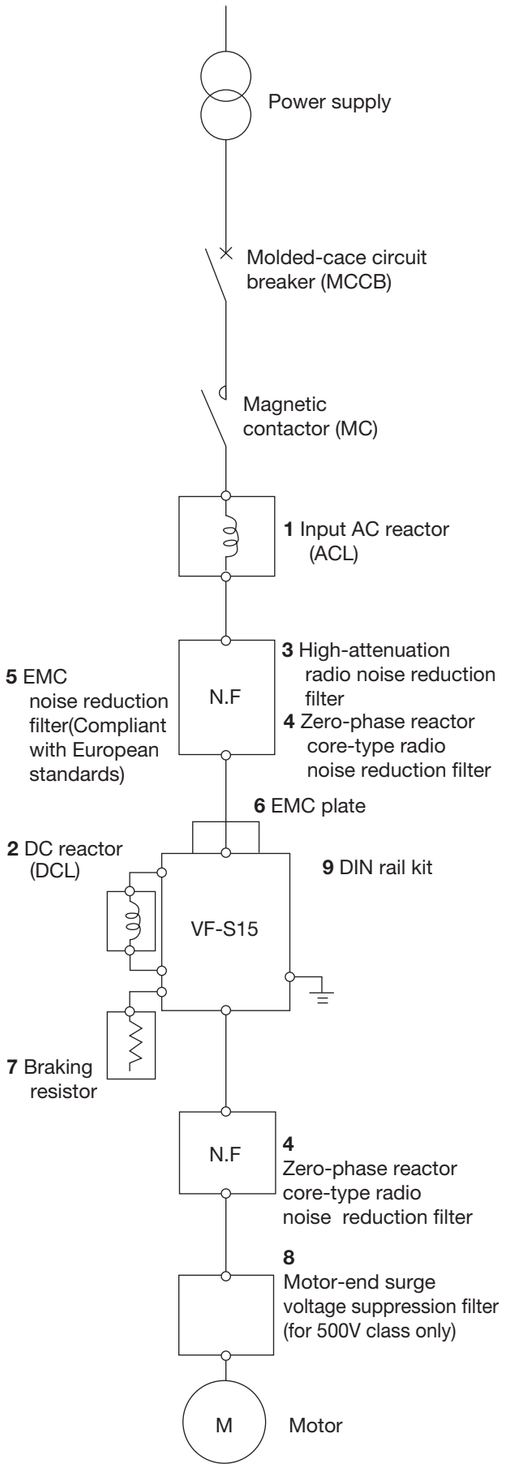
Peripheral devices



No.	Device		Function and purpose	Refer to
1	Input AC reactor (ACL)		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 500 kVA or more and 10 times or more than the inverter capacity or when a distorted wave generation source such as a thyristor unit or a large-capacity inverter is connected in the same distribution system. Reactor type / Effect: Improvement of power factor / Suppression of harmonic / Suppression of external surge Input AC reactor: ○ / ○ / ○ DC reactor: ○ Large / ○ Large / × ○ Large : Large effective. ○ : effective. ×: ineffective	P.17
2	DC reactor (DCL)		Generally, a DC reactor improves the power factor more than an input AC reactor. When the inverter is used along with equipment for which a high degree of reliability is required, an input AC reactor capable of suppressing external surges should be used along with a DC reactor.	P.17
3	Radio noise reduction filter	High-attenuation radio noise filter (NF type)	These types of filters are not necessary because all single-phase 240V or 3-phase 500V models have a built-in EMC noise filter, The built-in filter meets IEC61800-3. But install these filters if necessarily of noise reduction move and more. • Effective to prevent interference in audio equipment used near the inverter. • Install on the input side of the inverter. • Provided with wide-range attenuation characteristics from AM radio bands to near 10MHz. • Use when equipment readily affected by noise is installed in the peripheral area.	P.18
4	Radio noise reduction filter	Zero-phase reactor core-type	• Effective to prevent interference in audio equipment used near the inverter. • Effective in noise reduction on both input and output sides of the inverter. • Provided with attenuation characteristics of several dB in frequencies from AM radio bands to 10MHz. • For noise countermeasures, insert on the secondary side of the inverter.	P.18
5	Radio noise reduction filter	EMC noise filter (Compliant with European standards)	A high-attenuation compact EMC noise filter that can be Foot-mounted and Side-mounted. With this filter on, the inverter complies with the following standards.	-
6	EMC plate		A steel plate used to connect shielded earth wires from inverter's power cables or to connect earth wires from external devices.	P.10
7	Braking resistor		Use when rapid deceleration or stop is frequently required or when it is desired to reduce the deceleration time with large load. This resistor consumes regenerative energy during power generation braking.	P.18
8	Motor-end surge voltage suppression filter (for 500V class only)		Use an insulation-reinforced motor or install the surge voltage restraint filter to prevent degrading motor insulation caused by surge voltage generation depending on cable length and wiring method, or use of a 500V class motor driven with an inverter.	P.19
9	DIN rail kit		Available for the 2.2kW (or 1.5kW) or less.	-
10	Parameter writer		Use this unit for batch read, batch copy, and batch writing of setting parameters.	P.16
11	Extension panel		Extended operation panel kit provided with LED indication section, RUN/STOP key, UP/DOWN key, Monitor key, and Enter key.	P.19
12	USB communication conversion unit		This unit is connected to a PLC or a computer to enable data communications. By connecting the connector cable, parameters can be easily adjusted, and data easily saved and written.	P.16
13	communication option		These options allow you to connect a upper controller to multiple inverters for data transfer.	P.16
14	Remote panel		This panel includes a frequency meter, a frequency regulator and RUN/STOP (forward/reverse run)switches.	P.19

