3797, No.4372, No.4438, No.4440, No.4442, No.4448, No.10500-No.10596, No.11950-No.11957, No.11960-No.11967, No.11970-No.11977, No.11980-No.11987, No.13811, No.13821-No.13829, No.13831-No.13838, No.13840-No.13843, No.13880-No.13911, No.13920-No.13951, No.13960-No.13991

3.12 SEFETY POSITION ERROR MONITORING FUNCTION

Both the CNC and the SV check whether the servo following error of each axis exceeds the limit of deviation specified by the parameters.
If the servo following error exceeds, an alarm is generated and MCC OFF signal (*MCFVx) is output immediately.
The relation between the safety monitoring state and the parameter of limit of deviation is shown in the following table.

	Safety monitoring is activated (In case *VLDVx =0)	**Safety monitoring is not activated (In case *VLDVx =1)**
Moving	No.1838	No.1841
Stopping	No.1839	No.1842
Servo-off	No.1840	No.1840

Error detected CPU	**Alarm**
CNC	SV1072/SV1071/SV1069
SV	SV0474/SV0475/SV1070

When position deviation exceeds the limit given by the parameter (No.1839 in stop state, No.1838 in moving state and No.1840 in servo off state) during safety monitoring, Monitoring result signal RSVx is set to “0” regardless of the state of Safety check request signal *VLDVx.

This function is valid after the reference position return is finished or the follow-up of absolute position is finished in case an absolute position coder.

> ⚠ **CAUTION**
> This function is activated only in position control mode. This function is not activated in torque and velocity control mode.

3.13 AMPLIFIER CIRCUIT MONITORING FUNCTION

The SV and the SP transmit the data of plural axes to amplifiers through one electronic circuit (LSI). The CNC, the SV and the SP check whether this transmission is performed normally without placing data on wrong address.
In case of servo amplifier, the CNC axis numbers kept by the CNC are compared with the CNC axis numbers kept by the SV. In case of spindle amplifier, the spindle numbers kept by the CNC are compared with the spindle number kept by the SP. The checking sequence is as follows.

[Checking sequence for servo amplifier]

<1> When a servo amplifier is set up at the first time, an alarm SV0498 is generated. At that time, the CNC transfers the CNC axis numbers to the SV and the SV keeps the data. Then the power of all CNC system (amplifiers are included) must be turned off and on.
When an alarm is generated after the configuration of servo amplifiers is changed, it is necessary to carry out the operation to send the CNC axis numbers to servo amplifiers. Set the parameter No.2212#4 to "1" then return to "0". Then turned off the power of all CNC system (amplifiers are included.)

<2> After the power-on, the CNC and the SV start monitoring the CNC axis numbers. The CNC monitors by comparing the CNC axis number kept by the CNC itself with that kept by the SV. The SV monitors by comparing the CNC axis numbers kept by the SV with that sent by the CNC.
When some error is found, an alarm SV0478 or SV0496 is output, and MCC Off signal (*DCALM) is turned to "0".

[Checking sequence for spindle amplifier]

<1> When spindle is set up, the spindle numbers are transferred from the SP to the CNC.

<2> The CNC compares the spindle numbers kept by the CNC itself with that sent from spindle amplifier. If inconsistency is found, an alarm SP0756 is output and MCC Off signal (*DCALM) is turned to "0".

<3> The SP compares the spindle numbers with that kept by the SP. If inconsistency is found, alarm SP9070 (Spindle alarm 70) is output, and MCC Off signal (*DCALM) is turned to "0".

3.14 SAFETY BRAKE SIGNAL OUTPUT FUNCTION

The CNC and the SV output the Safety Brake signal (*BRKx) to control the mechanical brake. When this signal is “0”, mechanical brake must be activated. When this signal is “1”, mechanical brake is allowed to be released.
These signals cannot be used with the ignore v-ready off for all axes signal <G_n066#0> and the ignore v-ready off for each axis <G_n192> at the same time.

When the inconsistency between the break signal on PMC and that on DCS PMC is lasted for the time that is specified by the parameter No.1945, the safety function sets MCC Off signal (*DCALM) to “0” and generates the alarm “safe I/O cross check error” (PW0010/PW0011).

3.15 CPU SELF TEST FUNCTION

The CNC, the PMC, the SV and the SP carry out the following self-diagnosis. If the error is detected, the alarm is generated and sets MCC Off signal (*DCALM) to “0”.

<1> CPU check
It is checked whether each CPU runs normally or not.
It is checked whether the instructions related to safety function is executed normally or not.

Error detected CPU	ALARM
CNC	PW0014
PMC	PW0009
SV	SV0484
SP	SP9074(Spindle alarm 74)

<2> Program monitoring
It is confirmed whether all safety related function run normally.

Error detected CPU	ALARM
CNC	PW0017 / SV0490
PMC	PW0008(DCS PMC) PW0009(PMC)
SV	SV0484
SP	SP9076 (Spindle alarm 76) SP0755

<3> Cross check
It is checked whether the result of the judgment about the safety related function of a CPU is consistent with that of another CPU.

If some error is found, an alarm is output.

	ALARM
SV relation	SV0490/SV0484
SP relation	SP9072(Spindle alarm 72) SP9077(Spindle alarm 77) SP9078(Spindle alarm 78) SP0755
PMC relation	PW0008(DCS PMC) PW0009(PMC)

3.16 RAM CHECK FUNCTION

ECC (Error Check and Correct) function is applied to the battery back-upped file memory. Then a single-bit error is corrected. And, when an error that cannot be corrected occurs, memory parity error is generated.

Other memory for dual check safety is checked as follows:(If the error is detected, the alarm is generated and sets MCC Off signal (*DCALM) to “0”)
1) Test at power-on
The several test patterns are written to the RAM area. It is checked whether the written test data are read correctly. If read error occurs, an alarm is generated.
2) Test during normal operation
RAM area is checked in turn at constant interval during normal operation. The several test patterns are written to the RAM. It is checked whether the written test data are read correctly. If read error occurs, an alarm is generated.

Alarm detected CPU	Alarm
CNC	PW0016
SV	SV0484
PMC	PW0008(DCS PMC) PW0009(PMC)
SP	SP9016(Spindle alarm 16)

3.17 CRC CHECK FUNCTION

At power-on and after power on, the data that are related to Dual Check Safety and stored in the ROM area are checked. The CNC software, the servo software, the PMC software and the spindle software are checked. If some error is found, an alarm is generated.

After power on

Error detected Software	Alarm
CNC software	CRC CHECK ERROR: NC BASIC.
Servo software	SERVO ROM TEST: CRC CHECK ERROR
PMC management software	LED “6”
Spindle software	Spindle alarm 75

After power on

Error detected Software	Alarm
CNC software	PW0018 CRC CHECK ERROR
PMC management software	SYS-ALM199 NON MASK INTERRUPT OTHER-CPU

3.18 SAFE STOP MONITORING

When a safety door is open, safe stop monitoring for servo axis and spindle can be realized by the combination of several functions.

Safe stop monitoring for servo axis

According to the safe speed monitoring for servo axis and the safe positing error monitoring, CNC and Servo monitor actual feedrate and deviation of each axis. When a safety door is open, monitoring of stop condition of each axis can be performed by the combination of the following three functions.

a) By the safety speed monitoring function, check whether the actual feed rate is lower than the safety level. If the feedrate exceeds the safety limit, an alarm is generated.
   Actual speed is calculated with the feedback of a position detector. So, even if command feedrate is 0, actual feedrate may be detected as not 0 when an axis is moved by external power. Set the value of safety limit that does not cause an alarm when feedrate command is 0.
b) By the safe positioning error monitoring function, check whether position deviation is within a safety limit. If an axis is moved unexpectedly, an alarm is generated.
c) According to "Axis moving signal MVx (Fn102)", check whether axis motion command is not given. (Axis moving signal is prepared for PMC and is not double check signal.)

Safe stop monitoring for spindle

According to the safe speed monitoring for spindle, CNC and Spindle monitor actual speed of each spindle. When a safety door is open, monitoring of stop condition of each spindle can be performed by the combination of the following two functions.

a) By the safety speed monitoring function, check whether the actual speed is lower than the safety level. If the feedrate exceeds the safety limit, an alarm is generated.
   Actual speed is calculated with the feedback of a position detector. So, even if command speed is 0, actual speed may be detected as not 0 when a spindle is moved by external power. Set the value of safety limit that does not cause an alarm when speed command is 0.
b) There is a possibility that spindle rotate at speed lower than safety speed limit. Then it is necessary to select the function to make position control loop, such as spindle positioning, Cs contouring control or spindle orientation.

4 INSTALLATION

The hardware installation such as field wiring, power supply, etc. should be referred to connection manual for CNC units and for servo amplifier. EMC problem should be referred to EMC guideline manual.

Degree of IP protection:
Servo Motors: IP55
Spindle Motors: IP54 with oil-seal, IP40 without oil-seal
Servo and Spindle amplifiers: IP1x
CNC and other accessories: IPxx

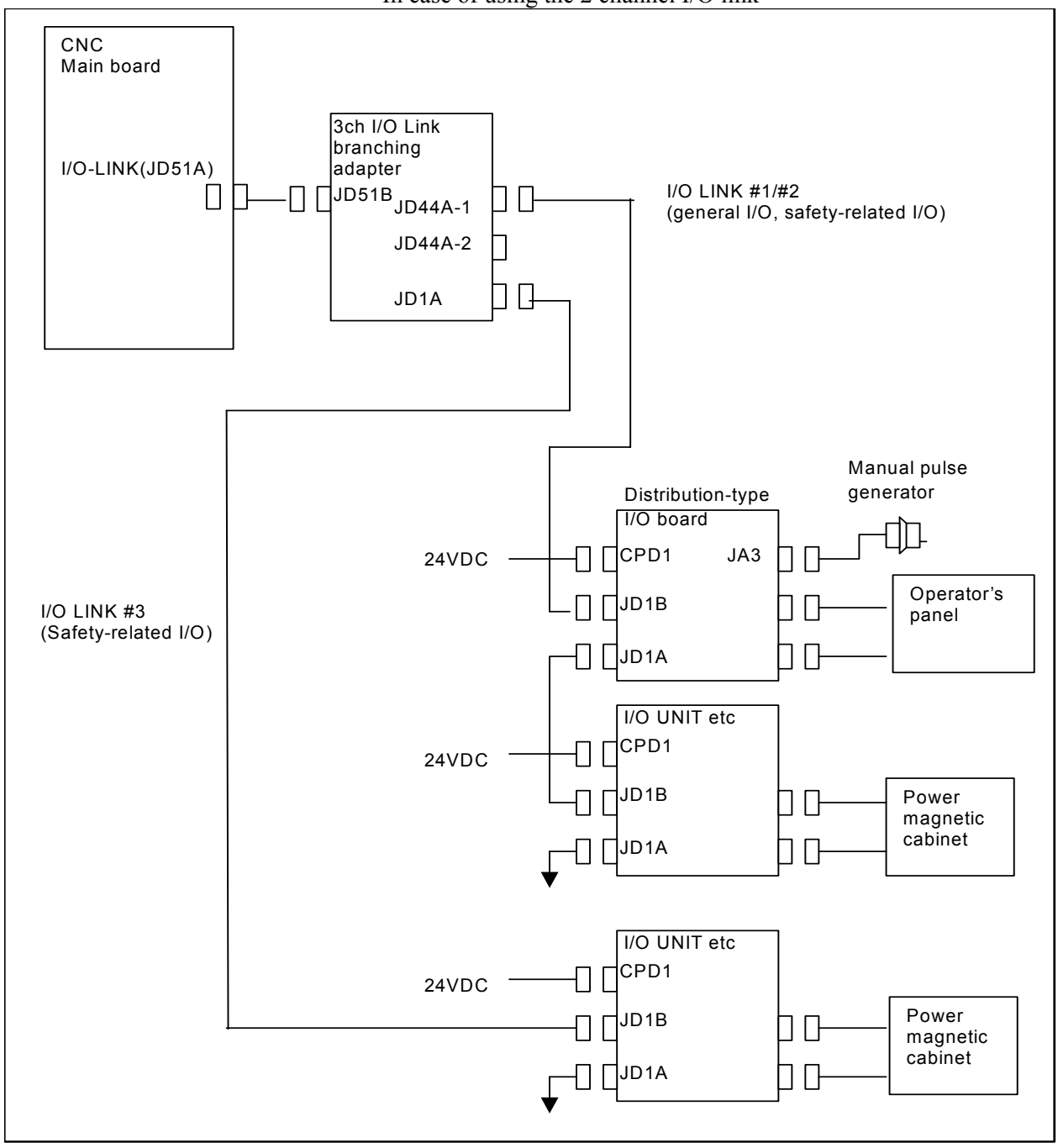
NOTE
Servo/Spindle amplifiers, CNC are to be installed in IP54 protected cabinets.

The peripheral units and the control unit have been designed on the assumption that they are housed in closed cabinets.

As for the environmental conditions for each unit, such as CNC controller, servo amplifier and etc, please refer to each connection manual.

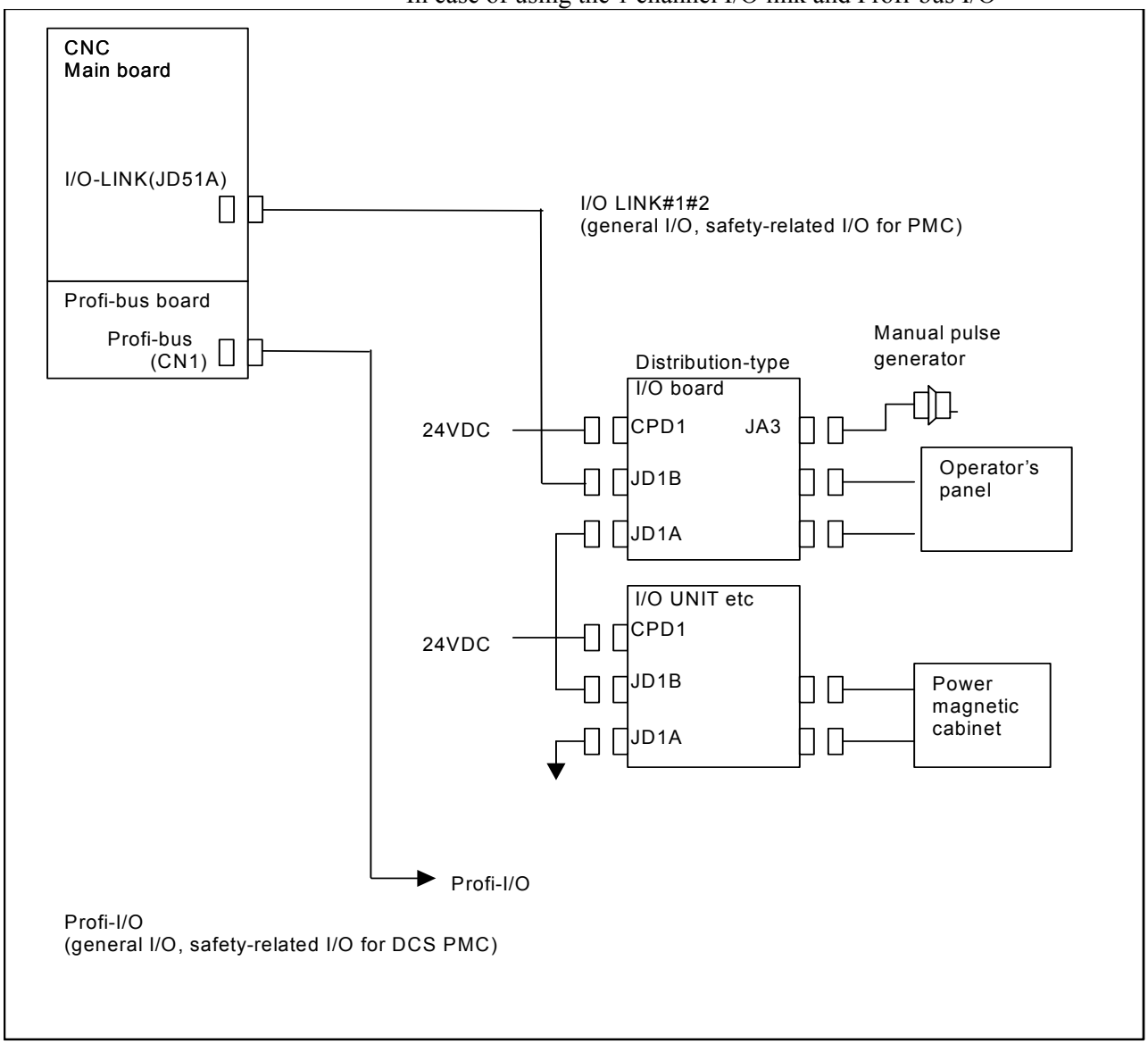
4.1 OVERALL CONNECTION DIAGRAM

In case of using the 2 channel I/O link



Above shows only the 2 channel I/O link for the safety-related I/Os of the Dual Check Safety Function. As for the other connections, please refer to the Connection manual.

In case of using the 1 channel I/O link and Profi-bus I/O



Above shows only the I/O link and Profi-bus for the safety-related I/Os of the Dual Check Safety Function. As for the other connections, please refer to the Connection manual.

5 I/O SIGNALS

5.1 OVERVIEW

The Dual Check Safety Function provides two input paths and two output paths for safe-related signals (safety signals).
For input signals (safety input signals), two paths are used: one path for input to the CNC via I/O Link#3,#4 or Profibus-DP (Note1), and another for input to the PMC via I/O Link#1,#2. The CNC (DCS PMC) and the PMC exchange the safety input signals with each other at all times to check each other. If a mismatch is found between a safety input signal via one path and the same signal via another path and such a state lasts for the period set in a parameter or more, the CNC (DCS PMC) and the PMC independently detect an alarm. (Dual-check for safety input signals)
For output signals (safety output signals), two paths are also used: one path for output from the CNC via the I/O Link#3,#4 or Profibus-DP, and another for output from the PMC via the I/O Link#1,#2. The MCC Off signal (*MCF) is output via these two paths. When both a signal via one path and the same signal via another path are 1, the signal is assumed to be 1. If either is 0, the signal is assumed to be 0. That is, if the signal (*MCF of DCS PMC)(Note2) via the I/O Link#3,#4 or Profibus-DP and the signal (*MCF of PMC)(Note2) via the I/O Link#1,#2 are both 1, the MCC may be turned on. If either is 0, the MCC must be turned off.

In Subsection 5.3, a signal name is followed by its symbol and addresses <via I/O Link#1,#2> and <via I/O Link#3,#4 or Profibus-DP>. Then, for an input signal, its classification, function, and operation are described, in this order. For an output signal, its classification, function, and output condition are described in this order.
For information about the emergency stop mode and MCC off Test mode described in Subsection 5.3, see Subsection 5.3.

NOTE
1 I/O Link and Profibus-DP can not be used for the safety X/Y signals at the same time.
2 DCS PMC : Dual Check Safety PMC PMC : Normal PMC (First PMC, Second PMC, Third PMC) Please refer to “FANUC Series 30*i*/300*i*/300*i*s-MODEL A PMCPROGRAMMING MANUAL(B-63983EN)”

5.2 SIGNAL ADDRESS

Via I/O Link#1/#2

PMC (n=0 to 9 (Path number-1))

	#7	#6	#5	#4	#3	#2	#1	#0
X008				*ESP			*ESP	*ESP

	#7	#6	#5	#4	#3	#2	#1	#0
Gn008				*ESP				

	#7	#6	#5	#4	#3	#2	#1	#0
Gn191					ORQ	OPT		

	#7	#6	#5	#4	#3	#2	#1	#0
Gn748		*SMC						

	#7	#6	#5	#4	#3	#2	#1	#0
Gn749								

	#7	#6	#5	#4	#3	#2	#1	#0
Gn750	*VLDV8	*VLDV7	*VLDV6	*VLDV5	*VLDV4	*VLDV3	*VLDV2	*VLDV1

	#7	#6	#5	#4	#3	#2	#1	#0
Gn751					*VLDP4	*VLDP3	*VLDP2	*VLDP1

	#7	#6	#5	#4	#3	#2	#1	#0
Gn752	SVA8	SVA7	SVA6	SVA5	SVA4	SVA3	SVA2	SVA1

	#7	#6	#5	#4	#3	#2	#1	#0
Gn753	SVB8	SVB7	SVB6	SVB5	SVB4	SVB3	SVB2	SVB1

	#7	#6	#5	#4	#3	#2	#1	#0
Gn754	SPB4	SPB3	SPB2	SPB1	SPA4	SPA3	SPA2	SPA1

	#7	#6	#5	#4	#3	#2	#1	#0
Fn191						RQT		*OPIHB

	#7	#6	#5	#4	#3	#2	#1	#0
Fn748	*DCALM						*MCF	

	#7	#6	#5	#4	#3	#2	#1	#0
Fn749								

	#7	#6	#5	#4	#3	#2	#1	#0
Fn750	RSV8	RSV7	RSV6	RSV5	RSV4	RSV3	RSV2	RSV1

	#7	#6	#5	#4	#3	#2	#1	#0
Fn751					RSP4	RSP3	RSP2	RSP1

	#7	#6	#5	#4	#3	#2	#1	#0
Fn752	*MCFV8	*MCFV7	*MCFV6	*MCFV5	*MCFV4	*MCFV3	*MCFV2	*MCFV1

	#7	#6	#5	#4	#3	#2	#1	#0
Fn753					*MCFP4	*MCFP3	*MCFP2	*MCFP1

	#7	#6	#5	#4	#3	#2	#1	#0
Fn754	*BRK8	*BRK7	*BRK6	*BRK5	*BRK4	*BRK3	*BRK2	*BRK1

	#7	#6	#5	#4	#3	#2	#1	#0
Fn755	SPS08	SPS07	SPS06	SPS05	SPS04	SPS03	SPS02	SPS01

	#7	#6	#5	#4	#3	#2	#1	#0
Fn756	SPS16	SPS15	SPS14	SPS13	SPS12	SPS11	SPS10	SPS09

	#7	#6	#5	#4	#3	#2	#1	#0
Fn757	SPS24	SPS23	SPS22	SPS21	SPS20	SPS19	SPS18	SPS17

	#7	#6	#5	#4	#3	#2	#1	#0
Fn758	SPS32	SPS31	SPS30	SPS29	SPS28	SPS27	SPS26	SPS25

	#7	#6	#5	#4	#3	#2	#1	#0
Fn766	POSE8	POSE7	POSE6	POSE5	POSE4	POSE3	POSE2	POSE1

Via I/O Link#3,#4 or Profibus-DP

DCS PMC (m=path(0 to 9)×20) 0 to 9: Path number-1

	#7	#6	#5	#4	#3	#2	#1	#0
X008				*ESP			*ESP	*ESP

	#7	#6	#5	#4	#3	#2	#1	#0
G000+m		*SMC						

	#7	#6	#5	#4	#3	#2	#1	#0
G001+m								

	#7	#6	#5	#4	#3	#2	#1	#0
G002+m	*VLDV8	*VLDV7	*VLDV6	*VLDV5	*VLDV4	*VLDV3	*VLDV2	*VLDV1

	#7	#6	#5	#4	#3	#2	#1	#0
G003+m					*VLDP4	*VLDP3	*VLDP2	*VLDP1

	#7	#6	#5	#4	#3	#2	#1	#0
G004+m	SVA8	SVA7	SVA6	SVA5	SVA4	SVA3	SVA2	SVA1

	#7	#6	#5	#4	#3	#2	#1	#0
G005+m	SVB8	SVB7	SVB6	SVB5	SVB4	SVB3	SVB2	SVB1

	#7	#6	#5	#4	#3	#2	#1	#0
G006+m	SPB4	SPB3	SPB2	SPB1	SPA4	SPA3	SPA2	SPA1

	#7	#6	#5	#4	#3	#2	#1	#0
G007+m								

	#7	#6	#5	#4	#3	#2	#1	#0
G008+m								

	#7	#6	#5	#4	#3	#2	#1	#0
G019+m				*ESP				

	#7	#6	#5	#4	#3	#2	#1	#0
F000+m	*DCALM						*MCF	

	#7	#6	#5	#4	#3	#2	#1	#0
F001+m								

	#7	#6	#5	#4	#3	#2	#1	#0
F002+m	RSV8	RSV7	RSV6	RSV5	RSV4	RSV3	RSV2	RSV1

	#7	#6	#5	#4	#3	#2	#1	#0
F003+m					RSP4	RSP3	RSP2	RSP1

	#7	#6	#5	#4	#3	#2	#1	#0
F004+m	*MCFV8	*MCFV7	*MCFV6	*MCFV5	*MCFV4	*MCFV3	*MCFV2	*MCFV1

	#7	#6	#5	#4	#3	#2	#1	#0
F005+m					*MCFP4	*MCFP3	*MCFP2	*MCFP1

	#7	#6	#5	#4	#3	#2	#1	#0
F006+m	*BRK8	*BRK7	*BRK6	*BRK5	*BRK4	*BRK3	*BRK2	*BRK1

	#7	#6	#5	#4	#3	#2	#1	#0
F007+m	SPS08	SPS07	SPS06	SPS05	SPS04	SPS03	SPS02	SPS01

	#7	#6	#5	#4	#3	#2	#1	#0
F008+m	SPS16	SPS15	SPS14	SPS13	SPS12	SPS11	SPS10	SPS09

	#7	#6	#5	#4	#3	#2	#1	#0
F009+m	SPS24	SPS23	SPS22	SPS21	SPS20	SPS19	SPS18	SPS17

	#7	#6	#5	#4	#3	#2	#1	#0
F010+m	SPS32	SPS31	SPS30	SPS29	SPS28	SPS27	SPS26	SPS25

	#7	#6	#5	#4	#3	#2	#1	#0
F018+m	POSE8	POSE7	POSE6	POSE5	POSE4	POSE3	POSE2	POSE1

	#7	#6	#5	#4	#3	#2	#1	#0
F019+m								*OPIHB

NOTE

1 The hatched signals are double-checking signals.
2 The Emergency Stop signals in X address are double checking signals.
3 When the number of path is 1, 32 points signals are provided in total. When the number of path is 2 or more, 64 points signals are provided in total.
4 The following signals are provided for each machine group. Emergency Stop (*ESP: X0008), Test Mode signal(OPT), Guard Open Request signal(ORQ), Guard Open Inhibit signal(*OPIHB), MCC Off signal (*MCF), MCC Contact State signal (*SMC)
5 The signal (Fxxxx/Gxxxx), which is provided for each machine group, is assigned in the path area for the smallest path number of the paths in the machine group.
Example) When the 3rd and 5th path belong to the 2nd machine group, test Mode signal (OPT) for the 2nd machine group is assigned at G2191#2 in 3rd path area.

5.3 SIGNALS

Emergency Stop signal (input)
***ESP <PMC:X008#4, #0, #1><DCS PMC:X008#4, #0, #1> (for each machine group)**
***ESP <PMC: Gn008#4> <DCS PMC: G(019+m)#4> (for each path)**

This is Emergency Stop signal. The Emergency Stop signal must be connected to the Emergency Stop input of the amplifier.

[Classification] Input signal (Dual signal)

[Function] Stops machine movement immediately in an emergency.
0: Emergency stop state
1: Normal state

[Operation] When Emergency Stop signal (*ESP) is set to 0, the CNC is reset, and the system enters emergency stop state. A machine tool builder must output a signal to shut off directly the MCC when “MCC Off signal” (*MCF) is set to “0”.

