OpenCable Specifications

OpenCable Host Device 2.1 Core Functional Requirements

OC-SP-HOST2.1-CFR-I03-080118

ISSUED

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Closed	A static document, reviewed, tested, validated, and closed to further engineering change requests to the specification through CableLabs.

Trademarks:

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1 INTRODUCTION (Informative)

1.1 OpenCable Overview

The goal of the OpenCable specifications is to help the cable industry deploy interactive services in North America. Information is presented in this document that defines the range of minimum capabilities to be supported by Bidirectional digital set-top boxes (OCS2.1) and integrated terminal devices (OCT2.1). OpenCable Project information including Unidirectional specifications and other OpenCable Project information is available on the OpenCable website http://www.opencable.com/.

The OpenCable specifications:

1. Provide integrated environments for broadcast services (analog and digital) and real-time interactive multimedia services.
2. Require standards and interoperability. OpenCable takes advantage of standard computing and network architectures, wherever possible, to minimize costs and maximize inclusion of emerging technologies. Standards may include international standards, North American standards, or published *de facto* industry standards. In all cases, the acquisition of the necessary software, hardware, and intellectual properties will be achievable at fair and reasonable costs. All standard interfaces will be in the public domain or will be available for license at a fair and reasonable cost. Closed proprietary systems are to be avoided.
3. Require portability. FCC regulations adopted under the "retail availability" provisions of the Communications Act provide for retail cable navigation devices to operate with CableCARD™ modules. The OpenCable system permits "point-of-deployment decisions" for network, security and operator-programmed user interfaces to enable the anticipated variety of retail devices and promotes the portability of such devices.
4. Define a renewable and replaceable core encryption system called the CableCARD device.
5. Provide cable Multiple System Operators (MSOs) the ability to inform the navigation device (Host) of the offered services and the Host device with the tools to display the cable services as intended by the MSO.
6. Co-exist with the embedded base of existing set-top devices.

1.2 OpenCable Host Device 2.1 Overview

This document describes the requirements for the OpenCable Host Device 2.1. These devices include OpenCable Set-top 2 (OCS2.1) and OpenCable Terminal 2 (OCT2.1) devices.

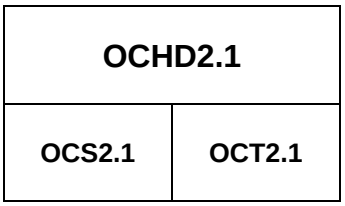


Figure 1.2–1 - OpenCable Host Device 2.1 Types

The goals and objectives of the OpenCable Host Device 2.1 are:

- To support non-scrambled analog services as well as new scrambled or in-the-clear digital services.
- To receive digital premium (scrambled) cable services via an interface with a CableLabs-Qualified CableCARD Device.

- To support interactive and two-way services through standardized Out-Of-Band (OOB) and DOCSIS® data channels and direct connection to the cable plant.

Information on the OpenCable Project can be obtained from the OpenCable website at http://www.opencable.com/, and information on the DOCSIS specifications (including DSG) can be found at the DOCSIS web site at http://www.cablemodem.com/.

Below is more detail on the basic functionality of the OpenCable Host Device 2.1 types.

OpenCable Set-top 2.1 (OCS2.1)

- Two-way connectivity support via both ANSI/SCTE 55-1,-2 OOB and DOCSIS with DSG functionality;
- OpenCable Application Platform (OCAP) 1.0 support;
- MPEG2 Main Profile @ Main Level (MP@ML) Standard Definition and Main Profile @ High Level (MP@HL) High-Definition decoding;
- AVC Main and High Profile @Level 3.0 and 4.0 that cover Standard and High Definition decoding as specified in [DVS 683];
- MPEG-1 audio (Layer I, II & III);
- MPEG-4 AAC, MPEG-4 HE-AAC and MPEG-4 HE-AAC-v2 audio ;
- Digital Visual Interface (DVI) or High-Definition Multimedia Interface (HDMI) output (source) with HDCP encryption;
- IEEE-1394 output (source) with DTCP encryption;
- Optional MPEG encoding of received analog channels for transport on the IEEE-1394 output;
- Multi-Stream or Single-Stream CableCARD interface support.

OpenCable Terminal 2.1 (OCT2.1)

- Two-way connectivity support via both ANSI/SCTE 55-1,-2 OOB and DOCSIS with DSG functionality;
- OpenCable Application Platform (OCAP) 1.0 support;
- MPEG2 Main Profile @ Main Level (MP@ML) Standard Definition and Main Profile @ High Level (MP@HL) High-Definition decoding and display;
- AVC Main and High Profile @Level 3.0 and 4.0 that cover Standard and High Definition decoding as specified in [DVS 683];
- MPEG-1 Audio (Layer I, II & III);
- MPEG-4 AAC, MPEG-4 HE-AAC and MPEG-4 HE-AAC-v2 Audio;
- Digital Visual Interface (DVI) or High-Definition Multimedia Interface (HDMI) input (sink) with HDCP encryption; DVI or HDMI output (source) optional;
- IEEE-1394 input (sink) with DTCP encryption including the capability to switch between analog and digital inputs as in [CEA-775-B];
- Multi-Stream or Single-Stream CableCARD interface support.

1.3 Compliance Notation

Throughout this document, the words used to provide normative statements are capitalized as shown below:

"SHALL"	This word means that the item is an absolute requirement of this specification.
"SHALL 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. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.

1.4 Glossary of Terms

This document uses the following terms:

CableCARD™ Device	A CableCARD device is a detachable device distributed by cable providers that connects to the Host Device. The interface between the CableCARD device and the Host Device is specified by the OpenCable CableCARD Interface 2.0 Specification or OpenCable CableCARD Interface Specification [CCIF2.0]. CableCARD functionality includes copy protection and private CA functions beyond the scope of this specification.
Card	CableCARD Device
Controlled Content	Content that has been transmitted from the CableCARD Device with the encryption mode indicator (EMI) bits set to a value other than zero.
Embedded Cable Modem (eCM)	A Cable Modem that is integrated into an OCHD2.1 for Out-Of-Band signaling, implemented according to the DOCSIS 2.0 spec [RFIv2.0], [eDOCSIS] and supports [DSG].
Network Controller	This is the computer system responsible for managing the CableCARD devices within a cable system. It manages CableCARD devices through control and information messages sent via a dedicated Out-Of-Band channel or DSG channel.
Non-volatile Memory	Memory that retains its contents after any of the following conditions occur: • Power is removed from the OCHD2.1 • OCHD2.1 is reset • New firmware image is downloaded Examples of non-volatile memory are flash, battery-backed RAM, and hard disk drive, but this definition does not limit non-volatile memory to these three types.
OC Signaling	OC_Signaling is a term used to defined types of download triggering message, such as the Common Download CVT or OCAP XAITs.

OpenCable Host Device 2.1	A cable receiver that is compliant with one of the hardware profiles defined by this specification. The OCHD2.1 profiles include: • OpenCable Set-top 2.1 (OCS2.1) • OpenCable Terminal 2.1 (OCT2.1)
OpenCable Set-top 2.1	A cable receiver that has no integrated display and is compliant with the OCS2.1 profile defined by this specification.
OpenCable Terminal 2.1	A cable receiver that includes an integrated display and is compliant with the OCT2.1 profile defined by this specification.
Out-Of-Band Messaging	The control and information messages sent from the Network Controller via the Host to the CableCARD requiring a dedicated QPSK channel or DSG channel that may contain the following types of messages: • Conditional Access (CA) messages including entitlements • System Information (SI) messages • Electronic Program Guide (EPG) messages • Emergency Alert System (EAS) messages • Other generic messages

1.5 Abbreviations and acronyms

AC-3	Audio Codec 3 (ATSC A/52B or Dolby Digital™)
AVC	Advanced Video Coding (MPEG-4 Part 10/ H.264)
CA	Conditional Access
CM	Cable Modem
CMTS	Cable Modem Termination System
CVCT	Cable Virtual Channel Table
DOCSIS®	Data-Over-Cable Service Interface Specifications
DSG	DOCSIS Set-top Gateway
DSGCC	DOCSIS Set-top Gateway Client Controller
DTCP	Digital Transmission Content Protection
DTLA	Digital Transmission Licensing Administrator
DVI	Digital Video Interface
DVS	Digital Video Subcommittee

E-AC-3	Enhanced Audio Codec 3 (ATSC A52B or Dolby Digital Plus™)
EAS	Emergency Alert System
eCM	Embedded Cable Modem
EPG	Electronic Program Guide
FAT Channel	Forward Application Transport Channel
FDC	Forward Data Channel
HD	High Definition
HDCP	High-Bandwidth Digital Content Protection
HDMI	High-Definition Multimedia Interface
HDTV	High Definition Television
HFC	Hybrid Fiber/Coax
IP	Internet Protocol
MAC	Media Access Control
MIB	Management Information Base
MMI	Man Machine Interface
MPEG	Moving Picture Experts Group
MPEG-1 AUDIO	MPEG-1 Audio (layer I, II & III) (ISO/IEC 11172-3)
MPEG-4 AUDIO	MPEG-4 AAC, MPEG-4 HE-AAC and MPEG-4 HE-AAC v2 Audio (ISO/IEC 14496-3)
MSO	Multiple System Operator
MTA	Media Terminal Adaptor
OCAP	OpenCable Application Platform
OCHD2.1	OpenCable Host Device 2.1 (includes OCS2.1 and OCT2.1 profiles)
OCS2.1	OpenCable Set-top 2.1
OCT2.1	OpenCable Terminal 2.1
OOB	Out-Of-Band

OSD	On-screen Display
POD Module	Point Of Deployment Module (also known as CableCARD Device)
RDC	Reverse Data Channel
SCTE	Society of Cable Telecommunications Engineers
SD	Standard Definition
SI	System Information
SNMP	Simple Network Management Protocol
SPTS	Single Program Transport Stream
TCP	Transmission Control Protocol
TVCT	Terrestrial Virtual Channel Table
UDP	User Datagram Protocol

2 REFERENCES

2.1 Normative References

In order to claim compliance with this specification, it is necessary to conform to the following standards and other works as indicated, in addition to the other requirements of this specification. Notwithstanding, intellectual property rights may be required to use or implement such normative references.

All references are subject to revision, and parties to agreement based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

[47CFR15]	47CFR15: Radio Frequency Devices, Class B, FCC.
[47CFR76]	47CFR76: Cable Television Service, FCC.
[A/52B]	ATSC A/52B: Digital Audio Compression Standard (AC-3, E-AC-3) 2005.
[A/53]	ATSC A/53: ATSC Digital Television Standard; Part 1:2007 Digital Television System.
[A/65C]	ATSC A/65C: Program and System Information Protocol for Terrestrial Broadcast and Cable (Revision C, with Amendment No. 1).
[AV/C]	AV/C: Digital Interface Command Set General Specification, Version 4.2.
[BPI+]	CM-SP-BPI+-I12-050812, Data-Over-Cable Service Interface Specifications, Baseline Privacy Plus Interface Specification, August 12, 2005, Cable Television Laboratories, Inc.
[CCCP2.0]	OC-SP-CCCP2.0-I08-071113, OpenCable CableCARD Copy Protection 2.0 Specification, November 13, 2007, Cable Television Laboratories, Inc.
[CCIF2.0]	OC-SP-CCIF2.0-I13-080118, OpenCable CableCARD Interface 2.0 Specification, January 18, 2008, Cable Television Laboratories, Inc.
[CEA 708C]	CEA 708C: Digital Television (DTV) Closed Captioning, July 30, 2006.
[CEA-23-A]	CEA-23-A: RF Interface Specification for Television Receiving and Cable Television Systems, December 2004.
[CEA-542-B]	EIA/CEA-542-B: Cable Television Channel Identification Plan.
[CEA-608-D]	CEA-608-D: Recommended Practice for Line 21 Data Service, August 1, 2005.
[CEA-766-B]	CEA-766-B: U.S. Regional Rating Table (RRT) and Content Advisory Descriptor for Transport of Content Advisory Information Using ATSC A/65 Program and System Information Protocol (PSIP).
[CEA-770.3-C]	CEA-770.3-C: High Definition TV Analog Component Video Interface.
[CEA-775-B]	CEA-775-B, 2004: DTV 1394 Interface Specification.
[CEA-861-D]	CEA-861-D: A DTV Profile for Uncompressed High Speed Digital Interfaces, July 18, 2006.
[CEA-931-B]	CEA-931-B: Remote Control Command Pass-through Standard for Home Networking.
[CHILA]	CableLabs Card-Host Interface License Agreement.
[DSG]	CM-SP-DSG-I11-071206, DOCSIS Set-top Gateway (DSG) Interface Specification, December 6, 2007, Cable Television Laboratories, Inc.
[DTCP]	5C Digital Transmission Content Protection Specification and License.

[DVI]	Digital Visual Interface, Digital Display Working Group, Revision 1.0, April 2, 1999.
[DVS 683]	SCTE DVS 683r3: AVC Video Systems and Transport Constraints for Cable Television (in-progress).
[eDOCSIS]	CM-SP-eDOCSIS-I13-070803, Data-Over-Cable Service Interface Specifications, eDOCSIS Specification, August 3, 2007, Cable Television Laboratories, Inc.
[EIA-679-B]	EIA-679-B (Part B): National Renewable Security Standard, March 2000.
[ETSI TS 101 154 v1.8.1]	Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream.
[HDCP]	High-bandwidth Digital Content Protection System, Digital Content Protection LLC, Revision 1.1, 9 June, 2003.
[HDMI]	High-Definition Multimedia Interface, Specification Version 1.0, December 9, 2002.
[IEC 60958-1]	IEC 60958 (2004-03): Digital Audio Interface: Part 1: General.
[IEC 60958-3]	IEC 60958 (2006-05): Digital Audio Interface: Part 3: Consumer applications.
[IEC 61937]	IEC 61937 (2000-04): Digital audio - Interface for non-linear PCM encoded audio bitstreams applying IEC 60958.
[IEC 61937-3]	IEC 61937 (2003-05): Digital audio - Interface for non-linear PCM encoded audio bitstreams- Part 3: Non-linear PCM bitstreams according to the AC-3 audio formats.
[IEC 61937-4]	IEC 61937 (2003-05): Digital audio - Interface for non-linear PCM encoded audio bitstreams- Part 4: Non-linear PCM bitstreams according to the MPEG audio formats.
[IEC 61937-6]	IEC 61937 (2003-05): Digital audio - Interface for non-linear PCM encoded audio bitstreams- Part 6: Non-linear PCM bitstreams according to the MPEG-2 AAC and MPEG-4 AAC audio formats.
[IEEE-1394]	IEEE-1394, 1995: Standard for a High Performance Serial Bus.
[ISO 11172-3]	ISO/IEC 11172-3, 1993: Information technology—Generic coding of moving pictures and associated audio for digital storage media up to about 1.5 Mbits/s – Part 3: Audio.
[ISO 13818-1/Amd 3]	ISO/IEC 13818-1:2000/Amendment 3, 2004: Transport of AVC video data over ITU-T Rec. H.222.0 | ISO/IEC 13818-1 streams.
[ISO 13818-1]	ISO/IEC 13818-1, 2000: Information technology—Generic coding of moving pictures and associated audio (MPEG): Systems.
[ISO 13818-2]	ISO/IEC 13818-2, 2000: Information technology—Generic coding of moving pictures and associated audio (MPEG): Video.
[ISO 14496-10]	ISO/IEC 14496-10:2005: Information technology - Coding of audio-visual objects - Part 10: Advanced Video Coding.
[ISO 14496-3]	ISO/IEC 14496-3, 2005: Information technology - Coding of audio-visual objects – Part 3 Audio including amendment 1: "Bandwidth Extension" and amendment 2 "Parametric coding for High Quality Audio".
[ITU-R-BT.709-2]	ITU-R-BT.709-2: Parameter Values for the HDTV Standard for Production and International Program Exchange.
[Macrovision]	Specifications of the Macrovision Copy Protection Process for STB/IRD Products Revision 7.1.S1, (October 1, 1999).
[MIB-HOST]	OpenCable Host Device 2.X MIB Specification, OC-SP-MIB-HOST2.X-I03-071113, November 13, 2007, Cable Television Laboratories, Inc.

[MULPIv3.0]	CM-SP-MULPIv3.0-I06-071206, DOCSIS 3.0 MAC and Upper Layer Protocols Interface Specification, December 6, 2007, Cable Television Laboratories, Inc.
[OCAP]	OC-SP-OCAP1.0.1-070824, OpenCable Application Platform Specification (OCAP) 1.0, August 24, 2007, Cable Television Laboratories, Inc.
[OC-CD]	OC-SP-CDL2.0-I06-080118, OpenCable Common Download Specification, January 18, 2008, Cable Television Laboratories, Inc.
[OC-FPEXT]	OC-SP-OCAP-FPEXT-I02-071220, OCAP Front Panel Extension, December 20, 2007, Cable Television Laboratories, Inc.
[OC-SEC]	OC-SP-SEC-I07-061031, OpenCable System Security Specification, October 31, 2006, Cable Television Laboratories, Inc.
[OSSIv2.0]	SP-OSSIv2.0-I10-070803, Data-Over-Cable Service Interface Specifications, Operations Support System Interface Specification, August 3, 2007, Cable Television Laboratories, Inc.
[RFC 1112]	Host Extensions for IP Multicasting.
[RFC 1157]	A Simple Network Management Protocol (SNMP).
[RFC 1901]	Introduction to Community-based SNMPv2.
[RFC 1902]	Structure of Management Information for Version 2 of the Simple Network Management Protocol (SNMPv2).
[RFC 2131]	Dynamic Host Configuration Protocol.
[RFC 2132]	DHCP Options and BOOTP Vendor Extensions.
[RFC 2669]	DOCSIS Cable Device MIB Cable Device Management Information Base for DOCSIS compliant Cable Modems and Cable Modem Termination Systems.
[RFC 2790]	Host Resources MIB.
[RFC 2863]	The Interfaces Group MIB.
[RFC 3396]	Encoding Long Options in the Dynamic Host Configuration Protocol (DHCPv4).
[RFC 3411]	An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks.
[RFC 3412]	Message Processing and Dispatching for the Simple Network Management Protocol (SNMP).
[RFC 3413]	Simple Network Management Protocol (SNMP) Applications.
[RFC 3414]	User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3).
[RFC 3415]	View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP).
[RFC 3417]	Transport Mappings for the Simple Network Management Protocol (SNMP).
[RFC 3418]	Management Information Base (MIB) for the Simple Network Management Protocol (SNMP).
[RFC 3584]	Coexistence between Version 1, Version 2, and Version 3 of the Internet-standard Network Management Framework.
[RFC 4293]	Management Information Base for the Internet Protocol (IP).
[RFIv2.0]	CM-SP-RFIv2.0-I11-060602: Data-Over-Cable Service Interface Specifications, Radio Frequency Interface Specification, June 2, 2006, Cable Television Laboratories, Inc.

[SCTE 02]	ANSI/SCTE 02, 2006: Specification for "F" Port (Female, Indoor) Physical Dimensions.
[SCTE 07]	ANSI/SCTE 07, 2006: Digital Transmission Standard for Cable Television.
[SCTE 18]	SCTE 18, 2007 (ANSI-J-STD-042-2007): Emergency Alert Message for Cable.
[SCTE 20]	ANSI/SCTE 20, 2004: Method for Carriage of Closed Captions and Non-Real Time Sampled Video. Note: Non-Real Time Sampled Video support is "optional" for Host Devices.
[SCTE 21]	ANSI/SCTE 21, 2001 R2006: Standard for Carriage of NTSC VBI Data in Cable Digital Transport Streams.
[SCTE 26]	ANSI/SCTE 26, 2004: Home Digital Network Interface Specification with Copy Protection.
[SCTE 28]	ANSI/SCTE 28, 2004: HOST-POD Interface Standard.
[SCTE 40]	ANSI/SCTE 40, 2004: Digital Cable Network Interface Standard.
[SCTE 43]	ANSI/SCTE 43, 2005: Digital Video Systems Characteristics Standard for Cable Television.
[SCTE 54]	ANSI/SCTE 54, 2006: Digital Video Service Multiplex and Transport System Standard for Cable Television.
[SCTE 55-1]	ANSI/SCTE 55-1, 2002: February 25, 2002, Digital Broadband Delivery System: Out-of-Band Transport Part 1: Mode A.
[SCTE 55-2]	ANSI/SCTE 55-2, 2002: March 10, 2002, Digital Broadband Delivery System: Out-of-Band Transport Part 2: Mode B.
[SCTE 65]	ANSI/SCTE 65, 2002: Service Information Delivered Out-of-Band for Digital Cable Television.
[SMPTE-170M]	SMPTE 170M (1999), Television – Composite Analog Video Signal – NTSC for Studio Applications.

2.2 Informative References

[TIA-250-C] EIA/TIA-250-C: Electrical Performance Standards for Television Relay Facilities.

[MIL-C-39012] MIL-C-39012: General Specifications for Connectors, Coaxial, Radio Frequency.

2.3 Reference Acquisition

CableLabs Specifications:

Cable Television Laboratories, Inc., 858 Coal Creek Circle, Louisville, CO 80027;
Phone: 303-661-9100; Fax 303-661-9199; http://www.cablelabs.com/

SCTE/DVS Standards:

SCTE - Society of Cable Telecommunications Engineers Inc., 140 Philips Road, Exton, PA 19341
Phone: 610-363-6888 / 800-542-5040; Fax: 610-363-5898; http://www.scte.org/

ISO/IEC Standards:

ISO Central Secretariat: International Organization for Standardization (ISO), 1, rue de Varembé, Case postale 56, CH-1211 Geneva 20, Switzerland; Internet: http://www.iso.ch/

HDCP Specifications and License

Digital Content Protection, LLC, C/O Intel Corporation, Stephen Balogh, JF2-55, 2111 NE 25th Ave Hillsboro, OR 97124; http://www.digital-cp.com/

HDMI Specifications

HDMI Licensing, LLC, 1060 E. Arques Avenue, Suite 100, Sunnyvale, CA 94085, USA; http://www.hdmi.org/

DTCP Specifications and License

Digital Transmission Licensing Administrator, LLC, 225 B Cochrane Circle, Morgan Hill, California 95037 USA; http://www.dtcp.com/

DDWG Specifications:

Digital Display Working Group (DDWG), M/S JF3-361; 2111 NE 25th Avenue, Hillsboro, OR 97124-5961, USA. Fax +1-503-264-5959; Email: ddwg.if@intel.com; Internet: www.ddwg.org

FCC Specifications:

http://wireless.fcc.gov/rules.html

DVB/ETSI Specifications:

www.dvb.org
www.etsi.org

3 OVERVIEW OF CORE SERVICES AND FUNCTIONALITIES

3.1 OpenCable Host Device 2.1 components

This section describes the core services that OCHD2.1s support, as well as the core functions required to implement those services. A block diagram of the OpenCable Set-top Device components is shown below.

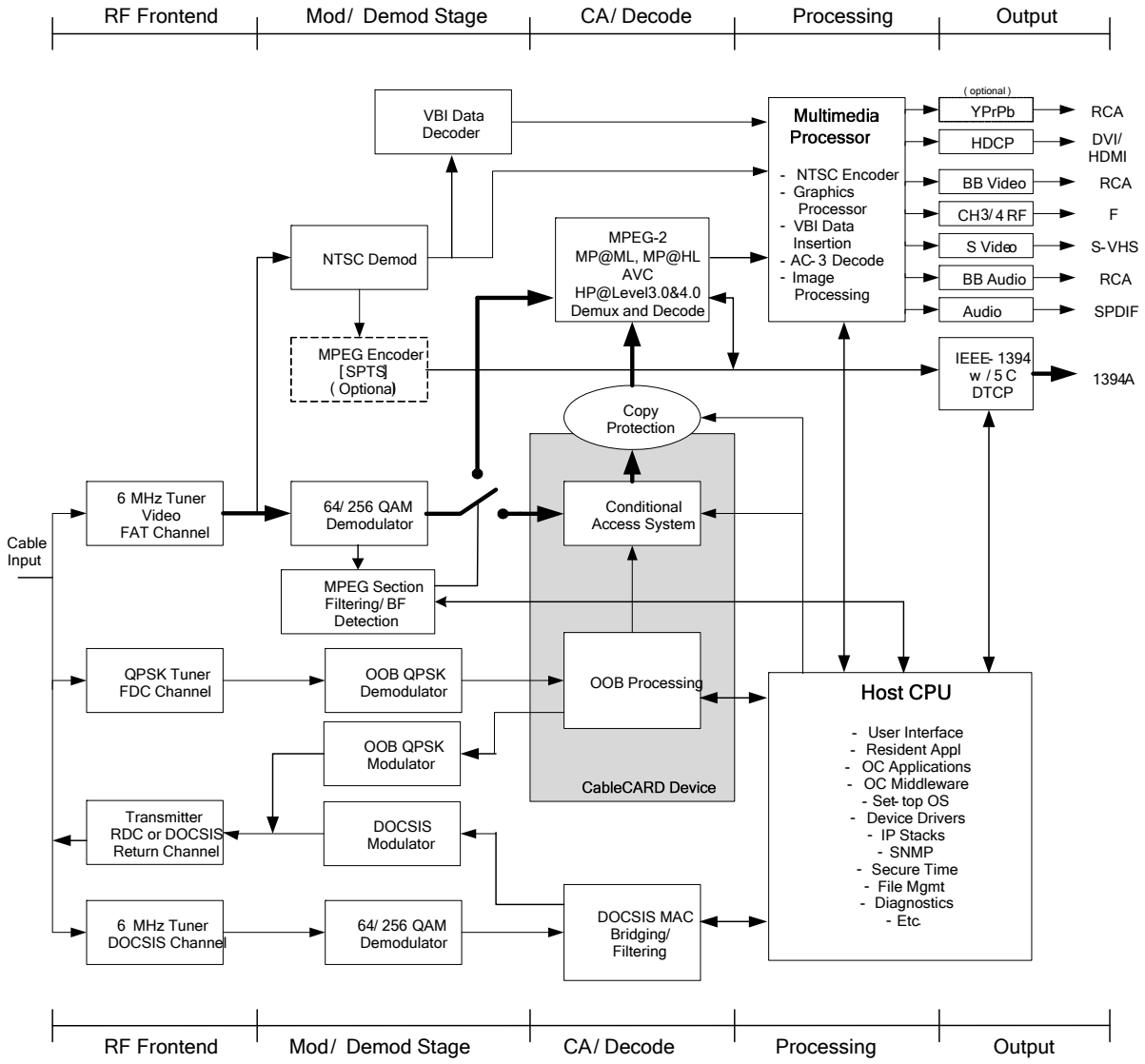


Figure 3.1–1 - Block Diagram of the OpenCable Set-top 2.1 (Informative)

The OCHD2.1 receives multimedia information by tuning to one of many 6 MHz input channels available via a bi-directional or uni-directional cable connection. When the input channel is an analog channel, the signal is processed via the NTSC decoder and the VBI data decoder. When the input channel is a digital channel, it is processed via the QAM demodulator and then passed to the CableCARD Device where secure and scrambled information is processed. Unscrambled information is passed through the CableCARD Device to the MPEG-2 Transport

Demultiplexer. When the CableCARD Device is not inserted, the output of the QAM demodulator is routed directly to the MPEG-2 Transport Demultiplexer. The multi-media processor handles the synchronization and display of audio-visual material.

Based on the network configuration, the OCHD2.1 receives control information and other data by either tuning to an Out-Of-Band (OOB) Forward Data Channel (FDC) channel or via the DSG channel. The Out-Of-Band mode is communicated by the CableCARD Device to the Host via the CableCARD Interface [CCIF2.0]. The transport of the OOB (FDC / RDC) messaging is detailed in [SCTE 55-2] and [SCTE 55-1]. The transport of the DSG messaging is detailed in [DSG]. The Host cannot assume which mode is supported on the network; therefore both modes must be available within the Host.

3.1.1 Core Services (Informative)

The following services are provided by the Core Requirements for OCHD2.1s:

- Analog NTSC audio-visual programming: (unscrambled).
- Digital audio-visual programming utilizing MPEG-2 main profile @ main level and main profile @ high level video and Dolby AC-3 audio including broadcast (unscrambled), subscription-based (scrambled), music channels, Impulse Pay-Per-View (scrambled), VOD and Subscription VOD (scrambled), Switched digital broadcast and other interactive services.
- Digital audio-visual programming utilizing AVC Main and High profile @Level 3.0 and 4.0 video (as specified in [DVS 683]) and Dolby AC-3, E-AC-3, MPEG-1 AUDIO and MPEG-4 AUDIO (referred in this document) including broadcast (unscrambled), subscription-based (scrambled), music channels, Impulse Pay-Per-View (scrambled), VOD and Subscription VOD (scrambled), Switched digital broadcast and other interactive services.
- [OCAP] based interactive applications.

