

8. FR-ZPG PLG FEEDBACK UNIT

8.1 Features

The FR-ZPG PLG feed back unit is used with a speed detector (pulse encoder, PLG) to allow the motor speed to be detected by the speed detector and feedback to the inverter so that the inverter output frequency is controlled to keep the motor speed constant to load variations!

- The speed control loop formed by software processing using the speed detection signal from the pulse encoder allows the ratio of speed variation to load variation to be extremely reduced to within 0.2%.
- Allows the actual motor speed to be monitored by the parameter unit.
- Allows setting and adjustment to be made from the parameter unit for way of operation.

8.2 Structure

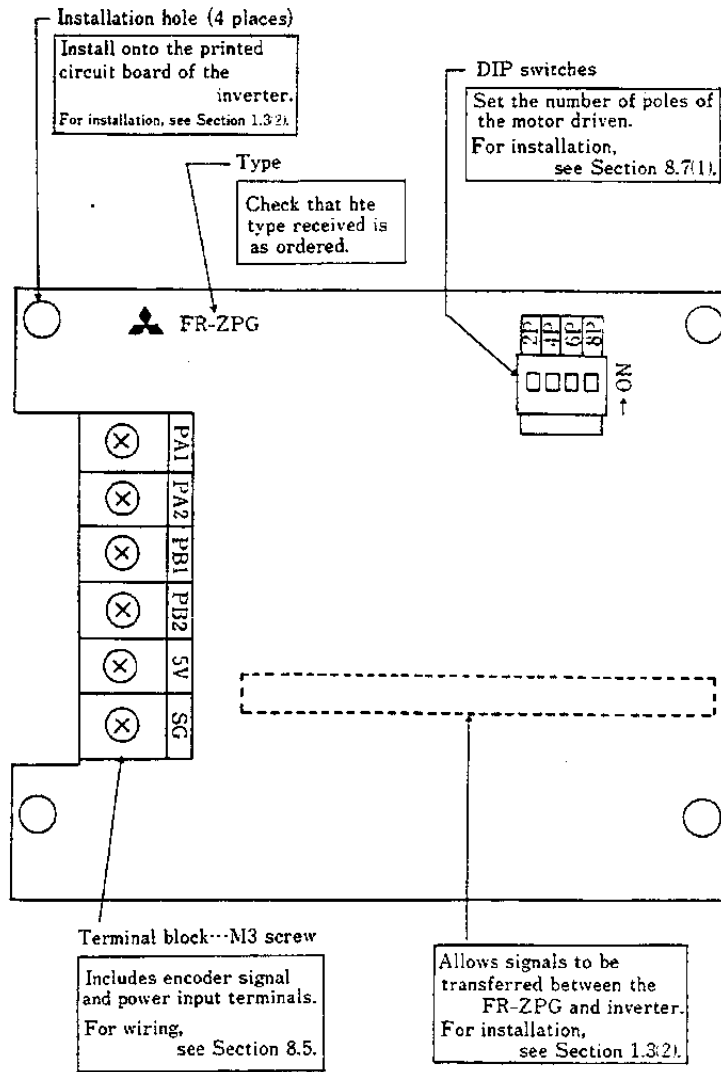


Fig. 8.1 Structure

8.3 Specifications

- Drive motor 2-, 4-, 6- or 8-pole standart motor
- Functions
 - Speed feedback range setting
 - Feedback gain setting
 - Actual speed display
- Speed detector (Pulse encoder) 1024 pulses/rotation (P/R) line driver type
LED type pulse encoder

Recommended : Tamagawa Seiki's TS1508N207

(Connector coupled)