In emergency stop state, a machine tool builder must check “MCC Contact State signal” (*SMC). If *SMC signal is “0” (MCC is on), a machine tool builder must not release the guard lock signal of protective door.

In general, Emergency Stop signal (*ESP) is specified by the pushbutton switch B contact. When an emergency stop occurs, the servo ready signal SA is set to 0.

If the input of the Emergency Stop signal is detected, the CNC automatically specifies a command to zero the speed of a servo motor and reduces the speed to zero (controlled stop). (See below note) After the servo motor slows down and stops, the power is turned off, and the servo motor is brought into the dynamic brake stop state.
The spindle motor is slowed down by the PMC command (see below note) and the power is shut off.

⚠ CAUTION

1 The Emergency Stop signal for DCS PMC is assigned to each machine group, like the signal for PMC.
<X008#4> for 1st machine group
<X008#0> for 2nd machine group
<X008#1> for 3rd machine group
2 The related parameter must be set in order to perform the controlled stop of a servo motor. If the parameter is not set, a servo motor is stopped by dynamic brake control just after an emergency stop is detected.
3 A spindle motor is slowed down by the command (PMC ladder program). If the PMC does not command to slow down, the spindle motor continues rotating at the speed prior to power-down and runs by inertia (and eventually stopping in the end). When safety function is active (protective door is open) and abnormal speed is given due to the trouble of PMC, the spindle is brought into safe stop state.
4 The Emergency Stop signals for every machine group, <X008#4> <X008#0> <X008#1>, are checked doubly in PMC and DCS PMC.

⚠ WARNING

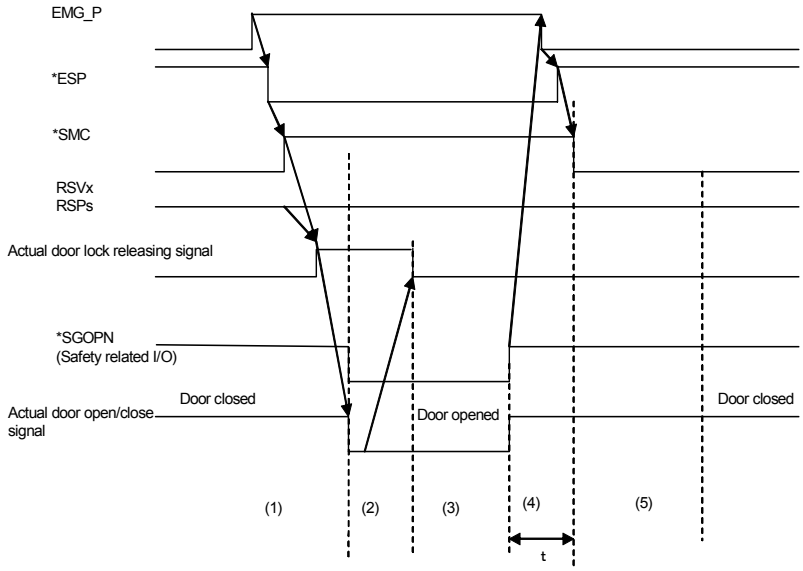
A machine tool builder must make the ladder to control to open and shut protective door in emergency stop state. For instance, a machine tool builder must make the ladder program for procedure to inhibit to open the protective door in emergency stop state.

IMPORTANT

1 Emergency stop button must fulfill the Standard IEC60947-5-1.This is mandatory.
2 As MCC Off signal (*MCF) is effective for each machine group, MCC is controlled per a machine group. Then, although the Emergency Stop signal by G signal is effective for each path, design to turn on Emergency Stop by G signal of all paths in a machine group at the same time.

Example of protective door open/shut sequence

The following figure shows the sequence in case of emergency stop.



A machine tool builder must design the ladder program as follows:

(1) In case Emergency Stop signal (*ESP) is input, the guard lock signal is turned off after confirming safety machine position, safety speed and safety position error by the Monitoring Result signals RSVx/RSPs.
(2) In this example, it is assumed that a protective door with an electronic door lock is applied. When a door is opened, door lock releasing signal must be turned off. At the same time, Guard State signal (*SGOPN: machine side signal) is changed to show guard-releasing state.
(3) This is door open state
(4) Protective door is shut and locked. Then Emergency Stop signal (*ESP) is released. Pay attention the time “t”.
(5) After Emergency Stop signal is released, CNC turns MCC Off signal (*MCF) to “1”.

Test Mode signal (input)

OPT <PMC:Gn191#2> (for each machine group)

When this signal is input, MCC off Test is carried out. MCC off Test checks whether the contact of the MCC is abnormally closed or not. MCC Off Test Execution Request signal (RQT) notifies that MCC off Test should be executed. Input this signal while servo ready signal (SA) is set to “1”.

When MCC off Test is carried out by manual operation, input this signal after preparing to carry out MCC off Test by PMC.

[Classification] Input signal (Single signal)

[Function] This signal notifies CNC to enter MCC off Test mode.

0: not enter MCC off Test mode

1: enter MCC off Test mode

Test Mode signal (OPT) through I/O Link#3, 4, Profibus-DP is not provided.

[Operation] When this signal (OPT) is set to "1", CNC turns on/off MCC in various combinations with MCC Off signals *MCF(PMC)/*MCF(DCS PMC). And CNC checks whether MCC Contact State signals *SMC(PMC)/ *SMC(DCS PMC) are input in proper combination corresponding to the combination with MCC Off signals.

However MCC off Test should not be carried out in case of emergency stop state, servo alarm state or spindle alarm state.

Avoid VRDY OFF alarm by MCC off Test by using all axes of each path VRDY off alarm ignore signal IGNVRY <Gn066#0> or each axis VRDY off alarm ignore signal IGNVRY1 to IGNVRY8 <Gn192>.

If MCC off Test is not completed within the time specified by the parameter No.1946, a servo alarm SV0488 occurs.

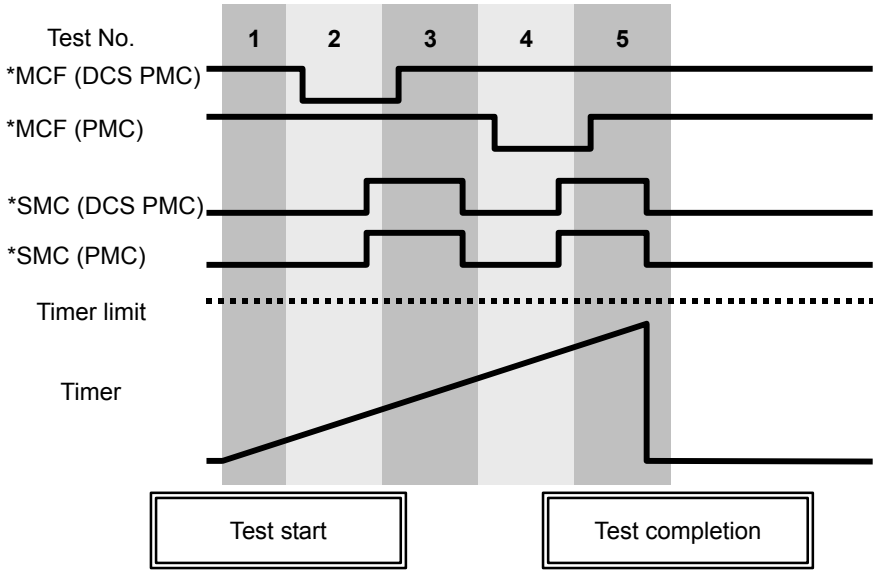
⚠ CAUTION

1 While MCC off Test is being carried out, do not turn Test Mode signal (OPT) to "0".
2 It is not permitted to carry out MCC off Test for plural machine groups simultaneously. Carry out MCC off Test for only one machine group independently.
3 If MCC is shared between two or more machine groups and MCC off Test is carried out in a machine group, VRDY off alarm in another machine group, which shared MCC, must be ignored by using all axes of each path VRDY off alarm ignore signal IGNVRY <Gn066#0> or each axis VRDY off alarm ignore signal IGNVRY1 to IGNVRY8 <Gn192>.
4 The MCC shall have forced guided contacts , and must fulfill the standard IEC60204 and IEC 60255. This is mandatory.

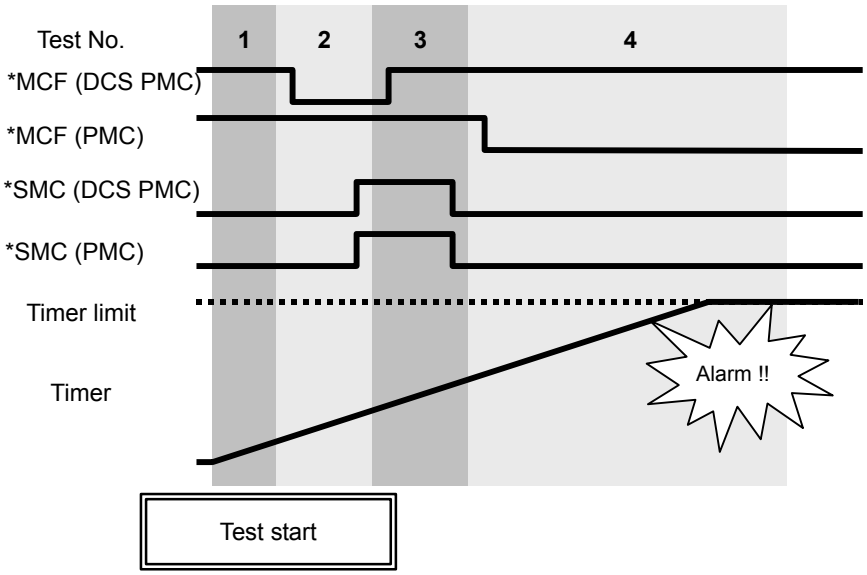
⚠ WARNING

While the MCC off Test processing is in progress, the MCC Off signal (*MCF) goes high and low to turn on and off the MCC. Carry out the MCC off Test in such a state that the turning on or off of the MCC will not cause a problem.

NOTE
If MCC off Test is executed when MCC is forced to shut off in emergency stop state, servo alarm state or spindle alarm state, the test cannot be executed normally. MCC off Test should be executed only when the test can be executed normally.



Example 1) Timing chart 1 of MCC off test (normal state)



Example 2) Timing chart 2 of MCC off test (abnormal state)

Guard Open Request signal (input)
ORQ <PMC: Gn191#3>（for each machine group)

This signal is input when an operator intends to release the guard lock and open the protective door.

[Classification] Input signal (Single signal)

[Function] In order to open the protective door, this signal requests CNC to unlock the guard lock with the Dual Check Safety Function. Guard Open Request signal (ORQ) is not input via the DCS PMC.

0: not request to open guard lock.
1: request to open guard lock

[Operation] When CNC detects that the Guard Open Request signal (ORQ) is 1, CNC returns Guard Open Inhibit signal (*OPIHB). A machine tool builder must design the PMC ladder program so that the guard lock is released after judging the result of safety machine position check, safety speed check, safety position error check to be safe or other safety condition such as Dual Check alarm status signal to be safe.

This signal is not a safety signal that is checked doubly. But this is an important signal to make up the safety system. Then a machine tool builder must design the proper ladder program to deal with this signal.

IMPORTANT
The mistake of the ladder program cannot be checked. So be sure to perform the confirmation of the safety function. (refer to the chapter 7)

Guard State signal (Machine side input signal)
***SGOPN <PMC:X machine side signal><DCS PMC:X machine side signal> (for each safety door)**

Input the guard state of the protective door to this signal. When the protective door is open (Guard State signal (*SGOPN) =0), set Safety Check Request signal (*VLDVx, *VLDPs) to “0” in order to activate the alarm monitoring of safety functions.

[Classification] Input signal (Dual signal)

[Function] Guard State signal informs CNC of the guard open/closed state for the Dual Check Safety Function.

0: Guard open state
1: Guard closed state

[Operation] When Guard State signal (*SGOPN) is “0”, the ladder program turn Safety Check Request signal (*VLDVx, *VLDPs) to “0” in order to activate the alarm monitoring of safety speed, safety machine position and safety position error. If the ladder program detects abnormal condition in each CPU, it generates a safety related alarm and stops motors.

IMPORTANT
As for the contacts for Guard State signal, it is recommended to fulfill the Standard IEC60947-5-1.

MCC Contact State (input)

***SMC <PMC: Gn748#6><DCS PMC: G(000+m)#6> (for each machine group)**

The state of MCC contact is checked doubly. It is not possible to check whether the contact of MCC is melted and adhered abnormally because MCC contact is closed during normal operation. The state of MCC contact can be checked by performing MCC off Test.

[Classification] Input signal (Dual signal)

[Function] MCC Contact State signals (*SMC) inform CNC of the MCC state for the Dual Check Safety Function.
0: MCC-on state
1: MCC-off state

[Operation] MCC Contact State signals (*SMC) is used to check if the MCC Off signals (*MCF) operates normally in MCC off Test mode.
When the MCC Contact State signals (both *SMC(PMC) and *SMC(DCS PMC)) are 1 in the emergency stop state (*ESP=0), it is possible to design the ladder program to release the guard lock.

> ⚠ **CAUTION**
> Input this signal according to the MCC state.

Safety Check Request signal (input)

***VLDVx <PMC:Gn750#0 to #7><DCS PMC:G(002+m)#0 to #7> (for each axis)**

***VLDPs <PMC:Gn751#0 to #3><DCS PMC:G(003+m)#0 to #3> (for each spindle)**

If these signals are set to “0” when Guard State signal (*SGOPN: machine side signal) is “0”, the alarm monitoring of safety speed, safety machine position and safety position error is activated.

[Classification] Input signal (Dual signal)

[Function] Safety Check Request signals request each CPU to carry out the safety check for the Dual Check Safety Function.
These signals select a servo axis and a spindle that must be checked when a protective door is open.
0: Alarm by safety check is monitored, as a protective door is open.
1: Alarm by safety check is not monitored, as a protective door is closed

[Operation] Each CPU carries out the safety check of the servo axis and the spindle that are selected by these signals. (Safety speed for a spindle, safety speed, safety machine position and safety position error for a servo axis.) If each CPU finds out any problem, it generates a safety related alarm and stops motors.

Guard Open Inhibit signal (output)

***OPIHB <PMC: Fn191#0><DCS PMC: F(019+m)#0> (for each machine group)**

CNC returns these signals as answer when CNC detects that Guard Open Request signal (ORQ) is set to "1".

[Classification] Output signal (Not checked doubly)

[Function] When CNC receives Guard Open Request signal (ORQ) =1, CNC returns these signal as answer. CNC outputs Guard Open Inhibit signal (*OPIHB) through both PMC and DCS PMC.
0: Inhibit guard open
1: Permit guard open

[Operation] A machine tool builder can release a guard lock by his ladder program when Guard Open Inhibit signal (*OPIHB) =1, Monitoring Result signal (RSVx/RSPs) =1 and the condition of machine side is confirmed to be safe.

IMPORTANT
The mistake of the ladder program cannot be checked. So be sure to perform the confirmation of the safety function. (refer to the chapter 7)

Monitoring Result signal (output)

RSVx <PMC:Fn750#0 to #7><DCS PMC:F(002+m)#0 to #7> (for each axis)

RSPx <PMC:Fn751#0 to #3><DCS PMC:F(003+m)#0 to #3> (for each spindle)

These signals show the result of monitoring safety speed, safety machine position and safety position error.
By checking these signals, a machine tool builder can judge whether a machine is in safe state or not. When a machine is judged to be in safe state, it is necessary to turn on the signal for releasing a guard lock and outputs a signal actually to open a protective door.

[Classification] Output signal (Output to both PMC but not checked doubly)

[Function] These signals show the result of monitoring of the Dual Check Safety Function.
These signals notify that an abnormal condition is detected in safety monitoring function of the Dual Check Safety Function, such as safety speed check, safety machine position check and safety position error check.
In the following case, these signals are turned to "0".
0: In dangerous condition (Abnormal condition is detected by safety function.)
In the following case, these signals are turned to "1".
1: In safe condition (Abnormal condition is not detected.)

[Operation] Each CPU notifies PMC of the result of safety monitoring through these signal.
A machine tool builder can release a guard lock by his ladder program when Guard Open Inhibit signal (*OPIHB) =1, these Monitoring Result signal (RSVx/RSPx) =1 and the condition of machine side is confirmed to be safe.

MCC Off signal (output)

***DCALM <PMC: F0748#7><DCS PMC: F000#7> (for all system)**

In case this signal is “0”, MCC is shut off through 2 channels of I/O line respectively.
This signal is set to “0”, when a crosscheck alarm of safety related signals or a CPU self-diagnosis alarm occurs.
A machine tool builder makes a ladder program to output a signal to shut off MCC when this signal is turned to “0”. If necessary, control DO signal for peripheral devices.

[Classification] Output signal (This signal output to both PMC but is not monitored doubly)

[Function] This is a signal to turn on MCC when both a crosscheck alarm and a CPU self-diagnosis alarm are not caused.
0: MCC off
1: MCC on

[Operation] When each CPU finds out any abnormal condition, it generates an alarm and turns off this signal at the same time.

MCC Off signal (output)

***MCF <PMC: Fn748#1, DCS PMC: F(000+m)#1> (for each machine group)**

In case this signal is “0”, MCC is shut off through 2 channels of I/O Link line respectively.
This signal is set to “0”, when Emergency Stop signal (*ESP) is “0” or MCC off Test is carried out.
A machine tool builder makes a ladder program to output a signal to shut off MCC when this signal is turned to “0”.

[Classification] Output signal (This signal output to both PMC but is not monitored doubly)

[Function] When the Dual Check Safety Function is applied, this signal allows turning on MCC.
When either MCC Off signal through PMC or that through DCS PMC is “0”, MCC is turned off. When both MCC Off signal through PMC and that through DCS PMC is “1”, MCC is turned on.
0: MCC off
1: MCC on

[Operation] When Emergency Stop signal is input, CNC turns off this signal.
When MCC off Test is carried out, CNC turns off this signal, too.

[Output condition] In the following case, this signal turns to “0” (not permit MCC on)
- MCC off Test is carried out.
- In emergency stop state

In other than the above case, this signal turns to “1” (permit MCC on).

MCC Off signal (output)

***MCFVx <PMC: Fn752#0 to #7><DCS PMC: F(004+m)#0 to #7> (for each axis)**

In case this signal is “0”, MCC is shut off through 2 channels of I/O line respectively.
This signal is set to “0”, when an alarm occurs in safety speed check, safety machine position check or safety position error check for each servo axis.
A machine tool builder makes a ladder program to output a signal to shut off the MCC of the path that the axis belongs, when this signal is turned to “0”.

[Classification] Output signal (This signal output to both PMC but is not monitored doubly)

[Function] When the Dual Check Safety Function is applied, this signal allows turning on MCC.
0: MCC off
1: MCC on

[Operation] If each CPU finds out the abnormal state of the axis when Safety Check Request signal for the axis (*VLDVx)=0, each CPU brings the axis into controlled stop state at first. In case of an alarm of Safety Speed Monitoring or Safety Machine Position Monitoring, each CPU watches whether the axis is decelerated and stopped or not. If the axis does not stop, each CPU turns this signal corresponding to the alarm axis to “0”. In case of an alarm of Safety Position Error Monitoring, each CPU turns this signal corresponding to the alarm axis to “0” immediately.
In case of an alarm other than described above and related to data communication or position detector, each CPU turns this signal corresponding to the alarm axis to “0” immediately. But according to the parameter setting, it is possible to turn to “0” this signals of all the axes belonged to the path that involves the alarm axis in case of any servo alarms.

MCC Off signal (output)

***MCFPs <PMC: Fn753#0 to #3><DCS PMC: F(005+m)#0 to #3> (for each spindle)**

In case this signal is “0”, MCC is shut off through 2 channels of I/O Link line respectively.
This signal is set to “0”, when an alarm occurs in safety speed check for each spindle.
A machine tool builder makes a ladder program to output a signal to shut off the MCC of the path that the spindle belongs, when this signal is turned to “0”.

[Classification] Output signal (This signal output to both PMC but is not monitored doubly)

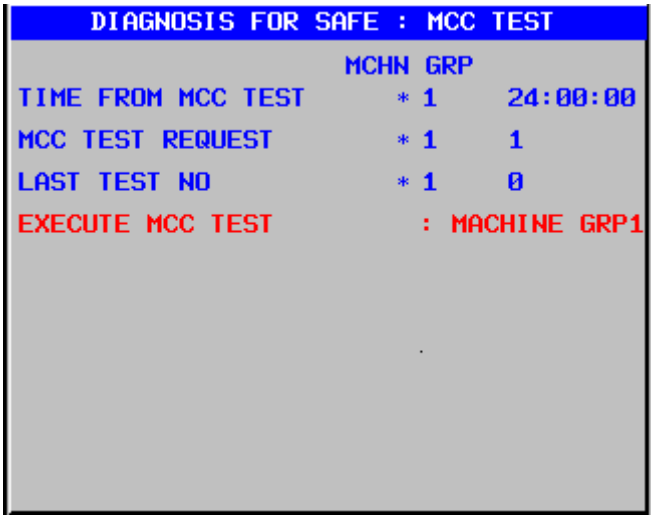
[Function] When the Dual Check Safety Function is applied, this signal allows turning on MCC.
0: MCC off
1: MCC on

[Operation] If each CPU finds out safety speed over alarm in safety speed monitoring when Safety Check Request signal for the spindle (*VLDPs)=0, each CPU brings the spindle into free run state at first.

After that, if the spindle is not decelerated, each CPU turns this signal to “0”.
In case of an alarm other than described above and related to data communication or position detector, each CPU turns this signal corresponding to the alarm spindle to “0” immediately. But according to the parameter setting (No.10500#1 = 1), it is possible to turn to “0” this signals of all the spindles belonged to the path that involves the alarm spindle in case of any spindle alarms.

MCC Off Test Execution Request signal (output)
RQT <PMC:Fn191#2> (for each machine group)

[Classification] Output signal (Single signal)
[Function] This signal notifies that MCC off Test mode is required and a check should be made to determine whether the safety output signals (MCC Off signal (*MCF)) operate normally. When MCC Off Test Execution Request signal (RQT) is set to 1, set MCC off Test mode and carry out a safety output signal MCC off Test as soon as possible.
When MCC Off Test Execution Request signal (RQT) is 1, a machine tool builder must make ladder not to release a guard lock.
Once a guard is closed when MCC Off Test Execution Request signal (RQT) is set to “1” while a guard is open by Guard Open Request signal (ORQ), it is necessary not to release a guard lock until MCC off Test request signal (RQT) turns to “0”.
When MCC Off Test Execution Request signal (RQT) is 1, the following screen is displayed and the warning “EXECUTE MCC TEST” is displayed.



MCC Off Test Execution Request signal (RQT) is not output via the DCS PMC.
Make a ladder program to lock a protective door when MCC Off Test Execution Request signal (RQT) =1.

[Output condition] In the following case, this signal is set to "1".

- MCC off Test is not completed after power-on (when bit 3 of parameter No.10500 is 0).
- Twenty-four hours have elapsed since the completion of the last MCC off Test.

In the following case, this signal sets to "0".

- MCC off Test is completed.

> **⚠ CAUTION**
> 1 Do not turn Test Mode signal (OPT) to "0" during MCC off Test.
> 2 In case that there are plural machine groups in a machine, carry out MCC off Test for each machine group independently.
> 3 If MCC is shared between two or more machine groups, do not carry out MCC off Test for those machine groups at the same time.
> 4 If MCC is shared between two or more machine groups and MCC off Test is carried out in a machine group, VRDY off alarm in another machine group, which shared MCC, must be ignored by using all axes of each path VRDY off alarm ignore signal IGNVRY <Gn066#0> or each axis VRDY off alarm ignore signal IGNVRY1 to IGNVRY8 <Gn192>.

> **⚠ WARNING**
> While the MCC off Test processing is in progress, the MCC Off signal (*MCF) goes high and low to turn on and off the MCC. Carry out the MCC off Test in such a state that the turning on or off of the MCC will not cause a problem.

Safety Brake signal (output)

***BRKx <PMC:Fn754#0 to #7><DCS PMC:F(006+m)#0 to #7> (for each axis)**

This signal is used to control mechanical brake of each axis.
CNC and SV output Safety Brake signal (*BRKx) to control mechanical brake. When *BRKx is "0", mechanical brake is active. When *BRKx is "1", mechanical brake is not active. Note that *BRKx cannot be used with all axes of each path VRDY off alarm ignore signal IGNVRY <Gn066#0> or each axis VRDY off alarm ignore signal IGNVRY1 to IGNVRY8 <Gn192>.

[Classification] Output signal (Dual signal)
[Function] When the Dual Check Safety Function is applied, this signal notifies to activate a mechanical brake. When MCC is off, a brake should be activated.

[Operation] In emergency stop state or alarm state, a mechanical brake is activated by this signal.
A machine tool builder must connect this signal to a mechanical brake.

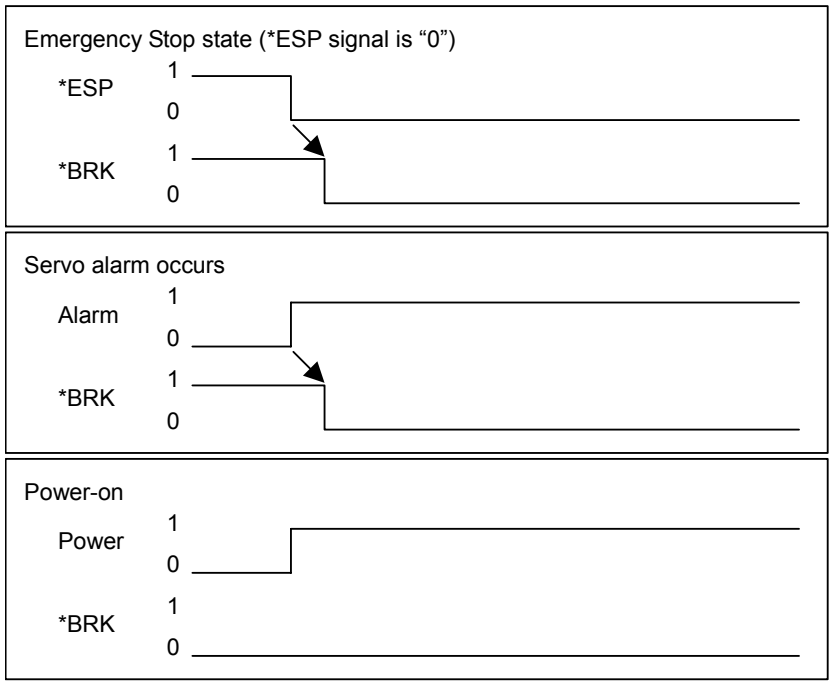
[Output condition] In the following case, this signal is "1".

- Releasing brake state

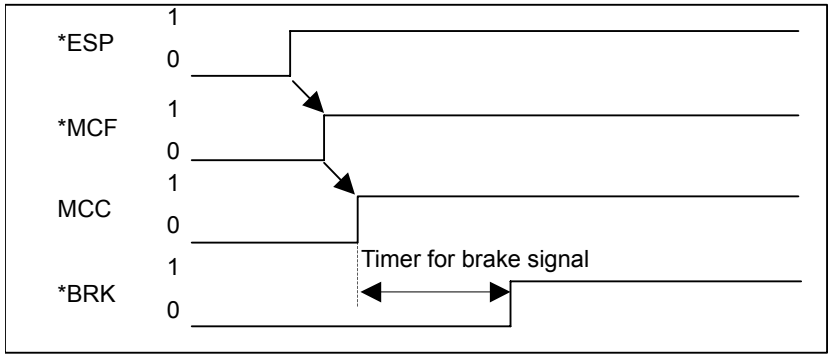
In the following case, this signal is "0".

