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ATTACHMENTS

1.0 INTRODUCTION

1.1 Objectives

The purpose of this document is to define a fiber optic Expanded Beam (EB) termini for the air transport industry. The goal is to avoid the proliferation of different designs of termini to serve the same functions on different aircraft models. This specification defines generic fiber optic EB termini needed for all types of aircraft.

Because the EB termini can be produced by multiple suppliers, variants exist for different cable types and installation methods.

In addition, airline maintenance costs will be reduced because the standardization will reduce the number of assembly procedures and tools, leading to savings in both actual maintenance costs, and also in the training of maintenance technicians.

1.2 Scope

This specification covers the dimensions, performance, and quality assurance criteria for fiber optic EB termini, including performance test requirements and procedures, suitable for use on commercial aircraft.

1.3 Benefits

The use of Expanded Beam provides several benefits, including:

- A larger interface area to minimize the effects of contamination, and subsequent loss of signal.
- High durability for multiple mating and un-mating cycles.
- Simple maintenance, inspection, and cleaning requirements.
- Reduced need for support equipment.

Airlines may benefit from lower maintenance costs as a result of all these characteristics.

1.4 Organization of this Specification

Section 1 introduces the objective and scope of ARINC Specification 845 and identifies the types of termini addressed within the document.

Section 2 provides the guidelines for the expected performance and physical characteristics of the fiber optic interconnect assemblies. These include material, construction criteria, environmental performance, and optical performance requirements.

Section 3 addresses performance test procedures.

The attachments provide the standard drawings for the termini addressed in this specification.

1.5 Type and Wavelength

1.5.1 Type

This specification covers the termini types found in Table 1-1.

Table 1-1 – ARINC 845 Expanded Beam Termini Types

ARINC 845 Termini Type	Connector Type	Connector Series	Contact Size	Electric Contact Type	
Type 1	EN 4644	N/A	16	N/A	EN 3155-076 (Male) EN 3155-077 (Female)
Type 2	EN 4165	Series 2	16	M39029/58-364 (Male) M39029/57-358 (Female)	EN 3155-008 (M16) EN 3155-003 (F16)
	D38999		16		
Type 3	EN 4165	Series 3	16	M39029/58-364 (Male) M39029/56-352 (Female)	EN 3155-008 (M16) EN 3155-009 (F16)
	D38999				
Type 4	ARINC 600	N/A	16	TBD	TBD

Regardless of type, the terminus design shall be compatible with ARINC Specification 802 loose and tight structure cables.

1.5.2 Termini Class

The termini classes are denoted by wavelength, core size, and return loss requirements.

Additional classes may be added in the future.

Table 1-2 – Termini Class Requirements

Class	Center Wavelength ±30 nm	Fiber Type	Return Loss (Minimum)
01	850 and 1300	Multimode 50/125 µm	12 dB
02	850 and 1300	Multimode 62.5/125 µm	12 dB
03	850 and 1300	Multimode 50/125 µm	20 dB
04	850 and 1300	Multimode 62.5/125 µm	20 dB
05	1310	Single Mode 9/125 µm	33 dB
06	1550	Single Mode 9/125 µm	33 dB

1.6 Environmental Categories

There are additional environmental requirements for the connectors, cables, and equipment that the termini will interface. It is important to consider these requirements during terminus design, production, and testing.

Table 1-4 – Termini Environmental Categories

Category	Requirements
Category 1	-55° to 125° C
Category 2	-65° C to 165° C

It is important to note that connector maximum operating capability will be limited to the equipment it is mounted on or mated to and the location of the equipment. Equipment categories are defined in Section 4 of RTCA DO-160/EUROCAE ED-14.

The upper temperature range of the connector will also be limited by the maximum long term operating temperature of the associated fiber optic cable assembly being used.

1.7 Relationship to Other Documents

The following ARINC documents address various aspects of design, implementation, testing and maintenance of fiber optic cable, components, and interfaces. These documents are intended to complement ARINC Specification 845.

- **ARINC Specification 801:** *Fiber Optic Connectors*
- **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*
- **ARINC Report 807:** *Fiber Optic Training Requirements*
- **ARINC Specification 846:** *Fiber Optic Termini, Mechanical Transfer*

ARINC Specification 600: *Air Transport Avionics Equipment Interfaces* provides the definition, guidance, and appraisal for design and acceptance of the mechanical, electrical, and environmental interfaces between LRUs and the racks for cabinets in which they are installed. It includes the physical drawings and dimensions for fiber optic inserts.

ARINC Specification 800: *Cabin Connectors and Cables, Part 2, Specification of Connectors, Contacts, and Backshells* defines the minimum acceptable provisions for connectorized fiber optic cable assemblies used in permanently installed airframe wire bundles used primarily in cabin systems.

2.0 PERFORMANCE GUIDELINES

2.1 Specification Sheets

The performance of individual items should be as specified herein and in accordance with the applicable attachment or specification drawing.

2.2 General Guidelines

In the event of any conflict between the guidelines of this specification and the drawings, the latter should be used. In case of conflicts with this specification and other documents, the guidelines of this specification should be used. The items furnished under this specification should be capable of passing the performance verification test specified herein.

2.2.1 Mateability

Enough dimensional information concerning the termini design is provided herein to ensure that all products, including connectors, from various manufacturers will be intermateable and interchangeable with each other. It is the responsibility of each manufacturer to perform a tolerance analysis of their design to ensure that it will mate to any appropriate connector and termini that is within specification tolerances.

Each new termini manufacturer should perform an interoperability test with connectors and termini from other manufacturers.

COMMENTARY

True position of contact cavities in connectors may vary between manufacturers. While termini mating can be achieved with very close tolerances, the mateability testing using connectors from various manufacturers may increase, or even decrease, mechanical and optical performance measurements.

The intent of this specification is to provide a standard termini for system architects to choose in system design. For system design guidance, reference ARINC Report 803.

Unless otherwise specified termini should fully populate connector specimens as specified in Table 2-1. Each test sample shall consist of three mated pairs of candidate and existing termini. The following combinations shall be tested:

- Male existing/female candidate
- Male candidate/female existing
- Male candidate/female candidate

The 3 mated pairs shall be tested in accordance with:

- Thermal Cycling – Section 2.4.4.1
- Vibration – Section 2.4.5.2
- Shock– Section 2.4.5.1
- Termini Mating Durability – Section 2.4.5.5

Insertion loss should be measured in accordance with Section 2.4.3.1.

2.0 PERFORMANCE GUIDELINES

Table 2-1 – Termini Interoperability

Connector/Series	Insert Identifier	Quantity	Insert Pattern (Cavities)
EN 4644		14	Size 16
EN 4165 Series 2	EN4165A08-161NB	8	Size 16
EN 4165 Series 3	EN4165B08-161NB	8	Size 16
D38999 Series 3	17-08	8	Size 16
ARINC 600	N/A	10	Size 16

2.2.2 Basic Design and Materials

The design and materials should be compatible with the environmental conditions similar to those encountered in the various zones of commercial aircraft as defined in Sections 1.4 and 1.5, i.e., pressure-altitude, temperature, humidity, vibration, and fluid exposure.

