

Medium-voltage Drives

FRENIC4600FM6e



Medium Voltage Drive



*INSPIRED INGENUITY GENUINE VALUE
MEANINGFUL PARTNERSHIPS POWERFUL SOLUTIONS*

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Company Profile

Founded in 1923, Fuji Electric is an internationally renowned major general industrial electronics equipment manufacturer, and our products are widely used in various fields such as power generation, iron and steel, oil & gas, mining, chemicals, cement, water plant.

Fuji Electric has continued its tireless efforts in the development and application of advanced power electronic technology that is a fusion of such fields as power semiconductors, microelectronic circuits, and automatic control systems.

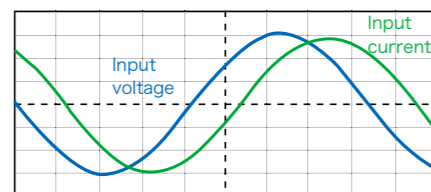
Since the 1980s we have been manufacturing and delivering to the world medium-voltage drives speed control devices for various types of load equipment drives. Among these, our FRENIC4600FM6e medium-voltage drive is a high-performance, high reliability medium-voltage drive speed control device.



Substantial reduction of harmonic current on power source side

- FRENIC4600FM6e suppresses the harmonics by using a multi-pulse diode rectification system (18 to 54 pulses), 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

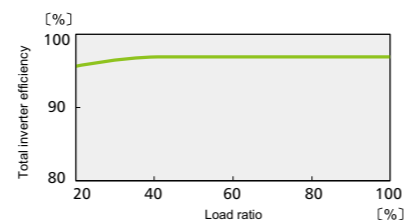
Order	5th	7th	11th	13th	17th
IEEE value (%)	4.00	2.86	1.83	1.49	1.14
Measured value (%)	0.58	1.0	0.20	0.32	0.75
Order	19th	23th	25th	35th	37th
IEEE value (%)	1.02	0.87	0.80	0.80	0.80
Measured value (%)	0.54	0.06	0.24	0.58	0.27

(*): Measure example from actual 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 harmonic losses.

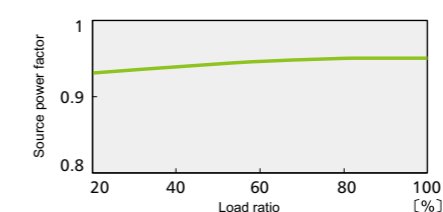
Total inverter efficiency curve (including input transformer)



Source power factor as high as 0.95 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 power factor compensation device mounted on the power source side is not necessary.
- A smaller power capacity suffices for inverter operation.

Source power factor curve



High-reliability

- High-precision speed-sensorless vector control is provided so that stable operation will be maintained from low speed to high speed even in the event of load fluctuations.
- The reliability is very high thanks to world-class IGBT components redundant bypass control technology and hierarchical fault alarm functions.
- A high-end 32-bit MCU oriented to motor control is used in the control device for high response speed and control accuracy.







Easy maintenance

- The inverter is air-cooled, requiring no cooling water.
- The operations including operation startup/stop, parameter setting, fault display, data monitoring and etc. can be easily performed through user-friendly human-machine operation interaction interface.
- Simple, built-in auto-tuning functions facilitate testing and adjustment.
- Fault diagnoses is easily performed.
- A dry-type input transformer is adopted.

Vector control

- For asynchronous motors and synchronous motors, the application of advanced and useful vector control technology can achieve high starting torque, rapid dynamic response and high load capacity and realize high-precision speed-sensorless vector control.



<ul style="list-style-type: none"> ■ Induced draft fan ■ Primary fan ■ Secondary fan ■ Blower fan ■ Condensate pump ■ Circulating pump ■ Feed pump ■ Coal mill 	<ul style="list-style-type: none"> ■ Blast furnace fan ■ Sintering fan ■ Circulation fan ■ Dust removal fan ■ Descaling pump ■ Water sending pump ■ Circulating pump 	<ul style="list-style-type: none"> ■ Compressor ■ Delivery pump ■ Refrigerator ■ Agitator 	<ul style="list-style-type: none"> ■ Water sending pump ■ Intake pump ■ Flood draining pump ■ Lift pump 	<ul style="list-style-type: none"> ■ Circulation fan ■ High temperature fan ■ Kiln head and kiln tail exhaust fans ■ Mill and crusher ■ Rotary kiln 	<ul style="list-style-type: none"> ■ Belt conveyor ■ Main fan ■ Hoist ■ Mixer ■ Testbed ■ Tube machine
<p style="text-align: center;">Electric power</p>	<p style="text-align: center;">Metallurgy</p>	<p style="text-align: center;">Petrochemical</p>	<p style="text-align: center;">Municipal water conservancy</p>	<p style="text-align: center;">Building materials</p>	<p style="text-align: center;">Others</p>
					



Application in the electric power industry

FRENIC4600 series high voltage inverters are widely applied in the electric power industry. They have been widely applied for coal-fired power generation, cogeneration, waste incineration (biomass power generation), gas turbine power generation and photothermal power generation. Among them, Guangdong Huaxia Yangxi Power Plant Phase II 2x1240MW project, Shenneng Anhui Pingshan Power Plant Phase II 1x1350MW project, the waste power generation project of Shenzhen Energy and Environmental Protection Co., Ltd., Minhong class H gas turbine power generation project of Shanghai Electric Power are all industry benchmark. Shenneng Anhui Pingshan Power Plant Phase II project is a national demonstration project of coal-fired units. It has the coal-fired power generating unit with the world's largest unit capacity and creates the new global record of generating efficiency of the coal-fired

power generating unit, namely, the net coal consumption rate of 251 g/kW. Minhong class H gas turbine power generation project of Shanghai Electric Power has the maximum installed capacity in the domestic gas turbine power generation industry. For the Eastern Power Plan, Mawan Power Plant and Laohukeng Power Plant of Shenzhen Energy and Environmental Protection Co., Ltd., the total garbage power generation scale is the world's largest.

Application in the metallurgical industry

FRENIC4600 series high voltage inverters are widely used in the steel industry. They are widely applied not only in many large domestic iron and steel groups, China Baowu Steel Group, Tsingshan Iron & Steel, Panzhihua Iron & Steel, Anshan Iron & Steel, Jiyuan Iron & Steel and others, but also in many well-known steel producers abroad, such as POSCO, Nippon Steel & Sumitomo Metal Corporation, Formosa Ha Tinh Steel Corporation, JuRong Rock Cavern, EGE Steel, etc. Nearly 300 sets of FRENIC4600 high voltage inverters have been used in total by Baoshan Iron & Steel, Tsingshan Iron & Steel and POSCO. They have always been favored by customers due to high quality and meticulous services.



Application in petrochemical industry

FRENIC4600 series high voltage inverters are widely used in the petrochemical industry at home and abroad and have a lot of application performance in Wanhua Chemical, China National Salt Industry Group, Yadong Petrochemical, Formosa Plastics Heavy Industry, Yunfu Chemical, Liancheng Chemical, Petrobras, Singapore Refining Company, Mexico National Oil Company and other domestic and foreign projects. The company is one of winning bidders of Wanhua Chemical's annual framework and has a large number of heavy-duty applications such as compressors, extruders and mixers.

Application in municipal water conservancy industry

FRENIC4600 series high voltage inverters are widely used in the municipal water conservancy industry and have large amount of application performance in many municipal water conservancy projects both at home and abroad, such as Zhoushan Continental Diversion Project, Yaojiang Second Passage (Cijiang) Project, Dalian Water Affairs, Huayan Sino French Water, Xiamen Water Affairs, Indian water conservancy projects, VALE Water Plant, water treatment project in South Africa, water projects in Peru and so on. Among them, the inverter supplied for Sitarama Pump Station in India has a capacity of 35000KVA, which is the largest in the global water conservancy industry. For Xiepu Gate Station of Yaojiang Second Passage (Cijiang) Project, the designed drainage flow is 250m³/s and the designed flow for a single unit is 50m³/s, which are the largest for shaft tubular pump in China.



