25GS-PON Specification
25 Gigabit Symmetric Passive Optical Network

13 March 2026

Version 4.0

www.25gspon-msa.org

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

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.9807.1 adopted for 10G upstream specification instead of [IEEE 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.
V3.0	231102	Major additions and changes: • Specifications for DD40 (40 km reach) • Changes to the Initial Counter Block • Specifications for US Flexible FEC including PLOAM messages • Specifications for ONU OOB masks • Specifications for C+ PMD. • Specifications for E1 and E2 PMDs for 25G down/10G up asymmetric. • TDP testing in the non-linear fiber regime in support of higher loss PMDs. • New index factor value for 25GS-PON. • Changes to C.8.1.1.3 BWmap construction and parsing rules.
V4.0	TBD	Major additions and changes: • Relaxed OLT Tx extinction ratio (ER) • Move C+ to dedicated MPM specifications and add OPL class B+ and D • Add narrowband option for UW1, +/-2nm wide and centered at 1300nm • Add loss budget classes of E1 and E2 for 25G US • Clarification of IFC for upstream encryption • Added optional AES-256 data encryption • Added upstream wavelength and wavelength tolerance indicator (UWTI)

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, 50G-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 specified parts of:

- [IEEE 802.3ca] for PMD layer and FEC
- [ITU-T G.9807.1] for TC layer and 10G upstream PMD
- [ITU-T G.988] for OMCI

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

The following references contain provisions which, through reference in this text, constitute provisions of this Specification.

[ITU-T G.9807.1] Recommendation ITU-T G.9807.1 Amd.1 (05/2025), *10-Gigabit-capable symmetric passive optical network (XGS-PON).*

[ITU-T G.988] Recommendation ITU-T G.988 Amd.2 (05/2025), *ONU management and control interface (OMCI) specification.*

[ITU-T G.9804.2] Recommendation ITU-T G.9804.2 Amd3 (11/2025), *Higher speed passive optical networks – Common transmission convergence layer specification.*

[ITU-T G.9804.3] Recommendation ITU-T G.9804.3 Amd.3 (02/2026), *50-Gigabit-capable passive optical networks (50G-PON): Physical media dependent (PMD) layer specification.*

[IEEE 802.3ca] IEEE Std 802.3-2022, *IEEE Standard for Ethernet, clauses 141 and 142, physical layer for Nx25G-EPON passive optical networks.*

[BBF TR-385] Technical Report Broadband Forum TR-385, *YANG Modules for PON Management.*

4 Definitions

In addition to the definitions, abbreviations and acronyms 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

UWTI Upstream Wavelength and Wavelength Tolerance Indicator

5 Conventions

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.9807.1], "Overview of the XGS-PON Recommendation" applies to 25GS-PON, with the following modifications:

Δ References to the ITU-T G.987 series are replaced with references to [ITU-T 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.

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 need to be added to the Table 9.1.5-1 in ITU-T G.988 OMCI specification. These are taken from the "vendor-specific" range of 192…223":

Table 7.1 – Additions to Table 9.1.5-1 in ITU-T G.988 OMCI specification

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.

9.13.11 Enhanced security control

Master session key name

∆ If the selected hash function generates an MSK name with more than 128 bits, the result is truncated to the leftmost (most significant) 128 bits.

8 xPON YANG model

The 25GS-PON is supported by the [BBF TR-385].
The YANG modules are available in the Broadband Forum GitHub repository.
See https://github.com/BroadbandForum/yang/tree/master/standard/.

9 Adding AES-256

This section defines the AES-256 XGEM payload encryption. Support of this section is optional for both the OLT and ONU. If supported, the implementation shall comply with this section.

C.11.3.4 Upstream PLOAM message formats

C.11.3.4.3 Key_Report message

Table C.11.26 - Key_Report message

9-40	Key_Fragment	Key fragment, 32 bytes. Any padding that may be required is in the higher-numbered bytes of the message. For a report on the existing key, a single fragment containing the key name is sent. Key_Name = AES_CMAC (KEK, encryption_key | 0x333134313539323635333538393733933, 128). For a new key, the KEK_encrypted key is used: ∆ In case of an encryption key of 128 bit: KEK_Encrypted_key = AES_ECB_128 (KEK, encryption_key). ∆ In case of an encryption key of 256 bit: KEK_Encrypted_key = AES_ECB_256 (KEK, encryption_key).

C.15.3 Key derivation

C.15.3.1 Cryptographic method

∆ AES-256 is added to the PON system capability as an optional feature.

∆ The specification is extended to optionally support generation of a 256 bit authentication code using a key length K of 256 bit. The underlying block cipher is kept at 128 bit.

∆ The following notation specifies the generation of the 256 bit authentication code:

T = AES-ECMAC(K, M, 256) =
AES-CMAC (K,(MlessLastBlock), 128) | AES-CMAC(K, M, 128) (15-1b)

Where T is 256 bit in length and the MlessLastBlock is the penultimate CMAC block. The information message of the penultimate CMAC block is the information message M of the final CMAC block from which the last 128-bit block is truncated.

C.15.3.2 Master session key

Δ In case AES-256 is selected but a 128-bit MSK is available, a 256-bit MSK is derived using equation (15-1b) and the AES-128 cipher. For registration based MSK derivation, the CMAC key K is the default value (0x55)16 , and the message M is the Registration_ID. For secure mutual authentication, the CMAC key K is the pre-shared key (PSK). In the OMCI-based method, the message M is the concatenation of the OLT_challenge and ONU_challenge values (see clause 9.13.11 of [ITU-T G.988]).

Δ In case the length of the cipher is shorter than the length of the MSK, the MSK is truncated to its leftmost (most significant) bits as needed to match the cipher length. In case the length of the cipher matches the length of the MSK, the MSK is used without modification.

C.15.3.3 Derived shared keys

Δ In case the selected cipher is AES-256, the derived shared keys can be derived as follows:

SK = AES-ECMAC (MSK, (SN | PON-TAG| PON-TAG | SN), 256) (C.15-3b)

OMCI_IK = AES-ECMAC(SK, "OMCIIntegrityKeyMakeOMCImoreSafe", 256) (C.15.4b)

KEK = AES-ECMAC(SK, "KeyEncryptionKeyMakeKEKMoreSafey", 256) (C.15.6b)

C.15.4 XGEM payload encryption system

C.15.4.1 Cryptographic method

Δ AES-256 can optionally be used as cipher to encrypt XGEM payload.

C.15.5 Data encryption key exchange and activation mechanism

C.15.5.2 Cryptographic method

Δ Optionally the data encryption keys can be encrypted by the ONU using the AES-256 block cipher used in Electronic Codebook mode (AES-ECB).

Δ For the purposes of this specification, both the block size and the key length are equal to 128 bits (mandatory support) or both can be 256 bits (optional support).

C.15.7 Integrity protection and data origin verification for OMCI

C.15.7.1 Cryptographic method

Δ The mandatory default CMAC code is constructed using AES-128 and the 128-bit OMCI_IK (C.15.4). Optionally, if supported and per configuration via OMCI, AES-256 can be used as underlying cipher together with the 256-bit version of the OMCI_IK (C.15.4b).

