Troubleshooting and Maintenance

6

In This Chapter.... page

Troubleshooting

Safety Messages

Please read the following safety messages before troubleshooting or performing maintenance on the inverter and motor system.

WARNING: Wait at least five (5) minutes after turning OFF the input power supply before performing maintenance or an inspection. Otherwise, there is the danger of electric shock.

WARNING: Make sure that only qualified personnel will perform maintenance, inspection, and part replacement. Before starting to work, remove any metallic objects from your person (wristwatch, bracelet, etc.). Be sure to use tools with insulated handles. Otherwise, there is a danger of electric shock and/or injury to personnel.

WARNING: Never remove connectors by pulling on its wire leads (wires for cooling fan and logic P.C. board). Otherwise, there is danger of fire due to wire breakage and/or injury to personnel.

General Precautions and Notes

- Always keep the unit clean so that dust or other foreign matter does not enter the inverter.
- Take special care to avoid breaking wires or making connection mistakes.
- Firmly connect terminals and connectors.
- Keep electronic equipment away from moisture and oil. Dust, steel filings and other foreign matter can damage the inverter, causing unexpected accidents, so take special care.

Inspection Items

This chapter provides instructions or checklists for these inspection items:

- Daily inspection
- Periodic inspection (approximately once a year)
- Insulation resistance test

Troubleshooting Tips

The table below lists typical symptoms and the corresponding solution(s).

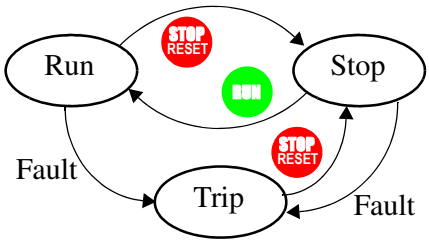
Symptom/condition		Probable Cause	Solution
The motor will not run.	The inverter outputs U, V, W are not supplying voltage.	• Is the frequency command source A001 parameter setting correct? • Is the Run command source A002 parameter setting correct?	• Make sure the parameter setting A001 is correct. • Make sure the parameter setting A002 is correct.
		• Is power being supplied to terminals [R], [S], and [T] ([L1], [L2], and [L3])? If so, the POWER lamp should be ON.	• Check terminals [R], [S], and [T] ([L1], [L2], and [L3]), then [U], [V], and [W] ([T1], [T2], and [T3]). • Turn ON the power supply or check fuses.
		• Is there an error code *EXX.X* displayed?	• Press the Func. key and determine the error type. Eliminate the error cause, then clear the error (Reset).
		• Are the signals to the intelligent input terminals correct? • Is the Run Command active? • Is the [FW] terminal (or [RV]) connected to P24 (via switch, etc.)	• Verify the terminal functions for C001 - C008 are correct. • Turn ON Run command enable. • Supply 24V to [FW] or [RV] terminal, if configured.
		• Has the frequency setting for F001 been set greater than zero? • Are the control circuit terminals [H], [O], and [L] connected to the potentiometer?	• Set the parameter for F001 to a safe, non-zero value. • If the potentiometer is the frequency setting source, verify voltage at [O] > 0V.
		• Is the RS (reset) function or FRS (free-run stop) function ON?	• Turn OFF the command(s).
	Inverter outputs U, V, W are supplying voltage.	• Is the motor load too heavy?	• Reduce load or test the motor independently of the load.
The direction of the motor is reversed.		• Are the connections of output terminals [U/T1], [V/T2], and [W/T3] correct? • Is the phase sequence of the motor forward or reverse with respect to [U/T1],[V/T2], and [W/T3]?	• Make connections according to the phase sequence of the motor. In general: FWD = U-V-W, and REV=U-W-V.
		• Are the control terminals [FW] and [RV] wired correctly? • Is parameter F004 properly set?	• Use terminal [FW] for forward, and [RV] for reverse. • Set motor direction in F004.

Symptom/condition		Probable Cause	Solution
The motor speed will not reach the target frequency (desired speed).		• If using the analog input, is there current or voltage at [O] or [OI]?	• Check the wiring. • Check the potentiometer or signal generating device.
		• Is the load too heavy?	• Reduce the load. • Heavy loads activate the overload restriction feature (reduces output as needed).
		• Is the inverter internally limiting the output frequency?	• Check max frequency setting (A004) • Check frequency upper limit setting (A061) • If using analog inputs, check their settings (A101– A104) or (A111–A114), or (A011–A014)
The rotation is unstable.		• Is the load fluctuation too great? • Is the supply voltage unstable? • Is the problem occurring at a particular frequency?	• Increase the motor capacity (both inverter and motor). • Fix power supply problem. • Change the output frequency slightly, or use the jump frequency setting to skip the problem frequency.
The RPM of the motor does not match the inverter output frequency setting.		• Is the maximum frequency setting A004 correct? • Does the monitor function D001 display the expected output frequency?	• Verify the V/F settings match motor specifications. • Make sure all scaling (such as A011 to A014) is properly set.
A parameter will not change after an edit (reverts to old setting).	True for certain parameters	• Is the inverter in Run Mode? Some parameters cannot be edited during Run Mode.	• Put inverter in Stop Mode (press the Stop/reset key). Then edit the parameter.
	True for all parameters	• If you're using the [SFT] intelligent input (software lock function)—is the [SFT] input ON?	• Change the state of the SFT input, and check the B031 parameter (SFT mode).

