MITSUBISHI
INVERTER
Instruction Manual

AUTOMATION CONTROL COMPATIBLE UNIT
TYPE FR-EPD

- PI Control
- Programmed Operation Battery Backup

Warning symbols For your own safety please pay special attention to instructions containing these symbols:

This warning symbol indicates the presence of dangerous voltage. It informs you of high voltage conditions, situations and locations that may cause death or serious injury if you do not follow precautions.

This symbol indicates a general warning.

This warning symbol indicates an electrostatic discharge hazard.

NOTES inform you of situations or conditions which will damage machinery or cause additional motor-operation downtime if you do not take suggested steps to correct or address such situations or conditions.

Thank you for choosing the option unit for the Mitsubishi FREQROL transistorized frequency inverters. Please read this manual carefully to make optimum use of this option unit.

Automatic Control Compatible Unit (FR-EPD)
This option unit is a multi-function unit designed for use in automatic control operation and has the following functions:

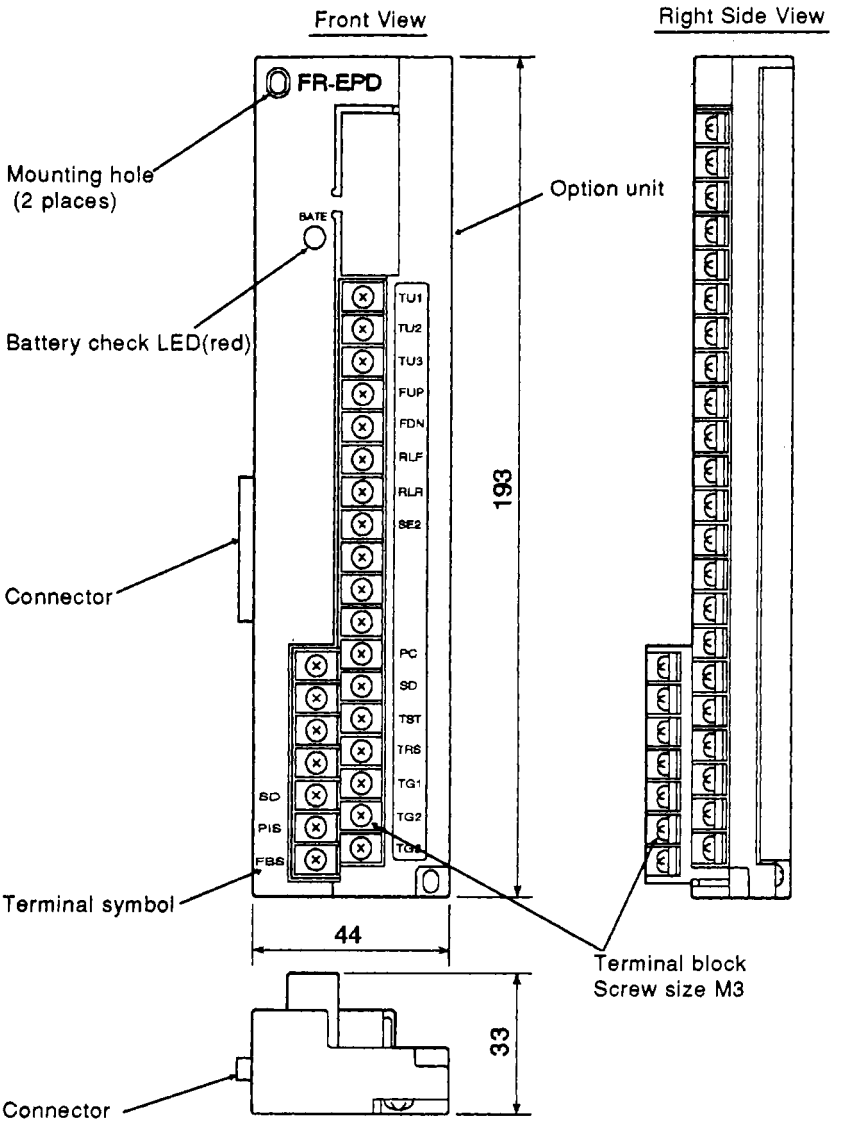
- PI control
- Programmed operation battery backup

CONTENTS

CAUTION Since this option unit has multiple functions, the settings of its functions are as listed in the following table. To make the required function valid, set the corresponding parameter in accordance with the relevant page.

Function	Initial Setting	Remarks
PI control	Invalid	Before shipment from the factory, terminals PIS-SD are disconnected. To use PI control, connect these terminals. (See page 5.)
Programmed operation battery backup	Invalid	The factory setting of Pr. 79 is "0". (See page 16.)