Application in the building materials industry

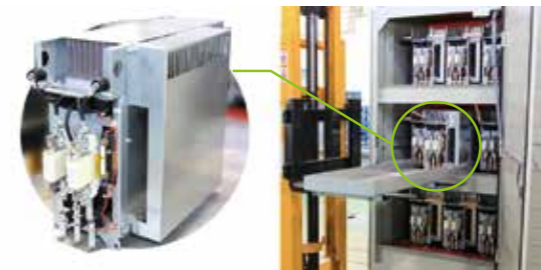
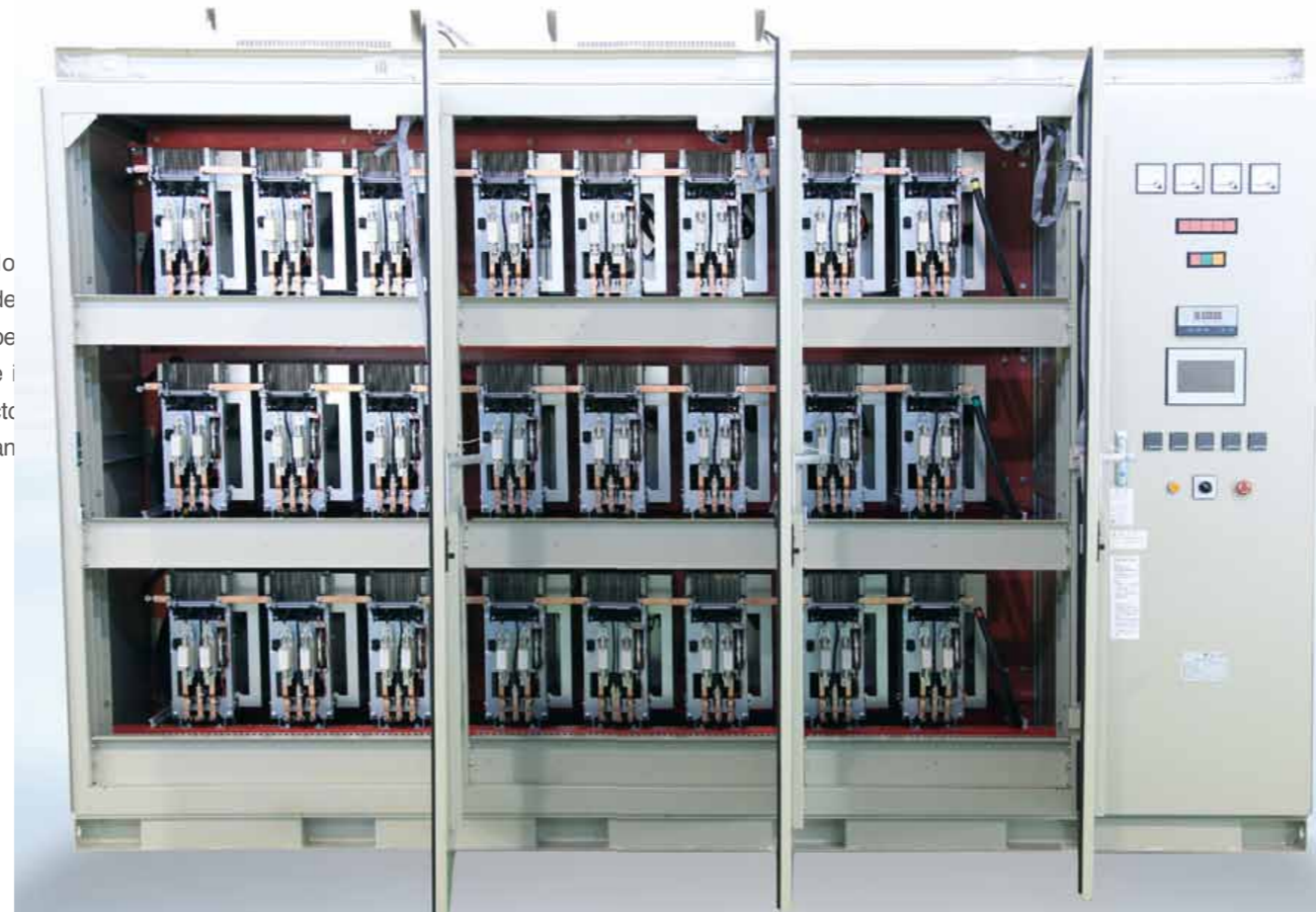
FRENIC4600 series high voltage inverters are widely used in building materials industry and have large amount of application performance in many outstanding cement enterprises both at home and abroad, such as Conch Cement, Pacific Cement (Japan), Yadong Cement (Taiwan), Votorantim Cement (Brazil), Wagners Cement (Australia), VAN Cement (Turkey) and so on. The company is an outstanding supplier of Conch Cement and has supplied nearly 100 units for Conch Cement since 2010. FRENIC4600 series high voltage inverters are used by both the two clinker cement production lines with daily output of 12,000 tons which are currently the largest in the world and the most advanced in technology and have been running well by so far. The company has been highly recognized by customers due to high product quality and meticulous services.



Application in other industries

FRENIC4600 series high voltage inverters are widely applied in the all kinds of testbeds, rubber industry, and the load of belt conveyors. Inverters supplied for 624 test benches in Mianyang have the ultra-large capacity up to 10500KVA. The company is also suppliers of Shenyang Blower Works Test Bench, Atlas Test Bench, Shanghai Blower Works Test Bench and others. For the internal mixer load in the rubber industry, FRENIC4600 series high voltage inverters also have many application cases for Yokohama Tires, Kenda Tire, Double-Coin Tires (Thailand) and others. Besides, they are also long-term matching products of Huadian Heavy Industries, Longking Environmental Protection and other domestic leading belt conveyor integration manufacturers.

The FRENIC4600 series high-voltage inverters employ international advanced electrical technology, have the cascade structure optimization design for multi-level units and are equipped with highly integrated dedicated motor control MCU. There is no need to configure higher harmonic filters and power factor regulating capacitors for them. They have very high reliability and are easy to operate and maintain.



IGBT- insulated gate bipolar transistor

- IGBT adopts the Fuji Electric 7th IGBT device with the military level, which has the top packaging technology, has low loss, low heat and high reliability, and has incomparable congenital advantages over other frequency inverter manufacturers.
- Fuji Electric is one of the largest IGBT suppliers in the world.
- At present, there are only two inverter manufacturers in the world, which use the self-development IGBT.

Master control PC board

- The most suitable 32-bit MCU for industrial motor control is onboard. The voltage detection system adopts a dedicated ARM sampling base board, with high response speed and control accuracy. For variable-torque loads, the high control performance with short acceleration time and no over-current for acceleration is provided.
- A flexible field interface with user is provided and operations are convenient and easy. Customization can be made in accordance with customers' requirements.

Cooling fan

- Air-cooled inverters make maintenance easy.
- The cooling fan on the top of the cabinet adopts the Germanic imported brand, which has high reliability, low noise and no maintenance.

Inverter cell

- The number of inverter cells has been substantially reduced by adopting a singlephase, 2-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.
- It employs the latest 1700V Fuji high-voltage IGBT and achieves the leading global supply performance. During its high-reliability operation, its MTBF reaches 100,000h.

※ MTBF, "Mean Time Between Failure."

Input multiplex-winding transformer

- Harmonic current on the power source side is low due to a multiplex configuration of the secondary winding.
- Multi-pulse rectification (18 to 54 pulses) and the generation of harmonics meet the IEEE standard.
- There is no need to install filter and power factor improvement capacitors.
- Input transformer and inverter panel is no longer necessary.
- The integrated design of dry-type isolation transformer can protect motors, simplify installation and reduce installation costs.



Main circuit configuration

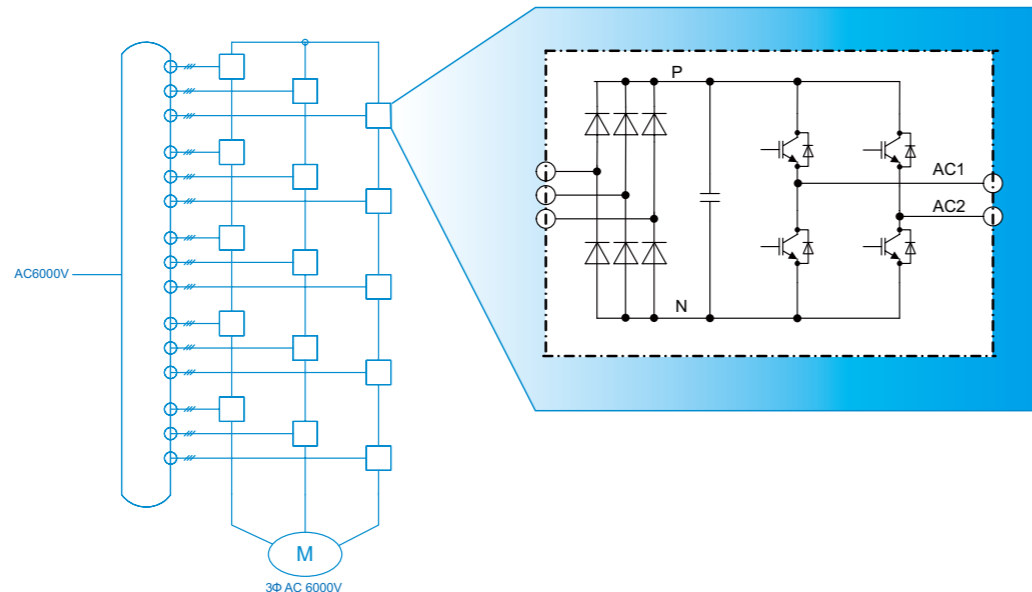


Fig.1 Main circuit configuration of 6KV type

Fig.2 Internal configuration of inverter cell

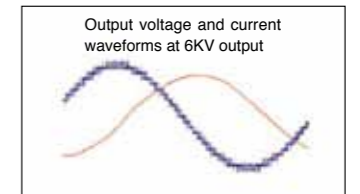
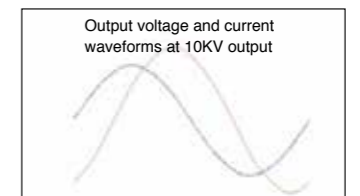
Friendly to machines

- If a harmonic current component is contained in the inverter output current, a torque pulsation occurs on the output shaft of a motor. A torque pulsation means a change in rotational speed or a large vibration if the frequency of the torque pulsation matches the natural frequency of the mechanical system and torque pulsation is large.
- In FRENIC4600FM6e, the harmonic component on the output side is extremely small due to the multi-level PWM control and the main component of torque pulsation is at around the carrier frequency (several kHz). Therefore, torque pulsation hardly affects the machine side.



Friendly to motors

- The multi-level PWM control provides an almost sinusoidal output current waveform, thus reducing motor torque pulsation.
- Because the output current is almost sinusoidal, a motor suffers less loss due to harmonics.
- The multi-level (max. 17 levels) PWM control minimizes switching surge and thereby reduces stress on the motor.
- There is no need to reduce motor capacity after applying inverter drive.
- There is no need for special cables, etc. after applying 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.



- FRENIC4600FM6e consists of an input transformer and 15 inverter cells in case of the 6kV type as shown in Fig. 1 (the 10kV type has 24 inverter cells).

- Each inverter unit is a single-phase 2-level inverter and can reach 69V output voltage. As shown in Figure 3, each phase at the 6kV level includes 5 pieces of inverter unit connected in series and the phase voltage is approximately 3,465V. The star connection is used for three phases and the line voltage can reach 6,000V.

- As shown in Fig. 4, each phase at the 10kV level includes 8 pieces of inverter units connected in series and the phase voltage is approximately 5,774V. The star connection is used for three phases and the line voltage can reach 10,000V.

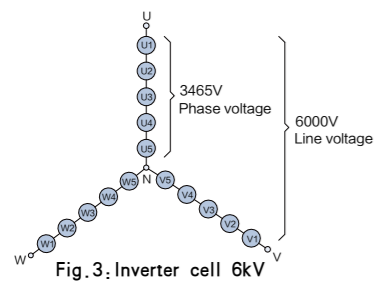


Fig. 3: Inverter cell 6kV

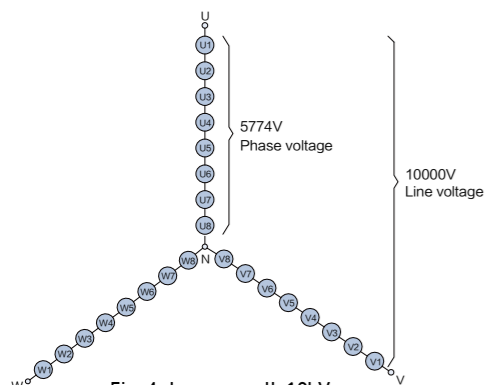


Fig. 4: Inverter cell 10kV

Vector Control Technology of Synchronous Motor

FRENIC4600FM6e uses high-speed MCU as its core. Meanwhile, it loads with worldwide advanced vector control programs and establishes a high-performance controller platform. It is suitable for the situations with high speed regulation requirements and frequent startup.

