Designation: B878 − 97 (Reapproved 2014)

Standard Test Method for Nanosecond Event Detection for Electrical Contacts and Connectors[1]

This standard is issued under the fixed designation B878; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method describes equipment and techniques for detecting contact resistance transients yielding resistances greater than a specified value and lasting for at least a specified minimum duration.

1.2 The minimum durations specified in this standard are 1, 10, and 50 nanoseconds (ns).

1.3 The minimum sample resistance required for an event detection in this standard is 10 Ω.

1.4 An ASTM guide for measuring electrical contact transients of various durations is available as Guide B854.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to become familiar with all hazards including those identified in the appropriate Material Safety Data Sheet (MSDS) for this product/material as provided by the manufacturer, to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B542 Terminology Relating to Electrical Contacts and Their Use

B854 Guide for Measuring Electrical Contact Intermittences

2.2 *Other Standards:*

IEC 801-2 ed 2:91 [3]

EN 50 082-1:94 [3]

3. Terminology

3.1 *Definitions*—Many terms used in this standard are defined in Terminology B542.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *event, n*—a condition in which the sample resistance increases by more than 10 Ω for more than a specified time duration.

4. Significance and Use

4.1 The tests in this test method are designed to assess the resistance stability of electrical contacts or connections.

4.2 The described procedures are for the detection of events that result from short duration, high-resistance fluctuations, or of voltage variations that may result in improper triggering of high speed digital circuits.

4.3 In those procedures, the test currents are 100 mA (±20 mA) when the test sample has a resistance between 0 and 10 Ω. Since the minimum resistance change required to produce an event (defined in 3.2.1) is specified as 10 Ω (see 1.3), the voltage increase required to produce this event must be at least 1.0 V.

4.4 The detection of nanosecond-duration events is considered necessary when an application is susceptible to noise. However, these procedures are not capable of determining the actual duration of the event detected.

4.5 The integrity of nanosecond-duration signals can only be maintained with transmission lines; therefore, contacts in series are connected to a detector channel through coaxial cable. The detector will indicate when the resistance monitored exceeds the minimum event resistance for more than the specified duration.

4.6 The test condition designation corresponding to a specific minimum event duration of 1, 10, or 50 ns is listed in Table 1. These shall be specified in the referencing document.

[1] This test method is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.11 on Electrical Contact Test Methods.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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TABLE 1 Test Condition Designations for Specific Minimum Event Durations

Test Condition	Event Duration, min
A	1 nanosecond
B	10 nanoseconds
C	50 nanoseconds

5. Apparatus

5.1 *Detector*—The detector used shall be an AnaTech 64 EHD, 32 EHD, or equivalent. The detector shall meet the following requirements:

5.1.1 *Electromagnetic Interference (EMI)*—The detector shall pass the European Community (EC) electrostatic discharge (ESD) requirement for computers (EN 50 082-1:94 based on IEC 801-2, ed. 2:91). The performance criteria is "1) normal performance within the specification limits;" that is, no channel is allowed to trip. Air discharge voltages shall include 2, 4, 8, and 15 kV. Contact discharge voltages shall include 2, 4, 6, and 8 kV. Detector inputs shall be protected with coaxial shorts.

5.1.2 *dc Current*—Each channel shall supply 100 ± 20 mA when the sample being tested has a resistance between 0 and 10 Ω.

5.1.3 *Input Impedance:*

5.1.3.1 *Direct Current (dc)*—The detector source resistance (impedance) shall be 50 Ω when the sample resistance is between 0 and 10 Ω.

5.1.3.2 *RF Input Impedance*—A Time Domain Reflectometer (TDR) or Network Analyzer Time Domain Reflectometer (NATDR) shall be used to measure the reflection in percent of a (simulated) 0.5 ns risetime step when the sample direct current resistance is 10 Ω and the detector current is 100 mA. (The 10 Ω sample resistance is put on the bias port for NATDR.) An acceptable detector shall reflect less than 30 % amplitude.

