OpenCable™ Specifications

OpenCable Host Device 2.1
Core Functional Requirements

OC-SP-HOST2.1-CFR-I17-130418

ISSUED

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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.

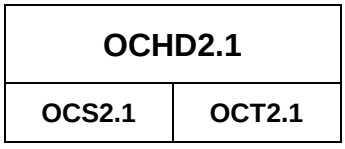

Figure 1.2-1 - OpenCable Host Device 2.1 Types

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 DOCSIS Set-top Gateway (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) 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 [SCTE 128];
- 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 or alternative IP-based home networking interface;
- 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) 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 [SCTE 128];
- 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], or alternative IP-based home networking interface;
- 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 [CCIF]. 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 either the DOCSIS 2.0 spec [RFIv2.0] or the DOCSIS 3.0 spec [MULPIv3.0], [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 Bundle	The OpenCable Bundle defines a set of specifications required to build a specific version of an OpenCable device. See [OC-BUNDLE].
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
DPB	Decoded Picture Buffer
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
NAL	Network Abstraction Layer
NMS	Network Management System
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
S3D	Stereoscopic 3D
SAR	Sample Aspect Ratio
SCTE	Society of Cable Telecommunications Engineers
SEBC	DOCSIS Set-top Extender Bridge Client
SEBS	DOCSIS Set-top Extender Bridge Server
SD	Standard Definition
SDL	Specification and Descriptor Language
SEI	Supplemental Enhancement Information
SI	System Information
SNMP	Simple Network Management Protocol
SPS	Sequence Parameter Set
SPTS	Single Program Transport Stream
SRAP	SCTE Random Access Point
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.

References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific:

- For a specific reference, subsequent revisions do not apply.
- For a non-specific, non-Bundle reference, the latest version applies.
- For non-specific CableLabs references that are part of the [OC-BUNDLE], the versions mandated in a particular Bundle apply.

[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+] Data-Over-Cable Service Interface Specifications, Baseline Privacy Plus Interface Specification, CM-SP-BPI+-C01-081104, November 4, 2008, Cable Television Laboratories, Inc.

[CANN-DHCP] CableLabs DHCP Options Registry Specification, CL-SP-CANN-DHCP-Reg-I09-120809, August 9, 2012, Cable Television Laboratories, Inc.

[CCCP] CableCARD Copy Protection 2.0 Specification, OC-SP-CCCP2.0, Cable Television Laboratories, Inc. Referenced in [OC-BUNDLE].

[CCIF] CableCARD Interface 2.0 Specification, OC-SP-CCIF2.0, Cable Television Laboratories, Inc. Referenced in [OC-BUNDLE].

[CDL] Common Download 2.0, OC-SP-CDL2.0, Cable Television Laboratories, Inc. Referenced in [OC-BUNDLE].

[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-E]	CEA-861-E: A DTV Profile for Uncompressed High Speed Digital Interfaces, March 2008.
[CEA-931-B]	CEA-931-B: Remote Control Command Pass-through Standard for Home Networking.
[CEP]	OC-SP-CEP3.0-I04-121210, December 10, 2012, OpenCable Content Encoding Profiles 3.0 Specification, Cable Television Laboratories, Inc.
[CHILA]	CableLabs Card-Host Interface License Agreement.
[DSG]	DOCSIS Set-top Gateway (DSG) Interface Specification, CM-SP-DSG-I23-130404, April 4, 2013, 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 714]	SCTE DVS 714, Constraints on AVC Video Coding for Digital Program Insertion.
[eDOCSIS]	Data-Over-Cable Service Interface Specifications, eDOCSIS Specification, CM-SP-eDOCSIS-I25-130404, April 4, 2013, Cable Television Laboratories, Inc.
[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.
[HDMI]	High-Definition Multimedia Interface, Specification Version 1.3a, November 10, 2006.
[HOST-MIB]	OpenCable Host Device 2.X MIB Specification, OC-SP-MIB-HOST2.X, Cable Television Laboratories, Inc. Referenced in [OC-BUNDLE].
[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.
[IPv6]	DOCSIS 2.0 + IPv6 Cable Modem Specification, CM-SP-DOCSIS2.0-IPv6-I07-130404, April 4, 2013, Cable Television Laboratories, Inc.
[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).

[MULPIv3.0] DOCSIS 3.0 MAC and Upper Layer Protocols Interface Specification, CM-SP-MULPIv3.0-I21-130404, April 4, 2013, Cable Television Laboratories, Inc.

[OC-BUNDLE] OpenCable Bundle Requirements, OC-SP-BUNDLE. See Section 2.3.1 to acquire this specification.

[OC-SEC] OpenCable System Security Specification, OC-SP-SEC, Cable Television Laboratories, Inc. Referenced in [OC-BUNDLE].

[OCAP] OpenCable Application Platform (OCAP), OC-SP-OCAP, Cable Television Laboratories, Inc. Referenced in [OC-BUNDLE].

[OCAP-FP] OCAP Front Panel Extension, OC-SP-OCAP-FPEXT, Cable Television Laboratories, Inc. Referenced in [OC-BUNDLE].

[OC-HNP2.0] OpenCable Home Networking Protocol 2.0, OC-SP-HNP2.0, Cable Television Laboratories, Inc. Referenced in [OC-BUNDLE].

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[RFC 1901] Introduction to Community-based SNMPv2.

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[RFC 2030] Simple Network Time Protocol (SNTP) Version 4 for IPv4, IPv6 and OSI.

[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 3203] DHCP reconfigure extension. Y. T'Joens, C. Hublet, P. De Schrijver. December 2001.

[RFC 3315] Dynamic Host Configuration Protocol for IPv6.

[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).

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[RFC 3418] Management Information Base (MIB) for the Simple Network Management Protocol (SNMP).

[RFC 3419] Textual Conventions for Transport Addresses (SNMP).

[RFC 3584] Coexistence between Version 1, Version 2, and Version 3 of the Internet-standard Network Management Framework.

[RFC 3646] DNS Configuration Options for Dynamic Host Configuration Protocol for IPv6.

[RFC 3927] Dynamic Configuration of IPv4 Link-Local Addresses.

[RFC 4291] IP Version 6 Addressing Architecture.

[RFC 4293] Management Information Base for the Internet Protocol (IP).

[RFC 4861] Neighbor Discovery for IP Version 6.

[RFC 4862] IPv6 Stateless Address Autoconfiguration.

[RFC 5246] The Transport Layer Security (TLS) Protocol Version 1.2.

[RFIv2.0] CM-SP-RFIv2.0-C02-090422, Data-Over-Cable Service Interface Specifications, Radio Frequency Interface Specification, April 22, 2009, 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 127] ANSI/SCTE 127, 2007: Carriage of Vertical Blanking Interval (VBI) Data in North American Digital Television Bitstreams.

[SCTE 128] ANSI/SCTE 128, 2010-a: AVC Video Systems and Transport Constraints 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, 2009: Digital Video Service Multiplex and Transport System Standard for Cable Television.

[SCTE 55-1] ANSI/SCTE 55-1, 2009: Digital Broadband Delivery System: Out-of-Band Transport Part 1: Mode A.

[SCTE 55-2] ANSI/SCTE 55-2, 2008: Digital Broadband Delivery System: Out-of-Band Transport Part 2: Mode B.

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2.3 Reference Acquisition

2.3.1 OpenCable Bundle Requirements

The OpenCable Bundle Requirements specification [OC-BUNDLE] indicates the set of CableLabs specifications required for the implementation of the OpenCable Bundle. The version number of [OC-BUNDLE] corresponds to the release number of the OpenCable Bundle that it describes. One or more versions of [OC-BUNDLE] reference this specification. Current and past versions of [OC-BUNDLE] may be obtained from CableLabs at http://www.cablelabs.com/opencable/specifications.

2.3.2 Other References

CableLabs Specifications:

Cable Television Laboratories, Inc., 858 Coal Creek Circle, Louisville, CO 80027;
Phone: +1-303-661-9100; Fax +1-303-661-9199; http://www.cablelabs.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

DTCP Specifications and License

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

DVB/ETSI Specifications:

www.dvb.org; www.etsi.org

FCC Specifications:

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

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/

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/

SCTE/DVS Standards:

SCTE - Society of Cable Telecommunications Engineers Inc., 140 Philips Road, Exton, PA 19341 Phone: +1-610-363-6888 / +1-800-542-5040; Fax: +1-610-363-5898; http://www.scte.org/

UPnP Specifications:

http://www.upnp.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.

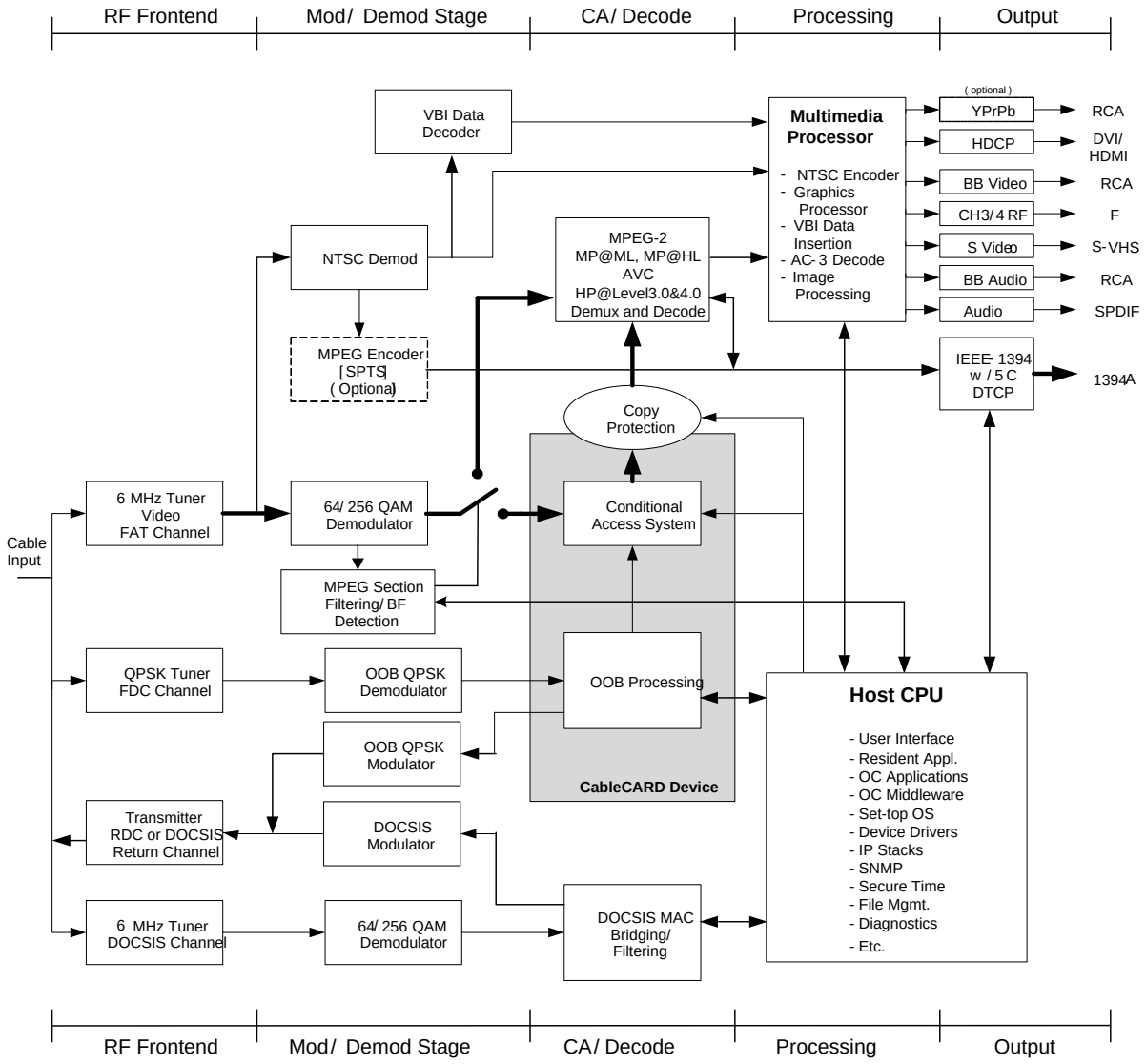


Figure 3.1-1 - Block Diagram of the OpenCable Set-top 2.1 (Informative)

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 [CCIF]. 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 [SCTE 128]) 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 54-1002 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], or alternative IP-based home networking interface
- CableCARD digital interface (see OpenCable CableCARD Interface 2.0 Specification [CCIF])
- OpenCable CableCARD Copy Protection 2.0 Specification [CCCP]

- Out-Of-Band messaging via [DSG]
- An embedded cable modem with DSG functionality compliant with [RFIv2.0] or [MULPIv3.0]
- 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 [CCCP]: 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 [CDL] and [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 [CCCP].

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 [CCCP].

4.5 Digital Program Copy Protection

If present, 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 [CCCP].

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 [CCCP] 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 IEEE 1394 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, if present, 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 Ohms):

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 1002 MHz (FAT channel and DOCSIS downstream)
- 70 to 130 MHz (OOB FDC channel)
- 5 to 42 MHz (OOB RDC channel and DOCSIS upstream)

The OCHD2.1 MAY utilize Set-top Extender Bridge (SEB) services via the Home Network for interactive IP traffic as defined in [DSG]. This optional method supplements DOCSIS downstream and upstream channels in cases where two-way communications are required but the Host2.1 is unable to acquire an upstream channel.

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 1002 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. It is expected that only QAM channels will be present above 864 MHz.

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 [CCIF].

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 [CCIF].

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 1002 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 1002 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 (54-1002 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, 54-744 MHz at input level of +15 dBmV, at least 43 QAM channels, 744-1002 MHz, at RF input level of +9 dBmV. *(See Note 2)*
12.	X-Mod.	Not worse than -57 dBc Channel loading assumptions: At least 110 AM-VSB channels, 54-744 MHz at input level of +15 dBmV, at least 43 QAM channels, 744-1002 MHz, at RF input level of +9 dBmV. *(See Note 2)*

	Parameter	Requirement
13.	CSO	Not worse than -60 dBc Channel loading assumptions: At least 110 AM-VSB channels, 54-744 MHz at input level of +15 dBmV, at least 43 QAM channels, 744-1002 MHz, at RF input level of +9 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, 54-744 MHz at input level of +15 dBmV, at least 43 QAM channels, 744-1002 MHz, at RF input level of +9 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	$\leq$ 0.25 µsec/MHz across the 6-MHz channel
20.	Phase Noise Tolerance	$\leq$ -88 dB/Hz @ 10 kHz offset (relative to the center of QAM signal spectrum)
21.	Amplitude Ripple Tolerance Digital channels Analog channels	 $\leq$ 5 dB p-p within the 6 MHz channel $\leq$ 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 µsec *(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 1002 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 - 1002 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 either [RFIv2.0] for DOCSIS 2.0 implementations or [MULPIv3.0] for DOCSIS 3.0 implementations.

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

	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

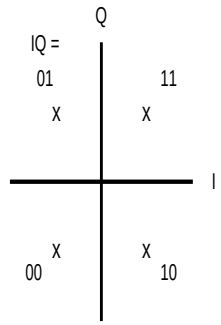
16 us burst noise not greater than -12 dBmV at 10 Hz rep rate

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 either [RFIv2.0] for DOCSIS 2.0 implementations or [MULPIv3.0] for DOCSIS 3.0 implementations.

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

	Parameter	Values for OOB-RDC
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.	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 - 1002 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 is described in [CCIF].

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

The OCHD2.1 SHALL be constructed to accommodate CableCARD devices having a physical length that may vary from 85 mm up to and including 102 mm.

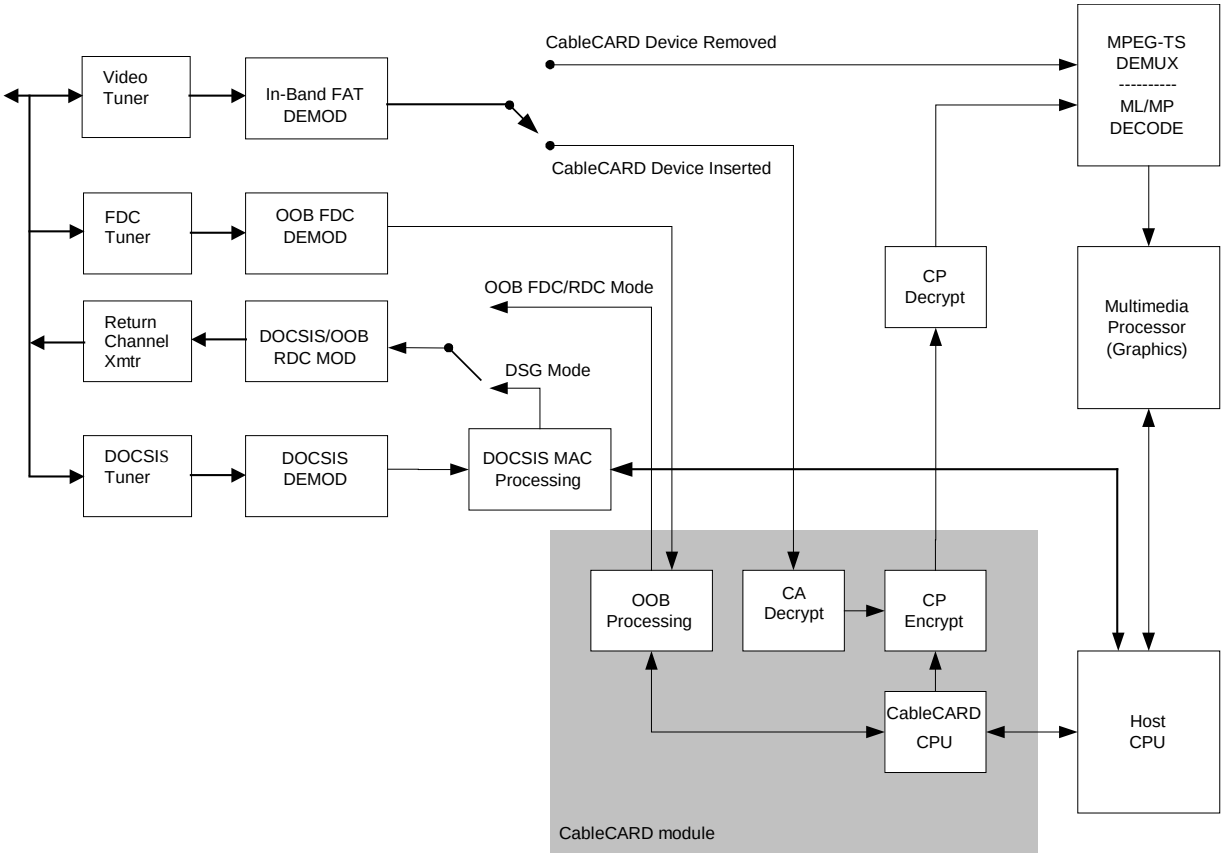


Figure 6-1 - Block Diagram of the OpenCable CableCARD Interface (Informative)

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 [SCTE 128] 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 [SCTE 128] 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.

When the OCHD2.1 is operating without a Card, it SHALL NOT use the Set-top Extender Bridge (SEB).

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 [CCCP] 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 [CCIF].

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 [CDL].

The OCHD2.1 SHALL support upgrade of the following functional components by mechanisms specified in [CDL] 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 affect 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 unique 48-bit MAC address SHALL be associated with the eSTB when operating in DSG mode.

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

The OCHD2.1 SHALL have a unique 48-bit MAC address assigned for each OCAP Home Networking interface [HOST-HN2.0] providing functionality that is separate from the eSTB MAC address.

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 1 and 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].

6.6 Generic Feature Control Resource Requirements

The OCHD2.1 SHALL include every non-reserved feature ID in table 9.15-2 of [CCIF] each time it sends the feature_list() APDU to the Card.

The OCHD2.1 SHALL store the generic features listed in Table 6.6-1 in such a way that the OCHD2.1 does not have to query the Card each time the OCHD2.1 needs to know the value of one of the generic features.

If the Card supports a generic feature that is not in Table 6.6-1, the OCHD2.1 SHALL accept the generic feature when sent from the Card in the feature_parameters() APDU, but is not required to store the value.

Table 6.6-1 - Generic Features Stored in the Host

Generic Feature
RF Output Channel
Purchase PIN
Parental Control PIN
Timezone
Daylight Savings Control
AC Outlet
Language
Rating Region
EAS Location Code
VCT_ID
Turn On Channel
Terminal Association
Common Download Group ID
Zip Code
RF Output Channel

The OCHD2.1 SHALL set aside a minimum of 256 bytes to store the terminal association generic feature. If the terminal association generic feature is longer than 256 bytes, the OCHD2.1 MAY truncate its value.

The OCHD2.1 SHALL set aside a minimum of 10 bytes to store the zip code generic feature. If the zip code generic feature is longer than 10 bytes, the OCHD2.1 MAY truncate its value.

6.7 Card SNMP Message Support

6.7.1 Support Functionality (Informative)

The OCHD2.1 provides a limited form of SNMP communication by proxy support (i.e., queries and sets) for Cards. This enables the Card to utilize the OCHD2.1 SNMP agent's communication capabilities with the Network Management System (NMS) to transport vendor-specific diagnostic information to network managers.

Figure 6.7-1 presents the initial flow of a single query, an SNMP GetRequest.

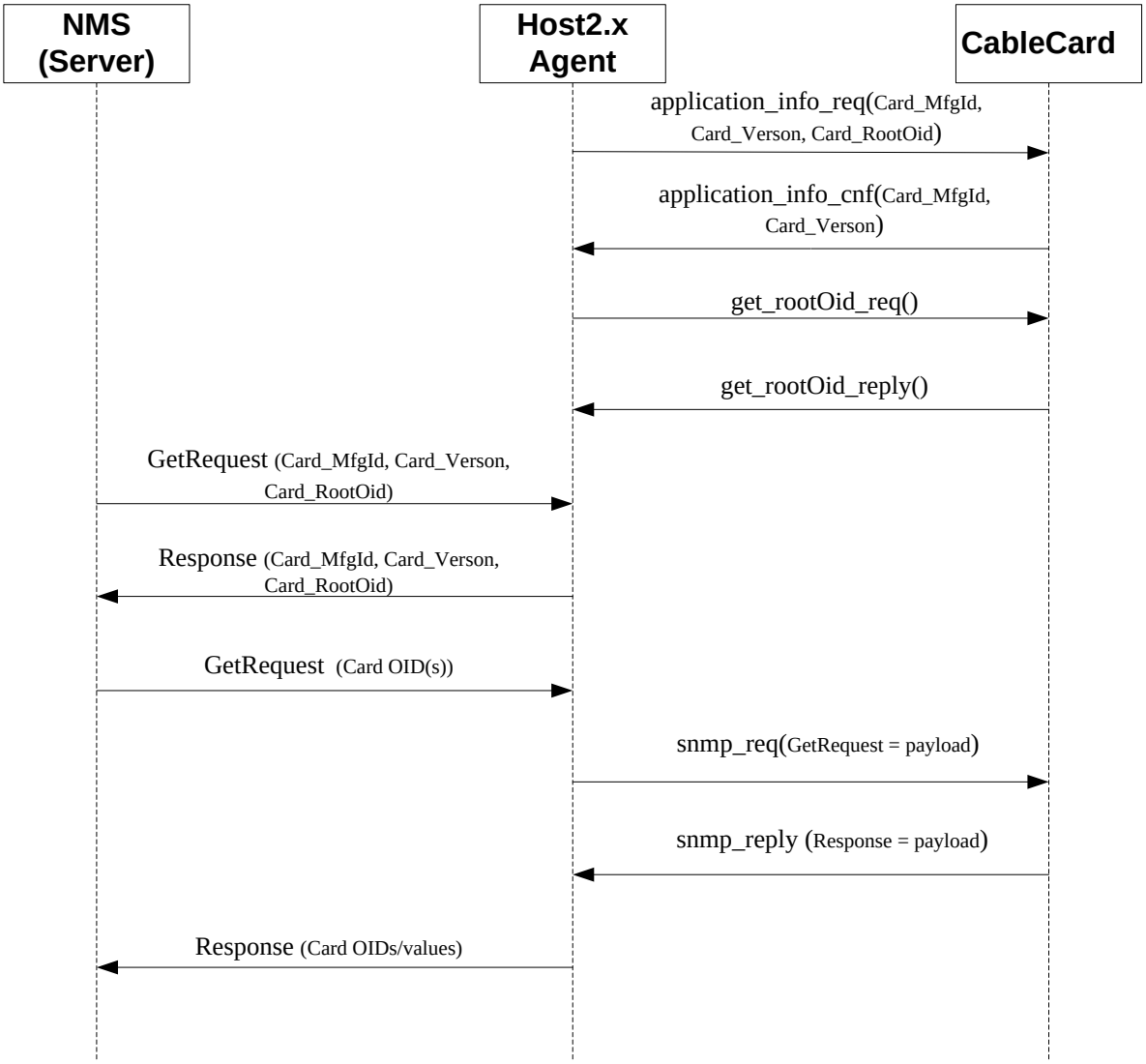


Figure 6.7-1 - Initial Flow of an SNMP GetRequest

The data exchange overview follows.

1. During initialization, the Card may open a session to the Card Access MIB resource (not shown here).
2. The Host collects the Card manufacturer/vendor Identifier, version, MAC address, serial number, and manufacturer/vendor private MIB root object identification (OID) for the Card. Note that in some cases the CA

system identifier may be required to resolve the exact Card root OID. This can be found in the Host2.x MIB object, ocStbHostCASystemIdentifier.

3. The Host stores the information in the Host2.x MIB. It may be transferred later to the headend via standard SNMP GetRequests.
4. The Headend NMS uses the private Card MIB to form the SNMP queries (GetRequests and GetNextRequests). Note that the Host 2.1 IP address is the PDU destination-not the Card.
5. The Host 2.1 examines the variable-binding list and determines which entries are 1) invalid, 2) objects managed by the Host SNMP Agent, and 3) prefixed by the Card root OID. In this diagram, one or more VARBIND OIDs that match the Card root OID are extracted from the original GetRequest and transferred in the ***snmp_req()*** APDU.
6. The Card will build a properly formatted SNMP Response PDU and send it to the Host 2.1 in the ***snmp_reply()*** APDU.
7. The Host 2.1 will extract the OID and its value from the Response PDU and add it to the SNMP response that will be sent to the NMS at the headend.

Note that the Card MIB is not part of the OCHD2.1 Host MIB. Therefore, an SNMP walk of the Host MIB will not include any of the Card MIB OIDs.

6.7.2 Mixed Object Identifier Processing (Informative)

Mixed Object Identifiers[1], or mixed OIDs, may be contained in a variable-binding list sent to a Host in SNMP queries or modifications. The NMS may send such an SNMP request to the Host and it will expect a single response from the agent regardless of the number of bindings in the request. The agent will examine the variable-binding list and will process each binding as follows.

1. Each object managed directly by the Host agent will be paired with its current value and added to the variable-binding list that will be sent to the NMS in the Response-PDU
2. All objects managed by the Card (i.e., an object in the Card MIB subtree), will be sent in one or more SNMP messages, each encapsulated in the payload of a ***snmp_req()*** APDU.
3. The Host will wait a finite period of time for the Card to return the completed variable-binding list in an ***snmp_reply()*** APDU.
4. After receiving a reply, the Host adds the Card variable-binding list to the Response-PDU and then sends the Response PDU to the NMS.

An example of a GetNextRequest with mixed OIDs follows.

For the purposes of this example, assume the following MIB objects exist for the Host and the Card.

- Host managed objects: sysUpTime, ocStbCardBindingStatus
- Card managed objects: cardStatus, cardChannelMap (note that these are fictitious for demonstrative purposes only)

The OID names will be used instead of the ASN.1 encoded values. The SNMP request PDU format is included here to clarify the terms and phrases used throughout this section.

[1] The Host may receive SNMP messages containing mixed OID requests, which are defined as messages specifying some OIDs destined for the Host and other OIDs destined for the Card.

Version	Community	PDU-type	Req_Id	Error Status	Error Index	Variable-Binding List

Figure 6.7-2 - SNMP Request PDU format

The NMS sends a GetRequest-PDU to the host for the objects listed above. Figure 6.7-3 represents the three steps required to build and return a Response-PDU.

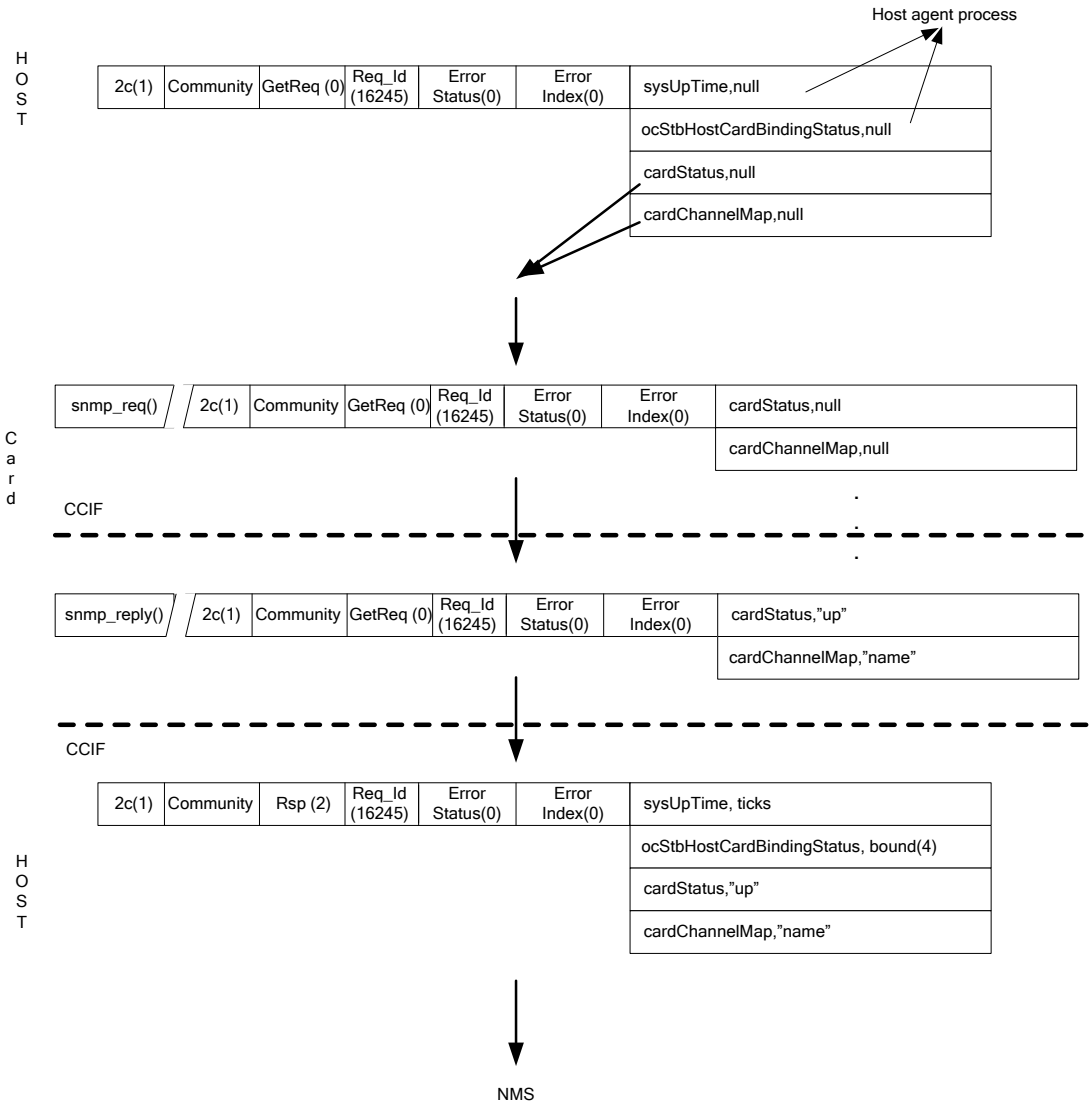


Figure 6.7-3 - Example Response-PDU

- In this example, the Host agent processes the MIB objects it manages.
- The agent identifies the two card objects as part of the Card subtree by comparing the OID prefixes to the ocStbHostCardRootOid. The Host modifies the variable-binding list by reducing it to those OIDs managed by the Card. It encapsulates the GetRequest in the ***snmp_req()*** and forwards it to the Card for processing. The Host will wait for the Card's response or a timeout.

- The Card retrieves the values for the OIDs in the GetRequest and returns the completed variable-binding list to the Host in the ***snmp_reply()*** APDU.
- The Host combines the variable-bindings from the Card with those it processed for the objects it manages into a single SNMP Response-PDU.

6.7.3 GetBulkRequest Processing (Informative)

GetBulkRequest PDUs require more processing by the Host agent on behalf of the Card. Specifically, the agent will convert the GetBulkRequests into GetNextRequests to be sent to the Card. The number of GetNextRequests to be formed and transmitted to the Card is dependent on the GetBulkRequest-PDU fields, *non-repeaters* and *max-repetitions*. Notice in the PDU format in Figure 6.7-4 that the error indicators of the SNMP request/response PDUs have been replaced.

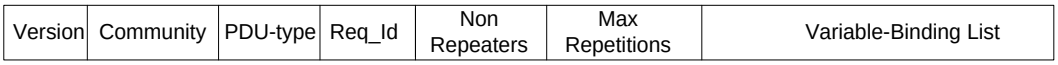


Figure 6.7-4 - GetBulkRequest PDU format

See [RFC 3416] for the explanation of these fields during normal GetBulkRequest processing by an agent. This proxied GetBulkRequest example demonstrates how these fields will inform the GetNextRequest creation and transmission by the Host agent.

Assume the following in this example.

- The GetBulkRequest variable-binding list is restricted to Card OIDs, although this is not a restriction.
- No errors are encountered by the Host agent or the Card.
- Four Card OIDs in the GetBulkRequest in the variable-binding list. Two OIDs are non-repeaters and two OIDs are subject to max-repetitions (i.e., two "repeaters").
- All Card OIDs in Table 6.7-1 below are demonstrative only and do not reflect any Card manufacturer's implementation.
- Each Table in the example has only one conceptual row instantiated; thus, each GetNextRequest will generate a columnar value instead of multiple instantiations of a single "column".

Table 6.7-1 - GetBulkRequest example

Object Name	OID	Value
cardVersion	1.3.6.1.4.1.9876.2.3.1	"1.2.3.a"
cardStatus	1.3.6.1.4.1.9876.2.3.2	"operational"
cardPgmStatusTable	1.3.6.1.4.1.9876.2.3.1.4.6	
cardPgmStatusTableEntry	1.3.6.1.4.1.9876.2.3.1.4.6.1	
cardPgmStatusTableIndex	1.3.6.1.4.1.9876.2.3.1.4.6.1.1	1 (not accessible)
cardPgmStatusProgramNumber	1.3.6.1.4.1.9876.2.3.1.4.6.1.2	33
cardPgmStatusCCI	1.3.6.1.4.1.9876.2.3.1.4.6.1.3	0x00
cardAppTable	1.3.6.1.4.1.9876.2.3.1.4.7	
cardAppTableEntry	1.3.6.1.4.1.9876.2.3.1.4.7.1	

Object Name	OID	Value
cardAppTableIndex	1.3.6.1.4.1.9876.2.3.1.4.7.1.1	1 (not accessible)
cardAppName	1.3.6.1.4.1.9876.2.3.1.4.7.1.2	"sample"
cardAppStatus	1.3.6.1.4.1.9876.2.3.1.4.7.1.3	"not responding"

Figure 6.7-5 offers a graphic representation of the GetBulkRequest sent by the NMS to the Host.

