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PROGRAM AND SYSTEM INFORMATION PROTOCOL FOR TERRESTRIAL BROADCAST AND CABLE (REVISION A)

AND

AMENDMENT NO. 1

ADVANCED TELEVISION SYSTEMS COMMITTEE

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PROGRAM AND SYSTEM INFORMATION PROTOCOL FOR TERRESTRIAL BROADCAST AND CABLE – REVISION A

ATSC STANDARD

Table of Contents

PROGRAM AND SYSTEM INFORMATION PROTOCOL FOR TERRESTRIAL BROADCAST AND CABLE – REVISION A

ATSC STANDARD

1. SCOPE

1.1 Purpose

This document defines a Standard for System Information (SI) and Program Guide (PG) data compatible with digital multiplex bit streams constructed in accordance with ISO/IEC 13818-1 (MPEG-2 Systems). The document defines the standard protocol for transmission of the relevant data tables contained within packets carried in the Transport Stream multiplex. The protocol defined herein will be referred to as **Program and System Information Protocol (PSIP).**

This standard was prepared by the Advanced Television Systems Committee (ATSC) Technology Group on Distribution (T3). The document was approved by the members of the ATSC on 23 December 1997. Revision A to PSIP (31 May 2000) is the result of incorporating PSIP Corrigendum A/66 and PSIP Amendment A/67 after their approval by the full ATSC. Please note that there is an Amendment No. 1 to this revision located at the end of this document. This amendment, featuring the Directed Channel Change capability, was approved by the ATSC membership on 31 May 2000.

For an informative description of the purpose, concepts, and tables defined in this protocol, first time readers are encouraged to start with Annex D.

1.2 Application

This document describes tables that shall be applicable to terrestrial (over-the-air) and cable signals. Some PSIP tables apply to terrestrial broadcast, some apply to cable, and others apply to both.

1.2.1 Terrestrial Broadcast

The following PSIP data shall be included in all ATSC-compliant Transport Streams to be transmitted via terrestrial broadcast:

- The Terrestrial Virtual Channel Table (TVCT) defining, at a minimum, MPEG-2 programs embedded in the Transport Stream in which the TVCT is carried.

NOTE: The user’s attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, no position is taken with respect to the validity of this claim, or of any patent rights in connection therewith. The patent holder has, however, 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. Details may be obtained from the publisher. This document will undergo periodic review and may be subject to change by ballot of the ATSC membership.

- The Master Guide Table (MGT) defining the type, packet identifiers, and versions for all the other PSIP tables in this Transport Stream, except for the System Time Table (STT).
- The Rating Region Table (RRT) defining the TV parental guideline system referenced by any content advisory descriptor carried within the Transport Stream.
- The System Time Table (STT), defining the current date and time of day.
- A service_location_descriptor for each digital virtual channel in the VCT.
- The first four Event Information Tables (EIT-0, EIT-1, EIT-2 and EIT-3) describing 12 hours of events (TV programs), each with a coverage of 3 hours, and including all of the virtual channels listed in the TVCT.

1.2.2 Cable

The following PSIP data shall be included in all ATSC-compliant Transport Streams to be transmitted via cable:

- The Cable Virtual Channel Table (CVCT) defining, at a minimum, the virtual channel structure for the collection of MPEG-2 programs embedded in the Transport Stream in which the CVCT is carried.
- The Master Guide Table (MGT) defining the type, packet identifiers, and versions for all of the other PSIP tables included in this Transport Stream except for the System Time Table (STT).
- The Rating Region Table (RRT) defining the TV parental guideline system referenced by any content advisory descriptor carried within the Transport Stream.
- The System Time Table (STT), defining the current date and time of day.

1.3 Organization

The sections of this document are organized as follows:

- **Section 1 —** Provides this general introduction.
- **Section 2 —** Lists references and applicable documents.
- **Section 3 —** Provides a definition of terms and a list of acronyms and abbreviations used in this document.
- **Section 4 —** Describes the data structure of the PSIP tables.
- **Section 5 —** Describes the overall table hierarchy.
- **Section 6 —** Describes formats for all of the PSIP tables.
- **Section 7 —** Describes PSIP STD model.
- **Annex A—** Describes the daylight savings time control.
- **Annex B —** Describes the assignment of major_channel_number values for terrestrial

broadcast in the U.S.

- **Annex C —** Describes the standard Huffman tables for text compression.
- **Annex D** — Provides an overview of PSIP for terrestrial broadcast with application examples.
- **Annex E** — Describes the typical sizes of PSIP tables.
- **Annex F** — Provides an overview of Huffman-based text compression.
- **Annex G** — Provides an overview of the use of PSIP for cable.

2. REFERENCES

The following documents are applicable to this Standard:

1. ATSC Standard A/52 (1995), Digital Audio Compression (AC-3) (*normative*).
2. ATSC Standard A/53 (1995), ATSC Digital Television Standard (*normative*).
3. ATSC Standard A/55 (1996), Program Guide for Digital Television (*informative*).
4. ATSC Standard A/56 (1996), System Information for Digital Television (*informative*).
5. ATSC Standard A/57 (1996), Program/Episode/Version Identification (*normative*). [A/57 is being revised as of 5/31/00]
6. ISO 639, Code for the Representation of Names of Languages, 1988 (*informative*).
7. ISO CD 639.2, Code for the Representation of Names of Languages: alpha-3 code, Committee Draft, dated December 1994 (*normative*).
8. ISO/IEC 10646-1:1993, Information technology — Universal Multiple-Octet Coded Character Set (UCS) — Part 1: Architecture and Basic Multilingual Plane (*normative*).
9. ISO/IEC 8859**,** Information Processing — 8-bit Single-Octet Coded Character Sets, Parts 1 through 10 (*normative*).
10. ITU-T Rec. H.222.0 | ISO/IEC 13818-1:1996, Information Technology — Generic coding of moving pictures and associated audio — Part 1: Systems (*normative*).
11. ITU-T Rec. H.262 | ISO/IEC 13818-2:1996, Information Technology — Generic coding of moving pictures and associated audio — Part 2: Video (*normative*).
12. Digital Video Transmission Standard for Cable Television, SCTE DVS-031, Rev. 2, 29 May 1997 (*informative*).
13. EIA-708A *Specification for Advanced Television Closed Captioning (ATVCC)*, Electronic Industry Association (*normative*).
14. EIA-752 *Specification for Transport of Transmission Signal Identifier (TSID) Using Extended Data Service)*, Electronic Industry Association (*normative*).
15. Record of Test Results for Digital HDTV Grand Alliance System, September 8,

1995, Advanced Television Test Center (*Informative*).

16. EIA-766 *Specification for U.S. Region Rating Table (RRT) and Content Advisory Descriptor for Transport of Content Advisory Information Using ATSC A/65 Program and System Information Protocol (PSIP)*, Electronic Industry Association (*normative*).

3. DEFINITIONS

3.1 Compliance Notation

As used in this document, *"shall"* or *"will"* denotes a mandatory provision of the standard. *"Should"* denotes a provision that is recommended but not mandatory. *"May"* denotes a feature whose presence does not preclude compliance, that may or may not be present at the option of the implementer.

3.2 Acronyms and Abbreviations

The following acronyms and abbreviations are used within this specification:

ATSC	Advanced Television Systems Committee
bslbf	bit serial, leftmost bit first
BMP	Basic Multilingual Plane
CAT	Conditional Access Table
CRC	Cyclic Redundancy Check
CVCT	Cable Virtual Channel Table
DTV	Digital Television
EPG	Electronic Program Guide
EIT	Event Information Table
EMM	Entitlement Management Message
ETM	Extended Text Message
ETT	Extended Text Table
GPS	Global Positioning System
PSIP	Program and System Information Protocol
MGT	Master Guide Table
MPAA	Motion Picture Association of America
MPEG	Moving Picture Experts Group
NVOD	Near Video On Demand
OOB	Out of Band
PAT	Program Association Table
PCR	Program Clock Reference
PES	Packetized Elementary Stream
PID	Packet Identifier
PMT	Program Map Table
PTC	Physical Transmission Channel
SCTE	Society of Cable Telecommunications Engineers

SI	System Information
STD	System Target Decoder
STT	System Time Table
rpchof	remainder polynomial coefficients, highest order first
RRT	Rating Region Table
TS	Transport Stream
TVCT	Terrestrial Virtual Channel Table
unicode	Unicode™
UTC	Coordinated Universal Time[1]
uimsbf	unsigned integer, most significant bit first
VCT	Virtual Channel Table. Used in reference to either TVCT or CVCT.

3.3 Definition of Terms

The following terms are used throughout this document:

descriptor: A data structure of the format: descriptor_tag, descriptor_length, and a variable amount of data. The tag and length fields are each 8 bits. The length specifies the length of data that begins immediately following the descriptor_length field itself. A descriptor whose descriptor_tag identifies a type not recognized by a particular decoder shall be ignored by that decoder. Descriptors can be included in certain specified places within PSIP tables, subject to certain restrictions (see Table 6.16). Descriptors may be used to extend data represented as fixed fields within the tables. They make the protocol very flexible since they can be included only as needed. New descriptor types can be standardized and included without affecting receivers that have not been designed to recognize and process the new types.

digital channel: A set of one or more digital elementary streams. See *virtual channel*.

event: A collection of elementary streams with a common time base, an associated start time, and an associated end time. An event is equivalent to the common industry usage of "television program."

instance: See *table instance*.

logical channel: See *virtual channel*.

physical channel: A generic term to refer to the each of the 6-8 MHz frequency bands where television signals are embedded for transmission. Also known as the physical transmission channel (PTC). One analog virtual channel fits in one PTC but multiple digital virtual channels typically coexist in one PTC.

physical transmission channel: See *physical channel*.

program element: A generic term for one of the elementary streams or other data streams that may be included in a program. For example: audio, video, data, etc.

program: A collection of program elements. Program elements may be elementary streams. Program elements need not have any defined time base; those that do have a common time base

[1] Since unanimous agreement could not be achieved by the ITU on using either the English word order, CUT, or the French word order, TUC, a compromise to use neither was reached.

are intended for synchronized presentation. The term *program* is also commonly used in the context of a "television program" such as a scheduled daily news broadcast. In this specification the term "event" is used to refer to a "television program" to avoid ambiguity.

region: As used in this document, a region is a geographical area consisting of one or more countries.

section: A data structure comprising a portion of an *ISO/IEC 13818-1* defined table, such as the Program Association Table (PAT), Conditional Access Table (CAT), or Program Map Table (PMT). All sections begin with the table_id and end with the CRC_32 field, and their starting points within a packet payload are indicated by the pointer_field mechanism defined in the *ISO/IEC 13818-1* International Standard.

stream: An ordered series of bytes. The usual context for the term *stream* is the series of bytes extracted from Transport Stream packet payloads which have a common unique PID value (e.g., video PES packets or Program Map Table sections).

table: PSIP is a collection of tables describing virtual channel attributes, event features, and others. PSIP tables are compliant with the private section syntax of ISO/IEC 13818-1.

table instance: Tables are identified by the table_id field. However, in cases such as the RRT and EIT, several instances of a table may be defined simultaneously. All instances have the same PID and table_id but different table_id_extension.

virtual channel: A virtual channel is the designation, usually a number, that is recognized by the user as the single entity that will provide access to an analog TV program or a set of one or more digital elementary streams. It is called "virtual" because its identification (name and number) may be defined independently from its physical location. Examples of virtual channels are: digital radio (audio only), a typical analog TV channel, a typical digital TV channel (composed of one audio and one video stream), multi-visual digital channels (composed of several video streams and one or more audio tracks), or a data broadcast channel (composed of one or more data streams). In the case of an analog TV channel, the virtual channel designation will link to a specific physical transmission channel. In the case of a digital TV channel, the virtual channel designation will link both to the physical transmission channel and to the particular video and audio streams within that physical transmission channel.

3.4 Section and Data Structure Syntax Notation

This document contains symbolic references to syntactic elements. These references are typographically distinguished by the use of a different font (e.g., restricted), may contain the underscore character (e.g., sequence_end_code) and may consist of character strings that are not English words (e.g., dynrng).

The formats of sections and data structures in this document are described using a C-like notational method employed in *ISO/IEC 13818-1*.

4. DATA STRUCTURE

This section describes the data structure common to all PSIP tables. It also lists valid table_id and PID values for every table that belongs to PSIP.

4.1 Table Format

Tables defined in this Standard are structured in the same manner used for carrying *ISO/IEC 13818-1* -defined PSI tables, shown in Table 4.1. The structure conforms to the generic private section syntax defined in ISO/IEC 13818-1

Table 4.1 Table Format Used in PSIP

Syntax	Bits	Format
typical_PSI_table( ) {		
table_id	8	uimsbf
section_syntax_indicator	1	‘1’
private_indicator	1	‘1’
reserved	2	‘11’
section_length	12	uimsbf
table_id_extension	16	uimsbf
Reserved	2	‘11’
version_number	5	uimsbf
current_next_indicator	1	bslbf
section_number	8	uimsbf
last_section_number	8	uimsbf
protocol_version	8	uimsbf
actual_table_data	*	
CRC_32	32	rpchof
}		

4.2 Table ID Ranges and Values

Table 4.2 defines Table ID ranges and values.

Table 4.2 ID Ranges and Values

Table ID Value (hex)	Tables	PID	Ref.
	ISO/IEC 13818-1 Sections:		
0x00	PROGRAM ASSOCIATION TABLE (PAT)	0	Ref. [10]
0x01	CONDITIONAL ACCESS TABLE (CAT)	1	Ref. [10]
0x02	TS PROGRAM MAP TABLE (PMT)	per PAT	Ref. [10]
0x03-0x3F	[ISO Reserved]		
	User Private Sections:		
0x40-0x7F	[User Private for other systems]		
0x80-0xBF	[User Private]		
	Other documents:		
0xC0-0xC6	[Used in other systems]		
	PSIP Tables:		
0xC7	MASTER GUIDE TABLE (MGT)	0x1FFB	Sec.6.2
0xC8	TERRESTRIAL VIRTUAL CHANNEL TABLE (TVCT)	0x1FFB	Sec.6.3.1
0xC9	CABLE VIRTUAL CHANNEL TABLE (CVCT)	0x1FFB	Sec.6.3.2
0xCA	RATING REGION TABLE (RRT)	0x1FFB	Sec.6.4
0xCB	EVENT INFORMATION TABLE (EIT)	per MGT	Sec.6.5
0xCC	EXTENDED TEXT TABLE (ETT)	per MGT	Sec.6.6
0xCD	SYSTEM TIME TABLE (STT)	0x1FFB	Sec.6.1
0xCE-0xDF	[Reserved for future ATSC use]		
0xE0-0xE5	[Used in other systems]		
0xE6-0xFE	[Reserved for future ATSC use]		
0xFF	**Inter-message Filler**		

Tables defined in this PSIP Standard, and any created as user extensions to it are considered "private" with respect to *ISO/IEC 13818-1*. Table types 0x40 through 0xBF are user defined (outside the scope of this PSIP Standard).

4.3 Extensibility

The PSIP protocol describes a number of tables conveying system information and content guide data structures. The Standard is designed to be extensible via the following mechanisms:

1. **Reserved Fields:** Fields in this Standard marked reserved shall be reserved for use either when revising this Standard, or when another standard is issued that builds upon this one. See Section 4.4 below.
2. **Standard Table Types:** As indicated in Table 4.2, table_id values in the range 0xCE-0xDF and 0xE6-0xFE shall be reserved for use either when revising this PSIP Standard, or when another standard is issued that builds upon this one.
3. **User Private Table Types:** As indicated in Table 4.2, table_id values in the range 0x40 through 0xBF shall be reserved for "user private" use.
4. **User Private Descriptors:** Privately defined descriptors may be placed at designated locations throughout the tables described in this Standard. Ownership of one or more

user private descriptors may be indicated by the presence of an MPEG registration_descriptor() preceding the descriptor(s).

5. **Protocol Version Field:** Initially this field is set to 0, but after approval, future structural modifications shall be accommodated by defining different protocol version numbers.

4.4 Reserved Fields

reserved — Fields in this PSIP Standard marked "reserved" shall not be assigned by the user, but shall be available for future use. Decoders are expected to disregard reserved fields for which no definition exists that is known to that unit. Each bit in the fields marked "reserved" shall be set to one until such time as they are defined and supported.

user_private — Indicates that the bit or bit field is not defined within the scope of this Standard. The owner of the bit, and hence the entity defining its meaning, is derived via its context within a message.

zero — Indicates that the bit or bit field shall have the value zero.

5. TABLE HIERARCHY AND STRUCTURE REQUIREMENTS

The Program and System Information Protocol (PSIP) is a collection of hierarchically arranged tables for describing system information and program guide data. These tables are packetized and multiplexed according to the transport protocol detailed in ISO/IEC 13818-1.

The base PID (base_PID) is an explicitly defined value (0x1FFB) used to identify the packets for the following tables for terrestrial and cable systems: The System Time Table (STT), the Master Guide Table (MGT), the Rating Region Table (RRT), and the Virtual Channel Table (VCT). Several Event Information Tables (EIT) are also part of the PSIP data structures, with their PIDs explicitly defined in the MGT. Figure 5.1 illustrates the relations between these elements.

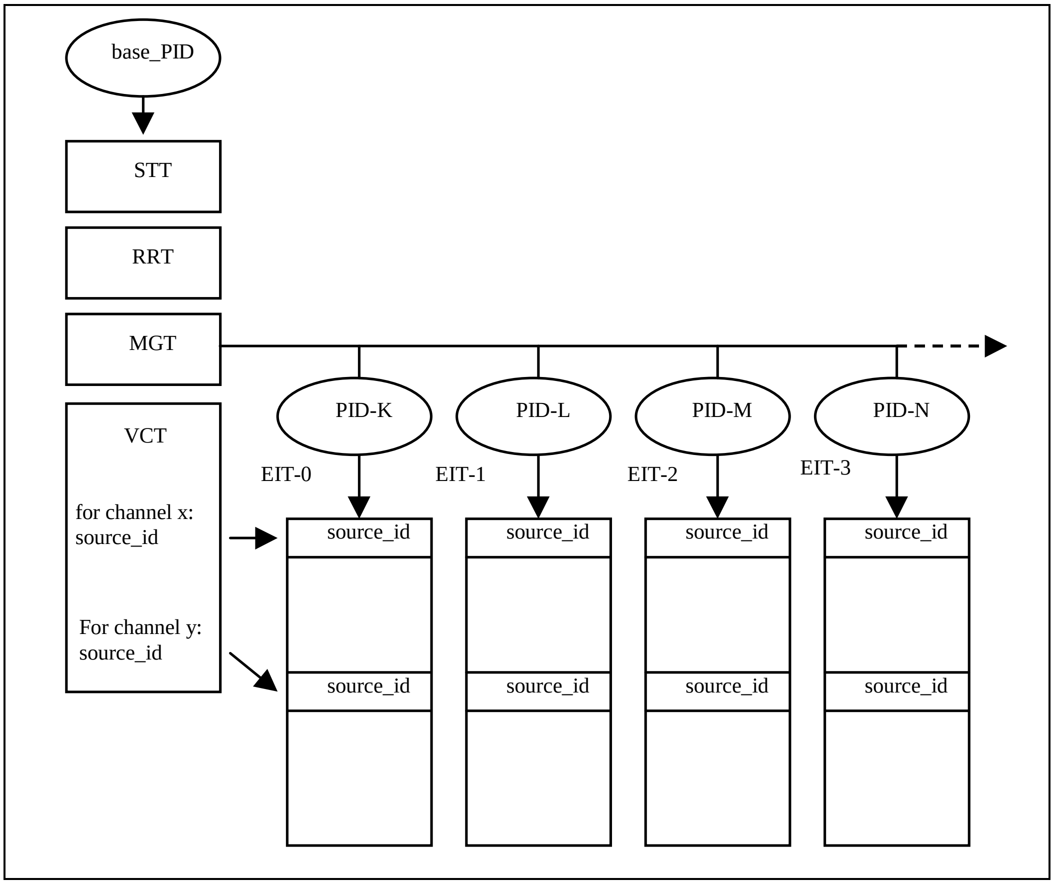

Figure 5.1 Table Hierarchy for the Program and System Information Protocol (PSIP)

As the name indicates, the System Time Table (STT) carries time information needed for any application requiring synchronization. The Rating Region Table (RRT) defines rating tables valid for different regions or countries. The Master Guide Table (MGT) defines sizes, PIDs, and version numbers for all of the relevant tables. The Virtual Channel Table (VCT) actually exists in two versions: one for terrestrial and a second one for cable applications. Its purpose is to tabulate virtual channel attributes required for navigation and tuning. The terrestrial and cable versions are similar in structure, with the latter redefining the semantics of some fields pertinent to cable operations.

Each of the Event Information Tables (EITs) lists TV programs (events) for the virtual channels described in the VCT. The EITs are sequentially and chronologically organized from EIT-0 to EIT-127. The first table (EIT-0), corresponds to the currently valid list of events. The second table (EIT-1) corresponds to the next time window, and so on.

During remultiplexing, EIT tables which originally existed in separate Transport Streams may be multiplexed into a common Transport Stream or *vice versa*. For this reason, it is very convenient to synchronize the start times and durations of the EITs. Consequently, the next three synchronization rules shall be followed when EIT tables are prepared.

Requirement 1: *Each EIT shall have a duration of 3 hours.*

Requirement 2: *Start times for EITs are restricted to 0:00 (midnight), 3:00, 6:00, 9:00, 12:00 (noon), 15:00, 18:00 and 21:00. All of these times are UTC.*

Requirement 3: *EIT-0 lists all of the available events for the current 3-hour time segment. EIT-1 lists all of the available events for the next 3-hour time segment, and likewise, non-overlapping sequential time windows are allocated for all of the other EITs.*

For example, a broadcast group operating in the Eastern time zone of the U.S. at 15:30 EDT (19:30 UTC) is required to carry EIT-0 describing events from 14:00 to 17:00 EDT (18:00 to 21:00 in UTC time) plus EIT-1, EIT-2, and EIT-3 covering the next 9-hour interval between 17:00 to 2:00 EDT. At 17:00 EDT, the first table, EIT-0, will be obsolete while EIT-1 will still be valid. At this time, simply by shifting the listed PID values in the MGT, EIT-1 becomes EIT-0 and EIT-2 becomes EIT-1. Updating tables then becomes a process of shifting the list of PIDs in the MGT and their corresponding version numbers. However, updates and/or corrections to the information in the EITs may be performed at any time since the decoder monitors the MGT continuously, where the most current copy of the version number is maintained. Updates and/or corrections to the EIT (other than shifting) shall be signaled by increasing the version number by one.

Besides listing the PIDs for all of the EITs, the Master Guide Table (MGT) also lists a set of PIDs for Extended Text Tables (ETTs). The ETTs carry relatively long text messages for describing events and virtual channels. Each EIT has either zero or one associated ETT. Similarly, The VCT has either zero or one associated ETT. Figure 5.2 illustrates the concept.

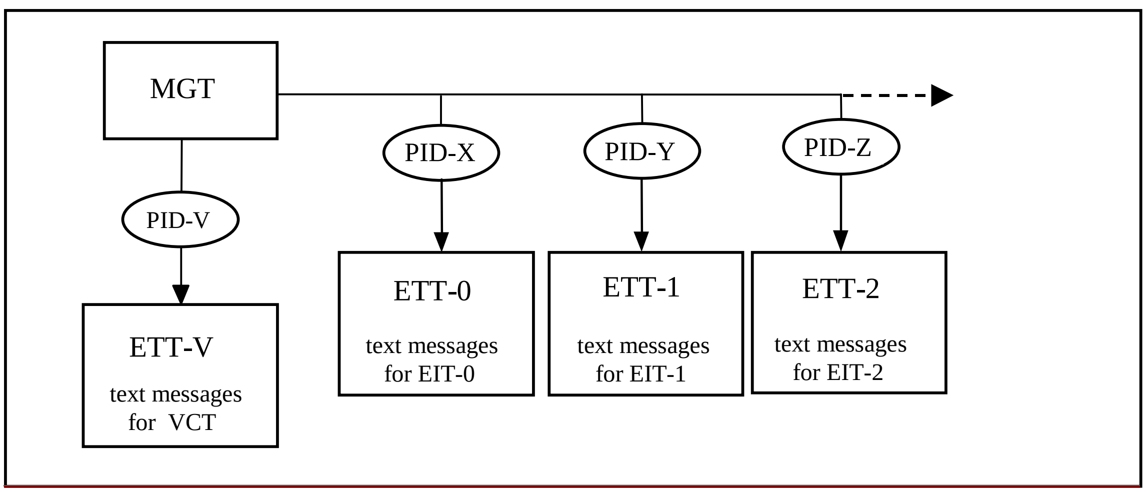

Figure 5.2 Extended Text Tables (ETTs) Defined to Carry Text Messages for Describing Virtual Channels and Events.

5.1 Requirements for Terrestrial Broadcast

The rules governing the transport of PSIP tables for terrestrial broadcast are:

Requirement 4: *Every digital Transport Stream in terrestrial broadcast shall include the STT, the RRT, the TVCT, the MGT, and the first four Event Information Tables (EIT-0,* *EIT-1, EIT-2 and EIT-3). All of the other EITs and the whole collection of ETTs are optional.*

Requirement 5: *The PSIP tables shall describe all of the digital channels multiplexed in the Transport Stream. For convenience, the tables may optionally include information about analog channels as well as other digital channels available in different Transport Streams.*

5.2 Requirements for Cable

The rules governing the transport of PSIP tables for cable are:

Requirement 6: *The required tables for a cable system are: the STT, the RRT, the CVCT, and the MGT.*

Requirement 7: *The PSIP tables shall describe all of the digital channels multiplexed in the Transport Stream. For convenience, the tables may optionally include information about analog channels as well as other digital channels available in different Transport Streams.*

6. SPECIFICATIONS

This chapter describes the bit stream syntax and semantics for the System Time Table (STT), Master Guide table (MGT), Virtual Channel Table (VCT), Rating Region Table (RRT), Event Information Table (EIT), Extended Text Table (ETT), core descriptors, and the multiple string structure.

6.1 System Time Table (STT)

The System Time Table provides the current date and time of day information.

The following constraints apply to the Transport Stream packet carrying the STT:

- PID for STT shall have the value 0x1FFB (base_PID)
- transport_scrambling_control bits shall have the value ‘00’
- adaptation_field_control bits shall have the value ‘01’

The bit stream syntax for the System Time Table is shown in Table 6.1.

Table 6.1 Bit Stream Syntax for the System Time Table

Syntax	Bits	Format
system_time_table_section () {		
table_id	8	0xCD
section_syntax_indicator	1	'1'
private_indicator	1	'1'
reserved	2	'11'
section_length	12	uimsbf
table_id_extension	16	0x0000
reserved	2	'11'
version_number	5	'00000'
current_next_indicator	1	'1'
section_number	8	0x00
last_section_number	8	0x00
protocol_version	8	uimsbf
system_time	32	uimsbf
GPS_UTC_offset	8	uimsbf
daylight_savings	16	uimsbf
for (I = 0;I< N;I++) {		
descriptor()		
}		
CRC_32	32	rpchof
}		

table_id — This is an 8-bit field, which shall be set to 0xCD, identifying this table as the System Time Table.

section_syntax_indicator — This 1-bit field shall be set to '1'. It denotes that the section follows the generic section syntax beyond the section length field.

private_indicator — This 1-bit field shall be set to '1'.

section_length — 12-bit field specifying the number of remaining bytes in this section immediately following the section_length field up to the end of the section. The value of the section_length shall be no larger than 1021.

table_id_extension — This 16-bit field shall be set to 0x0000.

version_number — This 5-bit field shall have a value of zero.

current_next_indicator — This 1-bit indicator is always set to '1' for an STT section; the STT sent is always currently applicable.

section_number — The value of this 8-bit field shall always be 0x00 (this table is only one section long).

last_section_number — The value of this 8-bit field shall always be 0x00.

protocol_version — An 8-bit unsigned integer field whose function is to allow, in the future, this table type to carry parameters that may be structured differently than those defined in the current protocol. At present, the only valid value for protocol_version is zero. Non-zero values of

protocol_version may only be processed by decoders designed to accommodate the later versions as they become standardized.

system_time — A 32-bit unsigned integer quantity representing the current system time as the number of GPS seconds since 12 am, January 6th, 1980. The count of GPS seconds and leap second count shall be accurate and correct to within plus or minus four seconds, as timed at the arrival in the decoder of the Transport Stream packet carrying the last byte of the CRC.

GPS_UTC_offset — An 8-bit unsigned integer that defines the current offset in whole seconds between GPS and UTC time standards. To convert GPS time to UTC, the GPS_UTC_offset is subtracted from GPS time. Whenever the International Bureau of Weights and Measures decides that the current offset is too far in error, an additional leap second may be added (or subtracted), and the GPS_UTC_offset will reflect the change.

daylight_savings — Daylight Savings Time Control bytes. Refer to Annex A for the use of these two bytes.

