

TECHNICAL REPORT



**Information technology – Generic cabling for customer premises –
Part 9908: Guidance for the support of higher speed applications over optical
fibre channels**

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Part 9908: Guidance for the support of higher speed applications over optical fibre channels

FOREWORD

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ISO/IEC TR 11801-9908, which is a Technical Report, was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

The list of all currently available parts of the ISO/IEC 11801 series, under the general title *Information technology – Generic cabling for customer premises*, can be found on the IEC and ISO websites.

The text of this Technical Report is based on the following documents:

DTR	Report on voting
JTC1-SC25/2927/DTR	JTC1-SC25/2940/RVDTR

Full information on the voting for the approval of this Technical Report can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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INTRODUCTION

The need to support cost-efficient high-speed applications over optical fibre has resulted in the availability of a wide variety of applications and implementation options. The available options to support high-speed applications over optical fibre have multiplied in recent years, and the trend towards higher speeds can be expected to continue. Innovative techniques to maximize the useful life of installed infrastructure include the use of multi-level encoding schemes, wavelength division multiplexing, parallel fibre transmission, and new cabled optical fibre categories. In order to make informed decisions regarding the optimal infrastructure choices to support deployment of high-speed applications today, and enable the optimal migration path to higher speeds in the future, cabling system specifiers, designers and users need to have a good understanding of the duplex and parallel application options, and their connectivity choices.

This document describes the options for high-speed applications utilizing duplex and parallel optical fibre channels and identifies relevant migration considerations when upgrading or planning to upgrade to higher speed applications.

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INFORMATION TECHNOLOGY – GENERIC CABLING FOR CUSTOMER PREMISES –

Part 9908: Guidance for the support of higher speed applications over optical fibre channels

1 Scope

This part of ISO/IEC 11801, which is a Technical Report,

- provides a listing of the data centre application options currently available or in process of standardization utilizing duplex and parallel optical fibre channels;
- identifies migration considerations when upgrading to higher speed applications.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 11801-1, *Information technology – Generic cabling for customer premises – Part 1: General requirements*

ISO/IEC 14763-2, *Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 11801-1 and ISO/IEC 14763-2 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.2 Abbreviated terms

MPO Multi-fibre push on

MSA Multi-Source Agreement

4 Applications for 10 gigabits per second and beyond

The need to support cost-efficient high-speed applications over multimode fibre has resulted in the availability of a wide variety of applications and implementation options.

Multimode options are shown in Table 1, Table 2, and Table 3.

Single-mode options are shown in Table 4, Table 5 and Table 6.

In Annex A, Table A.1 lists all the multimode options and Table A.2 lists all the single mode options.

Table 1 – Multimode applications standardized in IEEE for Ethernet and INCITS for Fibre Channel

Data rate	Duplex fibre applications	Parallel fibre applications	Maximum reach m			Number of fibre pairs
			OM3	OM4	OM5	
10 Gbit/s	10GBASE-SR		300	400		1
16 Gbit/s	16GFC-SW		100	125		1
25 Gbit/s	25GBASE-SR		70	100		1
32 Gbit/s	32GFC-SW		70	100		1
40 Gbit/s		40GBASE-SR4	100	150 ^a		4
50 Gbit/s	50GBASE-SR		70	100		1
64 Gbit/s	64GFC-SW		70	100		1
100 Gbit/s		100GBASE-SR2	70	100		2
		100GBASE-SR4	70	100 ^a		4
		100GBASE-SR10	100	150 ^a		10
200 Gbit/s		200GBASE-SR4	70	100		4
400 Gbit/s		400GBASE-SR16	70	100		16
		400GBASE-SR4.2	70	100	150	4
		400GBASE-SR8	70	100		8

^a Minimum cabled optical fibre performance of Category OM4 is specified (subject to a maximum total connecting hardware loss of 1,0 dB).

Table 2 – Multimode applications in progress of standardization in IEEE for Ethernet and INCITS for Fibre Channel

Data rate	Duplex fibre applications	Parallel fibre applications	Maximum reach m			Number of fibre pairs
			OM3	OM4	OM5	
128 Gbit/s		128GFC-SW4	70	100	100	4
256 Gbit/s		256GFC-SW	70	100	100	4

Table 3 – Multimode applications covered by Multi-Source Agreements

Data rate	Duplex applications	Parallel applications	Maximum reach m			Number of fibre pairs
			OM3	OM4	OM5	
40 Gbit/s	40G-SWDM4		240	350	440	1
100 Gbit/s	100G-SWDM4		75	100	150	1
400 Gbit/s		400G-BD4.2	70	100	150	4

NOTE The maximum channel attenuation values at the specified reaches for the applications in Table 1, Table 2 and Table 3 can be found in ISO/IEC 11801-1 and/or the relevant application standard or Multi-Source Agreement.

