Fuji Electric

Innovating *Energy Technology*

Low Voltage AC drives for HVAC applications

FRENIC-HVAC

Smile to the environment

CEN-AR1EN19.02

Large Contribution to Reducing Global Warming (Environmental Protection) with Energy Saving

50% of energy consumption in office buildings is related to air conditioning. The FRENIC-HVAC series is the dedicated inverter for HVAC that features functions and performances offer the optimal thermal environment for the people working in the building by keeping the energy consumption in various devices (compressor, condenser water pump, AHU and others) to the minimum.
Fuji Electric contributes largely to global environment by realizing carbon dioxide reduction with energy saving by the inverter.

Wide variation in model capacity (0.75 - 710) kW

Standard type (EMC filter built-in type)
0.75 to 710kW (Protective structure IP21 or IP55 can be selected with the model between 0.75 and 90kW.)

DCR built-in + EMC filter built-in type
0.75 to 90kW (Protective structure IP21 or IP55 can be selected with the model between 0.75 and 90kW.)

Inverter capacity	EMC Filter	DC Reactor	Protective structure
0.75 kW to 90 kW	Built-in	Built-in	IP21/IP55
110 kW to 710 kW	Built-in	External	IP00

Optimal control with energy-saving function

- Linearization function
- Temperature difference constant control and pressure difference constant control
- Energy saving functions including wet-bulb temperature presumption control
- Automatic energy-saving operation

Slim body

The first slim body design among the Fuji Electric inverters.
The size is the same for IP21 and IP55 .

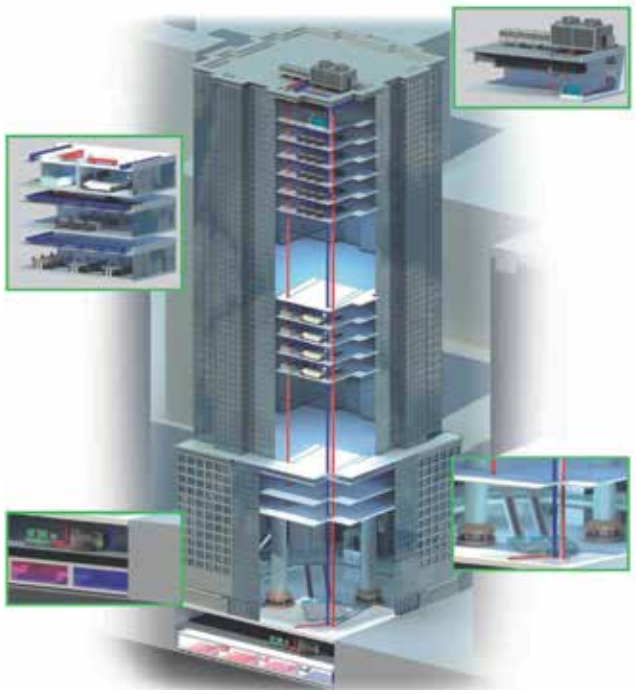
Functions suitable for HVAC use

- 4PID control • Fire mode (forced operation)
- Pick-up operation function • Real time clock
- Torque vector control • Filter clogging prevention function
- Customized logic • User friendly, useful keypad

DCR built-in + EMC filter built-in type • Password function

Significant energy saving realized

For an air-conditioning heat source system, the needed quantity of the cooling or heating water fluctuates generally in seasons or days and nights. Therefore, operations continuing in a water conveyance pressure constant control may lead to high operating unnecessary pressures on terminals at low operating state. Thus, the pump consumes an ineffectual electric power for maintaining the high water conveyance pressure.
FRENIC-HVAC can perform an estimated terminal pressure control by linearization function which estimates target pressure from load flow rate. It is possible to reduce the ineffectual pump power consumption and to achieve a great energysaving effect together with maintaining comfortable current air conditioning.



Optimum control for HVAC facilities

• Cooling tower fan

The cooling tower fan is used to cool the heat of cooling water by emitting it into the air. The fan speed is adjusted optimally according to the cooling water temperature at the outlet. Moreover, the inverter estimates the wet-bulb temperature automatically to control the fan so that the temperature of cooling water (wet bulb) is interlocked to the air temperature (Wet-bulb temperature presumption control).

• Chilled water pump

The chilled water pump circulates the chilled water generated with the freezing machine to the air conditioner and fan coil. The pump speed is adjusted optimally according to the header pressure. Moreover, the pump conveyance pressure can be controlled to proper value by converting the flow rate signal to the target pressure using the linearization function (Linearization function).

• Cooling water pump

The cooling water pump circulates the cooling water to the cooling tower in order to cool the heat generated by the freezing machine. The pump speed is adjusted optimally according to the temperature and flow rate of cooling water. Moreover, the inverter can control the cooling pump so that the difference of cooling water temperature at between the inlet and outlet becomes always constant. (Temperature difference constant control).

• Supply fan / return fan

The speed of supply and return fans is adjusted optimally according to the pressure, discharge temperature, room temperature, and others. Moreover, the highest level of carbon dioxide is selected automatically by detecting the level in room to control it to stay within the allowable level.