CRC_32 — This is a 32-bit field that contains the CRC value that ensures a zero output from the registers in the decoder defined in Annex A of ISO/IEC 13818-1 "MPEG-2 Systems" after processing the entire System Time Table section.

6.2 Master Guide Table (MGT)

The MGT lists version numbers, length in bytes, and PIDs for all of the PSIP tables with the exception of the STT which works independently from the other tables.

The Master Guide Table is carried in a single section with table ID 0xC7, and obeys the syntax and semantics of the Private Section as described in Section 2.4.4.10 and 2.4.4.11 of ISO/IEC 13818-1. The following constraints apply to the Transport Stream packet (or packets) carrying the MGT:

- PID for MGT shall have the value 0x1FFB (base_PID)
- transport_scrambling_control bits shall have the value '00'
- adaptation_field_control bits shall have the value '01'
- payload_unit_start_indicator of the Transport Stream packet carrying the table_id field of the MGT section shall be 1 (first Transport Stream packet of the section)
- pointer_field of the Transport Stream packet carrying the table_id field of the MGT section shall have the value 0x00 (section starts immediately after the pointer_field)

The bit stream syntax for the Master Guide Table is shown in Table 6.2.

Table 6.2 Bit Stream Syntax for the Master Guide Table

Syntax	Bits	Format
master_guide_table_section () {		
table_id	8	0xC7
section_syntax_indicator	1	‘1’
private_indicator	1	‘1’
reserved	2	‘11’
section_length	12	uimsbf
table_id_extension	16	0x0000
reserved	2	‘11’
version_number	5	uimsbf
current_next_indicator	1	‘1’
section_number	8	0x00
last_section_number	8	0x00
protocol_version	8	uimsbf
tables_defined	16	uimsbf
for (i=0;i<tables_defined;i++) {		
table_type	16	uimsbf
reserved	3	‘111’
table_type_PID	13	uimsbf
reserved	3	‘111’
table_type_version_number	5	uimsbf
number_bytes	32	uimsbf
reserved	4	‘1111’
table_type_descriptors_length	12	uimsbf
for (k=0;k<N;k++) {		
descriptor()		
}		
}		
reserved	4	‘1111’
descriptors_length	12	uimsbf
for (I = 0;I< N;I++) {		
descriptor()		
}		
CRC_32	32	rpchof
}		

table_id — This is an 8-bit field which shall be set to 0xC7, identifying this table as the Master Guide Table.

section_syntax_indicator — This 1-bit field shall be set to ‘1’. It denotes that the section follows the generic section syntax beyond the section length field.

private_indicator — This 1-bit field shall be set to ‘1’.

section_length — 12-bit field specifying the number of remaining bytes in this section immediately following the section_length field up to the end of the section. The value of the section_length shall be no larger than 4093.

table_id_extension — This 16-bit field shall be set to 0x0000.

version_number **—** This 5-bit field is the version number of MGT. The version number shall be incremented by 1 modulo 32 when any field in the table_types defined in the loop below or the MGT itself changes.

current_next_indicator **—** This 1-bit indicator is always set to '1' for the MGT section; the MGT sent is always currently applicable.

section_number **—** The value of this 8-bit field shall always be 0x00 (this table is only one section long).

last_section_number **—** The value of this 8-bit field shall always be 0x00.

protocol_version **—** An 8-bit unsigned integer field whose function shall be to allow, in the future, this table type to carry parameters that may be structured differently than those defined in the current protocol. At present, the only valid value for protocol_version is zero. Non-zero values of protocol_version may only be processed by decoders designed to accommodate the later versions as they become standardized.

tables_defined **—** This 16-bit unsigned has a range of 6 – 370 (for terrestrial) and 2 – 370 for cable.

table_type **—** This 16-bit unsigned integer specifies the type of table, based on Table 6.3.

Table 6.3 Table Types

table_type	**Meaning**
0x0000	**Terrestrial VCT with** current_next_indicator=**1**
0x0001	**Terrestrial VCT with** current_next_indicator=**0**
0x0002	**Cable VCT with** current_next_indicator=**1**
0x0003	**Cable VCT with** current_next_indicator=**0**
0x0004	**channel ETT**
0x0005-0x00FF	**[Reserved for future ATSC use]**
0x0100-0x017F	**EIT-0 to EIT-127**
0x0180-0x01FF	**[Reserved for future ATSC use]**
0x0200-0x027F	**event ETT-0 to event ETT-127**
0x0280-0x0300	**[Reserved for future ATSC use]**
0x0301-0x03FF	**RRT with rating_region 1-255**
0x0400-0x0FFF	**[User private]**
0x1000-0xFFFF	**[Reserved for future ATSC use]**

table_type_PID — This 13-bit field specifies the PID for the table_type described in the loop.

table_type_version_number— This 5-bit field reflects the version number of the table_type described in the loop. The value of this field shall be the same as the version_number entered in the corresponding fields of tables and table instances. For example, the value of this field for EIT-3 will be the same as that of the version_number that appears in the actual EIT-3. The version number for the next VCT (current_next_indicator = 0) shall be one unit more (modulo 32) than the version number for the current VCT (current_next_indicator = 1).

number_bytes — This 32-bit unsigned integer field indicates the total number of bytes used for the table_type described in the loop.

table_type_descriptors_length — Total length of the descriptors for the table_type described in the loop (in bytes).

descriptors_length — Total length of the MGT descriptor list that follows (in bytes).

CRC_32 — This is a 32-bit field that contains the CRC value that ensures a zero output from the registers in the decoder defined in Annex A of ISO/IEC 13818-1 "MPEG-2 Systems" after processing the entire Master Guide Table section.

6.3 Virtual Channel Table (VCT)

The Virtual Channel Table (VCT) contains a list of attributes for virtual channels carried in the Transport Stream. Any changes in the virtual channel structure shall be conveyed with a new version number. The basic information contained in the VCT table body includes Transport Stream ID, channel number (major and minor), short channel name, carrier frequency, program number, access controlled flag, location field for extended text messages, and service type. Additional information may be carried by descriptors which may be placed in the descriptor loop after the basic information.

The Virtual Channel Table may be segmented into as many as 256 sections. One section may contain information for several virtual channels, but the information for one virtual channel shall not be segmented and put into two or more sections. Thus for each section, the first field after protocol_version shall be num_channels_in_section.

6.3.1 Terrestrial Virtual Channel Table

The Terrestrial Virtual Channel Table is carried in private sections with table ID 0xC8, and obeys the syntax and semantics of the Private Section as described in Section 2.4.4.10 and 2.4.4.11 of ISO/IEC 13818-1. The following constraints apply to the Transport Stream packets carrying the VCT sections:

- PID for Terrestrial VCT shall have the value 0x1FFB (base_PID)
- transport_scrambling_control bits shall have the value '00'
- adaptation_field_control bits shall have the value '01'

The bit stream syntax for the Terrestrial Virtual Channel Table is shown in Table 6.4.

table_id — An 8-bit unsigned integer number that indicates the type of table section being defined here. For the terrestrial_virtual_channel_table_section(), the table_id shall be 0xC8.

section_syntax_ indicator — The section_syntax_indicator is a one-bit field which shall be set to '1' for the terrestrial_virtual_channel_table_section().

private_indicator — This 1-bit field shall be set to '1'.

section_length — This is a twelve bit field, the first two bits of which shall be ‘00’. It specifies the number of bytes of the section, starting immediately following the section_length field, and including the CRC. The value in this field shall not exceed 1021.

transport_stream_id — The 16-bit MPEG-2 Transport Stream ID, as it appears in the Program Association Table (PAT) identified by a PID value of zero for this multiplex. The transport_stream_id distinguishes this Terrestrial Virtual Channel Table from others that may be broadcast in different PTCs.

Table 6.4 Bit Stream Syntax for the Terrestrial Virtual Channel Table

Syntax	Bits	Format
terrestrial_virtual_channel_table_section () {		
table_id	8	0xC8
section_syntax_indicator	1	‘1’
private_indicator	1	‘1’
reserved	2	‘11’
section_length	12	uimsbf
transport_stream_id	16	uimsbf
reserved	2	‘11’
version_number	5	uimsbf
current_next_indicator	1	bslbf
section_number	8	uimsbf
last_section_number	8	uimsbf
protocol_version	8	uimsbf
num_channels_in_section	8	uimsbf
for(i=0; i<num_channels_in_section; i++) {		
short_name	7*16	unicode™ BMP
reserved	4	‘1111’
major_channel_number	10	uimsbf
minor_channel_number	10	uimsbf
modulation_mode	8	uimsbf
carrier_frequency	32	uimsbf
channel_TSID	16	uimsbf
program_number	16	uimsbf
ETM_location	2	uimsbf
access_controlled	1	bslbf
hidden	1	bslbf
reserved	2	‘11’
hide_guide	1	bslbf
reserved	3	‘111’
service_type	6	uimsbf
source_id	16	uimsbf
reserved	6	‘111111’
descriptors_length	10	uimsbf
for (i=0;i<N;i++) {		
descriptor()		
}		
}		
reserved	6	‘111111’
additional_descriptors_length	10	uimsbf
for(j=0; j<N;j++) {		
additional_descriptor()		
}		
CRC_32	32	rpchof
}		

version_number — This 5 bit field is the version number of the Virtual Channel Table. For the current VCT (current_next_indicator = 1), the version number shall be incremented by 1 whenever the definition of the current VCT changes. Upon reaching the value 31, it wraps around to 0. For the next VCT (current_next_indicator = 0), the version number shall be one unit more than that of the current VCT (also in modulo 32 arithmetic). In any case, the value of the version_number shall be identical to that of the corresponding entries in the MGT.

current_next_indicator — A one-bit indicator, which when set to '1' indicates that the Virtual Channel Table sent is currently applicable. When the bit is set to '0', it indicates that the table sent is not yet applicable and shall be the next table to become valid.

section_number — This 8 bit field gives the number of this section. The section_number of the first section in the Terrestrial Virtual Channel Table shall be 0x00. It shall be incremented by one with each additional section in the Terrestrial Virtual Channel Table.

last_section_number — This 8 bit field specifies the number of the last section (that is, the section with the highest section_number) of the complete Terrestrial Virtual Channel Table.

protocol_version — An 8-bit unsigned integer field whose function is to allow, in the future, this table type to carry parameters that may be structured differently than those defined in the current protocol. At present, the only valid value for protocol_version is zero. Non-zero values of protocol_version may only be processed by decoders designed to accommodate the later versions as they become standardized.

num_channels_in_section — This 8 bit field specifies the number of virtual channels in this VCT section. The number is limited by the section length.

short_name — The name of the virtual channel, represented as a sequence of one to seven 16-bit character codes coded in accordance with the Basic Multilingual Plane (BMP) of Unicode™, as specified in ISO 10646-1. If the name of the virtual channel is shorter than seven Unicode™ characters, one or more instances of the null character value 0x0000 shall be used to pad the string to its fixed 14-byte length.

major_channel_number — A 10-bit number that represents the "major" channel number associated with the virtual channel being defined in this iteration of the "for" loop. Each virtual channel shall be associated with a major and a minor channel number. The major channel number, along with the minor channel number, act as the user's reference number for the virtual channel. The major_channel_number shall be between 1 and 99. For major_channel_number assignments in the U.S., refer to Annex B.

minor_channel_number — A 10-bit number in the range 0 to 999 that represents the "minor" or "sub-" channel number. This field, together with major_channel_number, performs as a two-part channel number, where minor_channel_number represents the second or right-hand part of the number. When the service_type is analog television, minor_channel_number shall be set to 0. Services whose service_type is either ATSC_digital_television or ATSC_audio_only shall use minor numbers between 1 and 99. For other types of services, such as data broadcasting, valid minor virtual channel numbers are between 1 and 999

modulation_mode — An 8-bit unsigned integer number that indicates the modulation mode for the transmitted carrier associated with this virtual channel. Values of modulation_mode are defined by this standard in Table 6.5. For digital signals, the standard values for modulation mode (values below 0x80) indicate transport framing structure, channel coding, interleaving, channel modulation, forward error correction, symbol rate, and other transmission-related parameters, by means of a reference to an appropriate standard. Values of modulation_mode 0x80 and above are outside the scope of ATSC. These may be used to specify non-standard modulation modes in private systems. A value of 0x80 for modulation_mode indicates that modulation parameters are specified in a private descriptor. The modulation_mode field shall be disregarded for inactive channels.

Table 6.5 Modulation Modes

modulation_mode	Meaning
0x00	[Reserved]
0x01	**Analog** — The virtual channel is modulated using standard analog methods for analog television.
0x02	**SCTE_mode_1** — The virtual channel has a symbol rate of 5.057 Msps, transmitted in accordance with *Digital Transmission Standard for Cable Television*, Ref. [12] (Mode 1). Typically, mode 1 will be used for 64-QAM.
0x03	**SCTE_mode_2** — The virtual channel has a symbol rate of 5.361 Msps, transmitted in accordance with *Digital Transmission Standard for Cable Television*, Ref. [12] (Mode 2). Typically, mode 2 will be used for 256-QAM.
0x04	**ATSC (8 VSB)** — The virtual channel uses the 8-VSB modulation method conforming to the *ATSC Digital Television Standard A/53*. Ref. [2].
0x05	**ATSC (16 VSB)** — The virtual channel uses the 16-VSB modulation method conforming to the *ATSC Digital Television Standard A/53,* Ref. [2].
0x06-0x7F	[Reserved for future use by ATSC]
0x80	Modulation parameters are defined by a private descriptor
0x81-0xFF	[User Private]

carrier_frequency — A 32-bit unsigned integer that represents the carrier frequency associated with the analog or digital transmission associated with this virtual channel, in units of one Hz. For VSB-modulated signals, the given carrier_frequency represents the location of the pilot tone; for analog signals, it represents the frequency of the picture carrier. In the case of a digital terrestrial broadcast signal that is transmitted at multiple carrier frequencies (via one or more translators), the carrier_frequency may be specified as zero. In such cases, the receiver is expected to associate the Transport Stream identified by the given transport_stream_id with the frequency tuned to acquire it.

For the ATSC Digital Television Standard, where the PTC bandwidth is 6 MHz, the pilot tone is located 310 kHz[2] above the lower edge of the physical transmission channel, or 2.690 MHz below the specified center of the band. Similarly, for analog NTSC transmitted in the US, the

[2] This is the nominal value. To minimize interference for various combinations of nearby TV stations precision offsets of 19.403 kHz or 28.615 kHz may be used (See Ref. [15] page I-3-15). The actual frequency may also shift due to the +/- 10 kHz offsets used in the NTSC assignments.

picture carrier is 1.25 MHz above the lower edge of the 6 MHz physical transmission channel. The carrier_frequency field shall be disregarded for inactive channels.

channel_TSID — A 16-bit unsigned integer field in the range 0x0000 to 0xFFFF that represents the MPEG-2 Transport Stream ID associated with the Transport Stream carrying the MPEG-2 program referenced by this virtual channel. For inactive channels, channel_TSID represents the ID of the Transport Stream that will carry the service when it becomes active. The receiver may use the channel_TSID to verify that a Transport Stream acquired at the referenced carrier frequency is actually the desired multiplex. Analog signals may have a TSID provided that it is different from any DTV Transport Stream identifier; that is, it shall be truly unique if present.[3] A value of 0xFFFF for channel_TSID shall be specified for analog channels that do not have a valid TSID.

program_number — A 16-bit unsigned integer number that associates the virtual channel being defined here with the MPEG-2 PROGRAM ASSOCIATION and TS PROGRAM MAP tables. For virtual channels representing analog services, a value of 0xFFFF shall be specified for program_number. For inactive channels (those not currently present in the Transport Stream), program_number shall be set to zero. This number shall **not** be interpreted as pointing to a Program Map Table entry.

ETM_location — This 2-bit field specifies the existence and the location of an Extended Text Message (ETM), based on Table 6.6.

Table 6.6 ETM Location

ETM_location	Meaning
0x00	No ETM
0x01	ETM located in the PTC carrying this PSIP
0x02	ETM located in the PTC specified by the channel_TSID
0x03	[Reserved for future ATSC use]

access_controlled — A 1-bit Boolean flag that indicates, when set, that the events associated with this virtual channel may be access controlled. When the flag is set to 0, event access is not restricted.

hidden — A 1-bit Boolean flag that indicates, when set, that the virtual channel is not accessed by the user by direct entry of the virtual channel number. Hidden virtual channels are skipped when the user is channel surfing, and appear as if undefined, if accessed by direct channel entry. Typical applications for hidden channels are test signals and NVOD services. Whether a hidden channel and its events may appear in EPG displays depends on the state of the hide_guide bit.

hide_guide — A Boolean flag that indicates, when set to 0 for a hidden channel, that the virtual channel and its events may appear in EPG displays. This bit shall be ignored for channels which do not have the hidden bit set, so that non-hidden channels and their events may always be included in EPG displays regardless of the state of the hide_guide bit. Typical applications for hidden channels with the hide_guide bit set to 1 are test signals and services accessible through

[3] A method to include such a unique 16-bit "Transmission Signal ID" in the NTSC VBI is specified in the EIA-752 specification.

application-level pointers.

An *inactive channel* is defined as a channel that has program guide data available, but the channel is not currently on the air. Inactive channels are represented as hidden channels with the hide_guide bit set to 0. The Transport Stream shall not carry a Program Map Table representing an inactive channel.

service_type — A 6-bit enumerated type field that identifies the type of service carried in this virtual channel, based on Table 6.7.

Table 6.7 Service Types

service_type	Meaning
0x00	[Reserved]
0x01	**analog_television** — The virtual channel carries analog television programming
0x02	**ATSC_digital_television** — The virtual channel carries television programming (audio, video and data) conforming to the ATSC Digital Television Standard
0x03	**ATSC_audio_only** — The virtual channel conforms to the ATSC Digital Television Standard, and has one or more standard audio and data components but no video.
0x04	**ATSC_data_broadcast_service** — Conforming to the ATSC data broadcast standard under development by T3/S13.
0x05-0x3F	[Reserved for future ATSC use]

source_id — A 16-bit unsigned integer number that identifies the programming source associated with the virtual channel. In this context, a *source* is one specific source of video, text, data, or audio programming. Source ID value zero is reserved. Source ID values in the range 0x0001 to 0x0FFF shall be unique within the Transport Stream that carries the VCT, while values 0x1000 to 0xFFFF shall be unique at the regional level. Values for source_ids 0x1000 and above shall be issued and administered by a Registration Authority designated by the ATSC.

descriptors_length — Total length (in bytes) of the descriptors for this virtual channel that follows.

additional_descriptors_length — Total length (in bytes) of the VCT descriptor list that follows.

CRC_32 — This is a 32-bit field that contains the CRC value that ensures a zero output from the registers in the decoder defined in Annex A of ISO/IEC 13818-1 "MPEG-2 Systems" after processing the entire Terrestrial Virtual Channel Table section.

For inactive channels, the short_name, major_channel_number, and minor_channel_number fields reflect the name and channel number of the inactive channel, and may be used in construction of the program guide. The source_id for inactive channels is used, as it is for active channels, to link the virtual channel to the program guide data. The ETM_location indicates, as it does for active channels, the location of text related to the virtual channel. The service_type field and attribute flag access_controlled reflect the characteristics of the channel that will be valid when it is active.

6.3.2 Cable Virtual Channel Table

The Cable Virtual Channel Table is carried in private sections with table ID 0xC9, and obeys the syntax and semantics of the Private Section as described in Section 2.4.4.10 and 2.4.4.11 of ISO/IEC 13818-1. The following constraints apply to the Transport Stream packets carrying the VCT sections:

- PID for Cable VCT shall have the value 0x1FFB (base_PID)
- transport_scrambling_control bits shall have the value ‘00’
- adaptation_field_control bits shall have the value ‘01’

The bit stream syntax for the Cable Virtual Channel Table is shown in Table 6.8. The semantics for the CVCT are the same as the TVCT except for those fields explicitly defined below.

table_id — An 8-bit unsigned integer number that indicates the type of table section being defined here. For the cable_VCT_section, the table_id shall be 0xC9.

major_channel_number — A 10-bit number in the range 1 to 999 that represents the “major” virtual channel number associated with the virtual channel being defined in this iteration of the “for” loop. Each virtual channel must be associated with a major and a minor virtual channel number. The major virtual channel number, along with the minor virtual channel number, act as the user’s reference number for the virtual channel.

minor_channel_number — A 10-bit number in the range 0 to 999 that represents the “minor” or “sub-“ virtual channel number. This field, together with major_channel_number, performs a two-part virtual channel number, where minor_channel_number represents the second or right-hand part of the number

Table 6.8 Bit Stream Syntax for the Cable Virtual Channel Table

Syntax	Bits	Format
cable_virtual_channel_table_section () {		
table_id	8	0xC9
section_syntax_indicator	1	‘1’
private_indicator	1	‘1’
reserved	2	‘11’
section_length	12	uimsbf
transport_stream_id	16	uimsbf
reserved	2	‘11’
version_number	5	uimsbf
current_next_indicator	1	bslbf
section_number	8	uimsbf
last_section_number	8	uimsbf
protocol_version	8	uimsbf
num_channels_in_section	8	uimsbf
for(i=0; i<num_channels_in_section;i++) {		
short_name	7*16	unicode™ BMP
reserved	4	‘1111’
major_channel_number	10	uimsbf
minor_channel_number	10	uimsbf
modulation mode	8	uimsbf
carrier_frequency	32	uimsbf
channel_TSID	16	uimsbf
program_number	16	uimsbf
ETM_location	2	uimsbf
access_controlled	1	bslbf
hidden	1	bslbf
path_select	1	bslbf
out_of_band	1	bslbf
hide_guide	1	bslbf
reserved	3	‘111’
service_type	6	uimsbf
source_id	16	uimsbf
reserved	6	‘111111’
descriptors_length	10	uimsbf
for (i=0;i<N;i++) {		
descriptor()		
}		
}		
reserved	6	‘111111’
additional_descriptors_length	10	uimsbf
for(j=0; j<N;j++) {		
additional_descriptor()		
}		
CRC_32	32	rpchof
}		

path_select — A 1-bit field that associates the virtual channel with a transmission path. For the cable transmission medium, path_select identifies which of two physical input cables carries the Transport Stream associated with this virtual channel. Table 6.9 defines path_select. When the channel is inactive, path_select shall reflect the characteristics of the channel that will be valid when it is again active.

Table 6.9 Path Select

path_select	Meaning
0	path 1
1	path 2

out_of_band — A Boolean flag that indicates, when set, that the virtual channel defined in this iteration of the "for" loop is carried on the cable on an out-of-band physical transmission channel whose frequency is indicated by carrier_frequency. When clear, the virtual channel is carried within a standard tuned multiplex at that frequency. When the channel is inactive, out_of_band shall reflect the characteristics of the channel that will be valid when it is again active.

source_id — A 16-bit unsigned integer number that identifies the programming source associated with the virtual channel. In this context, a *source* is one specific source of video, text, data, or audio programming. Source ID value zero is reserved to indicate that the programming source is not identified. Source ID values in the range 0x0001 to 0x0FFF shall be unique within the Transport Stream that carries the VCT, while values 0x1000 to 0xFFFF shall be unique at the regional level. Values for source_Ids 0x1000 and above shall be issued and administered by a Registration Authority designated by the ATSC.

6.4 Rating Region Table (RRT)

The Rating Region Table (RRT) carries rating information for multiple geographical regions. Each RRT instance, identified by rating_region (the 8 least significant bits of table_id_extension), conveys the rating system information for one specific region. The size of each RRT instance shall not be more than 1024 bytes (including section header and trailer), and it shall be carried by only one MPEG-2 private section.

The following constraints apply to the Transport Stream packets carrying the RRT sections.

- PID shall have the value 0x1FFB (base_PID)
- transport_scrambling_control bits shall have the value '00'
- adaptation_field_control bits shall have the value '01'

The bit stream syntax for the Rating Region Table is shown in Table 6.10.

table_id — This is an 8-bit field, which shall be set to 0xCA, identifying this table as the Rating Region Table (RRT).

section_syntax_indicator — This 1-bit field shall be set to '1'. It denotes that the section follows the generic section syntax beyond the section length field.

private_indicator — This 1-bit field shall be set to '1'.

section_length — 12-bit field specifying the number of remaining bytes in this section immediately following the section_length field up to the end of the section. The value of the section_length shall be no larger than 1021.

Table 6.10 Bit Stream Syntax for the Rating Region Table

Syntax	Bits	Format
rating_region_table_section () {		
table_id	8	0xCA
section_syntax_indicator	1	'1'
private_indicator	1	'1'
reserved	2	'11'
section_length	12	uimsbf
table_id_extension {		
reserved	8	0xFF
rating_region	8	uimsbf
}		
reserved	2	'11'
version_number	5	uimsbf
current_next_indicator	1	'1'
section_number	8	uimsbf
last_section_number	8	uimsbf
protocol_version	8	uimsbf
rating_region_name_length	8	uimsbf
rating_region_name_text()	var	
dimensions_defined	8	uimsbf
for(i=0; i<dimensions_defined;i++) {		
dimension_name_length	8	uimsbf
dimension_name_text()	var	
reserved	3	'111'
graduated_scale	1	bslbf
values_defined	4	uimsbf
for (j=0;j<values_defined;j ++) {		
abbrev_rating_value_length	8	uimsbf
abbrev_rating_value_ text()	var	
rating_value_length	8	uimsbf
rating_value_ text()	var	
}		
}		
reserved	6	'111111'
descriptors_length	10	uimsbf
for (i=0;i<N;i++) {		
descriptor()		
}		
CRC_32	32	rpchof
}		

rating_region — An 8-bit unsigned integer number that defines the rating region to be associated with the text in this rating_region_table_section(). The value of this field is the identifier of this rating region, and thus this field may be used by the other tables (e.g. MGT) for referring to a specific rating region table. Values of rating_region are defined in Table 6.11.

Table 6.11 Rating Regions

rating_region	Rating Region Name
0x00	Forbidden
0x01	**US (50 states + possessions)**
0x02-0xFF	[Reserved]

version_number — This 5-bit field is the version number of the Rating Region table identified by combination of the fields table_id and table_id_extension. The version number shall be incremented by 1 modulo 32 when any field in this instance of the Rating Region Table changes. The value of this field shall be the same as that of the corresponding entry in MGT.

current_next_indicator — This 1-bit indicator is always set to '1'.

section_number — The value of this 8-bit field shall always be 0x00.

last_section_number — The value of this 8-bit field shall always be 0x00.

protocol_version — The value of this 8-bit field shall always be 0x00.

rating_region_name_length — An 8-bit unsigned integer number that defines the total length (in bytes) of the rating_region_name_text() field to follow.

rating_region_name_text() — A data structure containing a multiple string structure which represents the rating region name, e.g. "U.S. (50 states + possessions)", associated with the value given by rating_region. Text strings are formatted according to the rules outlined in Section 6.8. The display string for the rating region name shall be limited to 32 characters or less.

dimensions_defined — This 8-bit field (1-255) specifies the number of dimensions defined in this rating_region_table_section().

dimension_name_length — An 8-bit unsigned integer number that defines the total length in bytes of the dimension_name_text() field to follow.

dimension_name_text() — A data structure containing a multiple string structure which represents the dimension name being described in the loop. One dimension in the U.S. rating region, for example, is used to describe the MPAA list. The dimension name for such a case may be defined as "MPAA". Text strings are formatted according to the rules outlined in Section 6.8. The dimension name display string shall be limited to 20 characters or less.

graduated_scale — This 1-bit flag indicates whether or not the rating values in this dimension represent a graduated scale, i.e., higher rating values represent increasing levels of rated content within the dimension. Value 1 means yes, while value 0 means no.

values_defined — This 4-bit field (1-15) specifies the number of values defined for this particular dimension.

abbrev_rating_value_length — An 8-bit unsigned integer number that defines the total length (in bytes) of the abbrev_rating_value_text() field to follow.

abbrev_rating_value_text() — A data structure containing a multiple string structure which represents the abbreviated name for one particular rating value. The abbreviated name for rating value 0 shall be set to a null string, i.e., "". Text strings are formatted according to the rules outlined in Section 6.8. The abbreviated value display string shall be limited to 8 characters or less.

rating_value_length — An 8-bit unsigned integer number that defines the total length (in bytes) of the rating_value_text() field to follow.

rating_value_text() — A data structure containing a multiple string structure which represents the full name for one particular rating value. The full name for rating value 0 shall be set to a null string, i.e., “”. Text strings are formatted according to the rules outlined in Section 6.8. The rating value display string shall be limited to 150 characters or less.

descriptors_length — Length (in bytes) of all of the descriptors that follow this field.

CRC_32 — This is a 32-bit field that contains the CRC value that ensures a zero output from the registers in the decoder defined in Annex A of ISO/IEC 13818-1 “MPEG-2 Systems” after processing the entire Rating Region Table section.

6.5 Event Information Table (EIT)

The Event Information Table (EIT) contains information (titles, start times, etc.) for events on defined virtual channels. An event is, in most cases, a typical TV program, however its definition may be extended to include particular data broadcasting sessions and other information segments. Up to 128 EITs may be transmitted and each of them is referred to as EIT-k, with k = 0, 1, … 127.

