

# Ziggo DOCSIS interface specifications

Version 1.0 Final (20-1-2022)



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# 1. Conventions

Throughout this document, the words that are used to define the significance of particular requirements are capitalized. These words are:

"MUST, SHALL" This word means that the item is an absolute requirement of this specification.

"MUST NOT" This phrase means that the item is an absolute prohibition of this specification.

"SHOULD" This word means that there MAY exist valid reasons in particular circumstances to ignore this item, but the full implications SHOULD be understood and the case carefully weighed before choosing a different course.

"SHOULD NOT" This phrase means that there MAY exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications SHOULD be understood and the case carefully weighed before implementing any behavior described with this label.

"MAY" This word means that this item is truly optional.

## 2. Contact

Queries regarding this specification can be addressed to:

[CPE\\_supplier@vodafoneziggo.com](mailto:CPE_supplier@vodafoneziggo.com)

Please note that this is an address for hardware vendors only. Information for individual customers regarding the use of own devices on the Ziggo network is available here:

<https://www.ziggo.nl/klantenservice/apparaten/wifi-modems/eigen-modem>

### 3. Scope

This document describes the DOCSIS protocol requirements for the Internet Service over the Ziggo cable network at the dedicated data RF Interface and the main characteristics of the dedicated data RF interface in the Ziggo cable network at the user's coaxial passive network termination point as well as the Ethernet based passive network termination point. This document describes the typical limits or values within which the RF characteristics can be expected to remain for networks that are built according to Ziggo specifications at installation time.

The interface specification does not apply under abnormal operating conditions such as:

- operating conditions arising as a result of operating services other than DOCSIS 3.x over the dedicated data RF interface.
- operating conditions arising as a result of a fault, maintenance and construction work or to minimize the extend of interruption of service.
- operating conditions arising as a result of force majeure or third-party interference.
- operating conditions arising as a result of test signal injection governed by regulation.
- In case of non-compliance of a network user's installation or non-compliance of equipment with the relevant standards or non-compliance with the technical requirements for connection, established either by this interface specification or the public authorities including the relevant limits for electromagnetic compatibility.

The characteristics given in this interface specification are intended to be used to derive and specify requirements for equipment such as coaxial cables and cable modems to connect them to the dedicated data RF interface or Ethernet interface. The values in this interface specification take precedence over requirements in equipment product standards and installation standards. The given characteristics are not intended to be used as electromagnetic compatibility levels or user emission limits in the Ziggo network.

This interface specification may be changed at any time and may break backward compatibility with previous versions. Manufacturers are therefore asked to provide regular software updates. The user of this interface specification has to check for the newest version available from Ziggo. This interface specification may be superseded in total or in part by the terms of a contract between the individual network user and Ziggo.

## 4. References

In the case of a conflict between specific requirements in this document with requirements in any of the directly or indirectly referenced documents, the specific requirements of this document are applicable.

### 4.1. Normative References

ANSI/TIA/EIA 568-B Commercial Buildings Telecommunications Cabling Standard

CFR Pt. 68 FCC CFR Pt. 68; 1999

CL-SP-CANN-DHCP CableLabs' DHCP Options Registry (newest version)

ETSI EN 302 878-1 Access, Terminals, Transmission and Multiplexing (ATTM); Third Generation Transmission Systems for Interactive Cable Television Services – IP Cable Modems; Part 1: General; DOCSIS 3.0

IEC 60068-1:2014 Environmental testing – Part 1: General and guidance

IEC 61000-4-5:2014 Electromagnetic compatibility (EMC) Part 4-5: Testing and measurement techniques - Surge immunity test

IEC 61196-2 Radio-frequency cables - Specifications - Part 2: Semi-rigid radio-frequency and coaxial cables with polytetrafluoroethylene (PTFE) insulation - Sectional specification

IEEE 802.3 802.3-2015 - IEEE Standard for Ethernet, ISBN 978-1-5044-0078-7

NEN 1010:2020 Electrical installations for low-voltage – Dutch implementation of the HD-IEC 60364 series

NEN-EN 50083-2:2012 Cable networks for television signals, sound signals and interactive services - Part 2: Electromagnetic compatibility for equipment

NEN-EN 50083-2:A1:2015 Amendment A1

NEN-EN 50117-2-1:2005 Coaxial cables - Part 2-1: Sectional specification for cables used in cabled distribution networks - Indoor drop cables for systems operating at 5 MHz - 1000 MHz

NEN-EN 50117-2-4:2004 Coaxial cables - Part 2-4: Sectional specification for cables used in cabled distribution networks - Indoor drop cables for systems operating at 5 MHz - 3000 MHz

NEN-EN 50117-2-4:A1:2008 Amendment A1

NEN-EN 50117-2-4:A2:2013 Amendment A2

NEN-EN 50289-1-6:2002 Communication cables - Specifications for test methods Part 1-6: Electrical test methods - Electromagnetic performance

NEN-EN-IEC 60728-3:2011 Cable networks for television signals, sound signals and interactive services - Part 3: Active wideband equipment for cable networks