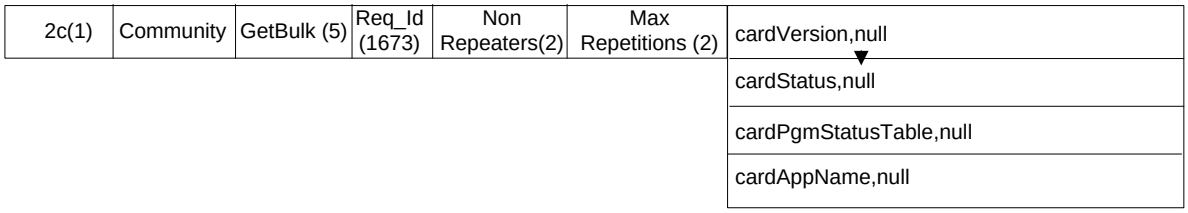


Figure 6.7-5 - GetBulkRequest

The number of GetNextRequests the Host must generate and send to the card is six, based on the following calculation:

Total GetNextRequests = N + (M * R), where

N is the minimum of

- the value of the Non-Repeaters field in the request
- the number of variable bindings in the request

M is the Max-Repetitions field of the request.

R is the maximum of

- the total number of variable bindings in the request - N
- zero

The Repeaters count, R, is typically derived by subtracting the number of Non-Repeaters from the total number of OIDs in the GetBulkRequest variable-binding list (i.e., Repeaters = Total # OIDs - Non-Repeaters).

In other words, the Host performs a simple GetNextRequest for the first N variable-bindings in the request and performs M GetNextRequests for each of the remaining R variable-bindings in the request list.

Table 6.7-2 depicts the flow of GetNextRequests that the Host generates and sends to the Card in response to the GetBulkRequest. The message sequence begins *after* receiving the GetBulkRequest from the NMS and ends immediately prior to sending the Response-PDU.

Table 6.7-2 - Flow of GetNextRequests

Message	Direction Host--Card	OID	VARBIND Value
GetNext	→	1.3.6.1.4.1.9876.2.3.1	--
Response	←	1.3.6.1.4.1.9876.2.3.1.0	"1.2.3.a"
GetNext	→	1.3.6.1.4.1.9876.2.3.2	--

Message	Direction Host--Card	OID	VARBIND Value
Response	←	1.3.6.1.4.1.9876.2.3.2.0	"operational"
GetNext	→	1.3.6.1.4.1.9876.2.3.1.4.6	--
Response	←	1.3.6.1.4.1.9876.2.3.1.4.6.1.1.1	1
GetNext	→	1.3.6.1.4.1.9876.2.3.1.4.6.1.1.1	--
Response	←	1.3.6.1.4.1.9876.2.3.1.4.6.1.2.1	33
GetNext	→	1.3.6.1.4.1.9876.2.3.1.4.7.1.2	--
Response	←	1.3.6.1.4.1.9876.2.3.1.4.6.1.2.1.1	"sample"
GetNext	→	1.3.6.1.4.1.9876.2.3.1.4.6.1.2.1.1	--
Response	←	1.3.6.1.4.1.9876.2.3.1.4.6.1.2.2.1	"not responding"

The GetBulkRequest Response-PDU is graphically presented below.

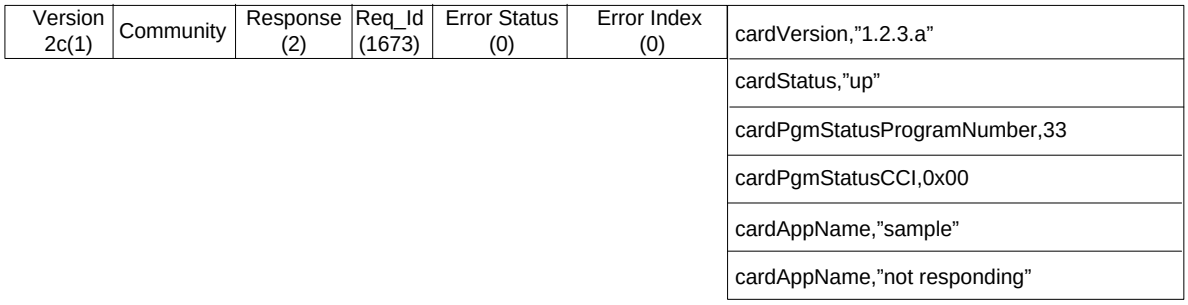


Figure 6.7-6 - GetBulkRequest Response-PDU

The Response-PDU uses the same Request ID as that contained in the original GetBulkRequest. In addition, the six variable-bindings are returned instead of the four originally received.

6.7.4 Support Requirements (Normative)

Note: For the purposes of this section, the term "SNMP queries" is interchangeable with SNMP GetRequest and GetNextRequest PDUs. GetBulkRequests require special processing by the OCHD2.1 agent.

The OCHD2.1 SHALL discard any SNMP packet targeted for the Card other than GetRequest, GetNextRequest, GetBulkRequest, and SetRequest PDUs.

The OCHD2.1 agent SHALL format and send GetRequest, GetNextRequest, and SetRequest PDUs to the Card using the ***snmp_req()*** APDU as defined in [CCIF].

The OCHD2.1 agent SHALL accept Response-PDUs from the Card using the ***snmp_reply()*** APDU.

The OCHD2.1 SHALL determine that the Card supports SNMP message processing if the Card requests that a session be opened to the Card Access MIB resource.

The OCHD2.1 SHALL send a ***get_rootOid_req()*** APDU to request the root OID of the Card MIB after the Card has opened a session to the MIB resource. The Card MIB is expected to be defined in the private namespace of the Card manufacturer's MIB.

The OCHD2.1 SHALL store the Card root OID in the Host2.x MIB [HOST-MIB].

The OCHD2.1 SHALL store a 0.0 for the Card root OID object in the Host2.x MIB [HOST-MIB] until the Card opens a session to the Card Access MIB resource.

SNMP message processing support requires the NMS send all SNMP "queries" and "sets" for either the OCHD2.1 *or* Card to the OCHD2.1 IP address. Upon receiving each message, the OCHD2.1 determines the final destination(s) of the message by examining the OID(s) in the embedded VARBIND list.

The OCHD2.1 SHALL support SNMPv2c GetRequest, GetNextRequest, GetBulkRequest, and SetRequest PDUs on behalf of the Card.

The OCHD2.1 SHALL send a modified SNMP GetRequest, GetNextRequest, and SetRequest PDUs to the Card on behalf of the NMS if the original message contains mixed OIDs.

The OCHD2.1 SHALL send SNMP GetRequest, GetNextRequest, and SetRequest PDUs to the Card encapsulated in an ***snmp_req()*** APDU containing only OIDs in the Card's MIB subtree.

The OCHD2.1 SHALL combine the VARBIND lists from the OCHD2.1 agent and the ***snmp_reply()*** APDU from the Card to create a single SNMP Response-PDU with the same Request ID carried in the original GetRequest, GetNextRequest, or SetRequest PDU. This Response-PDU will be forwarded to the SNMP NMS.

The OCHD2.1 SHALL set a response timeout value of five seconds that will be used to determine that a response is not forthcoming from the Card. If a response is not received after sending the request in a period less than this value, the Host will discard the original request.

The OCHD2.1 SHALL process GetBulkRequests on behalf of the Card as follows:

The OCHD2.1 SHALL use GetNextRequests to acquire the variable-bindings from the Card.

The OCHD2.1 SHALL send a single GetNextRequest to the Card for each Card OID contained in the first N variable-bindings in the GetBulkRequest variable-binding list, where N is defined in Section 6.7.3.

The OCHD2.1 SHALL send a sequence of M GetNextRequests for each of the remaining R variable-bindings that contain a Card OID, where M and R are defined in Section 6.7.3.

If the Card responds to a GetNextRequest with an "EndofMIBView", the OCHD2.1 SHALL terminate further GetNextRequests for the current repeating sequence.

If the Card responds to a GetNextRequest with an error, the OCHD2.1 SHALL send a Response-PDU to the NMS with this error and terminate the GetBulkRequest processing.

The OCHD2.1 SHALL combine the GetNext Responses from the Card with any variable-bindings generated by the host SNMP agent as a result of the same GetBulkRequest (e.g., Host2.x MIB objects). The combined variable-bindings list will be sent to the NMS in a single Response-PDU subject to limitations specified in [RFC 3416].

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 [CCCP].

If the OCS2.1 includes an RF-modulated output, it SHALL be compliant with the following tables: Table 7.3-1, Table 8.3-1, Table 8.3-2, and 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 [CCIF].

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, and 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 [CCIF].

If the OCS2.1 includes an RF-modulated output, the output SHALL use a female "F" connector 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 an 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 an 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, if such interface is present.

The OCT2.1 SHALL provide at least one 4-pin or 6-pin standard IEEE-1394 connector operated as a sink device, if such interface is present.

If the OCS2.1 includes the ability to generate VBI lines as per [CEA-2020], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the AMOL-48 PES data as defined in [SCTE 127] is included in the PES data field.

If the OCS2.1 includes the ability to generate VBI lines as per [CEA-2020], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the AMOL-96 PES data as defined in [SCTE 127] is included in the PES data field.

If the OCS2.1 includes the ability to generate VBI lines as per [CEA-516], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the NABTS PES data as defined in [SCTE 127] is included in the PES data field.

If the OCS2.1 includes the ability to generate VBI lines as per [CEA-2020], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the TVG2X PES data as defined in [SCTE 127] is included in the PES data field.

If the OCS2.1 includes the ability to generate VBI lines as per [SMPTE 12M], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the VITC PES data as defined in [SCTE 127] is included in the PES data field.

If the OCS2.1 includes the ability to generate VBI lines as per [IEC 61880], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the Copy Protection data as defined in [SCTE 127] is included in the PES data field.

If the OCS2.1 generates VBI lines as per [IEC 61880] resulting from the presence of [SCTE 127] Copy Protection data, it SHALL include the 2-bit aspect ratio and display format as per [IEC 61880].

If the OCT2.1 includes the ability to generate VBI lines as per [CEA-2020], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the AMOL-48 PES data as defined in [SCTE 127] is included in the PES data field.

If the OCT2.1 includes the ability to generate VBI lines as per [CEA-2020], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the AMOL-96 PES data as defined in [SCTE 127] is included in the PES data field.

If the OCT2.1 includes the ability to generate VBI lines as per [CEA-516], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the NABTS PES data as defined in [SCTE 127] is included in the PES data field.

If the OCT2.1 includes the ability to generate VBI lines as per [CEA-2020], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the TVG2X PES data as defined in [SCTE 127] is included in the PES data field.

If the OCT2.1 includes the ability to generate VBI lines as per [SMPTE 12M], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the VITC PES data as defined in [SCTE 127] is included in the PES data field.

If the OCT2.1 includes the ability to generate VBI lines as per [IEC 61880], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the Copy Protection data as defined in [SCTE 127] is included in the PES data field.

If the OCT2.1 generates VBI lines as per [IEC 61880] resulting from the presence of [SCTE 127] Copy Protection data, it SHALL include the 2-bit aspect ratio and display format as per [IEC 61880].

7.2 OpenCable Host Input Devices

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.

Table 7.2-1 - Function Key Shapes and Colors

Function Key	Shape	Color
Function Key 0	Circle	Red: Pantone 200
Function Key 1	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
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 above (immediately preceding Table 7.2-1) and supports all the keys identified in [OCAP] Table 25-6.

Option 2: Do not supply a keyboard and provide details on either: a) 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 all the keys identified in [OCAP] Table 25-6, or b) Identify the licensable wireless protocol that 3rd party vendors can implement (with or without disclosing the details of the codes and protocols) that supports all the keys identified in [OCAP] Table 25-6.

If the wireless keyboard is the only input device supplied with the OCHD2.1, then it SHALL meet all the requirements specified above (immediately preceding Table 7.2-1).

Note: Regardless of which option is chosen, at least one functional wireless keyboard must be provided with the OCHD2.1 at the time of submission for certification testing.

7.3 RF Output Requirements (Channel 3/4 RF Output)

The OCS2.1 SHALL be compliant with the Channel 3/4 RF Performance Parameters in Table 7.3-1, if supported.

Table 7.3-1 - Channel 3/4 RF Output Performance Parameters (0° - 40° C)

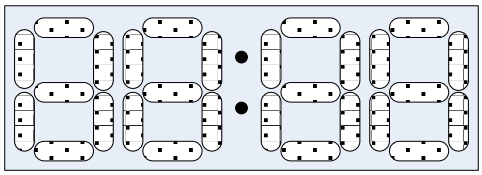
	Parameter	Requirement
1.	RF Output Carrier Frequencies	Channels 3 & 4 STD
2.	RF Output Impedance	75 ohm, unbalanced
3.	RF Output Return Loss	Ch ¾ RF output: 10 dB minimum for either channel
4.	Ch ¾ RF Output Level	+4.5 dBmV to +15 dBmV
5.	Ch ¾ RF Output Level Stability	Not vary more than ±1.5 dB
6.	Output 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
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 (54-1002 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, 54-744 MHz, at input level of +15 dBmV, at least 43 QAM channels, 744-1002 MHz, at RF input level of +9 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 [OCAP-FP], 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 [OCAP-FP].

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 [OCAP-FP].

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). [2]

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. [3]

8.2 Digital Video

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

The OCHD2.1 SHALL have the capability to tune digital channels from 54 to 1002 MHz according to the STD, IRC, and HRC channel plans as defined in [CEA-542-B].

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) [SCTE 128].

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) [SCTE 128].

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[4] digital channel, the OCT2.1 SHALL be capable of acquiring and displaying signals with no disruption lasting longer than 2.5 seconds (secs). [2]

When switched from one analog channel to a reference[4] digital channel, the outputs of any OCHD2.1 SHALL have no interruption lasting longer than 2.5 seconds (secs). [3]

[2] With respect to channel changes, the term “disruptions” includes: black frames, picture instability, macroblocking, freeze-frames, audible artifacts including muting.
[3] With respect to channel changes, the term “interruption” includes: loss-of-signal, black-frames, freeze-frames, discontinuities, macroblocking, audible artifacts including muting.
[4] 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 between two reference[4] 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). [2]

When switched between two reference[4] 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). [3]

When switched between two reference[4] 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). [2]

When switched between two reference[4] 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). [3]

When switched between two reference[4] 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). [2]

When switched between two reference[4] 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). [3]

When switched between two reference[4] 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). [2]

When switched between two reference[4] 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). [3]

When switched between two reference[4] 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). [2]

When switched between two reference[4] digital channels with different video coding standards, the outputs of any OCHD2.1 SHALL have no interruption lasting longer than 2.5 seconds (secs). [3]

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 with a minimum storage size of 20 Kbytes.

The OCHD2.1 SHALL store the XAIT table, as defined in [OCAP], in non-volatile memory with a minimum storage size of 16 Kbytes.

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 [SCTE 128].

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 [SCTE 128].

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 [SCTE 128].

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, [SCTE 128] 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 [SCTE 128].

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 [SCTE 128]. These optional elements or information specified in [SCTE 128] 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 [SCTE 128].

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 [SCTE 128].

The OCHD2.1 SHALL be able to process all of the VUI syntax elements specified in Table 7 of [SCTE 128].

The OCHD2.1 SHALL process AVC streams with the constraints specified in Tables 9A, 9B, and 9C of [SCTE 128] 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 [SCTE 128].

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 [SCTE 128] with the constraints and extensions that apply to video as specified in Table 9 of [SCTE 128].

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 [SCTE 128].

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 [SCTE 128] 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 [SCTE 128].

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 [SCTE 128] 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 256-QAM 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.

The OCHD2.1 AVC decoder SHALL process end_of_stream_rbsp() syntax elements required by applications, such as DPI, where another bitstream follows the end_of_stream NAL unit.

The OCHD2.1 AVC decoder SHALL process the bitstream following an end_of_stream_rbsp() syntax element. The bitstream following the end_of_stream NAL unit will start with an IDR picture in accordance with [SCTE 128], may signal an SRAP (in accordance with [DVS 714]) and may be accompanied by a time base discontinuity.

If the first picture output from the DPB for the following bitstream does not immediately follow the last output picture from the DPB for the stream with end_of_stream_rbsp() syntax element, then the OCHD2.1 AVC decoder SHALL repeat the last output picture from the DPB until the first picture from the following bitstream is output from the DPB.

For streams that conform to [SCTE 128]/[DVS 714] where only the horizontal resolution changes in SPS, the OCHD2.1 AVC decoder SHALL NOT infer the no_output_of_prior_pics_flag to be '1' when it is set to '0' in the IDR access unit.

The OCHD2.1 AVC decoder SHALL correctly process the no_output_of_prior_pics_flag in the IDR access unit that follows the access unit with an end_of_stream_rbsp().

If the no_output_of_prior_pics_flag is set to '0', then the OCHD2.1 AVC decoder SHALL output all of the decoded pictures in the DPB.

If the no_output_of_prior_pics_flag is set to '1', then the OCHD2.1 AVC decoder SHALL NOT output and SHALL clear the pictures in the DPB.

In all other cases (such as vertical resolution or frame rate changes in SPS), the OCHD2.1 AVC decoder can infer the no_output_of_prior_pics_flag to be '1' even though it is set to '0'.

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 [CCIF], 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].

The OCHD2.1 SHALL exclude from the channel map a channel defined by a VCM entry when a DCM section in the same SVCT has the range_defined field set to 'no' for the range the channel is in.

The OCHD2.1 SHALL include in the channel map a channel defined by a VCM entry when no DCM section in the same SVCT includes the channel in a channel range.

The OCHD2.1 SHALL include in the channel map a channel which is defined by a VCM entry when a DCM section in the same SVCT has the range_defined field set to 'yes' for the range the channel is in.

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 [SCTE 128].

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 [SCTE 128].

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, if such interface is present.

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 [SCTE 128].

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 [SCTE 128], if such interface is present.

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 such interface is present.

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, if such interface is present.

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
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
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:

Note 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].

If the OCS2.1 includes an HDMI or DVI output, it SHALL be compliant with mandatory elements of [CEA-861-E] for source devices.

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 requirements in this section are conditional mandatory and only apply if the IEEE-1394 interface is present. If the IEEE-1394 interface is not present, an alternative home networking interface as identified in [OC-HNP2.0] SHALL be implemented.

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 the requirement below (see REQ3446)

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 [HOST-MIB].

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.

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.

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 [SCTE 128] 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-E], except for the 640x480p format, which is optional.

The OCS2.1 SHALL include support for the video identification code (VIC) 32 (1920x1080p/24.0Hz), as defined in Table 2 of [CEA-861-E].

The OCS2.1 SHALL include support for the video identification code (VIC) 34, (1920x1080p/29.970 and 30Hz) as defined in Table 2 of [CEA-861-E].

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

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

If the OCT2.1 includes a 1080p display at any internal refresh rate, it SHALL include support for the VIC 32 (1920x1080p/24.0Hz) and VIC 34 (1920x1080p/29.97 or 30Hz) as defined in Table 2 of [CEA-861-E].

Note: Other formats listed in [CEA-861-E] 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-E].

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.

The OCS2.1 SHALL include a “reverse-telecine”, format conversion and/or deinterlace processor to permit output according to VIC32 timing requirements identified above, when the compressed video input signal is any interlaced format with film-mode tags (top_field_first and repeat_first_field) used to indicate the 3:2 pull-down process has been detected.

The OCS2.1 SHALL Enable VIC32 timing when any of the following is true:

- The OCS2.1 has read the CEA Extension provided in the sink’s EDID data structure that identifies VIC32 timing as the preferred format by placement of VIC32 in the first position of the short video descriptor according to [CEA-861-E].
- The OCS2.1 has read the CEA Extension provided in the sink’s EDID data structure that identifies VIC32 timing as a supported format by placement of VIC32 in any position of the short video descriptor according to [CEA-861-E], and the source video material was encoded in the 1920x1080p/24Hz (or 23.967Hz) mode.
- The OCS2.1 has read the CEA Extension provided in the sink’s EDID data structure that identifies VIC32 timing as a supported format in any position of the short video descriptor according to [CEA-861-E], and the user has manually selected this output mode.
- The OCS2.1 has read the CEA Extension provided in the sink’s EDID data structure and was not able to identify VIC32 timing as a supported format in any position of the short video descriptor according to [CEA-861-E], and the user has manually selected this output mode, and the Host has established that the sink device can support this mode through a self-test process.

The OCS2.1 SHALL Enable VIC34 timing when any of the following is true:

- The OCS2.1 has read the CEA Extension provided in the sink’s EDID data structure that identifies VIC34 timing as the preferred format by placement of VIC34 in the first position of the short video descriptor according to [CEA-861-E].
- The OCS2.1 has read the CEA Extension provided in the sink’s EDID data structure that identifies VIC34 timing as a supported format by placement of VIC34 in any position of the short video

descriptor according to [CEA-861-E], and the source video material was encoded in the 1920x1080p/30Hz (or 29.97Hz) mode.

- The OCS2.1 has read the CEA Extension provided in the sink's EDID data structure that identifies VIC34 timing as a supported format by placement of VIC34 in any position of the short video descriptor according to [CEA-861-E], and the user has manually selected this output mode.
- The OCS2.1 has read the CEA Extension provided in the sink's EDID data structure and was not able to identify VIC34 timing as a supported format by placement of VIC34 in any position of the short video descriptor according to [CEA-861-E], and the user has manually selected this output mode, and the Host has established that the sink device can support this mode through a self-test process.

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-E].

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-E].

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.

8.6 Stereoscopic 3D Support

This subsection lists the requirements on an OCHD2.1 with respect to the stereoscopic 3D formats and HDMI interfaces.

8.6.1 3D Coding (format) Support

The OCS2.1 SHALL detect the presence of all stereoscopic 3D (S3D) formats defined by and signaled according to [CEP].

The OCS2.1 SHALL process these S3D formats, whether received by MPEG-2 or AVC/H.264 transmission, according to the requirements set forth in Section 8.6.

Note: It is expected that all S3D video transmissions will meet the content encoding requirements of [CEP].

8.6.2 InBand Metadata Processing Requirements

The OCS2.1 SHALL recognize the presence and format of AVC/H.264 S3D video streams signaled in the AVC/H.264 frame_packing_arrangement SEI message as constrained by [CEP].

The OCS2.1 SHALL map this format information into an HDMI Vendor-Specific InfoFrame (VSI) [HDMI] according to Table 8.6-1.

The OCS2.1 SHALL respond to changes in this data at random-access points [SCTE 128]. The response to these changes is not necessarily seamless.

The OCS2.1 SHALL recognize the presence and format of MPEG-2 S3D video streams signaled by the 3d_frame_packing_data() structure carried in the Picture Level user_data as defined in [CEP].

The OCS2.1 SHALL map this format information into an HDMI Vendor-Specific InfoFrame (VSI) [HDMI] according to Table 8.6-1.

The OCS2.1 SHALL respond to changes in this data at GOP boundaries. The response to these changes is not necessarily seamless [ISO 13818-2].

8.6.3 STB 3DTV Interface Requirements

The following requirements are only applicable when the HDMI interface is active.

The OCS2.1 SHALL determine supported S3D display formats as reported by the connected sink device in the HDMI E-EDID Vendor-Specific Data Block (VSDB).

The OCS2.1 SHALL limit the output of all content detected as S3D exclusively to the HDMI interface.

The OCS2.1 SHALL NOT permit the transmission of content detected as and formatted in any S3D format to any analog output.

Note: This requirement is not meant as any restriction on the use of anaglyph 3D or 3D to 2D conversion or on-screen notifications for use on analog outputs.

When connected to a display device via HDMI that does not report any of the S3D formats defined in [CEP] and the OCS2.1 is tuned to a source of S3D content, it SHALL:

Generate an on-screen warning message if the value of the ocStbHostDVIHDMI3DIncompatibilityMsgDisplay MIB object is set to true(1), indicating that an incompatibility may exist between the source format and the display device capabilities. If generated, this message will be displayed for no less than 30 seconds.

Transmit the S3D content if the value of the ocStbHostDVIHDMI3DIncompatibilityControl MIB object is set to passthru3D(1). If a user message is generated, it will be displayed in the same panelization arrangement as the detected S3D content.

Block the transmission of S3D content if the value of the ocStbHostDVIHDMI3DIncompatibilityControl MIB object is set to block3D(2). If a user message is generated, it will be displayed in 2D.

Note: Certain DTVs may support S3D formats but are not capable of reporting 3D support in the E-EDID.

Note: These requirements only apply to HW-generated user messages.

When the OCS2.1 is connected to a display device other than via HDMI, is tuned to a source of S3D content and the value of the ocStbHostDVIHDMI3DIncompatibilityMsgDisplay MIB object is set to true(1), it SHALL display an on-screen warning message for no less than 30 seconds indicating that S3D requires a connection to HDMI.

This message SHALL be displayed in 2D.

The OCS2.1 SHALL use the [HDMI] Vendor Specific InfoFrame (VSI) to indicate S3D format types for all versions of HDMI implementations that carry frame-compatible S3D formats according to Table 8.6-1.

The OCS2.1 SHALL support the 3D signaling requirements in sections 8.2.3, H.1, and H.2 of [HDMI] for source devices according to Table 8.6-1.

An OCS2.1 that does not support the 3D frame packing ability of [HDMI] or is operating with HDMI Sink devices that do not support 3D frame packing ability, SHALL NOT perform format conversion, frame-rate conversion, stretching or zooming on any decoded S3D video, even if so directed by SAR values of 1:2 or 2:1, i.e., the device operates in pass-through mode.

Note: This does not preclude other post-decode operations such as scaling of the video to fit in a quarter-screen EPG window.

An OCS2.1 that supports the 3D frame packing ability of [HDMI] MAY "upscale" the 3D frame-compatible formats (half resolution) to the 3D frame-packing (full resolution) formats, when operating with HDMI sink devices that support these formats.

When an OCS2.1 is using the 3D frame packing ability of [HDMI], it SHALL observe the SAR values contained in the SEI frame_packing_arangement SEI message for AVC streams or the 3d_frame_packing_data() structure carried in the Picture Level user_data. for MPEG2 streams [CEP].

8.6.4 Closed Caption Requirements

Closed Caption decoding for S3D video formats by the STB shall operate as with 2D programming with the following changes:

The OCS2.1 SHALL render closed captions as duplicated images on each "half-frame" to match the decoded frame-compatible S3D format including the frame_grid_alignment data provided in the SEI message or 3D_frame_packing_data().

The OCS2.1 MAY render closed captions with depth offset (disparity) to enable placement in the z-space in front of the S3D program material as determined by the operator or the subscriber.

If the OCS2.1 uses any provided depth offset (disparity) metadata to render closed captions, it SHALL establish the z-space placement without exceeding frame boundaries.

8.6.5 Graphics and OSD Requirements

The OCS2.1 SHALL render graphics and on-screen displays (OSD) as duplicated images on each "half-frame" to match the decoded frame-compatible S3D format including the frame_grid_alignment data provided in the SEI message or 3D_frame_packing_data().

> When rendering on-screen displays (OSD) over 3D content, the OCS2.1 MAY process the 3D source video in such a way that duplicated left or duplicated right images may be used on each "half-frame" so that the resulting image will appear as 2D, but will remain panelized (i.e., both panels are exactly the same).

Graphics and OSD generated by the OCS2.1 are not required to have 3-dimensional volume (i.e., they may be rendered as duplicate monoscopic images) but SHOULD be rendered with a depth offset between the L/R frames to place them properly in z-space.

The OCS2.1 MAY generate graphics and OSD that include depth offset (disparity) to enable placement in z-space in front of the S3D program material as determined by the operator or the subscriber.

While transmitting S3D content, the OCS2.1 SHALL NOT generate graphics and OSD that use 3D/2D switching (HDMI VSI) that force the 3D display to 2D mode when stereoscopic rendering is not possible.

8.6.6 EAS Requirements

EAS (force-tune) requirements for S3D programs will be treated as ordinary channel changes except that user action is not required.

When an EAS force-tune from a S3D program to a 2D program is indicated, the OCS2.1 SHALL signal the TV via HDMI VSI to deactivate 3D viewing mode.

When an EAS triggers an OSD from a S3D program, the OCS2.1 SHOULD use the 2D rendering mode described in Section 8.6.5.

Table 8.6-1 - Mapping of SEI format information to HDMI Vendor Specific Infoframes

SEI Format Values	HDMI VSI Values
SbS (1920x1080i60) • frame_packing_arrangement_type = 0000011 (3 decimal) • quincunx_sampling_flag = 0 • frame0_grid_position_x: 0100 (4 decimal) • frame0_grid_position_y: 1000 (8 decimal) • frame1_grid_position_x: 0100 (4 decimal) • frame1_grid_position_y: 1000 (8 decimal) • frame_packing_arrangement_id: 0 • content_interpretation_type: 000001 (frame 0: L, frame 1: R) • spatial_flipped_flag: 0 • frame0_flipped_flag: 0 • field_views_flag: 0 • current_frame_is_frame0_flag: 0 • frame0_self_contained_flag: 0 • frame1_self_contained_flag: 0 • frame_packing_arrangement_reserved_byte: 00000000 • frame_packing_arrangement_repetition_period: 1 • frame_packing_arrangement_extension_flag: 0	24 bit IEEE Registration Identifier = 0x000C03 HDMI_Video_Format [3bits] = 010 HDMI_VIC [1byte] = (not present) 3D_Structure [4bits] = 1000 3D_Ext_Data [4bits] = 0000 3D_Meta_present [1bit] = 0
TaB (1920x1080p24) • frame_packing_arrangement_type = 0000100 (4 decimal) • quincunx_sampling_flag = 0 • frame0_grid_position_x: 1000 (8 decimal) • frame0_grid_position_y: 0100 (4 decimal) • frame1_grid_position_x: 1000 (8 decimal) • frame1_grid_position_y: 0100 (4 decimal) • frame_packing_arrangement_id: 0 • content_interpretation_type: 000001 (frame 0: L, frame 1: R) • spatial_flipped_flag: 0 • frame0_flipped_flag: 0 • field_views_flag: 0 • current_frame_is_frame0_flag: 0 • frame0_self_contained_flag: 0 • frame1_self_contained_flag: 0 • frame_packing_arrangement_reserved_byte: 00000000 • frame_packing_arrangement_repetition_period: 1 • frame_packing_arrangement_extension_flag: 0	24 bit IEEE Registration Identifier = 0x000C03 HDMI_Video_Format [3bits] = 010 HDMI_VIC [1byte] = (not present) 3D_Structure [4bits] = 0110 3D_Ext_Data [4bits] = (not present) 3D_Meta_present [1bit] = 0

SEI Format Values	HDMI VSI Values
TaB (1280x720p60) • frame_packing_arrangement_type = 0000100 (4 decimal) • quincunx_sampling_flag = 0 • frame0_grid_position_x: 1000 (8 decimal) • frame0_grid_position_y: 0100 (4 decimal) • frame1_grid_position_x: 1000 (8 decimal) • frame1_grid_position_y: 0100 (4 decimal) • frame_packing_arrangement_id: 0 • content_interpretation_type: 000001 (frame 0: L, frame 1: R) • spatial_flipped_flag: 0 • frame0_flipped_flag: 0 • field_views_flag: 0 • current_frame_is_frame0_flag: 0 • frame0_self_contained_flag: 0 • frame1_self_contained_flag: 0 • frame_packing_arrangement_reserved_byte: 00000000 • frame_packing_arrangement_repetition_period: 1 • frame_packing_arrangement_extension_flag: 0	24 bit IEEE Registration Identifier = 0x000C03 HDMI_Video_Format [3bits] = 010 HDMI_VIC [1byte] = (not present) 3D_Structure [4bits] = 0110 3D_Ext_Data [4bits] = (not present) 3D_Meta_present [1bit] = 0

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 [SCTE 128].

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 [SCTE 128].

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™ (AC-3) AND Dolby Digital Plus (E AC-3) 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 [SCTE 128].

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

	Parameter	Requirement
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	5.09V-6.22V p-p with digital level(s) at (0 dBFS), and excluding the effects of AC-3 and/or E AC-3 dialogue normalization and dynamic range compression. NOTE 1: This condition is for the purpose of provisioning the output voltage level during design ONLY. NOTE 2: OpenCable Host Devices deployed to consumers/subscribers must always apply both dialogue normalization and dynamic range control. E AC-3 and AC-3 RF Mode is the recommended default for OpenCable Host Devices.
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: 800mV p-p with 400 Hz test tone at +/- 25 kHz p-p audio subcarrier deviation. Note: The 800 mV p-p level is strongly advised as of 2009. BTSC Signal: 800mV p-p with 400 Hz test tone at +/- 12.5 kHz p-p audio subcarrier deviation for L&R channel. Note: The 800 mV p-p level is strongly advised as of 2009.
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.

	Parameter	Requirement
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 standby mode is not defined in this document. See [OCAP].

10.1 CableCARD Standby Mode Power Management

The minimum power requirements for OCHD2.1 standby mode SHALL include the following:

The OCHD2.1 OOB receiver (including the DOCSIS 2.0 DSG embedded cable modem) circuitry SHALL be fully powered when a Card is inserted.

The OCHD2.1 OOB transmitter (including the DOCSIS 2.0 DSG embedded cable modem) circuitry SHALL be fully powered when a Card is inserted.

The Card SHALL be fully powered when inserted.

If the OCHD2.1 implements a DOCSIS 3.0 eCM, the following requirements apply:

When entering standby mode, the eSTB SHOULD send an indication to the eCM that it is going into standby mode.

When exiting standby mode, the eSTB SHOULD send an indication to the eCM that it is coming out of standby mode.

NOTE: The eCM can use this indication to enter or exit 1x1 mode.

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

Application Information

Firmware Version

MAC 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

Signaling Status

Card Status

SEB Status

The Host SHALL display diagnostics when triggered by the "Exit" key, followed by the "Down" key, followed by a second depression of the "Down" key, followed by the "2" key - that is, "Exit"-"Down"-"Down"- "2".

The "Exit" key SHALL be depressed for >2 seconds.

The interval between key depressions (e.g., "Down" - "2") SHALL NOT exceed two seconds.

The Host SHALL respond to the "Power On/Off" key while displaying diagnostics.

The Host SHALL leave the diagnostics display if there has been no interaction with the display for five minutes.

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 Power Status

The OCHD2.1 SHALL be capable of displaying and reporting power status information.

The displayed status SHALL be equivalent to the value in the Host MIB object, ocStbHostPowerStatus, displayed as one of: On/Active, Standby.

11.1.2 Boot Status

The OCHD2.1 SHALL be capable of displaying and reporting boot status information.

The displayed status SHALL be equivalent to the value in the Host MIB object, ocStbHostBootStatus, displayed as one of: Boot completed successfully; Boot completed with errors; Boot in progress with code download; Boot in progress, no code download; Boot waiting for initial monitor application; Boot process in unknown state.

11.1.3 Memory Allocation

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

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)

The values displayed for each memory type SHALL equal the values in the Host MIB object, ocStbHostSystemMemoryReportTable.

11.1.4 Application Information

The OCHD2.1 SHALL be capable of displaying and reporting the following application information for each available application:

The displayed application name SHALL equal the value in the Host MIB object, ocStbHostSoftwareAppNameString.

The displayed version number SHALL equal the value in the Host MIB object, ocStbHostSoftwareAppVersionNumber.

The displayed application status SHALL equal the value in the Host MIB object, ocStbHostSoftwareStatus, displayed as one of: Running, Paused, Loaded, Not Loaded, Destroyed.

The displayed OrgID SHALL equal the value in the Host MIB object, ocStbHostSoftwareOrganizationId.

The displayed AppID SHALL equal the value in the Host MIB object, ocStbHostSoftwareApplicationId.

11.1.5 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.

The displayed firmware version SHALL equal the value in the Host MIB object, ocStbHostSoftwareFirmwareVersion.

The displayed firmware release date SHALL equal the value in the Host MIB object, ocStbHostSoftwareFirmwareReleaseDate.

11.1.5.1 Firmware Download Status

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

The displayed firmware download status SHALL be equivalent to the value in the Host MIB object, ocStbHostFirmwareCodeDownloadStatus, displayed as one of: Started, Complete, Failed.

If the download failed, then the "FAILED" status SHALL be followed by one of the applicable Error Codes defined in Table 11.1-1 and equal to the Host MIB object ocStbHostFirmwareDownloadFailedStatus. It is displayed as "CdlError xx".

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 less-than the codeAccessStart value currently held in the Host device.
CDL-ERROR-5	Improper code file controls - The manufacturer's PKCS #7 signingTime is greater than the CVC validity end time.
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 less-than the codeAccessStart value currently held in the Host device.
CDL-ERROR-10	Improper code file controls - The cosigner's PKCS #7 signingTime is greater than CVC validity end time.

