

# ***TOSVERT VF-AS3***

## Digital Encoder Instruction Manual

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## TOSHIBA INDUSTRIAL PRODUCTS AND SYSTEMS CORPORATION

### NOTICE

1. Make sure that this instruction manual is delivered to the end user of Digital Encoder option.
2. Read this manual before installing or operating the option. Keep it in a safe place for reference.
3. All information contained in this manual will be changed without notice.



# I

## Safety precautions

I

II

The items described in the instruction manual and on the inverter itself are very important so that you can use safely the inverter, prevent injury to yourself and other people around you as well as to prevent damage to property in the area. Thoroughly familiarize yourself with the symbols and indications shown below and then continue to read the manual. Make sure that you observe all warnings given.

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### Explanation of markings

Marking	Meaning of marking
 WARNING	Indicates that errors in operation will lead to death or serious injury.
 CAUTION	Indicates that errors in operation will lead to injury <sup>*1</sup> to people or that these errors will cause damage to physical property <sup>*2</sup> .

<sup>\*1</sup> Such things as injury, burns or electric shock that will not require hospitalization or long periods of outpatient treatment.

<sup>\*2</sup> Physical property damage refers to wide-ranging damage to assets and materials.

### Meanings of symbols

Marking	Meaning of marking
	Indicates an inhibition (Don't do it). Detailed information on the inhibition is described in illustration and text in or near the symbol.
	Indicates a mandatory action that must be followed. Detailed information on the mandatory action is described in illustration and text in or near the symbol.
	Indicates a warning or caution. Detailed information on the warning or caution is described in illustration and text in or near the symbol.

## ■ Limitation of use

### WARNING



Prohibited

- Never use the option with any device other than applicable TOSVERT series inverters. This will result in accident.

## ■ Handling in general

### WARNING



Disassembly  
inhibited

- Never disassemble, modify or repair the option. This can result in electric shock, fire or injury. For repairs, call your Toshiba distributor.



Prohibited

- Do not put or insert any kind of objects into the option (electrical wire cuttings, rods, wires etc). This can result in damage or fire.
- Do not splash water or any other fluid over the option, do not touch the option with wet hands. This can result in damage or fire.
- Do not apply shock (falling, etc.) on the option. This can result in damage or malfunction.
- Do not touch the connector to the inverter (refer to the outline drawing). This can result in damage or accident.



Mandatory  
action

- Turn off the power immediately in case of abnormalities such as smoke, abnormal odor, noise or blind display. Neglect of these conditions can result in fire. For repairs, call your Toshiba distributor.
- Operate under the environmental conditions prescribed in this manual. Operations under any other condition can result in malfunction.

## ■ Disposal

### CAUTION






Prohibited

- If you dispose of the option, have it done by a specialist in industrial waste disposal\*. If you dispose of the option by yourself, this can result in producing noxious gases, resulting in injury.
- (\*) Persons who specialize in the processing of waste and known as "Industrial Waste Product Collectors and Transporters" or "Industrial Waste Disposal Persons." Please observe any applicable law, regulation, rule or ordinance for industrial waste disposal.

■ Wiring - Installation

I

<div> WARNING</div>	
<div> Prohibited</div>	<ul style="list-style-type: none"><li>• Do not use the option if it is damaged or any part of it is missing. Operating the defective product can result in electric shock or fire. For repairs, call your Toshiba distributor.</li><li>• Do not connect any wire other than applicable wire to the option. This can result in malfunction or accident.</li><li>• Do not pull the cable and the connector connected to the option. This can result in damage or malfunction.</li><li>• Do not touch the metal part of the power circuit terminals when connecting the connector to the option. This can result in injury.</li></ul>
<div> Mandatory action</div>	<ul style="list-style-type: none"><li>• The following steps must be performed before wiring and installation. Turn off all input power, wait at least 15 minutes, and confirm that the charge lamp of the inverter is no longer lit. If steps above are not properly performed, this can result in electric shock.</li><li>• Use an emergency stop device and an additional safety device in your system to prevent serious accident due to the option malfunctions. Usage without any emergency stop device or any additional safety device can result in accident or injury.</li></ul>



Thank you for purchasing the Digital Encoder option for TOSVERT VF-AS3 series inverter. This option is applicable as PG feedback interface for differential line driver output (TIA/EIA RS422) type encoder.

This manual contains instructions of this option.



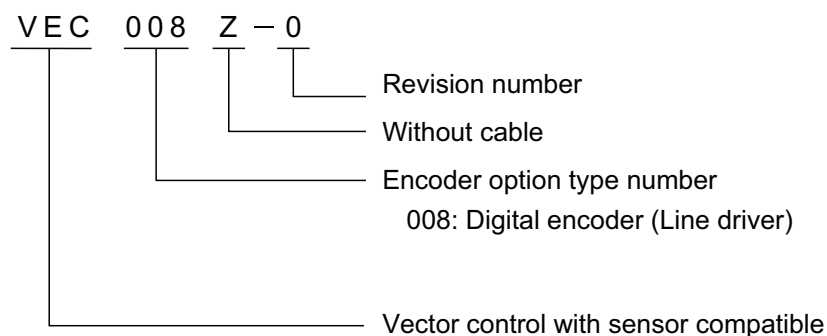
## CAUTION



Prohibited

- Do not use the encoder out of applicable type specified in this manual. This can result in damage or accident.

