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## G.8023

### Corrigendum 1

(11/2018)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA,  
DIGITAL SYSTEMS AND NETWORKS

Packet over Transport aspects – Ethernet over Transport  
aspects

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Characteristics of equipment functional blocks  
supporting Ethernet physical layer and Flex  
Ethernet interfaces

### Corrigendum 1

Recommendation ITU-T G.8023 (2018) – Corrigendum 1

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*For further details, please refer to the list of ITU-T Recommendations.*

# Recommendation ITU-T G.8023

## Characteristics of equipment functional blocks supporting Ethernet physical layer and Flex Ethernet interfaces

### Corrigendum 1

#### Summary

Recommendation ITU-T G.8023 specifies both the functional components and the methodology that should be used in order to specify the Ethernet physical layer and Flex Ethernet interfaces.

Corrigendum 1 contains text modifications:

- to correct the description of the ETC40G and ETC100G reference points in clause 6.3;
- to correct the description of the dCCM mismatch detection process in clause 7.2.2.

#### History

Edition	Recommendation	Approval	Study Group	Unique ID*
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#### Keywords

Ethernet, functional blocks, physical layer.

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## **Introduction**

Recommendation ITU-T G.8023 forms part of a suite of ITU-T Recommendations covering the full functionality of Ethernet transport network architecture and equipment (e.g., Recommendations ITU-T G.8010/Y.1306 and ITU-T G.8021/Y.1341) and follows the principles defined in Recommendation ITU-T G.806.

This Recommendation specifies a library of basic building blocks and a set of rules by which they may be combined in order to describe Ethernet physical layer and Flex Ethernet interfaces. The building blocks are based on atomic modelling functions and combination rules defined in Recommendation ITU-T G.806.

This Recommendation includes atomic functions that replace the atomic functions that were previously published in clause 10 of Recommendation ITU-T G.8021 (2016).

# Recommendation ITU-T G.8023

## Characteristics of equipment functional blocks supporting Ethernet physical layer and Flex Ethernet interfaces

### Corrigendum 1

*Editorial note: This is a complete-text publication. Modifications introduced by this corrigendum are shown in revision marks relative to Recommendation ITU-T G.8023 (2018).*

#### 1 Scope

This Recommendation specifies the functions required to insert and extract information to/from an Ethernet physical layer (PHY) as defined in [IEEE 802.3], including the FlexE shim as defined in the OIF-FLEXE implementation agreement, for the purposes of mapping into an optical channel data unit (ODU) as defined in [ITU-T G.798], or performing media access control (MAC) layer operations on Ethernet frames as defined in [ITU-T G.8021].

#### 2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T G.709] Recommendation ITU-T G.709/Y.1331 (2016), *Interfaces for the optical transport network (OTN)*.
- [ITU-T G.798] Recommendation ITU-T G.798 (2017), *Characteristics of optical transport network hierarchy equipment functional blocks*.
- [ITU-T G.805] Recommendation ITU-T G.805 (2000), *Generic functional architecture of transport networks*.
- [ITU-T G.806] Recommendation ITU-T G.806 (2012), *Characteristics of transport equipment – Description methodology and generic functionality*.
- [ITU-T G.809] Recommendation ITU-T G.809 (2003), *Functional architecture of connectionless layer networks*.
- [ITU-T G.959.1] Recommendation ITU-T G.959.1 (2016), *Optical transport network physical layer interfaces*.
- [ITU-T G.7041] Recommendation ITU-T G.7041/Y.1303 (2016), *Generic framing procedure*.
- [ITU-T G.8010] Recommendation ITU-T G.8010/Y.1306 (2004), *Architecture of Ethernet layer networks*.
- [ITU-T G.8021] Recommendation ITU-T G.8021/Y.1341 (2018), *Characteristics of Ethernet transport network equipment functional blocks*.
- [IEEE 802.1AB] IEEE 802.1AB (2016), *IEEE Standard for Local and metropolitan area networks: Station and Media Access Control Connectivity Discovery*.

- [IEEE 802.1X] IEEE 802.1X (2010), *IEEE Standard for Local and metropolitan area networks – Port-Based Network Access Control*.
- [IEEE 802.3] IEEE 802.3 (2015), *IEEE Standard for Ethernet*.
- [IEEE 802.3bs] IEEE 802.3bs (2017), *IEEE Standard for Ethernet – Amendment 10: Media Access Control Parameters, Physical Layers and Management Parameters for 200 Gb/s and 400 Gb/s Operation*.
- [IEEE 802.3by] IEEE 802.3by (2016), *IEEE Standard for Ethernet – Amendment 2: Media Access Control Parameters, Physical Layers, and Management Parameters for 25 Gb/s Operation*.
- [OIF FLEXE IA] Optical Internetworking Forum, *Flex Ethernet Implementation Agreement 1.1* (2017).

### 3 Definitions

#### 3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

- 3.1.1 **1000BASE-X**: [IEEE 802.3]
- 3.1.2 **100GBASE-R**: [IEEE 802.3]
- 3.1.3 **200GBASE-R**: [IEEE 802.3]
- 3.1.4 **25GBASE-R**: [IEEE 802.3]
- 3.1.5 **40GBASE-R**: [IEEE 802.3]
- 3.1.6 **400GBASE-R**: [IEEE 802.3]
- 3.1.7 **access point**: [ITU-T G.805]
- 3.1.8 **adaptation**: [ITU-T G.805]
- 3.1.9 **adapted information**: [ITU-T G.805]
- 3.1.10 **characteristic information**: [ITU-T G.805]
- 3.1.11 **connection point**: [ITU-T G.805]
- 3.1.12 **consequent actions**: [ITU-T G.805]
- 3.1.13 **defect correlations**: [ITU-T G.805]
- 3.1.14 **defects**: [ITU-T G.805]
- 3.1.15 **flow point**: [ITU-T G.809]
- 3.1.16 **optical tributary signal**: [ITU-T G.959.1]
- 3.1.17 **reconciliation sublayer**: [IEEE 802.3]
- 3.1.18 **termination flow point**: [ITU-T G.809]
- 3.1.19 **traffic unit**: [ITU-T G.809]
- 3.1.20 **trail termination**: [ITU-T G.805]

#### 3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

- 3.2.1 **electrical tributary signal**: Electrical signal that is placed within a network media channel for transport across an electrical link.



#### **4 Abbreviations and acronyms**

This Recommendation uses the following abbreviations and acronyms:

AI	Adapted Information
AP	Access Point
CBR	Constant Bit Rate
CI	Characteristic Information
CK	Clock
COMMS	Communications channel
CP	Connection Point
CRC	Cyclic Redundancy Check
D	Data
DE	Drop Eligibility
EMF	Equipment Management Function
ERSy	Ethernet Reconciliation sublayer for PHY y
ESMC	Ethernet Synchronization Message Channel
ETCy	Ethernet Coding sublayer for PHY y
ETH	Ethernet MAC layer
ETSi[G]	Electrical Tributary Signal or Electrical Tributary Signal Group
FCS	Frame Check Sequence
FlexE	Flex-Ethernet
FlexEC	Flex-Ethernet Client
FP	Flow Point
FS	Frame Start
IF	In-Frame
ILA	In-multiLane-Alignment
MAC	Media Access Control
MFS	MultiFrame Start
MI	Management Information
MP	Management Point
ODU	Optical channel Data Unit
OOF	Out-Of-Frame
OLA	Out-of-multilane-Alignment
OTN	Optical Transport Network
OTSi[G]	Optical Tributary Signal or Optical Tributary Signal Group
P	Priority
PCS	Physical Coding Sublayer
PDU	Protocol Data Unit

PHY	Ethernet Physical layer
PMA	Physical Medium Attachment
PP	replication Point
RP	Remote Point
RPF	Remote PHY Fault
SSF	Server Signal Fail
TCP	Termination Connection Point
TFP	Termination Flow Point
TP	Timing Point
VLAN	Virtual Local Area Network

## 5 Conventions

For the basic methodology to describe transport network functionality of network elements, refer to clause 5 of [ITU-T G.806]. For Ethernet-specific extensions to the methodology, see clause 5 of [ITU-T G.8010].

The convention MI\_[IEEE 802.3] is used to indicate the MI\_ input/output signals required to map the management attributes, defined in clause 30 of [IEEE 802.3], for the [IEEE 802.3] processes supported by this adaptation function. Their detailed definition is intentionally left outside the scope of this Recommendation.

The following conventions are used in naming layer networks:

The server layer for the adaptation functions is modelled as a group of one or more optical or electrical signals. xTSi[G] is used to indicate this generically. The 'x' takes the value O or E when naming specific server layers; the G is present for the case where a group of signals is used or absent when only a single signal is present.

y is used as a variable for the client layer in the adaptation functions, specifically:

CBRy is used to indicate a nominal rate of a constant bit rate (CBR) signal, with 'y' indicating the rate using the form "unit value, unit, [fractional unit value]", for example 10G3 for a signal with a nominal rate of 10.3 Gbps.

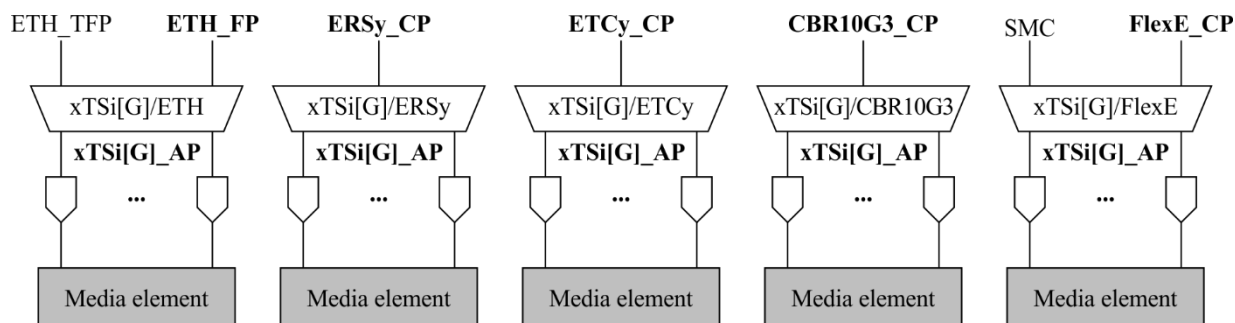
ERSy indicates a reconciliation sublayer of an Ethernet PHY, and ETCy indicates a coding sublayer of an Ethernet PHY, with 'y' describing the PHY using IEEE nomenclature, minus the word BASE. For example, the coding sublayer for 1000BASE-X PHY would be ETC1000X.

The label *[IEEE 802.3] processes* is used in multiple process diagrams to refer to processes performed by an adaptation function that are defined in [IEEE 802.3]. The processes referenced may encompass the entire 802.3 PHY, or only some of the sublayers of the PHY, depending on the nature of the specific adaptation function. The text that accompanies the process diagrams clarifies which portions of the PHY are being referenced.

## 6 xTSi[G] to client layer adaptation functions

The modelling of the Ethernet PHY relies heavily on existing description in [IEEE 802.3]. The physical lanes of the PHY are modelled as optical tributary signals (OTSi) or electrical tributary signals (ETSi) with modulators/demodulators, as is done with optical transport network (OTN) signals in [ITU-T G.798].

This clause describes the adaptation functions for the OTSi[G] and ETSi[G] to the client. In addition to the MAC layer as a client, several different types of clients are defined based on the different types of mappings of Ethernet into OTN. Figure 6-1 illustrates the OTSi[G] and ETSi[G] to client adaptation functions.



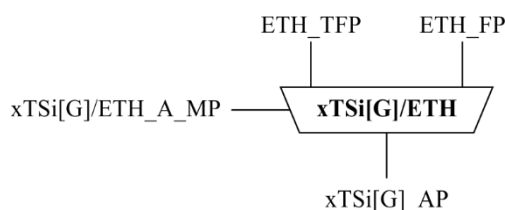
NOTE – In case of a single OTSi or ETSi, only one OTSi/ETSi modulator/demulator is applicable

G.8023(18)\_F6-1

**Figure 6-1 – OTSi[G] and ETSi[G] to client adaptation functions**

### 6.1 xTSi[G] to ETH adaptation functions (xTSi[G]/ETH\_A)

The xTSi[G] to Ethernet MAC layer (ETH) adaptation functions fully encapsulate a single Ethernet PHY layer with no FlexE shim and adapts it to MAC layer frames. Adaptation of a FlexE signal is discussed in clauses 6.5, 7 and 8. Figure 6-2 illustrates the xTSi[G] to ETH adaptation function (xTSi[G]/ETH\_A). Information crossing the ETH flow point (ETH\_FP) and ETH termination flow point (ETH\_TFP) is referred to as ETH characteristic information (ETH\_CI). Information crossing the xTSi[G] access point (xTSi[G]\_AP) is referred to as xTSi[G] adapted information (xTSi[G]\_AI).

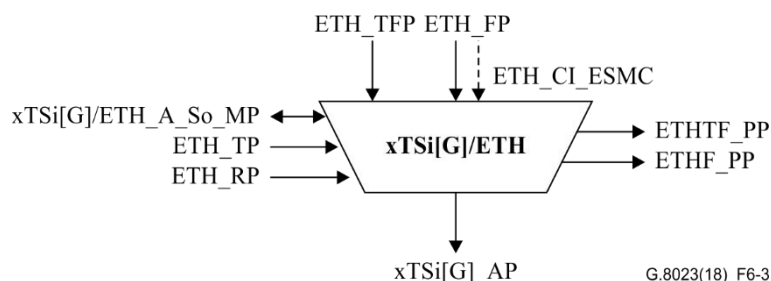


G.8023(18)\_F6-2

**Figure 6-2 – xTSi[G] to ETH adaptation function**

#### 6.1.1 xTSi[G] to ETH adaptation source function (xTSi[G]/ETH\_A\_So)

**Symbol**



G.8023(18)\_F6-3

**Figure 6-3 – xTSi[G]/ETH\_A\_So symbol**

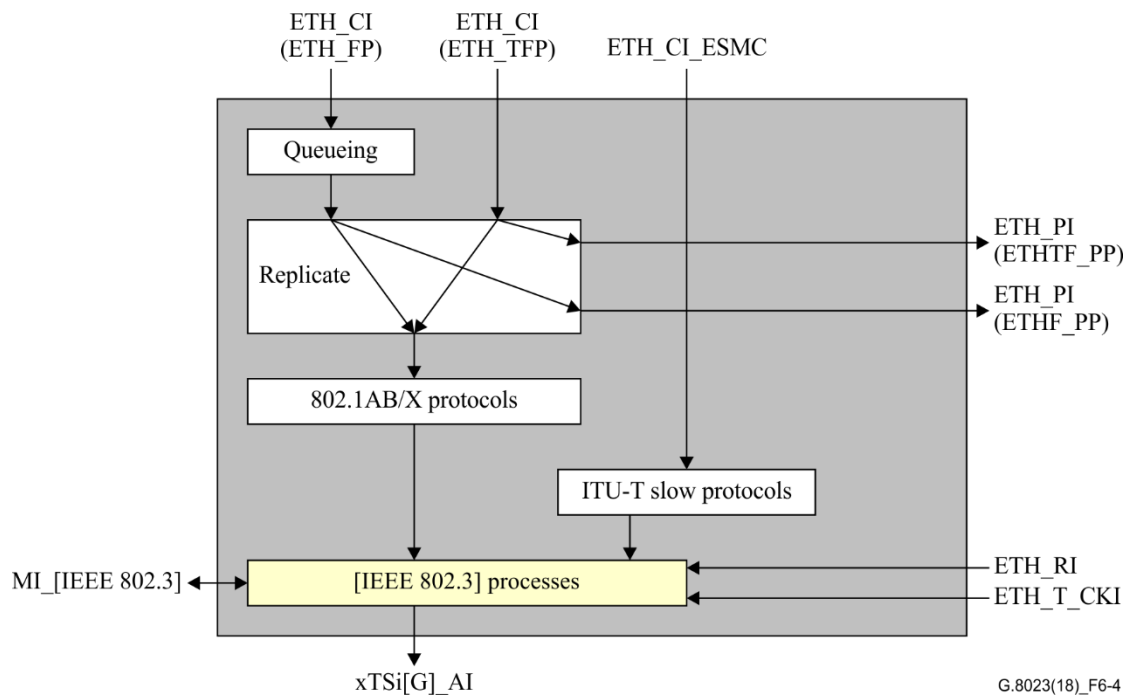
## Interfaces

**Table 6-1 – xTSi[G]/ETH\_A\_So interfaces**

Inputs	Outputs
<b>ETH_TFP:</b> ETH_CI_D ETH_CI_P ETH_CI_DE  <b>ETH_FP:</b> ETH_CI_D ETH_CI_P ETH_CI_DE ETH_CI_SSF ETH_CI_SSFrdi ETH_CI_SSFfdi ETH_CI_ESMC  <b>ETH_TP:</b> ETH_TI_CK  <b>xTSi[G]/ETH_A_RP:</b> xTSi[G]/ETH_A_RI_RSF  <b>xTSi[G]/ETH_A_So_MP:</b> xTSi[G]/ETH_A_So_MI_[IEEE 802.3] xTSi[G]/ETH_A_So_MI_FTSEnable	<b>xTSi[G]_AP:</b> xTSi[G]_AI_D[1..N] (Note)  <b>ETHTF_PP:</b> ETH_PI_D ETH_PI_P ETH_PI_DE  <b>ETHF_PP:</b> ETH_PI_D ETH_PI_P ETH_PI_DE  <b>xTSi[G]/ETH_A_RP:</b> xTSi[G]/ETH_A_RI_FTS  <b>xTSi[G]/ETH_A_So_MP:</b> xTSi[G]/ETH_A_So_MI_[IEEE 802.3]
NOTE – When the PHY has only one OTSi, there is only one OTSi_AI_D signal.	