Error Code	Definition
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	Reserved for future definition.
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 for CVCs other than the eCM configuration file CVC.
CDL-ERROR-25	SNMP CVC validation failure.

11.1.6 MAC and Network Addresses

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

The MAC address of the eSTB, Card and eCM. The address may be in MAC or EUI-64 address form.

The displayed Card MAC address SHALL equal the value in the Host MIB object, ocStbHostCardMacAddress.

The displayed eSTB MAC address SHALL equal the value in the eSTB IF-MIB object, ifPhysAddress of the ifTable (ifIndex 1).

The displayed eCM MAC address SHALL equal the value obtained from the cable modem.

MAC addresses SHALL be displayed as dot-separated hexadecimal octets (xx.xx.xx.xx.xx.xx).

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

Network address of the eSTB, eCM, and the Card (if assigned).

The displayed Card IP address SHALL equal the value in the Host MIB object ocStbHostCardIpAddress.

The displayed eSTB IP address SHALL equal the value in the OCHD2.1 IP-MIB object ipNetToPhysicalNetAddress associated with ifIndex = 1.

The displayed eCM IP address SHALL equal the IP address assigned to the eCM, if it is populated in the ipAddrTable or ipAddressTable [RFC 4293].

IP addresses SHALL be displayed using IPv4 dot notation address or IPv6 colon notation.

11.1.7 Status of FDC

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

The displayed FDC frequency value SHALL equal the value in the Host MIB object ocStbHostQpskFDCFreq when adjusted for differences in measurement units. The value of the frequency SHALL be displayed in red if the less than 70MHz or greater than 130MHz.

The displayed FDC carrier lock value SHALL equal the value in the Host MIB object, ocStbHostQpskFDCStatus.

The displayed FDC power value SHALL equal the value in the Host MIB object, ocStbHostQpskFDCPower, when adjusted for differences in measurement units.

The displayed FDC SNR value SHALL equal the value in the Host MIB object, ocStbHostQpskFDCSNR, when adjusted for differences in measurement units.

The text of the power value in the FDC status SHALL be yellow when the value is between -12dBmV and -15dBmV or between +12dBmV and +15dBmV.

The text of the power value in the FDC status SHALL be red when the value is lower than -15dBmV or greater than +15dBmV.

11.1.8 Status of FAT

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

Each inband tuner SHALL have its status information displayed in a separate column identified with a unique number, e.g., TUNER-1.

The displayed tuner frequency value SHALL equal the value in the Host MIB object ocStbHostInBandTunerFrequency when adjusted for differences in measurement units.

The displayed modulation mode value SHALL equal the value in the Host MIB object ocStbHostInBandTunerModulationMode.

The displayed value for received power level SHALL equal the value in the Host MIB object ocStbHostInBandTunerPower, when adjusted for differences in measurement units.

The displayed power level SHALL be accurate to within 6 dBmV of the actual received level, in tenths of dBmV (peak level for analog, average level for others), across the RF Input Level Range defined in Table 5.3-1.

The text of the power value in the FAT display SHALL be yellow when the value is between -12dBmV and -15dBmV or between +12dBmV and +15dBmV.

The text of the power value in the FAT display SHALL be red when the value is lower than -15dBmV or greater than +15dBmV.

The displayed tuner SNR value SHALL equal the value in the Host MIB object ocStbHostInBandTunerSNRValue when adjusted for differences in measurement units.

The displayed SNR value SHALL be accurate to within 3 dB of the actual received level, in tenths of dB, if the currently tuned channel is a digital QAM channel, across an SNR range of 22 dB to 32 dB for 64 QAM and 28 dB to 38 dB for 256 QAM.

If the modulation mode is 64 QAM, the text of the SNR value SHALL be red when the value is lower than 25dB.

If the modulation mode is 256 QAM, the text of the SNR value SHALL be red when the RF power is between -10dBmV and -15dBmV AND SNR is less than 36dB.

If the modulation mode is 256 QAM, the text of the SNR value SHALL be red when the RF power is between -10dBmV and +15dBmV AND SNR is less than 33dB.

The displayed value for carrier lock SHALL report "locked" if the value in the Host MIB object ocStbHostInBandTunerState is "foundQam" or "foundSync"; otherwise report "unlocked" for any other value.

The displayed PCR lock value, if tuned to a digital QAM channel, SHALL equal the value in the Host MIB object ocStbHostMpeg2ContentPCRLockStatus.

The displayed value for successful tune count SHALL equal the value in the Host MIB object ocStbHostInBandTunerTotalTuneCount less the value in ocStbHostInBandTunerTuneFailureCount. Referred to in Figure 11.2-7 as STuneCount.

The displayed value for failed tune count SHALL equal the value in the Host MIB object, ocStbHostInBandTunerTuneFailureCount.

Any non-zero tune failure count SHALL be displayed in red text.

The displayed value for last failed frequency SHALL equal the value in the Host MIB object ocStbHostInBandTunerTuneFailFreq when adjusted for differences in measurement units.

The last failed frequency value SHALL be set to zero if a tune failure has not been detected since the last boot cycle.

The displayed value for correctable errors SHALL equal the value in the Host MIB object ocStbHostInBandTunerCorrecteds.

The displayed value for uncorrectable errors SHALL equal the value in the Host MIB object ocStbHostInBandTunerUncorrectables.

11.1.9 Status of RDC

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

The displayed RDC frequency value SHALL equal the value in the Host MIB object ocStbHostQpskRDCFreq when adjusted for differences in measurement units.

The displayed RDC power level value SHALL equal the value in the Host MIB object ocStbHostQpskRDCPower when adjusted for differences in measurement units.

The displayed RDC Data Rate SHALL equal the value in the Host MIB object ocStbHostQpskRDCDataRate.

11.1.10 Current Channel Status

The OCHD2.1 SHALL be capable of displaying and reporting the following current channel information for each channel selected for any purpose, e.g., presentation, recording:

The displayed value for MPEG program number SHALL equal the value in the Host MIB object ocStbHostMpeg2ContentProgramNumber.

The displayed value for CCI SHALL equal the value in the Host MIB object ocStbHostMpeg2ContentCCIValue.

If the EMI bits indicate 11b for copy never, the text SHOULD appear in red.

11.1.11 DVI / HDMI Port Status

The OCHD2.1 SHALL be capable of displaying and reporting the following status information for each HDMI port:

Each HDMI port SHALL have its status information displayed in a separate column identified by its port number, e.g., HDMI-1.

The displayed value for connection status for each interface SHALL equal the value in the Host MIB object, ocStbHostDVIHDMIConnectionStatus.

The displayed value for connected device type for each interface SHALL equal the value in the Host MIB object, ocStbHostDVIHDMIAttachedDeviceType.

The displayed value for HDCP status for each interface SHALL be equivalent to the value in the Host MIB object, ocStbHostDVIHDMIHostDeviceHDCPStatus. The displayed status should present the enumerated text of the MIB object value (e.g., 'compliantHDCPdevice(2)' should be displayed instead of the integer, '2').

The displayed value for Horizontal Resolution for each interface SHALL be derived from the value in the Host MIB object ocStbHostDVIHDMIOutputFormat.

The displayed value for Vertical Resolution for each interface SHALL be derived from the value in the Host MIB object ocStbHostDVIHDMIOutputFormat.

The displayed value for frame rate for each interface SHALL be equivalent to the value in the Host MIB object ocStbHostDVIHDMIFrameRate. The actual frame rate should be displayed rather than the enumeration value reported in the MIB.

The displayed value for aspect ratio for each interface SHALL be equivalent to the value in the Host MIB object ocStbHostDVIHDMIAspectRatio.

The displayed value for Scanning Format for each interface SHALL be derived from the value in the Host MIB object ocStbHostDVIHDMIOutputFormat and reported as either "interlaced" or "progressive".

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:

The displayed value for DOCSIS downstream center frequency SHALL equal the value in the Host eCM MIB object docsIfDownChannelFrequency.

The displayed value for DOCSIS downstream received power level SHALL equal the value in the Host eCM MIB object docsIfDownChannelPower when adjusted for different units of magnitude.

If the OCHD2.1 contains a DOCSIS 2.0 eCM, the displayed value for DOCSIS downstream carrier lock status SHALL report locked if the Host eCM MIB object, docsIfCmStatusValue, reflects an initialization state dependent upon a locked downstream carrier as defined in [RFIv2.0]. Otherwise, unlocked should be reported.

If the OCHD2.1 contains a DOCSIS 3.0 eCM, the displayed value for DOCSIS downstream carrier lock status SHALL report locked if the Host eCM MIB object, docsIf3CmStatusValue, reflects an initialization state dependent upon a locked downstream carrier as defined in [MULPIv3.0]. Otherwise, unlocked should be reported.

The displayed value for DOCSIS downstream SNR SHALL equal the value in the Host eCM MIB object, docsIfSigQSignalNoise.

The displayed value for DOCSIS upstream center frequency SHALL be equivalent to the value in the Host eCM MIB object docsIfUpChannelFrequency.

The displayed value for DOCSIS upstream power level SHALL equal the value in the Host eCM MIB object docsIfCmStatusTxPower when adjusted for differences in measurement units.

11.1.13 Signaling Status

The OCHD2.1 SHALL be capable of displaying and reporting the status of signaling as follows:

The displayed value for unbound application signaling SHALL equal the value indicated in the Host MIB object ocStbHostSoftwareApplicationInfoSigLastReadStatus.

If the value for application signaling status is "error", it SHALL be displayed in red.

The displayed value for PAT and PMT timeouts SHALL equal the values indicated in the Host MIB objects ocStbHostPatTimeoutCount and ocStbHostPmtTimeoutCount, respectively.

These objects reflect the number of timeouts since the last reboot.

The displayed value for Inband and OOB object carousel timeouts SHALL equal the values indicated in the Host MIB objects ocStbHostInbandCarouselTimeoutCount and ocStbHostOobCarouselTimeoutCount, respectively.

These objects reflect the number of timeouts since the last reboot.

11.1.14 Status of Card

The OCHD2.1 SHALL be capable of displaying and reporting the following Card status:

The displayed value for OOB mode SHALL equal the value in the Host MIB object ocStbHostOobMessageMode.

The displayed value for card certificate check SHALL equal the value in the Host MIB object ocStbHostCardCpCertificateCheck.

The displayed value for CP status SHALL equal the value in the Host MIB object ocStbHostCardCpAuthKeyStatus. An indication of not ready SHOULD be displayed in red text.

The displayed value for CCI challenge count SHALL equal the value in the Host MIB object ocStbHostCardCpCciChallengeCount.

Card CCI Challenge Message Count SHALL be the number of times the challenge message was sent (see [CCCP] table 11.7-2).

The displayed value for Copy Protection Key Generation Count SHALL equal the value in the Host MIB object ocStbHostCardCpKeyGenerationReqCount.

Card Copy Protection Key Generation Count SHALL be the decimal value of the number of times keys have been generated as defined in [CCCP].

The displayed value for Card ID SHALL equal the value in the Host MIB object ocStbHostCardId.

The displayed value for Host ID SHALL equal the value in the Host MIB object ocStbHostHostId.

The displayed value for Card Manufacturer ID SHALL equal the value in the Host MIB object ocStbHostCardMfgId.

The displayed value for CP System ID SHALL equal the value in the Host MIB object ocStbHostCardCpIdList.

The displayed value for CA Status SHALL be equivalent to the value in the Host MIB object ocStbHostCardBindingStatus. A status of "ready" should be reported if the MIB object value is bound(4) and "not ready" for all other MIB object values. An indication of not ready SHOULD be displayed in red text.

The displayed value for CA System ID SHALL equal the value in the Host MIB object ocStbHostCASystemIdentifier.

The displayed value for Generic Feature Resource SHALL equal the value in the Host MIB object ocStbHostCardOpenedGenericResource.

The displayed value for time zone offset SHALL equal the value in the Host MIB object ocStbHostCardTimeZoneOffset.

The displayed value for daylight savings time delta SHALL equal the value in the Host MIB object ocStbHostCardDaylightSavingsTimeDelta.

The displayed value for daylight savings entry time SHALL equal the value in the Host MIB object ocStbHostCardDaylightSavingsTimeEntry in human-readable YYYY-MM-DD,HH:MM format.

The displayed value for daylight savings exit time SHALL equal the value in the Host MIB object ocStbHostCardDaylightSavingsTimeExit in human-readable YYYY-MM-DD,HH:MM format.

The displayed value for EA location SHALL equal the value in the Host MIB object ocStbHostCardEaLocationCode.

The displayed value for VCT-ID SHALL equal the value in the Host MIB object ocStbHostCardVctId.

11.1.15 SEB Status

If the OCHD2.1 supports SEB, the OCHD2.1 SHALL display the DOCSIS Set-top Gateway Set-top Device MIB object, dsgIfStdDsgSebRole value.

When the OCHD2.1 is unable to initialize SEB functionality, it SHALL display the applicable information as described below.

When the OCHD2.1 is operating in DSG two-way mode but is unable to initialize the SEBS function, it SHALL display each applicable reason listed below.

- DSG MIB Object, dsgIfStdDsgSebControlObject, is “FALSE”
- NACO = 0
- Insufficient CPE Count to support a SEBC
- ifAdminStatus = down
- All Home Network links down
- Unknown Cause

When the OCHD2.1 is operating in DSG one-way mode but is unable to initialize the SEBC function, it SHALL display each applicable reason listed below.

- DSG MIB Object, dsgIfStdDsgSebControlObject, is “FALSE”
- ifAdminStatus = down
- All Home Network links down
- Unknown Cause

When the OCHD2.1 is operating as an SEB Client but is unable to detect a SEB Server, it SHALL be capable of displaying the docsDevEventTable log entry with error code set to P21.24 and the associated "Event Message" Annex A.

When the OCHD2.1 is operating as an SEB Client and is unable to establish a tunnel with any detected SEB Server, it SHALL be capable of displaying the docsDevEventTable log entry "Error Code Set" and "Event Message" Annex A corresponding to this condition.

When operating as an SEB Server, the OCHD2.1 SHALL be capable of displaying and reporting the following SEB status information.

Advertised Figure of Merit (FOM)

Maximum number of SEB Clients supported

Number of SEB Clients currently connected

Connected Device MAC addresses

Connected Device IP addresses

Connected Device Type (eSTB, eCM or Card) associated with the MAC Address / IP Address pair.

When operating as an SEB Client and connected to a SEB Server, the OCHD2.1 SHALL be capable of displaying and reporting the following SEB status information.

Server MAC address

Server IP address

SEB Server FOM

Connected devices Type (eSTB, eCM or Card)

Connected devices MAC addresses

Connected devices IP addresses

11.2 Host Diagnostics UI Requirements

This section defines the layout and navigation of the hardware platform diagnostics.

11.2.1 User Interface Layout

This section defines the screen layout requirements for the platform diagnostics application.

For the purposes of validating implementations against these templates, the following attributes of the templates are to be considered:

- Unless otherwise specified, all specified labels and fields are required.
- The relative placement of fields to corresponding labels.
- The presence but not the exact amount of white-space.
- Fixed label text.
- Labels and values must be easily distinguishable, but exact font styling is unimportant unless otherwise specified.

In the templates, fixed labels are styled as bold, and dynamic labels and fields are not. This distinction is not required by the implementation.

11.2.1.1 Main Menu Page Requirements

This section defines the screen layout requirements for the top level diagnostics screens.

The OCHD2.1 diagnostic application SHALL implement the Main Menu Page template as depicted in Figure 11.2-1.

The Main Menu Page SHALL be divided into the Category Frame, Page Frame and Instruction Frame.

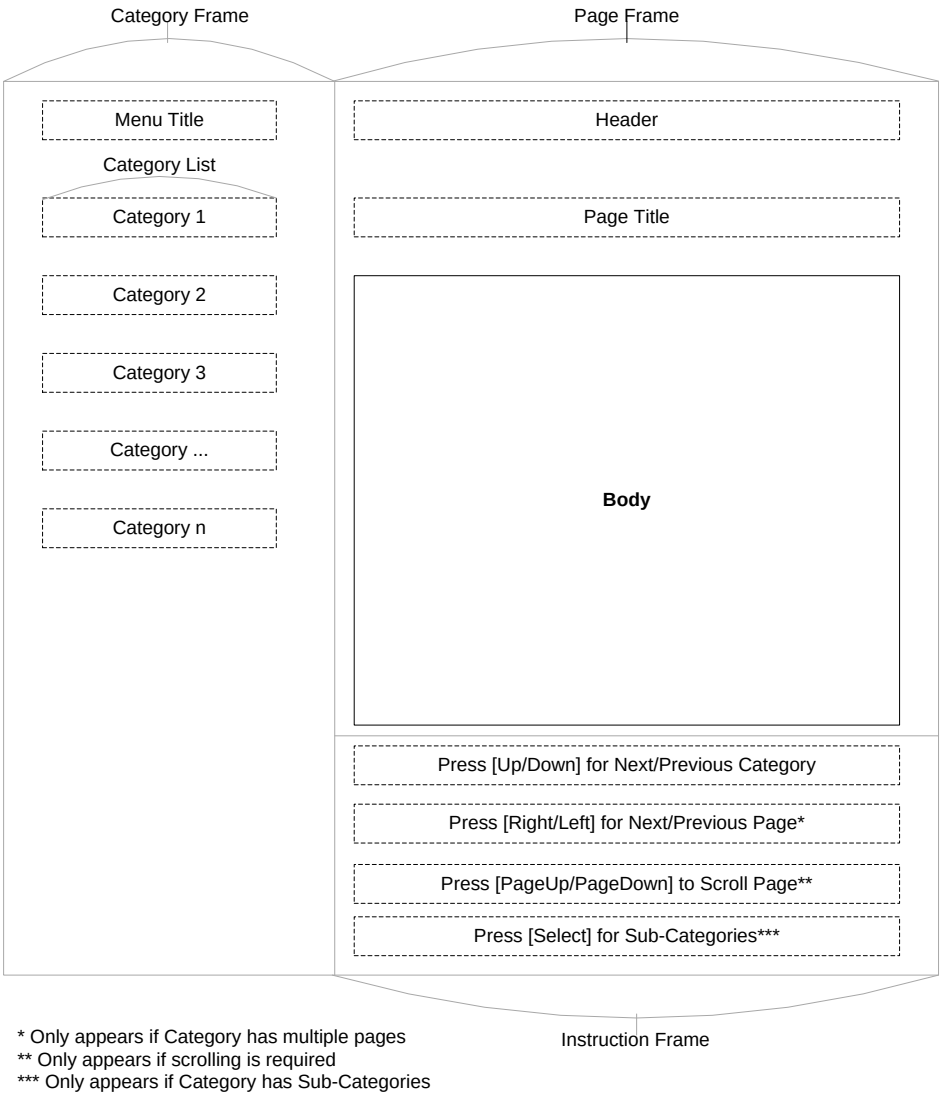


Figure 11.2-1 - Main Menu Page Template

The Category Frame in the OCHD2.1 Main Menu Page SHALL list, by category, the available diagnostics or options that can be selected.

The Category Frame SHALL contain a "Menu Title" field presented in yellow text.

The Page Frame in the OCHD2.1 Main Menu Page SHALL contain a "Header" field that displays the same text as the Category selected. The Page Frame Body is where the desired diagnostic information is displayed.

The "Header" field in the Page Frame SHALL be presented in green text.

The Page frame in the OCHD2.1 Main Menu page SHALL contain a "Page Title" field, which is used to label the selected diagnostics page.

The "Page Title" field SHALL also include a label using the format "Page x of y" in the event that the Category has more than one page associated with it.

The "Page Title" field in the Page Frame SHALL be presented in light blue text.

The Instruction Frame in the OCHD2.1 Main Menu Page SHALL contain an area where the diagnostic application explains key command options.

The Instruction frame SHALL contain the text: "Press [Up/Down]for Next/Previous Category".

If a Category uses more than one page, the Instruction Frame SHALL contain the text: "Press [Right/Left] for Next/Previous Page".

If the information for a Page does not fit on the screen, the Instruction Frame SHALL contain the text: "Press [PageUp/PageDown] to scroll".

See Figure 11.2-2 for an example of a Main Menu Page implementation.

11.2.1.2 Main Menu Page Navigation

The OCHD2.1 diagnostic application SHALL implement the following behavior for RIGHT/LEFT Arrow Keys:

The RIGHT/LEFT Arrow Keys SHALL only be recognized if the current Category has multiple pages.

The OCHD2.1 diagnostic application SHALL implement the following behavior when multiple pages exist in the current Category:

On Right arrow, the Next page for the selected Category SHALL be displayed.

On Left arrow, the Previous page for the selected Category SHALL be displayed.

Page order within a Category SHALL wrap. For pages 1…n, if a user presses Right arrow when they are on page n, they are taken to page 1. Alternately, if a user presses the Left arrow key when they are on page 1, they are taken to page n.

The OCHD2.1 diagnostic application SHALL implement the following behavior for UP/DOWN Arrow Keys:

The UP/DOWN Arrow Keys SHALL be used to highlight the selection in the Category Frame through the list of categories.

On Down arrow, the Category below the current position in the list is highlighted and its first (or only) page information is displayed in the Page Frame Body.

On Up arrow, the Category above the current position in the list is highlighted and its first (or only) page information is displayed in the Page Frame Body.

The Category List SHALL wrap. For Categories 1…n, if a user presses Down arrow when they are on Category n, they are taken to Category 1. Alternately, if a user presses the UP arrow key when they are on Category 1, they are taken to Category n.

The OCHD2.1 diagnostic application SHALL implement the following behavior for Page UP/DOWN Keys:

The Page UP/DOWN Keys SHALL only be recognized if not all information for the current Page fits on the screen.

The OCHD2.1 diagnostic application SHALL implement the following behavior when not all information for a Page fits on the screen:

On Page DOWN, the displayed information for the current Page SHALL be scrolled up to enable display of subsequent information.

On Page UP, the displayed information for the current Page SHALL be scrolled down to enable display of preceding information.

The scrolling operation SHALL NOT wrap. If a user presses the Page UP key when the top of the current Page is displayed, nothing happens; if a user presses the Page DOWN key when the bottom of the current Page is displayed, nothing happens.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the EXIT Key:

The EXIT Key SHALL exit the Diagnostic Pages.

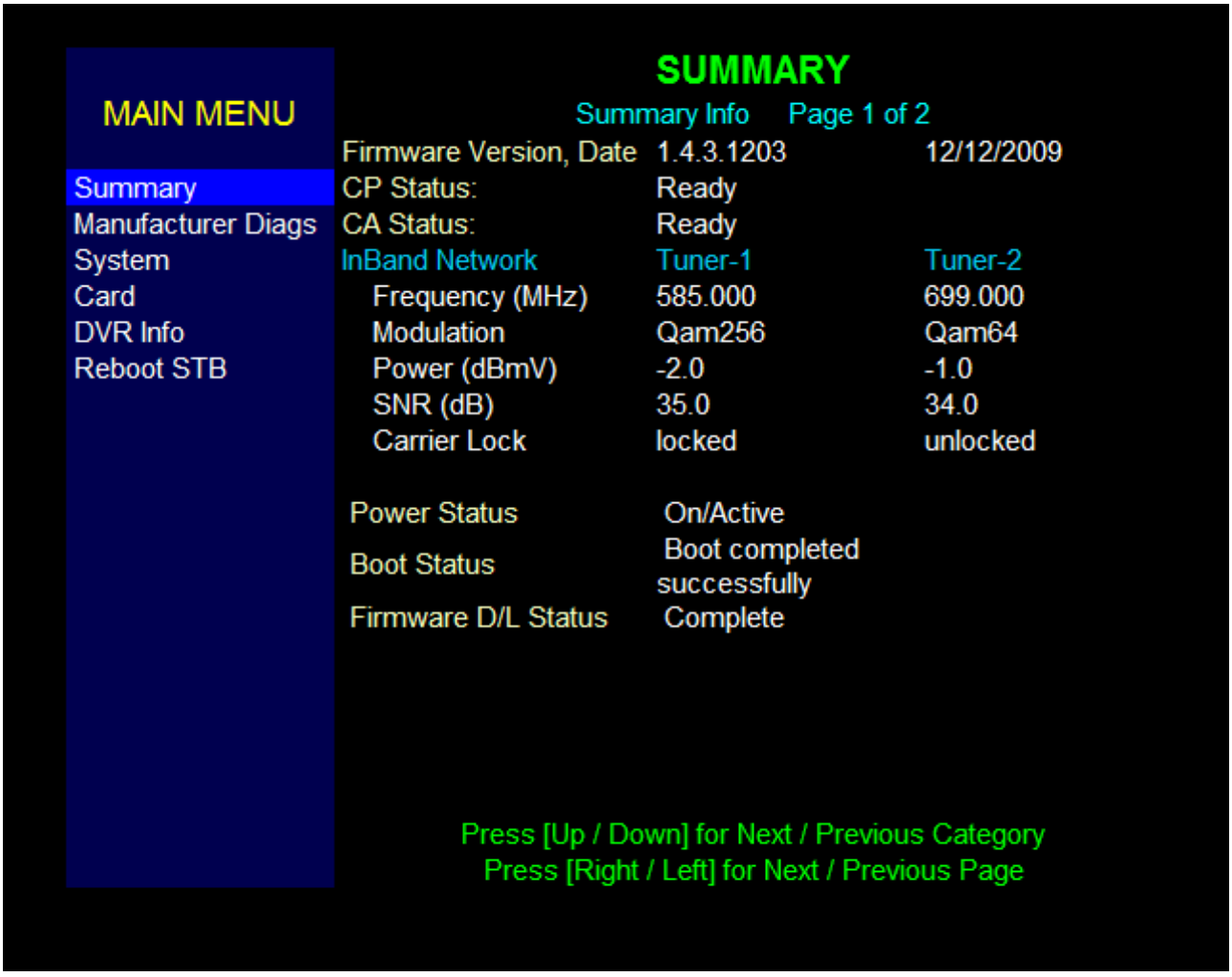


Figure 11.2-2 - Main Menu Page Example

11.2.1.3 Sub-Level Page Requirements

This section defines the screen layout requirements for the sub-level diagnostics screens. Sub-level screens exist where a category has other sub-categories of diagnostics. An example of this would be that Card diagnostics has several MMI screens underneath that category.

The OCHD2.1 diagnostic application SHALL implement the sub-level page template as depicted in Figure 11.2-3.

The OCHD2.1 diagnostic application SHALL implement the following behavior for Sub-Level Menus:

If a Sub-Category uses more than one page, the Instruction Frame in the OCHD2.1 Sub-Level menu screen SHALL contain the text: "Press [Right/Left] for Next/Previous Page".

If a Sub-Category does not itself have further Sub-Categories, the Instruction Frame SHALL contain the text: “Press [Last] for Parent Category".

If a Sub-Category has one or more Sub-Categories, the Instruction Frame SHALL contain the text: "Press [Select] for Sub-Categories, [Last] for Parent Category".

The Instruction frame SHALL contain the text: "Press [Up/Down]for Next/Previous Sub-Category".

The OCHD2.1 diagnostic application SHALL implement the following behavior for the SELECT Key:

The SELECT Key SHALL only be recognized if the current Category has sub-categories.

When the SELECT Key is recognized, the current Category name moves to the Menu Title field.

When the SELECT Key is recognized, the sub-categories list populates Category 1-n slots in the Category Frame.

When the SELECT Key is recognized, the Page Frame Body is updated with the first (or only) page information for the first sub-category in the list. See Figure 11.2-3.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the LAST Key:

The LAST Key SHALL only be recognized if the user is on a sub-category page.

The LAST key event SHALL navigate back up to the previous Category page.

An example implementation of the sub-level diagnostics page is shown in Figure 11.2-4.

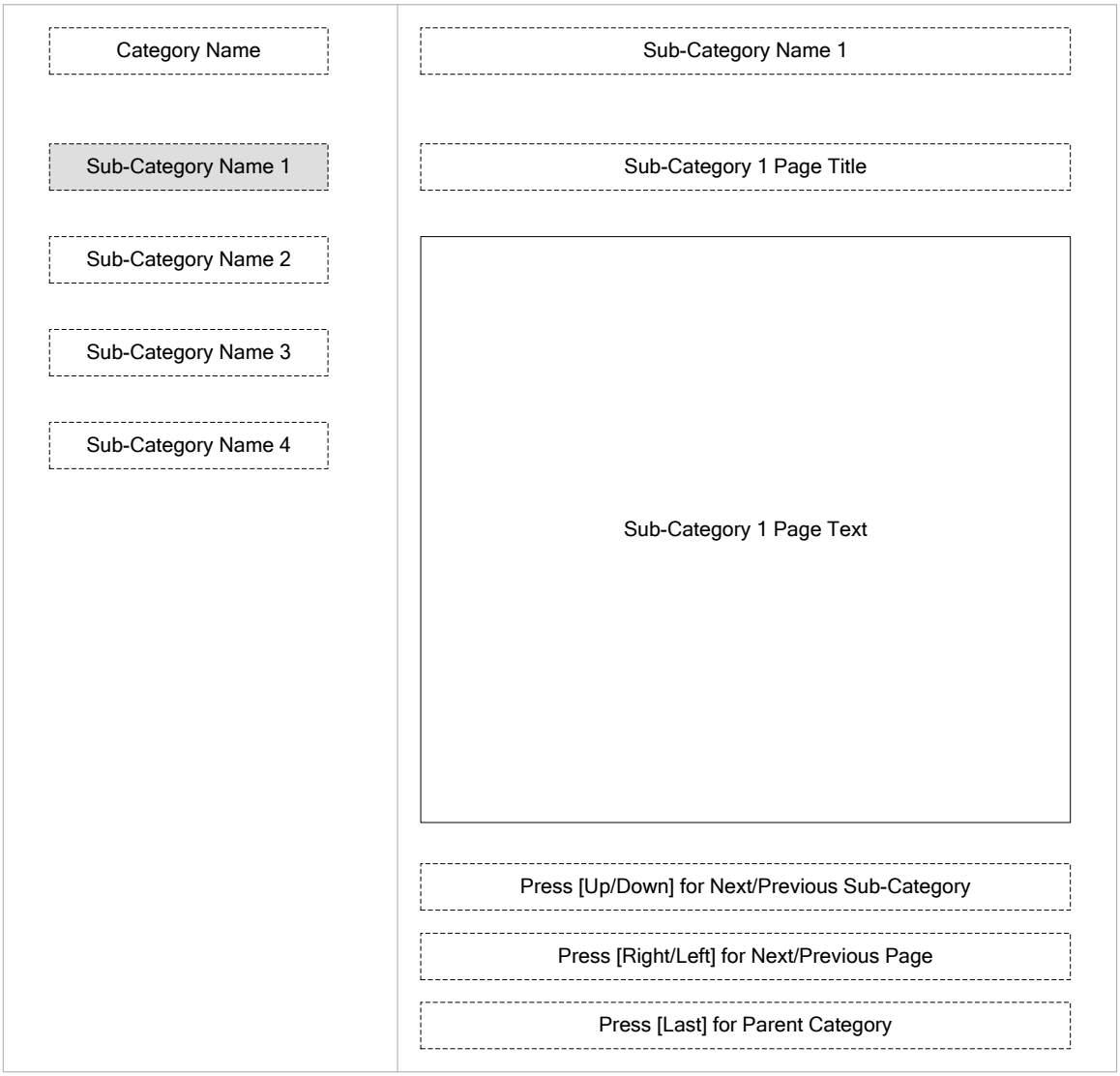


Figure 11.2-3 - Sub-Level Menu Template

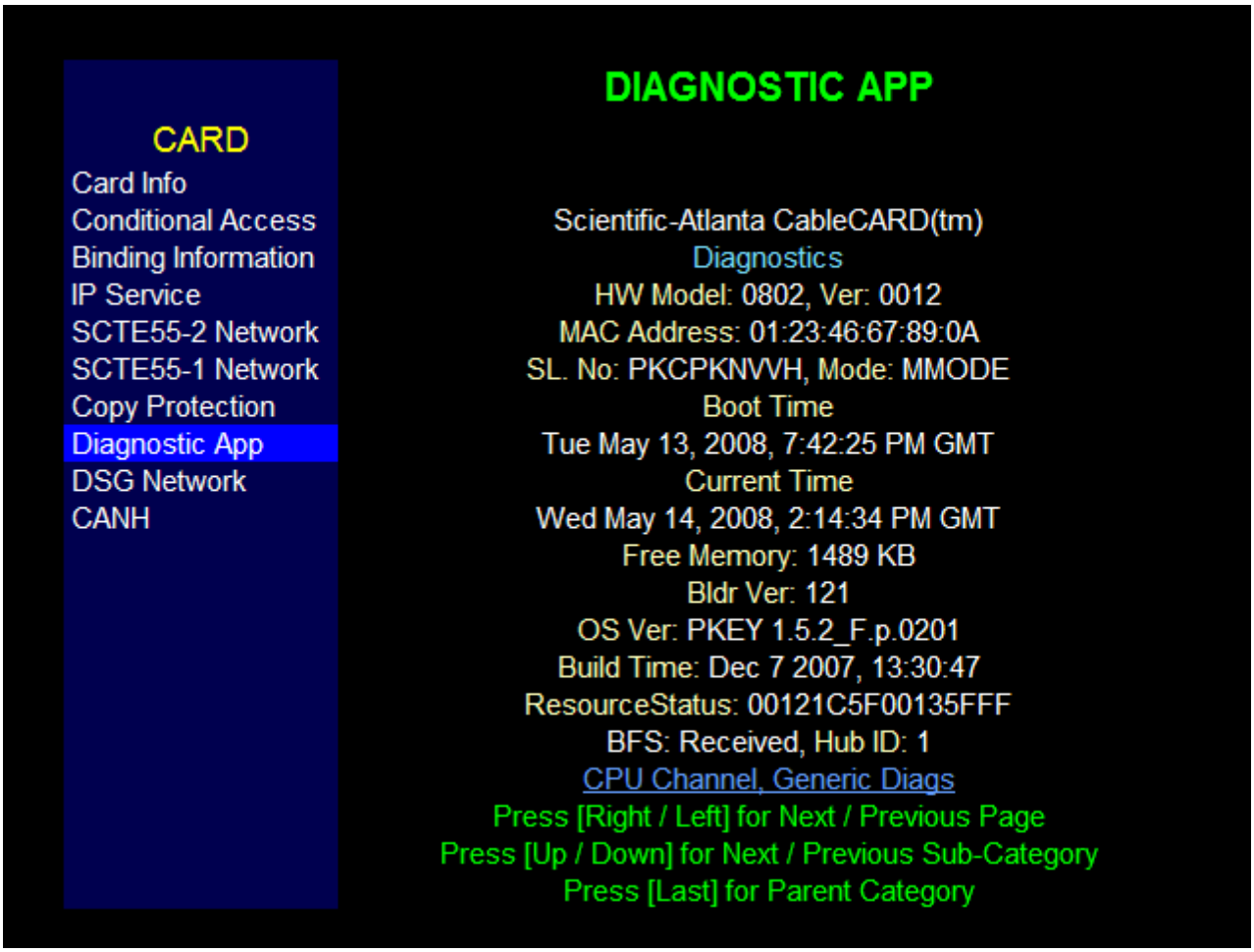


Figure 11.2-4 - Sub-Level Page example

11.2.2 Host Diagnostics Requirements

This section defines the OCHD2.1 hardware diagnostics user interface (UI) requirements.

11.2.2.1 General Requirements

The OCHD2.1 diagnostic screens SHALL be updated by the platform software, including the OS, stack, boot loader, etc.

The OCHD2.1 diagnostics SHALL NOT be updated or written by the guide application (i.e., Passport, iGuide, SARA, ODN, MDN, etc.).

The OCHD2.1 diagnostic UI SHALL be operational when the device is NOT connected to a cable network.

The OCHD2.1 diagnostic UI SHALL be operational when connected to a cable network.

The OCHD2.1 diagnostic UI SHALL be operational whenever the Digital Navigator is operational.

The OCHD2.1 diagnostic UI SHALL be operational whenever the Digital Navigator is NOT operational.

