FLEXSTRIP* Jumpers

1. INTRODUCTION

1.1. Purpose

Testing was performed on the TE Connectivity FLEXSTRIP Jumpers to determine its conformance to the requirements of Product Specification 108-2135 Revision D.

1.2. Scope

This report covers the electrical, mechanical, and environmental performance of the FLEXSTRIP Jumpers. Testing was performed at the Engineering Assurance Product Test Laboratory between 04Dec03 and 11Oct04. The test file numbers for this testing are CTLE 166-001, 166-002, 169-001, 169-002, 172-001, 172-002, 175-001, 175-002 and 175-004. This documentation is on file at and available from the Engineering Assurance Product Test Laboratory.

1.3. Conclusion

The FLEXSTRIP Jumpers listed in paragraph 1.5., conformed to the electrical, mechanical, and environmental performance requirements of Product Specification 108-2135 Revision A.

1.4. Product Description

FLEXSTRIP Jumpers provide a multi-conductor board-to-board connection without wire stripping, cutting to length or special solder preparation. They are highly flexible and come in a wide range of lengths and conductor pitches.

1.5. Test Specimens

Test specimens were representative of normal production lots. Specimens identified with the following part numbers were used for test:

Test Group	Quantity	Part Number	Description
1	4	FSN-634A-10	Nomex, .075 inch pitch, 34 inch length
	4	FSN-234A-10	Nomex, .100 inch pitch, 34 inch length
	4	FSN-934A-10	Nomex, 1.0 mm pitch, 34 inch length
	4	FSN-834A-10	Nomex, 1.25 mm pitch, 34 inch length
	4	FST-634A-10	PTFE, .075 inch pitch, 34 inch length
	4	FST-234A-10	PTFE, .100 inch pitch, 34 inch length
	4	FST-934A-10	PTFE, 1.0 mm pitch, 34 inch length
	4	FST-834A-10	PTFE, 1.25 mm pitch, 34 inch length
	4	FSK-634A-10	Kapton, .075 inch pitch, 34 inch length
	4	FSK-234A-10	Kapton, .100 inch pitch, 34 inch length
	4	FSK-934A-10	Kapton, 1.0 mm pitch, 34 inch length
	4	FSK-834A-10	Kapton, 1.25 mm pitch, 34 inch length
	4	FSP-634A-10	Polyester, .075 inch pitch, 34 inch length
	4	FSP-234A-10	Polyester, .100 inch pitch, 34 inch length
	4	FSP-934A-10	Polyester, 1.0 mm pitch, 34 inch length

Figure 1 (cont)

| Indicates Change

1	4	FSK-212A-10	Kapton, .100 inch pitch, 12 inch length
	4	FSK-612A-10	Kapton, .075 inch pitch, 12 inch length
	4	FSK-912A-10	Kapton, 1.0 mm pitch, 12 inch length
1,2,3,4,5, 6,7,8,9,10	4 each	FST-112A-10	PTFE, .050 inch pitch, 12 inch length
	4 each	FST-612A-10	PTFE, .075 inch pitch, 12 inch length
	4 each	FSP-112A-10	Polyester, .050 inch pitch, 12 inch length
	4 each	FSP-612A-10	Polyester, .075 inch pitch, 12 inch length
	4 each	FSK-112A-10	Kapton, .050 inch pitch, 12 inch length
	4 each	FSK-612A-10	Kapton, .075 inch pitch, 12 inch length
	4 each	FSN-112A-10	Nomex, .050 inch pitch, 12 inch length
	4 each	FSN-612A-10	Nomex, .075 inch pitch, 12 inch length
1,2,3,4,5, 6,7,8,10	4 each	FSK-212A-10	Kapton, .100 inch pitch, 12 inch length
	4 each	FST-212A-10	PTFE, .100 inch pitch, 12 inch length
	4 each	FSN-212A-10	Nomex, .100 inch pitch, 12 inch length
	4 each	FSP-212A-10	Polyester, .100 inch pitch, 12 inch length
1,3,4,8,9	4 each	FSK-312A-10	Kapton, .125 inch pitch, 12 inch length
	4 each	FST-312A-10	PTFE, .125 inch pitch, 12 inch length
	4 each	FSP-312A-10	Polyester, .125 inch pitch, 12 inch length
	4 each	FSN-312A-10	Nomex, .125 inch pitch, 12 inch length
3,4,8	4 each	FSK-412A-10	Kapton, .150 inch pitch, 12 inch length
	4 each	FST-412A-10	PTFE, .150 inch pitch, 12 inch length
	4 each	FSP-412A-10	Polyester, .150 inch pitch, 12 inch length
	4 each	FSN-412A-10	Nomex, .150 inch pitch, 12 inch length
	4 each	FSK-512A-10	Kapton, .200 inch pitch, 12 inch length
	4 each	FST-512A-10	PTFE, .200 inch pitch, 12 inch length
	4 each	FSP-512A-10	Polyester, .200 inch pitch, 12 inch length
	4 each	FSN-512A-10	Nomex, .200 inch pitch, 12 inch length
1,3,4,8	4 each	FSP-712A-10	Polyester, 2.0 mm pitch, 12 inch length
	4 each	FST-712A-10	PTFE, 2.0 mm pitch, 12 inch length
	4 each	FSN-712A-10	Nomex, 2.0 mm pitch, 12 inch length
	4 each	FSK-712A-10	Kapton, 2.0 mm pitch, 12 inch length
3,4,5,8	4 each	FSN-912A-10	Nomex, 1.0 mm pitch, 12 inch length
	4 each	FST-912A-10	PTFE, 1.0 mm pitch, 12 inch length
	4 each	FSK-912A-10	Kapton, 1.0 mm pitch, 12 inch length
	4 each	FSP-912A-10	Polyester, 1.0 mm pitch, 12 inch length
	4 each	FSN-812A-10	Nomex, 1.25 mm pitch, 12 inch length
	4 each	FST-812A-10	PTFE, 1.25 mm pitch, 12 inch length
	4 each	FSK-812A-10	Kapton, 1.25 mm pitch, 12 inch length
	4 each	FSP-812A-10	Polyester, 1.25 mm pitch, 12 inch length
10	4	FSK-212A-10	Kapton, .100 inch pitch, 12 inch length
	4	FSK-612A-10	Kapton, .075 inch pitch, 12 inch length
	4	FSK-912A-10	Kapton, 1.0 mm pitch, 12 inch length