NEN-EN-IEC 60728-4: 2008 Cable networks for television signals, sound signals and interactive services - Part 4: Passive wideband equipment for coaxial cable networks

NEN-EN-IEC 60728-11:2017 Cable networks for television signals, sound signals and interactive services - Part 11: Safety

NEN-EN-IEC 61169-1:2013 Radio-frequency connectors - Part 1: Generic specification - General requirements and measuring methods

NEN-EN-IEC 61169-2:2007 Radio-frequency connectors - Part 2: Sectional specification - Radio frequency coaxial connectors of type 9,52

NEN-EN-IEC 61169-24:2010 Radio-frequency connectors - Part 24: Sectional specification - Radio frequency coaxial connectors with screw coupling, typically for use in 75  $\Omega$  cable networks (type F)

NEN-EN-IEC 62153-4-3:2013 Metallic communication cable and components test methods: Electromagnetic compatibility (EMC) Test method for: Screening attenuation, transfer impedance with Triaxial method.

NEN-EN-IEC 62153-4-4: 2015 Metallic communication cable and components test methods: Electromagnetic compatibility (EMC) Test method for: Screening attenuation, transfer impedance with Triaxial method.

NEN-EN-IEC 62153-4-7: 2016 Metallic communication cable and components test methods: Electromagnetic compatibility (EMC) Test method for: Screening attenuation, transfer impedance with Triaxial method.

NEN-IEC 60728-2:2010 Cable networks for television signals, sound signals and interactive services - Part 2: Electromagnetic compatibility for equipment



NEN ISO 8601-1:2019 Date and time – Representations for information interchange – Part 1: Basic rules

RFC3663 IPv6 Prefix Options for Dynamic Host Configuration Protocol (DHCP) version 6

RFC6333 Dual-Stack Lite Broadband Deployments Following IPv4 Exhaustion

RFC6334 Dynamic Host Configuration Protocol for IPv6 (DHCPv6) Option for Dual-Stack Lite

## 4.2. Informative References

BSI Testkonzept für Breitband-Router, (DSL-, Kabel-, SOHO-, CE-, CPE-Router, IADs); May/2016

NEN NTA 5175:2016 Technische richtlijnen voor Centrale antenne-inrichtingen (CAI)

## 4.3. Reference Acquisition

BSI Router Testkonzept: <https://www.bsi.bund.de/SharedDocs/Downloads/DE/BSI/Cyber-Sicherheit/Themen/Testkonzept-Breitbandrouter.pdf>

CableLabs specifications: <http://www.cablelabs.com>

FCC: <https://www.fcc.gov>

IEEE: <http://www.ieee.org>

IETF RFCs: <http://www.ietf.org>

ITU recommendations: <http://www.itu.int>

NEN: <https://www.nen.nl>

Telecommunications Industry Association: <https://www.tiaonline.org/>

## 5. Definitions and abbreviations

### 5.1. Definitions

**Cable Modem (CM):** modulator-demodulator at subscriber locations intended for use in conveying data Communications on a cable television system

**Cable Modem Termination System (CMTS):** cable modem termination system, located at the cable television system headend or distribution hub, which provides complementary functionality to the cable modem to enable data connectivity to a wide-area network

**Cable Network:** coaxial-based broadband access network in the form of either an all-coax or Hybrid Fibre/Coax (HFC) network

**Carrier Hum Modulation:** peak-to-peak magnitude of the amplitude distortion relative to the RF carrier signal level due to the fundamental and low-order harmonics of the power-supply frequency

**Composite Second Order beat (CSO):** peak of the average level of distortion products due to secondorder non-linearity's in cable system equipment

**Composite Triple Beat (CTB):** peak of the average level of distortion components due to third-order non-linearity's in cable system equipment

**customer:** human being or organization that accesses the network in order to communicate via the services provided by the network

**downstream:** in cable television, the direction of transmission from the headend to the subscriber

**dynamic range:** ratio between the greatest signal power that can be transmitted over a multichannel analogue transmission system without exceeding distortion or other performance limits, and the least signal power that can be utilized without exceeding noise, error rate or other performance limits

**group delay:** difference in transmission time between the highest and lowest of several frequencies through a device, circuit or system

**hum modulation:** undesired modulation of the television visual carrier by the fundamental or low-order harmonics of the power supply frequency, or other low-frequency disturbances

**Hybrid Fibre/Coax (HFC) system:** broadband bidirectional shared-media transmission system using fibre trunks between the headend and the fibre nodes, and coaxial distribution from the fibre nodes to the customer locations

**impulse noise:** noise characterized by non-overlapping transient disturbances

**layer:** subdivision of the Open System Interconnection (OSI) architecture, constituted by subsystems of the same rank

**micro-reflections:** echoes in the forward transmission path due to departures from ideal amplitude and phase characteristics

**mid split:** frequency division scheme that allows bi-directional traffic on a single coaxial cable

**Orthogonal Frequency Division Multiplexing:** method of efficiently encoding digital data on multiple carrier frequencies.