Table 8. 1 Connector (Output Signal) Pin Numbers

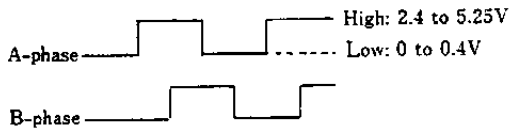


Fig. 8. 2 Output Pulse Specifications

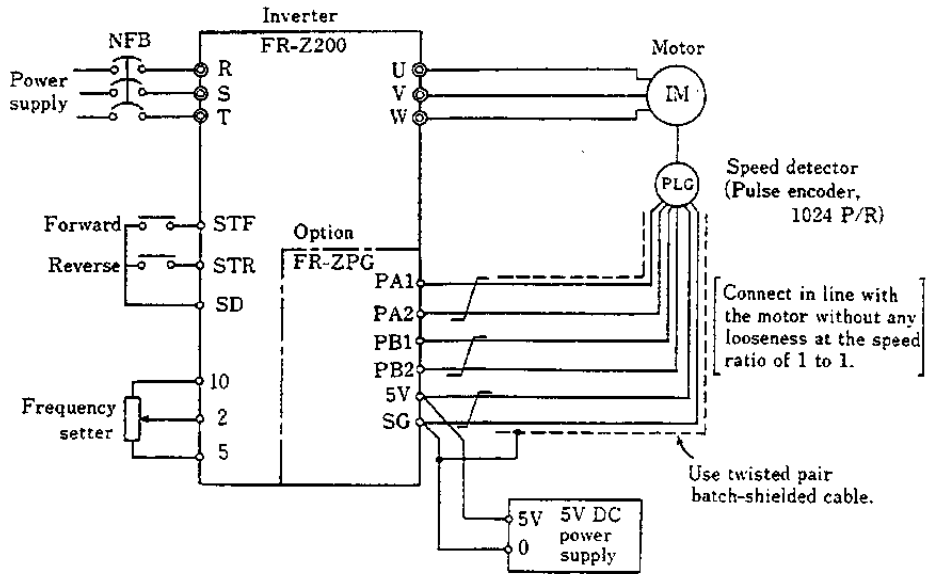
Pin Number	Signal
A	A-phase signal
N	A-phase reverse signal
C	B-phase signal
R	B-phase reverse signal
H	+5V power input
K	Power supply common
E	Case ground

★The pulse encoder must be ordered together with a connector.

- Speed variation ratio Within 0.2% of the maximum speed (1800 rpm) (load variation 0 to 100%* ... 6Hz or more)
* : Load variation 100% indicates the maximum value of the continuous operation torque value to the running frequency in the motor output characteristic (see the catalog and technical information).
- Speed control range Equivalent to that of the inverter.
Note that the maximum speed can be controlled up to "maximum frequency" minus "slip without feedback control." The highest speed can be controlled up to the equivalent of 3600rpm on the motor shaft.
- Power supply (for pulse encoder and option unit)
5VDC. Current capacity 400mA or more.
Current consumption : ● Pulse encoder.....approx. 350mA
● Optin unit.....approx. 50mA
Power supply example : EX15-5 (5V, 3a)

8.4 Wirig

(1) Wiring example



5V power supply must be user-prepared.

Fig. 8.3

(2) Wiring instructions

① Use a twisted pair batch-shielded cable (0.2mm² or larger) between the FR-ZPG and encoder.

If a long cable is used, the voltage supplied to the encoder may be reduced due to voltage drop. To keep the encoder voltage within the alloed value, the cables to the power supply (5V) and ground (SG) must be connected in parallel as indicated in Table 8.2 or a twisted pair batch-shielded cabel of larger size must be used.

If the cabel length is over 30m, use 6 or more cables in parallel or a 1.25mm² or larger cable and increase the 5V power supply slightly (about 5.5V). This allows the cable length to be increased up to 100m. In this case, the voltage applied across terminals 5V and SG must not exceed 6V to protect the option unit and encoder.

The cable length must not be exceed 100m to prevent malfunction.

② The cables connected between the FR-ZPG and encoder must be kept away from any source of noise (e.g. main circuit, high-voltage circuit) to prevent the influence of noise.