### <Description of the Encoder option>



Important

#### Firmware compatibility

- VF-AS3 of CPU version "V102" is limited in the maximum frequency of input pulse (160kHz at maximum).
- VF-AS3 of CPU version "V102" and "V104" are limited in induction motor for closed loop control. Refer to inverter instruction manual for the check method of the CPU version.
- VF-AS3 of CPU version "V102" and "V104" are limited not to use Z and NZ phase signals.





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# 1

## Names of the Parts

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II

External views of the Encoder option are described in this section together with the names of parts.

### ■ External views and names of parts on the option

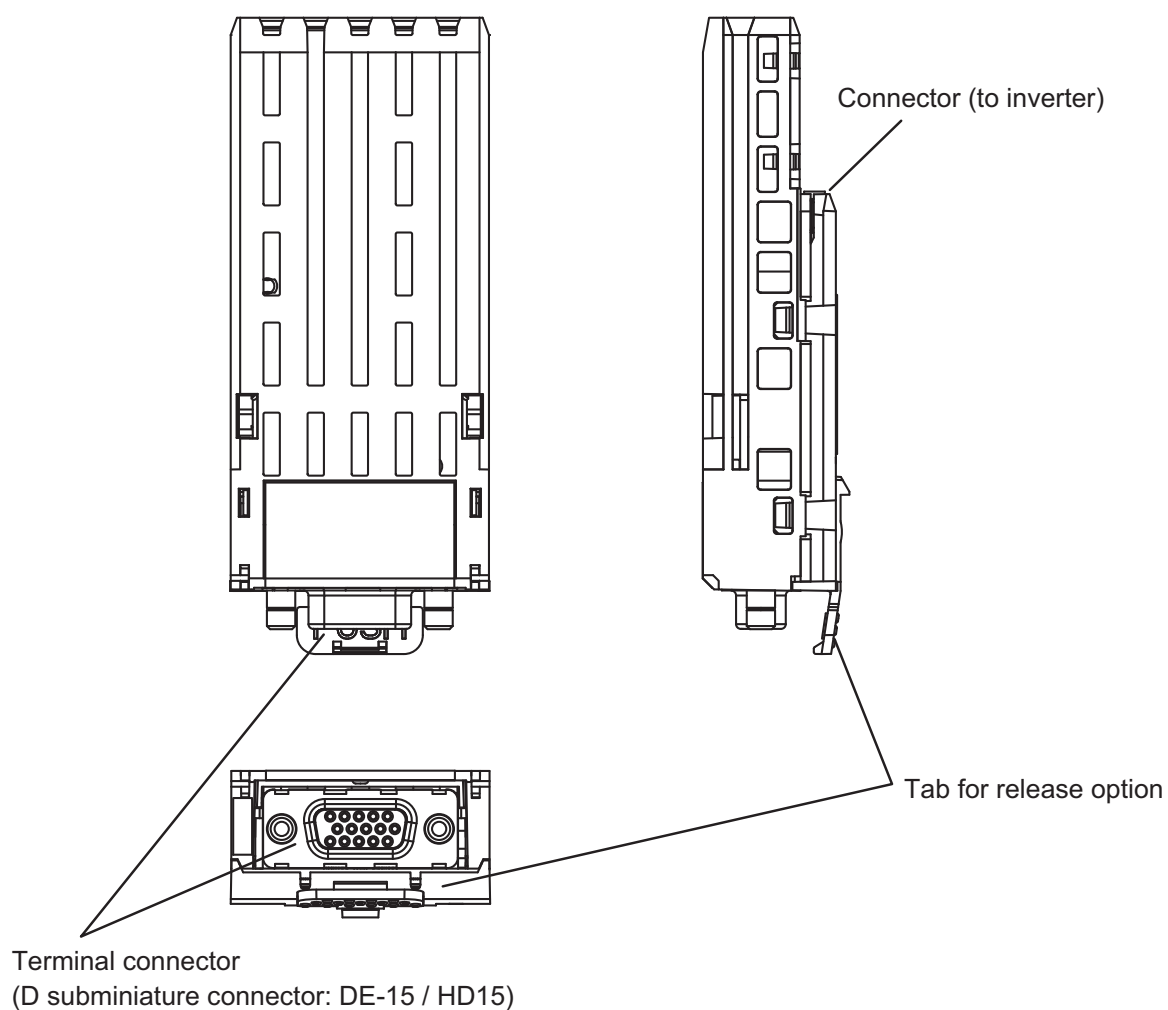
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# 2

## Connection to the Inverter

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Install the Encoder option to the inverter according to the procedures below.

