

# TOSHIBA

Variable Speed Drive

## **TOSVERT™ VF-nC3**



# Transistor Inverter

# TOSVERT™ VF-nC3

Operation

Triple  
Simple  
Features

Set Up

Installation

Simple  
Operation

## The “turn-and-push” setting dial makes setup easily.

The large setting dial at the center of the front panel allows you to set the parameters easily. Just turn the setting dial until you get the right parameter and push the setting dial to select.

You can also use the setting dial to set the reference frequency.



## The Extension panel option allows to operate the VF-nC3 in front of the cabinet.

An extension panel option installed on the surface of the cabinet can operate the VF-nC3 in front of the cabinet.

It is possible to monitor the output frequency on the VF-nC3 and the output current on the extension panel option (RKP007Z). It is possible to use it as a digital meter.

\*The extension panel option is connected to the inverter with the optional cable.

In the extension panel option, there is no setting dial.

# Simple Set Up

## Easy to set parameters

① Showing most frequently used parameters in easy mode.

EASY key allows you switch between Easy mode and Standard mode.

**Easy mode** : Scrolls through a list of only seven parameters.

You can optionally add up to 24 parameters to the list.

**Standard mode** : Rotates through all parameters.

② Guides you step by step through parameters you need to set up.

Since the guidance feature shows one parameter at a time according to the selected function, you can interactively edit its value. Auto-guidance function is available with motor parameter setup, preset speed selection and analog signal control, etc.

③ Searching for a history of changes in history function.

History function makes change of parameter setting easily when some parameters are repeatedly set by the trial run and the adjustment,etc... History function automatically searches for 5 latest parameters that are set with different values from the standard default setting.

④ Searching and resetting of changed parameters.

User parameter group, *Grp*, automatically searches for only those parameters that are set with different values from the standard default setting and display them.

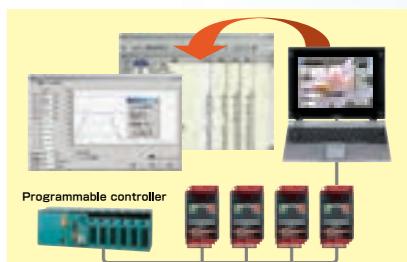
This function makes the parameter setting check and resetting easily.

EASY Key



Easy mode      Standard mode

Communication Network



A RJ45 connector for RS485 communication is located on the bottom of the VF-nC3.

## Simple Installation

### The vertically oriented main circuit terminal block allows easy wiring.

Like power distribution devices, the main circuit terminal block of the VF-nC3 is vertically oriented to make wiring easy and minimize tangles of cable.

Side-by-side installation



### Side-by-side installation for space-saving

Generally, inverters must be placed in consideration of radiation of heat. The VF-nC3 can be placed side by side with no gap, saving inside of control panel space.\*1

Main circuit terminal block cover



### The covers for the main circuit terminal block ensure safety.

You can remove the covers for the main circuit terminal block with a screwdriver. Since the covers can be attached after the wiring of the main circuit terminal block, the VF-nC3 can be installed easily and safely.

\*1:Necessary to reduce output current on some conditions.

## ●Models and Applicable Motors

| Voltage<br>(Input / Rated Output) | Applicable Motor Capacity (kW) |     |     |      |     |     |     |
|-----------------------------------|--------------------------------|-----|-----|------|-----|-----|-----|
|                                   | 0.1                            | 0.2 | 0.4 | 0.75 | 1.5 | 2.2 | 4.0 |
| 3ph-240V/3ph-240V                 |                                |     |     |      |     |     |     |
| 1ph-240V/3ph-240V                 |                                |     |     |      |     |     |     |
| 1ph-120V/3ph-240V                 |                                |     |     |      |     |     |     |

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## Application Examples

### Excellent Motor Control

The VF-nC3 brings out the best performance for kinds of different machine by various motor control modes suitable for its load characteristics.

#### If you just want to change the motor speed

First, select the default Constant V/f mode. If the default does not offer enough torque or you want to save more energy than the default provides, then you can select V/f Control mode to modify its parameters.

#### If you need higher torque for heavy-duty machines

Application examples: Conveyers; food mixers and slicers; exercise treadmills; car washing machines; applications for moving heavy or viscous materials; applications that require quick acceleration, etc.

The VF-nC3 supports sensorless vector control mode to generate stable, high-torque power from motor startup to a predefined, desired motor operating speed.

It is easy to set up motor parameters to achieve optimal vector control. You can do this simply by setting in the values on the name plate of a motor and selecting Auto-Tuning. The Auto-Guidance feature further simplifies setup by showing you necessary parameters once at a time interactively.

The factory defaults are set to values of the Toshiba standard motor (same capacity, 4-pole, 200 V, 60 Hz).

#### To save energy

Application examples: Fans; pumps; machines with small load variations that do not require high motor torque

The VF-nC3 offers Automatic Energy-Saving mode suitable for fans and pumps, which produces optimal current according to the load level.(You need to set up the motor parameters.)

### Long Lifetime

#### Designed for 10 years of operation

The main-circuit capacitor, cooling fan and control board capacitors are designed for 10 years lifetime design.

(Conditions: Average annual ambient temperature = 40°C; output current = 80% of the rated current ; 24 hours / 365 days. The designed lifetime is calculated value, not guaranteed one.)

The cooling fan is automatically turned on and off to further prolong the total lifetime.

Additionally, the VF-nC3 provides a capability to turn on and off cooling fans automatically in order to further prolong their lifetimes. This leads to energy-saving because cooling fans can be stopped while the VF-nC3 is idle.

#### Monitor informs when to replace major parts

The VF-nC3 tells you when to replace major parts and keeps track of the cumulative operation time. Since the VF-nC3 can generate warning, you can prevent a problem before it occurs.

### Eco Design

#### Compliant with the European RoHS Directive

#### Built-in noise filters to suppress electromagnetic noise

The single-phase 240V model have built-in EMC noise filter comply with the European EMC Directive to reduce radio-frequency noise from the inverter.

This saves space and wiring, compared to using an external noise filter.

Single-phase 240V model: European EMC Directive  
IEC/EN 61800-3 1st Environment, C1

### Wide Variety of Applications

The VF-nC3 supports a wide range of machines, operating conditions and meets the needs of different geographical areas.

#### ① Sink/source control logic

The VF-nC3 can be configured for both sink and source logic according to the target machine and the location where it is used.

#### ② Power supplies: three-phase 240 V, single-phase 240 V and single-phase 120 V

The VF-nC3 can be used for a wide variety of applications from industrial machines to everyday equipment.

Note: For single-phase 240V and 120V inputs, the VF-nC3 provides a three-phase 240V output.

#### ③ Maximum ambient temperature: 60°C

In many cases, the temperature in a cabinet gets higher than the ambient temperature. The VF-nC3 can be used at higher ambient temperatures\*1.

#### ④ Maximum altitude: 3000 meters

The VF-nC3 can be used at high altitudes\*1.

#### ⑤ Operating frequency range: 0.1 Hz to 400 Hz

The VF-nC3 supports a wide range of speed from low speed machines to high speed motors.

#### ⑥ Programmable input and output terminals

The functions of the input and output terminals are programmable to meet the requirements for external circuitries and applications. Each terminal can be configured into a multi-functional terminal, and make it possible to simplify external circuitry.

### Safety Features

#### Protects the setting parameters

The VF-nC3 provides protection for the setting parameters. For enhanced security, you can use a four-digit password.

The VF-nC3 has a feature for saving and restoring a set of parameters.

#### The Monitor mode shows the load conditions.

##### ① Monitoring the operating conditions

The front panel shows the operating conditions such as output current, rotational direction, input and output power, and so on. This feature is useful for checking the load conditions and adjusting parameters.

##### ② Checking the trip status\*2.

In the event of a protection trip, you can check the output current, input voltage and the like on a monitor to identify the cause of the problem and take countermeasures. The VF-nC3 remembers information about the last four trips even after you power it off.

### Global Compliance

The VF-nC3 is compliant with major international standards.



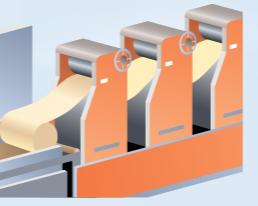
EC directive (CE marking), UL, CSA

\*1: The maximum output current may be limited or the label at the top of the unit need be removed, depending on the operating conditions.

\*2 You can use the Monitor mode through RS485 communication.

### Food Processing Machinery

Bakery equipment, confectionery equipment, tea-making machines, noodle-making machines, candy-wrapping machines, rice/barley milling machines, flour milling machines, food mixers, food slicers, fruit sorting machines, etc.



Food Processing Machine  
(Noodle-Making Machine)

#### You can set the operating frequency according to the required work rate.

1. You can fine-tune the operating frequency via an external contact inputs, depending on the conditions that workpiece materials and processes to be performed.
2. The frequency is selectable in up to 15 steps through external contact inputs.
3. The frequency is linearly adjustable via an analog input in the range 0.4 to 20 mA, 0 to 10 V or 0 to 5 V.(an external potentiometer)
4. The VF-nC3 can be programmed for smooth inching motion for final finishing work.

