

MITSUBISHI ADJUSTABLE SPEED DRIVE SERIES

AC SPINDLE DRIVE UNITS
FREQROL-SE
STANDARD SPECIFICATIONS

MITSUBISHI ELECTRIC CORPORATION

NAGOYA WORKS

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1. INTRODUCTION

Mitsubishi's FREQROL-SE series of brushless AC spindle drive units are developed in order to cope with the recent requirements in the machine tool industry.

The controllers are DDC inverters which incorporate the our inverter technology which has been accumulated over many years and its vast store of experience in electrical products for machine tools as well as the latest microprocessor technology and power electronics technology. As a result, they offer stable and high-response drive with low vibration and low noise over a wide speed control range and their braking energy can be regenerated in the power supply.

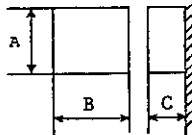
The motors feature the adoption of a unique cooling system for a compact and totally enclosed construction. Since they have no mechanical sliding parts, they are capable of operating at high speeds, they display outstanding immunity from environmental factors and they obviate the need for both inspection and maintenance.

Last but not least, all-electric orientation functions are enabled simply by adding a detector externally. All these features join forces to produce a broad-based enhancement of machine functions.

2. FEATURES

Features of Mitsubishi's new AC spindle drive units

| Item | Specification/ performance | Remarks |
|---|--|---|
| (1) Highly accurate control | Highly accurate control based on current control type of vector control. | 1. 16-bit microprocessor adopted. |
| (2) High speeds | 112 frame: 8000 rpm 132 frame: 6000 rpm | 1. Special cooling construction adopted. 2. Special bearings for high speeds. 3. Built-in detectors adopted. |
| (3) Reduced vibration levels | 132 frame and below: V5 class 160 frame and above: V10 class | 1. Special bearings provided. 2. Improved balancing precision. 3. Enhanced machining precision. |
| (4) Increased precision | All units come under Mitsubishi's machining precision class A control. | Improved machining and assembly precision. |
| (5) Reduced temperature rise | The effects of heat on the machine tool have been cut by: 1. Reduced temperature rise in flanges and shaft ends. 2. Axial direction air expelled to non-load side. | Special cooling construction adopted. |
| (6) Improved reliability | 1. Longer service life through reduced bearing temperature. 2. Coupling-free design thanks to built-in detectors. | 1. Special cooling construction adopted. 2. Special high-speed bearings provided. (Bearing service life: More than double that of current bearings). |
| (7) Refined exterior design | This makes the equipment look classy and supports the improvement in the machine tool's air of precision. | 1. Black-finish paint used. (Munsell: 5.27G2.46/0.21) 2. Cosmetic panels mounted on sides. 3. Two-tone printed rating nameplate employed. 4. Hexagon socket head bolts used. |
| (8) Immunity from power supply problems | 1. High-efficiency and high-response power regeneration. 2. Protection from power supply problems such as both instantaneous outages and voltage drops. | 1. All-transistor type of regenerative converters used. |

| Item | Specification/ performance | Remarks | | | | | | | | | | | | | | |
|--|---|--|---------------|-----------------|-----|------------|--|----------------------|-------------|-------------|-------------|----------------------|---------------|---------------|---------------|--|
| (9) Multiple-application specifications | <ul style="list-style-type: none">o Base speed, maximum speedo Interface specificationso Digital speed BCD/binary conversions can be made with DIP switches. | | | | | | | | | | | | | | | |
| (10) Minimal adjustments and uniform characteristics | <ol style="list-style-type: none">1. Orient adjustments made with DIP switches.2. Minimal effects of temperature fluctuations and individual differences in parts. | 1. Position and speed loops digitized by microprocessor. | | | | | | | | | | | | | | |
| (11) Reduced size of controller | <div></div> <table><tr><th colspan="2">30-minute output rating</th><th>5.5K, 7.5K, 11K</th><th>15K</th><th>18.5K, 22K</th></tr><tr><td rowspan="2">External dimensions AxBxC, unit:mm</td><td>Standard (open type)</td><td>500x314x285</td><td>700x314x285</td><td>750x314x345</td></tr><tr><td>Enclosed type (Note)</td><td>(550x340x345)</td><td>(750x340x345)</td><td>(800x340x345)</td></tr></table> | 30-minute output rating | | 5.5K, 7.5K, 11K | 15K | 18.5K, 22K | External dimensions AxBxC, unit:mm | Standard (open type) | 500x314x285 | 700x314x285 | 750x314x345 | Enclosed type (Note) | (550x340x345) | (750x340x345) | (800x340x345) | |
| 30-minute output rating | | 5.5K, 7.5K, 11K | 15K | 18.5K, 22K | | | | | | | | | | | | |
| External dimensions AxBxC, unit:mm | Standard (open type) | 500x314x285 | 700x314x285 | 750x314x345 | | | | | | | | | | | | |
| | Enclosed type (Note) | (550x340x345) | (750x340x345) | (800x340x345) | | | | | | | | | | | | |
| (12) Compatibility with FR-SX | <ol style="list-style-type: none">1. Electrical specifications and connector pins for inputs/ outputs are identical.2. Mounting dimensions of motors are identical. | | | | | | | | | | | | | | | |

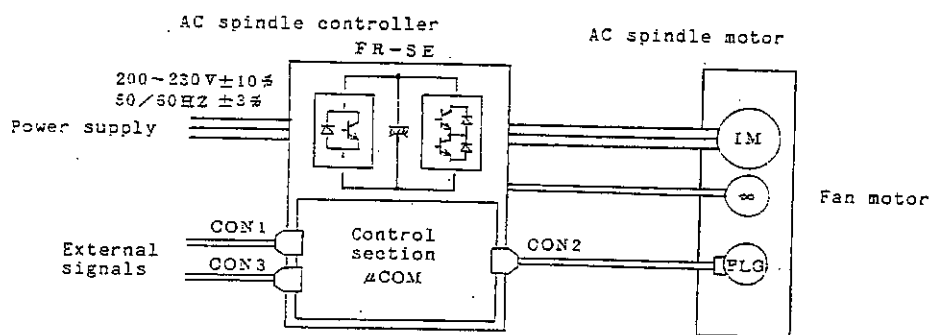
Note: The external dimensions of the enclosed type do not include the optional mounting fixture.

3. CONSTRUCTION

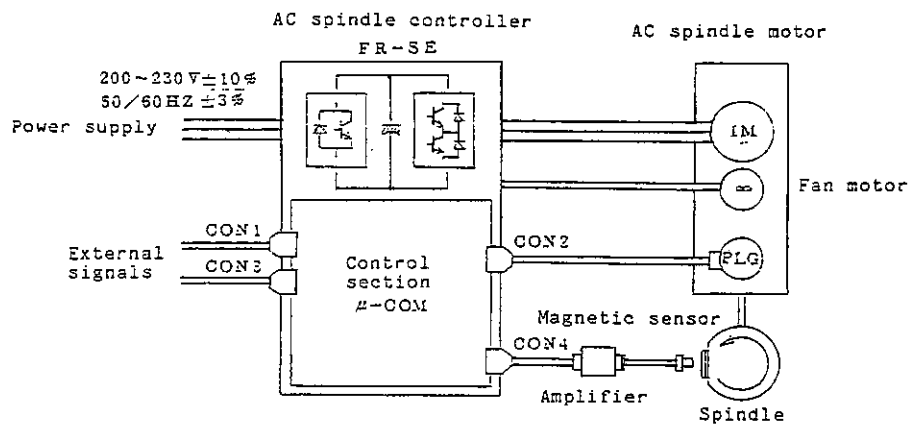
Shown below is the basic construction of the FR-SE type of AC spindle units.

(1) Basic construction

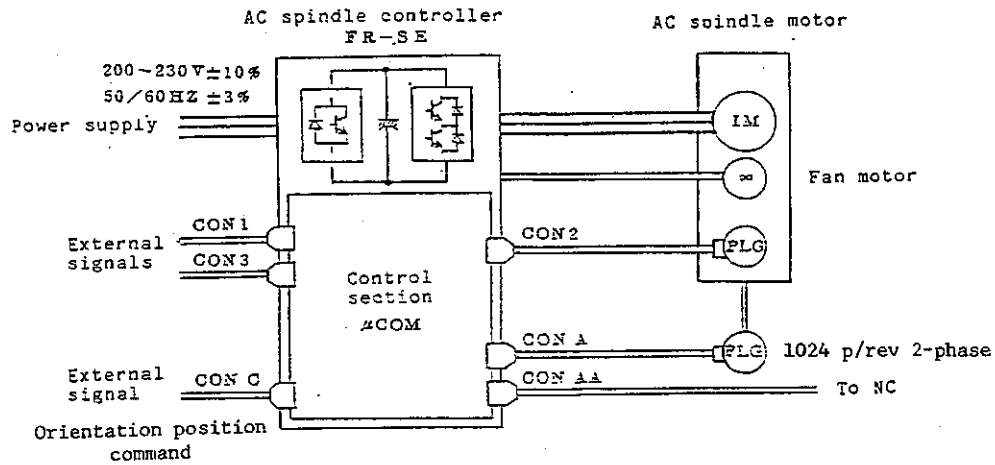
- (a) Type SJ AC spindle motor (with speed detector)
- (b) Type FR-SE AC spindle controller
- (c) Spare fuse



(2) Magnetic sensor system with single point orientation unit



(3) Encoder system with multiple point orientation unit



(4) Internal construction of controller

| Construction | Circuit board construction |
|--|--------------------------------|
| (a) Basic construction | SE-PW, SE-I01, SE-CPU1 or CPU2 |
| (b) Magnetic sensor system With single point orientation unit | SE-PW, SE-I01, SE-CPU1 |
| (c) Encoder system With multiple point orientation unit | SW-PW, SE-I01, SE-CPU2 |

4. AC SPINDLE MOTORS

4.1 STANDARD SPECIFICATIONS

| | | | | | | | |
|---|---------------------------|--|------|------|------|-------|------|
| Output power | Continuous rating (KW) | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 |
| | 30-minute rating (KW) | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 |
| | 50% ED rating (KW) | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 |
| Speed | Base speed (RPM) | 1500 | | | | | |
| | Max. speed (RPM) (Note 1) | 8000 | | 6000 | | 4500 | |
| Frame number | | A112 | B112 | B132 | | C132 | A160 |
| Continuous rated torque (Kgm) | | 2.4 | 3.57 | 4.87 | 7.15 | 9.74 | 12.0 |
| G D ² (Kgm ²) | | 0.08 | 0.10 | 0.17 | 0.21 | 0.27 | 0.55 |
| Weight (Kg) | | 60 | 70 | 100 | 110 | 130 | 175 |
| Allowable radial load (Kg) | | 150 | 200 | 300 | | | |
| Cooling fan (W) | | 35 | | | | | 100 |
| Vibration | | V5 | | | | | V10 |
| Noise (db(A)) | | 75 | | | | | 80 |
| Installation | | Output shaft is horizontal or vertically downward. | | | | | |
| Allowable overload | | 1 minute at 120% of 30-minute rated output. | | | | | |
| Ambient temperature (°C) | | 0 ~ 40 | | | | | |
| Insulation | | class F | | | | | |
| Color of paint | | Munsell 5.27 G 2.46 / 0.21 | | | | | |
| Accessories | | Pulse generator, overheating detector | | | | | |
| Controller type FR-SE-2- | | 5.5K | 7.5K | 11K | 15K | 18.5K | 22K |
| Power capacity (KVA) | | 9 | 12 | 17 | 23 | 28 | 33 |
| Power supply and power line frequency (Note 2) | | 200 / 200 ~ 230 V ± 10%, 50 / 60 Hz ± 3% | | | | | |
| | | | | | | | |

Note 1: A reduced output is obtained for speeds of 4500 rpm and above; this is calculated by:

$$30 \text{ minute rating} \times \frac{4500}{\text{Rotational speed}}$$

Note 2: A power transformer should be provided for use at all voltages not listed here.

4.2 SEMI-STANDARD SPECIFICATIONS

Use the 1150 RPM base below if it is not possible to provide a high reduction gear ratio in the gear system.

| | | | | | | | | |
|---|--------------------------|--|------|------|------|------|-------|------|
| Output power | Continuous rating (KW) | 2.2 | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 |
| | 30-minute rating (KW) | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 |
| | 50% ED rating (KW) | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 |
| Speed | Base speed (RPM) | 1150 | | | | | | |
| | Max speed (RPM) (Note 3) | 8000 | | 6000 | | | 4600 | |
| Frame number | | A112 | B112 | B132 | | C132 | A160 | B160 |
| Continuous rated torque (kgm) | | 1.86 | 3.13 | 4.66 | 6.35 | 9.32 | 12.7 | 15.7 |
| G D ² (kgm ²) | | 0.08 | 0.10 | 0.17 | 0.21 | 0.27 | 0.55 | 0.69 |
| Weight (Kg) | | 60 | 70 | 100 | 110 | 130 | 175 | 200 |
| Allowable radial load (Kg) | | 150 | 200 | 300 | | | | |
| Cooling fan (W) | | 35 | | | | | 100 | |
| Vibration | | V5 | | | | | V10 | |
| Noise (db)(A) | | 75 | | | | | 80 | |
| Installation | | Output shaft is horizontal or vertically downward. | | | | | | |
| Allowable overload | | 1 minute at 120% of 30-minute rated output. | | | | | | |
| Ambient temperature (°C) | | 0 ~ 40 | | | | | | |
| Insulation | | class F | | | | | | |
| Color of paint | | Munsell 5.27 G 2.46 / 0.21 | | | | | | |
| Accessories | | Pulse generator, overheating detector | | | | | | |
| | | | | | | | | |
| Controller type FR-SE-2- | | 3.7K | 5.5K | 7.5K | 11K | 15K | 18.5K | 22K |
| Power capacity (KVA) | | 6 | 9 | 12 | 17 | 23 | 28 | 33 |
| Power supply and power line frequency (Note 4) | | 200 / 200 ~ 230 V ± 10 % , 50 / 60 Hz ± 3 % | | | | | | |
| | | | | | | | | |