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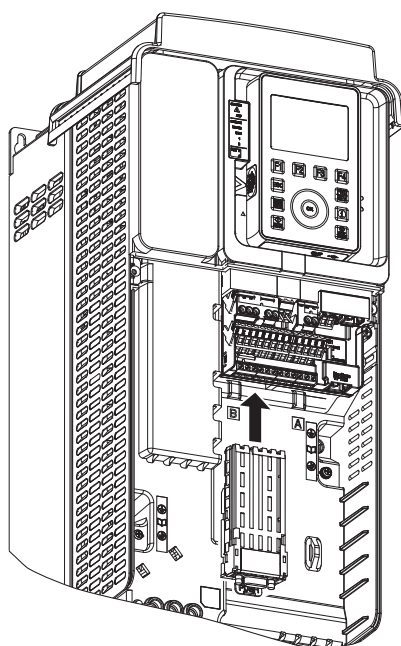
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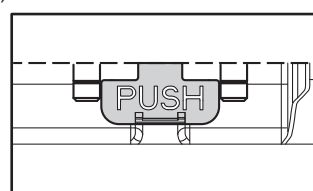
### 2. 1 Installation to the Inverter

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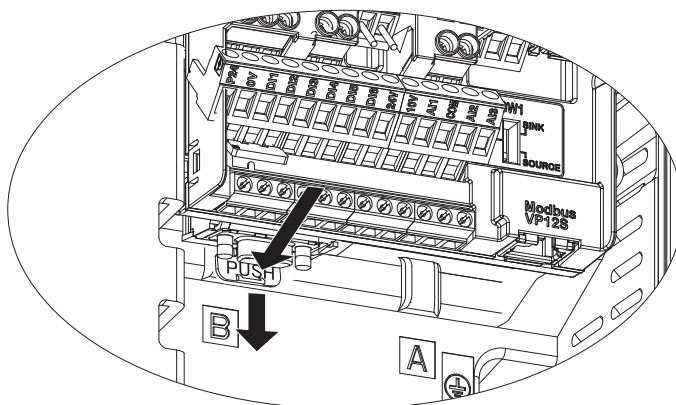
Insert the option into the **slot B** straightly and slowly. Keep the option from hitting other parts near slot.

2)



The option should be inserted until the body is totally covered by the slot. (Refer to the picture above)

#### ■ Removing



Remove the option in the direction of arrow while pushing the "PUSH" tab by a screw driver.

## 2.2 Wiring



Important

- This option is applicable with the feedback signal dedicated to the 2-phase pulse. Single phase pulse input is not applicable.

### 2

#### 2.2.1 Connector

15pin D subminiature connector (high density type: DE-15 / HD15) is prepared in this option. Pin numbers of connector are shown the figure in below. Prepare the same type male connector separately for the cable end of interconnection cable.

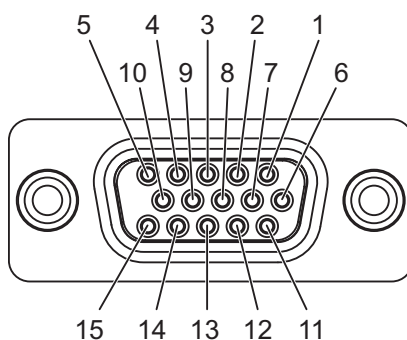


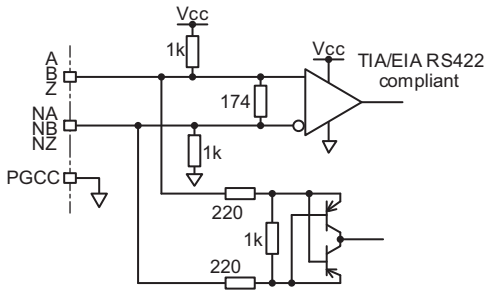
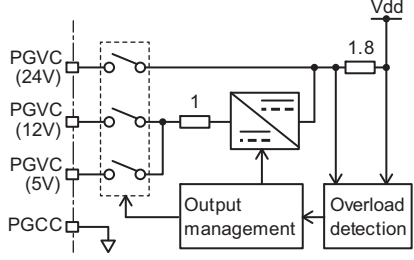
Fig.1 - Encoder interface connector (D subminiature)

## 2. 2. 2 Pin assignment

Table 1. Pin assignment

No.	Symbol	Input/ output	Function / Electrical specifications	Internal circuit
1	A	Input	Phase A PG feedback (TIA/EIA-RS422) Termination: 120Ω	Refer to (a)
2	NA	Input		
3	PGVC (24V)	Output	Power supply for encoder DC 24V (+10/-15%), 100mA	Refer to (b)
4	Z	Input	Phase Z PG feedback (TIA/EIA-RS422) Termination: 120Ω	Refer to (a)
5	NZ	Input		
6	-	-	(don't use)	-
7	PGVC (12V)	Output	Power supply for encoder DC 12V (+/-5%), 100mA	Refer to (b)
8	PGCC	Common	Equipotential terminal for encoder	
9	-	-	(NC)	-
10	B	Input	Phase B PG feedback (TIA/EIA-RS422) Termination: 120Ω	Refer to (a)
11	NB	Input		
12	-	-	(don't use)	-
13	-	-		
14	-	-		
15	PGVC (5V)	Output	Power supply for encoder DC 5.2V (+/-5%), 250mA	Refer to (b)
Housing	Shield	-	Cable shield (metal housing of connector) This part is connected to PE terminal inside the inverter	-

Table 2. Internal circuit

	Internal circuit
(a)	
(b)	



### 2. 2. 3 Signaling

As for the encoder feedback signals, Terminal A and NA are connected for Phase A, Terminal B and NB are connected for Phase B.

The polarity of the pulse input signal should be as follows.

Non-inverting input side: A, B

Inverting input side: NA, NB

The signal feedback from the encoder should have the waveform shown in Fig.2 in terms of the motor rotation direction. The encoder installation direction and signal wiring should be done accordingly.



