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COMPACT TYPE INVERTER FVR-K7S

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1. FOREWORD

Multifunctionalization is one branch of general purpose inverters which are represented by the all-digital type. On the other hand, because limited functions are acceptable, there is a demand for an inverter which is simple to operate. Fuji Electric placed the FVR-K5 Series on the market and has received valuable suggestions from numerous sources through its sale. The newly developed FVR-K7S, which reflects these proposals extensively, is outline.

2. CONSTRUCTION AND SPECIFICATIONS

An exterior view of the FVR-K7S Series is shown in *Fig. 1* and its standard specifications are given in *Table 1*. The main features of the FVR-K7S are described below.

2.1 Expanded capacity range

Whereas the old FVR-K5 Series has two models of 0.4kW and 0.75kW, the FVR-K7S Series has been expanded to one small capacity model and three large capacity models. The 0.2kW model, in particular, was developed to meet the needs of a broad range of fields extending up to consumer applications.

2.2 All models have a fully enclosed construction and are compact

Generally, the outside dimensions of an inverter are governed by the floor space of the internal parts layout and cooling design for the heat generated by the power circuit.

(1) Miniaturization of control circuit

Most of the functions of the control circuit were provided on one chip by developing a DSP (Digital Signal Processor) as the operation element and an ultra LSI for the peripheral circuitry. As a result, the PC board area was reduced substantially and reliability was improved.

(1) Miniaturization of main circuit

For the 0.2 to 0.75kW models, cooling design and minimization of the parts occupancy area were pursued exhaustively by using Fuji Electric's original high heat conduction printed circuit board and mounting the main circuit parts at chip level and all the other heat generating parts on this printed circuit board.

Fig. 1 FVR-K7S

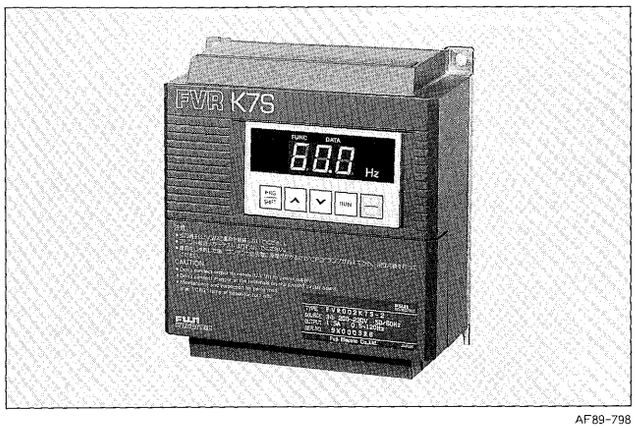

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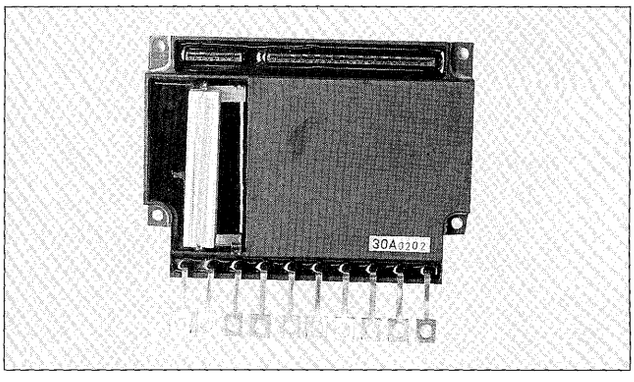
Fig. 2 Composite power module



For the 1.5 to 3.7kW models, a composite power module housing all the main circuit parts except the capacitor as shown in *Fig. 2* was developed and the dimensions were reduced and a wireless main circuit construction was established.

Hardwiring between power module and printed circuit board and between printed circuit boards was eliminated and assembly and maintenance workability were improved considerably by using a card wire system.