Figure 1 (end)

1.6. Environmental Conditions

Unless otherwise stated, the following environmental conditions prevailed during testing:

- Temperature: 15 to 35°C
- Relative Humidity: 25 to 75%

1.7. Qualification Test Sequence

Test or Examination	Test Group (a)									
	1	2	3	4	5	6	7	8	9	10
	Test Sequence (b)									
Initial examination of product	1	1	1	1	1	1	1	1	1	1
Current rating				2						
Dielectric withstanding voltage	3,8	3,7			4		3,6	3,6	3,6	
Dry heat								4		
Insulation resistance	2,7	2,6			3		2,5	2,5	2,5	
Capacitance			2							
Characteristic impedance			3							
Cold bend	4									
Flexibility					2					
Long term flex						2				
Fold							4			
Flammability										2
Solderability		4								
Resistance to soldering heat		5								
Thermal shock	5									
Damp heat, steady state	6									
Solvent resistance									4	
Final examination of product	9	8	4	3	5	3	7	7	7	

NOTE

(a) See paragraph 4.1.A.
(b) Numbers indicate sequence in which tests are performed

Figure 2

2. SUMMARY OF TESTING

2.1. Initial Examination of Product - All Test Groups

All specimens submitted for testing were representative of normal production lots. A Certificate of Conformance was issued by Product Assurance. Specimens were visually examined and no evidence of physical damage detrimental to product performance was observed.

2.2. Current Rating - Test Group 4

Test specimens, with the 10 conductors series wired, produced a temperature rise of less than 30°C when subjected to the current level specified in Figure 3.

	Pitch (inch)						Pitch (millimeter)		
	.050	.075	.100	.125	.150	.200	1.00	1.25	2.00
Amperes	1.6	2	3	3.5	3.5	4	1	1.6	2

Figure 3

2.3. Dielectric Withstanding Voltage - Test Groups 1, 2, 5, 7, 8 and 9

No evidence of dielectric breakdown, flashover or leakage greater than 1 milliampere with a potential applied between bussed odd and even conductors and between all conductors and foil.

2.4. Dry Heat - Test Group 8

No evidence of physical damage was visible as a result of exposure to a dry heat environment.

2.5. Insulation Resistance - Test Groups 1, 2, 5, 7, 8 and 9

All insulation resistance measurements were greater than 1000 megohms ($1x10^9$ ohms).

2.6. Capacitance - Test Group 3

All capacitance measurements were equal to or less than the values listed in Figure 4.

Insulation Type	Pitch (inch)						Pitch (millimeter)		
	.050	.075	.100	.125	.150	.200	1.00	1.25	2.00
Polyester	16.5	12.2	11.1	9.2	8.0	6.8	20.4	16.2	11.6
Nomex	16.4	12.1	11.2	9.0	7.9	6.7	23.7	16.7	11.6
PTFE	16.0	12.7	11.4	9.5	8.4	7.1	19.8	16.8	11.6
Kapton	14.9	11.1	10.4	8.8	7.8	6.6	18.5	15.4	10.6

NOTE *All values in picofarads.*

Figure 4

2.7. Characteristic Impedance - Test Group 3

All characteristic impedance measurements were equal to or less than the values listed in Figure 5.

