

Troubleshooting a Variable Frequency Drive

Newsletter

Introduction

In many industrial and commercial plants, automation of any process and associated control relies heavily on motors and adjustable speed drives. AC Adjustable Speed Drives (ASD) have become the most popular variable speed control devices used in this area and as well as in residential applications. They are commonly used to control air handlers, chillers, pumps, conveyors, fans, compressors to highly sophisticated multi-drive machines. The increased usage of variable-frequency drives (VFDs) presents maintenance and troubleshooting of such important industrial equipment with challenges of learning to maintain, troubleshoot, and operate this equipment efficiently to minimize plant downtime.

In this technical article, I will explain what is a variable speed drive and the troubleshooting tips with Agilent U1253B handheld multimeter.



Agilent Technologies

What is a Variable Speed Drive?

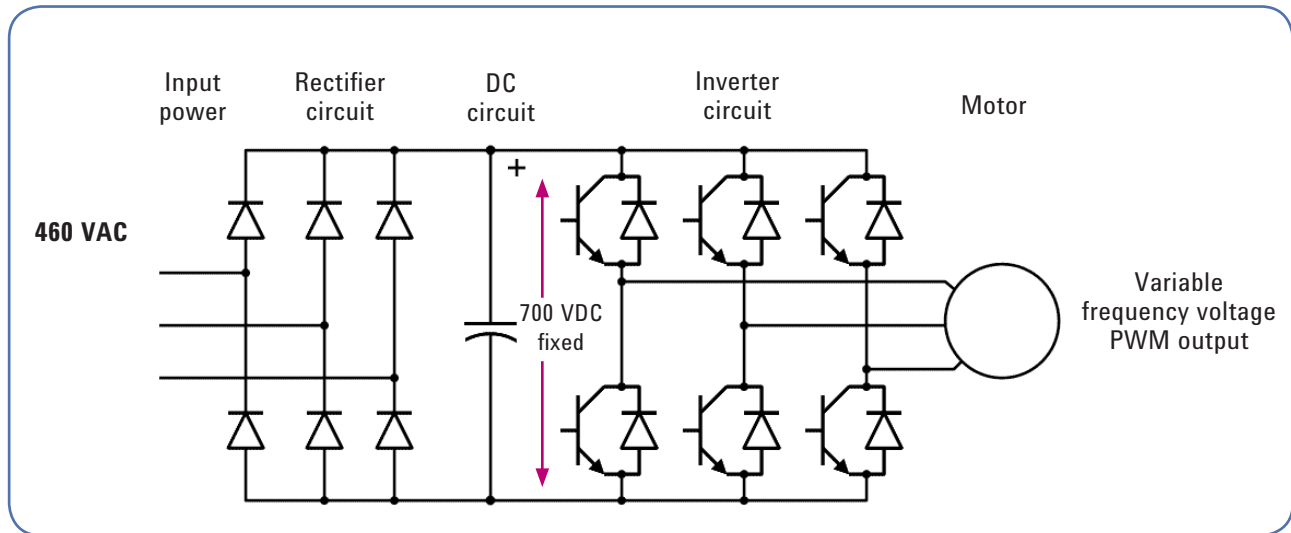


Figure 1. Variable speed drive building blocks

DEFINITION

Variable speed drives are electronic controller used to control the rotational speed of an electric motor. The electric motor can be either an induction motor or a synchronous motor. Variable speed drives change the induction motor speed by varying the frequency of the voltage used to power it. Variable frequency drives are also known as adjustable-frequency drives (AFD), adjustable speed drives (ASD), variable-speed drives (VSD), variable frequency drives (VFD), frequency converters (FC), AC drives, microdrives or inverter drives. Variable speed drive often uses less energy than an alternative fixed speed mode of operation. Typically, you can save 20-50% of energy when using fans and pumps with variable speed drive.

THREE MAIN COMPONENTS

RECTIFIER CIRCUIT UNIT

Firstly, variable speed drive converts AC input power to DC intermediate power using a three phase full-wave-diode bridge.

DC CIRCUIT UNIT

Then DC intermediate power is stored in high-power capacitors that are capable of holding a lethal charge for several minutes.

INVERTER CIRCUIT UNIT

Lastly, the inverter unit takes the electrical energy from the DC circuit and converts into quasi-sinusoidal AC power that can be used by the AC motor. The inverter is using pulse width modulation techniques to create three-phase AC voltage output for the motor.

