PUBLICLY AVAILABLE SPECIFICATION

IEC PAS 62410

First edition
2005-08

Real-time Ethernet SERCOS III

Reference number
IEC/PAS 62410:2005(E)

Publication numbering

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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE XE

For price, see current catalogue

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Real-time Ethernet SERCOS III

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The Interest Group SERCOS interface (IGS) has the patent applications listed below:

German Publication Number DE 102 37 097 A1.

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IEC-PAS 62410 has been processed by subcommittee 65C: Digital communications, of IEC technical committee 65: Industrial-process measurement and control.

The text of this PAS is based on the following document:	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document
Draft PAS	**Report on voting**
65C/358/NP	65C/374/RVN

Following publication of this PAS, the technical committee or subcommittee concerned will transform it into an International Standard.

It is intended that the content of this PAS will be incorporated in the future new editions of the various parts of the IEC 61158 series and IEC 61784 series according to the structure of these series.

This PAS shall remain valid for an initial maximum period of three years starting from 2005-08. The validity may be extended for a single three-year period, following which it shall be revised to become another type of normative document or shall be withdrawn.

INTRODUCTION

This PAS relates to the integration of SERCOS III fieldbus specification in future editions of IEC 61158 and IEC 61784 series.

It shows in various clauses what updates are required in each of these individual standards. All definitions, abbreviations and symbols that relate to SERCOS III appear together in Section F, which belongs to the updates of IEC 61784-2, as a temporary fix.

NOTE 1 Some sections of this PAS still refer to IEC 61491. As it has been decided to split this standard into future IEC 61800 series, under consideration, (power drive systems) and IEC 61158/61784 series (communication) according to 65C/365/RQ, references to these new standards will be incorporated later on, in accordance with the relevant SC22G and SC65C working groups.

NOTE 2 For the reader who is unfamiliar with SERCOS interfaces, 17.3 of Section F can serve as a preface to the specific details which follow in later clauses.

NOTE 3 A temporary "Type S" has been allocated for SERCOS III.

The SERCOS/CPF16 standard structure is described in the table below.

IEC 61784-1 (new edition)	Communication profiles CP16/1 and CP16/2.	
	CP16/1 fits to the existing SERCOS specification IEC 61491:2002 (fibre optic media, 2 and 4 Mbit/s). IEC 61491 (new edition) shall not specify any communication and refer instead to CP16/1 in IEC 61784-1 after release of its new edition according to this structure proposal.	
	CP16/2 fits to the 2nd SERCOS generation (fibre optic media, 2, 4, 8 and 16 Mbit/s), which is downwards compatible to IEC 61491:2002 (CP16/1) while specifying additional features.	
IEC 61784-2 (1st edition)	Communication profiles CP16/3.	
	CP16/3 fits to the newest, real-time Ethernet SERCOS generation, which is application compatible to IEC 61491:2002 (CP16/1) and CP16/2 while specifying additional communication features.	Defined in the PAS.
IEC 61158-2 (new edition)	Physical layer specification for all CPF16 profiles (Type not yet known)	
	Type specifications for CP16/1 and CP16/2	
	Type specifications for CP16/3	Defined in the PAS
IEC 61158-3 (new edition)	Data Link layer service specification for all CPF16 profiles (Type not yet known)	
	Type specifications for CP16/1 and CP16/2	
	Type specifications for CP16/3	Defined in the PAS
IEC 61158-4 (new edition)	Data Link layer protocol specification for all CPF16 profiles (Type not yet known)	
	Type specifications for CP16/1 and CP16/2	
	Type specifications for CP16/3	Defined in the PAS

IEC 61158-5 (new edition)	Application Link layer service specification for all CPF16 profiles (Type not yet known)	
	Type specifications for CP16/1 and CP16/2	
	Type specifications for CP16/3	Defined in the PAS
IEC 61158-6 (new edition)	Application Link layer protocol specification for all CPF16 profiles (Type not yet known)	
	Type specifications for CP16/1 and CP16/2	
	Type specifications for CP16/3	Defined in the PAS

Section A – Update of IEC 61158-2

0 Introduction

0.5 Major Physical Layer variations specified in IEC 61158-2

0.5.1 Type S: optical media and twisted-pair wire

Type S specifies the following synchronous transmission:

a) optical fibre medium, at 2, 4, 8 and 16 Mbit/s;

b) twisted-pair wire medium, at 100 Mbit/s, according to ISO/IEC 8802-3 – 100Base-TX;

c) optical fibre medium, at 100 Mbit/s, according to ISO/IEC 8802-3 – 100Base-FX

2 Normative references

IEC 61491:2002, *Electrical equipment of industrial machines – Serial data link for real-time communication between controls and drives.*

