



GE Fanuc Automation

Computer Numerical Control Products

Series 15 / 150 – Model B

Maintenance Manual

GFZ-62075E/03

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Warnings, Cautions, and Notes as Used in this Publication

Warning

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

Caution

Caution notices are used where equipment might be damaged if care is not taken.

Note

Notes merely call attention to information that is especially significant to understanding and operating the equipment.

This document is based on information available at the time of its publication. While efforts have been made to be accurate, the information contained herein does not purport to cover all details or variations in hardware or software, nor to provide for every possible contingency in connection with installation, operation, or maintenance. Features may be described herein which are not present in all hardware and software systems. GE Fanuc Automation assumes no obligation of notice to holders of this document with respect to changes subsequently made.

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1. GENERAL

This manual describes preventive maintenance, quick troubleshooting procedures, check points, adjustments, and parameter details. It also covers various additional technical information (Appendixes).

Refer to the OPERATOR'S MANUAL and CONNECTING MANUAL, as required.

The CNC is an integral part of the CNC machine tool. A dust-proof enclosed structure, a cooling method, and wiring between units are designed and manufactured by each machine tool builder. Refer to the machine tool builder manual that addresses these issues.

Refer to the following materials for the details of the information listed below:

Parameters for the digital servo unit: FANUC AC SERVO AMPLIFIER MAINTENANCE MANUAL (B-65005E)
FANUC AC SERVO MOTOR α Series PARAMETER MANUAL (B-65150E)

DI/DO interface between the CNC and PMC: FANUC Series 15-MODEL B CONNECTION MANUAL (B-62073E)

Related manuals of FANUC Series 15-MODEL B are as follows:

FANUC Series 15-MODEL B DESCRIPTION (B-62072E)

FANUC Series 15/150-MODEL B CONNECTION MANUAL (B-62073E)

FANUC Series 15-MODEL B CONNECTION MANUAL (BMI interface) (B-62073E-1)

FANUC Series 15-MODEL B For Lathe OPERATOR'S MANUAL (PROGRAMMING) (B-62554E/01)

FANUC Series 15-MODEL B For Lathe OPERATOR'S MANUAL (OPERATION) (B-62554E-1/01)

FANUC Series 15-MODEL B For Machining Center OPERATOR'S MANUAL (PROGRAMMING) (B-62564E/01)

FANUC Series 15-MODEL B For Machining Center OPERATOR'S MANUAL (OPERATION) (B-62564E-1/01)

FANUC Series 15-MODEL B PARAMETER MANUAL (B-62560/01)

* FANUC Series 15/150-MODEL B MAINTENANCE MANUAL (B-62075E)

FANUC PMC-MODEL N/NA PROGRAMMING MANUAL (Ladder Language) (B-61013E)

FANUC PMC-MODEL N/NA PROGRAMMING MANUAL (PASCAL Language) (B-61013E-1)

FANUC PMC-MODEL N/NA PROGRAMMING MANUAL (C Language) (B-61013E-2)

CONVERSATIONAL AUTOMATIC PROGRAMMING FUNCTION FOR LATHE

(Series 16, Series 15-MODEL B) OPERATOR'S MANUAL (B-61804E-2)

CONVERSATIONAL AUTOMATIC PROGRAMMING FUNCTION FOR MACHINING CENTER

(Series 15-MF, Series 15-MFB) PROGRAMMING MANUAL (B-61263E)

CONVERSATIONAL AUTOMATIC PROGRAMMING FUNCTION FOR MACHINING CENTER

(Series 15-MF, Series 15-MFB) OPERATOR'S MANUAL (B-61264E)

*This manual.

This manual describes the following products:

| Product name | Abbreviations | |
|------------------------|---------------|---------------|
| FANUC Series 15 – TB | 15 – TB | Series 15 – B |
| FANUC Series 150 – TB | | |
| FANUC Series 15 – TFB | 15 – TFB | |
| FANUC Series 15 – TTB | 15 – TTB | |
| FANUC Series 150 – TTB | | |
| FANUC Series 15 – TTFB | 15 – TTFB | |
| FANUC Series 15 – MB | 15 – MB | |
| FANUC Series 150 – MB | | |
| FANUC Series 15 – MFB | 15 – MFB | |

NOTE For maintenance of FANUC MMC-IV, see “FANUC MMC-IV Connection and Maintenance Manual (B-62493E)”.

Explanation of terms frequently used in CNC are:

Least input increment

The minimum unit for program input of the move command

Least command increment

The minimum unit of a command to be given from CNC to the machine tool

Detection unit

The minimum unit of detectable axis move distance

Command multiplier (CMR)

A constant to enable the weight of CNC command pulses to match the weight of pulses from the detector

Detection multiplier (DMR)

A constant to enable the weight of CNC command pulses to match the weight of pulses from the detector

NOTE The relations among the least input increment, detection unit, CMR, and DMR are as specified below.

Least input increment= CMR × detection unit

Detection unit= Move amount per revolution of motor/(DMR × number of pulses of detector per revolution of motor)

The flexible feed gear function in the digital servo unit defines constant DMR using two parameters n and m (DMR = n/m).

CRT/MDI panel

CRT and Manual Data Input

This operator's panel is used to input command to CNC or display CNC conditions using key switches.

Parameter

A value set in the CNC which enables the CNC to fully utilize the machine tools functional characteristics.

1.1 Configuration of the CNC Control Equipment

The CNC control equipment consists of the following: the CNC control unit performing arithmetic processing for numerical control, the CRT/MDI unit displaying set data, the servo motors which actually operate the machine tool, and the servo amplifier. In this section, the structure and internal configuration of the CNC control unit and CRT/MDI unit will be outlined.

1.1.1 Configuration of the CNC control unit

The CNC control unit consists of the control unit rack, the power unit and printed circuit boards installed in the rack.

On top of the rack is a cooling fan motor. At the rear there is a back plane in which the printed circuit boards are plugged. As shown in the figure below, the upper cover of the control rack opens providing access to the fan motor for possible replacement.

The power unit is installed in the slot closest to the right edge of the rack. The PMC board is inserted into the second slot (slot 1) from the right rack edge. The main CPU board is inserted into the third slot (slot 2) from the right rack edge.

When sub CPU board (or additional axis board) is inserted, it is inserted into the fourth slot (slot 3) from the right rack edge. The remaining other slots are used for option boards. The sequence order of the option boards in the option slots makes no difference in the CNC operation. However, in order to avoid confusion, option boards are inserted according to kinds of the boards.

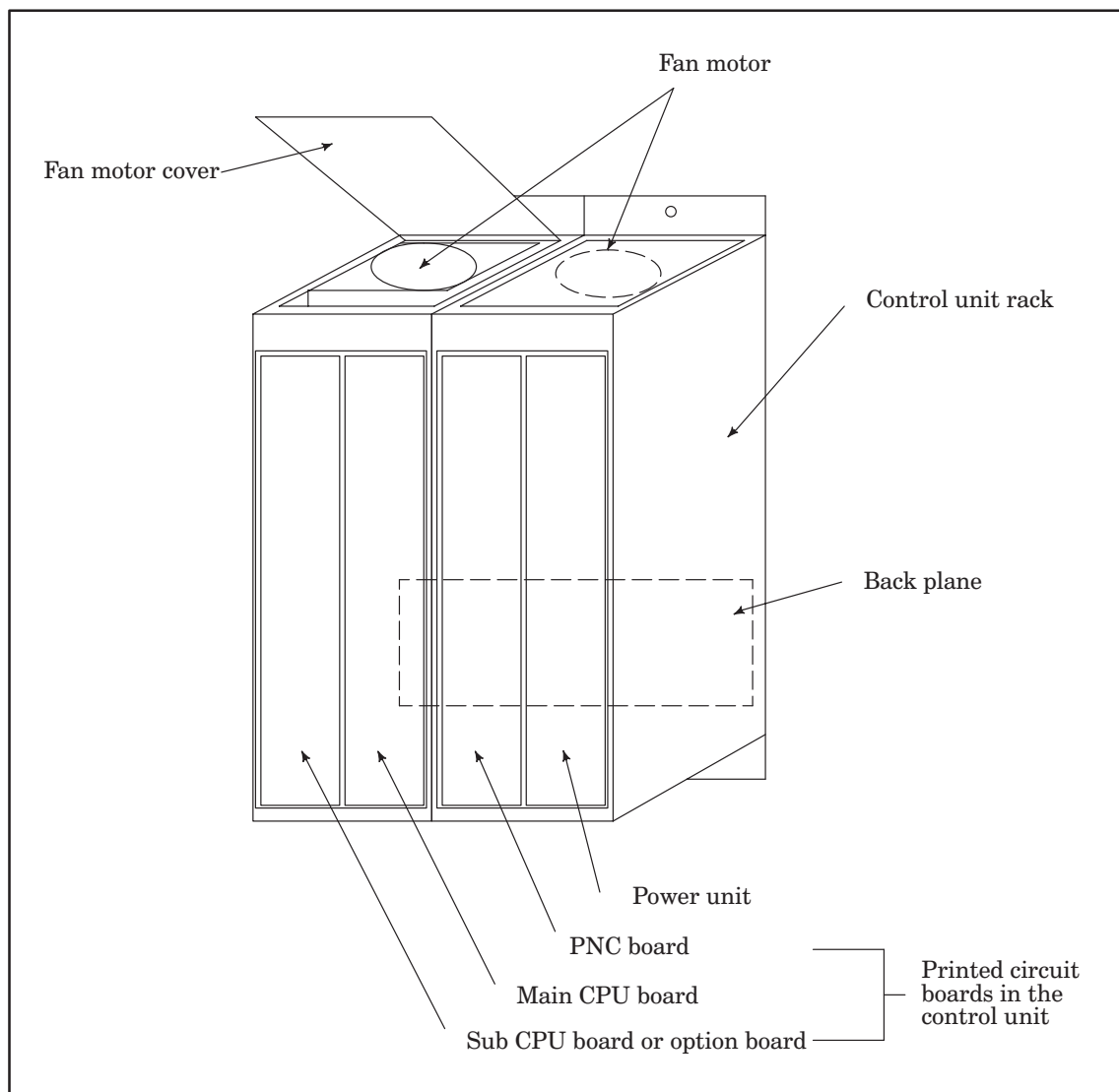


Fig. 1.1.1 (a) Control Unit Structure

Various racks for a control unit, power units, and printed circuit boards shown in the figure below can be used to configure a control units. Combination of these components depends on a machine tool for which the control unit is used.

Fig. 1.1.1 (b) shows the configuration of the control unit of the Series 15-B.

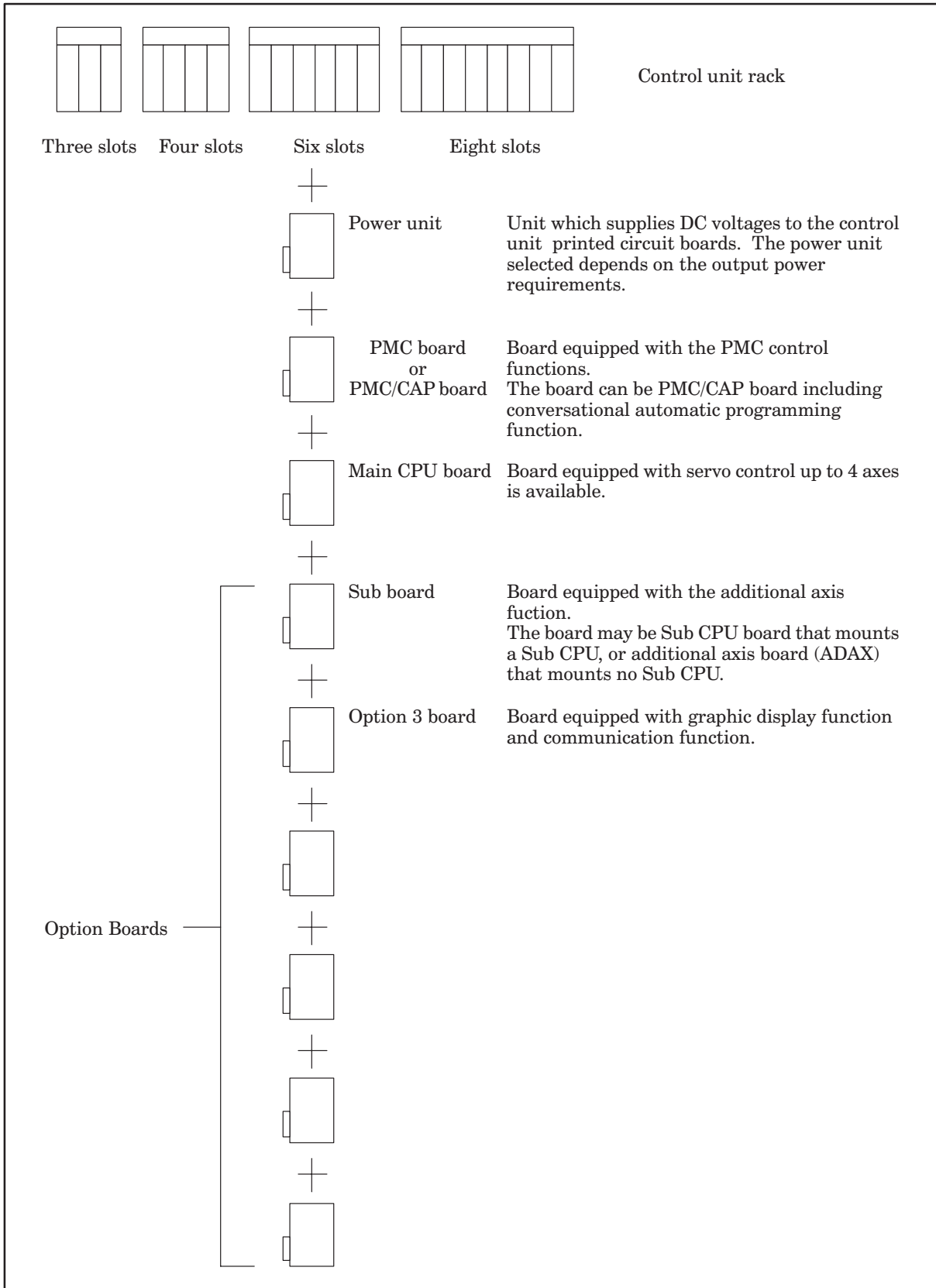


Fig. 1.1.1 (b) Configuration of the Control Unit (Series 15-B)

1.1.2 Configuration of the printed circuit boards in the CNC control unit

As shown in Fig. 1.1.2, a printed circuit board consists of a printed circuit board and a number of modules installed perpendicularly to the board.

At the front of a printed circuit board, the interface connectors and LED display are installed and a plastic front panel is attached. There is also a connector attached at the rear edge of the printed circuit board for connecting to the F-BUS back plane.

The modules are small printed circuit boards with surface mount devices mounted on both sides. One edge of each module board has connector electrodes. Module boards are attached by inserting them in the module connectors on the printed circuit board, simplifying the replacement of the module boards. There are a number of modules types available and the circuit function for each is different. Therefore, the connector location for installing each module on the printed circuit board is fixed. If a module is not installed in the correct connector, the system may fail to operate correctly and the circuitry of the control unit or the module itself may be damaged. However, some modules (ROM, SRAM, etc.) are interchangeable with respect to the signal assignment, enabling the insertion of the module to the connector of the interchangeable module.

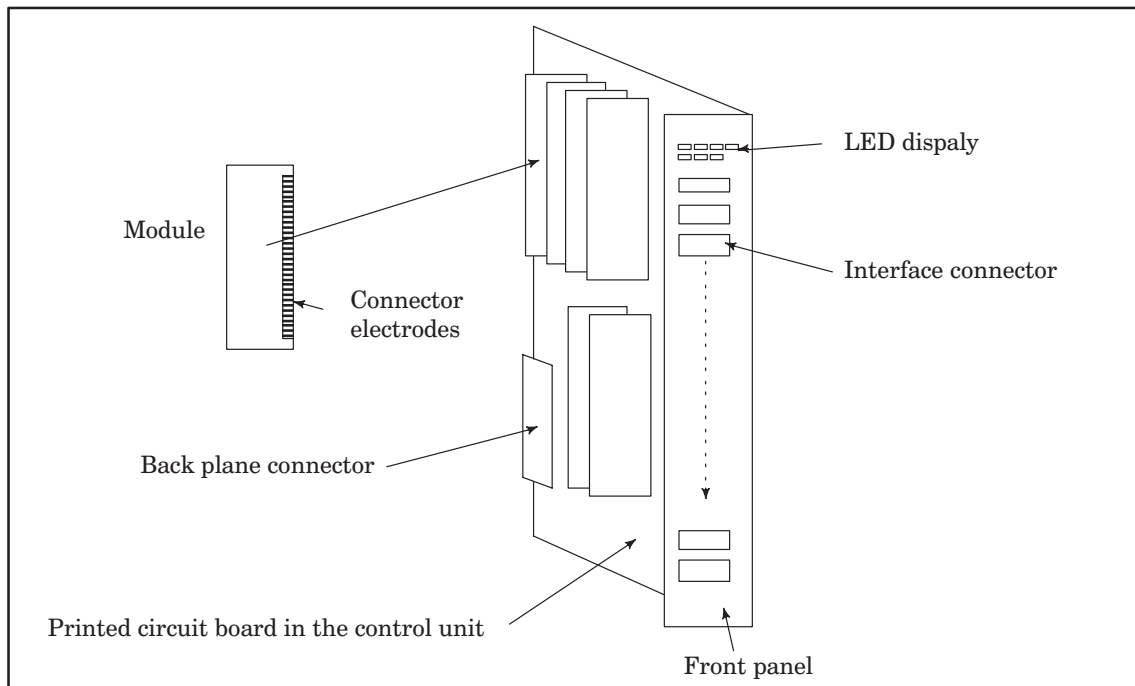


Fig. 1.1.2 Configuration of the Printed Circuit Boards in the CNC Control Unit

1.1.3 Configuration of the CRT/MDI unit

The CRT/MDI unit consists of the parts shown in Fig. 1.1.3. The unit is constructed of a CRT display and plastic panel screwed to a metal panel.

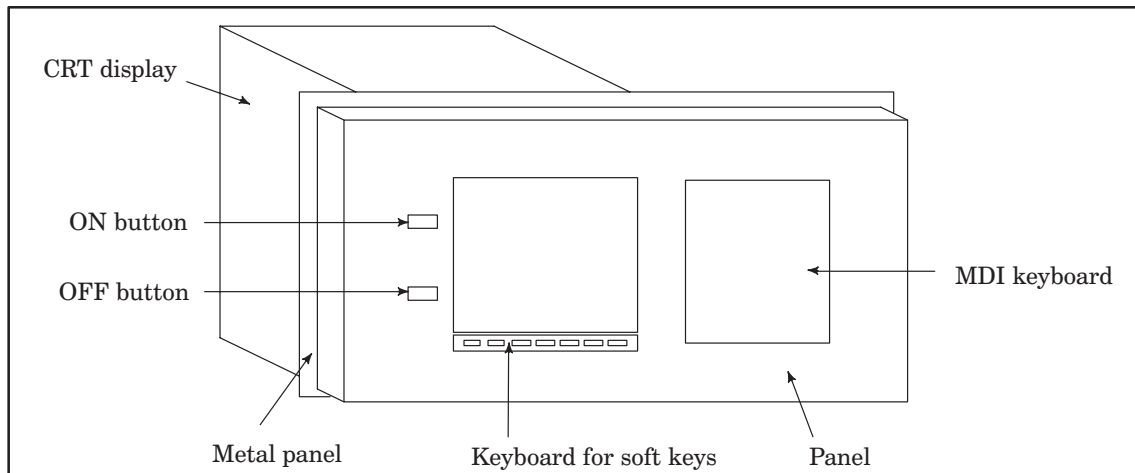


Fig. 1.1.3 CRT/MDI Unit Configuration

1.2 Block Diagram for the CNC Control Unit

Series 15-B block diagram for the CNC control unit is described in fig. 1.2 (a) to (c).

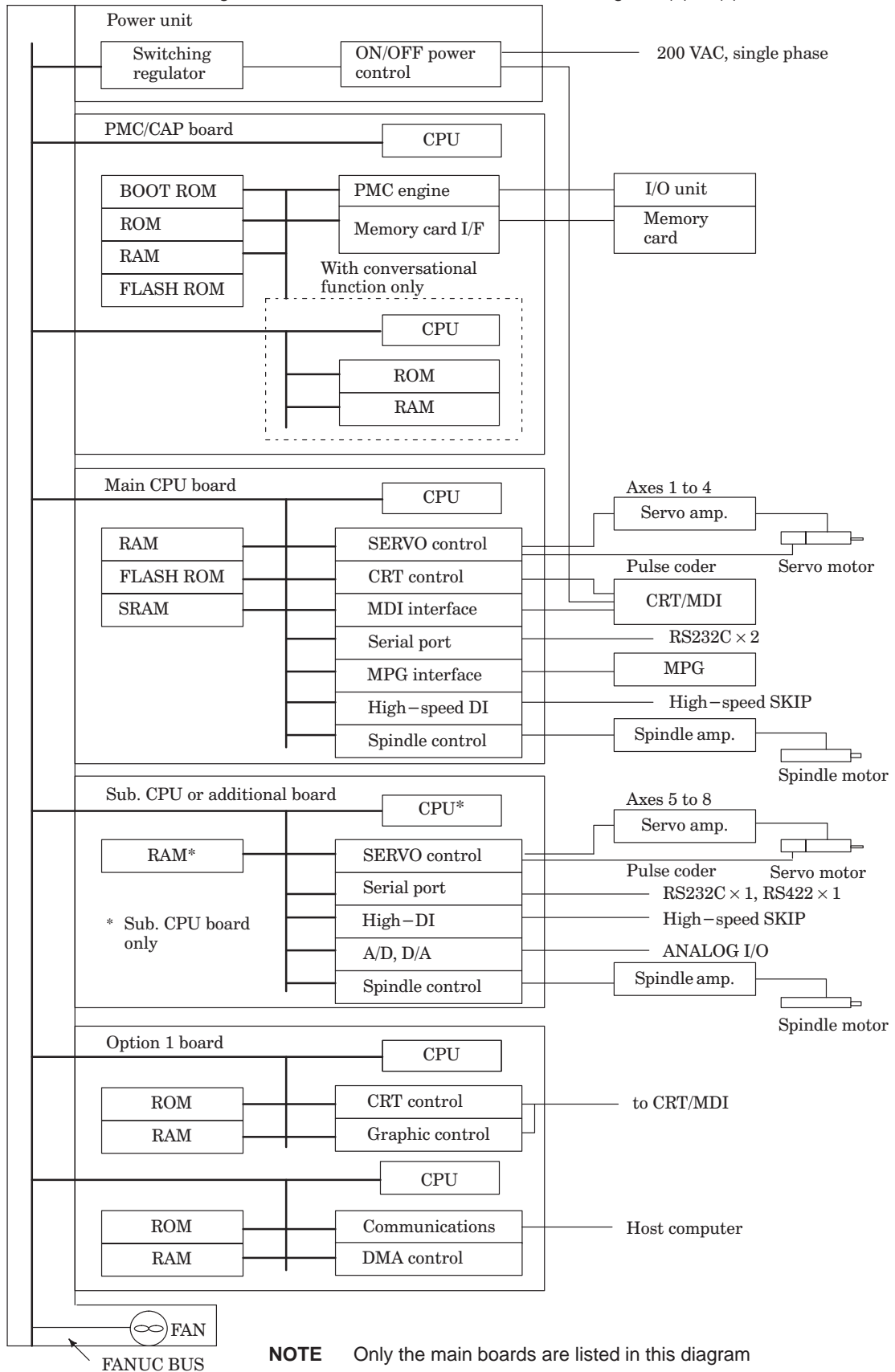


Fig. 1.2 (a) Block Diagram for Series 15-B Standard System

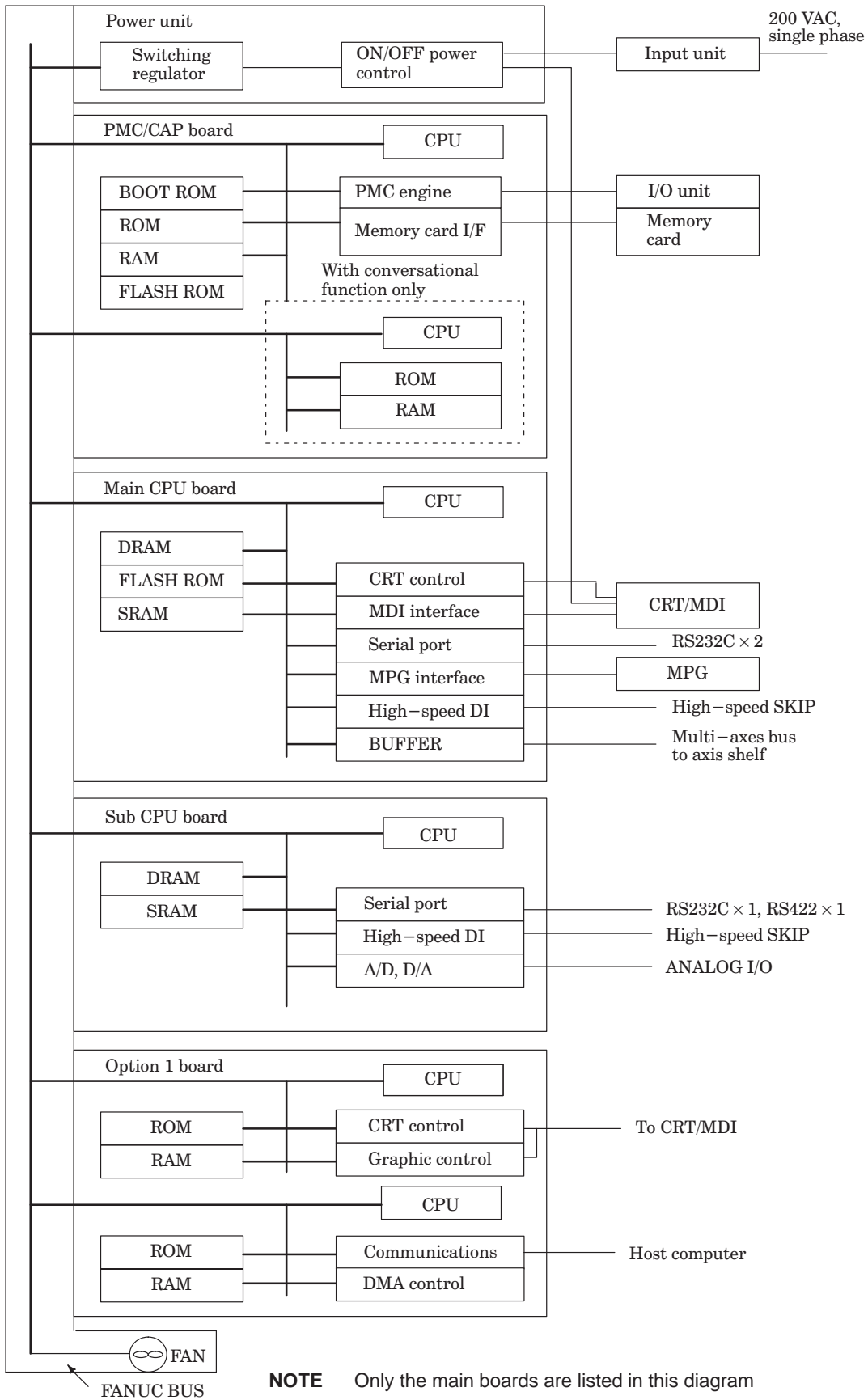


Fig. 1.2 (b) Block Diagram for Series 15-B Multi-axes System (Main Shelf Side)

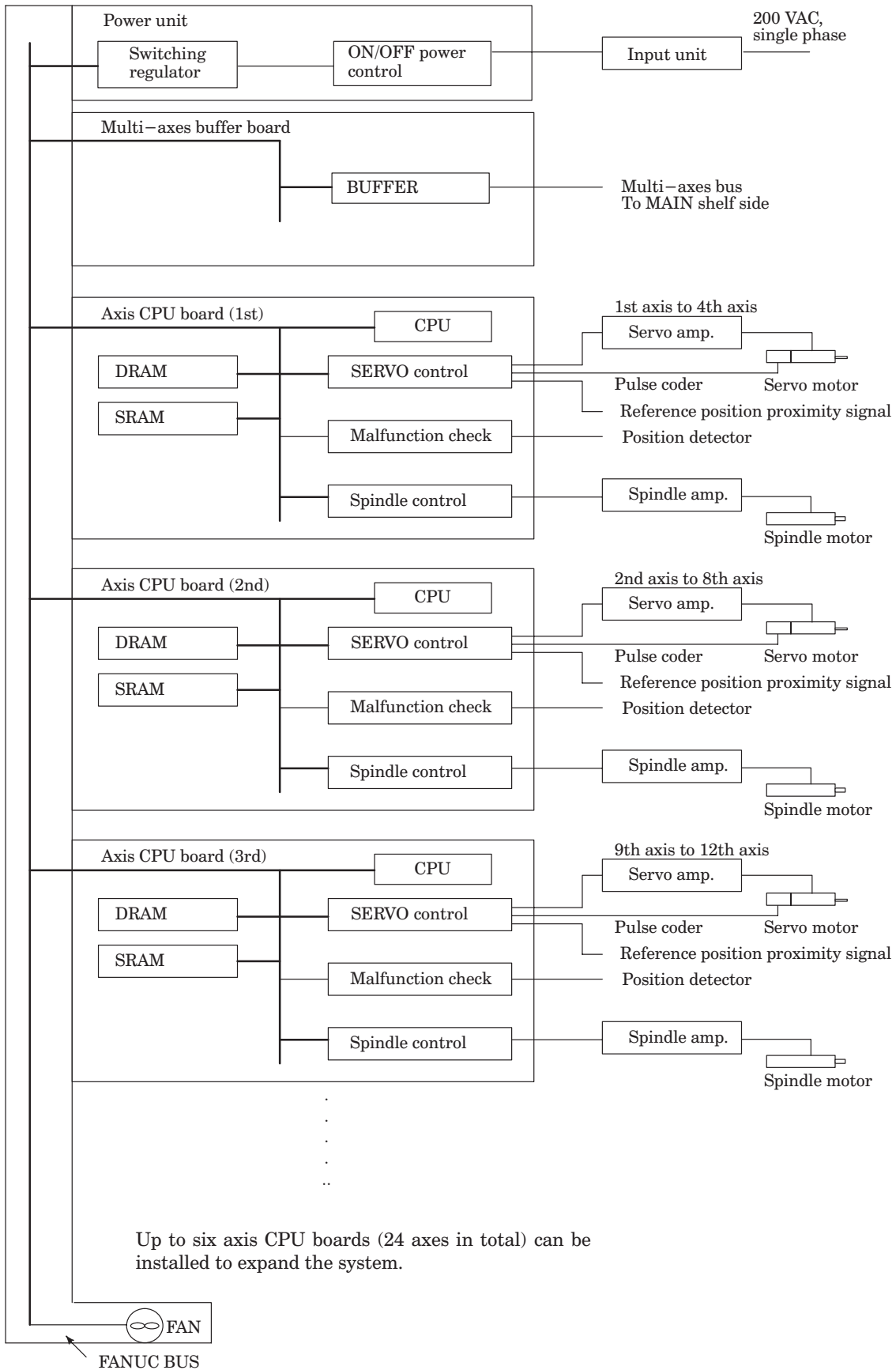


Fig. 1.2 (c) Block Diagram for Series 15-B Multi-axes System (Axis shelf side)

1.3 List of the Printed Circuit Boards and Units of Series 15-B

(a) Control unit rack

Control unit rack

| Name | | Drawing No. | Remarks | | |
|-------------------|----------------|-----------------------|------------------------|-----------------------|--------------------|
| Control unit rack | 3 – SLOT | A02B-0162-C001 | FANUC name plate | Standard | Without Sub.BUS |
| | 4 – SLOT | A02B-0162-C002 | | | |
| | 6 – SLOT | A02B-0162-C003 | | | |
| | 8 – SLOT | A02B-0162-C004 | | | |
| | 6 – SLOT | A02B-0162-C008 | | Response to MMC-IV | |
| | 8 – SLOT | A02B-0162-C009 | | | |
| | 3 – SLOT | A02B-0162-C011 | GE-Fanuc name plate | Standard | |
| | 4 – SLOT | A02B-0162-C012 | | | |
| | 6 – SLOT | A02B-0162-C013 | | | |
| | 8 – SLOT | A02B-0162-C014 | | | |
| | 6 – SLOT | A02B-0162-C018 | | Response to MMC-IV | |
| | 8 – SLOT | A02B-0162-C019 | | | |
| | 4 – SLOT | A02B-0162-C022 | FANUC name plate | Standard | With Sub.BUS |
| | 6 – SLOT | A02B-0162-C023 | | | |
| | 8 – SLOT | A02B-0162-C024 | | | |
| | 6 – SLOT | A02B-0162-C028 | | Response to MMC-IV | |
| | 8 – SLOT | A02B-0162-C029 | | | |
| | 4 – SLOT | A02B-0162-C032 | GE-Fanuc name plate | Standard | |
| | 6 – SLOT | A02B-0162-C033 | | | |
| | 8 – SLOT | A02B-0162-C034 | | | |
| 6 – SLOT | A02B-0162-C038 | Response to MMC-IV | | | |
| 8 – SLOT | A02B-0162-C039 | | | | |

Power unit

| Name | | Drawing No. | Remarks |
|------------|----|----------------|---------|
| Power unit | AI | A02B-1212-0471 | |
| | BI | A02B-1212-0531 | |

Control unit PCB

| Name | | Drawing No. | Remarks | | Module ID |
|-----------------------|---|----------------------------------|--|-------------------------------------|-----------|
| Main CPU board | Standard Main-B | A16B-2201-0320 | | | 71 |
| | High-speed Main-A | A16B-2201-0300 | | | 62 |
| | Main C | A16B-3200-0060 | Level up | | 97 |
| | High-speed Max Main-A | A16B-2201-0340 | For multiaxis control, synchronous control, and malfunction check | | 67 |
| PMC board | Without conversational CPU for PMC - NA | A16B-2201-0371 A16B-2201-0391 | | | 77 |
| | Without conversational CPU for PMC - NB | A16B-2201-0381 A16B-2201-0811 | | | 6B |
| | Without conversational CPU for PMC - NA | A16B-2201-0390 | | | 77 / 6D |
| | Without conversational CPU for PMC - NB | A16B-2201-0810 | | | 7B / 6D |
| Additional axis board | | A16B-2201-0311 | | | 63 |
| Axis CPU board | | A16B-2201-0360 | | | 7A |
| Buffer board | | A16B-2201-0351 | | | 68 |
| Sub CPU board | Standard Max Sub-B | A16B-2201-0331 | Only for multiaxis control, synchronous control, and malfunction check | | 73 |
| | High-speed Sub-A | A16B-2201-0310 | | | 63 |
| | Sub-C | A16B-2202-0571 | Level up | | A1 |
| Option 1 board | Graphic+Remote buffer | A16B-2200-0910 | Increase of graphic CPU RAM | For 14" CRT, 10" LCD, or 9" graphic | 45 / 3F |
| | Graphic+DNC1 | A16B-2200-0911 | | | 45 / 3F |
| | Graphic | A16B-2200-0912 | | | 45 |
| | Graphic | A16B-2200-0917 | Graphic CPU RAM (standard) | | 45 |
| | Graphic+Remote buffer | A16B-2200-0915 | | | 45 / 3F |
| | Graphic+Remote buffer | A16B-2200-0918 | Increase of graphic CPU RAM | For 9.5" LCD, 8.4" LCD, or MMC-IV | 45 / 3F |
| | Graphic+DNC1 | A16B-2200-0916 | | | 45 / 3F |
| | Graphic | A16B-2200-0919 | | | 45 |
| | Remote buffer | A16B-2200-0913 | | | 3F |
| | DNC1 | A16B-2200-0914 | | | 3F |
| RISC board | | A16B-2201-0710 | | | 7F |
| ROM cassette adapter | | A20B-2000-0760 | | | 74 |

Back plane PCB

| Name | | Drawing No. | Remarks | |
|------------|---------|----------------|--------------------|--|
| Back plane | 3-SLOT | A20B-2000-0900 | Standard | |
| | 4-SLOT | A20B-2000-0710 | | |
| | 6-SLOT | A20B-2000-0720 | | |
| | 8-SLOT | A20B-2000-0730 | | |
| | 6-SLOT | A20B-2001-0650 | Response to MMC-IV | |
| | 8-SLOT | A20B-2001-0660 | | |
| | SUB BUS | A20B-1005-0270 | | |

Module (For main CPU board)

| Name | | Drawing No. | Remarks |
|------------------------|------------------------------------|----------------------------------|----------------------------|
| Spindle control module | Serial spindle+ High-speed skip | A20B-2900-0672 | |
| | Analog spindle+ High-speed skip | A20B-2900-0770 | |
| Peripheral module | | A20B-2900-0660 | |
| FLASH ROM module | 6MB | A20B-2900-0810 | |
| | 4MB | A20B-2900-0811 | |
| | 2MB | A20B-2900-0812 | |
| DRAM module | 8MB | A20B-2900-0650 | For MAIN-C |
| | 4MB | A20B-2900-0651 | |
| | 2MB | A20B-2900-0800 | |
| | 6MB | A20B-2901-0940 | |
| | 4MB | A20B-2901-0941 | |
| | 2MB | A20B-2901-0942 | |
| High-speed SRAM module | | A20B-2900-0641 | |
| SRAM module | 2MB | A20B-2900-0682 | |
| | 1MB | A20B-2900-0680 | |
| | 512KB | A20B-2900-0681 | |
| | 256KB | A20B-2900-0700 | |
| | 128KB | A20B-2900-0701 | |
| | 64KB | A20B-2900-0711 | |
| Servo control module | | A20B-2901-0340 | Cannot be used for MAIN-C. |
| | | A20B-2902-0180 | |
| Servo interface module | | A20B-2900-0830 A20B-2901-0360 | |
| CRT control module | | A20B-2900-0691 | 9" CRT control |

Module (For PMC/conversational board)

| Name | | Drawing No. | Remarks |
|---------------------------|------------|----------------|-----------------|
| PMC CPU module | For PMC-NA | A20B-2900-0780 | |
| | For PMC-NB | A20B-2901-0581 | |
| PMC engine module | For PMC-NA | A20B-2900-0790 | |
| | For PMC-NB | A20B-2901-0660 | |
| DRAM module | 2MB | A20B-2900-0653 | |
| | 512KB | A20B-2900-0803 | |
| SRAM module | 1.25MB | A20B-2901-0400 | For PMC-NB only |
| | 512KB | A20B-2901-0402 | |
| Conversational CPU module | | A20B-2901-0390 | |
| EPROM module | 1MB | A20B-2900-0290 | |
| | 768KB | A20B-2900-0291 | |
| | 512KB | A20B-2900-0292 | |

Module (For PMC/conversational board)

| Name | | Drawing No. | Remarks |
|-------------|-------|----------------|---------|
| DRAM module | 1MB | A20B-2900-0550 | |
| | 512KB | A20B-2900-0551 | |
| | 128KB | A20B-2900-0555 | |
| SRAM module | 512MB | A20B-2900-0541 | |

Module (For Sub CPU board, additional axis board, or axis CPU board)

| Name | | Drawing No. | Remarks |
|--|---------------------------------|----------------------------------|---|
| Spindle control module | Analog spindle+ High-speed skip | A20B-2900-0770 | |
| | Serial spindle+ High-speed skip | A20B-2900-0672 | For axis CPU |
| Analog input & Serial communication module | | A20B-2900-0721 | Serial communication is each one channel of RS-422 or RS-232-C. |
| Servo control module | | A20B-2901-0340 | Cannot be used for SUB-C |
| | | A20B-2902-0180 | |
| Servo interface module | | A20B-2901-0360 A20B-2900-0830 | |
| DRAM module | 2MB | A20B-2900-0800 | |
| | 1MB | A20B-2900-0802 | |
| | 2MB | A20B-2901-0942 | For SUB-C |
| High-speed SRAM module | | A20B-2900-0641 | |
| SRAM module | 512KB | A20B-2900-0681 | |
| | 256KB | A20B-2900-0700 | |

Module (For RISC board)

| Name | | Drawing No. | Remarks |
|-------------|-------|----------------|---------|
| SRAM module | 512KB | A20B-2900-0541 | |
| ROM module | 512KB | A20B-2900-0292 | |

Module (For option 1 board)

| Name | | Drawing No. | Remarks |
|------------------------------|----------------|----------------|---|
| CRT control module | 14"CRT | A20B-2901-0370 | Standard |
| | 10"LCD 10" PDP | A20B-2901-0372 | |
| | 9.5" 8.4" LCD | A20B-2902-0272 | |
| | 9"CRT 9"PDP | A20B-2901-0371 | |
| | 14"CRT | A20B-2901-0373 | MMC-III |
| | 10"LCD | A20B-2901-0375 | |
| | MMC-IV | A20B-2902-0275 | MMC-IV |
| Communication control module | | A20B-2900-0361 | |
| Graphic control module | | A20B-2900-0310 | Standard |
| | | A20B-2900-0311 | When MMC-IV or the 9.5" or 8.4" LCD is used |
| Graphic CPU module | | A20B-2900-0350 | |

(b) External control unit (except I/O unit)

| Name | | Drawing N | Remarks |
|----------------------------------|-----------------------|----------------|--|
| 9" CRT/MDI unit | monochrome vertical | A02B-0162-C041 | |
| | monochrome horizontal | A02B-0162-C042 | |
| | color vertical | A02B-0162-C051 | |
| | color horizontal | A02B-0162-C052 | |
| 9" small type CRT/MDI unit | monochrome | M | A02B-0162-C101 |
| | | T | A02B-0162-C102 |
| 9" PDP/MDI unit | monochrome vertical | A02B-0162-C061 | |
| | monochrome horizontal | A02B-0162-C062 | |
| 9.5" LCD/MDI unit | color vertical | A02B-0162-C131 | |
| | color horizontal | A02B-0162-C132 | |
| | color vertical | A02B-0162-C141 | |
| | color horizontal | A02B-0162-C142 | |
| 10" LCD/MDI unit | color vertical | A02B-0162-C071 | |
| | color horizontal | A02B-0162-C072 | |
| 10" PDP/MDI unit | monochrome vertical | A02B-0162-C081 | |
| | monochrome horizontal | A02B-0162-C082 | |
| 14" CRT/MDI unit | color vertical | A02B-0162-C091 | |
| | color horizontal | A02B-0162-C092 | |
| | color vertical | A02B-0162-C121 | For MMC-IV |
| | color horizontal | A02B-0162-C122 | For MMC-IV |
| 9" separate CRT unit | monochrome | A02B-0162-C043 | |
| | color | A02B-0162-C053 | |
| 9" separate PDP unit | monochrome | A02B-0162-C063 | |
| Separate MDI unit | | A02B-0162-C111 | |
| Connection unit 1 | | A02B-1005-0310 | DI/DO=96/64 |
| Connection unit 2 | | A02B-1003-0200 | DI/DO=96/64 |
| Operator's panel connection unit | A | DI/DO=64/32 | A16B-2200-0661 |
| | B | DI/DO=96/64 | A16B-2200-0660 |
| Optical I/O link adapter | | A13B-0154-B001 | It is used also for serial spindle interface |

(c) I/O Unit-MODEL A

| Name | | Drawing No. | Remarks | | | | | |
|---|----------------|----------------|--|-------|----------------|-----------|-----------------|----------------|
| Basic unit | ABU10A | A03B-0807-J001 | It's possible to mount up to 10 modules. | | | | | |
| | ABU10B | A03B-0807-J004 | | | | | | |
| Basic unit | ABU05A | A03B-0807-J002 | It's possible to mount up to 5 modules. | | | | | |
| | ABU05B | A03B-0807-J003 | | | | | | |
| Interface module | AIF01A | A03B-0807-J011 | For slave | | | | | |
| | AIF01B | A03B-0807-J012 | | | | | | |
| | AIF02C | A03B-0807-J013 | | | | | | |
| Digital input module | | Drawing No. | Type | Point | Voltage | Po-rarity | Resp onse | Connection |
| *1.When input is Lo level, it will be considered to turn on. (0V common) *2.When Input is Hi level, it will be considered to turn on. (24V common) | AID32A1 | A03B-0807-J101 | Non-inslation type DC input | 32 | DC24V | Both | 20ms | Connector A |
| | AID32B1 | A03B-0807-J102 | | 32 | DC24V | Both | 2ms | Connector A |
| | AID32H1 | A03B-0807-J111 | | 32 | DC24V | Both | 2ms:8 20ms:8 | Connector A |
| | AID16C | A03B-0807-J103 | Inslation type DC input | 16 | DC24V | *1 NEG | 20ms | Terminal block |
| | AID16D | A03B-0807-J104 | | 16 | DC24V | *2 DOS | 20ms | Terminal block |
| | AID16K | A03B-0807-J113 | | 16 | DC24V | *1 NEG | 2ms | Terminal block |
| | AID16L | A03B-0807-J114 | | 16 | DC24V | *2 POS | 2ms | Terminal block |
| | AID32E1 | A03B-0807-J105 | Inslation type DC input | 32 | DC24V | Both | 20ms | Connector A |
| | AID32E2 | A03B-0807-J110 | | 32 | DC24V | Both | 20ms | Connector B |
| | AID32F1 | A03B-0807-J106 | | 32 | DC24V | Both | 2ms | Connector A |
| AID32F2 | A03B-0807-J109 | 32 | | DC24V | Both | 2ms | Connector B | |
| AID16G | A03B-0807-J107 | AC input | | 16 | AC100 -115V | ON OFF | 30ms 45ms | Terminal block |

I/O Unit-MODEL A

| Name | | Drawing No. | Remarks | | | | | | |
|--|---------------------|----------------|--------------------------------|-------------------------|---------------|-----------|-------------|----------------|----------------|
| Digital output module | | Drawing No. | Type | point | Voltage | Po-rarity | Resp once | Connection | |
| *3.When turning on, output becomes Lo level. (0V common) *4.When turning on output becomes Lo level. (24V common) | AOD32A1 | A03B-0807-J162 | Non - inslation type DC output | 32 | DC5 -24V | *3 NEG | 0.3A | Connection A | |
| | AOD08C | A03B-0807-J151 | Inslation type DC output | 8 | DC12 -24V | *3 NEG | 2A | Terminal block | |
| | AOD08D | A03B-0807-J152 | | 8 | | *4 POS | 2A | Terminal block | |
| | AOD16C | A03B-0807-J153 | | 16 | | *3 NEG | 0.5A | Terminal block | |
| | AOD16D | A03B-0807-J154 | | 16 | | *4 POS | 0.5A | Terminal block | |
| | AOD32C1 | A03B-0807-J155 | | 32 | | *3 NEG | 0.3A | Connector A | |
| | AOD32D1 | A03B-0807-J156 | | 32 | | *4 POS | 0.3A | Connector A | |
| | AOD32D2 | A03B-0807-J167 | | 32 | | *4 POS | 0.3A | Connector B | |
| | AOA05E | A03B-0807-J157 | | AC output | | 5 | AC100 -230V | | 2A |
| | AOA08E | A03B-0807-J158 | 8 | | | 1A | | Terminal block | |
| | AOA12F | A03B-0807-J159 | 12 | | AC100 -115V | | | 0.5A | Terminal block |
| | AOR08G | A03B-0807-J160 | Relay output | 8 | AC250V /DC30V | | 4A | Terminal block | |
| | AOR16G | A03B-0807-J161 | | 16 | | | 2A | Terminal block | |
| | AOR16H2 | A03B-0807-J165 | | 16 | | DC30V | | 2A | Connector B |
| | Name | | Drawing No. | Remarks | | | | | |
| | Analog input module | AAD04A | A03B-0807-J051 | Analog input 4 channels | | | | | |
| Analog output module | ADA02A | A03B-0807-J052 | Analog output 2 channels | | | | | | |
| High-speed counter module | ACT01A | A03B-0807-J052 | Pulse input 1 channel | | | | | | |

2. MAINTENANCE EQUIPMENT

2.1 Maintenance Equipment

The following equipment is recommended.

1) Measuring instruments

Table 2.1 Measuring Instruments for Maintenance

| Instrument | Requirements | Usage |
|--------------|--|---------------------------------------|
| AC voltmeter | Capable of measuring AC powersupply voltages within a tolerance of $\pm 2\%$. | Measurement of AC powersupply voltage |
| DC voltmeter | Capable of measuring DC voltages of 10V and 30V within a tolerance of $\pm 2\%$ (digital voltmeter may be required). | Measurement of DC powersupply voltage |

2) Tools

Phillips screwdriver : large, medium and small

Standard screwdriver : large, medium and small

2.2 Main Spare Parts

The following replacement parts should be available:

– Fuses (see 8.1)

3. TROUBLESHOOTING AND ACTION TO BE TAKEN

3.1 Procedures for Troubleshooting

The procedures for troubleshooting are classified according to the status of the disabled NC unit as follows. Take the appropriate corrective action as listed below.

- | | |
|--|-----------------|
| (1) Action to be taken when a system alarm is displayed | See Item 3.2.1. |
| (2) Action to be taken when an error code is displayed | See Item 3.2.2. |
| (3) An alarm LED lights: | See Item 3.2.3. |
| (4) The machine cannot be operated in the jog mode: | See Item 3.2.4. |
| (5) The machine cannot be operated by the manual pulse generator: | See Item 3.2.5. |
| (6) The spindle cannot be operated in the synchronous feed mode: | See Item 3.2.6. |
| (7) The machine cannot be operated in the automatic mode: | See Item 3.2.7. |
| (8) The input/output devices of the reader/punch interface do not operate correctly: | See Item 3.2.8. |
| (9) The machine does not return to the correct reference position: | See Item 3.2.9. |

| |
|---|
| Items to be checked when a problem occurs |
|---|

Check the following items and report the results when contacting your FANUC Service Center.

- (1) Nature of the problem
 - i) Mode
 - ii) Operation or program employed and the tool offset value when the problem occurs
 - iii) Alarm message
 - iv) Frequency with which the problem occurs
 - v) The magnitude of a positional error, if any
 - vi) The position at which the problem occurred
 - vii) If a system alarm occurs, which LEDs on the PCB are on
- (2) Miscellaneous information
 - i) Series and edition of the software displayed on the screen when the power is turned on
 - ii) Description of the system parameter (Check the system parameter setting of the machine with the parameter list supplied with to the unit.)

3.2 Problems and Corrective Measures

3.2.1 System alarm

If the CNC system encounters a serious failure in the hardware or software and the system decides it impossible to continue operation, it stops normal operation and enters the system alarm state. In this state, the system automatically analyzes possible causes of the failure and displays the result on the screen. In most cases, it is not possible for users to restore the system. Check the items described in 3.1 and contact your FANUC Service Center.

All information displayed on the screen is stored in the memory in the CNC system. Therefore, it is possible to refer to the information on the system history screen after the system is restored and the power is turned on again.

For details on the system alarms and how to display the system history screen, refer to Appendixes 1 and 2.

3.2.2 Action to be taken when an error code is displayed

If the CNC system detects an error, it displays the corresponding error code and alarm message on the screen. The error codes and alarm messages are listed in the Operator's Manual (Programming). For an explanation of servo alarms, refer to the relevant maintenance manual. Each servo alarm is described, together with the corresponding corrective action.

The following covers important alarms and the actions to be taken.

(1) PS200 PULSE CODER SYNCHRONOUS ERROR

While returning to the reference position, either a one-rotation signal is not sent from the pulse coder or the signal is sent but the motion is too slow.

When a pulse coder is employed, the reference counter is synchronized with the one-rotation signal the first time the machine returns to the reference position after the power is turned on or an emergency stop is reset. In this synchronization, the following conditions must be met so that the same edge of the one-rotation signal can be detected.

(A) The positional deviation (diagnosis function No. 3000) must be at least 128.

(B) One or more one-rotation signals must be sent after the positional deviation (diagnosis function No. 3000) has been at least 128 (but before the deceleration dog is released again).

The one-rotation signal is not used when the machine returns to the reference position the second or subsequent time. Thus, this alarm does not occur after the machine has returned to reference position the first time.

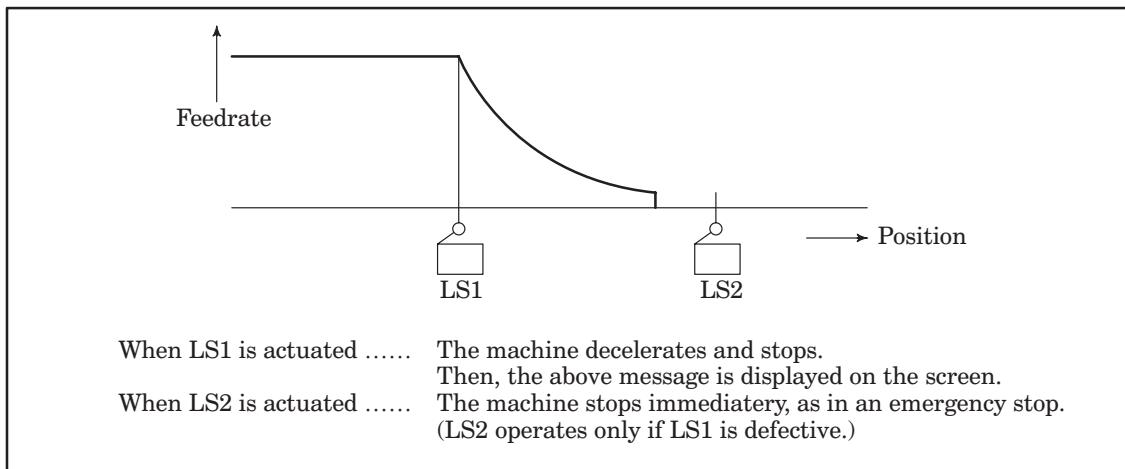
| Item | Possible cause of the problem | How to check the cause | Action to take |
|------|--|--|---|
| 1 | The feedrate is too slow. | Return the machine to the reference position under the same system conditions system as when the alarm occurred. Then, check the positional deviation (diagnostic data, parameter No.3000) using the self-diagnosis function and check that the deviation exceeds 128. In particular, carefully check the deviation when the machine returns to the reference position from the position at which the deceleration dog is pressed. | Increase the feedrate. When the position gain is 30sec^{-1} , the feedrate should be 300 mm/min or more. |
| 2 | The position at which the machine starts returning to the reference position is too close to the reference position. | Check the distance between the start position and the reference position. | Use a start position whose distance from the reference position is equivalent to two or more motor rotations. |
| 3 | The power supply voltage to the pulse coder is too low. | Check that the voltage through the pulse coder is 4.75V or above. <div style="border: 1px solid black; padding: 5px; margin: 5px 0;"> To check the voltage through the pulse coder, remove the cover of the servo motor and measure the voltage between the positive and negative terminals on the printed circuit board of the pulse coder or between the land connected to the +5 V and the 0 V lines. </div> | The voltage drop through the cables must be 0.2V or less in total in both the 5-V line and 0-V line. |
| 4 | The pulse coder is defective | Replace the pulse coder and check that the error is eliminated. | Replace the pulse coder. |
| 5 | The main CPU board or sub board is defective. | Replace the printed circuit board to which the erroneous axis is connected, and check that the error is eliminated. | Replace the pulse coder. |

(2) OT 007 + OVERTRAVEL (HARD)

OT 008 – OVERTRAVEL (HARD)

The above alarm message is displayed on the screen if the machine reaches the end of the stroke. When this alarm occurs in the automatic mode, the machine stops motion along all axes. In the manual mode, only motion along the axis on which the alarm occurred stops.

Each axis of the machine is equipped with two limit switches (LS1 and LS2) as shown below along each direction, and they stop the movable parts of the machine.



(Causes and counter measures)

1. The wrong reference position was specified in setting the coordinate system.
→ Modify the program.
2. The program has bugs in it. → Modify the program.

(How to reset the error)

(a) When only LS1 is actuated:

Move the machine manually in the opposite direction in the jog, step, or handle mode and disengage it from the limit switch. Then, press the RESET button on the MDI panel.

NOTE It is only possible to move the machine toward the normal operating area.

(b) When both LS1 and LS2 are actuated:

1. Press on the 2ND LS release button.
2. Follow the same step as above for resetting LS1.

NOTE For a machine on which LS1 does not operate when LS2 is actuated, the machine can be moved manually in both directions. Take care not to move the machine in the wrong direction.

(3) OT 001 + OVERTRAVEL (SOFT1) }
OT 006 – OVERTRAVEL (SOFT3) } Stored stroke limit alarms

The above alarm message is displayed on the screen when the machine reaches the stored stroke limit. When this alarm occurs in the automatic mode, the machine stops moving along all axes. In the manual mode, only motion along the axis on which the alarm occurred stops.

(Causes)

- (a) The program has bugs in it.
- (b) The wrong stroke limit was stored.

(Check)

The position of the machine in the machine coordinate system relative to the reference position can be checked on the position display screen.

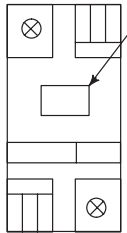
(Counter measures)

- (a) Modify the program.
- (b) Store a correct stroke limit.

(How to reset the error)

- (a) The machine can be moved only toward the normal operating ranges.
- (b) When the machine has stopped in the restricted zone and cannot escape it, press the emergency stop button to reset the alarm. Then, specify G23 on the MDI panel to disable the stored stroke limit function and move the machine in the jog mode.

(4) SV 013 IMPROPER V-READY OFF

| Item | Possible cause of the problem | How to check the cause | Action to take |
|------|--|--|--|
| 1 | Fault analysis | Check if green LED DRDY lights in servo amplifier PCB. | Proceed to item 2 when LED DRDY lights. Proceed to item 8 when it does not light. |
| 2 | Fault analysis | Check if alarm LED lights in servo amplifier PCB. | If this LED lights, locate and eliminate the cause of the alarm (see the following 1st, A-D).prossees to item 3, when this LED does not light. |
| 3 | Fault analysis | Check if electromagnetic contractor MCC is turned on in servo amplifier. | Proceed to item 8 when MCC is energized. Proceed to item 4 when it is not energized. |
| 4 | Fault analysis | Check if 100V is applied between terminals (3) and (4) of terminal board T1 of servo amplifier. | Proceed to item 9 when power is applied. Proceed to item 5 if not applied. |
| 5 | Signals from machine tool | Check 100V power supply Check if emergency stop signal is sent from machine tool or if the machine tool is ready for operation. | Restore to normal conditions. |
| 6 | Trouble in servo amplifier | Servo amplifier PCB or MCC is defective. | Replace. |
| 7 | Poor contact | Poor contact between servo amplifier and main CPU or option 2 board, or a problem in master PCB. | Replace. |
| 8 | Poor contact | Poor contact inside servo amplifier or a trouble in servo amplifier PCB. | Replace. |
| 9 | No fuse breaker in turned off. | Check the no fuse breaker button on/off state | If it is not off, proceed to item 6. |
| 10 | No fuse breaker functions | <p>The operating conditions as illustrated below.</p>  <p>While the motor operates normally, this lever is at upper position and the ON indication can be seen. If the circuit breaker trips, the lever moves to the lower position and the OFF indication appears. To reset the breaker turn off the three-phase power supply, and move the lever to the upper position.</p> | Reset the no fuse breaker after turning off the power supply. (if the no fuse breaker trips immediately then wait for about 10 minutes before attempting another breaker reset.) |
| 11 | Diode module, surge absorber (TNR) or other parts are faulty in servo amplifier. | No fuse breaker functions when power supply is turned on after the corrective action in item 1. | Replace diode module DS or surge absorber (ZNR) of servo amplifier. |

- (5) SV 008 EXCESS ERROR (STOP)
 SV 009 EXCESS ERROR (MOVING)
 Excessive positional deviation alarm

| Item | Possible cause of the problem | How to check the cause | Action to take |
|------|---|---|---|
| 1 | An incorrect positional deviation is specified. | Check that the settings in parameter Nos. 1828 to 1830 conform to the parameter list supplied with the NC unit. | Set the parameters to the correct settings. |
| 2 | Overshoot | When the current necessary to accelerate or decelerate the motor in accordance with the the acceleration/deceleration of the NC unit does not pass through the motor, the amount of error in the positioning control circuit increases for some time. | Increase the rapid traverse time constant of the NC unit. (Specify it on the control unit.) |
| 3 | The input power supply voltage is too low. | Measure the input power supply voltage and check that it is within the range of +10% to -15%. | Set the proper voltage on the input tap of the power transformer for the servo. |
| 4 | Incorrect cable connection | Check that cables such as the motor power line are connected correctly. | Connect the cables correctly. |
| 5 | The main CPU board or sub board is defective, or the printed circuit board of the servo amplifier is defective. | If a spare board is available, replace defective board and check that the alarm does not occur. When using a new board, ensure that it is correctly adjusted and set. | Replace the printed circuit board. |

3.2.3 Lighting of alarm LEDs on PCBs

If an alarm condition occurs, an alarm message is usually displayed on the CRT screen. The state of the PCB when the alarm occurred is indicated by the LEDs on the front panel of each control unit PCBs, as shown below. When a system alarm occurs, the alarm message displayed on the screen, together with the LED indications on each PCB, help you to determine the cause. Record the LED indications for each PCB to enable rapid recovery of the system.

For the descriptions of LED lamps on each printed circuit board, see Chapter 7.

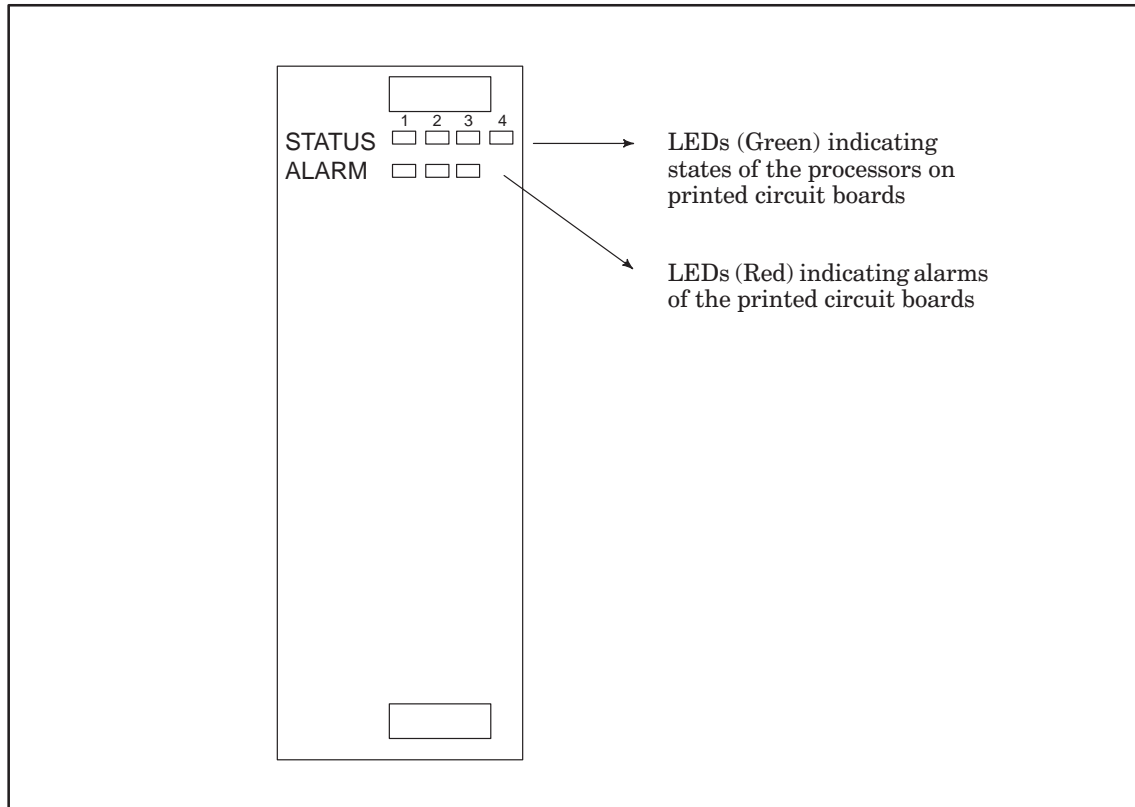


Fig. 3.2.3 LED Display for the Printed Circuit Boards in the Control Unit

3.2.4 The machine cannot be operated in the jog mode.

| Item | Possible cause of the problem | How to check the cause | Action to take |
|------|--|--|-----------------------|
| 1 | Failure analysis | Check whether the position display changes with the display lock (DLK) turned off. | |
| | | 1. The position display changes but the machine cannot be moved. | See Item 2. |
| | | 2. Neither the position display changes nor can the machine be moved. | See Item 5. |
| 2 | The machine lock (MLK) is on. | Check the MLK signal in the DGN data. | |
| 3 | The servo off signal is on. | Check the servo off signal in the DGN data. Check parameter No. 1802. | |
| 4 | Malfunction in the servo system | Refer to the "FANUC AC Servo Unit Maintenance Manual." | |
| 5 | The interlock signal is on. The JOG override is 0%. | Check DGN data (parameter No. 1000). | |
| 6 | The mode signal is not input. | Check that JOG or J + H is displayed for the status. | |
| 7 | The feed axis direction signal is not input. | Check the DGN data to see if the feed axis direction signal is input. Note When an axis command is input before the jog mode is selected, movement along the specified axis will not start. To start the movement, cancel the axis command and then input it again. | |
| 8 | An improper jog feedrate is specified. | Check parameter No. 1423. If the machine cannot be operated at rapid traverse, check the rapid traverse feedrate in parameters No. 1420 and thereafter. | |
| 9 | External reset (ERS) is on. Reset and rewind (RRW) is on. | Check that RSET is displayed for the status. | Check the connection. |
| 10 | Reference position return (ZRN) is on. | Check that REF is displayed for the status. | Check the connection. |

3.2.5 The machine cannot be operated by the manual pulse generator.

| Item | Possible cause of the problem | How to check the cause | Action to take |
|------|---|--|----------------|
| 1 | Failure analysis | Check whether the position display changes when the display lock (DLK) is off. | |
| | | 1. The position display changes but the machine cannot be moved. | See Item 2. |
| | | 2. Neither the position display changes nor can the machine be moved. | See Item 5. |
| 2 | The machine lock (MLK) is on. | Check the DGN data. | |
| 3 | The servo off signal is on. | Check the DGN data. Check parameter No. 1802. | |
| 4 | Malfunction in the servo system | Refer to the "FANUC AC Servo Unit Maintenance Manual." | |
| 5 | The interlock signal is on. The JOG override is 0%. | Check the DGN data. (parameter No. 1000). | |
| 6 | The mode signal is not input. | Check that HND or J + H is displayed for the status. | |
| 7 | The feed axis selection signal is not input. | Check the DGN data to see if the feed axis selection signal is input. | |
| 8 | External reset (ERS) is on. Reset and rewind (RRW) is on. | Check that RSET is displayed for the status. | |
| 9 | Reference position return (ZRN) is on. | Check that REF is displayed for the status. | |
| 10 | The manual pulse generator is defective. The cables are defective. | | |
| 11 | Correct options are not added. | Check the options with the data sheet. | |

3.2.6 The spindle cannot be operated in the synchronous feed mode.

| Item | Possible cause of the problem | How to check the cause | Action to take |
|------|----------------------------------|--|-----------------------------|
| 1 | Incorrect cable connection | Check the connection between the NC unit and the position coder. | |
| 2 | The spindle speed is incorrect. | Check the spindle speed on the screen. Check the DGN data. (parameter No. 1000). | |
| 3 | The position coder is defective. | | Replace the position coder. |
| 4 | The main CPU board is defective. | | Replace the main CPU board. |

3.2.7 The machine cannot be operated in the automatic mode.

| Item | Possible cause of the problem | How to check the cause | Action to take |
|------|--|---|----------------|
| 1 | Failure analysis | Turn the start button on and off in the automatic mode (T, D, or MEM). | |
| | | 1. The automatic operation startup (STL) lamp does not light. | See Item 2. |
| | | 2. The automatic operation startup (STL) lamp lights but the spindle does not move. | See Item 6. |
| 2 | The mode signal is not input. | Check that TAPE, MEM, or MDI is displayed for the status. | |
| 3 | The start signal is not input. | Check the start signal in the DGN data. | |
| 4 | Automatic operation hold signal (*SP) | Check that HOLD is displayed for the status. | |
| 5 | A reset signal is input. | Check that RSET is displayed for the status indication on the screen. Check the DGN data (parameter No. 1000). | |
| 6 | <ol style="list-style-type: none"> 1. The override is 0%. 2. Start lock and interlock are on. 3. The machine is making a position check. 4. The machine is waiting for a rotation signal to spindle 1 in thread cutting. 5. The machine is waiting for the spindle to rotate in the feed-per-rotation operation. 6. The machine is waiting for the spindle speed arrival signal. 7. The machine is reading data from the tape reader. | Check the DGN data (parameter No. 1000 and 1001). | |

3.2.8 The input/output unit of the reader/punch interface do not operate correctly.

| Item | Possible cause of the problem | How to check the cause | Action to take |
|------|---|---|---|
| 1 | Failure analysis | The machine cannot punch or read. PUNCH or READ is not displayed at the bottom of the screen during the above operation. | Check the procedure for the operation again, then see Item 2. |
| | | The machine cannot punch or read. "PUNCH" or "READ" is displayed at the bottom of the screen during the above operation. | See Item 5. |
| | | An alarm occurred. | See Item 3.2. |
| 2 | The reset signal is input. | Check the DGN data (parameter No. 1000). Check that RSET is displayed for the status. | |
| 3 | The mode signal is not input. | Check the DGN data (parameter No. 003) to see if either the EDT mode or MEM mode is set to 1. | |
| 4 | Correct options are not added. | Check the options with the data sheet. | |
| 5 | Improper setup | Check that correct input/output unit are selected in the setup procedure. (This can be checked by referring to parameter Nos. 20 and thereafter.) | |
| 6 | An improper baud rate is specified. | Check parameter Nos. 5001 and thereafter to see if the correct values for the following items are specified for each input/output unit selected in the setup procedure. 1. Baud rate 2. Stop bit 3. Whether the control code is used | |
| 7 | Operational error (improper operation) of the input/output unit | Check the operation by referring to the Operation Manual for the input/output unit. | |
| 8 | Incorrect cable connection | Check that the connection and wiring of the cables is correct. (The signal cables must be connected according to the specifications established between the machine tool builder and the input/output unit manufacturers.) | |
| 9 | The main CPU board or sub board is defective. | | Replace the printed circuit board. |

3.2.9 The machine does not return to the correct reference position.

(1) The position has deviated by one grid.

| Item | Possible cause of the problem | How to check the cause | Action to take |
|------|--|---|---|
| 1 | The position of the deceleration dog is not correct. | While moving the machine from the reference position toward the deceleration dog, monitor the deceleration signal using the diagnosis function, and read the position data on the NC unit to find out the distance between the reference position and the deceleration dog. | The distance from when the machine separates from the deceleration dog until it reaches the reference position must be set to about half the distance moved by one revolution of the motor (or $1/2 \lambda$ for Resolver or Inductosyn). |
| 2 | The deceleration dog is too short. | Determine the length of the deceleration dog using the above procedure. | Refer to the Connection Manual and change the dog to one having the required length. |
| 3 | The switch for the reference position approach signal is not installed at the proper position. | While moving the machine from the reference position toward the switch for the reference position approach signal, monitor the reference position approach signal using the diagnosis function. Read the position data on the NC unit to determine the distance between the reference position and the switch for the reference position approach signal. | The distance between the reference position and the switch for the reference position approach signal must be set to about half the grid spacing (one-half the distance moved by one revolution of the motor for the pulse coder, or $1/2 \lambda$ for Resolver or Inductosyn). |

(2) The deviation of the return position is random.

| Item | Possible cause of the problem | How to check the cause | Action to take |
|------|--|--|--|
| 1 | Noise | Check that shield of each cable is grounded. Check that a spark killer is attached to the solenoid coil. Check that the cable for the pulse coder is not routed with a power cable. | Ground the cable shield. Attach a spark killer. Separate the cables. |
| 2 | The power supply voltage to the pulse coder is too low. | Check that the voltage through the pulse coder is 4.75 V or more. (To check the voltage through the pulse coder, remove the cover of the servo motor and measure the voltage between the positive and negative terminals on the printed circuit board of the pulse coder or between the +5 V terminal and the 0 V diagnostic land.) | The total voltage drop through the cables must be 0.2 V or less in both the 5-V line and 0-V line. |
| 3 | The coupling between the servo motor and the machine is loose. | Put a marking on the motor shaft and check how the machine position corresponds to the motor rotation. | Tighten the coupling. |
| 4 | The pulse coder is defective. | Replace the pulse coder and check that the error is eliminated. | |
| 5 | The main CPU board or sub board is defective. | Replace the printed circuit board and check that the error is eliminated. | |

(3) The deviation of the return position is very small.

| Item | Possible cause of the problem | How to check the cause | Action to take |
|------|--|---|---|
| 1 | Momentary cable disconnection Improper connection of connectors | Check that the cable connectors are clamped and fixed securely. Check the soldering of each connector again. Check the cables are not disconnected, particularly at the bent portions. | Correct any improper cable connection. |
| 2 | The Main CPU board, sub CPU board, or additional axis board is defective, or servo amplifier is defective. | Specify 0 for bit 7 of parameter No. 1800 to suppress drift compensation, and check the positional deviation using the diagnosis function (DGN data in parameter Nos. 3000 and thereafter). The variation of the offset results in positional deviation and variation when the machine stops moving. Replace the main CPU or sub board, or the printed circuit board of the servo amplifier. | Replace the axis control printed circuit board or the printed circuit board of the servo amplifier. |

How to check the reference position return motion and the position of the deceleration dog

(1) Set each parameter according to the table below.

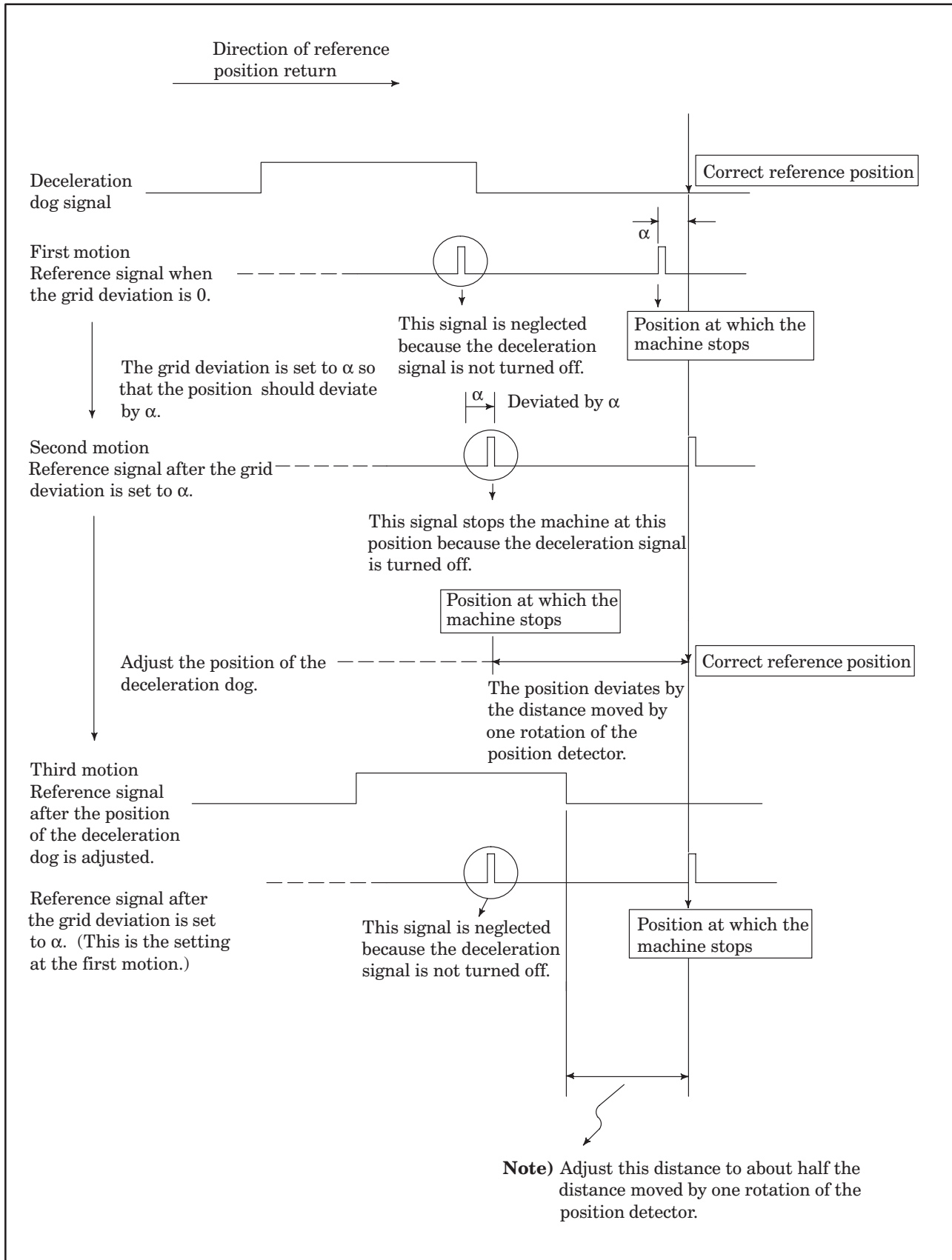
For parameter No. 1850, set the grid deviation to 0 at the beginning.

| Parameter No. | Description |
|---------------|--|
| 1400 | Sets whether manual rapid traverse is effective without returning the machine to the reference position. |
| 1006 | Direction of reference position return |
| 1816 | Sets the capacity of the reference counter for the X and Z axes in that order. |
| 1005 | Sets whether the reference position return function is effective, and sets how the machine is returned. |
| 1850 | Sets the grid deviation for the X and Z axes in that order. |
| 1425 | Sets the low feedrate (FL) in the reference position return motion. |
| 1240 A | Sets the coordinates of the reference position in the machine coordinate system. |
| 1024 | Sets the FM feedrate for reference position return with the magnetic switch. |

(2) Return the machine to the reference position and check that the motion is normal.

If the reference position needs to be adjusted, follow the procedure below.

- (i) For the grid method: The reference position can be adjusted by changing the grid deviation (parameter No. 1580). If the reference position needs to be moved by the distance moved by one rotation of the position detector (pulse coder or Resolver), also move the deceleration dog.
 - (ii) For the magnetic switch method: Adjust the position of the proximity switch.
- (3) Check the position of the deceleration dog. (Only when the grid method is used)
- (i) Return the machine to the reference position.
 - (ii) Note down the displayed position of the machine when at the reference position.
 - (iii) While checking the deceleration dog signal (*DECX or *DECZ) using the diagnosis function, move the machine at low speed from the reference position toward the dog until this signal turns on.
 - (iv) From the results obtained in (ii) and (iii) above, calculate the distance from the reference position to the position at which the deceleration dog signal turns on. Adjust the position of the deceleration dog so that this distance is about half the distance moved by one rotation of the position detector.



3.3 Displaying Conditions Using the Self-diagnosis Function

To quickly determine a breakdown cause the following should be done.

First, it has to be determined whether the breakdown occurred in the NC internal section, or the PMC, or on the machine tool side.

There are times when it appears that a breakdown has occurred even when a breakdown has not actually occurred. For example, when the machinery ceases to operate because the control unit is waiting for an external machine tool signal.

In this case, the condition of the interface between the CNC and PMC, or between the CNC and the machinery, and the conditions within the CNC needs to be investigated.

