

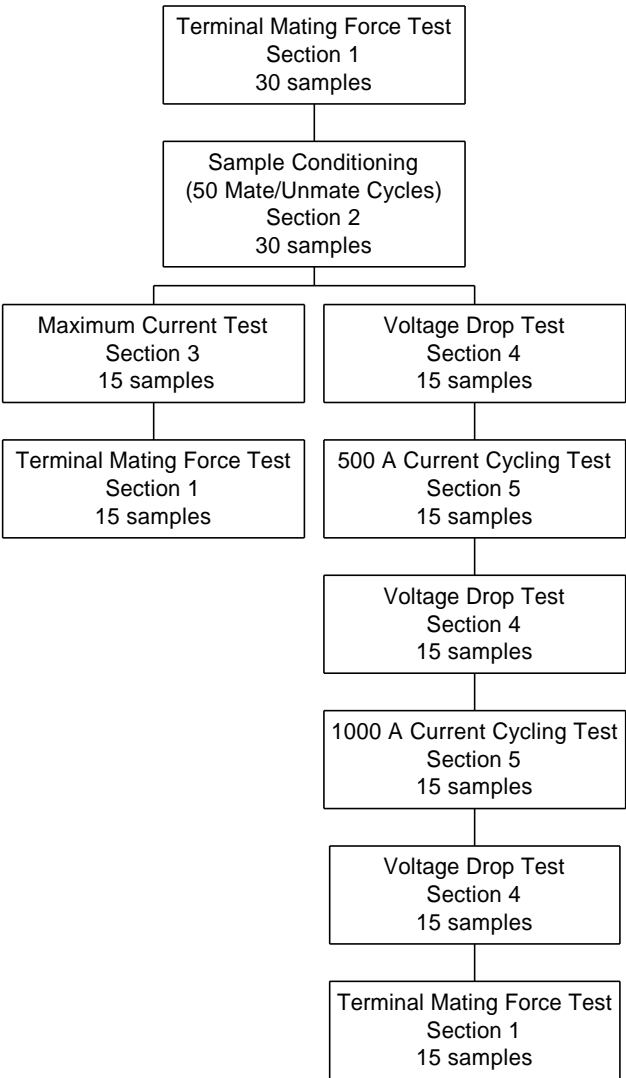
Draft Proposal
42 Volt Battery Connection Test Procedure
03/24/00

Scope: This procedure is intended only as a means of comparing various terminal design proposals for 42 volt battery positive and negative connections. Further testing and evaluation must determine final suitability for use and application.

Test Conditions: All tests are conducted at ambient relative humidity and 23°C +/-3°C temperature.

Sample Quantities: 15 sample sets are to be used in each test. The same sample set must be used completely throughout each leg of the flow chart below.

Test Flow Chart



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1. TERMINAL TO TERMINAL ENGAGE FORCE

1.1 Purpose

Quantify the force required to engage the male and female terminals to each other. Measurement of forces before and after conditioning gives a subjective measure of the terminal's ability to retain contact normal force.

1.2 Equipment

Push tester with peak reading feature.

1.3 Sample preparation

Crimp harness side terminal samples to standard XLPE **32.0** mm² (2 AWG) automotive cable per manufacturer's specification. Cable samples shall be 500mm in length.

1.4 Procedure

1. Secure connectors to be mated into fixtures on fixed and moveable sides of push tester. Use of the test fixture in figure 3.2.1-A or B may be helpful.
2. Insert mating terminals together at a uniform rate of (50+/-10)mm/min until fully engaged. Engage distance must be equal to that of the final design when packaged into a connector or housing.
3. Record peak force and graph force vs. distance from initial contact of terminals to final engaged position.

1.5 Acceptance Criteria

The maximum force for manually assembled terminals is not specified (to reach full engagement). The maximum delta between readings taken at the beginning and end of the flow chart is 50% of the original reading. Final requirements for total engage force of the combined terminal and connector will be < 75 Newtons.