#### RUN and STOP keys

The VF-nC3 can be programmed to generate one-shot pulses. Thus, operators can use a pedal switch to start and stop a machine.

#### Ensures safety in the event of an instantaneous power failure.

Even when an instantaneous power failure occurs, the VF-nC3 can use regenerative energy from motor to bring the machine to a halt. The VF-nC3 ensures safety by preventing the machine to continue running by sheer inertia.

#### Low noise

The VF-nC3 helps reduce acoustic noise from motors to the level that commercial power supply drive generates.

#### Controls a machine with multiple inverters.

1. VF-nC3 can be controlled simultaneously through RS485 communication.
2. Each inverter can switch among multiple motors if their operations do not overlap in the course of a work process. The VF-nC3 can toggle between the basic settings for two motors.
3. VF-nC3 units can be installed side by side to save control panel space.

#### Maximum ambient temperature: 60°C

The VF-nC3 can be used in high-temperature environments\*.

\* Depending on the operating conditions, the maximum output current may be limited or the label at the top of the unit may need to be removed.

#### Protects the setting parameters.

The VF-nC3 provides password protection for parameters to prevent them from being altered inadvertently.

#### High torque from startup to the rated speed

The VF-nC3 offers vector control and automatic torque boost control modes to achieve strong, stable torque from the start of a motor to the rated rotation speed.

The VF-nC3 can control the motor to work persistently even when mixing viscous materials or cutting hard stuff.

Frequency up/down input control

Preset speed operation

Jog run

3-wire control mode

Deceleration stop in case of power failure

PWM carrier frequency setting

Switching to No.2 motor setting

Password lock

S-curve acceleration/deceleration, second acceleration/deceleration times

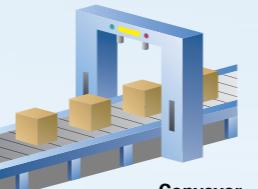
Quick deceleration control

Low-speed detection output signal

Free unit selection

### Conveyance Machinery

Conveyors, automatic warehousing systems, etc.



Conveyor

#### Prevents the collapse of cargo on the conveyor.

The VF-nC3 allows you to mitigate the shocks caused in starting and stopping a conveyor and change the acceleration/deceleration rates according to the conveyor characteristics and its applications.

#### Improves the braking performance.

The VF-nC3 can slow down a high-inertia machine in a short period of time without causing an overvoltage trip by increasing the energy consumed by the motor.

#### Provides an operating status signal to the brake motor.

The VF-nC3 can turn on and off the braking circuitry in accordance with the inverter operating status.

#### Shows the conveyor speed.

You can keep track of the operating status of a machine by displaying the conveyor speed on the inverter panel. If you use an optional remote panel, you can check the conveyor speed near the machine.

\* The speed indication on the VF-nC3 is a value calculated from the operating frequency, may differ from the actual conveyor speed.

#### The VF-nC3 provides smooth start up by high output torque.

The VF-nC3 offers vector control and automatic torque boost control modes to achieve strong, stable torque from the start of a motor to the rated speed.

Additionally, the VF-nC3 responds quickly to abrupt load changes to keep a constant speed.

PID control

Regenerative power ride-through control

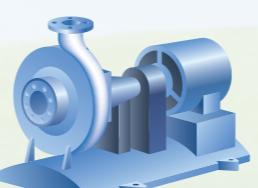
Auto restart control

Overload stall

Overvoltage limit operation

### Fans & Pumps

Built-in fans and pumps in industrial machines; water supply and sewage systems; driers, etc.



Pump

#### Energy-saving mode

The Variable Torque and Automatic Energy-Saving modes help saving energy by passing optimal current in accordance with the load.

#### Automatic process control

The VF-nC3 can be programmed to control temperatures, pressures and flow rates automatically. For temperature control, the PID control polarity is selectable via an input signal according to the selection of heating or cooling; this helps simplify system.

#### Allows a motor to keep running and accelerate smoothly upon the recovery of power even in the event of an instantaneous power failure\*.

Upon instantaneous power failure, the VF-nC3 utilizes regenerative energy from a motor to keep a machine running\*. After power recovery, the VF-nC3 senses the motor's rotation speed and accelerates it smoothly to the programmed frequency.

\* The running period varies with the mechanical characteristics and load conditions. The motor might free-run.

#### Enables an uninterrupted operation without causing a trip

The VF-nC3 automatically lowers the operating frequency in the event of an overloaded condition. This prevents an overload trip for fans and pumps in which current decreases in proportion to the frequency. Also, if you decelerate a high-inertia apparatus like a fan at a quick rate, an overvoltage trip tends to occur due to regenerative energy. To avoid an overvoltage trip, the VF-nC3 allows you to adjust the braking period.

PID control

Regenerative power ride-through control

Auto restart control

Overload stall

Overvoltage limit operation

### Health, medical and nursing care equipment

Stair lifts  
Nursing beds  
Bubble baths  
Health care equipment (Treadmills)  
Medical equipment (X-ray machines) etc.



Treadmill

### Environment and daily-life-related machinery

Commercial ironing boards  
Car washing machines  
Garbage disposers  
Dust collectors  
Driers etc.



Commercial ironing board



Car washing machine

### Packing machinery

Inner packaging machines  
Packing machines  
Outer packaging machines  
Membrane packing machines etc.



Band tightener

# Panel and operation procedure



**TOSVERT™  
VF-nC3**

## Power on (setup parameter)

① When power on the inverter for the first time, **SET** is blinking.



② Select an area code by the setting dial.  
**JP/USA/ASIA/EU**



③ Press the center of the setting dial to confirm your change. When **In Et** is displayed and then **0.0**, you finish setting the setup parameter.



## Monitor display

The LEDs on the operation panel display the following symbols indicate operations and parameters.

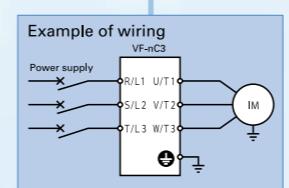
### LED(number)

|   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | - |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | - |

### LED(alphabet)

|    |    |   |   |    |    |    |    |    |    |    |    |    |    |    |
|----|----|---|---|----|----|----|----|----|----|----|----|----|----|----|
| Aa | Bb | C | c | Dd | Ee | Ff | Gg | H  | h  | I  | i  | Jj | Kk | Ll |
| R  | b  | E | c | d  | E  | F  | G  | H  | h  | I  | i  | U  | /  | L  |
| Mm | Nn | O | o | Pp | Qq | Rr | Ss | Tt | Uu | Vv | Ww | Xx | Yy | Zz |
| R  | n  | O | o | P  | Q  | r  | S  | t  | U  | u  | /  | /  | Y  | /  |

## Panel and operation procedure



### Monitoring

① Displays operation frequency.



Pressing the MODE key twice ...



② Displays the motor rotating direction.



Turning the setting dial clockwise ...



③ Displays operation frequency command value.



Turning the setting dial clockwise ...



④ Displays output current (%/ampere)



Turning the setting dial clockwise, the various data are displayed such as input voltage, output voltage, the status of input/output terminal signals. Pressing the MODE key ...

⑤ Displays operation frequency (returns to the beginning).



\*If you press the center of the setting dial without changing the setting, the next parameter ("dEC") is displayed.

### Setting

① Turn on the power. **0.0** is displayed.



Pressing the mode key ...



② Displays "RUE".



Turning the setting dial until "RUE" is displayed ...



③ Displays "RUE".



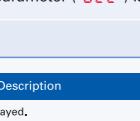
Press the center of the setting dial...



④ Displays the setting value.



Turn the setting dial and press the center of the setting dial...

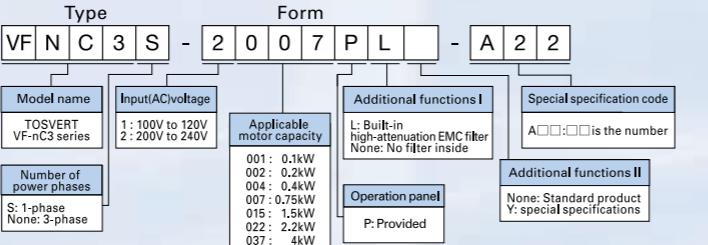


⑤ Displays "RUE", and the setting value alternately, and then the setting is completed.\*



