25GS-PON Specification
25 Gigabit Symmetric Passive Optical Network

2 March 2023

Version 2.0 Corrigendum 2

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TITLE: 25GS-PON / 25G TDM PON Specification

SUMMARY:
This specification describes a 25-Gigabit-capable asymmetric and symmetric passive optical network (25GS-PON) system in an optical access network for residential, business, mobile back/mid-haul and other applications. This system operates over a point-to-multipoint optical access infrastructure at the nominal data rate of 25 Gbit/s in the downstream and both 10 and 25 Gbit/s in the upstream directions. This specification contains the general requirements, physical media dependent layer requirements, transmission convergence layer requirements and management layer requirements of the 25GS-PON system.

Table of Contents

1 Document Revision History 4

2 Scope and Introduction 4

3 References 4

4 Definitions 5

5 Conventions 5

6 Overview of the 25GS-PON Recommendation 5

7 OMCI Specification 17

8 xPON YANG model 18

9 Appendix: General statements on the relationship with XGS-PON TC layer requirements 19

10 Bibliography 23

1 Document Revision History

Document Revision	Date	Revision Comments
V1.0	201007	25GS-PON Specification (initial version)
V2.0	210810	Major changes: • PMD: N1 downstream PMD amended and N2 loss budget added. • PMD: XGS G.9807 adopted for 10G upstream specification instead of 802.3ca, for both N1 and N2 • PMD: UW3 wavelength tolerance changed from 1284-1287 to 1284-1288 nm. • OMCI: 25GS-PON-specific MEs changed from reserved to vendor fields.
V2.0 Corrigendum 1	220211	Addition of an explicit statement that interleaving is not included. Plus two other minor corrections.
V2.0 Corrigendum 2	230303	Addition of LDPC test vectors. Plus some other clarifications.

2 Scope and Introduction

This specification defines a 25-Gigabit-capable asymmetric and symmetric passive optical network (25GS-PON) system in an optical access network for residential, business, mobile back/mid-haul and other applications. 25GS-PON systems are able to operate on the same optical distribution network (ODN) as legacy PON systems. Co-existence of 25GS-PON with G-PON, XG-PON, XGS-PON and NG-PON2 is supported.

This specification re-uses existing industry standards, recommendations, and specifications (referred to as “standards” in this document) to the maximum extent possible. This specification is written as a delta-specification with respect to:

- IEEE Std 802.3ca™-2020 for PMD layer and FEC
- ITU-T G.9807.1 for TC layer
- ITU-T G.988 for OMCI
- BBF TR-385 for Yang models.

The referenced standards each follow different formatting, style and document structure. This document, for purposes of clarity, will follow the structure used in ITU-T G.9807.1.

3 References

- ITU-T G.9807.1
- ITU-T G.988

- IEEE Std 802.3ca™-2020
- BBF TR-385 Issue 1

4 Definitions

In addition to the definitions, abbreviations and acronymns documented in the references, this specification uses the following.

Terms

- **25GS-PON**: A passive optical network (PON) system that operates at a nominal line rate of 25 Gbit/s downstream and both 10 and 25 Gbit/s upstream.

Abbreviations and Acronyms

LDPC	Low Density Parity Check

5 Conventions

Many of the conventions in ITU-T G.9807.1 are followed. In addition this specification uses the following conventions:

- **Transmission order** - The order of transmission of information in all the diagrams is first from left to right and then from top to bottom unless explicitly called out as different. The most significant bit (bit 31) is illustrated at the left in all the diagrams (e.g. Row 1, Column 1).
- **Reserved bit(s)** - The value of a reserved bit or reserved bit for future standardization shall be set to "0".
- **Non-Sourced bit(s)** - The value of any non-sourced bit shall read back as "0".

The requirements for 25GS-PON are referenced to existing standards and simply extended to 25G as necessary. This "delta" document only documents the changes required to specify 25GS-PON. These "deltas" are noted with the "**Δ**" symbol.

6 Overview of the 25GS-PON Recommendation

Section 6 of ITU-T G.9807, "Overview of the XGS-PON Recommendation" applies to 25GS-PON, with the following modifications:

Δ References to the G.987 series are replaced with references to G.9807.1.
Δ IEEE 802.3ca is the reference for 25G downstream and upstream.
Δ The wavelength bands mentioned are specified in Annex B of this document.

Annex B: Physical media dependent (PMD) layer specifications

B1. 25G downstream and 25G upstream PMD

The PMD requirements for the 25G signals of 25GS-PON are contained in clause 141 of *IEEE Std 802.3ca™ 2020, Draft Standard for Ethernet, Amendment: Physical Layer Specifications and Management Parameters for 25 Gb/s and 50 Gb/s Passive Optical Networks*, with several exceptions as noted herein.

25GS-PON will support the PHY links in 802.3ca Table141-2 for 25G symmetric, for both "medium" (24dB) and "high" (29dB) loss budgets. There are six exceptions to these specifications, noted below.

Δ **Exception 1.** 25GS-PON supports slightly different line rates, as specified in Table B.1. The line rate for nominal 25 Gbit/s downstream and upstream signals is 2.5 times the XGS-PON line rate [ITU-T G.9807.1].

Nominal line rate [Gbit/s]	Direction	802.3ca line rate [Gbit/s]	25GS-PON line rate [Gbit/s]
25	downstream	25.78125	24.8832
25	upstream	25.78125	24.8832

Table B.1: 25GS-PON line rates.

Δ **Exception 2.** As indicated in 802.3ca Table 141-2, 25G EPON PHY links support a 14 dB range of ODN loss: the difference between the minimum and the maximum channel insertion loss. ITU-T PONs support a wider range, 15 dB. To ensure that 25GS-PON can operate on 29 dB N1 ODNs designed for ITU-T PONs, the minimum channel insertion loss specified in 802.3ca Table 141-2 for the "high" power class is decreased by 1 dB for 25GS-PON, as indicated in Table B.2. As a result, the 25GS-PON "high" power class will support the exact same loss range as the XGS-PON N1 class loss budget.

PHY link name	802.3ca minimum channel insertion	25GS-PON minimum channel insertion
25/25-PQ30*	15 dB	14 dB

Table B.2: 25GS-PON minimum channel insertion loss, delta to 802.3ca Table 141-2.

*denotes either G (using upstream wavelength UW0) or X (using upstream wavelength UW1).

To accommodate this, the Average receive power, each channel (max) parameter in 802.3ca Tables 141.18 and 141-22 is adjusted upwards by 1 dB. The values are indicated in Tables B.5 and B.6.