**passive network termination point (AOP):** customer terminal with minimum optical/electrical spacing to the CMTS

**PHYSical (PHY) layer:** layer 1 in the Open System Interconnection (OSI) architecture; the layer that provides services to transmit bits or groups of bits over a transmission link between open systems and which entails electrical, mechanical and handshaking procedures

**Quadrature Amplitude Modulation (QAM):** method of modulating digital signals onto a radiofrequency carrier signal involving both amplitude and phase coding

**Radio Frequency (RF):** in cable television systems, this refers to electromagnetic signals in the range 5 MHz to 1.794 GHz

**return loss (RL):** parameter describing the attenuation of a guided wave signal (e.g. via a coaxial cable) returned to a source by a device or medium resulting from reflections of the signal generated by the source

**terminal:** equipment connected to a telecommunication network to provide access to one or more specific services

Very High Frequency (VHF):

**Ziggo:** Ziggo B.V and/or Ziggo Services B.V.

## 5.2. Abbreviations

**AD:** Frequency dependent Amplitude Distortion (Peak to Peak)

AFTR Address Family Transition Router  
AOP Abonnee Overname Punt (Coax Network Termination Point in Dutch)  
ASCII American Standard Code for Information Interchange  
BER Bit Error Rate  
BPI+ Baseline Privacy Plus  
BSI Bundesamt für Sicherheit in der Informationstechnik  
C/(N+IM) Carrier (C) to Noise (N) and Intermodulation (IM) ratio  
CableLabs Cable Television Laboratories, Inc.  
CM Cable Modem  
CMCI Cable Modem to CPE Interface  
DHCP Dynamic Host Configuration Protocol  
DOCSIS Data Over Cable Service Interface Specification  
DS Downstream  
DS-Lite Dual-Stack Lite  
ERMI European Retail Market Information  
eRouter embedded Router  
FCC Federal Communications Commission  
FQDN Fully Qualified Domain Name  
IEEE Institute of Electrical and Electronics Engineers  
IETF Internet Engineering Task Force

IP Internet Protocol  
ITU International Telecommunication Union  
OSI Open Systems Interconnection  
MAC Media Access Control  
MER Modulation Error Rate  
MICE Mechanical, Ingress, Climatic and Chemical, Electromagnetic  
OFDM Orthogonal Frequency-Division Multiplexing  
PD Frequency dependent Phase Distortion (Peak to Peak)  
QAM Quadrature Amplitude Modulation  
RCP Receive Channel Profile  
RF Radio Frequency  
SC Single Carrier  
SI Système international d'unités  
SNMP Simple Network Management Protocol  
SNR Signal to Noise Ratio  
UGS Unsolicited Grant Synchronization  
US Upstream  
VAC Volt Alternating Current  
VDC Volt Direct Current

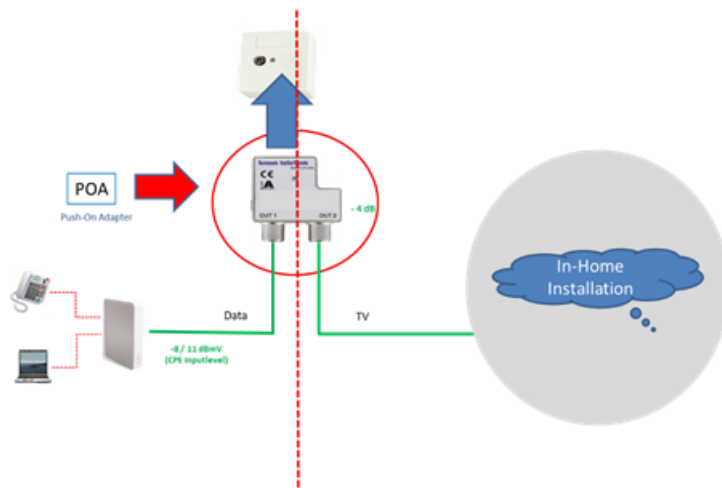


## 6. Interface connectors

### 6.1. General

The AOP mechanical interface consists of either an IEC 61169-2 push-on connector or an IEC 61169-24 F-connector. A splitter will be mounted onto this to split the signal for television and data. Finally, Ziggo supplies cables to connect the splitter to the modem with a clamp-type connector as customers cannot be expected to tighten a screw-type F-connector accurately to the specified torque. The modem must have an F-connector conforming to requirements listed below.

Example of a typical Ziggo installation



## 6.2. Environmental profile and safety

The technical requirements of the present document apply under the environmental profiles in ETSI ETS 300 019-1-3 assuming accordance with NEN NTA 5175:2016. If not stated otherwise Class 3.1 typically applies for AOP inside customer homes. Equipotential bonding of the AOP according to NEN1010:2020 cannot be assumed for all installations. Therefore, overvoltage protection cannot be assumed.

## 6.3. Mechanical interface description

This clause describes and defines the mechanical coaxial connector as assumed present on a modem device connected to the Ziggo network.

