

FVR-G2 SERIES FOR GENERAL-PURPOSE INVERTER

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1 FOREWORD

For general-purpose inverters, high functionality and compactness in size are highly demanded, and in response to the demand, integration and miniaturization of power converting elements and control elements as IC and power transistors are greatly advanced. Furthermore, for general-purpose inverters, it is important to take notice of their ease in handling as well as their applications to the fields that have no highly technological engineering techniques and maintenance techniques.

The FVR-G2 Series are the general purpose inverters developed in order to cope with such market demand taking up thorough miniaturization, economicity and high functionality as a goal.

As a machine model series, enclosed type from 2 to 13kVA and totally enclosed type from 2 to 6 kVA are available. In this report, description is made as to the features of this series.

2 SPECIFICATIONS

Fig. 1 shows the outer view and *Table 1*, the specifications.

2.1 Miniaturization

Miniaturization was the main theme of development of this series. The principal points are the following.

- (1) Miniaturization of print board
 - (a) Semi-custom LSI are equipped.
 - (b) In order to mount the power circuit on print board, DC-DC converter circuits have been adopted so that transformers are discarded.
 - (c) Detecting circuits are now all in hybrid IC's.
 - (d) 16-bit CPUs have been adopted and transfer from hardware to software in large scale has been carried out.

- (2) Miniaturization of inner mechanism

By compounding main circuit parts, number of internal parts are reduced in large scale and, at the same time, by adopting a high-efficiency coolant, though the whole

Fig. 1 FVR-G2 series

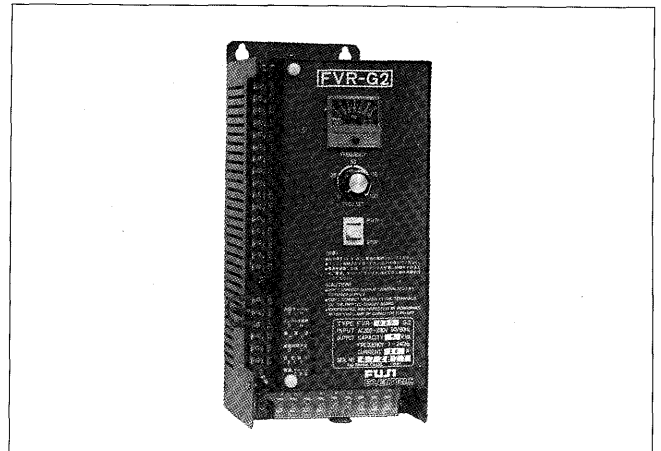
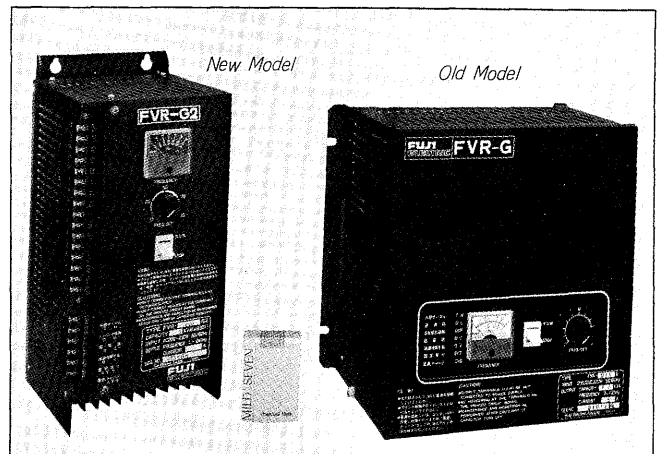


Fig. 2 Comparison of old and new FVR-G2 (2 kVA)



series are of self-cooling type, miniaturization of the device has been attained with a success.

In comparison with the conventional types of devices, the new models succeeded in reducing both floor area and volume by 60%. *Fig. 2* shows the comparison between old and new models of 2 kVA FVR-G2.

