FT4310 Bypass Diode Tester Measurement Principles

Masao Higuchi
Product Marketing Division1 Product Marketing Department
HIOKI E.E. CORPORATION, 81 Koizumi, Ueda, Nagano, Japan

The FT4310 is a bypass diode tester that can detect open faults in bypass diodes by string regardless of whether the photovoltaic cells in question are exposed to sunlight, eliminating the need to cover cells prior to measurement. This paper provides a simple explanation of the underlying measurement principles.

Figure 1 illustrates the current-voltage characteristics of a photovoltaic cell, while Figure 2 provides a simple circuit block diagram for the FT4310. In fact, a control block with a microcontroller and other components is necessary but has been omitted from the diagram.

First, the string to be measured is disconnected from the grid. At this stage, the string will be in the open state, and point A in Figure 1 illustrates the string's operating point.

Next, S2 is closed on the A side to energize capacitor C to the predetermined voltage Vc, which is greater than the voltage needed in order to turn on all the bypass diodes on the string.

When S1 is closed, the string is shorted by diode D, causing its operating point to move to point B in Figure 1. At this time, the short-circuit current Isc flows to the circuit. Next, to ensure that the bypass diode is not damaged, the current control circuit is configured so that the current flowing to the circuit does not exceed Isc + α. In this way, we avoid damaging the bypass diode with an overcurrent since the circuit current will not exceed Isc + α.
*For the FT4310, α is set to 1 A. Once the current limit has been set, S2 is moved to the B side to discharge the capacitor.

Photovoltaic cells are a constant current source, and as such, the only current that flows through them is the current that they generate. Consequently, if the bypass diode is operating properly, the charge stored in the capacitor will flow through the bypass diode. If the current at this point is limited, the overall current will be limited to Isc + α, with α representing the current that flows to the bypass diode. This causes the operating point to move to D. The voltage Vfs such that the current Isc + α flows will appear across the string.

If the bypass diode is experiencing an open fault when S2 is moved to the B side, the charge discharged from the capacitor will flow as a portion of the current generated by the photovoltaic cell instead of flowing to the bypass diode. In other words, the capacitor's discharge current will be limited to Isc. In this case, the overall current will not exceed Isc, and the operating point will move to C since the string will exhibit the capacitor terminal voltage Vc the instant S2 is moved to B. Subsequently, the operating point will move on the red line toward B since the voltage will decline as the capacitor charge decreases. In this way, it is possible to detect the bypass diode's open fault by observing whether the current that flows when the capacitor is discharged exceeds Isc.

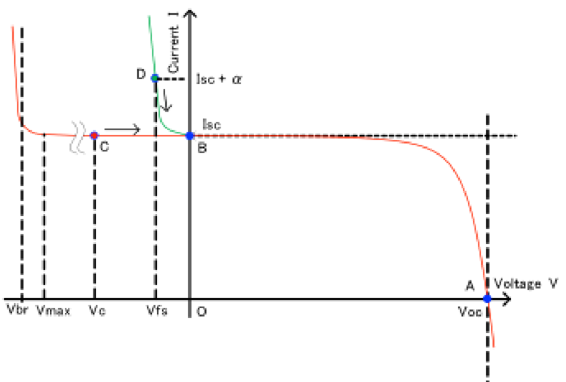

Figure 1. Current-voltage characteristics of a photovoltaic cell

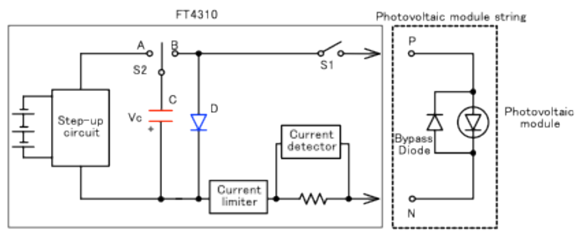

Figure 2. Measurement principle circuit