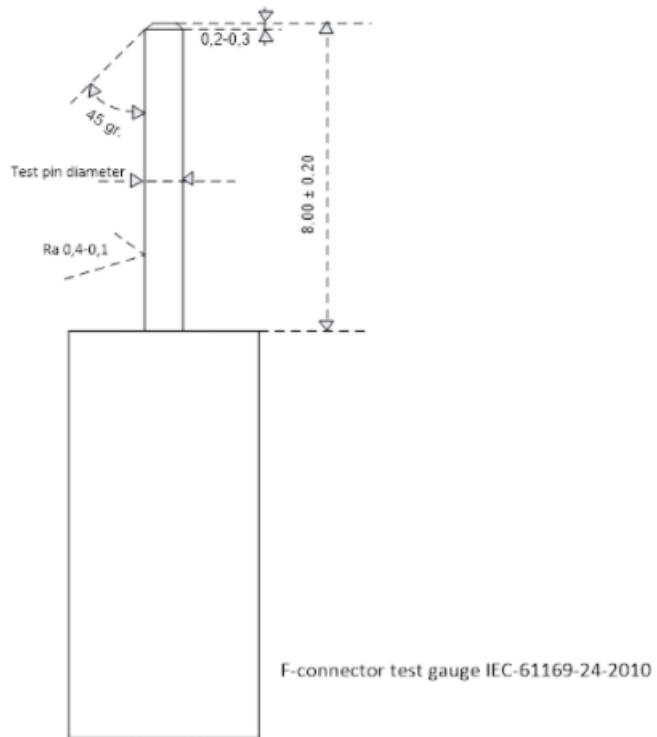
Item	Description	Remark	Specification	Measurement Protocol	
3.1.1.1	Impedance	5 - 2000 MHz	75 $\Omega$	Vendor statement	
3.1.1.2	Connector in		(C9, C12) / F	Appendix B	
3.1.1.4	Insertion loss after power surge <sup>[1]</sup>	5 - 1006 MHz	$\leq 0,5$ dB	IEC 60728-4 §4.3	
		1006 - 1218 MHz	$\leq 1,0$ dB		
		1218 - 2000 MHz	$\leq 1,2$ dB		
3.1.1.5	Return loss after power surge	5 - 12 MHz	$\geq 13$ dB	IEC 60728-4 §4.6	
		12 - 40 MHz	$\geq 20$ dB		
		40 - 2000 MHz	$\geq 20$ dB - 1.5 dB/oct.		
3.1.1.8	Screening effectiveness:	Transfer impedance Triaxial Tube in Tube Method	5 - 15 MHz	$\leq 5$ m $\Omega$	IEC 62153-4-7
			15 - 30 MHz	$\leq 2,5$ m $\Omega$	
			30 - 300 MHz	$\geq 95$ dB	
			300 - 470 MHz 470 - 950 MHz	$\geq 90$ dB $\geq 85$ dB $\geq 70$ dB	



		950 - 2000 MHz		
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### 6.3.1. Description of F-connectors

This type of connectors has screw locking with a 3/8-32UNEF-2"B" thread. Normally, the plug will be a free connector, the socket a fixed connector. The design of the male connector is such that the inner conductor of the cable serves as the male contact. The physical characteristics of the F-connector must be accordance the dimensions as stated in IEC 61169-24 2010.



The female contact of the F-connector shall at least be able to accept male contacts/test gauges with a diameter range between 0,70-1,2 mm.

### 6.3.2. Clamp force/withdrawal test

To verify that the center female contact of the socket does not suffer from deformation, when mated with the range of inner conductors specified, a test has been prescribed which measures the force, required to withdraw the selection of precision test gauges, out of the female connector under test.

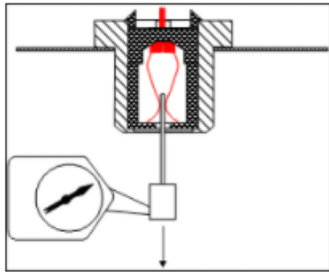


Figure 4: Example of Clamp force test set up

General Products					
Test sequence	1	2	3	4	5
Test gauge diameter (mm)	0,70	1,20	0,70	1,20	0,70
Clamping force min. (grams)	115		115		115
Clamping force tests must be performed at room temperature					
Test gauge tolerance: +/- 0.01 mm					

### 6.3.3. Insertion force test

To verify that the range of center male contacts of the connector does not suffer from deformation when mated with the inner socket conductor, a test has been prescribed which measures the force, required to insert the selection of precision test gauges, into the female connector under test.

Depending on the test gauge diameter a sliding scale of the insertion force is presented in the table below:

	General Products			
Test sequence	1	2	3	4
Test gauge diameter (mm)	0,70	0,80	1,136	1,20
Insertion force (grams)	≤ 800	≤ 1500	≤ 2000	≤ 3000
	Test must be performed at room temperature			
	Test gauge tolerance: +/- 0,01 mm			

The insertion force applied at the applicable test gauge diameter, as mentioned in this table, shall not exceed mentioned insertion force values.

