MICROSENS

FlexRate 200G Muxponder (MS430943/4M)

Overview

FlexRate 200G Muxponder is a part of MICROSENS MSP3000 Platform, a high performance and flexible carrier-class transmission system. The MSP3000 Platform enables increasing transport capacities in CWDM, DWDM and SDH networks. The use of wide range TDM modules permits to reduce the number of necessary wavelengths and to decrease the overall cost of the application. Ethernet over SDH modules enable using existing SONET/SDH infrastructure for IP transmission.

The general features of the system:

- 19" 2U Chassis with 6 module slots and management card
- 19" 7U Chassis with 20 module slots and management card
- Hot swappable modules & power supplies
- Redundant power supplies with -48 VDC input (opt. 230 VAC)
- Exchangeable air- and filter module
- Wide range of functional xWDM and TDM modules available

The functional modules of MSP3000 Platform include:

- 10G/100G/200G TDM modules
- 10/100G transponders
- Dedicated family for DCI applications
- 10G protocol converter 10G LAN to 10G WAN (OC-192/STM-64)
- DWDM MUX/DeMUX, OADMs, EDFAs, ROADM, Fiber monitoring, etc

Introduction

The MS430943/4M is a HW platform allowing two different operating modes:

- 200G Metro Reach (MR) Muxponder: This function transport two 100GbE signals over a 200G line interface.
- 100G Ultra Long Haul (ULH) Transponder: This function transport one 100GbE signals over a 100G line interface.

! Warning. When a MS430943/4M is inserted in a MS430504M chassis, a MS430946M (single slot airflow module) must be inserted in the slot immediately on the right of the MS430943/4M. The MS430943/4M can be operated in a MS430503M chassis without the use of Airflow module.

! Warning. The MS430943/4M can not be inserted in a old 2HU and 6HU chassis.

Features

- Two configurable 100 Gigabit Ethernet / OTU4 client port interfaces
- RMON on 100 Gigabit Ethernet input and output signals
- QSFP28 modules for client port physical interfacing
- Two operational mode:
  - 200G Metro Reach (MR) Transponder
  - 100G Ultra Long Haul (ULH) Transponder
- Proprietary line format,
  - 252.01536 Gb/s bit rate in 200G-MR mode
  - 127.156 Gb/s bit rate in 100G-ULH mode
- DDM (Digital Diagnostic Monitoring) information from QSFP28 and line transceiver
- Dual Fiber (MS430943M) and Single Fiber (MS430944M) versions.

System description 200G-MR Mode

The block diagram for the MS430943/4M is given in Figure 1.

The MS430943/4M is a bi-directional device. It therefore has different sections:

- Upstream Section: from two 100GbE / OTU4 optical inputs to 200G optical output
- Downstream Section: from 200G optical input to two 100GbE / OTU4 optical outputs

- Common sections composed of :
  - Controller block, providing interfacing to the chassis controller board hosting the SNMP Agent.
  - Power supplies: generates different internal power supplies from the -48V – input
  - Front panel LEDs indicating the status of the ports, line and the Flexrate module common functions

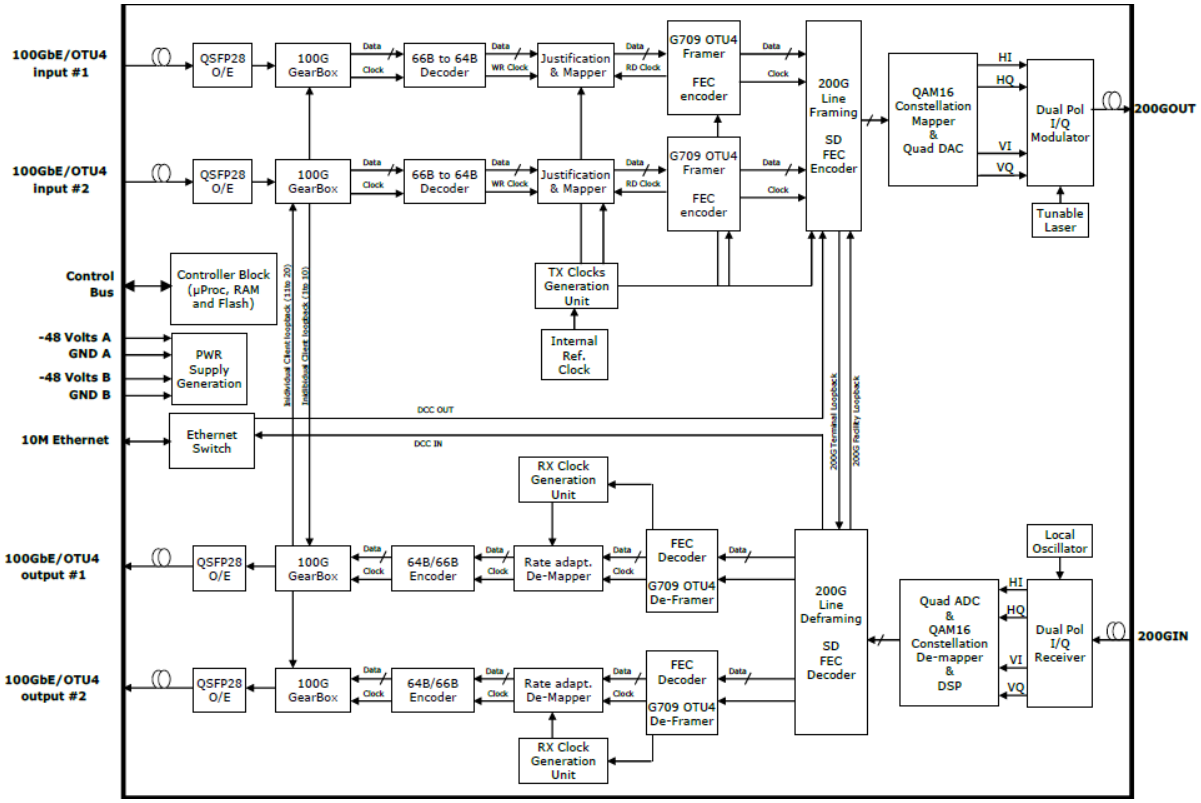

Figure 1: Block diagram (200G-MR).

Upstream section

Input Ports interfacing

The upstream section has two 100GbE/OTU4 client inputs.
Client physical interfacing is done through standard QSFP28 modules.

In 100GbE:
The upstream client port is 66B to 64B decoded. If invalid 66B blocks are received, they are replaced by the /E/ control code.

In OTU4:
The upstream client port is process to terminate the GFEC and potential error are corrected. The OTU4signal (without FEC) is provided to the mapper.

The following information is provided to the controller:

- QSFP28 absence
- Loss of optical input signal
- Loss of synchronization on incoming signal:
- Loss of 66B/64B decoder sync (100GbE) or Loss of Frame (OTU4)
- Counting of incoming errors:
- MAC frames FCS errors counting (100GbE) or input SM-BIP8 (OTU4)
- DDM information

RMON (Remote Network Monitoring)
Remote Network Monitoring functionality is provided on the 100GbE incoming client port. The upstream client port is 66B to 64B decoded to provide the RMON statistics.

The following statistics are made available on a per port basis:

- Packet counters:

Total number of packets (including, broadcast packets, and multicast packets) received

- CRC errors counter

Total number of packets received that either a bad Frame Check Sequence (FCS) with an integral number of octets (FCS Error) or a bad FCS with a non-integral number of octets (Alignment Error).

Mapper

In 100GbE:

Each incoming signal must be synchronized to the local clock prior of adaptation to long distance transport. The incoming signal is therefore mapped in an OTU4C2 and the synchronisation is performed thanks to a justification process which can tolerate ±100 ppm frequency deviation to the nominal 100 GbE LAN bit rate

In OTU4:

Each incoming signal must be synchronized to the local clock prior of adaptation to long distance transport. The incoming signal is therefore mapped in an OTU4C2 and the synchronisation is performed thanks to a justification process which can tolerate ±20 ppm frequency deviation to the nominal OTU4 bit rate

The mapper inserts additional information:

- Client Signal Fail indication: a bit in the mapping frame is set in case one of the following conditions are present on the incoming signal
    - QSFP28 not present
    - Loss of incoming signal.
    - Loss of synchronization on incoming signal

The following information is provided to the controller on a per port basis:

- Client Signal Fail asserted

The following controls can be sent to each Mapper

- Client Facility Loopback
- Client Terminal Loopback

G709 OTU4 Framer

Each mapped 100GbE client signal is then encapsulated in a G709 ODU4 payload

Each payload is framed into a G709 OTU4 output signal.

