



Sabritec Qualification Test Report Summary

Qualification of Multimode Fiber Optic Termini, and Type 1,
Category 2 Connectors per ARINC Specification 801



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1 Scope

The purpose of this document is to summarize the test results documented in Sabritec Qualification Test Report 684, which defined the test samples, test sequence, and test methods used in the Qualification of Sabritec's ARINC 801 Fiber Optic Termini and Type I, Category 2 Connectors to ARINC 801 Specification. The complete test report is on file at Sabritec.

2 Order of Precedence

In case of a conflict between the text of this document and the applicable referenced documents, the text of this document took precedence.

3 Description of Test Articles

Style LM termini intended for multimode cables with loose structure, were installed in Type 1, Category 2 circular multi-way connectors. These termini are designed for use with generic fiber optic connectors needed for commercial aircraft. The connectors are environment resisting connectors for continuous operation at any temperature between -55°C (-67°F) and 70°C (158°F), and are suitable for use in most pressurized and non-pressurized areas of an aircraft where the pressure is normally no lower than the altitude equivalent of 15,200 m (50,000 ft.). All optical performance tests were performed at a nominal wavelength of 1300 nm for multimode. Multimode tests used a launch condition as defined in TIA/EIA-455-54.

Table 1: Description of Test Articles

ARINC Designator	Sabritec Part Number	Qty	Description
LM	238500-8000	192	Terminus, Fiber Optic, ARINC 801, Multimode, Pull Proof
Type 1, Category 2	236433-2000	6	Plug, D38999/26, Insert Arrangement 21-16, 'N' Polarization, W/Alignment Sleeve Holder
Type 1, Category 2	236433-3000	6	Receptacle, D38999/20, Insert Arrangement 21-16, 'N' Polarization
MGL-1	-	960 m	Cable, Fiber Optic, 62.5/125um MM, Loose Style
N/A	236433-2001	6	Cable Assembly, D38999/26, Insert Arrangement 21-16, ARINC 801 Termini to FC Connectors, 62.5/125 Multimode, 5 Meters, Serialized 1A – 6 A
N/A	236433-3001	6	Cable Assembly, D38999/20, Insert Arrangement 21-16, ARINC 801 Termini to FC Connectors, 62.5/125 Multimode, 5 Meters, Serialized 1B – 6 B

4 References

ARINC Specification 801	Fiber Optic Connectors Fiber Optic Set
ARINC Specification 802	Fiber Optic Cables
ARINC Report 803	Fiber Optic System Design Guidelines
ARINC Report 804	Fiber Optic Active Device Specification
ARINC Report 805	Fiber Optic Test Procedures
ARINC Report 806	Fiber Optic Installation and Maintenance Procedures
EIA-364-13B	Connector Coupling Force
TIA/EIA-455-171	Attenuation
EIA-364-24B	Maintenance Aging
EIA-364-32C	Thermal Shock (Temperature Cycling)
TIA/EIA-455—5C	Humidity
TIA/EIA-455-11C	Vibration
TIA/EIA-455-14A	Mechanical Shock
EIA-364-09C	Connector Coupling Durability
TIA/EIA-455-4C	Temperature Life
TIA/EIA-455-16A	Salt Spray (Corrosion) Test for Fiber Optic Components
TIA/EIA-455-15A	Altitude Immersion
TIA/EIA-455-107	Return Loss
TIA/EIA-455-12A	Fluid Resistance
EIA-364-38B	Termini Retention Force
TIA/EIA-455-172	Fire Resistance
ANSI/NCSL Z540-1-1994	Calibration System Requirements
QMM 400B	Sabritec Quality Assurance Manual

5 Test Equipment and Facilities

5.1 Test Equipment

Table 2 lists the equipment used during the performance of the testing required herein.

Table 2: Test Equipment

Manufacturer	Description and Model	Sabritec Serial Number
Exfo	Multifunction Loss Tester (Model FOT-930)	S/N 357117
Brown and Sharp	Dial Calipers	S/N 253
Motic	Microscope	S/N 30871
Thermotron	Humidity/Thermal Chamber	S/N 058
Chatillon	Force Measure Gauge (Model #dpp10)	S/N 249
Sabritec	Terminus Walkout Fixture	N/A
CE Comp	Altitude Chamber	S/N 991

5.2 Facilities

Sabritec used its own facilities for testing and that of Exporion Photonics, Newbury Park, CA, and Kitco Fiber Optics, Virginia Beach, VA.