Optimal structure design

User friendly keypad

- **The regulator is indicated by enlarging the LCD.**

1. Present value (PV)
2. Setting value (SV)
3. Manipulating value (MV)
4. Frequency
5. Output current
6. Output voltage
7. Torque
8. Rotation speed
9. Power consumption
10. Cumulative energy

*Possible to show understandable indications through the unit conversion function.
*Multi-language function: 19 languages + user customized language supported.

- **Multi-language supported: 19 languages + user customized language**

Language				
English	Dutch	Turkish	Greek	Vietnamese
Spanish	Italian	Russian	Malay	Chinese
German	Czech	Swedish	Indonesian	Thai
French	Polish	Portuguese	Japanese	

Real time clock (RTC) provided as standard

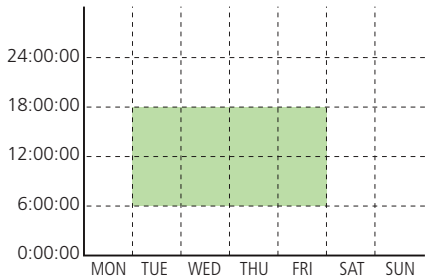
- **Alarm information with date and time**
  - Alarm information for last ten times is stored and displayed with date and time.

Easy failure analysis

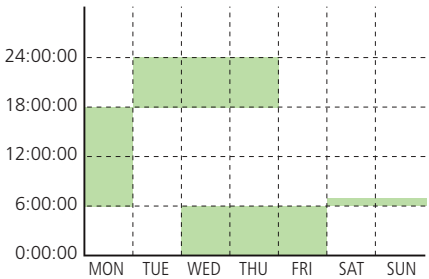
- **Timer function**
  - Possible to set up to four timers a week.
  - Possible to set flag holidays (20 days a year).

Operation schedule can be set according to actual condition by using four timers

Example **When operation is performed in the same schedule through a week**



When operation schedule varies depending on the day of the week



- **Unit conversion function between PV and SV values**
  - Unit conversion allows you to easily set data.

Function	Units				
Unit conversion	No conversion	%	r/min	kW	m^3/s
	m^3/min	m^3/h	L/s	L/min	L/h
	Pa	kPa	MPa	mbar	bar
	mmHg	psi	mWG	inWG	K
	°C	°F	ppm		

FRN 0.75 AR1 M - 4 E

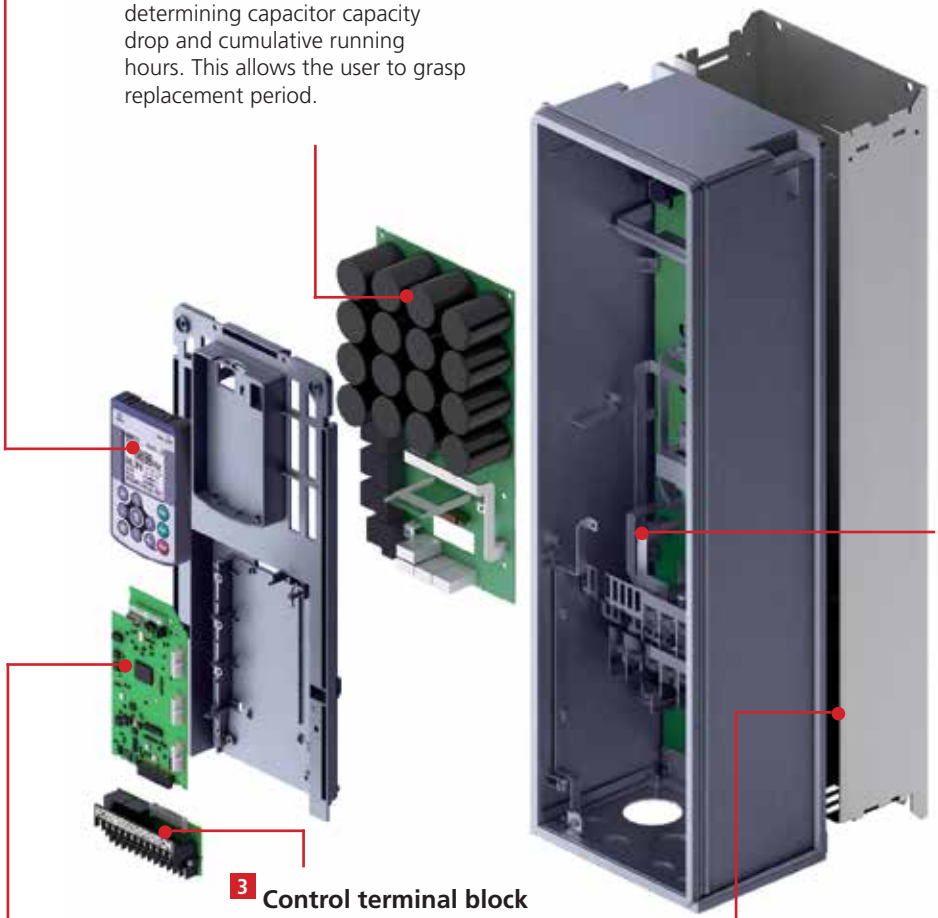
- FRN — Series name: FRN
- 0.75 — Standard applicable motor capacity
- AR1 — Applied for: HVAC
- M — Protection structure: M: IP21 L:I P55 S: IP00
- 4 — Input power supply: 4: 400 V
- E — Destination: E: Europe