3.1.2 Core Functions and Features (Informative)

The following features and functions are necessary to support the core services:

- Input range of 54-864 MHz or greater, analog and digital (64/256 QAM) tuning and demodulation
- Closed Caption pass-through (line 21, fields 1 and 2) output for analog video input (OCS2.1)
- Closed Caption reinsertion into the VBI of reconstructed analog video output when input is digital video
- Copy protection on analog and digital outputs including the ability to disable outputs under OCAP control
- Emergency Alert System signaling (compliant with [SCTE 18])
- QPSK Out-Of-Band receiver compliant with [SCTE 55-2] and [SCTE 55-1]
- QPSK Out-Of-Band transmitter compliant with [SCTE 55-2] and [SCTE 55-1]
- Analog NTSC RF Channel ¾ output (OCS2.1)
- Baseband Video output (OCS2.1)
- L&R Baseband Audio outputs (OCS2.1)
- SP/DIF Digital Audio output (OCS2.1)
- High speed IEEE-1394 digital interface (see [SCTE 26]) with [DTCP]
- CableCARD digital interface (see OpenCable CableCARD™ Interface 2.0 Specification or OpenCable CableCARD Interface Specification [CCIF2.0])
- OpenCable CableCARD Copy Protection 2.0 Specification [CCCP2.0]
- Out-Of-Band messaging via [DSG]
- An embedded cable modem with DSG functionality compliant with [RFIv2.0]
- Optional High-definition analog output ([CEA-770.3-C] Analog Component Video specification)

- Digital Visual Interface (DVI) or High-Definition Multimedia Interface (HDMI) for uncompressed digital video with [HDCP]
- Implementation of [OCAP] middleware including processing of interactive services

3.2 General Compliance (Normative)

Any features of an OCHD2.1 mandated by law or FCC regulation (e.g., Emergency Alert System, V-Chip) will be supported in the Core Requirements for all OCHD2.1s.

The OCHD2.1 manufacturer SHALL confirm compliance with all applicable FCC rules and regulations.

The OCHD2.1 manufacturer SHALL confirm compliance with all applicable UL rules and regulations.

4 SECURITY

This section describes requirements for copy protection of video programs, security of video streams, conditional access to video streams, and security of transmitted data.

4.1 Conditional Access

The OCHD2.1 SHALL utilize the Card to perform the following Conditional Access functions as defined in [CCCP2.0]: CA descrambling, authorization, entitlement, and Copy Protection encryption.

The OCHD2.1 SHALL NOT implement the following Conditional Access functions: CA descrambling, authorization, entitlement, and Copy Protection encryption.

4.2 Partitioning of Memory

Memory in the OCHD2.1 SHALL be partitioned such that separate partitions are maintained solely for the operation of CableLabs certified software, which is not to be overwritten by any mechanism other than those specified in the [OC-CD] and the [OC-SEC].

The CableLabs certified software in OCHD2.1 memory partitions SHALL have sole access to the Out of Band channels.

4.3 Certificate Storage and Management

The OCHD2.1 SHALL store the various certificates and any associated private/public keys as defined in [OC-SEC].

4.4 Analog Program Copy Protection

The OCS2.1 SHALL be capable of adding copy protection to NTSC analog video outputs derived from digital programs in accordance with the [Macrovision] standard.

The control of Macrovision mode SHALL be dictated by the APS bits of the CCI byte as defined in [CCCP2.0].

If the OCT2.1 includes analog video outputs, it SHALL be capable of adding copy protection to NTSC analog video outputs derived from digital programs in accordance with the [Macrovision] standard.

The control of Macrovision mode SHALL be dictated by the APS bits of the CCI byte as defined in [CCCP2.0].

4.5 Digital Program Copy Protection

The [IEEE-1394] digital interface on the OCHD2.1 SHALL support both Full Authentication and Restricted Authentication copy protection requirements as defined by [DTCP].

The OCHD2.1 SHALL implement M-Mode copy protection as defined in [CCCP2.0].

The OCHD2.1 SHALL NOT change the CCI value used to control content output except as follows:

to a default CCI Value when a channel change occurs,

to a new authenticated CCI value received from the Card

from a default CCI Value to Error CCI Value in the manner specified in [CCCP2.0].

The OCHD2.1 SHALL ignore any OCAP commands that would change the effect of CCI received from the Card.

The OCHD2.1 SHALL include CA descriptors, in the ca_pmt() APDU, associated with the CA_system_id passed by the Card, in the ca_info() APDU, omitting CA descriptors associated with other CA system IDs.

The OCHD2.1 SHALL acquire the association between MPEG program number, ECM-PID and elementary stream PIDs, for the purposes of CP-encryption and CCI authentication, either before sending the transport stream to the Card or after receiving it back from the Card.

The OCHD2.1 SHALL acquire MPEG program number, ECM-PID, and elementary stream packet ID for all content by filtering the MPEG transport stream, either before output to or after reception from the Card interface, but not both.

4.6 HD Copy Control

The following describe the requirements of the OCHD2.1 to ensure protection of HD content when required.

Control of copy control mechanisms on HD outputs is determined by the status of CCI bits. The cable operator determines the control policy through agreements between the operator and the content provider and asserts that policy with the CCI bits.

The OCHD2.1 SHALL provide output control for Controlled Content [CCCP2.0] on all outputs in accordance with specific instructions provided by the Monitor Application as defined in [OCAP].

The OCHD2.1 SHALL have the functionality to allow the Monitor Application the ability to enable or disable the program content stream out the following outputs under OCAP software control [OCAP]:

IEEE 1394

Analog Component Video (Y,Pb,Pr)

DVI

HDMI

any other outputs defined by OCAP specifications.

When an output port is disabled under OCAP software control, the OCHD2.1 SHALL provide a method to display a user message over this same port at the time the port is disabled for program content. The format and content of this message is unspecified.

If the IEEE1394 output is disabled under OCAP software control, then the OCHD2.1 SHALL display a user message over all analog outputs and signal to the connected device via the External Jack Selection, as defined in [SCTE 26], that the analog port should be utilized.

If the connected device does not support External Jack Selection, then the OCHD2.1 SHALL display the user message on all analog output ports.

The user message SHALL be displayed for a period that does not exceed 30 seconds.

If analog component video outputs are present, the OCHD2.1 SHALL provide a "Constrained Image" when the Constrained Image Trigger (CIT) bit in the CCI byte has a value equal to "1".

A Constrained Image as defined by the [CHILA] license agreement SHALL have the visual equivalent of not more than 520,000 pixels per frame; for example, an image of 960 (h) by 540 (v) pixels for a 16x9 aspect ratio.

If a Constrained Image is created by the OCHD2.1, it SHALL be sent to the analog component video interface with one of the scanning formats described in Table 1 of [CEA-770.3-C].

NOTE: This may require up-converting the Constrained Image via interpolation or line doubling in order to match one of the output scanning formats.

The OCHD2.1 SHALL provide a method for software, in particular the OCAP Monitor Application, to determine the status of copy control mechanisms (enabled/disabled) on digital output ports, including the [DTCP] status of the IEEE-1394 port and the [HDCP] status of the DVI or HDMI port.

5 BI-DIRECTIONAL PHYSICAL LAYER CHARACTERISTICS

5.1 RF Interface

The OCHD2.1 SHALL comply with the mechanical and electrical interface requirements as defined in section 3 of [CEA-23-A].

5.1.1 Maximum Individual Carrier Amplitude

The OCHD2.1 SHALL be capable of meeting the FAT and FDC channel performance requirements in the presence of interfering signals, where the maximum RMS value of any individual interfering signal does not exceed the following limits (measured across 75 Ω):

0.5 MHz to 42 MHz +42 dBmV

42 MHz to 52 MHz 0 dBmV

52 MHz to 54 MHz -17 dBmV

The maximum rms value of any individual signal whose frequency exceeds 54 MHz is less than +20 dBmV across a 75 ohm terminating impedance measured at the input to the Host Device.

5.2 Communication Channels

The OCHD2.1 SHALL have the following communication channels:

Forward Application Transport (FAT) channels which carry MPEG-2 Program Streams or NTSC analog signals

Forward Data Channel (OOB FDC)

Reverse Data Channel (OOB RDC)

DOCSIS downstream and upstream channels

DSG tunnels using DOCSIS downstream channels

Note: The frequency range for each downstream tuner or upstream transmitter is:

- 54 to 864 MHz (FAT channel and DOCSIS downstream)
- 70 to 130 MHz (OOB FDC channel)
- 5 to 42 MHz (OOB RDC channel and DOCSIS upstream).

5.2.1 Forward Application Transport (FAT) Channel

The forward application transport channel is a 64 or 256 Quadrature Amplitude Modulation (QAM) channel, according to [SCTE 07], that transports approximately 27 or 39 megabits/second, respectively. The OCHD2.1 is instructed to tune to a particular FAT channel when a subscriber requests a service that requires transport on a FAT channel. FAT channels that are present on the cable plant will adhere to the STD, HRC or IRC frequency plans of [CEA-542-B] and can be located anywhere in the 54 to 864 MHz range.

The OCHD2.1 SHALL be capable of receiving and demodulating a Forward Application Transport channel with either 64 or 256 QAM modulation.

The OCHD2.1 SHALL be compliant with [SCTE 07] for the transmission physical layer modulation and coding.

5.2.2 NTSC Analog Channels

The OCHD2.1 SHALL receive all existing unscrambled analog channels that are NTSC RF AM-VSB modulated in accordance with applicable FCC rules.

NTSC analog channels will adhere to the STD, HRC or IRC frequency plans of [CEA-542-B] and can be located anywhere in the 54 to 864 MHz range.

5.2.2.1 Vertical Blanking Interval

The Vertical Blanking Interval (VBI) contains data on line 21 of an NTSC analog television signal. During this period, the headend can insert VBI data signals on line 21 for closed captioning. VBI data can be inserted within field 1, field 2 or both, on any analog channel operating in the 54 to 864 MHz range.

The OCS2.1 SHALL include the capability to pass through VBI closed caption information, text mode data services, and extended data services data present on line 21 (field 1 and 2) for all NTSC analog signals. The format of this data is defined in [CEA-608-D].

If analog video outputs are present, the OCT2.1 SHALL include the capability to pass through VBI closed caption information, text mode data services, and extended data services data present on line 21 (field 1 and 2) for all NTSC received analog signals. The format of this data is defined in [CEA-608-D].

5.2.3 Out-Of-Band Signaling

5.2.3.1 OOB-FDC and OOB-RDC

The RF front end provides the generic QPSK physical layer common to the OpenCable choices. These have the following characteristics:

Forward receiver: 1.544/3.088 Mbps and 2.048 Mbps

Reverse transmitter: 1.544/3.088 Mbps and 256 Kbps

Based on the network configuration, the Out-Of-Band Messaging for the OpenCable Host Device is implemented over the OOB-FDC / OOB-RDC communication channels or the DSG communication channel. The Out-Of-Band mode is communicated by the Card to the Host via the CableCARD Interface.

The OCHD2.1 SHALL be capable of receiving an Out-Of-Band Forward Data channel and passing the demodulated signal to the Card per [CCIF2.0].

[REQtemp01] The OCHD2.1 SHALL be compliant with [SCTE 55-2] and [SCTE 55-1] for the OOB FDC and OOB RDC transmission physical layer modulation.

The OCHD2.1 SHALL have an Out-Of-Band Reverse Data Channel QPSK transmitter used only under control of the Card as specified in [CCIF2.0].

5.3 Physical Layer Specifications

5.3.1 FAT Channel, FDC Characteristics and RF Performance

The OCHD2.1 SHALL decode the Forward Application Transport channel over the range of input parameters as defined in Table 5.3-1 while operating with the downstream transmission characteristics defined by [SCTE 40].

The OCHD2.1 SHALL tune and receive digital signals that fall within the ranges specified in Table 5.3-1 (QAM signals).

Table 5.3-1 - Analog and FAT Channel: RF Performance Parameters (0° - 40° C)

	Parameter	Requirement
1.	RF Input Channel Bandwidth	6 MHz
2.	RF Input Tuning Range	54 MHz to 864 MHz IRC/HRC/STD Channel Plans
3.	RF Input Return Loss	6 dB minimum over full tuning range
4.	RF Input Impedance	75 ohm unbalanced
5.	RF Input Level Range	Analog visual carrier© from 0 dBmV minimum to +15 dBmV maximum; Analog aural carrier from -10 to -17 dBc; Digital QAM 64 signal from -15 dBmV to +15 dBmV; Digital QAM 256 signal from -12 dBmV to +15 dBmV
6.	AGC Range	NTSC baseband video output level variation of not more than ±1 dB with the analog visual carrier or digital QAM signal input level ranges stated above. *(See Note 1)*
7.	AFC Range	Better than ±125 kHz or nominal tuning resolution of 62.5 kHz
8.	LO Leakage (Input EMC)	-37 dBmV over 54 MHz to 864 MHz
9.	Conversion Isolation: RF Input to Converted RF Output	65 dB minimum; where isolation is defined here as the ratio between the converted signal and the unconverted signal present at the channel ¾ RF output. This parameter SHALL be met with the output measured on the same frequency as the input of the converter, and applies to all assigned input carrier frequencies over the input level range defined in 5 above. *(See Note 2)*
10.	RF Bypass Isolation	60 dB minimum over the input tuning range (54-864 MHz) when internal RF bypass option is installed. *(See Note 2)*
11.	CTB	Not worse than -63 dBc Channel loading assumptions: At least 110 AM-VSB channels at input level of +15 dBmV, at least 20 QAM channels at RF input level of +5 dBmV. *(See Note 2)*
12.	X-Mod.	Not worse than -57 dBc Channel loading assumptions: At least 110 AM-VSB channels at input level of +15 dBmV, at least 20 QAM channels at RF input level of +5 dBmV. *(See Note 2)*

	Parameter	Requirement
13.	CSO	Not worse than -60 dBc Channel loading assumptions: At least 110 AM-VSB channels at input level of +15 dBmV, at least 20 QAM channels at RF input level of +5 dBmV. *(See Note 2)*
14.	Spurious Emissions within the output channel (channel ¾) bandwidth	Not worse than -60 dBc Channel loading assumptions: At least 110 AM-VSB channels at input level of +15 dBmV, at least 20 QAM channels at RF input level of +5 dBmV. *(See Note 2)*
15.	Spurious Emissions outside the output channel (other than channel ¾)	Not worse than -10 dBc *(See Note 2)*
16.	Signal Leakage/RFI	Per [47CFR15]
17.	AM Hum Modulation	Not greater than 3% p-p *(See Note 2)*
18.	Adjacent Channel Rejection	60 dB min *(See Note 2)*
19.	Group Delay Variation Tolerance	≤ 0.25 µsec/MHz across the 6-MHz channel
20.	Phase Noise Tolerance	≤ -88 dB/Hz @ 10 kHz offset (relative to the center of QAM signal spectrum)
21.	Amplitude Ripple Tolerance Digital channels Analog channels	 ≤ 5 dB p-p within the 6 MHz channel ≤ 4 dB p-p within the 6 MHz channel
22.	Micro-reflection Tolerance (assumes one dominant echo with max. specified amplitude in dB relative to the primary QAM signal)	-10 dB at < 0.5 µsec -15 dB at < 1 µsec -20 dB at < 1.5 µsec -30 dB at < 4.5 µsec Echoes > 4.5 µ*sec (see Note 3*)
23.	Burst Noise Tolerance	Not longer than 25 µsec at 10 Hz repetition rate
24.	Image Rejection *(See Note 2)*	Image response less than 60 dBc at final IF or baseband video output, 54 to 714 MHz Image response less than 50 dBc at final IF or baseband video output, 714 to 860 MHz 60dB standard to apply at 714 MHz Two equal power CW signals, +15 dBmV $F_{image} = F_{desired} + 90$ MHz
25.	Spurious Emissions, 5 – 864 MHz	< -37 dBmV

Table Notes:

1. *Applicable only when analog video outputs are provided.*
2. *Applicable only when converted RF outputs are provided.*
3. *Micro-reflection longer than 4.5 microseconds rarely occur in conventional cable television systems. Moreover, very low-level micro-reflections (e.g., -40dB) longer than 4.5 microseconds cannot be measured reliably with readily available instruments. Studies on the subject of long Micro-reflections are continuing, which may result in quantifying this parameter at a future date.*

The OCHD2.1 SHALL meet all FDC performance parameters specified in Table 5.3-2 while operating with the downstream transmission characteristics defined by [SCTE 40].

The OCHD2.1 SHALL tune and receive digital signals that fall within the ranges specified in Table 5.3-2 (QPSK FDC signals).

Table 5.3-2 - FDC Channel: RF Performance Parameters (0° - 40° C)

	Parameter	Requirement
1.	Transmission Rate	1.544/3.088 Mbps [SCTE 55-2] 2.048 Mbps [SCTE 55-1]
2.	RF Input Channel Spacing	1.0/2.0 MHz [SCTE 55-2] 1.8 MHz [SCTE 55-1]
3.	RF Input Tuning Range	70 MHz to 130 MHz
4.	Nominal carrier frequency	Any integer multiple of 250 kHz between the minimum and maximum carrier frequencies, inclusive and the specific fixed frequency of 104.200 MHz.
5.	Frequency acquisition range	+/- 50 ppm
6.	RF Input level range	-15 to +15 dBmV rms (75 ohms) (*See Note 1*)
7.	Differential Encoding	The differential encoder SHALL accept bits (A, B) in sequence and generate phase changes as follows: A B Phase Change default alternative 0 0 none none 0 1 +90 deg -90 deg 1 0 -90 deg +90 deg 1 1 180 deg 180 deg
8.	Group Delay variation tolerance	200 ns max in channel, measured over Nyquist bandwidth
9.	Channel Tune / Carrier acquisition time	< 500ms
Table Notes: *1. See Section 5.3.1.2 for the variation in level between adjacent channels*		

The OCHD2.1 SHALL use a female "F" connector meeting [SCTE 02] for the RF input.

The "F" connector for RF input on the OCHD2.1 SHALL be labeled "Cable In."

5.3.1.1 DOCSIS Downstream Channel

The downstream RF performance parameters for the eCM of the OpenCable Host Device are detailed in [RFIv2.0].

5.3.1.2 RF Signal Levels and Adjacent Channel Characteristics

5.3.1.2.1 RF Signal Levels

The OCHD2.1 SHALL be capable of receiving an analog signal with a visual signal level that is within ± 3 dB of the visual signal level of any adjacent analog channel (within a 6 MHz nominal frequency separation) as specified in [47CFR76].

To determine the adjacent channel characteristics between digital and analog signals, the following information is provided. The nominal relative carrier power levels for analog and digital signals are given by:

Analog channel:	0 dBc (reference level)
256 QAM FAT:	-5 ± 2 dBc
QPSK FDC:	-8 ± 5 dBc
64 QAM FAT:	-10 ± 2 dBc

The OCHD2.1 SHALL be capable of receiving a digital signal with an average RMS signal power that is within ± 6 dB of its nominal level with respect to the nominal level of the adjacent channel digital or analog signal.

It is noted that the nominal carrier power levels provided above fall within the absolute power range for digital signals, -15 dBmV to +15 dBmV. The nominal analog signal power is measured as the peak envelope power (PEP), which is the average of all the analog RMS carrier power levels measured during horizontal sync level. The nominal digital signal power is measured as the average of all the digital RMS signal power levels.

5.3.1.2.2 Adjacent Channel Characteristics

The OCHD2.1 SHALL be capable of receiving digital and analog signals with Adjacent Channel performance as characterized in Table 5.3-3.

Table 5.3-3 - Adjacent Channel Characteristics

Annex A	Desired (D) Channel Modulation	Undesired (U) Adjacent Channel Modulation	Worst Case D/U Ratio
1.	Analog NTSC	64-QAM	-1 dB
2.	Analog NTSC	256-QAM	-6 dB
3.	Analog NTSC	QPSK FDC	-6 dB
4.	64-QAM	Analog NTSC	-21 dB
5.	64-QAM	256-QAM	-21 dB
6.	64-QAM	QPSK FDC	-21 dB
7.	256-QAM	Analog NTSC	-16 dB
8.	256-QAM	64-QAM	-11 dB
9.	256-QAM	QPSK FDC	-16 dB
10.	QPSK FDC	Analog NTSC	-22 dB
11.	QPSK FDC	64-QAM	-17 dB
12.	QPSK FDC	256-QAM	-22 dB

5.3.1.3 Combined Distortion Characteristics

The OCHD2.1 SHALL be capable of receiving digital 64 QAM with characteristics:

Level = -10 dBmV on channel 82

Interleaver depth of greater than or equal to I=64 (J=2)

33 dB C/N

-18 dB ghost at 0.5 us

25 us burst noise not greater than -15 dBmV at 10 Hz rep rate

The OCHD2.1 SHALL be capable of receiving digital 256 QAM with characteristics:

Level = -7 dBmV on channel 82

Interleaver depth of greater than or equal to I=64 (J=2)

36 dB C/N

-18 dB ghost at 0.5 us

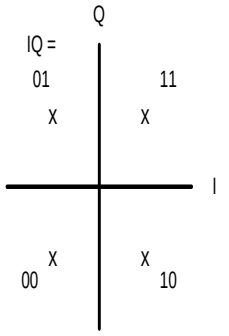
16 us burst noise not greater than -12 dBmV at 10 Hz rep rate

5.3.2 Upstream Transmission Characteristics

The upstream transmitter of the OCHD2.1 SHALL meet the performance requirements from the combined OpenCable RDC specifications, as specified in Table 5.3-4, and the DOCSIS return channel specifications as specified in [RFIv2.0].

Table 5.3-4 - Reverse Data Channel RF & Modulation Performance Parameters (0° - 40° C)

	Parameter	Values for OOB-RDC
1.	Transmission Rate	1.544/3.088 Mbps [SCTE 55-2] 256 Kbps [SCTE 55-1]
2.	Output Channel Spacing	1.0/2.0 MHz [SCTE 55-2] 192 KHz [SCTE 55-1]
3.	Modulation type	Differentially-Encoded QPSK only
4.	RF Output Frequency Range	5 MHz to 42 MHz edge-to-edge
5.	Frequency Step Size Granularity *(Note 1)*	2 KHz
6.	Frequency Accuracy	+/- 50 ppm
7.	Differential Encoding	The differential encoder SHALL accept bits (A, B) in sequence and generate phase changes as follows: A B Phase Change default alternative 0 0 none none 0 1 +90 deg -90 deg 1 0 -90 deg +90 deg 1 1 180 deg 180 deg

	Parameter	Values for OOB-RDC
8.	Quadrant Mapping	 QPSK
13.	I/Q amplitude imbalance	< 1 dB
14.	I/Q phase imbalance	< 2 degree
15.	Transmit level range at Host RF connector.	8 to 57 dBmV
16.	Level step size	< 2 dB
17.	Level absolute accuracy	< +/- 2 dB
18.	Level flatness, 5 - 42MHz	< 2 dB
19.	Spurious outputs, 5 - 42 MHz	< -45 dBc
20.	Harmonic outputs, 10 - 42MHz	< -45 dBc
21.	Out-of-band spurious and harmonics, 54 – 864 MHz	< -37 dBmV
22.	Noise Power Density, as measured +/- $f_w/2$ from center channel frequency, where f_w is the channel spacing. Carrier level > 35 dBmV	> 113 dBc in 1 Hz
23.	Noise Power Density, 5 to 42 MHz when transmitter is idle	< - 105 dBmV (1 Hz) 75 ohms
24.	Return Loss, 75 ohms, 5 to 14 MHz 14 to 26 MHz 26 to 42MHz	 > 9 dB > 11 dB > 6 dB

6 CABLECARD INTERFACE

The OCHD2.1 provides an interface to the CableCARD Device to facilitate the processing of digital information received over the forward application transport (FAT) channel and the OOB forward data channel (FDC) or the OOB channel using the DOCSIS DSG tunnels [DSG]. The interface between the OCHD2.1 and the Card are described in [CCIF2.0].

The OCHD2.1 SHALL only implement the Host side of the Multi-Stream (M-Mode) CableCARD Interface according to [CCIF2.0].

The OCHD2.1 SHALL store the following generic features in non-volatile memory:

RF Output Channel

Timezone

Daylight Savings Control

The OCHD2.1 SHALL store the following generic features in non-volatile memory, if supported:

Parental Control PIN

Parental Control Settings

AC Outlet

Language

EAS Location Code

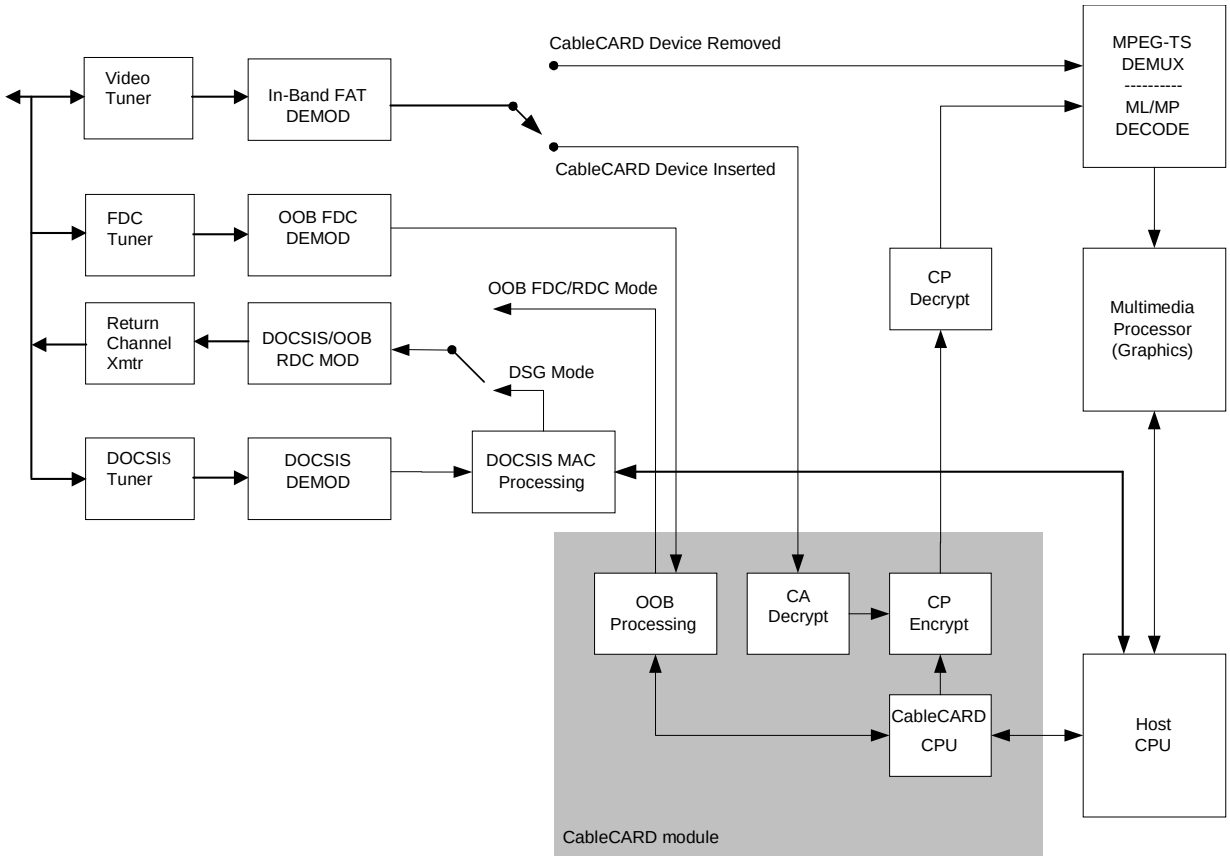


Figure 6–1 - Block Diagram of the OpenCable CableCARD Interface (Informative)

6.1 OpenCable Host Device Functionality without a CableCARD Device

The OCHD2.1 will function without a CableCARD Device and process the analog or digital signals received via the FAT channels directly. The Host will have the following minimum functional characteristics without the CableCARD Device:

When the OCS2.1 is operating without a Card, it SHALL demodulate and output unscrambled analog NTSC audio-visual programming transported according to STD, HRC or IRC frequency plans as specified in [CEA-542-B].

When the OCT2.1 is operating without a Card, it SHALL demodulate and display unscrambled analog NTSC audio-visual programming transported according to STD, HRC or IRC frequency plans as specified in [CEA-542-B].

When the OCS2.1 is operating without a Card, it SHALL discover, decode and output unscrambled digital standard definition and high definition audio-visual programming conforming to MPEG-2 Main Profile @ Main Level or Main Profile @ High Level and Dolby AC-3 audio as specified in Table 3 of [SCTE 43] and transported according to STD, HRC or IRC frequency plans as specified in [CEA-542-B].

When the OCT2.1 is operating without a Card, it SHALL discover, decode and display unscrambled digital standard definition and high definition audio-visual programming conforming to MPEG-2 Main Profile @ Main Level or Main Profile @ High Level and Dolby AC-3 audio as specified in Table 3 of [SCTE 43] and transported according to STD, HRC or IRC frequency plans as specified in [CEA-542-B].

When the OCS2.1 is operating without a Card, it SHALL discover, decode and output unscrambled digital standard definition and high definition audio-visual programming conforming to AVC Main and High Profile @ Level 3.0 and 4.0 as specified in [DVS 683] with Dolby AC-3, E-AC-3, MPEG-1 AUDIO and MPEG-4 AUDIO as referred in this document and transported in adherence to STD, HRC or IRC frequency plans as specified in [CEA-542-B].