∆ Exception 3: WDM co-existence with XGS-PON and GPON.

For 25GS-PON, a new third upstream wavelength is defined, UW3, to support simultaneous WDM co-existence between 25GS-PON, XGS-PON and GPON. This wavelength is 1286 +/-2 nm[1]. See Figure B.1. Except for the wavelength, all other PMD values for UW3 are the same as for UW0 and UW1. Implementation of this wavelength is optional.

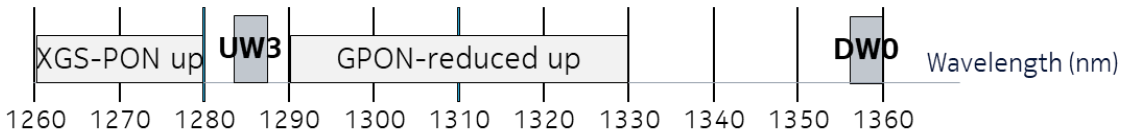

Figure B.1. Upstream wavelength UW3 to support triple co-existence.

∆ Exception 4: Versatile WDM configuration (ONU blocking filter for co-existence)

25GS-PON ONUs shall tolerate interferers from legacy GPON, XG(S)-PON and future PON systems. The specified X/S tolerance mask is indicated in Figure B.2, which is a modification of Fig. B.10.1 in ITU-T G.9807.1. The value, Y, is 9 dB.

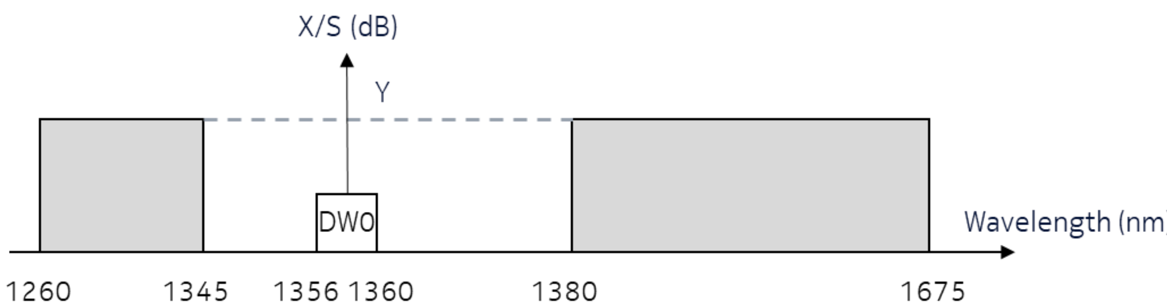

Figure B.2. X/S tolerance mask for ONU

∆ Exception 5: 25G downstream optical levels, for 29 dB N1 ODNs.

The 25G downstream PMD for 29 dB N1 ODNs is obtained in the following way:

1. The optical levels in 802.3ca Table 141–16—OLT transmit characteristics, high power class are adjusted 0.8 dB downwards as indicated in Table B.4.
2. The optical levels in 802.3ca Table 141–22—ONU receive characteristics, high power class are adjusted 0.8 dB downwards as indicated in Table B.5.

∆ Exception 6. Addition of 31 dB N2 loss budget class.

The 25G downstream and upstream optical levels for 31 dB N2 ODNs are obtained in the following way:

[1] The rationale for this wavelength choice is explained in contribution D042 to ITU-T SG15/Q2 interim meeting, October 2019. In summary, the short wavelength end of the O-band is chosen for low dispersion and for sufficient downstream-upstream wavelength separation.

1. The N2 downstream OLT optical levels are 2 dB higher than for N1 as indicated in Table B.4.
2. The optical levels in 802.3ca Table 141-18—OLT receive characteristics, high power class, are adjusted 2 dB downwards. The values are indicated in Table B.6.

The PMDs for the 25GS-PON ONU are the same for both N1 and N2 loss budget classes.

Parameter	802.3ca Table 141–16	25GS-PON N1 [Note 1]	25GS-PON, N2 [Note 2]
Average launch power, each channel (max)	7.8	7	9
Optical Modulation Amplitude (OMA), each channel (min)	4.9	4.1	6.1
Launch power in OMA minus TDP, each channel (min) for extinction ratio ≥ 9 dB for extinction ratio < 9 dB	 4.8 4.9	 4 4.1	 6 6.1

Table B.4 25GS-PON OLT transmitter optical levels for N1 and N2 loss budget classes.

Parameter	802.3ca Table 141-22	25GS-PON, N1 and N2
Average receive power, each channel (max)	–7.2	-7 [Note 3]
Receiver sensitivity (OMA), each channel (max)	–24.1	-24.9 [Note 1]
Stressed receiver sensitivity (OMA), each channel (max)	–22.6	-23.4 [Note 1]

Table B.5 25GS-PON ONU receiver optical levels for N1 and N2 loss budget classes.

Parameter	802.3ca Table 141-18	25GS-PON, N1	25GS-PON, N2 [Note 2]
Average receive power, each channel (max)	-6	-5 [Note 4]	-7
Receiver sensitivity (OMA), each channel (max)	-24.3	-24.3	-26.3
Stressed receiver sensitivity (OMA), each channeld (max)	-22.8	-22.8	-24.8

Table B.6 25GS-PON OLT receiver optical levels for N1 and N2 loss budget classes.

Note 1. Accomodates Exception 5.
Note 2. Accomodates Exception 6.

Note 3. Acommodates Exceptions 2 and 5.
Note 4. Accomodates Exception 2.

B2. 10G upstream PMD

The PMD requirements for 10G upstream signals for 25GS-PON asymmetric are contained in Table B.9.4 of *ITU-T G.9807.1*, for both N1 (29 dB) and N2 (31 dB) loss budget.

The operating wavelength band specified in Table B.9.4 is 1260-1280 nm. This corresponds to UW0 in IEEE 802.3ca. Additionally, UW1 (from IEEE 802.3ca) and UW3 (new for the 25GS-PON MSA) are also usable wavelengths for 10G upstream.

Annex C Transmission convergence layer spec. of 25GS-PON

The TC-Layer requirements for 25GS-PON are contained in ITU-T G.9807.1 [1]. Changes required for an implementation to comply with the 25GS-PON specification are noted herein. This includes the substitution of G.9807 R-S FEC with 802.3ca LDPC FEC for 25G downstream and 25G upstream signals, but not for 10G upstream.