# Specifications and dimensions

## ■ Explanation of the name plate label



## ■ 3-phase 240V class

| Rating | Item   | Specification                                    |          |          |                   |          |           |            |  |  |  |  |
|--------|--|--|----------|----------|-------------------|----------|-----------|------------|--|--|--|--|
|        |  | 3-phase 240V class                               |          |          |                   |          |           |            |  |  |  |  |
|        | Input voltage class                          | 3-phase 240V class                               |          |          |                   |          |           |            |  |  |  |  |
|        | Applicable motor (kW)                        | 0.1  | 0.2      | 0.4      | 0.75              | 1.5      | 2.2       | 4.0        |  |  |  |  |
|        | Type   | VFNC3  |          |          |                   |          |           |            |  |  |  |  |
|        | Form   | 2001P  | 2002P    | 2004P    | 2007P             | 2015P    | 2022P     | 2037P      |  |  |  |  |
|        | Output Capacity (kVA) Note 1)                | 0.3  | 0.6      | 1.0      | 1.6               | 2.9      | 3.9       | 6.4        |  |  |  |  |
|        | Output current(A) Note 2)                    | 0.7(0.7)   | 1.4(1.4) | 2.4(2.4) | 4.2(3.6)          | 7.5(7.5) | 10.0(8.5) | 16.7(14.0) |  |  |  |  |
|        | Output voltage Note 3)                       | 3-phase 200V to 240V                             |          |          |                   |          |           |            |  |  |  |  |
|        | Overload current rating                      | 150% - 60 seconds, 200% - 0.5 second             |          |          |                   |          |           |            |  |  |  |  |
|        | Voltage-frequency                            | 3-phase 200V to 240V - 50/60Hz                   |          |          |                   |          |           |            |  |  |  |  |
|        | Allowable fluctuation                        | Voltage 170 to 264V Note 4), frequency $\pm 5\%$ |          |          |                   |          |           |            |  |  |  |  |
|        | Required Power supply capacity (kVA) Note 5) | 0.5  | 0.8      | 1.4      | 2.5               | 4.3      | 5.7       | 9.2        |  |  |  |  |
|        | Protective method (IEC60529)                 | IP20   |          |          |                   |          |           |            |  |  |  |  |
|        | Cooling method                               | Self-cooling                                     |          |          | Forced air-cooled |          |           |            |  |  |  |  |
|        | Color  | RAL 3002 / 7016                                  |          |          |                   |          |           |            |  |  |  |  |
|        | Built-in filter                              | —  |          |          |                   |          |           |            |  |  |  |  |

## ■ 1-phase 240V class / 1-phase 120V class

| Rating | Item   | Specification                                    |          |          |                   |   |           |          |              |          |          |
|--------|--|--|----------|----------|-------------------|---|-----------|----------|--------------|----------|----------|
|        |  | 1-phase 240V class                               |          |          |                   | 1-phase 120V class                              |           |          |              |          |          |
|        | Applicable motor (kW)                        | 0.1  | 0.2      | 0.4      | 0.75              | 1.5   | 2.2       | 0.1      | 0.2          | 0.4      | 0.75     |
|        | Type   | VFNC3S   |          |          |                   | VFNC3S  |           |          |              |          |          |
|        | Form   | 2001PL   | 2002PL   | 2004PL   | 2007PL            | 2015PL  | 2022PL    | 1001P    | 1002P        | 1004P    | 1007P    |
|        | Output Capacity (kVA) Note 1)                | 0.3  | 0.6      | 1.0      | 1.6               | 2.9   | 3.9       | 0.3      | 0.6          | 1.0      | 1.6      |
|        | Output current(A) Note 2)                    | 0.7(0.7)   | 1.4(1.4) | 2.4(2.4) | 4.2(3.2)          | 7.5(7.5)  | 10.0(9.1) | 0.7(0.7) | 1.4(1.4)     | 2.4(2.4) | 4.2(4.0) |
|        | Output voltage Note 3)                       | 3-phase 200V to 240V                             |          |          |                   | 3-phase 200V to 240V                            |           |          |              |          |          |
|        | Overload current rating                      | 150% - 60 seconds, 200% - 0.5 second             |          |          |                   | 150% - 60 seconds, 200% - 0.5 second            |           |          |              |          |          |
|        | Voltage-frequency                            | 1-phase 200V to 240V - 50/60Hz                   |          |          |                   | 1-phase 100V to 120V - 50/60Hz                  |           |          |              |          |          |
|        | Allowable fluctuation                        | Voltage 170 to 264V Note 4), frequency $\pm 5\%$ |          |          |                   | Voltage 85 to 132V Note 4), frequency $\pm 5\%$ |           |          |              |          |          |
|        | Required Power supply capacity (kVA) Note 5) | 0.5  | 0.8      | 1.3      | 2.3               | 4.0   | 5.4       | 0.4      | 0.7          | 1.3      | 2.1      |
|        | Protective method (IEC60529)                 | IP20   |          |          |                   | IP20  |           |          |              |          |          |
|        | Cooling method                               | Self-cooling                                     |          |          | Forced air-cooled |   |           |          | Self-cooling |          |          |
|        | Color  | RAL 3002 / 7016                                  |          |          |                   | RAL 3002 / 7016                                 |           |          |              |          |          |
|        | Built-in filter                              | EMC filter                                       |          |          |                   | —   |           |          |              |          |          |

Note 1. Capacity is calculated at 220V for output voltage.

Note 2. Indicates rated output current setting when the PWM carrier frequency (parameter F300) is 4kHz or less. Between 5 kHz and 12 kHz, the rated output current is indicated in the ( ). Above 13 kHz, the output current must be reduced. The default setting of the PWM carrier frequency is 12kHz.

Note 3. Maximum output voltage is the same as the input voltage. In case of 1-phase 120V class, maximum output voltage is same as twice the input voltage.

With regard to 120V models, the output voltage may decrease about 10 to 20 % if motor load is applied. When operating VF-nC3 in conjunction with general-purpose motor (200V), it is necessary to reduce the motor load.

Note 4. 180V-264V (240V class), 90V-132V (120V class) when the inverter is used continuously (load of 100%).

Note 5. Required power supply capacity varies with the value of the power supply side inverter impedance (including those of the input reactor and cables).

## ■ External dimensions

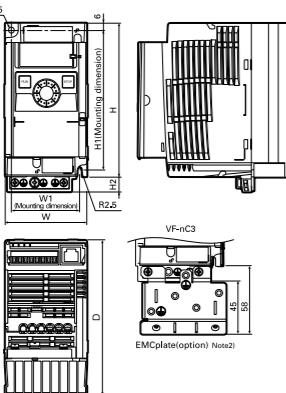


Fig. A

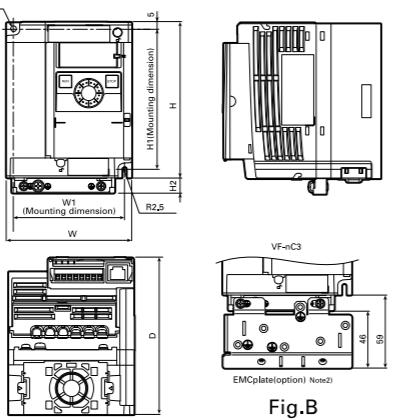


Fig. B

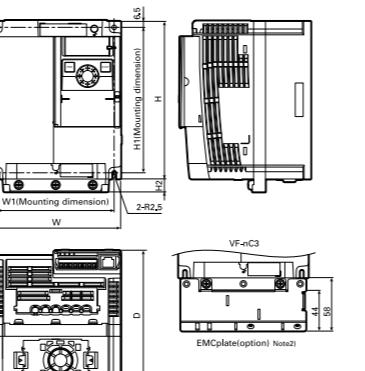


Fig. C

## ■ Dimensions (mm)

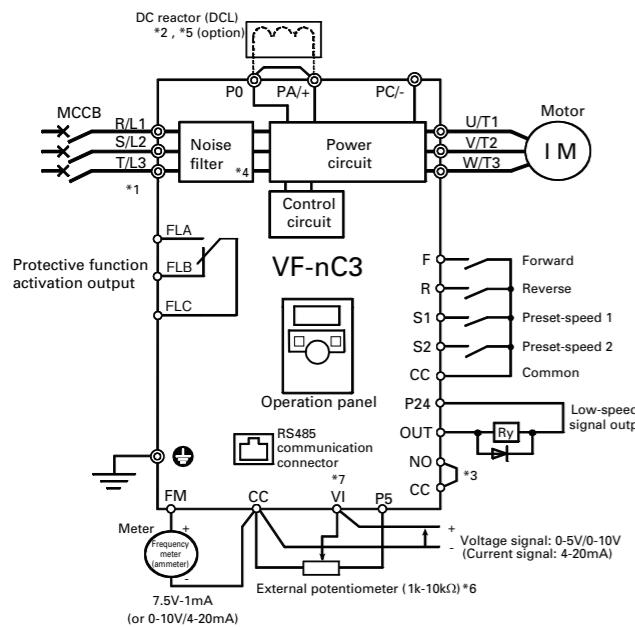
| Voltage class | Applicable motor (kW) | Inverter type | Dimensions (mm) |     |     |     |     |    | Drawing | Approx. weight(kg) |
|---------------|-----------------------|---------------|-----------------|-----|-----|-----|-----|----|---------|--------------------|
|               |                       |               | W               | H   | D   | W1  | H1  | H2 |         |                    |
| 3-phase 240V  | 0.1                   | VFNC3-2001P   | 72              | 130 | 102 | 60  | 131 | 13 | A       | 1.0                |
|               | 0.2                   | VFNC3-2002P   |                 |     | 121 |     |     |    |         |                    |
|               | 0.4                   | VFNC3-2004P   |                 |     | 131 | 93  |     |    |         |                    |
|               | 0.75                  | VFNC3-2007P   |                 |     | 156 | 93  | 118 | 12 | B       | 1.5                |
|               | 1.5                   | VFNC3-2015P   |                 |     | 141 | 126 | 157 |    |         |                    |
|               | 2.2                   | VFNC3-2022P   |                 |     | 140 | 170 | 14  |    |         |                    |
| 1-phase 240V  | 0.1                   | VFNC3S-2001PL | 72              | 130 | 102 | 60  | 131 | 13 | A       | 1.0                |
|               | 0.2                   | VFNC3S-2002PL |                 |     | 121 |     |     |    |         |                    |
|               | 0.4                   | VFNC3S-2004PL |                 |     | 131 |     |     |    |         |                    |
|               | 0.75                  | VFNC3S-2007PL |                 |     | 156 | 93  | 118 | 12 | B       | 1.5                |
|               | 1.5                   | VFNC3S-2015PL |                 |     | 141 | 126 | 157 |    |         |                    |
|               | 2.2                   | VFNC3S-2022PL |                 |     | 140 | 170 | 14  |    |         |                    |
| 1-phase 120V  | 0.1                   | VFNC3S-1001P  | 72              | 130 | 102 | 60  | 131 | 13 | A       | 1.0                |
|               | 0.2                   | VFNC3S-1002P  |                 |     | 121 |     |     |    |         |                    |
|               | 0.4                   | VFNC3S-1004P  |                 |     | 131 |     |     |    |         |                    |
|               | 0.75                  | VFNC3S-1007P  | 105             |     | 156 | 93  | 118 | 12 | B       | 1.5                |

