Proposed Wording, with specific temperature discussion

Annex 66A

(informative)

Environmental Characteristics for Ethernet Subscriber Access Networks

66A.1 Introduction

The purpose of IEEE 802.3ah (EFM), and its distinction from traditional Ethernet networks, is that it specifies functionality required for the subscriber access network, i.e., public network access. Network design considerations for "public" access that may differ from traditional Ethernet LANs include the operation, administration and management (OAM) function, and the regulatory requirements, as well as the environmental factors which are addressed in this annex.

The optical link is expected to operate over a reasonable range of environmental conditions related to temperature, humidity, and physical handling (such as shock and vibration). Implementers are expected to indicate in their literature the operating environmental conditions to facilitate selection, installation, and maintenance, and may also give summary information on a product label. The normative specifications of this standard are understood to apply over the range of conditions defined by the implementer. Specific requirements and values for these parameters are considered to be beyond the scope of this standard. However, this informative annex provides information, to both the design engineer and the eventual user of specific product implementations, on the environmental factors to be considered when designing EFM network topologies. It is intended to record the assumptions used in developing the specifications and give the reader guidance on what environmental conditions might be seen as reasonable. The following sections give an example of likely deployment of the different physical layer types, followed by a discussion of temperature issues. Informative references may be found in Annex *ref*.

It is believed that the most critical environmental factor on an Ethernet terminal will be temperature and that the most temperature sensitive element in a link is the semiconductor laser. The temperature sensitivity of these components may impact potential deployment scenarios if not considered. The remaining environmental factors (humidity, vibration, ect.) are not considered to be of major importance and may be handled by conventional design practice. Therefore, the remainder of this annex addresses temperature.

66A.2 Terminal deployment scenarios

The terminal equipment of a link may or may not be in a weatherprotected environment. 100BASE-LX10 links may be widely deployed with conventional building cabling for general purpose IT applications, as well as in Ethernet subscriber access applications. The other link types in Table 66A-1 are intended for Ethernet subscriber access applications. The table gives an example deployment scenario. Other scenarios are also supported by this standard, and may be deployed in significant numbers.

Table 66A-1 Informative deployment examples

Head end (nearer the core of the network)	Customer premises (nearer the periphery of the network)
Weatherprotected	**Not weatherprotected or weatherprotected**
100BASE-LX10	100BASE-LX10
100BASE-BX10-D	100BASE-BX10-U
1000BASE-LX10	1000BASE-LX10
1000BASE-BX10-D	1000BASE-BX10-U
1000BASE-PX10-D	1000BASE-PX10-U
1000BASE-PX20-D	1000BASE-PX20-U
10PASS-T	10PASS-T
2BASE-TL	2BASE-TL

This example scenario places the customer premises equipment in a non-weatherprotected position, e.g. the outside wall of a house, to allow ease of access for installation and maintenance. Where the premises is a large building such as a hotel, apartment block or office, a space such as a basement within the building may be accessible enough.

It is expected that the physical format of the equipment at each end of the link will be different; however, this is outside the scope of the standard. The physical layer type (e.g. 2BASE-TL) and the PMD type (e.g. 1000BASE-PX20-U) are classifications of the signal on the line, and do not imply a temperature range or physical format.

66A.3 Temperature

Large portions of Ethernet Subscriber Access optical and copper links are expected to operate in environmental conditions consistent with the outside plant. However, it is recognized that the exact requirements for a particular deployment will vary greatly depending on the geographic location, system structure, and governing regulations. It is also recognized that portions of the network may be deployed in more benign and protected environments and that in some geographic location the outside environment may also be considered benign.

Because of this, it is considered impractical to normatively define actual temperature ranges. To do so would require excess cost and design complexity for many situations where they are not warranted by the operational objectives of a deployment. Because of the great variation in possible deployments, and through a desire to not force undesired design complexity and cost where it is not needed, the following approach has been followed.