The explanation on displaying the breakdown condition of the CNC using the self-diagnostics function is shown below.

The following is an example of the five soft keys on 9" CRT/MDI unit. For a unit having 10 soft keys, such as a 14" CRT/MDI unit, the operation is basically the same. For general key operations, refer to the Operator's Manual.

The following shows the five soft keys on a 9" CRT/MDI unit.

| | | | | | |
|----------|---------|--------|---------|---------|---|
| POSITION | PROGRAM | OFFSET | PRG-CHK | CHAPTER | + |
|----------|---------|--------|---------|---------|---|

The names of the soft keys in the frames are displayed on the bottom line of the screen.

The + sign in the rightmost frame indicates that there are other soft keys which do not fit on the screen.

3.3.1 Diagnosis function for the interface with machine tools

The PMC sits between the CNC and machine tool and controls the logical relations for signals between them. Because the PMC actually exists as a separate internal function in the NC control unit, the CNC interface signals cannot be considered physical interface signals with the machine tool, that is DI/DO electric signals.

By using the self-diagnostics function, the logic state of each interface signal in the NC control unit can be displayed. Signals F, G, X and Y indicated in Fig. 3.3.1 can be displayed.

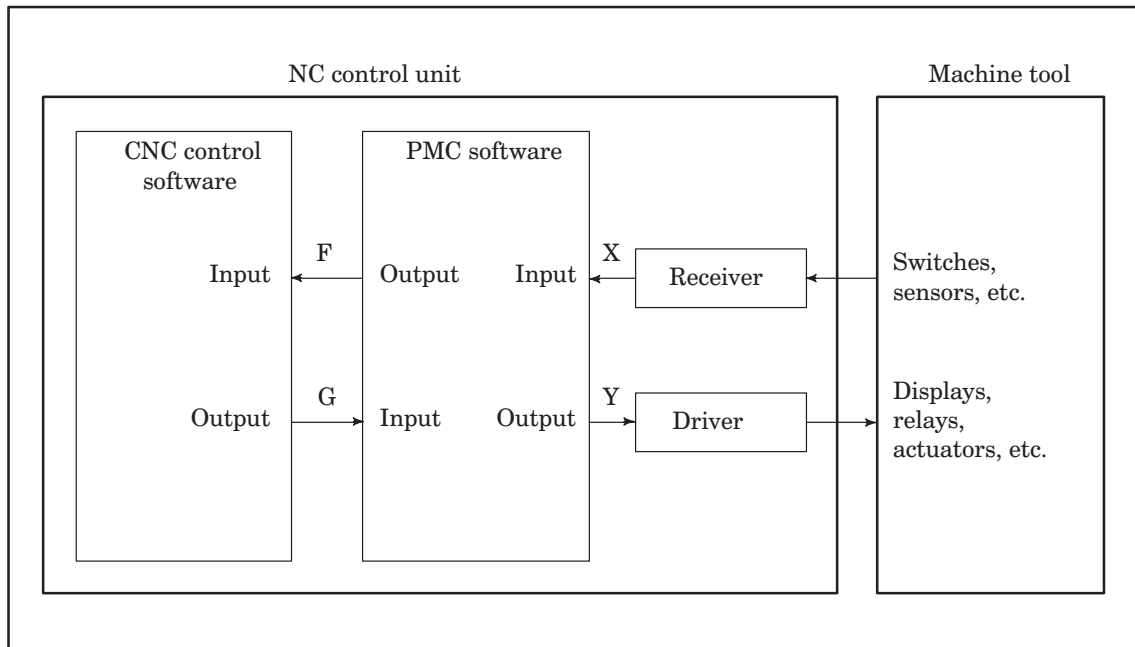


Fig. 3.3.1 Interface Signals that can be Displayed Using the Self-Diagnostics Function

For signal interfaces between the CNC and PMC, see Appendix 3. For details of each signal, refer to the following manuals:

FANUC Series 15-MODEL B Connection Manual (BMI Interface) B-62073E-1

Displaying the status of the signals which interface with the machine

- (a) Press the **CNC/PMC** key on the keyboard. The soft keys for the PMC basic menu appear.

| | | | | | |
|-------|-------|-------|-------|--|-------|
| PCMDI | PCLAD | PCDGN | PCPRM | | -ETC- |
|-------|-------|-------|-------|--|-------|

- (b) Press the **PCDGN** soft key. The PMC diagnostic function screen appears.

| | | | | | |
|--------|--------|--------|-------|-------|-------|
| SEARCH | 1 BYTE | M.SRCH | TRACE | TITLE | -ETC- |
|--------|--------|--------|-------|-------|-------|

- (c) Enter the address at which data is to be displayed from the keyboard and press the **SEARCH** soft key. The first 10-bytes of data from the specified address are displayed with the bit pattern on the screen.

Example X 1 0 0 SEARCH

- (d) Repeat the operation in (c) to display data at another address. Press the **↑** or **↓** key to display the previous or following address.

- (e) Press the **CNC/PMC** key to display the CNC screen.

NOTE The procedure above can also be used to display or modify the status of the PMC internal relays in addition to the status of the F, G, X, and Y signals. For details, refer to the following manual:

FANUC PMC-N/NA Programming Manual (Ladder language) B-61013E

FANUC PMC-NB Programming Manual (Ladder language) B-61863E

3.3.2 Function to display the CNC internal status

This function displays the simple internal status of CNC software. Specify the DIAGNOSIS screen on the SERVICE function menu to display the status.

When the machine stops moving along an axis during automatic operation, this function can be used to check whether the machined stopped because of a dwell command or position check, or because the interlock signal was set high.

If an alarm related to a servo amplifier or serial pulse coder occurs, this function can also be used to check the details of the error in addition to the displayed error message.

Displaying the CNC internal status

- (a) Press the function menu key (leftmost soft key) several times until the following function selection soft keys appear.

| | | | | | |
|---------|---------|---------|--|---------|---|
| SETTING | SERVICE | MESSAGE | | CHAPTER | + |
|---------|---------|---------|--|---------|---|

- (b) Press the **SERVICE** key to display the maintenance screen. When diagnostic data is not displayed on the maintenance screen (when DIAGNOSIS is not displayed at top left of the screen), press the **SERVICE** key several times until diagnostic data appears.

- (c) Scroll the screen using the **↑** or **↓** key or enter the number of the diagnostic data to be displayed from the keyboard, then press the **INP-NO.** key.

The soft keys automatically change to the following keys when a data number is entered.

| | | | | | |
|--|--|--|--|---------|---|
| | | | | INP-NO. | + |
|--|--|--|--|---------|---|

Example 1 0 0 0 INP-NO.

(1) Displaying the status of the PMC interface signals

The status of the interface signals (F and G) between the PMC and CNC can be displayed using the procedure described in Section 3.3.1. The status can also be displayed as the CNC internal status. The following table lists the correspondence between the numbers of this diagnostic data and address numbers (F000 and after and G000 and after) in Section 3.3.1.

| | Output from the CNC (G000 and after) | Input to the CNC (F000 and after) |
|-------------------------|---|--------------------------------------|
| For the BMI interface | Diagnostic numbers 0 and after | Diagnostic numbers 200 and after |
| For the FS3/6 interface | Diagnostic numbers 400 and after | Diagnostic numbers 500 and after |

For example, data passed to the PMC through address G010 by the CNC is displayed as diagnostic data with number 10 (for the BMI interface) or number 410 (for the FS3/6 interface). For the interface signals, see Appendix 3.

For details of each signal, refer to the corresponding interface connection manual. (See Section 3.3.1.)

(2) Displaying the status when it appears that a command is not being executed

| Number | Bit | Display | Internal status when 1 is displayed |
|--------|-----|---------------------|--|
| 1000 | 0 | INPOSITION CHECK | The position is being checked. |
| | 1 | FEED RATE OVERRIDE | The feedrate override is 0%. |
| | 2 | JOG FEED OVERRIDE | The jog feedrate override is 0%. |
| | 3 | INT./START LOCK ON | The start lock or interlock is on. |
| | 4 | SPEED ARRIVAL CHECK | The CNC is waiting for the speed-attained signal to be turned on. |
| | 5 | WAIT REVOLUTION | The CNC is waiting for the signal indicating that the spindle rotates once during threading. |
| | 6 | STOP POSITION CODER | The CNC is waiting for the position coder to rotate during spindle feed per rotation. |
| 1001 | 7 | BACKGROUND READING | The CNC is reading the tape in the foreground. |
| | 0 | BACKGROUND READING | The CNC is reading the tape in the background. |

(3) Displaying the start disable status

The details of the start disable status are displayed.

If a bit is on, correct the error and start the machine.

When the operator starts the machine, the bit is cleared. Only one of the following bits is on at the same time. If there are two or more causes, only the bit corresponding to the last cause is on.

| Number | Bit | | | | | | | |
|--------|-----|-----|-----|-----|-----|-----|----|----|
| 1005 | #15 | #14 | #13 | #12 | #11 | #10 | #9 | #8 |

| Number | Bit | | | | | | | |
|--------|-----|----|----|----|----|----|----|----|
| 1006 | #7 | #6 | #5 | #4 | #3 | #2 | #1 | #0 |

The bits indicate the following status when 1 is displayed for them:

- #0 : The automatic operation stop signal (*SP) is low.
- #1 : An alarm occurred.
- #2 : The SRN or BRN signal is on.
- #3 : An attempt was made to execute the same program in the background.
- #4 : The device is not ready in the tape mode.
- #5 : MDI execution data remains.
- #6 : The tool retraction signal (TRESC) is on. Alternatively, the machine is not at the position when the tool retraction signal was input.
- #7 : The status does not permit the program to be executed in reverse.
- #8 : The status of a DI or DO signal is invalid for a manual numerical command.(*1)
- #9 : The status of a DI or DO signal is invalid for repositioning.(*2)
- #10 : Other than the above(*3)
- #11 to #15: Not used.

*1 The DO DEN or IPEN signal is high.

Constant surface speed control is being executed.

The status of the DI HEAD1/2 signal is invalid in the MDI mode. (Only for the Series 15-TT)

*2 The DO OP signal is low for return operation.

The DI MLK signal is on.

The DO STL signal is on.

*3 The system enters the start lock state during tracing.

A tool is being retracted in the hobbing machine.

On the bed grinder, an alarm is issued or the DI MLK signal is on.

The axis to be retracted in the jog mode is at a position at which starting is disabled.

(4) Displaying the type of an alarm

The type of the alarm issued is displayed.

When the alarm status is released, the corresponding bit is set to 0.

| Number | Bit | | | | | | | |
|--------|-----|-----|-----|-----|-----|-----|----|----|
| 1007 | #15 | #14 | #13 | #12 | #11 | #10 | #9 | #8 |

| Number | Bit | | | | | | | |
|--------|-----|----|----|----|----|----|----|----|
| 1008 | #7 | #6 | #5 | #4 | #3 | #2 | #1 | #0 |

Each bit indicates an alarm type when 1 is displayed for the bit as follows:

- #0 : Background P/S alarm
- #1 : Foreground P/S alarm
- #2 : Overheating
- #3 : Sub-CPU error
- #4 : Excessive synchronous error
- #5 : Parameter writing switch on
- #6 : Overtravel/external data input/output error
- #7 : PMC error
- #8 : External alarm message
- #9 : Not used.
- #10 : Serious P/S
- #11 : Not used.
- #12 : Servo alarm
- #13 : I/O error
- #14 : Input of a parameter requiring power disconnection
- #15 : System error

(5) Displaying the warning status

The warning status is displayed.

When the warning status is released, the bit is set to 0.

| Number | Bit | | | | | | | |
|--------|-----|----|----|----|----|----|----|----|
| 1009 | #7 | #6 | #5 | #4 | #3 | #2 | #1 | #0 |

A bit indicates the following status when 1 is displayed for it.

- #0 : The system is in the warning state.
- #1 to #7 : Not used.

(6) Displaying the reset status

The reset status and the status of input signals related to feed hold are displayed.

| Number | Bit | | | | | | | |
|--------|-----|---|---|---|-----|-----|-----|-----|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 1010 | | | | | | | | |
| | | | | | RST | ERS | RRW | ESP |

The bits indicate the following status when 1 is displayed for them:

ESP : The emergency stop status is indicated.

RRW : The reset and rewind signal is on.

ERS : The external reset signal is on.

RST : The reset key is pressed.

(7) Displaying the details of a TH alarm

The details of a TH alarm are displayed.

| Number | Display | Description |
|--------|---------------------------|--|
| 1100 | POSITION (CHARACTER) F | Location of the character for which a TH alarm is issued indicated as the number of characters from the beginning of the block (TH alarm in the foreground) |
| 1101 | BIT PATTERN (CHARACTER) F | Read code of the character for which a TH alarm is issued with a bit pattern (TH alarm in the foreground) |
| 1100 | POSITION (CHARACTER) B | Location of the character for which a TH alarm is issued indicated as the number of characters from the beginning of the block (TH alarm in the background) |
| 1101 | BIT PATTERN (CHARACTER) B | Read code of the character for which a TH alarm is issued with a bit pattern (TH alarm in the background) |

(8) Displaying position deviation

The positional deviation of each axis is displayed.

| Number | Display | Description |
|--------|---------------|---|
| 3000 | X SERVO ERROR | Positional deviation along the X-axis in the detection unit |
| | Y SERVO ERROR | Positional deviation along the Y-axis in the detection unit |
| | Z SERVO ERROR | Positional deviation along the Z-axis in the detection unit |
| | : | |
| | : | |

(9) Displaying servo control information

Servo control information is displayed.

| | |
|--------------|---------------------------------------|
| 3010 to 3023 | Servo control information for axis 1 |
| 3030 to 3043 | Servo control information for axis 2 |
| 3050 to 3063 | Servo control information for axis 3 |
| 3070 to 3083 | Servo control information for axis 4 |
| 3090 to 3103 | Servo control information for axis 5 |
| 3110 to 3123 | Servo control information for axis 6 |
| 3130 to 3143 | Servo control information for axis 7 |
| 3150 to 3163 | Servo control information for axis 8 |
| 3170 to 3183 | Servo control information for axis 9 |
| 3190 to 3203 | Servo control information for axis 10 |
| 3210 to 3223 | Servo control information for axis 11 |
| 3230 to 3243 | Servo control information for axis 12 |
| 3250 to 3263 | Servo control information for axis 13 |
| 3270 to 3283 | Servo control information for axis 14 |
| 3290 to 3303 | Servo control information for axis 15 |

· Checking a disconnection or overload alarm

If a message indicating an overload alarm (SV 023) or disconnection alarm (SV 015) appears on the screen, check the diagnostic data to see if the data indicates an overload or disconnection alarm. The number of the diagnostic data is 3014 for axis 1, 3034 for axis 2, 3054 for axis 3, and the start number + 4 for other axes.

| #7 | #6 | #5 | #4 | #3 | #2 | #1 | #0 |
|-----|------|-----|------|------|------|------|------|
| OVL | LVAL | OVC | HCAL | HVAL | DCAL | FBAL | OFAL |

When an overload alarm is issued: #7 = 1

When a disconnection alarm is issued: #1 = 1

Details of digital servo alarms

| #7 | #6 | #5 | #4 | #3 | #2 | #1 | #0 |
|-----|------|-----|------|------|------|------|------|
| OVL | LVAL | OVC | HCAL | HVAL | DCAL | FBAL | OFAL |

| Symbol | Description |
|--------|---|
| OFAL | LSI OVERFLOW An overflow alarm occurred in the digital servo. |
| FBAL | PULCO DISCONNECTION A disconnected pulse coder alarm occurred. |
| DCAL | EXCESS I FROM MOTOR A regenerative discharge circuit alarm occurred in the servo amplifier. (LED DC on the servo amplifier is on.) |
| HVAL | EXCESS V TO MOTOR An overvoltage alarm occurred in the servo amplifier. (LED HV on the servo amplifier is on.) |
| HCAL | ABNORMAL CURRENT IN SERVO An abnormal current alarm occurred in the servo amplifier. (LED HC on the servo amplifier is on.) |
| OVC | EXCESS CURRENT IN SERVO An overcurrent (overload) alarm occurred in the servo amplifier. |
| LVAL | POWER V TOO LOW An insufficient voltage alarm occurred in the servo amplifier. (LED LV on the servo amplifier is on.) |
| OVL | SV OVERLOAD An overload alarm occurred in the servo motor or amplifier. When this alarm occurs in the servo amplifier, the servo amplifier, separate discharge unit, or power transformer is overheated. (LED OH on the servo amplifier is on.) |

Then check the diagnostic data to determine the cause of the alarm. The number of the diagnostic data is 3015 for axis 1, 3035 for axis 2, 3055 for axis 3, and the start number + 5 for other axes.

Check bits 7 and 4 at the address to determine the cause of the alarm by consulting the following table.

| #7 | #6 | #5 | #4 | #3 | #2 | #1 | #0 |
|------|----|----|------|----|----|----|----|
| ALDF | | | EXPC | | | | |

| Cause of the alarm | 7 bit ALDF | 4 bit EXPC |
|--|------------|------------|
| Motor overheated | 1 | 0 |
| Amplifier overheated | 0 | 0 |
| Disconnected built-in pulse coder (hard) | 1 | 0 |
| Disconnected separate pulse coder (hard) | 1 | 1 |
| Disconnected pulse coder (soft) | 0 | 0 |

Example When a disconnection alarm (SV 015) is issued for axis 1, assume that the diagnostic data of Nos. 3014 and 3015 is as follows:

No. 3014: 00000010

No. 3015: 10110100

FBAL (bit 1) of diagnostic data No. 3014 is set to 1.

Both ALDF (bit 7) and EXPC (bit 4) of diagnostic data No. 3015 are set to 1. The diagnostic data indicates that the cause of the alarm is a disconnected separate pulse coder (hard).

· Checking an absolute-position detection alarm

If an alarm is detected at power-on when the absolute position is detected optionally, the message SV101 DATA ERROR (ABS PCDR) or OT032 NEED ZRN (ABS PCDR) appears. The cause of the alarm is indicated in the diagnostic data.

If the alarm message SV101 DATA ERROR (ABS PCDR) or OT032 NEED ZRN (ABS PCDR) appears on the screen, the cause of the alarm is indicated in the diagnostic data. The number of the diagnostic data is 3018 for axis 1, 3038 for axis 2, 3058 for axis 3, and the start number + 8 for other axes.

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

| | | | | | | | |
|--------|-------|-------|-------|-------|--------|--------|--------|
| APMVAL | APPER | APFER | APTER | APCER | APBATZ | APPLSM | APNZRN |
|--------|-------|-------|-------|-------|--------|--------|--------|

| Symbol | Description (Action to be taken) |
|--------|--|
| APNZRN | Absolute-position detection is not correlated with the reference position. (Action: Correlate absolute-position detection with the reference position.) |
| APPLSM | A pulse error alarm occurred. (Action: Correlate the absolute-position detection with the reference position.) |
| APBATZ | The voltage of the battery of the absolute pulse coder is 0. (Action: Replace the battery and correlate absolute-position detection with the reference position.) |
| APCER | A communication error occurred during data transmission. (Action: Replace the pulse coder.) |
| APTER | A time-out error occurred during data transmission. (Action: Replace the pulse coder.) |
| APFER | A framing error occurred during data transmission. (Action: Replace the pulse coder.) |
| APPER | A parity error occurred during data transmission. (Action: Replace the pulse coder.) |
| APMVAL | An excessive motor displacement alarm occurred. This alarm occurs if the machine moves by more than 24,000 pulses in the detection unit at power-on. (Action: Take appropriate action for the machine so that it does not move at power-on.) |

3.4 Displaying System Configurations

The software and hardware configuration of the CNC unit can be displayed on the CRT display. This feature allows you to easily obtain hardware or software information necessary, for example, when maintaining the CNC.

The system configuration screen displays the following information:

- (1) Software information : The series and edition of the CNC control software, assemblies providing the software, and DRAM size are displayed. The machine name is displayed if registered in PRM 2390 to 2399.
The series and edition are also displayed for other software, including that enabling help messages, system boot, digital servos, serial spindle amplifiers, and PMC control.
- (2) Slot information : For each slot (physical slot) on the FBUS, the type and ID of the PCB inserted into that slot, if any, is displayed. If the PCB features a CPU, the series and edition of the software are also displayed.
- (3) Module information : The names and types of the modules mounted on each PCB are displayed. No information is displayed for those PCBs on which no module is mounted.

(1) Displaying information (When 9" CRT/MDI is used)

1. Specify the SERVICE screen.

| | | | | | |
|---------|---------|---------|--|---------|---|
| SETTING | SERVICE | MESSAGE | | CHAPTER | + |
|---------|---------|---------|--|---------|---|

2. Press the SYSTEM soft key.

| | | | | | |
|-------|-------|---------|---------|---------|---|
| PARAM | PITCH | DIAGNOS | DSP.MEM | CHAPTER | + |
|-------|-------|---------|---------|---------|---|

| | | | | | |
|--|--------|--|--|---------|---|
| | SYSTEM | | | CHAPTER | + |
|--|--------|--|--|---------|---|

3. Press the page keys ( ) to switch the screen.

(2) Screen

(a) Software information (When 9" CRT/MDI is used)

| | | |
|---------------------------------------|---------------|------------------|
| SYSTEM CONFIG (SOFTWARE) 01234 N12345 | | |
| CNC SYSTEM ID | : | SERIES / EDITION |
| F15M9A1. | : | AAB12. 00013. |
| ASSEMBLY | EDITION | DRAM SIZE |
| BASIC4. | 00015. | 8MBYTE6. |
| OPTION A1 | 0001 | |
| OPTION A2 | 0001 | |
| OPTION A3 | 0001 | MACHINE NAME |
| OPTION A4 | — | ABCDEFGHIJ7. |
| BASIC (SUB) | 0001 | |
| OPTION S1 | — | |
| MEM *** STOP **** * 01:23:45 LSK | | |
| | SYSTEM | CHAPTER+ |

1. CNC system ID
2. CNC control software series
3. CNC control software general edition
4. Assemblies providing CNC control software
5. Edition of each assembly (A dash indicates that the assembly is not used.)
6. DRAM size of CNC
7. Machine name (displayed only when set in PRM 2390 to 2399)

```

SYSTEM CONFIG (SOFTWARE)  O1234 N12345

SOFTWARE KIND   : SERIES / EDITION
HELP MESSAGE1. : AH002. / 00013.
SYSTEM BOOT    : 6014 / 0005
DIGITAL SERVO  : 9060 / 0005
SERIAL SPDL #1 : 9A20 / 0008
SERIAL SPDL #2 : 9A20 / 0008
PMC-NA        : 4046 / 0005
GRAPHIC       : 6001 / 0003
RMT BUF/DNC1  : 609A / 0004

MEM *** STOP **** *** *** 01:23:45 LSK
          SYSTEM                CHAPTER+

```

1. Software type
2. Software series
3. Software edition

(b) Slot information

```

SYSTEM CONFIG (SLOT)      O1234 N12345

SLOT      KIND          ID          SER./VER.
1.00:0    CNC CPU BOARD2. 3.1262:37  AAB1/00014.
02:1      PMC CPU BOARD  2077:3D   4046/0005
03:3      CNC SUB CPU BOARD F163:3A   AAB1/0001
04:4      GRAPHIC        0145:40   6001/0003
84:6      REMOTE BUFFER   013F:3C   609A/0004

MEM *** STOP **** *** *** 01:23:45 LSK
          SYSTEM                CHAPTER+

```

1.: Slot number

XX : X

- Physical slot number of FBUS 00 to 0F (primary slots on the front)
80 to 8F (secondary slots on the back)
- Logical slot number (slot number, logically assigned by CNC control software immediately after power-on)

2. : Type of printed-circuit board

3. : ID number

XXXX : XX

| | | |
|--|-------------|-------------------------------|
| Module ID (See Section 1.3 for details.) | XX3F : | Remote buffer mode |
| | XX45 : | Graphic CPU board |
| | XX62 : | Main CPU board (high-speed) |
| | XX63 : | Additional axis/sub-CPU board |
| | XX6B : | PMC-NB board |
| | XX6C : | FAPT/IAP CPU board |
| | XX71 : | Main CPU board (standard) |
| | XX74 : | ROM cassette adapter |
| | XX77 : | PMC-NA board |
| | Software ID | 37 : |
| | 39 : | NON CPU SUB |
| | 3A : | SUB CPU |
| | 3C : | RMT-BUF/DNC1 |
| | 3D : | PMC-NA CPU |
| | 40 : | Graphic CPU |
| | 41 : | ROM cassette adapter |
| | 42 : | PMC-NB CPU |
| | 44 : | DNC1 #2 |
| | 45 : | FAPT CPU |
| | 4C : | TC CPU |
| | 4D : | IAP CPU |

4. : Series and edition of software (displayed only for modules featuring a CPU)

(c) Module information

```

SYSTEM CONFIG (MODULE)  O1234 N12345

1.CMC MAIN CPU BOARD
MODULE
2.PROGRAM MEMORY (FROM) : 6MBYTE3.
MAIN MEMORY (DRAM) : 4MBYTE
MAIN MEMORY (SRAM) : TYPE A
TAPE MEMORY (FILE) : 512KBYTE
PERIPHERAL MODULE : -
CHARACTER CONTROL : 9" CRT
SPINDLE CONTROL : SERIAL, HI-DI
SERVO CONTROL 1/2 : DIGITAL
SERVO CONTROL 3/4 : DIGITAL

MEM *** STOP **** *** 01:23:45 LSK
SYSTEM CHAPTER+

```

1. Name of printed-circuit board

Module information is displayed for the following printed-circuit boards (if mounted):

- | | |
|----------------------------------|------------------------------|
| (1) CNC main CPU board | (2) CNC sub-CPU board |
| (3) Additional axis board 1 | (4) Additional axis board 2 |
| (5) PMC-NA CPU board | (6) PMC-NB CPU board |
| (7) Graphic CPU board | (8) Remote buffer/DNC2 board |
| (9) DNC1 CPU board | (10) CAP/FAPT CPU board |
| (11) RISC CPU board | (12) MMC-II main CPU board |
| (13) MMC-II graphic CPU board | (14) MMC-III main CPU board |
| (15) Axis CPU board (multi-axis) | |

2. Module name

The names of the modules mounted on the printed-circuit board, if any, are displayed.

3. Module type

The type of each module is displayed if there are two or more types of a certain module, such as types having different capacities. A dash is displayed for those modules for which there is only a single type.

– Modules mounted on each printed-circuit board

1) CNC main CPU board

| Module name | Module types (number of types) |
|-------------------------------|---------------------------------------|
| 1. Program memory (FROM) | 2M, 4M, 6M, 8M, 10M, 12M, 14MBYTE (7) |
| 2. Main memory (DRAM) | 2M, 4M, 8MBYTE (3) |
| 3. Main memory (SRAM) | TYPE-A, B, C, D, E, F, G, (7) |
| 4. Tape storage memory (FILE) | 64K, 128K, 256K, 512K, 1M, 2MBYTE (6) |
| 5. Peripheral module | – (1) |
| 6. Character control | 9", 10", 14" (3) |
| 7. Spindle control | SERIAL, ANALOG, (HDI) (4) |
| 8. Axis control 1/2 | DIGITAL, ANALOG (2) |
| 9. Axis control 3/4 | DIGITAL, ANALOG (2) |

2) CNC sub-CPU board

| Module name | Module types (number of types) |
|----------------------------|---------------------------------------|
| 1. Sub-CPU memory 1 (DRAM) | 1M, 1.25M, 2M, 4M, 8M (5) |
| 2. Sub-CPU memory 1 (SRAM) | TYPE-A, B, C, D, E, F, G, (7) |
| 3. Sub-CPU memory 2 | 64K, 128K, 256K, 512K, 1M, 2MBYTE (6) |
| 4. Spindle control | SERIAL, ANALOG, (HDI) (4) |
| 5. Axis control 5/6 | DIGITAL, ANALOG (2) |
| 6. Axis control 7/8 | DIGITAL, ANALOG (2) |
| 7. Analog I/O module | PORT-B, ANALOG-IN/OUT (7) |

3) Additional axis board 1

| Module name | Module types (number of types) |
|----------------------|--------------------------------|
| 1. Spindle control | SERIAL, ANALOG, (HDI) (4) |
| 2. Axis control 5/6 | DIGITAL, ANALOG (2) |
| 3. Axis control 7/8 | DIGITAL, ANALOG (2) |
| 4. Analog I/O module | PORT-B, ANALOG-IN/OUT (7) |

4) Additional axis board 2

| Module name | Module types (number of types) |
|----------------------|--------------------------------|
| 1. Axis control 9/10 | DIGITAL, ANALOG (2) |

5) PMC-NA CPU board

| Module name | Module types (number of types) |
|--------------------------|--------------------------------|
| 1. CPU module | – (1) |
| 2. PMC engine module | BOC2 (1) |
| 3. Optional DRAM module | 512K, 1M, 2MBYTE (3) |
| 4. Program memory (FROM) | 1M, 1.5M, 2MBYTE (3) |

6) PMC-NB CPU board

| Module name | Module types (number of types) |
|--------------------------|--------------------------------|
| 1. CPU module | – (1) |
| 2. PMC engine module | PMP (1) |
| 3. Optional DRAM module | 512K, 1M, 2MBYTE (3) |
| 4. Program memory (FROM) | 1M, 1.5M, 2MBYTE (3) |
| 5. EPROM module | 512K, 768K, 1MBYTE (3) |

7) Graphic CPU board

| Module name | Module types (number of types) |
|----------------------|--------------------------------|
| 1. CPU module | – (1) |
| 2. Character control | 9", 10", 14" (3) |
| 3. Graphic engine 1 | – (1) |
| 4. Graphic engine 2 | – (1) |

8) Remote buffer/DNC2

| Module name | Module types (number of types) |
|-------------------------|--------------------------------|
| 1. Communication module | — (1) |

9) DNC1 CPU board

| Module name | Module types (number of types) |
|-------------------------|--------------------------------|
| 1. Communication module | — (1) |

10) CAP/FAPT CPU board

| Module name | Module types (number of types) |
|-----------------|--------------------------------|
| 1. CPU module | — (1) |
| 2. EPROM module | 512K, 768K, 1MBYTE (3) |
| 3. SRAM module | 128K, 256K, 512K, 1MBYTE (4) |
| 4. DRAM module | 128K, 256K, 512K, 1MBYTE (4) |

11) RISC CPU board

| Module name | Module types (number of types) |
|------------------|--------------------------------|
| 1. EPROM module | 512K, 1MBYTE (2) |
| 2. SRAM module | 512K, 1MBYTE (2) |
| 3. DRAM module 1 | 1M, 2MBYTE (2) |
| 4. DRAM module 2 | 1M, 2MBYTE (2) |

12) MMC-II main CPU board

| Module name | Module types (number of types) |
|----------------------|-----------------------------------|
| 1. RAM file module | 128K, 256K, 512K, 1M, 2M, 4M, (6) |
| 2. ROM file module 1 | 128K, 256K, 512K, 1M, 2M, 4M, (6) |
| 3. ROM file module 2 | 128K, 256K, 512K, 1M, 2M, 4M, (6) |
| 4. SCC module | — (1) |
| 5. DMA module | — (1) |
| 6. DRAM module 1 | 1M, 2M, 4M, 8M (4) |
| 7. DRAM module 2 | 1M, 2M, 4M, 8M (4) |

13) MMC-II graphic board

| Module name | Module types (number of types) |
|-------------------|--------------------------------|
| 1. Graphic engine | — (1) |

14) MMC-III main CPU board

| Module name | Module types (number of types) |
|--------------------------|--|
| 1. System control | 2-PORT, 3-PORT (2) |
| 2. Graphic control | 4-SCREEN, 8-SCREEN (2) |
| 3. Character control | — (1) |
| 4. Main memory (DRAM) | 1.5M, 2.5M, 3.5M, 4.5M, 6M, 8MBYTE (6) |
| 5. Program memory (FROM) | 1M, 2M, 3M, 4M, 6MBYTE (5) |
| 6. Data file (SRAM) | 128K, 256K, 1M, 2MBYTE (4) |

15) Axis CPU board (axis CPU 1 to 6)

| Module name | Module types (number of types) |
|-------------------------------|--------------------------------|
| 1. Axis CPU memory (DRAM) | 1M, 1.25M, 2M, 4M, 8M (5) |
| 2. Spindle control | SERIAL, ANALOG, (N-ZERO) (4) |
| 3. Axis control 1/2 | DIGITAL, ANALOG (2) |
| 4. Axis control 3/4 | DIGITAL, ANALOG (2) |
| 5. Malfunction check module 1 | 2-POS, 4-POS (2) |
| 6. Malfunction check module 2 | 2-POS, 4-POS (2) |

4. CONFIRMING POWER SOURCE VOLTAGE AND POWER CONNECTION

4.1 Confirming Power Source Voltage

4.1.1 Power supply in the control unit

Confirm that the AC power being supplied to connector CP1 of the power supply in the control unit fulfills the following conditions.

200 VAC +10% -15%, 50/60Hz ±1Hz, single phase

220 VAC +10% -15%, 50/60Hz ±1Hz, single phase

The following two LEDs are located on the power supply of the control unit.

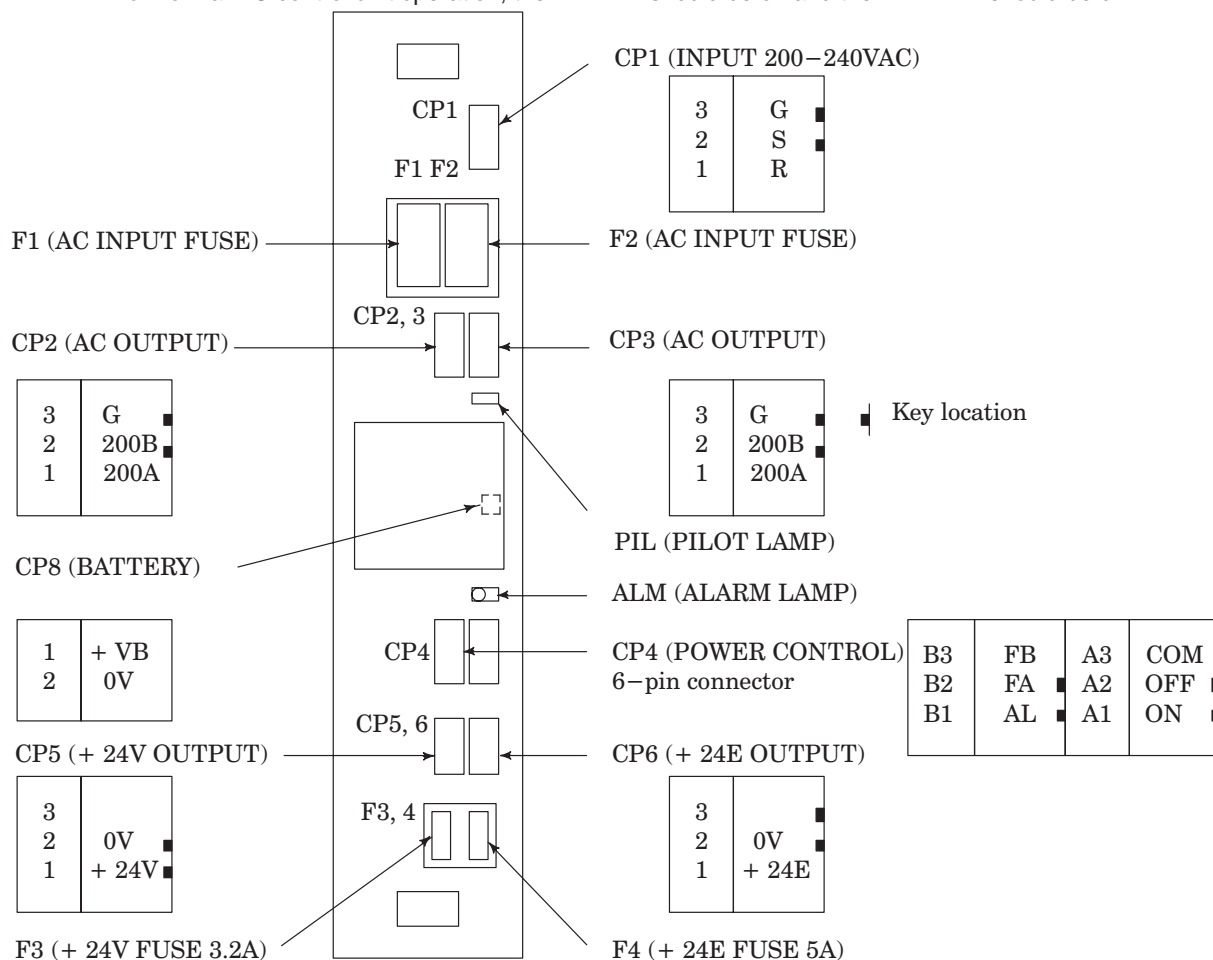
PIL (green) : Pilot lamp

Indicates the power supply unit is ready for operation.

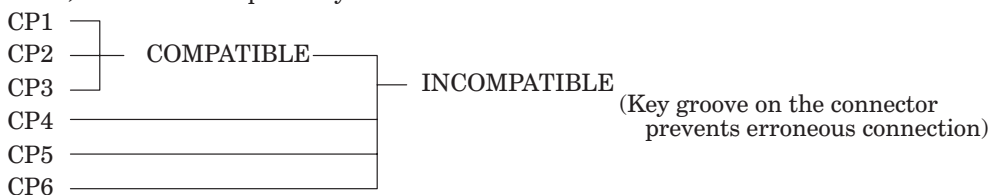
ALM (red) : Alarm lamp

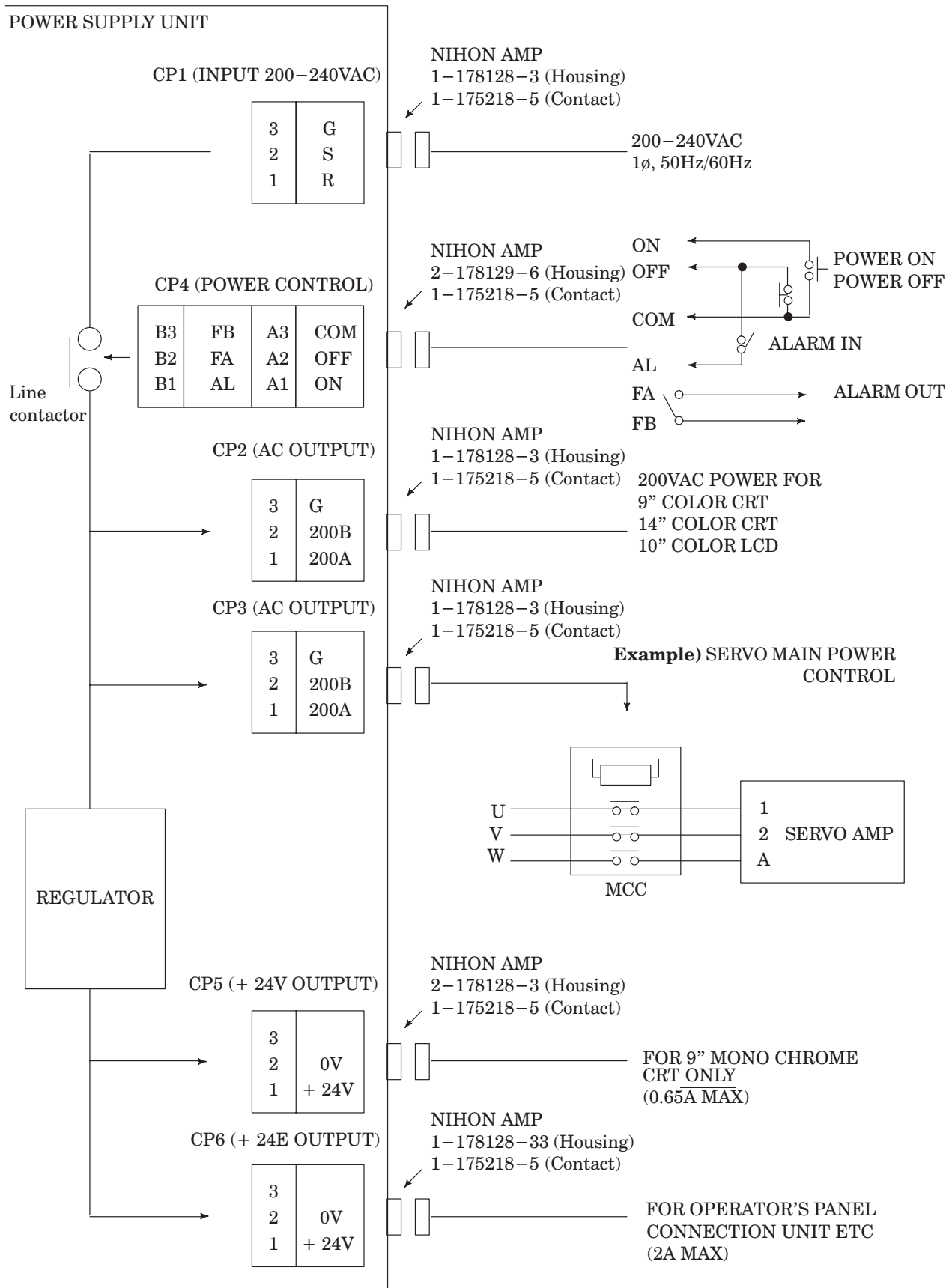
This LED indicates the power supply has detected a fault. The fault could be the result of something like a direct current output short-circuit.

For normal NC control unit operation, the PIL LED should be on and the ALM LED should be off.



Note 1) Connector compatibility





4.1.2 Servo amplifier

- (1) Checking the voltage of the control section of the servo amplifier

Check the DC voltage of the control section of the servo amplifier for each axis. Refer to the maintenance manual of each servo unit for details of how to perform this check.

- (2) 100 V power supply for MCC control

To operate the conductor (MCC) which connects the servo amplifier output to the servo motor, 100 VAC must be supplied to the servo amplifiers for each axis.

When checking the voltage, it is necessary to release the emergency stop switches on the operator's panel and machine. Otherwise, the emergency stop contact in the power supply would close, resulting in the output of an alarm.

4.1.3 Checking the ground connection

Check that the SYSTEM GND of the NC unit is correctly grounded. Check also that each individual unit is correctly grounded.

For details of grounding, refer to the item covering countermeasures against noise in the FANUC Series 15-MODEL B Connection Manual (B-62073).

4.2 Confirmation of Power Supply Connection

4.2.1 Tap change of control power transformer

A control power transformer is required when the input power supply is other than 200 VAC 50/60 Hz or 220 VAC 50/60 Hz.

Check the transformer tap, and confirm that the voltage (at the NC power supply terminal) is within +10% and -15% of the tap voltage. If the voltage is outside this range, the tap must be changed.

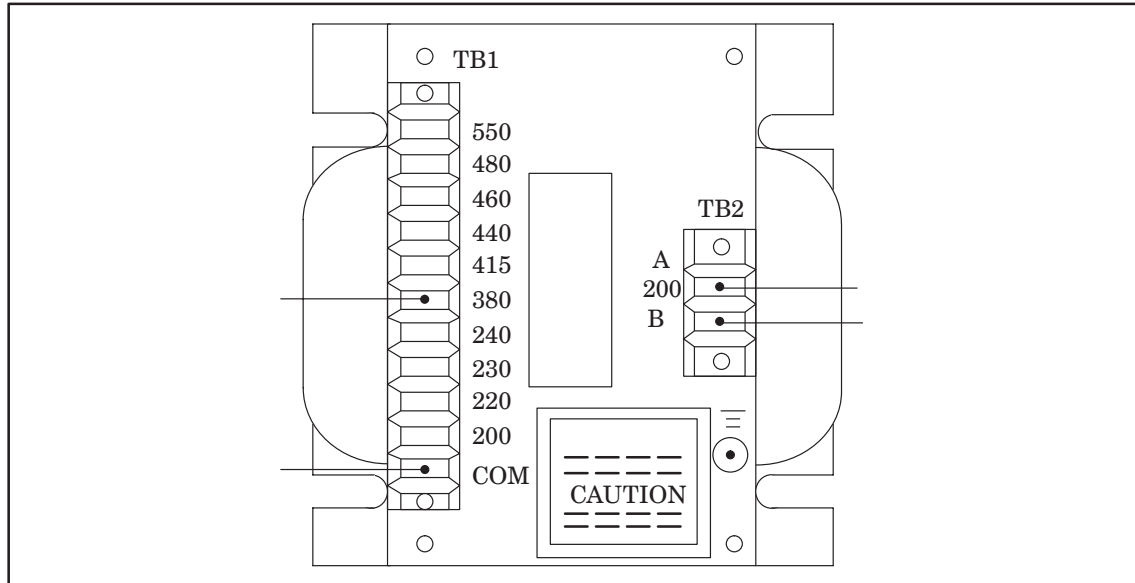


Fig. 4.2.1 Tap connection for 380 VAC

4.2.2 Connection of AC servo power transformer

A power transformer is required when the input power supply is other than 200 to 230 VAC. In this case, make sure the input tap of the power supply transformer is set according to the input voltage when connecting the power supply cable to the AC servo unit.

If set incorrectly, the AC servo amplifier may cause trouble.

1) Primary side connection

Connection of the transformer terminals and power supply cables U, V, and W must follow the input supply voltage specifications in Table 4.2.2.

Table 4.2.2 Connection of Input Power Cables for the Transformer and Connection between Primary Terminals

| Power voltage | Connection of power cables U, V, W | Terminals to be connected | Remarks |
|---------------|------------------------------------|-----------------------------|------------------|
| 200V | U-7, V-15, W-23 | 8-15, 16-23, 24-7 | Delta connection |
| 220V | U-6, V-14, W-22 | 8-14, 16-22, 24-6 | |
| 230V | U-5, V-13, W-21 | 8-13, 16-21, 24-5 | |
| 240V | U-4, V-12, W-20 | 8-12, 16-20, 24-4 | |
| 380V | U-6, V-14, W-22 | 8-16, 16-24 or (8-16-24) | Star connection |
| 415V | U-4, V-12, W-20 | | |
| 460V | U-3, V-11, W-19 | | |
| 480V | U-2, V-10, W-18 | | |
| 550V | U-1, V-9, W-17 | | |

4.3 Confirming CNC Control Unit Connection

4.3.1 Series 15-MB total connection diagram (In case of serial spindle)

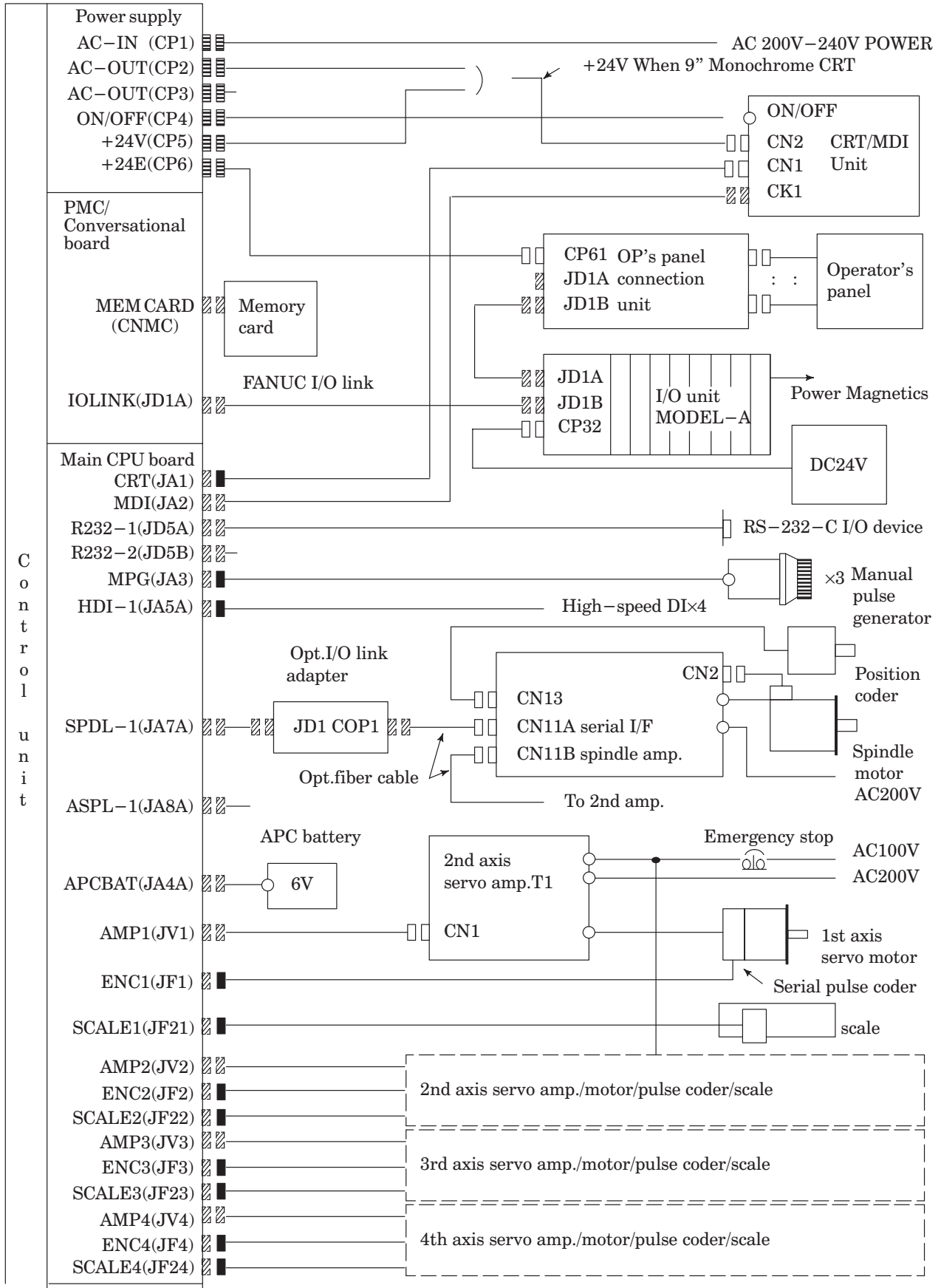


Fig. 4.3.1 (a) Total Connection Diagram (1/2)

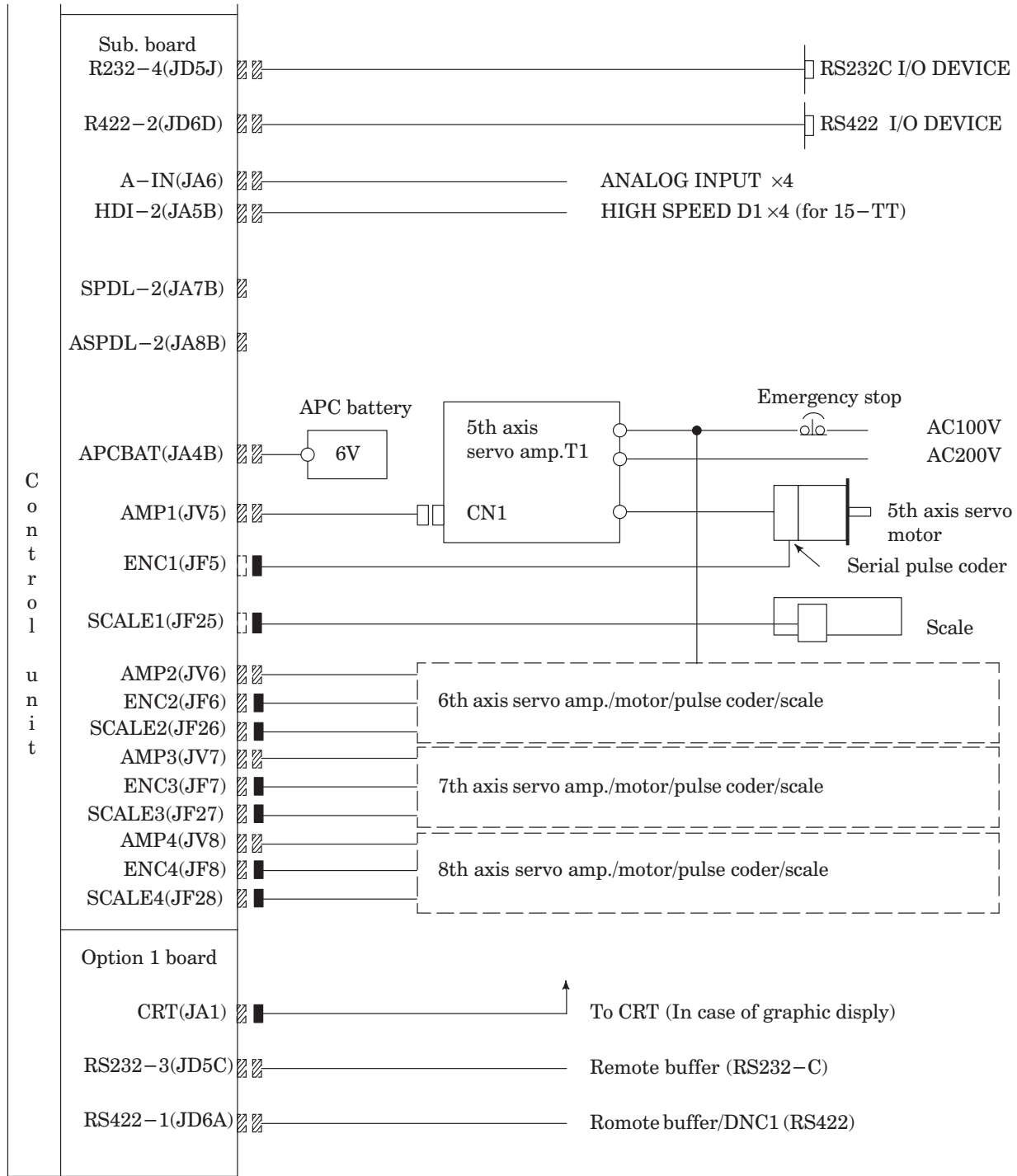


Fig. 4.3.1 (a) Total Connection Diagram (2/2)

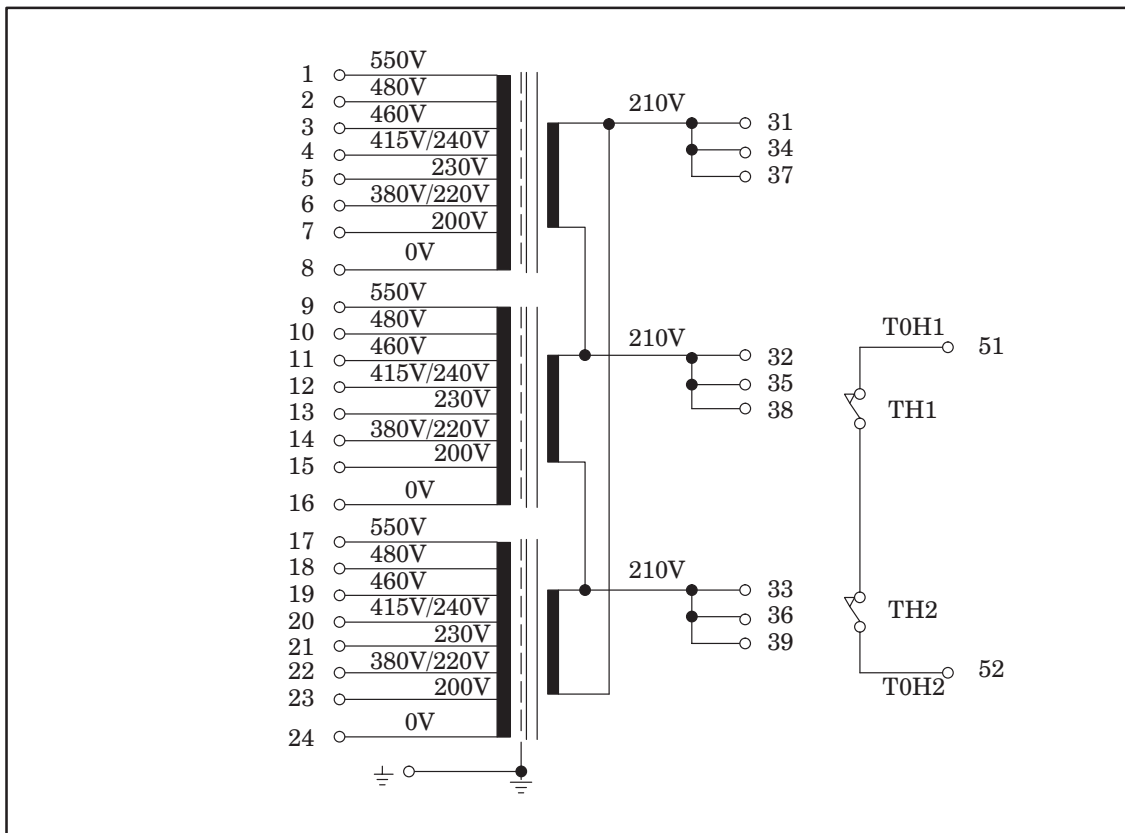


Fig. 4.3.1 (b) Connection Diagram

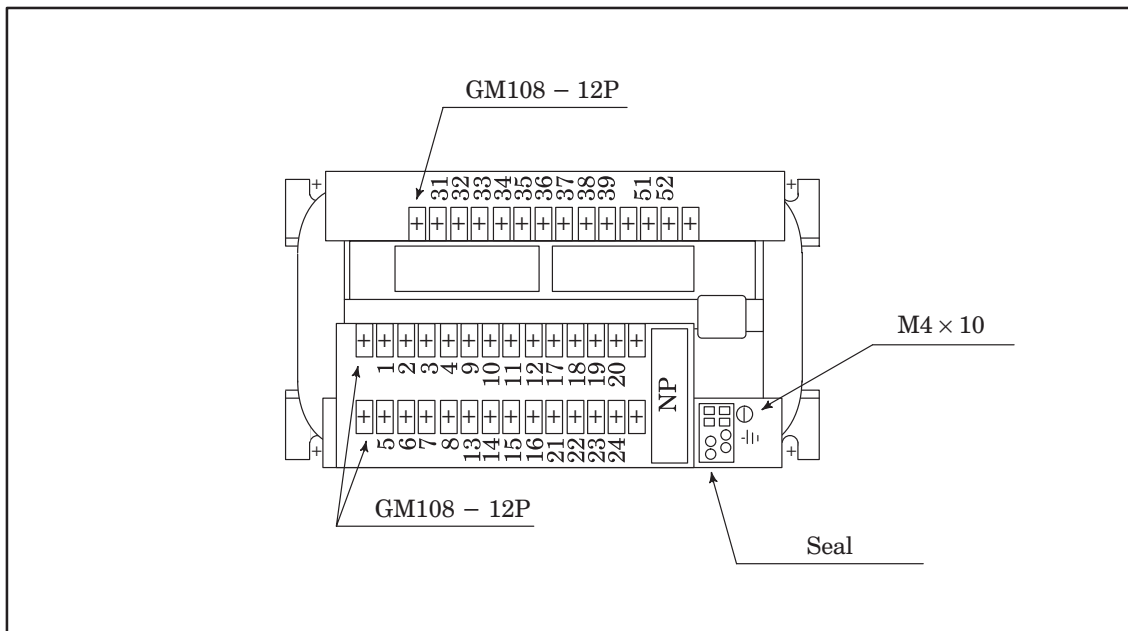


Fig. 4.3.1 (c) Pin Assignment of the Servo Power Transformer

4.3.2 Connection of FANUC I/O Link

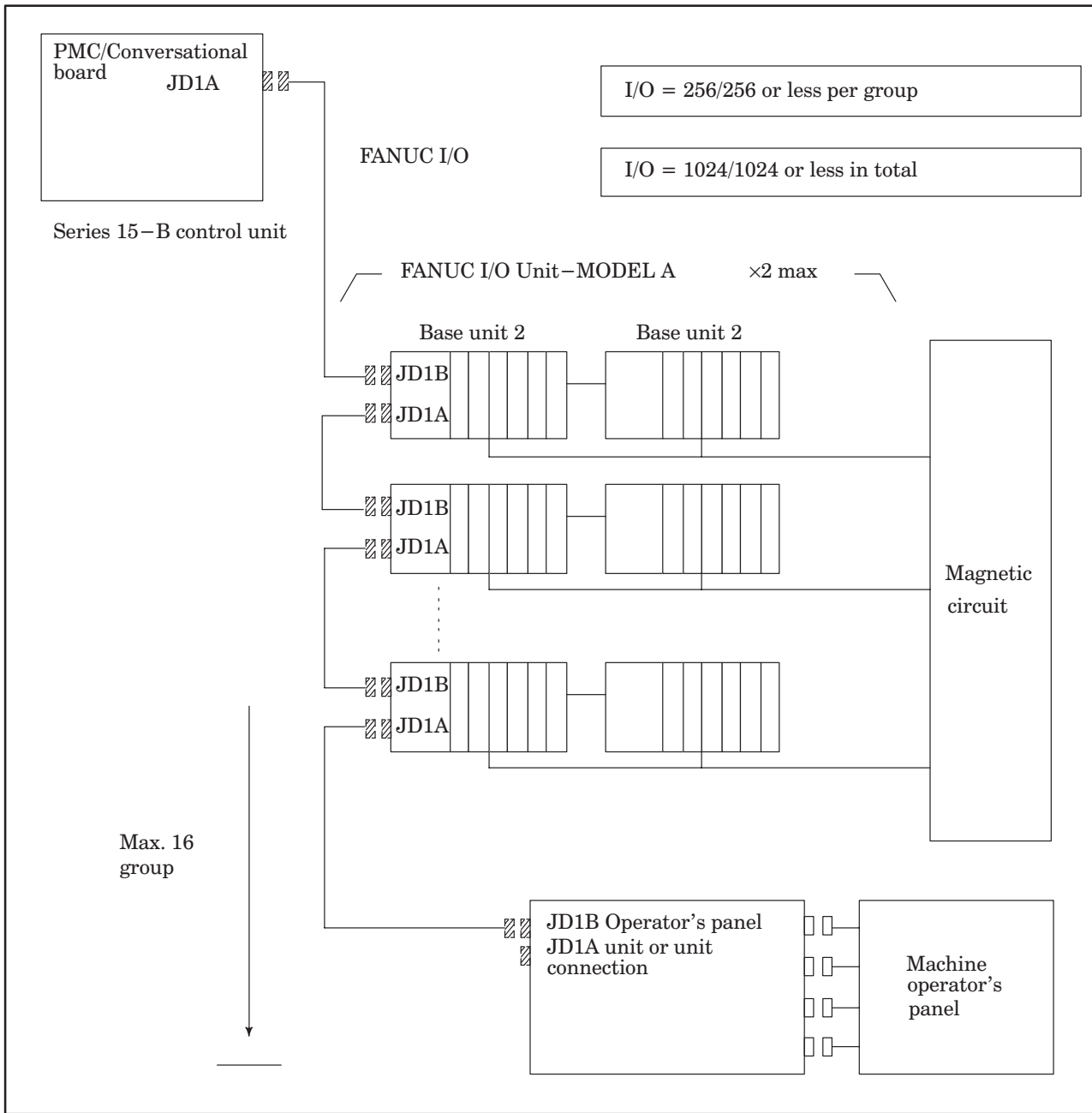
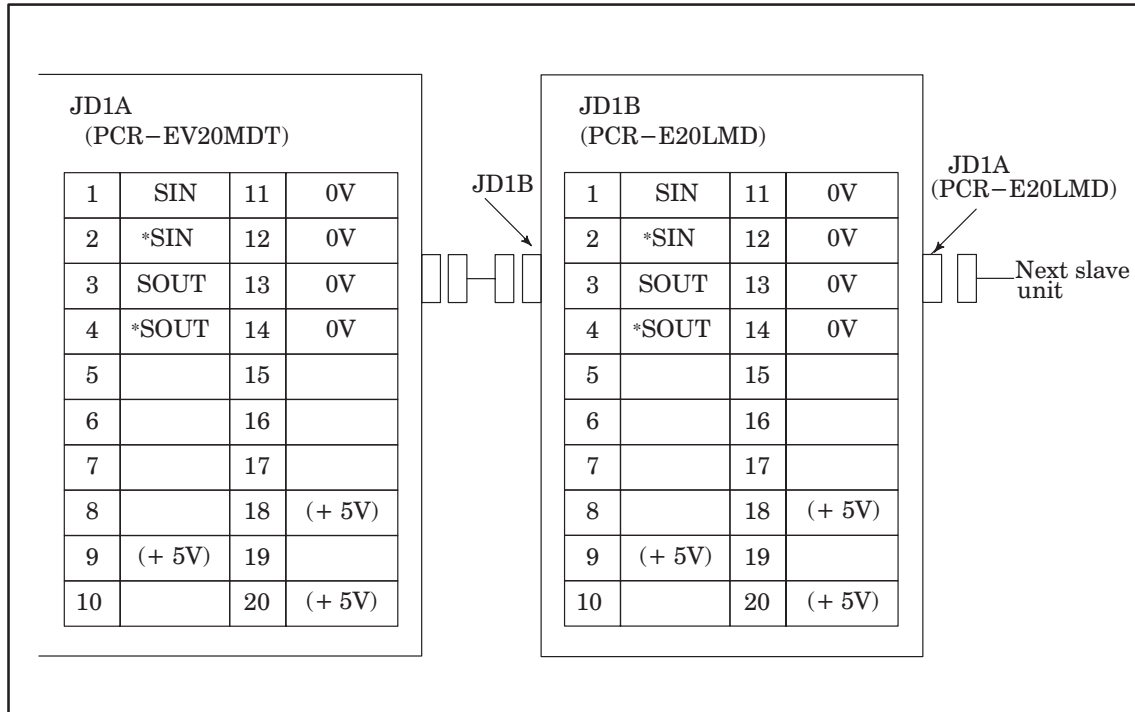


Fig. 4.3.2 I/O Link connection Diagram

- (1) Connection of FANUC I/O link by metal cable
Series 15-B control unit or former slave unit

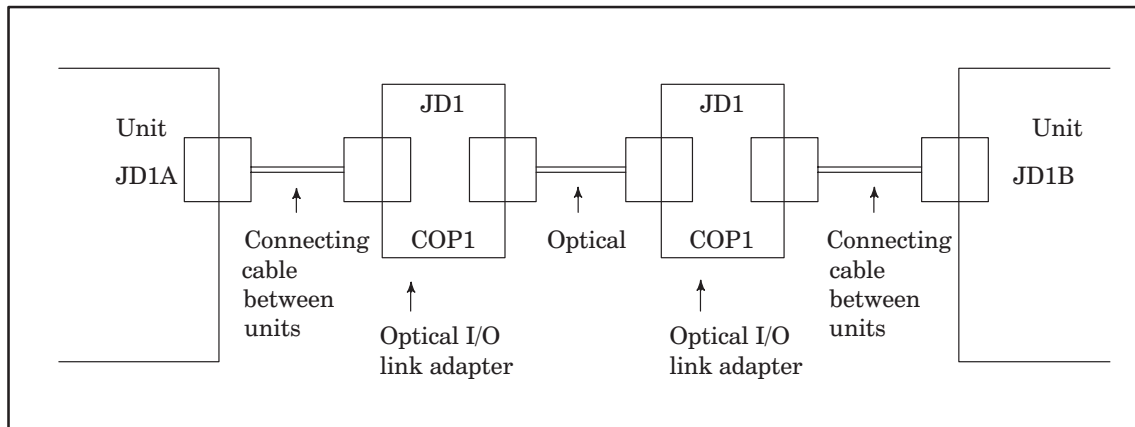


+5 V terminals are for an optical I/O link adapter. They are not used when connecting with a metal cable.

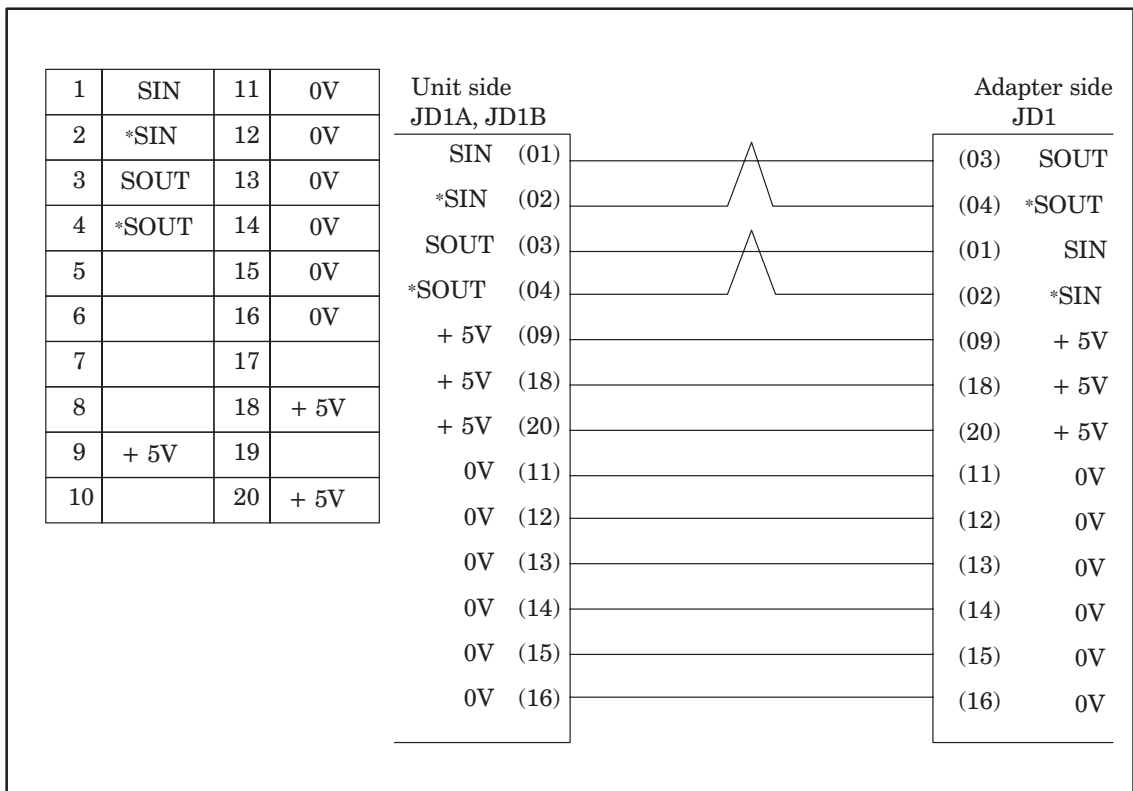
- (2) Connection of FANUC I/O link by optical fiber cable

The FANUC I/O Link can be extended to the maximum length of 200 m with optical fiber cables using an optical I/O link adapter.

- (a) Connection diagram



(b) Interunit connecting cables



1. Recommended connector for cable side : PCR-E20FS (made by HONDA communication Co., Ltd.)
2. Recommended cable (wire material): A66L-0001-0284#10P
3. Cable length: Max. 2 m (when the recommended cable is used)

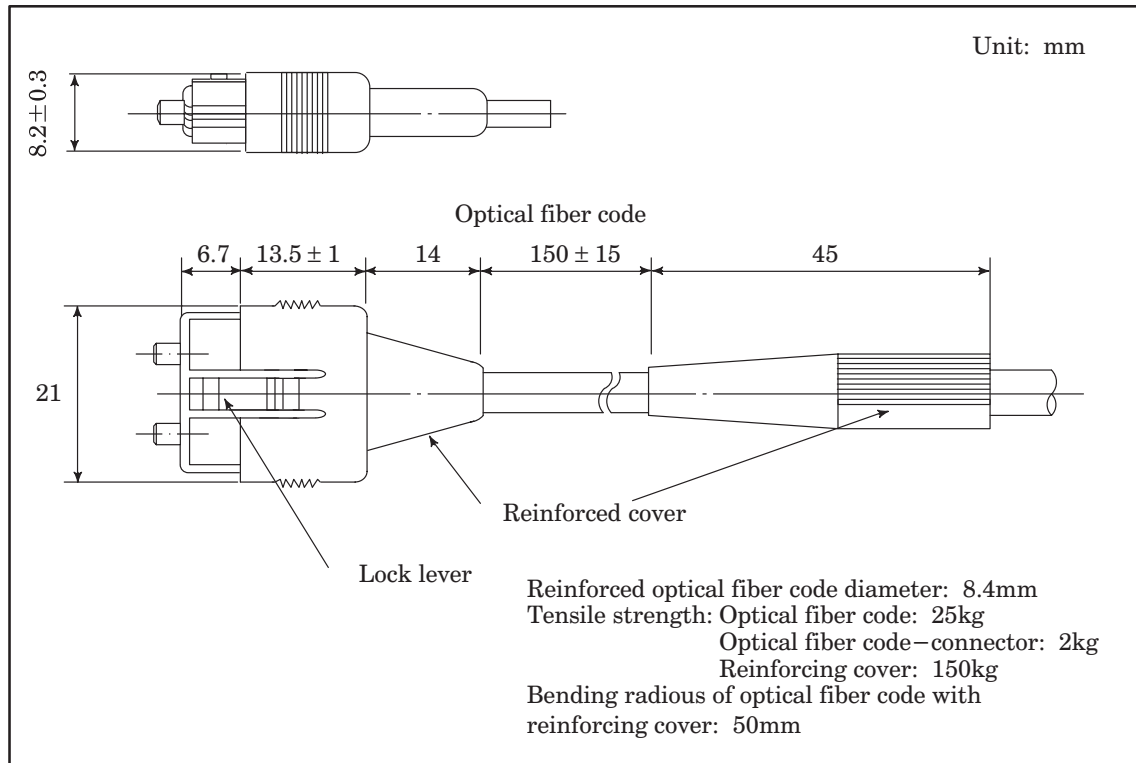
(c) Optical cable

1. Specification: A66L - 6001 - 0009 (Make sure to use one with this specification)
2. Cable length: Max. 200 m

4.3.3 Optical fiber cable

This CNC uses optical cables for connections between the control unit and the I/O unit. Unlike the conventional power cables, optical fiber cables need special care in installation and handling.

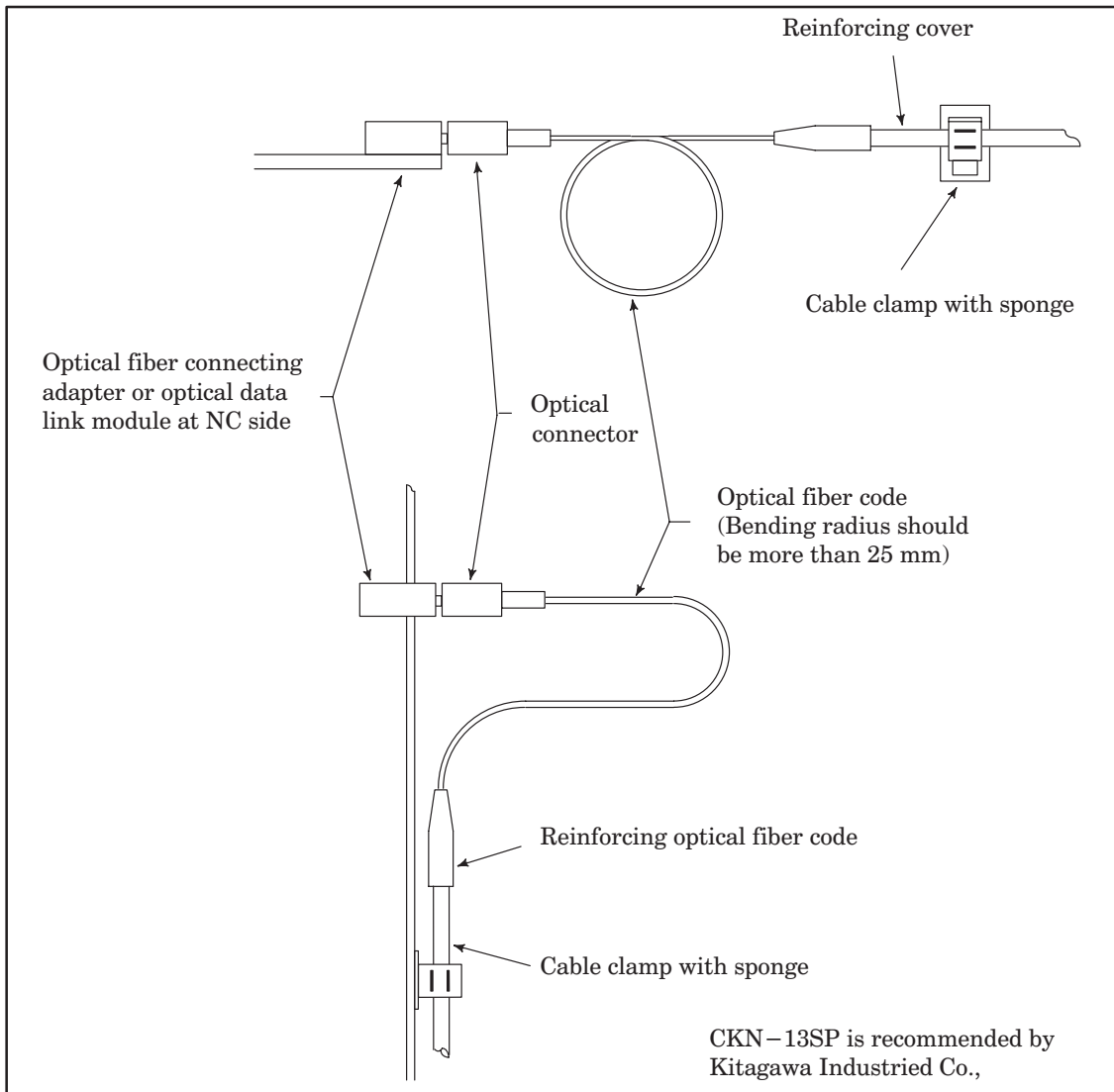
(1) External view of optical fiber cable



- (a) Standard length of an optical fiber cable is 5, 10, and 15 meters.
- (b) An optical fiber cable cannot be cut and joined at machine manufacturers side.
- (c) If it needs to relay on cabling, use optical fiber adapter. Up to one relay points are allowed on a transmission line.

