

mitsubishi

TRANSISTORIZED FREQUENCY INVERTER

DEVIATION DETECTOR

TYPE FR-FD
Instruction Manual

DEVIATION DETECTOR type FR-FD

The Deviation Detector, FR-FD*, is a converter that changes angular displacement (phase shift), detected by synchronizer, to DC voltage signal. Besides mechanical displacement, the synchronizer is capable of detecting tension, weight and angular difference between two rotating shafts. Therefore, it can be used in a control system with the FREQROL inverter.

*Note: A number in * is suffixed for the different power supply. Refer to the Table. 1.*

1. OUTLINE DRAWING

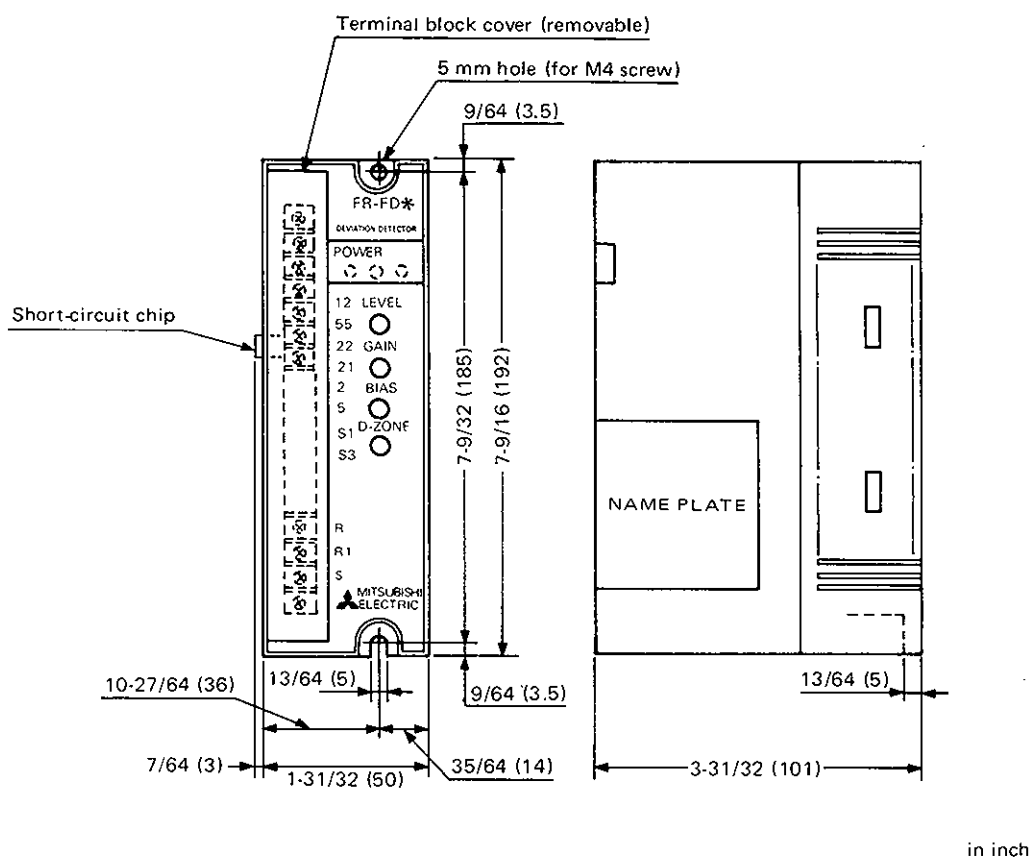


Fig. 1 Outline Drawing

2. INSTALLATION

- (1) Do not install the preamplifier in a place exposed to the direct rays of the sun, and a place where temperature and humidity are high, and a place where there are a lot of dust and corrosive gases. Be sure to install the preamplifier in a clean and dry place. (The unit is not a totally enclosed type.)
- (2) Install the preamplifier in a place which is not liable to be filled with heat. Install the preamplifier so that the wiring distance between the inverter and preamplifier is minimum (e.g., install them inside the same control box).
- (3) Since cables protrude from the left side face of unit, install the preamplifier considering the wiring space of cables.

3. WIRING

- (1) Remove the terminal cover. To remove the terminal cover, pull the recessed portions on the left side toward you as shown in Fig. 2.
- (2) Connect the power supply across R and S. (For the type without suffix number, it is possible to connect the power supply across R1 and S depending on line voltage.) If incorrect wiring is done, the internal transformer may burn. (See the block diagram in Fig. 5.)
- (3) When it is required to provide a relay contact to the signal line, connect two contacts of microcurrent switching relay in parallel (or twin contact) to prevent improper contact.
- (4) Use twisted wire or shielded wire for signal line. Separate the signal line from the power line.

