



IPC-TM-650 TEST METHODS MANUAL

1 Scope This method describes the test procedures required to measure the characteristic impedance of flat cables.

To keep this test method as simple and straightforward as possible, balanced and differential signal lines are not addressed. Also, the effect of flat cable against a ground plane is not shown, because of the difficulty in determining what a lab standard ground plane should be.

1.2 General Characteristic impedance (Z_0) for high frequency pulses is defined electrically as the square root of the inductance divided by the capacitance (C). In equation form:

$$Z_0 = \sqrt{\frac{L}{C}}$$

Accuracy and consistency of impedance is required to match the characteristics of the other electronic circuit components. Variations and mismatches in impedance create undesirable pulse reflections and pulse distortions. These reflections and distortions increase attenuation and crosstalk. The characteristic impedance of flat cables is primarily dependent upon the dielectric properties of the insulation and the cable geometry. It is directly proportional to conductor spacing and is inversely proportional to conductor size and the effective dielectric constant of the insulation. Therefore, consistency of impedance is achieved by maintaining uniformity of the insulation dielectric constant and by maintaining accurate control over conductor dimensions and spacing of adjacent conductors.

Characteristic impedance (Z_0) is usually measured by time domain reflectometry (TDR).

Measurement of Z_0 with a TDR consists of sending a pulse down a length of cable and then comparing the reflection obtained to that obtained from a laboratory standard of known impedance. Z_0 of a cable is fully defined when three values have been measured:

1. The average Z_0 for all signal lines in a length of cable when the cable is suspended in air.
2. The maximum change in impedance (or reflection coefficient) at any point on any signal line of the cable when the cable is suspended in air.
3. The maximum change in impedance when the cable is clamped against a ground plane.

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Measurement of the preceding values is performed by use of the setup illustrated in Figure 1. The laboratory standard is connected to the TDR generator output, and the cable with unknown Z_0 is connected to the end of the laboratory standard. When a single-ended (unbalanced) cable is to be tested, connection to the laboratory standard consists of (1) the cable signal conductor to the laboratory-standard signal conductor, and (2) the ground conductors associated with the cable signal conductor to the laboratory standard ground. The far end of the cable may be left unterminated, or it may be terminated with a precision resistor to verify the laboratory standard. Balanced cable (which carries simultaneous positive and negative pulses) cannot be directly tested for impedance in this manner; however, a close approximation can be achieved by selecting an axis of symmetry between two signal conductors and then testing only one signal conductor and its associated ground conductor.

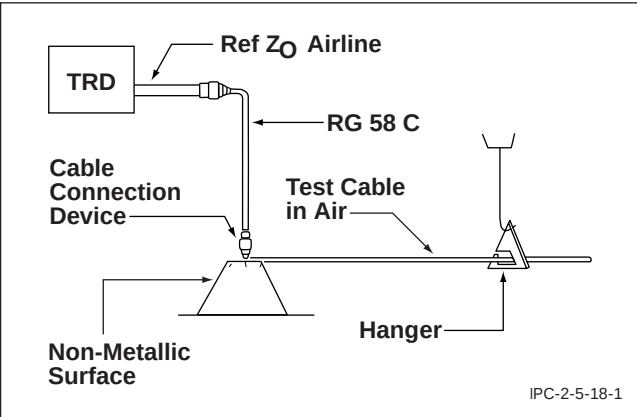


Figure 1 TDR Test Set-up for Measuring Characteristic Impedance

The typical oscilloscope trace obtained when testing a cable is illustrated in Figure 2.

3 Test Specimen

3.1 One pre-production or production sample 0.9 m to 3 m long. The number of test samples should be determined by the manufacturer and/or user.

