

# What you need to know about input impedance

## Low Z and High Z

### Application Note

With a dual impedance meter, an electrician can safely troubleshoot sensitive electronic or control circuits as well as circuits that may contain ghost voltages, and can more reliably determine whether voltage is present on a circuit.

While almost all users of electrical test tools are aware of the difference between true-rms and average responding meters, many are not aware of input impedance as it relates to electrical test tools.

Input impedance refers to the impedance value between the input test jacks of an electrical test tool when it is selected to measure voltage. Two categories of input impedance exist: low impedance and high impedance. The symbol for impedance is  $Z$ , and some literature refers to test tool input impedance as either Low Z or High Z.

Both Low Z and High Z types of test tools offer benefits to troubleshooters, but you do need to consider the application where the tool is used.

#### When to use low impedance?

Electrical test tools with a low input impedance include solenoid-type voltage testers, basic electrical testers, and analog meters. The input impedance of Low Z test tools ranges from about  $2\text{ k}\Omega$  to  $100\text{ k}\Omega$ .

Low Z test tools do not pick up stray magnetic fields from fluorescent fixtures, energized electrical equipment, or current-carrying conductors, and display an ever-changing voltage.

This ever-changing voltage is known as **ghost voltage** or stray voltage.

Ghost voltage can appear when the test leads are plugged into the test tool but not connected to a voltage source. Ghost voltage can also appear when the test leads are plugged into the test tool connected to a de-energized source whose conductors are in proximity to an energized source. Ghost voltage can confuse a technician as to whether a circuit is energized or not.

The main advantage of low impedance input test tools is that they are not susceptible to ghost voltage.

Low Z tools should only be used for testing power circuits or other circuits where low impedance will not negatively impact or alter circuit performance.

#### When to use high impedance?

Electrical test tools with a high input impedance include digital multimeters (DMMs) and digital clamp meters. The input impedance of High Z test tools ranges from about  $1\text{ M}\Omega$  to  $10\text{ M}\Omega$ . In simple terms, this means that, when the DMM is placed across a circuit for a measurement, it will have little impact on circuit performance. This is the desired effect for most voltage measurement applications and is especially important for sensitive electronics or control circuits.

The main advantage of high impedance input test tools is that they do not trip GFCI receptacles or breakers, and they do not accidentally act as a closed switch when used with solid state input.



A disadvantage of High Z test tools is they are susceptible to ghost voltages; Low Z test tools are not susceptible.

## GFCIs

Ground fault circuit interrupter (GFCI) receptacles and circuit breakers are intended to protect personnel. When a Low Z test tool is used to measure the voltage between the HOT and GROUND of a GFCI receptacle or the HOT and GROUND of a circuit protected by a GFCI breaker, the GFCI plug or breaker will trip. This is because the Low Z test tool provides a path between HOT and GROUND that has a low impedance and draws enough current to activate the protective function of the GFCI plug or breaker. This feature can be used to test the functionality of GFCI plugs or breakers in a newly wired residence.

GFCIs are also used to protect the control circuits in manufacturing facilities where moisture is commonly present. Lost production and damaged product can result if a GFCI is

inadvertently tripped in a control panel and equipment stops running. Note that low impedance test tools do not cause tripping of ground fault units found in electronic circuit breakers. The GFCI function in electronic circuit breakers is intended to protect equipment, not personnel.

By their very nature, high impedance input, High Z test tools do not allow current to flow and do not act as a closed switch. Thus High Z test tools do not cause GFCI receptacles or circuit breakers to trip when used to measure voltage between the HOT and GROUND. Also, high Z testers do not act as a closed switch when measuring voltage across a solid state input, such as a PLC input.