1. STRUCTURE


Front View
Right Side View
FR-EPD
Mounting hole
(2 places)
Option unit
BATE
Battery check LED(red)
TU1
TU2
TU3
FUP
FDN
RLF
RLR
SE2
193
Connector
PC
SD
TST
TRS
TG1
TG2
SD
PIS
FBS
Terminal symbol
44
Terminal block
Screw size M3
33
Connector

2. INSTALLATION

Remove the inverter cover and install the option unit with the following procedure.

2.1 Pre-Installation Checks

⚠ (1) Check the inverter type.
This option unit may only be used with the FREQROL-A200E series inverters and must not be used with any other series (e.g. A200, A100, Z and F series). If you connect forcibly, the inverter may be damaged.

⚠ (2) Make sure that the inverter input power is off.
The inverter may become faulty if the option unit is installed with the input power on. (The inverter or option unit may be damaged and the inverter may display the alarm "E CPU".)

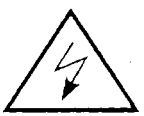
(3) Check that the following accessories are supplied with the option unit.
- 1 - Instruction manual
- 2 - Mounting screws M3 x 14

2.2 Installation Procedure

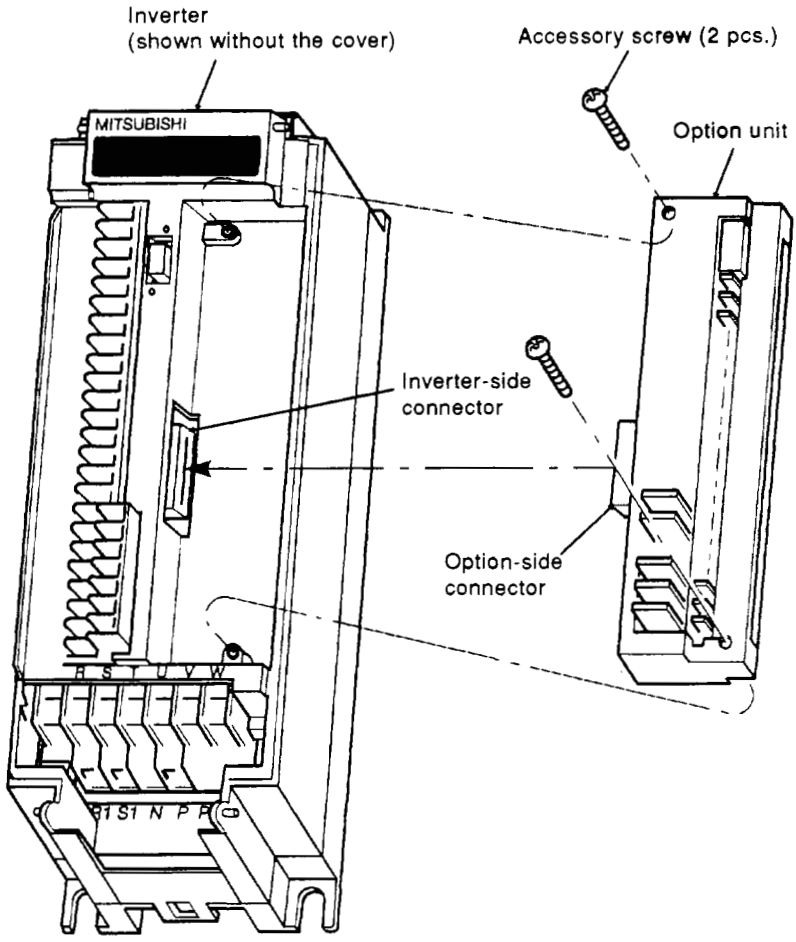
(1) Insert the connector of the option unit far into the connector of the inverter.
(2) Securely fix the option unit to the inverter at the top and bottom with the accessory mounting screws. If the screw holes in the option unit do not match those in the inverter, check that the connectors have fitted correctly.
(3) For the installation diagram, see page 3.

* The empty terminals , which are used inside the option, must not be used as relay terminals. Otherwise, the option unit may be damaged.

Note: Route the cables neatly in the wiring space so that when the front cover is reinstalled, the cables to the inverter control circuit terminals and option teminals are not caught between the inverter and cover.