## Processes

A process diagram of this function is shown in Figure 6-4.



**Figure 6-4 – xTSi[G]/ETH\_A\_So process**

### Processes

The queueing, replicate, and 802.1AB/X protocols processes are defined in clause 8 of [ITU-T G.8021].

#### *ITU slow protocols*

The ITU slow protocols use OUI=0x0019A7. The ITU-T slow protocol process allows for multiplexing multiple ITU defined protocols by using an ITU-T subtype.

The ITU slow protocols source process takes an incoming protocol data unit (PDU) and creates an ETH\_CI traffic unit by adding the ITU-T subtype and encapsulating the resulting ITU-T slow protocol PDU within the Organization Specific Data (as defined in Annex 57B of [IEEE 802.3]):

DA=01-80-C2-00-00-02 (hex)

SA=local MAC address

EtherType=88-09 (hex)

Slow protocol type=0A (hex)

OUI=0x0019A7

Organization specific data=ITU-T slow protocol PDU.

#### *Supported ITU-T subtypes*

01: Ethernet synchronization message channel (ESMC) as defined in [ITU-T G.8264]. The ESMC PDUs are received from the CI\_ESMC.

#### *"Fault propagation" process*

When the CI\_SSF and the MI\_FTSEnable (forced transmitter shutdown) are true and RI\_RSF (remote signal fail) is false, this process forces the transmitter shutdown by either turning off the output transmitting device or inserting error codes (e.g., /V/, 10B\_ERR for 1 GbE).

As soon as the transmitter shutdown is forced, the RI\_FTS is asserted. The RI\_FTS is reset after the forcing of transmitter shutdown is removed.

When the CI\_SSFr<sub>di</sub> is true and the PHY supports remote fault signalling, this process inserts the PHY-specific remote fault signal.

When the CI\_SSF<sub>di</sub> is true and the PHY supports local fault signalling, this process inserts the PHY-specific local fault signal.

NOTE 1 – Further details have been intentionally left out of this Recommendation.

**[IEEE 802.3] processes:** The [IEEE 802.3] processes represent the entire physical layer in the IEEE 802.3 model, as well as the MAC frame counting, frame check sequence (FCS) generation, generation of 802.3 slow protocols, and multiplexing of organization-specific and 802.3 slow protocols.

NOTE 2 – This Recommendation defines these processes by reference to [IEEE 802.3] and intentionally does not provide details, as this functionality is well understood from the IEEE work.

**Defects:** None.

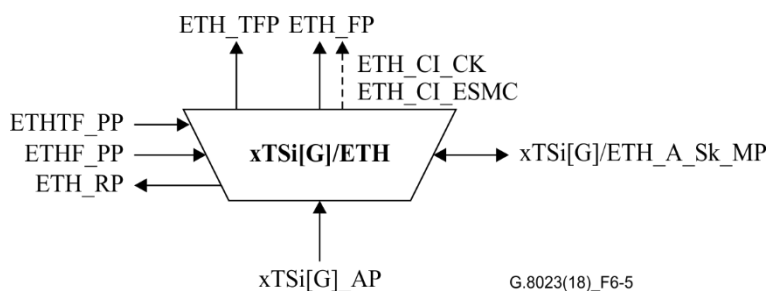
**Consequent actions:** None.

**Defect correlations:** None.

**Performance monitoring:** For further study.

### 6.1.2 xTSi[G] to ETH adaptation sink function (xTSi[G]/ETH\_A\_Sk)

**Symbol**



**Figure 6-5 – xTSi[G]/ETH\_A\_Sk symbol**

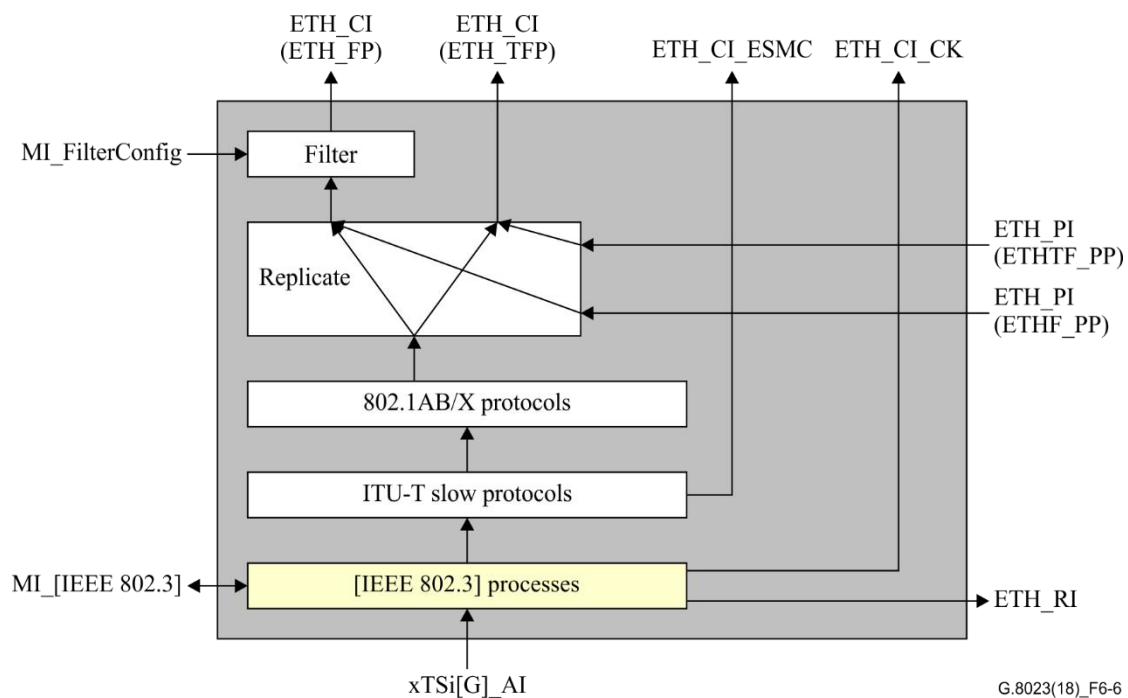
## Interfaces

**Table 6-2 – xTSi[G]/ETH\_A\_Sk interfaces**

Inputs	Outputs
<b>xTSi[G]_AP:</b> xTSi[G]_AI_D[1..N] (Note)	<b>ETH_TFP:</b> ETH_CI_D ETH_CI_P ETH_CI_DE
<b>ETHTF_PP:</b> ETH_PI_D ETH_PI_P ETH_PI_DE	<b>ETH_FP:</b> ETH_CI_D ETH_CI_P ETH_CI_DE ETH_CI_SSF ETH_CI_SSFrdi ETH_CI_SSFfdi ETH_CI_CK ETH_CI_ESMC
<b>ETHF_PP:</b> ETH_PI_D ETH_PI_P ETH_PI_DE	
<b>xTSi[G]/ETH_A_RP:</b> xTSi[G]/ETH_A_RI_FTS	<b>xTSi[G]/ETH_A_RP:</b> xTSi[G]/ETH_A_RI_RSf
<b>xTSi[G]/ETH_A_Sk_MP:</b> xTSi[G]/ETH_A_Sk_MI_[IEEE 802.3] xTSi[G]/ETH_A_Sk_MI_FilterConfig	<b>xTSi[G]/ETH_A_Sk_MP:</b> xTSi[G]/ETH_A_Sk_MI_[IEEE 802.3]
NOTE – When the PHY has only one OTSi, there is only one OTSi_AI_D signal.	

## Processes

A process diagram of this function is shown in Figure 6-6.



**Figure 6-6 – xTSi[G]/ETH\_A\_Sk process**

The filter, replicate, and 802.1AB/X protocols processes are defined in clause 8 of [ITU-T G.8021].

**[IEEE 802.3] processes:** The [IEEE 802.3] processes represent the entire physical layer in the IEEE 802.3 model, plus the MAC length check, MAC frame check, MAC frame counting, slow protocols demultiplexing, and 802.3 slow protocols processing. Pause frames are always discarded.

NOTE – This Recommendation defines these processes by reference to [IEEE 802.3] and intentionally does not provide details, as this functionality is well understood from the IEEE work.

#### *ITU slow protocols*

The ITU slow protocols use OUI=0x0019A7. The ITU-T slow protocol process allows for multiplexing multiple ITU defined protocols by using an ITU-T subtype.

ITU slow protocols sink process separates the ETH\_CI traffic units carrying ITU slow protocol PDUs with supported ITU-T subtypes from the rest of the ETH\_CI traffic units. The former are passed to the corresponding processing function; the latter are passed through.

For the PDUs with supported ITU-T subtypes, this process extracts the ITU-T slow protocol PDU from the Organization Specific Data field of the received ETH\_CI traffic units and removes the ITU-T subtype from it. The resulting PDU is forwarded to the protocol process identified by the removed ITU-T subtype.

#### *Supported ITU-T subtypes*

01: ESMC as defined in [ITU-T G.8264].

#### **Defects**

The definition of defects used by xTSi[G]/ETH\_A\_Sk is outside the scope of this Recommendation.

#### **Consequent actions**

When an incoming signal failure is detected as specified in [IEEE 802.3], and the RI\_FTS is false, the aSSF consequent action is triggered.

NOTE 1 – aRSF is generated and communicated to the paired xTSi[G]/ETH\_A\_So (RI\_RSf) to prevent a forced transmitter shutdown in case of an incoming signal failure. This Recommendation does not specify the remote fault indication signalling.

When a PHY-specific remote fault signalling (as defined in [IEEE 802.3]) is detected, and the PHY supports remote fault signalling, the aSSFrdi consequent action is triggered.

When a PHY-specific local fault signalling (as defined in [IEEE 802.3]), and the PHY supports local fault signalling, the aSSFfdi consequent action is triggered.

NOTE 2 – Further details are intentionally left outside the scope of this Recommendation.

**Defect correlations:** None.

**Performance monitoring:** For further study.

## **6.2 OTSi to 10G Ethernet reconciliation sublayer adaptation functions (OTSi/ERS10G\_A)**

The OTSi to ERS10G adaptation functions perform the adaptation between the optical signal and the characteristic information of an ERS10G signal. They are used only in conjunction with the ODU2P/ERS10G\_A functions defined in clause 14.3.3 of [ITU-T G.798].

#### **ERS10G characteristic information**

The ERS10G\_CI is a stream of ERS10G\_CI\_D traffic units, complemented with the ERS10G\_CI\_SSF signal. The ERS10G\_CI\_D traffic units carry either an Ethernet data frame, including the preamble, or an ordered set, as defined in clause 7.9 of [ITU-T G.7041]. The ordered

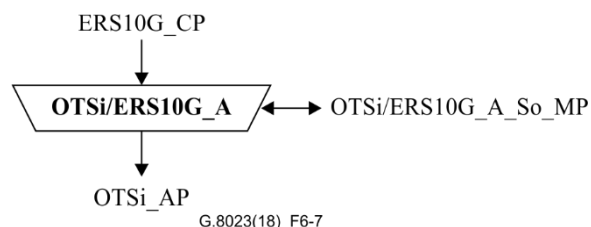


sets may carry local fault or remote fault indications. The ERS10G\_CP reference point is located within the reconciliation sublayer (see Figure 44-1 of [IEEE 802.3]).

NOTE – There is no Ethernet MAC process in these adaptation functions. Consequently, since no error checking is performed on the Ethernet MAC frames, errored MAC frames are forwarded in both ingress and egress directions.

### 6.2.1 OTSi to 10G Ethernet reconciliation sublayer source adaptation function (OTSi/ERS10G\_A\_So)

#### Symbol



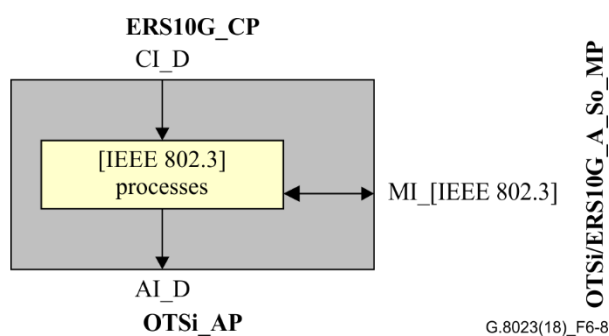
**Figure 6-7 – OTSi/ERS10G\_A\_So function**

#### Interfaces

**Table 6-3 – OTSi/ERS10G\_A\_So inputs and outputs**

Input(s)	Output(s)
<b>ERS10G_CP:</b> ERS10G_CI_D	<b>OTSi_AP:</b> OTSi_AI_D
<b>OTSi/ERS10G_A_So_MP:</b> OTSi/ERS10G_A_So_MI_[IEEE 802.3]	<b>OTSi/ERS10G_A_So_MP:</b> OTSi/ERS10G_A_So_MI_[IEEE 802.3]

#### Processes



**Figure 6-8 – xTSi/ERS10G\_A\_So processes**

**[IEEE 802.3] processes:** The [IEEE 802.3] processes represent the whole functionality of the physical layer in [IEEE 802.3] model below the ERS10G\_CP reference point.

NOTE – This Recommendation defines these processes by reference to [IEEE 802.3] and intentionally does not provide details, as this functionality is well understood from the IEEE work.

**Defects:** None.

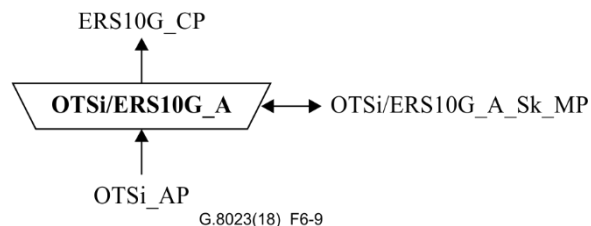
**Consequent actions:** None.

**Defect correlations:** None.

**Performance monitoring:** None.

## 6.2.2 OTSi to 10G Ethernet reconciliation sublayer sink adaptation function (OTSi/ERS10G\_A\_Sk)

### Symbol



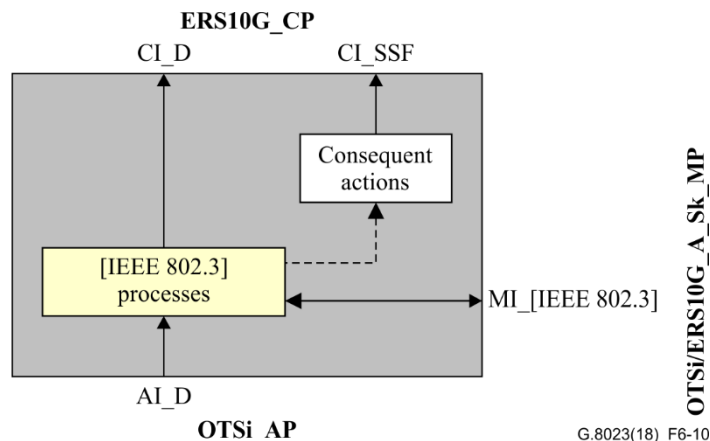
**Figure 6-9 – OTSi/ERS10G\_A\_Sk function**

### Interfaces

**Table 6-4 – OTSi/ERS10G\_A\_Sk inputs and outputs**

Input(s)	Output(s)
<b>OTSi_AP:</b> OTSi_AI_D	<b>ERS10G_CP:</b> ERS10G_CI_D ERS10G_CI_SSF
<b>OTSi/ERS10G_A_Sk_MP:</b> OTSi/ERS10G_A_Sk_MI_[IEEE 802.3]	<b>OTSi/ERS10G_A_Sk_MP:</b> OTSi/ERS10G_A_Sk_MI_[IEEE 802.3]

### Processes



**Figure 6-10 – OTSi/ERS10G\_A\_Sk processes**

**[IEEE 802.3] processes:** The [IEEE 802.3] processes represent the whole functionality of the physical layer in [IEEE 802.3] model below the ERS10G\_CP reference point.

NOTE – This Recommendation defines these processes by reference to [IEEE 802.3] and intentionally does not provide details, as this functionality is well understood from the IEEE work.

### Defects

The definition of the defects used by the OTSi/ERS10G\_A\_Sk is outside the scope of this Recommendation.

