

Chapter 7 MAINTENANCE AND INSPECTION

Perform daily and periodic inspection to avoid trouble and keep reliable operation for a long time. Take care of the following items during work.

WARNING

- Before proceeding to the maintenance and inspection, turn OFF the power and wait more than five minutes. Make sure that the LED monitor is turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P (+) and N (-) has dropped below the safe voltage (+25 VDC).

Electric shock may occur.

- Maintenance, inspection, and parts replacement should be made only by authorized persons.
- Take off the watch, rings and other metallic matter before starting work.
- Use insulated tools.
- Never modify the inverter.

Electric shock or injuries could occur.

7.1 Daily Inspection

Visually inspect errors in the state of operation from the outside without removing the covers while the inverter operates or while it is turned ON.

- Check if the expected performance (satisfying the standard specification) is obtained.
- Check if the surrounding environment satisfies Chapter 2, Section 2.1 "Operating Environment."
- Check that the LED monitor displays normally.
- Check for abnormal noise, odor, or excessive vibration.
- Check for traces of overheating, discoloration and other defects.

7.2 Periodic Inspection

Perform periodic inspection by the following items of the list of periodic inspection in Table 7.1. Before performing periodic inspection, be sure to stop the motor, turn OFF the inverter, and shut down power supply. Then remove the covers of the control and main circuit terminal blocks.

Table 7.1 List of Periodic Inspections

Check part	Check item	How to inspect	Evaluation criteria
Environment	1) Check the ambient temperature, humidity, vibration and atmosphere (dust, gas, oil mist, or water drops).	1) Check visually or measure using apparatus.	1) The standard specification must be satisfied.
	2) Check if tools or other foreign materials or dangerous objects are left around the equipment.	2) Visual inspection	2) No foreign or dangerous objects are left.
Voltage	Check if the voltages of the main and control circuit are correct.	Measure the voltages using a multimeter or the like.	The standard specification must be satisfied.

Table 7.1 List of Periodic Inspections (Continued)

Check part	Check item	How to inspect	Evaluation criteria	
Keypad	<ol style="list-style-type: none"> 1) Check if the display is clear. 2) Check if there is missing parts in the characters. 	<ol style="list-style-type: none"> 1), 2) Visual inspection	<ol style="list-style-type: none"> 1), 2) The display can be read and there is no fault.	
Structure such as frame and cover	<ol style="list-style-type: none"> 1) Abnormal noise and excessive vibration 2) Loosen bolts (tightened parts) 3) Deformation and breakage 4) Discoloration and deformation caused by overheat 5) Check for foulness and dust. 	<ol style="list-style-type: none"> 1) Visual or hearing inspection 2) Retighten. 3), 4), 5) Visual inspection	<ol style="list-style-type: none"> 1), 2), 3), 4), 5) No abnormalities	
Main circuit	Common	<ol style="list-style-type: none"> 1) Check if bolts and screws are tight and not missing. 2) Check the devices and insulators for deformation, cracks, breakage and discoloration caused by overheat and deterioration. 3) Check for foulness and dust. 	<ol style="list-style-type: none"> 1) Retighten. 2), 3) Visual inspection	<ol style="list-style-type: none"> 1), 2), 3) No abnormalities
	Conductor and wire	<ol style="list-style-type: none"> 1) Check the conductor for discoloration and distortion caused by overheat. 2) Check the sheath of the cable for cracks and discoloration. 	<ol style="list-style-type: none"> 1), 2) Visual inspection	<ol style="list-style-type: none"> 1), 2) No abnormalities
	Terminal block	Check that the terminals are not damaged.	Visual inspection	No abnormalities
	DC link bus capacitor	<ol style="list-style-type: none"> 1) Check for electrolyte leakage, discoloration, cracks and swelling of the case. 2) Check if the safety valve does not protrude remarkably. 3) Measure the capacitance if necessary. 	<ol style="list-style-type: none"> 1), 2) 3) Measure discharge time with capacitance probe. Visual inspection	<ol style="list-style-type: none"> 1), 2) 3) The discharge time is not shorter than time specified by the replacement manual. No abnormalities
	Braking resistor	<ol style="list-style-type: none"> 1) Check for odor caused by overheat and cracked insulator. 2) Check for broken wire. 	<ol style="list-style-type: none"> 1) Smelling and visual inspection 2) Visual inspection or measurement with multimeter under disconnection of one lead 	<ol style="list-style-type: none"> 1) No abnormalities 2) Within $\pm 10\%$ of the specified resistance
	Transformer and reactor	Check for abnormal roaring noise and odor.	Hearing, visual and smelling inspection	No abnormalities
	Magnetic contactor and relay	<ol style="list-style-type: none"> 1) Check for chatters during operation. 2) Check for rough contacts. 	<ol style="list-style-type: none"> 1) Hearing inspection 2) Visual inspection 	<ol style="list-style-type: none"> 1), 2) No abnormalities