SM-BIP8 is calculated and inserted in its corresponding locations in the outgoing signal.

The following information is provided to the controller on a per port basis:

- SM-BDI inserted

FEC encoder

Standard G709 OTU4 FEC encoding is performed and inserted in dedicated bytes of the G709 OTU4.

Line Framing & SD FEC

The two G709 OTU4 frame are then interleaved and inserted in proprietary frame. A proprietary Software-Decision FEC encoding is performed and inserted in the unused bytes of the line frame.

10M DCC

The 10M DCC allows inserting a 10Mb/s Ethernet data communication channel coming from the Ethernet switch and transported in the 200G proprietary frame.

It is inserted in 200G frame aoverheads bytes, insuring transparent transport of the two client stream (100GbE or OTU4).

The following controls can be sent to the Framer

- 200G Facility Loopback
- 200G Terminal Loopback

QAM16 Constellation mapper and Quad DAC

The QAM16 Constellation is then applied on the proprietary frame and the Quad DAC is generating the four PAM4 33.067 Gb/s lanes which are transmitted to the line modulator.

Line Modulator Block

The Line modulator is combining the four PAM4 33.067 Gb/s lanes into a proprietary 264.536 Gb/s signal using DP-QAM16 modulation (I/Q modulation on horizontal and vertical polarizations)

A tunable laser block is driven by the line modulator to allow the tuning of the Line DWDM Channel.

The following alarms can be read from the Line Modulator Block:

- Transmitter fault
- Transmitter not ready
- DDM information

The following controls can be sent to the Line Modulator:

- Shut down optical transmitter
- Line DWDM Channel (50GHz grid)

DownStream Section

Line Receiver Block

The Line Receiver extracts the four PAM4 33.067 Gb/s optical signals from the line interface using the I/Q demodulation on horizontal and vertical polarizations.

The Line receiver is driven by a Laser local Oscillator for coherent detection of the 200G signal.

These four lanes are then transmitted to the ADC and QAM16 constellation demapper block.

The following alarms can be read from the Line Optical Interface:

- Loss of input signal
- Receiver not ready
- DDM information

Quad ADC, QAM16 Constellation Demapper and DSP

The four PAM4 33.067 Gb/s lane signal is converted from Analog to Digital format and Digital Signal Processing is performed on the digital signal for

- Skew compensation
- Chromatic dispersion compensation
- Phase and frequency recovery

The 200G proprieraty line frame is then recovered and transmitted to the Line Deframing block.

Line Deframing & SD FEC

The 200G proprietary input line signal at 264.536 Gb/s is decoded to extract the two G709 OTU4 frame, which are transmitted to the de-framer block.

This block performs Soft Decision Forward Error Correction Decoding. The FEC Decoder is responsible for detecting and correcting data errors accumulated during transmission and restoring the G709 OTU4 frames.

10M DCC

The 10M DCC allows giving access to a 10Mb/s Ethernet data communication channel transported in the 200G proprietary frame.

It is extracted from 200G frame overheads bytes and passed to the Ethernet switch.

The following parameters can be read from the Line Optical Interface:

- SD FEC corrected errors counting.

G709 OTU4 De-Framer

For each of the two G709 OTU4, frame alignment is performed and SM-BIP8 parity calculation is computed.

HD FEC decoder

Standard FEC decoding is performed and HD-FEC corrected errors counting is performed.

The following information is provided to the controller for the G709 OTU4 incoming signal:

- Loss of Frame on incoming signal
- SM-IAE received
- SM-BDI received
- SM-BIP8 errors counting
- HD FEC corrected errors counting

De-Mapper

<u>In 100GbE:</u>

The 100GbE is extracted from the OTU4C2

The de-justification process allows recovering the 100GbE data stream mapped at the far end.

The de-mapper has an associated PLL for regenerating the far end incoming clock frequency, based on the information received from the de-justification mechanism.

This previous conditions ensures that clock tolerance up to ±100 ppm on incoming signal can be compensated for.

In OTU4:

The OTU4 is extracted from the OTU4C2.

The de-justification process allows recovering the OTU4 data stream mapped at the far end.

The de-mapper has an associated PLL for regenerating the far end incoming clock frequency, based on the information received from the de-justification mechanism.

This previous conditions ensures that clock tolerance up to ±20 ppm on incoming signal can be compensated for.

Client Signal Fail information is also extracted and reported to the controller block.

Under failure conditions, an output client AIS (CAIS) signal is inserted on the outgoing client port.

The alarms leading to assertion of client AIS are:

- Loss of optical input signal
- Loss of Frame on G709 OTU4 input.
- SM-IAE received on the G709 OTU4 input.
- Incoming CSF detected on individual channel

The client AIS signal when asserted shuts down the client optical output.

The following information is provided to the application processor on a per port basis:

- CSF received
- CAIS asserted

Output port interfacing

In 100GbE:

64B/66B encoding is performed. Errors which can have happened on the transmission line may lead to words which are not recognized by the encoder. Under such condition, they are replaced by the /E/ error code.

In OTU4:

Standard GFEC is re-encoded

The data is serialized and converted to an optical signal by a QSFP28 Transceiver.

The following information is provided to the control block:

- Optical transmitter failure
- DDM information.

The following configuration information is received from the control block on a per port basis:

- Optical output shut-down

RMON (Remote Network Monitoring)

Remote Network Monitoring functionality is provided on the 100GbE outgoing client port. The downstream client port is 66B to 64B decoded to provide the RMON statistics.

The following statistics are made available on a per port basis:

- Packet counters:

Total number of packets (including, broadcast packets, and multicast packets) transmitted

- CRC errors counter

Total number of packets transmitted that either a bad Frame Check Sequence (FCS) with an integral number of octets (FCS Error) or a bad FCS with a non-integral number of octets (Alignment Error).

Maintenance Loop backs

Client Terminal Loopback
As a test feature, an individual Client Terminal Loopback can be performed for maintenance operations. The client signal extracted from the line input signal is looped back to the line output signal. The description of the data path in case of Client Terminal Loopback is described on Figure 2

Client Facility Loopback
As a test feature, an individual Client Facility Loopback can be performed for maintenance operations. The client signal received on an input port is looped back on the corresponding outgoing client port. The description of the data path in case of Client Facility Loopback is described on Figure 3

Line Terminal Loopback
As a test feature, a Line Terminal Loopback can be performed for maintenance operations, allowing looping back the transmitted 200Gb/s signal on the downstream section. The description of the data path in case of Line Terminal Loopback is described on Figure 4.

Line Facility Loopback
As a test feature, a Line Facility Loopback can be performed for maintenance operations, allowing looping back the received 200Gb/s signal on the upstream section. The description of the data path in case of Line Facility Loopback is described on Figure 5.

