e-Front runners

Fuji Medium-voltage IGBT Inverters

FRENIC4600FM5e

AC Adjustable Speed Drive

Fuji Electric Systems Co., Ltd.

REC 92-50

Environment-friendly inverters.

Fuji medium-voltage IGBT inverter FRENIC4600FM5e is used for direct variable-speed control of medium-voltage motors, and greatly raises the efficiency and power factor, stabilizes motor operation and conserves energy.

Compact design for space saving

- The industry's smallest-class inverter achieved by significant panel size reduction

Ideal inverter for power sources and motors

- The multi-phase diode rectifier system reduces harmonics on the power source side.
- Due to the use of Fuji Electric's unique multi-level PWM control system, the switching surge is reduced and existing motors (standard ones) can be operated.

High-efficiency and high-power factor

- The use of a multi-phase diode, full-wave rectifier provides a high-power factor (95% or more) on the power source.
- The elimination of output transformers for operation has improved total efficiency (approx. 97%).
- Fuji Electric's original multi-level PWM control has reduced the IGBT switching loss.

10kV 1,200kVA

High-reliability

- Higher equipment reliability is achieved by reducing the number of inverter cells by using a single-phase, 3-level inverter, etc..
- Stable operation is maintained despite load fluctuations, by the simple sensor-less vector control function.
- The control device has a 32-bit MPU for quick response and high-accuracy.

Contributes to energy saving

- A substantial energy saving is achieved by variable-speed control of a square-law reduced torque load such as a fan or pump.

Vector control (option)

- Vector control with a speed sensor is available (as an option) for equipment having high speed and torque accuracy requirements.

Easy maintenance

- The inverter is air-cooled, requiring no cooling water.
- Start/stop operation, parameter setting, fault display and data monitoring are performed from the touch panel with simple loader functions.
- Simple, built-in auto-tuning functions facilitate testing and adjustment.
- Fault diagnoses are easily performed.
- A dry-type input transformer is adopted.

Simple circuit configuration

High-reliability and simple-maintenance inverters utilizing the latest power electronics such as 3-level inverter, mounting of special MPU and no need for harmonic filter/power-factor regulating capacitor.

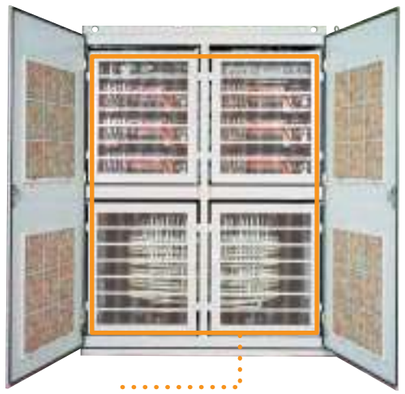
Cooling fan

- Air-cooled inverters make maintenance easy.

Input multiplex-winding transformer

- Harmonic current on the power source side is low due to a multiplex configuration of the secondary winding.
- An equivalence of 36-phase rectification is effected, so harmonic current satisfies the standard level of IEEE.
- Harmonic filters and power factor improving capacitors are not needed.
- Because a dry-type input transformer is used in the panel, external cabling work between the input transformer and inverter panel is no longer necessary.

10kV 1,200kVA



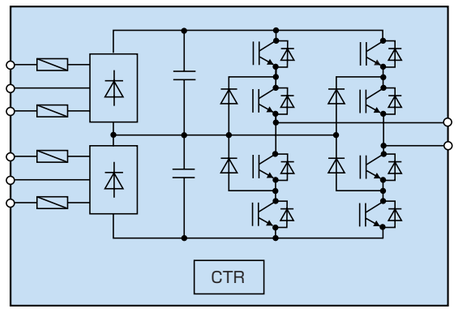
When requested, protection covers can be provided inside the inverter panel (as an option). Protection covers will protect from unexpected contact with live metal parts of the main circuit.

Master control PC board

- Mounting of a 32-bit MPU, and a special MPU in the voltage and current detection system offers a quick response and high accuracy.
- Incorporation of a simple sensor-less vector control function enables inverters to maintain stable operation irrespective of load fluctuation even without a speed sensor.

Inverter cell

- The number of inverter cells has been substantially reduced by adopting a single-phase, 3-level inverter design.
- Each inverter cell alone can be replaced easily, because the controller, diodes, IGBT elements and DC intermediate capacitor are combined into an integral body.

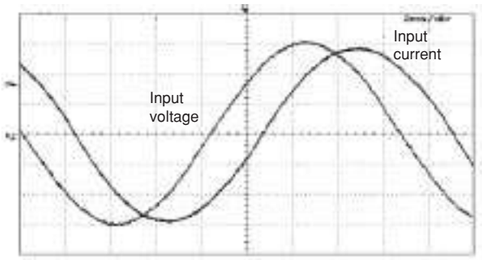


Clean power input

Substantial reduction of harmonic current on power source side

Due to progress in power electronics, semiconductors have recently been used for industrial electrical equipment and household electrical appliances in order to enhance convenience and ease of operation. However, due to harmonic currents generated from such equipment and appliances, the voltage of the power system is often distorted and many troubles occur in equipment connected to the power system. However, because the use of equipment containing power electronics will increase, measures for suppressing harmonics need to be improved.
FRENIC4600FM5e suppresses the harmonics by using a multi-phase diode rectification system (equivalent to 36-phase rectification), thereby substantially reducing the generation of harmonics in comparison with previous models.
The harmonic generation level stipulated in IEEE-519 (1992) is satisfied.
This inverter is ideal for power sources.

