

Yaskawa Electric

America

Unit Troubleshooting Manual

Section One:

Introduction & Checks Without Power

GPD 506/P5 and GPD 515/G5

(0.4 ~ 160kW)

Introduction

This manual is divided into three sections:

- **Section One** is called “Checks Without Power”; it explains the steps used to check out the inverter, with no power applied, using an ohmmeter.
 - **Section Two** is called “Power Checks”; this section explains a systematic method of applying power to the inverter and checking various points on the inverter to verify proper operation.
 - **Section Three** is called “Fault Codes”; this section explains the fault indications, possible causes, and corrective actions.
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- *This document can also be used with GPD 505/P5 inverters, but some part numbers may be different.*
 - *In this document, test and check point details pertaining to the GPD 506/P5 can also be considered for the GPD 505/P5 unless otherwise noted.*
 - *Mfg. part numbers and YEA code numbers listed in this manual are subject to change.*

Introduction

Decoding the model number

CIMR-G5U23P7

Inverter

Product

GPD 515/G5

GPD 506/P5

Specification

U or M - Americas

A - Japan/Asia

E - Europe

Model Number

Voltage Rating

2 - 230V 3 phase

4 - 460V 3 phase

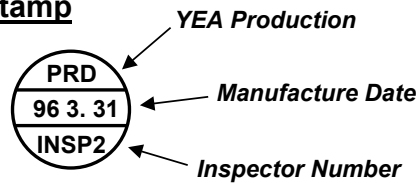
5 - 600V 3 phase

Inverter Markings

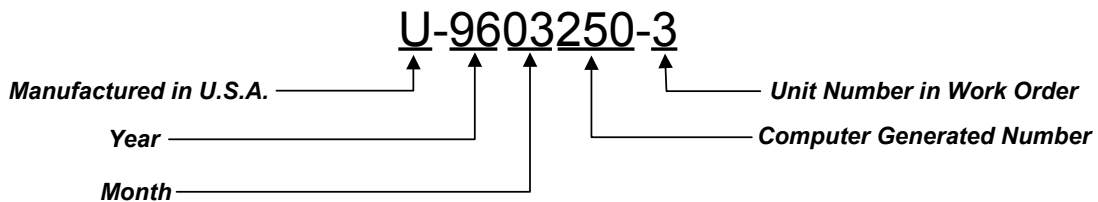
On every Yaskawa inverter is an inspection stamp and lot number. The information contained in the inspection stamp is the date and year that the inverter was tested. The lot number contains more detail about when the inverter was produced. The date stamp information and lot number are needed when submitting a warranty claim to Yaskawa.

Assembled in the U.S.A.

Inspection Stamp



Lot Number

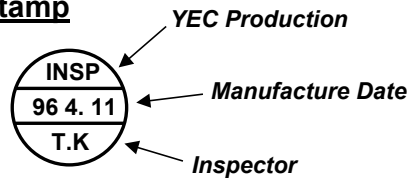


Inverter Markings

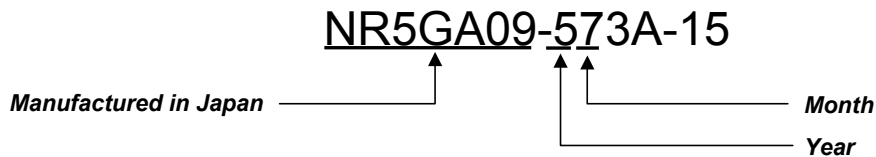
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Manufactured in Japan

Inspection Stamp



Lot Number



Test Equipment

The basic tools used for troubleshooting a Yaskawa inverter are as follows;

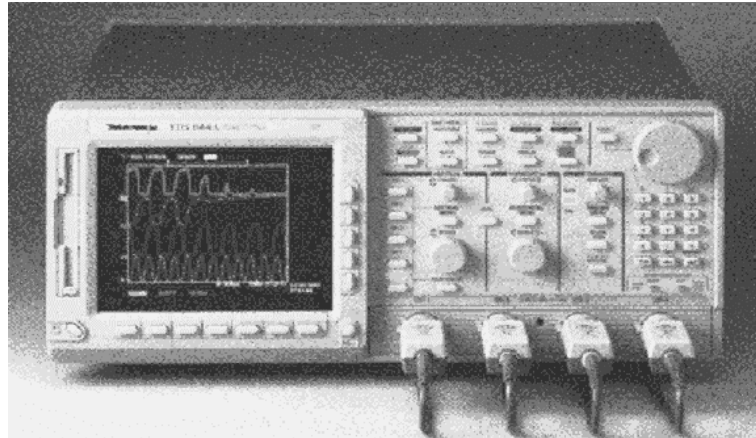


Analog Multimeter



Digital Multimeter

Test Equipment

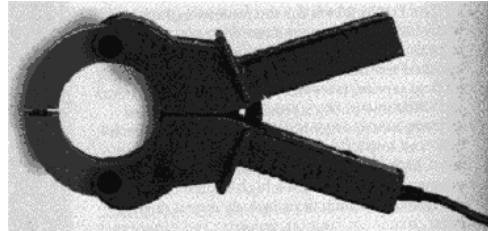


- An ungrounded Oscilloscope with a 10X and 100X probe.
- A 30 watt, 500 ohm resistor.

Test Equipment

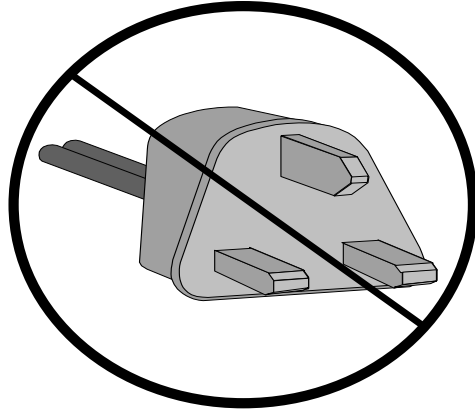


True RMS clamp meter



AC Clamp-on
current probe

Section One: Checks Without Power



Unit Elementary Diagram Review

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Main Circuit Test Procedure



This test procedure must be performed before making a repair.

TEST PROCEDURE CHECKLIST

Check box when completed

- 1. Check DC bus voltage.
- 2. Check input diodes.
- 3. Check soft charge resistor(s).
- 4. Check soft charge contactor.
- 5. Check DC bus fuse.
- 6. Check the braking circuit. (If internal)
- 7. Check output transistors.
- 8. Check snubber circuit.
- 9. Check the control power fuse.
- 10. Check the cooling fan(s).
- 11. Check the cooling fan(s) fuse.

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⚠ WARNING
LETHAL VOLTAGES ARE PRESENT!

Before attempting any checks in this troubleshooting manual, make sure that the three phase power is disconnected and locked out. With power removed from the unit, the DC bus capacitors will stay charged for several minutes. The charge LED in the unit will glow red until the DC bus voltage is below 10 VDC. To ensure that the DC bus is completely discharged, measure between the positive and negative bus with a DC voltmeter set to the highest scale.

Checking the inverter for power

Test Equipment - DC voltmeter set to the highest scale

This test is a mandatory safety check! Before touching any components inside the inverter, perform the following test. Look at the charge LED on the inverter. If high voltage is present on the DC bus, the charge LED will glow red. As the DC bus capacitors discharge, the charge LED will fade out. There is a possibility that voltage will be present on the DC bus even when the charge LED is off. To determine if the DC bus is completely discharged, measure between the positive and negative portions of the DC bus with a DC voltmeter. Set the meter to it's highest scale and place the positive lead onto the positive portion of the DC bus and place the negative lead onto the negative portion of the DC bus. If the measured voltage is below 10 VDC, you can safely work inside the unit.



