



The Fibreoptic Industry Association

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## AN OVERVIEW OF SINGLEMODE OPTICAL FIBRE SPECIFICATIONS

by

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There are two primary sources of specification of singlemode optical fibre:

- the ITU-T G.65x series;
- IEC 60793-2-50 (and the equivalent to BS EN 60793-2-50).

At the time of writing 19 different singlemode optical fibre specifications defined by the ITU-T. These are:

- ITU-T G.652a, b, c and d;
- ITU-T G.653a and b;
- ITU-T G.654a, b and c;
- ITU-T G.655a, b, c, d and e;
- ITU-T G.656;
- ITU-T G.657 Categories A1, A2, B1 and B2.

Each type has its own area of application and the evolution of these optical fibre specifications reflects the evolution of transmission system technology from the earliest installation of singlemode optical fibre through to the present day.

The G.652a and G.652b specifications entitled "Characteristics of a single-mode optical fibre and cable" define an optical fibre with performance specified at 1310 nm, 1550 nm and 1625 nm but intended for use at, and with a zero chromatic dispersion slope in, the 1310nm region. These optical fibres would be expected to be found in extended length LAN, MAN and access network systems. The more recent variants (G.652.c and G.652.d) are not specified at 1625 nm but feature a reduced water peak that allows them to be used in the wavelength region between 1310 nm and 1550 nm supporting Coarse Wavelength Division Multiplexed (CWDM) transmission.

The G.653 specifications entitled "Characteristics of a dispersion-shifted single-mode optical fibre and cable" define an optical fibre with performance specified at 1310 nm and 1550 nm but with a zero chromatic dispersion slope in the 1550nm region. Such optical fibres were developed to support long-haul singlemode transmission systems using erbium-doped fibre amplifiers (EDFA) that only operate in the third window.

The G.654 specifications entitled "Characteristics of a cut-off shifted single-mode optical fibre and cable" define an optical fibre with performance specified at 1550 nm only and which only support singlemode transmission in that wavelength region.

The G.655 specifications entitled "Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable" define an optical fibre with performance specified at 1550 nm and 1625 nm but with a non-zero chromatic dispersion slope in these wavelength regions. Such optical fibres were developed to support long-haul systems that use Dense Wavelength Division Multiplexed (DWDM) transmission operating at 1530nm to 1625nm.

The G.656 specification entitled "Characteristics of a fibre and cable with Non-Zero Dispersion for Wideband Optical Transport" defines an optical fibre with performance specified at 1460 nm and 1625 nm but with a non-zero chromatic dispersion slope in these wavelength regions. Such optical fibres were developed to support long-haul systems that use CWDM and DWDM transmission over the specified wavelength range.

The G.657 specifications entitled "Characteristics of a bending loss insensitive single mode optical fibre and cable for the access network" define optical fibres that produce lower levels of attenuation due to bends. The title is slightly misleading since these are not "bend insensitive" but "less bend-sensitive" products. G.657 Category A1 and A2 optical fibres are intended to be compatible with the G.652 optical fibres whereas G.657 Category B2 and B3 optical fibres are not necessarily so (as it may have a much lower mode field diameter (MFD) as shown in Table 1).

Variants G.657 Category A1 and A2 optical fibres feature a reduced water peak specification that allows them to be used in the wavelength region between 1310 nm and 1625 nm - supporting Coarse Wavelength Division Multiplexed (CWDM) transmission.

Variants G.657 Category B2 and B3 optical fibres have a specified attenuation at 1310 nm, 1550 nm and 1625 nm but do not have transmission performance required specified at intermediate wavelengths.

The application area for G.657 optical fibres lies within premises where cables are subjected to much tighter bends than in external installations. It should be pointed out these optical fibres are not specified to have increased strength under bend conditions.

IEC 60793-2-50:2008 (automatically published as EN 60793-2-50 and BS EN 60793-2-50) specifies seven different single mode optical fibres (which are equivalent to 16 of the ITU-T specifications):

- Type B1.1: equivalent to ITU-T G.652a and b;
- Type B1.2: equivalent to ITU-T 654 b and c (654.a seems to be no longer supported);
- Type B1.3: equivalent to ITU-T G.652c and d;
- Type B2: equivalent to ITU-T G.653a and b;
- Type B4: equivalent to ITU-T G.655c, d and e (655.a and 655.b seem to be no longer supported);;
- Type B5: equivalent to ITU-T G.656;
- Type B6: equivalent to ITU-T G.657.

In addition to the different applications for which the optical fibres are used and the wavelengths at which they are specified, there are substantial differences in the specific construction of the optical fibres. The most obvious of the construction differences is their mode field diameter

As shown in Table 1, the mode field diameters of optical fibres meeting these specifications can differ substantially. The tolerances shown in Table 1 are wider than those typically stated by manufacturers.

Proposed IEC 60793-2-50: 2008	ITU-T	Nominal MFD <sub>min</sub> (µm)	Nominal MFD <sub>max</sub> (µm)	MFD tolerance (µm)	Wavelength (nm)
Type B1.1	G652a, b	8.6	9.5	0.6	1310
-	G654a	9.5	10.5	0.7	1550
Type B1.2_b	G654b		13.00		
Type B1.2_c	G654c		10.5		
Type B1.3	G652c, d	8.6	9.5	0.6	1310
Type B2	G.653a, b	7.8	8.5	0.8	1550
-	G.655a	8.0	11.0	0.7	1550
-	G.655b				
Type B4_c	G.655c				
Type B4_d	G.655d				
Type B4_e	G.655e				
Type B5	G.656	7.0	11.0	0.7	1550
Type B6_a	G.657 Categories A1/2	8.6	9.5	0.4	1310
Type B6_b	G.657 Categories B2/3	6.3	9.5	0.4	1310

Table 1: Mode Field Diameter (MFD) specifications of singlemode optical fibre

Mode field diameter mismatches can dramatically affect losses at joints. For more information see FIA Technical Support Document TSD-2000-4-1-1.

ITU-T G.65\* standards are available for free download from <http://www.itu.int/publications/>.

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