- Activating brake state

(a) In case *BRK signal is "0"



(b) In case BRK signal is "1"
When emergency stop is released (*ESP signal is "1"), MCC can be enabled l (*MCF signal is "1"). After that, when MCC is turned on, Safety Brake signal *BRK is turned to "1" after the time specified by the parameter No.1950 is elapsed.



NOTE
Regular maintenance of a brake must be done.

Safety Position Switch signal (output)

SPS1 to SPS32<PMC:Fn755 to Fn758><DCS PMC:F(007+m) to F(010+m)>

This signal shows whether the machine position of a servo axis is within the range specified by the parameter or not.

[Classification] Output signal (Dual signal)

[Function] This signal notifies that the machine position of the axis specified by the safety parameter (No.13880 to No.13911) is within the range specified by the safety parameter (No.13920 to No.13951, No.13960 to No.13991). In case of single path system, up to 32 points can be used.
In case of 2 or more path system, another 32 points in 2 path area can be used. Then up to 64 points can be used at maximum. This signal notifies that the machine position of the axis specified by the safety parameter (No.10501 to No.10532) is within the range specified by the safety parameter (No.10533 to No.10564, No.10565 to No.10596).

NOTE
In case of 3 or more path system, safety position switch can be assigned up to 16 points per 1 group to the output signal (F area) and totally up to 4 groups can be used in the CNC system.
Two areas per a path are provided to assign. It is possible to assign the signal to an appropriate area.

[Output condition] In the following case, this signal is set to "1".

- The machine position of the axis is within the specified range.

In the following case, this signal is set to "0".

- The machine position of the axis is out of the specified range.

[Note] When the axis is just on the boundary of the range (machine position is equal to parameter setting value), it is regarded that the machine position is within the range.
If the state of two Safety Position Switch of the signal of DCS PMC side and the signal of PMC side is different more than the specified period, each CPU shuts off MCC by DCS alarm (PW0010,PW0011).

NOTE
Position switch signal is activated when the reference point correspond to the axis is established after power-on. The state of position switch is kept to “0” till then.
Once activating, position is always checked and state of signal is changed according to the result of checking. Even if the reference point is lost, the state of signal is changed according to the coordinate kept in both CNC and servo CPU. So if the special procedure is required when the reference point is lost, design the ladder program by combining with Position Information Effect signal (POSEx).

Safety Speed/Safety Position Selection signal A

SVAx <PMC:Gn752#0 to #7> <DCS PMC:G(004+m)#0 to #7> (for each axis)

SPAs <PMC:Gn754#0 to #3> <DCS PMC:G(006+m)#0 to #3> (for each spindle)

Safety speed/safety position selection signal B

SVBx <PMC:Gn753#0 to #7> <DCS PMC:G(005+m)#0 to #7> (for each axis)

SPBs <PMC:Gn754#4 to #7> <DCS PMC:G(006+m)#4 to #7> (for each spindle)

[Classification] Input signal (Dual signal)

[Function] When the Dual Check Safety Function is activated, it is possible to select safety limit speed and safety machine position of each axis.
This signal is prepared for each axis and each spindle. The final number in the signal name shows the number of the controlled axis and spindle.

SVA<u>x</u>, SVB<u>x</u>

<u>x</u> 1: Select safety speed/safety machine position of the 1st axis
2: Select safety speed/safety machine position of the 2nd axis
3: Select safety speed/safety machine position of the 3rd axis
: :
: :

SPA<u>y</u>, SPB<u>y</u>

<u>y</u> 1: Select safety speed of the 1st spindle
2: Select safety speed of the 2nd spindle
: :
: :

[Operation] According to the combination of Safety Speed/Safety Machine Position Selection signal, safety speed and safety machine position are selected as the following table.

Safety Speed/ Safety Machine Position Selection signal		Safety limit speed		Safety machine position	
SVAn SPAn	SVBn SPBn	Parameter for servo axis	Parameter for spindle	+ direction parameter	- direction parameter
0	0	Safety limit speed 1		Safety machine position 1	
		No.13821	No.4372	No.13831	No.13832
1	0	Safety limit speed 2		Safety machine position 2	
		No.13822	No.4438	No.13833	No.13834
0	1	Safety limit speed 3		Safety machine position 3	
		No.13823	No.4440	No.13835	No.13836
1	1	Safety limit speed 4		Safety machine position 4	
		No.13824	No.4442	No.13837	No.13838

⚠ CAUTION
Safety Speed/Safety Machine Position Selection signal is a safety signal. This signal is input through both PMC and DCS PMC. Both CNC and PMC check doubly inconsistency of this signal.

Position Information Effect signal

POSEx <PMC: Fn766#0 to #7><DCS PMC: F(018+m)#0 to #7> (for each axis)

This signal is output when Dual Check Safety function is activated and the reference point is established. When the reference point is not established, the machine system is in danger state because Safety Machine Position Monitoring and Safety Position Error Monitoring are not active. If this signal is "0", Machine Tool Builder has to control not to open the protective door.

[Classification] Output signal (This signal output to both PMC but is not monitored doubly)

[Function] This signal informs whether the reference point is established or not.
0: The reference point is not established.
1: The reference point is established.

[Operation] Each CPU informs whether the reference point is established or not.
In the following case, this signal is turned to "1".

- After the reference point is established.
- When the follow up operation of absolute pulse coder is finished after power-on

In the following case, this signal is turned to "0".

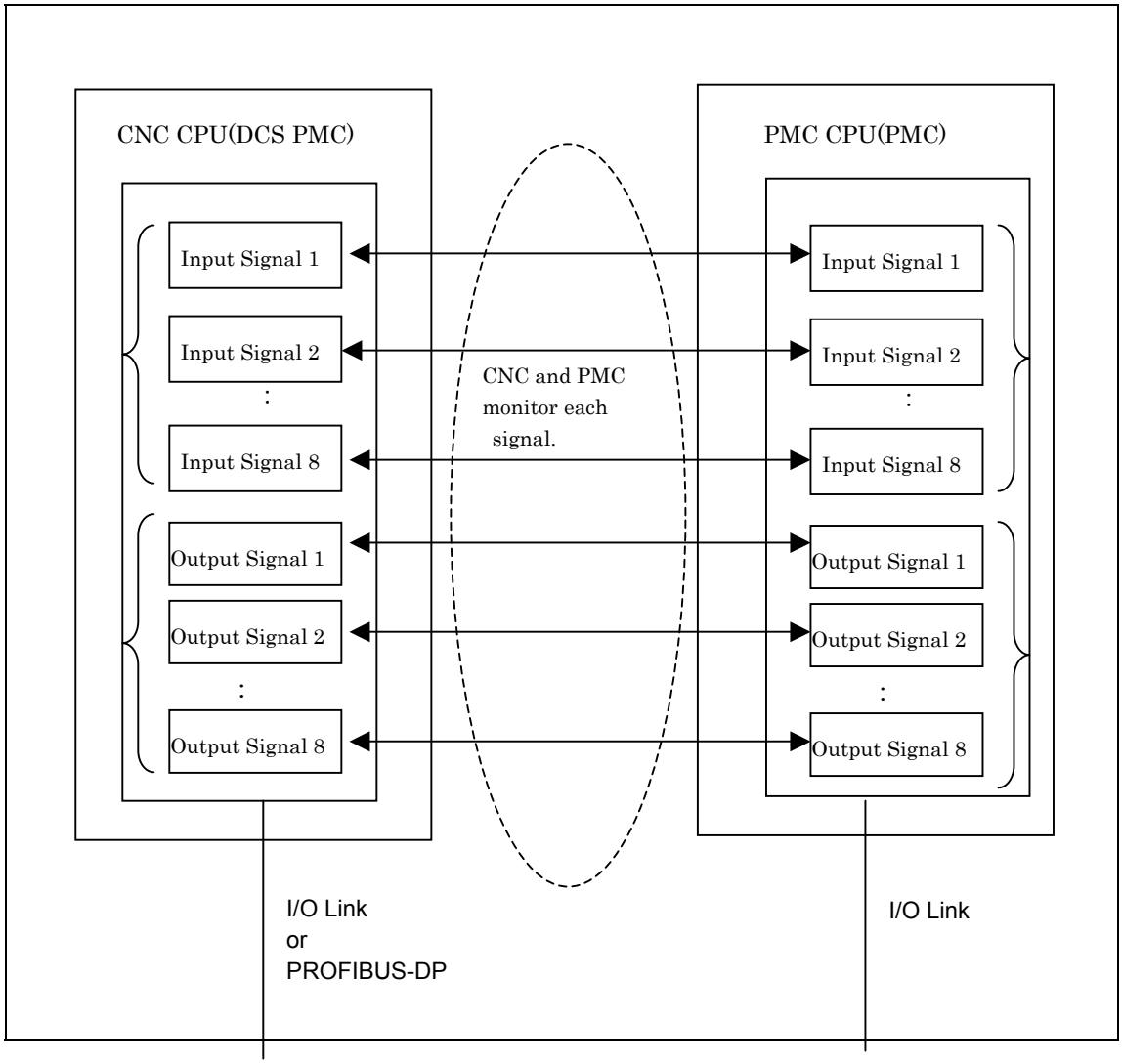
- When the reference point is lost

NOTE
In case that the reference point is re-established, this signal is turned to "0" till the reference point is re-established from the dog-signal is turned off.

Programmable Safety I/O signals

[Classification] Input/Output signal (Dual signal)

[Function] The 8 bytes (64 bit) programmable safe I/Os can be freely defined as the different address from the above basic safe signals. Each byte of 8 byte programmable safe I/Os can be assigned on either address of X/Y or R or D by parameter. Each byte of the programmable safe I/O between the PMC and DCS PMC is cross-checked by the CNC and PMC.



[Operation] The combinations of cross-checking these signals are defined by using Safety parameters as follows.

Signal type	Combination No.	CNC (DCS PMC)	PMC(PMC)
input	1	No. 11950	No. 11970
	2	No. 11951	No. 11971
	3	No. 11952	No. 11972
	4	No.11953	No.11973
	5	No.11954	No.11974
	6	No.11955	No.11975
	7	No.11956	No.11976
	8	No.11957	No.11977
output	1	No.11960	No.11980
	2	No.11961	No.11981
	3	No.11962	No.11982
	4	No.11963	No.11983
	5	No.11964	No.11984
	6	No.11965	No.11985
	7	No.11966	No.11986
	8	No.11967	No.11987

5.4 GENERAL PURPOSE I/O SIGNAL

How to turn off general purpose signal

When it is confirmed that *DCALM, *MCF, *MCFVx and *MCFPs is “0”, turn general purpose I/O signal off if necessary.

(a) In case MCC off Test is carried out,

When RQT=1 and OPT=1, ignore *MCF=0.

(b) In case of emergency stop (*ESP=0)

When *ESP=0, ignore *MCF=0.

5.5 NOTE ON MULTI PATH CONTROL

This section describes cautions about safe-related I/O signals that should be taken in multi-path control.

5.5.1 Machine Group And Multi Path Control

CNC can treat servo axes and spindles by dividing into two classes of groups, machine group and path
In case that a machine has plural machine parts that are controlled independently, machine group is provided to control a part of machine in such machine. Emergency stop is prepared for each machine group.
The signals for MCC off Test and protective door open/close sequence are provided for each machine group.

In case that a work piece is machined by plural cutters and plural programs at the same time, multi path control is applied. An alarm is checked by each path. If servo alarm occurs in a path, MCC of all axes in the path is shut off.
In case of the alarm by safety check function, MCC of all axes in the path are shut off. Then the safety area should be set for each path basically.

When plural safety areas are defined in a path, MCC may be shut off by an alarm that occurs in another safety area.
When the safety area is composed by the axes that change assignment to a path, MCC of other axes are not always shut off. So wire the MCC of all paths, which include the axes changed assignment to the path, to shut off at the same time.

The safety signals that are cross-checked are provided both on PMC and DCS PMC for each path. The state must be controlled to be equal.

NOTE

When “Composite control” or “Path speed control of Multi path control” is specified, it is possible to give a command to control a servo axis or a spindle in another path. But in this case, the correspondence between a path and a belonging servo axis or spindle is not changed. An alarm related to a servo axis or a spindle occurs in the path that the axis and the spindle originally belong to, and MCC shut off signal correspond to the axis or spindle is output also in original path.
Then, as the path that gives a command and the path that an axis and a spindle belongs to should be regarded as the same group, it is necessary to wire MCC off signal (*MCFVx, *MCFPs) to shut off the MCC of both path at the same time when “Composite control” or “Path speed control of Multi path control” is specified.

6 PARAMETERS

6.1 OVERVIEW

The parameters related to the dual check safety function (safety parameters) are protected by a code (No. 3225) for the safety parameters. The value of a safety parameter cannot be modified unless the same value as the code for the safety parameters is set as the key (No. 3226) for the safety parameters.
The safety parameters are stored in two locations on the CNC. The CNC, PMC, servo and spindle software check the matching of the parameters stored at the two locations. If a mismatch is found, an alarm is issued.

If the setting of a safety parameter is modified, the power must be turned off then back on. The new setting of the parameter becomes effective after the power is turned back on.

6.2 DATA TYPE

Parameters are classified by data type as follows:

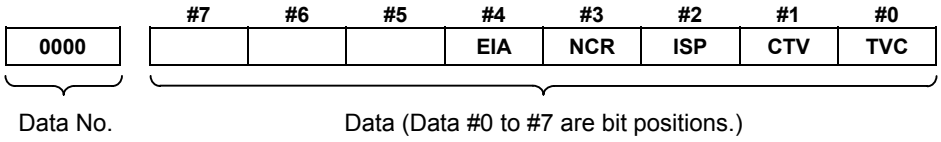
Data type	Valid data range	Remarks
Bit	0 or 1	
Bit machine group		
Bit path		
Bit axis		
Bit spindle		
Byte	-128 to 127 0 to 225	Some parameters handle these types of data as unsigned data.
Byte machine group		
Byte path		
Byte axis		
Byte spindle		
Word	-32768 to 32767 0 to 65535	Some parameters handle these types of data as unsigned data.
Word machine group		
Word path		
Word axis		
Word spindle		
2-word	0 to ±999999999	Some parameters handle these types of data as unsigned data.
2-word machine group		
2-word path		
2-word axis		
2-word spindle		
Real	See the Standard Parameter Setting Tables.	
Real machine group		
Real path		
Real axis		
Real spindle		

NOTE

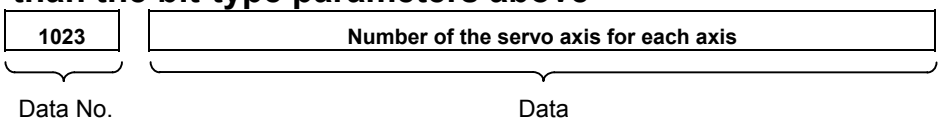
1 Each of the parameters of the bit, bit machine group, bit path, bit axis, and bit spindle types consists of 8 bits for one data number (parameters with eight different meanings).
2 The machine group type allows data to be set separately for each machine group.
3 The path type allows data to be set separately for each path.
4 The axis type allows data to be set separately for each control axis.
5 The spindle type allows data to be set separately for each spindle axis.
6 The valid data range for each data type indicates a general range. The range varies according to the parameters. For the valid data range of a specific parameter, see the explanation of the parameter.

6.3 REPRESENTATION OF PARAMETERS

Parameters of the bit type, bit machine group type, bit path type, bit axis type, and bit spindle type



Parameters other than the bit-type parameters above



NOTE

1 The parameters, which are described here, are related directly to Dual Check Safety function. As for the other parameters, please refer to the parameter manual (B-63950EN).

2 A parameter usable with only one path control type, namely, the lathe system (T series) or the machining center system (M series), is indicated using two rows as shown below. When a row is blank, the parameter is not usable with the corresponding series.

[Example 1]

Parameter HTG is a parameter common to the M and T series, but Parameters RTV and ROC are parameters valid only for the T series.

	#7	#6	#5	#4	#3	#2	#1	#0	
1403	RTV		HTG	ROC					T series
			HTG						M series

[Example 2]

The following parameter is provided only for the M series.

1411		T series
	Cutting feedrate	M series

3 When "to" is inserted between two parameter numbers, there are parameters with successive numbers between the two starting and ending parameter numbers, but those intermediate parameter numbers are omitted for convenience.

4 The lower-case letter "x" or "s" following the name of a bit-type parameter indicates the following:

- "□□□x" : Bit axis type parameters
- "○○○s" : Bit spindle type parameters

6.4 STANDARD PARAMETER STTING TABLES

Overview

This section defines the standard minimum data units and valid data ranges of the CNC parameters of the real type, real machine group type, real path type, real axis type, and real spindle type. The data type and unit of data of each parameter conform to the specifications of each function.

Explanation

(A) Length and angle parameters (type 1)

Unit of data	Increment system	Minimum data unit	Valid data range
mm deg.	IS-A	0.01	-999999.99 to +999999.99
	IS-B	0.001	-999999.999 to +999999.999
	IS-C	0.0001	-99999.9999 to +99999.9999
	IS-D	0.00001	-9999.99999 to +9999.99999
	IS-E	0.000001	-999.999999 to +999.999999
inch	IS-A	0.001	-99999.999 to +99999.999
	IS-B	0.0001	-99999.9999 to +99999.9999
	IS-C	0.00001	-9999.99999 to +9999.99999
	IS-D	0.000001	-999.999999 to +999.999999
	IS-E	0.0000001	-99.9999999 to +99.9999999

(B) Length and angle parameters (type 2)

Unit of data	Increment system	Minimum data unit	Valid data range
mm deg.	IS-A	0.01	0.00 to +999999.99
	IS-B	0.001	0.000 to +999999.999
	IS-C	0.0001	0.0000 to +99999.9999
	IS-D	0.00001	0.00000 to +9999.99999
	IS-E	0.000001	0.000000 to +999.999999
inch	IS-A	0.001	0.000 to +99999.999
	IS-B	0.0001	0.0000 to +99999.9999
	IS-C	0.00001	0.00000 to +9999.99999
	IS-D	0.000001	0.000000 to +999.999999
	IS-E	0.0000001	0.0000000 to +99.9999999

(C) Velocity and angular velocity parameters

Unit of data	Increment system	Minimum data unit	Valid data range
mm/min degree/min	IS-A	0.01	0.0 to +999000.00
	IS-B	0.001	0.0 to +999000.000
	IS-C	0.0001	0.0 to +99999.9999
	IS-D	0.00001	0.0 to +9999.99999
	IS-E	0.000001	0.0 to +999.999999
inch/min	IS-A	0.001	0.0 to +96000.000
	IS-B	0.0001	0.0 to +9600.0000
	IS-C	0.00001	0.0 to +4000.00000
	IS-D	0.000001	0.0 to +400.000000
	IS-E	0.0000001	0.0 to +40.0000000

(D)Acceleration and angular acceleration parameters

Unit of data	Increment system	Minimum data unit	Valid data range
mm/sec^2 deg./sec^2	IS-A	0.01	0.00 to +999999.99
	IS-B	0.001	0.000 to +999999.999
	IS-C	0.0001	0.0000 to +99999.9999
	IS-D	0.00001	0.00000 to +9999.99999
	IS-E	0.000001	0.000000 to +999.999999
inch/sec^2	IS-A	0.001	0.000 to +99999.999
	IS-B	0.0001	0.0000 to +99999.9999
	IS-C	0.00001	0.00000 to +9999.99999
	IS-D	0.000001	0.000000 to +999.999999
	IS-E	0.0000001	0.0000000 to +99.9999999

Notes

(1) Values are rounded up or down to the nearest multiples of the minimum data unit.

(2) A valid data range means data input limits, and may differ from values representing actual performance.

(3) For information on the ranges of commands to the CNC, refer to Appendix, "List of Command Ranges," in the "USER'S MANUAL" (B-63944EN).

(4) The setting value of the parameter related with length and angle depends on whether the attribute of the axis is diameter specification or radius specification. In case safety function, set the parameter according to the attribute of the axis at power on.
Even if the attribute is changed after power on, changed value is not used by each safety function. Each safety function refers to the value that is specified at power on. .

6.5 PARAMETERS

0980 **Machine group number of each path**

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Byte path
[Valid data range] 1 to 3
Set the machine group number which each path belongs.

NOTE
When 0 is set, each path is assumed to belong to machine group 1.

0981 **Absolute path number of each axis**

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Byte axis
[Valid data range] 1 to 10
Set the path to which each axis belongs.

NOTE
When 0 is set each axis is assumed to belong to path 1.

0982 **Absolute path number of each spindle**

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Byte spindle
[Valid data range] 1 to 10
Set the path to which each spindle belongs.

NOTE
When 0 is set each axis is assumed to belong to path 1.

1023	Servo axis number of each axis

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Byte axis
[Valid data range] 0 to Number of controlled axis

Set the servo axis for each control axis. Usually set to same number as the control axis number.
The control axis number is the order number that is used for setting the axis-type parameters or axis-type machine signals With an axis for which Cs contour control/spindle positioning is to be performed, set "-(spindle number)" as the servo axis number.
Example)
When performing Cs contour control on the fourth control axis by using the first spindle, set -1.

1240	Coordinates value of the reference position in the machine coordinate system

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Real axis
[Unit of data] mm, inch, degree (machine unit)
[Minimum unit of data] Depend on the increment system of the applied axis
[Valid data range] 9 digit of minimum unit of data (Refer to standard parameter setting table(A). But in case that CMR≥1, data range becomes 1/CMR of 9 digits of minimum unit of data.)
(When the increment system is IS-B and CMR=1, -999999.999 to +999999.999)
(When the increment system is IS-B and CMR=2, -499999.999 to +499999.999)

NOTE
Whether to specify this parameter by using a diameter value or radius value depends on whether the corresponding axis is based on diameter specification or radius specification.

Set the coordinate values of the reference position in the machine coordinate system.

1838 **Position deviation limit for each axis in moving state during safety check**

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] 2-word axis
[Unit of data] Detection unit
[Valid data range] 0 to 99999999

Position deviation limit for each axis in moving state for safety check of Dual Check Safety function is specified.
If position deviation of a moving axis exceeds position deviation limit while Safety Check is carried out (Safety Monitoring Request "*VLDVx" =0), a servo alarm (SV0475, SV1071) is generated and axes are stopped immediately like emergency stop state.
In Dual Check Safety function, position deviation is always checked by CNC and Servo. In case that Safety Check is carried out (Safety Monitoring Request "*VLDVx" =0), the servo alarm (SV0475,SV1071) is generated when each CPU finds out that the deviation exceeds position deviation limit in moving state.

1839 **Position deviation limit for each axis in stopped state during safety check**

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] 2-word axis
[Unit of data] Detection unit
[Valid data range] 0 to 99999999

Set the positioning deviation limit in stopped state for each axis for Dual Check Safety function.
If the positioning deviation exceeds the positioning deviation limit during stopped state while Safety Check is carried out (Safety Monitoring Request "*VLDVx" =0), a servo alarm (SV0474, SV1072) is generated, and operation is stopped immediately (as in emergency stop).
In Dual Check Safety function, position deviation is always checked by CNC and Servo. In case that Safety Check is carried out (Safety Monitoring Request "*VLDVx" =0), servo alarm (SV0474,SV1072) is generated when each CPU finds out that the deviation exceeds position deviation limit in stopped state.

1840	Position deviation limit for each axis in servo-off state during safety check

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] 2-word axis
[Unit of data] Detection unit
[Valid data range] 0 to 99999999

Set the positioning deviation limit in servo-off state for each axis for Dual Check Safety function.
If the positioning deviation exceeds the positioning deviation limit during servo-off, a servo alarm (SV1069,SV1070) is generated, and operation is stopped immediately (as in emergency stop).
In Dual Check Safety function, position deviation is always checked by CNC and Servo. In case that Safety Check is carried out (Safety Monitoring Request "*VLDVx" =0), servo alarm (SV1069,SV1070) is generated when each CPU finds out that the deviation exceeds position deviation limit in servo-off state.

1841	Position deviation limit of each axis in moving state during other than Dual Check Safety monitoring (for Dual Check Safety Function)

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] 2 word axis
[Unit of data] Detection unit
[Valid data range] 0 to 99999999

Set the positioning deviation limit in moving state for each axis for Dual Check Safety function, in case that Safety Check is not carried out (Safety Monitoring Request "*VLDVx"=1).
In case that Safety Check is not carried out (Safety Monitoring Request "*VLDVx" =1), servo alarm (SV0475,SV1071) is generated and operation is stopped immediately (as in emergency stop), when each CPU finds out that the deviation exceeds position deviation limit in moving state.
If the value of this parameter is "0", the parameter No.1828 is used for the value of deviation limit in moving state.

In case that Safety Check is carried out (Safety Monitoring Request "*VLDVx" =0), the parameter No.1838 is used for the value of deviation limit in moving state.

1842	Position deviation limit of each axis in stopped state during other than Dual Check Safety monitoring (for Dual Check Safety Function)

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] 2 word axis
[Unit of data] Detection unit
[Valid data range] 0 to 99999999

Set the positioning deviation limit in stopped state for each axis for Dual Check Safety function, in case that Safety Check is not carried out (Safety Monitoring Request "*VLDVx"=1).
In case that Safety Check is not carried out (Safety Monitoring Request "*VLDVx" =1), servo alarm (SV0474,SV1072) is generated and operation is stopped immediately (as in emergency stop), when each CPU finds out that the deviation exceeds position deviation limit in stopped state.
If the value of this parameter is "0", the parameter No.1829 is used for the value of deviation limit in stopped state.

In case that Safety Check is carried out (Safety Monitoring Request "*VLDVx" =0), the parameter No.1839 is used for the value of deviation limit in stopped state.

	#7	#6	#5	#4	#3	#2	#1	#0
1902		DCE						

[Input type] Parameter input
[Data type] Bit

NOTE
When this parameter is set, the power must be turned off before operation is continued.

 # 6 DCE Dual Check Safety function is
0: inactive.
1: active.

This parameter invalidates Dual Check Safety function temporarily.
In the system with Dual Check Safety function, this parameter is used when the system set up without wiring and ladder related with Dual Check Safety in order to set up other function.

NOTE
When Dual Check Safety function is used, this parameter must be set to “1”. If Dual Check Safety function is ordered and this parameter is “0”, an alarm (DS0022) is displayed at power-on. This alarm can be reset by pushing “CAN” and “RESET” key on MDI at the same time.

	#7	#6	#5	#4	#3	#2	#1	#0
1904		DCN						

[Input type] Parameter input
[Data type] Bit axis

NOTE
When this parameter is set, the power must be turned off before operation is continued.

 # 6 DCN The checks of the target axis by Dual Check Safety function are:
0: carried out.
1: not carried out.

NOTE
1 It is not possible to inhibit each check of Dual Check Safety Function of all axes by the parameter DCN.
2 Set the DCN bit to 1 for the slave axis under tandem control or for the tool axis of a simple electronic gear box or electronic gear box 2-pair.
3 The checks by the dual check safety function are not carried out on an axis for which the DCN bit is set to 1. Set the DCN bit to 0 for normal axes.