C.6 25GS-PON transmission convergence layer overview

C.6.1.1 Supported nominal line rates

Δ A 25GS-PON OLT supports the following line rates:

Downstream line rate (Gbit/s)	Upstream line rate (Gbit/s)
24.8832	24.8832
24.8832	9.95328
24.8832	24.8832 and 9.95328

Table C.6.1. 25GS-PON OLT Supported line rates

Δ A 25GS-PON ONT supports the following line rates:

Downstream line rate (Gbit/s)	Upstream line rate (Gbit/s)
24.8832	24.8832
24.8832	9.95328

Table C.6.2 25GS-PON ONU Supported line rates

C.6.1.5.7 Allocation identifier (Alloc-ID)

Δ A 25GS-PON OLT uses broadcast Alloc-ID 1020 to signal any DS-25Gbit/s and US-25Gbit/s capable ONU that it can use this allocation to transmit the serial number response.

Δ A 25GS-PON OLT uses broadcast Alloc-ID 1019 to signal any DS-25Gbit/s and US-10Gbit/s capable ONU that it can use this allocation to transmit the serial number response.

Δ A 25GS-PON OLT may not use Alloc-IDs 1021, 1022 and 1023.

Alloc-ID 0…1018 is the available default Allocation-ID range.
Note: for co-existence with XGS-PON, the Alloc-ID's 1019 & 1020 shall not be used.

C.6.1.6 Media access control

Δ The start pointers and grant size locations in the BWmap are expressed in units of:
16 Bytes for an ONU transmitting at 10 Gbit/s in the upstream direction.

40 Bytes for an ONU transmitting at 25 Gbit/s in the upstream direction.

C.7 25GS-PON Resource allocation and quality of service
No deltas.

C.8 25GS-PON transmission convergence framing sublayer overview

C.8.1.1. Downstream 25GS-PON TC framing

Δ The 25GS-PON downstream FS frame is 330536 bytes.

- The total PHY frame size is:	388800 Bytes
- PSBd is not included in the FS frame:	- 24 Bytes
- FEC-parity is not included in the FS frame:	- 58240 Bytes
	330536 Bytes

C.8.1.1.2.3 StartTime field

Same 9720 equally spaced time intervals.
One interval accommodates 16 bytes at 10 Gbit/s.
Δ One interval accommodates 40 bytes at 25 Gbit/s.

C.8.1.1.2.4 GrantSize field

The granularity of the GrantSize field varies with the upstream linerate:
For ONU's transmitting at 10 Gbit/s, the GrantSize refers to 16 bytes. The minimum non-zero value of GrantSize is 1, which can be used for a DBRu-only transmission (4 byte DBRu field, followed by a 12 byte idle) and for minimum size payload allocations (16 bytes)
Δ **For ONU's transmitting at** 25 Gbit/s, the GrantSize refers to 40 bytes.The minimum non-zero value of GrantSize is 1, which can be used for a DBRu-only transmission (4 byte DBRu field, followed by a 36 byte idle) and for minimum size payload allocations (40 bytes)

C.8.1.1.3 BWmap construction and parsing rules

Maximum GrantSize value of any individual allocation:
Same 9720 equally spaced time intervals.
For 10 Gbit/s upstream rate – 9 719 (referring to 16-byte blocks).
Δ **F**or 25 Gbit/s upstream rate – 9 719 (referring to 40-byte blocks).

The maximum FS burst size, that is, the sizes of all allocations within the burst allocation series together with the FS burst overhead:
For 10 Gbit/s upstream rate – 155 520 bytes.
Δ **For 25 Gbit/s upstream rate – 388 800 bytes.**

For 10 Gbit/s, the FS burst has the following constraint:

$$\text{StartTime} + \sum_n \text{GrantSize}_n \leq 14580$$

Δ **For 25 Gbit/s, the FS burst has the following constraint:**

$$(\text{StartTime} + \sum_n \text{GrantSize}_n) * 2.5 \leq 30990$$

C.9 25GS-PON encapsulation method

C.9.1.1 FS payload structure

Δ The size of the FS payload in a given downstream FS frame is equal to the FS frame size (which is fixed 330 536 bytes) less the sum of the sizes of its FS frame header and FS frame trailer.

C.10 25GS-PON PHY adaptation sublayer

C.10.1.1 Downstream PHY frame

Δ The duration of a downstream PHY frame is 125 μs, which corresponds to the size of 388 800 bytes (97 200 words) at the downstream line rate of 25 Gbit/s.
The PSBd is 24 bytes and the remaining Phy frame payload is 388 776 bytes.

C.10.1.1.3 ONU downstream synchronization

Δ The downstream synchronization statemachine is updated to be able to reliably operate under high (1E-2) BER conditions. The following diagram (Figure C.10.4) shows the reference statemachine.

Hunt state: The initial synchronization state is the Hunt state. In the Hunt state, the synchronization function of the ONU searches for the Psync pattern over all bit alignments in the downstream data pattern. When the exact Psync pattern has been detected, the statemachine transitions to the Pre-Sync state.

Pre-Sync state: When in the Pre-Sync state both the Psync pattern as the LDPC-decoder results are used to determine the synchronization state: when more than N_{eps} errors are detected in the Psync pattern, the state machine falls back to the Hunt state. When in the Pre-Sync state a LDPC-codeword is correctly decoded, the statemachine further transitions to the Sync state. At each frame start, the SFC is latched then HEC-13 corrected and used to descramble the data for that frame. When the statemachine transitions to the Sync state, the current SFC value is latched into an Internal Frame Counter (IFC) which is then used by the ONU in all states except the Hunt and Pre-Sync states.

Sync state: When in the Sync state and the decoding of a LDPC-codeword fails, the statemachine transitions into the Re-Sync state.

Re-Sync state: When in the Re-Sync state and a LDPC-codeword is correctly decoded, the statemachine transitions back into the Sync state. When it detects M-1 consecutive LDPC-decoding fails of the first LDPC-codeword, the statemachine state changes to the Hunt state. The recommended value of M is 3.