Insulation Type	Pitch (inch)						Pitch (millimeter)		
	.050	.075	.100	.125	.150	.200	1.00	1.25	2.00
Polyester	98	109	115	138	152	174	89	98	118
Nomex	97	115	117	143	152	176	78	91	116
PTFE	101	113	114	135	149	176	87	95	118
Kapton	100	118	119	140	154	177	83	99	123

NOTE *All values in ohms..*

Figure 5

2.8. Cold Bend - Test Group 1

No physical damage or delamination of the insulating material was visible.

2.9. Flexibility - Test Group 5

No discontinuities greater than 1 microsecond or evidence of physical damage occurred on any specimen after being flexed 75 times from 10.75 inches to 1 inch and from being flexed 180 degrees over a ⅛ inch diameter mandrel 50 times.

2.10. Long Term Flex - Test Group 6

No discontinuities greater than 1 microsecond or evidence of physical damage occurred on any specimen after being flexed 1000 times 90 degrees in each direction over a 1 inch diameter mandrel.

2.11. Fold - Test Group 7

No evidence of physical damage was visible on any specimen after folding the jumper transversely and applying a load for 15 minutes.

2.12. Flammability - Test Group 10

All specimens exhibited a maximum burn rate of less than 1 inch per minute.

2.13. Solderability - Test Group 2

All specimens exhibited a continuous solder coating, free from defects, over 95% of the critical surface areas of the exposed conductors.

2.14. Resistance to Soldering Heat - Test Group 2

No evidence of physical damage to the conductors or insulating material was visible as a result of exposure to soldering heat.

2.15. Thermal Shock - Test Group 1

No evidence of physical damage was visible as a result of thermal shock testing.

2.16. Damp Heat, Steady State - Test Group 1

No evidence of physical damage was visible as a result of exposure to a high humidity environment.

2.17. Solvent Resistance - Test Group 9

No evidence of physical damage was visible as a result of exposure to 4 different cleaning solvents.

2.18. Final Examination of Product - All Test Groups

Specimens were visually examined and no evidence of physical damage detrimental to product performance was observed.

3. TEST METHODS

3.1. Initial Examination of Product

A Certificate of Conformance was issued stating that all specimens in this test package were produced, inspected, and accepted as conforming to product drawing requirements, and were manufactured using the same core manufacturing processes and technologies as production parts.

3.2. Current Rating

Temperature rise was measured on unstressed specimens using infrared imaging. Specimens were prepared by series wiring all 10 conductors of each jumper so that they would be energize simultaneously. All specimens were placed in a stable air environment provided by a temperature rise enclosure. Specimens were energized using the current levels specified in Figure 3 and then allowed to stabilize before the temperature was measured. The ambient temperature was then subtracted from the measured temperature to find the temperature rise.

3.3. Dielectric Withstanding Voltage

A. Test 1

A test potential of 500 to 1500 volts, 60 Hz AC (voltage dependent on conductor pitch/centerline) was applied at a rate of 500 volts per second between separately bussed odd and even conductors of all specimens. The potential was applied for 1 minute and then returned to zero.

B. Test 2

A test potential of 500 to 1500 volts, 60 Hz AC (voltage dependent on conductor pitch) was applied at a rate of 500 volts per second between all conductors and aluminum foil wrapped around the specimen. One edge of the foil was 0.25 inch from the edge of the insulation and the foil was 2.5 inches long. Leakage current was set for 1 milliamperes maximum for both tests. The AC potential applied to each pitch for both test 1 and test 2 is listed in Figure 6.

	Pitch (inch)						Pitch (millimeter)		
	.050	.075	.100	.125	.150	.200	1.00	1.25	2.00
Volts AC	1050	1250	1500	1500	1500	1500	500	1050	1250

Figure 6

3.4. Dry Heat

All specimens were exposed to a temperature of 136°C for 7 days.

3.5. Insulation Resistance

Insulation resistance was measured between separately bussed odd and even conductors of all specimens. A test voltage of 500 volts DC was applied for 1 minute before the resistance was recorded.

3.6. Capacitance

Capacitance was measured on each specimen while bussed in a ground-signal-ground configuration, with all grounds bussed together. Measurements were made at a test frequency of 1 MHz between each signal and the ground bus. Each specimen was suspended in air to ensure no contact to anything that would influence the capacitance measurement.

3.7. Characteristic Impedance

Characteristic impedance was measured on each test specimen while bussed in a ground-signal-ground configuration, with all grounds bussed together. All measurements were made using a Time Domain Reflectometry oscilloscope.

3.8. Cold Bend

Specimens were flexed into a "U" around a ⅛ inch diameter mandrel and taped in place to maintain the shape. Specimens were then exposed to a temperature of -20°C for 1 hour, after which they were allowed to stabilize at room ambient for 1 hour. Specimens were then removed from the mandrel, bent straight and visually inspected for physical damage.

