



***Society of Cable
Telecommunications
Engineers***

**ENGINEERING COMMITTEE
Data Standards Subcommittee**

AMERICAN NATIONAL STANDARD

ANSI/SCTE 137-6 2017

**Modular Headend Architecture Part 6:
Edge QAM Video Stream Interface**

NOTICE

The Society of Cable Telecommunications Engineers (SCTE) Standards and Operational Practices (hereafter called “documents”) are intended to serve the public interest by providing specifications, test methods and procedures that promote uniformity of product, interchangeability, best practices and ultimately the long term reliability of broadband communications facilities. These documents shall not in any way preclude any member or non-member of SCTE from manufacturing or selling products not conforming to such documents, nor shall the existence of such standards preclude their voluntary use by those other than SCTE members.

SCTE assumes no obligations or liability whatsoever to any party who may adopt the documents. Such adopting party assumes all risks associated with adoption of these documents, and accepts full responsibility for any damage and/or claims arising from the adoption of such documents.

Attention is called to the possibility that implementation of this document may require the use of subject matter covered by patent rights. By publication of this document, no position is taken with respect to the existence or validity of any patent rights in connection therewith. If a patent holder has filed a statement of willingness to grant a license under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license, then details may be obtained from the standards developer. SCTE shall not be responsible for identifying patents for which a license may be required or for conducting inquiries into the legal validity or scope of those patents that are brought to its attention.

Patent holders who believe that they hold patents which are essential to the implementation of this document have been requested to provide information about those patents and any related licensing terms and conditions. Any such declarations made before or after publication of this document are available on the SCTE web site at <http://www.scte.org>.

All Rights Reserved

© Society of Cable Telecommunications Engineers, Inc. 2017
140 Philips Road
Exton, PA 19341

Note: DOCSIS® is a registered trademark of Cable Television Laboratories, Inc., and is used in this document with permission.

Contents

1	SCOPE	1
1.1	INTRODUCTION AND PURPOSE	1
1.2	REQUIREMENTS AND CONVENTIONS	1
2	REFERENCES	2
2.1	NORMATIVE REFERENCES	2
2.2	INFORMATIVE REFERENCES	2
2.3	REFERENCE ACQUISITION	3
3	TERMS AND DEFINITIONS	4
4	ABBREVIATIONS AND ACRONYMS	5
5	TECHNICAL OVERVIEW	7
5.1	VIDEO EQAM REFERENCE ARCHITECTURE	7
5.1.1	<i>Video EQAM Block Diagram</i>	7
5.1.2	<i>Static vs. Dynamic Sessions</i>	8
5.1.3	<i>Input TS Processing</i>	9
5.1.4	<i>QAM Channel Processing</i>	10
5.1.5	<i>Redundancy</i>	10
5.1.6	<i>Summary of Session Types</i>	10
6	STREAM INPUT SPECIFICATIONS	12
6.1	STREAM INPUT ETHERNET INTERFACE SPECIFICATIONS	12
6.2	MPEG-2 TRANSPORT STREAM OVER IP INTERFACE SPECIFICATIONS	12
6.2.1	<i>MPEG-2 Input Transport Streams</i>	13
6.2.2	<i>IP Unicast and Multicast</i>	14
6.2.3	<i>Private Data Streams</i>	14
6.3	INPUT STREAM NETWORK DE-JITTERING SPECIFICATION	14
7	STREAM INPUT TO OUTPUT ROUTING	16
7.1	STATIC PORT MAP BASED ROUTING	16
7.2	DYNAMIC ERMI-2 SIGNALING BASED ROUTING	16
7.3	SIMULTANEOUS HANDLING OF DIFFERENT SESSION TYPES	17
7.4	MPTS INPUT ROUTING	18
7.5	INPUT TO OUTPUT LATENCY	18
8	QAM CHANNEL PROCESSING	19
8.1	MULTIPLEXING MODE	19
8.1.1	<i>General Multiplexing Requirements</i>	19
8.1.2	<i>Multiplexing with Input SPTS Streams</i>	23
8.1.3	<i>Multiplexing with Single Program Demux from Input MPTS</i>	23
8.1.4	<i>Multiplexing with Entire "Pre-conditioned" MPTS</i>	24
8.2	PASSTHROUGH MODE	24
9	ENCRYPTION AND ENCRYPTION INTERFACE	25
9.1	VIDEO PROGRAM ENCRYPTION	25
9.2	VIDEO PROGRAM SCRAMBLING	25
9.3	ENCRYPTION CONDITIONAL ACCESS CONTROL MESSAGES	25
10	STREAM OUTPUT SPECIFICATION	28