5.1.4 *Amplitude Sensitivity*—Amplitude required to trip the detector with a 1 nanosecond duration pulse shall be no more than 120 % of the direct current trip amplitude. One nanosecond pulse duration shall be measured at 90 % of the pulse amplitude, and the rise and fall times shall be less than 0.5 ns. Pulse low level shall be 0 V. These shall be measured with a 1 GHz bandwidth oscilloscope and a pulse generator (see Fig. 1).

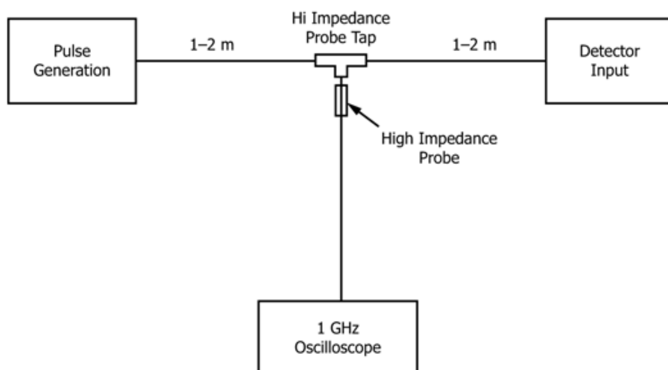


FIG. 1 Equipment Setup for Amplitude Sensitivity Measurement

5.1.4.1 The same requirements shall be met for the 10 and 50 ns detector settings, but the pulse rise and fall times can now be less than 2 ns.

5.1.5 *Accuracy*—It shall be possible to adjust the detector to trip at 10 ± 1 Ω for all channels in use.

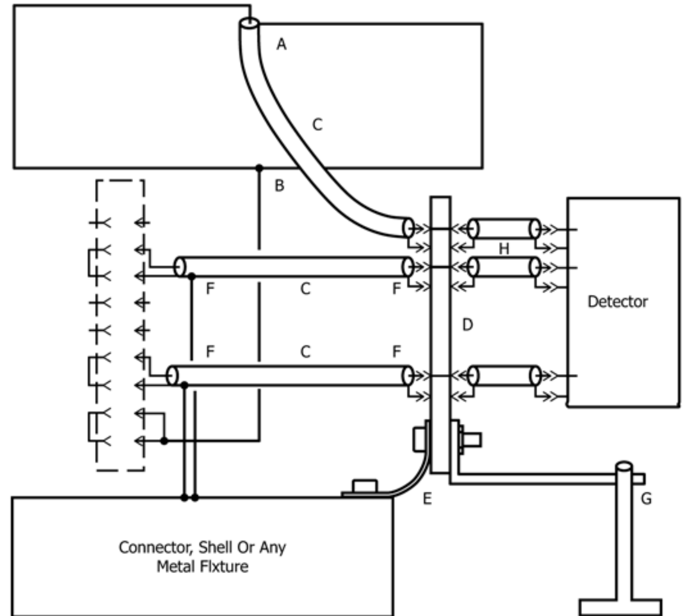
5.2 *Test Setup*—Recommended equipment is as shown in Fig. 2. A short flexible ground strap directs ground loop currents away from the sample (see Fig. 2, Note E). The RG-223 coaxial cable is well shielded whereas the short 50 Ω miniature coaxial cable is flexible. Each EMI loop is connected to a detector channel and is used as a control.

5.3 *Sample and EMI Loop Preparation*—The sample circuit shall have a resistance of less than 4 Ω.

5.3.1 *Sample Wiring:*

5.3.1.1 A contact or series-wired contacts (see Fig. 3, Note A) shall be wired from the center conductor to the braid of miniature 50-Ω coaxial cable (see Fig. 2, Note C).

