

# **Multilane MM Optics: Eye Safety Categories**

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# References

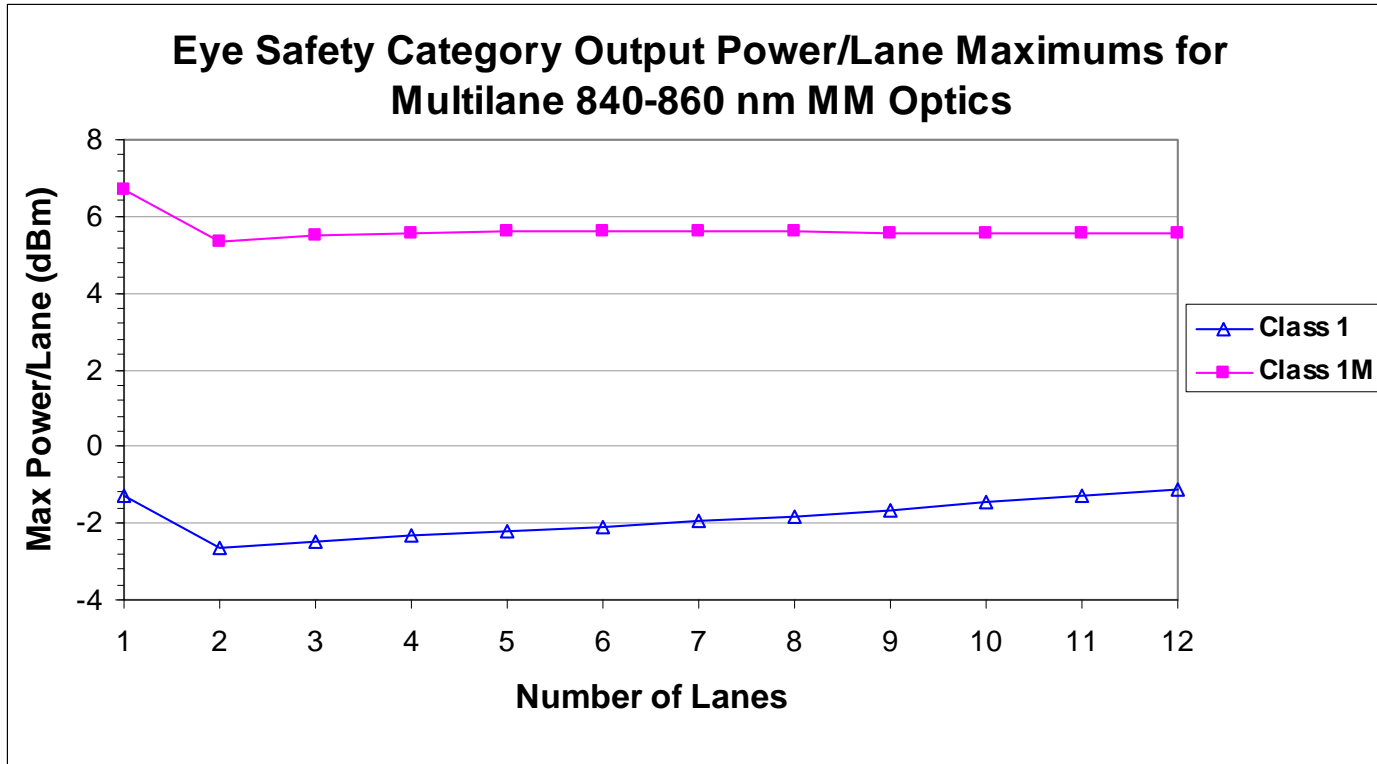
- [1] IEC 60825-1 (Second edition 2007-03) Safety of laser products – Part 1: Equipment classification and requirements
- [2] IEC 60825-1 (Edition 1.2 2001-08) Safety of laser products – Part 1: Equipment classification, requirements and user's guide
- [3] IEC 60825-2 (Second edition 2000-05) Safety of laser products – Part 2: Safety of optical fibre communication systems
- [4] IEC 60825-2 (2004 Amendment 1 2006-11) Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS)
- [5] 21 CFR 1040.10 (Title 21, Vol. r81, Revised April 1 2007) Performance Standards for Light-Emitting Products
- [6] Laser Products – Conformance with IEC 60825-1 and IEC 60601-2-22; Guidance for Industry and FDA Staff (Laser Notice No. 50, June 24, 2007)