10.1	OUTPUT MPEG-2 TRANSPORT STREAM GENERAL REQUIREMENTS	28
10.2	OUTPUT MPEG-2 TRANSPORT STREAM OPERATIONAL REQUIREMENTS	28
10.2.1	Output Stream Set up Time	28
11	REDUNDANCY SPECIFICATIONS	29
11.1	REDUNDANCY INTRODUCTION.....	29
11.1.1	Redundancy: Efficiency	29
11.1.2	Redundancy: Quality of Service Types	29
11.1.3	Redundancy: Failover transition	30
11.1.4	Redundancy: Input Interface basic rules	30
11.1.5	Redundancy: Management and Control	30
11.2	REDUNDANCY GENERAL REQUIREMENTS.....	30
11.2.1	Input Interface Redundancy.....	30
11.2.2	Input TS Source Redundancy.....	31
11.2.3	Output TS Redundancy	32
12	INPUT AND OUTPUT MONITORING	33
12.1	INPUT TRANSPORT STREAM MONITORING	33
12.2	INPUT TS PROGRAM STREAM BIT RATE MONITORING	34
12.3	OUTPUT TS PROGRAM STREAM BANDWIDTH UTILIZATION MONITORING	34

Figures

Figure 5–1 - Video EQAM Block Diagram.....	8
Figure 6–1 - MPEG-2 Transport Stream over UDP/IP	12

Tables

Table 5–1 - Summary of Dynamic Session Types	11
Table 5–2 - Summary of Static Session Types	11
Table 8–1 - Well-known PIDs and PID Range.....	22

1 SCOPE

NOTE: This document is identical to SCTE 137-6 2010 except for informative components which may have been updated such as the title page, NOTICE text, headers and footers. No normative changes have been made to this document.

1.1 Introduction and Purpose

This specification is a component of the Modular Headend Architecture. In particular, it defines the data plane requirements for receiving, processing, and transmitting MPEG transport streams in EQAMs, compliant with the Video EQAM or Universal EQAM profiles described in the Architectural Overview of the Modular Headend Architecture [SCTE 137-7]

It should be noted that this document refers to "MPEG video" support as a short-hand to designate support for the delivery of [ISO/IEC 13818-1] compliant MPEG transport streams that may carry audio material, video material, data, or a combination.

The EQAM supporting MPEG video has one or more IP network interfaces (e.g., Gigabit Ethernet) for receipt of IP-encapsulated MPEG transport stream packets that may arrive from a VOD or streaming server. The EQAM can be configured either statically (via [SCTE 137-5]) or dynamically (via ERMI-2, as defined in [SCTE 137-4]) to process the incoming MPEG transport streams, generate a Multiple Program Transport Stream (MPTS), and then, from that MPTS, generate a QAM modulated RF waveform that is transmitted at a particular frequency on an RF output of the device.

1.2 Requirements and Conventions

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

"MUST"	This word means that the item is an absolute requirement of this specification.
"MUST NOT"	This phrase means that the item is an absolute prohibition of this specification.
"SHOULD"	This word means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighed before choosing a different course.
"SHOULD NOT"	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
"MAY"	This word means that this item is truly optional. 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.