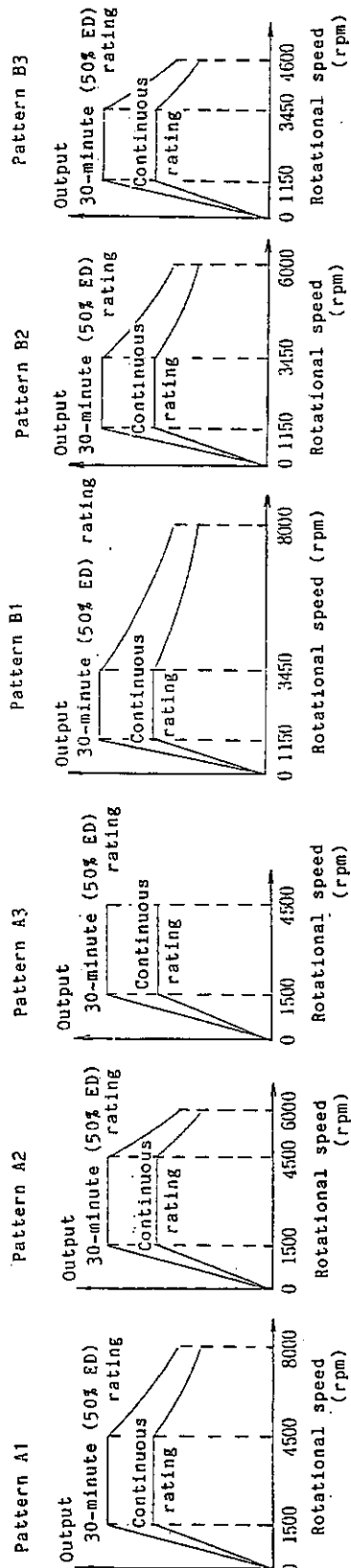
Note 3: A reduced output is obtained for speeds of 3450 rpm and above; this is calculated by:

$$\text{Rating} \times \frac{3450}{\text{Rotational speed}}$$

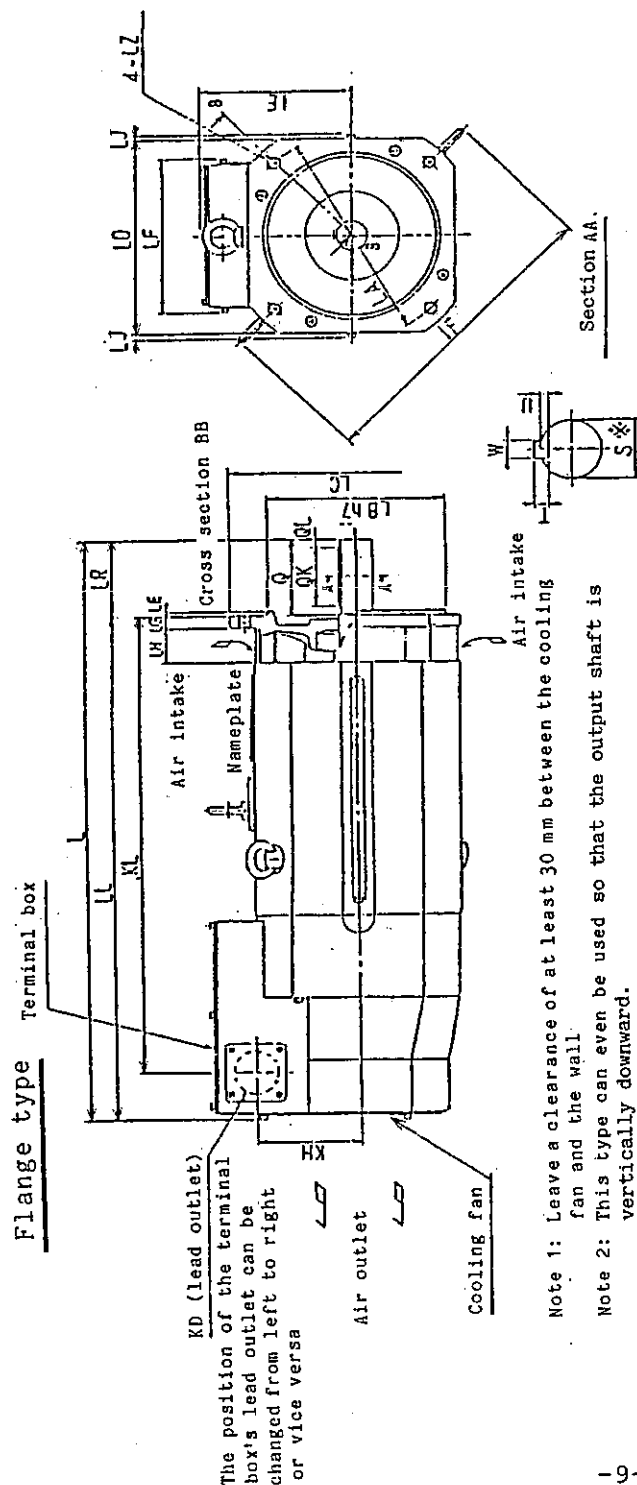
Note 4: A power transformer should be provided for use at all voltages not listed here.

Speed output characteristics

| Type | Standard (1500 RPM base speed) | | | | | | Semi-standard (1150 RPM base speed) | | | | | |
|---|--------------------------------|---------|--------|--------|----------|--------|-------------------------------------|---------|---------|--------|--------|----------|
| | SJ-5.5A | SJ-7.5A | SJ-11A | SJ-15A | SJ-18.5A | SJ-22A | SJ-3.7B | SJ-5.5B | SJ-7.5B | SJ-11B | SJ-15B | SJ-18.5B |
| Continuous rated output (kW) | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 2.2 | 3.7 | 5.5 | 7.5 | 11 | 15 |
| 30-minute (or 50% ED) rated output (kW) | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 |
| Reduced continuous rated output (kW) | 2.0 | 3.0 | 5.5 | 8.0 | 11 | — | 0.9 | 1.5 | 3.0 | 4.0 | 6.0 | 11 |
| Output characteristics pattern | A1 | | | A2 | | | B1 | | | B2 | | |

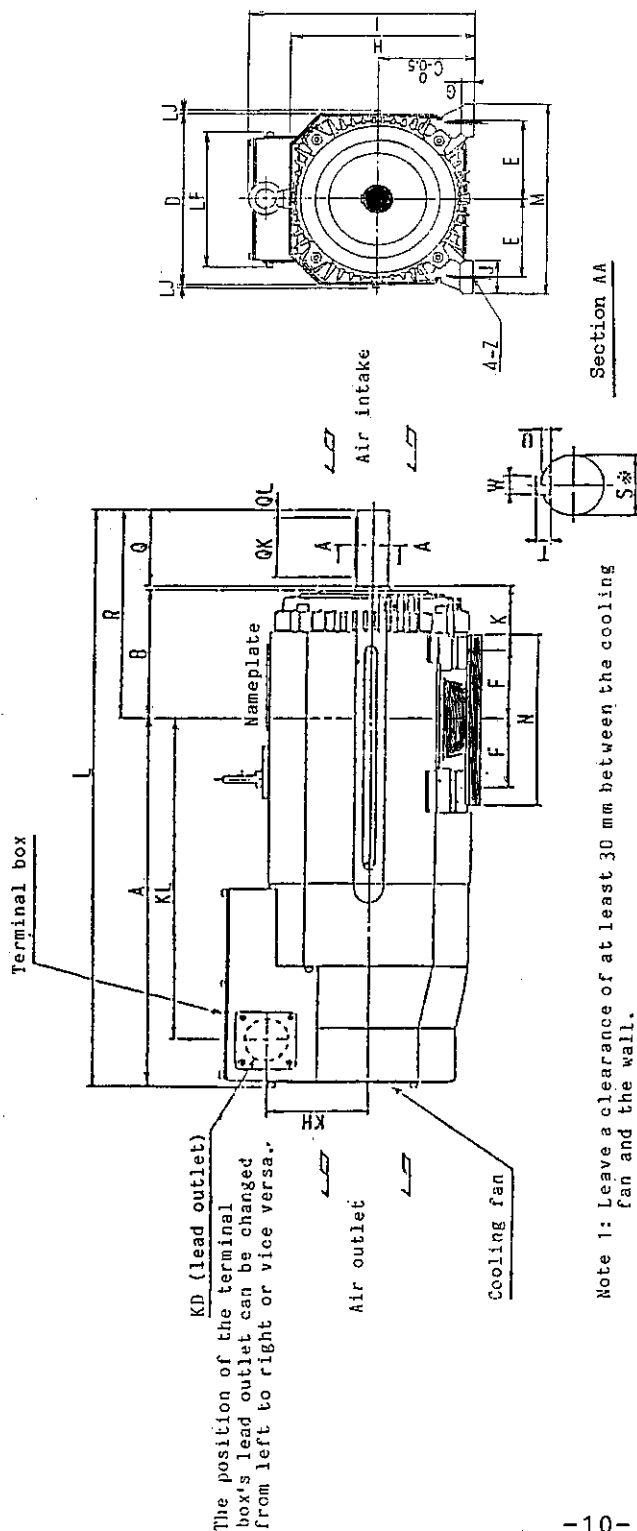


4.3 OUTLINE DRAWINGS OF NEW AC SPINDLE MOTORS



| Frame number | Motor | | | | | | | | | | | | | | Shaft end | | | | | | | | | | | |
|--------------|-------|-----|----|-------|-----|-----|-----|-----|-----|----|-----|----|----|----|-----------|----|-----|-----|-----|----|----|----|----|----|------|----|
| | L | IE | KD | KL | KH | LA | LB | LC | LD | LE | LF | LG | LH | LJ | LL | LZ | IP | LR | Q | QK | S | T | U | W | QL | % |
| A112P | 549 | 152 | 44 | 438 | 102 | 215 | 180 | 250 | 204 | 5 | 164 | 13 | 37 | 7 | 489 | 15 | 317 | 60 | 60 | 45 | 28 | 7 | 4 | 7 | 75 | h6 |
| H112P | 614 | 152 | 44 | 483 | 102 | 215 | 180 | 250 | 204 | 5 | 164 | 13 | 37 | 7 | 534 | 15 | 317 | 80 | 80 | 63 | 32 | 8 | 5 | 10 | 8 | h6 |
| H132P | 677 | 180 | 44 | 516 | 117 | 265 | 230 | 300 | 250 | 5 | 164 | 20 | 39 | 7 | 567 | 15 | 376 | 110 | 110 | 80 | 48 | 9 | 55 | 14 | 10 | h6 |
| G132P | 742 | 180 | 44 | 581 | 117 | 265 | 230 | 300 | 250 | 5 | 164 | 20 | 39 | 7 | 632 | 15 | 376 | 110 | 110 | 80 | 48 | 9 | 55 | 14 | 10 | h6 |
| A160P | 785 | 206 | 51 | 600.5 | 133 | 300 | 250 | 350 | 310 | 5 | 189 | 20 | 50 | 7 | 675 | 19 | 438 | 110 | 110 | 90 | 55 | 10 | 6 | 16 | 10.5 | m6 |
| B160F | 850 | 206 | 51 | 665.5 | 133 | 300 | 250 | 350 | 310 | 5 | 189 | 20 | 50 | 7 | 740 | 19 | 438 | 110 | 110 | 90 | 55 | 10 | 6 | 16 | 10.5 | m6 |

Foot-mounting type



Note 1: Leave a clearance of at least 30 mm between the cooling fan and the wall.

| Frame number | Motor | | | | | | | | | | | | | | | | | | | | Shaft end | | | | | | | | | |
|--------------|-------|-------|-----|-----|-----|-------|----|-----|-----|----|-----|----|-------|-----|-----|----|-----|-----|-----|----|-----------|----|-------|----|----|-----|----|------|----|--|
| | A | B | C | D | E | F | G | H | I | J | K | LD | KL | KH | LP | LJ | L | M | N | Z | Q | OK | R | S | T | U | W | QL | W | |
| A112M | 349 | 135 | 112 | 206 | 95 | 70 | 15 | 215 | 264 | 40 | 70 | 44 | 298 | 102 | 164 | 6 | 549 | 230 | 180 | 12 | 60 | 45 | 200 | 28 | 7 | 4 | 7 | 7.5 | h6 | |
| H112M | 394 | 135 | 112 | 206 | 95 | 70 | 15 | 215 | 264 | 40 | 70 | 44 | 343 | 102 | 164 | 6 | 614 | 230 | 180 | 12 | 80 | 63 | 220 | 32 | 8 | 5 | 10 | 8 | h6 | |
| H132M | 389 | 173 | 132 | 252 | 108 | 89 | 17 | 258 | 312 | 45 | 89 | 44 | 338 | 117 | 164 | 6 | 677 | 260 | 218 | 12 | 110 | 80 | 288 | 48 | 9 | 5.5 | 14 | 10 | h6 | |
| C132L | 441.5 | 185.5 | 132 | 252 | 108 | 101.5 | 17 | 258 | 312 | 45 | 89 | 44 | 390.5 | 117 | 164 | 6 | 742 | 260 | 243 | 12 | 110 | 80 | 300.5 | 48 | 9 | 5.5 | 14 | 10 | h6 | |
| A160L | 440 | 230 | 160 | 312 | 127 | 127 | 20 | 316 | 366 | 55 | 108 | 51 | 365.5 | 133 | 189 | 6 | 785 | 310 | 304 | 15 | 110 | 90 | 345 | 55 | 10 | 6 | 16 | 10.5 | m6 | |
| U160L | 505 | 230 | 160 | 312 | 127 | 127 | 20 | 316 | 366 | 55 | 108 | 51 | 430.5 | 133 | 189 | 6 | 850 | 310 | 304 | 15 | 110 | 90 | 345 | 55 | 10 | 6 | 16 | 10.5 | m6 | |

5. AC SPINDLE CONTROLLERS

5.1 SPECIFICATIONS

| Type FR-SE-2- | | 5.5K | 7.5K | 11K | 15K | 18.5K | 22K |
|---------------------------------------|--------------------|---|------|-----|-----|-------|-----|
| 50% ED Output | Output power | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 |
| | Power capacity | 9 | 12 | 17 | 23 | 28 | 33 |
| Weight | Open type unit | 25 | | 30 | 37 | 48 | |
| | Enclosed type unit | 30 | | 36 | 45 | 56 | |
| Total heat generation (W) (Note 2) | | 340 | 400 | 490 | 590 | 700 | 810 |
| Main circuitry system | | Transistorized sinusoidal wave PWM inverter | | | | | |
| Control system | | Vector control, all-digital speed control using pulse generator feedback. | | | | | |
| Braking system | | Power regenerative braking | | | | | |
| Speed control range | | 35 - 10000 RPM | | | | | |
| Speed fluctuation rate | | Max. 0.2% of maximum speed (at 10-100% load fluctuation) | | | | | |
| Speed commands (Note 1) | | Digital commands: Binary 12-bit or BCD 2-digits Analog commands : +10V max. (approx. 10 kilohms input impedance) | | | | | |
| Ambient temperature humidity | | -5 ~ 55°C/45 ~ 85% | | | | | |
| Atmosphere | | No noxious gases or dust (environmental resistance performance conforms to JEM1103 grade C) | | | | | |
| Vibration | | Max. 0.5G | | | | | |
| Standards conformed to | | I E C | | | | | |
| Cooling | | Air cooling with fan | | | | | |

Note 1: Selection between the binary 12-bit and BCD 2-digit format is enabled by the internal DIP switches and that between the digital and analog commands is enabled by external inputs.