1945	Safety input signal check timer

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Word machine group
[Unit of data] msec
[Valid data range] 0 to 1000
Input/output signals related to Dual Check Safety function (safety double input/output signals) are transmitted through two paths, “I/O Link #1 or #2” and “I/O Link#3, #4 or Profibus-DP”. CNC CPU and PMC CPU exchange the input/output signals with each other at all time to check each other. If a mismatch between double input/output signals through two paths lasts greater than the time set in this

parameter, alarm PW0010, PW0011, PW0012 or PW0013 is generated.
If a value of less than 16 is specified, it is assumed that 16 ms is specified.
If a value of more than 1000 is specified, it is assumed that 1000 ms is specified.

NOTE
The same value is applied to each path that belongs to a machine group.

1946 **MCC off Test timer**

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Word machine group
[Unit of data] msec
[Valid data range] 0 to 32767
When MCC off Test mode is selected with Dual Check Safety function, CNC CPU carries out MCC off Test by the safety output signal (*MCF). If MCC off Test is not completed within the time set in this parameter, a servo alarm SV0488 is generated.
If a value of less than 0 is specified, it is assumed that 10000 ms is specified.

NOTE
The same value is applied to each path that belongs to a machine group.

1948 **MCC off timer 2**

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Word machine group
[Unit of data] msec
[Valid data range] 0 to 32767
CNC CPU and PMC CPU set MCC Off signal (*MCFVx) to 0, when an axis is not stopped within the time set by this parameter after Safe Speed Monitoring or Safe Machine Position Monitoring function of Dual Check Safety function detects abnormal condition.

NOTE
The same value is applied for each path that belongs to a machine group.

1950	Brake signal timer

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Word machine group
[Unit of data] msec
[Valid data range] 0 to 32767
Set a time period from when CNC CPU and Servo CPU in Dual Check Safety function detects that the servo amplifier is ready (MCC on state) until Safety Brake signal (*BRKx) goes 1 (brake release enabled).

NOTE
The same value is applied for each path that belongs to a machine group.

3021	Address to which an axis signal is assigned

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Byte axis
[Valid data range] 0 to 7, 10 to 17, 20 to 27, ... , 90 to 97
For each axis of the CNC, set a PMC interface address.
Set a value according to the tables below.

Value of parameter No. 3021 (tens digit)

Setting value	Input signal address	Output signal address
0	G0000 to G0999	F0000 to F0999
1	G1000 to G1999	F1000 to F1999
	. . .	
9	G9000 to G9999	F9000 to F9999

Value of parameter No. 3021 (ones digit)

Setting value	Input signal address	Output signal address
0	#0	#0
1	#1	#1
	. . .	
7	#7	#7

[Example of setting]

Axis number	No.3021	Signal allocation
1	0	+J1<G0100.0>, -J1<G0102.0>, ZP1<F0090.0>, ...
2	1	+J2<G0100.1>, -J2<G0102.1>, ZP2<F0090.1>, ...
3	2	+J3<G0100.2>, -J3<G0102.2>, ZP3<F0090.2>, ...
4	10	+J4<G1100.0>, -J4<G1102.0>, ZP4<F1090.0>, ...
5	11	+J5<G1100.1>, -J5<G1102.1>, ZP5<F1090.1>, ...

If eight or less axes are used per path, the following signal allocation results when 0 is set for all axes:
Axis 1 of path 1 = Setting equivalent to 0
Axis 2 of path 1 = Setting equivalent to 1
:
Axis 1 of path 2 = Setting equivalent to 10
:

NOTE
Set this parameter when more than eight axes are used per path.
The valid data range varies, depending on the NC system type.

3022 **Address to which a spindle signal is assigned**

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Byte spindle
[Valid data range] 0to3,10to13,20to23, ... ,90to93
For each axis of the CNC, set a PMC interface address.
Set a value according to the tables below.

Value of parameter No. 3022 (tens digit)

Setting value	Input signal address	Output signal address
0	G0000 to G0999	F0000 to F0999
1	G1000 to G1999	F1000 to F1999
	. . .	
9	G9000 to G9999	F9000 to F9999

Value of parameter No. 3022 (ones digit)

Setting value	Input signal address	Output signal address
0	Bit position A	Bit position A
1	Bit position B	Bit position B
2	Bit position C	Bit position C
3	Bit position D	Bit position D

(The bit positions A, B, C and D vary, depending on the type of signal.)
[Example of setting]

Spindle number	No.3022	Signal allocation
1	0	TLMLA<G0070.0>, TLMHA<G0070.1>, ALMA<F0045.0>, ...
2	1	TLMLB<G0074.0>, TLMHB<G0074.1>, ALMB<F0049.0>, ...
3	10	TLMLA<G1070.0>, TLMHA<G1070.1>, ALMA<F1045.0>, ...
4	11	TLMLB<G1074.0>, TLMHB<G1074.1>, ALMB<F1049.0>, ...

If four or less axes are used per path, the following signal allocation results when 0 is set for all axes:
Axis 1 of path 1 = Setting equivalent to 0
Axis 2 of path 1 = Setting equivalent to 1
:
Axis 1 of path 2 = Setting equivalent to 10

NOTE
Set this parameter when more than four axes are used per path.
The valid data range varies, depending on the system software.

3225 **Code for safety parameters**

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] 2-word
[Valid data range] 0 to 99999999

Set a code (password) for protecting against modifications to parameters related to Dual Check Safety function (safety parameters). When a code for safety parameters is set other than the value "0", the parameters are locked. In this state, the setting (code) is not displayed but is blank, and safety parameter input is disabled.
If an attempt is made to input data in a locked safety parameter, the result indicated in the table below is produced, depending on the method of input. No attempt is successful.

Input method	Result
MDI input	Warning "WRITE PROTECT"
Input via reader/puncher interface	No alarm is generated. But parameter input is disabled.
Input through window function	Completion code 7 (WRITE PROTECT)

If the value other than "0" is set to this parameter, the safety parameter cannot be modified. The safety parameters can be set when the safety

parameters are not locked, that is, when the code for safety parameters is 0, or when the code for safety parameters is the same as the key for safety parameters (No. 3226).
The following safety parameters are protected by a code for safety parameters:

No.980, No.981, No.982, No.1023, No.1240, No.1838, No.1839, No.1840, No.1841, No.1842, No.1902, No1904, No.1945, No.1946, No.1948, No.1950, No.3021, No.3022, No.3225, No.3717, No.3797, No.4372, No.4438, No.4440, No.4442, No.4448, No.10500, No.10501-No.10596, No.11950-No.11957, No.11960-N0.11967, No.11970-No.11977, No.11980-No-11987, No.13811, No.13821-No.13829, No.13831~No.13838, No.13840-No.13843, No.13880-No.13911, No.13920-No.13951, No.13960-No.13991

NOTE
Once parameters are locked, the lock must be released or memory must be cleared before the safety parameters can be modified. Moreover, the code for the safety parameters cannot be modified in locked condition. Be careful when setting a code for safety parameters.

3226	Key for safety parameters

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] 2-word
[Valid data range] 0 to 99999999
When the same value as the code for safety parameters No.3225 is set in this parameter, the key is opened to enable modifications to the safety parameters. The value set in this parameter is not displayed.
When the value other than 0 is set to the code for safety parameters No.3225 and the value is different from this parameter, the key is locked and the safety parameters can not be modified.
When the power is turned off, the value set in this parameter is cleared to 0. Then the power-off results in the locked state.

3717	Motor number to each spindle

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Byte spindle
[Valid data range] 0 to Maximum number of controlled axes
Set a spindle amplifier number to be assigned to each spindle.
0: No spindle amplifier is connected.
1: Spindle motor connected to amplifier number 1 is used.
2: Spindle motor connected to amplifier number 2 is used.
to
n: Spindle motor connected to amplifier number n is used.

	#7	#6	#5	#4	#3	#2	#1	#0
3797								DCN

[Input type] Parameter input
[Data type] Bit spindle

NOTE
When this parameter is set, the power must be turned off before operation is continued.

 # 0 DCN Each safety check of Dual Check Safety function for the specified spindle is
0: carried out.
1: not carried out.
Set “1” to this bit for the spindle that is not required to apply Dual Check Safety.

4372	Safe speed 1 for each spindle
4438	Safe speed 2 for each spindle
4440	Safe speed 3 for each spindle
4442	Safe speed 4 for each spindle

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Word spindle
[Unit of data] min^{-1}
[Valid data range] 0 to 32767

Set a safe speed for each spindle in terms of motor speed. In case Dual Check Safety function is activated, CNC and Spindle always check the speed of each spindle motor. When it is detected that revolution speed of spindle exceeds safety speed limit, Monitoring Result signal (RSPs) is set to "0". Moreover if the safety check is carried out (Safety Check Request signal *VLDPs ="0"), an alarm SP0757(CNC side) or SP9069(Spindle side) occurs.
Safety Speed can be set up to 4 data. Which speed should be selected is decided by Safety Speed Selection signal (SPAs/SPBs). Please refer more detail to the description about Safety Speed/Safety Position Selection signal.

⚠ CAUTION
After Safety Speed parameters No.4372, No.4438, No.4440 or No.4442 has been modified, the power must be turned off then back on for the setting to become effective.

4448	Stop check level

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Word spindle
[Unit of data] min^{-1}
[Valid data range] 0 to 32767

When a spindle motor is in free-run state because of excess of safety speed, a motor is regarded as stop state if the speed of a spindle motor becomes lower than the value set by this parameter. In this condition, an alarm can be reset. The setting value must be lower than the parameter "Safe Speed for each spindle".

	#7	#6	#5	#4	#3	#2	#1	#0
10500					STP		APM	AVM

[Input type] Parameter input
[Data type] Bit path

NOTE
When this parameter is set, the power must be turned off before operation is continued.

 # 0 AVM In case that a servo alarm occurs,
0: MCC off signal (*MCFVx) is turned to “0” when some servo alarm occurs.
1: MCC off signal (*MCFVx) is turned to “0” when any servo alarm occurs.

In case that this parameter is set to “1”, MCC off signal (*MCFVx) of all axes, which belong to the same path as the alarm axis, are turned to “0” when a servo alarm occurs.

 # 1 APM In case that a spindle alarm (SPxxxx) occurs
0: MCC off signal (*MCFPs) is turned to “0” when some spindle alarm occurs.
1: MCC off signal (*MCFPs) is turned to “0” when any spindle alarm occurs.

In case that this parameter is set to “1”, MCC off signal (*MCFPs) of all spindles, which belong to the same path as the alarm spindle, are turned to “0” when a spindle alarm occurs.

 # 3 STP When the power is turned on, a MCC off test is:
0: Carried out. (The screen is changed to Dual Check Safety Diagnosis screen automatically and the warning "EXECUTE MCC TEST" is displayed at power-on, and MCC off Test execution request signal (RQT) is output.)
1: Not carried out.

⚠ CAUTION
1 The STP parameter is used temporarily, for example, when a MCC off Test is not to be made at power-on as in the case of machine adjustment.
2 After adjustment, set STP = 0.
3 Even when STP = 1, a MCC off Test is required if the power is turned 24 hours or more after the completion of the previous MCC off Test.
4 The same value must be set to the path that belongs to the same machine group.
5 The screen is changed to “ALARM SCREEN” when an alarm occurs at power-on. In this case, Dual Check Safety Diagnosis screen is not displayed at power-on automatically.

13810 **Timer to start safety I/O signal after power-on**

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Word
[Unit of data] msec
[Valid data range] 0 to 32767
In Dual Check Safety function, the time from “CNC start-up” to “I/O cross check error start” is specified just after power-on.

13811 **Hysteresis width of position switch (Dual Check Safety)**

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Real axis
[Unit of data] mm, inch, deg (Machine unit)
[Least unit of data] According to the input increment of corresponding axis
[Valid data range] 0 or positive 9 digit of least input increment of data (Refer to standard parameter setting table(B). But in case that CMR≥1, data range becomes 1/CMR of 9 digits of least input increment of data.)
(When the increment system is IS-B and CMR=1, 0 to +999999.999)
(When the increment system is IS-B and CMR=2, 0 to +499999.999)

NOTE
Whether to specify this parameter by using a diameter value or radius value depends on whether the corresponding axis is based on diameter specification or radius specification.

Position switch sometimes turns on and off repeatedly near the boundary of position switch area by very small vibration of a servo motor. According to this problem, position switch is inconvenient to use. So “hysteresis” described below is applied.

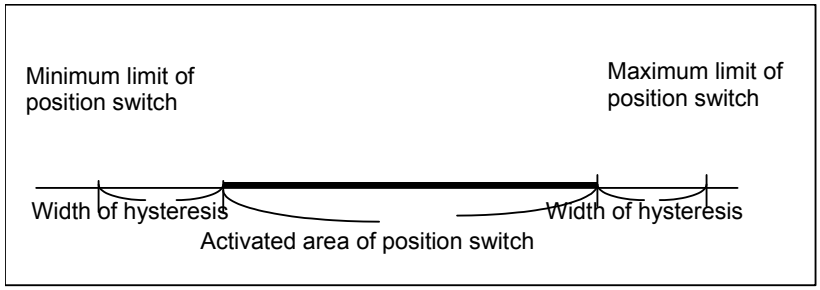


Fig.6.5(a) Measuring area of position switch in case state of switch is “0”

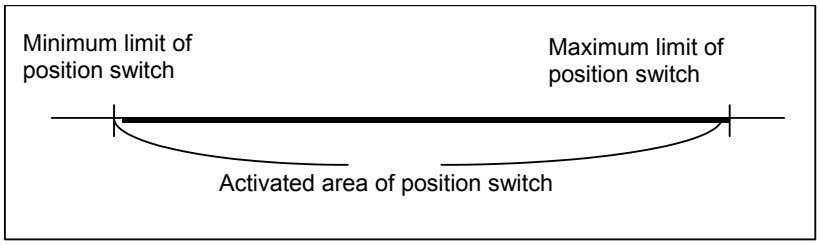


Fig.6.5(b) Measuring area of position switch in case state of switch is “1”

The position switch is checked at every sampling period. When the minimum and maximum limit of position switch are given like above figure, activated area is checked by the area shown in the figure 6.5(a) considering hysteresis if the state of position switch measured at last time is “0”. And activated area is checked by the area shown in the figure 6.5(b) not considering hysteresis if the state of position switch measured at last time is “1”. According to this, it is possible to suppress frequent changing of position switch.

13821	**Safety limit speed 1 in position control for each axis**
13822	**Safety limit speed 2 in position control for each axis**
13823	**Safety limit speed 3 in position control for each axis**
13824	**Safety limit speed 4 in position control for each axis**

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Real axis
[Unit of data] mm/min, inch/min, degree/min (machine unit)
[Minimum unit of data] Depend on the increment system of the applied axis

[Valid data range] Refer to the standard parameter setting table (C)
(When the increment system is IS-B, 0.0 to +240000.0)
Set a safety speed for each axis in position control.
CNC and Servo always check the velocity command of each axis in Dual Check Safety function. If the speed is exceeded the safety limit even on one axis, Monitoring Result signal (RSVx) corresponding to that axis is set to "0". Moreover if Safety Check request signal (*VLDVx) is set to "0", an alarm SV0476 or SV0494 is generated for the corresponding axis.
A safety speed parameter for each axis in feed control is from No.13826 to No.13829.
Up to 4 safety speed can be specified. Safety speed is selected by Safety Speed / Safety Position Selection signal (SVAx/SVBx). As for the detail of Safety Speed / Safety Position Selection signal, refer to the description about Safety Speed / Safety Position Selection signal.

⚠ CAUTION
1 The safety speed checks are made on the basis of the speed converted to the detection unit. Accordingly, a calculation error may occur.
2 After safety speed parameters No.13821 to No.13824 have been set, the power must be turned off then back on for the setting to become effective

13825 **Speed regarded as axis stop for Dual Check Safety**

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Real axis
[Unit of data] mm/min, inch/min, degree/min (machine unit)
[Minimum unit of data] Depend on the increment system of the applied axis
[Valid data range] 0 to 10000
This parameter sets the speed regarded as axis stop in case that an abnormal condition is found in safety speed check or safety machine position check of Dual Check Safety function.

When an abnormal condition is found in safety speed check or safety machine position check, a servo alarm occurs. And whether MCC off signal (*MCFVx) is turned off or not is decided by judging if an axis is stopped after the decided time elapse. At that time, this parameter gives the speed to judge axis stop.
In case an abnormal condition is detected and an axis is stopped within the given time, an MCC is not turned off. Then the system can be recovered by reset operation without power-off.

NOTE
In case of velocity control, set the value calculated by the following formula to this parameter when R(min^{-1}) is the velocity, at which the axis is regarded as stopped.

Setting value = R * PLS * Minimum data unit (Machine unit) * N / CMR

PLS: Pulse per one revolution of motor (Detection unit)
CMR: Command multiplier
N: In case of diameter specification, N=2.
In other case, N=1.
Minimum data unit: Refer to "STANDARD PARAMETER SETTING TABLE".

13826	Safety limit speed 1 in velocity control for each axis
13827	Safety limit speed 2 in velocity control for each axis
13828	Safety limit speed 3 in velocity control for each axis
13829	Safety limit speed 4 in velocity control for each axis

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] 2-word axis
[Unit of data] min^{-1}
[Valid data range] 0 to maximum motor speed
This parameter sets the safety speed 1 to 4 for each axis in velocity control mode in Dual Check Safety function.

13831	Safety machine position 1 for each axis (+ direction)
13832	Safety machine position 1 for each axis (- direction)
13833	Safety machine position 2 for each axis (+ direction)
13834	Safety machine position 2 for each axis (- direction)
13835	Safety machine position 3 for each axis (+ direction)
13836	Safety machine position 3 for each axis (- direction)

13837	Safety machine position 4 for each axis (+ direction)

13838	Safety machine position 4 for each axis (- direction)

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Real axis
[Unit of data] mm, inch, degree (machine unit)
[Minimum unit of data] Depend on the increment system of the applied axis
[Valid data range] 9 digits of minimum unit of data (Refer to standard parameter setting table(A). But in case that CMR≥1, data range becomes 1/CMR of 9 digits of minimum unit of data.)
(When the increment system is IS-B and CMR=1, -999999.999 to +999999.999)
(When the increment system is IS-B and CMR=2, -499999.999 to +499999.999)

NOTE
Whether to specify this parameter by using a diameter value or radius value depends on whether the corresponding axis is based on diameter specification or radius specification.

Set a safe machine position for each axis.
CNC and Servo always check the machine position on each axis in Dual Check Safety function.
If the machine position is out of the safety machine range even on one axis, Monitoring Result signal (RSVx) corresponding to that axis is set to "0". Moreover if Safety Check request signal (*VLDVx) is set to "0", an alarm SV0477 or SV0495 is generated for the corresponding axis.
Up to 4 safety machine position can be specified. Safety machine position is selected by Safety Speed / Safety Position Selection signal (SVAx/SVBx). As for the detail of Safety Speed / Safety Position Selection signal, refer to the description about Safety Speed / Safety Position Selection signal.

⚠ CAUTION
The safety machine position checks are made on the basis of the machine position to the detection unit. Accordingly, a calculation error may occur.

⚠ WARNING

1 CNC and Servo check the machine position of only each axis whose reference position is established, and not check it of each axis whose reference position is not established.
2 After safety machine position parameters No.13831 to No.13838 have been set, the power must be turned off then back on for the setting to become effective.

13840	Address to which safety position switch 1 to 16 are assigned
13841	Address to which safety position switch 17 to 32 are assigned
13842	Address to which safety position switch 33 to 48 are assigned
13843	Address to which safety position switch 49 to 64 are assigned

NOTE

When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Byte
[Valid data range] 0 to 1, 10 to 11, 20 to 21, ... , 90 to 91

According to this parameter, the address to output 64 points of position switch signals can be assigned for each 16 points. The assigning addresses are F*755 to F*756 (PMC) / F(007+m) to F(008+m) (DCS PMC) and F*757 to F*758 (PMC) / F(009+m) to F(010+m) (DCS PMC) in each path. (*: 0 to 9 [path])

The units of this parameter value specifies which address the signal of each path should be output to, “F*755 to F*756” (PMC) / “F(007+m) to F(008+m)” (DCS PMC) or “F*757 to F*758” (PMC) / “F(009+m) to F(010+m)” (DCS PMC).

Setting value	Assigned address
0	F*755 to F*756(PMC), F(007+m) to F(008+m) (DCS PMC)
1	F*757 to F*758(PMC), F(009+m) to F(010+m) (DCS PMC)

The tens of this parameter value specify which path the signal should be output to.

Setting value	Output path
0	Path 1
1	Path 2
...	
9	Path 10

[Example]

Parameter No.	Setting value	Output address of position switch signal
13870	00	F755-F756 (1st to 16th position switch)(PMC) F008-F008 (1st to 16th position switch)(DCS PMC)
13871	01	F757-F758 (17th to 32nd position switch) (PMC) F009-F010 (17th to 32nd position switch)(DCS PMC)
13872	50	F5755-F5756 (33rd to 48th position switch) (PMC) F107-F108 (33rd to 48th position switch)(DCS PMC)
13873	71	F7757-F7758 (49th to 64th position switch) (PMC) F109-F110 (49tht to 64th position switch)(DCS PMC)

NOTE

1 If all setting values are “0”, the output address is regarded as follows.
Position switch 1 to 16: F755-F756(PMC) / F007-F008(DCS PMC)
Position switch 17 to 32: F757-F758(PMC) / F009-F010(DCS PMC)
Position switch 33 to 48: F1755-F1756(PMC) / F027-F028(DCS PMC)
Position switch 49 to 64: F1757-F1758(PMC) / F029-F030(DCS PMC)

2 Do not assign two or more position switch to the same address.

13880	**Axis corresponding to the 1st safe position switch**
13881	**Axis corresponding to the 2nd safe position switch**
…	
13910	**Axis corresponding to the 31st safe position switch**
13911	**Axis corresponding to the 32nd safe position switch**
10501	**Axis corresponding to the 33rd safe position switch**
10502	**Axis corresponding to the 34th safe position switch**
…	
10531	**Axis corresponding to the 63rd safe position switch**
10532	**Axis corresponding to the 64th safe position switch**

NOTE

When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Byte
[Valid data range] 0 to Number of controlled axes

These parameters specify the control-axes numbers corresponding to the 1st thorough 64th safe position switch functions. A corresponding position switch signal is output to "I/O Link#1 or #2" and "I/O Link#3, #4 or Profibus-DP" when the machine coordinate value of a corresponding axis is within the range that is set using a parameter.

⚠ WARNING

1 Set 0 for those position switch numbers that are not to be used. (The safe position switch signal of that number is not output.)
2 The safe position switch signal for the axis whose parameter No.1904#6 is 1 (Dual Check Safety is disabled) is not output.
3 After safety position switch parameters No.13880 to No.13911, No.10501 to No.10532 have been set, the power must be turned off then back on for the setting to become effective

13920	Maximum operation range of the 1st safe position switch
13921	Maximum operation range of the 2nd safe position switch
:	
13950	Maximum operation range of the 31st safe position switch
13951	Maximum operation range of the 32nd safe position switch
10533	Maximum operation range of the 33rd safe position switch
10534	Maximum operation range of the 34th safe position switch
:	
10563	Maximum operation range of the 63rd safe position switch
10564	Maximum operation range of the 64th safe position switch

NOTE

When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Real
[Unit of data] mm, inch, degree (machine unit)
[Minimum unit of data] Depend on the increment system of the reference axis
[Valid data range] 9 digits of minimum unit of data (Refer to standard parameter setting table(A). But in case that CMR≥1, data range becomes 1/CMR of 9 digits of minimum unit of data.)
(When the increment system is IS-B and CMR=1, -999999.999 to +999999.999)
(When the increment system is IS-B and CMR=2, -499999.999 to +499999.999)

NOTE
Whether to specify this parameter by using a diameter value or radius value depends on whether the corresponding axis is based on diameter specification or radius specification.

These parameters set the maximum operation range of the 1st through 64th safe position switches.

⚠ CAUTION
1 When the machine position is on the boundary of the specified ranges (machine position = parameter setting value), it is considered within the specified ranges.
2 When the setting of operation range is “maximum operation range < minimum operation range”, the safe position switch is not output.
3 If parameter No.13920 to No.13951, No.13533 to No.13564 are changed, please turn the power of the machine off once.

13960	Minimum operation range of the 1st safe position switch
13961	Minimum operation range of the 2nd safe position switch
:	
13990	Minimum operation range of the 31st safe position switch
13991	Minimum operation range of the 32nd safe position switch
10565	Minimum operation range of the 33rd safe position switch
10566	Minimum operation range of the 34th safe position switch
:	
10595	Minimum operation range of the 63rd safe position switch
10596	Minimum operation range of the 64th safe position switch

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] Real
[Unit of data] mm, inch, degree (machine unit)
[Minimum unit of data] Depend on the increment system of the reference axis

[Valid data range] 9 digits of minimum unit of data (Refer to standard parameter setting table(A). But in case that CMR≥1, data range becomes 1/CMR of 9 digits of minimum unit of data.)
(When the increment system is IS-B and CMR=1, -999999.999 to +999999.999)
(When the increment system is IS-B and CMR=2, -499999.999 to +499999.999)

NOTE
Whether to specify this parameter by using a diameter value or radius value depends on whether the corresponding axis is based on diameter specification or radius specification.

These parameters set the minimum operation range of the 1st through 64th safe position switches.

⚠ CAUTION
1 When the machine position is on the boundary of the specified ranges (machine position = parameter setting value), it is considered within the specified ranges.
2 When the setting of operation range is “maximum operation range < minimum operation range”, the safe position switch is not output.
3 If parameter No.13960 to No.13991, No.10565 to No.10596 are changed, please turn the power of the machine off once.

11950	1st byte address of Safety input signal for CNC CPU
11951	2nd byte address of Safety input signal for CNC CPU
:	
11957	8th byte address of Safety input signal for CNC CPU

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] 2-Word
[Valid data range] 0 to 3999999
These parameters set the address of the 1st through 8th double checked input signals of CNC CPU (DCS PMC).

Setting value = TYPE + ADRS
ADRS = Byte address

TYPE	Meaning
0	This signal is not checked.
1000000	X address
2000000	R address
3000000	D address

Ex.) X8 : setting value = 1000008
R8 : setting value = 2000008

11960	1st byte address of Safety output signal for CNC CPU
11961	2nd byte address of Safety output signal for CNC CPU
:	
11967	8th byte address of Safety output signal for CNC CPU

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] 2-word
[Valid data range] 0 to 3999999
These parameters set the address of the 1st through 8th double checked output signals of CNC CPU(DCS PMC).

Setting value = TYPE + ADRS
ADRS = Byte address

TYPE	Meaning
0	This signal is not checked.
1000000	Y address
2000000	R address
3000000	D address

Ex.) Y8 : setting value = 1000008
R8 : setting value = 2000008

11970	1st byte address of Safety input signal for PMC CPU
11971	2nd byte address of Safety input signal for PMC CPU
	:
11977	8th byte address of Safety input signal for PMC CPU

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] 2-word
[Valid data range] 0 to 303999999
These parameters set the address of the 1st through 8th double checked input signals of PMC CPU.

Setting value = TYPE + ADRS
ADRS = Byte address

TYPE	Meaning
0	This signal is not checked
101000000	X address of 1st PMC
102000000	R address of 1st PMC
103000000	D address of 1st PMC
104000000	E address of 1st PMC
201000000	X address of 2nd PMC
202000000	R address of 2nd PMC
203000000	D address of 2nd PMC
204000000	E address of 2nd PMC
301000000	X address of 3rd PMC
302000000	R address of 3rd PMC
303000000	D address of 3rd PMC

Ex.) X8 of 1sr PMC : setting value = 101000008
X8 of 2nd PMC: setting value = 201000008

11980	1st byte address of Safety output signal for PMC CPU
11981	2nd byte address of Safety output signal for PMC CPU
:	
11987	8th byte address of Safety output signal for PMC CPU

NOTE
When this parameter is set, the power must be turned off before operation is continued.