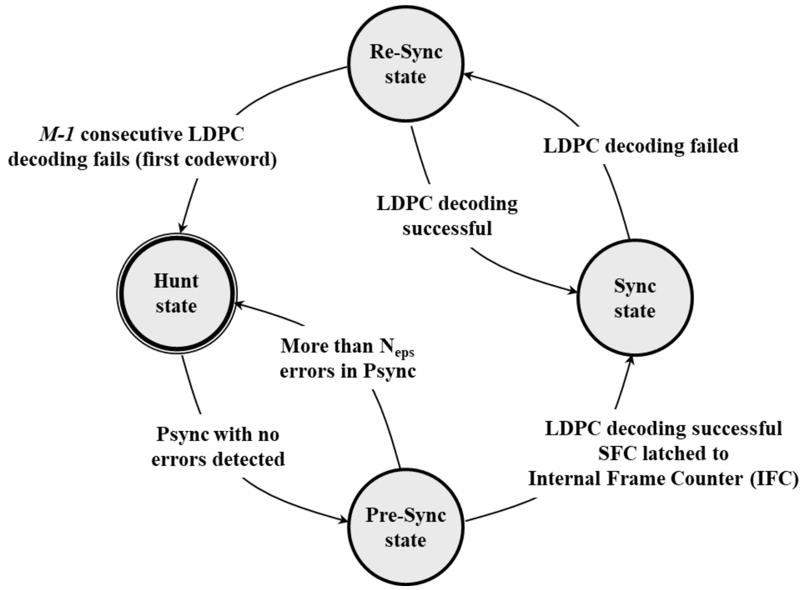

Figure C.10.4 DS reference synchronization statemachine

C.10.1.1.4 Downstream PHY frame payload

Δ The payload of a downstream PHY frame has the size of 388 776 bytes.

C.10.1.2 Upstream PHY frames and upstream PHY bursts

Δ The duration of an upstream PHY frame is 125 µs, which corresponds to the size of 388 800 bytes (97 200 words) at the downstream line rate of 25 Gbit/s.

C.10.1.3 Δ Forward error correction

Δ For a line rate of 10 Gbit/s, in upstream direction, the FEC code is RS(248,216) which is the truncated form of RS(255,223). RS(248,216) is described in Annex C.B of ITU-T G.9807.1 [1].

Δ For a line rate of 25Gbit/s, in both downstream and upstream directions, the FEC code is LDPC(17152,14592) which is the punctured form of LDPC(17664,14592). The LDPC(17152,14592) and LDPC(17664,14592) codes are formally described in Annex C.B of this specification.

C.10.1.3.1.1 Downstream FEC codeword

Δ For 25 Gbit/s nominal line rate, the downstream FEC code is LDPC(17152,14592). Each downstream PHY frame contains 182 FEC codewords. The first 181 codewords are 2144 bytes long, the last one is a short codeword of 712 bytes.

Δ Within a full codeword, 1824 data bytes are followed by 320 parity bytes. The last short codeword is 712 bytes: 392 bytes of data, followed by 320 parity bytes.

Δ In a downstream PHY frame, the first codeword starts with the 25th byte of the PHY frame (the first byte of the downstream FS header section), the second codeword starts from the 2169th byte of the PHY frame, and the third codeword starts from the 4313th byte of the PHY frame, etc.

C.10.1.3.1.1 Upstream FEC codeword

For 10 Gbit/s, the upstream FEC code is RS(248, 216).

Δ For 25Gbit/s, the upstream FEC code is LDPC(17152,14592).

C.10.1.3.2.4 Upstream FEC on/off control

Δ For 25Gbit/s, FEC is always enabled.

C.11 25GS-PON PLOAM messaging channel

C.11.2.1 ONU-ID

Δ The value 1020 (0x3FC) is reserved for broadcasting Burst Profile messages to ONUs with 25Gbit/s Downstream and 25Gbit/s Upstream burst-rate capability.
Δ The value 1019 (0x3FB) is reserved for broadcasting Burst Profile messages to ONUs with 25Gbit/s Downstream and 10 Gbit/s Upstream burst-rate capabilities.
Δ The value 1023 (0x3FF) is used for broadcasting all other PLOAM message types.

C.11.3.3 Downstream PLOAM message formats

C.11.3.3.1 Burst_Profile message

Table C.11.4 – Burst_Profile message

- Octet 1-2: ONU-ID extra reserved values:
  - Δ ONU-ID = 0x03FC identifies a message to all 25 Gbit/s downstream and 25 Gbit/s upstream capable ONUs.
  - Δ ONU-ID = 0x03FB identifies a message to all 25 Gbit/s downstream and 10 Gbit/s upstream capable ONUs.
- Octet 5: the rate bit only applies for 10 Gbit/s downstream capable ONU's.
- Octet 6: only applies for 10 Gbit/s upstream capable ONU's.

C.11.3.3.2 Assign_ONU-ID message

Table C.11.6 – Assign_ONU-ID message

Octet	Content	Description
15	Reserved	Set to 0x00 by the transmitter; treated as "don't care" by the receiver.

C.11.3.4 Upstream PLOAM message formats

C.11.3.4.1 Serial_Number_ONU message

Table C.11.24 – Serial_Number_ONU message

Octet	Content	Description
37	Reserved	Set to 0x00 by the transmitter; treated as "don't care" by the receiver.

C.12 25GS-PON ONU activation

No deltas.

C.13 25GS-PON OLT and ONU timing relationships

C.13.1.6 In-service equalization delay adjustment

	In integer bit periods for specified line rate	
	9.95328 Gbit/s	∆ 24.8832 Gbit/s
DOW_i	± 32 bits	± 32 bits
TIW_i	± 64 bits	± 64 bits

Table C.13.1 Suggested thresholds for DOWi and TIWi

C.14 25GS-PON performance monitoring, supervision and defects

No deltas

C.15 25GS-PON security

C.15.4.3 Initial counter block

∆ In the downstream direction, the FS frame of the framing sublayer (see Figure C.8.1) is partitioned into 16-byte blocks, and these blocks are sequentially numbered from 0 to 20658 (25G, FEC on), the last block being half-size. The size of the sequence number is 15 bits.

∆ At 25 Gbit/s upstream line rate, the largest StartTime is 8264.

∆ At 25 Gbit/s upstream line rate, the largest possible 16-byte block number in an upstream burst is determined by the FS burst specification constraint (see clause C.8.1.1.3)

$$\Delta \; (StartTime + \sum_n GrantSize_n) * 2.5 \leq 30990 < 2^{16}$$

Please note that FEC for 25G in the upstream direction is always enabled.

∆ For 25Gbit/s rates, the 128-bit initial counter block as input for the AES calculation is structured as follows:

Initial counter(127..80) : Superframe Counter (47..0)
Initial counter(79..64) : Intra frame Counter (15..0)
Initial counter(63..16) : Superframe Counter (47..0)
Initial counter(15..0) : Intra frame Counter (15..0)

C.16 25GS- PON power management
No deltas

C.17 25GS-PON channel management
Not applicable to 25GS PON.

C.18 25GS-PON system protection
No deltas

C.19 25GS-PON Rogue behaviour and its mitigation
No deltas

Annex C.B LDPC based Forward error correction used in 25GS-PON.

The used low-density parity check (LDPC) FEC mothercode used for 25GS-PON is based on the mothercode specified by the IEEE Std 802.3ca™-2020[2].

