

# **mitsubishi** **TRANSISTORIZED** **FREQUENCY INVERTER**

**SOFT STARTER**

**TYPE FR-FC**  
*Instruction Manual*

## SOFT STARTER type FR-FC

The Soft Starter "FR-FC\*" is used with the FREQROL inverter to gradually increase or decrease the speed control signal level at starting and stopping the system, or changing the speeds, in order to eliminate a shock that otherwise will be given to the machine, or to synchronize starting or stopping of two or more motors when inertia force of the motors differs from motor to motor because of individual load difference.

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

### 1. OUTLINE DRAWING

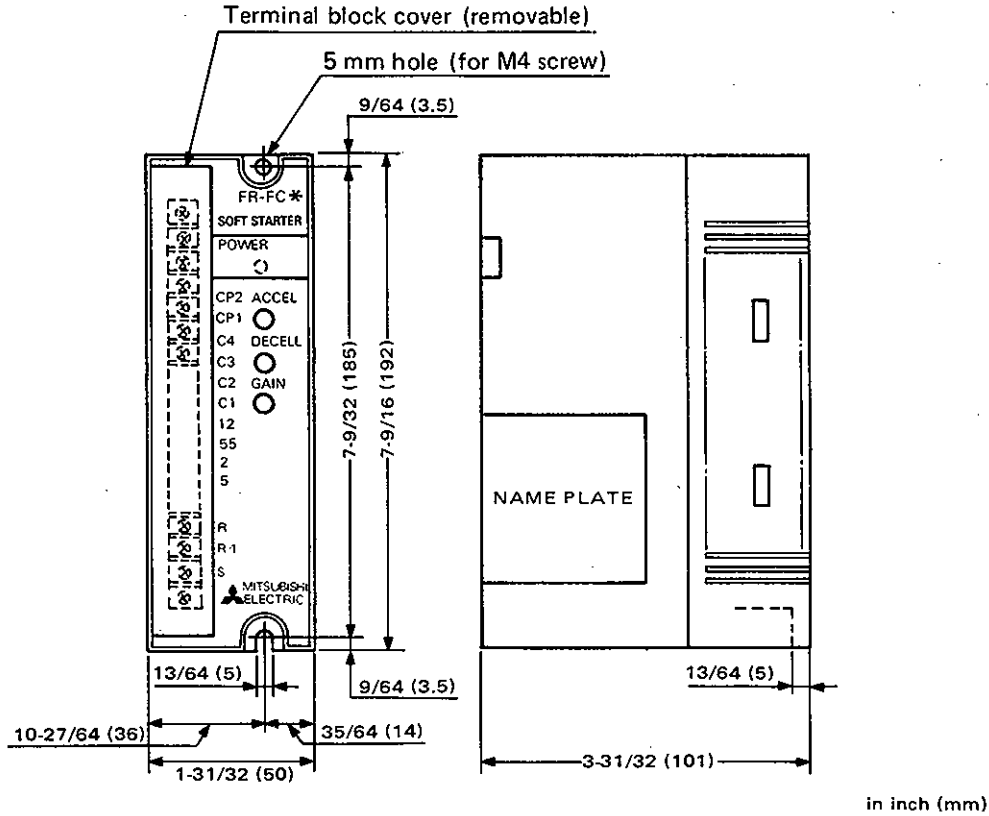


Fig. 1 Outline Drawing

### 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 the power line.

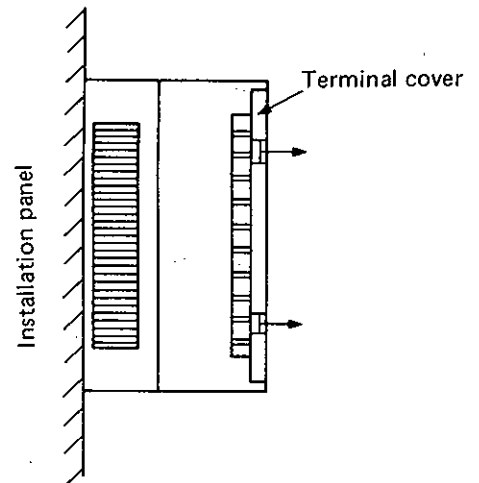


Fig. 2

### 4. SPECIFICATIONS

Power supply:	Refer to the Table. 1
Allowable line voltage fluctuation range:	±10%
Power consumption:	Approx. 3VA
Frequency setting input signal:	0 to 5V DC, input impedance 11±1kΩ (input of 0 to 10V is also possible)
Frequency setting output signal:	0 to 5V DC, 7.5mA (This controller can connect a maximum of 15 inverters. When input signal is 0 to 10V, output signal is also 0 to 10V.)
Ramp time:	<p>"ACCEL"      0.15 to 1.3 sec    adjustable</p> <p>                  0.75 to 7.5 sec    adjustable (at connection of C1-C2)</p> <p>                  5 to 50 sec        adjustable (at connection of C1-C2-C3)</p> <p>                  10 to 90 sec       adjustable (at connection of C1-C2-C3-C4)</p> <p>"DECEL"      Same as "ACCEL"</p> <p><i>Note: When input and output signals of 0 to 10V DC are used, ramp time is twice larger than the above values.</i></p>