[Input type] Parameter input
[Data type] 2-word
[Valid data range] 0 to 303999999

These parameters set the address of the 1st through 8th double checked output signals of PMC CPU.

Setting value = TYPE + ADRS
ADRS = Byte address

TYPE	Meaning
0	This signal is not checked
101000000	Y address of 1st PMC
102000000	R address of 1st PMC
103000000	D address of 1st PMC
104000000	E address of 1st PMC
201000000	Y address of 2nd PMC
202000000	R address of 2nd PMC
203000000	D address of 2nd PMC
204000000	E address of 2nd PMC
301000000	Y address of 3rd PMC
302000000	R address of 3rd PMC
303000000	D address of 3rd PMC

Ex.) Y8 of 1st PMC: setting value = 101000008
Y8 of 2nd PMC: setting value = 201000008

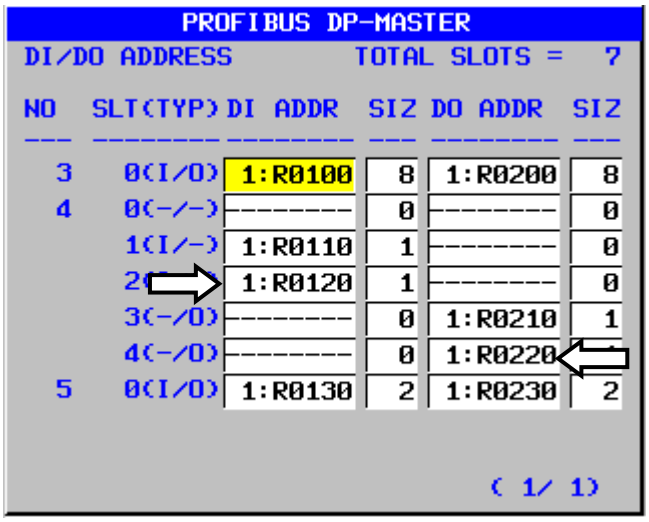
6.6 PROFIBUS-DP parameter settings

PROFIBUS DI/DO signals can be assigned to Dual Check Safety PMC per each slot unit.
To configure PROFIBUS parameters, please refer to "Chapter II.SETTING" of "FANUC PROFIBUS-DP board (for Series 30*i*-MODEL-A) Operator's manual / B-63994EN". The following is the additional information relating to Dual Check Safety function.

Assigning PROFIBUS DI/DO signals to Dual Check Safety PMC

Assigning PROFIBUS DI/DO signals to Dual Check Safety PMC can be set up as follows.

1. Press soft key [DI/DO ADDR] to display the DI/DO ADDRESS screen.
2. Set the DI/DO addresses (DI ADDR and DO ADDR) according to the following format.
   S : <PMC-address>
   For R0500 of Dual Check Safety PMC, for example, "S:R0500" must be entered.
   X and R address is available to DI ADDRess.
   Y and R address is available to DO ADDRess.
   If there is no ":" key in your CNC unit, it is substituted with the "/" or "EOB" key.



Broken wire detection

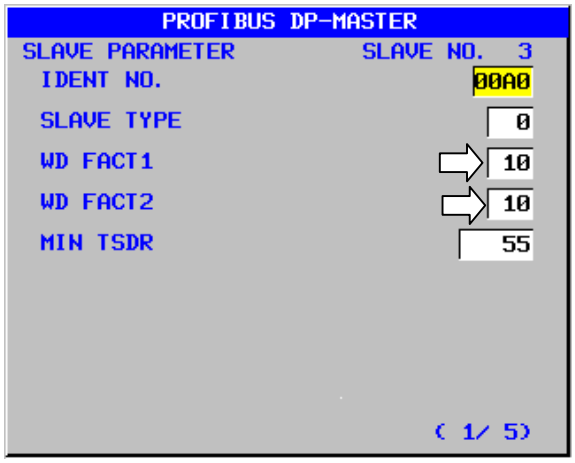
"Broken wire detection" enables slaves to monitor the communication interval, detect the communication error when a slave cannot receive data from the Master, and clear the DO data which is received from Master.
"Broken wire detection" and "Watchdog time" are configured with Slave parameters which are transferred from Master to Slaves during initialization.
When PROFIBUS-DP signal is used for Dual Check Safety, please activate "Broken wire detection".

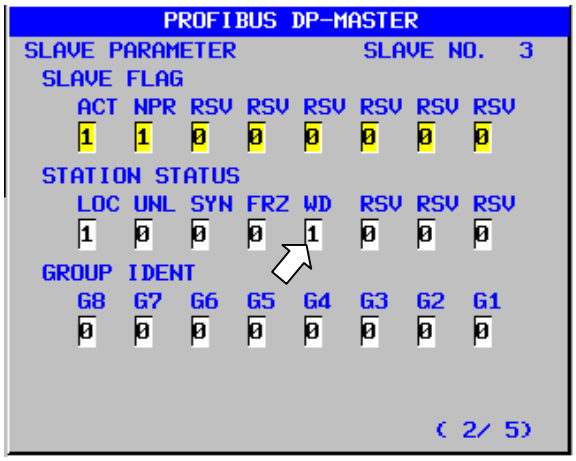
"Watchdog time" should be set to several times longer than the refresh time in consideration of re-transmission. The refresh time can be observed in STATUS INFORMATION screen of PROFIBUS setting screen.

"Broken wire detection" and "Watchdog time" can be configured in PROFIBUS setting screen.
When "1" is set into "WD", "Broken wire detection" becomes active.
"Watchdog time" is calculated with the following expression.

10 x WD_FACT1 x WD_FACT2 (ms)

For example, in the following setting, "Broken wire detection" will activate when a watchdog time of 250ms expires.





7 START-UP

7.1 START-UP OPERATION

The machine tool builder has to do tests for insulation and protective bonding. Testing must be performed according to Chapter 19.2 and 19.3 of the standard IEC 60204-1 by an appropriately authorized person and recorded.

Continuity of the protective bonding circuit

When the machine is installed and the electrical connections are complete, including those to the power supply, the continuity of the protective bonding circuit can be verified by a loop impedance test in accordance with 612.6.3 of IEC 60364-6-61. For further details, please refer to Chapter 19.2 of IEC 60204-1.

Insulation resistance tests

The insulation resistance measured at 500 V d.c. between the power circuit conductors and the protective bonding circuit is to be not less than 1 M Ω. For further details, please refer to Chapter 19.3 of IEC 60204-1.

7.1.1 Acceptance test and report for safety functions

Acceptance test for Safety function

The machine tool builder is to conduct a dual check safety function check test during machine start-up operation.
In this test, limits need to be exceeded to check that the dual check safety function operates normally.

Acceptance report

A qualified person is to check each dual check safety function and record the test results in a check report.

NOTE
When modifying dual check safety function data, conduct an additional check test on the modified dual check safety function and record the test results in a check report.

Safety-related I/O monitoring test

Data cross-check operation is tested with the I/O device connector detached.

MCC off Test check

The test mode signal is used to check that a MCC off Test is conducted.
Negative test:

Conduct a MCC off Test by disconnecting the MCC contact signal (input). Check that an alarm is issued and the MCC remains to be shut off.

Safety limitation speed monitoring test

This test checks that when the actual speed exceeds a speed limit, safety stop state is set by a stop response.

Safety machine position monitoring test

A positional limit test is conducted by making many different movements.
A positional limit is placed at the center of an axis, and the position is moved at many different speeds in a rapid traverse mode. Thus, the distance traveled on the axis until stop state is set by a stop response is measured. The machine tool builder is to determine a safety limit stop position including a safety margin.

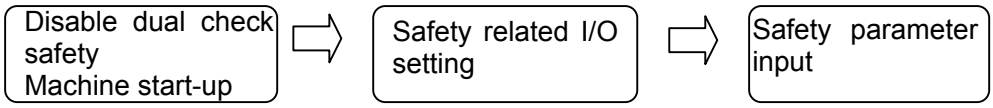
Data modification

The user needs to enter the correct password before setting safety parameters with the system. After a safety parameter is modified, a check test needs to be conducted on the related safety function, and the test results need to be recorded in a report.

7.2 START-UP OF THE SAFETY FUNCTION

7.2.1 Initial start-up

Main flow



Step 1

Initial state

First, check that the machine starts up normally when the dual check safety function is disabled.

Preparation 1	Disable the dual check safety function.	Bit 6 (DCE) of PRM No. 1902 = 0
Preparation 2	Wire to control the MCC	Connect the relay to control MCC with I/O output

NOTE

When the dual check safety function is disabled, the MCC Off signal (*DCALM, *MCFVx, *MCFPs) is set to “1”. （The MCC Off signal (*MCF) is changed according to the emergency stop signal.) So, make a ladder program to output DO signal to control the relay for the MCC control according to the MCC Off signal.

Step 2

DCS PMC side I/O setting

Make the settings as for the I/O Link#3,#4 or Profibus. Make a ladder program for the safe related I/O. (PMC/DCS PMC)

In case Profibus is used, please refer to the sub-section “5.6 Assignment of PROFIBUS DI/DOs to Dual Check Safety PMC”

Step 3

Safety parameter input

Enable the dual check safety function, and enter the safety parameters.

Preparation 1	Enable the dual check safety function.	Bit 6 of PRM No. 1902 = 1

Set the safety parameters indicated in the table below.

Parameter setting	Meaning
980	Machine group number of each path
981	Absolute path number of each axis
982	Absolute path number of each spindle

Parameter setting	Meaning
1023	Servo axis number of each axis
1240	Coordinates value of the reference position in the machine coordinate system
1838	Position deviation limit for each axis in moving state
1839	Position deviation limit for each axis in stopped state
1840	Position deviation limit for each axis in servo-off state
1841	Position deviation limit of each axis in moving state during other than Dual Check Safety monitoring (for Dual Check Safety Function)
1842	Position deviation limit of each axis in stopped state during other than Dual Check Safety monitoring (for Dual Check Safety Function)
1904#6	Enable safety function for each axis
1945	Timer for safety input signal check
1946	Timer for MCC off Test
1948	Timer 2 for MCC off
1950	Break signal timer
3717	Motor number to each spindle
3797#0	Enable safety function for each spindle
4372	Safety speed 1 on each spindle
4438	Safety speed 2 on each spindle
4440	Safety speed 3 on each spindle
4442	Safety speed 4 on each spindle
4448	Speed regarded as spindle stop for Dual Check Safety
13821	Safety speed 1 on each axis
13822	Safety speed 2 on each axis
13823	Safety speed 3 on each axis
13824	Safety speed 4 on each axis
13825	Speed regarded as axis stop for Dual Check Safety
13831	Safety position 1 (+ direction) on each axis
13832	Safety position 1 (- direction) on each axis
13833	Safety position 2 (+ direction) on each axis
13834	Safety position 2 (- direction) on each axis
13835	Safety position 3 (+ direction) on each axis
13836	Safety position 3 (- direction) on each axis
13837	Safety position 4 (+ direction) on each axis
13838	Safety position 4 (- direction) on each axis

Step 4

If alarm SV0478 or SV0496 occurs, set the parameter No.2212#4 is set to “1” and then set to “0”.
Then turn off the CNC and the amplifier. And turn on the CNC and the amplifier.

Step 5

Execution of general machine tests
Axis and spindle optimization
Dual check safety function adjustment (safety limitation speed, safety machine position, Safe position error monitoring)

Step 6

Test for checking the safety function
Check test execution and report creation

Step 7

Parameter preservation

Save all parameters including the safety parameters. The parameters are used to start up the series.

Step 8

Set a password.

A password is used to disable unauthorized persons from modifying safety parameters. Before safety parameters of the equipment for which a password (No. 3225) is set can be modified, the password value must be set as the keyword (No. 3226). Only those persons authorized to conduct a check test should know the password value.

7.2.2 Series start-up

The parameters for the safety monitoring function are transferred together with other parameters to the CNC as in the case of normal series start-up. Perform a safety function check test in addition to the normal start-up procedure.

7.2.3 Troubleshooting

Alarms related to the safety function are output on the ALARM screen.
Correct the cause of trouble according to the chapter describing alarms and messages in this manual. When a component related to the safety function is to be replaced, an authorized person must conduct a safety function check test.

8 ALARM MESSAGE

Alarm

When Dual Check Safety function finds out some abnormal condition in safety check and generates an alarm, the alarm can be reset by reset operation if the abnormal condition is cleared.
However, if the problem related with the system is found and an alarm is generated when unfit condition is found by double check function of signals or so on, alarm cannot be cancelled by a reset. In this case, to cancel the alarms, turn off the power.

- Servo Alarms (SV alarm)

No.	Message	Description
SV0474	EXCESS ERROR (STOP:SV)	The Servo detected that the positional deviation during stopping exceeded the parameter (No. 1839, No.1842) setting value.
SV0475	EXCESS ERROR (MOVE:SV)	The Servo detected that the positional deviation during traveling exceeded the parameter (No. 1838, No.1841) setting value
SV0476	ILLEGAL SPEED CMD. (SV)	The Servo detected that the specified speed on the axis exceeded the safety speed (parameter No. 13821 to 13824, No. 13826 to 13829) during safety monitoring (the safety check request signal (*VLDVx) is 0). When the guard is open, confirm a proper value is set to parameter (No. 13821 to 13824, No. 13826 to 13829), and the operation is done within the safety speed.
SV0477	ILLEGAL MACHINE POS.(SV)	The Servo detected that the machine position on the axis is not in the safety area (parameter No.13831 to 13838) during safety monitoring (the safety check request signal (*VLDVx) is 0). When the guard is open, confirm a proper value is set to parameter No.13831 to 13838 and do an operation in the safety area. The safe machine position monitoring is done after the machine reference position is established.
SV0478	ILLEGAL AXIS DATA (SV)	The Servo detected that an error occurred on the axis during axis data transfer. If the alarm occurs after performing axis number setting for the servo amplifier, set parameter No.2212#4 to 1, and reset the bit to 0, and then turn off the power to the entire system. In the other case, replace the servo amplifier if the alarm occurred.
SV0481	SAFETY PARAM ERROR(SV)	Error detected for safety parameter check function by Servo.
SV0484	SAFETY FUNCTION ERROR (SV)	An error occurred in safety functions of Servo: 1. The Servo or CNC detected the inexecution of servo software safety functions. 2. A mismatch between the servo software results of the safety functions and the CNC results of them occurred. 3. An error occurred in a servo CPU test. 4. An error occurred in a servo RAM test. In case of 1, 3 and 4, replace the axis control card.
SV0488	SELF TEST OVER TIME	MCC off Test was not completed within the specified time (parameter No. 1946). Check the MCC contact.

No.	Message	Description
SV0489	SAFETY PARAM ERROR(CNC)	Error for safety parameter check function is detected on n-th axis by CNC.
SV0490	SAFETY FUNCTION ERROR (CNC)	An error occurred in safety functions of CNC: 1. The Servo detected the inexecution of CNC safety functions. 2. A mismatch between the CNC results of the safety functions and the Servo results of them occurred. Replace the CPU card.
SV0494	ILLEGAL SPEED CMD. (CNC)	The CNC detected that the specified speed exceeded the setting (parameter No. 13821 to 13824 in case of position control, No. 13826 to 13829 in case of velocity control) during safety monitoring (the safety check request signal(*VLDVx) is 0). When the guard is open, confirm a proper value is set to parameter (No. 13821 to 13824, No. 13826 to 13829), and the operation is done within the safety speed.
SV0495	ILLEGAL MACHINE POS.(CNC)	The CNC detected that the machine position is not in the safety area (parameter No.13831 to 13838) during safety monitoring (the safety check request signal(*VLDVx) is 0). When the guard is open, confirm proper values is set to parameter No. No.13831 to 13838, and operation is done in the safety area. The safe machine position monitoring is done for the axis whose machine reference position is established.
SV0496	ILLEGAL AXIS DATA (CNC)	The CNC detected that an error occurred during axis data transfer. If the alarm occurs after performing axis number setting for the servo amplifier, set parameter No.2212#4 to 1, and reset the bit to 0, and then turn off the power to the entire system. In the other case, replace the servo amplifier where the alarm occurred.
SV0498	AXIS NUMBER NOT SET (CNC)	The CNC detected that the axis number is not set with the servo amplifier. Turn off the power to the entire system. Then an axis number is automatically set.
SV1068	DUAL CHECK SAFTY ALARM	The alarm which shut off the MCC(system common) occurred in the dual check safety function.
SV1069	EXCESS ERROR (SERVO OFF: CNC)	The CNC detected that the positional deviation at servo off time exceeded the parameter (No. 1840) setting value.
SV1070	EXCESS ERROR (SERVO OFF:SV DSP)	The Servo detected that the positional deviation at servo off time exceeded the parameter (No. 1840) setting value.
SV1071	EXCESS ERROR (MOVE: CNC)	The CNC detected that the positional deviation during moving exceeded the parameter (No.1838, No.1841) setting value.
SV1072	EXCESS ERROR (STOP:CNC)	The CNC detected that the positional deviation during stopping exceeded the parameter (No.1839, No.1842) setting value.

- Spindle Alarms (SP alarm)

No.	Message	Description
SP0755	SAFETY FUNCTION ERROR	An error occurred in safety functions of the n-th spindle: ・The CNC detected that the safely function of the n-th spindle was not executed. ・A mismatch between the CNC results of the safety functions and the Spindle results of them occurred.
SP0756	ILLEGAL AXIS DATA	The CNC CPU detected that the connection state and the hardware setting of the spindle amplifier were incompatible on the n-th spindle. If an alarm occurs because of the configuration change of the spindle amplifier, set the spindle amplifier correctly.

No.	Message	Description
SP0757	SAFETY SPEED OVER	The CNC CPU detected that during safety monitoring (the safety check request signal(*VLDPs) is 0), the spindle motor speed was greater than the safety speed (parameter No. 4372, 4438, 4440, or 4442) on the n-th spindle. Operate within the safety speed.
SP1700	SAFETY PARAM ERROR	The CNC CPU detected error in safety parameter check function.

- Alarms requiring power to be turned off (PW alarm)

No.	Message	Description
PW0008	CPU SELF TEST ERROR(DCS PMC)	The DCS PMC detected the error in the CPU self test function and RAM check function.
PW0009	CPU SELF TEST ERROR(PMC)	The PMC detected the error in the CPU self test function and RAM check function.
PW0010	SAFE I/O CROSS CHECK ERROR(DCS PMC)	The DCS PMC detected the error of system define safe I/O in the I/O cross check function.
PW0011	SAFE I/O CROSS CHECK ERROR(PMC)	The PMC detected the error of system define safe I/O in the I/O cross check function.
PW0012	USER I/O CROSS CHECK ERROR(DCS PMC)	The DCS PMC detected the error of user define safe I/O in the I/O cross check function.
PW0013	USER I/O CROSS CHECK ERROR(PMC)	The PMC detected the error of user define safe I/O in the I/O cross check function.
PW0014	CPU TEST ALARM (CNC)	An error occurred in a CNC CPU test.
PW0015	SAFETY PARAM ERROR	The CNC detected error for safety parameter check function.
PW0016	RAM CHECK ERROR	The CNC detected error in RAM check function.
PW0017	INEXECUTION OF SAFETY FUNCTIONS	The CNC detected abnormal condition in the execution of CNC safety functions.
PW0018	CRC CHECK ERROR	The CNC detected the CRC check error in the CNC ROM.

- Other alarms (DS alarm)

No.	Message	Description
DS0022	DUAL CHECK SAFETY IS NOT WORKED	Dual Check Safety function is unavailable by setting a parameter No.1902#6 to 0.

- Serial Spindle Alarms

No.	Message	SP indication	Faulty location and remedy	Description
SP9016	SSPA:16 RAM ERROR	16	Replace the SPM unit.	An error occurred in a spindle RAM test. Replace spindle amplifier module.
SP9069	SAFETY SPEED OVER	69	1 Check the safety speed parameter (parameter No.4372/ No.4438/No.4440 /No.4442). 2 Perform operation at a speed not exceeding the safety speed.	The spindle detected that the speed of the spindle motor exceeded the safety speed (parameter No. 4372/No.4438/No.4440 /No.4442) during safety monitoring (the safety check request signal (*VLDPs) is 0).
SP9070	ILLEGAL AXIS DATA	70	1 Check the spindle amplifier connection state and spindle amplifier hardware setting. 2 If this alarm is issued because the spindle amplifier configuration is changed, correct the setting on the spindle amplifier side.	The spindle detected a mismatch between the spindle amplifier connection state and spindle amplifier hardware setting. If this alarm is issued because the spindle amplifier configuration is changed, correct the setting on the spindle amplifier side.
SP9071	SAFETY PARAM ERROR	71	Set the safety parameter again. The following are spindle safety parameters. (No.4372/No.4438 /No.4440/No.4442/No.4448)	The spindle detected a safety parameter error.
SP9072	MISMATCH RESULT OF MOTOR SPEED CHECK	72	Replace the SPM control printed-circuit board.	The spindle detected a mismatch between the CNC result of the motor speed check and the spindle result of it.
SP9074	CPU TEST ERROR	74	Replace the SPM control printed-circuit board.	An error occurred in a spindle amplifier CPU test.
		75	Replace the SPM control printed-circuit board.	An error occurred in a spindle ROM CRC test.
SP9076	INEXECUTION OF SAFETY FUNCTIONS	76	Replace the SPM control printed-circuit board.	Any safety function was not executed.
SP9077	MISSMATCH THE RESULTS OF AXIS NUMBER CHECK	77	Replace the SPM control printed-circuit board.	The spindle detected a mismatch between the CNC result of the axis number check and the spindle result of it.
SP9078	MISSMATCH THE RESULTS OF SAFETY PARAMETER	78	Set the safety parameter again. The following are spindle safety parameters. (No.4372/No.4438 /No.4440/No.4442/No.4448)	The spindle CPU detected a mismatch between the CNC result of the safety parameters check and the spindle result of it.
		79	Replace the SPM control printed-circuit board.	The safety functions at power-up for spindle were not executed.

- Boot System Alarms

Message	Description
CRC CHECK ERROR:NC BASIC.	CRC error occurs in CNC BASIC ROM. Please install CNC BASIC ROM in flash memory again.

- Servo Alarms to turn MCC off Signal (*MCFVx) to “0”

In case that the parameter No.10500#0 (AVM) is set to “0”, the MCC off Signal (*MCFVx) of an alarm axis is turned to “0” immediately when the alarm related to data communication or detector occurs. The following table shows this kind of servo alarm.

Number	Message	Description
SV0301	APC ALARM: COMMUNICATION ERROR	Since the absolute-position detector caused a communication error, the correct machine position could not be obtained. (data transfer error) The absolute-position detector, cable, or servo interface module is thought to be defective.
SV0302	APC ALARM: OVER TIME ERROR	Since the absolute-position detector caused an overtime error, the correct machine position could not be obtained. (data transfer error) The absolute-position detector, cable, or servo interface module is thought to be defective.
SV0303	APC ALARM: FRAMING ERROR	Since the absolute-position detector caused a framing error, the correct machine position could not be obtained. (data transfer error) The absolute-position detector, cable, or servo interface module is thought to be defective.
SV0304	APC ALARM: PARITY ERROR	Since the absolute-position detector caused a parity error, the correct machine position could not be obtained. (data transfer error) The absolute-position detector, cable, or servo interface module is thought to be defective.
SV0305	APC ALARM: PULSE ERROR	Since the absolute-position detector caused a pulse error, the correct machine position could not be obtained. The absolute-position detector or cable is thought to be defective.
SV0306	APC ALARM: OVER FLOW ERROR	Since the amount of positional deviation overflowed, the correct machine position could not be obtained.
SV0307	APC ALARM: MOVEMENT EXCESS ERROR	Since the machine moved excessively, the correct machine position could not be obtained.
SV0360	ABNORMAL CHECKSUM(INT)	The checksum alarm occurred on the built–in Pulsecoder.
SV0361	ABNORMAL PHASE DATA(INT)	The phase data abnormal alarm occurred on the built–in Pulsecoder.
SV0362	ABNORMAL REV. DATA(INT)	The speed count abnormal alarm occurred on the built-in Pulsecoder.
SV0363	ABNORMAL CLOCK(INT)	The clock alarm occurred on the built–in Pulsecoder.
SV0364	SOFT PHASE ALARM(INT)	A digital servo soft detected an abnormality on the built in Pulsecoder.
SV0365	BROKEN LED(INT)	The digital servo software detected abnormal data on the built–in Pulsecoder.
SV0366	PULSE MISS(INT)	A pulse error occurred on the built–in Pulsecoder.
SV0367	COUNT MISS(INT)	A count error occurred on the built–in Pulsecoder.
SV0368	SERIAL DATA ERROR(INT)	The communications data could not be received from the built–in Pulsecoder.
SV0369	DATA TRANS. ERROR(INT)	A CRC error or stop bit error occurred in the communications data from the built–in Pulsecoder.
SV0380	BROKEN LED(EXT)	Separate detector error
SV0381	ABNORMAL PHASE (EXT)	An abnormal alarm in the position data occurred on the separate linear scale.
SV0382	COUNT MISS(EXT)	A count error occurred on the separate detector.
SV0383	PULSE MISS(EXT)	A pulse error occurred on the separate detector.
SV0384	SOFT PHASE ALARM(EXT)	The digital servo software detected abnormal data on the separate detector.
SV0385	SERIAL DATA ERROR(EXT)	The communications data could not be received from the separate detector.
SV0386	DATA TRANS. ERROR(EXT)	A CRC error or stop bit error occurred in the communications data from the standalone detector.

Number	Message	Description
SV0387	ABNORMAL ENCODER(EXT)	An abnormality occurred on a separate detector. For more information, contact the scale manufacturer.
SV0445	SOFT DISCONNECT ALARM	The digital servo software detected a disconnected Pulsecoder.
SV0448	UNMATCHED FEEDBACK ALARM	The sign of the feedback signal from the standalone detector is opposite to that from the feedback signal from the built–on Pulsecoder.
SV0453	SPC SOFT DISCONNECT ALARM	Software disconnection alarm of the α pulse coder. Turn off the power to the CNC, then remove and insert the pulse coder cable. If this alarm is issued again, replace the pulse coder.
SV0460	FSSB DISCONNECT	The FSSB connection was discontinued. Or, the FSSB connection cable was disconnected or broken. The amplifier was turned off. In the amplifier, the low-voltage alarm occurred.
SV0462	SEND CNC DATA FAILED	The correct data could not be received on a slave side because of the FSSB communication error.
SV0463	SEND SLAVE DATA FAILED	The correct data could not be received in the servo software because of the FSSB communication error.
SV0474	EXCESS ERROR(STOP:SV)	The Servo detected that the positional deviation during stopping exceeded the parameter (No. 1839, No.1842) setting value.
SV0475	EXCESS ERROR(MOVE:SV)	The Servo detected that the positional deviation during traveling exceeded the parameter (No. 1838, No.1841) setting value.
SV1067	FSSB:CONFIGURATION ERROR(SOFT)	The FSSB configuration error occurred. (Detected in software). Or, there is a difference in the type of connected amplifier and FSSB setting.
SV5134	FSSB:OPEN READY TIME OUT	In the initialization, the FSSB could not be in an open ready sate. The axis card is thought to be defective.
SV5136	FSSB:NUMBER OF AMP. IS INSUFFICIENT	The number of amplifier identified by the FSSB is insufficient than the number of control axes. Or, the setting of the number of axes or the amplifier connection is in error.
SV5137	FSSB:CONFIGURATION ERROR	An FSSB configuration error occurred. The connecting amplifier type is incompatible with the FSSB setting value.
SV5139	FSSB : ERROR	Servo initialization did not terminate normally. The optical cable may be defective, or there may be an error in connection to the amplifier or another module. Check the optical cable and the connection status.
SV5197	FSSB:OPEN TIME OUT	The initialization of the FSSB was completed, but it could not be opened. Or, the connection between the CNC and the amplifier in is incorrect.
SV5311	FSSB : ILLEGAL CONNECTION	1. This alarm is issued if axes, whose servo axis numbers (parameter No. 1023) are even and odd numbers, are allocated to the amplifiers connected to the FSSBs of different paths. 2. This alarm is issued if an attempt is made to set up for use of the pulse modules connected to the FSSBs of different paths. And the system did not satisfy the requirements for performing HIGH SPEED HRV control.

