

FRENIC4400VM5/FM5

DC-link 3-level Inverter with Vector and V/f Control



FRENIC4400VM5/FM5

AC Adjustable Speed Drive

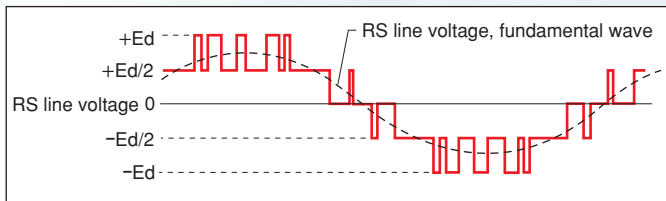
Fuji Electric Systems Co., Ltd.

High-accuracy and High-performance IGBT 3-level PWM Inverter

3-level PWM inverter

The adoption of 3-level PWM control enables an output voltage of 800V AC, hence a single unit can have a rated capacity of 1200kVA. Furthermore, the influence exerted over the motor/machine side can be reduced, as a 3-level inverter is capable of reducing the output harmonics and torque pulsation.

Output voltage waveform of 3-level inverter



IGBT utilized

This inverter has achieved a quick response, low-loss and simplification of the inverter control circuit due to the use of an IGBT (insulated-gate bipolar transistor).

Reduction of harmonic current on power supply side

The adoption of a diode converter of 12-phase rectification method permits reduction of the harmonic current on the power supply side. (Adoption of PWM converter (power supply harmonics \doteq 0) is also feasible.)

Touch panel equipped with a liquid crystal display (*) (LCD)

Setting, running, monitoring and maintenance functions are all adjustable from the touch panel, equipped with a LCD on the unit front.

The LCD displays various data as well as key operational guidance on the bottom, thus facilitating operation.

(*): Available in both Japanese and English (switchable)



FRENIC4400VM5
Vector control inverter

FRENIC4400FM5
V/f control inverter

Enhanced support tools (option)

Analog output for chart, PC loader, web-based remote monitoring, a high speed data acquisition system and other support tools are enhanced.

Connectable to different transmission lines (option)

Connectable with a PLC or other high order controller at high speed and with limited wiring. In addition to Fuji's original D-line, T-link and SX bus, the PROFIBUS-DP, which is a typical open bus, is usable.

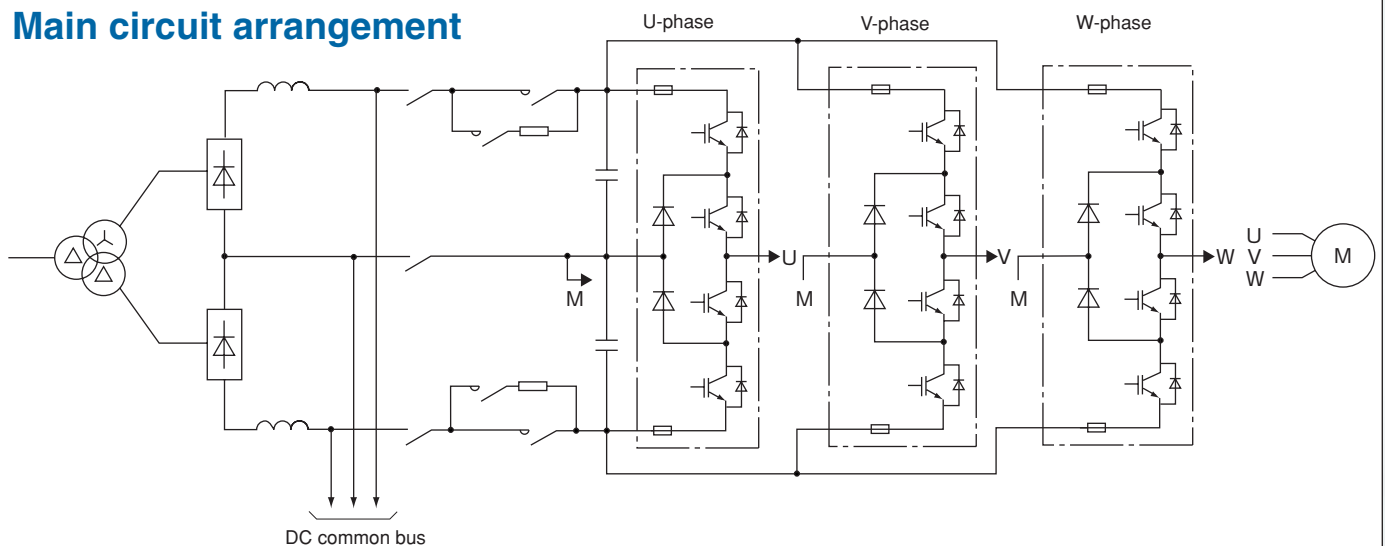
Wide choice of plant control functions

Based on previous operational experiences in different plants to date, various control functions useful for plant control are provided.

Highly-effective plant operation

The DC-link system allows power operational and regenerative energy to be transmitted and received via a DC common bus for highly efficient plant operation.