Ambient temperature:	-10°C to +50°C (to be free from freezing)

### 5. PRINCIPLE

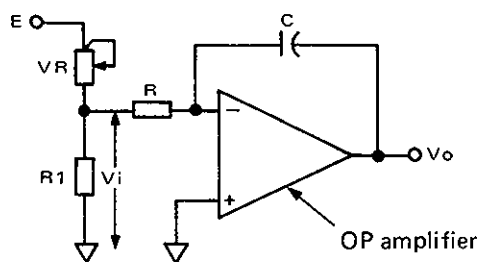


Fig. 3 Principle of Ramp Time

Ramp time

$$t = \frac{V_o}{V_i} RC \dots\dots\dots(1)$$

$$= \frac{V_o}{\frac{R1}{R1 + VR} E} RC = \frac{V_o RC}{R1E} (R1 + VR)$$

when R/R1E is assumed to be a constant replaced with "k",

$$t = kV_oC(R1 + VR) \dots\dots\dots(2)$$

$$V_o = t/kC(R1 + VR) \dots\dots\dots(3)$$

When a voltage of speed presetting signal at E (V) is given at the input signal, the voltage is divided by R1 and VR and a voltage Vi is given to the OP amplifier (operation amplifier). The OP amplifier then produces an output Vo with a time delay length of which is dependent on the values of R and C, as represented by expression (1).

From expression (2), it is obvious that ramp time "t" (soft start time or soft stop time) linearly varies according to the values VR and C.

On the other hand, Vo also varies linearly in proportion to the "t" variation and increases up to the level equal to the input signal level.

The soft starter "FR-FC\*" is based on the principle that ramp time is changed by varying resistance VR (ACCEL and DECEL in the actual circuit), and the presetting time range is changeable by using an additional capacitor C.

(Speed setting select switch)