# Connection diagram and terminal functions

## Standard connection diagram

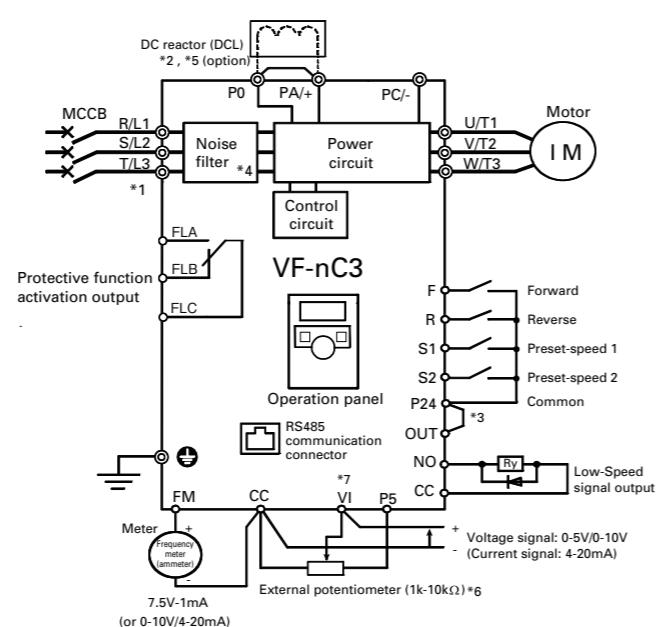
### Standard connection diagram-(sink logic)

(Negative)(common:CC)



### Standard connection diagram-(source logic)

(Positive)(common:P24)



## Main circuit terminal functions

| Terminal symbol | Terminal function   |  |
|-----------------|---|--|
|                 | Grounding terminal for connecting inverter.   |  |
| R/L1,S/L2,T/L3  | 1-phase 120V class: single-phase 100 to 120V-50/60Hz<br>1-phase 240V class: single-phase 200 to 240V-50/60Hz  | 3-phase 240V class: three-phase 200 to 240V-50/60Hz<br>* Single-phase input: R/L1 and S/L2/N terminals |
| U/T1,V/T2,W/T3  | Connect to a (three-phase induction) motor.   |  |
| PC/-            | This is a negative potential terminal in the internal DC main circuit. DC common power can be input across the PA terminals (positive potential). DC common power can not connect to 1-phase 120V models. |  |
| PO, PA/+        | Terminals for connecting a DC reactor (DCL: optional external device). Shorted by a short bar when shipped from the factory. Before installing DCL, remove the short bar.                                 | 1-phase 120V models cannot be used with DC reactors.   |

## Control circuit terminal functions

| Terminal symbol   | Terminal function   | Electrical specifications  |
|-------------------|---|--|
| F                 | Shorting across F-CC causes forward rotation; open causes slowdown and stop. (When ST is always ON)3 different functions can be assigned.   | No voltage logic input<br>24Vdc-5mA or less  |
| R                 | Shorting across R-CC causes reverse rotation; open causes slowdown and stop. (When ST is always ON)3 different functions can be assigned.   | * Sink/Source selectable using parameter F109=7<br>(Explanation in case of sink logic)   |
| S1                | Shorting across S1-CC causes preset speed operation. 2 different functions can be assigned.   |  |
| S2                | Shorting across S2-CC causes preset speed operation. 2 different functions can be assigned.   |  |
| CC                | Control circuit's equipotential terminal (2 terminals)  |  |
| P5                | Analog power supply output  | 5Vdc (permissible load current: 10mA)  |
| VI                | Multifunction programmable analog input. Factory default setting: 0-10Vdc(10 bits resolution) and 0-60Hz (0-50Hz) frequency input. The function can be changed to 4-20mA(0-20mA) current input by parameter F109=1 setting and 0-5Vdc (10 bits resolution) voltage input by parameter F109=3 setting. By changing parameter F109=2 setting, this terminal can also be used as a multifunction programmable logic input terminal. Be sure to insert a resistor between P24-VI (4.7kΩ-1/2W) in case of sink logic, between VI-CC in case of source logic. | 5V/10Vdc<br>(internal impedance: 40kΩ)<br>4-20mA<br>(internal impedance: 250Ω)<br>Note)  |
| FM                | Multifunction programmable analog output. Standard default setting: output frequency. The function can be changed to 0-10Vdc voltage or 0-20mA(4-20mA) current output by parameter F581 setting.  | 1mA full-scale ammeter<br>0-20mA (4-20mA) DC ammeter<br>Permissible load resistance: 750Ω or less<br>0-10V DC volt meter                     |
| P24               | 24Vdc power output  | 24Vdc-100mA  |
| OUT NO            | Multifunction programmable open collector output. Standard default setting : low speed signal. Multifunction output terminals to which two different functions can be assigned. The NO terminal is an isolating output terminal. It is insulated from the CC terminal. By changing parameter settings, these terminals can also be used as multifunction programmable pulse train output terminals.   | Open collector output 24Vdc-100mA<br>To output pulse trains, a current of 10mA or more needs to be passed. Pulse frequency range: 38~1600pps |
| FLA<br>FLB<br>FLC | Multifunction programmable relay contact output. Detects the operation of the inverter's protection function. Contact across FLA-FLC is closed and FLB-FLC is opened during protection function operation.  | 250Vac-2A<br>(cosφ=1): at resistance load<br>30Vdc-1A, 250Vac-1A, (cosφ=0.4)   |

Note) If 4-20mA is selected, when the inverter's power is ON, the internal impedance is 250Ω, but when the power is OFF, the internal impedance increases very much to approximately 40kΩ.

## Wiring devices

| Voltage class | Applicable motor (kW) | Inverter type | Input current (A) |                 | Molded-case circuit breaker (MCCB)<br>Earth leakage circuit breaker (ELCB) Note4) | Rated current (A) Note1 2) 3) | Rated current (A) | Wire size (mm <sup>2</sup> ) Note8) |                       |                        |     |
|---------------|-----------------------|---------------|-------------------|-----------------|---|-------------------------------|-------------------|-------------------------------------|-----------------------|------------------------|-----|
|               |                       |               | No reactor        | With DC reactor |   |                               |                   | Main circuit Note5)                 | DC reactor (optional) | Grounding cable Note7) |     |
| 3-phase 240V  | 0.1                   | VFNC3-2001P   | 1.2               | 0.6             | 5   | 5                             | 20                | 20                                  | 1.5(1.5)              | 1.5                    | 2.5 |
|               | 0.2                   | VFNC3-2002P   | 2.0               | 0.9             | 5   | 5                             | 20                | 20                                  | 1.5(1.5)              | 1.5                    | 2.5 |
|               | 0.4                   | VFNC3-2004P   | 3.6               | 1.8             | 5   | 5                             | 20                | 20                                  | 1.5(1.5)              | 1.5                    | 2.5 |
|               | 0.75                  | VFNC3-2007P   | 6.3               | 3.5             | 10  | 5                             | 20                | 20                                  | 1.5(1.5)              | 1.5                    | 2.5 |
|               | 1.5                   | VFNC3-2015P   | 11.1              | 6.6             | 15  | 10                            | 20                | 20                                  | 1.5(1.5)              | 1.5                    | 2.5 |
|               | 2.2                   | VFNC3-2022P   | 14.9              | 9.3             | 20  | 15                            | 20                | 20                                  | 2.5(1.5)              | 1.5                    | 2.5 |
|               | 4.0                   | VFNC3-2037P   | 23.8              | 16.1            | 30  | 30                            | 32                | 20                                  | 4.0(2.5)              | 4.0                    | 4.0 |
| 1-phase 240V  | 0.1                   | VFNC3S-2001PL | 2.0               | 1.2             | 5   | 5                             | 20                | 20                                  | 1.5(1.5)              | 1.5                    | 2.5 |
|               | 0.2                   | VFNC3S-2002PL | 3.4               | 2.1             | 5   | 5                             | 20                | 20                                  | 1.5(1.5)              | 1.5                    | 2.5 |
|               | 0.4                   | VFNC3S-2004PL | 5.9               | 4.1             | 10  | 5                             | 20                | 20                                  | 1.5(1.5)              | 1.5                    | 2.5 |
|               | 0.75                  | VFNC3S-2007PL | 10.2              | 7.7             | 15  | 10                            | 20                | 20                                  | 1.5(1.5)              | 1.5                    | 2.5 |
|               | 1.5                   | VFNC3S-2015PL | 17.8              | 14.8            | 30  | 20                            | 20                | 20                                  | 2.5(2.5)              | 1.5                    | 2.5 |
|               | 2.2                   | VFNC3S-2022PL | 24                | 20.3            | 30  | 30                            | 32                | 32                                  | 4.0(4.0)              | 1.5                    | 4.0 |
|               | 0.1                   | VFNC3S-1001P  | 3.5               | —               | 5   | —                             | 20                | —                                   | 1.5                   | —                      | 2.5 |
| 1-phase 120V  | 0.2                   | VFNC3S-1002P  | 6.0               | —               | 10  | —                             | 20                | —                                   | 1.5                   | —                      | 2.5 |
|               | 0.4                   | VFNC3S-1004P  | 11.4              | —               | 15  | —                             | 20                | —                                   | 2.5                   | —                      | 2.5 |
|               | 0.75                  | VFNC3S-1007P  | 18.9              | —               | 30  | —                             | 20                | —                                   | 4.0                   | —                      | 4.0 |