Important

- Forward rotation or reverse rotation is judged from the feedback pulses of Phase A and Phase B (2-phase pulse that have 90 degrees of phase difference). Therefore, it should be noted that, when connections are wrong, there is possibility for abnormal rotation of the motor.

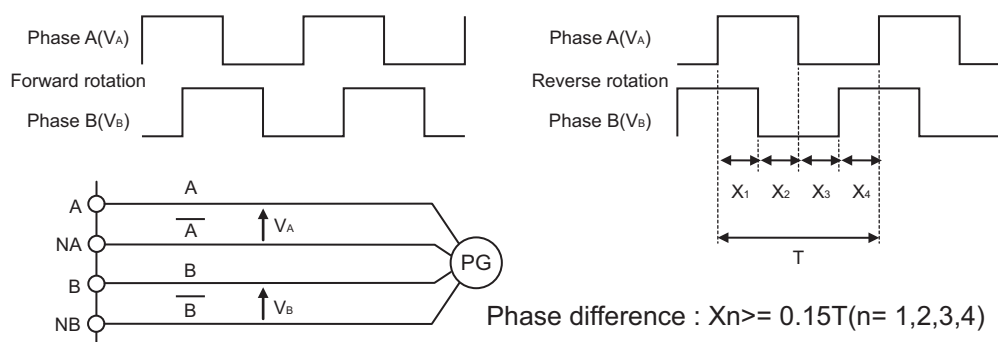


Fig.2 - Judge on normal and reverse rotations by the encoder feedback of two phases (Phases A and B)

## 2. 2. 4 Wiring with encoder

When wiring, follow the instructions bellow.

- Use twisted pair shield wire for A/NA, B/NB, Z/NZ and PGVC/PGCC each
- For PGVC, select a pin according to the encoder supply specification.  
Parameter configuration is also needed (See Chapter 3)
- Do not connect any wire to unused pins
- Recommended wire size is 0.25 mm<sup>2</sup> (AWG26) for signal line (A, NA, B, NB, Z and NZ), 0.5mm<sup>2</sup> (AWG20) for power supply (PGVC and PGCC)
- The cable length is 100m at maximum. At that time, supply voltage drop by wire impedance should be taken into account.



Important

- Separate the encoder cable, at least 20cm away from power (Power supply and motor) cable.

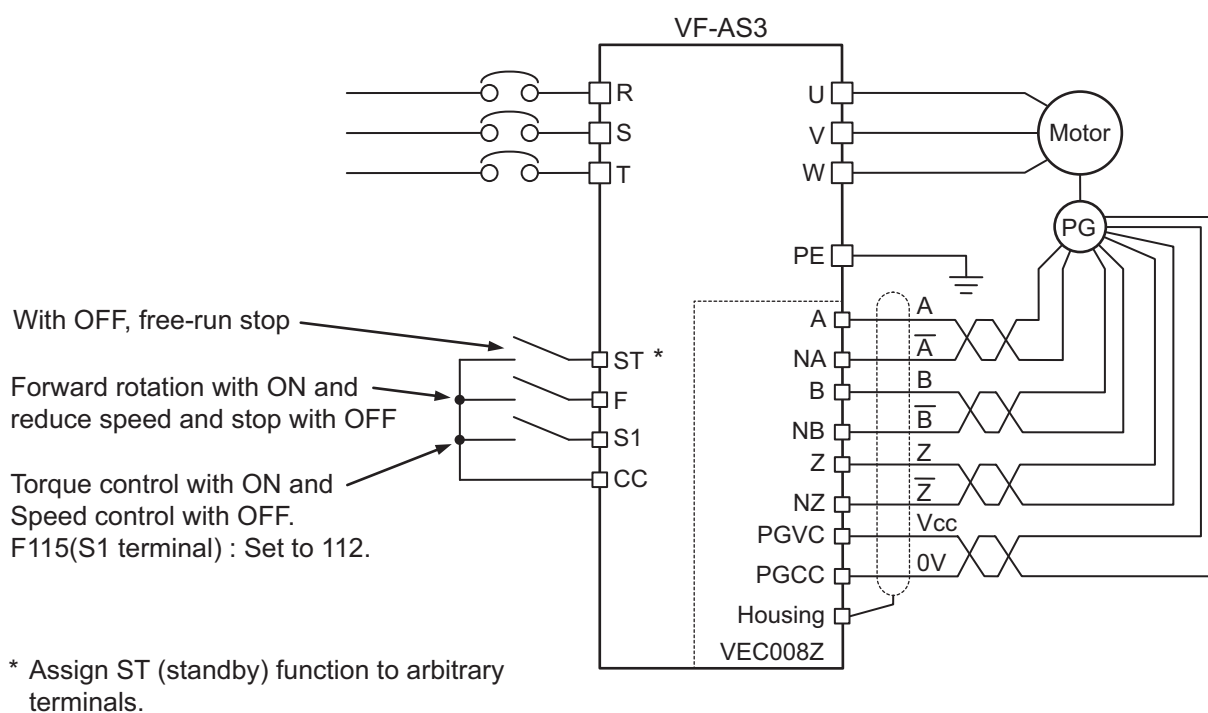


Fig.3 - Example of wiring for line driver encoder  
(Speed/Torque switching operation)



Important

- When using two-phase output type encoder, motor forward and reverse rotation can be judged by encoder.  
When prohibition on reverse rotation is set by the inverter parameter (F311=1) and when the motor is rotating to reverse direction due to an external force, the inverter starts with reverse operation in accordance with the motor's rotation direction for a time and the motor will be able to shift to the forward rotation and the smooth startup becomes possible.

