3M

4000-D Super Mini Module

Tech Report

November 1997
80-6107-6132-4-B

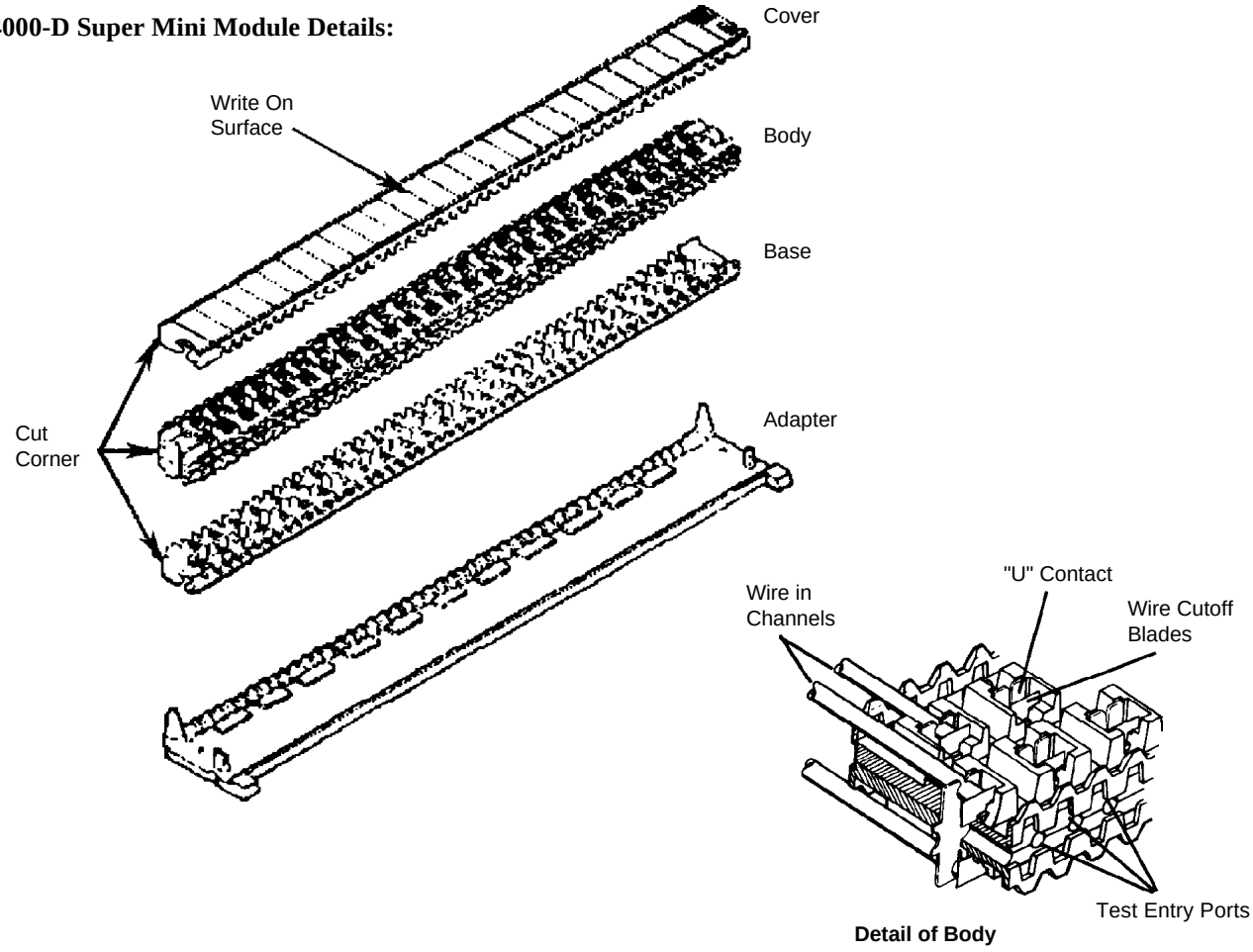
Contents:

1.0 Product Description

The 4000-D Super Mini Module is the straight splicing module of 3M Telecom System's 25 pair Modular System Splicing (MS^2). The 4000-D Super Mini can connect up to 25 conductor pairs and can accommodate the 4005-DPM Super Mate Module for plug connecting applications. The Super Mini Module accepts 22-28 AWG (0.65-0.32 mm) solid copper conductors with PIC, pulp or paper insulation in the insulation displacement contact (IDC) at both ends of the element.