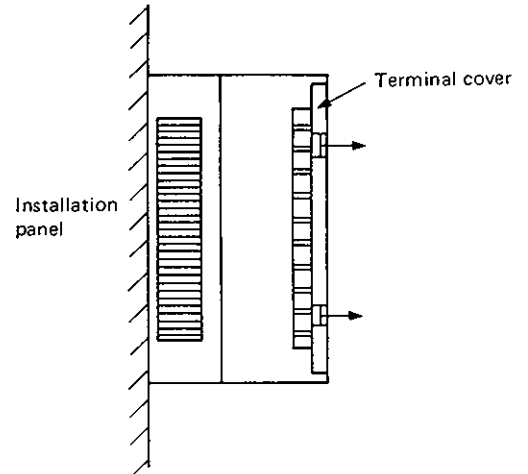


Fig. 2

4. SPECIFICATIONS

Power supply:	Refer to the Table. 1
Allowable line voltage fluctuation range:	$\pm 10\%$
Power consumption:	Approx. 5VA
Standard sensitivity*:	Output voltage $\pm 4V$ /synchronous phase shift angle $\pm 60^\circ$
Max. sensitivity*:	Output voltage $\pm 4V$ /synchronous phase shift angle $\pm 20^\circ$ (three times of standard sensitivity)
Min. sensitivity:	0
Bias adjustment:	Output voltage $\pm 2.5V$
Adjustment of dead zone*:	5-step selection, synchronous shift angle $\pm 3^\circ$ for each step (at the setting of standard sensitivity)
Device associated:	Synchronizer YVGC-790W
Ambient temperature:	$-10^\circ C$ to $+50^\circ C$ (to be free from freezing)

Note: The characteristics marked * are those when the following synchronizer is used:

Synchronizer unit: YVGC-790W (Matsushima Machine Lab.) Incorporated synchronizer: TS5N3E12 (Tamagawa)

5. PRINCIPLE OF SYNCHRONIZER

(1) Characteristics of Synchronizer

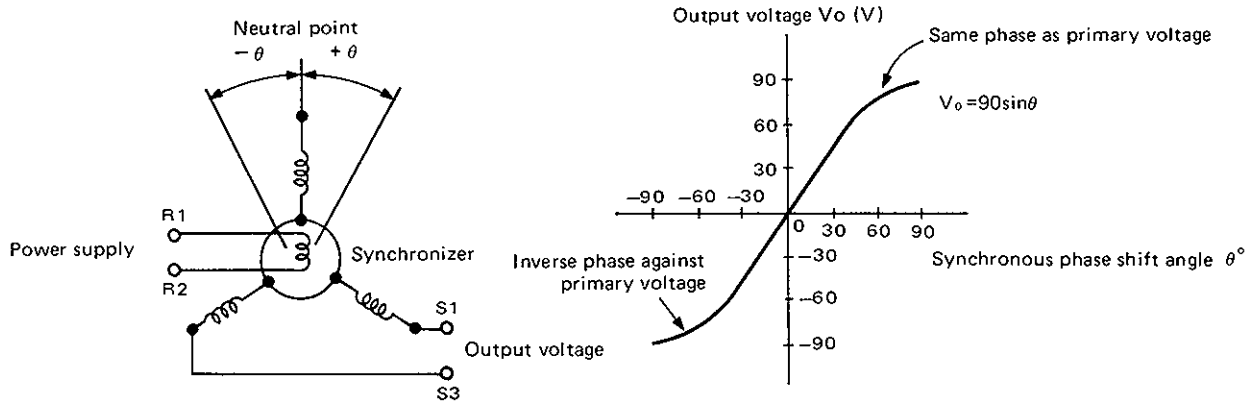


Fig. 3 Characteristics of Synchronizer

When rated voltage is applied to the primary of synchronizer as shown in Fig. 3, the secondary output voltage changes in accordance with phase shift of the synchronizer.

The synchronizer generates no output voltage while the synchronizer shaft is at the neutral position, but generates AC output voltage with the same phase as that on the primary side when the synchronizer shaft rotates in the positive direction. Output voltage with phase inverse to that on the primary side (180° phase shifting) is generated when the synchronizer shaft rotates in the negative direction.