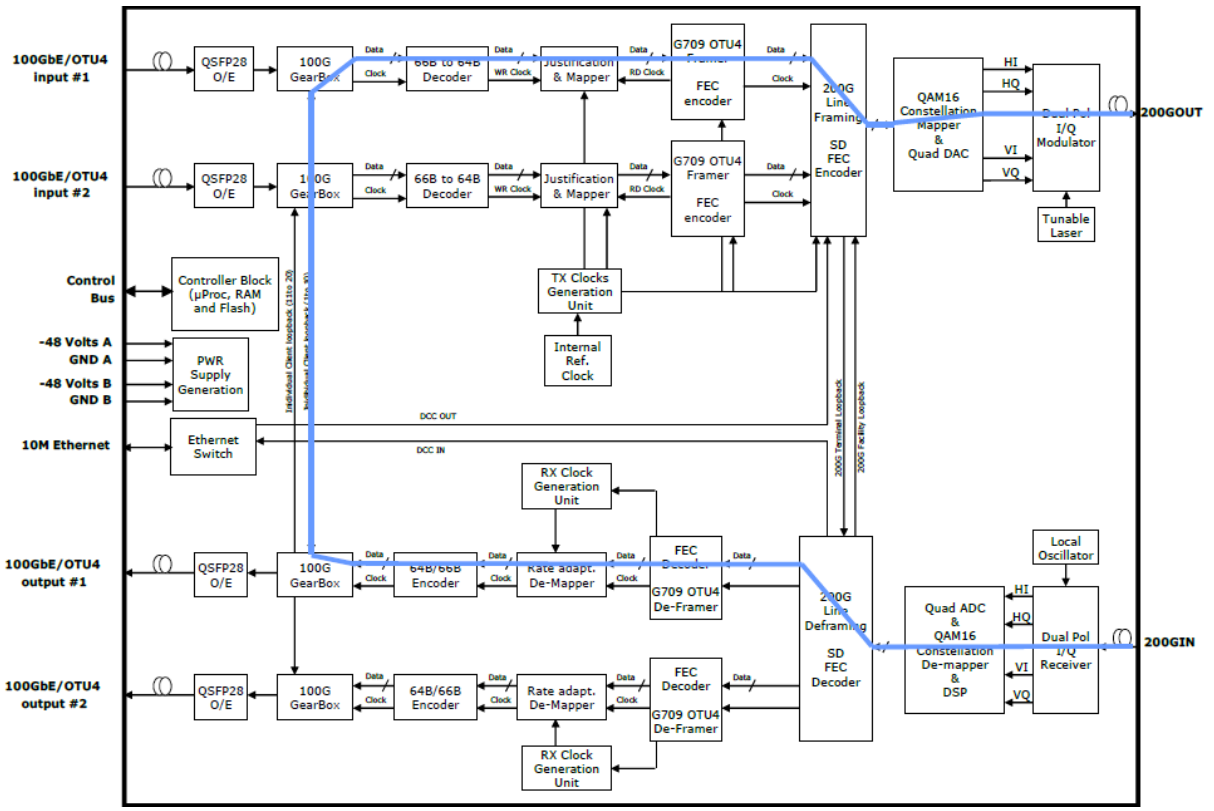

Figure 2: Signal data path in Client Terminal Loopback operation (200G-MR).

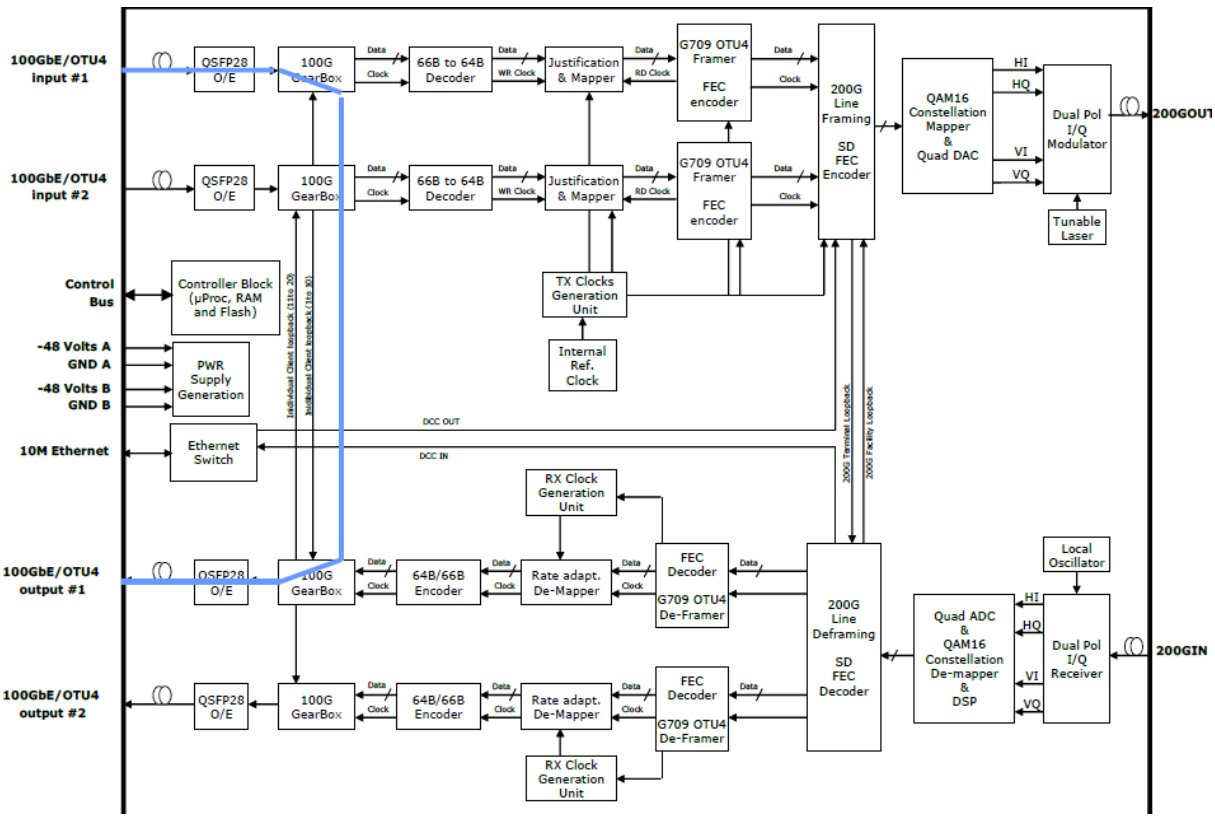

Figure 3: Signal data path in Client Facility Loopback operation (200G-MR)

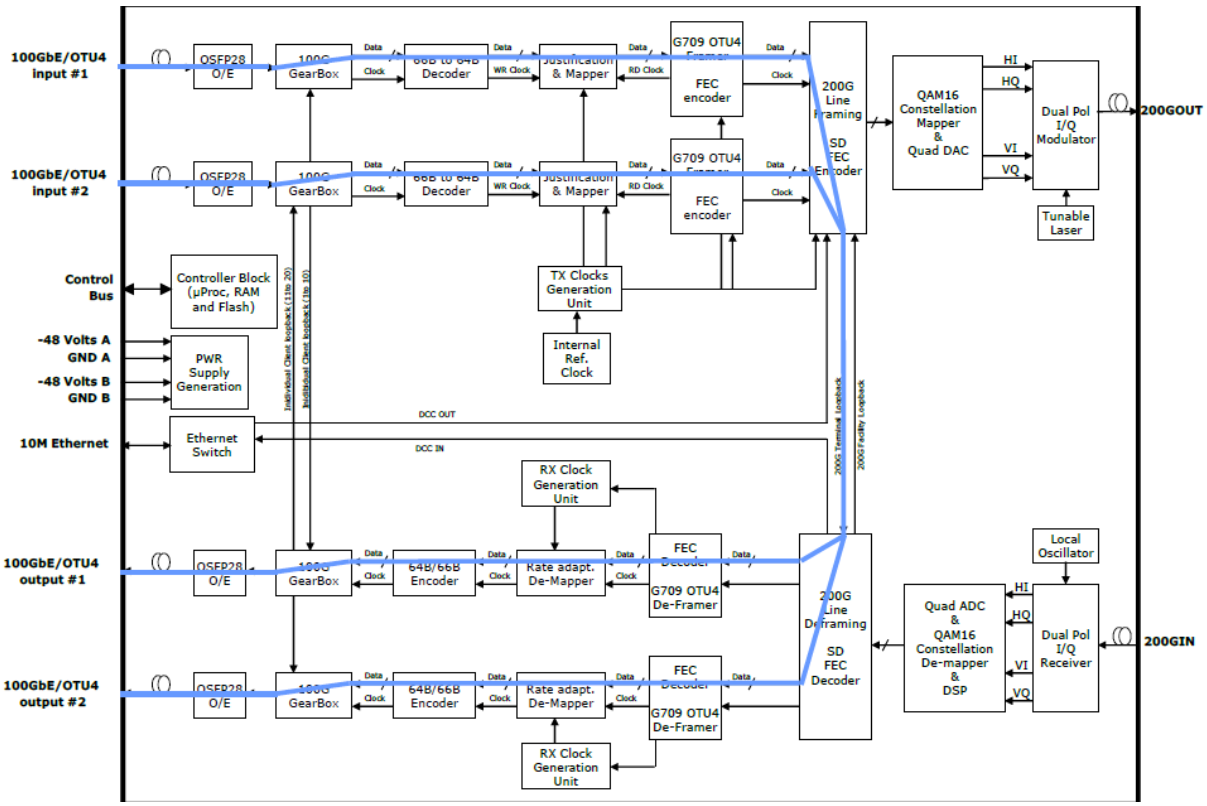

Figure 4: Signal data path in Line Terminal Loopback operation (200G-MR).