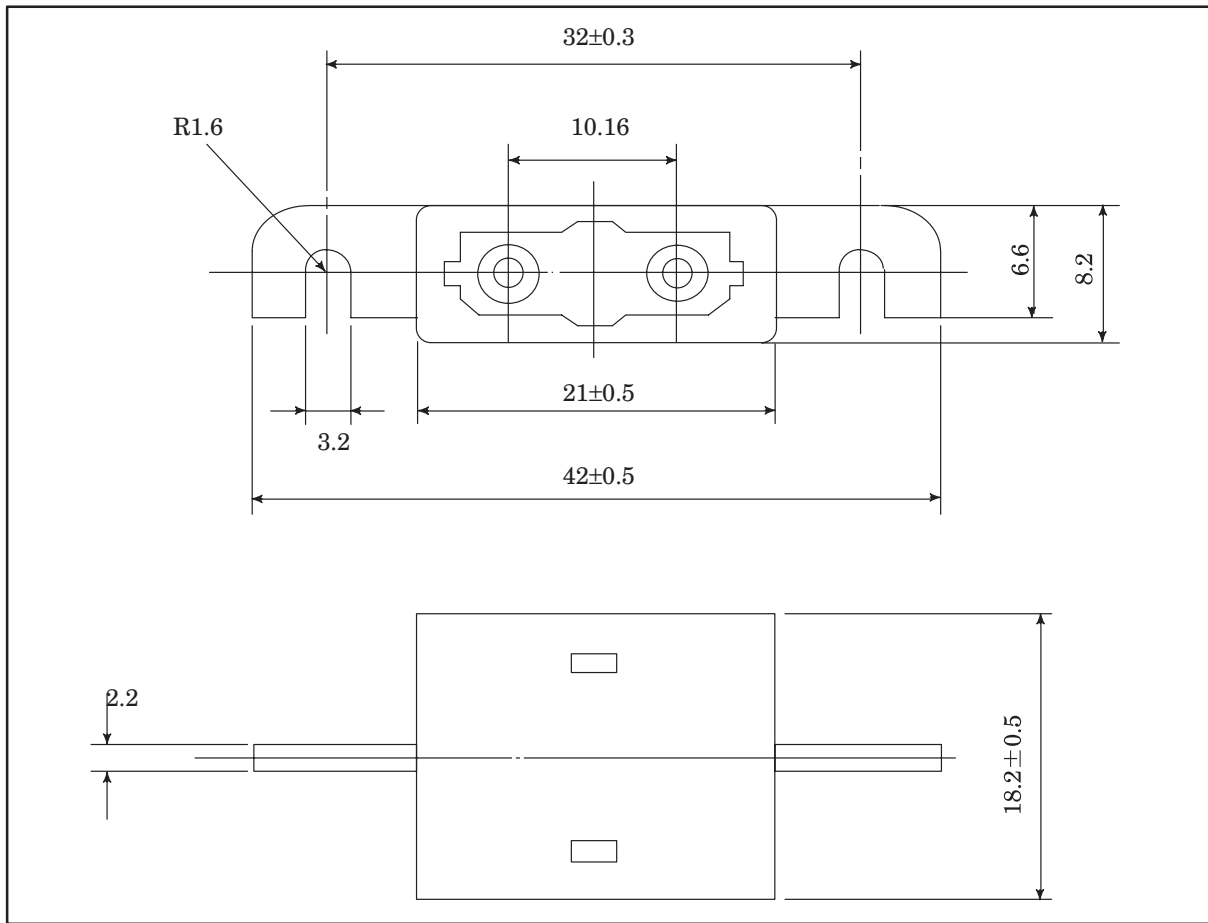
(2) Optical fiber cable clamping method

When reinforcing cover is fixed at cable clamp with sponge, enough sag at optical fiber code as shown below is necessary so that connecting part of optical should not be weighed directly by optical fiber cable.

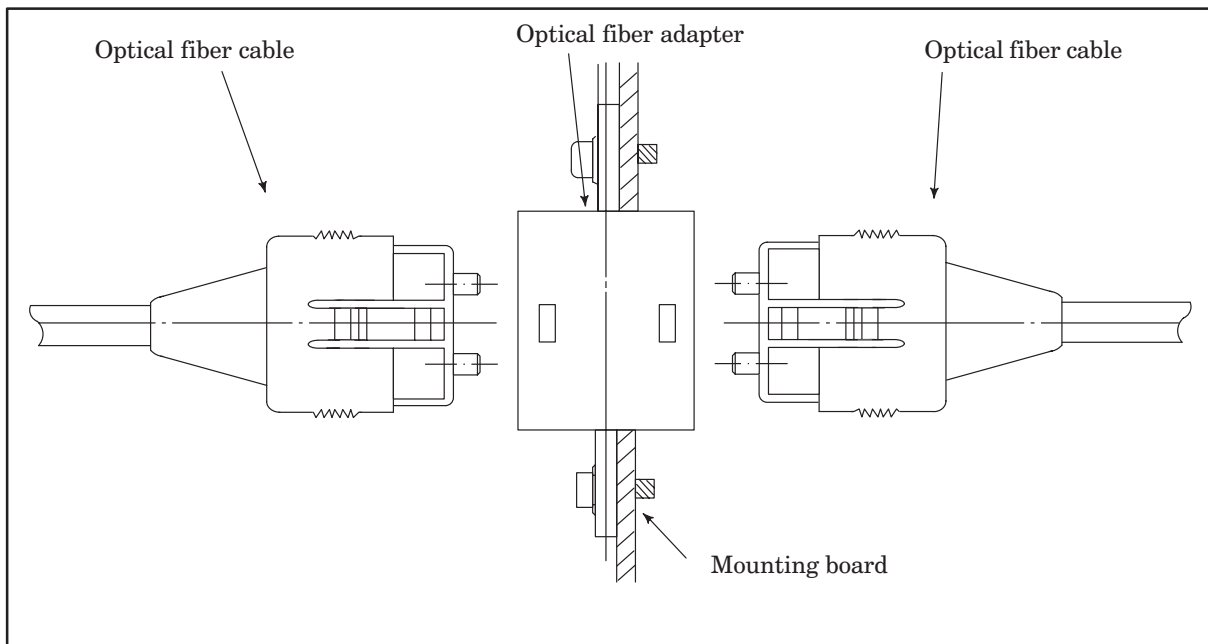


(3) Relay using an optical fiber adapter

(a) External view of an optical fiber adapter



(b) Example of the use of an optical fiber adapter



NOTE Up to one relay points are permitted.

(4) Maximum transmission distance by optical fiber cable

Maximum transmission distance by optical fiber cable is shown below:

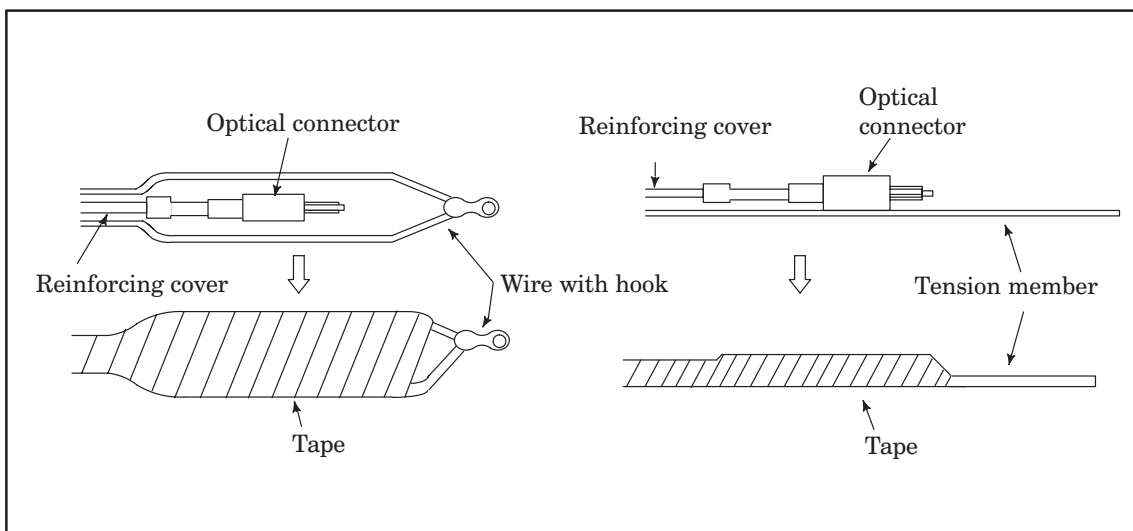
Maximum transmission distance varies depend on numbers of relay points by optical fiber adapter.

| Relay points | Max. trans. distance (total) |
|--------------|------------------------------|
| 0 | 200m |
| 1 | 100m |

(5) Notice of optical fiber cable handling

- (a) Even though reinforcing cover used on the optical fiber code has enough mechanical strength, be sure not to be damaged by heavy materials drop.
- (b) Detaching and attaching of optical connector should always be made by touching connector. Optical fiber code should not be touched when replacement.
- (c) Optical connector is automatically locked with upper side lock levels after being connected. It is impossible to pull out the connector without releasing the lock levers.
- (d) Optical connector can not be connected oppositely. Be sure the connector direction when connection is done.
- (e) Optical connector should be processed as follows before laying of optical fiber cable.
 - Fix a reinforcing cover to a wire with hook or tension member by a tape.

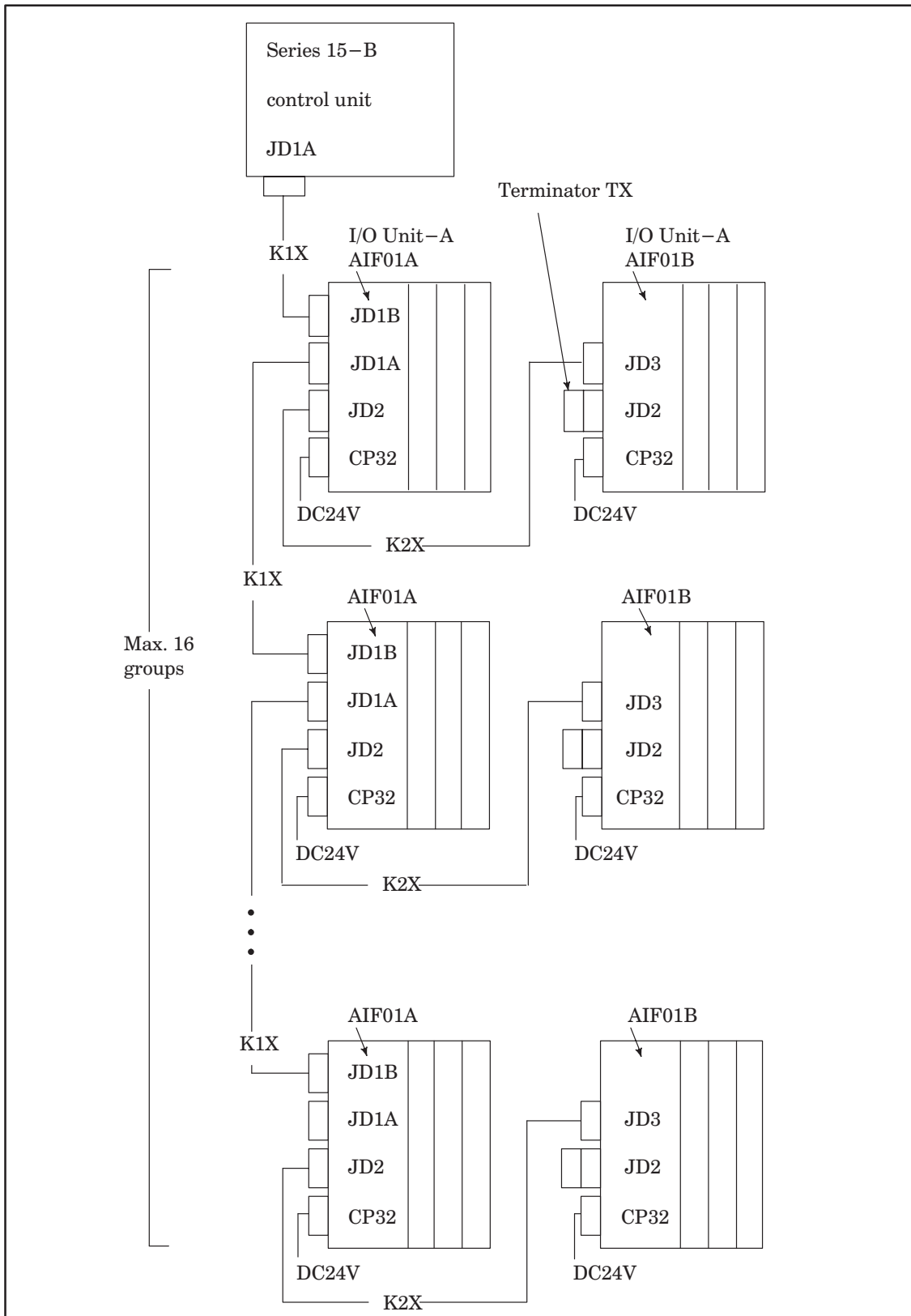
At laying hook the wire or pull the tension member taking enough care that optical connector does not receive pulling strength.



- (f) Reinforcing cover is fixed to cable lamp so that optical fiber cable could not weigh directly the connecting part of connector.
- (g) Notice that optical connector's chip is clear.
 - The attached protect cap must be always put on when optical connector is not used.
 - Remove dirty with a clear tissue or absorbent cotton (cotton with ethyle alcohol is applicable). No other organic solvent than ethyl alcohol can not be used.

4.3.4 Connection of I/O Unit—MODEL A

(1) Connection diagram

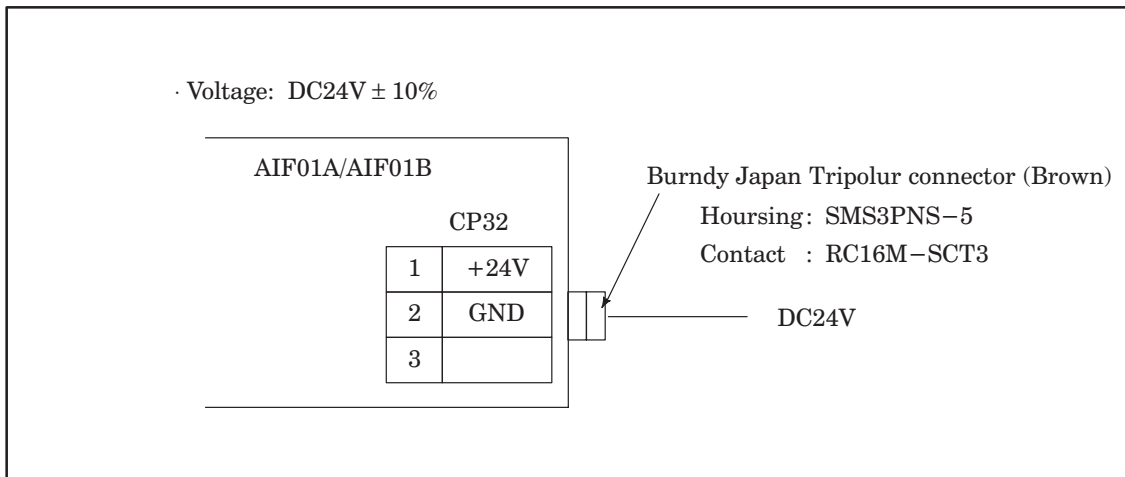


NOTE 1 Number of I/O Units and connecting method are restricted depending on the allocation of the I/O points.

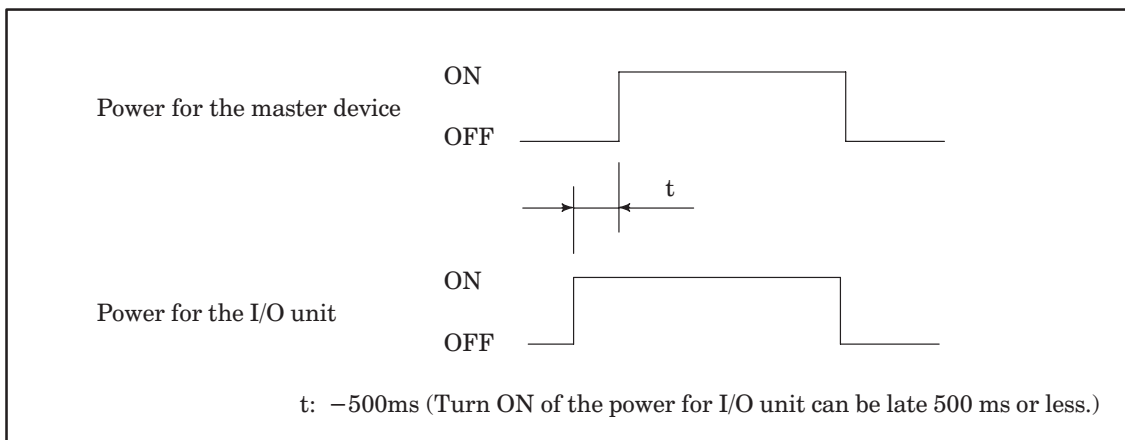
NOTE 2 Cable K1X can be an optical fiber cable by using the Optical I/O link adapter.

(2) Connecting input power source

Connect the following power source to the connector CP32 of the interface module (AIF01A or AIF01B).

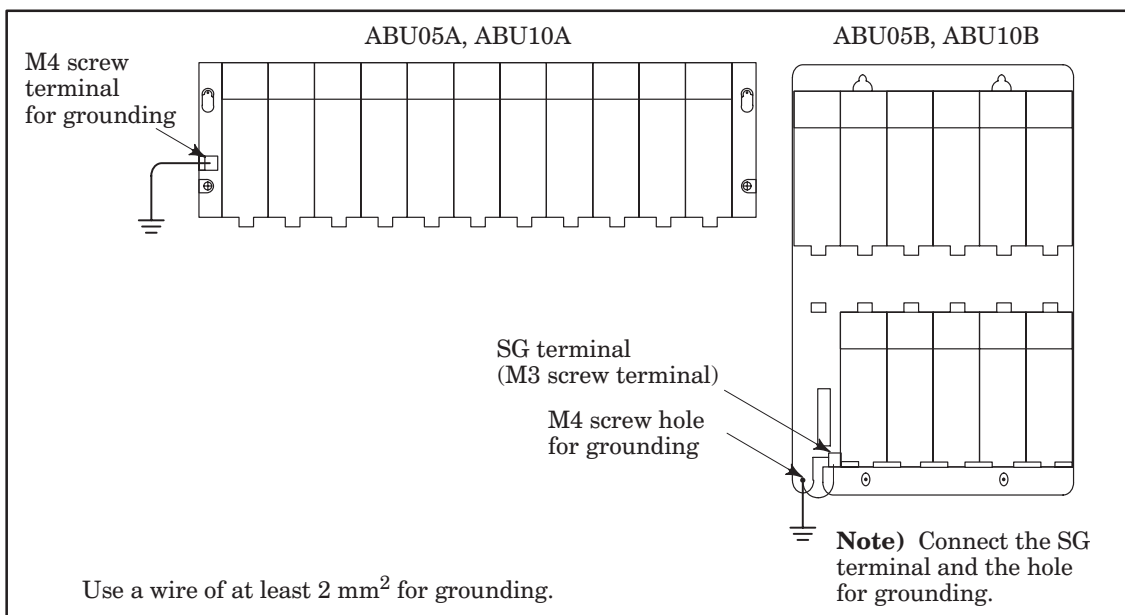


NOTE Turn ON the power for the I/O unit just when or before the power for the CNC is turned ON. When the CNC power is turned OFF, make sure to turn the power to the I/O unit OFF as well.



(3) Grounding

(a) Ground the base unit (ABU05A/B, ABU10A/B) by its grounding terminal

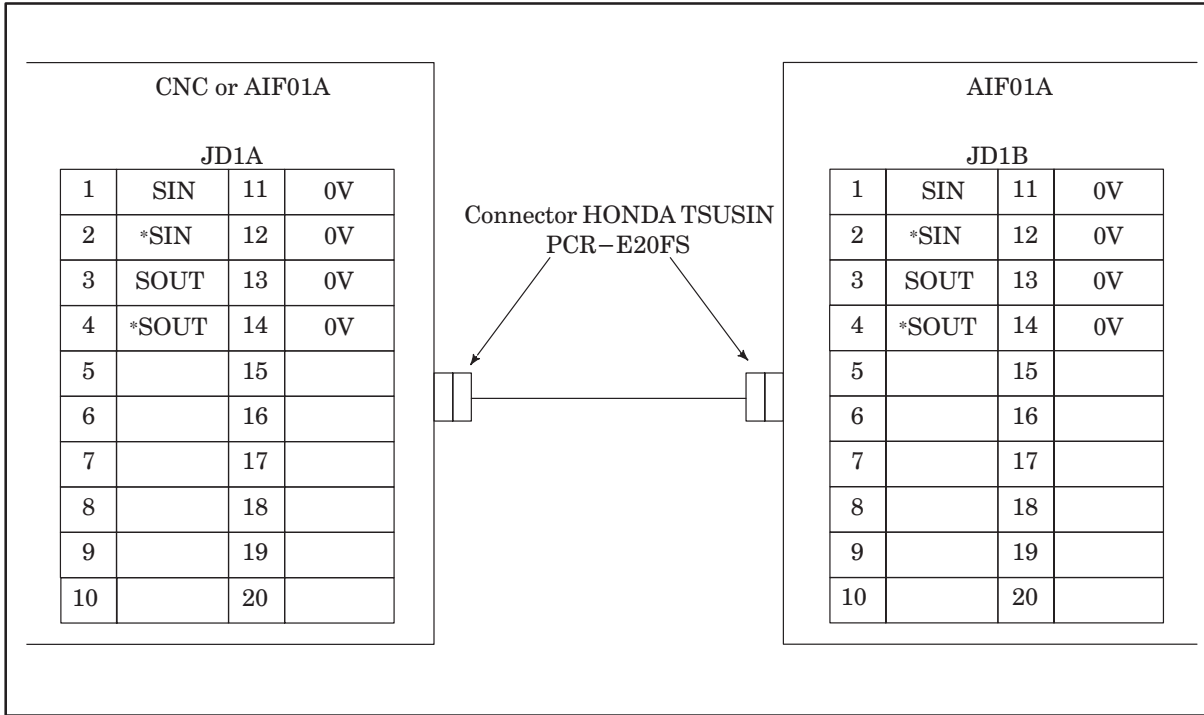


(b) When the cable K1X runs between different cabinets, make sure to connect the cabinets with a grounding wire more than 5.5 mm².

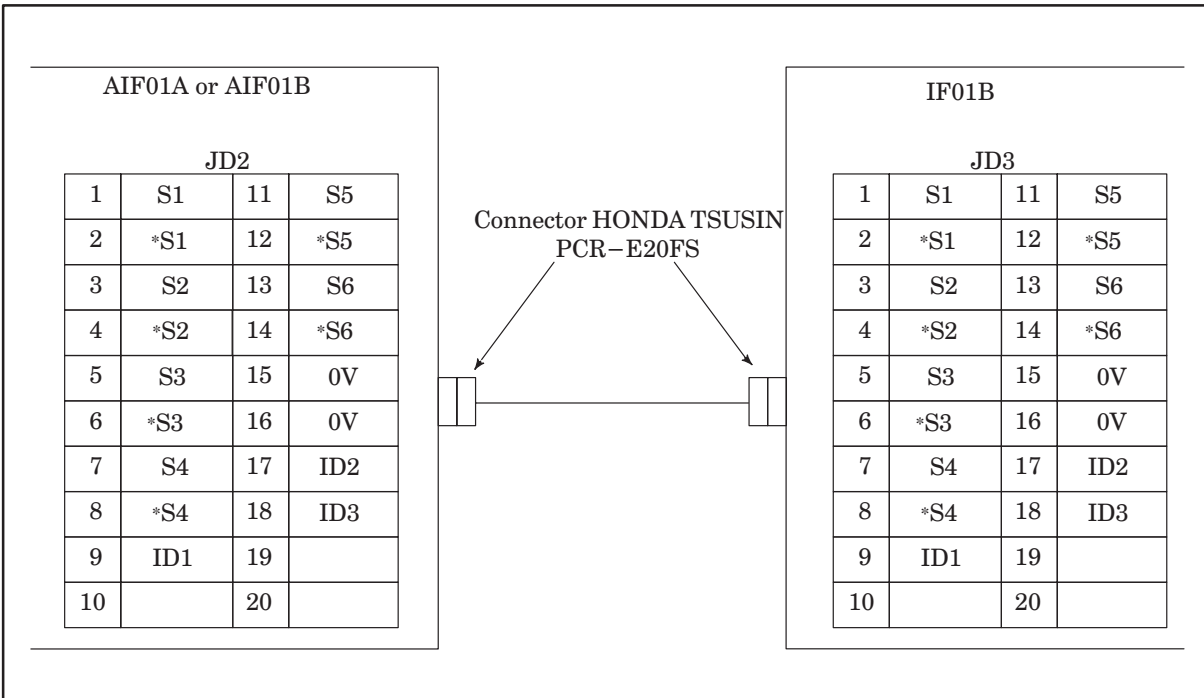
(4) Connecting signal cables

Details of the cables K1X, K2X and the terminator shown in the general connection diagram are as follows.

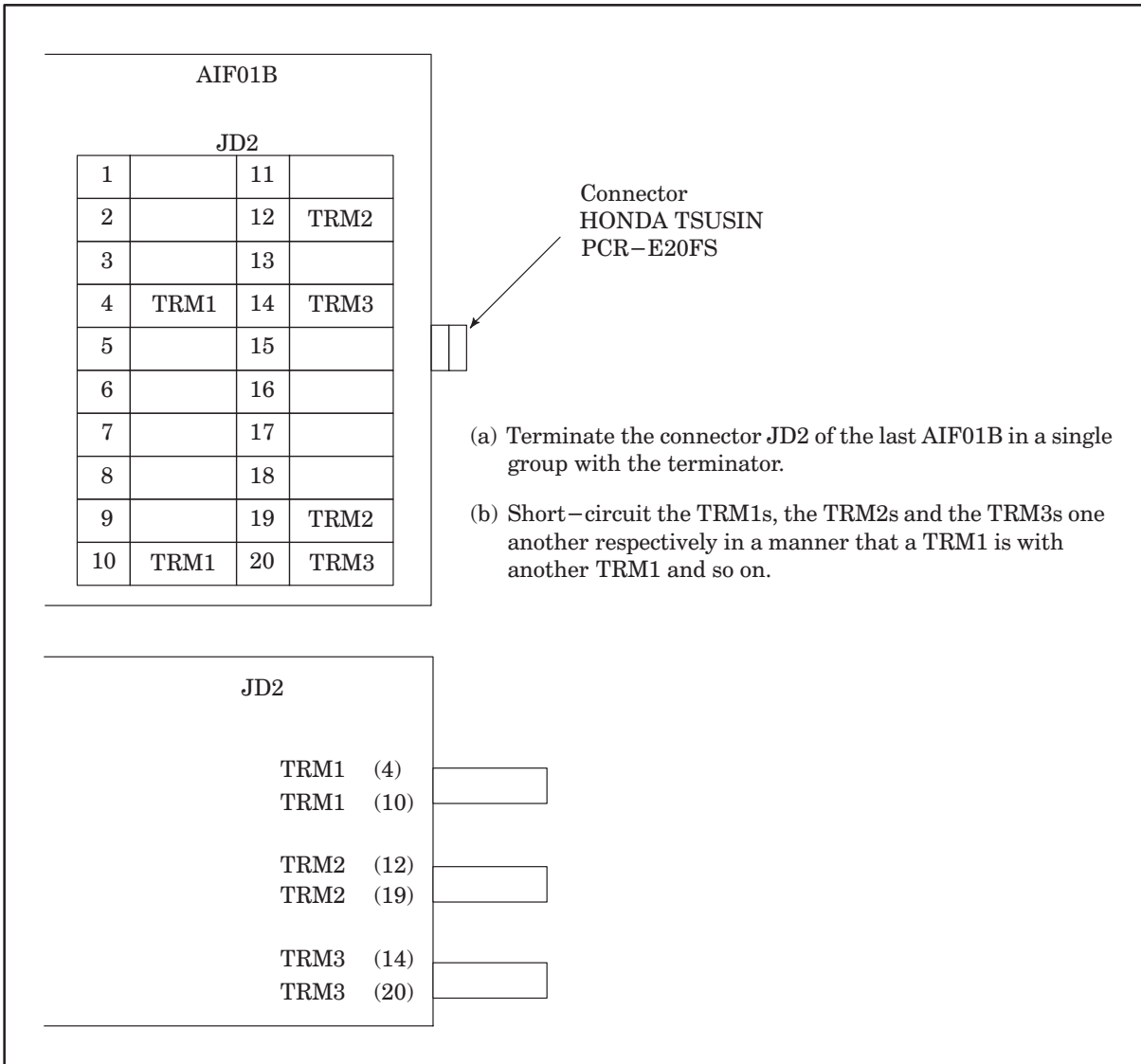
(a) Cable K1X



(b) Cable K2X

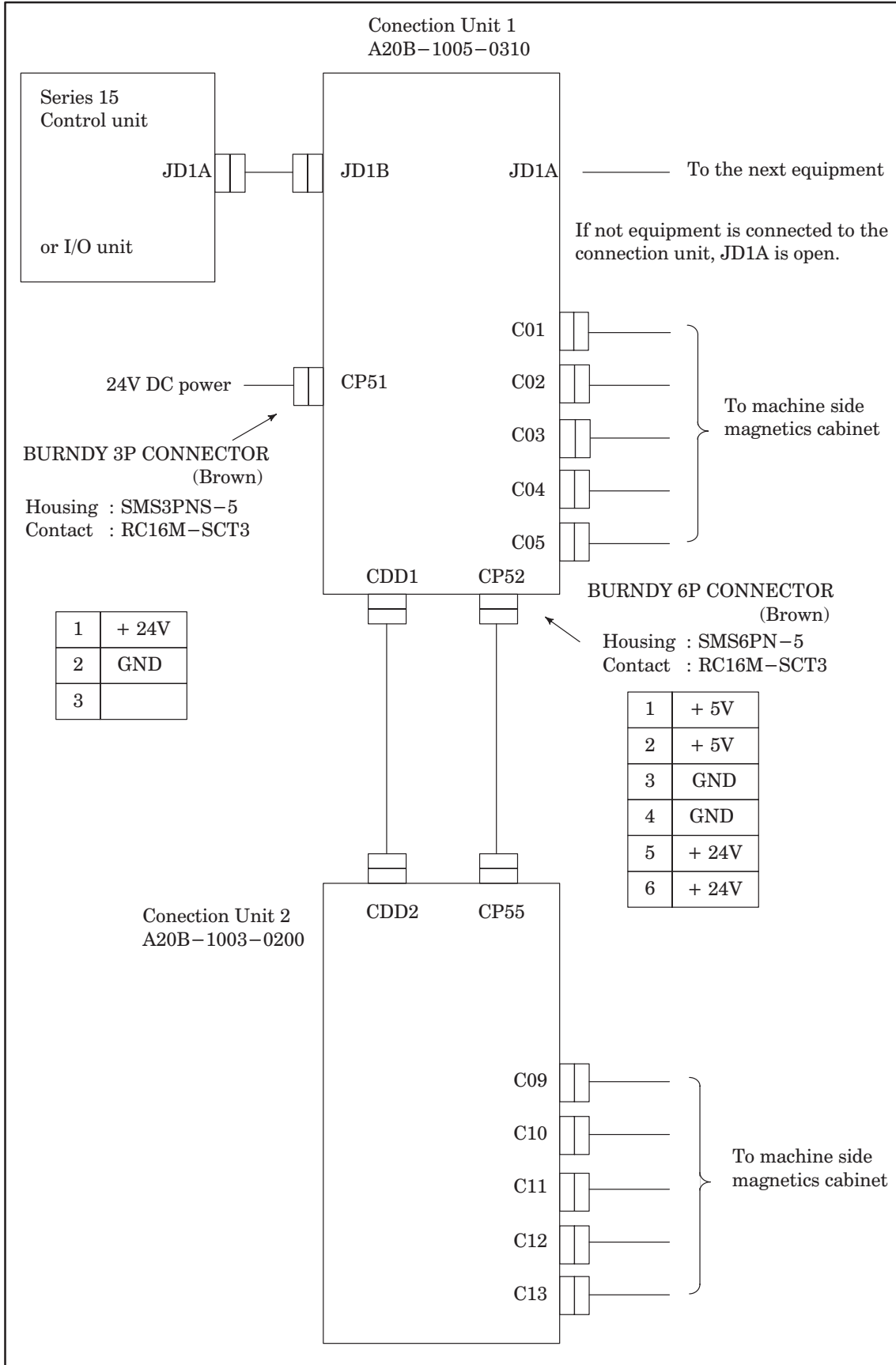


(c) Terminator TX



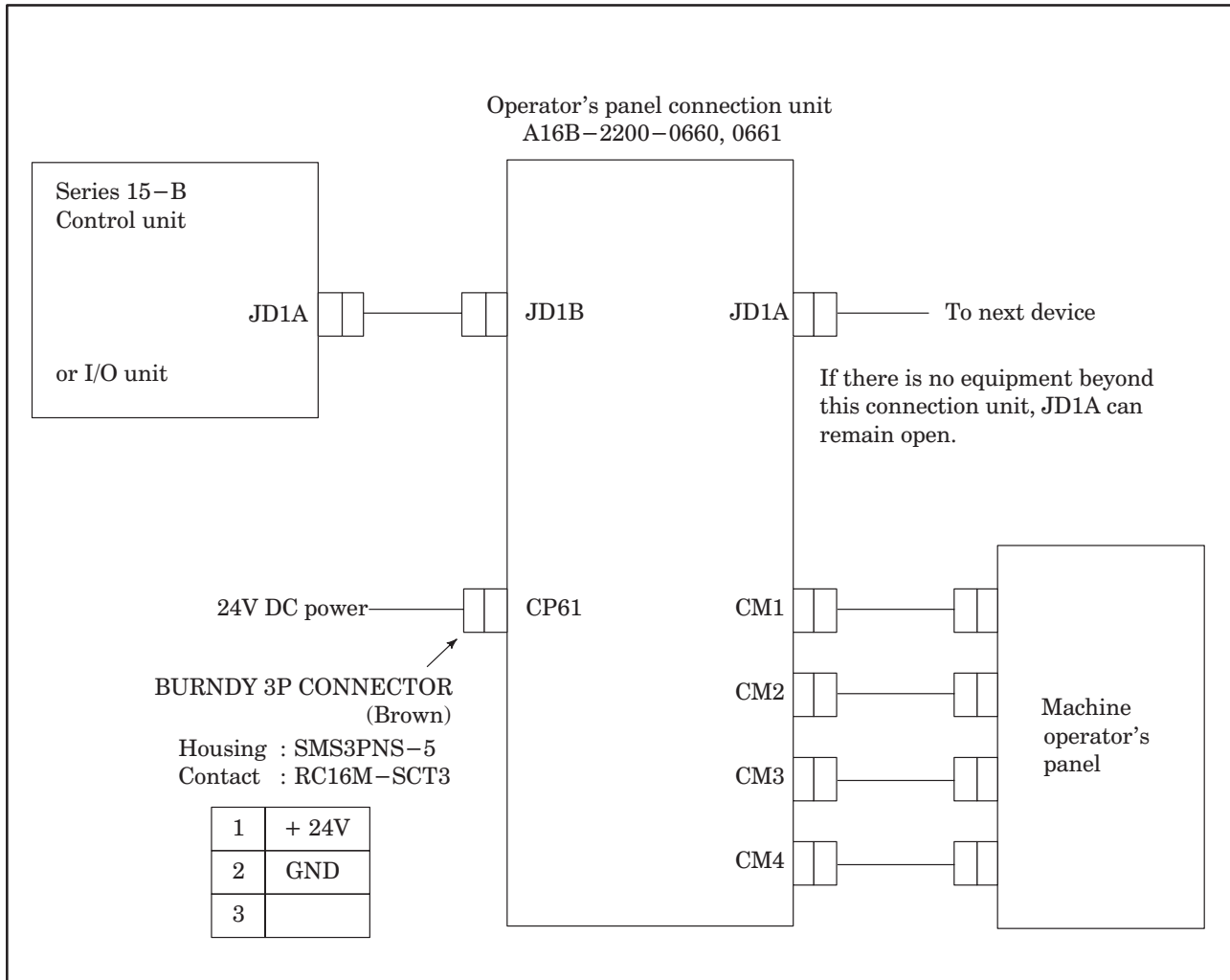
4.3.5 Connection with Connection unit

(1) Connection diagram



4.3.6 Connection of operator's panel connection unit

(1) Connection diagram



(2) Connector layout for operator's panel connection unit

CM1

| | | | | | |
|----|------|----|------|------|------|
| 1 | DI00 | | 33 | | |
| 2 | DI03 | | 34 | DI02 | |
| 3 | DI06 | 19 | DI01 | 35 | DI05 |
| 4 | DI11 | 20 | DI04 | 36 | DI10 |
| 5 | DI14 | 21 | DI07 | 37 | DI13 |
| 6 | DI17 | 22 | DI12 | 38 | DI16 |
| 7 | DI22 | 23 | DI15 | 39 | DI21 |
| 8 | DI25 | 24 | DI20 | 40 | DI24 |
| 9 | DI27 | 25 | DI23 | 41 | DI26 |
| 10 | DI32 | 26 | DI30 | 42 | DI31 |
| 11 | DI35 | 27 | DI33 | 43 | DI34 |
| 12 | DI40 | 28 | DI36 | 44 | DI37 |
| 13 | DI43 | 29 | DI41 | 45 | DI42 |
| 14 | DI46 | 30 | DI44 | 46 | DI45 |
| 15 | DI51 | 31 | DI47 | 47 | DI50 |
| 16 | DI54 | 32 | DI52 | 48 | DI53 |
| 17 | DI56 | | | 49 | DI55 |
| 18 | COM1 | | | 50 | DI57 |

| | | | | | | | | |
|------------------|------|------|------|------|------|------|------|------|
| Address | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| X _n | DI07 | DI06 | DI05 | DI04 | DI03 | DI02 | DI01 | DI00 |
| X _{n+1} | DI17 | DI16 | DI15 | DI14 | DI13 | DI12 | DI11 | DI10 |
| X _{n+2} | DI27 | DI26 | DI25 | DI24 | DI23 | DI22 | DI21 | DI20 |
| X _{n+3} | DI37 | DI36 | DI35 | DI34 | DI33 | DI32 | DI31 | DI30 |
| X _{n+4} | DI47 | DI46 | DI45 | DI44 | DI43 | DI42 | DI41 | DI40 |
| X _{n+5} | DI57 | DI56 | DI55 | DI54 | DI53 | DI52 | DI51 | DI50 |

CM2

| | | | | | |
|----|------|----|------|------|------|
| 1 | DI60 | | 33 | | |
| 2 | DI63 | | 34 | DI62 | |
| 3 | DI66 | 19 | DI61 | 35 | DI65 |
| 4 | DI71 | 20 | DI64 | 36 | DI70 |
| 5 | DI74 | 21 | DI67 | 37 | DI73 |
| 6 | DI77 | 22 | DI72 | 38 | DI76 |
| 7 | DI82 | 23 | DI75 | 39 | DI81 |
| 8 | DI85 | 24 | DI80 | 40 | DI84 |
| 9 | DI87 | 25 | DI83 | 41 | DI86 |
| 10 | DI92 | 26 | DI90 | 42 | DI91 |
| 11 | DI95 | 27 | DI93 | 43 | DI94 |
| 12 | DIA0 | 28 | DI96 | 44 | DI97 |
| 13 | DIA3 | 29 | DIA1 | 45 | DIA2 |
| 14 | DIA6 | 30 | DIA4 | 46 | DIA5 |
| 15 | DIB1 | 31 | DIA7 | 47 | DIB0 |
| 16 | DIB4 | 32 | DIB2 | 48 | DIB3 |
| 17 | DIB6 | | | 49 | DIB5 |
| 18 | COM2 | | | 50 | DIB7 |

| | | | | | | | | |
|-------------------|------|------|------|------|------|------|------|------|
| X _{n+6} | DI67 | DI66 | DI65 | DI64 | DI63 | DI62 | DI61 | DI60 |
| X _{n+7} | DI77 | DI76 | DI75 | DI74 | DI73 | DI72 | DI71 | DI70 |
| X _{n+8} | DI87 | DI86 | DI85 | DI84 | DI83 | DI82 | DI81 | DI80 |
| X _{n+9} | DI97 | DI96 | DI95 | DI94 | DI93 | DI92 | DI91 | DI90 |
| X _{n+10} | DIA7 | DIA6 | DIA5 | DIA4 | DIA3 | DIA2 | DIA1 | DIA0 |
| X _{n+11} | DIB7 | DIB6 | DIB5 | DIB4 | DIB3 | DIB2 | DIB1 | DIB0 |

NOTE Address No. n can be decided by machine tool builders.

CM3

| | | | | | |
|----|------|----|------|------|------|
| 1 | DO00 | | 33 | +5N | |
| 2 | DO03 | | 34 | DO02 | |
| 3 | DO06 | 19 | DO01 | 35 | DO05 |
| 4 | DO11 | 20 | DO04 | 36 | DO10 |
| 5 | DO14 | 21 | DO07 | 37 | DO13 |
| 6 | DO17 | 22 | DO12 | 38 | DO16 |
| 7 | DO22 | 23 | DO15 | 39 | DO21 |
| 8 | DO25 | 24 | DO20 | 40 | DO24 |
| 9 | DO27 | 25 | DO23 | 41 | DO26 |
| 10 | DO32 | 26 | DO30 | 42 | DO31 |
| 11 | DO35 | 27 | DO33 | 43 | DO34 |
| 12 | DO40 | 28 | DO36 | 44 | DO37 |
| 13 | DO43 | 29 | DO41 | 45 | DO42 |
| 14 | DO46 | 30 | DO44 | 46 | DO45 |
| 15 | DO51 | 31 | DO47 | 47 | DO50 |
| 16 | DO54 | 32 | DO52 | 48 | DO53 |
| 17 | DO56 | | | 49 | DO55 |
| 18 | COM3 | | | 50 | DO57 |

Address

| | | | | | | | | |
|------------------|------|------|------|------|------|------|------|------|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Y _n | DO07 | DO06 | DO05 | DO04 | DO03 | DO02 | DO01 | DO00 |
| Y _{n+1} | DO17 | DO16 | DO15 | DO14 | DO13 | DO12 | DO11 | DO10 |
| Y _{n+2} | DO27 | DO26 | DO25 | DO24 | DO23 | DO22 | DO21 | DO20 |
| Y _{n+3} | DO37 | DO36 | DO35 | DO34 | DO33 | DO32 | DO31 | DO30 |
| Y _{n+4} | DO47 | DO46 | DO45 | DO44 | DO43 | DO42 | DO41 | DO40 |
| Y _{n+5} | DO57 | DO56 | DO55 | DO54 | DO53 | DO52 | DO51 | DO50 |

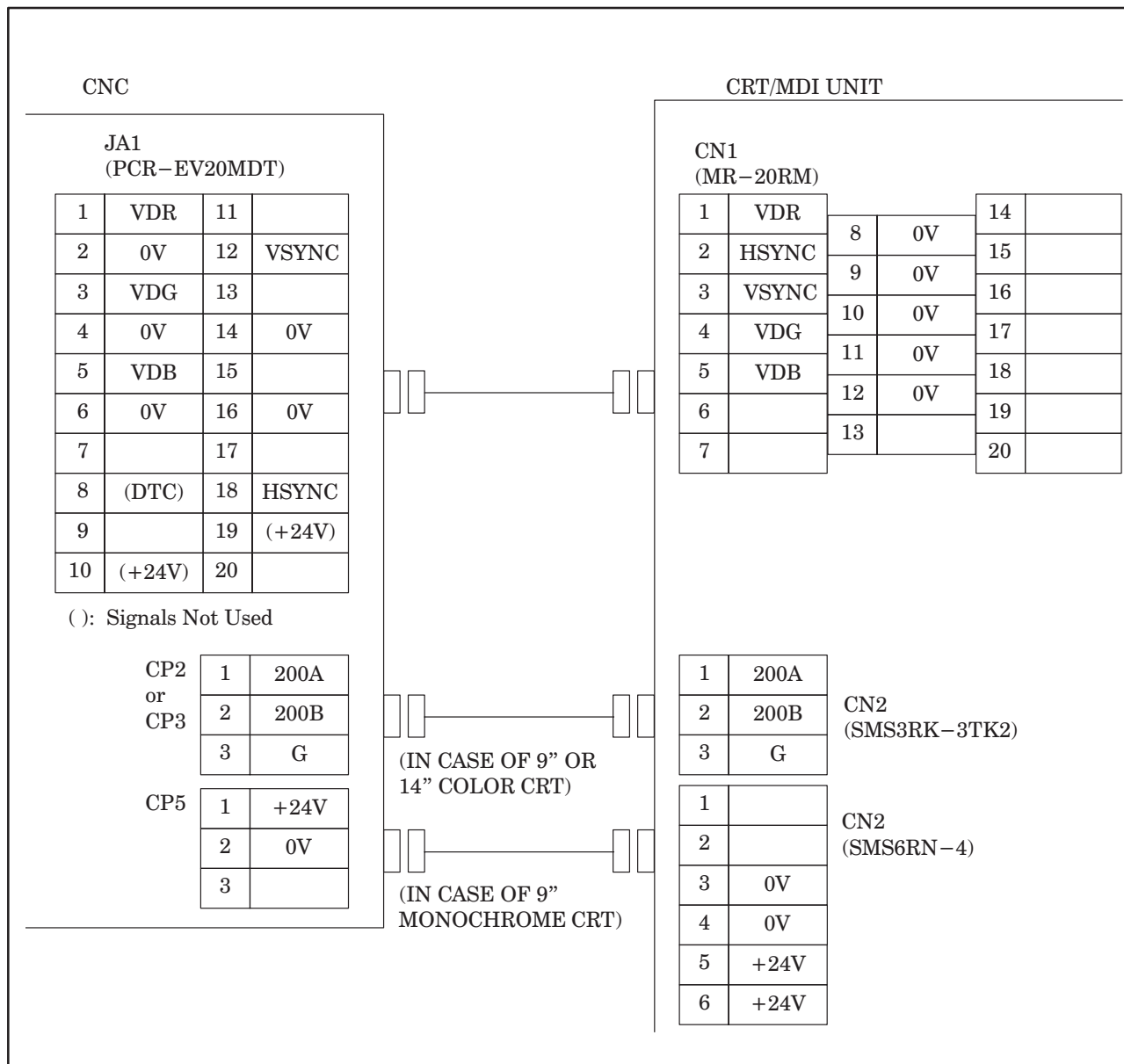
CM4

| | | | | | |
|---|------|----|------|------|------|
| 1 | DO61 | | 14 | DO60 | |
| 2 | DO64 | 8 | DO62 | 15 | DO63 |
| 3 | DO67 | 9 | DO65 | 16 | DO66 |
| 4 | DO72 | 10 | DO70 | 17 | DO71 |
| 5 | DO75 | 11 | DO73 | 18 | DO74 |
| 6 | | 12 | DO76 | 19 | DO77 |
| 7 | COM4 | 13 | | 20 | |

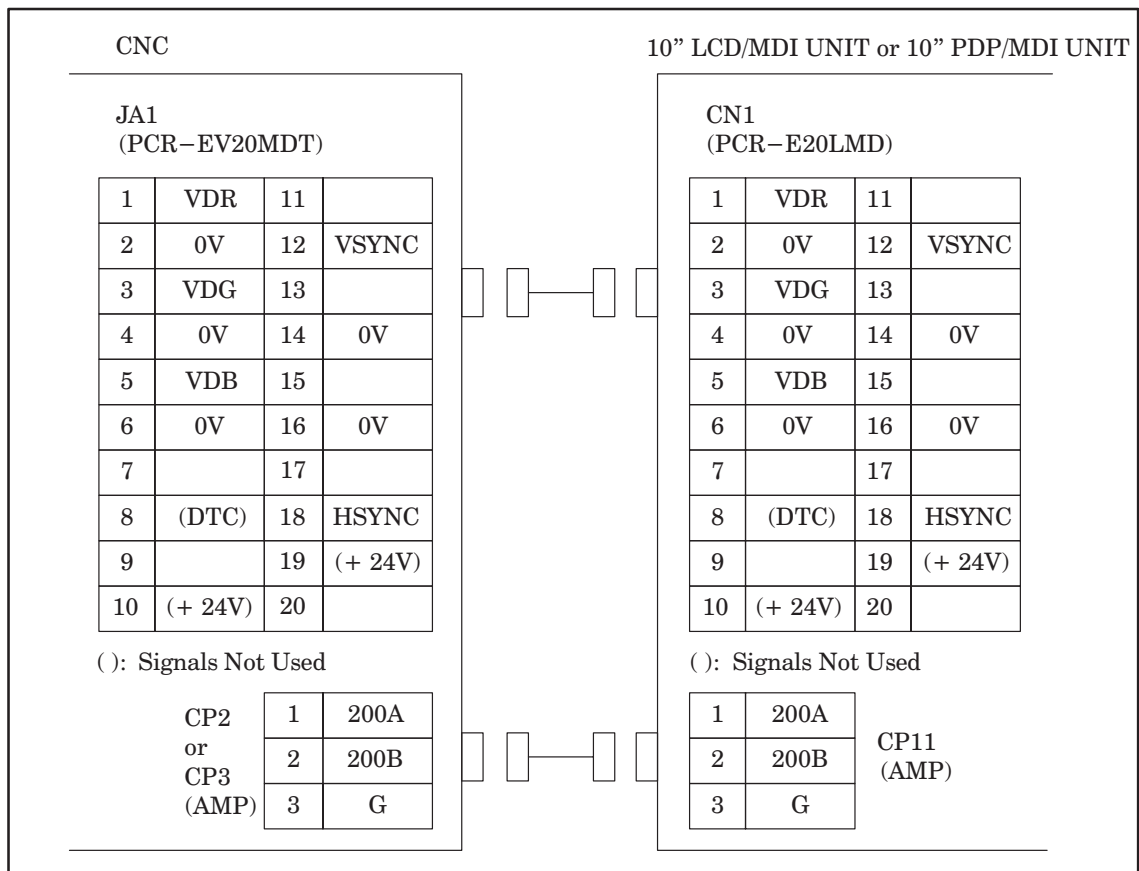
| | | | | | | | | |
|------------------|------|------|------|------|------|------|------|------|
| Y _{n+6} | DO67 | DO66 | DO65 | DO64 | DO63 | DO62 | DO61 | DO60 |
| Y _{n+7} | DO77 | DO76 | DO75 | DO74 | DO73 | DO72 | DO71 | DO70 |

NOTE Address No. n can be decided by machine tool builders.

4.3.7 CRT display interface

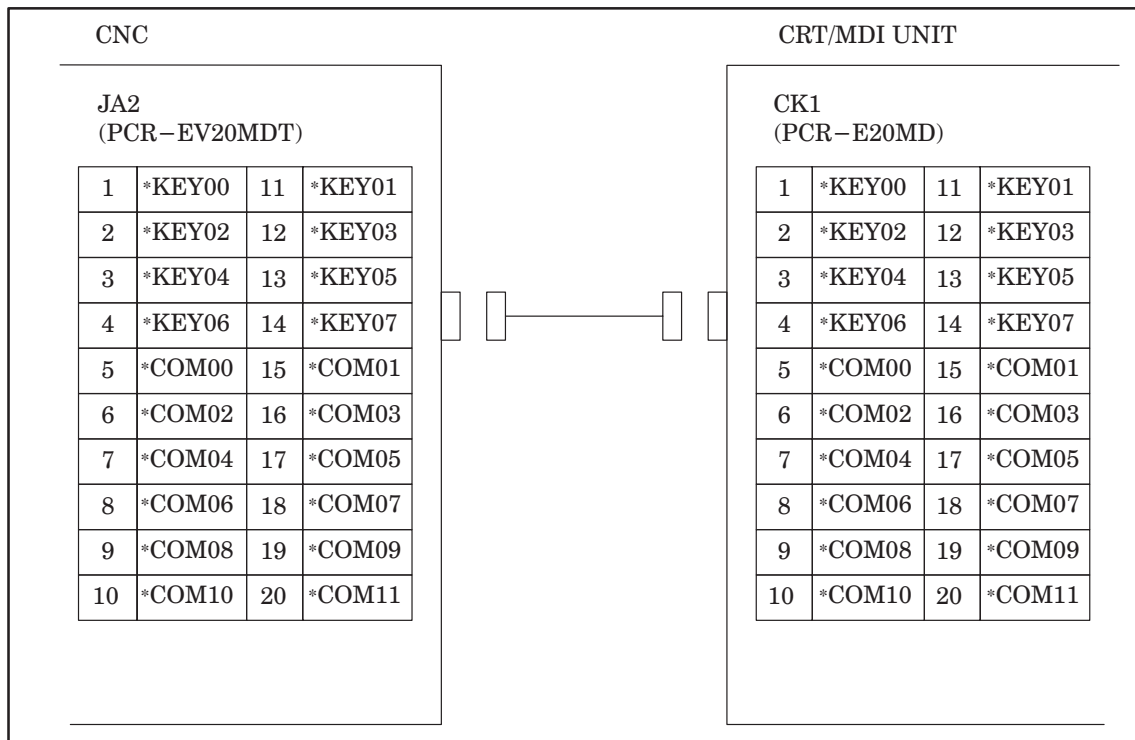


4.3.8 LCD-PDP display interface

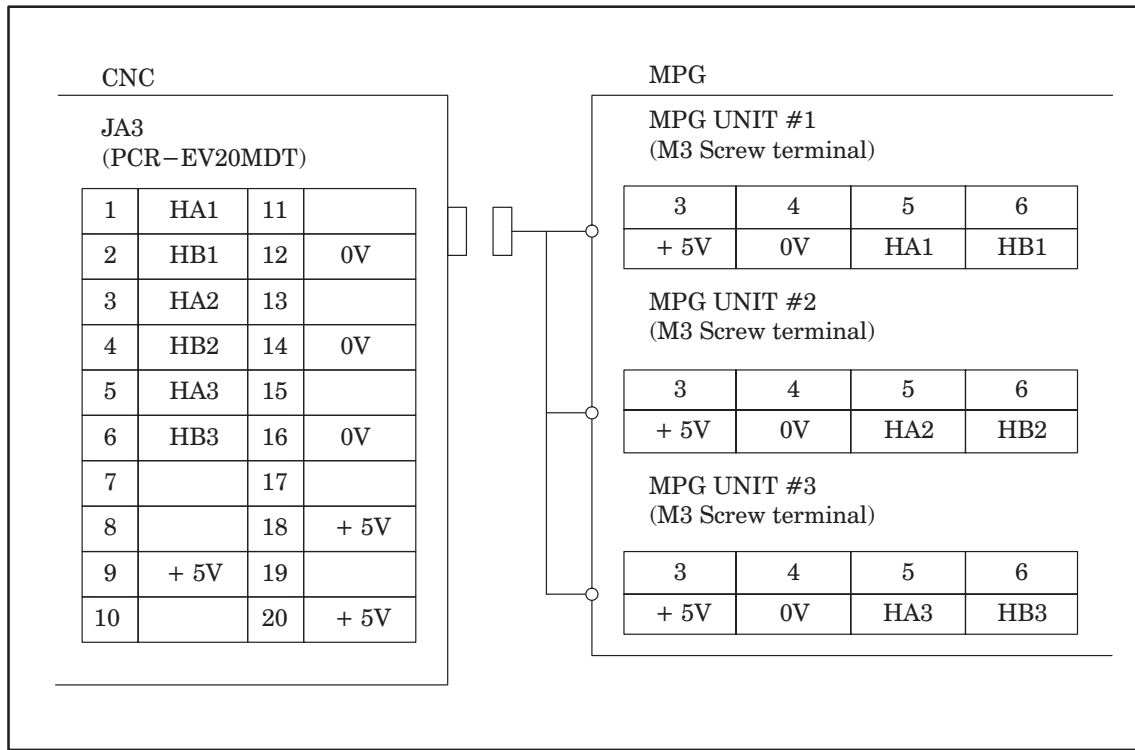


4.3.9 Keyboard interface

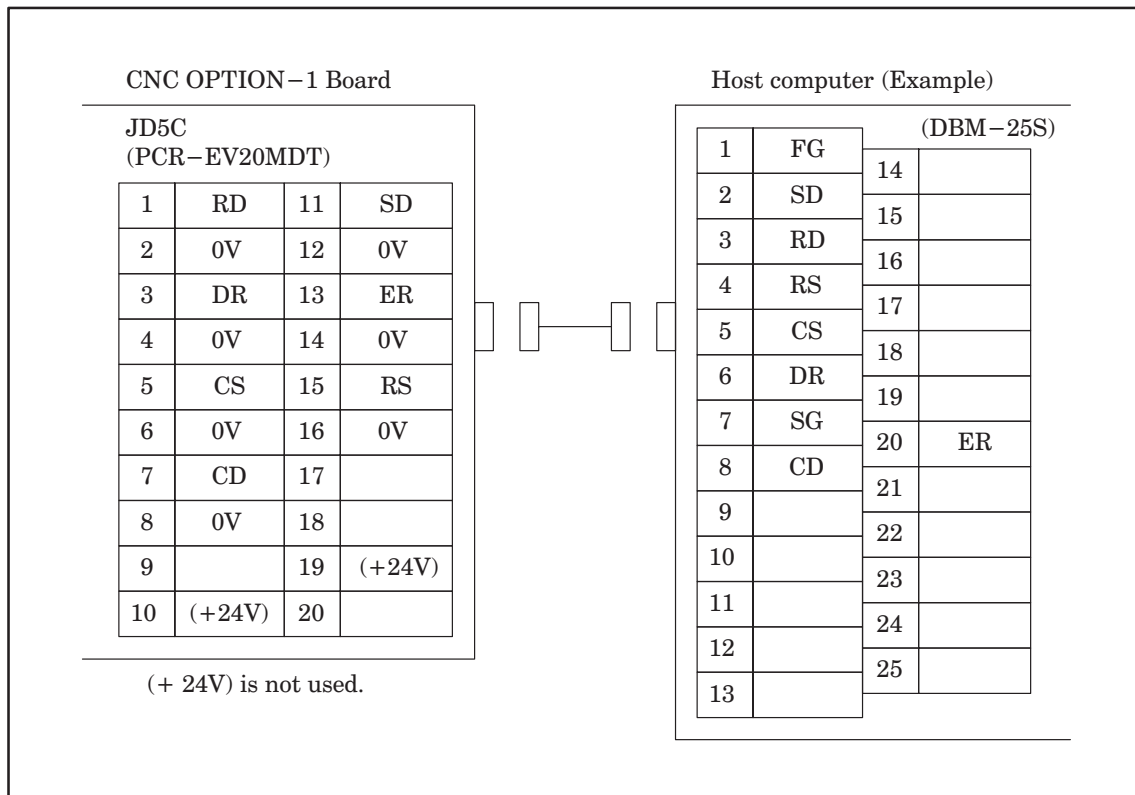
The keyboard interface specification is common to all Series 15-B MDI units.



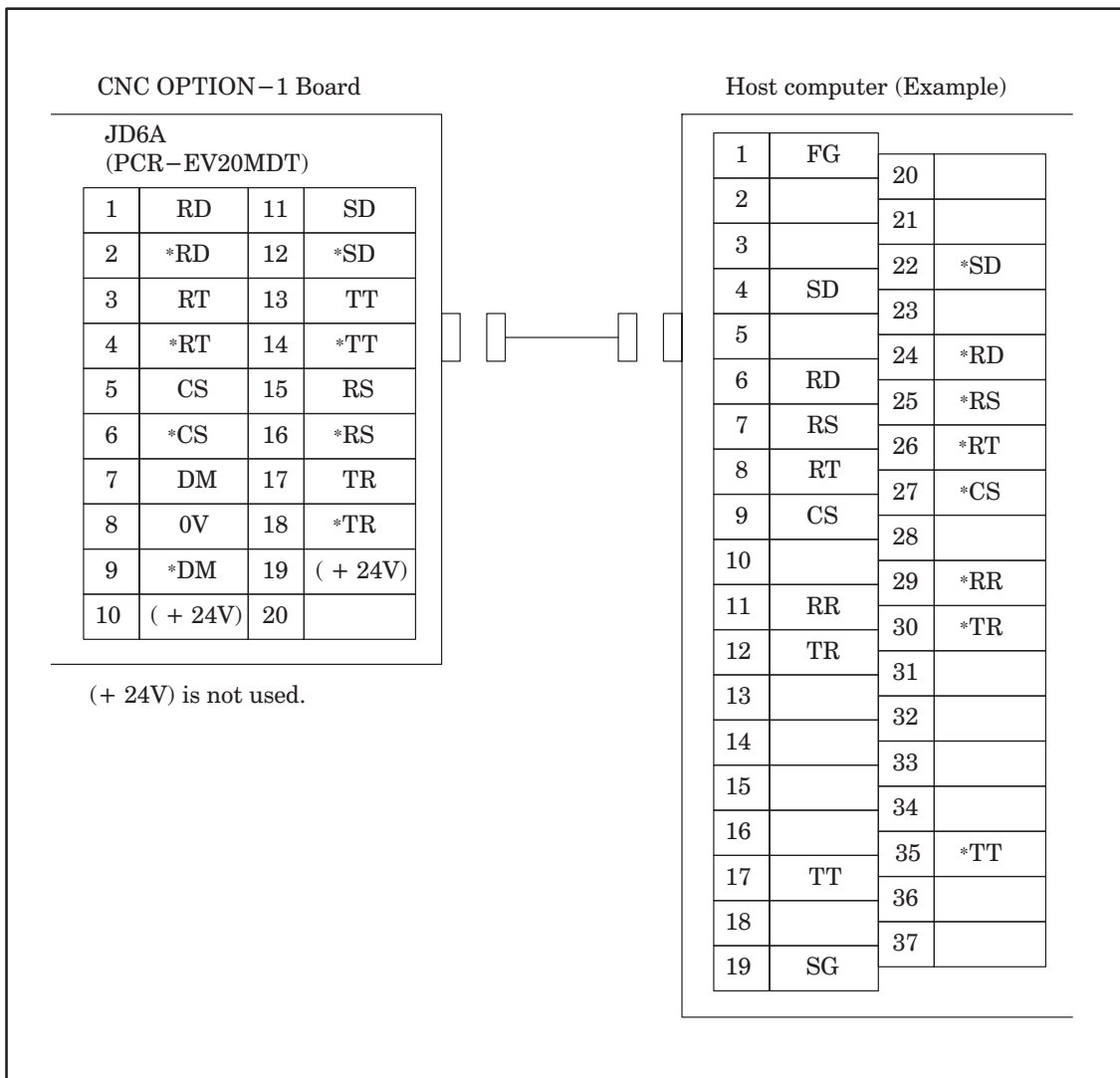
4.3.10 Manual pulse generator interface



4.3.11 Remote buffer interface (RS-232-C)



4.3.12 Remote buffer interface (RS-422)



4.4 Confirmation of Connection between CNC Control Unit and Servo

Servo interface of Series15-B has following features.

- Digital control AC servo motor
- Motor feedback : Serial pulsecoder
 - 1) 40,000 pulse/rev incremental pulsecoder
 - 2) 1,000,000 pulse/rev absolute pulsecoder
- Scale feedback : A/B/Z signal interface

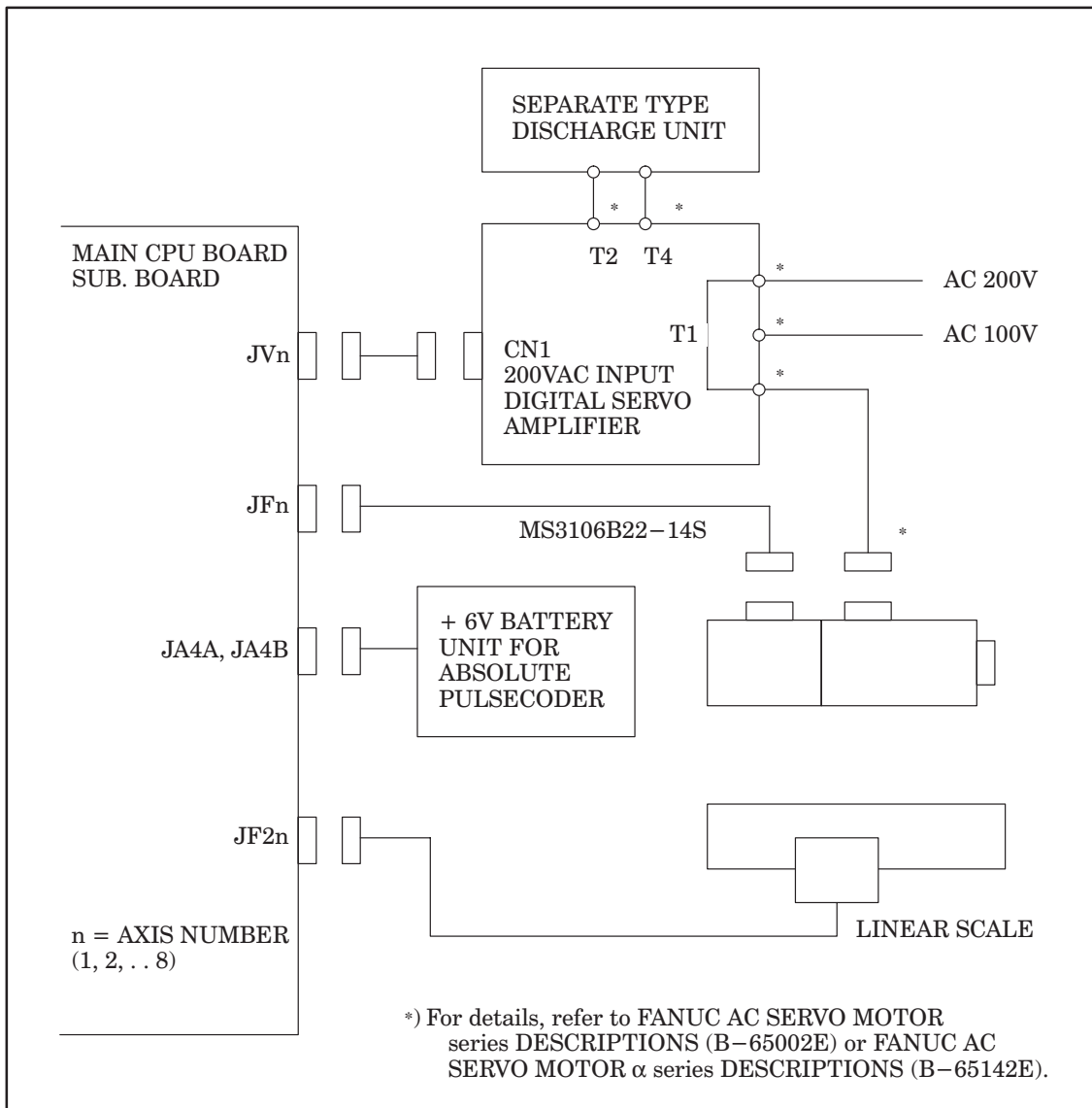
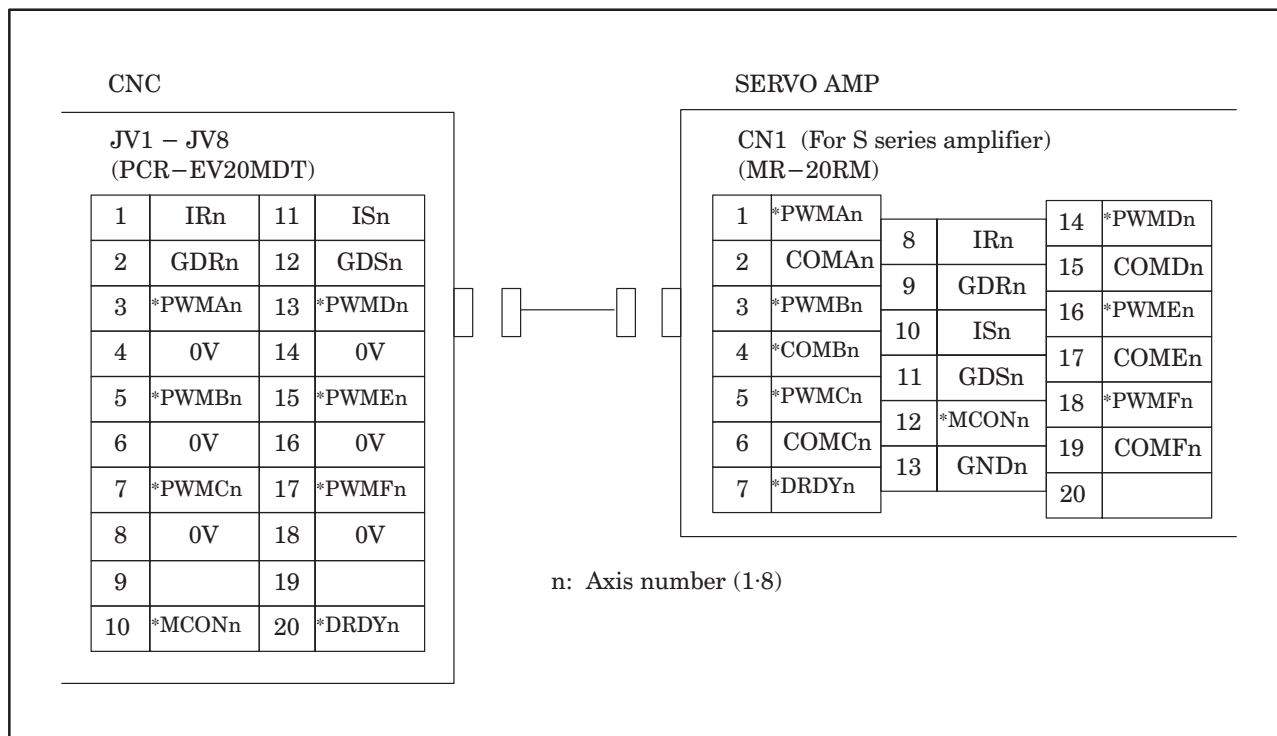


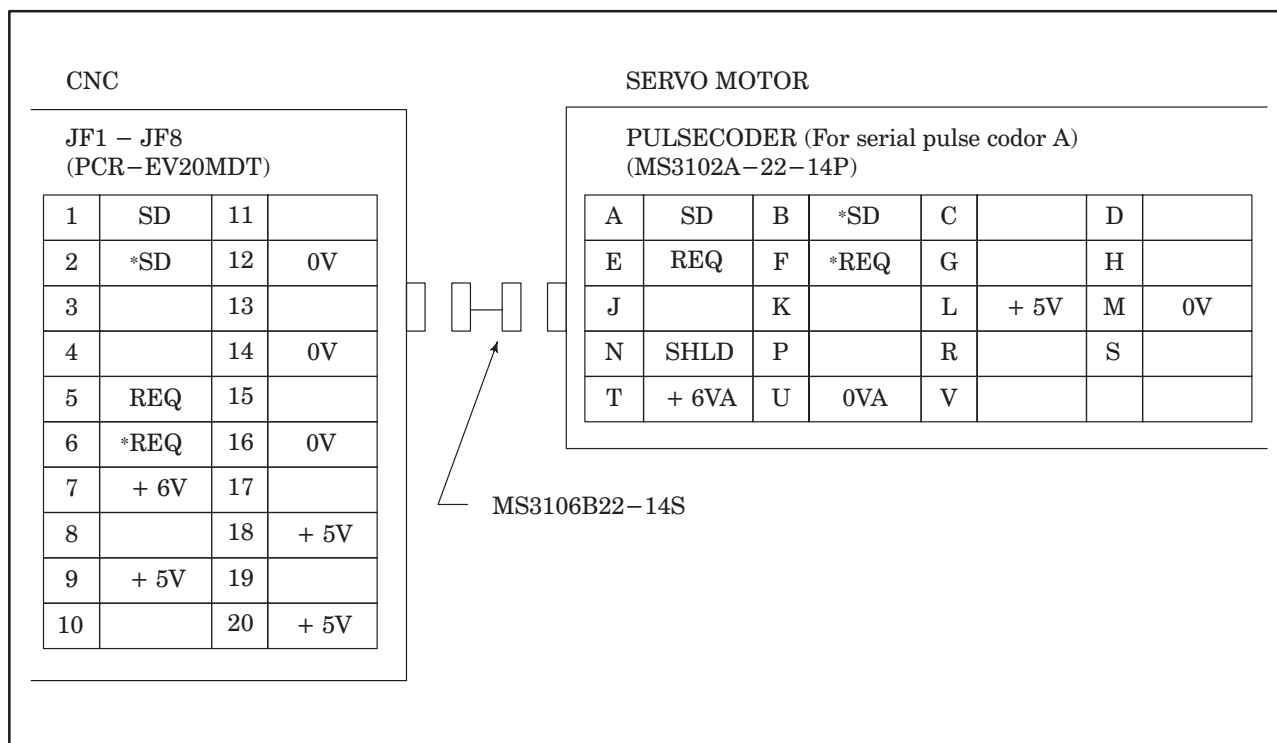
Table 4.4 Connector name for each interface

| Interface | Main CPU board | | | | Sub board | | | |
|------------------|----------------|----------|----------|----------|-----------|----------|----------|----------|
| | 1st axis | 2nd axis | 3rd axis | 4th axis | 5th axis | 6th axis | 7th axis | 8th axis |
| Servo amplifier | JV1 | JV2 | JV3 | JV4 | JV5 | JV6 | JV7 | JV8 |
| Motor pulsecoder | JF1 | JF2 | JF3 | JF4 | JF5 | JF6 | JF7 | JF8 |
| Linear scale | JF21 | JF22 | JF23 | JF24 | JF25 | JF26 | JF27 | JF28 |

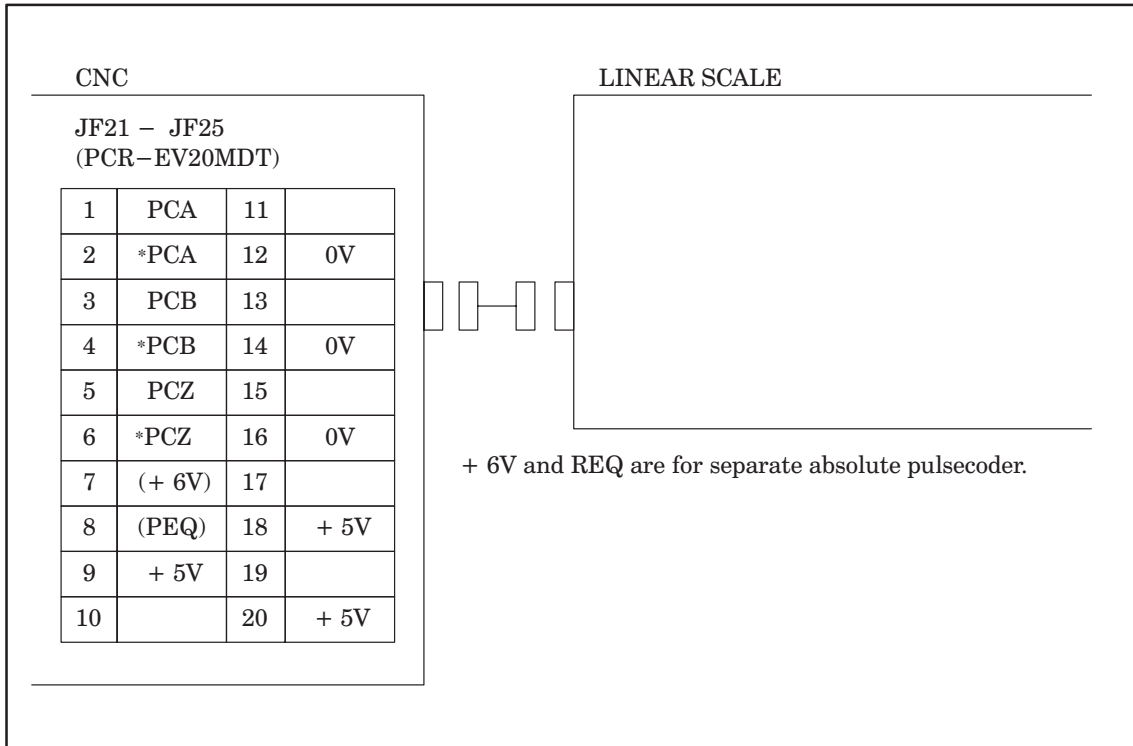
(1) Servo amp interface



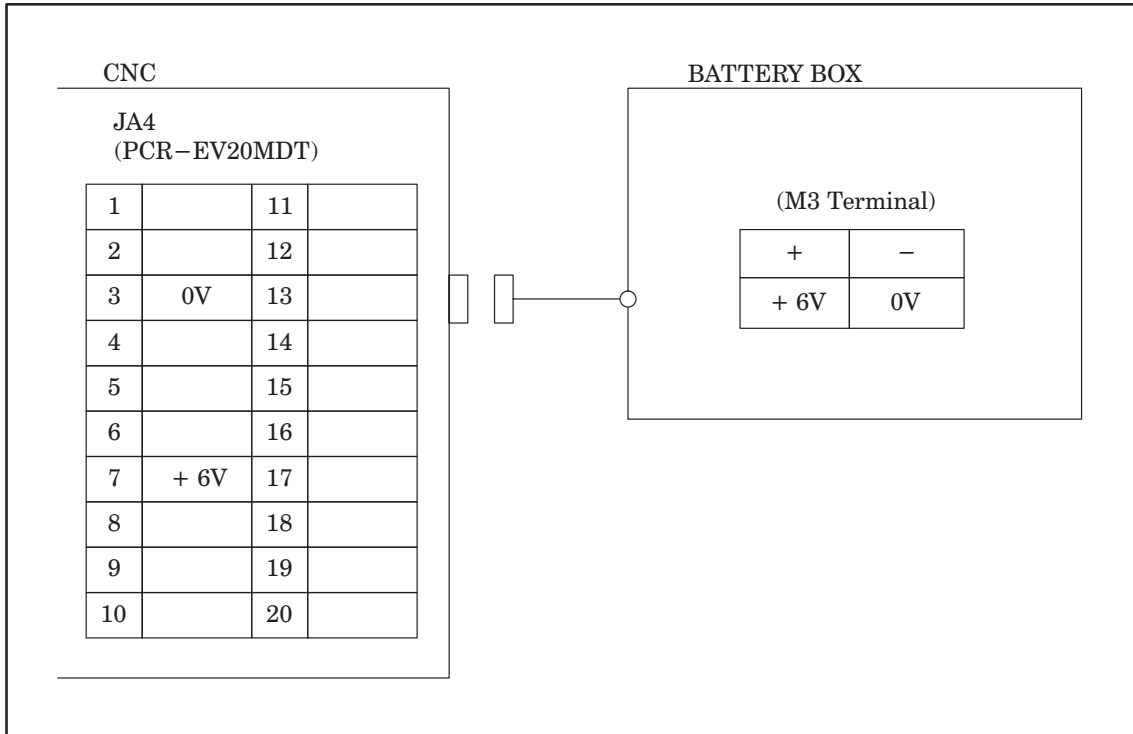
(2) Serial pulsecoder interface



(3) Linear scale interface



(4) APC battery interface



Connecting a motor normally or in reverse (relationships between the connection and direction of rotation)
The following explains connection of a motor to rotate in the direction of B in the figure with a command in which a positive value is specified.

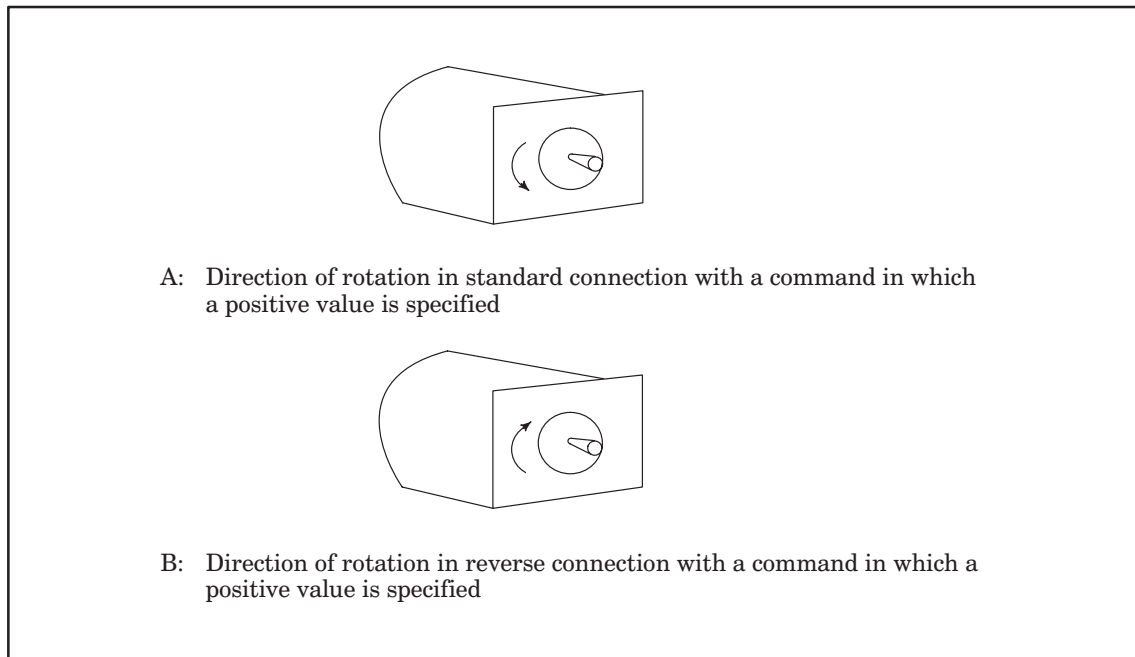


Fig. 4.4.3 Servo motor connection and direction of rotation

(1) For a built-in pulse coder

For a digital servo, the cables does not need to be exchanged because the direction can be changed using parameter No. 1879.