Each EIT-k can have multiple instances, each of which contains information for one virtual channel, and each of which is identified by the combination of table_id and source_id. Each EIT-k instance may be segmented into as many as 256 sections. One section may contain information for several events, but the information for one event shall not be segmented and put into two or more sections. Thus the first field after protocol_version for each section shall be num_events_in_section.

PSIP supports up to 128 EITs, each of which provides the event information for a certain time span. For terrestrial broadcast, at least the first four EITs shall be included in the Transport Stream. Any event programmed for a time interval that extends over one or more EITs shall be described in each of these EITs, with the same event_id. For instance, an event that starts at 17:30 UTC and lasts until 19:30 UTC will appear in two EITs with the same event_id, the EIT covering 15:00-18:00 (UTC) as well as the EIT covering 18:00-21:00 (UTC). For a particular virtual channel, an event_id identifies uniquely each of the events programmed for the 3-hour interval of an EIT.

Each virtual channel defined in the VCT shall have a corresponding instance of EIT-k, unless the virtual channel belongs to a group sharing the same source_id. Virtual channels sharing a source_id appear in applications such as NVOD. In such a case, the entire group will have a unique instance of EIT-k identified precisely by the source_id. If a virtual channel has no event in the time span covered by EIT-k, its corresponding EIT instance shall have only one section, and the field num_events_in_section shall be set to zero.

Events shall be in the order of their starting times, i.e., the start time of the first event shall be ahead of that of the second event, and the start time of the last event in section one shall be equal or less than that of the first event in section two with the equality holding only when both events are the same.

For NVOD services, event entries in the EIT correspond to events scheduled in the virtual channel that carry the time_shifted_descriptor (the reference virtual channel). However, an NVOD event shall be listed in applicable EITs even when the NVOD event has finished in the reference virtual channel as long as the NVOD event remains on the air as a time shifted service in complementary virtual channels. Hence, an EIT may contain, in some cases, an expired event describing NVOD services.

The Event Information Table is carried in private sections with table ID 0xCB, and obeys the syntax and semantics of the Private Section as described in Section 2.4.4.10 and 2.4.4.11 of ISO/IEC 13818-1. The following constraints apply to the Transport Stream packets carrying the EIT sections:

- PID for EIT-k shall have the same value as specified in the MGT, and shall be unique among the collection of table_type_PID values listed in the MGT.
- transport_scrambling_control bits shall have the value ‘00’.
- adaptation_field_control bits shall have the value ‘01’.

The bit stream syntax for the Event Information Table is shown in Table 6.12.

table_id — This is an 8-bit field which shall be set to 0xCB, identifying this section as belonging to the Event Information Table.

section_syntax_indicator — This 1-bit field shall be set to ‘1’. It denotes that the section follows the generic section syntax beyond the section length field.

private_indicator — This 1-bit field shall be set to ‘1’.

section_length — 12-bit field specifying the number of remaining bytes in this section immediately following the section_length field up to the end of the section, including the CRC_32 field. The value of this field shall not exceed 4093.

source_id — This 16-bit field specifies the source_id of the virtual channel carrying the events described in this section.

version_number — This 5-bit field is the version number of EIT-i. The version number shall be incremented by 1 modulo 32 when any field in the EIT-i changes. Note that the version_number for EIT-i has no relation with that for EIT-j when j is not equal to i. The value of this field shall be identical to that of the corresponding entry in the MGT.

current_next_indicator — This 1-bit indicator is always set to ‘1’ for EIT sections; the EIT sent is always currently applicable.

section_number — This 8-bit field gives the number of this section.

last_section_number — This 8-bit field specifies the number of the last section.

protocol_version — An 8-bit unsigned integer field whose function is to allow, in the future, this table type to carry parameters that may be structured differently than those defined in the current protocol. At present, the only valid value for protocol_version is zero. Non-zero values of

protocol_version may only be processed by decoders designed to accommodate the later versions as they become standardized.

Table 6.12 Bit Stream Syntax for the Event Information Table

Syntax	Bits	Format
event_information_table_section () {		
table_id	8	0xCB
section_syntax_indicator	1	'1'
private_indicator	1	'1'
reserved	2	'11'
section_length	12	uimsbf
source_id	16	uimsbf
zero	2	'00'
version_number	5	uimsbf
current_next_indicator	1	'1'
section_number	8	uimsbf
last_section_number	8	uimsbf
protocol_version	8	uimsbf
num_events_in_section	8	uimsbf
for (j = 0; j< num_events_in_section;j++) {		
reserved	2	'11'
event_id	14	uimsbf
start_time	32	uimsbf
reserved	2	'11'
ETM_location	2	uimsbf
length_in_seconds	20	uimsbf
title_length	8	uimsbf
title_text()	var	
reserved	4	'1111'
descriptors_length	12	
for (i=0;i<N;i++) {		
descriptor()		
}		
}		
CRC_32	32	rpchof
}		

num_events_in_section — Indicates the number of events in this EIT section. Value 0 indicates no events defined in this section.

event_id — This field specifies the identification number of the event described. This number will serve as a part of the event ETM_id (identifier for event extended text message).

start_time — A 32-bit unsigned integer quantity representing the start time of this event as the number of GPS seconds since 12 am, January 6^{th}, 1980.

ETM_location — This 2-bit field specifies the existence and the location of an Extended Text Message (ETM), based on Table 6.13

Table 6.13 ETM Location

ETM_location	Meaning
0x0	No ETM
0x1	ETM located in the PTC carrying this PSIP
0x2	ETM located in the PTC carrying this event
0x3	[Reserved for future ATSC use]

length_in_seconds — Duration of this event in seconds.

title_length — This field specifies the length (in bytes) of the title_text(). Value 0 means that no title exists for this event.

title_text() — The event title in the format of a multiple string structure (see Section 6.8).

descriptors_length — Total length (in bytes) of the event descriptor list that follows.

CRC_32 — This is a 32-bit field that contains the CRC value that ensures a zero output from the registers in the decoder defined in Annex A of ISO-13818-1 “MPEG-2 Systems” after processing the entire Event Information Table section.

6.6 Extended Text Table (ETT)

The Extended Text Table (ETT) contains Extended Text Message (ETM) streams, which are optional and are used to provide detailed descriptions of virtual channels (channel ETM) and events (event ETM). An ETM is a multiple string data structure (see Section 6.8), and thus, it may represent a description in several different languages (each string corresponding to one language). If necessary, the description may be truncated to fit allocated display space.

Within a Transport Stream, the Extended Text Message is carried on a private section with table ID 0xCC. Each description is distinguished by its unique 32-bit ETM_id immediately after the field protocol_version. This allows the receiver to search for a single description quickly without having to parse the payload of a large table.

The ETT section for a virtual channel or an event is carried in the home physical transmission channel (the physical transmission channel carrying that virtual channel or event) with PID specified by the field table_type_PID in corresponding entries in the MGT. This specific PID is exclusively reserved for the ETT stream.

The following constraints apply to the Transport Stream packets carrying the ETT sections.

- PID for ETT shall have the same value as the field table_type_PID in corresponding entries in the MGT, and shall be unique among the collection of table_type_PID values listed in the MGT.
- transport_scrambling_control bits shall have the value ‘00’
- adaptation_field_control bits shall have the value ‘01’

The bit stream syntax for the Extended Text Table is shown in Table 6.14.

Table 6.14 Bit Stream Syntax for the Extended Text Table

Syntax	Bits	Format
extended_text_table_section () {		
table_id	8	0xCC
section_syntax_indicator	1	'1'
private_indicator	1	'1'
reserved	2	'11'
section_length	12	uimsbf
table_id_extension	16	0x0000
reserved	2	'11'
version_number	5	uimsbf
current_next_indicator	1	'1'
section_number	8	0x00
last_section_number	8	0x00
protocol_version	8	uimsbf
ETM_id	32	uimsbf
extended_text_message ()	var	
CRC_32	32	rpchof
}		

table_id — Identifies this section as belonging to a Extended Text Table. (0xCC)

section_syntax_indicator — This 1-bit field shall be set to '1'. It denotes that the section follows the generic section syntax beyond the section length field.

private_indicator — This 1-bit field shall be set to '1'.

section_length — 12-bit field specifying the number of remaining bytes in the section immediately following the section_length field up to the end of the section. The value of the section_length shall be no larger than 4093.

table_id_extension — This 16-bit field shall be set to 0x0000.

version_number — For the channel ETT, this 5-bit field indicates the version number of the channel ETT. The version number shall be incremented by 1 modulo 32 when any ETM in the channel ETT changes. For event ETT, this 5-bit field indicates the version number of event ETT-i, where i, as in the EIT case, is the index of time span. The version number shall be incremented by 1 modulo 32 when any ETM in the event ETT-i changes. Note that the version_number for event ETT-i has no relation with that for event ETT-j when j is not equal to i. The value of this field shall be identical to that of the corresponding entry in the MGT.

current_next_indicator — This 1-bit indicator is always set to '1' for ETT sections; the ETT sent is always currently applicable.

section_number — The value of this 8-bit field shall always be 0x00 (this table is only one section long).

last_section_number — The value of this 8-bit field shall always be 0x00.

protocol_version — An 8-bit unsigned integer field whose function is to allow, in the future, this table type to carry parameters that may be structured differently than those defined in the current protocol. At present, the only valid value for protocol_version is zero. Non-zero values of

protocol_version may only be processed by decoders designed to accommodate the later versions as they become standardized.

ETM_id — Unique 32-bit identifier of this extended text message. This identifier is assigned by the rule shown in Table 6.15.

Table 6.15 ETM ID

	MSB			LSB	
Bit	**31 16**	**15 2**	**1**	**0**
channel ETM_id	source_id	0 …… 0	0	0
event ETM_id	source_id	event_id	1	0

extended_text_message() — The extended text message in the format of a multiple string structure (see Section 6.8).

CRC_32 — This is a 32-bit field that contains the CRC value that ensures a zero output from the registers in the decoder defined in Annex A of ISO-13818-1 "MPEG-2 Systems" after processing the entire Transport Stream ETT section.

6.7 Core Descriptors

Table 6.16 lists all of the core descriptors and their descriptor tags. The Service location descriptor shall always be present in the terrestrial VCT (shown with an "S"). When present, some descriptors shall be in each indicated location (shown with an "M"). Some descriptors also may be present in a second location within either the terrestrial or the cable case (shown with an "O"). Asterisks mark the tables where the descriptors may appear without restrictions. The range of MPEG-2-defined or reserved descriptor tags is between 0x02 and 0x3F plus 0xFF.

Table 6.16 List of Descriptors for PSIP Tables.

Descriptor Name	**Descriptor tag**	**Terrestrial**				**Cable**			
		PMT	**MGT**	**VCT**	**EIT**	**PMT**	**MGT**	**VCT**	**EIT**
stuffing descriptor	0x80	*	*	*	*	*	*	*	*
AC-3 audio descriptor	0x81	M			M	M			O
caption service descriptor	0x86	O			M	M			O
content advisory descriptor	0x87	O			M	M			O
extended channel name descriptor	0xA0			M				M	
service location descriptor	0xA1			S				M	
time-shifted service descriptor	0xA2			M				M	
component name descriptor	0xA3	M				M			
user private	0xC0-0xFE	*	*	*	*	*	*	*	*

6.7.1 AC-3 Audio Descriptor

The AC-3 audio descriptor, as defined in Ref. [1] and constrained in Annex B of Ref. [2] , may be used in the PMT and/or in EITs.

6.7.2 Program Identifier Descriptor

The program_identifier_descriptor, as defined in Ref. [5], shall not be used in any PSIP descriptor loops.

6.7.3 Caption Service Descriptor

The caption service descriptor provides closed captioning information, such as closed captioning type and language code for events with closed captioning service. This descriptor shall not appear on events with no closed captioning service.

The bit stream syntax for the closed captioning service descriptor is shown in Table 6.17.

Table 6.17 Bit Stream Syntax for the Caption Service Descriptor

Syntax	Bits	Format
caption_service_descriptor () {		
descriptor_tag	8	0x86
descriptor_length	8	uimsbf
reserved	3	‘111’
number_of_services	5	uimsbf
for (i=0;i<number_of_services;i++) {		
language	8*3	uimsbf
cc_type	1	bslbf
reserved	1	‘1’
if (cc_type==line21) {		
reserved	5	‘11111’
line21_field	1	bslbf
}		
else		
caption_service_number	6	uimsbf
easy_reader	1	bslbf
wide_aspect_ratio	1	bslbf
reserved	14	‘11111111111111’
}		
}		

descriptor_tag — An 8-bit field that identifies the type of descriptor. For the caption_service_descriptor() the value is 0x86.

descriptor_length — An 8-bit count of the number of bytes following the descriptor_length itself.

number_of_services — An unsigned 5-bit integer in the range 1 to 16 that indicates the number of closed caption services present in the associated video service. Note that if the video service does not carry television closed captioning, the caption_service_descriptor() shall not be present either in the Program Map Table or in the Event Information Table.

Each iteration of the "for" loop defines one closed caption service present as a sub-stream within the 9600 bit per second closed captioning stream. Each iteration provides the sub-stream's language, attributes, and (for advanced captions) the associated Service Number reference. Refer to Ref. [13] for a description of the use of the Service Number field within the syntax of the closed caption stream.

language — A 3-byte language code per ISO 639.2/B (Ref. [7]) defining the language associated with one closed caption service. The ISO_639_language_code field contains a three-character code as specified by ISO 639.2/B. Each character is coded into 8 bits according to ISO 8859-1 (ISO Latin-1) and inserted in order into the 24-bit field.

cc_type — A flag that indicates, when set, that an advanced television closed caption service is present in accordance with Ref. [13]. When the flag is clear, a line-21 closed caption service is present. For line 21 closed captions, the line21_field field indicates whether the service is carried in the even or odd field.

line21_field — A flag that indicates, when set, that the line 21 closed caption service is associated with the field 2 of the NTSC waveform. When the flag is clear, the line-21 closed caption service is associated with field 1 of the NTSC waveform. The line21_field flag is defined only if the cc_type flag indicates line-21 closed caption service.

caption_service_number — A 6-bit unsigned integer value in the range zero to 63 that identifies the Service Number within the closed captioning stream that is associated with the language and attributes defined in this iteration of the "for" loop. See Ref. [13] for a description of the use of the Service Number. The caption_service_number field is defined only if the cc_type flag indicates closed captioning in accordance with Ref. [13].

easy_reader — A Boolean flag which indicates, when set, that the closed caption service contains text tailored to the needs of beginning readers. Refer to Ref. [13] for a description of "easy reader" television closed captioning services. When the flag is clear, the closed caption service is not so tailored.

wide_aspect_ratio — A Boolean flag which indicates, when set, that the closed caption service is formatted for displays with 16:9 aspect ratio. When the flag is clear, the closed caption service is formatted for 4:3 display, but may be optionally displayed centered within a 16:9 display.

6.7.4 Content Advisory Descriptor

The Content Advisory Descriptor is used to indicate, for a given event, ratings for any or all of the rating dimensions defined in the RRT (Rating Region Table). Ratings may be given for any or all of the defined regions, up to a maximum of 8 regions per event. An Event without a Content Advisory Descriptor indicates that the rating value for any rating dimension defined in any rating region is zero. The absence of ratings for a specific dimension is completely equivalent to having a zero-valued rating for such a dimension. The absence of ratings for a specific region implies the absence of ratings for all of the dimensions in the region. The absence of a Content Advisory Descriptor for a specific event implies the absence of ratings for all of the regions for the event.

The bit stream syntax for the Content Advisory Descriptor is shown in Table 6.18.

descriptor_tag — This 8-bit unsigned integer shall have the value 0x87, identifying this descriptor as content_advisory_descriptor.

descriptor_length — This 8-bit unsigned integer specifies the length (in bytes) immediately following this field up to the end of this descriptor.

rating_region_count — A 6-bit unsigned integer value in the range 1 to 8 that indicates the number of rating region specifications to follow.

rating_region — An unsigned 8-bit integer that specifies the rating region for which the data in the bytes to follow is defined. The rating_region associates ratings data given here with data defined in a Ratings Region Table tagged with the corresponding rating region.

rated_dimensions — An 8-bit unsigned integer field that specifies the number of rating dimensions for which content advisories are specified for this event. The value of this field shall not be greater than the value specified by the field dimensions_defined in the corresponding RRT section.

Table 6.18 Bit Stream Syntax for the Content Advisory Descriptor

Syntax	Bits	Format
content_advisory_descriptor () {		
descriptor_tag	8	0x87
descriptor_length	8	uimsbf
reserved	2	‘11’
rating_region_count	6	
for (i=0; i<rating_region_count; i++) {		
rating_region	8	uimsbf
rated_dimensions	8	uimsbf
for (j=0;j<rated_dimensions;j++) {		
rating_dimension_j	8	uimsbf
reserved	4	‘1111’
rating_value	4	uimsbf
}		
rating_description_length	8	uimsbf
rating_description_text()	var	
}		
}		

rating_dimension_j — An 8-bit unsigned integer field specifies the dimension index into the RRT instance for the region specified by the field rating_region. These dimension indices shall be listed in numerical order, i.e., the value of rating_dimension_j+1 shall be greater than that of rating_dimension_j.

rating_value — A 4-bit field represents the rating value of the dimension specified by the field rating_dimension_j for the region given by rating_region.

rating_description_length — An 8-bit unsigned integer value in the range zero to 80 that represents the length of the rating_description_text() field to follow.

rating_description_text() — The rating description in the format of a multiple string structure (see Section 6.8). The rating_description display string shall be limited to 16 characters or less. The rating description text shall represent the program’s rating in an abbreviated form suitable for onscreen display. The rating description text collects multidimensional text information into a single small text string. If “xxx” and “yyy” are abbreviated forms for rating values in two dimensions, then “xxx-yyy” and “xxx (yyy)” are examples of possible strings represented in rating_description_text().

6.7.5 Extended Channel Name Descriptor

The extended channel name descriptor provides the long channel name for the virtual channel containing this descriptor.

The bit stream syntax for the extended channel name descriptor is shown in Table 6.19.

Table 6.19 Bit Stream Syntax for the Extended Channel Name Descriptor

Syntax	Bits	Format
extended_channel_name_descriptor () {		
descriptor_tag	8	0xA0
descriptor_length	8	uimsbf
long_channel_name_text()	var	
}		

descriptor_tag — This 8-bit unsigned integer shall have the value 0xA0, identifying this descriptor as extended_channel_name_descriptor().

descriptor_length — This 8-bit unsigned integer specifies the length (in bytes) immediately following this field up to the end of this descriptor.

long_channel_name_text() — The long channel name in the format of a multiple string structure (see Section 6.8).

6.7.6 Service Location Descriptor

This descriptor specifies the stream types, PID and language code for each elementary stream. An instance of this descriptor shall appear in the TVCT for each active channel. A service_location_descriptor() shall not be present for any inactive channel. When present, the service_location_descriptor() must be valid for the current event in the corresponding virtual channel.

Note that for cable, the information in the service_location_descriptor() is carried in the PMT with the syntax defined by Ref. [10].

The bit stream syntax for the service_location_descriptor() is shown in Table 6.20.

Table 6.20 Bit Stream Syntax for the Service Location Descriptor

Syntax	Bits	Format
service_location_descriptor () {		
descriptor_tag	8	0xA1
descriptor_length	8	uimsbf
reserved	3	'111'
PCR_PID	13	uimsbf
number_elements	8	uimsbf
for (i=0;i<number_elements;i++) {		
stream_type	8	uimsbf
reserved	3	'111'
elementary_PID	13	uimsbf
ISO_639_language_code	8*3	uimsbf
}		
}		

descriptor_tag — This 8-bit unsigned integer shall have the value 0xA1, identifying this descriptor as service_location_descriptor().

descriptor_length — This 8-bit unsigned integer specifies the length (in bytes) immediately following this field up to the end of this descriptor.

PCR_PID — This is a 13 bit field indicating the PID of the Transport Stream packets which shall contain the PCR fields valid for the program specified by program_number. If no PCR is associated with a program definition for private streams then this field shall take the value of 0x1FFF.

number_elements — This 8-bit unsigned integer indicates the number of PIDs used for this program.

stream_type — This 8-bit unsigned integer field specifies the type of the elementary stream according to Table 6.21.

Table 6.21 Stream Type Assignments

Value	Description
0x00	ITU-T | ISO/IEC Reserved
0x01-0x7F	As specified in Table 2.29 (Stream type assignments) of Ref. [10]
0x80	[Used in other systems]
0x81	ATSC A/53 audio
0x82-0x84	[Used in other systems]
0x85	UPID (Ref.[5])
0x86-0xBF	Reserved
0xC0-0xFF	User Private

elementary_PID — Packet Identifier for the elementary stream.

ISO_639_language_code — This 3-byte (24 bits) field, based on ISO 639.2/B, specifies the language used for the elementary stream. In case of no language specified for this elementary stream, e.g. video, each byte shall have the value 0x00.

6.7.7 Time-Shifted Service Descriptor

This descriptor links one virtual channel with one or more virtual channels that carry the same programming on a time-shifted basis. The typical application is for Near Video On Demand (NVOD) services.

The bit stream syntax for the time_shifted_service_descriptor() is shown in Table 6.22.

Table 6.22 Bit Stream Syntax for the Time Shifted Service Descriptor

Syntax	Bits	Format
time_shifted_service_descriptor () {		
descriptor_tag	8	0xA2
descriptor_length	8	uimsbf
reserved	3	'111'
number_of_services	5	uimsbf
for (i=0;i<number_of_services;i++) {		
reserved	6	'111111'
time_shift	10	uimsbf
reserved	4	'1111'
major_channel_number	10	uimsbf
minor_channel_number	10	uimsbf
}		
}		

descriptor_tag — This 8-bit unsigned integer shall have the value 0xA2, identifying this descriptor as time_shifted_service_descriptor().

descriptor_length — This 8-bit unsigned integer specifies the length (in bytes) immediately following this field up to the end of this descriptor.

number_of_services — A 5-bit number in the range 1 to 20 that indicates the number of time-shifted services being defined here.

time_shift — A 10-bit number in the range 1 to 720 that represents the number of minutes the time-shifted service indicated by major_channel_number and minor_channel_number is time-shifted from the virtual channel associated with this descriptor.

major_channel_number — A 10-bit number in the range 1 to 999 that represents the "major" channel number associated with a time-shifted service.

minor_channel_number — A 10-bit number in the range 0 to 999 that, when non-zero, represents the "minor" or "sub-" channel number of the virtual channel that carries a time-shifted service.

6.7.8 Component Name Descriptor

Table 6.23 defines the component_name_descriptor(), which serves to define an optional textual name tag for any component of the service.

Table 6.23 Bit Stream Syntax for the Component Name Descriptor

Syntax	Bits	Format
component_name_descriptor() {		
descriptor_tag	8	0xA3
descriptor_length	8	uimsbf
component_name_string()	var	
}		

descriptor_tag — This 8-bit unsigned integer shall have the value 0xA3, identifying this descriptor as component_name_descriptor.

descriptor_length — This 8-bit unsigned integer specifies the length (in bytes) immediately following this field up to the end of this descriptor.

component_name_string() — The name string in the format of a multiple string structure (see Section 6.8).

6.7.9 Stuffing Descriptor

For certain applications it is necessary to define a block of N bytes as a placeholder. The N bytes themselves are not to be processed or interpreted. The stuffing_descriptor() is specified for this purpose. The stuffing_descriptor() is simply a descriptor type for which the contents, as indicated by the descriptor_length field, are to be disregarded. The tag type for the stuffing descriptor is 0x80. The stuffing_descriptor() may appear where descriptors are allowed in any table defined in the PSIP.

6.7.10 Descriptors for Inactive Channels

The service_location_descriptor() shall not be present for inactive channels. Any other descriptors, if present, shall provide valid information about the inactive channel. The extended_channel_name_descriptor(), for example, can be used to provide the long-form channel name of the inactive channel.

6.8 Multiple String Structure

This is a general data structure used specifically for text strings. Text strings appear as event titles, long channel names, the ETT messages, and RRT text items. The bit stream syntax for the Multiple String Structure is shown in Table 6.24.

number_strings — This 8-bit unsigned integer field identifies the number of strings in the following data.

ISO_639_language_code — This 3-byte (24 bits) field, in conformance with ISO 639.2/B, specifies the language used for the i^{th} string.

number_segments — This 8-bit unsigned integer field identifies the number of segments in the following data. A specific mode is assigned for each segment.

Table 6.24 Bit Stream Syntax for the Multiple String Structure

Syntax	Bits	Format
multiple_string_structure () {		
number_strings	8	uimsbf
for (i= 0;i< number_strings;i++) {		
ISO_639_language_code	8*3	uimsbf
number_segments	8	uimsbf
for (j=0;j<number_segments;j++) {		
compression_type	8	uimsbf
mode	8	uimsbf
number_bytes	8	uimsbf
for (k= 0;k<number_bytes;k++)		
compressed_string_byte [k]	8	bslbf
}		
}		
}		

compression_type — This 8-bit field identifies the compression type for the j^th^ segment. Allowed values for this field are shown in Table 6.25.

Table 6.25 Compression Types

compression_type	compression method
0x00	No compression
0x01	Huffman coding using standard encode/decode tables defined in Table C.4 and C.5 in Annex C.
0x02	Huffman coding using standard encode/decode tables defined in Table C.6 and C.7 in Annex C.
0x03 to 0xAF	reserved
0xB0 to 0xFF	user private

mode — An 8-bit value representing the text mode to be used to interpret characters in the segment to follow. See Table 6.26 for definition. Mode values in the range zero through 0x3E select 8-bit Unicode™ character code pages. Mode value 0x3F selects 16-bit Unicode**™** character coding. Mode values 0x40 through 0xDF are reserved for future use by ATSC. Mode values 0xE0 through 0xFE are user private. Mode value 0xFF indicates the text mode is not applicable. Decoders shall ignore string bytes associated with unknown or unsupported mode values.

number_bytes — This 8-bit unsigned integer field identifies the number of bytes that follows.

compressed_string_byte[k] — The kth byte of the jth segment.

Table 6.26 Modes

Mode	Meaning	Language(s) or Script
0x00	Select ISO/IEC 10646-1 Page 0x00	ASCII, ISO Latin-1 (Roman)[4]
0x01	Select ISO/IEC 10646-1 Page 0x01	European Latin (many) [5]
0x02	Select ISO/IEC 10646-1 Page 0x02	Standard Phonetic
0x03	Select ISO/IEC 10646-1 Page 0x03	Greek
0x04	Select ISO/IEC 10646-1 Page 0x04	Russian, Slavic
0x05	Select ISO/IEC 10646-1 Page 0x05	Armenian, Hebrew
0x06	Select ISO/IEC 10646-1 Page 0x06	Arabic[6]
0x07-0x08	Reserved	-
0x09	Select ISO/IEC 10646-1 Page 0x09	Devanagari[7], Bengali
0x0A	Select ISO/IEC 10646-1 Page 0x0A	Punjabi, Gujarati
0x0B	Select ISO/IEC 10646-1 Page 0x0B	Oriya, Tamil
0x0C	Select ISO/IEC 10646-1 Page 0x0C	Telugu, Kannada
0x0D	Select ISO/IEC 10646-1 Page 0x0D	Malayalam
0x0E	Select ISO/IEC 10646-1 Page 0x0E	Thai, Lao
0x0F	Select ISO/IEC 10646-1 Page 0x0F	Tibetan
0x10	Select ISO/IEC 10646-1 Page 0x10	Georgian
0x11-0x1F	Reserved	-
0x20	Select ISO/IEC 10646-1 Page 0x20	Miscellaneous
0x21	Select ISO/IEC 10646-1 Page 0x21	Misc. symbols, arrows
0x22	Select ISO/IEC 10646-1 Page 0x22	Mathematical operators
0x23	Select ISO/IEC 10646-1 Page 0x23	Misc. technical
0x24	Select ISO/IEC 10646-1 Page 0x24	OCR, enclosed alpha-num.
0x25	Select ISO/IEC 10646-1 Page 0x25	Form and chart components
0x26	Select ISO/IEC 10646-1 Page 0x26	Miscellaneous dingbats
0x27	Select ISO/IEC 10646-1 Page 0x27	Zapf dingbats
0x28-0x2F	Reserved	-
0x30	Select ISO/IEC 10646-1 Page 0x30	Hiragana, Katakana
0x31	Select ISO/IEC 10646-1 Page 0x31	Bopomopho, Hangul elem.
0x32	Select ISO/IEC 10646-1 Page 0x32	Enclosed CJK Letters, ideo.
0x33	Select ISO/IEC 10646-1 Page 0x33	Enclosed CJK Letters, ideo.
0x34-0x3E	Reserved	-
0x3F	Select 16-bit ISO/IEC 10646-1 mode	all
0x40-0xDF	Reserved	
0xE0-0xFE	User private	
0xFF	Not applicable	

7. PSIP STD MODEL

7.1 Buffer Model for Terrestrial Broadcast

[4] The languages supported by ASCII plus the Latin-1 supplement include Danish, Dutch, English, Faroese, Finnish, Flemish, German, Icelandic, Irish, Italian, Norwegian, Portuguese, Spanish and Swedish. Many other languages can be written with this set of characters, including Hawaiian, Indonesian, and Swahili.