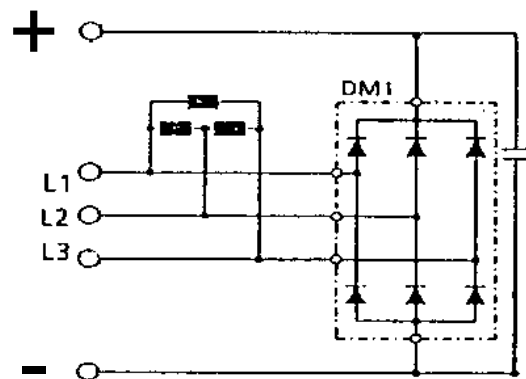
Input Diodes

On small horsepower models, the input diodes are located inside the power module PM1 or in a separate module labeled DM1. Larger horsepower models have separate 2-in-1 style diode modules. The input diodes rectify or transform the three-phase input AC voltage into a DC voltage. The DC voltage level is proportional to the input AC voltage and is the main reference voltage in the inverter called the DC Bus. The DC bus voltage should normally be about 325 VDC for a 230V model, 650 VDC for a 460V model and 845 VDC for a 600V model.



6-in-1 style
diode module
(DM1 type)

2-in-1 style
diode module

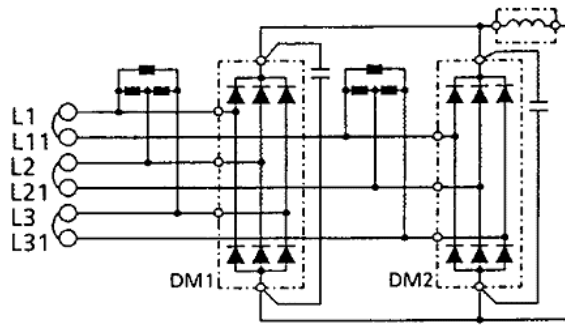


Schematic diagram

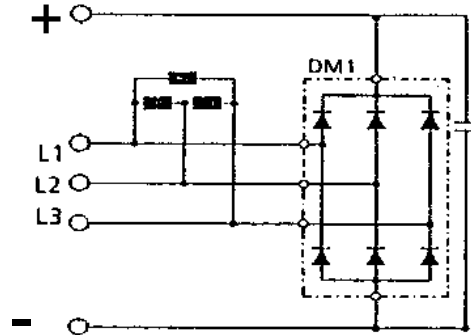


Input Diodes

Certain GPD 506/P5 inverters come equipped with a 12 pulse, dual diode input section. This leads to a reduction of the input current distortion to help meet harmonic distortion specifications. The schematic diagrams of a dual diode input and a 6 pulse diode input are shown below.



Diode configuration for 12 pulse input used in GPD 506/P5 inverters.

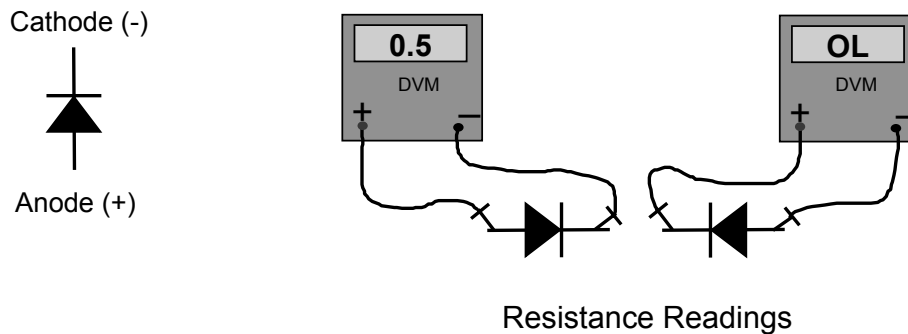


Diode configuration for 6 pulse input used in GPD 515/G5 inverters.



Input Diodes

The individual diodes that form the three-phase input rectifier bridge can easily be checked by measuring the forward and reverse resistance of the diodes. Simply use an analog or digital meter and measure the resistance across each diode. Refer to the elementary diagram to determine the relationship between the main input terminals (L1, L2, L3) and the DC bus terminals. By checking the resistance from each input terminal to the positive bus and the negative bus (then swapping your meter leads) you can check each of the diodes. Remember, you should see a resistance reading typical of a diode, with low resistance in one direction and fairly high resistance after you swap the meter leads.





Input Diode Check

**Test Equipment - Analog Ohmmeter Set to R X 1 Scale
or Digital Multimeter set to the Diode Check.**

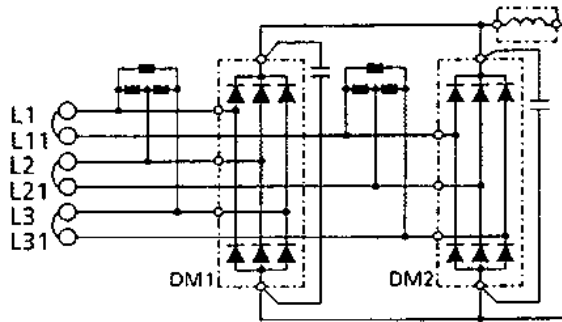
Step No.	Ohmmeter Positive Lead	Ohmmeter Negative Lead	Expected Reading (Analog Meter)	Expected Reading (Digital Meter)
1	L1 Terminal L2 Terminal L3 Terminal	Terminal labeled (+)	Approximately 10 Ohms	Approximately 0.5 Volts
2	L1 Terminal L2 Terminal L3 Terminal	Terminal labeled (-)	Infinite Ohms	0L displayed
3	Terminal labeled (-)	L1 Terminal L2 Terminal L3 Terminal	Approximately 10 Ohms	Approximately 0.5 Volts
4	Terminal labeled (+)	L1 Terminal L2 Terminal L3 Terminal	Infinite Ohms	0L displayed



Input Diode Check

**Test Equipment - Analog Ohmmeter Set to R X 1 Scale
or Digital Multimeter set to the Diode Check.**

For GPD 506/P5 inverters with 12 pulse input, follow the diode check procedure also checking terminals L11, L21, and L31. Refer to the following list for a test point for the (-) DC bus and (+) DC bus.



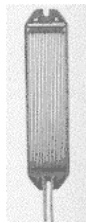
Voltage	Model	Connector	(-) DC bus	(+) DC bus
230V	18kW & 22kW	19CN	Pin 1	Pin 5
	30kW ~ 75kW	26CN	Pin 5	Pin 1
460V	18kW ~ 45kW	19CN	Pin 1	Pin 5
	55kW ~ 160kW	26CN	Pin 5	Pin 1



Soft Charge Resistor/Contactor

The soft charge resistor, or current-limiting resistor, works in conjunction with the soft charge contactor to slowly charge the DC bus capacitors and minimize the inrush current, when power is applied to the inverter. With no power applied to the inverter, the DC bus is discharged and the contacts on the soft charge contactor are open.

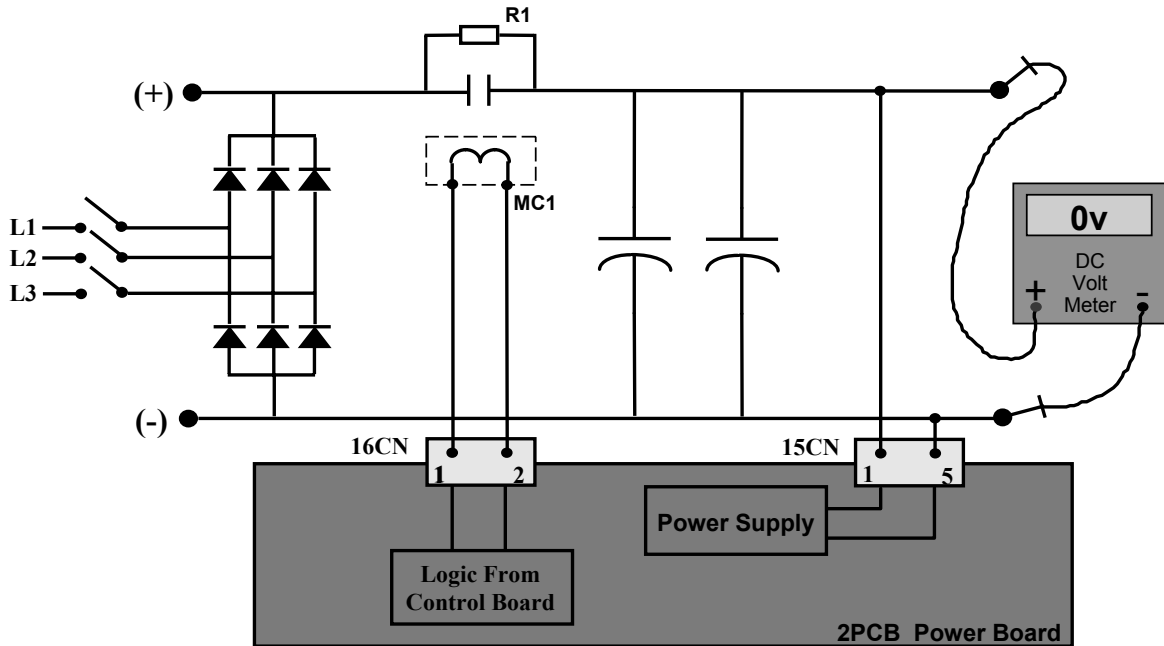
The purpose of the soft charge contactor is to bypass the soft charge resistor after the DC bus voltage has reached its normal operating level. When input power is applied to the inverter, the DC bus voltage starts to increase. The contacts on the contactor are open, so the current that is charging up the DC bus capacitors is passing through the soft charge resistor. The soft charge resistor acts like a control valve, and allows the DC bus capacitors to charge slowly. When the DC bus voltage has risen above the under voltage detection point (190 VDC for 230V units, 380 VDC for 460V units and 546 VDC for 600V units), the contacts on the contactor close bypassing the soft charge resistor. If a soft charge resistor was not used, the large inrush current would damage the input diodes.