The OCHD2.1 diagnostic UI SHALL be launched according to Section 11.

The OCHD2.1 diagnostic UI SHALL terminate whenever the "Exit" key is received.

The OCHD2.1 SHALL navigate through the various diagnostic UI screen options using the navigational up, down, left and right buttons on the remote control.

The OCHD2.1 SHALL navigate through the various diagnostic UI screen options using the front panel buttons "channel +"(up), "channel -"(down), "volume -"(left) and "volume +" (right) buttons on the front panel.

The OCHD2.1 SHALL use the SELECT key on the front panel or remote control for selecting various options in the diagnostic UI.

If a SELECT button is not available on the front panel, the OCHD2.1 SHALL use the INFO key.

The OCHD2.1 diagnostic application SHALL be capable of displaying diagnostic information with zero, 10%, 20% or 100% translucency. When diagnostic information is displayed in a translucent manner, the content associated with the currently tuned-to channel will be visible behind the diagnostic information.

The OCHD2.1 diagnostic application, when displayed, SHALL default to 10% translucency.

The OCHD2.1 diagnostic application SHALL allow the translucency levels to be cycled through by pressing the GUIDE key on the remote control or front panel.

The information displayed by the OCHD2.1 diagnostic application SHALL be updated every five seconds.

The OCHD2.1 SHALL reboot the platform when the front panel POWER button is pressed and held for 10 seconds or more.

11.2.2.2 Main Menu

This section defines requirements for the Main Menu page in the OCHD2.1 diagnostic UI.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the Main Menu Page:

The OCHD2.1 diagnostic application SHALL default to the Main Menu Page.

The OCHD2.1 diagnostic application Main Menu Page SHALL comply with the Main Menu Page Template defined in Section 11.2.1.1.

The Main Menu Page SHALL have the following options in the Category list of the Category Frame: Summary, Manufacturer Diags, System, Card, and Reboot STB.

Categories for OpenCable Extensions, such as DVR and Home Networking, SHALL be added above the Reboot STB Category.

The Reboot STB Category SHALL always appear last.

The Main Menu Page SHALL default to displaying the Summary Category page in the Page Frame Body.

11.2.2.2.1 Summary Diagnostics Category

There are two pages that can be displayed in the Page Frame when in the "Summary" Category: the "Summary Info" page and the "Error Summary" page.

11.2.2.2.1.1 Summary Info Page Definition

The "Summary Info" page displays summary system information.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the Summary Info page:

The Page Frame Body of the Summary Info page SHALL follow the template as defined in Figure 11.2-5.

The "Page Title" field in the Page Frame of the Summary Info page SHALL be labeled "Summary Info". The Summary Info page is the first page in this category.

The "Summary Info" page SHALL display the Firmware Version and Firmware Release Date as defined in Section 11.1.5.

The "Summary Info" page SHALL display the Provisioning (CP) Status as defined in Section 11.1.14.

The "Summary Info" page SHALL display the Conditional Access Status as defined in Section 11.1.14.

The "Summary Info" page SHALL display a group of parameters labeled as "InBand Network" as follows for each tuner:

- Tuner frequency as defined in Section 11.1.8.
- Modulation mode as defined in Section 11.1.8.
- Received Power as defined in Section 11.1.8.
- SNR as defined in Section 11.1.8.
- Carrier Lock as defined in Section 11.1.8.

The "Summary Info" page SHALL display the Power Status as defined in Section 11.1.1.

The "Summary Info" page SHALL display the Boot Status as defined in Section 11.1.2.

The "Summary Info" page SHALL display the Firmware Download Status as defined in Section 11.1.5.1. An example Summary Info Page is shown in Figure 11.2-2.

11.2.2.2.1.2 Error Summary Page Definition

The "Error Summary" page displays all of the high level error information that a field technician uses when first experiencing a problem.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the Error Summary Information page:

The Page Frame Body of the Error Summary Info page SHALL follow the template as defined in Figure 11.2-6.

The "Page Title" field in the Page Frame SHALL be labeled "Error Summary". The Error Summary page is the second page in this category.

The "Error Summary" page SHALL display the Application Signaling Status as defined in Section 11.1.13.

The "Error Summary" page SHALL display the PAT, PMT Timeout Count as defined in Section 11.1.13.

The "Error Summary" page SHALL display the IB, OOB Carousel Timeout Count as defined in Section 11.1.13.

The "Error Summary" page SHALL display a group of parameters labeled as "InBand Network" as follows for each tuner:

- Failed Tune Count as defined in Section 11.1.8.
- Last Failed Freq as defined in Section 11.1.8.

An example Error Summary Page is shown in Figure 11.2-20.

11.2.2.2.2 System Diagnostics Category

There are eight pages that can be displayed in the Page Frame when in the "System" Category: the "InBand Network" page, the "OOB Network" page, the "DOCSIS" page, the "DEVICE ADDRESSES" page, the "OCAP APPS" page, the "MEMORY TABLE" page, the "HDMI INFO" page, and the "SEB Status" page.

11.2.2.2.2.1 InBand Network Page Definition

The "InBand Network" page displays information about the state of the InBand signal processing chain.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the InBand page:

The Page Frame Body of the InBand Network page SHALL follow the template as defined in Figure 11.2-7.

The "Page Title" field in the Page Frame of the InBand Network page SHALL be labeled "InBand Network". The InBand Network page is the first page in this category.

The "InBand Network" page SHALL display a group of parameters labeled as "InBand Network" as follows for each tuner:

- Successful Tune Count as defined in Section 11.1.8.
- Failed Tune Count as defined in Section 11.1.8.
- Last Failed Frequency as defined in Section 11.1.8.
- Correctable Errors as defined in Section 11.1.8.
- Uncorrectable Errors as defined in Section 11.1.8.
- PCR Lock as defined in Section 11.1.8.
- MPEG Program number as defined in Section 11.1.10.
- CCI Value as defined in Section 11.1.10.

An example InBand Network Page is shown in Figure 11.2-21.

11.2.2.2.2.2 OOB Network Page Definition

The "OOB Network" page displays information about the state of the SCTE-55 OOB connection.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the OOB Network page:

The Page Frame Body of the Error OOB Network page SHALL follow the template as defined in Figure 11.2-8.

The "Page Title" field in the Page Frame SHALL be labeled "OOB Network". The OOB Network page is the second page in this category.

The "OOB Network" page SHALL display a group of parameters labeled as "OOB" as follows:

- FDC frequency as defined in Section 11.1.7.
- RDC frequency as defined in Section 11.1.9.
- FDC Power as defined in Section 11.1.7.
- RDC Power as defined in Section 11.1.9.

The "OOB Network" page SHALL display the RDC Data Rate as defined in Section 11.1.9.

The "OOB Network" page SHALL display the FDC Carrier Lock status as defined in Section 11.1.7.

The "OOB Network" page SHALL display the FDC SNR information as defined in Section 11.1.7.

An example OOB Network Page is shown in Figure 11.2-22.

11.2.2.2.2.3 DOCSIS Page Definition

The "DOCSIS" page displays information about the state of the embedded cable modem.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the DOCSIS page:

The Page Frame Body of the DOCSIS page SHALL follow the template as defined in Figure 11.2-9.

The "Page Title" field in the Page Frame SHALL be labeled "DOCSIS". The DOCSIS page is the third page in this category.

The "DOCSIS" page SHALL display a group of parameters labeled as "DOCSIS" as follows:

- Downstream Center Freq as defined in Section 11.1.12.
- Downstream Rvcd Power as defined in Section 11.1.12.
- Downstream Carrier Lock as defined in Section 11.1.12.
- Downstream SNR as defined in Section 11.1.12.
- Upstream Center Freq as defined in Section 11.1.12.
- Upstream Power as defined in Section 11.1.12.

An example DOCSIS Page is shown in Figure 11.2-23.

11.2.2.2.2.4 DEVICE ADDRESSES Page Definition

The "DEVICE ADDRESSES" page displays all of the MAC and network addresses for the interfaces within the device.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the DEVICE ADDRESSES page:

The Page Frame Body of the DEVICE ADDRESSES page SHALL follow the template as defined in Figure 11.2-10.

The "Page Title" field in the Page Frame SHALL be labeled "DEVICE ADDRs". The DEVICE ADDRESSES page is the fourth page in this category.

The "DEVICE ADDRESSES" page SHALL display the Card MAC Address as defined in Section 11.1.6.

The "DEVICE ADDRESSES" page SHALL display the eSTB MAC Address as defined in Section 11.1.6.

The "DEVICE ADDRESSES" page SHALL display the eCM MAC Address as defined in Section 11.1.6.

The "DEVICE ADDRESSES" page SHALL display the Card IP Address as defined in Section 11.1.6.

The "DEVICE ADDRESSES" page SHALL display the eSTB IP Address as defined in Section 11.1.6.

The "DEVICE ADDRESSES" page SHALL display the eCM IP Address as defined in Section 11.1.6.

11.2.2.2.2.5 OCAP APPS Page Definition

The "OCAP APPS" page displays information about unbound OCAP applications.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the OCAP APPS page:

The Page Frame Body of the OCAP APPS page SHALL follow the template as defined in Figure 11.2-11.

The "Page Title" field in the Page Frame SHALL be labeled "OCAP APPS". The OCAP APPS page is the fifth page in this category.

The "OCAP APPS" page SHALL display the Application Name as defined in Section 11.1.4.

The "OCAP APPS" page SHALL display the Application Version as defined in Section 11.1.4.

The "OCAP APPS" page SHALL display the Org ID as defined in Section 11.1.4.

The "OCAP APPS" page SHALL display the App ID as defined in Section 11.1.4.

The "OCAP APPS" page SHALL display the Application Status as defined in Section 11.1.4.

11.2.2.2.2.6 MEMORY TABLE Page Definition

The "MEMORY TABLE" page displays information about the amount and type of memory implemented within the device.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the MEMORY TABLE page:

The Page Frame Body of the MEMORY TABLE page SHALL follow the template as defined in Figure 11.2-12.

The "Page Title" field in the Page Frame SHALL be labeled "MEMORY TABLE". The MEMORY TABLE page is the sixth page in this category.

The "MEMORY TABLE" page SHALL display the Memory Type and Memory Size, for each type, as defined in Section 11.1.3.

11.2.2.2.2.7 HDMI INFO Page Definition

The "HDMI INFO" page displays all of the information that is useful when troubleshooting the uncompressed digital video interface.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the HDMI INFO page:

The Page Frame Body of the HDMI INFO page SHALL follow the template as defined in Figure 11.2-13.

The "Page Title" field in the Page Frame SHALL be labeled "HDMI INFO". The HDMI INFO page is the seventh page in this category.

The "HDMI INFO" page SHALL display a group of parameters labeled as "HDMI" as follows for each HDMI output :

- Connection status as defined in Section 11.1.11
- Connected Device type as defined in Section 11.1.11
- HDCP Status as defined in Section 11.1.11
- Horizontal Resolution as defined in Section 11.1.11
- Vertical Resolution as defined in Section 11.1.11
- Frame Rate as defined in Section 11.1.11
- Aspect Ratio as defined in Section 11.1.11
- Scanning Format as defined in Section 11.1.11

11.2.2.2.2.8 SEB Status Page Definition

The "SEB Status" page displays useful information when troubleshooting a SEB server or a SEB client.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the SEB Status page:

The SEB Status page SHALL be the eighth page in the SYSTEM category.

If SEB is not supported, the “Page Title" SHALL be labeled “SEB Not Supported”.

If SEB is not supported, the Page Frame Body SHALL be blank.

If SEB initialization was unsuccessful, the “Page Title" SHALL be labeled “SEB Initialization Unsuccessful”.

If SEB Server initialization was unsuccessful, the Page Frame Body SHALL follow the template as defined in Figure 11.2-15.

If the SEB Server initialization was unsuccessful, it SHALL report the applicable failure reason(s) as defined in Section 11.1.15.

If SEB Client initialization was unsuccessful, the Page Frame Body SHALL follow the template as defined in Figure 11.2-16.

If the SEB Client initialization was unsuccessful, it SHALL report the applicable failure reason(s) as defined in Section 11.1.15.

If SEB Server successfully initialized, the Page Frame Body SHALL follow the template as defined in Figure 11.2-17.

If SEB Client successfully initialized and connected to a SEB Server, the Page Frame Body SHALL follow the template as defined in Figure 11.2-18.

If SEB Client successfully initialized but cannot detect or connect to a SEB Server, the Page Frame Body SHALL follow the template as defined in Figure 11.2-19.

If SEB is supported, the SEB Role SHALL be displayed as defined in Section 11.1.15.

If SEB Server initialization was successful, the “Page Title" SHALL be labeled “SEB Server Status”.

If SEB Server is initialized, it SHALL display the Server information as follows:

- The Figure of Merit as defined in Section 11.1.15.
- The Maximum number of SEB Clients supported as defined in Section 11.1.15.
- Number of SEB Clients currently connected as defined in Section 11.1.15.
- The Connected Devices information as defined in Section 11.1.15.

If SEB Client initialization was successful, the “Page Title" SHALL be labeled “SEB Client Status”.

If SEB Client is initialized and is connected to a SEB Server, the OCHD2.1 SHALL display the Client information as follows:

- The Server MAC address as defined in Section 11.1.15.
- The Server IP address as defined in Section 11.1.15.
- The Server FOM as defined in Section 11.1.15.
- The Connected Devices information as defined in Section 11.1.15.

If SEB Client is initialized and it cannot detect a SEB Server, the OCHD2.1 SHALL display the condition as defined in Section 11.1.15.

If SEB Client is initialized and cannot connect to a detected SEB Server, the OCHD2.1 SHALL display the reason as defined in Section 11.1.15.

11.2.2.2.3 Manufacturer Diagnostics Category

The Manufacturer Diagnostics page links to extended platform information that a technician can use to debug field issues. These linked pages show host-specific diagnostic information. Some of the options available when selecting this category will vary from vendor to vendor.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the Manufacturer Diagnostics page:

The "Page Title" field in the Page Frame SHALL be labeled "MFG Diagnostics".

A single line of text SHALL be displayed in the Page Frame Body as follows: "Press SELECT key to enter MFG Diagnostics."

If the SELECT remote control key or front panel button is received, the application will proceed to the host-specific Manufacturer Diagnostics Sub-Pages.

An example Manufacturer Diagnostics Page is shown in Figure 11.2-24.

11.2.2.2.4 DVR Diagnostics Category

The DVR Diagnostics Category appears if the OCHD2.1 supports the OpenCable Host DVR Extension [OCAP-DVR].

The OCHD2.1 diagnostic application SHALL display the DVR Diagnostics Category in the Category Frame in the Main Menu Page only if the device implements [OCAP-DVR].

The OCHD2.1 diagnostic application SHALL implement the following behavior for the DVR Diagnostics page, when supported:

The "Page Title" field in the Page Frame SHALL be labeled "DVR Information".

All DVR diagnostics pages SHALL follow the Sub-Level Page Requirements defined in Section 11.2.1.3.

A single line of text SHALL be displayed in the Page Frame Body as follows: "Press SELECT key to enter DVR diagnostics".

Pressing the SELECT key accesses vendor-specific diagnostics for the DVR's hard disk drive.

11.2.2.2.5 Card Diagnostics Category

The Card Diagnostics Category allows access to the summary diagnostics that are available from the Card.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the Card page:

The "Page Title" field in the Page Frame SHALL be labeled "Card Diagnostics".

A single line of text SHALL be displayed in the Page Frame Body as follows: "Press SELECT key to enter Card Diags".

The OCHD2.1 diagnostic application SHALL implement the following behavior when the SELECT key is pressed while the Card Category is highlighted:

A Sub-Level Page is displayed that SHALL meet the requirements defined in Section 11.2.1.3.

The Sub-Level Page SHALL contain "Card Info" as the first Sub-Category in the Category Frame. An example Card Diagnostics Page is shown in Figure 11.2-25.

11.2.2.2.5.1 Card Info Page Definition

This section defines requirements for the "Card Info" page. This page is a summary page for all of the Card information. This page is presented when the Card Info Sub-Category is highlighted.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the Card Info page:

The "Page Title" field in the Page Frame SHALL be labeled "CARD INFO".

The Page Frame Body of the Card Info page SHALL follow the template as defined in Figure 11.2-14.

The "Card Info" page SHALL display the Card OOB Mode as defined in Section 11.1.14.

The "Card Info" page SHALL display a group of parameters labeled as "CP Certificate" as follows:

- Results of the certificate check as defined in Section 11.1.14.
- Copy Protection Provisioning status as defined in Section 11.1.14.
- Card CCI Challenge Message Count as defined in Section 11.1.14.
- Copy Protection Key Generation Request Count as defined in Section 11.1.14.

The "Card Info" page SHALL display a group of parameters labeled as "CP ID List" as follows:

- Card ID as defined in Section 11.1.14.
- Host ID as defined in Section 11.1.14.
- Card Manufacturer ID as defined in Section 11.1.14.
- Conditional Access Status as defined in Section 11.1.14.
- Copy Protection System ID as defined in Section 11.1.14.
- Conditional Access System ID as defined in Section 11.1.14.
- Generic Feature Resource Identifier as defined in Section 11.1.14.
- Time-Zone as defined as defined in Section 11.1.14.
- Daylight Saving parameters as defined in Section 11.1.14.
- EA Location as defined as defined in Section 11.1.14.
- VCT-ID as defined in Section 11.1.14.

11.2.2.2.5.2 Card MMI Sub-Categories

The Card MMI pages are resident diagnostics screens within the Card itself. The screens can vary between CA vendors' Cards. The diagnostics application presents these pages as Sub-Categories listed below the Card Info Sub-Category.

The OCHD2.1 diagnostic application SHALL provide Sub-Categories below the Card Info Sub-Category for Card applications reported in the ***application_info_cnf()*** APDU.

There SHALL be one Sub-Category per application reported in the ***application_info_cnf()*** APDU.

Each Sub-Category SHALL be labeled with the application name reported in the ***application_info_cnf()*** APDU.

Sub-Categories SHALL be presented in the order found in the ***application_info_cnf()*** APDU.

Pages for each Sub-Category shall be rendered from the HTML retrieved via the application URL reported in the ***application_info_cnf()*** APDU.

Within a Sub-Category, page navigation via the Right button SHALL follow the first hyperlink in the currently-displayed page. If the page has no hyperlink, the Right button SHALL be ignored.

Within a Sub-Category, page navigation via the Left button SHALL revert to the previous page in the hyperlink chain. If the current page is the initial page for the Card application, the Left button SHALL be ignored.

An example Card MMI Page is shown in Figure 11.2-4.

11.2.2.2.6 Reboot STB Category

This option gives the user the ability to reboot the device.

The OCHD2.1 diagnostic application SHALL implement the following behavior for the Reboot STB Page:

The "Page Title" field in the Page Frame SHALL be labeled "Reboot the STB".

The diagnostic application SHALL display the following text in the Page Frame Body: "Press and hold the SELECT key for 5 seconds to reboot the STB".

The STB reboot SHALL be equivalent to a power reset of the device.

An example Reboot Page is shown in Figure 11.2-26.

Firmware Version, Date:	[ocStbHostSoftwareFirmwareVersion]	[ocStbHostSoftwareFirmwareReleaseDate]
CP Status:	[ocStbHostCardCpAuthKeyStatus]	
CA Status	[ocStbHostCardBindingStatus]	
InBand Network	**Tuner-1**	**Tuner-2**
Frequency (MHz)	[ocStbHostInBandTunerFrequency]	[ocStbHostInBandTunerFrequency]
Modulation	[ocStbHostInBandTunerModulationMode]	[ocStbHostInBandTunerModulationMode]
Power (dBmV)	[ocStbHostInBandTunerPower]	[ocStbHostInBandTunerPower]
SNR (dB)	[ocStbHostInBandTunerSNRValue]	[ocStbHostInBandTunerSNRValue]
Carrier Lock	[ocStbHostInBandTunerState]	[ocStbHostInBandTunerState]
Power Status	[ocStbHostPowerStatus]	
Boot Status	[ocStbHostBootStatus]	
Firmware D/L Status	[ocStbHostFirmwareCodeDownloadStatus]	(Error Code, if needed)

Figure 11.2-5 - Summary Info Page Template

Application Signaling	[ocStbHostSoftwareApplicationInfoSigLastReadStatus]	
PAT, PMT Timeouts	[ocStbHostPatTimeoutCount]	[ocStbHostPmtTimeoutCount]
IB, OOB OC Timeouts	[ocStbHostInBandCarouselTimeoutCount]	[ocStbHostOobCarouselTimeoutCount]
InBand Network	**Tuner-1**	**Tuner-2**
Failed Tune Count	[ocStbHostInBandTuneFailureCount]	[ocStbHostInBandTuneFailureCount]
Last Failed Freq	[ocStbHostInBandTuneFailFreq]	[ocStbHostInBandTuneFailFreq]

Figure 11.2-6 - Error Summary Page Template

InBand	**Tuner-1**	**Tuner-2**
Success Tune Count	[STuneCount]	[STuneCount]
Failed Tune Count	[ocStbHostInBandTuneFailureCount]	[ocStbHostInBandTuneFailureCount]
Last Failed Freq	[ocStbHostInBandTuneFailFreq]	[ocStbHostInBandTuneFailFreq]
Correctable	[ocStbHostInBandTunerCorrectables]	[ocStbHostInBandTunerCorrectables]
Uncorrectable	[ocStbHostInBandTunerUncorrectables]	[ocStbHostInBandTunerUncorrectables]
PCR Lock	[ocStbHostMpeg2ContentPCRLockStatus]	[ocStbHostMpeg2ContentPCRLockStatus]
MPEG Program	[ocStbHostMpeg2ContentProgramNumber]	[ocStbHostMpeg2ContentProgramNumber]
CCI	[ocStbHostMpeg2ContentCCIValue]	[ocStbHostMpeg2ContentCCIValue]

Figure 11.2-7 - InBand Network Page Template

OOB	**FDC**	**RDC**
Frequency (MHz)	[ocStbHostQpskFDCFreq]	[ocStbHostQpskRDCFreq]
Power (dBmV)	[ocStbHostQpskFDCPower]	[ocStbHostQpskRDCPower]
RDC Data Rate (kbps)		[ocStbHostQpskRDCDataRate]
FDC Lock	[ocStbHostQpskFDCStatus]	
FDC SNR (dB)	[ocStbHostQpskFDCSNR]	

Figure 11.2-8 - OOB Network Page Template

DOCSIS	
Downstream Center Freq	[docsIfDownChannelFrequency]
Downstream Rvcd Power	[docsIfDownChannelPower]
Downstream Carrier Lock	[docsIfCmStatusValue] (DOCSIS2.0) or [docsIf3CmStatusValue] (DOCSIS3.0)
Downstream SNR	[docsIfSigQSignalNoise]
Upstream Center Freq (MHz)	[docsIfUpChannelFrequency]
Upstream Power	[docsIfCmStatusTxPower]

Figure 11.2-9 - DOCSIS Page

Device Addrs	**MAC**	**IP**
eSTB	[ifPhysAddress]	[eSTB]
eCM	[eCM1]	[eCM2]
Card	[ocStbHostCardMacAddress]	[ocStbHostCardIpAddress]

Figure 11.2-10 - Device Addresses Page Template

Name	Version	Org ID	App ID	Status
[ocStbHostSoftwareAppNameString]				
	[ocStbHostSoftwareAppVersionNumber]	[ocStbHostSoftwareOrganizationId]	[ocStbHostSoftwareApplicationID]	[ocStbHostSoftwareStatus]
…				
	…	…	…	…
…				
	…	…	…	…

Figure 11.2-11 - OCAP APPS Page Template

Type	Size (KB)
[ocStbHostSystemMemoryReportMemoryType]	[ocStbHostSystemMemoryReportMemorySize]
…	…
…	…
…	…
…	…
…	…
…	…

Figure 11.2-12 - Memory Table Page Template

HDMI	**HDMI-1**
Connection status	[cStbHostDVIHDMIConnectionStatus]
Connected Device type	[ocStbHostDVIHDMIAttachedDeviceType]
HDCP Status	[ocStbHostDVIHDMIHostDeviceHDCPStatus]
Horizontal Resolution	derived from [ocStbHostDVIHDMIOutputFormat]
Vertical Resolution	derived from [ocStbHostDVIHDMIOutputFormat]
Frame Rate	[ocStbHostDVIHDMIFrameRate]
Aspect Ratio	[ocStbHostDVIHDMIAspectRatio]
Scanning Format	derived from [ocStbHostDVIHDMIOutputFormat]

Figure 11.2-13 - HDMI INFO Page Template

OOB Mode	[ocStbHostOobMessageMode]	
CP Certificate		
Certificate Check	[ocStbHostCardCpCertificateCheck]	
CP Status	[ocStbHostCardCpAuthKeyStatus]	
CCI Challenge Count	[ocStbHostCardCpCciChallengeCount]	
Key Generation Count	[ocStbHostCardCpKeyGenerationReqCount]	
CP ID List		
Card ID	[ocStbHostCardId]	
Host ID	[ocStbHostHostId]	
Card Manufacturer ID	[ocStbHostCardMfgId]	
CA Status	[ocStbHostCardBindingStatus]	
CP System ID	[ocStbHostCardCpIdList]	
CA System ID	[ocStbHostCASystemIdentifier]	
Generic Feature Resource	[ocStbHostCardOpenedGenericResource]	
Time Zone, DST Delta	[ocStbHostCardTimeZoneOffset]	[ocStbHostCardDaylightSavingsTimeDelta]
DST Entry, Exit	[ocStbHostCardDaylightSavingsTimeEntry]	[ocStbHostCardDaylightSavingsTimeExit]
EA Location	[ocStbHostCardEaLocationCode]	
VCT ID	[ocStbHostCardVctId]	

Figure 11.2-14 - Card Info Page Template

SEB Server Unable to Initialize for the following reason(s)

{reason 1}

{reason 2}

{reason 3}

{reason 4}

{reason 5}

Figure 11.2-15 - Unsuccessful SEB Server Initialization Page Template

SEB Client Unable to Initialize for the following reason(s)

{reason 1}

{reason 2}

{reason 3}

{reason 4}

Figure 11.2-16 - Unsuccessful SEB Client Initialization Page Template

SEB Server Status

SEB Role (dsgIfStdDsgSebRole): {value}

Maximum number of SEB Clients supported: {value}

Number of SEB Clients served: {value}

Figure of Merit (FOM): {value}

Connected Device Table

Client Device MAC Address	Client device IP Address	Client Device Type
{Client-1 MAC address}	{ Client-1 IP address}	{client-1 device type1}
{Client-1 MAC address}	{ Client-1 IP address}	{client -1 device type2}
.	.	.
.	.	.
{Client-n MAC address}	{ Client-n IP address}	{client-n type}

Figure 11.2-17 - SEB Server Status Page Template

SEB Client Status

SEB Role (dsgIfStdDsgSebRole): {value}

Server IP address: {IP address} **Server MAC address:** {MAC address}

Server FOM: {Server advertised value}

Connected Device Table

{Device1 MAC address}	{ Device1 IP addresses}	{Device 1 type}
{Device2 MAC addresses}	{ Device2 IP addresses}	{Device 2 type}
{Device3 MAC addresses}	{ Device3 IP addresses}	{Device 3 type}