Table 7.1 List of Periodic Inspections (Continued)

Check part		Check item	How to inspect	Evaluation criteria
Control circuit	Printed circuit board	1) Check for loose screws and connectors. 2) Check for odor and discoloration. 3) Check for cracks, breakage, deformation and remarkable rust. 4) Check the capacitors for electrolyte leaks and deformation.	1) Retighten. 2) Smelling and visual inspection 3), 4) Visual inspection	1), 2), 3), 4) No abnormalities
Cooling system	Cooling fan	1) Check for abnormal noise and excessive vibration. 2) Check for loose bolts. 3) Check for discoloration caused by overheat.	1) Hearing and visual inspection, or turn manually (be sure to turn the power OFF). 2) Retighten. 3) Visual inspection	1) Smooth rotation 2), 3) No abnormalities
	Ventilation path	Check the heat sink, intake and exhaust ports for clogging and foreign materials.	Visual inspection	No abnormalities

If the inverter is stained, wipe it off with a chemically neutral cloth to remove dust and use a vacuum cleaner.

7.3 List of Periodical Replacement Parts

Each part of the product has its own service life that will vary according to the environmental and operating conditions. It is recommended that the following parts be replaced as specified below.

When the replacement is necessary, consult your Fuji Electric representative.

Table 7.2 Replacement Parts

Part name	Standard replacement intervals
DC link bus capacitor	10 years
Electrolytic capacitors on the printed circuit boards	10 years
Cooling fan	10 years

(Note) These replacement intervals are based on the estimated service life of the inverter at an ambient temperature of 40°C (104°F) under 80% of full load. In environments with an ambient temperature above 40°C (104°F) or a large amount of dust or dirt, the replacement intervals may need to be reduced.

Standard replacement intervals mentioned above is only a guide for replacement, not a guaranteed service life.

7.3.1 Judgment on service life

(1) Viewing data necessary for judging service life; Measurement procedures

Through Menu #5 "Maintenance Information" in Programming mode, you can view on the keypad various data (as a guideline) necessary for judging whether key components such as the DC link bus capacitor, electrolytic capacitors on the printed circuit boards, and cooling fan are approaching their service life.

①-1 Measuring the capacitance of the DC link bus capacitor (in comparison with that at factory shipment)

Measure the capacitance of the DC link bus capacitor according to the procedure given below. The result will be displayed on the keypad as a ratio (%) to the initial capacitance at the time of factory shipment.

Procedure for measuring capacitance

- 1) To ensure validity in the comparative measurement, put the condition of the inverter back to the state at factory shipment.
 - Remove the option card (if already in use) from the inverter.
 - In case another inverter is connected via the DC link bus to the P(+) and N(-) terminals of the main circuit, disconnect the wires. (You do not need to disconnect a DC reactor (optional), if any.)
 - In case the standard keypad has been replaced with an optional multi-function keypad after the purchase, put back the original standard keypad.
 - Turn OFF all the digital input signals fed to terminals [FWD], [REV], and [X1] through [X5] of the control circuit.
 - If a potentiometer is connected to terminal [13], disconnect it.
 - If an external apparatus is attached to terminal [PLC], disconnect it.
 - Ensure that transistor output signals ([Y1] and [Y2]) and relay output signals ([30A/B/C]) will not be turned ON.



If negative logic is specified for the transistor output and relay output signals, they are considered ON when the inverter is not running. Specify positive logic for them.

- Keep the ambient temperature within 25°C (77°F) ±10°C (50°F).
- 2) Switch ON the main circuit power.
 - 3) Confirm that the cooling fan is rotating and the inverter is in stopped state.
 - 4) Switch OFF the main circuit power.
 - 5) Start the measurement of the capacitance of the DC link bus capacitor. Make sure that ". . . ." appears on the LED monitor.
 - If ". . . ." does not appear on the LED monitor, the measurement will not start. Check the conditions listed in 1).
 - 6) Once ". . . ." has disappeared from the LED monitor, switch ON the main circuit power again.
 - 7) Select Menu #5 "Maintenance Information" in Programming mode and note the reading (relative capacitance (%) of the DC link bus capacitor).
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①-2 Measuring the capacitance of the DC link bus capacitor (during power-off time under ordinary operating condition)

If the measuring method for discharging condition of the DC link bus capacitor during a power-off time under the ordinary operating condition at the end user's installation is different from the initial measuring method at the time of factory shipment, the capacitance of the DC link bus capacitors can not be measured. Follow the procedure mentioned below when you measure the capacitance of the DC link bus capacitors under the ordinary operating condition at the end User's installation.

