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100. Physical Medium Attachment (PMA) Sublayer, Physical Medium Dependent (PMD) Sublayer, and Medium for Coaxial Distribution Networks, Type <EPoC_PMD_NAME>

100.1 Overview

This clause describes the Physical Medium Attachment (PMA), the Physical Medium Dependent (PMD) sublayer, and Medium Dependent Interface (MDI) used with {EPoC_PMD_NAME} point-to-multipoint (P2MP) networks. These are passive or active multipoint coaxial distribution networks (CDN) that connect multiple DTEs using a single shared coaxial link. The architecture is asymmetric, based on a tree and branch topology utilizing passive or active coaxial splitters. This type of network requires that the Multipoint MAC Control sublayer exists above MAC instances, as described in {Clause 102}.

100.1.1 Terminology and Conventions

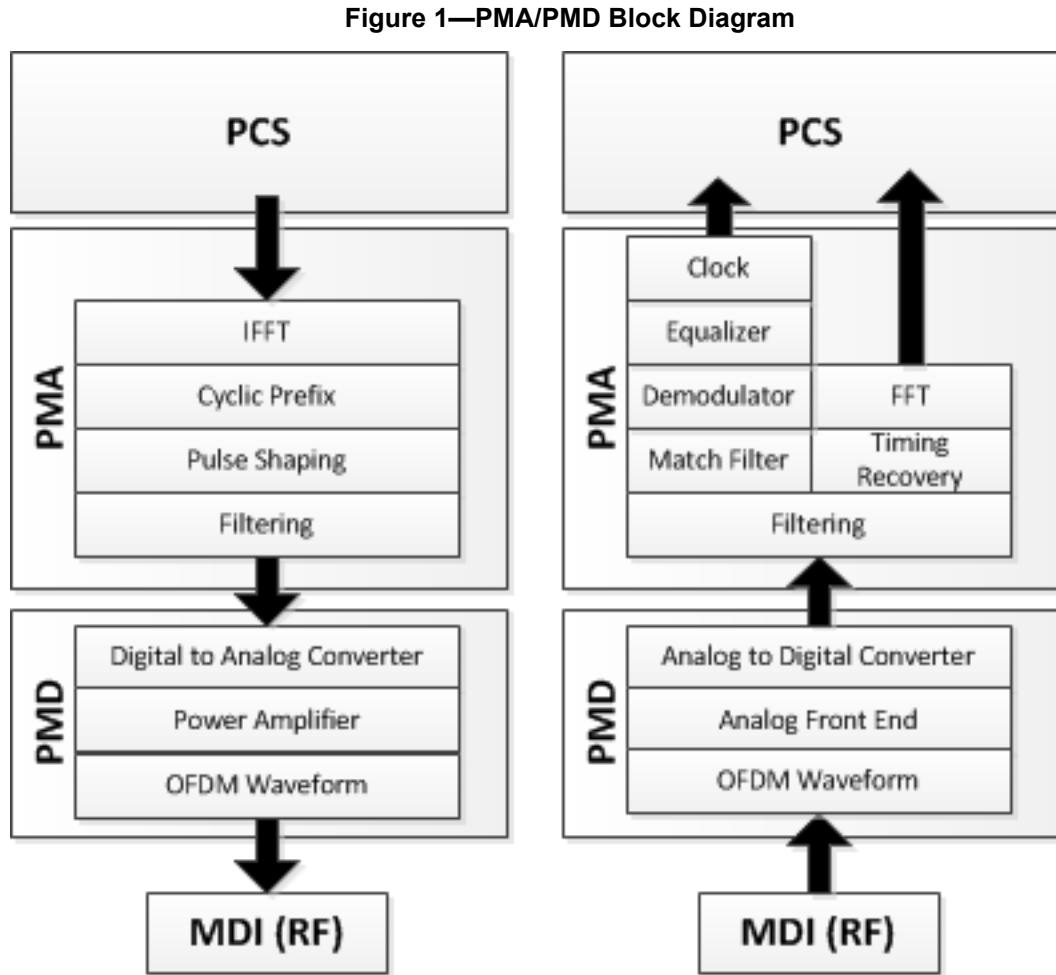
The notation used in the state diagrams in this clause follows the conventions in {21.5}. Should there be a discrepancy between a state diagram and descriptive text, the state diagram prevails. The notation ++ after a counter indicates it is to be incremented by 1. The notation — after a counter indicates it is to be decremented by 1. The notation -= after a counter indicates that the counter value is to be decremented by the following value. The notation += after a counter indicates that the counter value is to be incremented by the following value. Code examples given in this clause adhere to the style of the “C” programming language.