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 [IEEE 802.3ca], with several exceptions as noted herein.

25GS-PON will support the PHY links in [IEEE 802.3ca] Table141-2 for 25G symmetric, for both “medium” (24dB) and “high” (29dB) loss budgets. There are 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].

Table B.1 - 25GS-PON line rates

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

Δ **Exception 2.** As indicated in [IEEE 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 [IEEE 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.

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

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

* 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 [IEEE 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.

For loss budgets>N1, the 15 dB difference between the minimum and the maximum channel insertion loss is retained.

∆ 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 (Note). 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.

NOTE - The short wavelength end of the O-band is chosen for low dispersion and for sufficient downstream-upstream wavelength separation.

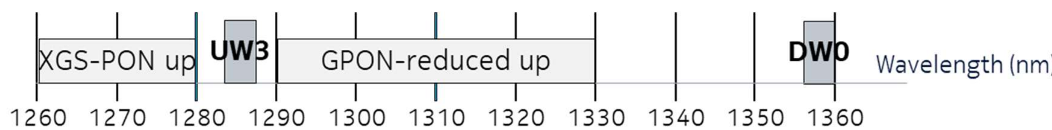

Figure B.1 - Upstream wavelength UW3 to support triple co-existence.

∆ Exception 3b: Narrowband version for UW1 (UW1-NB).

For 25GS-PON, a new narrowband upstream wavelength is defined as UW1-NB for the 25G upstream rate. This wavelength is a narrowband version of UW1 and it uses 1300 +/-2 nm (Note). Except for the wavelength allocation and spectral width, all other PMD values for UW1-NB are the same as for UW0, UW1 and UW3. Implementation of this wavelength is optional.

NOTE – The center wavelength of the Option 2 of [ITU-T G.9804.3] is selected and a 4 nm spectral width is used to take the advantage of SOA-PIN receivers with narrowband optical filter.

∆ 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.

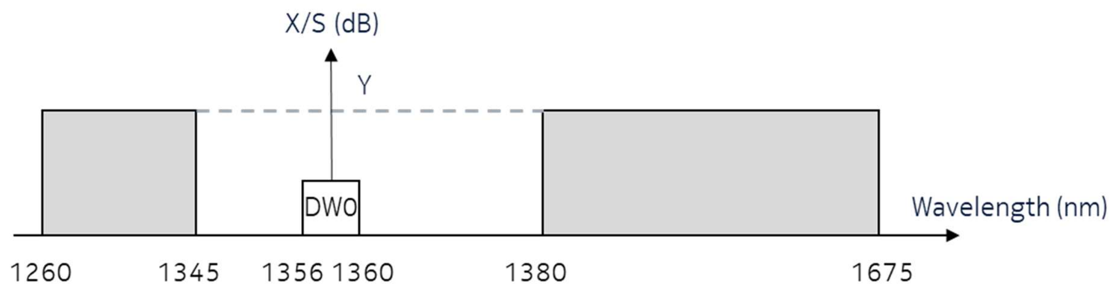

Figure B.1 - X/S tolerance mask for ONU

Δ **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 [IEEE 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 [IEEE 802.3ca] Table 141–22—ONU receive characteristics, high power class are adjusted 0.8 dB downwards as indicated in Table B.5.
3. The minimum ER in [IEEE 802.3ca] Table 141–16—OLT transmit characteristics, high power class is adjusted 1 dB downwards as indicated in Table B.4 and B.4a to provide greater flexibility in meeting the 25GS OLT transmitter OMA specifications.

Δ **Exception 6.** Addition of loss budgets >N1 29 dB and 40 km reach.

The PMDs in [IEEE 802.3ca] enable transmission distances from 0-20 km, which corresponds to a differential distance (DD) of 20 km. 25GS-PON also supports a differential distance of 0-40 km. These two categories of differential distance are referred to DD20 and DD40 respectively. The TDP for DD40 is adjusted to account for higher dispersion penalty. The OMA minus TDP for the DD40 OLT transmitter is relaxed to account for the lower fiber attenuation relative to the upstream at 20 km.

The 25G downstream and upstream optical levels for the non-MPM cases 31 dB N2, 33 dB E1 and 35 dB E2 ODNs and the MPM cases 28 dB B+, 32 dB C+ and 35 dB D ODNs are obtained in the following way:

1. The N2, E1 and E2 downstream OLT optical levels are 2, 4 and 6 dB higher respectively than for N1 as indicated in Table B.4.
2. The B+, C+ and D downstream OLT optical levels are -1, 3 and 6 dB higher respectively than for N1 as indicated in Table B.4a.
3. The optical levels in [IEEE 802.3ca] Table 141-18—OLT receive characteristics, high power class, are adjusted 2, 4 and 6 dB downwards for non-MPM cases N2, E1 and E2 respectively. The values are indicated in Table B.7. The optical levels in [IEEE 802.3ca] Table 141-18—OLT receive characteristics, high power class, are adjusted -1, 3, and 6 dB downwards for MPM cases B+, C+ and D respectively. The values are indicated in Table B.7a. Optical levels for 10G upstream for E1 and E2 are addressed in section B2 below.

The PMDs for 25GS-PON symmetrical ONUs are the same for N1, N2, E1, E2, B+, C+ and D loss budget classes. The PMDs for 25GS-PON asymmetrical ONU are the same for N1, N2, C+, E1 and E2 loss budget classes.

Table B.4 - 25GS-PON OLT transmitter optical levels for N1, N2, E1 and E2 loss budget classes for non-MPM cases

Parameter	[IEEE 802.3ca] Table 141–16	25GS-PON N1 [Note 1]		25GS-PON, N2 [Note 2]		25GS-PON, E1 [Note 2]		25GS-PON, E2 [Note 2]		Unit
		DD20	DD40 [Note 5]	DD20	DD40 [Note 5]	DD20	DD40 [Note 5]	DD20	DD40 [Note 5]	
Average launch power, each channel (max)	7.8	7	7	9	9	11	11	13	13	dBm
Optical Modulation Amplitude (OMA), each channel (min)	4.9	4.1	4.1	6.1	6.1	8.1	8.1	10.1	10.1	dBm
Launch power in OMA minus TDP, each channel (min) for extinction ratio ≥ 9 dB for extinction ratio > 8dB and < 9 dB for extinction ratio ≤ 8 dB	 4.8 4.9 5.0	 4 4.1 4.2	 3.5 3.6 3.7	 6 6.1 6.2	 5.5 5.6 5.7	 8 8.1 8.2	 7.5 7.6 7.7	 10 10.1 10.2	 9.5 9.6 9.7	dBm
Transmitter and dispersion penalty (TDP), each channel (max)	1.5	1.5	3.5	1.5	3.5	1.5	3.5	1.5	3.5	dB
Extinction ratio (min)	8	7	7	7	7	7	7	7	7	dB