Figure 11.2-18 - SEB Client Status Page Template

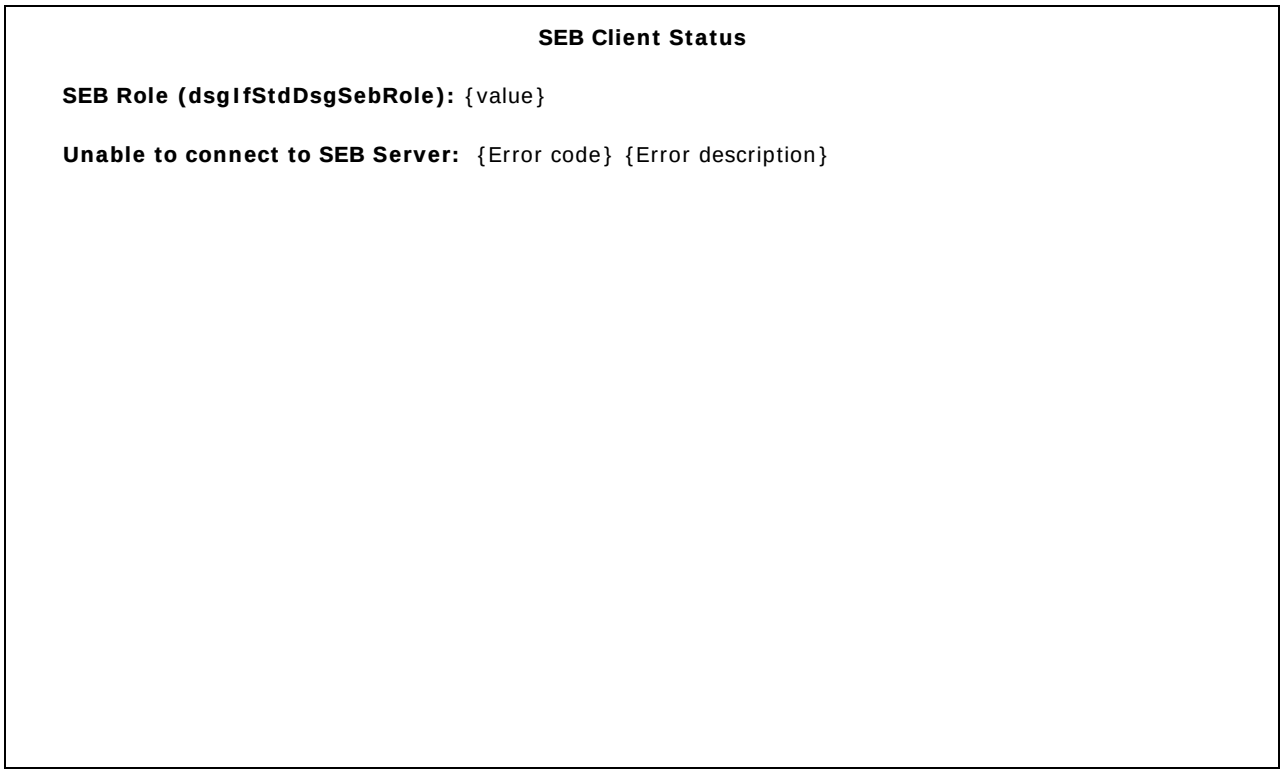


Figure 11.2-19 - SEB Client Status Page - Unable to Connect Template

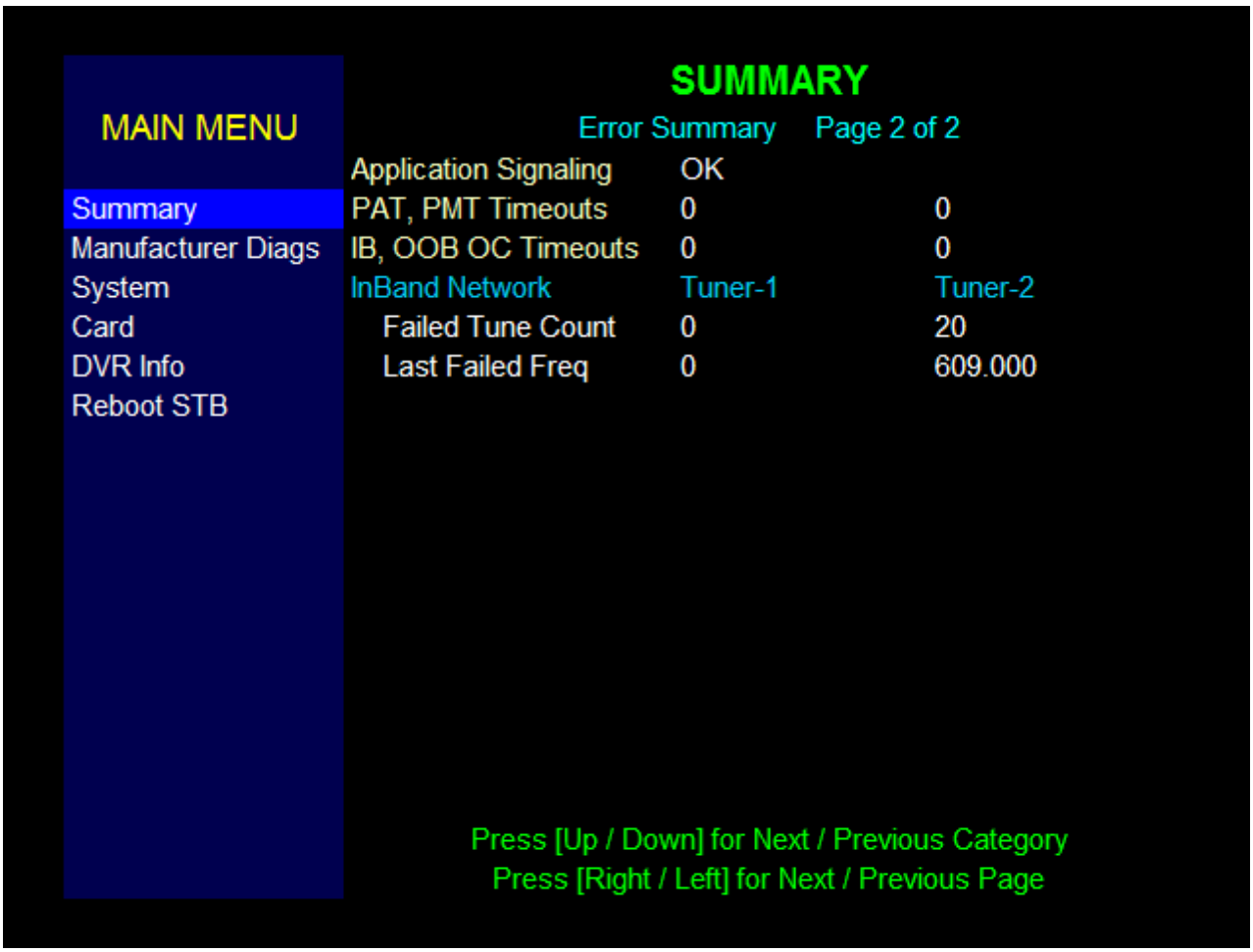


Figure 11.2-20 - Error Summary Page Example

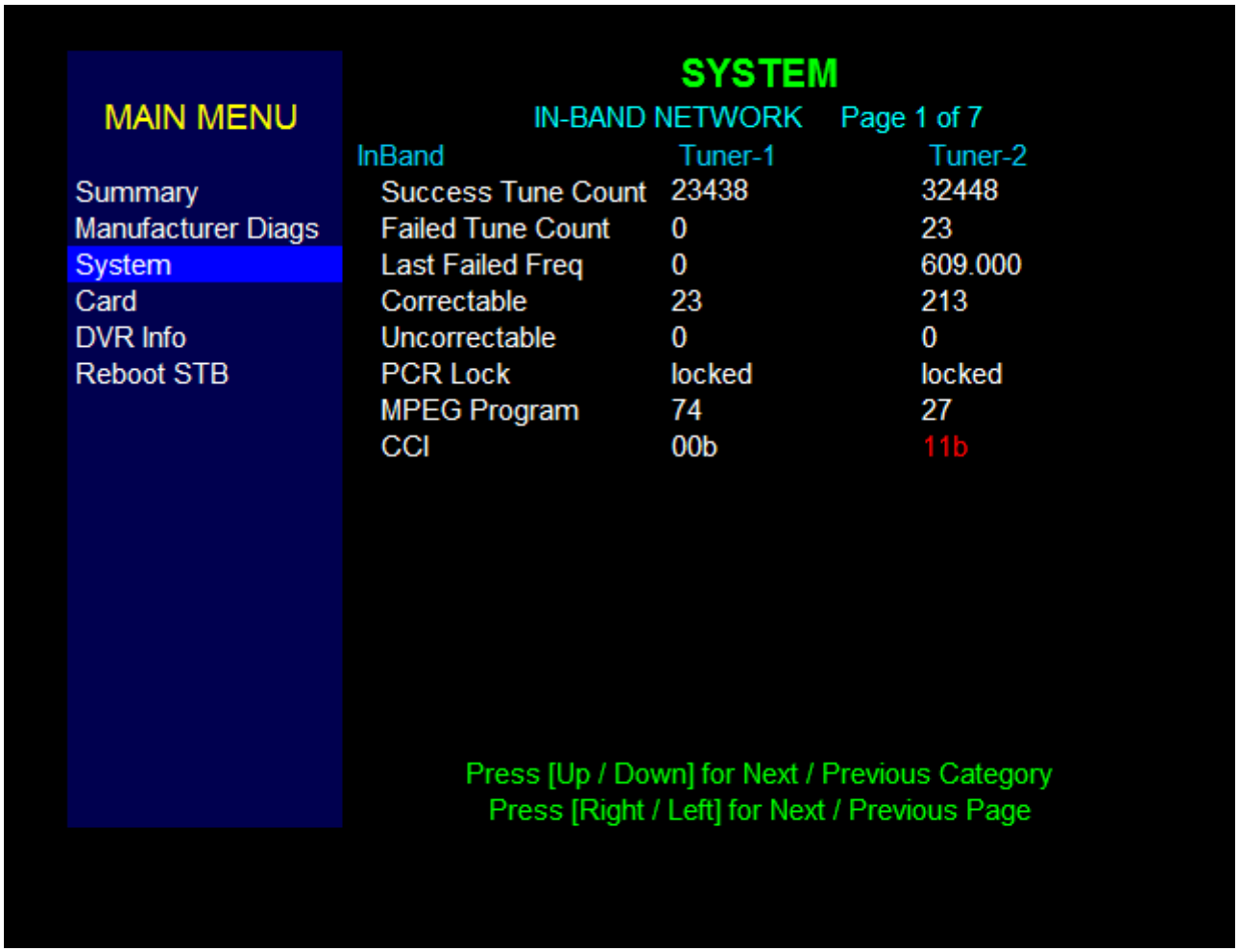


Figure 11.2-21 - Inband Network Page Example

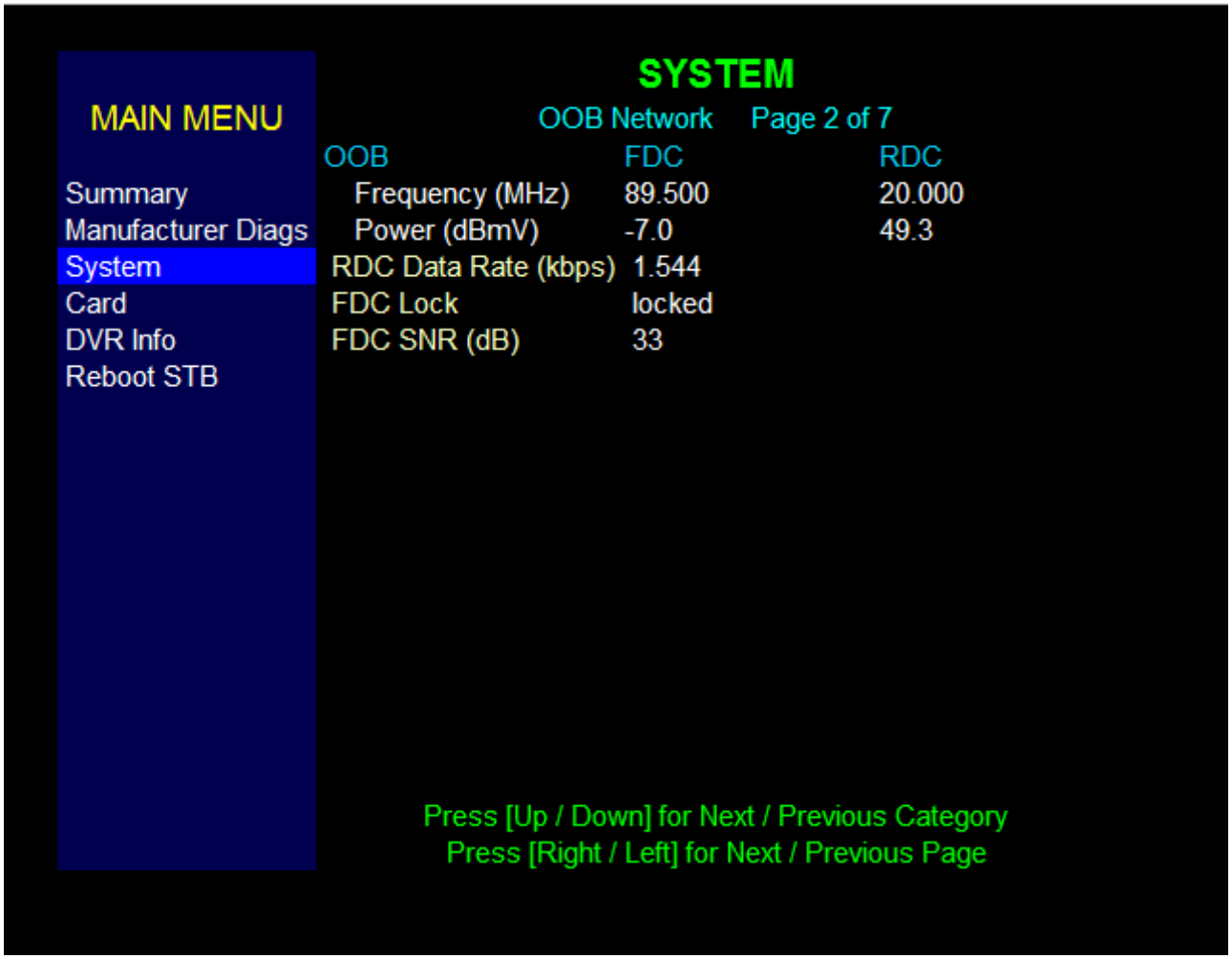


Figure 11.2-22 - OOB Network Page Example

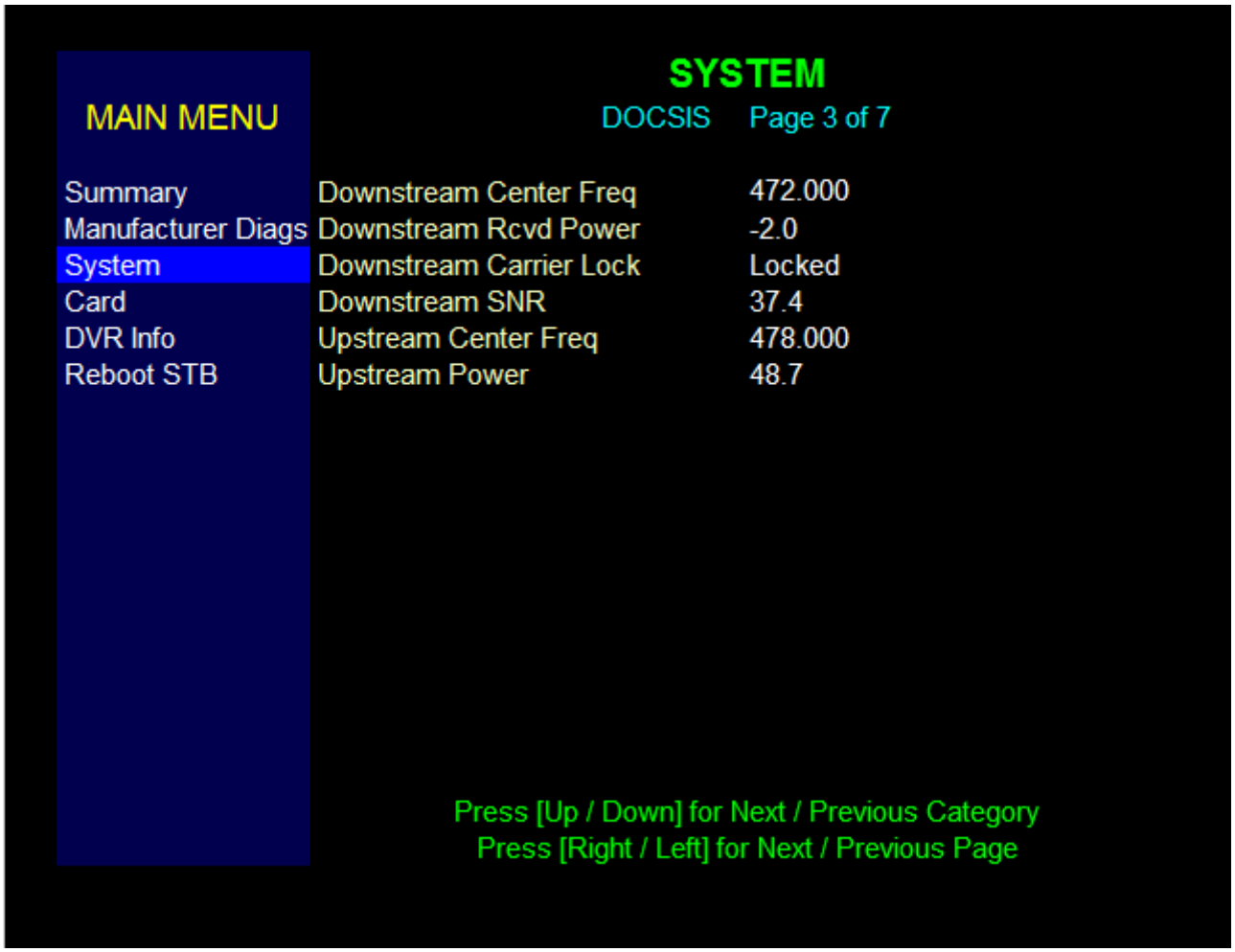


Figure 11.2-23 - DOCSIS Page Example

Figure 11.2-24 - MFG Diags Page Example

Figure 11.2-25 - Card Diags Page Example

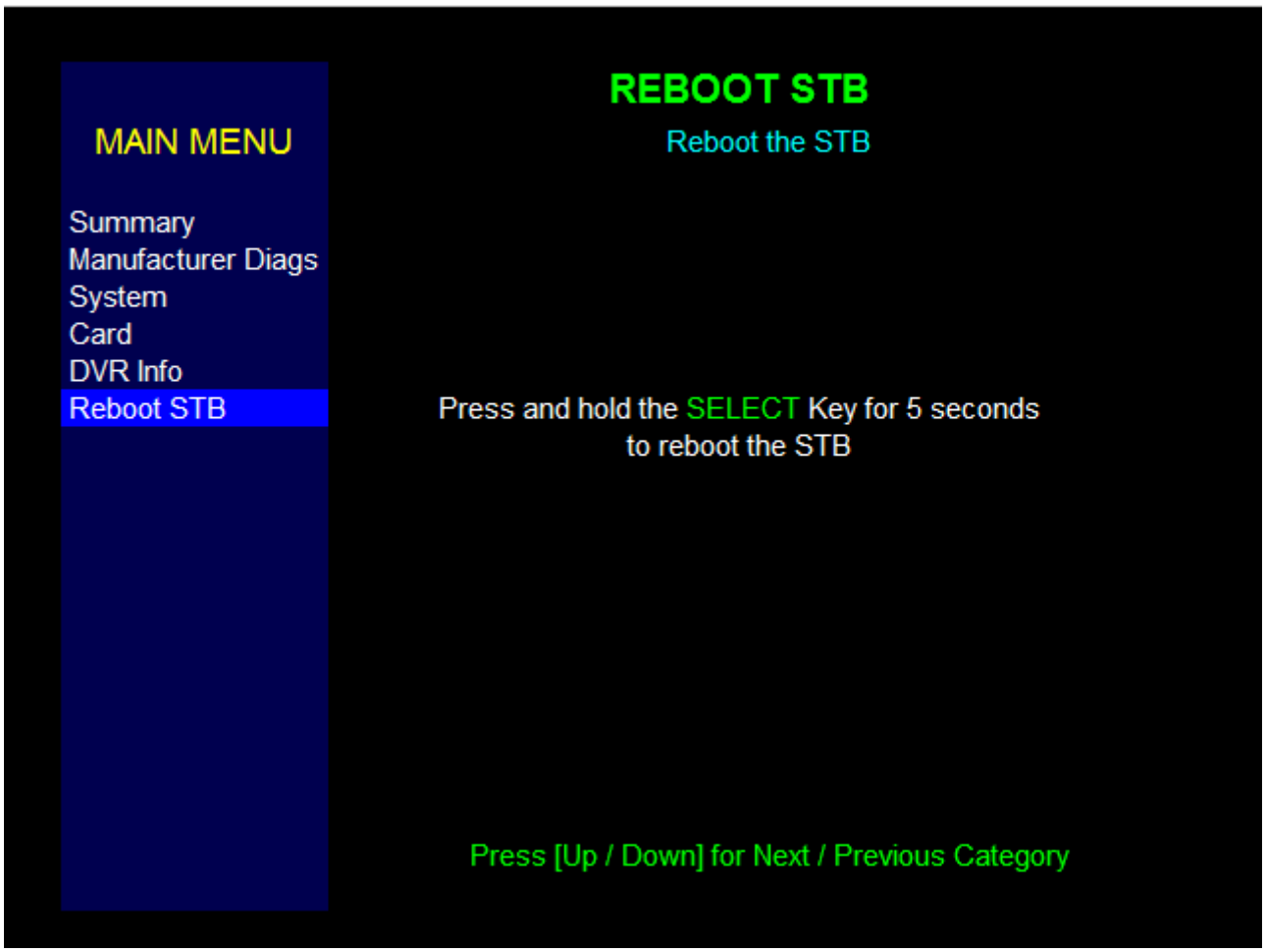


Figure 11.2-26 - Reboot Page Example

11.3 Initialization (Bootup) Screen

The OCHD2.1 supports the display of standardized screens as an installation and troubleshooting aid when deploying these devices on OCAP-enabled cable plants. The process of "booting up" an OpenCable device on a typical plant is a complex set of events, each of which must be accomplished successfully before the device is fully functional. OpenCable set-top devices are required to render these screens to their analog and digital outputs, and terminal devices are required to render these screens on their built-in display. The display of these screens is only applicable when a Card is installed in the Host device. The display of these screens is only applicable for a Host terminal device when the cable tuner input is selected.

Note: Video output to digital interfaces is not anticipated until the applicable level of firmware/drivers has been loaded such that the product can drive these interfaces. There is no expectation that the boot loader can or will drive these interfaces.

11.3.1 Initialization Diagnostics

The OCHD2.1 SHALL be capable of displaying the following event and status information upon startup/reboot:

- Boot Status
- Host Validation Status
- OCAP Firmware Download Status
- Card Firmware Download Status
- OCAP Stack Initialization Status
- XAIT Status
- Initial Monitor Application Launch Status
- OOB Initialization Status
- DOCSIS Initialization Status
- eSTB IP Address Acquisition Status
- SI Acquisition Status

Note: The above list does not define a particular sequence of events, since some processes may occur in parallel and some processes are independent of one another.

The OCHD2.1 may display a manufacturer or MSO-specific "splash" screen, if available, until any remote control key is pressed, at which time the initialization screen SHALL be displayed.

The OCHD2.1 SHALL display the initialization screen whenever the device is rebooted or power is cycled.

The OCHD2.1 SHALL NOT display the initialization screen if the device transitions to standby mode during boot up.

The OCHD2.1 SHALL remove the initialization screen from the display under the following conditions:

If the initial application launched is the Monitor Application, the screen is to be removed when the Monitor Application calls monitorConfiguringSignal (see [OCAP]), under the assumption that it will take control of the screen.

The screen is to be removed if an EAS message is received or an EAS force tune is signaled and resumed after the EAS message duration, if the set-top device is powered on.

The screen is to be removed if the host device boot process stalls at a particular step for more than five minutes, to prevent screen burn in, and is to be resumed by pressing any remote control key.

The screen is to be removed if the initial OCAP auto-start application is not a Monitor Application.

The OCHD2.1 SHALL remove the initialization screen from the display if the OCAP Watch TV module has been activated and any of the following events has occurred:

The OCHD2.1 was unable to acquire an XAIT from the network.

The OCHD2.1 was unable to launch the Initial Monitor Application.

11.3.1.1 Boot Status

The OCHD2.1 SHALL display the Boot Status in the following manner:

Once the boot process has started, the OCHD2.1 SHALL display the following text: Booting

The above text SHALL be displayed in yellow until startup is complete, thereafter displayed in green.

If the boot process does not complete successfully (e.g., low-level software/firmware errors, hard disk drive errors, operating system initialization errors or CCIF initialization errors) the OCHD2.1 SHALL display the following text: Boot Error

The above text SHALL be displayed in red.

11.3.1.2 Host Validation Status

The OCHD2.1 SHALL display the Host Validation Status in the following manner:

If the OCHD2.1 receives the ***CP_valid_cnf()*** APDU with status = 0x00, it SHALL display the following text: Host Validation Status = In Progress

The above text SHALL be displayed in yellow.

If the OCHD2.1 receives the ***CP_valid_cnf()*** APDU with status = 0x01, 0x02, 0x03, 0x04 or 0x05, it SHALL display the following text: Host Validation Status = Failed

The above text SHALL be displayed in red.

If the OCHD2.1 receives the ***CP_valid_cnf()*** APDU with status = 0x07, it SHALL display the following text: Host Validation Status = Not Validated

The above text SHALL be displayed in orange.

If the OCHD2.1 receives the ***CP_valid_cnf()*** APDU with status = 0x06, it SHALL display the following text: Host Validation Status = Validated

The above text SHALL be displayed in green.

11.3.1.3 OCAP Firmware Download Status

The OCHD2.1 SHALL display the OCAP Firmware Download Status in the following manner:

If the OCHD2.1 has received a signal indicating the start of an OCAP firmware download, it SHALL display the following text, along with a progress bar indicating percentage complete: OCAP Firmware Download [Progress Bar showing % Complete]

The above text SHALL be displayed in yellow until download is complete and thereafter may be displayed in green.

The above text SHALL be displayed only if an actual download has been signaled and started.

If the OCAP Firmware Download does not complete successfully, the OCHD2.1 SHALL display the following text: OCAP Firmware Download Error

The above text SHALL be displayed in red.

11.3.1.4 Card Firmware Download Status

The OCHD2.1 SHALL display the Card Firmware Download Status in the following manner:

If the OCHD2.1 has received a ***firmware_upgrade()*** APDU signaling start of a Card image download, it SHALL display the following text, along with a progress field containing one of Started / Complete: Card Firmware Download [Started / Complete]

The above text SHALL be displayed in yellow until the device receives a ***firmware_upgrade_complete()*** APDU signaling that the download is complete, thereafter displayed in green.

The above text SHALL be displayed only if an actual download has been signaled and started.

If the Card has signaled the start of an image download with the ***firmware_upgrade()*** APDU and a ***timeout_type*** value of 0x00, 0x001, or 0x002, and timeout period expires, then the OCHD2.1 SHALL display the following text: Card Firmware Download Error

The above text SHALL be displayed in red.

11.3.1.5 OCAP Stack Initialization Status

The OCHD2.1 SHALL display the OCAP Stack Initialization Status in the following manner:

While the OCAP Stack is initializing, the OCHD2.1 SHALL display the following text: OCAP Stack Initialization

The above text SHALL be displayed in yellow until stack initialization is complete, thereafter displayed in green.

If the OCAP Stack Initialization does not complete successfully, the OCHD2.1 SHALL display the following text: OCAP Stack Initialization Error

The above text SHALL be displayed in red.

11.3.1.6 XAIT Status

The OCHD2.1 SHALL display the XAIT Status in the following manner:

When the OCHD2.1 has validated an XAIT received from the network, it SHALL display the following text: XAIT Acquisition

The above text SHALL be displayed in yellow until a valid XAIT has been acquired from the network, thereafter displayed in green.

If an XAIT is received from the network but does not validate successfully, the OCHD2.1 SHALL display the following text: Error Reading XAIT

The above text SHALL be displayed in red.

11.3.1.7 Initial Monitor Application Status

The OCHD2.1 SHALL display the Initial Monitor Application Status in the following manner:

When the OCHD2.1 has launched the Initial Monitor Application, it SHALL display the following text: Initial Monitor Application Launch

The above text SHALL be displayed in yellow until the Initial Monitor Application has launched, thereafter displayed in green.

If the Initial Monitor Application does not start successfully, the OCHD2.1 SHALL display the following text: Initial Monitor Application Launch Failed

The above text SHALL be displayed in red.

11.3.1.8 OOB Initialization Status

The OCHD2.1 SHALL display the OOB Initialization Status in the following manner:

If the OCHD2.1 is operating in SCTE-55 OOB Mode and has not received the ***OOB_RX_tune_req()*** APDU from the Card defining the OOB frequency and data rate, then it SHALL display the following text in yellow: OOB Downstream Established

The above text SHALL be displayed in green when the device is able to acquire carrier lock on the requested OOB frequency.

If the OCHD2.1 is operating in OOB mode and has responded to the Card with ***OOB_TX_tune_cnf()*** indicating status_field = Tuning granted (0x00), then it SHALL display the following text: OOB Initialization Complete

The above text SHALL be displayed in green.

If the OCHD2.1 responds to an ***OOB_RX_tune_req()*** APDU with an ***OOB_RX_tune_cnf()*** APDU indicating status_field = Tuning denied (0x01, 0x02, 0x03 or 0x04), it SHALL display the following text: OOB Initialization Failed

The above text SHALL be displayed in red.

If the OCHD2.1 responds to an ***OOB_TX_tune_req()*** APDU with an ***OOB_TX_tune_cnf()*** APDU indicating status_field = Tuning denied (0x01, 0x02, 0x03 or 0x04), it SHALL display the following text: OOB Initialization Failed

The above text SHALL be displayed in red.

11.3.1.9 DOCSIS Initialization Status

The OCHD2.1 SHALL display the DOCSIS Initialization Status in the following manner when operating in DSG 2-way Mode:

If the OCHD2.1 has not received a ***DSG_directory()*** message from the Card, it SHALL display the following text in red: DOCSIS Initialization

The above text SHALL be displayed in yellow when the Host has received a ***DSG_directory()*** APDU from the Card indicating that the DOCSIS downstream has been established.

When the Host sends the Card a ***DSG_message()*** APDU with message_type = 2-Way OK,UCID (0x01), the above text SHALL be displayed in green.

The OCHD2.1 SHALL display the DOCSIS Initialization Status in the following manner when operating in DSG One-way Mode:

If the OCHD2.1 has not received a ***DSG_directory()*** message from the Card, it SHALL display the following text in red: DSG 1-Way Initialization

The above text SHALL be displayed in green when the Host has received a ***DSG_directory()*** APDU from the Card indicating that the DOCSIS downstream has been established.

11.3.1.10 eSTB IP Address Acquisition Status

The OCHD2.1 SHALL display the eSTB IP Address Acquisition Status in the following manner:

The OCHD2.1 SHALL display the following text: eSTB IP Address Acquisition

The above text SHALL be displayed in yellow until IP address acquisition is complete, thereafter displayed in green.

If eSTB address acquisition failed, the OCHD2.1 SHALL display the following text: eSTB IP Address Acquisition Failed

The above text SHALL be displayed in red.

11.3.1.11 SI (System Information) Acquisition Status

The OCHD2.1 SHALL display the SI Acquisition Status in the following manner:

The OCHD2.1 SHALL display the following text, where xxx is the total number of virtual channels acquired: SI Acquisition # of Channels = xxx

The above text SHALL be displayed in yellow until the NIT and STT have been received, thereafter displayed in green.

The # of Channels text SHALL be displayed on the right side aligned with the progress bar for OCAP firmware download.

The OCHD2.1 SHALL report the value 0 as the total number of virtual channels acquired until the VCT has been received.

11.3.2 Display requirements

The OCHD2.1 initialization screen SHALL follow the layout template as defined in Figure 11.3-1.

The OCHD2.1 initialization screen SHALL only display one of OOB Initialization / DOCSIS Initialization Status.

If an MSO-specific logo has been loaded onto the OCHD2.1, it SHALL display that logo on the initialization screen. Definition of the loading of a MSO-specific logo is outside the scope of this specification.

If the MSO-supplied logo is not available, the OCHD2.1 SHALL display the <tru2way> logo [tru2way] in its place.

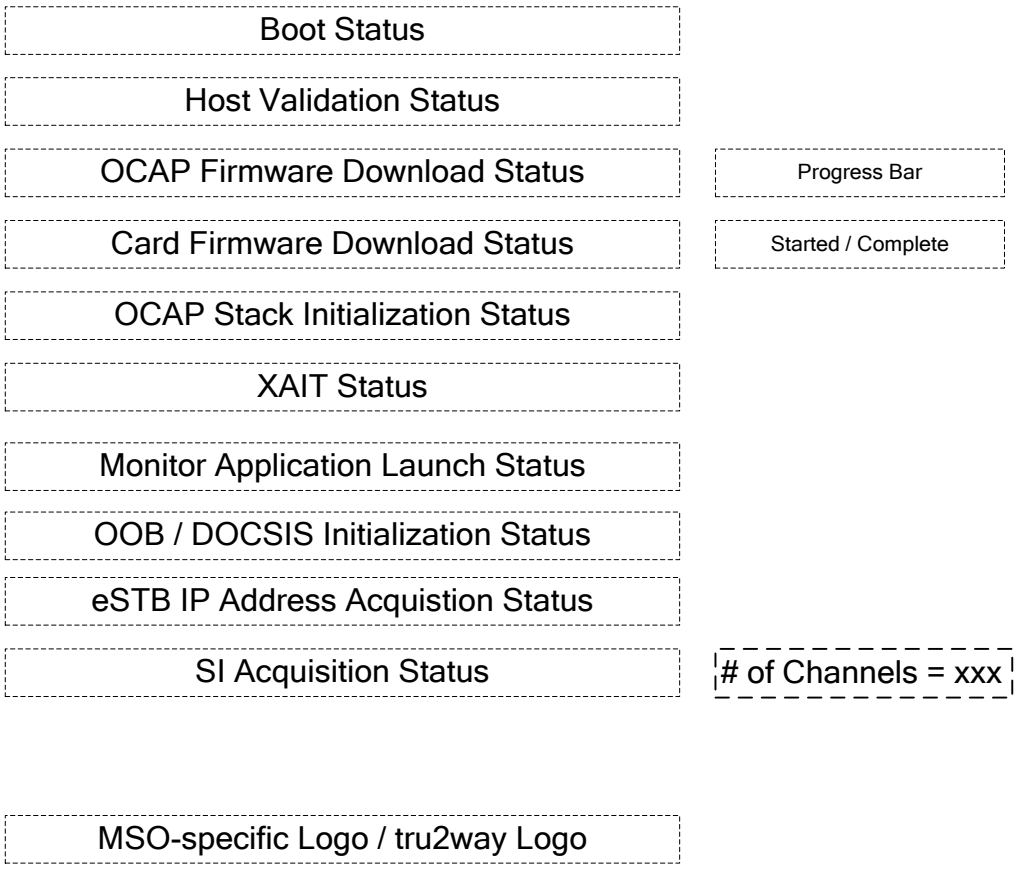


Figure 11.3-1 - Initialization Screen Layout

11.4 Front Panel Diagnostics (Conditional Mandatory)

This section defines requirements for OpenCable Set-top (OCS2.1) devices that implement the optional Front Panel Extension [OCAP-FP]. It specifies the messages to be displayed on the front panel during boot up of the device.

11.4.1 Standard Boot Messages

If the OCS2.1 supports [OCAP-FP], it SHALL display the standard boot messages to the front panel LED display as defined in Table 11.4-1.

If the Card upgrade and the host common download upgrade occurs simultaneously, the host device SHALL display the common download progress on the front panel.

Table 11.4-1 - Standard Boot Messages

State	Front Panel Display	Notes
boot	boot 	
OCAP Image download	Cd%% 	Front Panel Display should be Cd followed by digits representing the percentage complete of the image download starting at 00 ending at 99.
Card Image Download	 	Alternate “dnLd” and “CArd”
OCAP Stack Init	OCAP 	
XAIT Init	Ait 	To be displayed when the host is in the process of acquiring XAIT after having initialized the OCAP stack.
Initial Monitor App Launch	APP 	The host MUST clear the front panel display after initial Monitor app calls the method MonitorConfiguringSignal().

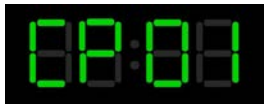
11.4.2 Critical Error Messages

Critical Errors are those of a nature that prevents cable service from being provided to the device.

If the OCS2.1 supports [OCAP-FP], it SHALL display the critical error messages to the front panel LED display as defined in Table 11.4-2.

Table 11.4-2 - Critical Error Messages

Error State	Front Panel Display	Comments
Low-level software/firmware errors, hard disk drive errors, OS init errors	Exxx 	xxx = Mfr-specific error code
CCIF Init Error	CCer 	er = item number from [CCIF] Table B-1 Error Handling. The Host reports that subset of interface initialization errors of which it can detect and has knowledge of, and within this class only those that represent critical errors that would prevent cable services from being provided to the device.

Error State	Front Panel Display	Comments
Cablecard and Host not bound.	noCA 	To be displayed until mutual authentication binding is completed, as defined in [CCCP] Section 4.1.
Host not Authorized	noCP 	To be displayed after noCA until Card Validation Status Reply Message is received with a Status_field = 0x06 (Validated), as defined in [CCCP] Section 11.8.
Not bound for Card reasons 0x01	CP01 	To be displayed when the ***CP_valid_cnf()*** APDU is received with a status field = 0x01, as defined in [CCCP] Section 11.8.
Not bound, Host Certificate Invalid 0x02	CP02 	To be displayed when the ***CP_valid_cnf()*** APDU is received with a status field = 0x02, as defined in [CCCP] Section 11.8.
Not bound, failed to verify Host's SIGNH 0x03	CP03 	To be displayed when the ***CP_valid_cnf()*** APDU is received with a status field = 0x03, as defined in [CCCP] Section 11.8.
Not bound, failed to match AuthKey from Host 0x04	CP04 	To be displayed when the ***CP_valid_cnf()*** APDU is received with a status field = 0x04, as defined in [CCCP] Section 11.8.
Binding Failed, other reasons 0x05	CP05 	To be displayed when the ***CP_valid_cnf()*** APDU is received with a status field = 0x05, as defined in [CCCP] Section 11.8.
Not Validated, validation revoked 0x08	CP08 	To be displayed when the ***CP_valid_cnf()*** APDU is received with a status field = 0x08, as defined in [CCCP] Section 11.8.
OCAP Middleware Startup Error	OCxx 	xx = Mfr-specific error code

11.4.3 Non-critical Error Messages

If the OCS2.1 supports [OCAP-FP], it SHALL display the Non-critical error messages to the front panel LED display as defined in Table 11.4-3.

The Non-critical error messages SHALL alternate with other front panel messages.

Table 11.4-3 - Non-critical Error Messages

Error State	Front Panel Display	Comments
Common Download CVT Error	ECVT 	The conditions under which this error is displayed include, but are not limited to, • CVT Invalid • CVT Damaged • CVT Mismatch - VendorID • CVT Mismatch - Hardware • CVT Mismatch - HostMACAddress • CVT Mismatch - HostID • CVT Mismatch - GroupID • CVT PKCS#7 validation failure This error condition may be removed after a vendor specific amount of time not less than one minute. If previous platform image is available, boot should continue.
CD Image Download Error	Edxx 	xx = According to Table 11.4-4 This error condition may be removed after a vendor-specific amount of time not less than one minute. If previous platform image is available, boot should continue.
Error Reading XAIT	EAxx 	xx = Mfr-specific error code The XAIT Error Message should continue to be displayed until a XAIT is successfully processed. Video out error message SHALL be displayed for 30 seconds then WatchTV module must start.
Error on Start of Initial Monitor App	IAxx 	xx = Mfr-specific error code Watch TV module must start.

Table 11.4-4 - Error Codes

Error Code	Condition	Comments
Ed02 - Ed25	CVC and image authentication failures	These error conditions correspond to existing error codes defined for MIB object ocStbHostFirmwareDownloadFailedStatus MIB in [HOST-MIB] and codes defined in Table 11.1-1.
Ed26	File not found	
Ed27	Server not available	
Ed90	Downloaded image is corrupt	This error corresponds to the imageCorrupted condition reported by MIB object ocStbHostFirmwareImageStatus.
Ed91	Exhausted maximum number of reboot retries	This error corresponds to the imageMaxRebootRetry condition reported by MIB object ocStbHostFirmwareImageStatus.

Error Code	Condition	Comments
Ed98	General code download failure.	This error corresponds to the imageMaxDownloadRetry condition reported by MIB object ocStbFirmwareImageStatus or any other failure conditions not represented by other defined codes.

11.4.4 General Requirements

If the OCS2.1 supports [OCAP-FP], it SHALL implement the following requirements with respect to front panel diagnostics:

The OCS2.1 SHALL alternate the front panel display between the required Non-Critical error code and all other required front panel display messages.

The OCS2.1 SHALL alternate the front panel display between the required Non-Critical error code and any application messages that are written via the OCAP front panel extension API.

When alternating an error message on the front panel display, the OCS2.1 SHALL display each message for 10 seconds, then cycle to the alternate message.

The OCS2.1 SHALL continue to display all error messages until the error condition is cleared.

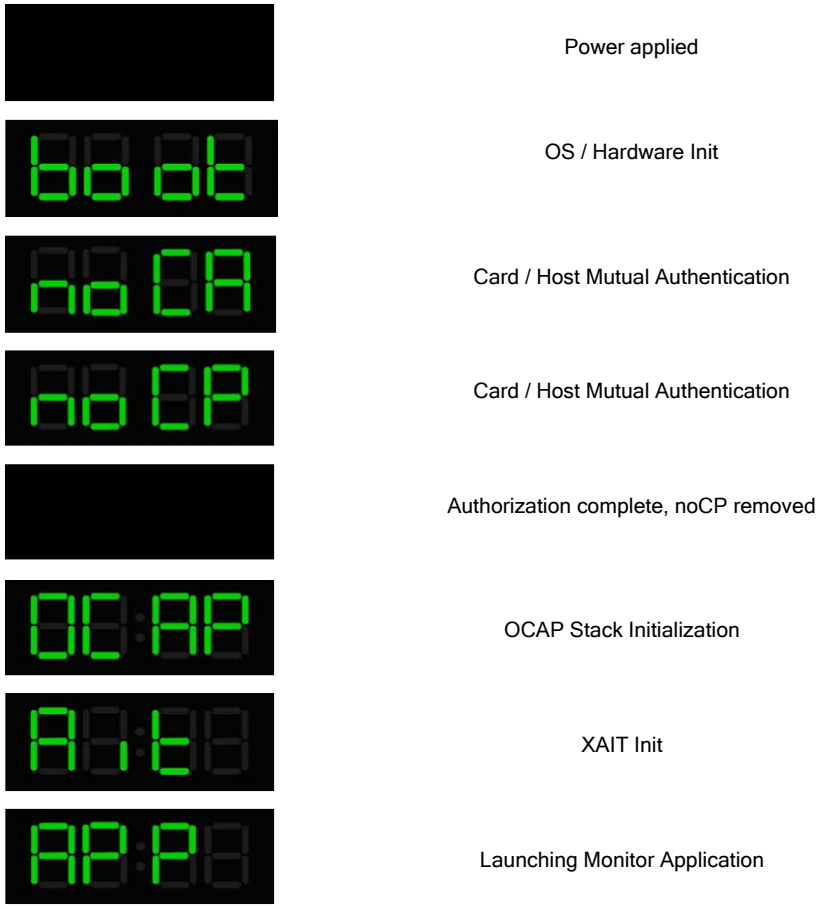


Figure 11.4-1 - Normal Boot Sequence

Figure 11.4-2 - Boot Sequence - OCAP Image Download

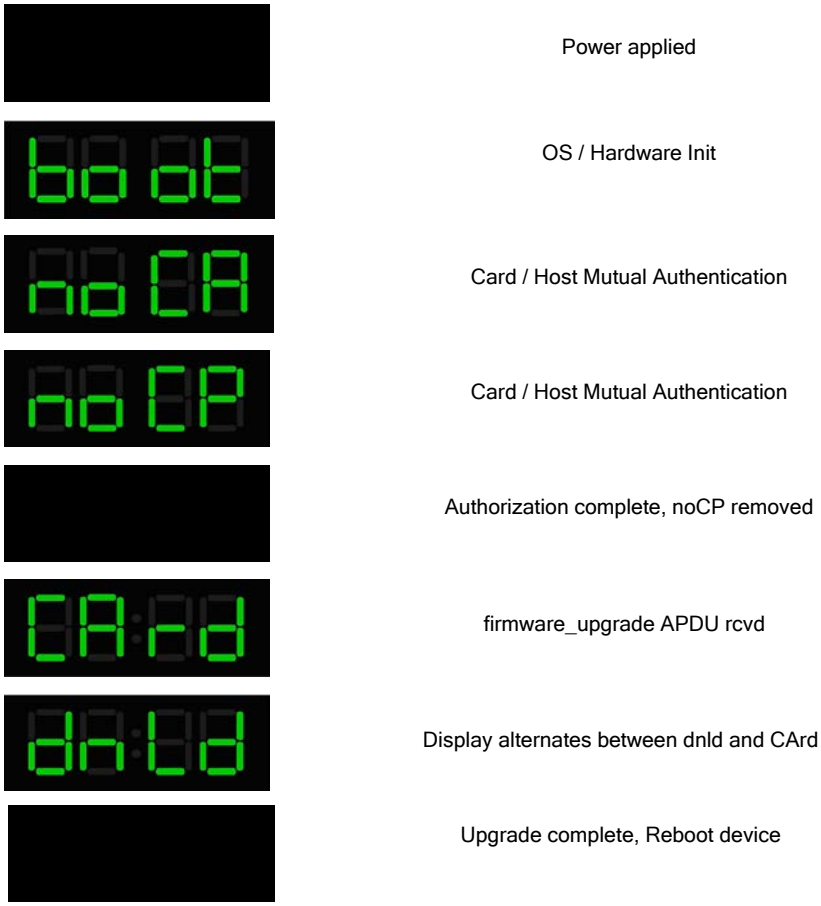


Figure 11.4-3 - Boot Sequence - Card Firmware Upgrade

11.5 Panic Dump Diagnostics

The OCHD2.1 may generate a Panic Dump file as a result of a serious error. The OCHD2.1 supports SNMP Notification using SNMPv2c Trap messages to signal one or more headends when a new dump file is available for transfer. After receiving a "panic dump" Notification, a headend may initiate a binary TFTP session with the OCHD2.1 to transfer the file. Parameters affecting the dump file delivery mechanism are controlled by MIB objects in [HOST-MIB].