Note 1. Be sure to attach a surge killer to the exciting coil of the relay and the magnetic contactor.

Note 2. When using the auxiliary contacts 2a of the magnetic contactor MC for the control circuit, connect the contacts 2a in parallel to increase reliability.

Note 3. When a motor is driven by commercial power supply using commercial power supply/inverter switching circuit, use a magnetic contactor appropriate AC-3 class the motor rated current. Note 4. Select an MCCB with a rated interrupting current appropriate to the capacity of the power supply, because short-circuit currents vary greatly depending on the capacity of the power supply and the condition of the wiring system. The MCCB, MC and ELCB in this table were selected, on the assumption that a power supply with a normal capacity would be used.

Note 5. Sizes of the wires connected to the input terminals R/L1, S/L2 and T/L3 and the output terminals U/T1, V/T2 and W/T3 when the length of each wire does not exceed 30m.

The numeric values in parentheses refer to the sizes of wires to be used when a DC reactor is connected.

Note 6. For the control circuit, use shielded wires 0.75 mm<sup>2</sup> or more in diameter.

Note 7. For grounding, use a cable with a size equal to or larger than the above.

Note 8. The wire sizes specified in the above table apply to HV wires (copper wires shielded with an insulator with a maximum allowable temperature of 75°C) used at an ambient temperature of 50°C or less.

## Multifunction programmable logic input/output

### Logic input terminal

| Terminal symbol | Parameter | Function                                   | Action  | Default setting                  |
|-----------------|-----------|--|---|----------------------------------|
| F               | F111      | Input terminal selection 1A                | Set the function number to each parameters. Two or more functions can be set to one terminal. All functions operate by the signal input | 2(Forward run)                   |
|                 | F151      | Input terminal selection 1B                |   | 0(No function)                   |
|                 | F155      | Input terminal selection 1C                |   | 0(No function)                   |
| R               | F112      | Input terminal selection 2A                | Set the function number to each parameters. Two or more functions can be set to one terminal. All functions operate by the signal input | 4(Reverse run)                   |
|                 | F152      | Input terminal selection 2B                |   | 0(No function)                   |
| S1              | F113      | Input terminal selection 3A                | Set F109=2 (Logic input) for logic input.   | 10(Preset-speed command 1)       |
|                 | F153      | Input terminal selection 3B                |   | 0(No function)                   |
| S2              | F114      | Input terminal selection 4A                | Set F109=2 (Logic input) for logic input.   | 12(Preset-speed command 2)       |
|                 | F154      | Input terminal selection 4B                |   | 0(No function)                   |
| VI              | F109      | Analog/logic input selection (VI terminal) | Set the function number.  | 0(Voltage input signal 0 to 10V) |
|                 | F115      | Input terminal selection 5                 |   | 14(Preset-speed command 3)       |

Note) When using the VI terminal as logic input terminal, be sure to connect a resistor between P24 and VI terminals in case of sink logic, between VI and CC terminals in case of source logic. (Recommended resistance: 4.7kΩ-1/2W)

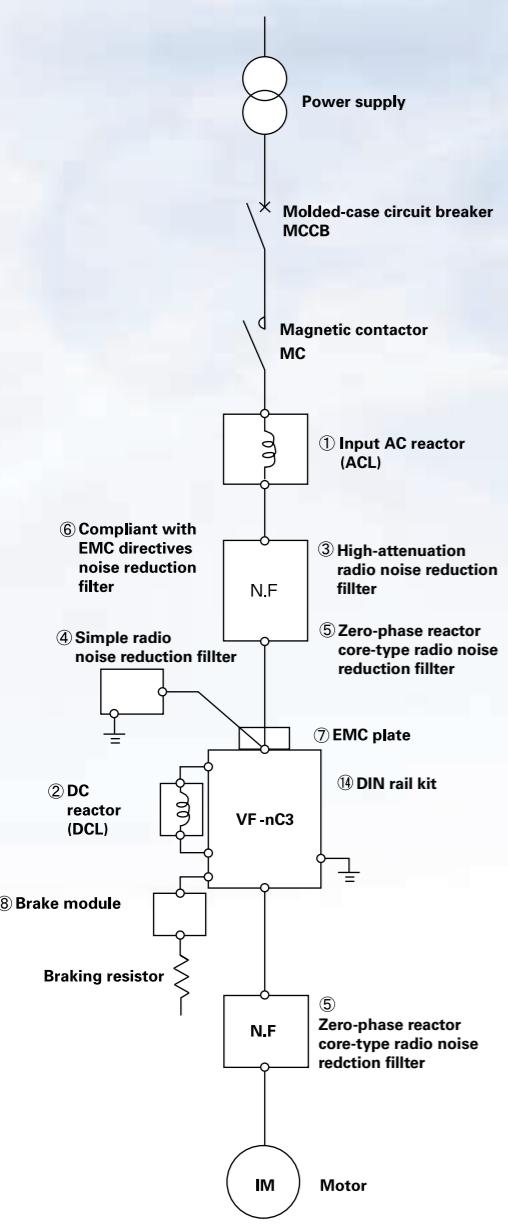
### Logic output terminal

| Terminal symbol | Parameter | Function                                  | Action  | Default setting                  |
|-----------------|-----------|---|---|----------------------------------|
| OUT             | F130      | Output terminal selection 1A              | Set the function number to each parameters. In case of using one function, please set F130. | 4(Low speed detection)           |
|                 | F137      | Output terminal selection 1B              |   | 255(Always ON)                   |
| F139            | F139      | Output terminal logic selection           | In case of set two functions, OUT outputs by 'AND'/OR' logic.                               | 0(AND)                           |
|                 | F669      | Logic output/pulse train output selection |   | 0(Logic)                         |
| FL(A, B, C)     | F132      | Output terminal selection 2               | Set the function number.  | 10(Failure signal (trip output)) |
|                 | F133      | Output terminal selection 3               |   | 11(Failure signal (trip output)) |

Note) All of logic output terminals are turned off about 0.5 to 1 second when power-on and fault reset. Please pay attention to use negative