Major performance:

- High starting torque at low speed and rapid torque response at high speed.
- It employs motor rotor positioning technology to ensure a successful startup of synchronous motors.
- The inverter can automatically adjust exciting current and improve the efficiency of system.

Cell Automatic Bypass Function

- The automatic unit bypass function is selected to significantly reduce shutdown faults and greatly improve the reliability of product.
- FRENIC4600FM6e is able to accurately locate fault points and bypass faulty cells.
- With the bypass control completely separated from individual power cells, FRENIC4600FM6e can ensure that faulty power cells will be automatically bypassed within less than half a second.



Control Functions

The CPU for the FRENIC4600FM6e series of medium voltage inverter's basic control system (control, operation program, and all types of interfaces), high speed computing electric current control system, and medium voltage command processing and output voltage pulse waveform processing system has a 32-bit RISC processor.

The system provides the best control for all types of functions and internally integrates the following functions:

Logic Function

- Provides system operation and stoppage through software based on external logic and control signals.

Regulation Function

- Provides the best regulation control based on the sampling control principle.

Control Parameter Setting Function

- Can set all system control parameters through the operations panel, programmer, POD, or central monitoring system and provide the best adjustment capability.

Malfunction Detection Function

- When failure occur, it confirms information through the operations panel's monitor, POD, programmer, or central monitoring system.

Independent Operation Function

- Can control operation of the FRENIC4600FM6e with no need to connect to the DCS. The operation methods include communications, external input access operations, analog command operations, and operations panel operations.

Power Outage Protection System

- When power outages occur, processing can proceed without power, with the RAM data having backup capacity, allowing data to be maintained for one week without power. It also backs up the settings data in flash memory, meaning that the settings will not be lost when there is a power outage.

On-line Analog Data Output

- During operation, the related data can be output in analog mode.

Momentary interruption introduction

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

- 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.
- 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.
- 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.

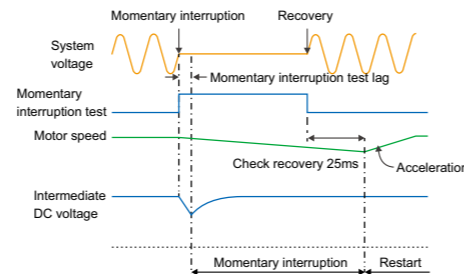


Fig.5 Sequence During Continuous Operation

Notes1) A voltage drop due to a momentary power interruption will be detected at 65% or less of the rated voltage.

Notes2) Operation can be continued within 300ms at a voltage drop due to a momentary power interruption (option).

Synchronization undisturbed switch

- Shockless switching between inverter operation and commercial power operation allowed by phase control according to system voltage.
An electric reactor must be installed on the output side of the inverter to enable this function.

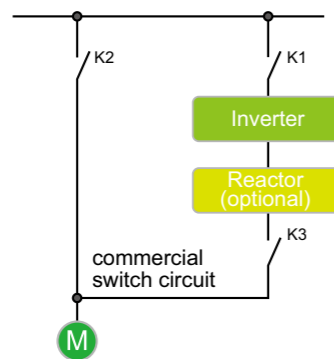


Fig.6 Power system diagram

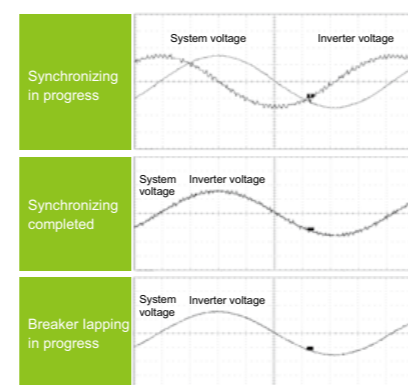


Fig.7 Synchronization/parallel off waveform

Simple operation and monitoring on the 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.

Act display

- Displays 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.



Trans. menu

- Displays the transmission status and I/O data value.

Running, Start condition

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

Fault code

- Fault history of up to 100 occurrences can be checked.

Trip data

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

Miscellaneous

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

Auto tuning

- The motor can be tuned.

Log out

- The screen can be monitored, in which the parameter can not be changed.

Screen examples



- Running
- Setting
- Monitor
- Start condition
- Fault history

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, recover and compare setting data

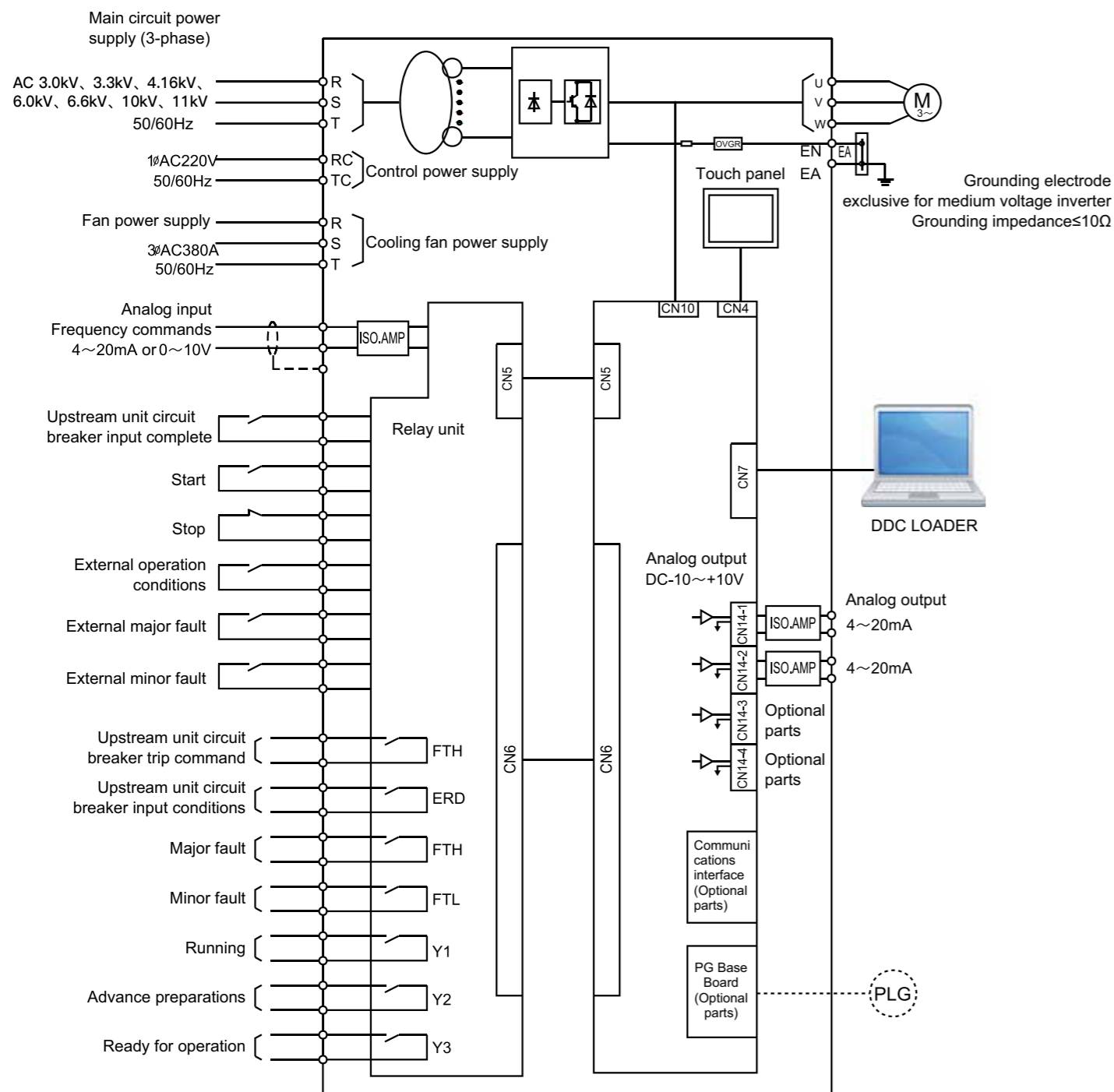
The set data can be saved in the EPROM of the touch panel. The saved data can also be loaded and compared with other saved data.

