MOPA Tight Sync:

Standardization of Tight Sync parameters in SFF 8636 and CMIS

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DRAFT – includes open points

Project proposal: Add Synchronization registers to SFF-8636

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Tight Sync - parameters

- Tight Sync indicator
- Number of lanes for which delays are specified
- Operational mode
- Temp dependent curve coefficients
- Curve coefficients for Rx Optical power dependent delay
- Largest value of Rx delays
- Average value of Rx delay Lane 1
- Average value of Tx delay Lane 1
- Same for lanes 2,3,4

As included in SNIA SFF 8472 (optical module)

Table 13-1 Register Summary Page 03h – Calibration format for Optical Modules

	A2h	Size Bytes	Name	Description
	128-129	2	Format ID	CA1Bh – Indicates page 03h has calibration format for Optical Modules
1)	130-149	20	Common Header	Common Header, see section 13.3
	150	1	Nb_Lanes	Number of lanes for which delays are specified in the module. For SFF 8472 this value is 1.
	151	1	Op_Mode_Id	ID of the "Operational mode" associated with the values of the page. For SFF 8472 this value is 0.
	152-154	3	Rx_Pwr_Dly(0)	Curve coefficient for RX optical power dependent delay
	155-157	3	Rx_Pwr_Dly(1)	Curve coefficient for RX optical power dependent delay
2)	158-160	3	Rx_Pwr_Dly(2)	Curve coefficient for RX optical power dependent delay
	161-163	3	Rx_Pwr_Dly(3)	Curve coefficient for RX optical power dependent delay
	164-166	3	Rx_Pwr_Dly(4)	Curve coefficient for RX optical power dependent delay
	167-168	2	T_Detune_Offset	Temperature dependent laser wavelength de-tuning offset
	169-170	2	T_Detune_Slope	Temperature dependent laser wavelength de-tuning slope
	171-174	4	Delta_Rx_Max	Largest value of the 3-sigma standard deviations of all (one for SFF8472) reported Average Receiving delays, in ns
	175-178	4	Delta_Tx_Max	Largest value of the 3-sigma standard deviations of all (one for SFF8472) reported Average Transmitting delays, in ns
	179-182	4	Avg_Rx_Lane	Average Receiving delay on Lane, in ns
	183-186	4	Avg_Tx_Lane	Average Transmitting delay on Lane, in ns
	187-254	68	Reserved 00h	All bytes 00h
	255	1	CC_CALIB	Checkcode over bytes 128-254

See 13.4 Calibration format for Optical Modules.

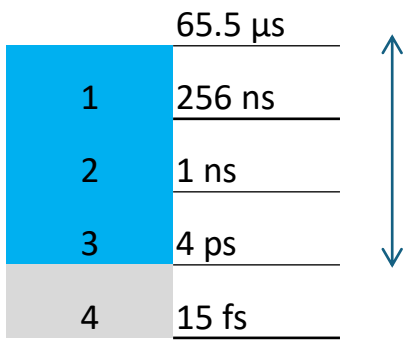
Table 13-3 Register Groups for Page 03h

A2h	Size Bytes	Name	Description
130	1	Version	This version number shall be 01h
131-133	3	Calibration Date	
134-139	6	Cal Uniq ID	Calibration Unique Identifier (CUI). Calibration Responsible
140	1	Stratum	Calibration Stratum. 0 is the highest precision.
141-149	9	Reserved	Common header section. Reserved 00h.

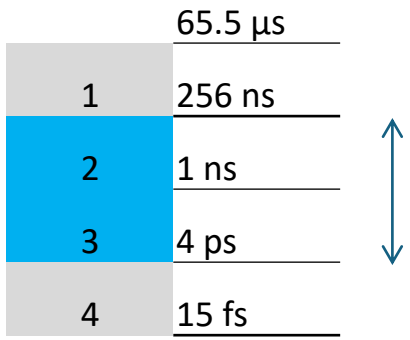
1 Module Calibration info
- Not relevant for telecom applications (no individual module calibrations) => not needed
- Relevant for extreme accuracy applications (physics) => needed in such modules