100.1.2 Goals and Objectives

100.1.3 Positioning of the PMA and PMD Sublayers within the IEEE 802.3 Architecture

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100.1.4 PMA/PMD Block Diagram



This section might need to be expanded into much more detail than what was shown in 10G-EPON. What we need to show is interaction between PMD and PMA similar to Figure 95-3, but we can also show more details on internal PMD structure, relative to functional blocks etc.

100.2 PMA Functional Specification

100.2.1 PMA Service Interface

100.2.1.1 Delay Constraints

A critical subclause which provides delay constraints for PMD we specify for EPoC. Usually, we provide delay and variability (jitter) in here, expressed in units of TQ.

100.2.1.1.1 Relative Processing Delays	1
Requirements for messaging processing delay through the PMD	2
100.2.1.2 PMA_UNITDATA.request	3
Describes how the data is transferred from PMA (digital interface) into analog front-end	4
100.2.1.3 PMA_UNITDATA.indication	5
Describes how the data is transferred to PMA (digital interface) from analog front-end	6
100.2.1.4 PMA_SIGNAL.request	7
Describes how the PMA controls the transmitter state (on / off). It will be needed for burst mode transmission. We could also control the status of the auto-negotiation process, data rate control etc. To be discussed in more detail later.	8
100.2.1.5 PMA_SIGNAL.indication	9
Describes how the PMA learns about the incoming signal (presence of data). It will be needed for burst mode transmission and continuous mode transmission alike. Here, we will be also able to indicate whether the link is operating, in hunting mode, stable, etc.	10
100.2.2 CLT Transmit OFDM Numerology	11
100.2.2.1 Number of Channels, Channel size and Sampling Frequency	12
The EPoC PHY shall use two OFDM channels for data in the downstream direction. An OFDM downstream channel shall have a bandwidth of 192 MHz with an OFDM sampling frequency of integer multiples of 10.24 MHz.	13
<i>Decision 7: Downstream OFDM sampling frequency - Motion 12, September 2012</i>	14
The EPoC PHY shall support combining multiple 192 MHz OFDM channels for the purpose of increasing capacity.	15
<i>Decision 8: Support for higher capacity - Motion 14, September 2012</i>	16
The EPoC system shall provide a granularity of 1 MHz for setting the center frequency of an OFDM channel.	17
<i>Decision 30: Center Frequency Granularity - Motion 16, March 2013</i>	18
100.2.2.1.1 PLC Channel Size	19
The downstream PLC shall be 400KHz wide.	20
<i>Decision 39: PLC Subcarriers - Motion 26, March 2013</i>	21
100.2.2.2 FFT size(s)	22
An OFDM channel shall be composed of x sub-carriers.	23
100.2.2.3 Available Subcarriers	24
An OFDM channel shall be composed of x sub-carriers.	25

Sub-carriers within an OFDM channel shall have a spacing of either 25MHz or 50 MHz. The sub-carrier spacing shall be consistent within an OFDM channel (within a system? Can you have one channel with 50 MHz spacing and another channel with 25 MHz spacing?)	1 2 3 4
The EPoC PHY shall support the exclusion of one or more sub-carriers.Excluded sub-carriers may be present in any portion of the OFDM channel. An OFDM channel shall have at least 24 MHz of contiguous spectrum between excluded sub-carriers.Contiguous sub-carriers may have contain nulled sub-carriers that do not carry data; these nulled sub-carriers do not make the block of sub-carriers non-contiguous.	5 6 7 8 9
Excluded sub-carriers in the downstream shall be communicated to the CNU from the CLT via the PHY link channel.	10 11 12
The PLC shall be composed of either eight sub-carriers with a spacing of 50 MHz or 16 sub-carriers with a spacing of 25 MHz.	13 14
<i>Decision 5: OFDM Subcarrier Exclusion - Motion 10, September 2012</i>	15
<i>Decision 14: Exclusion subbands placement - Motion 6, January 2013</i>	16
<i>Decision 17: Downstream subcarrier spacings - Motion 11, January 2013</i>	17
<i>Decision 33: Exclusion bands configured by PLC - Motion 19, March 2013</i>	18
<i>Decision 35: Minimum contiguous spectrum - Motion 21, March 2013</i>	19
<i>Decision 39: PLC Subcarriers - Motion 26, March 2013</i>	20
100.2.2.4 Cyclic prefix	21
An OFDM channel shall use a cyclic prefix size of x .	22 23
The PLC shall use the same cyclic prefix used by downstream OFDM channels.	24 25
The CNU shall automatically detect the CP size used by the PLC.	26
<i>Decision 12: PHY Link downstream cyclic prefix auto-detect - Motion 4, January 2013</i>	27
<i>Decision 13: PHY Link downstream cyclic prefix and symbol duration - Motion 5, January 2013</i>	28
100.2.2.5 Pulse Window Shaping (alpha and filter type)	29
<i>Decision 23: Windowing - Motion 9, March 2013</i>	30 31 32
100.2.2.6 Guard Size	33 34 35
100.2.2.7 Cyclic Prefix Prepend	36 37 38 39
Describes the size and structure of the cyclic prefix	40 41 42 43
100.2.3 CNU Transmit OFDMA Numerology	44 45
100.2.3.1 Number of Channels, Channel Size, and Sampling Frequency	46 47
The EPoC PHY shall use a single OFDMA channel for data in the upstream direction.An OFDMA channel shall have a bandwidth of 192 MHz.	48 49 50
<i>Decision 24: Upstream RF bandwidth - Motion 10, March 2013</i>	51 52 53 54