■Current waveform on power source side



■Harmonic current content

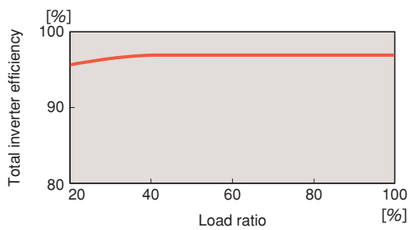
Order	5th	7th	11th	13th	17th	19th	23rd	25th	35th	37th
IEEE value [%]	4.00	2.86	1.83	1.49	1.14	1.02	0.87	0.80	0.80	0.80
Measured value (*) [%]	0.58	1.0	0.20	0.32	0.75	0.54	0.06	0.24	0.58	0.27

(*): Example value from our full load test

Total inverter efficiency as high as approximate 97%

- Because an output transformer is unnecessary, inherent losses are eliminated.
- Multi-level PWM control minimizes switching loss.
- Because the harmonic current on the power source side is reduced, the primary winding of the input transformer has a reduced loss due to the harmonics.

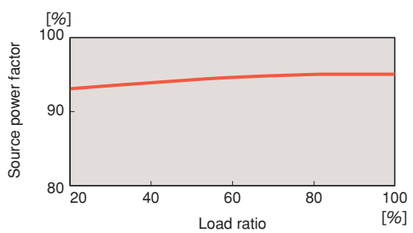
■Total inverter efficiency curve (including input transformer)



Source power factor as high as 95% or more

- Due to full-wave rectification with multi-phase diodes, operation is allowed with the source power factor (power factor on power source side) set at a high level.
- A phase advancing capacitor and a DC reactor for improving the source power factor are unnecessary.
- A smaller power capacity suffices for inverter operation.

■Source power factor curve



Note: The efficiency and power factor data on this page are calculated by assuming that a 315kW motor is operated at the rated speed with a 3.3kV-input, 390kVA-output inverter. The data on efficiency is obtained using Fuji Electric's standard 4-pole motor.

Friendly to machines

If a harmonic current component is contained in the inverter output current, a torque ripple occurs on the output shaft of a motor. A torque ripple means a change in rotational speed or a large vibration if the frequency of the torque ripple matches the natural frequency of the mechanical system and torque ripple is large.

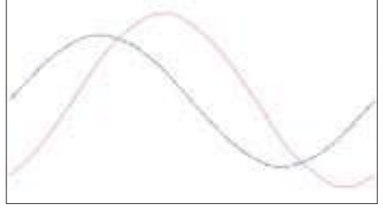
In FRENIC4600FM5e, the harmonic component on the output side is extremely small due to the multi-level (max. 21 levels) PWM control and the main component of torque ripple is at around the carrier frequency (several kHz). Therefore, torque ripple hardly affects the machine side.

Friendly to motors

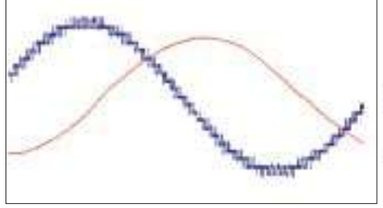
- The multi-level PWM control provides an almost sinusoidal output current waveform, thus reducing motor torque ripple.
- Because the output current is almost sinusoidal, a motor suffers less loss due to harmonics.
- The multi-level (max. 21 levels) PWM control minimizes switching surge and thereby reduces stress on the motor.
- There is no need to reduce motor capacity due to inverter drive.
- There is no need for special cables, etc. due to inverter drive.
- This inverter is applicable not only to a square-law reduced torque load, but also to a constant torque load such as an extruder.
- For driving a large-capacity motor in a system that has a small power capacity, voltage fluctuation, etc. due to the starting current of a motor will cause problems. However, because the starting current can be suppressed by the soft start of this inverter, operation can be performed.

: output voltage waveform : output current waveform

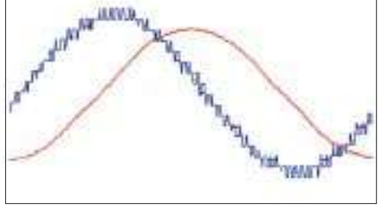
Output voltage and current waveforms at 10kV output



Output voltage and current waveforms at 6.6kV output



Output voltage and current waveforms at 3.3kV output

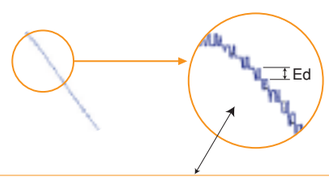


Note

Surge voltage and multi-level output

The output voltage waveform of a PWM inverter is a DC chopping voltage (called "pulse voltage = surge voltage") whose amplitude is determined by voltage Ed of the DC intermediate circuit. When this surge voltage of inverter output is applied to a motor through a cable, the voltage is reflected repeatedly between the motor terminal and inverter terminal.
A sharp overvoltage higher than the inverter output voltage is thus generated at the motor terminal, which may cause dielectric breakdown of the winding.
The maximum level of the overvoltage rises close to twice the DC intermediate circuit voltage Ed of the inverter. Fuji Electric's medium-voltage inverter suppresses the DC intermediate voltage level so as to realize an output voltage waveform at 21 levels in the 10kV class, at 13 levels in the 6kV class and 9 levels in the 3kV class. As a result, the overvoltage generated at the motor terminal can be suppressed.

Output voltage waveform (21 levels) in 10kV class



In the 10kV class Fuji Electric's medium-voltage inverter, the output voltage changes in 21 steps (corresponding to 21 levels) within 1/4 cycle. The voltage value of one step equals the DC intermediate circuit voltage Ed. Therefore, for the same voltage output, a larger number of steps means a smaller voltage value at one step. Thus, Fuji Electric's inverter can also reduce the surge voltage appearing at the motor terminal and thereby moderate the stress applied to the motor.