The overall results of these are shown in *Table 2*. As much smaller size than other Fuji Electric products was

Table 1 Standard specifications (extract)

Item \ Model			FVR002 K7S-2	FVR004 K7S-2	FVR008 K7S-2	FVR015 K7S-2	FVR022 K7S-2	FVR037 K7S-2
Standard applicable motors (kW)			0.2	0.4	0.75	1.5	2.2	3.7
Output	Rated capacity (kVA)		0.6	1.2	2.0	3.2	4.4	6.8
	Rated output voltage (V)		3-phase, 3-wire type 200 to 230					
	Rated output frequency (Hz)		50Hz, 60Hz, 50~100Hz, 60~120Hz					
	Rated output current (A)		1.5	3	5	8	11	17
	Overload current rating		150% for 1 min (inverse time characteristic)					
Power supply	Rated input AC voltage		3-phase, 3-wire 200 to 230V, 50/60Hz Allowable fluctuation: +10%, −15%, frequency ±5%, voltage unbalance within 35					
Condition			Indoors, altitude 1000m or less, no direct sunlight, corrosive gas, oil mist, or dust Ambient temperature −10 to +50°C (ventilation cover removed if temperature is over +40°C) Relative humidity 20 to 90% (no condensation), 0.6G or less (conforms to JIS C 0911)					
Construction			Fully-enclosed self-cooling type (IP40 JEM1030)			Fully-enclosed fored air cooling type (IP40 JEM1030) *Fan not enclosed.		
Approx. weight (kg)			1.3	1.6	2.1	3.3	3.4	3.5
Control specifications	Control system		Vector dispersion PWM control					
	Output frequency range		0.5~120Hz					
	Frequency resolution		Output frequency: 0.1Hz (step=0.01Hz), setting: digital 0.1Hz, analog 0.02Hz (at 60Hz)					
	Frequency temperature fluctuation		Digital ±0.01% (at 25°C ±10°C), analog ±0.2% (at 60Hz)					
	Voltage/frequency characteristic (V/f)		4 patterns, torque boost: 16 kinds					
	Acceleration/deceleration		Independent setting of acceleration/deceleration times (time 50Hz 0.17 to 250 secs, 60Hz 0.2 to 300 secs)					
	Braking torque	Regenerative braking	Condenser regenerative braking (Braking resistor is optional for 1.5kW and larger models)					
		DC braking	Braking time 0.; 1 to 10 secs variable, braking voltage 0 to 10% variable, braking start frequency 0.5 to 60Hz variable					
Protection functions			Stall prevention, overcurrent, overvoltage, undervoltage, momentary power interruption, inverter overheating, external alarm					
Operation	Frequency setting signal		Voltage input DC0 to +10V, current input DC4 to 20mA selectable					
	Input signal (contact input)		Forward command, reverse command, multi-stage frequency selection, free running command, external alarm input, alarm reset command					
	External output signal (contact output)		Batch alarm output (30A, 30C: contact capacity AC250V, cosϕ=0.3)					
Frequency setting signal	Frequency monitor output		DC0 to +10V (voltage adjustment range DC6.5 to 10.5V)					
	7-segment LED display		Set frequency, output frequency, function code, set data, individual alarm cause display; Displays present and past three times					
	Charge lamp		Lights when DC capacitor voltage is charged.					
Standard functions			No. 2 acceleration/deceleration time switching, upper limit limiter, lower limit limiter, bias.					

realized and the smallest class dimensions in the world were achieved. Fully enclosed construction at these dimensions is another big feature.

2.3 Simple operation even though digital

As shown by *Fig. 1*, a simple system limited to 3 digits LED and five keys is used. At function setting, basically, the 1st digit shows the function and the remaining two digits display the data code.

2.4 Outline of control functions

From the standpoint of operability, the conventions are selected in order of need and the following functions are installed as standard:

(1) Frequency setting

Besides external analog signal (variable resistor, 0-10V, 4-20mA), digital frequency setting of up to 4 stages is possible by key operation. The 2nd to 4th stages frequency is selected by external signal (X1, X2).

Upper and lower limit frequencies and bias frequency setting is also possible by key operation.

(2) Frequency meter output

The operating frequency is digitally displayed on front panel LEDs, but a 10V/highest frequency analog output is provided for those who wish analog display. Since the output corresponding to the highest frequency can be varied over the 6.5 to 105V range, a variable resistor for meter adjustment is unnecessary.

(3) Adjustable DC braking

DC braking with 60Hz or less arbitrary setting brake starting frequency, 0.1 to 10 seconds braking time, 0 to 10% voltage adjustment for braking force, and other

adjustment functions is possible.

(4) AVR control

Since 150 to 230V variable setting AVR control of the maximum output voltage is possible and the optimum voltage for the motor can be selected.