Monitoring Trip Events, History, & Conditions

Fault Detection and Clearing

The microprocessor in the inverter detects a variety of fault conditions and captures the event, recording it in a history table. The inverter output turns OFF, or "trips" similar to the way a circuit breaker trips due to an over-current condition. Most faults occur when the motor is running (refer to the diagram to the right). However, the inverter could have an internal fault and trip in Stop Mode. In either case, you can clear the fault by pressing the Stop/Reset key. Additionally, you can clear the inverter's cumulative trip history by performing the procedure "Restoring Factory Default Settings" on page 6–9 (setting B_84=00 will clear the trip history but leave inverter settings intact).



Error Status Codes

The conditions at the time of an error provide important clues to help you understand the cause. The SJ300 inverter displays a "status at trip point" digit to the right of the decimal point for some error codes. For example, E07.2 means Error 7 occurred and the inverter status was condition # "2" when the error occurred.

Status Codes	Inverter Status	Status Codes	Inverter Status
---.0	Reset	---.5	f0 stop
---.1	Stop	---.6	Starting
---.2	Deceleration	---.7	DC braking
---.3	Constant speed	---.8	Overload restriction
---.4	Acceleration	---.9	Auto-tuning

Error Codes

An error code will appear on the display automatically when a fault causes the inverter to trip. The following table lists the cause associated with the error.

Error Code	Name	Probable Cause(s)
E01	Over current event while at constant speed	The inverter output was short-circuited, or the motor shaft is locked or has a heavy load. These conditions cause excessive current for the inverter, so the inverter output is turned OFF. The dual-voltage motor is wired incorrectly. Note: The SJ300 will over current trip at nominally 200% of rated current for models up to –550xxx; nominally 180% of rated current for models –750xxx to –1500xxx.
E02	Over current event during deceleration	
E03	Over current event during acceleration	
E04	Over current event during other conditions	DC braking power(A054) is set too high, or a current transformer error occurred, or a noise source induced the error.

Error Code	Name	Probable Cause(s)
E05	Overload protection	When a motor overload is detected by the electronic thermal function, the inverter trips and turns OFF its output.
E06	Braking resistor overload	When the regenerative braking resistor exceeds the usage time allowance or usage ratio, the inverter trips and turns OFF its output to the motor.
E07	Over voltage protection	When the DC bus voltage exceeds a threshold, due to regenerative energy from the motor.
E08	EEPROM error	When the built-in EEPROM memory has problems due to noise or excessive temperature, the inverter trips and turns OFF its output to the motor.
E09	Under-voltage error	A decrease of internal DC bus voltage below a threshold results in a control circuit fault. This condition can also generate excessive motor heat or cause low torque. The inverter trips and turns OFF its output.
E10	CT (current transformer) error	If a strong source of electrical interference is close to the inverter or a fault occurs in a built-in CT (current transformer), the inverter trips and turns its output OFF.
E11	CPU error	A malfunction in the built-in CPU has occurred, so the inverter trips and turns OFF its output to the motor.
E12	External trip	A signal on an intelligent input terminal configured as EXT has occurred. The inverter trips and turns OFF the output to the motor.
E13	USP	When the Unattended Start Protection (USP) is enabled, an error occurred when power is applied while a Run signal is present. The inverter trips and does not go into Run Mode until the error is cleared.
E14	Ground fault	The inverter is protected by the detection of ground faults between the inverter output and the motor during powerup tests. This feature protects the inverter, and does not protect humans.
E15	Input over-voltage	When the input voltage is higher than the specified value, it is detected 60 seconds after powerup and the inverter trips and turns OFF its output.
E16	Instantaneous power failure	When the input power is removed for more than 15ms, the inverter trips and the output to the motor turns OFF. If the power failure duration exceeds the duration set in parameter B002, it is considered a power failure. When input power is restored, the inverter restarts if the Run signal is present, depending on the restart condition.
E21	Inverter thermal trip	When the inverter internal temperature is above the threshold, the thermal sensor in the inverter module detects the excessive temperature of the power devices and trips, turning the inverter output OFF.