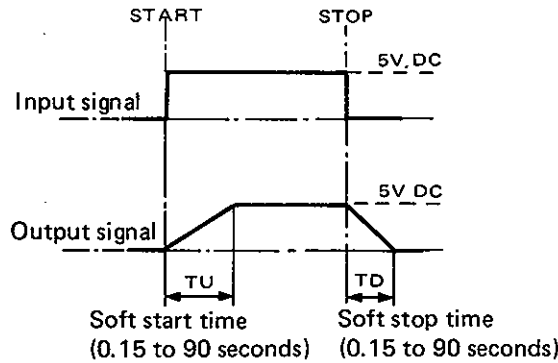


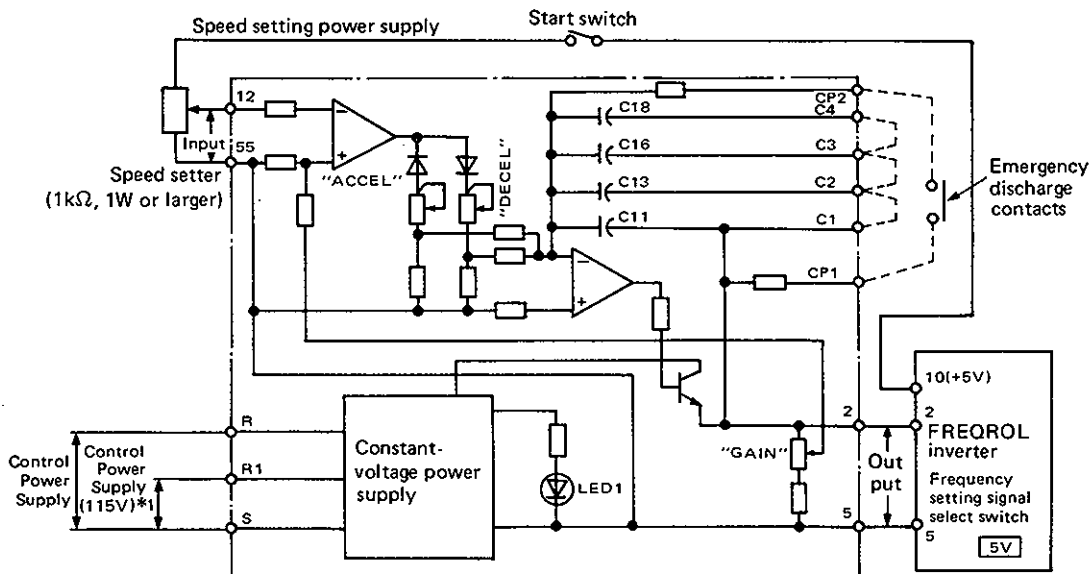
Fig. 4 Acceleration and Deceleration Characteristics

## 6. CIRCUIT CONSTRUCTION

Fig. 5 shows the block diagram of the circuit incorporated in the soft starter. As the VR mentioned in Section 4, "ACCEL" is used for acceleration control and "DECEL" is used for deceleration control. C11 to C18 are used for capacitor C.

For frequency setting input signal, the frequency setting power supply incorporated in the control panel (terminal 10, 5V DC) is used. When a frequency presetting input signal (0 to 5V DC) divided by the frequency setter is given across terminals 12 and 55, the frequency presetting output signal increases linearly with time up to the level equal to the input signal level and is developed across terminals 2 and 5 after the preset time (TU) has elapsed. On the contrary, when the input signal is interrupted, the output signal linearly decreases and reaches 0V after the preset time (TD) has elapsed.

If it is desired to immediately stop the motor free without soft stop, a circuit which permits short-circuiting across terminals CP-1 and CP-2 when the input signal is stopped (the start switch is set to "STOP" position when AS-OX\* is used, for example) to discharge electricity from the capacitor should be provided. In order to immediately stop the motor, however, it is necessary to obtain required brake torque. Therefore, select the inverter to have a capacity proportional to load or use a mechanical brake.



Note1) 115V AC power supply can be connected only for the type with no suffix. No.

Fig. 5 Block Diagram of Circuit Incorporated in Soft Starter

## 7. ADJUSTMENT

The ramp times at soft start and soft stop are adjustable, respectively, by means of variable resistors "ACCEL" and "DECEL" on the unit front panel. The ramp time can be increased by turning the VR clockwise. The ramp time range can be changed to any extent by shorting terminals C1 to C4 and adding a capacitor. No adverse influence is not given when the ACCEL or DECEL is turned during operation.

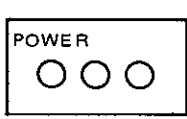
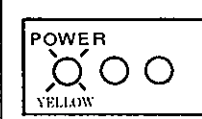
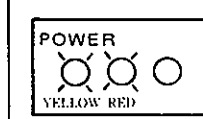
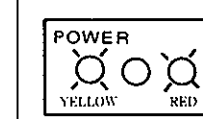
The gain setter "GAIN" is provided to adjust the output signal voltage in relation to the input signal voltage. This setter is factory-adjusted to 1 (5V output at 5V input).

Short of terminals C1 to C4	Time adjusting range by ACCEL and DECEL
No short	0.15 to 1.3 sec.
Short of C1-C2	0.75 to 7.5 sec.
Short of C1-C2-C3	5 to 50 sec.
Short of C1-C2-C3-C4	10 to 90 sec.

Table. 1 FR-FC \* Ramp Time Adjusting Range

- Note:
1. When input signal is 10V, above values are doubled.
  2. Set the acceleration/deceleration time of inverter unit so that the time is shorter than the preset time on FR-FC\*.