### 3. 1 Performance of vector control with PG sensor

Using the pulse-row feedback signal from the encoder installed on the motor shaft or load rotation shaft, vector control with sensor can be conducted.

- Speed control operation: 0 speed to 150% torque,  
speed control range 1:1000 (1000 ppr-PG)  
speed accuracy  $\pm 0.02\%$  (50Hz base digital input)
- Torque control operation: Torque control accuracy:  $\pm 10\%$   
(torque control range: -100% to 100%)

#### 3. 1. 1 Parameter setting for vector control with PG sensor

During operation with vector control with sensor, it would be necessary to set the following parameters shown below.

##### ■ Set V/f pattern

Table 3-1. parameter of control pattern

Title	Function Name	Parameter Setting	Setting at Shipment
Pt	V/f Pattern	0: V/f constant 1: Variable torque 2: Automatic torque boost 3: Vector control 1 4: Energy savings 5: Dynamic energy savings (for fan and pump) 6: PM motor control 7: V/f 5-point setting 8: - 9: Vector control 2 (speed / torque) 10: PG feedback control 11: PG feedback vector control (speed / torque) 12: PG feedback PM motor control (speed / torque)	0

When conducting vector control with sensor (speed/torque control) with this board option, [Pt] = "10", "11", "12" should be set.

For torque control operation, it is necessary to allocate control switching (torque/position) to one of the terminal function selection [F111] to [F118] (input terminal function selection 1 to 8) (when [CMOd] ="0") or to allocate to communication control switching (when [CMOd] ="2" to "5"), in addition to the above parameters.

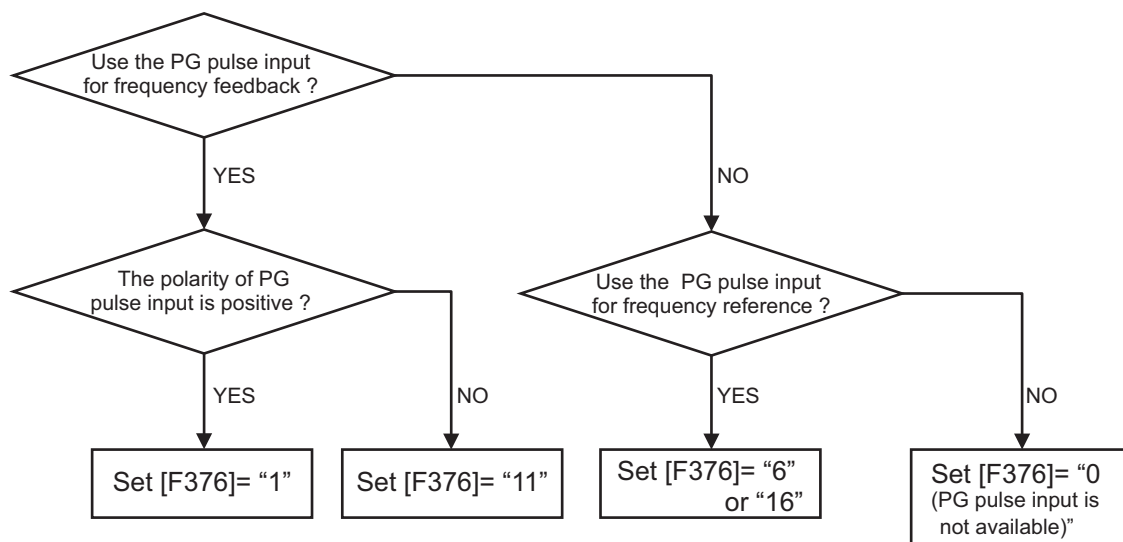
For details of adjustment methods by the speed control command and torque control command, refer to the inverter manual.

### ■ Set parameters of PG sensor

Table 3-2. Parameters of PG sensor

Title	Function Name	Parameter Setting	Setting at Shipment
F375	PG pulses number	1 - 9999	1000
F376	PG select	0: PTI (Command) – PTI (FB) 1: PTI (Command) – Digital option (FB) 2: - 3: PIT (Command) - Resolver option 4,5: - 6: Digital option (Command) - Non FB 7 - 9: - 10: PTI (Command) - PTI (FB inversion) 11: PTI (Command) - Digital option (FB inversion) 12: - 13: PIT (Command) - Resolver option (FB inversion) 14,15: - 16: Digital option (Command inversion) - Non FB	0
F377	PG option disconnection detection	0: Disabled 1: Enabled	0
F379	PG option voltage	0: 5V 1: 12V 2: 24V	0

- (1) The PG pulses number [F375] is the number of encoder output pulses per one motor rotation.
- (2) The PG option voltage [F379] is the supplied voltage to PG option.
- (3) For PG select [F376], set as follows:



- (4) PG option disconnection detection [F377]="1" : in case PG option is not connected, or PG at least one pulse is missed, E-12 trip occurs.  
It is necessary to reset the inverter power to enable the changes.