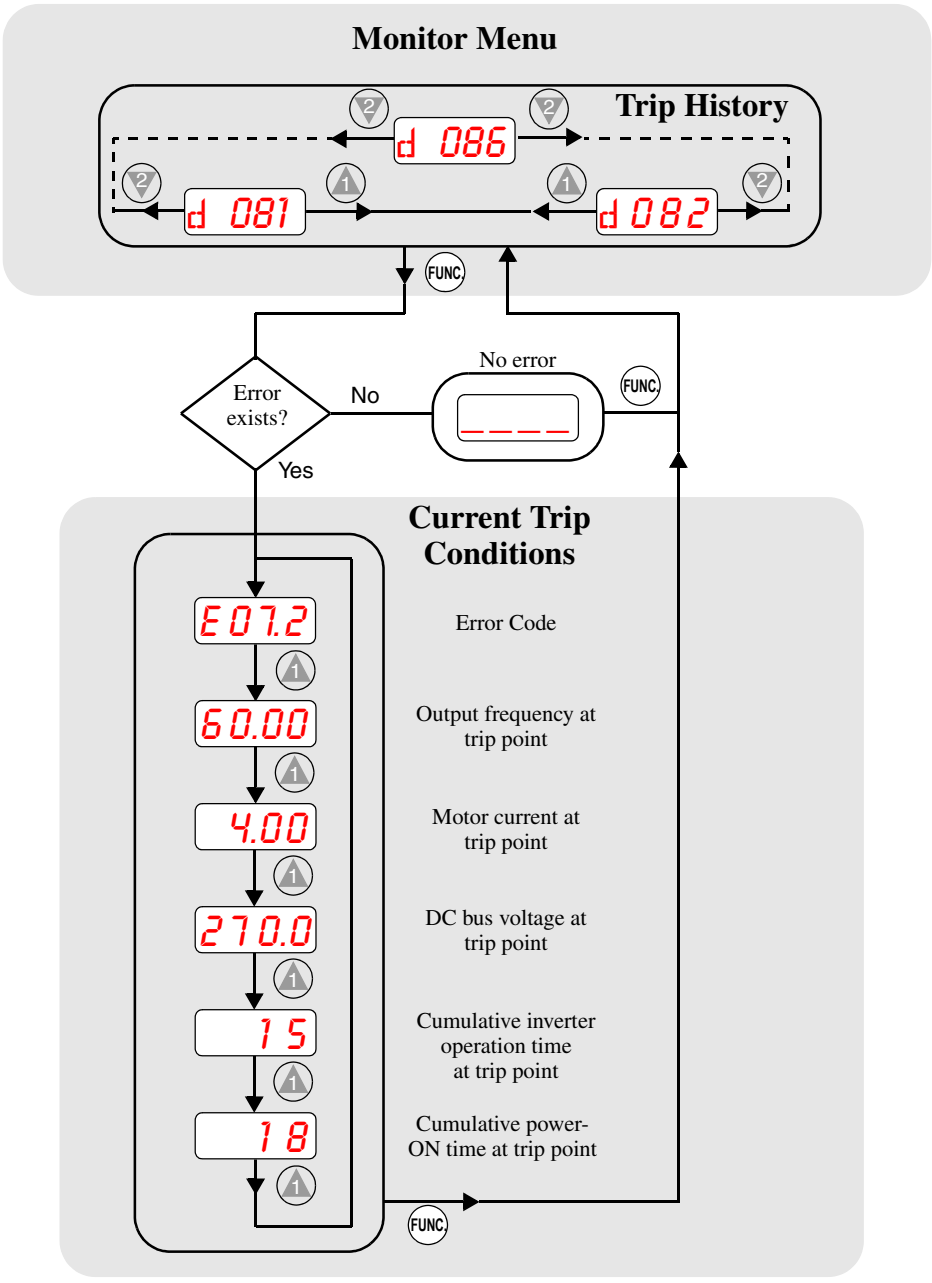
Error Code	Name	Probable Cause(s)
E23	Gate array error	An internal inverter error has occurred in communications between the CPU and gate array IC.
E24	Phase failure detection	One of three lines of the 3-phase power is missing.
E30	IGBT error	When an instantaneous over-current condition occurs on any IGBT (output transistor) device, the inverter alarm trips. then it turns the outputs OFF in order to protect the circuitry.
E35	Thermistor	When a thermistor is connected to terminals [THM] and [CM1] and the inverter has sensed the temperature is too high, the inverter trips and turns OFF the output.
E36	Brake error	When the inverter releases the brake and cannot detect whether the external brake is ON or OFF within the waiting time (set by parameter B024), the inverter trips and turns OFF the output to the motor.
----	Under-voltage (brownout) with output shutoff	Due to low input voltage, the inverter turns its output OFF and tries to restart. If it fails to restart, then the alarm trips to record the under-voltage error event.
E6X	Expansion card #1 connection error	An error has occurred in an expansion card or at its connecting terminals. Please refer to the manual for the expansion card for additional details.
E7X	Expansion card #2 connection error	

NOTE: If an EEPROM error (E08) occurs, be sure to confirm the parameter data values are still correct.

Trip History and Inverter Status

We recommend that you first find the cause of the fault before attempting clearing it. When a fault occurs, the inverter stores important performance data at the moment of the fault. To access the data, use the monitor functions (Dxxx) and select D081 for details about the present fault (E_n). The previous five faults are stored in D081 to D086, with D (E_{n-1} to E_{n-5}). Each error shifts D081–D085 to D082–D086, and writes the new error to D081.

The following Monitor Menu map shows how to access the error codes. When fault(s) exist, you can review their details by first selecting the proper function: D081 is most recent, and D086 is the oldest.



Restoring Factory Default Settings

You can restore all inverter parameters to the original factory (default) settings for the intended country of use. After initializing the inverter, use the powerup test in Chapter 2 to get the motor running again. To initialize the inverter, follow the steps below.