Table 4 – Single-mode applications standardized in IEEE for Ethernet and INCITS for Fibre Channel

Data rate	Single fibre or duplex applications	Parallel applications	Maximum reach for OS2 ^a m	Number of fibre pairs
25 Gbit/s	25GBASE-LR		10 000	1
32 Gbit/s	3200-SM-LC-L		10 000	1
40 Gbit/s	40GBASE-FR		2 000	1
	40GBASE-LR4		10 000	1
50 Gbit/s	50GBASE-FR		2 000	1
	50GBASE-LR		10 000	1
100 Gbit/s	100GBASE-DR		500	1
	100GBASE-LR4		10 000	1
128 Gbit/s		128GFC-PSM4	500	4
	128GFC-CWDM4		2 000	1
200 Gbit/s		200GBASE-DR4	500	4
	200GBASE-FR4		2 000	1
	200GBASE-LR4		10 000	1
400 Gbit/s		400GBASE-DR4	500	4
	400GBASE-FR8		2 000	1
	400GBASE-LR8		10 000	1

^a OS1a is not listed because the loss budget for 10 000 m applications is insufficient to support this maximum reach using minimally compliant OS1a cabling. Minimally compliant OS1a cabling can support 2 000 m and 500 m applications to their maximum reach by reducing the loss budget allocation for connection and splice loss.

Table 5 – Single-mode applications in progress of standardization in IEEE for Ethernet and INCITS for Fibre Channel

Data rate	Single fibre or duplex applications	Parallel applications	Maximum reach for OS2 ^a m	Number of fibre pairs
64 Gbit/s	64GFC-LW		10 000	1
100 Gbit/s	100GBASE-FR1		2 000	1
	100GBASE-LR1		10 000	1
400 Gbit/s	400GBASE-FR4		2 000	1
	400GBASE-LR4		6 000	1

^a OS1a is not listed because the loss budget for 10 000 m applications is insufficient to support this maximum reach using minimally compliant OS1a cabling. Minimally compliant OS1a cabling can support 2 000 m and 500 m applications to their maximum reach by reducing the loss budget allocation for connection and splice loss.

Table 6 – Single-mode applications covered by Multi-Source Agreements

Data rate	Single fibre or duplex applications	Parallel applications	Maximum reach for OS2 ^a m	Number of fibre pairs
100 Gbit/s		100G-PSM4	500	4
	100GE-CWDM4		2 000	1
	100G-CLR4		2 000	1
	100G-CWDM4-OCF		2 000	1
	100GE-4WDM-10		10 000	1
400 Gbit/s	400GE-CWDM8-2		2 000	1
	400GE-CWDM8-10		10 000	1

^a OS1a is not listed because the loss budget for 10 000 m applications is insufficient to support this maximum reach using minimally compliant OS1a cabling. Minimally compliant OS1a cabling can support 2 000 m and 500 m applications to their maximum reach by reducing the loss budget allocation for connection and splice loss.