Note 2: This is the amount of heat generated with a continuous rating. In the case of the enclosed unit, the amount of heat generated outside the panel is approximately equivalent to (total heat generation - 120) x 0.7 (W).

5.2 PROTECTION FUNCTIONS

| Name | Function | Description |
|---------------------------|---|--|
| OVER HEAT (MOTOR) | Overload protection | When an overload occurs or when the blower motor stops and the motor itself overheats, the base amp. is cut off and the main circuitry contactor is set OFF. |
| EXCESSIVE SPEED ERROR | Excessive speed error | When the error between the command speed and current speed becomes excessive, the base amp. is cut off and the main circuitry contactor is set OFF. |
| BREAKER TRIP | Short-circuit/ grounding protection | When a high current flows to the main circuitry, the base amp. is cut off and the main circuitry contactor is set OFF. |
| PHASE LOSS | Phase loss protection | The main circuitry contactor is set OFF. |
| EXTERNAL EMERGENCY | External emergency stop | After the emergency stop signal has been received from the external source and the motor has stopped by regenerative braking, the base amp. is cut off and the main circuitry contactor is set OFF. |
| OVER SPEED | Over speed protection | When the speed exceeds 115% of the maximum speed, the base amp. is cut off and main circuitry contactor is set OFF. |
| IOC TRIP (CONVERTER) | Instantaneous over current protection | When an over current flows to the converter, the base amp. is cut off and the main circuitry contactor is set OFF. |
| OVER HEAT (CONTROLLER) | Main circuitry overload protection Air cut-off protection | When the ambient temperature is abnormal or when an overload occurs or when the air-cooling fan stops and the main circuitry elements over heat, the base amp. is cut off and the main circuitry contactor is set OFF. |

| Name | Function | Description |
|-----------------------------------|--|--|
| UNDER VOLTAGE | Main power supply drop protection | When the supply voltage drops, the base amp. is cut off and the main circuitry contactor is set OFF. |
| OVER (VOLTAGE REGENERATION) | Main circuitry over voltage protection | When an over voltage occurs with regeneration of the main circuitry's capacitor voltage, the base amp. is cut off and the main circuitry contactor is set OFF. |
| IOC TRIP (INVERTER) | Instantaneous over current protection | When an over current flows to the inverter, the base amp. is cut off and the main circuitry contactor is set OFF. |

Note:

When any of these protection functions except the external emergency stop signal is activated, the base amp. (the inverter and regenerative converter) is cut off, the main circuitry contactor is set OFF and the motor stops by free-running.

5.3 AUXILIARY FUNCTIONS

| Function | Application | Details | Output |
|---|------------------------------------|---|----------------------|
| Load meter signal | Load meter connections | Connect a single-deflection DC 1mA meter; full-scale and 3V or 10V/120% load outputs under a 120% (100-120% adjustable) are obtained. | |
| Speed meter signal | Speed meter connections | Connect a single-deflection DC 1mA meter; full-scale and 10V/maximum speed outputs at maximum speed are obtained. | |
| Zero speed signal | Machine interlock | An ON-setting contact signal is obtained at less than a motor speed of 50 rpm or 25 rpm. | Contact/open emitter |
| Up to speed signal | Answer back to NC | Obtained is a signal which actuates the output transistors at within +/- 15% of the set speed. | Open emitter |
| Load detection signal | Cutter intrusion prevention | Obtained is a signal which actuates the output transistors above a current value (110% output) near the current limit value (120% output). | Open emitter |
| Overried | Overriede with automatic operation | Variable range: 50-120% Released by controller terminal signal DEF off. | |
| Orientation (optional function) | Orientation | Single point positioning possible for magnetic sensor system, multiple-point positioning possible for encoder system. Started by orientation start signals (ORC1, ORC2); orientation finish signal is output upon completion. | Contact/open emitter |
| Torque limitation | Gear shift, etc. | With gear shifting, etc., the torque limitation is temporarily reduced and the spindle motor is operated. During torque limitation, signal for output transistor continuity. | Open emitter |
| Speed detection signal | | Obtained is a signal which activates the output transistors with a motor speed absolute value of less than the prescribed detection level. Speed detection value ranges from 2% to 58% in 8% steps and can be set to any of 8 steps. | Open emitter |
| Acceleration/deceleration time constant | | Acceleration/deceleration of speed command is restricted. | |

Front panel



AC SPINDLE CONTROLLER model FR-SE

CONTROL INDICATORS

| | | |
|-----------------------|-------|-------------------|
| <input type="radio"/> | LED1 | PHASE SEQUENCE |
| <input type="radio"/> | LED2 | READY |
| <input type="radio"/> | LED3 | CW DRIVE |
| <input type="radio"/> | LED4 | CCW DRIVE |
| <input type="radio"/> | LED5 | SPEED DETECTION |
| <input type="radio"/> | LED6 | CURRENT DETECTION |
| <input type="radio"/> | LED7 | UP TO SPEED |
| <input type="radio"/> | LED8 | APPROACH |
| <input type="radio"/> | LED9 | IN POSITION |
| <input type="radio"/> | LED10 | ZERO SPEED |
| <input type="radio"/> | LED11 | SENSITIVITY |

ORIENTATION (OPTION) ←

FAULT INDICATORS

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|-----------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|
| <input type="radio"/> LED12 (AL8) | | | | | | | | ● | ● | ● | ● | ● | ● | ● | ● |
| <input type="radio"/> LED13 (AL4) | | | | ● | ● | ● | ● | | | | | ● | ● | ● | ● |
| <input type="radio"/> LED14 (AL2) | | ● | ● | | | ● | ● | | | ● | ● | | | ● | ● |
| <input type="radio"/> LED15 (AL1) | ● | | ● | | ● | | ● | | ● | | ● | | ● | | ● |

MOTOR OVER HEAT
EXCESSIVE SPEED ERROR
BLANK
BREAKER TRIP
PHASE LOSS
EXTERNAL EMERGENCY
OVER SPEED
CONVERTER I.O.C.
CONTROLLER OVER HEAT
UNDER VOLTAGE
OVER VOLTAGE
INVERTER I.O.C.
CPU FAULT1
CPU FAULT2
CPU FAULT3

| | |
|--------|----------------------|
| TYPE | FR-SE - - K - |
| BN | 00000000 |
| SERIAL | 00000000000000000000 |

TYPE

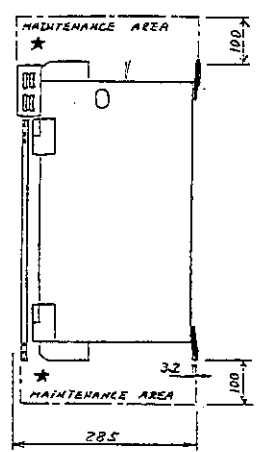
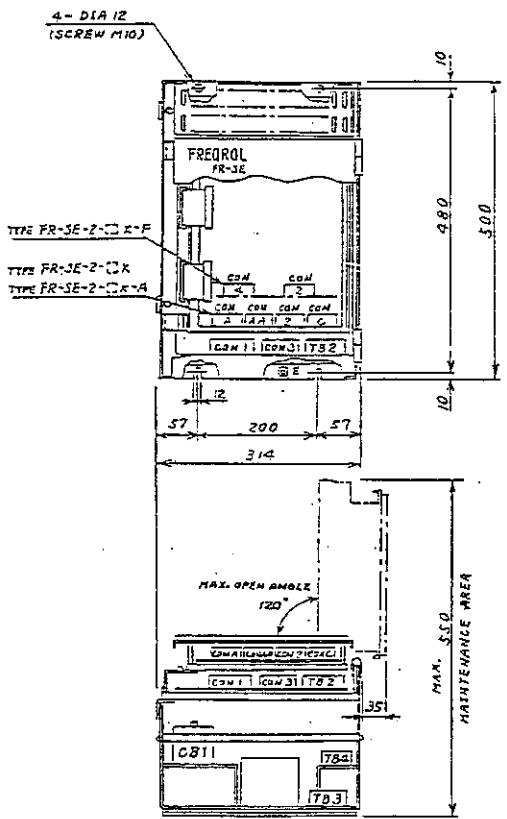
Nameplate serial manufacturing check number
number date

number of order
parts list

5.4 OUTLINE DRAWINGS (Open type)

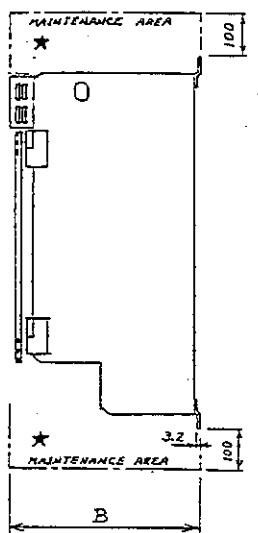
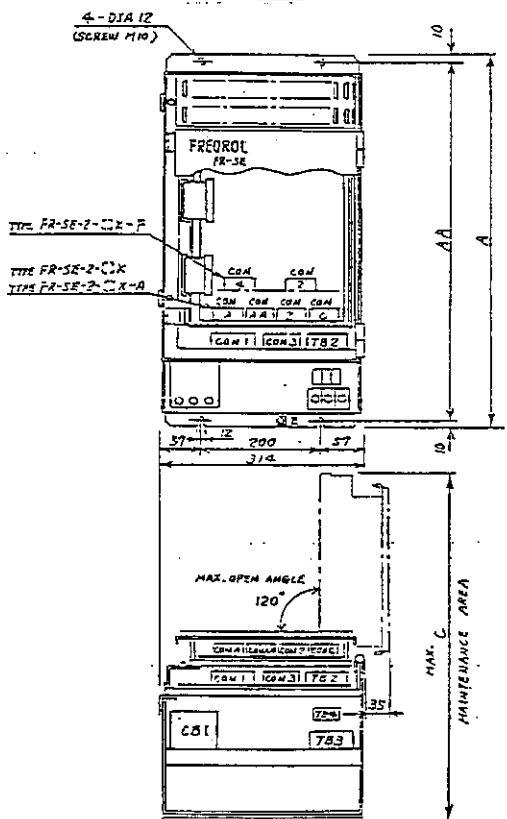
Note: Areas marked with an asterisk (*) denote that a clearance should be left for wiring and heat dissipation.

FR-SE-2-3.7~11K



| Capacity | Terminal block screw sizes | | | | |
|--------------------|----------------------------|-----|-----|------|-------|
| | CB1 | TB3 | TB2 | TB4 | EARTH |
| FR-SE-2- 3.7k~7.5k | M5 | M5 | M3 | M3.5 | M6 |
| FR-SE-2- 11k | M5 | M6 | M3 | M3.5 | M6 |

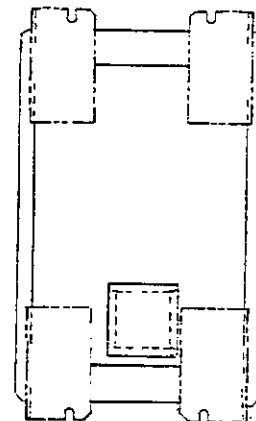
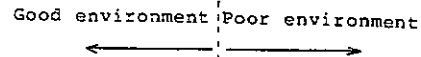
FR-SE-2-15~22K



| Table of changed dimensions | | | | | Terminal block screw sizes | | | | |
|-----------------------------|-----|-----|-----|-----|----------------------------|-----|-----|------|-------|
| Capacity | A | AA | B | C | CB1 | TB3 | TB2 | TB4 | EARTH |
| FR-SE-2-15K | 700 | 680 | 285 | 550 | M8 | M6 | M3 | M3.5 | M8 |
| FR-SE-2-18,5K,22K | 750 | 730 | 345 | 610 | M8 | M8 | M3 | M3.5 | M8 |

FR - SE - 2 - 3.7-11K c

(A) Mounting fixture

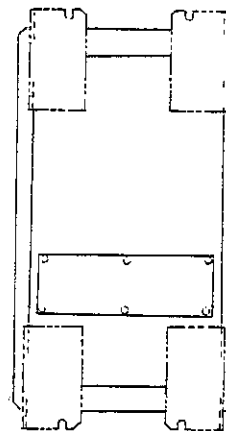
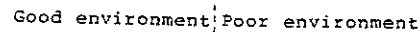
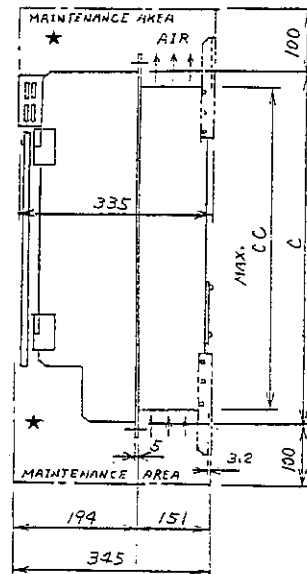


Rear view

1. The air has been cut off at the broken line area (intermediate panel) in the side view. Referring to the mounting reference diagram, decide whether the environment is good or poor and mount, and proceed with the mounting.
2. Provide clearances for the connections and heat dissipation in the ranges designated by an asterisk.
3. Mounting fixture (A) is optional.
4. The terminal block screw sizes are identical to those of the standard (open) type.