### Consequent actions

When an incoming signal failure is detected, as specified in [IEEE 802.3], the aSSF consequent action is triggered.

NOTE 1 – Further details are intentionally left outside the scope of this Recommendation.

NOTE 2 – The replacement signal is generated in the subsequent adaptation source function ODU2P/ETHPP-OS\_A\_So defined in 14.3.3 of [ITU-T G.798].

**Defect correlations:** None.

**Performance monitoring:** None.

### 6.3 xTSi[G] to Ethernet coding adaptation functions (xTSi[G]/ETCy\_A)

The set of xTSi[G] to ETCy (y=1000X, 25GR, 40GR, 100GR, 200GR, 400GR) adaptation functions adapt between a group of one or more optical signals (depending on the client) and the characteristic information of the ETCy layer. These functions are used in conjunction with functions that provide codeword-transparent mapping into a non-Ethernet server layer.

The following specific functions are defined:

OTSi/ETC1000X\_A  
xTSi/ETC25GR\_A  
xTSi[G]/ETC40GR\_A  
xTSiG/ETC100GR\_A  
OTSiG/ETC200GR\_A  
OTSiG/ETC400GR\_A

#### ETCy characteristic information

The ETCy\_CI is a stream of ETCy\_CI\_D traffic units, complemented with the ETCy\_CI\_CK and the ETCy\_CI\_SSF signals. For the case of ETC200GR and ETC400GR, the CI is further complemented with ETCy\_CI\_AM\_SF and ETCy\_CI\_FEC\_DEG signals, corresponding to rx\_am\_sf<2:0> and tx\_am\_sf<2:0>, and FEC\_degraded\_SER, respectively, in [IEEE 802.3bs].

The ETC1000X\_CI\_D traffic units carry 8B/10B codewords of the 1000BASE-X physical coding sublayer (PCS), as defined in clause 36 of [IEEE 802.3].

The ETC25GR\_CI\_D traffic units carry the 64b/66b codewords of the 25GBASE-R PCS, as defined in clauses 49 and clause 107 of [IEEE 802.3].

The ETC40GR\_CI\_D traffic units and ETC100GR\_CI\_D traffic units carry 64b/66b codewords of the 40GBASE-R or 100GBASE-R PCS, respectively, as defined in clause 82 of [IEEE 802.3].

The ETC200GR\_CI\_D and ETC400GR\_CI\_D traffic units carry 64b/66b codewords of the 200GBASE-R and 400GBASE-R PCS, respectively, as defined in clause 119 of [IEEE 802.3bs].

For 1000BASE-X interfaces, the ETC1000X\_CP reference point is the interface between the PCS and physical medium attachment (PMA) sublayers as shown in Figure 34-1 of [IEEE 802.3].

For 25GBASE-R interfaces, the ETC25GR\_CP reference point is the interface between the PCS and PMA (or FEC) sublayers, as shown in Figure 107-2 of [IEEE 802.3by].

For 40GBASE-R interfaces, the ETC40GR\_CP reference point is within the 40GBASE-R PCS. With respect to Figure 82.2 of [IEEE 802.3], in the source function, the reference point is below the Alignment insertion process; in the sink function, it is between the alignment lock/lane deskew and lane reorder processes. ~~between the encode/decode and scramble/descramble processes; see Figure 82-2 of [IEEE 802.3].~~

For 100GBASE-R interfaces, the ETC100GR\_CP reference point is within the 100GBASE-R PCS. With respect to Figure 82.2 of [IEEE 802.3], in the source function, the reference point is below the alignment insertion process; in the sink function, it is between the alignment lock/lane deskew and

lane reorder processes, ~~between the encode/decode and scramble/descramble processes; see Figure 82-2 of [IEEE 802.3].~~

For 200GBASE-R interfaces, the ETC200GR\_CP reference point is within the 200GBASE-R PCS, between the encode/decode and rate match process and the transcode/reverse transcode process, including the FEC\_degraded\_SER and rx\_local\_degraded bits; see Figure 119-2 and clause 19.2.4.1 of [IEEE 802.3bs].

For 400GASE-R interfaces, the ETC400GR\_CP reference point is within the 400GBASE-R PCS, between the encode/decode and rate match process and the transcode/reverse transcode process, including the FEC\_degraded\_SER and rx\_local\_degraded bits; see Figure 119-2 of and clause 19.2.4.1 [IEEE 802.3bs].

### 6.3.1 xTSi[G] to Ethernet coding adaptation source function (xTSi[G]/ETCy\_A\_So)

#### Symbol

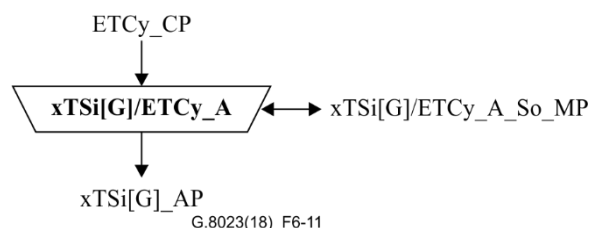


Figure 6-11 – xTSi[G]/ETCy\_A\_So function

#### Interfaces

Table 6-5 – xTSi[G]/ETCy\_A\_So inputs and outputs

Input(s)	Output(s)
<b>ETCy_CP:</b> ETCy_CI_CK ETCy_CI_D  For y=200GR or 400GR: ETCy_CI_AM_SF[2:0]	<b>xTSi[G]_AP:</b> xTSi_AI_D[1..N] (Note)
<b>xTSi[G]/ETCy_A_So_MP:</b> xTSi[G]/ETCy_A_So_MI_[IEEE 802.3]	<b>xTSi[G]/ETCy_A_So_MP:</b> xTSi[G]/ETCy_A_So_MI_[IEEE 802.3]
NOTE – When the PHY has only one OTSi, there is only one OTSi_AI_D signal.	

#### Processes

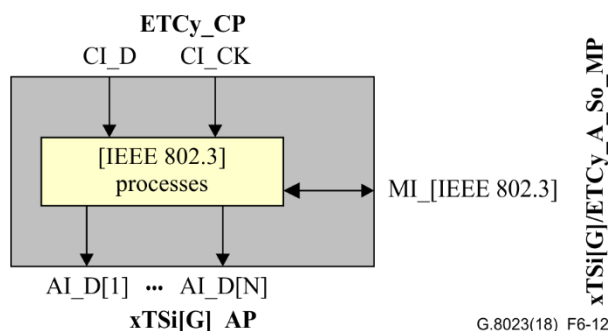


Figure 6-12 – xTSi[G]/ETCy\_A\_So processes

**[IEEE 802.3] processes:** The [IEEE 802.3] processes represent the whole functionality of the physical layer in IEEE 802.3 model below the ETCy\_CP reference point.

NOTE – This Recommendation defines these processes by reference to [IEEE 802.3] and intentionally does not provide details, as this functionality is well understood from the IEEE work.

**Defects:** None.

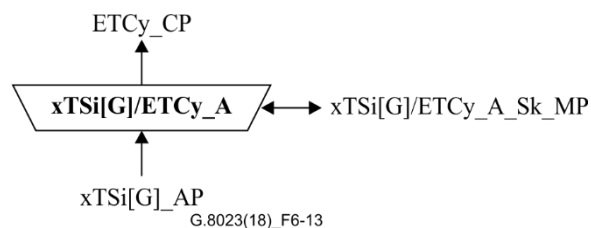
**Consequent actions:** None.

**Defect correlations:** None.

**Performance monitoring:** None.

### 6.3.2 xTSi[G] to Ethernet coding adaptation sink function (xTSi[G]/ETCy\_A\_Sk)

**Symbol**



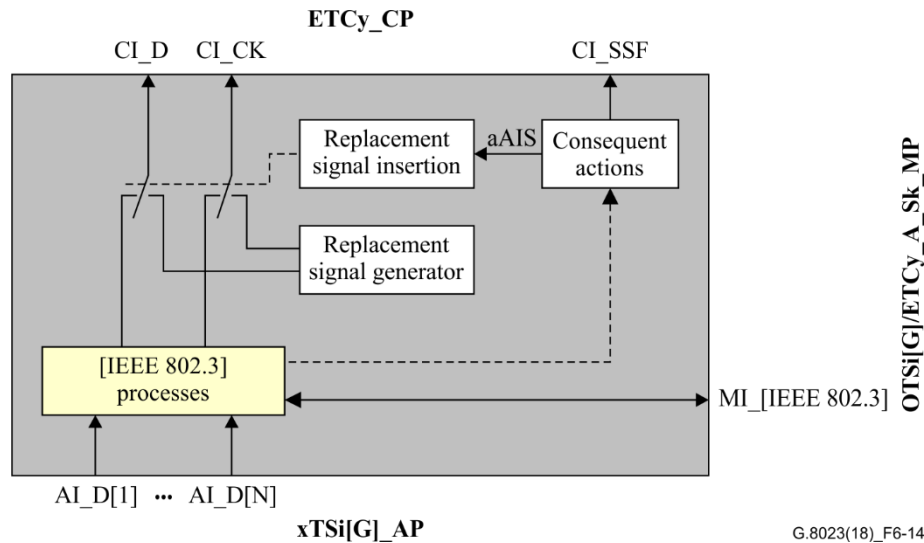
**Figure 6-13 – xTSi[G]/ETCy\_A\_Sk function**

**Interfaces**

**Table 6-6 – xTSi[G]/ETCy\_A\_Sk inputs and outputs**

Input(s)	Output(s)
<b>xTSi[G]_AP:</b> xTSi_AI_D[1..N] (Note)	<b>ETCy_CP:</b> ETCy_CI_CK ETCy_CI_D ETCy_CI_SSF  For y=200GR or 400GR: ETCy_CI_AM_SF[2:0] ETCy_CI_FEC_DEG
<b>xTSi[G]/ETCy_A_Sk_MP:</b> xTSi[G]/ETCy_A_Sk_MI_[IEEE 802.3]	<b>xTSi[G]/ETCy_A_Sk_MP:</b> xTSi[G]/ETCy_A_Sk_MI_[IEEE 802.3]
NOTE – When the PHY has only one OTSi, there is only one OTSi_AI_D signal.	

## Processes



**Figure 6-14 – xTSi[G]/ETCy\_A\_Sk processes**

**[IEEE 802.3] processes:** The [IEEE 802.3] processes represent the whole functionality of the physical layer in IEEE 802.3 model below the ETcy\_CP reference point.

NOTE 1 – This Recommendation defines these processes by reference to [IEEE 802.3] and intentionally does not provide details, as this functionality is well understood from the IEEE work.

### Defects

The definition of the defects used by the xTSi[G]/ETCy\_A\_Sk is outside the scope of this Recommendation.

### Consequent actions

When an incoming signal failure is detected, as specified in [IEEE 802.3], aSSF and aAIS consequent actions are triggered.

NOTE 2 – Further details are intentionally left outside the scope of this Recommendation.

On declaration of aAIS, the function shall output a replacement signal.

For 1000BASE-X, the replacement signal is defined in clause 17.7.1.1 of [ITU-T G.709].

For 25GBASE-R, the replacement signal is defined in clause 17.13 of [ITU-T G.709].

For 40GBASE-R clients, the replacement signal is defined in clause 17.7.4 of [ITU-T G.709].

For 100GBASE-R clients, the replacement signal is defined in clause 17.7.5 of [ITU-T G.709].

For 200GBASE-R clients, the replacement signal is defined in clause 17.13 of [ITU-T G.709].

For 400GBASE-R clients, the replacement signal is defined in clause 17.13 of [ITU-T G.709].

**Defect correlations:** None.

**Performance monitoring:** None.

## 6.4 OTSi to CBR10G3 adaptation functions (OTSi/CBR10G3\_A)

The OTSi to CBR10G3 adaptation functions perform the adaptation between the optical signal and the characteristic information of a CBR10G3 signal. It is used in conjunction with the ODU2eP/CBR10G3\_A function as specified in clause 14.3.1 of [ITU-T G.798].

## CBR10G3 characteristic information

The CBR10G3\_CP reference point is located within the PMA sublayer as shown in Figure 44-1 of [IEEE 802.3], at the point where conversion between the serial bit stream and the 16-bit data occurs.

### 6.4.1 OTSi to CBR10G3 adaptation source function (OTSi/CBR10G3\_A\_So)

#### Symbol

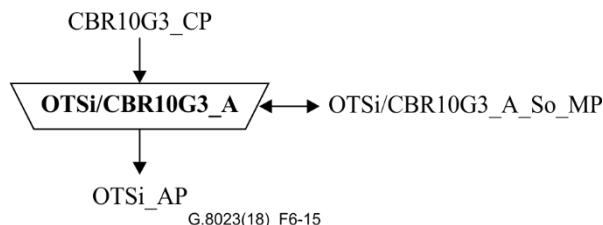


Figure 6-15 – OTSi/CBR10G3\_A\_So function

#### Interfaces

Table 6-7 – OTSi/CBR10G3\_A\_So inputs and outputs

Input(s)	Output(s)
<b>CBR10G3_CP:</b> CBR10G3_CI_CK CBR10G3_CI_D	<b>OTSi_AP:</b> OTSi_AI_D
<b>OTSi/CBR10G3_A_So_MP:</b> OTSi/CBR10G3_A_So_MI_[IEEE 802.3]	<b>OTSi/CBR10G3_A_So_MP:</b> OTSi/CBR10G3_A_So_MI_[IEEE 802.3]

#### Processes

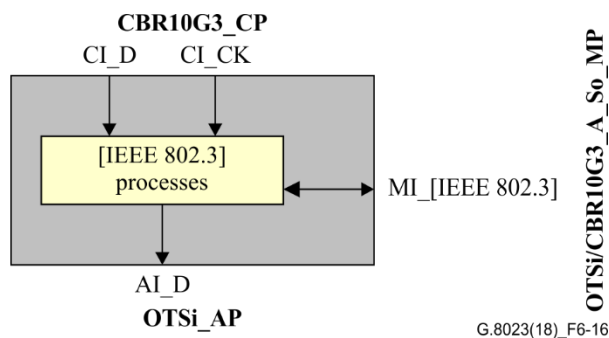


Figure 6-16 – xTSi(G)/CBR10G3\_A\_So processes

**[IEEE 802.3] processes:** The [IEEE 802.3] processes represent the whole functionality of the physical layer in IEEE 802.3 model below the CBR10G3\_CP reference point.

NOTE – This Recommendation defines these processes by reference to [IEEE 802.3] and intentionally does not provide details on it, as this functionality is well understood from the IEEE work.

**Defects:** None.

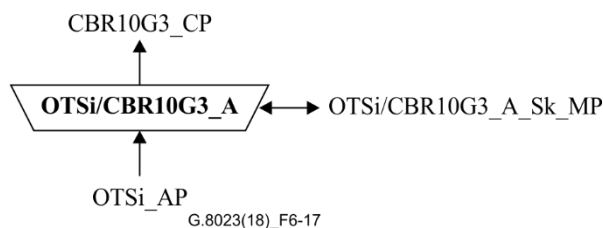
**Consequent actions:** None.

**Defect correlations:** None.

**Performance monitoring:** None.

## 6.4.2 OTSi to CBR10G3 adaptation sink function (OTSi/CDR10G3\_A\_Sk)

### Symbol



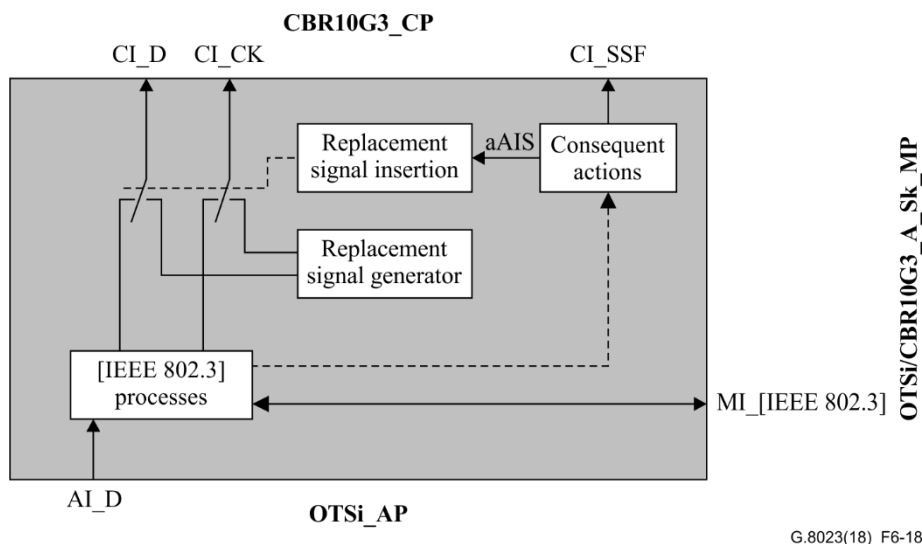
**Figure 6-17 – OTSi/CDR10G3\_A\_Sk function**

### Interfaces

**Table 6-8 – OTSi/CDR10G3\_A\_Sk inputs and outputs**

Input(s)	Output(s)
<b>OTSi_AP:</b> OTSi_AI_D	<b>CDR10G3_CP:</b> CDR10G3_CI_CK CDR10G3_CI_D CDR10G3_CI_SSF
<b>OTSi/CDR10G3_A_Sk_MP:</b> OTSi/CDR10G3_A_Sk_MI_[IEEE 802.3]	<b>OTSi/CDR10G3_A_Sk_MP:</b> OTSi/CDR10G3_A_Sk_MI_[IEEE 802.3]

### Processes



**Figure 6-18 – OTSi/CDR10G3\_A\_Sk processes**

**IEEE 802.3] processes:** The IEEE processes represent the whole functionality of the physical layer in IEEE 802.3 below the CDR10G3\_CP reference point.