When the OCT2.1 is operating without a Card, it SHALL discover, decode and display unscrambled digital standard definition and high definition audio-visual programming conforming to AVC Main and High Profile @ Level 3.0 and 4.0 as specified in [DVS 683] with Dolby AC-3, E-AC-3, MPEG-1 AUDIO and MPEG-4 AUDIO as referred in this document and transported in adherence to STD, HRC or IRC frequency plans as specified in [CEA-542-B].

When the OCHD2.1 is operating without a Card and is tuned to a digital transport stream containing multiple programs, it SHALL identify each program by the one-part channel number specified in the CVCT delivered in the in-band PSIP [A/65C] stream, if such data is present.

Each program SHALL be identified by the two-part channel number if the one-part channel number is not specified in the CVCT.

When the OCHD2.1 is operating without a Card and is tuned to a digital transport stream containing multiple programs, it SHALL identify each program by the two-part channel number specified in the TVCT, in the absence of the CVCT delivered in the in-band PSIP [A/65C] stream, if such data is present.

When the OCHD2.1 is operating without a Card, it SHALL process in-band System and Service Information, for programs that are transported unscrambled, in accordance with section 5.5 of [SCTE 54].

When the OCHD2.1 is operating without a Card, it SHALL NOT use any channel map previously created from OOB data while operating with a Card.

When the OCHD2.1 is operating without a CableCARD Device, it SHALL disable the Reverse Data Channel (RDC) transmit function.

6.2 Man Machine Interface (MMI) Support

The OCHD2.1 will be capable of operating in a unidirectional system and will support copy protection in this operational case. As defined in the OpenCable Copy Protection 2.0 Specification [CCCP2.0] for a unidirectional system, the copy protection system performs authorization utilizing the MMI resource.

The OCHD2.1 SHALL support a navigation method to allow user navigation with the MMI resource defined in [CCIF2.0].

6.3 Software

6.3.1 Middleware

The OCHD2.1 SHALL contain a certified implementation of [OCAP].

6.3.2 Software Download

The OCHD2.1 SHALL support the download of a Monolithic Firmware Image [eDOCSIS] according to the transmission and security protocols specified in [OC-CD].

The OCHD2.1 SHALL support upgrade of the following functional components by mechanisms specified in [OC-CD] in a manner that does not compromise the integrity of the separate components:

embedded Cable Modem (eCM) code including DSG functionality

OCAP implementation including any underlying Operating System (OS)

Persistent applications such as the Navigation system

For example, an upgrade to DSG functionality must not effect the behavior of the OCAP environment or persistent applications.

6.4 Host MAC Address

The OCHD2.1 is required to have a unique MAC address. The MAC address will be utilized by the headend as a means to associate a requested IP address with the OCHD2.1.

The OCHD2.1 SHALL have a unique 48-bit MAC address.

The first 24 bits of the MAC address SHALL consist of an Organizationally Unique Identifier (OUI) assigned to an OCHD2.1 vendor by the IEEE.

The remaining 24 bits of the MAC address SHALL consist of a unique 24-bit value that is generated by the OCHD2.1 vendor.

The OCHD2.1 SHALL NOT utilize the MAC address of the IEEE-1394 interface for the MAC address used for IP Unicast support.

6.5 Support for Local Time Calculation

The OCHD2.1 SHALL implement calculation of local time by using the following parameters:

system_time with GPS_UTC_offset as defined in [SCTE 65]

time_zone_offset from the Generic Feature Control time_zone() message

daylight_savings_control, daylight_savings_delta, daylight_savings_entry_time, and daylight_savings_exit_time from the Generic Feature Control daylight_savings() message

NOTE: Similar information may be present in the SCTE 65 daylight_savings_time_descriptor(). Currently SCTE 65 Profile 1and 2 don't allow daylight_savings_time_descriptor() for this descriptor to be present in the system_time_table_section() message.

The OCHD2.1 SHALL NOT use the daylight_savings_time_descriptor() if received in the system time table as defined in [SCTE 65].

7 MULTI-MEDIA INTERFACES

7.1 OpenCable Host Device Outputs

The required outputs from the OCS2 are shown schematically in Figure 3.1–1 and detailed below. Some of the outputs shown Figure 3.1–1 are optional for the OCT2.1. Copy protection will be applied as defined in Sections 4.4, 4.5, and 4.6 above. Copy protection signaling is described in the [CCCP2.0].

The OCS2.1 SHALL have a RF-modulated output compliant with the following tables:

Table 7.3-1

Table 8.3-1

Table 8.3-2

Table 9.2–1

The default channel setting for the RF-modulated output SHALL be configurable by the cable operator using the Generic Feature resource defined in [CCIF2.0].

If the OCT2.1 includes a RF-modulated output, it SHALL be compliant with the following tables:

Table 7.3-1

Table 8.3-1

Table 8.3-2

Table 9.2–1

The default channel setting for the RF-modulated output, if present, SHALL be configurable by the cable operator using the Generic Feature resource defined in [CCIF2.0].

The OCS2.1 SHALL use a female "F" connector on the RF modulated output in compliance with [SCTE 02].

The connector SHALL be labeled "To TV / VCR".

If the OCT2.1 includes a RF-modulated output, the output SHALL use a female "F" connector in compliance with [SCTE 02].

The connector SHALL be labeled "To TV / VCR".

The OCS2.1 SHALL provide composite baseband video compliant with the following tables:

Table 8.3-1

Table 8.3-2

The OCS2.1 SHALL provide L&R baseband audio outputs compliant with the following tables:

Table 9.2-2

Table 9.2-3

If the OCT2.1 includes composite baseband video outputs, it SHALL be compliant with the following tables:

Table 8.3-1

Table 8.3-2

If the OCT2.1 includes L&R baseband audio outputs, it SHALL be compliant with the following tables:

Table 9.2-2

Table 9.2-3

The OCS2.1 SHALL use a female RCA phono connector for composite baseband video output.

The RCA phono connector SHALL have a yellow dielectric.

The RCA phono connector SHALL be labeled "Video" or "Video Out".

If the OCT2.1 includes a composite baseband video output, it SHALL use a female RCA phono connector.

The RCA phono connector SHALL have a yellow dielectric.

The RCA phono connector SHALL be labeled "Video" or "Video Out".

The OCS2.1 SHALL include a S-Video output that uses a female 4-pin Mini DIN connector.

The 4-pin Mini DIN connector for S-Video output SHALL be labeled "S-Video".

If the OCT2.1 includes a S-Video output, it SHALL use a female 4-pin Mini DIN connector.

The 4-pin Mini DIN connector for S-Video output SHALL be labeled "S-Video".

The OCS2.1 SHALL use female RCA phono connectors for L & R audio outputs.

The RCA phono connector for the right audio output SHALL have a red dielectric.

The RCA phono connector SHALL be labeled to indicate the function of right audio output, for example: "R", "Right" or "Right Audio".

The RCA phono connector for the left audio output SHALL have a white dielectric.

The RCA phono connector SHALL be labeled to indicate the function of left audio output, for example: "L", "Left" or "Left Audio".

If the OCT2.1 includes L & R audio outputs, it SHALL use female RCA phono connectors.

The RCA phono connector for the right audio output SHALL have a white dielectric.

The RCA phono connector SHALL be labeled to indicate the function of right audio output, for example: "R", "Right" or "Right Audio".

The RCA phono connector for the left audio output SHALL have a white dielectric.

The RCA phono connector SHALL be labeled to indicate the function of left audio output, for example: "L", "Left" or "Left Audio".

The OCS2.1 SHALL use a female RCA phono connector, [IEC 61937] optical connector or both, for the S/P DIF audio output.

The connector for the S/P DIF audio output SHALL be labeled to indicate the function; for example "Digital Audio Output".

If the OCT2.1 includes a S/P DIF audio output, it SHALL use a female RCA phono connector, an [IEC 61937] optical connector or both.

The connector for the S/P DIF audio output SHALL be labeled to indicate the function; for example "Digital Audio Output".

The OCS2.1 SHALL provide at least one 4-pin or 6-pin standard IEEE-1394 connector operated as a source device.

The OCT2.1 SHALL provide at least one 4-pin or 6-pin standard IEEE-1394 connector operated as a sink device.

7.2 OpenCable Host Input Devices

[REQtemp07] The OCHD2.1 SHALL be supplied with at least one input device with the following characteristics:

The input device SHALL support all of the required keys identified in [OCAP] Table 25-5.

The four required function keys SHALL be identified as shown in Table 7.2-1.

The keys corresponding to certain KeyEvents SHALL be labeled as shown in Table 7.2-2.

Note: The physical layout and placement of any particular key is not specified and can be determined by the manufacturer.

Table 7.2-1 - Function Key Shapes and Colors

Function Key	Shape	Color
Function Key 0	Circle	Red: Pantone 200
Function Key 1	Star or diamond	Green: Pantone 355
Function Key 2	Square	Blue: Pantone 300
Function Key 3	Triangle	Yellow: Pantone 803

Table 7.2-2 - Key Event Labels

KeyEvent	Key Label
VK_ENTER	Select
VK_GUIDE	Guide
VK_MENU	Menu
VK_INFO	Info
VK_EXIT	Exit
VK_LAST	Last
VK_NEXT_FAVORITE_CHANNEL	Favorite

KeyEvent	Key Label
VK_ON_DEMAND	On Demand

The OCHD2.1 SHALL provide support for a wireless keyboard using one of the following options:

Option 1: Supply a wireless keyboard that meets all the requirements specified in [REQtemp07].

Option 2: Do not supply a keyboard and provide details on either:

The exact codes and protocol that are used by the wireless receiver in the Host device, with a release that allows 3rd party vendors to build a compatible keyboard that supports the requirements of [REQtemp07].

Identify the licensable wireless protocol that 3rd party vendors can implement (with or without disclosing the details of the codes and protocols) that supports the requirements of [REQtemp07].

Option 3: Do not supply a keyboard and implement an IR receiver that is compatible with an IR protocol that CableLabs specifies. The exact codes and protocols are to be determined.

7.3 RF Output Requirements (Channel ¾ RF Output)

The OCS2.1 SHALL be compliant with Table 7.3-1 Channel ¾ RF Output Performance Parameters.

Table 7.3-1 - Channel ¾ RF Output Performance Parameters (0° - 40° C)

	Parameter	Requirement
1.	RF Output Carrier Frequencies	Channels 3 & 4 STD
2.	RF Output Impedance	75 ohm, unbalanced
3.	RF Output Return Loss	Ch ¾ RF output: 10 dB minimum for either channel
4.	Ch ¾ RF Output Level	+4.5 dBmV to +15 dBmV
5.	Ch ¾ RF Output Level Stability	Not vary more than ±1.5 dB
6.	Output Visual Carrier Frequency Accuracy	Within ±80 kHz or better
7.	Output Video Frequency Response for RF Output (worst case for analog NTSC or digital MPEG input signals)	-2 to +2 dB, -500 kHz to 3.75 MHz
8.	Terminal Contribution to Output Frequency Response for RF Output (worst case for analog NTSC or digital MPEG input signals)	-1 to +1 dB, -500 kHz to 3.75 MHz
9.	Output Visual/Aural Carrier Level Difference	Aural carrier is –10 to –17 dB relative to visual carrier level
10.	Output Visual/Aural Carrier Frequency Separation	4.5 MHz, ±5 kHz
11.	Output Depth of Modulation	85%, with variation not more than +5% to -2.5%
12.	Modulation Variation with APL	Not more than ±5%, relative to 50% APL over 10 % to 90% APL range

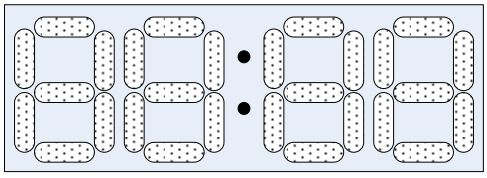
	Parameter	Requirement
13.	Conversion Isolation: RF Input to Converted RF Output	65 dB minimum; where isolation is defined here as the ratio between the converted signal and the unconverted signal present at the channel ¾ RF output. This parameter SHALL be met with the output measured on the same frequency as the input of the converter, and applies to all assigned input carrier frequencies over the input level range defined in 5 above.
14.	RF Bypass Isolation	60 dB minimum over the input tuning range (54-864 MHz) when internal RF bypass option is installed
15.	Spurious Emissions within the output channel (channel ¾) bandwidth	Not worse than –60 dBc Channel loading assumptions: At least 110 AM-VSB channels at input level of +15 dBmV, at least 20 QAM channels at RF input level of +5 dBmV.
16.	Spurious Emissions outside the output channel (other than channel ¾)	Not worse than –10 dBc
17.	AM Hum Modulation	Not greater than 3% p-p

7.4 OpenCable Host Front Panel

The OCHD2.1 MAY incorporate a front panel display that is separate from a main video display.

If the OCHD2.1 incorporates a front panel display to support the OCAP Front Panel Extension API, as specified in Annex A of [OC-FPEXT], it SHALL incorporate at least a POWER Display and MESSAGE Display, and at least 4-digit 7-segment display in a format such that time may be displayed and include a colon in the middle of the display.

The following is an example of a 4-digit 7-segment display:



If the OCHD2.1 is designed with a front panel display to support the OCAP Front Panel Extension API and includes RF Bypass functionality, it SHALL incorporate an RF BYPASS display that is active when the RF Bypass is active.

If the OCHD2.1 is designed with a front panel display, the MonitorAppPermission javadoc SHALL contain an additional row in the permissions table as defined in [OC-FPEXT].

frontpanel	Allows use of the front panel API.	Allows an application to get the front panel manager singleton and use the front panel API to modify the front panel display.

If the OCHD2.1 implements the OCAP Front Panel Extension API, the Document Type Definition of the Permission Request File SHALL contain a “frontpanel” entry in the OCAP:MonitorAppPermission element as defined in [OC-FPEXT].

8 VIDEO

8.1 Analog Video

The OCHD2.1 will be introduced into an environment containing many existing analog set-top devices. The OCHD2.1 will be able to receive analog services that are unscrambled. Analog video and audio will be NTSC-decoded in accordance with current cable-system practice and applicable FCC rules.

8.1.1 Analog Tuning

The OCHD2.1 SHALL have the capability to tune and demodulate NTSC analog channels from 54 to 864 MHz according to the STD, IRC, and HRC channel plans as defined in [CEA-542-B].

When switched from one analog channel to another analog channel, the OCT2.1 SHALL be capable of acquiring and displaying signals with no disruption lasting longer than 1.0 second (sec).[1]

When switched from one analog channel to another analog channel, the OCHD2.1 SHALL have no interruption lasting longer than 1.0 second (sec) on any analog output.[2]

8.2 Digital Video

The OCHD2.1 is required to handle digital transport streams according to the following requirements.

8.2.1 MPEG-2 Transport

The OCHD2.1 SHALL be able to demultiplex and decode a MPEG-2 video (stream type 0x02 or 0x80) within a MPEG-2 transport multiplex compliant to [SCTE 54] containing both MPEG-2 video (stream type 0x02 or 0x80) [SCTE 43] and AVC video (stream type 0x1B) [DVS 683].

The OCHD2.1 SHALL be able to demultiplex and decode an AVC video (stream type 0x1B) within a MPEG-2 transport multiplex compliant to [SCTE 54] containing both MPEG-2 video (stream type 0x02 or 0x80) [SCTE 43] and AVC video (stream type 0x1B) [DVS 683].

The OCHD2.1 SHOULD use audio muting and black frames to mask the effect of disruptions and interruptions during all channel changes.

When switched from one analog channel to a reference[3] digital channel, the OCT2.1 SHALL be capable of acquiring and displaying signals with no disruption lasting longer than 2.5 seconds (secs).[1]

[1] With respect to channel changes, the term “disruptions” includes: black frames, picture instability, macroblocking, freeze-frames, audible artifacts including muting.

[2] With respect to channel changes, the term “interruption” includes: loss-of-signal, black-frames, freeze-frames, discontinuities, macroblocking, audible artifacts including muting.

[3] For this requirement a reference signal with a MPEG2 video with GOP structure = 30 frames or a reference signal with an AVC video stream having a SRAP at 1 second intervals will be used. The reference stream will ensure the difference between PTS and PCR for SRAP is less than or equal to 500ms.

When switched from one analog channel to a reference[3] digital channel, the outputs of any OCHD2.1 SHALL have no interruption lasting longer than 2.5 seconds (secs).[2]

When switched between two reference[3] digital channels with same picture resolution within the same multiplex and the same video coding standard, the OCT2.1 SHALL be capable of acquiring and displaying signals with no disruption lasting longer than 2.0 seconds (secs).[1]

When switched between two reference[3] digital channels with same picture resolution within the same multiplex and the same video coding standard, the outputs of any OCHD2.1 SHALL have no interruption lasting longer than 2.0 seconds (secs).[2]

When switched between two reference[3] digital channels with different picture resolutions in the same multiplex and the same video coding standard, the OCT2.1 SHALL be capable of acquiring and displaying signals with no disruption lasting longer than 2.0 seconds (secs).[1]

When switched between two reference[3] digital channels with different picture resolutions in the same multiplex and same video coding standard, the outputs of any OCHD2.1 SHALL have no interruption lasting longer than 2.0 seconds (secs).[2]

When switched between two reference[3] digital channels with different picture resolutions in different multiplexes and the same video coding standard, the OCT2.1 SHALL be capable of acquiring and displaying signals with no disruption lasting longer than 2.5 seconds (secs).[1]

When switched between two reference[3] digital channels with different picture resolutions in different multiplex and the same video coding standard, the outputs of any OCHD2.1 SHALL have no interruption lasting longer than 2.5 seconds (secs).[2]

When switched between two reference[3] digital channels with same picture resolutions in different multiplexes and the same video coding standard, the OCT2.1 SHALL be capable of acquiring and displaying signals with no disruption lasting longer than 2.5 seconds (secs).[1]

When switched between two reference[3] digital channels with same picture resolutions in different multiplex and the same video coding standard, the outputs of any OCHD2.1 SHALL have no interruption lasting longer than 2.5 seconds (secs).[2]

When switched between two reference[3] digital channels with different video coding standards, the OCT2.1 SHALL be capable of acquiring and displaying signals with no disruption lasting longer than 2.5 seconds (secs).[1]

When switched between two reference[3] digital channels with different video coding standards, the outputs of any OCHD2.1 SHALL have no interruption lasting longer than 2.5 seconds (secs).[2]

The OCHD2.1 SHALL store System Information tables (e.g., NTT, NIT and VCT) required to build the video channel map in non-volatile memory.

8.2.2 Digital Video Decoding

The OCHD2.1 AVC decoder SHALL be able to parse and decode the normative elements from [ISO 14496-10] that are specified with constraints in [DVS 683].

The OCHD2.1 AVC decoder SHALL NOT be adversely affected by the presence or absence of optional and informative elements from [ISO 14496-10].

The OCHD2.1 AVC decoder SHALL NOT be adversely affected by the presence or absence of optional and informative elements specified in [DVS 683].

The OCHD2.1 AVC decoder SHALL be able to parse and process all the 'in-band' normative elements from [ISO 14496-10] Annex D (SEI messages) and Annex E (VUI syntax elements) that are specified with constraints in [DVS 683].

Note: Even though these are optional elements in the AVC specification, which allows applications to convey these elements either in-band or out-of-band, [DVS 683] mandates transmission of some of these elements in-band.

The OCHD2.1 AVC decoder SHALL be able to parse and process all the normative elements from [ISO 13818-1/Amd 3] that are specified with constraints in [DVS 683].

The OCHD2.1 AVC decoder SHALL NOT be adversely affected by the presence or absence of optional elements from [ISO 13818-1] (such as data in adaptation headers) that are specified with constraints in [DVS 683]. These optional elements or information specified in [DVS 683] may be present for the benefit of AVC receivers that support dedicated applications such as PVR, DPI, VOD, etc.

The OCHD2.1 AVC decoder SHALL be capable of processing AVC bitstreams that have profile_idc = 100 and the constraints on SPS/VUI/PPS parameters specified in [DVS 683].

The OCHD2.1 AVC decoder SHALL be capable of processing AVC bitstreams that have profile_idc(s) = 77 and the constraints on SPS/VUI/PPS parameters specified in [DVS 683].

The OCHD2.1 SHALL be able to process all of the VUI syntax elements specified in Table 4 of [DVS 683].

The OCHD2.1 SHALL process AVC streams with the constraints specified in Table 9 of [DVS 683] and correctly process the no_output_of_prior_pics_flag in the IDR picture of sequence after the transition in horizontal resolution only.

In all other cases the OCHD2.1 can infer no_output_of_prior_pics_flag = 1 and clear the DPB buffer.

The OCHD2.1 AVC decoder SHALL discard any unrecognized SEI payloads encountered in the video bit stream.

The OCHD2.1 SHALL be able to decode all MPEG-2 formats in Table 3 of [SCTE 43].

The OCHD2.1 AVC decoder SHALL be able to decode all AVC formats in Table 9 of [DVS 683].

The OCHD2.1 SHALL be able to convert the decoded picture to the selected resolution of any supported output interface.

The OCHD2.1 SHALL decode MPEG-2 Main Profile @ Main Level and Main Profile @ High Level per [ISO 13818-2] with the constraints and extensions that apply to video as specified in [A/53].

The OCHD2.1 SHALL decode AVC Main and High Profile @ Level 3.0 and 4.0 as specified in [DVS 683] with the constraints and extensions that apply to video as specified in Table 9 of [DVS 683].

The OCS2.1 SHALL decode MPEG-2 video with resolutions shown in Table 3 of [SCTE 43].

The OCS2.1 SHALL decode AVC video with resolutions shown in Table 9 in [DVS 683].

The OCT2.1 SHALL decode MPEG-2 video with resolutions shown in Table 3 of [SCTE 43] with the following condition: The resolution of the displayed image will be at the option of the OCT2.1 manufacturer.

The OCT2.1 SHALL decode AVC video with resolutions shown in Table 9 of [DVS 683] with the following condition: The resolution of the displayed image will be at the option of the OCT2.1 manufacturer.

The OCS2.1 SHALL decode MPEG-2 video with aspect ratios listed in Table 3 of [SCTE 43].

The OCS2.1 SHALL decode AVC video with aspect ratios listed in Table 9 of [DVS 683].

The OCT2.1 SHALL decode MPEG-2 video with aspect ratios as shown in Table 3 of [SCTE 43] with the following conditions:

The aspect ratio of the displayed image will be at the option of the OCT2 manufacturer. As a minimum, user options to select letterbox and cropping of pictures that do not match the aspect ratio of the display device SHALL be provided.

The OCT2.1 SHALL decode AVC video with aspect ratios as shown in Table 9 of [DVS 683] with the following conditions:

The aspect ratio of the displayed image will be at the option of the OCT2.1 manufacturer. As a minimum, user options to select letterbox and cropping of pictures that do not match the aspect ratio of the display device SHALL be provided.

The OCHD2.1 MPEG-2 decoder SHALL support decoding of an MPEG-2 Main Profile @ High Level Single Program Transport Stream encoded at a constant bit rate (CBR) of 38.81070 Mbps or variable bit rate (VBR), with peak rates up to 38.81070 Mbps, the maximum payload rate for a 256QAM channel.

The OCHD2.1 AVC decoder SHALL be capable of decoding an AVC Main and High Profile @ Level 3.0 and 4.0 video elementary stream encoded at a maximum bit rate as specified in Annex A of [ISO 14496-10].

Note: The bit rate value for the AVC Bitstream is application-dependent and limited by the contiguous bandwidth of the transmission channel. In the application of AVC transmission over a 64-QAM channel, bit rate value, in combination with other components in the MPEG-2 Transport multiplex, conforms to a channel bit-rate of less than or equal to 27.0 Mbps; in transmissions over 256-QAM channels to less than or equal to 38.8107 Mbps.

The OCHD2.1 MPEG-2 decoder SHALL support error concealment to minimize macroblock and stream synchronization errors.

The OCHD2.1 AVC decoder SHALL support error concealment to minimize macroblock and stream synchronization errors.

NOTE: Standard test streams for MPEG-2 and AVC with known errors will be used to evaluate error concealment implementations.

8.2.3 Digital Television (DTV) Out-of-Band Service/System Information

The OCHD2.1 SHALL process out-of-band System and Service Information [SCTE 65] that is sent across the CableCARD interface in Extended Channel data flows, using Service_type = MPEG_section, as defined in [CCIF2.0], or sent in a DSG broadcast tunnel that is terminated directly.

The OCHD2.1 SHALL be able to extract the channel map used for program navigation from the System Information tables for all profiles specified in [SCTE 65].

8.2.4 Digital Television (DTV) Closed Captioning

The OCS2.1 SHALL extract NTSC closed captioning information when present in the MPEG-2 Picture Level user_data as specified in section 4 of [CEA 708C], or as specified in [CEA-608-D] and transported according to [SCTE 21] or [SCTE 20]. This will include all data of *cc_type* 00 and 01, as defined in [CEA 708C].

The OCS2.1 SHALL reconstruct the MPEG-2 Picture Level user_data on line 21 VBI (both field 1 and field 2) according to [CEA-608-D] on all NTSC analog video outputs.

NOTE: There may be other closed captioning and extended data structures present in the MPEG-2 Picture Level user_data.

The OCS2.1 SHALL extract NTSC closed captioning information when present in AVC stream as specified in [CEA-608-D] and transported according to [DVS 683].

The OCS2.1 SHALL reconstruct line 21 VBI (both field 1 and field 2) according to [CEA-608-D] on all NTSC analog video outputs.

If the OCT2.1 includes NTSC analog video outputs, it SHALL extract NTSC closed captioning information, when present in the MPEG-2 Picture Level user_data, as specified in section 4 of [CEA 708C], or as specified [CEA-608-D] and transported according to [SCTE 21] or [SCTE 20]. This will include all data of *cc_type* 00 and 01, as defined in [CEA 708C].

The OCT2.1 SHALL reconstruct the MPEG-2 Picture Level user_data on line 21 VBI (both field 1 and field 2) according to [CEA-608-D] on all NTSC analog video outputs.

If the OCT2.1 includes NTSC analog video outputs, it SHALL extract NTSC closed captioning information, when present in the AVC video stream, as specified in [CEA-608-D] and transported according to [DVS 683].

The OCT2.1 SHALL reconstruct line 21 VBI (both field 1 and field 2) according to [CEA-608-D] on all NTSC analog video outputs.

If the OCS2.1 provides analog component video outputs, decoding of NTSC closed captioning data SHALL be provided.

The OCS2.1 SHALL provide decoding of NTSC closed captioning data on uncompressed digital video outputs.

If the OCT2.1 provides analog component video outputs, decoding and display of NTSC closed captioning data SHALL be provided.

The OCT2.1 SHALL provide decoding of NTSC closed captioning data on uncompressed digital video outputs, if present.

The OCS2.1 SHALL extract the Digital Television closed captioning (DTVCC) information when present in the MPEG-2 Picture Level user_data, as specified in section 9 of [CEA 708C] and delivered according to [SCTE 21] using an extension to the Picture Level user_data defined in [A/53] (with cc_type set to '10' or '11').

The OCHD2.1 SHALL pass-through all DTVCC, when present in the MPEG-2 Picture Level user_data, to the IEEE-1394 interface.

The OCS2.1 SHALL extract the Digital Television closed captioning (DTVCC) information when present in the AVC video stream as specified in [CEA 708C] and delivered according to [DVS 683].

The OCS2.1 SHALL pass-through to the IEEE-1394 interface any Digital Television closed captioning (DTVCC) information when present in the AVC video stream as specified in [CEA 708C] and delivered according to [DVS 683].

In the case where an MPEG Picture Level user_data is transported according to [SCTE 21] or [SCTE 20], the OCHD2.1 MAY use closed captioning data recovered from either standard.

The OCHD2.1 SHALL process the caption_service_descriptor, when present, as defined in [A/65C] and carried in either the PMT of the in-band MPEG-2 transport stream or passed across the CableCARD Interface Extended Channel when receiving profile 4, 5 or 6 of [SCTE 65].

8.2.5 Digital Television (DTV) Content Advisory Information

To support the interoperable availability of content advisory information for Host Devices and/or CableCARD Devices, OpenCable specifies the use of MPEG-2 Picture Level user_data found in [SCTE 21], the content_advisory_descriptor passed across the CableCARD Interface Extended Channel, or the content_advisory_descriptor found in section 6.9.3 of [A/65C]. The syntax follows Table 6.27 in that reference. This descriptor is placed in the Program Map Table (PMT) as permitted in accordance with the standard descriptor mapping for the TS_program_map_section() found in [ISO 13818-1].

The only rating region currently defined for OpenCable use is Region One (value 0x01 for the rating_region field). Semantics for the coding of the fields found in the PSIP Content Advisory Descriptor follow the rules given in section 6.9.3 of [A/65C].

The OCS2.1 SHALL extract content advisory information formatted as defined in [CEA-608-D] when such information is transported according to [SCTE 21] or [SCTE 20].

If the OCT2.1 includes NTSC analog video outputs, it SHALL extract content advisory information as defined in [CEA-608-D] when such information is transported according to [SCTE 21] or [SCTE 20].

The OCHD2.1 MAY extract content advisory information from the content_advisory_descriptor as defined in [A/65C] and [CEA-766-B] when such information is transported in the PMT of the in-band MPEG-2 transport stream or passed across the CableCARD Interface Extended Channel when receiving profile 3, 4, 5 or 6 of [SCTE 65].