100.2.3.2 Sub-Band width(s)	1
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100.2.3.3 FFT size(s)	5
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100.2.3.4 Subcarrier width	9
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	11
	12
100.2.3.5 Number of Subcarriers	13
	14
	15
	16
100.2.3.6 Subcarrier Group Size	17
	18
	19
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100.2.3.7 Subcarrier Per Transmitter	21
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	24
100.2.3.8 Available Subcarriers	25
	26
Total subcarriers available for payload after all of the overhead is accounted for.	27
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100.2.3.9 Cyclic prefix/Guard Size	29
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100.2.3.10 Pulse Window Shaping (alpha and filter type)	33
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100.3 PMD Functional Specification	37
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100.3.1 PMD Service Interface	39
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100.3.1.1 Delay Constraints	41
	42
A critical subclause which provides delay constraints for PMD we specify for EPoC. Usually, we provide delay and variability (jitter) in here, expressed in units of TQ.	43
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100.3.1.1.1 Relative Processing Delays	46
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Requirements for messaging processing delay through the PMD	48
	49
100.3.1.2 PMD_UNITDATA.request	50
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Describes how the data is transferred from PMD (digital interface) into analog front-end	52
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100.3.1.3 PMD_UNITDATA.indication	1
Describes how the data is transferred to PMD (digital interface) from analog front-end	2
100.3.1.4 PMD_SIGNAL.request	3
Describes how the PMD controls the transmitter state (on / off). It will be needed for burst mode transmission. We could also control the status of the auto-negotiation process, data rate control etc. To be discussed in more detail later.	4
100.3.1.5 PMD_SIGNAL.indication	5
Describes how the PMD learns about the incoming signal (presence of data). It will be needed for burst mode transmission and continuous mode transmission alike. Here, we will be also able to indicate whether the link is operating, in hunting mode, stable, etc.	6
100.3.2 PMD Transmit Function	7
100.3.2.1 Modulation Formats	8
The EPoC PHY shall support the following downstream modulation order for data channels:	9
— 16QAM	10
— 256QAM	11
— 512QAM	12
— 1024QAM	13
— 2048QAM	14
— 4096QAM	15
The EPoC PHY shall support the following upstream modulation orders for data channels:	16
— 16QAM	17
— 256QAM	18
— 512QAM	19
— 1024QAM	20
The PLC shall use a fixed 16QAM modulation order.	21
Details the modulation formats that must be supported for each channel - PLC, Data, and pilots for DS and US (e.g.256QAM, 512QAM, 1024QAM etc.)	22
Where do we talk about MMP?	23
<i>Decision 6: Multiple Modulation Orders - Motion 11, September 2012</i>	24
<i>Decision 11: Downstream PHY link modulation order - Motion 3, January 2013</i>	25
<i>Decision 19: Multiple Modulation Profiles - Motion 4, March 2013</i>	26
100.3.2.1.1 Total Information Data Rate for OFDM Channels	27
In baseline channel conditions, as defined in Annex x, a192 MHz OFDM channel shall target a 1.6 Gbps data rate at MAC/PLS. The MAC/PLS date rate shall scale linearly with the number of OFDM channels, in the same baseline channel conditions in each channel.	28
<i>Decision 40: Downstream MAC/PLS data rate target - Motion 27, March 2013</i>	29
<i>Decision 9: Data scaling with OFDM channels - Motion 6, November 2012</i>	30