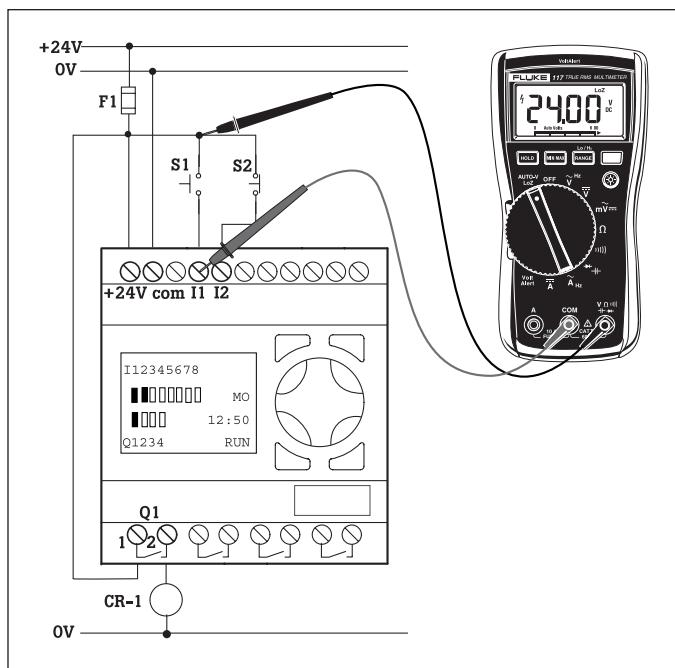
## The best of both worlds

With dual impedance meters, electricians can safely troubleshoot sensitive electronic or control circuits, as well as circuits that may contain ghost voltages, and can more reliably determine whether voltage is present on a circuit.

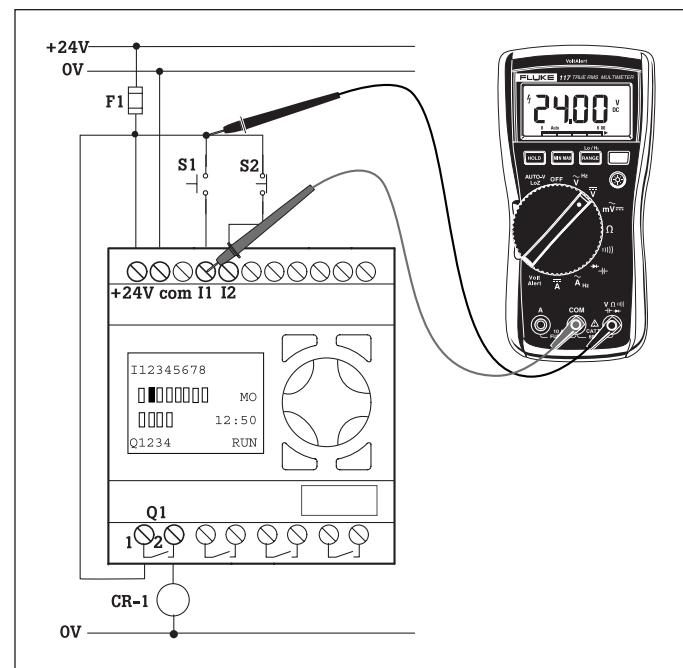
On the Fluke 114, 116, and 117 DMMs, the meter's regular Vac and Vdc switch positions are high impedance. Use these switch positions for most troubleshooting scenarios and especially on sensitive electronic loads. The Fluke low impedance function is called Auto-V/LoZ.

**Auto-V** stands for automatic volts. This feature automatically determines whether the measured signal is ac voltage or dc voltage, selects the correct function and range, and displays the correct information.

**LoZ** stands for Low Impedance (Z). This feature presents a low impedance input to the circuit under test. This reduces the possibility of false readings due to ghost voltages and improves accuracy when testing to determine absence or presence of voltage. Use the Auto-V/LoZ switch position on the DMM when readings are suspect (ghost voltages may be present) or when testing for the presence of voltage.



The LoZ setting on a dual impedance meter causes I1 to read S1 as closed. As a result, Q1 (Output 1) is turned on.



A dual impedance meter in volts dc does not cause I1 to read S1 as closed. As a result, Q1 (output 1) is not turned on.

## Summary

Technicians need to know whether their test tool has a low input impedance or high input impedance. Technicians also need to understand the advantages and disadvantages of each.

It is not necessary to carry both a low input and high input impedance electrical testers. The Fluke 114, 116, 117, and 289 are true-RMS digital multimeters that have a Low Z function. The Low Z function allows the user to select a low impedance input for voltage measurements when appropriate.

## Which tools are high impedance, low impedance, dual function?

Low Impedance	High Impedance	High Impedance with Low Z Function
Solenoid-type testers (various manufacturers)	Fluke 87V Industrial Multimeter	Fluke 114 Digital Multimeter (DMM)
Fluke 113 DMM	Fluke 1587 Insulation Multimeter	Fluke 116 DMM
Analog meters	Fluke 179 DMM	Fluke 117 DMM
Fluke T+PRO Electrical Tester	Fluke 83V Industrial Multimeter	Fluke 289 Logging Multimeter
	Fluke 233 DMM	
	Fluke CNX™ 3000 Wireless Multimeter	
	Fluke T5-600 Voltage, Continuity and Current Tester	
	Fluke T5-1000 Voltage, Continuity and Current Tester	
	Fluke 376 Clamp Meter	

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Printed in U.S.A. 7/2014 6002580B\_EN

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