# Outline

- Eye safety category question for multilane fiber optics
- Applicable Standards & Terminology
- Class 1 & Class 1M Requirements
- Conclusion & Next Steps

# Eye Safety Category Maximums

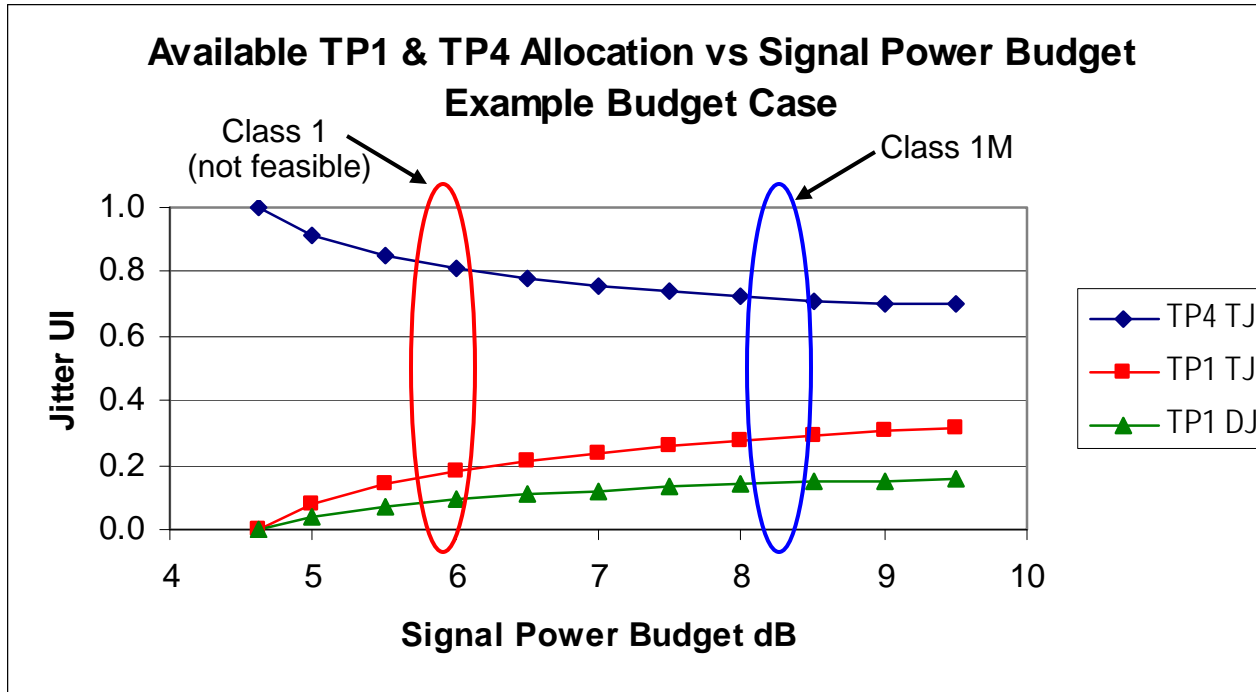
## Impact of Multiple Lanes



- The worst case impact (approximately 1.4 dB down from a single lane case) occurs for two adjacent lanes.
- The drop in max power conflicts with jitter allocation targets that require a larger signal budget.