1 User-friendly, easy to see dedicated keypad

Multi-language supported, HELP function featured, unit setting with SV and PV values, data copy (three kinds), detachable and can be attached on the panel (using an optional cable)

4 Capacitor board

Outputs the life prediction signal determining capacitor capacity drop and cumulative running hours. This allows the user to grasp replacement period.



5 Cooling fan

Easy replacement just by simply removing and attaching the part. Life prolongation is possible by controlling ON and OFF.

6 EMC filter

Drastically reduces noise. Provided to units of all capacities. Conforming to IEC61800-3.

3 Control terminal block

The detachable control terminal block is adopted. This allows the unit to be replaced easily without disconnecting cables.

2 Control board

USB port equipped.
Max. three types of built-in optional boards can be mounted all together.
Optional battery connection.
Various communications options.

Standard equipment	Optional Equipment
• BACnet MS/TP • Modbus RT • Metasys N2	• LonWorks • DeviceNet • Ethernet • CANopen • Profibus • CC-Link

7 DCR

Drastically reduces harmonic noise. Conforming to IEC/EN61000-3-2 and IEC/EN61000-3-12. Provided as standard (to models up to 90kW), and can be attached externally as an option (to models from 110kW to 710kW).

8 Environmental immunity

3C2, IEC 60721-3-3 supported.

9 Others

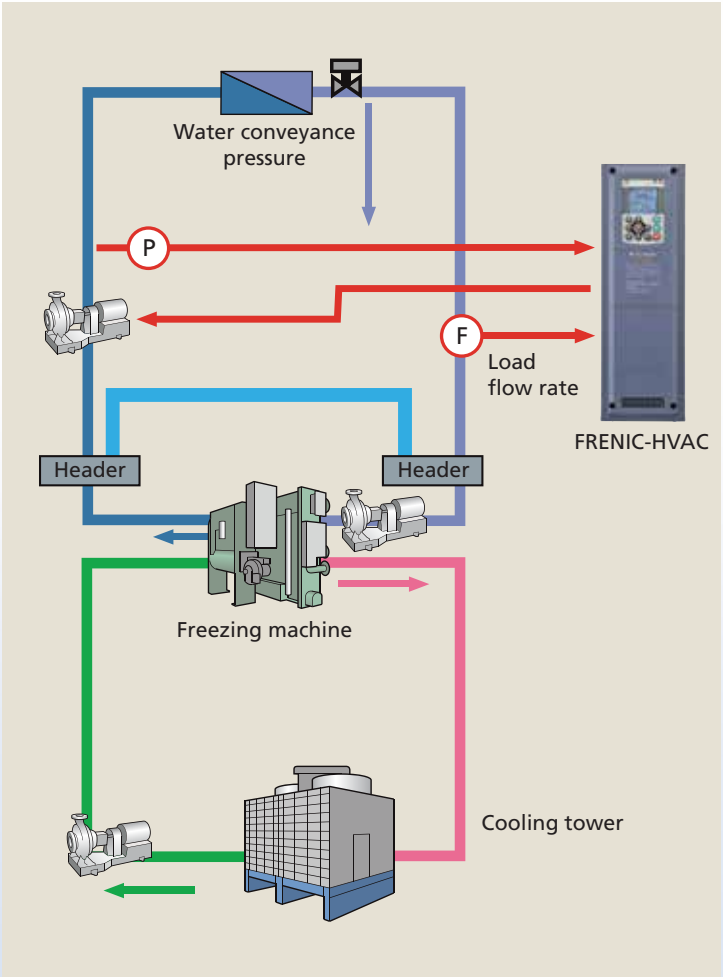
Support/analysis software by loader, RTC backup by battery (option)