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2. TERMINAL MECHANICAL CYCLING

2.1 Purpose

The purpose of this procedure is to precondition the connection system pair prior to a test sequence. All samples, which are to be tested to any of the subsequent procedures, must be subjected first to this conditioning procedure.

2.2 Equipment

None

2.3 Sample Preparation

Use samples which have completed the terminal engage force test (para. 1)

2.4 Procedure

- Clamp the battery side (panel mount) terminal into the test fixture. (figure 3.2.1-A or B)
- Completely mate and unmate terminal pairs 50 times.
- Re-mate terminals for one last time in preparation for test sequences.

2.5 Acceptance Criteria

None

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3. MAXIMUM TEST CURRENT CAPABILITY

3.1 Purpose

This test is used to determine the maximum test current at which a terminal system can operate in a room temperature environment before excessive thermal degradation and/or resistance begins to occur. Results of this test are NOT to be used for actual terminal application in a vehicle.

This test allows comparison between different terminal designs as to their maximum current carrying capability in standard, repeatable conditions, when one of the terminals is attached to a cable conductor, and the other is mounted to a standard test fixture to simulate a header or panel mount situation.

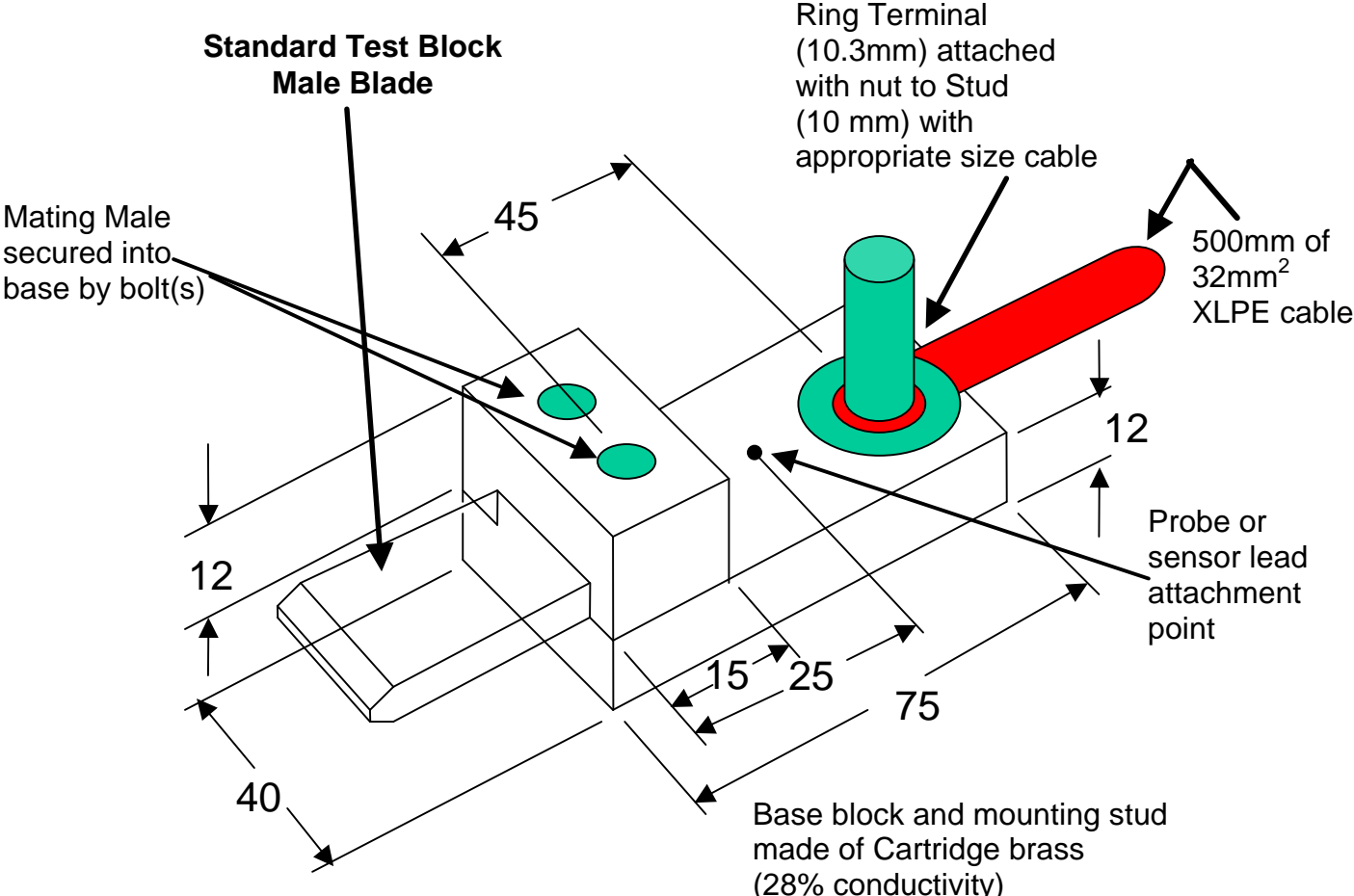
3.2 Equipment

- Digital Multimeter (DMM)
- DC Current Supply capable of 200 amps
- Current shunts (Size as required, $\pm 1\%$)
- Thermocouples (Type "J")
- Data Logger (As required)
- Test Fixture (figure 3.2-I A or B)

3.3 Sample preparation

Use 15 of the samples that have completed the sample conditioning procedure (para. 2)

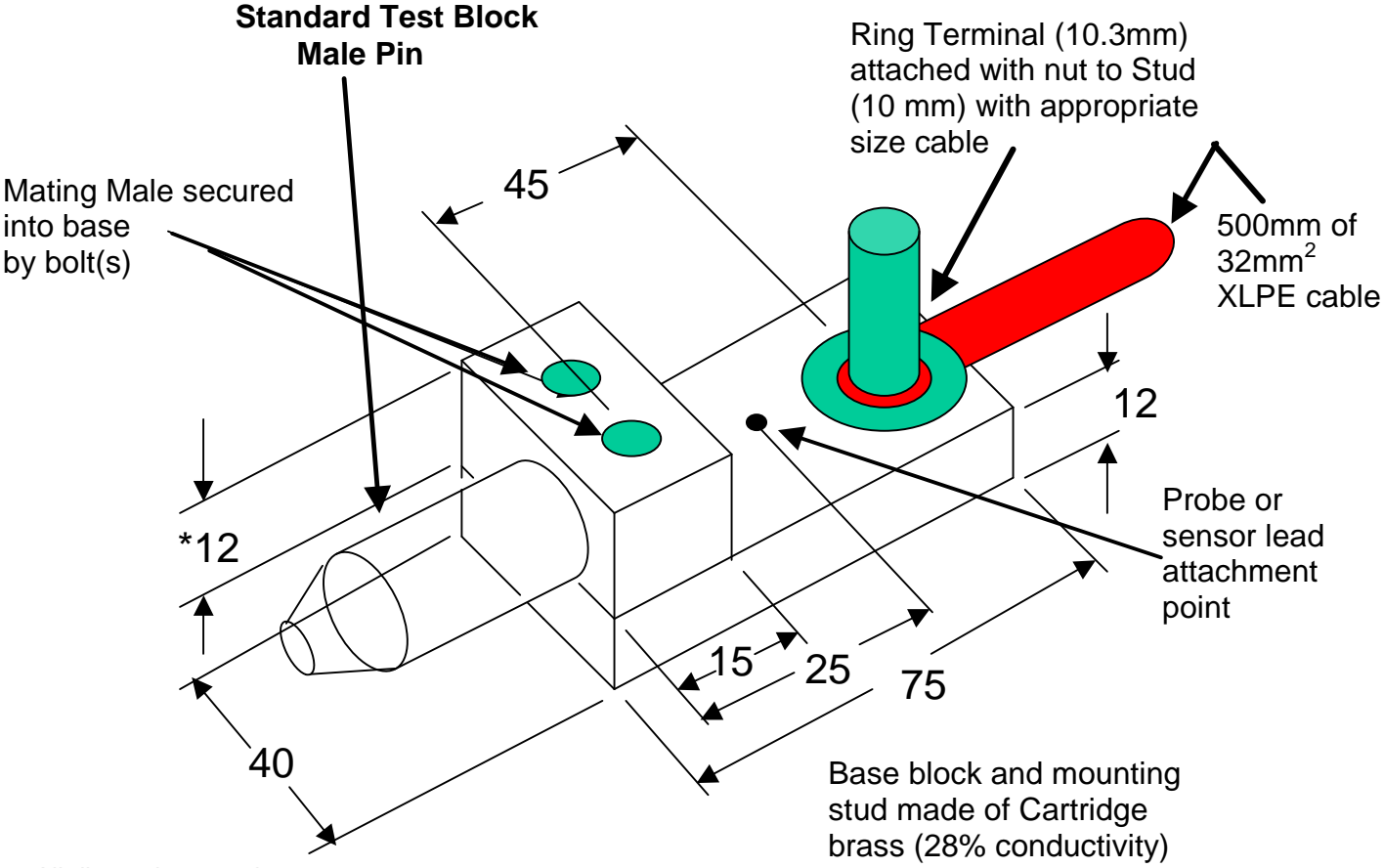
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Note: All dimensions are in mm