Main circuit arrangement



Specifications

VM5/FM5

Common specifications

(*): Option

Type		Common to FRENIC4400VM5/FM5		
Main circuit system		Voltage-type IGBT sine wave PWM inverter		
Output voltage		3-phase, 800V AC		
Overload capability		150% for 1min		
Control power supply		3-phase, 200/220V - 15 to +10%		
Control function	Start/stop	Key operation	Touch panel, Loader (*)	
		External signal	Contact input, Analog input ($\pm 10V$)	
		Transmission link operation	D-line/T-link (*), SX bus (*), PROFIBUS-DP (*)	
	Contact input		Built-in 12 points + 4 points (*) (2 points selectable $\times 1$, $\times 2$)	
	Speed setting		Various transmission links, External signals, Touch panel, Loader (*) key operation	
	Operation status signal		<ul style="list-style-type: none"> Relay output (built-in 9 points + 8 points (*)) 3 points selectable (Y1, Y2, Y3) Analog output (built-in 4 points + externally mounted 4 points (*) + built-in 2 points (*)) 	
	Rotating motor pickup		The rotating motor is picked up in inverter operation (SY0).	
	Restart after momentary power failure		Inverter is restarted without stopping the motor.	
	Touch panel		Each constant setting, Startup conditions, Control data digital display, Fault cause display, Fault point data display	
	Loader (*)		Setting item, Startup conditions, Control data digital display, Fault cause display, Fault trace data display (*1)	
	Analog output		Analog output of arbitrary control data	
	Charge lamp		Comes on when residual voltage (25V DC or larger) is in the main circuit.	
	Protection	Protection level		Classified into the following 4 levels. <ul style="list-style-type: none"> Major fault: Trips instantly. Medium fault: Quickly decelerates and trips to stop after the set time has elapsed. Minor fault 1: Cannot be restarted once it is stopped. Minor fault 2: Display only
Overvoltage		Actuated when the DC main circuit voltage exceeds 1580V DC		
Undervoltage		On detecting undervoltage of DC intermediate voltage, inverter stops.		
Overheat		Protects the inverter by detecting the temperature of the heat sink inside the inverter.		
Short-circuit		Detected by "overcurrent."		
Overcurrent		Actuated when the output current peak value exceeds the overcurrent level (fixed).		
Ground fault		By the operation of the converter side ground fault detection relay, inverter stops.		
Motor (*2)		Protected by electronic thermal function and temperature detection. "Overload", "Motor overheat", "Startup congestion", "Overspeed"		
Environment	Installation location		Indoors, Free from corrosive gas, inflammable gas, dust, or explosive gas	
	Ambient temp.		0 to +40°C	
	Ambient humidity		20 to 90% RH (no condensation)	
	Cooling method		Forced air-cooled system	
	Altitude		Up to 1000m	
	Vibration		4.9m/s ² or lower (at 10 to 50Hz)	
	Storage (ambient temp.)		- 5 to +40°C	
Applicable standard		JEC-2410 (JIS, JEM, etc.)		

Note: (*1) Stores and displays control data of 225 points for the past two 1ms sampling.
(*2) Only VM5 has the function of "motor overheat" and "overspeed" protection.

Individual specifications

(**): To be developed

Type		FRENIC4400VM5		
Motor control system		Vector control		
Function	Speed control	ASR fixed cycle 1ms		
		Vector control	Maximum speed	100Hz on inverter output frequency basis
			Control range	1:1000
			Control response	25Hz (mechanical systems not included)
			Speed control accuracy	$\pm 0.01\%$ of the maximum speed
	PG frequency		100kHz or lower	
	Torque accuracy		$\pm 5\%$ of the rated torque	
	Setting resolution		$\pm 0.005\%$ of the max. speed (20000d/100%)	
	Acceleration/deceleration time		0 to 550.00s Linear (break point) acceleration/deceleration Acceleration/deceleration settable by transmission 2 types of deceleration for emergency stop	
	Control function	Multiplex winding motor driving		Up to 24 windings (8 multiplexing) without the output reactor
Start/stop operation selection		The timing for releasing the brake or starting ASR can be controlled by 3 different signals (SY1, 2 and 3 by transmission)		
Droop control		Torque drooping characteristics according to the speed. A fixed drooping type or speed command proportional type.		
Torque control		Torque limit (2 types of transmission) Torque compensation (Transmission 2 types + analog input 1 point) Mechanical loss torque is compensated by polygonal approximation with set value (forward/reverse: 14 points)		
Torque bias		Analog torque setting, Transmission torque setting (2 lines), Mechanical loss pattern, etc.		
Observer		Load disturbance observer Vibration suppression observer		
Acceleration/deceleration forcing		Upon calculating the acceleration/deceleration torque based on the moment of inertia J and acceleration		
Backlash correction		Corrects backlash during mechanical drive by several motors		
Higher setting		Sets the speed higher than normal to cope with load impact		
$\omega 2$ lock		Applies an electromagnetic brake during excitation to prevent the motor from needless rotation		
di/dt limitation		Limits the gradient of the torque current command		
Special braking		Stops the motor without regeneration (**)		