The dump file header format is defined in this document. However, the dump file content and format, the triggering event(s), and recovery procedures are vendor-specific and outside the scope of this document.

The steps to enable a Panic Dump file transfer follow.

1. The OCHD2.1 SNMP Notification tables must be configured during initialization using one or more TLV38s. These tables define one or more authorized receivers and Notification PDU requirements (e.g., SNMPv2-Trap-PDU) for each receiver.
2. The Trap Notification is enabled by setting the OCHD2.1 MIB object, ocStbHostDumpEventCount, to a positive integer value. Because the default value of ocStbHostDumpEventCount is 0, this MIB object must be set via an SNMP Varbind in the eCM configuration file (TLV11) or by an explicit SNMP SET command. Note that the object ocStbHostDumpEventCount is persistent through reboots. The ocStbHostDumpEventCount is decremented by one each time a dump triggering event occurs until the count reaches zero. If the

ocStbHostDumpEventCount value is greater than zero, the OCHD2.1 must send a SNMPv2-Trap-PDU to a Notification Receiver. Depending upon how the eSTB SNMP Agent is configured, additional SNMP traps or informs may be sent to other Notification receivers, with the caveat that only one Notification is sent per event to each defined receiver. It is incumbent on the system administrator to configure the eSTB SNMP Agent to send notifications in the correct format to the correct destination.

3. The MIB object ocStbHostDumpEventTimeout controls when recovery procedures will commence. When a dump file is generated, the OCHD2.1 informs the SNMP NMS of the event, and then sets a timer for ocStbHostDumpEventTimeout seconds. The OCHD2.1 must initiate recovery procedures when the timer expires, even if a dump transfer is in progress. For that reason, it is important to set the timer value large enough to process both the notifications and the dump file transfer. If the dump file transfer completes before the timer expires, the OCHD2.1 may cancel the timer and immediately initiate recovery. The disposition of the dump file after the timer expiration is manufacturer defined (e.g., deleted).
4. The notification and file transfer mechanism may be tested ad hoc by setting the MIB object ocStbHostDumpNow to 1. This forces the generation of a dump file and the subsequent notification process by the eSTB SNMP Agent.

Figure 11.5-1 below depicts the panic dump process.

Figure 11.5-1 - SDL Diagram of Panic Dump Process

If the MIB object ocStbHostDumpEventCount value is greater than zero, and the panic dump triggering event occurs, the OCHD2.1 SHALL generate an SNMPv2-Trap-PDU.

The OCHD2.1 SHALL include the panic dump file path/filename in the Notification-PDU.

The OCHD2.1 SHALL generate only one SNMP Notification for each panic dump triggering event for each eligible SNMP Notification Receiver.

The OCHD2.1 SHALL store the value of the ocStbHostDumpEventCount object in non-volatile memory and restore it after an OCHD2.1 initialization. The value may be overridden by a TLV11 varbind in the eCM configuration file.

The OCHD2.1 SHALL decrement the ocStbHostDumpEventCount object value by 1 when a triggering event occurs.

If the MIB object ocStbHostDumpEventCount value is zero and the panic dump triggering event occurs, the OCHD2.1 SHALL immediately enter the manufacturer-defined recovery.

The OCHD2.1 SHALL transmit the dump file only when it receives a TFTP "Get" from the headend.

The OCHD2.1 SHALL create a filename for the dump consisting of:

<Host MAC Address><date><local time>.dmp
where date is ddmmyy
and time is seconds past midnight
e.g., 00012345678907090819800.dmp
MAC = 00-01-23-45-67-89
Date = July 9, 2008
Time = 5:30 AM

The OCHD2.1 SHALL construct the contents of the dump file according to Table 11.5-1.

Table 11.5-1 - Dump File Format (Version 2)

Header	Bytes	Max	Comment
Protocol Header Type	1	0xFF	0x01 - This is a dump from a Panic Dump.
Protocol Version	1	0xFF	0x02 - This is the second version of this protocol.
Reset Delay	1	0xFF	Default value = 5. Value may never be set to 0.
MAC Address	6		CableCARD MAC Address.
Platform Identifier Length	1		Length of the Platform Identifier field.
Platform Identifier	N		The sysDescr object as reported in the Host MIB.
Time Stamp	8		TimeStamp class represents the Network Time Protocol (NTP) timestamp as defined in [RFC 1305] and SNTP [RFC 2030]. It is represented as a 64-bit unsigned fixed-point number in seconds relative to 0-hour on 1-January-1900. The 32-bit low-order bits are the fractional seconds whose precision is about 200 picoseconds. Assumes overflow date when date passes MAX_LONG and reverts back to 0 is 2036 and not 1900. Test for most significant bit: if MSB=0, then 2036 basis is used; otherwise, 1900 if MSB=1.

Header	Bytes	Max	Comment
Message Type	1	0x02	Message Type - defines this message type. 0x01 = host binary dump due to a trigger flag asserting. 0x02 = forced host binary dump triggered by SNMP.
Free RAM	4		Amount of unused random access memory available (bytes).
Allocated RAM	4		Amount of used random access memory (bytes).
Largest Free Block	4		Largest contiguous block of unallocated memory (bytes).
JVM Heap Size	4		Size of the sum of all Java Virtual Machine Heaps (bytes).
Message Length	4		Length of this file - Limited to128K for DAVIC systems, 512K bytes for DOCSIS systems.
Message Body	M		Message Data - Binary, vendor-specific data to aid in debugging the reason for this message.
CRC32	4		CCIT CRC-32 check number for all above data.

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.
10a.	Line Surge Test	UL 1449 Measured Limiting Voltage test Duty Cycle Test Abnormal Over Voltage Tests.

	Parameter	Requirement
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)*
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)*

	Parameter	Requirement
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 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.

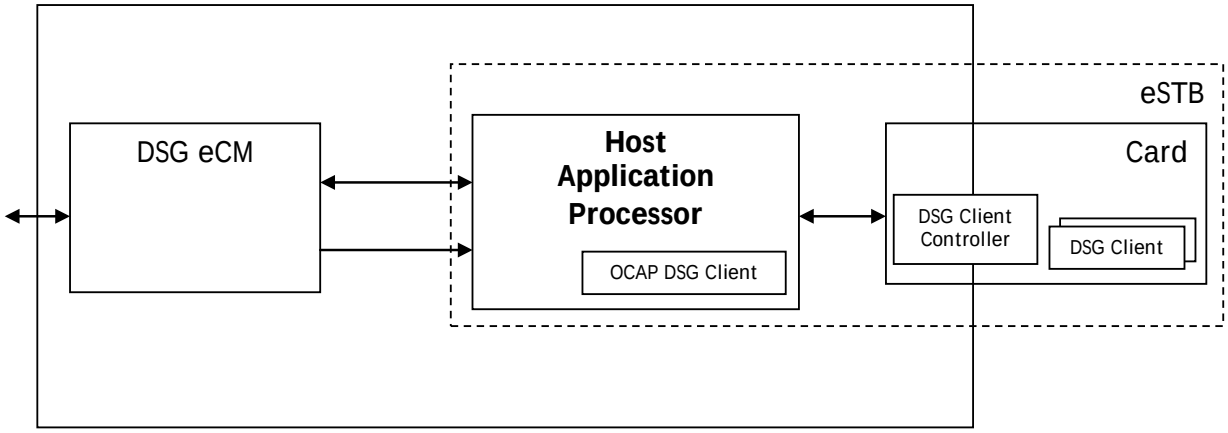


Figure 13-1 - Host 2.1 DSG architecture

In Advanced DSG mode, SCTE 65 SI messages, SCTE 18 EAS messages, CVTs, and OCAP XAITs 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 Advanced DSG Mode, the return path is through the DOCSIS upstream channel. In Advanced DSG one-way mode, the DOCSIS return path is not present or has been disabled. If the OCHD2.1 is acting as a Set-top Extender Bridge (SEB) Client as per [DSG], then the return path is through the DOCSIS upstream channel of the SEB Server via the home network interface.

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, 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 eCM in the OCHD2.1 SHALL be implemented according to [RFIv2.0] for DOCSIS 2.0 implementations or [MULPIv3.0] for DOCSIS 3.0 implementations, and support IPv6 according to [IPv6].

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 support 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. 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. 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 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:

1. 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.
2. 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.
3. 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.

After the OCHD2.1 issues the ***DSG_message()*** APDU with message_type 0x03 (Downstream_Scan_Completed), it SHALL immediately initiate another downstream scan.

4. 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.

5. 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), with the value of UCID set to 255.

   When the OCHD2.1 supports SEB per [DSG], it SHALL comply with the following:

   The OCHD2.1 SHALL initiate the DSG Set-top Extender Bridge (SEB) operation attempting to become a DSG SEB Server if it completes DOCSIS registration,

   If the OCHD2.1 fails to complete DOCSIS registration, it SHALL initiate SEB Client operation and attempt to locate a SEB Server before notifying the Card that it has transitioned to one-way mode.

   If the OCHD2.1 locates an SEB Server and has acquired the IP address mode and UCID from the Server, it SHALL indicate 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 SHALL notify the Card of DOCSIS registration failure by sending DSG_message() indicating Entering_One-Way_mode only after it has failed to locate an SEB Server.

   When operating as an SEB Client, the OCHD2.1 disables all upstream transmissions and only utilizes its eCM to acquire downstream DSG tunnels. All other IP data is received via the home network by way of the SEB Server. The SEB Client is required to discard all packets received on the eCM, except DSG downstream tunnel requested by the Card and DSG Clients resident on the OCHD2.1.

   The OCHD2.1 SHALL remain operating as an SEB Client as long as it is able to communicate with the SEB Server, until such time as it loses communication with the SEB Server and is not able to discover another Server.

   The OCHD2.1 SHALL initiate DOCSIS registration if it is no longer able to communicate with an SEB Server.

   The OCHD2.1 SHALL terminate SEB Client functionality and disconnect from an SEB Server if the eCM re-establishes 2-way communication as a result of Tdsg3 retry.

6. 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.

7. 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.

8. 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, detects an eCM MAC layer reinitialization, or after a change to the Primary Downstream Channel.. The DCD message is defined in [DSG].

9. 10. 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.

11. 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.

12. 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].

13. 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.

    When operating as an SEB Client, the OCHD2.1 SHALL send the ***DSG_message()*** APDU with message type of Dynamic Channel Change (Depart), including the applicable init_type value, whenever the state of the DynamicChannelChange variable of the SEB Server changes to a value of 0x00 thru 0x05.

    The OCHD2.1 SHALL send the ***DSG_message()*** APDU with the message type of 2-way OK, UCID, whenever the state of the DynamicChannelChange variable of the SEB Server changes to a value of 0xFF and it had previously sent a ***DSG_message()*** APDU indicating a Dynamic Channel Change as per above.

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

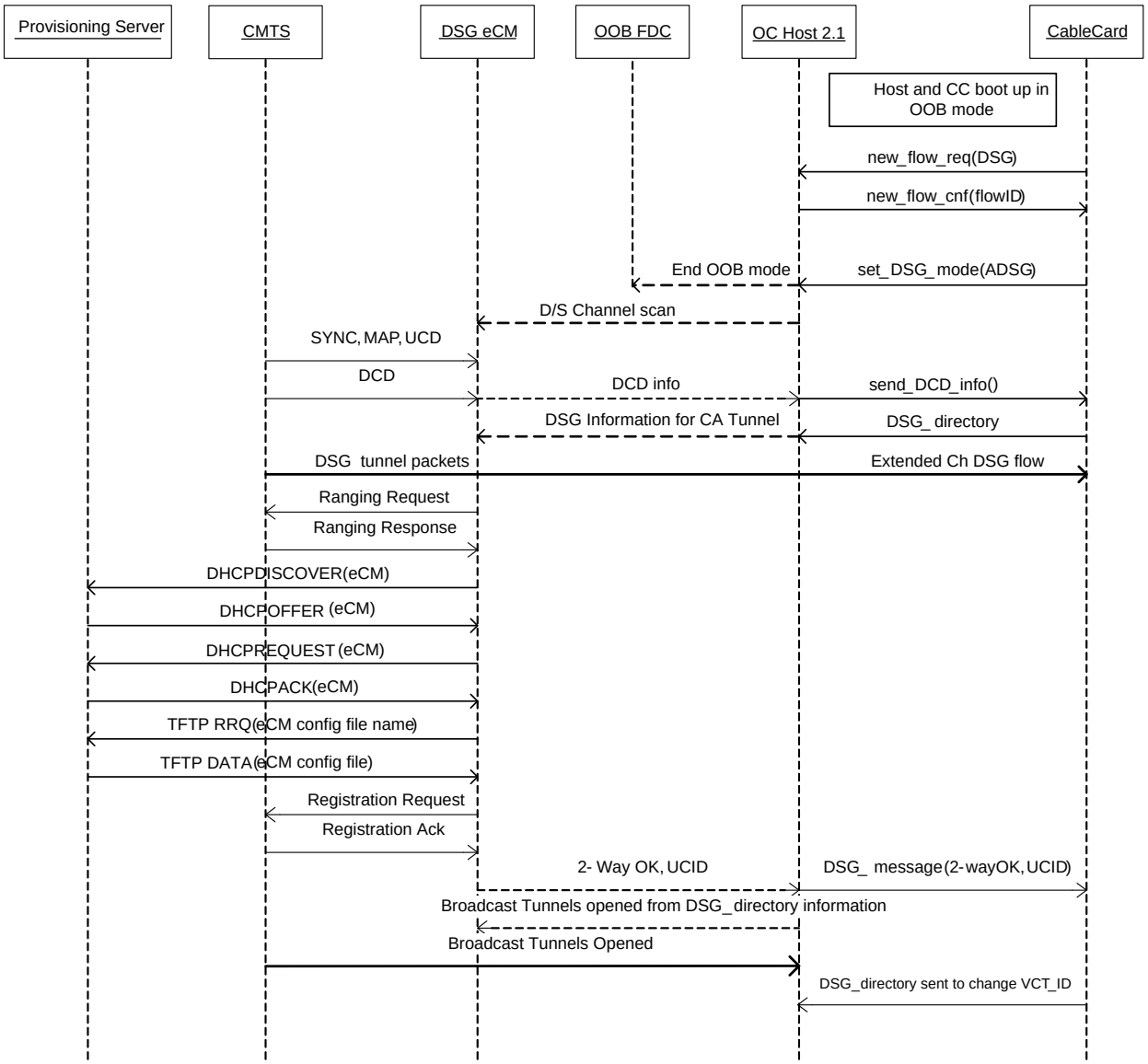


Figure 13.2-1 - Sample Advanced Mode Message Flow (Informative)

13.3 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".

13.4 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.
2. 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.
3. 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).
4. 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.
5. The OCHD2.1 forwards the DSG Application tunnel data to the OCAP application associated with the application_id of the DSG tunnel.

13.5 IP Unicast and Multicast Flows

This section describes the interaction between the OCHD2.1 and Card when the OCHD2.1 requires two-way IPv4 communication that utilizes an IP Unicast and/or IP Multicast flow that traverses the Card/Host Interface.

This section does not apply to Socket flows, to OCHD2.1s operating in IPv6 mode, or to OCHD2.1s operating in DSG mode.

An IP Unicast or IP Multicast flow is only supported when the device acting as the modem is provisioned with an IPv4 address. IP Unicast and IP Multicast flows are not supported when the modem device is provisioned with an IPv6 address. When IPv6 addressing is utilized, Extended Channel Socket Flows must be used.

The Extended Channel supports delivery of IPv4 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 IPv4 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 IPv4 address for use by the OCHD2.1. The IPv4 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 IPv4 packets received to the assigned OCHD2.1 IPv4 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 IPv4 unicast data received from the OCHD2.1 is transmitted to the network if physically possible.

When in QPSK mode, the Card may send broadcast IPv4 data to the OCHD2.1, and the Card may receive broadcast IPv4 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 IPv4 data to the multicast IPv4 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.

When in QPSK mode, the Card is the network interface and modem. If the OCHD2.1 requests an IPv4 address, the Card provides an IPv4 address based on the vendor's proprietary mechanisms. This may be accomplished with DHCP.

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.

13.6 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 a socket for TCP, 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, except when operating as an SEB Client, in which case it forwards data to the home network 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.

The OCHD2.1 SHALL NOT forward inbound UDP packets where the Source IP Address of the packet does not match the remote IP address specified when creating the Socket Flow.

The OCHD2.1 MAY filter inbound UDP packets by discarding packets whose Source UDP port does not match the remote port specified when creating the Socket Flow.

The OCHD2.1 SHALL forward inbound UDP packets that satisfy the following conditions: the packet's Source IP Address matches the remote IP address specified when the Socket Flow was created, the packet's Source UDP Port matches the remote port specified when the Socket Flow was created, and the packet's Destination UDP Port matches the local port specified when the Socket Flow was created.

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, except when operating as a SEB Client, in which case it forwards data to the Card that been received via the home network interface.

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, or the home network interface when operating as a SEB Client.

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).

13.7 IP Address Acquisition

This section describes how the eSTB will acquire and renew its IP addresses.

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 initiate the IP Address Acquisition process described in Figure 13.7-1 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 will send the ***DSG_message()*** APDU "eCM cannot forward 2-Way traffic" when forwarding restrictions are present. See [MULPIv3.0] for detailed information on DOCSIS provisioning that will result in forwarding restrictions.

The eSTB will determine the desired provisioning mode as described in Section 15.2.6. Based on the desired provisioning mode, the eSTB will attempt to acquire a global IPv4 address, IPv6 address, or both on the eSTB WAN-facing interface.

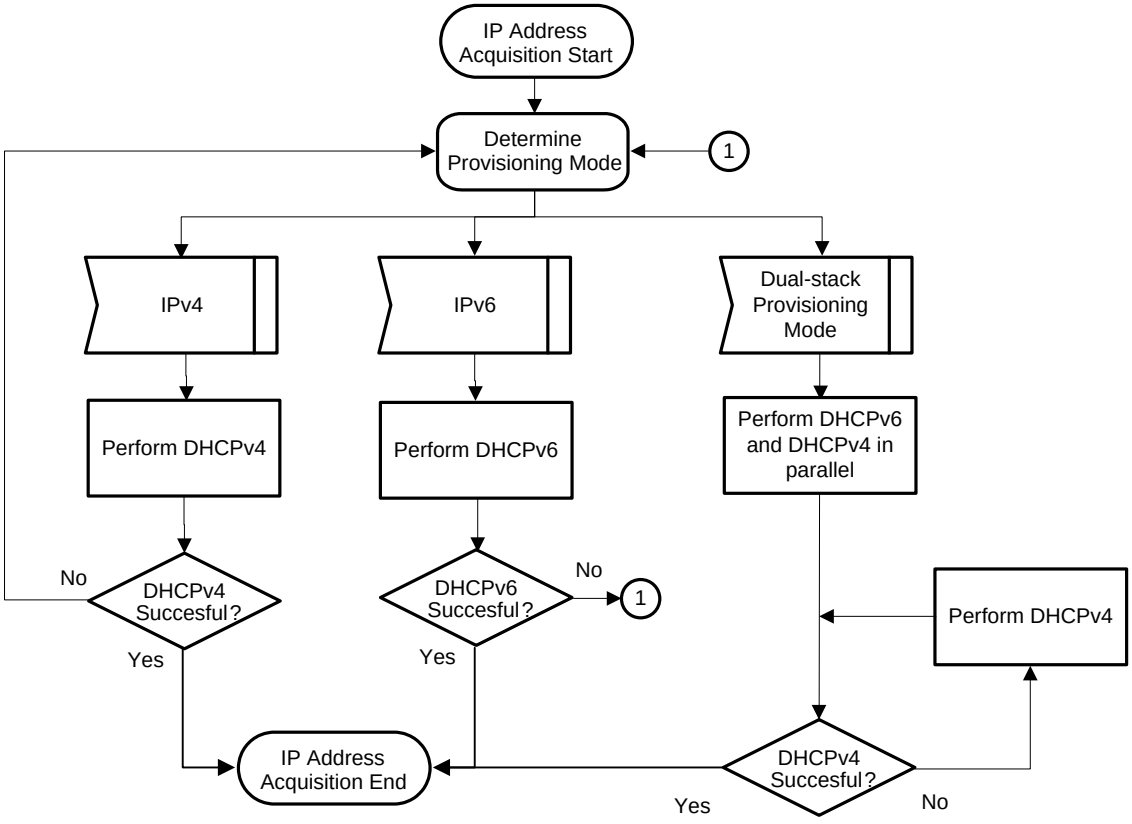


Figure 13.7-1 - Overview of IP Address Acquisition Process

The detailed requirements for each provisioning mode are specified in the remainder of this section.

An OCHD2.1 that supports DSG SEB, as defined in [DSG], utilizes link-local IP address assignment, as defined in [RFC 3927], to discover and initiate communications prior to acquiring an IP address via DHCP.

If an OCHD2.1 supports SEB, fails DOCSIS registration, and has an active home network interface, then it SHALL provision itself with a link-local address as defined in [RFC 3927], prior to initiating any DHCP transactions.

If an OCHD2.1 supports SEB, completes DOCSIS registration, and has an active home network interface, it SHALL provision itself with a link-local address as defined in [RFC 3927], to be utilized on the home network interface for SEB transactions.

When operating as an SEB Client, the OCHD2.1 SHALL initiate all DHCP transactions over the home network interface.

When operating as an SEB Server, the OCHD2.1 SHALL forward DHCP messages received on its home network interface, from a known SEB Client, to its eCM.

The OCHD2.1 SHALL forward DHCP messages received on its eCM interface, destined for known SEB Clients, to its home network interface.

13.7.1 IPv4 Address Acquisition

This section describes how an OCHD2.1 operating in IPv4 acquires and renews its IPv4 addresses.

13.7.1.1 eSTB IPv4 Address Acquisition

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

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 13.7-2.

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 13.7-2.

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 13.7-2.

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.

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 DHCP field required within the DHCPOFFER/DHCPACK message it receives from the DHCP server during initial IP address lease acquisition, other than *yiaddr* and appropriate Server Identifier values, is missing or is invalid in the DHCPACK message during a DHCP Renew or Rebind, the OCHD2.1, when operating as an SEB Client, 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).

If any of the following DHCP fields 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].

- Yiaddr

- Subnet Mask, Option 1
- Router, Option 3
- Lease time, Option 51
- Server Identifier, Option 54

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 following DHCP fields within the DHCPACK message it receives from the DHCP server during a DHCP Renew or Rebind.

- Yiaddr
- Subnet Mask, Option 1
- Router, Option 3
- Lease time, Option 51
- Server Identifier, Option 54

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 of the following DHCP fields, 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.

- Subnet Mask, Option 1
- Router, Option 3
- Lease time, Option 51
- Server Identifier, Option 54

An example of an invalid field would be an option that is syntactically malformed (e.g., with an incorrect option length).

The eSTB SHOULD also implement a different retransmission strategy for the RENEWING and REBINDING states, as recommended in [RFC 2131], which is based on one-half of the remaining lease time.

The eSTB SHALL limit the number of retransmissions to five or fewer for the DHCPDISCOVER and DHCPREQUEST messages.

[RFC 3203] describes an extension to DHCPv4 that allows a DHCP server to send a FORCERENEW message that forces a client to renew its lease.

The eSTB SHALL ignore all received FORCERENEW messages.

The backoff values for retransmission of DHCPDISCOVER messages SHOULD be chosen according to a uniform distribution between the minimum and maximum values in the rows of Table 13.7-1.

Table 13.7-1 - DHCP Backoff Distribution Values

Backoff Number	Minimum (sec.)	Maximum (sec.)
1	3	5
2	7	9
3	15	17
4	31	33
5	63	65

Table 13.7-2 - 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
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

13.7.1.2 IPv4 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.

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

When operating as an SEB Client, if the OCHD2.1 receives a UPnP ByeBye from the SEB Server and then reconnects with an SEB Server (either the same or different one), it SHALL confirm the eSTB IP address lease by entering the INIT-REBOOT state for the lease as defined in [RFC 2131].

In addition to the requirements above, all other aspects of eSTB and Card IPv4 address lease expiration SHALL be performed by the OCHD2.1 according to [RFC 2131].

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).

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

When operating as an SEB Client, if the OCHD2.1 detects that the SEB Server has left the network (e.g., UPnP ByeBye, the TCP connection to the SEB Tunnel is closed, etc.), is not able to complete DOCSIS registration, and is not able to locate another SEB Server, it SHALL notify the Card via the ***DSG_message()*** APDU with message_type = 0x02 (Entering_one_way_mode).

When either DOCSIS registration completes or another SEB Server is discovered, the OCHD2.1 SHALL enter the INIT-REBOOT state as defined in [RFC 2131], for the eSTB'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).

When operating as an SEB Server, if the OCHD2.1 has eCM forwarding restricted, the OCHD2.1 SHALL terminate SEB Server operation and notify the devices on the network via a UPnP ByeBye, as defined in [DSG].

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).

When operating as an SEB Server, if the OCHD2.1 detects that eCM forwarding restrictions have been removed, it SHALL attempt to re-establish itself as an SEB Server as defined in [DSG].

13.7.2 IPv6 Address Acquisition

This section describes how the OCHD2.1 operating in IPv6 mode will acquire and renew its IPv6 address.

13.7.2.1 eSTB IPv6 Address Acquisition

This section describes how the eSTB is provisioned with an IPv6 address and associated configuration parameters. The requirements in this section apply only to eSTBs that have been instructed to operate in IPv6 mode.

The eSTB's IPv6 address acquisition process includes the assignment of a link-local address, an IPv6 address, and other IPv6 configuration parameters. These steps are described in the following sub-sections.

13.7.2.1.1 Obtain Link-Local Address

The OCHD2.1 SHALL construct a link-local address for its eSTB according to the procedure in section 5.3 of [RFC 4862].

The OCHD2.1 SHALL use the Modified EUI-64 identifier based on its 48-bit MAC address for its eSTB's management interface as described in [RFC 4291].

After constructing the link-local address, the OCHD2.1 SHALL use Duplicate Address Detection (DAD), as described in section 5.4 of [RFC 4862], to confirm that the constructed link-local address is not already in use.

If the OCHD2.1 determines that the constructed link-local address is already in use, the OCHD2.1 SHALL consider that IPv6 address acquisition has failed and follow the procedures in section 5.4.5 of [RFC 4862].

There are security implications if services on the OCHD2.1 are accessible via the Link-Local IPv6 address, as the CMTS may not have the ability to selectively block Link-Local IPv6 traffic that is initiated from the premises of other subscribers.

The Link-Local IPv6 address is only used for IPv6 provisioning traffic to and from the CMTS during acquisition of the routable IPv6 address, and as such the operator will not need to send or receive any application traffic to the OCHD2.1 using its Link-Local IPv6 address. Therefore, this specification restricts the OCHD2.1 to not accept or transmit any IPv6 traffic using its Link-Local IPv6 address for any application other than IPv6 provisioning, Neighbor Discovery and MLDv1/MLDv2.

When the OCHD2.1 has been provisioned using IPv6, it SHALL NOT bind any services or applications to its Link-Local IPv6 address except those that support provisioning of the IPv6 stack, such as DHCPv6.

13.7.2.1.2 Obtain Default Routers

The OCHD2.1's eSTB SHALL perform router discovery as specified in [RFC 4861]. The eSTB identifies neighboring routers and default routers from the received Router Advertisements (RAs).

13.7.2.1.3 IPv6 Address and Other Configuration Parameters

The OCHD2.1 SHALL use DHCPv6 [RFC 3315] to acquire an IPv6 address and configuration information for its eSTB.

The OCHD2.1 SHALL support the Reconfigure Key Authentication Protocol as described in [RFC 3315],

The eSTB sends Solicit and Request messages, as described in sections 17.1.1 and 18.1.1, respectively, of [RFC 3315]. The Solicit and Request messages SHALL include the following:

A Client Identifier option (OPTION_CLIENT_ID) containing the DUID for this eSTB. The DUID SHALL be based on the eSTB's link layer address as described in section 9.4 of [RFC 3315].

An IA_NA option (OPTION_IA_NA) to obtain its IPv6 address.

A Reconfigure Accept option (OPTION_RECONF_ACCEPT) to indicate the eSTB is willing to accept Reconfigure messages.

An Options Request option (OPTION_ORO) requesting the following options:

Domain list option (OPTION_DOMAIN_LIST) as defined in [RFC 3646]

DNS Recursive Name Server (OPTION_DNS_SERVERS) as defined in [RFC 3646]

A Vendor Class option (OPTION_VENDOR_CLASS) containing 32-bit number 4491 (the Cable Television Laboratories, Inc. enterprise number) and the string "OpenCable2.1".

A Vendor Specific Information option (OPTION_VENDOR_OPTS) as defined in section 22.17 of [RFC 3315] containing the options in the following table. The enterprise-number field must be set to CableLabs' enterprise number: 4491. The option codes come from [CANN-DHCP].

Table 13.7-3 - Vendor Specific Information Options

Option code	Value	Description
2	"ESTB"	Device Type(CL_OPTION_DEVICE_TYPE)

Option code	Value	Description
3	“ECM:ESTB”	"ECM:ESTB" = An Embedded STB(CL_OPTION_EMBEDDED_COMPONENTS_LIST)
4	"<device serial number>"	Device serial number e.g., "123456" (CL_OPTION_DEVICE_SERIAL_NUMBER)
5	"<Hardware version>"	Hardware version number. Identical to value as reported in the <Hardware version> field in the MIB object sysDescr. e.g., "v.3.2.1"(CL_OPTION_HARDWARE_VERSION_NUMBER)
6	"<Software version>"	Software version number. Identical to value as reported in the <Software version> field in the MIB object sysDescr. e.g., "v.1.0.2"(CL_OPTION_SOFTWARE_VERSION_NUMBER)
7	"<Boot ROM version>"	Boot ROM version. Identical to value as reported in the <Boot ROM version> field in the MIB object sysDescr. e.g., "Bv4.5.6"(CL_OPTION_BOOT_ROM_VERSION)
8	"<OUI>"	A 6-octet, hexadecimal-encoded, vendor-specific Organization Unique Identifier (OUI) that may match the OUI in the eCM's MAC address.(CL_OPTION_VENDOR_OUI)
9	"<Model number>"	Device model number. Identical to value as reported in the <Model number> field in MIB object sysDescr. e.g., "T3000"(CL_OPTION_MODEL_NUMBER)
10	"<Vendor name>"	Vendor name or ID. Identical to value as reported in the <Vendor name> field in the MIB object sysDescr. e.g., "XYZ Corp"(CL_OPTION_VENDOR_NAME)
36	“<MAC Address>”	MAC Address(CL_OPTION_DEVICE_ID)

A Rapid Commit option (OPTION_RAPID_COMMIT) indicating that the eSTB is willing to perform a 2-message DHCPv6 message exchange with the server.

The eSTB SHALL use the following values for retransmission of the Solicit message (see section 14 of [RFC 3315] for details):

IRT (Initial Retransmission Time) = SOL_TIMEOUT

MRT (Maximum Retransmission Time) = SOL_MAX_RT

MRC (Maximum Retransmission Count) = 4

MRD (Maximum Retransmission Duration) = 0

If the MRC value is exceeded before the eSTB receives a Reply from a DHCP server, the OCHD2.1 SHALL consider IPv6 provisioning to have failed.

The DHCPv6 server may be configured to use a 2 message Rapid Commit sequence. The DHCP server and eSTB follow [RFC 3315] in the optional use of the Rapid Commit message exchange.

The DHCP server responds to Solicit messages and Request messages with Advertise and Reply messages (depending on the use of Rapid Commit). The Advertise and Reply messages may include other configuration parameters, as requested by the eSTB, or as configured by the administrator to be sent to the eSTB.

13.7.3 IPv6 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.

If the OCHD2.1 detects an eCM MAC layer re-initialization, temporarily added and then removed eCM forwarding restrictions or transition from one-way to two-way state, it SHALL confirm the eSTB IPv6 address lease by sending a Confirm message as defined in [RFC 2131] after receiving the 2_Way OK indication from the eCM.

The OCHD2.1 SHALL NOT use its eSTB IPv6 address until it receives a Response message from the DHCP server confirming its address.

If the OCHD2.1 does not receive a response to the Confirm message before the message transmission process terminates, the OCHD2.1 SHALL restart its DHCP process by sending a Solicit message.

All other aspects of IPv6 address lease expiration SHALL be performed by the OCHD2.1 according to [RFC 2131].

When operating as an SEB Client, if the OCHD2.1 detects a loss of and then reacquisition of an SEB Server, it SHALL confirm the eSTB IPv6 address lease by sending a Confirm message as defined in [RFC 2131] after receiving the IP address mode, with a value of IPv6, from the DSG SEB Server.

13.7.4 Dual-stack Provisioning Mode (DPM)

The requirements in this sub-section only apply to the WAN-facing interface (ifIndex 1).

In Dual-stack Provisioning Mode (DPM), the eSTB attempts to acquire both IPv6 and IPv4 addresses and parameters through DHCPv6 and DHCPv4 [RFC 2131], [RFC 3315].

When the eSTB is configured for DPM, its DHCPv4 and DHCPv6 clients operate independently. For example, the lease times for the IPv4 and IPv6 addresses may be different, and the DHCP clients need not attempt to extend the leases on the IP addresses simultaneously.

If the eSTB is directed through TLV (Type 1) to operate in DPM, it SHALL perform IPv6 network connectivity as specified in Section 13.7.2.

The eSTB SHALL also perform IPv4 network connectivity as specified in Section 13.7.1.

The IPv4 and IPv6 address acquisition processes SHALL start no more than 5 seconds apart.

If provisioning of any one address family fails, the eSTB SHALL maintain operation as along as the acquisition of at least one address family is successful.