2 REFERENCES

The following documents contain provisions, which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and users of this document are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

2.1 Normative References

- [ISO/IEC 13818-1] ISO/IEC 13818-1:2000, Information technology, Generic coding of moving pictures, and associated audio information: Systems.
- [ISO/IEC 8802-2] ISO/IEC 8802-2:1998, Information technology, Telecommunications and information exchange between systems, Local and metropolitan area networks, Specific requirements, Part 2: Logical link control.
- [ISO/IEC 8802-3] ISO/IEC 8802-3:2000, Information technology, Telecommunications and information exchange between systems, Local and metropolitan area networks, Specific requirements, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.
- [ITU-T J.83] ITU-T Recommendation, J.83, (04/97) Digital multi-programme systems for television sound and data services for cable distribution.
- [SCTE 52] ANSI/SCTE 52 2008, Data Encryption Standard - Cipher Block Chaining Packet Encryption Specification.
- [SCTE 54] ANSI/SCTE 54 2006, Digital Video Service Multiplex and Transport System Standard for Cable Television.
- [SCTE 137-1] ANSI/SCTE 137-1 2007, Modular Headend Architecture Part 1: DOCSIS Timing Interface.
- [SCTE 137-4] ANSI/SCTE 137-4 2007, Modular Headend Architecture Part 4: Edge Resource Manager Interface. (Formerly known as SCTE 139)
- [SCTE 137-5] SCTE 137-5 2010, Modular Headend Architecture Part 5: Edge QAM Provisioning and Management Interface.

2.2 Informative References

This specification uses the following informative references.

- [CEP] Content Encoding Profiles 2.0 Specification, MD-SP-VOD-CEP2.0-I02-070105, January 5, 2007, Cable Television Laboratories, Inc.
- [E-BIF] OpenCable Enhanced TV Binary Interchange Format 1.0 Specification, OC-SP-ETV-BIF1.0-I04-070921, September 21, 2007, Cable Television Laboratories, Inc.
- [IANA] Internet Assigned Numbers Authority, <http://www.iana.org/assignments/multicasting-addresses>.
- [ISO/IEC 13818-2] ISO/IEC 13818-2:2000 Information technology -- Generic coding of moving pictures and associated audio information: Video.
- [ITU-T H.264] ITU-T Recommendation H.264 (05/03), Advanced video coding for generic audiovisual services.
- [RFC 894] IETF RFC 894, A Standard for the Transmission of IP Datagrams over Ethernet Networks, April 1984.

[SCTE 18]	ANSI/SCTE 18 2007, Emergency Alert Messaging for Cable.
[SCTE 133]	ANSI/SCTE 133 2007, Downstream RF Interface.
[SCTE 137-7]	SCTE 137-7 2010, Modular Headend Architecture Part 7: EQAM Architectural Overview Technical Report
[SMPTE 421M]	SMPTE 421M-2006 Television, VC-1 Compressed Video Bitstream Format and Decoding Process.

2.3 Reference Acquisition

- 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>
- Internet Engineering Task Force (IETF) Secretariat, 46000 Center Oak Plaza, Sterling, VA 20166, Phone +1-571-434-3500, Fax +1-571-434-3535, <http://www.ietf.org>
- International Telecommunication Union - Telecommunication Standardization Sector (ITU-T), <http://www.itu.int/itu-t/>
- International Organization for Standardization (ISO), <http://www.iso.org>
- Society of Cable Telecommunications Engineers (SCTE), 140 Philips Rd., Exton, PA 19341-1318, Phone: +1-610-363-6888, Fax: 610-363-5898, <http://www.scte.org>
- The Society of Motion Picture and Television Engineers (SMPTE), 3 Barker Ave., White Plains, NY 10601, +1-914-761-1100, <http://www.smpte.org>

3 TERMS AND DEFINITIONS

This specification uses the following terms:

CA_descriptor	Conditional Access descriptor, as defined in ISO/IEC 13818-1. Each CA_descriptor provides the PID for EMMs for a particular conditional access system.
Edge QAM	A head-end or hub device that receives packets of digital video or data from the operator network. It re-packetizes the video or data into an MPEG transport stream and digitally modulates the transport stream onto a downstream RF carrier using QAM.
ERMI-1	A registration interface between an ERM and an EQAM defined in [SCTE 137-4]. This interface is used to register and unregister EQAM resources (i.e., QAM channels) with an ERM.
ERMI-2	A control interface between an EQAM and an ERM defined in [SCTE 137-4]. This interface is used by an ERM to request QAM channel resource from an EQAM, and by an EQAM to deliver resources to an ERM.
MAC Domain	A grouping of layer two devices that can communicate with each other without using bridging or routing. In DOCSIS, a MAC domain is the group of CMs that are using upstream and downstream channels linked together through a MAC forwarding entity.
Service Group	An HFC service group (also known as a service group) is a portion of an HFC access network used to deliver a set of services to a population of cable modems that share a common spectrum of RF channels.
Jitter	Variability in the delay of a stream of incoming packets making up a flow, such as a voice communication.