5 Optical fibre cabling infrastructure considerations

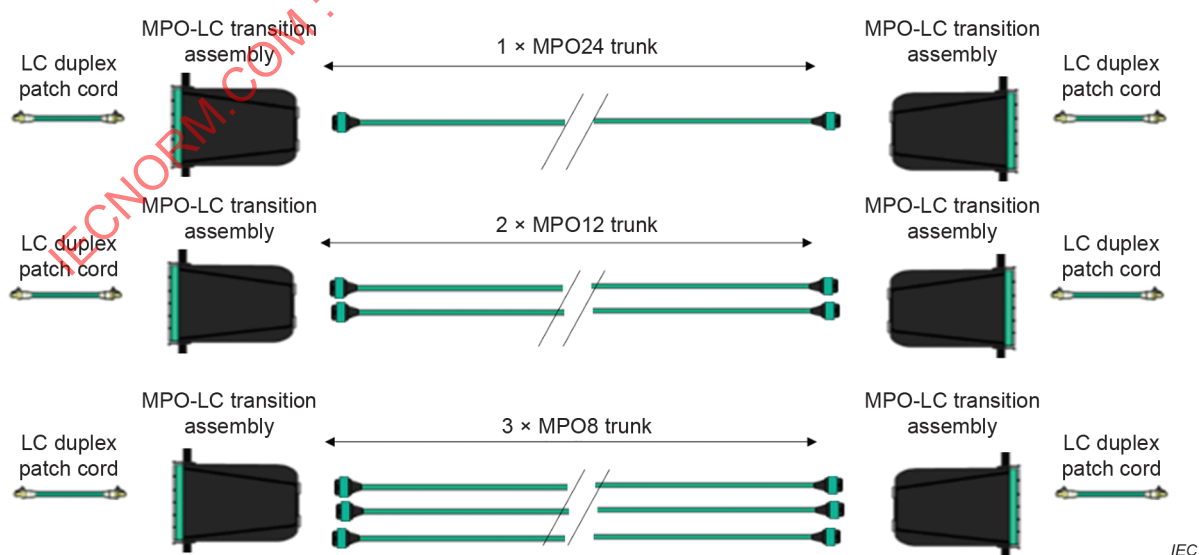
5.1 Array-based fibre cabling systems

Array-based optical fibre cabling systems are used because they provide for rapid installation and flexible migration options for duplex and parallel applications.

5.2 Array-based fibre cabling systems for duplex applications

5.2.1 General

Array-based optical fibre cabling systems support duplex applications with the use of MPO to duplex fibre transition assemblies or harnesses. MPO to duplex transition assemblies typically breakout four, six or twelve duplex connections. Typically, this results in the support of thirty-six, forty-eight, or up to seventy-two duplex circuits per rack unit. Figure 1 illustrates the use of MPO to duplex fibre transition assemblies with MPO24, MPO12 or MPO8 trunks.



NOTE See ISO/IEC 14763-2:2019, Annex A, for polarity maintenance of array connecting hardware interfaces.

Figure 1 – Example array-based cabling constructions for multiple duplex fibre applications

5.2.2 Data rate upgrades for duplex multimode channels

Referring to Table 1, Table 2 and Table 3, the incremental upgrade path for Ethernet over duplex channels is as follows:

10GBASE-SR → 25GBASE-SR → 40G-SWDM4 → 50GBASE-SR → 100G-BiDi or 100G-SWDM4

Referring to Table 1, Table 2 and Table 3, the incremental upgrade path for Fibre Channel over duplex channels is as follows:

16GFC Fibre Channel → 32GFC Fibre Channel → 64GFC Fibre Channel

5.2.3 Data rate upgrades for single fibre or duplex single-mode channels

Referring to Table 4, Table 5 and Table 6, the incremental upgrade paths for Ethernet over duplex channels are as follows:

25GBASE-LR → 40GBASE-LR4 → 50GBASE-LR → 100GBASE-LR4 or 100GBASE-LR1 or 100GE-4WDM-10 → 200GBASE-LR4 → 400GBASE-LR8 or 400GBASE-LR4 or 400GE-CWDM8-10

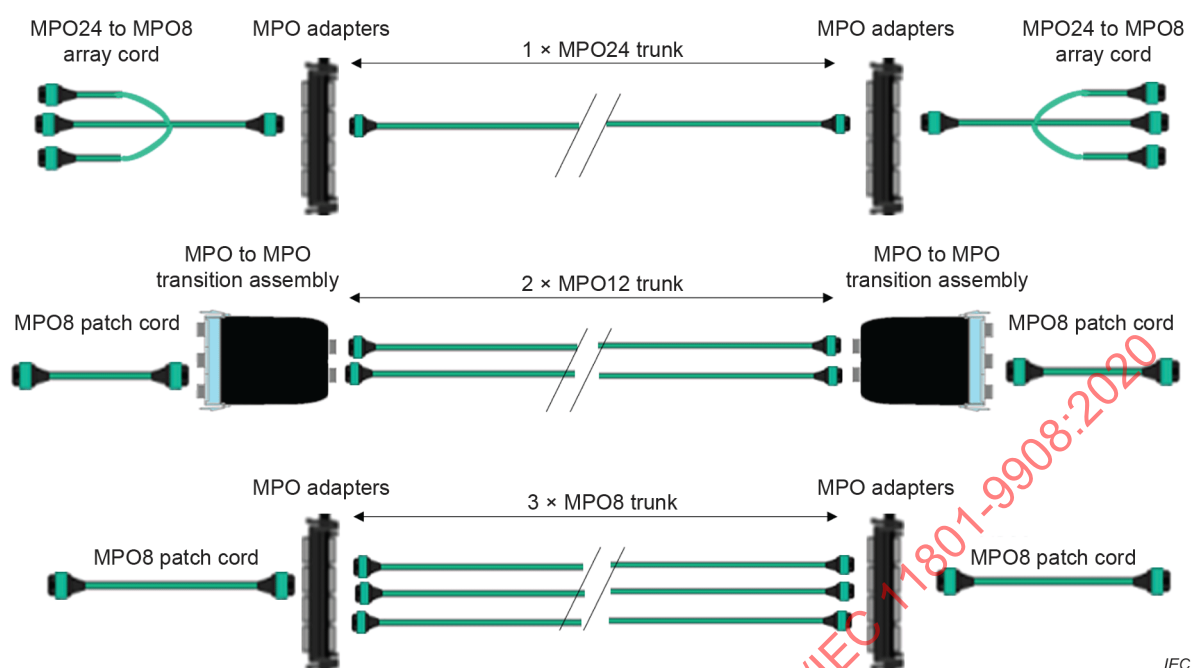
40GBASE-FR → 50GBASE-FR → 100GBASE-FR1 or 100GE-CWDM4 or 100G-CLR4 or 100G-CWDM4-OCF → 200GBASE-FR4 → 400GBASE-FR8 or 400GBASE-FR4 or 400GE-CWDM8-2