No.	Action	Display	Func./Parameter
1	Use the FUNC, ▲1, and ▼2 keys to navigate to the "B" Group.	b - -	"B" Group selected
2	Press the FUNC key.	b001	First "B" parameter selected
3	Press and hold the ▲1 key until ->	b085	Country code for initialization selected
4	Press the FUNC key.	02	00 = Japan, 01 = Europe, 02 = U.S.
5	Confirm the country code is correct. Do not change it unless you are absolutely sure the power input voltage range and frequency match the country code setting. To change the country code, press ▲1 or ▼2 to set; STR to store.		
6	Press the FUNC key.	b085	Country code for initialization selected
7	Press the ▼2 key.	b084	Initialization function selected
8	Press the FUNC key.	00	00 = initialization disabled, clear trip history only
9	Press the ▲1 key.	01	01 = enable initialization
10	Press the STR key.	b084	Initialization now enabled to restore all defaults
11	Press and hold the FUNC, ▲1, and ▼2 keys. Do not let release yet.	b084	First part of special key sequence, the "B" is flashing.
12	Holding the keys above, press and hold the STOP/RESET (STOP) key for 3 sec.	b084	Final part of special key sequence, "B084" is flashing
13	When the b084 display function begins blinking, release the STOP/RESET, FUNC, ▲1, and ▼2 keys together.	0 EU or OUSA	Default parameter country code shown during initialization process (left-most character displays alternating pattern)
14	Initialization is complete.	d 01	Function code for output frequency monitor shown

NOTE: Initialization cannot be performed with a remote operator panel. Disconnect the device and use the inverter's front panel keypad.

Maintenance and Inspection

Monthly and Yearly Inspection Chart

Item Inspected		Check for...	Inspection Cycle		Inspection Method	Criteria
			Month	Year		
Overall	Ambient environment	Extreme temperatures & humidity	✔		Thermometer, hygrometer	Ambient temperature between -10 to 50°C, non-condensing
	Major devices	Abnormal vibration, noise	✔		Visual and aural	Stable environment for electronic controls
	Power supply voltage	Voltage tolerance	✔		Digital volt meter, measure between inverter terminals [L1], [L2], [L3]	200V class: 200 to 240V 50/60 Hz 400V class: 380 to 460V 50/60 Hz
Main circuit	Ground Insulation	Adequate resistance		✔	Megger test	500VDC, reading of 5M ohms or greater, see next section for test details
	Mounting	No loose screws		✔	Torque wrench	M3: 0.5 – 0.6 Nm M4: 0.98 – 1.3 Nm M5: 1.5 – 2.0 Nm
	Components	Overheating		✔	Thermal trip events	No trip events
	Housing	Dirt, dust		✔	Visual	Vacuum dust and dirt
	Terminal block	Secure connections		✔	Visual	No abnormalities
	Smoothing capacitor	Leaking, swelling	✔		Visual	No abnormalities
	Relay(s)	Chattering		✔	Aural	Single click when switching ON or OFF
	Resistors	Cracks or discoloring		✔	Visual	Use Ohm meter to check braking resistors
	Cooling fan	Noise	✔		Power down, manually rotate	Rotation must be smooth
		Dust	✔		Visual	Vacuum to clean
Control circuit	Overall	No odor, discoloring, corrosion		✔	Visual	No abnormalities
	Capacitor	No leaks or deformation	✔		Visual	Undistorted appearance
Display	LEDs	Legibility	✔		Visual	All LED segments work

Note 1: The life of a capacitor is affected by the ambient temperature. See “Capacitor Life Curve” on page 6–12.

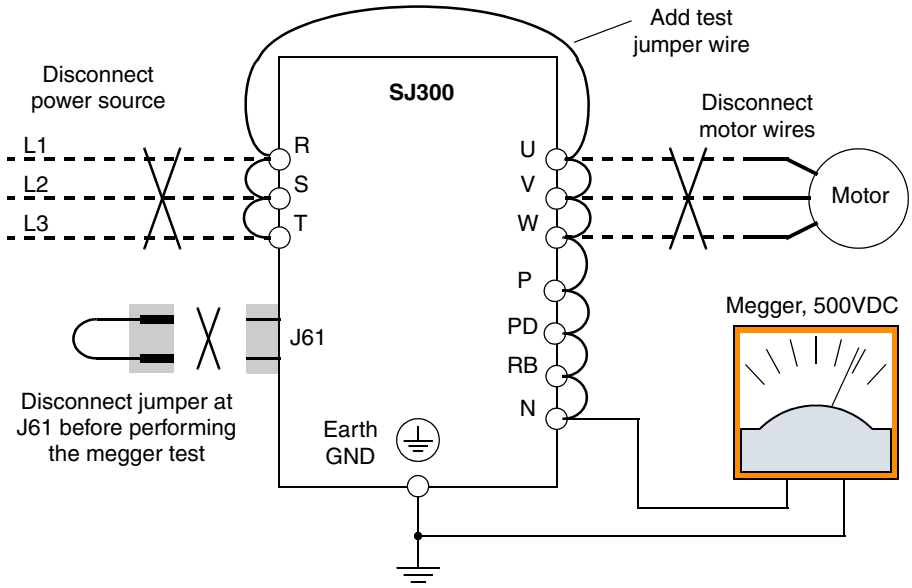
Note 2: The inverter must be cleaned periodically. If dust accumulates on the fan and heat sink, it can cause overheating of the inverter.

Megger Test

The *megger* is a piece of test equipment that uses a high voltage to determine if an insulation degradation has occurred. For inverters, it is important that the power terminals be isolated from the Earth GND terminal via the proper amount of insulation.

The circuit diagram below shows the inverter wiring for performing the megger test. Just follow the steps to perform the test:

1. Remove power from the inverter and wait at least 5 minutes before proceeding.
2. Open the front housing panel to access the power wiring.
3. Remove all wires to terminals [R, S, T, PD, P, N, RB, U, V, and W]. Most importantly, the input power and motor wires will be disconnected from the inverter.
4. Remove the jumper at connector J61. It is located on the main circuit board beside the power terminals.
5. Use a bare wire and short terminals [R, S, T, PD, P, N, RB, U, V, and W] together as shown in the diagram.
6. Connect the megger to the inverter Earth GND and to the shorted power terminals as shown. Then perform the megger test at 500 VDC and verify 5MΩ or greater resistance.