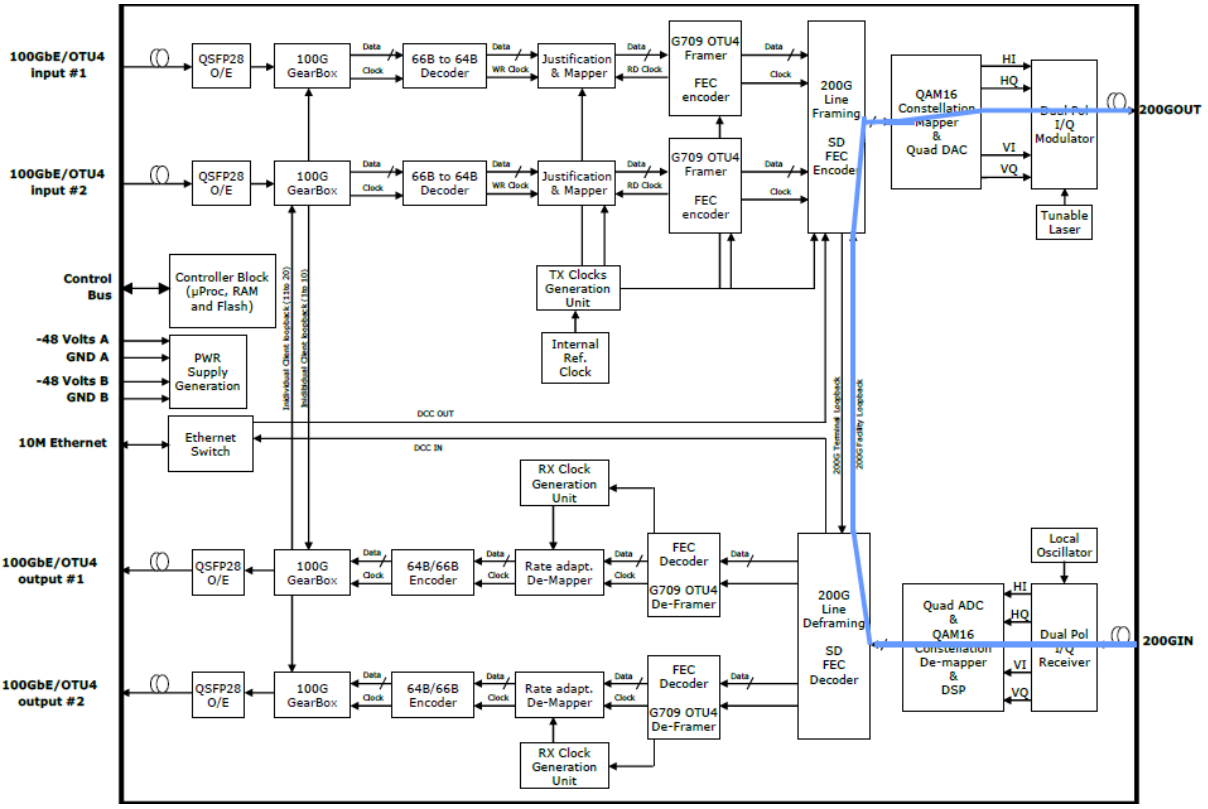

Figure 5: Signal data path in Line Facility Loopback operation (200G-MR)

Clock Generation Unit

UpStream Clock Generation Unit
The UpStream Clock generation unit generates all internal clock signals required by the upstream part of the MS430943/4M. The reference clock is internal to the MS430943/4M and has a stability of +/- 20 ppm.

DownStream Clock Generation Unit
The DownStream Clock generation unit generates all internal clock signals required by the downstream part of the MS430943/4M.

It generates in particular the 100GbE reference clocks recovered from the incoming Line signal which are fed to the individual de-mappers.

Controller Block
The controller block is composed of a microprocessor associated with Flash and RAM memories.

The controller block collects information from different functional blocks and configures the HW according to a configuration file received.

The raw information (alarms, monitoring, inventory …) generated by the HW are processed by the microprocessor and delivered to the Management Unit as high level consolidated data.

Out of Service and In Service states

Client port

An individual command is accessible to set the client port Out of Service.

When the client port is Out of Service, an Out of Service information is sent over the line interface to inform the far end client port that the local client port is Out of Service. The client port provides the following additional information:

- Local OS: The local client port is Out of Service

An Out of Service client port has the following behaviour

- The QSFP28 Laser is be shut down
- All the alarms of the client port are masked (except Local OS and Distant OS).
- All the counters of the client port are disabled (the invalid bit is set).
- All the QSFP28 measures of the client port are disabled (the value is set to 0).

When the client port is In Service, all the disabled features previously named are enabled again. The alarms are unmasked and the Out of Service information is not sent anymore over the line interface.

Line port

An individual command is accessible to set the line port Out of Service

Linked to the Out of Service state, the line port has the following additional information:

- Local OS: The local line port is Out of Service.

An Out of Service line port has the following behaviour:

- The 200G Line transmit Laser is shut down
- All the alarms of the line port are masked (except Local OS).
- All the counters of the line port are disabled (the invalid bit is set).
- All the 200G Line interfacing measures of the line port are disabled (the value is set to 0).

When the line port is In Service, all the disabled features previously named are enabled again and the alarms are unmasked.

Power Supplies

The power supply block generates from the received external -48 volts, the different internal supplies needed.

Interface Specifications (200G-MR)

Client Interfaces Optical Characteristics

Client interfaces are provided by QSFP28 transceivers. The optical characteristics are therefore given in the data sheet of the QSFP28 plugged into theFlexrate module.

MS430943M Line Interface characteristics

The optical characteristics for this interface are given in the following table:

General	Value			Unit
	Min	Typ	Max	
Bit Rate nominal		264.536		Gb/s
Line Coding		DP-QAM16		-
CD Tolerance	-24000		+24000	ps/nm
OSNR penalty @ +/- 24000ps/nm			0.5	dB
PMD Tolerance			30	ps
OSNR EOL (back to back)	21			dB
Transmitter	**Value**			**Unit**
DWDM ITU Channel range	17		61	
DWDM Wavelength range (50 GHz grid)	1528.77	-	1563,86	nm
	191.70	-	196.10	THz
Centre wavelength tolerance (EOL)	- 2.5	-	+ 2.5	GHz
SMSR	40	-	-	dB
Pout (average value)		3	-	dBm
Receiver	**Value**			**Unit**
DWDM ITU Channel range	17		61	
DWDM Wavelength range (50 GHz grid)	1528.77	-	1563,86	nm
	191.70	-	196.10	THz
Pin_{min} (sensitivity for BER @ 10^{-12}, average value, $OSNR_{min}$=25dB)	-25	-15	-5	dBm
Pin_{min} (sensitivity for BER @ 10^{-12}, average value, $OSNR_{min}$=21dB)	-15	-13	-9	dBm
Receiver Reflectance			-27	dB

Table 1: MS430943M Line Optical Characteristics (200G-MR)

MS430944M Line Interface characteristics

The optical characteristics for this interface are given in the following table:

General	Value			Unit
	Min	Typ	Max	
Bit Rate nominal		264.536		Gb/s
Line Coding		DP-QAM16		-
CD Tolerance	-24000		+24000	ps/nm
OSNR penalty @ +/- 24000ps/nm			0.5	dB
PMD Tolerance			30	ps
OSNR EOL (back to back)	21			dB
Transmitter	**Value**			**Unit**
DWDM ITU Channel range	17		61	
DWDM Wavelength range (50 GHz grid)	1528.77	-	1563,86	nm
	191.70	-	196.10	THz
Centre wavelength tolerance (EOL)	- 2.5	-	+ 2.5	GHz
SMSR	40	-	-	dB
Pout (Tunable)	-25	-	3	dBm
Receiver	**Value**			**Unit**
DWDM ITU Channel range	17		61	
DWDM Wavelength range (50 GHz grid)	1528.77	-	1563,86	nm
	191.70	-	196.10	THz
Pin_{min} (sensitivity for BER @ 10^{-12}, average value, $OSNR_{min}$=25dB)	-25	-15	-5	dBm
Pin_{min} (sensitivity for BER @ 10^{-12}, average value, $OSNR_{min}$=21dB)	-15	-13	-9	dBm
Receiver Reflectance			-27	dB

Table 2: MS430944M Line Optical Characteristics (200G-MR)

System description 100G-ULH Mode

The block diagram for the MS430943/4M is given in Figure 6.