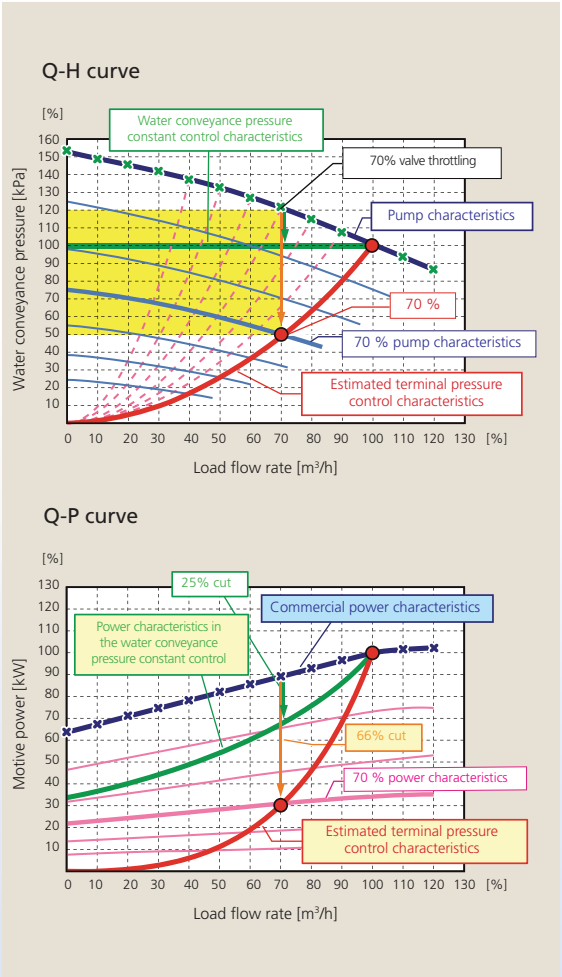
Functions suitable for HVAC use

Linearization function

This function estimates the target pressure using the load flow rate, which allows the estimated terminal pressure to be controlled. For an air-conditioning heat source system, the needed quantity of the cooling or heating water fluctuates generally in seasons or days and nights. Therefore, operations continuing in a water conveyance pressure constant control may lead to high operating unnecessary pressures on terminals at low operating state.

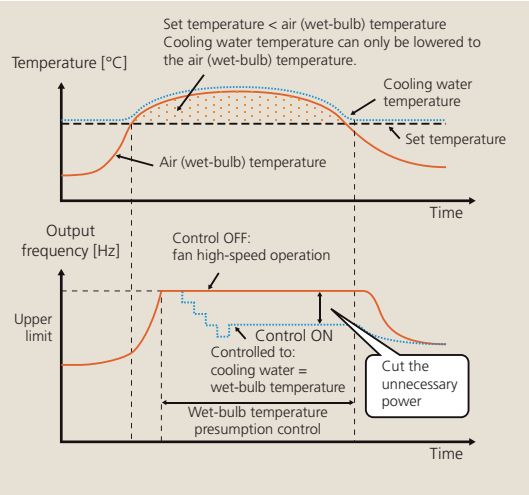
Thus, the pump consumes an ineffectual electric power for maintaining the high water conveyance pressure. Based on the calculated value and water conveyance pressure of estimated terminal pressure using the detected load flow rate, PID control is performed. It is possible to reduce the ineffectual pump power consumption and to achieve a great energy-saving effect together with maintaining comfortable current air conditioning.





Wet-bulb temperature presumption control

This function is optimal for controlling the fan of cooling tower. Since the wet-bulb temperature would become higher than the set temperature when the air temperature is particularly high, water temperature will not reach the set temperature. Therefore, the fan keeps rotating at high speed, failing in energy-saving operation. FRENIC-HVAC automatically estimates the wet-bulb temperature and controls the fan so that the cooling water is interlocked with the air temperature in order not to use unnecessary electric power.

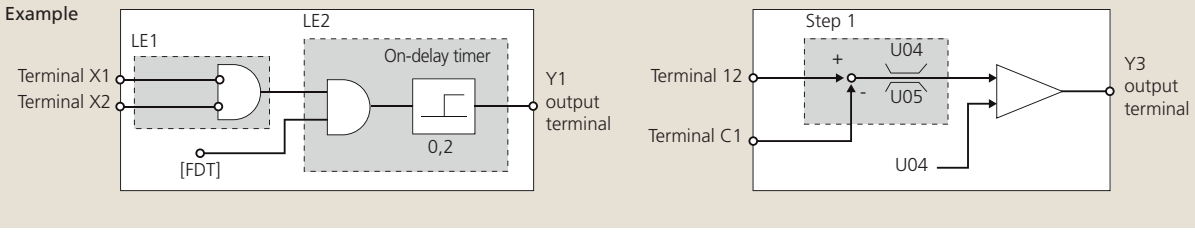


Filter clogging prevention function

This function detects clogging of the fan filter with dust or other materials using the output current and pressure sensor value.
When clogging is detected, the fan is rotated in reverse to eject dust, and then resumes rotation in forward to blow air.
In addition, the function notifies you of maintenance necessity with the alarm signal.

Customized logic

The customized logic interface function is provided to the inverter body. This enables forming of logic circuit and arithmetic circuit to the digital and analog input and output signals, allowing simple relay sequence to be built while processing the signals freely. 14 steps can be used.



Standard 4PID control

The 4PID control is featured as standard. One PID module is used to control the output frequency of the inverter, and the other three PIDs can be used to control the external system. To utilize all of four PIDs, the optional card (OPC-AIO) needs to be mounted.

Fire mode (forced operation)

This mode ignores (retry) the inverter protection function to continue the operation. In that way, the inverter keeps operating the fan and pump as much as possible in case of emergency such as fire.