3.9. Flexibility

A. Step One

Both ends of 12 inch long specimens were soldered to small PC boards. Conductors on each, were wired to provide a series circuit which was connected to a discontinuity monitor set to detect discontinuities of 1 microsecond or greater. A maximum of 4 specimens of each pitch were fixtured on the durability machine at one time. The stroke of the machine was adjusted so that when at its minimum, the distance between the PC boards was 1 inch, and when at its maximum, the distance was 10.75 inches. The durability machine was operated at a minimum cycle rate of 20 seconds per cycle for 75 cycles.

B. Step Two

The same specimens as subjected to Step 1 were flexed 180 degrees (90 degrees in each direction) over 2, ⅛ inch diameter mandrels, at a rate of 16 cycles per minute, for 50 cycles. A load/weight (dependent on conductor size, see Figure 7) was attached to the end of each specimen to keep it taught around the radius of the mandrels.

Conductor Diameter (mm [in])	Wire Size (AWG)	Load (grams/conductor)
0.32 [.0126]	28	5
0.40 [.0157]	26	15
0.50 [.0197]	24	50

Figure 7

3.10. Long Term Flex

Specimens were series wired to monitor discontinuities of 1 microsecond or greater while being cycled. They were then fixtured on a cycling machine and flexed 180 degrees (90 degrees in each direction) over 1 inch mandrels at a rate of 14 cycles per minute, for 1000 cycles. A load/weight was attached to the end of each specimen to keep the jumpers taught around the radius of the mandrels.

3.11. Fold

Specimens were folded transversely 180 degrees and a 30-psi load was applied to the fold area for 15 minutes. Specimens were then unfolded and a 30-psi load was applied to the previously folded area for 15 minutes, after which, specimens were visually inspected for physical damage.

3.12. Flammability

Specimens were clamped with the 1 inch width vertical and the bottom edge horizontal. The tip of the flame from a Bunsen burner mounted on a 20 degree block was applied to the bottom edge of the test specimen for 5 seconds or until the specimen ignited, then removed. The time interval between flame removal and when the specimen stopped burning was recorded. The distance burned vertically from the edge of the specimen was then measured and the burn rate calculated.

3.13. Solderability

Conductors of the specimens to be evaluated were immersed in flux type "ROL0" (previous designation "R"), trade name Kester 145, for 5 to 10 seconds. The specimens were then removed from the flux and the excess was allowed to drain off for 5 to 20 seconds. Specimens were attached to a dipping machine where the dross and any oxidized flux were skimmed away. Conductors were immersed at a rate of approximately 1 inch per second into a soldering bath filled with melted solder with a composition of 95-96.5% tin, 3-4% silver, and 0.5-1% copper, controlled at 245 ± 5°C [473°F] until the entire surface to be evaluated was coated. Specimens were held in the solder bath for 4.5 to 5.5 seconds. Conductors were removed from the solder at a rate of approximately 1 inch per second and then subjected to a 5 minute cleaning in isopropyl alcohol. Conductors were then visually examined under a microscope at 10X magnification to determine results.

3.14. Resistance to Soldering Heat

The same specimens exposed to the solderability test were again tested as outlined in paragraph 3.13. with the exception that specimens were dipped for 10 seconds (except for polyester specimens which were dipped for 2 seconds) rather than 5.

3.15. Thermal Shock

Specimens were subjected to 5 cycles of thermal shock with each cycle consisting of 30 minute dwells at -65 and 125°C. The transition between temperatures was less than 1 minute.

3.16. Damp Heat, Steady State

All specimens were exposed to an environment of 40°C at 90 to 95% RH for 96 hours.

3.17. Solvent Resistance

Specimens were subjected to solvents shown in Figure 8. A graduated cylinder was filled with the solvent to a depth of 4.5 inches. The cylinder was placed in an oven and heated to the temperatures shown with a tolerance of +2.8/-0°C and was maintained at that temperature level for 15 minutes prior to proceeding with the test. One end of each specimen was immersed in the solvent, to a length of approximately 4.5 inches, for the time period indicated. After removal from the solvent, the specimen was wiped dry and allowed to recover in room ambient conditions for 5 minutes, prior to final examination. Specimens of 3 different size pitches were subjected to each solvent.

Solvent	Description	Chemical Class	Temperature (̀C)	Time (Minutes)
A	Ionox FC	Alcohol based	65.6	5
B	Axarel 32	Aliphatic hydrocarbon with DBE	60.0	10
C	Bioact EC-15	Ester plus glycol	71.1	10
D	Synergy CCS	Terpene and alcohol	25.0	10

Figure 8

3.18. Final Examination of Product

Specimens were visually examined for evidence of physical damage detrimental to product performance.