FLUKE®

How Stray Voltage Affects Multimeter Measurements

...and What You Can Do About It.

Application Note

For most electrical measurements in the industrial environment, a high impedance digital multimeter or electrical tester is the appropriate tool. These test instruments have a relatively high input impedance (>1 megohm), which means that when connected, they don't load the circuit under test. These test tools generally will not affect circuit operation or circuit measurements.

On the other hand, low impedance test instruments can seriously load down a circuit under test and, in some cases, can adversely affect circuit operation and circuit measurements. This can happen with sensitive control circuits or in many electronic circuits found within industrial machinery.

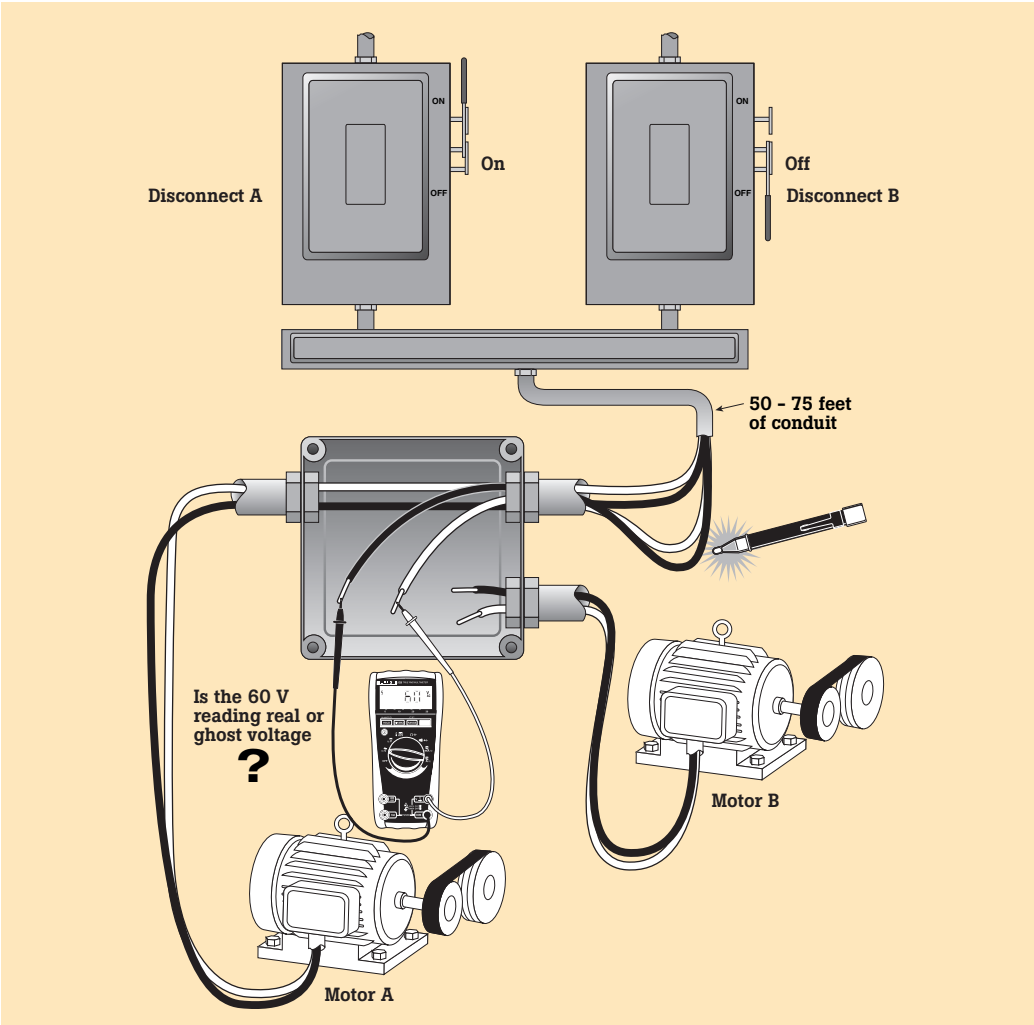
However, even with a high impedance multimeter, there's still one confusing measurement situation that can occur in facilities or manufacturing plants. It's called stray or ghost voltage, and it happens specifically when using a high impedance test instrument for day to day measurements.

Stray or ghost voltages occur from capacitive coupling between energized circuits and non energized, non connected adjacent wiring. Because of this coupling effect and the multimeter's high impedance, it's not always possible to determine if the circuit under test is energized or de-energized, and this creates confusion for the person performing the test.