Main circuit configuration

Fig. 1 Main circuit configuration of 10kV type

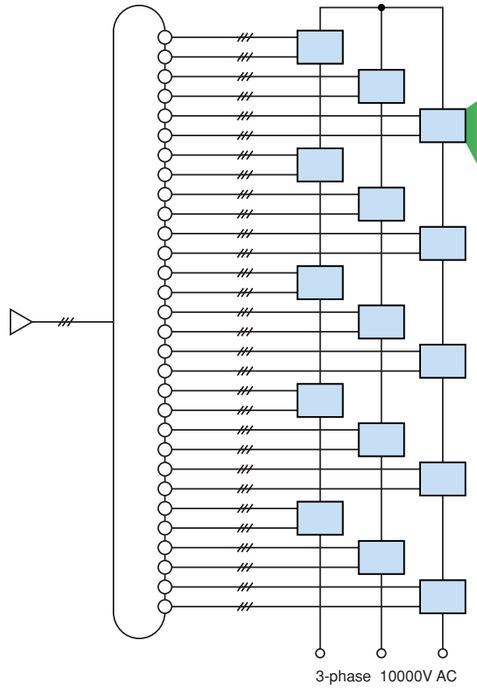
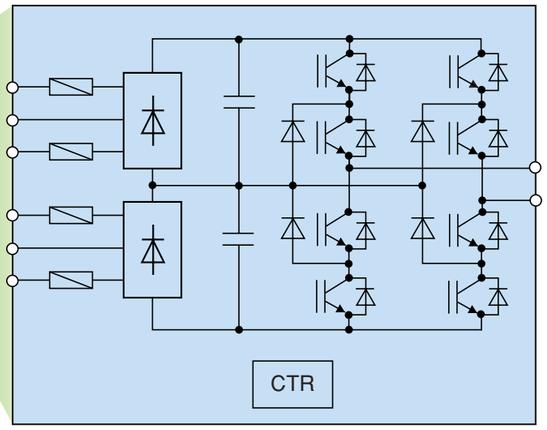


Fig. 2 Internal configuration of inverter cell



●Principle of operation

FRENIC4600FM5e consists of an input transformer and 15 inverter cells in case of the 10kV type as shown in Fig. 1 (the 6kV type has 9 inverter cells and the 3kV type has 6 inverter cells.).
One inverter cell consists of a single-phase, 3-level inverter and can receive an output voltage of 1,155V.
As shown in Fig. 1, the 10kV type obtains a phase voltage of about 5,775V by connecting 5 inverter cells vertically and a star connection of the vertical cell pairs can generate a line voltage of about 10,000V.
Use of the single-phase, 3-level inverter doubles the output voltage obtainable from one cell when compared with a single-phase, 2-level inverter. Therefore, an output voltage of 10kV, 6kV, 3kV can be obtained by using a smaller number of inverter cells. (See Figs. 3 and 4.)

Fig. 3 3-level voltage output

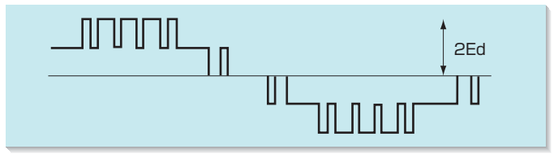
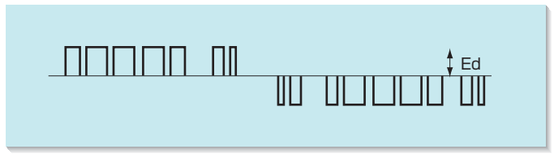


Fig. 4 2-level voltage output



Ed: DC intermediate circuit voltage

Commercial power supply bypass circuit/restarting function after momentary interruption

●Shockless switching between inverter operation and commercial power operation allowed by phase control according to system voltage. (See Fig. 5.)
(Synchronizing/parallel off function: option)
An electric reactor must be installed on the output side of the inverter to enable this function.

●Changeover to the starting circuit by commercial power supply can be made by installing a bypass circuit (option) on the inverter output side.
In this configuration, motor drive power supply is duplicated, and changeover between commercial power supply and inverter operation is allowed for running a motor at the rated speed. (See Fig. 6.)

●In the event of a voltage drop due to a momentary power interruption, the operation processing pattern can be selected according to the application.

1. Selection of major fault at voltage drop due to momentary power interruption
The inverter is stopped in the major fault status and the motor is set in the free run status.

2. Selection of restart under free run (option)
Inverter operation is stopped and the motor is set in the free run status. Upon power recovery, the motor under deceleration in free run or under stop is automatically accelerated again through a speed search function.

3. Selection of continuing operation at voltage drop due to momentary power interruption (option)
Inverter operation is continued without setting the motor in the free run status even when a voltage drop due to a momentary power interruption occurs. As soon as line voltage is recovered, the motor is accelerated again back to the operating speed.

Notes:
(1) A voltage drop due to a momentary power interruption will be detected at 85% or less of the rated voltage.
(2) Operation can be continued within 300ms at a voltage drop due to a momentary power interruption (option).