Figure 3.2-IA

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Notes: All dimensions are in mm

* This dimension may increase depending upon pin diameter.

Figure 3.2-IB

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3.4 Procedure

1. Use the test fixture shown in figure 3.2-I A, or B (or equivalent modified only to accept the proposed battery terminal) to mount the panel (battery) side of the terminal. Assemble the circuit shown in Figure 3.2-II, using **15** terminal pairs. Attach conductor ends of the terminal pairs to form one continuous series circuit from test fixture-to-test fixture. Ring terminals are used to make the cable attachments at the test fixtures. Attach the thermocouples to the hottest external surface point of each mated pair as shown in Figure 4.4-I. Experimentation may be needed to locate the point of maximum temperature. Thermocouples shall be no larger than 0.060mm^2 or 30AWG. Attach the assembled circuit to a non-conductive surface, such as wood or high temperature plastic, leaving a minimum of 50 mm between test samples.

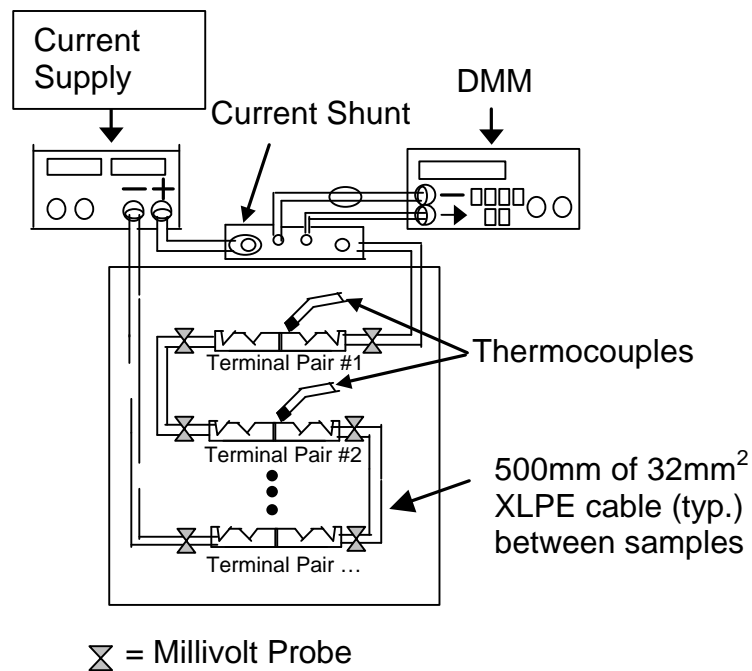


Figure 3.2-II: Set-Up for Maximum Test Current

2. Conduct this test in an open bench, draft free environment at $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$. An ambient temperature sensor must be placed on the same plane as the test samples, 30 to 60 cm from the nearest sample.
3. Adjust the current supply to zero amps output and then turn on the supply and the DMM's.
4. Slowly increase the current supply output until it is providing 75 amps.

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5. Wait at least 15 minutes for the circuit temperature to reach Steady State (temperature variation is less than 1°C per minute). Then record the ambient temperature and the temperature of each terminal pair interface.

Note: Throughout this entire procedure, when using DC current for testing of samples, thermocouple readings shall be taken with polarity on the samples in both directions and then averaged to eliminate error due to thermocouple effect.

6. Increase the current by 15 amps and repeat Step 5.
7. Continue to increase the current in increments of 15 amps, repeating Step 5 after each incremental increase until the temperature of any terminal interface exceeds a 55 °C rise, or the maximum temperature recommended by the terminal manufacturer, whichever is lower.
8. Graph the data with temperature rise on the Y-axis and current (in amps) on the X-axis. Note that this data is NOT to be used as guidance for any actual application of the TUT. (Terminal Under Test)