Soft Charge Resistor/Contactor

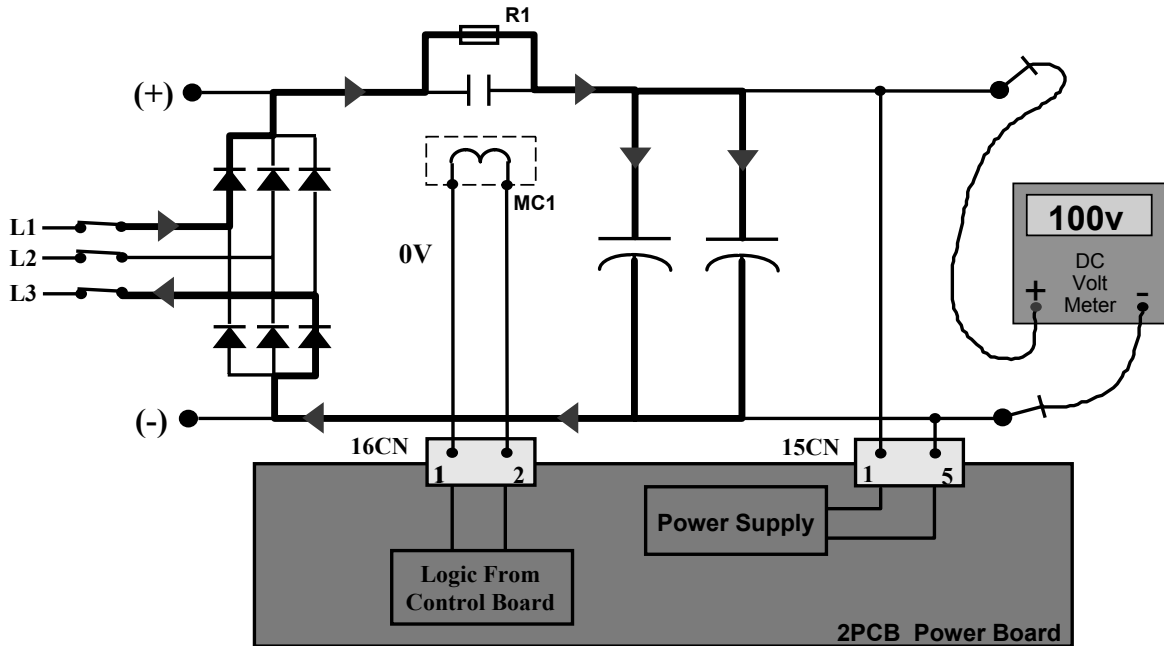
typical for 0.4kW through 15kW models





Soft Charge Resistor/Contactor

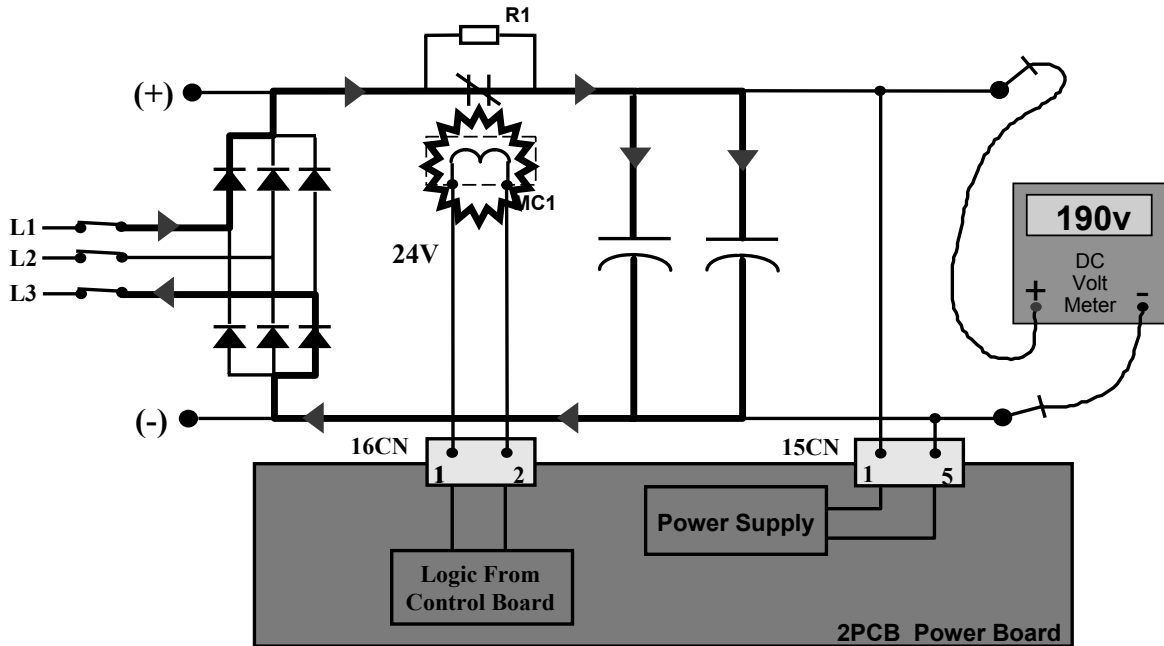
typical for 0.4kW through 15kW models





Soft Charge Resistor/Contactor

typical for 0.4kW through 15kW models





Soft Charge Resistor/Contactor

The soft charge resistor/contacter will change with the capacity of the inverter. 7.5kW and smaller models use resistors mounted on the power board. 11kW and 15kW models use a single resistor mounted in the main circuit. In 230V units 1.5kW and smaller and 460V units 4.0kW and below, the contactor is soldered to the powerboard.

Soft Charge Resistor Check for 0.4 kW through 15 kW models:

The first step is a visual inspection. Many times a damaged soft charge resistor has physical damage, such as burn marks, discoloration, or has been broken into pieces. If there is no physical evidence of damage, a check with an ohmmeter must be performed. Locate the soft charge resistor(s) inside the inverter unit. With an ohmmeter set to the R x 1 scale, measure across the resistor(s). If the resistor(s) is damaged, the measured value will be infinite ohms (burned open).

Soft Charge Contactor Check for 0.4 kW through 15 kW models :

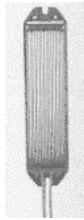
With an ohmmeter set to the R x 1 scale or the ohm setting, measure across the contacts and press in the plunger. On the smaller capacity inverters, the contactor will be totally enclosed and this step can not be performed. When the plunger is pushed in, the resistance across the contacts should read 0 ohms. When the plunger is released, the resistance will be the ohmic value of the soft charge resistor. On the units with the board mounted contactor, verify that the contacts read infinite ohms across each contact. Measure across the coil of the contactor, it should read about 300 ohms.



Soft Charge Resistor/Contactor

for 18kW through 160kW models

After the 230V contactor has energized, an “answer back” auxiliary contact closes. When this contact is closed, the control board receives a signal indicating that the soft charge contactor has energized. If the control board does not receive this signal, the inverter will not operate and an undervoltage fault will be displayed on the digital operator.



