Understanding the CAT Ratings on a Voltmeter

A voltmeter is a widely used instrument in the electrical industry, utilized to measure voltages at various circuit points mainly in order to troubleshoot a problem. A voltmeter can tell the condition of a battery, if a wire is broken, if a relay isn't working, if a fuse is blown (even if it looks good), a light socket is not grounded or whatever is not functioning in your system. Low cost voltmeters starting from $30 are available in the market, and one has to be very careful to select the right meter when the voltage is high and the system is complex. Using a properly rated test instrument on the circuit can mean the difference between completing the task without incident or suffering a serious injury. Safety of the leads and probes is just as important, if not more important, than that of the meter itself. Injuries can happen to anyone, even to a senior electrician with 30-odd years of experience, if proper instrumentation and procedures are not used.

As distribution systems and loads become more complex, the possibility of transient over voltages (shown in Figure 2) increases. Capacitors, motors and equipment such as variable speed drives, can be prime generators of voltage spikes. Lightning strikes on transmission lines also cause extremely hazardous high energy transients. If you are taking measurements on electrical systems, these transients are 'invisible' and largely unavoidable hazards. They occur regularly, and can reach peak values in the many thousands of volts.

According to the Occupational Safety and Health Administration (OSHA), 52 workers were electrocuted and sustained fatal injuries in 2010. With this in mind, it has become increasingly important to use test instruments that provide the highest levels of protection.

Current Standards

Test instruments that meet the requirements of IEC standard 61010-1 and the U.S. standards based on it, such as UL 61010B-1, provide transient protection levels far greater than the instrument's maximum rated input. This type of protection wasn't required in instruments designed to older standards like IEC 348 and UL 1244. The old standard, IEC 348 was based on steady-state voltages. IEC 61010 is based on over-voltage transients, as well as steady-state voltages. IEC 61010 refers to low voltage (<1000 V). Even when we talk about the utility level, we are referring to the low voltage secondary of the utility distribution transformer. The primary of the transformer is normally connected to a distribution level voltage in excess of 1000 V and therefore not covered by IEC 61010.

Using a test instrument without this additional protection against transient over voltages is a major hazard for personnel, even resulting in serious injury or death as well as a major source of equipment damage.

What is a CAT rating?

As the modern industry continues its quest to keep electricians safe, new standards and test instruments designed with safety and convenience in mind continue to help make that possible. In support of this goal, measurement category ratings continue to meet the minimum UL requirements, thus giving peace of mind when testing on an energized system. The level and energy of voltage impulses is dependent on the location. The closer the location is to the power source, the higher the available fault current, the higher the category.

Categories are defined by probability of over-voltage, the higher the over-voltage, the higher the category. All categories apply to low voltage only (<1000 V). Within each category (from CAT IV to CAT I) there are 'working voltages'; 1000 V, 600 V, 300 V, 150 V, 50 V. The standard recognizes that within a given category, higher voltages require higher levels of protection.

IEC 61010 defines four categories:

CAT IV "Origin of installation" Utility level and any outside cable run

CAT III Distribution wiring, including "mains" bus, feeders and branch circuits, permanently installed loads.

CAT II Receptacle outlet circuit, plug-in loads.

CAT I Protected electronic circuits.