# Peripheral devices

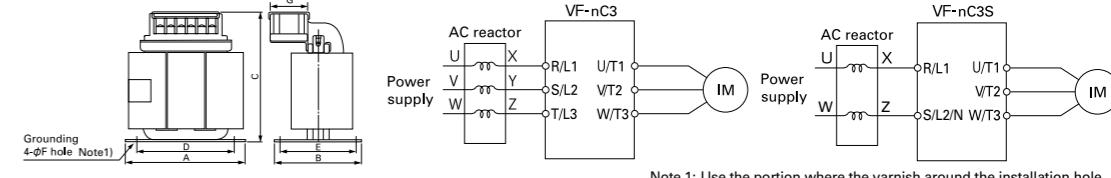


| No.              | Device   | Function, Purpose, etc.  | Refer to                   |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
|------------------|--|--|----------------------------|--------|--|--|--------------------------|-----------------------|----------------------------|------------------|---|---|---|------------|--------|--------|---|------|
| ①                | Input AC reactor                                     | Used to improve the input power factor, reduce the harmonics, and suppress external surge on the inverter power source side. Install when the power capacity is 200kVA or more and 10 times or more than the inverter capacity or when distorted wave generation source such as a thyristor unit or a large-capacity inverter is connected in the same distribution system.  |                            |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
| ②                | DC reactor   | <table border="1" data-bbox="911 287 1356 390"> <thead> <tr> <th rowspan="2">Reactor type</th><th colspan="3">Effect</th></tr> <tr> <th>Power factor improvement</th><th>Harmonics suppression</th><th>External surge suppression</th></tr> </thead> <tbody> <tr> <td>Input AC reactor</td><td>○</td><td>○</td><td>○</td></tr> <tr> <td>DC reactor</td><td>○Large</td><td>○Large</td><td>X</td></tr> </tbody> </table> <p>○:Effective   ○Large:Highly effective   X:Ineffective</p> <p>Improves the power factor more than the input reactor. When the facility applying the inverter requires high reliability, it is recommended to use the DC reactor with an input reactor effective for external surge suppression.</p> | Reactor type               | Effect |  |  | Power factor improvement | Harmonics suppression | External surge suppression | Input AC reactor | ○ | ○ | ○ | DC reactor | ○Large | ○Large | X | P.14 |
| Reactor type     | Effect   |  |                            |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
|                  | Power factor improvement                             | Harmonics suppression  | External surge suppression |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
| Input AC reactor | ○  | ○  | ○                          |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
| DC reactor       | ○Large   | ○Large   | X                          |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
| ③                | High-attenuation filter (LC filter)<br>NF type       | <p>These type of filters are not necessary for single-phase 240V (built-in EMC noise filter) model.<br/>The built-in filter meets IEC61800-3.</p> <ul style="list-style-type: none"> <li>● Effective to prevent interference with audio equipment used near the inverter.</li> <li>● Install on the input side of the inverter.</li> <li>● Provided with wide-range attenuation characteristics from AM radio bands to near 10MHz.</li> <li>● Use when equipment readily affected by noise is installed in the peripheral area.</li> </ul>   |                            |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
| ④                | Simple filter (capacitive filter)<br>Capacitor type  | <ul style="list-style-type: none"> <li>● Effective to prevent interference with audio equipment used near the inverter.</li> <li>● Install on the input side of the inverter.</li> <li>● Attenuation characteristic is available only in a specific frequency and, effective in suppressing noise in a specific AM radio station (e.g., weak radio waves in mountainous regions).</li> <li>● Increases leakage current because this is a capacitor-based filter. When the power supply is equipped with an ELCB, avoid using too many filters of this type.</li> </ul>   | P.14                       |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
| ⑤                | Zero-phase reactor (inductive filter)<br>core type   | <ul style="list-style-type: none"> <li>● Effective to prevent interference with audio equipment used near the inverter.</li> <li>● Effective in noise reduction on both input and output sides of the inverter.</li> <li>● Provided with attenuation characteristics of several dB in frequencies from AM radio bands to 10MHz.</li> <li>● For noise countermeasures, insert on the secondary side of the inverter.</li> </ul>   |                            |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
| ⑥                | Compliant with EMC directives noise reduction filter | <p>This noise filter complies with European EMC Directive.<br/>*These type of filters are not necessary for single-phase 240V (built-in EMC noise filter) model.<br/>The built-in filter meets IEC61800-3 C1.</p>  | —                          |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
| ⑦                | EMC plate  | A steel plate used to connect shielded grounding cables from inverter's power cables or to connect grounding cables from external devices.   | P.7                        |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
| ⑧                | Brake module   | Use when rapid deceleration or stop is frequently required or when it is desired to reduce the deceleration time with large load. This module and resistor consumes regenerative energy during power generation braking. For 0.1 to 2.2kW models. <Type: BRMD0015Z>  | —                          |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
| ⑨                | Extension panel (parameter writer)                   | <p>LED remote keypad is for extension. It is provided with an LED display, some operational keys.</p> <p>The panel with parameter writer function can setup and read the parameters for inverter.</p>  | P.15                       |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
| ⑩                | USB communication conversion unit                    | <p>This unit is connected to a PLC or a computer to enable data communications.</p> <p>By connecting the connector cable, parameters can be easily adjusted, and data easily saved and written.</p>  | P.15                       |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
| ⑪                | Remote panel   | Has a built-in frequency meter, frequency setter and RUN-STOP (forward run, reverse run) switch.   | P.15                       |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
| ⑫                | Frequency meter                                      | Use to mount the meter on an external operation unit.  | P.15                       |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
| ⑬                | FRH kit  | FRH-kit includes frequency setting resistor, panel and knob for an external operation unit.  | P.15                       |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |
| ⑭                | DIN rail kit   | Use to mount the inverter on DIN rails. For 0.1 to 2.2kW models. <Type:DIN003Z, DIN005Z>   | —                          |        |  |  |                          |                       |                            |                  |   |   |   |            |        |        |   |      |

## ■ Peripheral devices

| Voltage class | Inverter model | Applicable motor (kW) | Input AC reactor (ACL) | DC reactor (DCL)                                 | Radio noise reduction filter  |               |  |
|---------------|----------------|-----------------------|------------------------|--|---|---------------|--|
|               |                |                       |                        |  | High-attenuation filter   | Simple filter | Zero-phase reactor   |
| 3-phase 240V  | VFNC3-2001P    | 0.1                   | PFL-2001S              | DCL3-4004  | NF3005A-MJ  | RCL-M2        | RC5078ZZ<br><br>If the cable thickness is 5.5mm <sup>2</sup> or more, please select RC9129ZZT. |
|               | VFNC3-2002P    | 0.2                   | PFL-2001S              | DCL3-4007  | NF3005A-MJ  |               |  |
|               | VFNC3-2004P    | 0.4                   | PFL-2005S              | DCL3-4015  | NF3005A-MJ  |               |  |
|               | VFNC3-2007P    | 0.75                  | PFL-2005S              | DCL3-2007  | NF3005A-MJ  |               |  |
|               | VFNC3-2015P    | 1.5                   | PFL-2011S              | DCL3-2015  | NF3015A-MJ  |               |  |
|               | VFNC3-2022P    | 2.2                   | PFL-2011S              | DCL3-2022  | NF3015A-MJ  |               |  |
|               | VFNC3-2037P    | 4.0                   | PFL-2018S              | DCL3-2037  | NF3020A-MJ  |               |  |
| 1-phase 240V  | VFNC3S-2001PL  | 0.1                   | PFL-2005S              | DCL3-4007  | The EMC noise filter is built into the 1ph-240V models by the standard. | RC5078ZZ      |  |
|               | VFNC3S-2002PL  | 0.2                   | PFL-2005S              | DCL3-4015  |   |               |  |
|               | VFNC3S-2004PL  | 0.4                   | PFL-2005S              | DCL3-2007  |   |               |  |
|               | VFNC3S-2007PL  | 0.75                  | PFL-2011S              | DCL3-2015  |   |               |  |
|               | VFNC3S-2015PL  | 1.5                   | PFL-2018S              | DCL3-2037  |   |               |  |
|               | VFNC3S-2022PL  | 2.2                   | PFL-2018S              | DCL3-2037  |   |               |  |
| 1-phase 120V  | VFNC3S-1001P   | 0.1                   | PFL-2005S              | 1ph-120V models cannot be used with DC reactors. | NF3005A-MJ  | RCL-M2        | RC5078ZZ   |
|               | VFNC3S-1002P   | 0.2                   | PFL-2005S              |  | NF3015A-MJ  |               |  |
|               | VFNC3S-1004P   | 0.4                   | PFL-2018S              |  | NF3015A-MJ  |               |  |
|               | VFNC3S-1007P   | 0.75                  | PFL-2018S              |  | NF3020A-MJ  |               |  |

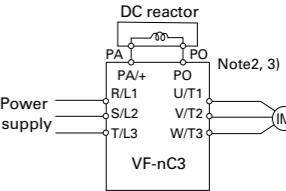
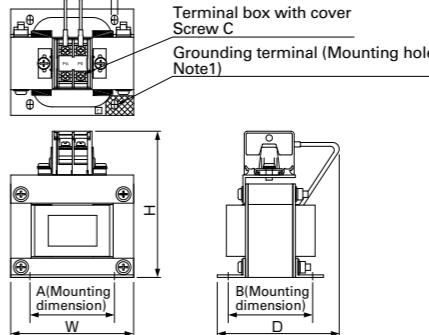
| Devices   | External dimensions and connections  |
|---|--|
|  | <br><b>Power supply</b> |



Note 1: Use the portion where the varnish around the installation hole is removed for wiring grounding wire.

| Model     | Rating                           | Inverter type |                                     | Dimensions(mm) |    |     |     |    |   |    | Terminal<br>(Terminal block) | Approx.<br>mass<br>(kg) |
|-----------|----------------------------------|---------------|-------------------------------------|----------------|----|-----|-----|----|---|----|------------------------------|-------------------------|
|           |                                  | VFNC3-        | VFNC3S-                             | A              | B  | C   | D   | E  | F | G  |                              |                         |
| PFL-2001S | 3-phase 200V class -1.7A-50/60Hz | 2001P,2002P   | —                                   | 105            | 65 | 115 | 90  | 55 | 5 | 40 | M 3.5                        | 1.0                     |
| PFL-2005S | 3-phase 200V class -5.5A-50/60Hz | 2004P,2007P   | 2001PL,2002PL<br>2004PL,1001P,1002P | 105            | 65 | 115 | 90  | 55 | 5 | 40 | M 3.5                        | 1.2                     |
| PFL-2011S | 3-phase 200V class -11A-50/60Hz  | 2015P,2022P   | 2007PL                              | 130            | 70 | 140 | 115 | 60 | 5 | 50 | M4                           | 2.3                     |
| PFL-2018S | 3-phase 200V class -18A-50/60Hz  | 2037P         | 2015PL,2022PL<br>1004P,1007P        | 130            | 70 | 140 | 115 | 60 | 5 | 50 | M4                           | 2.5                     |

## Input AC reactor (ACL)

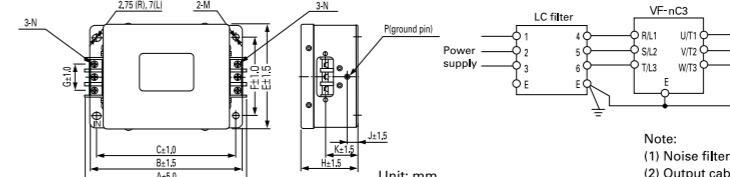


Note 1: Use the portion where the varnish around the installation hole is removed for wiring grounding wire.  
Note 2: Remove the jumper across terminals PO-PA/+.  
Note 3: Maximum wire length is 5m.