Referring to Table 4, Table 5 and Table 6, the incremental upgrade path for Fibre Channel over duplex channels is as follows:

3200-SM-LC-L → 64GFC-LW → 128GFC-CWDM4

5.3 Array-based fibre cabling systems and migration from duplex to parallel applications

Array-based optical fibre cabling systems that are initially installed to support duplex applications with the use of MPO to duplex transition assemblies can be migrated to support parallel applications by replacing the duplex transition assemblies with MPO adapters or MPO conversion assemblies. However, unless there is sufficient dark fibre provisioned during installation, and/or the pathways are designed to easily accommodate additional fibre trunks, the conversion can trade, for example, twelve 1-pair channels for only three 4-pair channels. Figure 2 illustrates some options for migration to parallel applications for the channels illustrated in Figure 1.



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Figure 2 – Example array-based cabling constructions for parallel fibre applications

5.4 Array-based fibre cabling systems for parallel applications

5.4.1 General

Array-based optical fibre cabling systems that are initially installed using MPO adapters or MPO-MPO transition assemblies provide an efficient way to support parallel applications. The use of MPO adapters typically requires the selection of the correct MPO trunk for the supported application (see options for 2, 4, 8, 10, and 16 fibre pairs shown in Table 1, Table 2 and Table 3). MPO-MPO transition assemblies and array cords allow the use of 8-, 12- and 24-fibre MPO trunks for applications requiring different parallel fibre counts, as required, with the ability to achieve 100 % fibre utilization. See Figure 2 for some options for parallel applications support.

5.4.2 Data rate upgrades for parallel multimode channels

Referring to Table 1, Table 2 and Table 3, the incremental upgrade path for Ethernet over 4-pair parallel fibre channels is as follows:

40GBASE-SR4 → 100GBASE-SR4 → 200GBASE-SR4 → 400GBASE-SR4.2 or 400G-BD4.2

Referring to Table 1, Table 2 and Table 3, there is no incremental 4-pair upgrade path for Fibre Channel at the time of publication of this document.

5.4.3 Data rate upgrades for parallel single-mode channels

Referring to Table 4, Table 5 and Table 6, the incremental upgrade path for Ethernet over 4-pair parallel channels is as follows:

200GBASE-DR4 → 400GBASE-DR4

Referring to Table 4, Table 5 and Table 6, there is no incremental 4-pair upgrade path for Fibre Channel at the time of publication of this document.

6 Multimode fibre cabling selection guidance

The choice of what multimode fibre cabling to install depends on the applications to be deployed and the channel length to be supported. The supported application lengths for OM3, OM4 and OM5 are listed in Table 1, Table 2 and Table 3. In addition to supporting the same 850 nm and 1 300 nm bandwidth as OM4, OM5 supports longer channel lengths than OM3 and OM4 for applications using multiple wavelengths in the 850 nm to 953 nm wavelength range. These include 400GBASE-SR4.2 in Table 2 and all applications in Table 3. Effective modal bandwidth guidance for OM3 and OM4 for wavelengths in the 850 nm to 953 nm range is provided in IEC 60793-2-10.

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Annex A (informative)

Summary of optical fibre applications

A.1 Duplex and parallel multimode fibre applications

Table A.1 lists the duplex and parallel multimode fibre applications covered in this document, including their status as a standard, standard in progress at the time of publication of this document, or Multi-Source Agreement.

