MITSUBISHI ELECTRIC
Changes for the Better

Automating the World

FACTORY AUTOMATION

WHITE PAPER

Active front end drive by FR-A842

The inverter, which converts DC to AC for motor drive, and the PWM converter, which converts DC to AC for power regeneration, are identical in terms of DC-AC conversion and have the same circuit configuration. Therefore, by simply modifying the internal software, the FR-A842, converter-separated type inverter, can be easily utilized as the PWM converter(AFE) without any changes to the unit itself.

To configure PWM converter using the FR-A842, you can easily achieve this by combining the options and reactors shown in the table 1 below as illustrated in Fig. 2, and by changing the parameter (Pr.328 Inverter/Converter Switching). By using the FR-A842 as the PWM converter, the benefits on the right can be achieved:

-Energy Saving:
Regeneration capability is 100% continuous, 150% for 60 seconds

-Harmonic Suppression:
THDi ≤ 5%
THDv: Compliant with IEEE519
K5=0(Harmonic suppression guidelines in Japan)

-High Power Factor:
Power factor of 0.99 or higher (at 100% load)

- Standardization of Maintenance Inventory

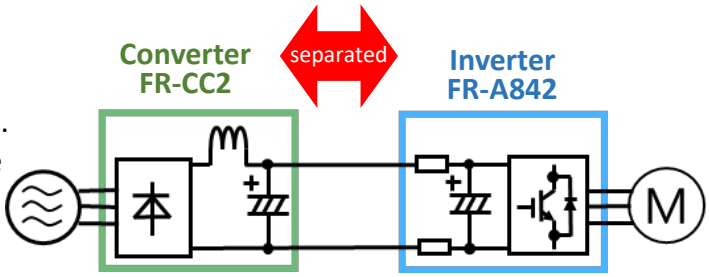

Fig. 1: Separated Type Inverter

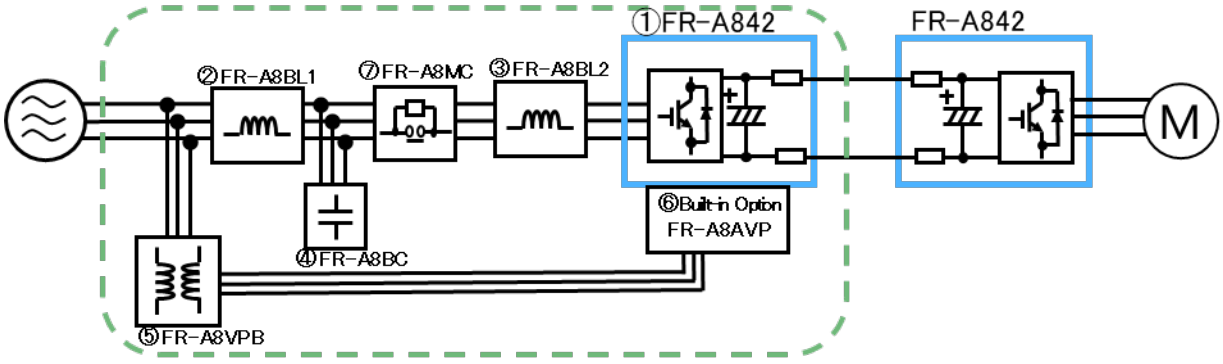

Fig. 2: PWM Converter Configuration

Table 1: Options Combination Table

Converter Capacity	①Converter	②Dedicated filter reactor	③Dedicated reactor for PWM control	④Dedicated filter capacitor	⑤Phase detection transformer box	⑥Phase Detection Option	⑦Dedicated circuit parts for inrush current protection
315kW	FR-A842-315K	FR-A8BL1-H315K	FR-A8BL2-H315K	FR-A8BC-H400K	FR-A8VPB-H	FR-A8AVP	FR-A8MC-H355K
355kW	FR-A842-355K	FR-A8BL1-H355K	FR-A8BL2-H355K				
400kW	FR-A842-400K	FR-A8BL1-H400K	FR-A8BL2-H400K				FR-A8MC-H500K
450kW	FR-A842-450K	FR-A8BL1-H450K	FR-A8BL2-H450K	FR-A8BC-H500K			
500kW	FR-A842-500K	FR-A8BL1-H500K	FR-A8BL2-H500K				

Operation of Each Option

Next, we will provide an overview of the operation of each option.

<②/③/④ LCL Filter Circuit>

The PWM converter controls the current so that a sinusoidal current, in phase with the power supply voltage, flows into the power supply. To achieve this, the converter outputs a voltage that is PWM-controlled at a constant carrier frequency. An LCL filter is installed to prevent the carrier frequency components from leaking into the power supply current. The transfer characteristics of the LCL filter are designed with constants that can sufficiently attenuate the carrier frequency components. In the example characteristics below, the carrier components are significantly attenuated. Additionally, harmonics such as the 3rd and 5th components of the power supply frequency are suppressed through control. Therefore, this LCL filter is used to suppress the carrier frequency components that cannot be suppressed by control.