(2) When a separate pulse coder or linear scale is used

When the motor is to rotate in the direction opposite to that specified in a command for a digital servo, the direction can be changed using parameter No. 1879.

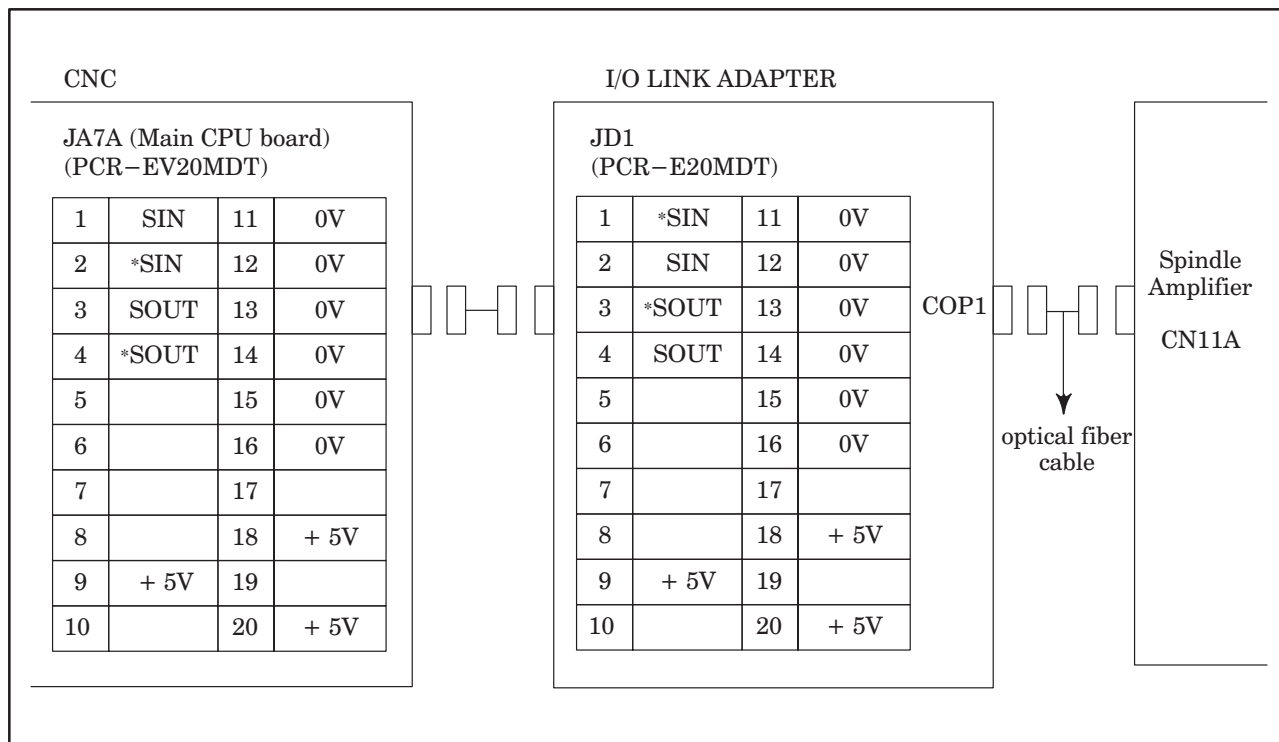
When the motor rotates in the direction opposite to that of a separate pulse coder, exchange the cables of the separate pulse coder as follows.

For a linear scale, the same operation is required. If a delay occurs between the PCB feedback signal and PCA phase for a command to rotate the motor in the forward direction, perform operations (a) and (b).

- (a) Exchange the PCA signal with the PCB signal.
- (b) Exchange the *PCA signal with the *PCB signal.

4.5 Confirming the Connection between the CNC Control Unit and Spindle Motor

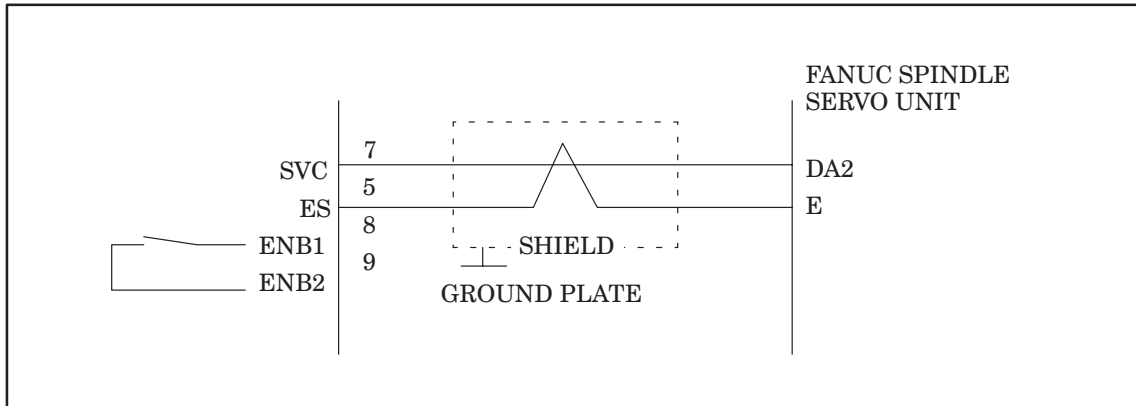
(1) Serial Spindle Interface



(2) Analog Spindle Interface

| CNC (MAIN CPU) | | | | Signal name | Description |
|-----------------------|-------|----|-------|---|--|
| JA8A (PCR-EV20MDT) | | | | SVC, ES | Spindle command voltage and common |
| 1 | 0V | 11 | 0V | ENB1, ENB2 | Spindle enable signal (Note 1) |
| 2 | CLKX0 | 12 | CLKX1 | CLKX0, CLKX1 FSX0, FSX1 DX0, DX1 ±15V, +5V, 0V | Feed axis check signal (Note 2) |
| 3 | 0V | 13 | 0V | | |
| 4 | FSX0 | 14 | FSX1 | | |
| 5 | ES | 15 | 0V | | |
| 6 | DX0 | 16 | DX1 | | |
| 7 | SVC | 17 | -15V | | |
| 8 | ENB1 | 18 | +5V | | |
| 9 | ENB2 | 19 | +15V | | |
| 10 | +15V | 20 | +5V | | |

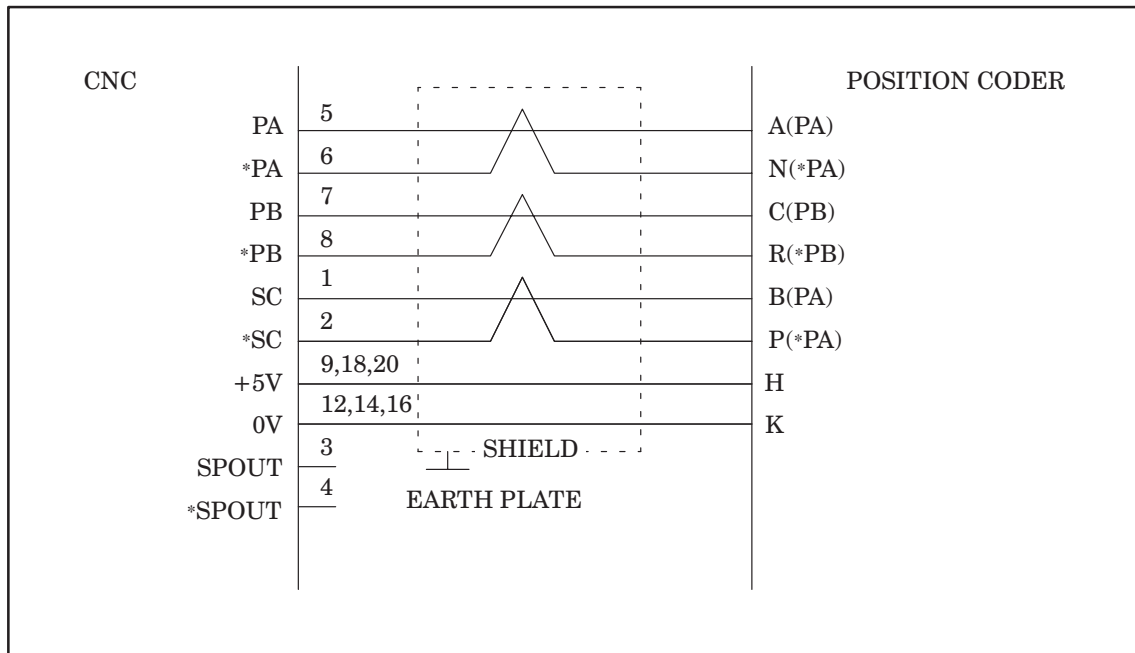
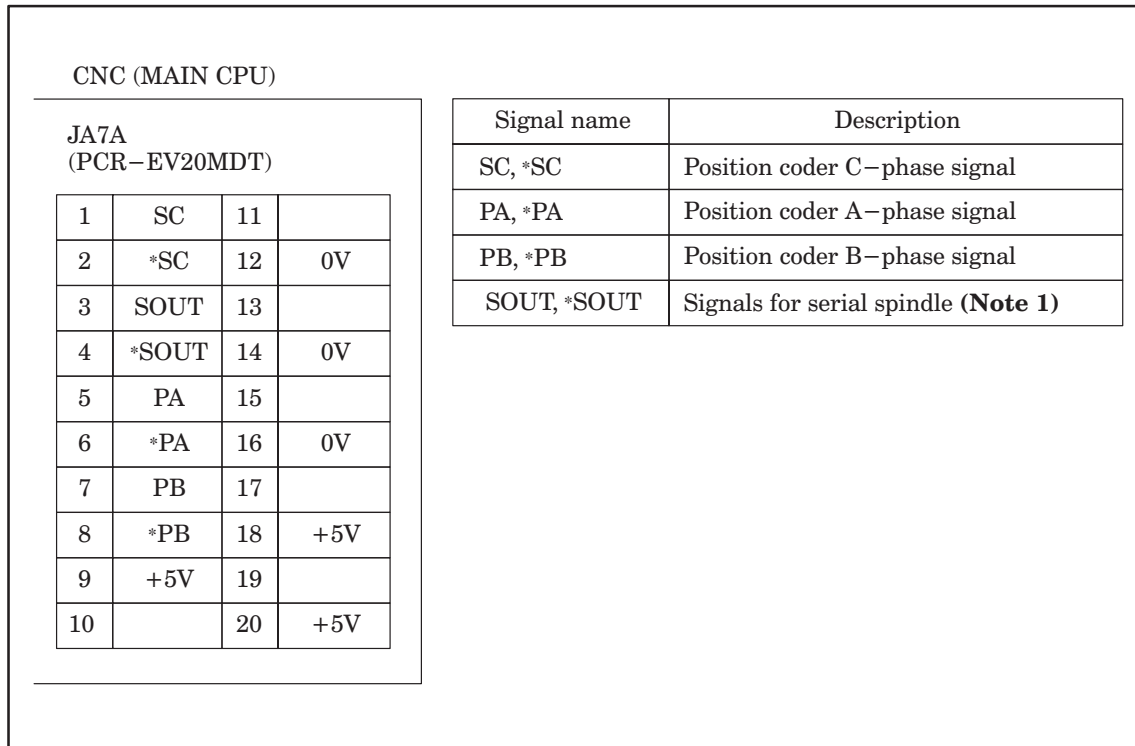
CABLE WIRING



NOTE 1 ENB1 and 2 turn on when a spindle command voltage is effective. These signals are not used when FANUC Spindle Servo Unit is used.

NOTE 2 Feed axis check signal is used when a feed axis is checked or a service work is done. This signal is not used for spindle control.

(3) Position Coder Interface



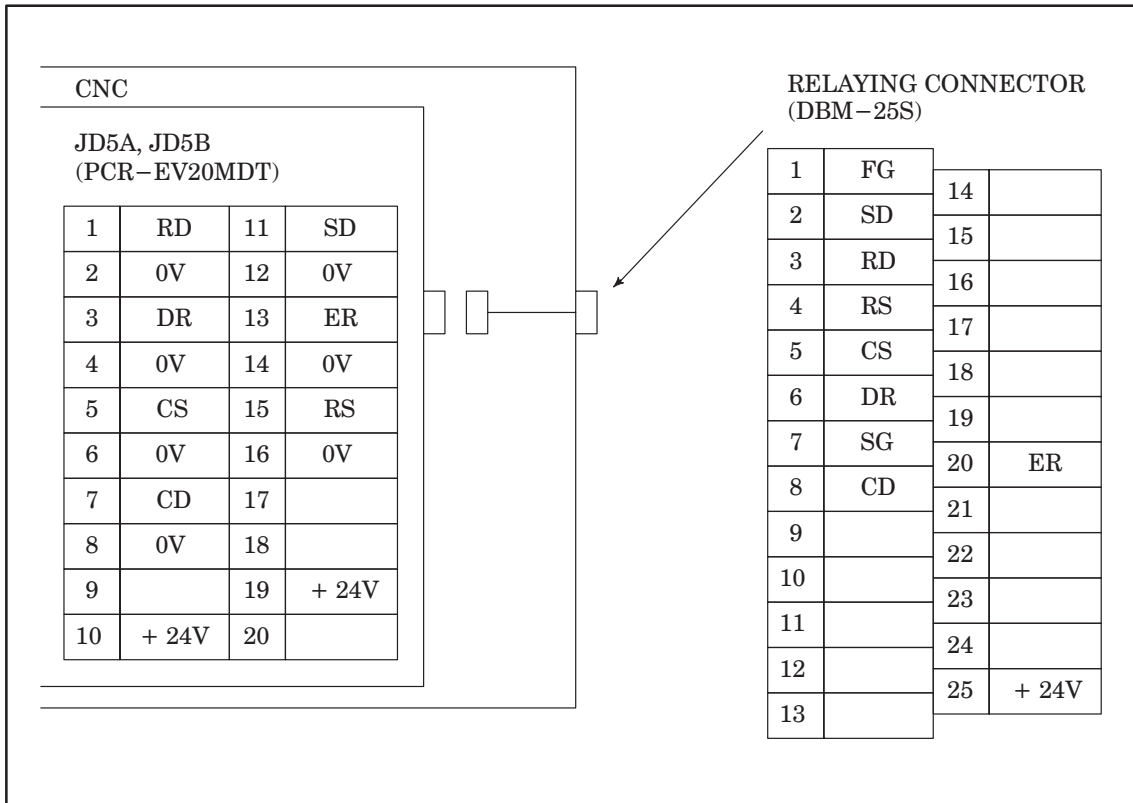
Recommended cable

A66L-0001-0286 (#20AWG×6+#24AWG×3) MAX LENGTH 20m.

NOTE 1 Signals SPOUT and *SPOUT are for serial spindle. These signals are not used for Analog spindle.

4.6 Confirming the Connection between the NC Control Unit and I/O devices

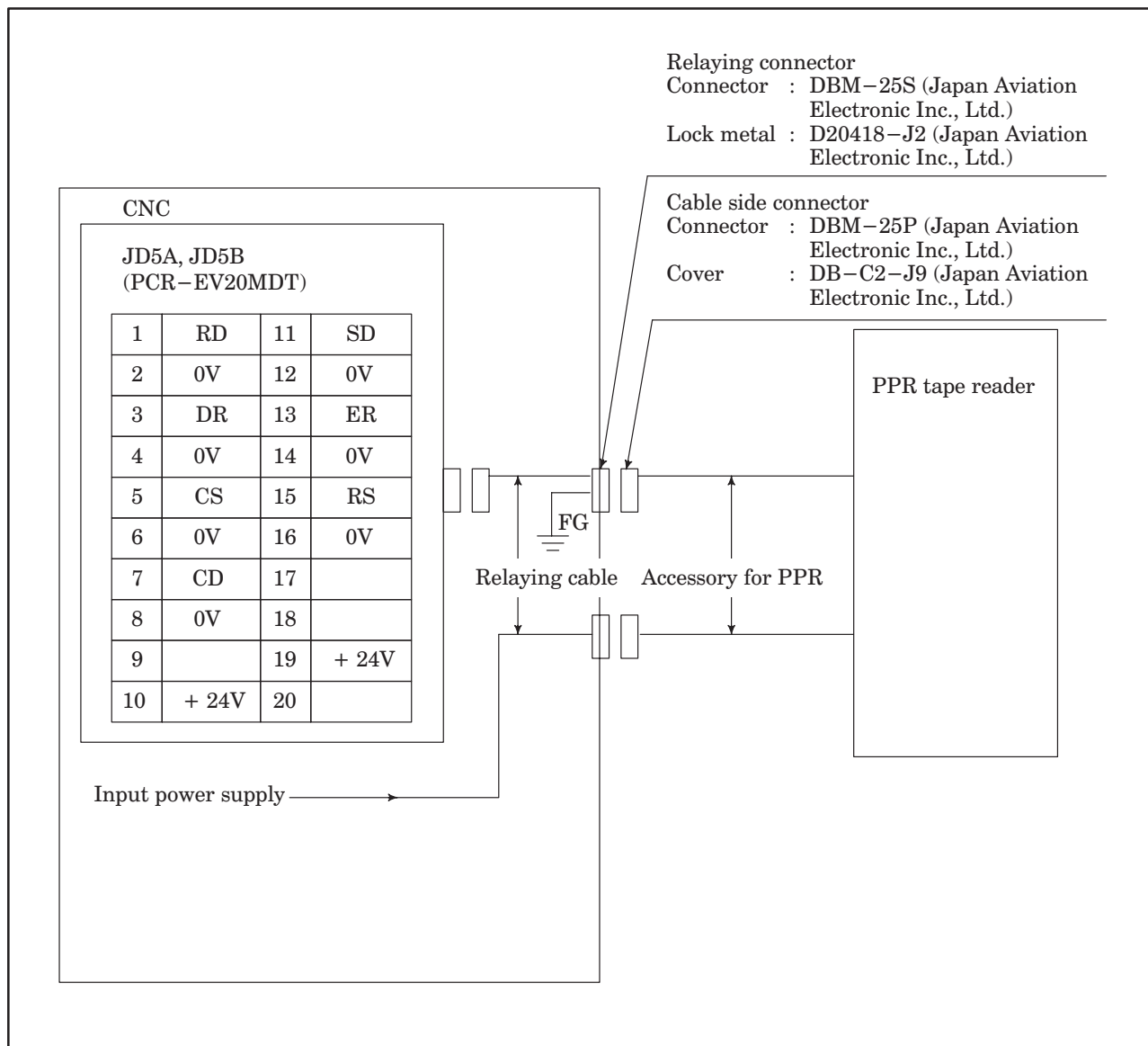
4.6.1 RS-232-C serial port



4.6.2 PPR connection

RELAYING CONNECTOR SIGNAL LAYOUT

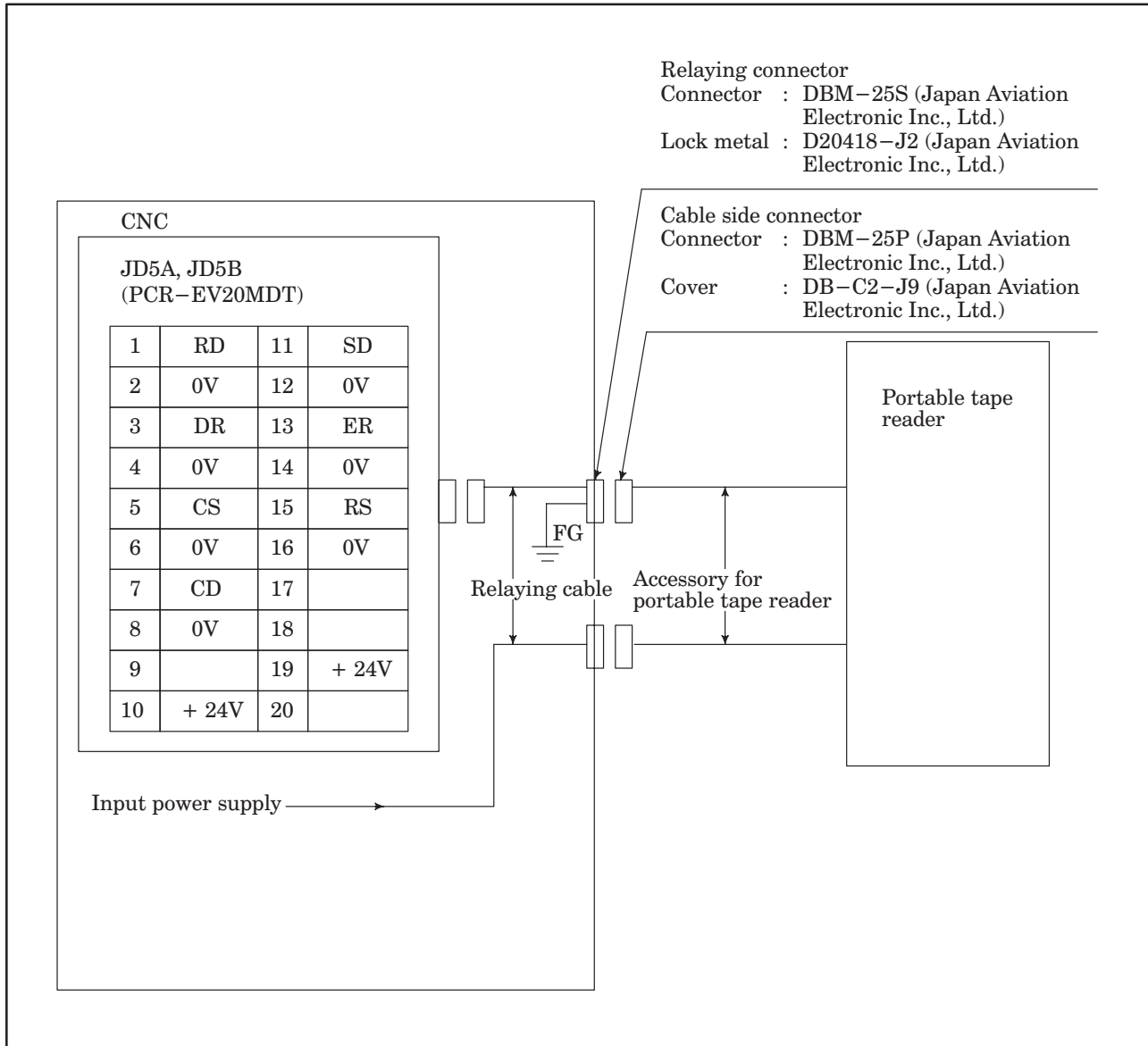
| | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|------|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| FG | SD | RD | RS | CS | DR | SG | CD | | | | | |
| 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | |
| | | | | | | ER | | | | | +24V | |



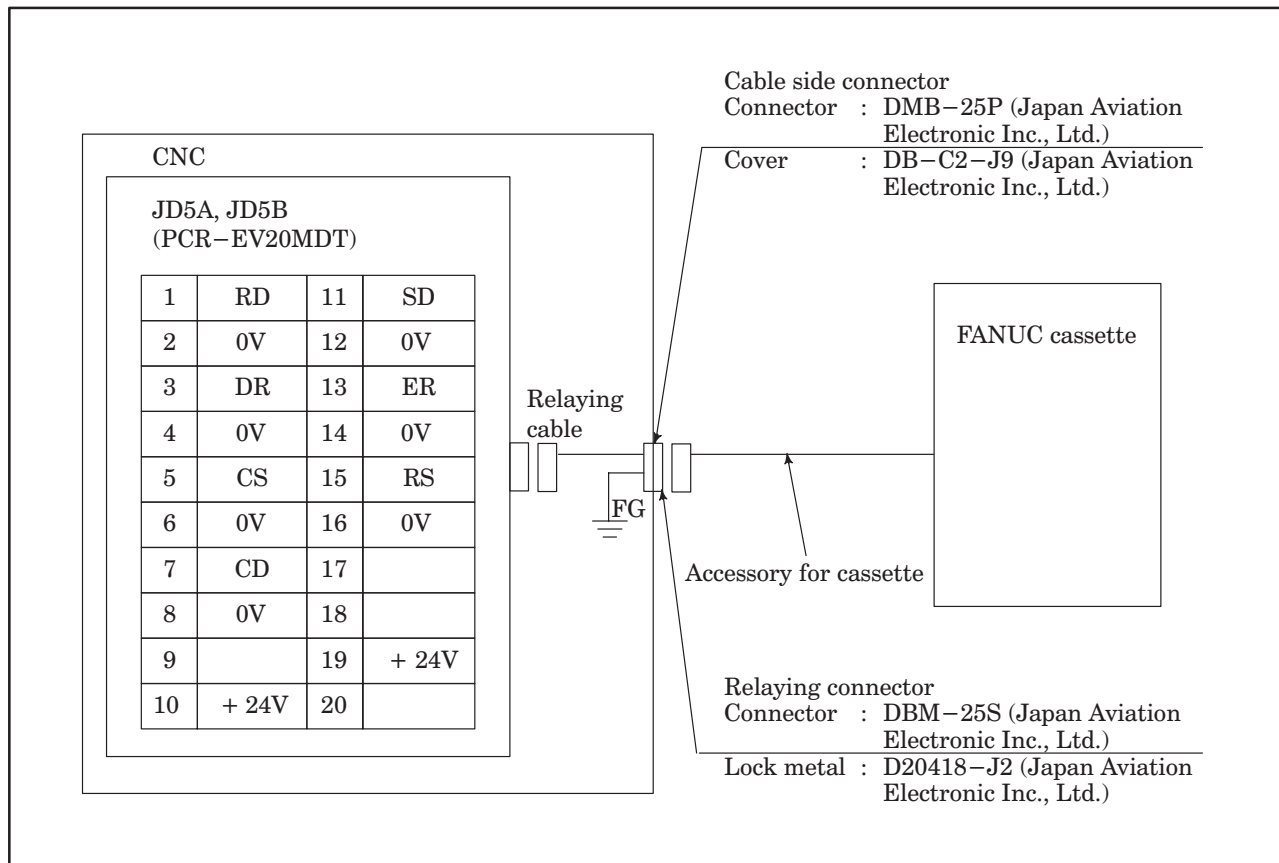
4.6.3 Portable tape reader connection

RELAYING CONNECTOR SIGNAL LAYOUT

| | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|------|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| FG | SD | RD | RS | CS | DR | SG | CD | | | | | |
| 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | |
| | | | | | | ER | | | | | +24V | |



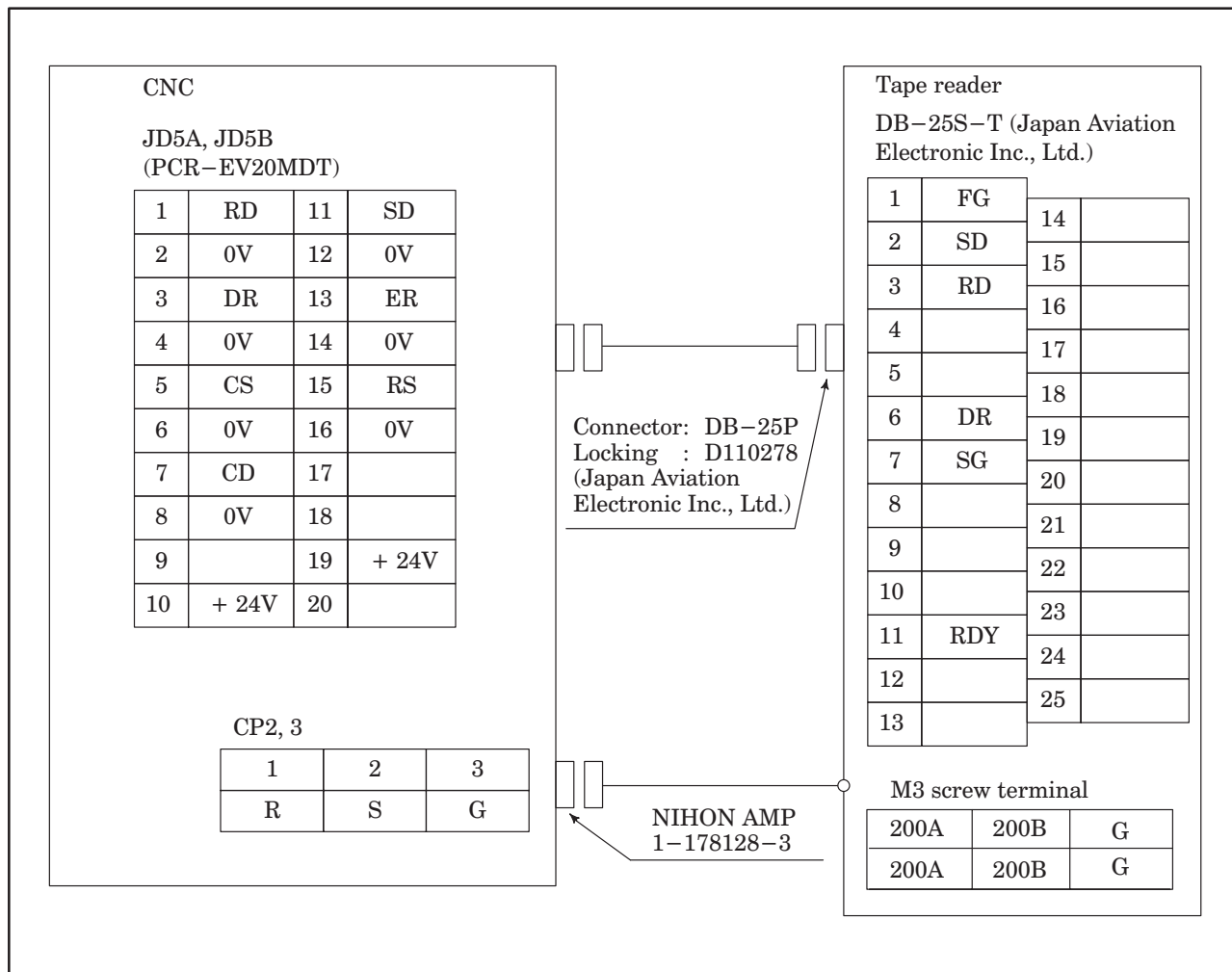
4.6.4 FANUC Cassette connection



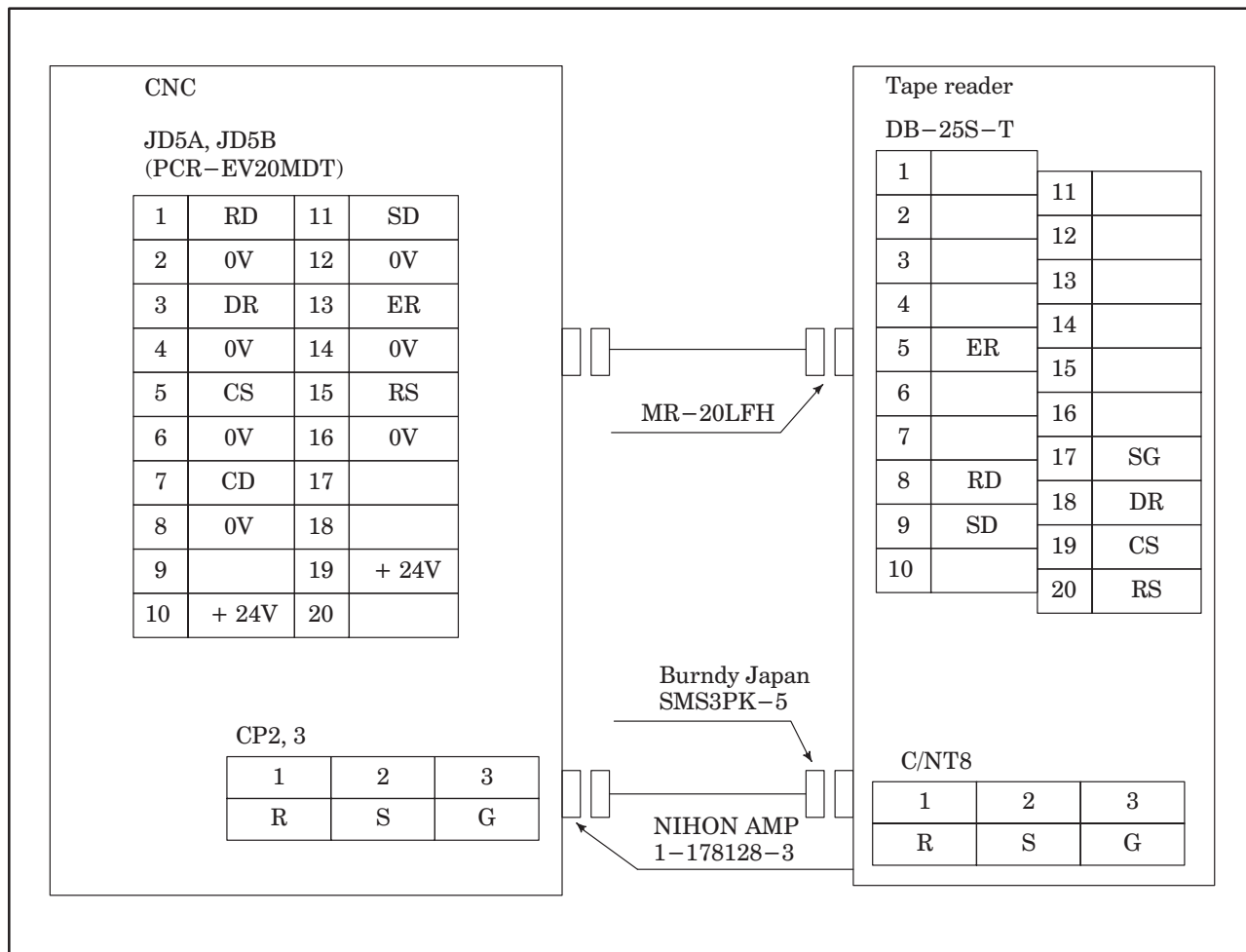
RELAYING CONNECTOR SIGNAL LAYOUT

| | | | | | | | | | | | | |
|----|----|----|----|----|----|----|----|----|----|----|------|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| FG | SD | RD | RS | CS | DR | SG | CD | | | | | |
| 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | |
| | | | | | | ER | | | | | +24V | |

4.6.5 Connection of tape reader without reels



4.6.6 Connection of tape reader with reels



5. STARTUP AND ADJUSTMENTS

5.1 Startup and Adjustment Procedures

After installation, adjust the CNC according to the following procedures. See items specified in the remarks column for details.

Table 5.1 Startup and Adjustment Procedure

| No. | Contents | Remarks |
|-----|---|-------------------|
| 1 | Check the external views of control unit and the servo unit. | See Item 5.1 (1) |
| 2 | Check the connection of screw terminals. | See Item 5.1 (2) |
| 3 | Check external cable connections. | See Item 5.1 (3) |
| 4 | When the power source for NC is OFF, connect the power input cable. | See Item 5.1 (4) |
| 5 | Check the connections of connectors and PCBs. | See Item 5.1 (5) |
| 6 | Confirm the settings of the following: ·Transformer Taps ·Servo amplifier PCB ·Control PCB | See Item 5.1 (6) |
| 7 | Check input power source voltage, frequency and phase rotation. | See Item 5.1 (7) |
| 8 | Check that output voltages are not shorted to ground. | See Item 5.1 (8) |
| 9 | Turn power on and check for proper output voltages. | See Item 5.1 (9) |
| 10 | Check interface between NC and machine side. | See Item 5.1 (10) |
| 11 | Setting and confirmation should be made for each parameter and setting data. | See Item 5.1 (11) |
| 12 | Turn power off. | See Item 5.1 (12) |
| 13 | Connect motor power cable. | See Item 5.1 (13) |
| 14 | Turn power on. | See Item 5.1 (14) |
| 15 | Check movement of each axis by using manual feed operation. | See Item 5.1 (15) |
| 16 | Check the servo system. | See Item 5.1 (16) |
| 17 | Check whether all functions of NC operate normally. | See Item 5.1 (17) |

(1) Check external or internal view of control unit and servo unit

| Items |
|---|
| Check for dirt and damage on the exterior of CRT/MDI unit, internal position display unit and internal manual operation board etc.. |
| Check for loose, fixtures, PCBs, and servo amplifiers, etc.. |
| Check for damage to cables. (Sheath strippings etc.) |

(2) Check that the connection of screw terminals is correct

| Items |
|--|
| Terminal block of input transformer for control. (Primary and secondary side) |
| Terminal block for 1st servo power transformer. (Primary side, secondary side 100A, B TOH 1,2) |
| Terminal block for 2nd servo power transformer. (Primary side, secondary side TOH 1,2) |
| If the terminal block has provisions for a cover, confirm the cover is provided and properly attached. |

(3) External cables connection

| Items |
|--|
| After stripping external cover of the cable, confirm that the cable is connected to the ground plate by a metal clamp. |
| Confirm that the proper sized earth ground cable is connected between the NC and the machine magnetics cabinet. |
| Check the protection earth is connected at one point to earth ground from the machine magnetics cabinet. |
| Check that all signal cables are made into same ground plate. |
| Check that cable specifications are as designated by the connection manual. (For motor signal) |
| Check that cable specifications are as designated by the connection manual. (For motor drive) |
| Check that cable specifications are as designated by the connection manual. (For servo amplifier interface) |
| Check that cable specifications are as designated by the connection manual. (For position coder) |
| Check that cable specifications are as designated by the connection manual. (For spindle analog output) |
| Check that cable specifications are as designated by the connection manual. (For manual pulse generator) |
| Check that cable specifications are as designated by the connection manual. (For the CRT/MDI) |
| Check that cable specifications are as designated by the connection manual. (For reader/puncher interface) |

(4) Connect the power input cable while the CNC power off

| Items |
|--|
| The motor power cables should remain disconnected. |

(5) Check the mounting state of connectors and PCBs

| Items |
|--|
| Are nail type fixtures fitted with brown connector for power source? |
| Are all PCBs and PCBs cables fully inserted? |

(6) Setting confirmation

(a) Tap set of transformer (see 4.2)

| Items |
|---|
| Tap setting of servo power transformer (see 4.2.2). |
| Tap setting of input transformer for control (see 4.2.1). |

(b) Setting on AC servo amplifier PCB.

(c) Setting on AC spindle servo unit PCB.

(7) Check input power source voltage, and frequency

| Items |
|---|
| When power source is used for control unit and servo unit, confirm the input is applied as follows: 200/220 VAC + 10%, -15% 50/60 Hz \pm 1 Hz, 3 ϕ (However, a combination with 220 V and 50 Hz is not allowed.) |
| Power source input for control unit only is applied as follows: 200/220 VAC + 10%, -15% 50/60 Hz \pm 3%, 1 ϕ (However, a combination with 220 V and 50 Hz is not allowed.) |
| Power source input for servo unit only is applied as follows: 200/220 VAC + 10%, -15% 50/60 Hz \pm 1 Hz, 3 ϕ (However, a combination with 220 V and 50 Hz is not allowed.) |
| The power source for the export transformer matches one of the following voltages: 200/220/230/240/380/415/440/450/480/550 VAC +10%, -15% |
| Check that the input power capacity is sufficient to meet the consumptive power requirements of the control unit and the servo unit. |

(8) Confirm that output power lines are not short-circuited with the ground line

| Items |
|--|
| When the DC power line outputs (+24V and +24E) from the power supply unit are used, confirm that they are not short-circuited to the ground in the cable. Check for short-circuits at the cable connector. |

(9) Turn power on and check output voltage (Refer to section 4.1)

| Items | | |
|---|--------|-------------------|
| Confirm each output voltage at test points on servo amp. PCB. | (+24V) | +22 to 27V |
| | (+15V) | +14.55 to 15.45V |
| | (-15V) | -14.55 to -15.45V |

(10) Check interface signal between CNC and machine side

| Items |
|---|
| See Section 3.3.1, "Diagnostic functions related to interfaces to the machine." |

(11) Set and confirm each parameter and setting data

| Items |
|--|
| See Chapter 6, "Displaying and Specifying Parameters." |

(12) Turn off the power supply

(13) Connect the motor power line

(14) Turn on the power supply

| Items |
|---|
| Perform the corrective action according to the alarm list, if an alarm occurred. |
| Repeat the power on/off operation and emergency stop several times, and make sure that the motor does not rotate. |

(15) Examine the movement of each axis by manual feed

| Items |
|---|
| Try moving each axis by 10 μ m increments using the MPG or incremental feed, and check if the machine moves the commanded distance. |
| Intentionally trip the machine mounted limit switches while manually jog feeding each axis with a low override setting. Make sure that the machine stops moving when an overtravel alarm is detected. |
| Move each axis while changing the override by manual JOG feed and manual rapid traverse, and confirm that alarms like excessive error, etc. do not appear even at the maximum feedrate. |

(16) Check the servo system

| Items | |
|--|--|
| Operate each axis using the F4 digit feed in MDI mode, and check the positional deviation amount (DGN No. 300). Determine the servo loop gain from the feedrate and positional deviation amount by the following equation. | |
| $G = \frac{16.7F}{E}$ | F : Feedrate (mm/min) (0.1 in/min) , (deg/min) E : Positional deviation amount (0.001 mm) , (0.001 in) , (0.01 deg) G : Servo loop gain (sec ⁻¹) (standard: 30 sec ⁻¹) |
| Check the servo loop gain given by the above calculation is within $\pm 10\%$ of the desired value. | |

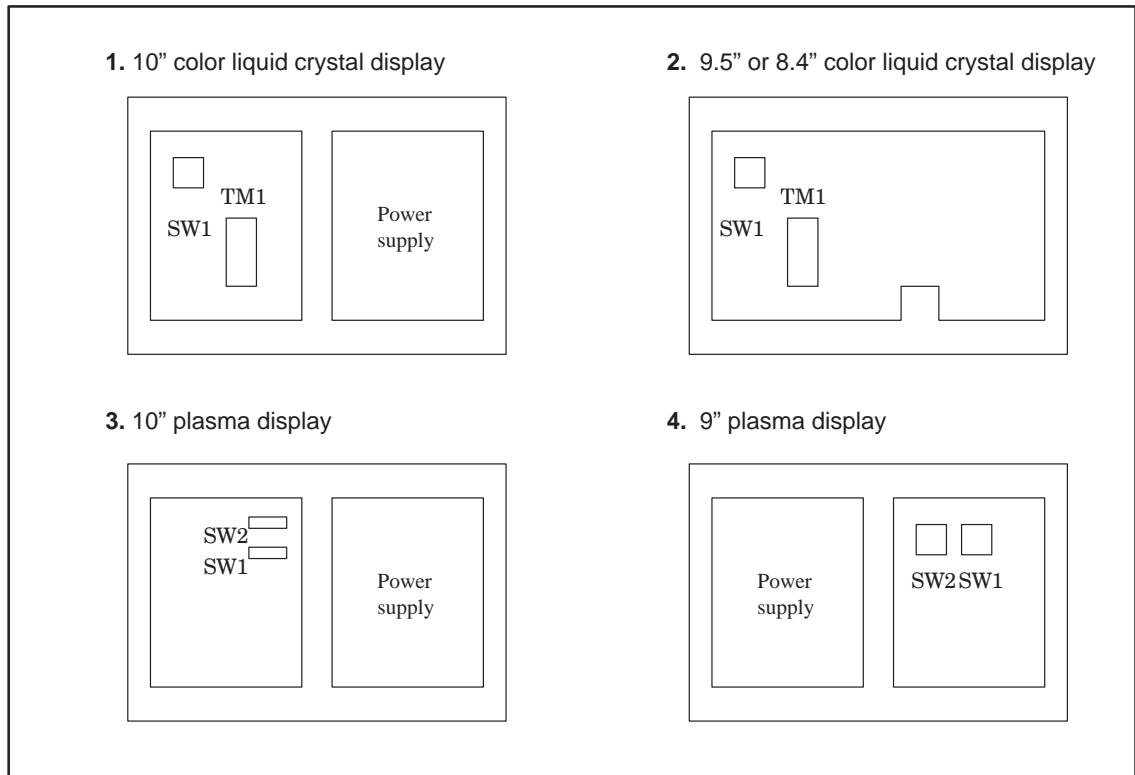
(17) Confirm that all CNC functions operate normally

| Items | |
|---|--|
| Perform a reference point return procedure. | |
| Perform the procedure or setting the grid shift amount. This setting will only become effective after power is turned off and on again. | |
| Confirmation is required. | |
| Execute the supplied machine test tapes while carefully observing the machine for any errors. | |

5.2 Adjusting a Flat Display

Flat displays, such as color liquid crystal displays and plasma displays, require fine adjustment of the video signal. This adjustment is necessary to compensate for variations in the signal resulting from differences in the CNC unit and the cables being used.

- Location of adjustment switches (rear of display)



- Suppressing flicker

To suppress flicker, set the following switches:

- | | |
|--|-----|
| 1. 10" color liquid crystal display : | TM1 |
| 2. 9.5" or 8.4" color liquid crystal display : | TM1 |
| 3. 10" plasma display : | SW2 |
| 4. 9" plasma display : | SW1 |

Change the setting of the switch and note the range where no flicker occurs. When several settings eliminate flicker completely, set the switch to the middle position of those settings.

Example When no flicker occurs with settings 2 to 6, set the switch to 4.

- Adjusting the horizontal position

To adjust the horizontal position of the screen, use the following switches:

- | | |
|--|-----|
| 1. 10" color liquid crystal display : | SW1 |
| 2. 9.5" or 8.4" color liquid crystal display : | SW1 |
| 3. 10" plasma display : | SW1 |
| 4. 9" plasma display : | SW2 |

You can move the screen horizontally in units of dots. Adjust the screen so that the entire screen can be seen. There is only one such position. The screen is factory-set to this position and usually need not be adjusted.

- Others

Do not change any settings other than the above, including the volume control.

6. DISPLAYING AND SPECIFYING PARAMETERS

6.1 Displaying Parameters

6.1.1 Displaying parameters other than those related to pitch error compensation

(1) Press the **SERVICE** soft key, then press the **PARAM** soft key to display the parameter screen.

(2) Enter the number of the parameter to be displayed and press the **INP-NO.** soft key.

The screen can also be changed using the cursor or page key instead of entering the number.

6.1.2 Displaying parameters related to pitch error compensation

(1) Press the **SERVICE** soft key, then press the **PITCH** soft key to display the parameter screen.

(2) Enter the number of the parameter to be displayed and press the **INP-NO.** soft key.

The screen can also be changed using the cursor or page key instead of entering the number.

6.2 Specifying Parameters

6.2.1 Formats of parameter tapes

(1) Formats of parameter tapes other than those for pitch error compensation

The parameters can be classified according to the data types as follows:

| Data type | Valid range | Remarks |
|-------------|---------------------|---------|
| Bit | 0 or 1 | |
| Bit axis | 0 or 1 | |
| Byte | 0 to ± 127 | |
| Byte axis | 0 to ± 127 | |
| Word | 0 to ± 32767 | |
| Word axis | 0 to ± 32767 | |
| 2 word | 0 to ± 99999999 | |
| 2-word axis | 0 to ± 99999999 | |

NOTE 1 The axis type of data can be specified separately for each axis.

NOTE 2 The valid ranges are listed for general reference. The valid range depends on the parameter. For details, see description of each parameter.

(a) Format of bit-type parameter tapes

Nnnnn Ppppppppp ;

Nnnnn : Specify a parameter No. with a 4-digit number following N. (Positive integer)

Ppppppppp : Specify parameter values (0 or 1) with an 8-digit number following P.

Eight bit-type parameters are provided for each parameter No. Specify 0 or 1 for the least significant digit as the bit 0 parameter value and for the most significant digit as the bit 7 parameter value. (Positive integer)

:: End of block (ISO code: LF; EIA code: CR)

NOTE 1 The addresses N and P must be specified in the order shown above.

NOTE 2 The leading zeros can be omitted.

Example

N0000 P00010001 ; or N0 P10001 ;

(b) Format of bit-axis-type parameter tapes

Nnnnn Aaa Ppppppppp ;

Nnnnn : Specify a parameter No. with a 4-digit number following N. (Positive integer)

Aaa : Specify the axis number (1 to 15). (Positive integer)

Ppppppppp : Specify parameter values (0 or 1) with an 8-digit number following P.

Eight bit-type parameters are provided for each parameter No. Specify 0 or 1 for the least significant digit as the bit 0 parameter value and for the most significant digit as the bit 7 parameter value. (Positive integer)

:: End of block (ISO code: LF; EIA code: CR)

NOTE 1 The addresses N, A, and P must be specified in the order shown above.

NOTE 2 The leading zeros can be omitted.

Example

N0012 A1 P00000011 ; or N12 A1 P11 ;

N0012 A2 P00000010 ; or N12 A1 P10 ;

N0012 A3 P00000010 ; or N12 A1 P10 ;

Parameters for two or more axes can be specified in one block as follows:

N12 A1 P11 A2 P10 A3 P10 ;

(c) Format of byte-type parameter tapes

Nnnnn Pp... ;

Nnnnn : Specify a parameter No. with a 4-digit number following N. (Positive integer)

Pp... : Specify the parameter value with a number following P. (Integer)

The valid range depends on the parameter.

:: End of block (ISO code: LF; EIA code: CR)

NOTE 1 The addresses N and P must be specified in the order shown above.**NOTE 2** The leading zeros can be omitted.**Example**

N2010 P100 ;

(d) Format of byte-axis-type parameter tapes

Nnnnn Aaa Pp... ;

Nnnnn : Specify a parameter No. with a 4-digit number following N. (Positive integer)

Aaa : Specify the axis number (1 to 15). (Positive integer)

Pp... : Specify the parameter value with a number following P. (Integer)

The valid range depends on the parameter.

:: End of block (ISO code: LF; EIA code: CR)

NOTE 1 The addresses N, A, and P must be specified in the order shown above.**NOTE 2** The leading zeros can be omitted.**Example**

N1020 A1 P88 ;

N1020 A2 P89 ;

N1020 A3 P90 ;

Parameters for two or more axes can be specified in one block as follows:

N1020 A1 P88 A2 P89 A3 P90 ;

(e) Format of word-type parameter tapes

Same as that of byte-type parameter tapes

(f) Format of word-axis-type parameter tapes

Same as that of byte-axis-type parameter tapes

(g) Format of 2-word-type parameter tapes

Same as that of byte-type parameter tapes

(h) Format of 2-word-axis-type parameter tapes

Same as that of byte-axis-type parameter tapes

Example of a parameter tape other than that for pitch error compensation

% ;

N0 P1 ;

N3 P0 ;

N10 P10 ;

N11 P0 ;

:

:

:

%

(2) Formats of parameter tapes for pitch error compensation

Nnnnnn Ppp ;

Nnnnnn : Specify a parameter No. with a 5-digit number (10000 + pitch error compensation number) following N. (Positive integer)

Ppp : Specify the value of the pitch error compensation parameter with a number following P. (Integer)
Specify a number between -7 and 7.

:: End of block (ISO code: LF; EIA code: CR)

NOTE The addresses N and P must be specified in the order shown above.

Example of a parameter tape for pitch error compensation (ISO code)

```
% ;
N10000 P1 ;
N10001 P4 ;
N10002 P-7;
N10003 P-3;
N10004 P2 ;
:
:
:
%
```

6.2.2 Specifying parameters through the reader/punch interface

- (1) Put the CNC in the MDI mode or place it in the emergency stop state.
- (2) Press the **SETTING** soft key to display the setting screen.
- (3) Enter 8000.
- (4) Press the **INP-NO.** soft key to display parameter No. 8000.
- (5) Enter 1 and press the **INPUT** soft key. Parameter PWE is set to 1 and parameters can be specified. The CNC enters the alarm status.
- (6) Press the function menu key to put the soft keys in the function selection mode.
- (7) Press the **SERVICE** soft key, then press the **PARAM** soft key to display the parameter screen.
- (8) Turn on the power to a unit connected to the reader/punch interface and insert a medium such as a tape or disk which contains parameters in the unit.
- (9) Press the **READ** soft key, then press the **ALL** soft key to read parameters through the reader/punch interface.
- (10) Turn off the CNC power.

6.2.3 Specifying parameters through the MDI

- (1) Put the CNC in the MDI mode or place it in the emergency stop state.
- (2) Press the **SETTING** soft key to display the setting screen.
- (3) Enter 8000.
- (4) Press the **INP-NO.** soft key to display parameter No. 8000.
- (5) Enter 1 and press the **INPUT** soft key. Parameter PWE is set to 1 and parameters can be specified. The CNC enters the alarm status.
- (6) Press the function menu key to put the soft keys in the function selection mode.
- (7) Press the **SERVICE** soft key, then press the **PARAM** soft key (the **PITCH** soft key for pitch error compensation parameters) to display the parameter screen.
- (8) Enter the Nos. of the parameters to be specified and press the **INP-NO.** soft key to display the parameters on the parameter screen.
- (9) Enter the value to be specified and press the **INPUT** soft key to set the value.

To specify values continuously for the parameter with the specified No. and the subsequent parameters, separate the values with a semicolon (;).

Example

Enter 10 ; 20 ; 30 ; 40 and press the **INPUT** soft key. 10, 20, 30, and 40 are specified for the parameter at the cursor and the subsequent three parameters, respectively.

- (10) Repeats steps (7), (8), and (9).
- (11) After specifying the parameters, set the PWE bit of parameter No. 8000 to 0 to inhibit setting the parameters.
- (12) Reset the CNC to release the alarm indicated by the message PARAMETER SETTING ENABLED. If the alarm message PARAMETER REQUIRING NC POWER-OFF WAS SPECIFIED is displayed, turn off the CNC power.

6.3 Outputting Parameters

6.3.1 Outputting all parameters

- (1) Connect an output unit to the reader/punch interface.
- (2) Put the CNC in the EDIT mode.
- (3) Press the **SERVICE** soft key, then press the **PARAM** soft key to display the parameter screen.
- (4) Press the **PUNCH** soft key, then press the **ALL** soft key to output all parameters.

6.3.2 Outputting the parameters excluding those related to pitch error compensation

- (1) Connect an output unit to the reader/punch interface.
- (2) Put the CNC in the EDIT mode.
- (3) Press the **SERVICE** soft key, then press the **PARAM** soft key to display the parameter screen.
- (4) Press the **PUNCH** soft key, then press the **PARAM** soft key to output all parameters excluding those related to pitch error compensation.

6.3.3 Outputting parameters for pitch error compensation

- (1) Connect an output unit to the reader/punch interface.
- (2) Put the CNC in the EDIT mode.
- (3) Press the **SERVICE** soft key, then press the **PITCH** soft key to display the parameter screen.
- (4) Press the **PUNCH** soft key, then press the **PITCH** soft key to output pitch error compensation parameters.

NOTE If an attempt is made to output parameters to a FANUC Cassette (a floppy disk) which contains a parameter file, the alarm DR OFF occurs and no parameters are written. In this case, use an empty disk or delete the existing parameter file, then output the parameters.

6.4 Parameters

Parameters are specified by type of function as follows. For details, see operator's manual (Appendix)

Parameter list

1) Parameters related to setting

| Parameter No. | Contents |
|---------------|--|
| 0000 | TV check is performed or not. TV check is performed or not during control out. ISO code is with parity bit or not. Method of punching EOB by ISO code. Punch code is ISO or EIA. |
| 0010 | Input unit is by metric or inch. Single block stop in custom macro is performed or not. |
| 0011 | 08000 to 08999 programs can be edited or not. 08000 to 08999 programs are displayed on executing. |
| 0012 | Mirror image ON/OFF. Each axis scaling Validity/Invalidity. |
| 0020, 0021 | Input device No. for foreground. |
| 0022, 0023 | Input device No. for background. |

2) Parameters related to timer

| Parameter No. | Contents |
|---------------|---|
| 0100 | Timer 1 (Accumulated power on hour). |
| 0101 | Timer 2 (Accumulated automatic operation hour). |
| 0102 | Timer 3 (Accumulated automatic operation hour). |

3) Parameters related to axis control

| Parameter No. | Contents |
|---------------|---|
| 1000 | In-position and interlock condition. |
| 1002 | Linear axis detection unit. |
| 1004 | Each axis setting unit. Input unit is multiplied by 10 or not. |
| 1005 | Setting related to reference point return. External deceleration signal, machine lock, and axis detach signal are valid or invalid. |
| 1006 | Setting inch/metric conversion is required or not. Setting machine coordinate system for stroke check and automatic reference point return. Setting machine coordinate system for stored pitch error compensation. Axis movement amount is specified by diameter or radius. Specifying manual reference point return direction. |
| 1020 | Program axis name of each axis. |
| 1021 | Axis number in parallel axis. |
| 1022 | Specifying each axis in basic coordinate system. |
| 1023 | Servo axis number of each axis. |
| 1030 | 2nd auxiliary function command address. |
| 1031 | Standard axis. |

4) Parameters related to coordinate system

| Parameter No. | Contents |
|---------------|---|
| 1220 | Each axis external work zero point offset value. |
| 1221 | Work zero point offset value of work coordinate system 1. |
| 1222 | Work zero point offset value of work coordinate system 2. |
| 1223 | Work zero point offset value of work coordinate system 3. |
| 1224 | Work zero point offset value of work coordinate system 4. |
| 1225 | Work zero point offset value of work coordinate system 5. |
| 1226 | Work zero point offset value of work coordinate system 6. |
| 1240 | Coordinate value of the 1st reference point in the machine coordinate system. |
| 1241 | Coordinate value of the 2nd reference point in the machine coordinate system. |
| 1242 | Coordinate value of the 3rd reference point in the machine coordinate system. |
| 1243 | Coordinate value of the 4th reference point in the machine coordinate system. |
| 1260 | Movement value of rotary axis per rotation. |

5) Parameters related to feed rate

| Parameter No. | Contents |
|---------------|---|
| 1400 | Dry run is valid or invalid for rapid traverse command. Dry run is valid or invalid for thread cutting command. Manual rapid traverse is valid or invalid from reference point return after power on. Skip function feed rate. Positioning is by non-linear interpolation type or linear interpolation type. 2nd feed rate override is valid or invalid. |
| 1401 | External deceleration invalid for all feeds or only for rapid traverse. |
| 1410 | Dry run rate. |
| 1412 | Percentage to rapid traverse override F1. |
| 1413 | Manual handle feed allowable flow. |
| 1414 | Magnification n of manual handle feed. |
| 1420 | Rapid traverse rate of each axis. |
| 1421 | Fo-rate for each axis rapid traverse override. |
| 1422 | Maximum cutting feed rate of each axis. |
| 1423 | Jog feed rate of each axis. |
| 1424 | Manual reference point return FM rate of each axis. |
| 1425 | Manual reference point return FL rate of each axis. |
| 1426 | External deceleration rate for cutting feed. |
| 1427 | External deceleration rate at rapid traverse of each axis. |
| 1428 | Feed rate of skip function. |

6) Parameters related acceleration/deceleration control

| Parameter No. | Contents |
|---------------|--|
| 1600 | Rapid traverse acceleration/deceleration is by linear or exponential. |
| 1620 | Linear type rapid traverse acceleration/deceleration time constant of each axis. |
| 1621 | Linear type rapid traverse acceleration/deceleration FL rate of each axis. |
| 1622 | Cutting feed acceleration/deceleration constant time of each axis. |
| 1623 | Cutting feed acceleration/deceleration FL rate of each axis. |
| 1624 | Jog feed acceleration/deceleration constant time of each axis. |
| 1625 | Jog feed acceleration/deceleration FL rate of each axis. |

| Parameter No. | Contents |
|---------------|---|
| 1626 | Chamfering time constant at thread cutting cycle of each axis. |
| 1627 | FL rate at thread cutting cycle of each axis. |
| 1628 | Exponential type rapid traverse acceleration/deceleration time constant of each axis. |
| 1629 | Exponential type rapid traverse acceleration/deceleration FL rate of each axis. |
| 1630 | Parameter 1 to establish linear acceleration/deceleration prior to interpolation. |
| 1631 | Parameter 2 to establish linear acceleration/deceleration prior to interpolation. |

7) Parameters related to servo

| Parameter No. | Contents |
|---------------|---|
| 1800 | Automatic drift compensation is performed or not. Servo alarm occurs or not when velocity control ready signal (VRDY) turns on before position control ready signal turns on. Follow-up is performed or not during servo-off. |
| 1802 | Automatic setting of phase shift value has completed or not. Servo off signal is valid or invalid. |
| 1810 | Feed back pulse frequency is checked or not. Setting of compensational rate of backlash and pitch error compensation. Position control LSI is checked or not at turning on power. Feed back pulses of pulse coder is monitored or not. |
| 1815 | Position detective method is by digital feed back or analog feed back. Whether the position detector is an optical scale. Tolerance when the feed back pulses of the pulse coder are monitored. |
| 1816 | Setting of reference counter capacity. Setting of detective multiplier. |
| 1820 | Command multiplier (CMR) of each axis. |
| 1825 | Servo loop gain of each axis. |
| 1826 | Loop gain multiplier of each axis. |
| 1827 | In-position width of each axis. |
| 1828 | Position deviation limit value at servo off of each axis. |
| 1829 | Position deviation limit value at stoppage of each axis. |
| 1830 | Position deviation limit value at servo off at each axis. |
| 1831 | Lowest clamp value of velocity command value of each axis. |
| 1832 | Feed stop position deviation of each axis. |
| 1833 | Position detector phase shift value of each axis. |
| 1834 | Drift compensation amount of each axis. |
| 1835 | Number of pulse per pulse coder one rotation. |
| 1850 | Grid shift amount of each axis. |
| 1851 | Backlash compensation of each axis. |
| 1890 | Feed back pulse check move distance of each axis. |

8) Parameters related to DI/DO

| Parameter No. | Contents |
|---------------|--|
| 2000 | Resetting signal (RST) is always output or only when reset button on MDI panel is pressed. Rewinding signal (RWD) is output only when tape reader is rewinded or when either tape reader or program in memory is rewinded. Cycle start lamp signal (STL) is output or not during operation by manual numeric command. Cycle start lamp signal is output or not when programs are registered by cycle start signal in tape editing mode. Cycle operating signal (OP) is turned on or not at searching for sequence number. MDI mode can be started or not by pressing start button on the panel. Programs are registered by cycle start signal in tape editing mode or not. |
| 2001 | Reset or alarm is effective at emergency stop. If all of the mode selection signal turn off, no mode is assumed, or the previously selected mode is assumed. Incremented feed amount is specified by magnification specification signals MP1, MP2, and MP3. Rapid traverse override signal ROV1 and ROV2 has a standard interface or logical 0/1 reverse interface. Selection BMI or FS3/FS6 as machine interface. Selection FS3 or FS6 interface. External operation command signal EF is output or not. |
| 2010 | Delay time of strobe signal MF, SF, TF, BF. |
| 2011 | Acceptance width of M, S, T and B function completion signal (FIN). |
| 2014 | Mode un selected status ignore time. |
| 2015 | Invalid mode selection status ignore time. |
| 2016 | Manual feed rate override clamp value. |
| 2017 | Software operator's panel (+) direction command button. |
| 2021 | Software operator's panel (-) direction command button. |

9) Parameters related to MDI/EDIT/CRT

| Parameter No. | Contents |
|---------------|---|
| 2200 | All of the programs are loaded at once by external I/O device next to programs previously loaded or after deleting previous programs. When programs with the same program number as the one already loaded, program can not be loaded by alarm or loaded after deleting previously loaded programs. M02, M30 and M99 are assumed as program end or not in program loading. M99 is assumed as program end in program loading. Program No. 09000 – 09999 are deleted or not by all program deleting operation or command. |
| 2201 | Program editing of program No. 09000 to 09999 is prohibited or not. Program No. 09000 – 09999 are displayed or not during execution. Single block is stopped or not at the macro statement of programs 09000 – 09999. |
| 2202 | Display on external position display and position display on CRT are by standard unit or by 10 magnification of standard unit. External position display, CRT relative position display and absolute position display include tool length compensation value or not. External position display, CRT relative position display, CRT relative position display and absolute position display include tool length compensation value or not. External position display, CRT relative position display and absolute position display include tool radius compensation/tool nose R compensation value or not. External position display, CRT relative position display and absolute position display are with considering the delay at acceleration/deceleration control or not. External position display, CRT relative position display and absolute position display are with considering the delay in servo or not. Machine position display or CRT is with considering the delay at acceleration/deceleration control or not. Machine position display on CRT is with considering the delay at servo or not. |

| Parameter No. | Contents |
|--------------------|---|
| 2203 | Machine position display on CRT is by detective unit or inch/metric unit. |
| 2311 to 2388 | Names of general-purpose switches on the software operator panel. |

10) Parameters related to programming

| Parameter No. | Contents |
|--------------------|---|
| 2400 | Decimal point is input by conventional or calculator method. Feed per minute F code in metric without decimal point is processed by 1 mm/min or 0.1 mm/min unit. Commands of inch input and metric input are G20/21 or G70/71. Condition setting of M30 at memory operation. Always dwell per minute or dwell per minute in feed per minute mode and dwell per revolution in feed per revolution in feed per revolution mode. G code system selection. |
| 2401 | Mode at power turn on and in clear status. |
| 2402 | Travel command path for absolute are same as for incremental or not after manual intervention by manual absolute on. Whether the workpiece coordinate system is preset at manual reference position return. E code specification |
| 2410 | Arc radius error limit value. |
| 2411 to 2418 | M codes 1 – 8 which do not perform buffering. |
| 2900 | Distance between double turrets. |

11) Parameters related to Reader/puncher interface

| Parameter No. | Contents |
|--|---|
| 5001 to 5003 | I/O device No. connected to Reader /puncher interface. |
| 5011 | I/O device No. connected to ASR33/44 interface. |
| 5110, 5120, 5130, 5140, 5150, 5160 | Reader/puncher device specification number corresponding to device No. 1 – 6. |
| 5110, 5121, 5131, 5141, 5151, 5161 | Stop bit number of Reader/puncher device corresponding to device No. 1 – 6. |
| 5112, 5122, 5132, 5142, 5152, 5162 | Band rate corresponding to device No. 1 – 6. |

12) Parameters related to stroke limit

| Parameter No. | Contents |
|---------------|---|
| 5200 | Stored stroke limit inhibited area is in interior or exterior. |
| 5210 | Stored stroke limit is checked or not. |
| 5220 | (+) direction coordinate value of stored stroke limit 1 of each axis. |
| 5221 | (-) direction coordinate value of stored stroke limit 1 of each axis. |
| 5222 | (+) direction coordinate value of stored stroke limit 2 of each axis. |
| 5223 | (-) direction coordinate value of stored stroke limit 2 of each axis. |
| 5224 | (+) direction coordinate value of stored stroke limit 3 of each axis. |
| 5225 | (-) direction coordinate value of stored stroke limit 3 of each axis. |

13) Parameters related pitch error compensation

| Parameter No. | Contents |
|---------------|--|
| 5420 | Pitch error compensation number for reference point of each axis. |
| 5421 | Pitch error compensation point number nearest the “-” end of each axis. |
| 5422 | Pitch error compensation point number nearest the “+” end of each axis. |
| 5423 | Pitch error compensation magnification for each axis. |
| 5424 | Interval of pitch error compensation for each axis. |
| 5425 | Movement amount per rotation in rotating axis type pitch error compensation. |

14) Parameters related to inclination compensation

| Parameter No. | Contents |
|--------------------|--|
| 5461 to 5464 | Compensation point number a – d on each axis. |
| 5471 to 5474 | Compensation α to ε at points a to d for each axis. |

15) Parameters related to straightness compensation

| Parameter No. | Contents |
|----------------------|--|
| 5481 5482 5483 | Axis number of moving axis. |
| 5491 5492 5493 | Axis number of compensation axis related to moving axis. |
| 5501 to 5524 | Points a to d at which compensation is applied for axes 1 to 3 along which the tool moves. |
| 5551 to 5574 | Compensation at points a to d for axes 1 to 3 along which the tool moves. |

16) Parameters related to spindle control

| Parameter No. | Contents |
|--------------------|--|
| 5600 | Voltage polarity of spindle speed analog output. Gear change system during thread cutting or tapping. Spindle orientation or gear shift is performed by spindle orientation signal (SOR). Spindle speed output is by analog or 12 bit binary output. |
| 5601 | Spindle override is valid or invalid. Spindle override is valid or invalid during thread cutting or tapping. When spindle speed command beyond maximum spindle speed, speed is clamped to maximum speed or an alarm occurs. Gear select signal output is code output or signal output corresponding to gear selection. SF signal is output or not when gear select signal is output or when S code is commanded. Type of spindle speed analog output/spindle speed binary output. Gear selection on the machine side. |
| 5602 | Spindle stop signal (SSTP) input type. One of gear select signal and BCD S code is output or both of them are inputted. Gear select signal input type. Alarm of spindle velocity control unit is checked or not. Tool position offset amount is excluded or not from the preset position of constant surface speed controlled axis. Tool length compensation amount is excluded or not from the preset position of constant surface speed controlled axis. Preset position or end point coordinate value is used in positioning command during constant surface speed control. Speed arrival signal is used or not. |
| 5603 | Gear select condition for 3/6 interface. Position coder disconnection is checked or not. |
| 5610 | Gear ratio of spindle to position coder. |
| 5611 | Sampling number for finding the moving average of spindle speed. |
| 5612 | Spindle speed unit generated by BMI. |
| 5613 | Offset voltage compensation value of spindle speed analog output. |
| 5614 | Gain adjusting data of spindle speed analog output. |
| 5615 | Spindle speed during spindle gear shift. |
| 5616 | Time upto new spindle speed after spindle gear select signal is output. |
| 5617 | Spindle speed during spindle orientation. |
| 5618 | Minimum clamp speed of spindle motor. |
| 5619 | Maximum clamp speed of spindle motor. |
| 5620 | Time for checking the speed arrival signal. |
| 5621 to 5628 | Maximum spindle speed corresponding to gears. |
| 5631 to 5637 | Spindle speed at each gear switching point during tapping and thread cutting. |
| 5640 | Axis number of constant surface speed. |
| 5641 to 5648 | Minimum spindle speed at gear during constant surface speed control. |

17) Parameters related to tool compensation

| Parameter No. | Contents |
|---------------|--|
| 6000 | New offset value is valid after the next block where D or H code is specified or valid after the next block. Tool position compensation is specified by D code or H code. Tool position compensation is effective or not for arc command. Axis selection for tool length compensation. Tool length compensation vector can be cleared by reset or not. Offset number of tool position offset is specified by low order two digits or by low order one digit of the T code. Condition to execute tool position offset. |
| 6001 | Start up type of tool R compensation or tool nose R compensation. Condition of interference check of tool R compensation or tool nose R compensation. Tool position compensation geometry offset is performed shifting work coordinate system or by moving the tool. Tool wear offset of tool position compensation is performed by shifting work coordinate system or moving the tool. Offset number specifying method of geometry and wear in tool position compensation. Offset state when tool number 0 is specified. |
| 6002 | Setting of offset amount unit. Tool position compensation amount is specified by diameter or radius value. Position record signal (PRC) is used or not when tool position offset is inputted directly. |
| 6010 | Limit value to ignore small movement amount created by tool R compensation. |
| 6011 | Denominator constant by three-dimensional tool offset. |

18) Parameters related to canned cycle

| Parameter No. | Contents |
|---------------|--|
| 6200 | Selection of drilling axis in canned cycle. Dwell command is valid or not by P in canned tapping cycle. Tool return direction and movement amount in canned fine boring cycle and canned back boring cycle after spindle orientation. Movement to drilling point in canned cycle is done by rapid traverse or by linear interpolation. Initial level point is changed or not when origin setting is above by reset or MDI during canned cycle. G80 and G81 are specified by canned cycle or external operation command. |
| 6201 | Spindle control in canned cycle is performed or not by M code. M05 is output or not when spindle rotation direction is changed. FFIN signal or FIN signal which corresponds to SSP signal and SRV signal. FMF signal is output or not after returning to R point or initial point when SSP and SRV are output. FMF signal is output or not when SSP and SRV are output. |
| 6202 | Cutting cycle is performed or not at the block which has no movement command during signal cutting cycle mode. Finishing workpiece is performed or not at the end of roughing cycle. Override can be applied or not to infeed during roughing cycle. |
| 6210 | Return amount of canned cycle G73. |
| 6211 | Clearance amount of canned cycle G83. |
| 6212 | Chamfering amount of thread cutting cycle. |
| 6213 | Chamfering angle of thread cutting cycle. |
| 6214 | Overcutting override value of roughing cycle. |
| 6215 | Retract amount in roughing cycle. |
| 6216 | Clearance amount in rough cutting cycle. |
| 6217 | Return amount in peck cycle. |
| 6218 | Minimum cutting amount in thread cutting cycle. |
| 6219 | Finish allowance in thread cutting cycle. |

| Parameter No. | Contents |
|---------------|--|
| 6220 | Number or spark-out in thread cutting cycle. |
| 6240 | Tool retract direction after G76, G87 orientation. |

19) Parameters related to scaling and coordinate system rotation

| Parameter No. | Contents |
|---------------|---|
| 6400 | Designation of angle of coordinate system rotation. |
| 6410 | Magnification of scaling. |
| 6411 | Angle of coordinate system rotation. |

20) Parameters related to automatic corner override

| Parameter No. | Contents |
|---------------|---|
| 6610 | Minimum reduction ratio at cycle internal cutting speed. |
| 6611 | Effective angle for internal corner automatic override. |
| 6612 | Reduction ratio at internal corner automatic override. |
| 6613 | Deceleration distance to the end point for internal corner automatic corner override. |
| 6614 | Deceleration distance from the start point for internal corner automatic corner override. |

21) Parameters related to one directional positioning

| Parameter No. | Contents |
|---------------|--|
| 6820 | One directional positioning and approach amount. |

22) Parameters related to custom macro

| Parameter No. | Contents |
|--------------------|--|
| 7000 | Custom macro is called or not by T, S and B codes. Custom common variables 1 #100 – #199 are cleared or not by reset. |
| 7010 | EIA code which represents is set by hole pattern. |
| 7011 | EIA code which represents is set by hole pattern. |
| 7012 | EIA code which represents # is set by hole pattern. |
| 7013 | EIA code which represents * is set by hole pattern. |
| 7014 | EIA code which represents = is set by hole pattern. |
| 7033 | M code that enables custom macro interrupts. |
| 7034 | M code that disables custom macro interrupts. |
| 7050 to 7059 | G code for calling the custom macro of program No. 9010 to 9019. |
| 7071 to 7079 | M code for calling the custom macro of program No. 9001 to 9009. |

23) Parameters related to skip function

| Parameter No. | Contents |
|--------------------|----------------------------|
| 7211 to 7214 | Feedrate of skip function. |

24) Parameters related to automatic tool compensation

| Parameter No. | Contents |
|--------------------|---|
| 7311 to 7313 | Measurement feedrate with tool measurement 1 – 3. |
| 7321 to 7323 | γ value of tool measurement 1 – 3. |
| 7331 to 7333 | ε value of tool measurement 1 – 3. |

25) Parameters related to service

| Parameter No. | Contents |
|---------------|---|
| 8000 | Parameters setting which can not be specified by setting input are forbidden or allowed. CRT screen when an error is caused. When parameter PWE is 1, an error is indicated or not. |
| 8010 | When power is turned off, parameter at data number 8000 is set to 0 or maintained. |

6.5 Setting and Displaying PMC Data (using the PCPRM soft key)

Parameters for the timer, counter, keep relay, and data table are set and displayed using the CRT/MDI unit. Press the **PCPRM** soft key on the PMC main menu to display the following menu before setting or displaying PMC data.

| | | | | |
|-------|--------|--------|------|-----|
| TIMER | COUNTR | KEEPRL | DATA | POS |
|-------|--------|--------|------|-----|

For setting data, the CNC must be in the MDI mode or emergency stop mode.

6.5.1 Setting and displaying timer data

The following describes how to set and display data for the variable timer. Pressing the **TIMER** soft key displays the timer screen.

| TIMER | | | |
|-------|-------|-----|------|
| No | DATA | No | DATA |
| 001 | 2000 | 016 | 1000 |
| 002 | 10000 | : | : |
| : | : | : | : |
| : | : | : | : |
| : | : | : | : |
| : | : | : | : |
| 015 | 0 | 030 | 0 |

Fig. 6.5.1 Timer Screen

| Timer number \ Period | Minimum period | Maximum period |
|-----------------------|----------------|----------------|
| | 1 to 8 | 50ms |
| 9 to 40 | 8ms | 262.136sec |

(1) Setting and displaying data using the CRT/MDI panel

- To set data, put the CNC in the MDI mode or emergency stop mode. Then turn on the PWE bit of CNC parameter No. 8000 to allow parameters to be set. For displaying data, these operations are not needed.
- Press the **PCPRM** soft key on the PMC main menu. Then press the **TIMER** soft key to display the timer screen (see Fig. 6.5.1).
- Press the **↓** page key until the screen which contains the desired timer data is displayed. To set data, follow steps 4. to 6. below.
- Place the cursor where data is to be set on the screen using the cursor keys.
- Enter timer data using the numeric keys. To complete data setting, press the **INPUT** key. To set additional data, repeat steps 3. to 5..
- Turn off the PWE bit of CNC parameter No. 8000 after the data has been set. Press the **RET** key to return to the PMC main menu.

6.5.2 Setting and displaying counter data

The following describes how to set and display preset and cumulative values for the counter. Pressing the **COUNTR** soft key displays the counter screen.

| COUNTER | | | |
|---------|---------|--------|---------|
| No | ADDRESS | PRESET | CURRENT |
| 01 | C00 | 26520 | 1120 |
| 02 | C04 | 1200 | 0 |
| 03 | C08 | 0 | 0 |
| : | | | |
| : | | | |
| : | | | |
| : | | | |
| : | | | |
| : | | | |
| 15 | | | |

Fig. 6.5.2 Counter Screen

(1) Setting and displaying data using the CRT/MDI panel

1. Press the **PCPRM** soft key on the PMC main menu. Then press the **COUNTR** soft key to display the counter screen (see Fig. 6.5.2).
2. Press the **↓** page key until the screen which contains the desired counter data is displayed. To set data, follow steps 3. to 6. below.
3. Put the CNC in the MDI mode or emergency stop mode. When the BMI interface is used, set the KEY4 signal to 1. When the interface equivalent to FS3 or FS6 is used, set the KEY signal to 1.
4. Place the cursor where data is to be set on the screen using the cursor keys.
5. Enter counter data using the numeric keys. To complete the data setting, press the **INPUT** key. To set additional data, repeat steps 4. and 5..
6. Press the **RET** key to return to the PMC main menu after the data has been set.

6.5.3 Setting and displaying keep relay data and data for controlling the retained memory

The following describes how to set and display keep relay data and data for controlling the retained memory. Pressing the **KEEPRL** soft key displays the keep relay screen.

| KEEP RELAY | | |
|------------|---------|----------|
| No | ARRDESS | DATA |
| 01 | K00 | 10100011 |
| 02 | K01 | 00011100 |
| : | | |
| : | | |
| : | | |
| : | | |
| : | | |
| : | | |
| : | | |
| 15 | K14 | 11000101 |

Fig. 6.5.3 Keep Relay Screen

(1) Setting and displaying keep relay data

1. To set data, put the CNC in the MDI mode or emergency stop mode. Then turn on the PWE bit of CNC parameter No. 8000 to allow parameters to be set. For displaying data, these operations are not needed.