But troubleshooting a variable speed drive is always a challenge. VFD consist of a complicated combination of electric power components and sensitive electronic circuits.

Troubleshooting a Variable Speed Drive



Variable speed drive is a sensitive electronic device. The drive will respond to fluctuations in system conditions and eventually drop off on a fault indication, depending on what part of the system is malfunctioning.

When VFD goes down, remember to check the basics (the controller display, connections, and temperatures), check the motor, and check the drive to get some clue which part of the drive went wrong. The best way to start troubleshooting the VFD is by doing a thorough visual inspection. Clean up dirt, dust and corrosion build up on the heatsink of the drive. Then check all wiring connections for tightness. Loose connections in the wiring of the drive to the incoming power and to the motor are a major cause of drive failure.

Incoming three phase power must be checked and it should not exceed 5% of deviation. Unbalanced line voltage can cause significant problems in the drives. Lastly, check the drive output for voltage and current. Problems with the input to the drive can cause a number of failures. A drive can experience overvoltage or undervoltage trips due to line surges or sags. Besides that, a drive may also experience overcurrent trips or possibly a motor-related fault such as an overload.

If the problem still persist after visual inspection, a few simple tips below could be helpful for troubleshooting variable speed drive.



Tip 1 : Check the Input Rectifier

Before you start, always remember to remove the power and wait until there is no voltage present on the DC bus. Get a handheld multimeter probe on the DC BUS to check. Switch on your Agilent U1253B to Diode Check mode. Place the black lead from the negative terminal of U1253B onto the positive DC bus. Often this is labeled as “+” on or near the power terminals. If you are unsure, please check with the manufacturer.

Then, place the red lead onto each of the incoming three phases to check the rectifier diode. You should read a forward diode voltage drop (0.3 V to 0.6 V) on each input terminal. After this, you can place the red lead (positive terminal of U1253B) on the negative bus. This is usually labeled as “-” on or near the power terminals. Place the black lead from the negative terminal of U1253B on all the three incoming phases and look for a forward diode drop. If you read both forward bias and reverse bias under the configuration mentioned above, the input bridge is most likely shorted. However, if you read open circuit for both forward bias and reverse bias, then likely the charge resistor is open.