## 8. INDICATIONS OF LAMPS ON UNIT FRONT PANEL

Lamp indication				
Operation mode	Power off	Power on Constant-speed operation (including stop)	Power on During acceleration	Power on During deceleration

- Note: When operation is switched from acceleration/deceleration to constant-speed operation, ACCEL/DECEL red lamp flickers.

## 9. APPLICATION EXAMPLE OF PARALLEL RUNNING

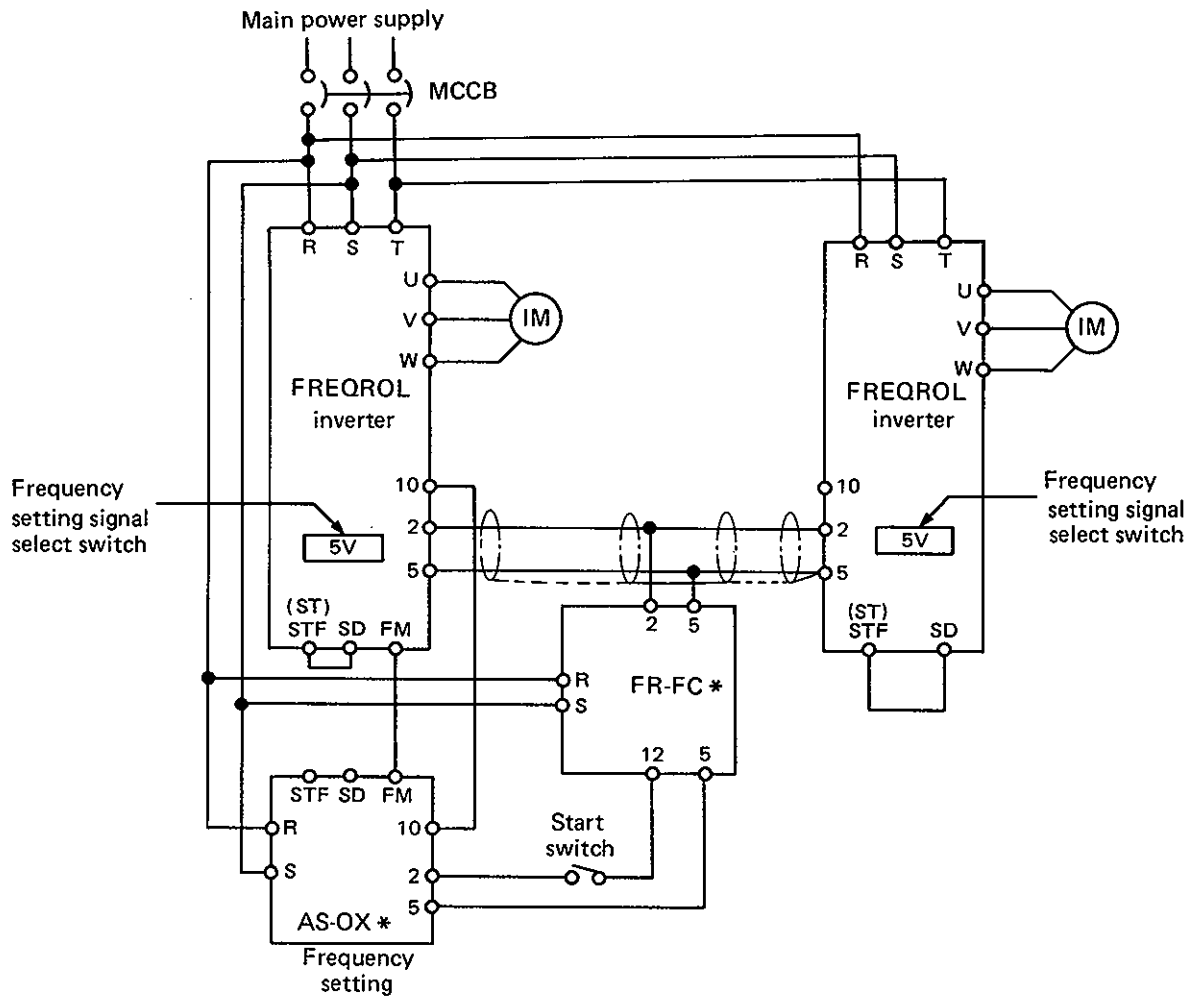
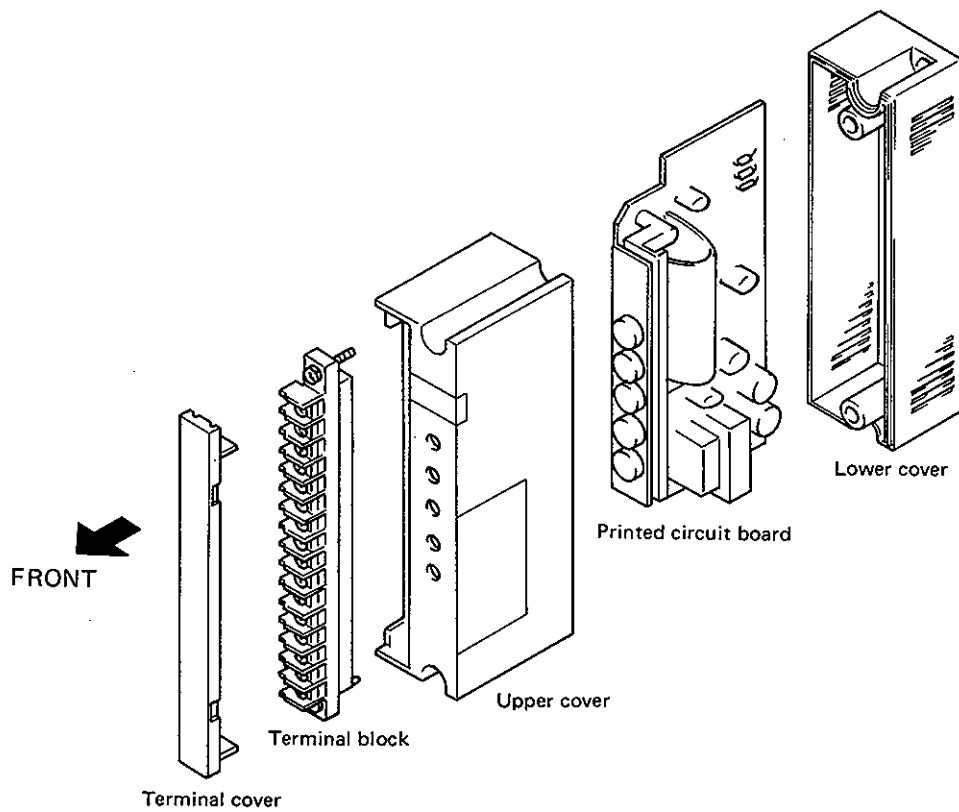