[5] When combined with page zero (ASCII and ISO Latin-1), covers Afrikaans, Breton, Basque, Catalan, Croatian, Czech, Esperanto, Estonian, French , Frisian, Greenlandic, Hungarian, Latin, Latvian, Lithuanian, Maltese, Polish, Provencal, Rhaeto-Romanic, Romanian, Romany, Sami, Slovak, Slovenian, Sorbian, Turkish, Welsh, and many others.

[6] Also Persian, Urdu, Pashto, Sindhi, and Kurdish.

[7] Devanagari script is used for writing Sanskrit and Hindi, as well as other languages of northern India (such as Marathi) and of Nepal (Nepali). In addition, at least two dozen other Indian languages use Devanagari script.

Table 7.1 lists the maximum cycle time for all PSIP tables, except EITs and ETTs. Table 7.2 lists the maximum transmission rate for PSIP packet streams according to their PIDs. The recommended maximum cycle time for EIT-0 is 500 ms.

Table 7.1 Maximum Cycle Time for the STT, MGT, VCT and RRT

Table	**STT**	**MGT**	**VCT**	**RRT**
Cycle time (ms)	1000	150	400	60000

Table 7.2 Maximum Rate for Each PSIP Packet Stream

PID	**base_PID**	**EIT_PID**	**ETT_PID**
Rate (bps)	250,000	250,000	250,000

For terrestrial broadcast applications the following constraints apply:

- In terrestrial broadcast applications, the PSIP elementary streams identified by Transport Stream packets with PID 0x1FFB (base_PID), EIT PIDs and ETT PIDs shall adhere to an STD model with the following parameters:
- sb_leak_rate shall be 625 (indicating a leak rate of 250,000 bps)
- sb_size shall be 1024 (indicating a smoothing buffer size of 1024 bytes)

7.2 Buffer Model for Cable

Transmission rates for cable will be standardized by the SCTE.

ANNEX A

(Normative)

DAYLIGHT SAVINGS TIME CONTROL

In order to convert GPS into local time, the receiver needs to store a time offset (from GPS to local time) in local memory and an indicator as to whether daylight savings is observed. These two quantities can be obtained from the user interface (indicating time zone and daylight savings observance) or from the conditional access system, if present, and stored in non-volatile receiver memory.

Since there is a common time (GPS) transmitted in the PSIP, there needs to be a mechanism to indicate when the receiver should switch into (or out of) daylight savings time at the appropriate local time. Once all the receivers have transitioned at their local times, the entire system can be shifted into daylight savings time. This is accomplished by appropriate setting of the daylight_savings in the STT. The structure of daylight savings time control is shown in Table A.1, and the basic use of daylight savings fields through the year is shown in Table A.2.

Table A.1 Structure of Daylight Savings Time Control

Syntax	Bits	Format
daylight_savings () {		
DS_status	1	bslbf
reserved	2	'11'
DS_day_of_month	5	uimsbf
DS_hour	8	uimsbf
}		

DS_status — This bit indicate the status of daylight savings.

DS_status = '0': Not in daylight savings time.

DS_status = '1': In daylight savings time.

DS_day_of_month — This 5-bit unsigned integer field indicates the local day of the month on which the transition into or out of daylight savings time is to occur (1-31).

DS_hour — This 8-bit unsigned integer field indicates the local hour at which the transition into or out of daylight savings time is to occur (0-18). This usually occurs at 2 a.m. in the U.S.

Table A.2 Basic Use of Daylight Savings Fields Through the Year

Conditions	DS_status	DS_day_ of_month	DS_hour
At the beginning of the year (January) daylight savings is off. This is the status of the fields until:	0	0	0
• When the transition into daylight savings time is within less than one month, the DS_day_of_month field takes the value day_in, and the DS_hour field takes the value hour_in. The DS_status bit is 0 indicating it is not yet daylight savings time. (The transition is to occur on the day_in day of the month at hour=hour_in; for example, if the transition were on April 15 at 2 a.m., then day_in=15 and hour_in=2)	0	day_in	hour_in
• After all time zone daylight transitions (within the span of the network) have occurred, the DS_status bit takes the value 1, indicating that daylight savings time is on. The DS_day_of_month field and the DS_hour field take the value 0. (In the U.S., this transition has to occur no later than 7 p.m. Pacific Time on the day day_in). This is the status of the fields until:	1	0	0
When the transition out of daylight savings time is within less than one month, the DS_day_of_month field takes the value day_out, and the DS_hour field takes the value hour_out. The DS_status bit is 1 indicating it is still daylight savings time. (The transition is to occur on the day_out day of the month at hour=hour_out; for example, if the transition were on October 27 at 2 a.m., then day_out=27 and hour_out=2)	1	day_out	hour_out
• After all time zones (within the span of the network) have shifted out of daylight savings time, the DS_status bit takes the value 0, indicating that daylight savings time is off. The DS_day_of_month field and the DS_hour field take the value 0. (In the U.S., this transition has to occur no later than 7 p.m. Pacific Time on the day day_out). This finishes the cycle.	0	0	0

ANNEX B

(Normative)

ASSIGNMENT OF MAJOR CHANNEL NUMBER VALUES FOR TERRESTRIAL BROADCAST IN THE U.S.

The assignment of major_channel_number values in the U.S. is based on the rules below.

- For broadcasters with existing NTSC licenses, the major_channel_number for the existing NTSC channels, as well as the Digital TV channels, controlled by the broadcaster, shall be set to the current NTSC RF channel number. E.g. Assume a broadcaster who has an NTSC broadcast license for RF channel 13 is assigned RF channel 39 for Digital ATSC broadcast. That broadcaster will use major_channel_number 13 for identification of the analog NTSC channel on RF channel 13, as well as the digital channels it is controlling on RF channel 39.
- For a new broadcaster without an existing NTSC license, the major_channel_number for the Digital TV channels controlled by the broadcaster shall be set to the FCC assigned RF channel number for ATSC Digital TV broadcast. E.g. Assume a broadcaster who currently has no NTSC broadcast license applies and receives a license for Digital ATSC broadcast on RF channel 49. That broadcaster will use major_channel_number 49 for identification of the digital channels that it is controlling on RF channel 49.
- The two provisions above assign major_channel_number values 2 through 69 uniquely to broadcasters with license to broadcast NTSC and/or Digital ATSC signals.
- Values for major_channel_number from 70 to 99 may be used to identify groups of digital services carried in an ATSC multiplex that the broadcaster wishes to be identified by a different major channel number. Values 70 through 99 must be unique in each potential receiving location or the receiver will not be able to correctly select such services. For example a local broadcaster transmitting community college lectures in its bit stream may want to use a major_channel_number different than its own major_channel_number for the virtual channel carrying the lectures. The assessment of the feasibility of using this capability, as well as the coordination process for assignment of these major_channel_number values is beyond the scope of this document.

ANNEX C

(Normative)

STANDARD HUFFMAN TABLES FOR TEXT COMPRESSION[8]

This Annex describes the compression method adopted for the transmission of English-language text strings in PSIP. The method distinguishes two types of text strings: titles and program descriptions. For each of these types, Huffman tables are defined based on 1st-order conditional probabilities. Section C.2 defines standard Huffman encode and decode tables optimized for English-language text such as that typically found in program titles. Section C.3 defines Huffman encode and decode tables optimized for English-language text such as that typically found in program descriptions. Receivers supporting the English language are expected to support decoding of text using either of these two standard Huffman compression tables.

The encode tables provide necessary and sufficient information to build the Huffman trees that need to be implemented for decoding. The decode tables described in Tables C.5 and C.7 are a particular mapping of those trees into a numerical array suitable for storage. This array can be easily implemented and used with the decoding algorithm. However, the user is free to design its own decoding tables as long as they follow the Huffman trees and rules defined in this Annex.

C1. CHARACTER SET DEFINITION

This compression method supports the full ISO/IEC 8859-1 (Latin-1) character set, although only characters in the ASCII range (character codes 1 to 127) can be compressed. The following characters have special definitions:

Table C.1 Characters with Special Definitions

Character	Value (Decimal)	Meaning
String Terminate (ASCII Null)	0	The *Terminate* character is used to terminate strings. The Terminate character is appended to the string in either compressed or uncompressed form. The first encoded character in a compressed string is encoded/decoded from the Terminate sub-tree. In other words, when encoding or decoding the first character in a compressed string, assume that the previous character was a Terminate character.
Order-1 Escape (ASCII ESC)	27	Used to escape from first-order context to uncompressed context. The character which follows the Escape character is uncompressed.

[8] Tables C.4 through C.7 are © 1997 General Instrument Corporation. Unlimited use in conjunction with this ATSC standard is granted on a royalty-free basis by General Instrument Corporation. All other rights are reserved.

C1.1 First Order Escape

The order-1 Huffman trees are *partial*, that is, codes are not defined for every possible character sequence. For example, the standard decode tables do not contain codes for the character sequence *qp*. When uncompressed text contains a character sequence which is not defined in the decode table, the order-1 escape character is used to escape back to the uncompressed context. Uncompressed symbols are coded as 8-bit ASCII (Latin I). For example, the character sequence *qpa* would be coded with *compressed q*, *compressed ESC, uncompressed p*, *compressed a*.

First-order escape rules for compressed strings:

- Any character which follows a first-order escape character is an uncompressed (8-bit) character. (Any character which follows an uncompressed escape character is compressed).
- Characters (128 .. 255) cannot be compressed.
- Any character which follows a character from the set (128 .. 255) is uncompressed.

C1.2 Decode Table Data Structures

Decode tables have two sections:

- **Tree Root Offset List:** Provides the table offsets, in *bytes* from the start of the decode table, for the roots of the 128 first-order decode trees. The list is contained in bytes (0 .. 255) of the decode table, and is defined by the first “for” loop in Table C.1.
- **Order-1 Decode Trees:** Each and every character in the range (0 .. 127) has a corresponding first-order decode tree. For example, if the previous character was "s", then the decoder would use the "s" first-order decode tree (decode tree #115) to decode the next character (ASCII "s" equals 115 decimal). These 128 decode trees are delimited by the second “for” loop in Table C.2.

Decode tables have the following format:

Table C.2 Decode Table Format

Syntax	Bits	Format
decode_table() {		
for (i==0; i<128; i++) {		
byte_offset_of_char_i_tree_root	16	uimsbf
}		
for (i==0; i<128; i++) {		
character_i_order_1_tree()	8*M	
}		
}		

Note that even though the ISO Latin-1 character set supports up to 256 characters, only the first 128 characters may be represented in compressed form.

C1.2.1 Tree Root Byte Offsets

byte_offset_of_character_i_tree_root — A 16-bit unsigned integer specifying the location, in bytes from the beginning of the decode table, of the root for the i^{th} character's order-1 tree.

C1.2.2 Order-1 Decode Trees

Order-1 decode trees are binary trees. The roots of the decode trees are located at the table offsets specified in the tree root offset list. The left and right children of a given node are specified as *word* offsets from the root of the tree (a *word* is equivalent to two bytes).

Decode trees have the following format:

Table C.3 Decode Tree Format

Syntax	Bits	Format
character_i_order_1_tree() {		
for (j==0; j<N; j++) {		
left_child_word_offset_or_char_leaf	8	uimsbf
right_child_word_offset_or_char_leaf	8	uimsbf
}		
}		

left_child_word_offset_or_char_leaf — An 8-bit unsigned integer number with the following interpretation: If the highest bit is cleared (i.e. bit 7 is zero), the number specifies the offset, in words, of the left child from the root of the order-1 decode tree; if the highest bit is set (bit 7 is one), the lower 7 bits give the code (e.g., in ASCII) for a leaf character.

right_child_word_offset_or_char_leaf — An 8-bit unsigned integer number with the following interpretation: If the highest bit is cleared (i.e. bit 7 is zero), the number specifies the offset, in words, of the right child from the root of the order-1 decode tree; if the highest bit is set (bit 7 is one), the lower 7 bits give the code (e.g., in ASCII) for a leaf character.

It can be seen from Figure F.3 that each node (corresponding to one iteration of the for-loop) has a byte for the left child or character, and a byte for the right child or character.

Characters are *leaves* of the order-1 decode trees, and are differentiated from intermediate nodes by the byte's most significant bit. When the most significant bit is set, the byte is a character leaf. When the most significant bit is not set, the byte contains the tabular word offset of the child node.

C2. STANDARD COMPRESSION TYPE 1 ENCODE/DECODE TABLES

The following encode/decode tables are optimized for English-language program title text. These tables correspond to multiple_string_structure() with compression_type value 0x01, and a mode equal to 0xFF.

Table C.4 English-language Program Title Encode Table

Prior Symbol: 0 Symbol: 27 Code: 11001011
Prior Symbol: 0 Symbol: '$' Code: 1100101011
Prior Symbol: 0 Symbol: '2' Code: 011010010
Prior Symbol: 0 Symbol: '4' Code: 1100101010
Prior Symbol: 0 Symbol: '7' Code: 011010011
Prior Symbol: 0 Symbol: 'A' Code: 0111
Prior Symbol: 0 Symbol: 'B' Code: 1001
Prior Symbol: 0 Symbol: 'C' Code: 1011
Prior Symbol: 0 Symbol: 'D' Code: 11011
Prior Symbol: 0 Symbol: 'E' Code: 10001
Prior Symbol: 0 Symbol: 'F' Code: 11000
Prior Symbol: 0 Symbol: 'G' Code: 11100
Prior Symbol: 0 Symbol: 'H' Code: 11111
Prior Symbol: 0 Symbol: 'I' Code: 10000
Prior Symbol: 0 Symbol: 'J' Code: 01100
Prior Symbol: 0 Symbol: 'K' Code: 1100110
Prior Symbol: 0 Symbol: 'L' Code: 11101
Prior Symbol: 0 Symbol: 'M' Code: 1010
Prior Symbol: 0 Symbol: 'N' Code: 0011
Prior Symbol: 0 Symbol: 'O' Code: 011011
Prior Symbol: 0 Symbol: 'P' Code: 11110
Prior Symbol: 0 Symbol: 'Q' Code: 01101000
Prior Symbol: 0 Symbol: 'R' Code: 11010
Prior Symbol: 0 Symbol: 'S' Code: 000
Prior Symbol: 0 Symbol: 'T' Code: 010
Prior Symbol: 0 Symbol: 'U' Code: 0110101
Prior Symbol: 0 Symbol: 'V' Code: 1100111
Prior Symbol: 0 Symbol: 'W' Code: 0010
Prior Symbol: 0 Symbol: 'Y' Code: 1100100
Prior Symbol: 0 Symbol: 'Z' Code: 110010100
Prior Symbol: 1 Symbol: 27 Code: 1
Prior Symbol: 2 Symbol: 27 Code: 1
Prior Symbol: 3 Symbol: 27 Code: 1
Prior Symbol: 4 Symbol: 27 Code: 1
Prior Symbol: 5 Symbol: 27 Code: 1
Prior Symbol: 6 Symbol: 27 Code: 1
Prior Symbol: 7 Symbol: 27 Code: 1
Prior Symbol: 8 Symbol: 27 Code: 1
Prior Symbol: 9 Symbol: 27 Code: 1
Prior Symbol: 10 Symbol: 27 Code: 1
Prior Symbol: 11 Symbol: 27 Code: 1
Prior Symbol: 12 Symbol: 27 Code: 1
Prior Symbol: 13 Symbol: 27 Code: 1
Prior Symbol: 14 Symbol: 27 Code: 1
Prior Symbol: 15 Symbol: 27 Code: 1
Prior Symbol: 16 Symbol: 27 Code: 1
Prior Symbol: 17 Symbol: 27 Code: 1
Prior Symbol: 18 Symbol: 27 Code: 1
Prior Symbol: 19 Symbol: 27 Code: 1
Prior Symbol: 20 Symbol: 27 Code: 1
Prior Symbol: 21 Symbol: 27 Code: 1
Prior Symbol: 22 Symbol: 27 Code: 1
Prior Symbol: 23 Symbol: 27 Code: 1
Prior Symbol: 24 Symbol: 27 Code: 1
Prior Symbol: 25 Symbol: 27 Code: 1
Prior Symbol: 26 Symbol: 27 Code: 1
Prior Symbol: 27 Symbol: 27 Code: 1
Prior Symbol: 28 Symbol: 27 Code: 1
Prior Symbol: 29 Symbol: 27 Code: 1
Prior Symbol: 30 Symbol: 27 Code: 1
Prior Symbol: 31 Symbol: 27 Code: 1
Prior Symbol: ' ' Symbol: 27 Code: 10010100
Prior Symbol: ' ' Symbol: '&' Code: 010001
Prior Symbol: ' ' Symbol: ''' Code: 010000100
Prior Symbol: ' ' Symbol: '-' Code: 00000001
Prior Symbol: ' ' Symbol: '1' Code: 010000101
Prior Symbol: ' ' Symbol: '2' Code: 00000010
Prior Symbol: ' ' Symbol: '3' Code: 01000001
Prior Symbol: ' ' Symbol: '9' Code: 000000000
Prior Symbol: ' ' Symbol: 'A' Code: 10111
Prior Symbol: ' ' Symbol: 'B' Code: 0010
Prior Symbol: ' ' Symbol: 'C' Code: 1100
Prior Symbol: ' ' Symbol: 'D' Code: 11100
Prior Symbol: ' ' Symbol: 'E' Code: 011010
Prior Symbol: ' ' Symbol: 'F' Code: 10011
Prior Symbol: ' ' Symbol: 'G' Code: 00001
Prior Symbol: ' ' Symbol: 'H' Code: 10101
Prior Symbol: ' ' Symbol: 'I' Code: 111111
Prior Symbol: ' ' Symbol: 'J' Code: 111110
Prior Symbol: ' ' Symbol: 'K' Code: 010011
Prior Symbol: ' ' Symbol: 'L' Code: 11110
Prior Symbol: ' ' Symbol: 'M' Code: 0101
Prior Symbol: ' ' Symbol: 'N' Code: 10110
Prior Symbol: ' ' Symbol: 'O' Code: 011011
Prior Symbol: ' ' Symbol: 'P' Code: 11101
Prior Symbol: ' ' Symbol: 'Q' Code: 100100011
Prior Symbol: ' ' Symbol: 'R' Code: 10100
Prior Symbol: ' ' Symbol: 'S' Code: 1101
Prior Symbol: ' ' Symbol: 'T' Code: 1000
Prior Symbol: ' ' Symbol: 'U' Code: 1001001
Prior Symbol: ' ' Symbol: 'V' Code: 1001011
Prior Symbol: ' ' Symbol: 'W' Code: 0011
Prior Symbol: ' ' Symbol: 'X' Code: 0000000010
Prior Symbol: ' ' Symbol: 'Y' Code: 000001
Prior Symbol: ' ' Symbol: 'Z' Code: 00000011
Prior Symbol: ' ' Symbol: 'a' Code: 01100
Prior Symbol: ' ' Symbol: 'b' Code: 10010101
Prior Symbol: ' ' Symbol: 'c' Code: 01000000
Prior Symbol: ' ' Symbol: 'd' Code: 01000011
Prior Symbol: ' ' Symbol: 'e' Code: 0000000011
Prior Symbol: ' ' Symbol: 'f' Code: 10010000
Prior Symbol: ' ' Symbol: 'i' Code: 010010
Prior Symbol: ' ' Symbol: 'l' Code: 100100010
Prior Symbol: ' ' Symbol: 'o' Code: 0001
Prior Symbol: ' ' Symbol: 't' Code: 0111
Prior Symbol: '!' Symbol: 0 Code: 1
Prior Symbol: '!' Symbol: 27 Code: 01
Prior Symbol: '!' Symbol: ' ' Code: 00
Prior Symbol: '"' Symbol: 27 Code: 1
Prior Symbol: '#' Symbol: 27 Code: 1
Prior Symbol: '$' Symbol: 27 Code: 1
Prior Symbol: '$' Symbol: '1' Code: 0
Prior Symbol: '%' Symbol: 27 Code: 1
Prior Symbol: '&' Symbol: 27 Code: 0
Prior Symbol: '&' Symbol: ' ' Code: 1
Prior Symbol: ''' Symbol: 27 Code: 011
Prior Symbol: ''' Symbol: ' ' Code: 010
Prior Symbol: ''' Symbol: '9' Code: 0001
Prior Symbol: ''' Symbol: 'd' Code: 0000
Prior Symbol: ''' Symbol: 's' Code: 1
Prior Symbol: ''' Symbol: 't' Code: 001
Prior Symbol: '(' Symbol: 27 Code: 1
Prior Symbol: ')' Symbol: 27 Code: 1
Prior Symbol: '*' Symbol: 27 Code: 00
Prior Symbol: '*' Symbol: 'A' Code: 01
Prior Symbol: '*' Symbol: 'H' Code: 10
Prior Symbol: '*' Symbol: 'S' Code: 11
Prior Symbol: '+' Symbol: 27 Code: 1
Prior Symbol: ',' Symbol: 27 Code: 0
Prior Symbol: ',' Symbol: ' ' Code: 1
Prior Symbol: '-' Symbol: 27 Code: 01
Prior Symbol: '-' Symbol: ' ' Code: 111
Prior Symbol: '-' Symbol: '-' Code: 1101
Prior Symbol: '-' Symbol: '1' Code: 1000
Prior Symbol: '-' Symbol: 'A' Code: 001
Prior Symbol: '-' Symbol: 'M' Code: 000
Prior Symbol: '-' Symbol: 'R' Code: 1001
Prior Symbol: '-' Symbol: 'S' Code: 1010
Prior Symbol: '-' Symbol: 'T' Code: 1011
Prior Symbol: '-' Symbol: 'U' Code: 1100
Prior Symbol: '.' Symbol: 0 Code: 111
Prior Symbol: '.' Symbol: 27 Code: 101
Prior Symbol: '.' Symbol: ' ' Code: 0
Prior Symbol: '.' Symbol: '.' Code: 110
Prior Symbol: '.' Symbol: 'I' Code: 10010
Prior Symbol: '.' Symbol: 'S' Code: 1000
Prior Symbol: '.' Symbol: 'W' Code: 10011
Prior Symbol: '/' Symbol: 27 Code: 1
Prior Symbol: '0' Symbol: 0 Code: 01
Prior Symbol: '0' Symbol: 27 Code: 001
Prior Symbol: '0' Symbol: ' ' Code: 10
Prior Symbol: '0' Symbol: '-' Code: 000
Prior Symbol: '0' Symbol: '0' Code: 11
Prior Symbol: '1' Symbol: 0 Code: 010
Prior Symbol: '1' Symbol: 27 Code: 011
Prior Symbol: '1' Symbol: ' ' Code: 110
Prior Symbol: '1' Symbol: '0' Code: 111
Prior Symbol: '1' Symbol: '1' Code: 100
Prior Symbol: '1' Symbol: '2' Code: 101
Prior Symbol: '1' Symbol: '9' Code: 00
Prior Symbol: '2' Symbol: 0 Code: 11
Prior Symbol: '2' Symbol: 27 Code: 10
Prior Symbol: '2' Symbol: '0' Code: 01
Prior Symbol: '2' Symbol: '1' Code: 000
Prior Symbol: '2' Symbol: ':' Code: 001
Prior Symbol: '3' Symbol: 0 Code: 0
Prior Symbol: '3' Symbol: 27 Code: 11
Prior Symbol: '3' Symbol: '0' Code: 10
Prior Symbol: '4' Symbol: 27 Code: 0
Prior Symbol: '4' Symbol: '8' Code: 1
Prior Symbol: '5' Symbol: 27 Code: 1
Prior Symbol: '6' Symbol: 27 Code: 1
Prior Symbol: '7' Symbol: 27 Code: 0
Prior Symbol: '7' Symbol: '0' Code: 1
Prior Symbol: '8' Symbol: 27 Code: 0
Prior Symbol: '8' Symbol: ' ' Code: 1
Prior Symbol: '9' Symbol: 27 Code: 11
Prior Symbol: '9' Symbol: '0' Code: 01
Prior Symbol: '9' Symbol: '1' Code: 100
Prior Symbol: '9' Symbol: '3' Code: 101
Prior Symbol: '9' Symbol: '9' Code: 00
Prior Symbol: ':' Symbol: 27 Code: 0
Prior Symbol: ':' Symbol: ' ' Code: 1
Prior Symbol: ';' Symbol: 27 Code: 1
Prior Symbol: '<' Symbol: 27 Code: 1
Prior Symbol: '=' Symbol: 27 Code: 1
Prior Symbol: '>' Symbol: 27 Code: 1
Prior Symbol: '?' Symbol: 0 Code: 1
Prior Symbol: '?' Symbol: 27 Code: 0
Prior Symbol: '@' Symbol: 27 Code: 1
Prior Symbol: 'A' Symbol: 27 Code: 00010
Prior Symbol: 'A' Symbol: ' ' Code: 010