Table B.4a - 25GS-PON OLT transmitter optical levels for B+, C+ and D loss budget classes for MPM cases

Parameter	[IEEE 802.3ca] Table 141–16	25GS-PON B+ [Note 1]		25GS-PON, C+ [Note 2]		25GS-PON, D [Note 2]		Unit
		DD20	DD40 [Note 5]	DD20	DD40 [Note 5]	DD20	DD40 [Note 5]	
Average launch power, each channel (max)	7.8	6	6	10	10	13	13	dBm
Optical Modulation Amplitude (OMA), each channel (min)	4.9	3.1	3.1	7.1	7.1	10.1	10.1	dBm
Launch power in OMA minus TDP, each channel (min) for extinction ratio ≥ 9 dB for extinction ratio >8 dB and < 9 dB for extinction ratio ≤8 dB	 4.8 4.9 5.0	 3 3.1 3.2	 2.5 2.6 2.7	 7.0 7.1 7.2	 6.5 6.6 6.7	 10 10.1 10.2	 9.5 9.6 9.7	dBm
Transmitter and dispersion penalty (TDP), each channel (max)	1.5	1.5	3.5	1.5	3.5	1.5	3.5	dB
Extinction ratio (min)	8	7	7	7	7	7	7	dB

Table B.5 - 25GS-PON ONU receiver optical levels for N1, N2, E1, E2, B+, C+ and D loss budget classes

Parameter	[IEEE 802.3ca] Table 141-22	25GS-PON, N1, N2, E1, E2, B+, C+ and D	Unit
Average receive power, each channel (max)	–7.2	-7 [Note 3]	dBm
Receiver sensitivity (OMA), each channel (max)	–24.1	-24.9 [Note 1]	dBm
Stressed receiver sensitivity (OMA), each channel (max)	–22.6	-23.4 [Note 1]	dBm

Table B.6 - 25GS-PON ONU transmitter optical levels for N1, N2, E1, E2, B+, C+ and D loss budget classes

Parameter	[IEEE 802.3ca] Table 141-20	25GS-PON, N1, N2, E1, E2, B+, C+ and D		Unit
		DD20	DD40 [Note 6]	
Launch power in OMA minus TDP, each channel (min) for extinction ratio ≥ 6 dB for extinction ratio < 6 dB	4 4.2	4 4.2	4 4.2	dBm
Transmitter and dispersion penalty (TDP), each channel (max)	2	2	2.5	dB

Table B.7 - 25GS-PON OLT receiver optical levels for N1, N2, E1 and E2 loss budget classes for non-MPM cases

Parameter	[IEEE 802.3ca] Table 141-18	25GS-PON, N1	25GS-PON, N2 [Note 2]	25GS-PON, E1 [Note 2]	25GS-PON, E2 [Note 2]	Unit
Average receive power, each channel (max)	-6	-5 [Note 4]	-7	-9	-11	dBm
Receiver sensitivity (OMA), each channel (max)	-24.3	-24.3	-26.3	-28.3	-30.3	dBm
Stressed receiver sensitivity (OMA), each channel (max)	-22.8	-22.8	-24.8	-26.8	-28.8	dBm

Table B.7a - 25GS-PON OLT receiver optical levels for B+, C+ and D loss budget classes for MPM cases

Parameter	[IEEE 802.3ca] Table 141-18	25GS-PON, B+ [Note 2]	25GS-PON, C+ [Note 2]	25GS-PON, D [Note 2]	Unit
Average receive power, each channel (max)	-6	-4	-8	-11	dBm
Receiver sensitivity (OMA), each channel (max)	-24.3	-23.3	-27.3	-30.3	dBm
Stressed receiver sensitivity (OMA), each channel (max)	-22.8	-21.8	-25.8	-28.8	dBm

NOTE 1 - Accommodates Exception 5.
NOTE 2 - Accommodates Exception 6.
NOTE 3 - Accommodates Exceptions 2 and 5.
NOTE 4 - Accommodates Exception 2.
NOTE 5 - A DD40 OLT port must support ONUs at both short (up to 20 km) and long distances (up to 40 km) on the same ODN. Therefore, the DD40 OLT transmitter must support TDP(max) and OMA minus TDP(min) for both DD20 at 20 km and DD40 at 40 km.
NOTE 6 - The DD40 ONU transmitter must support maximum TDP for both DD20 at 20 km and DD40 at 40 km.

Δ **Exception 7.** Transmitter and dispersion penalty (TDP) test.

The TDP test in the linear power regime of the fiber shall be performed as described in clause 141.7.9 of [IEEE 802.3ca] with the exception that the launch power to the test fiber is sufficiently low such that the fiber is operated in its linear power regime, and no channel filter is used. Alternatively, the same test setup used for the TDP test in the nonlinear power regime of the fiber, described below and illustrated in Figure B.3, may be used. However, in that case an additional optical attenuator is introduced between DUT and the first section of the test fiber, and the reflectance of the controlled optical backreflector is adjusted appropriately as described in point c) below.

The TDP test in the nonlinear power regime of the fiber shall be performed for power budget classes where the average launch power per channel exceeds 8 dBm. The test setup for performing the TDP test in the nonlinear power regime of the fiber is illustrated in Figure B.3. The test follows a similar procedure as described in clause 141.7.9 of [IEEE 802.3ca], with the following exceptions:

a) The test fiber is split into two sections such that when concatenated, the two sections jointly provide channel requirements as specified in clause 141.7.9.2 of [IEEE 802.3ca].
b) The output of the DUT is connected directly to the first section of the test fiber such that the optical power launched into the first section of the test fiber is at its maximum operating level. The length of the first section of the test fiber is chosen such that the second section of the test fiber is operated in its linear power regime when both sections of the test fiber are concatenated.
c) A polarization rotator and a controlled optical backreflector are placed in between the first and the second section of the test fiber. The reflectance of the controlled optical backreflector is appropriately adjusted to account for the insertion loss of the optical path between the DUT output and the controlled optical backreflector input. This insertion loss is determined when launch power to the first section of the test fiber is sufficiently low such that it is operated in the linear power regime. The state of polarization of the back-reflection is adjusted to create the greatest RIN at the DUT.
d) The second section of the test fiber is connected to the output of the controlled optical backreflector.

TDP is then the higher of: TDP measured in the linear power regime of the fiber and TDP measured in the nonlinear power regime of the fiber, and must comply with the relevant TDP OLT transmit characteristics.