6 Calibration

All test equipment used in the performance of the tests required herein was calibrated in accordance with ANSI/NCSL Z540-1-1994. Records of all equipment are maintained in accordance with ANSI/NCSL Z540-1-1994 and made available for review. Unless otherwise specified, Sabritec Quality Assurance verified that all test data and collection methods were accurate and reliable.

7 Test Sequence

The Test Report is broken into four (4) groups, of test sequences. Three groups (A-C) were comprised of two mated connector pairs with fully populated optical cavities (16 terminus pairs). Twelve of those 16 pairs were chosen to satisfy the minimum required test configuration. The Intermateability group was comprised of one mated connector pair with fully populated optical cavities (6 terminus pairs). Each pair of connectors went through the listed tests in the order specified. The connectors had the termini in each cavity terminated to ARINC 802 MGL-1 cable. The test sequence and results are listed in Table 3.

8 Test Results

Test Procedure	Para Ref	Pass/Fail Criteria	Results
Intermateability/Interoperability	12.1	Connectors and termini shall be intermateable and interoperable with currently qualified product.	Pass
Attenuation	12.2	Maximum attenuation shall be 0.3 dB.	Pass
Group A (2 Mated Samples)			
Examination of Product - Initial	12.3	Visual & Dimensional requirements.	Pass
Connector Coupling Torque	12.4	2.26 N-m (20 in-lbs) maximum.	Pass
Attenuation	12.2	Maximum attenuation = 0.3 dB.	Pass
Maintenance Aging	12.5	Terminus Ins Force = 36 N (8 lbs) max.	Pass
Thermal Cycling	12.6	Change in transmittance = .25 dB max.	Pass
Connector Coupling Durability	12.7	Change in transmittance = .25 dB max.	Pass
Altitude Immersion	12.8	Change in transmittance = .25 dB max.	Pass
Return Loss	12.9	> 20 dB for MM PC polished termini.	Pass
Terminus Retention Force	12.10	53.4 N (12 pounds). No damage to the termini, the connector insert or the retention mechanism.	Pass
Terminus Insertion/Extraction Force	12.11	Record values.	Pass
Examination of Product	12.3	Visual requirements.	Pass
Group B (2 Mated Samples)			
Examination of Product - Initial	12.3	Visual & Dimensional requirements.	Pass
Connector Coupling Torque	12.4	2.26 N-m (20 in-lbs) maximum.	Pass
Attenuation	12.2	Maximum attenuation = 0.3 dB.	Pass
Maintenance Aging	12.5	Terminus Ins Force = 36 N (8 lbs) max.	Pass
Humidity	12.12	Change in transmittance = .25 dB max.	Pass
Vibration	12.13	Optical discontinuities = 1 μ s max. Change in transmittance = .25 dB max.	Pass
Mechanical Shock	12.14	Optical discontinuities = 1 μ s max. Change in transmittance = .25 dB max.	Pass
Salt Spray	12.15	Pass Visual tests.	Pass
Terminus Retention Force	12.10	53.4 N (12 pounds). No damage to the termini, the connector insert or the retention mechanism.	Pass
Terminus Insertion/Extraction Force	12.11	Record values.	Pass
Examination of Product	12.3	Visual requirements.	Pass
Group C (2 Mated Samples)			
Examination of Product - Initial	12.3	Visual & Dimensional requirements.	Pass
Connector Coupling Torque	12.4	2.26 N-m (20 in-lbs) maximum.	Pass
Attenuation	12.2	Maximum attenuation = 0.25 dB.	Pass
Thermal Cycling	12.6	Change in transmittance = .25 dB max.	Pass
Temperature Life	12.16	Change in transmittance = .25 dB max.	Pass
Terminus Walkout Resistance	12.17	Termini shall not become dislodged from their normal positions.	Pass
Examination of Product	12.3	Visual requirements.	Pass

9 Initial insertion Loss Test Results

Sample 1AB

Cavity No.	Insertion Loss
A	0.06 dB
C	0.14 dB
D	0.11 dB
E	0.12 dB
F	0.16 dB
G	0.10 dB
H	0.08 dB
J	0.10 dB
K	0.13 dB
L	0.10 dB
M	0.06 dB
N	0.05 dB

Sample 2AB

Cavity No.	Insertion Loss
A	0.07 dB
B	0.02 dB
C	0.15 dB
D	0.12 dB
F	0.12 dB
H	0.13 dB
K	0.17 dB
L	0.02 dB
M	0.14 dB
P	0.13 dB
R	0.11 dB
S	0.03 dB