Prior Symbol: 'A' Symbol: '*' Code: 1101000
Prior Symbol: 'A' Symbol: '-' Code: 1101001
Prior Symbol: 'A' Symbol: '.' Code: 1101010
Prior Symbol: 'A' Symbol: 'B' Code: 110110
Prior Symbol: 'A' Symbol: 'b' Code: 110010
Prior Symbol: 'A' Symbol: 'c' Code: 01100
Prior Symbol: 'A' Symbol: 'd' Code: 001
Prior Symbol: 'A' Symbol: 'f' Code: 01101
Prior Symbol: 'A' Symbol: 'g' Code: 011110
Prior Symbol: 'A' Symbol: 'i' Code: 110011
Prior Symbol: 'A' Symbol: 'l' Code: 100
Prior Symbol: 'A' Symbol: 'm' Code: 111
Prior Symbol: 'A' Symbol: 'n' Code: 101
Prior Symbol: 'A' Symbol: 'p' Code: 110111
Prior Symbol: 'A' Symbol: 'r' Code: 0000
Prior Symbol: 'A' Symbol: 's' Code: 00011
Prior Symbol: 'A' Symbol: 't' Code: 011111
Prior Symbol: 'A' Symbol: 'u' Code: 11000
Prior Symbol: 'A' Symbol: 'v' Code: 1101011
Prior Symbol: 'A' Symbol: 'w' Code: 01110
Prior Symbol: 'B' Symbol: 27 Code: 00010
Prior Symbol: 'B' Symbol: 'A' Code: 000110
Prior Symbol: 'B' Symbol: 'C' Code: 0000
Prior Symbol: 'B' Symbol: 'S' Code: 000111
Prior Symbol: 'B' Symbol: 'a' Code: 111
Prior Symbol: 'B' Symbol: 'e' Code: 01
Prior Symbol: 'B' Symbol: 'i' Code: 1010
Prior Symbol: 'B' Symbol: 'l' Code: 1011
Prior Symbol: 'B' Symbol: 'o' Code: 110
Prior Symbol: 'B' Symbol: 'r' Code: 001
Prior Symbol: 'B' Symbol: 'u' Code: 100
Prior Symbol: 'C' Symbol: 27 Code: 00101
Prior Symbol: 'C' Symbol: ' ' Code: 10110
Prior Symbol: 'C' Symbol: 'A' Code: 0011100
Prior Symbol: 'C' Symbol: 'B' Code: 001111
Prior Symbol: 'C' Symbol: 'O' Code: 101110
Prior Symbol: 'C' Symbol: 'a' Code: 100
Prior Symbol: 'C' Symbol: 'e' Code: 101111
Prior Symbol: 'C' Symbol: 'h' Code: 01
Prior Symbol: 'C' Symbol: 'i' Code: 00110
Prior Symbol: 'C' Symbol: 'l' Code: 000
Prior Symbol: 'C' Symbol: 'o' Code: 11
Prior Symbol: 'C' Symbol: 'r' Code: 1010
Prior Symbol: 'C' Symbol: 'u' Code: 00100
Prior Symbol: 'C' Symbol: 'y' Code: 0011101
Prior Symbol: 'D' Symbol: 27 Code: 01001
Prior Symbol: 'D' Symbol: 'a' Code: 10
Prior Symbol: 'D' Symbol: 'e' Code: 111
Prior Symbol: 'D' Symbol: 'i' Code: 110
Prior Symbol: 'D' Symbol: 'o' Code: 00
Prior Symbol: 'D' Symbol: 'r' Code: 011
Prior Symbol: 'D' Symbol: 'u' Code: 0101
Prior Symbol: 'D' Symbol: 'y' Code: 01000
Prior Symbol: 'E' Symbol: 27 Code: 011
Prior Symbol: 'E' Symbol: 'C' Code: 1010
Prior Symbol: 'E' Symbol: 'a' Code: 111
Prior Symbol: 'E' Symbol: 'd' Code: 000
Prior Symbol: 'E' Symbol: 'l' Code: 1100
Prior Symbol: 'E' Symbol: 'm' Code: 0100
Prior Symbol: 'E' Symbol: 'n' Code: 1101
Prior Symbol: 'E' Symbol: 'q' Code: 101110
Prior Symbol: 'E' Symbol: 's' Code: 10110
Prior Symbol: 'E' Symbol: 'u' Code: 101111
Prior Symbol: 'E' Symbol: 'v' Code: 100
Prior Symbol: 'E' Symbol: 'x' Code: 001
Prior Symbol: 'E' Symbol: 'y' Code: 0101
Prior Symbol: 'F' Symbol: 27 Code: 011111
Prior Symbol: 'F' Symbol: ' ' Code: 011110
Prior Symbol: 'F' Symbol: 'L' Code: 01110
Prior Symbol: 'F' Symbol: 'a' Code: 10
Prior Symbol: 'F' Symbol: 'e' Code: 0110
Prior Symbol: 'F' Symbol: 'i' Code: 110
Prior Symbol: 'F' Symbol: 'l' Code: 000
Prior Symbol: 'F' Symbol: 'o' Code: 010
Prior Symbol: 'F' Symbol: 'r' Code: 111
Prior Symbol: 'F' Symbol: 'u' Code: 001
Prior Symbol: 'G' Symbol: 27 Code: 10110
Prior Symbol: 'G' Symbol: '.' Code: 101010
Prior Symbol: 'G' Symbol: 'A' Code: 101111
Prior Symbol: 'G' Symbol: 'a' Code: 1110
Prior Symbol: 'G' Symbol: 'e' Code: 110
Prior Symbol: 'G' Symbol: 'h' Code: 10100
Prior Symbol: 'G' Symbol: 'i' Code: 100
Prior Symbol: 'G' Symbol: 'l' Code: 101011
Prior Symbol: 'G' Symbol: 'o' Code: 01
Prior Symbol: 'G' Symbol: 'r' Code: 00
Prior Symbol: 'G' Symbol: 'u' Code: 1111
Prior Symbol: 'G' Symbol: 'y' Code: 101110
Prior Symbol: 'H' Symbol: 0 Code: 111010
Prior Symbol: 'H' Symbol: 27 Code: 111011
Prior Symbol: 'H' Symbol: 'a' Code: 110
Prior Symbol: 'H' Symbol: 'e' Code: 10
Prior Symbol: 'H' Symbol: 'i' Code: 1111
Prior Symbol: 'H' Symbol: 'o' Code: 0
Prior Symbol: 'H' Symbol: 'u' Code: 11100
Prior Symbol: 'I' Symbol: 0 Code: 1000
Prior Symbol: 'I' Symbol: 27 Code: 1001
Prior Symbol: 'I' Symbol: ' ' Code: 11110
Prior Symbol: 'I' Symbol: '.' Code: 111110
Prior Symbol: 'I' Symbol: ':' Code: 101110
Prior Symbol: 'I' Symbol: 'I' Code: 1100
Prior Symbol: 'I' Symbol: 'T' Code: 101111
Prior Symbol: 'I' Symbol: 'c' Code: 10110
Prior Symbol: 'I' Symbol: 'm' Code: 1010
Prior Symbol: 'I' Symbol: 'n' Code: 0
Prior Symbol: 'I' Symbol: 'r' Code: 111111
Prior Symbol: 'I' Symbol: 's' Code: 1101
Prior Symbol: 'I' Symbol: 't' Code: 1110
Prior Symbol: 'J' Symbol: 27 Code: 000
Prior Symbol: 'J' Symbol: 'a' Code: 01
Prior Symbol: 'J' Symbol: 'e' Code: 11
Prior Symbol: 'J' Symbol: 'o' Code: 10
Prior Symbol: 'J' Symbol: 'u' Code: 001
Prior Symbol: 'K' Symbol: 27 Code: 000
Prior Symbol: 'K' Symbol: 'a' Code: 0100
Prior Symbol: 'K' Symbol: 'e' Code: 001
Prior Symbol: 'K' Symbol: 'i' Code: 1
Prior Symbol: 'K' Symbol: 'n' Code: 0111
Prior Symbol: 'K' Symbol: 'o' Code: 0101
Prior Symbol: 'K' Symbol: 'u' Code: 0110
Prior Symbol: 'L' Symbol: 27 Code: 01001
Prior Symbol: 'L' Symbol: ' ' Code: 01000
Prior Symbol: 'L' Symbol: 'a' Code: 10
Prior Symbol: 'L' Symbol: 'e' Code: 011
Prior Symbol: 'L' Symbol: 'i' Code: 11
Prior Symbol: 'L' Symbol: 'o' Code: 00
Prior Symbol: 'L' Symbol: 'u' Code: 0101
Prior Symbol: 'M' Symbol: 27 Code: 1011111
Prior Symbol: 'M' Symbol: '*' Code: 10111100
Prior Symbol: 'M' Symbol: 'T' Code: 10111101
Prior Symbol: 'M' Symbol: 'a' Code: 11
Prior Symbol: 'M' Symbol: 'c' Code: 101110
Prior Symbol: 'M' Symbol: 'e' Code: 1010
Prior Symbol: 'M' Symbol: 'i' Code: 100
Prior Symbol: 'M' Symbol: 'o' Code: 00
Prior Symbol: 'M' Symbol: 'r' Code: 10110
Prior Symbol: 'M' Symbol: 'u' Code: 010
Prior Symbol: 'M' Symbol: 'y' Code: 011
Prior Symbol: 'N' Symbol: 27 Code: 1000
Prior Symbol: 'N' Symbol: ' ' Code: 110001
Prior Symbol: 'N' Symbol: 'B' Code: 1001
Prior Symbol: 'N' Symbol: 'F' Code: 110010
Prior Symbol: 'N' Symbol: 'N' Code: 110000
Prior Symbol: 'N' Symbol: 'a' Code: 1101
Prior Symbol: 'N' Symbol: 'e' Code: 0
Prior Symbol: 'N' Symbol: 'i' Code: 111
Prior Symbol: 'N' Symbol: 'o' Code: 101
Prior Symbol: 'N' Symbol: 'u' Code: 110011
Prior Symbol: 'O' Symbol: 27 Code: 010
Prior Symbol: 'O' Symbol: ' ' Code: 001
Prior Symbol: 'O' Symbol: 'd' Code: 01110
Prior Symbol: 'O' Symbol: 'f' Code: 11010
Prior Symbol: 'O' Symbol: 'l' Code: 1100
Prior Symbol: 'O' Symbol: 'n' Code: 10
Prior Symbol: 'O' Symbol: 'p' Code: 0001
Prior Symbol: 'O' Symbol: 'r' Code: 0110
Prior Symbol: 'O' Symbol: 's' Code: 01111
Prior Symbol: 'O' Symbol: 'u' Code: 111
Prior Symbol: 'O' Symbol: 'v' Code: 11011
Prior Symbol: 'O' Symbol: 'w' Code: 0000
Prior Symbol: 'P' Symbol: 27 Code: 111111
Prior Symbol: 'P' Symbol: ' ' Code: 1111100
Prior Symbol: 'P' Symbol: '.' Code: 011001
Prior Symbol: 'P' Symbol: 'G' Code: 111101
Prior Symbol: 'P' Symbol: 'R' Code: 111100
Prior Symbol: 'P' Symbol: 'a' Code: 00
Prior Symbol: 'P' Symbol: 'e' Code: 010
Prior Symbol: 'P' Symbol: 'i' Code: 0111
Prior Symbol: 'P' Symbol: 'l' Code: 1110
Prior Symbol: 'P' Symbol: 'o' Code: 110
Prior Symbol: 'P' Symbol: 'r' Code: 10
Prior Symbol: 'P' Symbol: 's' Code: 1111101
Prior Symbol: 'P' Symbol: 'u' Code: 01101
Prior Symbol: 'P' Symbol: 'y' Code: 011000
Prior Symbol: 'Q' Symbol: 27 Code: 00
Prior Symbol: 'Q' Symbol: 'V' Code: 01
Prior Symbol: 'Q' Symbol: 'u' Code: 1
Prior Symbol: 'R' Symbol: 27 Code: 10001
Prior Symbol: 'R' Symbol: 'a' Code: 101
Prior Symbol: 'R' Symbol: 'e' Code: 11
Prior Symbol: 'R' Symbol: 'h' Code: 10000
Prior Symbol: 'R' Symbol: 'i' Code: 00
Prior Symbol: 'R' Symbol: 'o' Code: 01
Prior Symbol: 'R' Symbol: 'u' Code: 1001
Prior Symbol: 'S' Symbol: 27 Code: 101110
Prior Symbol: 'S' Symbol: ' ' Code: 1110100
Prior Symbol: 'S' Symbol: '*' Code: 1011000
Prior Symbol: 'S' Symbol: '.' Code: 1011011
Prior Symbol: 'S' Symbol: 'a' Code: 1111
Prior Symbol: 'S' Symbol: 'c' Code: 11100
Prior Symbol: 'S' Symbol: 'e' Code: 000
Prior Symbol: 'S' Symbol: 'h' Code: 100
Prior Symbol: 'S' Symbol: 'i' Code: 1100
Prior Symbol: 'S' Symbol: 'k' Code: 101111
Prior Symbol: 'S' Symbol: 'l' Code: 1011001
Prior Symbol: 'S' Symbol: 'm' Code: 1110110
Prior Symbol: 'S' Symbol: 'n' Code: 1110111
Prior Symbol: 'S' Symbol: 'o' Code: 1010
Prior Symbol: 'S' Symbol: 'p' Code: 001
Prior Symbol: 'S' Symbol: 'q' Code: 1011010
Prior Symbol: 'S' Symbol: 't' Code: 01
Prior Symbol: 'S' Symbol: 'u' Code: 1101
Prior Symbol: 'S' Symbol: 'w' Code: 1110101
Prior Symbol: 'T' Symbol: 27 Code: 1111010
Prior Symbol: 'T' Symbol: '-' Code: 11110110
Prior Symbol: 'T' Symbol: 'N' Code: 11110111
Prior Symbol: 'T' Symbol: 'V' Code: 111100
Prior Symbol: 'T' Symbol: 'a' Code: 1010
Prior Symbol: 'T' Symbol: 'e' Code: 1011
Prior Symbol: 'T' Symbol: 'h' Code: 0
Prior Symbol: 'T' Symbol: 'i' Code: 1110
Prior Symbol: 'T' Symbol: 'o' Code: 110
Prior Symbol: 'T' Symbol: 'r' Code: 100
Prior Symbol: 'T' Symbol: 'u' Code: 111110
Prior Symbol: 'T' Symbol: 'w' Code: 111111
Prior Symbol: 'U' Symbol: 27 Code: 101
Prior Symbol: 'U' Symbol: '.' Code: 1001
Prior Symbol: 'U' Symbol: 'l' Code: 1000
Prior Symbol: 'U' Symbol: 'n' Code: 0
Prior Symbol: 'U' Symbol: 'p' Code: 11
Prior Symbol: 'V' Symbol: 0 Code: 000
Prior Symbol: 'V' Symbol: 27 Code: 0011
Prior Symbol: 'V' Symbol: ' ' Code: 01010
Prior Symbol: 'V' Symbol: 'C' Code: 01011
Prior Symbol: 'V' Symbol: 'a' Code: 011
Prior Symbol: 'V' Symbol: 'e' Code: 0100
Prior Symbol: 'V' Symbol: 'i' Code: 1
Prior Symbol: 'V' Symbol: 'o' Code: 0010
Prior Symbol: 'W' Symbol: 27 Code: 00011
Prior Symbol: 'W' Symbol: 'F' Code: 000100
Prior Symbol: 'W' Symbol: 'W' Code: 000101
Prior Symbol: 'W' Symbol: 'a' Code: 111
Prior Symbol: 'W' Symbol: 'e' Code: 110
Prior Symbol: 'W' Symbol: 'h' Code: 001
Prior Symbol: 'W' Symbol: 'i' Code: 01
Prior Symbol: 'W' Symbol: 'o' Code: 10
Prior Symbol: 'W' Symbol: 'r' Code: 0000

Prior Symbol: 'X' Symbol: 27 Code: 1
Prior Symbol: 'Y' Symbol: 27 Code: 001
Prior Symbol: 'Y' Symbol: 'a' Code: 000
Prior Symbol: 'Y' Symbol: 'e' Code: 01
Prior Symbol: 'Y' Symbol: 'o' Code: 1
Prior Symbol: 'Z' Symbol: 27 Code: 00
Prior Symbol: 'Z' Symbol: 'a' Code: 01
Prior Symbol: 'Z' Symbol: 'o' Code: 1
Prior Symbol: '[' Symbol: 27 Code: 1
Prior Symbol: '\' Symbol: 27 Code: 1
Prior Symbol: ']' Symbol: 27 Code: 1
Prior Symbol: '^' Symbol: 27 Code: 1
Prior Symbol: '_' Symbol: 27 Code: 1
Prior Symbol: '`' Symbol: 27 Code: 1
Prior Symbol: 'a' Symbol: 0 Code: 00010
Prior Symbol: 'a' Symbol: 27 Code: 1111010110
Prior Symbol: 'a' Symbol: ' ' Code: 10110
Prior Symbol: 'a' Symbol: ''' Code: 11110100
Prior Symbol: 'a' Symbol: ':' Code: 1111010111
Prior Symbol: 'a' Symbol: 'b' Code: 010010
Prior Symbol: 'a' Symbol: 'c' Code: 11111
Prior Symbol: 'a' Symbol: 'd' Code: 10100
Prior Symbol: 'a' Symbol: 'e' Code: 101011000
Prior Symbol: 'a' Symbol: 'f' Code: 10101101
Prior Symbol: 'a' Symbol: 'g' Code: 01000
Prior Symbol: 'a' Symbol: 'h' Code: 0100111
Prior Symbol: 'a' Symbol: 'i' Code: 10111
Prior Symbol: 'a' Symbol: 'j' Code: 101011001
Prior Symbol: 'a' Symbol: 'k' Code: 101010
Prior Symbol: 'a' Symbol: 'l' Code: 001
Prior Symbol: 'a' Symbol: 'm' Code: 0101
Prior Symbol: 'a' Symbol: 'n' Code: 110
Prior Symbol: 'a' Symbol: 'p' Code: 111100
Prior Symbol: 'a' Symbol: 'r' Code: 100
Prior Symbol: 'a' Symbol: 's' Code: 1110
Prior Symbol: 'a' Symbol: 't' Code: 011
Prior Symbol: 'a' Symbol: 'u' Code: 1111011
Prior Symbol: 'a' Symbol: 'v' Code: 00011
Prior Symbol: 'a' Symbol: 'w' Code: 1010111
Prior Symbol: 'a' Symbol: 'x' Code: 111101010
Prior Symbol: 'a' Symbol: 'y' Code: 0000
Prior Symbol: 'a' Symbol: 'z' Code: 0100110
Prior Symbol: 'b' Symbol: 0 Code: 11111
Prior Symbol: 'b' Symbol: 27 Code: 111101
Prior Symbol: 'b' Symbol: ' ' Code: 0110
Prior Symbol: 'b' Symbol: 'a' Code: 00
Prior Symbol: 'b' Symbol: 'b' Code: 01111
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Prior Symbol: 'b' Symbol: 'o' Code: 110
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Prior Symbol: 'c' Symbol: 'G' Code: 1000010
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Prior Symbol: 'c' Symbol: 'e' Code: 111
Prior Symbol: 'c' Symbol: 'h' Code: 101
Prior Symbol: 'c' Symbol: 'i' Code: 0011
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Prior Symbol: 'c' Symbol: 's' Code: 00100
Prior Symbol: 'c' Symbol: 't' Code: 000
Prior Symbol: 'c' Symbol: 'u' Code: 01010
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Prior Symbol: 'd' Symbol: 0 Code: 011
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Prior Symbol: 'd' Symbol: 'd' Code: 100000
Prior Symbol: 'd' Symbol: 'e' Code: 00
Prior Symbol: 'd' Symbol: 'g' Code: 100001
Prior Symbol: 'd' Symbol: 'i' Code: 1001
Prior Symbol: 'd' Symbol: 'l' Code: 1011010
Prior Symbol: 'd' Symbol: 'o' Code: 101111
Prior Symbol: 'd' Symbol: 'r' Code: 101100
Prior Symbol: 'd' Symbol: 's' Code: 0101
Prior Symbol: 'd' Symbol: 'u' Code: 101101111
Prior Symbol: 'd' Symbol: 'v' Code: 10001
Prior Symbol: 'd' Symbol: 'w' Code: 10110110
Prior Symbol: 'd' Symbol: 'y' Code: 0100
Prior Symbol: 'e' Symbol: 0 Code: 001
Prior Symbol: 'e' Symbol: 27 Code: 1010111100
Prior Symbol: 'e' Symbol: ' ' Code: 01
Prior Symbol: 'e' Symbol: '!' Code: 1010111101
Prior Symbol: 'e' Symbol: ''' Code: 10101100
Prior Symbol: 'e' Symbol: '-' Code: 1010111110
Prior Symbol: 'e' Symbol: ':' Code: 00010010
Prior Symbol: 'e' Symbol: 'a' Code: 1000
Prior Symbol: 'e' Symbol: 'b' Code: 10101101
Prior Symbol: 'e' Symbol: 'c' Code: 100111
Prior Symbol: 'e' Symbol: 'd' Code: 00011
Prior Symbol: 'e' Symbol: 'e' Code: 10100
Prior Symbol: 'e' Symbol: 'f' Code: 1001100
Prior Symbol: 'e' Symbol: 'g' Code: 1010100
Prior Symbol: 'e' Symbol: 'h' Code: 1010111111
Prior Symbol: 'e' Symbol: 'i' Code: 10101110
Prior Symbol: 'e' Symbol: 'j' Code: 000100000
Prior Symbol: 'e' Symbol: 'k' Code: 1010101
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Prior Symbol: 'e' Symbol: 'n' Code: 1110
Prior Symbol: 'e' Symbol: 'o' Code: 000101
Prior Symbol: 'e' Symbol: 'p' Code: 000001
Prior Symbol: 'e' Symbol: 'q' Code: 000100001
Prior Symbol: 'e' Symbol: 'r' Code: 110
Prior Symbol: 'e' Symbol: 's' Code: 1111
Prior Symbol: 'e' Symbol: 't' Code: 10110
Prior Symbol: 'e' Symbol: 'u' Code: 000100010
Prior Symbol: 'e' Symbol: 'v' Code: 000000
Prior Symbol: 'e' Symbol: 'w' Code: 10111
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Prior Symbol: 'e' Symbol: 'y' Code: 00001
Prior Symbol: 'e' Symbol: 'z' Code: 000100011
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Prior Symbol: 'f' Symbol: 'i' Code: 1001
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Prior Symbol: 'f' Symbol: 'o' Code: 1010
Prior Symbol: 'f' Symbol: 'r' Code: 111111
Prior Symbol: 'f' Symbol: 's' Code: 111110
Prior Symbol: 'f' Symbol: 't' Code: 1000
Prior Symbol: 'f' Symbol: 'u' Code: 1111000
Prior Symbol: 'g' Symbol: 0 Code: 110
Prior Symbol: 'g' Symbol: 27 Code: 1110000
Prior Symbol: 'g' Symbol: ' ' Code: 01
Prior Symbol: 'g' Symbol: ''' Code: 1001100
Prior Symbol: 'g' Symbol: ':' Code: 11100010
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Prior Symbol: 'g' Symbol: 'g' Code: 1111010
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Prior Symbol: 'g' Symbol: 't' Code: 1001101
Prior Symbol: 'g' Symbol: 'u' Code: 111100
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Prior Symbol: 'h' Symbol: 'e' Code: 0
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Prior Symbol: 'h' Symbol: 'y' Code: 101000
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Prior Symbol: 'i' Symbol: 27 Code: 00110110
Prior Symbol: 'i' Symbol: ' ' Code: 000100
Prior Symbol: 'i' Symbol: '!' Code: 001101000
Prior Symbol: 'i' Symbol: 'a' Code: 00011
Prior Symbol: 'i' Symbol: 'b' Code: 0011000
Prior Symbol: 'i' Symbol: 'c' Code: 1111
Prior Symbol: 'i' Symbol: 'd' Code: 0010
Prior Symbol: 'i' Symbol: 'e' Code: 1101
Prior Symbol: 'i' Symbol: 'f' Code: 00111
Prior Symbol: 'i' Symbol: 'g' Code: 1100
Prior Symbol: 'i' Symbol: 'i' Code: 00110010
Prior Symbol: 'i' Symbol: 'k' Code: 00110011
Prior Symbol: 'i' Symbol: 'l' Code: 0110
Prior Symbol: 'i' Symbol: 'm' Code: 11101
Prior Symbol: 'i' Symbol: 'n' Code: 10
Prior Symbol: 'i' Symbol: 'o' Code: 0100
Prior Symbol: 'i' Symbol: 'p' Code: 000101
Prior Symbol: 'i' Symbol: 'r' Code: 11100
Prior Symbol: 'i' Symbol: 's' Code: 0111
Prior Symbol: 'i' Symbol: 't' Code: 0101
Prior Symbol: 'i' Symbol: 'v' Code: 0000
Prior Symbol: 'i' Symbol: 'x' Code: 001101001
Prior Symbol: 'i' Symbol: 'z' Code: 00110111
Prior Symbol: 'j' Symbol: 27 Code: 10
Prior Symbol: 'j' Symbol: 'a' Code: 11
Prior Symbol: 'j' Symbol: 'o' Code: 0
Prior Symbol: 'k' Symbol: 0 Code: 01
Prior Symbol: 'k' Symbol: 27 Code: 00011
Prior Symbol: 'k' Symbol: ' ' Code: 111
Prior Symbol: 'k' Symbol: ':' Code: 00001
Prior Symbol: 'k' Symbol: 'T' Code: 000000
Prior Symbol: 'k' Symbol: 'a' Code: 001111
Prior Symbol: 'k' Symbol: 'e' Code: 10
Prior Symbol: 'k' Symbol: 'f' Code: 000100
Prior Symbol: 'k' Symbol: 'i' Code: 110
Prior Symbol: 'k' Symbol: 'l' Code: 000101
Prior Symbol: 'k' Symbol: 'o' Code: 000001
Prior Symbol: 'k' Symbol: 's' Code: 0010
Prior Symbol: 'k' Symbol: 'w' Code: 001110
Prior Symbol: 'k' Symbol: 'y' Code: 00110
Prior Symbol: 'l' Symbol: 0 Code: 1000
Prior Symbol: 'l' Symbol: 27 Code: 0111001
Prior Symbol: 'l' Symbol: ' ' Code: 010
Prior Symbol: 'l' Symbol: ''' Code: 01100010
Prior Symbol: 'l' Symbol: '-' Code: 11110011
Prior Symbol: 'l' Symbol: ':' Code: 01100011
Prior Symbol: 'l' Symbol: 'a' Code: 1110
Prior Symbol: 'l' Symbol: 'b' Code: 0110000
Prior Symbol: 'l' Symbol: 'c' Code: 01110000
Prior Symbol: 'l' Symbol: 'd' Code: 000
Prior Symbol: 'l' Symbol: 'e' Code: 110
Prior Symbol: 'l' Symbol: 'f' Code: 1111000
Prior Symbol: 'l' Symbol: 'i' Code: 001
Prior Symbol: 'l' Symbol: 'k' Code: 011001
Prior Symbol: 'l' Symbol: 'l' Code: 101
Prior Symbol: 'l' Symbol: 'm' Code: 1111010
Prior Symbol: 'l' Symbol: 'o' Code: 11111
Prior Symbol: 'l' Symbol: 'r' Code: 11110010
Prior Symbol: 'l' Symbol: 's' Code: 01101
Prior Symbol: 'l' Symbol: 't' Code: 011101
Prior Symbol: 'l' Symbol: 'u' Code: 01111
Prior Symbol: 'l' Symbol: 'v' Code: 1111011
Prior Symbol: 'l' Symbol: 'w' Code: 01110001
Prior Symbol: 'l' Symbol: 'y' Code: 1001
Prior Symbol: 'm' Symbol: 0 Code: 0100
Prior Symbol: 'm' Symbol: 27 Code: 010101