ISO/IEC 8802-3:2001, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and Physical Layer specifications.*

29 Type S: Medium Attachment Unit: Ethernet 100Base-TX and 100 Base-FX

29.1 Transfer medium part of physical layer

29.1.1 Basics

The physical layer of the SERCOS profile is according to ISO/IEC 8802-3. Therein the transmission mode and the physical layer are specified. The transmission rate is 100 Mbit/s.

29.1.2 Topology

29.1.2.1 General

A SERCOS network uses slaves with integrated repeaters which have a constant delay time (t_{rep}, input → output). The topology consists of point-to-point transmission lines and participants. The master and the slaves are part of the network and are its participants. The connection line between the participants is a shielded CAT5 (or better) cable.

Each participant has two communication ports (port 1 and port 2). Port 1 (P1) and port 2 (P2) are interchangeable (see slave 3 in Figure 1 and Figure 2 for an example).

The topology can be either a ring structure or a line structure. A ring has two logical channels (see Figure 1) and a line has only one logical channel (see Figure 2).

The difference between ring and line structure is that the ring has a built-in redundancy against transmission media errors (e.g. cable break) and is therefore preferred.

A control unit may have one or more master interfaces depending on configuration. Each master handles only one network on the physical layer.

Slave interfaces are used to connect the devices to the network. At the physical layer, a slave represents the connection of one or more devices to the network. Logically, one slave with several devices acts the same as several slaves with each one device. The slaves are connected to each other physically through the network. Communication takes place between the master and the slaves; cross communication between the slaves is also supported.

The physical arrangement of slaves in the network is independent from the predefined device address ADR for the slave, as well as from the sequence of the real-time data fields in the AT and MDT. See 33.3.2 “Device address ADR” in IEC 61158-4, as well as 16.2 “Data transfer in RT channel” in IEC 61158-5.

Any slave can recognize the topology at any time, since there is a distinction between primary and secondary telegrams. This is important when a slave is added to the communication at a later point in time (hot plug). When a slave receives telegrams with the same SERCOS type on both ports (MDT0-P or MDT0-S) it recognizes a line. When it receives a MDT0-P on one port and a MDT0-S on the other port, it recognizes a ring.

29.1.2.2 Ring structure

The ring structure consists of a primary and secondary channel. All slaves work in forwarding mode (see Figure 1). Redundancy against cable break is achieved through this ring. It is also possible to open the ring and insert/remove slaves during operation (hot plug).