Sample 3AB

Cavity No.	Insertion Loss
A	0.06 dB
B	0.02 dB
C	0.14 dB
D	0.06 dB
E	0.05 dB
F	0.06 dB
G	0.08 dB
H	0.09 dB
J	0.15 dB
K	0.08 dB
L	0.10 dB
M	0.04 dB

Sample 4AB

Cavity No.	Insertion Loss
C	0.07 dB
D	0.19 dB
F	0.14 dB
H	0.11 dB
J	0.25 dB
K	0.11 dB
L	0.04 dB
M	0.08 dB
N	0.22 dB
P	0.07 dB
R	0.12 dB
S	0.19 dB

Sample 5AB

Cavity No.	Insertion Loss
A	0.11 dB
B	0.22 dB
C	0.12 dB
D	0.02 dB
F	0.04 dB
G	0.10 dB
H	0.12 dB
K	0.11 dB
L	0.08 dB
M	0.12 dB
N	0.07 dB
S	0.02 dB

Sample 6AB

Cavity No.	Insertion Loss
A	0.15 dB
B	0.04 dB
C	0.10 dB
D	0.06 dB
E	0.05 dB
F	0.12 dB
G	0.19 dB
H	0.03 dB
J	0.05 dB
L	0.18 dB
N	0.04 dB
S	0.22 dB

Average Insertion Loss for all samples: 0.10 dB

10 Return Loss Test Results

Sample 1AB

Cavity No.	Return Loss
A	41.4 dB
C	26.3 dB
D	35.6 dB
E	42.2 dB
F	45.6 dB
G	34.4 dB
H	42.3 dB
J	24.8 dB
K	36.1 dB
L	39.2 dB
M	41.0 dB
N	44.6 dB

Sample 2AB

Cavity No.	Return Loss
A	33.6 dB
B	37.9 dB
C	40.1 dB
D	33.7 dB
F	35.8 dB
H	37.0 dB
K	30.8 dB
L	37.8 dB
M	38.8 dB
P	35.1 dB
R	40.2 dB
S	45.0 dB

Average Return Loss for all samples: 37.47 dB

11 Test Procedures

11.1 Intermateability/Interoperability

Requirements:

When tested as specified in paragraph 2.2.1 of ARINC Specification 801, all products shall be intermateable with each other. In addition, all multimode termini shall be both intermateable and interchangeable.

Procedure:

A tolerance analysis of Sabritec's design was made to ensure that it will mate to any appropriate connector that is within specification tolerances. Sabritec performed a connector interoperability test with connectors and termini from the existing and qualified manufacturer. Qualification termini were inserted into and fully populated the connector specimens as specified in Table 5. Insertion loss was measured in accordance with 2.4.1.1 @ 1300 nm.

Table 3: Connector Interoperability

Configuration No	Connector Receptacle	Connector Plug
1	Radiall	Sabritec
2	Sabritec	Radiall
3	Sabritec	Sabritec

11.2 Attenuation

Requirements:

When tested as specified in paragraph 2.4.1.1 of ARINC Specification 801 and in accordance with TIA/EIA-455-171, Method D1 (multimode), fiber optic interconnect assemblies shall have a maximum attenuation of 0.3 dB for multimode connectors.

Procedure:

- For multimode tests, launch conditions were as defined in TIA/EIA-455-54 or IEC 60793-1-40 (TIA-455-78), paragraph A.1.3, 1300 nm. If necessary, a cladding mode stripper was used between the launch system and the fiber under test and between the fiber under test and the detector.
- For all tests all cables that are part of the test setup were fabricated such that the optical fibers are precisely centered in the termini, in order to ensure that the test results were not skewed by errors introduced by test cables with off-centered fibers.

11.3 Examination of Product

Requirements:

Connector assemblies and detail parts or subassemblies shall be examined as specified in paragraph 3.1.2 of ARINC Specification 801 and shall meet the requirements specified herein. Connectors and optical termini shall be examined for appearance, fit, and adherence to specified tolerances. Particular attention shall be given to neatness and thoroughness of marking parts, plating, staking, bonding, and freedom of parts from burrs and sharp edges.

Table 4: Examination of Product Attributes

	Attribute	1st Exam	Later Exams
a)	Marking	X	X
b)	Workmanship	X	X
c)	General Design	X	
d)	Materials	X	X
e)	Plating	X	
f)	Staking	X	
g)	Bonding	X	
h)	Coupling Nut/Ring	X	X
i)	Connector Accessories	X	X
j)	Dimensions	X	
l)	Master Keyway	X	

First examination is intended to cover those items for which there is a specific requirement. Later examinations are intended to cover those items for which there is a specific requirement that could change during, or be altered by subsequent testing.