Informative temperature classifications for terminal ambient, and where supplied, terminal equipment case temperature have been gathered from other documents. From these the expected component temperature range has been inferred. It is believed that the most temperature sensitive element is any semiconductor laser, therefore the normative PMD specifications of Clauses 58, 59 and 60 have been chosen with the intent of consistency with the majority of the informative temperature ranges shown in Table 66A-2. That is, the specifications are adequately loose to allow for the expected temperature variation of the components. The exceptions are the non-wetherprotected extremes of hot and cold

66A.3.1 Examples of terminal temperature ranges

Examples of temperature ranges which may be applicable to terminal locations, equipment and the components within are given in Table 66A-2. These have been taken from available standards and are arranged in order of increasing severity.

The references generally classify the ambient temperatures. Partially weatherprotected locations are possible e.g. underground or shaded. Other locations may have heat traps, such as enclosures exposed to the sun or locations such as telephone booths. The column labeled “Assumed component temperature” is the working assumptions for the component case temperatures needed for the various applications. Because equipment design and thermal strategies may vary, the relation between the two temperatures may be different for different implementations. These component temperatures were used to develop the optical and electrical specifications of this standard.

The required temperature range will vary with the geographic region. Coastal regions are not usually extreme. Tropical regions are usually hot or hot and wet. The widest temperature swings are found in dry regions in the interior of large continents, e.g. central North America or central Asia. As may be seen, the Telecommunications equipment for use in North America is commonly designed to meet the extended temperature range. High altitude may reduce the efficacy of air cooling systems. To an extent, this is offset by the typically cooler air temperature at high altitude. Direct sunshine can add up to 1120 W/m^2 heating.

The temperatures included in Table 66A-2 are those that are documented in available standards. These are dominantly European and North American. Other portions of the world tend to use more application specific temperature specifications. However, the limits of Table 66A-2 catch a full range of possible applications.

Table 66A-2 Informative temperature examples (in order of increasing severity)

Climate or location	Specified ambient temperature	Assumed component temperature	Reference
Weatherprotected			
Telecom control rooms	15 to 30°C	15 to 50ºC	ETSI Class 3.6
Temperature controlled	5 to 40°C (-5 to 45ºC with cooling failure)	0 to 65ºC	ETSI Class 3.1
Controlled - long term	5 to 40°C (-5 to 50ºC short term)	0 to 70ºC	Telcordia GR-63
Partly temperature-controlled	-5 to 45°C	-5 to 65ºC	ETSI Class 3.2
Not temperature-controlled	-25 to 55°C	-25 to 75ºC	ETSI Class 3.3
Sheltered locations	-40 to 40°C	-40 to 60ºC	ETSI Class 3.5
Extended/uncontrolled	-40 to 46°C (-40 to 65°C inside enclosure)	-40 to 85ºC	Telcordia GR-487, GR-468
Sites with heat trap	-40 to 70°C	-40 to 85ºC	ETSI Class 3.4
Non-weatherprotected			
Temperate	-33 to 40°C	-33 to 60ºC	ETSI Class 4.1
Extended	-45 to 45°C	-45 to 65ºC	ETSI Class 4.1E
Extremely cold	-65 to 35°C	-65 to 55ºC	ETSI Class 4.2L
Extremely warm dry	-20 to 55°C	-20 to 75ºC	ETSI Class 4.2H

The temperature of metal surfaces which can be touched may be controlled by safety regulations such as Telcordia GR-499-CORE (60ºC maximum). This standard does not give guidance on the applicability of such regulations.

Generally, the use of fans is acceptable in office equipment located in protected locations. However, their use is discouraged in many remote locations due to their power consumption and noise. Noise is of particular concern in a domestic situation.

66A.3.2 Temperature impact on optical components

Components are often commercially available in two grades, 0 to 70 °C and -40 to 85 °C, although optoelectronic components are also available in -20 or -10 to 85 °C grade, depending on format. The GBIC MSA requires an operating temperature range of 0 to 50°C in moving air. Because of the varied physical format of equipment and components, the reader is advised to refer to specific product literature or multi source agreements for precise information.