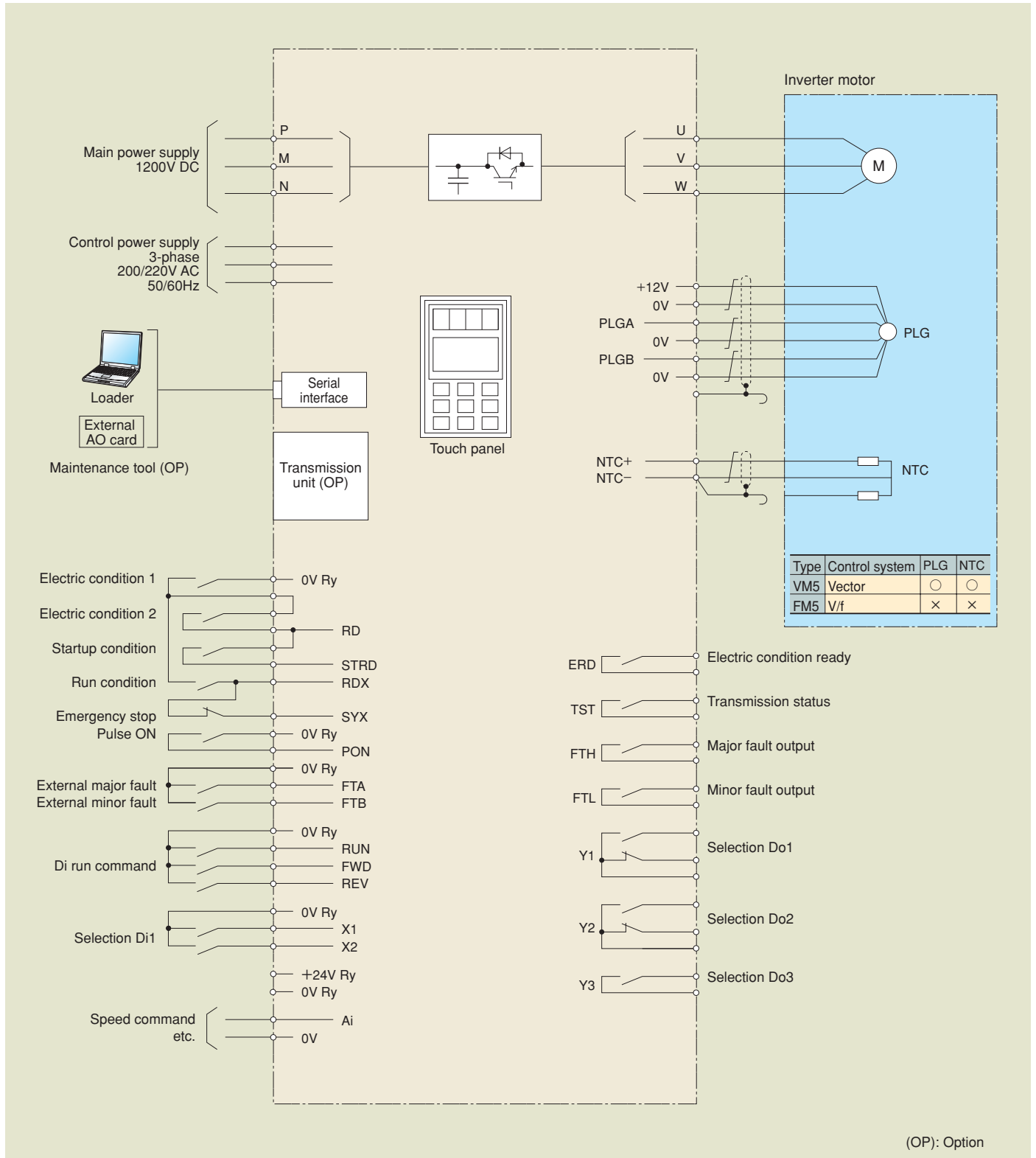
Type		FRENIC4400FM5	
Motor control system		V/f controlled AVR	
Function	Output frequency		2.5 to 100Hz
	Frequency control range		1:80
	Frequency control accuracy		$\pm 0.01\%$ of the maximum frequency
	Field control range		1:4
	Restart after momentary power failure		Inverter is restarted without stopping the motor.

Transmission options

Card name	Use
DSM card	Connects the inverter with the host PLC via D-line, T-link
SX bus card	Connects the inverter with the host PLC via SX bus
PSB card	Connects the inverter with the host PLC via PROFIBUS-DP