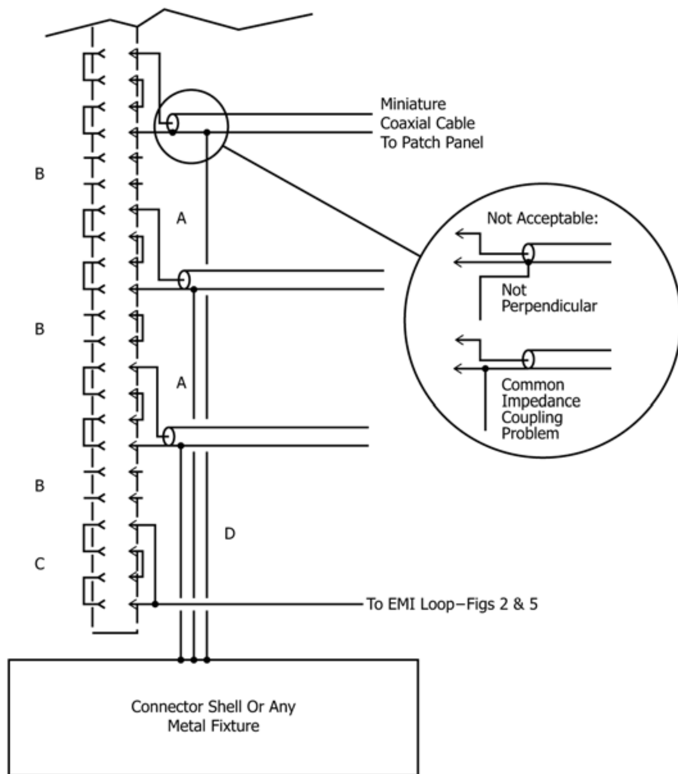
5.3.1.2 The sample, as wired to the miniature coaxial cable for testing, shall be capable of passing short duration pulses. A time domain reflectometer (TDR) shall be used to measure the transition time of a fast risetime step (<60 ps) reflected from the sample under test. On the waveform, find the point representing the far end of the miniature 50-Ω coaxial cable (see Fig. 4, Point 1). Also find the last point on the waveform where the voltage amplitude is 20 % of Point 1 (see Fig. 4, Point 2). The time between these points shall be less than the



NOTE 1—

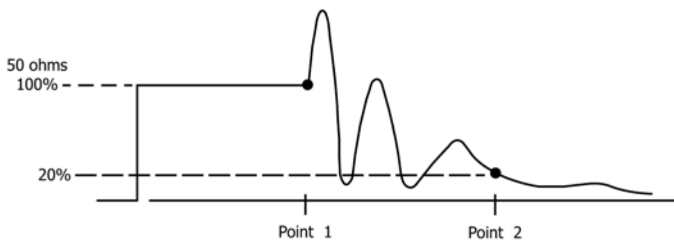
A One square meter EMI loop monitored at top center (see 6.1).
B Connection to series wired sample circuit with the greatest capacitance shell or other metal fixturing (see 6.1).
C Miniature coaxial cable (50 Ω) (see 5.3.1.1).
D Patch panel, coaxial through-bulkhead RF connectors in metal panel.
E Short flexible ground strap, 70 mm long and >25 mm wide (see 7.3).
F Strain relief coaxial cable at these locations.
G Physical support for patch panel.
H RG-223 double braid coaxial cable.

FIG. 2 Ten and Fifty Nanosecond Fixturing



NOTE 1—
A Series-wired contacts (see 5.3.1).
B Contacts skipped to reduce crosstalk (see 5.3.2.2).
C The circuit with maximum capacitance to fixture (see 6.1.1).
D The very short miniature coaxial cable ground (see 5.3.2.1).

FIG. 3 Example of Series-Wired Sample



NOTE 1—Requirement is that Point 2–Point 1 <minimum event duration from Fig. 1.