External options

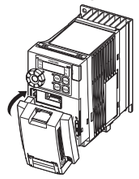
Voltage class	Inverter model	Applicable motor (kW)	Input AC reactor	DC reactor	Radio noise reduction filter: High-attenuation	Radio noise reduction filter: Core-type	Braking resister	Motor-end surge voltage suppression filter	DIN rail
3-phase 240V	VFS15-2004PM-W	0.4	PFL-2005S	DCL2-2004	NF3005A-MJ	RC5078	PBR-2007	-	DIN003Z
	VFS15-2007PM-W	0.75	PFL-2005S	DCL2-2007	NF3005A-MJ	RC5078	PBR-2007	-	DIN003Z
	VFS15-2015PM-W	1.5	PFL-2011S	DCL2-2015	NF3015A-MJ	RC5078	PBR-2022	-	DIN005Z
	VFS15-2022PM-W	2.2	PFL-2011S	DCL2-2022	NF3015A-MJ	RC5078	PBR-2022	-	DIN005Z
	VFS15-2037PM-W	4.0	PFL-2018S	DCL2-2037	NF3020A-MJ	RC5078	PBR-2037	-	-
	VFS15-2055PM-W	5.5	PFL-2025S	DCL2-2055	NF3030A-MJ	RC9129	PBR7-004W015	-	-
	VFS15-2075PM-W	7.5	PFL-2050S	DCL2-2075	NF3040A-MJ	RC9129	PBR7-004W015	-	-
	VFS15-2110PM-W	11	PFL-2050S	DCL2-2110	NF3050A-MJ	RC9129	PBR7-008W7R5	-	-
	VFS15-2150PM-W	15	PFL-2100S	DCL2-2150	NF3080A-MJ	RC9129	PBR7-008W7R5	-	-
1-phase 240V	VFS15S-2002PL-W	0.2	PFL-2005S	DCL2-2004	The EMC noise filter is built into the 1ph-240V and 3ph-500V models by the standard.	RC5078	PBR-2007	-	DIN003Z
	VFS15S-2004PL-W	0.4	PFL-2005S	DCL2-2007		RC5078	PBR-2007	-	DIN003Z
	VFS15S-2007PL-W	0.75	PFL-2011S	DCL2-2022		RC5078	PBR-2007	-	DIN003Z
	VFS15S-2015PL-W	1.5	PFL-2018S	DCL2-2037		RC5078	PBR-2022	-	DIN005Z
	VFS15S-2022PL-W	2.2	PFL-2018S	DCL2-2037		RC5078	PBR-2022	-	DIN005Z
3-phase 500V	VFS15-4004PL-W	0.4	PFL-4012S	DCL2-4004		RC5078	PBR-2007	MSF-4015Z	DIN005Z
	VFS15-4007PL-W	0.75	PFL-4012S	DCL2-4007		RC5078	PBR-2007	MSF-4015Z	DIN005Z
	VFS15-4015PL-W	1.5	PFL-4012S	DCL2-4015		RC5078	PBR-2007	MSF-4015Z	DIN005Z
	VFS15-4022PL-W	2.2	PFL-4012S	DCL2-4022		RC5078	PBR-2007	MSF-4037Z	-
	VFS15-4037PL-W	4.0	PFL-4012S	DCL2-4037		RC5078	PBR-4037	MSF-4037Z	-
	VFS15-4055PL-W	5.5	PFL-4025S	DCL2-4055		RC9129	PBR7-004W060	MSF-4075Z	-
	VFS15-4075PL-W	7.5	PFL-4025S	DCL2-4075		RC9129	PBR7-004W060	MSF-4075Z	-
	VFS15-4110PL-W	11	PFL-4025S	DCL2-4110		RC9129	PBR7-008W030	MSF-4150Z	-
	VFS15-4150PL-W	15	PFL-4050S	DCL2-4150		RC9129	PBR7-008W030	MSF-4150Z	-