It is desirable for the eSTB to notify the DHCP server before an SNMP-initiated reset or other type of reset. Under these circumstances, the eSTB will release the IPv4 address, IPv6 address, or both depending on the current IP provisioning mode TLV (Type 1).

An eSTB with an unexpired IPv4 address SHALL send a DHCPRELEASE message as described in [RFC 2131] immediately prior to acting upon any reset event.

An eSTB with an unexpired IPv6 address SHALL send a RELEASE message as described in [RFC 3315] immediately prior to acting upon any reset event.

Note: A reset event is caused by a write to the ocStbHostRebootReset MIB object, the Host Reset Vector, or through an OCAP API.

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 [HOST-MIB]), 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 [HOST-MIB]. 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].

When operating as an SEB Client, the OCHD2.1 SHALL only support the MIB objects applicable for the eSTB, as defined in Section 14, with the following exceptions:

The OCHD2.1 SHALL respond to SNMP GET and SET messages addressed to the eSTB that are targeted to the DSG MIB [DSG].

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 Annex A of [HOST-MIB].

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] for DOCSIS 2.0 implementations or [OSSIv3.0] for DOCSIS 3.0 implementations, 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 [HOST-MIB].

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 [HOST-MIB] 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

MIB Object	OCHD2.1	Card
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)
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 1 above is the eSTB interface of an SEB Client connected to the SEB Server’s eCM interface ifIndex 17 [eDOCSIS] via proxy of the home network interface. Packets leaving the SEB Server’s eCM interface 17 arrive at SEB Client's 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.

ifIndex 2 above is the Card's interface of an SEB Client connected to the SEB Server’s eCM interface ifIndex 17 [eDOCSIS] via proxy of the home network interface. Packets leaving the SEB Server’s eCM interface 17 arrive at SEB Client's Card interface 2 and vice versa. ifIndex 2 is only applicable when the Card has opened a Unicast IP Flow.

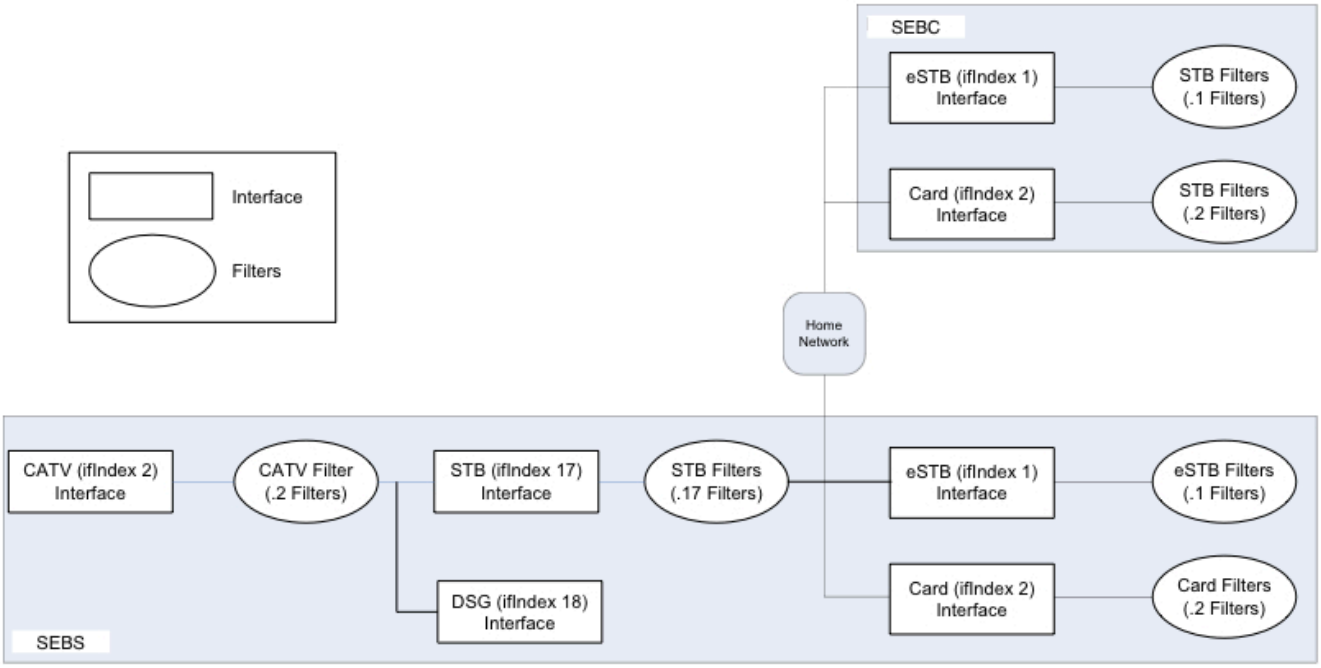


Figure 14.3-1 - SEB Interface Implementation (Informative)

*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 MAY 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 [HOST-MIB] 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	
ipNetToPhysicalIfIndex	ifIndex = 1	
ipNetToPhysicalNetAddressType	ipv4, ipv6	
ipNetToPhysicalNetAddress	IPv4 or IPv6 Address, if acquired; otherwise 0.0.0.0	
ipNetToPhysicalPhysAddress	STB Host MAC Address	
ipNetToPhysicalLastUpdated	sysUptime value from last update	
ipNetToPhysicalType	local(5)	
ipNetToPhysicalState	For IPv4: unknown(6)	
ipNetToPhysicalRowStatus	active(1)	

The OCHD2.1 SHALL implement the MIB table ipAddressTable defined in [RFC 4293] to report all IP addresses associated with the two-way IP OCHD2.1 interface as defined in Annex A of [HOST-MIB] using the ifIndex values defined in Table 14.3-3.

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 [HOST-MIB].

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 Annex A and log those events in the SNMP MIB Table docsDevEventTable (see Annex A of [HOST-MIB]).

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.

Note: The permissible BIT values for the docsDevEvReporting object [RFC 2669] have been superseded by [OSSIv2.0] as follows:

- local-nonvolatile(0)

- traps(1)
- syslog(2)
- local-volatile(3)

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 [HOST-MIB].

The OCHD2.1 SHALL include a row in the hrStorage table for each fixed-size logical RAM-backed memory segment except the JVM and video memory.

The hrStorageDescr object for each hrStorage row SHALL uniquely identify the storage described by the row.

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 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, it SHALL implement Table 14.4-1, which 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]
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]

Sub-TLVs	Variable Name	Associated MIB Object
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] IPv6: transportDomainUdpIpv6 [RFC 3419]
snmpTargetAddrTAddress (IP Address and UDP Port)	IPv4: SnmpUDPAddress [RFC 3417] OCTET STRING (6) Octets 1-4: <*TAddress*> Octets 5-6: <*TAddress*> IPv6: TransportAddressIPv6 [RFC 3419] OCTET STRING (18) Octets 1-16: <TAddress> Octets 17-18: <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

Column Name (* = Part of Index)	Column Value
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> IPv6: TransportAddressIPv6 [RFC 3419] OCTET STRING (18) Octets 1-16: <*TMask*> Octets 17-18: <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)

14.5 SNMPv3 Notification Receiver Configuration File TLV

This section specifies processing requirements for the SNMPv3 Notification Receiver TLV [MULPIv3.0] when present in the configuration file. The SNMPv3 Notification Receiver TLV is used to configure the Host2.1 SNMP agent with the SNMP entities eligible to receive SNMP Notification PDUs - both Inform and Trap. If the Host2.1 supports SNMPv1v2 Coexistence, Notification Receiver TLV(s) are used to populate the SNMPv3 tables for notification transmission. This section describes the tables and entries the OCHD2.1 will populate based on the SNMPv3 Notification Receiver TLV in order to cause the desired trap transmission:

- snmpNotifyTable
- snmpTargetAddrTable
- snmpTargetParamsTable
- snmpNotifyFilterProfileTable
- snmpNotifyFilterTable
- snmpCommunityTable
- usmUserTable
- vacmContextTable
- vacmSecurityToGroupTable
- vacmAccessTable
- vacmViewTreeFamilyTable

The mapping from the TLV to these tables is described in the following section.

14.5.1 Mapping of TLV fields into created SNMPv3 table rows

The following sections illustrate how the fields from the config file SNMPv3 Notification Receiver TLV elements are placed into the SNMPv3 tables. The TLV fields are shown below as:

Table 14.5-1 - SNMPv3 Notification Receiver TLV Mapping

Sub-TLVs	Variable Name	Associated MIB Object
SNMPv3 Notification Receiver IPv4 Address	*TAddress*	snmpTargetAddrTAddress [RFC 3413]
SNMPv3 Notification Receiver IPv6 Address	*TAddress*	snmpTargetAddrTAddress [RFC 3413]
SNMPv3 Notification Receiver UDP Port Number	*Port*	snmpTargetAddrTAddress [RFC 3413]
SNMPv3 Notification Receiver Trap Type	*TrapType*	see following sections
SNMPv3 Notification Receiver Timeout	*Timeout*	Future (SNMP Inform) snmpTargetAddrTimeout [RFC 3413]
SNMPv3 Notification Receiver Retries	*Retries*	Future (SNMP Inform) snmpTargetAddrRetryCount [RFC 3413]
SNMPv3 Notification Receiver Filtering Parameters	*FilterOID*	Optional
SNMPv3 Notification Receiver Security Name	*SecurityName*	Optional

The variable names from Table 14.5-1 are defined as follows:

<*TAddress*> A 32-bit IPv4 or IPv6 address of a notification receiver

<*Port*> A 16-bit UDP Port number on the notification receiver to receive the notifications

<*TrapType*> Defines the notification type

<*Timeout*> 16-bit timeout, in milliseconds to wait before sending a retry of an Inform Notification

<*Retries*> 16-bit number of times to retry an Inform after the first Inform transmission

<*FilterOID*> The OID of the snmpTrapOID value that is the root of the MIB subtree that defines all of the notifications to be sent to the Notification Receiver.

<*SecurityName*> The security name specified on the TLV element, or "@ STBnotifyconfig " if not specified.

Table 14.5-2 through Table 14.5-13 are shown in the order that the agent will search down through them when a notification is generated in order to determine to whom to send the notification, and how to fill out the contents of the notification packet.

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

The Community Name for traps in SNMPv1 and SNMPv2 packets is configured as "public". The Security Name in traps and informs in SNMPv3 packets where no security name has been specified is configured as "@STBnotifyconfig", in which case the security level is "noAuthNoPriv".

Several columnar objects are configured with a value beginning with the string "@STBnotifyconfig ". If these tables are configured through other mechanisms, network operators should not use values beginning with to avoid conflicts with the mapping process specified here.

14.5.1.1 snmpNotifyTable

The snmpNotifyTable is defined in the "Notification MIB Module" section of [RFC 3413].

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create two rows with fixed values if one or more SNMPv3 Notification Receiver TLV elements are present in the config file.

Table 14.5-2 - snmpNotifyTable

Column Name (* = Part of Index)	1st Row Column Value	2nd Row Column Value
* snmpNotifyName	"@STBnotifyconfig_inform"	"@STBnotifyconfig_trap"
snmpNotifyTag	"@STBnotifyconfig_inform"	"@STBnotifyconfig_trap"
snmpNotifyType	inform (2)	trap (1)
snmpNotifyStorageType	volatile (2)	volatile (2)
snmpNotifyRowStatus	active (1)	active (1)

14.5.1.2 snmpTargetAddrTable

The snmpTargetAddrTable is defined in the "Definitions" section of [RFC 3413].

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create one row in snmpTargetAddrTable for each SNMPv3 Notification Receiver Ipv4 Address encoding and SNMPv3 Notification Receiver IPv6 Address encoding of SNMPv3 Notification Receiver TLV in the config file.

Thus, two entries are created in this table if both SNMPv3 Notification Receiver IPv4 Address and SNMPv3 Notification Receiver IPv6 Address sub-TLVs are included in the same TLV. All other parameters are the same.

Table 14.5-3 - snmpTargetAddrTable

Column Name (* = Part of Index)	Column Value
* snmpTargetAddrName	"@STBnotifyconfig_n_IPv[4 | 6]" where n is 0..m-1 and m is the number of SNMPv3 Notification Receiver config file TLVs @STBnotifyconfig_n_IPv4 is for an entry created if SNMPv3 Notification Receiver config file TLV contains <TrapType> of TDomain SnmpUDPAddress @STBnotifyconfig_n_IPv6 is for an entry created if SNMPv3 Notification Receiver config file TLV contains <TrapType> of TDomain TransportAddressIPv6
snmpTargetAddrTDomain	IPv4: snmpUDPDomain [RFC 3417] IPv6: transportDomainUdpIpv6 [RFC 3419]
snmpTargetAddrTAddress (IP Address and UDP Port of the Notification Receiver)	IPv4: SnmpUDPAddress [RFC 3417] OCTET STRING (6) Octets 1-4: <*TAddress*> Octets 5-6: <*Port*> IPv6: TransportAddressIPv6 [RFC 3419] OCTET STRING (18) Octets 1-16: <*TAddress*> Octets 17-18: <*Port*>
snmpTargetAddrTimeout	<*Timeout*>
snmpTargetAddrRetryCount	<*Retries*>
snmpTargetAddrTagList	"@STBnotifyconfig_trap" if <*TrapType*> is 1, 2, or 4 "@STBnotifyconfig_inform" if <*TrapType*> is 3 or 5,
snmpTargetAddrParams	"@STBnotifyconfig_n"
snmpTargetAddrStorageType	volatile (2)
snmpTargetAddrRowStatus	active (1)

14.5.1.3 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 SNMPv3 Notification Receiver TLV in the config file.

Table 14.5-4 - snmpTargetAddrExtTable

Column Name (* = Part of Index)	Column Value
* snmpTargetAddrName	"@STBnotifyconfig_n_IPv[4 | 6]" where n is 0..m-1 and m is the number of SNMPv3 Notification Receiver config file TLVs (see Table 14.5-3 for details).
snmpTargetAddrTMask	<Zero-length OCTET STRING>
snmpTargetAddrMMS	SM Maximum Message Size

14.5.1.4 snmpTargetParamsTable

The snmpTargetParamsTable is defined in the "Definitions" section of [RFC 3413].

If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create one row in snmpTargetParamsTable for each SNMPv3 Notification Receiver TLV in the config file.

Table 14.5-5 - snmpTargetParamsTable

Column Name (* = Part of Index)	Column Value
* snmpTargetParamsName	"@STBnotifyconfig_n" where n is 0..m-1 and m is the number of SNMPv3 Notification Receiver config file TLVs
snmpTargetParamsMPModel SYNTAX: SnmpMessageProcessingModel	SNMPv1 (0) if <*TrapType*> is 1 SNMPv2c (1) if <*TrapType*> is 2 or 3 SNMPv3 (3) if <*TrapType*> is 4 or 5
snmpTargetParamsSecurityModel SYNTAX: SnmpSecurityModel	SNMPv1 (1) if <*TrapType*> is 1 SNMPv2c (2) if <*TrapType*> is 2 or 3 USM (3) if <*TrapType*> is 4 or 5 **Note:** The mapping of SNMP protocol types to value here are different from snmpTargetParamsMPModel
snmpTargetParamsSecurityName	If <*TrapType*> is 1, 2, or 3, or if the <*Security Name*> field is zero-length: "@STBnotifyconfig" If <*TrapType*> is 4 or 5, and the <*Security Name*> field is non-zero length: <*SecurityName*>
snmpTargetParamsSecurityLevel	If <*TrapType*> is 1, 2, or 3, or if the <*Security Name*> field is zero-length: noAuthNoPriv (1) If <*TrapType*> is 4 or 5, and the <*Security Name*> field is non-zero length: The security level of <*SecurityName*>
snmpTargetParamsStorageType	volatile (2)
snmpTargetParamsRowStatus	active (1)

14.5.1.5 snmpNotifyFilterProfileTable

The snmpNotifyFilterProfileTable is defined in the "Notification MIB Module" section of [RFC 3413].

The OCHD2.1 MAY create one row in snmpNotifyFilterProfileTable for each SNMPv3 Notification Receiver TLV that has a non-zero <*FilterOID*>.

Table 14.5-6 - snmpNotifyFilterProfileTable

Column Name (* = Part of Index)	Column Value
* snmpTargetParamsName	"@STBnotifyconfig_n" where n is 0..m-1 and m is the number of SNMPv3 Notification Receiver config file TLVs
snmpNotifyFilterProfileName	"@STBnotifyconfig_n" where n is 0..m-1 and m is the number of SNMPv3 Notification Receiver config file TLVs
snmpNotifyFilterProfileStorType	volatile (2)
snmpNotifyFilterProfileRowStatus	active (1)

14.5.1.6 snmpNotifyFilterTable

The snmpNotifyFilterTable is defined in the "Notification MIB Module" section of [RFC 3413].

If the OCHD2.1 supports SNMPv1v2c Coexistence, it MAY create one row in snmpNotifyFilterTable for each SNMPv3 Notification Receiver TLV that has a non-zero <*FilterOID*>.

Table 14.5-7 - snmpNotifyFilterTable

Column Name (* = Part of Index)	Column Value
* snmpNotifyFilterProfileName	"@STBnotifyconfig_n" where n is 0..m-1 and m is the number of SNMPv3 Notification Receiver config file TLVs
* snmpNotifyFilterSubtree	<*FilterOID*>
snmpNotifyFilterMask	<Zero-length OCTET STRING>
snmpNotifyFilterType	included (1)
snmpNotifyFilterStorageType	volatile (2)
snmpNotifyFilterRowStatus	active (1)

14.5.1.7 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 with fixed values if one or more SNMPv3 Notification Receiver TLVs are present in the config file. This causes SNMPv1 and v2c notifications to contain the community string in snmpCommunityName.

Table 14.5-8 - snmpCommunityTable

Column Name (* = Part of Index)	Column Value
* snmpCommunityIndex	"@STBnotifyconfig"
snmpCommunityName	"public"
snmpCommunitySecurityName	"@STBnotifyconfig"
snmpCommunityContextEngineID	<the engineID of the OCHD2.1 associated SNMP Entity>
snmpCommunityContextName	<Zero-length OCTET STRING>
snmpCommunityTransportTag	<Zero-length OCTET STRING>

Column Name (* = Part of Index)	Column Value
snmpCommunityStorageType	volatile (2)
snmpCommunityStatus	active (1)

14.5.1.8 usmUserTable

The usmUserTable is defined in the "Definitions" section of [RFC 3414].

If the OCHD2.1 supports SNMPv1v2c Coexistence, it MAY create one row in usmUserTable with fixed values if one or more SNMPv3 Notification Receiver TLVs are present in the config file. Other rows are created, one each time the engine ID of a trap receiver is discovered. This specifies the user name on the remote notification receivers to which notifications are to be sent.

One row in the usmUserTable is created. When the engine ID of each notification receiver is discovered, the agent copies this row into a new row and replaces the 0x00 in the usmUserEngineID column with the newly-discovered value.

Table 14.5-9 - usmUserTable

Column Name (* = Part of Index)	Column Value
* usmUserEngineID	0x00
* usmUserName	"@STBnotifyconfig" When other rows are created, this is replaced with the <*SecurityName*> field from the SNMPv3 Notification Receiver config file TLV.
usmUserSecurityName	"@STBnotifyconfig" When other rows are created, this is replaced with the <*SecurityName*> field from the SNMPv3 Notification Receiver config file TLV.
usmUserCloneFrom	<don't care> This row cannot be cloned.
usmUserAuthProtocol	None When other rows are created, this is replaced with None or MD5, depending on the security level of the V3 User.
usmUserAuthKeyChange	<don't care> Write-only
usmUserOwnAuthKeyChange	<don't care> Write-only
usmUserPrivProtocol	None When other rows are created, this is replaced with None or DES, depending on the security level of the V3 User.
usmUserPrivKeyChange	<don't care> Write-only
usmUserOwnPrivKeyChange	<don't care> Write-only
usmUserPublic	<Zero-length OCTET STRING>
usmUserStorageType	volatile (2)
usmUserStatus	active (1)

14.5.1.9 vacmContextTable

The vacmContextTable is defined in the "Definitions" section of [RFC 3415].

If the OCHD2.1 supports SNMPv1v2c Coexistence and a Notification Receiver TLV38 is received, it SHALL create one row in vacmContextTable with the zero length octet string for vacmContextName object.

Table 14.5-10 - vacmContextTable

Column Name (* = Part of Index)	Column Value
* vacmContextName	<Zero-length OCTET STRING>

14.5.1.10 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 vacmSecurityToGroupTable with fixed values if one or more SNMPv3 Notification Receiver TLVs are present in the config file.

Table 14.5-11 depicts the two rows with fixed values which are used for the SNMPv3 Notification Receiver TLV entries with <*TrapType*> set to 1, 2, or 3, or with a zero-length <*SecurityName*>.

Table 14.5-11 - vacmSecurityToGroupTable

Column Name (* = Part of Index)	First Row Column Value	Second Row Column Value
* vacmSecurityModel	SNMPV1 (1)	SNMPV2c (2)
* vacmSecurityName	"@STBnotifyconfig"	"@STBnotifyconfig"
vacmGroupName	"@STBnotifyconfigV1"	"@STBnotifyconfigV2"
vacmSecurityToGroupStorageType	volatile (2)	volatile (2)
vacmSecurityToGroupStatus	active (1)	active (1)

14.5.1.11 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 with fixed values if one or more SNMPv3 Notification Receiver TLVs are present in the config file.

Table 14.5-12 depicts the two rows with fixed values which are used for the SNMPv3 Notification Receiver TLV entries with <*TrapType*> set to 1, 2, or 3, or with a zero-length <*SecurityName*>.

Table 14.5-12 - vacmAccessTable

Column Name (* = Part of Index)	Column Value	Column Value
* vacmGroupName	"@STBnotifyconfigV1"	"@STBnotifyconfigV2"
* vacmAccessContextPrefix	<zero-length string>	<zero-length string>
* vacmAccessSecurityModel	SNMPV1 (1)	SNMPV2c (2)
* vacmAccessSecurityLevel	noAuthNoPriv (1)	noAuthNoPriv (1)

Column Name (* = Part of Index)	Column Value	Column Value
vacmAccessContextMatch	exact (1)	exact (1)
vacmAccessReadViewName	<Zero-length OCTET STRING>	<Zero-length OCTET STRING>
vacmAccessWriteViewName	<Zero-length OCTET STRING>	<Zero-length OCTET STRING>
vacmAccessNotifyViewName	"@STBnotifyconfig"	"@STBnotifyconfig"
vacmAccessStorageType	volatile (2)	volatile (2)
vacmAccessStatus	active (1)	active (1)

14.5.1.12 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 with fixed values if one or more SNMPv3 Notification Receiver TLVs are present in the config file.

This row is used for the SNMPv3 Notification Receiver TLV entries with <*TrapType*> set to 1, 2, or 3 or with a zero-length <*SecurityName*>.

Table 14.5-13 - vacmViewTreeFamilyTable

Column Name (* = Part of Index)	Column Value
* vacmViewTreeFamilyViewName	"@STBnotifyconfig"
* vacmViewTreeFamilySubtree	1.3
vacmViewTreeFamilyMask	<default from MIB>
vacmViewTreeFamilyType	included (1)
vacmViewTreeFamilyStorageType	volatile (2)
vacmViewTreeFamilyStatus	active (1)

14.6 Host MIB Access Via OOB and Local Loopback

14.6.1 MIB access via the local loopback address

In order to give SNMP access to co-located applications, the OCHD2.1 eSTB Agent SHALL listen on a local loopback address.

The agent SHALL allow such access from the local loopback IP address 127.0.0.1.

The agent SHALL allow read access to MIB objects using the default community name "public" unless it is specified through an alternate provisioning mechanism (e.g., TLV217).

The agent SHALL allow write access to MIB objects using the default community name "private" unless it is specified through an alternate provisioning mechanism (e.g., TLV217).

The agent MAY allow read access using other default community names.

The agent MAY allow write access using other default community names.

14.6.2 MIB access via OOB

In order to give SNMP access to remote applications using the OOB, the OCHD2.1 eSTB Agent SHALL listen on the Extended Channel.

The agent SHALL allow read access to MIB objects using the default community name “public” unless it is specified through an alternate provisioning mechanism (e.g., TLV217).

The agent SHALL allow write access to MIB objects using the default community name “private” unless it is specified through an alternate provisioning mechanism.

When operating in OOB mode, the Host SHALL send a ***new_flow_req()*** APDU with service_type = 0x01 (IP unicast) to obtain an extended channel IP flow for use by the eSTB SNMP agent.

14.7 OCHD2.1 eSTB Access to eCM MIB Objects

In order to include eCM status information in the Host diagnostic functionality, the OCHD2.1 eSTB SHALL have SNMP read access to the eCM MIB objects listed in Table 14.7-1. OCHD2.1 eSTB eCM MIB access is limited to the objects in this table.

When operating in SEB mode, the OCHD2.1 SHALL have SNMP read access to the DSG MIB [DSG].

Table 14.7-1 - OCHD2.1 eSTB eCM MIB Objects

docsIfDownChannelFrequency
docsIfDownChannelPower
docsIfCmStatusValue
docsIfSigQSignalNoise
docsIfUpChannelFrequency
docsIfCmStatusTxPower

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 DHCP (see Section 13.4).
- Proxy of OCHD2.1 configuration parameters in the form of TLVs by 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 processing of the eSTB TLVs passed by the eCM and DHCP address acquisition.

Table 15.1-1 - Provisioning steps of the OCHD2.1

Flow Step	Operation	Description	Requirement	eSAFE MIB esafeProvisioningStatusProgress
OCHD2.1-Prov-0	"2-Way OK, UCID" (See [DSG])	The eCM signals to the eSTB the message 2-Way OK, UCID	Section 13.7.1.1	(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	IPv4 Address Acquisition	eSTB acquires an IPv4 address	Section 13.7.1	(2) inProgress
OCHD2.1-Prov-3	IPv6 Address Acquisition	eSTB acquires an IPv6 address	Section 13.7.2	(2) inProgress
OCHD2.1-Prov-4	OCHD2.1 provisioning completed	The OCHD2.1 provisioning is completed		(3) finished

If a failure occurs in processing the eSTB TLVs, the value of the eSAFE MIB object `esafeProvisioningStatusFailureFlow` SHALL be set to OCHD2.1-Prov-1, and the value of the eSAFE MIB object `esafeProvisioningStatusProgress` SHALL be set to (3) finished.

If a failure occurs in acquiring an IPv4 address, the value of the eSAFE MIB object `esafeProvisioningStatusFailureFlow` SHALL bet set to OCHD2.1-Prov-2, and the eSAFE MIB object `esafeProvisioningStatusProgress` SHALL be set to (3) finished.

If a failure occurs in acquiring an IPv6 address, the value of the eSAFE MIB object `esafeProvisioningStatusFailureFlow` SHALL be set to OCHD2.1-Prov-3, and the eSAFE MIB object `esafeProvisioningStatusProgress` SHALL be set to (3) finished.

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]. 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 above relies on the eCM registration process (see [RFIv2.0]), which supports acceptable security provisions for the OCHD2.1 configuration parameters defined in Section 15.2. 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.

When acquiring an IPv4 address, 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.

When acquiring an IPv6 address, the eCM in the OCHD2.1 SHALL include in the [eDOCSIS] eCM DHCP "eCM config file encapsulation" option 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 but before beginning its IP address acquisition process.

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 [HOST-MIB]) 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 I401.1 when unrecognized TLVs or sub-TLVs are present in the configuration file.

The OCHD2.1 SHALL create a log entry with an error code I401.2 in case of an invalid TLV Type encoding.

The OCHD2.1 SHALL create a log entry with an error code I401.3 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 I453.1 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 I453.2 if the sub-TLV 53.2 SNMPv1v2c Transport Address Access is not present.

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 I453.3 for each repeated sub-TLVs other than sub-TLV 53.2.

The OCHD2.1 SHALL retain the first sub-TLV and discard the remaining sub-TLVs.

The OCHD2.1 SHALL create a log entry with an error code I453.4 if a value within a TLV 53 is rejected due to SNMP syntax conflicts. These conflicts may include values outside of prescribed ranges, invalid lengths, and other syntax errors. For example, sub-TLV 53.2.1, the SNMP Transport Address, might specify an incorrectly constructed IP address with a length other than either that of an IPv4 or IPv6 address.

The OCHD2.1 SHALL create a log entry with an error code I453.5 if a value within a TLV 53 is rejected because it exceeds the entry limit for the applicable table.

The OCHD2.1 SHALL create a log entry with an error code I453.6 if a TLV 53 attempts to create an SNMP table entry that 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 I453.3 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 I453.2 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.

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.

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 I454.1 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 I454.2 if multiple sub-TLVs of the same type are included in a TLV 54.4.

The OCHD2.1 SHALL create a log entry with an error code I454.3 if a value within a TLV 54 is rejected due to SNMP syntax conflicts.

The OCHD2.1 SHALL create a log entry with an error code I454.4 if a value within a TLV 54 is rejected because it exceeds the entry limit for the applicable table.

The OCHD2.1 SHALL create a log entry with an error code I454.5 if a TLV 54 attempts to create an SNMP table entry that 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.

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 unrecognized SNMP MIB objects in TLV 11 and create a log entry with an error code I411.1 in case of an unrecognized OID in the varbind list.

The OCHD2.1 SHALL create a log entry with an error code I411.2 in case of duplicated SNMP MIB object instances in TLV 11 being set to the same or different value.

The OCHD2.1 SHALL create a log entry with an error code I411.3 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 I443.1 if the Vendor ID TLV 8 is not the first sub-TLV in a Vendor Specific Information TLV 43.

Type	Length	Value
43	N	

15.2.6 IP Mode Control

This TLV (Type 1) is used to inform the OCHD2.1 in which IP mode it should operate.

Note: This TLV is only to be used to control the IP address mode of the eSTB WAN-facing interface.

The eSTB in the OCHD2.1 SHALL acquire an IPv4 address and operate in IPv4 mode when the value of IP Mode Control TLV 1 is set to 0.

The eSTB in the OCHD2.1 SHALL acquire an IPv6 address and operate in IPv6 mode when the value of IP Mode Control TLV 1 is set to 1.

The eSTB in the OCHD2.1 SHALL acquire both an IPv4 and IPv6 address and operate in Dual-stack mode when the value of IP Mode Control TLV 1 is set to 2.

If IP Mode Control TLV 1 is not present, the eSTB in the OCHD2.1 SHALL acquire an IP address on its WAN-facing interface (ifIndex 1) as follows:

If the eCM has acquired an IPv4 address, the OCHD2.1 acquires an IPv4 address.

If the eCM has acquired an IPv6 address, the OCHD2.1 acquires an IPv6 address.

If the eCM has acquired an IPv4 address and an IPv6 address, the OCHD2.1 acquires both IPv4 and IPv6 addresses.

The OCHD2.1 uses an implementation-specific mechanism to determine which IP address type(s) the eCM has successfully acquired. The OCHD2.1 SHALL query the eCM's IP address types immediately upon completion of all the following processes: the IPv4 address acquisition process, the IPv6 address completion process, and the CMTS registration process. When the eCM is operating in Dual-stack Provisioning Mode, it is possible for the eCM to register with the CMTS while there are still DHCPv4 retries remaining. In this case, the OCHD2.1 SHALL wait until all DHCPv4 retries are exhausted before querying the eCM.

The OCHD2.1 SHALL create a log entry with an error code I401.11 if multiple TLV1s are received. The value of the first received TLV1 is retained and the subsequent TLV1s are discarded.

Type	Length	Value
1	1	0: IPv4 1: IPv6 2: Dual-stack Provisioning Mode

15.2.7 SNMPv3 Notification Receiver

This TLV specifies a Network Management Station that will receive notifications from the Host. If the Host supports SNMPv1v2 Coexistence mode, then see 14.5 for related tables definition requirements. Otherwise, internal representation and storage is manufacturer-defined. Up to 10 of these elements may be included in the configuration file. Please refer to [MULPIv3.0] for additional details of TLV-38 usage.

The OCHD2.1 SHALL use TLV 38 to define SNMP Notification Receivers.

The OCHD2.1 SHALL support multiple but unique instances of TLV 38.

The OCHD2.1 SHALL discard duplicate TLV 38 (i.e., identical).

The OCHD2.1 MAY support the UDP port number assigned with sub-TLV38.2.

The OCHD2.1 MAY support the Notification Receiver Timeout assigned with sub-TLV38.4. This is applicable only to SNMP Inform PDUs.

The OCHD2.1 MAY support the Notification Receiver Retries assigned with sub-TLV38.5. This is applicable only to SNMP Inform PDUs.

The OCHD2.1 MAY support Notification Receiver Filtering assigned with sub-TLV38.6.

The OCHD2.1 MAY specify Notification Receiver Security Name with sub-TLV38.7.

The OCHD2.1 SHALL require sub-TLV38.1 (IPv4) or TLV38.8 (IPv6).

The OCHD2.1 SHALL require at least one sub-TLV 38.3 with SNMPv2c Trap Type (2).

The OCHD2.1 SHALL create a log entry with an error code I438.1 if duplicate (i.e., identical) Type 38 TLVs are received in the configuration file.

The OCHD2.1 SHALL create a log entry with an error code I438.2 if no IP address is specified in either sub-TLV 38.1 or sub-TLV 38.8.

The OCHD2.1 SHALL create a log entry with an error code I438.3 if at least one of the Notification Receiver sub-types TLV38.3 does NOT specify SNMPv2c Trap Type (2).

The OCHD2.1 SHALL create a log entry with an error code I438.4 if an IPv6 address specified in sub-TLV38.8 (IP mode) is not consistent with the IP version specified in TLV-1.

Type	Length	Value
38	N	composite

15.2.7.1 SNMPv3 Notification Receiver IPv4 Address

This sub-TLV specifies the IPv4 address of the notification receiver.

Type	Length	Value
38.1	4	IPv4 Address

15.2.7.2 SNMPv3 Notification Receiver UDP Port Number

This sub-TLV specifies the UDP port number of the notification receiver. If this sub-TLV is not present, the default value of 162 should be used.

Type	Length	Value
38.2	2	UDP port number

15.2.7.3 SNMPv3 Notification Receiver Trap Type

Type	Length	Value
38.3	2	trap type

This sub-TLV specifies the type of trap to send. The trap type may take values:

1 = SNMP v1 trap in an SNMP v1 packet
2 = SNMP v2c trap in an SNMP v2c packet
3 = SNMP inform in an SNMP v2c packet
4 = SNMP v2c trap in an SNMP v3 packet
5 = SNMP inform in an SNMP v3 packet

15.2.7.4 SNMPv3 Notification Receiver Timeout

This sub-TLV specifies the timeout value to use when sending an optional Inform message to the notification receiver.

Type	Length	Value
38.4	2	time in milliseconds

15.2.7.5 SNMPv3 Notification Receiver Retries

This sub-TLV specifies the number of times to retry sending an optional Inform message if an acknowledgement is not received.

Type	Length	Value
38.5	2	number of retries

15.2.7.6 SNMPv3 Notification Receiver Filtering Parameters

This sub-TLV specifies the ASN.1 formatted Object Identifier of the snmpTrapOID value that identifies the notifications to be sent to the notification receiver. SNMP v3 allows the specification of which Trap OIDs are to be sent to a trap receiver. This object specifies the OID of the root of a trap filter sub-tree. All Traps with a Trap OID contained in this trap filter sub-tree SHALL be sent by the OCHD2.1 to the trap receiver. This object starts with the ASN.1 Universal type 6 (Object Identifier) byte, then the ASN.1 length field, then the ASN.1 encoded object identifier components.

Type	Length	Value
38.6	N	filter OID

15.2.7.7 SNMPv3 Notification Receiver Security Name

This sub-TLV specifies the V3 Security Name to use when sending a V3 Notification. This sub-TLV is only used if Trap Type is set to 4 or 5. This name must be a name specified in a config file TLV Type 34 as part of the Diffie-Helman (DH) Kickstart procedure. The notifications will be sent using the Authentication and Privacy Keys calculated by the modem during the DH Kickstart procedure.

This sub-TLV is not required for Trap Type = 1, 2, or 3 above. If it is not supplied for a Trap type of 4 or 5, then the V3 Notification will be sent in the noAuthNoPriv security level using the security name "@config".