100.3.2.1.2 Total Information Data Rate for OFDMA Channels	1
100.3.2.2 Frequency Plan	2
Range of transmitter frequencies	3
100.3.2.2.1 FDD/TDD Downstream Frequency Plan	4
The EPoC PHY shall support an upper band edge of at least 5 GHz. <i>Decision 31: RF Spectrum Upper Bound - Motion 17, March 2013</i>	5
100.3.2.2.2 FDD Upstream Frequency Plan	6
100.3.2.3 Carrier Muting	7
100.3.3 CLT Transmitter Requirements	8
100.3.3.1 CLT Transmit Power Requirements	9
Transmit power requirements for the CLT, including range of reported transmit power per channel, step size of power commands, step size accuracy, and absolute accuracy of CLT.	10
100.3.3.1.1 OFDM Transmit Power Calculations	11
100.3.3.1.2 Transmit Power Step Size	12
100.3.3.1.3 PAPR	13
100.3.3.2 CLT Transmit Fidelity Requirements	14
100.3.3.2.1 Spectral Nulling	15
100.3.3.2.2 Adjacent Channel Spurious Emissions	16
100.3.3.2.3 Spurious Emissions in the Frequency Range	17
100.3.3.2.4 Spurious Emissions During Burst On/Off Transients	18

100.3.3.2.5 Modulation Error Ratio	1
Includes definitions and requirements	2
100.3.3.2.6 Filter Distortion	3
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100.3.3.2.7 Carrier Phase Noise	9
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100.3.3.2.8 Channel Frequency Accuracy	12
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100.3.3.2.9 Modulation Rate Accuracy	17
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100.3.3.2.10 Modulation Timing Jitter	20
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	24
100.3.4 CNU Transmitter Requirements	25
100.3.4.1 CNU Transmitter Pre-Equalizer	26
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100.3.4.2 CNU Transmit Power Requirements	31
	32
Transmit power requirements the CNU, including range of reported transmit power per channel, step size of power commands, step size accuracy, and absolute accuracy of CNU.	33
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100.3.4.2.1 OFDMA Transmit Power Calculations	36
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100.3.4.2.2 Transmit Power Step Size	40
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100.3.4.2.3 Transmit Power Requirements with Multiple Transmitters	44
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100.3.4.2.4 PAPR	48
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100.3.4.3 CNU Transmitter Burst Timing Ramp Up/Down	52
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100.3.4.4 CNU Transmitter Frequency Agility and Range	1
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100.3.4.5 CNU Transmitter Capabilities	5
	6
Describes what CNU capabilities the CNU must report to the FCU and OLT - TDD capable, for example	7
	8
100.3.4.6 CNU Transmitter Fidelity Requirements	9
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100.3.4.6.1 Adjacent Channel Spurious Emissions	13
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100.3.4.6.2 Spurious Emissions in the Upstream Frequency Range	17
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100.3.4.6.3 Spurious Emissions During Burst On/Off Transients	21
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100.3.4.6.4 Modulation Error Ratio	25
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100.3.4.6.5 Carrier Phase Noise	29
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100.3.4.6.6 Channel Frequency Accuracy	33
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100.3.4.6.7 Modulation Rate Accuracy	37
	38
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100.3.4.6.8 Modulation Timing Jitter	41
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	43
	44
100.3.4.6.9 Clock Recovery	45
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100.3.5 PMD Receive Function	49
	50
100.3.5.1 PMD Auto-Negotiation Function	51
	52
This subclause will be brand new and will describe the process of auto-negotiating data rate across EPoC link	53
	54