- Spindle Alarms to turn MCC off Signal (*MCFPs) to “0”

In case that the parameter No.10500#1 (APM) is set to “0”, the MCC off Signal (*MCFPs) of an alarm spindle is turned to “0” immediately when the alarm related to data communication or detector occurs. The following table shows this kind of spindle alarm.

Number	Message	Description
SP1220	NO SPINDLE AMP.	Either the cable connected to a serial spindle amplifier is broken, or the serial spindle amplifier is not connected.
SP1225	CRC ERROR (SERIAL SPINDLE)	A CRC error (communications error) occurred in communications between the CNC and the serial spindle amplifier.
SP1226	FRAMING ERROR (SERIAL SPINDLE)	A framing error occurred in communications between the CNC and the serial spindle amplifier.
SP1227	RECEIVING ERROR (SERIAL SPINDLE)	A receive error occurred in communications between the CNC and the serial spindle amplifier.
SP1228	COMMUNICATION ERROR (SERIAL SPINDLE)	A communications error occurred between the CNC and the serial spindle amplifier.
SP1229	COMMUNICATION ERROR SERIAL SPINDLE AMP.	A communications error occurred between serial spindle amplifiers (motor Nos. 1 and 2, or motor Nos. 3–4).
SP1245	COMMUNICATION DATA ERROR	A communication data error was detected on the CNC.
SP1246	COMMUNICATION DATA ERROR	A communication data error was detected on the CNC.
SP1247	COMMUNICATION DATA ERROR	A communication data error was detected on the CNC.
SP1976	SERIAL SPINDLE COMMUNICATION ERROR	The amplifier No. could not be set to the serial spindle amplifier.
SP1977	SERIAL SPINDLE COMMUNICATION ERROR	An error occurred in the spindle control software.
SP1978	SERIAL SPINDLE COMMUNICATION ERROR	A time–out was detected during communications with the serial spindle amplifier.
SP1979	SERIAL SPINDLE COMMUNICATION ERROR	The communications sequence was no longer correct during communications with the serial spindle amplifier.
SP1980	SERIAL SPINDLE AMP. ERROR	Defective SIC–LSI on serial spindle amplifier
SP1981	SERIAL SPINDLE AMP. ERROR	An error occurred during reading of the data from SIC–LSI on the analog spindle amplifier side.
SP1982	SERIAL SPINDLE AMP. ERROR	An error occurred during reading of the data from SIC–LSI on the serial spindle amplifier side.
SP1983	SERIAL SPINDLE AMP. ERROR	Could not clear on the spindle amplifier side.
SP1987	SERIAL SPINDLE CONTROL ERROR	Defective SIC–LSI on the CNC
SP9073	MOTOR SENSOR DISCONNECTED	The motor sensor feedback signal is not present.
SP9081	1-ROT MOTOR SENSOR ERROR	The one-rotation signal of the motor sensor cannot be correctly detected.
SP9082	NO 1-ROT MOTORSENSOR	The one-rotation signal of the motor sensor is not generated.
SP9083	MOTOR SENSOR SIGNAL ERROR	An irregularity was detected in a motor sensor feedback signal.

Reference of Dual Check Alarm message

Dual Check Alarm by Servo CPU and CNC CPU

No.	Message (Servo)	No.	Message (CNC)
SV0474	EXCESS ERROR(STOP:SV)	SV1072	EXCESS ERROR(STOP:CNC)
SV0475	EXCESS ERROR(MOVE:SV)	SV1071	EXCESS ERROR(MOVE:CNC)
SV0476	ILLEGAL SPEED CMD.(SV)	SV0494	ILLEGAL SPEED CMD.(CNC)
SV0477	ILLEGAL MACHINE POS.(SV)	SV0495	ILLEGAL MACHINE POS.(CNC)
SV0478	ILLEGAL AXIS DATA(SV)	SV0496	ILLEGAL AXIS DATA(CNC)
SV0481	SAFETY PARAM ERROR(SV)	SV0489	SAFETY PARAM ERROR(CNC)
SV0484	SAFETY FUNCTION ERROR(SV)	SV0490	SAFETY FUNCTION ERROR(CNC)
SV1070	EXCESS ERROR(SERVO OFF:SV)	SV1069	EXCESS ERROR(SERVO OFF:CNC)

Dual Check Alarm by Spindle CPU and CNC CPU

No.	Message (Spindle)	No.	Message (CNC)
SP9069 (69)	SAFETY SPEED OVER	SP0757	SAFETY SPEED OVER
SP9070 (70)	ILLEGAL AXIS DATA	SP0756	ILLEGAL AXIS DATA
SP9071 (71)	SAFETY PARAM ERROR	SP1700	SAFETY PARAMETER ERROR
SP9072 (72)	MISMATCH RESULT OF MOTOR SPEED CHECK	SP0755	SAFETY FUNCTION ERROR
SP9076 (76)	INEXECUTION OF SAFETY FUNCTIONS		
SP9077 (77)	MISMATCH RESULT OF AXIS NUMBER CHECK		
SP9078 (78)	MISMATCH RESULT OF SAFETY PARAMETER		

Dual Check Alarm by PMC CPU and CNC CPU (Power must be off)

No.	Message (PMC)	No.	Message (CNC)
PW0008	CPU SELF TEST ERROR(DCS PMC)	PW0009	CPU SELF TEST ERROR(PMC)
PW0010	SAFE I/O CROSS CHECK ERROR(DCS PMC)	PW0011	SAFE I/O CROSS CHECK ERROR(PMC)
PW0012	USER I/O CROSS CHECK ERROR(DCS PMC)	PW0013	USER I/O CROSS CHECK ERROR(PMC)

9 DIAGNOSIS

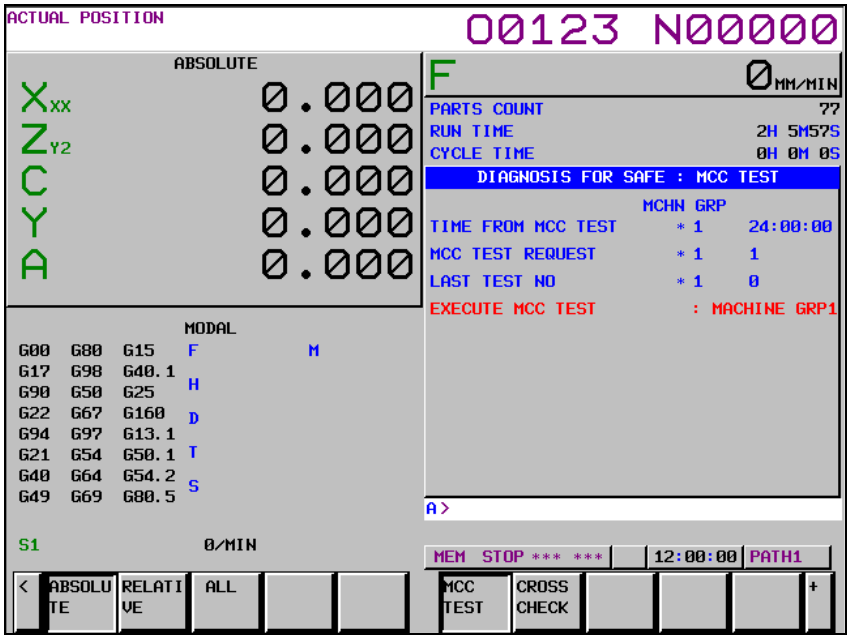
The diagnosis screen for the maintenance operation of the Dual Check Safety function is displayed in the group of [SYSTEM] screens.
The operation to select the Dual Check Safety diagnosis screen is as a follows:

(1) Press the [SYSTEM] key.
(2) Press the continuous menu key [+] key several times then the [DUAL CHECK] soft key is displayed.
(3) Press the [DUAL CHECK] soft key then the Dual Check Safety diagnosis screen is displayed.

The state of MCC OFF TEST, the state of signals in case that the alarm related to safety occurs and the cause of alarm is displayed on the Dual Check Safety diagnosis screen.

9.1 MCC OFF TEST STATUS SCREEN

By pressing [MCC TEST] soft key, the following MCC OFF TEST STATUS screen is displayed.



The following items are displayed for each machine group.

Passing time from the last MCC OFF TEST

Passing time from the last MCC OFF TEST is displayed.
Count of time is stopped when reaching 24:00:00.
24:00:00 is displayed at power-on.

MCC OFF TEST execution request

The CNC system notifies that it is necessary to select MCC OFF TEST mode and check whether MCC off signal (*MCF) works normally or not. When the MCC OFF TEST execution request signal is turned to “1”, select MCC OFF TEST mode and execute MCC OFF TEST as soon as possible.

Last number of test sequence

The current sequence number of MCC OFF TEST is displayed. If MCC OFF TEST is finished normally, “0” is displayed. Refer to the section of “MCC OFF TEST” for further detail.

Message

When the power is turned on or 24 hours passes from the last MCC OFF TEST, this screen is selected and the message “EXECUTE MCC TEST” is displayed.

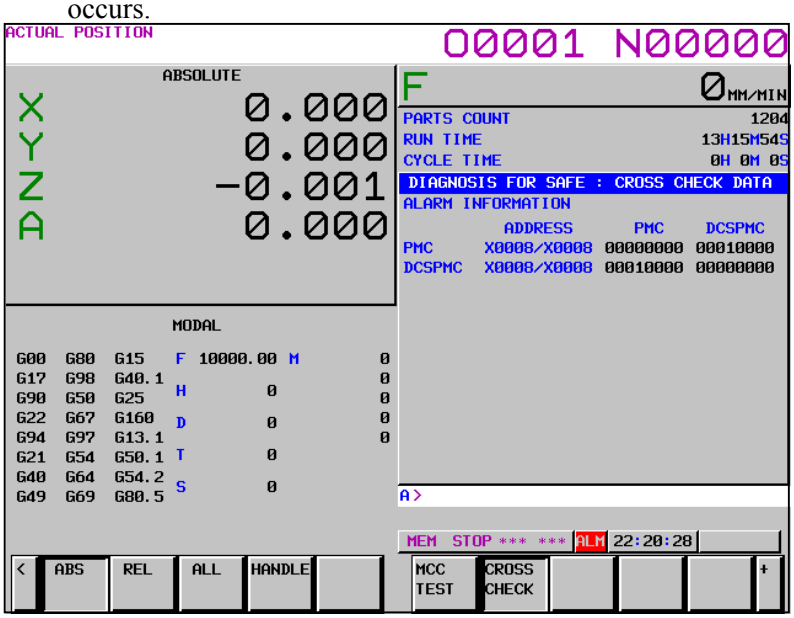
9.2 CROSS CHECK DATA SCREEN

The CROSS CHECK DATA screen displays

(1) [ALARM INFORMATION] SCREEN

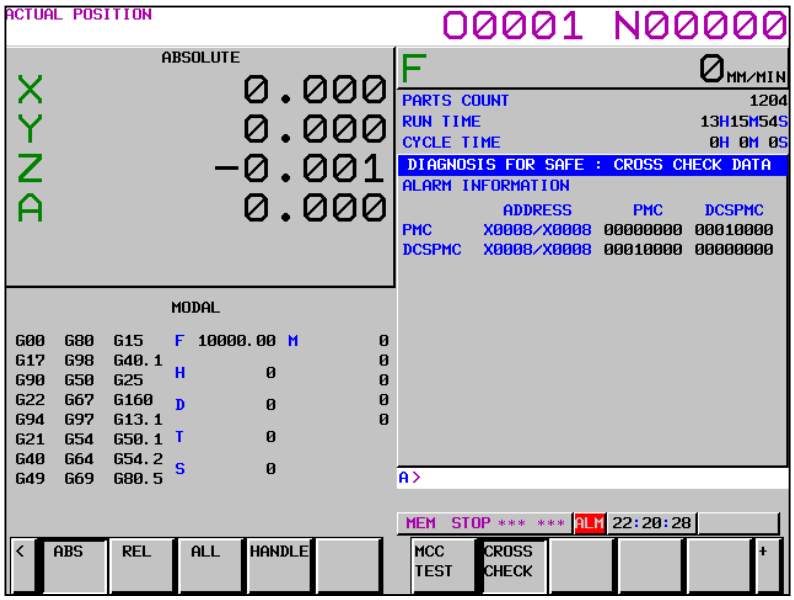
Press the [CROSS CHECK] soft key then the screen shown below appears.

This screen shows the DI/DO status when the cross check alarm occurs.



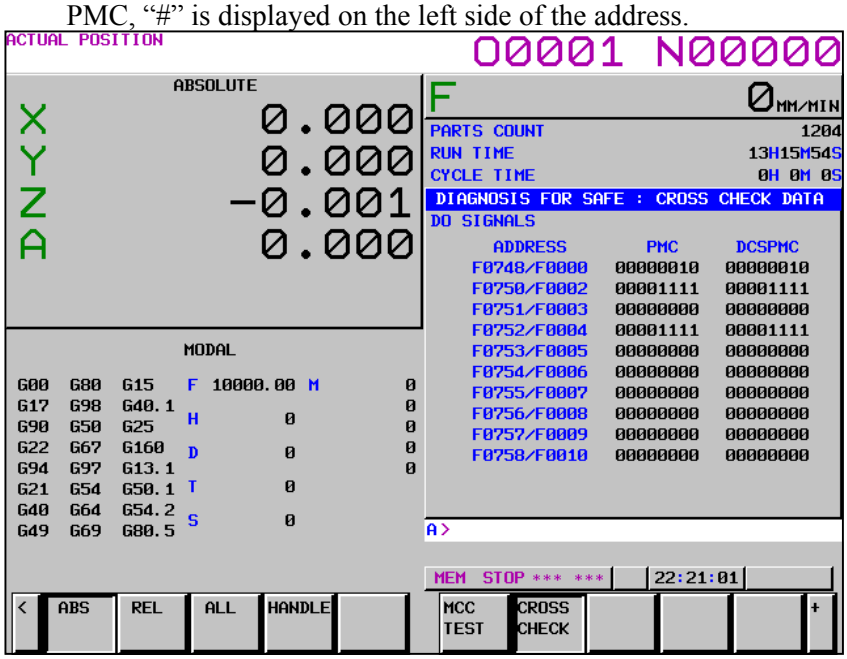
(2) [DI SIGNAL STAUS] SCREEN

Press the [PAGE DOWN] key and select the second page. The screen shown below appears. This screen shows the current DI status. If there is difference of DI state between PMC and DCS PMC, “#” is displayed on the left side of the address.



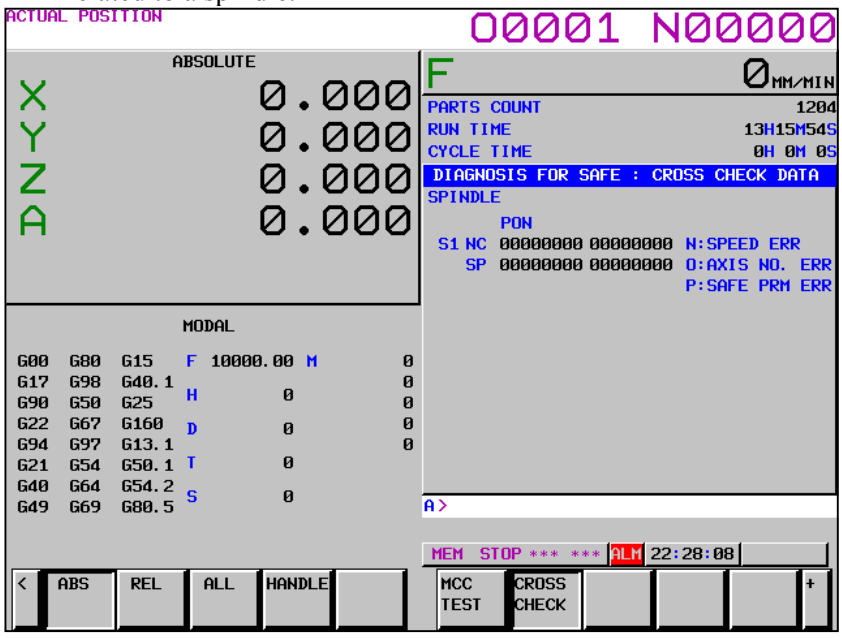
(3) [DO SIGNAL STATUS] SCREEN

Press the [PAGE DOWN] key and select the third page. The screen shown below appears. This screen shows the current DO status. If there is difference of DO state between PMC and DCS PMC, "#" is displayed on the left side of the address.



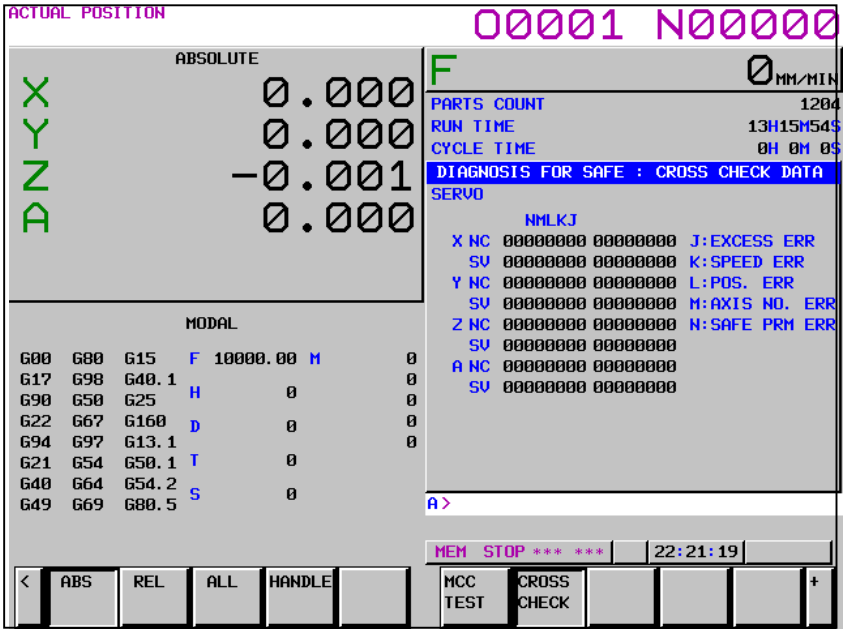
(4) [SPINDLE STATUS] SCREEN

Press the [PAGE DOWN] key and select the fourth screen. The screen shown below appears. When the judging result of safety function of CNC is not the same as other CPU, the cross check alarm occurs. This screen shows the cause of cross check alarm related to a spindle.



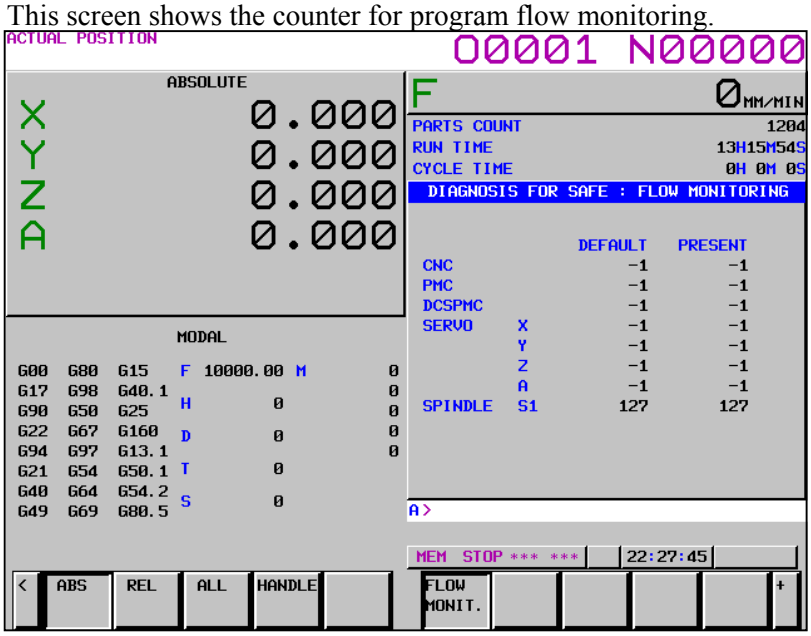
(5) [SERVO STATUS] SCREEN

Press the [PAGE DOWN] key and select the fifth page. The screen shown below appears. When the judging result of safety function of CNC is not the same as other CPU, the cross check alarm occurs. This screen shows the cause of cross check alarm related to a servo motor.



9.3 FLOW MONITORING SCREEN

The FLOW MONITORING screen displays
Press the [+] continuous menu soft key.
And press the [FLOW MONIT.] soft key. The screen shown below appears.
This screen shows the counter for program flow monitoring.



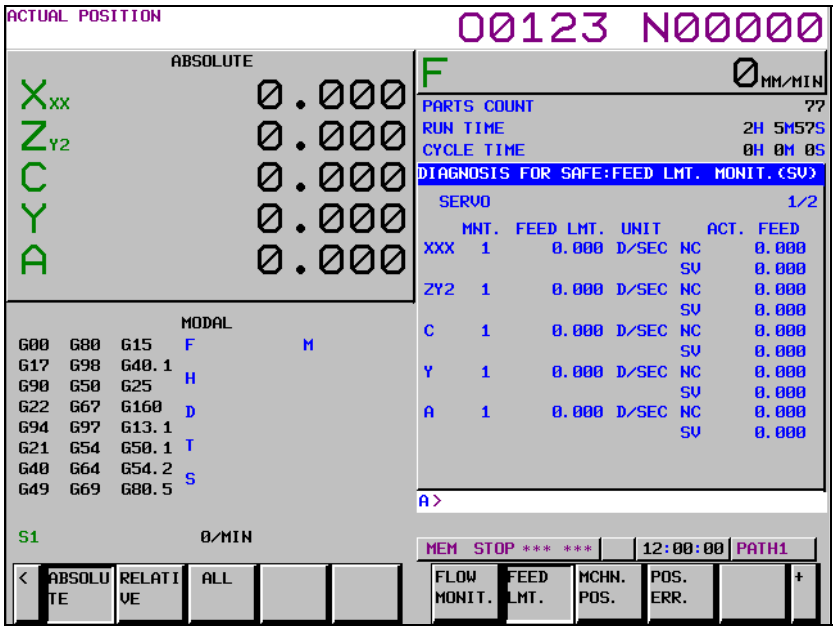
If each safety function works normally, the present value shows the same value as the default.

9.4 FEED LIMIT MONITORING SCREEN

(1) SERVO

The data that are related to the safety limitation feed of the servo and the Dual Check Safety function are displayed.

Press the [FEED LMT.] soft key. The screen shown below appears.



The following items (a) to (d) are displayed for every servo axis.

(a) MNT. 0:Not Monitoring / 1:Monitoring

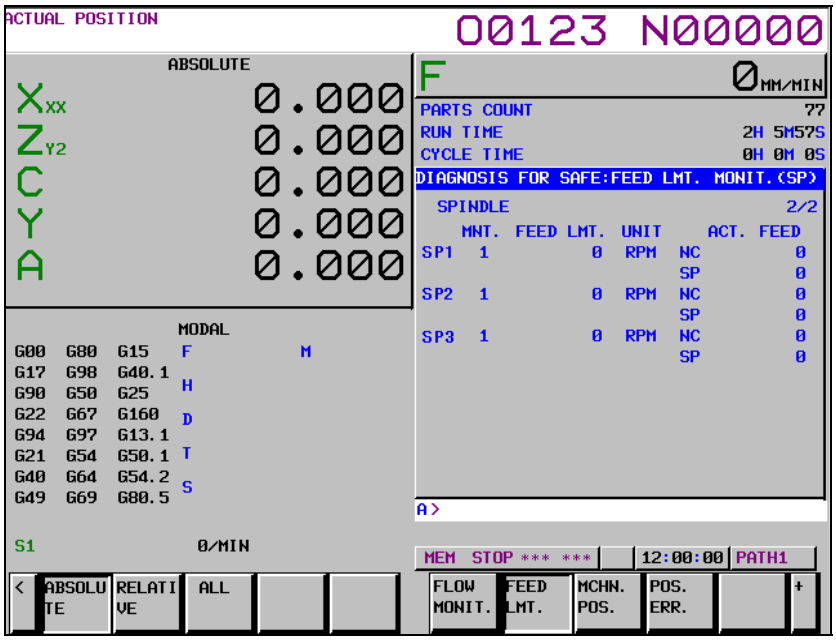
(b) FEED LMT. In the safety limitation feed 1 to 4 (Set by the parameter No.13821 to No.13829), the safety limit feed that is selected by the Safety speed/Safety Position Selection signal A,B(SVAx,SVBx) is displayed

(c) UNIT Unit of feed (Position control:D/sec Velocity control:min^{-1})

(d) ACT. FEED Current actual feed rate（NC side and Servo side）

(2) SPINDLE

The data that are related to the safety limitation feed of the spindle and the Dual Check Safety function are displayed.
Press the [PAGE DOWN] key, the screen of the Safety limitation feed of the spindle shown below appears.



The following items (a) to (d) are displayed for every spindle axis.

(a) MNT. 0:Not Monitoring / 1:Monitoring

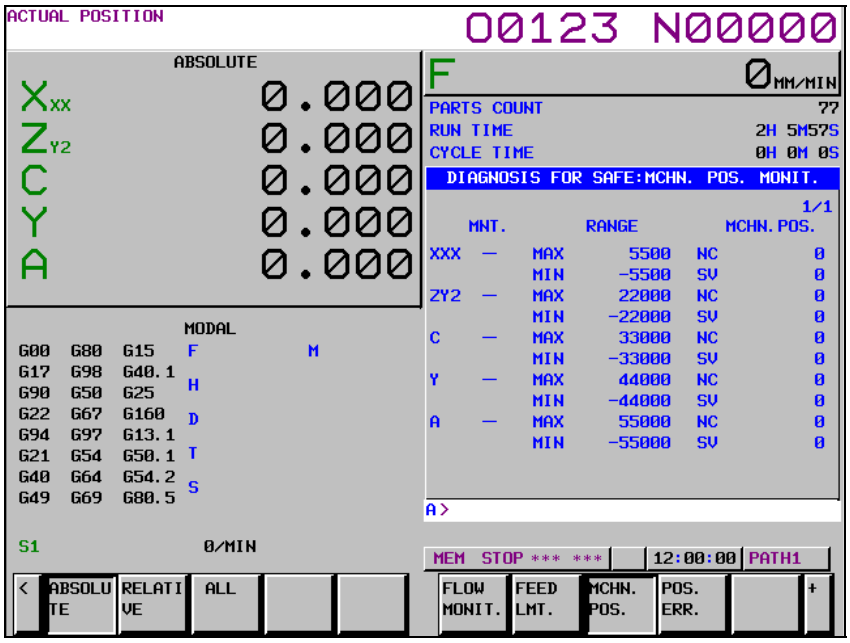
(b) FEED LMT. In the Safety feed limit 1 to 4 (Set by the parameter No.4372, 4442 to 4444), the safety limit feed that is selected by the Safety speed/Safety Position Selection signal A,B (SPAx, SPBx) is displayed

(c) UNIT Unit of the feed (min^{-1})

(d) ACT. FEED Current actual feed rate（NC side and Spindle side)

9.5 SAFE MACHINE POSITIONING MONITORING SCREEN

The data that are related to the safe machine positioning monitoring of the Dual Check Safety function are displayed.
Press the [MCHN. POS.] soft key, The screen shown below appears.