Password

Function codes can be read/write, displayed or hidden by setting the two passwords. This prevents erroneous operation or overwriting of function codes. In addition, if a wrong password was input exceeding the specified number of times, the inverter is restricted from operating as the user is regarded as improper.

Pick-up operation function

The pick-up operation function enables smooth starts. If you wish to run a fan currently not run by the inverter and in idle mode, this function searches the speed regardless of the direction of rotation and pick up the motion smoothly. This function allows for smooth operation such as when switching the power supply from the commercial power to inverter in a momentary action.

Standard specifications

3-phase, 400 V series (0.75 to 710 kW)

Item			Specifications													
Model	FRN□□□AR1□-4E: HVAC		0.75	1.5	2.2	4.0	5.5	7.5	11	15	18.5	22	30	37	45	55
Applicable standard motor (rated output) [kW]*1			0.75	1.5	2.2	4.0	5.5	7.5	11	15	18.5	22	30	37	45	55
Output ratings	Rated capacity [kVA]*2		1.9	3.1	4.1	6.8	10	14	18	24	29	34	45	57	69	85
	Voltage [V]*2		3-phase, 380 to 480 V (with AVR function)													
	Rated current [A]		2.5	4.1	5.5	9.0	13.5	18.5	24.5	32	39	45	60	75	91	112
	Overload current rating		110%-1min (Overload tolerated interval: compliant with IEC 61800-2)													
	Rated frequency [Hz]		50, 60 Hz													
Input power supply	Main power supply (no. of phase, voltage, frequency)		3-phase, 380 to 440 V, 50 Hz / 3-phase 390 to 480 V, 60 Hz													
	Control power supply auxiliary-input (no. of phase, voltage, frequency)		Single phase, 380 to 480 V, 50/60 Hz													
	Voltage, frequency variations		Voltage: +10 to -15% (Unbalance rate between phases is within 2%)*4 Frequency : +5 to -5%													
	Rated input current [A]		1.6	3.0	4.3	7.4	10.3	13.9	20.7	27.9	34.5	41.1	55.7	69.4	83.1	102
	Required power supply capacity [kVA]		1.2	2.1	3.0	5.2	7.2	9.7	15	20	24	29	39	49	58	71
Braking	Braking torque [%]*5		20										10 to 15			
	DC braking		Braking starting frequency: 0.0 to 60.0Hz, Braking time: 0.0 to 30.0s, Braking level: 0 to 60%													
EMC filter (IEC/EN61800-3:2004)			Compliant with EMC standard: Emission: 1st Env. (Category C2) / Immunity: 1st and 2nd Env.													
DC Reactor			Built-in (IEC/EN61000-3-2, IEC/EN61000-3-12)													
Compliant with Electrical Safety Standards			UL508C, C22.2No.14, IEC/EN61800-5-1:2007													
"#" Enclosure (IEC/EN60529)			IP21/IP55													
Cooling method			Fan cooling													
Weight/Mass [kg]		IP21/IP55	10	10	10	10	10	10	18	18	18	18	23	23	50	50

Item			Specifications													
Model	FRN□□□AR1□-4E: HVAC		75	90	110	132	160	200	220	280	315	355	400	500	630	710
Applicable standard motor (rated output) [kW]*1			75	90	110	132	160	200	220	280	315	355	400	500	630	710
Output ratings	Rated capacity [kVA]*2		114	134	160	192	231	287	316	396	445	495	563	731	891	1044
	Voltage [V]*2		3-phase, 380 to 480V (with AVR function)													
	Rated current [A]		150	176	210	253	304	377	415	520	585	650	740	960	1170	1370
	Overload current rating		110%-1min (Overload tolerated interval: compliant with IEC 61800-2)													
	Rated frequency [Hz]		50, 60 Hz													
Input power supply	Main power supply (no. of phase, voltage, frequency)		3-phase, 380 to 440 V, 50 Hz / 3-phase 390 to 480 V, 60 Hz													
	Control power supply auxiliary-input (no. of phase, voltage, frequency)		Single phase, 380 to 480V, 50/60 Hz													
	Voltage, frequency variations		Voltage: +10 to -15% (Unbalance rate between phases is within 2%)*4 Frequency : +5 to -5%													
	Rated input current [A]		136	162	201	238	286	357	390	500	559	628	705	881	1115	1256
	Required power supply capacity [kVA]		95	113	140	165	199	248	271	347	388	436	489	611	773	871
Braking	Braking torque [%]*5		10 to 15													
	DC braking		Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0s, Braking level: 0 to 60%													
EMC filter (IEC/EN61800-3:2004)			same as 0.75 to 55 kW	Compliant with EMC standard: Emission: 2nd Env. (Category C3) / Immunity: 1st and 2nd Env.												
DC Reactor			IEC/EN61000-3-2, IEC/EN61000-3-12													
Compliant with Electrical Safety Standards			UL508C, C22.2No.14, IEC/EN61800-5-1:2007													
"#" Enclosure (IEC/EN60529)			IP21/IP55	IP00												
Cooling method			Fan cooling													
Weight/Mass [kg]		IP21/IP55	70	70												
		IP00			62	64	94	98	129	140	245	245	245	330	530	530

