Annex 69A

(normative)

Interference tolerance testing

69A.1 Introduction

A major problem in communicating across crowded backplanes is interference. The interfering signal can come from a variety of sources including:

a) Crosstalk from other data channels running the same kind of signals as the channel of interest. This type of interference is usually subdivided into:
   1) Far-end crosstalk (FEXT) coming from data traveling in the same general direction as the channel of interest.
   2) Near-end crosstalk (NEXT) originating from a channel with a transmitter near the receiver of the channel of interest.

b) Self interference caused by reflections due to impedance discontinuities, stubs, etc. This is a form of intersymbol interference (ISI) that is beyond what a reasonable equalizer can compensate **for**.

c) Alien crosstalk which is defined to be interference from unrelated sources such as clocks, other kinds of data, power supply noise, etc.

For the channel to work, the receiver must be able to extract correct data from the lossy channel in the presence~~s~~ of interference. The ability of the receiver to extract data in the presence of interference is an important characteristic of the receiver and needs to be measured. This ability is called interference tolerance.

69A.2 Test setup

With the exceptions of 2.5GBASE-KX and 5 GBASE-KR, the interference tolerance test is performed with the setup shown in Figure 69A–1. **For 2.5GBASE-KX and 5 GBASE-KR, the interference tolerance test is performed with the setup shown in Figure 128B–1 130B–1.**

Figure 69A–1—Interference tolerance test setup

Figure 128B–1 130B-1—Interference tolerance test setup

69A.2.1Pattern generator

For 1000BASE-KX and 10GBASE-KX4, the amplitude delivered by the pattern generator to the test channel shall be no greater than the specified minimum transmitter output amplitude for the port type being tested adjusted by a gain b_{TC} as defined in 69A.2.2.

For 2.5GBASE-KX, the peak-to-peak amplitude delivered by the pattern generator, as measured on a sequence of alternating ones and zeros, shall be no more than 800 mV, adjusted by a gain b_{TC} as defined in 69A.2.2.

For **5GBASE-KR,** 10GBASE-KR and 40GBASE-KR4, the peak-to-peak amplitude delivered by the pattern generator, as measured on a sequence of alternating ones and zeros, shall be no more than 800 mV, adjusted by a gain b_{TC} as defined in 69A.2.2, regardless of equalization setting.

The signaling speed of the pattern generator shall be offset ±100 ppm relative to the nominal signaling speed of the port type being tested.

The pattern generator shall have jitter on its output. This jitter shall consist of sinusoidal jitter at a frequency no less than 1/250 of signaling speed, duty cycle distortion, and random jitter. The random jitter shall be measured at the output of a single pole high-pass filter with cut-off frequency at 1/250 of the signaling speed. The sinusoidal jitter, duty cycle distortion, and random jitter shall each be no less than the amount specified for the port type being tested.

The pattern generator may include equalization depending on the port type being tested. For 1000BASE-KX **and 2.5GBASE-KX**, the pattern generator shall not include equalization. **For 5GBASE-KR, equalization equivalent to a two-tap transversal filter meeting the requirements of 130.7.1.11 shall be included.**
For 10GBASE-KX4, the pattern generator shall include equalization such that the differential output template defined in 71.7.1.6 is met. For 10GBASE-KR, equalization equivalent to a three-tap transversal filter meeting the requirements of 72.7.1.10 shall be included.

For 1000BASE-KX, 10GBASE-KX4, 10GBASE-KR and 40GBASE-KR4, the applied transition time at the pattern generator output shall be no less than the minimum value specified for the port type being tested. If the transition time of the pattern generator is less than the minimum specified applied transition time, an equivalent stress may be introduced in the test channel. The test channel, defined in 69A.2.2, is chosen so that the insertion loss of the test channel has a specific relationship to the maximum fitted attenuation, A_{max}, defined in 69B.4.2. If the minimum specified applied transition time is T_r(min), and the transition time of the pattern generator is T_r, then the test channel may be used to generate an equaivalent stress by incrementing the parameter b_3 in A_{max} by $\otimes b_3$ as defined in Equation (69A–1).