100.3.6 CNU Receive Requirements	1
100.3.6.1 Input Signal Characteristics at CNU Receiver	2
Describes the characteristics of the input signal at the receiver(e.g, signal level, power spectral density (PSD) etc.),.	3
100.3.6.2 CNU Tuner Frequency Range	4
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100.3.6.3 Frame Error Rate	8
	9
Specifies the downstream frame error ratio. From objectives: better than 10^-6 at the MAC/PLS service interface. Complete details required (channel conditions, frame sizes, etc.).	10
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100.3.6.4 Input Return Loss	13
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100.3.6.5 Input Impedance	15
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100.3.6.6 Image Rejection Performance	17
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For example: Performance MUST be met with an analog or a digital signal at +10 dBc in any portion of the RF band. For adjacent and nonadjacent channels.	19
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100.3.6.7 Multi-Channel Receiver Operation	23
	24
Are there any requirements for multi-channel receiver requirements needed?	25
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100.3.6.8 Reconfiguration of CNU Receiver	27
	28
Specifies requirements for the CNU to dynamically change the receive channel parameters it is currently using. This could be used for modulation profiles, bit loading, etc.	29
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100.3.6.9 PMD Transmit Enable Function	32
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Assuming burst mode transmission is done in upstream only	34
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100.3.6.10 PMD Signal Detect	36
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Table similar to Table 95-4 will need to be specified in here, indicating when and how signal presence is detected and when it is not	38
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100.3.7 CLT Receive Requirements	41
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100.3.7.1 Input Signal Characteristics at CLT Receiver	44
	45
Describes the characteristics of the input signal at the receiver (e.g, signal level, power spectral density (PSD), .	46
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100.3.7.2 Tuner Frequency Range	1
	2
100.3.7.3 Frame Error Rate	3
	4
Specifies the downstream frame error ratio. From objectives: better than 5×10^{-5} at the MAC/PLS service interface. Complete details required (channel conditions, frame sizes, etc.).	5
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	7
100.3.7.4 Input Return Loss	8
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100.3.7.5 Input Impedance	10
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100.3.7.6 Image Rejection Performance	12
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Performance MUST be met with an analog or a digital signal at +10 dBc in any portion of the RF band.	14
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Covers adjacent and non-adjacent channels	16
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100.3.7.7 Multi-Channel Receiver Operation	18
	19
Are there any requirements for multi-channel receiver requirements needed? Not defined yet.	20
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100.3.7.8 PMD Signal Detect	22
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100.4 Definitions of Parameters and Measurement Methods	26
	27
10G-EPON spec contains several subclauses which are not going to be applicable to coaxial plant. The list below accounts for the subclauses most likely to apply to coaxial section, but also other (new) subclauses are possible, as long as TF agrees to their presence.	28
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100.4.1 Insertion Loss?	32
	33
Is this channel model defined	34
	35
100.4.2 Test Patterns	36
	37
	38
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100.4.3 Frequency and Frequency Range Measurement	40
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	42
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100.4.4 RF Power Measurements	44
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100.4.5 Transmit Waveform and MER (Constellation diagram)	48
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100.4.6 Transmit Penalty?	1
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100.4.7 Receive Sensitivity	5
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100.4.8 Stressed Receiver Conformance Test	9
We will need to discuss whether such a test makes sense for RF devices.	10
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100.4.9 Jitter Measurements	13
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100.4.10 Transmitter On/Off Timing Measurements	17
Might be needed if transmitter is indeed switched on/off between bursts.	18
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100.4.11 Receiver Settling Timing Measurement	21
Might be needed for CLT Rx, where bursts from individual CNUs are incoming time interleaved.	22
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100.5 Environmental, Safety, and Labeling	25
10G-EPON spec contains several subclauses which are not going to be applicable to coaxial plant. The list below accounts for the subclauses most likely to apply to coaxial section, but also other (new) subclauses are possible, as long as TF agrees to their presence. The set below is a minimum set which has been used for PMD description in the past. This set is likely to be extended	26
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100.5.1 General Safety	32
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100.5.2 RF Safety	36
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100.5.3 Installation	40
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100.5.4 Environment	44
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100.5.5 PMD Labeling?	48
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100.6 Channel Characteristics	1
The channel is composed of coax, active components (amps,) and passive components (taps, etc). This should refer to the channel model appendix.	2
100.6.1 Coaxial Cabling Model	3
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100.6.2 Coaxial Cable	6
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100.6.3 Coaxial Connectors	10
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100.6.4 Medium Dependent Interface (MDI)	14
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	17
100.7 EEE Capability	18
This subclause might contain summary of the EEE capabilities for this PMD type. Given that it is a new PMD design, the suggestion is to in-build EEE capability from day one, rather than add it in a fashion similar to P802.3az project. This material will all be new in 802.3bn	19
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100.8 TimeSync Capability	25
This subclause might contain summary of the TimeSync capabilities for this PMD type. Given that it is a new PMD design, we can embed TimeSync capability from day one. This involves primarily guaranteeing repeatable and stable delay as well as support for specific capability registers. See Clause 90 for more details.	26
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100.9 Protocol implementation conformance statement (PICS) proforma for Clause 100, Physical Medium Dependent (PMD) sublayer and medium for coaxial distribution networks, type EPoc_PMD_Name	36
To be filled in once the main spec is ready (Clause 100 work is largely technically complete)	37
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