Communication

Name		Type-form
CC-Link communication option		CCL003Z
PROFIBUS-DP communication option		PDP003Z
Device Net communication option		DEV003Z
EtherNet/IP – Modbus TCP communication option		IPE002Z
EtherCAT communication option		IPE003Z
CAN open Communication option	RJ45 connector 2 port type	CAN001Z
	D-sub connector (9pins) type	CAN002Z
	Open connector (5pins) type	CAN003Z
Communication option adapter		SBP009Z

Option adapter is necessary to use the communication option.

Mount the option



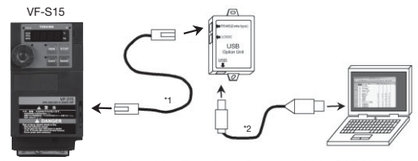
Mount it to the front of inverter. The depth is increase 25mm.

Operation option

USB communication conversion unit

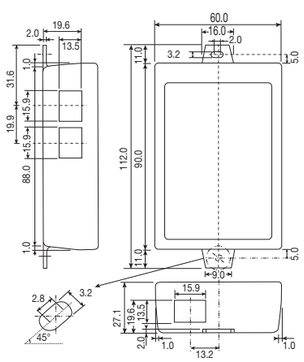
Type-form: USB001Z
Inverter can be management and setting on a PC

Connection



*1: USB communication conversion unit cable. Type-form (inverter side): CAB0011(1m), CAB0013(3m), CAB0015(m)
*2: Cable is USB cable (USB1.1/2.0 A-B connect type) for PC side.

Dimension



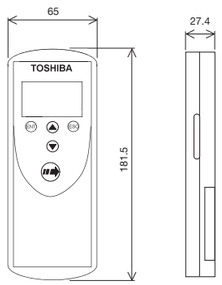
Unit:mm

Parameter writer

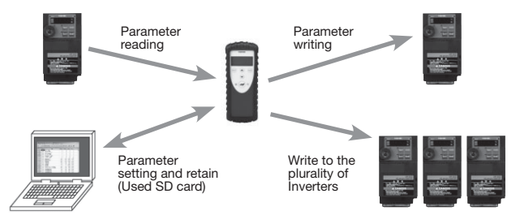
Type-form: PWU003Z
Parameter can be read/write without power supply to the inverter. And inverter can be management and setting on a PC.

Connect to inverter

Outline drawing



Read/write/restore of parameters



Specification

Items	Specification
Battery	AA size battery or Nickel metal hydride: Used 4 batteries Note) Batteries are not attached
languages	Japanese, English, Spanish, German, Italian, French
Data storage	SD card, SDHC card (Format is FAT32)
Attachment	USB cable, RJ45 cable(1m), SD card, Carry case, Shock-absorb cover, Wrist strap, Manual(Japanese/English)

Dimension and Connection

Input AC reactor

Dimension

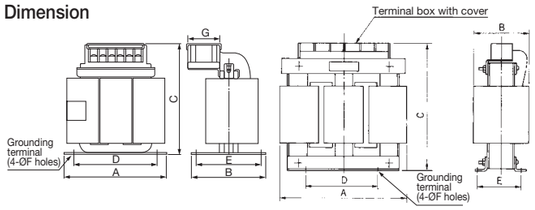
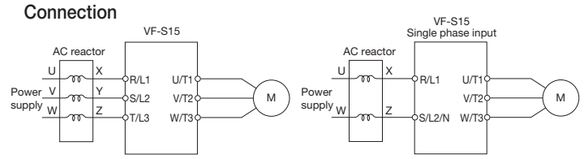