Table 8.2 Cable Sizes

Cable Length	Use of 0.2mm ² Cable	Use of Larger-Size Cable
Within 10m	2 or more cables in parallel	0.4mm ² or more
Within 20m	4 or more cables in parallel	0.75mm ² or more
Within 30m	6 or more cables in parallel	1.25mm ² or more
Within 100m	6 or more cables in parallel Power supply about 5.5V	1.25mm ² or more Power supply about 5.5V

8.5 Terminals

Table 8.3 Terminals

Symbol	Terminal	Description
PA1	Encoder A-phase signal input terminal	Connect the A-phase signal wire from the encoder.
PA2	Encoder A-phase reverse signal input terminal (A-phase common)	Connect the A-phase reference signal wire from the encoder.
PB1	Encoder B-phase signal input terminal	Connect the B-phase signal wire from the encoder.
PB2	Encoder B-phase reverse signal input terminal (B-phase common)	Connect the B-phase reference signal wire from the encoder.
5V	Power (positive) input terminal	Connect the positive wire of the 5V power supply.
SG	Power supply ground terminal	Connect the ground wire of the 5V power supply and the shield of the shielded cable.

8.6 Operation

(1) Principle

The output frequency of the inverter is varied so that the speed setting matches the motor speed detected by the encoder.

Namely, since $(\text{inverter output frequency}) = (\text{motor speed}) + (\text{motor slip})$, the inverter output frequency is controlled so that:

$$(\text{output frequency}) = (\text{speed setting}) + (\text{motor slip})^*$$

to achieve:

$$(\text{speed setting}) = (\text{motor speed})$$

The speed variation can be suppressed in reference to the load variation.

* The motor slip value is negative during regenerative operation.

(2) Functions

The following speed feedback functions can be performed from the parameter unit (FR-PU01):

Table 8.4 Parameter List

Parameter	Function	Setting Range	Minimum Increment	Factory Setting	Remarks
55	Speed feedback range	0.01 to 360Hz	3	0.01Hz	Set to 0 to disable speed feedback control.
56	Feedback gain	0.01 to 100	0.01	1	
37	Speed display (actual speed display)	0.2 to 10. 11 to 9999	Integer	0	The data type displayed depends on the set value. See paragraph (3).

* Parameters 55 and 56 in the above table are only valid (allow read and write) when the PLG feedback unit (FR-ZPG) is installed in the inverter.

● Speed feedback range

Indicates the range of frequency which can be increased or decreased from the target value (speed set value) during feedback control.

For example, when the speed feedback range has been set to 3Hz and the speed set value to 50Hz, the inverter output frequency is controlled at 50 ± 3Hz, i.e. between 47 and 53Hz, in accordance with the load variation.

● Feedback gain

Defines the feedback response.

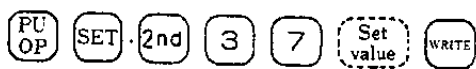
(3) Actual speed display

The FR-ZPG allows the actual speed of the shaft where the encoder is installed (such as motor or load shaft) to be indicated on the parameter unit display.

The output across the frequency meter terminal FM and SD of the inverter corresponds to the actual speed.

① Displaying procedure

Press the parameter unit keys in the following sequence to select speed display (parameter 37) :



Set (input) Value	Parameter Unit Display	FM Terminal Output* 3
0	Output frequency (Hz)	Output frequency
2 to 10* 1 (Number of motor poles)	Zotor speed (rpm)	Frequency corresponding to the speed indicated on the left
11 to 9998	Load speed* 2	

Fig. 8. 4 Actual Speed Display Method

* 1 : Set the number of poles as specified by the DIP switch (SW1).

* 2 : Enter the speed at 60Hz.

* 3 : The FM terminal output signal is of the level at the output frequency corresponding to the speed displayed.

* 4 : For notes on the speed display, see the inverter instruction manual.

★ If the set value of parameter 37 is "zero," both the parameter unit display and FM terminal output correspond to the inverter output frequency and do not correspond to the actual speed.

② Monitoring the direction of encoder rotation

The rotation direction can be monitored on the parameter unit.

· Forward run : The Hz (or A, V) monitoring mode indicator lamp is lit.

· Forward run : The Hz (or A, V) monitoring mode indicator lamp is flickers.

* The inverter's forward or reverse command (signal) must match the encoder's rotation direction.

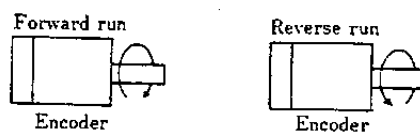


Fig. 8. 5 Direction of Encoder Rotation

8.7 Adjustment

(1) Setting the number of motor poles

Set the number of poles of the motor driven using the DIP switch (SW1) on the FR-ZPG.
Set the corresponding DIP switch knob to ON.