7. After completing the test, disconnect the megger from the inverter.
8. Reconnect the jumper at connector J61 as before.
9. Reconnect the original wires to terminals [R, S, T, PD, P, N, RB, U, V, and W].

CAUTION: Do not connect the megger to any control circuit terminals such as intelligent I/O, analog terminals, etc. Doing so could cause damage to the inverter.

CAUTION: Never test the withstand voltage (HIPOT) on the inverter. The inverter has a surge protector between the main circuit terminals above and the chassis ground.

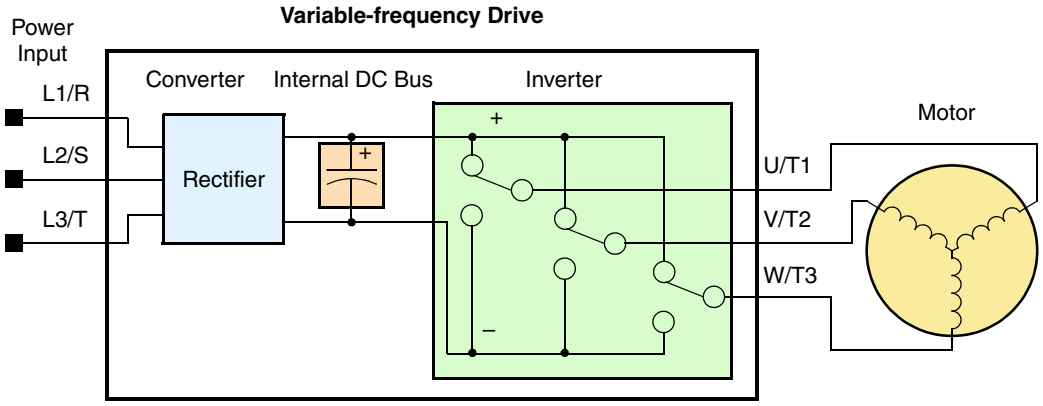
Spare parts

We recommend that you stock spare parts to reduce down time, including parts listed below:

Part description	Symbol	Quantity		Notes
		Used	Spare	
Cooling fan	FAN	1, 2, 3... (depends on model)	1 or 2	Fan unit at top of housing in all models
Auxiliary cooling fan	FAN	0 or 1... (depends on model)	0 or 1	–150Lxx, –185Lxx, and –220Lxx models
Capacitor bank	CB	1	1	All models

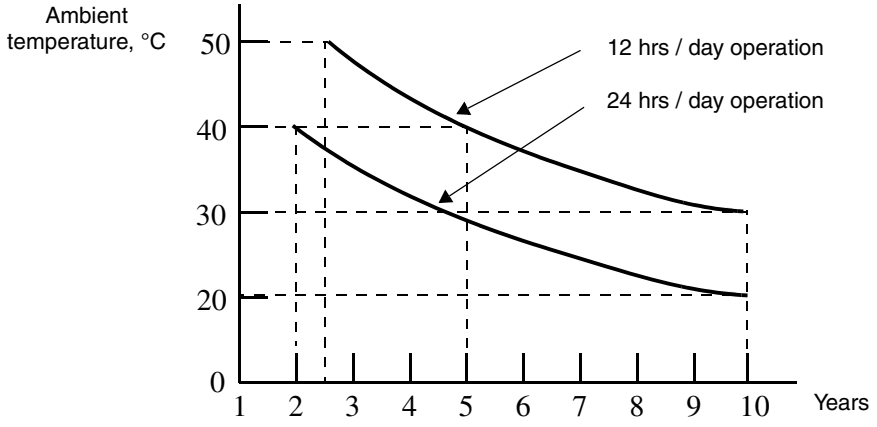
Capacitor Life Curve

The DC bus inside the inverter uses a large capacitor as shown in the diagram below. The capacitor handles high voltage and current as it smooths the power for use by the inverter. So, any degradation of the capacitor will affect the performance of the inverter. The capacitor bank in SJ300 series inverters is replaceable. This section will show you how to replace it in the field.



Capacitor life is reduced in higher ambient temperatures, as the graph below demonstrates. Be sure to keep the ambient temperature at acceptable levels, and perform maintenance inspections on the fan, heat sink, and other components. If the inverter is installed on a cabinet, the ambient temperature is the temperature inside the cabinet.

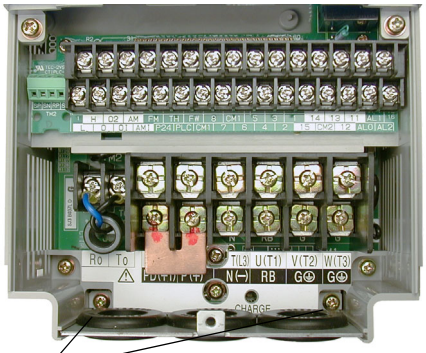
Capacitor Life Curve



Capacitor Replacement

The capacitor bank consists of an assembly that slides out of the SJ300 unit. This means that no soldering is required!