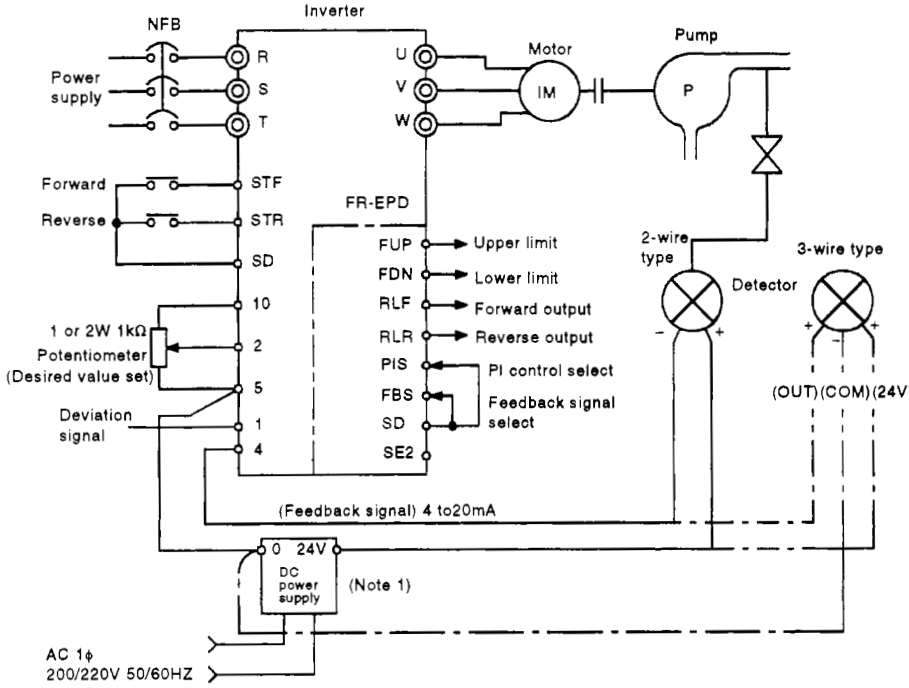
Warning! Hazardous voltage present.
Always isolate the power from the inverter, and wait 5 minutes to ensure the charge lamp has gone out before inserting or removing this option unit, or touching the terminals.


Inverter
(shown without the cover)
Accessory screw (2 pcs.)
Option unit
MITSUBISHI
Inverter-side
connector
Option-side
connector
R S T U V W
R1 S1 N P P1

3. PI CONTROL

This function allows the inverter to carry out process control, e.g. flow or pressure control.

3.1 Wiring Example



Note 1: The power supply should be selected in accordance with the power specifications of the detector used.

3.2 Terminals

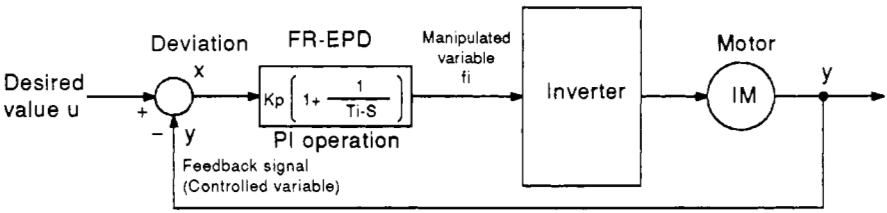
Symbol	Terminal	Description
PIS	PI control select input terminal	Connect with terminal SD to enable PI operation.
FBS	Feedback signal select terminal	Connect with terminal SD to input a 4-20mA signal from the detector as a process value signal.
SD	Input signal common terminal	Common terminal for PIS and FBS. Common to terminal SD of the inverter.
FUP	* Upper limit output terminal	Gives output if the process value exceeds the upper limit set value. Open collector output.
FDN	* Lower limit output terminal	Gives output if the process value falls below the lower limit set value. Open collector output.
RLF	Forward output terminal	Gives output when the display of the parameter unit is forward (FWD). Open collector output.
RLR	Reverse output terminal	Gives output when the display of the parameter unit is reverse (REV). Open collector output.
SE2	Output signal common terminal	Common terminal for FUP, FDN, RLF and RLR. Isolated from the inverter terminal SE.

Note: Allowable load of open collector output: 24VDC 0.1A

* Made valid when PI control is selected (terminals PIS-SD are connected).

3.3 Operation

(1) PI control system configuration



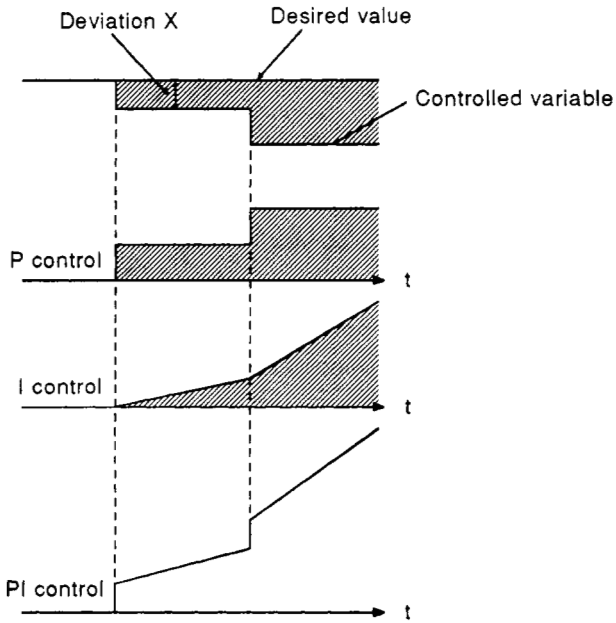
Kp: Proportional constant Ti: Integral time S: Differentiator

(2) Features of PI control

1) PI control

A combination of proportional control (P) and integral control (I) for providing a manipulated variable in response to deviation and changes with time.