FR-SE-2-15~22 K

(A) Mounting Fixture



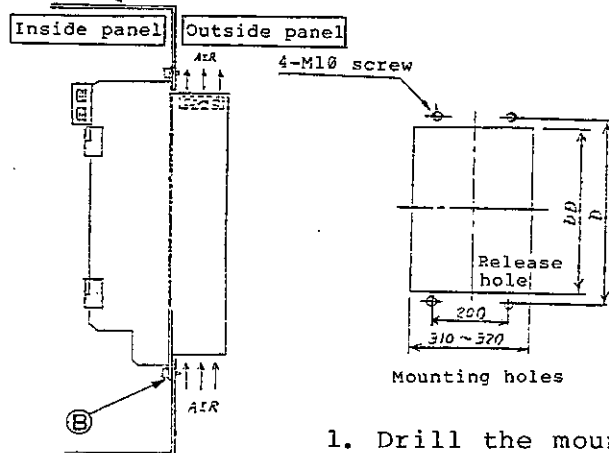
| | A | AA | B | BB | C | CC |
|-------------------|-----|-----|-----|-----|-----|-----|
| FR-SE-2-15K | 800 | 780 | 750 | 730 | 700 | 680 |
| FR-SE-2-18.5K.22K | 850 | 830 | 800 | 780 | 750 | 730 |

1. The air has been cut off at the broken line area (Intermediate panel) in the side view. Referring to the mounting reference diagram, decide whether the environment is good or poor and mount, and proceed with the mounting.
2. Provide clearances for the connections and heat dissipation in the ranges designated by an asterisk.
3. Mounting fixture (A) is optional.
4. The terminal block screw sizes are identical to those of the standard (open) type.

Mounting reference diagram

Example 1: Intermediate panel system

power supply board

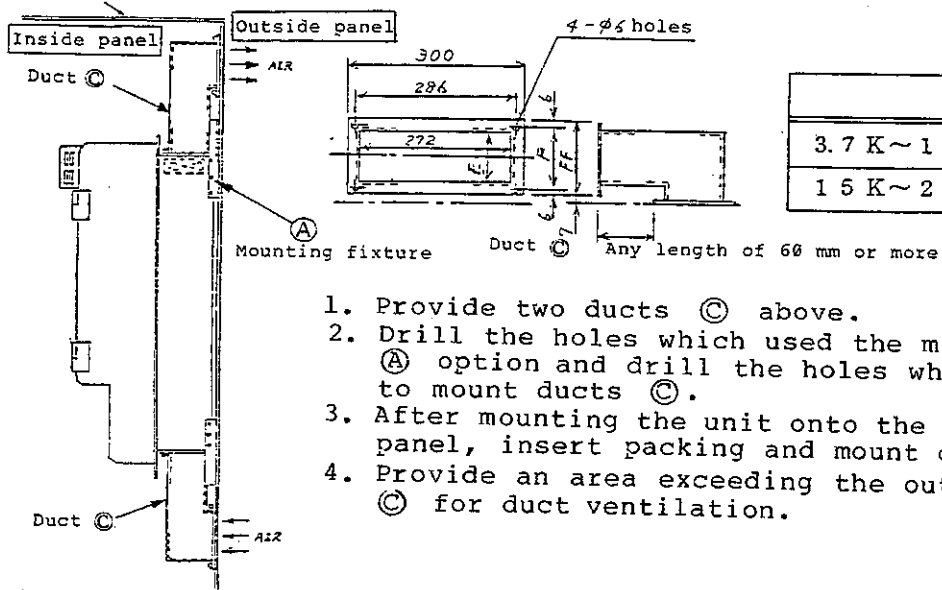


| | D | DD |
|--------------|-----|-----|
| 3.7 K ~ 11 K | 530 | 500 |
| 15 K | 730 | 700 |
| 18.5 K, 22 K | 780 | 750 |

1. Drill the mounting holes in the power supply board, as shown in the figure above.
2. Insert packing between the intermediate panel area and the power supply board and mount at the four locations ③ using the bolts.

Example 2: Duct system

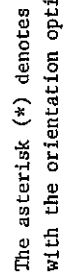
Power supply board



| | E | F | FF |
|--------------|-----|-----|-----|
| 3.7 K ~ 11 K | 92 | 96 | 108 |
| 15 K ~ 22 K | 126 | 130 | 142 |

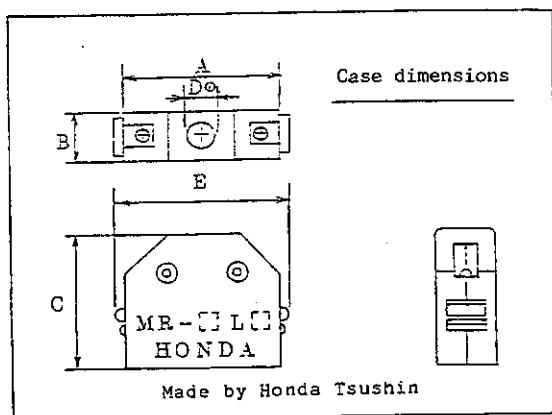
1. Provide two ducts ③ above.
2. Drill the holes which used the mounting fixture ① option and drill the holes which will be used to mount ducts ③.
3. After mounting the unit onto the power supply panel, insert packing and mount ducts ③.
4. Provide an area exceeding the outlet of ducts ③ for duct ventilation.

Magnetic sensor system with single point orientation unit



5.6 CONNECTOR DESCRIPTION

The cable connectors are not supplied with the equipment and should be provided by the user. Connectors made by Honda Tsushin are compatible.



| No. of pins - | Type | A | B | C | Dφ | E |
|---------------|--------|------|----|------|----|--------|
| 50 | MR-50L | 67.9 | 18 | 44.8 | 16 | (73.5) |
| 20 | MR-20L | 39.3 | 18 | 39.8 | 11 | (44.9) |

CON 1

MR-50LF

| | | | | | | | | | | | | | | | | | |
|-----|-----|------|------|-----|-----|-----|-----|------|------|------|------|------|-----|-------|-------|-----|-----|
| 50 | 49 | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 |
| SM1 | LM1 | ESP2 | ESP1 | SRI | SRN | R12 | R11 | R10 | R9 | R8 | R7 | R6 | R5 | R4 | R3 | R2 | R1 |
| | | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | | |
| | | SE2 | SE1 | SES | RP | OR2 | OR3 | ORC2 | ORC1 | CTM | ORA2 | ORA1 | TL2 | ARST2 | ARST1 | | |
| 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| OM | CTL | OR1 | ORS | OS | RO | FC | FA | | | SET2 | SET1 | OT | TL1 | ZS2 | ZS1 | SM0 | LM0 |

CON 2

MR-20LF

| | | | | | | |
|----|------|----|----|------|------|-----|
| 20 | 19 | 18 | 17 | 16 | 15 | 14 |
| SS | | | RB | PB | RA | PA |
| | 13 | 12 | 11 | 10 | 9 | 8 |
| | R15C | | | | | COM |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | N15C | | | OES1 | OES2 | AGA |

CON 3

MR-20LM

| | | | | | | |
|-----|-----|-----|-----|-----|------|-----|
| 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| ZSO | USO | VRO | CDO | FLO | ORA0 | COM |
| | 8 | 9 | 10 | 11 | 12 | 13 |
| | AL1 | AL2 | AL4 | AL8 | | COM |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| TLO | | | DEF | OD | DIG | OA |

- o In case of a magnetic sensor orientation (option) use the connector indicated below.

CON 4

MR-20LF

| | | | | | | |
|----|----|-----|-----|-----|-----|-----|
| 20 | 19 | 18 | 17 | 16 | 15 | 14 |
| OG | OH | P15 | LSC | LSA | MSC | MSA |
| | 13 | 12 | 11 | 10 | 9 | 8 |
| | | | | | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | | | | | | |

- o In case of an encoder system orientation (option) the connectors indicated below.

CONA • CONAA

MR-20LF

| | | | | | | |
|----|-----------------|-----|-----------------|----|-----------------|----|
| 20 | 19 | 18 | 17 | 16 | 15 | 14 |
| OG | \overline{PB} | PB | \overline{PA} | PA | \overline{SC} | SC |
| | 13 | 12 | 11 | 10 | 9 | 8 |
| | | | | | | |
| 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| | P5H | P5H | P5H | OH | OH | OH |

CONC

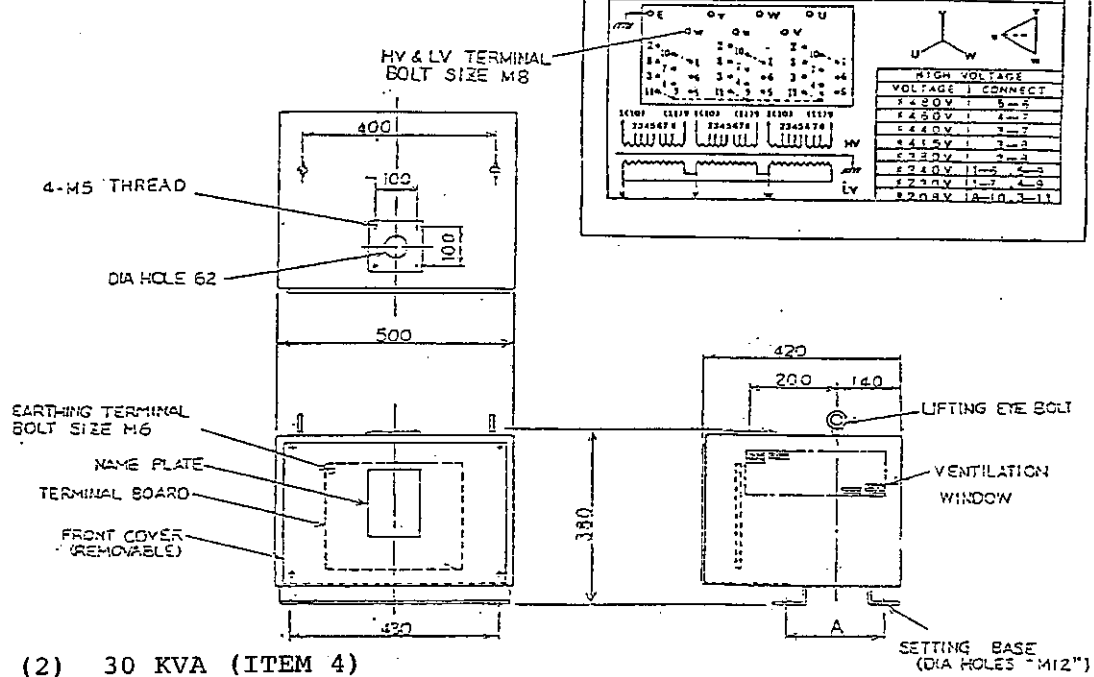
MR-20LM

| | | | | | | |
|----|-----|-----|-----|-----|-----|-----|
| 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| OL | 12H | 11H | 10H | 09H | 08H | 07H |
| | 8 | 9 | 10 | 11 | 12 | 13 |
| | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | 06H | 05H | 04H | 03H | 02H | 01H |

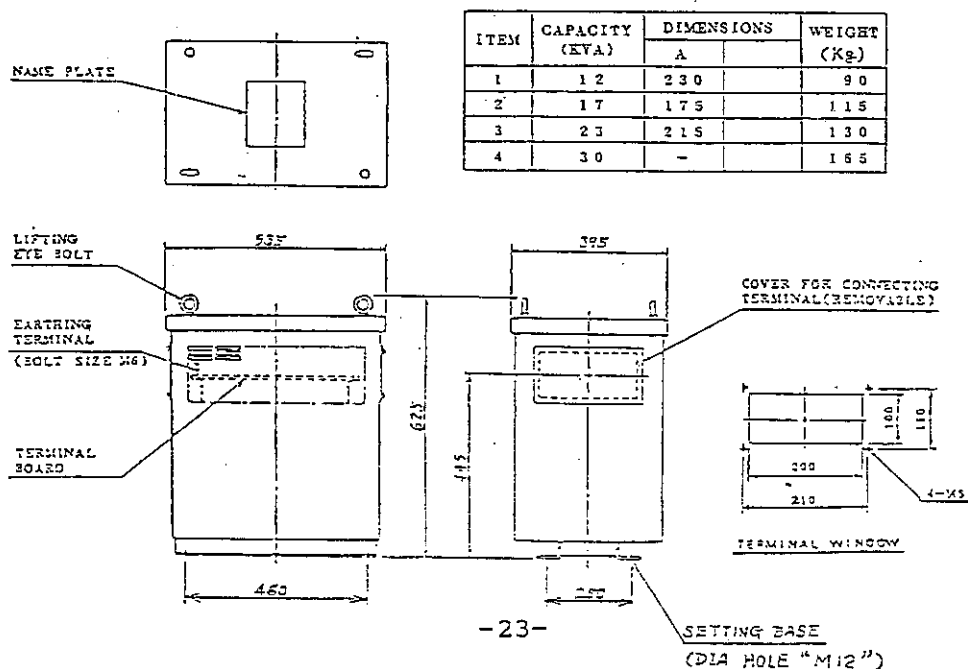
5.7 VOLTAGE-REDUCING POWER TRANSFORMER (OPTION)

Provide a voltage-reducing power transformer when supplying power is the 400V class to the equipment.

