

# Fibre optic communication system design guides —

## Part 6: Skew design in parallel optical interconnection systems

ICS 33.180.30

# National foreword

This Published Document reproduces verbatim IEC TR 61282-6:2003.

The UK participation in its preparation was entrusted by Technical Committee GEL/86, Fibre optics, to Subcommittee GEL/86/3, Fibre optic systems and active devices, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

## Cross-references

The British Standards which implement international publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 27 February 2003

## Summary of pages

This document comprises a front cover, an inside front cover, the IEC TR title page, pages 2 to 21 and a back cover.

The BSI copyright date displayed in this document indicates when the document was last issued.

## Amendments issued since publication

| Amd. No. | Date | Comments |
|----------|------|----------|
|          |      |          |
|          |      |          |
|          |      |          |
|          |      |          |
|          |      |          |

© BSI 27 February 2003

**RAPPORT  
TECHNIQUE  
TECHNICAL  
REPORT**

**CEI  
IEC**

**TR 61282-6**

Première édition  
First edition  
2003-01

---

---

**Guides de conception des systèmes  
de communication à fibres optiques –**

**Partie 6:  
Conception d'obliquité dans les systèmes  
d'interconnexion optiques parallèles**

**Fibre optic communication system  
design guides –**

**Part 6:  
Skew design in parallel optical  
interconnection systems**



Numéro de référence  
Reference number  
CEI/IEC/TR 61282-6:2003

## CONTENTS

|                                                                                                          |    |
|----------------------------------------------------------------------------------------------------------|----|
| FOREWORD.....                                                                                            | 3  |
| INTRODUCTION.....                                                                                        | 5  |
| 1 Scope.....                                                                                             | 6  |
| 2 Configuration of a parallel optical interconnection.....                                               | 6  |
| 2.1 Schematic diagram of a parallel optical interconnection.....                                         | 6  |
| 2.2 Data latch.....                                                                                      | 7  |
| 2.3 Clock transmission scheme .....                                                                      | 7  |
| 3 Skews in parallel optical interconnection .....                                                        | 8  |
| 3.1 Definitions of skews .....                                                                           | 8  |
| 3.2 Mechanisms of skew generation in interconnection systems.....                                        | 9  |
| 3.3 Tolerance in the skew-setup/hold time.....                                                           | 10 |
| 4 Practical skew design method .....                                                                     | 11 |
| 4.1 General description of a skew design .....                                                           | 11 |
| 4.2 Skew determination and verification .....                                                            | 12 |
| 5 Examples of skew measurements.....                                                                     | 16 |
| 5.1 Configuration.....                                                                                   | 16 |
| 5.2 Temperature dependence of transmitter skew .....                                                     | 17 |
| 5.3 Transmitter skew.....                                                                                | 18 |
| 5.4 Receiver skew due to the receiving power difference.....                                             | 18 |
| 5.5 Receiver skew.....                                                                                   | 19 |
| Annex A Note concerning optical fibre ribbon skew.....                                                   | 20 |
| Bibliography.....                                                                                        | 21 |
| Figure 1 – Configuration of parallel optical interconnection .....                                       | 6  |
| Figure 2 – Clock transmission schemes .....                                                              | 8  |
| Figure 3 – Definition of skew in an optical parallel interconnection.....                                | 9  |
| Figure 4 – Receiver skew from the optical level difference .....                                         | 10 |
| Figure 5 – Definition of transmitter skew .....                                                          | 11 |
| Figure 6 – Definition of receiver skew .....                                                             | 11 |
| Figure 7 – System configuration in case of simultaneous clock transmission.....                          | 12 |
| Figure 8 – Explanation diagram of skew in case of simultaneous clock transmission.....                   | 13 |
| Figure 9 – System configuration in case of clock extraction from the representative port .....           | 14 |
| Figure 10 – Explanation diagram of skew in case of clock extraction from<br>the representative port..... | 14 |
| Figure 11 – System configuration in case of system clock supply.....                                     | 15 |
| Figure 12 – Explanation diagram of skew in case of system clock supply.....                              | 16 |
| Figure 13 – A schematic diagram of the transmitter and receiver module .....                             | 17 |
| Figure 14 – Temperature dependence of transmitter skew .....                                             | 17 |
| Figure 15 – Accumulation curve of transmitter skew at 0 °C and 80 °C case temperature .....              | 18 |
| Figure 16 – An example of receiver skew affected by receiving power level .....                          | 18 |
| Figure 17 – Accumulation curve of transmitter skew with PinH = –12 and –3 dBm .....                      | 19 |

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## FIBRE OPTIC COMMUNICATION SYSTEM DESIGN GUIDES –

## Part 6: Skew design in parallel optical interconnection systems

## FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
- 3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
- 4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
- 5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
- 6) Attention is drawn to the possibility that some of the elements of this technical report may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example “state of the art”.

