

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/inspection jobs, turn OFF the power and wait more than five minutes for models of 30HP for 208V, 40HP for 460V or below, or ten minutes for models of 40HP for 208V, 50HP for 460V or above. Make sure that the LED monitor and charging lamp (on models of 40HP for 208V, 50HP for 460V or above) are 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 overheat, discoloration and other defects.

7.2 Periodic Inspection

Perform periodic inspection by following the 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). 2) Check if tools or other foreign matter or dangerous objects are left around the equipment.	1) Check visually or measure using apparatus. 2) Visual inspection	1) The standard specification must be satisfied. 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.
Keypad	1) Check if the display is clear. 2) Check if there is missing parts in the characters.	1), 2) Visual inspection	1), 2) The display can be read and there is no fault.

Table 7.1 Continued

Check part		Check item	How to inspect	Evaluation criteria
Structure such as frame and cover		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.	1) Visual or hearing inspection 2) Retighten. 3), 4), 5) Visual inspection	1), 2), 3), 4), 5) No abnormalities
Main circuit	Common	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.	1) Retighten. 2), 3) Visual inspection	1), 2), 3) No abnormalities
	Conductor and wire	1) Check the conductor for discoloration and distortion caused by overheat. 2) Check the sheath of the cable for cracks and discoloration.	1), 2) Visual inspection	1), 2) No abnormalities
	Terminal block	Check that the terminals are not damaged.	Visual inspection	No abnormalities
	Filtering capacitor	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.	1), 2) Visual inspection 3) Measure discharge time with capacitance probe.	1), 2) No abnormalities 3) The discharge time is not shorter than time specified by the replacement manual.
	Transformer and reactor	Check for abnormal roaring noise and odor.	Hearing, visual and smelling inspection	No abnormalities
	Magnetic contactor and relay	1) Check for chatters during operation. 2) Check for rough contacts.	1) Hearing inspection 2) Visual inspection	1), 2) No abnormalities
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 matter.	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, contact your Fuji Electric representative.

Table 7.2 Replacement Parts

Part name	Standard replacement intervals
DC link bus capacitor	10 years
Electrolytic capacitor on the printed circuit board	10 years
Cooling fan	10 years (5HP for 208V and 7HP for 460V or below) 10 years (7.5HP for 208V and 10HP for 460V) 7 years (40HP for 208V, 50HP for 460V or above)
Fuse	10 years (125HP for 208V, 125HP for 460V or above)

(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.

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, the electrolytic capacitor on the printed circuit board, and the 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.)
 - Disconnect power wires for the auxiliary input to the control circuit (R0, T0).
 - 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] - [Y3]) and relay output signals ([Y5A/C] and [30A/B/C]) will not be turned ON.

Note 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 $25 \pm 10^{\circ}\text{C}(77 \pm 50^{\circ}\text{F})$.
- 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.

Note 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.

①-2 Measuring the capacitance of the DC link bus capacitor (during power-off time under ordinary operating condition)

In general, the 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 that under which the initial measurement is conducted at the time of factory shipment. As a result, the measured data for the DC link bus capacitor may not be updated. A method is provided, therefore, that allows you to measure the capacitance of the DC link bus capacitor during an ordinary power-off time by taking on (assuming) its discharging condition during a power-off time under the ordinary operation condition at the end user's installation.

Presented below is the procedure for taking on the discharging condition during a power-off time 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 capacitor on the printed circuit board

Move to Menu #5 "Maintenance Information" in Programming mode and check the accumulated run time of the electrolytic capacitor on the printed circuit board. This value is calculated from the cumulative total number of hours a voltage has been applied on the electrolytic capacitor, adjusted with ambient temperature, and is used as the basis for judging whether it has reached its service life. 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] to [Y3]) and the relay contact terminals ([Y5A] - [Y5C], and [30A/B/C]) as soon as any of the conditions listed under the "Judgment level" column has been exceeded.

The early warning signal is also turned ON when a lock condition on the internal air circulation DC fan (on 208V inverters with a capacity of 50HP or above; on 460V inverters with a capacity of 75HP or above) has been detected.

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 capacitor on the printed circuit board	87000 hours or longer as accumulated run time
Cooling fan	Accumulated run time \geq 61000 hours (5HP for 208V and 7HP for 460V or below) Accumulated run time \geq 40000 hours (7.5HP for 208V and 10HP for 460V) Accumulated run time \geq 25000 hours (40HP for 208V, 50HP for 460V or above) (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

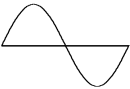
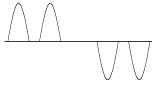
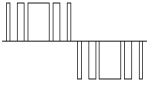
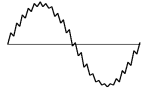




Because the voltage and current of the power supply (input, primary circuit) of the main circuit of the inverter and those of the motor (output, secondary circuit) include harmonic components, the readings may vary with the type of the meter. Use meters indicated in Table 7.4 when measuring with meters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

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

Table 7.4 Meters for Measurement of Main Circuit

Item	Input (primary) side			Output (secondary) side			DC link bus voltage (P (+)-N (-))
	Voltage	Current	Wattmeter	Voltage	Current	Wattmeter	
Waveform							
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.

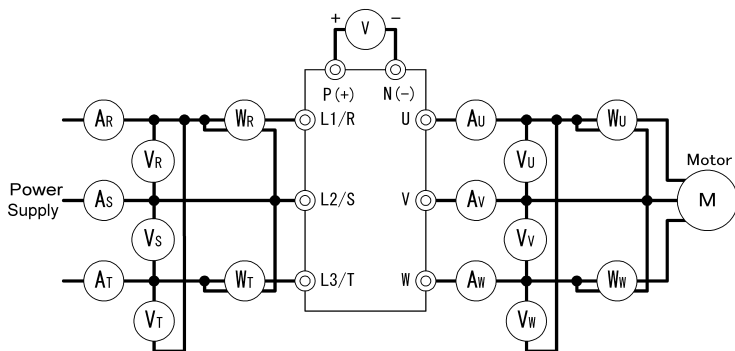


Figure 7.1 Connection of Meters

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 terminal (⊕).
- 5) 5 MΩ (1 MΩ 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.)

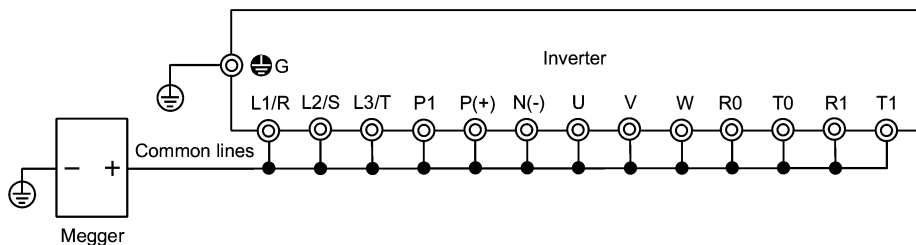


Figure 7.2 Megger Test

(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. 1 MΩ 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

(1) When making an inquiry

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

- 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 (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)

(2) Product warranty

The term of product warranty is one year after the purchase or 24 months from the month and year of production specified on the nameplate, whichever comes first. However, the product will not be repaired free of charge in the following cases, even if the warranty term has not expired.

- 1) The cause includes incorrect usage or inappropriate repair or modification.
- 2) The product is used outside the standard specified range.
- 3) The failure is caused by dropping, damage or breakage during transportation after the purchase.
- 4) The cause is earthquake, fire, storm or flood, lightening, excessive voltage, or other types of disaster or secondary disasters.