----- **Procedure for setting up measurement condition** -----


- 1) Set function code H98 (Protection/maintenance function) to enable the user to specify the judgment criteria for the service life of the DC link bus capacitor (Bit 3) (refer to function code H98).
- 2) Place the inverter in stopped state.
- 3) Place the inverter in the state of power-off under ordinary operating conditions.
- 4) Set both function codes H42 (Capacitance of DC link bus capacitor) and H47 (Initial capacitance of DC link bus capacitor) to "0000."
- 5) Switch OFF the inverter.

Measure the discharging time of the DC link bus capacitor and save the result in function code H47 (Initial capacitance of DC link bus capacitor).

The condition under which the measurement has been conducted will be automatically collected and saved.


During the measurement, ". . . ." will appear on the LED monitor.

- 6) Switch ON the inverter again. Confirm that H42 (Capacitance of DC link bus capacitor) and H47 (Initial capacitance of DC link bus capacitor) hold right values. Move to Menu #5 "Maintenance Information" and confirm that the relative capacitance (ratio to full capacitance) is 100%.

 **Note** If the measurement has failed, "0001" is entered into both H42 and H47. Check whether there has been any mistake in operation and conduct the measurement again.

To change the settings back to the state at the time of factory shipment, set H47 (Initial capacitance of DC link bus capacitor) to "0002"; the original values will be restored.

Hereafter, each time the inverter is switched OFF, the discharging time of the DC link bus capacitor is automatically measured if the above condition is met.

 **Note** The condition given above produces a rather large measurement error. If this mode gives you a lifetime alarm, set H98 (Maintenance operation) back to the default setting (Bit 3 (Specify service life criteria for replacing the DC link bus capacitor) = 0) and conduct the measurement under the condition at the time of factory shipment.

② Electrolytic capacitors on the printed circuit boards

Move to Menu #5 "Maintenance Information" in Programming mode and check the accumulated run time of the electrolytic capacitors on the printed circuit boards. This value is calculated from the cumulative total number of hours a voltage has been applied on the electrolytic capacitor. The value is displayed on the LED monitor in units of 1000 hours.

③ Cooling fan

Select Menu #5 "Maintenance Information" and check the accumulated run time of the cooling fan. The inverter accumulates hours for which the cooling fan has run. The display is in units of 1000 hours. The accumulated time should be used just a guide since the actual service life will be significantly affected by the temperature and operation environment.

(2) Early warning of lifetime alarm

For the components listed in Table 7.3, you can get an early warning of lifetime alarm at one of the transistor output terminals ([Y1] and [Y2]) and the relay contact terminals ([30A/B/C]) as soon as any of the conditions listed under the "Judgment level" column has been exceeded. When the replacement data of any parts exceeds the judgment level, this signal comes ON.

Table 7.3 Criteria for Issuing a Lifetime Alarm

Parts to be replaced	Judgment level
DC link bus capacitor	85% or lower of the capacitance than that of the factory setting
Electrolytic capacitors on the printed circuit boards	87000 hours or longer as accumulated run time (estimated service life at the inverter's ambient temperature of 40°C (104°F) under 80% of full load)
Cooling fan	87000 hours or longer as accumulated run time (estimated service life at the inverter's ambient temperature of 40°C (104°F) under 80% of full load)

7.4 Measurement of Electrical Amounts in Main Circuit

Because the voltage and current of the power supply (input, primary circuit) of the main circuit of the inverter and those of the motor (output, secondary circuit) include harmonic components, the readings may vary with the type of the meter. Use meters indicated in Table 7.4 when measuring with meters for commercial frequencies.

The power factor cannot be measured by a commercially available power-factor meter that measures the phase difference between the voltage and current. To obtain the power factor, measure the power, voltage and current on each of the input and output sides and calculate in the following formula.