2. Press the **PCPRM** soft key on the PMC main menu. Then press the **KEEPRL** soft key to display the keep relay screen (see Fig. 6.5.3).
 3. Press the **↓** page key until the screen which contains the desired keep relay data is displayed. To set data, follow steps 4 to 6 below.
 4. Place the cursor where data is to be set on the screen using the cursor keys.
 5. Enter keep relay data (bit pattern) using the numeric keys. Press the **INPUT** key to complete the data setting. To set additional data, repeat steps 4 and 5.
 6. Press the **RET** key to return to the PMC main menu after the data has been set.
- (2) Data for controlling retained memory is set and displayed in the same way as for keep relay data. For setting or displaying data for controlling retained memory, display the screen which contains a line with number 17 in the NO column and address K16 in the ADDRESS column. Only the sixth and seventh bits in the DATA column of this line can be used for data setting.

6.5.4 Setting and displaying data in the data table

Press the **DATA** soft key on the PMC parameter menu to display the screen of data for controlling the data table (see Fig. 6.5.4 (a)).

When the data for controlling the data table is valid, data table group 1 is displayed by pressing the page key (see Fig. 6.5.4 (b) and Fig. 6.5.4 (c)). Pressing the page key repeatedly lists the contents of the table in sequence. After all the data in data table group 1 have been displayed, subsequent data table groups (data table group 2, data table group 3, ..., data table group n) are displayed in order.

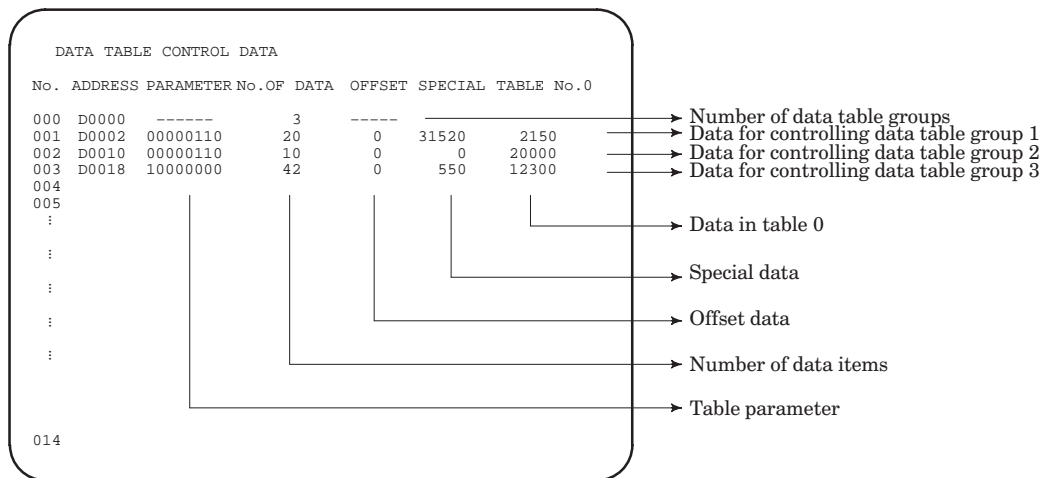


Fig. 6.5.4 (a) Screen of Data for Controlling the Data Table

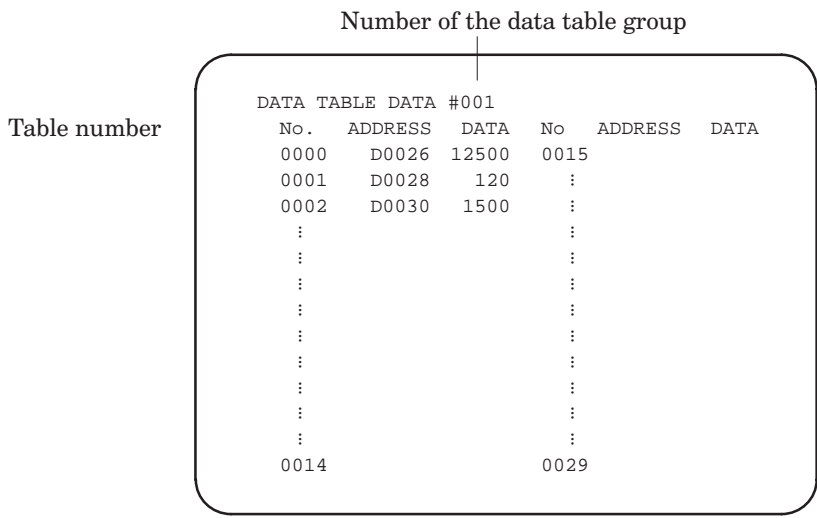


Fig. 6.5.4 (b) Data Table Screen

| No. | ADDRESS | TOOL No. | MAX. | AVERAGE |
|-----|---------|----------|------|---------|
| 01 | D0320 | 11252 | 250 | 80 |
| 02 | D0324 | 14 | 190 | 62 |
| 03 | D0328 | 1240 | 200 | 73 |
| : | | | | |
| : | | | | |
| : | | | | |
| : | | | | |
| : | | | | |
| : | | | | |
| : | | | | |
| : | | | | |
| : | | | | |
| : | | | | |
| 15 | | | | |

Fig. 6.5.4 (c) Data Table Screen of Data to Be Monitored

(This is the screen which displays teaching data set in MONI (SUB 47) for monitor control.)

(1) Setting and displaying data for controlling the data table

The data for controlling data table groups is displayed as shown in Fig. 6.5.4 (a). A line starting with number 000 in the NO. column must contain the number of data table groups in the NO. OF DATA column.

Lines starting with numbers 001 or more in the NO. column give data for controlling data table groups. (The numbers in the NO. column correspond to the data table group numbers.)

The following data is set and displayed using the CRT/MDI unit.

PARAMETER : Table parameter

NO. OF DATA : Number of data items.

(A line starting with 000 in the NO. column must contain the number of data table groups in the NO. OF DATA column.)





OFFSET : Offset data

SPECIAL : Special data

TABLE NO. 0 : Data in table 0

1. To set data, put the CNC in the MDI mode or emergency stop mode. When the BMI interface is used, set the KEY4 signal to 1. When the interface equivalent to FS3 or FS6 is used, set the KEY signal to 1. For displaying data, these operations are not needed.
2. Press the **PCPRM** soft key on the PMC main menu. Then press the **DATA** soft key.
3. The screen of data for controlling the data table is displayed as shown in Fig. 6.5.4 (a). Pressing the **↓** page key displays the screen which contains control data lines starting with numbers 015 or more in the NO. column. To set data, follow steps 4. to 8. below.
4. Place the cursor where data is to be set on the screen using the cursor keys of the CRT/MDI unit.
5. Enter data for controlling the data table using the numeric keys. Then press the **INPUT** key.
6. At the cursor position, the old data is overwritten with new data.
7. To set additional data, repeat steps 4. to 6..
8. To set data in the data table after the data for controlling the data table has been set, press the **↓** page key until the data table screen is displayed (see item (2) below). To return to the PMC main menu, press the **RET** key.

(2) Setting and displaying data in the data table

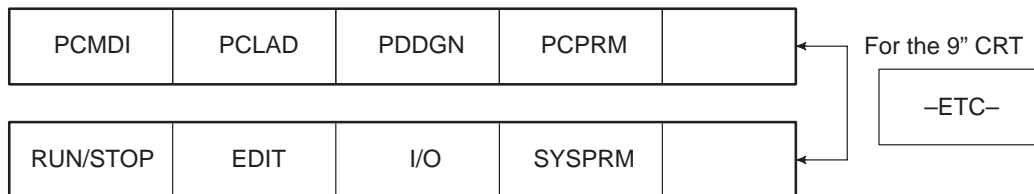
1. To set data, put the CNC in the MDI mode or emergency stop mode. When the BMI interface is used, set the KEY4 signal to 1. When an interface equivalent to FS3 or FS6 is used, set the KEY signal to 1. For displaying data, these operations are not needed.
2. Press the **PCPRM** soft key on the PMC main menu. Then press the **DATA** soft key.
The screen of data for controlling the data table is displayed as shown in Fig. 6.5.4 (a). Press the  page key until the data table screen is displayed (see Fig. 6.5.4 (b)).
The table of data table group 1 is displayed first. Pressing the  page key changes to the next data table. Press the  page key until the table of the desired data table group is displayed.
3. When the data table group has more than 30 data items, pressing the  page key displays the 30th and subsequent data items. To set data, follow the steps 4. to 8. below.
4. Place the cursor where data is to be set on the screen using the cursor keys of the CRT/MDI unit.
5. Enter data in the data table using the numeric keys. Then press the **INPUT** key.
6. At the cursor position, the old data is overwritten with new data.
7. To set additional data, repeat steps 4. to 6..
8. Press the **RET** key to return to the PMC main menu after the data has been set in the data table.


6.5.5 Inputting and outputting PMC data (when the reader/punch interface is used)

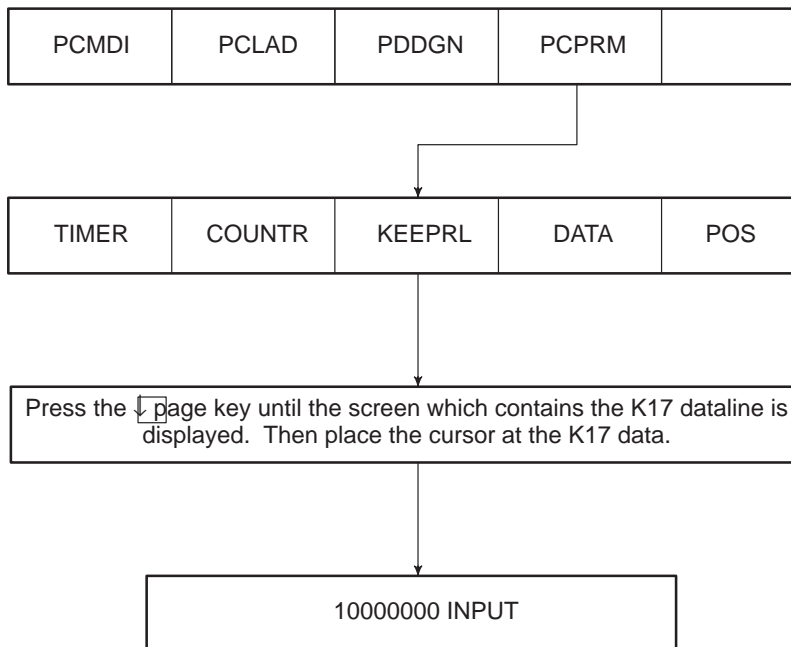
(1) Setting the input/output channel

When inputting and outputting data, the input/output channel must be correctly set. Once the input/output channel has been set, the setting is maintained even after the CNC is turned off. Therefore, further channel setting is normally not required. If the input/output channel must be again set for some reason, follow the steps below.

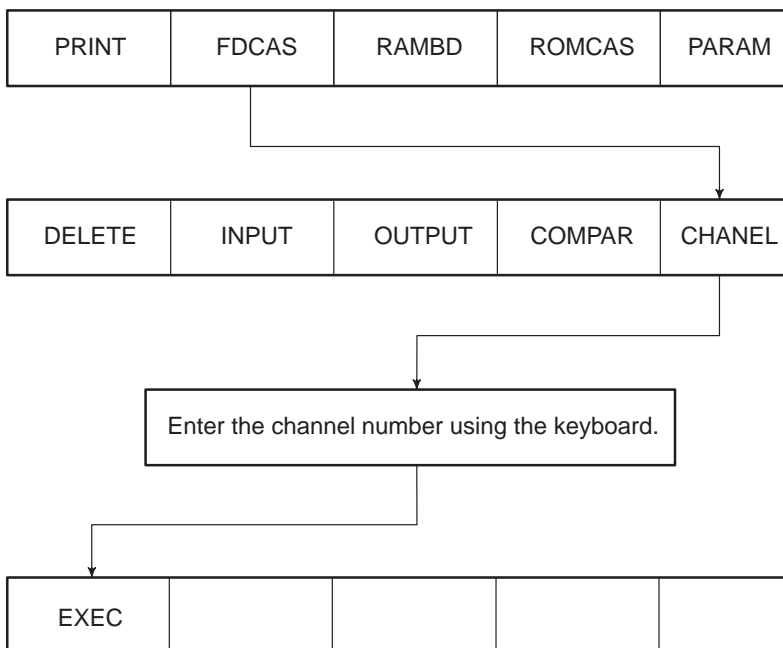
1. Press the **CNC/PMC** key to display the PMC screen. When the lower soft key list as shown in the figure below is displayed on the PMC screen, steps 2. to 8. are not needed.



2. Press the **CNC/PMC** key to display the NC screen. Then put the CNC in the MDI mode or emergency stop mode.
3. Press the **SETTING** soft key to display the setting screen.
4. Enter 8000 and press the **INP-NO.** soft key. Parameter No. 8000 is now displayed.
5. If PWE, the lowest bit of parameter No. 8000, is set to 0, change it to 1. Then press the **INPUT** soft key. This sets the PWE bit to 1 and puts the NC in the alarm mode.
6. Press the **CNC/PMC** soft key to display the PMC screen.
7. Press the **PCPRM** soft key. Then press the **KEEPRL** soft key to display the keep relay screen. Press the  page key until the screen which contains the K17 data line is displayed. When this screen is displayed, place the cursor at the K17 data using the cursor keys. Then enter 10000000 and press the **INPUT** soft key. This sets the highest bit of the K17 data to 1. (Keep record of the original K17 data until step 10.)



8. Press the return key on the right of the soft keys several times to display the soft key menu as shown in the figure in step 1..
9. Press the soft keys [I/O], [FDCAS], and [CHANEL] in that order. Then enter the valid channel number using the keyboard and press the [EXEC] key.



10. If the K17 data for the keep relay was changed in step 7., restore it to the original setting.

NOTE To change the baud rate, press the [PCPRM] soft key on the menu as shown in the figure in step 1., and press the [MODE] soft key. Then place the cursor at DATA TRANSFER RATE (AUX) using the [↓] key. Press the soft key to display the desired baud rate.

(2) Inputting PMC data

1. Connect the reader/punch interface of the CNC to the input device which contains PMC data. Then turn the CNC on.
2. Put the CNC in the MDI mode or emergency stop mode.
3. Press the [SETTING] soft key to display the setting screen.
4. Enter 8000 and press the [INP-NO.] soft key. Parameter No. 8000 is displayed.

5. If PWE, the lowest bit of parameter No. 8000, is set to 0, change it to 1. Then press the **INPUT** soft key. This sets the PWE bit to 1 and puts the NC in the alarm mode.
6. Press the **NC/PC** soft key to display the PMC screen.

| | | | | |
|-------|-------|-------|-------|--|
| PCMDI | PCLAD | PDDGN | PCPRM | |
|-------|-------|-------|-------|--|

7. Press the PCPRM soft key to display the PC parameter screen. The soft keys are displayed as shown below.

| | | | | | |
|-------|-------|--------|------|-----|----------------|
| TIMER | PCLAD | KEEPRL | DATA | POS | ← -ETC- |
| MODE | I/O | CLRPRM | | | |

8. Press the I/O soft key. (For the 9" CRT, press the **-ETC-** key.)

| | | | | |
|--|-------|--------|--|--|
| | INPUT | OUTPUT | | |
|--|-------|--------|--|--|

9. Press the INPUT soft key. Then enter the name or number of the file and press the **EXEC** key.

| | | | | |
|------|--|--|--|--|
| EXEC | | | | |
|------|--|--|--|--|

10. The correspondig addresses are displayed to show that the data has been correctly input.

NOTE When data is read, if RAMENABLE OFF is displayed, this means that the RAM for the PMC is protected. Press the **MODE** soft key on the menu as shown in the figure in step 7.. Then place the cursor at RAM ENABLE using the **↓** key and press the **ON** softkey.

(3) Outputting PMC data

1. Connect the reader/punch interface of the CNC to the device which outputs PMC data. Then turn the CNC on.
2. Press the NC/PC soft key to display the PMC screen.

| | | | | |
|-------|-------|-------|-------|--|
| PCMDI | PCLAD | PDDGN | PCPRM | |
|-------|-------|-------|-------|--|

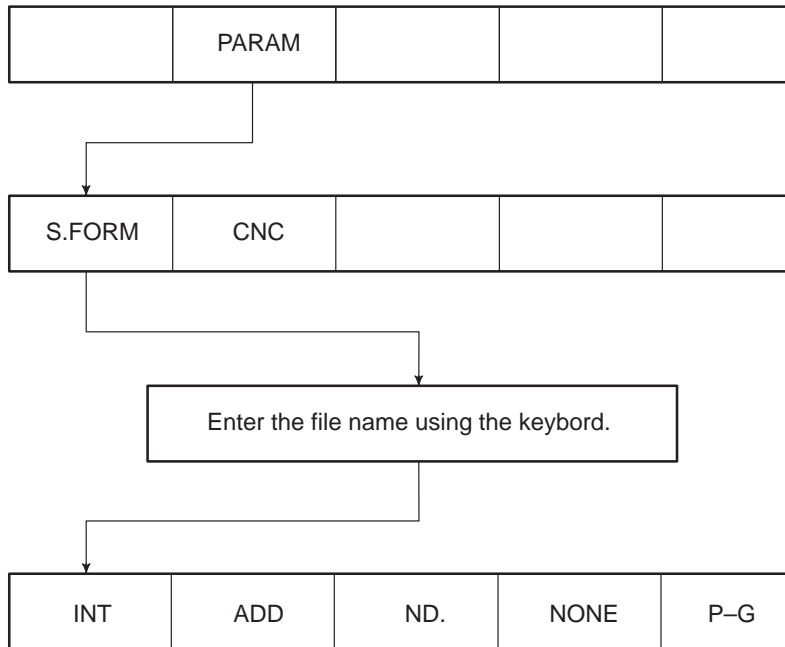
3. Press the **PCPRM** soft key to display the PC parameter screen. The soft keys are displayed as shown below.

| | | | | | |
|-------|-------|--------|------|-----|----------------|
| TIMER | PCLAD | KEEPRL | DATA | POS | ← -ETC- |
| MODE | I/O | CLRPRM | | | |

4. Press the **I/O** soft key. (For the 9" CRT, press the **-ETC-** key.)

| | | | | |
|--|-------|--------|--|--|
| | INPUT | OUTPUT | | |
|--|-------|--------|--|--|

5. Press the soft keys **OUTPUT**, **PARAM**, and **S.FORM** in that order. Enter the file name using the keyboard and press the **ADD** key. Then the device outputs the data.



6. The corresponding addresses are displayed to show that the data is normally output.

6.6 Input/Output of CNC Data

6.6.1 Setting the parameters necessary for input/output

The FS15B allows you to set the parameters necessary for data communication via the RS-232C, RS-422, or remote buffer interface, from a single screen. Once you have set the parameters, the settings are held, even when the power is disconnected.

- Selecting the RS-232C screen

To select the RS-232C screen, press the SETTING function selection key repeatedly until the screen appears, or press the SETTING key, then RS-232C soft key.

RS-232C screen for 9" CRT/MDI

```

SETTING(RS232C)          00001 N00000
TV CHECK   =ON          TV(COMMENT)=ON
I/O CODE   =ISO
EOB CODE   =LF/CR/CR  PNCH
F.G. INP DVC = 1      RS232C DVC TYPE =   8
      OUT DVC = 1      CHANL1 STOP BITS=   2
B.G. INP DVC = 2      RS232C DVC TYPE =   8
      OUT DVC = 2      CHANL2 STOP BITS=   2
                          BAUD RATE= 9600
                          RS232C DVC TYPE =   8
                          CHANL2 STOP BITS=   2
                          BAUD RATE= 9600

By "SELECT +/-" Key, please select
OFF/ON.

MDI ***  RESET  ***          13:33:08
SELECT+  SELECT-          CHAPTER
  
```



Switched with page key  or .

```

SETTING(RS232C)          00001 N00000
TV CHECK   =ON          TV(COMMENT)=ON
I/O CODE   =ISO
EOB CODE   =LF /CR/CR  PNCH
F.G. INP DVC = 1      RS232C DVC TYPE =   8
      OUT DVC = 1      CHANL3 STOP BITS=   2
B.G. INP DVC = 2      RS422  DVC TYPE =   8
      OUT DVC = 2      STOP BITS=   2
                          BAUD RATE= 9600
                          RS422  DVC TYPE =   8
                          STOP BITS=   2
                          BAUD RATE= 9600

By "SELECT +/-" key, please select
OFF/ON.

MDI ***  RESET  ***          13:33:08
SELECT+  SELECT-          CHAPTER
  
```

* The second page is displayed only when the reader/punch interface B option is installed.

When the remote buffer interface option is installed, the remote buffer setting screen is displayed on the third page. Refer to the remote buffer supplementary explanation for details of the values to be set.

– Setting parameters

position the cursor to the parameter to be set, then change its value by pressing the SELECT+ or SELECT– soft key. Each parameter can be set to a value within the range specified for that parameter. (To display the SELECT+ and SELECT– soft keys, press the CHAPTER key.)

* Parameters can be set regardless of the current mode.

* You cannot enter a value directly. Use the soft keys to change the value to the desired value.

(A) TV CHECK

ON : Performs TV check.

OFF : Does not perform TV check.

(B) TV(COMMENT)

ON : Performs TV check for comments also (during control out).

OFF : Does not perform TV check for comments.

(C) I/O CODE or IN/OUT CODE

ISO : Uses ISO code for input/output.

EIA : Uses EIA code for input/output.

ASCII : Uses ASCII code for input/output.

(D) EOB CODE

LF/CR/CR PNCH : The EOB code is LF/CR/CR PNCH.

LF PNCH : The EOB code is LF PNCH.

(E) F.G. INP DVC

F.G. OUT DVC

Specify the channel used in the foreground. The table below lists the correspondence between the channel numbers and the connectors on the NC unit.

| Channel No | Connector No. on NC unit | Interface used |
|------------|-------------------------------|-----------------|
| 1 | JD5A on main CPU board | RS232C |
| 2 | JD5B on main CPU board | RS232C |
| 3 | JD5J on main CPU board | RS232C |
| 10* | JD5C or JD6A on OPTION1 board | RS232C or RS422 |
| 13 | JD6D on SUB board | RS422 |

* Whether the RS-232C or RS-422 interface is used for the OPTION1 board depends on the setting of bit 0 of parameter No. 5000.

(F) B.G. INP DVC

B.G. OUT DVC

Specify the channel used in the background. The correspondence between the channel numbers and connector is the same as that for the channel used in the foreground.

(G) DVC TYPE

Specify the I/O device connected to each channel.

| Value of DVC TYPE | I/O device |
|-------------------|--|
| 1 | Tape reader with serial interface (control code: DC1 to DC4) |
| 2 | Tape reader with serial interface (control code: not used) |
| 3 | Personal computer, etc. (control code: DC1 to DC4) |
| 4 | Personal computer, etc. (control code: not used) |
| 5 | Tape reader with rewind function |
| 6 | FANUC PPR, Handy File (local mode) |
| 7 | FANUC Cassette (bubble cassette) |
| 8 | FANUC Floppy Cassette, Handy File (remote mode) |
| | FANUC Program File Mate |

(H) STOP BIT

Specify the number of stop bits, 1 or 2.

* The standard setting is two stop bits for FANUC I/O devices.

Corresponding parameters

| Item | Corresponding parameter/bit | Set value | |
|--|--|--|---|
| TV CHECK | Bit 0 (TVC) of parameter No. 0000 | OFF (0) ON (1) | |
| TV (COMMENT) | Bit 1 (CTV) of parameter No. 0000 | ON (0) OFF (1) | |
| 14 : IN/OUT CODE 09 : I/O CODE | Bit 2 (ISP) of parameter No. 0000 Bit 4 (EIA) of parameter No. 0000 | EIA : #4 =1 ISO : #4/#2 =0.0 ASCII : #4/#2 =0.1 | |
| EOB CODE | Bit 3 (NCR) of parameter No. 0000 | LF/CR/CR PUNCH (0) LF PUNCH (1) | |
| 14 : INPUT DVC 09 : INP DVC | Foreground: Parameter No. 0020 Background: Parameter No. 0022 | * * * * 1, 2, 3, 4, 9, 10, 13, 15, 16 Values with * can be specified only on the parameter screen. | |
| 14 : OUTPUT DVC 09 : OUT DVC | Foreground: Parameter No. 0021 Background: Parameter No. 0023 | | |
| DVC TYPE | Parameter No. 5110, 5120, 5130, 5140, 5150, or 5160 | 1, 2, 3, 4, 5, 6, 7, 8, | |
| STOP BITS | Parameter No. 5111, 5121, 5131, 5141, 5151, or 5161 | 1, 2 | |
| BAUD RATE | Parameter No. 5112, 5122, 5132, 5142, 5152, or 5162 | 1 to 12 1 to 7 can be specified only on the parameter screen. | |
| R e m o t e b u f f e r | DVC TYPE | RS422 : Parameter No.5071 RS232C : Parameter No.5081 | RS422 : 0, 8 RS232C : 0, 7, 8 |
| | STOP BITS | RS422 : Parameter No.5072 RS232C : Parameter No.5082 | 1, 2 |
| | BAUD RATE | RS422 : Parameter No.5073 RS232C : Parameter No.5083 | RS422: 1 to 15 1 to 7 can be specified only on the parameter screen. RS232C: 1 to 12 1 to 7 can be specified only on the parameter screen. |
| | PROTOCOL | RS422 : Parameter No.5074 RS232C : Parameter No.5084 | B : (1) EXT-B : (2) A : (3)*1 *1 Including extended protocol A HDLC (5) can be specified only on the parameter screen. |

6.6.2 Outputting CNC parameters

See Section 6.3, "Outputting Parameters."

6.6.3 Outputting part programs

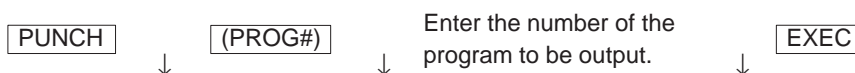
1. Enter EDIT mode.
2. Press the soft keys in the following order:



3. – When outputting all programs



- When outputting a specified program



6.6.4 Outputting offset data

1. Enter MDI or EDIT mode.
2. Press the soft keys in the following order:

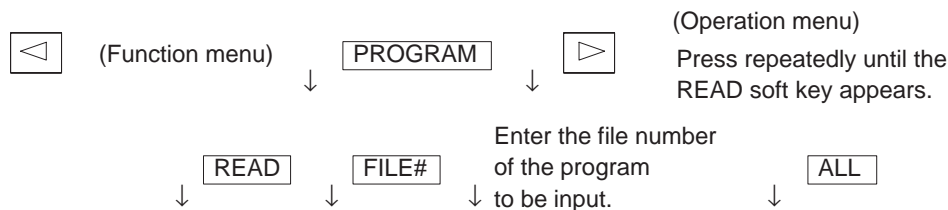


6.6.5 Inputting CNC parameters

See Section 6.2.2, "Specifying parameters through the reader/punch interface."

6.6.6 Inputting part programs

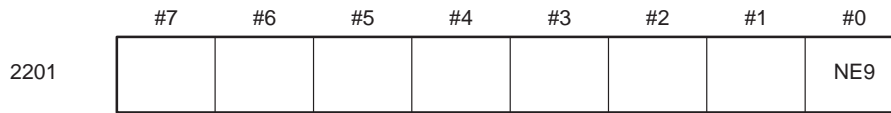
1. Enter EDIT mode.
2. Press the soft keys in the following order:



- Related parameters

| | #7 | #6 | #5 | #4 | #3 | #2 | #1 | #0 |
|------|----|----|----|----|----|----|----|-----|
| 0011 | | | | | | | | NE8 |

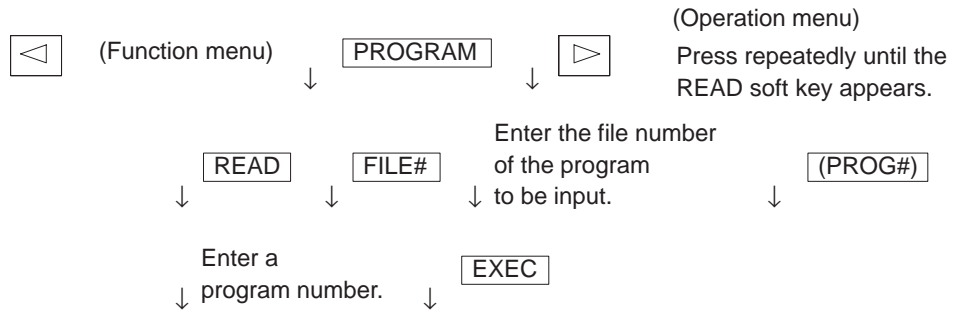
- #0 NE8 0 : Programs No. 8000 to 8999 can be edited.
 1 : Programs No. 8000 to 8999 cannot be edited.



#0 NE9 0 : Programs No. 9000 to 9999 can be edited.
 1 : Programs No. 9000 to 9999 cannot be edited.

6.6.7 Inputting offset data

1. Enter EDIT mode.
2. Press the soft keys in the following order:



* Enter a program number which is not being used.

3. Enter MEMORY (automatic operation) mode, then press the cycle start button.
 The program is executed and the input offset data is set.
4. Once the offset data has been set, the program loaded in step 2 is not necessary. Delete it.

7. CONFIGURATION OF THE PRINTED CIRCUIT BOARDS IN THE CONTROL UNIT

7.1 Power Unit Configuration

(1) Parts layout

Drawing number : A16B-1212-0471 (Power supply unit AI)

A16B-1212-0531 (Power supply unit BI)

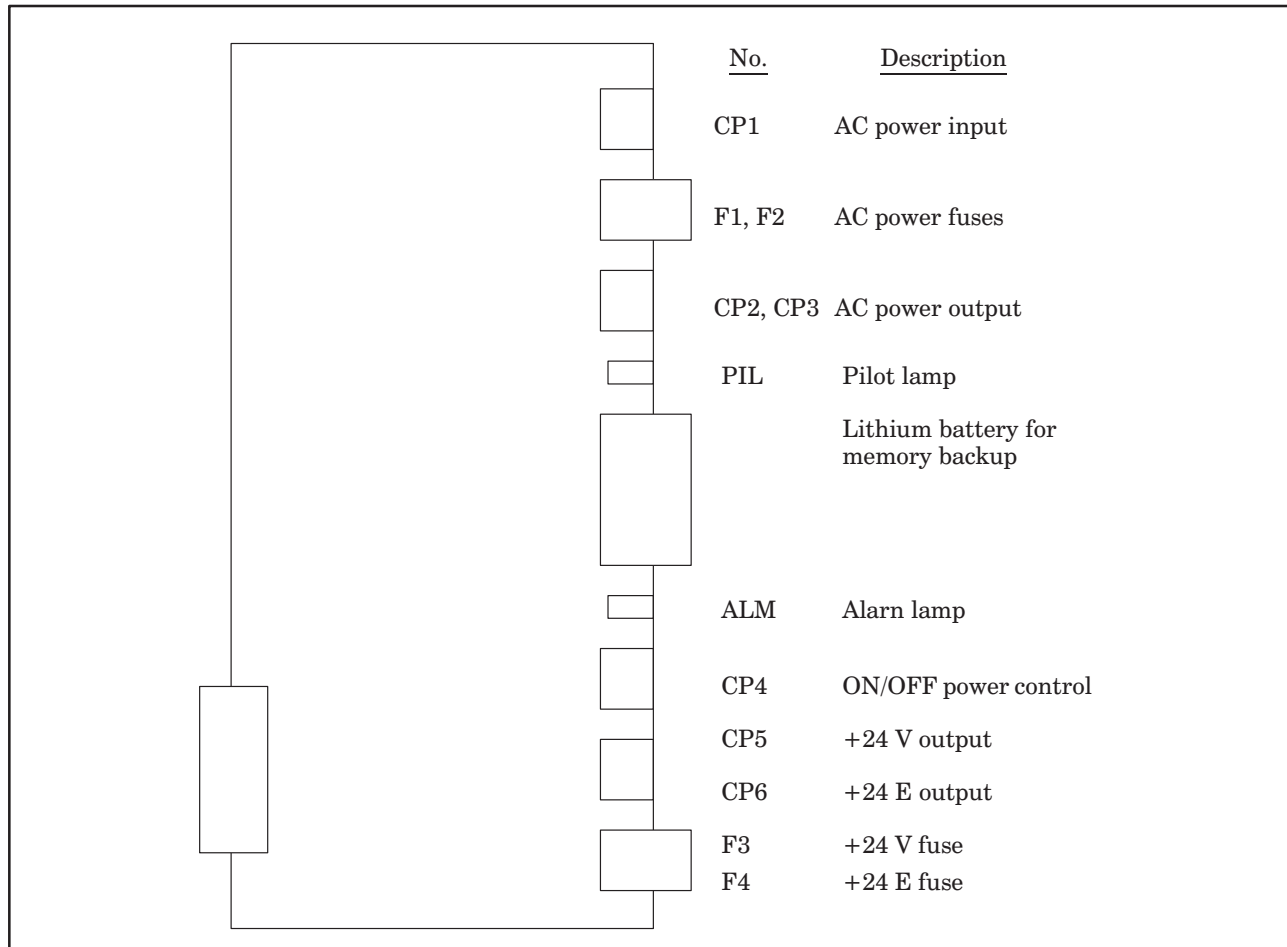


Fig. 7.1 (a) Power Unit Parts Layout

(2) Block diagram

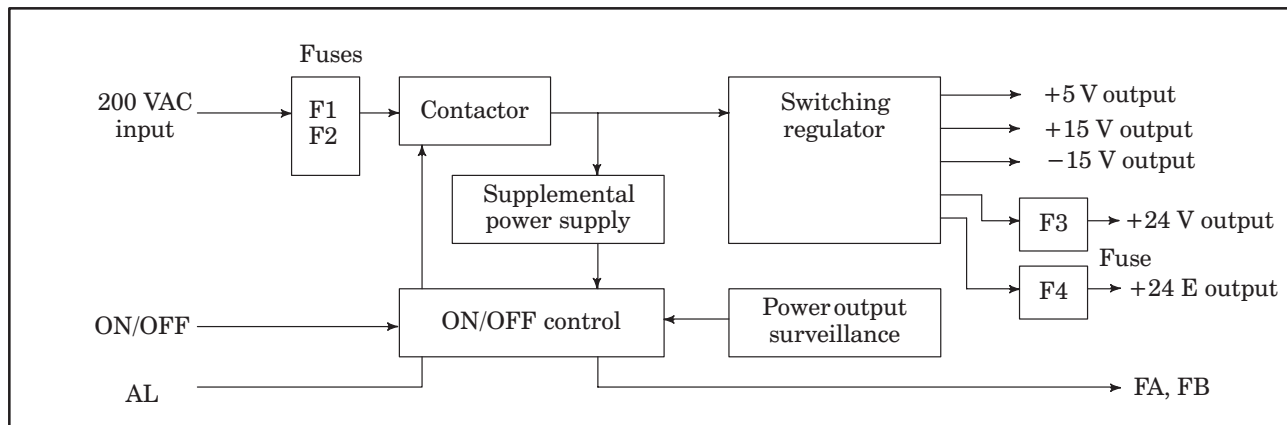


Fig. 7.1 (b) Power Unit Block Diagram

- (3) Adjustment
No adjustment is needed.
- (4) LED display

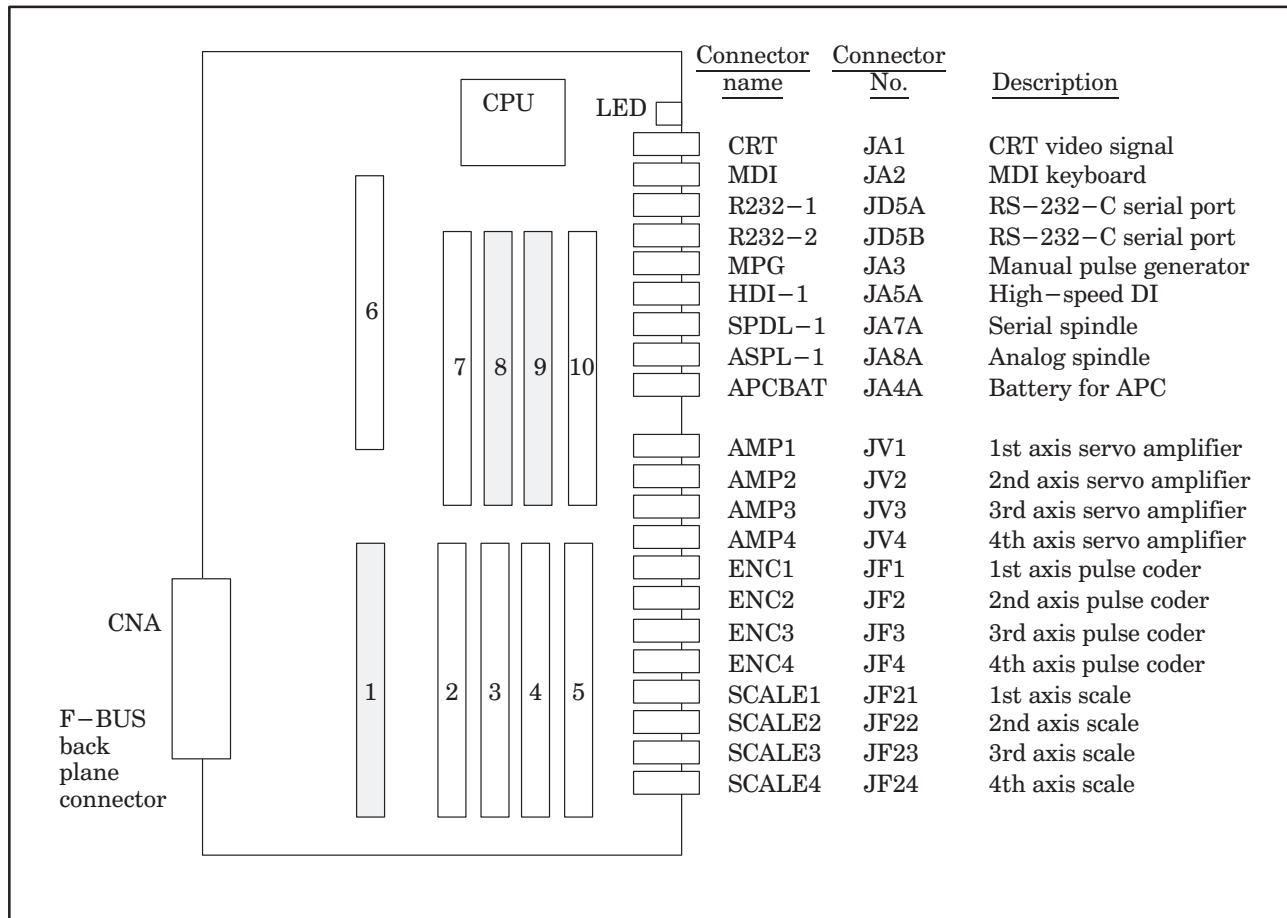
Table 7.1 LED Display of the Power Unit

| No. | LED display | NC status |
|-----|---------------|---|
| 1 | PIL ■ (green) | 200 VAC power is supplied to connector CP1. |
| 2 | ALM ■ (red) | Indicates that overvoltage, overcurrent, or voltage drop occurs at the output of the direct current power supply. |

7.2 Configuration of the CPU Board (MAIN-B)

(1) Parts layout

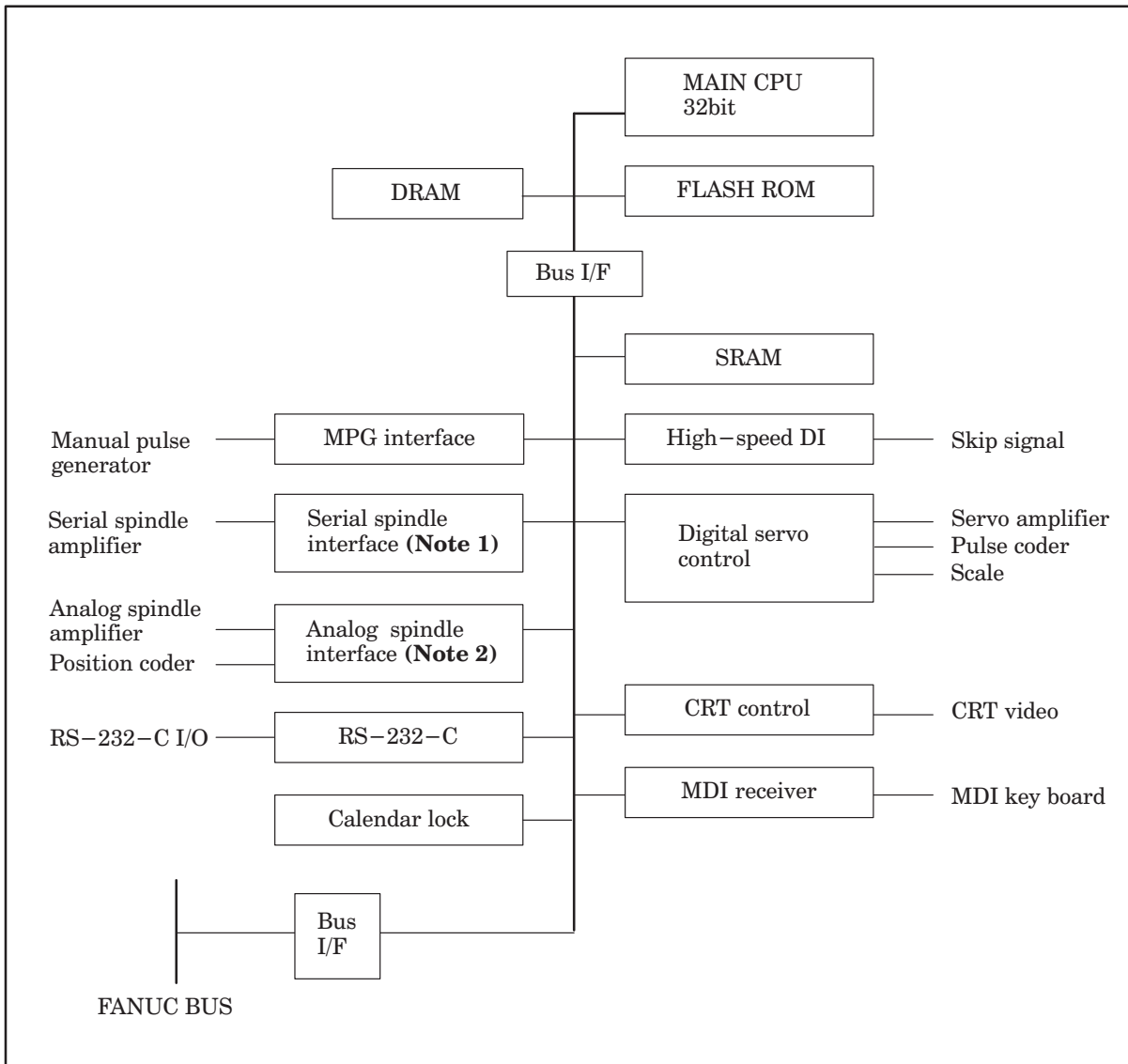
Drawing number : A16B-2201-0320



| No. | Module name | Function outline |
|-----|------------------------|--|
| 1 | SRAM module | Part programs strage, RAM for parameter |
| 2 | Servo control module | 3rd and 4th servo control |
| 3 | Servo control module | 1st and 2nd servo control |
| 4 | Servo interface module | 3rd and 4th amplifier, pulse coder interface |
| 5 | Servo interface module | 1st and 2nd amplifier, pulse coder interface |
| 6 | DRAM module | RAM for CNC system |
| 7 | FLASH ROM module | FLASH-EPROM for CNC system |
| 8 | Spindle control module | System clear, battery backup control, spindle control, HDI interface etc.... |
| 9 | Peripheral module | MDI, MPG, RS-232C, etc.... System timer, system clock, calendar clock |
| 10 | CRT control module | CRT display control |

NOTE means the module connected power supply for battery backup. If the module are taken away carelessly, the backup are lost.

(2) Block diagram



NOTE 1 When the module of analog spindle is built in as a module of spindle control, the series interface is not there.

NOTE 2 When a serial spindle module is mounted as the spindle control module, an analog spindle interface is not used.

(3) Adjustment

No adjustment is needed.

(4) LED display

□ : off ■ : Lit ★ : Flashing

1. LED display transition when the power is turned on

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | STATUS □□□□ | Power-off |
| 2 | STATUS ■■■■ | Initial state immediately after power-on |
| 3 | STATUS ■□□■ | Beginning of activation of the CNC software |
| 4 | STATUS □□□■ | End of CNC local RAM test |
| 5 | STATUS ■■■□ | End of CNC local RAM clear |
| 6 | STATUS □■■□ | FROM test in progress |
| 7 | STATUS ■■□□ | End of key initialization. Logical slot setting is completed. |
| 8 | STATUS □□■□ | End of CRT initialization. The CRT is ready for use. |
| 9 | STATUS ■■□■ | Waiting for the completion of setting of the PC boards connected to the FANUC bus (1) |
| 10 | STATUS □■□■ | IPL monitoring in progress |
| 11 | STATUS ■■□□ | End of IPL |
| 12 | STATUS ■□■□ | Waiting for the setting of *SYSFAIL |
| 13 | STATUS □□■□ | Waiting for the completion of setting of the PC boards connected to the FANUC bus (2) |
| 14 | STATUS □■□□ | Waiting for the completion of initialization of the servo |
| 15 | STATUS ■□□□ | Normal state. The power-on sequence is ended. |

2. LED display when an error occurs (STATUS LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | STATUS ★□□□ | An error (1) occurred in the DRAM module of the CNC. |
| 2 | STATUS □★□□ | An error occurred in the file SRAM. |
| 3 | STATUS ★★□□ | An error (2) occurred in the DRAM module of the CNC. |
| 4 | STATUS □□★□ | The CRT control module is not supported by the installed CNC software. |
| 5 | STATUS ★□★□ | The main CPU board is not supported by the installed CNC software. |
| 6 | STATUS □★★□ | An illegal PC board is installed in a slot of the FANUC bus. Two or more identical PC boards are installed when only one is permitted. |
| 7 | STATUS ★★★□ | A system error (stack overflow) occurred. |
| 8 | STATUS □□□★ | An illegal module is installed in the flash ROM module. |
| 9 | STATUS ★□□★ | A flash ROM file configuration error (CNC area) occurred. |
| 10 | STATUS □★□★ | A flash ROM file configuration error (PMC area) occurred. |
| 16 | STATUS □■■■ | A system error (NMI to the CNC CPU) occurred. |

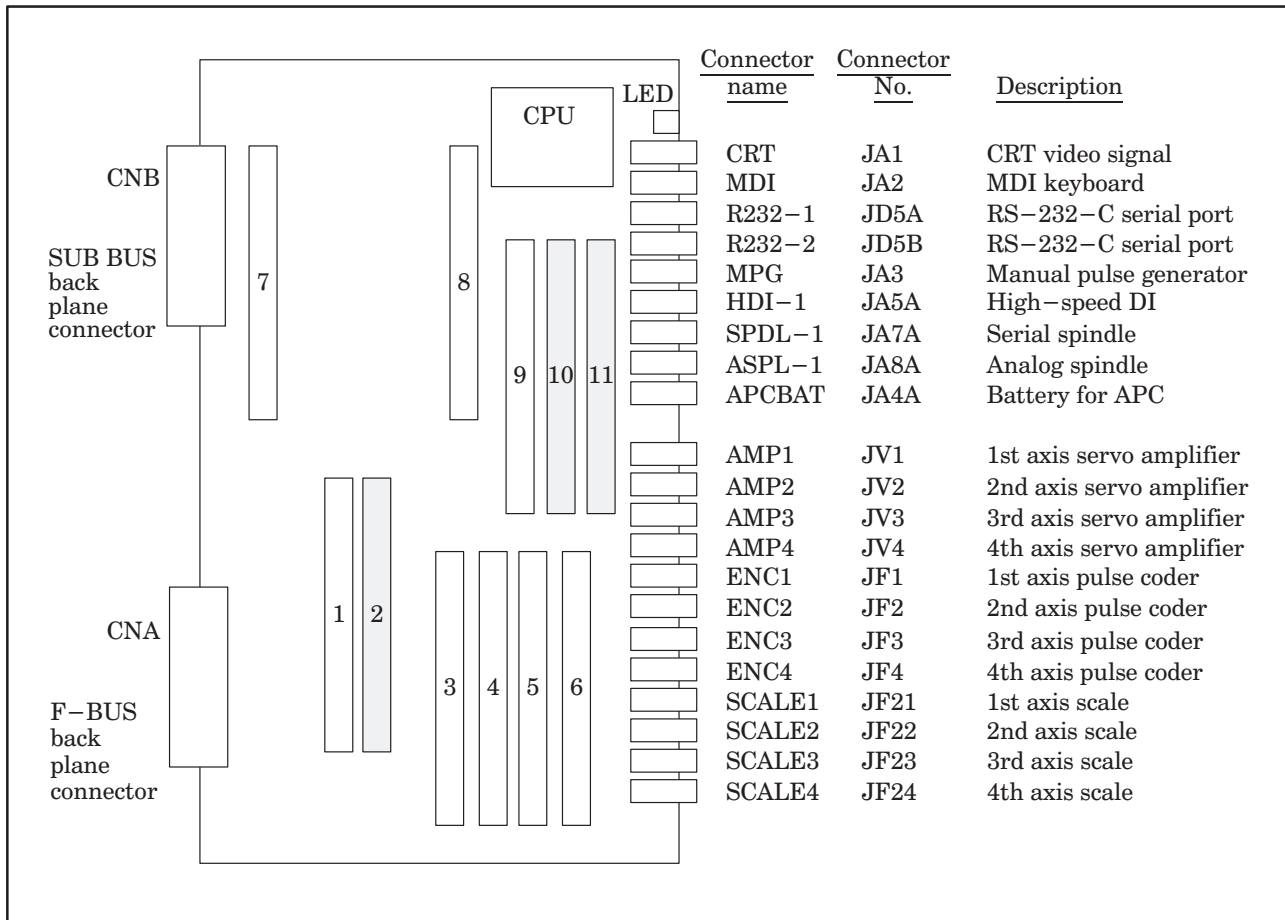
3. LED display (STATUS LED) when an error occurs

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | ALARM ■□□ | Battery voltage for backup decreases. |
| 2 | ALARM □■□ | SYSFAIL (A fault occurred on some modules of F-BUS) |
| 3 | ALARM ■■□ | SERVO ALARM |
| 4 | ALARM □□■ | SYSEMG (NMI occurred on some modules of F-BUS.) |
| 5 | ALARM ■□■ | ABC ALARM (Parity alarm on FILE SRAM, A fault of peripheral bus) |
| 6 | ALARM □■■ | Parity alarm occurred on DRAM area |

7.3 Configuration of the Main CPU Board (MAIN-A)

(1) Parts layout

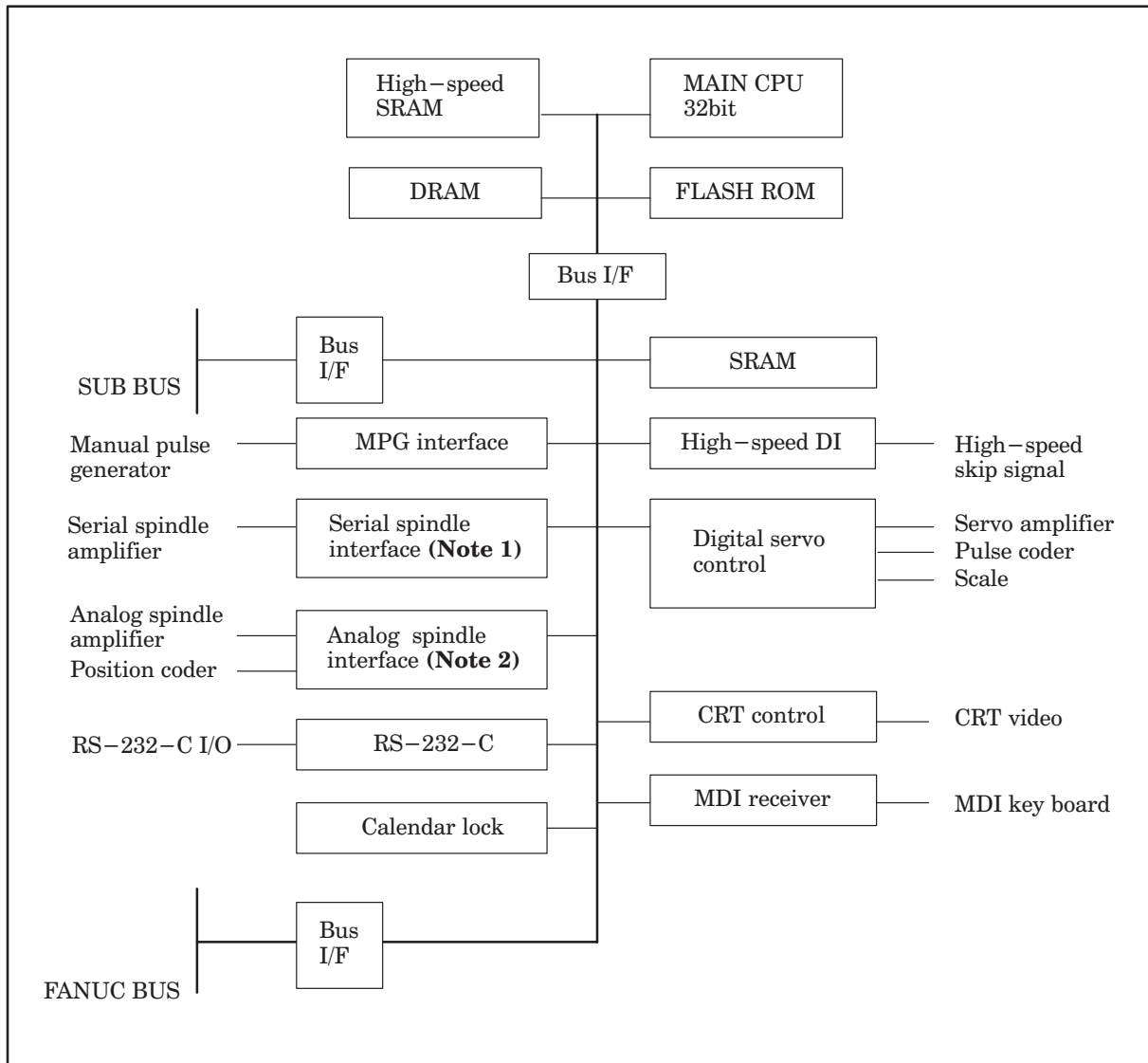
Drawing number : A16B-2201-0300



| No. | Module name | Function outline |
|-----|------------------------|--|
| 1 | CRT control module | CRT display control |
| 2 | SRAM module | Part program storage, RAM for parameter |
| 3 | Servo control module | 3rd and 4th servo control |
| 4 | Servo control module | 1st and 2nd servo control |
| 5 | Servo interface module | 3rd and 4th amplifier, pulse coder interface |
| 6 | Servo interface module | 1st and 2nd amplifier, pulse coder interface |
| 7 | High-speed SRAM module | High-speed RAM for CNC system |
| 8 | DRAM module | RAM for CNC system |
| 9 | FLASH ROM module | FLASH-EPROM for CNC system |
| 10 | Spindle control module | System clear, battery backup control, spindle control, HDI interface etc.... |
| 11 | Peripheral module | MDI, MPG, RS-232C, etc.... interface System timer, system clock, calendar clock |

NOTE means the module connected power supply for battery backup. If the module are taken away carelessly, the backup are lost.

(2) Block diagram



NOTE 1 When the module of analog spindle is built in as module of spindle control, the serial spindle interface is not there.

NOTE 2 When a serial spindle module is mounted as the spindle control module, an analog spindle interface is not used.

(3) Adjustment

No adjustment is needed.

(4) LED display

□ : Not lit ■ : Lit ★ : Blinking

STATUS LEDs are green. ALARM LEDs are red.

1. LED display transition when the power is turned on (STATUS LED)

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | STATUS □□□□ | Power-off |
| 2 | STATUS ■■■■ | Initial state immediately after power-on |
| 3 | STATUS ■□□■ | Beginning of activation of the CNC software |
| 4 | STATUS □□□■ | End of CNC local RAM test |
| 5 | STATUS ■■■□ | End of CNC local RAM clear |
| 6 | STATUS □■■□ | FROM test in progress |
| 7 | STATUS ■□■□ | End of key initialization. Logical slot setting is completed. |
| 8 | STATUS □□■□ | End of CRT initialization. The CRT is ready for use. |
| 9 | STATUS ■■□■ | Waiting for the completion of setting of the PC boards connected to the FANUC bus (1) |
| 10 | STATUS □■□■ | IPL monitoring in progress |
| 11 | STATUS ■■□□ | End of IPL |
| 12 | STATUS ■□■□ | Waiting for the setting of *SYSFAIL |
| 13 | STATUS □□■□ | Waiting for the completion of setting of the PC boards connected to the FANUC bus (2) |
| 14 | STATUS □■□□ | Waiting for the completion of initialization of the servo |
| 15 | STATUS ■□□□ | Normal state. The power-on sequence is ended. |

2. LED display when an error occurs (STATUS LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | STATUS ★□□□ | An error (1) occurred in the high-speed SRAM or DRAM module of the CNC. |
| 2 | STATUS □★□□ | An error occurred in the file SRAM. |
| 3 | STATUS ★★□□ | An error (2) occurred in the high-speed SRAM or DRAM module of the CNC. |
| 4 | STATUS □□★□ | The CRT control module is not supported by the installed CNC software. |
| 5 | STATUS ★□★□ | The main CPU board is not supported by the installed CNC software. |
| 6 | STATUS □★★□ | An illegal PC board is installed in a slot of the FANUC bus. Two or more identical PC boards are installed when only one is permitted. |
| 7 | STATUS ★★□□ | A system error (stack overflow) occurred. |
| 8 | STATUS □□□★ | An illegal module is installed in the flash ROM module. |
| 9 | STATUS ★□□★ | A flash ROM file configuration error (CNC area) occurred. |
| 10 | STATUS □★□★ | A flash ROM file configuration error (PMC area) occurred. |
| 16 | STATUS □■■■ | A system error (NMI to the CNC CPU) occurred. |

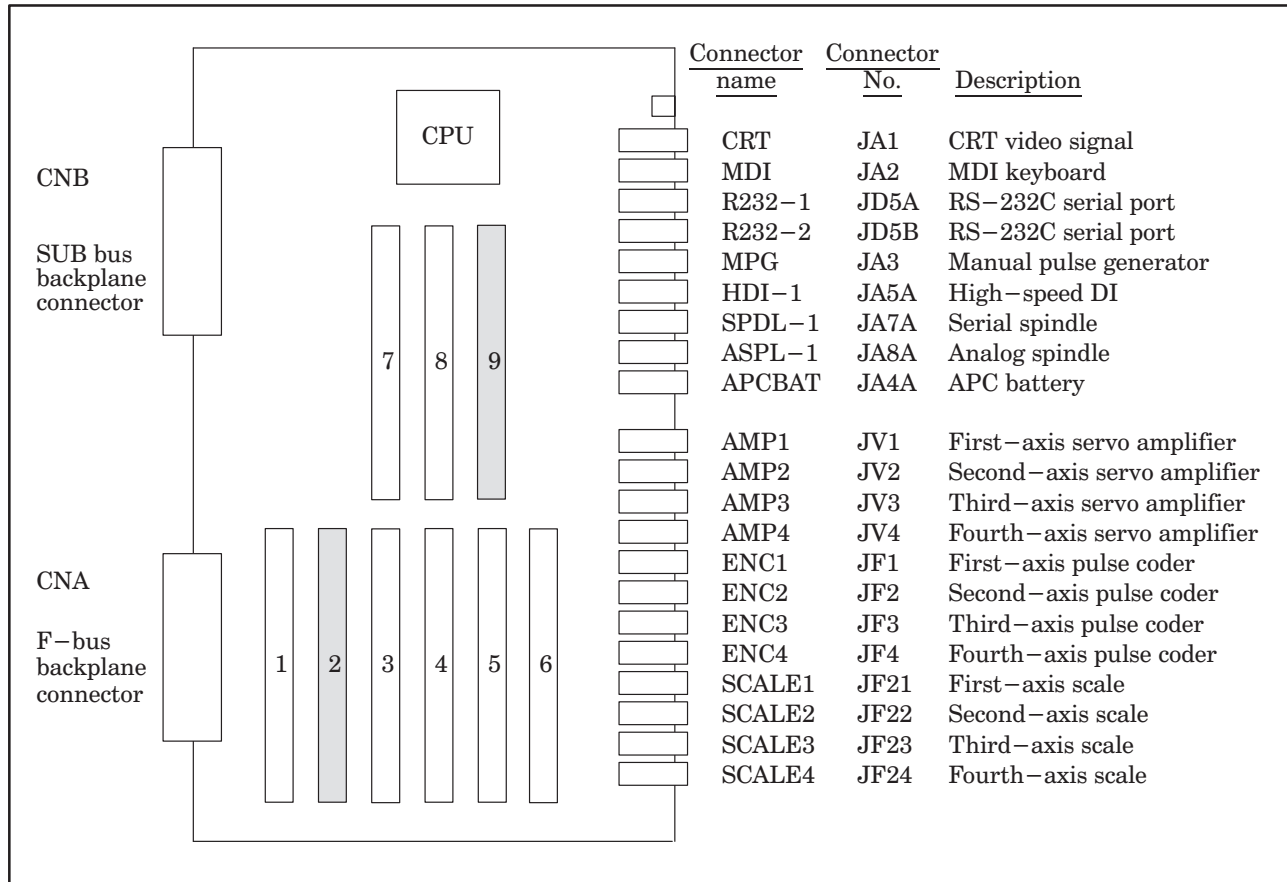
3. LED display when an error occurs (ALARM LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | ALARM ■□□ | The voltage of the backup battery has fallen below the specified minimum level. |
| 2 | ALARM □■□ | SYFAIL (fault in a module on the F-bus) occurred. |
| 3 | ALARM ■■□ | A servo alarm occurred. |
| 4 | ALARM □□■ | SYSEMG (NMI in a module on the F-bus) occurred. |
| 5 | ALARM ■□■ | An ABC alarm (parity alarm in the file SRAM, fault in the peripheral bus, SUB bus, or FANUC bus) occurred. |
| 6 | ALARM □■■ | A parity alarm occurred in the DRAM module. |
| 7 | ALARM ■■■ | A parity alarm occurred in the high-speed SRAM module. |

7.4 Configuration of the Upgraded Main CPU Board (MAIN-C)

(1) Parts layout

Drawing number : A16B-3200-0060



| No. | Module name | Function outline |
|-----|------------------------|--|
| 1 | CRT control module | CRT display control |
| 2 | SRAM module | Part program storage, RAM for parameters |
| 3 | Servo control module | Third-axis and fourth-axis servo control |
| 4 | Servo control module | First-axis and second-axis servo control |
| 5 | Servo interface module | Third-axis and fourth-axis amplifier, pulse coder interface |
| 6 | Servo interface module | First-axis and second-axis amplifier, pulse coder interface |
| 7 | DRAM module | RAM for CNC system |
| 8 | Flash ROM module | Flash EPROM for CNC system |
| 9 | Spindle control module | System clear, battery backup, spindle control, HDI interface, etc. |

NOTE Power for the battery backup is supplied to the module in the shaded box. If the module is disconnected, all data will be lost.

(2) Block diagram

See (2) in Section 7.2.

(3) Adjustment

No adjustment is needed.

(4) LED display

□ : Not lit ■ : Lit ★ : Blinking

STATUS LEDs are green. ALARM LEDs are red.

1. LED display transition when the power is turned on (STATUS LED)

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | STATUS □□□□ | Power-off |
| 2 | STATUS ■■■■ | Initial state immediately after power-on |
| 3 | STATUS ■□□■ | Beginning of activation of the CNC software |
| 4 | STATUS □□□■ | End of CNC local RAM test |
| 5 | STATUS ■■■□ | End of CNC local RAM clear |
| 6 | STATUS □■■□ | FROM test in progress |
| 7 | STATUS ■□■□ | End of key initialization. Logical slot setting is completed. |
| 8 | STATUS □□■□ | End of CRT initialization. The CRT is ready for use. |
| 9 | STATUS ■■□■ | Waiting for the completion of setting of the PC boards connected to the FANUC bus (1) |
| 10 | STATUS □■□■ | IPL monitoring in progress |
| 11 | STATUS ■■□□ | End of IPL |
| 12 | STATUS ■□■□ | Waiting for the setting of *SYSFAIL |
| 13 | STATUS □□■□ | Waiting for the completion of setting of the PC boards connected to the FANUC bus (2) |
| 14 | STATUS □■□□ | Waiting for the completion of initialization of the servo |
| 15 | STATUS ■□□□ | Normal state. The power-on sequence is ended. |

2. LED display when an error occurs (STATUS LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | STATUS ★□□□ | An error (1) occurred in the DRAM module of the CNC. |
| 2 | STATUS □★□□ | An error occurred in the file SRAM. |
| 3 | STATUS ★★□□ | An error (2) occurred in the DRAM module of the CNC. |
| 4 | STATUS □□★□ | The CRT control module is not supported by the installed CNC software. |
| 5 | STATUS ★□★□ | The main CPU board is not supported by the installed CNC software. |
| 6 | STATUS □★★□ | An illegal PC board is installed in a slot of the FANUC bus. Two or more identical PC boards are installed when only one is permitted. |
| 7 | STATUS ★★★□ | A system error (stack overflow) occurred. |
| 8 | STATUS □□□★ | An illegal module is installed in the flash ROM module. |
| 9 | STATUS ★□□★ | A flash ROM file configuration error (CNC area) occurred. |
| 10 | STATUS □★□★ | A flash ROM file configuration error (PMC area) occurred. |
| 16 | STATUS □■■■ | A system error (NMI to the CNC CPU) occurred. |

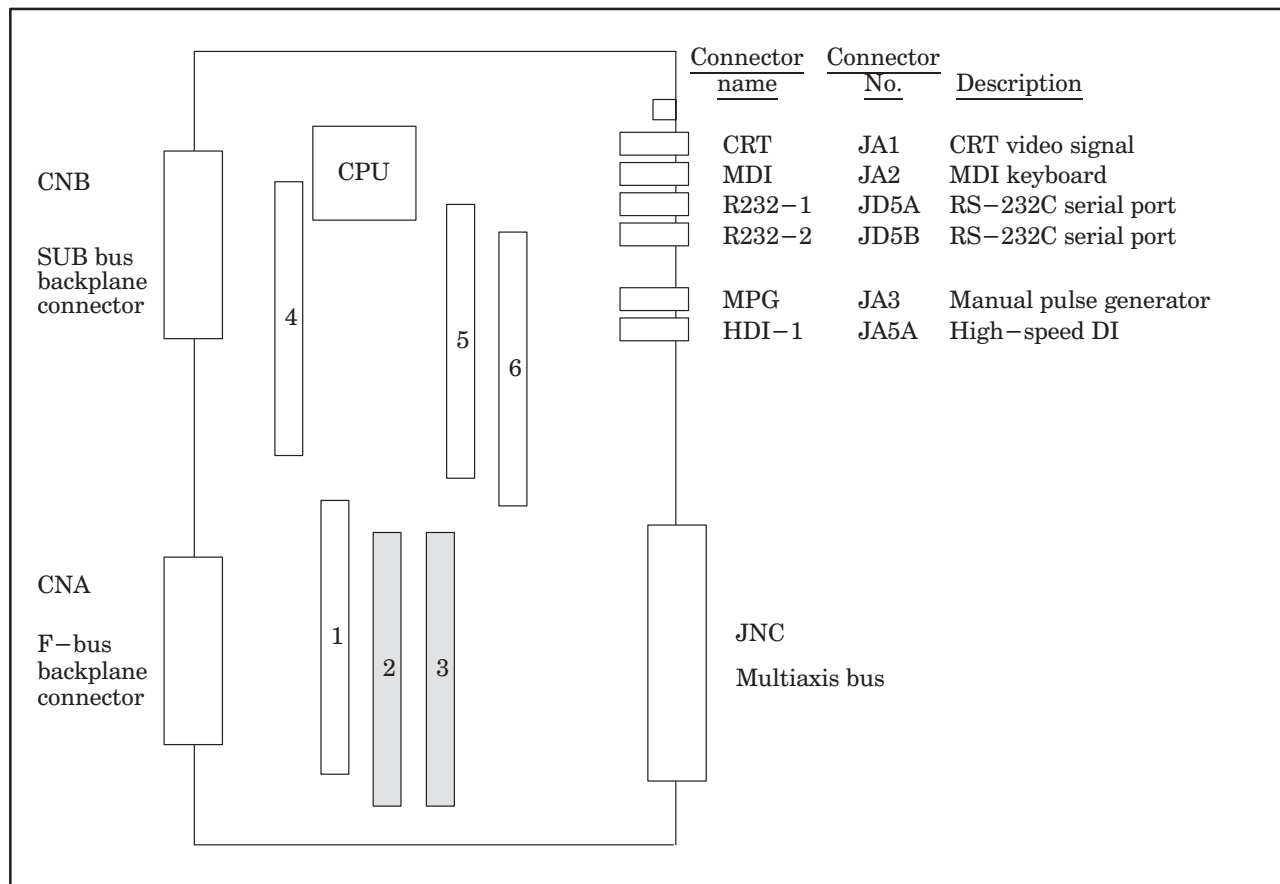
3. LED display when an error occurs (ALARM LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | ALARM ■□□ | The voltage of the backup battery has fallen below the specified minimum level. |
| 2 | ALARM □■□ | SYSFAIL (fault in a module on the F-bus) occurred. |
| 3 | ALARM ■■□ | A servo alarm occurred. |
| 4 | ALARM □□■ | SYSEMG (NMI in a module on the F-bus) occurred. |
| 5 | ALARM ■□■ | An ABC alarm (parity alarm in the file SRAM, fault in the peripheral bus, multiaxis bus, or FANUC bus) occurred. |
| 6 | ALARM □■■ | A parity alarm occurred in the DRAM module. |
| 7 | ALARM ■■■ | A parity alarm occurred in the shared RAM on the SUB board. |

7.5 Configuration of the High-Speed Multiaxis Main CPU Board (MAX MAIN-A)

(1) Parts layout

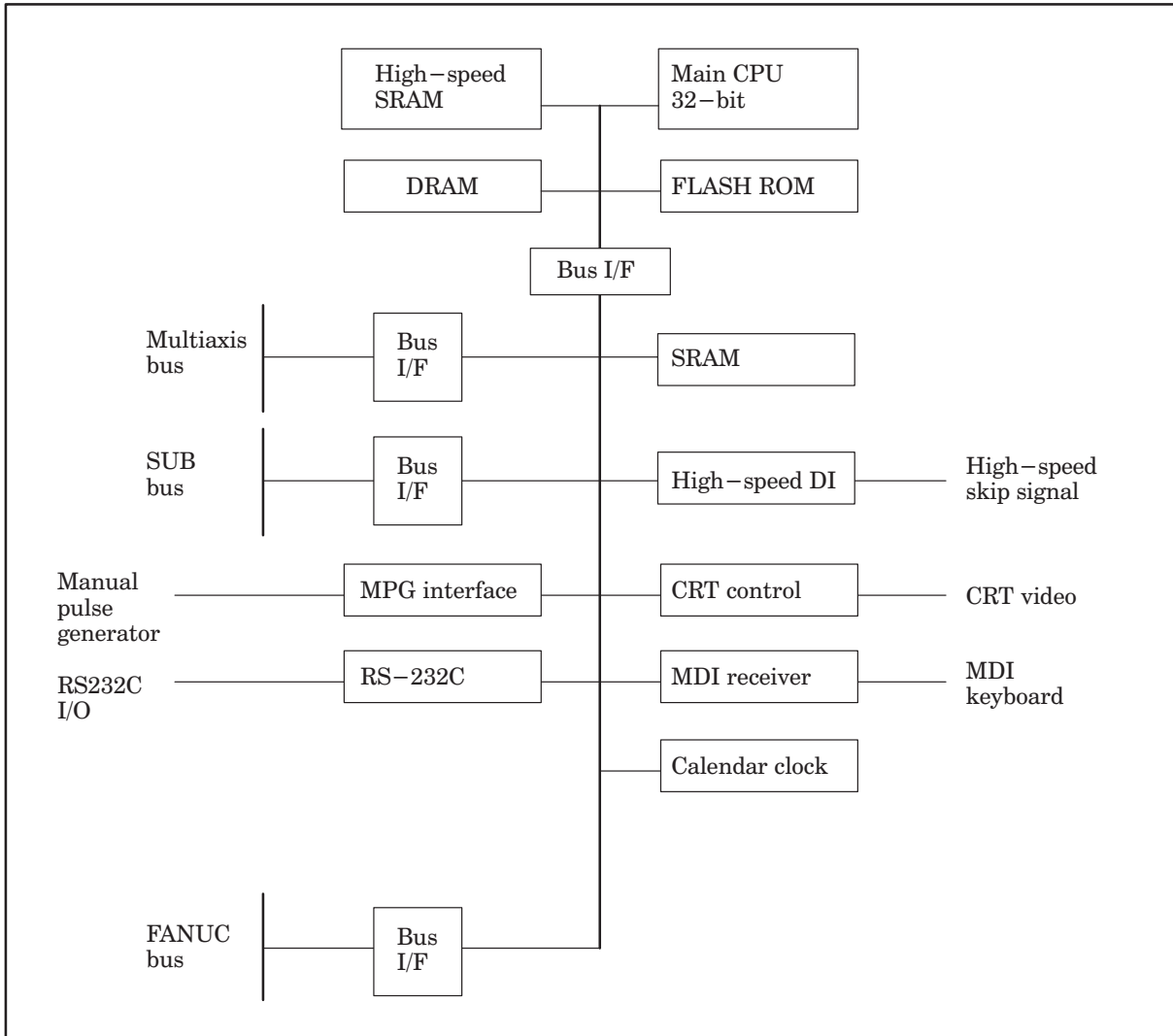
Drawing number : A16B-2201-0340



| No. | Module name | Function outline |
|-----|------------------------|---|
| 1 | CRT control module | CRT display control |
| 2 | SRAM module | Part program storage, RAM for parameters |
| 3 | Peripheral module | Interface such as MDI, MPG, and RS-232C, system timer, system clock, calendar clock |
| 4 | High-speed SRAM module | High-speed RAM for CNC system |
| 5 | DRAM module | RAM for CNC system |
| 6 | FLASH ROM module | FLASH EPROM for CNC system |

NOTE Power for the battery backup is supplied to the module in the shaded box. If the module is disconnected, all data will be lost.

(2) Block diagram



(3) Adjustment

No adjustment is needed.

Multi-axis main board

(4) LED display

□ : Not lit ■ : Lit ★ : Blinking

STATUS LEDs are green. ALARM LEDs are red.