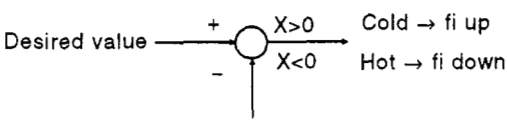
(Response for stepped changes of the controlled variable)

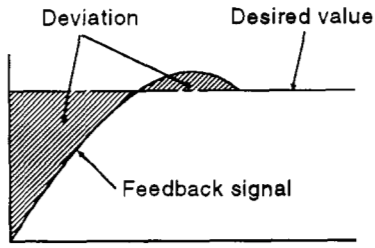


Note: The PI control is the addition of the P and I control.

2) Reverse action Increases the manipulated value (output frequency) if deviation X is positive and decreases the manipulated value if deviation is negative.

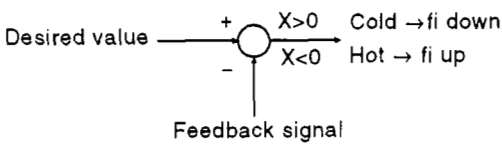
(Heating)

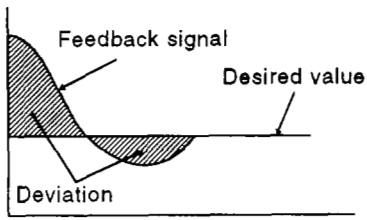




3) Forward action Increases the manipulated value (output frequency) if deviation X is negative and decreases the manipulated value if deviation is positive.

(Cooling)





Relationship between Deviation and Manipulated Variable (Output Frequency)

	Deviation	
	Positive	Negative
Reverse action	↗	↘
Forward action	↘	↗

3.4 Setting Method

(1) Terminal setting

1) Before starting the PI control, connect the FR-EPD terminals PIS and SD. When these terminals are disconnected, the inverter performs ordinary operations without PI control.
2) Input the desired value across the inverter terminals 2-5 or into parameter number 133 and input the feedback signal across the inverter terminals 4-5. In this case, the FR-EPD terminals FBS and SD should be connected.
3) The deviation signal calculated outside the inverter should be input across terminals 1-5 after disconnecting terminals FBS and SD.
4) Setting method

Item	Input Method	Description	
Desired value	Across inverter terminals 2-5	Define 0V as 0% 5V as 100%	When the set value of Pr. 73 (voltage selection) is 1, 3, 5, 11, 13 or 15 (5V is selected for terminal 2)
		Define 0V as 0% 10V as 100%	When the set value of Pr. 73 (voltage selection) is 0, 2, 4, 10, 12 or 14 (10V is selected for terminal 2)
	Parameter number 133	Set the desired value (%) in Pr. 133.	
Deviation signal	Across inverter terminals 1-5	Define -5V as -100% 0V as 0% +5V as +100%	When the set value of Pr. 73 (voltage selection) is 2, 3, 5, 12, 13 or 15 (5V is selected for terminal 1)
		Define -10V as -100% 0V as 0% +10V as +100%	When the set value of Pr. 73 (voltage selection) is 0, 1, 4, 10, 11 or 14 (10V is selected for terminal 1)
Feedback signal	Across inverter terminals 4-5	The feedback signal of 4mA correspond to 0% and 20mA to 100%.	

(2) Parameter

Parameter List

Parameter	Description	Range	Minimum Input Increment	Factory Setting	Remarks
128	PI control selection	0, 1	——	0	0: PI reverse action 1: PI forward action
129*	PI proportional band	0.1 to 1000% 9999	0.1%	100%	Set to 9999 to use integral control only.
130*	Integral time	0.1 to 3600 seconds 9999	0.1 seconds	1 second	Set to 9999 to use proportional control only.
131	Upper limit	0 to 100% 9999	0.1%	9999	FUP is output if the feedback value exceeds the upper limit value setting.
132	Lower limit	0 to 100% 9999	0.1%	9999	FDN is output if the feedback value falls below the lower limit value setting.
133*	PI control desired value for PU operation	0 to 100%	0.01%	0%	Only valid during PU or combined PU/external operation.

Note: *The set values of Pr. 129, 130 and 133 may be changed during operation.

(3) Parameter setting

1) PI control selection (Pr. 128)

Set the reverse or forward action in Pr. 128 in accordance with the system controlled,

e.g. Reverse action (Pr. 128 = 0).....For heating, pressure control, etc.

Forward action (Pr. 128 = 1).....For cooling, etc.

2) PI proportional band (Pr. 129)

1/(PI proportional band value) = gain Kp.