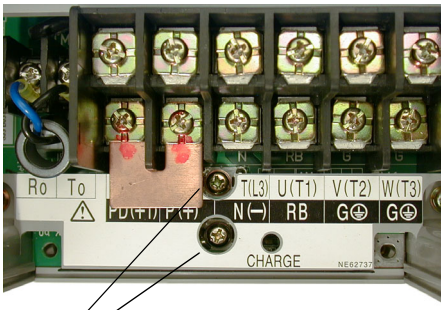
1. First, make sure that all power is removed from the unit, and that you have waited 5 minutes before accessing the wiring area. Then you'll need to remove the metal wire entry plate located at the bottom of the unit. This may require you to disconnect all wires to the power terminals. Then, just loosen the screws as shown, and slide the wire entry plate outward on its guides to remove.



Retention screws for wire entry plate

WARNING: The screws that retain the capacitor bank assembly are part of the electrical circuit of the high-voltage internal DC bus. Be sure that all power has been disconnected from the inverter, and that you have waited at least 5 minutes before accessing the terminals or screws. Be sure the charge lamp is extinguished. Otherwise, there is the danger of electrocution to personnel.

2. The capacitor bank assembly is locked into the inverter via two screws that also make the electrical connection to the internal DC bus. These two screws are accessible just below the power terminals as shown to the right.

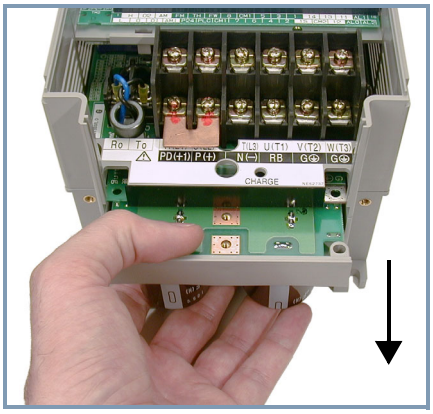


Retention screws for capacitor bank

3. Grasp the capacitor bank assembly and gently slide it out of the unit as shown to the right. DO NOT try to force the removal; it will slide out easily if all the screws in the steps above have been removed.

4. Then slide in the new unit and replace all the screws removed in steps 1) and 2).

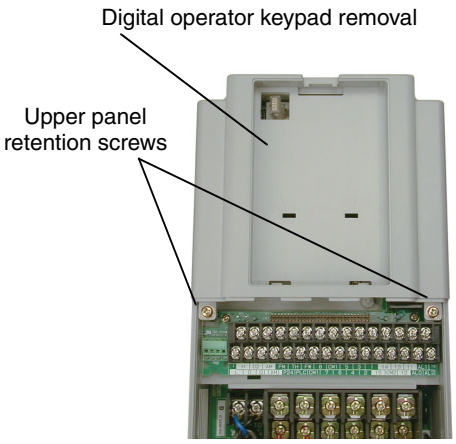
CAUTION: Do not operate the inverter unless you have replaced the two screws that connect the capacitor bank assembly to the internal DC bus. Otherwise, damage to the inverter may occur.


Pull capacitor bank assembly outward from SJ300 unit to remove

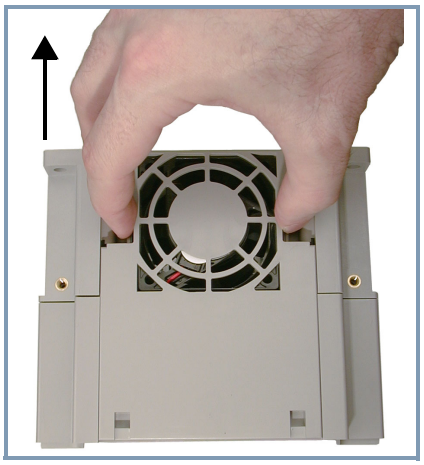
Fan Assembly Replacement

The SJ300 Series inverters have field-replaceable fan units. They include an internal connector for easy removal and replacement. You will need to remove the front panel covers to remove the fan assembly. First, be sure to remove power from the unit and wait at least 5 minutes before accessing the wiring area.

1. Remove the digital operator from the front panel. Then remove the bottom front panel to expose the wiring area as shown. This will also expose the retention screws for the top front panel. Remove these screws, which will allow the front panel to hinge upward and unfasten from the unit.

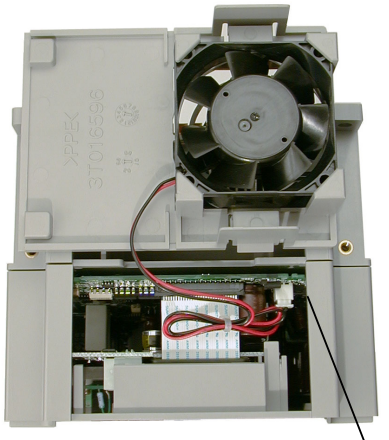


2. After removing all front panel pieces, locate the thumb latches in the top of the inverter housing. Grasp and push the releases inward as shown to the right, and gently pull upward to remove the fan assembly.



CAUTION: Remove the fan assembly carefully, since it is attached to the unit via connecting wires.

3. After unfastening the fan assembly, turn it over to expose the connecting wires. Then locate the PWB connector as shown. Disconnect the wiring.
4. Connect the new fan assembly wiring. The polarized plug will ensure a proper connection.
5. Snap the replacement fan into place.
6. Replace all front panel pieces and retention screws.