Table 2 Outline dimensions comparison

Comparison item		Old mode<note>	FVR-K7S	Ratio
0.2kW use	Outline dimensions (mm)	194x255x75	160x170x80	–
	Installation area (cm^2)	495	272	55%
	Volume (cm^3)	3,710	2,176	59%
0.4kW use	Outline dimensions (mm)	194x255x75	160x170x100	–
	Installation area (cm^2)	495	272	55%
	Volume (cm^3)	3,710	2.720	73%
0.75kW use	Outline dimensions (mm)	194x255 x75	160x170x115	–
	Installation area (cm^2)	495	272	55%
	Volume (cm^3)	3,710	3,128	84%
1.5kW use 2.2kW use 3.7kW use	Outline dimensions (mm)	220x300x165	160x200x170	–
	Installation area (cm^2)	660	320	48%
	Volume (cm^3)	10,890	5,440	50%

< Note > 0.2 to 09.75kW use are compared to FVR-K5 Series.
1.5 to 3.7kW use are compared to FVR-G5E Series.

Typical functions were described above. For other general functions, see *Table 1*.

3. CIRCUIT CONFIGURATION

The circuit configuration of the FVR-K7S Series is shown in *Fig. 3* since a shunt resistance system is for current detection at the main circuit, the circuit is small and stable current detection can be performed over the entire frequency range. For 1.5kW and larger models, a braking discharge transistor is built-in as standard.

The control circuit mounts a 3-bit DSP as the operation element and a processing speed approximately 50 times faster than that of the old models is realized. As a result, the output frequency change resolution is improved to 0.01Hz and smooth motor acceleration/deceleration was realized. The response time for external signals was also shortened considerably. The part enclosed in the broken lines in *Fig. 3* is the part consisting of DSP and ultra LSI. Most control is processed in the range of these two parts.

4. OPERATING CHARACTERISTICS

Typical operating characteristics are introduced.

4.1 Noise characteristic

In *Fig. 4*, the noise when the same motor was driven by the FVR-K7S and an old type is frequency analyzed. Audibly, whereas the old type makes a high frequency metallic sound, the new type makes a pure low sound. This