Inverter standard specifications

Inverter type		FRENIC4600FM6e
Input	Main circuit	3-phase 3kV、3.3kV、4.16kV、6kV、6.6kV、10kV、11kV 50/60Hz
	Control circuit	single-phase 220V 50/60Hz
	Fan power supply	3-phase 380V 50/60Hz
	Allowable power variation	Voltage: -35% ~ +10%, Frequency: ± 5%
Control	Control system	Simple vector control with V/f constant control without speed sensor Vector control with speed sensor (induction motor) vector control without speed sensor (induction motor) vector control with speed sensor *speed detection options (synchronous motor) vector control without speed sensor (synchronous motor)
	Output frequency control range	0Hz to 72Hz (option to 120Hz)
	Output frequency accuracy	Relative maximum frequency ± 0.5% (when the analog frequency is the baseline input)
	Output frequency resolution	0.005%
	Accel./decel. time	0.1 to 5500s
	Overload capability	110% for 60s (cold start, the cooling body temperature need to be below 40 °C)
	Main control function	Current limit, stall prevention, jump frequency setting, automatic deceleration, momentary drop protection and stop/restart (option)
	Protection function	Overcurrent, main circuit fuse blown, overvoltage, undervoltage, CPU fault, cooling fan stop
	Transmission function (option)	T-LINK, Modbus, Profibus-DP
	Structure	Panel structure
Degree of protection		IP31 (up to IP42, option)
Cooling		Forced ventilation with ceiling fan (Leather tone non gloss)
Coating color		RAL7032 (Leather tone non gloss)
Ambient conditions	Ambient temperature	0 ~ +40° C (Storage temp.: -10 ~ +60° C)
	Humidity	90% RH below (no condensation), option: 95% RH max
	Altitude	Altitude: 1,000 meters and below (high altitude is optional)
	Vibration	4.9m/s ² and below (10 to 50Hz)
	Installation place	Indoor, general environment free from corrosive gas, dust and flammable/ explosive gas
Applicable standard	IEC,GB,DL	



Standard connection diagram



Standard interface

Input side

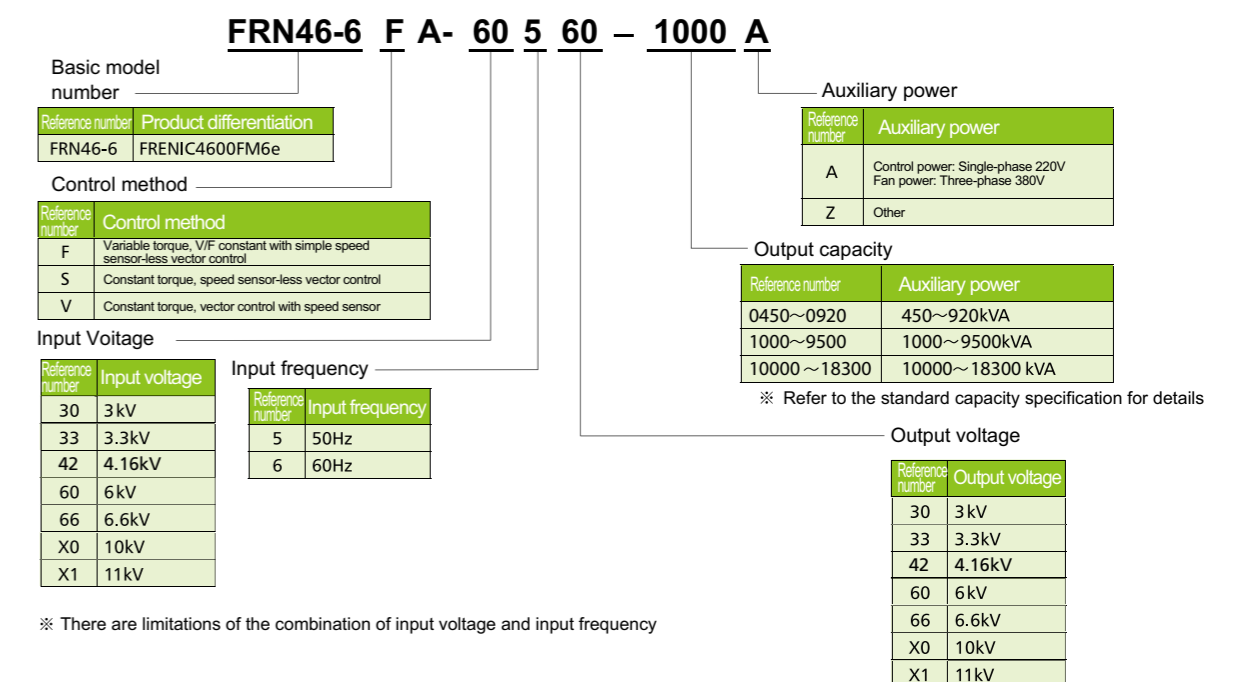
Main circuit power supply	3-phase 3, 3.3, 4.16, 6, 6.6, 10, 11kV, 50/60Hz	
Control power supply	Single phase 220V, 50/60Hz	
Fan power supply	3-phase 380V, 50/60Hz	
Frequency setting	0 to 10V/0 to 100% or 4 to 20mA/0 to 100%	Input impedance 1M Ω Input impedance 250 Ω
Run command	Closure for run ("a" contact)	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)	
Under operation	Closure under operation ("a" contact)	
Major fault	Closure at major fault ("a" contact)	Dry contact (contact capacity: 250V AC, 2A or 30V DC, 3A)
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 10V	Load resistance 10k Ω or more
	4 20mA	Load resistance 750 Ω or less

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

Selection explanation



Standard capacity selections

Voltage rating 3kV						
Model	Rated capacity [kVA]	Rated current [A]	Maximum current (overload) [A]	Applied electric motor power (reference) [kW]	External appearance (reference)	Approximate weight [kg]
FRN46-6□A-30□30-0500□	500	93	102	400	Fig.1	4500
FRN46-6□A-30□30-0700□	700	130	143	560	Fig.1	4800
FRN46-6□A-30□30-0900□	900	178	196	700	Fig.1	5000
FRN46-6□A-30□30-1200□	1200	227	250	900	Fig.2	6250
FRN46-6□A-30□30-1350□	1350	266	293	1120	Fig.2	6450
FRN46-6□A-30□30-1600□	1600	312	343	1320	Fig.2	6800
FRN46-6□A-30□30-2000□	2000	385	423	1600	Fig.3	8000
FRN46-6□A-30□30-2250□	2250	443	487	1800	Fig.3	8400
FRN46-6□A-30□30-2600□	2600	500	550	2250	Fig.4	9600
FRN46-6□A-30□30-3150□	3150	635	699	2700	Fig.5	11300
FRN46-6□A-30□30-3500□	3500	675	743	3000	Fig.5	11300
FRN46-6□A-30□30-4700□	4700	914	1006	4000	Fig.6	13500
FRN46-6□A-30□30-4950□	4950	962	1059	4400	Fig.6	13500

Voltage rating 3.3kV						
Model	Rated capacity [kVA]	Rated current [A]	Maximum current (overload) [A]	Applied electric motor power (reference) [kW]	External appearance (reference)	Approximate weight [kg]
FRN46-6□A-33□33-0550□	550	93	102	450	Fig.1	4500
FRN46-6□A-33□33-0740□	740	130	143	630	Fig.1	4800
FRN46-6□A-33□33-1000□	1000	178	196	800	Fig.1	5000
FRN46-6□A-33□33-1300□	1300	227	250	1050	Fig.2	6250
FRN46-6□A-33□33-1500□	1500	266	293	1250	Fig.2	6450
FRN46-6□A-33□33-1750□	1750	312	343	1450	Fig.2	6800
FRN46-6□A-33□33-2200□	2200	385	423	1750	Fig.3	8000
FRN46-6□A-33□33-2500□	2500	443	487	2000	Fig.3	8400
FRN46-6□A-33□33-2850□	2850	500	550	2350	Fig.4	9600
FRN46-6□A-33□33-3600□	3600	635	699	2800	Fig.5	11300
FRN46-6□A-33□33-3850□	3850	675	743	3400	Fig.5	11300
FRN46-6□A-33□33-5200□	5200	914	1006	4500	Fig.6	13500
FRN46-6□A-33□33-5500□	5500	962	1059	4700	Fig.6	13500

※1: The applicable motor output is the reference value of FE's standard 4-pole motors.

※2: External appearance and weight are for reference only. Please take the final drawing as the standard.

Standard capacity selections

Voltage rating 4.16kV						
Model	Rated capacity [kVA]	Rated current [A]	Maximum current (overload) [A]	Applied electric motor power (reference) [kW]	External appearance (reference)	Approximate weight [kg]
FRN46-6□A-42□42-0700□	700	97	107	580	Fig.1	3800
FRN46-6□A-42□42-0970□	970	135	148	800	Fig.1	4400
FRN46-6□A-42□42-1250□	1250	178	196	1000	Fig.1	4600
FRN46-6□A-42□42-1650□	1650	229	252	1300	Fig.2	7600
FRN46-6□A-42□42-1900□	1900	266	293	1600	Fig.2	7700
FRN46-6□A-42□42-2250□	2250	312	343	1800	Fig.2	7900
FRN46-6□A-42□42-2750□	2750	382	420	2350	Fig.3	10000
FRN46-6□A-42□42-3200□	3200	443	487	2700	Fig.3	10200

※1: The applicable motor output is the reference value of FE's standard 4-pole motors.

※2: External appearance and weight are for reference only. Please take the final drawing as the standard.

Standard capacity selections

Voltage rating 6kV						
Model	Rated capacity [kVA]	Rated current [A]	Maximum current (overload) [A]	Applied electric motor power (reference) [kW]	External appearance (reference)	Approximate weight [kg]
FRN46-6□A-60□60-0450□	450	44	48	355	Fig.1	2950
FRN46-6□A-60□60-0510□	510	49	54	400	Fig.1	3050
FRN46-6□A-60□60-0550□	550	53	58	450	Fig.1	3100
FRN46-6□A-60□60-0610□	610	59	65	500	Fig.1	3200
FRN46-6□A-60□60-0700□	700	67	74	560	Fig.1	3250
FRN46-6□A-60□60-0770□	770	74	82	630	Fig.1	3300
FRN46-6□A-60□60-0880□	880	87	96	710	Fig.1	3600
FRN46-6□A-60□60-1000□	1000	93	102	800	Fig.1	3700
FRN46-6□A-60□60-1100□	1100	106	117	900	Fig.2	3800
FRN46-6□A-60□60-1200□	1200	115	127	1000	Fig.2	4200
FRN46-6□A-60□60-1350□	1350	130	143	1120	Fig.2	4300
FRN46-6□A-60□60-1500□	1500	144	158	1250	Fig.2	4400
FRN46-6□A-60□60-1700□	1700	162	178	1400	Fig.2	4500
FRN46-6□A-60□60-1850□	1850	178	196	1500	Fig.2	4600
FRN46-6□A-60□60-2000□	2000	192	211	1600	Fig.3	7100
FRN46-6□A-60□60-2250□	2250	218	240	1800	Fig.3	7150
FRN46-6□A-60□60-2500□	2500	241	265	2000	Fig.3	7650
FRN46-6□A-60□60-2750□	2750	266	293	2240	Fig.3	7750
FRN46-6□A-60□60-3000□	3000	289	318	2500	Fig.3	7900
FRN46-6□A-60□60-3300□	3300	312	343	2800	Fig.3	8000
FRN46-6□A-60□60-3700□	3700	356	392	3150	Fig.4	10100
FRN46-6□A-60□60-4000□	4000	385	424	3500	Fig.4	10300
FRN46-6□A-60□60-4600□	4600	443	487	3800	Fig.4	10800
FRN46-6□A-60□60-4800□	4800	462	508	4000	Fig.5	11700
FRN46-6□A-60□60-5200□	5200	500	550	4200	Fig.5	11800
FRN46-6□A-60□60-5900□	5900	563	619	5000	Fig.6	11800
FRN46-6□A-60□60-6600□	6600	635	699	5600	Fig.6	16500
FRN46-6□A-60□60-7000□	7000	675	743	6000	Fig.6	16950
FRN46-6□A-60□60-7500□	7500	722	794	6300	Fig.7	20500
FRN46-6□A-60□60-8360□	8360	803	883	7200	Fig.7	21500
FRN46-6□A-60□60-9400□	9400	900	990	8000	Fig.7	23700
FRN46-6□A-60□60-10000□	10000	962	1058	8600	Fig.7	25500

※1: The applicable motor output is the reference value of FE's standard 4-pole motors.