## DC reactor (DCL)

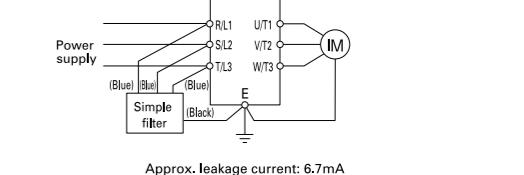
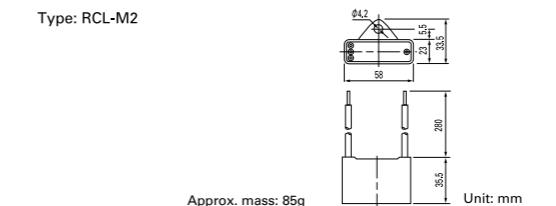
1ph-120V models  
cannot be used with  
DC reactors.  
Please select input  
AC reactors.

## High-attenuation radio noise reduction filter (NF type)

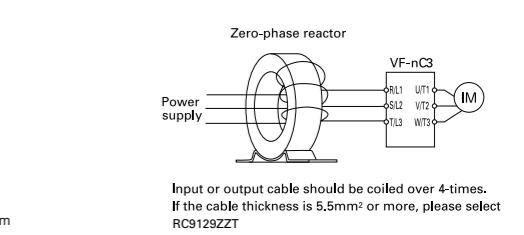
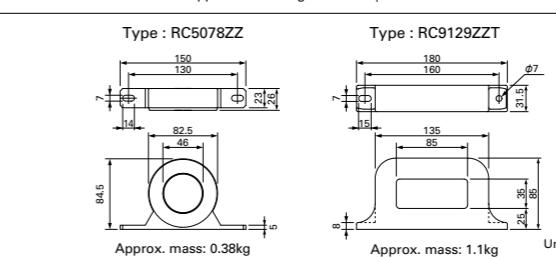


(1) Noise filter should be connected to the inverter main circuit primary side.  
(2) Output cable should be kept away from the input cable.

## Simple radio noise reduction filter (capacitive filter)



## Zero-phase reactor core-type radio noise reduction filter



## Devices

| External dimensions and connections           |   |
|---|---|
| <b>Extension panel</b><br>                    |   |
| <b>USB communications conversion unit</b><br> | <p>• Inverter unit connection cable. Model: CAB0011(1m), CAB0013(3m), CAB0015(5m).<br/>   • USB cable(A-B connection type).<br/>   USB a commercially available USB cable. (Compliant with USB1.1/2.0)<br/>   Recommended cable length : 1m or less</p> |
| <b>Remote panel</b><br>                       | <p>Notice:<br/>   Cable length is less than 30m (between inverters and panels).</p>   |
| <b>Frequency meter</b><br>                    |   |
| <b>FRH kit</b><br>                            |   |

## For inverter users

### 1. When studying how to use our inverters

#### ○Notes

##### Leakage current

This inverter uses high-speed switching semiconductors for PWM control. When a relatively long cable is used for power supply to an inverter, current may leak from the cable or the motor to the ground because of its capacitance, adversely affecting peripheral equipment. The intensity of such a leakage current depends on the PWM carrier frequency setting, the lengths of the input and output cables, etc., of the inverter. To prevent current leakage, it is recommended to take the following measures.

##### 【Effects of leakage current】

Leakage current which increases when an inverter is used may pass through the following routes:

- Route (1) ...  
Leakage due to the capacitance between the ground and the noise filter
- Route (2) ...  
Leakage due to the capacitance between the ground and the inverter
- Route (3) ...  
Leakage due to the capacitance between ground and the cable connecting the inverter and the motor
- Route (4) ...  
Leakage due to the capacitance of the cable connecting the inverter and the motor in another power distribution line

Route (5) ...  
Leakage through the grounding line common to motors

Route (6) ...  
Leakage to another line because of the capacitance of the ground

Leakage current which passes through the above routes may cause the following trouble.

- Malfunction of a leakage circuit breaker(ELCB) in the same or another power distribution line
- Malfunction of a ground-relay installed in the same or another power distribution line
- Noise produced at the output of an electronic device in another power distribution line
- Activation of an external thermal relay installed between the inverter and the motor, at a current below the rated current

Note) In the case of this inverter, the PWM carrier frequency can be decreased to 2.0kHz. Decreasing the carrier frequency results in an increase in electromagnetic noise from the motor.

#### Ground fault

Before beginning operation, thoroughly check the wiring between the motor and the inverter for incorrect wiring or short circuits. Do not ground the neutral point of any star-connected motor.

#### Radio interference

##### 【Noise produced by inverters】

Since this inverter performs PWM control, it produces noise and sometimes affects nearby instrumental devices, electrical and electronic systems, etc. The effects of noise greatly vary with the noise resistance of each individual device, its wiring condition, the distance

between it and the inverter, etc.

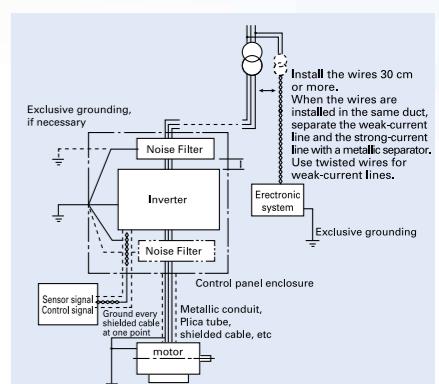
##### 【Measures against noises】

According to the route through which noise is transmitted, the noises produced by an inverter are classified into transmission noise, induction noise and radiation noise.

##### 【Examples of protective measures】

- Separate the power line from other lines, such as weak-current lines and signal lines, and install them apart from each other.
- Install a noise filter in each inverter. It is effective for noise prevention to install noise filters in other devices and systems, as well.
- Shield cables and wires with grounded metallic conduits, and cover electronic systems with grounded metallic cases.
- Separate the power distribution line of the inverter from that of other devices and systems.
- Install the input and output cables of the inverter apart from each other.
- Use shielded twisted pair wires for wiring of the weak-current and signal circuits, and always ground one of each pair of wires.
- Ground the inverter with grounding wires as large and short as possible, separately from other devices and systems.

1ph-240V models have built-in EMC noise filters on their input side, and reduce noise greatly.



#### Power factor improvement capacitors

Do not install a power factor improvement capacitors on the output side of the inverter.

Installing a power factor improvement capacitor on the output side causes current containing harmonic components to flow into the capacitor, adversely affecting the capacitor itself or causing the inverter to trip. To improve the power factor, install an input AC reactor on the primary side of the inverter or install a DC reactor.

#### Installation of input AC reactors

These devices are used to improve the input power factor and suppress high harmonic currents and surges. Install an input AC reactor when using this inverter under the following conditions:

- (1) When the power source capacity is 200kVA or more, and when it is 10 times or more greater than the inverter capacity.
- (2) When the inverter is connected the same power distribution system as a thyristor-committed control equipment.
- (3) When the inverter is connected to the same power distribution system as that of distorted wave-producing systems, such as arc furnaces and large-capacity inverters.

## 2. Selecting the Capacity (model) of the Inverter

### ○Selection

#### Capacity

Refer to the applicable motor capacities listed in the standard specifications.

When driving some motors in parallel, select such an inverter that the sum of the motor rated current multiplied by 1.05 to 1.1 is less than the inverter's rated output current value.

#### Acceleration/deceleration times

The actual acceleration and deceleration times of a motor driven by an inverter are determined by the torque and moment of inertia of the load, and can be calculated by the following equations.