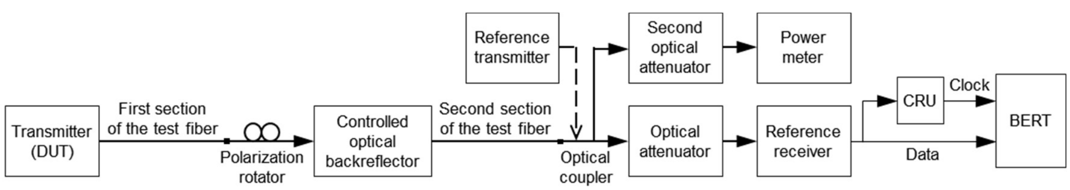

Figure B.3 - Test setup for measurement of transmitter and dispersion penalty in the nonlinear power regime of the fiber

In addition to measuring the TDP, it is necessary to determine if the optical power reaching the end of the second section of the test fiber is sufficient. This may be done using a power meter as shown in Figure B.3, where the power meter is connected to the end of the second section of the test fiber through an optical coupler and a second optical attenuator. The second optical attenuator is set such that the optical power measured by the power meter, while launch power to the first section of the test fiber is sufficiently low such that the fiber is operated in its linear power regime, corresponds to the relevant maximum optical path loss of the relevant loss budget class. When launch power into the first section of the test fiber is at its maximum operating level, the average optical power measured by the power meter, when converted to OMA using ER at the input to the reference receiver, must be greater than or equal to the "receiver sensitivity (OMA), each channel (max)" for the relevant loss budget class.

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 N1 (29 dB), N2 (31 dB), C+ (32 dB), E1 (33 dB) and E2 (35 dB) loss budgets and both DD20 and DD40 differential distance categories.

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.

B3. ONU OOB masks

There is a small probability that an ONU from one PON generation with a fully compliant transmitter can produce an excess of out-of-band (OOB) noise that could cause interference in the upstream transmissions of another PON generation co-existing on the same fiber. In order to reduce the probably of such an occurrence, 25GS-PON ONUs must meet the following requirements:

1. ONUs using the UW0 wavelength, both 10G and 25G upstream, shall meet the OOB mask defined for the Basic Wavelength Set, in Annex B.A of [ITU-T G.9807.1].

2. ONUs using the UW1 wavelength, both 10G and 25G upstream, shall meet the OOB mask defined for the Option 2 Wavelength Set in section 9.2.7.2.1 of [ITU-T G.9804.3], with λ_1 = 1288 nm.

3. ONUs using the UW3 wavelength, both 10G and 25G upstream, shall meet the OOB mask defined for the Option 3 Wavelength Set in section 9.2.7.2.1 of [ITU-T G.9804.3].

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

The TC-Layer requirements for 25GS-PON are contained in [ITU-T G.9807.1]. Changes required for an implementation to comply with the 25GS-PON specification are noted herein. This includes the substitution of G.9807.1 RS FEC with [IEEE 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 25GS-PON OLT supports the following line rates:

Table C.6.1 - 25GS-PON OLT Supported 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

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

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

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

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 25GS-PON, XGS-PON should not use Alloc-ID’s 1019 & 1020.

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 line rate:
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

9) Maximum GrantSize value of any individual allocation:
Same 9720 equally spaced time intervals.
For 10 Gbit/s upstream rate – 9719 (referring to 16-byte blocks)
Δ For 25 Gbit/s upstream rate – 9719 (referring to 40-byte blocks)

10) Δ The maximum upstream 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

Δ Rule 11) of the C.8.1.1.3 BWmap construction and parsing rules to be removed.
There is no Rule 11) constraint applicable both for 10 Gbit/s as well as for 25Gbit/s.

In case the OLT sends large grants at 10 Gb/s extending further than 69% (FEC disabled) or 79% (FEC enabled) into the next frame with upstream AES encryption enabled, the 14-bit IFC field used in the Initial Counter Block (see section C.15.4.3) will wrap around and potentially result in repeated Output Counter Block values (the output of the AES CTR-

Engine). Consequently, encryption will be weakened if packets from the same ONU use the same Output Counter Block value. For ONUs with upstream encryption enabled the OLT shall avoid scheduling bursts that may result in overlapping Output Counter Block values.

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.10.1.1.1.3 Operation control structure

Δ **UWTI**: a 4-bit field, positioned in the 4 LSBs of the PON-ID field in the PSBd, replacing the DWLCH ID field and its functionality. This field consists of a 4-bit upstream wavelength and wavelength tolerance option code for which the values of the codes correspond with the following wavelengths:

UWTI code values – Upstream wavelength and wavelength tolerance options
- UWTI = 0001: UW0
- UWTI = 0010: UW1
- UWTI = 0011: UW3
- UWTI = 0100: UW1-NB
- UWTI = 0000: Value 0000 indicates that the OLT doesn't have the ability to recognize and send the right UWTI. In this case, the ONU will ignore this field during activation and continues the activation process.

Other values are reserved.

C.10.1.1.3 ONU downstream synchronization

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

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 state machine transitions to the Pre-Sync state.

Pre-Sync state: When in the Pre-Sync state, both the Psync pattern and 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 state machine 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 state machine 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 state machine transitions into the Re-Sync state.

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

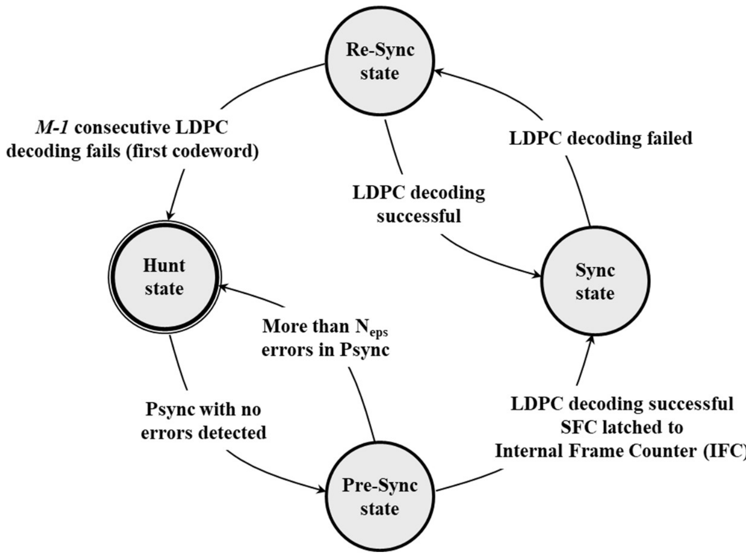

Figure C.10.4 - DS reference synchronization state machine

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].

Δ For a line rate of 25Gbit/s, in both downstream and upstream directions, the mandatory default 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.

Δ For the upstream line rate of 25Gbit/s, ONUs and OLTs may additionally support one or more optional FEC codes derived from the same LDPC(17664, 14592) mother code but with different amounts of shortening and puncturing than the default code. Two optional codes are specified. The optional Code 1 is LDPC(15872, 14592) and offers a higher throughput than the default code. The optional Code 2 is a range of LDPC codes from LDPC(12800, 9728) down to LDPC(8704, 5632) and offers a higher margin than the default code. The optional codes are described in Annex C.B.

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 default upstream FEC code is LDPC(17152,14592).

Δ For 25Gbit/s, the optional Code 1 (high-throughput code) is LDPC(15872, 14592).

Δ For 25Gbit/s, the optional Code 2 (high-margin code) is a range of LDPC codes from LDPC(12800, 9728) down to LDPC(8704, 5632).

Δ An ONU always activates using the default code.