The MS430943/4M is a bi-directional device. It therefore has different sections:

- Upstream Section: from two 100GbE / OTU4 optical inputs to 100G optical output
- Downstream Section: from 100G optical input to two 100GbE / OTU4 optical output

- Common sections composed of :
  - Controller block, providing interfacing to the chassis controller board hosting the SNMP Agent.
  - Power supplies: generates different internal power supplies from the -48V – input
  - Front panel LEDs indicating the status of the ports, line and the Flexrate module common functions

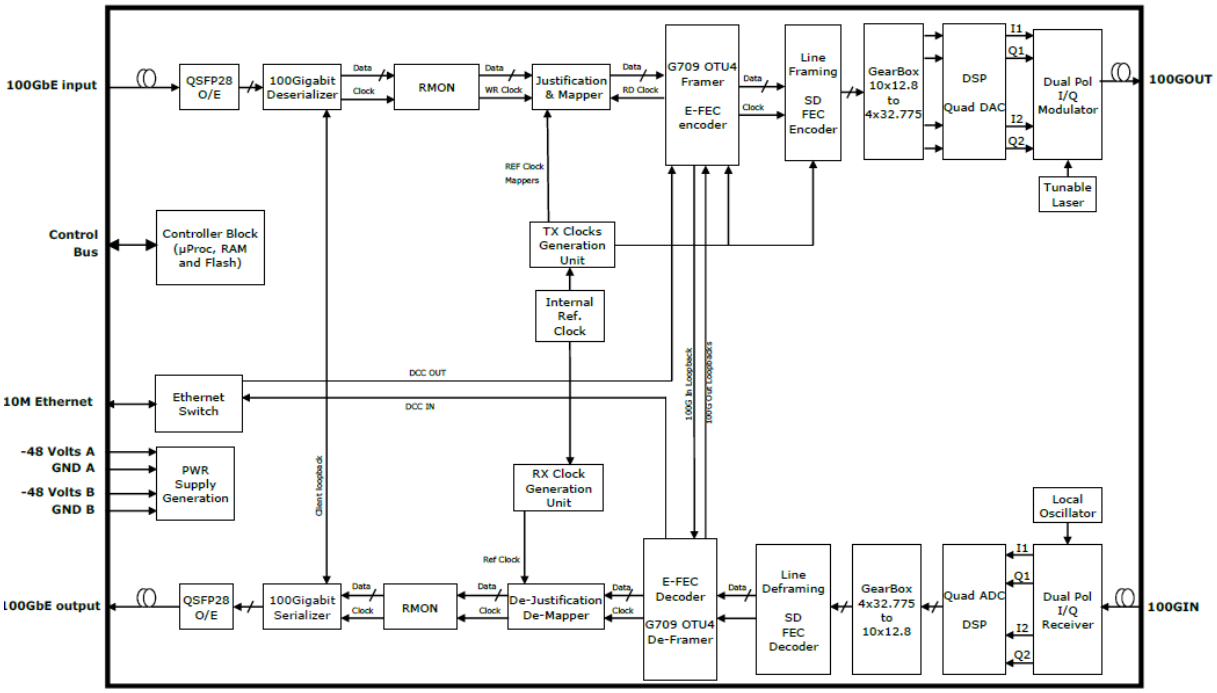

Figure 6: Block diagram (100G-ULH).

Upstream section

Input Ports interfacing

The upstream section has two 100GbE/OTU4 client inputs.
Client physical interfacing is done through standard QSFP28 modules.

In 100GbE:
The upstream client port is 66B to 64B decoded. If invalid 66B blocks are received, they are replaced by the /E/ control code.

In OTU4:
The upstream client port is process to terminate the GFEC and potential error are corrected. The OTU4signal (without FEC) is provided to the mapper.

The following information is provided to the controller:

- QSFP28 absence

- Loss of optical input signal
- Loss of synchronization on incoming signal:
- Loss of 66B/64B decoder sync (100GbE) or Loss of Frame (OTU4)
- Counting of incoming errors:
- MAC frames FCS errors counting (100GbE) or input SM-BIP8 (OTU4)
- DDM information

RMON (Remote Network Monitoring)
Remote Network Monitoring functionality is provided on the 100GbE incoming client port. The upstream client port is 66B to 64B decoded to provide the RMON statistics.

The following statistics are made available on a per port basis:

- Packet counters:

Total number of packets (including, broadcast packets, and multicast packets) received

- CRC errors counter

Total number of packets received that either a bad Frame Check Sequence (FCS) with an integral number of octets (FCS Error) or a bad FCS with a non-integral number of octets (Alignment Error).

Mapper

In 100GbE:

Each incoming signal must be synchronized to the local clock prior of adaptation to long distance transport. The incoming signal is therefore mapped in an OTU4C2 and the synchronisation is performed thanks to a justification process which can tolerate ±100 ppm frequency deviation to the nominal 100 GbE LAN bit rate

In OTU4:

The OTU4 signal is transparently transmited to the Framer

The mapper inserts additional information:

- Client Signal Fail indication: a bit in the mapping frame is set in case one of the following conditions are present on the incoming signal
    - QSFP28 not present
    - Loss of incoming signal.
    - Loss of synchronization on incoming signal

The following information is provided to the controller on a per port basis:

- Client Signal Fail asserted

G709 OTU4 Framer

Each mapped 100GbE client signal is then encapsulated in a G709 ODU4 payload.

The payload is framed into a G709 OTU4 output signal.

SM-BIP8 is calculated and inserted in its corresponding locations in the outgoing signal.

The following information is provided to the controller on a per port basis:

- SM-BDI inserted

FEC encoder

E- FEC encoding is performed and inserted in dedicated bytes of the G709 OTU4.

10M DCC

The 10M DCC allows inserting a 10Mb/s Ethernet data communication channel coming from the Ethernet switch and transported in the G709 OTU4 frame.

It is inserted in unused bytes of the G709 OTU4 frame.

The following controls can be sent to the Framer

- 100G In loop-back

Line Framing & SD FEC

The Line framing block is encapsulating the G709 OTU4 frame in a line splitted in ten 12.78 Gb/s lanes.

A proprietary Software-Decision FEC encoding is performed and inserted in the unused bytes of the line frame.

GearBox

The gear box is convering the ten 12.78 Gb/s lanes into four 32.775 Gb/s lanes which are transmitted to the line modulator.

DSP and Quad DAC

Digital Signal Processing is processed on the digital signal to perform

- Pulse shaping

Each individual 32.775 Gb/s lane signal is then converted from Digital to Analog format

Line Modulator Block

The Line modulator is combining the four 32.775 Gb/s lanes into a proprietary 131.1 Gb/s signal using DP-QPSK modulation based (I/Q modulation on horizontal and vertical polarizations).

A tunable laser block is linked to the line modulator to allow the tuning of the Line DWDM Channel.

The following alarms can be read from the Line Modulator Block:

- Transmitter fault
- Transmitter not ready
- DDM information

The following controls can be sent to the Line Modulator:

- Shut down optical transmitter
- Line DWDM Channel (50GHz grid)

DownStream Section

Line Receiver Block

The Line Receiver extracts the four 32.775 Gb/s optical signals from the line interface using the I/Q modulation on horizontal and vertical polarizations.

The Line receiver is linked to a Laser local Oscillator for coherent detection of the 100G signal.

These four lanes are then transmistted to the ADC and DSP block.