(1) 12 - 23 KVA (ITEM 1 - 3)

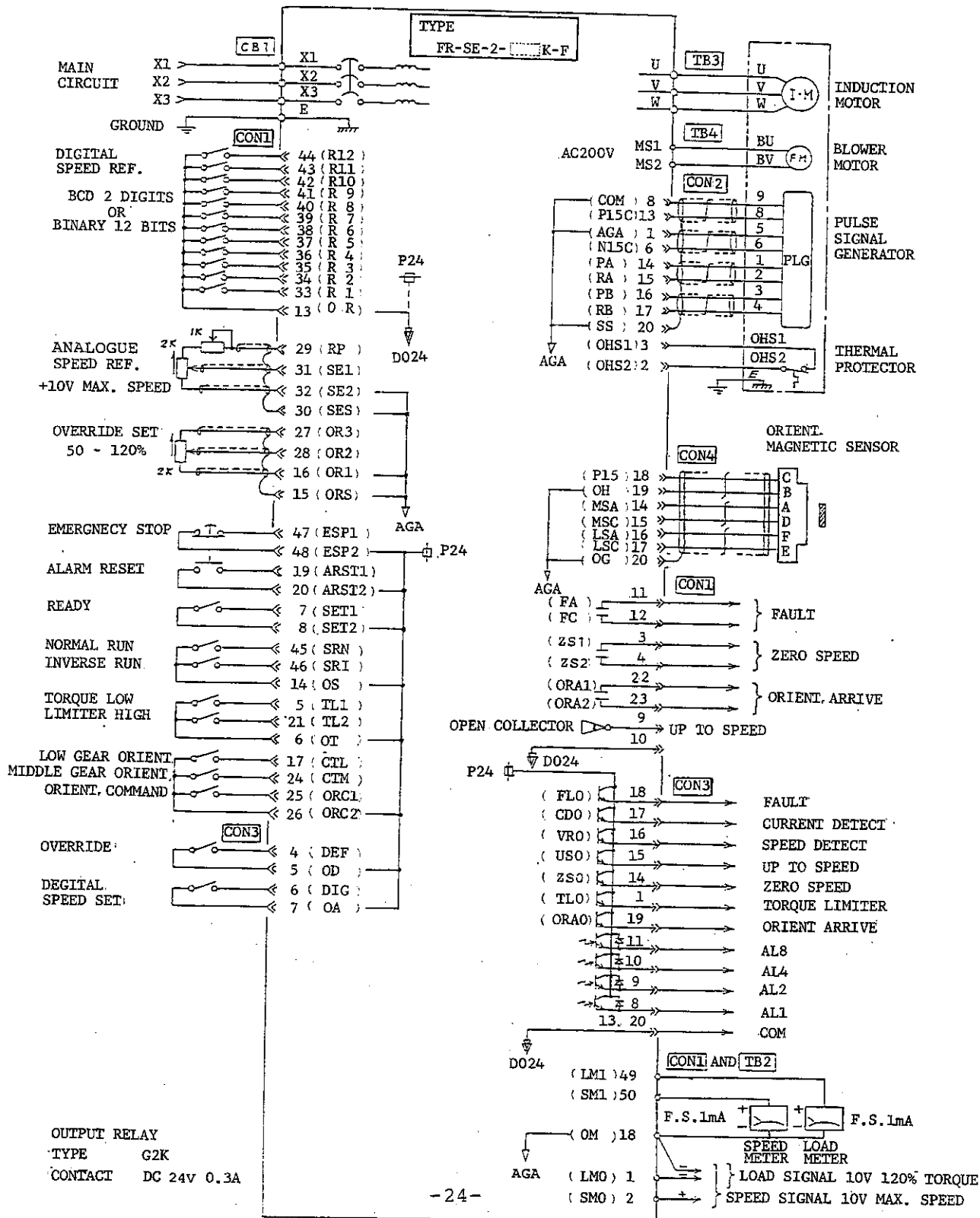


(2) 30 KVA (ITEM 4)

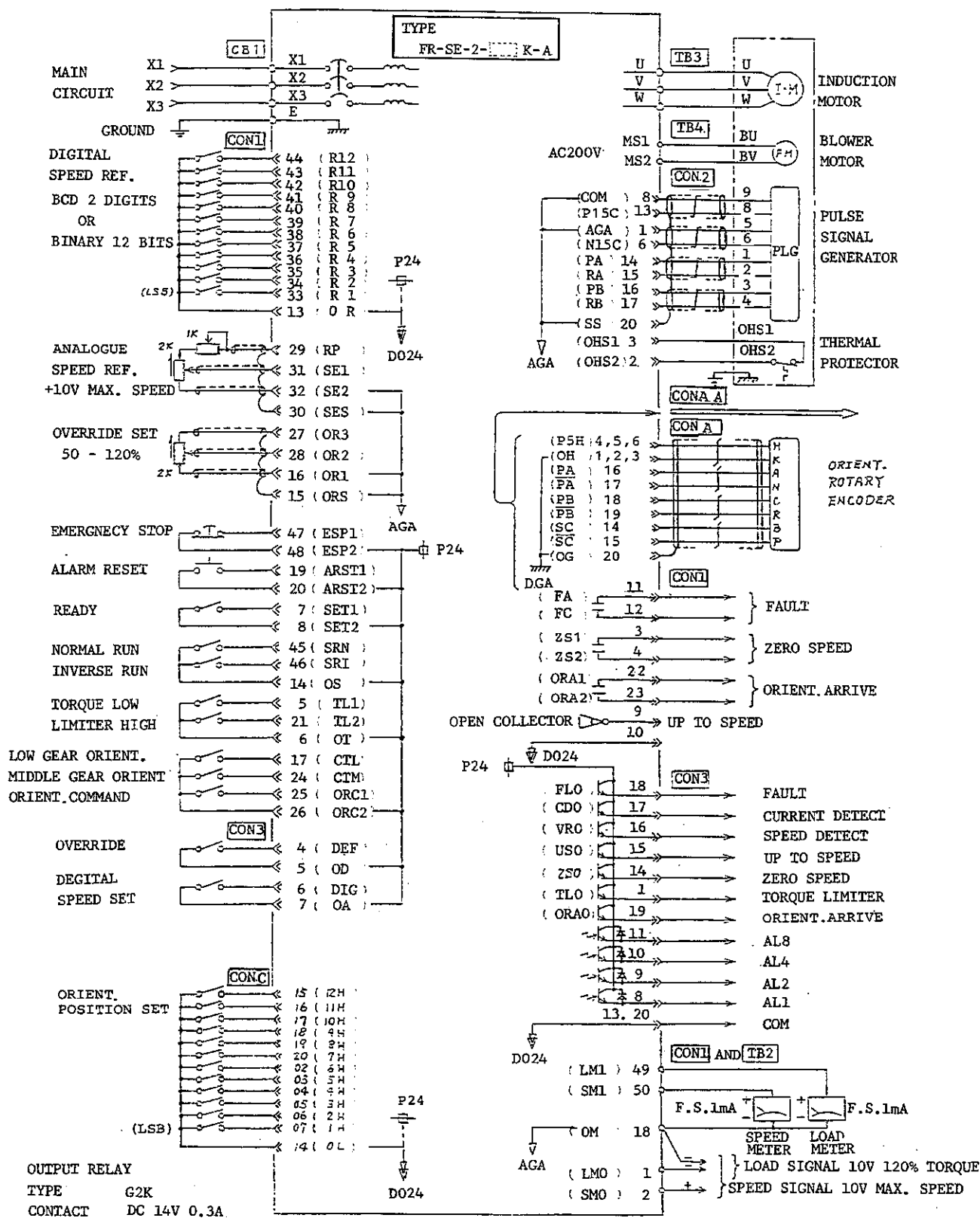


6. EQUIPMENT CONNECTIONS

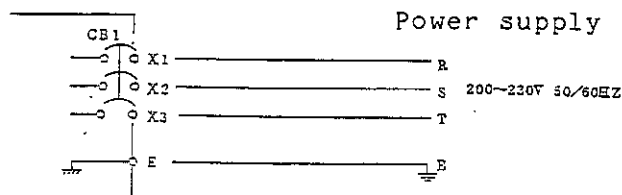
6.1 MAGNETIC SENSOR SYSTEM WITH SINGLE POINT ORIENTATION



6.2 ENCODER SYSTEM WITH MULTIPLE POINT ORIENTATION



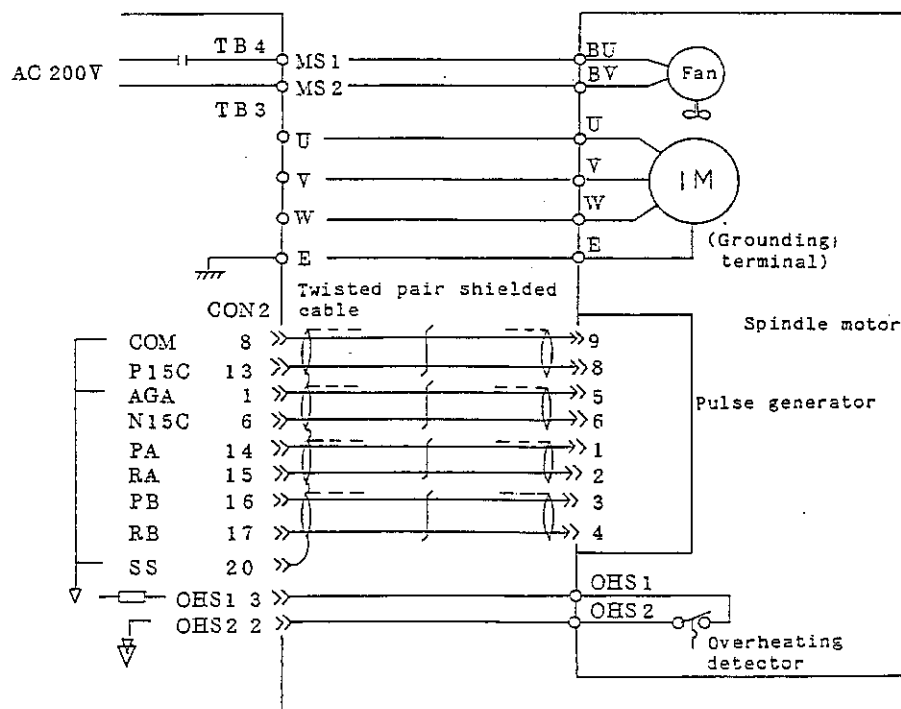
6.3 INCOMING POWER



- (a) The value pertaining to the power supply equipment capacity listed in the specifications columns should be adhered to.
- (b) Use the size of electrical wire mentioned on page 52 for the incoming power supply.

If wires are to be laid over a long distance, use thickish wires in order to avoid increasing power line fluctuations.

6.4 MOTORS



- (a) The fan for cooling the motor operates while the machine ready signal is ON.
- (b) Refer to page 52 for the size of the main circuitry
- (c) Use a twisted pair shielded wire for the cable to the pulse generator.

6.5 CONTROL INPUT SIGNALS

[1] Machine set-up ready signal (SET1, SET2)

- (1) This signal make the base amp. cut-off, main circuitry contactor ON (closed) and the fan motor set on.
- (2) In case that this signal is OFF in operating the motor stop by free-running and base amp. is cut off.
- (3) In cases that the operator touches the spindle directly for setting or replacing the workpieese or tools, set the machine set-up ready signal OFF as a safety measure. This need not be done when there is an extremely high frequency of use (several hundred times a day).

[2] Emergency stop (ESP1, ESP2) normally ON

- (1) When the emergency stop signal contact is set OFF (open) the motor decelerates and stops with regenerative operation and the base amp. is cut off after the motor has stopped. SW7-2 on the CPU card can be used to select whether fault signals are to be output or not.
- (2) When the emergency stop signal contact is set to ON (close) again, operation is enabled.

In this case, operation follows immediately when the rotation command is set from OFF to ON.

Therefore, set the forward and reverse signals to the reset status with an external sequence.

| | | |
|------|---|-----------------------------|
| SW7- | 2 | |
| | o | LED ON with emergency stop |
| | x | LED OFF with emergency stop |

[3] Alarm reset signal (ARST1, 2)

These signals set the trouble flags and microcomputer on the FR-SE to the all-reset (initialization) status.

The pushbutton on the circuit board also serves to reset the microcomputer and trouble flags.

[4] Speed command digital/analog selection signal (DIG, OA)

When the input contact is ON(close), the digital setting speed command (automatic from NC) is effective: when it is OFF(open), the analog setting speed command (manual VR setting) is effective.

The digital setting speed command (binary 12 bits/BCD 2 digits) can be selected using the DIP switch inside the unit.

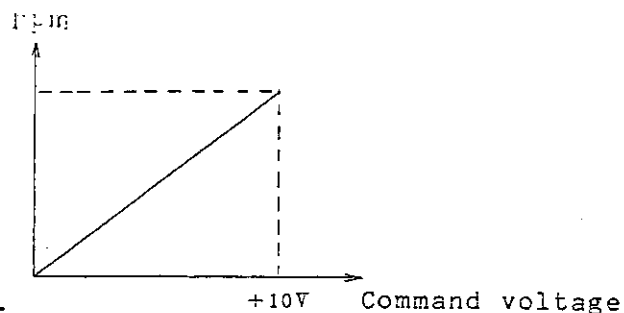
| | | |
|------|---|--------------------------------|
| SW6- | 3 | |
| | o | Speed command in binary format |
| | x | Speed command in BCD format |

Note: "o" denotes the switch ON side, "x" the OFF side.

[5] Analog speed command voltage (SE1, SE2)

Maximum speed
(3450/4500/4600
6000/8000/10000) rpm.

The maximum speed is
set with the DIP switches.



- (1) Supply a positive voltage as the command voltage.
 - (2) The motor rotates in the forward or reverse direction with the forward or reverse direction command. (It does not rotate with the command voltage alone.)
 - (3) The motor may not stop completely even with a speed command voltage of 0V due to offset or other factors.
 - (4) Cut off the forward and reverse rotation commands in order to stop the motor completely.
 - (5) The maximum speed and base speed are selected by the DIP switch settings.
 - (6) An external input signal is used to switch over to the digital speed command.
- [6] Digital speed input commands
- Both the BCD coded 2-digit (S2-digit) 8-bit and pure binary 12-bit digital speed input signals can be selected by using the DIP switch.

(Example)

BCD coded 2-digit (S2-digit) 8-bit signal

| BCD code | Motor speed (6000 rpm) | Motor speed (4500 rpm) |
|----------|------------------------|------------------------|
| 00 | 0 rpm | 0 rpm |
| 01 | 60 rpm | 45 rpm |
| 02 | 120 rpm | 90 rpm |
| o | o | o |
| o | o | o |
| o | o | o |
| o | o | o |
| 98 | 5940 rpm | 4455 rpm |
| 99 | 6000 rpm | 4500 rpm |

When the BCD code is "99":

| | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|----------------|
| 9 | | | | 9 | | | | |
| 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | |
| R08 | R07 | R06 | R05 | R04 | R03 | R02 | R01 | Input terminal |

Pure binary 12-bit signal

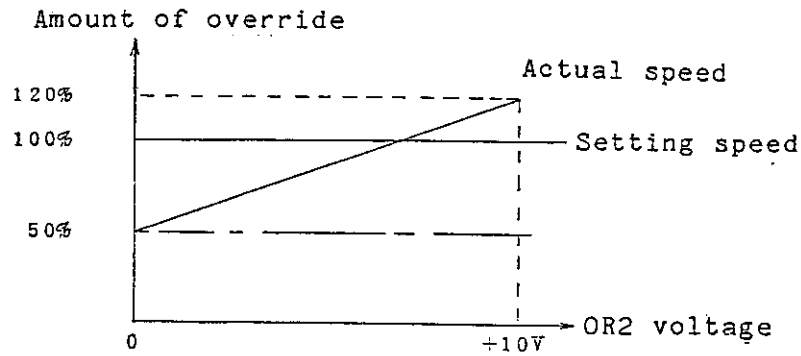
| Binary code | Motor speed (6000 rpm) | Motor speed (4500 rpm) |
|-------------|------------------------|------------------------|
| (000) H | 0 | 0 |
| • | • | • |
| • | • | • |
| • | • | • |
| • | • | • |
| • | • | • |
| (800) H | 3000 rpm | 2250 rpm |
| • | • | • |
| • | • | • |
| • | • | • |
| (FFF) H | 6000 rpm | 4500 rpm |

| | | | | | | | | | | | |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------------|
| (2183) D = (887) H | | | | | | | | | | | |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| R12 | R11 | R10 | R09 | R08 | R07 | R06 | R05 | R04 | R03 | R02 | R01 |
| | | | | | | | | | | | Input terminal |

(Note) The numbers in parentheses followed by H are in hexadecimal notation; those in parentheses followed by D are in decimal notation.