4 ABBREVIATIONS AND ACRONYMS

This specification uses the following abbreviations:

ARP	Address Resolution Protocol
ASM	Any Source Multicast
AVC	Advanced Video CODEC
CA	Conditional Access
CAS	Conditional Access System
CAT	Conditional Access Table
CBR	Constant Bit Rate
DSM-CC	Digital Storage Media Command and Control
DTS	Decoding Timestamp
DVB	Digital Video Broadcasting
EBIF	Enhanced TV Binary Interchange Format
ECM	Entitlement Control Message
ECMG	ECM Generator
EMM	Entitlement Management Message
EMMG	EMM Generators
EQAM	Edge QAM
ERM	Edge Resource Manager
ERMI	Edge Resource Management Interfaces
ES	Elementary Stream
EISS	Element used to create ETV Integrated Signaling Streams
ETV	Enhanced Television
HD	High Definition
IANA	Internet Assigned Numbers Authority
ICMP	Internet Control Message Protocol
IEEE	Institute of Electrical and Electronics Engineers
IGMP	Internet Group Management Protocol
IP	Internet Protocol
ISO	International Organization for Standardization
MPEG	Moving Picture Experts Group
MPTS	Multiple Program Transport Stream
PAT	Program Association Table
PCR	Program Clock Reference
PID	Packet Identifier

PMT	Program Map Table
PSI	Program Specific Information
PTS	Presentation Timestamp
QAM	Quadrature Amplitude Modulator
RF	Radio Frequency
RFC	Request for Comment
RTP	Real-time Transport Protocol.
SD	Standard Definition
SDV	Switched Digital Video
SPTS	Single Program Transport Stream
SSM	Source Specific Multicast
STB	Set-top Box
TS	Transport Stream
TSDT	Transport Stream Description Table
TSID	Transport Stream Identifier
UDP	User Datagram Protocol
VBR	Variable Bit Rate
VOD	Video on Demand

5 TECHNICAL OVERVIEW

The role of the EQAM in the video-on-demand and switched-digital-video architecture is to receive an IP unicast or multicast stream containing MPEG transport stream packets, and then produce that transport stream on one or more RF outputs for transmission over the hybrid fiber-coax cable plant.

5.1 Video EQAM Reference Architecture

5.1.1 Video EQAM Block Diagram

Figure 5–1 shows a conceptual block diagram of a video EQAM. The EQAM has a management and control interface through which configuration messages, resource management traffic, and network management information pass. It also has one or more input interfaces upon which the IP-encapsulated MPEG transport streams arrive. Those input interfaces feed input transport stream processing blocks that handle de-multiplexing the individual transport streams (based on UDP destination port number or IP multicast address information) from the input interface, providing de-jittering of those transport streams, and routing them to the appropriate QAM channel processing blocks.

Each QAM Channel Processing block handles the generation of an output MPTS for a single QAM channel. It could be in passthrough mode, in which case it accepts a single MPEG Transport Stream from the input TS processing block, performs minimal processing, and forwards it to the QAM channel for modulation and transmission. Alternatively, it could be in multiplexing mode, in which case it accepts a number of input transport streams (SPTS and/or MPTS), selects certain programs from those inputs, can perform program number remapping and PID remapping, generates PSI information, and multiplexes the selected programs into an output MPTS, which is then forwarded to the QAM channel for modulation and transmission.

Each physical RF Port on the output of the EQAM may produce multiple QAM channels (this example shows four), although that is not a required functionality in this specification.