The following alarms can be read from the Line Optical Interface:

- Loss of input signal
- Receiver not ready
- DDM information

Quad ADC and DSP

Each individual 32.755 Gb/s lane signal is converted from Analog to Digital format and Digital Signal Processing is processed on the digital signal to perform

- Skew compensation
- Chromatic dispersion compensation
- Phase and frequency recovery

Gearbox

The gear box is convering the four 32.755 Gb/s lanes into ten 12.8 Gb/s lanes which are transmitted to the line deframing.

Line Deframing & SD FEC

The 100G proprietary input line signal at 131.1 Gb/s is decoded to extract the G709 OTU4 frame, which is transmitted to the de-framer block.

This block performs Soft Decision Forward Error Correction Decoding. The FEC Decoder is responsible for detecting and correcting data errors accumulated during transmission and restoring the G709 OTU4 frame.

The following parameters can be read from the Line Optical Interface:

- SD-FEC corrected errors counting.

10M DCC

The 10M DCC allows giving access to a 10Mb/s Ethernet data communication channel transported in the G709 OTU4 frame.

It is extracted unused bytes of the G709 OTU4 frame and passed to the Ethernet switch.

G709 OTU4 De-Framer

G709 OTU4 frame alignment is performed and SM-BIP8 parity calculation is computed.

The following information is provided to the controller for the G709 OTU4 incoming signal:

- Loss of Frame on incoming signal
- SM-IAE received
- SM-BDI received
- SM-BIP8 errors counting
- E-FEC corrected errors counting

FEC decoder

E-FEC decoding is performed and HD-FEC corrected errors counting is performed

De-Mapper

<u>In 100GbE:</u>

The de-justification process allows recovering the 100GbE data stream mapped at the far end.

The de-mapper has an associated PLL for regenerating the far end incoming clock frequency, based on the information received from the de-justification mechanism.

This previous conditions ensures that clock tolerance up to ±100 ppm on incoming signal can be compensated for.

In OTU4:

The OTU4 frame is transparently transmitted to the output power interface.

Client Signal Fail information is also extracted and reported to the controller block.

BIP-8 parity (CBIP) is computed over mapped client data and compared to the received BIP-8. Error counting is performed and the result is reported to the controller block.

Under failure conditions, an output client AIS (CAIS) signal is inserted on the outgoing client port.

The alarms leading to assertion of client AIS are:

- Loss of optical input signal
- Loss of Frame on G709 OTU4 input.
- SM-IAE received on the G709 OTU4 input.
- Incoming CSF detected on individual channel

The client AIS signal when asserted shuts down the client optical output.

The following information is provided to the application processor on a per port basis:

- CSF received
- BIP-8 errors counting
- CAIS asserted

Output port interfacing

In 100GbE:

64B/66B encoding is performed. Errors which can have happened on the transmission line may lead to words which are not recognized by the encoder. Under such condition, they are replaced by the /E/ error code.

In OTU4:

Standard GFEC is re-encoded

The data is serialized and converted to an optical signal by a QSFP28 Transceiver.

The following information is provided to the control block:

- Optical transmitter failure
- DDM information.

The following configuration information is received from the control block on a per port basis:

- Optical output shut-down

RMON (Remote Network Monitoring)

Remote Network Monitoring functionality is provided on the 100GbE outgoing client port. The downstream client port is 66B to 64B decoded to provide the RMON statistics.

The following statistics are made available on a per port basis:

- Packet counters:

Total number of packets (including, broadcast packets, and multicast packets) transmitted

- CRC errors counter

Total number of packets transmitted that either a bad Frame Check Sequence (FCS) with an integral number of octets (FCS Error) or a bad FCS with a non-integral number of octets (Alignment Error).

Maintenance Loop backs

Client Terminal Loopback
As a test feature, an individual Client Terminal Loopback can be performed for maintenance operations. The client signal extracted from the line input signal is looped back to the line output signal. The description of the data path in case of Client Terminal Loopback is described on Figure 7

Client Facility Loopback
As a test feature, an individual Client Facility Loopback can be performed for maintenance operations. The client signal received on an input port is looped back on the corresponding outgoing client port. The description of the data path in case of Client Facility Loopback is described on Figure 8

Line Terminal Loopback
As a test feature, a Line Terminal Loopback can be performed for maintenance operations, allowing looping back the transmitted 200Gb/s signal on the downstream section. The description of the data path in case of Line Terminal Loopback is described on Figure 9.

Line Facility Loopback
As a test feature, a Line Facility Loopback can be performed for maintenance operations, allowing looping back the received 200Gb/s signal on the upstream section. The description of the data path in case of Line Facility Loopback is described on Figure 10.

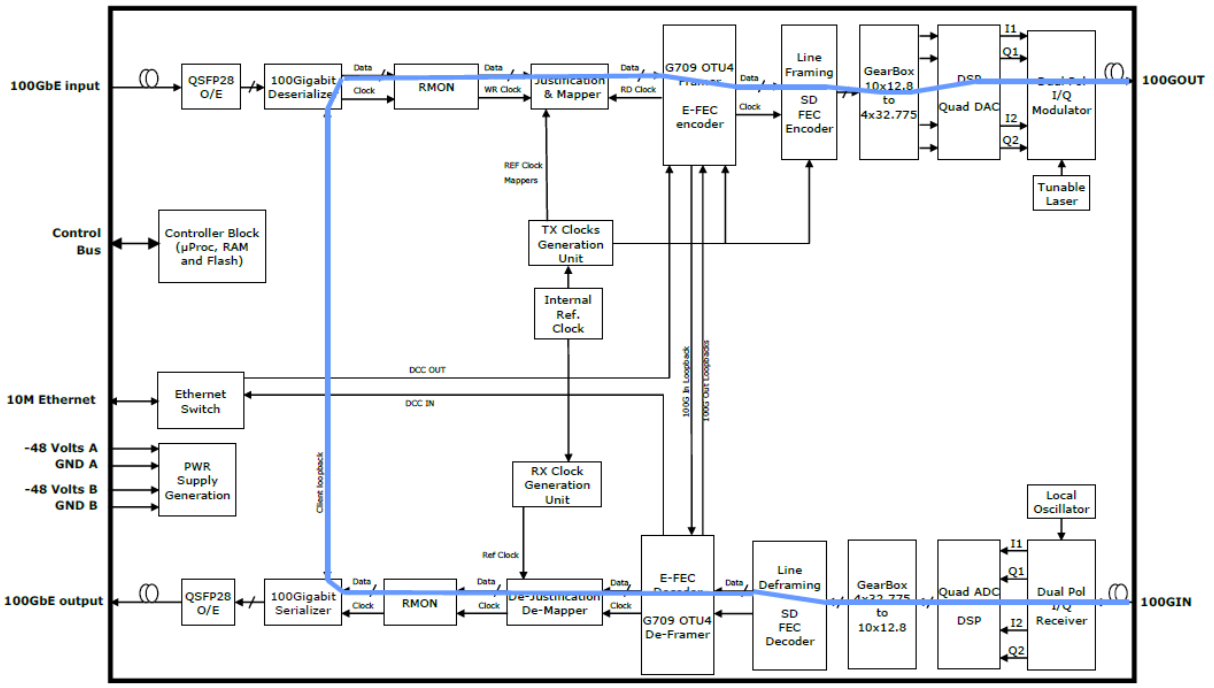

Figure 7: Signal data path in Client Terminal Loopback operation (100G-ULH).