Fig.A Fig.B

Connection



Reactor model	Rating	Inverter model	Dimensions (mm)							Diagram	Terminals	Approx. Weight (kg)
			A	B	C	D	E	F	G			
PFL-2005S	3-phase 240V class -5.5A-50/60Hz	VFS15-2004PM-W, 2007PM-W VFS15S-2002PL-W, 2004PL-W	105	65	115	90	55	5	40	A	M3.5	1.2
PFL-2011S	3-phase 240V class -11A-50/60Hz	VFS15-2015PM-W, 2022PM-W VFS15S-2007PL-W	130	70	140	115	60	5	50		M4	2.3
PFL-2018S	3-phase 240V class -18A-50/60Hz	VFS15-2037PM-W VFS15S-2015PL-W, 2022PL-W	130	70	140	115	60	5	50		M4	2.5
PFL-2025S	3-phase 240V class -25A-50/60Hz	VFS15-2055PM-W	125	100	130	50	83	7	-	B	M4	2.6
PFL-2050S	3-phase 240V class -50A-50/60Hz	VFS15-2075PM-W, 2110PM-W	155	115	140	50	95	7	-		M6	3.4
PFL-2100S	3-phase 240V class -100A-50/60Hz	VFS15-2150PM-W	230	150	210	60	90	8	-		M8	8.2
PFL-4012S	3-phase 500V class-12.5A-50/60Hz	VFS15-4004PL-W~4037PL-W	125	95	130	50	79	7	-	B	M4	2.3
PFL-4025S	3-phase 500V class -25A-50/60Hz	VFS15-4055PL-W~4110PL-W	155	110	155	50	94	7	-		M4	4.9
PFL-4050S	3-phase 500V class -50A-50/60Hz	VFS15-4150PL-W	155	140	165	50	112	7	-		M6	6.6

DC reactor

Dimension

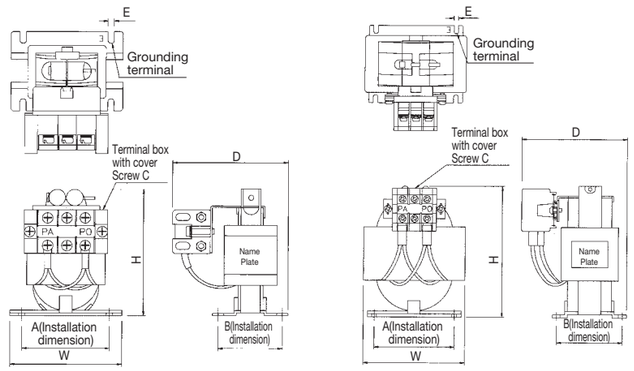
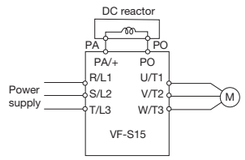


Fig.A Fig.B

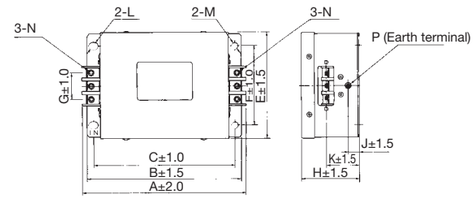
Connection



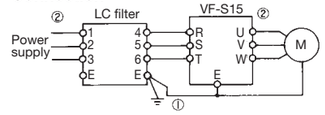
Reactor model	Inverter model	Dimensions(mm)							Diagram	Approx. Weight (kg)
		W	H	D	A	B	C	E		
DCL2-2004	VFS15-2004PM-W, VFS15S-2002PL-W	72	92	75	57	42	M3.5	4.5	A	0.6
DCL2-2007	VFS15-2007PM-W, VFS15S-2004PL-W	72	94	80	57	42	M3.5	4.5		0.7
DCL2-2015	VFS15-2015PM-W	75	99	79	60	42	M3.5	4.5		0.9
DCL2-2022	VFS15-2022PM-W, VFS15S-2007PL-W	74	101	81	59	47	M3.5	4.5		1.0
DCL2-2037	VFS15-2037PM-W, VFS15S-2015PL-W,2022PL-W	81	115	99	65	56	M4	5.0		1.6
DCL2-2055	VFS15-2055PM-W	94	124	116	78	61	M5	5.0		2.3
DCL2-2075	VFS15-2075PM-W	94	119	116	78	61	M5	5.0		2.3
DCL2-2110	VFS15-2110PM-W	124	124	131	108	71	M8	5.0		3.3
DCL2-2150	VFS15-2150PM-W	124	122	131	108	71	M8	5.0		3.4
DCL2-4004	VFS15-4004PL-W	71	94	73	57	37	M3.5	4.5	A	0.6
DCL2-4007	VFS15-4007PL-W	69	104	80	55	42	M3.5	4.5		0.7
DCL2-4015	VFS15-4015PL-W	72	109	81	57	42	M3.5	4.5		1.0
DCL2-4022	VFS15-4022PL-W	74	108	86	59	47	M3.5	4.5		1.2
DCL2-4037	VFS15-4037PL-W	83	119	99	66	61	M3.5	5.5	B	1.9
DCL2-4055	VFS15-4055PL-W	83	119	103	66	61	M4	5.5		2.0
DCL2-4075	VFS15-4075PL-W	90	134	108	73	61	M4	5.5		2.5
DCL2-4110	VFS15-4110PL-W	103	149	121	84	66	M5	5.5		3.6
DCL2-4150	VFS15-4150PL-W	109	152	128	91	73	M5	5.5		4.3

High attenuation radio noise reduction filter

Dimension



Connection



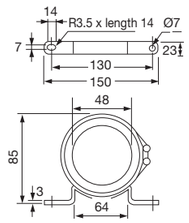
Note:(1) Noise filter should be connected to the inverter main circuit primary side.
(2) Output cable should be kept away from the input cable.