※2: External appearance and weight are for reference only. Please take the final drawing as the standard.

Standard capacity selections

Voltage rating 6.6kV						
Model	Rated capacity [kVA]	Rated current [A]	Maximum current (overload) [A]	Applied electric motor power (reference) [kW]	External appearance (reference)	Approximate weight [kg]
FRN46-6□A-66□66-0500□	500	44	48	400	Fig.1	2950
FRN46-6□A-66□66-0550□	550	49	54	450	Fig.1	3050
FRN46-6□A-66□66-0600□	600	53	58	500	Fig.1	3100
FRN46-6□A-66□66-0670□	670	59	65	560	Fig.1	3200
FRN46-6□A-66□66-0770□	770	67	74	630	Fig.1	3250
FRN46-6□A-66□66-0840□	840	74	82	710	Fig.1	3300
FRN46-6□A-66□66-1000□	1000	87	96	800	Fig.1	3600
FRN46-6□A-66□66-1100□	1100	93	102	900	Fig.1	3700
FRN46-6□A-66□66-1200□	1200	106	117	1000	Fig.2	3800
FRN46-6□A-66□66-1300□	1300	115	127	1120	Fig.2	4200
FRN46-6□A-66□66-1500□	1500	130	143	1250	Fig.2	4300
FRN46-6□A-66□66-1650□	1650	144	158	1400	Fig.2	4400
FRN46-6□A-66□66-1850□	1850	162	178	1500	Fig.2	4500
FRN46-6□A-66□66-2000□	2000	178	196	1600	Fig.2	4600
FRN46-6□A-66□66-2200□	2200	192	211	1800	Fig.3	7100
FRN46-6□A-66□66-2500□	2500	218	240	2000	Fig.3	7150
FRN46-6□A-66□66-2750□	2750	241	265	2240	Fig.3	7650
FRN46-6□A-66□66-3000□	3000	266	293	2500	Fig.3	7750
FRN46-6□A-66□66-3300□	3300	289	318	2800	Fig.3	7900
FRN46-6□A-66□66-3600□	3600	312	343	3000	Fig.3	8000
FRN46-6□A-66□66-4000□	4000	356	392	3500	Fig.4	10100
FRN46-6□A-66□66-4400□	4400	385	424	4000	Fig.4	10300
FRN46-6□A-66□66-5100□	5100	443	487	4200	Fig.4	10800
FRN46-6□A-66□66-5300□	5300	462	508	4500	Fig.5	11700
FRN46-6□A-66□66-5700□	5700	500	550	4800	Fig.5	11800
FRN46-6□A-66□66-6500□	6500	563	619	5600	Fig.6	11800
FRN46-6□A-66□66-7250□	7250	635	699	6000	Fig.6	16500
FRN46-6□A-66□66-7700□	7700	675	743	6500	Fig.6	16950
FRN46-6□A-66□66-8300□	8300	722	794	7200	Fig.7	20500
FRN46-6□A-66□66-9200□	9200	803	883	8000	Fig.7	21500
FRN46-6□A-66□66-10000□	10000	900	990	8600	Fig.7	23700
FRN46-6□A-66□66-11000□	11000	962	1058	9500	Fig.7	25500

※1: The applicable motor output is the reference value of FE's standard 4-pole motors.

※2: External appearance and weight are for reference only. Please take the final drawing as the standard.

Standard capacity selections

Voltage rating 10kV						
Model	Rated capacity [kVA]	Rated current [A]	Maximum current (overload) [A]	Applied electric motor power (reference) [kW]	External appearance (reference)	Approximate weight [kg]
FRN46-6□A-X0□X0-0500□	500	29	32	400	Fig.1	3700
FRN46-6□A-X0□X0-0625□	625	36	40	500	Fig.1	3900
FRN46-6□A-X0□X0-0700□	700	40	44	560	Fig.1	4000
FRN46-6□A-X0□X0-0800□	800	46	51	630	Fig.1	4100
FRN46-6□A-X0□X0-0920□	920	53	58	710	Fig.1	4200
FRN46-6□A-X0□X0-1000□	1000	58	64	800	Fig.1	4300
FRN46-6□A-X0□X0-1160□	1160	67	74	900	Fig.1	4600
FRN46-6□A-X0□X0-1280□	1280	74	81	1000	Fig.1	4700
FRN46-6□A-X0□X0-1350□	1350	78	86	1120	Fig.1	4800
FRN46-6□A-X0□X0-1500□	1500	87	96	1250	Fig.1	4900
FRN46-6□A-X0□X0-1600□	1600	93	102	1300	Fig.1	5000
FRN46-6□A-X0□X0-1700□	1700	98	108	1400	Fig.2	6000
FRN46-6□A-X0□X0-1850□	1850	107	118	1500	Fig.2	6100
FRN46-6□A-X0□X0-2000□	2000	115	127	1600	Fig.2	6700
FRN46-6□A-X0□X0-2250□	2250	130	143	1800	Fig.2	6800
FRN46-6□A-X0□X0-2500□	2500	144	158	2000	Fig.2	6950
FRN46-6□A-X0□X0-2750□	2750	159	175	2240	Fig.2	7050
FRN46-6□A-X0□X0-3080□	3080	178	196	2500	Fig.2	7150
FRN46-6□A-X0□X0-3350□	3350	193	212	2800	Fig.3	9900
FRN46-6□A-X0□X0-3750□	3750	217	239	3200	Fig.3	11500
FRN46-6□A-X0□X0-4200□	4200	242	266	3600	Fig.3	11600
FRN46-6□A-X0□X0-4600□	4600	266	293	4000	Fig.3	11800
FRN46-6□A-X0□X0-5000□	5000	289	318	4300	Fig.4	11900
FRN46-6□A-X0□X0-5400□	5400	312	343	4500	Fig.4	13000
FRN46-6□A-X0□X0-5850□	5850	338	372	5000	Fig.5	13050
FRN46-6□A-X0□X0-6600□	6600	381	419	5600	Fig.5	14200
FRN46-6□A-X0□X0-7000□	7000	404	444	6000	Fig.6	19650
FRN46-6□A-X0□X0-7700□	7700	443	487	6500	Fig.6	19850
FRN46-6□A-X0□X0-8000□	8000	462	508	6800	Fig.6	20300
FRN46-6□A-X0□X0-8700□	8700	500	550	7400	Fig.6	20400
FRN46-6□A-X0□X0-10500□	10500	606	667	9000	Fig.7	22000
FRN46-6□A-X0□X0-11700□	11700	675	743	10000	Fig.7	22400
FRN46-6□A-X0□X0-13500□	13500	779	857	12000	Fig.8	28800
FRN46-6□A-X0□X0-16500□	16500	962	1058	15000	Fig.8	28800

※1: The applicable motor output is the reference value of FE's standard 4-pole motors.

※2: External appearance and weight are for reference only. Please take the final drawing as the standard.

Standard capacity selections

Voltage rating 11kV						
Model	Rated capacity [kVA]	Rated current [A]	Maximum current (overload) [A]	Applied electric motor power (reference) [kW]	External appearance (reference)	Approximate weight [kg]
FRN46-6□A-X1□X1-0625□	625	33	36	500	Fig.1	4100
FRN46-6□A-X1□X1-0700□	700	37	41	560	Fig.1	4300
FRN46-6□A-X1□X1-0800□	800	42	46	630	Fig.1	4400
FRN46-6□A-X1□X1-0920□	920	48	53	710	Fig.1	4500
FRN46-6□A-X1□X1-1000□	1000	52	57	800	Fig.1	4600
FRN46-6□A-X1□X1-1150□	1150	60	66	900	Fig.1	4700
FRN46-6□A-X1□X1-1250□	1250	67	74	1000	Fig.1	5100
FRN46-6□A-X1□X1-1350□	1350	71	78	1120	Fig.1	5200
FRN46-6□A-X1□X1-1500□	1500	79	87	1250	Fig.1	5200
FRN46-6□A-X1□X1-1600□	1600	84	92	1300	Fig.1	5300
FRN46-6□A-X1□X1-1750□	1750	93	102	1400	Fig.1	5400
FRN46-6□A-X1□X1-1850□	1850	97	107	1500	Fig.2	8100
FRN46-6□A-X1□X1-2000□	2000	105	116	1600	Fig.2	8200
FRN46-6□A-X1□X1-2250□	2250	118	130	1800	Fig.2	9000
FRN46-6□A-X1□X1-2500□	2500	130	143	2000	Fig.2	9200
FRN46-6□A-X1□X1-2750□	2750	144	158	2240	Fig.2	9300
FRN46-6□A-X1□X1-3100□	3100	163	179	2500	Fig.2	9400
FRN46-6□A-X1□X1-3400□	3400	178	196	2800	Fig.2	9600
FRN46-6□A-X1□X1-3750□	3750	197	217	3200	Fig.3	11400
FRN46-6□A-X1□X1-4200□	4200	220	242	3600	Fig.3	13100
FRN46-6□A-X1□X1-4600□	4600	241	265	4000	Fig.3	13300
FRN46-6□A-X1□X1-5000□	5000	266	293	4300	Fig.3	13500
FRN46-6□A-X1□X1-5400□	5400	283	311	4500	Fig.3	13800
FRN46-6□A-X1□X1-6000□	6000	312	343	5000	Fig.3	14400
FRN46-6□A-X1□X1-6600□	6600	346	381	5600	Fig.4	21800
FRN46-6□A-X1□X1-7000□	7000	367	404	6000	Fig.4	22000
FRN46-6□A-X1□X1-7700□	7700	404	444	6500	Fig.5	22300
FRN46-6□A-X1□X1-8400□	8400	443	487	7000	Fig.5	22500
FRN46-6□A-X1□X1-8700□	8700	457	503	7500	Fig.5	23100
FRN46-6□A-X1□X1-9500□	9500	500	550	8000	Fig.5	23200
FRN46-6□A-X1□X1-11500□	11500	604	664	10000	Fig.6	30500
FRN46-6□A-X1□X1-12800□	12800	675	743	11000	Fig.6	30500
FRN46-6□A-X1□X1-15000□	15000	787	866	13000	Fig.7	36900
FRN46-6□A-X1□X1-18300□	18300	962	1058	15000	Fig.7	36900

※1: The applicable motor output is the reference value of FE's standard 4-pole motors.