### 6.3.4. Mechanical strength/withstand tightening torque

The F-ports shall be able to withstand the minimum specified tightening torque of 5 Nm without damage.

## 6.4. Electrical performance characteristics

For electrical performance characteristics please refer to NEN-IEC 60728-2 Cable networks for television signals, sound signals and interactive services - Part 2: Electromagnetic compatibility for equipment



## 7. DOCSIS 3.x network RF characteristics

### 7.1. Downstream frequency range

The DOCSIS downstream frequency range according to CM-SP-PHYv3.1-I18-210125, B.6.3.2 shall be 112 to 1200MHz MHz (centre frequency, 112 to 1794 MHz optional).

### 7.2. Downstream RF performance

Metric	At CPE
SNR	$\geq 35\text{dB}$
Rx	$-8 < \text{Rx} < 11\text{dBmV}$
CER	0%

### 7.3. Upstream frequency range

Upstream upper band edges other than those specified in CM-SP-PHYv3.1-I18-210125 are not supported at the AOP and MAY NOT be used. The usable Frequency Range is 15 MHz to 204 MHz. Nominal minimum SC US channel count is 4.

The modem MUST support a frequency switchable split (upstream/downstream) at 85MHz and 204 MHz (diplexer).1218 MHz

### 7.4. Upstream RF performance

Reference channel bandwidth is 6.4MHz. Nominal values are valid for 99.5 % of the time.

Metric	At CPE
SNR 16QAM	$\geq 28\text{dB}$
SNR 64QAM	$\geq 31\text{dB}$
Tx	$36 < T_x < 51\text{dBmV}$
Rx	$-1 < R_x < 0\text{dBmV}$
CER	0%

## 8. DOCSIS 3.x physical interface requirements

The following table describes the DOCSIS physical interface requirements at the AOP based on and in line with CM-SP-PHYv3.1-I18-210125.

Index		Description	relevant for IF Spec	informative	mandatory	optional
<b>1</b>		<b>SCOPE</b>				
	1.1	Introduction and Purpose	x	x		
	1.2	Background	x	x		
	1.2.1	Broadband Access Network	x	x		
	1.2.2	Network and System Architecture	x	x		
	1.2.3	Service Goals	x	x		
	1.2.4	Statement of Compatibility	x	x		
	1.2.5	Reference Architecture	x	x		
	1.2.6	DOCSIS 3.1 Documents	x	x		
	1.3	Requirements	x		x	
	1.4	Conventions	x		x	
	1.5	Organization of Document	x	x		
<b>2</b>		<b>REFERENCES</b>				
	2.1	Normative References	x	x		
	2.2	Informative References	x	x		
	2.3	Reference Acquisition	x	x		
<b>3</b>		<b>TERMS AND DEFINITIONS</b>	<b>x</b>		<b>x</b>	
<b>4</b>		<b>ABBREVIATIONS AND ACRONYMS</b>	<b>x</b>		<b>x</b>	
<b>5</b>		<b>OVERVIEW AND FUNCTIONAL ASSUMPTIONS</b>	<b>x</b>	<b>x</b>		
	5.1	Overview		x		
	5.2	Functional Assumptions		x		
	5.2.1	Equipment Assumptions		x		
	5.2.2	RF Channel Assumptions		x		

		5.2.3	Transmission Levels		x		
		5.2.4	Frequency Inversion		x		
<b>6</b>			<b>PHY SUBLAYER FOR SC-QAM</b>				
	6.1		Scope	x		x	
	6.2		Upstream Transmit and Receive	x		x	
	6.2.1		Overview	x		x	

<b>Index</b>			<b>Description</b>	<b>relevant for IF Spec</b>	<b>informative</b>	<b>mandatory</b>	<b>optional</b>
		6.2.2	Signal Processing Requirements	x		x	
		6.2.3	Modulation Formats	x		x	
		6.2.4	R-S Encode	x		x	
		6.2.5	Upstream R-S Frame Structure (Multiple Transmit Channel Mode Enabled)	x		x	
		6.2.6	Upstream R-S Frame Structure (Multiple Transmit Channel Mode Disabled)	x		x	
		6.2.7	TDMA Byte Interleaver	x		x	
		6.2.8	Scrambler (randomizer)	x		x	
		6.2.9	TCM Encoder		x		
		6.2.10	Preamble Prepend	x		x	
		6.2.11	Modulation Rates	x		x	
		6.2.12	S-CDMA Framer and Interleaver		x		
		6.2.13	S-CDMA Framer		x		
		6.2.14	Symbol Mapping	x		x	
		6.2.15	S-CDMA Spreader		x		
		6.2.16	Transmit Pre-Equalizer	x		x	
		6.2.17	Spectral Shaping	x		x	
		6.2.18	Relative Processing Delays		x		
		6.2.19	Transmit Power Requirements	x		x	
		6.2.20	Burst Profiles	x		x	
		6.2.21	Burst Timing Convention	x		x	