2.2 Higher Functionality

The series have the following features so as to match

Table 1 Specifications of FVR-G2 series

Applicable motor output (kW)			0.4	0.75	1.5	2.2	3.7	5.5	7.5	
Inverter model			FVR-015G2	G2 S G2 C G2 CS	FVR-030G2	G2 S G2 C G2 CS	FVR-050G2	G2 S G2 C G2 CS	FVR-075G2 G2 S FVR-100G2 G2 S	
Inverter capacity(kVA)			2		4		6		13	
Rated output current (A)			5		10		16		33	
Input	Voltage and Frequency	Three-phase three-wire system 200~230V, 50/60 Hz								
	Allowable variation	Voltage, 180~253V Frequency, ±5%								
Output	Voltage (V)	Three-phase three-wire system 200, 220, 230 (proportional response to input voltage)								
	Frequency (Hz)	50, 60, 100, 120, 150, 180, 200, 240								
Control system			Sinusoidal wave, PWM control							
Frequency control range			1~240 Hz (Operable from 0.5 Hz) Control range 1:50~1:240							
Frequency precision			±0.5% of maximum frequency (at 25.±10°C)							
Frequency resolution			0.03 Hz (at 1~60 Hz)							
Voltage/frequency ratio			V/f pattern switching (14 patterns) V/f intensity switching (16 steps) (with square-number reduction torque response)							
Overcurrent resistance			150% one minute (non timing characteristics)							
Soft start/soft stop			Switchover of 0.18~12s. 15~1,800s. (Both start and stop time can be adjusted individually. With short setting time, acceleration and deceleration can be made automatically.)							
Stall prevention			Motors are designed not to stall during overcurrent and overvoltage age suppression.							
Operating system			Advance and reverse operation (terminals for inching and inverter stop, provided)							
Converter efficiency			95% or more							
Speed setting signal			DC 0~-10V (Input impedance, 22 kΩ), 4~20 mA DC 0~+10V (Input impedance, 22 kΩ).							
Braking			Braking circuit incorporated. Braking torque 40~100%. Braking torque reinforceable by option)							
			100%		65%	45%	40%			
Protective function	Inverter interruption	Inverter overheat	Abnormal heating of inverter inner mechanism due to overload is detected.							
		Overcurrent	Starting current at the time of motor acceleration and regenerative current at the time of deceleration are detected.							
		Overvoltage	Regenerative voltage at the time of deceleration and decelerating time error are detected.							
		Undervoltage	Undervoltage of commercial power supply is detected.							
	Instantaneous current interruption		Operates without anomalies with instantaneous current interruption of commercial power supply within 15 m. After restauration, when operating instruction is issued, operation will be restarted automatically.							
	Output terminal short circuit		When inverter output terminal is short-circuited, inverter is protected. (Enclosed type with 6 kVA or less only)							
	External thermal		At motor thermal contact, inverter will stop. (After restauration, automatically accelerated)							
LED display			Internal voltage residue, externally set signal ON, overcurrent, inverter overheat, erroneous deceleration time (overvoltage)							
Environment	Location		Indoors, altitude, 1,000 m or less, no corrosive gas nor dust.							
	Ambient temperature		-10~40°C (inside the panel, -10~50°C, with front panel removed)							
	Ambient humidity		Relative humidity 90% or less (no condensation)							
Construction	Unit type with enclosure protective case									
	En-closed type	With control panel	FVR-015 G2	FVR-030 G2	FVR-050 G2	FVR-075 G2	FVR-100 G2			
		Without control panel	FVR-015 G2 S	FVR-030 G2 S	FVR-050 G2 S	FVR-075 G2 S	FVR-100 G2 S			
	With totally enclosed case unit type									
	Totally enclosed type	With control panel	FVR-015 G2 C	FVR-030 G2 C	FVR-050 G2 C	—	—			
		Without control panel	FVR-015 G2 CS	FVR-030 G2 CS	FVR-050 G2 CS	—	—			
Approximate weight (kg)		Enclosed type	4.5	6.5	7	16	21			
		Totally enclosed type	5	8	11.5	—	—			

the use as general-purpose electric device:

- (1) Expansion of frequency control range
Diversification of V/f patterns, and selecting notches

available are 14.

- (2) Diversification of applications
Torque boosts are available in 16 types (among which,

2 torque boosts are of square-number reduction type), so that an optimum inverter operation can be made for not only constant torque load but also for loads for fans.

(3) High functionality

Jogging operation, two-step speed switching and accelerating and decelerating time switchover that needed up to now external sequence devices are incorporated into inverters as standard circuits, so that the new types of inverters are particularly advantageous for transfer and locating operations.

(4) Perfectioning of protective circuits

Since they are used in combination with various sorts of electric motors, they are equipped with protective circuits that prevent anomalies from being emerged by any circumstance of operation. For example, they protect the device in safety even when terminals are short circuited due to erroneous wiring. And the operation of the protective circuit is indicated by LED according to the cause of trouble, so that their trouble shooting can be made very easily.

2.3 Higher Performance

When an acceleration or deceleration is made within a short time, if inverter frequency change is made within too short a time, an excessive current will flow. In order to prevent such problems, an optimum stall control mode is made possible to select according to the load condition and by making output frequency operation minute.

