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ELECTRICAL CONNECTOR TEST FIXTURE CRITERIA

1.0 SCOPE

This document suggests guidelines for the design and function of electrical connector testing equipment as it applies to the reliable testing for continuity, function, presence, and terminal retention.

2.0 CONNECTOR "TESTABILITY" EVALUATION

Reliability of test results depends on the level of accessibility (testability) to the components being tested. A list of high level accessibility features that are required for reliable test results with standard test equipment follows:

1. Test fixtures require same axial plane access to terminals for testing.

2. Push-testing requires adequate connector terminal leading edge access for confirming locked position.

3. Presence testing equipment requires access to non-conductive connector components (TPAs, clips and gaskets).

4. Non-conductive component seating features require access to TPAs, clips and gaskets.

Where access to terminals and other components is restricted, (i.e. TPAs obscure terminals' leading edges) modified or specialized testing fixtures may be required.

3.0 TEST ENVIRONMENT EVALUATION

Knowledge of the test environment is critical when creating test equipment that is reliable and conducive to operator efficiency.

Applying the harness covering (tape, tubing, sleeve, etc.) prior to testing may restrict the rotation of the connector and the ability of the operator to avoid obstacles when testing with hand-held testing tools or loading connector into standard test equipment. Ergonomics must be considered when evaluating applications and test fixture design solutions.

The air quality, maintenance schedules and general cleanliness of the testing environment may impact test results and/or fixture design elements such as pin selections and guards. (See 5.0 Proper Test Probe Selection and 9.0 Maintenance)

Longevity and durability requirements of test fixtures should also be considered. These requirements will be dictated by the environment surrounding test, operator handling and expected number of test cycles. Testing fixtures with longevity

requirements should be constructed with robust materials that will maintain close tolerances. They should feature replaceable and serviceable high wear components such as test probes, guards and inserts. Test fixtures for tight quarters that are required to be more compact and ergonomic will need to be constructed of robust, machineable materials.

Color coding of test fixtures should be considered to aid operator efficiency when applicable.

4.0 CONNECTOR PROTECTION DURING TESTING

Test fixtures should be constructed of non-abrasive, electrically insulated material that can be machined to very close tolerances. Test fixtures that are not designed with proportions based on critical dimensions found on mating surfaces of connectors have the potential of damaging connectors and their components during testing.

Reliable testing depends on safe test fixture/connector interfacing. Directing the test equipment or connector into test position should not interfere with test or damage components of the connector or test fixture.

In standard harness connector testing, part nests, inserts and shrouds that maintain same axial plane during insertion will aid and protect connector and terminals during insertion.

Ergonomic, single-hand operation test fixtures will facilitate quick and careful insertion into connectors for function testing.

Latches should not interfere with connector engagement. They should hold securely for duration of test and disengage quickly and easily (single-handed) without harm to connector, terminals, wire crimps or wires. Test fixture and latch should be designed to promote proper use and discourage or even prevent operator from disengaging connector by pulling or shaking connector free by the wires.

Proper test probe selection and travel is required to assure safe testing that does not damage connector or its components. (See section 5.0 below for in-depth discussion)

5.0 PROPER TEST PROBE SELECTION, TRAVEL AND LOCATION

Proper test probe selection is critical and must be carefully considered in order to prevent violation and/or contamination of connector terminals and facilitate accurate test results. The least invasive pin designs must be selected. Standard as well as custom pin designs must be considered when designing a test fixture. The probe

selected must be of appropriate size, have correct tip configuration, adequate spring force with appropriate inherent travel, and a surface capable of resisting corrosion.

A too small probe tip choice may violate or damage the inner mating surfaces. The terminal, connector, or harness may be tested successfully by violating terminals, but the result in the final product could be unreliable and may cause product failure at a later date. Many terminals could be damaged or contaminated by repeated insertions of the same violating contact pin in many different connectors.

The proper probe "Touch" location may differ from the mating surface of the terminal. Touching a beam or contact surface may damage a terminal. Often connectors are designed with probe access on the outside or corners of the terminal, away from the contact surface. The acceptable "Touch" location must be defined and considered before selecting probe.

Test probe travel must be limited to prevent contact which may violate terminals and produce incorrect results. Travel can be controlled by the probe length or setting the depth position of the probe. Shouldered probes that can stop on a feature of the connector housing can also be used to limit the depth of travel. Blade test probes set in the testing fixture at 90 degrees to the mating terminal is another way to limit the probe depth of travel if the connector design allows this access.

Testing probes must not disturb, damage or un-seat non-conductive connector components during insertion or disengagement.

Test environment must be evaluated for air and surface contamination before choosing test probe tip. Contaminated terminals and improper probe tips may cause intermittence during testing thus allowing the possibility of unreliable results.

Generally, male terminals (blades/pins) may be successfully probed with a concave or flat tip. Female terminals (blade/pin receptacle) may be successfully probed with a convex or flat tip.

Non-conductive component presence testing should be performed with proper switch probes that are carefully placed within test fixture to produce accurate results.