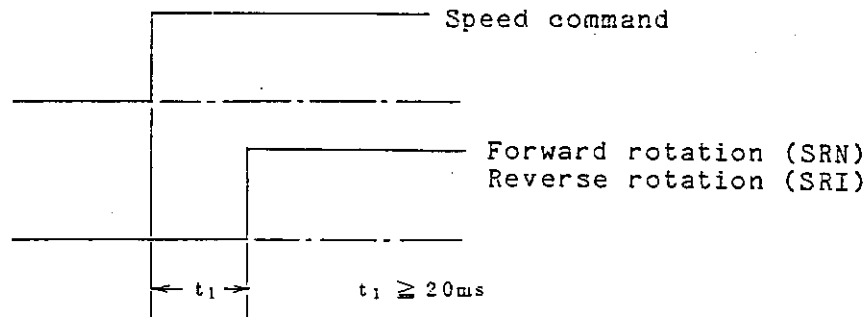
[7] Speed override signal (DEF, OD) (OR1, OR2, OR3)

- (1) Speed override is effective when the DEF contact is ON (closed).
- (2) Speed override using an external control can be varied from 50% to 120%.
- (3) This signal is valid whether the digital or analog speed command. Make the override invalid when supplying the analog command with a manual control.



[8] Forward rotation command (SRN, OS)

- (1) While the contact is ON(closed), the spindle motor rotates in the counterclockwise direction, as seen from the shaft side, in accordance with the command speed.
- (2) When the contact is set off (open), the spindle motor first decelerates and stops and then the transistor base amp. is cut off after the spindle motor has stopped.
- (3) Orientation operation has priority when an orient. command is

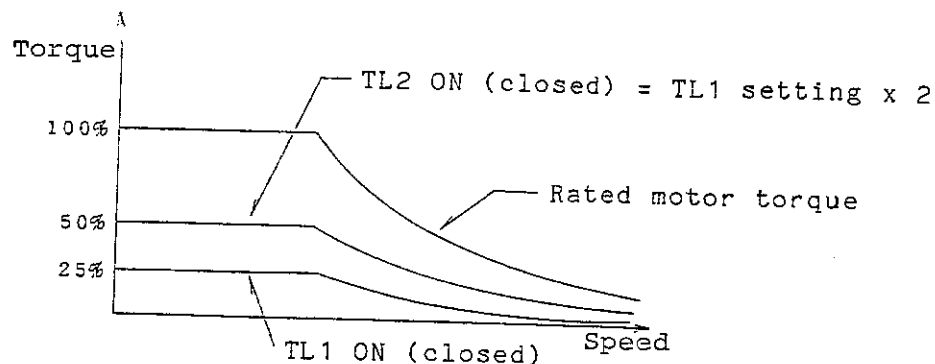


[9] Reverse rotation command (SRI, OS)

- (1) While the contact is ON (closed), the spindle motor rotates in the clockwise direction, as seen from the shaft side, in accordance with the command speed.
- (2) When the contact is set off (open), the spindle motor first decelerates and stops and then the transistor base amp is cut off after the spindle motor has stopped.
- (3) The spindle motor stops when both the forward and reverse rotation commands are issued simultaneously.
- (4) The orientation operation takes precedence when the orientation command has been supplied.

[10] Torque limit command signal (TL1, TL2, OT)

For the machine type of spindle orientation or gear shifting torque limit entails temporarily reducing the output torque of the spindle motor for instance, and rotating the spindle motor.



| External command | Internal command |
|------------------|---|
| TL1 | <div> <div> 25% 20% 15% 10% </div> <div> } } } } </div> DIP switch selection (SW5-1,2) </div> |
| TL2 | (TL1) x 2-fold |

[11] Orientation signal (ORC1-ORC2)

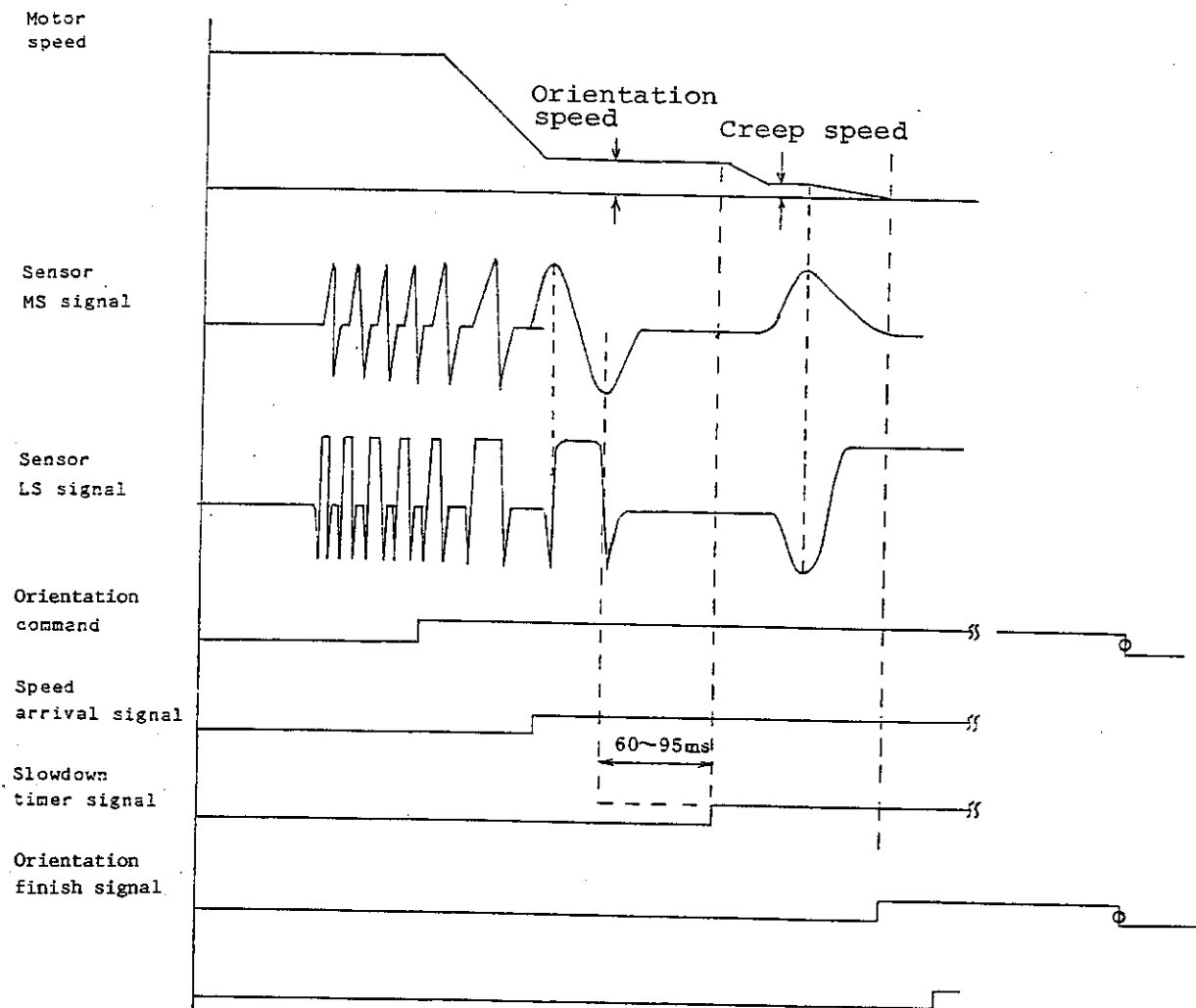
(1) This is the orientation operation start signal. When this signal contact is ON(closed), orientation starts regardless of the operation signal (SRN, SRI).

(2) Spindle speed

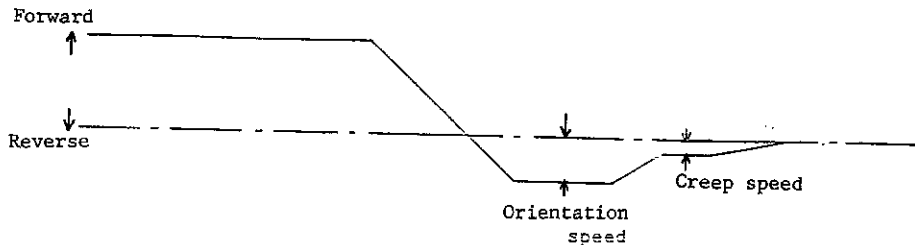
| Spindle gear shift selection | Low spindle speed (CTL) | Medium spindle speed (CTM) |
|------------------------------|-------------------------|----------------------------|
| High speed H | OFF (open) | OFF (open) |
| Medium speed M | OFF (open) | ON (closed) |
| Low speed L | ON (closed) | OFF (open) |

↑
Use the (H) and (L) gears for 2 speeds.

Q Mode of operation for magnetic sensor type single-point orientation (within controller internal construction (b))



When the operating direction and orientation rotation direction are reversed in a state where the orientation direction is fixed (internal DIP switch selection)



Operation

- (a) When the orientation command is set ON, the motor speed is switched from the operating speed to the orientation speed.
- (b) When the motor speed arrives as the orientation speed, the speed arrival signal is set ON.
- (c) After the speed arrival signal is set ON, the slow-down timer starts to operate by the timing at which the sensor's LS signal drops to the low level. (Software timer)
- (d) Slow-down timer 60-95ms (software timer: DIP switch setting)

The motor speed is switched from the orientation speed to the creep speed by this timer's counting up.

- (e) A switch is made to the position loop by the timing at which the sensor's LS signal rises to the high level at the creep speed.
- (f) The Spindle stops at the zero voltage position of MS signal from the sensor by means of position loop control.
- (g) The orientation finish signal is set ON (output contact closed).

Orientation rotation direction 3-step selection(DIP switch setting)

| | |
|---------|--|
| (1) PRE | Orientation in the same direction as in the previous operation |
| (2) CW | Forward motor rotation orientation |
| (3) CCW | Reverse motor rotation orientation |

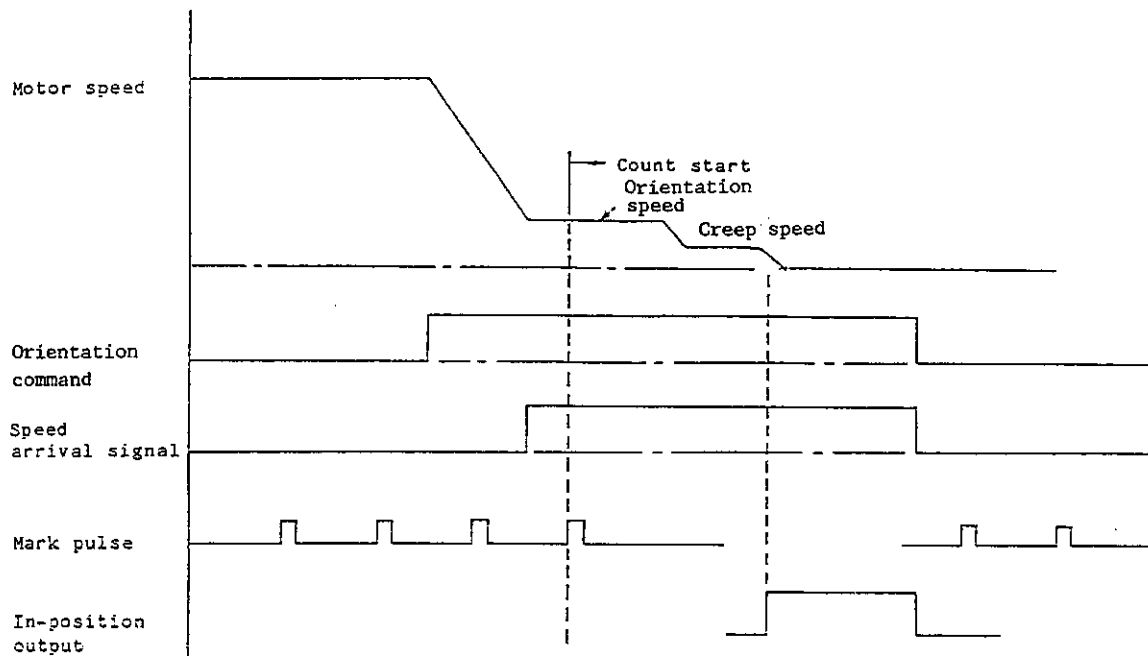
Orientation test PB (ST2)

- (1) ST2 is made effective with SW6-1 OFF.
- (2) While ST2 is ON, the motor rotates at the orientation speed; setting it to OFF results in orientation stop.

Magnetic sensor orientation in-position range

- (1) Either ± 1 deg. or ± 5 deg. can be selected by the DIP switch.

- o Mode of operation for encoder type multiple-point orientation (with controller internal construction (c))



Operation

- (a) The orientation position, given in 12-bit binary format from the external source with the orient command, is read in and the operation speed is switched to the orientation speed.
- (b) When the motor speed reaches the orientation speed, the speed arrival signal goes ON.
- (c) After the speed arrival signal has gone ON, counting starts when the mark pulse is supplied. The motor speed remains at the orientation speed.
- (d) The motor speed is switched from the orientation speed to the creep speed when it reaches 146 to 225 degrees before the target point.
- (e) A switch is made to the position loop at 15 to 25 degrees before the target value and the motor stops at the target value.
- (f) The orientation finish signal (ORA1-ORA2) contacts close in the range of the target value +/- the inposition range (set by rotary switch).
- (g) When the orientation command is released, the motor is reset to the speed corresponding to the speed command given at that time.
- (h) When re-orientation is performed from the orientation state, the spindle rotates once and orientation is performed.

However, depending on the orientation position given from the external source and the setting of the position shift rotary switch (12-bit), the spindle will rotate more than once.