Prior Symbol: 'm' Symbol: ' ' Code: 001
Prior Symbol: 'm' Symbol: 'a' Code: 101
Prior Symbol: 'm' Symbol: 'b' Code: 0000
Prior Symbol: 'm' Symbol: 'e' Code: 11
Prior Symbol: 'm' Symbol: 'i' Code: 011
Prior Symbol: 'm' Symbol: 'm' Code: 0001
Prior Symbol: 'm' Symbol: 'o' Code: 1001
Prior Symbol: 'm' Symbol: 'p' Code: 1000
Prior Symbol: 'm' Symbol: 's' Code: 010111
Prior Symbol: 'm' Symbol: 'u' Code: 010110
Prior Symbol: 'm' Symbol: 'y' Code: 010100
Prior Symbol: 'n' Symbol: 0 Code: 000
Prior Symbol: 'n' Symbol: 27 Code: 01110011
Prior Symbol: 'n' Symbol: ' ' Code: 110
Prior Symbol: 'n' Symbol: ''' Code: 011101
Prior Symbol: 'n' Symbol: ':' Code: 1001010
Prior Symbol: 'n' Symbol: 'a' Code: 11100
Prior Symbol: 'n' Symbol: 'b' Code: 111010000
Prior Symbol: 'n' Symbol: 'c' Code: 01111
Prior Symbol: 'n' Symbol: 'd' Code: 001
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Prior Symbol: 'n' Symbol: 'o' Code: 1110111
Prior Symbol: 'n' Symbol: 'r' Code: 111010100
Prior Symbol: 'n' Symbol: 's' Code: 0110
Prior Symbol: 'n' Symbol: 't' Code: 1111
Prior Symbol: 'n' Symbol: 'u' Code: 11101001
Prior Symbol: 'n' Symbol: 'v' Code: 0111000
Prior Symbol: 'n' Symbol: 'y' Code: 100100
Prior Symbol: 'n' Symbol: 'z' Code: 01110010
Prior Symbol: 'o' Symbol: 0 Code: 00101
Prior Symbol: 'o' Symbol: 27 Code: 01110001
Prior Symbol: 'o' Symbol: ' ' Code: 0101
Prior Symbol: 'o' Symbol: ''' Code: 01110000
Prior Symbol: 'o' Symbol: '.' Code: 0111011010
Prior Symbol: 'o' Symbol: '?' Code: 011101100
Prior Symbol: 'o' Symbol: 'a' Code: 1100010
Prior Symbol: 'o' Symbol: 'b' Code: 001001
Prior Symbol: 'o' Symbol: 'c' Code: 110000
Prior Symbol: 'o' Symbol: 'd' Code: 01111
Prior Symbol: 'o' Symbol: 'e' Code: 0111001
Prior Symbol: 'o' Symbol: 'f' Code: 1001
Prior Symbol: 'o' Symbol: 'g' Code: 00010
Prior Symbol: 'o' Symbol: 'h' Code: 0111010
Prior Symbol: 'o' Symbol: 'i' Code: 01110111
Prior Symbol: 'o' Symbol: 'k' Code: 1100011
Prior Symbol: 'o' Symbol: 'l' Code: 0100
Prior Symbol: 'o' Symbol: 'm' Code: 1000
Prior Symbol: 'o' Symbol: 'n' Code: 111
Prior Symbol: 'o' Symbol: 'o' Code: 0011
Prior Symbol: 'o' Symbol: 'p' Code: 01101
Prior Symbol: 'o' Symbol: 'r' Code: 101
Prior Symbol: 'o' Symbol: 's' Code: 11001
Prior Symbol: 'o' Symbol: 't' Code: 00011
Prior Symbol: 'o' Symbol: 'u' Code: 1101
Prior Symbol: 'o' Symbol: 'v' Code: 01100
Prior Symbol: 'o' Symbol: 'w' Code: 0000
Prior Symbol: 'o' Symbol: 'x' Code: 0010000
Prior Symbol: 'o' Symbol: 'y' Code: 0010001
Prior Symbol: 'o' Symbol: 'z' Code: 0111011011
Prior Symbol: 'p' Symbol: 0 Code: 1101
Prior Symbol: 'p' Symbol: 27 Code: 101110
Prior Symbol: 'p' Symbol: ' ' Code: 010
Prior Symbol: 'p' Symbol: ''' Code: 1100101
Prior Symbol: 'p' Symbol: 'a' Code: 1001
Prior Symbol: 'p' Symbol: 'd' Code: 101111
Prior Symbol: 'p' Symbol: 'e' Code: 111
Prior Symbol: 'p' Symbol: 'h' Code: 11000
Prior Symbol: 'p' Symbol: 'i' Code: 1010
Prior Symbol: 'p' Symbol: 'l' Code: 0110
Prior Symbol: 'p' Symbol: 'm' Code: 1100100
Prior Symbol: 'p' Symbol: 'o' Code: 00
Prior Symbol: 'p' Symbol: 'p' Code: 0111
Prior Symbol: 'p' Symbol: 'r' Code: 10001
Prior Symbol: 'p' Symbol: 's' Code: 10000
Prior Symbol: 'p' Symbol: 't' Code: 10110
Prior Symbol: 'p' Symbol: 'y' Code: 110011
Prior Symbol: 'q' Symbol: 27 Code: 0
Prior Symbol: 'q' Symbol: 'u' Code: 1
Prior Symbol: 'r' Symbol: 0 Code: 1001
Prior Symbol: 'r' Symbol: 27 Code: 01100101
Prior Symbol: 'r' Symbol: ' ' Code: 1111
Prior Symbol: 'r' Symbol: ''' Code: 0110011
Prior Symbol: 'r' Symbol: ',' Code: 110011101
Prior Symbol: 'r' Symbol: '.' Code: 0111100
Prior Symbol: 'r' Symbol: ':' Code: 110011100
Prior Symbol: 'r' Symbol: 'a' Code: 000
Prior Symbol: 'r' Symbol: 'b' Code: 01111101
Prior Symbol: 'r' Symbol: 'c' Code: 0111111
Prior Symbol: 'r' Symbol: 'd' Code: 11000
Prior Symbol: 'r' Symbol: 'e' Code: 101
Prior Symbol: 'r' Symbol: 'f' Code: 11001111
Prior Symbol: 'r' Symbol: 'g' Code: 0111101
Prior Symbol: 'r' Symbol: 'i' Code: 010
Prior Symbol: 'r' Symbol: 'k' Code: 110010
Prior Symbol: 'r' Symbol: 'l' Code: 0011
Prior Symbol: 'r' Symbol: 'm' Code: 011000
Prior Symbol: 'r' Symbol: 'n' Code: 01101
Prior Symbol: 'r' Symbol: 'o' Code: 1101
Prior Symbol: 'r' Symbol: 'p' Code: 01111100
Prior Symbol: 'r' Symbol: 'r' Code: 01110
Prior Symbol: 'r' Symbol: 's' Code: 1110
Prior Symbol: 'r' Symbol: 't' Code: 1000
Prior Symbol: 'r' Symbol: 'u' Code: 1100110
Prior Symbol: 'r' Symbol: 'v' Code: 01100100
Prior Symbol: 'r' Symbol: 'y' Code: 0010
Prior Symbol: 's' Symbol: 0 Code: 11
Prior Symbol: 's' Symbol: 27 Code: 0010011
Prior Symbol: 's' Symbol: ' ' Code: 01
Prior Symbol: 's' Symbol: ''' Code: 001011010
Prior Symbol: 's' Symbol: ',' Code: 001011011
Prior Symbol: 's' Symbol: '.' Code: 00100101
Prior Symbol: 's' Symbol: ':' Code: 0000001
Prior Symbol: 's' Symbol: '?' Code: 001011100
Prior Symbol: 's' Symbol: 'C' Code: 001011101
Prior Symbol: 's' Symbol: 'H' Code: 001011110
Prior Symbol: 's' Symbol: 'a' Code: 101010
Prior Symbol: 's' Symbol: 'c' Code: 101011
Prior Symbol: 's' Symbol: 'd' Code: 001011111
Prior Symbol: 's' Symbol: 'e' Code: 1011
Prior Symbol: 's' Symbol: 'f' Code: 00000000
Prior Symbol: 's' Symbol: 'h' Code: 00001
Prior Symbol: 's' Symbol: 'i' Code: 0011
Prior Symbol: 's' Symbol: 'k' Code: 000001
Prior Symbol: 's' Symbol: 'l' Code: 00101010
Prior Symbol: 's' Symbol: 'm' Code: 00000001
Prior Symbol: 's' Symbol: 'n' Code: 00101011
Prior Symbol: 's' Symbol: 'o' Code: 10100
Prior Symbol: 's' Symbol: 'p' Code: 001000
Prior Symbol: 's' Symbol: 'r' Code: 00100100
Prior Symbol: 's' Symbol: 's' Code: 0001
Prior Symbol: 's' Symbol: 't' Code: 100
Prior Symbol: 's' Symbol: 'u' Code: 0010100
Prior Symbol: 's' Symbol: 'y' Code: 00101100
Prior Symbol: 't' Symbol: 0 Code: 010
Prior Symbol: 't' Symbol: 27 Code: 11000010
Prior Symbol: 't' Symbol: ' ' Code: 101
Prior Symbol: 't' Symbol: ''' Code: 11000011
Prior Symbol: 't' Symbol: ':' Code: 110110000
Prior Symbol: 't' Symbol: '?' Code: 110110001
Prior Symbol: 't' Symbol: 'a' Code: 0000
Prior Symbol: 't' Symbol: 'b' Code: 100000
Prior Symbol: 't' Symbol: 'c' Code: 1101101
Prior Symbol: 't' Symbol: 'd' Code: 11000000
Prior Symbol: 't' Symbol: 'e' Code: 011
Prior Symbol: 't' Symbol: 'h' Code: 111
Prior Symbol: 't' Symbol: 'i' Code: 001
Prior Symbol: 't' Symbol: 'l' Code: 10001
Prior Symbol: 't' Symbol: 'm' Code: 100001
Prior Symbol: 't' Symbol: 'n' Code: 11011001
Prior Symbol: 't' Symbol: 'o' Code: 1001
Prior Symbol: 't' Symbol: 'r' Code: 11010
Prior Symbol: 't' Symbol: 's' Code: 0001
Prior Symbol: 't' Symbol: 't' Code: 110111
Prior Symbol: 't' Symbol: 'u' Code: 11001
Prior Symbol: 't' Symbol: 'w' Code: 11000001
Prior Symbol: 't' Symbol: 'y' Code: 110001
Prior Symbol: 'u' Symbol: 0 Code: 0011110
Prior Symbol: 'u' Symbol: 27 Code: 000100
Prior Symbol: 'u' Symbol: ' ' Code: 001110
Prior Symbol: 'u' Symbol: 'a' Code: 00110
Prior Symbol: 'u' Symbol: 'b' Code: 10011
Prior Symbol: 'u' Symbol: 'c' Code: 11100
Prior Symbol: 'u' Symbol: 'd' Code: 10000
Prior Symbol: 'u' Symbol: 'e' Code: 0010
Prior Symbol: 'u' Symbol: 'f' Code: 0011111
Prior Symbol: 'u' Symbol: 'g' Code: 11101
Prior Symbol: 'u' Symbol: 'i' Code: 00011
Prior Symbol: 'u' Symbol: 'k' Code: 0001010
Prior Symbol: 'u' Symbol: 'l' Code: 0000
Prior Symbol: 'u' Symbol: 'm' Code: 10010
Prior Symbol: 'u' Symbol: 'n' Code: 110
Prior Symbol: 'u' Symbol: 'p' Code: 10001
Prior Symbol: 'u' Symbol: 'r' Code: 01
Prior Symbol: 'u' Symbol: 's' Code: 101
Prior Symbol: 'u' Symbol: 't' Code: 1111
Prior Symbol: 'u' Symbol: 'z' Code: 0001011
Prior Symbol: 'v' Symbol: 27 Code: 0010
Prior Symbol: 'v' Symbol: 'a' Code: 000
Prior Symbol: 'v' Symbol: 'e' Code: 1
Prior Symbol: 'v' Symbol: 'i' Code: 01
Prior Symbol: 'v' Symbol: 'o' Code: 00111
Prior Symbol: 'v' Symbol: 's' Code: 00110
Prior Symbol: 'w' Symbol: 0 Code: 001
Prior Symbol: 'w' Symbol: 27 Code: 01010
Prior Symbol: 'w' Symbol: ' ' Code: 011
Prior Symbol: 'w' Symbol: ''' Code: 010010
Prior Symbol: 'w' Symbol: 'a' Code: 000
Prior Symbol: 'w' Symbol: 'b' Code: 010011
Prior Symbol: 'w' Symbol: 'c' Code: 010111
Prior Symbol: 'w' Symbol: 'e' Code: 1111
Prior Symbol: 'w' Symbol: 'i' Code: 1100
Prior Symbol: 'w' Symbol: 'l' Code: 010110
Prior Symbol: 'w' Symbol: 'n' Code: 1110
Prior Symbol: 'w' Symbol: 'o' Code: 1101
Prior Symbol: 'w' Symbol: 'r' Code: 01000
Prior Symbol: 'w' Symbol: 's' Code: 10
Prior Symbol: 'x' Symbol: 0 Code: 110
Prior Symbol: 'x' Symbol: 27 Code: 1010
Prior Symbol: 'x' Symbol: ' ' Code: 1011
Prior Symbol: 'x' Symbol: 'a' Code: 000
Prior Symbol: 'x' Symbol: 'e' Code: 001
Prior Symbol: 'x' Symbol: 'i' Code: 100
Prior Symbol: 'x' Symbol: 'p' Code: 111
Prior Symbol: 'x' Symbol: 't' Code: 01
Prior Symbol: 'y' Symbol: 0 Code: 10
Prior Symbol: 'y' Symbol: 27 Code: 111110
Prior Symbol: 'y' Symbol: ' ' Code: 0
Prior Symbol: 'y' Symbol: '!' Code: 1101101
Prior Symbol: 'y' Symbol: ''' Code: 110101
Prior Symbol: 'y' Symbol: '-' Code: 11110101
Prior Symbol: 'y' Symbol: 'a' Code: 1101110
Prior Symbol: 'y' Symbol: 'b' Code: 1111011
Prior Symbol: 'y' Symbol: 'c' Code: 11110100
Prior Symbol: 'y' Symbol: 'd' Code: 1100000
Prior Symbol: 'y' Symbol: 'e' Code: 11001
Prior Symbol: 'y' Symbol: 'i' Code: 1100001
Prior Symbol: 'y' Symbol: 'l' Code: 111111
Prior Symbol: 'y' Symbol: 'm' Code: 1101111
Prior Symbol: 'y' Symbol: 'n' Code: 1100010
Prior Symbol: 'y' Symbol: 'o' Code: 1100011
Prior Symbol: 'y' Symbol: 'p' Code: 1101000
Prior Symbol: 'y' Symbol: 's' Code: 1110
Prior Symbol: 'y' Symbol: 't' Code: 1101001
Prior Symbol: 'y' Symbol: 'v' Code: 1101100
Prior Symbol: 'y' Symbol: 'w' Code: 111100
Prior Symbol: 'z' Symbol: 0 Code: 110
Prior Symbol: 'z' Symbol: 27 Code: 100
Prior Symbol: 'z' Symbol: ' ' Code: 000

Prior Symbol: 'z' Symbol: 'a' Code: 01
Prior Symbol: 'z' Symbol: 'e' Code: 1010
Prior Symbol: 'z' Symbol: 'i' Code: 111
Prior Symbol: 'z' Symbol: 'y' Code: 001
Prior Symbol: 'z' Symbol: 'z' Code: 1011
Prior Symbol: '{' Symbol: 27 Code: 1
Prior Symbol: '|' Symbol: 27 Code: 1
Prior Symbol: '}' Symbol: 27 Code: 1
Prior Symbol: '~' Symbol: 27 Code: 1
Prior Symbol: 127 Symbol: 27 Code: 1

Table C.5 English-language Program Title Decode Table

0	1	76	1	152	3	228	6	304	212	380	185	456	35
1	0	77	218	153	50	229	102	305	18	381	1	457	36
2	1	78	1	154	3	230	6	306	19	382	167	458	37
3	58	79	220	155	62	231	154	307	20	383	177	459	38
4	1	80	1	156	3	232	6	308	21	384	236	460	39
5	60	81	230	157	82	233	208	309	22	385	209	461	40
6	1	82	1	158	3	234	6	310	23	386	2	462	1
7	62	83	232	159	100	235	252	311	24	387	173	463	128
8	1	84	1	160	3	236	7	312	25	388	178	464	160
9	64	85	234	161	122	237	34	313	26	389	218	465	155
10	1	86	1	162	3	238	7	314	155	390	227	466	155
11	66	87	240	163	148	239	44	315	155	391	179	467	155
12	1	88	1	164	3	240	7	316	155	392	3	468	155
13	68	89	242	165	152	241	70	317	155	393	228	469	155
14	1	90	1	166	3	242	7	318	155	394	230	470	177
15	70	91	244	167	164	243	84	319	155	395	4	471	155
16	1	92	2	168	3	244	7	320	155	396	155	472	155
17	72	93	6	169	200	245	124	321	155	397	226	473	155
18	1	94	2	170	3	246	7	322	155	398	5	474	155
19	74	95	18	171	222	247	138	323	155	399	6	475	160
20	1	96	2	172	3	248	7	324	155	400	7	476	4
21	76	97	20	173	230	249	140	325	155	401	8	477	243
22	1	98	2	174	3	250	7	326	155	402	9	478	228
23	78	99	28	175	244	251	142	327	155	403	213	479	185
24	1	100	2	176	4	252	7	328	155	404	10	480	1
25	80	101	40	177	4	253	144	329	155	405	214	481	244
26	1	102	2	178	4	254	7	330	155	406	11	482	160
27	82	103	48	179	6	255	146	331	155	407	217	483	155
28	1	104	2	180	4	256	27	332	155	408	12	484	2
29	84	105	52	181	12	257	28	333	155	409	166	485	3
30	1	106	2	182	4	258	180	334	155	410	233	486	155
31	86	107	54	183	16	259	164	335	155	411	203	487	155
32	1	108	2	184	4	260	178	336	155	412	197	488	155
33	88	109	56	185	18	261	183	337	155	413	207	489	155
34	1	110	2	186	4	262	218	338	155	414	13	490	1
35	90	111	58	187	20	263	1	339	155	415	14	491	2
36	1	112	2	188	4	264	209	340	155	416	202	492	155
37	92	113	60	189	22	265	2	341	155	417	201	493	193
38	1	114	2	190	4	266	3	342	155	418	15	494	200
39	94	115	62	191	24	267	155	343	155	419	199	495	211
40	1	116	2	192	4	268	4	344	155	420	16	496	155
41	96	117	70	193	26	269	213	345	155	421	17	497	155
42	1	118	2	194	4	270	217	346	155	422	225	498	155
43	98	119	72	195	28	271	5	347	155	423	18	499	160
44	1	120	2	196	4	272	203	348	155	424	19	500	7
45	100	121	74	197	82	273	214	349	155	425	198	501	8
46	1	122	2	198	4	274	6	350	155	426	210	502	177
47	102	123	76	199	106	275	207	351	155	427	200	503	210
48	1	124	2	200	4	276	7	352	155	428	206	504	211
49	104	125	78	201	142	277	8	353	155	429	193	505	212
50	1	126	2	202	4	278	202	354	155	430	196	506	213
51	106	127	80	203	174	279	9	355	155	431	208	507	173
52	1	128	2	204	4	280	201	356	155	432	204	508	205
53	108	129	82	205	238	281	197	357	155	433	20	509	193
54	1	130	2	206	5	282	198	358	155	434	21	510	1
55	110	131	84	207	6	283	10	359	155	435	239	511	2
56	1	132	2	208	5	284	210	360	155	436	194	512	3
57	112	133	126	209	40	285	196	361	155	437	215	513	160
58	1	134	2	210	5	286	199	362	155	438	22	514	4
59	114	135	146	211	68	287	204	363	155	439	205	515	155
60	1	136	2	212	5	288	208	364	155	440	23	516	5
61	116	137	172	213	114	289	200	365	155	441	244	517	6
62	1	138	2	214	5	290	215	366	155	442	212	518	160
63	118	139	186	215	118	291	206	367	155	443	24	519	5
64	1	140	2	216	5	292	11	368	155	444	25	520	201
65	120	141	210	217	144	293	193	369	155	445	26	521	215
66	1	142	2	218	5	294	12	370	155	446	195	522	211
67	206	143	228	219	190	295	194	371	155	447	211	523	1
68	1	144	2	220	5	296	205	372	155	448	27	524	2
69	210	145	250	221	214	297	195	373	155	449	28	525	155
70	1	146	3	222	6	298	13	374	155	450	29	526	174
71	212	147	6	223	10	299	14	375	155	451	30	527	128
72	1	148	3	224	6	300	15	376	41	452	31	528	3
73	214	149	30	225	68	301	16	377	42	453	32	529	4
74	1	150	3	226	6	302	211	378	216	454	33	530	155
75	216	151	38	227	100	303	17	379	229	455	34	531	155

532	2	611	243	690	2	769	233	848	7	927	225	1006	128
533	3	612	227	691	242	770	225	849	225	928	233	1007	2
534	173	613	230	692	233	771	3	850	229	929	239	1008	3
535	155	614	247	693	229	772	229	851	8	930	3	1009	225
536	1	615	3	694	239	773	4	852	206	931	229	1010	4
537	128	616	245	695	3	774	238	853	160	932	16	1011	5
538	160	617	4	696	225	775	11	854	198	933	17	1012	6
539	176	618	5	697	4	776	186	855	245	934	170	1013	7
540	4	619	6	698	10	777	212	856	1	935	236	1014	198
541	5	620	242	699	11	778	174	857	2	936	241	1015	215
542	128	621	7	700	241	779	242	858	155	937	174	1016	1
543	155	622	8	701	245	780	227	859	194	938	160	1017	155
544	177	623	9	702	243	781	1	860	3	939	247	1018	242
545	178	624	10	703	1	782	160	861	225	940	237	1019	2
546	160	625	11	704	237	783	2	862	4	941	238	1020	3
547	176	626	12	705	249	784	128	863	239	942	1	1021	232
548	185	627	228	706	195	785	155	864	5	943	2	1022	229
549	1	628	160	707	2	786	237	865	233	944	155	1023	225
550	2	629	13	708	236	787	3	866	6	945	235	1024	4
551	3	630	236	709	238	788	201	867	7	946	3	1025	233
552	2	631	238	710	228	789	243	868	9	947	4	1026	239
553	3	632	14	711	248	790	244	869	10	948	5	1027	5
554	177	633	237	712	3	791	4	870	228	949	6	1028	155
555	186	634	15	713	155	792	5	871	243	950	227	1029	155
556	1	635	16	714	246	793	6	872	230	951	7	1030	2
557	176	636	17	715	4	794	7	873	246	952	239	1031	239
558	155	637	18	716	5	795	8	874	247	953	8	1032	225
559	128	638	8	717	225	796	9	875	240	954	233	1033	155
560	128	639	9	718	6	797	10	876	242	955	245	1034	1
561	1	640	193	719	7	798	2	877	1	956	9	1035	229
562	176	641	211	720	8	799	3	878	236	957	225	1036	1
563	155	642	155	721	9	800	155	879	2	958	229	1037	239
564	155	643	1	722	7	801	245	880	3	959	240	1038	155
565	184	644	195	723	8	802	1	881	160	960	232	1039	225
566	155	645	2	724	160	803	225	882	155	961	10	1040	155
567	155	646	233	725	155	804	239	883	4	962	11	1041	155
568	155	647	236	726	204	805	229	884	5	963	12	1042	155
569	155	648	3	727	1	806	5	885	245	964	13	1043	155
570	155	649	242	728	229	807	233	886	6	965	244	1044	155
571	176	650	245	729	2	808	225	887	7	966	14	1045	155
572	155	651	4	730	236	809	239	888	238	967	15	1046	155
573	160	652	239	731	245	810	245	889	8	968	232	1047	155
574	2	653	225	732	239	811	238	890	11	969	10	1048	155
575	3	654	5	733	3	812	155	891	12	970	173	1049	155
576	177	655	229	734	233	813	229	892	160	971	206	1050	155
577	179	656	6	735	242	814	1	893	243	972	155	1051	155
578	185	657	7	736	4	815	2	894	249	973	1	1052	25
579	176	658	11	737	5	816	3	895	174	974	214	1053	26
580	1	659	12	738	225	817	4	896	210	975	2	1054	155
581	155	660	193	739	6	818	4	897	199	976	245	1055	186
582	155	661	249	740	9	819	5	898	1	977	247	1056	229
583	160	662	1	741	10	820	160	899	155	978	3	1057	234
584	155	663	194	742	174	821	155	900	2	979	4	1058	248
585	155	664	207	743	236	822	1	901	245	980	225	1059	1
586	155	665	229	744	249	823	245	902	3	981	229	1060	2
587	155	666	245	745	193	824	2	903	4	982	233	1061	230
588	155	667	155	746	232	825	229	904	5	983	5	1062	167
589	155	668	233	747	1	826	239	905	233	984	242	1063	3
590	155	669	2	748	155	827	3	906	236	985	6	1064	250
591	155	670	160	749	2	828	225	907	6	986	239	1065	232
592	155	671	3	750	3	829	233	908	229	987	7	1066	4
593	128	672	4	751	4	830	8	909	7	988	8	1067	247
594	155	673	5	752	225	831	9	910	239	989	9	1068	5
595	155	674	242	753	245	832	170	911	8	990	238	1069	245
596	19	675	6	754	233	833	212	912	225	991	3	1070	226
597	20	676	236	755	5	834	1	913	9	992	236	1071	6
598	170	677	7	756	229	835	155	914	242	993	174	1072	235
599	173	678	225	757	6	836	227	915	10	994	1	1073	7
600	174	679	8	758	242	837	2	916	1	995	155	1074	240
601	246	680	9	759	239	838	242	917	245	996	2	1075	8
602	231	681	232	760	7	839	3	918	155	997	240	1076	128
603	244	682	10	761	8	840	229	919	214	998	6	1077	246
604	226	683	239	762	239	841	4	920	4	999	233	1078	231
605	233	684	5	763	5	842	245	921	5	1000	160	1079	9
606	1	685	6	764	128	843	249	922	232	1001	195	1080	228
607	2	686	249	765	155	844	233	923	155	1002	239	1081	10
608	194	687	155	766	245	845	5	924	1	1003	155	1082	160
609	240	688	1	767	1	846	239	925	245	1004	229	1083	233
610	155	689	245	768	2	847	6	926	2	1005	1	1084	11

1085	227	1164	14	1243	247	1322	226	1401	239	1480	128	1559	229
1086	249	1165	15	1244	18	1323	245	1402	230	1481	3	1560	232
1087	12	1166	14	1245	19	1324	247	1403	236	1482	240	1561	4
1088	13	1167	15	1246	225	1325	155	1404	247	1483	239	1562	225
1089	237	1168	174	1247	20	1326	236	1405	225	1484	4	1563	235
1090	14	1169	245	1248	21	1327	1	1406	1	1485	160	1564	5
1091	15	1170	247	1249	22	1328	249	1407	186	1486	5	1565	226
1092	243	1171	1	1250	238	1329	238	1408	2	1487	233	1566	6
1093	16	1172	236	1251	243	1330	2	1409	155	1488	6	1567	7
1094	17	1173	2	1252	23	1331	3	1410	249	1489	225	1568	227
1095	236	1174	228	1253	128	1332	4	1411	3	1490	7	1569	8
1096	18	1175	231	1254	24	1333	242	1412	4	1491	8	1570	231
1097	244	1176	242	1255	25	1334	5	1413	5	1492	9	1571	244
1098	242	1177	3	1256	242	1335	128	1414	243	1493	229	1572	9
1099	19	1178	155	1257	26	1336	6	1415	6	1494	24	1573	128
1100	238	1179	239	1258	27	1337	160	1416	7	1495	25	1574	246
1101	20	1180	4	1259	160	1338	225	1417	8	1496	226	1575	240
1102	21	1181	246	1260	28	1339	239	1418	233	1497	234	1576	10
1103	22	1182	5	1261	29	1340	7	1419	160	1498	242	1577	228
1104	23	1183	6	1262	160	1341	244	1420	9	1499	232	1578	11
1105	24	1184	249	1263	11	1342	233	1421	128	1500	236	1579	243
1106	10	1185	243	1264	245	1343	8	1422	229	1501	237	1580	247
1107	11	1186	7	1265	155	1344	9	1423	10	1502	250	1581	12
1108	243	1187	233	1266	1	1345	10	1424	21	1503	155	1582	13
1109	155	1188	225	1267	236	1346	11	1425	22	1504	1	1583	239
1110	245	1189	8	1268	243	1347	12	1426	167	1505	245	1584	236
1111	226	1190	9	1269	242	1348	21	1427	186	1506	2	1585	160
1112	1	1191	128	1270	128	1349	22	1428	227	1507	3	1586	14
1113	128	1192	10	1271	225	1350	161	1429	247	1508	246	1587	15
1114	160	1193	11	1272	2	1351	248	1430	242	1509	4	1588	237
1115	2	1194	229	1273	3	1352	233	1431	173	1510	186	1589	230
1116	229	1195	12	1274	244	1353	235	1432	226	1511	230	1590	16
1117	242	1196	13	1275	233	1354	1	1433	1	1512	5	1591	245
1118	233	1197	160	1276	239	1355	128	1434	2	1513	6	1592	17
1119	3	1198	30	1277	230	1356	155	1435	155	1514	235	1593	18
1120	236	1199	31	1278	4	1357	250	1436	230	1515	239	1594	19
1121	4	1200	155	1279	5	1358	226	1437	3	1516	7	1595	20
1122	249	1201	161	1280	6	1359	2	1438	237	1517	167	1596	21
1123	5	1202	173	1281	7	1360	3	1439	246	1518	249	1597	242
1124	239	1203	232	1282	229	1361	4	1440	4	1519	8	1598	22
1125	6	1204	234	1283	8	1362	160	1441	235	1520	9	1599	238
1126	225	1205	241	1284	9	1363	240	1442	5	1521	10	1600	23
1127	7	1206	245	1285	10	1364	5	1443	244	1522	11	1601	24
1128	8	1207	250	1286	15	1365	6	1444	6	1523	227	1602	25
1129	9	1208	1	1287	16	1366	7	1445	7	1524	12	1603	26
1130	16	1209	2	1288	186	1367	225	1446	8	1525	238	1604	14
1131	17	1210	3	1289	249	1368	8	1447	243	1526	225	1605	15
1132	195	1211	4	1290	167	1369	230	1448	9	1527	13	1606	237
1133	204	1212	186	1291	244	1370	242	1449	245	1528	243	1607	167
1134	199	1213	248	1292	155	1371	237	1450	10	1529	14	1608	155
1135	155	1214	167	1293	1	1372	246	1451	239	1530	233	1609	228
1136	227	1215	226	1294	231	1373	9	1452	11	1531	15	1610	1
1137	1	1216	233	1295	236	1374	228	1453	12	1532	16	1611	249
1138	128	1217	5	1296	2	1375	10	1454	128	1533	244	1612	243
1139	236	1218	6	1297	238	1376	239	1455	249	1534	128	1613	242
1140	249	1219	7	1298	3	1377	244	1456	225	1535	228	1614	244
1141	2	1220	230	1299	239	1378	236	1457	13	1536	229	1615	2
1142	243	1221	237	1300	245	1379	243	1458	228	1537	17	1616	232
1143	3	1222	231	1301	4	1380	231	1459	233	1538	18	1617	3
1144	245	1223	235	1302	242	1381	229	1460	160	1539	231	1618	236
1145	4	1224	8	1303	5	1382	11	1461	14	1540	160	1619	240
1146	5	1225	9	1304	6	1383	227	1462	15	1541	19	1620	4
1147	242	1226	246	1305	233	1384	12	1463	236	1542	20	1621	225
1148	6	1227	240	1306	7	1385	13	1464	229	1543	21	1622	233
1149	233	1228	10	1307	243	1386	14	1465	16	1544	22	1623	5
1150	160	1229	239	1308	225	1387	15	1466	17	1545	23	1624	6
1151	7	1230	11	1309	8	1388	16	1467	18	1546	27	1625	128
1152	8	1231	227	1310	9	1389	17	1468	19	1547	28	1626	160
1153	239	1232	12	1311	10	1390	18	1469	20	1548	174	1627	7
1154	244	1233	13	1312	11	1391	19	1470	10	1549	250	1628	8
1155	9	1234	14	1313	229	1392	238	1471	11	1550	191	1629	9
1156	10	1235	249	1314	128	1393	20	1472	249	1551	1	1630	10
1157	225	1236	15	1315	12	1394	239	1473	155	1552	167	1631	229
1158	11	1237	228	1316	232	1395	1	1474	245	1553	155	1632	239
1159	232	1238	236	1317	160	1396	155	1475	243	1554	2	1633	11
1160	235	1239	16	1318	13	1397	225	1476	1	1555	233	1634	12
1161	229	1240	229	1319	14	1398	11	1477	2	1556	248	1635	13
1162	12	1241	17	1320	229	1399	12	1478	226	1557	249	1636	155
1163	13	1242	244	1321	13	1400	212	1479	237	1558	3	1637	245

1638	24	1682	17	1726	14	1770	225	1814	9	1858	8	1902	8
1639	25	1683	229	1727	15	1771	243	1815	244	1859	9	1903	229
1640	186	1684	18	1728	239	1772	10	1816	10	1860	243	1904	9
1641	172	1685	19	1729	16	1773	239	1817	11	1861	10	1905	10
1642	246	1686	20	1730	17	1774	11	1818	12	1862	5	1906	11
1643	155	1687	21	1731	243	1775	12	1819	243	1863	6	1907	12
1644	240	1688	22	1732	18	1776	13	1820	238	1864	155	1908	13
1645	226	1689	23	1733	233	1777	233	1821	13	1865	160	1909	14
1646	1	1690	25	1734	19	1778	128	1822	14	1866	225	1910	243
1647	230	1691	26	1735	229	1779	229	1823	242	1867	229	1911	15
1648	2	1692	167	1736	20	1780	14	1824	15	1868	233	1912	16
1649	167	1693	172	1737	21	1781	160	1825	16	1869	1	1913	17
1650	174	1694	191	1738	244	1782	15	1826	4	1870	128	1914	128
1651	231	1695	195	1739	22	1783	232	1827	229	1871	240	1915	18
1652	3	1696	200	1740	23	1784	16	1828	243	1872	2	1916	5
1653	227	1697	228	1741	160	1785	17	1829	239	1873	244	1917	6
1654	245	1698	230	1742	24	1786	18	1830	155	1874	3	1918	229
1655	4	1699	237	1743	128	1787	19	1831	1	1875	4	1919	250
1656	237	1700	242	1744	20	1788	17	1832	225	1876	160	1920	160
1657	5	1701	174	1745	21	1789	18	1833	2	1877	19	1921	249
1658	6	1702	236	1746	186	1790	235	1834	3	1878	227	1922	155
1659	7	1703	238	1747	191	1791	250	1835	233	1879	173	1923	1
1660	235	1704	249	1748	228	1792	128	1836	11	1880	228	1924	128
1661	8	1705	1	1749	247	1793	230	1837	12	1881	233	1925	233
1662	9	1706	2	1750	155	1794	155	1838	167	1882	238	1926	2
1663	238	1707	3	1751	167	1795	1	1839	226	1883	239	1927	225
1664	242	1708	4	1752	1	1796	160	1840	236	1884	240	1928	3
1665	10	1709	186	1753	238	1797	2	1841	227	1885	244	1929	4
1666	228	1710	5	1754	2	1798	3	1842	242	1886	246	1930	155
1667	11	1711	155	1755	3	1799	233	1843	1	1887	161	1931	155
1668	249	1712	245	1756	4	1800	225	1844	155	1888	225	1932	155
1669	236	1713	6	1757	227	1801	4	1845	2	1889	237	1933	155
1670	12	1714	7	1758	226	1802	228	1846	3	1890	1	1934	155
1671	13	1715	8	1759	237	1803	240	1847	4	1891	226	1935	155
1672	244	1716	9	1760	5	1804	237	1848	233	1892	2	1936	155
1673	128	1717	235	1761	249	1805	226	1849	239	1893	3	1937	155
1674	14	1718	240	1762	6	1806	227	1850	238	1894	4	1938	155
1675	239	1719	10	1763	244	1807	231	1851	229	1895	167	1939	155
1676	243	1720	11	1764	7	1808	236	1852	225	1896	5		
1677	160	1721	12	1765	236	1809	5	1853	128	1897	6		
1678	225	1722	225	1766	8	1810	229	1854	5	1898	247		
1679	15	1723	227	1767	245	1811	6	1855	160	1899	7		
1680	233	1724	13	1768	242	1812	7	1856	6	1900	155		
1681	16	1725	232	1769	9	1813	8	1857	7	1901	236		

C3. STANDARD COMPRESSION TYPE 2 HUFFMAN ENCODE/DECODE TABLES

The following encode/decode tables are optimized for English-language program description text. These tables correspond to multiple_string_structure() with compression_type value 0x02, and mode equal to 0xFF.