The acceleration and deceleration times of an inverter can be set individually. In any case, however, they should be set longer than their respective values determined by the following equations.

|                   |  |
|-------------------|--|
| Acceleration time | $ta = \frac{(JM+JL) \times \Delta N}{9.56 \times (TM - TL)} \text{ (sec.)}$  |
| Deceleration time | $ta = \frac{(JM+JL) \times \Delta N}{9.56 \times (TB + TL)} \text{ (sec.)}$  |
| Conditions        | <p>JM : Moment of inertia of motor (kg.m<sup>2</sup>)<br/>     JL : Moment of inertia of load (kg.m<sup>2</sup>)<br/> <math>\Delta N</math> : Difference in rotating speed between before and after acc. or dec. (min.<sup>-1</sup>)<br/>     TL : Load torque (N.m)<br/>     TM : Motor rated torque x 1.2 to 1.3 (N.m) ... V/f control<br/>         : Motor rated torque x 1.5 (N.m)<br/>         : Vector operation control<br/>     TB : Motor rated torque x 0.2 (N.m)<br/>     (When a braking resistor or a braking resistor unit is used:<br/>         Motor rated torque x 0.8 to 1.0 (N.m))   </p> |

reduced according to the frequency. Regarding the allowable torque characteristic, please confirm its motor manufacturer.

When constant-torque operation must be performed at low speeds, use a Toshiba VF motor designed specifically for use with inverters.

#### Starting characteristics

When a motor is driven by an inverter, its operation is restricted by the inverter's overload current rating, so the starting characteristic is different from those obtained from commercial power supply operation.

Although the starting torque is smaller with an inverter than with the commercial power supply, a high starting torque can be produced at low speeds by adjusting the V/f pattern torque boost amount or by employing vector control. When a larger starting torque is necessary, select an inverter with a larger capacity and examine the possibility of increasing the motor capacity.

## 3. When installing, wiring and operating the inverter

### ○Selection

#### Installing precautions

(1) Do not install in any location of high temperature, high humidity, moisture condensation and freezing. Do not install the inverter where there are gases that corrode metal or solvents that adversely affect plastic. Avoid locations where there is exposure to water and/or where there may be large amounts of dust and metallic fragments. In this case, please install inverters in the enclosure type cabinet. The cabinet must be considered its size and the cooling method to allow the specifications of an ambient temperature for inverters.

(2) Must be installed in non-inflammables such as metals. The rear panel gets very hot. If installation is in an inflammable object, this can result in fire.

(3) Inverters should be arranged in horizontal rows.

#### Wiring precautions

##### Installing a molded-case circuit breaker [MCCB]

(1) Install a molded-case circuit breaker (MCCB) on the inverter's power supply input to protect the wiring.

(2) Avoid turning the molded-case circuit breaker on and off frequently to turn on/off the motor. To turn on/off the motor frequently, close/break the control terminals F (or R)-CC.

##### Installing a magnetic contactor [MC] [primary side]

(1) To prevent an automatic restart after the power interruption or overload relay has tripped, or actuation of the protective circuit, install an electro-magnetic contact in the power supply.

(2) The inverter is provided with a fault detection relay (FL), so that, if its contacts are connected to the operation circuit of the magnetic contactor on the primary side, the magnetic contactor will be opened when the protective circuit of the inverter is activated.

(3) The inverter can be used without a magnetic contactor. In this case, use an MCCB (equipped with a voltage tripping device) for opening the primary circuit when the inverter protective circuit is activated.

- (4) Avoid turning the magnetic contactor on and off frequently to turn on/off the motor.
- (5) To turn on/off the motor frequently, close/break the control terminals F (or R)-CC.
- (6) Install surge suppressor on any magnetic contactor and relay coils used around the inverter.
- (7) If using a braking resistor, install a magnetic contactor (MC) to the power supply of the inverter, so that the power circuit opens when the internal overload relay of the braking resistor is activated.

##### Installing a magnetic contactor [MC] [secondary side]

- (1) As a rule, if a magnetic contactor is installed between the inverter and the motor, do not turn of ON/OFF while running. (If the secondary-side contactor is turned of ON/OFF while running, a large current may flow in the inverter, causing inverter damage and failure.)
- (2) A magnetic contactor may be installed to change the motor or change to the commercial power supply when the inverter is stopped. Always use an interlock with the magnetic contactor in this situation so that the commercial power supply is not applied to the inverter's output terminals.

##### External signal

- (1) Use a relay rated for low currents. Mount a surge suppressor on the excitation coil of the relay.
- (2) When wiring the control circuit, use shielded wires or twisted pair cables.
- (3) Because all of the control terminals except FLA, FLB and FLC are connected to electronic circuits, insulate these terminals to prevent them from coming into contact with the main circuit.

##### Installing an overload relay

- (1) This inverter has an electronic-thermal overload protective function. However, in the following cases, the thermal relay operation level must be adjusted or an overload relay matching the motor's characteristics must be installed between the inverter and the motor.
  - (a) When using a motor having a rated current value different from that of the equivalent.
  - (b) When driving several motors simultaneously.

## 4. When changing the motor speed

### ○Application to standard motors

#### Vibration

When a motor is operated with an industrial inverter, it experiences more vibrations than when it is operated by the commercial power supply. The vibration can be reduced to a negligible level by securing the motor and machine to the base firmly. If the base is weak, however, the vibration may increase at a light load due to resonance with the mechanical system.

Setting the jump frequency or changing the PWM carrier frequency enable to reduce vibration.

#### Acoustic noise

The magnetic noise of motors with inverter drives is changed by PWM carrier frequency. In case of high PWM carrier frequency settings, its acoustic noise is almost same as commercial power supply drives. Moreover, when the motors are operated over rated rotation, the windy noise of the motors is increased.

#### Reduction gear, belt, chain

Note that the lubrication capability of a reducer or a converter used as the interface of the motor and the load machine may affected at low speeds. When operating at a frequencies exceeding 60 Hz or higher, power transmission mechanisms such as reduction gear, belts and chains, may cause problems such as production of noise, a reduction in strength, or shortening of service life.

#### Frequency

Before setting the maximum frequency to 60 Hz or higher, confirm that this operating range is acceptable for the motor.

#### Starting method

When you drive the motor with changeable connection between star-connection and delta-connection for decreasing starting current, please connect delta-connection only. If you

change motor connection while inverter drives, the protective function of inverter occurs.

### ○Application to special motors

#### Gear motor

When using an inverter to drive a gear motor, inquire of the motor manufacturer about its continuous operation range due to the followings:

- The low-speed operation of a gear motor may cause insufficient lubrication
- The loss of a gear may be increasing than commercial power supply drives.
- In case of the high frequency operation, the acoustic noise and motor temperature may be higher.

#### Toshiba Gold Motor

##### (High-efficiency power-saving motor)

Inverter-driven operation of Toshiba Gold Motors is the best solution for saving energy. This is because these motors have improved efficiency, power factor, and noise/vibration reduction characteristics when compared to standard motors.

#### Pole-changing motor

Pole-changing motors can be driven by this inverter. Before changing poles, however, be sure to let the motor come to a complete stop. If you change motor connection while inverter drives, the protective function of inverter occurs.

#### Underwater motors

Note that underwater motors have higher rated current than general motors.

The current ratings of underwater motors are relatively high. So, when selecting an inverter, you must pay special attention to its current rating so that the current rating of the motor is below that of the inverter.

When the lengths of the motor cable are long, please use thicker cable than a table of "Wiring

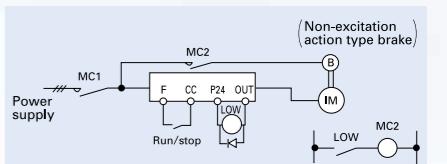
devices" because the maximum torque is decreased by the voltage dropping. Moreover, please pay attention to select leakage circuit breakers.

#### Single-phase motor

Because single-phase motors are equipped with a centrifugal switch and capacitors for starting, they cannot be driven by an inverter. When single phase motors are driven by inverters, a centrifugal switch and capacitors may be broken. If only a single-phase, power system is available a 3-phase motor can be driven by using a single-phase input inverter to convert it into a 3-phase 240V output. (A special inverter and a 3-phase 240V motor are required.)

#### Braking motor

When using a braking motor, if the braking circuit is directly connected to the inverter's output terminals, the brake cannot be released because of the lowered starting voltage. Therefore, when using a braking motor, connect the braking circuit to the inverter's power supply side, as shown on the below. Usually, braking motors produce larger noise in low speed ranges.



**For users of the products :** Our variable speed drives are designed to control the speeds of three-phase motors for general industry.

### **Precautions**

- \* Please read the instruction manual before installing or operating the drive unit.
- \* This product is intended for general purpose uses in industrial application. It cannot be used applications where may cause big impact on public uses, such as power plant and railway, and equipment which endanger human life or injury, such as nuclear power control, aviation, space flight control, traffic, safety device, amusement, or medical. It may be considerable whether to apply, under the special condition or an application where strict quality control may not be required. Please contact our headquarters, branch, or local offices printed on the front and back covers of this catalogue.
- \* When exporting Toshiba variable speed drive separately or combined with your equipment, please be sure to satisfy the objective conditions and inform conditions listed in the export control policies, so called Catch All restrictions, which are set by the Ministry of Economy, Trade and Industry of Japan, and the appropriate export procedures must also be taken.
- \* Please use our product in applications where do not cause serious accidents or damages even if product is failure, or please use in environment where safety equipment is applicable or a backup circuit device is provided outside the system.
- \* Please do not use our product for any load other than three-phase motors.
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