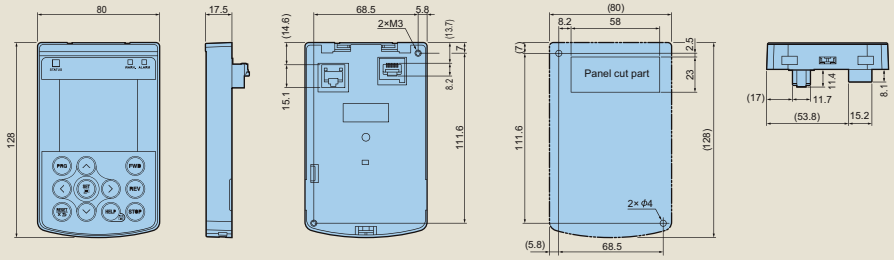
*1) Applicable standard motors are the case of Fuji Electric's 4-pole standard motors.
*2) The rated capacity indicates the case of 440V ratings.
*3) Output voltage cannnot exceed the power supply voltage.
*4) Interphase voltage unbalance ratio [%] = (max. voltage [V] - min. voltage [V])/3-phase average voltage [V]× 67 (See IEC61800-3.) When unbalance ratio is between 2 and 3% please use optional AC reactor (ACR).
*5) Average braking torque obtained by use of a motor (Varies with the efficiency of the motor).

Dimensions

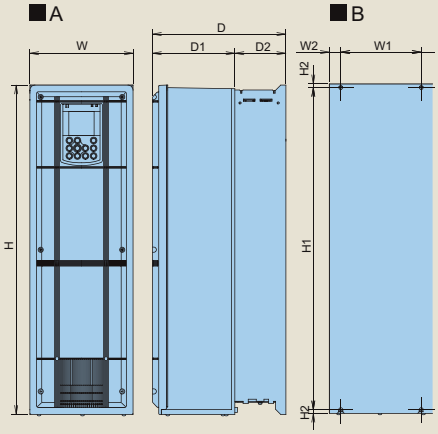
Power supply voltage	Applicable standard motor (kW)	Inverter model	Outside dimensions (mm)						Mounting dimensions (mm)				
			View	W	H	D	D1	D2	View	W1	W2	H1	H2
3-phase 400 V	0.75	FRN0.75AR1□-4E	A	150	465	262	162	100	B	115	17	451	7
	1.5	FRN1.5AR1□-4E											
	2.2	FRN2.2AR1□-4E											
	3.7	FRN3.7AR1□-4E											
	5.5	FRN5.5AR1□-4E											
	7.5	FRN7.5AR1□-4E											
	11	FRN11AR1□-4E		203	585					158	22	571	
	15	FRN15AR1□-4E											
	18.5	FRN18.5AR1□-4E											
	22	FRN22AR1□-4E											
	30	FRN30AR1□-4E		203	645							631	
	37	FRN37AR1□-4E											
	45	FRN45AR1□-4E		265	736	284	184			180	42	716	12
	55	FRN55AR1□-4E											
	75	FRN75AR1□-4E		300	885	368	241	127		215		855	15
	90	FRN90AR1□-4E											
	110	FRN110AR1S-4E	C	530	740	315	135	180	D	430	50	710	
	132	FRN132AR1S-4E											
	160	FRN160AR1S-4E			1000	360	180					970	
	200	FRN200AR1S-4E											
	220	FRN220AR1S-4E		680						580			
	280	FRN280AR1S-4E											
	315	FRN315AR1S-4E			1400	440	260					1370	
	355	FRN355AR1S-4E											
	400	FRN400AR1S-4E											
	500	FRN500AR1S-4E		880						780			
	630	FRN630AR1S-4E		1000	1550	500	313	186		900		1520	
	710	FRN710AR1S-4E											

□ Protective structure: M : IP21, L : IP55, S: IP00. Type of frame: up to 37 kW plastic enclosure and 45 kW and above metal enclosure.