Soft charge resistor

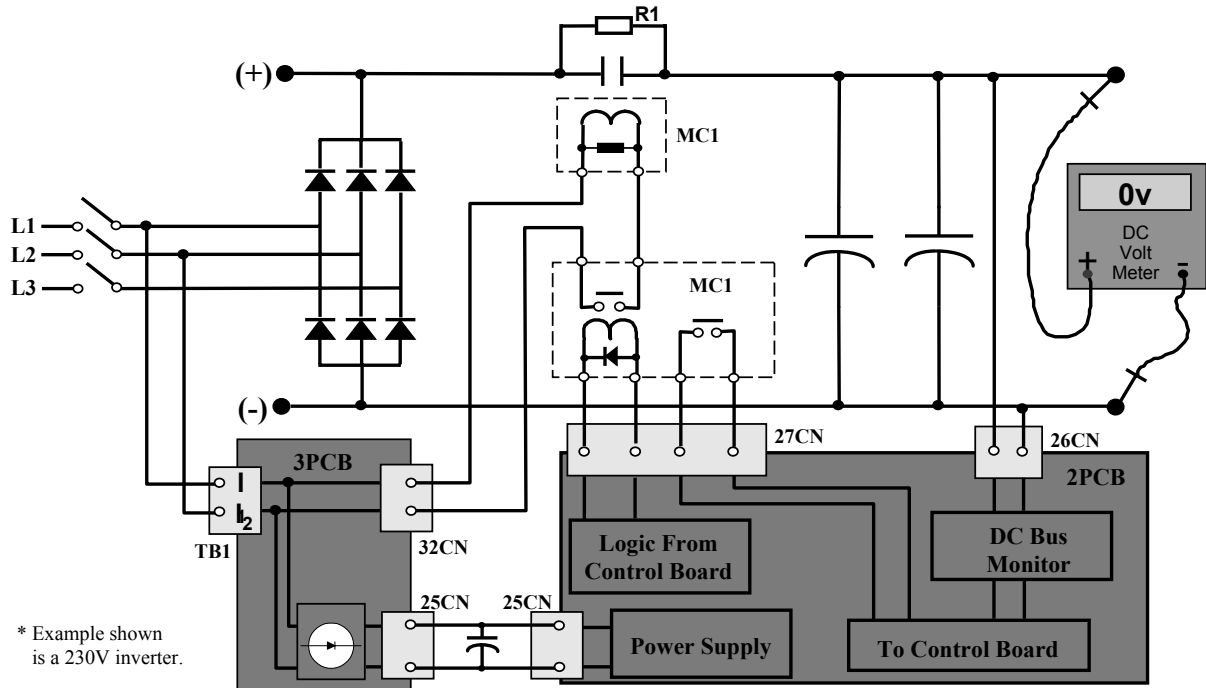


Soft charge contactor



Soft Charge Resistor/Contactor

typical for 18kW through 160kW models

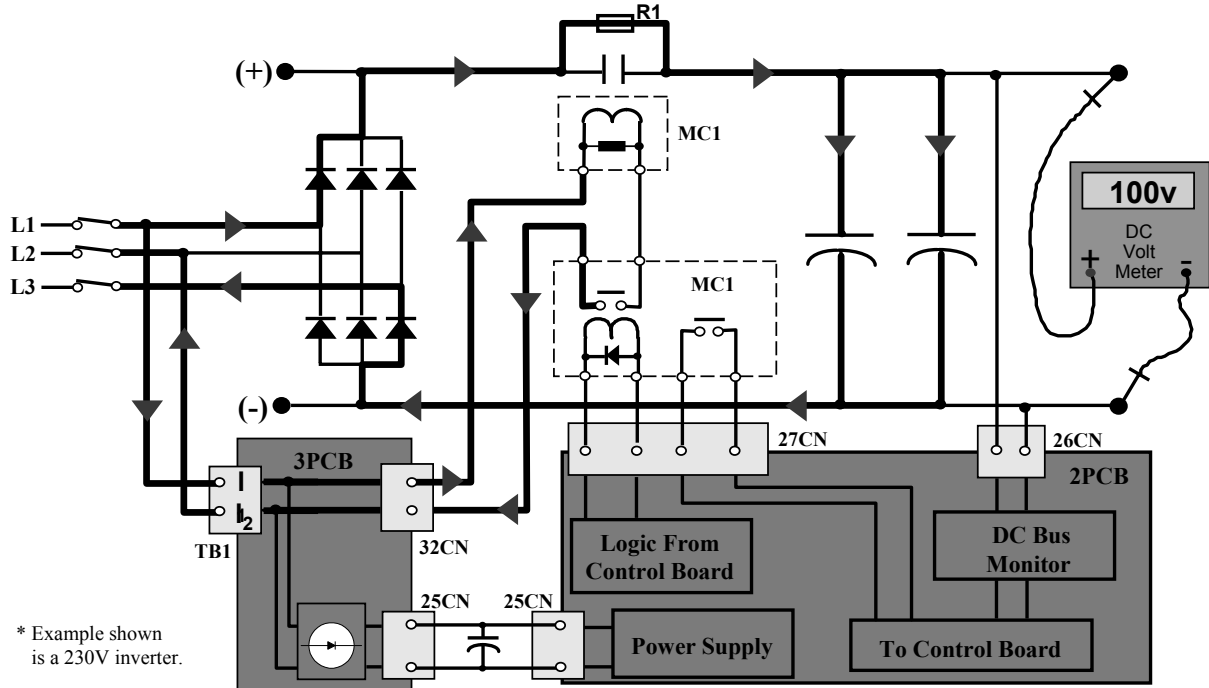


* Example shown is a 230V inverter.



Soft Charge Resistor/Contactor

typical for 18kW through 160kW models

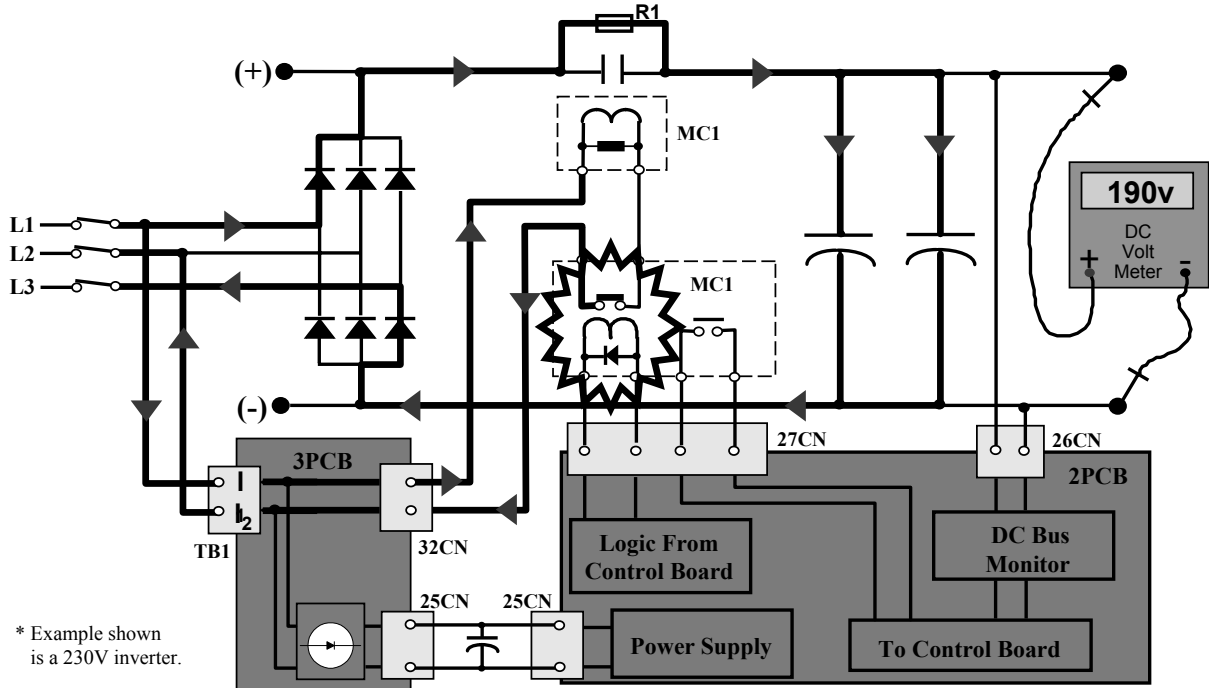


* Example shown is a 230V inverter.