Fig. 5 Synchronization/parallel off waveform

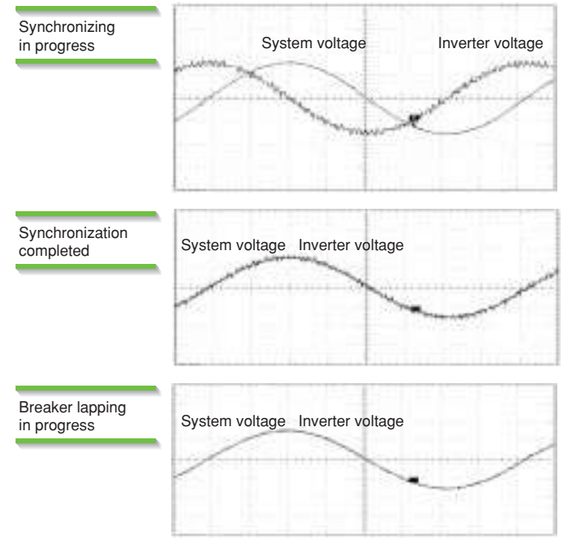
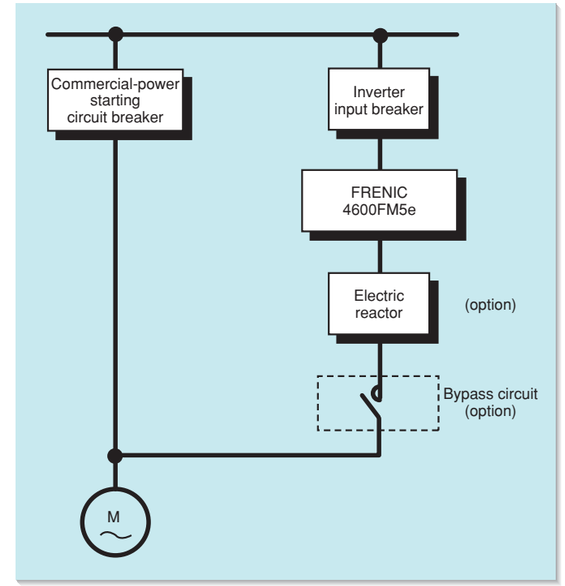


Fig. 6 Power system diagram



Simple operation and monitoring on the 5.7" LCD touch panel

Setting

The control parameters can be set, changed, and displayed.

DIO display, AIO display

Displays the I/O status and function assignment data.

Actual value

Lists the actual value of each part of the inverter (such as frequency reference, voltage reference, current reference, and current detection).

Monitor

Displays the actual value of each part of the inverter by the control block.

Transmission screen

Displays the transmission status and I/O data value.

Operation screen, Startup conditions

The frequency setting and operation conditions (approved or unapproved) can be checked.

Fault screen, Fault history

Displays the date and time of occurrence of faults (major, medium, and minor faults) along with their causes. Fault history of up to 100 occurrences can be checked.

Trip data

Displays the data of each part at the time fault occurs.

Assistance

The time setting of the internal clock and inverter data can be checked.

Auto tuning

The motor can be tuned.

Language

The language for the LCD can be selected from Chinese and Japanese.

Screen examples

Setting window | Actual value indication window | Monitoring window | Startup conditions window | Fault history window

Display description of the touch panel

No.	Description	Number of items
1	Current, voltage and frequency at present (*)	7
2	Parameter setting items	About 320
3	Di/Do status display	7
4	Controller RAM data	About 80
5	Ai/Ao status display	11
6	Sent/received data	About 20
7	Cause of fault	20
8	Present time, operation time	3

(*): Displays 7 items on the 2-image screen.

Other functions

Fault history

Displays a chronological record of 100 faults with the cause and the date and time of occurrence.

Trip data display

Displays the sampling values of internal data and bit data ON/OFF status in the event of a fault.

Save of set data, load, and comparison

The set data can be saved in the EPROM of the touch panel.
The saved data can also be loaded and compared with other saved data.

Large LCD touch panel (option)

This is a setting and monitoring tool for facilitating operation and monitoring on a 10.4-inch LCD.

Main functions of LCD touch panel

- Inverter start/stop
- Setting, change and indication of control parameters
- Bar graph display of actual value data
- Indication of fault cause (First fault/detailed indication)
- Trend display
- Test run, etc.

DDC loader for a maintenance tool (option)

Although maintenance and adjustment can be performed from the touch panel mounted on the panel face, an optional DDC loader is available as a maintenance/adjustment tool. The DDC loader using a notebook computer is easy to use because of its interactive mode.

Main functions of maintenance tool

- Setting, change, indication and saving of control parameters
- Running status display
  Block diagram display, actual value indication, internal data listing
- Indication of fault cause
  First fault, detailed indication, trace-back data
- Test run

Internal data indication window

Data setting window

Operation monitoring window

Operation monitoring window

Trend data window

Standard specifications

Voltage classes [kV]	10																				
Output: Rated capacity (*1) [kVA]	500	620	700	800	900	1040	1200	1350	1470	1700	1850	2030	2350		2600	3050	3500	3700	4000	4600	5300
Output: Rated current (*2) [A]	28	35	40	46	51	60	68	77	84	98	106	117	134		150	176	202	213	230	265	306
Output: Max. current (at overload) [A]	30	37	42	48	54	63	71	81	89	102	112	123	141		157	184	212	224	242	278	321
Applicable max. motor output (*3) [kW]	400	500	560	630	710	800	1000	1120	1250	1400	1500	1600	2000		2240	2500	2800	3000	3150	3550	4000
Input: Main circuit (3-phase)	10000V, 50Hz																				
Input: Capacity of control power supply [kVA]	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5	2.5	2.5	2.5	2.5		3.5	3.5	3.5	3.5	3.5	3.5	4.5
Input: Capacity of fan power supply [kVA]	3.0	3.0	3.0	3.0	3.0	3.0	3.0	4.5	4.5	4.5	4.5	4.5	4.5		7.5	7.5	7.5	10.5	10.5	10.5	12.0

Voltage classes [kV]	6																			
Output: Rated capacity (*1) [kVA]	420	500	600	700	860	1000	1200	1400	1600	1800	2100		2360	2700	3200	4000	4700	5500	6400	9500
Output: Rated current (*2) [A]	41	50	59	68	84	98	115	134	153	173	202		227	262	306	385	459	529	612	918
Output: Max. current (at overload) [A]	43	52	61	72	88	103	121	141	160	181	212		238	275	321	462	482	555	643	964
Applicable max. motor output (*3) [kW]	340	410	490	570	700	800	960	1120	1280	1450	1680		1900	2200	2560	3200	3860	4000	5140	7700
Input: Main circuit (3-phase)	6000/6600V, 50Hz																			
Input: Capacity of control power supply [kVA]	1.5	1.5	1.5	1.5	2.5	2.5	2.5	2.5	3.5	3.5	3.5		4.5	4.5	5.5	7.5	7.5	9.5	9.5	14.5
Input: Capacity of fan power supply [kVA]	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	6.0	6.0	6.0		6.0	6.0	9.0	12.0	12.0	15.0	15.0	27.0