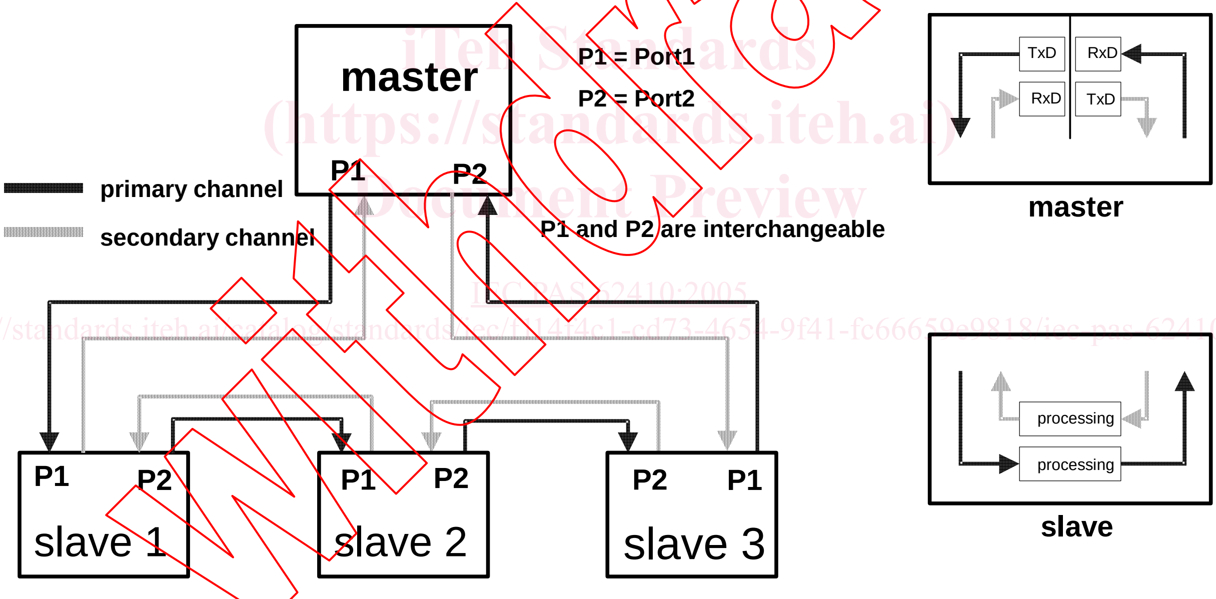

Figure 1 – Ring structure

29.1.2.3 Line structure

The line structure consists of either a primary or secondary channel. The last physical slave performs the loopback function. This is shown in Figure 2 with the loopback of slave 3. All other slaves work in forwarding mode. No redundancy against cable break is achieved. It is also possible to insert and remove slaves during operation (hot plug). This is restricted to the last physical slave. The ports which are not used for SERCOS communication (e.g., master port 2 and slave 3 port 1) can be used with IP communication. The master may communicate with slaves using two lines.

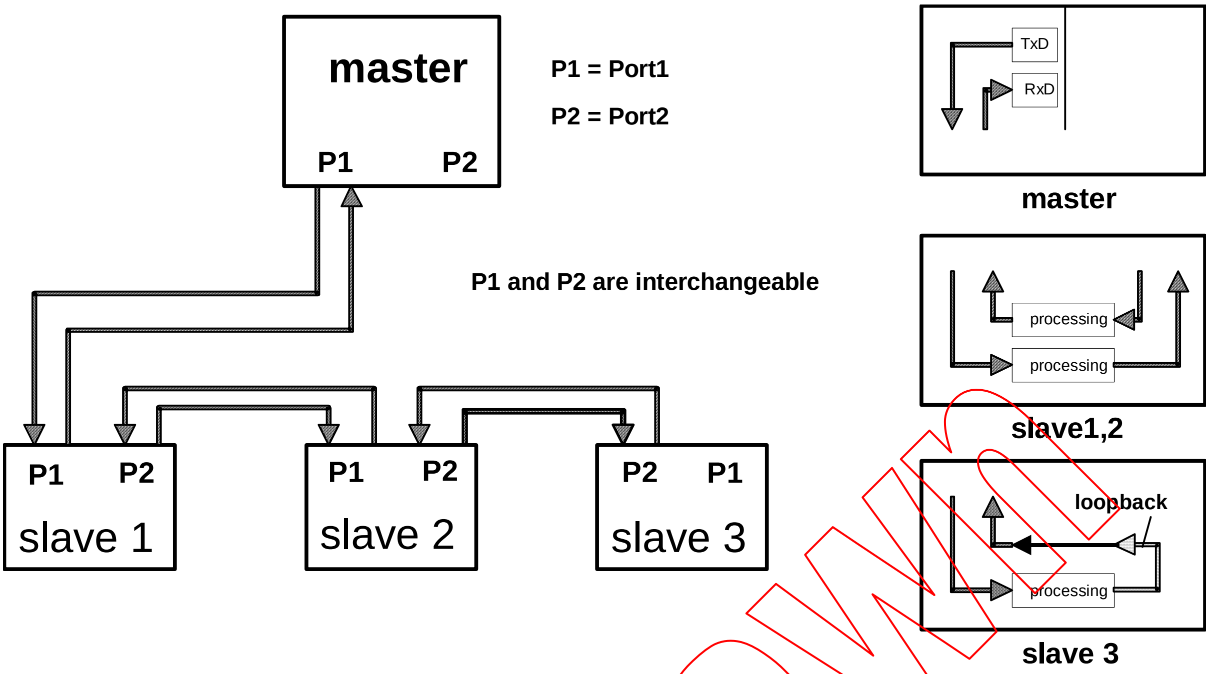

Figure 2 – Line structure

29.1.2.4 Transmission media

29.1.2.4.1 Transmission medium 100Base-TX

The characteristics of the 100Base-TX network are specified in ISO/IEC 8802-3. To ensure maximum noise immunity only shielded cables and connectors shall be used.

SERCOS devices shall use the MDI-X-ports with auto crossover function. The advantage is that standard cables as well as crossover cables (TxD / RxD) can be used.