2 "corrections" in Q7.24 format for delay i.f.o. Rx_pwr polynomial:
- Not relevant for telecom applications => not needed
- Relevant for extreme accuracy applications (physics) => needed in such modules

format Avg_Tx/Rx: q16.16 in ns (of which q16.8 is sufficient for 10ps – 50µs)



format Delta_Tx/Rx: q16.16 in ns (of which q8.8 is sufficient for 10ps – 100ns)



Required memory space for only telecom tight sync parameters

Operational modes

Operational mode = any setting that can lead to a different value of internal latency, such as
- Rate
- FEC type
- (coherent) equalizer
- CDR mode (bypass or signal path)

Approach must allow to add modes in flexible way.
Min space for # modes to be supported assumed 4,
max is TBD

Approach must allow to have different lanes in different modes (only relevant if separate optical lanes), to be handled by the host.

Proposal: **1 page per operational mode containing the latencies of all lanes when in this given operational mode**
=> Host can read any lane in any mode.

Per operational mode: in function of # lanes

#lanes	Fixed (bytes)	Common for lanes: Delta (bytes)	# lanes: Avg (bytes)	Total (bytes)
1 (SFP)	2	8	8	18
2 (SFP-DD)	2	8	16	26
4 (QSFP)	2	8	32	42
8 (QSFP-DD)	2	8	64	74

In total: fixed + (common + avg) * #operational modes, min 4 modes to be supported

#lanes	Total, 1 mode (bytes / min #pages)	Total, 2 modes (bytes / min #pages)	Total, 4 modes (bytes / min #pages)	Total, 8 modes (bytes / min #pages)
1 (SFP)	18 / 1	34 / 1	66 / 1	130 / 2
2 (SFP-DD)	26 / 1	50 / 1	98 / 1	194 / 2
4 (QSFP)	42 / 1	82 / 1	162 / 2	322 / 3
8 (QSFP-DD)	74 / 1	146 / 2	290 / 3	578 / 5

Assuming: 128-byte pages

As included in SNIA SFF 8472 (calibration module)

Table 13-2 Register Summary Page 03h – Calibration format for Loopback Modules

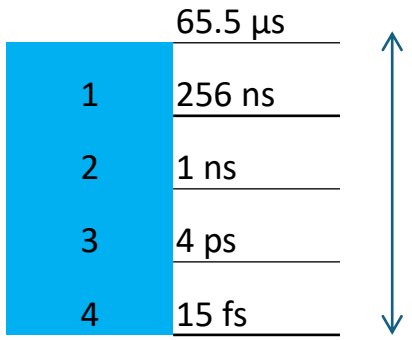
A2h	Size Bytes	Name	Description
128-129	2	Format ID	100Bh – Indicates page 03h has calibration format for Loopback Modules
130-149	20	Common Header	Common Header, see section 13.3
150-153	4	Calibration Inaccuracy	Largest value of the 3-sigma standard deviations of all reported delays.
154	1	Reserved 00h	Byte 00h
155-158	4	Tx_to_Rx Delay	Delay from looped back Tx to Rx port
159	1	Reserved 00h	Byte 00h
160-163	4	Tx_to_Mon Delay	Delay from Tx port to MON monitoring connector
164	1	Reserved 00h	Byte 00h
165-168	4	Rx_to_Mon Delay	Delay from Rx port to MON monitoring connector
169-254	86	Reserved 00h	All bytes 00h
255	1	CC_CALIB	Checkcode over bytes 128-254

See 13.5 Calibration format for Loopback Modules.

Table 13-3 Register Groups for Page 03h

A2h	Size Bytes	Name	Description
130	1	Version	This version number shall be 01h
131-133	3	Calibration Date	
134-139	6	Cal Uniq ID	Calibration Unique Identifier (CUI). Calibration Responsible
140	1	Stratum	Calibration Stratum. 0 is the highest precision.
141-149	9	Reserved	Common header section. Reserved 00h.

format Delay, calibration inaccuracy:
q16.16 in ns, allowing 15fs – 65µs

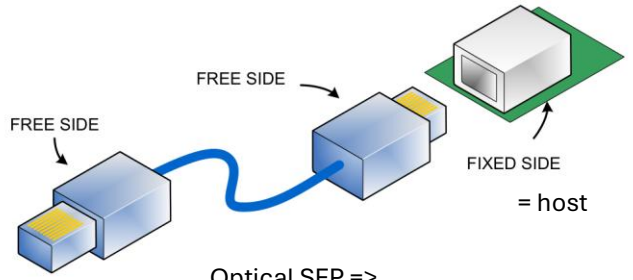


Including calibration module info into SFF 8636?