Where are stray voltages encountered?

The most common place to encounter stray voltage is in unused cable runs or electrical wiring in existing conduit. When facilities or buildings are built and wired, it's very common for electricians to pull extra wire through the conduit for future use.

These wires are typically left unconnected until needed, but are subject to capacitive coupling from the powered wires. Another example is an open ground or neutral on a 120 V branch circuit or in card cages where 120 volt control circuits are used to control assembly line or conveyor functions.



What does stray voltage look like?

Generally, for most electrical measurements, a high impedance multimeter is the best tool, since you don't want the meter loading the circuit and affecting the circuit measurements. However, when dealing with capacitive coupling, a high impedance meter between ground or neutral to the unconnected cable or open connection will indicate some amount of voltage present. Typically this measured voltage reading may be as high as 50 % of the energized voltage in the same proximity.

Is this voltage real? Yes, it is, but it's a static voltage, containing no real energy or current flow. When it comes to determining whether a circuit or connection is energized, this stray voltage reading presents a real source of confusion. Is the connection really hot or not?

The Fluke TL225 Stray Voltage Adapter Test Lead Set

The Fluke Stray Voltage Adapter Test Lead Set is an accessory that allows a high impedance multimeter to measure circuits, connections, cables or connectors subject to stray voltages. The adapter provides a low impedance load to the measured circuit, desensitizing the meter to low energy, spurious sources of interference. If the measurement points are energized with a "hard" voltage, the meter will simply display the voltage reading. If the measurement points contain a stray or ghost voltage, the meter will read very close to zero volts, indicating the circuit or connection is not energized.

Warning

The stray voltage adapter is designed to be used in conjunction with high impedance digital multimeters for measurements on power circuits, to help determine whether the circuit is energized or not. The adapter presents a 3 kΩ load to the circuit under test and thus will dissipate any stray voltage present if the circuit is not energized.

This adapter should not be used on low voltage control circuits or anywhere where the circuit under test could be adversely affected by this low impedance load. The adapter is designed to handle continuously applied power system voltages without damage, however proper use of this adapter is for intermittent use to determine whether a circuit is energized or not.

Figure A

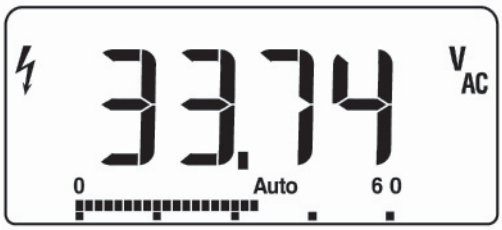


Figure B

Figure C

Sample measurement scenario

Figure A is a normal reading for an energized 120 volt branch circuit between hot and neutral. This reading is displayed on the meter with or without using the stray voltage adapter.

Figure B is the measurement displayed with the high impedance DMM between neutral and an unconnected wire in the same conduit as a 120 volt branch circuit feed. Note the high impedance meter is displaying 33 volts. This is a capacitively coupled stray voltage reading.

Figure C is displaying the result of the measurement from Figure B when the stray voltage adapter is placed in the circuit. Note that the reading is now 13 millivolts or very close to zero volts, a non-energized connection.

The low impedance presented by the stray voltage adapter dissipates the stray voltage. If the reading in Figure B was a "hard" voltage, the reading in Figure C would have been the same reading as in Figure A.

Safety

Testing for stray voltage is a measurement typically made for a short period of time, such as less than a minute. The stray voltage eliminator module contained within the TL225 test lead kit is designed to withstand a continuous application of 1000 volts or less. The module has been tested to meet the IEC 1010-1 second edition CAT IV 600 V/CAT III 1000 V measurement category rating.

On a more personal safety note: If you've ever doubted your multimeter readings, consider the environment you're working in. Does it contain the ingredients for capacitive coupling? If it does, and if you need to rely on hot-or-not readings, you may want to consider adapting your multimeter. Stray voltage is confusing at best, and dangerous at worst. Don't be fooled!

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Fluke Corporation
PO Box 9090, Everett, WA USA 98206

Fluke Europe B.V.
PO Box 1186, 5602 BD
Eindhoven, The Netherlands

For more information call:
In the U.S.A. (800) 443-5853 or
Fax (425) 446-5116
In Europe/M-East/Africa +31 (0) 40 2675 200 or
Fax +31 (0) 40 2675 222
In Canada (800)-36-FLUKE or
Fax (905) 890-6866
From other countries +1 (425) 446-5500 or
Fax +1 (425) 446-5116
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