4 Equipment/Apparatus

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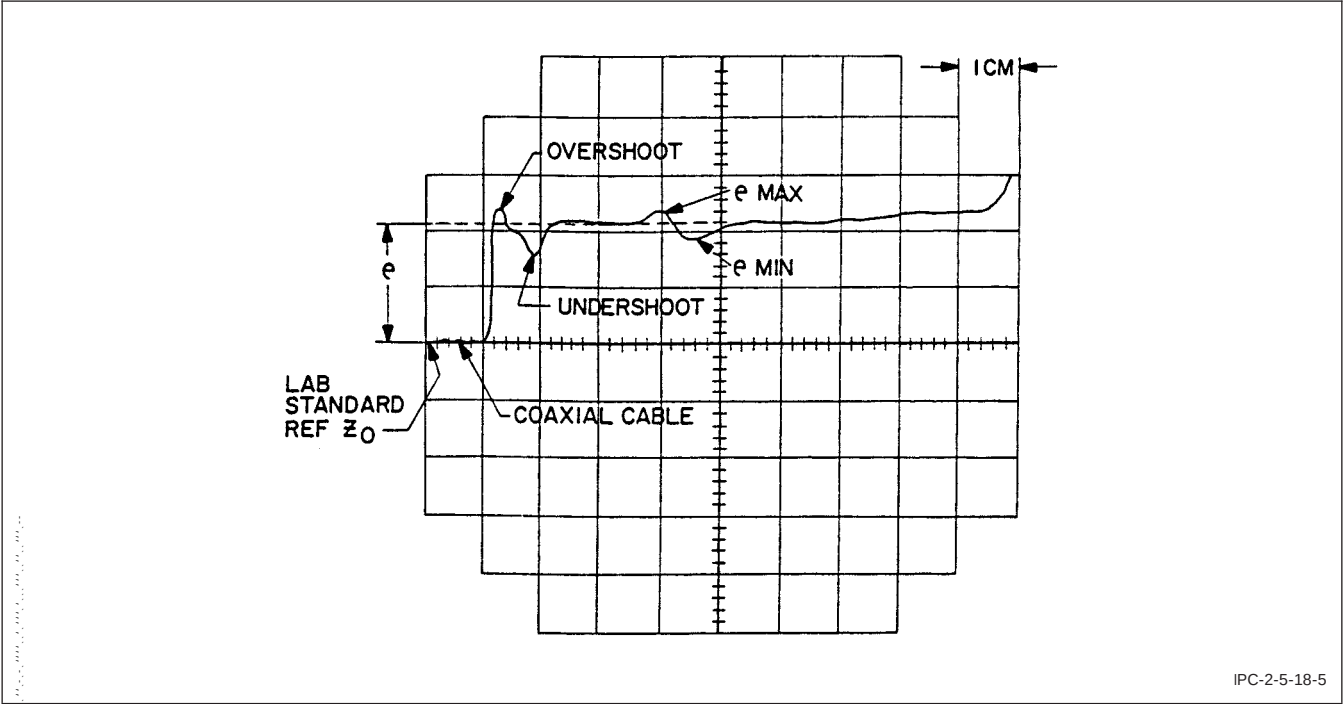


Figure 2 TDR Trace for a Typical Cable

4.1 In this test, characteristic impedance is measured by TDR. Commercial TDRs are readily available and consist of pulse generator and sampling oscilloscopes. Rise times of the pulses are usually less than 250 picoseconds (250 x 10⁻¹² sec.), which gives a resolution sufficient to detect discontinuities smaller than 2.5 cm in length. Since the pulse rise times generally used now in electronic equipment are not this fast, a TDR is adequate for testing. Also required for this test is a lab standard air line to establish a reference impedance (Z₀ ref.) and a standard cable connection device at the air line output (see Figure 1).

4.2 A TDR, such as a Hewlett-Packard 1415A, Hewlett-Packard 1815A, Tektronix 1 S2, or equivalent

4.3 The standard air line used should be a General radio 874-L20 (20 cm), 874-L30 (30 cm), or equivalent for Z₀ = 50Ω.

4.4 Cable Holders Fixture of plexiglass or other nonmetallic material. Cable hangers to suspend the cable in air. Refer to Figure 3.

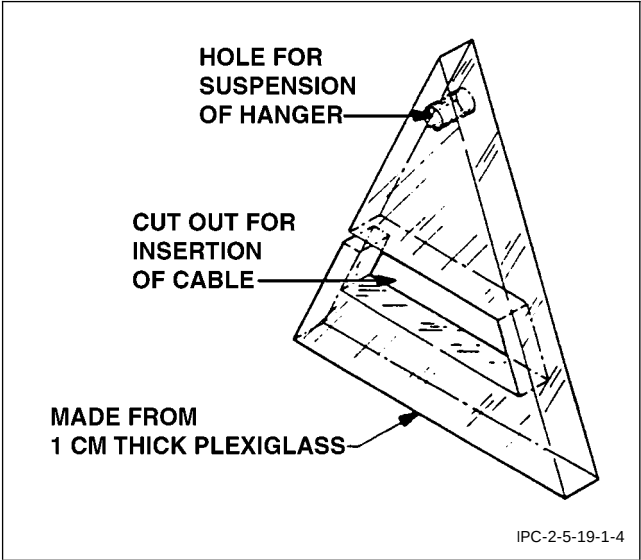


Figure 3 Sample Cable Hanger

4.5 The standard cable connection device used should match Figure 4. It is made from a General radio cable connector type 874-C62A.