11.4 Connector Coupling Force or Torque

Requirements:

When tested as specified in paragraph 2.4.3.6 of ARINC Specification 801 and in accordance with EIA-364-13B, connectors with coupling rings shall not exceed 2.26 N-m (20 inch-pounds) of torque. Connectors shall be fully populated with optical termini.

11.5 Maintenance Aging

Requirements:

When tested as specified in paragraph 2.4.3.7 of ARINC Specification 801 and in accordance with EIA-364-24B, the terminus insertion force shall not exceed 36 N (8 pounds).

Procedure:

All termini were removed and reinstalled ten times using the appropriate insertion and removal tools and were measured during the first and last cycles.

11.6 Thermal Cycling

Requirements:

When tested as specified in paragraph 2.4.2.1 of ARINC Specification 801 and in accordance with EIA-364-32C, fiber optic interconnect assemblies shall pass optical and visual inspection. Effects of thermal shock testing may include:

1. Excessive permanent dimensional changes
2. Cracking delamination of finishes
3. Cracking and crazing of embedding and encapsulating compounds
4. Opening of seals and seams
5. Leakage of potting materials
6. Excessive displacement or rupture of connector shells, inserts, contacts, wire or sealing plugs
7. Excessive hardening or softening of resilient dielectric materials
8. Fusing or seizure of mating specimen components and contacts
9. Change in electrical characteristics
10. Changes in mating and unmating characteristics

Procedure:

Category 2 connectors were tested using Test Condition I, 50 cycles, see Tables 5 and 6. Fiber optic interconnect assemblies were inspected for the following post Thermal Cycling.

Table 5: Thermal Shock Test Conditions

Step	Test Condition I	
	Temperature (°C)	Time (Minutes)
1	-55 +0/-3	See Table 7
2	25 +10/-5	5 max
3	85 +3/-0	See Table 7
4	25 +10/-5	5 max

Table 6: Exposure Time at Temperature Extremes

Mass of Specimen	Minimum Time for Steps 1 and 3 (hrs)
28 g (1 oz) and below	1/2; or 1/4 (when specified)
> 28 g (1 oz) to 136 g (0.3 lb) inclusive	1/2
> 136 g (0.3 lb) to 1.36 kg (3 lb) inclusive	1
> 1.36 kg (3 lb) to 13.6 kg (30 lb) inclusive	2
> 13.6 kg (30 lb) to 136 kg (300 lb) inclusive	4

11.7 Connector Coupling Durability

Requirements:

When tested as specified in paragraph 2.4.3.5 of ARINC Specification 801 and in accordance with EIA-364-09C, connectors fully populated with optical termini shall pass optical and visual inspection with the following details and exceptions:

Procedure:

1. One hundred cycles of engagement and separation were performed.
2. Engagement and complete separation was accomplished so that the plug and receptacle were completely separated during each cycle.
3. The connectors were fully mated and unmated at a maximum rate of 5 cycles per minute.
4. Termini were cleaned prior to final measurements.

11.8 Altitude

Requirements:

When tested as specified in paragraph 2.4.2.6 of ARINC Specification 801 and in accordance with TIA-455-15A, fiber optic interconnect assemblies shall pass optical and visual inspection.

Procedure:

Category 2 connectors were tested at a minimum pressure equivalent to an altitude of 15,200 m (50,000 ft.).

11.9 Return Loss

Requirements:

When tested as specified in paragraph 2.4.1.2 of ARINC Specification 801 and in accordance with TIA/EIA-455-107, the Return Loss shall be a minimum of 20 dB for multimode PC polished termini.

11.10 Terminus Retention Force

Requirements:

When tested as specified in paragraph 2.4.3.3 of ARINC Specification 801 and in accordance with EIA-364-38B, the termini shall be retained with no damage to the termini, the connector insert or the retention mechanism.

Procedure:

The test load was 53.4 N (12 pounds). Per EIA-364-38B, only 20% of contacts tested.

11.11 Terminus Insertion and Extraction Force

Procedure:

Record values of Termini Insertion & Extraction Force.

11.12 Humidity

Requirements:

When tested as specified in paragraph 2.4.2.4 of ARINC Specification 801 and in accordance with TIA/EIA-455-5C, fiber optic interconnect assemblies shall pass optical and visual inspection.