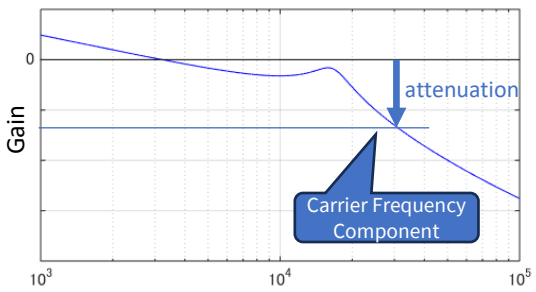

Fig. 3 Example of LCL Filter Characteristics

<⑤/⑥ Phase Detection>

It is necessary to detect the power supply phase to control the power supply current in accordance with the power supply voltage phase. The phase is detected using the phase detection transformer box ⑤ and captured with the phase detection option ⑥. This enables high power factor and harmonic suppression.

<⑥ Converter Switching>

After attaching the phase detection option ⑥ to the built-in option connection connector of the inverter main unit, write the specified values (3100, 5010, 1000) into Pr.328. This transfers the converter control information stored in the phase detection option ⑥ to the inverter main unit, switching the inverter control to converter control. The switching process takes approximately 300 seconds. The same procedure can be used to switch back to inverter control. Always refer to the phase detection option's instruction manual for the switching procedure.

<⑦ Dedicated Inrush Current Suppression Component>

To prevent excessive current from flowing when the power is turned on, the DC bus voltage is initially charged through a resistor immediately after power-on and then connected via a magnetic contactor after charging. By connecting as described in the instruction manual, the PWM converter detects the DC bus voltage and controls the magnetic contactor at the appropriate timing.

Common DC bus connection

•A single PWM converter can connect to 10 inverters.
•Select the PWM converter capacity and the connected inverter capacities according to the following criteria.

$$\frac{Converter\ Capacity}{2} \leq \sum Inverter\ Capacity \leq Converter\ Capacity$$

•When connecting multiple inverters, it is recommended to set fuses corresponding to the motor capacity.
•The total wiring length between the converter and inverters should be 50 meters or less.
•The number of connected inverters mentioned above is a guideline; the actual number of connectable inverters may vary depending on capacity and output.
•If you need to connect more inverters, please contact our sales department.

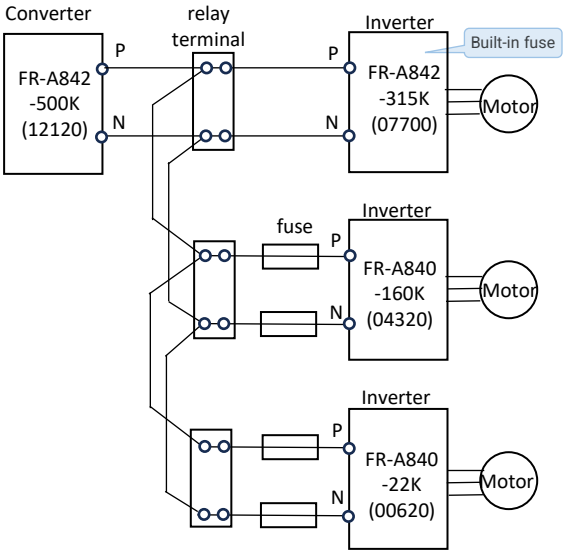

Fig.4 Example of common bus connection

Specifications and Strategies for Output increase

Table 2 shows the specifications when using the FR-A842 as the PWM converter. The maximum rated output power is 595 kW. This value is based on the converter output shown in Fig. 5, with the input voltage of AC 400V. The converter output and motor output are calculated using the following formulas.

Converter Output = √3 × Rated Current × Input Voltage × Power Factor × Converter Efficiency

Motor Output = Converter Output × Inverter Efficiency × Motor Efficiency

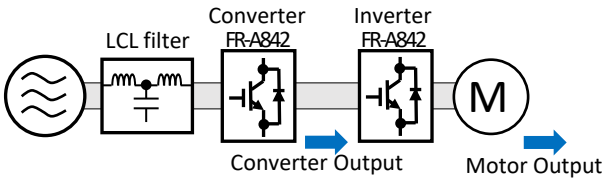

Fig.5 Converter Output and Motor Output

From this formula, it can be understood that the converter output and motor output can be increased by the input voltage. Therefore, Table 3 shows the output based on the input voltage. From this table, the maximum motor output can reach up to 664 kW (886 HP).

Table 2. Converter Ratings

Model FR-A842-[]	315K	355K	400K	450K	500K
	07700	08660	09620	10940	12120
Applicable inverter capacity(kW)	315	355	400	450	500
Rated output capacity(kW) *1	375	423	476	536	595
Rated voltage(V)	3 Phases 380 to 500V 50Hz/60Hz				
Rated current(A)	564	636	716	806	895
Overload current rating	150% 60s				
Permissible power supply voltage fluctuation	323 to 506V 50Hz/60Hz				
Input power factor	0.99 or more (when load ratio is 100%)				
Power supply harmonic suppression effect	K5=0, THDi=5% or less, THDv: IEEE519 compliant				

*1: DC output capacity when input voltage is AC400V. ND rating only.

Table 3. Output increase with input voltage

Input Voltage	Converter output		Motor output	
	kW	HP	kW	HP
380V	566	745	505	673
400V	**595**	794	531	709
420V	625	834	558	744
440V	655	873	585	779
460V	685	913	611	815
480V	715	952	638	850
500V	744	992	**664**	**886**

Conditions: FR-A842-500K, Rated Current = 595A, Power Factor = 0.99, Converter Efficiency = 0.97, Inverter Efficiency = 0.97, Motor Efficiency = 0.92
•The performance of the FR-A842 with output enhancement has been confirmed, but the voltage tolerance of the motor and other peripheral devices needs to be verified separately.