The magnitude of secondary output voltage is in direct proportion with shifting angle (sine component) in reference to the neutral position.

When this type of synchronizer is used to detect any angular displacement of rotative machine and its output voltage is rectified by the synchronous rectifier mentioned below, angular displacement from the neutral point can be quantitatively measured and the direction of the displacement can be also detected.

(2) Synchronous rectifier used in deviation detector

By rectifying output voltage from the synchronizer, positive (plus) DC voltage is obtained when the synchronizer output voltage is at the same phase as that on the primary voltage, while negative (minus) DC voltage is obtained when the synchronizer output voltage is at the phase inverse to that on the primary voltage.

The principle of the rectification is schematically explained in Fig. 4. The dotted lines presenting assumed contact movement in Fig. 4 indicate the resultant function of the synchronous rectifier. In the case of the "FR-FD*" a non-contact solid state rectifying circuit is employed.

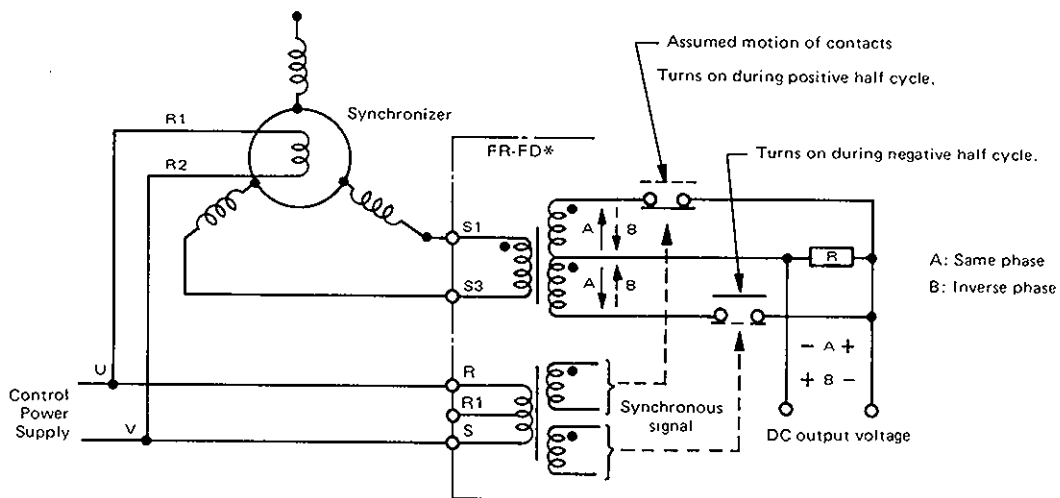


Fig. 4 Principle of Synchronous Rectifier

6. CIRCUIT CONSTRUCTION

In addition to the synchronous rectifying circuit, the FR-FD* has a built-in constant-voltage power supply circuit to permit bias adjustment, sensitivity adjustment and dead zone adjustment, as shown in Fig. 5. Further, detection signal and frequency setting signal are operated and output.