2.2.3 Dissimilar Methods

Unless otherwise protected against electrolytic corrosion, dissimilar metals should not be employed in intimate contact with each other in a connector or in any mated pairs of connectors. Dissimilar metals are defined in MIL-STD-889.

2.2.4 Finish

All metal parts should be made of corrosion-resistant materials or be protected to meet the performance requirements of this specification.

2.2.5 Non-Magnetic

Non-magnetic material and components should be used to the greatest extent possible. The permeability of the basic termini should be less than 2.0 MU. The permeability should be checked by the instrument described in ASTM A342, EN 2591-513, or equivalent.

2.2.6 Resilient Materials

Resilient materials should have shore hardness, electrical, and mechanical characteristics suitable for the purpose intended.

2.2.7 Weight

Termini should be a minimum weight consistent with performance requirements and within the limitations of sound design practices.

2.2.8 Durability

Termini should be designed and constructed to withstand handling and maintenance functions incident to installation and service.

2.2.9 Marking

Marking techniques and materials selected for the marking of termini should be permanent and of a color that contrasts with the material on which the marking is applied. Characters or other markings should be of sufficient size and resolution to be completely understood without magnification.

2.3 Common Termini Interface Design

2.3.1 Termini to Contact Cavity Dimensional Requirements

2.3.1.1 Dimensions

The termini shall fit a size 16 cavity per the appropriate industry connector specification. Refer to Attachments in Table 2-2 for specific requirements.

Table 2-2 – Termini Dimensions

ARINC 845 Termini Type	Connector Type	Attachment
Type 1	EN 4644	TBD
Type 2	EN 4165	TBD
	D38999	TBD
Type 3	EN 4165	TBD
	D38999	TBD
Type 4	ARINC 600	TBD

2.3.2 Sealing

2.3.2.1 Interfacial Sealing

The pin termini shall conform to the interfacial seal design of the appropriate connector type specification (i.e., D38999, EN 4644, EN 4165, and ARINC 600).

2.3.2.2 Cable Sealing Grommet

The termini design shall provide adequate provisions to ensure sealing. The termini shall not damage the sealing grommet during insertion and removal.

2.3.3 Alignment

The socket termini design shall include an alignment solution that remains interoperable and intermateable with other termini designs from various suppliers.

Features such as alignment replacement, contact repair, etc. may be documented here.

2.3.4 Socket Spring Usage

The socket termini may include a spring to ensure proper air gap distance and contact mating force. If used, the mating force shall conform to Table 2-3.

2.3.5 Optical Interface

The termini-to-termini interface key characteristics are defined in Table 2-3. Where applicable, the equipment used for measurement and the process reference is noted.

2.0 PERFORMANCE GUIDELINES

Table 2-3 – Interface Requirements

Parameter	Value (>12dB RL)	Value (>20dB RL)	Units
Beam size (13.5%) Tolerance: +- 3% This value is a function of the lens material	0 mm: 0.278 50 mm: 3.230 100 mm: 6.270	0 mm: 0.303 50 mm: 3.548 100 mm: 6.901	mm
Air gap distance (between lenses)	0.90 +/- 0.2	0.90 +/- 0.2	mm
Angle of Beam Divergence (at 100 mm)	1.72 +/- 0.1	1.89 +/- 0.1	degrees
Maximum Beam Centroid Angle	50 mm: 0.145 100 mm: 0.171	50 mm: 0.165 100 mm: 0.185	degrees
Maximum beam angle error	0.03	0.03	degrees
Beam Ellipticity (13.5%)	>90	>90	%
Spring Force (Radiall)			
Mating Force (Radiall)			
~~Pin terminus mating diameter~~	~~1.628 mm nominal~~		
~~Socket terminus mating diameter~~	~~1.628 mm nominal~~		
~~Angle of divergence~~	~~TBD~~		
Lateral Offset Need Clarification at F2F	TE: Not really needed. If so, provide reason?	TE: Not really needed. If so, provide reason?	
Beam angle error from mechanical axis	TBD		
~~Beam centroid (beam profile)~~	~~TBD~~		
~~Beam circularity~~	~~TBD~~		
~~Spring Force (if applicable)~~	~~TBD~~		
Clip to Clip	See attachments 3 and 4		
Clip to Tip	See attachments 5, 6, 7, 8		
Clip to tip (socket)	TBD		
~~Depth of engagement~~	~~TBD~~		
~~Ferrule OD~~	See attachments 3, 4, 5, 6, 7, 8		
~~Tip to Lens~~	Same as Lens Air Gap Distance above		

Notes:

1. All measurements were performed with a Thorlabs BP209-IR Dual Scanning Slit Beam Profiler. All procedures used are found in the BP209 Operations Manual found at Thorlabs website.

2.0 PERFORMANCE GUIDELINES

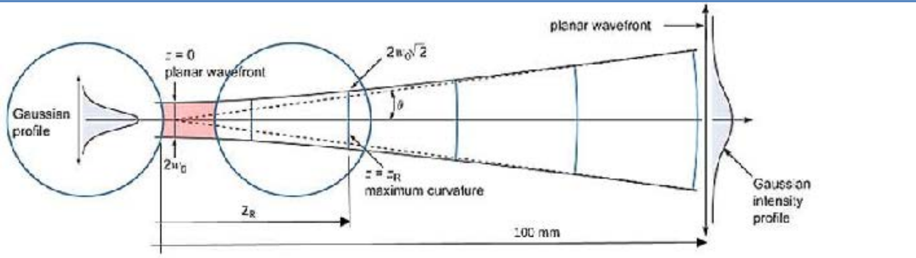
Test results for EN4165 (ARINC 809) connector with Insert type 16-08. update: 1/19/2016
The test program is on-going. Tests completed so far are reported.
Samples: 4 x EN4165-Mono connectors with Type 2 Pin and Sockets. Total: 32 Channels, WL: 1300nm
Termini: Type 2 (springless). Launch Condition: Arinc-805-4