		6.2.22	Fidelity Requirements	x		x	
		6.2.23	Upstream Demodulator Input Power Characteristics	x	x		
		6.2.24	Upstream Electrical Output from the CM	x		x	
		6.2.25	Upstream CM Transmitter Capabilities	x		x	
	6.3		Downstream Transmit		x		
		6.3.1	Downstream Protocol		x		
		6.3.2	Spectrum Format		x		
		6.3.3	Scalable Interleaving to Support Video and High-Speed Data Services		x		
		6.3.4	Downstream Frequency Plan		x		
		6.3.5	DRFI Output Electrical		x		
		6.3.6	CMTS or EQAM Clock Generation		x		
		6.3.7	Downstream Symbol Clock Jitter for Synchronous Operation		x		
		6.3.8	Downstream Symbol Clock Drift for Synchronous Operation		x		
		6.3.9	Timestamp Jitter		x		
	6.4		Downstream Receive	x		x	
		6.4.1	Downstream Protocol and Interleaving Support	x		x	
		6.4.2	Downstream Electrical Input to the CM	x		x	
		6.4.3	CM BER Performance	x		x	
		6.4.4	Downstream Multiple Receiver Capabilities	x		x	

Index			Description	relevant for IF Spec	informative	mandatory	optional
		6.4.5	Non-Synchronous DS Channel Support	x		x	
<b>7</b>			<b>PHY SUBLAYER FOR OFDM</b>				
	7.1		Scope	x		x	
	7.2		Upstream and Downstream Frequency Plan	x		x	
		7.2.1	Downstream CM Spectrum	x		x	
		7.2.2	Downstream CMTS Spectrum	x	x		
		7.2.3	Upstream CM Spectrum	x		x	

		7.2.4	Upstream CMTS Spectrum	x	x		
		7.2.5	Channel Band Rules	x	x		
	7.3		OFDM Numerology	x		x	
		7.3.1	Downstream OFDM Numerology	x		x	
		7.3.2	Upstream OFDMA Numerology	x		x	
		7.3.3	Subcarrier Clocking	x		x	
	7.4		Upstream Transmit and Receive	x		x	
		7.4.1	Signal Processing Requirements	x		x	
		7.4.2	Time and Frequency Synchronization	x		x	
		7.4.3	Forward Error Correction	x		x	
		7.4.4	Data Randomization	x		x	
		7.4.5	Time and Frequency Interleaving and De-interleaving	x		x	
		7.4.6	Mapping of Bits to Cell Words	x		x	
		7.4.7	Mapping and De-mapping Bits to/from QAM Subcarriers	x		x	
		7.4.8	REQ Messages	x		x	
		7.4.9	IDFT	x		x	
		7.4.10	Cyclic Prefix and Windowing	x		x	
		7.4.11	Burst Timing Convention	x		x	
		7.4.12	Fidelity Requirements	x		x	
		7.4.13	Cable Modem Transmitter Output Requirements	x		X	
		7.4.14	CMTS Receiver Capabilities	x	x		
		7.4.15	Ranging	x		x	
		7.4.16	Upstream Pilot Structure	x		x	
		7.4.17	Upstream Pre-Equalization	x		x	
	7.5		Downstream Transmit and Receive	x		x	
		7.5.1	Overview	x		x	
		7.5.2	Signal Processing	x		x	
		7.5.3	Time and Frequency Synchronization	x		x	

		7.5.4	Downstream Forward Error Correction	x		x	
		7.5.5	Mapping Bits to QAM Constellations	x		x	
		7.5.6	Interleaving and De-interleaving	x		x	
		7.5.7	IDFT	x		x	

Index			Description	relevant for IF Spec	informative	mandatory	optional
		7.5.8	Cyclic Prefix and Windowing	x		x	
		7.5.9	Fidelity Requirements	x	x		
		7.5.10	Independence of Individual Channels Within Multiple Channels on a Single RF Port	x	x		
		7.5.11	Cable Modem Receiver Input Requirements	x		x	
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VIII.4		Engineering Changes for CM-SP-PHYv3.1-I05-150326	x	x		
VIII.5		Engineering Changes for CM-SP-PHYv3.1-I06-150611	x	x		
VIII.6		Engineering Changes for CM-SP-PHYv3.1-I07-150910	x	x		
VIII.7		Engineering Change for CM-SP-PHYv3.1-I08-151210	x	x		
VIII.8		Engineering Changes for CM-SP-PHYv3.1-I09-160602	x	x		
VIII.9		Engineering Changes for CM-SP-PHYv3.1-I10-170111	x	x		
VIII.10		Engineering Changes for CM-SP-PHYv3.1-I11-170512	x	x		

## 9. DOCSIS 3.x upper layer requirements

### 9.1. MAC and upper layer

Where the NVT-ASCII character set is referenced in the CableLabs' DHCP Options Registry, ASCII graphics characters (hexadecimal 20 through 7E) MUST be used. For DOCSIS 3.1, RMVI Sub-Options MUST be present.

The following minimum requirements are applicable

- At least 8 upstream service flows MUST be supported, 4 of which can be UGS-only.