The OCS2.1 SHALL pass-through to the IEEE-1394 interface, content advisory information, when such information is present in the received digital video stream.

If the OCT2.1 includes an IEEE-1394 interface operated as a source device, it SHALL pass-through to the interface content advisory information, when such information is present in the received digital video stream.

The OCS2.1 SHALL reconstruct line 21 on the NTSC analog video output using the content advisory XDS packet as specified in [CEA-608-D], when such information is present in the received signal.

If the OCT2.1 includes NTSC analog video outputs, it SHALL reconstruct line 21 on the NTSC analog video output using the content advisory XDS packet as specified in [CEA-608-D], when such information is present in the received signal.

If the OCS2.1 includes analog component video outputs, decoding of content advisory information SHALL be provided as required by [47CFR15].

The OCS2.1 SHALL provide decoding of content advisory information on uncompressed digital video outputs.

If the OCT2.1 provides analog component or uncompressed digital video outputs, decoding and display of content advisory information SHALL be provided.

The OCHD2.1 SHALL have *a priori* knowledge of the U.S. RRT (Region Rating Table for Region One) that is defined in [CEA-766-B] (i.e., the table is stored in the OCHD2.1).

> The U.S. RRT SHALL be the default RRT. It is noted that this approach is consistent with that specified in Annex C.1 of [SCTE 65].

8.2.6 Digital Television (DTV) Emergency Alert Service (EAS)

The OCHD2.1 processes emergency messages that utilize the EAS message syntax, which is compatible with MPEG-2 transport and is defined in [SCTE 18]. For in-band transmission, it appears in the transport packet with the same PID as those used for Service/System Information (SI). The table ID for the EAS message is 0xD8 as defined in [SCTE 18]. For out-of-band (OOB) transmission, the EAS message is transmitted according to [SCTE 18].

The OCHD2.1 SHALL process EAS messages, when received, as defined in [SCTE 18].

8.3 Video Performance Specifications

The OCHD2.1 SHALL meet all performance requirements for Composite Analog Video Outputs specified in Table 8.3-1.

Each line item parameter in Table 8.3-1 SHALL apply to both baseband and RF-modulated output video unless otherwise stated.

Table 8.3-1 - Composite Analog Video Output Performance Parameters (0 °- 40° C)

	Parameter	Requirement
1.	Video Standard	NTSC composite, EIA-563
2.	Signal Level (composite video)	1.0 volt peak-to-peak, sync tip (-40 IRE) to reference white (100 IRE) ±10%
3.	Long Time Distortion (Bounce)	±1%, settle in less than 1 second
4.	Field Time Distortion	±4%
5.	Line Time Distortion	Baseband: ±2%, RF Modulated: ±3
6.	Short Time Distortion	±6% (Rising and/or Falling)
7.	Chroma to Luminance Gain Inequality	Not more than ±10 % (+30% to -50% for OCT2s)
8.	Chroma to Luminance Delay for Baseband Video Output (box only, not including headend and plant)	≤ 100 nsec (AM-VSB analog)
9.	Frequency Response for Baseband Video Output (worst case for analog NTSC or digital MPEG input signals)	-2 to +2 dB, 0 kHz to 3.75 MHz (+2 to -6 dB for OCT2s).
10.	Terminal Contribution to Output Frequency Response for RF Output (worst case for analog NTSC or digital MPEG input signals)	-1 to +1 dB, 0 kHz to 3.75 MHz
11.	Luminance Non-Linearity	5% p-p maximum
12.	Chroma Non-Linear Phase Distortion	± 5°
13.	Chroma Non-Linear Gain Distortion	±5%
14.	Chroma/Luma Intermod	±3%
15.	Differential Gain (over 10% to 90% APL range)	10% peak to peak max. for RF modulated output; 5% peak to peak max. for baseband video output
16.	Differential Phase (over 10% to 90% APL range)	10° peak to peak max. for RF modulated output; 5° peak to peak max. for baseband video output
17.	920 kHz Beat	-52 dBc

	Parameter	Requirement
18.	Video Signal-to-Noise Ratio (over the full input tuning range)	For RF Modulated Output: 53 dB with a digital input signal and 48 dB with an analog input signal at 0 dBmV (51 dB and 44 dB, respectively, for Terminal Devices). (*Note 1)* For Baseband Video Output: 57 dB with a digital input signal and 49 dB with an analog input signal at 0 dBmV (55 dB and 45 dB, respectively, for Terminal Devices. (*Note 1*)
19.	Baseband Video Output Impedance	75 ohm ± 10%
20.	Baseband Video Output Return Loss	16 dB minimum across video bandwidth
Table Notes: *1. Video SNR measured with Unified Weighting filter.*		

The OCHD2.1 SHALL meet all performance requirements for Analog Video Outputs when processing a digital video source as specified in Table 8.3-2.

Table 8.3-2 - Analog Video Output Performance when processing a digital video program source (0°- 40° C)

	Parameter	Requirement
1.	Bar Level (rel. Back Porch)	100 IRE nominal
2.	Sync Polarity	Negative (normal)
3.	Sync Level (rel. Back Porch)	40 IRE ±4
4.	Color Burst Amplitude	40 IRE ±4
5.	Color Burst Duration	2.5 microseconds = 9 cycles ±1 (EIA RS-170)
6.	Front Porch Duration	1.4 microseconds minimum (+4 IRE to -20 IRE)
7.	Sync to Setup Duration	8.5 microseconds minimum (-20 IRE to +4 IRE)
8.	Horizontal Blanking Duration	10.9 microseconds, ±0.3 microseconds (+4 IRE to -4 IRE)
9.	Sync Pulse Duration	4.7 microseconds, ±0.2 microsecond (50% width)
10.	Sync Pulse Rise Time	140 nsec ± 30 nsec (10% to 90% amplitude)
11.	Equalization Pulse	2.3 microseconds ±0.2 (50% width)
12.	Vertical Pulse	(H/2 - 4.7 microsecond) ±0.2 (50% width)
13.	Breezeway Duration	0.6 microseconds
14.	Setup	7.5 IRE

8.4 HD Physical Interfaces

In addition to the analog audio and video interfaces defined in Section 7, the OCHD2.1 may have the output interface requirements defined in this section.

8.4.1 HD Analog Component Video Interface

If analog component video outputs are present, the OCHD2.1 SHALL comply with [CEA-770.3-C] and employ three RCA Phono jack connectors as designated in section 10 of [CEA-770.3-C] and labeled as in Table 8.4-1.

Table 8.4-1 - Connector Color Code Assignment

Signal Assignment (Label)	Color Code
Y	Green
Pb	Blue
Pr	Red

If analog component video outputs are present on the OCHD2.1, a user controlled selection switch (hardware or software) SHALL be provided to allow the user to match the HD output format with the chosen display.

8.4.2 Uncompressed Digital Video Interface

The OCS2.1 SHALL provide support for an uncompressed digital video interface (output) using either Digital Visual Interface [DVI] or High-Definition Multimedia Interface [HDMI].

If the OCS2.1 includes a DVI output, it SHALL use a female DVI-D connector, which at a minimum supports the Single Link Transmission Minimized Differential Signaling as defined in [DVI].

If the OCS2.1 includes an HDMI output, it SHALL use a female HDMI connector, which at a minimum supports the Single Link Transmission Minimized Differential Signaling as defined in [HDMI].

The OCT2.1 SHALL provide support for an uncompressed digital video interface (input) using either Digital Visual Interface [DVI] or High-Definition Multimedia Interface [HDMI].

If the OCT2.1 includes a DVI input, it SHALL use a female DVI-D connector, which at a minimum supports the Single Link Transmission Minimized Differential Signaling as defined in [DVI].

If the OCT2.1 includes an HDMI input, it SHALL use a female HDMI connector, which at a minimum supports the Single Link Transmission Minimized Differential Signaling as defined in [HDMI].

The OCT2.1 MAY provide support for an uncompressed digital video interface (output) using either Digital Visual Interface [DVI] or High-Definition Multimedia Interface [HDMI].

If the OCT2.1 includes a DVI output, it SHALL use a female DVI-D connector, which at a minimum supports the Single Link Transmission Minimized Differential Signaling as defined in [DVI].

If the OCT2.1 includes an HDMI output, it SHALL use a female HDMI connector, which at a minimum supports the Single Link Transmission Minimized Differential Signaling as defined in [HDMI].

If the OCT2.1 includes both an input and an output DVI and/or HDMI connector, then each connector SHALL be labeled to indicate whether it is a input or output.

The OCHD2.1 SHALL employ the HDCP encryption system on the DVI or HDMI interface as defined in [HDCP].

The OCHD2.1 SHALL enable HDCP encryption at all times when video is transmitted over the DVI or HDMI interface.

If HDCP authentication fails, then the OCHD2.1 SHALL not transmit video over the DVI or HDMI interface, excluding any alerts generated by the device informing the user of the condition.

Note: Continued transmission of a blank video field over the DVI or HDMI interface for the purpose of muting video in this case is acceptable.

8.4.3 IEEE-1394 Digital Interface

The IEEE-1394 interface on the OCS2.1 SHALL include:

copy protection as defined in Section 4.5

compliance with section 4.1, Initialization and Configuration, and section 4.2, AV/C Discovery Process, of [SCTE 26]

Analog / Digital source selection function as defined in sections 4.11 and 6.1 of [CEA-775-B], unless the Host Device supports requirement [REQtemp02]

support for [CEA-931-B] PASS THROUGH control commands: tune function, mute function, and restore volume function

support for the POWER control commands (power on, power off, and status inquiry) defined in [AV/C]

The IEEE-1394 interface on the OCT2.1 SHALL include:

copy protection as defined in Section 4.5

compliance with section 4.1, Initialization and Configuration, and section 4.2, AV/C Discovery Process, of [SCTE 26]

bit-mapped graphics support (profile 0b) as defined in Section 4.3.5 of [SCTE 26]

all normative elements of [CEA-775-B]

Analog / Digital source selection function as defined in Sections 4.11 and 6.1 of [CEA-775-B]

Any OCHD2.1 that supports IEEE-1394 source functionality but does not include an MPEG-2 encoder with the ability to encode graphics or user interface messages for delivery over the interface, SHALL do a verification of the External Jack Selection function, as defined in [SCTE 26], on any sink device connected to an isochronous output plug of the device.

If the connected sink device does not support the External Jack Selection function and it is determined that the sink device is a display device (TV/monitor), the OCHD2.1 SHALL disconnect the isochronous output plug preventing isochronous MPEG-2 streams to that sink device.

If the OCHD2.1 disconnects the isochronous output plug to the sink device, it SHALL refuse any further connections to that device and update the status of the IEEE-1394 Port Status - A/D Source Selection status as defined in Section 11.1.10.

If the connected sink device supports the External Jack Selection function and either the OCHD2.1 or the sink device does not support On-Screen Display (OSD) over the interface, the OCHD2.1 SHALL utilize the External Jack Selection function to switch the sink device to an analog input port when delivery of user interface messages is required.

Note: User interface messages include, at a minimum, Diagnostic Screens, MMI and EAS alerts.

Note 1: This requirement regarding digital output to display devices places no restriction on the functionality of the 1394 port for digital output to non-display devices that may be on the same 1394 bus such as a digital VCR.

Note 2: Support for OSD over IEEE-1394 is optional. In the event that the source device does support OSD and the source device determines that the sink device also supports OSD, then the use of the External Jack Selection function is not required.

[REQtemp02] If an OCHD2.1 supports IEEE-1394 source functionality and includes an MPEG-2 encoder, then it SHALL be designed to encode analog services for delivery over the 1394 interface as a single program transport stream.

[REQtemp03] If an OCHD2.1 supports IEEE-1394 source functionality and includes an MPEG-2 encoder that is designed such that it has the ability to encode graphics, then the device SHALL encode any graphics or user interface messaging for delivery over the interface as a single program transport stream.

Note: User interface messages includes, at a minimum, Diagnostic Screens, MMI and EAS alerts.

The IEEE-1394 interface (source or sink) on the OCHD2.1 SHALL support the transfer of MPEG-2 single program transport streams (SPTS) via the Isochronous Data Channel (IDC) as specified in section 11 of [CEA-775-B].

The OCS2.1 SHALL support simultaneous local decoding and pass-through to the IEEE-1394 interface compressed standard and high definition MPEG-2 A/V programming.

The OCS2.1 SHALL have the capability to function as the Isochronous Resource Manager (IRM) as defined in section 8 of [IEEE-1394].

The OCS2.1 SHALL have the capability to function as the Cycle Master as defined in section 8 of [IEEE-1394].

8.5 Signal Formats

This subsection lists the requirements on an OCHD2.1 with respect to the scanning formats and colorimetry of the HD interfaces.

8.5.1 Scanning Formats for the HD Analog Component Video Interface

If analog component video outputs are present on the OCHD2.1, each of the MPEG formats described in Table 3 of [SCTE 43] and AVC formats described in Table 6 of [DVS 683] SHALL be converted to the selected HD output format on the interface.

If analog component video outputs are present on the OCHD2.1, it SHALL employ the Y', P_B', P_R' component format according to section 8 of [CEA-770.3-C].

8.5.2 Colorimetry for the HD Analog Component Video Interface

If analog component video outputs are present on the OCHD2.1, the colorimetry SHALL correspond to the requirements in [ITU-R-BT.709-2] and section 5 of [CEA-770.3-C].

If analog component video outputs are present on the OCHD2.1, the MPEG sequence display extension SHALL be observed (when present in the transport stream) to determine when color matrix conversion is necessary.

If the MPEG sequence display extension is not included in the transport stream for any standard definition MPEG formats listed in Table 3 of [SCTE 43], the colorimetry SHALL be converted from [SMPTE-170M] to [ITU-R-BT.709-2].

8.5.3 Scanning Formats for the DVI/HDMI Interface

The scanning systems supported on the DVI or HDMI output of the OCS2.1 SHALL include all of those identified as mandatory for a source device in [CEA-861-D], except for the 640x480p format, which is optional.

Note: Other formats listed in [CEA-861-D] as optional may also be provided.

The DVI or HDMI input of a OCT2.1 SHALL support the mandatory parts of [CEA-861-D] for a sink device.

Note: Other formats listed in [CEA-861-D] as optional may also be supported.

The OCS2.1 SHALL convert each of the MPEG formats described in Table 3 of [SCTE 43] to the user selected or preferred format and aspect ratio of the display device connected to the DVI or HDMI output as discovered via the Enhanced Extended Display Identification Data (E-EDID) Detailed Timing Descriptions or the CEA Timing Extensions structure communicated from the display to the host device, as constrained by [CEA-861-D].

In the event that the E-EDID data structure or CEA EDID timing extension does not contain a supported timing format or cannot be read, then the DVI or HDMI output SHALL use 640x480p mode, if available.

If the OCS2.1 does not support 640x480p mode, then 720x480p mode MAY be utilized, if available.

If the OCS2.1 does not support either mode, then the DVI or HDMI output SHALL be disabled.

8.5.4 Video Transmission Format for the DVI/HDMI Interface

If the OCHD2.1 implements a DVI interface, it SHALL employ the RGB component format according to section 5 of [CEA-861-D].

If the OCHD2.1 implements an HDMI interface, it SHALL employ the RGB component format according to [HDMI].

If the OCHD2.1 implements an HDMI interface and analog component interfaces, it SHALL also support the YCbCr format according to [HDMI].

8.5.5 Colorimetry for the DVI/HDMI Interface

The DVI or HDMI interface on the OCHD2.1 SHALL employ the colorimetry requirements according to section 5 of [CEA-861-D].

The OCHD2.1 SHALL observe the MPEG sequence display extension (when present in the transport stream), to determine when color matrix conversion is necessary.

8.5.6 Simultaneous Outputs

All video and graphics of the OCS2.1 (including on-screen displays and set-up menus) MAY be output simultaneously to the composite baseband video output, an analog component video output (if present), and the DVI or HDMI digital output, subject to copy control restrictions. Note that this may require simultaneous output to interfaces that use different color spaces (RGB for DVI and YPrPb for NTSC and HD analog).

The video format of the OCS2.1 analog component video output MAY match that of the DVI or HDMI output.

Standard Definition video received either as an analog or digital signal by the OCS2.1 SHALL be up-converted to support any active High Definition output.

The OCHD2.1 SHALL present any selected and authorized video simultaneously on the composite baseband, S-video and the modulated RF output.

9 AUDIO

The OCHD2.1 SHALL be capable of decoding Dolby AC-3 and E-AC-3 audio in accordance with [A/52B] as constrained per [A/53], with additional data rates up to 448 kbps.

The OCHD2.1 SHALL be capable of decoding MPEG-1 audio [ISO 11172-3] and MPEG-4 audio [ISO 14496-3].

The OCHD2.1 SHALL be capable of decoding MPEG-1 audio and MPEG-4 audio with Sampling Rates of 32 kHz, 44.1 kHz and 48 kHz per decoding constraints specified in Section 6.1.4 of [ETSI TS 101 154 v1.8.1].

The OCHD2.1 SHALL be capable of decoding Dolby AC-3 and E-AC-3 audio with Sampling Rates specified in [A/52B] as constrained per [A/53].

The OCHD2.1 SHALL be capable of decoding MPEG-1 layer I & II audio per decoding constraints specified in sections 6.1.1 – 6.1.6 of [ETSI TS 101 154 v1.8.1].

The OCHD2.1 SHALL be capable of decoding MPEG-1 layer III audio as specified in [ISO 11172-3].

The OCHD2.1 SHALL be capable of decoding MPEG-4 audio per decoding constraints specified in Section 6.4 of [ETSI TS 101 154 v1.8.1]

The OCHD2.1 SHALL present the audio component of selected and authorized digital signals simultaneously on the baseband left and right outputs, the modulated RF output, and the digital outputs for all video compression formats listed in Table 3 of [SCTE 43] and Table 9 of [DVS 683].

If the OCT2.1 includes audio outputs, it SHALL present the audio component of selected and authorized digital signals simultaneously on the baseband left and right outputs, the modulated RF output, and the digital outputs for all video compression formats listed in Table 3 of [SCTE 43] and Table 9 of [DVS 683].

The OCS2.1 SHALL present the audio component of selected analog signals on the baseband left and right outputs and the modulated RF output.

The audio component MAY be present on the digital outputs.

If the OCT2.1 includes audio outputs, it SHALL present the audio component of selected analog signals simultaneously on the baseband left and right outputs and the modulated RF output, if present.

The audio component MAY be present on the digital outputs.

The OCHD2.1 SHALL use the ISO 639 language descriptor, if present in the PMT, as defined in [ISO 13818-1] and constrained by [SCTE 54], to identify the language associated with audio elementary streams.

The OCHD2.1 SHALL be certified by Dolby Laboratories Inc. for Dolby Digital™ decoding.

9.1 Audio Performance Specifications

All audio performance requirements are valid over the operational environmental parameters defined in Table 9.2–1, Table 9.2-2, and Table 9.2-3. These parameters apply to all OCHD2.1s with audio outputs.

9.2 Music Channel Services

Some music channel services provide both an audio elementary stream and a low frame-rate video elementary stream, typically at the rate of one frame every six seconds with a data rate of 50 kbps. These low frame-rate video elementary streams have the **low_delay** flag set to "1" in the sequence_extension(), following the sequence_header() of the video_sequence(). The following is from the MPEG-2 Video standard [ISO 13818-2] concerning the use of the **low_delay** flag.

> "**low_delay** - This flag, when set to "1", indicates that the sequence does not contain any B-pictures, that the frame reordering delay is not present in the VBV description and that the bitstream may contain 'big pictures'.

'Big pictures' are images that may reside in the VBV buffer for longer than two fields. The VBV buffer will be examined periodically before removing the coded picture to prevent buffer underflow. See section C.7 of [ISO 13818-2] for details.

The OCHD2.1 MPEG-2 decoder SHALL be capable of decoding video elementary streams when the low_delay flag in the video sequence extension is enabled.

The OCHD2.1 AVC decoder SHALL be capable of decoding video elementary streams with the low_delay flag enabled as referred in [DVS 683].

The OCS2.1 SHALL meet all audio performance requirements for RF Outputs as specified in Table 9.2–1.

The OCT2.1 SHALL meet all audio performance requirements for RF Output, if present, as specified in Table 9.2–1.

Table 9.2–1 - RF Output Audio Performance

	Parameter	Requirement
1.	Modulated Audio Mode	Monophonic or BTSC encoded
2.	Modulation Note: For set-tops with volume control, this spec applies when commanded to "unity" or "nominal" gain	50 kHz peak deviation ±7 kHz for a digital audio signal of 400Hz at 0dBFS. For analog inputs, the RF output MUST reproduce the original carrier deviation, + or - 10%.
3.	Audio Mute	Minimum 48 dB attenuation

The OCS2.1 SHALL meet all audio performance requirements for Baseband Outputs as specified in Table 9.2-2.

The OCT2.1 SHALL meet all audio performance requirements for Baseband Outputs, if present, as specified in Table 9.2-2.

Table 9.2-2 - Baseband Audio Output when a Digital Service is Selected

	Parameter	Requirement
1.	Audio Frequency Response	+/-1 dB from 20 Hz to 20 kHz
2.	Audio Mute	Minimum 60 dB attenuation
3.	Baseband Audio Output Impedance	< 5k ohm for each L&R audio outputs
4.	Audio Output Signal Level (as measured into a 100k ohm load) Note: For set-tops with volume control, this spec applies when commanded to "unity" or "nominal" gain	2.16V p-p to 6.22V p-p with digital levels (0 dBFS), and excluding the effects of dialog normalization and dynamic range compression

	Parameter	Requirement
5.	Intermodulation Distortion (CCIF method using 4040 Hz and 3960 Hz tones at -14 dBFS input per tone)	0.15% max. referenced to output
6.	Stereo L&R Channel Separation	60 dB min. from 20 Hz to 20 kHz
7.	Stereo L&R Channel Gain Difference	+/- 0.5 dB max. from 20 Hz to 20 kHz, referenced to the left channel response
8.	Stereo L&R Channel Phase Difference	5° max. from 20 Hz to 20 kHz
9.	Total Harmonic Distortion	0.3% max. from 20 Hz to 20 kHz at -10 dB relative to full scale
10.	Audio Signal-to-Noise Ratio Note: For set-tops with volume control, this spec applies when commanded to "unity" or "nominal" gain	80 dB min., 20 Hz to 20 kHz, with 1 kHz test tone at full scale encoder input, dialog normalization and dynamic range compression disabled, using CCIR- 2k weighting
11.	Audio to Video Transmission Time Difference	± 20 msec max

The OCS2.1 SHALL meet all audio performance requirements for Baseband Outputs as specified in Table 9.2-3.

The OCT2.1 SHALL meet all audio performance requirements for Baseband Outputs, if present, as specified in Table 9.2-3.

Table 9.2-3 - Baseband Audio Output with Analog Service*

	Parameter	Requirement
1.	Audio Frequency Response	Mono or BTSC Signal: ±3 dB from 50 Hz to 13 kHz (50 Hz to 10 kHz for Terminal Devices).
2.	Audio Mute	Minimum 60 dB attenuation.
3.	Baseband Audio Output Impedance	< 5k ohm for each L&R audio outputs.
4.	Audio Output Signal Level (as measured into a 100k ohm load) Note: For set-tops with volume control, this spec applies when commanded to "unity" or "nominal" gain	Mono Signal: 1.2V p-p, +/- 10%, with 400 Hz test tone at +/-25 KHz p-p audio subcarrier deviation. BTSC Signal: 1.2V p-p, +/- 10%, with 400 Hz test tone at +/- 12.5 kHz p-p audio subcarrier deviation for each L&R channel.
5.	Stereo L&R Channel Separation	BTSC Signal: 20 dB min. at 1 kHz.
6.	Stereo L&R Channel Gain Difference	BTSC Signal: +/- 0.5 dB maximum from 50 Hz to 13 kHz, referenced to the left channel response.
7.	Stereo L&R Channel Phase Difference	BTSC Signal: 15° maximum from 50 Hz to 13 kHz.
8.	Total Harmonic Distortion	Mono and BTSC Signals: 3.5% max. from 50 Hz to 13 kHz.
9.	Audio Signal-to-Noise Ratio Note: For set-tops with volume control, this spec applies when commanded to "unity" or "nominal" gain	Mono and BTSC: 48 dB min., 50 Hz to 13 kHz, referenced to a 1000 Hz test tone at +/- 25 kHz p-p audio subcarrier deviation, CCIR-2k weighting (45 dB min. from 50 Hz to 10kHz for Terminal Devices).

Table Notes:

* *Requirements are based on input test signals provided by NTSC and BTSC signal sources RF modulated to Channel 4.*

10 OPENCABLE HOST DEVICE POWERING STATES

Once AC power is applied to the OCHD2.1 and the Card is installed and initialized, the OCHD2.1 always has access to network services through the Out-Of-Band channel for network monitoring purposes or for receipt of messages, alarms, or notifications. When the OCHD2.1 is "On" (in a video viewing state), it is fully active and providing services that are displayed on the subscriber's television. When it is in "Standby"(powered on but in a non-viewing state), it still maintains network connectivity and is still consuming power and running the processor, operating system, and navigator shell.

When the OCHD2.1 is disconnected from AC power or from the cable connection, it is not connected to the network. When reconnected, the OCHD2.1 does not have to re-initialize, but will re-establish network connectivity. The AC power up sequence is slightly longer than the "Standby " to "On" sequence.

The operation of the OCHD2.1 in background (Standby) mode is not defined in this document.

10.1 CableCARD Background Mode Power Management

The minimum power requirements for OCHD2.1 background (Standby) mode SHALL include the following:

The OCHD2.1 OOB receiver (including the embedded cable modem) circuitry SHALL be fully powered when a Card is inserted.

The OCHD2.1 OOB transmitter (including the embedded cable modem) circuitry SHALL be fully powered when a Card is inserted.

The Card SHALL be fully powered when inserted.

11 OPENCABLE HOST DEVICE DIAGNOSTICS

The OCS2.1 SHALL be capable of performing self-diagnostics and displaying the following conditions via the LED readout:

Power status

Boot status

Indication of fatal error (e.g., Checksum error)

The OCHD2.1 SHALL be capable of performing self-diagnostics and displaying the following information via the on-screen display (OSD):

Power status

Boot status

Memory Allocation

Software Version

Firmware Version

MAC Addresses

Network Addresses

Status of FDC

Status of FAT

Status of RDC

Current Channel Status

IEEE-1394 Port Status

DVI / HDMI Port Status

Status of DOCSIS transport channels

Home Network Status

The OCHD2.1 OSD display of diagnostics SHALL be triggered by a pre-determined keystroke sequence, which is defined by the manufacturer.

11.1 Diagnostic Parameters

The following subsections describe the self-diagnostic parameters that are displayed via the OSD and reported to the Card.

11.1.1 Memory Allocation

The OCHD2.1 SHALL be capable of displaying and reporting the following memory allocation information:

Type of memory being reported (as applicable: ROM, DRAM, SRAM, Flash, HDD, DVD, and NVM)

Physical size of memory type (in kilobytes, defined to 1024 bytes)

11.1.2 Software Version Number

The OCHD2.1 SHALL be capable of displaying and reporting the following software version information for all available applications:

Application name string

Application version number

Software status (active, inactive or downloading)

Application signature (If applicable)

11.1.3 Firmware Version

The OCHD2.1 SHALL be capable of displaying and reporting the following firmware version information:

Firmware version number of entire firmware image

Firmware release or installation date of entire firmware image

11.1.3.1 Firmware Download Status

The OCHD2.1 SHALL be capable of displaying the following firmware download status:

Download Status – one of “COMPLETE”, “DOWNLOADING”, “FAILED”

Download Fail Status – one of the applicable Error Codes defined in Table 11.1-1:

Note: Display of Error Code may include additional textual description.

Table 11.1-1 - Download Fail Status Error Codes

Error Code	Definition
CDL-ERROR-1	No Failure
CDL-ERROR-2	Improper code file controls - CVC subject organizationName for manufacturer does not match the Host device manufacturer name
CDL-ERROR-3	Improper code file controls - CVC subject organizationName for code cosigning agent does not match the Host device current code cosigning agent.
CDL-ERROR-4	Improper code file controls - The manufacturer's PKCS #7 signingTime value is equal-to or less-than the codeAccessStart value currently held in the Host device.
CDL-ERROR-5	Improper code file controls - The manufacturer's PKCS #7 validity start time value is less-than the cvcAccessStart value currently held in the Host device.