1. LED display transition when the power is turned on (STATUS LED)

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | STATUS □□□□ | Power-off |
| 2 | STATUS ■■■■ | Initial state immediately after power-on |
| 3 | STATUS ■□□■ | Beginning of activation of the CNC software |
| 4 | STATUS □□□■ | End of CNC local RAM test |
| 5 | STATUS ■■■□ | End of CNC local RAM clear |
| 6 | STATUS □■■□ | FROM test in progress |
| 7 | STATUS ■□■□ | End of key initialization. Logical slot setting is completed. |
| 8 | STATUS □□■□ | End of CRT initialization. The CRT is ready for use. |
| 9 | STATUS ■■□■ | Waiting for the completion of setting of the PC boards connected to the FANUC bus (1) |
| 10 | STATUS □■□■ | IPL monitoring in progress |
| 11 | STATUS ■■□□ | End of IPL |
| 12 | STATUS ■□■□ | Waiting for the setting of *SYSFAIL |
| 13 | STATUS □□■□ | Waiting for the completion of setting of the PC boards connected to the FANUC bus (2) |
| 14 | STATUS □■□□ | Waiting for the completion of initialization of the servo |
| 15 | STATUS ■□□□ | Normal state. The power-on sequence is ended. |

2. LED display when an error occurs (STATUS LED)

| No. | LED display | NC status |
|-----|--------------|--|
| 1 | STATUS ★□□□ | An error (1) occurred in the high-speed SRAM or DRAM module of the CNC. |
| 2 | STATUS □★□□ | An error occurred in the file SRAM. |
| 3 | STATUS ★★□□ | An error (2) occurred in the high-speed SRAM or DRAM module of the CNC. |
| 4 | STATUS □□★□ | The CRT control module is not supported by the installed CNC software. |
| 5 | STATUS ★□★□ | The main CPU board is not supported by the installed CNC software. |
| 6 | STATUS □★★□ | An illegal PC board is installed in a slot of the FANUC bus. Two or more identical PC boards are installed when only one is permitted. |
| 7 | STATUS ★★★□ | A system error (stack overflow) occurred. |
| 8 | STATUS □□□★ | An illegal module is installed in the flash ROM module. |
| 9 | STATUS ★□□★ | A flash ROM file configuration error (CNC area) occurred. |
| 10 | STATUS □★□★ | A flash ROM file configuration error (PMC area) occurred. |
| 16 | STATUS □■■■■ | A system error (NMI to the CNC CPU) occurred. |

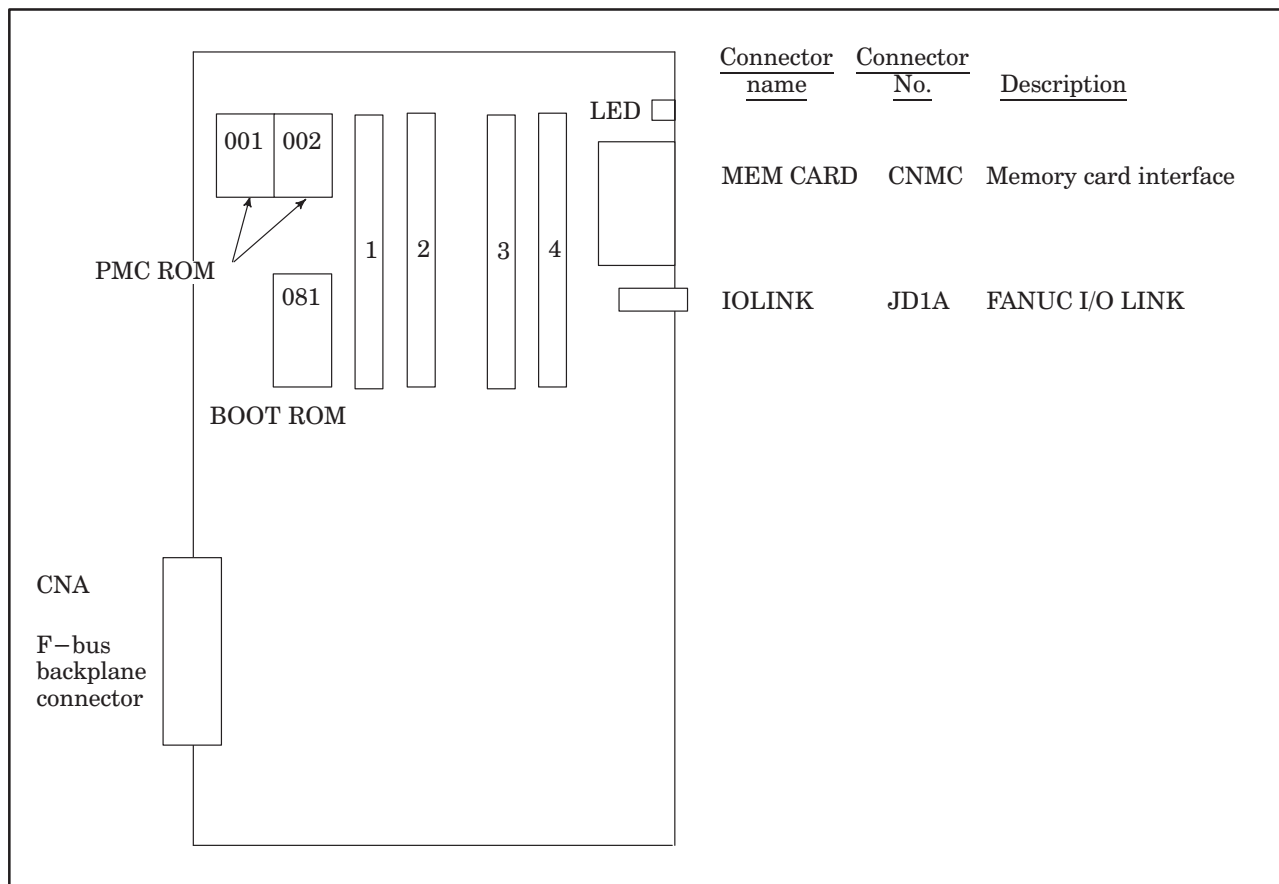
3. LED display when an error occurs (ALARM LED)

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | ALARM ■□□ | The voltage of the backup battery has fallen below the specified minimum level. |
| 2 | ALARM □■□ | SYSFAIL (fault in a module on the F-bus) occurred. |
| 3 | ALARM ■■□ | A servo alarm occurred. |
| 4 | ALARM □□■ | SYSEMG (NMI in a module on the F-bus) occurred. |
| 5 | ALARM ■□■ | An ABC alarm (parity alarm in the file SRAM, fault in the peripheral bus, SUB bus, multiaxis bus, or FANUC bus) occurred. |
| 6 | ALARM □■■ | A parity alarm occurred in the DRAM module. |
| 7 | ALARM ■■■ | A parity alarm occurred in the high-speed SRAM module. |

7.6 Configuration of the PMC-NA Board

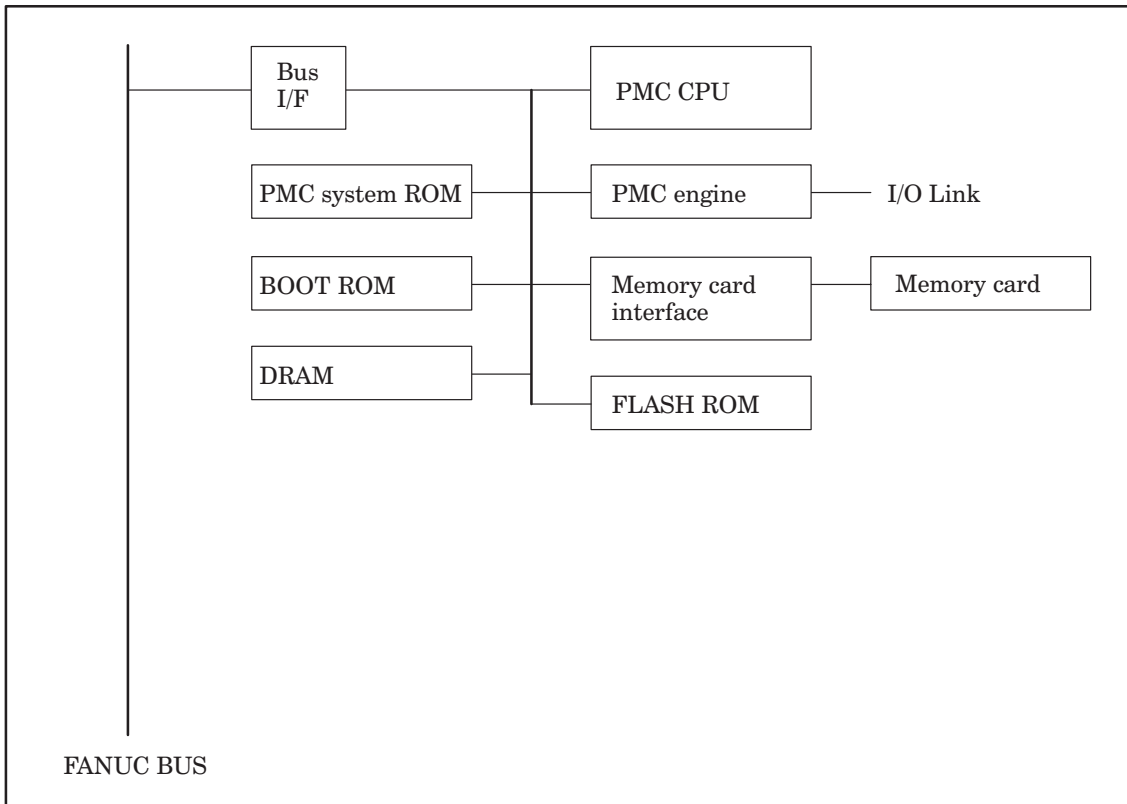
(1) Parts layout

Drawing number : A16B-2201-0371 (PMC-NA board without conversational function)



| No. | Module name | Function outline |
|-----|-------------------|---|
| 1 | PMC CPU module | CPU module for PMC-NA |
| 2 | PMC engine module | PMC operation control, I/O Link control |
| 3 | DRAM module | Work RAM for PMC-NA |
| 4 | FLASH ROM module | FLASH EPROM |

(2) Block diagram

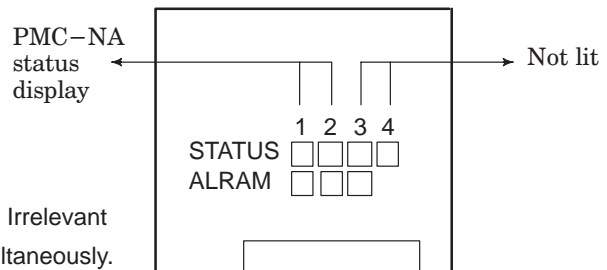


(3) Adjustment

No adjustment is needed.

(4) LED display

Of the STATUS LEDs provided at the top on the front edge of the PMC-NA board, only two are valid as shown on the right:



Legend

- : Not lit ■ : Lit ★☆ : Blinking ◆ : Irrelevant
- ★★ represents that the two LEDs blink simultaneously.
- ★☆ represents that the two LEDs blink alternately.

(a) STATUS LED display for the PMC-NA function

1. STATUS LED display transition when the power is turned on

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | STATUS □□□□ | Power-off |
| 2 | STATUS ■■□□ | Initial state immediately after power-on or the state in which the PMC CPU is not operating |
| 3 | STATUS □■□□ | Initial state. PMC initialization is in progress. |
| 4 | STATUS ■□□□ | Initial state PMC ROM parity check, transfer of a Ladder or PASCAL program to DRAM in progress, SLC initialization in progress (IPL is completed in the CNC and the NC ready status is awaited.) |
| 5 | STATUS □□□□ | Normal state |

2. STATUS LED display when an error occurs

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | STATUS ★★□□ | An error occurred in another PC board. |
| 2 | STATUS ■★□□ | An error occurred during transfer from or to DI/DO. The DRAM module to be installed on the main CPU is defective. |
| 3 | STATUS ★■□□ | A RAM parity error occurred in the PMC engine module (upon accessing the BOC). |
| 4 | STATUS □★□□ | A RAM parity error occurred in the PMC engine module or PMC DRAM module (upon accessing the CPU). |
| 5 | STATUS ★y□□ | A failure (BUS ERR, ADDR ERR, ILL INST, ZERO DIV, etc.) occurred in the PMC function. The PMC ROM is defective. |

(b) ALARM LED display

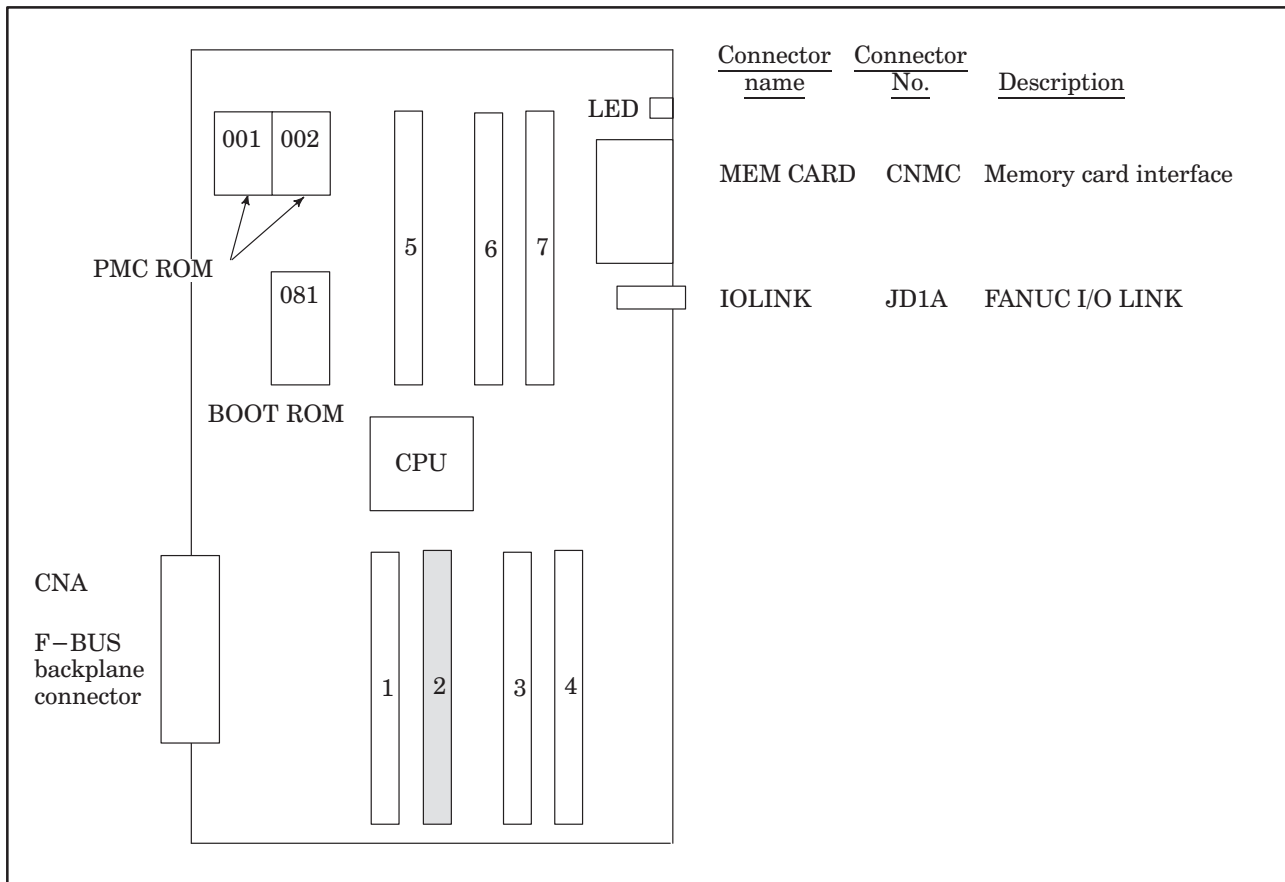
| No. | LED display | NC status |
|-----|-------------|---|
| 1 | ALARM □■□ | The PMC CPU asserts SYSFAIL. |
| 2 | ALARM ■■□ | The PMC CPU is in the stop state. |
| 3 | ALARM □□■ | An error (SLC error) occurred during data transfer to or from DI/DO. |
| 4 | ALARM ■■■ | A RAM (RAM on the PMC engine module or PMC DRAM module) parity error occurred in the PMC. |

7.7 Configuration of the PMC-NA Board with or without the Conversational Function

(1) Parts layout

Drawing numbers : A16B-2201-0390 (PMC-NA board with conversational function)

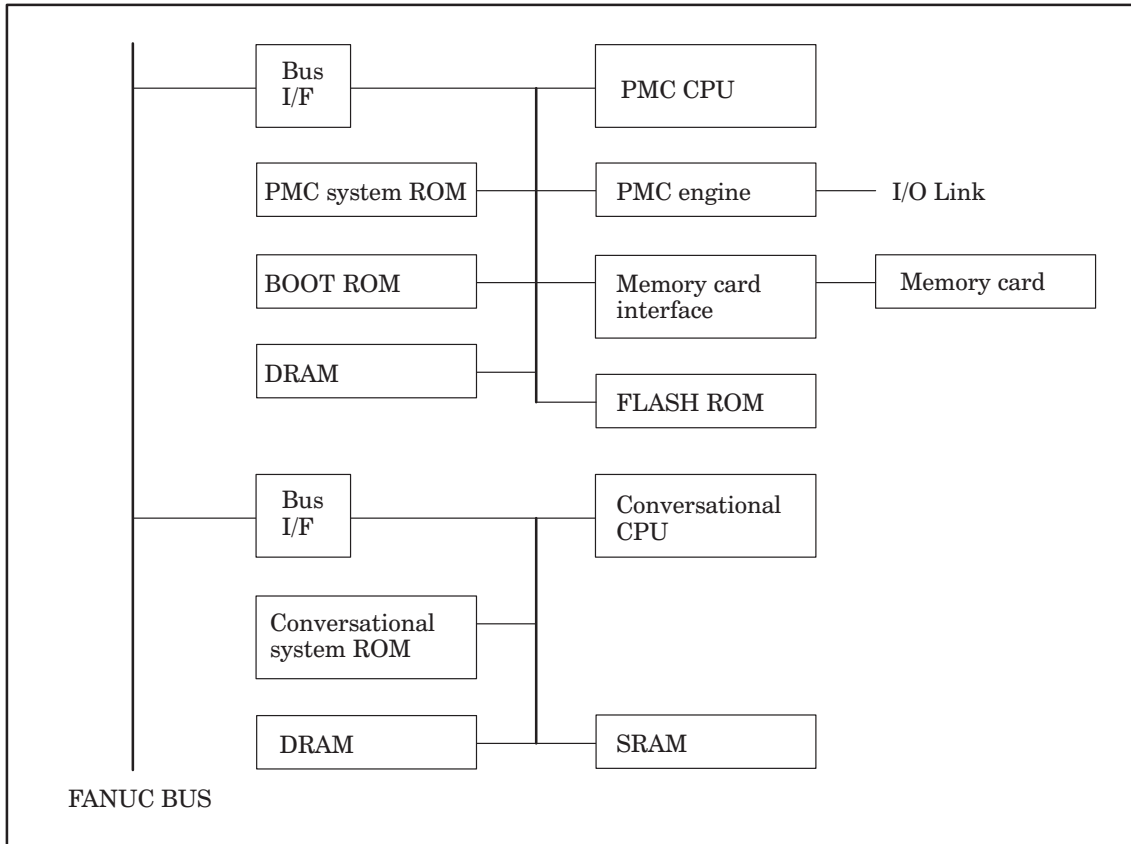
A16B-2201-0391 (PMC-NA board without conversational function)



| No. | Module name | Function outline |
|-----|---------------------------|--|
| 1 | Conversational CPU module | CPU module for the conversational function |
| 2 | SRAM module | Sub-memory for the conversational function |
| 3 | DRAM module | Work DRAM for the conversational function |
| 4 | ROM module | System ROM for the conversational function |
| 5 | PMC engine module | PMC operation control, I/O Link control |
| 6 | DRAM module | Work RAM for PMC-NA |
| 7 | FLASH ROM module | FLASH EPROM |

NOTE Power for the battery backup is supplied to the module in the shaded box. If the module is disconnected, all data will be lost.

(2) Block diagram



(3) Adjustment

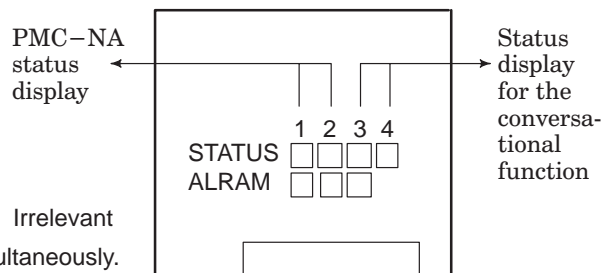
No adjustment is needed.

(4) LED display

The STATUS LEDs at the top of the front of the PMC-NA board having the conversational function are used for independent functions, as shown on the right.

Legend

- : Not lit ■ : Lit ★★ : Blinking ◆ : Irrelevant
- ★★ represents that the two LEDs blink simultaneously.
- ★☆ represents that the two LEDs blink alternately.



(a) LED display for the PMC-NA function

1. STATUS LED display transition when the power is turned on

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | STATUS □□□□ | Power-off |
| 2 | STATUS ■■◆◆ | Initial state immediately after power-on or the state in which the PMC CPU is not operating |
| 3 | STATUS □■◆◆ | Initial state. PMC initialization is in progress. |
| 4 | STATUS ■□◆◆ | Initial state PMC ROM parity check, transfer of a Ladder or PASCAL program to DRAM in progress, SLC initialization in progress (IPL is completed in the CNC and the NC ready status is awaited.) |
| 5 | STATUS □□◆◆ | Normal state |

2. STATUS LED display for the PMC-NA function upon the occurrence of an error

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | STATUS ★★◆◆ | An error occurred in another PC board. |
| 2 | STATUS ■★◆◆ | An error occurred during transfer to or from DI/DO. Alternatively, the DRAM module on the main CPU board is defective. |
| 3 | STATUS ★■◆◆ | A RAM parity error occurred in the PMC engine module (upon accessing the BOC). |
| 4 | STATUS □★◆◆ | A RAM parity error occurred in the PMC engine module or PMC DRAM module (upon accessing the CPU). |
| 5 | STATUS ★y◆◆ | A failure (BUS ERR, ADDR ERR, ILL INST, ZERO DIV, etc.) occurred in the PMC function. The PMC ROM is defective. |

(b) STATUS LED display for the conversational function (TF, TTF, MF)

1. STATUS LED display transition when the power is turned on

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | STATUS □□□□ | Power-off |
| 2 | STATUS ◆◆□■ | Waiting for initialization of the main CPU (waiting for ID setting) |
| 3 | STATUS ◆◆■□ | Initialized state |
| 4 | STATUS ◆◆□□ | Normal state |

2. STATUS LED display for the conversational function upon the occurrence of an error (TF, TTF)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | STATUS ◆◆★★ | An error occurred in another PC board. |
| 2 | STATUS ◆◆□★ | A RAM parity error occurred on the PC board for the conversational function. |
| 3 | STATUS ◆◆★☆ | A defective ROM module was detected on the PC board for the conversational function. |
| 4 | STATUS ◆◆■□ | The CPU for the conversational function performed illegal processing. |

3. STATUS LED display for the conversational function when an error occurs (MF)

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | STATUS ◆◆★★ | An error occurred in another PC board or the CPU for the conversational function. |

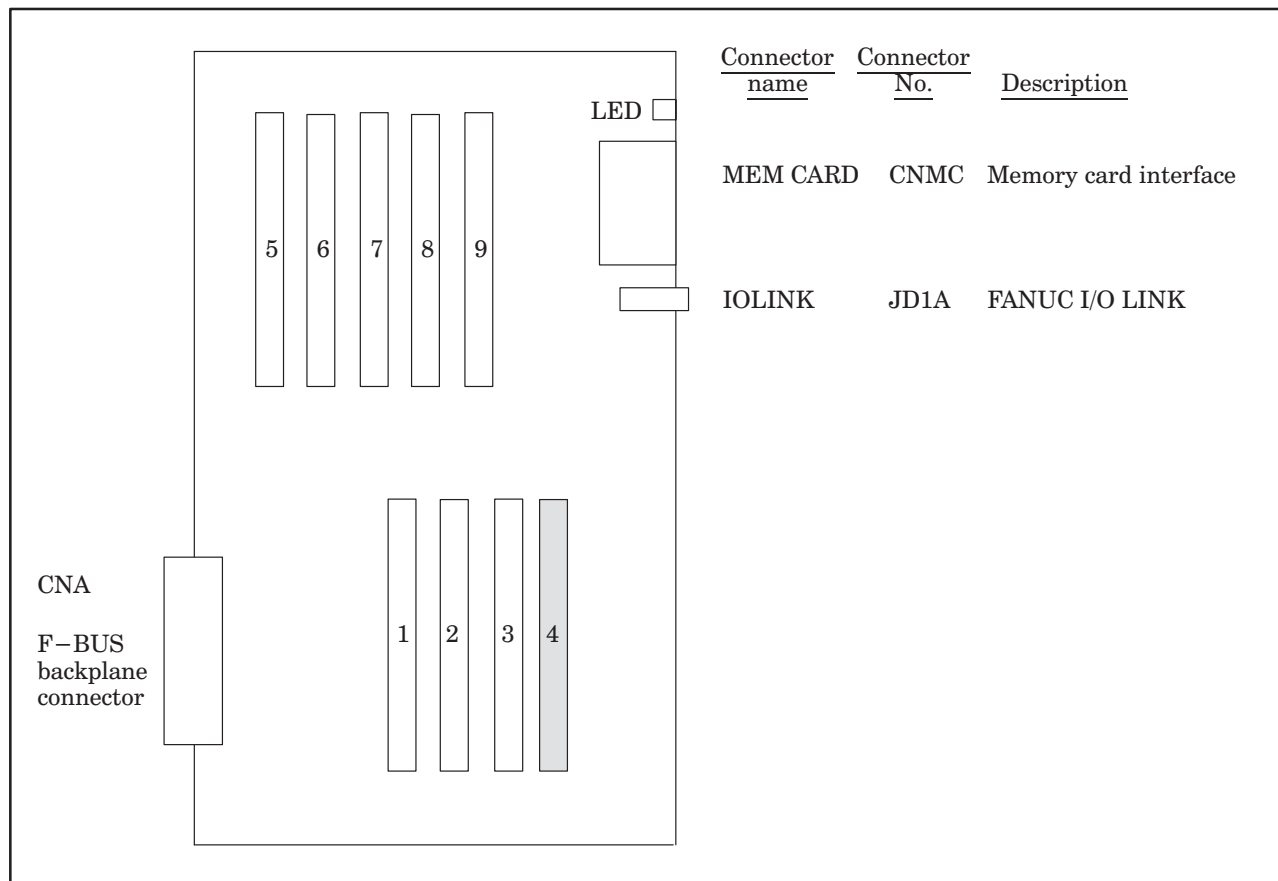
(c) ALARM LED display

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | ALARM ■□□ | The CPU for the conversational function asserts SYSFAIL. |
| 2 | ALARM □■□ | The PMC CPU asserts SYSFAIL. |
| 3 | ALARM ■■□ | The PMC CPU is in the stop state. |
| 4 | ALARM □□■ | An error (SLC error) occurred during data transfer to or from DI/DO. |
| 5 | ALARM ■■■ | A RAM (RAM on the PMC engine module or PMC DRAM module) parity error occurred in the PMC. |

7.8 Configuration of the PMC-NB Board with or without the Conversational Function

(1) Parts layout

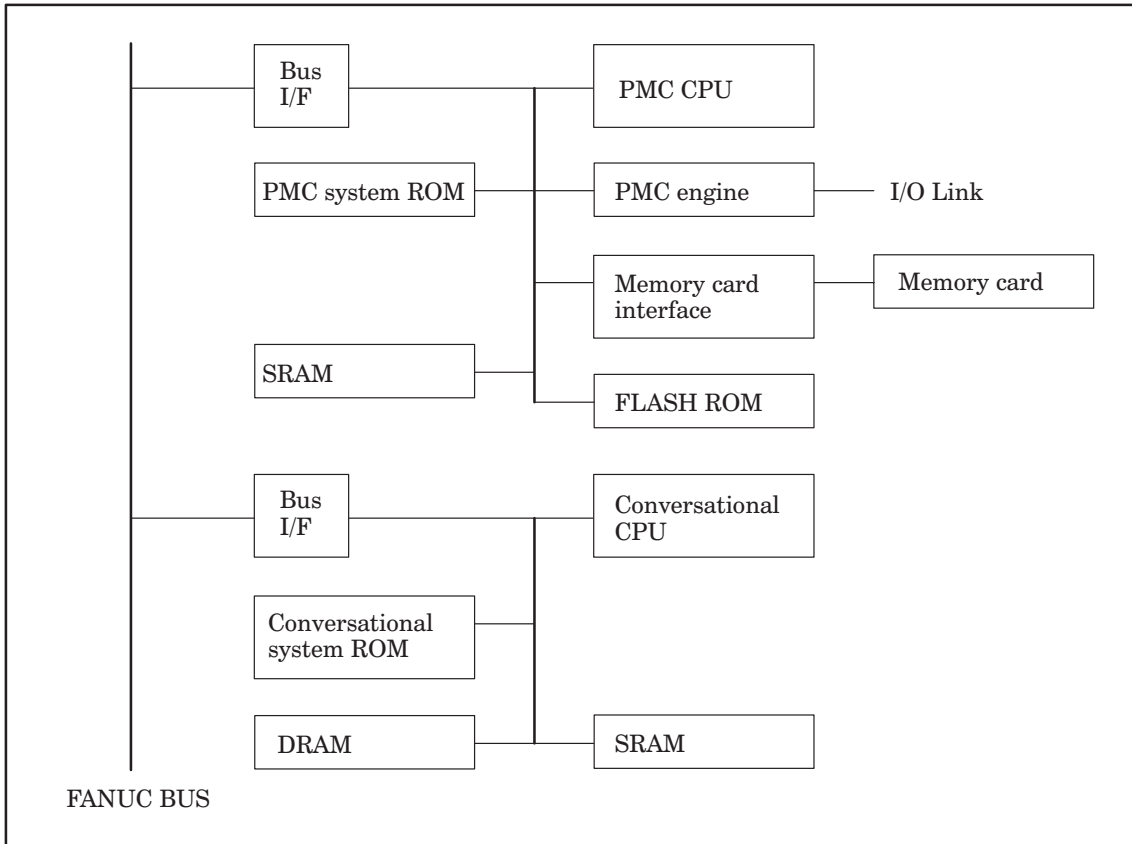
Drawing numbers : A16B-2201-0810 (PMC-NB board with conversational function)
 A16B-2201-0811 (PMC-NB board without conversational function)
 A16B-2201-0381 (PMC-NB board without conversational function)



| No. | Module name | Function outline |
|-----|---------------------------|---|
| 1 | Conversational CPU module | CPU module for conversational function |
| 2 | DRAM module | Work RAM for conversational function |
| 3 | ROM module | System ROM for conversational function |
| 4 | SRAM module | Sub-memory for conversational function |
| 5 | ROM module | System ROM for PMC-NB |
| 6 | PMC CPU module | CPU module for PMC-NB |
| 7 | PMC engine module | PMC operation control, I/O Link control |
| 8 | SRAM module | Work RAM for PMC-NB |
| 9 | FLASH ROM module | FLASH EPROM |

NOTE Power for battery backup is supplied to the module in the shaded box. If the module is disconnected, all data will be lost.

(2) Block diagram



(3) Adjustment

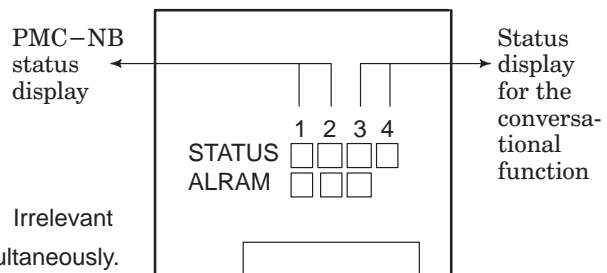
No adjustment is needed.

(4) LED display

The STATUS LEDs at the top of the front of the PMC-NB board having the conversational function are used for independent functions, as shown on the right.

Legend

- : Not lit ■ : Lit ★★ : Blinking ◆ : Irrelevant
- ★★ represents that the two LEDs blink simultaneously.
- ★☆ represents that the two LEDs blink alternately.



(a) LED display for the PMC-NB function

1. STATUS LED display transition when the power is turned on

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | STATUS □□□□ | Power-off |
| 2 | STATUS ■■◆◆ | Initial state immediately after power-on or the state in which the PMC CPU is not operating |
| 3 | STATUS □■◆◆ | Initial state. PMC initialization is in progress. |
| 4 | STATUS ■□◆◆ | Initial state PMC ROM parity check, transfer of a Ladder or PASCAL program to DRAM in progress, SLC initialization in progress (IPL is completed in the CNC and the NC ready status is awaited.) |
| 5 | STATUS □□◆◆ | Normal state |

2. STATUS LED display for the PMC-NB function when an error occurs

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | STATUS ★★◆◆ | An error occurred in another PC board. |
| 2 | STATUS ■★◆◆ | An error occurred during transfer to or from DI/DO. The DRAM module on the main CPU board is defective. The PMC system ROM module is defective. |
| 3 | STATUS ★■◆◆ | A RAM parity error occurred in the PMC engine module (during access to the PMC). |
| 4 | STATUS □★◆◆ | A RAM parity error occurred in the PMC engine module or PMC SRAM module (during access to the CPU). |
| 5 | STATUS ★☆◆◆ | A failure (BUS ERR, INVALID OPCODE, etc.) occurred in the PMC function. The PMC ROM is defective. |

(b) STATUS LED display for the conversational function (TF, TTF, MF)

1. STATUS LED display transition when the power is turned on

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | STATUS □□□□ | Power-off |
| 2 | STATUS ◆◆□■ | Waiting for initialization of the main CPU (waiting for ID setting) |
| 3 | STATUS ◆◆■□ | Initialized state |
| 4 | STATUS ◆◆□□ | Normal state |

2. STATUS LED display for the conversational function when an error occurs (TF, TTF)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | STATUS ◆◆★★ | An error occurred in another PC board. |
| 2 | STATUS ◆◆□★ | A RAM parity error occurred on the PC board for the conversational function. |
| 3 | STATUS ◆◆★☆ | A defective ROM module was detected on the PC board for the conversational function. |
| 4 | STATUS ◆◆■□ | The CPU for the conversational function performed illegal processing. |

3. STATUS LED display for the conversational function when an error occurs (MF)

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | STATUS ◆◆★★ | An error occurred in another PC board or the CPU for the conversational function. |

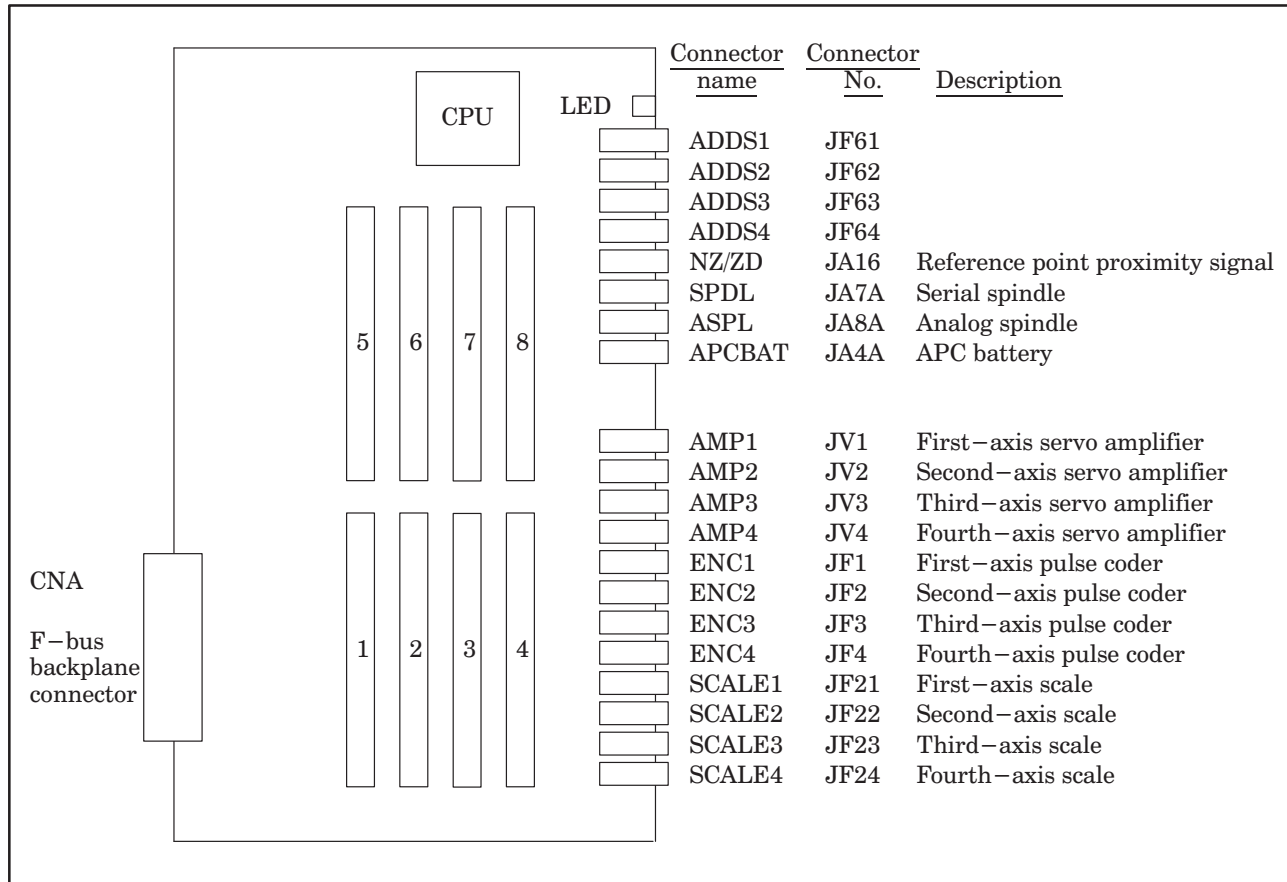
(c) ALARM LED display

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | ALARM ■□□ | The CPU for the conversational function asserts SYSFAIL. |
| 2 | ALARM □■□ | The PMC CPU asserts SYSFAIL. |
| 3 | ALARM ■■□ | The PMC CPU is in the stop state. |
| 4 | ALARM □□■ | An error (SLC error) occurred during data transfer to or from DI/DO. |
| 5 | ALARM ■■■ | A RAM (RAM on the PMC engine module or PMC SRAM module) parity error occurred in the PMC. |

7.9 Configuration of the Axis CPU Board (ACPU)

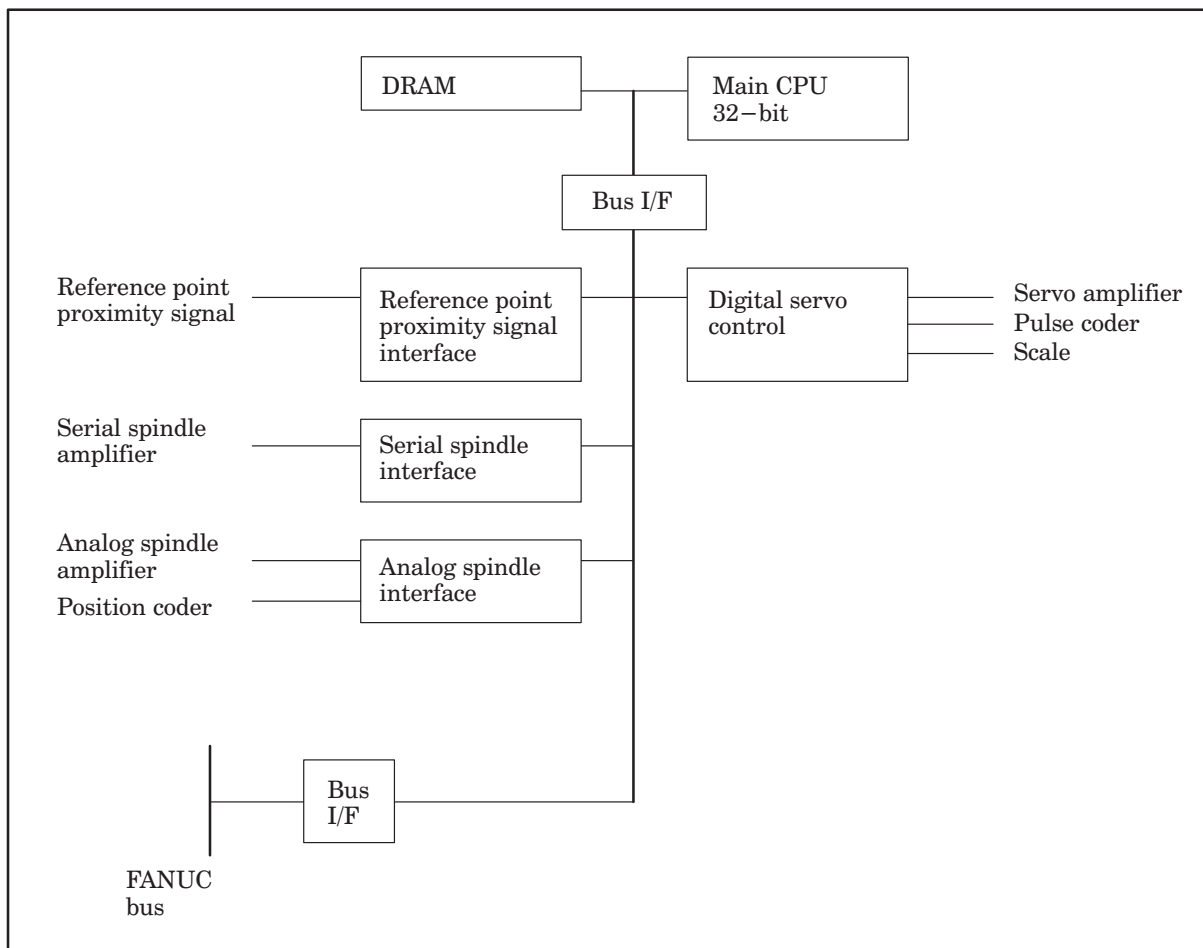
(1) Parts layout

Drawing number : A16B-2201-0360



| No. | Module name | Function outline |
|-----|---------------------------|---|
| 1 | Servo control module | Third-axis and fourth-axis servo control |
| 2 | Servo control module | First-axis and second-axis servo control |
| 3 | Servo interface module | Third-axis and fourth-axis amplifier, pulse coder interface |
| 4 | Servo interface module | First-axis and second-axis amplifier, pulse coder interface |
| 5 | DRAM module | RAM for the axis CPU system |
| 6 | Error motion check module | First-axis and second-axis error motion check interface |
| 7 | Error motion check module | Third-axis and Fourth-axis error motion check interface |
| 8 | Spindle control module | Spindle control, reference point proximity signal interface |

(2) Block diagram



(3) Adjustment

No adjustment is needed.

(4) LED display

□ : Not lit ■ : Lit ★ : Blinking

STATUS LEDs are green. ALARM LEDs are red.

1. LED display transition when the power is turned on (STATUS LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | STATUS □□□□ | Power-off |
| 2 | STATUS ■■■■ | State in which the axis CPU is not started |
| 3 | STATUS ■□□■ | Beginning of the activation of the axis CPU software |
| 4 | STATUS □□□■ | End of the axis CPU local RAM test |
| 5 | STATUS ■■■□ | End of the axis CPU local RAM clear |
| 6 | STATUS □■■□ | Waiting for a response from the main CPU (1) |
| 7 | STATUS ■□■□ | Waiting for a response from the main CPU (2) |
| 8 | STATUS □□■□ | Waiting for a response from the main CPU (3) |
| 9 | STATUS ■■□□ | Waiting for a response from the digital servo |
| 10 | STATUS □■□□ | Waiting for a response from the main CPU (4) |
| 15 | STATUS ■□□□ | Normal state. The power-on sequence is ended. |

2. LED display when an error occurs (STATUS LED)

| No. | LED display | NC status |
|-----|--------------|--|
| 1 | STATUS ★□□□ | An error occurred in the DRAM of the axis CPU. |
| 2 | STATUS □★□□ | An unsupported component is installed in the DRAM of the axis CPU. |
| 3 | STATUS □★★□ | A logical slot setting error occurred. |
| 4 | STATUS □■■■■ | A system error occurred. |

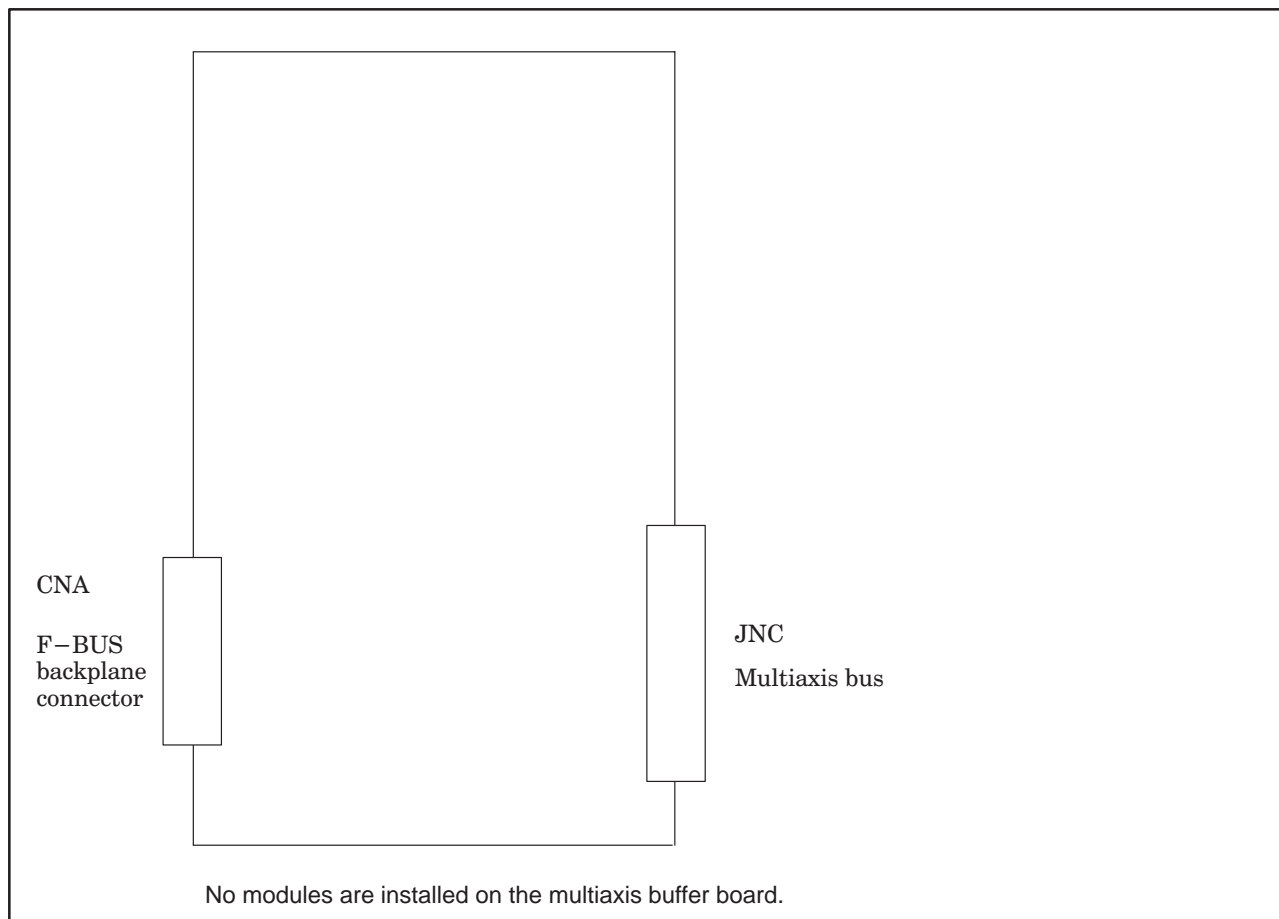
3. LED display when an error occurs (ALARM LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 2 | ALARM □■□ | SYSFAIL (fault in a module on the F-BUS) occurred. |
| 3 | ALARM ■■□ | A servo alarm occurred. |
| 4 | ALARM □□■ | SYSEMG (NMI in a module on the F-BUS) occurred. |
| 5 | ALARM ■□■ | A bus error occurred (F-BUS, servo, spindle module). |
| 6 | ALARM □■■ | A parity alarm occurred in the DRAM module. |

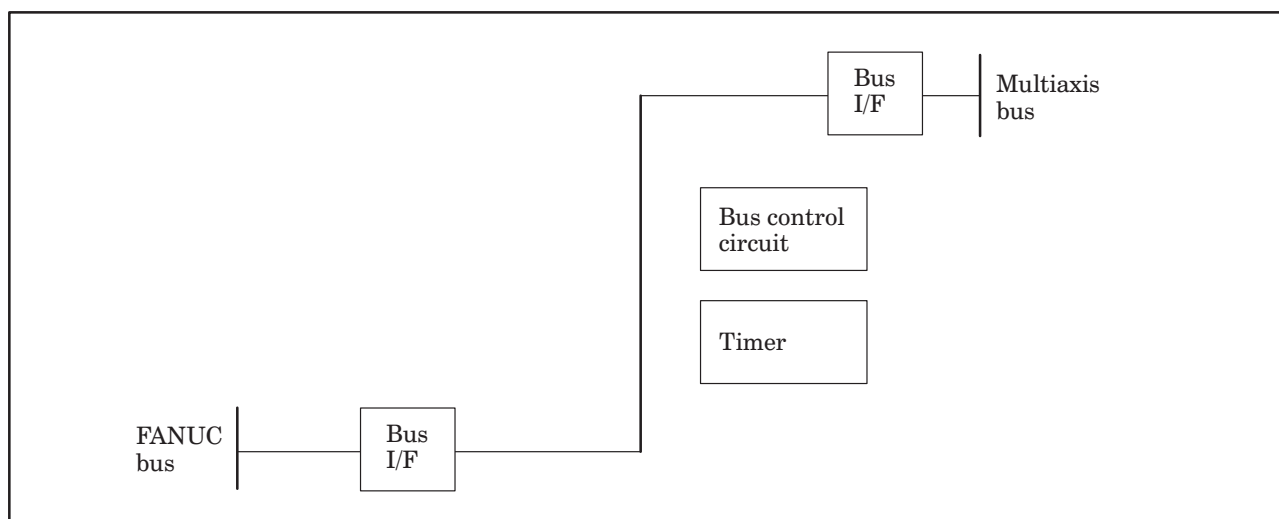
7.10 Configuration of the Multiaxis Buffer Board

(1) Parts layout

Drawing number : A16B-2201-0351



(2) Block diagram



(3) Adjustment

No adjustment is needed.

(4) LED display

□ : Not lit ■ : Lit ★ : Blinking

STATUS LEDs are green. ALARM LEDs are red.

1.2. The STATUS LEDs (green LEDs) on this PC board have no meaning.

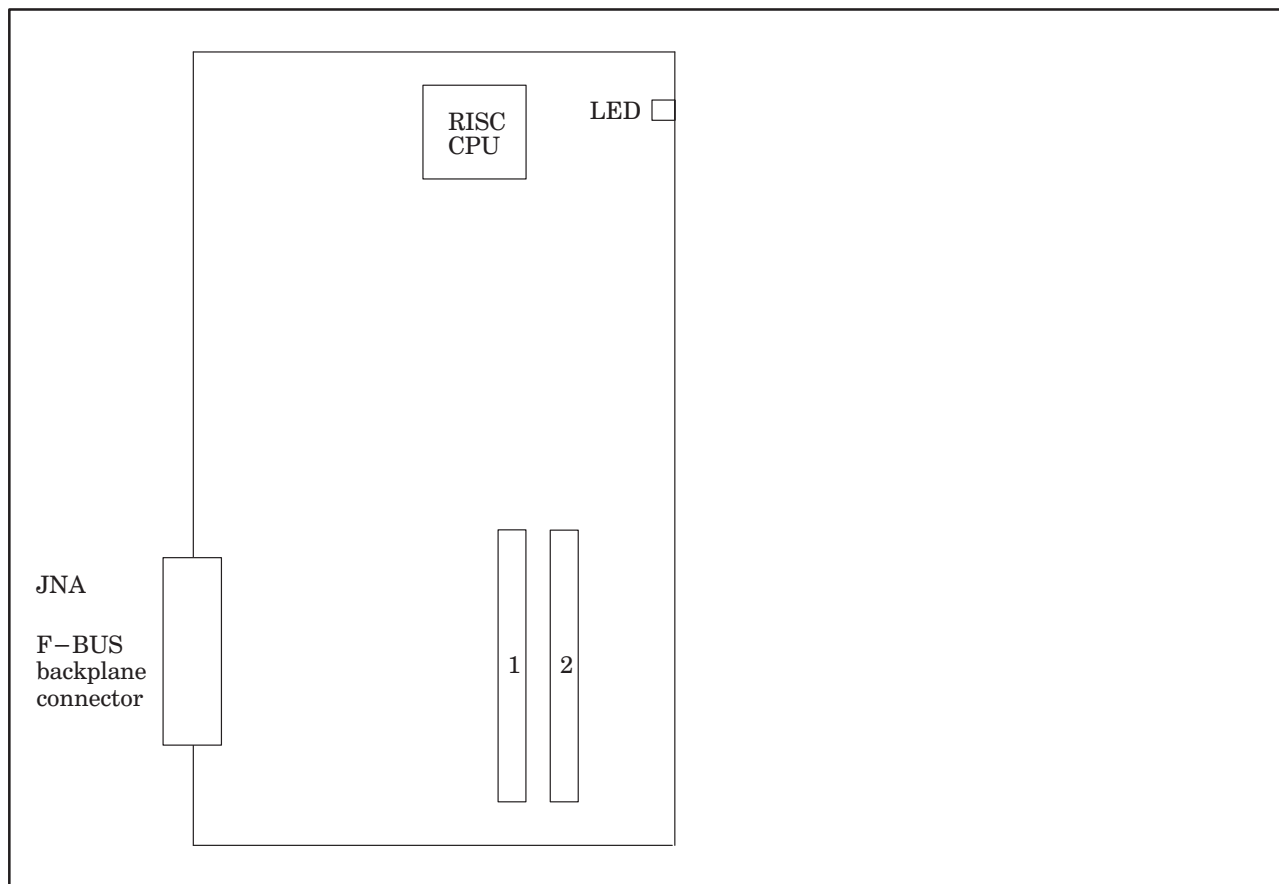
3. LED display when an error occurs (ALARM LED)

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | ALARM □■□ | SYSFAIL occurred in the axis shelf. (A fault occurred in a module of the axis shelf.) |
| 2 | ALARM □■■ | SYSEMG occurred in the axis shelf. (An NMI occurred in a module of the axis shelf.) |
| 3 | ALARM ■□■ | A bus error occurred during write access from the main shelf. |
| 4 | ALARM ■■□ | A bus error occurred in the F-bus of the axis shelf. |

7.11 Configuration of the RISC Board

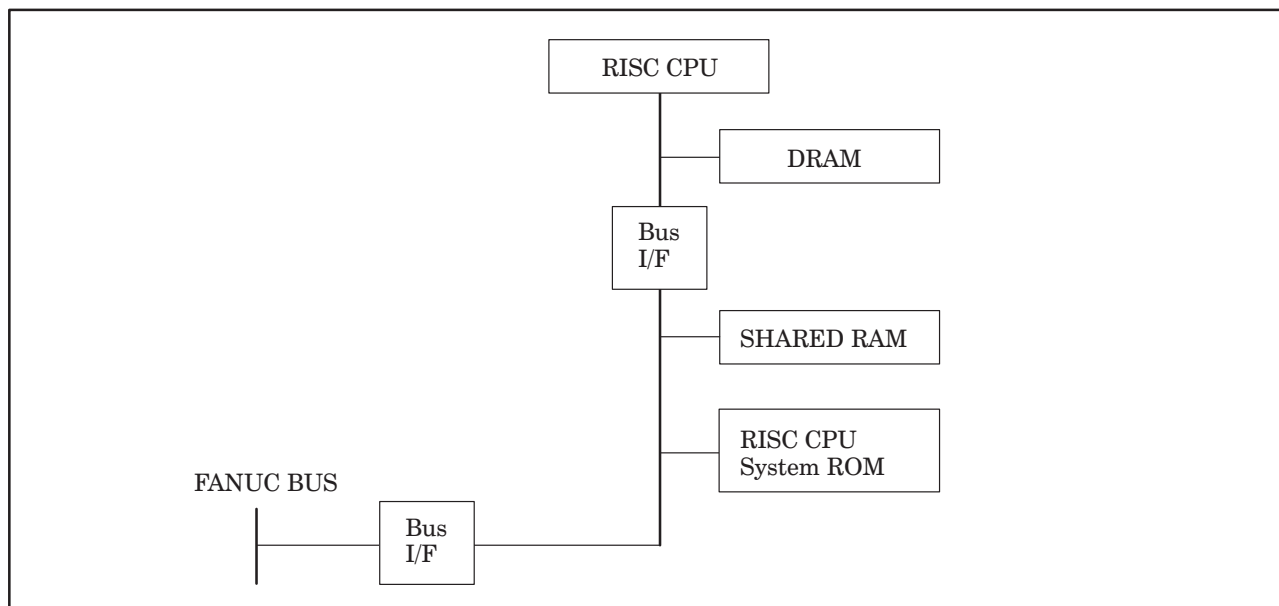
(1) Parts layout

Drawing number : A16B-2201-0710/02A and on



| No. | Module name | Function outline |
|-----|-------------|---------------------|
| 1 | SRAM module | For SHARED RAM |
| 2 | ROM module | Memory for RISC CPU |

(2) Block diagram



(3) Adjustment

No adjustment is needed.

(4) LED display

□ : Not lit ■ : Lit ★ : Blinking

STATUS LEDs are green. ALARM LEDs are red.

1. LED display when the power is turned on (Nos.1 to 8) and during operation (Nos. 9 to 12)
(STATUS LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | STATUS □□□□ | Power-off |
| 2 | STATUS ■■■■ | Immediately after power-on or the state in which the RISC CPU is not started |
| 3 | STATUS □□□■ | DRAM or SHARED RAM test in progress (If an error is detected during the test, this LED display is held and not changed.) |
| 4 | STATUS □□■□ | ROM test in progress (If an error is detected during the test, this LED display is held and not changed.) |
| 5 | STATUS ■□□□ | Waiting for the processing by the CNC (1) |
| 6 | STATUS ■□□■ | Waiting for the processing by the CNC (2) |
| 7 | STATUS ■□■□ | Waiting for the processing by the CNC (3) |
| 8 | STATUS ■■□□ | Waiting for the processing by the CNC (4) |
| 9 | STATUS □□□★ | Waiting for RISC mode |
| 10 | STATUS □★□★ | Waiting for the input of an NC statement |
| 11 | STATUS □★★□ | Executing a command in RISC mode |
| 12 | STATUS ★□□□ | Resetting |

2. LED display when an error occurs (STATUS LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | STATUS □□□■ | An error occurred during test of the DRAM or SRAM module (shared RAM) on the RISC board. |
| 2 | STATUS □□■□ | An error occurred during test of the ROM module. |
| 3 | STATUS □□■■ | A synchronization signal cannot be detected from the main CPU. |
| 4 | STATUS □■□□ | An error occurred during access to the F-bus. (The module ID cannot be read correctly.) |
| 5 | STATUS ■■■□ | A system error occurred. |

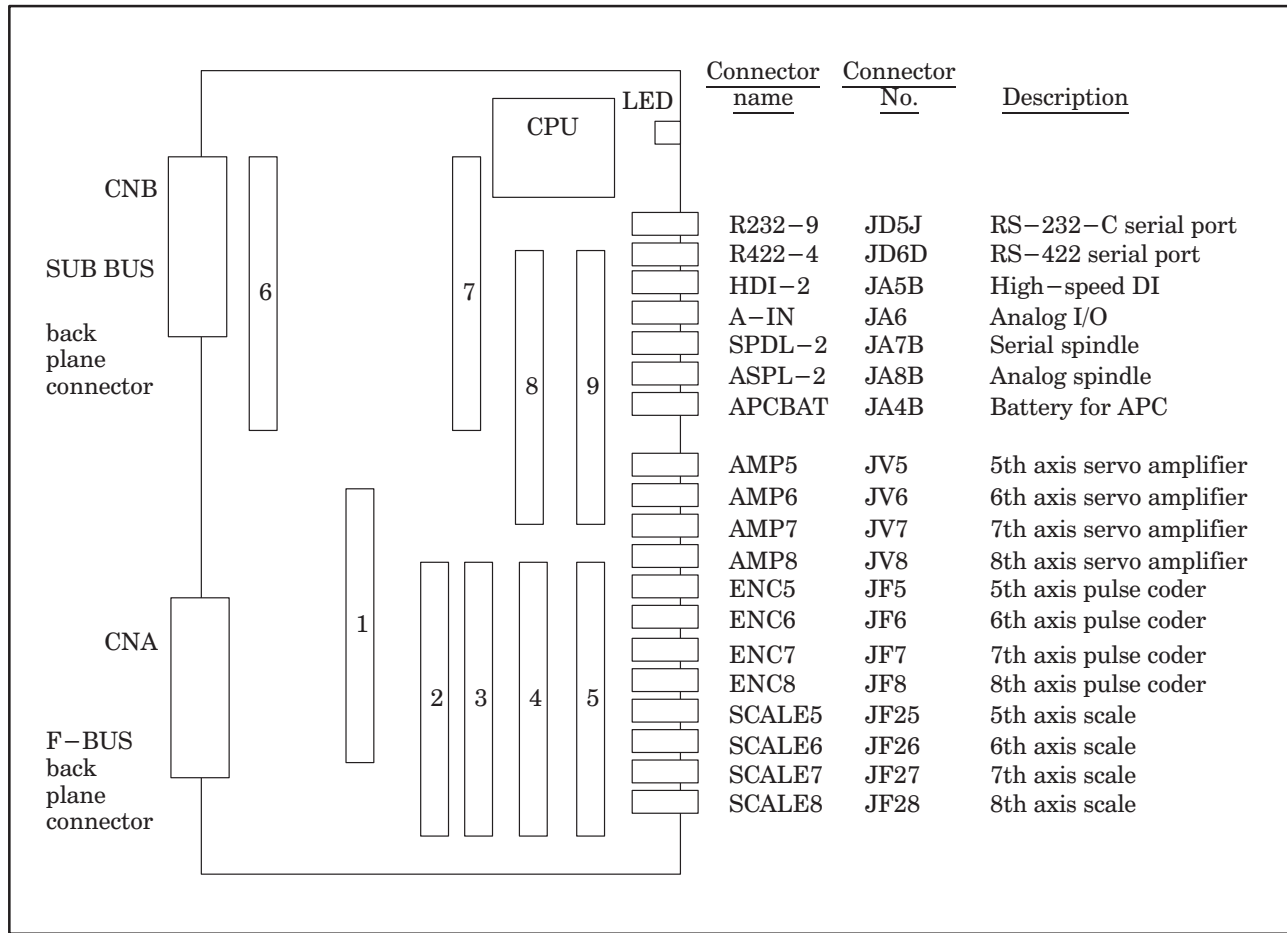
3. LED display when an error occurs (ALARM LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | ALARM ■□□ | The RISC CPU is not started. |
| 2 | ALARM □■□ | A parity alarm occurred in the SRAM module. |
| 3 | ALARM □□■ | A parity alarm occurred in the DRAM on the RISC board. |

7.12 Configuration of the Sub. CPU board (SUB-A)

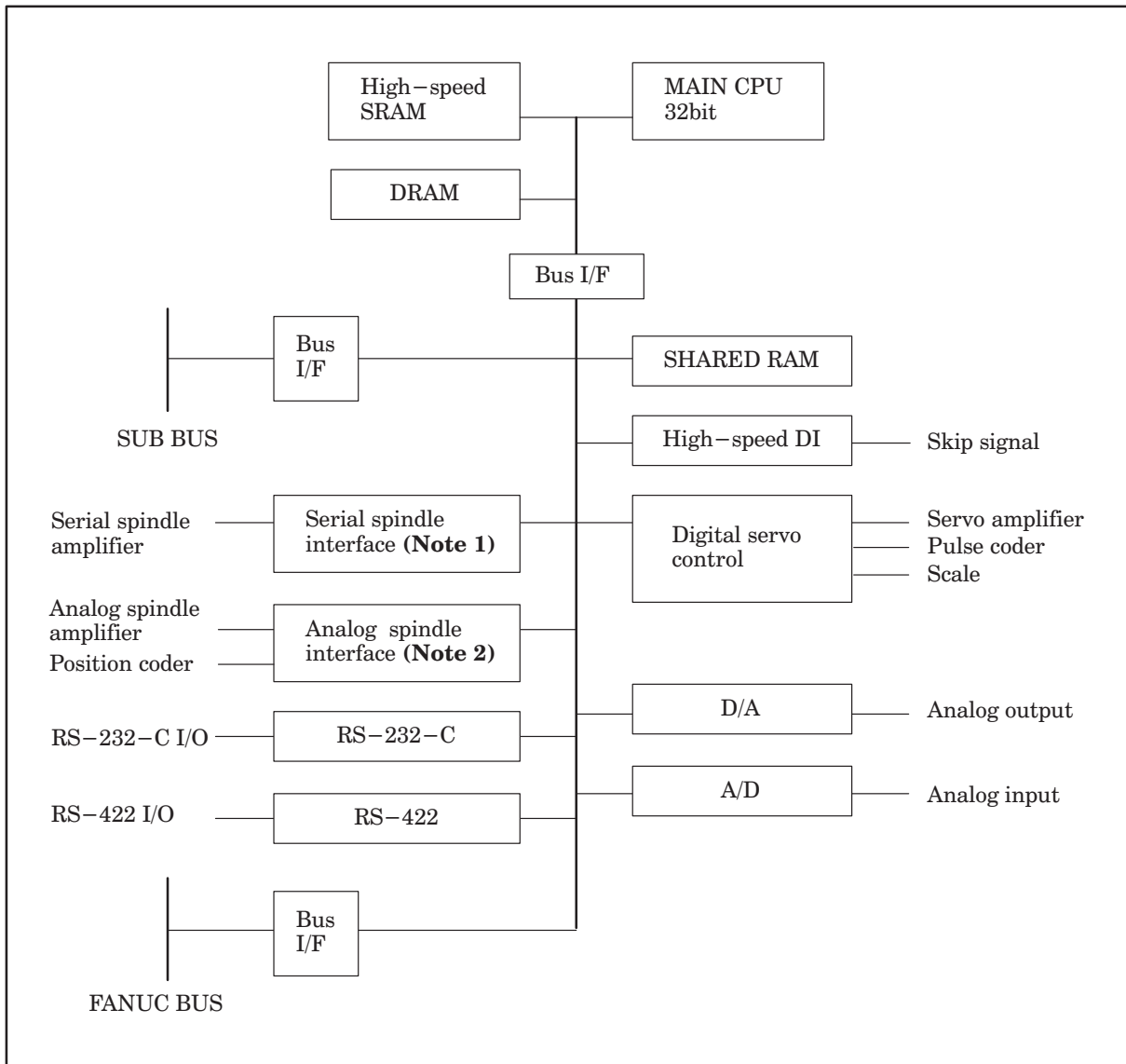
(1) Parts layout

Drawing number : A16B-2201-0310



| No. | Module name | Function outline |
|-----|--|---|
| 1 | SRAM module | For SHARED RAM |
| 2 | Servo control module | 7th and 8th servo control |
| 3 | Servo control module | 5th and 6th servo control |
| 4 | Servo interface module | 7th and 8th amplifier, pulse coder interface |
| 5 | Servo interface module | 5th and 6th amplifier, pulse coder interface |
| 6 | High-speed SRAM module | High-speed RAM for sub.system |
| 7 | DRAM module | RAM for sub.system |
| 8 | 2nd spindle control module | 2nd spindle control, HDI interface etc.... |
| 9 | Analog I/O & Serial communication module | Input/Output of analog, RS-232C, RS-422 interface |

(2) Block diagram



NOTE 1 When the module of analog spindle is built in as a module of spindle control, the serial spindle interface is not there.

NOTE 2 When a serial spindle module is mounted as the spindle control module, an analog spindle interface is not used.

(3) Adjustment

No adjustment is needed.

(4) LED display

□ : Not lit ■ : Lit ★ : Blinking

STATUS LEDs are green. ALARM LEDs are red.

1. LED display transition when the power is turned on (STATUS LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | STATUS □□□□ | Power-off |
| 2 | STATUS ■■■■ | Initial state immediately after power-on |
| 3 | STATUS ■□□■ | State in which the sub-CPU software is to be activated |
| 4 | STATUS □□□■ | Beginning of the activation of the sub-CPU software |
| 5 | STATUS ■■■□ | Beginning of the sub-CPU local RAM test |
| 6 | STATUS □■■□ | End of the sub-CPU local RAM test |
| 7 | STATUS ■□■□ | End of initialization of a custom LSI chip |
| 8 | STATUS □□■□ | Beginning of the internal processing of the sub-CPU |
| 9 | STATUS ■■□□ | Waiting for the processing by the main CPU (1) |
| 10 | STATUS □■□■ | Waiting for the processing by the main CPU (2) |
| 11 | STATUS ■□□□ | Normal state. The power-on sequence has ended. |

2. LED display when an error occurs (STATUS LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | STATUS ★□★★ | An error occurred in the local RAM of the sub-CPU. |
| 2 | STATUS □■■■ | A system error occurred. |

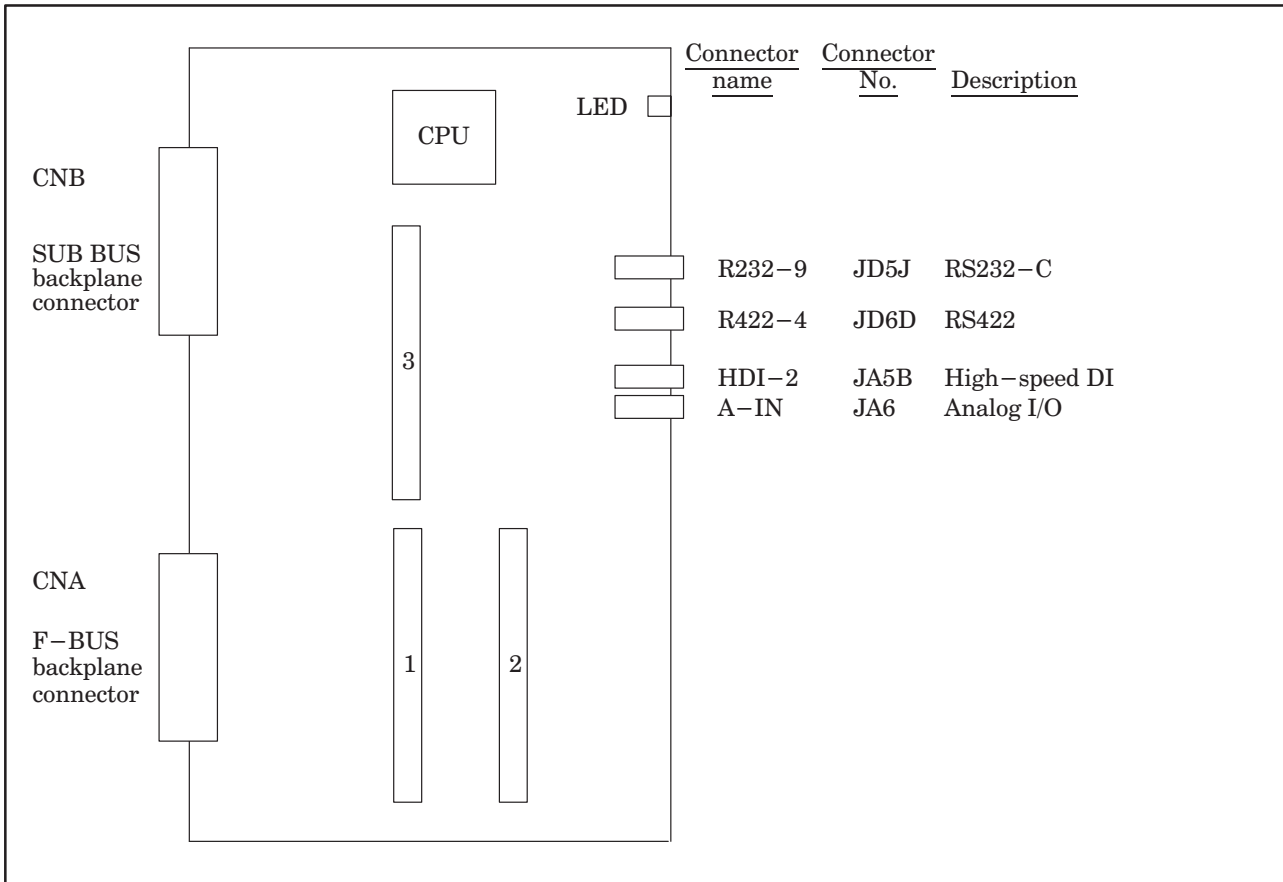
3. LED display when an error occurs (ALARM LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | ALARM ■□□ | The sub-CPU is not started. |
| 2 | ALARM □■□ | SYSFALL (fault in a module on the F-bus) occurred. |
| 3 | ALARM ■■□ | A servo alarm occurred. |
| 4 | ALARM □□■ | SYSEMG (NMI in a module on the F-bus) occurred. |
| 5 | ALARM ■□■ | An ABC alarm (parity alarm in shared RAM, fault in the peripheral bus, SUB bus, FANUC bus) occurred. |
| 6 | ALARM □■■ | A parity alarm occurred in the DRAM module. |
| 7 | ALARM ■■■ | A parity alarm occurred in the high-speed SRAM module. |

7.13 Configuration of the Standard Multiaxis Sub-CPU Board (MAX SUB-B)

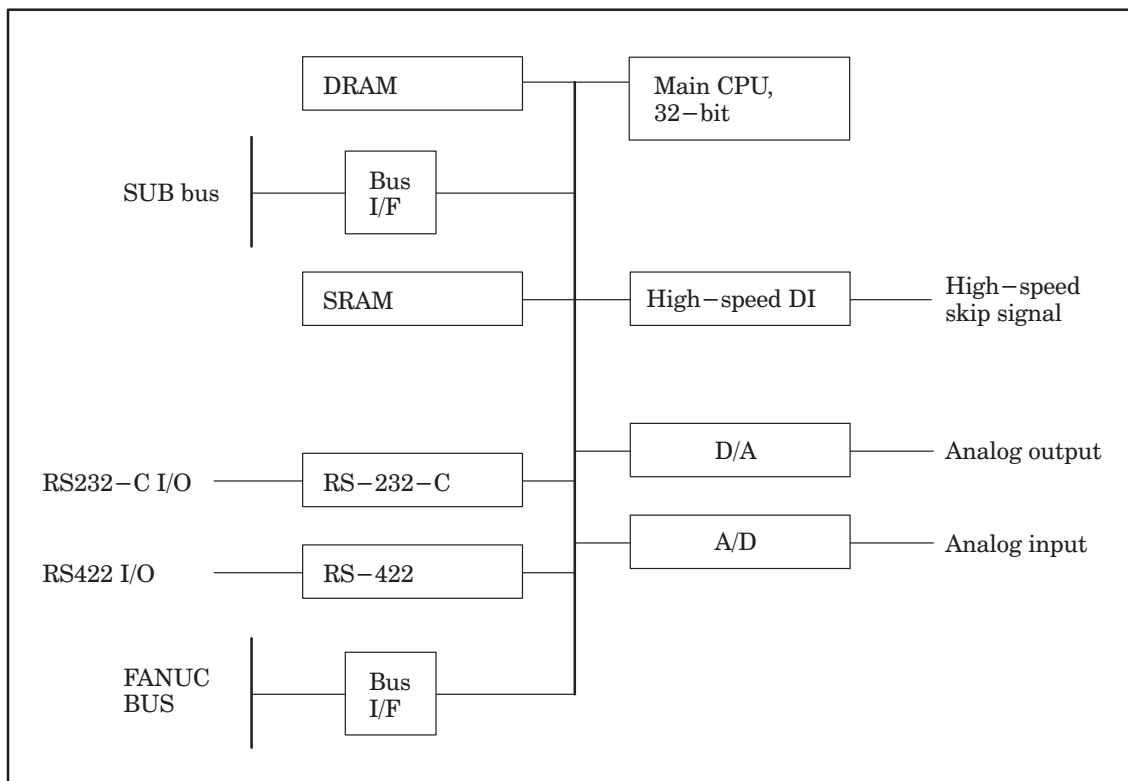
(1) Parts layout

Drawing number : A16B-2201-0331



| No. | Module name | Function outline |
|-----|--|---|
| 1 | SRAM module | For SHARED RAM |
| 2 | Analog I/O and serial communication module | Analog input/output, RS-232C and RS-422 interface |
| 3 | DRAM module | RAM for subsystem |

(2) Block diagram



(3) Adjustment

No adjustment is needed.

(4) LED display

□ : Not lit ■ : Lit ★ : Blinking

STATUS LEDs are green. ALARM LEDs are red.

1. LED display transition when the power is turned on (STATUS LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | STATUS □□□□ | Power-off |
| 2 | STATUS ■■■■ | Initial state immediately after power-on |
| 3 | STATUS ■□□■ | State in which the sub-CPU software is to be activated |
| 4 | STATUS □□□■ | Beginning of the activation of the sub-CPU software |
| 5 | STATUS ■■■□ | Beginning of the sub-CPU local RAM test |
| 6 | STATUS □■■□ | End of the sub-CPU local RAM test |
| 7 | STATUS ■□□□ | End of initialization of a custom LSI chip |
| 8 | STATUS □□■□ | Beginning of sub-CPU's internal processing |
| 9 | STATUS ■■□□ | Waiting for the processing by the main CPU (1) |
| 10 | STATUS □■□■ | Waiting for the processing by the main CPU (2) |
| 11 | STATUS ■□□□ | Normal state. The power-on sequence is ended |

2. LED display when an error occurs (STATUS LED)

| No. | LED display | NC status |
|-----|--------------|--|
| 1 | STATUS ★□★★ | An error occurred in the local RAM of the sub-CPU. |
| 2 | STATUS □■■■■ | A system error occurred. |

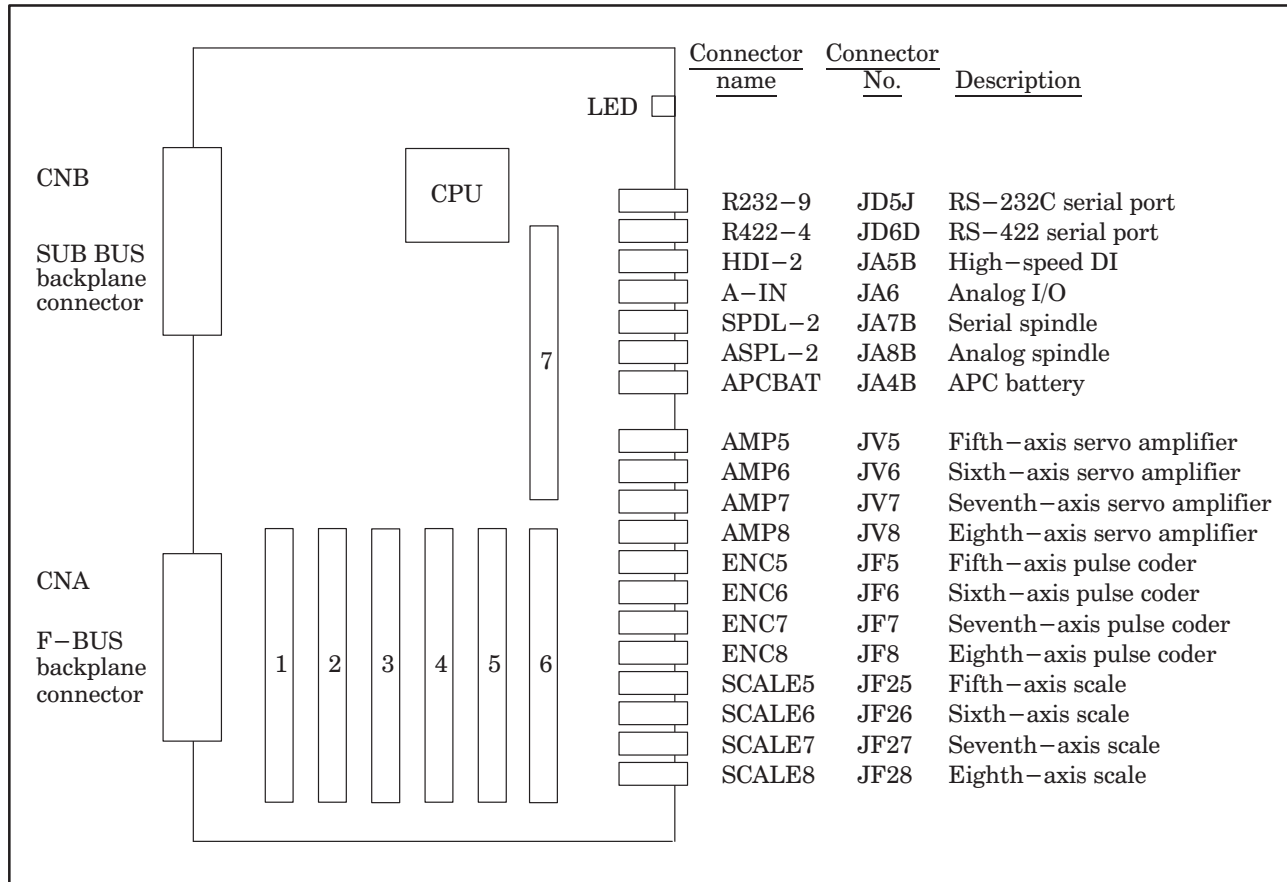
3. LED display when an error occurs (ALARM LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | ALARM □■□ | SYSFAIL (fault in a module on the F-bus) occurred. |
| 2 | ALARM ■■□ | A servo alarm occurred. |
| 3 | ALARM □□■ | SYSEMG (NMI in a module on the F-bus) occurred. |
| 4 | ALARM ■□■ | An ABC alarm (parity alarm in the shared RAM, fault in the peripheral bus, SUB bus, FANUC bus) occurred. |
| 5 | ALARM □■■ | A parity alarm occurred in the DRAM module. |

7.14 Configuration of the Upgraded Sub-CPU Board (SUB-C)

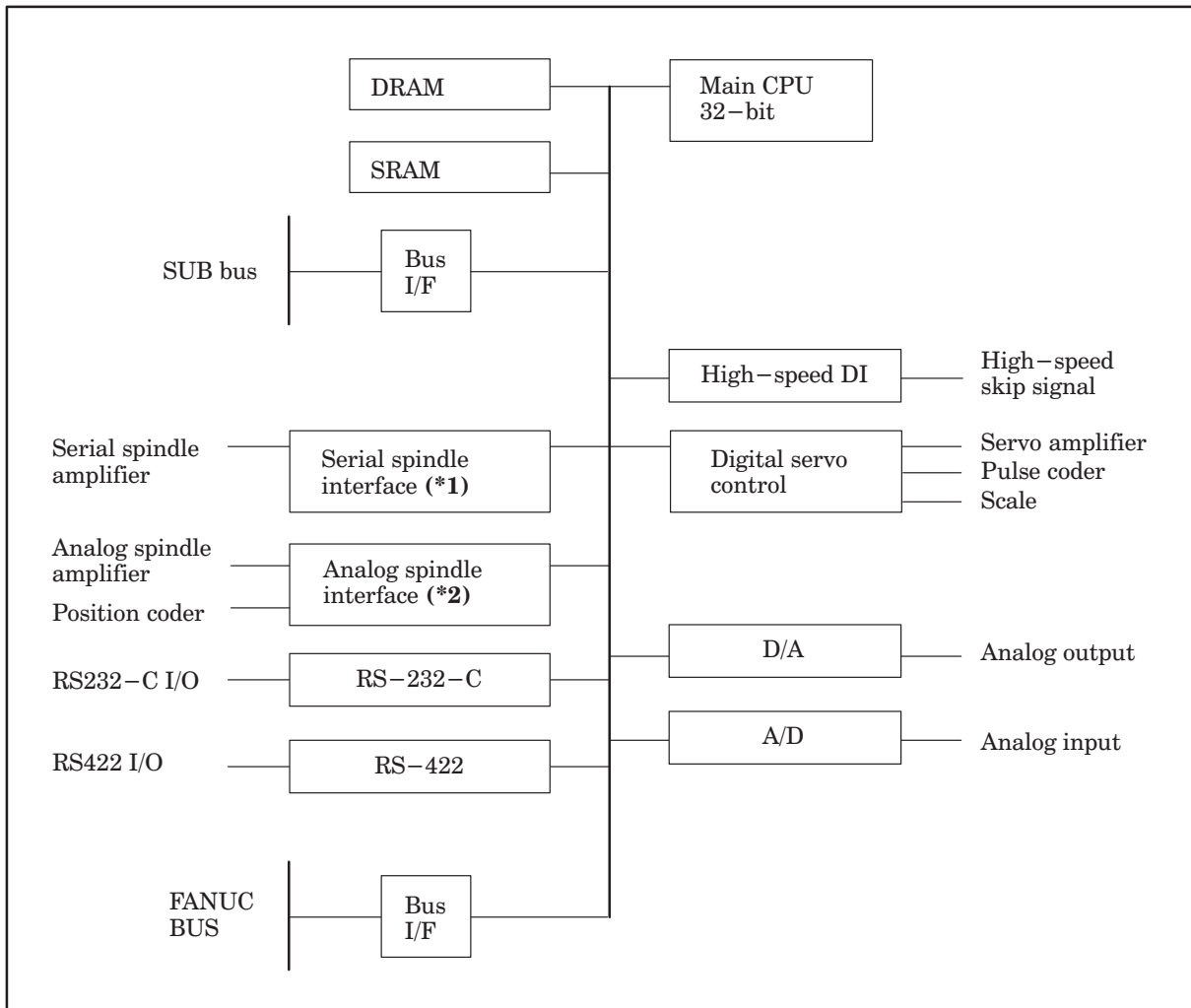
(1) Parts layout

Drawing number : A16B-2202-0571



| No. | Module name | Function outline |
|-----|--|---|
| 1 | Analog I/O & serial communication module | Analog input/output, RS-232C and RS-422 interface |
| 2 | Second spindle control module | Second spindle control, HDI interface, etc. |
| 3 | Servo control module | Seventh-axis and eighth-axis servo control |
| 4 | Servo control module | Fifth-axis and sixth-axis servo control |
| 5 | Servo interface module | Seventh-axis and eighth-axis servo amplifier, pulse coder interface |
| 6 | Servo interface module | Fifth-axis and sixth-axis servo amplifier, pulse coder interface |
| 7 | DRAM module | RAM for subsystem |

(2) Block diagram



NOTE 1 If the analog spindle module is mounted as the spindle control module, the serial spindle interface is not included.