29.1.2.4.2 Transmission medium 100Base-FX

The characteristics of the 100Base-FX network are specified in ISO/IEC 8802-3.

29.2 Communication mechanisms

29.2.1 General

Master and slave have the same hardware properties. Each port is assigned to a processing unit and a multiplexer (see Figure 3). The functions in the master and the slave depend on the topology and on the time slot within the communication cycle (RT channel or IP channel).

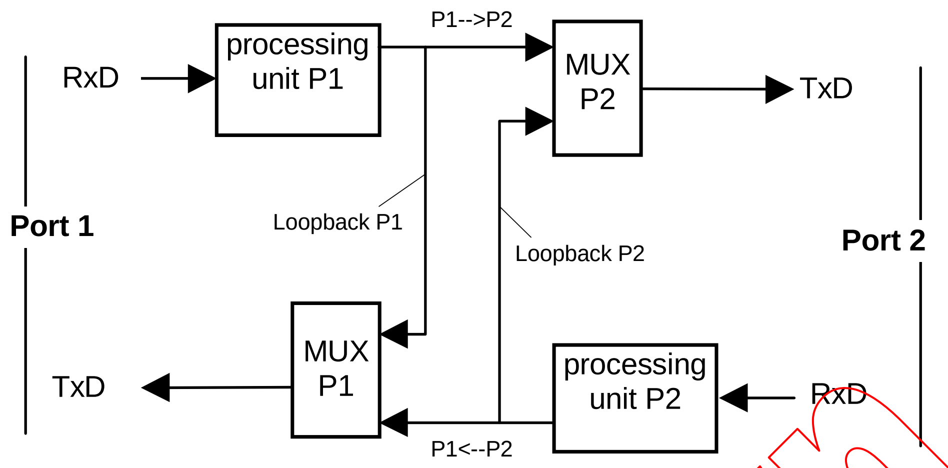

Figure 3 – Block diagram of master and slave

29.2.2 Forwarding

In the slave, the data from RxD (P1) shall be passed on with or without change to TxD (P2). The data from RxD (P2) shall be passed on with or without change to TxD (P1). See "Forwarding P1 → P2" and "Forwarding P2 → P1" in Figure 4). While the RT channel is active, the data shall be passed on, delayed by t_{REP}. While the IP channel is active, forwarding shall always be active and data shall be passed on, either at once or later in time, depending upon communication load.

In the master, forwarding shall always be switched off while the RT channel is active. While the IP channel is active, forwarding shall be:

- switched off if the master is connected to a single line configuration (only P1 or P2 is connected) or to an error-free ring configuration;
- activated if the master is connected to two independent lines or to a faulty ring configuration. Depending on the master's functionality, the telegrams may be passed on either at once or later in time.

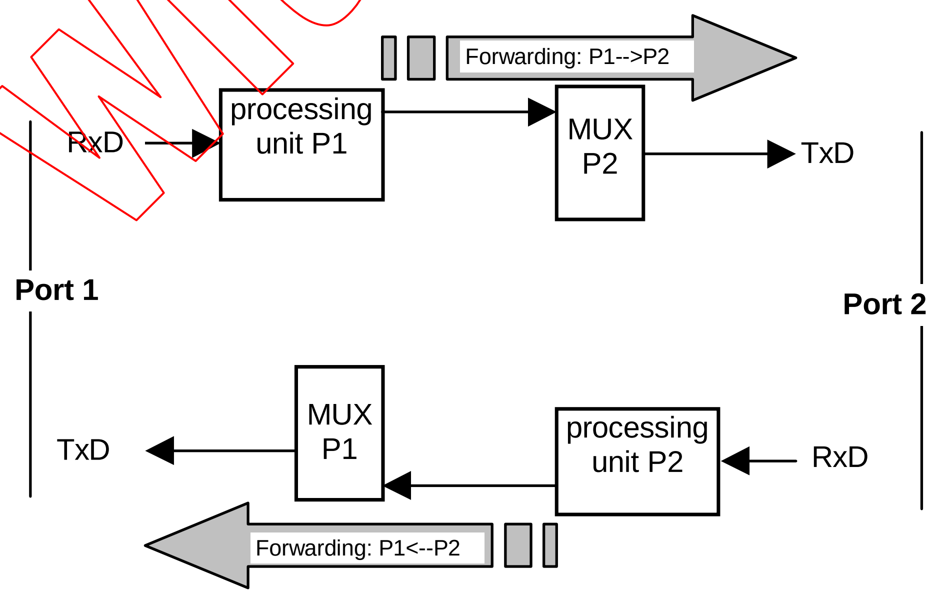

Figure 4 – Forwarding

29.2.3 Loopback

In the slave, the data from RxD (P1 or P2) shall be passed on with or without change to TxD (P1 and P2). Loopback may be activated either at P1 or P2 depending on the topology, but not at both ports simultaneously. The states are called "loopback P1", respectively "loopback P2". See Figure 5. While the IP channel is active, loopback shall never be active. While the RT channel is active, the slave shall activate loopback in the following (and only in those) cases:

