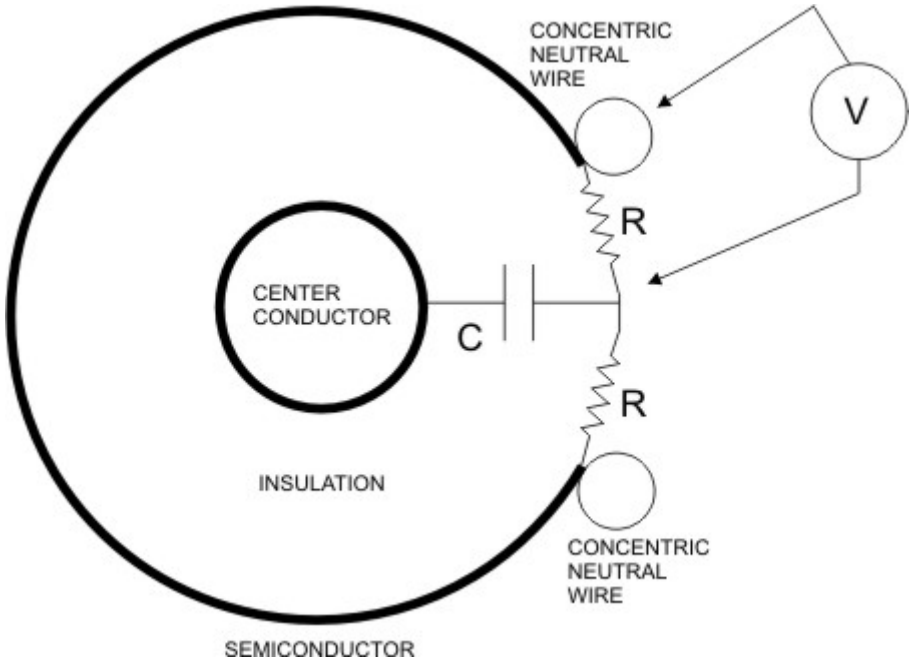
Live Wire

Principal of Operation

The Live Wire is basically a specialized voltmeter. It determines the energized status of URD concentric cable by sensing the small voltage between one of its concentric neutral ground wires and the underlying semiconducting insulation shielding. This small voltage is amplified and its magnitude indicates if the cable is energized or not. Here is how it works.

Figure 1.1 below illustrates a cross section of a portion of URD cable. The primary center conductor is surrounded by thick insulation. A thin layer of semiconducting material is extruded over the insulation to relieve electrical stress. The semiconducting sheath is surrounded by a number of individual concentric ground wires. The figure illustrates two of them.

Figure 1.1



Electrically, the insulation forms a capacitor between the primary center conductor and the semiconducting sheath. Current at the line frequency flows through this capacitance to the semiconducting sheath and then flows through the semiconducting sheath to the concentric neutral wires. As this current flows through the semiconducting sheath, a small voltage is formed between the semiconducting sheath and the concentric neutral wires. In the figure, the capacitance is represented by "C" and the resistance of the semiconducting sheath between the concentric neutral wires, and a point midway between two adjacent wires, is represented by "R". The voltage formed across "R" is measured by the voltmeter "V".

The resistance "R" varies widely from cable to cable depending on its design, age, and condition. The voltage formed across "R" is vary small (millivolts) and also varies widely from cable to cable. The Live Wire tool is the voltmeter "V" that measures this small voltage and uses it to determine the energized status of the URD cable.

The Live Wire Voltmeter

Before the Live Wire measures the small semiconductor sheath voltage, it first needs to determine if proper contact has been made with the cable. A reading of zero volts indicates that either the cable is unenergized or that a poor contact was made to the cable by the Live Wire. To rule out the poor contact possibility, the Live Wire first acts as an ohmmeter and checks that the resistance between the barrel and center conductor is in the expected range. This ohmmeter measurement is made continually, even during voltage measurements.

If the resistance is too low, the Live Wire illuminates the SHORT lamp to indicate that the user has probably contacted the concentric ground wires with both the barrel and the center probe. If the resistance is too high, the Live Wire illuminates the OPEN lamp to indicate that an improper contact has been make to the cable. Usually, just moving to a different spot on the cable will provide a good resistance reading.

If both the SHORT and OPEN lamps are off, the Live Wire measures the semiconducting sheath voltage and compares the reading against an upper and lower threshold. If the voltage is below the lower threshold, the cable is assumed to be unenergized and the DEAD lamp is illuminated. If the voltage is above the upper threshold, the cable is assumed to be energized and the LIVE lamp is illuminated. If the voltage falls between the two thresholds, the UNKNOWN lamp is illuminated.

In addition to being a simultaneous ohmmeter and voltmeter, the Live Wire also incorporates sophisticated signal filtering to eliminate interference. The instrument operates from a 9 volt battery and automatically turns itself on and off when applied to the cable. Once applied to the cable, a status indication is available almost immediately. Multiple probes of the cable can be obtained within just a few seconds.

Sources of Error

In the laboratory on clean cables, the Live Wire works flawlessly. Unfortunately, unjacketed cables in the ground suffer from various degrees of corrosion. If the instrument will not turn on or if only an OPEN lamp is obtained, the cable is either badly corroded or the semiconducting sheath has deteriorated. Hot brushing the cable will usually solve the corrosion problem. However, heat, age, and contamination can increase the resistance of the semiconducting material to the point that it loses its semiconducting properties and becomes an insulator. If hot brushing the cable doesn't turn off the OPEN lamp, the semiconductor is most likely bad and energized status cannot be determined.

Another source of error on unjacketed cables is stray ground currents flowing in the outer semiconducting sheath. Stray ground currents are most common on abandoned unjacketed cables whose concentric has been removed from ground at one or both ends. Due to the high resistance of semiconducting material, it only requires currents on the order of milliamps to produce the small voltages that indicate an energized cable. The result is a false positive. A dead cable appears to be live. Placing a ground clamp on either side of the area on the cable being probed and connecting the clamps together will shunt these currents around the probing area and lead to a correct dead indication.

On jacketed cables, corrosion, stray ground currents, and contamination problems seldom occur since the jacket protects the semiconducting sheath from the elements. Unfortunately, in certain lot codes of some brands of jacketed cables, the voltage produced in the semiconducting sheath when energized is very small. If it falls below the green threshold, a false negative will be indicated. That is, a live cable appears to be dead. Lowering the green threshold is not a good solution because it will lead to more false positives on normal cables.

Live Wire Usefulness

The Live Wire is very useful once its limitations are understood. It is not an absolute indicator of energized cables. Instead, it is one more good technique a lineman can use in trying to determine if a cable is energized or not. Most of the time, the OPEN and SHORT lamps will indicate when the tool cannot be applied at all. There are also subtle indications, like the speed at which the status lamps illuminate, that with experience a lineman can use to help determine the validity of the readings. Using the Live Wire is not like clipping a standard voltmeter onto a bare cable and taking a reading. With the Live Wire, experience makes a difference and that experience comes from using it routinely.

The bottom line is that the Live Wire will significantly reduce the incidence of hot spiking. However, the basic principal of operation, upon which the instrument is designed, simply does not apply on some cables. Therefore, it is not possible to totally eliminate all incidents of hot spiking with this instrument.