The most temperature sensitive sub-component in an Ethernet terminal is expected to be the semiconductor laser, if for a fiber optic link. There are two categories of laser presently commonplace in the physical layers addressed here; Fabry-Perot (FP), a type of multi longitudinal mode (MLM) laser, and distributed feedback (DFB), a type of single longitudinal mode (SLM) laser.

Fabry-Perot lasers may have a temperature coefficient of wavelength around 0.45 nm/°C, so the operating wavelength of a particular FP may vary by 55 nm over the range -40 to 85 °C. The operating wavelength windows within this standard are generally 100 nm wide where FPs are anticipated, allowing adequate margin for manufacturing tolerances. To allow for the widest variety of implementation the spectral width is specified as a function of wavelength where appropriate. However, the requirement for low error rates over substantial distances of fiber, as specified by transmitter and dispersion penalty (TDP), forces the implementer of 1000 Mb/s FP laser based implementations to pay careful attention to both wavelength and spectral width to avoid excessive mode partition noise. In practice, the full range of wavelengths in the standard is not actually available for use because at the temperature extremes the required spectral width would be too narrow. It can be seen that the wider the temperature range required, the more precisely the wavelength and spectral width must be contained to achieve a particular reach. This may have an impact on cost. This consideration would be expected to apply to 1000BASE-LX10, 1000BASE-BX10-U and 1000BASE-PX10-U.

Where the dispersion of the link or the wavelength limits are more demanding than can be met cost-effectively with FPs, DFBs may be used. They may have a temperature coefficient of wavelength under 0.1 nm/°C and much narrower spectral widths than FPs. Because only a single longitudinal mode is present, a DFB does not suffer from mode partition noise. DFBs are generally more expensive than FPs, and DFBs for extended temperature use may be more expensive again. A DFB's lasing wavelength varies at 0.1 nm/°C while its gain peak varies at around 0.45 nm/°C. At extremes of temperature these two wavelengths are far apart and the laser may perform poorly. For this reason, DFBs for extended temperature range may be more expensive again. This consideration would be expected to apply to 1000BASE-BX10-D, 1000BASE-PX10-D and 1000BASE-PX-20.

For the purposes of this standard, the normative PMD specifications of Clauses 58, 59 and 60 have been chosen to be consistent with implementation over the -40ºC to 85ºC component case temperature range. This is viewed as being of an adequately wide range to be applicable to the majority of the environments of Table 66A-2. However, conformance with this temperature range is not required. This allows lower cost components to be had for those applications that require less extreme temperature ranges. This may be done by taking advantage of the reduced wavelength change to ease the central wavelength tolerance and spectral width requirements from the trade-off curves and more particularly, the TDP limit. This allows equipment and component suppliers, at their discretion, to develop systems and components that tolerate less severe environmental conditions that they view as suitable for their market as long as the PMD is consistent with the PICS proforma of the relevant clause. This limitation assures interoperability while allowing the equipment to be developed for specific markets.

References

1. GR-63-CORE, “Network Equipment Building System (NEBS) Requirements: Physical Protection” (Issue 2, April 2002)

2. GR-468-CORE, “Generic Reliability Assurance Requirements for Optoelectronic Devices Used In Telecommunications Equipment” (Issue 1, Dec. 1998)

3. GR-487-CORE, “Generic Requirements for Electronic Equipment Cabinets” (Issue 2, March 2000)

4. GR-499-CORE, “Transport Systems Generic Requirements (TSGR): Common Requirements” (Issue 2, Dec. 1998)

5. ETSI EN 300 019-1-3 V2.1.1 (2002-11) “Environmental Engineering (EE); Environmental conditions and environmental test for telecommunications equipment; Part 1-3: Classification of environmental conditions; Stationary use at weatherprotected locations”

6. ETSI EN 300 019-1-4 V2.1.1 (2002-11) “Environmental Engineering (EE); Environmental conditions and environmental test for telecommunications equipment; Part 1-4: Classification of environmental conditions; Stationary use at non-weatherprotected locations”