Clinton
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Locating Shorts in Medium and High Voltage Cables

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FL-20A Cable Fault Locator Operation

The Clinton FL-20A Cable Fault Locator's "Shorts" mode uses a resistance bridge based on the Wheatstone Bridge principle. The shorts test requires that during the bridge measurement, current must flow from the red and blue probes, which are attached to each end of the cable under test, to the reference ground conductor, connected to the green probe.

Inner conductors that make direct physical contact constitute a direct short. By contrast, an event where conductors do not touch but an arc occurs between them during hipot testing at high voltage is called a high voltage short.

The FL-20A locates high voltage faults with a 20kV high voltage generator. When shorted conductors fail at high voltages, a bridge measurement can still be made because the HV generator will allow the shorted conductor to discharge to the reference ground conductor. The bridge measurement is made only when current flows or when arcing. If insufficient current flows, the test will give inaccurate results or no results at all.

Testing Medium and High Voltage Cables

Medium and high voltage cables present unique problems in cable fault location. Some faults in medium and high voltage cables break down at low voltages. As long as the cables are high enough in total loop resistance (250 milliohms or more), the results will be accurate. It is those faults that break down at higher hipot voltage that are suspect.

In these types of cables, the physical distances between the defects causing the shorts are often relatively large, so the fault locator may not be able to produce enough voltage to flow current from one to another. In general, if the cable fails hipot testing at a test voltage of 20 kVDC or 14 kVAC, or above, the FL-20A will not have enough test voltage to generate the sustained arc necessary for shorts testing.

There are additional difficulties at these voltages. The dynamics of this current flow is complex, because arcs flashing within the inside of the cable are actually tracking along the different surfaces of the conductors. The energy of the arc causes burning and carbonization along its path, increasing surface resistivity between the shorted conductors. When the resistance becomes high enough, the arc will seek a slightly different pathway. With enough arcing, the entire area becomes carbonized. If the resistance between the shorted conductors is high enough, arcing may stop entirely at a given test voltage.

However, while arcing may stop, current can continue to flow. In some cases, enough current will flow to cause the FL-20A to continue trying to locate the fault. In these situations the results will be inaccurate. In severe cases, the FL-20A will show an error message.

The reason the results can be inaccurate are best understood by looking at the schematic diagram of a typical fault.

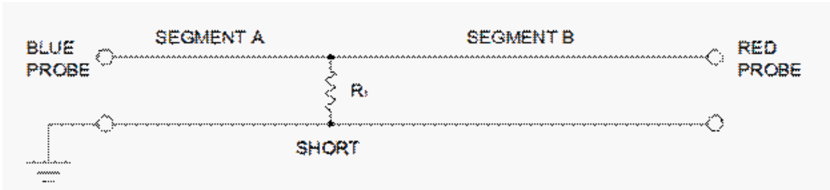

Figure 1

All Clinton cable fault locators require a high degree of consistency of resistance per unit of measure of the various conductors in order to locate short circuits. During the bridge measurement, the total resistance of Segment A plus the value of R1 equals the resistance of Segment B. This is referred to as "balancing the resistances" and is the basis of cable fault location of short circuited conductors.

When there is significant arcing and carbonization, there may be multiple current pathways, each with a different resistance. This is illustrated below in Figure 2.

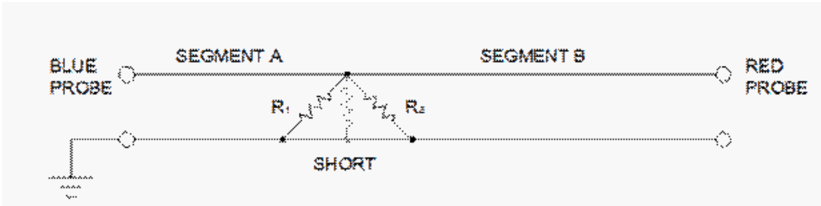

Figure 2

The FL-20A will try to balance the resistance of Segment A to Segment B first using one resistance, (R1) but then the arc will move to another site (R2) with lower resistance. The unit will then try to balance these two segments.

Regardless of which of the resistances the FL-20A balances, the result will likely not be very accurate because the carbon at the fault site adds an unknown level of resistance, making balancing the resistances difficult.

For this reason, the location of shorts revealing themselves at voltages above 15 kVDC or 10.5 kVAC should be suspect unless the FL reports "Standard" or "Exceptional" accuracy.

Recommendations

1. Record the actual voltage where a cable fails during hipot testing. Halt the test immediately after failure.
2. When hipot testing cables, do not allow the hipot tester to keep burning a fault once it is detected. This will reduce accuracy in fault location with the FL-20A.
3. When using the FL-20A on cables that failed hipot testing above 15.00 kVDC or 10.5 kVAC, regard the results as suspect unless the FL-20A reports "Standard" or "Exceptional" results.