The mothercode is a 12×69 quasi-cyclic matrix with a circulant size of 256. As a result, a codeword is 69x256 = 17664 bits in size of which payload is 57x256 bits = 14592 bits and parity is 12×256 bits = 3072 bits. This is then noted as LDPC(17664,14592).

The selected LDPC code for 25GS-PON is a non shortened and 2 column (512bits) punctured code, based on the IEEE 802.3ca task force mothercode.
The puncturing is applied from the right side of the Matrix.

The interleaving described in IEEE Std 802.3ca™-2020 is not used.

As a result, the selected code for 25GS-PON is LDPC(17152,14592), which has the following characteristics:

- Codeword length: 17152 bits
- Payload length: 14592 bits
- Parity length: 2560 bits

Golden vectors to be added for reference

7 OMCI Specification

25GS PON has minimal impact on the ITU-T G.988 Recommendation for OMCI. The following two new plug-in unit types to represent 25GS-PON needs be added to the Table 9.1.5-1 in G.988 OMCI specification. These are taken from the “vendor-specific” range of 192…223”:

222	25G-PON25G10	25G-PON interface, 25G downstream and 10G upstream
223	25G-PON25G25	25G-PON interface, 25G downstream and 25G upstream

25GS-PON equipment vendors shall not use these values for other purposes.

All MEs applicable to XGS-PON are also applicable to 25GS-PON, including:

- ME 453 in Clause 9.2.22: Enhanced FEC performance monitoring history data.
- ME 454 in Clause 9.2.23: Enhanced TC performance monitoring history data.

No new MEs are defined for 25GS-PON.

8 xPON YANG model

Because 25GS-PON is 'linear' extrapolation of the XGS-PON standard, the data model structure of TR-385 Issue 1 nicely fits with only minimal extensions required for 25GS-PON specificities. The analysis shows that TR-385 only needs to define a new xPON type identity "twentyfivegs" and apply it to a very limited places in the TR. All changes are backward compatible or captured by editorial updates.

Identified changes

The 25GS-PON type requires a new identity to be added to **WT-385/bbf-xpon-types.yang**:

```
identity twentyfivegs-pon {
  base channel-pair-type-base;
  description
    "This identity is used to denote a 25GS-PON
     channel-pair,per ITU-T <tbd>.";
}
```

The new 25GS-PON type needs to be taken in to account at the following places:

- WT-385/body/bbf-xpon-channel-pair-body.yang
  - The "wavelength-prof-ref" is also applicable to 25GS-PON
  - Update the description of the "channel-pair-line-rate" YANG leaf to tell that it is not applicable to 25Gs-PON. This is no more than an editorial update.

- WT-385/body/bbf-xpon-channel-termination-body.yang
  - Add "leaf twentyfivegs-pon-id" YANG leaf; contents expected to be similar to "xgs-pon-id" YANG leaf.

- WT-385/body/bbf-xpon-channel-partition-body.yang
  - Update the description of the "downstream-fec" YANG leaf; similar with XGS. Add also ITU-T reference.
  - Add ITU-T references for the "multicast-aes-indicator" YANG leaf

- WT-385/body/bbf-xponani-ani-body.yang
  - Update "upstream-fec" YANG leaf: always on for 25 Gbit/s

- WT-385/body/bbf-xponvani-v-ani-body.yang
  - Update "upstream-fec" YANG leaf: always on for 25 Gbit/s

- Update description field of ONU-ID, Gemport-IDs and Alloc-IDs to cope with the case of 25GS-PON type. This is no more than an editorial update.
  - WT-385/body/bbf-xpon-channel-group-body.yang
  - WT-385/body/bbf-xponani-ani-body.yang
  - WT-385/body/bbf-xponvani-v-ani-body.yang

9 Appendix: General statements on the relationship with XGS-PON TC layer requirements.

(This appendix does not form an integral part of this specification.)

25GS-PON will be a ‘linear’ extrapolation of the XGS-PON standard with mainly the following characteristics:

In the downstream direction:

- Rate 24.8832 Gbit/s – further referred to as 25Gbit/s (10x GPON, 2.5x XGS-PON).
- Keeping the 125us frame structure.
- XGS-PON Compatible SDU mapping.
- Identical PSBd, FSheader,XGEM, FStrailer structure and bit definitions.
- Identical ONU ID, Alloc-ID, XGEM Port-ID.
- New reserved broadcast alloc-IDs for 25G ONUs are needed.
- New reserved broadcast ONU-IDs for 25G ONUs are needed.
- Blocks are defined as 40 bytes (XG-PON 4 bytes, XGS-PON 16 bytes).
- Identical BWmap partition definition and function.
- Block size means compatibility with 2.5G / 10G DBA, identical 9720 allocation start locations in a frame.
- 25Gbit/s DS uses LDPC FEC (using shorted/punctured codeword based on IEEE Mothercode).

In the upstream direction:

- Rate 24.8832 Gbit/s – further referred to as 25Gbit/s (10x GPON, 2.5x XGS-PON).
- Blocks are defined as 40 bytes (XG-PON 4 bytes, XGS-PON 16 bytes).
- XGS-PON Compatible SDU mapping.
- Identical PSBu, FSheader, Allocation overhead, XGEM, FStrailer structure and bit definitions.
- Identical ONU-ID, Alloc-ID, XGEM Port-ID.
- 25Gbit/s US uses LDPC FEC (using shorted/punctured codeword based on IEEE Mothercode)

10 Appendix: LDPC test vectors

(This appendix does not form an integral part of this specification.)

10.1 Full length all-idle payload codeword

The following test vector provides an example of a full length LDPC encoded codeword.

As payload, the vector contains a TC-layer compliant all-idle pattern.

The total length of the LDPC codeword is 17152 bits (or 2144 bytes), the (all-idle) payload length is 14592 bits (or 1824 bytes) and the parity length is 2560 bits (or 320 bytes).