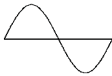
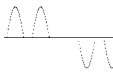
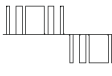
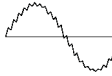




■ Three-phase input

$$\text{Power factor} = \frac{\text{Electric power (W)}}{\sqrt{3} \times \text{Voltage (V)} \times \text{Current (A)}} \times 100 \%$$

■ Single-phase input

$$\text{Power factor} = \frac{\text{Electric power (W)}}{\text{Voltage (V)} \times \text{Current (A)}} \times 100 \%$$

Table 7.4 Meters for Measurement of Main Circuit

Item	Input (primary) side			Output (secondary) side			DC link bus voltage (P (+)-N (-))
Waveform	Voltage 		Current 	Voltage 		Current 	
Name of meter	Ammeter AR, AS, AT	Voltmeter VR, VS, VT	Wattmeter WR, WT	Ammeter AU, AV, AW	Voltmeter VU, VV, VW	Wattmeter WU, WW	DC voltmeter V
Type of meter	Moving iron type	Rectifier or moving iron type	Digital AC power meter	Digital AC power meter	Digital AC power meter	Digital AC power meter	Moving coil type
Symbol of meter			—	—	—	—	

Note

It is not recommended that meters other than a digital AC power meter be used for measuring the output voltage or output current since they may cause larger measurement errors or, in the worst case, they may be damaged.

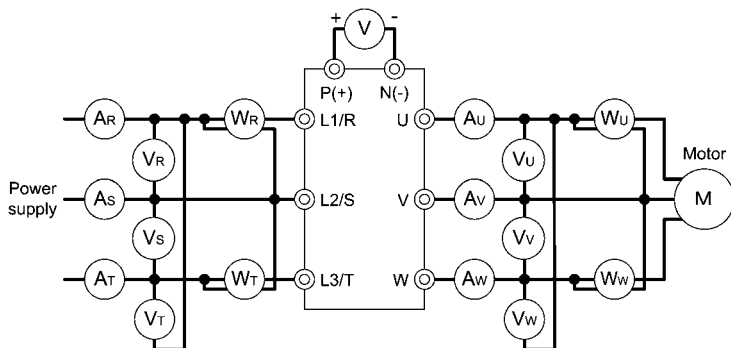


Figure 7.1 Connection of Meters

7.5 Insulation Test

Because an insulation test is made in the factory before shipment, avoid a Megger test.

If a Megger test is unavoidable, follow the procedure below. Because a wrong test procedure will cause breakage of the inverter, take sufficient care.

A dielectric strength test will cause breakage of the inverter similarly to the Megger test if the test procedure is wrong. When the dielectric strength test is necessary, contact your Fuji Electric representative.

(1) Megger test of main circuit

- 1) Use a 500 VDC Megger and shut off the main power supply without fail during measurement.
- 2) If the test voltage leaks to the control circuit due to the wiring, disconnect all the control wiring.
- 3) Connect the main circuit terminals with a common cable as shown in Figure 7.2.
- 4) The Megger test must be limited to across the common line of the main circuit and the ground (⊕).
- 5) 5 M Ω (1 M Ω for the EMC filter built-in type of inverters) or a larger value displayed at the Megger indicates a correct state. (The value is for a discrete inverter.)

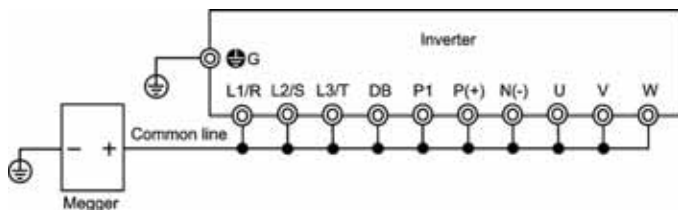


Figure 7.2 Megger Test

(2) Dielectric strength test of control circuit

Do not perform a Megger test or dielectric strength test for the control circuit. Prepare a high resistance range tester for the control circuit.

- 1) Disconnect all the external wiring from the control circuit terminals.
- 2) Perform a continuity test to the ground. One M Ω or a larger measurement indicates a correct state.

(3) Dielectric strength test of external main circuit and sequence control circuit

Disconnect all the inverter terminals so that the test voltage is not applied.

7.6 Inquiries about Product and Guarantee

7.6.1 When making an inquiry

Upon breakage of the product, uncertainties, failure or inquiries, inform your Fuji Electric representative of the following information.

- 1) Inverter type (Refer to Chapter 1, Section 1.1.)
- 2) SER No. (serial number of equipment) (Refer to Chapter 1, Section 1.1.)
- 3) Function codes and their data that you changed from the factory defaults (Refer to Chapter 3, Section 3.4.3.)
- 4) ROM version (Refer to Chapter 3, Section 3.4.6.)
- 5) Date of purchase
- 6) Inquiries (for example, point and extent of breakage, uncertainties, failure phenomena, and other circumstances)

7.6.2 Product warranty

To all our customers who purchase Fuji Electric FA Components & Systems' products:

Please take the following items into consideration when placing your order.