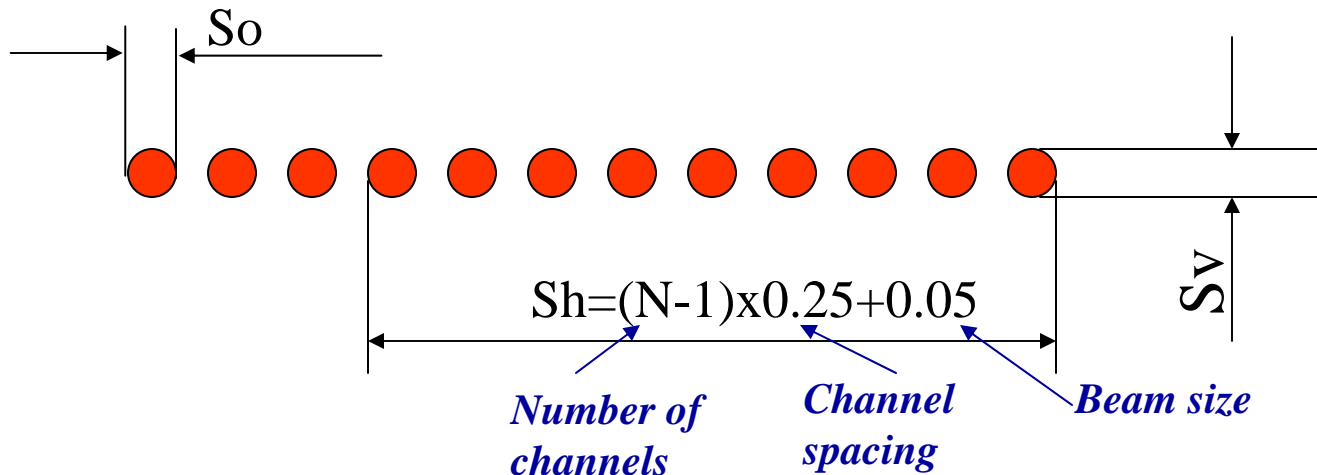
# Eye Safety Category

## Class 1 or Class 1M?



- Existing Class 1 eye safety category maximums (~1.4 dB lower due to multiple sources) limit the signal power budget to less than 6 dB requiring unrealistic jitter allocations for the host at TP1 & TP4 as shown in the above chart. Class 1M permits more practical budgets.
- Existing parallel modules are normally Class 1M.

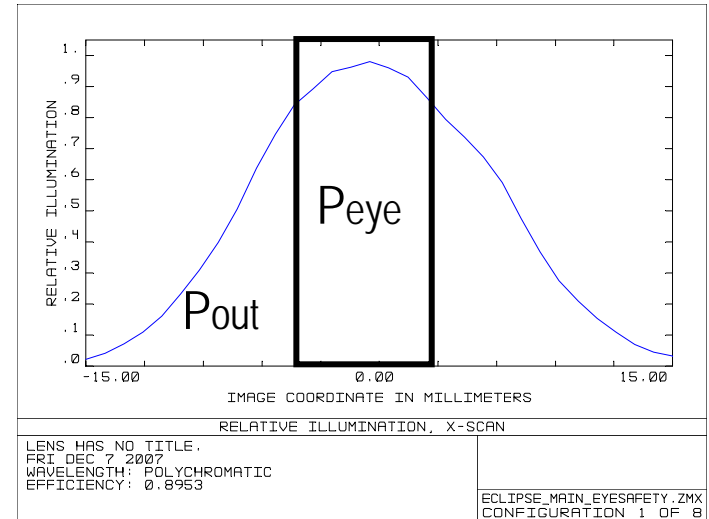
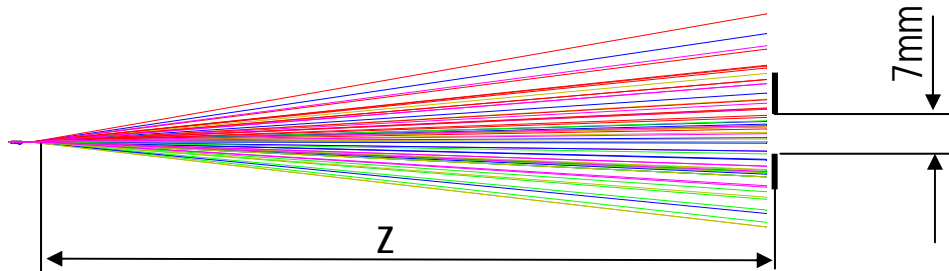
# Apparent source size calculation for 1x12 parallel fiber ribbon cable



Out of fiber

- Individual source size:  $S_o = 0.05\text{mm}$  (fiber size)
- Vertical source size:  $S_v = 0.15\text{mm}$  (minimum)
- Horizontal source size:  $S_h = (N-1) \times 0.25 + 0.05$
- Apparent source size:  $ASS = (S_v + S_h) / 2$
- Source subtended angle:  $a(\text{mrad}) = ASS / 100\text{mm}$

# Aperture Power Collection Ratio



Beam at distance  $Z$  from fiber

# Eye Safety

## Applicable Standards

The primary relevant standards include:

- IEC 60825-1 Safety of laser products – Part 1: Equipment classification and requirements
- IEC 60825-2 Safety of laser products – Part 2: Safety of optical fibre communication systems
- 21 CFR 1040.10 Performance Standards for Light-Emitting Products – Laser products

IEC 60825-1 and 21 CFR 1040.10 address determination and classification of radiation levels and associated marking requirements for laser based products and equipment. IEC 60825-2 addresses requirements for optical fiber communication systems.