NOTE 1 – This Recommendation defines these processes by reference to [802.3] and intentionally does not provide details, as this functionality is well understood from the IEEE work.

### Defects

The definition of the defects used by the OTSi/CDR10G3\_A\_Sk is outside the scope of this Recommendation.



## Consequent actions

When an incoming signal failure is detected, as specified in [IEEE 802.3], aSSF and aAIS consequent actions are triggered.

NOTE 2 – Further details are intentionally left outside the scope of this Recommendation.

On declaration of aAIS, the function shall output a replacement signal, as defined in clause 17.2 of [ITU-T G.709] and clause 14.3.1.3 of [ITU-T G.798].

**Defect correlations:** None.

**Performance monitoring:** None.

## 6.5 OTSi[G] to Flex Ethernet (FlexE) adaptation functions (OTSi[G]/FlexE\_A)

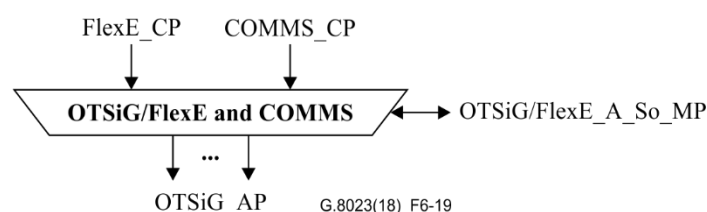
The OTSiG to FlexE adaptation functions perform the adaptation between the group of optical signals related with a PHY that is part of a FlexE group and the characteristic information of the FlexE layer signal.

The FlexE characteristic information is defined in clause 7.

### 6.5.1 OTSiG to FlexE adaptation source function (OTSiG/FlexE\_A\_So)

The information flow and processing of the OTSiG/FlexE\_A\_So function is defined with reference to Figures 6-19 and 6-20.

#### Symbol



**Figure 6-19 – OTSiG/FlexE\_A\_So function**

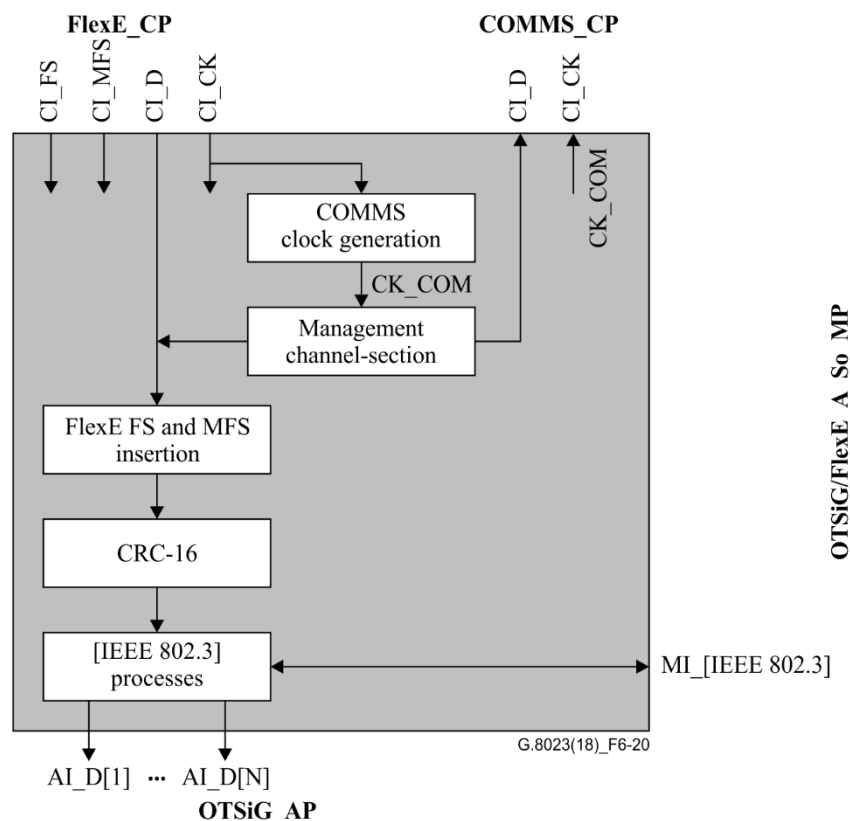
#### Interfaces

**Table 6-9 – OTSiG/FlexE\_A\_So inputs and outputs**

Input(s)	Output(s)
<b>FlexE_CP:</b> FlexE_CI_CK FlexE_CI_D FlexE_CI_FS FlexE_CI_MFS	<b>OTSiG_AP:</b> OTSiG_AI_D[1..N]
<b>COMMS_CP:</b> COMMS_CI_D	<b>COMMS_CP:</b> COMMS_CI_CK
	<b>OTSiG/FlexE_A_So_MP:</b> OTSiG/FlexE_A_So_MI_[IEEE 802.3]

#### Processes

The processes associated with the OTSiG/FlexE\_A\_So function are as depicted in Figure 6-20.



**Figure 6-20 – OTSiG/FlexE\_A\_So processes**

**Communications channel (COMMS) clock (CK) generation:** The function shall generate the COMMS clock (CK\_COM) by dividing the clock (CI\_CK) by a factor of 81844.

**Management channel – section:** The management channel is optional. When used, the incoming COMMS\_CI\_D data is inserted into the management channel – section field as described in clause 7.3.5 of [OIF FLEXE IA]. When it is not used, Ethernet idle control blocks are inserted as described in clause 7.3.5 of [OIF FLEXE IA].

**FlexE FS and MFS insertion:** The function shall insert the FlexE frame alignment signal (i.e., frame start (FS)) and FlexE multiframe alignment signal (i.e., multiframe start (MFS)) as described in clause 7.3.1 of [OIF FLEXE IA]. The FlexE frame alignment signal is defined by the pattern "0x4B" in bits 0 to 7 and the pattern 0x5 in bits 32 to 35.

**Cyclic redundancy check (CRC)-16:** See clause 7.3.9 of [OIF FLEXE IA]. The function shall compute the CRC-16 and insert the calculated CRC-16 value into the CRC-16 byte of FlexE overhead field.

**[IEEE 802.3] processes:** The [IEEE 802.3] processes represent the whole functionality of the PCS sublayer below the FlexE shim, as well as the PMA and PMD sublayers in the IEEE 802.3 model.

NOTE – This Recommendation defines these processes by reference to [IEEE 802.3] and intentionally does not provide details, as this functionality is well understood from the IEEE work.

**Defects:** None.

**Consequent actions:** None.

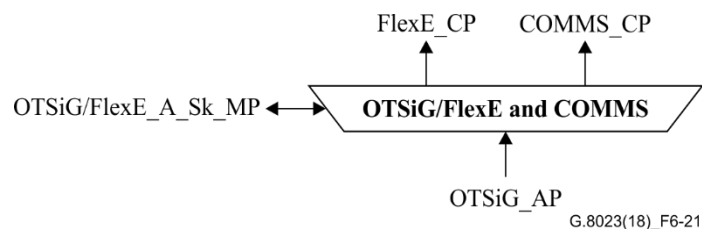
**Defect correlations:** None.

**Performance monitoring:** None.

### 6.5.2 OTSiG to FlexE adaptation sink function (OTSiG/FlexE\_A\_Sk)

The information flow and processing of the OTSiG/FlexE\_A\_Sk function is defined with reference to Figures 6-21 and 6-22.

#### Symbol



**Figure 6-21 – OTSiG/FlexE\_A\_Sk function**

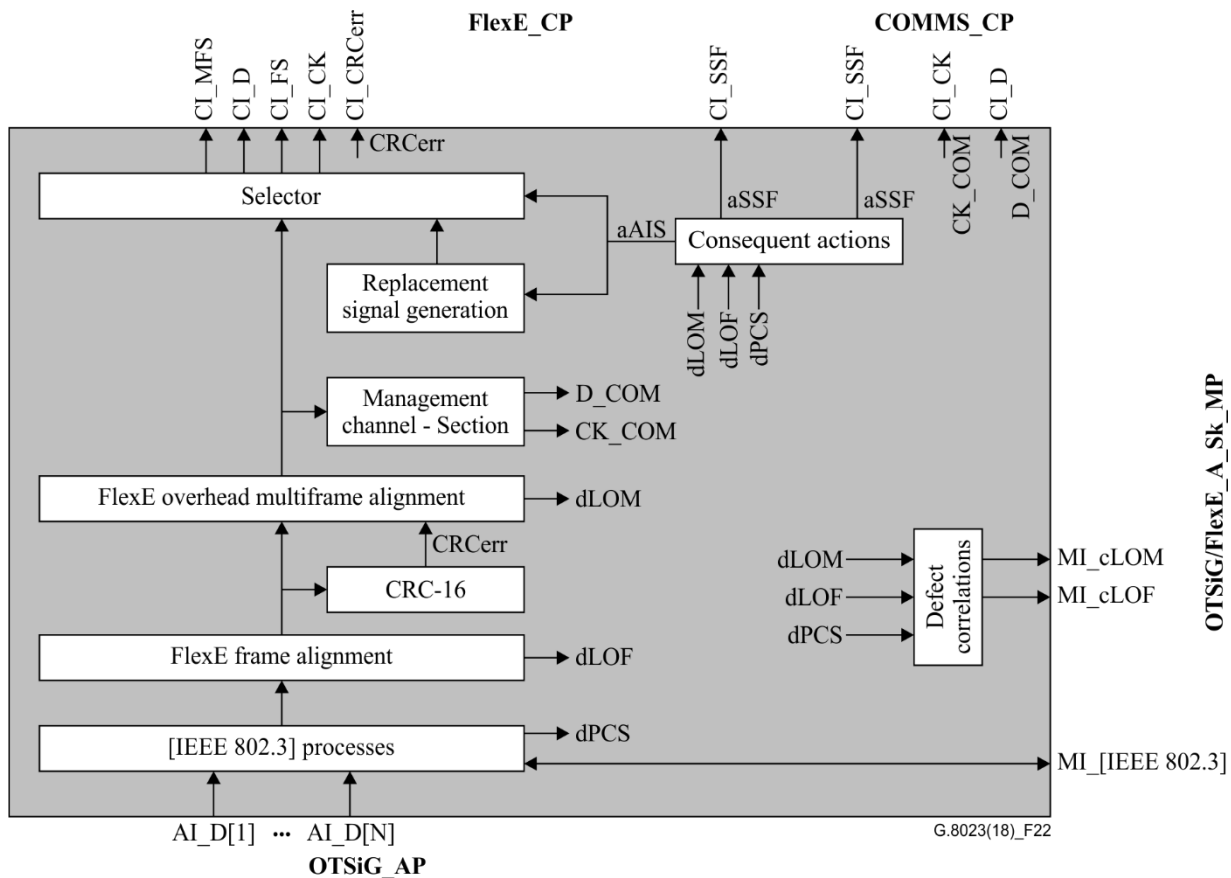
#### Interfaces

**Table 6-10 – OTSiG/FlexE\_A\_Sk inputs and outputs**

Input(s)	Output(s)
<b>OTSiG_AP:</b> OTSiG_AI_D[1..N]  <b>OTSiG/FlexE_A_Sk_MP:</b> OTSiG/FlexE_A_Sk_MI_1second	<b>FlexE_CP:</b> FlexE_CI_CK FlexE_CI_D FlexE_CI_FS FlexE_CI_MFS FlexE_CI_CRCerr FlexE_CI_SSF  <b>COMMS_CP:</b> COMMS_CI_D COMMS_CI_CK COMMS_CI_SSF  <b>OTSiG/FlexE_A_Sk_MP:</b> OTSiG/FlexE_A_Sk_MI_[IEEE 802.3] OTSiG/FlexE_A_Sk_MI_cLOF OTSiG/FlexE_A_Sk_MI_cLOM

#### Processes

The processes associated with the OTSiG/FlexE\_A\_Sk function are as depicted in Figure 6-22.



**Figure 6-22 – OTSiG/FlexE\_A\_Sk processes**

**[IEEE 802.3 processes]:** The [IEEE 802.3] processes represent the whole functionality of the PCS sublayer below the FlexE shim, as well as the PMA and PMD sublayers in the IEEE 802.3 model.

NOTE – This Recommendation defines these processes by reference to [IEEE 802.3] and intentionally does not provide details, as this functionality is well understood from the IEEE work.

**FlexE frame alignment:** The function shall recover the FlexE frame start through recognizing the FlexE block 1 of the FlexE overhead frame as described in clause 7.3.1 of [OIF FLEXE IA]. The FlexE block 1 of the FlexE overhead frame is encoded as a special ordered set (the sync header is 10, the control block type is 0x4B (ordered set), and the "O" code is 0x5) and present once per  $(1023 \times 20 + 1) \times 8$  blocks. The process has two states, out-of-frame (OOF) and in-frame (IF). The frame alignment start shall be maintained during the OOF state. In the OOF state, the frame alignment shall be assumed to be recovered and the IM state shall be entered, when a valid FlexE block 1 is found in two consecutive FlexO overhead frames. In the IF state, out-of-multiframe (OOM) shall be entered when FlexE block 1 of the FlexE overhead frame is lost if the sync header, control block type, or O code do not match at the expected position for five occurrences.

**CRC-16:** See clause 7.3.9 of [OIF FLEXE IA]. The CRC-16 is extracted from the CRC-16 field. If the extracted CRC-16 value can be divisibility by the expected polynomial, CRCerr is set to 0 (the default value); otherwise, CRCerr is set to 1.

**FlexE overhead multiframe alignment:** The function shall recover the FlexE overhead multi frame start of 32 frames through recognizing the OMF overhead with a good CRC (CRCerr = 0). The OMF (overhead multiframe) bit has a value of "0" for the first sixteen overhead frames of the overhead multiframe, and a value of "1" for the last sixteen overhead frames of the overhead multiframe, as described in clause 7.3.1 of [OIF FLEXE IA]. The specific process is described in clause B.2.1.2 of [ITU-T G.798].

**Management channel – section:** The management channel is for user specific and the corresponding COMMS data (D\_COM) and COMMS clock (CK\_COM) is extracted from the management channel – section field described in clause 7.3.5 of [OIF FLEXE IA].

**Replacement signal generation:** When aAIS is true, the function shall provide for a FlexE replacement signal and clock generation process that generates a stream of local fault sequence ordered sets as specified in clause 5.2.2.3 of [OIF FLEXE IA].

**Selector:** The function shall select the normal FlexE signal or the replacement signal. When aAIS is true, it shall select the replacement signal. Otherwise, it shall select the normal FlexE signal.

## Defects

The function shall detect dPCS, dLOF and dLOM.

**dPCS:** This defect represents any defect detected by the [IEEE 802.3] processes in the portion of the PCS below the FlexE shim, or in the PMA or PMD sublayers.

**dLOF:** The loss of FlexE frame defect dLOF is generated based on the state of the FlexE Frame alignment process. See dLOF described in clause B.1.1.1.1 of [ITU-T G.798].

**dLOM:** The loss of FlexE overhead multiframe defect dLOM is generated based on the state of the FlexE overhead multiframe alignment process. See dLOM described in clause B.1.1.1.2 of [ITU-T G.798].

## Consequent actions

aSSF  $\leftarrow$  dLOM or dLOF or dPCS

aAIS  $\leftarrow$  dLOM or dLOF or dPCS

On declaration of aAIS, the function shall output an FlexE replacement signal, which consists of a continuous stream of Local Fault ordered sets at a bit rate of  $103.125 \text{ Gb/s} \times \frac{16383}{16384} \pm 100 \text{ ppm}$ , within two FlexE frames. On clearing aAIS, the FlexE replacement signal shall be removed within two FlexE frames, with normal data being output. The FlexE replacement signal clock, frame start and multiframe start shall be independent from the incoming clock, frame start and multiframe start. The FlexE replacement signal clock has to be within the frequency range  $103.125 \text{ Gb/s} \times \frac{16383}{16384} \pm 100 \text{ ppm}$ .