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.11.3.1 Downstream PLOAM message summary

Table C.11.2 – Downstream PLOAM messages

Δ The Table C.11.2 is extended with the Get_Set_Capabilities message summary as can be found in Table 11-3 in [ITU-T G.9804.2].

C.11.3.2 Upstream PLOAM message summary

Table C.11.3 – Upstream PLOAM messages

Δ The Table C.11.3 is extended with the ONU_Capabilities message summary as can be found in Table 11-4 in [ITU-T G.9804.2].

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 ONUs.
- Octet 6: only applies for 10 Gbit/s upstream capable ONUs.

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.

Δ C.11.3.3.32 Get_Set_Capabilities message
Section C.11.3.3.32 Get_Set_Capabilities message defines the Get_Set_Capabilities message as specified in section 11.3.3.20 and Table 11-24 in [ITU-T G.9804.2].

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.

Δ C.11.3.4.32 ONU_Capabilities message
Section C.11.3.4.32 ONU_Capabilities message defines the ONU_Capabilities message as specified in section in section 11.3.4.9 and Table 11-33 in [ITU-T G.9804.2].

C.12 25GS-PON ONU activation

C.12.1.3 Causal sequence of activation events

Δ The activating ONU attains PSync and superframe synchronization and collects the TC-layer protocol version and the burst profile information. The ONU also collects the upstream wavelength and wavelength tolerance option information and proceeds with registration if the information matches that of the ONU. Actions to take upon a mismatch between the OLT and ONU of the TC-layer version or the supported Upstream Wavelength and wavelength Tolerance option are implementation specific.

C.12.1.4 XGS-PON ONU activation cycle state machine

C.12.1.4.1 States, timers and inputs

Table C.12.1 - ONU activation cycle states

ONU State/Substate		Semantics
Ref	Full name	
O1	O1/Profile Learning ≡ O1.2	The ONU parses the PLOAM partition of downstream FS frames and starts collecting burst profile information. Δ Once sufficient information is collected and the wavelength tolerance option indicated in the UWTI field matches that of the ONU, the ONU proceeds with activation and transitions to Serial Number state (O2-3).

Table C.12.3 - ONU activation cycle state machine inputs

Input	Applicable states	Semantics
Downstream synchronization events		
Δ UWT match	O1	Result of internal evaluation: the supported upstream wavelength and wavelength tolerance option indicated in the UWTI field match that of the ONU.

C.12.1.4.2 ONU state diagram

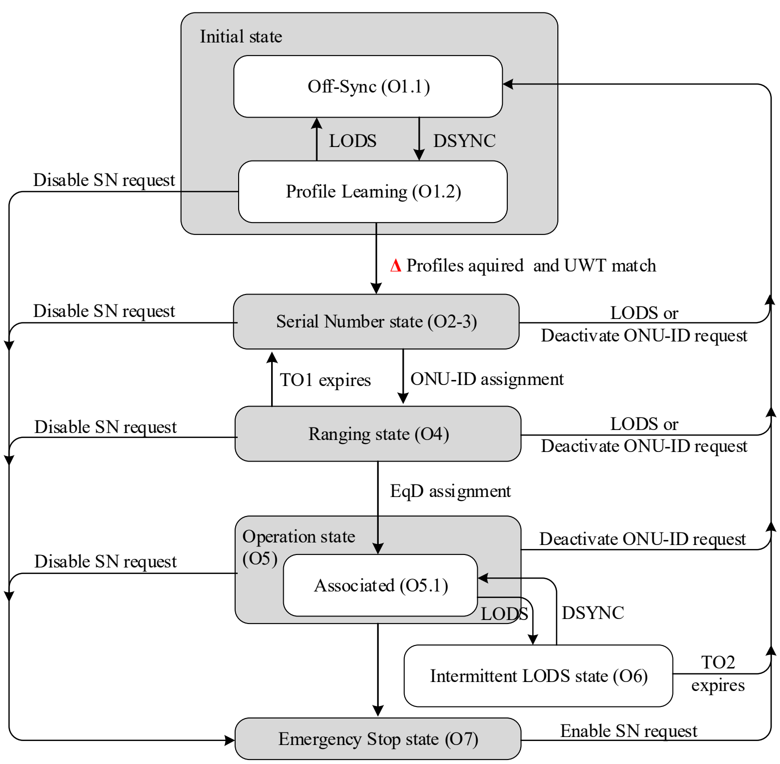

Figure C.12.1 - XGS-PON ONU state diagram

C.12.1.4.3 ONU state transition table

Table C.12.4 - XGS-PON ONU activation cycle state transition table

Events	ONU activation cycle states Initial state O1	
	Off-Sync **O1.1**	**Profile Learning** **(O1.2)**
∆ Profiles acquired and UWT match		= => O2-3

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

C.13.1.6 In-service equalization delay adjustment

Table C.13.1 - Suggested thresholds for DOWi and TIWi

	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

C.13.2.3.2 Fibre propagation delay

∆ The index factor for 25GS-PON is 0.500004 for all upstream wavelength options.

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

∆ Table C.14.1 - Performance monitoring parameters

- The Corrected FEC bytes counter content in the table is replaced by the below specified content: Corrected FEC bits or bytes.
- The Bits or bytes in error-free and correctable upstream FEC codewords counter is added as specified in the table below.
- Note 3 and Note 4 specified in the table below, are added.

Table C.14.1 - Performance monitoring parameters

Corrected FEC bits or bytes [Note 4]	M	The number of bits or bytes that were corrected by the FEC function [Note 3]	Yes, for all traffic flows	Yes, if upstream FEC is enabled for ONU_i	N/A	
Bits or bytes in error-free and correctable upstream FEC codewords [Note 4]	M	The number of transmitted bits or bytes (including parity) in FEC codewords that were error-free or contained errors but were corrected by the FEC function	No	Yes, if upstream FEC is enabled for ONU_i	N/A	
NOTE 3 –The count shall report the number of corrected bits or bytes only within the actually transmitted portion of the error-free and correctable codewords, including the parity bits. NOTE 4 – When the used FEC is RS-FEC then the count is done per byte, in case the used FEC is LDPC-FEC then the count is done per bit.						

C.15 25GS-PON security

C.15.4.3 Initial counter block

Δ 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.

Δ In the downstream direction, the 128-bit initial counter block as input for the AES calculation is structured as follows:

Initial counter(127..79) : Superframe Counter (48..0)
Initial counter(78..64) : Intra frame Counter (14..0)
Initial counter(63..15) : Superframe Counter (48..0)
Initial counter(14..0) : Intra frame Counter (14..0)

Δ 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.

Δ In the upstream direction, 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))

For upstream, the lower half of the ICB fields are taken bit-complement, indicated in the above structure by the ~() operator.