Error Code	Definition
CDL-ERROR-6	Improper code file controls - The manufacturer's CVC validity start time is less-than the cvcAccessStart value currently held in the Host device.
CDL-ERROR-7	Improper code file controls - The manufacturer's PKCS #7 signingTime value is less-than the CVC validity start time.
CDL-ERROR-8	Improper code file controls - Missing or improper extendedKeyUsage extension in the manufacturer CVC.
CDL-ERROR-9	Improper code file controls - The cosigner's PKCS #7 signingTime value is equal-to or less-than the codeAccessStart value currently held in the Host device.
CDL-ERROR-10	Improper code file controls - The cosigner's PKCS #7 validity start time value is less-than the cvcAccessStart value currently held in the Host device.
CDL-ERROR-11	Improper code file controls - The cosigner's CVC validity start time is less-than the cvcAccessStart value currently held in the Host device.
CDL-ERROR-12	Improper code file controls - The cosigner's PKCS #7 signingTime value is less-than the CVC validity start time.
CDL-ERROR-13	Improper code file controls - Missing or improper extended key-usage extension in the cosigner's CVC.
CDL-ERROR-14	Code file manufacturer CVC validation failure.
CDL-ERROR-15	Code file manufacturer CVS validation failure.
CDL-ERROR-16	Code file cosigner CVC validation failure.
CDL-ERROR-17	Code file cosigner CVS validation failure.
CDL-ERROR-18	Improper eCM configuration file CVC format (e.g., missing or improper key usage attribute).
CDL-ERROR-19	eCM configuration file CVC validation failure.
CDL-ERROR-20	Improper SNMP CVC format.
CDL-ERROR-21	CVC subject organizationName for manufacturer does not match the Host devices manufacturer name.
CDL-ERROR-22	CVC subject organizationName for code cosigning agent does not match the Host devices current code cosigning agent.
CDL-ERROR-23	The CVC validity start time is less-than or equal-to the corresponding subject's cvcAccessStart value currently held in the Host device.
CDL-ERROR-24	Missing or improper key usage attribute.
CDL-ERROR-25	SNMP CVC validation failure.

11.1.4 MAC Addresses

The OCHD2.1 SHALL be capable of displaying and reporting the following media access control (MAC) address information:

Type of device (as applicable: Host, Card, IEEE-1394, USB, eCM)

MAC address of each reported device

If multiple devices of the same type exist, the MAC address for each device.

11.1.5 Network Addresses

The OCHD2.1 SHALL be capable of displaying and reporting the following network address information:

Network address of device

If multiple network addresses exist, the network address for each device

11.1.6 Status of FDC

The OCHD2.1 SHALL be capable of displaying and reporting the following forward data channel (FDC) information:

FDC center frequency, in MHz

Carrier lock status (locked/not locked)

11.1.7 Status of FAT

The OCHD2.1 SHALL be capable of displaying and reporting the following forward application transport (FAT) channel information:

Modulation mode; (NTSC, 64 QAM, 256 QAM, or other)

Carrier lock status if the currently tuned channel is a digital QAM channel

PCR lock status if the currently tuned channel is a digital QAM channel

Numeric estimate of the channel's signal to noise ratio, accurate to within 3 dB of the actual received level, in tenths of dB if the currently tuned channel is a digital QAM channel

Numeric estimate of the signal level, accurate to within 6 dBmV of the actual received level, in tenths of dBmV (peak level for analog, average level for others)

A reported power change in the same direction of not less than 0.5 dB and not more than 2.0 dB for any 1 dB change in input level or SNR

11.1.8 Status of RDC

If the return data channel (RDC) is established, the OCHD2.1 SHALL be capable of displaying and reporting the following reverse data channel (RDC) information:

RDC center frequency, in MHz

RDC transmitter power level, in dBmV

RDC data rate (256 kbps, 1544 kbps or 3088 kbps)

11.1.9 Current Channel Status

The OCHD2.1 SHALL be capable of displaying and reporting the following current channel information:

Channel type; analog or digital

Authorization status; OCHD2.1 is authorized or not authorized for currently tuned service

Purchasable status; currently tuned service may be purchased

Purchased status; currently tuned service is/is not purchased

Preview status; currently tuned service is/is not in preview mode

Parental control status, if utilizing parental control; when currently tuned service is blocked/not blocked via parental control

11.1.10 IEEE-1394 Port Status

The OCHD2.1 SHALL be capable of displaying and reporting the following IEEE-1394 Port status information:

Loop status (loop/no loop exists)

Root status (OCHD2.1 is/is not Root node)

Cycle Master status (OCHD2.1 is/is not Cycle Master)

A/D Source Selection status (Monitor does/does not support A/D source selection function

Port connection status

Port 1 — connected/not connected

Port 2 — connected/not connected

Total number of nodes (devices) connected to IEEE-1394 bus, with the following information for each node: device subunit type, A/D Source Selection Status, and EUI 64.

11.1.11 DVI / HDMI Port Status

The OCHD2.1 SHALL be capable of displaying and reporting the following DVI / HDMI Port status information:

Connection status (no connection exists, device connected – not repeater, device connected – repeater)

Connected device type

Connected device color space

HDCP status (not enabled/enabled)

Host Device HDCP status

non HDCP device

compliant HDCP device

revoked HDCP device

Video format

The number of horizontal lines associated with the video format on the DVI / HDMI link

The number of vertical lines associated with the video format on the DVI / HDMI link

The scan rate associated with the video format on the DVI / HDMI link

The aspect ratio associated with the video format on the DVI / HDMI link (4:3, 16:9)

Progressive or interlaced video

Audio format

Audio format type

Audio sample size

Audio sample frequency

11.1.12 Status of DOCSIS transport channels

The OCHD2.1 SHALL be capable of displaying and reporting the following DOCSIS transport channels status information:

Downstream center frequency, in MHz

Downstream received power level, in dBmV

Downstream carrier lock status (locked/not locked)

Upstream transmitter center frequency, in MHz

Upstream transmitter power level, in dBmV

Upstream symbol rate, in Msymbols/sec

Upstream modulation type

11.1.13 Home Network Status

The OCHD2.1 SHALL be capable of displaying and reporting the following Home Network status information, if supported:

Maximum number of clients the Host can support

Host Digital Rights Management (DRM) capability

Number of connected clients

Client MAC addresses

Client IP addresses

Client DRM capability

12 MECHANICAL

The OCHD2.1 SHALL be capable of dissipating the heat, while satisfying the requirement of item 15 of Table 12–1, from a Card drawing an average of 2.5 watts across the CableCARD interface if it supports both S-Card and M-Card.

The OCHD2.1 SHALL be capable of dissipating the heat, while satisfying the requirement of item 15 of Table 12–1, from a Card drawing an average of 1.5 watts across the CableCARD interface if it supports M-Card only.

The OCHD2.1 SHALL have a non-removable nameplate(s) or sticker(s) that includes the following information:

Vendor ID: 24-bit vendor ID represented as 3 bytes (6 hexadecimal digits).

Vendor Name: 40 ASCII characters maximum

Serial Number or Serial No: 40 ASCII character maximum

Note: Vendor ID should be assigned by CableLabs to ensure uniqueness.

The OCHD2.1 SHALL meet the operational environmental / mechanical requirements as specified in Table 12–1.

Table 12–1 - Environmental / Mechanical Requirements

(Meet all operational specs. without malfunction, or hard or soft failures, under the following)

	Parameter	Requirement
1.	Required Compliance	All applicable regulatory requirements including, but not limited to: FCC, UL, CSA, and EIA
2.	Input Line Voltage	95 to 125 volts AC
3.	Input Line Frequency	57 to 63 Hz
4.	Nominal Power Consumption	To be specified in watts by manufacturer
5.	Physical Security/Tampering-Resistance	Secure means of evidencing entry into the security portions of the device
6.	RF Susceptibility	RF field of 2 volts/ meter from 40 MHz to 1 GHz
7.	Radiated RF	[47CFR15] compliant
8.	Conducted	[47CFR15], ANSI C63.4-1992 compliant
9.	Lightning Surge Tolerance	UL 1409 voltage surge test 38.1, UL 1449, IEEE C62.41, IEEE 587 compliant. RF Input: 1.5 kV at 1kV/usec, 60 amp peak; AC line input: 6 kV, oscillatory 0.5 µsec rise time 100 kHz.
10.	Line Surge Test	FCC part 68, UL 1459, CSA compliant. Metallic: 3500 v minimum at 5 µsec max. rise time and 600 µsec min. fall time, 20 joules min. Longitudinal: 6500 v at 5 µsec max. rise time, 600 µsec min. decay time, 30 joules min. Note: Only applies to a Host with a phone return modem.

	Parameter	Requirement
10a.	Line Surge Test	UL 1449 Measured Limiting Voltage test Duty Cycle Test Abnormal Over Voltage Tests.
11.	Power Cross (if Host supports phone modem return)	Metallic: will survive 10 events of 600 v, 10 sec duration and operate. Longitudinal: will survive 10 events of 600 v, 10 sec duration and operate.
12.	Electrostatic Discharge	IEC 801-2, withstand 10 discharges at 15 kV to each corner and center of keypad, through a 150 pf capacitor in series with 150 ohm resistor, with device chassis grounded to ESD generator
13.	Brown Out Effects	No corruption of non-volatile memory due to input voltage fluctuations from nominal to zero volts
14.	Operating Ambient Temperature and Humidity	0° to 40° C and 5% to 95% RH non-condensing humidity *(See Note 1)*
15.	External Surface Temperature (with 125 vac input applied and device on, 25° C ambient temperature, without internal or external fan)	UL 1409 compliant. No external protruding surface point hotter than 50° C for metallic and 60° C for nonmetallic surfaces. No non-accessible surface point hotter than 65° C.
16.	Storage Temperature (non-powered, non-operating)	-20° to +60° C *(See Note 1)*
17.	Storage Humidity (non-powered, non-operating)	5% to 95% RH non-condensing at 40° C *(See Note 1)*
18.	Altitude	Operating: -150 to 10,000 ft. AMSL Storage: -150 to 15,000 ft. AMSL *(See Note 1)*
19.	Thermal Shock	Device meets all operational specs after subjection to: -40° C. for 30 minutes +25° C. for 10 minute +60° C. for 30 minutes *(See Note 1)*
20.	Humidity Shock	Mil-std-810d method 507.2 Device meets all operational specs after subjection to: raise temp to +60° C and 95% RH over 26 hrs., maintain for 6 hrs., drop to 85% RH while reducing temp to +30° C over 8 hrs., maintain +30° C and 95% RH for 8 hrs. Repeat for 10 cycles. *(See Note 1)*
21.	Solvent Resistance	No external surface deformation effect of common household solvents, cleaners, waxes *(See Note 1)*
22.	Shipping Vibration	Fully operational after subjection to swept frequency vibration test applied in each of x, y, z planes with excursion of 0.3 inches at a frequency varied from 10 to 30 Hz back to 10 Hz done six times within 30 minutes. *(See Note 1)*
23.	Mounting Feet	No marks or stain to varnished wooden surface after 40° C and 95% RH exposure for 10 days under force of 0.75 kg *(See Note 1)*
24.	Keypad Keys	Fully operational after subjection to 100,000 cycles of each key through its full travel to closure with a 10- to 12-ounce force applied at 60 times per minute. *(See Note 1)*

	Parameter	Requirement
25.	Impact Test	Device will not develop any openings creating electrical shock risks after subjection to an impact force of 5 ft. lbs. obtained from a free fall of a 2-inch diameter solid smooth steel sphere weighing 1.18 lbs. *(See Note 1)*
26.	Static Load on Keypad Keys	No mechanical damages or visible deformation after keypad subjection to a static load of 25 lbs. in the direction of operation of the keys. *(See Note 1)*
27.	Handling Drop Test	Device fully operational and not develop any openings exposing risk of electrical shock after subjection to one drop on the face of the device from a height of 20 inches onto a 2-inch thick smooth surface concrete floor. *(See Note 1)*
28.	Strain Relief Test	For permanently attached power supply cords, device will withstand steady pull force of 35 lbs. applied to the cord. *(See Note 1)*
29.	Non-volatile Memory Battery Life	Batteries used to back up non-volatile memory will have a minimum life of: unplugged: 1.5 yrs storage life @ 60° C or less; powered 8 yrs @ 40° C or less.
30.	Microphonic Shock	Device will remain error- or interference-free (i.e., no audio pops, clicks, no data errors, no video artifacts) when subjected to tapping with a reasonable force by placing device on a hard surface without padding or mats and inducing 20 taps from knuckles, flat hands, fists, finger nails, screwdriver handles, plastic hammers to all external surfaces of the device. *(See Note 1)*

Table Notes:

1. *For OCT2.1s, these parameters are superseded by the manufacturer's specifications.*

13 DSG MODE OPERATION

This section details the OpenCable Host 2.1 operation when using the DSG channel for Out-of-Band communication in Basic or Advanced DSG mode. There is some overlap between this section and both the DSG and Card interface specifications. This section is not intended to contradict or redefine anything listed in the other specifications.

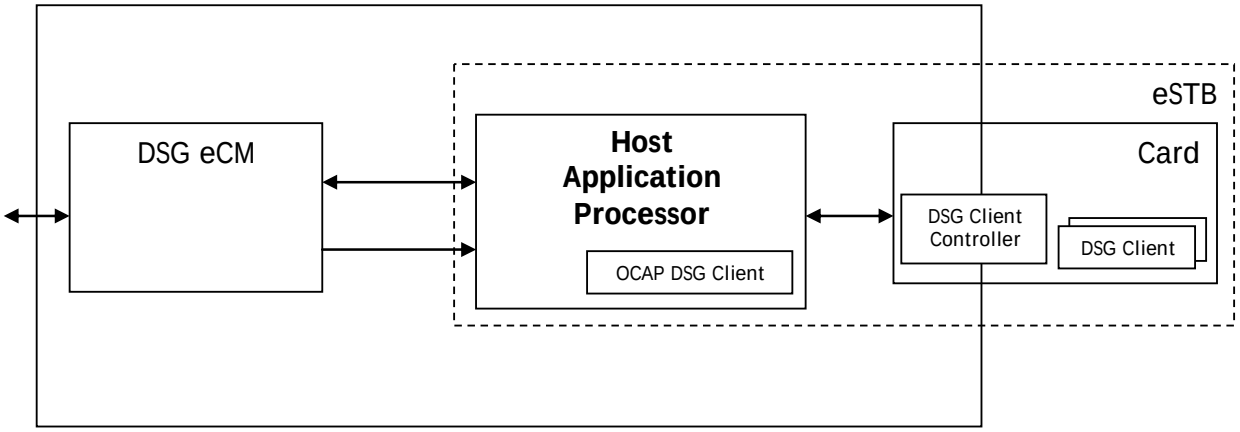


Figure 13–1 - Host 2.1 DSG architecture

There are two different operational modes defined for DSG operation, Basic and Advanced Mode.

In Basic DSG mode, all SCTE 65 SI messages, SCTE 18 EAS messages, CVTs, and OCAP XAITs SHALL be received by the OCHD2.1 via the Extended channel.

In Advanced DSG mode, these messages may be terminated directly in the OCHD2.1 or may be received by the OCHD2.1 via the Extended channel.

In Advanced DSG Mode using Extended Channel resource version 3 or 4, all SCTE 65 SI messages, SCTE 18 EAS messages, CVTs, and OCAP XAITs SHALL be received by the OCHD2.1 via an Extended channel MPEG flow.

In Basic and Advanced DSG Mode, the return path is through the DOCSIS upstream channel. In Basic DSG one-way and Advanced DSG one-way mode, the DOCSIS return path is not present or has been disabled.

In Advanced DSG Mode using the DSG resource and Extended Channel resource version 5, all SCTE 65 SI messages, SCTE 18 EAS messages, CVTs, and OCAP XAITs SHALL be received directly by the OCHD2.1 directly from the eCM or via an Extended channel MPEG flow as signaled by the Card in the ***DSG_directory()*** APDU. In that APDU, dir_entry_type = 0x01 indicates that the data is provided via DSG directly from the eCM, while dir_entry_type = 0x02 indicates that the data is provided via an Extended channel MPEG flow.

If the OCHD2.1 receives the dir_entry_type = 0x01 (ADSG Filter) for SCTE 65 SI messages, SCTE 18 EAS messages, CVTs, or OCAP XAITs in the ***DSG_directory()*** APDU, it SHALL use the associated DSG filter to acquire the indicated flow directly from the eCM.

If the OCHD2.1 receives the dir_entry_type = 0x01 (ADSG Filter) in the ***DSG_directory()*** APDU and does not recognize the dsg_client_id, it SHALL ignore the ADSG Filter associated with this entry (that is, these parameters are not forwarded to the eCM).

If the OCHD2.1 receives the dir_entry_type = 0x02 for SCTE 65 SI messages, SCTE 18 EAS messages, CVTs, or OCAP XAITs in the ***DSG_directory()*** APDU, it SHALL open an Extended channel MPEG flow for the SI Base PID using the ***new_flow_req()*** APDU to acquire the indicated flow.

If the OCHD2.1 receives SCTE 65 SI messages, SCTE 18 EAS messages, CVTs, or OCAP XAITs over both a DSG Broadcast Tunnel and an Extended channel MPEG flow, the information on the Broadcast Tunnel SHALL take precedence.

On some cable plants, the SCTE 65 Broadcast tunnel might contain more than one Virtual Channel Table designated by different vct_ids. The Card determines the correct vct_id and passes this to the OCHD2.1. If the Card does not pass a vct_id to the OCHD2.1, the device uses a default vct_id.

The vct_id sent by the Card in the ***DSG_directory()*** APDU SHALL be used by the OCHD2.1 to identify the correct Virtual Channel Table from the SCTE 65 Broadcast tunnel when multiple instances of the VCT are present.

The OCHD2.1 SHALL use the Virtual Channel Table containing the default vct_id value of zero (0x0000) unless notified by the Card to use a different value.

The OCHD2.1 SHALL use the default vct_id of zero (0x0000) to identify the Virtual Channel Table after a power cycle or reboot.

In some systems, it might be necessary to use UCID of the DOCSIS upstream channel to facilitate regionalization. The DCD message can contain UCID as a classifier for specific DSG Tunnels.

If a UCID other than 0x00 is included with the ADSG_Filter() table as part of an entry in the ***DSG_directory()*** APDU, the OCHD2.1 SHALL use this UCID as a classifier to determine which tunnels to open when the eCM UCID has been acquired.

> The OCHD2.1 SHALL NOT use UCID as a classifier to determine which tunnels to open when operating in One-Way mode or the eCM UCID is unknown.

If UCID = 0x00 is included with the ADSG_Filter() table as part of an entry in the ***DSG_directory()*** APDU, the OCHD2.1 SHALL NOT use UCID as a classifier to determine which tunnels to open.

In Advanced DSG mode, UDP/IP packets delivered directly to DSG clients on the OCHD2.1 may have a multicast IP destination address that does not have the IP multicast address to multicast MAC Address mapping as defined in [RFC 1112]. DSG clients on the OCHD2.1 are expected to disregard any mapping between IP multicast address and Ethernet multicast address and consume all IP packets delivered to the DSG client on the applicable DSG Tunnel(s).

The following messages are used for Advanced DSG mode configuration when a session to the DSG resource has been opened:

- ***inquire_DSG_mode ()*** – The OCHD2.1 can query the Card for the preferred operational mode for the network.
- ***set_DSG_mode ()*** – The Card can inform the OCHD2.1 of the preferred operational mode for the network, either QPSK mode, Basic DSG mode, Basic DSG One-way mode, Advanced DSG mode, or Advanced DSG One-way mode.
- ***DSG_error ()*** – The Card can inform the OCHD2.1 of errors that occur while operating in Advanced DSG mode.
- ***DSG_directory ()*** – The Card uses the DSG_directory() APDU to pass DSG Advanced Mode configuration parameters.
- ***send_DCD_info ()*** – The Card/OCHD2.1 uses the send_DCD_info() to pass TLVs contained in the DCD message.

- ***DSG_message ()*** – This message is used by the OCHD2.1 to pass the upstream channel ID (UCID) to the Card or to indicate certain eCM operational states.

The following messages are used for Basic DSG mode configuration:

- ***inquire_DSG_mode ()*** – The OCHD2.1 can query the Card for the preferred operational mode for the network.
- ***set_DSG_mode ()*** – The Card can inform the OCHD2.1 of the preferred operational mode for the network, either QPSK mode, Basic DSG mode or Basic DSG One-way mode.
- ***DSG_error ()*** – The Card can inform the OCHD2.1 of errors that occur while operating in DSG mode.
- ***DSG_message ()*** – This message is used by the OCHD2.1 to indicate certain eCM operational states.

The eCM in the OCHD2.1 SHALL be implemented according to [RFIv2.0].

The eCM in the OCHD2.1 SHALL comply with the requirements specified in [eDOCSIS].

The OCHD2.1 SHALL implement the eSTB eSAFE (embedded Service/Application Functional Entity) as specified in [eDOCSIS].

The OCHD2.1 SHALL implement the eSTB logical interfaces according to [eDOCSIS].

The OCHD2.1 SHALL NOT implement the DSG Client Controller (DSGCC) function as specified in [DSG].

The eCM in the OCHD2.1 SHALL NOT operate in any DSG mode until the operational mode is established by the DSGCC in the ***set_DSG_mode ()*** APDU.

The eCM in the OCHD2.1 SHALL not operate in any DSG mode in the absence of a Card, i.e., tunnel packet forwarding disabled.

The eCM in the OCHD2.1 SHALL remain tuned to a valid DSG channel and continue to forward tunnel packets to the eSTB regardless of the state of upstream channel connectivity.

When operating in Advanced DSG Mode, the OCHD2.1 SHALL NOT determine the validity of or make decisions regarding DCD messages received from the eCM except as defined in [DSG].

The OCHD2.1 SHALL NOT forward DCD messages to the DSGCC when operating in Basic mode.

The OCHD2.1 SHALL forward all DSG packets with MAC addresses provided by the Card to the Card when operating in Basic DSG mode.

The OCHD2.1 SHALL support both Basic and Advanced mode as defined in [DSG].

The OCHD2.1 SHALL provide a packet buffer with a minimum size of 16 kilobytes for receiving DSG tunnel traffic and DCD fragments.

NOTE: This buffer is for the temporary storage of packets received by the eCM before they are forwarded across the Card interface. Even though DSG tunnels may be rate-shaped individually to a total of 2.048 Mbps, they are not rate-shaped as an aggregate. This buffer size assumes maximum length packets arriving from eight different tunnels back-to-back plus space for DCD message fragments.

13.1 DSG mode selection

1. After initialization, authentication and binding are completed, the OCHD2.1 operates in SCTE 55 mode while the Card downloads a configuration message from the network controller indicating the desired operational mode.

2. The Card prepares for the transfer of DSG tunnel packets over the Extended Channel by issuing the ***new_flow_req()*** APDU to the OCHD2.1 with service_type = 0x03 (DSG). The OCHD2.1 responds with the ***new_flow_cnf()*** APDU with *status_field* = 0x00 (Request granted) and assigns a unique Flow_ID regardless of whether the OCHD2.1 is currently operating in the SCTE 55 mode or in any DSG mode and the DSG flow has not been established.

3. If DSG advanced mode is to be established, the Card sends the ***set_DSG_mode()*** APDU to the OCHD2.1 and signals either *Advanced_DSG_mode* or *Advanced_DSG_One-Way_mode* depending on whether the upstream transmitter is to be enabled or not.

4. If DSG basic mode is to be established, the Card sends the ***set_DSG_mode()*** APDU to the OCHD2.1 and signals either *DSG_mode* or *DSG_One-Way_mode* depending on whether the upstream transmitter is to be enabled or not. This message will include a list of MAC addresses for the eCM to bridge to the Card.

5. The OCHD2.1 MAY issue the ***inquire_DSG_mode()*** APDU to query the Card as to which operational mode will be used. In either case, eCM initialization will not commence until one of the DSG modes is set by the Card.

Upon receiving the ***new_flow_req()*** APDU with service_type = 0x03 (DSG), the OCHD2.1 SHALL grant the DSG flow regardless of whether the OCHD2.1 is operating in the SCTE 55 mode or operating in any DSG mode and the DSG flow has not been established.

When the OCHD2.1 sends the ***new_flow_cnf()*** APDU as a response to the ***new_flow_req()*** APDU with service_type = 0x03 (DSG), the status_field of the ***new_flow_cnf()*** APDU SHALL only contain the value 0x00 or 0x01.

If the OCHD2.1 receives a ***set_DSG_mode()*** APDU to switch to any DSG mode while operating in the SCTE 55 mode, it SHALL discard any SI data (including the SI tables stored in non-volatile memory acquired when the OCHD2.1 was in SCTE 55 mode), and any EAS data that it received from the Card in the SCTE 55 mode.

If the OCHD2.1 receives a ***set_DSG_mode()*** APDU to switch to SCTE 55 mode or a different DSG mode (i.e., Basic or Advanced). while operating in any DSG mode, it SHALL discard any SI data (including the SI tables stored in non-volatile memory), and any EAS data that it received from the Card in the DSG mode.

Upon receipt of a ***set_DSG_mode()*** APDU containing operational_mode not equal to SCTE 55, the OCHD2.1 SHALL delete any SCTE 55-related Extended channel flows prior to requesting DSG related Extended channel flows.

The OCHD2.1 SHALL terminate the use of the SCTE 55 FDC receiver until a ***set_DSG_mode()*** APDU is received with operational_mode equal to SCTE_55.

Upon receipt of a ***set_DSG_mode()*** APDU containing operational_mode equal to SCTE_55, the OCHD2.1 SHALL delete any Basic or Advanced DSG-related Extended channel flows prior to requesting SCTE_55 related Extended channel flows.

The OCHD2.1 SHALL terminate the use of the eCM until a ***set_DSG_mode()*** APDU is received with operational_mode not equal to SCTE_55.

The OCHD2.1 SHALL verify the IP packet header checksum before sending any DSG packets to the Card over an Extended channel DSG flow.

13.2 DSG Advanced Mode Operation

The following steps define the flow of Advanced DSG mode in an OCHD2.1 when using the DSG resource:

- Once an ADSG operational mode has been established, the OCHD2.1 begins to scan for a valid DSG channel. The DSG eCM downstream scan is identical to the standard DOCSIS scan with the additional requirement that the downstream contain a DCD message.

- When the eCM finds a DOCSIS channel containing a DCD message, the OCHD2.1 sends the contents of the DCD message to the Card using the ***send_DCD_info()*** APDU. If the Card determines that the downstream channel is valid, it sends the ***DSG_directory()*** APDU to the OCHD2.1 containing a list of DSG filters available for OCHD2.1 use, and also a list of DSG filters identifying DSG packets to be forwarded to the Card. The eCM will then remain on the current downstream channel. If the Card determines that the downstream channel is not valid, it sends a ***DSG_error()*** APDU to the OCHD2.1 with the error_status field set to invalid_dsg_channel, and the eCM will resume the downstream scan.

- If the eCM scans the entire downstream spectrum and does not find a DOCSIS channel containing a DCD message, the OCHD2.1 issues the ***DSG_message()*** APDU with message_type 0x03 (Downstream_Scan_Completed) to inform the Card that it has done a complete scan. At this point, or at any other time, the Card may switch to another out-of-band mode by issuing a ***set_DSG_mode()*** APDU.

- As soon as the OCHD2.1 receives the ***DSG_directory()*** APDU, it can begin forwarding DSG packets to the Card (or terminate DSG packets directly) while the eCM continues the normal DOCSIS initialization sequence.

- When DOCSIS registration is complete and eCM forwarding is not restricted, the OCHD2.1 indicates to the Card that 2-Way operation is functional by issuing the ***DSG_message() APDU*** with message_type 0x01 (2-way OK,UCID).

- The OCHD2.1 forwards DSG packets requested by the Card across the Extended Channel interface via the DSG flow, if open. If the DSG flow is not open, the packets are to be dropped.

- After locating a DOCSIS channel containing a DCD message, the OCHD2.1 SHALL pass the initial received DCD message TLVs to the Card using the ***send_DCD_info ()*** APDU.

- After the initial DCD message has been sent using the ***send_DCD_info ()*** APDU, the OCHD2.1 SHALL only send the DCD message TLVs when it detects a change in the configuration count change field in the DCD message or detects an eCM MAC layer reinitialization. The DCD message is defined in [DSG].

- When the UCID has been acquired from the eCM, the OCHD2.1 SHALL use the ***DSG_message()*** APDU to send the UCID to the Card.

  OCHD2.1-specific DSG tunnels will be designated in the ADSG_Filter() table contained in the number_of_host_entries field in the ***DSG_directory()*** APDU. The Card may send all of the entries defined in the DCD message to the OCHD2.1 or may modify the list it sends.

- In case of a shortage of network resources, the OCHD2.1 SHALL give priority to the ADSG_Filters specified as Card entries in the ***DSG_directory()*** APDU.

- If the default UCID = 0x00 is included with the ADSG_Filter() table as part of an entry in the ***DSG_directory()*** APDU, the OCHD2.1 SHALL open this tunnel if the eCM UCID is not known or the host device is running in Advanced One-Way Mode. If the Host cannot find its UCID in the list of tunnels in the DSG_directory, the Host is expected to open the default tunnel. When UCID is used as a classifier in a DSG Rule, it is expected that a default rule, with a lower priority that does not use UCID as a classifier, will be present in the DCD message as defined in [DSG].

- The OCHD2.1 SHALL send a ***DSG_message ()*** APDU with a message type of eCM Reset whenever the eCM enters the "Continue scanning for DSG Channel" state as shown in Figure 5-4 of [DSG]. This ensures the DSG-CC on the Card will react to a ***send_DCD_info ()*** APDU generated by the OCHD2.1 from the DCD of the new downstream, even if the Configuration Change Count (CCC) field happens to contain the same value as the Configuration Change Count (CCC) from the old downstream's DCD.