Soft Charge Resistor/Contactor

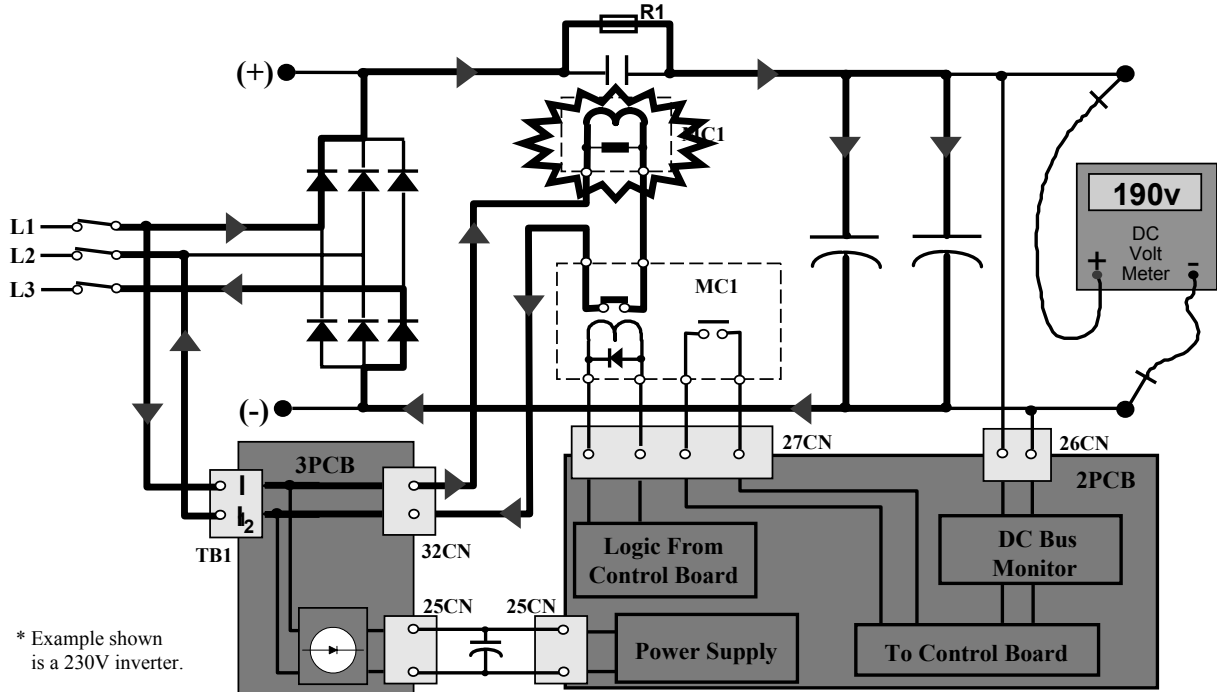
typical for 18kW through 160kW models





Soft Charge Resistor/Contactor

typical for 18kW through 160kW models

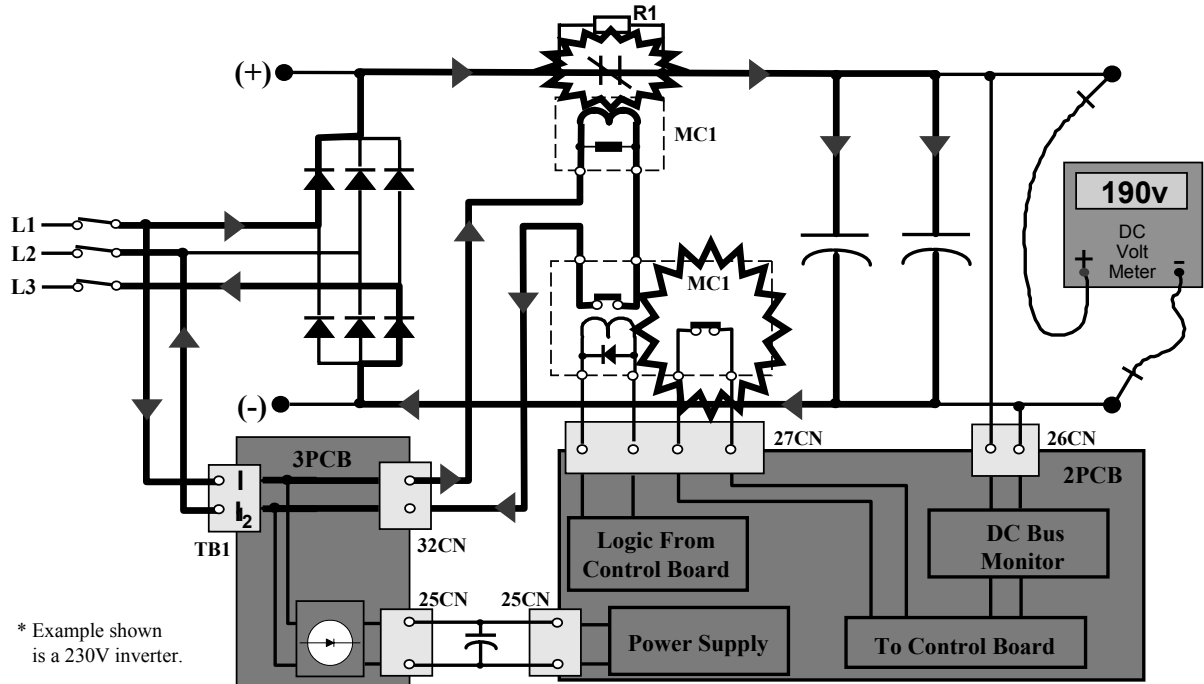


* Example shown is a 230V inverter.



Soft Charge Resistor/Contactor

typical for 18kW through 160kW models



* Example shown is a 230V inverter.



Soft Charge Resistor/Contactor

Soft Charge Resistor Check for 18 kW through 160 kW models:

The first step is a visual inspection. Many times a damaged soft charge resistor has physical damage, such as burn marks, discoloration, or has been broken into pieces. If there is no physical evidence of damage, a check with an ohmmeter must be performed. Locate the soft charge resistor(s) inside the inverter unit. With an ohmmeter set to the R x 1 scale, measure across the resistor(s). If the resistor(s) is damaged, the measured value will be infinite ohms (burned open).

Soft Charge Contactor Check for 18 kW through 160 kW models :

With an ohmmeter set to the R x 1 scale or the ohm setting, measure across the contacts and press in the plunger. On smaller capacity inverters, the contactor may be totally enclosed and this step can not be performed. When the plunger is pushed in, the resistance across the contacts should read 0 ohms. When the plunger is released, the resistance will be the ohmic value of the soft charge resistor

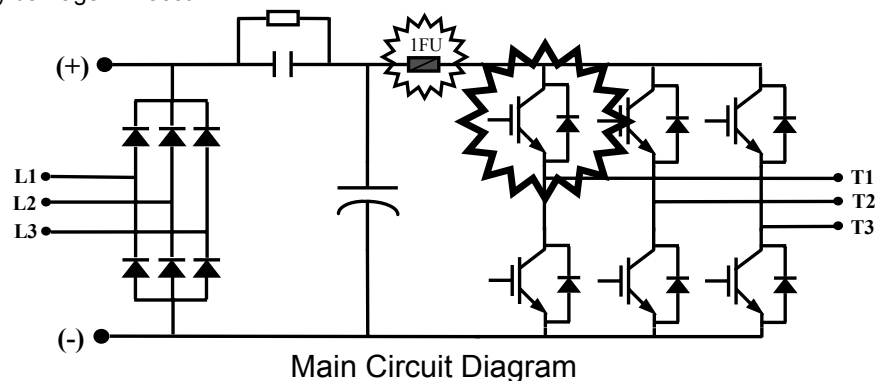
With an ohmmeter set to the R X 1 scale or the ohm setting, measure across the 230V coil, the resistance should be close to 175 ohms. Measure across the 24V auxiliary coil, the resistance should be about 2.2M ohms. These values may vary dependent upon the model being tested. The coils can be tested by applying the appropriate voltage and verifying that the contacts change states.