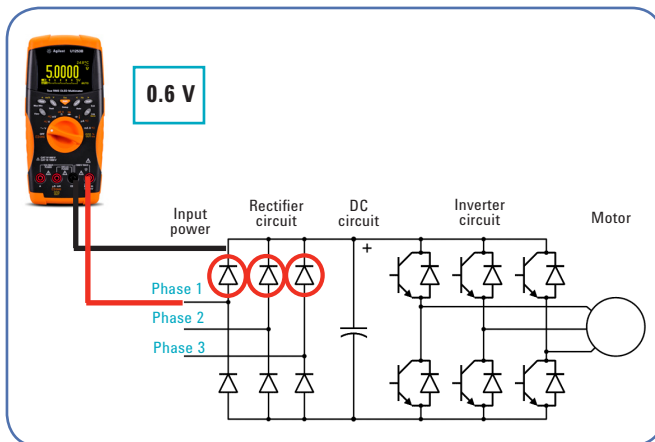


Figure 2. Testing upper rectifier diode for forward bias

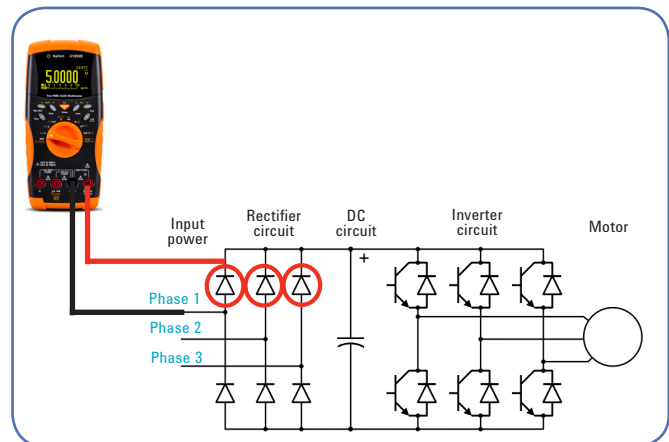


Figure 3. Testing upper rectifier diode for reverse bias

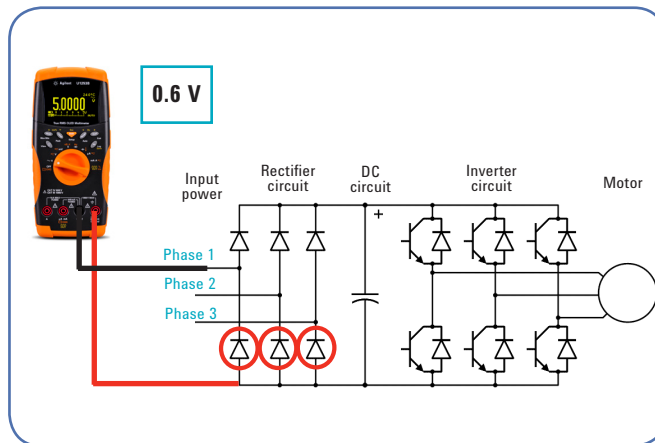


Figure 4. Testing lower rectifier diode for forward bias

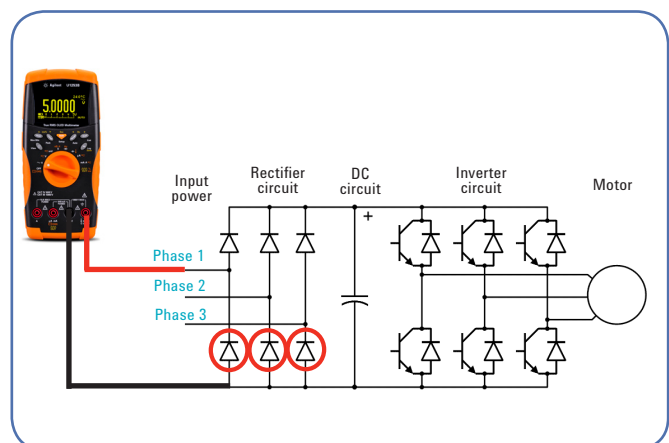


Figure 5. Testing lower rectifier diode for reverse bias

Tip 2 : Check the Variable Speed Drive Output

Keeping the red lead of U1253B on the negative bus “-”, and place the black lead of U1253B on each of the three motor output terminals. You should read again, a forward diode drop. Now, reverse the configuration by placing the black lead of U1253B on the positive bus “+”, and the red lead of U1253B on each of the motor output terminals. Look for a forward diode drop. If you read both forward bias and reverse bias under the configuration mentioned above, the output device is shorted. If you read an open circuit, then either the output device is damaged or the DC Bus fuse is open. Physically inspect the output devices. They can fail in a manner where they can be physically explode, but you will still read the diode drop.