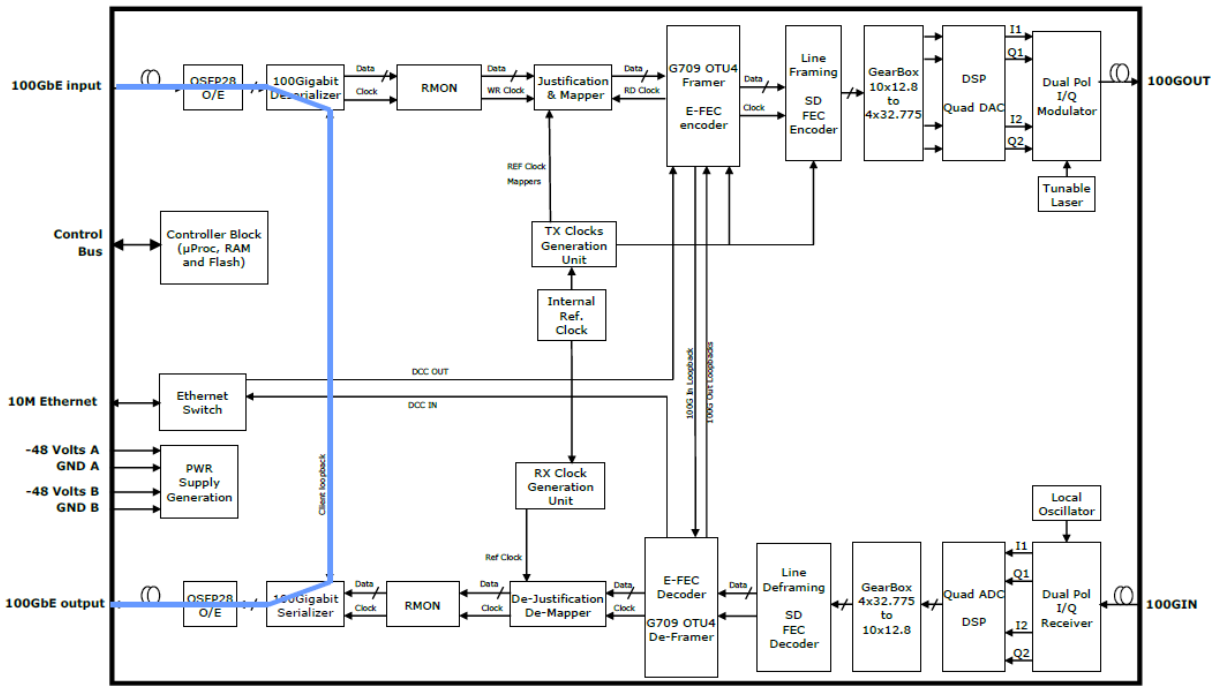

Figure 8: Signal data path in Client Facility Loopback operation (100G-ULH)

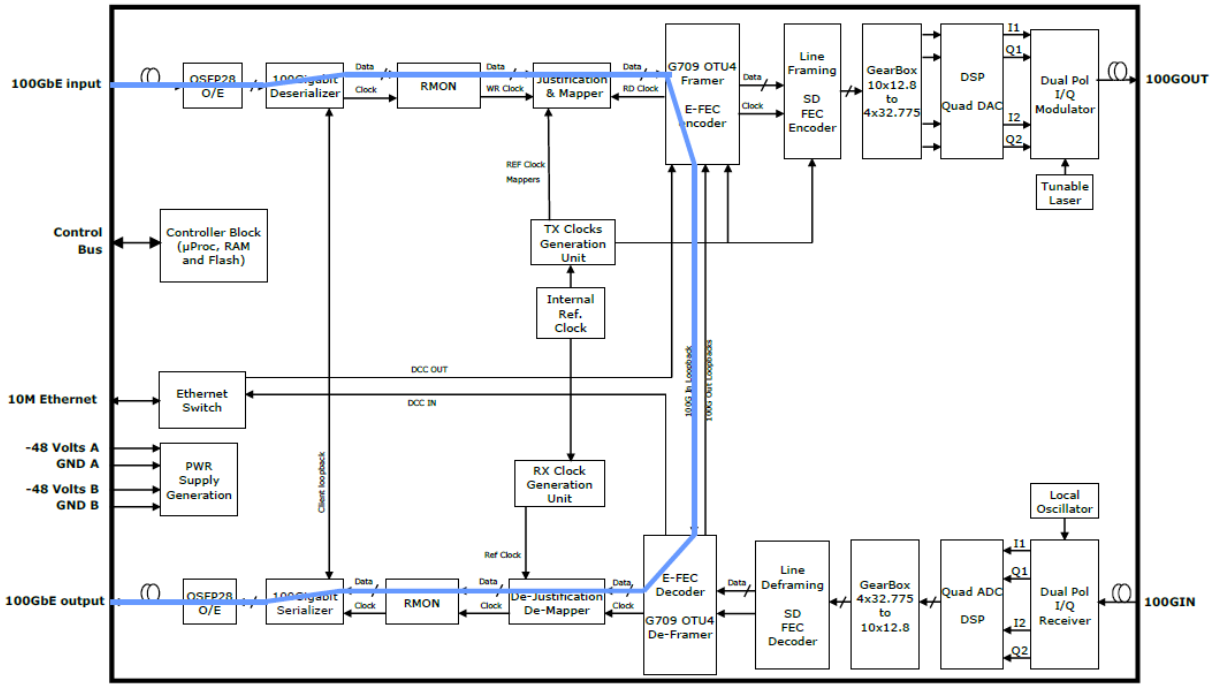

Figure 9: Signal data path in Line Terminal Loopback operation (100G-ULH).

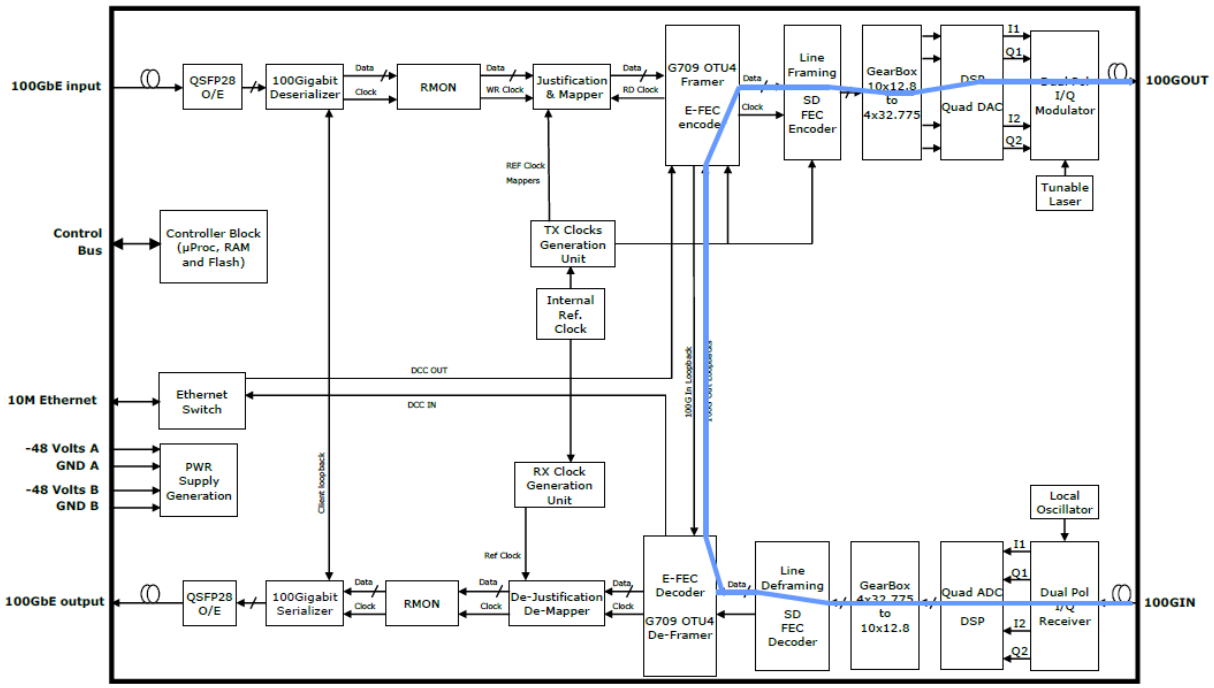

Figure 10: Signal data path in Line Facility Loopback operation (100G-ULH)

Clock Generation Unit

UpStream Clock Generation Unit
The UpStream Clock generation unit generates all internal clock signals required by the upstream part of the MS430943/4M. The reference clock is internal to the MS430943/4M and has a stability of +/- 20 ppm.

DownStream Clock Generation Unit
The DownStream Clock generation unit generates all internal clock signals required by the downstream part of the MS430943/4M.

It generates in particular the 100GbE reference clocks recovered from the incoming Line signal which are fed to the individual de-mappers.

Controller Block
The controller block is composed of a microprocessor associated with Flash and RAM memories.