## Defect correlations

cLOF  $\leftarrow$  dLOF and (not dPCS)

cLOM  $\leftarrow$  dLOM and (not dLOF) and (not dPCS)

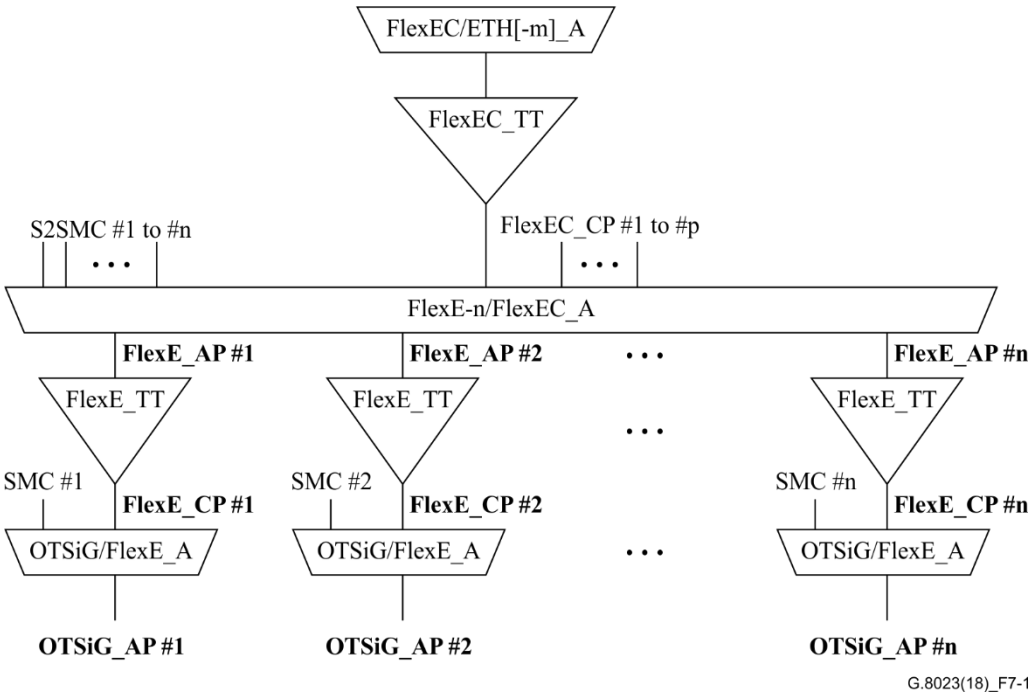
## Performance monitoring

Performance monitoring is part of the [IEEE 802.3] processes. There is no additional performance monitoring for the FlexE-related processes.

## 7 Flex Ethernet (FlexE) functions

Figure 7-1 illustrates the FlexE and FlexE client adaptation functions. While these are modelled as multiple layer networks, the intent of FlexE technology is to provide a mechanism for bonding PCS lanes from one or more PHYs into a larger PHY, which is traditionally an adaptation function. The FlexE model is not intended to imply that connection functions exist for the FlexE or FlexEC information.

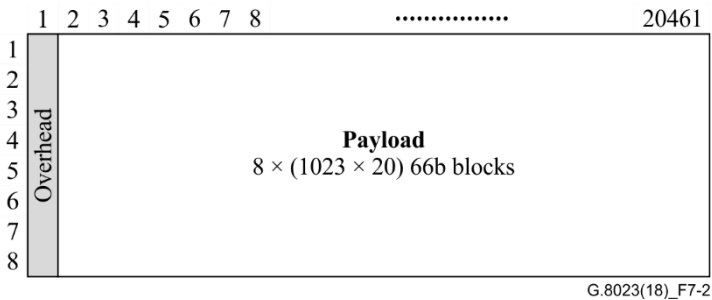
The information crossing the FlexE connection point (FlexE\_CP) is referred to as the FlexE characteristic information (FlexE\_CI). The information crossing the FlexE access point (FlexE\_AP) is referred to as the FlexE adapted information (FlexE\_AI). The information crossing the FlexEC connection point (FlexEC\_CP) is referred to as the FlexEC characteristic information (FlexEC\_CI).



**Figure 7-1 – FlexE and FlexE client adaptation functions**

The FlexE characteristic information (FlexE\_CI) is a stream of FlexE\_CI traffic units complemented with FlexE\_CI\_CK, FlexE\_CI\_FS, FlexE\_CI\_MFS, FlexE\_CI\_CRCerr, and FlexE\_CI\_SSF signals. The FlexE\_CI traffic unit defines the FlexE\_CI\_D signal as the FlexE frame defined in Figure 7-2, with FlexE overhead per Figure 11 of [OIF FLEXE IA] except for the section management channel, CRC-16, frame alignment, and multiframe alignment fields. The shim-to-shim management overhead is optional. If it is not used, it is filled with Ethernet Idle control blocks, per clause 7.3.5 of [OIF FLEXE IA]. The RES overhead is set to all-ZEROs.

NOTE – The section management overhead, CRC-16, frame alignment, and multiframe alignment overhead fields of the FlexE overhead are processed in the OTSiG/FlexE\_A function; see clause 6.5.



**Figure 7-2 – FlexE frame**

The FlexE adapted information (FlexE\_AI) is a stream of FlexE\_AI traffic units complemented with FlexE\_AI\_CK, FlexE\_AI\_FS, FlexE\_AI\_MFS, FlexE\_AI\_CRCerr and FlexE\_AI\_TSF signals. The FlexE\_AI traffic unit defines the FlexE\_AI\_D signal, which consists of the FlexE\_CI without the remote PHY fault (RPF) overhead. The mapping-specific overhead depends on the client mapping scheme. In case of COMMS access at the FlexE\_AP, it also includes the FlexE Shim-to-Shim Management Channel overhead (S2SMC).

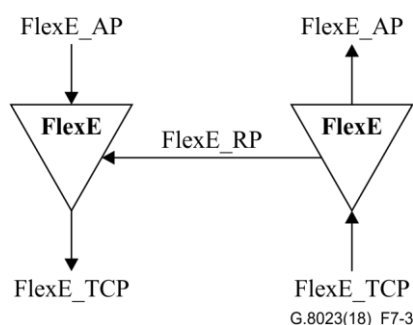
The FlexEC characteristic information (FlexEC\_CI) is a stream of FlexEC\_CI traffic units complemented with FlexEC\_CI\_CK and FlexEC\_CI\_SSF signals. The FlexEC\_CI traffic unit defines the FlexEC\_CI\_D signal as the FlexEC 66b block stream with the bit rates of 10, 40 and  $n \times 25$  Gbit/s ( $n \geq 1$ ) defined in Table 7-1.

**Table 7-1 – FlexEC clients**

FlexEC bit rate	Bit rate	Clock tolerance	Encoding	AM
10G	10 312 500 (kbit/s)	$\pm 100$ ppm	Clause 82 64b/66b	No
40G	41 250 000 (kbit/s)	$\pm 100$ ppm	Clause 82 64b/66b	No
$n \times 25$ G	$n \times 25$ 781 250 (kbit/s)	$\pm 100$ ppm	Clause 82 64b/66b	No

## 7.1 FlexE trail termination function (FlexE\_TT)

The FlexE\_TT function terminates the section monitoring overhead of the FlexE overhead to determine the status of the FlexE trail. Figure 7-3 shows the combination of the unidirectional sink and source functions to form a bidirectional function.



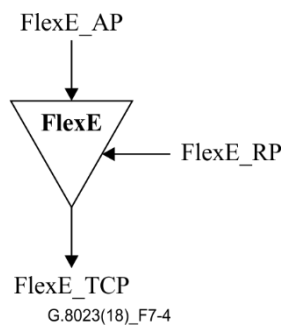
**Figure 7-3 – FlexE\_TT**

### 7.1.1 FlexE trail termination source function (FlexE\_TT\_So)

The FlexE\_TT\_So function adds section monitoring overhead – including the RPF signal – to the FlexE signal at its FlexE\_AP.

The information flow and processing of the FlexE\_TT\_So function is defined with reference to Figures 7-4 and 7-5.

#### Symbol



**Figure 7-4 – FlexE\_TT\_So function**

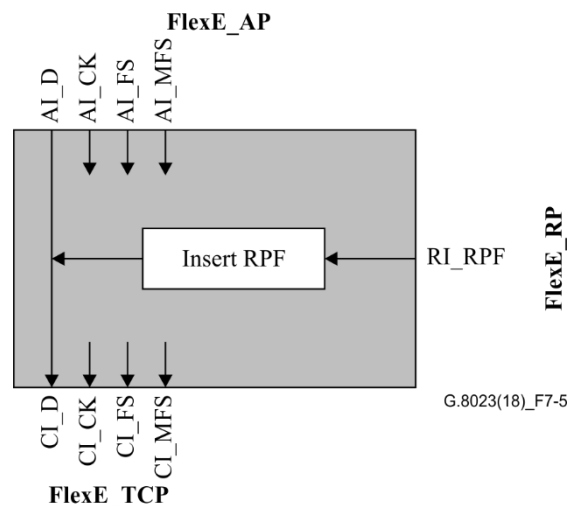
## Interfaces

**Table 7-2 – FlexE\_TT\_So inputs and outputs**

Input(s)	Output(s)
<b>FlexE_AP:</b> FlexE_AI_CK FlexE_AI_D FlexE_AI_FS FlexE_AI_MFS <b>FlexE_RP:</b> FlexE_RI_RPF	<b>FlexE_TCP:</b> FlexE_CI_CK FlexE_CI_D FlexE_CI_FS FlexE_CI_MFS

## Processes

The processes associated with the FlexE\_TT\_So function are as depicted in Figure 7-5.



**Figure 7-5 – FlexE\_TT\_So processes**

**RPF:** The remote PHY fault indication is inserted in the RPF bit position as described in clause 7.3.8 of [OIF FLEXE IA]. Its value is derived from reference point FlexE\_RP. Upon the declaration/clearing of aRPF at the termination sink function, the trail termination source function shall have inserted/removed the RPF indication within 50 ms.

**Defects:** None.

**Consequent actions:** None.

**Defect correlations:** None.

**Performance monitoring:** None.

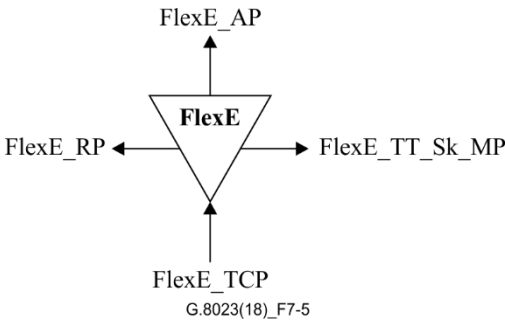
### 7.1.2 FlexE trail termination sink function (FlexE\_TT\_Sk)

The FlexE\_TT\_Sk function reports the state of the FlexE trail. It extracts FlexE monitoring overhead – including the RPF signal – from the FlexE signal at its FlexE\_TCP, detects for the RPF defect, and forwards the error and defect information as backward indications to the companion FlexE\_TT\_So function.

The information flow and processing of the FlexE\_TT\_Sk function is defined with reference to Figures 7-6 and 7-7.



**Symbol**



**Figure 7-6 – FlexE\_TT\_Sk function**

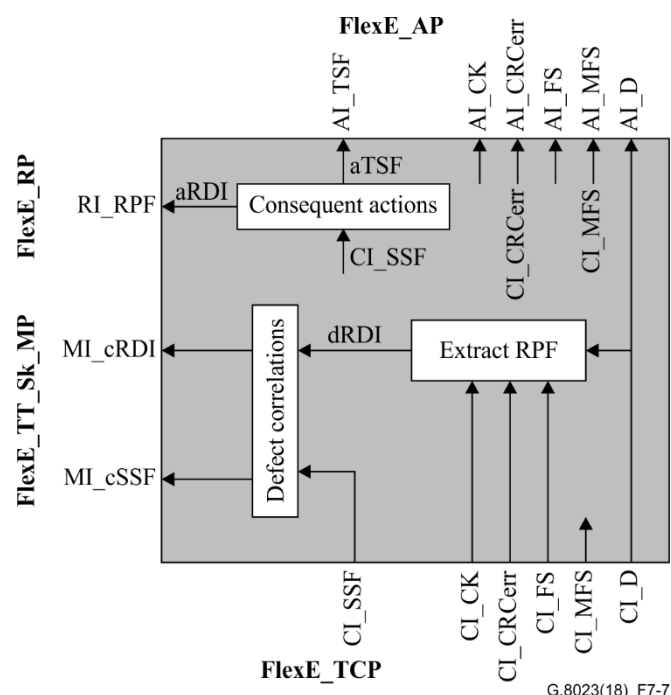
**Interfaces**

**Table 7-3 – FlexE\_TT\_Sk inputs and outputs**

Input(s)	Output(s)
<b>FlexE_TCP:</b> FlexE_CI_CK FlexE_CI_D FlexE_CI_FS FlexE_CI_MFS FlexE_CI_SSF FlexE_CI_CRCerr	<b>FlexE_AP:</b> FlexE_AI_CK FlexE_AI_D FlexE_AI_FS FlexE_AI_MFS FlexE_AI_CRCerr FlexE_AI_TSF <b>FlexE_RP:</b> FlexE_RI_RPF <b>FlexE_TT_Sk_MP:</b> FlexE_TT_Sk_MI_cRDI FlexE_TT_Sk_MI_cSSF

**Processes**

The processes associated with the FlexE\_TT\_Sk function are as depicted in Figure 7-7.



**Figure 7-7 – FlexE\_TT\_Sk processes**

**RPF:** The remote PHY fault indication shall be recovered from the RPF bit position of FlexE overhead field with the good CRC (CRCerr = 0) as described in clause 7.3.8 of [OIF FLEXE IA]. It shall be used for RPF defect detection.

## Defects

The function shall detect the dRDI defect.

**dRDI:** If the extracted RPF is "1" with the good CRC, dRDI shall be set to true; otherwise, dRDI shall be set to false; dRDI shall be set to false during CI\_SSF.

## Consequent actions

The function shall perform the following consequent actions:

aRDI ← CI\_SSF

aTSF ← CI\_SSF

## Defect correlations

The function shall perform the following defect correlations to determine the most probable fault cause. This fault cause shall be reported to the equipment management function (EMF).

cSSF ← CI\_SSF

cRDI ← dRDI and (not CI\_SSF)

**Performance monitoring:** None.

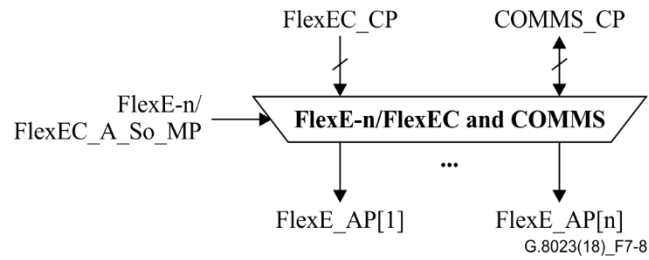
## 7.2 FlexE-n to FlexE client adaptation function (FlexE-n/FlexEC\_A)

The FlexE-n to FlexEC adaptation functions perform the adaptation between the FlexE-n layer adapted information and the characteristic information of the FlexE client signals.

### 7.2.1 FlexE-n to FlexE client adaptation source function (FlexE-n/FlexEC\_A\_So)

The information flow and processing of the FlexE-n/FlexEC\_A\_So function is defined with reference to Figures 7-8 and 7-9.