FIG. 4 TDR Measurement Trace of Sample Circuit

minimum duration of the event identified in Table 1. Each series-wired sample circuit shall be measured.

5.3.2 *Electromagnetic Interference (EMI) Concerns of Sample Wiring*—At least three major paths for EMI can be identified in the sample fixturing.

5.3.2.1 EMI couples to the sample through the parasitic capacitance between the sample and any metal fixturing. To greatly reduce this coupling, the miniature coaxial cable shield shall be connected to the metal fixturing as close to the connector-under-test as possible. This connection shall be as short as possible and perpendicular to nearby sample conductors (see Fig. 3, Note D). This is done for the sample channels only, not the control channels.

NOTE 1—If there is no metal fixturing within 5 cm of the sample circuit, all connections to metal fixturing in this standard may be ignored.

5.3.2.2 Large EMI currents in adjacent contacts can couple through crosstalk or capacitance to monitored channels. To reduce this, no conductor of any type may be connected to contacts not being monitored for the event. It is recommended that monitored contacts be evenly distributed around the connector to minimize crosstalk with other monitored channels (see Fig. 3, Note B).

5.3.2.3 The loop area of the sample circuits shall be minimized to reduce magnetic field coupling.

5.3.3 *Control Channel(s)*—Anytime a failure is indicated, it is possible that the real cause was actually electromagnetic interference (EMI), and not the connector-under-test. The goal of the control channel(s) is to detect EMI at levels much lower than required to trigger an event on a sample channel. During testing, the control channels shall be monitored with the same detector values as used on the sample circuits. An event observed on a control channel invalidates any other events detected during the polling period. See 7.6 to define polling period.

6. Preliminary Procedures

6.1 *For Test Conditions B and C (Ten and Fifty nanoseconds, respectively):*

6.1.1 A control channel shall consist of a separate loop of wire with an area of one square meter suspended above the sample(s) and monitored through a miniature coaxial cable attached at the top center of the loop (see Fig. 2, Notes A and B).

6.1.2 Find the series wired circuit with the greatest capacitance to the fixturing metal, measured without any coaxial cable attached. Instead of connecting this to a miniature coaxial cable, connect it to the center of the control channel loop, opposite the coaxial cable connection (see Fig. 2, Note B). A separate sample may be required if the sample has only one contact.

6.2 *For Test Condition A (One nanosecond):*

6.2.1 Three control channels shall be provided, consisting of 3 nested, mutually perpendicular loops (see Fig. 5). Each loop shall have a nominal area of 36 square cm (for example, $6 \times 6 \pm 0.5$ cm). These loops shall be suspended over the sample(s).

6.2.2 Find the series-wired circuit with the greatest capacitance to the fixturing metal, measured without any coaxial cable attached. Instead of connecting this to a miniature coaxial cable, connect it to the center of one of the control channel loops, opposite the coaxial cable connection. A separate sample may be required if the sample has only one contact.

7. Procedure

7.1 Prepare samples and measure the fall time per 5.3.1.2, using TDR. If this requirement cannot be met, fewer contacts in series or better fixture wiring may be required.

7.2 Place the EMI loop(s) of 5.3.3 over the sample and connect to the sample circuit with the greatest capacitance.

7.3 Assemble the equipment as indicated in Fig. 2 (or Fig. 5 for one nanosecond). The 50 Ω miniature coaxial cable and especially the ground strap shall be kept as short as practical