Filter model	Rated current (A)	Inverter model	Dimensions (mm)													Approx. Weight (kg)
			A	B	C	E	F	G	H	J	K	L	M	N	P	
NF3005A-MJ	5	VFS15-2004PM-W~2007PM-W VFS15S-2022PL-W	174.5	160	145	110	80	32	70	20	45	R2.75 Length 7	ø5.5	M4	M4	1.0
NF3015A-MJ	15	VFS15-2015PM-W, 2022PM-W VFS15S-2004PL-W~2015PL-W														1.6
NF3020A-MJ	20	VFS15-2037PM-W														
NF3030A-MJ	30	VFS15-2055PM-W VFS15S-2022PL-W														
NF3040A-MJ	40	VFS15-2075PM-W	217.5	200	185	120	90	44	70	20	43			M5	M4	2.7
NF3050A-MJ	50	VFS15-2110PM-W	267.5	250	235	170	140		90	30	60	R3.25 Length 8	ø6.5	M6	M4	4.6
NF3080A-MJ	80	VFS15-2150PM-W	294.5	280	260	200	150	57	100	30	65			M8	M6	7.0
NF3010C-MJ	10	VFS15-4004PL-W~4037PL-W	174.5	160	145	110	80	32	70	20	45	R2.75 Length 7	ø5.5	M4	M4	1.4
NF3015C-MJ	15	VFS15-4055PL-W														1.6
NF3020C-MJ	20	VFS15-4075PL-W														1.6
NF3030C-MJ	30	VFS15-4110PL-W	214	200	185	120	90	32	70	20	43					1.6
NF3040C-MJ	40	VFS15-4150PL-W	217.5					44						M5	M4	2.7

Note: For the inverter models ending with -PL, same noise filter as the ones described here is built-in standard.

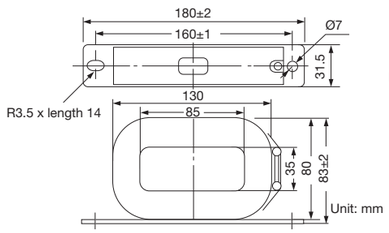
Zero-phase reactor core-type radio noise filter

Type-form: RC5078
Dimension



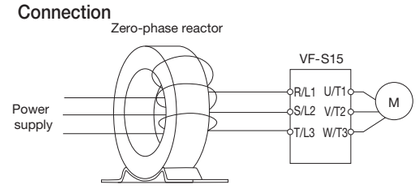
Approx weight: 0.48kg

Type-form: RC9129
Dimension



Approx weight: 1.38kg

Connection



Input or Output cable should be coiled over 4-times.
RC5078 is recommended for the models 4.0 kW or less