Otherwise, the following table describes the DOCSIS MULPI interface requirements at the AOP based on and in line with [11].

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	1.2.2	DOCSIS Network and System Architecture	x	x		
	1.2.3	Service Goals	x	x		
	1.2.4	Statement of Compatibility	x	x		
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	1.4	Conventions	x		x	
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	2.2		Informative References	x	x		
	2.3		Reference Acquisition	x	x		
<b>3</b>			<b>TERMS AND DEFINITIONS</b>	<b>x</b>		<b>x</b>	
<b>4</b>			<b>ABBREVIATIONS AND ACRONYMS</b>	<b>x</b>		<b>x</b>	
<b>5</b>			<b>OVERVIEW AND THEORY OF OPERATIONS</b>				
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	5.2		Technical Overview	x	x		
		5.2.1	CMTS and CM Models	x	x		
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		5.2.4	QoS	x		x	
		5.2.5	Multicast Operation	x		x	
		5.2.6	Network and Higher Layer Protocols	x		x	
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<b>Index</b>			<b>Description</b>	<b>relevant for IF Spec</b>	<b>informative</b>	<b>mandatory</b>	<b>optional</b>
<b>1</b>			<b>SCOPE</b>				
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		1.2.1	Broadband Access Network	x	x		
		1.2.2	DOCSIS Network and System Architecture	x	x		
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		1.2.4	Statement of Compatibility	x	x		
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		6.1.3	Future Use	x	x		
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		6.2.2	Packet-Based MAC Frames	x		x	
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	6.3		Segment Header Format	x		x	
	6.4		MAC Management Messages	x		x	
		6.4.1	MAC Management Message Header	x		x	
		6.4.2	Time Synchronization (SYNC)	x		x	
		6.4.3	Upstream Channel Descriptor (UCD)	x		x	
		6.4.4	Upstream Bandwidth Allocation Map (MAP)	x		x	
		6.4.5	Ranging Request Messages	x		x	
		6.4.6	Ranging Response (RNG-RSP)	x		x	
		6.4.7	Registration Request Messages	x		x	
		6.4.8	Registration Response Messages	x		x	
		6.4.9	Registration Acknowledge (REG-ACK)	x		x	
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		6.4.11	Upstream Channel Change Response (UCC-RSP)	x		x	
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		6.4.14	Dynamic Service Addition - Acknowledge (DSA-ACK)	x		x	
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<b>Index</b>			<b>Description</b>	<b>relevant for IF Spec</b>	<b>informative</b>	<b>mandatory</b>	<b>optional</b>
<b>1</b>			<b>SCOPE</b>				
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Index		Description	relevant for IF Spec	informative	mandatory	optional
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	1.2.2	DOCSIS Network and System Architecture	x	x		
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		6.5.2	Timestamp Message Block	x		x	
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		6.5.4	Message Channel Message Block	x		x	
		6.5.5	Trigger Message Block	x		x	
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		7.1.5	Extended Timestamp	x		x	
		7.1.6	Timestamp Rules for Systems with both Primary Capable OFDM Channels and Primary Capable SC-QAM Channels	x		x	
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		7.5.3	Service Classes	x		x	
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		1.2.1	Broadband Access Network	x	x		
		1.2.2	DOCSIS Network and System Architecture	x	x		
		1.2.3	Service Goals	x	x		
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		1.2.2	DOCSIS Network and System Architecture	x	x		
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## 9.2. Security layer

- Compliance with CM-SP-SECv3.1-I09-200407 with the exception of the requirements defined in EuroDOCSIS BPI+ requirements MUST be accomplished.
- Certificate requirements are defined in EuroDOCSIS BPI+; requirements specified in this document take precedence over requirements in CM-SP-SECv3.1-I09-200407.

The following table describes the DOCSIS SEC interface requirements at the AOP based on and in line with CM-SP-SECv3.1-I09-200407.

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		1.2.4	Statement of Compatibility	x	x		
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<b>3</b>			<b>TERMS AND DEFINITIONS</b>	<b>x</b>		<b>x</b>	
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Index			Description	relevant for IF Spec	informative	mandatory	optional
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		7.1.2	Encrypted Multicast	x		x	
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		8.4.6	Interoperability Issues	x		x	
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		9.3.1	Securing DHCP on the Cable Network Link	x		x	
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<b>Index</b>			<b>Description</b>	<b>relevant for IF Spec</b>	<b>informative</b>	<b>mandatory</b>	<b>optional</b>
<b>1</b>			<b>SCOPE</b>	<b>x</b>	<b>x</b>		
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### 9.3. OSS layer

Compliance with CM-SP-CM-OSSlv3.1-I19-210419 MUST be accomplished.

The following table describes the DOCSIS OSSI interface requirements at the AOP based on and in line with CM-SP-OSSlv3.1-I12-180509.