The parity bytes are marked <u>Underlined</u>.

```
      0..255:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
    256..511:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
    512..767:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
   768..1023:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  1024..1279:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  1280..1535:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  1536..1791:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  1792..2047:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  2048..2303:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  2304..2559:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  2560..2815:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  2816..3071:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  3072..3327:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  3328..3583:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  3584..3839:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  3840..4095:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  4096..4351:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  4352..4607:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  4608..4863:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  4864..5119:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  5120..5375:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  5376..5631:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  5632..5887:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  5888..6143:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  6144..6399:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  6400..6655:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  6656..6911:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  6912..7167:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  7168..7423:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  7424..7679:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  7680..7935:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  7936..8191:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  8192..8447:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  8448..8703:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  8704..8959:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  8960..9215:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  9216..9471:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  9472..9727:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
  9728..9983:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
 9984..10239:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
10240..10495:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
10496..10751:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
10752..11007:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
11008..11263:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
11264..11519:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
11520..11775:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
11776..12031:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
12032..12287:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
12288..12543:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
12544..12799:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
12800..13055:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
13056..13311:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
13312..13567:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
13568..13823:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
13824..14079:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
14080..14335:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
14336..14591:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
14592..14847:  F4CF_AFF6_B126_F3BB_F4CF_AFF6_B126_F3BB_F4CF_AFF6_B126_F3BB_F4CF_AFF6_B126_F3BB
14848..15103:  DD31_1649_8B0A_D2A8_DD31_1649_8B0A_D2A8_DD31_1649_8B0A_D2A8_DD31_1649_8B0A_D2A8
15104..15359:  56CC_99DE_9EA7_77F3_56CC_99DE_9EA7_77F3_56CC_99DE_9EA7_77F3_56CC_99DE_9EA7_77F3
15360..15615:  FBC6_32FF_AF21_AC6F_FBC6_32FF_AF21_AC6F_FBC6_32FF_AF21_AC6F_FBC6_32FF_AF21_AC6F
15616..15871:  7B99_578C_A835_C7AC_7B99_578C_A835_C7AC_7B99_578C_A835_C7AC_7B99_578C_A835_C7AC
15872..16127:  5F09_FBC1_2F76_88BB_5F09_FBC1_2F76_88BB_5F09_FBC1_2F76_88BB_5F09_FBC1_2F76_88BB
16128..16383:  42BC_B309_5369_1781_42BC_B309_5369_1781_42BC_B309_5369_1781_42BC_B309_5369_1781
16384..16639:  688B_494C_4F0B_C772_688B_494C_4F0B_C772_688B_494C_4F0B_C772_688B_494C_4F0B_C772
16640..16895:  B2DA_9339_ADA2_6C1C_B2DA_9339_ADA2_6C1C_B2DA_9339_ADA2_6C1C_B2DA_9339_ADA2_6C1C
16896..17151:  86D4_3F73_C049_E6BB_86D4_3F73_C049_E6BB_86D4_3F73_C049_E6BB_86D4_3F73_C049_E6BB
```

10.2 Shortened all-idle payload codeword

The following test vector provides an example of a shortened LDPC encoded codeword (the last idle-payload codeword of a downstream frame).

As payload, the vector contains a TC-layer compliant all-idle pattern.

The total length of the LDPC codeword is 5696 bits (or 712 bytes), the (all-idle) payload length is 3136 bits (or 392 bytes) and the parity length is 2560 bits (or 320 bytes).

The parity bytes are marked `Underlined`.

```
   0..  255:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
 256..  511:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
 512..  767:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
 768.. 1023:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
1024.. 1279:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
1280.. 1535:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
1536.. 1791:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
1792.. 2047:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
2048.. 2303:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
2304.. 2559:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
2560.. 2815:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
2816.. 3071:  0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF_0000_299E_0000_FFFF
3072.. 3327:  0000_299E_0000_FFFF_9FE7_D109_E49F_2506_830F_621C_8D4A_158E_B0E0_BE03_21C2_F6F8
3328.. 3583:  5808_3188_2507_36D3_5045_97E7_7278_74EA_1163_CEDA_EC6B_B728_0514_3AE0_1EDA_14AF
3584.. 3839:  4754_AE2F_A707_AF06_1916_ECC5_94F6_6CEE_D7E3_81BA_6A6A_F793_491F_CAF1_72F9_A8F5
3840.. 4095:  0CB7_48AD_00F0_3275_47C3_C51B_C15E_B0BC_4D04_CB71_63C9_0849_77C8_280D_F764_E6C4
4096.. 4351:  DF94_076B_2E10_4864_D7E8_0A6F_721F_D3B5_E858_E691_BEFE_1B5E_3060_C368_4E98_1CF7
4352.. 4607:  D56A_0419_2CA5_F93C_6813_82F5_E6AD_6A21_9DEF_38E5_9CA7_54A5_8933_066D_F6BE_AB82
4608.. 4863:  50A4_48F2_9E7A_4FA5_E485_A745_E8D9_7557_287C_B99A_6EFA_3B00_4DF9_5518_02D2_61CD
4864.. 5119:  9AE2_72AA_7ABF_3F29_8F1D_FD27_71B7_A542_F8A3_A021_CB96_0FEC_2D62_2B50_60C7_58D6
5120.. 5375:  4ACB_09CB_5088_B1BD_1B98_4F5D_FF22_A8B8_55EB_6845_2902_FBD9_1638_3D78_9320_C052
5376.. 5631:  0228_5E8A_6CBD_190B_325A_948F_4754_DB9C_7227_282B_149D_5730_1F62_5E73_8F86_511E
5632.. 5695:  7ED9_FE43_8BFA_71B7
```

10.3 Full length incrementing payload codeword

The following test vector provides an example of a full length LDPC encoded codeword.

As payload, the vector contains an incrementing string of words.

The total length of the LDPC codeword is 17152 bits (or 2144 bytes), the payload length is 14592 bits (or 1824 bytes) and the parity length is 2560 bits (or 320 bytes).