The following items (a) to (c) are displayed for every servo axis.

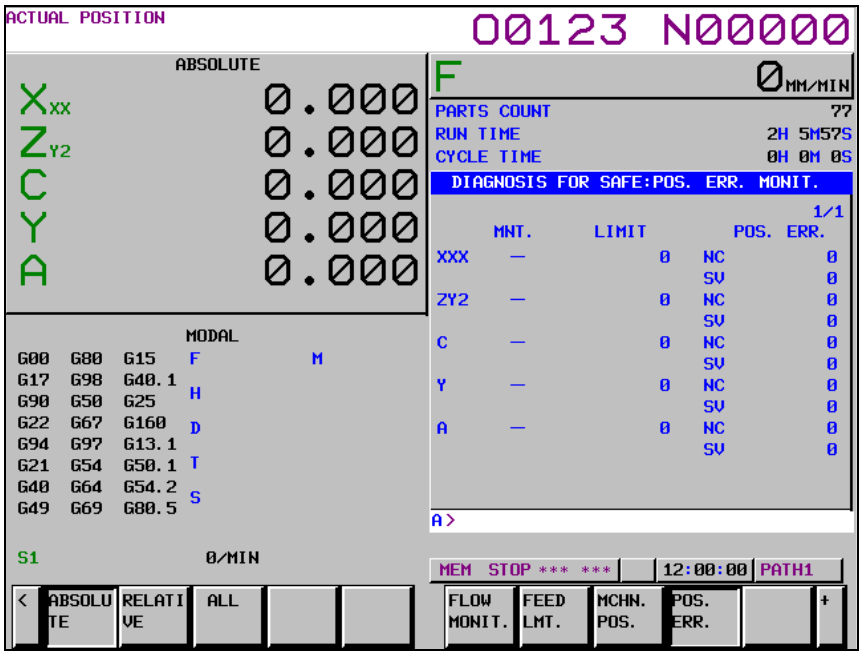
(a) MNT. 0:Not Monitoring / 1:Monitoring/-: The reference position is not established

(b) RANGE In the safety machine position 1 to 4 (Set by the parameter No.13830 to 13838), the upper limit value and lower limit value of the safety machine position that are selected by the Safety speed/Safety Position Selection signal A,B (SVAx, SVBx) are displayed

(c) MCHN. POS. Current machine position (NC side and Spindle side)

9.6 SAFETY POSITION ERROR MONITORING SCREEN

The data that are related to the safety position error monitoring of the Dual Check Safety function are displayed.
Press the [POS. ERR.] soft key, The screen shown below appears.



The following items (a) to (c) are displayed for every servo axis.

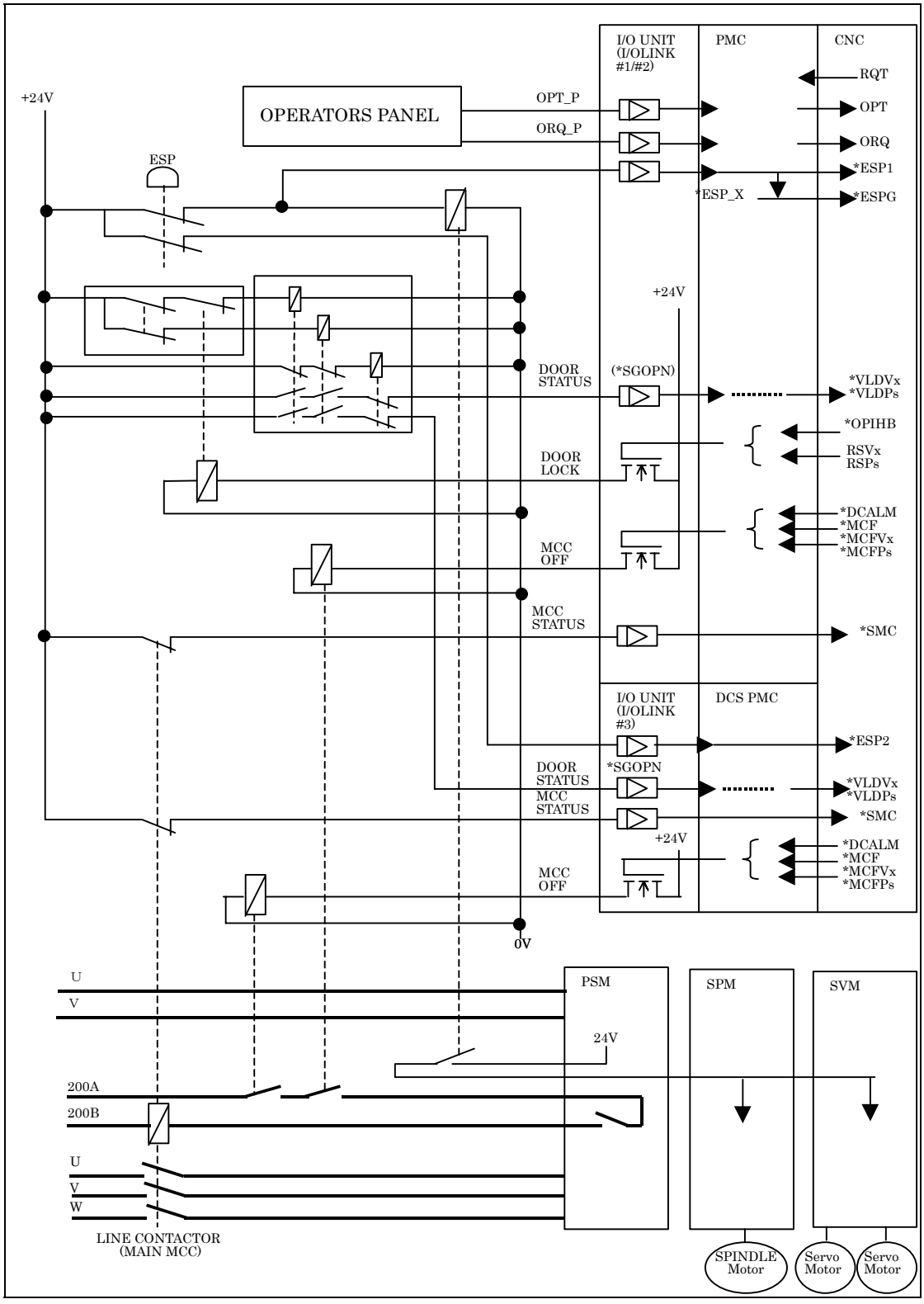
(a) MNT. 0:Not Monitoring / 1:Monitoring/-: The reference position is not established

(b) LIMIT In the safety positioning error, the limit values corresponding to the current state (Stopping/Moving/Servo off) are displayed

(c) POS. ERR. Current positioning error (NC side and Servo side)

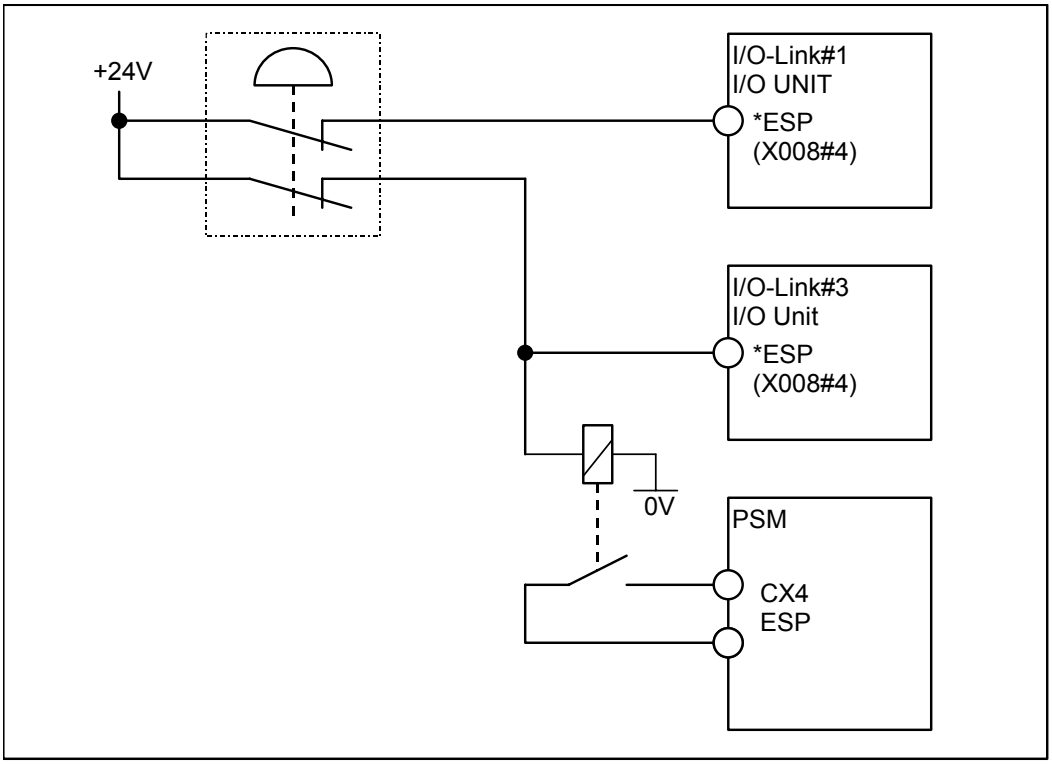
10 SAMPLE SYSTEM CONFIGURATION

10.1 SAMPLE CONFIGURATION



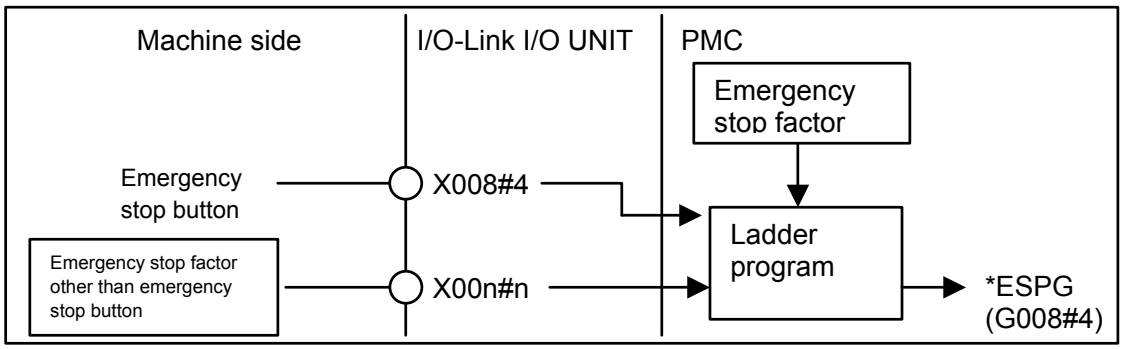
10.2 SAMPLE CONNECTIONS

10.2.1 Emergency Stop Signal (*ESP)



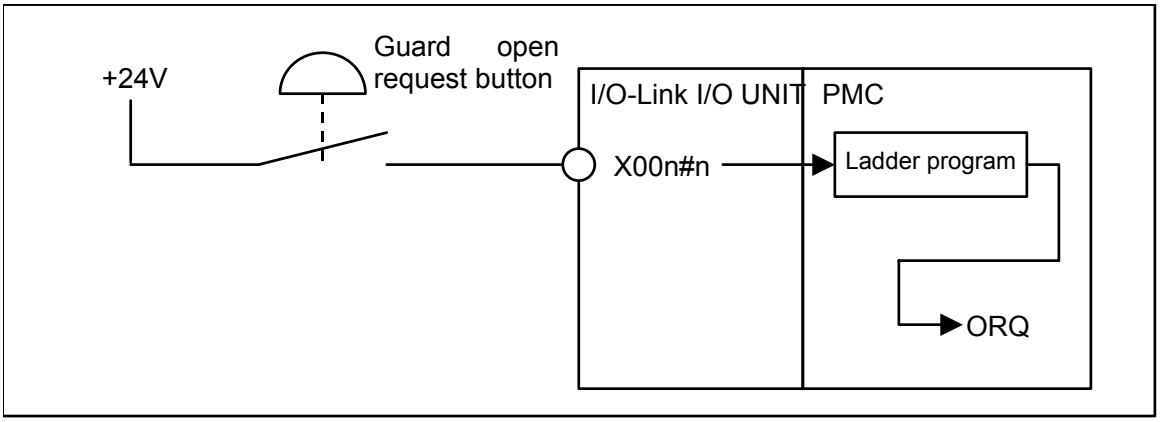
NOTE

Use a two-contact emergency stop button with a forced dissociation mechanism.
Connect the emergency stop button to the PSM, as illustrated in the figure. When the signal is input, the spindle slows down and stops.
Input a power-down factor to [G008#4] other than the signal from the emergency stop button. Create a Ladder program so that [X008#4] becomes a factor of [G008#4].



IMPORTANT
Emergency stop button must fulfill the Standard IEC60947-5-1.This is mandatory.

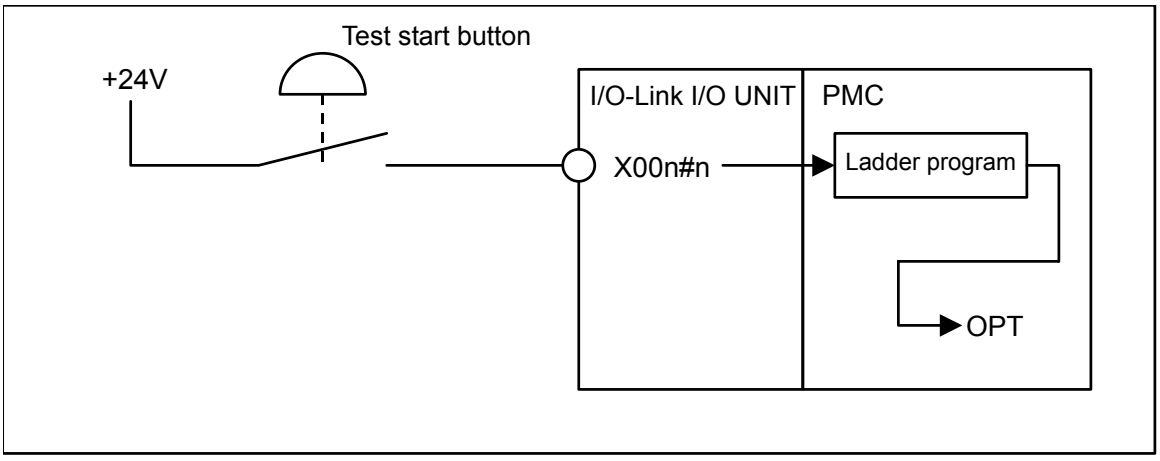
10.2.2 Guard Open Request Signal (ORQ)



NOTE

Create a Ladder program of conditions for making a guard open request and then input the program to the PMC side.
When the guard open request signal (ORQ) is input, CNC will output the *OPNIHB signal. After the ladder program confirms the safety status, the signal for the guard unlock enable signal should be outputted by the ladder program. Also, the ladder program should inform the status of guard open by the *VLDVx and *VLDPs signals.
If the input of ORQ is canceled while the guard is open, the ladder program should enter a safely stopped status (state in which the guard is open although the guard open request signal is not input). Close the guard (*VLDVx and *VLDPs are set to 1), then cancel this signal.

10.2.3 Test Mode Signal (OPT)

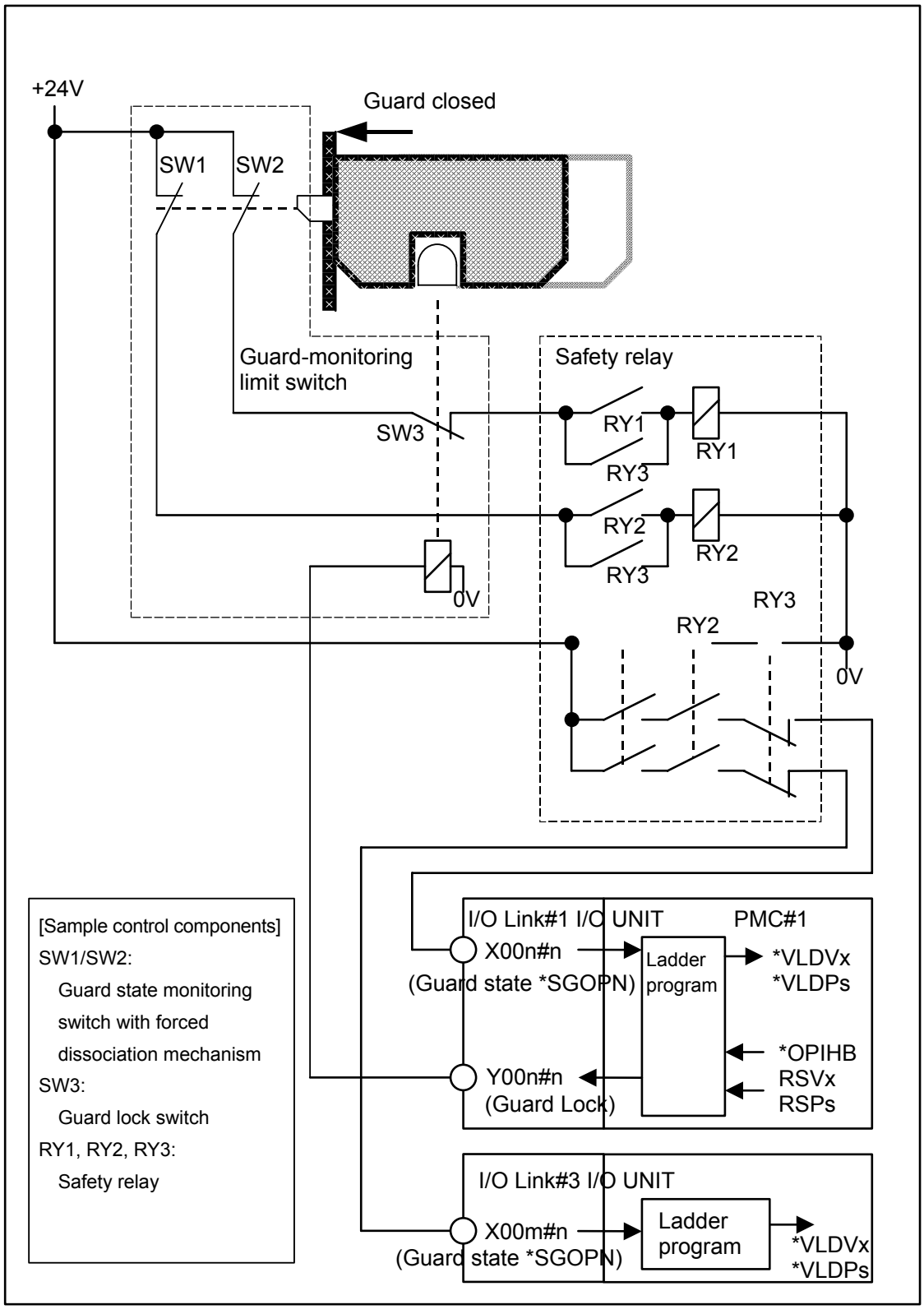


NOTE

When all the conditions for the MCC off test become ready, this signal (OPT) should be set to “1”.

10.2.4 Guard Open Inhibit Signal (*OPIHB), Monitoring Result Signal (RSVx,RSPx), Safety check Request Signal (*VLDVx,*VLDPs)

PERATING PRINCIPLE



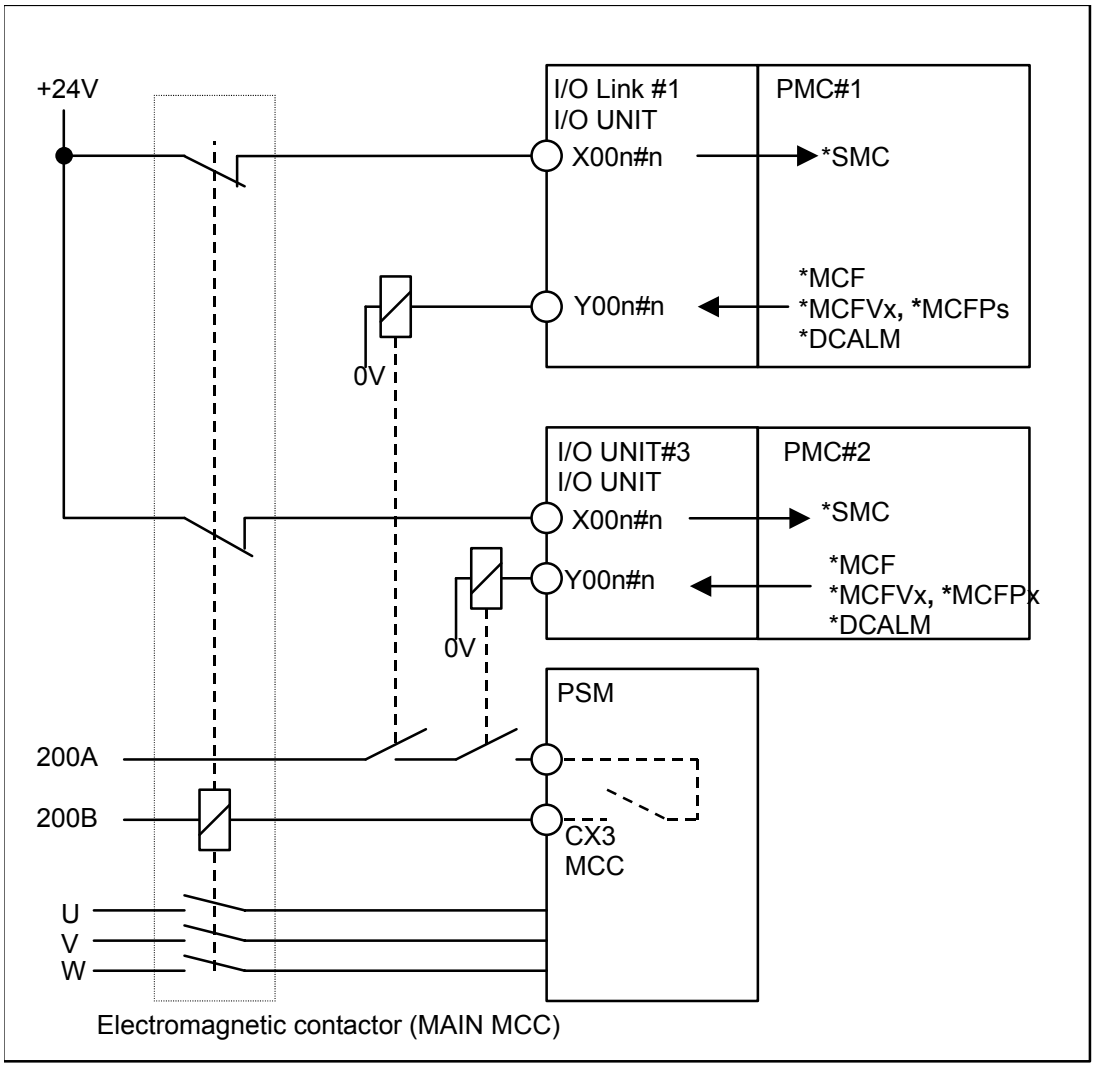
This section describes the operation of various guard monitoring limit switches with lock mechanism and safety relays.
State transition of components

		SW1	SW2	SW3	RY1	RY2	RY3	*SGOPN (*VLDVx, *VLDPs)
1	Guard closed Guard locked	CLOSE	CLOSE	CLOSE	ON	ON	OFF	1
2	Guard closed Guard unlocked	CLOSE	CLOSE	OPEN	OFF	ON	OFF	0
3	Guard opened Guard unlocked	OPEN	OPEN	OPEN	OFF	OFF	ON	0
4	Guard opened Guard locked	OPEN	OPEN	CLOSE	OFF	OFF	ON	0
1	Guard closed Guard locked	CLOSE	CLOSE	CLOSE	ON	ON	OFF	1

In a normal operation, the transition of 1, 2, 3, 4,1, 2, and so on is repeated.
RY3 detects whether RY1 and RY2 contacts are made. If an unusual event is detected, *SGOPN input is turned off.

NOTE
The guard state is monitored, and the guard state signal (*VLDVx,*VLDPs) affects the dual check safety function.
The illustrated sample system determines that the guard is open (sets *VLDVx and *VLDPs to 0) when the guard is unlocked.
When the guard open request signal (ORQ) is accepted, CNC will negate the guard open inhibit signal (*OPIHB).
Machine tool builder can create the signal to release the guard-lock by his ladder program, when the following conditions are met.
*OPIHB=1, RSVx and RSPs to be refered=1 and the safety conditions of the machine

10.2.5 MCC Off Signal (*MCF,*MCFVx,*MCFPs,*DCALM), MCC Contact State Signal (*SMC)



NOTE

Only in case that all the signals (*MCF, *MCFVx, *MCFPx, *DCALM) of the PMC side are “1”, the signal which turns on the MCC should be asserted by the ladder program. Also in the DCS PMC side, similar logic should be made.
Also connect the MCC control signal to PSM, as illustrated in the figure. If an error occurs in the PSM, the PSM turns off the MCC.
Any equipment should not be connected on the 3- phase AC line between the MAIN MCC and PSM.

⚠ **CAUTION**

The MCC shall have forced guided contacts , and must fulfill the standard IEC60204 and IEC 60255. This is mandatory.