## ■ Set motor parameters

Table 3-3. Motor parameters

Title	Function Name	Parameter Setting	Setting at Shipment
F400	Offline auto-tuning	0: - 1: Reset motor parameters (0 after execution) 2: Auto-tuning at run command (0 after execution) 3: Auto-tuning at TB ON 4: Motor parameters auto calculation (0 after execution) 5: 4+2 (0 after execution) 6: Auto-tuning at run command during TB is ON 7: Auto-tuning F402 only at run command during TB is ON	0
F401	Slip frequency gain	0 – 250%	70
F405	Motor rated capacity (motor name plate)	0.10 – 315.0kW	Depends on type.
F415	Motor rated current (motor name plate)	Depend on capacity	
F417	Motor rated speed (motor name plate)	100 – 64000min <sup>-1</sup>	
F402	Automatic torque boost	0.01 – 30.00%	
F416	Motor no load current	10 – 90%	
F412	Leakage inductance	0.0 – 25.0%	

The motor parameters require setting according to the motor used. For details, refer to the inverter instruction manual.

### 3. 1. 2 Monitoring method for feedback amount

Motor rotation speed can be monitored.

The motor is equipped with status monitor which is displayed on the panel and analog monitor which used analog output terminals ([FM], [AM] terminals)

Set items (1) or (2) for motor speed monitoring.

- (1) Speed feedback (real-time value) with sign(+/-) (Unit: Hz/free unit)

The real-time display of motor speed can be made (Monitor display setting: "153").

- (2) Speed feedback (one-second filter) with sign(+/-) (Unit: Hz/free unit)

The filtered motor speed (feedback value) is displayed. (Monitor display setting: "154").

The monitoring for the above (1) or (2) is possible also in cases except for [Pt] = "10, 11, 12 (PG feedback vector control operation)". For example, the monitoring can be used for confirmation of the initial PG feedback amount in open loop (V/F operation and the like).

#### <Setting method for status monitoring>

In order to monitor motor rotation speed in condition monitoring, it is necessary to change the setting for extended parameters ([F710] to [F718]).

Refer to Monitoring Operating Condition section of the inverter manual.

#### <Setting method for analog monitoring>

In order to monitor motor rotation speed by the analog output terminal, it is necessary to change the setting for basic parameter ([FMSL], [FM]).

Refer to Meter Setting and Calibration section of the inverter manual.

### 3. 1. 3 Confirmation of PG's rotational direction

PG's connection in A and B phases and rotational direction of motor can be confirmed as follows.

Set the parameters changed back to the original values following confirming the rotational direction.

- (1) Set parameter [Pt: V/F control selected] = "0: constant torque characteristics".
- (2) Set parameter [F711: status monitor 1 display selected] = "153: Signed speed feedback (real-time value)".
- (3) Enter an operating command for positive rotation and command frequency of 1-10Hz to the inverter.
- (4) Confirm the motor be turning in the positive direction.
- (5) Display status monitor "1" by using the status monitor indication of inverter.
- (6) Monitor display, when PG input is determined positive turn 3Hz, "3.0" is displayed. When it is determined negative turn 3.0Hz, "-3.0" is displayed. When determined negative rotation, PG's A/B phase connections and motor wiring are not correct. They must be corrected.

### 3. 1. 4 Abnormal speed detection function

\* Parameter

Table 3-4. Parameters for abnormal speed detection

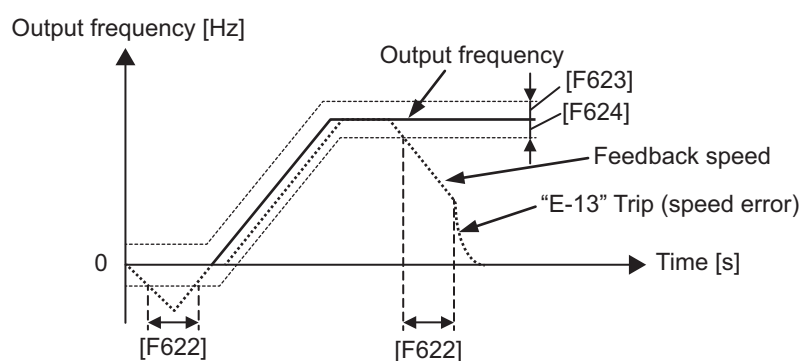
Title	Function Name	Adjustment Range	Setting at Shipment
F622	Abnormal speed detection time	0.01 – 100.00sec	0.01
F623	Abnormal speed increase band	0.0: Disabled, 0.01 – 30.00Hz	0.00
F624	Abnormal speed decrease band	0.0: Disabled, 0.01 – 30.00Hz	0.00

\* Functions

If speed feedback (Estimated speed) > (Output frequency + [F623]) or speed feedback (Estimated speed) < (Output frequency - [F624]), and a certain period of time set with [F622: Abnormal speed detection time], a trip occurs.

You can provide range for a detection level of a trip with a setting of [F623: Abnormal speed increase band] and [F624: Abnormal speed decrease band]

During torque control, if speed feedback (Estimated speed) > (Speed upper limit + [F623]) or > (Speed lower limit - [F624]) a certain period of time set with [F622: Abnormal speed detection time], "E-13" trip occurs.



