

Loss Budget Specification for Fiber Optic Links

RATIONALE

The aerospace industry requires precise standards for avionics system design. To ensure that the aerospace fiber optics industry also adopts these same high standards, it is essential that a common set of fiber optic system design procedures be established. This document outlines procedures needed for digital avionics fiber optic link system design that help to assure it complies with aerospace industry best practices.

It also provides an easily specified document for use during a complex system acquisition referencing back to the previously approved standard AS5603 for the detailed calculations.

1. SCOPE

This document defines a quantified means of specifying a digital fiber optic link loss budget:

- Between end users and system integrators
- Between system integrators and subsystem suppliers
- Between subsystem suppliers and component vendors

The standard specifies methods and the margin required for categories of links.

2. APPLICABLE DOCUMENTS

The following publications for a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of the 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 724-776-4970 (outside USA), www.sae.org.

AS5603 Digital Fiber Optic Loss Budget Methodology for Aerospace Platforms

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<http://www.sae.org/technical/standards/AS5750>**

2.2 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI Z136.1 American National Standard for Safe Use of Lasers

3. REQUIREMENTS

In order to perform a digital optical loss budget calculation, a method and several parameters must be selected and defined.

Standards document AS5603 details three methods for calculating a digital optical loss budget. These include the Worst Case Method, the Statistical Method, and the Numerical (Simulation) Method. As described by AS5603, these methods require increasing effort but provide increasing accuracy. The entity requesting the digital optical loss budget calculation shall select one of methods listed in Table 1. If the requesting entity does not select one of the methods listed in Table 1, the Worst Case Method shall be selected. The entity performing the digital optical loss budget calculation shall use one of the allowed methods corresponding to the selected method specified in Table 1.

TABLE 1 - ALLOWED DIGITAL OPTICAL LOSS BUDGET METHODS

Selected Method		Allowed Method of Calculation		
		Worst Case	Statistical	Numerical (Simulation)
I	Worst Case	Allowed	Allowed	Allowed
II	Statistical	X	Allowed	Allowed
III	Numerical (Simulation)	X	X	Allowed

Standards document AS5603 lists two parameters that are required for calculating a digital optical loss budget and one parameter that is suggested. The first required parameter is the required margin, M_{REQ} , of the optical system. The second required parameter is the confidence level, C , needed for meeting the M_{REQ} of the system. The suggested parameter is the required saturation margin, $M_{REQ(SAT)}$, of the optical system. Because these parameters are inherently linked together, relevant categories defining these parameters are called out in Table 2 of this document. The entity requesting the digital optical loss budget calculation shall select one of the categories in Table 2. If the requesting entity does not select one of the categories listed in Table 2, Category A shall be selected.

TABLE 2 - DIGITAL OPTICAL LOSS BUDGET CATEGORIES AND DEFINED PARAMETERS

Category	Required		Optional	Intended Use
	M_{REQ}	C	$M_{REQ(SAT)}$	
	dB	%	dB	
A	1.5	99.9999	0	Flight Critical Systems
B	3	99.99	0	
C	4.5	99	0	
D	1.5	99.99	0	Mission Critical Systems
E	3	99	0	
F	4.5	95	0	
G	0	99.99	0	Non-Mission Critical Systems
H	1.5	99	0	
I	3	95	0	
J	0	95	0	Prototypes
Z	As Defined	As Defined	As Defined	As Defined

Category A, B, and C are intended for flight critical systems (flight safety or safety of flight) and for systems with high availability requirements. Note that these three categories are intended to yield statistically equivalent performance.

Category D, E, and F are intended for mission critical systems (mission essential). Note that these three categories are intended to yield statistically equivalent performance.

Category G, H, and I are intended for non-mission critical systems (non-mission essential). Note that these three categories are intended to yield statistically equivalent performance.

Category J is intended for experimental and demonstration systems with limited lifetimes. This category is also used to show feasibility of systems where the exact components and cable runs are not production-defined, such as experimental systems.

Category Z is intended for systems where the requesting entity and the performing entity have negotiated specific parameters for the target system.

4. DOCUMENTATION

Unless otherwise specified, the following data shall be reported:

1. Title of results: Digital Fiber Optic Loss Budget Calculation
2. Identification of standard used (AS5750)
3. Identification of fiber optic link whose loss budget is being calculated (adequate information accurately documenting link physical characteristics and operational parameters, e.g. fiber type, length, wavelength, etc.).
4. Date the loss budget calculation was performed
5. Loss budget calculation method used (I – Worst Case, II – Statistical, or III – Numerical (Simulation))
6. Identification of loss budget category (A, B, C, etc)
7. For category Z, defined parameter values for M_{REQ} , C, and optionally $M_{REQ(SAT)}$
8. Numerical results of the loss budget calculation
9. Pass / fail results of the loss budget calculation

United States military applications require that the following information shall also be reported for each test. For other (nonmilitary) applications, this information need not be reported but shall be available for review upon request.

10. Responsible entity performing the loss budget calculation

5. SPECIFICATION AND INFORMATION REQUIREMENTS

The following details shall be specified when using this standard:

1. Base loss budget calculation method to be used (I – Worst Case, II – Statistical, or III – Numerical (Simulation)). If no method has been selected, I – Worst Case is selected by default
2. Loss budget calculation category to be used (A, B, C, etc). If no category has been selected, category A is selected by default
3. If loss budget calculation category Z, the specific defined parameter values for M_{REQ} , C, and optionally $M_{REQ(SAT)}$
4. Relevant physical and operational parameters, e.g. fiber type, length, wavelength, etc,