Braking resistor

Dimension

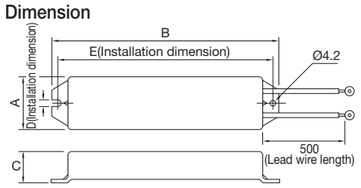


Fig.A

Connection

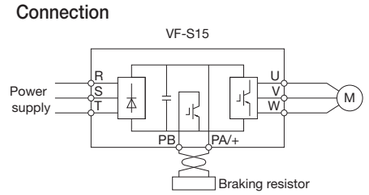


Fig.C

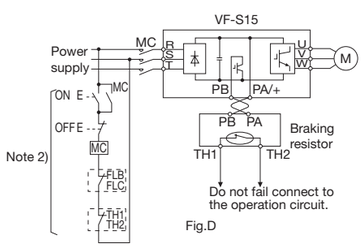


Fig.D

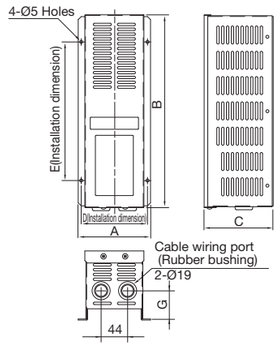


Fig.B

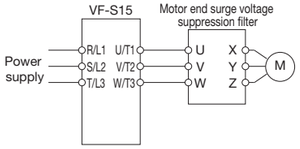
Resistor model	Rating	Inverter model	Dimensions (mm)						External dimension/Connection diagram	Approx. Weight (kg)
			A	B	C	D	E	G		
PBR-2007	120W-200Ω	VFS15-2004PM-W~2007PM -W VFS15S-2002PL-W~2007PL-W VFS15-4004PL-W~4022PL-W Note1)	42	182	20	4.2	172	-	A & C	0.28
PBR-2022	120W-75Ω	VFS15-2015PM-W, 2022PM-W VFS15S-2015PL-W, 2022PL-W								
PBR-2037	120W-40Ω	VFS15-2037PM-W								
PBR-4037	120W-160Ω	VFS15-4037PL-W								
PBR7-004W015	440W-15Ω	VFS15-2055PM-W, 2075PM-W	120	320	115	110	230	48	B & D	3.4
PBR7-004W060	440W-60Ω	VFS15-4055PL-W, 4075PL-W								
PBR7-008W7R5	880W-7.5Ω	VFS15-2110PM-W, 2150PM-W	120	350	190	110	230	150		5.4
PBR7-008W030	880W-30Ω	VFS15-4110PL-W, 4150PL-W								

Note1: Braking resisters for VFS15-4004PL-W~4022PL-W are the same type of those for VFS15-2004PM-W~2007PM-W.

Motor end surge voltage suppression filter (for 500V class only)

Filter model	Applicable motor (kW)	Dimensions (mm)			Terminal screw	Grounding screw	Approx. Weight (kg)
		W	H	D			
MSF-4015Z	0.4,0.75,1.5	310	255	300	M4	M4	12
MSF-4037Z	2.2,3.7	310	255	300	M4	M4	20
MSF-4075Z	5.5,7.5	310	315	350	M5	M4	30
MSF-4150Z	11,15	330	355	400	M6	M5	40

Connection

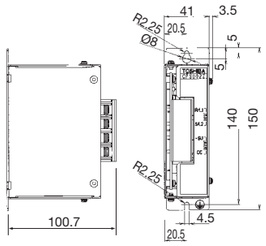


Be sure to set the inverter output frequency to 60Hz or less, and the carrier frequency to about 15kHz or less.

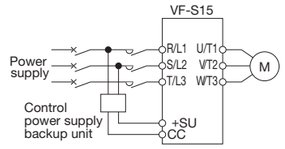
Control power supply backup unit

Type-form: CPS002Z 240V/500V

Dimension



Connection

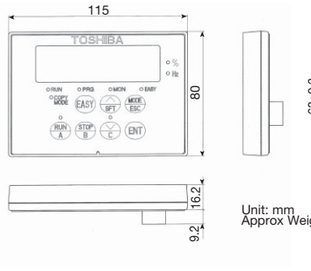


Unit: mm
Approx Weight: 0.40kg

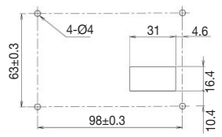
Extension panel

Type-form: RKP002Z (It has parameter copy function)

Dimension



Panel cutout dimension

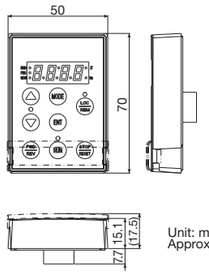


Unit: mm
Approx Weight: 0.11kg

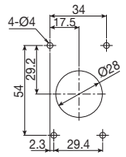
Communication cable model: CAB0011 (1m), CAB0013 (3m), CAB0015 (5m)

Type-form: RKP007Z

Dimension



Panel cutout dimension



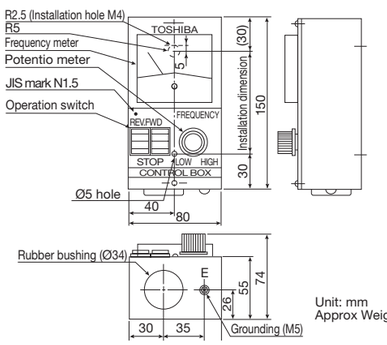
Unit: mm
Approx Weight: 39g

Communication cable model: CAB0071 (1m), CAB0073 (3m), CAB0075 (5m)

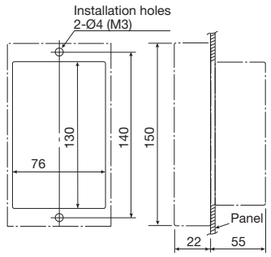
Remote panel

Type-form: CBVR-7B1

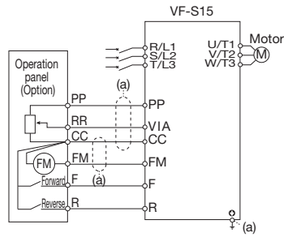
Dimension



Panel cutout dimension



Connection



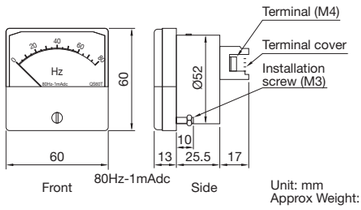
Unit: mm
Approx Weight: 0.7kg

note) The wire length should be 30m or less the inverter and the operation panel.