TBC with Nikhef/CERN

Proposal for including Tight Sync parameters in SNIA SFF 8636

Existing memory pages (128 bytes)



Optical SFP =>
Free side = Active Optical 'AO'

Purpose: introduce new parameters and keeping backwards compatibility

- 4 electrical Lanes to be supported
- Existing lower memory page: anything to change? Backward compatibility?
  - Only 5 unused bytes ("reserved")
  - Bytes 107-108 on page 00h: unsigned 16-bit values for the propagation delay of the non-separable free side device (in units of 10ns).
    - Not suited: Not per lane, no operational modes, too coarse granularity, no deltas => cannot be used for tight sync
  - Needs new page via "page-select" byte (127) value to new pages
  - Advertising of support of Tight Sync parameters ?
    - Eg bit 2 or 3 in byte 117 of lower page 00h ?
    - Other?
- Defining new upper pages for Tight Sync: where?
  - can "reserved" pages be used? (22h-7Fh)
  - can "vendor specific" pages be used? (04h-1Fh & 80h-FFh)

Selection which upper page:
00h, 01h, 02h, 03h, 20h, 21h

RO

RW

Table 6-1 Common Memory Map

From	To	Content	No. of bytes	Type
2-Wire Serial Address 1010000x				
Lower Page 00h				
0	2	ID and Status	3	Read-Only
3	21	Interrupt Flags (Clear on read)	19	Read-Only
22	33	Free Side Device Monitors	12	Read-Only
34	81	Channel Monitors	48	Read-Only
82	85	Reserved	4	Read-Only
86	99	Control	14	Read/Write
100	106	Free Side Interrupt Masks	7	Read/Write
107	110	Free Side Device Properties	4	Read-Only
111	112	Assigned to PCI Express	2	Read/Write
113	117	Free Side Device Properties	5	Read-Only
118	118	Reserved	1	Read/Write
119	122	Optional Password Change	4	Write-Only
123	126	Optional Password Entry	4	Write-Only
127	127	Page Select Byte	1	Read/Write
Upper Page 00h				
128	128	Identifier	1	Read-Only
129	191	Base ID Fields	63	Read-Only
192	223	Extended ID	32	Read-Only
224	255	Vendor Specific ID	32	Read-Only
Page 01h (Optional)				
128	255	Reserved (previously for SFF-8079 support)	128	Read-Only
Page 02h (Optional)				
128	255	User EEPROM Data	128	Read/Write
Page 03h (Optional)				
128	175	Free Side Device Thresholds	48	Read-Only
176	223	Channel Thresholds	48	Read-Only
224	229	Tx EQ, Rx Output and TC Support	6	Read-Only
230	241	Channel Controls	12	Read/Write
242	251	Channel Monitor Masks	10	Read/Write
252	255	Reserved	4	Read/Write
Pages 04h-1Fh (Optional)				
128	255	Vendor Specific	128	Read/Write
Pages 20h-21h (Optional)				
128	255	PAM-4 and WDM Features	128	Read/Write
Pages 22h-7Fh (Optional)				
128	255	Reserved	128	Read/Write
Pages 80h-FFh (Optional)				
128	255	Vendor Specific	128	Read/Write

Positioning of new pages - *mode*:*tight_sync*:*register*

bank:*page*:*byte*

- SFP112 => 1 lane
  - Parameters as per SFF 8472; single lane in 1 page of delays per operational
- QSFP => 4 lanes
  - Parameters as per SFF 8472
  - Grouping 4 lanes in 1 page of delays per operational mode and 1 bank per operational mode
- QSFP-DD or OSFP => 8 lanes
  - Parameters as per SFF 8472
  - Grouping 8 lanes in 1 page of delays per operational mode and 1 bank per operational mode
- COBO: TBD if relevant or purely analog?

Page: 1 new needed; which one to choose?