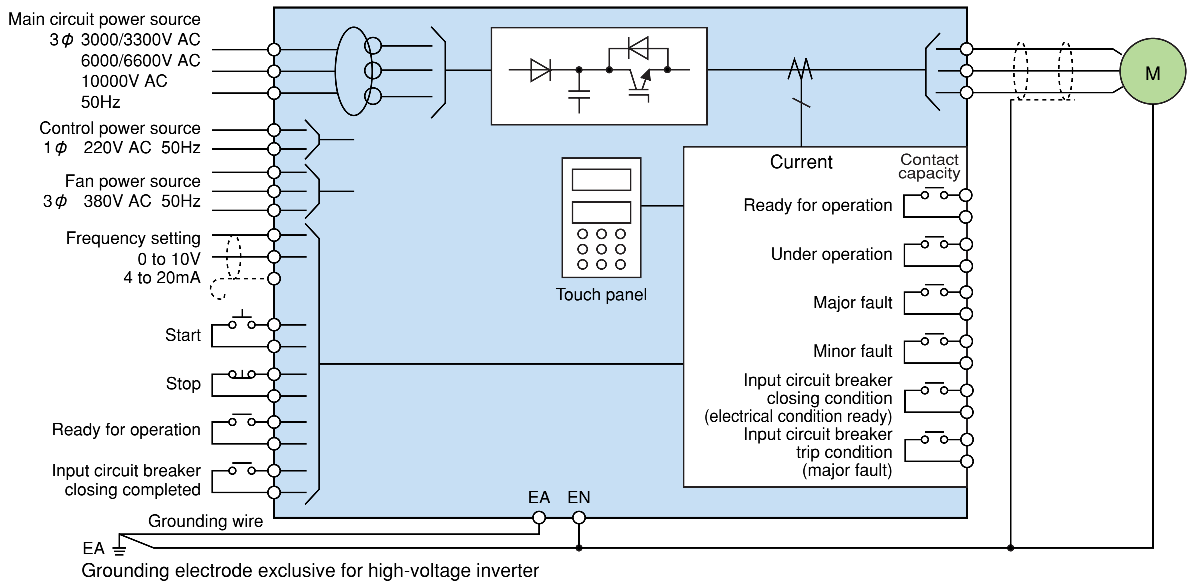
Voltage classes [kV]	3								
Output: Rated capacity (*1) [kVA]	350	500	700	1050	1350	1600	2350	3200	4750
Output: Rated current (*2) [A]	68	98	134	202	262	306	459	612	918
Output: Max. current (at overload) [A]	72	103	141	212	275	321	482	643	964
Applicable max. motor output (*3) [kW]	285	400	560	840	1100	1280	1930	2570	3850
Input: Main circuit (3-phase)	3000/3300V, 50Hz								
Input: Capacity of control power supply [kVA]	Contact us for details.								
Input: Capacity of fan power supply [kVA]									

Fuji product name		FRENIC4600FM5e
Input	Power supply	Control power supply: single phase, 220V, 50Hz, Fan power supply: 3-phase, 380V, 50Hz
Input	Cell control power source	Supplied from AC main circuit (from secondary side of input transformer)
Input	Allowable power variation	Voltage: ±10%, Frequency: ±5%
Control	Control system	V/f constant with simple sensor-less vector control
Control	Output frequency	Range: 0.2 to 50/60Hz (up to 120Hz as an option), Accuracy: ±0.5% at max. frequency (at analog frequency standard input), Resolution: 0.005%
Control	Accel./decel. time	0.1 to 5500s
Control	Overload capability	105% 60s (*2), 120% for 60s under condition of cold start if cooling fin temperature is less than 40℃.
Control	Main control function	Current limit, stall prevention, jump frequency setting, automatic deceleration, momentary drop protection and stop/restart (option)
Control	Protection function	Overcurrent, main circuit fuse blown, overvoltage, undervoltage, CPU fault, cooling fan stop
Control	Transmission function (option)	T-link, PROFIBUS-DP, Modbus
Structure	Panel	Steel panel, self-standing, enclosed, Degree of protection: IP31 (Others: option), Cooling method: forced ventilation with ceiling fan
Structure	Finish color	RAL 7032 (inside and outside)
Ambient conditions	Temperature	Ambient temp.: 0 to +40℃, Storage temp.: −10 to +60℃, Transport temp.: −10 to +70℃ (+60 to +70℃: within 24h)
Ambient conditions	Humidity	85% RH max. (no condensation)
Ambient conditions	Installation place	Indoor, Site altitude: up to 1000m above sea level, Acceleration vibration: 4.9m/s² acceptable (10 to 50Hz), Atmosphere: general environment free from corrosive gas, dust and flammable/explosive gas
Applicable standard		IEC, JIS, JEM, JEC

(*1): The rated output capacity is the value when the input and output voltage are 3 and 6kV, respectively. At 3.3 and 6.6kV, the output capacity must be multiplied by 1.1.
(*2): The output current is limited when the output frequency is 25Hz or less. (The output current is 70% when the output frequency is 0.2Hz.)
(*3): The applicable motor output is the reference value of Fuji Electric's standard 3kV, 6kV and 10kV, 4-pole motors.