(i) Stop position

The stop position is controlled by the 12-bit contact signal (01H-12H), and when all the signals are OFF, the reference stop position is established (0 degrees).

$$\text{Stop position} = \frac{360}{4096} [(H12) \cdot 2^{11} + (H11) \cdot 2^{10} + \dots + (H1) \cdot 2^0]$$

Example: When H10 only is ON

$$\frac{360}{4096} \times 512 (= 2^9) = 45^\circ$$

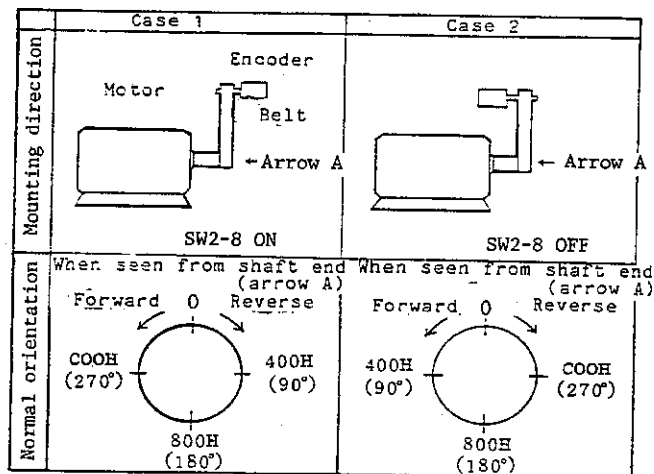
Least command increment:

$$360^\circ / 4096 = 0.088^\circ$$

1 deg., 10 deg.:

Integral degree indexing becomes the least command increment (0.088 deg.) integral multiple, and this is a setting error.

The stop positions based on the encoder mounting direction are shown as follows:

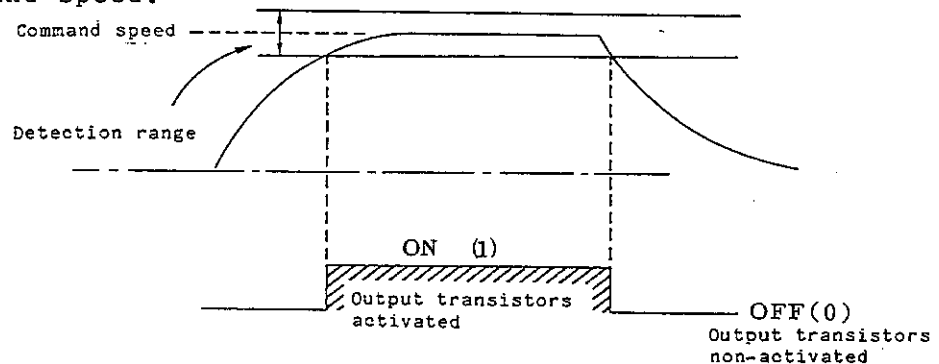


- (j) The orientation status is maintained even when the machine set-up ready signal (SET1, SET2) is set ON after it has been set OFF in the orientation stop status.

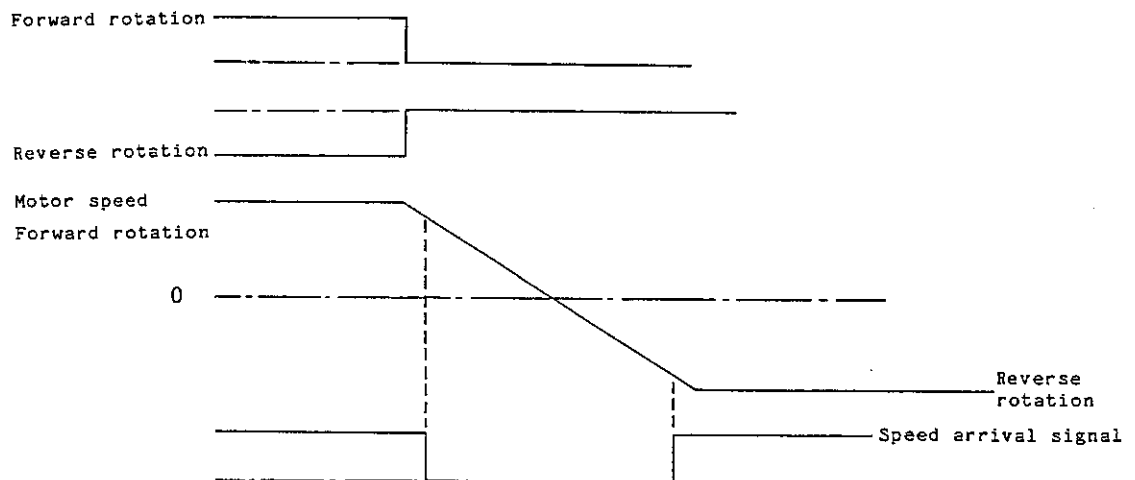
6.6 CONTROL OUTPUT SIGNAL

[1] Up to speed signal (USO) (open emitter output)

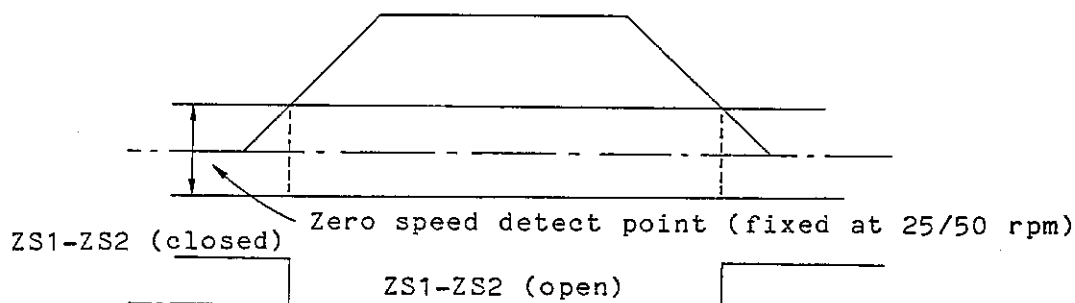
- (1) The output transistors are activated when the actual rotation speed of the spindle motor reaches $\pm 15\%$ of the command speed.



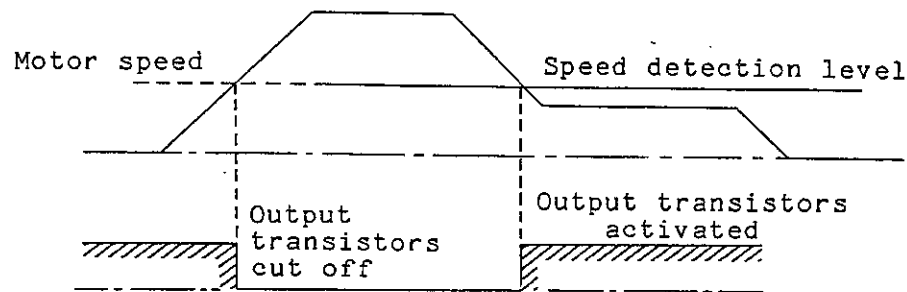
- (2) This signal is not output unless SRN or SRI is set ON. It is not output upon completion of the orientation.
- (3) This signal is used as the check signal for the forward rotation (M03) and reverse rotation (M04) commands.
- (4) When the reverse rotation signal is set ON, the spindle motor starts decelerating and the upto speed signal is set OFF. And when the upto speed signal is set ON again, the reverse rotation command is completed.



- [2] Zero speed signals (ZS1, ZS2), (ZSO) (contacts) (open emitter outputs)
- (1) When the actual rotation speed of the spindle motor falls below the zero detection point with respect to the stop command, the zero speed signal (ZS1, ZS2) is set on (closed).
 - (2) Simultaneously, the output transistor is activated.



- (3) This signal is output when the above condition is met regardless of the rotation signals (SRN, SRI).
 - (4) Minimum output pulse width: Approx. 200ms
 - (5) The zero speed can be set to 25 or 50 rpm using the DIP switch provided.
- [3] Torque limiting signal (TLO) (open emitter output)
- The output transistors are activated while the torque limit signals (TL1, TL2) are input and the torque is being limited.
- [4] Speed detect signal (open emitter output) (VRO)
- (1) The output transistors are activated when the speed falls below the motor speed set by the DIP switch.



- (2) The speed detection range can be set in 8 steps from 2% to 58% at 8% intervals.
- (3) This signal activates the output transistors when the speed falls below the detection level setting containing a motor speed absolute value, regardless of the rotation command (SRN, SRI).
- [5] Spindle failure signals (FA-FC) (FO) (contacts)
(open emitter output)

- (1) Refer to the table below for the relay outputs.

| Mode | Relay | Contact | Open emitter transistors |
|---------|-------|---------|--------------------------|
| Normal | Make | Closed | Activated |
| Trouble | Break | Open | Not activated |

- (2) Failures are indicated by LEDs 12-15 on the SE-I01 circuit board and signals are output in AL8-AL1 binary code. Refer to the table on the next page for the codes.
- (3) The fault signal is output for about 1 second while the control power rises after the power has been switched on.

Alarm signals

0: LED OFF, output = High (transistors cut off)

1: LED ON, output = Low (transistors activated)

| No. | Output | | | | Alarm signal significance | Details | Reset method |
|-----|--------------|--------------|--------------|--------------|---------------------------|--|---|
| | AL8 LED12 | AL4 LED13 | AL2 LED14 | AL1 LED15 | | | |
| 1 | 0 | 0 | 0 | 1 | Motor over heating | This is detected when the temperature inside the motor has exceeded the prescribed level. | Alarm reset PB after motor has cooled OFF. |
| 2 | 0 | 0 | 1 | 0 | Excessive speed error | This is detected when the motor speed differs greatly from the command value. | After the motor has stopped, eliminate the cause and use alarm reset or reset PB. |
| 3 | 0 | 0 | 1 | 1 | (Spare) | | |
| 4 | 0 | 1 | 0 | 0 | Breaker trip | This signal is output when an abnormal current flows to the input and the breaker trips. | |
| 5 | 0 | 1 | 0 | 1 | Phase loss | This detects phase loss in the input with resetting and power switch on. | |
| 6 | 0 | 1 | 1 | 0 | Emergency stop | This indicates that the emergency stop pushbutton on the external control panel is ON. | External emergency stop PB to OFF |
| 7 | 0 | 1 | 1 | 1 | Over speed | This occurs when the motor speed exceeds 115% of its rated speed. | |
| 8 | 1 | 0 | 0 | 0 | Converter over-current | This detects an over-current in the converter. | |
| 9 | 1 | 0 | 0 | 1 | Controller over-heating | Overheating is detected when the temperature of the heat sinks of the semiconductors, the ambient temperature etc. is abnormally high. | |
| 10 | 1 | 0 | 1 | 0 | Under voltage detection | This detects that the input voltage is more than 15ms and less than 170 V. | |
| 11 | 1 | 0 | 1 | 1 | Over voltage detection | This detects that the converter's DC voltage is abnormally high. | |
| 12 | 1 | 1 | 0 | 0 | Inverter over-current | This detects an over-current in the inverter. | |
| 13 | 1 | 1 | 0 | 1 | CPU fault 1 | Microcomputer fault | |
| 14 | 1 | 1 | 1 | 0 | " 2 | " | |
| 15 | 1 | 1 | 1 | 1 | " 3 | " | |

The circuit diagram illustrates a motor speed and load monitoring system using an LM124M quad op-amp. The op-amp is configured with two comparators (LM1 and LM2) and two monostable multivibrators (LMO and SMO). The input signals are derived from a load meter (LM) and a speed meter (SM), both with a 1mA full scale. The load meter signal is connected to the non-inverting input of LM1 (pin 49) and the non-inverting input of LMO (pin 18). The speed meter signal is connected to the non-inverting input of LM2 (pin 50) and the non-inverting input of SMO (pin 2). The op-amp is powered by a 10V supply. The output of LM1 (pin 49) is connected to the load meter. The output of LM2 (pin 50) is connected to the speed meter. The output of LMO (pin 18) is connected to the load signal output (10V/120% load). The output of SMO (pin 2) is connected to the speed signal output (10V/max. speed). The circuit includes several resistors and capacitors for timing and signal conditioning. VR15 and VR14 are variable resistors used for calibration. The circuit is labeled with component values and pin numbers, and includes a legend for the load and speed signals.

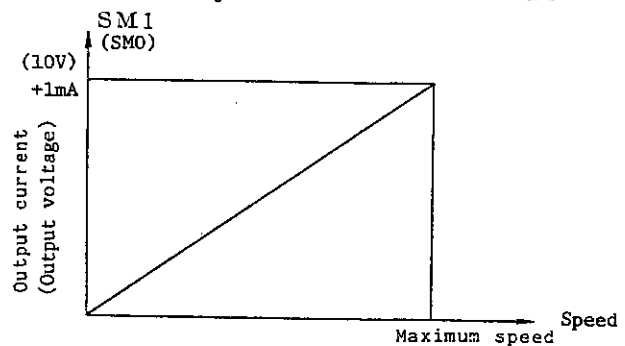
(a) It is recommended that a speed meter with the following specifications be used.

- (i) Type: Type YM-8G DC ammeter (made by Mitsubishi)
- (ii) Rating: DC 1mA full scale
- (iii) Internal impedance: Approx. 80 ohms

(b) DC +1mA flows from (SM1) at the maximum motor speed regardless of the direction of the motor's rotation.

(c) The full scale should be calibrated with meter adjust VR14 when using an instrument with a very different internal impedance.

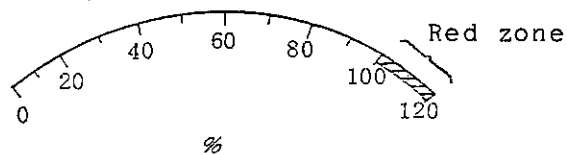
SM1
↑ (SM0)



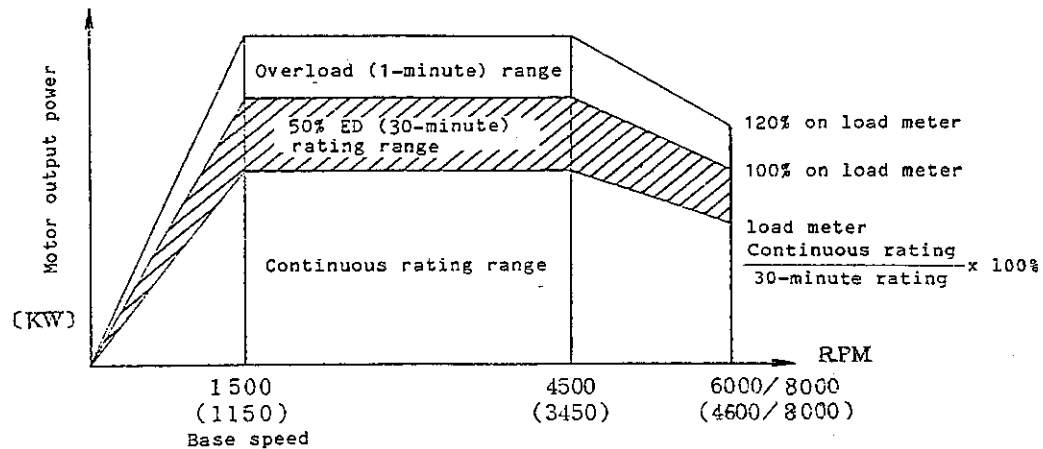
- 43-

[2] Load-meter

- (a) It is recommended that a load meter with the following specifications be used.
 - (i) Type: Type YM-8G DC ammeter (made by Mitsubishi)
 - (ii) Rating: DC 1mA full scale, BKO-C1529H79 specifications
 - (iii) Internal impedance: Approx. 80 ohms
 - (iv) Scale



- (b) The polarity of the current flowing from terminal (LM1) is constant, regardless of the direction of the motor's rotation.
- (c) The load meter displays the ratio of the load to the motor's rated output as a percentage. See the figure below for the relationship between the motor output power and the load meter display.