Standard interface

VM5/FM5

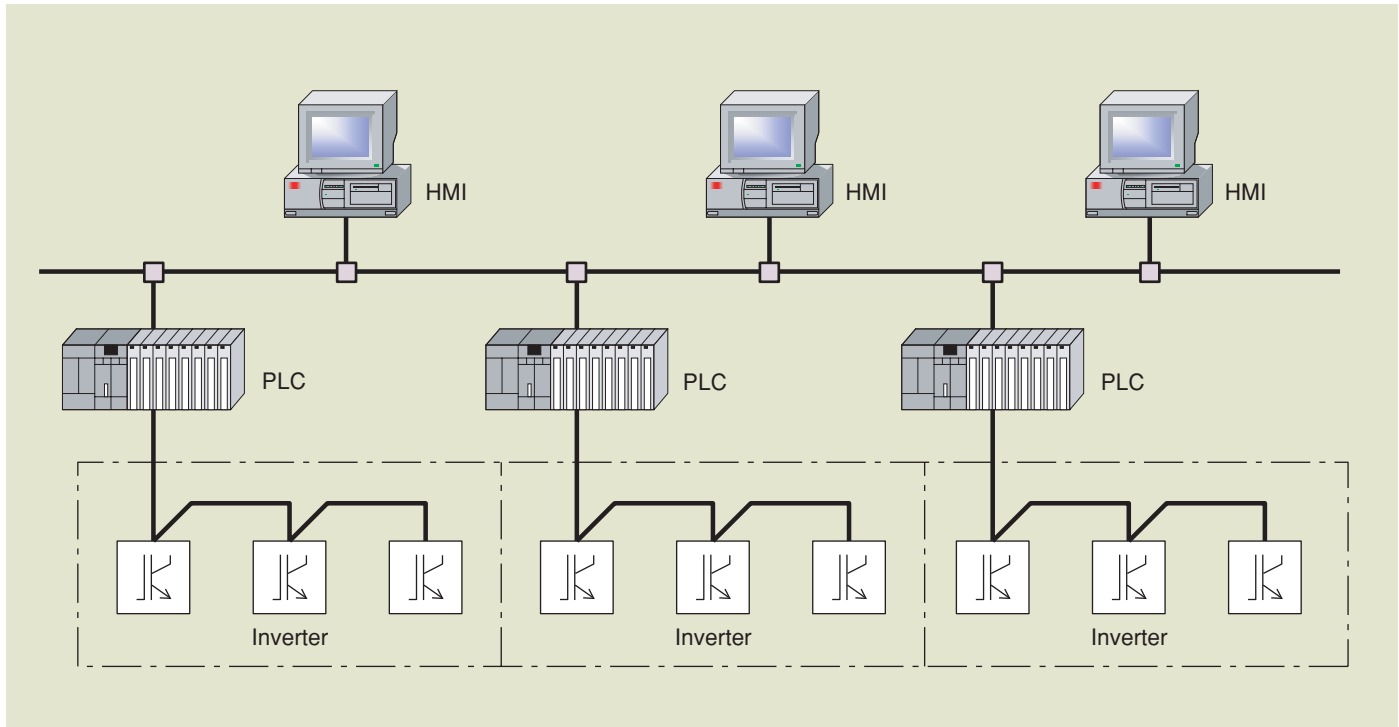


(OP): Option

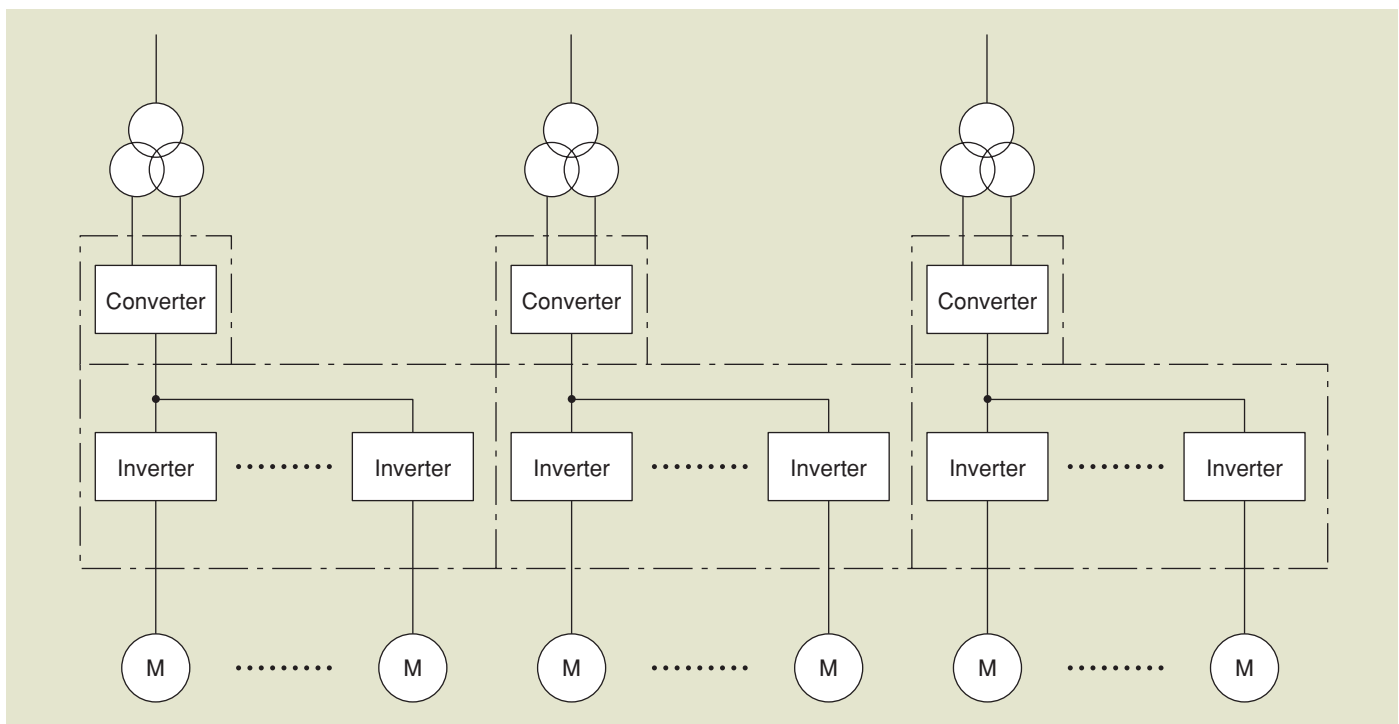
Example of system configuration and single-line diagram

VM5/FM5

System configuration



Single-line diagram



Data setting and monitoring (dedicated touch panel)

VM5/FM5

The touch panel equipped with a LCD displays a lot of information, and facilitates the functions of data setting, running operation and monitoring. On the bottom of the LCD, key operational guidance appears, allowing you to perform almost all operations without referring to the instruction manual.