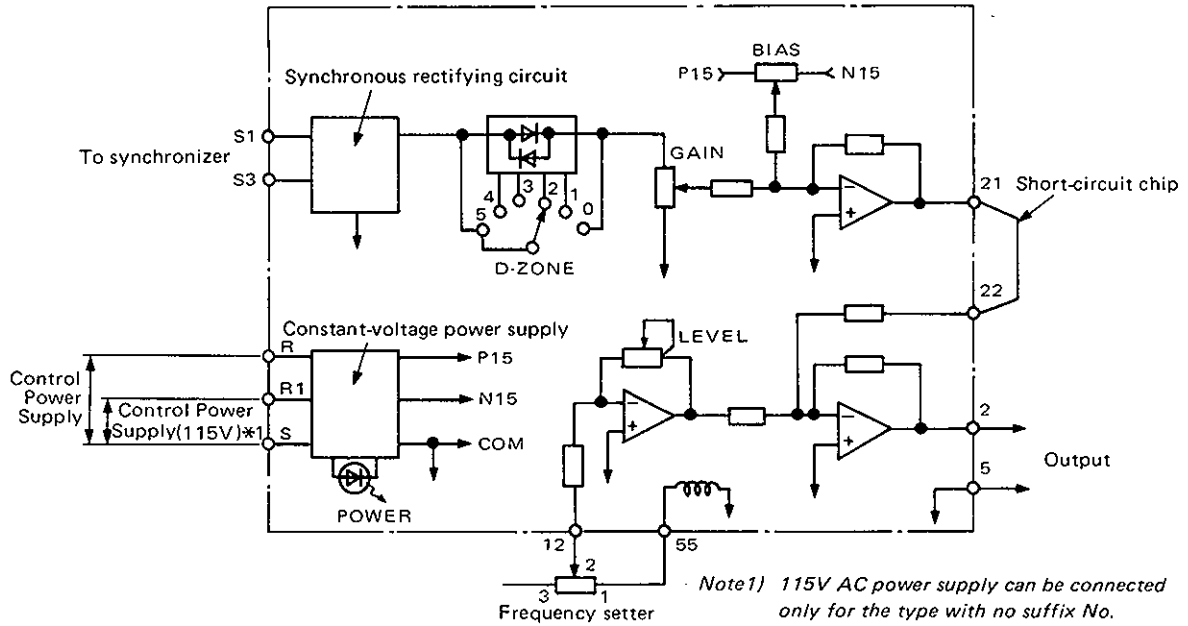


Fig. 5 Block Diagram of FR-FD* Deviation Detector

7. ADJUSTMENT

(1) Sensitivity adjustment

The sensitivity is the ratio of output DC voltage to phase shift angle of synchronizer shaft, and can be adjusted through the VR "GAIN". The characteristic curves of the VR are shown in Fig. 6. The sensitivity reaches maximum (over $\pm 4V$ at $\pm 20^\circ$) when the VR is fully turned clockwise, and minimum (no output) when fully turned counterclockwise. The VR is factory-adjusted to the standard setting ($\pm 4V$ at $\pm 60^\circ$). After the adjustment of sensitivity, measure voltage across terminals 21 and 5 with a circuit tester.

(2) Bias adjustment

To adjust the bias voltage, turn "BIAS". The bias voltage is fed from the regulated power supply, and adjusted to provide the output voltage of synchronizer rectifying circuit with positive or negative bias voltage.

When the neutral position of the synchronizer does not meet the reference point of the associated machine shaft, or when the reference point must be shifted in connection with the synchronizer neutral position, "BIAS" is turned to shift the position where voltage across deviation detector output terminals 21 and 5 is 0V.

The positive bias reaches maximum (over +2.5V) when "BIAS" is fully turned clockwise and the negative bias reaches maximum (below -2.5V) when turned counterclockwise.

The neutral position can also be adjusted by use of two right-hand side indicator lamps on the unit front panel (the left-hand side lamp is the power lamp). Turn "BIAS" in the direction of lit lamp until two lamps are off.

The characteristic curves of bias are shown in Fig. 7. "BIAS" is factory-adjusted to zero bias (standard bias).

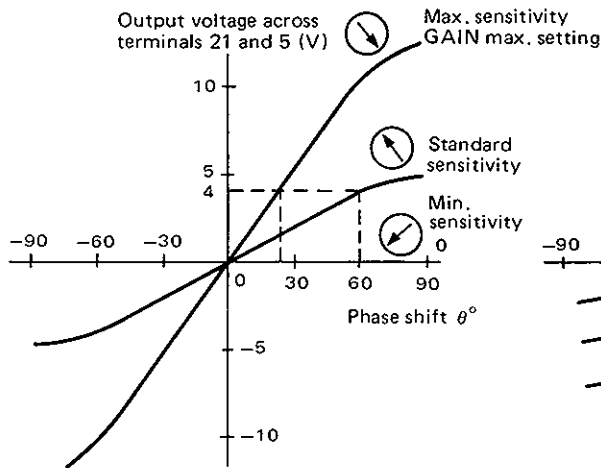


Fig. 6 Sensitivity Adjustment

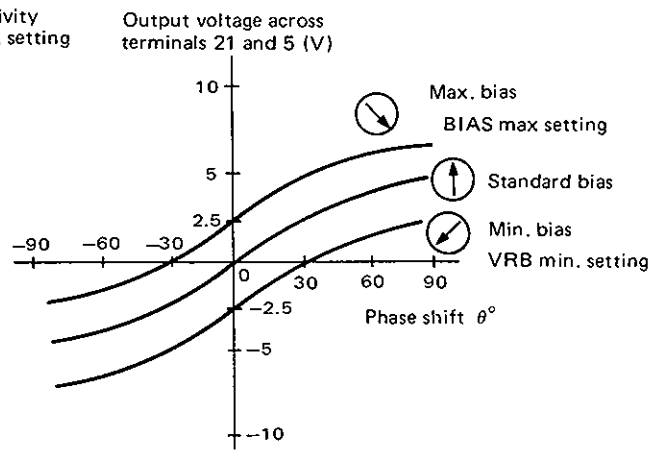


Fig. 7 Bias Adjustment

(3) Dead zone adjustment

The dead zone is adjusted by changing the setting of the select switch D-ZONE, thereby the number of diodes connected in series to the rectifier output is changed.