The 4000-C, an encapsulated version of the 4000-D module, is available for applications requiring moisture resistance due to high humidity or condensation.

4000-D Super Mini Module Details:



Detail of Body

4000-D Super Mini Module Basic Properties

Dimensions:

Length .....6.48 in. (164.5 mm)
Width .....0.59 in. (15.0 mm)
Crimp Height .....0.36 in. (9.1 mm)

Material Composition:

Molded Plastic Components.....Polycarbonate
Contact Elements .....Tin Plated Phosphor Bronze Alloy
Wire Cut-Off Blades.....300 Series Stainless Steel

Application:

Wire Range .....22 to 28 AWG (0.65 to 0.32 mm) solid copper
Max. Insulation O.D. .....0.065 in. (1.65 mm)

The 4075-S sealant box is used with the 4000-D module to provide moisture protection for outside plant applications.

Splicing equipment used for Super Mini and Super Mate Modules include: 4030 Air/Hydraulic Crimping Unit, 4031 Hand/Hydraulic Crimping Unit, 4036 Hand/Hydraulic Crimping Unit. The 4041 Splicing Head is used for splicing both Super Mini and Super Mate Modules. Hand tools include: The 4051 Wire Insertion and Cut-off Tool, 4052 Check Comb and the 4053 Cover Removal Tool. Both the 4047 Pair Test Plug and 4048S Super Mini 25 Pair Probe can be used for testing either Super Mini or Super Mate Modules.

2.0 TEST PROGRAM OVERVIEW

To predict the long-term performance reliability of the 4000-D Super Mini Module, the modules have been subjected to a number of tests which expose them to conditions more severe than anticipated in actual use. The tests are based upon telephone industry performance specifications and are believed to represent the most severe requirements from that industry.

The test conditions provide accelerated aging, allowing the prediction of long-term performance within a relatively short time period. During the tests, such parameters as Connection Resistance, Insulation Resistance, Dielectric Strength and Physical Performance are monitored to determine the overall stability and reliability of the modules.

3.0 CONNECTION STABILITY TESTS

Connection resistance is the parameter usually measured and considered indicative of contact performance. It is the change in connection resistance and its variability that provides insight to the connector's electrical stability. Connection resistance for data and telecommunication circuits is measured based on ASTM B539-80, method C, Dry Circuit Testing. This test method sets maximum limits for voltage and current at 20 millivolts and 100 milliamperes respectively. This low level of electrical excitation is similar to actual conditions and is capable of detecting any resistive film that may have formed in the connection.

The samples are mounted on specially designed printed circuit (PC) boards with traces that permit classical 4-wire measurement techniques to be employed. These PC boards interface with 3M Telecom's computerized data acquisition system. This automated system takes precise voltage measurements which are used to calculate changes in connection resistance with an resolution of 0.001 milliohm.

Initial connection resistance is taken prior to exposure to the stress environment and after any mechanical preconditioning. This initial reading is used as the baseline for subsequent readings taken during and after exposure to the stress condition in determining the change in connection resistance. The targeted performance is to have less than 1.0 milliohm change per connection.

3.1 Temperature Cycle

Test samples are subjected to 512 8-hour cycles between temperatures of -40°F (-40°C) and 140°F (60°C), with a one-hour minimum dwell at each temperature extreme. This 170 day test evaluates connection stability through exposure to thermal change, which causes various contraction and expansion stresses.