Number of Motor Poles	DIP Switch	Factory Setting
2	2 P	All OFF
4	4 P	
6	6 P	
8	8 P	

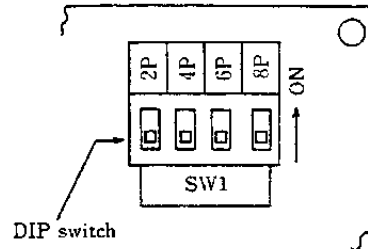


Fig. 8.6 Setting of the Number of Motor Poles

Note 1 : The alarm display (E. OPT) provided at power on indicates that the inverter is inoperable due to either of the following states :

- The number of motor poles has not been set.
- Two or more DIP switches are ON.

- 2 : Moving any DIP switch during operation does not activate alarm and does not change the set value. The old value is changed to a new value when the motor is restarted after a stop.
- 3 : When the number of poles (2 to 10) has been set in parameter 37, check that the set value matches the DIP switch (SW1) setting.

(2) Setting the speed feedback range

Convert the slip (rpm) of the rated motor speed (rated load) into frequency and set that value.

Example : Rated speed of the 4P motor is 1740rpm/60Hz

$$\text{Slip } N = (\text{synchronous speed}) - (\text{rated speed}) \\ = 1800 - 1740 = 60 (\text{rpm})$$

Frequency f equivalent to slip

$$f = \frac{N \times (\text{number of poles})}{120} = \frac{60 \times 4}{120} = 2 (\text{Hz})$$

* Response slows if the feedback range setting is a too large.

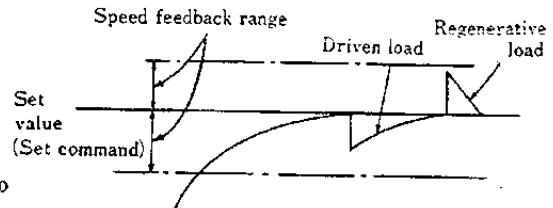


Fig. 8.7

(3) Setting the feedback gain

Set if rotation is instable or response is slow.

- When the set value is increased, response is faster but overcurrent or rotational instability is more liable to occur.
- When the set value is decreased, response is slower but rotation is more stable.

8.8 Typical Application

- (1) Machines on which load variation is steep.
- (2) Joint operation of machines driven from several motors. Especially effective for application where the loads cannot be balance.
- (3) Machines to be operated at constant speed if the load varies.

8.9 Precautions

- (1) During acceleration or deceleration, speed feedback control is not performed to prevent hunting. Speed feedback control is performed after the set speed is reached.
- (2) In actual speed display mode, the number of motor poles (parameter 37) must be set to the same number as that defined by the motor pole number setting DIP switch (SW1).
"Err" displayed indicates that there is a discrepancy in settig or an odd value has been set.
- (3) A failure to set the number of motor poles or wrong setting causes the ALARM lamp to be lit, "E. OPT" to be displayed on the parameter unit, and the inverter to be stopped.
Check the DIP switch (SW1) knob positions.
- (4) The pulse encoder must be coupled in line with the motor shaft without any mechanical looseness at the speed ratio of 1 to 1. Operation cannot be performed at the set speed if the speed ratio is not 1:1.
The pulse encoder used with other than a motor shaft may cause instable rotation and will not ensure the specified accuracy.
- (5) The rotating direction of the motor must be the same as that of the pulse encoder. Otherwise, speed feedback control cannot be performed.
- (6) Extremely note the wiring of the pulse encoder.
If the A-phase and B-phase signal connections are reverse, the inverter can be operated but speed feedback control cannot be done.
- (7) Speed feedback control is stopped if the pulse signal from the pulse encoder is switched off during inverter operation due to open wire, etc.
In this case, the inverter keeps running without a stop and does not output alarm.
- (8) If the motor is forced to accelerate (regenerative operation) or decelerate (e.g. motor lock) by external force, the output frequency of the inverter is (speed set value) (value within the speed feedback range) and does not follow the motor speed.