In order to improve the output waveform, the current

waveforms are approached as near to that of sinusoidal wave AC as possible thus, trying to reduce the motor loss as well as vibrations and noise.

3 CIRCUIT COMPOSITION

3.1 Circuit Operation

Fig. 3 shows a block diagram of control circuit of this series.

(1) Main circuit

The main circuit has a function of converting three-phase AC from commercial power source into DC in the converter unit (diode rectifier circuit), then this DC power is converted again into AC frequency and voltage of determined value in the inverter unit (six-arm transistor).

The unit giving ON/OFF signal of six-arm transistor is the control circuit.

(2) Control circuit

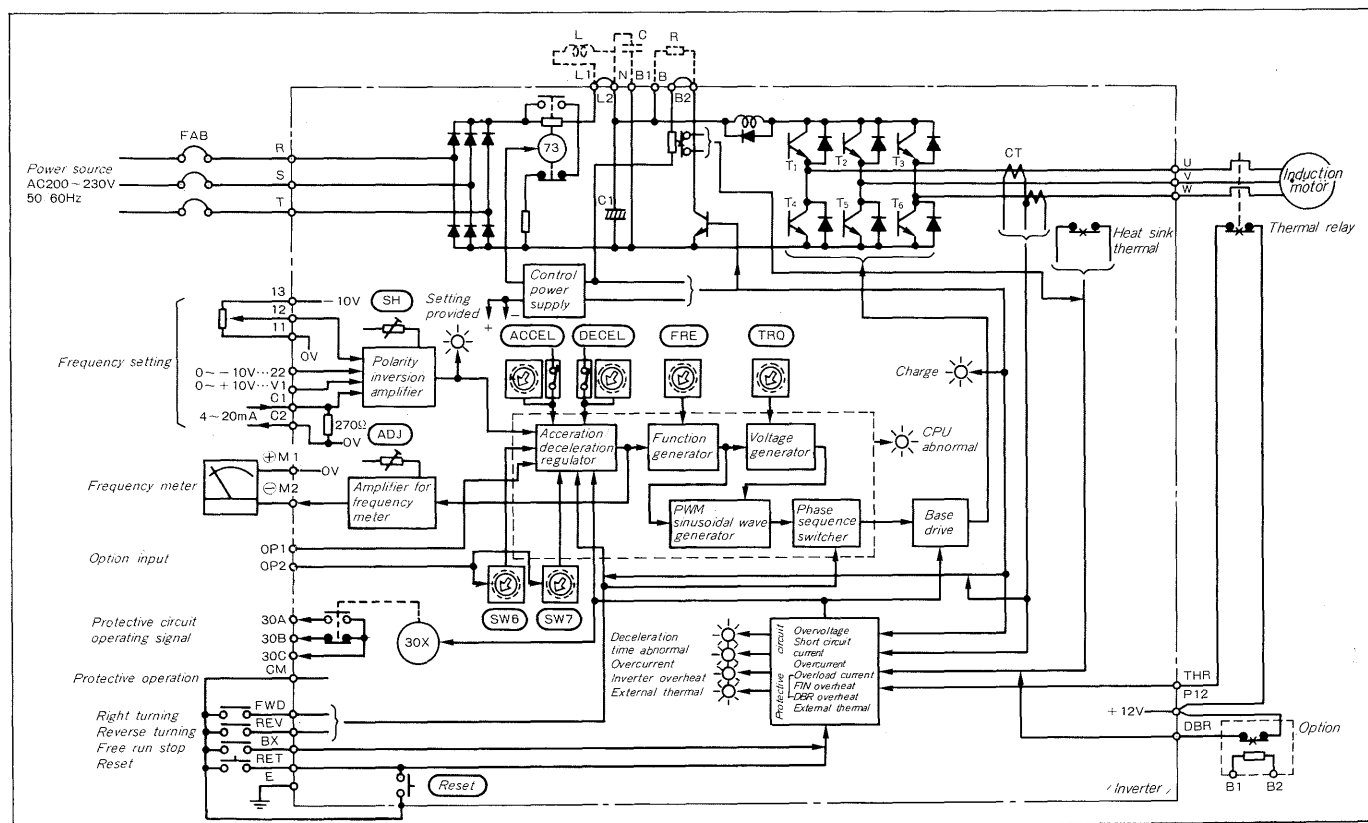
The part surrounded by broken lines in Fig. 3 is the area functioning with 16-bit CPU.

Receiving signals from Setting Input Unit, Detector Circuit and Amplifier Circuit calculating operation, control, instruction, and waveform generation are processed in this part. Classified according to functions, they are: Power supply circuit, input/output detector circuit, and main control circuit.