ARINC-845	Test Type	Reference	Test Limits	Requirement per A-845	Actual Results	Pass / Fail	Transm Change per A-845	Pass / Fail	unit
Section 2.4.3	Insertion Loss	Class 01, 03, 04	Intial IL	<1.50	<0.82	Pass	N/A	N/A	dB
Section 2.4.3	Return Loss	Table 1-2	Initial RL, 12+dB lens	>20	>15.3	Pass	N/A	N/A	dB
Section 2.4.3	Return Loss	Table 1-2	Initial RL, 20+dB lens	>12	>28.4	Pass	N/A	N/A	dB
Section 2.4.4.2	Temperature Life	IL - During Test	1,000 hrs at 125C	<1.50	<0.88	Pass	+/- 0.5	Pass	dB
Section 2.4.4.2	Temperature Life	IL - After Test	1,000 hrs at 125C	<1.50	<0.87	Pass	+/- 0.5	Pass	dB
Section 2.4.4.2	Temperature Life	RL - After Test	1,000 hrs at 125C	>12 & >20	>13.2 & >24.0	Pass	N/A	N/A	dB
Section 2.4.4.1	Thermal Cycling, Cat 1	IL - During Test	TC -50/+125C, 3-5C per min, 50X	<1.50	<1.19	Pass	+/- 0.5	Pass	dB
Section 2.4.4.1	Thermal Cycling, Cat 1	IL - After Test	TC -50/+125C, 3-5C per min, 50X	<1.50	<1.13	Pass	+/- 0.5	Pass	dB
Section 2.4.4.1	Thermal Cycling, Cat 1	RL- After Test, 12dB/20dB lens	TC -50/+125C, 3-5C per min, 50X	>12 & >20	>13.2 & >24.0	Pass	>12 & >20	Pass	dB
Section 2.4.4.1	Thermal Cycling, Cat 2	IL - During Test	TC -65/+165C, 3-5C per min, 50X	<1.50	<1.29	Pass	+/- 0.75	Pass	dB
Section 2.4.4.1	Thermal Cycling, Cat 2	IL - After Test	TC -65/+165C, 3-5C per min, 50X	<1.50	<1.06	Pass	+/- 0.75	Pass	dB
Section 2.4.4.1	Thermal Cycling, Cat 2	RL- After Test, 12dB/20dB lens	TC -65/+165C, 3-5C per min, 50X	>12 & >20	>13.0 & >24.2	Pass	>12 & >20	Pass	dB
Insertion Loss - Post thermal testing			1668 hrs total	<1.50	<1.06	Pass	+/- 0.5	Pass	dB
Return Loss - Post thermal testing (12dB / 20dB)			1668 hrs total	>12 & >20	>13.2 & >24.0	Pass	>12 & >20	Pass	dB
Section 2.4.5.2	Random Vibration, Signal Discontinuity	Monitor 4 channels per conn. For discontinuity per TIA/EIA-455-32	EN2591-403: 2012(E), Fig 2, Level E	4-ch, Discont. Limit: >1.0dB for >1.0usec	Monitored 8 ch per conn. Result: No discont for limit >0.5dB >1.0usec	Pass	N/A	N/A	dB
Section 2.4.5.2	Random Vibration, IL	IL after test	EN2591-403: 2012(E), Fig 2, Level E	<1.50	<1.10	Pass	+/- 0.5	Pass	dB
Section 2.4.5.1	Mechanical Shock, Signal discontinuity	Monitor 4 channels per conn. For discontinuity per TIA/EIA-455-32	EN2591-402: 2012(E), Method A	4-ch, Discont. Limit: >1.0dB for >1.0usec	Monitored 8 ch per conn. Result: No discont for limit >0.5dB	Pass	N/A	N/A	dB
Section 2.4.5.1	Mechanical Shock, IL	IL after test	EN2591-402: 2012(E), Method A	<1.50	<1.14	Pass	+/- 0.5	Pass	dB

Figure 2-1 – Launch Conditions and Test Data

2.3.6 Beam Characteristics

Figure 2-2 provides additional considerations for termini suppliers when designing for interoperability.



The surface of the receiving lens needs to be positioned (z) well within the Rayleigh distance (z_R) and preferably within the Near-field zone ($z<<z_R$). For multimode, the Rayleigh distance z_R is typically less than 50mm and the Near-field is less than 25 mm. For single mode z_R is less than 10 mm and the Near-field is within a few mm's. The divergence angle of the far-field beam (at 100 mm) will not really contribute any useful information.

I suggest that we only use the Near-field to specify the beam size. Perhaps in increments of 5mm from the lens surface through the extent of the Rayleigh distance z_R.

Rayleigh Distance: $z_R = \frac{\pi w_0^2}{\lambda},$

Radius of beam at distance z from waist $w(z) = w_0 \sqrt{1 + \left(\frac{z}{z_R}\right)^2}$

Beam Divergence $\theta \simeq \frac{\lambda}{\pi w_0}$ [radians]
Only valid for z >> z(R)

Figure 2-2 – Suggestions to the Beam Characteristics

2.3.7 Cable Compatibility

The termini should be compatible with an ARINC 802 cable diameter of 1.73 mm (0.068 inch) minimum and a maximum cable diameter of 2.00 mm (0.079 inch) maximum.

2.3.8 Pull-Proof Termini

The cable attachment to the terminus assembly shall not affect the optical interface of the terminus when a force is exerted on the cable.

Radiall: Is this valid for all configurations?

2.3.9 Cable Retention

The cable retention force for a terminus attached to a 1.8 mm jacketed cable shall be a minimum of 68 Newtons (15 pounds).

When pull forces are applied to the cable assembly the maximum forces should not exceed the tensile strength of the cable defined in ARINC Specification 802.

2.4 Fiber Optic Interconnect Assembly Performance Specification

A fiber optic interconnect assembly is composed of:

- A connector type as defined in Table 1-1
- A terminus as defined in Table 1-1
- A fiber optic cable compliant with ARINC Specification 802

The assembly should be assembled per ARINC Report 806.

2.4.1 Examination of Product

The termini body shall be visually examined per TIA/EIA-455-13 using 5X magnification. The termini end faces shall be examined with the procedures and meet the requirements per ARINC Report 805.

2.4.2 Equipment Calibration

Equipment used for the optical measurements of attenuation, optical return loss, and transmittance change shall be calibrated in accordance with ANSI/NCSLI Z540.3 by a calibration laboratory accredited for the measurements in accordance with IEC 17025.

2.4.3 Optical

Unless otherwise specified, all optical performance tests should be performed at a nominal wavelength of 850 nm and 1300 nm for multimode or 1310 nm or 1550 nm for single mode.

Radiall: Confirm the launch conditions used.

1. For single mode tests use launch conditions as defined in ARINC Report 805.
2. For multimode tests use launch conditions as defined in ARINC Report 805. If necessary, use a cladding mode stripper between the launch system and the fiber under test and between the fiber under test and the detector.
3. The use of Aerospace Measurement Quality Jumpers (AMQJ) is important to ensure repeatable and accurate optical measurements. See ARINC Report 805 for Expanded Beam AMQJ specifications.

COMMENTARY

Normal practice in the test industry is to tighten the test limits for a part to account for the inaccuracy of the test equipment. For example, if one wants a part 12 inches long with a tolerance of 0.50 inches, and a ruler being used has an accuracy of 0.10 inches, the test limits would be defined as 12 inches plus or minus 0.40 inches. Only if the test equipment inaccuracy is less than 10% of the required tolerance may the equipment inaccuracy be ignored.

This approach does not work for some fiber optic measurements using today's test equipment. One cannot use normal practice to measure an optical loss of 1 dB maximum using a test system that has a 1 dB inaccuracy: there would be no tolerance band at all. Indeed, current industry practice is to widen the test limits by the amount of test system inaccuracy so as to allow most parts to pass the test.

This practice will be allowed until such time as more accurate test instruments become available. In the meantime, system designers must understand it is realized that a specification of 1 dB loss maximum may in fact have a loss greater than 1 dB.

2.4.3.1 Insertion Loss

Fiber optic interconnect assemblies should be tested in accordance with TIA/EIA-455-171, Method D1 for multimode, and Method D3 for single mode.

Maximum insertion loss for should be per Table 2-4.

