

## Safety Certifications of High Voltage Probes and Dividers above 10 kV

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High voltage measurements are inherently unsafe. This fact leads to the fact that there are no probes (or dividers) which are “safety certified” (UL, CE, etc). The reason for this is that probe has two leads – one of which is usually “ground” which go to the probe either separately or more commonly as a coaxial cable. If this ground is connected to the wrong place in the circuit, the coaxial cable is a direct and dangerous hazard. This dangerous situation becomes less dangerous when the coax is connected to a grounded measurement device such as an oscilloscope. This also becomes less dangerous if the ground clip of the probe can be connected directly to a true ground.

Connection to ground should itself be carefully considered. For example when connected to an oscilloscope the ground is actually connected to the 3<sup>rd</sup> prong of a 3 pronged plug through a circuit board trace. If the ground clip is misplaced an energetic HV system can drive high currents through this circuit board trace, the trace will literally evaporate, and the end of the probe will no longer be grounded. A ground point can also be difficult or impossible to define properly if fast pulses are used in the system. Conventional “Earth Grounds” are often highly inductive leading to the use of “screened rooms” or screened enclosures.

Low voltage probes covered by IEC-61010 (for example) are protected by making all parts of the probe insulated against the maximum voltage (typically 1 kV). This is comparatively simple at 1 kV although the hazards above still exist. At (say) 60 kV as in a PVM-5 probe, we would have to insulate the cable against 100 kV. This would require us to use an X-ray type cable instead of an RG-223 coax. Safety would not be improved but no one would buy a probe which used an X-ray cable to connect to an oscilloscope.

The most common probe in the world is the Tektronix 6015. While all of Tektronix’ low voltage probes comply with IEC61010 the 6015 – at only 40 kV – makes no claim of compliance with any such standards. When CE compliance became an important consideration we worked with a knowledgeable consulting company and received the letter attached.

In our view a starting point (many other measures may be required) towards HV safety is:

Verification that a ground points is valid (connected at low resistance)

Careful placement of the ground clip (unless there are ground loop problems)

All equipment must be designed with shutoffs so connections can be made when equipment is turned off

Never work on energized equipment

Connect the probe/divider to grounded equipment before energizing

Avoid using floating equipment (equipment not connected to true ground) even if differential measurement techniques are required to do this

Never “float” equipment without a sign or some reminder (I always forget a scope is floating after an hour or so)