- during CP0, as soon as an MDT0 has been received at a port (P1 or P2), but only as long as no MDT0 has been received at the other port;
- when the slave is the last physical one in the line topology;
- when a cable fault is detected.

The master shall have no loopback functionality.

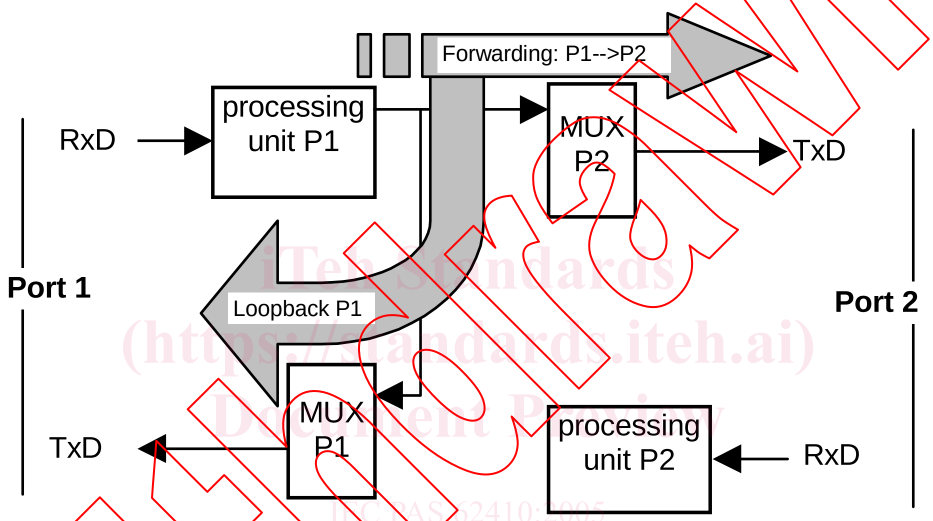

Figure 5 – Loopback

29.2.4 Device behaviour by addresses 0 and 255

Slaves with device addresses 0 and 255 shall also behave as described in 29.2.2 and 29.2.3. They shall also evaluate MDT0 in the same matter as the slaves with other addresses.

29.2.5 Redundancy of RT-Communication with ring topology

29.2.5.1 Ring topology without fault

Figure 6 shows an error free ring topology. The master shall send all telegrams with the same content on the P channel and on the S channel. Each slave shall receive both telegrams, work on the assigned data fields in P und S channel, and pass them on in their respective channels. Likewise, the master shall receive the telegrams from the slaves twice and process the data from the slave only once (either P or S channel).