### 3. 1. 5 Accuracy of speed control

The accuracy of speed control with the PG feedback can be obtained by the following formulae.

Accuracy of speed control = Command frequency accuracy + feedback detection accuracy

$$\text{Command frequency accuracy} = \pm \frac{0.01 \text{ (Hz)}}{F_c \text{ (Hz)}} \times 100 \times \frac{1}{2} \text{ [%]}$$

(using digital command)

$$\text{Feedback detection accuracy} = \pm \frac{1}{(F_c/(P/2)) \times PG \times PH \times (1/R_T)} \times 100 \times \frac{1}{2} \text{ [%]}$$

$F_c$  : Inverter output frequency

$P$  : Number of motor poles

$PG$  : Number of PG pulses/rotation

$PH$  : 4

$R_T$  : Refer to below table

Inverter capacity	Speed response $R_T$
2.2kW or less	300 rad/s
3.7kW to 7.5kW	180 rad/s
11kW or more	90 rad/s

### 3. 1. 6 Easy positioning PID control

#### \* Functions

This function, which is aimed at retaining the load at standstill at its normal stop position, is used along with the speed sensor vector control function to prevent the position of an elevator at standstill from shifting.

Switching to position control takes place when the load is at a standstill.

The settings of these parameters take effect only in sensor speed control mode.

Please refer to E6582112 in detail.



## 3.2 Pulse input command (speed command selection)

It is possible to input inverter operation frequency command by PG pulse signals.

This command cannot be used when vector control operation with sensor is effective.

- Inverter output frequency can be controlled in ratio with the pulse output signal from the pulse oscillator.
- By inputting two-phase pulse with 90 degrees phase difference, it is possible to input forward and reverse rotation commands.

See 2.2.3 for detail connection

### 3.2.1 Pulse input setting parameter

#### ■ Set frequency command selection

Table 3-5. Parameter for frequency command selection

Title	Function Name	Adjustment Range	Setting at Shipment
FMOd	Frequency command select 1	17: High resolution pulse train (option)	1
F200	Frequency command priority select	0: [FMOd]/[F207] (switched by TB) 1: [FMOd]/[F207] (switched by [F208])	0
F207	Frequency command select 2	Same as [FMOd] (1 - 23)	3
F208	Frequency command switching frequency	0.1 – [FH] Hz	0.1

#### ■ Set frequency point setting

Table 3-6. Parameter for frequency point setting

Title	Function Name	Adjustment Range	Setting at Shipment
F234	RP/high speed pulse input point 1 setting	-100 – 100%	0
F235	RP/high speed pulse input point 1 frequency	0.0 – [FH] Hz	0.0
F236	RP/high speed pulse input point 2 setting	-100 – 100%	100
F237	RP/high speed pulse input point 2 frequency	0.0 – [FH] Hz	80.0

#### \* Calculation of the reference frequency

The input pulse frequency is calculated to the percent base data. The calculated percent data is converted to the frequency in accordance with 2 point setting (from [F234] to [F237]). Refer to the below figure. By inputting two-phase pulse with 90 degrees phase difference, it is possible to input forward and reverse rotation commands.

$$\text{Percent base data} = \frac{\text{InputPulsefrequency}}{\text{PG input pulse} \times \text{Maximumfrequency}} \times 100 [\%]$$