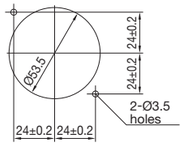
Frequency meter

Type-form: QS60T

Dimension



Panel cutout dimension



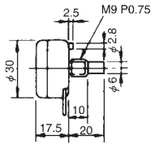
Unit: mm
Approx Weight: 75g

FRH kit

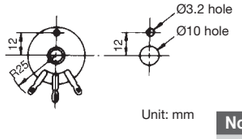
Type-form: FRH-KIT*K

- Frequency setting resistor (RV30YN-20S-B302)

Dimension



Panel cutout dimension



Unit: mm

- Frequency setting panel (60 x 45mm)
- Frequency setting knob <K-3>

*3pcs in one set.

No.	Connection terminal
1	CC
2	VIA
3	PP

To users of our inverters

1. For inverter users

Notes

Leakage current

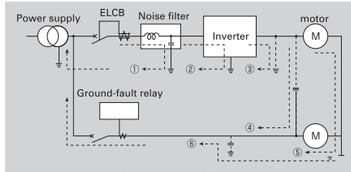
This inverter uses high-speed switching semiconductors for PWM control.
When a relatively long cable is used for power supply to an inverter, current may leak from the cable or the motor to the ground because of its capacitance, adversely affecting peripheral equipment. Installation of radio noise reduction filter may also increase leakage current. 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 reduction 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 motor and an inverter 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 troubles.

- 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.



Leakage current flow routes

[Measures against effects of leakage current]
The measures against the effects of leakage current are as follows:

1) Measures to prevent the malfunction of leakage circuit breakers (ELCB)
   (1) Decrease the PWM carrier frequency of the inverter. Note)
   (2) Use radio-frequency interference-proof ELCBs as ground-fault interrupters in not only the system into which the inverter is incorporated but also other systems. When ELCBs are used, the inverter can operate with high PWM carrier frequency.
   (3) When connecting multiple inverters to a single ELCB, use an ELCB with a high current sensitivity or reduce the number of inverters connected to the ELCB.
2) Measures against malfunction of ground-fault relay:
   (1) Decrease the PWM carrier frequency of the inverter. Note)
   (2) Install ground-fault relays with a high-frequency protective function in both the same and other lines. When ELCBs are used, the inverter can operate with high PWM carrier frequency.
3) Measures against noise produced by other electric and electronic systems:
   (1) Separate the grounding line of the inverter from that of the affected electric and electronic systems.
   (2) Decrease the PWM carrier frequency of the inverter. Note)
4) Measures against malfunction of external thermal relays:
   (1) Remove the external thermal relay and use the electronic thermal function of the inverter instead.
   (Not apply to cases where a single inverter is used to drive more than one motor. Refer to the instruction manual for measures to be taken when thermal relays cannot be removed.)
   (2) Decrease the PWM carrier frequency of the inverter. Note)
5) Measures by means of wiring and grounding
   (1) Separate the inverter's grounding wire from that of other systems or install the grounding wire of each system separately to the grounding point.
   (2) Use the shortest possible cables (100m or less) to connect the inverter to the motor. If the wire length is long, especially with the models of 4.0kW or less, perhaps over current trip occurs by charging current through the capacitance of cable. Use the separate cable to reduce the capacitance of cable, or install the filter between the inverter and the motor as countermeasures against over current trip.
   (3) If the inverter has a high-attenuation EMC noise reduction filter, change the grounding capacitor switch to reduce the leakage current. Note that doing so leads to a reduction in the noise attenuating effect.

Note) In the case of this inverter, the PWM carrier frequency can be decreased to 2.0kHz.
Decrease 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

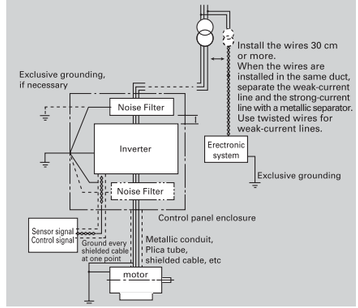
[Noise produced by inverters]
Since this inverter performs PWM control, it produces noise and sometimes affects nearby instrumental devices, electrical and electronic systems, etc. The effects of noise greatly vary with the noise resistance of each individual device, its wiring condition, the distance 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 reduction filter in each inverter. It is effective for noise prevention to install noise reduction 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.