The following figure is an example of the initial message exchange between the Card and the OCHD2.1 for Advanced Mode Operation:

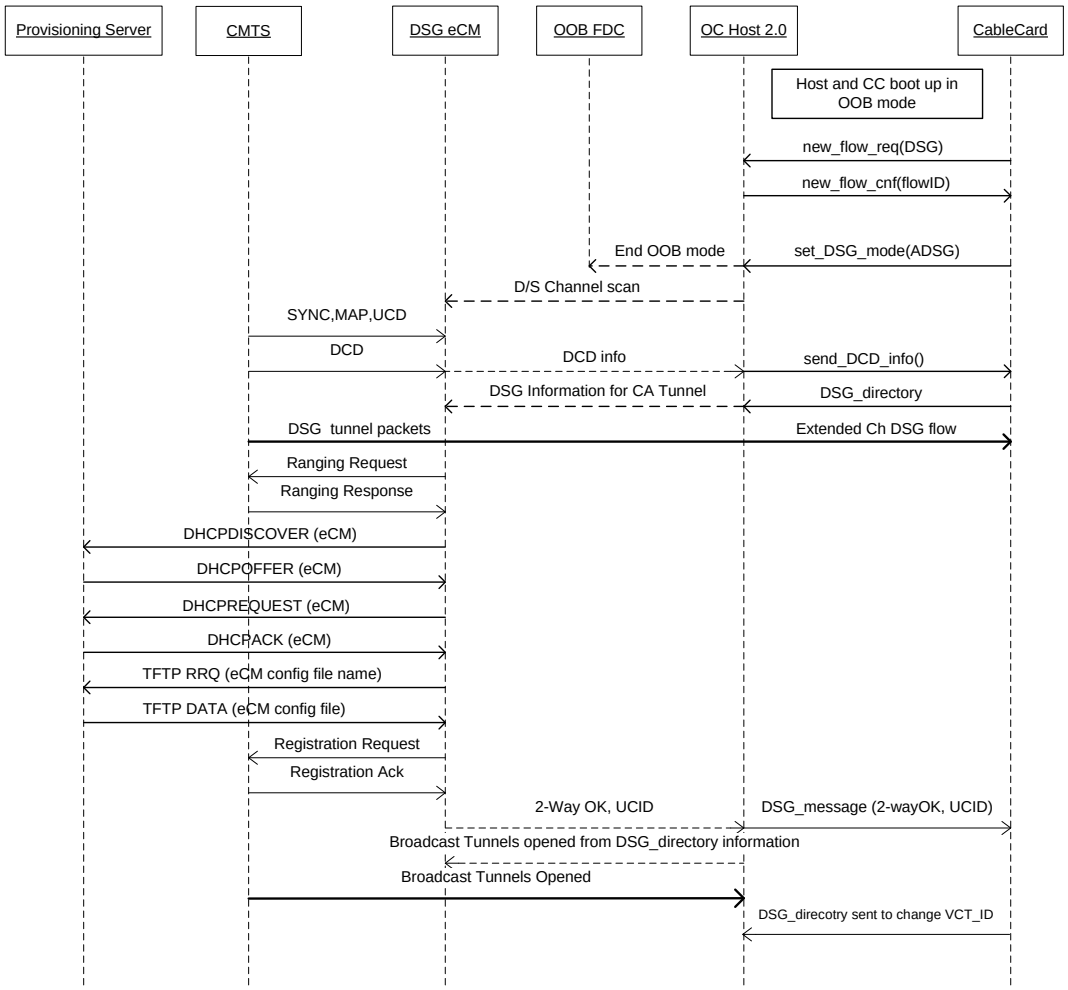


Figure 13.2–1 - Sample Advanced Mode Message Flow (Informative)

13.3 DSG Basic Mode Operation

1. Once the operational mode has been established, the OCHD2.1 begins to scan for a valid DSG channel. The DSG eCM downstream scan is identical to the standard DOCSIS scan with the additional requirement that the downstream contain appropriate DSG tunnels.

2. When the eCM finds a DOCSIS downstream containing the appropriate MAC addresses as specified in the ***set_DSG_mode()*** APDU, it remains on that downstream.

3. If the eCM scans the entire downstream spectrum once and does not find a DOCSIS channel containing the appropriate tunnels, the OCHD2.1 issues the ***DSG_message()*** APDU with *message_type* 0x03 (Downstream_Scan_Completed) to inform the Card that it has done a complete scan. The Card tells the Host to switch to another out-of-band mode by issuing a ***set_DSG_mode()*** APDU.

4. When the eCM has found a valid DSG channel, it immediately begins forwarding DSG packets to the Card and continues the normal DOCSIS initialization sequence.

The Card provides the OCHD2.1 with a set of MAC Addresses that the eCM uses to filter DSG tunnels.

- The eCM utilizes the presence/absence of the requested tunnel MAC Address to determine if a downstream channel contains valid DSG tunnels.
- The OCHD2.1 does not forward the DCD messages, if present, to the Card.
- The OCHD2.1 forwards all DSG packets to the Card over the extended channel via a DSG flow type.

The following figure is an example of the initial message exchange between the Card and the OCHD2.1 for DSG Basic Mode operation:

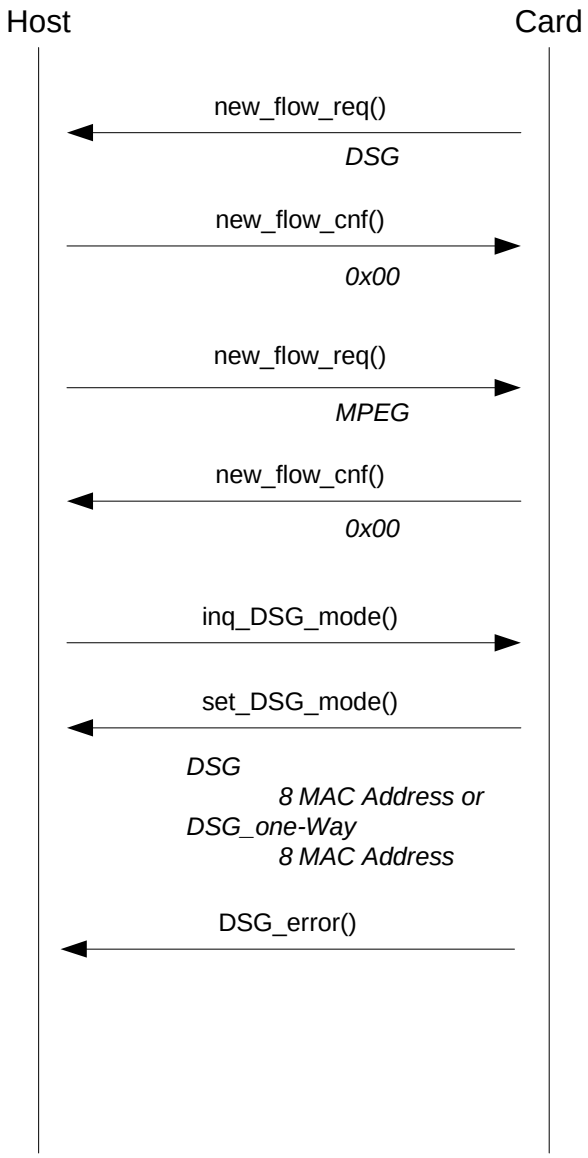


Figure 13.3–1 - Sample Basic DSG Mode Message Flow (Informational)

13.4 Broadcast Tunnels

The OpenCable use of the term "Broadcast Tunnel" describes a DSG Tunnel that is always connected and may be consumed directly by the OCHD2.1, if present. Currently there are three defined types of Broadcast Tunnels; SCTE 65, SCTE 18 and tunnels containing CVTs and/or OCAP XAITs. SCTE 65 Broadcast Tunnels contain data associated with the SCTE 65 specification for Service Information. SCTE 18 Broadcast Tunnels contain data associated with the SCTE 18 specification for Emergency Alert Messages. Other Broadcast Tunnels contain the OCAP XAIT messages that signal unbound applications and Common Download Code Version Tables that signal OCHD2.1 code image upgrade. Each of these tunnel types carries a specific type(s) of industry-standard data and do not contain any other data types. The data in these tunnels are delivered as MPEG sections within a UDP packet and use the BT header as defined in [DSG]. These tunnels may be processed directly by the OCHD2.1.

NOTE: [DSG] defines a "Broadcast Client ID" type. The OpenCable "Broadcast Tunnels" are associated with specific DSG Broadcast Client ID values. [DSG] may also define additional Broadcast Client Ids which are not associated with OpenCable "Broadcast Tunnels".

13.5 Application tunnels

Application Tunnels are DSG tunnels that carry data flows intended for applications running on the OCHD2.1 or carry operational code file images to upgrade the software of the OCHD2.1. Application Tunnels may contain DSMCC Object or Data Carousels or application specific data formats. If the Application Tunnel contains a Data Carousel (Common Download) or an Object Carousel (OCAP), the stream will use the DSG Carousel Header as part of the MPEG section/UDP structure as defined in [DSG].

One method for OCAP applications to request and receive application tunnels is described below.

1. The OCAP application registers with the OCHD2.1 by providing its textual name (source_name) through the appropriate OCAP API.

   Assuming that the OCHD2.1 has already received the SCTE 65 Network Text Table (NTT) delivered directly over a DSG Broadcast tunnel or via the Extended Channel, the source_name_subtable (SNS) is parsed for all mappings between source_name() and application_id. Using the SNS, the OCHD2.1 makes an association between the textual_name provided by the OCAP application and an application_id.

2. The DSGCC parses the DCD message for all DSG Rules and issues the ***DSG_directory()*** APDU. The OCHD2.1 will parse the directory for desired application_ids for the DSG Classifier parameters (MAC address, Source/Dest IP address, TCP/UDP Port address). The OCHD2.1 SHALL ignore any parameters passed in the ***DSG_directory()*** APDU associated with application_ids it does not recognize (i.e., these parameters are not forwarded to the eCM).

3. For application_ids that the OCHD2.1 recognizes, the device forwards the addresses to the eCM, which begins filtering the desired DSG tunnel packets based on MAC address / DSG Classifier Parameters and passing these packets to the OCHD2.1.

4. The OCHD2.1 forwards the DSG Application tunnel data to the OCAP application associated with the application_id of the DSG tunnel.

13.6 Internet Protocol Flows

The Extended Channel supports delivery of IP packets across the Card interface for OCHD2.1s. Both unicast (point-to-point) and multicast (point-to-multipoint) addressing are supported by this protocol. If the OCHD2.1 is in OOB mode, then the Card is the link device and services the IP flow via utilization of the OCHD2.1's RDC and, if able, supplies the OCHD2.1 with an IP address. On request of a ***new_flow_req()*** APDU from the OCHD2.1, the Card responds to the request to open the flow by obtaining an IP address for use by the OCHD2.1. The IP address is returned in the ***new_flow_cnf()*** APDU message.

Informative Note: The Card is not required to grant a request for service type IP Unicast when requested by the OCHD2.1.

When in QPSK mode (Card is the link modem) the Card transmits all unicast IP packets received to the assigned OCHD2.1 IP address to the OCHD2.1 when the OCHD2.1 has successfully opened a unicast IP flow. The Card may drop packets when its buffers become full if the OCHD2.1 is unable to absorb the packets as fast as they are being transmitted.

When in QPSK mode and the Card has opened an IP flow to the OCHD2.1, any IP unicast data received from the OCHD2.1 is transmitted to the network if physically possible.

When in QPSK mode, the Card may send broadcast IP data to the OCHD2.1, and the Card may receive broadcast IP packets from the OCHD2.1.

If the Card supports multicast and is in QPSK mode and has granted the OCHD2.1 a multicast IP flow, all IP data to the multicast IP address is transmitted to the OCHD2.1. The Card may drop packets when its buffers become full if the OCHD2.1 is unable to absorb the packets as fast as they are being transmitted.

In DSG mode, the Card resides at the Network Layer, and the OCHD2.1 SHALL utilize its eCM to provide the Data Link Layer to the underlying DOCSIS network.

When the Card needs to utilize the DOCSIS network to transfer IP packets upstream, it first submits a ***new_flow_req()*** APDU to the OCHD2.1 to establish an IP flow to transfer IP packets between the Card and the OCHD2.1's eCM interface. The Card submits its MAC address in its request to the OCHD2.1 for an IP flow. The Card MAY request a Socket flow if it does require a separate IP address.

If the OCHD2.1 grants the new IP flow request, it utilizes DHCP to acquire an IP address for the Card and sends this information, along with the DOCSIS maximum transmission unit (MTU) (1500 bytes for IP packets) to the Card in a ***new_flow_cnf()*** APDU. The OCHD2.1 now opens an IP flow to the Card over the Extended channel.

When operating in any DSG mode (OCHD2.1 is the link modem), the OCHD2.1 SHALL forward packets received from the eCM interface destined to the Card IP address via the granted IP Unicast flow.

The OCHD2.1 MAY drop packets when its buffers become full if the Card is unable to absorb the packets as fast as they are being transmitted.

The OCHD2.1 MAY drop packets received from the Card if the buffering for these packets is exceeded.

When operating in any DSG mode, the OCHD2.1 SHALL transmit to the network any IP unicast data received from the Card, if physically possible.

When operating in any DSG mode, the OCHD2.1 MAY send broadcast IP packets to the Card, and the OCHD2.1 MAY receive broadcast IP packets from the Card.

When operating in any DSG mode, the OCHD2.1 SHALL grant a multicast IP flow when requested by the Card and transmit all multicast IP packets from the assigned multicast IP address to the Card, if the host device supports IP multicast.

The OCHD2.1 MAY drop packets when its buffers become full if the Card is unable to absorb the packets as fast as they are being transmitted.

The OCHD2.1 utilizes the Extended Channel's IP flow to forward certain IP packets it receives over the eCM interface to the Card. The forwarding rules are described in Section 13.6.4.

When operating in any DSG mode and an established IP flow becomes unavailable for any reason, the OCHD2.1 SHALL report this event to the Card using the ***lost_flow_ind()*** APDU.

One example case where a flow may become unavailable is due to a change in the state of the eCM that may have resulted from a change via SNMP to the eCM's operational state.

When in QPSK mode, the Card is the network interface and modem. If the OCHD2.1 requests an IP address, the Card provides an IP address based on the vendor's proprietary mechanisms. This may be accomplished with DHCP.

When in DSG mode, the OCHD2.1 is the network interface and modem. The Card may request an IP flow (and hence an IP address) from the OCHD2.1 using the ***new_flow_req()*** APDU by requesting a service_type = 0x01 (IP unicast).

If the OCHD2.1 has received a ***new_flow_req()*** APDU with service_type = 0x01 (IP unicast) and has not yet completed its network initialization, it SHALL respond with the ***new_flow_cnf()*** APDU with status_field = 0x03 (Request denied, network unavailable or not responding).

If the OCHD2.1 denies the request for an IP flow, the Card SHOULD periodically attempt to open an IP flow. Once the OCHD2.1 successfully completes its network initialization and receives its IP address, it SHOULD respond to Card requests for an IP flow by acting as a DHCP proxy and attempt to obtain an IP address for the Card. If an IP address is obtained in this manner, the OCHD2.1 will respond to the Card with the ***new_flow_cnf()*** APDU with status_field = 0x00. If an IP address is not obtained for whatever reason, the OCHD2.1 will respond with the ***new_flow_cnf()*** APDU with status_field = 0x05, and the IP flow will not be opened. The Card may continue to attempt to open the flow.

When the Card changes the mode from QPSK to DSG, if there is an IP flow open, the Card SHOULD send a ***lost_flow_ind()*** APDU with reason_field = 0x00 for the flow ID assigned to the OCHD2.1's IP_U flow. The OCHD2.1 SHOULD respond with the ***lost_flow_cnf()*** APDU with status_field = 0x00. While it can be assumed that the flow is closed, the OCHD2.1 SHOULD send a ***delete_flow_req()*** APDU to the Card to ensure that the flow is deleted. When a OCHD2.1 receives a ***lost_flow_ind()*** APDU or sends a ***delete_flow_req()*** APDU for the IP_U flow, it SHOULD discard the previously assigned IP address.

When the Card changes the mode from DSG to QPSK, if there is an IP flow open, the OCHD2.1 SHOULD send a ***lost_flow_ind()*** APDU with reason_field = 0x00 for the flow ID assigned to the Card's IP_U flow. The Card SHOULD respond with the ***lost_flow_cnf()*** APDU with status_field = 0x00. While it can be assumed that the flow is closed, the Card SHOULD send a ***delete_flow_req()*** APDU to the OCHD2.1 to ensure that the flow is deleted. When a Card receives a ***lost_flow_ind()*** APDU or sends a ***delete_flow_req()*** APDU for the IP_U flow, it SHOULD discard the previously assigned IP address.

13.6.1 eSTB DHCP Requirements

This section describes how the eSTB acquires an IP address through DHCP for its own use.

After the eCM has completed the DOCSIS registration process and if eCM forwarding has not been restricted, it will notify the eSTB by issuing the "2-Way OK,UCID" message as defined in [DSG]. This message is forwarded to the DSG Client controller on the Card using the ***DSG_message()*** APDU, which indicates that the eCM has established two-way IP connectivity.

After the OCHD2.1 has sent the ***DSG_message()*** APDU indicating "2-Way OK,UCID", it SHALL invoke DHCP mechanisms according to [RFC 2131] in order to acquire an IP address for the eSTB and any other parameters needed to establish IP connectivity.

If eCM forwarding is restricted and the eSTB has not been provisioned, then the OCHD2.1 SHALL NOT perform any actions with regard to IP provisioning over the eCM interface.

The OCHD2.1 SHALL deny any request from the Card to open an IP flow until the eSTB has acquired an IP address.

The OCHD2.1 DHCP client behavior during all phases of operation, including initial IP address lease acquisition and lease renewal, SHALL be in accordance with the Client requirements of [RFC 2131] and the DHCP option requirements of [RFC 2132].

The following fields SHALL be present in the DHCPDISCOVER and DHCPREQUEST message from the OCHD2.1 for the eSTB and set as described below.

The hardware type (htype) SHALL be set to 1 (Ethernet).

The hardware length (hlen) SHALL be set to 6.

The client hardware address (chaddr) SHALL be set to the 48-bit MAC address associated with the OCHD2.1.

The Client-identifier option (61) SHALL be included with the hardware type set to 1 and the value set to the same 48-bit MAC address as the chaddr field.

The "parameter request list" option (55) SHALL be included with the following option codes present in the list:

Option code 1 (Subnet Mask)

Option code 3 (Router Option)

Option code 6 (Domain Name Server)

Option code 15 (Domain Name)

Option code 23 (Default time to live)

Option code 51 (IP address lease time)

Option code 54 (Server Identifier)

To enable class identification, DHCP option 60 SHALL be included containing the character string "OpenCable2.1" using characters from the NVT ASCII character set with no terminating NULL.

DHCP option 43 and its sub-options 2, 3, 4, 5, 6, 7, 8, 9, 10 and 54 SHALL be included. Details of DHCP option 43 and its sub-options for the eSTB are further defined below.

DHCP option 50, Requested IP Address, SHALL only be included in DHCPREQUEST messages.

The following requirements pertain to the option 43 sub-options in the DHCPDISCOVER and DHCPREQUEST messages from the eSTB.

DHCP option 43 in the eSTB is a compound option. The content of option 43 is composed of one or more sub-options. The option begins with a type octet with the value of number 43, followed by a length octet. The length octet is followed by the number of octets of data equal to the value of the length octet. The value of the length octet does not include the two octets specifying the tag and length. Each sub-option begins with a tag octet containing the sub-option code, followed by a length octet that indicates the total number of octets of data. The value of the length octet does not include itself or the tag octet. The length octet is followed by "length" octets of sub-option data. An example of the option 43 suboptions is given in Table 13.6-1.

The definitions of DHCP option 43 sub-options SHALL conform to requirements imposed by [RFC 2132].

An example implementation of the Vendor Specific Information Option (DHCP option 43) is shown in Table 13.6-1.

The OCHD2.1 SHALL encode each of the DHCP option 43 sub-options 2, 3, 4, 5, 6, 7, 8, 9, 10, and 54 as a character string consisting of characters from the NVT ASCII character set with no terminating NULL.

The OCHD2.1 MAY include Option 43 sub-option 1 in DHCPDISCOVER and DHCPREQUEST messages.

If DHCP option 43 sub-option 1 is included in DHCP client messages, the OCHD2.1 SHALL encode this sub-option by the number of octets equal to the value of the length octet of this sub-option, with each octet codifying a requested sub-option.

If the length octet of sub-option 1 is 0 (because there are no requested sub-options), this sub-option SHOULD be omitted from DHCP option 43.

The OCHD2.1 SHALL include DHCP option 43 sub-option 2 containing the character string "ESTB" (without the quotation marks).

The OCHD2.1 SHALL include DHCP option 43 sub-option 3 containing a colon-separated list of all eSAFE types in the device, including at a minimum the colon-separated character string "ECM:ESTB" (without the quotation marks).

The OCHD2.1 SHALL include DHCP option 43 sub-option 4 containing the device serial number.

The OCHD2.1 SHALL include DHCP option 43 sub-option 5 containing the Hardware version number, identical to the value as reported in the <Hardware version> field in the MIB object sysDescr.

The OCHD2.1 SHALL include DHCP option 43 sub-option 6 containing the Software version number, identical to the value as reported in the <Software version> field in the MIB object sysDescr.

The OCHD2.1 SHALL include DHCP option 43 sub-option 7 containing the Boot ROM version number, identical to the value as reported in the <Boot ROM version> field in the MIB object sysDescr.

The OCHD2.1 SHALL include DHCP option 43 sub-option 8 containing a 6-octet (6 NVT ASCII characters), hexadecimally-encoded, vendor-specific Organization Unique Identifier (OUI) that uniquely identifies the OCHD2.1 manufacturer.

A vendor MAY use the same OUI as in the OCHD2.1's MAC address, and MAY use a single OUI to identify all its products.

The OCHD2.1 SHALL include DHCP option 43 sub-option 9 containing the Model number, identical to the value as reported in the <Model number> field in the MIB object sysDescr.

The OCHD2.1 SHALL include DHCP option 43 sub-option 10 containing the Vendor name, identical to the value as reported in the <Vendor name> field in the MIB object sysDescr.

The OCHD2.1 SHALL include DHCP option 43 sub-option 54 containing the 40-bit HOST_ID, identical to the value in the Host X.509 certificate.

If the total number of octets in all DHCP option 43 sub-options exceeds 255 octets, the OCHD2.1 SHALL follow [RFC 3396] to split the option into multiple smaller options.

An example of DHCP option 60 and the DHCP option 43 suboptions is given in Table 13.6-1.

The following requirements pertain to the DHCPACK message.

The OCHD2.1 SHALL ignore any DHCP options delivered by the DHCP server in the DHCP message that the eSTB does not require or cannot interpret.

[REQtemp04] The OCHD2.1 SHALL verify the existence of the following DHCP fields within the DHCPOFFER/DHCPACK message it receives from the DHCP server during initial IP address lease acquisition:

The IP address to be used by the eSTB (yiaddr)

The subnet mask to be used by the eSTB (Subnet Mask, Option 1)

A list of IP addresses of one or more routers to be used for forwarding eSTB-originated IP traffic (Router, Option 3); the eSTB is not required to use more than one router IP address for forwarding but SHALL use at least one.

The IP Address Lease Time (Lease Time, Option 51)

The Server Identifier of the DHCP server (Server Identifier, Option 54)

If any of the DHCP fields required in [REQtemp04] are absent from the DHCPACK message, the OCHD2.1 SHALL reject the offered lease and restart its DHCP IP address acquisition process from the INIT state as defined in [RFC 2131].

The OCHD2.1 SHALL disregard any TFTP Server Name (either option 66 or 'siaddr' field of header) and Bootfile Name (either option 67 or 'file' field of header) parameters defined in a DHCPACK/DHCPOFFER message and not download a configuration file using these parameters.

The OCHD2.1 SHALL verify the existence of the DHCP fields required in [REQtemp04] within the DHCPACK message it receives from the DHCP server during a DHCP Renew or Rebind.

If the DHCPACK message does not contain the *yiaddr* field, the OCHD2.1 SHALL restart its DHCP IP acquisition process from the INIT state as defined in [RFC 2131].

If any DHCP field required in [REQtemp04], other than *yiaddr*, is missing or is invalid in the DHCPACK message during a DHCP Renew or Rebind, the OCHD2.1 SHALL ignore any invalid fields, preserve any field values from its initial IP address acquisition or a previous Renew or Rebind, and continue with normal operation. An example of an invalid field would be an option that is syntactically malformed (e.g., with an incorrect option length).

13.6.2 Card DHCP Requirements

The section describes how the OCHD2.1 acquires an IP address through DHCP on behalf of the Card.

After the eSTB has successfully completed the IP address acquisition, it can grant an IP flow across the extended channel when it receives a ***new_flow_req()*** APDU from the Card with service_type = 0x01 (IP unicast).

The OCHD2.1 SHALL use the Card's MAC address and options field provided in the ***new_flow_req()*** APDU with service_type = 0x01 (IP unicast), to obtain an IP address for the Card using DHCP.

The OCHD2.1 SHALL act as a DHCP client for the Card and adhere to all Client requirements specified in [RFC 2131] and the DHCP option requirements of [RFC 2132].

The OCHD2.1 SHALL save the value sent in the MAC_address field of the ***new_flow_req()*** APDU with service_type = 0x01(IP unicast), for use in subsequent operations performed on behalf of the Card.

When performing DHCP operations on behalf of the Card, the OCHD2.1 SHALL confirm that any received DHCPOFFER messages are in response to the initial DHCPDISCOVER message by matching the Transaction ID field (xid), verifying that the *chaddr* field contains the Card MAC address and the destination MAC address is the Card MAC address.

When performing DHCP operations on behalf of the Card, the OCHD2.1 SHALL confirm that any received DHCPACK messages are in response to the previous DHCPREQUEST message by matching the Transaction ID

field (xid), verifying that the *chaddr* field contains the Card MAC address and the destination MAC address is the Card MAC address.

Once the OCHD2.1 acquires a unique IP address for the Card, it SHALL send the ***new_flow_cnf ()*** APDU granting the requested IP Unicast flow and assigning a unique flow_id. In this confirmation message, the OCHD2.1 includes the IP address assigned to the Card.

The OCHD2.1 SHOULD set the option_field_length field in the ***new_flow_cnf()*** confirmation message to 0.

When performing DHCP operations on behalf of the Card, the OCHD2.1 SHALL save the values returned in the *yiaddr* field (IP address assigned to the Card) and option 51 (IP Address Lease Time) of the DHCPACK message in storage for use in subsequent DHCP operations on behalf of the Card (INIT-REBOOT, RENEW, REBIND).

All OCHD2.1 DHCP transactions associated with acquiring the IP address for the Card SHALL be over the eCM interface and not propagate to any other interface on the OCHD2.1.

The OCHD2.1 SHALL populate Ethernet frames using the Card MAC address as the source MAC address for all DCHP packets initiated on behalf of the Card.

When performing DHCP operations on behalf of the Card, the OCHD2.1 SHALL populate the source IP address field with "0.0.0.0" in the IP header prior to obtaining an IP address.

The following fields SHALL be present in the DHCPDISCOVER and DHCPREQUEST message sent by the OCHD2.1 on behalf of the Card and set as described below:

The hardware type (htype) SHALL be set to 1 (Ethernet).

The hardware length (hlen) SHALL be set to 6.

The client hardware address (chaddr) SHALL be set to the 48-bit MAC address received in the ***new_flow_req()*** APDU.

The Client-identifier option (61) SHALL be included with the hardware type set to 1 and the value set to the same 48-bit MAC address as the chaddr field.

The "parameter request list" option (55) SHALL be included with the following option codes present in the list:

Option code 1 (Subnet Mask)

Option code 3 (Router Option)

Option code 23 (Default time to live)

Option code 51 (IP address lease time)

Option code 54 (Server Identifier)

The OCHD2.1 SHALL NOT reformat option 43 and 60 obtained from the ***new_flow_req()*** APDU.

DHCP option 50, Requested IP Address, SHALL only be included in DHCPREQUEST messages.

When performing DHCP operations on behalf of the Card, the OCHD2.1 SHALL ignore any DHCP options delivered by the DHCP server that the Card does not require.

[REQtemp05] When performing DHCP operations on behalf of the Card, the OCHD2.1 SHALL verify the existence of the following DHCP fields within the DHCPACK message it receives from the DHCP server during initial IP address lease acquisition:

The IP address to be used by the Card (yiaddr)

The subnet mask to be used by the OCHD2.1 on behalf of the Card (Subnet Mask, Option 1)

A list of IP addresses of one or more routers to be used for forwarding Card-originated IP traffic (Router, Option 3). The OCHD2.1 is not required to use more than one router IP address for forwarding but SHALL use at least one.

The IP Address Lease Time (Lease Time, Option 51)

The Server Identifier of the DHCP server (Server Identifier, Option 54)

If any of the DHCP fields required in [REQtemp05] are absent from the DHCPACK message, the OCHD2.1 SHALL reject the offered lease and restart the DHCP Card IP address acquisition process from the INIT state as defined in [RFC 2131].