Up and down keys

Used for changing the Data Indication Nos. and the data setting values.

Program key

Reverts to the monitor screen (default) from any screen.

Shift key (digit shift)

Used to move the cursor from one digit to another in order to change data.

Reset key

When normal:
Assigned to "return" and "cancel" functions.
Returns to the previous layer.
At tripping:
Releases the stop status due to tripping.

Function/data selection key

Assigned to "enter" and "OK" functions.



LED monitor (4 digits)

Displays the number of revolutions (changeable). Any of 8 different data indicated on the LCD on the monitor screen can be selected arbitrarily. At tripping: "Err" blinks automatically, alerting you to the trip.

LCD monitor

Displays various information, including operational, set and fault data over a maximum of 5 lines × 13 characters. Operational guidance appears on the bottom. On tripping, the trip data automatically appears.

Normal, reverse and stop keys

The operation can be started or stopped on the touch panel.

Example of actual screen display

The monitor screen (default screen after turning on power) continually displays all of the current running statuses: speed command, detection, output current, output voltage and key operational guidance.

Use of touch panel (the No. of items is for VM5)

Menu	Description	No. of items
Initial	Monitor screen: Current, voltage and frequency display	Selected out of 2 pictures
M01	Parameter setting reference and change	About 200
M02	Di/Do bit on/off status reference	7 pictures
M03	Ai/Ao voltage reference	2 pictures
M04	Inverter internal data display	About 90
M05	Transmission, sent/received data reference	About 60
M06	Inverter start, stop operation	1 picture
M07	Inverter startup condition on/off reference	2 pictures
M08	Latest fault code (simultaneous occurrence) reference	Up to 20
M09	Error history reference	Latest 40
M10	Inverter inside data reference on trip	About 20
M11	Present time setting, operating time reference, parameter setting control, liquid crystal concentration adjustment, etc.	About 10 pictures

Introduction of some functions

●M09: Error history

Displays a chronological record of the past 40 faults with the causes and the time and date of occurrence, thereby allowing you to trace back errors.

●M10: Trip data display

Displays internal data sampling values and bit data on/off, allowing you to know the fault circumstances.

●M11: Save of parameter settings, load, and comparison

Inverter parameter settings can be saved in batch form into nonvolatile memory using the touch panel. They are retained when the power is turned off. The saved data can also be loaded to the inverter. Current inverter settings and values saved on the touch panel can be compared with each other.

Inverter application and dimensions

VM5/FM5

Basic inverter capacity and bank units

Capacity [kVA]	1200	2000	2400	4000	3600	6000
Composition (unit quantity) (*)	1		2 multiplex		3 multiplex	
Current [A]	866	1443	866×2	1443×2	866×3	1443×3
Overload capability	150% for 1min					
Approx. mass [kg]	1600	2300	2600	4400	3600	6700

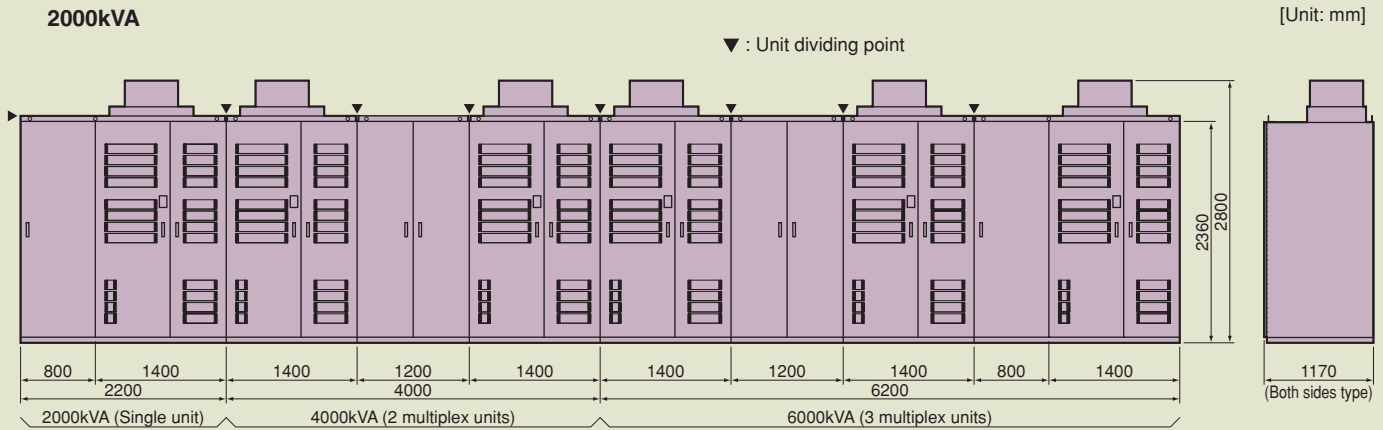
(*): Available maximum unit is 8 multiplex.