3.5 Acceptance Criteria

None

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4. CONNECTION RESISTANCE (VOLTAGE DROP) TEST PROCEDURE

4.1 Purpose

Assure connection system resistance integrity.

4.2 Equipment

- Digital Multi Meter
- DC current supply capable of 150 amps
- Current shunts ((Size as required, $\pm 1\%$)
- Thermocouples (Type "J")
- Data logger (as required)
- Test fixture (figure 3.2-I A, or B)

4.3 Sample Preparation

Use 15 of the samples that have completed the sample conditioning procedure (para. 2)

4.4 Procedure

1. Conduct this test in an open bench, draft free environment at $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$. An ambient temperature sensor must be placed on the same plane as the test samples, 30 to 60 cm from the nearest sample.
2. Use the test fixture shown in figure 3.2-I A, or B to mount the panel (battery) side of the terminal. Assemble the circuit shown in Figure 3.2-II, using **15** terminal pairs. Millivolt readings may be taken by attaching sense leads or by probing with test probes. Choose preferred method of taking voltage readings (soldered/welded test lead or probe), and record the method chosen. Attach the millivolt leads (if used) to the terminals and test fixtures as shown in Figures 4.4-I and 3.2-I A or B. Attach the thermocouples to the hottest external point of each mated pair as shown in Figure 4.4-I. Experimentation may be needed to locate the point of maximum temperature. All millivolt leads and thermocouple leads must be no larger than 0.060 mm^2 (30 AWG) wire. Attach conductor ends of the terminal pairs to form one continuous series circuit from test fixture to test fixture. Ring terminals are used to make the cable attachments at the test fixtures. Attach the assembled circuit to a non-conductive surface, such as wood or high temperature plastic, leaving a minimum of 50 mm between test samples.
3. Adjust the current supply to provide a test current of 50 amps. More than one terminal pair may be tested in series as long as each terminal pair receives the total test current of 50 amp. Allow 30 minutes after turning on the power supply for terminal temperatures to stabilize (less than 1°C variation per minute). Record ambient and terminal interface temperatures.

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4. Measure voltage from points A to B. Calculate and record the voltage drop at each sample terminal interface (A to B) using the following formula:
Total Connection Resistance = $V_{AB} \div \text{Test Current (I)}$
5. Repeat step 3 and 4 at current levels of 100 and 150 amps.