Table 2-4 – Maximum Insertion Loss Requirements

	Maximum Insertion Loss	
	Initial	**Post Test**
Multimode	1.50 dB	1.50 dB
Single Mode	2.00 dB	2.00 dB

2.4.3.2 Return Loss

Fiber optic interconnect assemblies should be tested in accordance with TIA/EIA-455-107. Unless otherwise specified, the return loss for any test should not exceed those found in Table 1-2 in Section 1.5.2.

Minimum return loss is very dependent on emitter, system needs, signal type, and wavelength. A higher minimum return loss could be required for certain applications. For more information, refer to ARINC Report 803.

2.4.3.3 Transmittance Change

Where test specify transmittance change measurement, the transmittance change should be measured in accordance with TIA/EIA-455-20 Method B. Measurements should be made before, during and after the test. The measurement made during a test need not be continuous unless otherwise specified, but should be made at the extremities of the test conditions. For example, during a thermal cycling test measurements should be taken at the low and high temperature extremes.

Unless otherwise specified, the transmittance change for any test should not exceed:

- Category 1 ±0.50 dB
- Category 2 ±0.75 dB

2.4.4 Environment

2.4.4.1 Thermal Cycling

Fiber optic interconnect assemblies shall be tested in accordance with TIA 455-3. Note that the requirement to use of 500 meters of cable shall be changed to a minimum of 3 meters of cable on both sides of the connector(s). The connectors shall meet the Transmittance Change requirement of Section 2.4.3.3 continuously throughout and after the test. The minimum temperature shall be -55 °C and the maximum temperature shall be the lessor of the category of termini, or as specified by the ARINC Specification 802 fiber optic cable specification used.

All connector termini types shall be tested using Test Condition C-4 (50 cycles), except the temperature ramp rate is between 3-5 °C per minute.

2.4.4.2 Temperature Life

Fiber optic interconnect assemblies shall be tested in accordance with TIA/EIA-455-4C for 1000 hours duration at 125 °C, taking into consideration the temperature limitation of the connectors, termini, cable, and epoxy used in the assemblies. The connectors shall meet the transmittance change requirement of Section 2.4.3 post-test.

2.4.4.3 Fluid Resistance

Fluid resistance testing is not required for an ARINC 845 terminus not installed in a connector. However, fluid resistance testing should be carried out on a mated pair of termini installed in the appropriate connectors for the application. Testing should be carried out in accordance with TIA/EIA-455-12, or with the respective connector qualification specification. For a list of fluids to use in testing, reference ARINC Specification 800, Part 4, and ARINC Specification 801.

2.4.4.4 Humidity

Fiber optic interconnect assemblies shall be tested in accordance with TIA/EIA-455-5C, using Test Method A and Exposure Time A. The connectors shall meet the transmittance change requirement of Section 2.4.3.3 continuously throughout and after the test.

Radiall: Shouldn’t this be coupled with temperature cycling?

2.4.4.5 Altitude

Fiber optic interconnect assemblies shall be tested in accordance with TIA-455-15A. Termini installed in appropriate connectors should be tested at a minimum pressure equivalent to an altitude of 15,200 m (50,000 ft.). The connectors shall meet the transmittance change requirement of Section 2.4.3.3 continuously throughout and after the test.

2.4.4.6 Fire Resistance

This section is for future applications and/or requirements.

2.4.5 Mechanical

2.4.5.1 Shock

Mated termini shall be tested in accordance with the requirements found in the connector series that the termini is intended to be installed.

Where applicable, connector pairs should be held together by their coupling mechanisms. Where there are no coupling mechanisms, other means may be used. Cables should be supported not closer than 7.6 cm (3 in) or further away than 25.4 cm (10 in) from the rear of the connectors. The first cable support should be on the same structure as the connectors.

Optical discontinuities should be monitored throughout the test per TIA/EIA-455-32, Test Condition B. Any discontinuity in excess of 1 dB and in excess of one microsecond constitutes a test failure.

Optical transmittance shall be measured before and after the shocks, but need not be monitored during the shock application when the discontinuity detector is in use (4 mated termini minimum should be measured). The connectors shall meet the transmittance change requirement of Section 2.4.3.3.

2.4.5.2 Vibration

Mated termini shall be tested in accordance with the requirements found in the connector series that the termini is intended to be installed.

Where applicable, connector pairs should be held together by their coupling mechanisms. Where there are no coupling mechanisms, other means may be used. Cables should be supported not closer than 7.6 cm (3 in) or further away than 25.4 cm (10 in) from the rear of the connectors. The first cable support should be on the same structure as the connectors.

Optical discontinuities should be monitored throughout the test per TIA/EIA-455-32, Test Condition B. Any discontinuity in excess of 1 dB and in excess of one microsecond constitutes a test failure.

Optical transmittance shall be measured before and after vibration, but need not be monitored during vibration when the discontinuity detector is in use (4 mated termini minimum should be measured). The connectors shall meet the transmittance change requirement of Section 2.4.3.3.

2.4.5.3 Termini Retention Force

Fiber optic interconnect assemblies should be tested in accordance with EIA-364-38B, except that the test load should be 53.4 N (12 pounds.) The termini should be retained with no damage to the termini, the connector insert or the retention mechanism. The duration of the test shall be one hour.

COMMENTARY

This test is intended to prove the integrity of the connector terminus retention feature. It is not intended to prove the attachment of the cable terminus. The termini retention to the fiber optic cable should be validated as part of the termini termination process.

2.4.5.4 Termini Walkout Resistance

At least two contact cavities in each connector should be tested for termini walkout resistance. The test fixture should consist of a thirteen Newton (3 pound) weight attached to an appropriately sized stranded steel cable that is crimped into the appropriate termini for the connector being tested. The connector should be mounted to a rotating fixture so that the steel cable exits the connector at the 45 ±5 degree angle at every point during the fixture rotation. The connector orientation should be fixed so that the connector itself does not rotate as it is carried around the circular path. See Figure 2-1 for an example of a satisfactory fixture.

Each 360 degree rotation of the fixture is one cycle. Connectors should be tested for 100 cycles at a rate of 10 to 20 cycles per minute. During this test, the termini should not become dislodged from their normal position. Contact cavities subjected to this test should be excluded from further testing.

2.0 PERFORMANCE GUIDELINES

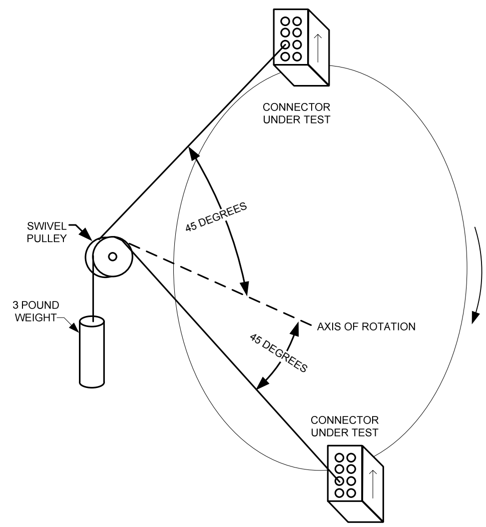


Figure 2-1 – Termini Walk-Out Test Fixture

2.4.5.5 Termini Mating Durability

The intent of this test is for determining mechanical durability. The method of determining durability is to measure transmittance change after mating tests. Termini shall be installed in respective connectors and mated and unmated in accordance with EIA/TIA-455-21.