If Pr.129 is small, the manipulated value varies greatly with a slight change of the controlled variable.

Hence, as Pr.129 is small, the response sensitivity improves but the stability deteriorates, e.g. hunting occurs.

3) Integral time (Pr. 130)

Integral time = Ti.

(I/Ti) is closely related to the gain of the integration term of the PI equation.

If Pr. 130 is small, the controlled variable reaches the desired value earlier, but hunting can occur more easily.

4) Upper limit, lower limit (Pr. 131) (Pr. 132)

An alarm can be output if the feedback signal comes out of the setting range.

Set the upper limit value in Pr. 131 and the lower limit value in Pr. 132.

The feedback signal of 4mA corresponds to 0% and 20mA to 100%.

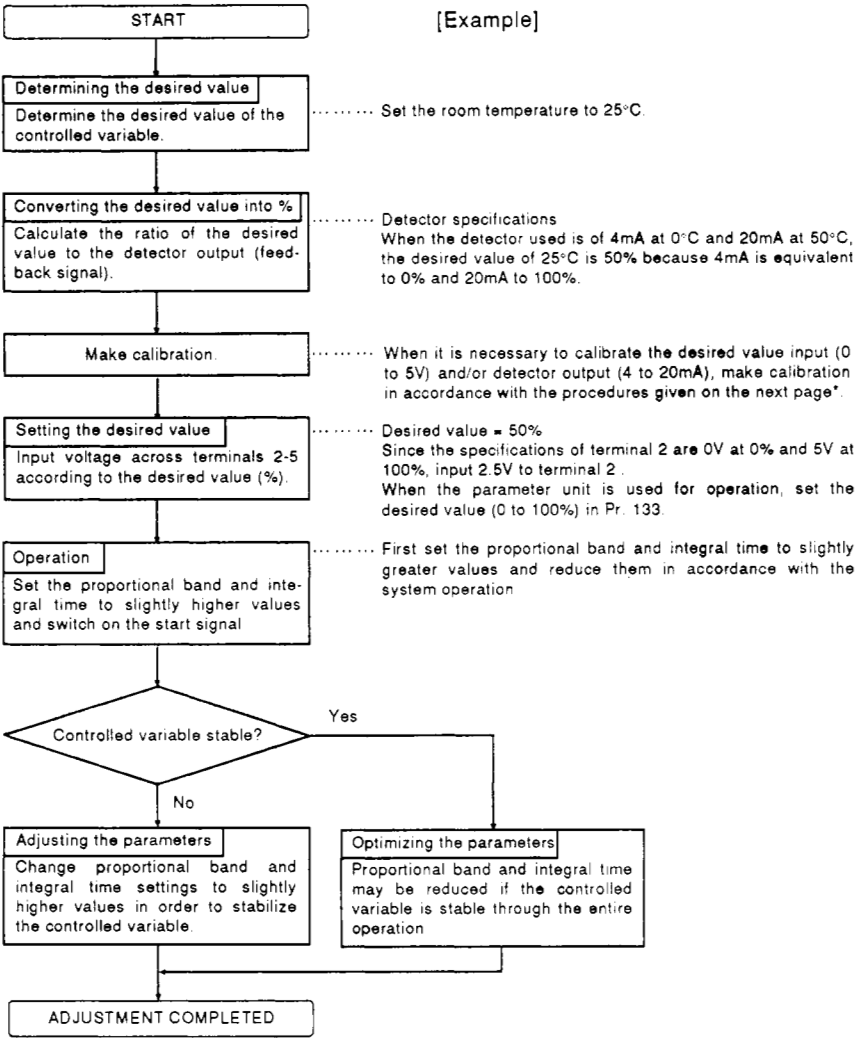
5) PI control desired value for PU operation (Pr. 133)

Set the desired value (%) in parameter number 133. It is valid for the PU operation only. In this case, the frequency set in Pr. 902 is equivalent to 0% and that in Pr. 903 to 100%.

For external operation, the desired value is the voltage across the inverter terminals 2-5.

3.5 Adjustment Example

In the following example, a detector of 4mA at 0°C and 20mA at 50°C is used to adjust room temperature to 25°C by PI control. The desired value is given across the inverter terminals 2 and 5 (0-5V).



PI CONTROL

- When calibration is required → Calibrate the detector output and the desired value setting input using calibration parameters 902 to 905. Make calibration in the PU mode when the inverter is at a stop.

(1) The desired value input calibration

1) Input a voltage for the desired value setting of 0% (e.g. 0V) across terminals 2-5.
2) Calibrate using Pr. 902 (frequency setting voltage bias). At this time, input the frequency which should be output by the inverter at the deviation of 0% (e.g. 0Hz).
3) Input a voltage for the desired value setting of 100% (e.g. 5V) across terminals 2-5.
4) Calibrate using Pr. 903 (frequency setting voltage gain). At this time, input the frequency which should be output by the inverter at the deviation of 100% (e.g. 60Hz).