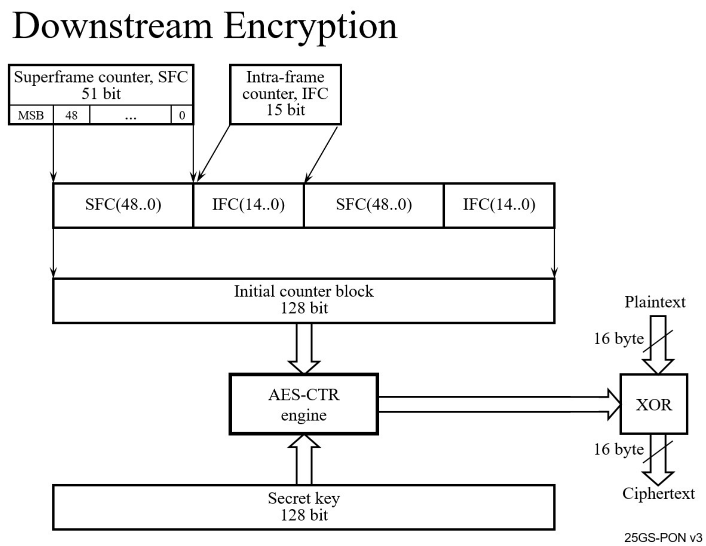

Figure C.15.2a - Initial counter block construction for downstream encryption

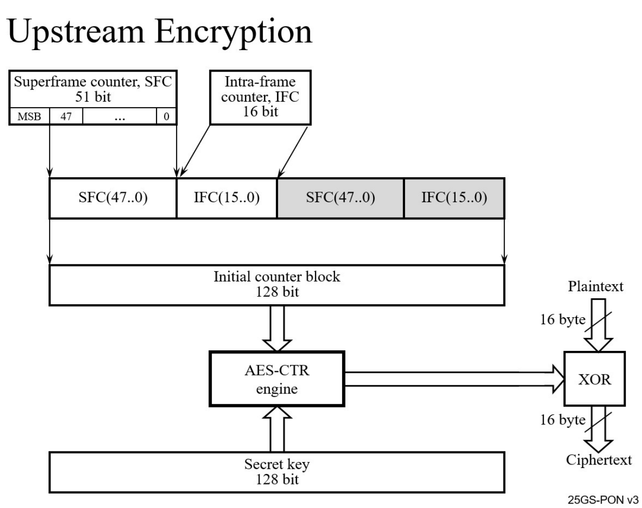

Figure C.15.2b – Initial counter block construction for upstream encryption (for upstream, the shaded fields are taken in bit-complement)

Δ In the upstream direction, the FS burst of the framing sublayer (see Figure C.8.5) is partitioned into 16-byte blocks, and these blocks are sequentially numbered from S to (S+X). Here S= (StartTime * 40/16) for the 24.8832 Gbit/s upstream line rate, S=StartTime for the 9.95328 Gbit/s upstream line rate, and X is the number of complete and incomplete 16-byte blocks in the FS burst, less 1.

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 mother code used for 25GS-PON is based on the mother code specified by the [IEEE 802.3].

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

The optional Code 1 (high-throughput LDPC code) for 25GS-PON is a non-shortened and 7 column (1792bits) punctured code, based on the same mother code as the default code. The puncturing is applied to specific columns of the Matrix. The exact location of the punctured columns can be found below.

The optional Code 2 (high-margin LDPC code) for 25GS-PON is a range of shortened and non-punctured codes, based on the same mother code as the default code. The number of shortened information bits S equal to S = 256 * CS, where CS is the number of shortened columns communicated via octet 9 of Get_Set_Capabilities message by the setting of the FEC code 2 (high margin code). Allowed values for CS are integers between and including 19 and 35.

The interleaving described in [IEEE 802.3ca] 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

The optional high throughput code for 25GS-PON is LDPC(15872, 14592), which has the following characteristics:

- Codeword length: 15872 bits
- Payload length: 14592 bits
- Parity length: 1280 bits.
- [69,66,64,63,61,60,58] identify the column indices of the punctured parity-check bits (counting starts at 1).

The optional high margin code range for 25GS-PON is LDPC(12800, 9728) to LDPC(8704, 5632), which have the following characteristics:

- Codeword length: 17664 - S bits
- Payload length: 14592 - S bits
- Parity length: 3072 bits.
- The description of the value S can be found earlier in this Annex.

Annex C.D – Secure mutual authentication using IEEE 802.1X

(This annex does form an integral part of this specification.)

Δ This Annex is replaced by the Annex D of [ITU-T G.9804.2].

Annex J – Cipher and keys switching procedure

(This annex does form an integral part of this specification.)

This Annex is added and is the same as Annex J of [ITU-T G.9804.2].

Appendix I – General statements on the relationship with XGS-PON TC layer requirements

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

25GS-PON is 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 802.3ca] Mother code).

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 802.3ca] Mother code).

Appendix II – LDPC test vectors

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

II.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 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_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
```

II.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
```

II.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
```

II.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
```

II.5 High Throughput – full size codeword – Idle payload

High Throughput examples exhibit an increased coding rate via rearranged and expanded puncturing of the parity segment.

High Throughput Full Size codeword comprised of 14,592 IDLE payload bits and 1,280 parity bits. Matrix columns [66, 65, 62, 61, 60, 59, 58] have been punctured (counting starts at 1).

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:   5F09_FBC1_2F76_88BB_5F09_FBC1_2F76_88BB_5F09_FBC1_2F76_88BB_5F09_FBC1_2F76_88BB
14848..15103:   42BC_B309_5369_1781_42BC_B309_5369_1781_42BC_B309_5369_1781_42BC_B309_5369_1781
15104..15359:   86D4_3F73_C049_E6BB_86D4_3F73_C049_E6BB_86D4_3F73_C049_E6BB_86D4_3F73_C049_E6BB
15360..15615:   FBC6_32FF_AF21_AC6F_FBC6_32FF_AF21_AC6F_FBC6_32FF_AF21_AC6F_FBC6_32FF_AF21_AC6F
15616..15871:   FE01_A803_896E_EA84_FE01_A803_896E_EA84_FE01_A803_896E_EA84_FE01_A803_896E_EA84
```

II.6 High Throughput – full size codeword – Incrementing payload

High Throughput examples exhibit an increased coding rate via rearranged and expanded puncturing of the parity segment.

High Throughput Full Size codeword comprised of 14,592 incrementing payload bits and 1,280 parity bits. Matrix columns [66, 65, 62, 61, 60, 59, 58] have been punctured.

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