Table A.1 – Duplex and parallel multimode fibre applications

Data rate	Status	Duplex fibre applications	Parallel fibre applications	Maximum reach m			Number of fibre pairs
				OM3	OM4	OM5	
10 Gbit/s	Standard	10GBASE-SR		300	400	400	1
16 Gbit/s	Standard	16GFC-SW		100	125	125	1
25 Gbit/s	Standard	25GBASE-SR		70	100	100	1
32 Gbit/s	Standard	32GFC-SW		70	100	100	1
40 Gbit/s	MSA	40G-SWDM4		240	350	440	1
40 Gbit/s	Standard		40GBASE-SR4	100	150	150	4
50 Gbit/s	Standard	50GBASE-SR		70	100	100	1
64 Gbit/s	Standard	64GFC-SW		70	100	100	1
100 Gbit/s	MSA	100G-BiDi		70	100	150	1
100 Gbit/s	MSA	100G-SWDM4		75	100	150	1
100 Gbit/s	Standard		100GBASE-SR2	70	100	100	2
100 Gbit/s	Standard		100GBASE-SR4	70	100	100	4
100 Gbit/s	Standard		100GBASE-SR10	100	150	150	10
128 Gbit/s	Standard in progress		128GFC-SW4	70	100	100	4
200 Gbit/s	Standard		200GBASE-SR4	70	100	100	4
256 Gbit/s	Standard in progress		256GFC-SW	70	100	100	4
400 Gbit/s	Standard		400GBASE-SR4.2	70	100	150	4
400 Gbit/s	MSA		400G-BD4.2	70	100	150	4
400 Gbit/s	Standard		400GBASE-SR8	70	100	100	8
400 Gbit/s	Standard		400GBASE-SR16	70	100	100	16

A.2 Single fibre, duplex, and parallel single-mode fibre applications

Table A.2 lists the single fibre, duplex, and parallel single-mode fibre applications covered in this document, including their status as a standard, standard in progress at the time of publication of this document, or Multi-Source Agreement.

Table A.2 – Single fibre, duplex and parallel single-mode fibre applications

Data rate	Status	Single fibre or duplex applications	Parallel applications	Maximum reach for OS2 ^a m	Number of fibre pairs
25 Gbit/s	Standard	25GBASE-LR		10 000	1
32 Gbit/s	Standard	3200-SM-LC-L		10 000	1
40 Gbit/s	Standard	40GBASE-FR		2 000	1
	Standard	40GBASE-LR4		10 000	1
64 Gbit/s	Standard in Progress	64GFC-LW		10 000	1
50 Gbit/s	Standard	50GBASE-FR		2 000	1
	Standard	50GBASE-LR		10 000	1
100 Gbit/s	Standard	100GBASE-DR		500	1
100 Gbit/s	Standard	100GBASE-LR4		10 000	1
100 Gbit/s	Standard in Progress	100GBASE-FR1		2 000	1
100 Gbit/s	Standard in Progress	100GBASE-LR1		10 000	1
100 Gbit/s	MSA		100G-PSM4	500	4
100 Gbit/s	MSA	100GE-CWDM4		2 000	1
100 Gbit/s	MSA	100G-CLR4		2 000	1
100 Gbit/s	MSA	100G-CWDM4-OCF		2 000	1
100 Gbit/s	MSA	100GE-4WDM-10		10 000	1
128 Gbit/s	Standard		128GFC-PSM4	500	4
128 Gbit/s	Standard	128GFC-CWDM4		2 000	1
200 Gbit/s	Standard		200GBASE-DR4	500	4
200 Gbit/s	Standard	200GBASE-FR4		2 000	1
200 Gbit/s	Standard	200GBASE-LR4		10 000	1
400 Gbit/s	Standard		400GBASE-DR4	500	4
400 Gbit/s	Standard	400GBASE-FR8		2 000	1
400 Gbit/s	Standard	400GBASE-LR8		10 000	1
400 Gbit/s	Standard in Progress	400GBASE-FR4		2 000	1
400 Gbit/s	Standard in Progress	400GBASE-LR4		6 000	1
400 Gbit/s	MSA	400GE-CWDM8-2		2 000	1

^a OS1a is not listed because the loss budget for 10 000 m applications is insufficient to support this maximum reach using minimally compliant OS1a cabling. Minimally compliant OS1a cabling can support 2 000 m and 500 m applications to their maximum reach by reducing the loss budget allocation for connection and splice loss.