- Reserved: 50h – 9Fh
- Vendor-specific: B0h - FFh

Banking: 4+ needed

- Per page up to 256

1 lane: 1 bank per operational mode:

Byte	Size	Register name	Description
128	1	Tight_Sync	01h value indicates Tight Sync information
TBD	1	Nb_lanes	Number of lanes for which delays are specified in the module. Value = 01
	1	Op_Mode_ID	ID of the “operational mode” associated with the values of the page.
	15	(Rx Pwr Delay?)	Curve coefficients for Rx optical power dependent delay
	4	Delta_Rx_Max	Largest value of the 3sigma of all reported avg Rx delays
	4	Delta_Tx_Max	Largest value of the 3sigma of all reported avg Tx delays
	4	Avg_Rx_Lane1	Average Receiving delay on Lane 1, in ns
	4	Avg_Tx_Lane1	Average Transmitting delay on Lane 1, in ns
	71	Reserved 00h	All bytes 00h

4 lanes: 1 bank per operational mode:

Byte	Size	Register name	Description
128	1	Tight_Sync	01h value indicates Tight Sync information
TBD	1	Nb_lanes	Number of lanes for which delays are specified in the module. Value = 04
	1	Op_Mode_ID	ID of the “operational mode” associated with the values of the page.
	15	(Rx Pwr Delay?)	Curve coefficients for Rx optical power dependent delay
	4	Delta_Rx_Max	Largest value of the 3sigma of all reported avg Rx delays
	4	Delta_Tx_Max	Largest value of the 3sigma of all reported avg Tx delays
	4	Avg_Rx_Lane1	Average Receiving delay on Lane 1, in ns
	4	Avg_Tx_Lane1	Average Transmitting delay on Lane 1, in ns
	4	Avg_Rx_Lane2	Average Receiving delay on Lane 2, in ns
	4	Avg_Tx_Lane2	Average Transmitting delay on Lane 2, in ns
	4	Avg_Rx_Lane3	Average Receiving delay on Lane 3, in ns
	4	Avg_Tx_Lane3	Average Transmitting delay on Lane 3, in ns
	4	Avg_Rx_Lane4	Average Receiving delay on Lane 4, in ns
	4	Avg_Tx_Lane4	Average Transmitting delay on Lane 4, in ns
	71	Reserved 00h	All bytes 00h

8 lanes: 1 bank per operational mode:

Byte	Size	Register name	Description
128	1	Tight_Sync	01h value indicates Tight Sync information
TBD	1	Nb_lanes	Number of lanes for which delays are specified in the module. Value = 08
	1	Op_Mode_ID	ID of the “operational mode” associated with the values of the page.
	15	(Rx Pwr Delay?)	Curve coefficients for Rx optical power dependent delay
	4	Delta_Rx_Max	Largest value of the 3sigma of all reported avg Rx delays
	4	Delta_Tx_Max	Largest value of the 3sigma of all reported avg Tx delays
	4	Avg_Rx_Lane1	Average Receiving delay on Lane 1, in ns
	4	Avg_Tx_Lane1	Average Transmitting delay on Lane 1, in ns
	4	Avg_Rx_Lane2	Average Receiving delay on Lane 2, in ns
	4	Avg_Tx_Lane2	Average Transmitting delay on Lane 2, in ns
	4	Avg_Rx_Lane3	Average Receiving delay on Lane 3, in ns
	4	Avg_Tx_Lane3	Average Transmitting delay on Lane 3, in ns
	4	Avg_Rx_Lane4	Average Receiving delay on Lane 4, in ns
	4	Avg_Tx_Lane4	Average Transmitting delay on Lane 4, in ns
	4	Avg_Rx_Lane5	Average Receiving delay on Lane 5, in ns
	4	Avg_Tx_Lane5	Average Transmitting delay on Lane 5, in ns
	4	Avg_Rx_Lane6	Average Receiving delay on Lane 6, in ns
	4	Avg_Tx_Lane6	Average Transmitting delay on Lane 6, in ns
	4	Avg_Rx_Lane7	Average Receiving delay on Lane 7, in ns
	4	Avg_Tx_Lane7	Average Transmitting delay on Lane 7, in ns
	4	Avg_Rx_Lane8	Average Receiving delay on Lane 8, in ns
	4	Avg_Tx_Lane8	Average Transmitting delay on Lane 8, in ns
	39	Reserved 00h	All bytes 00h