```
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:  11FF_24EE_91D9_FA68_187A_74CA_A696_6FF2_7096_C54C_4F16_C055_5075_C0B6_B1E8_A862
14848..15103:  E3BF_4D83_5086_BDDD_9449_67C3_C814_EAD3_BD92_852D_FA9E_6CC0_7489_C7A5_BE6C_D8A5
15104..15359:  D207_8418_B37E_B756_8561_7D94_F4B0_4184_B5C9_C849_0A52_5DF3_648E_E47E_ACDC_D7BD
15360..15615:  07BB_6790_43DE_F36A_473C_D676_411C_8D7D_03CD_6FA6_1400_C793_C611_40E5_706B_A1DF
15616..15871:  AAD5_776F_ED31_FB70_3C8E_38A6_DF1E_0A35_10DF_C870_C657_13D2_1AEB_BDFA_CF86_878E
```

II.7 High Margin – 19 columns shortened – Idle payload

High Margin examples exhibit a decreased coding rate via shortened payload segments and with no puncturing of the parity segment.

High Margin Maximum Length codeword comprised of 9,728 IDLE payload bits and 3,072 parity bits.

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_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:  3D0D_4688_2068_8C0F_3D0D_4688_2068_8C0F_3D0D_4688_2068_8C0F_3D0D_4688_2068_8C0F
 9984..10239:  3B31_B118_6AC2_6E12_3B31_B118_6AC2_6E12_3B31_B118_6AC2_6E12_3B31_B118_6AC2_6E12
10240..10495:  04A0_E9D5_8A1E_2CE3_04A0_E9D5_8A1E_2CE3_04A0_E9D5_8A1E_2CE3_04A0_E9D5_8A1E_2CE3
10496..10751:  EA02_CA5A_F186_C19B_EA02_CA5A_F186_C19B_EA02_CA5A_F186_C19B_EA02_CA5A_F186_C19B
10752..11007:  9C4C_9F8F_3128_8941_9C4C_9F8F_3128_8941_9C4C_9F8F_3128_8941_9C4C_9F8F_3128_8941
11008..11263:  511B_59D1_E84D_D9DB_511B_59D1_E84D_D9DB_511B_59D1_E84D_D9DB_511B_59D1_E84D_D9DB
11264..11519:  6950_B07C_929D_496D_6950_B07C_929D_496D_6950_B07C_929D_496D_6950_B07C_929D_496D
11520..11775:  7CC5_C02C_22C4_B2FD_7CC5_C02C_22C4_B2FD_7CC5_C02C_22C4_B2FD_7CC5_C02C_22C4_B2FD
11776..12031:  6E27_6DC9_F091_838D_6E27_6DC9_F091_838D_6E27_6DC9_F091_838D_6E27_6DC9_F091_838D
12032..12287:  E6B4_828A_B547_F411_E6B4_828A_B547_F411_E6B4_828A_B547_F411_E6B4_828A_B547_F411
12288..12543:  EA02_E3C4_F186_3E64_EA02_E3C4_F186_3E64_EA02_E3C4_F186_3E64_EA02_E3C4_F186_3E64
12544..12799:  D0E8_054E_707C_8618_D0E8_054E_707C_8618_D0E8_054E_707C_8618_D0E8_054E_707C_8618
```

II.8 High Margin – 19 columns shortened – Incrementing payload

High Margin examples exhibit a decreased coding rate via shortened payload segments and with no puncturing of the parity segment.

High Margin Maximum Length codeword comprised of 9,728 Incrementing payload bits and 3,072 parity bits.

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

```
      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:   404F_7D59_CBC7_3F89_865F_6990_15AD_963B_C781_D715_0F38_06AC_2DA1_F7BB_1A09_DABB
    9984..10239:   9C74_3CA5_7B69_F945_7384_7541_C1E1_ABD9_E748_1E19_DCB3_02DE_B6AE_1CB6_2C13_3A86
   10240..10495:   15AA_823D_8F4B_166A_4745_70D2_34FC_8F27_0B5D_9DE7_CB65_BA43_2A10_C023_881A_4667
   10496..10751:   459D_F0D5_8FA0_8AFB_BB3A_7640_7D41_0673_A18C_5DCB_E110_559D_ED0E_2BE4_07F4_CDC9
   10752..11007:   42A8_407A_AAE6_5037_5A39_31E1_0AC3_22B6_7F79_4F57_E95A_3870_3BA1_D19E_3102_7535
   11008..11263:   5164_6457_81F6_3EEB_5404_37C5_B401_7E0F_D1DF_5847_1289_E0C6_682D_B379_7D44_3A7E
   11264..11519:   1161_26D7_7EC6_084C_95B0_E161_6C12_B0EB_87B4_648D_DC6B_3692_977B_EA0F_8038_00AC
   11520..11775:   086B_A23A_DFD1_D7C3_F7A1_E7A4_B4F9_D93F_5C14_26A0_953D_9A37_004F_29B8_7F93_8F95
   11776..12031:   EF8A_02C3_2D04_9B47_3B4D_D97A_B8D2_5B52_1E4C_AEDA_3E1B_F3D1_01EB_570F_8359_1102
   12032..12287:   D022_E060_A3C6_7B76_4804_F4DF_F9E8_D079_2AF2_C08E_F149_ECA6_A9B3_A91D_571B_9F50
   12288..12543:   449C_F1D7_8EA3_8BFF_BA3F_7746_7C46_077B_A085_5CC1_E01B_5491_EC03_2AEA_06FB_CD99
   12544..12799:   DF15_8B0A_51D3_4345_D55E_BA63_1BF6_D8F6_1E69_E36C_BEDD_D233_D199_3F60_D3AA_A0DA
```

II.9 High Margin – 35 columns shortened – Idle payload

High Margin examples exhibit a decreased coding rate via shortened payload segments and with no puncturing of the parity segment.

High Margin Maximum Length codeword comprised of 5,632 IDLE payload bits and 3,072 parity bits.