The EQAM may be subdivided internally into multiple QAM Processing Blocks in which each input interface and output RF port is associated with a single QAM Processing Block. In this case, the input transport streams arriving at an input interface associated with one QAM Processing Block cannot be routed to RF Ports associated with a different QAM Processing Block. This might be the case for an EQAM implemented as a series of linecards in a chassis that provides a single management and control interface.

In the case where the EQAM can route any input transport stream to any QAM Channel, the EQAM could be considered to be implemented as a single QAM processing block.

This example shows three input interfaces and four RF Ports (each producing four QAM channels) per QAM Processing Block. This is simply meant as an illustrative example.

This block diagram is intended to provide insight into the functionality provided by the video EQAM; it is not intended to mandate a particular internal architecture or implementation.

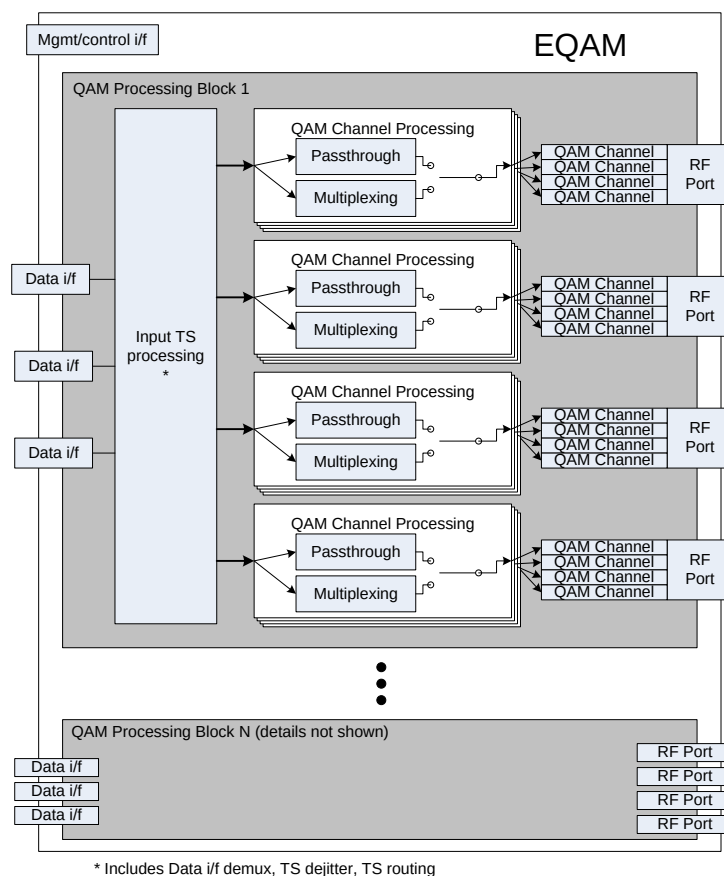


Figure 5-1 - Video EQAM Block Diagram

5.1.2 Static vs. Dynamic Sessions

The term "session" in the context of an EQAM supporting VOD and SDV refers to the mapping of a single input transport stream (SPTS or MPTS), arriving encapsulated in UDP/IP, to a single output transport stream that is modulated on a particular QAM carrier.

The video EQAM supports two mechanisms for the establishment of sessions.

The first mechanism is invoked during initial boot-up and configuration, or during a maintenance window, and involves the EQAM being pre-configured to map particular input streams to particular output streams. This mechanism is called "static port mapping," "static session setup," or "table mode." In a static port mapping, the EQAM is provided with a particular UDP destination port number upon which to expect to receive a particular input SPTS, and an output QAM channel and MPEG Program Number that is to be the destination for the program contained in the input SPTS. When packets with the specified UDP destination port number are received on any input data interface within the QAM Processing Block associated with the specified QAM channel, the EQAM extracts the MPEG-TS packets and begins the processing steps that will result in those MPEG-TS packets being transmitted out the specified QAM channel, using the specified MPEG Program Number. If no packets are received with the designated UDP destination port number, the EQAM simply does not forward any MPEG packets for that program. In a static port mapped environment, each QAM channel on the EQAM might be configured with a large number of static port maps, only a handful of which might be in use at any given time.