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<b>Index</b>			<b>Description</b>	<b>relevant for IF Spec</b>	<b>informative</b>	<b>mandatory</b>	<b>optional</b>
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	1.2		Background	x	x		
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		1.2.2	Network and System Architecture	x	x		
		1.2.3	Service Goals	x	x		
		1.2.4	Statement of Compatibility	x	x		
		1.2.5	Reference Architecture	x	x		
		1.2.6	DOCSIS 3.1 Documents	x	x		
	1.3		Requirements	x	x		

	1.4		Conventions	x	x		
	1.5		Organization of Document	x	x		
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	1.2		Background	x	x		
		1.2.1	Broadband Access Network	x	x		
		1.2.2	Network and System Architecture	x	x		
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	1.4		Conventions	x	x		
	1.5		Organization of Document	x	x		
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		1.2.1	Broadband Access Network	x	x		
		1.2.2	Network and System Architecture	x	x		
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		1.2.4	Statement of Compatibility	x	x		
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		1.2.1	Broadband Access Network	x	x		
		1.2.2	Network and System Architecture	x	x		
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	1.4		Conventions	x	x		
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Index		Description	relevant for IF Spec	informative	mandatory	optional
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	1.2	Background	x	x		
	1.2.1	Broadband Access Network	x	x		
	1.2.2	Network and System Architecture	x	x		
	1.2.3	Service Goals	x	x		
	1.2.4	Statement of Compatibility	x	x		
	1.2.5	Reference Architecture	x	x		
	1.2.6	DOCSIS 3.1 Documents	x	x		
	1.3	Requirements	x	x		
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<b>Index</b>			<b>Description</b>	<b>relevant for IF Spec</b>	<b>informative</b>	<b>mandatory</b>	<b>optional</b>
<b>1</b>			<b>SCOPE</b>				
	1.1		Introduction and Purpose	x	x		
	1.2		Background	x	x		
		1.2.1	Broadband Access Network	x	x		
		1.2.2	Network and System Architecture	x	x		
		1.2.3	Service Goals	x	x		
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		1.2.6	DOCSIS 3.1 Documents	x	x		
	1.3		Requirements	x	x		
	1.4		Conventions	x	x		
	1.5		Organization of Document	x	x		
		1.5.1	Annexes (Normative)	x	x		
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	II.5		Common Terms Shortened		x		
		II.5.1	Exceptions		x		
<b>APPENDIX III</b>			<b>ACKNOWLEDGEMENTS (INFORMATIVE)</b>				
<b>APPENDIX IV</b>			<b>REVISION HISTORY</b>				

#### 9.4. Registration and provisioning

- During registration cable modems will receive a generic configuration file with maximum sustained traffic rates for raw internet access in bit/s (gross IP service data rate) considering SI decimal prefixes. All network provided channels MUST be supported to achieve the maximum configurable traffic rate per network segment.
- Vendor and model fields of the system descriptor (sysDescr) MUST NOT change during the lifetime of the product.

## 10. IP-addresses for devices behind the cable modem (informative)

IP-capable devices/interfaces behind the cable modem can be assigned with IP configuration in one of the three possible scenarios:

1. IPv4-only configuration – each allowed device/interface will receive a native IPv4 address and other corresponding configuration to use for inbound/outbound IPv4-based traffic
2. Dual-Stack – each allowed device/interface will receive a native IPv4 address and a global IPv6 address as well as a delegated prefix in the range of /56 to /64 to use for inbound/outbound IPv4- and IPv6-based traffic respectively
3. Dual-Stack Lite – each allowed device/interface will receive a global IPv6 address as well as a delegated prefix in the range of /56 to /64 to use for inbound/outbound IPv6-based traffic. Also, DS-Lite configuration will be assigned to the device/interface for IPv4-based traffic.

### 10.1. DHCPv4

The following information MUST be requested by the DHCP client and will then be provided by DHCP server:

- IP-address
- Subnet mask
- Gateway address (router option)
- DNS-server

### 10.2. DHCPv6

The following information MUST be requested by the DHCP client and thus will be provided by DHCPv6

- IPv6-address
- DNS-server
- DS-Lite option (if requested see 10.3 below)

- Delegated prefix

To avoid a configuration conflict, the configuration of the router device WAN behind/in the cable modem MUST be done via respective DHCP and other procedures such as static configuration MUST NOT be used.

### 10.3. DS-Lite

Dual-Stack Lite is implemented according to RFC6333. The FQDN of the AFTR device is provided to the client-router according to RFC6334. DS-Lite MUST NOT be activated if an IPv4 public lease is obtained.

### 10.4. Prefix delegation

IPv6 Prefix delegation according to RFC3633 MUST be supported.

### 10.5. Multicast

If the modem contains an eRouter, IGMP proxy and IPv4 multicast forwarding SHOULD be supported as described by DOCSIS CM-SP-eRouter-119-160923 specification 9.6.

## 11. Annex A Security recommendations

It is strongly recommended that modemrouter devices should conform to BSI "Testkonzept für Breitbandrouter" recommendations, in particular the exclusion criteria listed in table 33.

## 12. History

<b>Document history</b>		
V 1.0	20-01-2022	Release version