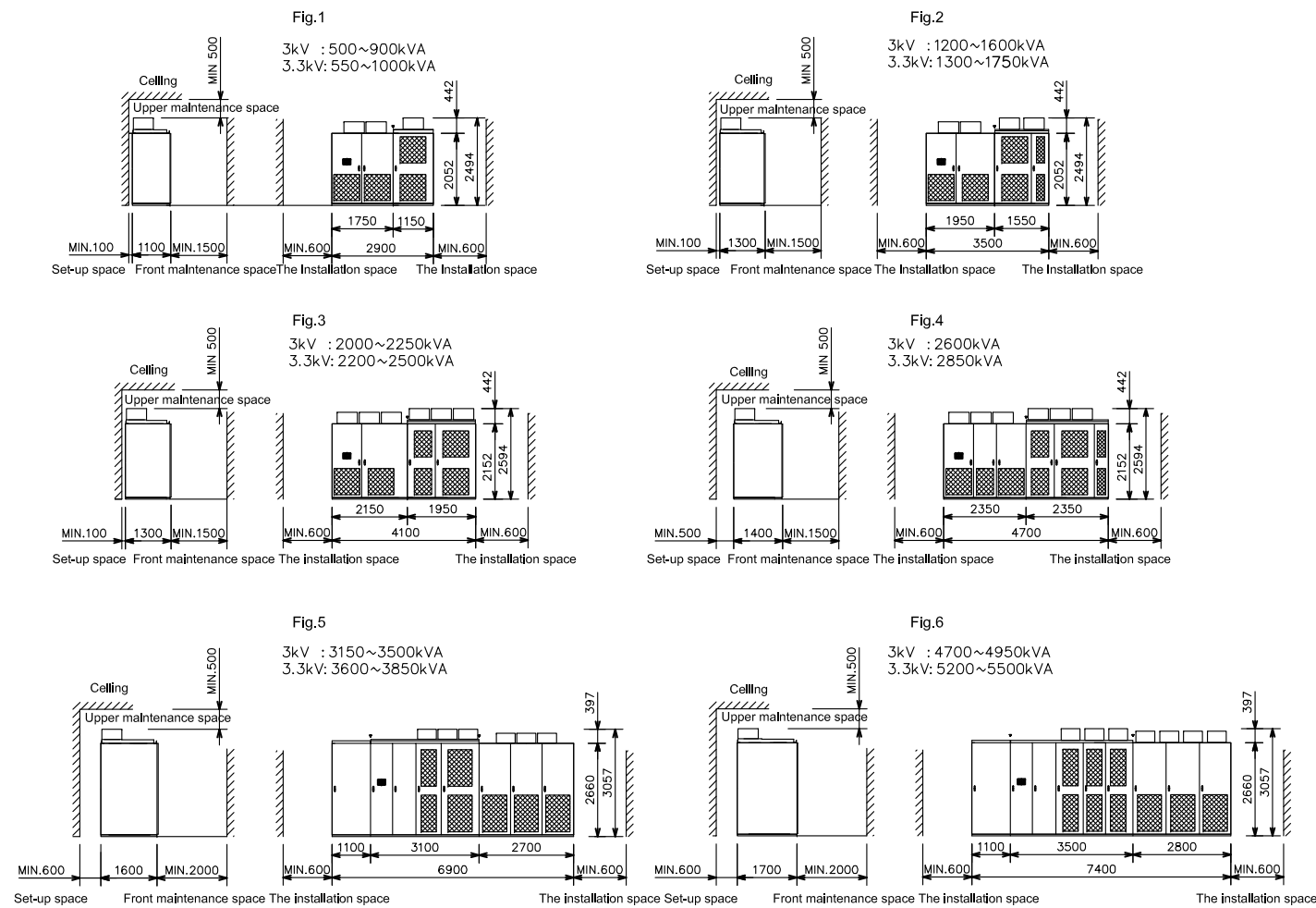
※2: External appearance and weight are for reference only. Please take the final drawing as the standard.

FRENIC4600FM6e

Capacity Selections

External appearance

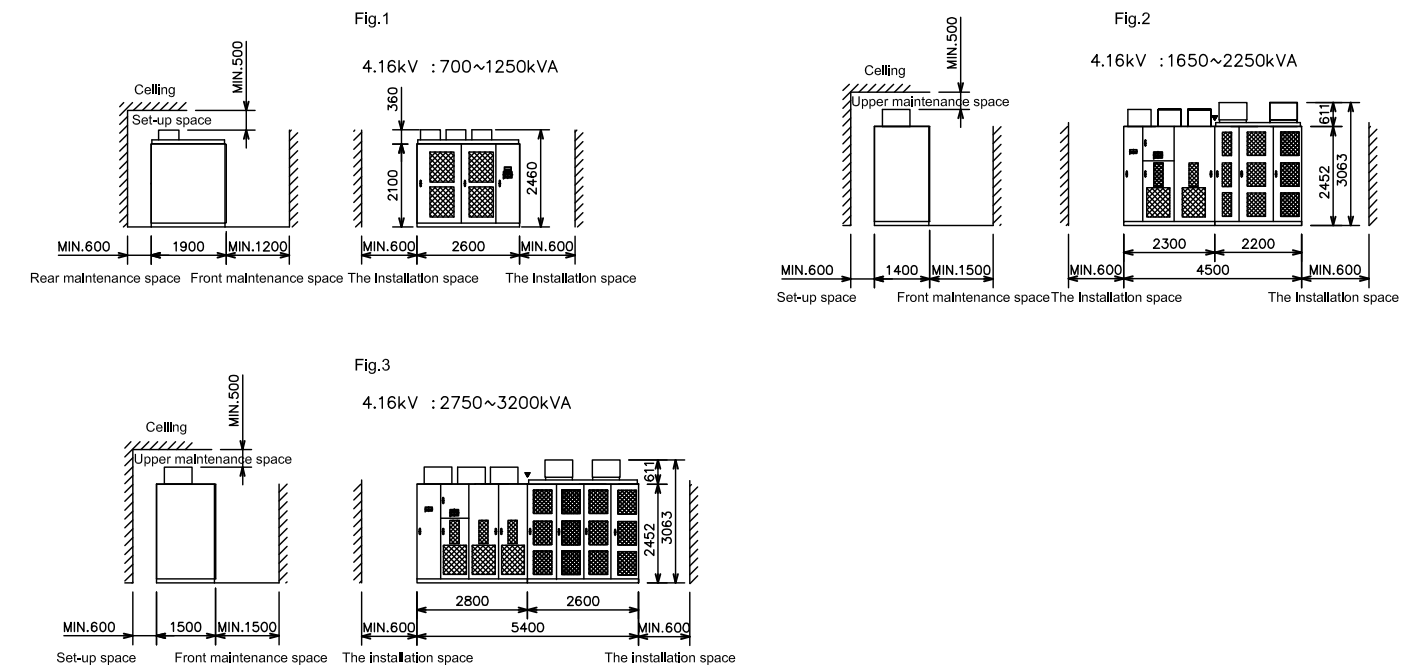
3kV series, 3.3kV series



※ 1) Above is the standard reference chart appearance. If customers need, our company can provide non-standard design according to the customers' requirements.
 ※ 2) Please contact our sales staff for more than 5500kVA products.

External appearance

4.16kV series



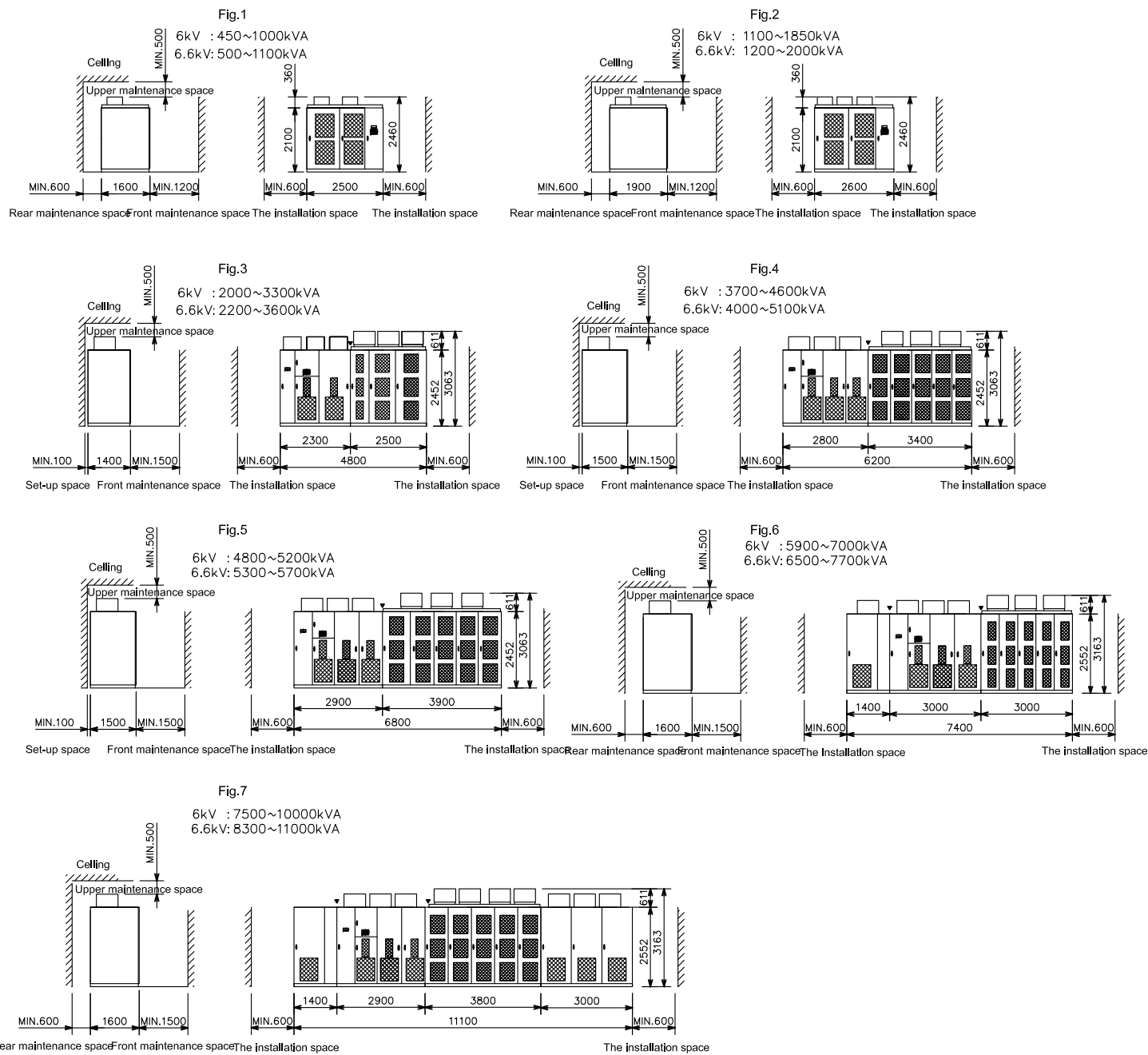
※ 1) Above is the standard reference chart appearance. If customers need, our company can provide non-standard design according to the customers' requirements.
 ※ 2) Please contact our sales staff for more than 3200kVA products.