Each diode becomes conductive only when a forward voltage over 0.5 to 0.7V is applied to it. Therefore, since dead zone becomes wider with the increase of conductive diodes, the maximum dead zone can be obtained when the D-ZONE is set to notch "5".

When the D-ZONE is set to notch "0", all diodes are short-circuited. Before adjusting sensitivity or bias voltage, set the D-ZONE to notch "0". Then adjust the dead zone for the associated machine.

Fig. 8 shows an example where the dead zone is adjusted to $\pm 12^\circ$ in terms of phase shift angle after the sensitivity and bias voltage have been adjusted to standard values.

Since each one notch of the D-ZONE develops $\pm 3^\circ$ of dead zone, $\pm 12^\circ$ dead zone can be obtained when the D-ZONE is set to notch "4".

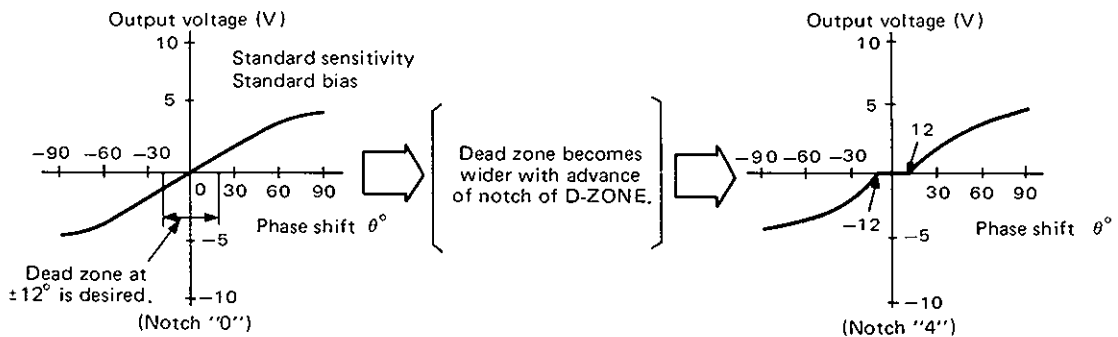


Fig. 8 Example of Dead Zone Adjustment

(4) Frequency setting signal adjustment (LEVEL)

When the output signal is used for the input signal at gain 1, e.g. output signal 0 to 5V across terminals 2 and 5 is used for input signal 0 to 5V across terminals 12 and 55 or output signal 0 to 10V is used for input signal 0 to 10V, this adjustment is not required. (Factory-set to gain 1)

For example, when the output signal 0 to 5V is used for the input signal 0 to 10V (gain 0.5), this adjustment is required. Make this adjustment with the VR "LEVEL". First, open the circuit across terminals 21 and 22 (remove the short-circuit chip) so that the detection signal is not input. Then, set the input signal to the maximum by use of the external frequency setter. Measure the voltage across terminals 2 and 5 with the circuit tester and adjust the VR "LEVEL" until the required voltage is arrived. Fig. 9 shows the change of output voltage by the VR "LEVEL".

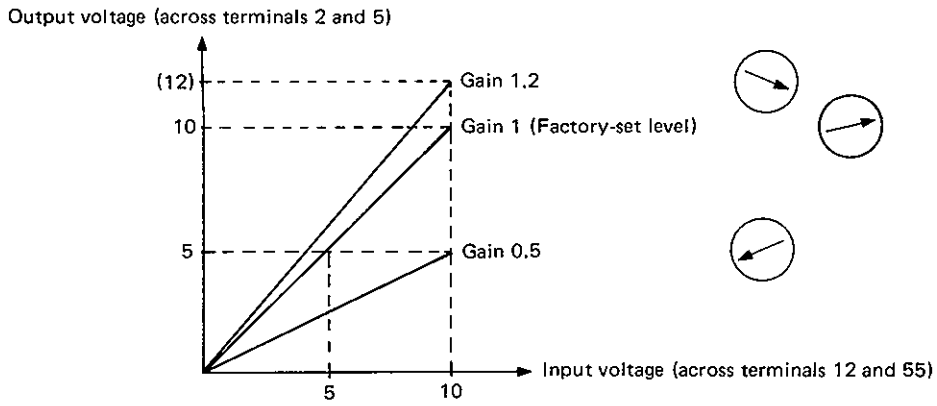


Fig. 9 LEVEL Adjustment

(5) Factory setting

For the setting of sensitivity, bias, dead zone, and frequency setting signal, adjustment can be made with the VRs and dial located on the front panel.