The change in optical transmittance shall be measured after 500 mating cycles. Cleaning of the termini is permitted prior to optical measurement pre-test and post-test.

The connectors shall meet the transmittance change requirement of Section 2.4.3.3.

2.4.5.6 Connector Coupling Force or Torque

Connectors should be tested in accordance with EIA-364-13. Terminus design engagement force shall not exceed the engagement force required for a specified connector shell size. This relationship can be managed by suppliers by limiting the amount of optical contacts installed in a connector.

Terminus design shall not prevent the connector from meeting the coupling force/torque requirements of the connectors. The coupling torque is considered at maximum when the connector ceases to turn with reasonable force.

Connectors should be fully populated with optical termini with cables attached.

2.4.5.7 Maintenance Aging

Fiber optic interconnect assemblies shall be tested in accordance with EIA-364-24. All termini should be removed and reinstalled ten times using the appropriate insertion and removal tools. Termini insertion force shall be measured during the first and last cycles and should not exceed 36 N (8 pounds).

At the conclusion of testing, no damage to connector sealing performance shall be evident.

3.0 QUALIFICATION TESTS

3.1 General

Fiber optic termini tested prior to the release of the latest revision of ARINC Specification 845 are acceptable.

3.1.1 Performance

Fiber optic interconnect assemblies, which are composed of connectors, optical cables, and termini, should be designed to meet the performance requirements specified herein when tested in accordance with the specified methods in Section 2.

3.1.2 Workmanship

Optical termini should be fabricated in a manner such that the criteria for appearance, fit, and adherence to specified tolerances are observed. Particular attention should be given to neatness and thoroughness of marking parts, plating, staking, bonding, and freedom of parts from burrs and sharp edges.

3.1.3 Test Conditions

Unless otherwise specified, tests and examinations required by this specification should be conducted within the range of environmental conditions noted.

Temperature -	23 ºC to 27 ºC (73 ºF to 81 ºF)
Relative Humidity -	30 to 80 percent
Barometric Pressure -	610 to 787 mm of mercury (24 to 31 inches of mercury)

3.2 Connectors and Termini

3.2.1 Test Groups

For all groups the samples should comprise a minimum of two mated connector pairs of each connector type being tested. Optical cavities shall be fully populated with at least 24 terminus pairs of the same type.

Table 3-1 – Connector Test Groups

Connector/Series	Insert	Mated Pairs
EN 4644	Qty 14 Size 16	2 fully populated connector pairs
EN 4165	08-16	3 fully populated connector pairs
D38999 Series 2	16-8	3 fully populated connector pairs
D38999 Series 3	17-8	3 fully populated connector pairs
ARINC 600	Qty 10 Size 16	3 fully populated connector pairs

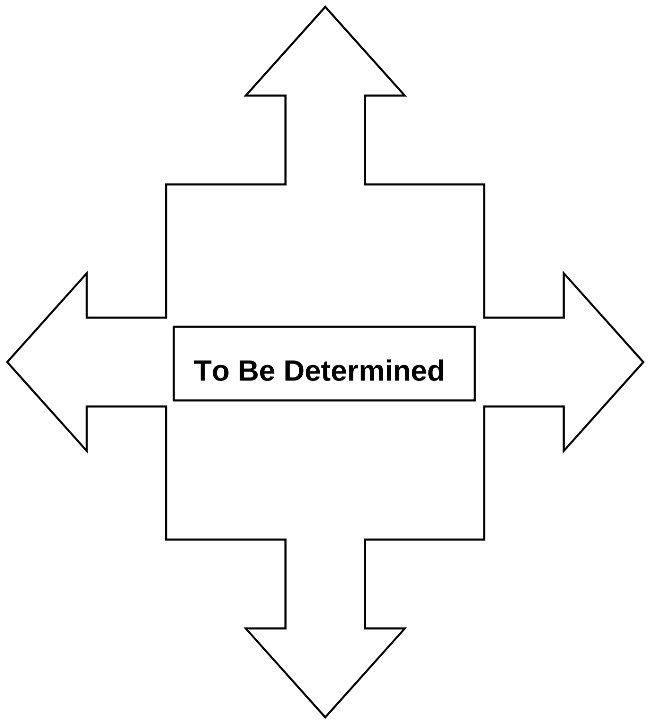
3.2.2 Test Applicability Matrix

Table 3-1 – Performance Verification Tests

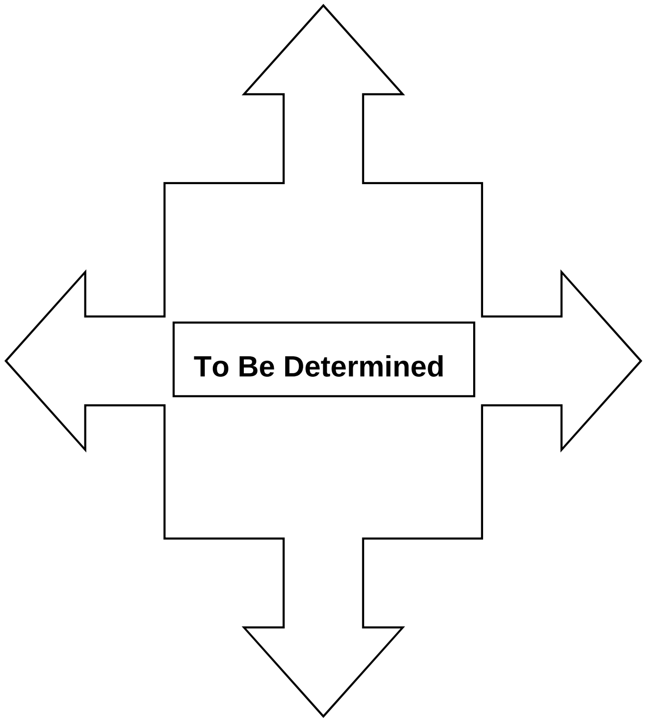
Test	Section No.	Termini Type	Termini Category	Sample Group			
				A	B	C	D
Examination of Product	2.4.1	1, 2, 3, 4	1, 2	X	X	X	X
Termini Retention Force	2.4.5.3	1, 2, 3, 4	1, 2	X	X		
Insertion Loss	2.4.3.1	1, 2, 3, 4	1, 2	X	X	X	X
Return Loss	2.4.3.2	1, 2, 3, 4	1, 2	X	X	X	X
Connector Coupling Forces	2.4.5.6	1, 2, 3, 4	1, 2		X	X	
Termini Retention Force	2.4.5.3	1, 2, 3, 4	1, 2			X	
Insertion Loss	2.4.3.1	1, 2, 3, 4	1, 2		X		
Termini Mating Durability	2.4.5.5	1, 2, 3, 4	1, 2	X			
Maintenance Aging	2.4.3.1	1, 2, 3, 4	1, 2	X			
Insertion Loss	2.4.3.1	1, 2, 3, 4	1, 2	X			
Thermal Cycling	2.4.4.1	1, 2, 3, 4	1, 2		X		X
Insertion Loss	2.4.3.1	1, 2, 3, 4	1, 2		X		X
Altitude Immersion	2.4.4.6	1, 2, 3	1, 2		X		
Insertion Loss	2.4.3.1	1, 2, 3	1, 2		X		
Temperature Life	2.4.4.2	1, 2, 3, 4	1, 2				X
Termini Walk-out	2.4.5.4	1, 2, 3, 4	1, 2		X		
Insertion Loss	2.4.3.1	1, 2, 3, 4	1, 2		X	X	X
Vibration	2.4.5.2	1, 2, 3, 4	1, 2			X	
Mechanical Shock	2.4.5.1	1, 2, 3, 4	1, 2			X	
Insertion Loss	2.4.3.1	1, 2, 3, 4	1, 2			X	
Humidity	2.4.4.4	1, 2, 3, 4	1, 2			X	
Salt Spray	2.4.4.5	N/A (1)	N/A	X		X	
Fluid Immersion	2.4.4.3	1, 2, 3, 4	1, 2	X		X	
Insertion Loss	2.4.3.1	1, 2, 3, 4	1, 2	X		X	
Examination of Product	2.4.1	1, 2, 3, 4	1, 2	X	X	X	X