## Symbol



**Figure 7-8 – FlexE-n/FlexEC\_A\_So function**

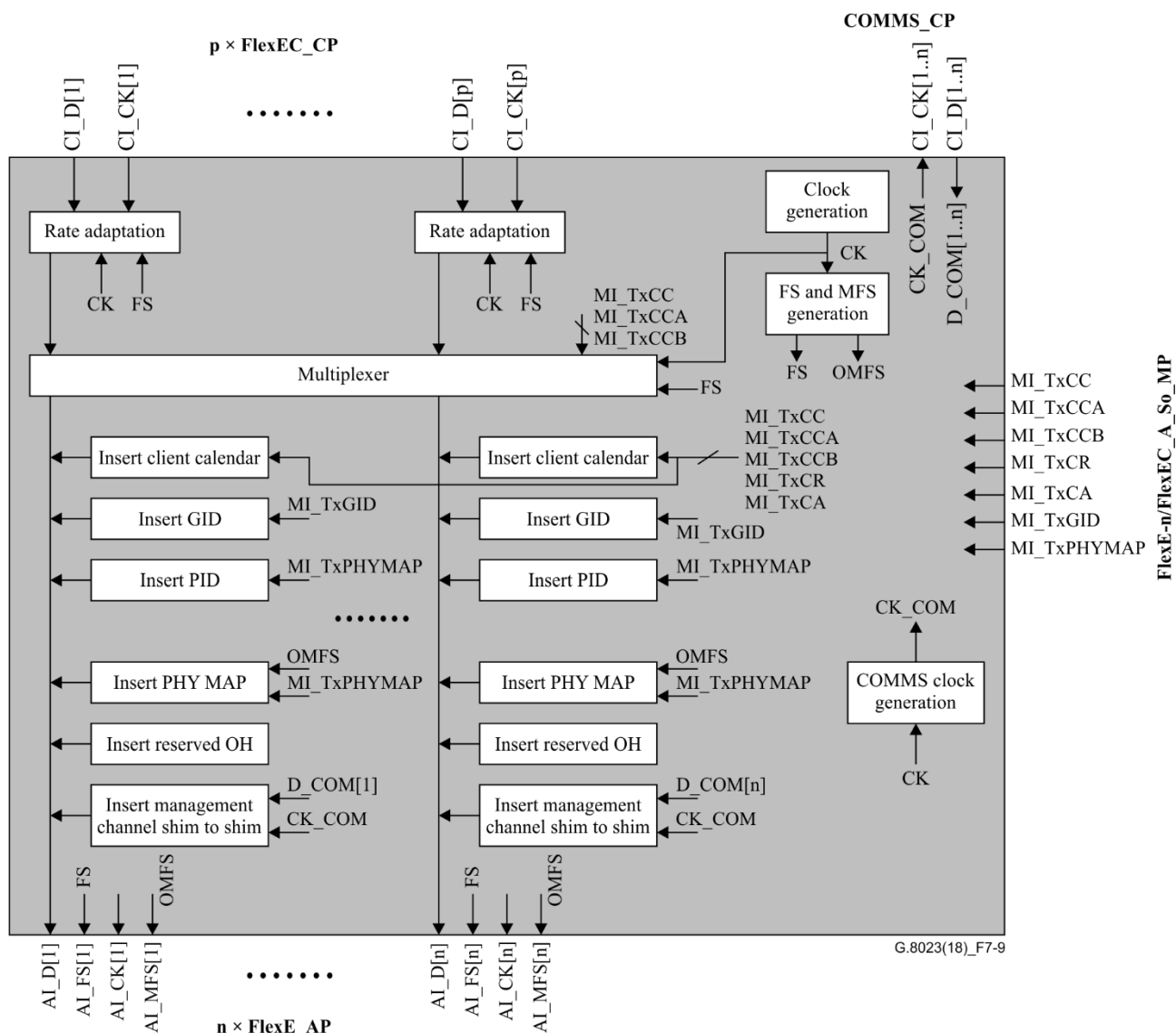
## Interfaces

**Table 7-4 – FlexE-n/FlexEC\_A\_So inputs and outputs**

Input(s)	Output(s)
<p><b>p × FlexEC_CP:</b> FlexEC_CI_CK FlexEC_CI_D</p> <p><b>n × COMMS_CP:</b> COMMS_CI_D</p> <p><b>FlexE-n/FlexEC_A_So_MP:</b> FlexE-n/FlexEC_A_So_MI_TxCC FlexE-n/FlexEC_A_So_MI_TxCCA FlexE-n/FlexEC_A_So_MI_TxCCB FlexE-n/FlexEC_A_So_MI_TxCR FlexE-n/FlexEC_A_So_MI_TxCA FlexE-n/FlexEC_A_So_MI_TxGID FlexE-n/FlexEC_A_So_MI_TxPHYMAP</p>	<p><b>n × FlexE_AP:</b> FlexE_AI_D FlexE_AI_CK FlexE_AI_FS FlexE_AI_MFS</p> <p><b>n × COMMS_CP:</b> COMMS_CI_CK</p>

## Processes

The processes associated with the FlexE-n/FlexEC\_A\_So function are as depicted in Figure 7-9.



**Figure 7-9 – FlexE-n/FlexEC\_A\_So processes**

**Clock generation:** The function shall generate a local FlexE clock (FlexE\_AI\_CK) of "16383/16384 × 103 125 000 kHz ± 100 ppm" from a free-running oscillator.

**FS and MFS generation:** The function shall generate FlexE frame start (FS) and FlexE overhead multiframe start (MFS) signals as described in clause 7.3.1 of [OIF FLEXE IA].

**Rate adaptation:** The function shall adjust the FlexEC signals applied at the FlexEC\_CP input ports to the required rate through insertion of IDLE blocks and deletion of IDLE and Ordered Set blocks as described in clause 5.2.1.2 of [OIF FLEXE IA].

**Multiplexing:** The function assigns the individual FlexEC to specific calendar slots of the FlexE-n payload area as defined by the client calendar configuration in use (see clause 7.4 of [OIF FLEXE IA]). The calendar configuration in use is configured either by the MI\_TxCCA or the MI\_TxCCB as indicated by the MI\_TxCC, described in clauses 7.3.2 and 7.3.4 of [OIF FLEXE IA].

NOTE – It is assumed that the optional client calendar configuration protocol, as defined in clause 7.3.4 of [OIF FLEXE IA], may be implemented by the EMF.

**Insert client calendar:** The function shall insert the calendar configuration information into the FlexE overhead fields as defined in clauses 6.3, 7.3.2 and 7.3.4 of [OIF FLEXE IA]. The "calendar configuration in use" overhead bits are set as configured by the MI\_TxCC; the "client carried calendar A/B" overhead fields are set extracting the sub-calendar information from the configured

MI\_TxCCA and MI\_TxCCB. The "client switch request" and "client switch acknowledged" overhead bits are set as configured by the MI\_TxCR and MI\_TxCA.

**FlexE GID:** The FlexE group identifier is inserted in the FlexE Group Number field. Its value is configured via the MI\_TxGID. The GID format is described in clause 7.3.6 of [OIF FLEXE IA].

**FlexE PID:** The FlexE physical interface identifier is inserted in the PHY number field. Its value for each PHY member of FlexE group is a unique one and can be configured via the MI\_PHYMAP. The PID format is described in clause 7.3.3 of [OIF FLEXE IA].

**FlexE PHY MAP:** The FlexE PHY MAP is inserted in the OMF and PHY MAP fields using the multiframe structure shown in Figure 11 of [OIF FLEXE IA]. Its value is configured via the MI\_PHYMAP. The PHY MAP format is described in clause 7.3.3 of [OIF FLEXE IA].

**Reserved OH:** The function shall insert "all zero" in the reserved overhead field and in bit 36 to 63 of the FlexE overhead in row 1 as described in clause 7.3.7 of [OIF FLEXE IA].

**Management channel – shim to shim:** The management channel is for user specific and inserted the incoming COMMS (CI\_D) data into the management channel – shim to shim field described in clause 7.3.5 of [OIF FLEXE IA].

**COMMS clock generation:** The function shall generate the COMMS clock (CI\_CK\_COM) by dividing the local FlexE clock (CK) by a factor of 3/163688.

**Defects:** None.

**Consequent actions:** None.

**Defect correlations:** None.

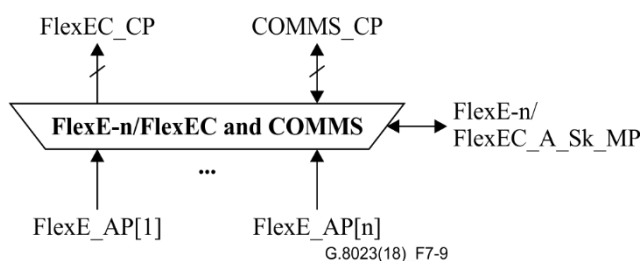
**Performance monitoring:** None.

### 7.2.2 FlexE-n to FlexE client adaptation sink function (FlexE-n/FlexEC\_A\_Sk)

The FlexE-n to FlexEC adaptation sink function is defined for FlexE client signals (10G, 40G, and  $n \times 25\text{G}$  FlexE client signals).

The information flow and processing of the FlexE-n/FlexEC\_A\_Sk function is defined with reference to Figures 7-10 and 7-11.

#### Symbol



**Figure 7-10 – FlexE-n/FlexEC\_A\_Sk function**

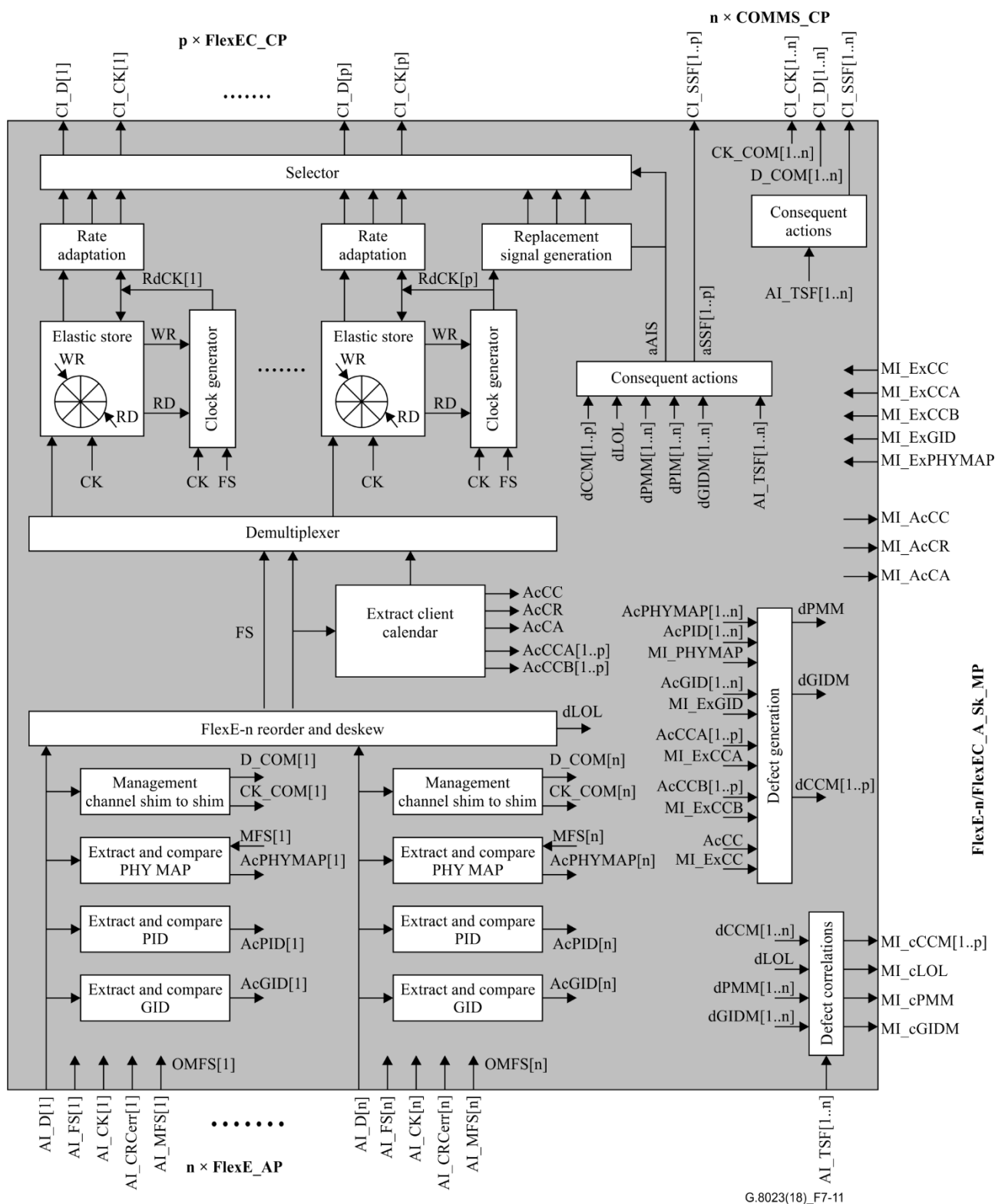
## Interfaces

**Table 7-5 – FlexE-n/FlexEC\_A\_Sk inputs and outputs**

Input(s)	Output(s)
<b>n × FlexE_AP:</b> FlexE_AI_D FlexE_AI_CK (Note) FlexE_AI_FS FlexE_AI_MFS FlexE_AI_CRCerr FlexE_AI_TSF  <b>FlexE-n/FlexEC_A_Sk_MP:</b> FlexE/FlexEC_A_Sk_MI_ExCC FlexE/FlexEC_A_Sk_MI_ExCCA FlexE/FlexEC_A_Sk_MI_ExCCB FlexE/FlexEC_A_Sk_MI_ExGID FlexE/FlexEC_A_Sk_MI_ExPHYMAP	<b>p × FlexEC_CP:</b> FlexEC_CI_CK FlexEC_CI_D FlexEC_CI_SSF  <b>n × COMMS_CP:</b> COMMS_CI_D COMMS_CI_CK COMMS_CI_SSF  <b>FlexE-n/FlexEC_A_Sk_MP:</b> FlexE-n/FlexEC_A_Sk_MI_AcCC FlexE-n/FlexEC_A_Sk_MI_AcCR FlexE-n/FlexEC_A_Sk_MI_AcCA FlexE-n/FlexEC_A_Sk_MI_cCCM[1..p] FlexE-n/FlexEC_A_Sk_MI_cLOL FlexE-n/FlexEC_A_Sk_MI_cPMM FlexE-n/FlexEC_A_Sk_MI_cGIDM
NOTE – It needs only to select one clock of them to use, e.g., FlexE_AI_CK[1].	

## Processes

The processes associated with the FlexE-n/FlexEC\_A\_Sk function are as depicted in Figure 7-11.



**FlexE OH extraction:** The function shall extract the overhead of FlexE group interface (GID, PID, PHY MAP and client calendar) from each of the  $n$  FlexE\_AI signals as defined in clause 7.3 of [OIF FLEXE IA].

**FlexE GID:** The GID fields shall be read from the FlexE overhead and processed as specified in clause B.2.2.1 of [ITU-T G.798]. The accepted GID values are available at the MP (MI\_AcGID[i]) and are used for dGIDM defect detection.

**FlexE PID:** The PID fields shall be read from the FlexE overhead and processed as specified in clause B.2.2.2.2 of [ITU-T G.798]. The accepted PID values are available at the MP (MI\_AcPID[i]) and are used for dPMM defect detection.

**FlexE PHY MAP:** The MAP fields shall be read from the FlexE overhead and processed as specified in clause B.2.2.3.2 of [ITU-T G.798]. The accepted PHY MAP values are available at the MP (MI\_AcPHYMAP[i]) and are used for dPMM defect detection.

**Management channel – shim to shim:** The management message channel is for user specific and the corresponding COMMS data (D\_COM) and COMMS clock (CK\_COM) is extracted from the management channel – shim to shim field described in clause 7.3.5 of [OIF FLEXE IA].

**FlexE-n reorder and deskew:** The function shall include reordering and deskewing processes.

*Reordering:* The process shall reorder n lanes of FlexE PHY based on PID clause 7.3.3 of [OIF FLEXE IA].

*Deskewing:* The process shall compensate the skew between n FlexE PHY based on FlexE frame start indication (alignment markers) as described in clause 7.3.1 of [OIF FLEXE IA]. The alignment process shall establish the delay compensation, compensating the differential delay between the PHY lane signals as given in clause 6.4 of [OIF FLEXE IA]. The compensation between the PHY lanes is achieved by an elastic store per PHY lane. Each PHY lane signal shall be written into an elastic store with the FlexE frame start indication. Each elastic store shall be capable of compensating at least 300 ns of absolute differential delay between the PHY lanes. The process has two states, out-of-multilane-alignment (OLA) and in-multilane-alignment (ILA). The alignment start shall be maintained during the OLA state. In the OLA state, if the bytes of the PHY lane signals can be written consistently into the elastic store in the presence of a differential delay in line without exceeding the buffering time, the ILA state shall be entered. In this case, the differential delay can be compensated. In the ILA state, if the differential delay between two PHY lanes exceeds the maximum delay that can be compensated, the OLA state shall be entered.

**FlexE OH client calendar:** The calendar information shall be read from the calendar configuration in use (C), client calendar A and B, calendar switch request (CR) and calendar switch acknowledge (CA) overheads as defined in clauses 6.4, 7.3.2 and 7.3.4 of [OIF FLEXE IA].

*Calendar configuration in use overhead (C):* The "calendar configuration in use" overhead from each member shall be accepted (AcCC[i]) by majority vote of the 3 C overhead bits. Furthermore, it shall confirm the accepted "AcCC" by unanimity of n PHY members of FlexE group.

*Client calendar A and B overheads:* The "client calendar A" and "client calendar B" overhead fields from each member shall be read and the calendar slot information shall be accepted in overhead frames with good CRC (AcCCA[i] and AcCCB[i]). The client calendar mismatch process reports the client calendar mismatch defect (dCCM[1..p]) for p FlexEC clients.

*Calendar switch request overhead (CR):* The "calendar switch request" overhead from each member shall be read and the calendar switch request information shall be accepted in overhead frames with good CRC (AcCR[i]). Furthermore, it shall confirm the accepted "AcCR" value by unanimity of n PHY members of FlexE group.

*Calendar switch acknowledge overhead (CA):* The "calendar switch acknowledge" overhead from each member shall be read and the calendar switch acknowledge information shall be accepted in overhead frames with good CRC (AcCA[i]). Furthermore, it shall confirm the accepted "AcCA" value by unanimity of n PHY members of FlexE group.