The standard setting (factory setting) is shown in Fig. 10.

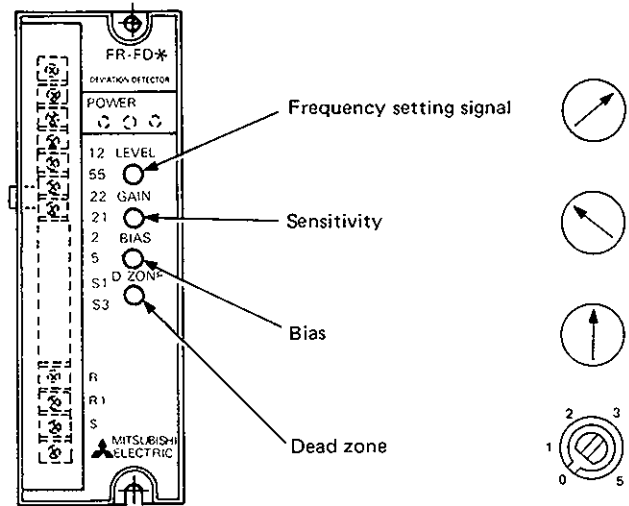


Fig. 10 Standard Setting

8. APPLICATION

(1) Continuous speed control operation

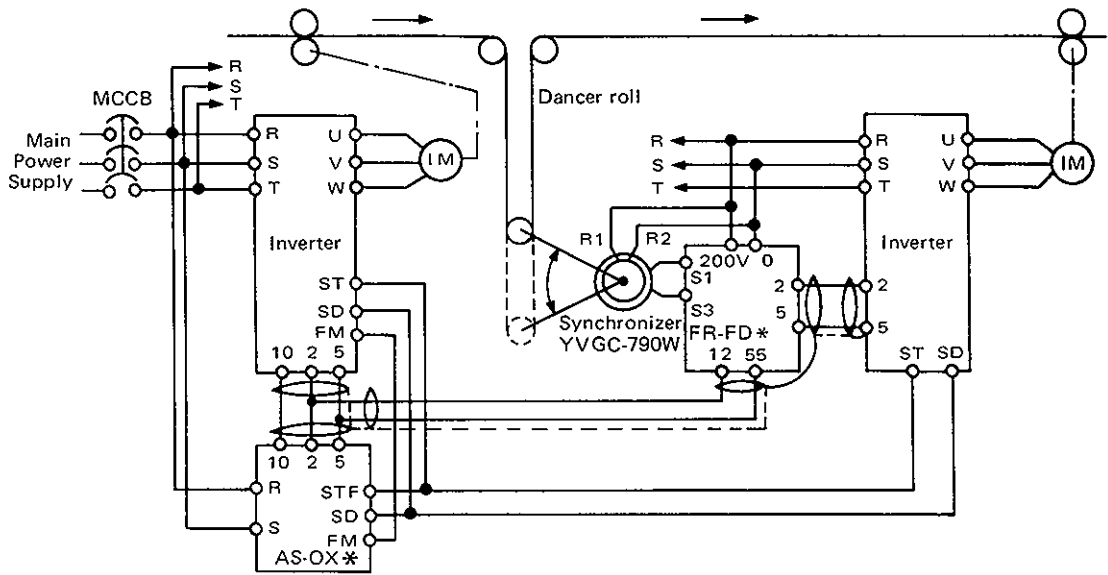


Fig. 11 Continuous Speed Control Operation Example

(2) Synchronous operation

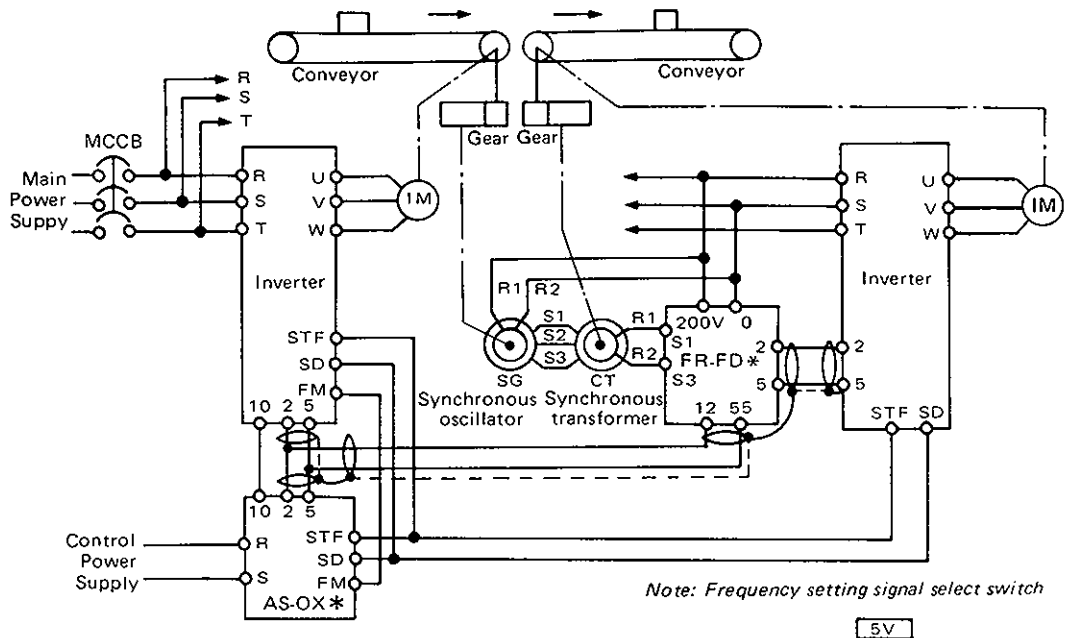


Fig. 12 Synchronous Operation Example Fig. 13

(3) Switching between independent operation and synchronous operation

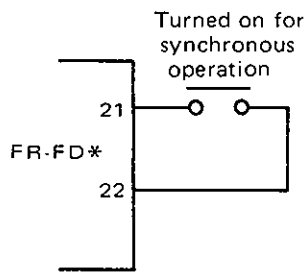


Fig. 13

A. Independent operation

By breaking the connection across terminals 21 and 22, operation can be performed only by the frequency setting signal, without regard to the detection signal.