■ Keypad

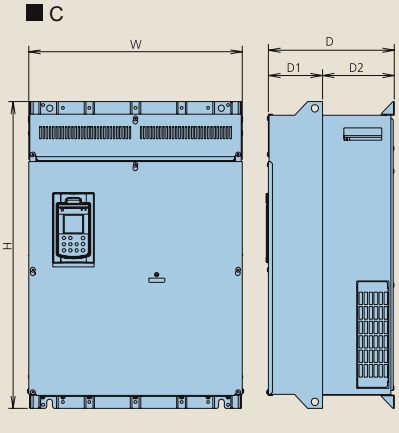


■ A



■ B

■ C



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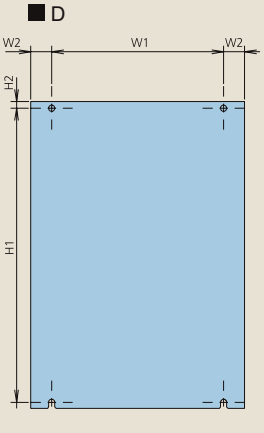
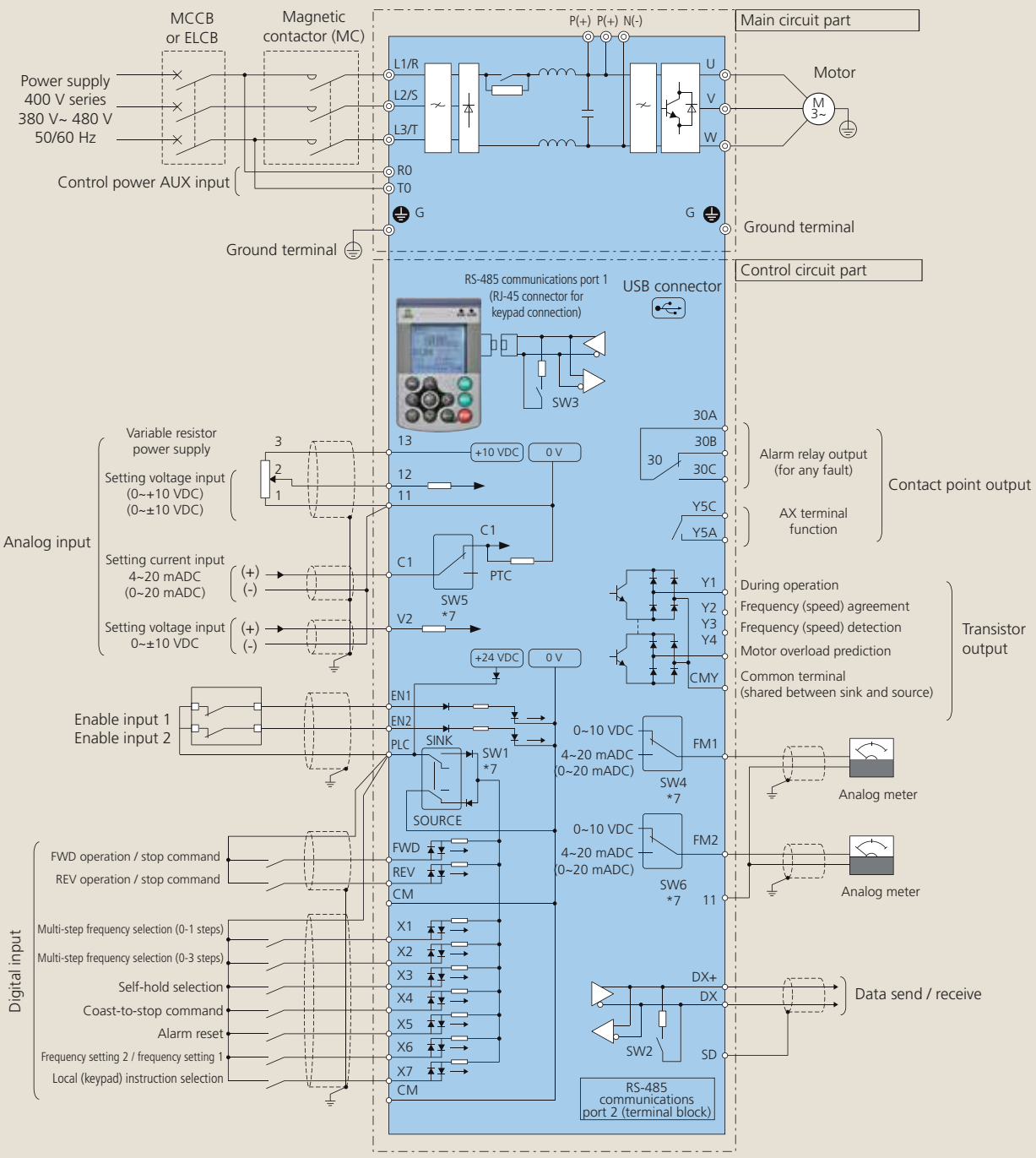


Wiring diagram

Basic configuration diagram

Factory shipped condition: with SOURCE mode input and enable input function



Options

Relay output interface card (OPC-RY)

This is an optional card that converts the transistor output at terminals Y1 to Y4 on the inverter body to relay output (1c). Each card has two relay outputs, and four relay outputs are available by installing two cards.
Note: When the card is mounted, the terminals Y1 to Y4 are on the inverter body.

Relay output:	2 circuits built-in
Signal type:	1c
Contact point capacity:	AC 250 V; 0,3 A cos φ = 0.3
	DC 48 V; 0,5 A (resistance load)

Relay output interface card (OPC-RY2)

This optional card allows relay outputs (1a) to be added.

Relay output:	7 circuits built-in
Signal type:	1a
Contact point capacity:	AC 250 V; 0,3 A cos φ = 0.3
	DC 48 V; 0,5 A (resistance load)

Analog input interface card (OPC-AIO)

This card allows analog input and output to be used.