(3) Power supply circuit

Receiving DC intermediate voltage of the inverter as an input, the circuit effectuates chopper control and generates

Fig. 3 Total block diagram of FVR-G2



low-voltage DC power, so that this constitutes a small-sized power source with low loss.

(4) Input/Output detector circuit

The circuit consists of frequency setting circuit and protective circuit.

- (a) Integration is made as semi-custom LSI combining together A/D converter circuit for digitalizing signals from frequency setting circuit with storage timer.
- (b) For the protective circuit, in particular for protection from overvoltage and overcurrent, two systems, momentaneous interruption control and suppression control are mounted.

(5) Main control circuit

This circuit consists of the area surrounded by broken lines of Fig. 3 and base drive circuit. Output waveform generation is effectuated by real-time event timer located within CPU, interceptable with the highest priority. The output waveform is calculated in its pulse width per each carrier and then it is outputted.

The data on pulse width are preset to exclusive timer and waveforms are outputted in three phases simultaneously.

4 OPERATION CHARACTERISTICS AND APPLICATION TECHNIQUE

Fig. 4 shows transit response characteristics. Part (a) indicates the case of 100% load, while (b) and (c), 160% load.

From (a) and (c), it is known that, when the load becomes from 100% to 160%, the accelerating time will be automatically extended from 0.29 seconds to 0.39 seconds. This shows that the stall prevention function is operating.

Likewise, with (b) and (c), it is known that when torque boost is made stronger (setting TRQ to F), the accelerating time will be shortened and can output larger torque.

Fig. 5 shows the difference in acceleration/deceleration characteristics between this series and conventional type FVR-G. In particular, it is obvious from the figure, that the accelerating characteristics are largely improved under the full load condition.

Fig. 6 indicates current waveforms when the series machine is combined with a general-purpose motor of 3.7 kW, 4 poles. Ideal fundamental waves are obtained for

Fig. 4 FVR-G2 transit response characteristics (general-purpose electric motor, 0.75 kW)

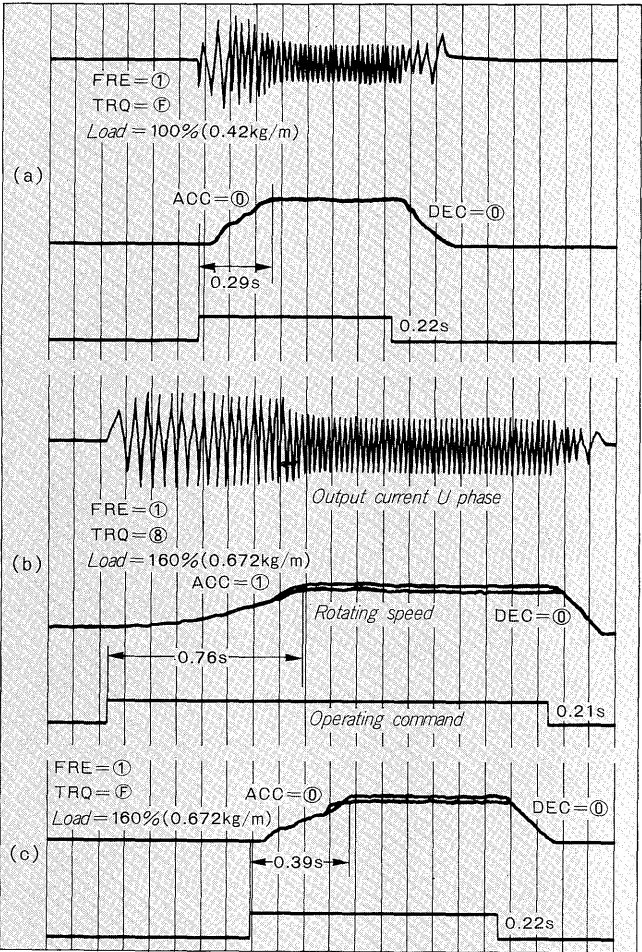


Fig. 5 Comparison of acceleration/deceleration characteristic between new and old models

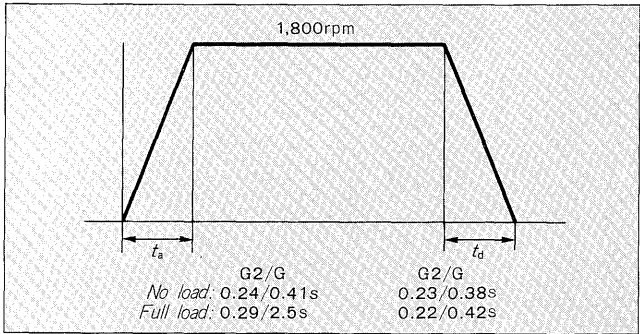


Fig. 6 FVR-G2 current waveform (driving general-purpose electric motor 3.7 kW)