Fig. 3 FVR-K7S circuit configuration

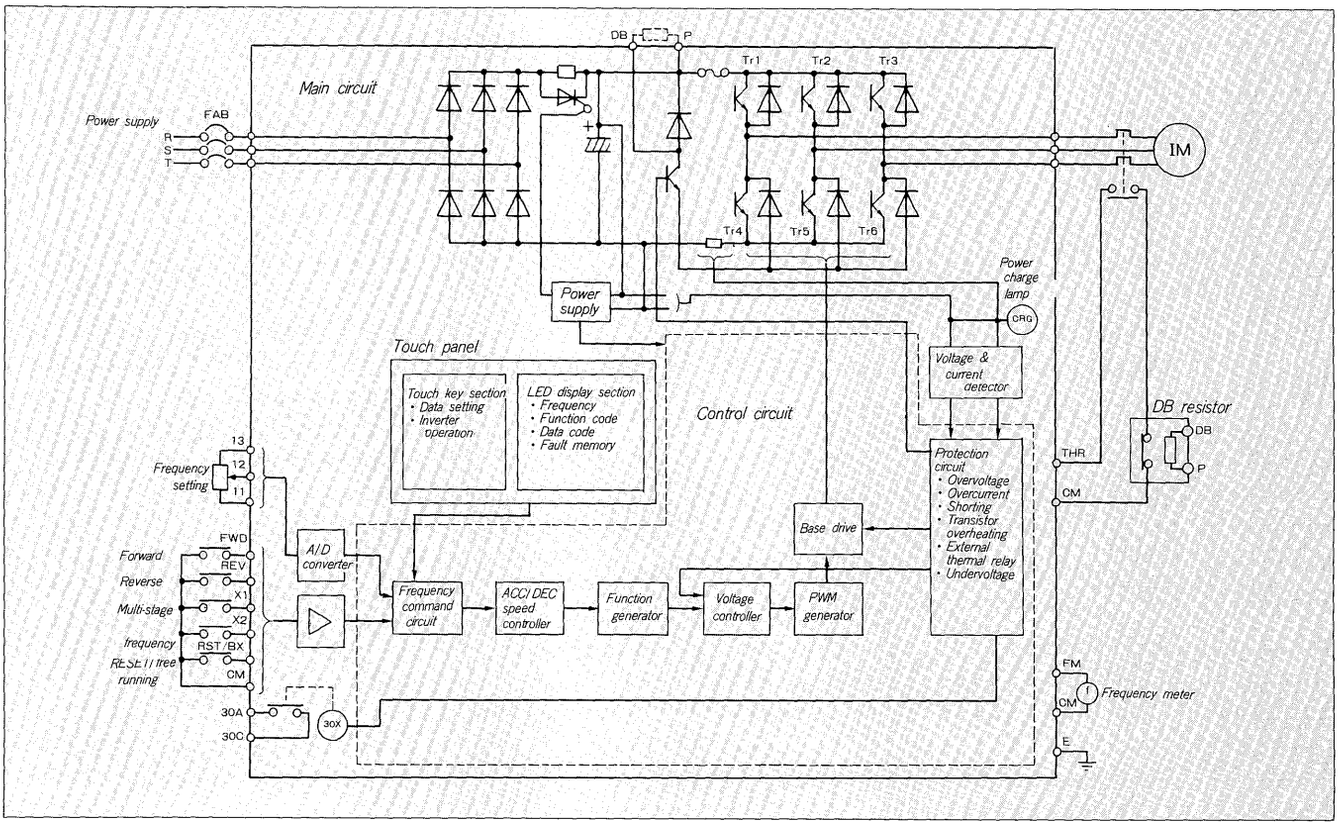
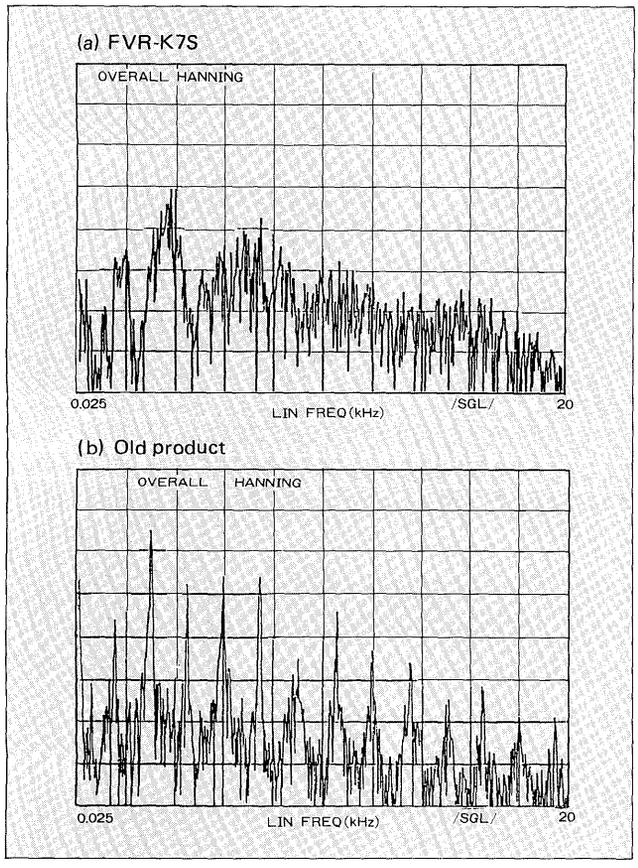


Fig. 4 Motor noise frequency spectrum comparison

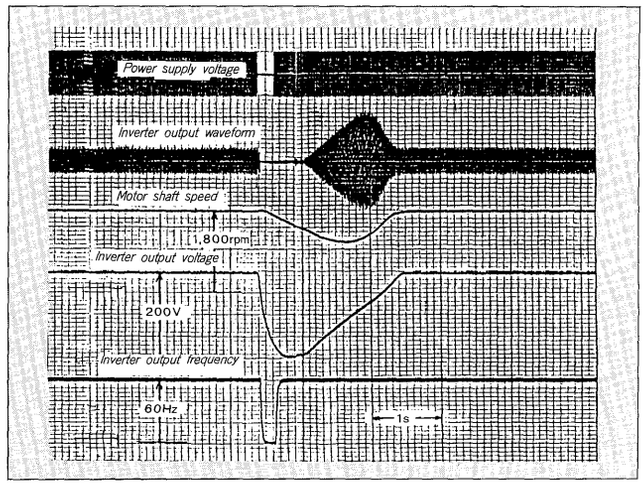


is the effect of the newly developed vector dispersion PWM control system.

4.2 Momentary power interruption restarting characteristics

Figure 5 is an example of the operating characteristics

Fig. 5 Momentary power interrupt restarting characteristics



when the standard momentary power interruption restarting function was selected. When the power recovers, pull-in operation is performed by a method which raises the voltage slowly.

When overcurrent tripping occurred during pull-in, the pull-in operation is repeated while changing the frequency.

5. CONCLUSION

The FVR-K7S Series was outlined above. Since the conditions not satisfied by the old model are substantially met, much is expected of the FVR-K7S Series in a wide range of applications. We solicit the cooperation and guidance of these concerned in the future.