General Inverter Electrical Measurements

The following table specifies how to measure key system electrical parameters. The diagrams on the next page show inverter-motor systems and the location of measurement points for these parameters.

Parameter	Circuit location of measurement	Measuring instrument	Notes	Reference Value
Supply voltage E_1	E_R – across L1 and L2 E_S – across L2 and L3 E_T – across L3 and L1	Moving-coil type voltmeter or rectifier type voltmeter	Fundamental wave effective value	Commercial supply voltage (200V class) 200-240V, 50/60 Hz 400V class 380-460V, 50/60 Hz
Supply current I_1	I_r – L1, I_s – L2, I_t – L3	Moving-coil type ammeter	Total effective value	—
Supply power W_1	W_{11} – across L1 and L2 W_{12} – across L2 and L3	Electronic type wattmeter	Total effective value	—
Supply power factor Pf_1	$Pf_1 = \frac{W_1}{\sqrt{3} \times E_1 \times I_1} \times 100\%$			—
Output voltage E_0	E_U – across U and V E_V – across V and W E_W – across W and U	Rectifier type voltmeter	Total effective value	—
Output current I_o	I_U – U I_V – V I_W – W	Moving-coil type ammeter	Total effective value	—
Output power W_o	W_{01} – across U and V W_{02} – across V and W	Electronic type wattmeter	Total effective value	—
Output power factor Pf_o	Calculate the output power factor from the output voltage E, output current I, and output power W. $Pf_0 = \frac{W_0}{\sqrt{3} \times E_0 \times I_0} \times 100\%$			—

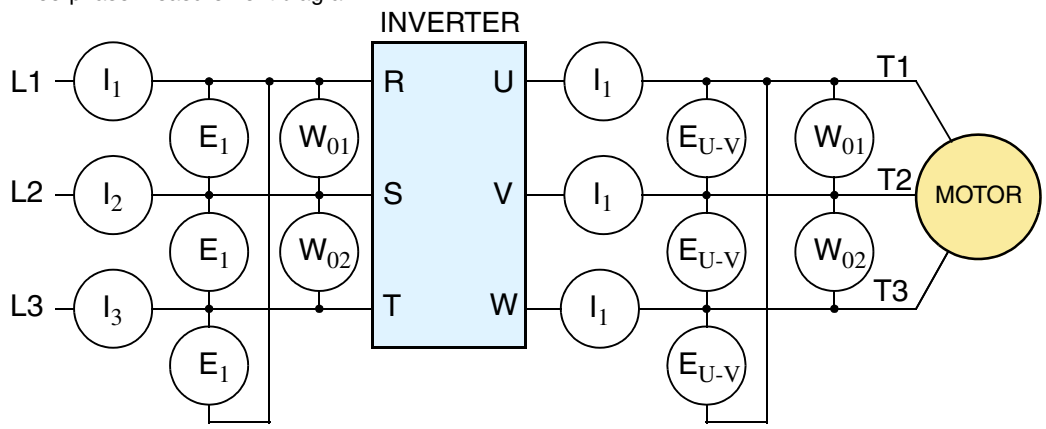
Note 1: Use a meter indicating a fundamental wave effective value for voltage, and meters indicating total effective values for current and power.

Note 2: The inverter output has a distorted waveform, and harmonic frequencies may cause erroneous readings. However, the measuring instruments and methods listed above provide reasonably accurate results.

Note 3: A general-purpose digital volt meter (DVM) is not usually suitable to measure a distorted waveform (not pure sinusoid).

The figure below shows measurement locations for voltage, current, and power measurements listed in the table on the previous page. The voltage to be measured is the fundamental wave effective voltage. The power to be measured is the total effective power.