DC Bus Fuse

The DC Bus fuse is located in the positive portion of the DC bus in 460v and 600v units, 3.7kW and smaller (5.5 and smaller for 230v units), and in the negative portion in all other sizes. The DC bus fuse is used to protect the main circuit components if the output transistors short. If the DC bus fuse is open, at least one of the output transistors has failed. When a transistor fails, there is a short between the positive and negative portions of the DC bus. Again, the DC bus fuse does not protect the transistors, but protects the rest of the main circuit from the high current present during a short. **Never replace the DC bus fuse without first checking all of the output transistors.**

Caution: If the DC bus fuse is replaced without replacing the shorted output transistor, non-warranty damage will occur.



Typical for 3.7kW models and below. All other models have fuse in negative portion of the DC bus.



DC Bus Fuse

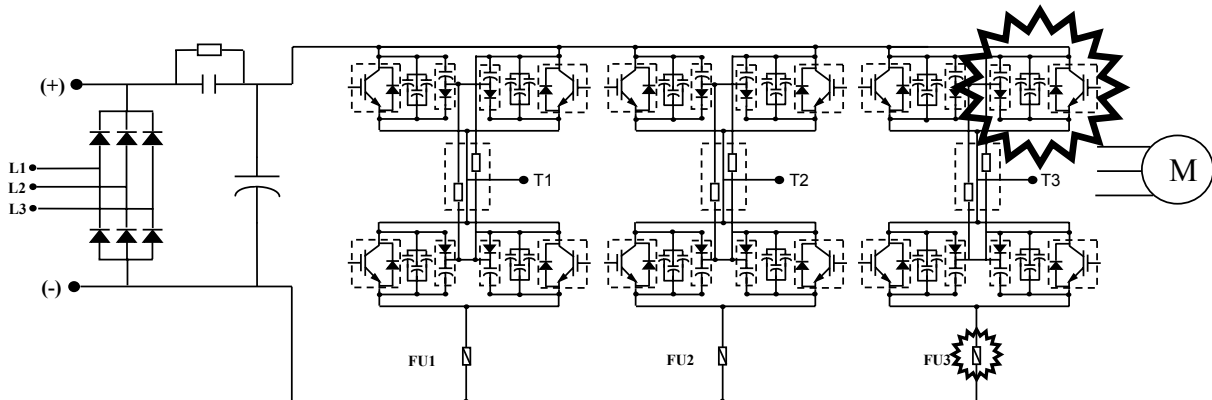


for models 2030 through 2075 and 4055 through 4160

Some larger models employ three DC bus fuses instead of one. If the DC bus fuse(s) are open, at least one of the output transistors has failed. When a transistor fails, there is a short between the positive and negative portions of the DC bus. Again, the DC bus fuse(s) do not protect the transistors, but protects the rest of the main circuit from the high current present during a short.

Never replace the DC bus fuse (s) without first checking all of the output transistors.

Caution: If the DC bus fuse(s) are replaced without replacing the shorted output transistor, non-warranty damage will occur.



Main Circuit Diagram



Braking Circuit

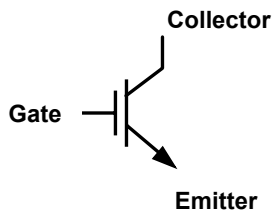


For 230V 0.4 kW-7.5kW models, 460V 0.4kW-15kW models and 600V 1.5kW-22kW models

**Test Equipment - Analog Ohmmeter Set to R X 1 Scale
or Digital Multimeter set to the Diode Check.**

The braking transistor is located in the main circuit and works in conjunction with the braking resistor option installed to terminals B1 and B2. The transistor turns on when the DC bus voltage reaches 380VDC for 230V models, 760VDC for 460V models and 990VDC for 600V models. The transistor can be checked by following the steps below. The most common failure is for the transistor to be shorted between the collector and emitter. Readings will vary depending on inverter size.

Braking Transistor Check



IGBT

Step No.	Ohmmeter Positive Lead	Ohmmeter Negative Lead
1	Connect to B2 terminal	Connect to the Emitter
2	Connect to the Emitter	Connect to B2 terminal
3	Connect to the Gate	Connect to the Emitter
4	Connect to the Emitter	Connect to the Gate
5	Connect to B2 terminal	Connect to the Gate
6	Connect to the Gate	Connect to B2 terminal



Braking Circuit

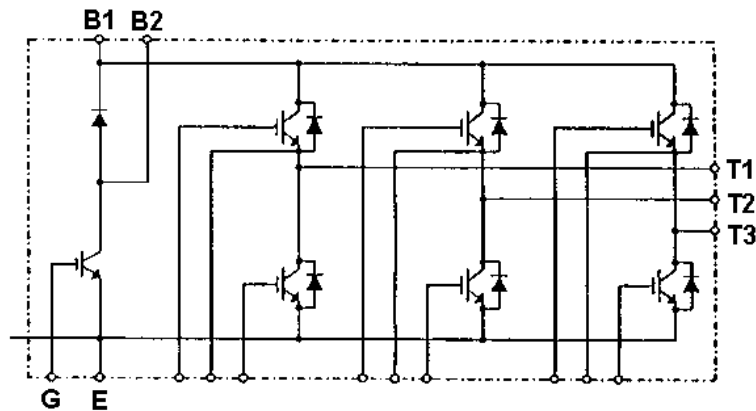


For 230V 0.4 kW-7.5kW models, 460V 0.4kW-15kW models and 600V 1.5kW-22kW models

**Test Equipment - Analog Ohmmeter Set to R X 1 Scale
or Digital Multimeter set to the Diode Check.**

Braking Diode Check

Step No.	Ohmmeter Positive Lead	Ohmmeter Negative Lead	Expected Reading (Analog Meter)	Expected Reading (Digital Meter)
1	Connect to B2	Connect to B1	10 Ohms	0.5-1.5 Volts
2	Connect to B1	Connect to B2	Infinite Ohms	OL Displayed

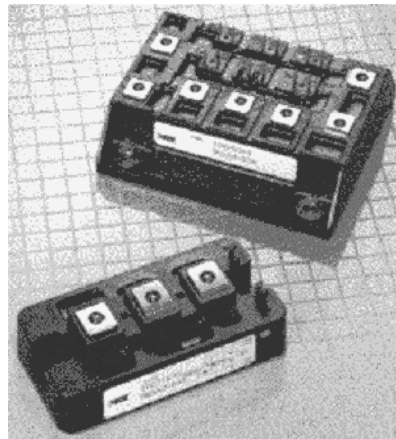
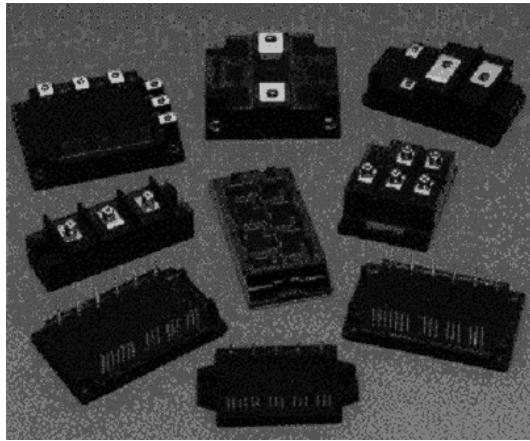


* The B1 Terminal is connected to the Positive portion of the DC bus.



Output Transistors

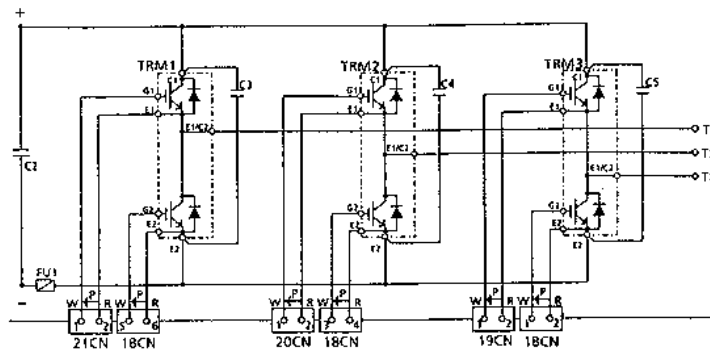
The output transistors are used to switch the DC bus voltage to allow current to flow to the motor. Think of them as switches that turn on and off very quickly to supply power to the motor. Large capacity inverters use the single pair style transistors while the smaller capacity inverters use the 6-in-1 style transistor module. In the single pair transistor, one transistor switches positive DC voltage to the motor, while the other transistor switches negative DC voltage to the motor. The terminals labeled T1, T2, and T3 are the leads that go out to the motor.