Table C.6 English-language Program Description Encode Table

Prior Symbol: 0 Symbol: 27 Code: 1110000
Prior Symbol: 0 Symbol: '"' Code: 111001
Prior Symbol: 0 Symbol: 'A' Code: 010
Prior Symbol: 0 Symbol: 'B' Code: 0011
Prior Symbol: 0 Symbol: 'C' Code: 0111
Prior Symbol: 0 Symbol: 'D' Code: 11101
Prior Symbol: 0 Symbol: 'E' Code: 10010
Prior Symbol: 0 Symbol: 'F' Code: 10110
Prior Symbol: 0 Symbol: 'G' Code: 011011
Prior Symbol: 0 Symbol: 'H' Code: 10111
Prior Symbol: 0 Symbol: 'I' Code: 011000
Prior Symbol: 0 Symbol: 'J' Code: 1100
Prior Symbol: 0 Symbol: 'K' Code: 00101
Prior Symbol: 0 Symbol: 'L' Code: 10011
Prior Symbol: 0 Symbol: 'M' Code: 1111
Prior Symbol: 0 Symbol: 'N' Code: 00100
Prior Symbol: 0 Symbol: 'O' Code: 011001
Prior Symbol: 0 Symbol: 'P' Code: 000
Prior Symbol: 0 Symbol: 'R' Code: 1000
Prior Symbol: 0 Symbol: 'S' Code: 1010
Prior Symbol: 0 Symbol: 'T' Code: 1101
Prior Symbol: 0 Symbol: 'V' Code: 1110001
Prior Symbol: 0 Symbol: 'W' Code: 011010
Prior Symbol: 1 Symbol: 27 Code: 1
Prior Symbol: 2 Symbol: 27 Code: 1
Prior Symbol: 3 Symbol: 27 Code: 1
Prior Symbol: 4 Symbol: 27 Code: 1
Prior Symbol: 5 Symbol: 27 Code: 1
Prior Symbol: 6 Symbol: 27 Code: 1
Prior Symbol: 7 Symbol: 27 Code: 1
Prior Symbol: 8 Symbol: 27 Code: 1
Prior Symbol: 9 Symbol: 27 Code: 1
Prior Symbol: 10 Symbol: 27 Code: 1
Prior Symbol: 11 Symbol: 27 Code: 1
Prior Symbol: 12 Symbol: 27 Code: 1
Prior Symbol: 13 Symbol: 27 Code: 1
Prior Symbol: 14 Symbol: 27 Code: 1
Prior Symbol: 15 Symbol: 27 Code: 1
Prior Symbol: 16 Symbol: 27 Code: 1
Prior Symbol: 17 Symbol: 27 Code: 1
Prior Symbol: 18 Symbol: 27 Code: 1
Prior Symbol: 19 Symbol: 27 Code: 1
Prior Symbol: 20 Symbol: 27 Code: 1
Prior Symbol: 21 Symbol: 27 Code: 1
Prior Symbol: 22 Symbol: 27 Code: 1
Prior Symbol: 23 Symbol: 27 Code: 1
Prior Symbol: 24 Symbol: 27 Code: 1
Prior Symbol: 25 Symbol: 27 Code: 1
Prior Symbol: 26 Symbol: 27 Code: 1
Prior Symbol: 27 Symbol: 27 Code: 1
Prior Symbol: 28 Symbol: 27 Code: 1
Prior Symbol: 29 Symbol: 27 Code: 1
Prior Symbol: 30 Symbol: 27 Code: 1
Prior Symbol: 31 Symbol: 27 Code: 1
Prior Symbol: ' ' Symbol: 27 Code: 101000001
Prior Symbol: ' ' Symbol: '"' Code: 111111010
Prior Symbol: ' ' Symbol: '(' Code: 1111111100
Prior Symbol: ' ' Symbol: '-' Code: 11111111110
Prior Symbol: ' ' Symbol: '/' Code: 11111111111
Prior Symbol: ' ' Symbol: '1' Code: 0101011
Prior Symbol: ' ' Symbol: '2' Code: 0100010
Prior Symbol: ' ' Symbol: '3' Code: 1111111101
Prior Symbol: ' ' Symbol: '4' Code: 110010100
Prior Symbol: ' ' Symbol: '5' Code: 1111111110
Prior Symbol: ' ' Symbol: '7' Code: 1010000000
Prior Symbol: ' ' Symbol: 'A' Code: 10010
Prior Symbol: ' ' Symbol: 'B' Code: 010100
Prior Symbol: ' ' Symbol: 'C' Code: 111100
Prior Symbol: ' ' Symbol: 'D' Code: 1111010
Prior Symbol: ' ' Symbol: 'E' Code: 0100011
Prior Symbol: ' ' Symbol: 'F' Code: 0101010
Prior Symbol: ' ' Symbol: 'G' Code: 000010
Prior Symbol: ' ' Symbol: 'H' Code: 1111011
Prior Symbol: ' ' Symbol: 'I' Code: 11001011
Prior Symbol: ' ' Symbol: 'J' Code: 000011
Prior Symbol: ' ' Symbol: 'K' Code: 1100100
Prior Symbol: ' ' Symbol: 'L' Code: 010110
Prior Symbol: ' ' Symbol: 'M' Code: 101001
Prior Symbol: ' ' Symbol: 'N' Code: 001100
Prior Symbol: ' ' Symbol: 'O' Code: 10100001
Prior Symbol: ' ' Symbol: 'P' Code: 001101
Prior Symbol: ' ' Symbol: 'R' Code: 1111100
Prior Symbol: ' ' Symbol: 'S' Code: 01001
Prior Symbol: ' ' Symbol: 'T' Code: 1100110
Prior Symbol: ' ' Symbol: 'U' Code: 111111011
Prior Symbol: ' ' Symbol: 'V' Code: 111111100
Prior Symbol: ' ' Symbol: 'W' Code: 010000
Prior Symbol: ' ' Symbol: 'Y' Code: 111111101
Prior Symbol: ' ' Symbol: 'Z' Code: 1010000001
Prior Symbol: ' ' Symbol: 'a' Code: 011
Prior Symbol: ' ' Symbol: 'b' Code: 10111
Prior Symbol: ' ' Symbol: 'c' Code: 10011
Prior Symbol: ' ' Symbol: 'd' Code: 10000
Prior Symbol: ' ' Symbol: 'e' Code: 100010
Prior Symbol: ' ' Symbol: 'f' Code: 11101
Prior Symbol: ' ' Symbol: 'g' Code: 100011
Prior Symbol: ' ' Symbol: 'h' Code: 0001
Prior Symbol: ' ' Symbol: 'i' Code: 10101
Prior Symbol: ' ' Symbol: 'j' Code: 11001111
Prior Symbol: ' ' Symbol: 'k' Code: 11111010
Prior Symbol: ' ' Symbol: 'l' Code: 010111
Prior Symbol: ' ' Symbol: 'm' Code: 00000
Prior Symbol: ' ' Symbol: 'n' Code: 1010001
Prior Symbol: ' ' Symbol: 'o' Code: 0010
Prior Symbol: ' ' Symbol: 'p' Code: 10110
Prior Symbol: ' ' Symbol: 'q' Code: 110010101
Prior Symbol: ' ' Symbol: 'r' Code: 00111
Prior Symbol: ' ' Symbol: 's' Code: 11100
Prior Symbol: ' ' Symbol: 't' Code: 1101
Prior Symbol: ' ' Symbol: 'u' Code: 11111011
Prior Symbol: ' ' Symbol: 'v' Code: 11111100
Prior Symbol: ' ' Symbol: 'w' Code: 11000
Prior Symbol: ' ' Symbol: 'y' Code: 11001110
Prior Symbol: '!' Symbol: 27 Code: 1
Prior Symbol: '"' Symbol: 0 Code: 000
Prior Symbol: '"' Symbol: 27 Code: 10
Prior Symbol: '"' Symbol: ' ' Code: 11
Prior Symbol: '"' Symbol: '.' Code: 001
Prior Symbol: '"' Symbol: 'H' Code: 010
Prior Symbol: '"' Symbol: 'T' Code: 011
Prior Symbol: '#' Symbol: 27 Code: 1
Prior Symbol: '$' Symbol: 27 Code: 1
Prior Symbol: '%' Symbol: 27 Code: 1
Prior Symbol: '&' Symbol: 27 Code: 1
Prior Symbol: ''' Symbol: 27 Code: 00
Prior Symbol: ''' Symbol: ' ' Code: 010
Prior Symbol: ''' Symbol: 's' Code: 1
Prior Symbol: ''' Symbol: 't' Code: 011
Prior Symbol: '(' Symbol: 27 Code: 1
Prior Symbol: ')' Symbol: 27 Code: 1
Prior Symbol: ')' Symbol: ',' Code: 0
Prior Symbol: '*' Symbol: 27 Code: 1
Prior Symbol: '+' Symbol: 27 Code: 1
Prior Symbol: ',' Symbol: 27 Code: 00
Prior Symbol: ',' Symbol: ' ' Code: 1
Prior Symbol: ',' Symbol: '"' Code: 01
Prior Symbol: '-' Symbol: 27 Code: 10
Prior Symbol: '-' Symbol: ' ' Code: 1110
Prior Symbol: '-' Symbol: 'a' Code: 000
Prior Symbol: '-' Symbol: 'b' Code: 0010
Prior Symbol: '-' Symbol: 'c' Code: 110
Prior Symbol: '-' Symbol: 'd' Code: 0011
Prior Symbol: '-' Symbol: 'e' Code: 0100
Prior Symbol: '-' Symbol: 'f' Code: 0101
Prior Symbol: '-' Symbol: 'r' Code: 1111
Prior Symbol: '-' Symbol: 's' Code: 011
Prior Symbol: '.' Symbol: 0 Code: 1
Prior Symbol: '.' Symbol: 27 Code: 000
Prior Symbol: '.' Symbol: ' ' Code: 01
Prior Symbol: '.' Symbol: '"' Code: 0010
Prior Symbol: '.' Symbol: 'J' Code: 00110
Prior Symbol: '.' Symbol: 'S' Code: 00111
Prior Symbol: '/' Symbol: 27 Code: 0
Prior Symbol: '/' Symbol: ' ' Code: 1
Prior Symbol: '0' Symbol: 27 Code: 100
Prior Symbol: '0' Symbol: ' ' Code: 111
Prior Symbol: '0' Symbol: '0' Code: 00
Prior Symbol: '0' Symbol: '7' Code: 101
Prior Symbol: '0' Symbol: 's' Code: 01
Prior Symbol: '0' Symbol: 't' Code: 110
Prior Symbol: '1' Symbol: 27 Code: 111
Prior Symbol: '1' Symbol: ' ' Code: 10
Prior Symbol: '1' Symbol: '8' Code: 110
Prior Symbol: '1' Symbol: '9' Code: 0
Prior Symbol: '2' Symbol: 27 Code: 101
Prior Symbol: '2' Symbol: ' ' Code: 11
Prior Symbol: '2' Symbol: '.' Code: 0
Prior Symbol: '2' Symbol: '6' Code: 100
Prior Symbol: '3' Symbol: 27 Code: 10
Prior Symbol: '3' Symbol: ' ' Code: 0
Prior Symbol: '3' Symbol: '0' Code: 11
Prior Symbol: '4' Symbol: 27 Code: 10
Prior Symbol: '4' Symbol: ' ' Code: 11
Prior Symbol: '4' Symbol: '.' Code: 0
Prior Symbol: '5' Symbol: 27 Code: 11
Prior Symbol: '5' Symbol: ' ' Code: 10
Prior Symbol: '5' Symbol: '.' Code: 0
Prior Symbol: '6' Symbol: 27 Code: 1
Prior Symbol: '7' Symbol: 27 Code: 0
Prior Symbol: '7' Symbol: ',' Code: 10
Prior Symbol: '7' Symbol: '.' Code: 11
Prior Symbol: '8' Symbol: 27 Code: 1
Prior Symbol: '9' Symbol: 27 Code: 110
Prior Symbol: '9' Symbol: ' ' Code: 111
Prior Symbol: '9' Symbol: '5' Code: 00
Prior Symbol: '9' Symbol: '6' Code: 01
Prior Symbol: '9' Symbol: '8' Code: 10
Prior Symbol: ':' Symbol: 27 Code: 0
Prior Symbol: ':' Symbol: ' ' Code: 1
Prior Symbol: ';' Symbol: 27 Code: 0
Prior Symbol: ';' Symbol: ' ' Code: 1
Prior Symbol: '<' Symbol: 27 Code: 1

Prior Symbol: '=' Symbol: 27 Code: 1
Prior Symbol: '>' Symbol: 27 Code: 1
Prior Symbol: '?' Symbol: 27 Code: 0
Prior Symbol: '?' Symbol: ' ' Code: 1
Prior Symbol: '@' Symbol: 27 Code: 1
Prior Symbol: 'A' Symbol: 27 Code: 10010
Prior Symbol: 'A' Symbol: ' ' Code: 11
Prior Symbol: 'A' Symbol: 'd' Code: 10011
Prior Symbol: 'A' Symbol: 'f' Code: 101000
Prior Symbol: 'A' Symbol: 'l' Code: 00
Prior Symbol: 'A' Symbol: 'm' Code: 10101
Prior Symbol: 'A' Symbol: 'n' Code: 01
Prior Symbol: 'A' Symbol: 'r' Code: 1011
Prior Symbol: 'A' Symbol: 's' Code: 10000
Prior Symbol: 'A' Symbol: 't' Code: 10001
Prior Symbol: 'A' Symbol: 'u' Code: 101001
Prior Symbol: 'B' Symbol: 27 Code: 10010
Prior Symbol: 'B' Symbol: 'a' Code: 101
Prior Symbol: 'B' Symbol: 'e' Code: 111
Prior Symbol: 'B' Symbol: 'i' Code: 00
Prior Symbol: 'B' Symbol: 'l' Code: 10011
Prior Symbol: 'B' Symbol: 'o' Code: 110
Prior Symbol: 'B' Symbol: 'r' Code: 01
Prior Symbol: 'B' Symbol: 'u' Code: 1000
Prior Symbol: 'C' Symbol: 27 Code: 01110
Prior Symbol: 'C' Symbol: 'a' Code: 00
Prior Symbol: 'C' Symbol: 'h' Code: 10
Prior Symbol: 'C' Symbol: 'i' Code: 01111
Prior Symbol: 'C' Symbol: 'l' Code: 110
Prior Symbol: 'C' Symbol: 'o' Code: 111
Prior Symbol: 'C' Symbol: 'r' Code: 0101
Prior Symbol: 'C' Symbol: 'u' Code: 0110
Prior Symbol: 'C' Symbol: 'y' Code: 0100
Prior Symbol: 'D' Symbol: 27 Code: 1111
Prior Symbol: 'D' Symbol: 'a' Code: 01
Prior Symbol: 'D' Symbol: 'e' Code: 100
Prior Symbol: 'D' Symbol: 'i' Code: 00
Prior Symbol: 'D' Symbol: 'o' Code: 101
Prior Symbol: 'D' Symbol: 'r' Code: 1101
Prior Symbol: 'D' Symbol: 'u' Code: 1110
Prior Symbol: 'D' Symbol: 'y' Code: 1100
Prior Symbol: 'E' Symbol: 27 Code: 10
Prior Symbol: 'E' Symbol: 'a' Code: 0110
Prior Symbol: 'E' Symbol: 'd' Code: 000
Prior Symbol: 'E' Symbol: 'i' Code: 0111
Prior Symbol: 'E' Symbol: 'l' Code: 001
Prior Symbol: 'E' Symbol: 'n' Code: 1100
Prior Symbol: 'E' Symbol: 'r' Code: 111
Prior Symbol: 'E' Symbol: 's' Code: 010
Prior Symbol: 'E' Symbol: 'v' Code: 1101
Prior Symbol: 'F' Symbol: 27 Code: 00
Prior Symbol: 'F' Symbol: 'e' Code: 100
Prior Symbol: 'F' Symbol: 'l' Code: 101
Prior Symbol: 'F' Symbol: 'o' Code: 01
Prior Symbol: 'F' Symbol: 'r' Code: 11
Prior Symbol: 'G' Symbol: 27 Code: 000
Prior Symbol: 'G' Symbol: 'a' Code: 110
Prior Symbol: 'G' Symbol: 'e' Code: 01
Prior Symbol: 'G' Symbol: 'i' Code: 100
Prior Symbol: 'G' Symbol: 'l' Code: 001
Prior Symbol: 'G' Symbol: 'o' Code: 1011
Prior Symbol: 'G' Symbol: 'r' Code: 111
Prior Symbol: 'G' Symbol: 'u' Code: 1010
Prior Symbol: 'H' Symbol: 27 Code: 010
Prior Symbol: 'H' Symbol: 'a' Code: 00
Prior Symbol: 'H' Symbol: 'e' Code: 011
Prior Symbol: 'H' Symbol: 'i' Code: 110
Prior Symbol: 'H' Symbol: 'o' Code: 10
Prior Symbol: 'H' Symbol: 'u' Code: 111
Prior Symbol: 'I' Symbol: 27 Code: 011
Prior Symbol: 'I' Symbol: ' ' Code: 000
Prior Symbol: 'I' Symbol: '.' Code: 100
Prior Symbol: 'I' Symbol: 'l' Code: 001
Prior Symbol: 'I' Symbol: 'n' Code: 11
Prior Symbol: 'I' Symbol: 'r' Code: 101
Prior Symbol: 'I' Symbol: 's' Code: 010
Prior Symbol: 'J' Symbol: 27 Code: 1000
Prior Symbol: 'J' Symbol: '.' Code: 1001
Prior Symbol: 'J' Symbol: 'a' Code: 111
Prior Symbol: 'J' Symbol: 'e' Code: 1101
Prior Symbol: 'J' Symbol: 'i' Code: 1100
Prior Symbol: 'J' Symbol: 'o' Code: 0
Prior Symbol: 'J' Symbol: 'u' Code: 101
Prior Symbol: 'K' Symbol: 27 Code: 111
Prior Symbol: 'K' Symbol: 'a' Code: 100
Prior Symbol: 'K' Symbol: 'e' Code: 0
Prior Symbol: 'K' Symbol: 'i' Code: 101
Prior Symbol: 'K' Symbol: 'r' Code: 110
Prior Symbol: 'L' Symbol: 27 Code: 0110
Prior Symbol: 'L' Symbol: 'a' Code: 11
Prior Symbol: 'L' Symbol: 'e' Code: 00
Prior Symbol: 'L' Symbol: 'i' Code: 0111
Prior Symbol: 'L' Symbol: 'o' Code: 10
Prior Symbol: 'L' Symbol: 'u' Code: 010
Prior Symbol: 'M' Symbol: 27 Code: 11010
Prior Symbol: 'M' Symbol: 'a' Code: 0
Prior Symbol: 'M' Symbol: 'c' Code: 11011
Prior Symbol: 'M' Symbol: 'e' Code: 1111
Prior Symbol: 'M' Symbol: 'i' Code: 10
Prior Symbol: 'M' Symbol: 'o' Code: 1100
Prior Symbol: 'M' Symbol: 'u' Code: 1110
Prior Symbol: 'N' Symbol: 27 Code: 1100
Prior Symbol: 'N' Symbol: 'a' Code: 111
Prior Symbol: 'N' Symbol: 'e' Code: 0
Prior Symbol: 'N' Symbol: 'i' Code: 1101
Prior Symbol: 'N' Symbol: 'o' Code: 10
Prior Symbol: 'O' Symbol: 27 Code: 10
Prior Symbol: 'O' Symbol: ''' Code: 010
Prior Symbol: 'O' Symbol: 'l' Code: 110
Prior Symbol: 'O' Symbol: 'n' Code: 011
Prior Symbol: 'O' Symbol: 'r' Code: 111
Prior Symbol: 'O' Symbol: 's' Code: 00
Prior Symbol: 'P' Symbol: 27 Code: 10010
Prior Symbol: 'P' Symbol: 'a' Code: 0
Prior Symbol: 'P' Symbol: 'e' Code: 111
Prior Symbol: 'P' Symbol: 'h' Code: 10011
Prior Symbol: 'P' Symbol: 'i' Code: 1000
Prior Symbol: 'P' Symbol: 'l' Code: 1101
Prior Symbol: 'P' Symbol: 'o' Code: 101
Prior Symbol: 'P' Symbol: 'r' Code: 1100
Prior Symbol: 'Q' Symbol: 27 Code: 1
Prior Symbol: 'R' Symbol: 27 Code: 0000
Prior Symbol: 'R' Symbol: '.' Code: 0001
Prior Symbol: 'R' Symbol: 'a' Code: 01
Prior Symbol: 'R' Symbol: 'e' Code: 10
Prior Symbol: 'R' Symbol: 'i' Code: 001
Prior Symbol: 'R' Symbol: 'o' Code: 11
Prior Symbol: 'S' Symbol: 27 Code: 1011
Prior Symbol: 'S' Symbol: '.' Code: 0001
Prior Symbol: 'S' Symbol: 'a' Code: 100
Prior Symbol: 'S' Symbol: 'c' Code: 0010
Prior Symbol: 'S' Symbol: 'e' Code: 1110
Prior Symbol: 'S' Symbol: 'h' Code: 110
Prior Symbol: 'S' Symbol: 'i' Code: 0011
Prior Symbol: 'S' Symbol: 'o' Code: 1111
Prior Symbol: 'S' Symbol: 't' Code: 01
Prior Symbol: 'S' Symbol: 'u' Code: 1010
Prior Symbol: 'S' Symbol: 'v' Code: 00000
Prior Symbol: 'S' Symbol: 'y' Code: 00001
Prior Symbol: 'T' Symbol: 27 Code: 1010
Prior Symbol: 'T' Symbol: 'V' Code: 1000
Prior Symbol: 'T' Symbol: 'a' Code: 1001
Prior Symbol: 'T' Symbol: 'e' Code: 11010
Prior Symbol: 'T' Symbol: 'h' Code: 0
Prior Symbol: 'T' Symbol: 'i' Code: 1011
Prior Symbol: 'T' Symbol: 'o' Code: 111
Prior Symbol: 'T' Symbol: 'r' Code: 1100
Prior Symbol: 'T' Symbol: 'w' Code: 11011
Prior Symbol: 'U' Symbol: 27 Code: 10
Prior Symbol: 'U' Symbol: '.' Code: 0
Prior Symbol: 'U' Symbol: 'n' Code: 11
Prior Symbol: 'V' Symbol: 27 Code: 111
Prior Symbol: 'V' Symbol: ' ' Code: 10
Prior Symbol: 'V' Symbol: 'e' Code: 110
Prior Symbol: 'V' Symbol: 'i' Code: 0
Prior Symbol: 'W' Symbol: 27 Code: 010
Prior Symbol: 'W' Symbol: 'a' Code: 111
Prior Symbol: 'W' Symbol: 'e' Code: 110
Prior Symbol: 'W' Symbol: 'h' Code: 011
Prior Symbol: 'W' Symbol: 'i' Code: 10
Prior Symbol: 'W' Symbol: 'o' Code: 00
Prior Symbol: 'X' Symbol: 27 Code: 1
Prior Symbol: 'Y' Symbol: 27 Code: 0
Prior Symbol: 'Y' Symbol: 'o' Code: 1
Prior Symbol: 'Z' Symbol: 27 Code: 1
Prior Symbol: '[' Symbol: 27 Code: 1
Prior Symbol: '\' Symbol: 27 Code: 1
Prior Symbol: ']' Symbol: 27 Code: 1
Prior Symbol: '^' Symbol: 27 Code: 1
Prior Symbol: '_' Symbol: 27 Code: 1
Prior Symbol: '`' Symbol: 27 Code: 1
Prior Symbol: 'a' Symbol: 27 Code: 111001101
Prior Symbol: 'a' Symbol: ' ' Code: 101
Prior Symbol: 'a' Symbol: ''' Code: 111001110
Prior Symbol: 'a' Symbol: '.' Code: 1110010
Prior Symbol: 'a' Symbol: 'b' Code: 001011
Prior Symbol: 'a' Symbol: 'c' Code: 11001
Prior Symbol: 'a' Symbol: 'd' Code: 00111
Prior Symbol: 'a' Symbol: 'e' Code: 0011001
Prior Symbol: 'a' Symbol: 'f' Code: 001010
Prior Symbol: 'a' Symbol: 'g' Code: 00100
Prior Symbol: 'a' Symbol: 'h' Code: 001100010
Prior Symbol: 'a' Symbol: 'i' Code: 111000
Prior Symbol: 'a' Symbol: 'k' Code: 110000
Prior Symbol: 'a' Symbol: 'l' Code: 1101
Prior Symbol: 'a' Symbol: 'm' Code: 11101
Prior Symbol: 'a' Symbol: 'n' Code: 01
Prior Symbol: 'a' Symbol: 'o' Code: 001100011
Prior Symbol: 'a' Symbol: 'p' Code: 00000
Prior Symbol: 'a' Symbol: 'r' Code: 100
Prior Symbol: 'a' Symbol: 's' Code: 0001
Prior Symbol: 'a' Symbol: 't' Code: 1111
Prior Symbol: 'a' Symbol: 'u' Code: 110001
Prior Symbol: 'a' Symbol: 'v' Code: 001101
Prior Symbol: 'a' Symbol: 'w' Code: 111001111
Prior Symbol: 'a' Symbol: 'x' Code: 111001100
Prior Symbol: 'a' Symbol: 'y' Code: 00001
Prior Symbol: 'a' Symbol: 'z' Code: 00110000
Prior Symbol: 'b' Symbol: 27 Code: 101000
Prior Symbol: 'b' Symbol: ' ' Code: 0101
Prior Symbol: 'b' Symbol: '.' Code: 101001
Prior Symbol: 'b' Symbol: 'a' Code: 100
Prior Symbol: 'b' Symbol: 'b' Code: 101010
Prior Symbol: 'b' Symbol: 'd' Code: 1010110
Prior Symbol: 'b' Symbol: 'e' Code: 00
Prior Symbol: 'b' Symbol: 'i' Code: 1011
Prior Symbol: 'b' Symbol: 'l' Code: 0100
Prior Symbol: 'b' Symbol: 'o' Code: 110
Prior Symbol: 'b' Symbol: 'r' Code: 1110
Prior Symbol: 'b' Symbol: 's' Code: 1010111
Prior Symbol: 'b' Symbol: 'u' Code: 1111
Prior Symbol: 'b' Symbol: 'y' Code: 011
Prior Symbol: 'c' Symbol: 27 Code: 00010
Prior Symbol: 'c' Symbol: ' ' Code: 10000
Prior Symbol: 'c' Symbol: ',' Code: 010000
Prior Symbol: 'c' Symbol: '.' Code: 0100011
Prior Symbol: 'c' Symbol: 'D' Code: 0100110
Prior Symbol: 'c' Symbol: 'a' Code: 110
Prior Symbol: 'c' Symbol: 'c' Code: 010010
Prior Symbol: 'c' Symbol: 'e' Code: 011
Prior Symbol: 'c' Symbol: 'h' Code: 111
Prior Symbol: 'c' Symbol: 'i' Code: 0101
Prior Symbol: 'c' Symbol: 'k' Code: 1001
Prior Symbol: 'c' Symbol: 'l' Code: 10001
Prior Symbol: 'c' Symbol: 'o' Code: 101
Prior Symbol: 'c' Symbol: 'q' Code: 0100010
Prior Symbol: 'c' Symbol: 'r' Code: 00011
Prior Symbol: 'c' Symbol: 't' Code: 001
Prior Symbol: 'c' Symbol: 'u' Code: 0000
Prior Symbol: 'c' Symbol: 'y' Code: 0100111
Prior Symbol: 'd' Symbol: 27 Code: 1010001
Prior Symbol: 'd' Symbol: ' ' Code: 11
Prior Symbol: 'd' Symbol: ''' Code: 01111010
Prior Symbol: 'd' Symbol: ',' Code: 101011
Prior Symbol: 'd' Symbol: '.' Code: 0100
Prior Symbol: 'd' Symbol: ';' Code: 01111011
Prior Symbol: 'd' Symbol: 'a' Code: 1000