FRENIC4600FM6e

Capacity Selections

External appearance

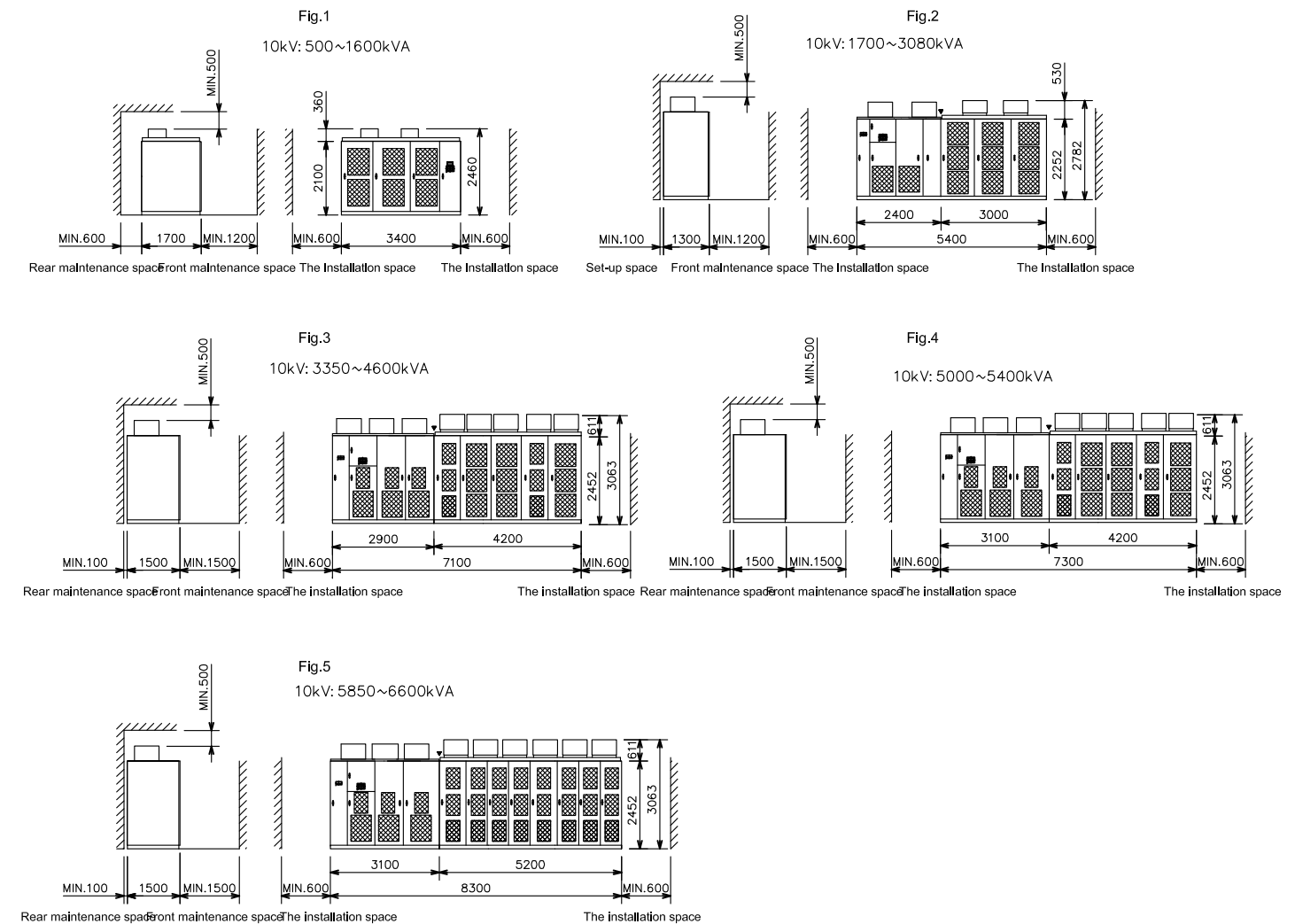
6kV series



※ 1) Above is the standard reference chart appearance. If customers need, our company can provide non-standard design according to the customers' requirements.
 ※ 2) Please contact our sales staff for more than 11000kVA products.

External appearance

10kV series



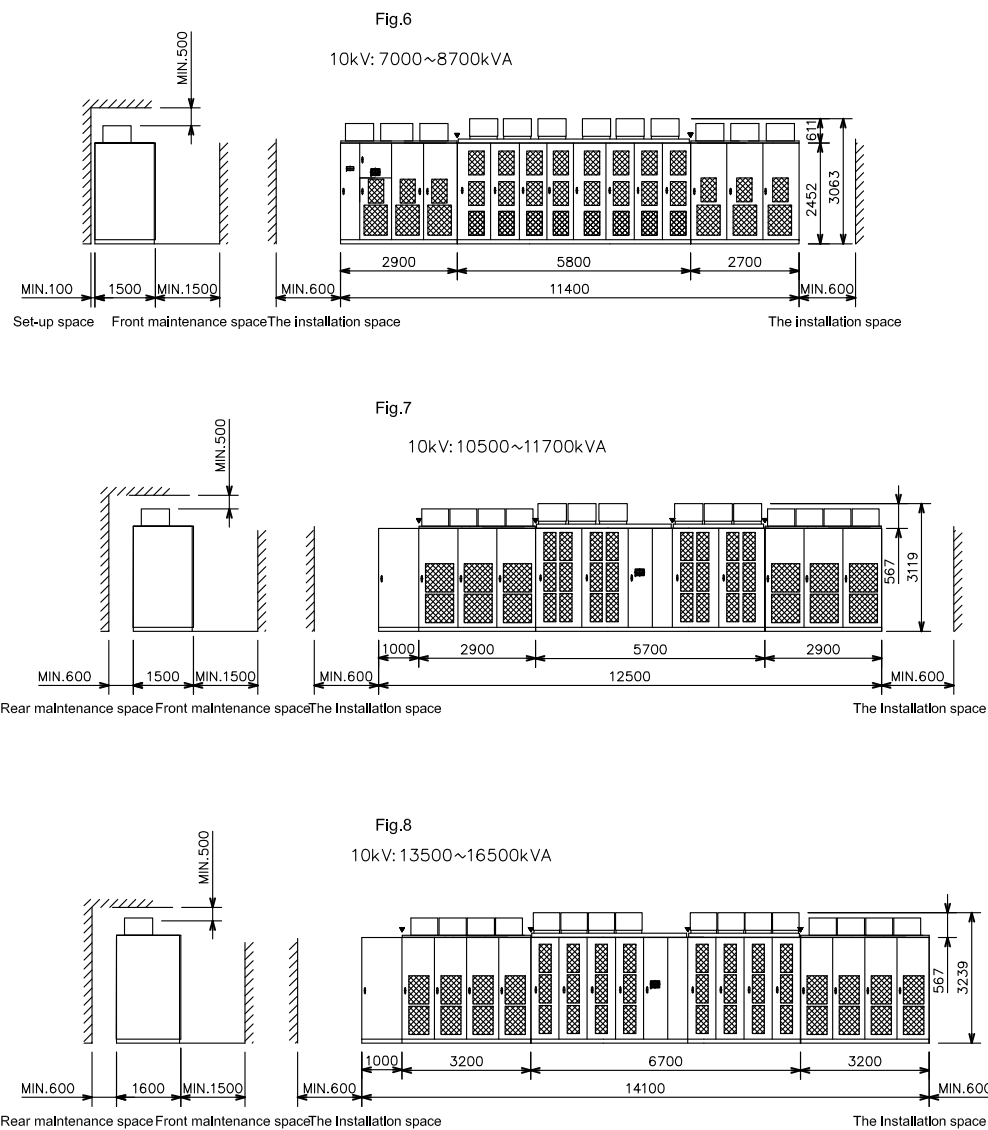
※ 1) Above is the standard reference chart appearance. If customers need, our company can provide non-standard design according to the customers' requirements.
 ※ 2) Please contact our sales staff for more than 16500kVA products.