Fig. 6 Example of Parallel Operation

## 10. MAINTENANCE AND INSPECTION

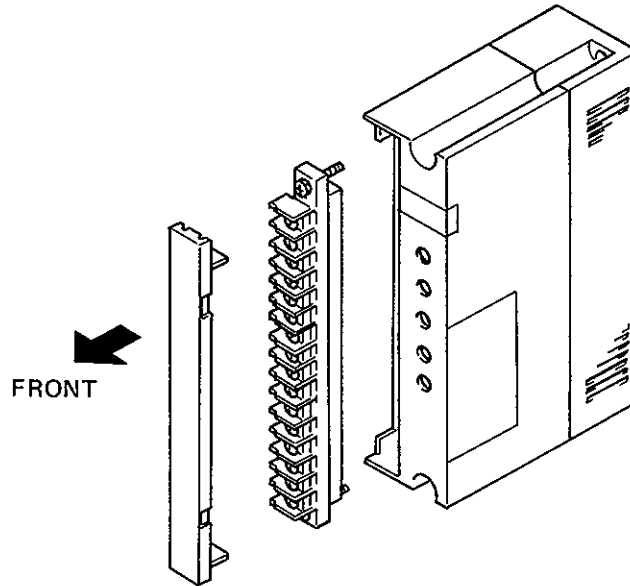
### (1) Internal inspection

By removing two screws from the rear surface of unit, the case is divided into two sections 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 screws 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.