Note: Single unit only is applied, if FM5 (V/f control) is selected.

Dimensions

Inverter panel (when diode converter is used)

2000kVA

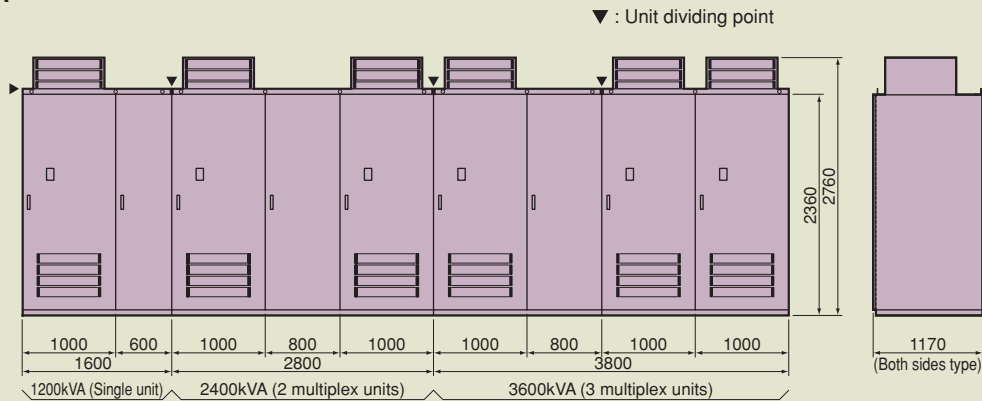


Note: Planned dimensions are indicated for 4,000kVA (2 multiplex units) and 6,000kVA (3 multiplex units). They are subject to change without prior notice.

Inverter panel: Self-standing, enclosed type

Finish color: JEM standard Munsell 5Y7/1 (semi-gloss) for internal and external

1200kVA



Inverter panel: Self-standing, enclosed type

Finish color: JEM standard Munsell 5Y7/1 (semi-gloss) for internal and external

Converter specifications and dimensions

VM5/FM5

- When regeneration function is generally unnecessary: Diode converter
- When the regenerative side capacity is smaller than that on the drive side: Combination of diode converter and PWM regenerative converter
- When regenerative capacity equivalent to that on the drive side is necessary: PWM converter (thyristor converter also available)

Specifications, dimensions and masses

Diode converter

Rated output capacity (*1) [kW] (at 1200V DC output)	Output current [A]	Input			Output		Dimensions W×D×H [mm]	Approx. mass [kg]
		Frequency	Voltage	Control power supply	Voltage	Overload capacity		
3300	2750	50/60Hz ±5%	2 systems of	3-phase, 200/220V -15 to +10%	1200V DC ±10% (depends on input voltage)	150% for 1min	1100×1170×2620	1100
5940	4950		3-phase 460V±10%				2200×1170×2620	2200

(*1): Diode converter of capacity over 5,940kW can also be produced. Please contact us for details.

PWM converter

Rated output capacity [kW]	Output current [A]	Input			Output		Dimensions (*2) W×D×H [mm]	Approx. mass [kg]
		Frequency	Voltage	Control power supply	Voltage	Overload capacity		
920 (unit capacity)	866	50/60Hz ±5%	3-phase, 720V ±10%	3-phase, 200/220V -15 to +10%	1250V DC	150% for 1min	1600×1170×2760	1600
920×2 (2 multiplex)	866×2						2800×1170×2760	2600
920×3 (3 multiplex)	866×3						4600×1170×2760	4200
1530 (unit capacity)	1443						2200×1170×2800	2300
1530×2 (2 multiplex)	1443×2						4000×1170×2800	4400
1530×3 (3 multiplex)	1443×3						6200×1170×2800	6700

(*2): Dimensions of PWM converter panels are same as those of inverter panels shown on P7.

The width of 920kW×3 (3 multiplex) panel only, however, is larger by 800mm than that of an inverter panel.

PWM regenerative converter

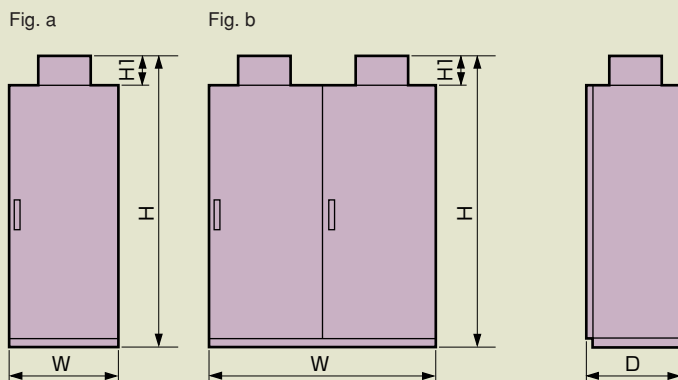
Peak regenerative amount [kW]	Regenerative voltage	Dimensions (*3) W×D×H [mm]	Approx. mass [kg]
1200 (unit capacity)	3-phase, 460V	1600×1170×2760	1600
1200×2 (2 multiplex)		3600×1170×2760	3200

(*3): Dimensions of PWM regenerative converter panels are same as those of inverter panels shown on P7.