The parity bytes are marked `Underlined`.

```
    0..255:  0001_0002_0003_0004_0005_0006_0007_0008_0009_000A_000B_000C_000D_000E_000F_0010
  256..511:  0011_0012_0013_0014_0015_0016_0017_0018_0019_001A_001B_001C_001D_001E_001F_0020
  512..767:  0021_0022_0023_0024_0025_0026_0027_0028_0029_002A_002B_002C_002D_002E_002F_0030
 768..1023:  0031_0032_0033_0034_0035_0036_0037_0038_0039_003A_003B_003C_003D_003E_003F_0040
1024..1279:  0041_0042_0043_0044_0045_0046_0047_0048_0049_004A_004B_004C_004D_004E_004F_0050
1280..1535:  0051_0052_0053_0054_0055_0056_0057_0058_0059_005A_005B_005C_005D_005E_005F_0060
1536..1791:  0061_0062_0063_0064_0065_0066_0067_0068_0069_006A_006B_006C_006D_006E_006F_0070
1792..2047:  0071_0072_0073_0074_0075_0076_0077_0078_0079_007A_007B_007C_007D_007E_007F_0080
2048..2303:  0081_0082_0083_0084_0085_0086_0087_0088_0089_008A_008B_008C_008D_008E_008F_0090
2304..2559:  0091_0092_0093_0094_0095_0096_0097_0098_0099_009A_009B_009C_009D_009E_009F_00A0
2560..2815:  00A1_00A2_00A3_00A4_00A5_00A6_00A7_00A8_00A9_00AA_00AB_00AC_00AD_00AE_00AF_00B0
2816..3071:  00B1_00B2_00B3_00B4_00B5_00B6_00B7_00B8_00B9_00BA_00BB_00BC_00BD_00BE_00BF_00C0
3072..3327:  00C1_00C2_00C3_00C4_00C5_00C6_00C7_00C8_00C9_00CA_00CB_00CC_00CD_00CE_00CF_00D0
3328..3583:  00D1_00D2_00D3_00D4_00D5_00D6_00D7_00D8_00D9_00DA_00DB_00DC_00DD_00DE_00DF_00E0
3584..3839:  00E1_00E2_00E3_00E4_00E5_00E6_00E7_00E8_00E9_00EA_00EB_00EC_00ED_00EE_00EF_00F0
3840..4095:  00F1_00F2_00F3_00F4_00F5_00F6_00F7_00F8_00F9_00FA_00FB_00FC_00FD_00FE_00FF_0100
4096..4351:  0101_0102_0103_0104_0105_0106_0107_0108_0109_010A_010B_010C_010D_010E_010F_0110
4352..4607:  0111_0112_0113_0114_0115_0116_0117_0118_0119_011A_011B_011C_011D_011E_011F_0120
4608..4863:  0121_0122_0123_0124_0125_0126_0127_0128_0129_012A_012B_012C_012D_012E_012F_0130
4864..5119:  0131_0132_0133_0134_0135_0136_0137_0138_0139_013A_013B_013C_013D_013E_013F_0140
5120..5375:  0141_0142_0143_0144_0145_0146_0147_0148_0149_014A_014B_014C_014D_014E_014F_0150
5376..5631:  0151_0152_0153_0154_0155_0156_0157_0158_0159_015A_015B_015C_015D_015E_015F_0160
5632..5887:  0161_0162_0163_0164_0165_0166_0167_0168_0169_016A_016B_016C_016D_016E_016F_0170
5888..6143:  0171_0172_0173_0174_0175_0176_0177_0178_0179_017A_017B_017C_017D_017E_017F_0180
6144..6399:  0181_0182_0183_0184_0185_0186_0187_0188_0189_018A_018B_018C_018D_018E_018F_0190
6400..6655:  0191_0192_0193_0194_0195_0196_0197_0198_0199_019A_019B_019C_019D_019E_019F_01A0
```

```
  6656..6911:  01A1_01A2_01A3_01A4_01A5_01A6_01A7_01A8_01A9_01AA_01AB_01AC_01AD_01AE_01AF_01B0
  6912..7167:  01B1_01B2_01B3_01B4_01B5_01B6_01B7_01B8_01B9_01BA_01BB_01BC_01BD_01BE_01BF_01C0
  7168..7423:  01C1_01C2_01C3_01C4_01C5_01C6_01C7_01C8_01C9_01CA_01CB_01CC_01CD_01CE_01CF_01D0
  7424..7679:  01D1_01D2_01D3_01D4_01D5_01D6_01D7_01D8_01D9_01DA_01DB_01DC_01DD_01DE_01DF_01E0
  7680..7935:  01E1_01E2_01E3_01E4_01E5_01E6_01E7_01E8_01E9_01EA_01EB_01EC_01ED_01EE_01EF_01F0
  7936..8191:  01F1_01F2_01F3_01F4_01F5_01F6_01F7_01F8_01F9_01FA_01FB_01FC_01FD_01FE_01FF_0200
  8192..8447:  0201_0202_0203_0204_0205_0206_0207_0208_0209_020A_020B_020C_020D_020E_020F_0210
  8448..8703:  0211_0212_0213_0214_0215_0216_0217_0218_0219_021A_021B_021C_021D_021E_021F_0220
  8704..8959:  0221_0222_0223_0224_0225_0226_0227_0228_0229_022A_022B_022C_022D_022E_022F_0230
  8960..9215:  0231_0232_0233_0234_0235_0236_0237_0238_0239_023A_023B_023C_023D_023E_023F_0240
  9216..9471:  0241_0242_0243_0244_0245_0246_0247_0248_0249_024A_024B_024C_024D_024E_024F_0250
  9472..9727:  0251_0252_0253_0254_0255_0256_0257_0258_0259_025A_025B_025C_025D_025E_025F_0260
  9728..9983:  0261_0262_0263_0264_0265_0266_0267_0268_0269_026A_026B_026C_026D_026E_026F_0270
 9984..10239:  0271_0272_0273_0274_0275_0276_0277_0278_0279_027A_027B_027C_027D_027E_027F_0280
10240..10495:  0281_0282_0283_0284_0285_0286_0287_0288_0289_028A_028B_028C_028D_028E_028F_0290
10496..10751:  0291_0292_0293_0294_0295_0296_0297_0298_0299_029A_029B_029C_029D_029E_029F_02A0
10752..11007:  02A1_02A2_02A3_02A4_02A5_02A6_02A7_02A8_02A9_02AA_02AB_02AC_02AD_02AE_02AF_02B0
11008..11263:  02B1_02B2_02B3_02B4_02B5_02B6_02B7_02B8_02B9_02BA_02BB_02BC_02BD_02BE_02BF_02C0
11264..11519:  02C1_02C2_02C3_02C4_02C5_02C6_02C7_02C8_02C9_02CA_02CB_02CC_02CD_02CE_02CF_02D0
11520..11775:  02D1_02D2_02D3_02D4_02D5_02D6_02D7_02D8_02D9_02DA_02DB_02DC_02DD_02DE_02DF_02E0
11776..12031:  02E1_02E2_02E3_02E4_02E5_02E6_02E7_02E8_02E9_02EA_02EB_02EC_02ED_02EE_02EF_02F0
12032..12287:  02F1_02F2_02F3_02F4_02F5_02F6_02F7_02F8_02F9_02FA_02FB_02FC_02FD_02FE_02FF_0300
12288..12543:  0301_0302_0303_0304_0305_0306_0307_0308_0309_030A_030B_030C_030D_030E_030F_0310
12544..12799:  0311_0312_0313_0314_0315_0316_0317_0318_0319_031A_031B_031C_031D_031E_031F_0320
12800..13055:  0321_0322_0323_0324_0325_0326_0327_0328_0329_032A_032B_032C_032D_032E_032F_0330
13056..13311:  0331_0332_0333_0334_0335_0336_0337_0338_0339_033A_033B_033C_033D_033E_033F_0340
13312..13567:  0341_0342_0343_0344_0345_0346_0347_0348_0349_034A_034B_034C_034D_034E_034F_0350
13568..13823:  0351_0352_0353_0354_0355_0356_0357_0358_0359_035A_035B_035C_035D_035E_035F_0360
13824..14079:  0361_0362_0363_0364_0365_0366_0367_0368_0369_036A_036B_036C_036D_036E_036F_0370
14080..14335:  0371_0372_0373_0374_0375_0376_0377_0378_0379_037A_037B_037C_037D_037E_037F_0380
14336..14591:  0381_0382_0383_0384_0385_0386_0387_0388_0389_038A_038B_038C_038D_038E_038F_0390
14592..14847:  8DE6_96EB_772C_45C6_1CE3_928C_A8E5_85D1_537D_F1E8_33EB_2698_7CAA_8089_12E0_036F
14848..15103:  5EE2_79B6_A95C_04BF_DD7C_09A1_0354_7D5B_44BD_94F3_2738_929B_C4EA_205D_E727_A15B
15104..15359:  930E_326B_9D79_EA42_FB08_EE2C_2B79_CF68_D133_3B02_9D71_D18A_1147_5566_1F8A_C8BA
15360..15615:  044B_6460_402E_F09A_44CC_D586_42EC_8E8D_003D_6C56_17F0_C463_C5E1_4315_739B_A20F
15616..15871:  5F5E_E57F_A13F_8CD0_C616_8609_243F_6C64_EE59_F786_311C_42C7_9915_9E84_EF4B_A132
15872..16127:  11FF_24EE_91D9_FA68_187A_74CA_A696_6FF2_7096_C54C_4F16_C055_5075_C0B6_B1E8_A862
16128..16383:  E3BF_4D83_5086_BDDD_9449_67C3_C814_EAD3_BD92_852D_FA9E_6CC0_7489_C7A5_BE6C_D8A5
16384..16639:  8883_6E16_1CF2_50DC_6BCE_4CEE_B5EF_B323_7859_75C3_5E67_3A2C_8B0F_021A_5353_0A76
16640..16895:  AE68_8438_4A58_7EEE_3B2C_7036_8F13_7BF7_5B86_4F88_D7AC_2FBF_CCE7_E925_55FC_526A
16896..17151:  D207_8418_B37E_B756_8561_7D94_F4B0_4184_B5C9_C849_0A52_5DF3_648E_E47E_ACDC_D7BD
```