Connection Resistance Change
(Data in Milliohms)

Wire Size AWG (mm)	Final Mean	Final Std. Dev.	Maximum Reading
26 (0.4)	-0.028	0.024	0.011
22 (0.65)	-0.003	0.009	0.006

3.2 Temperature Cycle with High Humidity

The 4000-D Super Mini Modules were subjected to 300 12-hour cycles between temperatures of 40°F (4°C) and 140°F (60°C) at 95% Relative Humidity, with a 3 and 3/4 hour minimum dwell at each temperature extreme. This 150 day test evaluates connection integrity in high humidity conditions with temperature cycling.

Connection Resistance Change
(Data in Milliohms)

Wire Size AWG (mm)	Final Mean	Final Std. Dev.	Maximum Reading
26 (0.4)	0.005	0.015	0.040
22 (0.65)	0.007	0.009	0.030

3.3 Stress Relaxation

The Stress Relaxation test subjects the 4000-D Super Mini Module to an ambient temperature of 244°F (118°C) for a period of 33 days. Following days 1,2,4,8,16 and 33, each sample is pulled momentarily with a 0.5 lb. (2.2 N) force. This mechanical disturbance is followed by connection resistance measurements.

This Stress Relaxation environment is intended to simulate the amount of relaxation which would occur at room temperature over the projected life of 40 years. Connection resistance changes less than 1.0 milliohm are considered acceptable.

Connection Resistance Change

(Data in Milliohms)

Wire Size AWG (mm)	Final Mean	Final Std. Dev.	Maximum Reading
26 (0.4)	-0.041	0.013	0.013
22 (0.65)	-0.029	0.007	-0.007

3.4 Heat-Cold Cycle

Test samples were put into customized test equipment with two separate chambers. This equipment cycled the test samples into a circulating air oven at 180°F (82°C) for 240 seconds and then immersed them into liquid nitrogen at -320°F (-195°C) for 20 seconds, a 500°F (277°C) temperature change. The test samples were cycled 100 times between these two temperature extremes.

This very extreme thermal cycle subjects the connections to severe stresses caused by the different thermal expansions and contractions. Connection resistance changes under 1.0 milliohm are considered to be acceptable.

Connection Resistance Change

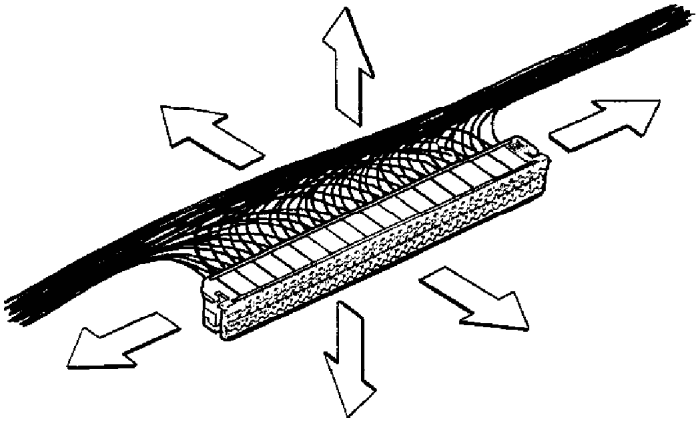
(Data in Milliohms)

Wire Size AWG (mm)	Final Mean	Final Std. Dev.	Maximum Reading
26 (0.4)	-0.003	0.016	0.125
22 (0.65)	-0.012	0.009	0.010

3.5 Vibration

In this test, samples were subject to 20 minutes of vibration in each of three mutually perpendicular planes. The vibration is a harmonic motion with an amplitude of 0.06 in. (1.5 mm) cycling from 10 to 55 to 10 Hertz in one minute.

The samples are monitored during this test for opens in circuit continuity of 10 microseconds or longer. Any loss in circuit continuity or change in connection resistance greater than 1.0 milliohm would constitute a failure.



Connection Resistance Change

(Data in Milliohms)

Wire Size AWG (mm)	Final Mean	Final Std. Dev.	Maximum Reading
26 (0.4)	-0.009	0.063	0.139
22 (0.65)	-0.001	0.003	0.007

4.0 Insulation Resistance Tests

High insulation resistance is needed in order to minimize excessive noise pick-up (i.e. crosstalk) and signal loss. The Super Mini's performance was evaluated in two different stress conditions. Readings were taken prior to, during and after exposure to the test condition at 250 volts DC.