Procedure:

Category 2 connectors were tested with Test Method A (Steady State) to a relative humidity of 90 to 95% and to a temperature of $40 \pm 2^\circ\text{C}$, and Exposure Time A (96 hours).

11.13 Vibration

Requirements:

When tested as specified in paragraph 2.4.3.2 of ARINC Specification 801 and in accordance with TIA/EIA-455-11C, there shall be no optical discontinuities in excess of one microsecond for mated pairs of connectors with termini, and there shall be no more than 0.25 dB change in optical transmittance between the initial measurement and any subsequent reading.

Procedure:

Connector pairs were held together by their coupling mechanisms. Cables were supported not closer than 7.6 cm (3 inches) or further away than 25.4 cm (10 inches) from the rear of the connectors. The first cable support was on the same structure as the connectors.

The detector being used was capable of detecting all optical discontinuities in excess of one microsecond. Optical transmittance was measured before and after the shocks, and was not monitored during the shock application when the discontinuity detector was in use.

Category 2 connectors were tested with Test Condition VI-G.

11.14 Mechanical Shock

Requirements:

When tested as specified in paragraph 2.4.3.1 of ARINC Specification 801 and in accordance with TIA-455-14-A, there shall be no optical discontinuities in excess of one microsecond for mated pairs of connectors with termini, and there shall be no more than 0.25 dB change in optical transmittance between the initial measurement and any subsequent reading.

Procedure:

Connector pairs were held together by their coupling mechanisms. Cables were supported not closer than 7.6 cm (3 inches) or further away than 25.4 cm (10 inches) from the rear of the connectors. The first cable support was on the same structure as the connectors.

The detector being used was capable of detecting all optical discontinuities in excess of one microsecond. Optical transmittance was measured before and after the shocks, and was not monitored during the shock application when the discontinuity detector was in use.

Category 2 connectors were tested with Test Condition D.

11.15 Salt Spray

Requirements:

When tested as specified in paragraph 2.4.2.5 of ARINC Specification 801 and in accordance with TIA/EIA-455-16A, fiber optic interconnect assemblies shall pass optical and visual inspection.

Procedure:

Category 2 connectors were tested with Test Condition I, (500 hours).

11.16 Temperature Life

Requirements:

When tested as specified in paragraph 2.4.2.2 of ARINC Specification 801 and in accordance with TIA/EIA-455-4C, fiber optic interconnect assemblies shall pass optical and visual inspection.

Procedure:

The temperature exposure was 70°C ± 2°C, for a duration of (1000 hours).

11.17 Terminus Walkout Resistance

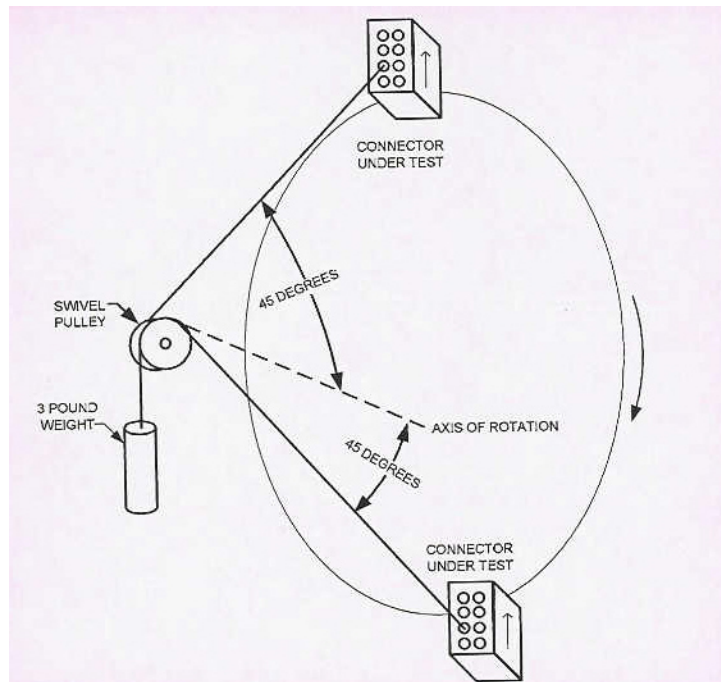
Requirements:

When tested as specified in paragraph 2.4.3.4 of ARINC Specification 801, termini shall not become dislodged from their normal positions.