10.4 Shortened length incrementing payload codeword

The following test vector provides an example of a shortened LDPC encoded codeword.

As payload, the vector contains an incrementing string of words.

The total length of the LDPC codeword is 5696 bits (or 712 bytes), the (all-idle) payload length is 3136 bits (or 392 bytes) and the parity length is 2560 bits (or 320 bytes).

The parity bytes are marked `Underlined`.

```
    0..255:  0001_0002_0003_0004_0005_0006_0007_0008_0009_000A_000B_000C_000D_000E_000F_0010
  256..511:  0011_0012_0013_0014_0015_0016_0017_0018_0019_001A_001B_001C_001D_001E_001F_0020
  512..767:  0021_0022_0023_0024_0025_0026_0027_0028_0029_002A_002B_002C_002D_002E_002F_0030
 768..1023:  0031_0032_0033_0034_0035_0036_0037_0038_0039_003A_003B_003C_003D_003E_003F_0040
1024..1279:  0041_0042_0043_0044_0045_0046_0047_0048_0049_004A_004B_004C_004D_004E_004F_0050
1280..1535:  0051_0052_0053_0054_0055_0056_0057_0058_0059_005A_005B_005C_005D_005E_005F_0060
1536..1791:  0061_0062_0063_0064_0065_0066_0067_0068_0069_006A_006B_006C_006D_006E_006F_0070
1792..2047:  0071_0072_0073_0074_0075_0076_0077_0078_0079_007A_007B_007C_007D_007E_007F_0080
2048..2303:  0081_0082_0083_0084_0085_0086_0087_0088_0089_008A_008B_008C_008D_008E_008F_0090
2304..2559:  0091_0092_0093_0094_0095_0096_0097_0098_0099_009A_009B_009C_009D_009E_009F_00A0
2560..2815:  00A1_00A2_00A3_00A4_00A5_00A6_00A7_00A8_00A9_00AA_00AB_00AC_00AD_00AE_00AF_00B0
2816..3071:  00B1_00B2_00B3_00B4_00B5_00B6_00B7_00B8_00B9_00BA_00BB_00BC_00BD_00BE_00BF_00C0
3072..3327:  00C1_00C2_00C3_00C4_0C9A_E1F9_AE14_13D4_E5DA_ED7F_96E9_0C94_E2EC_47D0_376F_81E6
3328..3583:  5FAC_9298_F728_EC7A_08D8_156E_9892_2A2A_810C_707C_33D2_D895_66A0_AA38_E844_B507
3584..3839:  F43A_75F0_92C1_C1C8_075F_9DBD_92B7_0755_45E2_8DDE_3FFB_3399_20D6_EA1C_2F6B_9E23
3840..4095:  53B3_15D3_1046_D489_8300_DCA0_33F7_74BB_0769_20AD_415B_53F2_8ADA_FACC_D00B_B520
4096..4351:  D387_8946_EAFA_B3E3_0181_284E_D91A_FB9B_D5A9_5633_7222_DE44_1DB9_CF9C_FB3F_D7ED
4352..4607:  69C6_2F82_2E82_DA65_E8FA_96C0_69D8_207F_B046_6432_7228_D6CD_29A1_9855_1C4D_BB9C
4608..4863:  7BC5_3E6D_5C97_D894_5E43_B180_3686_11A7_D4B5_E7BE_BDD8_65A6_5BDC_AC1D_C275_441E
4864..5119:  5971_B214_A2EA_2A15_26B8_A6D4_0E94_4895_C66C_412F_908C_2A41_BA0E_E7C7_903A_553B
5120..5375:  B18A_B8FB_6E71_060A_A79D_9792_4D47_C6EB_519B_E24E_D270_67E4_06E8_6DC7_4716_6F28
5376..5631:  7C14_5E0C_8A0F_F62D_FB33_20E0_C471_55AE_72F2_EF44_4595_DDA1_836A_BBDD_9BCB_A498
5632..5695:  397A_A2F6_BFCB_6B24
```

11 Bibliography

No further additions.