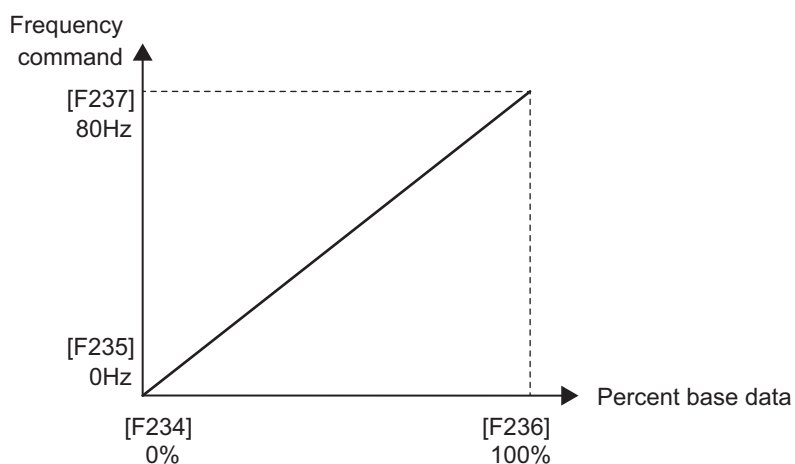


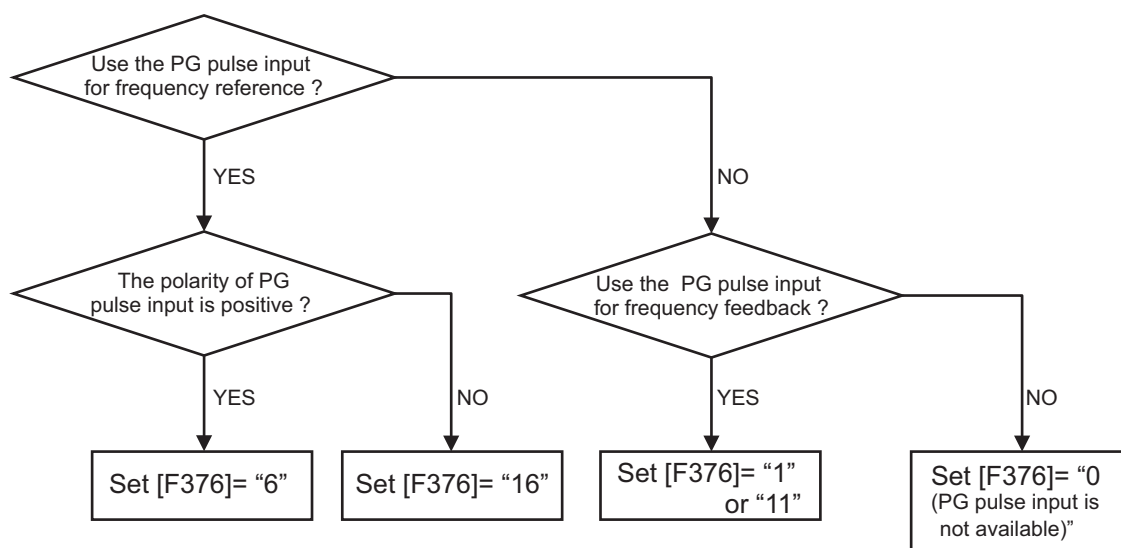
Figure 4 Percent base data and frequency command value

### ■ Set parameters of PG sensor

Table 3-7. Parameters of PG sensor

Title	Function Name	Adjustment Range	Setting at Shipment
F375	PG pulses number	1 - 9999	1000
F376	PG select	0: PTI (Command) – PTI (FB) 1: PTI (Command) – Digital option (FB) 2 - 5: - 6: Digital option (Command) - Non FB 7 - 9: - 10: PTI (Command) - PTI (FB inversion) 11: PTI (Command) - Digital option (FB inversion) 12 - 15: - 16: Digital option (Command inversion) - Non FB	0
F377	PG option disconnection detection	0: Disabled 1: Enabled	0
F379	PG option voltage	0: 5V 1: 12V 2: 24V	0

- (1) [F375: PG pulses number] is the number of encoder output pulses per one motor rotation.
- (2) [F379: PG option voltage] is the supplied voltage to PG option.
- (3) [F376: PG select], set as follows:



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- (4) PG option disconnection detection [F377] = "1": in case PG option is not connected, or PG at least one pulse is missed, "E-12" trip occurs.  
It is necessary to reset the inverter power to enable the changes.

### **3. 2. 2      Monitoring method of pulse input command**

The pulse input command frequency can be monitored.

In order to monitor the pulse input command frequency, set up the monitor display in the frequency command value [Unit: Hz/free unit].

The pulse input command frequency can be confirmed even before the motor is used.

Initial value can be confirmed for the combination testing.

For setting method of the condition monitor, refer to the inverter instruction manual in the "monitoring operation condition" section.



# 4

## Specification

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Item	Specification
Type form	VEC008Z
Product name	Digital Encoder
Function	PG feedback interface (Line driver type)
Applicable encoder	Incremental rotary encoder with differential line driver (TIA/EIA RS422) output
Pulse frequency	300kHz or less (Duty: 50% +/- 10%)
Power supply voltage for encoder (Open circuit voltage)	Pin3 (24V): 24V +10%/-15% Pin7 (12V): 12V +/-5% Pin15 (5V): 5.2V +/-5%
Maximum load of power supply for encoder	Pin3 (24V): 100mA Pin7 (12V): 100mA Pin15 (5V): 250mA
Recommended Cable	Multi-layer shielded cable Size: 0.25 mm <sup>2</sup> (AWG26) for signal line 0.5mm <sup>2</sup> (AWG20) for power supply Length: 100m or less
Connector	D subminiature connector (DE-15 / HD15)
Applicable model	VF-AS3 (Applicable on slot B)
Full-vector operation with sensor	Speed control operation: 150% torque at zero speed Speed control range: 1:1000(1000ppr PG) Speed accuracy ± 0.02% (50 Hz base digital input) Torque control operation: Torque control accuracy ± 10% Torque control range: -100 to 100%
Operation Environment	Operating temperature: -10 to 50°C (Inverter operating temperature), in accordance with inverter for other environment.
Storage temperature	-25 to 70°C



# 5 | Warranty

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Any part of the Digital Encoder option that is proved to be defective will be exchanged free of charge under the following conditions:

For standard default settings, refer to following table.

1. This warranty applies only to the option unit.
2. Any part of the option which fails or is damaged under normal use within 1 year from the date of delivery will be repaired free of charge.
3. For the following kinds of failure or damage, the repair cost shall be borne by the customer even within the warranty period.
  - i) Failure or damage caused by improper or incorrect use or handling, or unauthorized repair or modification of the option.
  - ii) Failure or damage caused by falling or an accident during transportation after the purchase.
  - iii) Failure or damage caused by fire, salty water or wind, corrosive gas, earthquake, storm or flood, lightning, abnormal voltage supply, or other natural disasters.
  - iv) Failure or damage caused by the use of the inverter and digital encoder option for any purpose or application other than the intended one.
4. All expenses incurred by Toshiba for on-site services shall be charged to the customer, unless a service contract is signed beforehand between the customer and Toshiba, in which case the service contract has priority over this warranty.