Notes: 1) Vector control with a speed sensor is available for equipment having high speed and torque accuracy requirements (option).
2) Regenerative braking is not provided.
3) The inverter unit requires a dedicated input breaker.

Standard connection diagram



Note: Be sure to use an EA grounding electrode exclusive for the high-voltage inverter, and isolate it from the main grounding lines of other devices.

Standard interface

Input side		
Main circuit power supply	3-phase 3000/3300/6000/6600/10000V, 50Hz	
Control power supply	Single phase 220V, 50Hz	
Fan power supply	3-phase 380V, 50Hz	
Frequency setting	0 to 10V/0 to 100%	Input impedance 1MΩ
	or 4 to 20mA/0 to 100%	Input impedance 250Ω
Run command	Opening for run ("a" contact)	Dry contact
Stop command	Opening for stop ("b" contact)	
Ready for operation	Closure when ready ("a" contact)	
Input circuit breaker status signal	Closure when closed ("a" contact)	
Output side		
Electrical condition ready	Closure when ready ("a" contact)	Dry contact (contact capacity: 250V AC, 2A or 30V DC, 3A)
Under operation	Closure under operation ("a" contact)	
Major fault	Closure at major fault ("a" contact)	
Minor fault	Closure at minor fault ("a" contact)	
Input circuit breaker closing condition	Closure when electrical condition ready ("a" contact)	
Input circuit breaker trip signal	Closure in major fault ("a" contact)	
Analog signal (option) (*)	0 to 10V	Load resistance 10kΩ or more
	4 to 20mA	Load resistance 750Ω or less

(*): The analog output signal is selectable (output current, output voltage, output frequency, and others).


10kV 1,200kVA

Outline dimensions

Dimensions

10kV

Capacity [kVA]	Outline drawing	Dimension [mm] A (Full width)	B (Transformer panel)	C (Converter panel)	D (Control output panel)	E (Fan)	F (Depth)	G (Maintenance space)	Approx. mass [kg]
500, 620, 700, 800	Fig. 1	4600	2200	1800	600	535	1400	1500	5700
900, 1040, 1200		4600	2200	1800	600	535	1400	1500	6500
1350, 1470, 1700		5500	2500	2400	600	535	1500	1500	7500
1850, 2030, 2350		5500	2500	2400	600	535	1500	1500	8800
2600, 3050, 3500	Fig. 2	6400	2800	3000	600	375	1600	1700	12100
3700, 4000, 4600		7500	3000	3900	600	600	1700	1700	13800
5300		7800	3000	4200	600	600	1800	1700	16300

Notes: (*1) The panel configurations shown above are typical examples.
They may differ depending on the capacity.
(*2) The structure is for maintenance from the front and the rear.
Be sure to allow the maintenance space listed in column G of the above table or more.
(*3) A cooling fan is installed on the panel. To facilitate maintenance and ensure cooling performance, allow designated space (Min. 500mm) between the top face of the fan and the ceiling.
(*4) The outline dimensions of the panel may be changed without notice. Contact us for details.

10kV series

Fig. 1 10kV: 500, 620, 700, 800, 900, 1040,1200, 1350, 1470, 1700, 1850, 2030, 2350kVA

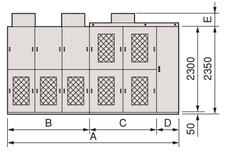
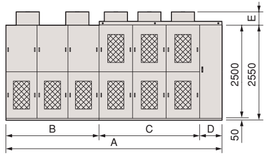
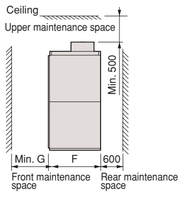


Fig. 2 10kV: 2600, 3050, 3500, 3700, 4000, 4600, 5300kVA



Side view



6kV

Capacity [kVA]	Outline drawing	Dimension [mm] A (Full width)	B (Transformer panel)	C (Converter panel)	D (Control output panel)	E (Fan)	F (Depth)	G (Maintenance space)	Approx. mass [kg]
420	Fig. 3	3600	1900	1000	600	535	1400	1500	4600
500		3600	1900	1000	600	535	1400	1500	4800
600		3600	1900	1000	600	535	1400	1500	5100
700		3600	1900	1000	600	535	1400	1500	5400
860		4000	2000	1400	600	535	1500	1500	6200
1000		4000	2000	1400	600	535	1500	1500	6700
1200		4000	2000	1400	600	535	1500	1500	7200
1400		4000	2000	1400	600	535	1500	1500	7600
1600	Fig. 4	4600	2300	1700	600	375	1600	1700	8700
1800		4600	2300	1700	600	375	1600	1700	9100
2100		4600	2300	1700	600	375	1600	1700	9600
2360		5200	2400	2200	600	600	1700	1700	10400
2700		5200	2400	2200	600	600	1700	1700	11000
3200		5400	2400	2400	600	600	1800	1700	12000
4000	Fig. 5	8400	2300	1400	1000	570	1500	1500	16900
4700		8400	2300	1400	1000	570	1500	1500	17900
5500	Fig. 6	12900	2400	3600	900	570	1400	1500	23500
6400		12900	2400	3600	900	570	1400	1500	24500
9500	Fig. 7	20800	5000	4800	1000	375	1900	1800	51000

Notes: (*1) The panel configurations shown above are typical examples.
They may differ depending on the capacity.
(*2) The structure is for maintenance from the front and the rear.
Be sure to allow the maintenance space listed in column G of the above table or more.
(*3) A cooling fan is installed on the panel. To facilitate maintenance and ensure cooling performance, allow designated space (Min. 500) between the top face of the fan and the ceiling.
(*4) A wiring duct is installed on the panel in Fig. 7 (height: 600mm).
(*5) The outline dimensions of the panel may be changed without notice. Contact us for details.