FRENIC4600FM6e

Capacity Selections

External appearance

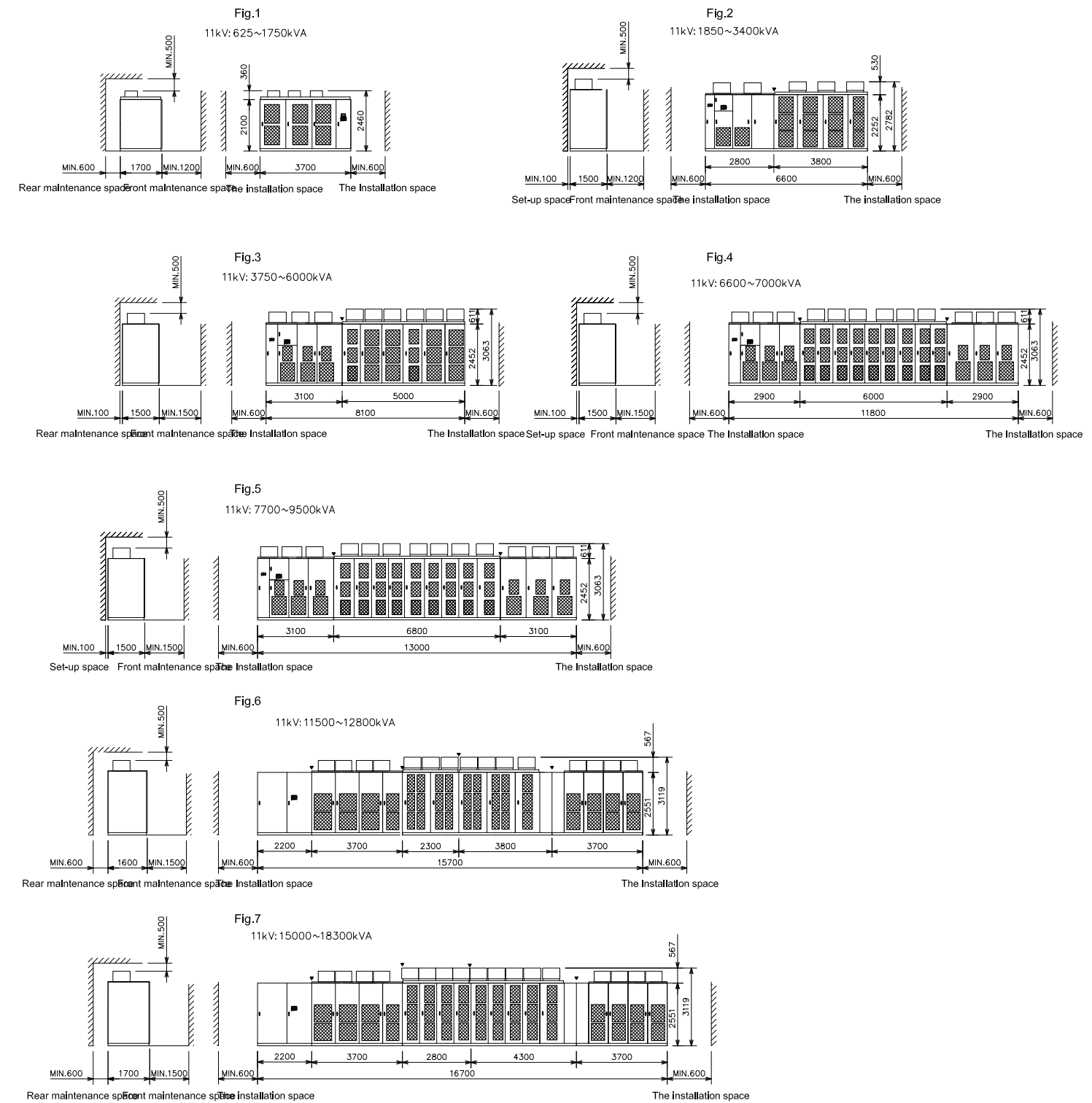
10kV series



- ※ 1) Above is the standard reference chart appearance. If customers need, our company can provide non-standard design according to the customers' requirements.
- ※ 2) Please contact our sales staff for more than 16500kVA products.

External appearance

11kV series



- ※ 1) Above is the standard reference chart appearance. If customers need, our company can provide non-standard design according to the customers' requirements.
- ※ 2) Please contact our sales staff for more than 18300kVA products.

FRENIC4600FM6e 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.



Energy-saving principle

Example

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

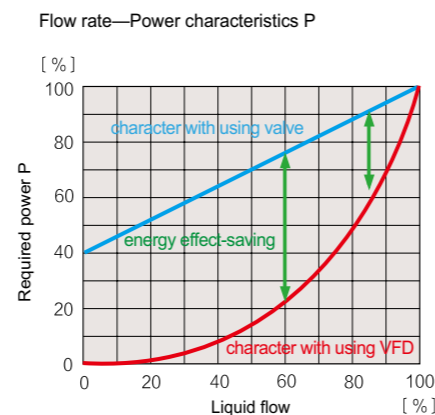
Inverter operation (adjustable speed control operation with inverter)

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

Flow rate—Power characteristics P



Energy-saving principle

We can get the following formula from the principle of fluid mechanics:

$$\frac{Q_1}{Q_2} = \frac{N_1}{N_2}, \frac{H_1}{H_2} = \left(\frac{N_1}{N_2}\right)^2, \frac{P_A}{P_C} = \left(\frac{N_1}{N_2}\right)^3$$

In the above formula: N— motor speed;
 Q— flow;
 H— pressure;
 P— shaft power.

The above formula shows that the load flow is proportional to the motor speed. The load pressure is proportional to the square of the motor speed. The load power is proportional to the cube of the motor speed.

Wealth of functions to accommodate every need

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 high 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 high efficient plant operation	400	900			
	FRENIC 4400VM5	Large-capacity vector controlled inverter • The capacity of FRENIC4400 series units has been increased due to 3-level control	800	6400			
	FRENIC 4400FM5	Large-capacity V/f controlled inverter • The capacity of FRENIC4400 series units has been increased due to 3-level control	800	2000			
	FRENIC 4700VM5	Medium-voltage large-capacity vector controlled inverter • The capacity of FRENIC4700 series units has been increased thanks to the series-connected device and 3-level control	3440	7800			
For general industry (medium voltage)	FRENIC 4800VM5	Medium-voltage, water-cooling, large-capacity and vector controlled inverter • The capacity of FRENIC4800 series units has been increased due to 3-level control • Downsizing achieved by adopting a water-cooling system	3100	24000			
	FRENIC 4600FM5e	High-high output frequency converter • compact and small structure • variable speed control to high voltage motor and save energy • circuit composition and control design to protect the motor • no pollution to power supply	3000/3300 4160 6000/6600 10000	4750/5200 3300 9500/10500 7950			
	FRENIC 4600FM6e	High voltage and large capacity V/f• inverter with vector control • technology with 2-level control • used in power plants, steel mills, cement plants • circuit composition and control design to protect the motor • no pollution	3000/3300 6000/6600 10000 11000	2500 22000 34000 35400			
For general industry (low voltage)	FRENIC-VG	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			



Overall system solution - "Intelligent and Efficient Power Pack"

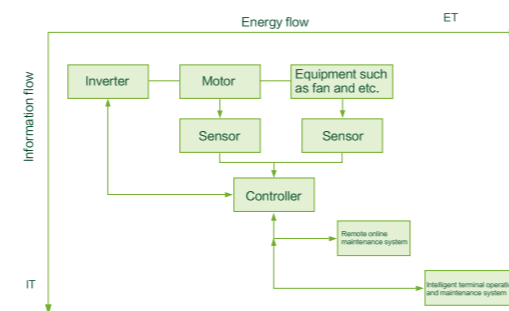
Our company advocates a new user-oriented sales mode, integrates the efficient intelligent drive system, power pack, contract energy management, full life cycle service mode and etc. and innovatively provides the overall system solution- 'Efficient Intelligent Power Pack' to users.

The 'Efficient Intelligent Power Pack' means the high integration of two dimensions including energy flow and information flow in the area of general-purpose machinery and equipment and it is the product of highly combined ET (energy) technology and IT

(Information) technology.

In terms of energy flow: Perform unified modeling with the inverter, motor and actuators (fan or pump or compressor) as a whole, optimize design and achieve high efficiency of system.

In terms of information flow: Use modern information technology, big data technology and fault diagnosis and early warning technology to achieve the high integration and intellectualization of system control, management and maintenance and care.



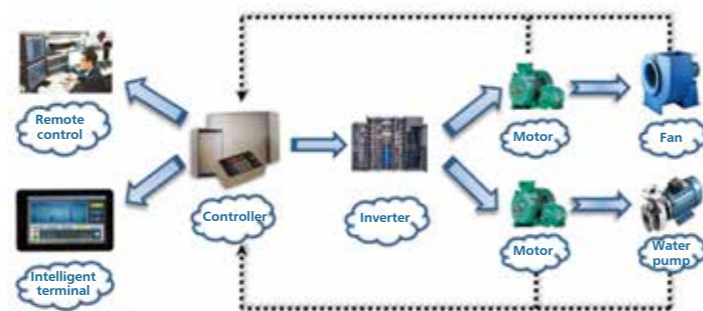
Advantages of "Intelligent and Efficient Power Pack"

Technical Advantages

- Unified modeling and integrated optimization design of system;
- Double optimization of both energy efficiency and control performance of system;
- Intelligent equipment maintenance and operation management;
- Remote monitoring;

Economic Advantages

- The High efficiency of system can supply stable energy-saving benefits to the users;
- The convenience of service can save substantial maintenance costs for users;
- The unity of suppliers can reduce the construction time and cost of projects for users.



Ordering Information

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

Application

Input specifications

- Rated voltage V ± %
- Rated frequency Hz ± %
- Control power source: 1 Φ, 2w, 220V, 50Hz
- Fan power 3 Φ, 3w, 380V, 50Hz

Speed range r/min ~ r/min

Commercial power source bypass circuit (with/without)

- One drive One Manual
- One drive One Automatic
- others

Load machine specifications

- Name (Pump, Fan, Blower, Air compressor, Other)
- Load torque characteristics (Square-law speed, Constant torque, Constant output)
- Load inertia after conversion into motor shaft (J): kg · m²

Drive motor

- Motor specifications (Existing, New installation)
- Rating
- Output kW, No. of poles P, Voltage kV, Frequency Hz, Speed r/min, Current A

Speed/frequency setting

- (Analog signal (4 to 20mA, 0 to 10V), Up/down signal,)

Ambient conditions

- Indoor use
- Humidity
- Temperature
- Altitude
- Provision of air conditioning
- Limit on carrying-in

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Information in this catalog is subject to change without notice.

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