The controller block collects information from different functional blocks and configures the HW according to a configuration file received.

The raw information (alarms, monitoring, inventory …) generated by the HW are processed by the microprocessor and delivered to the Management Unit as high level consolidated data.

Out of Service and In Service states

Client port

An individual command is accessible to set the client port Out of Service.

When the client port is Out of Service, an Out of Service information is sent over the line interface to inform the far end client port that the local client port is Out of Service. The client port provides the following additional information:

- Local OS: The local client port is Out of Service

An Out of Service client port has the following behaviour

- The QSFP28 Laser is be shut down
- All the alarms of the client port are masked (except Local OS and Distant OS).
- All the counters of the client port are disabled (the invalid bit is set).
- All the QSFP28 measures of the client port are disabled (the value is set to 0).

When the client port is In Service, all the disabled features previously named are enabled again. The alarms are unmasked and the Out of Service information is not sent anymore over the line interface.

Line port

An individual command is accessible to set the line port Out of Service

Linked to the Out of Service state, the line port has the following additional information:

- Local OS: The local line port is Out of Service.

An Out of Service line port has the following behaviour:

- The 100G Line transmit Laser is shut down
- All the alarms of the line port are masked (except Local OS).
- All the counters of the line port are disabled (the invalid bit is set).
- All the 100G Line interfacing measures of the line port are disabled (the value is set to 0).

When the line port is In Service, all the disabled features previously named are enabled again and the alarms are unmasked.

Power Supplies

The power supply block generates from the received external -48 volts, the different internal supplies needed.

Interface Specifications (100G-ULH)

Client Interfaces Optical Characteristics

Client interfaces are provided by QSFP28 transceivers. The optical characteristics are therefore given in the data sheet of the QSFP28 plugged into the Flexrate module.

MS430943M Line Interface characteristics

The optical characteristics for this interface are given in the following table:

General	Value			Unit
	Min	Typ	Max	
Bit Rate nominal		131.1		Gb/s
Line Coding		DP-QPSK		-
CD Tolerance	-55000		55000	ps/nm
OSNR penalty @ +/-55000 ps/nm			0.5	dB
PMD Tolerance			30	ps
OSNR EOL (back to back)	12.5			dB
Transmitter	**Value**			**Unit**
DWDM ITU Channel range	17		61	
DWDM Wavelength range (50 GHz grid)	1528.77	-	1563,86	nm
	191.70	-	196.10	THz
Centre wavelength tolerance (EOL)	- 2.5	-	+ 2.5	GHz
SMSR	40	-	-	dB
Pout (average value)		3	-	dBm
Receiver	**Value**			**Unit**
DWDM ITU Channel range	17		61	
DWDM Wavelength range (50 GHz grid)	1528.77	-	1563,86	nm
	191.70	-	196.10	THz
Pin_{min} (sensitivity for BER @ 10^{-12}, average value, $OSNR_{min}$=25dB)	-25	-15	-5	dBm
Pin_{min} (sensitivity for BER @ 10^{-12}, average value, $OSNR_{min}$=12.5dB)	-15	-13	-9	dBm
Receiver Reflectance			-27	dB

Table 3: MS430943M Line Optical Characteristics (100G-ULH)

MS430944M Line Interface characteristics

The optical characteristics for this interface are given in the following table:

General	Value			Unit
	Min	Typ	Max	
Bit Rate nominal		131.1		Gb/s
Line Coding		DP-QPSK		-
CD Tolerance	-55000		55000	ps/nm
OSNR penalty @ +/-55000 ps/nm			0.5	dB
PMD Tolerance			30	ps
OSNR EOL (back to back)	12.5			dB
Transmitter	**Value**			**Unit**
DWDM ITU Channel range	17		61	
DWDM Wavelength range (50 GHz grid)	1528.77	-	1563,86	nm
	191.70	-	196.10	THz
Centre wavelength tolerance (EOL)	- 2.5	-	+ 2.5	GHz
SMSR	40	-	-	dB
Pout (Tunable)	-25	-	3	dBm
Receiver	**Value**			**Unit**
DWDM ITU Channel range	17		61	
DWDM Wavelength range (50 GHz grid)	1528.77	-	1563,86	nm
	191.70	-	196.10	THz
Pin_{min} (sensitivity for BER @ 10^{-12}, average value, $OSNR_{min}$=25dB)	-25	-15	-5	dBm
Pin_{min} (sensitivity for BER @ 10^{-12}, average value, $OSNR_{min}$=12.5dB)	-15	-13	-9	dBm
Receiver Reflectance			-27	dB

Table 4: MS430944M Line Optical Characteristics (100G-ULH)

Appendixes

Laser Class

Laser Class	Risks	General Requirements
1	Considered safe to eye and Skin under all reasonably foreseeable conditions of operation.	Protective housing: may be required.

Module Leds description

LED	Status	Condition
SW	Green On	Normal
	Red On	SW Failure
HW	Green On	Normal
	Red ON	HW Failure
Line Los	Green	Normal
	Red	Loss of Signal
Line Fail	Green	Normal
	Red	Line Failure
	Red blinking	Line init.
Client LOS	Green	Normal
	Red	Loss of Signal
	OFF	Port not used
Client Fail	Green	Normal
	Red	Client failure
	OFF	Port not used

Front Panel Layout

The MS430943/4M is a single slot module. Clients are QSFP28 cages capable of hosting standard QSFP28 modules

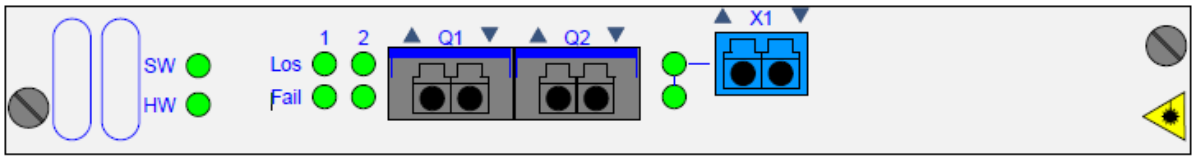

Figure 11: Front panel layout (200G-MR)

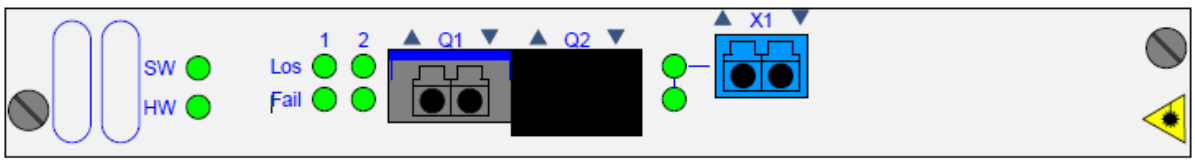

Figure 12: Front panel layout (100G-ULH)

Technical Specifications

Type	200G Flexrate Muxponder
Connectors	Local ports: QSFP28, Line ports: FFI
Line data rate	proprietary
Power consumption	60W equipped with QSFP28
Operating temp	0°C to 50°C
Storage temp	-20°C to 85°C

Order Information

Art. No.	Description	Connectors
Modules		
MS430943M	Single slot FlexRate Muxponder (Metro Regional 200G or Ultra Long Haul 100G) , 2 clients Ports (100Gbe or OTU4) , 1 Line Port with DCC, QSFP28 Clients and Tunable 100G ULH/200G MR Line Interface (QSFP28 Not Included, Tunable Line Interface Included). Compatible with MS430504M and MS430501/3M chassis (with Airflow Card for the MS430504M)	2x QSFP28 1x FFI
MS430944M	Single slot FlexRate Muxponder (Metro Regional 200G or Ultra Long Haul 100G) , 2 clients Ports (100Gbe or OTU4) , 1 Line Port with VOA & DCC, compatible with single Fiber configuration. QSFP28 Clients and Tunable 100G ULH/200G MR Line Interface (QSFP28 Not Included, Tunable Line Interface Included). Compatible with MS430504M and MS430501/3M chassis (with associated Airflow Card)	2x QSFP28 1x FFI
MS430946M	Airflow Optimization Module for installation of Flexrate cards in the 20slosts chassis. One Airflow card per Flexrate card to be installed in the MS430504M chassis.	NA