IEC 61282-6, which is a technical report, has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics.

The text of this technical report is based on the following documents:

|               |                  |
|---------------|------------------|
| Enquiry draft | Report on voting |
| 86C/343/DTR   | 86C/420/RVC      |

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

The committee has decided that the contents of this publication will remain unchanged until 2009. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

## INTRODUCTION

An explosive increase in data transmitted over networks is taking place. This will prompt investigation and development of Tb/s-class ATM (asynchronous-transfer-mode) switching systems, routers and massively parallel computers. The advance of these systems is driven mainly by the progress of silicon technology, to be more specific: enhancement of performance of CMOS-LSI to higher-speed and larger-scale-integration. Signal wiring, however, is becoming a bottleneck in the improvement of system performance according to the increasing throughput of LSI and printed board assembly. In these circumstances, optical interconnects have attracted attention to resolve the bottleneck. Optical interconnects are to realize signal wiring technology with high-density and high-throughput by optical signal transmission. This technology is applied to the signal transmission in comparatively short distances ranging from within-chip to within-building (less than 1 km).

Parallel optical interconnects, where each optical signal is synchronously transmitted through multiple fibres between multiport transmitter and receiver, are assumed to be the most promising means because of their high-throughput rate and cost-effectiveness. In the parallel optical interconnect, a skew, which is a propagation time deviation among channels, will be a serious issue. The skew of optical fibres is one or two orders in magnitude less than that of electrical wiring such as coaxial cables and twisted pair cables, etc. The careful management of skew is required, however, because increases of transmission speed and transmission distance are inevitable. Moreover, the skew is generated not only in fibre optic cables, but also by the differences of the interconnect lengths in transmitter and/or receiver circuits and printed circuit boards, and by the variance of turn-on delays in the laser diode and received optical power levels in the photodiode, etc. Therefore, it is important for users, system designers, and hardware suppliers to prescribe systematically the definitions, design method, and measurement method of skew from the standpoint of an optical system.

This technical report describes the definitions, classification and tolerance of skew in parallel optical interconnect systems.

## FIBRE OPTIC COMMUNICATION SYSTEM DESIGN GUIDES –

### Part 6: Skew design in parallel optical interconnection systems

#### 1 Scope

This technical report describes the definitions, classification, and tolerance of skew in parallel optical interconnect systems. Examples are given to illustrate the skew design method for allocating skew in the interconnect system. Annex A provides additional information on system-skew measurement.

NOTE Detailed definitions and a method of measuring the skew in optical fibre cables are beyond the scope of this document. They may be described in another IEC document.

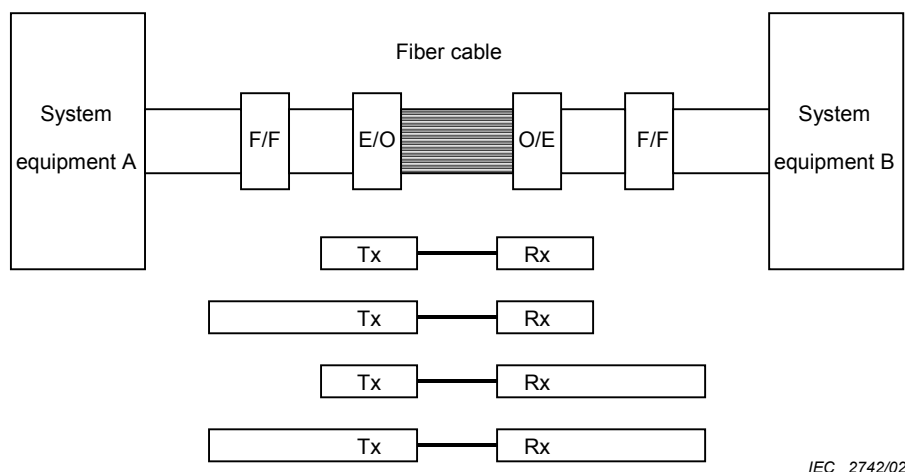
#### 2 Configuration of a parallel optical interconnection

##### 2.1 Schematic diagram of a parallel optical interconnection

In a parallel optical interconnect, transmission performance is attributed for the propagation time difference between the data and the clock during the latch-to-latch transmission, as well as in the electrical transmission. The basic elements of parallel optical interconnection are:

- optical transmitter array (including electrical-to-optical converter);
- optical fibre cable;
- optical receiver array (including optical-to-electrical converter); see Figure 1.

The skew in a parallel optical interconnect is defined for each of the elements above, corresponding to the configuration type of data latch and clock transmission scheme for synchronization.



IEC 2742/02

#### Key

E/O: electrical-to-optical converter

Tx: transmitter

O/E: optical-to-electrical converter

Rx: receiver

F/F: flip-flop circuit

**Figure 1 – Configuration of parallel optical interconnection**