While there will be time lags among these with respect to revisions, it's generally expected that eventually they will be harmonized. Revisions often occur first with IEC 60825-1. 21 CFR 1040.10 often permits conformance with IEC 60825-1 as a substitute for 21 CFR 1040.10 conformance. Most other standards refer to these, e.g. GR-253-CORE.



# Eye Safety Standards

## Terminology (1)

- **Class 1 laser product:** any laser product which does not permit human access to laser radiation in excess of the accessible emission limits of Class 1 for applicable wavelengths and emission durations [2]
- **Class 1M laser product:** any laser product in the wavelength range from 302.5 nm to 4000 nm which does not permit human access to laser radiation in excess of the accessible emission limits of Class 1 for applicable wavelengths and emission durations, where the level of radiation is measured according to clause 9.2g of IEC 60825-1, however, evaluated with smaller measurement apertures or at a greater distance from the apparent source than those used for Class 1 laser products. The output of a Class 1M product is therefore potentially hazardous when viewed using an optical instrument [2]
- **hazard level:** potential hazard at any accessible location within an optical fiber communication system. It is based on the level of optical radiation which could become accessible in reasonably foreseeable circumstances, e.g. a fiber cable break. It is closely related to the laser classification procedure in IEC 60825-1 [3]

# Eye Safety Standards

## Terminology (2)

- **location with controlled access:** location where access to the protective housing (enclosure) is controlled and is accessible only to authorized persons who have received adequate training in laser safety and the servicing of the system involved. Examples include optical cable ducts and switching centers. [3]
- **location with restricted access:** location where access to the protective housing (enclosure) is restricted and not open to the public. Examples include industrial and commercial premises. [3]
- **location with unrestricted access:** location where access to the protective housing (enclosure) is unrestricted. Examples include domestic premises and premises open to the public. [3]
- Data centers fit the definition of restricted locations.

# Eye Safety Standards

## Equipment Requirements Summary

- Equipment with Class 1 sources may not require marking. [2]
- Equipment with Class 1M sources require marking or, at the discretion of the manufacturer, warnings may instead be included in user information. [2]

# Eye Safety Standards

## System Requirements Summary [4]

Hazard Level	Location Type		
	Unrestricted	Restricted	Controlled
1	No requirements	No requirements	No requirements
1M	Hazard level 1 from connectors that can be opened by an end-user No labeling or marking requirement	No labeling or marking required if connectors that can be opened by the end-user are hazard level 1. If output is hazard level 1M then labeling or marking is required. *	No requirements

\* Where the accessible radiation at points of disconnection is hazard level 1 or hazard level 1M, it is permitted for this to be noted in information for the user instead of as a marking on (e.g.) the product, fiber or connector.

# Eye Safety Category Issue Summary

- Data centers fit the definition of restricted locations.
- Both Class 1 and Class 1M sources are permitted in restricted locations.
- Equipment with Class 1 sources may not require marking.
- Equipment with Class 1M sources require marking or, at the discretion of the manufacturer, warnings may instead be included in user information.
- Cables carrying Class 1M level signals require marking or warnings included in user information.
- A shift from Class 1 to Class 1M sources may generate new equipment marking requirements. Appropriate warnings in user information can replace the marking requirement for equipment and for cables and connectors in restricted locations.

# Eye Safety Category Issue with MM optics

## Conclusion & Recommendations

- Conclusion: While a shift to Class 1M from Class 1 may not present new and onerous requirements on equipment and systems, each manufacturer should evaluate their individual situation and arrive at their own conclusion.
- Next steps:
  - Determine individual practices regarding equipment marking including equipment with Class 1 and Class 1 sources
  - Investigate if any systems are in unrestricted environments where connectors are accessible