4.5 Acceptance Criteria

None.

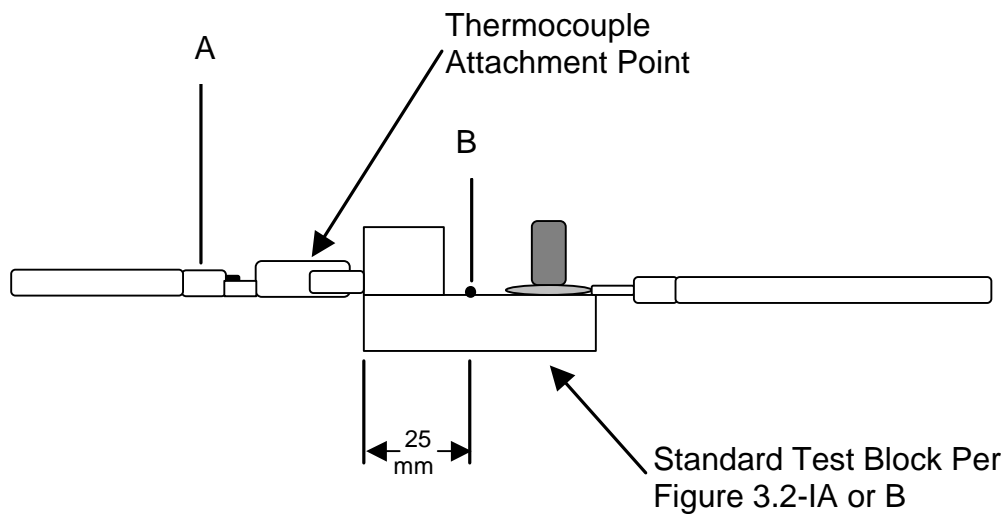


Figure 4.4 - I: Voltage Drop Test Setup
Test Lead Location

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5. CURRENT CYCLING

5.1 Purpose

This test simulates the main function of the terminal over the expected life of the vehicle. Current cycling is an accelerated aging test which electrically heats terminal interfaces and core conductor crimps, then allows them to cool under no/low current conditions, causing expansion and contraction that may affect connection resistance due to wear, oxidation and intermetallic growth.

5.2 Equipment

- Digital Multimeter (DMM)
- DC Current Supply (0 - 1000A, timer controlled)
- Current shunts (Size as required, $\pm 1\%$)
- Thermocouples (Type "J")
- Data Logger (As required)
- Test fixture per Figure 3.2-1A or B

5.3 Sample Preparation

Use the same samples and set-up from section 4.

5.4 Procedure

Note: The number of cycles has been chosen to accommodate 5 day per week laboratory operation.

1. This test is conducted at 23° C. (room temperature). An ambient temperature sensor must be placed on the same plane as the test samples, 30 to 60 cm from the nearest sample.
2. Connect a data logger to the voltage drop and thermocouple leads.
3. Set the power supply to provide the following current and time profile and run for 3000 cycles:
500 Amps for 10 seconds
45 amps for 110 seconds

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4. At the end of the 3000 cycles, rerun test 4. "Connection Resistance (Voltage Drop) Test Procedure".
5. Set the Power Supply to provide the following current and time profile and run for 1000 cycles:
1000 amps for 10 seconds
35 amps for 290 seconds
6. At the end of the 1000 cycles, rerun test 4. "Connection Resistance (Voltage Drop) Test Procedure".
7. For each set of data, calculate and record the Total Connection Resistance.
8. Create a graph showing total connection resistance, change in resistance, and contact temperature for each sample pair.
9. Verify conformance to the Acceptance Criteria of Section 5.5.

5.5 Acceptance Criteria

1. The measured temperature of any mated terminal pair must not exceed a 55 °C rise over ambient for any reading during the test.