Note: (1) On termini only (not in a connector)

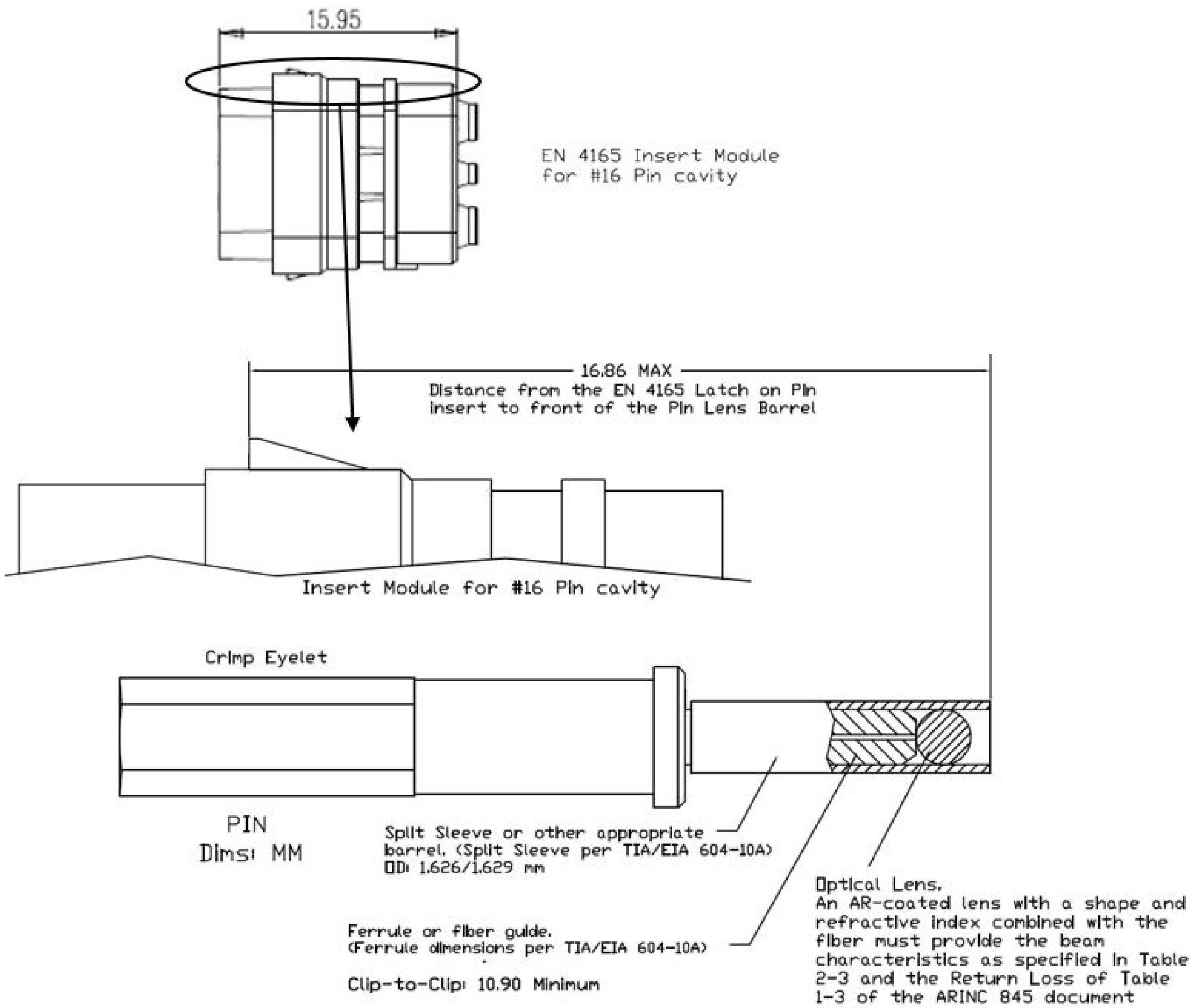
ATTACHMENT 1 ARINC 845 TYPE 1 PIN TERMINUS