When performing DHCP operations on behalf of the Card, the OCHD2.1 SHALL verify the existence of any DHCP fields required in [REQtemp05] within the DHCPACK message it receives from the DHCP server during a DHCP Renew or Rebind.

When performing DHCP operations on behalf of the Card, if the DHCPACK message does not contain the *yiaddr* field, the OCHD2.1 SHALL restart the DHCP IP acquisition process from the INIT state as defined in [RFC 2131].

When performing DHCP operations on behalf of the Card, if any DHCP field required in [REQtemp05], other than *yiaddr*, is missing or is invalid in the DHCPACK message during a DHCP Renew or Rebind, the OCHD2.1 SHALL ignore any invalid fields, preserve any field values from its initial IP address acquisition or a previous Renew or Rebind and continue with normal operation. An example of an invalid field would be an option that is syntactically malformed (e.g., with an incorrect option length).

13.6.3 IP Address Lease Renewal

The OCHD2.1 monitors the operational status of the eCM for changes in state, particularly a re-initialization of the eCM MAC layer, transition to One-Way operation, and changes in eCM forwarding restrictions.

[REQtemp06] If the OCHD2.1 detects an eCM MAC layer re-initialization, or temporarily added and then removed eCM forwarding restrictions, it SHALL confirm both the eSTB IP address lease and the Card's IP address lease by entering the INIT-REBOOT state for each of these leases as defined in [RFC 2131] after receiving the 2-Way OK indication from the eCM.

In addition to the requirements in [REQtemp06], all other aspects of eSTB and Card IP address lease expiration SHALL be performed by the OCHD2.1 according to [RFC 2131].

If an IP flow has been established across the CableCARD interface, then the OCHD2.1 indicates to the Card that the flow is lost by sending the ***lost_flow_ind()*** APDU with reason_field = 0x02 (Network down or busy). The Card responds with the ***lost_flow_cnf()*** APDU acknowledging that the flow has been lost and then requests that the flow be deleted by sending the ***delete_flow_req()*** APDU. The Card expects to receive the ***delete_flow_cnf()*** APDU in reply.

The Card MAY try to re-open lost IP flows by sending the ***new_flow_req()*** APDU.

If the OCHD2.1 does not terminate the IP flow when in the INIT-REBOOT state for the Card's IP address lease, then the OCHD2.1 MAY drop IP packets received from the Card when in this state.

If an IP flow has been established across the CableCARD interface AND the eSTB is forced into the INIT state, then the OCHD2.1 MAY continue to forward IP packets on behalf of the Card.

The OCHD2.1 SHALL monitor the lease expiration time of the Card's IP address and perform lease renewal on behalf of the Card as defined in [RFC 2131].

In the event that the renewal process causes the OCHD2.1 to enter the INIT state on behalf of the Card, or upon Card IP address lease expiration, it SHALL terminate any open IP flow by sending the ***lost_flow_ind()*** APDU with reason_field = 0x02 (Network down or busy).

The Card MAY try to re-open the IP flow by sending the ***new_flow_req()*** APDU.

If the OCHD2.1 detects that the eCM has transitioned from Two-Way operation to One-Way operation, it SHALL notify the Card via the ***DSG_message()*** APDU with message_type = 0x02 (Entering_one_way_mode).

If an IP flow has been established across the CableCARD interface AND the OCHD2.1 transitions to One-Way operation or eCM forwarding becomes restricted, the OCHD2.1 SHALL terminate the flow by sending the ***lost_flow_ind()*** APDU with reason_field = 0x02 (Network down or busy) and not permit any new IP flows until the eCM forwarding restrictions have been removed.

The Card MAY try to re-open the lost IP flow by sending the ***new_flow_req()*** APDU.

When the eCM transitions back to Two-way mode, the OCHD2.1 SHALL enter the INIT-REBOOT state as defined in [RFC 2131] both for the eSTB's IP address and the Card's IP address.

If the OCHD2.1 detects that eCM forwarding has been restricted, it SHALL notify the Card via the ***DSG_message()*** APDU with message_type = 0x07 (2-Way OK, but forwarding restricted).

If the OCHD2.1 detects that eCM forwarding restrictions have been removed, it SHALL notify the Card via the ***DSG_message()*** APDU with message_type = 0x01 (2-Way OK, UCID).

13.6.4 IP packet Forwarding

The section describes how the OCHD2.1 performs packet handling for IP packets transmitted by or destined to the Card.

The OCHD2.1 forwards IP packets on behalf of the Card by adding Ethernet framing to packets received from the Card and removing Ethernet framing from inbound packets before sending to the Card.

On receipt of an Ethernet frame from the eCM interface targeted to the MAC address of the Card, the OCHD2.1 SHALL extract the embedded IP packet and forward the packet to the Card via the granted IP unicast flow.

The OCHD2.1 SHALL only forward IP packets destined to the Card that have been received via the eCM interface or via applications resident on the Host.

The OCHD2.1 SHALL only forward IP packets received from the Card to the eCM interface or to applications resident on the Host.

The OCHD2.1 SHALL NOT forward to any interface other than the CableCARD interface any Ethernet frames or IP packets destined to the Card that have been received via the eCM interface.

On receipt of an IP packet from the Card via the IP unicast flow, the OCHD2.1 SHALL parse the packet's destination IP address and use the Card's address subnet mask to determine if the destination host is on a connected network.

When performing IP packet forwarding on behalf of the Card, if the OCHD2.1 has determined that the destination host is on a connected network, it SHALL perform ARP to acquire the destination host MAC address.

The ARP request payload SHALL contain sender's hardware address equal to the MAC address of the Card and the sender's protocol address equal to the IP address of the Card.

The source MAC address of the Ethernet frame containing the ARP request MAY contain either the Host MAC address or the Card MAC address.

When performing IP packet forwarding on behalf of the Card, if the OCHD2.1 has determined that the destination host is not on a connected network, it SHALL perform ARP to acquire the appropriate gateway MAC address.

The ARP request payload SHALL contain sender's hardware address, equal to the MAC address of the Card, and the sender's protocol address, equal to the IP address of the Card.

The source MAC address of the Ethernet frame containing the ARP request MAY contain either the Host MAC address or the Card MAC address.

When performing IP packet forwarding on behalf of the Card, after the proper destination MAC address has been determined, the OCHD2.1 SHALL encapsulate the IP packet within an Ethernet frame using the acquired destination MAC address as the frame's destination MAC address and the Card's MAC address as the frame's source MAC address.

The OCHD2.1 SHALL then forward the Ethernet frame to the eCM interface.

When performing IP packet forwarding on behalf of the Card, if the OCHD2.1 receives an ARP request packet with the target protocol address equal to the IP address of the Card, it SHALL send an ARP reply with sender's hardware address, equal to the MAC address of the Card, and the sender's protocol address, equal to the IP address of the Card.

Table 13.6-1 - Embedded OpenCable Host 2.1 Device DHCP Request

DHCP Request Options	Value	Description
CPE Option 60	"OpenCable2.1"	OpenCable Version
CPE Option 43 sub-option 1	"<null>"	The request sub-option vector is a list of sub-options (within option 43) to be returned to client by the server upon reply to the request. None defined.
CPE Option 43 sub-option 2	"ESTB"	Device type of the entity making the DHCP request.
CPE Option 43 sub-option 3	"ECM:ESTB"	List of eSAFEs.
CPE Option 43 sub-option 4	"<device serial number>"	Serial Number of eSTB. If Serial Number is not available, then other unique identifier (other than MAC Address), such as HOST_ID, may be utilized
CPE Option 43 sub-option 5	"<hardware version number>"	Hardware version number of eSTB
CPE Option 43 sub-option 6	"<firmware version number>"	Firmware version number of eSTB
CPE Option 43 sub-option 7	"<boot ROM version number>"	Boot ROM version number of eSTB

DHCP Request Options	Value	Description
CPE Option 43 sub-option 8	e.g., "0204DF"	A 6-octet, hexadecimal-encoded, vendor-specific Organization Unique Identifier (OUI) that may match the OUI in the eSTB's MAC address.
CPE Option 43 sub-option 9	e.g., "Xman200"	Vendor model number of eSTB
CPE Option 43 sub-option 10	e.g., "XYZ Broadband"	Vendor name
CPE Option 43 sub-option 54	e.g., "0A859B428"	40 bit HOST_ID as specified in Host X.509 certificate

13.7 Socket Flows

If the Card requires two-way communications in DSG mode and decides to open a Socket type connection, the Card can request a new flow using the ***new_flow_req()*** APDU with service_type = 0x04 (Socket).

The OCHD2.1 SHALL create a socket of the type specified by the protocol_flag field in a ***new_flow_req()*** APDU sent by the Card with service_type = 0x04 (Socket).

The OCHD2.1 SHALL bind the socket to the eSTB's IP address and the local port number specified by the local_port_number field in a ***new_flow_req()*** APDU sent by the Card with service_type = 0x04 (Socket).

If the Card has set the local port number field to 0 in a ***new_flow_req()*** APDU with service_type = 0x04 (Socket), the OCHD2.1 SHALL choose an appropriate local port number for this flow.

Informative note: It is expected that applications on the OCHD2.1 will not open ports that will be used by the Card.

If the remote address type = 0x00 (name) in a ***new_flow_req()*** APDU sent by the Card with service_type = 0x04 (Socket), the OCHD2.1 SHALL use DNS to determine the remote host's IP address using the name_byte field.

When establishing an IP socket, the OCHD2.1 SHALL connect the local socket to the socket on the remote host using the port number specified in remote_port_number specified in the ***new_flow_req()*** APDU.

Once the connection has been established to the remote host specified in a ***new_flow_req()*** APDU with service_type = 0x04 (Socket), the OCHD2.1 SHALL respond to with the ***new_flow_conf()*** APDU.

If the OCHD2.1 is unable to set up a requested socket flow, it SHALL respond to the Card with the ***new_flow_cnf()*** APDU containing the appropriate error value in the status field.

If the Card requests a socket flow for TCP, the OCHD2.1 SHALL attempt to establish a TCP connection for the number of seconds = connection_timeout as specified in the ***new_flow_req()*** APDU sent by the Card with service_type = 0x04 (Socket).

If the OCHD2.1 cannot establish a TCP connection after connection_timeout number of seconds, it SHALL respond to the Card using the ***new_flow_cnf()*** APDU with the status_field = 0x09 (Request Denied, could not establish TCP connection).

On receipt of data from the Card over the interface via the Socket Flow, the OCHD2.1 SHALL use the socket that was opened for the flow to send the data to the destination Host using the eCM interface.

When the socket has data ready to be read, the OCHD2.1 SHALL read the data, strip off the Ethernet, IP, TCP and UDP headers, and forward the data to the Card. The data forwarded to the Card will be the exact data that is returned from the OCHD2.1's socket read operation.

When performing socket operations on behalf of the Card, the OCHD2.1 SHALL NOT forward any data destined to the Card to any interface other than the CableCard interface.

When performing socket operations on behalf of the Card, the OCHD2.1 SHALL only forward to the Card data that has been received via the eCM interface, or via applications resident on the OCHD2.1, and which is destined to the Card.

When performing socket operations on behalf of the Card, the OCHD2.1 SHALL NOT forward any data received from the Card over the CableCard interface to any interface other than the eCM interface.

When an established socket flow is no longer needed by the Card, it will send the ***delete_flow_req()*** APDU, at which time the OCHD2.1 SHALL close the socket.

When an established socket has been successfully closed as a result of receiving the ***delete_flow_req()*** APDU, the OCHD2.1 SHALL send the ***delete_flow_cnf()*** APDU to the Card.

If the OCHD2.1 detects that an established socket is no longer valid, it SHALL send the ***lost_flow_ind()*** APDU to the Card with a reason_field = 0x02 (network down or busy).

14 MANAGEMENT REQUIREMENTS

This section details the OpenCable Host 2.1 device management requirements for SNMP in alignment with section 5.2 of [eDOCSIS]. The Management requirements in this section are divided into three parts: SNMP Protocol requirements covered in Section 14.1, MIB requirements in Section 14.2 (additional details covered in Annex A of [MIB-HOST]), and SNMP Access Control Configuration covered in section 14.4. The OCHD2.1 SNMP Management requirements are primarily defined for diagnostic and status report of the OCHD2.1 core functions and features (Section 3.1.2); therefore, SNMP write access is not commonly specified. In the case of SNMP MIB objects with write access being specified, those definitions should not overlap configuration functions that might be present in other interfaces such as [OCAP].

The configuration of the OCHD2.1 via SNMP is limited to the write access capabilities included in the MIB requirements of this section and [MIB-HOST]. It means that the configuration and provisioning of certain read-only MIB objects are performed by mechanisms such as Out-Of-Band signaling (Section 5.2.3), outside of the scope of this specification. In particular, the configuration of the OCHD2.1 SNMP Access Control mechanisms that provide SNMP access to SNMP entities in the role of managers is defined in Section 14.4 of this specification.

14.1 SNMP Protocol requirements

The OCHD2.1 MAY implement the SNMPv3 protocol framework as defined in STD 62 [RFC 3411] through [RFC 3415].

The OCHD2.1 SHALL implement either SNMPv1/v2c Coexistence as defined in [RFC 3584], or SNMPv2 Community-based Access as defined in [RFC 1901].

14.2 Requirements for SNMP MIB Modules

The OCHD2.1 SHALL support a minimum of 10 entries for each individual SNMP conceptual table defined in this specification, unless otherwise specified. For example, the mapping of a required number of provisioning parameters may translate to a different number of entries of an SNMP conceptual table, a requirement to map a complete set of MPEG descriptors into SNMP conceptual tables, etc.

14.2.1 Requirements for OC-STB-HOST-MIB MIB Module

This section describes the OCHD2.1 management requirements related to the OCHD2.1 Core Functional Requirements detailed in Section 3.1.2.

The OCHD2.1 SHALL implement the MIB objects of OC-STB-HOST-MIB as described in Annexes A and B of [MIB-HOST].

14.3 Additional MIB requirements for OCHD2.1

This section describes the OCHD2.1 management requirements not related to the OCHD2.1 Core Functional Requirements (Section 3.1.2). These requirements include standard IETF networking, interfaces and device parameters, as well as DOCSIS modeled requirements based on [OSSIv2.0] and [eDOCSIS] specifications.

14.3.1 Requirements for SNMPv2-MIB [RFC 3418]

The OCHD2.1 SHALL implement the MIB objects of system group in [RFC 3418].

The OCHD2.1 SHALL report the hardware version, Boot ROM image version, vendor name, software version, and model number in the sysDescr object (from [RFC 3418]) as described in Table 14.3-1.

The OCHD2.1 SHALL report each type-value pair in Table 14.3-1 separated with a colon and blank space. Each pair is separated by a ";" followed by a blank space. For instance, a sysDescr of an OCHD2.1 of vendor X, hardware version 5.2, Boot ROM version 1.4, SW version 2.2, and model number X will be as follows:

any text<<HW_REV: 5.2; VENDOR: X; BOOTR: 1.4; SW_REV 2.2; MODEL: X>>any text

Table 14.3-1 - [RFC 3418] sysDescr Format

To report	Format of each field
Hardware Version	HW_REV: <Hardware version>
Vendor Name	VENDOR: <Vendor name>
Boot ROM	BOOTR: <Boot ROM Version>
Software Version	SW_REV: <Software version>
Model Number	MODEL: <Model number>

14.3.2 Requirements for IF-MIB [RFC 2863]

The OCHD2.1 SHALL implement the MIB objects of ifGeneralInformationGroup from [RFC 2863] as described in Table 14.3-2 and Annex A of [MIB-HOST].

The OCHD2.1 MAY implement the MIB objects of ifPacketGroup, ifHCPacketGroup or ifVHCPacketGroup and ifCounterDiscontinuityGroup from [RFC 2863] for interfaces with IANA defined ifType as described in Annex A of [MIB-HOST] and Table 14.3-2.

If implemented, the OCHD2.1 SHALL have ifLinkUpDownTrapEnable set by default to 'false' for output interfaces with defined IANA ifType as well as any interface facing the eCM or the HFC network unless defined for this specification.

Table 14.3-2 - [RFC 2863] ifTable, MIB-Object Details for OCHD2.1 Interfaces

MIB Object	OCHD2.1	Card
ifIndex	1	2
ifDescr: MUST match the text	"OCHD2.1 Embedded IP 2-way Interface"	"CableCARD Unicast IP Flow"
ifType	Other(1)	Other(1)
ifMtu	0	0
ifSpeed	0	0
ifPhysAddress	OCHD2.1 MAC Address	If the IP_U flow does not exist, then this object should contain an octet string of zero length. Otherwise, this object should contain the Card's MAC address.
ifAdminStatus:	up(1)	up(1), down(2)*
ifOperStatus:	up(1), down(2)	up(1), down(2), notPresent(6)**
ifLastChange	<per RFC2863>	<per RFC2863>
ifInOctets	(n)	(n)
ifInUCastPkts	(n)	(n)

MIB Object	OCHD2.1	Card
ifInDiscards	(0)	(0)
ifInErrors	(0)	(0)
ifUnknownProtos	(0)	(0)
ifOutOctets	(n)	(n)
ifOutUCastPkts	(n)	(n)
ifOutDiscards	(0)	(0)
ifOUtErrors	(0)	(0)

Notes:

The SNMP management interface only requires to report the value 'up' for ifAdminStatus in the two-way interface. Other management interfaces may support the reporting of other values.

ifIndex 1 above is the eSTB interface connected to the eCM's interface ifIndex 17 [eDOCSIS]. Packets leaving eCM interface 17 arrive at eSTB interface 1 and vice versa.

ifIndex 2 above is the Card interface connected to the eCM's interface ifIndex 17 [eDOCSIS]. Packets leaving eCM interface 17 arrive at eSTB interface 2 and vice versa. ifIndex 2 is only applicable when the Card has opened a Unicast IP Flow.

* If the Card has opened a Unicast IP Flow, the OCHD2.1 SHALL set the value of ifAdminStatus for ifIndex 2 to up(1); else down(2).

** If the Card has opened a Socket Flow, the OCHD2.1 SHALL set the value of ifOperStatus for ifIndex 2 to notPresent(6).

14.3.3 Requirements for IP-MIB [RFC 4293]

The OCHD2.1 SHALL implement the MIB objects of ipNetToPhysicalGroup from [RFC 4293] to indicate the IP addresses associated to the two-way IP OCHD2.1 interface as defined in Annex A of [MIB-HOST] and Table 14.3-3.

The OCHD2.1 SHALL implement the IP and ICMP objects and statistics according to the [eDOCSIS] requirements.

Table 14.3-3 - [RFC 4293] ipNetToPhysicalTable, MIB-Object Details for OCHD2.1 Interfaces

MIB Object	OCHD2.1 IP two-way interface	Card IP Interface
ipNetToPhysicalIfIndex	ifIndex = 1	ifIndex = 2
ipNetToPhysicalNetAddressType	ipv4, ipv6	ipv4, ipv6
ipNetToPhysicalNetAddress	IPv4 or IPv6 Address, if acquired; otherwise 0.0.0.0	IPv4 or IPv6 Address, if acquired; otherwise 0.0.0.0
ipNetToPhysicalPhysAddress	STB Host MAC Address	Card MAC Address
ipNetToPhysicalLastUpdated	sysUptime value from last update	sysUptime value from last update
ipNetToPhysicalType	local(5)	local(5)
ipNetToPhysicalState	For IPv4: unknown(6)	For IPv4: unknown(6)
ipNetToPhysicalRowStatus	active(1)	active(1)

14.3.4 Requirements for DOCS-CABLE-DEVICE-MIB MIB Module

The OCHD2.1 SHALL implement a subset of MIB objects from DOCS-CABLE-DEVICE-MIB [RFC 2669] as described in Annex A of [MIB-HOST].

The OCHD2.1 is required to support the log event model for [OSSIv2.0] defined in [RFC 2669]. This event model consists of a eight Event levels (or priorities) to categorize events by their relevance.

The event levels from high to low priority are: Emergency (priority 1), Alert (priority 2), Critical (priority 3), Error (priority 4), Warning (priority 5), Notice (priority 6), Informational (priority 7), Debug (priority 8).

The control of the logging activities is performed by three modules:

- Local log: A local storage of events in two formats, volatile and a non-volatile. The volatile log clears the entries after the OCHD2.1 reinitializes. The non-volatile log persists its entries after OCHD2.1 reinitialization.
- Event Priority Dispatch: Based on the Event level, the events are sent to combinations of volatile log, non-volatile-log and event collector systems. [RFC 2669] defines the syslog and SNMP notification receivers as collector systems.
- Throttling mechanism: In order to reduce logging activity of events sent to collectors, [RFC 2669] provides mechanisms for controlling the number of events sent to collector systems.

This specification only requires support of local log in volatile and non-volatile formats, as well as the selection of the types of events levels to be logged locally. As an example, an MSO may decide to log only 'Error' and higher event level priorities.

The OCHD2.1 at initialization logs events with priorities 1..6, using the factory default settings as described in the requirements below. After completion of provisioning, the OCHD2.1 could be provisioned to log another set of event priorities.

The OCHD2.1 SHALL support the Event list defined in 4 and log those events in the SNMP MIB Table docsDevEventTable (see Annex A of [MIB-HOST]).

The OCHD2.1 SHALL support the SNMP MIB object docsDevEvControl from [RFC 2669].

The OCHD2.1 SHALL support the SNMP MIB docsDevEvControlTable from [RFC 2669] to determine the event priority of events to be logged in volatile and non-volatile format.

The OCHD2.1 SHALL support the SNMP MIB docsDevEventTable from [RFC 2669] to report logged in volatile and non-volatile events.

The OCHD2.1 SHALL support only BITS 0 and 3 of the SNMP MIB object docsDevEvReporting, and ignore other BITS.

Unless otherwise configured as a factory default, the OCHD2.1 SHALL log in the non-volatile local-log events with priority 'Emergency', 'Alert', 'Critical' and 'Error'.

Unless otherwise configured as a factory default, the OCHD2.1 SHALL log in the volatile local-log events with levels, Warning event (priority 5), Notice event (priority 6).

14.3.5 Requirements for HOST-RESOURCES-MIB [RFC 2790]

The OCHD2.1 SHALL implement a subset of MIB objects from HOST-RESOURCES-MIB as defined in Annex A of [MIB-HOST].

14.4 SNMP Access Control Configuration Requirements

The OCHD2.1 configures the SNMP Access Control for SNMP entities acting in role of 'managers' by supporting the SNMP Access Control TLVs defined in Section 15.2. The following section indicates the applicability of the SNMP Access Control TLVs for the cases where the OCHD2.1 supports SNMP community-based [RFC 1901] or SNMPv1 and SNMP v2c as specified in [RFC 3584].

This specification refers to "SNMPv1/v2c Coexistence" as the support of SNMPv1 or SNMPv2c messages exchange between the OCHD2.1 and other SNMP entities where the OCHD2.1 implements the SNMPv3 framework ([RFC 3411] through [RFC 3415]). For that purpose, [RFC 3584] defines special mappings of SNMP community names to SNMP security names to community to make use of the access control mechanism defined in [RFC 3415].

The OCHD2.1 SHALL ignore any SNMP request in the absence of SNMP Access Control configuration TLVs received during the OCHD2.1 provisioning process defined in Section 15.1.

14.4.1 SNMP Access Control Configuration for SNMP Community-based Access [RFC 1901]

If the OCHD2.1 supports SNMP community-based access, it SHALL NOT instantiate any proprietary MIB to report the configuration of the SNMP Access Control TLVs.

The OCHD2.1 SHALL NOT report such configuration under the OID sub-tree snmpV2.

The SNMP Access Control TLVs defined in section 15.2 are based on the SNMPv3 framework [RFC 3411]. However, in case the OCHD2.1 supports SNMP community-based access [RFC 1901], the requirements below define the corresponding mapping.

If the OCHD2.1 supports SNMP community-based access, it SHALL ignore the SNMPv3 Access View Configuration TLV.

If the OCHD2.1 supports SNMP community-based access, Table 14.4-1 defines the mapping of SNMPv1v2c Coexistence Configuration TLV elements to SNMP community-based parameters:

Table 14.4-1 - SNMP Community Based Configuration TLV Mapping

Sub-TLVs	Variable Name	Associated RFC term
SNMPv1v2c Community Name	*CommunityName*	SNMP community string [RFC 1901]
SNMPv1v2c Transport Address Access:		
SNMPv1v2c Transport Address	*TAddress*	IP Address bits– ignore TAddress UDP port information. See [RFC 3413]
SNMPv1v2c Transport Address Mask	*TMask*	IPAddress Mask bits – ignore TMask UDP port information. See [RFC 3584]

Sub-TLVs	Variable Name	Associated RFC term
SNMPv1v2c Access View Type	*AccessViewType*	If absent indicates read-only access, *AccessViewType* = '1' indicates read-only access. *AccessViewType* = '2' indicates read-write access
SNMPv1v2c Access View Name	*AccessViewName*	Ignore this sub-TLV

14.4.2 SNMP Access Control Configuration for SNMPv1v2c Coexistence Mode [RFC 3584]

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL by default add an exclusion rule for access to objects under the OID snmpV2.

The OCHD2.1 SHALL provide access to objects under the OID sub-tree snmpV2 in the case the SNMP Configuration TLV 'SNMP Access View Subtree' explicitly includes access to objects under the OID sub-tree snmpV2.

14.4.2.1 SNMPv1v2c Coexistence Configuration TLV

This section specifies the mapping of the SNMPv1v2c Coexistence Configuration TLV (see section 15.2) to SNMPv3 MIB objects. The SNMPv1v2c Coexistence Configuration TLV is used to configure SNMPv3 tables for SNMPv1 and v2c access.

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create entries in the following tables in order to cause the desired SNMP Access: snmpCommunityTable, snmpTargetAddrTable, vacmSecurityToGroupTable, and vacmAccessTable, as described in Table 14.4-2.

Table 14.4-2 - SNMPv1v2c Coexistence Configuration TLV Mapping

Sub-TLVs	Variable Name	Associated MIB Object
SNMPv1v2c Community Name	*CommunityName*	snmpCommunityTable [RFC 3584]
SNMPv1v2c Transport Address Access:		
SNMPv1v2c Transport Address	*TAddress*	snmpTargetAddrTAddress [RFC 3413]
SNMPv1v2c Transport Address Mask	*TMask*	snmpTargetAddrTMask [RFC 3584]
SNMPv1v2c Access View Type	*AccessViewType*	
SNMPv1v2c Access View Name	*AccessViewName*	Based on value of *AccessViewType:* vacmAccessReadViewName, vacmAccessWriteViewName [RFC 3415]

The OCHD2.1 is not required to verify the consistency of linkage of tables unless specified in the correspondent RFC's MIB objects the eSTB TLVs are configuring. It is intended that the SNMP agent will handle the corresponding configuration problems as part of the normal SNMP incoming requests (e.g., generating internal abstract data elements like noSuchView [RFC 3415]).

Table 14.4-4 through Table 14.4-9 describe the OCHD2.1 procedures to populate the SNMP Management Framework Message Processing and Access Control Subsystems [RFC 3412].

In configuring entries in these SNMPv3 tables, note the following:

The ReadViewName and WriteViewName may correspond to default entries as defined (if any), or entries created using SNMPv3 Access View Configuration (see Section 15.2).

14.4.2.1.1 snmpCommunityTable

The snmpCommunityTable is defined in the "SNMP Community MIB Module" section of [RFC 3584].

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create one row in snmpCommunityTable for each SNMPv1v2c Coexistence Configuration TLV as indicated in Table 14.4-3.

The OCHD2.1 SHALL set in snmpCommunityIndex the keyword @STBconfig_n where 'n' is a sequential number starting at 0 for each TLV processed (e.g., "@STBconfig_0", "@STBconfig_1", etc.).

Table 14.4-3 - snmpCommunityTable

Column Name (* = Part of Index)	Column Value
* snmpCommunityIndex	"@STBconfig_n" where n is 0..m-1 and m is the number of SNMPv1v2c Community Name sub-TLVs
snmpCommunityName	<*CommunityName*>
snmpCommunitySecurityName	"@STBconfig_n"
snmpCommunityContextEngineID	<the Engine ID of the OCHD2.1 associated SNMP Entity>
snmpCommunityContextName	<Zero-length OCTET STRING> or vendor specific
snmpCommunityTransportTag	"@STBconfigTag_n" where n is 0..m-1 and m is the number of SNMPv1v2c Coexistence Configuration TLVs
snmpCommunityStorageType	volatile (2)
snmpCommunityStatus	active (1)

14.4.2.1.2 snmpTargetAddrTable

For snmpTargetAddrTable, see "Definitions" section of [RFC 3413].

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create one row in snmpTargetAddrTable for each SNMPv1v2c Transport Address Access sub-TLV of the SNMPv1v2c Coexistence Configuration TLV as indicated in Table 14.4-4.