Type	Length	Value
38.7	N	security name

15.2.7.8 SNMPv3 Notification Receiver IPv6 Address

This sub-TLV specifies the IPv6 address of the notification receiver.

Type	Length	Value
38.8	16	IPv6 Address

15.2.8 SEB Server Enable TLS Cipher Suites

TLV 40 enumerates the Cipher Suites [RFC 5246] that will be used to establish the SEB Tunnel in devices implementing SEB Server functionality. Each bit enables or disables the specified Cipher Suite. When a bit is set to

"1", the SEBS-capable OCHD2.1 allows the TLS encryption using the specified protocol. When a bit is set to "0", the SEBS-capable OCHD2.1 does not perform TLS encryption using the specified protocol.

The OCHD2.1 MAY support the TLS Cipher Suite assignment with TLV 40.

The OCHD2.1 SHALL NOT support multiple instances of TLV 40.

If TLV 40 is not present in the configuration file, the OCHD2.1 SHALL use a default value of 0xE0.

The OCHD2.1 SHALL reject all instances of TLV 40 when multiple instances are received. This creates a condition requiring the default TLV 40 value be used.

The OCHD2.1 SHALL create a log entry with an error code I440.1 when it receives multiple instances of TLV 40.

Type	Length	Value
40	1	0 - 255

The bits are defined as follows:

0x80: TLS_RSA_WITH_3DES_EDE_CBC_SHA
0x40: TLS_RSA_WITH_AES_128_CBC_SHA
0x20: TLS_RSA_WITH_AES_256_CBC_SHA
0x10: TLS_RSA_WITH_NULL_SHA
0x08 through 0x01: Reserved

15.2.9 Home Network Prefix Validation

This TLV specifies valid or invalid network IDs used in the Home Network. Multiple elements of this type may be included in the configuration file. The Host creates an ordered list of configured prefixes, then searches for matches with the Subnet Prefix (Subnet Address AND Subnet Mask Length) and LAN network prefix.

The OCHD2.1 SHALL create an entry with an error code of I456.1 when a TLV39 is partially formed (i.e., cannot be used to create a complete row in the network prefix list).

The OCHD2.1 SHALL create an entry with an error code of I456.2 when a single TLV39 contains both IPv4 and IPv6 specific content. A single TLV39 defines either an IPv4 or IPv6 prefix.

The OCHD2.1 SHALL discard an incomplete TLV39.

The OCHD2.1 SHALL discard a TLV39 that contains both IPv4 and IPv6 specific content.

Type	Length	Value
39	N	composite

15.2.9.1 Instance Number

This sub-TLV specifies an integer to be used in the ordering of rows. The row ordering and hence the search order, is incrementing numerical order. The search begins with the lowest Instance Number and ends with the first match, or at the end of the list if no match is found.

Type	Length	Value
39.1	1	1-255: Instance Number

15.2.9.2 Prefix Usage

This sub-TLV specifies the action to be taken with the following subnet and mask.

Type	Length	Value
39.2	1	1: Accept 2: Discard

15.2.9.3 IP Address Version

This sub-TLV specifies IP version of the network address.

Type	Length	Value
39.3	1	1: IPv4 2: IPv6

15.2.9.4 IPv4 Prefix Length

This sub-TLV specifies the subnet mask length in CIDR notation.

Type	Length	Value
39.4	1	1-32: Number of bits in subnet mask.

15.2.9.5 IPv4 Subnet Address

This sub-TLV specifies the subnet address to be matched against the LAN network prefix.

Type	Length	Value
39.5	4	IPv4 Subnet Address

15.2.9.6 IPv6 Prefix Length

This sub-TLV specifies the subnet mask length in CIDR notation.

Type	Length	Value
39.6	1	1-128: Number of bits in subnet mask

15.2.9.7 IPv6 Network Address

This sub-TLV specifies the subnet address to be matched against the LAN network prefix.

Type	Length	Value
39.7	16	IPv6 Network Address

16 HDMI-CEC SUPPORT (CONDITIONAL MANDATORY)

The OpenCable set-top device, OCS2.1, is required to support either the DVI or HDMI digital interface. This section defines support for the HDMI-CEC protocol when the set-top device implements HDMI capability.

If the OCS2.1 supports HDMI capability, then it SHALL support all mandatory CEC functionality defined in the HDMI specification, [HDMI].

Required support for optional CEC functionality is defined in the following sections.

16.1 Overview of Application Features

The following four features describe the application functions to be supported by the OCS2.1 implementing CEC over HDMI.

- One Touch Play - When a user turns on the OCS2.1, a connected TV also wakes up automatically, selects the OCS2.1 as its input, and shows its contents on its screen.
- System Standby - When a user turns off the TV, OCS2.1 also turns off automatically.
- Remote OCS2.1 Control - While a TV screen shows content from OCS2.1, a user can operate the OCS2.1 using a TV remote instead of an OCS2.1 remote. The TV remote works in the same manner as the OCS2.1 remote, e.g., selecting a channel, navigating the guide.
- Device Select - When a user selects the OCS2.1 on the TV's GUI (e.g., from a list of connected devices), the OCS2.1 wakes up automatically, and the TV selects the OCS2.1 as its input and shows its contents on its screen.

16.2 Requirements for Application Features

This section specifies detailed requirements of each required application feature.

16.2.1 One Touch Play

When a user turns on the OCS2.1, it SHALL send a <Text View On> message to the TV and broadcast an <Active Source> message with its physical address, followed by a <Menu Status>["Activated"] message.

When the OCS2.1 receives a <Request Active Source> message while it is a current active source, it SHALL broadcast an <Active Source> message with its physical address and then send a <Menu Status>["Activated"] message.

16.2.2 System Standby

When the OCS2.1 receives a <Standby> message, it SHALL go into standby unless it is in a state that prevents this operation.

16.2.3 Remote OCS2.1 Control

When the OCS2.1 receives a <User Control Pressed> message with a user control code as specified in Table 16.2-1, it SHALL act in a manner identical to a user pressing the corresponding key on the OCS2.1's own remote control.

Note: When a user performs an operation of "Volume Up", "Volume Down" or "Mute Volume" via a controller that has audio output functionality, the controller may consume the input event itself or may pass it through to another

device, such as an AV amplifier. In this case, the controller does not have to send a <User Control Pressed> message with the corresponding user control code to OCS2.1.

A controller does not have to send a <User Control Pressed> ["Power Toggle Function"] message to theOCS2.1. In order to request the OCS2.1 to turn on or off, the controller may use System Standby feature and Device Select feature.

When the OCS2.1 becomes the active source (e.g., OCS2.1 broadcasts an <Active Source> message with its physical address), it SHALL send a <Menu Status>["Activated"] message to the TV after it broadcasts the <Active Source> message.

When the OCS2.1 receives a <Menu Request> message with any valid parameter while it is the current active source, it SHALL send a <Menu Status>["Activated"] message to the initiator of the <Menu Request> message.

Table 16.2-1 - Keys to be Passed Through

Key for OCS2.1	User Control Code (CEC)	
	Operation id	User Operation
VK_UP	0x01	Up
VK_DOWN	0x02	Down
VK_LEFT	0x03	Left
VK_RIGHT	0x04	Right
VK_SELECT	0x00	Select
VK_LAST	0x32	Previous Channel
VK_COLORED_KEY_0	0x72	F2 (Red)
VK_COLORED_KEY_1	0x73	F3 (Green)
VK_COLORED_KEY_2	0x71	F1 (Blue)
VK_COLORED_KEY_3	0x74	F4 (Yellow)
VK_0	0x20	Number 0
VK_1	0x21	Number 1
VK_2	0x22	Number 2
VK_3	0x23	Number 3
VK_4	0x24	Number 4
VK_5	0x25	Number 5
VK_6	0x26	Number 6
VK_7	0x27	Number 7
VK_8	0x28	Number 8
VK_9	0x29	Number 9
VK_EXIT	0x2C	Clear
VK_ENTER	0x2B	Enter
VK_PLAY	0x44	Play
VK_STOP	0x45	Stop
VK_RECORD	0x47	Record
VK_FAST_FWD	0x49	Fast Forward

Key for OCS2.1	User Control Code (CEC)	
	Operation id	User Operation
VK_REWIND	0x48	Rewind
VK_PAUSE	0x46	Pause
VK_PAGE_UP	0x37	Page Up
VK_PAGE_DOWN	0x38	Page Down
VK_MENU	0x09	Root Menu
VK_ON_DEMAND	0x52	Video on Demand
VK_GUIDE	0x53	Electronic Program Guide
VK_NEXT_FAVORITE_CHANNEL	0x2F	Next Favorite
VK_INFO	0x35	Display Information
VK_CHANNEL_UP	0x30	Channel Up
VK_CHANNEL_DOWN	0x31	Channel Down
VK_VOLUME_UP	0x41	Volume Up
VK_VOLUME_DOWN	0x42	Volume Down
VK_MUTE	0x43	Mute
VK_POWER	0x6B	Power Toggle Function

When the OCS2.1 receives a <User Control Pressed>["Power Off Function"] message while in power on state, it SHALL transition to a standby state.

When the OCS2.1 receives a <User Control Pressed>[“Mute Function”] message while in an un-muted state, it SHALL mute audio.

When the OCS2.1 receives a <User Control Pressed>[“Restore Volume Function”] message while in a muted state, it SHALL un-mute audio.

16.2.4 Device Select

When the OCS2.1 receives a <Give Device Power Status> message, it SHALL send a <Report Power Status> message with its current power status to the initiator of the <Give Device Power Status> message.

When the OCS2.1 receives a <User Control Pressed> ["Power "] message while in standby state, it SHALL turn on.

When OCS2.1 receives a <User Control Pressed> ["Power On Function"] message while in standby state, it SHALL turn on.

When the OCS2.1 receives a <Set Stream Path> message with its own physical address while in power on state, it SHALL broadcast an <Active Source> message with its physical address and then send a <Menu Status> ["Activated"] message to the TV. **Note:** It is allowed that the OCS2.1 send a <Text View On> message to the TV before it broadcasts the <Active Source> message.

16.3 Addressing Rules

This section specifies requirements for addressing rules in order that each application feature can function properly.

When the Hot Plug Detect signal (HPD) provided from the connected HDMI sink (e.g., a TV) is asserted (HPD has changed from Low to High), the OCS2.1 SHALL attempt to obtain a physical address from the connected HDMI sink.

The OCS2.1 SHALL retain the obtained physical address when the HPD from the connected HDMI sink is de-asserted (HPD has changed from High to Low), when the HDMI sink device is disconnected and when OCS2.1 goes into standby. **Note:** It is allowed that the OCS2.1 lose its physical address when the AC power of the OCS2.1 is off or when the HDMI functionality of the OCS2.1 is disabled.

16.4 Device Recognition

This section specifies requirements that the OCS2.1 shall support in order that a controller can recognize that the target is an OCS2.1 device.

After the OCS2.1 completes a successful initialization and address allocation, then it SHALL broadcast a <Device Vendor ID> message containing the vendor ID assigned to the manufacturer of the OCS2.1 device. When the OCS2.1 receives a <Give Device Vendor ID> message, it SHALL broadcast a <Device Vendor ID> message containing the vendor ID assigned to the manufacturer of the OCS2.1 device.

When the OCS2.1 receives a <Give OCHD Information> message, it SHALL respond with a <Report OCHD Information> message. <Give OCHD Information> and <Report OCHD Information> are vendor-specific commands defined in Table 16.4-1.

Table 16.4-1 - Definition of <Give OCHD Information> and <Report OCHD Information>

<Give OCHD Information>	
Opcode	<Vendor Command with ID>
Value	0xA0
Description	Requests device information. (Controller(ex.TV) → OCS2.1)
Parameters	VendorID (0x001000) Virtual opcode (0x01)
Parameter Description	CableLabs Vendor Id must be used when sending <Give OCHD Information>) Virtual opcode defined as <Give OCHD Information>
Response	Respond with <Report OCHD Information>
Directly Addressed	•
Broadcast	
Mandatory for Initiator	
Mandatory for Follower	OCS2.1

<Report OCHD Information>	
Opcode	<Vendor Command with ID>
Value	0xA0
Description	Reports device information. (OCS2.1 → Controller(ex.TV))
Parameters	VendorID (0x001000) Virtual opcode (0x02) Reserved (0x00)
Parameter Description	CableLabs Vendor Id must be used when sending <Report OCHD Information>) Virtual opcode defined as <Report OCHD Information> Reserved
Response	No response required
Directly Addressed	•
Broadcast	
Mandatory for Initiator	
Mandatory for Follower	

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] for DOCSIS 2.0 implementations or [OSSIv3.0] for DOCSIS 3.0 implementations). 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] for DOCSIS 2.0 implementations or [OSSIv3.0] for DOCSIS 3.0 implementations, 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] for DOCSIS 2.0 implementations or [OSSIv3.0] for DOCSIS 3.0 implementations.

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
General TLV Errors						
Prov	TLV PARSING	Notice	Unrecognized TLV or sub-TLVs detected <P1>	<P1>; 'TLVnn', where nn is the decimal type	I401.1	73040101
Prov	TLV PARSING	Notice	Invalid TLV Type encoding <P1>	<P1>; 'TLVnn', where nn is the decimal type	I401.2	73040102

Process	SubProcess	Event Level	Event message	Message Notes And Details	Error Code Set	Event ID
Prov	TLV PARSING	Notice	Resource limit reached		I401.3	73040103
TLV-1 Failures						
Prov	TLV-1 PARSING	Notice	TLV-1 - Multiple TLVs not allowed		I401.11	73041111
TLV-11 Failures						
Prov	TLV-11 PARSING	Notice	TLV-11 - unrecognized OID		I411.1	73041101
Prov	TLV-11 PARSING	Warning	TLV-11 - Multiple SET operations of object instance attempted		I411.2	73041102
Prov	TLV-11 PARSING	Warning	TLV-11 - Invalid varbind encoding		I411.3	73041103
TLV 38 Failures						
Prov	TLV-38 PARSING	Warning	TLV38 - Duplicate TLV Received		I438.1	73043801
Prov	TLV-38 PARSING	Critical	TLV38 - No Receiver IP Address received in TLV		I438.2	73043802
Prov	TLV-38 PARSING	Warning	TLV38 - No SNMPv2c Trap specified		I438.3	73043803
Prov	TLV-38 PARSING	Warning	TLV38 - Inconsistent IP address type specified in TLV1		I438.4	73043804
TLV 39 Failures						
Prov	TLV 39 PARSING	Warning	TLV39 - Incomplete TLV		I456.1	73045601
Prov	TLV 39 PARSING	Warning	TLV39 - Inconsistent IP version		I456.2	73045602
TLV 40 Failures						
Prov	TLV 40 PARSING	Critical	TLV40- Multiple Instances not allowed.		I440.1	73044001
TLV 43 Failures						
Prov	TLV 43 PARSING	Critical	TLV43 - Invalid Vendor ID encoding		I443.1	73044301
TLV 53 Failures						
Prov	TLV 53 PARSING	Critical	TLV53 - Community Name not present		I453.1	73045301
Prov	TLV 53 PARSING	Critical	TLV53 - Transport address not present		I453.2	73045302
Prov	TLV 53 PARSING	Warning	TLV53 - Multiple sub-TLVs not allowed.		I453.3	73045303

Process	SubProcess	Event Level	Event message	Message Notes And Details	Error Code Set	Event ID
Prov	TLV 53 PARSING	Warning	TLV53 - SNMP syntax conflicts detected		I453.4	73045304
Prov	TLV 53 PARSING	Warning	TLV53 - Insufficient table resources		I453.5	73045305
Prov	TLV 53 PARSING	Warning	TLV53 Attempt to create duplicate entry not allowed		I453.6	73045306
TLV 54 Failures						
Prov	TLV 54 PARSING	Warning	TLV54 - Access View Name not present		I454.1	73045401
Prov	TLV 54 PARSING	Warning	TLV54 - Multiple sub-TLVs not allowed		I454.2	73045402
Prov	TLV 54 PARSING	Warning	TLV54 SNMP syntax conflicts detected		I454.3	73045403
Prov	TLV 54 PARSING	Warning	TLV54 - Insufficient table resources		I454.4	73045404
Prov	TLV 54 PARSING	Warning	TLV54 - Attempt to create duplicate entry not allowed		I454.5	73045405
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 - Response doesn't contain ALL the valid fields for <P1>	<P1>: 'eSTB' or 'CC'	D03.1	68000301
Prov	DHCP	Critical	DHCP failed - RS sent, no RA received	Only applies to eSTB IPv6 addresses	D12.0	68001200
Prov	DHCP	Critical	DHCP Failed - Invalid RA	Only applies to eSTB IPv6 addresses	D12.1	68001201
Prov	DHCP	Critical	DHCP failed - DHCP Solicit sent, No DHCP Advertise received	Only applies to eSTB IPv6 addresses	D12.2	68001202
Prov	DHCP	Critical	DHCP failed - DHCP Request sent, No DHCP REPLY received	Only applies to eSTB IPv6 addresses	D12.3	68001203
Prov	DHCP	Critical	Link-Local address failed DAD	Only applies to eSTB IPv6 addresses	D13.1	68001301

Process	SubProcess	Event Level	Event message	Message Notes And Details	Error Code Set	Event ID
Prov	DHCP	Critical	DHCP lease address failed DAD	Only applies to eSTB IPv6 addresses	D13.2	68001302
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
OS/HW/Middleware Initialization						
Boot	HW/SW Init	Notice	Hardware and OS UP	Hardware and Operating system initialized per OCAP 20.2.2 - 2	B01.0	66000100
Boot	HW/SW Init	Notice	Execution Engine UP	Execution Engine Initialized per OCAP 20.2.2 - 3	B02.0	66000200
Boot	Card Binding	Notice	Copy Protection Resource opened		B03.0	66000300
Boot	Card Binding	Notice	Host AuthKey sent	Host response to Card Auth Key request	B04.0	66000400
Boot	Card Binding	Critical	Binding Failure: Card reasons		B05.0	66000500
Boot	Card Binding	Critical	Binding Failure: Invalid Host Cert		B06.0	66000600
Boot	Card Binding	Critical	Binding Failure: Invalid Host Signature		B07.0	66000700
Boot	Card Binding	Critical	Binding Failure: Invalid Host AuthKey		B08.0	66000800
Boot	Card Binding	Critical	Binding Failure: Other		B09.0	66000900
Boot	Card Binding	Critical	Card Validation Error: Validation revoked		B10.0	66001000
Boot	Card Binding	Critical	Binding Failure. Incompatible module	Error Code 161-64 issued per Annex B CCIF2	B11.0	66001100

Process	SubProcess	Event Level	Event message	Message Notes And Details	Error Code Set	Event ID
Boot	Card Binding	Notice	Binding Complete: Card/Host Validated		B12.0	66001200
Boot	Copy Protection	Notice	Copy Protection initiated	Card and Host have exchanged CPKey Generation messages	B13.0	66001300
Boot	OOB Support	Notice	FDC acquired	FDC downstream has been successfully acquired	B14.0	66001400
Boot	OOB Support	Notice	Set QPSK mode	Preferred operational mode for the network known to be QPSK	B15.0	66001500
Boot	OOB Support	Notice	Set Adv. DSG mode	Preferred operational mode for the network known to be Advanced DSG mode	B16.0	66001600
Boot	OOB Support	Notice	Set Adv. Dsg 1-way mode	Preferred operational mode for the network known to be Advanced DSG One-way mode.	B17.0	66001700
Boot	OOB Support	Notice	DSG acquired	DSG downstream has been successfully acquired	B18.0	66001800
Boot	OOB Support	Notice	DOCSIS 2-way established	DOCSIS upstream acquired	B19.0	66001900
Boot	OOB Support	Notice	VCT acquired	A complete VCT with the correct vct_id has been loaded	B20.0	66002000
Boot	OCAP Support	Notice	OCAP launched	An OCAP JVM has been started	B21.0	66002100
Boot	OCAP Support	Error	OCAP Startup Error	An Error has occurred during OCAP startup	B22.0	66002200
Boot	OCAP Support	Notice	XAIT received		B23.0	66002300

Process	SubProcess	Event Level	Event message	Message Notes And Details	Error Code Set	Event ID
Boot	OCAP Support	Error	Error reading XAIT		B24.0	66002400
Boot	OCAP Support	Notice	Initial Monitor App launched		B25.0	66002500
Boot	OCAP Support	Notice	Initial Monitor App Startup Error		B26.0	66002600
Boot	OCAP Support	Notice	Proprietary Condition Met	An implementation-specific condition required to start OCAP has been met (Note 1)	B27.xx	660027xx
SW D/L	Common Download	Notice	Host Image Download Complete		B28.0	66002800
SW D/L	Common Download	Error	Common Download CVT Error		B29.0	66002900
SW D/L	Common Download	Error	Host Image Download Error, <P1>	<P1>: Common Download Error code as defined in the Table 11.1-1.	B30.0	66003000
SW D/L	Card Firmware Upgrade	Notice	Card Image Download Complete		B31.0	66003100
SEB Operation						
SEB	Init	Notice	Link-Local address <P1> acquired for <P2>	<P1>:IP address	P1.1	80000101
SEB	Init	Notice	SEBC Initialization start		P1.2	80000102
SEB	Init	Notice	SEBC Initialization complete		P1.3	80000103
SEB	Init	Notice	SEBS Initialization start		P1.4	80000104
SEB	Init	Notice	SEBS Initialization complete		P1.5	80000105
SEB	Init	Warning	Unable to initialize SEB for unknown reason		P1.6	80000106
SEB	Init	Warning	Unable to initialize server - insufficient CPE count		P1.7	80000107
SEB	Init	Warning	Unable to initialize server - NACO = 0		P1.8	80000108
SEB	Init	Warning	Unable to initialize server - ifAdminStatus is down		P1.9	80000109
SEB	Init	Warning	Unable to initialize server - MIB Control Object is false		P1.10	80000110

Process	SubProcess	Event Level	Event message	Message Notes And Details	Error Code Set	Event ID
SEB	SEBS	Notice	SEB Server <P1> advertising FOM = <P2>	<P2>: UPnP friendly name <P2>: calculated FOM	P11.1	80001101
SEB	SEBS	Warning	SEBS Terminating - DSG two way lost		P11.2	80001102
SEB	SEBS	Warning	SEBS Terminating - SEB control object set to FALSE		P11.3	80001103
SEB	SEBS	Warning	SEBS Terminating - eCM exited 2-way communications		P11.4	80001104
SEB	SEBS	Warning	Tunnel request from <P1> rejected. Unable to authenticate device.	<P1>: SEBC friendly name <P2>: SEBC MAC	P11.5	80001105
SEB	SEBS	Warning	Tunnel request from <P1> rejected. SEBS at max CPE.	<P1>: SEBC friendly name <P2> SEBC MAC	P11.6	80001106
SEB	SEBS	Warning	SEBS rejected UPnP Action - unauthenticated source <P1>	<P1>: SEBC friendly name <P2>: SEBC MAC	P11.7	80001107
SEB	SEBS	Warning	SEBS rejected UPnP Query - unauthenticated source <P1>	<P1>: SEBC friendly name <P2>: SEBC MAC	P11.8	80001108
SEB	SEBS	Notice	Tunnel initialized for <P1>	<P1>: SEBC friendly name <P2>: SEBC MAC	P11.9	80001109
SEB	SEBS	Notice	Tunnel closed for <P1> Requested by SEBC.	<P1>: SEBC friendly name <P2>: SEBC MAC	P11.10	80001110
SEB	SEBC	Notice	SEBC discovered SEBS <P1>	<P1>: SEB Server MAC	P21.1	80002101
SEB	SEBC	Notice	Tunnel established with <p1>	<P1>: SEB Server MAC	P21.2	80002102
SEB	SEBC	Notice	ClientConnect successful using Port <P1> with <P2>	<P1>: TCP Tunnel Port <P2>: SEB Server MAC	P21.3	80002103

Process	SubProcess	Event Level	Event message	Message Notes And Details	Error Code Set	Event ID
SEB	SEBC	Warning	ClientConnect failed UPnP error 402 (Invalid Args) for <p1>	<P1>: SEB Server MAC	P21.4	80002104
SEB	SEBC	Warning	ClientConnect failed UPnP error 501 (Action Failed) for <p1>	<P1>: SEB Server MAC	P21.5	80002105
SEB	SEBC	Warning	ClientConnect failed UPnP error 606 (Action Not Authorized) by <p1>	<P1>: SEB Server MAC	P21.6	80002106
SEB	SEBC	Warning	ClientConnect failed Error 801 - SEBS <P1> at Max Number of Devices	<P1>: SEB Server MAC	P21.7	80002107
SEB	SEBC	Notice	ClientJoin successful <p1>	<P1>: Multicast address	P21.8	80002108
SEB	SEBC	Warning	ClientJoin failed for <p1> : 402 Invalid Arguments	<p1>: Multicast Address	P21.9	80002109
SEB	SEBC	Warning	ClientJoin failed for <P1> : 501 current state of service prevents invoking that action.	<P1>: Multicast Address	P21.10	80002110
SEB	SEBC	Warning	ClientJoin failed for <p1> 606 Action not authorized	<P1>: Multicast Address	P21.11	80002111
okSEB	SEBC	Notice	ClientAddDevice successful <p1> <p2>	<P1> device type <P2> Device MAC	P21.12	80002112
SEB	SEBC	Warning	ClientAddDevice failed 402 Invalid Args <P1> <P2>	<P1> device type <P2> Device MAC	P21.13	80002113
SEB	SEBC	Warning	ClientAddDevice for <P1> to SEBS <P1> failed 501 current state of service prevents invoking that action.	<P1> SEB client MAC <P2> SEB Server MAC	P21.14	80002114
SEB	SEBC	Warning	ClientAddDevice to SEBS <P1> failed Error 606 Action not authorized	<P1> SEB Server MAC	P21.15	80002115
SEB	SEBC	Warning	ClientAddDevice failed Error 801 - SEBS <P1> at Max Number of Devices	<P1> SEB Server MAC	P21.16	80002116
SEB	SEBC	Warning	ClientAddDevice failed Error 802 - SEBS <P1> has terminated SEBS services	<P1> SEB Server MAC	P21.17	80002117
SEB	SEBC	Notice	ClientRemoveDevice successful <p1> <p2>	<P1> device type <P2> Device MAC	P21.18	80002118

Process	SubProcess	Event Level	Event message	Message Notes And Details	Error Code Set	Event ID
SEB	SEBC	Warning	ClientRemoveDevice failed 402 Invalid Args <P1> <P2>	<P1> device type <P2> Device MAC	P21.19	80002119
SEB	SEBC	Warning	ClientRemoveDevice failed 501 current state of service prevents invoking that action. <P1> <P2>	<P1> device type <P2> Device MAC	P21.20	80002120
SEB	SEBC	Warning	ClientRemoveDevice failed Error 606 Action not authorized <P1> <P2>	<P1> device type <P2> Device MAC	P21.21	80002121
SEB	SEBC	Warning	ClientRemoveDevice failed Error 802 - SEBS has terminated services <P1> <P2>	<P1> device type <P2> Device MAC	P21.22	80002122
SEB	SEBC	Warning	ClientRemoveDevice failed Error 803 - unrecognized device <P1> <P2>	<P1> device type <P2> Device MAC	P21.23	80002123
SEB	SEBC	Warning	SEBC unable to detect SEBS		P21.24	80002124

Note 1: One or more B27.xx event codes may be posted, with each value of 'xx' representing a vendor-defined internal condition or conditions. However, all proprietary events required to permit the launch and operation of the OCAP stack must be reported in some B27.xx event code.

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

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I04-080404:

ECN	Description	Date
HOST2.1-CFR-N-08.1171-1	Add Host requirement to accommodate Cards of various lengths	2/29/08
HOST2.1-CFR-N-08.1172-1	Support for SCTE-127-2007	2/29/08
HOST2.1-CFR-N-08.1173-1	Minimum Size Limit of SI Data and XAIT Storage in Host and storage of XAIT in Host	2/29/08
HOST2.1-CFR-N-08.1182-1	Define ranges for required SNR & Signal Level accuracy of FAT	2/29/08
HOST2.1-CFR-N-08.1189-3	Change DVS-683 ref in Host 2.1 to SCTE 128	3/14/08
HOST2.1-CFR-N-08.1193-1	Add a requirement for SNMP community-based access support	3/14/08

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I05-080620:

ECN	Description	Date
HOST2.1-CFR-N-08.1170-5	Common Keystroke Diagnostics Entry Sequence	5/30/08
HOST2.1-CFR-N-08.1218-4	Support for IPv6	5/30/08
HOST2.1-CFR-N-08.1219-1	Clarification of allowed values for the docsDevEvReporting object	5/30/08
HOST2.1-CFR-N-08.1233-1	Clarification of required key support for wireless keyboard	5/30/08
HOST2.1-CFR-N-08.1234-1	Change support for Ch 3/4 RF output from mandatory to optional	5/30/08
HOST2.1-CFR-N-08.1239-1	Remove Host Default CCI and Error CCI	5/30/08
HOST2.1-CFR-N-08.1247-2	Generic Feature Control Resource Requirements	5/30/08
HOST2.1-CFR-N-08.1255-2	Specify remote device function key placement	5/30/08

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I06-081114:

ECN	Description	Date
HOST2.1-CFR-N-08.1123-4	DPI modifications	10/3/08
HOST2.1-CFR-N-08.1269-4	Host2.x-Card SNMP Message Format	10/17/08
HOST2.1-CFR-N-08.1295-2	Deprecate DSG Basic Mode	10/17/08
HOST2.1-CFR-N-08.1304-2	Removal of Option 3 for wireless keyboard implementations	10/17/08
HOST2.1-CFR-N-08.1305-1	Change OCAP reference from 1.0.2 to 1.0.1	10/3/08

ECN	Description	Date
HOST2.1-CFR-N-08.1308-1	Remove function key physical layout requirement on OCAP remotes	10/17/08

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I07-090206:

ECN	Description	Date
HOST2.1-CFR-N-08.1309-4	Host Panic Dump Diagnostics	1/16/09
HOST2.1-CFR-N-08.1361-1	Download Error Code corrections	1/16/09
HOST2.1-CFR-N-08.1365-1	TLV 53 IPv6 Correction	1/16/09
HOST2.1-CFR-N-08.1366-1	New Event Codes	1/16/09

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I08-090508:

ECN	Description	Date
HOST2.1-CFR-N-09.1373-1	Dolby Audio decoding requirements	4/17/09
HOST2.1-CFR-N-09.1380-1	Host Support for OCAP 1.1.1	4/17/09
HOST2.1-CFR-N-09.1385-1	Clarify DSG Channel Re-scan	4/17/09
HOST2.1-CFR-N-08.1386-2	Panic Dump Mods and Clarifications	4/17/09

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I09-090904:

ECN	Description	Date
HOST2.1-CFR-N-08.1315-5	Diagnostics Display	8/7/09
HOST2.1-CFR-N-08.1320-3	Create Boot Process events in docsDevEventTable	8/7/09
HOST2.1-CFR-N-08.1368-4	Host CFR 1GHz Tuning Requirements	8/7/09
HOST2.1-CFR-N-09.1372-5	CEC Functionality Requirement for OpenCable	8/7/09
HOST2.1-CFR-N-09.1374-3	Addition of mandatory support for 1080p24 output of STB host devices [Change #4 not incorporated]	8/7/09
HOST2.1-CFR-N-09.1381-1	Host Audio Specification Changes	8/7/09
HOST2.1-CFR-N-09.1382-6	Clarifications to Socket Flow behavior for UDP	6/2/09
HOST2.1-CFR-N-09.1403-2	Host eCM IPv6 requirements	8/7/09
HOST2.1-CFR-N-09.1407-3	Host Local and OOB MIB Access Requirements	8/7/09
HOST2.1-CFR-N-09.1412-1	Limited eCM MIB Access	8/7/09
HOST2.1-CFR-N-09.1416-5	Definition of Host Device Initialization Screens	8/7/09
HOST2.1-CFR-N-09.1417-1	Panic Dump Section Renumbering	8/7/09
HOST2.1-CFR-N-09.1420-2	Addition of optional DOCSIS 3.0 functionality	8/7/09
HOST2.1-CFR-N-09.1422-2	Front Panel Display Bootup Diagnostics	8/7/09

The following ECN was incorporated into OC-SP-HOST2.1-CFR-I10-091211:

ECN	Description	Date
HOST2.1-CFR-N-09.1441-2	Normative References Updates	11/20/09

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I11-100507:

ECN	Description	Date
HOST2.1-CFR-N-09.1455-2	Modify OSD App Signaling References	2/19/10
HOST2.1-CFR-N-10.1509-1	Event Code Update	3/5/10
HOST2.1-CFR-N-10.1534-1	CEC Requirement Corrections and Clarifications	4/16/10
HOST2.1-CFR-N-10.1537-1	Specify DCM behavior in creating channel map	4/30/10
HOST2.1-CFR-N-10.1538-2	Normative Reference Update	4/30/10
HOST2.1-CFR-N-10.1542-1	Memory heap representation in HR MIB	4/30/10

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I12-100910:

ECN	Description	Date
HOST2.1-CFR-N-10.1546-1	Remove pause (stop) the boot process associated to host validation with OCFPExt	6/25/10
HOST2.1-CFR-N-10.1557-2	Minor Adjustments to Diagnostic OSD	8/13/10
HOST2.1-CFR-N-10.1558-1	Clarify OSD HDMI MIB Value Reporting	8/13/10
HOST2.1-CFR-N-10.1561-1	Human-readable GPS Time	8/13/10
HOST2.1-CFR-N-10.1562-1	Improved Memory Page Template layout	8/13/10
HOST2.1-CFR-N-10.1564-1	OSD General Interpretation Improvements	8/13/10

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I13-110204:

ECN	Description	Date
HOST2.1-CFR-N-10.1576-4	3D Host Requirements	1/14/11
HOST2.1-CFR-N-10.1577-2	send_DCD_info() APDU DCC Operation Clarification	11/19/10
HOST2.1-CFR-N-10.1581-1	Configured Community Names for Loopback	11/5/10
HOST2.1-CFR-N-10.1589-1	Improved OCAP APPS Template Layout	11/19/10
HOST2.1-CFR-N-10.1621-1	Correct Host2.1 SCTE128 References	1/14/11

The following ECN was incorporated into OC-SP-HOST2.1-CFR-I14-110512:

ECN	Description	Date
HOST2.1-CFR-N-11.1653-3	Host CFR Reference edits for OpenCable bundle inclusion	5/9/11

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I15-120112:

ECN	Description	Date
HOST2.1-CFR-N-11.1671-2	Correct message length field for dump file format	7/15/11
HOST2.1-CFR-N-11.1674-3	Host changes for Set-top Extender Bridge	8/12/11
HOST2.1-CFR-N-11.1679-2	HN Network Prefix TLV	8/12/11
HOST2.1-CFR-N-11.1681-1	Add ipAddressTable to Host2.1	8/26/11
HOST2.1-CFR-N-11.1687-2	Host IPv4/v6 dual stack requirements	8/26/11
HOST2.1-CFR-N-11.1711-1	Host2.1 SEB Client provisioning	11/4/11
HOST2.1-CFR-N-11.1724-2	CFR BootUpPowerMode	12/16/11
HOST2.1-CFR-N-11.1733-2	Deprecate ADSG IP_U flow support	12/16/11

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I16-120531:

ECN	Description	Date
HOST2.1-CFR-N-11.1743-2	Overview of IP Address Acquisition Including Failure Cases	2/24/12
HOST2.1-CFR-N-12.1751-2	Change IEEE-1394 support to conditionally optional	2/24/12
HOST2.1-CFR-N-12.1766-1	Remove CableCard ipNetToPhysicalTable references	4/6/12
HOST2.1-CFR-N-12.1771-1	Remove race condition for set-top IP mode when TLV217.1 is absent	4/6/12

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I17-130418:

ECN	Author	Date	Description
HOST2.1-CFR-N-12.1812-2	Michon	2/22/13	DOCSIS 3.0 eCM 1x1 Mode
HOST2.1-CFR-N-13.1822-1	Skinner	4/5/13	send_DCD_info fix to account for Downstream Frequency Override