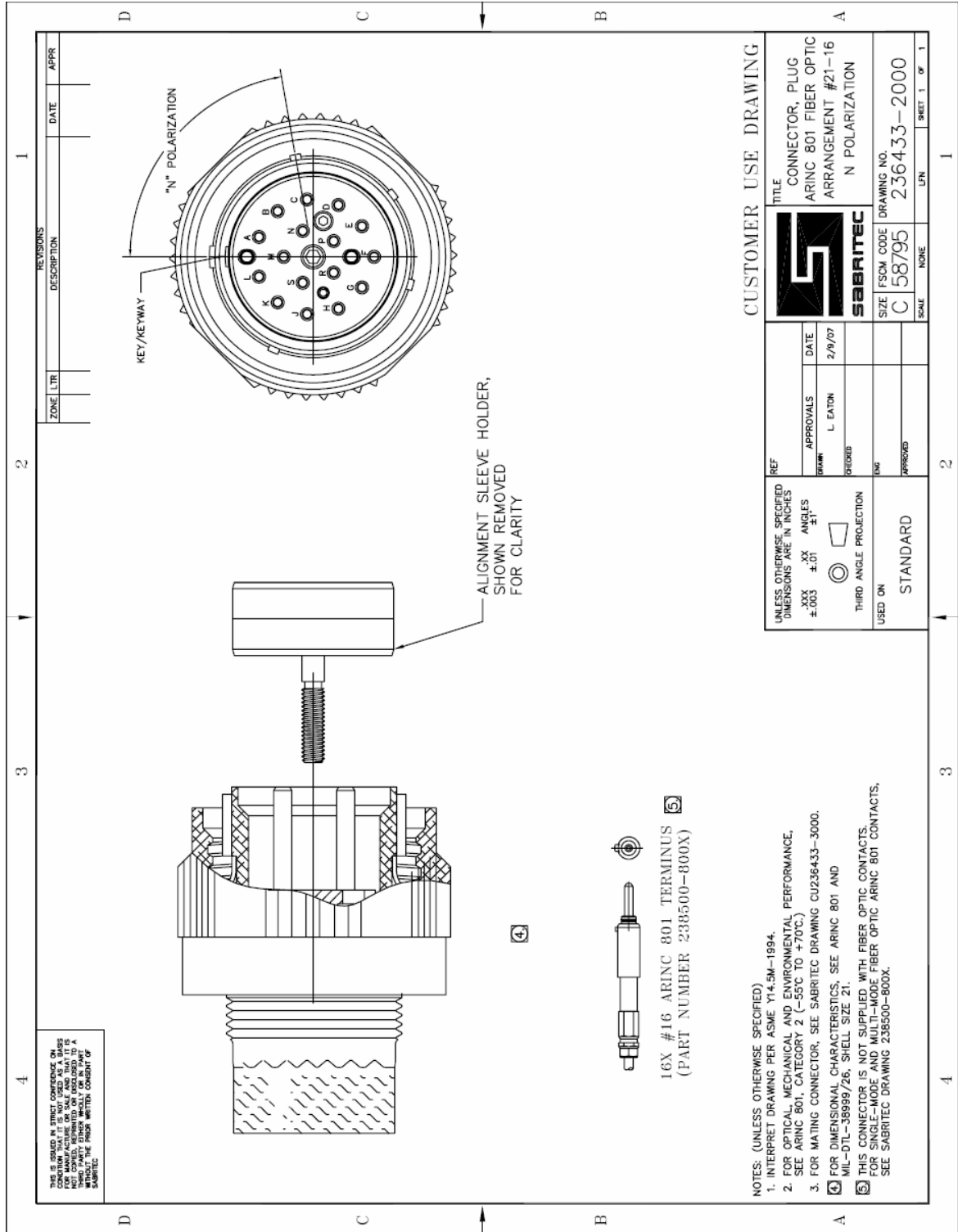
Procedure:

Two contact cavities in each connector were tested for termini walkout resistance. The test fixture consisted of a thirteen Newton (3 pound) weight attached to a fiber that was terminated into the terminus. The connector was mounted to a rotating fixture so that the fiber exited the connector at the 45 ± 5 degree angle at every point during the fixture rotation. The connector orientation was fixed so that the connector itself did not rotate as it was carried around the circular path. See Figure 1 for an example of the fixture. Each 360 degree rotation of the fixture is one cycle. Connectors were tested for 100 cycles at a rate of 10 to 20 cycles per minute. Contact cavities subjected to this test were excluded from further testing.

Figure 1: Terminus Walk-Out Test Fixture



Appendix A-2 – Assembly Drawing 236433-2000



Appendix A-2 – Assembly Drawing 236433-3000