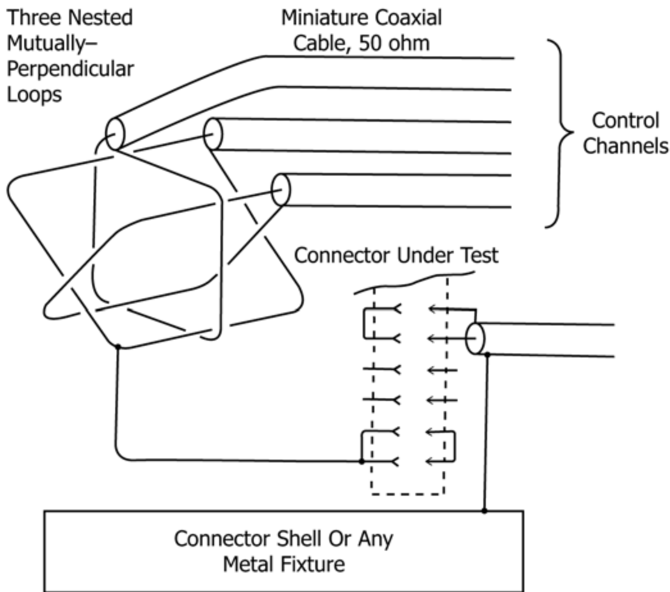


FIG. 5 One Nanosecond Fixturing with Nested 6 × 6 cm EMI Loops (see 6.2.1)

(see Fig. 2, Note E). Additionally, the miniature coaxial cable ground connection to connector shell or metal fixturing, or both, shall be as short as possible and perpendicular to nearby sample conductors (see 5.3.2.1 and Fig. 3).

7.4 Turn on the equipment. Set the equipment to deliver 100 ± 20 mA. Also set the detector to trip at 10 Ω above the initial resistance. Reset all channels. If the Detail Specification specifies using a current less than 80 mA or a threshold resistance less than 10 Ω , it may be necessary to add additional shielding, or to locate the test equipment in a shielded room or box.

7.5 Disconnect each sample from the detector by unmating the coaxial connectors. Confirm that the indicator trips when disconnected, as a functional check.

7.6 Apply the desired environmental stress to the connector-under-test. The test should be broken up into equal-length time periods. At the end of each, the status of each channel should be polled. Any events detected during a polling period which also registers an event on a control channel shall be considered EMI induced (not a connector failure).

7.7 At the end of testing, the failure indications at different polling times should be analyzed for patterns suggesting EMI, such as simultaneous events in different channels.

8. Report

8.1 In reporting the results of the test, the following information shall be given:

8.1.1 Contact positions tested on each channel.

8.1.2 Connectors tested.

8.1.3 Sample lead dress description (for example, how is the connection made between the coaxial cable and the sample conductors, or how is the wiring accomplished between sample conductors in series, etc.) or diagram.

8.1.4 EMI event history, detected on the EMI loop.

8.1.5 Environmental stresses applied.

8.1.6 Detected event history for each channel.

8.1.7 TDR results on sample setup verification.

8.1.8 Name of operator and date of test.

NOTE 2—The following details shall be specified in the referencing document:

(a) Samples and contacts to be tested.
(b) 1, 10, or 50 ns minimum duration.
(c) Resistance increase, if other than 10 Ω.
(d) Current, if other than 100 mA.

9. Precision and Bias

9.1 *Precision*—Test precision is determined by detector performance. One unit was evaluated which consisted of 64 detectors. In the 50 ns position, the duration sensitivity ranged between 45.4 and 51.0 ns (pulse amplitude twice the dc trip value). In the 10 ns position, it ranged between 8.5 and 9.7 ns. In the 1 ns position, a 1 ns pulse tripped two detectors when they had a peak amplitude equal to the dc trip voltage (other channels not tested). Thus, voltage amplitude sensitivity did not change between dc and the shortest duration of this test standard. All 64 channels were checked for the same using a 1.9 ns duration (90 % amplitude) pulse. The total variation was ±3 %.

9.2 *Bias*—This standard requires the detector to have a sample current tolerance and a given minimum (voltage) amplitude sensitivity to each event duration (see 5.1). The most significant possible errors will be EMI-produced false failure indications. Since each test location will have a different EMI environment, such errors will be impossible to predict precisely.

10. Keywords

10.1 event detection; nanosecond events; nanosecond intermittences

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