The width of a 2 multiplex panel, however, is larger by 800mm than that of an inverter panel.

Dimensions

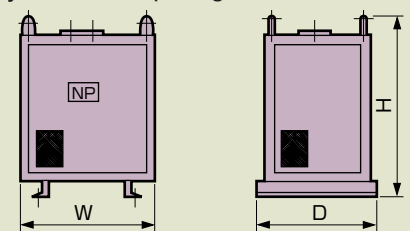
Diode converter panel



Diode converter panel: Self-standing, enclosed type
Finish color: Munsell 5Y7/1 for internal and external

Diode DC power supply current rank [A]	Dimensions [mm]				Fig.	Approx. mass [kg]
	W	D	H	H1		
2750	1100	1170	2630	270	a	1100
4950	2200				b	2200

Separately installed DCL (for diode converter) Separately installed ACL (for PWM converter) Separately installed Tr (for regenerative converter)



Dimensions of DCL

Diode DC power supply current rank [A]	Dimensions [mm]			Approx. mass [kg]
	W	D	H	
2750	800	720	1050	500
4400	1000	900	1400	950

Note: 2 units of DCL are required per converter, as DCL's are good for 3 levels.

Dimensions of ACL

ACL	Dimensions [mm]			Approx. mass [kg]
	W	D	H	
Single unit	1200	900	1600	1100

Note: An ACL is good for a unit PWM converter.

Dimensions of Tr

Tr	Dimensions [mm]			Approx. mass [kg]
	W	D	H	
Single unit	1150	1000	1600	1560

Note: A Tr is good for a unit regenerative converter.

Maintenance tool (option)

VM5/FM5

■ PC loader (FLOAD for Windows)

Although maintenance and adjustment can be performed from the touch panel mounted on the panel face, an optional PC loader is available as a maintenance/adjustment tool. The PC loader installed in a notebook PC, has better operability and visibility than the touch panel. The trace-back data is useful for locating any fault trip.

●Main functions of FLOAD for Windows

●Trace-back data

Upon fault occurrence, the cause as well as the waveform data and bit on/off statuses of the speed, current and other major items are registered. You can proceed to analysis of error circumstances, quick action and recovery. Details of up to 2 of the latest error occurrences can be retained.

●Control parameter setting, change, display and storage

Control parameter settings can be saved with arbitrary filenames and comments and changed on a PC. Thus, the inverter control parameters can be controlled on a PC.

●Running status display

Current inverter running statuses can be viewed at a glance thanks to the block diagram, actual value and internal data indications.

●Fault cause display

Up to 2 faults with up to 20 causes each are indicated together with the time and date of occurrence.

●Test run operation

The loader facilitates easy start and stop of the inverter while its statuses are displayed on the "running status indication screen".

●Multi-window display

Several window indications can be displayed on a single screen, thereby allowing you to simultaneously monitor multiple information sources.

■ External AO card (type: RGGW1AAU-0070D)

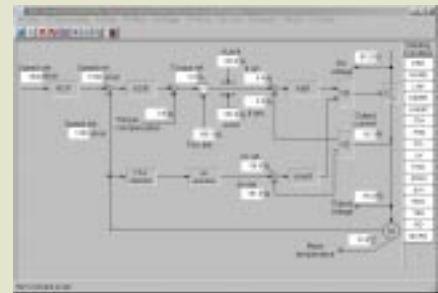
Inverter internal data (signal selection out of about 60 data) can be outputted by 4 channels in $\pm 10V$ of analog voltage. They are isolated from the inverter.

■ Special lifter

The inverter can be replaced by a small number of persons. The inverter, as well as the converter, can be handled upon changing the load bucket.



Trace-back data (inverter waveform at fault) window



Running status window



Multi-window display

■ plusFSITE (*1) (Field Web adapter)

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.)

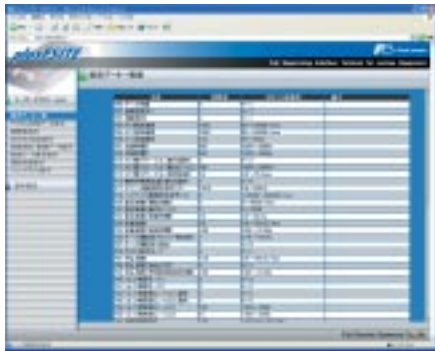
●Mail sending function

Actions can be reported periodically from inverters.

Upon fault occurrence, mail, including trace-back data, is transmitted.

●Applicable to the FRENIC4400VM5/FM5 and other Fuji Electric products.

(*1): plusFSITE: Fuji Supervising Interface Terminal for various Equipment



■ f(s)NISDAS (*2)

The inverter monitoring can be centralized at high speed.

●Main features

●Real time monitoring

Inverter data can be sampled every 10ms (for up to 32 inverters simultaneously).