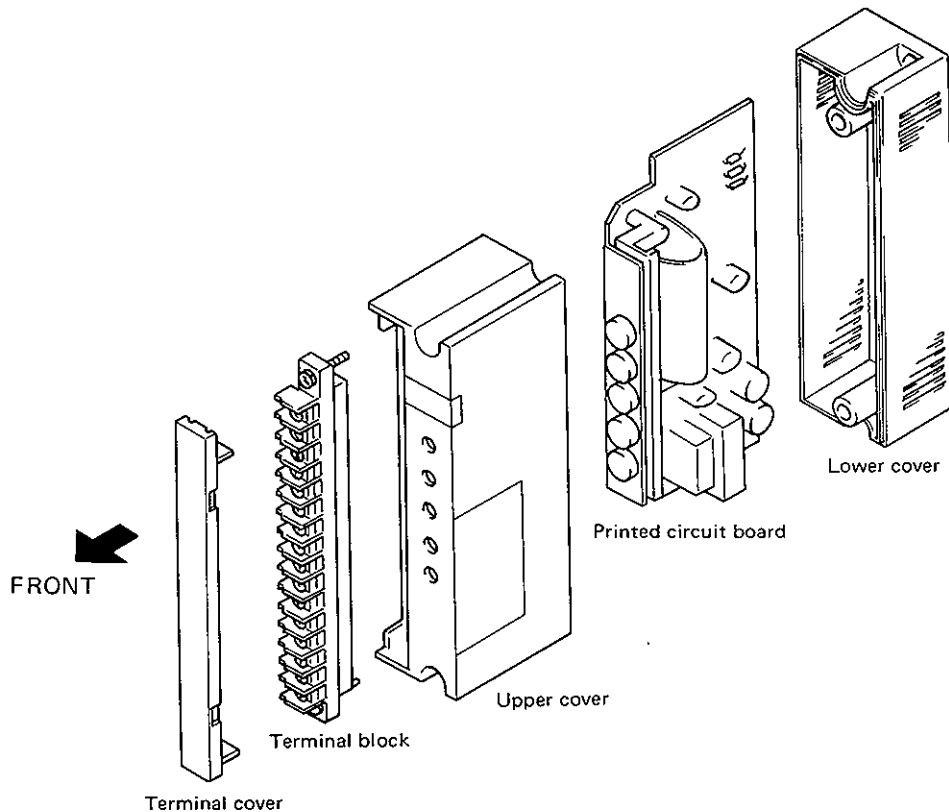
B. Synchronous operation

By causing short across terminals 21 and 22, speed is compensated by the detection signal to allow synchronous operation. When shipped, short-circuit chip is provided across terminals 21 and 22 for shorting the terminals.

9. MAINTENANCE AND INSPECTION

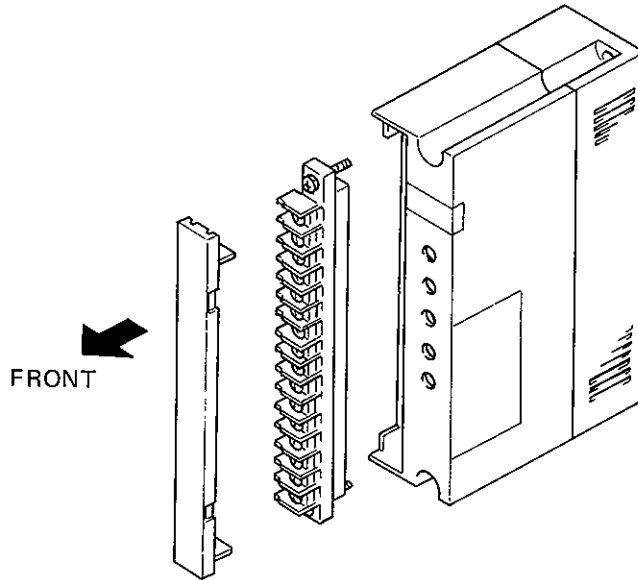
(1) Internal inspection

By removing two screws from the rear surface of unit, the case is divided into two section and a printed circuit board is exposed. Since the printed circuit board is of a card edge type, it can be pulled out of the case.



(2) Unit replacement

Should the unit be changed due to failure, etc., replacement can be made without disconnecting the cables which have already been wired. Remove the terminal cover and loosen the terminal block fixing screws at both ends of the terminal block. Then, the terminal block is lifted toward front. With the terminal block fixing screw disconnected from the case, pull the terminal block toward front. Then, the terminal block is removed from the case.



Suffix No.	Control power supply	
	FR series FR-FC, FD, FG, FA	ASPAC series AS-OX, OK, FK, OL, OH, OT
None, 1, 2	200/200/220VAC 50/60/60Hz 115VAC 60Hz	200/200/220VAC 50/60/60Hz
4	—	115VAC 60Hz
5	220VAC 50Hz	220VAC 50Hz
6	240VAC 50Hz	240VAC 50Hz

Table 1 Control Power Supply and Suffix No.

10. CAUTIONS ON HANDLING

- (1) For synchronizer, use that of rated control voltage for primary, and 75 to 100VAC for secondary.
- (2) If rotation of the synchronizer is in inverse direction in reference to the polarity of the output voltage of the deviation detector, change the polarity or rotating direction in one of the following methods:
 - Change the power supply terminals R and S of the deviation detector. (When 115V power supply is used, change R1 and S.)
 - Change the power supply terminals R1 and R2 of the synchronizer.
 - Change the synchronizer connection terminals S1 and S3 of the deviation detector.
 - Reverse the installing direction of the synchronizer. When the synchronous oscillator is used in combination with synchronous transformer and direction of rotation is inverse, change the connection between any two wires of the three wires S1, S2 and S3.
- (3) The range of phase shift should be restricted up to $\pm 60^\circ$ within which phase shift is almost directly proportional to output voltage.
- (4) When the synchronous oscillator is used in combination with synchronous transformer, speed of the synchronizer should be reduced to 5 to 6 rpm, and should not exceed 15 rpm.
If belt and pulleys are used to reduce the speed, slip-free belt, such as timing belt, should be used.
- (5) The output voltage of synchronizer varies depending on the fluctuation of line voltage. Therefore, the output signal of FR-FD* also varies. When control is adversely affected by the fluctuation of line voltage, provide a constant-voltage transformer on the power supply side of synchronizer.