Table 14.4-4 - snmpTargetAddrTable

Column Name (* = Part of Index)	Column Value
* snmpTargetAddrName	"@STBconfigTag_n_i" where n is 0..m-1 and m is the number of SNMPv1v2c Coexistence Configuration TLVs. i is 0..p-1 and p is the number of SNMPv1v2c Transport Address Access sub-TLV within the SNMPv1v2c Coexistence Configuration TLV n
snmpTargetAddrTDomain	IPv4: snmpUDPDomain [RFC 3417]

Column Name (* = Part of Index)	Column Value
snmpTargetAddrTAddress (IP Address and UDP Port)	IPv4: SnmpUDPAddress [RFC 3417] OCTET STRING (6) Octets 1-4: <*TAddress*> Octets 5-6: <*TAddress*>
snmpTargetAddrTimeout	Default from MIB
snmpTargetAddrRetryCount	Default from MIB
snmpTargetAddrTagList	"@STBconfigTag_n" where n is 0..m-1 and m is the number of SNMPv1v2c Coexistence Configuration TLVs.
snmpTargetAddrParams	<null character '00'h> - not used-
snmpTargetAddrStorageType	volatile (2)
snmpTargetAddrRowStatus	active (1)

14.4.2.1.3 snmpTargetAddrExtTable

The snmpTargetAddrExtTable is defined in the "SNMP Community MIB Module" section of [RFC 3584].

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create one row in snmpTargetAddrExtTable for each SNMPv1v2c Transport Address Access sub-TLV of the SNMPv1v2c Coexistence Configuration TLV as indicated in Table 14.4-5.

Table 14.4-5 - snmpTargetAddrExtTable

Column Name (* = Part of Index)	Column Value
* snmpTargetAddrName	"@STBconfigTag_n_i" where n is 0..m-1 and m is the number of SNMPv1v2c Coexistence Configuration TLVs i is 0,,p-1 and p is the number of SNMPv1v2c Transport Address Access sub-TLVs within the SNMPv1v2c Coexistence Configuration element n
snmpTargetAddrTMask	<Zero-length OCTET STRING> when <*TMask*> is not provided in the i-th sub-TLV IPv4: SnmpUDPAddress [RFC 3417] OCTET STRING (6) Octets 1-4: <*TMask*> Octets 5-6: <UDP Port>
snmpTargetAddrMMS	Maximum Message Size

14.4.2.1.4 vacmSecurityToGroupTable

The vacmSecurityToGroupTable is defined in the "Definitions" section of [RFC 3415].

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create two rows in vacmSecurityGroupTable for each SNMPv1v2c Coexistence Configuration TLV as indicated in Table 14.4-6.

The OCHD2.1 SHALL set in vacmSecurityName the keyword @STBconfig_n, where 'n' is a sequential number starting at 0 for each SNMPv1v2c Coexistence Configuration TLV processed (e.g., "@STBconfig_0", "@STBconfig_1", etc.).

The OCHD2.1 SHALL set in vacmGroupName the keyword @STBconfigV1_n for the first row and @STBconfigV2_n for the second row, where 'n' is a sequential number starting at 0 for each SNMPv1v2c Coexistence Configuration TLV processed (e.g., "@STBconfigV1_0", "@STBconfigV1_1", etc.).

Table 14.4-6 - vacmSecurityToGroupTable

Column Name (* = Part of Index)	First Row Column Value	Second Row Column Value
* vacmSecurityModel	SNMPV1 (1)	SNMPV2c (2)
* vacmSecurityName	"@STBconfig_n"	"@STBconfig_n"
vacmGroupName	"@STBconfigV1_n"	"@STBconfigV2_n"
vacmSecurityToGroupStorageType	volatile (2)	volatile (2)
vacmSecurityToGroupStatus	active (1)	active (1)

14.4.2.1.5 vacmAccessTable

The vacmAccessTable is defined in the "Definitions" section of [RFC 3415].

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create two rows in vacmAccessTable for each SNMPv1v2c Coexistence Configuration TLV as indicated in Table 14.4-7.

The OCHD2.1 SHALL set in vacmGroupName the keyword @STBconfigV1_n for the first row and @STBconfigV2_n for the second row, where 'n' is a sequential number starting at 0 for each SNMPv1v2c Coexistence Configuration TLV processed (e.g., "@STBconfigV1_0", "@STBconfigV1_1", etc.).

Table 14.4-7 - vacmAccessTable

Column Name (* = Part of Index)	Column Value	Column Value
* vacmGroupName	"@STBconfigV1_n"	"@STBconfigV2_n"
* vacmAccessContextPrefix	<zero-length string> or vendor specific (see 14.4.2.1.6).	<zero-length string> or vendor specific (see 14.4.2.1.6).
* vacmAccessSecurityModel	SNMPV1 (1)	SNMPV2c (2)
* vacmAccessSecurityLevel	noAuthNoPriv (1)	noAuthNoPriv (1)
vacmAccessContextMatch	exact (1)	exact (1)
vacmAccessReadViewName	When <*AccessViewType*> == '1' | '2' Set <*AccessViewName*> Otherwise, set <Zero-length OCTET STRING>	When <*AccessViewType*> == '1' | '2' Set <*AccessViewName*> Otherwise, set <Zero-length OCTET STRING>
vacmAccessWriteViewName	When <*AccessViewType*> == '2' Set <*AccessViewName*> Otherwise, set <Zero-length OCTET STRING>	When <*AccessViewType*> == '2' Set <*AccessViewName*> Otherwise, set <Zero-length OCTET STRING>
vacmAccessNotifyViewName	<Zero-length OCTET STRING>	<Zero-length OCTET STRING>
vacmAccessStorageType	volatile (2)	volatile (2)
vacmAccessStatus	active (1)	active (1)

14.4.2.1.6 vacmContextTable

The vacmContextTable is defined in the "Definitions" section of [RFC 3415].

The OCHD2.1 SHALL populate the vacmContextTable with the context name used by the OCHD2.1 to map the SNMPv1v2c Coexistence Configuration TLV information in the vacmAccessTable as indicated in Table 14.4-8.

Table 14.4-8 - vacmContextTable

Column Name (* = Part of Index)	Column Value
* vacmContextName	<zero-length string> or vendor specific (1)

Notes: (1) The OCHD2.1 may use the default Context (zero-length string) or a vendor-specific context to identify the Management Information Base (MIB) for the OCHD2.1 in the case the implementation supports multiple SNMP logical entities within the same SNMP entity (see [eDOCSIS].

14.4.2.2 *SNMPv3 Access View Configuration TLV*

This section specifies the mapping of the SNMPv3 Access View configuration TLV (see Section 15.2) to SNMPv3 MIB objects. The SNMPv3 Access View Configuration TLV is used to configure the table vacmViewTreeFamilyTable in a simplified way.

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create entries in vacmViewTreeFamilyTable as indicated in Table 14.4-9.

Table 14.4-9 - SNMPv3 Access View Configuration TLV Mapping

Sub-TLVs	Variable Name	Associated MIB Object [RFC 3415]
SNMPv3 Access View Name	*AccessViewName*	vacmViewTreeFamilyViewName
SNMPv3 Access View Subtree	*AccessViewSubTree*	vacmViewTreeFamilySubtree
SNMPv3 Access View Mask	*AccessViewMask*	vacmViewTreeFamilyMask
SNMPv3 Access View Type	*AccessViewType*	vacmViewTreeFamilyType

Disconnected entries in the OCHD2.1 SNMP access configuration database are not expected to be detected by the OCHD2.1 as part of the configuration. Eventually, the SNMP agent will not grant access to SNMP requests, for example, to disconnected Security Names and View trees as a result of a TLV configuration mistake.

Table 14.4-10 describes the OCHD2.1 procedures to populate the SNMP Management Framework Access Control Subsystem [RFC 3412].

14.4.2.2.1 vacmViewTreeFamilyTable

The vacmViewTreeFamilyTable is defined in the "Definitions" section of [RFC 3415].

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create one row in vacmViewTreeFamilyTable for each SNMPv3 Access View Configuration TLV as indicated in Table 14.4-10.

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create a log entry with an error code I409.0 when two SNMPv3 Access View Configuration TLVs have identical index components. In such instance, the OCHD2.1 would not be able to create an entry for the second TLV containing the duplicate index.

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL set the object vacmViewTreeFamilySubtree to OID 1.3.6 when no sub-TLV SNMPv3 Access View Subtree is defined in the SNMPv3 Access View Configuration TLV.

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL set the object vacmViewTreeFamilyMask to the default zero-length string when no sub-TLV SNMPv3 Access View Mask is defined.

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL set the object vacmViewTreeFamilyType to the default value 1 (included) when no sub-TLV SNMPv3 Access View Type is defined.

Table 14.4-10 - vacmViewTreeFamilyTable

Column Name (* = Part of Index)	Column Value
* vacmViewTreeFamilyViewName	*<AccessViewName>*
* vacmViewTreeFamilySubtree	*<AccessViewSubTree>*
vacmViewTreeFamilyMask	*<AccessViewMask>*
vacmViewTreeFamilyType	*<AccessViewType>*
vacmViewTreeFamilyStorageType	volatile (2)
vacmViewTreeFamilyStatus	active (1)

15 HOST 2.1 DEVICE OPERATIONAL PARAMETERS CONFIGURATION

This section defines the configuration of management related functions of the OCHD2.1.

15.1 Host 2.1 Device configuration

This specification defines a provisioning mechanism that consists of two phases:

- IP acquisition via DHCPv4 (see Section 13.5).
- Proxy of OCHD2.1 configuration parameters in the form of TLVs by the eCM.

15.1.1 eCM Proxy mechanism for the configuration of the OCHD2.1

For the purpose of configuring the OCHD2.1 by the means of this specification, the eCM supports the 'eCM Config File Encapsulation' TLV defined in [eDOCSIS]. After eCM registration, the eCM passes the content of TLV Type 217 to the OCHD2.1. Such content corresponds to the eSTB configuration TLVs (see Section 15.2).

The OCHD2.1 provisioning process defined below relies on the eCM registration process (see [RFIv2.0]), which supports acceptable security provisions for the OCHD2.1 configuration parameters defined in Section 14.4. An increase of the service sensitivity of new configuration parameters may determine the need of a more robust provisioning mechanism and perhaps independent of the eCM.

The Table 15.1-1 defines the basic provisioning steps for the OCHD2.1. After the OCHD2.1 receives a "2-Way OK UCID" from the eCM, it initiates a DHCP address acquisition and the processing of the eSTB TLVs passed by the eCM.

Table 15.1-1 - Provisioning steps of the OCHD2.1

Flow Step	Operation	Description	Requirement	eSAFE MIB esafeProvisioning StatusProgress
OCHD2.1-Prov-0	"2-Way OK, UCID" (See [DSG])	The eCM signals to the eSTB the message 2-Way OK, UCID	Section 13.6.1 eSTB DHCP Requirements	(1) notInitiated
OCHD2.1-Prov-1	eSTB TLVs processing	The OCHD2.1 process the eSTB TLVs received from the eCM (1)	See section 15.2 eSTB Configuration TLVs	(2) inProgress
OCHD2.1-Prov-2	DHCPDISCOVER	The OCHD2.1 sends a DHCPDISCOVER message	Section 13.6.1 eSTB DHCP Requirements	(2) inProgress
OCHD2.1-Prov-3	DHCPOFFER	The OCHD2.1 receives a DHCPDISCOVER message	Section 13.6.1 eSTB DHCP Requirements	(2) inProgress
OCHD2.1-Prov-4	DHCPREQUEST	The OCHD2.1 sends a DHCPREQUEST message	Section 13.6.1 eSTB DHCP Requirements	(2) inProgress

Flow Step	Operation	Description	Requirement	eSAFE MIB esafeProvisioning StatusProgress
OCHD2.1-Prov-5	DHCPACK	The OCHD2.1 receives a DHCPACK message and completes IP acquisition	Section 13.6.1 eSTB DHCP Requirements	(2) inProgress
OCHD2.1-Prov-6	OCHD2.1 provisioning completed	The OCHD2.1 provisioning is completed		(3) finished

Notes: (1) The eSTB TLVs processing (Flow Step OCHD2.1-Prov-1) could happen at any time after OCHD2.1-Prov-0 and prior to OCHD2.1-Prov-6 and may vary among implementations.

The OCHD2.1 SHALL include in the eCM DHCP option 43 sub-option 15 the text "ESTB" to indicate support of the eCM encapsulation TLV feature by the eSTB.

The OCHD2.1 SHALL pass the content of TLV 217 from the eCM config file to the eSTB. The mechanism to pass such content from the eCM to the eSTB is vendor-specific.

The OCHD2.1 SHALL parse the eSTB TLVs contained in TLV 217 only after receiving the "2-Way OK, UCID" message from the eCM.

During the OCHD2.1 configuration process, the OCHD2.1 SHALL provide the eCM with the Flow Step information and status for the CM to report the eSTB state in the esafeProvisioningStatusTable [eDOCSIS], utilizing the values defined in Table 15.1-1 for the esafeProvisioningStatusProgress object.

15.2 eSTB Configuration TLVs

This section defines the TLV requirements for the OCHD2.1 when operating in two-way DSG Mode. The OCHD2.1 is required to support the TLVs defined in this section. Some TLVs were initially defined in other specifications such as [RFIv2.0] and [MULPIv3.0]. The features around those TLVs are maintained. However, the behavior may be different to accommodate the OCHD2.1 provisioning needs.

In case of failure to set one or more configuration parameters, the OCHD2.1 logs the error condition in docsDevEventTable (see Annex A of [MIB-HOST]) and updates the eCM to properly report the status of esafeProvisioningStatusTable [eDOCSIS].

The OCHD2.1 SHALL process the eSTB Configuration TLVs and disregard unrecognized TLVs or sub-TLVs within a TLV.

The OCHD2.1 SHALL create a log entry with an error code I404.0 when unrecognized TLVs or sub-TLVs are present in the configuration process.

The OCHD2.1 SHALL create a log entry with an error code I405.0 in case of duplicated TLVs when not supported.

The OCHD2.1 SHALL create a log entry with an error code I406.0 in case of an invalid TLV Type encoding.

The OCHD2.1 SHALL create a log entry with an error code I408.0 when no resources are available or the limit of configurable elements is reached.

In the case of an error condition while processing configuration parameters, the OCHD2.1 SHALL update the eCM with the Provisioning step (see 15.1.1) and the error condition to be reported by the eCM in the esafeProvisioningStatusTable [eDOCSIS].

15.2.1 SNMPv1v2c Coexistence Configuration

This TLV (Type 53) specifies the SNMPv1v2c Coexistence Access Control configuration of the OCHD2.1. This TLV creates entries in SNMPv3 tables as specified in Section 14.4.

The OCHD2.1 SHALL create a log entry with an error code I407.0 if sub-TLV 53.1 SNMPv1v2c Community Name is not present in a TLV 53.

The OCHD2.1 SHALL create a log entry with an error code I407.0 if the sub-TLV 53.2 SNMPv1v2c Transport Address Access is not present in a TLV 53.

The OCHD2.1 SHALL support multiple instances of sub-TLV 53.2 SNMPv1v2c Transport Address Access within a TLV 53.

The OCHD2.1 SHALL create a log entry with an error code I405.0 for configuration cases that includes repeated sub-TLVs other than sub-TLV 53.2 and preserve the configuration of the first duplicated sub-TLV.

The OCHD2.1 SHALL create a log entry with an error code I406.0 if an OCHD2.1-created entry based on TLV 53 in any SNMP table is rejected due to SNMP syntax conflicts.

The OCHD2.1 SHALL create a log entry with an error code I408.0 if an OCHD2.1-created entry based on TLV 53 in any SNMP table is rejected due to reaching the limit in the number of entries supported for that table.

The OCHD2.1 SHALL create a log entry with an error code I409.0 if an OCHD2.1 created entry based on TLV 53 in any SNMP table already exists.

The OCHD2.1 SHALL support a minimum of five SNMPv1v2c Coexistence Configuration TLVs.

Type	Length	Value
53	N	Composite

Note: The number of entries an OCHD2.1 can support in SNMPv3 tables is independent of the number of TLVs the eCM supports.

15.2.1.1 SNMPv1v2c Community Name

This sub-TLV specifies the Community Name (community string) used in SNMP requests to the OCHD2.1.

Type	Length	Value
53.1	1..32	Text

15.2.1.2 SNMPv1v2c Transport Address Access

This sub-TLV specifies the Transport Address and Transport Address Mask pair used by the OCHD2.1 to grant access to the SNMP entity querying the OCHD2.1.

The OCHD2.1 SHALL create a log entry with an error code I407.0 if a sub-TLV Transport Address Access (Type 53.2) has more than one sub-TLV 53.2.1 or 53.2.2.

Type	Length	Value
53.2	N	Variable

15.2.1.2.1 SNMPv1v2c Transport Address

This sub-TLV specifies the Transport Address to use in conjunction with the Transport Address Mask used by the OCHD2.1 to grant access to the SNMP entity querying the OCHD2.1.

The OCHD2.1 SHALL create a log entry with an error code I407.0 if sub-TLV 53.2.1 is not present in the configuration sub-TLV 53.2.

Type	Length	Value
53.2.1	6 or 18	Transport Address

Note: Length is 6 bytes for IPv4 and 18 bytes for IPv6.

The OCHD2.1 is not required to support IPv6 Transport Addresses and ignores TLVs that includes those values.

15.2.1.2.2 SNMPv1v2c Transport Address Mask

This sub-TLV specifies the Transport Address Mask to use in conjunction with the Transport Address used by the OCHD2.1 to grant access to the SNMP entity querying the OCHD2.1. This sub-TLV is optional.

Type	Length	Value
53.2.2	6 or 18	Transport Address Mask

Note: Length is 6 bytes for IPv4 and 18 bytes for IPv6.

The OCHD2.1 is not required to support IPv6 Transport Addresses Masks and ignores TLVs that includes those values.

15.2.1.3 SNMPv1v2c Access View Type

This sub-TLV specifies the type of access to grant to the community name of this TLV. Sub-TLV Type 53.3 is optional. If sub-TLV 53.3 is not present in TLV-53, the default value of the access type to grant to the community name specified in sub-TLV 53.1 is read-only.

Type	Length	Value
53.3	1	1: Read-only 2: Read-write

15.2.1.4 SNMPv1v2c Access View Name

This sub-TLV specifies the name of the view that provides the access indicated in sub-TLV SNMPv1v2c Access View Type.

Type	Length	Value
53.4	1.32	String

15.2.2 SNMPv3 Access View Configuration

This TLV (Type 54) specifies the SNMPv3 Simplified Access View configuration of the OCHD2.1. This TLV creates entries in SNMPv3 tables as specified in Section 14.4.

The OCHD2.1 SHALL support a minimum of 10 SNMPv3 Access View Configuration TLVs (Type 54).

The OCHD2.1 SHALL create a log entry with an error code I407.0 if the sub-TLV SNMPv3 Access View Name (Type 54.1) is not present in TLV 54.

The OCHD2.1 SHALL support multiple TLVs with same value of SNMPv3 Access View Name sub-TLV (Type 54.1).

The OCHD2.1 SHALL create a log entry with an error code I407.0 if more than one sub-TLV of the same type are included in a TLV 54.4.

The OCHD2.1 SHALL create a log entry with an error code I404.0 if an OCHD2.1-created entry based on TLV 54 in an SNMP table is rejected due to syntax conflicts.

The OCHD2.1 SHALL create a log entry with an error code I408.0 if an OCHD2.1-created entry based on TLV 54 in an SNMP table is rejected due to reaching the limit in the number of entries supported for that table.

The OCHD2.1 SHALL create a log entry with an error code I409.0 if an OCHD2.1-created entry based on TLV 54 in an SNMP table already exists.

Type	Length	Value
54	N	Composite

Note: The number of entries a OCHD2.1 can support in SNMPv3 tables is independent of the number of TLVs the eCM supports for its own management configuration, in the case both CM and OCHD2.1 share the same SNMP entity (see [eDOCSIS] and [RFC 3411]).

15.2.2.1 SNMPv3 Access View Name

This sub-TLV specifies the administrative name of the View defined by this TLV.

The OCHD2.1 SHALL create a log entry with an error code I407.0 if sub-TLV 54.1 is not present within TLV-54.

Type	Length	Value
54.1	1..32	Text

15.2.2.2 SNMPv3 Access View Subtree

This sub-TLV specifies an ASN.1 formatted object Identifier that represents the filter sub-tree included in the Access View TLV.

The OCHD2.1 SHALL accept only encoded values that start with the ASN.1 Universal type 6 (Object Identifier) byte, followed by the ASN.1 length field, and then the ASN.1 encoded object identifier components. For example, the sub-tree 1.3.6 is encoded as 0x06 0x03 0x01 0x03 0x06.

If sub-TLV 54.2 is not included in TLV 54, the OCHD2.1 SHALL use as default the OID sub-tree 1.3.6.

Type	Length	Value
54.2	N	OID

15.2.2.3 SNMPv3 Access View Mask

This sub-TLV specifies the bit mask to apply to the Access View Subtree of the Access View TLV.

Type	Length	Value
54.3	0..16	Bits

The OCHD2.1 SHALL assign a zero-length string to SNMPv3 Access View Mask TLV 54.3 if TLV 54 is present but sub-TLV 54.3 is not included.

15.2.2.4 SNMPv3 Access View Type

This sub-TLV specifies the inclusion or exclusion of the sub-tree indicated by SNMPv3 Access View Subtree sub-TLV 54.2 in the SNMPv3 Access View Configuration TLV 54. The value 1 indicates the sub-tree of SNMPv3 Access View SubTree is included in the Access View. The value 2 indicates the sub-tree of SNMPv3 Access View Sub Tree is excluded from the Access View.

Type	Length	Value
54.4	1	1: included 2: excluded

The OCHD2.1 SHALL assign the value 'included' to SNMPv3 Access View Type sub-TLV 54.4 if TLV 54 is present but sub-TLV 54.4 is not included.

15.2.3 SNMP MIB Object

This TLV specifies the mechanism for setting writable SNMP MIB objects using eSTB TLV constructs.

The value of this TLV Type is one SNMP VarBind as defined in [RFC 1157]. The VarBind is encoded in ASN.1 Basic Encoding Rules, just as it would be if part of an SNMP Set request.

The OCHD2.1 SHALL treat TLV 11 as if it were part of an SNMP Set Request with the following caveats: It treats the request as fully authorized (it cannot refuse the request for lack of access privilege), and no SNMP response is generated by the OCHD2.1.

The OCHD2.1 SHALL process multiple TLV 11 encodings as if simultaneous.

The OCHD2.1 SHALL ignore unsupported SNMP MIB objects in TLV 11 and create a log entry with an error code I401.0 in case of an invalid varbind encoding.

The OCHD2.1 SHALL create a log entry with an error code I402.0 in case of duplicated SNMP MIB OIDs in TLV 11 - setting the same object instance to same or different value.

The OCHD2.1 SHALL create a log entry with an error code I403.0 in case of an invalid varbind encoding in TLV 11.

Type	Length	Value
11	N	SNMP varbind

15.2.4 Vendor ID Encoding

The Vendor ID is defined in [RFIv2.0] and used in this specification for similar purposes. The value field contains the vendor identification specified by the three-byte vendor-specific Organization Unique Identifier of the OCHD2.1 MAC address. This TLV is used in this specification as a sub-tlv of the Vendor Specific Information TLV. Other vendor specific areas of application are possible. This TLV has no meaning when used as a standalone TLV and is ignored by the OCHD2.1.

When used as a sub-field of the Vendor Specific Information field, this identifies the Vendor ID of the OCHD2.1s that are intended to use this information.

The Vendor ID 0xFFFFFF is a reserved value in [RFIv2.0] is not currently used in this specification, but stays reserved.

Type	Length	Value
8	3	OUI

15.2.5 Vendor Specific Information

This TLV type is used to extend the capabilities of the OCHD2.1 specification, through the use of vendor-specific features. The Vendor Specific Information TLV comes from [RFIv2.0], where it is defined as part of a multipurpose encapsulation known as DOCSIS Extension Field.

This TLV always includes only one Vendor ID field (see Section 15.2.4) to indicate that the settings apply to a specific vendor device.

The OCHD2.1 SHALL ignore a Vendor Specific Information TLV 43 that includes a Vendor ID different from that of the OCHD2.1.

The OCHD2.1 SHALL create a log entry with an error code I406.0 in the case the Vendor ID TLV 8 does not correspond to the first sub-TLV in a Vendor Specific Information TLV 43.

Type	Length	Value
43	N	

Annex A Format and Content for OCHD2.1 Events (Normative)

This Annex reuses the event framework used in DOCSIS. In particular, only the Local log requirements for [OSSIv2.0] are required for the OCHD2.1.

The format of Table A–1 is slightly different from the one in [OSSIv2.0]. A brief summary of the OCHD2.1 elements is below.

- Each row specifies a possible event that the OCHD2.1 logs to the available mechanisms.
- The first column (Process) indicates the stage where the event would happen. The currently defined processes are: 'Prov' Provisioning of the OCHD2.1, and DHCP renewal of DHCP.
- The second column (SubProcess) indicates a sub-process within the specified Process. For example, for the process 'Prov', the sub-process 'TLV PARSING' and DHCP (initial DHCP provisioning) are defined; the DHCP Process includes the 'Renewal' sub-process.
- The third column (Event Level) indicates the event level of the event (see [OSSIv2.0]). This column value is reported in the MIB object docsDevEvLevel of the docsDevEventTable.
- The fourth column (Event Message) indicates the event text to record. This column value is reported in the MIB object docsDevEvText of the docsDevEventTable.
- The Fifth column (Message Notes and Details) is a placeholder to indicate special interpretation of parameters or indications for the Event Message column.
- The sixth column (Error Code Set) correspond to an Encoding model of the events (originally defined in [OSSIv2.0]). This Error Code set is in the scope of the OCHD2.1 specification. However, some codes have been reused from DOCSIS for consistency. Because DOCSIS may extend this code set independently of the events defined in the Open Cable specification, corresponding Error Code Set would not be always the same for identical error conditions.
- The seventh column (Event ID) is a numeric representation of the Error Code Set. The mapping of Event ID and Error Code Set is defined in [OSSIv2.0], and this specification follows the same methodology. This column value is reported in the MIB object docsDevEvId of the docsDevEventTable.
- The eighth column (Notification Name) indicates the SNMP notification object type that this event would generate. Currently no notifications are defined. This column is left in the table format for future study.
- Additional formatting indications are described as well in [OSSIv2.0].

Table A–1 - eSTB Event List for the OCHD2.1

Process	SubProcess	Event Level	Event message	Message Notes And Details	Error Code Set	Event ID
TLV-11 Failures						
Prov	TLV-11 PARSING	Notice	TLV-11 - unrecognized OID		I401.0	73040100
Prov	TLV-11 PARSING	Warning	TLV-11 - Illegal Set operation failed		I402.0	73040200
Prov	TLV-11 PARSING	Warning	TLV-11 - Failed to set duplicate elements		I403.0	73040300
TLV Failures						
Prov	TLV PARSING	Notice	TLV - unrecognized Type		I404.0	73040400
Prov	TLV PARSING	Warning	TLV - Failed to set duplicate elements		I405.0	73040500

Process	SubProcess	Event Level	Event message	Message Notes And Details	Error Code Set	Event ID
Prov	TLV PARSING	Warning	TLV - illegal encoding failed		I406.0	73040600
Prov	TLV PARSING	Warning	TLV - Invalid element multiplicity		I407.0	73040700
Prov	TLV PARSING	Warning	TLV - Insufficient resources		I408.0	73040800
Prov	TLV PARSING	Warning	TLV- Element Already exist Failed creation		I409.0	73040900
DHCP IP Acquisition						
Prov	DHCP	Critical	DHCP FAILED – Discover sent, no offer received for <P1>	<P1>: 'eSTB' or 'CC'	D01.0	68000100
Prov	DHCP	Critical	DHCP FAILED – Request sent, No response for <P1>	<P1>: 'eSTB' or 'CC'	D02.0	68000200
Prov	DHCP	Critical	DHCP FAILED – Requested Info not supported for <P1>	<P1>: 'eSTB' or 'CC'	D03.0	68000300
Prov	DHCP	Critical	DHCP FAILED – Response doesn't contain ALL the valid fields for <P1>	<P1>: 'eSTB' or 'CC'	D03.1	68000301
DHCP IP Renewal						
DHCP		Error	DHCP RENEW sent – No response for <P1>	<P1>: 'eSTB' or 'CC'	D101.0	68010100
DHCP		Error	DHCP REBIND sent – No response for <P1>	<P1>: 'eSTB' or 'CC'	D102.0	68010200
DHCP		Error	DHCP RENEW sent – Invalid DHCP option for <P1>	<P1>: 'eSTB' or 'CC'	D103.0	68010300
DHCP		Error	DHCP REBIND sent – Invalid DHCP option for <P1>	<P1>: 'eSTB' or 'CC'	D104.0	68010400

APPENDIX I Revision History

The following ECN was incorporated into OC-SP-HOST2.1-CFR-I02-071113:

ECN	Description	Date
HOST2.1-CFR-N-1107-1	MIB sections reorganization	10/23/07

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I03-080118:

ECN	Description	Date
HOST2.1-CFR-N-1086-1	Change to number of required 1394 ports	12/7/07
HOST2.1-CFR-N-1138-1	Changes to sections 13, 14 and 15 for ReqPro compliance	12/21/07
HOST2.1-CFR-N-1145-1	Changes to sections 1 thru 12 for ReqPro compliance	12/21/07