Output Transistors

The transistors can be checked by simply measuring the resistance from the collector to the emitter. The power transistors used in Yaskawa inverters all have free-wheeling diodes connected in parallel with the collector-emitter junction. When measuring the resistance across the output transistors, you should use an ohmmeter or a digital multimeter and expect to see resistance readings characteristics of the free-wheeling diode. Resistance should be fairly low in the forward direction and very high in the reverse direction.



2PCB Power Board

* NOTE: If the DC bus fuse is open, choose a test point for the negative bus on the output transistor side of the fuse.



Output Transistor Check



for models 0.4kw through 15kW

**Test Equipment - Analog Ohmmeter Set to R X 1 Scale
or Digital Multimeter set to the Diode Check.**

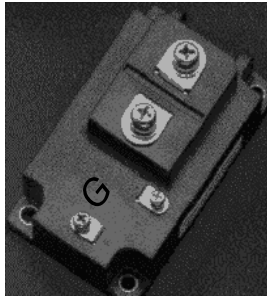
Step No.	Ohmmeter Positive Lead	Ohmmeter Negative Lead	Expected Reading (Analog Meter)	Expected Reading (Digital Meter)
1	T1 Terminal T2 Terminal T3 Terminal	Terminal labeled (+)	Approximately 10 Ohms	Approximately 0.5 Volts
2	T1 Terminal T2 Terminal T3 Terminal	Terminal labeled (-)	Infinite Ohms	OL displayed
3	Terminal labeled (-)	T1 Terminal T2 Terminal T3 Terminal	Approximately 10 Ohms	Approximately 0.5 Volts
4	Terminal labeled (+)	T1 Terminal T2 Terminal T3 Terminal	Infinite Ohms	OL displayed

Note: When a transistor fails, all the transistors in the failed phase must be replaced. They must be replaced with the identical transistor manufacturer and part number.

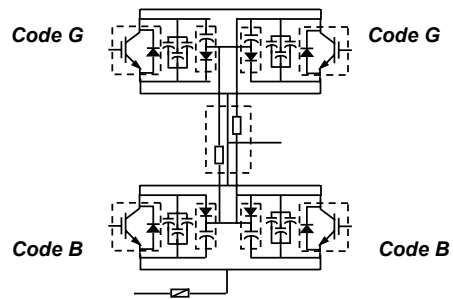


Parallel Transistors

Some inverter models have more than one transistor module per positive and negative phase. The transistor modules in each pair on the output phase must have the same gain code. The gain code signifies the characteristics of the device when it is tested by the manufacturer. The indication (2P) in the specifications column found in the parts list indicates that these transistors must be replaced in pairs. If one transistor module in a portion of the output phase is shorted, the other must also be replaced. All (4) of the transistors in a single phase do not have to have the same gain codes, only the transistors in parallel within that phase.



Transistor module with gain code

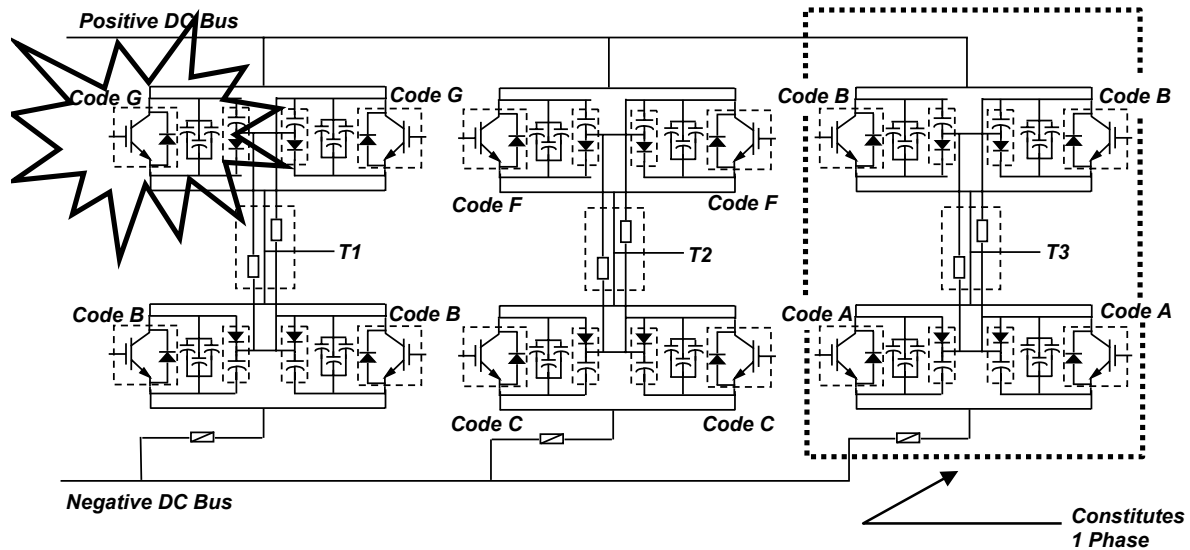


Schematic of parallel transistors



Parallel Transistors

If the transistor with gain code "G" in the positive portion of T1 shorted, YEA recommends that all four transistors in that phase be replaced. It is not required that all four transistors have identical gain codes. Only the transistors in parallel need to have the same gain code (as shown below). The gain code on transistors in parallel configurations must be identical.





Output Transistor Check



for models 18kw through 160kW

**Test Equipment - Analog Ohmmeter Set to R X 1 Scale
or Digital Multimeter set to the Diode Check.**

Step	Ohmmeter Positive Lead	Ohmmeter Negative Lead	Expected Reading (Analog Meter)	Expected Reading (Digital Meter)
1	T1, T2, T3 Terminals	Terminal labeled (+)	Approximately 4 Ohms	Approximately 0.5 Volts
2	T1, T2, T3 Terminals	Terminal labeled (-)	Infinite Ohms	OL displayed
3	Terminal labeled (-)	T1, T2, T3 Terminals	Approximately 4 Ohms	Approximately 0.5 Volts
4	Terminal labeled (+)	T1, T2, T3 Terminals	Infinite Ohms	OL displayed

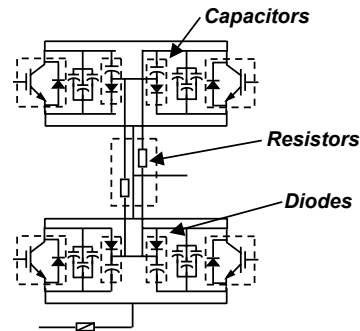
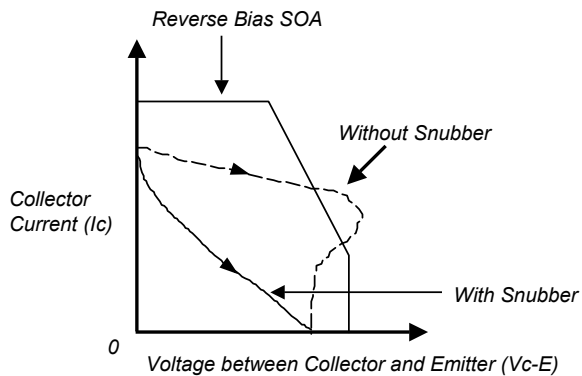
For GPD 506/P5 inverters, refer to the following connectors for a test point for the (-) DC bus and (+) DC bus.

Voltage	Model	Connector	(-) DC bus	(+) DC bus
230V	18kW & 22kW	19CN	Pin 1	Pin 5
	30kW ~ 75kW	26CN	Pin 5	Pin 1
460V	18kW ~ 45kW	19CN	Pin 1	Pin 5
	55kW ~ 160kW	26CN	Pin 5	Pin 1



Snubber Circuit

The snubber circuit is located in the main circuit attached to each of the output transistors between the collector and the emitter. The snubber circuit is typically found in 18kW models and larger. The snubber circuit may contain a capacitor, diode, and a resistor. When the IGBT is turned off, it may be damaged from surge voltage generated by unit wiring inductance. The snubber circuit absorbs the surge voltage to keep the voltage within the SOA (safe operating area) of the output transistor.