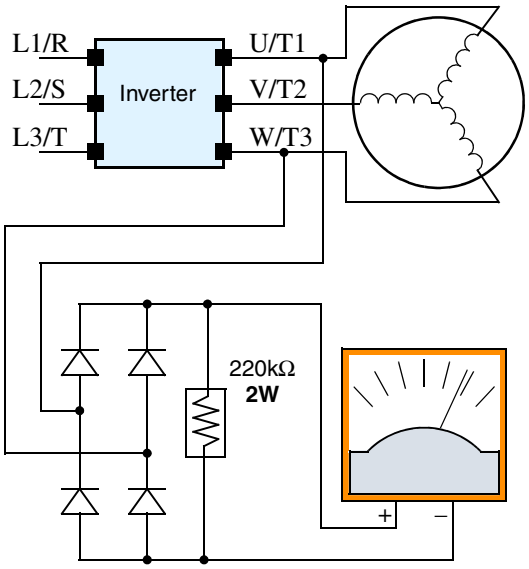
Three-phase measurement diagram



Inverter Output Voltage Measurement Techniques

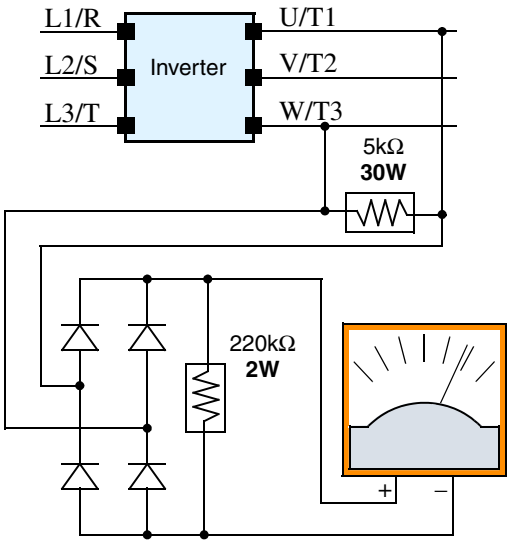
Taking voltage measurements around drives equipment requires the right equipment and a safe approach. You are working with high voltages and high-frequency switching waveforms that are not pure sinusoids. Digital voltmeters will not usually produce reliable readings for these waveforms. And, it is usually risky to connect high voltage signals to oscilloscopes. The inverter output semiconductors have some leakage, and no-load measurements produce misleading results. So, we highly recommend using the following circuits to measure voltage for performing the equipment inspections.

Voltage measurement *with* load



V class	Diode bridge	Voltmeter
200V class	600V 0.01A min.	300V range
400V class	1000V 0.1 A min.	600V range

Voltage measurement *without* load



V class	Diode bridge	Voltmeter
200V class	600V 0.01A min.	300V range
400V class	1000V 0.1 A min.	600V range

HIGH VOLTAGE: Be careful not to touch wiring or connector terminals when working with the inverters and taking measurements. Be sure to place the measurement circuitry above in an insulated housing before using them.

IGBT Test Method

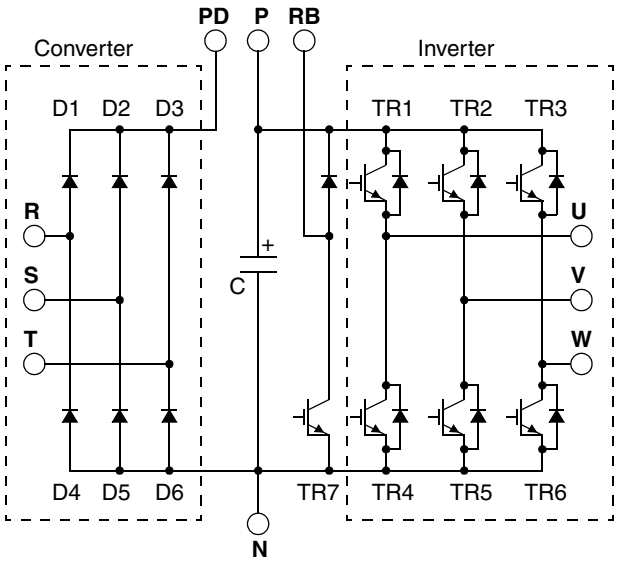
The following procedure will check the inverter transistors (IGBTs) and diodes:

1. Disconnect input power to terminals [R, S, and T] and motor terminals [U, V, and W].
2. Disconnect any wires from terminals [P] and [RB] for regenerative braking.
3. Use a Digital Volt Meter (DVM) and set it for 1 ohm resistance range. You can check the status of the charging state of terminals [R, S, T, U, V, W, RB, P, and N] of the inverter and the probe of the DVM by measuring the charging state.

Almost infinite ohms = "non-conducting," and 0 to 10 ohms = "conducting."

NOTE: The resistance values for the diodes or the transistors will not be exactly the same, but they will be close. If you find a significance difference, a problem may exist.

NOTE: Before measuring the voltage between [P] and [N] with the DC current range, confirm that the smoothing capacitor is discharged fully, then execute the tests.



Circuit Type		DVM Probe +	DVM Probe –	Measured Value
Converter	D1	R	PD	Non-conducting
		PD	R	Conducting
	D2	S	PD	Non-conducting
		PD	S	Conducting
	D3	T	PD	Non-conducting
		PD	T	Conducting
	D4	R	N	Conducting
		N	R	Non-conducting
	D5	S	N	Conducting
		N	S	Non-conducting
	D6	T	N	Conducting
		N	T	Non-conducting
Inverter	TR1	U	P	Non-conducting
		P	U	Conducting
	TR2	V	P	Non-conducting
		P	V	Conducting
	TR3	W	P	Non-conducting
		P	W	Conducting
	TR4	U	N	Conducting
		N	U	Non-conducting
	TR5	V	N	Conduct
		N	V	Non-conducting
	TR6	W	N	Conducting
		N	W	Non-conducting
Dynamic Braking (0.4kW–11kW)	TR7	RB	P	Non-conducting
		P	RB	Conducting
		RB	N	Non-conducting
		N	RB	Non-conducting

Warranty

Warranty Terms

The warranty period under normal installation and handling conditions shall be two (2) years from the date of manufacture (“DATE” on product nameplate), or one (1) year from the date of installation, whichever occurs first. The warranty shall cover the repair or replacement, at Hitachi's sole discretion, of ONLY the inverter that was installed.

1. Service in the following cases, even within the warranty period, shall be charged to the purchaser:
   - **a.** Malfunction or damage caused by mis-operation or modification or improper repair
   - **b.** Malfunction or damage caused by a drop after purchase and transportation
   - **c.** Malfunction or damage caused by fire, earthquake, flood, lightning, abnormal input voltage, contamination, or other natural disasters
2. When service is required for the product at your work site, all expenses associated with field repair shall be charged to the purchaser.
3. Always keep this manual handy; please do not lose it. Please contact your Hitachi distributor to purchase replacement or additional manuals.