NOTE 2 If the serial spindle module is mounted as the spindle control module, the analog spindle interface is not included.

(3) Adjustment

No adjustment is needed.

(4) LED display

□ : Not lit ■ : Lit ★ : Blinking

STATUS LEDs are green. ALARM LEDs are red.

1. LED display transition when the power is turned on (STATUS LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | STATUS □□□□ | Power-off |
| 2 | STATUS ■■■■ | Initial state immediately after power-on |
| 3 | STATUS ■□□■ | State in which the sub-CPU software is to be activated |
| 4 | STATUS □□□■ | Beginning of the activation of the sub-CPU software |
| 5 | STATUS ■■■□ | Beginning of the sub-CPU local RAM test |
| 6 | STATUS □■■□ | End of the sub-CPU local RAM test |
| 7 | STATUS ■□■□ | End of initialization of a custom LSI chip |
| 8 | STATUS □□■□ | Beginning of the sub-CPU's internal processing |
| 9 | STATUS ■■□□ | Waiting for the processing by the main CPU (1) |
| 10 | STATUS □■□■ | Waiting for the processing by the main CPU (2) |
| 11 | STATUS ■□□□ | Normal state. The power-on sequence has ended. |

2. LED display when an error occurs (STATUS LED)

| No. | LED display | NC status |
|-----|-------------|--|
| 1 | STATUS ★□★★ | An error occurred in the local RAM of the sub-CPU. |
| 2 | STATUS □■■■ | A system error occurred. |

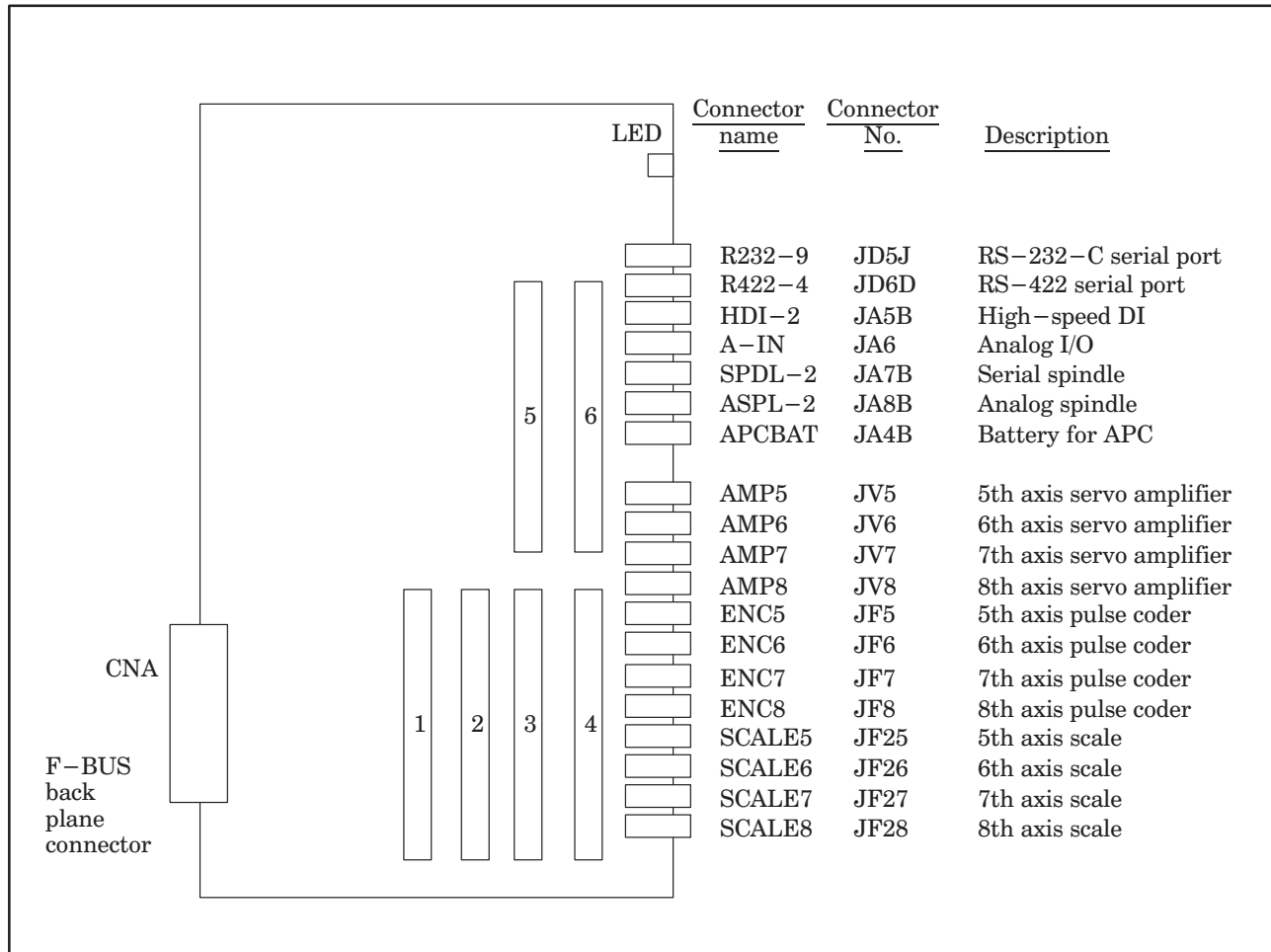
3. LED display when an error occurs (ALARM LED)

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | ALARM ■□□ | The sub-CPU has not started. |
| 2 | ALARM □■□ | SYSFAIL (fault in a module on the F-bus) occurred. |
| 3 | ALARM ■■□ | A servo alarm occurred. |
| 4 | ALARM □□■ | SYSEMG (NMI in a module on the F-bus) occurred. |
| 5 | ALARM ■□■ | An ABC alarm (fault in the peripheral bus, FANUC bus) occurred. |
| 6 | ALARM □■■ | A parity alarm occurred in the DRAM module. |
| 7 | ALARM ■■■ | A parity alarm occurred in the SRAM mounted on the sub-CPU. |

7.15 Configuration of additional axis (ADAX) board

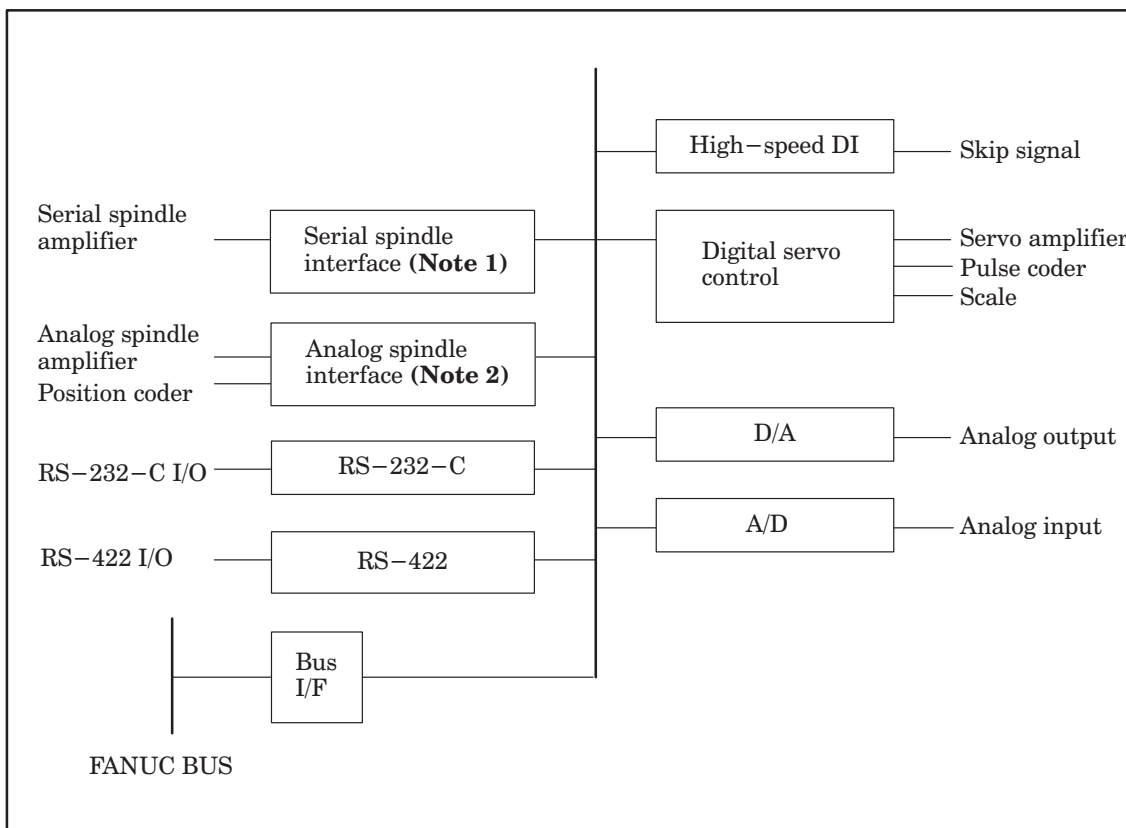
(1) Parts layout

Drawing number : A16B-2201-0311



| No. | Module name | Function outline |
|-----|---|---|
| 1 | Servo control module | 7th and 8th servo control |
| 2 | Servo control module | 5th and 6th servo control |
| 3 | Servo interface module | 7th and 8th amplifier, pulse coder interface |
| 4 | Servo interface module | 5th and 6th amplifier, pulse coder interface |
| 5 | 2nd spindle control module | 2nd spindle control, HDI interface etc.... |
| 6 | Analog I/O & serial communications module | Input/Output of Analog, RS-232C, RS-422 interface |

(2) Block diagram



NOTE 1 When the module of analog spindle is built in as a module of spindle control, the serial spindle interface is not there.

NOTE 2 When a serial spindle module is mounted as the spindle control module, an analog spindle interface is not used.

(3) Adjustment

No adjustment is needed.

(4) LED display

□ : Off ■ : Lit ★ : Flashing

The STATUS LEDs are green and the ALARM LEDs are red.

LED display when an error occurs (ALARM LED)

| No. | LED display | NC status |
|-----|-------------|---|
| 1 | ALARM ■□□ | Not used |
| 2 | ALARM □■□ | SYSFAIL (A fault occurred on some modules of F-BUS.) |
| 3 | ALARM ■■□ | SERVO ALARM |
| 4 | ALARM □□■ | SYSEMG (NMI occurred on some modules of F-BUS.) |
| 5 | ALARM ■□■ | ABC ALARM (PARITY ALARM on SHARED RAM, A fault of peripheral bus) |
| 6 | ALARM □■■ | Not used |
| 7 | ALARM ■■■ | Not used |

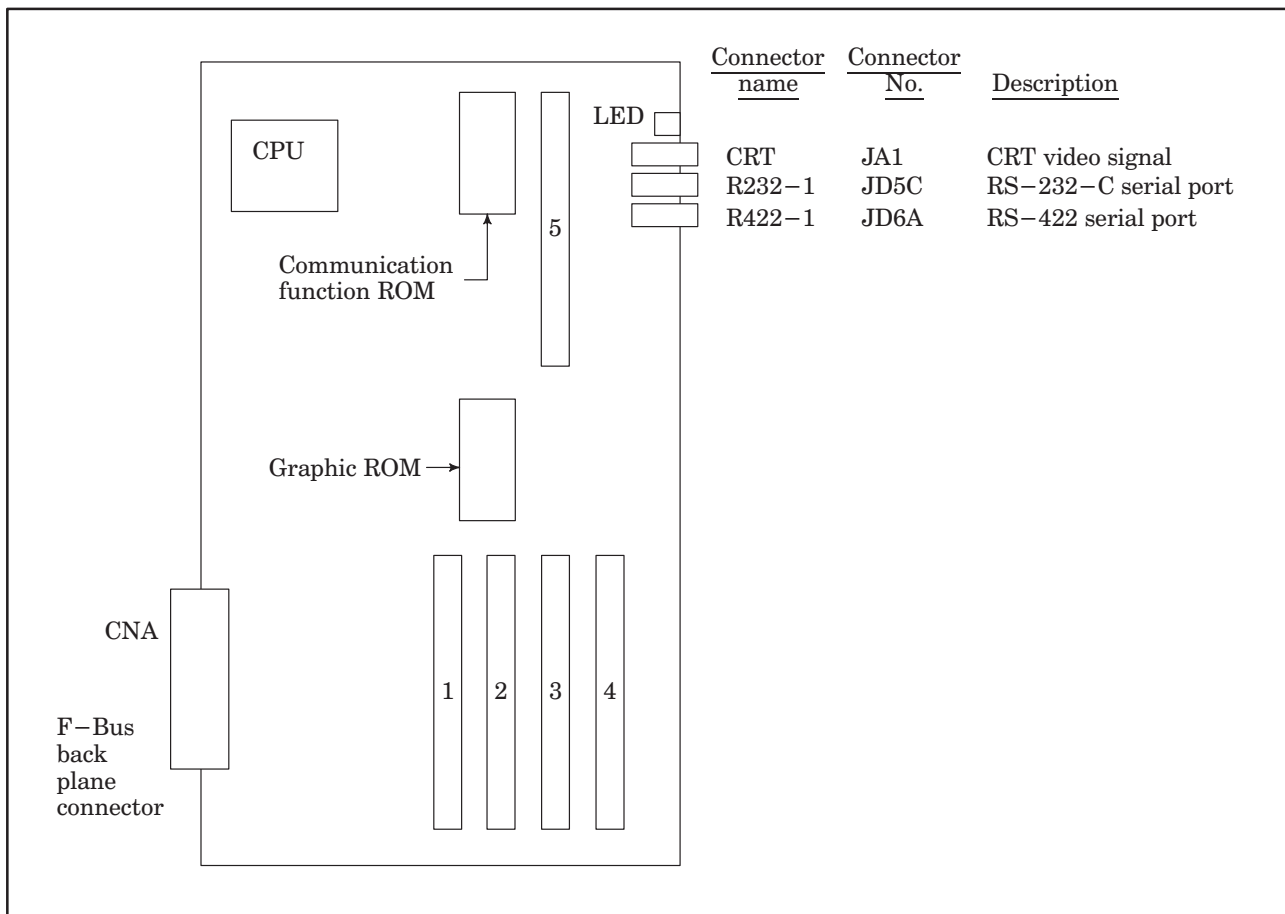
NOTE All the STATUS LED is always off

7.16 Configuration of the option 1 board

(1) Parts layout

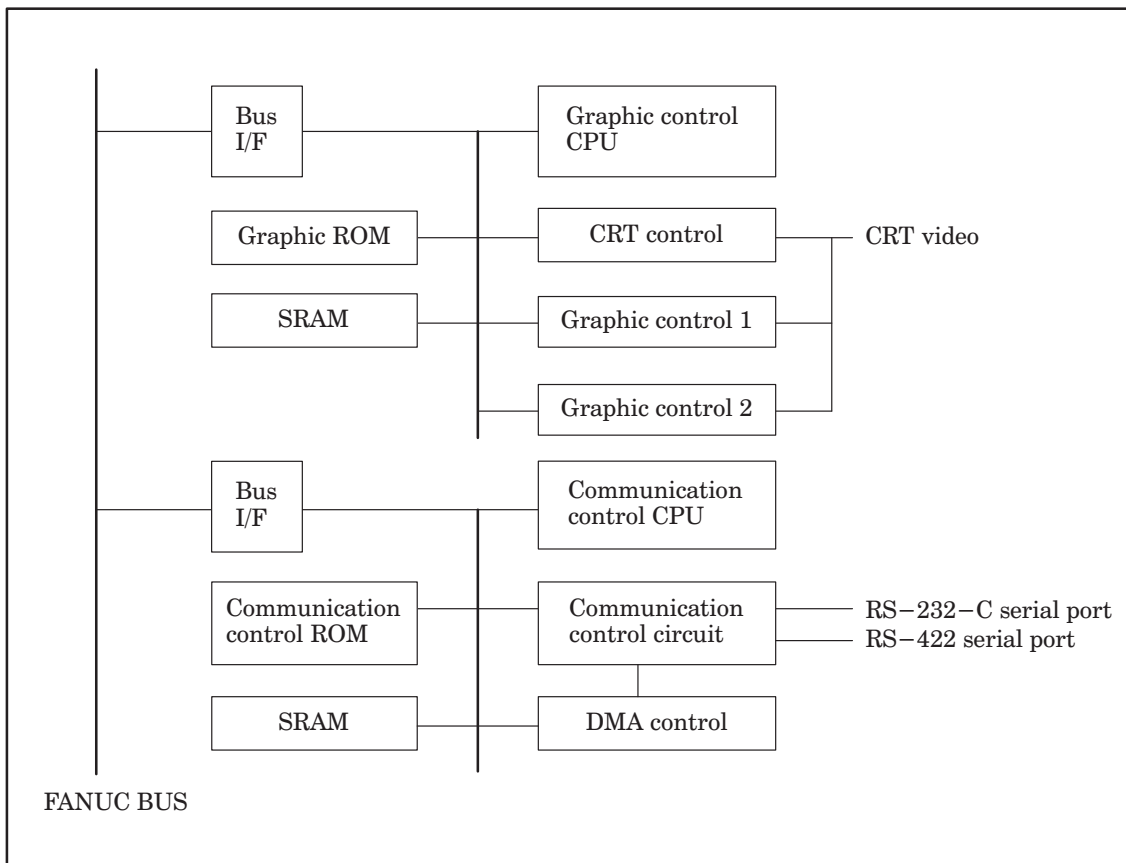
- Drawing number : A16B-2200-0910 (Remote buffer communication function+Graphic function)
 : A16B-2200-0911 (DNC1 communication function+Graphic function RAM added)
 : A16B-2200-0912 (Graphic function)
 : A16B-2200-0913 (Remote buffer communication function)
 : A16B-2200-0914 (DNC1 communication function)
 : A16B-2200-0915 (Remote buffer communication function+Graphic function RAM added)
 : A16B-2200-0916 (DNC1 communication function+*Graphic function RAM added)
 : A16B-2200-0917 (Graphic function RAM added)
 : A16B-2200-0918 (Remote buffer communication function+*Graphic function RAM added)
 : A16B-2200-0919 (*Graphic function RAM added)

* : For MMC-IV or 9.5"LCD



| No. | Module name | Function outline |
|-----|------------------------------|--|
| 1 | Graphic CPU module | Graphic display control CPU |
| 2 | Graphic engine module | Graphic display control circuit (No.2) Add in case of CAP II of FS15-TT. |
| 3 | Graphic engine module | Graphic display control circuit (No.1) |
| 4 | CRT control module | Character display control circuit for 9" CRT Character display control circuit for 10" LCD Character display control circuit for 14" CRT |
| 5 | Communication control module | Serial communication control, DMA control |

(2) Block diagram



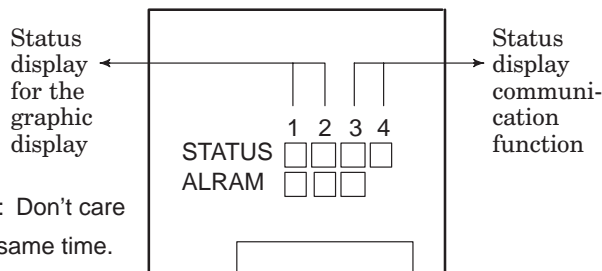
(3) Adjustment

No adjustment is needed.

(4) LED display

The STATUS LEDs in the front upper section of the option board are used for two independent functions as shown in the figure on the right.

- : Off ■ : Lit ★★ : Flashing ◆ : Don't care
- ★★ means both of LED are flashing at the same time.
- ★☆ means both of LED are flashing alternately.



(a) LED display of graphic display function

1. LED display transition when the power is turned on

| No. | LED display | NC status |
|-----|--------------------------|---|
| 1 | STATUS ■■■■ ALARM ■□□ | Startup status immediately after the power is turned on. |
| 2 | STATUS □■◆◆ ALARM □□□ | Waiting for setting each processor of ID in the system. |
| 3 | STATUS ■□◆◆ ALARM □□□ | Waiting for initialization of each processor in the system. |
| 4 | STATUS □□◆◆ ALARM □□□ | The initialization of graphic display function is completed and on executing. |

2. LED display when an error occurs

| No. | LED display | NC status |
|-----|---|---|
| 1 | STATUS <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | ROM parity error occurs. Change graphic ROM. |
| 2 | STATUS <input checked="" type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | RAM parity error occurs. Change option 1 board. |
| 3 | STATUS <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | Command error occurs. Change option 1 board. |
| 4 | STATUS <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | NMI from other boards. Check LED display of other boards. |
| 5 | STATUS <input checked="" type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | Bus error (Wrong memory access) occurs. Change option 1 board. |
| 6 | STATUS <input checked="" type="checkbox"/> y <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | Division error occurs. Change option 1 board. |
| 7 | STATUS <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | Incorrect interruption occurs. Change option 1 board. |

(b) Communication function (Display of remote buffer)

1. LED display transition when the power is turned on

| No. | LED display | NC status |
|-----|---|--|
| 1 | STATUS <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | Startup status immediately after power is turned on or remote buffer CPU is not executing. |
| 2 | STATUS <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | Initialization of remote buffer is beginning. |
| 3 | STATUS <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | Initialization of remote buffer is completed and status of waiting for command from CNC. |
| 4 | STATUS <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | Command is executed. |
| 5 | STATUS <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | On closing (After closing, back to the status of No.3.) |

2. LED display when an error occurs

| No. | LED display | NC status |
|-----|--|---|
| 1 | STATUS <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | ROM parity alarm occurred. |
| 2 | STATUS <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | RAM error of test |
| 3 | STATUS <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | A fault occurred in the remote buffer. (BUS ERROR, illegal interruption etc....) |
| 4 | STATUS <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> | NMI from other boards |
| 5 | STATUS <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> ALARM <input checked="" type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> | Parity alarm occurred on the work RAM of remote buffer. |

- ALARM LED (red LED) display when an error occurs

The FANUC Series 15-B has many monitoring circuits that constantly check whether the processor itself is operating normally and whether the signals are being normally transferred between processors. If an error occurs, the CNC can stop the operation because of these circuits. On the other hand, an error on a PC board may result in the activation of a monitoring circuit on the main board or sub-board. If this occurs, the ALARM LED (red LED) on the main board or sub-board may light, even though no error has occurred on the PC board.

The tables below list the ALARM LED statuses when an error occurs on the main board or on a sub-board:

ALARM LED display when an error occurs (when the main CPU is MAIN-A or MAIN-B)

| Main board | Sub-board | Description |
|--|--|--|
| <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> SYSEMG. | <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> SYSEMG. | An NMI error occurred on the PMC, remote buffer, or a PC board other than the main board or sub-board on the F-bus. The power supply unit supplies a lower-than-normal voltage. |
| <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> SERVO ALARM | <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> SYSFAIL | An error occurred in the servo module on the main board. The software detected an error on a PC board on the F-bus. |
| <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> SYSEMG. | <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> SERVO ALARM | An error occurred in the servo module of the sub-board. |

ALARM LED display when an error occurs (when the main CPU is MAIN-C)

| Main board | Sub-board | Description |
|--|--|--|
| <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> SYSFAIL | <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> SYSFAIL | The software detected an error on a PC board on the F-bus. |
| <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> SYSEMG. | <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> SYSEMG. | An NMI error occurred on the PMC, remote buffer, or a PC board other than main board or sub-board on the F-bus. The power supply unit supplies a lower-than-normal voltage. |
| <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> SERVO ALARM | <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> SYSFAIL | An error occurred in the servo module on the main board. |
| <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> SYSFAIL or <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> SYSEMG. | <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> SERVO ALARM | An error occurred in the servo module on the sub-board. |

8. HOW TO REPLACE FUSES, PRINTED CIRCUIT BOARDS, AND OTHER UNITS

8.1 How to Replace the Fuses in the Power Supply Unit

- (1) Check whether any of the fuses located the front panel of the power supply unit have blown. Each fuse has a small window in which a white marker appears when the fuse has blown.
- (2) If any of the fuses has blown, correct the condition which caused the fuse to blow.
- (3) Remove the blown fuses and insert the new fuses.
- (4) If the green PIL LED does not come on even though power is being supplied to AC connector CP1 of the power supply unit, fuse F5 in the power unit may have blown. As described in section 8.2, take out the power unit and replace fuse F5. (Make sure to turn off the AC power source before the replacement.)

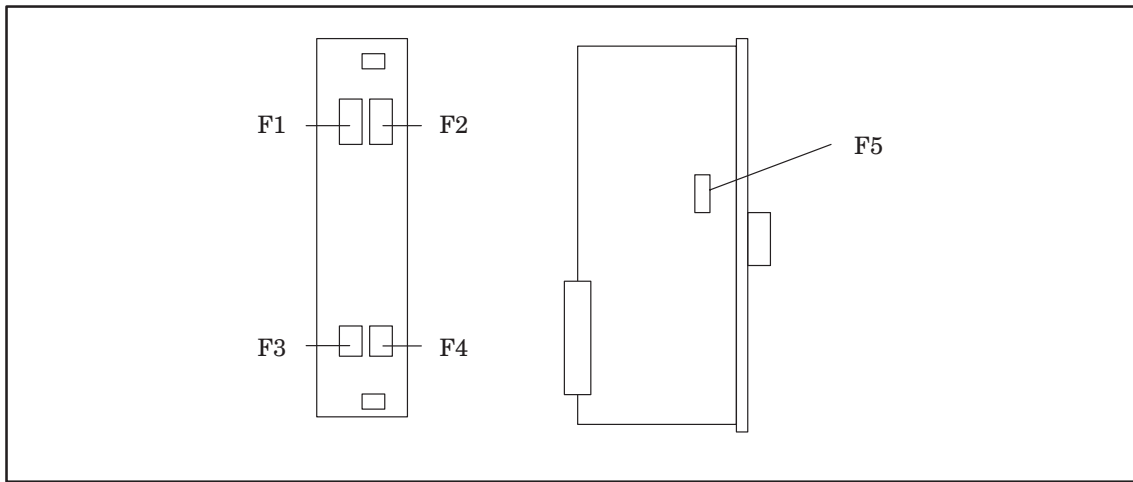


Fig. 8.1 Location of Fuses in the Power Supply Unit

Table 8.1 Table of Fuses

| Unit name | Part No. | Capacity | Specification | Description | |
|-------------------|----------|----------|---------------|----------------------|--|
| Power supply unit | AI | F1, F2 | 7.5A | A60L-0001-0245#GP75 | For 200 VAC power supply |
| | | F3 | 3.2A | A60L-0001-0075#3.2 | +24 V for use with a 9" monochrome CRT, the main CPU board, and optional printed circuit board |
| | | F4 | 5A | A60L-0001-0046#5.0 | For protection of the +24 E line in the machine tool from outside faults |
| | | F5 | 0.3A | A60L-0001-0290#LM03 | For the power supply unit |
| | BI | F1, F2 | 10A | A60L-0001-0245#GP100 | For 200 VAC power supply |
| | | F3 | 5A | A60L-0001-0075#5.0 | +24 V for use with a 9" monochrome CRT, the main CPU board, and optional printed circuit board |
| | | F4 | 5A | A60L-0001-0046#5.0 | For protection of the +24 E line in the machine tool from outside faults |
| | | F5 | 0.3A | A60L-0001-0290#LM03 | For the power supply unit |

8.2 How to Replace the Power Supply Unit

- (1) Make sure that the incoming AC power to the power supply unit is turned off.
- (2) Disconnect all cables connected to the power supply unit. Pinch the connectors to release the latches and withdraw the connectors.
- (3) Push down the top hand grip and push up the bottom hand grip on the front panel of the power supply unit. This releases the hand grip latches from the control unit rack. Now, remove the power supply unit from the control unit rack.
- (4) Insert the new power supply unit into the rightmost slot in the control unit rack. Push the power supply in gently until the latches lock.
- (5) Reconnect the cables to their original positions.

NOTE The power supply unit contains a battery for CNC memory backup. If the power supply unit is disconnected for longer than the specified period, the contents of CNC memory will be lost.

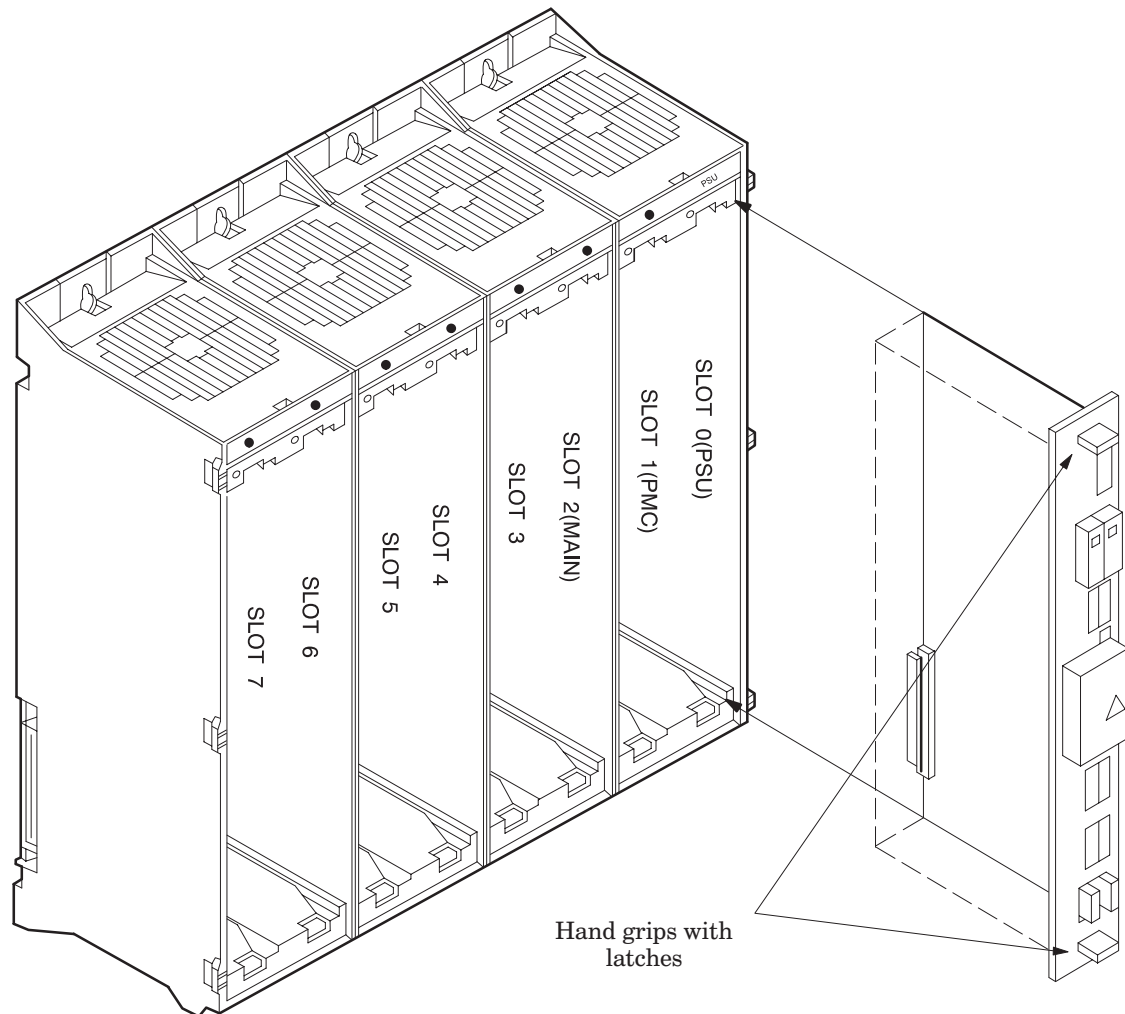


Fig. 8.2 Diagram of the Power Supply Unit

8.3 How to Replace the Printed Circuit Boards in the Control Unit

- (1) Make sure that the power supply unit is turned off.
- (2) Disconnect all cables connected to the printed circuit board in the control unit. Pinch the 20-pin half-pitch connector to release the latch. Withdraw the connector.
- (3) Push down the top hand grip and push up the bottom hand grip on the front panel of the printed circuit board. This releases the handgrip latches from the control unit rack. Now, remove the printed circuit board from the control unit.
- (4) Insert the new printed circuit board into the slot of the control unit rack. Push the printed circuit board in gently until the latches lock.
- (5) Reconnect the cables to their original positions.

NOTE To disconnect a PC board with memory which is backed up for replacement or other purposes (see Chapter 7), briefly turn the power on, then off again, immediately before disconnecting the board, and replace the PC board quickly. If the PC board is left disconnected for too long, the contents of CNC memory will be lost. If the PC board is disconnected without first turning the power on and off, the contents of CNC memory may be lost as soon as the board is disconnected.

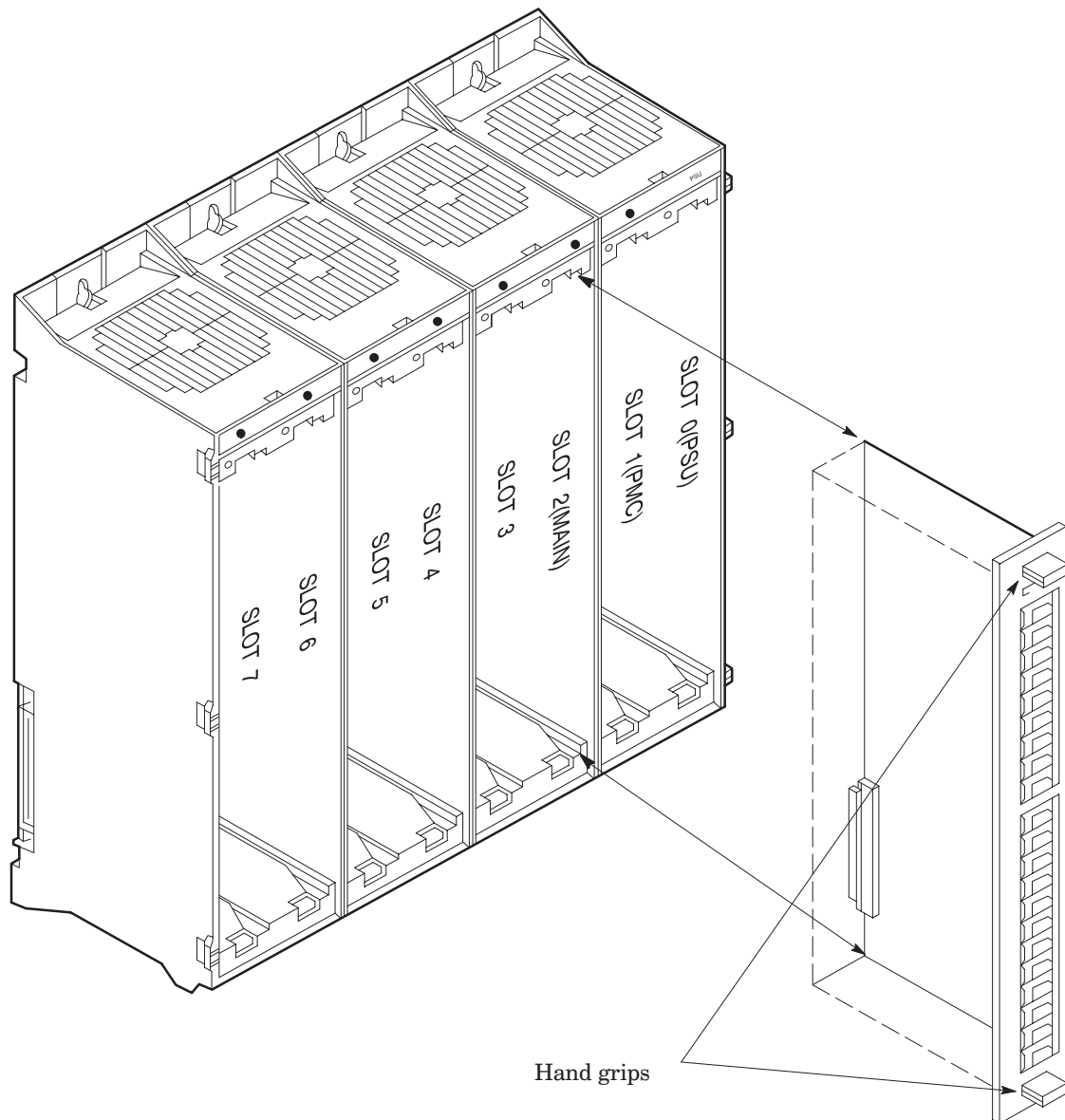
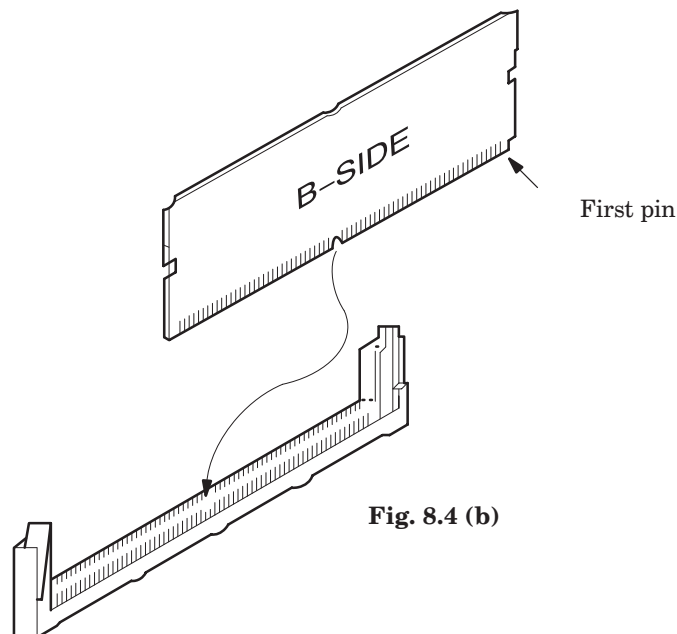
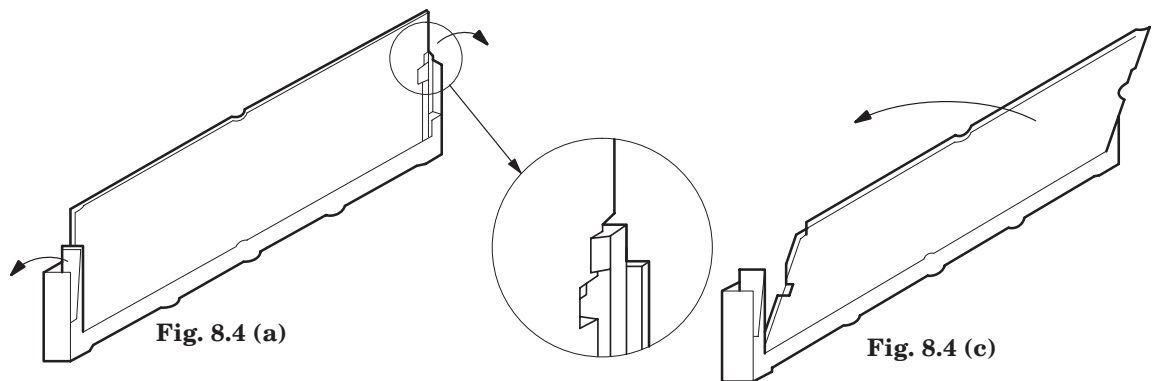


Fig. 8.3 Diagram of the Control Unit Printed Circuit Board

8.4 How to Replace the Modules

- (1) By pulling the latches located at both lengthwise edges of the module socket outwards, the module board will fall out diagonally due to pressure from the contact springs. (Refer to Fig. 8.4(a).)
- (2) When a leaning module board is touching a neighboring board, it may be difficult to remove. When this occurs, release the latches of the board being touched (as described in step (1)).
- (3) Now the module board is completely disconnected from the socket. Gently pull the module board straight (in the direction the board is leaning) out of the socket. Be careful when removing the module board since any kind of wrenching motion may cause damage to the socket or module contacts.
- (4) Insert the new module board diagonally into the socket. Insert the module board firmly until it is touching the bottom of the socket slot. (Refer to Fig. 8.4(b).)
- (5) While pushing on the upper edge of the module board, raise it until it is standing perpendicularly. (Refer to Fig. 8.4(c).)
- (6) Make sure that the latches at both ends of the module board are tightly locked. It is very important that the latches be locked properly. Insufficiently locked latches may result in a bad connection which in turn can lead to NC equipment operation errors.



8.5 How to Replace the Batteries

8.5.1 Procedure for replacing the dry cell for the control unit (memory back-up)

- (1) Use a lithium battery (ordering information : A02B-0120-K106).
- (2) Turn the machine (NC) power ON. (The battery can be replaced while the NC power is either on or off. To replace the battery while the NC power is off, briefly turn the NC power on and off beforehand and complete the replacement quickly. If the battery is left disconnected for too long while the NC power is off, the contents of NC memory will be lost.)
- (3) Remove the battery case on the front panel of the power unit. Hold and squeeze the top and bottom of the case while pulling it towards you.

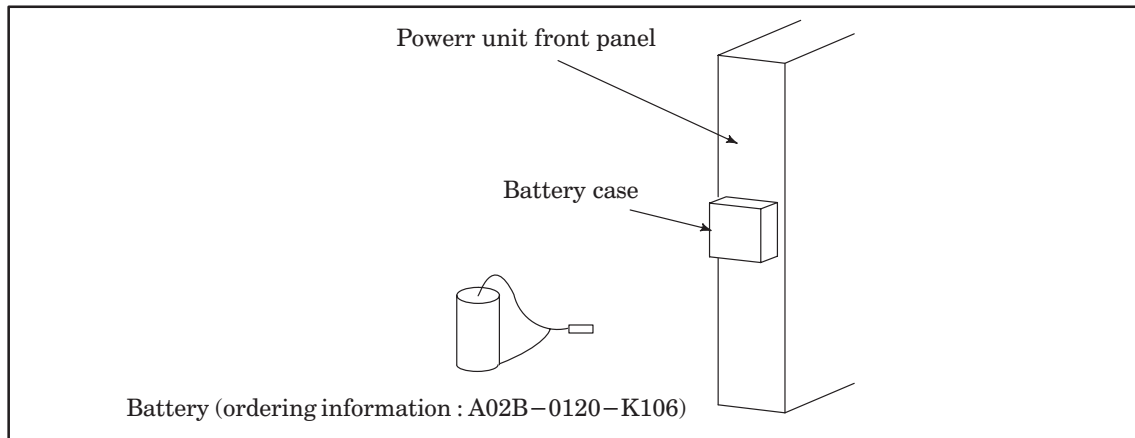


Fig. 8.5.1 (a) Battery(1)

- (4) Remove the connector attached to the battery.

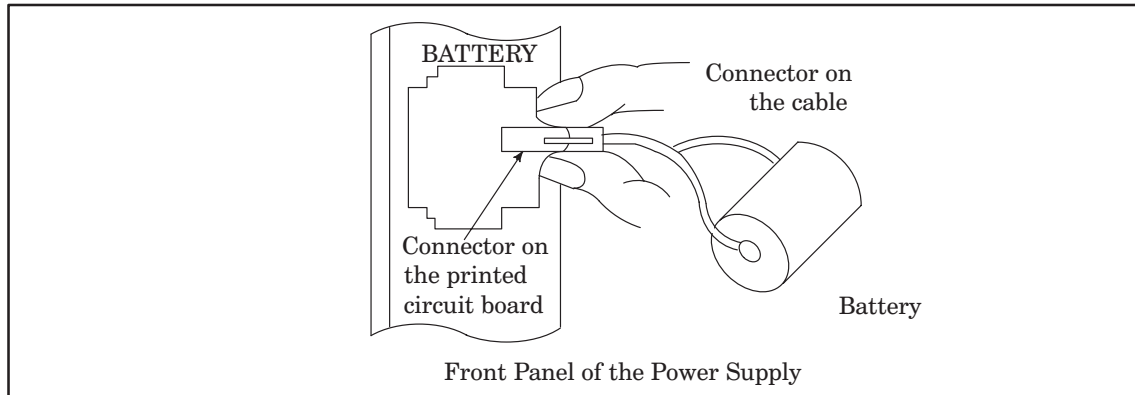


Fig. 8.5.1 (b) Battery(2)

- (5) Change the battery and reattach the connector.
- (6) Put the battery case back on.
- (7) Turn the machine (NC) power OFF.

8.5.2 Procedure for replacing the dry cell for the absolute pulse coder

- (1) Have 4 commercially available dry cell batteries ready.
- (2) Turn the machine (NC) power ON. (Change the batteries with the NC power ON. The recorded absolute position value will be lost if the batteries are changed with the power OFF.)
- (3) Loosen the battery case lid screws and remove the lid.
Refer to the machine tool builders' reference manuals for the location of the battery case.
- (4) Change the dry cell batteries in the case. Take care to place the batteries facing in the correct direction. (Insert the batteries as shown in the diagram with 2 facing one way and 2 the other.)

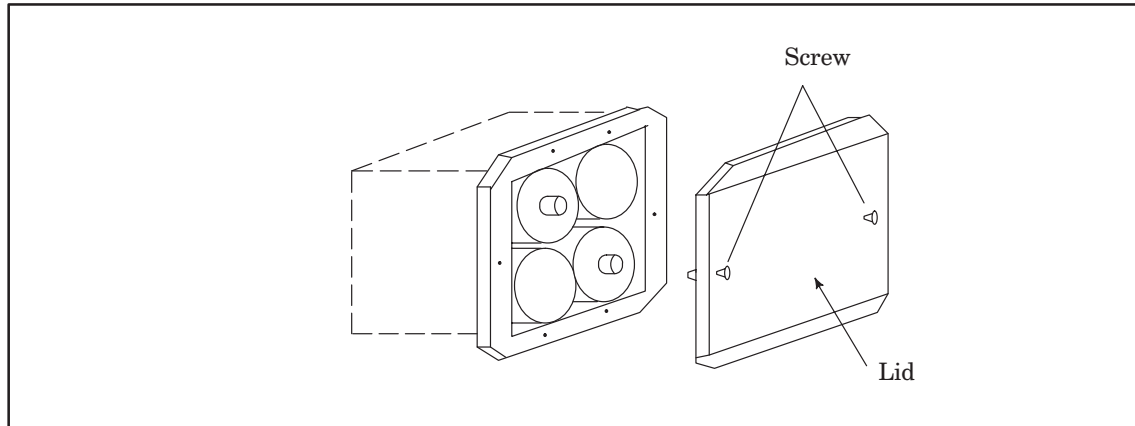


Fig. 8.5.2 Alkali Battery

- (5) Having exchanged the batteries put the lid back on.
- (6) Turn the machine (NC) power OFF.

8.6 How to Replace the Fan Motor

- (1) Remove the control section printed circuit board underneath the fan to be replaced by referring to the removal procedure described in section 8.3.
- (2) There is a backplane inside the slot. The fan motor cable coming from above is connected to the backplane. Grasp the left and right side of the cable connector attached to the backplane and remove it.
- (3) Opening the upper lid of the control section rack Insert a phillips head screwdriver into the hole at the center front of the lid. The latch holding the cover in place can be released by prying the screwdriver in the direction shown in item (3) of Fig. 8.6.
- (4) Open the lid sufficiently and remove the fan motor. Since the fan itself is not screwed into the rack, it can be easily removed.
- (5) Install the new fan motor. Guide the fan motor cable through the hole and into the rack.
- (6) Close the lid until the latch locks.
- (7) Attach the fan motor cable to the connector on the back plane. At this time, affix the middle portion of the cable to the hooks at the back of the rack.
- (8) Reinsert the removed control section printed circuit board by following the directions described in section 8.3.

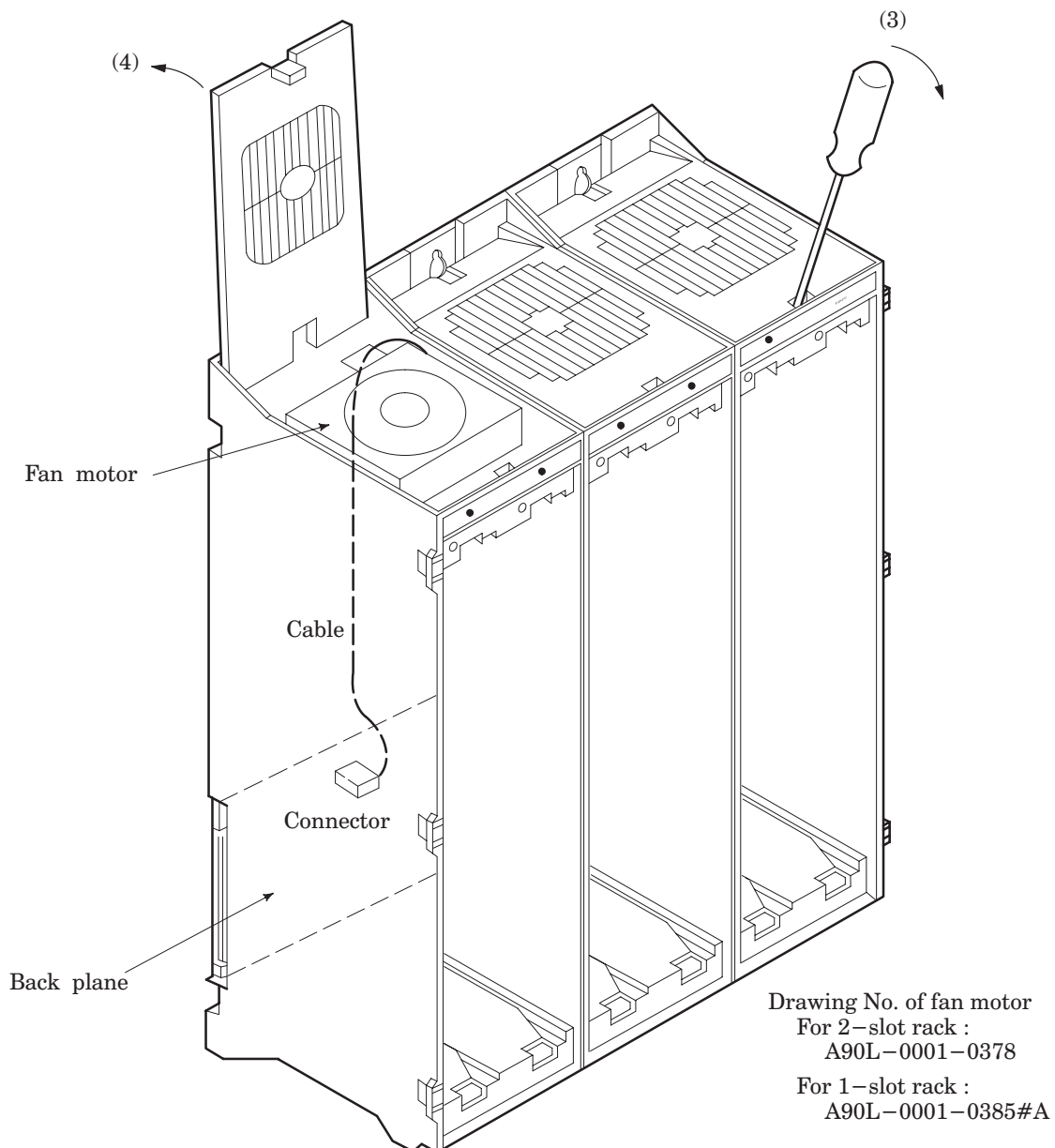


Fig. 8.6 Fan Motor Replacement

8.7 How to Replace the Card Cage in the Control Unit

- (1) Turn off the power supply and disconnect all the attached cables.
- (2) Unscrew and remove the screws holding the lower portion of the rack.
- (3) The screw holes in the upper portion of the rack are made for slide-off removal. Loosen the screws and remove the rack by lifting it up and away.
- (4) Temporarily position the new rack by guiding the screws through the holes in the upper portion of the rack.
- (5) Insert the screws for affixing the lower portion of the rack, then sufficiently tighten all the screws holding the rack.
- (6) Reconnect the cables to their original positions.

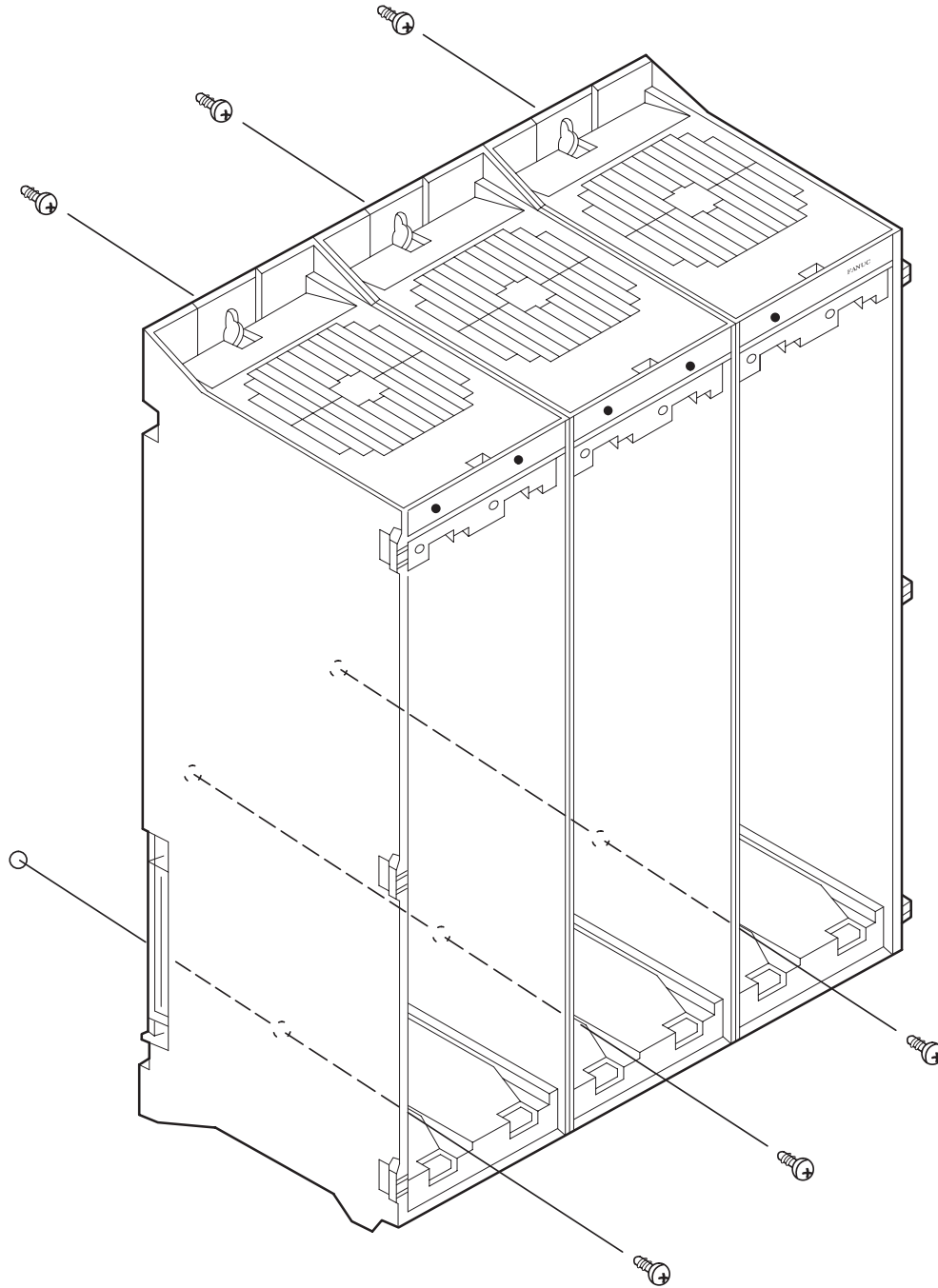


Fig. 8.7 Replacement of the Control Section Rack

8.8 How to Replace the MDI Keyboard

- (1) The small printed circuit board at the rear of the MDI keyboard can be seen from the back of the CRT/MDI control unit. There is a flat cable, coming from the soft keyboard, attached to this printed circuit board. Disconnect this cable.
- (2) Remove the cable attached to the power on/off button.
- (3) Remove the M3 screws from the front panel attached to the sheet metal panel of the CRT/MDI unit.
- (4) The keyboard is located in between the front panel and the sheet metal panel. The keyboard can now be removed (there are no screws holding the keyboard).
- (5) Insert the new keyboard into the front panel. Screw the front panel onto the sheet metal panel.
- (6) Reattach the power on/off cable and flat cable removed in steps (1) and (2) to their original positions.

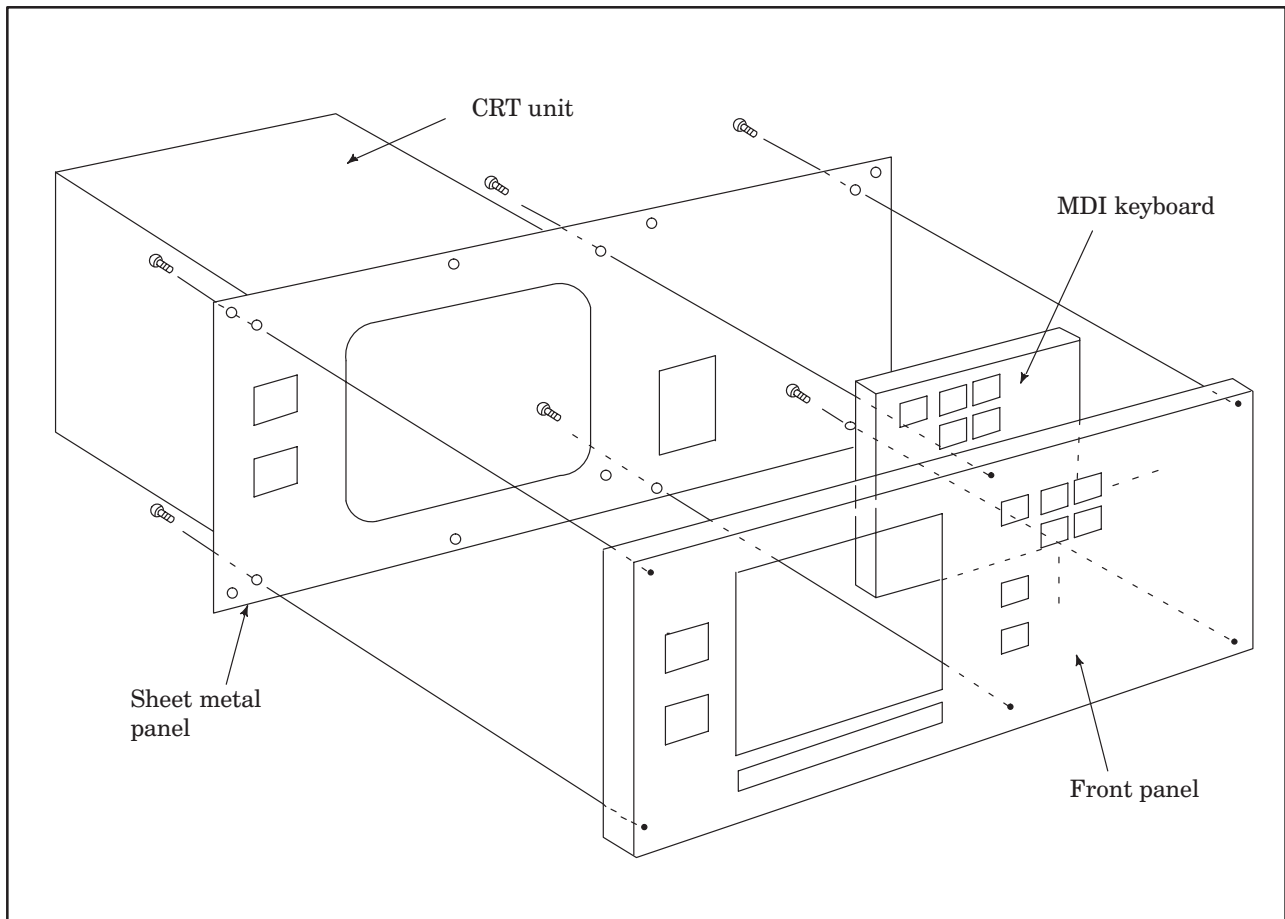


Fig. 8.8 MDI Keyboard Replacement

8.9 How to Replace the CRT Display

- (1) Disconnect the CRT unit power cable and the video signal cable.
- (2) When replacing a 9" monochrome CRT, remove the chloridized veneer cover and the four screws from the front of the CRT unit.
- (3) When replacing a 9" color CRT, remove the four screws in the front of the CRT unit.
- (4) When replacing a 14" color CRT, remove the two screws from the bottom of the CRT unit and pull it towards you.
- (5) Install the new CRT unit.
- (6) Reconnect the CRT power supply cable and video signal cable to their original positions.

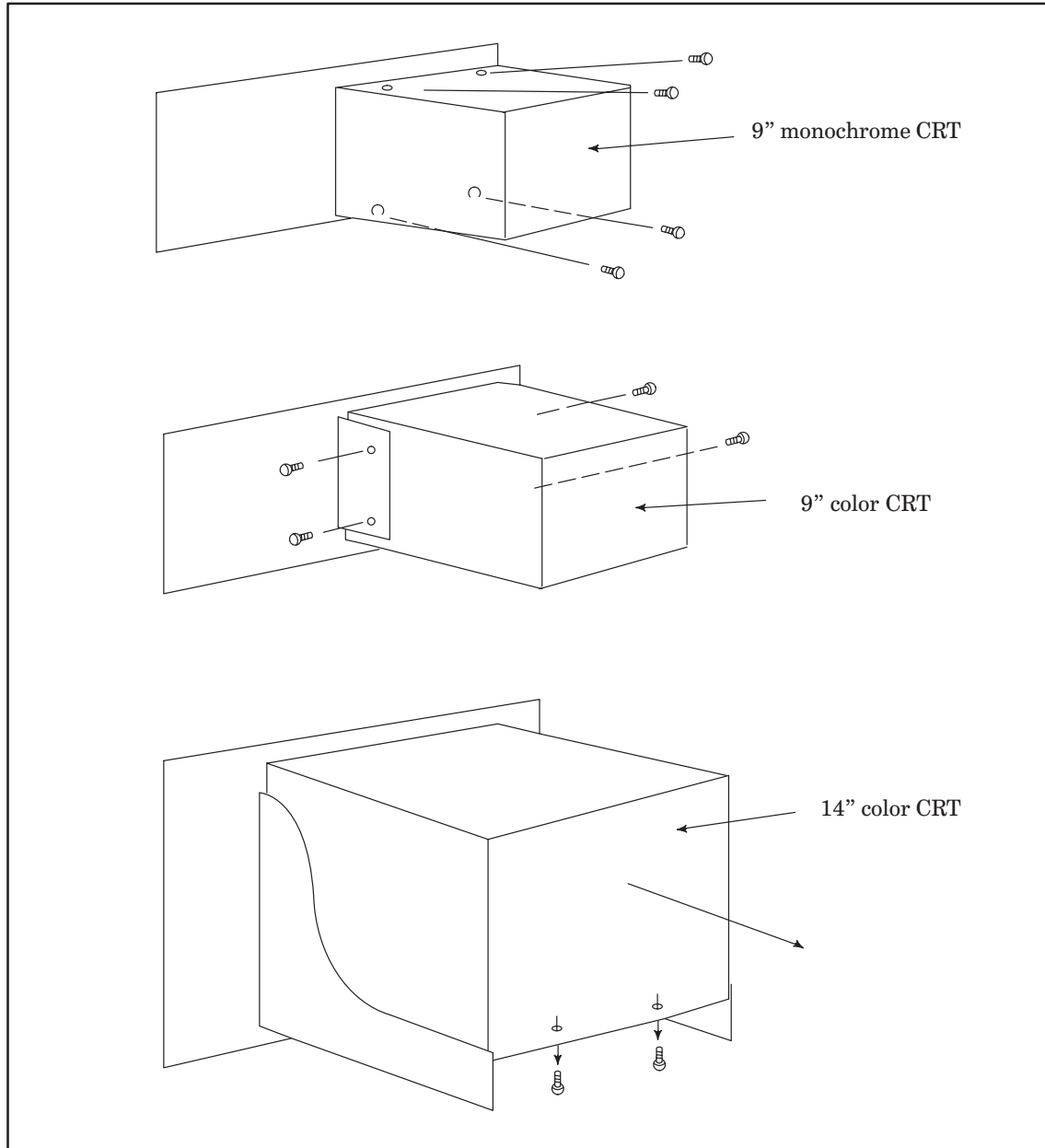


Fig. 8.9 Replacing the CRT Display

APPENDIX

APPENDIX 1. SYSTEM ALARMS

When the CNC disables subsequent operation due to a serious failure in the hardware or software, it enters the system alarm mode. The CNC stops normal operation to analyze the failure. Then the CNC displays the results of the analysis on the screen. This information is saved and can be referenced after the CNC is recovered from the failure and turned on again. Generally, it is difficult for the customer to recover the CNC system in the system alarm mode. Report the information displayed on the screen to the FANUC Service Center. Inform your FANUC Service center of the steps performed prior to the occurrence of the system alarm and the LED display on each PC board. This information is essential to correct diagnosis.

1.1 System Alarms When the CNC System Is Turned On

| No. | Alarm message | Description | Action |
|-----|--|---|---|
| 1 | ROM PARITY ERROR aaa bbb... | An error occurred during the F-ROM test. (A defective DRAM module for the main CPU occasionally causes this alarm.) aaa, bbb, ...: Number of the defective ROM | Rewrite the system data. Replace the F-ROM module. |
| 2 | RAM TEST: CNC stops without nothing being display after RAM TEST. | An error occurred during the RAM test for the servo module. | Replace the servo module. |
| 3 | RAM TEST: ERROR aaaaaa: wwwwwwww rrrrrrrr | An error occurred during the DRAM or high-speed SRAM module test for the main CPU. aaaaaa : Address wwwwwwww : Written data rrrrrrr : Read data | |
| 4 | IMPROPER NUMBER OF AXIS | The number of controlled axes specified in the parameter is greater than the number of actually supported axes. | Check the axis installation or SIF modules. Also check the parameter setting. |
| 5 | LOADING CNC DATA (This message continues to blink.) | The CNC system program was incorrectly loaded. The main CPU is not provided with the SRAM module. | Rewrite the system data. Replace the F-ROM module. |
| 6 | LOAD SYSTEM LABEL : ERROR SAVE SYSTEM LABEL : ERROR LOAD PC PARAMETER : ERROR CLEAR FILE #n : ERROR LOAD FILES : ERROR FILE PREPARATION : ERROR CLEAR FILE : ERROR aaaa bbbb cccc (This is displayed after one of the messages above.) | A file read/write error occurred in memory. | |
| 7 | FILE INITIALIZE : NO FILE FILE PREPARATION : NO FILE CLEAR FILE : NO FILE | The required memory for storing files has not been installed. | |
| 8 | CHECK FILE ID : ERROR | An invalid identification code was specified for the type of memory for storing files. | |

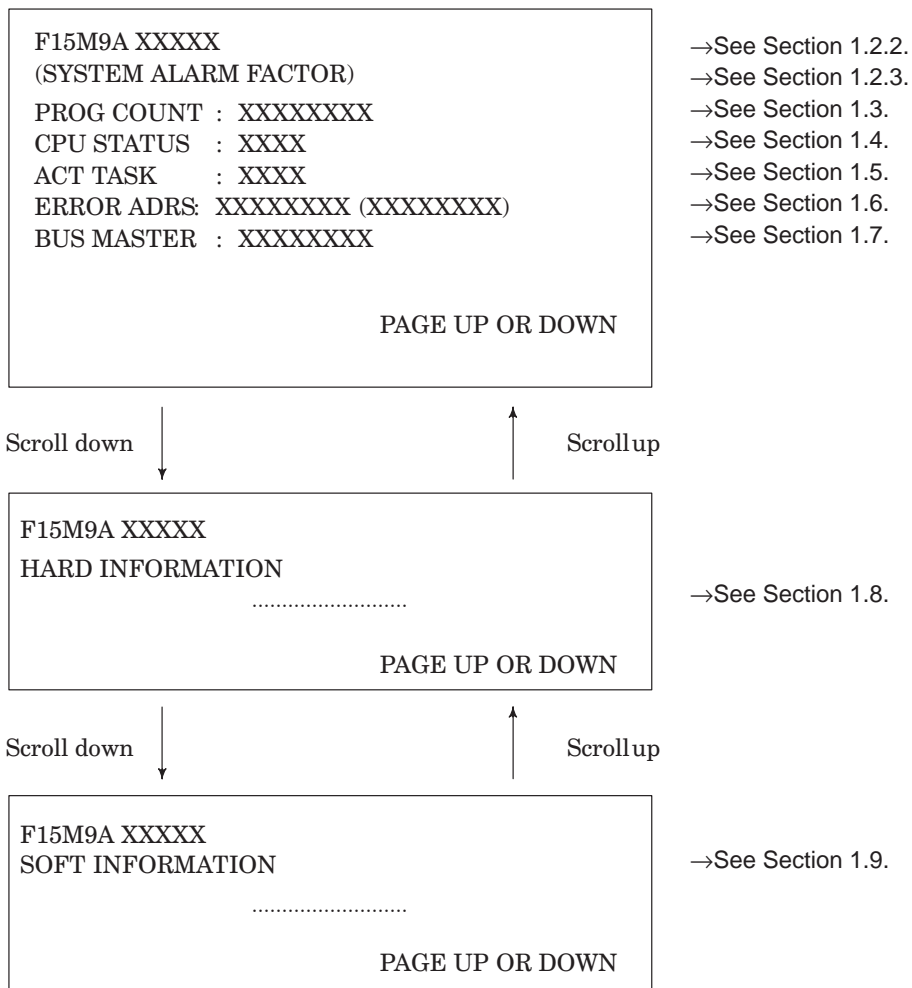
| No. | Alarm message | Description | Action |
|-----|---|---|--|
| 9 | FILE PREPARATION: NOT READY CLEAR FILE : NOT READY | Memory for storing files has not been correctly turned on. This message is normally displayed when an attempt is made to access a file after an error indicated by alarm 7 or 8 occurs. | |
| 10 | NO SYSTEM LABEL | A system label that includes the type and configuration of the system has not been reserved. This message is normally displayed when an attempt is made to access a system label after an error indicated by alarm 7 or 8 occurs. | |
| 11 | CHECK SYSTEM LABEL: ERROR | Invalid system label (See the description of system alarm 11 above for a system label.) This message is normally displayed when: <ul style="list-style-type: none"> – The installed memory for storing files has not been initialized for the device. – The memory has not been initialized after it was entirely cleared. | Initialize the system. |
| 12 | FILE #n : DATA BROKEN | The data in file n has been destroyed. This message is displayed when the CNC is turned off while the file is being accessed. | Clear the file and write data to the file again. |
| 13 | SLOTxx (yyyy) : xx = 00 to FF yyyy = 0000 to FFFF | The FBUS module is idle. (An FBUS module is a printed circuit board with slot number xx and identification number yyyy.) The low-order two digits of the ID represent the type of the PC board. For details of the relationship between the ID and the PC board, see Section 1.3. | Replace the FBUS module with a new one. |
| 14 | SLOTxx (yyyy) : ROM PARITY xx = 00 to FF yyyy = 0000 to FFFF | A RAM parity error occurred in the FBUS module. (An FBUS module is a printed circuit board with slot number xx and identification number yyyy.) | Replace the FBUS module with a new one. |
| 15 | SLOTxx (yyyy) : ROM PARITY xx = 00 to FF yyyy = 0000 to FFFF | A ROM parity error occurred in the FBUS module. (An FBUS module is a printed circuit board with slot number xx and identification number yyyy.) | Replace the ROM on the FBUS module with a new one. |
| 16 | SLOTxx (yyyy) : BUS ERROR xx = 00 A FF yyyy = 0000 A FFFF | A bus error occurred in the FBUS module. (An FBUS module is a printed circuit board with slot number xx and identification number yyyy.) | Replace the FBUS module or the ROM on the module with a new one. |
| 17 | SERVO ROM TEST : ERROR | An error occurred during the test of the area for the digital servo software for the F-ROM module. | |

NOTE When a system alarm is issued in the CNC system, the corresponding message appears on the screen. Then the CNC system enters the IPL mode and displays the IPL initial menu. Generally, normal operation can be restarted only after the cause of the system error has been eliminated.

1.2 System Alarms While the CNC System Is Operating

1.2.1 System alarm screen

When the CNC disables subsequent operation due to a serious failure in the hardware or software, it enters the system alarm mode. Then the CNC displays the information shown below on the screen.



1.2.2 Software series and edition

Character string XXXXX on the first line of the screen shows the series and edition of the software.

1.2.3 System alarms (SYSTEM ALARM FACTOR)

(1)

| No. | Alarm message | Description | Action |
|-----|--|--|--------|
| 1 | TRAP 15 | The system software was abnormally operating. | |
| 2 | ADDRESS ERROR | An address error occurred. | |
| 3 | ILLEGAL INSTRUCTION | An attempt was made to execute a non-executable instruction. | |
| 4 | ZERO DIVIDE | Division was attempted with divisor 0. | |
| 5 | CHECK INSTRUCTION | An overflow occurred in the register. | |
| 6 | TRAPV INSTRUCTION | An overflow trap occurred. | |
| 7 | PRIVILEGE VIOLATION | Violation of a privileged instruction occurred. | |
| 8 | TRACE | The CPU entered the trace mode. | |
| 9 | L1111 EMUL. | An attempt was made to execute an instruction with a code that cannot be used. | |
| 10 | L1010 EMUL. | An attempt was made to execute an instruction with a code that cannot be used. | |
| 11 | UNASSIGNED TRAP | An undefined trap instruction was executed. | |
| 12 | UNASSIGNED INTERRUPT | An undefined interrupt occurred. | |
| 13 | SPURIOUS INTERRUPT | An error occurred during the DRAM or high-speed SRAM test. | |
| 14 | DRAM SUM ERROR | A checksum error occurred. | |
| 15 | WATCHDOG ALARM | A watchdog error occurred. | |
| 16 | BUS ERROR | A bus error occurred. | |
| 17 | NOISE ON POWER SUPPLY | The power has dropped below the specified voltage. | |
| 18 | RAM PARITY | A RAM parity error occurred. | |
| 19 | ROM PARITY aaa bbb : PC010 | A ROM parity error occurred in the PMC. aaa, bbb: Number of the defective ROM | |
| 20 | RAM PARITY <a.RAM> bb (yyyyyy) : PC020 | A RAM parity error occurred in the PMC. a.RAM : Type of the RAM parity check B.RAM : Basic RAM board O.RAM : Optional RAM board S.RAM : Static RAM board P.RAM : PMC RAM board bb : Information about the RAM parity error | |
| 21 | BUS ERROR xxxxxx (yyyyyy) : PC040 | A bus error occurred in the PMC. (An address that cannot be used was accessed.) | |
| 22 | ADR ERROR xxxxxx (yyyyyy) : PC040 | An address error occurred in the PMC. (An odd address was accessed.) | |

| No. | Alarm message | Description | Action |
|-----|-------------------------------|---|--------|
| 23 | IRG ERROR (yyyyyy) : PC040 | The PMC CPU attempted to execute an instruction which cannot be executed. | |
| 24 | ZDV ERROR (yyyyyy) : PC040 | The PMC CPU attempted to divide a value by zero. | |
| 25 | CHK ERROR (yyyyyy) : PC040 | A register exceeding a range was detected when the PMC CPU checked the register limits. | |
| 26 | TPV ERROR (yyyyyy) : PC040 | An overflow trap occurred in the PMC. | |
| 27 | PRV ERROR (yyyyyy) : PC040 | Violation of a privileged instruction occurred in the PMC. | |
| 28 | TRC ERROR (yyyyyy) : PC040 | The PMC CPU entered the trace mode. | |
| 29 | L10 ERROR (yyyyyy) : PC040 | An attempt was made to execute an instruction with code Axxx in the PMC. | |
| 30 | L11 ERROR (yyyyyy) : PC040 | An attempt was made to execute an instruction with code Fxxx in the PMC. | |
| 31 | NAE ERROR (yyyyyy) : PC040 | An unexpected interrupt occurred in the PMC. | |
| 32 | SPI ERROR (yyyyyy) : PC040 | An unaccountable interrupt occurred in the PMC. | |
| 33 | NTP ERROR (yyyyyy) : PC040 | An unexpected trap occurred in the PMC. | |
| 34 | SLC ERROR aa : PC050 | A DI/DO error occurred. aa: Information about the DI/DO error | |
| 35 | PC500 WATCHDOG ALARM | A watchdog error occurred in the PMC. | |

(xxxxxx: Accessed address, yyyyyy: Address at which an error occurred)

One of the following messages is displayed to indicate the CPU where a system alarm was issued. This message is displayed after the alarm message.

| Message | Description |
|------------|---|
| CNC-MAIN | A system alarm was issued in the main CPU of the CNC. |
| CNC-SUB | A system alarm was issued in the subordinate CPU of the CNC. (This message can be displayed only when a system where a subordinate CPU is installed is used.) |
| CNC-AXIS#n | A system alarm was issued in axis control CPU n of the CNC. (This message can be displayed only when a system which controls multiple axes is used.) |
| SRVO-CPU#n | A system alarm was issued in digital servo CPU n. |

If a RAM parity alarm was issued, one of the following messages is displayed to indicate the relevant hardware. This message is displayed after the message which indicates the CPU where a system alarm was issued.

| Message | Description |
|----------|---|
| FILE-RAM | A RAM parity alarm was issued in the RAM for storing part programs. |
| DRAM | A DRAM parity alarm was issued in the RAM for storing the CNC control program. |
| SRAM | A RAM parity alarm was issued in the high-speed SRAM for storing the CNC control program. |

(2)

| Alarm message | Description | Action |
|------------------|--|--------|
| SYSTEM EMERGENCY | A serious failure occurred in the FBUS module. | |

The following message is displayed after the above message.