6kV series

Fig. 3 6kV: 420, 500, 600, 700, 860, 1000 1200, 1400kVA

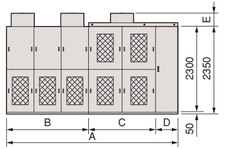
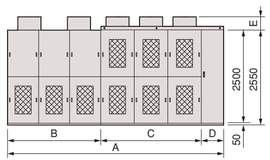


Fig. 4 6kV: 1600, 1800, 2100, 2360, 2700, 3200kVA



Side view

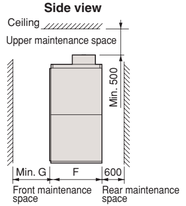
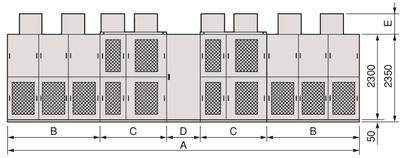


Fig. 5 6kV: 4000, 4700kVA



Side view

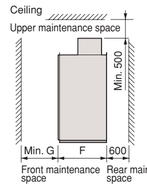
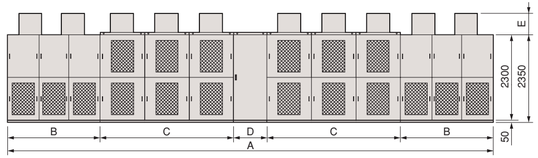


Fig. 6 6kV: 5500, 6400kVA



Side view

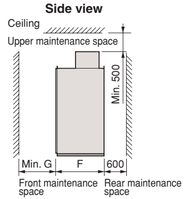
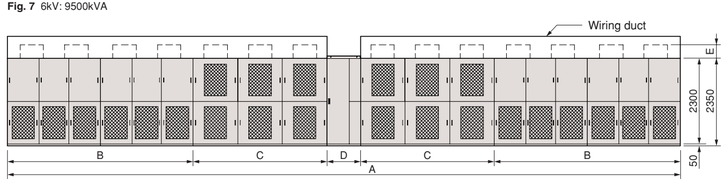
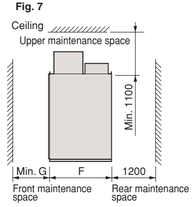


Fig. 7 6kV: 9500kVA



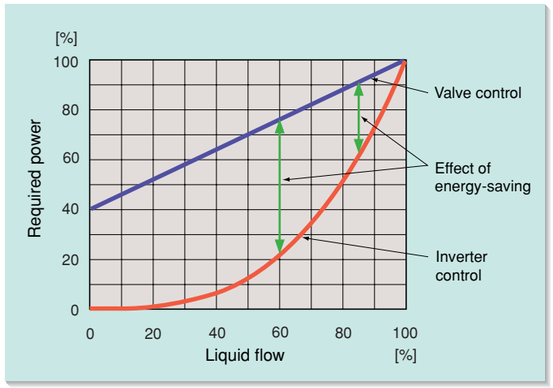
Side view
Fig. 7



FRENIC4600FM5e inverter operation promises substantial energy-saving and carbon dioxide reduction.

In air-conditioning or pumping facilities, fans or pumps typically run at a constant speed even when the load is light. Adjustable speed control according to the load (air or liquid flow) through inverter operation greatly reduces energy consumption and maintains the maximum possible motor efficiency even at low-speed operation.

Liquid flow and power characteristics



Example of application and energy-saving effect

The following example compares constant speed motor operation with valve (or damper) control, against inverter adjustable speed control operation, and shows the electric power saved.

● Example conditions for calculation

Motor output:
1,000kW, for annual operation time 4,000 hours
Operation pattern:
85% flow for 1/2 of overall time (2,000 hours)
60% flow for the remaining half (2,000 hours)

● Constant speed operation of motor (with valve control)

At 85% load of liquid flow (Q)
Required Power (P) = 91%×1,000kW = 910kW
At 60% load of liquid flow (Q)
Required Power (P) = 76%×1,000kW = 760kW
Annual power consumption
910kW×2,000h+760kW×2,000h = 3,340,000kWh

● Inverter operation (adjustable speed control operation with inverter)

At 85% load of liquid flow (Q)
Required Power (P) = 61%×1,000kW = 610kW
At 60% load of liquid flow (Q)
Required Power (P) = 22%×1,000kW = 220kW
Annual power consumption
610kW×2,000h+220kW×2,000h=1,660,000kWh

● Annual energy-saving

3,340,000−1,660,000 = 1,680,000kWh
(energy-saving = about 50%)
Carbon dioxide reduction = 635,040kg

Options

Field Web adapter (plusFSITE)

plusFSITE

This adapter enables users to carry out remote monitoring of inverters promptly and easily with their own personal computers without using a dedicated system.

Main features

● Web server function
Inverters can be monitored from the browser of a personal computer. (Display screen can be changed if requested.)


Setting data list window


Real-time operation status window


Real-time trend graph window

● Mail sending function
Actions can be reported periodically from inverters.

● Installation and wiring both easy
- A small and lightweight structure mountable on the front of the inverter panel
- Connectable with the loader connector of an inverter (RS-232C interface)
- Connectable with personal computers through LAN cable (IEEE802.3 10BASE-T)

● Equipped with a 32-bit RISC chip/real-time OS μITRON

● Protocol converting function
(Changeable from RS-232C to LAN)

● The corresponding drive unit is applicable to the FRENIC4600FM5e and other products of Fuji Electric.

LCD touch panel

The touch panel offers the following key loader functions:

● Start and stop of inverter
● Setting, change and display of control parameters
● Fault data display and fault resetting
● Data monitoring (LED display)

The contents of the above data are displayed on the LCD.

DDC loader

A loader using a notebook personal computer is available. The easy-to-use interactive type of loader offers the following functions.