**Demultiplexing:** The function activates the FlexEC and assigns the calendar slots of the FlexE-n payload area to the individual FlexEC as defined by the client calendar in use (see clause 7.5 of [OIF FLEXE IA]). The calendar configuration in use is derived by the configuration provided by either the MI\_ExCCA[1..p] or the MI\_ExCCB[1...p] as indicated by the MI\_ExCC or, when the



MI\_ExCC is set to any, by the accepted client calendar (AcCCA[1...p] or AcCCB[1...p]), as described in clauses 7.3.2 and 7.3.4 of [OIF FLEXE IA].

NOTE – It is assumed that the optional client calendar configuration protocol, as defined in clause 7.3.4 of [OIF FLEXE IA], may be implemented by the EMF.

**Clock generation:** The function shall generate an FlexEC clock (FlexEC\_CI\_CK[1..p]) from a free-running oscillator or the FlexE-n group clock with a bit rate as specified in Table 7-1.

**Rate adaptation:** The function shall adjust the demapped FlexEC to the required rate through insertion of IDLE blocks or deletion of IDLE or ordered set blocks as described in clauses 5.2.1.1 and 5.2.1.2 of [OIF FLEXE IA].

**Replacement signal generation:** When aAIS[j] is true, the function shall provide for a replacement signal of FlexEC and clock generation process that generates a stream of local fault sequence ordered sets as specified in clause 5.2.2.3 of [OIF FLEXE IA].

**Selector:** The function shall select the normal FlexEC signal or the replacement signal. When aAIS[j] is true, it shall select the replacement signal. Otherwise, it shall select the normal FlexEC signal.

## Defects

The function shall detect dGIDM, dPMM, dLOL and dCCM[j].

**dGIDM:** See clause B.1.1.2.1 of [ITU-T G.798].

**dPMM:** See clause B.1.1.2.2 of [ITU-T G.798].

**dLOL:** If the alignment process is in the out-of-alignment state, dLOL shall be set to true. dLOL shall be set to false when the alignment process is in the in-multilane-alignment state.

**dCCM[j] (client calendar mismatch):** The dCCM defect for FlexEC tributaries is based on comparing the AcCC/AcCCA/AcCCB and ExCC/ExCCA/ExCCB of all FlexE PHY instances. dCCM shall be detected for each FlexEC. The index j ranges from 1 to p and denotes the FlexEC tributary port. ~~Each FlexEC shall be corresponding to and CCM, e.g., dCCM[j] where j = 1 to p denotes FlexEC tributary port.~~

Upon accepting a new AcCC/AcCCA/AcCCB value for a FlexE PHY instances the nCCM anomalies for all tributary ports are initialized to false. The AcCC/AcCCA/AcCCB are then compared to the ExCC/ExCCA/ExCCB for all FlexE PHY instances.

When AcCC is equalling to ExCC and both them are equalling '~~0~~1', for each case where the AcCCA/and ExCCA values pertaining to the same tributary slot are not equal,

- a) if the tributary slot is allocated in the ExCCA value, the nCCManomaly of the tributary port subfield of the ExCCA value is set;
- b) if the tributary slot is allocated in the AcCCA value, the nCCManomaly of the tributary port subfield of the AcCCA value is set.

When AcCC is equalling to ExCC and both them are equalling '~~0~~1', for each case where the AcCCB/and ExCCB values pertaining to the same tributary slot are not equal,

- a) if the tributary slot is allocated in the ExCCB value, the nCCManomaly of the tributary port subfield of the ExCCB value is set;
- b) if the tributary slot is allocated in the AcCCB value, the nCCManomaly of the tributary port subfield of the AcCCB value is set.

The dCCM defect of each tributary port shall be set to the corresponding nCCM anomaly.

```

for trib_port = 1 to number_of_trib_ports
    nCCM[trib_port] = false

for FlexE = 1 to number_of_instances
    for trib_slot = 1 to number_of_trib_slots
        if AcCC == '1'0' and ExCC == '1'0'
            if AcCCA[FlexE][trib_slot] != ExCCA[FlexE][trib_slot]
                if ExCCA[FlexE][trib_slot].allocated
                    nCCM[ ExCCA[trib_slot].trib_port ] = true
                if AcCCA[FlexE][trib_slot].allocated
                    nCCM[ AcCCA[trib_slot].trib_port ] = true
        else if AcCC == '0'1' and ExCC == '0'1'
            if AcCCB[FlexE][trib_slot] != ExCCB[FlexE][trib_slot]
                if ExCCB[FlexE][trib_slot].allocated
                    nCCM[ ExCCB[trib_slot].trib_port ] = true
                if AcCCB[FlexE][trib_slot].allocated
                    nCCM[ AcCCB[trib_slot].trib_port ] = true

for trib_port = 1 to number_of_trib_ports
    dCCM[trib_port] = nCCM[trib_port]

```

#### Consequent actions

aSSF[j] ← dCCM[j] or dLOL or dPMM or dGIDM or  $\sum AI\_TSF[1..n]$  , where  $j = 1$  to  $p$

aAIS[j] ← dCCM[j] or dLOL or dPMM or dGIDM or  $\sum AI\_TSF[1..n]$  , where  $j = 1$  to  $p$

#### Defect correlations

cGIDM ← dGIDM and (not  $\sum AI\_TSF[1..n]$ )

cPMM ← dPMM and (not dGIDM) and (not  $\sum AI\_TSF[1..n]$ )

cLOL ← dLOL and (not dPMM) and (not dGIDM) and (not  $\sum AI\_TSF[1..n]$ )

cCCM[j] ← dCCM[j] and (not dLOL) and (not dPMM) and (not dGIDM) and (not  $\sum AI\_TSF[1..n]$ ), where  $j = 1$  to  $p$

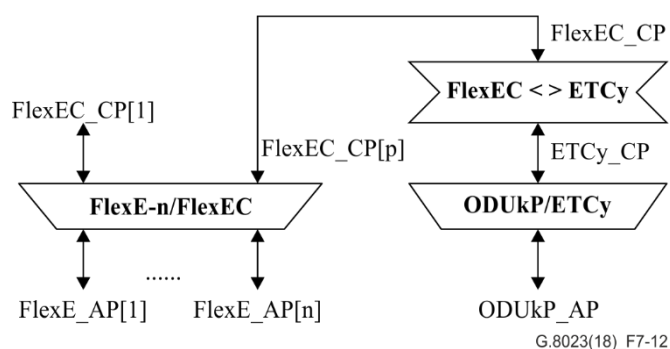
**Performance monitoring:** None.

### 7.3 Interworking function between FlexE Client and ETCy (FlexEC<>ETCy)

The FlexEC<>ETCy interworking functions perform the conversion between FlexEC\_CI signals and ETCy\_CI signals. It shall be used between FlexE-n/FlexEC\_A and ODUkP/ETCy\_A as shown in Figure 7-12.

**Table 7-6 – ETCy\_CI and FlexEC\_CI**

y	ETCy_CI				FlexEC_CI			
	Bit rate (kbit/s)	Clock tolerance (ppm)	Encoding	AM	Bit rate (kbit/s)	Clock tolerance (ppm)	Encoding	AM
10GR	10 312 500	±100	Clause 49 64b/66b	No	10 312 500	±100	Clause 82 64b/66b	No
25GR	25 781 250	±100	Clause 49 64b/66b	No	25 781 250	±100	Clause 82 64b/66b	No
40GR	41 250 000	±100	Clause 82 64b/66b	Yes	41 250 000	±100	Clause 82 64b/66b	No
100GR	103 125 000	±100	Clause 82 64b/66b	Yes	103 125 000	±100	Clause 82 64b/66b	No

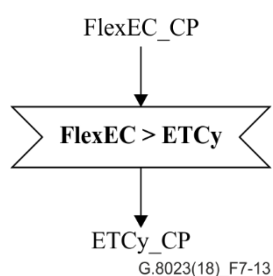


**Figure 7-12 – FlexEC<>ETCy function position**

### 7.3.1 FlexEC to ETCy interworking function (FlexEC> ETCy)

The information flow and processing of the FlexEC to ETCy interworking function is defined with reference to Figures 7-13, 7-14 and 7-15.

#### Symbol



**Figure 7-13 – FlexEC>ETCy function**

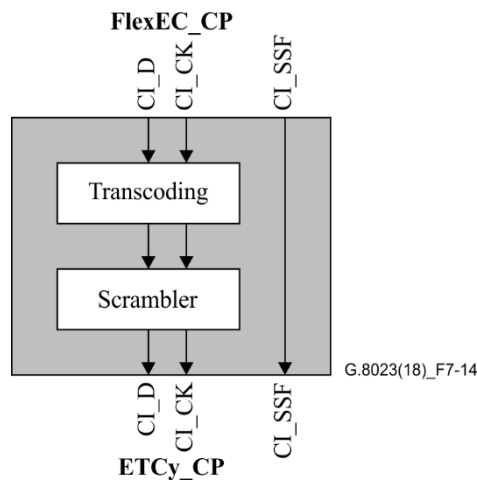
#### Interfaces

**Table 7-7 – FlexEC>ETCy inputs and outputs**

Input(s)	Output(s)
<b>FlexEC_CP:</b> FlexEC_CI_CK FlexEC_CI_D FlexEC_CI_SSF	<b>ETCy_CP:</b> ETCy_CI_CK ETCy_CI_D ETCy_CI_SSF

## Processes

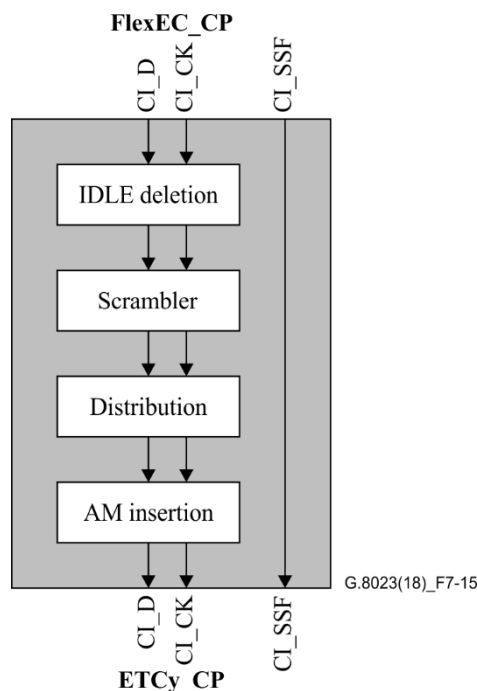
The processes associated with the FlexEC>ETCy function are as depicted in Figures 7-14 (y=10GR or 25GR) and 7-15 (y=40GR or 100GR).



**Figure 7-14 – FlexEC>ETCy processes (y = 10GR, 25GR)**

**Transcoding:** The function shall transcode 66B blocks based on clause 82 of [IEEE 802.3] to 66B blocks based on clause 49 of [IEEE 802.3].

**Scrambler:** The function shall scramble the 66B blocks as described in clause 49.2.6 of [IEEE 802.3].



**Figure 7-15 – FlexEC>ETCy processes (y = 40GR, 100GR)**

**IDLE deletion:** The function shall delete idle control characters or sequence ordered sets in the data stream of 66B blocks to accommodate the transmission of alignment markers as described in clause 82.2.4 of [IEEE 802.3].

**Scrambler:** The function shall scramble the input 66B blocks as described in clause 82.2.5 of [IEEE 802.3].

**Distribution:** The function shall distribute the scrambled 66B blocks into 4 (for ETC40GR) or 20 (ETC100GR) PCS lanes in a round-robin manner as described in clause 82.2.6 of [IEEE 802.3].

**Alignment marker insertion:** The function shall insert the alignment markers into 4 or 20 PCS lanes after every 16383 66-bit blocks on each PCS lane as described in clause 82.2.7 of [IEEE 802.3].

**Defects:** None.

**Consequent actions:** None.

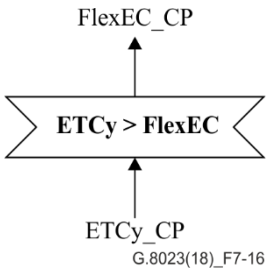
**Defect correlations:** None.

**Performance monitoring:** None.

**7.3.2 ETCy to FlexEC interworking function (ETCy>FlexEC)**

The information flow and processing of the ETCy>FlexEC function is defined with reference to Figures 7-16, 7-17 and 7-18.

**Symbol**



**Figure 7-16 – ETCy>FlexEC function**

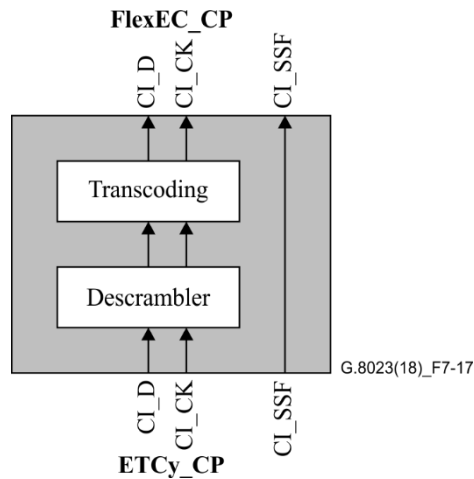
**Interfaces**

**Table 7-8 – ETCy>FlexEC inputs and outputs**

Input(s)	Output(s)
<b>ETCy_CP:</b> ETCy_CI_CK ETCy_CI_D ETCy_CI_SSF	<b>FlexEC_CP:</b> FlexEC_CI_CK FlexEC_CI_D FlexEC_CI_SSF

**Processes**

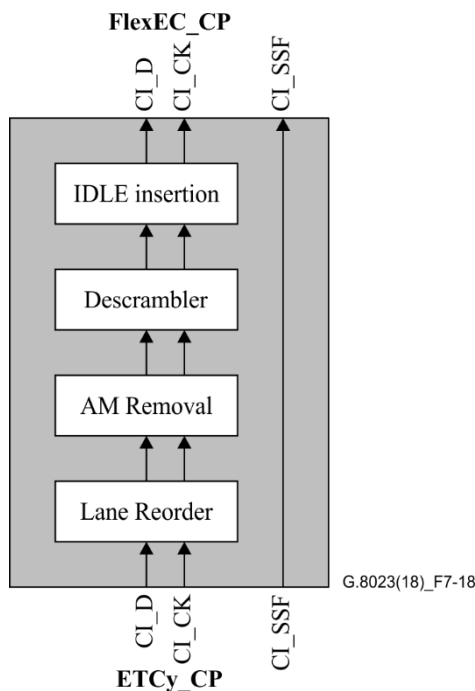
The processes associated with the ETCy>FlexEC function are as depicted in Figures 7-17 (y=10GR or 25GR) and 7-18 (y=40GR or 100GR).



**Figure 7-17 – ETCy>FlexEC processes (y = 10GR, 25GR)**

**Transcoding:** The function shall transcode 66B blocks based on clause 49 of [IEEE 802.3] to 66B blocks based on clause 82 of [IEEE 802.3].

**Descrambler:** The function shall descramble the input 66B blocks as described in clause 49.2.10 of [IEEE 802.3].



**Figure 7-18 – ETCy>FlexEC processes (y = 40GR, 100GR)**

**Lane reorder:** The function shall order the 4 (ETC40GR) or 20 PCS (ETC100GR) lanes according to their PCS lane number as described in the clause 82.2.14 of [IEEE 802.3].

**Alignment marker removal:** The function shall remove the alignment markers from the data stream of 66b blocks. Four alignment markers are removed per 4\*16383 66-bit blocks for ETC40GR and 20 alignment markers are removed per 20\*16383 66-bit blocks for ETC100GR.

**Descrambler:** The function shall descramble the input 66B blocks as described in clause 82.2.16 of [IEEE 802.3].

**IDLE insertion:** The function shall insert idle control characters in the data stream of 66B blocks to compensate for the removal of alignment markers as described in clause 82.2.15 of [IEEE 802.3].

**Defects:** None.

**Consequent actions:** None.

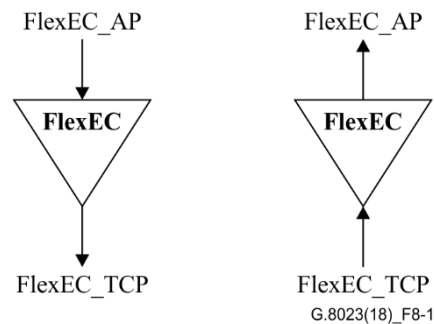
**Defect correlations:** None.

**Performance monitoring:** None.

**8 FlexE client functions**

**8.1 FlexE client trail termination function (FlexEC\_TT)**

The FlexEC\_TT function terminates the FlexE client layer. Figure 8-1 shows the combination of the unidirectional sink and source functions to form a bidirectional function. As there is no overhead defined for monitoring a FlexE client, this is a null function.

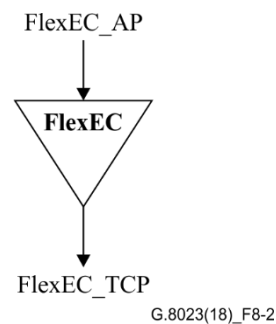


**Figure 8-1 – FlexEC\_TT**

**8.1.1 FlexEC trail termination source function (FlexEC\_TT\_So)**

The FlexEC\_TT\_So function is a null function. It passes the signal from the FlexEC\_AP to the FlexEC\_TCP.