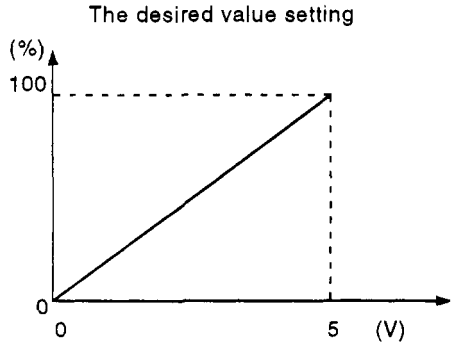
(2) Detector output calibration

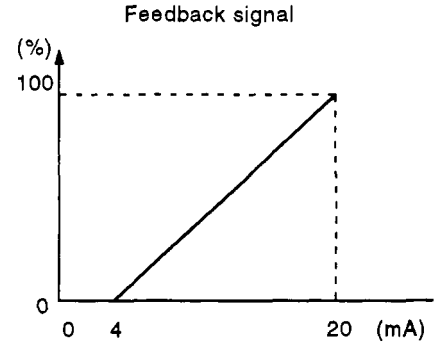
1) Input an output current for the detector setting of 0% (e.g. 4mA) across terminals 4-5.
2) Calibrate using Pr. 904 (frequency setting current bias).
3) Input an output current for the detector setting of 100% (e.g. 20mA) across terminals 4-5.
4) Calibrate using Pr. 905 (frequency setting current gain).

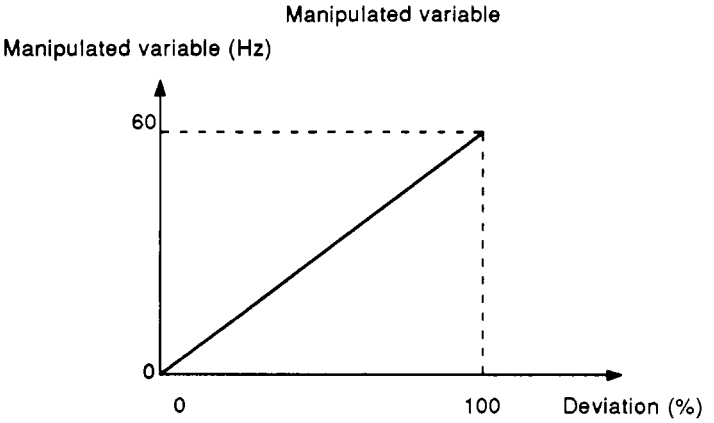
- The frequencies set in Pr.904 and Pr.905 should be identical those set in Pr.902 and Pr.903, respectively.

  (But the frequencies set in Pr.904 and Pr.905 are independent of the PI control.)

The results of the above calibrations are as shown below:






Manipulated variable
Manipulated variable (Hz)
60
0
0
100
Deviation (%)

3.6 Instructions

(1) With terminals PIS and SD connected, input a multi-speed (terminals RH, RM, RL) or jog operation (terminal JOG) signal to stop the PI control and start multi-speed or jog operation.

(2) When terminals FBS and SD are connected, note that the input signal across the inverter terminals 1-5 is added to the desired value across terminals 2-5.

(3) Set 5 (programmed operation mode) in Pr. 79 to disable PI control operation and enable programmed operation.

3.7 Specifications

(1) PI setting ranges

Proportional band (P) : 0.1 to 1000%

Integral time (I) : 0.1 to 3600 seconds

(2) Input signals

(a) Desired value, feedback signal and deviation

Input Specifications		Input Terminal, Input Method	Input Signal
Feedback signal of 4 to 20mA	Desired value	Inverter terminal 2	0 to 5V, 0 to 10V (DC)
		Parameter unit	Digital setting
	Feedback signal	Inverter terminal 4	4 to 20mA (DC)
Direct input of deviation	Deviation	Inverter terminal 1 *	0 to ±5V or 0 to ±10V (DC)

*: If a deviation value has been calculated outside the inverter, enter that value into the inverter terminal 1 (±10V or ±5V).
Also, the FR-EPD terminals FBS and SD must be disconnected.