11 COMPONENTS LIST

11.1 HARDWARE COMPONENTS

11.1.1 Hardware Components for Series 30*i*/300*i*/300*i*s-MODEL A

CNC Control unit

No.	Description	Specification Number	Remarks
1	Main board	A20B-8100-0980	
2	CPU card	A20B-3300-0471 A20B-3300-0470 A20B-3300-0473 A20B-3300-0474 A20B-3300-0477	
3	Axes control card	A20B-3300-0440 A20B-3300-0442 A20B-3300-0445 A20B-3300-0447 A20B-3300-0448	
4	PMC module	A20B-3900-0200	
5	FROM/SRAM module	A20B-3900-0160 A20B-3900-0161 A20B-3900-0163 A20B-3900-0164	
		A20B-3900-0183 A20B-3900-0180 A20B-3900-0181 A20B-3900-0182	
6	Power supply unit	A20B-8101-0010	
7	Back Panel	A20B-2003-0610	
8	Back Panel	A20B-2003-0600	

11.1.2 Hardware Components for Other Units

Other unit for CNC

No.	Description	Specification Number	Remarks
1	Separate detector I/F unit (Basic 4 axes)	A02B-0303-C205	
2	Separate detector I/F unit (Additional 4 axes)	A02B-0236-C204	
3	I/O module for operator's panel	A20B-2002-0470	
4	I/O module for operator's panel	A20B-2002-0520 A20B-2002-0521	
5	I/O module for connector panel (Basic module)	A03B-0815-C001	
6	I/O module for connector panel (Extension module)	A03B-0815-C002 A03B-0815-C003	
7	2A DO output module	A03B-0815-C004	
8	Analog input module	A03B-0815-C005	
9	Machine operator's panel main panel	A02B-0303-C231	
10	I/O card	A16B-2202-0730 A16B-2202-0731	
11	Control PCB for Machine operator's panel	A20B-8002-0020	
12	10 slots base Horizontal ABU10A	A20B-9001-0040 A03B-0819-C001	

No.	Description	Specification Number	Remarks
13	5 slots base Horizontal ABU05A	A20B-9001-0020 A03B-0819-C002	
14	10 slots base Vertical ABU10B	A20B-2000-0510 A03B-0819-C003	
15	5 slots base Vertical ABU05B	A20B-2003-0100 A03B-0819-C004	
16	Interface AIF01A	A20B-8000-0410 A03B-0819-C011	
17	Interface AIF01B	A20B-8000-0420 A03B-0819-C012	
18	DC digital input AID32A1	A20B-9000-0970 A03B-0819-C101	
19	DC digital input AID32B1	A20B-9000-0971 A03B-0819-C102	
20	DC Digital input AID16D	A20B-8002-0370 A03B-0819-C104	
21	DC Digital input AID16L	A20B-8002-0371 A03B-0819-C114	
22	DC digital input AID32E1	A20B-8002-0150 A03B-0819-C105	
23	DC digital input AID32F1	A20B-8002-0151 A03B-0819-C106	
24	AC digital input AIA16G	A20B-8000-0341 A03B-0819-C107	
25	DC digital input AID32F2	A20B-8002-0161 A03B-0819-C109	
26	DC digital input AID32E2	A20B-8002-0160 A03B-0819-C110	
27	DC digital input AID32H1	A20B-9000-0972 A03B-0819-C111	
28	DC digital input AID16G	A20B-8000-0342 A03B-0819-C115	
29	DC digital output AOD08D	A20B-9001-0220 A03B-0819-C152	
30	DC digital output AOD16D	A20B-9000-0921 A03B-0819-C154	
31	DC digital output AOD32D1	A20B-8000-0440 A03B-0819-C156	
32	AC digital output AOA05E	A20B-8000-0470 A03B-0819-C157	
33	AC digital output AOA08E	A20B-8000-0480 A03B-0819-C158	
34	AC digital output AOA12F	A20B-8000-0321 A03B-0819-C159	
35	Relay output AOR08G	A20B-9001-0200 A03B-0819-C160	
36	Relay output AOR16G	A20B-8000-0101 A03B-0819-C161	
37	Relay output AOR16H2	A20B-8000-0500 A03B-0819-C165	
38	DC digital output AOD32D2	A20B-8000-0510 A03B-0819-C167	

No.	Description	Specification Number	Remarks
39	DC digital output AOD16D2	A20B-9001-0490 A03B-0807-C171	
40	AC digital output AOA05E	A20B-8000-0471 A03B-0819-C176	
41	AC digital output AOA08E	A20B-8000-0481 A03B-0819-C177	
42	AC digital output AOA12F	A20B-8000-0322 A03B-0819-C178	
43	Relay output AOR08G	A20B-9001-0201 A03B-0819-C179	
44	Relay output AOR16G	A20B-8000-0102 A03B-0819-C180	
45	DC digital output AOD16DP	A20B-8002-0070 A03B-0819-C182	
46	Digital DC output AOD08DP	A20B-8002-0060 A03B-0819-C183	
47	DC digital input/output AIO40A	A20B-9001-0240 A03B-0807-C200	
48	Relay output AOR16G2	A20B-8002-0230 A03B-0819-C184	

11.2 SOFTWARE COMPONENTS

CNC CPU Software

Version	Revision	
FS30*i*	G001 / 23~ G011 / 23~ G021 / 23~	
FS300*i*	G001 / 23~ G011 / 23~ G021 / 23~	
FS300*i*s	G001 / 23~ G011 / 23~ G021 / 23~	

PMC CPU Software

Version	Revision	Remarks
FS30*i*	406N / 13~	
FS300*i*	406N / 13~	
FS300*i*s	406N / 13~	

Servo Software

Version	Revision	Remarks
Servo DSP	90D0/02~	
Servo DSP	90E0/02~	
Servo DSP	90D3/01~	
Servo DSP	90E3/01~	

Spindle Software

Version	Revision	Remarks
Spindle Software	9D70/A4~	

11.3 SERVO AMPLIFIER

SERVO AMPLIFIER α *i* series

Power Supply Module (α*i* series)

Series Name	Model Name	Type Designation	Remarks
α*i* PSM Standard	PSM-5.5*i*	A06B-6110-H006	
	PSM-11*i*	A06B-6110-H011	
	PSM-15*i*	A06B-6110-H015	
	PSM-26*i*	A06B-6110-H026	
	PSM-30*i*	A06B-6110-H030	
	PSM-37*i*	A06B-6110-H037	
	PSM-55*i*	A06B-6110-H055	
α*i* PSMR	PSMR-1*i*	A06B-6115-H001	
	PSMR-3*i*	A06B-6115-H003	
	PSMR-5.5*i*	A06B-6115-H006	

Spindle Amplifier Module (α*i* series)

Series Name	Model Name	Type Designation	Remarks
α*i* SPM Type A	SPM-2.2*i*	A06B-6111-H002#Hxxx	
	SPM-5.5*i*	A06B-6111-H006#Hxxx	
	SPM-11*i*	A06B-6111-H011#Hxxx	
	SPM-15*i*	A06B-6111-H015#Hxxx	
	SPM-22*i*	A06B-6111-H022#Hxxx	
	SPM-26*i*	A06B-6111-H026#Hxxx	
	SPM-30*i*	A06B-6111-H030#Hxxx	
	SPM-37*i*	A06B-6111-H037#Hxxx	
	SPM-45*i*	A06B-6111-H045#Hxxx	
	SPM-55*i*	A06B-6111-H055#Hxxx	
α*i* SPM Type B	SPM-2.2*i*	A06B-6112-H002#Hxxx	
	SPM-5.5*i*	A06B-6112-H006#Hxxx	
	SPM-11*i*	A06B-6112-H011#Hxxx	
	SPM-15*i*	A06B-6112-H015#Hxxx	
	SPM-22*i*	A06B-6112-H022#Hxxx	
	SPM-26*i*	A06B-6112-H026#Hxxx	
	SPM-30*i*	A06B-6112-H030#Hxxx	
	SPM-37*i*	A06B-6112-H037#Hxxx	
	SPM-45*i*	A06B-6112-H045#Hxxx	
	SPM-55*i*	A06B-6112-H055#Hxxx	

Servo Amplifier Module (αi series)

Series Name	Model Name	Type Designation	Remarks
αi SVM1	SVM1-20i	A06B-6117-H103	
	SVM1-20Li	A06B-6117-H153	
	SVM1-40i	A06B-6117-H104	
	SVM1-40Li	A06B-6117-H154	
	SVM1-80i	A06B-6117-H105	
	SVM1-80Li	A06B-6117-H155	
	SVM1-160i	A06B-6117-H106	
	SVM1-160Li	A06B-6114-H156	
αi SVM2	SVM2-4/4i	A06B-6117-H201	
	SVM2-20/20i	A06B-6117-H205	
	SVM2-20/20Li	A06B-6117-H255	
	SVM2-20/40i	A06B-6117-H206	
	SVM2-20/40Li	A06B-6117-H256	
	SVM2-40/40i	A06B-6117-H207	
	SVM2-40/40Li	A06B-6117-H257	
	SVM2-40/80i	A06B-6117-H208	
	SVM2-40/80Li	A06B-6117-H258	
	SVM2-80/80i	A06B-6117-H209	
	SVM2-80/80Li	A06B-6117-H259	
	SVM2-80/160i	A06B-6117-H210	
	SVM2-160/160i	A06B-6117-H211	
αi SVM3	SVM3-4/4/4i	A06B-6117-H301	
	SVM3-20/20/20i	A06B-6117-H303	
	SVM3-20/20/40i	A06B-6114-H304	

Sensor (αi series)

Series Name	Model Name	Type Designation	Remarks
PULSECODER	αA1000i (JN1)	A860-2000-T301 A860-2000-T311 A860-2000-T321	
	αA64i (JN1)	A860-2014-T301	
	βA64B (JN1)	A860-0374-T303	
	βA32B (D-sub)	A860-0374-T101	
	βA32B (cable+AMP)	A860-0374-T001	
	βI64B (JN1)	A860-0379-T303	
	βI32B (D-sub)	A860-0379-T101	
	βI32B (cable+AMP)	A860-0379-T001	
	αI1000*i* (JN1)	A860-2005-T301 A860-2005-T321	
	αA16000*i* (JN1)	A860-2001-T301 A860-2001-T321	
Spindle Sensor	MZ*i*	A860-2110-V001	
	M*i*	A860-2100-V001	
	BZ*i*(L1.2m)	A86L-0050-0024#F	
	BZ*i*(L2.5m)	A86L-0050-0024#G	
	BZ*i*(L3.5m)	A86L-0050-0024#H	
	CZ*i*(L1.2m)	A860-2140-T411	
	CZ*i*(L1.2m)	A860-2140-T511	
	CZ*i*(L1.2m)	A860-2140-T611	

High Resolution Serial Output Circuit

Series Name	Model Name	Type Designation	Remarks
High resolution serial output circuit	512/1ch	A860-0333-T001	
	512/2ch	A860-0333-T002	
	512/1ch	A860-0333-T501	
	2048/1ch	A860-0333-T201	
	2048/2ch	A860-0333-T202	
	2048/1ch	A860-0333-T301	
	2048/2ch	A860-0333-T302	
	2048/1ch	A860-0333-T701	
	2048/1ch	A860-0333-T801	

SERVO AMPLIFIER α HV*i* series

Power Supply Module (αHV*i* series)

Series Name	Model Name	Type Designation	Remarks
α*i* PSM Standard	PSM-11HV*i*	A06B-6120-H011	
	PSM-18HV*i*	A06B-6120-H018	
	PSM-30HV*i*	A06B-6120-H030	
	PSM-45HV*i*	A06B-6120-H045	
	PSM-75HV*i*	A06B-6120-H075	
	PSM-100HV*i*	A06B-6120-H100	

Spindle Amplifier Module (αHV*i* series)

Series Name	Model Name	Type Designation	Remarks
α*i* SPM Type A	SPM-5.5HV*i*	A06B-6121-H006#Hxxx	
	SPM-11HV*i*	A06B-6121-H011#Hxxx	
	SPM-15HV*i*	A06B-6121-H015#Hxxx	
	SPM-30HV*i*	A06B-6121-H030#Hxxx	
	SPM-45HV*i*	A06B-6121-H045#Hxxx	
	SPM-75HV*i*	A06B-6121-H075#Hxxx	
	SPM-100HV*i*	A06B-6121-H100#Hxxx	
α*i* SPM Type B	SPM-5.5HV*i*	A06B-6122-H006#Hxxx	
	SPM-11HV*i*	A06B-6122-H011#Hxxx	
	SPM-15HV*i*	A06B-6122-H015#Hxxx	
	SPM-30HV*i*	A06B-6122-H030#Hxxx	
	SPM-45HV*i*	A06B-6122-H045#Hxxx	
	SPM-75HV*i*	A06B-6122-H075#Hxxx	
	SPM-100HV*i*	A06B-6122-H100#Hxxx	

Servo Amplifier Module (αHV*i* series)

Series Name	Model Name	Type Designation	Remarks
α*i* SVM1	SVM1-10HV*i*	A06B-6127-H102	
	SVM1-10HVL*i*	A06B-6127-H152	
	SVM1-20HV*i*	A06B-6127-H103	
	SVM1-20HVL*i*	A06B-6127-H153	
	SVM1-40HV*i*	A06B-6127-H104	
	SVM1-40HVL*i*	A06B-6127-H154	
	SVM1-80HV*i*	A06B-6127-H105	
	SVM1-80HVL*i*	A06B-6127-H155	
α*i* SVM2	SVM2-10/10HV*i*	A06B-6127-H202	
	SVM2-10/10HVL*i*	A06B-6127-H252	
	SVM2-20/20HV*i*	A06B-6127-H205	
	SVM2-20/20HVL*i*	A06B-6127-H255	
	SVM2-20/40HV*i*	A06B-6127-H206	
	SVM2-20/40HVL*i*	A06B-6127-H256	
	SVM2-40/40HV*i*	A06B-6127-H207	
	SVM2-40/40HVL*i*	A06B-6127-H257	
	SVM2-40/80HV*i*	A06B-6127-H208	
	SVM2-80/80HV*i*	A06B-6127-H209	

SERVO AMPLIFIER βi series

Servo Amplifier Module (βi series)

Series Name	Model Name	Type Designation	Remarks
βi SVM1	SVM1-4i	A06B-6130-H001	
	SVM1-20i	A06B-6130-H002	
	SVM1-40i	A06B-6130-H003	
	SVM1-80i	A06B-6130-H004	

SERVO AMPLIFIER β HVi series

Servo Amplifier Module (βHVi series)

Series Name	Model Name	Type Designation	Remarks
βi SVM1	SVM1-20HVi	A06B-6131-H002	
	SVM1-40HVi	A06B-6131-H003	

APPENDIX

A Directives, Standards and Technical Conditions for 3rd Party Servo / Spindle Motors & Encoders when Applying FANUC / GE Fanuc Dual-check Safety

A.1 GENERAL

Applying 3rd party servo/spindle motors and 3rd party feedback devices with FANUC / GE Fanuc Dual-check Safety Function these 3rd party devices must comply with specific mandatory standards and directives, i. e. regulations regarding
- EMC and LVD
- IP classification
- Electrical safety and environmental testing

Further details regarding standards and directives to comply with are described under chapter 2 “Mandatory Standards and Directives”. Please refer to it.
The components also need to meet the technical requirements as specified in this document.

A.2 MANDATORY STANDARDS AND DIRECTIVES

(1) The standards and directives to be followed in general are listed below.

73/23/EEC	Low voltage directive (LVD)
93/68/EEC	Council directive from 19th February 1973 on the approximation of the laws of the member states relating electrical equipment designed for use in certain voltage limits (relating to electromagnetic compatibility)
89/336/EEC	Electromagnetic compatibility (EMC)
92/31/EEC	Council directive from 3rd May 1989 on the approximation of the laws of the member states
98/37/EEC	Machinery directive
DIN EN 60068	Environmental testing
EN 60204-1:1998	Safety of machinery - electrical equipment of machines
EN 60529:1991	Degrees of protection provided by enclosures (IP code), applicable for encoders (feedback devices)
IEC 60034-1:1999	General requirements for motors, to be considered for spindle/servo motors

(2) The standards and directives the 3rd party spindle/servo motors must comply with are listed below.

IEC 60034-1:1999	Rotating electrical machines - part 1: rating and performance
IEC 60034-5:2000	Rotating electrical machines - part 5: degrees of protection provided by the integral design of rotating electrical machines (IP code) – classification, applicable for motors
IEC 60034-11:1978	Rotating electrical machines - part 11: built-in thermal protection - chapter 1: rules for protection of rotating electrical machines
EN 61000-6-2:1999	Electromagnetic compatibility (EMC) - generic immunity standard Part 2: industrial environment
EN 55011-2:1998	Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment

(3) The standards and directives the linear motors and 3rd party feedback devices must comply with are listed below.

EN 60335-1:1995	Safety of household and similar electrical appliances - part 1: General requirements
EN 61000-6-2:1999	Electromagnetic compatibility (EMC) - generic immunity standard Part 2: industrial environment
EN 55011-2:1998	Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment

(4) The standards and directives the 3rd party feedback devices must comply with are listed below.

EN 50178:1997	Electronic equipment for use in power installations
EN 61000-6-2:1999	Electromagnetic compatibility (EMC) - generic immunity standard Part 2: industrial environment
EN 55011-2:1998	Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment

NOTE
1 All products should be considerd that the electrical safety of the final products can be guaranteed.
2 Degrees of protection provided by enclosures should be guaranteed according mandatory regulations for the machine applications.

A.3 SPINDLES

A.3.1 Spindle Motors – Driven by FANUC / GE Fanuc Spindle Amplifier

- 3-phase AC asynchronous motor, compact type or built-in type
- Input voltage: 200 V AC or 400 V AC
- Winding switching available, e.g. start/delta or 2 different windings like star/star
- Number of pole-pairs: 1, 2, 3 or 4
- Rated current must be equal or less than rated current of Spindle Amplifier.
- Maximum current must be equal or less than maximum current of Spindle Amplifier.
- Applicable maximum speed of spindle motors
  ⇨ maximum speed = 60 / pole-pairs * max output freq.

A.3.2 Spindle Encoder – Speed / Position Feedback Sensor Embedded in Motor

- Signal type: A/B-phase sine-wave for speed feedback
  Z-phase (one-per-rotation) signal for position feedback
- Signal specifications: see Attachment 1

A.4 SERVO

A.4.1 Servo Motors – Driven by FANUC / GE Fanuc Servo Amplifier

- 3-phase AC synchronous motor, compact type
- Input voltage: 200 V AC or 400 V AC
- Number of pole-pairs actually limited to 72
- Applicable maximum speed of servomotors = 60/pole-pairs * f_{max} (f_{max} = 266 Hz)
- Rated current must be equal or less than rated current of servo amplifier
- Maximum current must be equal or less than maximum current of servo amplifier
- Maximum peak current of servo amplifier must be less than demagnetization current of motor.
- Current at dynamic braking must not exceed the maximum DB current.
  Maximum DB current depends on servo amplifier model (DB resistor, relay contacts).
- Regenerated energy at dynamic braking must not exceed the DB resistor capacity.
  DB resistor capacity depends on servo amplifier model.

A.4.2 Servo Encoder – Speed / Position Feedback Sensor Embedded in Motor

A.4.2.1 Encoder with FANUC / GE Fanuc Serial Interface

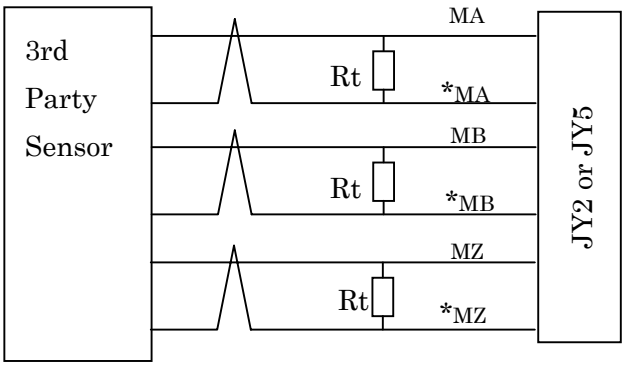
- Signal type: Special FANUC serial interface (e.g.: αA1000S, RCN723F, LC191F)
- Number of pulses per revolution: up to 2^{24} ppr

A.4.2.2 A/B-Phase Sine-wave Interface Connected to FANUC / GE Fanuc Interpolation Circuit

- Signal type:
  sine-wave 1V (peak-to-peak), e.g. Heidenhain ERM 180
- Number of pulses per revolution:
  up to 32768 ppr (32768 * 512 = 2^{24} ppr)
- Signal specification: see Attachment 2
- Maximum input frequency: 200 kHz

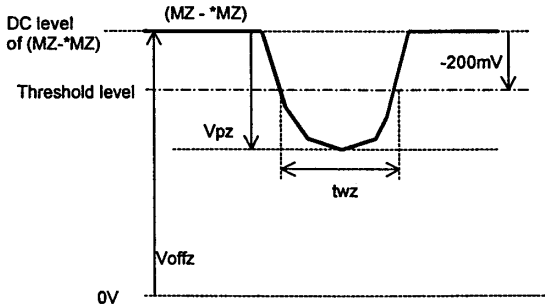
Attachment 1: Specification of 3rd Party Spindle Encoders

The GE Fanuc SPM does not include the *terminating resistor* (like e.g. Siemens).
Depending on the sensor supply voltage and the sensor output impedance, the signal amplitude varies.
In order to match the sensor output signals with the amplifier input requirement, the *terminating resistor* might be necessary. See table on following page for required signal specs.
If the *terminating resistor* is required, place it outside the SPM.

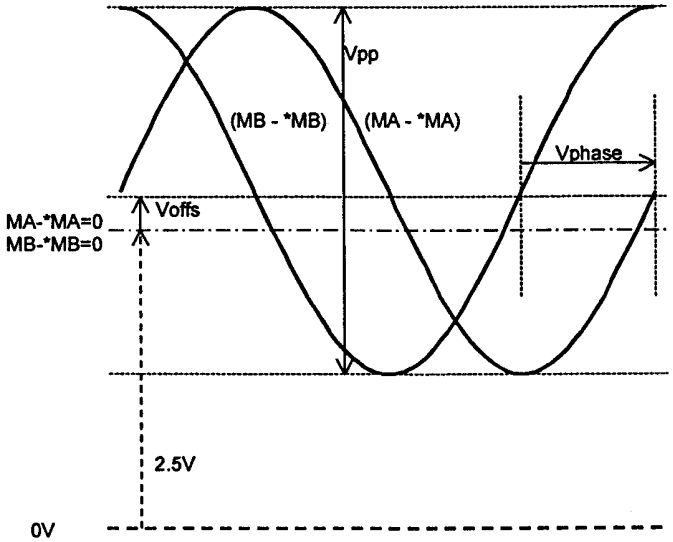


Rt is defined by the specification of the 3rd party sensor

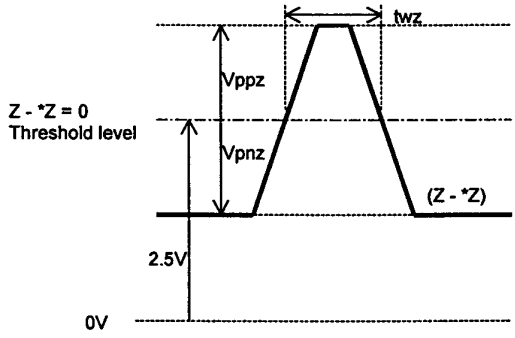
Z-Phase Signal (Type B)



A/B-Phase Signal



(Type A)



A/B-Phase Signals

		Symbol	Check Terminal	Value
1	Maximum Frequency	Fmax	PA1 and PB1 (from JY2) PA2 and PB2 (from JY5)	205 kHz in Spec A 256 kHz in Spec B
2	Signal Amplitude (MA - *MA) (MB - *MB)	Vpp Spec A		0.50 Vpp min 1.2 Vpp max (incl. tolerances)
		Vpp Spec B		0.60 Vpp min 1.2 Vpp max (incl. tolerances)
3	Signal Offset	Voffs		± 100 mV max
4	Signal Amplitude Difference (MA - *MA) / (MB - *MB)	Vppdef		1.00 ± 0.10 V max
5	Phase Offset (MA - *MA) (MB - *MB)	Vphase		90 ± 3 deg

Z-Phase Signal

	Type A	Symbol	Check Terminal	Value	
1	Pulse Width (MZ - *MZ)	twz	PS1 (from JY2) PS2 (from JY5)	4 µsec min	SPM type 1 (JY2): N4005#4 = 1
2	Signal Amplitude of Reference Signal (MZ - *MZ) x 2.4	Vppz		0.25 V min	
		Vpnz		0.25 V min	SPM type 4 (JY5): N4004#4 = 1

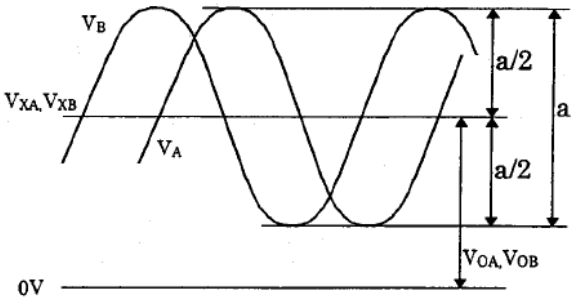
	Type B	Symbol	Check Terminal	Value	
1	Pulse Width (MZ - *MZ)	twz	PS1 (from JY2) PS2 (from JY5)	4 µsec min	SPM type 1 (JY2): N4005#4 = 0
2	Signal Amplitude of Reference Signal (MZ - *MZ) x 2.4	Vpz		0.25 V min	
3	Signal Offset (Z - *Z)	Voffz		3.5 V max 2 V min	SPM type 4 (JY5): N4004#4 = 0

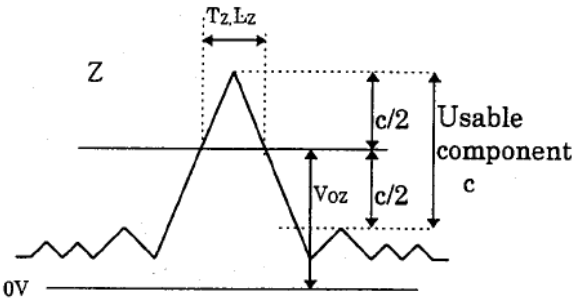
Attachment 2: Specification of 3rd Party Servo Encoders

(4) Input specifications and examples of available linear encoders

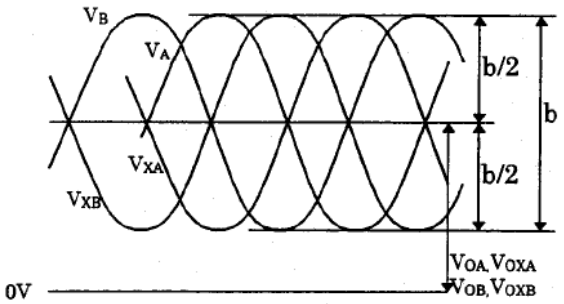
(4)-1 Input specifications

A/B(type Ⅰ)





A/B (type Ⅱ)



Item	Symbol	Specification Min.	Specification Typ.	Specification Max.	Unit
Amplitude (A/B phase)	type Ⅰ a of A,B phase type Ⅱ b of A phase+b of XA phase, b of B phase+b of XB phase	0.6	1.0	1.5	V_{P-P}
Amplitude (Z phase)	c pf Z pahse + c of XZ phaseZ	0.2	0.4	—	V
Center Level (DC Level)	type Ⅰ V_{OA},V_{XA} ,V_{OB},V_{XB} type Ⅱ V_{OA},V_{OXA} ,V_{OB},V_{OXB} V_{OZ},V_{OXZ}	2.0	2.5	3.0	V
Offset Voltage (A/B phase)	type Ⅰ $V_{OA}-V_{XA}$, $V_{OB}-V_{XB}$ type Ⅱ $V_{OA}-V_{OXA}$, $V_{OB}-V_{OXB}$	-0.1	0	+0.1	V
Offset Voltage (Z phase)	$V_{OZ}-V_{OXZ}$	-0.05	0	+0.05	V
Pulse width of Z	Tz	600	—	—	nSec
Length of Z	Lz	1/4	—	—	pitch of A(or B)
Input Impedance		100	120	140	Ω
Input Frequency		—	—	200 ①	kHz

* The position accuracy depends on the quality of the signal from the encoder.

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Revision Record

FANUC Series 30*i*/300*i*/300*i*s-MODEL A, Series 31*i*/310*i*/310*i*s-MODEL A5, Series 31*i*/310*i*/310*i*s-MODEL A, Series 32*i*/320*i*/320*i*s-MODEL A Dual Check Safety OPERATOR'S MANUAL (B-64004EN)

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