● Start and stop of inverter
● Online setting, change, display and printing of control parameters
● Fault resetting
● Trace-back data
● Fault data display and printing
● Data monitoring

Analog output unit (AO unit)

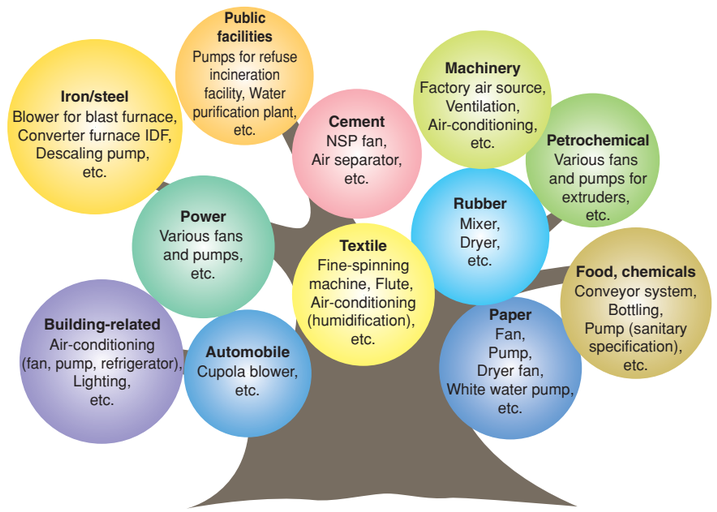
Data can be output in analog mode during operation. Output data can be freely selectable among about 100 items by operating the touch panel.

Lifter

A special lifter for drawing out inverter cells

Application	Series	Features	Output voltage [V]	Capacity range [kVA] (10 / 100 / 1000 / 10000)
For plant	FRENIC 4000VM5	Vector controlled inverter for plants • High-performance vector control system for quick response, high-accuracy and wide range speed control. • The DC-link system allows highly efficient plant operation.	400	5400
	FRENIC 4000FM5	V/f controlled inverter for plants • Frequency of fan, pump and group-driven motors can be controlled accurately. • The DC-link system allows highly efficient plant operation.	400	900
	FRENIC 4400VM5	Large-capacity vector controlled inverter • The capacity of FRENIC4000 series units has been increased due to 3-level control.	800	6000
	FRENIC 4400FM5	Large-capacity V/f controlled inverter • The capacity of FRENIC4000 series units has been increased due to 3-level control.	800	2000
	FRENIC 4700VM5	Medium-voltage large-capacity vector controlled inverter • The capacity of FRENIC4000 series units has been increased thanks to the series-connected device and 3-level control.	3440	7800
For general industry (medium-voltage)	FRENIC 4600FM5	Medium-voltage direct-output inverter • 3.3/6.6kV IGBT inverter • Variable speed operation of medium-voltage motors saves energy. • Circuit configuration and control are well designed for power supplies and motors.	3300 6600	3750 7500
	FRENIC 4600FM5e	Medium-voltage direct-output inverter (for fans and pumps) • Compact • Variable speed operation of medium-voltage motors saves energy. • Circuit configuration and control are well designed for power supplies and motors.	3000 6000 10000	4750 9500 5300
For general industry (low-voltage)	FRENIC 5000VG7S	High-performance vector controlled inverter	200 400	90kW 800kW
	FRENIC-MEGA	High-performance V/f controlled inverter	200 400	90kW 630kW
	FRENIC-ECO	V/f controlled inverter for fans and pumps	200 400	110kW 560kW

Examples of applications



Selection of inverter capacity

When selecting inverter capacity, select an inverter whose rated current value is larger than the operating current of the motor to be driven.

●Selection example 1

For driving a 6kV, 50Hz, 315kW, 4-pole motor:
Rated current value of motor: 38A
Operating current value of motor: 38A
→Select an inverter capacity of 420kVA (41A).
(38 < 41A)

●Selection example 2

For driving a 6kV, 50Hz, 630kW, 4-pole motor:
Rated current value of motor: 75A
Operating current value of motor: 56A
→Select an inverter capacity of 600kVA (59A).
(56 < 59A)

FRENIC4600FM5e (6kV 9,500kVA(*))

(*): Max. capacity of this model

Ordering Information

When placing an order or making an inquiry, please state the following.

Application of inverter						**Remarks:**
Load machine specifications						
Name: ☐Pump, ☐Fan, ☐Blower, ☐Air compressor, ☐Other ( )						
Load torque characteristics: ☐Square-law speed, ☐Constant torque, ☐Constant output						
Moment of load inertia after conversion into motor shaft (J): kg・m²						
Overload: %						
Input specifications						
Rated voltage: V± %			Rated frequency: Hz± %			
Control power source: -phase, -wires, V, Hz						
Drive motor						
Motor specifications: ☐Squirrel-cage rotor, ☐ ( ), ☐Existing, ☐New installation						
Rating	Output: kW		No. of poles:		Voltage: kV	
	Frequency: Hz		Speed: r/min		Current: A	
Speed control						
Controllable range: r/min to r/min						
Rotational frequency setting method						
☐Analog signal: 4 to 20mA, 0 to 10V, ☐Up/down signal, ☐ ( )						
Commercial power source bypass circuit						
☐with, ☐without						
Ambient conditions						
Install location: Indoor	Humidity: %RH		Temperature: ℃		Altitude: m	
Provision of air conditioning:			Limit on carrying-in:			

认证注册号	认证注册号	体系认证
ISO9001 ：00106Q116927R3M/3200	00106Q116927R3M/3200	CNAS C001-Q
ISO14001：00108E20998R1M/3200	00108E20998R1M/3200	CNAS C001-E

Our factories in China, where this instrument is manufactured, are ISO 9001 and ISO 14001 certified.

Printed on recycled paper

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