Test fixture manufacturers can provide recommendations for pin selection and pin maintenance schedules. (See 9.0 Maintenance)

6.0 CONNECTOR RETENTION DURING TESTING

Test fixtures should be equipped with a simple, durable, ergonomically operated (single-handed) retention device (i.e. latch) which will maintain reliable contact for

the duration of the test and encourage proper connector disengagement without damage to wires, connector or terminals.

DUT components should be analyzed carefully before choosing latch points. Non-critical characteristics are prone to revision.

Pneumatic latch releases may be incorporated into test fixture design. This option may be equipped with DUT retention in the event of failed tests.

Retention must be within close tolerances to confirm or deny terminal *location* and *position* within the connector body. The connector travel within the test fixture after the lock-up point by the retainer is crucial when checking for the locked position of the terminal. The contact pin must have a specified travel to contact the terminal only in the locked position. If a contact pin is set without regard to the locked position of the terminal, an erroneous test may result.

7.0 BUILT IN TOLERANCES

Connector retention and reliable testing require test fixtures to be designed with proper tolerances for accommodating slight variations in "identical" DUTs. In some instances, test fixture designers are supplied with DUT drawings in lieu of actual parts. Proper tolerances will allow for slight differences between drawing board and reality.

Connector molds may vary slightly. Some dimensions that are considered non-critical to DUT manufacturer and end user, may be modified and render "intolerant" testing equipment obsolete.

Retaining device tolerances should accommodate slight variations in latch points on devices under test.

Built in tolerances include controlled pin travel and restricted connector travel after retainer has locked the connector in test position. Contact pin travel may be established by measuring terminal in its locked and most rearward position within the connector cavity. Initial pin contact with terminal should not occur before connector is in the fully locked position within the test fixture. Pin travel may then be set to the minimum travel to maintain continuity.

If tolerances are exaggerated, operator may have to shift the connector within the cavity of the test block to get the probes to contact "Touch" points or non-conductive test component.

Best practices in test fixture designs utilize critical dimensions, similar to the mating connector's close tolerances, to achieve and maintain continual electrical contact

between the probes and test components during testing. Switch probe placement (although precisely chosen) should still allow for slight variations in DUT's non-conductive components (i.e. gaskets, seals).

8.0 NON-CONDUCTIVE COMPONENT SEATING

Testing fixtures may be designed with components such as inserts that will seat non-conductive components such as gaskets, seals, locks and clips as fixture tests for their presence.

As stated during the description of protection for connectors above, testing equipment designs must not damage connector or unseat components as fixture and connector disengage from the test.

9.0 MAINTENANCE

Maintenance requirements must be clearly defined. Some probe designs do not require cleaning or lubrication and could be damaged by improper maintenance. It is important to define any cleaning, lubricating, or other special instructions for the proper use of the fixtures. (See 3.0 Test Environment Evaluation and 5.0 Proper Test Probe Selection And Travel)

10.0 DEFINITIONS

Color Coding (test fixture) – test fixture component is machined or dyed to match production connector to aid operator efficiency.

Connector – electrical device under test (DUT) that links electrical wires for the purpose of transferring electricity.

Connector travel – range of movement of connector within test fixture when locked in test position.

Continuity Test Fixture - testing fixtures designed to confirm uninterrupted electrical transfer from one point to another typically through a test probe. Fixture may include other test functions. (See Function Test Fixture, Push Test Fixture, and Presence Test)

Device under test (DUT) – see connector.

Function Test Fixture – testing fixture designed to be used in place of mating connectors to simulate "powering-up".

Guard (test fixture) – protects test fixture wire connections to test probe.

Insert (test fixture) – test fixture component that protects and guides probes during connection to DUT.

Latch (test fixture) – secures test fixture to connector for the duration of test.

Latch point (DUT) – component of DUT that test fixture latches to during test.

Pneumatic Latch – air assisted mechanical retention device

One-Way Insertion – test fixture feature that mimics mating connector configuration and prohibits improper mating of test fixture to DUT.

Part Nest (test fixture) – pocket which holds and protects DUT while inserting and testing.

Pin Travel - range of movement of test probe within test fixture.

Presence Test – test fixture feature which senses for the presence of connector components. This testing is typically done with switch probes within a continuity testing or push test fixture.

Push Test Fixture – test fixture used to test for terminal retention within the connector using an industry defined force of 1-2 or 3-5 lbs. Fixture may also include continuity and presence sensing probes.

Shroud (test fixture) - component that protects insert and/or aids insertion.

Switch Probe – test probe that is a conductive (normally open) switch.

Terminal (connector) – electrical contact point.

Test Fixture – tools designed to check electrical connectors for continuity, function, terminal retention and non-conductive component presence (see Continuity Test Fixture, Function Test Fixture, Push-Test Fixture and Presence Test).

Test Probe – compliant pin for contacting terminals and other conductive connector components during test.

Touch location – acceptable position on DUT where test probe will not violate terminal or cause damage of any kind.

TPA – Terminal Position Assurance – typically non-conductive material which functions as a secondary terminal lock within connector.