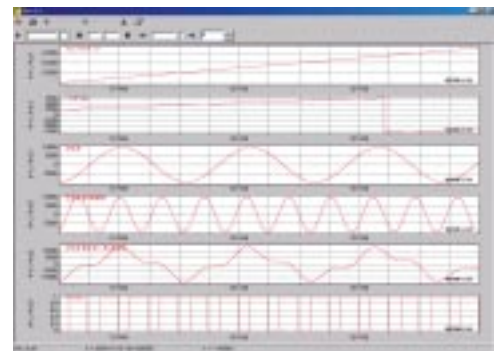
●Trace-back data acquisition

Trace-back data stored in the inverter can be acquired.

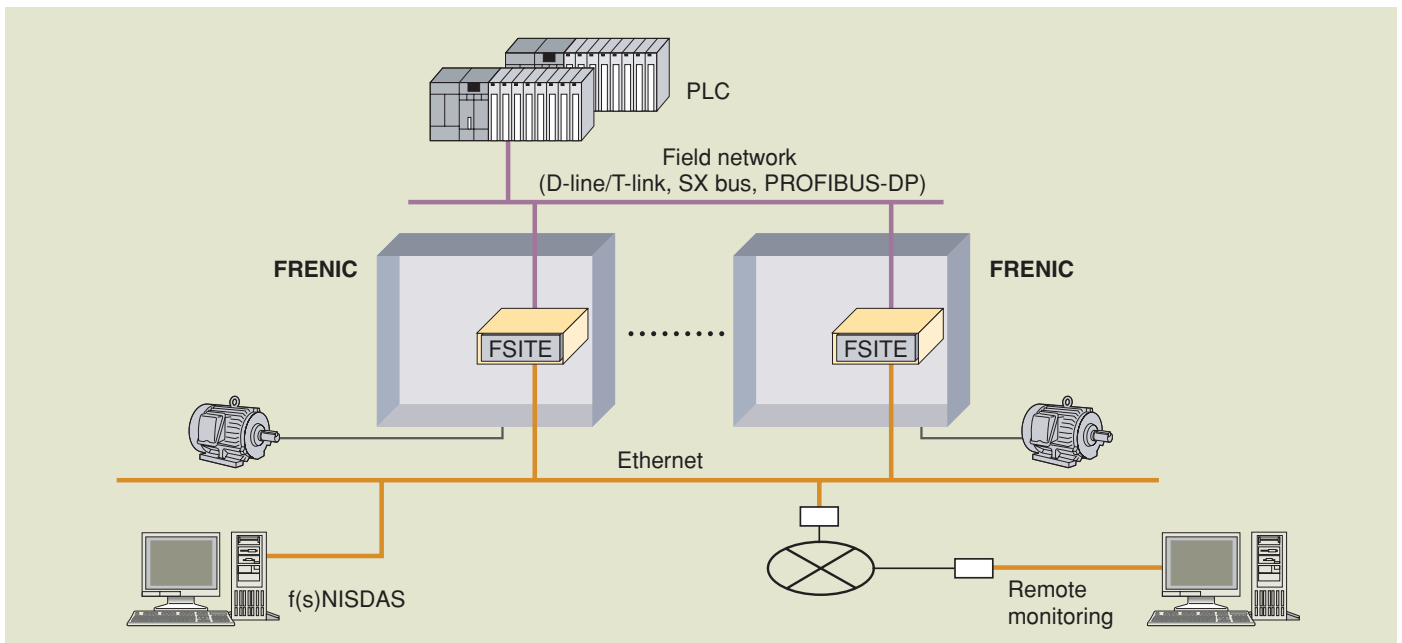
●PLC internal data acquisition

Fuji general-purpose PLC (MICREX-SX) internal data can be acquired.

(*2): f(s)NISDAS: Using open-Network & I.T., based on SX, Diagnosis and Analysis System



■ Example of system configuration



Adjustable speed drives of Fuji Electric group

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			
	LEONIC-M700	Thyristor converter for plants • Large-capacity thyristor converter for various types of control	220 DC 440 DC 750 DC	...			
	LEONIC-M Compact	Unit-type DC motor controller • Compact thyristor controller equipment intended for update from analog controller also	220 DC 440 DC	75kW 150kW			
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.	3300 6600 10000	5200 10500 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			

Ordering information

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

Application of inverter		Remarks:	
Load machine specifications			
Name: <input type="checkbox"/> Pump <input type="checkbox"/> Fan <input type="checkbox"/> Blower <input type="checkbox"/> Air compressor <input type="checkbox"/> Other ()			
Load torque characteristics: <input type="checkbox"/> Square-law speed <input type="checkbox"/> Constant torque <input type="checkbox"/> Constant output			
Moment of load inertia after conversion into motor shaft (J):			kg · m ²
Overload: %			
Input specifications			
Rated voltage: V ± %		Rated frequency: Hz ± %	
Control power source: -phase, -wire, V, Hz			
Driven motor			
Motor specifications: <input type="checkbox"/> Squirrel-cage rotor <input type="checkbox"/> () , <input type="checkbox"/> Existing <input type="checkbox"/> New installation			
Rating	Output: kW	No. of poles:	Voltage: kV
	Frequency: Hz	Speed: r/min	Current: A
Speed control			
Control range: r/min to r/min			
Rotational/frequency setting method			
Ambient conditions			
Installation location: Indoor	Humidity: %RH	Temperature: °C	Altitude: m
Provision of air conditioning:		Limit on carrying-in:	

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