4.1 Temperature Cycling with High Humidity

a) 4000D Super Mini Modules with 4075S Sealant Box applied: The 4000D Super Mini Modules were spliced and the 4075S Sealant boxes were applied. The samples were subjected to 150 12-hour temperature cycles between 40°F (4°C) and 140°F (60°C) at 95% relative humidity, with a 3 and 3/4 hour minimum dwell at each temperature extreme. During aging conditions the samples had 48 volts DC applied between tip and ring wires.

Insulation Resistance
(Data in ohms)

Wire Size AWG (mm)	Final Mean	Final Low
26 (0.4)	8.88×10^{11}	1.98×10^{10}
22 (0.65)	5.36×10^{11}	4.80×10^{10}

b) 4000C Super Mini Modules: The 4000C filled Super Mini Modules were spliced and subjected to 150 12-hour temperature cycles between 40°F (4°C) and 140°F (60°C) at 95% relative humidity, with a 3 hour minimum dwell at each temperature extreme. During aging conditions the samples had 48 volts DC applied between tip and ring wires.

Insulation Resistance
(Data in ohms)

Wire Size AWG (mm)	Final Mean	Final Low
26 (0.4)	7.15×10^{11}	1.99×10^{10}
22 (0.65)	5.99×10^{11}	3.49×10^{11}

This 75 day test evaluates insulation integrity in high humidity conditions with temperature cycling. The targeted performance is to have all the readings to be greater than 100 megohms (10^8 ohms).

4.2 Water Immersion

Super Mini/4075-S Sealant Box assemblies were submerged into 6.0 in. (15.2 cm) of water for 30 days. Submerged samples had 48 volts DC applied between all tip and ring conductors. Insulation resistance measurements were taken at the conclusion of the test between all tip and ring wires at a voltage of 250 volts DC.

This test evaluates the total Super Mini/4075-S Sealant Box system under the worst case conditions of water presence. The targeted performance is to have less than 10% of module readings below 1.0 megohm (10^8 ohms) and less than 25% of the readings below 100 megohms (10^8 ohms).

Insulation Resistance
(Data in ohms)

Wire Size AWG (mm)	Final Mean	Final Low	Percent less than 100 Megohms
26 (0.4)	5.76×10^{11}	6.3×10^{10}	0
22 (0.65)	7.49×10^{11}	2.0×10^{10}	0

5.0 DIELECTRIC STRENGTH TESTS

High connector dielectric strength prevents excessive maintenance due to temporary high voltage conditions from lightning or power line crosses. Various tests evaluate the dielectric strength of the Super Mini Module.

5.1 Dielectric Withstand (AC Voltage)

Samples without sealant boxes were tested in air by applying a 60 Hertz high voltage. This test checks the ability of the connector to resist spark-over from a high voltage power line cross. Targeted performance is to have no spark-over at the applied voltage.

Dielectric Withstand (AC Voltage)

Wire Size AWG (mm)	Circuit Measured	Applied Voltage	Test Duration	Result
22 (0.65)	Tip - Ring	2.0 KV	2 minute	Pass
22 (0.65)	Pair - Pair	3.0 KV	2 minute	Pass
26 (0.4)	Tip - Ring	2.0 KV	2 minute	Pass
26 (0.4)	Pair - Pair	3.0 KV	2 minute	Pass

5.2 Dielectric Withstand (Surge Voltage)

Samples were subjected to a 10 x 1000 microsecond high voltage pulse (10 microsecond rise time with a 1000 microsecond fall time).

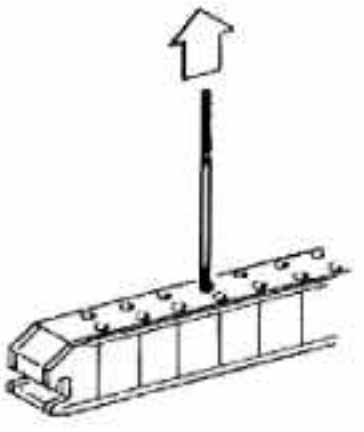
This test checks the ability of the connector to resist spark-over from a lightning surge. Targeted performance is to have no spark-over at the applied voltage.