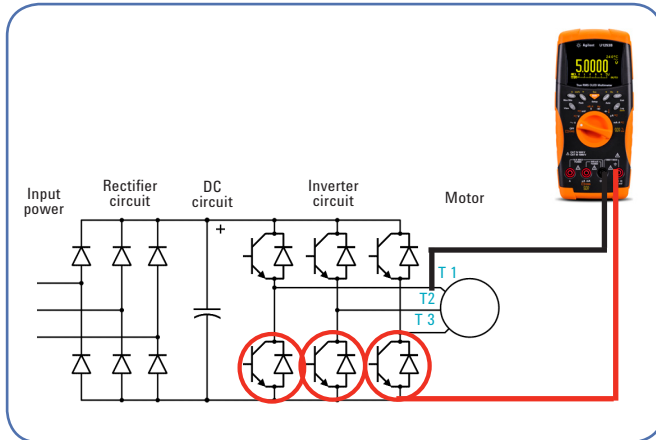


Figure 6. Testing lower output protection diode for forward bias

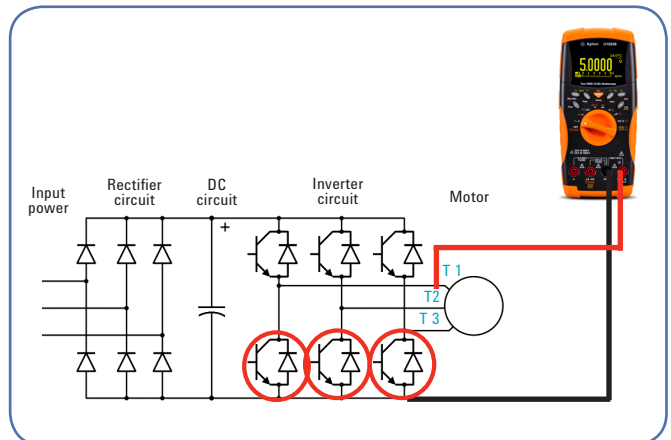


Figure 7. Testing lower output protection diode for reverse bias

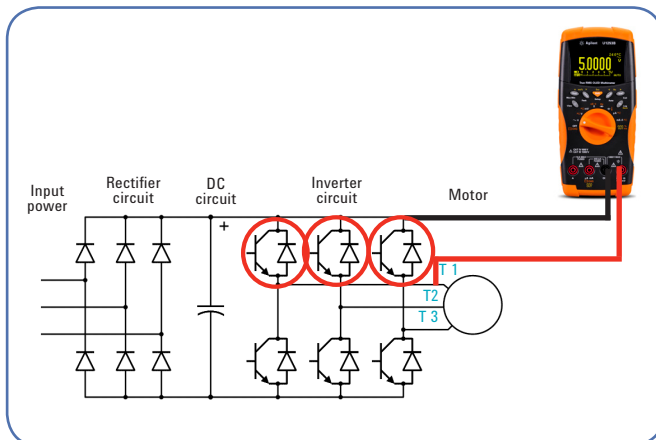


Figure 8. Testing upper output protection diode for forward bias

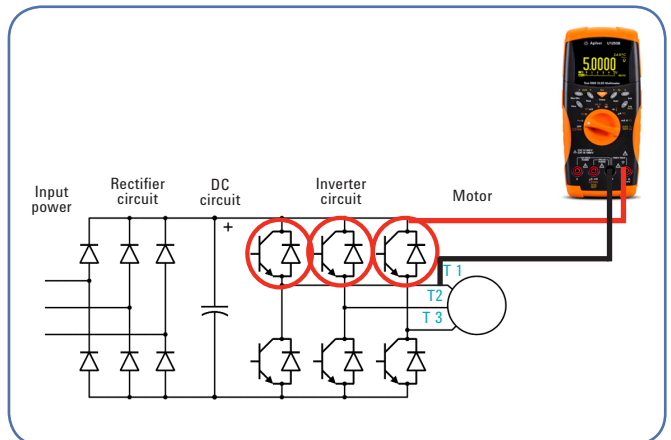


Figure 9. Testing upper output protection diode for reverse bias

Tip 3 : Check the Bus Capacitors

Firstly, physically inspect the capacitors for signs of damage like cracked or deformed casing, or the pressure plug popped out of the top. Then, set to Ohms measurement and start measuring the resistance across capacitor as shown in Figure 10. For a shorted capacitor, the multimeter will display reading close to 0 Ohm. In this case, you should not see a short. If your variable speed drive has several caps, it is possible that one could be opened. The only way to be certain of this is to put an oscilloscope on the bus and look for ripple. Caution, this is a power on check, and should only be done by technicians or engineers familiar with doing such tests on a high energy circuit.

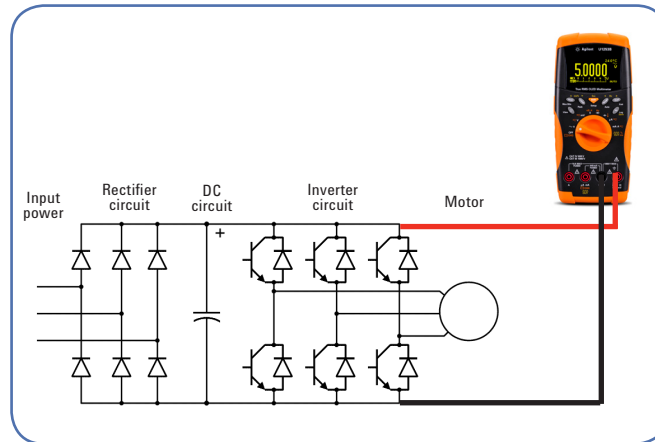


Figure 10. Checking bus capacitor for fault

Tip 4 : Check the Internal Power Supplies

Assuming that all of your power off checks pass, then apply power to the drive. In most VFDs, the power supplies are obtained from the DC bus via one or more switching power supplies. A quick check of this is to ensure that the keypad lights up. If it does not, that means your switching power supply is dead.

SUMMARY

The venerable electric motor that was the muscle of the industrial revolution is becoming the smart muscle of the computer-controlled plant and commercial facility of the future. The advent of powerful, reliable electronic drives are keeping motors in the forefront of this technological evolution. So, a reliable CAT IV safety rated handheld multimeter like Agilent U1253B is best suited for troubleshooting VFD and electric motors.



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