When requesting an estimate and placing your orders for the products included in these materials, please be aware that any items such as specifications which are not specifically mentioned in the contract, catalog, specifications or other materials will be as mentioned below.

In addition, the products included in these materials are limited in the use they are put to and the place where they can be used, etc., and may require periodic inspection. Please confirm these points with your sales representative or directly with this company.

Furthermore, regarding purchased products and delivered products, we request that you take adequate consideration of the necessity of rapid receiving inspections and of product management and maintenance even before receiving your products.

[1] Free of charge warranty period and warranty range

(1) Free of charge warranty period

- 1) The product warranty period is "1 year from the date of purchase" or 24 months from the manufacturing date imprinted on the name plate, whichever date is earlier.
- 2) However, in cases where the use environment, conditions of use, use frequency and times used, etc., have an effect on product life, this warranty period may not apply.
- 3) Furthermore, the warranty period for parts restored by Fuji Electric's Service Department is "6 months from the date that repairs are completed."

(2) Warranty range

- 1) In the event that breakdown occurs during the product's warranty period which is the responsibility of Fuji Electric, Fuji Electric will replace or repair the part of the product that has broken down free of charge at the place where the product was purchased or where it was delivered. However, if the following cases are applicable, the terms of this warranty may not apply.
 - ① The breakdown was caused by inappropriate conditions, environment, handling or use methods, etc. which are not specified in the catalog, operation manual, specifications or other relevant documents.
 - ② The breakdown was caused by the product other than the purchased or delivered Fuji's product.
 - ③ The breakdown was caused by the product other than Fuji's product, such as the customer's equipment or software design, etc.
 - ④ Concerning the Fuji's programmable products, the breakdown was caused by a program other than a program supplied by this company, or the results from using such a program.
 - ⑤ The breakdown was caused by modifications or repairs affected by a party other than Fuji Electric.
 - ⑥ The breakdown was caused by improper maintenance or replacement using consumables, etc. specified in the operation manual or catalog, etc.
 - ⑦ The breakdown was caused by a chemical or technical problem that was not foreseen when making practical application of the product at the time it was purchased or delivered.
 - ⑧ The product was not used in the manner the product was originally intended to be used.
 - ⑨ The breakdown was caused by a reason which is not this company's responsibility, such as lightning or other disaster.
- (2) Furthermore, the warranty specified herein shall be limited to the purchased or delivered product alone.
- (3) The upper limit for the warranty range shall be as specified in item (1) above and any damages (damage to or loss of machinery or equipment, or lost profits from the same, etc.) consequent to or resulting from breakdown of the purchased or delivered product shall be excluded from coverage by this warranty.

(3) Trouble diagnosis

As a rule, the customer is requested to carry out a preliminary trouble diagnosis. However, at the customer's request, this company or its service network can perform the trouble diagnosis on a chargeable basis. In this case, the customer is asked to assume the burden for charges levied in accordance with this company's fee schedule.

[2] Exclusion of liability for loss of opportunity, etc.

Regardless of whether a breakdown occurs during or after the free of charge warranty period, this company shall not be liable for any loss of opportunity, loss of profits, or damages arising from special circumstances, secondary damages, accident compensation to another company, or damages to products other than this company's products, whether foreseen or not by this company, which this company is not be responsible for causing.

[3] Repair period after production stop, spare parts supply period (holding period)

Concerning models (products) which have gone out of production, this company will perform repairs for a period of 7 years after production stop, counting from the month and year when the production stop occurs. In addition, we will continue to supply the spare parts required for repairs for a period of 7 years, counting from the month and year when the production stop occurs. However, if it is estimated that the life cycle of certain electronic and other parts is short and it will be difficult to procure or produce those parts, there may be cases where it is difficult to provide repairs or supply spare parts even within this 7-year period. For details, please confirm at our company's business office or our service office.

[4] Transfer rights

In the case of standard products which do not include settings or adjustments in an application program, the products shall be transported to and transferred to the customer and this company shall not be responsible for local adjustments or trial operation.

[5] Service contents

The cost of purchased and delivered products does not include the cost of dispatching engineers or service costs. Depending on the request, these can be discussed separately.

[6] Applicable scope of service

Above contents shall be assumed to apply to transactions and use of the country where you purchased the products.

Consult the local supplier or Fuji for the detail separately.