**Symbol**



**Figure 8-2 – FlexEC\_TT\_So function**

**Interfaces**

**Table 8-1 – FlexEC\_TT\_So inputs and outputs**

Input(s)	Output(s)
<b>FlexEC_AP:</b> FlexEC_AI_CK FlexEC_AI_D	<b>FlexEC_TCP:</b> FlexEC_CI_CK FlexEC_CI_D

**Processes**

There are no processes performed by this function.

**Defects:** None.

**Consequent actions:** None.

**Defect correlations:** None.

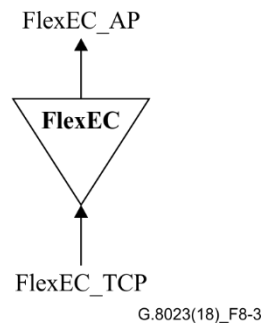
**Performance monitoring:** None.

**8.1.2 FlexEC trail termination sink function (FlexEC\_TT\_Sk)**

The FlexEC\_TT\_Sk function is a null function. It passes the signal from the FlexEC\_TCP to the FlexEC\_AP.

The information flow and processing of the FlexEC\_TT\_Sk function is defined with reference to Figures 8-3 and 8-4.

**Symbol**



**Figure 8-3 – FlexEC\_TT\_Sk function**

**Interfaces**

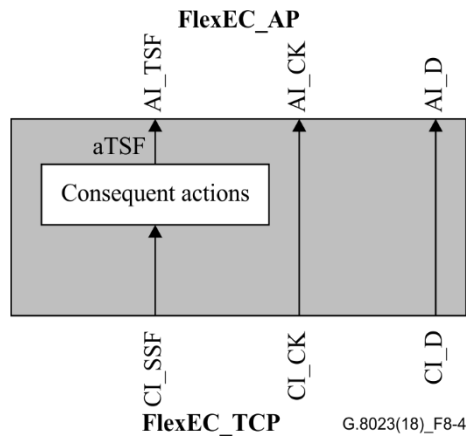
**Table 8-2 – FlexEC\_TT\_Sk inputs and outputs**

Input(s)	Output(s)
<b>FlexEC_TCP:</b> FlexEC_CI_CK FlexEC_CI_D FlexEC_CI_SSF	<b>FlexEC_AP:</b> FlexCE_AI_CK FlexEC_AI_D FlexEC_AI_TSF

**Processes**

The processes associated with the FlexEC\_TT\_Sk function are as depicted in Figure 8-4.





**Figure 8-4 – FlexEC\_TT\_Sk processes**

Defects: None.

#### **Consequent actions**

The function shall perform the following consequent actions:

aTSF ← CI\_SSF

**Defect correlations:** None.

**Performance monitoring:** None.

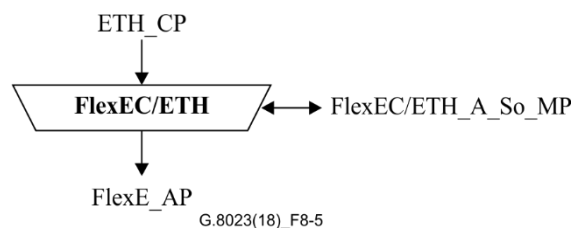
## **8.2 FlexE client to Ethernet MAC layer adaptation function (FlexEC/ETH\_A)**

The FlexEC to ETH adaptation functions perform the adaptation between a FlexE client signal and the Ethernet MAC layer.

### **8.2.1 FlexEC to ETH adaptation source function (FlexEC/ETH\_A\_So)**

The information flow and processing of the FlexEC/ETH\_A\_So function is defined with reference to Figures 8-5 and 8-6.

#### **Symbol**



**Figure 8-5 – FlexEC/ETH\_A\_So function**

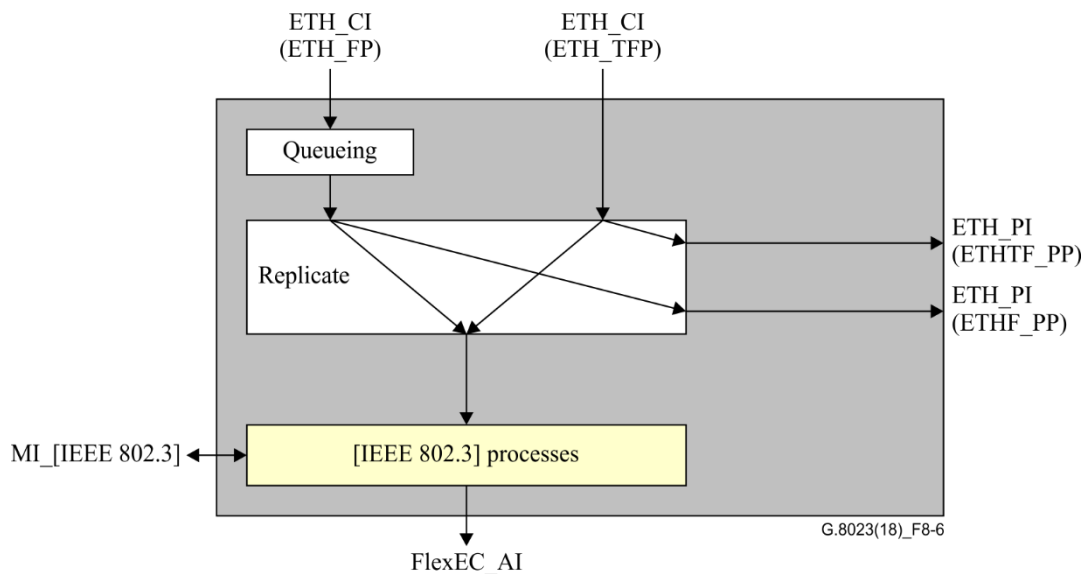
## Interfaces

**Table 8-3 – FlexEC/ETH\_A\_So inputs and outputs**

Input(s)	Output(s)
<b>ETH_TFP:</b> ETH_CI_D ETH_CI_P ETH_CI_DE  <b>ETH_FP:</b> ETH_CI_D ETH_CI_P ETH_CI_DE  <b>FlexEC/ETH_A_So_MP:</b> FlexEC.ETH_A_SO_MI_[IEEE 802.3]	<b>FlexEC_AP:</b> FlexEC_AI_D FlexEC_AI_CK  <b>ETHTF_PP:</b> ETH_CI_D ETH_CI_P ETH_CI_DE  <b>ETH_PP:</b> ETH_CI_D ETH_CI_P ETH_CI_DE  <b>FlexEC/ETH_A_So_MP:</b> FlexEC/ETH_A_So_MI_[IEEE 802.3]

## Processes

The processes associated with the FlexEC/ETH\_A\_So function are as depicted in Figure 8-6.



**Figure 8-6 – FlexEC/ETH\_A\_So processes**

The queueing and replicate processes are defined in clause 8 of [ITU-T G.8021].

**[IEEE 802.3] processes:** The [IEEE 802.3] processes represent the whole functionality of the PHY above the FlexE shim in the IEEE 802.3 model. This includes the reconciliation sublayer and the process of 64b/66b encoding, as well as MAC FCS generation and frame counting.

NOTE – This Recommendation defines these processes by reference to [IEEE 802.3] and intentionally does not provide details, as this functionality is well understood from the IEEE work.

**Defects:** None.

**Consequent actions:** None.

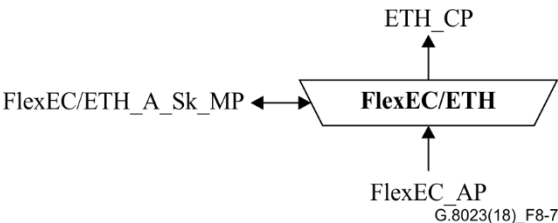
**Defect correlations:** None.

**Performance monitoring:** None.

**8.2.2 FlexEC to ETH adaptation sink function (FlexEC/ETH\_A\_Sk)**

The information flow and processing of the FlexEC/ETH\_A\_Sk function is defined with reference to Figures 8-7 and 8-8.

**Symbol**



**Figure 8-7 – FlexEC/ETH\_A\_Sk function**

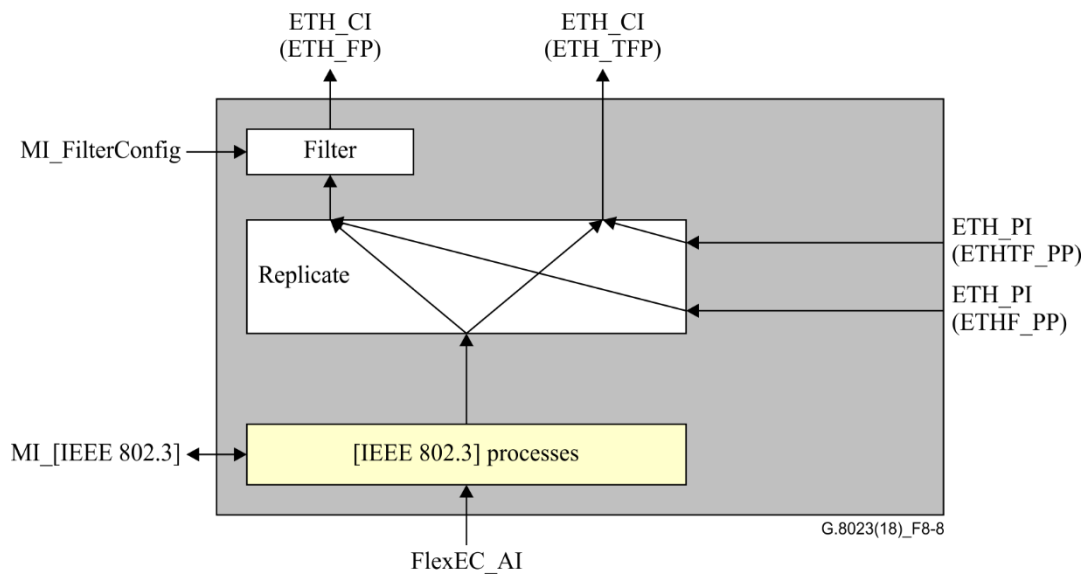
**Interfaces**

**Table 8-4 – FlexEC/ETH\_A\_Sk inputs and outputs**

Input(s)	Output(s)
<b>FlexEC_AP:</b> FlexEC_AI_D FlexEC_AI_CK FlexEC_AI_TSF	<b>ETH_TFP:</b> ETH_CI_D ETH_CI_P ETH_CI_DE ETH_CI_SSF
<b>ETHTF_PP:</b> ETH_CI_D ETH_CI_P ETH_CI_DE	<b>ETH_FP:</b> ETH_CI_D ETH_CI_P ETH_CI_DE ETH_CI_SSF
<b>ETH_PP:</b> ETH_CI_D ETH_CI_P ETH_CI_DE	<b>FlexEC/ETH_A_Sk_MP:</b> FlexEC/ETH_A_Sk_MI_[IEEE 802.3]
<b>FlexEC/ETH_A_Sk_MP:</b> FlexEC/ETH_A_Sk_MI_[IEEE 802.3] FlexEC/ETH_A_Sk_MI_FilterConfig	

**Processes**

The processes associated with the FlexEC/ETH\_A\_Sk function are as depicted in Figure 8-8.



**Figure 8-8 – FlexEC/ETH\_A\_Sk processes**

The filter and replicate processes are defined in clause 8 of [ITU-T G.8021].

**[IEEE 802.3] processes:** The [IEEE 802.3] processes represent the whole functionality of the PHY layer above the FlexE shim; this includes 64b/66b decoding and the reconciliation sublayer, as well as the MAC length check, MAC frame check and frame counting.

NOTE – This Recommendation defines these processes by reference to [IEEE 802.3] and intentionally does not provide details, as this functionality is well understood from the IEEE work.

#### Defects

The definition of the defects used by the FlexEC/ETH\_A\_Sk is outside the scope of this Recommendation.

**Consequent actions**  $aSSF \leftarrow AI\_TSF$

**Defect correlations** None.

**Performance monitoring** For further study.

## Annex A

### Overview related of FlexE atomic functions

(This annex forms an integral part of this Recommendation.)

This annex describes an overview related of FlexE atomic functions. The left side of Figure A.1 shows the atomic functions of FlexE from the OTSiG up through the ETH layer, including those functions necessary to support FlexE-aware mapping to OTN and FlexE termination with mapping of FlexE client to OTN or switching in the ETH layer. The right side of Figure A-1 shows the atomic functions related to mapping or interconnecting FlexE into OTN. It totally includes three cases. In the case 1, when mapping FlexE subrating signals into ODUflex (i.e., FlexE-aware mapping), it connects FlexE CI at FlexE\_CP into ODUflexP/FlexESG\_A (see clause 14.3.18 of [ITU-T G.798]); in the case 2, when mapping FlexE client signals into ODUflex, it connects FlexEC CI at FlexEC\_CP into ODUflexP/FlexEC\_A (see clause 14.3.17 of [ITU-T G.798]); in the case 3, when interconnecting FlexE client signal into the legacy ODUk mapping path, it needs first through the interworking atomic function of FlexEC to ETCy to perform the conversion between FlexEC\_CI signals and ETCy\_CI signals and then connects the conversed ETCy\_CI at ETCy\_CP into ODUkP/CBRx-g\_A (see clause 14.3.8 of [ITU-T G.798]).

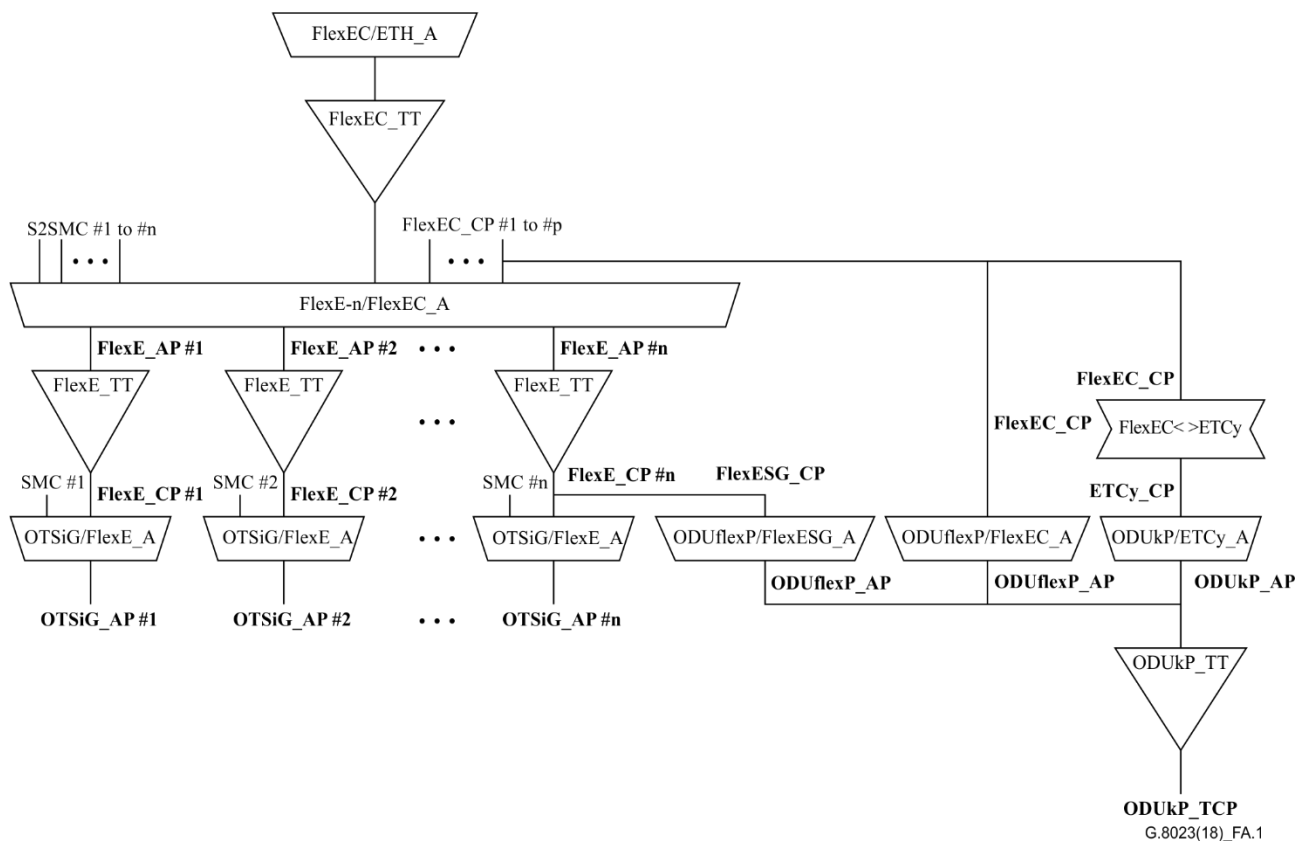


Figure A.1 – Overview of FlexE-related atomic functions





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