Dielectric Withstand (SurgeVoltage)

Wire Size AWG (mm)	Circuit Measured	Applied Voltage	Result
22 (0.65)	Tip - Ring	4.0 KV	Pass
22 (0.65)	Pair - Pair	5.0 KV	Pass
26 (0.4)	Tip - Ring	4.0 KV	Pass
26 (0.4)	Pair - Pair	5.0 KV	Pass

6.0 PHYSICAL TESTS

Three physical tests are used to evaluate the connector's ability to withstand the physical handling and abuse associated with the use of splicing and plugging modules



6.1 Tensile Strength

Both control wires and wires in Super Mini Modules were tested for tensile strength. Measurements were made with a cross-head speed of 2.4 in/min. (1.0 mm/sec).

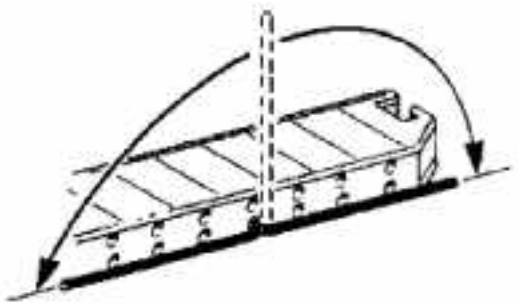
This test evaluates the wire tensile strength after inserting into a "U-contact" relative to control wires. Tensile strengths which exceed 85% of the strength of the original unspliced wire are considered acceptable.

Wire Size AWG (mm)	Control Wire Mean	Test Sample Mean	Test Sample Std. Dev.	Percent of Control Wire
26 (0.4)	8.26 lb. 36.8 N	7.91 lb. 35.2 N	0.17 lb. 0.75 N	95.7
22 (0.65)	21.7 lb. 96.5 N	20.7 lb. 92.0 N	0.53 lb. 2.37 N	95.3

6.2 Wire Torsion

With wired samples lying flat bottom down, conductors are bent up at 90 degrees. Then using a 2.0 inch (50.8 mm) crank arm, the conductors are rotated 90 degrees toward each end of the module.

This test evaluates the wire connection and strain relief when conductors are subjected to a torsional twist. Targeted performance is 10 rotations without a circuit discontinuity of greater than 10 microseconds or a break in the wire.

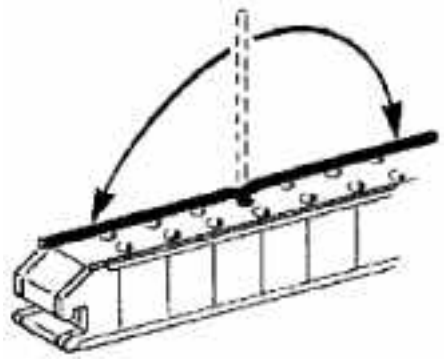


Wire Size AWG (mm)	No. Rotations to Each End	Circuit Discontinuities	Comments
26 (0.4)	10	none	No wire breakage or slipping in contact
22 (0.65)	10	none	No wire breakage or slipping in contact

6.3 Wire Bending

Using a 2.0 inch (50.8 mm) bending arm, the conductors are bent 90 degrees toward both ends of the test module.

This test evaluates the wire connection and strain relief when conductors are subjected to bending. Targeted performance is 10 bends without a circuit discontinuity of greater than 10 microseconds or a break in the wire.



Wire Size AWG (mm)	No. Bends to Each End	Circuit Discontinuities	Comments
26 (0.4)	10	none	No wire breakage or slipping in contact
22 (0.65)	10	none	No wire breakage or slipping in contact

7.0 CONCLUSION

Throughout this test program the 4000-D Super Mini Module has met or exceeded all targeted performance requirements. The excellent test results demonstrate the expected good performance in connection resistance stability, insulation resistance integrity, dielectric strength and physical robustness with the 4000-D.

For information concerning specific agency approvals please contact your 3M Telecom System representative.

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