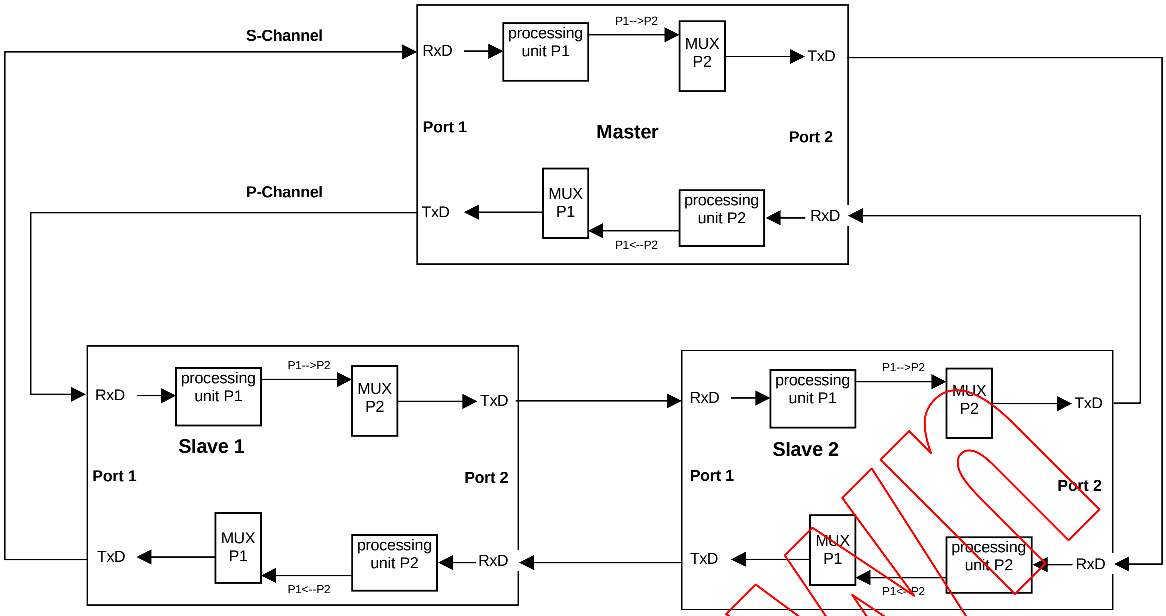

Figure 6 – Ring topology example with 2 slaves (example)

29.2.5.2 Cable faults between slaves

29.2.5.2.1 Case 1: Double channel interruption between two slaves

Figure 7 shows a first example of a faulty ring topology. Slave 1 shall detect an interruption at RxD of port 2 and close loopback at port 1. Slave 2 shall detect an interruption at RxD of port 1 and close loopback at port 2. The master shall receive the telegrams from slave 1 at port 1 only, and those from slave 2 at port 2 only.

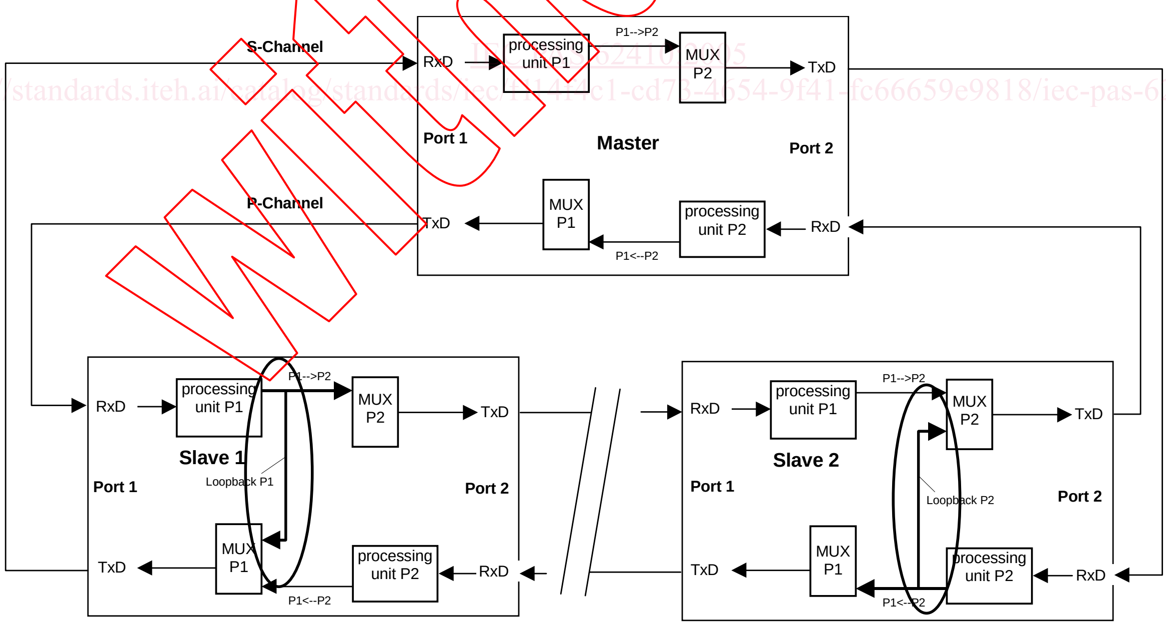

Figure 7 – Double channel interruption between two slaves (example)

29.2.5.2.2 Case 2: Single channel interruption between two slaves

Figure 8 shows another faulty ring topology example. Slave 1 shall detect an interruption at RxD of port 1 and close loopback at port 2. The master shall receive the telegrams from all slaves at port 1. At port 2, the master receives the telegrams from slave 2 in addition.