Analog input:	1 analog voltage input point (0 ~ ±10 V)
	1 analog current input point (4 ~ 20 mA)
Analog output:	1 analog voltage output point (0 ~ ±10 V)
	1 analog current output point (4 ~ 20 mA)

Analog current output interface card (OPC-AO)

This card allows two analog current output (4 to 20mA) points to be used. The card cannot be used together with OPC-AIO.

CC-Link communications card (OPC-CCL)

By connecting this card with the CC-Link master unit, the communications rate up to 10 Mbps can be supported and the transmission distance is covered up to 1200 m in total.

No. of connection units:	42 units
Communication method:	CC-Link Ver1.10 and Ver2.0
Communications rate:	156 kbps~

DeviceNet communications card (OPC-DEV)

This card enables operation instruction and frequency command to be set from the DeviceNet master, allowing operation conditions to be monitored and all the function codes to be changed and checked.

No. of connection nodes:	max. 64 units (including the master unit)
MAC ID:	0-63
Insulation:	500 V DC (photocoupler insulation)
Communications rate:	500 kbps / 250 kbps / 125 kbps
Network consumed power:	max. 80 mA, 24 VDC

PROFIBUS DP communications card (OPC-PDP2)

This card enables operation instruction and frequency command to be set from the PROFIBUS DP master, allowing operation conditions to be monitored and all the function codes to be changed and checked.

Communications rate:	9,6 kbps ~12 Mbps
Transmission distance:	~1,200 m
Connection connector:	6-pole terminal block

CANopen communications card (OPC-COP)

This card enables operation instruction and frequency command to be set from the CANopen master (such as PC and PLC), allowing all the function codes to be set and checked.

No. of connection nodes:	127 units
Communication rate:	20 k, 50 k, 125 k, 250 k, 500 k, 800 k, 1 Mbps
Transmission distance:	~2,500 m

LonWorks communications card (OPC-G1-LNW)

This card allows peripheral equipment (including a master unit) that is connected via LonWorks to be connected with the inverter, enabling operation instruction and frequency command to be set from the master unit.

Ethernet communications card (OPC-ETH)

Mounting the communications card OPC-ETH on the FRENIC-HVAC enables the user to control the FRENIC-HVAC as a slave unit by configuring and monitoring run and frequency commands and accessing inverter's function codes from the Ethernet master.

Pt100 temperature sensor input card (OPC-PT)

This product is a 2-channels resistance temperature detectors input card which can be equipped to FRENIC-HVAC series. This interface card allows the resistance temperature detector (hereafter RTD) to be directly connected without converters to the inverter and convert a temperature values into a digital value. Applicable RTD are "JPt100", "Pt100", "Ni100", "Pt1000", and "Ni1000".

Battery (OPK-BP)

Used for the real time clock activated while the inverter power is off. The real time clock can be operated even when no power is supplied inverter at electric power interruption.

Extension cable for remote operation (CB-□S)

This cable is used in connection between the inverter body and the keypad.

Optional type	Length (m)
CB-5S	5
CB-3S	3
CB-1S	1

Fuji Electric

Innovating *Energy Technology*

European Headquarters
Fuji Electric Europe GmbH
Goethering 58
63067 Offenbach/Main
Germany
Tel.: +49 69 669029 0
Fax: +49 69 669029 58
info.inverter@fujielectric-europe.com
www.fujielectric-europe.com

Spain
Fuji Electric Europe GmbH
Sucursal en España
C/ dels Paletes 8, Edifici B, Primera
Planta B, Parc Tecnològic del Vallès
08290 Cerdanyola (Barcelona)
Tel.: +34 93 5824333
Fax: +34 93 5824344
info.spain@fujielectric-europe.com
www.fujielectric-europe.com

Italy
Fuji Electric Europe GmbH
Filiale Italiana
Via Rizzotto 46
41126 Modena (MO)
Tel.: +39 059 4734266
Fax: +39 059 4734294
info.italy@fujielectric-europe.com
www.fujielectric-europe.com

United Kingdom
Fuji Electric Europe GmbH
UK Branch
Bedford i-Lab
Stannard Way, Priory Business Park
Bedford MK44 3RZ
Tel.: +44 1234 834 768
info.uk@fujielectric-europe.com
www.fujielectric-europe.com

Global Headquarters Japan
Fuji Electric Co., Ltd.
Gate City Ohsaki East Tower
11-2 Osaki 1-chome, Shinagawa-ku,
Tokio 141-0032 Japan
Tel.: +81 3 5435 7058
www.fujielectric.com

Switzerland
Fuji Electric Europe GmbH
Swiss Branch
Rietlistrasse 5
9403 Goldach
Tel.: +41 71 85829 49
Fax: +41 71 85829 40
info.swiss@fujielectric-europe.com
www.fujielectric-europe.com

France
Fuji Electric Europe GmbH
265 Rue Denis Papin
38090 Villefontaine
Tel.: +33 4 74 90 91 24
Fax: +33 4 74 90 91 75
info.france@fujielectric-europe.com
www.fujielectric-europe.com