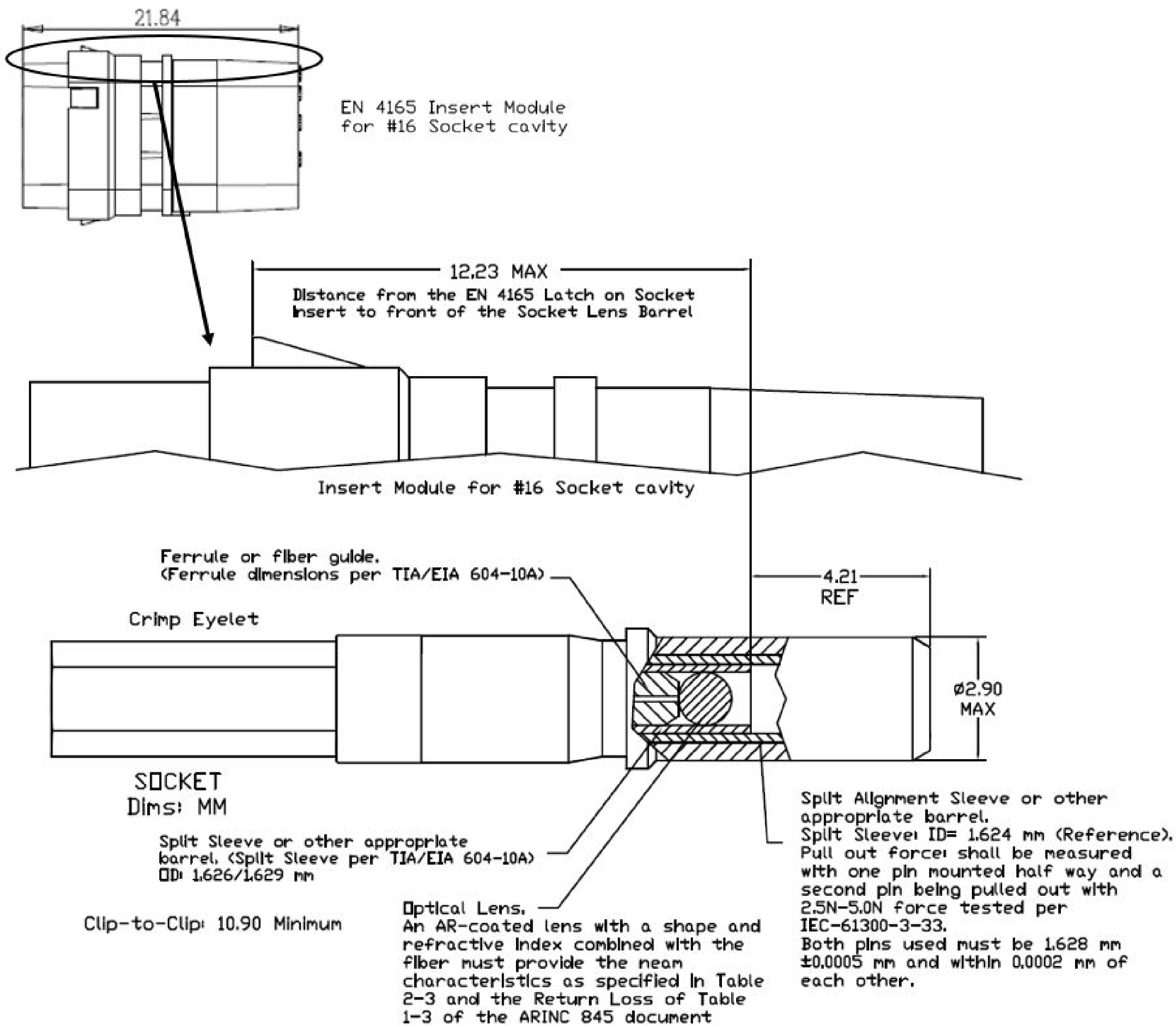
ATTACHMENT 2 ARINC 845 TYPE 1 SOCKET TERMINUS



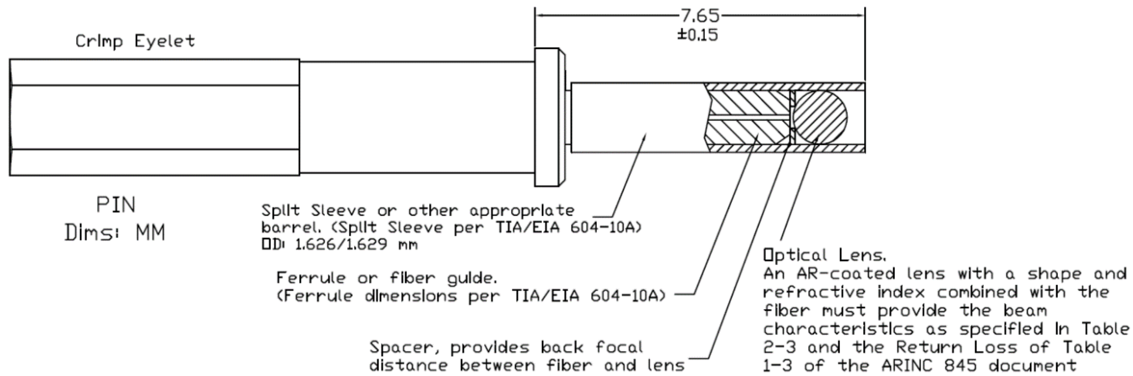
ATTACHMENT 3 ARINC 845 TYPE 2 PIN TERMINUS, CLASS 03 & 04