(b) Select signals (Contact input)

- PI control selection
- Feedback signal (4 to 20mA) selection

(3) Output signals (Open collector output)

* Permissible load 24V, 0.1A DC

- Upper limit
- Lower limit
- Rotation direction (forward rotation output, reverse rotation output)

(4) Functions (by using parameter unit)

- Upper limit value
- Lower limit value
- PI proportional band
- Integral time
- Reverse/Forward action selection
- PI control desired value setting at PU operation

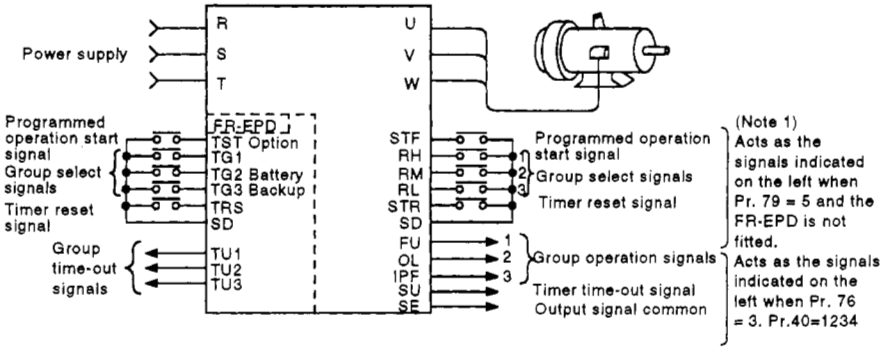
(5) Detector power supply

Use the appropriate power supply in accordance with the detector's power supply specifications. The detector power cannot be supplied from the inverter or the option unit.

4. PROGRAMMED OPERATION BATTERY BACKUP

This function allows the internal timer of the inverter to be battery-backed so that programmed operation, i.e. automatic operation performed under the control of the internal timer in accordance with the preset operation time of day, frequency and rotation direction, can be resumed at power restoration if the inverter power is switched off, or if there is a power failure.
Programmed operation can be performed by the inverter without the FR-EPD option fitted. During such programmed operation, however, its program will be cleared when the power is switched off, or if there is a power failure.

4.1 Wiring Example



Note 1: When 5 (programmed operation mode) is set in parameter 79, the terminals STF, RH, RM, RL and STR of the inverter without the FR-EPD option act as the start, group select and timer reset signals, but the above terminals of the inverter fitted with the FR-EPD option are invalid and do not function.

4.2 Terminals

Symbol	Terminal	Description
TG1, TG2, TG3	Group select signals	Used to select the group for programmed operation.
TRS	Timer reset signal	Input to reset the reference time of day to zero.
TST	Programmed operation start signal	Input to start programmed operation.
TU1, TU2, TU3	Group time-out signals	Output when the operation of the corresponding group is completed. Switched off when the other group starts operating or the timer is reset.

4.3 Settings

The programmed operation function is standard-equipped for the inverter. For full information on the settings, see the inverter instruction manual.

(1) Parameters

Parameter	Description	Range	Minimum Input Increment	Initial Setting	Remarks
Pr. 200	Programmed operation minute/second selection	0 to 3	1	0	0– minute/second unit, voltage monitoring 1– hour/minute unit, voltage monitoring 2– minute/second unit, reference time of day monitoring 3– hour/minute unit, reference time of day monitoring
Pr. 201 to 230	Programmed operation program setting	0 to 2 0 to 400Hz 0 to 99:59	1 0.1Hz Minute or second	9999	Rotation direction: 0-stop, 1-forward rotation, 2-reverse rotation Set frequency / Time of day { 9999 : no setting }
Pr. 231	Timer setting (note)	0 to 99.59	—	0	Set the current time of day. (RAM)

Note: When both the start signal and group select signal are entered, the timer setting is reset to 0. (When desired time is set, both signals should be being input.)

* Rewriting the set value of Pr. 200 independently changes the units set in Pr. 231 and Pr. 201 to 230.
* When 2 or 3 is set in Pr. 200, voltage monitoring is replaced by reference time of day monitoring.

(2) Setting the operation time of day, frequency and rotation direction

The above three items make up one point and can form up to three groups of 10 points.

Use parameters Pr. 200 to Pr. 231 for this setting.

	Set point	Rotation direction, frequency, start time of day
Group 1	No.1	Pr.201
	2	Pr.202
	3	Pr.203
	4	Pr.204
	⋮	⋮
	10	Pr.210
Group 2	No.11	Pr.211
	⋮	⋮
	20	Pr.220
Group 3	No.21	Pr.221
	⋮	⋮
	30	Pr.230

(3) Reference time of day

Programmed operation is performed in reference to the internal timer (RAM) of the inverter.

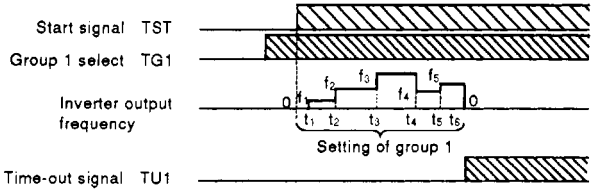
When the power is switched off, the timer (RAM) is battery-backed.

The reference time of day is reset by switching on the timer reset signal (across terminals TRS-SD).