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_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:   A1D9_A48E_7C0D_9E66_A1D9_A48E_7C0D_9E66_A1D9_A48E_7C0D_9E66_A1D9_A48E_7C0D_9E66
   5888..6143:   BAB2_BC58_7B3A_D4DF_BAB2_BC58_7B3A_D4DF_BAB2_BC58_7B3A_D4DF_BAB2_BC58_7B3A_D4DF
   6144..6399:   1872_A640_F415_0A19_1872_A640_F415_0A19_1872_A640_F415_0A19_1872_A640_F415_0A19
   6400..6655:   EE98_B38D_FE57_12F5_EE98_B38D_FE57_12F5_EE98_B38D_FE57_12F5_EE98_B38D_FE57_12F5
   6656..6911:   4FCC_2FAE_8260_34F0_4FCC_2FAE_8260_34F0_4FCC_2FAE_8260_34F0_4FCC_2FAE_8260_34F0
   6912..7167:   8D18_5E22_1EF6_D9EB_8D18_5E22_1EF6_D9EB_8D18_5E22_1EF6_D9EB_8D18_5E22_1EF6_D9EB
   7168..7423:   4123_F166_013F_06D6_4123_F166_013F_06D6_4123_F166_013F_06D6_4123_F166_013F_06D6
   7424..7679:   7F69_DDA2_20FD_665F_7F69_DDA2_20FD_665F_7F69_DDA2_20FD_665F_7F69_DDA2_20FD_665F
   7680..7935:   6F9F_5EF3_E991_A266_6F9F_5EF3_E991_A266_6F9F_5EF3_E991_A266_6F9F_5EF3_E991_A266
   7936..8191:   8806_FC69_BE4F_F651_8806_FC69_BE4F_F651_8806_FC69_BE4F_F651_8806_FC69_BE4F_F651
   8192..8447:   EE98_9A13_FE57_ED0A_EE98_9A13_FE57_ED0A_EE98_9A13_FE57_ED0A_EE98_9A13_FE57_ED0A
   8448..8703:   6C8C_4C0D_1BA3_AA62_6C8C_4C0D_1BA3_AA62_6C8C_4C0D_1BA3_AA62_6C8C_4C0D_1BA3_AA62
```

II.10 High Margin – 35 columns shortened – Incrementing payload

High Margin examples exhibit a decreased coding rate via shortened payload segments and with no puncturing of the parity segment.

High Margin Maximum Length codeword comprised of 5,632 Incrementing payload bits and 3,072 parity bits.

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:  6F5E_95FB_DF4B_1EA5_541D_6C10_A196_3D84_2FC7_52EA_59E7_C742_9D1A_5DF1_2529_9931
5888..6143:  FF5F_ED4C_1072_CFDB_7541_6798_B735_6261_08FC_913A_234B_E85C_8B8E_913F_21A8_3D69
6144..6399:  C70C_75BF_EF43_A7E9_D578_68EF_9C61_99F0_026D_1705_55C9_D60C_BBF8_717F_54DB_26F1
6400..6655:  FD5A_2CA2_E611_786B_5896_1942_B4DC_8AA3_2750_9220_537C_82C4_02B6_99FD_C0C1_92BF
6656..6911:  31EE_DAFF_F0E7_8F0A_07A3_148A_87D7_4151_6E55_77D7_09C5_51CE_81CB_EA4D_BD3A_DDEC
6912..7167:  D577_AC34_D9F8_2B80_612A_4A35_684F_A89E_AA87_ED73_DF04_D87E_97AA_A375_E881_4CCB
7168..7423:  1B7F_1A87_3DBE_6734_CBDB_8646_0142_AFD0_EC39_2261_7C31_063A_FB52_1068_CC72_AA5F
7424..7679:  2FC5_9C81_AB3A_96EC_B55C_23E9_40E8_B9A8_D220_1908_2C84_A55C_FE08_3C92_572C_3945
7680..7935:  6A50_3BDE_5474_0A8D_183F_40BE_F556_F2BE_C3F6_BB88_ADB6_C761_2074_F666_3726_8B4B
7936..8191:  9357_3895_F287_FDEE_C247_47DA_C589_5388_DBA5_6265_B92D_B98D_82E6_6D28_BDA2_7090
8192..8447:  FC2B_2DD0_E762_791F_59E3_1834_B5AB_8BDB_2629_935A_5207_83B8_03CB_9883_C1BE_92FF
8448..8703:  45CC_D145_A6F5_3EC6_8D9F_706E_0671_3816_BD34_D169_A99F_02A4_0F6A_B6E4_3C15_1266
```

Appendix III – Co-existence options

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

The 25GS-PON offers a variety of co-existence options and migration paths that we summarize in the following for the triple co-existence use cases and focused on the upstream spectral bands. Note that the different systems GPON, XGS-PON, 50G-PON and 25GS-PON apply in downstream distinct spectral bands. It should also be noted that dual co-existence use cases can be similarly supported.

If an operator has deployed GPON and XGS-PON, they can use UW3 to integrate 25GS-PON. The spectral allocations for upstream are shown in Figure III.1.

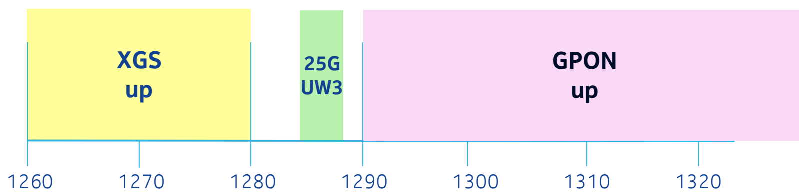

Figure III.1 – Co-existence of upstream bands for GPON, XGS-PON with 25GS-PON.

If an operator has GPON deployed and does not plan to deploy XGS-PON, but instead deploys 25GS-PON directly, either the UW3 or UW0 wavelength band can be selected (see Figure III.2). If UW3 is used for 25GS-PON, 50G-PON can co-exist under Option 1 (see Fig. 2a). Alternatively, if 25GS-PON UW0 is used, 50G-PON can migrate to the UW3 option (or Option 3 in [ITU-T G.9804.3] terminology) (see Figure III.2b).

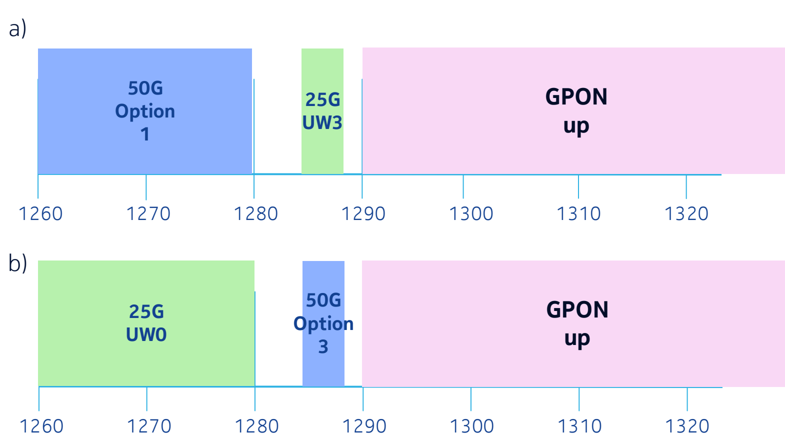

Figure III.2 – Co-existence for upstream bands for GPON with 25GS-PON and 50G-PON.

Finally, if an operator has XGS-PON deployed and deploys 25GS-PON, either the UW3 or UW1 wavelength band can be selected (see Figure III.3). If UW3 is selected for 25GS-PON, 50G-PON can co-exist under Option 2 (see Fig. 3a). Alternatively, if 25GS-PON UW1 is selected, 50G-PON can migrate to the UW3 option (Option 3, see Figure III.3b).

Figure III.3: Co-existence of upstream bands for XGS-PON with 25GS-PON and 50G-PON.

Further, the 25GS-PON MSA v4 introduces a UW1-NB option for which the following co-existence options can be summarized: if an operator has XGS-PON deployed and deploys 25GS-PON in the UW1-NB wavelength band, 50G-PON can co-exist under Option 3 (see Figure III.4).

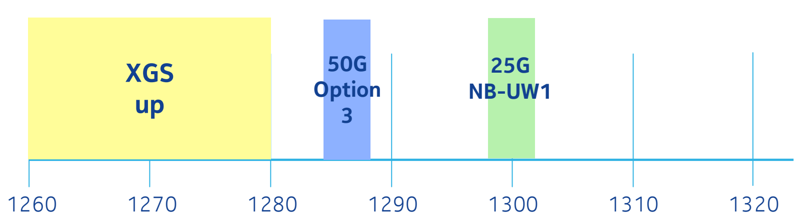

Figure III.4: Co-existence of upstream bands for XGS-PON with 25GS-PON and 50G-PON.

Bibliography

No further additions.