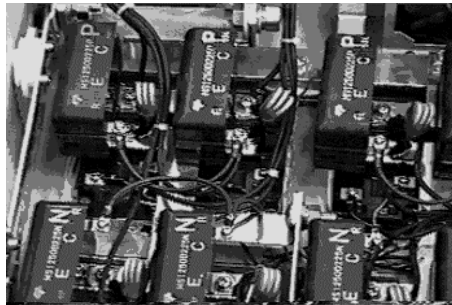
Output transistors
with snubber circuit



Snubber Circuit

Snubber circuit check:

With an ohmmeter set to the R x 1 scale or the diode check setting, measure across each diode in the circuit. You should see a resistance reading typical of a diode, with low resistance in one direction and high resistance in the other direction. The resistors can also be checked with an ohmmeter by measuring across each resistor. The snubber capacitors should be checked for physical damage and may also be checked with an ohmmeter. A high resistance value should be present. Refer to the Appendix of this document for detailed specifications for the snubber diode, resistor and capacitor.



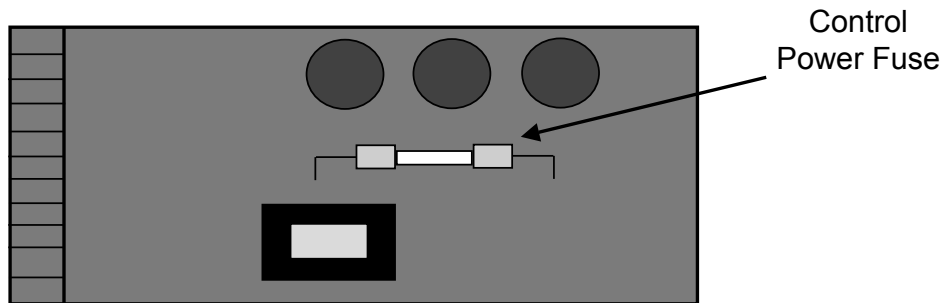
Snubber circuit of P5U4160



Control Power Fuse

for models 0.4kW through 15kW

All Yaskawa GPD 506/P5 and GPD 515/G5 inverters have a control power fuse. If the control power fuse is open, then the power board is defective. The fuse is soldered to the power board. The fuse can easily be checked using an ohmmeter set to the R X 1 scale. Place one lead of the ohmmeter on one side of the fuse, and place the other lead of the ohmmeter on the other side of the fuse. If the fuse is bad, the measured value will be infinite ohms.



Power Board

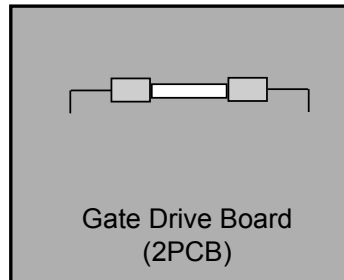


Control Power Fuse

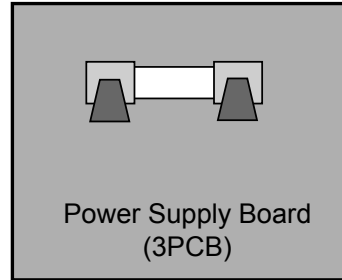
for models 18kw through 160kW

All Yaskawa GPD 506/P5 and GPD 515/G5 inverters have a control power fuse. The fuse is located on either the gate drive board (2PCB) or the power supply board (3PCB). If the fuse is located on the gate drive board (2PCB), it will be soldered to the board. If the control power fuse is open, then the gate drive board may be defective. On the larger inverter models, the fuse is a “plug in” type.

The fuse can easily be checked using an ohmmeter set to the R X 1 scale. Place one lead of the ohmmeter on one side of the fuse, and place the other lead of the ohmmeter on the other side of the fuse. If the fuse is bad, the measured value will be infinite ohms.



Solder type



Plug in type



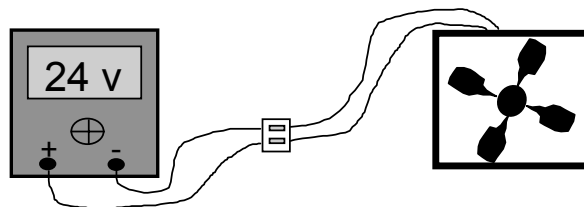
Cooling Fan

for models 0.4kw through 15kW



Most GPD 506/P5 and GPD 515/G5 units have a cooling fan that blows air across the heat sink on the back of the unit. If the cooling fan is not working properly, the inverter will trip on an overheat fault. 15kW models and below use a 24 VDC cooling fan.

Visually check the cooling fan to make sure it turns freely. If there is no physical evidence that the fan is bad, the motor can be checked with an ohmmeter or a 24 VDC power supply. Using an ohmmeter, measure across the fan motor terminals. If the measured value is 0 ohms, we can conclude that the motor is shorted, or if the measured value is infinite ohms, we can conclude that the motor is burned open. If the fan is not working, then disconnect the fan and apply 24 VDC to the fan to test the motor.



DC Power Supply

The fan connector plugs in to the powerboard at 9CN or 10CN.



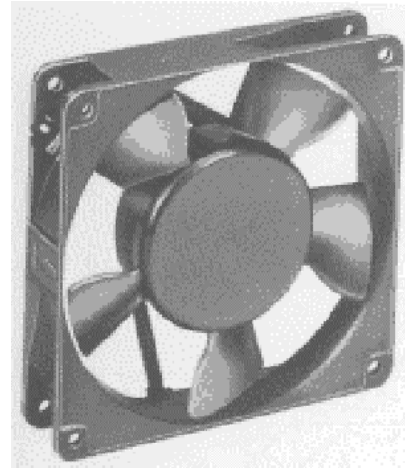
Cooling Fans

for models 18kW through 160kW



230V and 460V, 18kW through 160kW models have a 24V DC cooling fan and one or more 230V AC fans that blow air across the heat sink on the back of the unit. 600V, 18kW through 160kW models have one or more 230V AC fans that blow air across the heat sink on the back of the unit. If the cooling fan(s) are not working properly, the inverter will trip on an overheat fault.

Visually check the cooling fans to make sure that they turn freely. If there is no physical evidence that a fan is bad, the motor on the AC fans can be checked with an ohmmeter. Using an ohmmeter, measure across the fan motor terminals. If the fan motor is good, the measured value should be close to 500 ohms. If the measured value is 0 ohms, we can conclude that the motor is shorted, or if the measured value is infinite ohms, we can conclude that the motor is burned open. If the DC fan is not working, then disconnect the fan and apply 24 VDC to the fan to test the motor.





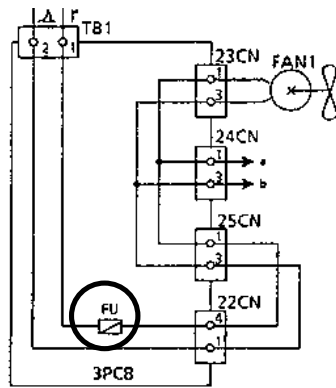
Cooling Fan Fuse



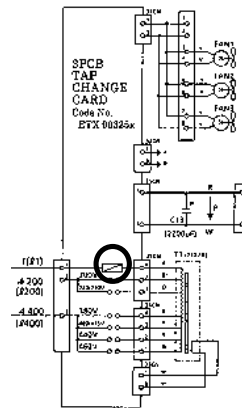
for models 18kW through 160kW

18kW through 160kW Yaskawa GPD 506/P5 and GPD 515/G5 inverters have a cooling fan fuse for the 230V AC fans. The fuse is located on either the power supply board or the tap change board (3PCB). If the cooling fan fuse is open, then the fan(s) may be defective.

The fuse can easily be checked using an ohmmeter set to the R X 1 scale. Place one lead of the ohmmeter on one side of the fuse, and place the other lead of the ohmmeter on the other side of the fuse. If the fuse is bad, the measured value will be infinite ohms.



Power supply board



Tap change board