4.4 Operation

(1) After the setting is completed in accordance with Section 4.3, switch on the required group select signal (for example, connect TG1 and SD to select group 1), then connect the start signal (TST). This automatically resets the internal timer (reference time of day) and the operation of the group selected is performed in accordance with the setting. After the operation of that group ends, the time-out signal is switched on at the corresponding time-out output terminal

(e.g. in case of group 1, the open collector across TU1 and SE2 is switched on).

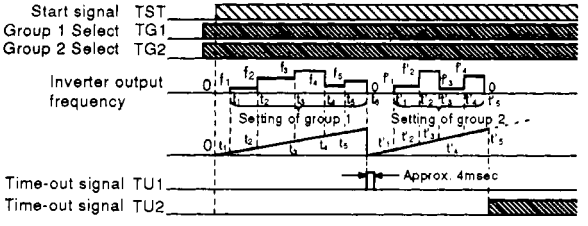


Note that operation is not started when the timer reset signal is on.

(2) Perform operation in the external operation mode.

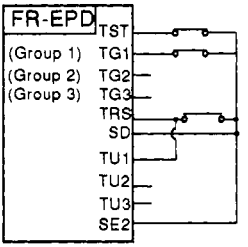
Programmed operation is not performed if any group select signal is switched on during the PU or data link operation.

(3) Selection of two groups at the same time causes operation to be performed in order of group 1, group 2 and group 3. For example, when groups 1 and 2 have been selected, group 1 operation is started, the reference time of day is reset on completion of group 1 operation, group 2 operation is started, and the TU2 time-out signal of group 2 is output on completion of group 2 operation.

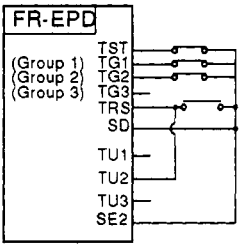


(4) To repeat the operation of the same group(s), reset the timer using the time-out signal as shown below.

1) To repeat group 1 only

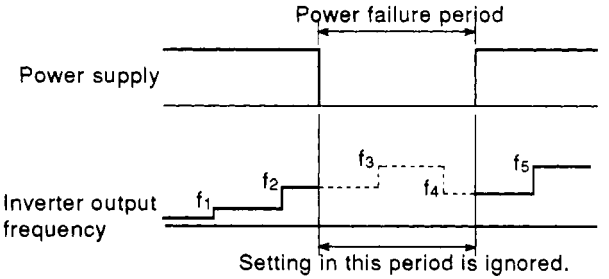


2) To repeat groups 1 and 2

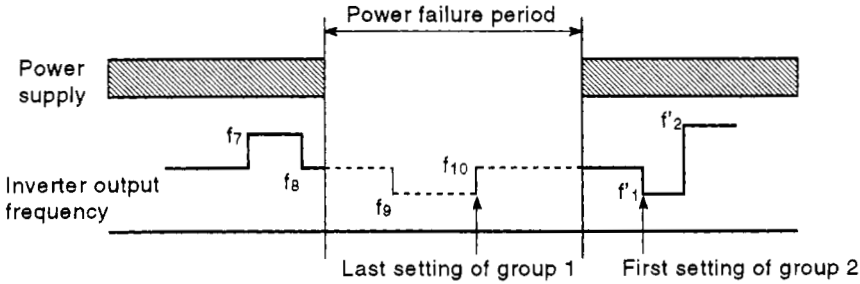


(5) Operation at occurrence of power failure

1) When a power failure occurs, operation is continued as shown below with the operation during the power failure period ignored. (The internal timer for programmed operation continues timing.)



2) When a power failure occured during operation with two or more groups selected at the same time and the power is then restored between the operations of groups 1 and 2, the operation is continued with the operation during the power failure period ignored as in 1.)



Example: A power failure occurred during operation with groups 1 and 2 selected, and the power was restored between the operations of groups and 2.

3) If the group selected has been changed during a power failure, the operation of the group selected is started from the beginning after the power is restored.
4) Operation is not performed if a power failure lasts until the timeout signal (terminals TU1 to TU3) is output.
5) When a power failure lasts for a long time, programmed operation is not resumed if the power is restored. Hence, group selection and time setting should be done again.

The permissible power failure period to continue programmed operation depends on the setting of Pr. 200:

- Max. 18 hours when Pr. 200 = 0
- Max. 30 days when Pr. 200 = 1

4.5 Instructions

The battery check LED on the front panel of the option unit is lit to indicate that the battery life has expired.

Change the battery together with the option unit. The Replacement of the battery only cannot be done.

4.6 SPECIFICATIONS

(1) Battery

Life: 10 years beginning on the date of manufacture

Type: Lithium battery

(2) Timer accuracy

Error of max. 0.9 seconds per day

REVISIONS

* The manual number is given on the bottom left of the back cover.

Print Date	*Manual Number	Revision
Feb., 1995	IB (NA) 66531-A	First edition

IB (NA) 66531-A (9502) MEE Printed in Japan