(69A–1)

For 2.5GBASE-KX and 5GBASE-KR, the applied transition time at the pattern generator output shall be no less than the minimum value specified for the port type being tested. If the transition time of the pattern generator is less than the minimum specified applied transition time, an equivalent stress may be introduced in the test channel. The test channel, defined in 69A.2.2, is chosen so that the insertion loss of the test channel has a specific relationship to the maximum fitted attenuation, A_{max}, defined in Annex 128C.4.2.

69A.2.2Test channel

The test channel is a 100 ∧ differential system consisting of a frequency-dependent attenuator and an interference injection block.

The interference injection block may be a pair of directional couplers, a pair of pick-off tees, or any other component, as long as the combination of the interference injection block and the frequency-dependent attenuator satisfies the requirements of the test channel.

The frequency dependent attenuator is recommended to be constructed in such a way that it accurately represents the insertion loss and group delay characteristics of differential traces on an FR-4 printed circuit board.

The test channel is specified with respect to transmission magnitude response, IL_{TC}, and return loss. Assuming the transmission magnitude response is measured at N uniformly-spaced frequencies f_n spanning the frequency range f_1 to f_2, the transmission magnitude is described by two parameters, m_{TC} and b_{TC}, as defined in Equation (69A–2) through Equation (69A–7).

(69A–2)
(69A–3)
(69A–4)
(69A–5)
(69A–6)
(69A–7)

The values f_1 and f_2 are a function of the port type under test (see Tables 69B–1 **and 128C–1). For 1000BASE-KX, 10GBASE-KX4, 10GBASE-KR and 40GBASE-KR4,** A_{max} is defined in 69B.4.2. **For 2.5GBASE-KX and 5GBASE-KR, Amax is defined in Annex 128C.4.2.**

The test channel shall have m_{TC} greater than the minimum value specified for the port type under test and the test being performed. The test channel return loss, as measured at TP1 and TP4, shall be greater than or equal to **11 dB for 2.5GBASE-KX, greater than or equal to 16 dB for 5GBASE-KR, and greater than or equal to** 20 dB **for 1000BASE-KX, 10GBASE-KX4, 10GBASE-KR and 40GBASE-KR4,** from f_{min} to f_2.

69A.2.3Interference generator

The interference generator is a broadband noise generator capable of producing white Gaussian noise with adjustable amplitude. The power spectral density shall be flat to ±3 dB from f_1 to 0.5 times the signaling speed for the port type under test with a crest factor of no less than 5. The noise shall be measured at the output of a filter connected to TP4. The filter for this measurement shall have no more than a 40 dB/decade roll-off and a 3 dB cut-off frequency at least 0.5 times the signaling speed.

69A.2.4Transmitter control

For 10GBASE-KR testing, the pattern generator is controlled by transmitter control. Transmitter control responds to inputs from the receiver to adjust the equalization of the pattern generator. The receiver may communicate through its associated transmitter, using the protocol described in 72.6.10, or by other means.

69A.3 Test methodology

For 2.5GBASE-KX testing, the pattern generator shall first be configured to transmit the test pattern defined in 128.6.2. For 5GBASE-KR testing, the pattern generator shall first be configured to transmit the test pattern defined in 130.6.2. Transmitter control and training are not applicable to 2.5GBASE-KX or 5GBASE-KR.

For 10GBASE-KR testing, the pattern generator shall first be configured to transmit the training pattern defined in 72.6.10.2. During this initialization period, the DUT shall configure the pattern generator equalizer, via transmitter control, to the coefficient settings it would select using the protocol described in 72.6.10. During training, the broadband noise measured at TP4 shall have RMS amplitude less than 1 mV.

The pattern generator shall be configured to transmit the test pattern defined for the port type under test.

The broadband noise source shall then be set to the amplitude specified for the port type being tested, as measured at TP4. The measured BER shall be less than the target BER specified for the port type under test.

The interference tolerance test parameters are specified in Table 70–7 for 1000BASE-KX, in Table 71–7 for 10GBASE-KX4, in Table 72–10 for 10GBASE-KR and 40GBASE-KR4, in Table 128-6 for 2.5GBASE-KX, and in Table 130-6 for 5GBASE-KR.