Note (1) In the case of a 15/18.5kW motor, the continuous rating corresponds to 80% on the load meter.

Note (2) The speeds in parentheses denote motors with a semi-standard 1150 rpm base speed.

(d) The full scale should be calibrated with the full scale adjust DIP switch and with VR15 when using an instrument with a very different internal impedance.

(e) The load meter output (LMO) can be set to 10V or 3V using the DIP switch provided.

[1] Input interface

Diagram of a 555 timer configured as a monostable multivibrator. The circuit includes a +24V supply, a 3.3K resistor, a 3.3K resistor, a 2.2μF capacitor, and a 555 timer. The output of the timer is connected to a speaker. A note indicates that the 555 timer is a 555C.

Current flowing to external contact: Approx. 7.2mA

* Note. The digital speed command and orient.position command are as shown in the figure below.

Open emitter

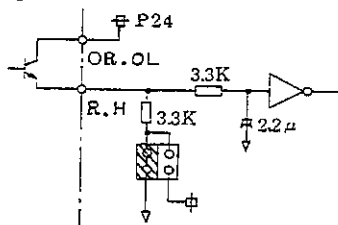


Figure 1: Analog speed command circuit diagram. The circuit includes a 2KΩ VR2 potentiometer connected to an 'Analog speed command' input. Its wiper is connected to terminal 31 (SE1). A 1KΩ potentiometer (VR1) is connected between terminal 29 (RP) and terminal 31. Its wiper is connected to terminal 32 (SE2). A 1680Ω resistor (CON1) is connected between terminal 29 and a +15V supply. A third potentiometer (VR3) is connected between terminal 32 and terminal 30 (SES).

VR1: For setting the upper limit speed

VR2: For setting the analog speed (+10V maximum speed)

(VR3: For setting the lower limit speed)

SE1 input impedance: 10-20 kohms

From RP the signal is output through the resistor from the +15V power supply.

The maximum speed is produced with the 10V voltage across SE1 and SE2. Depending on the application range, therefore, set the upper limit with VR1 and the lower limit with VR3.

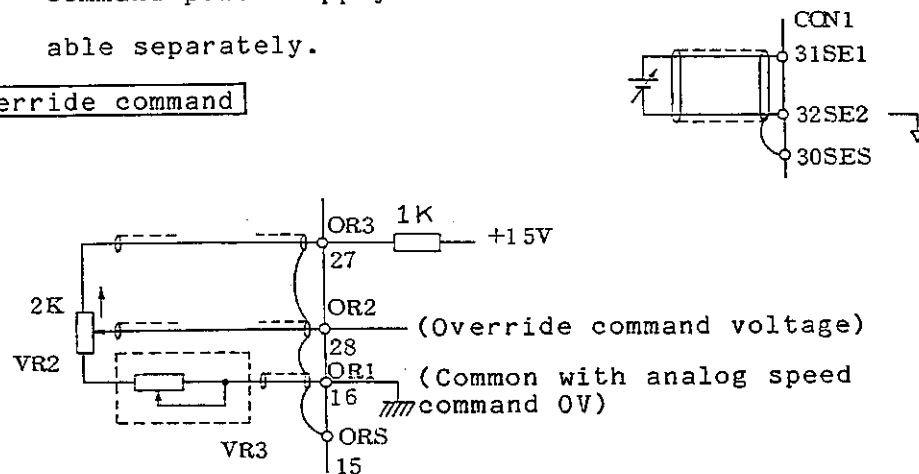
Refer to the figure on the

right when an analog speed

command power supply is avail-

able separately.

Override command



VR2: For setting the override

50-120% variable (OR2: 10V = 120%, 0V = 50%)

VR3: For setting the lower limit of the override

Mount for setting the lower limit range to any value except 50%.

OVR2: Input impedance 10-20 kohms

[3] Output interface

External contact output

Spindle alarm (FA-FC)

Zero speed (ZS1-ZS2)

Orientation finish (ORA1-ORA2)

Use the external output relay contacts under the following ratings:

| | |
|------------|---------------|
| DC 24V | 0.3A or less |
| AC 100 V | 0.1A or less |
| Chattering | 5msec or less |

Small relays are used and so when connecting an inductive load such as relays, provide DC relays as small as possible and connect the flywheel diode in parallel with the coil. If it is absolutely unavoidable for AC relays to be used, connect an RC surge absorber in parallel with the coil. With a lamp load reduce the rush current to 1A or less with a limiting resistance.

Open emitter output

Spindle alarm (FLO)
Current detection (CDO)
Speed detection (VR0)
Up to speed (USO)
Zero speed (ZSO)
Torque limiting (TLO)
Orientation finish (ORA0)
Alarm signal (AL8)
Alarm signal (AL4)
Alarm signal (AL2)
Alarm signal (AL1)

Output transistor ratings

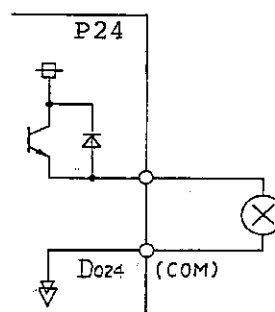
M54563P transistor array

$I_{cmax} = 500mA$

(Must be used at 50mA or less)

$V_{CEo max} = 24V$

$P_c = 1.47/7W$



6.9 LIST OF DIP SWITCH SETTINGS

| Type of function | Function | No. of switches | Outline of operation |
|--------------------|--|--------------------|--|
| Mode | Test/normal | 1 | Used at the normal position in normal operation. Used at the test position for orientation testing. |
| | Closed/open | 1 | Used at the closed position in normal operation. Used at the open loop position for speed detector go/no go discriminating, etc. |
| Speed command | Acceleration/deceleration time constant | 3 | Used to control acceleration of speed command; 8 settings possible |
| | BCD 2-digit/binary | 1 | Used to switch between BCD 2-digit (8-bit) and binary (12-bit) format for the digital speed setting input. |
| | Top speed setting H/L | 1 | Used to set the maximum speed: 3450/4600, 4500/6000, 6000/10000 settings possible. |
| | Base speed setting H/L | 1 | Used to set the base speed: 1150/1500 |
| Speed loop | Speed loop proportional constant Kp | Rotary switch 1 | Used to set the speed loop response to any of 16 steps. |
| | Speed loop integral constant Ki | Rotary switch 1 | Used to set the speed loop response to any of 16 steps. |
| Motor type | Motor constant setting | 4 | Used to set the constant in accordance with the type of motor. |
| Torque limiting | Torque limit value setting | 2 | Used to set the torque to 10%, 15%, 20%, or 25% with respect to the 120% output of the 30-minute rating. Double setting by means of external setting. |
| Input interface | Speed input emitter/collector | 1 | Used to select the open emitter or open collector for the speed command input. |
| | Position input (SE-CPU2) emitter/collector | 1 | Used to select the open emitter or open collector for the position command input. |
| Auxiliary function | Speed detection range | 3 | Used for setting to any of 8 steps at 8% intervals |
| | Zero speed detection range | 1 | Used to set the zero speed to 25 rpm or 50 rpm. |
| | Servo rigidity selection | 1 | Servo rigidity high/low selection |

| Type of function | Function | No. of switches | Outline operation |
|------------------|--|------------------------|---|
| Orientation | Orientation test | Pushbutton switch 1 | Effective in test only. The motor rotates at the prescribed orientation speed with the switch ON; if the switch is then set OFF, orientation is performed and the motor stops. |
| | Encoder (magnetic sensor) mounting direction | 1 | Used to set the direction in which the detector rotates with respect to the rotation direction of the motor. |
| | Magnetic sensor in-position range H/L | 1 | Used for position error range H/L setting at which the finish signal is output with magnetic sensor orientation. |
| | Orientation rotation direction | 2 | Used for setting to PRE, CW or CCW: PRE: Orientation from same rotation direction as previous motor rotation. CW : Orientation from forward rotation (clockwise) side. CCW: Orientation from reverse rotation (counterclockwise) side. |
| | Orientation speed | Rotary switch 1 | Used to set the orient. speed to any of 16 setps from 20 to 320 rpm at 20 rpm intervals. |
| | Creep speed H/L | 1 | Used for creep speed H/L switching. H = 30 rpm, L = 20 rpm. |
| | 1st deceleration point range | 3 | Used to set position range from orientation speed to creep speed |
| | 2nd deceleration point range | 3 | Used to set position range from creep speed to orientation speed |
| | Gear ratio | 24 | Used to select H, M and L gear combination. |
| | Encoder position shift | Rotary switch 3 | Used to select stop position every 360 deg/4096. |
| | Encoder in-position range | Rotary switch 1 | Used for position error range setting at which the finish signal is output with encoder orientation. |
| Others | Meter adjustment ON/OFF | 1 | When the switch is set ON, the load meter and speed meter output are output corresponding to full scale. |
| | Load meter output H/L | 1 | Used to switch the maximum voltage of the load meter output. H...10 V L...3 V |
| | Emergency stop LED ON/OFF | 1 | When the external emergency stop signal is input, this causes the LED to light and selects whether the alarm signal is to be output. |

6.10 LIST OF SETTING VARIABLE RESISTORS

| Card name | VR | Type of function | Function | Outline of operation | |
|-----------|------|------------------------------------|-----------------------------|-----------------------------------|---|
| SE-IO1 | VR15 | For meters | Load meter | Load meter adjustment | Used in conjunction with meter adjust DIP switch. |
| | VR14 | | Speed meter | Speed meter adjustment | |
| SE-CPU1 | VR 2 | Magnetic sensor system orientation | Magnetic sensor sensitivity | Magnetic sensor output adjustment | |
| | VR 1 | | Position shift | Stop position adjustment | |

7. CABLE SPECIFICATIONS

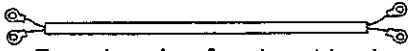
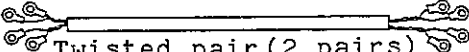
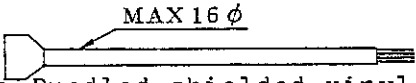
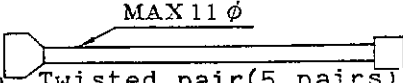
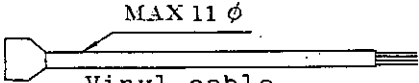
7.1 MAIN CIRCUITRY CABLES

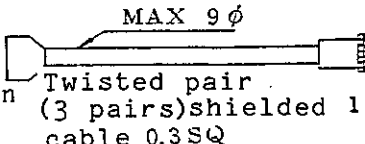
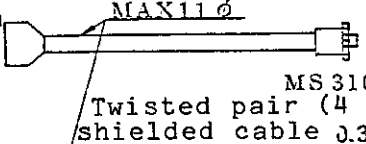
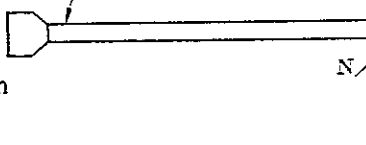
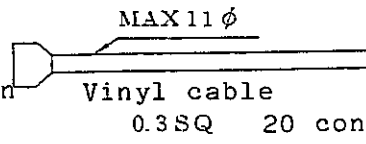
Select and provide the power supply and motor main circuitry cables from the table below in accordance with the motor capacity.

| Application | Motor capacity (continuous/30-minute rating) | | | | | |
|----------------|--|---------|--------|--------|---------|---------|
| | 3.7/5.5 | 5.5/7.5 | 7.5/11 | 11/15 | 15/18.5 | 18.5/22 |
| Incoming power | IV3.5SQ | IV8SQ | IV14SQ | IV22SQ | IV30SQ | IV38SQ |
| Motor output | IV3.5SQ | IV5.5SQ | IV8SQ | IV14SQ | IV22SQ | IV30SQ |

Selection standard: 30 deg.C ambient temperature, 3 wires in same tube, continuous rated load.

7.2 CONTROL CABLES

| Application | Code | Description |
|------------------------|-------|---|
| Fan motor | T B 4 |  <p>Tough-vinyl sheathed case 2SQ</p> |
| Indicators | T B 2 |  <p>Twisted pair (2 pairs) cable 0.3SQ</p> |
| Control signal | CON 1 | <p>Made by Honda Tsushin MR-50LF</p>  <p>Bundled shielded vinyl cable 0.2SQ 50 conductors</p> |
| Motor detection signal | CON 2 | <p>Made by Honda Tsushin MR-20LF</p>  <p>Twisted pair (5 pairs) shielded cable 0.3SQ</p> |
| Control signal | CON 3 | <p>Made by Honda Tsushin MR-20LM</p>  <p>Vinyl cable 0.3SQ 20 conductors</p> |

| Application | Code | Description |
|--|-------|---|
| Orientation magnetic sensor detection signal | CON 4 | <p>Made by Honda Tsushin MR-20LF</p>  <p>Twisted pair (3 pairs) shielded cable 0.3SQ</p> <p>Made by Tajimi Musen 116-12A10-7F</p> |
| Orientation encoder signals | CON A | <p>Made by Honda Tsushin MR-20LF</p>  <p>Twisted pair (4 pairs) shielded cable 0.3SQ</p> <p>PLG signal Cannon MS3106A20-29S</p> |
| | CONAA | <p>Made by Honda Tsushin MR-20LF</p>  <p>N/C side</p> |
| Orientation position data signal | CON C | <p>Made by Honda Tsushin MR-20LM</p>  <p>Vinyl cable 0.3SQ 20 conductors</p> |

Make the length of the orientation magnetic sensor detection signal cable and orientation encoder signal cable less than 20 meters.