On 1ph-240V and 3ph-500V models, noise can be greatly reduced as they have a built-in EMC noise reduction filter on their input side.



Power factor improvement capacitors

Do not install 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 a DC reactor or an input AC reactor on the primary side of the inverter.

Installation of input AC rectors

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 500kVA 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 a high-pole motor, special motor, or multiple 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	$ta = \frac{(JM+JL) \times \Delta N}{9.56 \times (TM-TL)}$ (sec.)
Deceleration time	$ta = \frac{(JM+JL) \times \Delta N}{9.56 \times (TB-TL)}$ (sec.)
Conditions	JM :Moment of inertia of motor ($kg \cdot m^2$) JL :Moment of inertia of load ($kg \cdot m^2$) (converted into value on motor shaft) ΔN :Difference in rotating speed between before and after acc. or dce. (min^{-1}) TL :Load torque (N·m) TM :Motor rated torque x 1.2~1.3 (N·m) ...V/f control :Motor rated torque x 1.5 (N·m) ...Vector operation control (In case of variable torque characteristic TM :Motor rated torque x 1.1 (N·m) ...V/f control :Motor rated torque x 1.2 (N·m) ...Vector operation control) TB :Motor rated torque x 0.2 (N·m) (When a braking resistor or a braking resistor unit is used: Motor rated torque x 0.8-1.0 (N·m))

[Allowable torque characteristics]
When a standard motor is combined with an inverter to perform variable speed operation, the motor temperature rises slightly higher than it normally does during commercial power supply operation. This is because the inverter output voltage has a sinusoidal (approximate) PWM waveform. In addition, the cooling becomes less effective at low speed, so the torque must be reduced according to the frequency. Regarding the allowable torque characteristic, please confirm with the motor manufacturer.
When constant-torque operation must be performed at low speeds, use a Toshiba constant-torque 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

Installing and wiring

[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.
(3) 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 failure 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 on/off while running. (If the secondary-side contactor is turned 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 source 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, FLC, RY or RC 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.
(2) When using the inverter to control the operation of a constant-torque motor, change the protective characteristic of the electronic thermal relay according to the setting of the constant-torque motor.
(3) In order to adequately protect a motor used for low-speed operation, we recommend the use of a motor equipped with an embedded thermal relay.

Wiring
(1) Do not connect input power to the output (motor side) terminals (U/T1,V/T2,W/T3). That will destroy the inverter and may result in fire. Please pay attentions of wiring before power supply turns-on.
(2) The DC terminals (PA/+, PO and PB) are for specified options. Do not connect other devices to these terminals.
(3) Within 15 minutes after turning off input power, do not touch wires of devices (MCCB) connected to the input side of the inverter.

Grounding
The inverters and motors must be connected to ground securely. In case of grounding for inverters, please use the grounding terminal of the inverter.

Operating precautions

(1) When the inverter operates in abnormal circumstances, the protective function activates to shut off the inverter output. However, the inverters can not stop the motors quickly. Please install the mechanical brake or maintenance function in the mechanical equipment and the device for which the emergency stop is necessary.
(2) When you drive the machine and the device that hangs the load repeatedly with the inverter, the semiconductor within inverter might cause thermal fatigue and it come to have a short life if a big current flows repeatedly when driving and stopping. In this case, it is possible to extend life span by controlling the starting current and the load current low or setting the PWM career frequency low. If you can not decrease the starting current, please select larger capacity of inverters for current margins.

4. When changing the motor speed

Application to standard motors

Vibration
When a motor is operated with an 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. In this case, using jump frequency to avoid resonant frequencies or changing PWM carrier frequency is also effective.

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 affect at low speeds.
When operating at 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 activates.

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 increased than commercial power supply drives.
- In case of the operation on high frequency exceeding 60Hz, the acoustic noise and motor temperature may be higher.

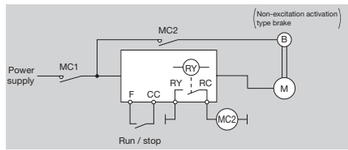
Toshiba Gold Motor (High-efficiency power-saving motor)
Inverter-driven operation of Toshiba Gold Motors is the best solution for saving energy. This is because these motors have improved efficiency, power factor, and noise/vibration reduction characteristics when compared to standard motors.

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 may activate.

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. In case of a single-phase, power system, a 3-phase motor can be driven by using a single-phase input inverter to convert it into a 3-phase 200V output. (A special inverter and a 3-phase 200V 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.



5. Disposal of the inverter

For safety's sake, do not dispose of the disused inverter yourself but ask an industrial waste disposal agent.
Disposing of the inverter improperly could cause its capacitor to explode and emit toxic gas, causing injury to persons.