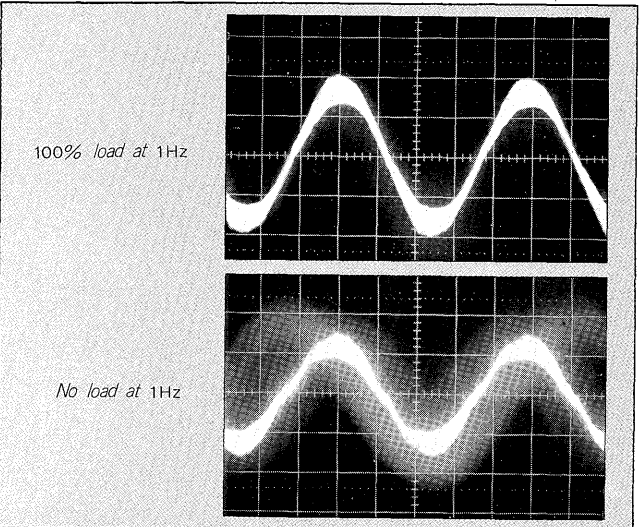
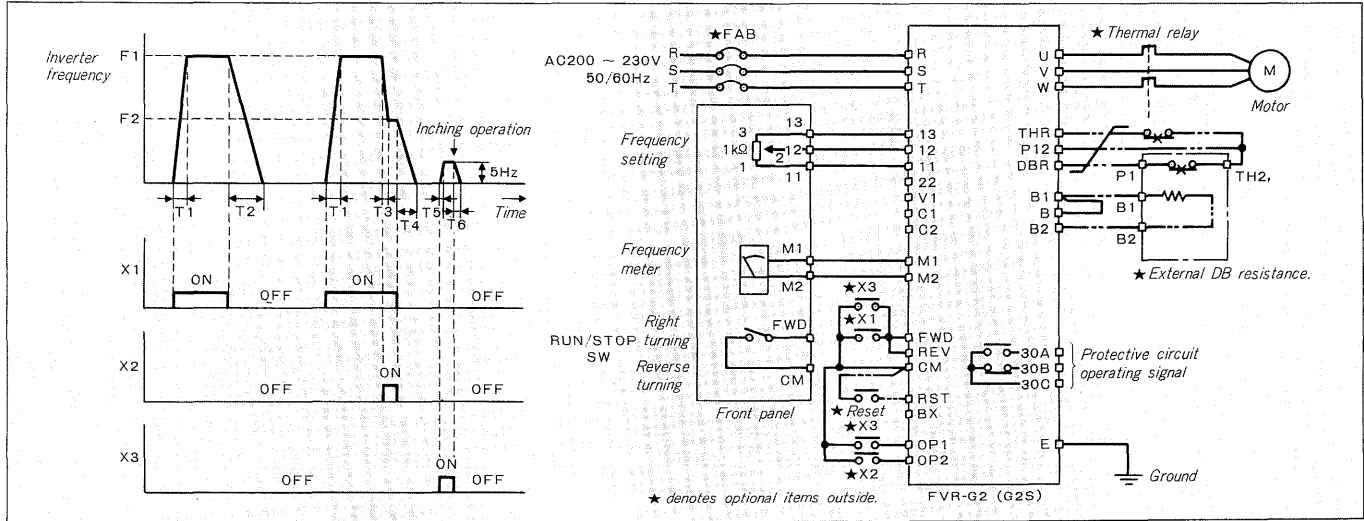


Fig. 7 FVR-G2 connection diagram



both full-load and no load condition with 1 Hz.

The connection diagram shown in Fig. 7 is a typical example of FVR-G2 applied for carrying operation.

As frequency setting two-step switching, jogging operation, and decelerating shoft time changeover programs are incorporated as standard specifications, the external sequence operating circuit is made extremely simple.

This function has obtained a big success among manufacturers of sets and panels.

5 SUMMARY

We believe that the general-purpose inverters' applications as variable speed equipment for general-purpose electric motor will expand more and more. Our prediction is that their use will be divided into two types: one for adaption to machines of still more advanced technology and another for easier adaption to variable-speed machines. In either case, we will do our best to heighten the degree of integration of control circuits, push forward our policy of miniaturization, obtaining higher performance, lower cost and easiness in handling, and increase in reliability as well as to cope with the expansion of application to variable-speed drive equipment.