ATTACHMENT 4 ARINC 845 TYPE 2 SOCKET TERMINUS (SPRINGLESS), CLASS 03 & 04

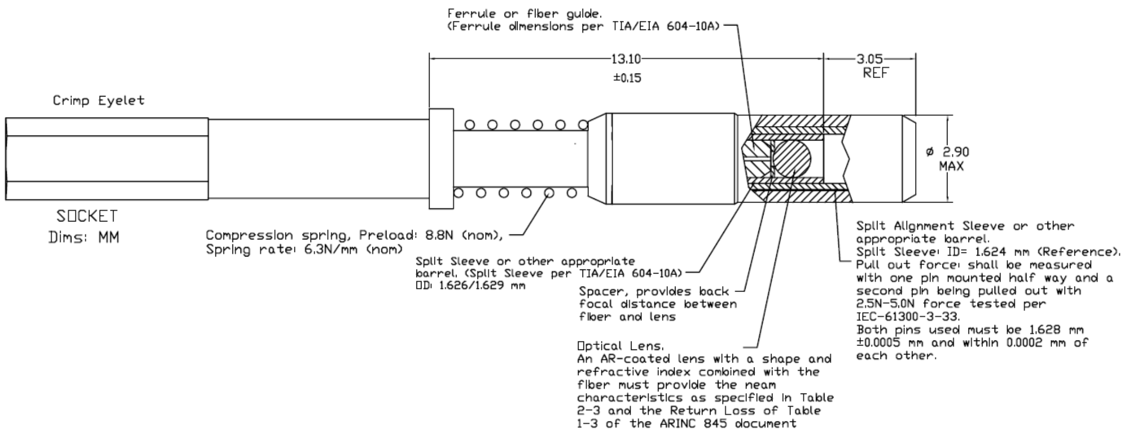


ATTACHMENT 5 ARINC 845 TYPE 3 PIN TERMINUS, CLASS 01 & 02

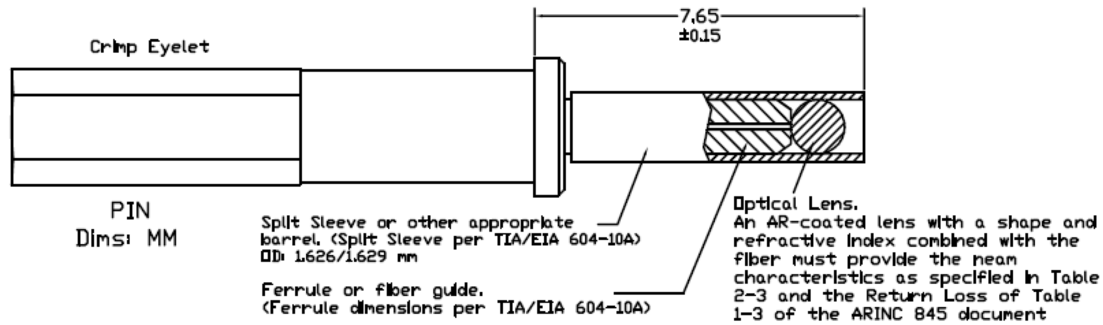


ATTACHMENT 6
ARINC 845 TYPE 3 SOCKET TERMINUS (WITH SPRING), CLASS 01 & 02

ATTACHMENT 6 ARINC 845 TYPE 3 SOCKET TERMINUS (WITH SPRING), CLASS 01 & 02

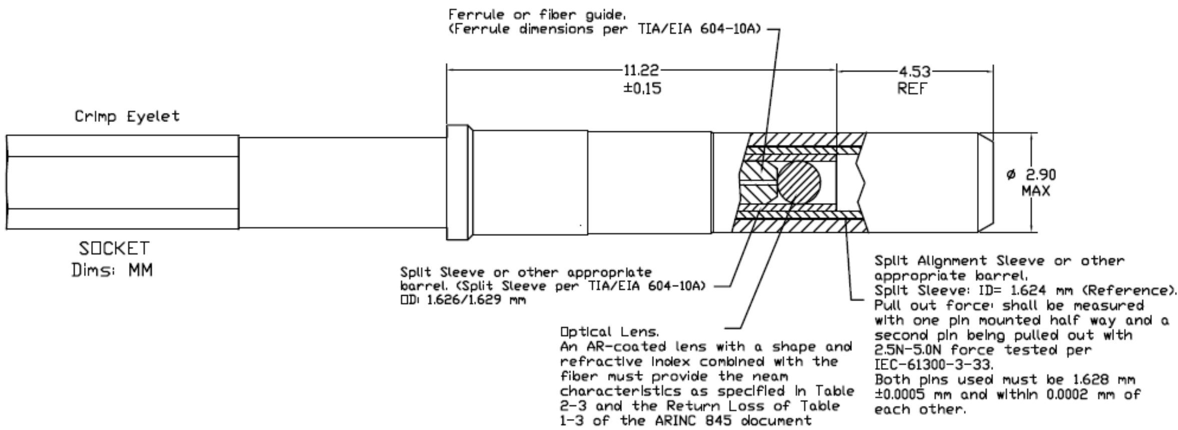


ATTACHMENT 7 ARINC 845 TYPE 3 PIN TERMINUS, CLASS 03 & 04



ATTACHMENT 8
ARINC 845 TYPE 3 SOCKET TERMINUS (SPRINGLESS), CLASS 03 & 04

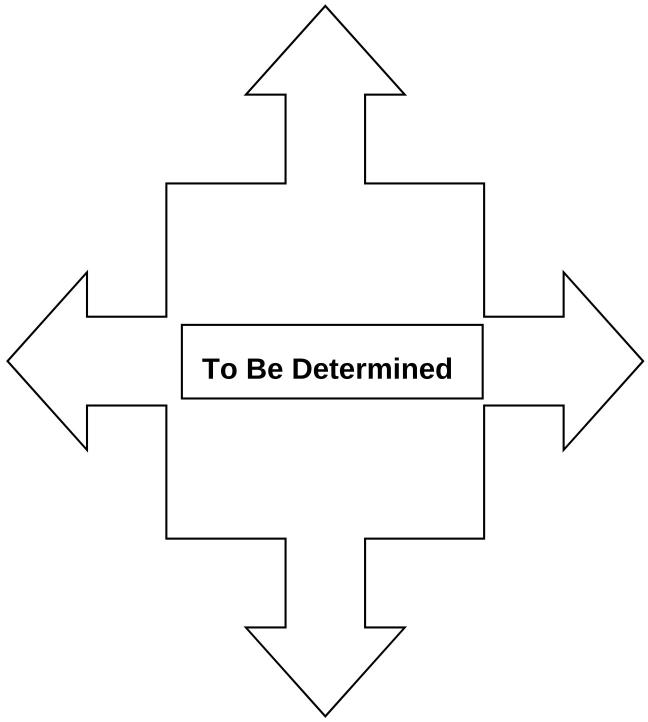
ATTACHMENT 8 ARINC 845 TYPE 3 SOCKET TERMINUS (SPRINGLESS), CLASS 03 & 04



ATTACHMENT 9 ARINC 845 TYPE 4 PIN

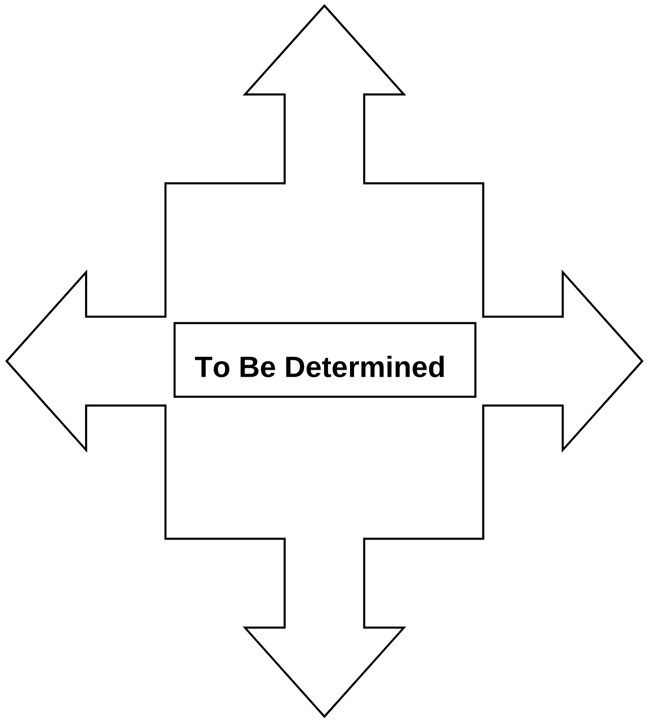
9.1

ARINC 600



ATTACHMENT 9
ARINC 845 TYPE 4 PIN

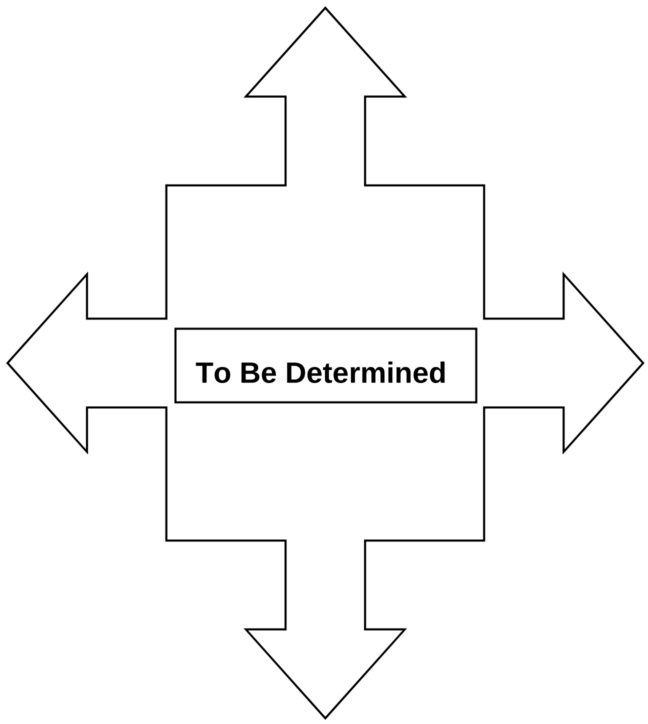
ARINC 845 Type 4 Pin



ATTACHMENT 10 ARINC 845 TYPE 4 SOCKET

10.1

ARINC 600



ATTACHMENT 10
ARINC 845 TYPE 4 SOCKET

ARINC 845 Type 4 Socket