



AEROSPACE RECOMMENDED PRACTICE

ARP6318™

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Verification of Discrete and Packaged Photonic Device Technology Readiness

RATIONALE

Technology readiness advancement and manufacturing readiness advancement is crucial to transitioning state-of-the-art photonic devices to aerospace platforms. Component life test data and packaging durability data reduces programmatic risk and accelerates technology readiness advancement, which in turn helps enable technology transition. The aerospace industry has had many fiber optics and photonics technology transition and insertion opportunities postponed or cancelled due to lack of information about photonic component reliability and packaging durability. This document presents an approach for nominal photonic device life test verification and packaged device environmental testing consistent with Technology Readiness Level (TRL) 6.

ARP6318 has been reaffirmed to comply with the SAE Five-Year Review policy.

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1. SCOPE

This document is intended for discrete and integrated digital, wavelength division multiplexing (WDM), and analog/radio frequency (RF) photonic components developed for eventual transition to aerospace platforms. The document provides the reasons for verification of photonic device life test and packaging durability. The document focuses on pre-qualification activity at the optical component level to achieve TRL 6. The recommended tests in this document are intended to excite typical failure mechanisms encountered with photonic devices in an aerospace operating environment, and to build confidence that a technology is qualifiable during a program's engineering and manufacturing development phase.

This recommended practice is targeting components to support electrical-to-optical, optical-to-electrical, or optical-to-optical functionality. Passive optical waveguide, fiber optic cable, and connector components that are integral to a photonic package are included. Component and photonic package radiation tolerance requirements are not within the scope of this recommended practice.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR5601	A Guideline for Application of RF Photonics to Aerospace Platforms
AIR6113	Guidelines for Design of Digital Fiber Optic Link Loss Budget Methodology
AIR6282	Fiber Optic Harsh Environment Test Methods Cross Reference Document

2.2 ARINC Publications

Available from ARINC, 2551 Riva Road, Annapolis, MD 21401-7435, Tel: 410-266-4000, www.arinc.com.

ARINC 804	Fiber Optic Active Device Specification
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2.3 U.S. Government Publications

Copies of these documents are available online at <http://quicksearch.dla.mil>.

MIL-PRF-38534 Hybrid Microcircuits, General Specification

MIL-STD 810	Environmental Engineering Considerations and Laboratory Tests
MIL-STD 883	Test Method Standard Microcircuits

2.4 Other Documents

Telcordia GR-468-CORE	Reliability Assurance for Optoelectronic Devices Contents
RTCA DO-160	Environmental Conditions and Test Procedures for Airborne Equipment

3. REFERENCES

The TRLs are defined in "DoD ASD(R&E) Technology Readiness Assessment Guidance of April 2011 and updated in May 2011." A pdf version of this document is available at <https://acc.dau.mil/CommunityBrowser.aspx?id=18545>.

4. ACRONYMS

The following acronyms may be used in this document:

AIR	Aerospace Information Report
ARP	Aerospace Recommended Practice
BER	Bit Error Rate
ER	Extinction Ratio
ESD	Electrostatic Discharge
HALT	Highly Accelerated Life Test
PIC	Photonic Integrated Circuit
PLC	Planar Lightwave Circuit

5. DEFINITIONS

Within this document certain terms related to fiber optic and photonic components are defined as follows:

BIT ERROR RATE: Bit Error Rate (BER) is that measure of bit errors per total bits transmitted at some specified point in the link. BER is often measured with a pseudo random bit pattern generator prior to the transmitter and an error analyzer at the receiver. A receiver's optical average power sensitivity is defined at a particular BER.

CARRIER CONTACTS: Electrical traces on a photonic device carrier submount. The carrier submount substrate is typically made of a ceramic insulating material, such as alumina or aluminum nitride. The carrier contacts are typically made of a conductive material, which is bondable by adhesive, or bump, flip chip, or wire bondable thin or thick film conductor material.

DETECTOR: A transduction device that transforms optical to electrical energy according to a defined relationship; a photodetector.

EMITTER: A transduction device that transforms electrical to optical energy, and launches optical radiation, according to a defined relationship; an optical source.

EXTINCTION RATIO: The ratio of power on ($P_{\max}$) to power off ($P_{\min}$), $ER = P_{\max}/P_{\min}$, often measured in [dB], i.e., $ER [dB] = 10\log(P_{\max}/P_{\min})$. Residual light existing in the off state contributes to zero-level noise. Modulation depth of a laser or light-emitting diode can directly impact Bit Error Rate (BER) performance independent of link loss.

EYE MASK: A figure of merit of transmitter optical performance used in conjunction with a transmitter eye diagram. A typical transmitter eye mask for 1 to 5 Gbps optical transmitters is shown Figure 1. Any "hits" inside the eye mask are generally considered unacceptable.