P-SLOT: nn L-SLOT: mm SOFT: AAAA#nnnn

| Message | Description |
|---------|--|
| P-SLOT | Number of the slot in which the module is inserted |
| L-SLOT | Logical slot number for the module |
| SOFT | Software used for the module |

(3)

| Message | Description | Action |
|--------------------|------------------------------------|--------|
| NON MASK INTERRUPT | An unaccountable alarm was issued. | |

The HARD INFORMATION screen is displayed to indicate the hardware status, preceded by the message above (see Section 1.8).

1.3 Program Counter (PROG COUNT)

The program counter of the CPU where an error occurred is displayed. When an error occurs in the digital servo CPU, 0 is displayed.

1.4 CPU Status (CPU STATUS)

The status of the CPU where an error occurred is displayed. When an error occurs in the digital servo CPU, 0 is displayed.

1.5 User Number for the Active Task (ACT TASK)

The user number for the active task in the CPU where an error occurred is displayed. When an error occurs in the digital servo CPU, 0 is displayed.

1.6 Address at which an Error Occurred (ERROR ADRS)

The address at which a bus error or RAM parity error occurred is displayed. 0 is displayed when an address error other than a bus error or RAM parity error occurs. 0 is displayed also when an address error occurs in the digital servo CPU. When the CPU detects the address at which a bus error occurred, the address is displayed in parentheses.

1.7 Master CPU of the Bus (BUS MASTER)

One of the following messages is displayed to indicate the master CPU of the bus when an error occurred.

| Message | Description |
|----------|--|
| CNC-MAIN | The main CPU of the CNC was the master CPU of the bus. |
| CNC-SUB | The subordinate CPU of the CNC was the master CPU of the bus. (This message can be displayed only when a system where a subordinate CPU is installed is used.) |
| OTHER | The CPU other than the two CPUs above was the master CPU of the bus. |

1.8 Hardware Status (HARD INFORMATION)

The hardware status when an error occurred is displayed. The display extends over two pages.

(Displayed information)

| Information | Display | Remarks |
|-------------------------|--------------------|--|
| SLOT_IO for each MODULE | HARD INFORMATION 1 | Status of the PC board to be installed |
| ABC-REG1 | HARD INFORMATION 2 | Status of the main CPU or sub-CPU when an error occurs |
| ABC2-REG1 | | |
| ABC-REG2 | | |
| ABC-REG5 | | |
| AMAC-REG(1-6) | | |

1.9 Software Status (SOFT INFORMATION)

The software status when an error occurred is displayed. The display extends over two pages.

(Displayed information)

| Information | Number of words | Remarks |
|------------------|-----------------|---|
| User stack | 32 | User stack when an alarm was issued |
| Data register | 16 | Data register when an alarm was issued |
| Address register | 16 | Address register when an alarm was issued |
| Supervisor stack | 32 | Supervisor stack when an alarm was issued |

APPENDIX 3. SIGNAL INTERFACE LIST BETWEEN CNC AND PMC

(1) BMI Signal list (In case of FS15-T and FS15-M)

BMI-DI1

| DGN No. | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0 | ERS | RRW | *SP | *ESP | SKIP1 | UINT | *CSL | *IT |
| 1 | SKIP4 | SKIP3 | SKIP2 | AE3 | AE2 | AE1 | *BSL | *AIT |
| 2 | ZRN | BRN | SRN | MOVL | TCHIN | | | |
| 3 | AGJ | EDT | MEM | T | D | J | H | S |
| 4 | MLK | DLK | ABS | OVC | SBK | BDT1 | DRN | AFL |
| 5 | KEY4 | KEY3 | KEY2 | KEY1 | F1D | FFIN | FIN | ST |
| 6 | RT | ROV2 | ROV1 | MP4 | MP2 | MP1 | | |
| 7 | BDT9 | BDT8 | BDT7 | BDT6 | BDT5 | BDT4 | BDT3 | BDT2 |
| 8 | TMRON | | PRC | | | | *CSMZ | *CHF |
| 9 | TLSKP | TL64 | TL32 | TL16 | TL08 | TL04 | TL02 | TL01 |
| 10 | TLRST | OMEP | OME | | HS3D | HS3C | HS3B | HS3A |
| 11 | HS2D | HS2C | HS2B | HS2A | HS1D | HS2C | HS1B | HS2A |
| 12 | *FV7 | *FV6 | *FV5 | *FV4 | *FV3 | *FV2 | *FV1 | *FV0 |
| 13 | *AFV7 | *AFV6 | *AFV5 | *AFV4 | *AFV3 | *AFV2 | *AFV1 | *AFV0 |

| | | BMI-DI2 | | | | | | | |
|----|--|---------|--------|--------|--------|--------|--------|--------|--------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 14 | | *JV15 | *JV14 | *JV13 | *JV12 | *JV11 | *JV10 | *JV9 | *JV8 |
| 15 | | *JV7 | *JV6 | *JV5 | *JV4 | *JV3 | *JV2 | *JV1 | *JV0 |
| 16 | | AJSTB | -AJ | +AJ | AJA12 | AJA11 | AJA10 | AJA9 | AJA8 |
| 17 | | AJA7 | AJA6 | AJA5 | AJA4 | AJA3 | AJA2 | AJA1 | AJA0 |
| 18 | | AJP2D | AJP2C | AJP2B | AJP2A | AJP1D | AJP1C | AJP1B | AJP1A |
| 19 | | *BECLP | *BEUCL | | WN16 | WN8 | WN4 | WN2 | WN1 |
| 20 | | | | | | | DIST26 | DIST25 | DIST24 |
| 21 | | DIST23 | DIST22 | DIST21 | DIST20 | DIST19 | DIST18 | DIST17 | DIST16 |
| 22 | | DIST15 | DIST14 | DIST13 | DIST12 | DIST11 | DIST10 | DIST9 | DIST8 |
| 23 | | DIST7 | DIST6 | DIST5 | DIST4 | DIST3 | DIST2 | DIST1 | DIST0 |
| 24 | | RISGN | | | RI12 | RI11 | RI10 | RI9 | RI8 |
| 25 | | RI7 | RI6 | RI5 | RI4 | RI3 | RI2 | RI1 | RI0 |
| 26 | | WOSET | GS4 | GS5 | GS1 | *SECLP | *SEUCL | | SPSTP |
| 27 | | CDV7 | CDV6 | CDV5 | CDV4 | CDV3 | CDV2 | CDV1 | CDV0 |
| 28 | | | | | | | SPC | SPB | SPA |

| | | BMI-DI3 | | | | | | | |
|----|--|---------|-------|--------|-------|-------|-------|-------|-------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 29 | | | | | | | | | |
| 30 | | | | | | | | | |
| 31 | | | | | | | | | |
| 32 | | EISTB | ERDRQ | EOREND | | | EXSTP | EXRD | EXPUN |
| 33 | | EIA7 | EIA6 | EIA5 | EIA4 | EIA3 | EIA2 | EIA1 | EIA0 |
| 34 | | EID47 | EID46 | EID45 | EID44 | EID43 | EID42 | EID41 | EID40 |
| 35 | | EID39 | EID38 | EID37 | EID36 | EID35 | EID34 | EID33 | EID32 |
| 36 | | EID31 | EID30 | EID29 | EID28 | EID27 | EID26 | EID25 | EID24 |
| 37 | | EID23 | EID22 | EID21 | EID20 | EID19 | EID18 | EID17 | EID16 |
| 38 | | EID15 | EID14 | EID13 | EID12 | EID11 | EID10 | EID9 | EID8 |
| 39 | | EID7 | EID6 | EID5 | EID4 | EID3 | EID2 | EID1 | EID0 |
| 40 | | | | | | | | | |
| 41 | | | | | | | | | |
| 42 | | | | | | | | | TL256 |
| 43 | | TL128 | | | | | | | |

| | | BMI-DI4 | | | | | | | |
|----|--|---------|-------|-------|-------|-------|-------|-------|-------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 44 | | | | | | | | | |
| 45 | | | | | | | | | |
| 46 | | | | | | | | | |
| 47 | | | | | | | | | |
| 48 | | UI031 | UI030 | UI029 | UI028 | UI027 | UI026 | UI025 | UI024 |
| 49 | | UI023 | UI022 | UI021 | UI020 | UI019 | UI018 | UI017 | UI016 |
| 50 | | UI015 | UI014 | UI013 | UI012 | UI011 | UI010 | UI009 | UI008 |
| 51 | | UI007 | UI006 | UI005 | UI004 | UI003 | UI002 | UI001 | UI000 |
| 52 | | UI131 | UI130 | UI129 | UI128 | UI127 | UI126 | UI125 | UI124 |
| 53 | | UI123 | UI122 | UI121 | UI120 | UI119 | UI118 | UI117 | UI116 |
| 54 | | UI115 | UI114 | UI113 | UI112 | UI111 | UI110 | UI109 | UI108 |
| 55 | | UI107 | UI106 | UI105 | UI104 | UI103 | UI102 | UI101 | UI100 |
| 56 | | UI231 | UI230 | UI229 | UI228 | UI227 | UI226 | UI225 | UI224 |
| 57 | | UI223 | UI222 | UI221 | UI220 | UI219 | UI218 | UI217 | UI216 |
| 58 | | UI215 | UI214 | UI213 | UI212 | UI211 | UI210 | UI209 | UI208 |

| | | BMI-DI5 | | | | | | | |
|----|--|---------|-------|-------|-------|-------|-------|-------|-------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 59 | | UI207 | UI206 | UI205 | UI204 | UI203 | UI202 | UI201 | UI200 |
| 60 | | UI331 | UI330 | UI329 | UI328 | UI327 | UI326 | UI325 | UI324 |
| 61 | | UI323 | UI322 | UI321 | UI320 | UI319 | UI318 | UI317 | UI316 |
| 62 | | UI315 | UI314 | UI313 | UI312 | UI311 | UI310 | UI309 | UI308 |
| 63 | | UI307 | UI306 | UI305 | UI304 | UI303 | UI302 | UI301 | UI300 |
| 64 | | DTCH1 | *SVF1 | *DEC1 | *IT1 | *-ED1 | *+ED1 | *-L1 | *+L1 |
| 65 | | | | *CL1 | PK1 | MLK1 | MI1 | -J1 | +J1 |
| 66 | | | | | | | | | |
| 67 | | | | | | | | | |
| 68 | | DTCH2 | *SVF2 | *DEC2 | *IT2 | *-ED2 | *+ED2 | *-L2 | *+L2 |
| 69 | | | | *CL2 | PK2 | MLK2 | MI2 | -J2 | +J2 |
| 70 | | | | | | | | | |
| 71 | | | | | | | | | |
| 72 | | DTCH3 | *SVF3 | *DEC3 | *IT3 | *-ED3 | *+ED3 | *-L3 | *+L3 |
| 73 | | | | *CL3 | PK3 | MLK3 | MI3 | -J3 | +J3 |

| | | BMI-DI6 | | | | | | | |
|----|--|---------|-------|-------|------|-------|-------|------|------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 74 | | | | | | | | | |
| 75 | | | | | | | | | |
| 76 | | DTCH4 | *SVF4 | *DEC4 | *IT4 | *-ED4 | *+ED4 | *-L4 | *+L4 |
| 77 | | | | *CL4 | PK4 | MLK4 | MI4 | -J4 | +J4 |
| 78 | | | | | | | | | |
| 79 | | | | | | | | | |
| 80 | | DTCH5 | *SVF5 | *DEC5 | *IT5 | *-ED5 | *+ED5 | *-L5 | *+L5 |
| 81 | | | | *CL5 | PK5 | MLK5 | MI5 | -J5 | +J5 |
| 82 | | | | | | | | | |
| 83 | | | | | | | | | |
| 84 | | DTCH6 | *SVF6 | *DEC6 | *IT6 | *-ED6 | *+ED6 | *-L6 | *+L6 |
| 85 | | | | *CL6 | PK6 | MLK6 | MI6 | -J6 | +J6 |
| 86 | | | | | | | | | |
| 87 | | | | | | | | | |

| | | BMI-DO1 | | | | | | | |
|-----|--|---------|---------|-------|-------|-------|-------|-------|-------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 200 | | MA | SA | OP | STL | SPL | RST | AL | RWD |
| 201 | | CSS | THRD | RPD | TAP | INCH | DST | IPEN | DEN |
| 202 | | MZRN | MBRN | MSRN | MMOVL | | | | |
| 203 | | MAGL | MEDT | MMEM | MT | MD | MJ | MH | MS |
| 204 | | MMLK | MDLK | MABS | | MSBK | MBDT1 | MDRN | MAFL |
| 205 | | MBDT9 | MBDT8 | MBDT7 | MBDT6 | MBDT5 | MBDT4 | MBDT3 | MBDT2 |
| 206 | | MSALM | EGPSALM | DIALM | SYALM | OTALM | OHALM | SVALM | PSALM |
| 207 | | TLCHB | TLCHA | ESEND | RPBSY | | | BCLP | BUCLP |
| 208 | | SSP | SRV | FMF | EF | BF | TF | SF | MF |
| 209 | | DM30 | DM02 | DM01 | DM00 | | | | |
| 210 | | R015 | R014 | R013 | R012 | R011 | R010 | R09 | R08 |
| 211 | | R07 | R06 | R05 | R04 | R03 | R02 | R01 | R00 |
| 212 | | AR15 | AR14 | AR13 | AR12 | AR11 | AR10 | AR9 | AR8 |
| 213 | | AR7 | AR6 | AR5 | AR4 | AR3 | AR2 | AR1 | AR0 |
| 214 | | MR15 | MR14 | MR13 | MR12 | MR11 | MR10 | MR9 | MR8 |

| | | BMI-DO2 | | | | | | | |
|-----|--|---------|-----|-----|-----|-----|-----|-----|-----|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 215 | | MR7 | MR6 | MR5 | MR4 | MR3 | MR2 | MR1 | MR0 |
| 216 | | M31 | M30 | M29 | M28 | M27 | M26 | M25 | M24 |
| 217 | | M23 | M22 | M21 | M20 | M19 | M18 | M17 | M16 |
| 218 | | M15 | M14 | M13 | M12 | M11 | M10 | M9 | M8 |
| 219 | | M7 | M6 | M5 | M4 | M3 | M2 | M1 | M0 |
| 220 | | S31 | S30 | S29 | S28 | S27 | S26 | S25 | S24 |
| 221 | | S23 | S22 | S21 | S20 | S19 | S18 | S17 | S16 |
| 222 | | S15 | S14 | S13 | S12 | S11 | S10 | S9 | S8 |
| 223 | | S7 | S6 | S5 | S4 | S3 | S2 | S1 | S0 |
| 224 | | T31 | T30 | T29 | T28 | T27 | T26 | T25 | T24 |
| 225 | | T23 | T22 | T21 | T20 | T19 | T18 | T17 | T16 |
| 226 | | T15 | T14 | T13 | T12 | T11 | T10 | T9 | T8 |
| 227 | | T7 | T6 | T5 | T4 | T3 | T2 | T1 | T0 |
| 228 | | B31 | B30 | B29 | B28 | B27 | B26 | B25 | B24 |
| 229 | | B23 | B22 | B21 | B20 | B19 | B18 | B17 | B16 |

| | | BMI-DO3 | | | | | | | |
|-----|--|---------|-------|--------|-------|-------|-------|-------|-------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 230 | | B15 | B14 | B13 | B12 | B11 | B10 | B9 | B8 |
| 231 | | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| 232 | | EOSTB | | EIREND | | | | | |
| 233 | | EOA7 | EOA6 | EOA5 | EOA4 | EOA3 | EOA2 | EOA1 | EOA0 |
| 234 | | EOD47 | EOD46 | EOD45 | EOD44 | EOD43 | EOD42 | EOD41 | EOD40 |
| 235 | | EOD39 | EOD38 | EOD37 | EOD36 | EOD35 | EOD34 | EOD33 | EOD32 |
| 236 | | EOD31 | EOD30 | EOD29 | EOD28 | EOD27 | EOD26 | EOD25 | EOD24 |
| 237 | | EOD23 | EOD22 | EOD21 | EOD20 | EOD19 | EOD18 | EOD17 | EOD16 |
| 238 | | EOD15 | EOD14 | EOD13 | EOD12 | EOD11 | EOD10 | EOD9 | EOD8 |
| 239 | | EOD7 | EOD6 | EOD5 | EOD4 | EOD3 | EOD2 | EOD1 | EOD0 |
| 240 | | BTAL | PBATL | PBATZ | | SPAL8 | SPAL4 | SPAL2 | SPAL1 |
| 241 | | | | | | | | | |
| 242 | | | SPCO | SPBO | SPAO | *REEL | SPAL | SCLP | SUCLP |
| 243 | | | | | | | | | |
| 244 | | | | | | | | | |

| | | BMI-DO4 | | | | | | | |
|-----|--|---------|-------|-------|-------|-------|-------|-------|-------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 245 | | | | | | | | | |
| 246 | | | | | | | | | |
| 247 | | | | | | | | | |
| 248 | | UO031 | UO030 | UO029 | UO028 | UO027 | UO026 | UO025 | UO024 |
| 249 | | UO023 | UO022 | UO021 | UO020 | UO019 | UO018 | UO017 | UO016 |
| 250 | | UO015 | UO014 | UO013 | UO012 | UO011 | UO010 | UO009 | UO008 |
| 251 | | UO007 | UO006 | UO005 | UO004 | UO003 | UO002 | UO001 | UO000 |
| 252 | | UO131 | UO130 | UO129 | UO128 | UO127 | UO126 | UO125 | UO124 |
| 253 | | UO123 | UO122 | UO121 | UO120 | UO119 | UO118 | UO117 | UO116 |
| 254 | | UO115 | UO114 | UO113 | UO112 | UO111 | UO110 | UO109 | UO108 |
| 255 | | UO107 | UO106 | UO105 | UO104 | UO103 | UO102 | UO101 | UO100 |
| 256 | | UO231 | UO230 | UO229 | UO228 | UO227 | UO226 | UO225 | UO224 |
| 257 | | UO223 | UO222 | UO221 | UO220 | UO219 | UO218 | UO217 | UO216 |
| 258 | | UO215 | UO214 | UO213 | UO212 | UO211 | UO210 | UO209 | UO208 |
| 259 | | UO207 | UO206 | UO205 | UO204 | UO203 | UO202 | UO201 | UO200 |

| | BMI-DO5 | | | | | | | |
|-----|---------|-------|-------|-------|-------|-------|-------|-------|
| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 260 | UO331 | UO330 | UO329 | UO328 | UO327 | UO326 | UO325 | UO324 |
| 261 | UO323 | UO322 | UO321 | UO320 | UO319 | UO318 | UO317 | UO316 |
| 262 | UO315 | UO314 | UO313 | UO312 | UO311 | UO310 | UO309 | UO308 |
| 263 | UO307 | UO306 | UO305 | UO304 | UO303 | UO302 | UO301 | UO300 |
| 264 | | INP1 | ZP41 | ZP31 | MD1 | MV1 | ZP21 | ZP1 |
| 265 | | | | | | | MMLK1 | MMI1 |
| 266 | | | | | | | | |
| 267 | | | | | | | | |
| 268 | | INP2 | ZP42 | ZP32 | MD2 | MV2 | ZP22 | ZP2 |
| 269 | | | | | | | MMLK2 | MMI2 |
| 270 | | | | | | | | |
| 271 | | | | | | | | |
| 272 | | INP3 | ZP43 | ZP33 | MD3 | MV3 | ZP23 | ZP3 |
| 273 | | | | | | | MMLK3 | MMI3 |
| 274 | | | | | | | | |

| | | BMI-DO6 | | | | | | | |
|-----|--|---------|------|------|-----|-----|------|-------|------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 275 | | | | | | | | | |
| 276 | | INP4 | ZP44 | ZP34 | MD4 | MV4 | ZP24 | ZP4 | |
| 277 | | | | | | | | MMLK4 | MMI4 |
| 278 | | | | | | | | | |
| 279 | | | | | | | | | |
| 280 | | INP5 | ZP45 | ZP35 | MD5 | MV5 | ZP25 | ZP5 | |
| 281 | | | | | | | | MMLK5 | MMI5 |
| 282 | | | | | | | | | |
| 283 | | | | | | | | | |
| 284 | | INP6 | ZP46 | ZP36 | MD6 | MV6 | ZP26 | ZP6 | |
| 285 | | | | | | | | MMLK6 | MMI6 |
| 286 | | | | | | | | | |
| 287 | | | | | | | | | |

(2) BMI signal list (In case of FS15-TT)

| | | BMI-DI1 | | | | | | | |
|----|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 00 | | | | | | SKIP1 #1 | UINT #1 | *CSL #1 | |
| 01 | | | | | AE3 #1 | AE2 #1 | AE1 #1 | *BSL #1 | *AIT #1 |
| 02 | | | | | | | | | |
| 03 | | | | | | | | | |
| 04 | | | | | OVC #1 | | BDT1 #1 | | |
| 05 | | | | | | | | FIN #1 | |
| 06 | | | | | | | | | |
| 07 | | BDT9 #1 | BDT8 #1 | BDT7 #1 | BDT6 #1 | BDT5 #1 | BDT4 #1 | BDT3 #1 | BDT2 #1 |
| 08 | | TMROM | | | | | | *CSMZ #1 | *CHF #1 |
| 09 | | TLSKP #1 | TL64 #1 | TL32 #1 | TL16 #1 | TL8 #1 | TL4 #1 | TL2 #1 | TL1 #1 |
| 10 | | TLRST #1 | | | | | | | |
| 11 | | | | | | | | | |
| 12 | | *FV7 #1 | *FV6 #1 | *FV5 #1 | *FV4 #1 | *FV3 #1 | *FV2 #1 | *FV1 #1 | *FV0 #1 |
| 13 | | *AFV7 #1 | *AFV6 #1 | *AFV5 #1 | *AFV4 #1 | *AFV3 #1 | *AFV2 #1 | *AFV1 #1 | *AFV0 #1 |
| 14 | | | | | | | | | |
| 15 | | | | | | | | | |

NOTE There are some signals which are provided for the first and second tool posts respectively and they provide just the same function.

These signals are identified by symbol #1 or #2 which is affixed to their names. Symbol #1 shows a signal exclusively provided for the first tool post, while symbol #2 shows a signal exclusively provided for the second tool post.

| | | BMI-DI2 | | | | | | | |
|----|-------------|----------|----------|------------|-----------|-----------|-----------|-----------|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 16 | | | | | | | | | |
| 17 | | | | | | | | | |
| 18 | | | | | | | | | |
| 19 | | | | WN16 #1 | WN8 #1 | WN4 #1 | WN2 #1 | WN1 #1 | |
| 20 | | | | | | | | | |
| 21 | | | | | | | | | |
| 22 | | | | | | | | | |
| 23 | | | | | | | | | |
| 24 | RISGN #1 | | | R12 #1 | R11 #1 | R10 #1 | R9 #1 | R8 #1 | |
| 25 | R7 #1 | R6 #1 | R5 #1 | R4 #1 | R3 #1 | R2 #1 | R1 #1 | R0 #1 | |
| 26 | | | | | | | | | |
| 27 | | | | | | | | | |
| 28 | | | | | | | | | |
| 29 | | | | | | | | | |
| 30 | | | | | | | | | |
| 31 | | | | | | | | | |

| | | BMI-DI3 | | | | | | | |
|----|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 32 | | UI031 #1 | UI030 #1 | UI029 #1 | UI028 #1 | UI027 #1 | UI026 #1 | UI025 #1 | UI024 #1 |
| 33 | | UI023 #1 | UI022 #1 | UI021 #1 | UI020 #1 | UI019 #1 | UI018 #1 | UI017 #1 | UI016 #1 |
| 34 | | UI015 #1 | UI014 #1 | UI013 #1 | UI012 #1 | UI011 #1 | UI010 #1 | UI009 #1 | UI008 #1 |
| 35 | | UI007 #1 | UI006 #1 | UI005 #1 | UI004 #1 | UI003 #1 | UI002 #1 | UI001 #1 | UI000 #1 |
| 36 | | UI131 #1 | UI130 #1 | UI129 #1 | UI128 #1 | UI127 #1 | UI126 #1 | UI125 #1 | UI124 #1 |
| 37 | | UI123 #1 | UI122 #1 | UI121 #1 | UI120 #1 | UI119 #1 | UI118 #1 | UI117 #1 | UI116 #1 |
| 38 | | UI115 #1 | UI114 #1 | UI113 #1 | UI112 #1 | UI111 #1 | UI110 #1 | UI109 #1 | UI108 #1 |
| 39 | | UI107 #1 | UI106 #1 | UI105 #1 | UI104 #1 | UI103 #1 | UI102 #1 | UI101 #1 | UI100 #1 |
| 40 | | UI231 #1 | UI230 #1 | UI229 #1 | UI228 #1 | UI227 #1 | UI226 #1 | UI225 #1 | UI224 #1 |
| 41 | | UI223 #1 | UI222 #1 | UI221 #1 | UI220 #1 | UI219 #1 | UI218 #1 | UI217 #1 | UI216 #1 |
| 42 | | UI215 #1 | UI214 #1 | UI213 #1 | UI212 #1 | UI211 #1 | UI210 #1 | UI209 #1 | UI208 #1 |
| 43 | | UI207 #1 | UI206 #1 | UI205 #1 | UI204 #1 | UI203 #1 | UI202 #1 | UI201 #1 | UI200 #1 |
| 44 | | *CHLD | CHPST | | | *CHP8 | *CHP4 | *CHP2 | *CHP0 |
| 45 | | UI323 #1 | UI322 #1 | UI321 #1 | UI320 #1 | UI319 #1 | UI318 #1 | UI317 #1 | UI316 #1 |
| 46 | | UI315 #1 | UI314 #1 | UI313 #1 | UI312 #1 | UI311 #1 | UI310 #1 | UI309 #1 | UI308 #1 |
| 47 | | UI307 #1 | UI306 #1 | UI305 #1 | UI304 #1 | UI303 #1 | UI302 #1 | UI301 #1 | UI300 #1 |

| | | BMI-DI4 | | | | | | | |
|----|--|-------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 48 | | | | | | SKIP1 #2 | UINT #2 | *CSL #2 | |
| 49 | | | | | AE3 #2 | AE2 #2 | AE1 #2 | *BSL #2 | *AIT #2 |
| 50 | | | | | | | | | |
| 51 | | | | | | | | | |
| 52 | | | | | OVC #2 | | BDT1 #2 | | |
| 53 | | | | | | | | FIN #2 | |
| 54 | | | | | | | | | |
| 55 | | BDT9 #2 | BDT8 #2 | BDT7 #2 | BDT6 #2 | BDT5 #2 | BDT4 #2 | BDT3 #2 | BDT2 #2 |
| 56 | | | | | | | | *CSMZ #2 | *CHF #2 |
| 57 | | TLSKP #2 | RITL64 #2 | TL32 #2 | TL16 #2 | TL8 #2 | TL4 #2 | TL2 #2 | TL1 #2 |
| 58 | | TLRST #2 | | | | | | | |
| 59 | | | | | | | | | |
| 60 | | *FV7 #2 | *FV6 #2 | *FV5 #2 | *FV4 #2 | *FV3 #2 | *FV2 #2 | *FV1 #2 | *FV0 #2 |
| 61 | | *AFV7 #2 | *AFV6 #2 | *AFV5 #2 | *AFV4 #2 | *AFV3 #2 | *AFV2 #2 | *AFV1 #2 | *AFV0 #2 |
| 62 | | | | | | | | | |
| 63 | | | | | | | | | |

| | | BMI-DI5 | | | | | | | |
|----|-------------|-----------|-----------|------------|-----------|-----------|-----------|-----------|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 64 | | | | | | | | | |
| 65 | | | | | | | | | |
| 66 | | | | | | | | | |
| 67 | | | | WN16 #2 | WN8 #2 | WN4 #2 | WN2 #2 | WN1 #2 | |
| 68 | | | | | | | | | |
| 69 | | | | | | | | | |
| 70 | | | | | | | | | |
| 71 | | | | | | | | | |
| 72 | RISGN #2 | | | R12 #2 | R11 #2 | R10 #2 | R9 #2 | R8 #2 | |
| 73 | R17 #2 | R16 #2 | R15 #2 | R14 #2 | R13 #2 | R12 #2 | R11 #2 | R10 #2 | |
| 74 | | | | | | | | | |
| 75 | | | | | | | | | |
| 76 | | | | | | | | | |
| 77 | | | | | | | | | |
| 78 | | | | | | | | | |
| 79 | | | | | | | | | |

BMI-DI6

| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 80 | UI031 #2 | UI030 #2 | UI029 #2 | UI028 #2 | UI027 #2 | UI026 #2 | UI025 #2 | UI024 #2 |
| 81 | UI023 #2 | UI022 #2 | UI021 #2 | UI020 #2 | UI019 #2 | UI018 #2 | UI017 #2 | UI016 #2 |
| 82 | UI015 #2 | UI014 #2 | UI013 #2 | UI012 #2 | UI011 #2 | UI010 #2 | UI009 #2 | UI008 #2 |
| 83 | UI007 #2 | UI006 #2 | UI005 #2 | UI004 #2 | UI003 #2 | UI002 #2 | UI001 #2 | UI000 #2 |
| 84 | UI131 #2 | UI130 #2 | UI129 #2 | UI128 #2 | UI127 #2 | UI126 #2 | UI125 #2 | UI124 #2 |
| 85 | UI123 #2 | UI122 #2 | UI121 #2 | UI120 #2 | UI119 #2 | UI118 #2 | UI117 #2 | UI116 #2 |
| 86 | UI115 #2 | UI114 #2 | UI113 #2 | UI112 #2 | UI111 #2 | UI110 #2 | UI109 #2 | UI108 #2 |
| 87 | UI107 #2 | UI106 #2 | UI105 #2 | UI104 #2 | UI103 #2 | UI102 #2 | UI101 #2 | UI100 #2 |
| 88 | UI231 #2 | UI230 #2 | UI229 #2 | UI228 #2 | UI227 #2 | UI226 #2 | UI225 #2 | UI224 #2 |
| 89 | UI223 #2 | UI222 #2 | UI221 #2 | UI220 #2 | UI219 #2 | UI218 #2 | UI217 #2 | UI216 #2 |
| 90 | UI215 #2 | UI214 #2 | UI213 #2 | UI212 #2 | UI211 #2 | UI210 #2 | UI209 #2 | UI208 #2 |
| 91 | UI207 #2 | UI206 #2 | UI205 #2 | UI204 #2 | UI203 #2 | UI202 #2 | UI201 #2 | UI200 #2 |
| 92 | UI331 #2 | UI330 #2 | UI329 #2 | UI328 #2 | UI327 #2 | UI326 #2 | UI325 #2 | UI324 #2 |
| 93 | UI323 #2 | UI322 #2 | UI321 #2 | UI320 #2 | UI319 #2 | UI318 #2 | UI317 #2 | UI316 #2 |
| 94 | UI315 #2 | UI314 #2 | UI313 #2 | UI312 #2 | UI311 #2 | UI310 #2 | UI309 #2 | UI308 #2 |
| 95 | UI307 #2 | UI306 #2 | UI305 #2 | UI304 #2 | UI303 #2 | UI302 #2 | UI301 #2 | UI300 #2 |

| | | BMI-DI7 | | | | | | | |
|-----|--------|---------|--------|--------|--------|--------|--------|--------|-----|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 96 | ERS | RRW | *SP | *ESP | | | | | *IT |
| 97 | | EDT | MEM | | D | J | H | S | |
| 98 | ZRN | | | | | | | | |
| 99 | MLK | DLK | ABS | | SBK | | DRN | AFL | |
| 100 | KEY4 | KEY3 | KEY2 | KEY1 | | | | ST | |
| 101 | RT | ROV2 | ROV1 | MP4 | MP2 | MP1 | | PRC | |
| 102 | | | | | HS3D | HS3C | HS3B | HS3A | |
| 103 | HS2D | HS2C | HS2B | HS2A | HS1D | HS1C | HS1B | HS1A | |
| 104 | *JV15 | *JV14 | *JV13 | *JV12 | *JV11 | *JV10 | *JV9 | *JV8 | |
| 105 | *JV7 | *JV6 | *JV5 | *JV4 | *JV3 | *JV2 | *JV1 | *JV0 | |
| 106 | | | | | | DIST26 | DIST25 | DIST24 | |
| 107 | DIST23 | DIST22 | DIST21 | DIST20 | DIST19 | DIST18 | DIST17 | DIST16 | |
| 108 | DIST15 | DIST14 | DIST13 | DIST12 | DIST11 | DIST10 | DIST9 | DIST8 | |
| 109 | DIST7 | DIST6 | DIST5 | DIST4 | DIST3 | DIST2 | DIST1 | DIST0 | |
| 110 | | | | | | | IHEAD2 | IHEAD1 | |
| 111 | | | | | | | | | |

| | | BMI-DI8 | | | | | | | |
|-----|-------|---------|--------|--------|-------|-------|-------|-------|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 112 | EISTB | ERDRQ | EOREND | EIHEAD | | EXSTP | EXRD | EXPUX | |
| 113 | EIA7 | EIA6 | EIA5 | EIA4 | EIA3 | EIA2 | EIA1 | EIA0 | |
| 114 | EID47 | EID46 | EID45 | EID44 | EID43 | EID42 | EID41 | EID40 | |
| 115 | EID39 | EID38 | EID37 | EID36 | EID35 | EID34 | EID33 | EID32 | |
| 116 | EID31 | EID30 | EID29 | EID28 | EID27 | EID26 | EID25 | EID24 | |
| 117 | EID23 | EID22 | EID21 | EID20 | EID19 | EID18 | EID17 | EID16 | |
| 118 | EID15 | EID14 | EID13 | EID12 | EID11 | EID10 | EID9 | EID8 | |
| 119 | EID7 | EID6 | EID5 | EID4 | EID3 | EID2 | EID1 | EID0 | |
| 120 | | | | | | | | | |
| 121 | | | | | | | | | |
| 122 | | | | | | | | | |
| 123 | | | | | | | | | |
| 124 | | | | | | | | | |
| 125 | | | | | | | | | |
| 126 | | | | | | | | | |
| 127 | | | | | | | | | |

| | | BMI-DI9 | | | | | | | |
|-----|-------|---------|-------|------|-------|-------|------|------|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 128 | DTCH1 | *SVF1 | *DEC1 | *IT1 | *-ED1 | *+ED1 | *-L1 | *+L1 | |
| 129 | | | | | MLK1 | MI1 | -J1 | +J1 | |
| 130 | | | | | | | | | |
| 131 | | | | | | | | | |
| 132 | DTCH2 | *SVF2 | *DEC2 | *IT2 | *-ED2 | *+ED2 | *-L2 | *+L2 | |
| 133 | | | | | MLK2 | MI2 | -J2 | +J2 | |
| 134 | | | | | | | | | |
| 135 | | | | | | | | | |
| 136 | DTCH3 | *SVF3 | *DEC3 | *IT3 | *-ED3 | *+ED3 | *-L3 | *+L3 | |
| 137 | | | | | MLK3 | MI3 | -J3 | +J3 | |
| 138 | | | | | | | | | |
| 139 | | | | | | | | | |
| 140 | DTCH4 | *SVF4 | *DEC4 | *IT4 | *-ED4 | *+ED4 | *-L4 | *+L4 | |
| 141 | | | | | MLK4 | MI4 | -J4 | +J4 | |
| 142 | | | | | | | | | |
| 143 | | | | | | | | | |

| | | BMI-DO1 | | | | | | | |
|-----|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-----------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 200 | CSS #1 | THRD #1 | RPO #1 | | | | | IPEN #1 | DEN #1 |
| 201 | | | | | | | MBDT1 #1 | | |
| 202 | MBDT9 #1 | MBDT8 #1 | MBDT7 #1 | MBDT6 #1 | MBDT5 #1 | MBDT4 #1 | MBDT3 #1 | MBDT2 #1 | |
| 203 | TLCHB #1 | TLCHA #1 | ESEND #1 | | | | | | |
| 204 | | | | | BF #1 | TF #1 | SF #1 | MF #1 | |
| 205 | DM30 #1 | DM02 #1 | DM01 #1 | DM00 #1 | | | | | |
| 206 | R015 #1 | R014 #1 | R013 #1 | R012 #1 | R011 #1 | R010 #1 | R09 #1 | R08 #1 | |
| 207 | R07 #1 | R06 #1 | R05 #1 | R04 #1 | R03 #1 | R02 #1 | R01 #1 | R00 #1 | |
| 208 | AR15 #1 | AR14 #1 | AR13 #1 | AR12 #1 | AR11 #1 | AR10 #1 | AR69 #1 | AR8 #1 | |
| 209 | AR7 #1 | AR6 #1 | AR5 #1 | AR4 #1 | AR3 #1 | AR2 #1 | AR1 #1 | AR0 #1 | |
| 210 | MR15 #1 | MR14 #1 | MR13 #1 | MR12 #1 | MR11 #1 | MR10 #1 | MR9 #1 | MR8 #1 | |
| 211 | MR7 #1 | MR6 #1 | MR5 #1 | MR4 #1 | MR3 #1 | MR2 #1 | MR1 #1 | MR0 #1 | |
| 212 | | | | | SPAL8 #1 | SPAL4 #1 | SPAL2 #1 | SPAL1 #1 | |
| 213 | | | | | | | | | |
| 214 | | | | | | | | | |
| 215 | | | | | | | | | |

BMI-DO2

| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 216 | M31 #1 | M30 #1 | M29 #1 | M28 #1 | M27 #1 | M26 #1 | M25 #1 | M24 #1 |
| 217 | M23 #1 | M22 #1 | M21 #1 | M20 #1 | M19 #1 | M18 #1 | M17 #1 | M16 #1 |
| 218 | M15 #1 | M14 #1 | M13 #1 | M12 #1 | M11 #1 | M10 #1 | M9 #1 | M8 #1 |
| 219 | M7 #1 | M6 #1 | M5 #1 | M4 #1 | M3 #1 | M2 #1 | M1 #1 | M0 #1 |
| 220 | S31 #1 | S30 #1 | S29 #1 | S28 #1 | S27 #1 | S26 #1 | S25 #1 | S24 #1 |
| 221 | S23 #1 | S22 #1 | S21 #1 | S20 #1 | S19 #1 | S18 #1 | S17 #1 | S16 #1 |
| 222 | S15 #1 | S14 #1 | S13 #1 | S12 #1 | S11 #1 | S10 #1 | S9 #1 | S8 #1 |
| 223 | S7 #1 | S6 #1 | S5 #1 | S4 #1 | S3 #1 | S2 #1 | S1 #1 | S0 #1 |
| 224 | T31 #1 | T30 #1 | T29 #1 | T28 #1 | T27 #1 | T26 #1 | T25 #1 | T24 #1 |
| 225 | T23 #1 | T22 #1 | T21 #1 | T20 #1 | T19 #1 | T18 #1 | T17 #1 | T16 #1 |
| 226 | T15 #1 | T14 #1 | T13 #1 | T12 #1 | T11 #1 | T10 #1 | T9 #1 | T8 #1 |
| 227 | T7 #1 | T6 #1 | T5 #1 | T4 #1 | T3 #1 | T2 #1 | T1 #1 | T0 #1 |
| 228 | B31 #1 | B30 #1 | B29 #1 | B28 #1 | B27 #1 | B26 #1 | B25 #1 | B24 #1 |
| 229 | B23 #1 | B22 #1 | B21 #1 | B20 #1 | B19 #1 | B18 #1 | B17 #1 | B16 #1 |
| 230 | B15 #1 | B14 #1 | B13 #1 | B12 #1 | B11 #1 | B10 #1 | B9 #1 | B8 #1 |
| 231 | B7 #1 | B6 #1 | B5 #1 | B4 #1 | B3 #1 | B2 #1 | B1 #1 | B0 #1 |

| | | BMI-DO3 | | | | | | | |
|-----|--|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 232 | | UO031 #1 | UO030 #1 | UO029 #1 | UO028 #1 | UO027 #1 | UO026 #1 | UO025 #1 | UO024 #1 |
| 233 | | UO023 #1 | UO022 #1 | UO021 #1 | UO020 #1 | UO019 #1 | UO018 #1 | UO017 #1 | UO016 #1 |
| 234 | | UO015 #1 | UO014 #1 | UO013 #1 | UO012 #1 | UO011 #1 | UO010 #1 | UO009 #1 | UO008 #1 |
| 235 | | UO007 #1 | UO006 #1 | UO005 #1 | UO004 #1 | UO003 #1 | UO002 #1 | UO001 #1 | UO000 #1 |
| 236 | | UO131 #1 | UO130 #1 | UO129 #1 | UO128 #1 | UO127 #1 | UO126 #1 | UO125 #1 | UO124 #1 |
| 237 | | UO123 #1 | UO122 #1 | UO121 #1 | UO120 #1 | UO119 #1 | UO118 #1 | UO117 #1 | UO116 #1 |
| 238 | | UO115 #1 | UO114 #1 | UO113 #1 | UO112 #1 | UO111 #1 | UO110 #1 | UO109 #1 | UO108 #1 |
| 239 | | UO107 #1 | UO106 #1 | UO105 #1 | UO104 #1 | UO103 #1 | UO102 #1 | UO101 #1 | UO100 #1 |
| 240 | | UO231 #1 | UO230 #1 | UO229 #1 | UO228 #1 | UO227 #1 | UO226 #1 | UO225 #1 | UO224 #1 |
| 241 | | UO223 #1 | UO222 #1 | UO221 #1 | UO220 #1 | UO219 #1 | UO218 #1 | UO217 #1 | UO216 #1 |
| 242 | | UO215 #1 | UO214 #1 | UO213 #1 | UO212 #1 | UO211 #1 | UO210 #1 | UO209 #1 | UO208 #1 |
| 243 | | UO207 #1 | UO206 #1 | UO205 #1 | UO204 #1 | UO203 #1 | UO202 #1 | UO201 #1 | UO200 #1 |
| 244 | | UO331 #1 | UO330 #1 | UO329 #1 | UO328 #1 | UO327 #1 | UO326 #1 | UO325 #1 | UO324 #1 |
| 245 | | UO323 #1 | UO322 #1 | UO321 #1 | UO320 #1 | UO319 #1 | UO318 #1 | UO317 #1 | UO316 #1 |
| 246 | | UO315 #1 | UO314 #1 | UO313 #1 | UO312 #1 | UO311 #1 | UO310 #1 | UO309 #1 | UO308 #1 |
| 247 | | UO307 #1 | UO306 #1 | UO305 #1 | UO304 #1 | UO303 #1 | UO302 #1 | UO301 #1 | UO300 #1 |

BMI-DO4

| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 248 | CSS #2 | THRD #2 | RPO #2 | | | | IPEN #2 | DEN #2 |
| 249 | | | | | | MBDT1 #2 | | |
| 250 | MBDT9 #2 | MBDT8 #2 | MBDT7 #2 | MBDT6 #2 | MBDT5 #2 | MBDT4 #2 | MBDT3 #2 | MBDT2 #2 |
| 251 | TLCHB #2 | TLCHA #2 | ESEND #2 | | | | | |
| 252 | | | | | BF #2 | TF #2 | SF #2 | MF #2 |
| 253 | DM30 #2 | DM02 #2 | DM01 #2 | DM00 #2 | | | | |
| 254 | R015 #2 | R014 #2 | R013 #2 | R012 #2 | R011 #2 | R010 #2 | R09 #2 | R08 #2 |
| 255 | R07 #2 | R06 #2 | R05 #2 | R04 #2 | R03 #2 | R02 #2 | R01 #2 | R00 #2 |
| 256 | AR15 #2 | AR14 #2 | AR13 #2 | AR12 #2 | AR11 #2 | AR10 #2 | AR69 #2 | AR8 #2 |
| 257 | AR7 #2 | AR6 #2 | AR5 #2 | AR4 #2 | AR3 #2 | AR2 #2 | AR1 #2 | AR0 #2 |
| 258 | MR15 #2 | MR14 #2 | MR13 #2 | MR12 #2 | MR11 #2 | MR10 #2 | MR69 #2 | MR8 #2 |
| 259 | MR7 #2 | MR6 #2 | MR5 #2 | MR4 #2 | MR3 #2 | MR2 #2 | MR1 #2 | MR0 #2 |
| 260 | | | | | SPAL8 #2 | SPAL4 #2 | SPAL2 #2 | SPAL1 #2 |
| 261 | | | | | | | | |
| 262 | | | | | | | | |
| 263 | | | | | | | | |

BMI-DO5

| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 264 | M31 #2 | M30 #2 | M29 #2 | M28 #2 | M27 #2 | M26 #2 | M25 #2 | M24 #2 |
| 265 | M23 #2 | M22 #2 | M21 #2 | M20 #2 | M19 #2 | M18 #2 | M17 #2 | M16 #2 |
| 266 | M15 #2 | M14 #2 | M13 #2 | M12 #2 | M11 #2 | M10 #2 | M9 #2 | M8 #2 |
| 267 | M7 #2 | M6 #2 | M5 #2 | M4 #2 | M3 #2 | M2 #2 | M1 #2 | M0 #2 |
| 268 | S31 #2 | S30 #2 | S29 #2 | S28 #2 | S27 #2 | S26 #2 | S25 #2 | S24 #2 |
| 269 | S23 #2 | S22 #2 | S21 #2 | S20 #2 | S19 #2 | S18 #2 | S17 #2 | S16 #2 |
| 270 | S15 #2 | S14 #2 | S13 #2 | S12 #2 | S11 #2 | S10 #2 | S9 #2 | S8 #2 |
| 271 | S7 #2 | S6 #2 | S5 #2 | S4 #2 | S3 #2 | S2 #2 | S1 #2 | S0 #2 |
| 272 | T31 #2 | T30 #2 | T29 #2 | T28 #2 | T27 #2 | T26 #2 | T25 #2 | T24 #2 |
| 273 | T23 #2 | T22 #2 | T21 #2 | T20 #2 | T19 #2 | T18 #2 | T17 #2 | T16 #2 |
| 274 | T15 #2 | T14 #2 | T13 #2 | T12 #2 | T11 #2 | T10 #2 | T9 #2 | T8 #2 |
| 275 | T7 #2 | T6 #2 | T5 #2 | T4 #2 | T3 #2 | T2 #2 | T1 #2 | T0 #2 |
| 276 | B31 #2 | B30 #2 | B29 #2 | B28 #2 | B27 #2 | B26 #2 | B25 #2 | B24 #2 |
| 277 | B23 #2 | B22 #2 | B21 #2 | B20 #2 | B19 #2 | B18 #2 | B17 #2 | B16 #2 |
| 278 | B15 #2 | B14 #2 | B13 #2 | B12 #2 | B11 #2 | B10 #2 | B9 #2 | B8 #2 |
| 279 | B7 #2 | B6 #2 | B5 #2 | B4 #2 | B3 #2 | B2 #2 | B1 #2 | B0 #2 |

BMI-DO6

| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 280 | UO031 #2 | UO030 #2 | UO029 #2 | UO028 #2 | UO027 #2 | UO026 #2 | UO025 #2 | UO024 #2 |
| 281 | UO023 #2 | UO022 #2 | UO021 #2 | UO020 #2 | UO019 #2 | UO018 #2 | UO017 #2 | UO016 #2 |
| 282 | UO015 #2 | UO014 #2 | UO013 #2 | UO012 #2 | UO011 #2 | UO010 #2 | UO009 #2 | UO008 #2 |
| 283 | UO007 #2 | UO006 #2 | UO005 #2 | UO004 #2 | UO003 #2 | UO002 #2 | UO001 #2 | UO000 #2 |
| 284 | UO131 #2 | UO130 #2 | UO129 #2 | UO128 #2 | UO127 #2 | UO126 #2 | UO125 #2 | UO124 #2 |
| 285 | UO123 #2 | UO122 #2 | UO121 #2 | UO120 #2 | UO119 #2 | UO118 #2 | UO117 #2 | UO116 #2 |
| 286 | UO115 #2 | UO114 #2 | UO113 #2 | UO112 #2 | UO111 #2 | UO110 #2 | UO109 #2 | UO108 #2 |
| 287 | UO107 #2 | UO106 #2 | UO105 #2 | UO104 #2 | UO103 #2 | UO102 #2 | UO101 #2 | UO100 #2 |
| 288 | UO231 #2 | UO230 #2 | UO229 #2 | UO228 #2 | UO227 #2 | UO226 #2 | UO225 #2 | UO224 #2 |
| 289 | UO223 #2 | UO222 #2 | UO221 #2 | UO220 #2 | UO219 #2 | UO218 #2 | UO217 #2 | UO216 #2 |
| 290 | UO215 #2 | UO214 #2 | UO213 #2 | UO212 #2 | UO211 #2 | UO210 #2 | UO209 #2 | UO208 #2 |
| 291 | UO207 #2 | UO206 #2 | UO205 #2 | UO204 #2 | UO203 #2 | UO202 #2 | UO201 #2 | UO200 #2 |
| 292 | UO331 #2 | UO330 #2 | UO329 #2 | UO328 #2 | UO327 #2 | UO326 #2 | UO325 #2 | UO324 #2 |
| 293 | UO323 #2 | UO322 #2 | UO321 #2 | UO320 #2 | UO319 #2 | UO318 #2 | UO317 #2 | UO316 #2 |
| 294 | UO315 #2 | UO314 #2 | UO313 #2 | UO312 #2 | UO311 #2 | UO310 #2 | UO309 #2 | UO308 #2 |
| 295 | UO307 #2 | UO306 #2 | UO305 #2 | UO304 #2 | UO303 #2 | UO302 #2 | UO301 #2 | UO300 #2 |

| | | BMI-DO7 | | | | | | | |
|-----|--|---------|-------|------|-------|-------|-------|--------|--------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 296 | | MA | SA | OP | STL | SPL | RST | AL | RWD |
| 297 | | | | | | INCH | DST | | |
| 298 | | MARN | | | | | | | |
| 299 | | | MEDT | MMEM | | MD | MJ | MH | MS |
| 300 | | MMLK | MDLK | MABS | | MSBK | | MDRN | MAFL |
| 301 | | | TLALM | | SYALM | OTALM | OHALM | SVALM | PSALM |
| 302 | | | | | RPBSY | | | | |
| 303 | | | | | | | | | |
| 304 | | | | | | | | | |
| 305 | | | | | | | | | |
| 306 | | | | | | | | | |
| 307 | | | | | | | | | |
| 308 | | | | | | | | | |
| 309 | | | | | | | | | |
| 310 | | | | | | | | OHEAD2 | OHEAD1 |
| 311 | | | | | | | | | |

| | | BMI-DO8 | | | | | | | |
|-----|-------|---------|-------|--------|--------|-------|-------|-------|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 312 | EOSTB | | | EIREND | EOHEAD | | | | |
| 313 | EOA7 | EOA6 | EOA5 | EOA4 | EOA3 | EOA2 | EOA1 | EOA0 | |
| 314 | EOD47 | EOD46 | EOD45 | EOD44 | EOD43 | EOD42 | EOD41 | EOD40 | |
| 315 | EOD39 | EOD38 | EOD37 | EOD36 | EOD35 | EOD34 | EOD33 | EOD32 | |
| 316 | EOD31 | EOD30 | EOD29 | EOD28 | EOD27 | EOD26 | EOD25 | EOD24 | |
| 317 | EOD23 | EOD22 | EOD21 | EOD20 | EOD19 | EOD18 | EOD17 | EOD16 | |
| 318 | EOD15 | EOD14 | EOD13 | EOD12 | EOD11 | EOD10 | EOD9 | EOD8 | |
| 319 | EOD7 | EOD6 | EOD5 | EOD4 | EOD3 | EOD2 | EOD1 | EOD0 | |
| 320 | | | | | *REEL | | | TCHK | |
| 321 | | | | | | | | | |
| 322 | | | | | | | | | |
| 323 | | | | | | | | | |
| 324 | | | | | | | | | |
| 325 | | | | | | | | | |
| 326 | | | | | | | | | |
| 327 | | | | | | | | | |

| | | BMI-DO9 | | | | | | | |
|-----|--|---------|------|------|------|-----|-----|-------|------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 328 | | | INP1 | ZP41 | ZP31 | MD1 | MV1 | ZP21 | ZP1 |
| 329 | | | | | | | | MMLK1 | MMI1 |
| 330 | | | | | | | | | |
| 331 | | | | | | | | | |
| 332 | | | INP2 | ZP42 | ZP32 | MD2 | MV2 | ZP22 | ZP2 |
| 333 | | | | | | | | MMLK2 | MMI2 |
| 334 | | | | | | | | | |
| 335 | | | | | | | | | |
| 336 | | | INP3 | ZP43 | ZP33 | MD3 | MV3 | ZP23 | ZP3 |
| 337 | | | | | | | | MMLK3 | MMI3 |
| 338 | | | | | | | | | |
| 339 | | | | | | | | | |
| 340 | | | INP4 | ZP44 | ZP34 | MD4 | MV4 | ZP24 | ZP4 |
| 341 | | | | | | | | MMLK4 | MMI4 |
| 342 | | | | | | | | | |
| 343 | | | | | | | | | |

NOTE Tool posts and BMI

15-TT controls turning machines which can turn one or two workpieces concurrently by operating two tool posts independently.

In other words, it is applicable to either turning machine (with 2 spindles and 2 tool posts) which can turn two workpieces concurrently by using two tool posts with two spindles, or turning machine (with 1 spindle and 2 tool posts) which can turn one workpiece concurrently by using two tool posts with one spindle.

The DI/DO signals of BMI can sorted when dividing them from the viewpoints of tool posts as described below.

(a) DI/DO signals common to two tool posts

A signal having a certain function is provided to both first and second tool posts in common. The reset signal, emergency signal, and other signals that select basic operation modes of the control unit belong to this group. If a memory command operation mode is selected, for example, the memory command operation is selected for both first and second tool posts in common.

Both first and second tool posts are reset or urgently stopped concurrently by the reset or emergency stop signal.

(b) DI/DO signals exclusively provided for individual tool posts

A signal having a certain signal is provided for the first tool post and second tool post independently. These signals are affixed with #1 or #2 at the end of their signal names.

Symbol #1 shows a signal exclusively provided for the first tool post, while symbol #2 shows a signal exclusively provided for the second tool post.

These signals are also subdivided into the following two groups.

– Spindle control DI/DO

The following signals belong to this group.

- i. Command spindle speed signals RO0 – RO15
- ii. Maximum spindle speed signals MR0 – MR15
- iii. Actual spindle speed signals AR0 – MR15
- iv. Spindle motor command voltage signals RISGN, RI0 – RI12

In case of 2 spindles and 2 tool posts;

Individual tool post spindles are controlled by using spindle control DI/DO exclusively provided for tool posts.

In case of 1 spindle and 2 tool posts;

The spindle common to two tool posts is controlled by using spindle control DI/DO signals provided for the first tool post.

– DI/DO other than those for spindle control

The feedrate override signal, auxiliary function code signals, stroke signal, etc. belong to this group. The override of the cutting feedrate can be independently applied to individual tool posts, and auxiliary function code signal and strobe signal are sent to these tool posts independently of each other.

The DI/DO signals provided for each control axis may be said to belong to “DI/DO exclusively provided for individual tool posts” because that the axis controls either tool post only. However, these signals are not affixed with divided by tool posts, but divided by control axis numbers as viewed from the entire system.

In the 15-TT the following three groups are provided as the configuration of control axes.

| | 1st axis | 2nd axis | 3rd axis | 4th axis | 5th axis |
|---|---------------|----------|-----------------|---------------|-----------------|
| 1 | 1st tool post | | 2nd tool post | | Not provided |
| | X1 | Z1 | X2 | Z2 | |
| 2 | 1st tool post | | | 2nd tool post | |
| | X1 | Z1 | Additional axis | X2 | Z2 |
| 3 | 1st tool post | | 2nd tool post | | Additional axis |
| | X1 | Z1 | X2 | Z2 | |

Two axes are provided for each tool post (or, 4 axes in total) as the basic configuration, and one additional axis is provided for either tool post (5 axes in total) as the optional configuration.

(3) FS6M interface signal list

| | | F6M · MI-DI1 | | | | | | | |
|-----|--------------|--------------|-------|-------|-------------|------------|------|------|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 400 | <u>DTCHX</u> | *SVFX | *DECX | *ITX | *-EDX | *+EDX | *-LX | *+LX | |
| 401 | HX | | | | <u>MLKX</u> | MIX | -X | +X | |
| 402 | <u>DTCHY</u> | *SVFY | *DECY | *ITY | *-EDY | *+EDY | *-LY | *+LY | |
| 403 | HY | | | | <u>MLKY</u> | MIY | -Y | +Y | |
| 404 | <u>DTCHZ</u> | *SVFZ | *DECZ | *ITZ | *-EDZ | *+EDZ | *-LZ | *+LZ | |
| 405 | HZ | | | | ZNG | <u>MIZ</u> | -Z | +Z | |
| 406 | 4NG | *SVF4 | *DEC4 | *IT4 | *-ED4 | *+ED4 | *-L4 | *+L4 | |
| 407 | H4 | | | | <u>MLK4</u> | MI4 | -4 | +4 | |
| 408 | MLK | DLK | ABS | OVC | SBK | BDT1 | DRN | AFL | |
| 409 | ZRN | <u>BRN</u> | SRN | KEY | FID | | FIN | ST | |
| 410 | ERS | RRW | *ST | *ESP | SKIP | UINT | SAR | | |
| 411 | GST | SOR | *SSTP | GRB | GRA | SPC | SPB | SPA | |
| 412 | AGJ | EDT | MEN | T | D | J | H | S | |
| 413 | MP4 | MP2 | MP1 | *FV16 | *FV8 | *FV4 | *FV2 | *FV1 | |

| | | F6M · MI-DI2 | | | | | | | |
|-----|--|--------------|-------|-------|-------|--------------|--------------|------|------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 414 | | RT | ROV2 | ROV1 | *JV16 | *JV8 | *JV4 | *JV2 | *JV1 |
| 415 | | BDT9 | BDT8 | BDT7 | BDT6 | BDT5 | BDT4 | BDT3 | BDT2 |
| | | AGSTB | AG24 | AG22 | AG221 | AG18 | AG14 | AG12 | AG11 |
| 416 | | TLRST | | | | | | | |
| 417 | | TLSKP | TL64 | TL32 | TL16 | TL08 | TL04 | TL02 | TL01 |
| 418 | | | | AGST | WN16 | WN8 | WN4 | WN2 | WN1 |
| 419 | | ESTB | EA6 | EA5 | EA4 | EA3 | EA2 | EA1 | EA0 |
| 420 | | ED15 | ED14 | ED13 | ED12 | ED11 | ED10 | ED9 | ED8 |
| 421 | | ED7 | ED6 | ED5 | ED4 | ED3 | ED2 | ED1 | ED0 |
| 422 | | UI15 | UI14 | UI13 | UI12 | UI11 | UI10 | UI9 | UI8 |
| 423 | | UI7 | UI6 | UI5 | UI4 | UI3 | UI2 | UI1 | UI0 |
| 424 | | SIND | | | R13I | R12I | R11I | R10I | R09I |
| 425 | | R08I | R07I | R06I | R05I | R04I | R03I | R02I | R01I |
| 426 | | 5NG | *SVF5 | *DEC5 | *IT5 | <u>*-ED5</u> | <u>*+ED5</u> | *-L5 | *+L5 |
| 427 | | H5 | | | | <u>MLK5</u> | MI5 | -5 | +5 |

(param.)

| | | F6M · MI-DO1 | | | | | | | | |
|-----|--|--------------|-------------|------------|------------|-------------|------------|-------------|------------|----------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| 500 | | MA | SA | OP | STL | SPL | RST | AL | RWD | |
| 501 | | <u>CSS</u> | <u>THRD</u> | <u>RPD</u> | <u>TAP</u> | <u>INCH</u> | DST | <u>IPEN</u> | DEN | |
| 502 | | SSP | SRV | FMF | EF | BF | TF | SF | MF | |
| 503 | | MMIY | SEY | ZP2Y | ZPY | MMIX | SEX | ZP2X | ZPX | |
| 504 | | MMI4 | SE4 | ZP24 | ZP4 | <u>MMIZ</u> | SEZ | ZP2Z | ZPZ | |
| 505 | | TLCHB | TLCHA | ESEND | EREND | MMI5 | <u>SE5</u> | ZP25 | ZP5 | |
| 506 | | M30 | M02 | M01 | M00 | M38 | M34 | M32 | <u>M31</u> | |
| 507 | | M28 | M24 | M22 | M21 | M18 | M14 | M12 | M11 | |
| 508 | | T48 | T44 | T42 | T41 | T38 | T34 | T32 | T31 | |
| 509 | | T28 | T24 | T22 | T21 | T18 | T14 | T12 | T11 | |
| 510 | | B28 | B24 | B22 | B21 | B18 | B14 | B12 | B11 | (param.) |
| | | S52 | S51 | S48 | S44 | S42 | S41 | GRB | GRA | S12BIT-A |
| | | S48 | S44 | S42 | S41 | S38 | S34 | S32 | S31 | S12BIT-B |
| 511 | | S38 | S34 | S32 | S31 | S28 | S24 | S22 | S21 | (param.) |
| | | S28 | S24 | S22 | S21 | S18 | S14 | S12 | S11 | S12BIT-A |
| | | S28 | S24 | S22 | S21 | S18 | S14 | S12 | S11 | S12BIT-B |

| | | F6M · MI-DO2 | | | | | | | | |
|-----|--|--------------|-------|-------|-------|-------|-------|-------|-------|----------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| 512 | | B18 | B14 | B12 | B11 | R12 | R11 | R10 | R09 | (param.) |
| | | B38 | S34 | S32 | S31 | R12 | R11 | R10 | R09 | S12BIT-A |
| | | S58 | S54 | S52 | S51 | R12 | R11 | R10 | R09 | S12BIT-B |
| 513 | | R08 | R07 | R06 | R05 | R04 | R03 | R02 | R01 | |
| 514 | | UO15 | UO14 | UO13 | UO12 | UO11 | UO10 | UO09 | UO08 | |
| 515 | | UO7 | UO6 | UO5 | UO4 | UO3 | UO2 | UO1 | UO0 | |
| 516 | | MMLK | MDLK | MABS | MZNG | MSBK | MBDT1 | MDRN | MAFL | |
| 517 | | MBDT9 | MBDT8 | MBDT7 | MBDT6 | MBDT5 | MBDT4 | MBDT3 | MBDT2 | |
| 518 | | | | | | | | BCLP | BUCL | |

*The underlined signals are added to 6M

DI DTCHX, Y, Z : detach axis
 MLKX, Y, 4, 5 : machine lock axis
 MIZ : mirror image
 * +ED4, 5, * -ED4, 5 : external deceleration
 BRN : block return
 DO CSS : constant cutting speed mode
 THRD : threading mode
 TAP : tapping mode
 INCH : inch input mode
 IPEN : interpolation end
 MMIZ : mirror imaged
 SE5 : axis select

*The following signals are not provided for 6T, but exclusively for 6M.

DI FID, angular jogs (AGJ, AGSTB, AGI1AAG24, AGST), OVRCD, *BECLP, *BEUCL
 DO SSP, SRV, FMF, EF, BF, M 3rd, S 5th, T 3rd-4th, B 1st-3rd, MZNG, BCLP, BUCL

*The following signals are defined in 6T, but not included in above.

DI STLK, XAE, ZAE, PRC, SMZ, CDZ, *SECLP, *SEUCL, SPSTP
 DO SCLP, SUCL

(4) FS6T interface signal list

| | | F6T·MI-DI1 | | | | | | | |
|-----|--------------|------------|-------|------|--------------|--------------|------|------|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 400 | <u>DTCHX</u> | *SVFX | *DECX | *ITX | <u>*-EDX</u> | <u>*+EDX</u> | *-LX | *+LX | |
| 401 | HX | | | | <u>MLKX</u> | MIX | -X | +X | |
| 402 | <u>DTCHZ</u> | *SVFZ | *DECZ | *ITZ | <u>*-EDZ</u> | <u>*+EDZ</u> | *-LZ | *+LZ | |
| 403 | HZ | | | | <u>MLKZ</u> | <u>MIZ</u> | -Z | +Z | |
| 404 | <u>DTCH3</u> | *SVF3 | *DEC3 | *IT3 | <u>*-ED3</u> | <u>*+ED3</u> | *-L3 | *+L3 | |
| 405 | H3 | | | | <u>MLK3</u> | MI3 | -3 | +3 | |
| 406 | <u>DTCH4</u> | *SVF4 | *DEC4 | *IT4 | <u>*-ED4</u> | <u>*+ED4</u> | *-L4 | *+L4 | |
| 407 | H4 | | | | <u>MLK4</u> | <u>MI4</u> | -4 | +4 | |
| 408 | MLK | DLK | ABS | OVC | SBK | BDT1 | DRN | AFL | |
| 409 | ZRN | <u>BRN</u> | SRN | KEY | | | FIN | ST | |
| 410 | ERS | RRW | *ST | *ESP | SKIP | UINT | SAR | STLK | |
| 411 | GST | SOR | *SSTP | | | SPC | SPB | SPA | |
| 412 | | EDT | MEN | T | D | J | HS | | |
| 413 | MP4 | MP2 | MP1 | | GR4 | GR3 | GR2 | GR1 | |

| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----|-------|------|------|-------|--------|--------|------|-------|
| 414 | RT | ROV2 | ROV1 | *OV16 | *OV8 | *OV4 | *OV2 | *OV1 |
| 415 | BDT9 | BDT8 | BDT7 | BDT6 | BDT5 | BDT4 | BDT3 | BDT2 |
| 416 | TLRST | | PRC | | ZAE | XAE | SMZ | CDZ |
| 417 | TLSKP | | | | TL08 | TL04 | TL02 | TL01 |
| 418 | | | | WN16 | WN8 | WN4 | WN2 | WN1 |
| 419 | ESTB | EA6 | EA5 | EA4 | EA3 | EA2 | EA1 | EA0 |
| 420 | ED15 | ED14 | ED13 | ED12 | ED11 | ED10 | ED9 | ED8 |
| 421 | ED7 | ED6 | ED5 | ED4 | ED3 | ED2 | ED1 | ED0 |
| 422 | UI15 | UI14 | UI13 | UI12 | UI11 | UI10 | UI9 | UI8 |
| 423 | UI7 | UI6 | UI5 | UI4 | UI3 | UI2 | UI1 | UI0 |
| 424 | SIND | | | R13I | R12I | R11I | R10I | R09I |
| 425 | R08I | R07I | R06I | R05I | R04I | R03I | R02I | R01I |
| 426 | | | | | *SECLP | *SEUCL | | SPSTP |
| 427 | | | | | | | | |

F6T·MI-DO1

| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----|-------------|-------------|------------|------------|-------------|------------|-------------|-----|
| 500 | MA | SA | OP | STL | SPL | RST | AL | RWD |
| 501 | <u>CSS</u> | <u>THRD</u> | <u>RPD</u> | <u>TAP</u> | <u>INCH</u> | DST | <u>IPEN</u> | DEN |
| 502 | | | | | | TF | SF | MF |
| 503 | <u>MMIZ</u> | <u>SEZ</u> | ZP2Z | ZPZ | <u>MMIX</u> | <u>SEX</u> | ZP2X | ZPX |
| 504 | <u>MMI4</u> | <u>SE4</u> | ZP24 | ZP4 | <u>MMI3</u> | <u>SE3</u> | ZP23 | ZP3 |
| 505 | TLCHB | TLCHA | ESEND | EREND | | | | |
| 506 | M30 | M02 | M01 | M00 | | | | |
| 507 | M28 | M24 | M22 | M21 | M18 | M14 | M12 | M11 |
| 508 | | | | | | | | |
| 509 | T28 | T24 | T22 | T21 | T18 | T14 | T12 | T11 |
| 510 | S48 | S44 | S42 | S41 | S38 | S34 | S32 | S31 |
| 511 | S28 | S24 | S22 | S21 | S18 | S14 | S12 | S11 |
| 512 | | | | | R12 | R11 | R10 | R09 |
| 513 | R08 | R07 | R06 | R05 | R04 | R03 | R02 | R01 |
| 514 | UO15 | UO14 | UO13 | UO12 | UO11 | UO10 | UO9 | UO8 |

F6T: MI-DO2

| | | | | | | | | |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|
| 515 | UO7 | UO6 | UO5 | UO4 | UO3 | UO2 | UO1 | UO0 |
| 516 | MMLK | MDLK | MABS | MZNG | MSBK | MBDT1 | MDRN | MAFL |
| 517 | MBDT9 | MBDT8 | MBDT7 | MBDT6 | MBDT5 | MBDT4 | MBDT3 | MBDT2 |
| 518 | | | | | | | SCLP | SUCL |

*The underlined signals are added to 6T.

DI DTCHX, Z, 3, 4 : detach axis

MLKX, Z, 3, 4 : machine lock axis

MIZ, 3, 4 : mirror image

* +EDX, Z, 3, 4: external deceleration

* -EDX, Z, 3, 4

BRN : block return

DO CSS : constant cutting speed mode

THRD : threading mode

TAP : tapping mode

INCH : inch input mode

IPEN : interpolation end

MMIX, Z, 3, 4 : mirror imaged

SEX, Z, 3, 4 : axis select

*The following signals are not provided for 6M, but exclusively for 6T.

DI STLK, XAE, ZAE, PRC, SMZ, CDZ, *SECCP, *SEUCL, SPSTP

DO SCLP, SUCL

*The following signals are defined in 6M, but not included in above.

DI F1D, angular jogs (AGJ, AGSTB, AG11 A AG24, AGST), OVRCD, *BECLP, *BEUCL

DO SSP, SRV, FMF, EF, BF, M 3rd, S 5th, T 3rd-4th, B 1st-3rd, MZNG, BCLP, BUDL

(5) FS3M interface signal list

| | | F3M-MI-DI1 | | | | | | | |
|-----|--------------|------------|-------|------------|-------------|------------|-----|------|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 400 | <u>DTCHX</u> | *SVFX | *DECX | *ITX | | | | | |
| 401 | HX/ROV1 | | | | <u>MLKX</u> | <u>MIX</u> | -X | +X | |
| 402 | <u>DTCHY</u> | *SVFY | *DECY | *ITY | | | | | |
| 403 | HY/ROV2 | | | | <u>MLKY</u> | <u>MIY</u> | -Y | +Y | |
| 404 | <u>DTCHZ</u> | *SVFZ | *DECZ | *ITZ | | | | | |
| 405 | HZ/DRN | | | | ZNG | <u>MIZ</u> | -Z | +Z | |
| 406 | | | | | | | | | |
| 407 | | | | | | | | | |
| 408 | MLK | DLK | ABS | <u>OVC</u> | SBK | BDT | | AFL | |
| 409 | ZRN | <u>BRN</u> | | KEY | | | FIN | ST | |
| 410 | ERS | | *ST | *ESP | SKIP | | SAR | *ILK | |
| 411 | | SOR | *SSTP | | | SPC | SPB | SPA | |
| 412 | | | | | | MD4 | MD2 | MD1 | |
| 413 | | MP2 | MP1 | | | | | | |

NOTE The additional underlined signals are newer than usual 3M.

| | | F3M-MI-DI2 | | | | | | | |
|-----|------|------------|------|------|------|------|------|------|------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 414 | RT | | | | | *OV8 | *OV4 | *OV2 | *OV1 |
| 415 | | | | | | | | | |
| 416 | | | | | | | | | |
| 417 | | | | | | | | | |
| 418 | | | | | | PN8 | PN4 | PN2 | PN1 |
| 419 | ESTB | EA6 | EA5 | EA4 | EA3 | EA2 | EA1 | EA0 | |
| 420 | ED15 | ED14 | ED13 | ED12 | ED11 | ED10 | ED9 | ED8 | |
| 421 | ED7 | ED6 | ED5 | ED4 | ED3 | ED2 | ED1 | ED0 | |
| 422 | UI15 | UI14 | UI13 | UI12 | UI11 | UI10 | UI9 | UI8 | |
| 423 | UI7 | UI6 | UI5 | UI4 | UI3 | UI2 | UI1 | UI0 | |
| 424 | SIND | SSIN | SGN | | R12I | R11I | R10I | R09I | |
| 425 | R08I | R07I | R06I | R05I | R04I | R03I | R02I | R01I | |

| | | F3M-MI-DO1 | | | | | | | |
|-----|----------|------------|-------------|------------|------------|-------------|-----|-------------|-----|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 500 | | MA | SA | OP | STL | SPL | RST | AL | |
| 501 | | <u>CSS</u> | <u>THRD</u> | <u>RPD</u> | <u>TAP</u> | <u>INCH</u> | DST | <u>IPEN</u> | DEN |
| 502 | | | | | | BF | TF | SF | MF |
| 503 | | | | ZP2Y | ZPY | | | ZP2X | ZPX |
| 504 | | | | | | | | ZP2Z | ZPZ |
| | | | | | | | | | EF |
| | (param.) | | | | | | | | |
| 505 | | | | | EREND | | | | |
| 506 | | <u>M30</u> | <u>M02</u> | <u>M01</u> | <u>M00</u> | | | | |
| 507 | | M28 | M24 | M22 | M21 | M18 | M14 | M12 | M11 |
| 508 | | | | | | | | | |
| 509 | | T28 | T24 | T22 | T21 | T18 | T14 | T12 | T11 |
| 510 | | S28 | S24 | S22 | S21 | S18 | S14 | S12 | S11 |
| | | | | | | | HIG | MDG | LWG |
| | (param.) | | | | | | | | |
| 511 | | B38 | B34 | B32 | B31 | B28 | B24 | B22 | B21 |
| 512 | | B18 | B14 | B12 | B11 | | | | |

| | | F3M-MI-DO2 | | | | | | | |
|-----|--|------------|------|------|------|------|------|-----|-----|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 513 | | | | | | | | | |
| 514 | | UO15 | UO14 | UO13 | UO12 | UO11 | UO10 | UO9 | UO8 |
| 515 | | UO7 | UO6 | UO5 | UO4 | UO3 | UO2 | UO1 | UO0 |
| 516 | | | | | | | | | |
| 517 | | | | | | | | | |
| 518 | | | | | ENB | | | | |

(6) FS3T interface signal list

| | | F3T.MI-DI1 | | | | | | | |
|-----|--------------|------------|-------|------------|-------------|------------|-----|------|------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 400 | <u>DTCHX</u> | *SVFX | *DECX | | | | | | |
| 401 | HX/ROV1 | | | | <u>MLKX</u> | MIX | -X | +X | |
| 402 | <u>DTCHZ</u> | *SVFZ | *DECZ | | | | | | *+LZ |
| 403 | HZ/ROV2 | | | | <u>MLKZ</u> | <u>MIZ</u> | -Z | +Z | |
| 404 | | | | | | | | | |
| 405 | | | | | | | | | |
| 406 | | | | | | | | | |
| 407 | | | | | | | | | |
| 408 | MLK | <u>DLK</u> | ABS | <u>OVC</u> | SBK | BDT | DRN | AFL | |
| 409 | ZRN | <u>BRN</u> | | KEY | | | FIN | ST | |
| 410 | ERS | | *SP | *ESP | SKIP | | SAR | STLK | |
| 411 | | SOR | *SSTP | | | SPC | SPB | SPA | |
| 412 | | | | | | MD4 | MD2 | MD1 | |
| 413 | | MP2 | MP1 | | | | GR2 | GR1 | |

NOTE The additional underlined signals are newer than usual 3T.

| | | F3T·MI-DI2 | | | | | | | |
|-----|------|------------|------|------|------|------|------|------|------|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 414 | RT | | | | | *OV8 | *OV4 | *OV2 | *OV1 |
| 415 | | | | | | | | | |
| 416 | | | PRC | | | ZAE | XAE | SWZ | CDZ |
| 417 | | | | | | | | | |
| 418 | | | | | | PN8 | PN4 | PN2 | PN1 |
| 419 | ESTB | EA6 | EA5 | EA4 | EA3 | EA2 | EA1 | EA0 | |
| 420 | ED15 | ED14 | ED13 | ED12 | ED11 | ED10 | ED9 | ED8 | |
| 421 | ED7 | ED6 | ED5 | ED4 | ED3 | ED2 | ED1 | ED0 | |
| 422 | UI15 | UI14 | UI13 | UI12 | UI11 | UI10 | UI9 | UI8 | |
| 423 | UI7 | UI6 | UI5 | UI4 | UI3 | UI2 | UI1 | UI0 | |
| 424 | SIND | SSIN | SGN | | | R12I | R11I | R10I | R09I |
| 425 | R08I | R07I | R06I | R05I | R04I | R03I | R02I | R01I | |

F3T-MI-DO1

| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|-----|------------|-------------|------------|------------|-------------|------|-------------|-----|
| 500 | MA | SA | OP | STL | SPL | RST | AL | |
| 501 | <u>CSS</u> | <u>THRD</u> | <u>RPD</u> | <u>TAP</u> | <u>INCH</u> | DST | <u>IPEN</u> | DEN |
| 502 | | | | | | TF | SF | MF |
| 503 | | | ZP2Z | ZPZ | | | ZP2X | ZPX |
| 504 | | | | | | | | |
| 505 | | | | EREND | | | | |
| 506 | | | | | | | | |
| 507 | M28 | M24 | M22 | M21 | M18 | M14 | M12 | M11 |
| 508 | | | | | | | | |
| 509 | T28 | T24 | T22 | T21 | T18 | T14 | T12 | T11 |
| 510 | | | | | | | | |
| 511 | S28 | S24 | S22 | S21 | S18 | S14 | S12 | S11 |
| 512 | | | | | R12 | R11 | R10 | R09 |
| 513 | R08 | R07 | R06 | R05 | R04 | R03 | R02 | R01 |
| 514 | UO15 | UO14 | UO13 | UO12 | UO11 | UO10 | UO9 | UO8 |

| | | F3T-MI-DO2 | | | | | | | |
|-----|--|------------|-----|-----|-----|-----|-----|-----|-----|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 515 | | UO7 | UO6 | UO5 | UO4 | UO3 | UO2 | UO1 | UO0 |
| 516 | | | | | | | | | |
| 517 | | | | | | | | | |
| 518 | | | | | ENB | | | | |

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| 03 | Feb., '95 | The following products are added • FANUC Series 150-TB • FANUC Series 150-TTB • FANUC Series 150-MB | | | |
| 02 | Aug., '94 | The explanation of various printed circuit boards was added to the paragraph of the control unit printed circuit boards. | | | |
| 01 | Jan., '93 | _____ | | | |

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