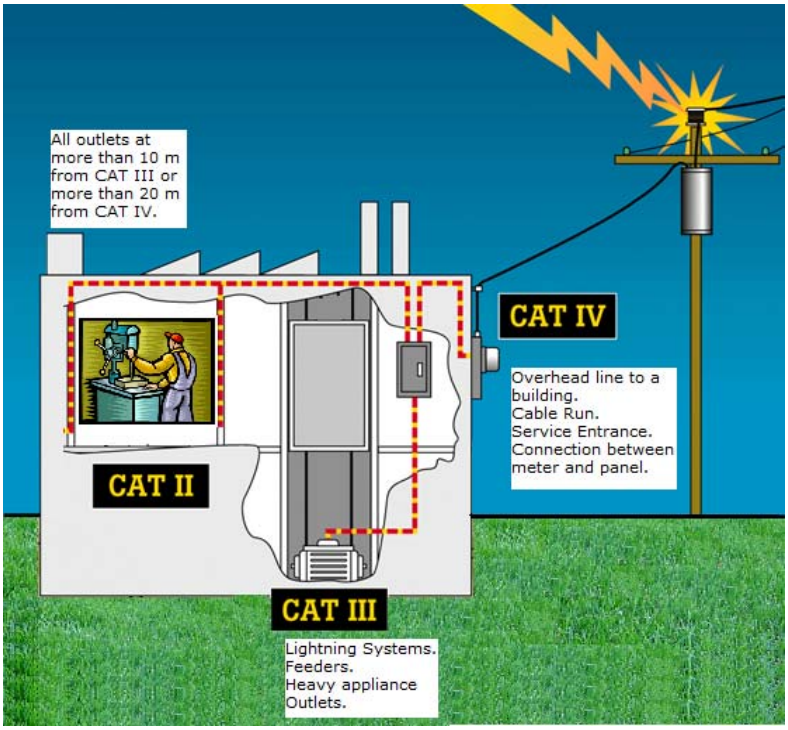

Figure 1 - The division of Categories as per IEC61010-1

A higher voltage within a category has a higher transient withstand, e.g.
CAT III – 600 V: 6.1 kV impulse
CAT III – 1000 V: 7.8 kV impulse

Phase to Neutral	Voltage Transients		
	CAT II	CAT III	CAT IV
50	520 V	806 V	1.55 kV
100	806 V	1.55 kV	2.55 kV
150	1.55 kV	2.55 kV	4.07 kV
300	2.55 kV	4.07 kV	6.1 kV
600	4.07 kV	6.1 kV	7.8 kV
1000	6.1 kV	7.8 kV	12.1 kV

Table 1 - Categories and associated Transient Voltages

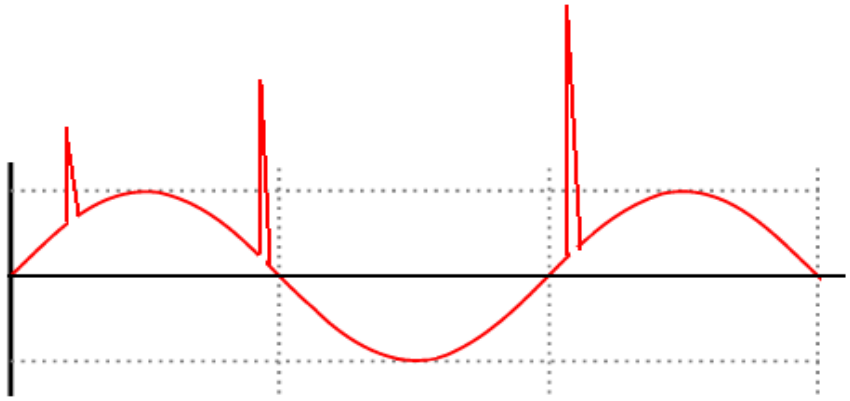

Figure 2 - Signal with Transients

If a customer looks only at the voltage rating without understanding the category concept, he could actually choose the CAT II-1000 V instrument thinking that it is "safer" than the CAT III-600 V instrument. It should be understood that even though the CAT II-1000 V rated working voltage is higher than the CAT III-600 V, the test impulse is the same. Both must withstand the same transient voltage. CAT III-1000 V (7.8 kV transient) is safer than CAT III-600 V (6.1 kV transient). But, CAT IV-600 V is the same as CAT III-1000 V.

All voltmeters are designed to measure nominal steady state voltages continuously while also being able to withstand a momentary high voltage spike or transient that hits the meter input without warning. It is important to note that the typical voltmeter is not designed to withstand a continuous overvoltage condition such as can be encountered at the utility service entrance or in many industrial settings. A hazardous and spectacular failure is likely to occur if an electrician were to probe a 4160 V line with a standard voltmeter. An ideal meter would have a combination of both steady state and transient overvoltage withstand capability.

TEGAM Model 110A

TEGAM's Model 110A was designed not only to withstand the transient hazards contemplated by IEC-61010, but also withstand the even more dangerous continuous overvoltage condition. Each instrument is factory tested to continuously withstand 2500 V and has been independently verified to 7500 V without incident.

The TEGAM Model 110A Safety Voltmeter is the only single switch, single range, digital voltmeter that automatically measures AC & DC volts to 1000 V for voltage troubleshooting, line clearing, lock out/tag out procedures and anywhere hazardous voltages may be present. The 110A has a 1 MΩ current limiting resistor in each lead to protect the user against arc-flash potential. Model 110A maintains a C-UL-US approval and meets Category IV-600 V and Category III-1000 V overvoltage protection under IEC-61010-1.

The 110A eliminates common errors such as 'Incorrect Function Selected', 'Incorrect Range Selected', 'Disconnected Meter Leads', 'Meter Not Rated for the Actual Voltage' and 'Meter Leads Do Not Limit Current'. It makes the measurement much safer compared to any regular multimeter, which creates a hazardous low impedance path when left in Ohms or Amps mode, reads incorrectly with partially disconnected leads and becomes an arc fault hazard when voltage limits are exceeded.

Figure 3 - TEGAM Model 110A

The 110A is safer by design and is proven to save lives, reduce injuries, and save time. Choose the best tool for the job!