Prior Symbol: 'd' Symbol: 'd' Code: 01010
Prior Symbol: 'd' Symbol: 'e' Code: 00
Prior Symbol: 'd' Symbol: 'f' Code: 10100000
Prior Symbol: 'd' Symbol: 'g' Code: 10101011
Prior Symbol: 'd' Symbol: 'i' Code: 1011
Prior Symbol: 'd' Symbol: 'l' Code: 011111
Prior Symbol: 'd' Symbol: 'm' Code: 10100001
Prior Symbol: 'd' Symbol: 'n' Code: 1010100
Prior Symbol: 'd' Symbol: 'o' Code: 0110
Prior Symbol: 'd' Symbol: 'r' Code: 01110
Prior Symbol: 'd' Symbol: 's' Code: 1001
Prior Symbol: 'd' Symbol: 'u' Code: 101001
Prior Symbol: 'd' Symbol: 'v' Code: 0111100
Prior Symbol: 'd' Symbol: 'w' Code: 10101010
Prior Symbol: 'd' Symbol: 'y' Code: 01011
Prior Symbol: 'e' Symbol: 27 Code: 101110011
Prior Symbol: 'e' Symbol: ' ' Code: 111
Prior Symbol: 'e' Symbol: ''' Code: 10111010
Prior Symbol: 'e' Symbol: ')' Code: 100110000
Prior Symbol: 'e' Symbol: ',' Code: 000111
Prior Symbol: 'e' Symbol: '-' Code: 10011001
Prior Symbol: 'e' Symbol: '.' Code: 00110
Prior Symbol: 'e' Symbol: ':' Code: 10011010
Prior Symbol: 'e' Symbol: 'a' Code: 1000
Prior Symbol: 'e' Symbol: 'b' Code: 0001100
Prior Symbol: 'e' Symbol: 'c' Code: 10010
Prior Symbol: 'e' Symbol: 'd' Code: 0000
Prior Symbol: 'e' Symbol: 'e' Code: 10100
Prior Symbol: 'e' Symbol: 'f' Code: 10111011
Prior Symbol: 'e' Symbol: 'g' Code: 0001101
Prior Symbol: 'e' Symbol: 'h' Code: 100110001
Prior Symbol: 'e' Symbol: 'i' Code: 000100
Prior Symbol: 'e' Symbol: 'k' Code: 10011011
Prior Symbol: 'e' Symbol: 'l' Code: 0010
Prior Symbol: 'e' Symbol: 'm' Code: 100111
Prior Symbol: 'e' Symbol: 'n' Code: 010
Prior Symbol: 'e' Symbol: 'o' Code: 001110
Prior Symbol: 'e' Symbol: 'p' Code: 001111
Prior Symbol: 'e' Symbol: 'r' Code: 110
Prior Symbol: 'e' Symbol: 's' Code: 011
Prior Symbol: 'e' Symbol: 't' Code: 10101
Prior Symbol: 'e' Symbol: 'u' Code: 101110010
Prior Symbol: 'e' Symbol: 'v' Code: 101100
Prior Symbol: 'e' Symbol: 'w' Code: 101111
Prior Symbol: 'e' Symbol: 'x' Code: 000101
Prior Symbol: 'e' Symbol: 'y' Code: 101101
Prior Symbol: 'e' Symbol: 'z' Code: 10111000
Prior Symbol: 'f' Symbol: 27 Code: 1110111
Prior Symbol: 'f' Symbol: ' ' Code: 10
Prior Symbol: 'f' Symbol: '.' Code: 1110110
Prior Symbol: 'f' Symbol: 'a' Code: 1111
Prior Symbol: 'f' Symbol: 'e' Code: 000
Prior Symbol: 'f' Symbol: 'f' Code: 0101
Prior Symbol: 'f' Symbol: 'i' Code: 001
Prior Symbol: 'f' Symbol: 'l' Code: 111010
Prior Symbol: 'f' Symbol: 'o' Code: 110
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Prior Symbol: 'f' Symbol: 't' Code: 0100
Prior Symbol: 'f' Symbol: 'u' Code: 11100
Prior Symbol: 'g' Symbol: 27 Code: 1111010
Prior Symbol: 'g' Symbol: ' ' Code: 10
Prior Symbol: 'g' Symbol: ''' Code: 1111011
Prior Symbol: 'g' Symbol: ',' Code: 111110
Prior Symbol: 'g' Symbol: '-' Code: 0101010
Prior Symbol: 'g' Symbol: '.' Code: 01011
Prior Symbol: 'g' Symbol: 'a' Code: 1110
Prior Symbol: 'g' Symbol: 'e' Code: 00
Prior Symbol: 'g' Symbol: 'g' Code: 0101011
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Prior Symbol: 'g' Symbol: 'o' Code: 0100
Prior Symbol: 'g' Symbol: 'r' Code: 111111
Prior Symbol: 'g' Symbol: 's' Code: 11000
Prior Symbol: 'g' Symbol: 'u' Code: 11001
Prior Symbol: 'g' Symbol: 'y' Code: 010100
Prior Symbol: 'h' Symbol: 27 Code: 1011100
Prior Symbol: 'h' Symbol: ' ' Code: 100
Prior Symbol: 'h' Symbol: ''' Code: 10101000
Prior Symbol: 'h' Symbol: ',' Code: 10101001
Prior Symbol: 'h' Symbol: '-' Code: 10101011
Prior Symbol: 'h' Symbol: '.' Code: 101001
Prior Symbol: 'h' Symbol: 'a' Code: 011
Prior Symbol: 'h' Symbol: 'e' Code: 11
Prior Symbol: 'h' Symbol: 'i' Code: 00
Prior Symbol: 'h' Symbol: 'n' Code: 101011
Prior Symbol: 'h' Symbol: 'o' Code: 010
Prior Symbol: 'h' Symbol: 'r' Code: 101111
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Prior Symbol: 'h' Symbol: 't' Code: 10110
Prior Symbol: 'h' Symbol: 'u' Code: 101000
Prior Symbol: 'h' Symbol: 'y' Code: 1011101
Prior Symbol: 'i' Symbol: 27 Code: 00011101
Prior Symbol: 'i' Symbol: ' ' Code: 0001111
Prior Symbol: 'i' Symbol: ',' Code: 100110100
Prior Symbol: 'i' Symbol: '.' Code: 10011000
Prior Symbol: 'i' Symbol: 'a' Code: 11010
Prior Symbol: 'i' Symbol: 'b' Code: 100110101
Prior Symbol: 'i' Symbol: 'c' Code: 1111
Prior Symbol: 'i' Symbol: 'd' Code: 10000
Prior Symbol: 'i' Symbol: 'e' Code: 1110
Prior Symbol: 'i' Symbol: 'f' Code: 100111
Prior Symbol: 'i' Symbol: 'g' Code: 10010
Prior Symbol: 'i' Symbol: 'k' Code: 10011011
Prior Symbol: 'i' Symbol: 'l' Code: 1100
Prior Symbol: 'i' Symbol: 'm' Code: 10001
Prior Symbol: 'i' Symbol: 'n' Code: 01
Prior Symbol: 'i' Symbol: 'o' Code: 11011
Prior Symbol: 'i' Symbol: 'p' Code: 000110
Prior Symbol: 'i' Symbol: 'r' Code: 0000
Prior Symbol: 'i' Symbol: 's' Code: 101
Prior Symbol: 'i' Symbol: 't' Code: 001
Prior Symbol: 'i' Symbol: 'v' Code: 00010
Prior Symbol: 'i' Symbol: 'x' Code: 00011100
Prior Symbol: 'i' Symbol: 'z' Code: 10011001
Prior Symbol: 'j' Symbol: 27 Code: 000
Prior Symbol: 'j' Symbol: 'a' Code: 001
Prior Symbol: 'j' Symbol: 'e' Code: 010
Prior Symbol: 'j' Symbol: 'o' Code: 1
Prior Symbol: 'j' Symbol: 'u' Code: 011
Prior Symbol: 'k' Symbol: 27 Code: 0000
Prior Symbol: 'k' Symbol: ' ' Code: 01
Prior Symbol: 'k' Symbol: ''' Code: 10000
Prior Symbol: 'k' Symbol: ',' Code: 10011
Prior Symbol: 'k' Symbol: '.' Code: 0001
Prior Symbol: 'k' Symbol: 'e' Code: 11
Prior Symbol: 'k' Symbol: 'i' Code: 101
Prior Symbol: 'k' Symbol: 'l' Code: 100100
Prior Symbol: 'k' Symbol: 'n' Code: 10001
Prior Symbol: 'k' Symbol: 's' Code: 001
Prior Symbol: 'k' Symbol: 'y' Code: 100101
Prior Symbol: 'l' Symbol: 27 Code: 0011100
Prior Symbol: 'l' Symbol: ' ' Code: 110
Prior Symbol: 'l' Symbol: ''' Code: 00111100
Prior Symbol: 'l' Symbol: ',' Code: 001101
Prior Symbol: 'l' Symbol: '-' Code: 00111101
Prior Symbol: 'l' Symbol: '.' Code: 00100
Prior Symbol: 'l' Symbol: 'a' Code: 000
Prior Symbol: 'l' Symbol: 'b' Code: 0011101
Prior Symbol: 'l' Symbol: 'c' Code: 00111111
Prior Symbol: 'l' Symbol: 'd' Code: 10111
Prior Symbol: 'l' Symbol: 'e' Code: 111
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Prior Symbol: 'l' Symbol: 'm' Code: 010111
Prior Symbol: 'l' Symbol: 'n' Code: 00111110
Prior Symbol: 'l' Symbol: 'o' Code: 1010
Prior Symbol: 'l' Symbol: 'p' Code: 00101
Prior Symbol: 'l' Symbol: 'r' Code: 10110111
Prior Symbol: 'l' Symbol: 's' Code: 01010
Prior Symbol: 'l' Symbol: 't' Code: 001100
Prior Symbol: 'l' Symbol: 'u' Code: 1011010
Prior Symbol: 'l' Symbol: 'v' Code: 101100
Prior Symbol: 'l' Symbol: 'y' Code: 0100
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Prior Symbol: 'm' Symbol: ' ' Code: 111
Prior Symbol: 'm' Symbol: ''' Code: 1010110
Prior Symbol: 'm' Symbol: '.' Code: 110101
Prior Symbol: 'm' Symbol: ':' Code: 1010111
Prior Symbol: 'm' Symbol: 'a' Code: 00
Prior Symbol: 'm' Symbol: 'b' Code: 10100
Prior Symbol: 'm' Symbol: 'e' Code: 01
Prior Symbol: 'm' Symbol: 'i' Code: 1100
Prior Symbol: 'm' Symbol: 'm' Code: 10110
Prior Symbol: 'm' Symbol: 'o' Code: 1000
Prior Symbol: 'm' Symbol: 'p' Code: 1001
Prior Symbol: 'm' Symbol: 's' Code: 10111
Prior Symbol: 'm' Symbol: 'u' Code: 11011
Prior Symbol: 'm' Symbol: 'y' Code: 110100
Prior Symbol: 'n' Symbol: 27 Code: 0100000
Prior Symbol: 'n' Symbol: ' ' Code: 10
Prior Symbol: 'n' Symbol: ''' Code: 0100011
Prior Symbol: 'n' Symbol: ',' Code: 111100
Prior Symbol: 'n' Symbol: '-' Code: 011011010
Prior Symbol: 'n' Symbol: '.' Code: 01100
Prior Symbol: 'n' Symbol: ':' Code: 011011011
Prior Symbol: 'n' Symbol: 'a' Code: 11111
Prior Symbol: 'n' Symbol: 'b' Code: 011011100
Prior Symbol: 'n' Symbol: 'c' Code: 01001
Prior Symbol: 'n' Symbol: 'd' Code: 110
Prior Symbol: 'n' Symbol: 'e' Code: 001
Prior Symbol: 'n' Symbol: 'f' Code: 01000101
Prior Symbol: 'n' Symbol: 'g' Code: 000
Prior Symbol: 'n' Symbol: 'i' Code: 01111
Prior Symbol: 'n' Symbol: 'j' Code: 011011101
Prior Symbol: 'n' Symbol: 'k' Code: 1111010
Prior Symbol: 'n' Symbol: 'l' Code: 01101100
Prior Symbol: 'n' Symbol: 'm' Code: 011011110
Prior Symbol: 'n' Symbol: 'n' Code: 01110
Prior Symbol: 'n' Symbol: 'o' Code: 1111011
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Prior Symbol: 'n' Symbol: 's' Code: 0101
Prior Symbol: 'n' Symbol: 't' Code: 1110
Prior Symbol: 'n' Symbol: 'u' Code: 0100001
Prior Symbol: 'n' Symbol: 'v' Code: 0110100
Prior Symbol: 'n' Symbol: 'y' Code: 0110101
Prior Symbol: 'n' Symbol: 'z' Code: 01000100
Prior Symbol: 'o' Symbol: 27 Code: 101010011
Prior Symbol: 'o' Symbol: ' ' Code: 001
Prior Symbol: 'o' Symbol: ',' Code: 01001111
Prior Symbol: 'o' Symbol: '-' Code: 01001110
Prior Symbol: 'o' Symbol: '.' Code: 0100110
Prior Symbol: 'o' Symbol: 'B' Code: 101010010
Prior Symbol: 'o' Symbol: 'a' Code: 100001
Prior Symbol: 'o' Symbol: 'b' Code: 110111
Prior Symbol: 'o' Symbol: 'c' Code: 100000
Prior Symbol: 'o' Symbol: 'd' Code: 110101
Prior Symbol: 'o' Symbol: 'e' Code: 1010101
Prior Symbol: 'o' Symbol: 'f' Code: 000
Prior Symbol: 'o' Symbol: 'g' Code: 1101000
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Prior Symbol: 'o' Symbol: 'i' Code: 1101101
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Prior Symbol: 'o' Symbol: 'l' Code: 0101
Prior Symbol: 'o' Symbol: 'm' Code: 1100
Prior Symbol: 'o' Symbol: 'n' Code: 111
Prior Symbol: 'o' Symbol: 'o' Code: 10100
Prior Symbol: 'o' Symbol: 'p' Code: 01000
Prior Symbol: 'o' Symbol: 'r' Code: 011
Prior Symbol: 'o' Symbol: 's' Code: 10001
Prior Symbol: 'o' Symbol: 't' Code: 10010
Prior Symbol: 'o' Symbol: 'u' Code: 1011
Prior Symbol: 'o' Symbol: 'v' Code: 101011
Prior Symbol: 'o' Symbol: 'w' Code: 10011
Prior Symbol: 'o' Symbol: 'x' Code: 10101000
Prior Symbol: 'o' Symbol: 'y' Code: 1101100
Prior Symbol: 'p' Symbol: 27 Code: 011011
Prior Symbol: 'p' Symbol: ' ' Code: 000
Prior Symbol: 'p' Symbol: '-' Code: 1010010
Prior Symbol: 'p' Symbol: '.' Code: 101000
Prior Symbol: 'p' Symbol: 'a' Code: 001
Prior Symbol: 'p' Symbol: 'e' Code: 110
Prior Symbol: 'p' Symbol: 'h' Code: 1111
Prior Symbol: 'p' Symbol: 'i' Code: 1011
Prior Symbol: 'p' Symbol: 'l' Code: 010

Prior Symbol: 'p' Symbol: 'm' Code: 1010011
Prior Symbol: 'p' Symbol: 'o' Code: 0111
Prior Symbol: 'p' Symbol: 'p' Code: 11101
Prior Symbol: 'p' Symbol: 'r' Code: 100
Prior Symbol: 'p' Symbol: 's' Code: 01100
Prior Symbol: 'p' Symbol: 't' Code: 11100
Prior Symbol: 'p' Symbol: 'u' Code: 10101
Prior Symbol: 'p' Symbol: 'y' Code: 011010
Prior Symbol: 'q' Symbol: 27 Code: 0
Prior Symbol: 'q' Symbol: 'u' Code: 1
Prior Symbol: 'r' Symbol: 27 Code: 10011111
Prior Symbol: 'r' Symbol: ' ' Code: 111
Prior Symbol: 'r' Symbol: ''' Code: 1001110
Prior Symbol: 'r' Symbol: ')' Code: 100111100
Prior Symbol: 'r' Symbol: ',' Code: 100100
Prior Symbol: 'r' Symbol: '-' Code: 11001100
Prior Symbol: 'r' Symbol: '.' Code: 10001
Prior Symbol: 'r' Symbol: ';' Code: 100111101
Prior Symbol: 'r' Symbol: 'a' Code: 1101
Prior Symbol: 'r' Symbol: 'b' Code: 11001101
Prior Symbol: 'r' Symbol: 'c' Code: 100001
Prior Symbol: 'r' Symbol: 'd' Code: 11000
Prior Symbol: 'r' Symbol: 'e' Code: 101
Prior Symbol: 'r' Symbol: 'f' Code: 110011111
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Prior Symbol: 'r' Symbol: 'i' Code: 010
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Prior Symbol: 'r' Symbol: 'n' Code: 01100
Prior Symbol: 'r' Symbol: 'o' Code: 000
Prior Symbol: 'r' Symbol: 'p' Code: 11001110
Prior Symbol: 'r' Symbol: 'r' Code: 100110
Prior Symbol: 'r' Symbol: 's' Code: 0111
Prior Symbol: 'r' Symbol: 't' Code: 0011
Prior Symbol: 'r' Symbol: 'u' Code: 100000
Prior Symbol: 'r' Symbol: 'v' Code: 110011110
Prior Symbol: 'r' Symbol: 'y' Code: 01101
Prior Symbol: 's' Symbol: 27 Code: 10011100
Prior Symbol: 's' Symbol: ' ' Code: 0
Prior Symbol: 's' Symbol: '"' Code: 100111100
Prior Symbol: 's' Symbol: ''' Code: 100111101
Prior Symbol: 's' Symbol: ',' Code: 111011
Prior Symbol: 's' Symbol: '.' Code: 1000
Prior Symbol: 's' Symbol: ';' Code: 11101011
Prior Symbol: 's' Symbol: 'a' Code: 110011
Prior Symbol: 's' Symbol: 'b' Code: 100111110
Prior Symbol: 's' Symbol: 'c' Code: 10010
Prior Symbol: 's' Symbol: 'e' Code: 1101
Prior Symbol: 's' Symbol: 'h' Code: 11000
Prior Symbol: 's' Symbol: 'i' Code: 11100
Prior Symbol: 's' Symbol: 'k' Code: 100111111
Prior Symbol: 's' Symbol: 'l' Code: 1110100
Prior Symbol: 's' Symbol: 'm' Code: 111010100
Prior Symbol: 's' Symbol: 'n' Code: 111010101
Prior Symbol: 's' Symbol: 'o' Code: 11110
Prior Symbol: 's' Symbol: 'p' Code: 1001101
Prior Symbol: 's' Symbol: 's' Code: 11111
Prior Symbol: 's' Symbol: 't' Code: 101
Prior Symbol: 's' Symbol: 'u' Code: 110010
Prior Symbol: 's' Symbol: 'w' Code: 10011101
Prior Symbol: 's' Symbol: 'y' Code: 1001100
Prior Symbol: 't' Symbol: 27 Code: 11000011
Prior Symbol: 't' Symbol: ' ' Code: 111
Prior Symbol: 't' Symbol: ''' Code: 11000100
Prior Symbol: 't' Symbol: ',' Code: 0111100
Prior Symbol: 't' Symbol: '-' Code: 01111110
Prior Symbol: 't' Symbol: '.' Code: 01101
Prior Symbol: 't' Symbol: ';' Code: 110000100
Prior Symbol: 't' Symbol: 'a' Code: 0100
Prior Symbol: 't' Symbol: 'b' Code: 110000101
Prior Symbol: 't' Symbol: 'c' Code: 11000101
Prior Symbol: 't' Symbol: 'e' Code: 101
Prior Symbol: 't' Symbol: 'h' Code: 00
Prior Symbol: 't' Symbol: 'i' Code: 1101
Prior Symbol: 't' Symbol: 'l' Code: 0111101
Prior Symbol: 't' Symbol: 'm' Code: 01111111
Prior Symbol: 't' Symbol: 'n' Code: 0111110
Prior Symbol: 't' Symbol: 'o' Code: 100
Prior Symbol: 't' Symbol: 'r' Code: 11001
Prior Symbol: 't' Symbol: 's' Code: 0101
Prior Symbol: 't' Symbol: 't' Code: 01100
Prior Symbol: 't' Symbol: 'u' Code: 01110
Prior Symbol: 't' Symbol: 'w' Code: 1100000
Prior Symbol: 't' Symbol: 'y' Code: 1100011
Prior Symbol: 'u' Symbol: 27 Code: 1001100
Prior Symbol: 'u' Symbol: ' ' Code: 100000
Prior Symbol: 'u' Symbol: 'a' Code: 100111
Prior Symbol: 'u' Symbol: 'b' Code: 100001
Prior Symbol: 'u' Symbol: 'c' Code: 10001
Prior Symbol: 'u' Symbol: 'd' Code: 11100
Prior Symbol: 'u' Symbol: 'e' Code: 11101
Prior Symbol: 'u' Symbol: 'g' Code: 11110
Prior Symbol: 'u' Symbol: 'i' Code: 10010
Prior Symbol: 'u' Symbol: 'k' Code: 1001101
Prior Symbol: 'u' Symbol: 'l' Code: 0100
Prior Symbol: 'u' Symbol: 'm' Code: 111111
Prior Symbol: 'u' Symbol: 'n' Code: 110
Prior Symbol: 'u' Symbol: 'o' Code: 11111010
Prior Symbol: 'u' Symbol: 'p' Code: 0101
Prior Symbol: 'u' Symbol: 'r' Code: 00
Prior Symbol: 'u' Symbol: 's' Code: 011
Prior Symbol: 'u' Symbol: 't' Code: 101
Prior Symbol: 'u' Symbol: 'v' Code: 11111011
Prior Symbol: 'u' Symbol: 'y' Code: 1111100
Prior Symbol: 'v' Symbol: 27 Code: 00010
Prior Symbol: 'v' Symbol: 'a' Code: 001
Prior Symbol: 'v' Symbol: 'e' Code: 1
Prior Symbol: 'v' Symbol: 'i' Code: 01
Prior Symbol: 'v' Symbol: 'o' Code: 0000
Prior Symbol: 'v' Symbol: 's' Code: 000110
Prior Symbol: 'v' Symbol: 'y' Code: 000111
Prior Symbol: 'w' Symbol: 27 Code: 011101
Prior Symbol: 'w' Symbol: ' ' Code: 001
Prior Symbol: 'w' Symbol: '.' Code: 011100
Prior Symbol: 'w' Symbol: 'a' Code: 010
Prior Symbol: 'w' Symbol: 'e' Code: 1110
Prior Symbol: 'w' Symbol: 'h' Code: 000
Prior Symbol: 'w' Symbol: 'i' Code: 10
Prior Symbol: 'w' Symbol: 'l' Code: 011110
Prior Symbol: 'w' Symbol: 'm' Code: 011111
Prior Symbol: 'w' Symbol: 'n' Code: 11111
Prior Symbol: 'w' Symbol: 'o' Code: 110
Prior Symbol: 'w' Symbol: 'r' Code: 0110
Prior Symbol: 'w' Symbol: 's' Code: 11110
Prior Symbol: 'x' Symbol: 27 Code: 10
Prior Symbol: 'x' Symbol: ' ' Code: 0110
Prior Symbol: 'x' Symbol: ',' Code: 0111
Prior Symbol: 'x' Symbol: '-' Code: 1100
Prior Symbol: 'x' Symbol: 'a' Code: 111
Prior Symbol: 'x' Symbol: 'e' Code: 00
Prior Symbol: 'x' Symbol: 'i' Code: 010
Prior Symbol: 'x' Symbol: 't' Code: 1101
Prior Symbol: 'y' Symbol: 27 Code: 01010
Prior Symbol: 'y' Symbol: ' ' Code: 1
Prior Symbol: 'y' Symbol: ''' Code: 010010
Prior Symbol: 'y' Symbol: ',' Code: 0001
Prior Symbol: 'y' Symbol: '.' Code: 0111
Prior Symbol: 'y' Symbol: ';' Code: 011001
Prior Symbol: 'y' Symbol: '?' Code: 0100110
Prior Symbol: 'y' Symbol: 'a' Code: 0100111
Prior Symbol: 'y' Symbol: 'b' Code: 0110000
Prior Symbol: 'y' Symbol: 'd' Code: 000001
Prior Symbol: 'y' Symbol: 'e' Code: 0010
Prior Symbol: 'y' Symbol: 'f' Code: 0110001
Prior Symbol: 'y' Symbol: 'i' Code: 000010
Prior Symbol: 'y' Symbol: 'l' Code: 01000
Prior Symbol: 'y' Symbol: 'm' Code: 000000
Prior Symbol: 'y' Symbol: 'n' Code: 01011
Prior Symbol: 'y' Symbol: 'o' Code: 01101
Prior Symbol: 'y' Symbol: 's' Code: 0011
Prior Symbol: 'y' Symbol: 'w' Code: 000011
Prior Symbol: 'z' Symbol: 27 Code: 100
Prior Symbol: 'z' Symbol: ' ' Code: 1110
Prior Symbol: 'z' Symbol: '.' Code: 1111
Prior Symbol: 'z' Symbol: 'a' Code: 000
Prior Symbol: 'z' Symbol: 'e' Code: 001
Prior Symbol: 'z' Symbol: 'i' Code: 110
Prior Symbol: 'z' Symbol: 'l' Code: 010
Prior Symbol: 'z' Symbol: 'o' Code: 101
Prior Symbol: 'z' Symbol: 'z' Code: 011
Prior Symbol: '{' Symbol: 27 Code: 1
Prior Symbol: '|' Symbol: 27 Code: 1
Prior Symbol: '}' Symbol: 27 Code: 1
Prior Symbol: '~' Symbol: 27 Code: 1
Prior Symbol: 127 Symbol: 27 Code: 1

Table C.7 English-language Program Description Decode Table

0	1	76	1	152	2	228	5	304	155	380	3	456	36
1	0	77	240	153	242	229	208	305	155	381	4	457	37
2	1	78	1	154	2	230	6	306	155	382	5	458	38
3	44	79	242	155	252	231	6	307	155	383	207	459	39
4	1	80	1	156	3	232	6	308	155	384	6	460	40
5	46	81	248	157	8	233	52	309	155	385	201	461	41
6	1	82	1	158	3	234	6	310	155	386	249	462	42
7	48	83	250	159	16	235	96	311	155	387	234	463	244
8	1	84	1	160	3	236	6	312	155	388	235	464	43
9	50	85	252	161	26	237	134	313	155	389	245	465	44
10	1	86	1	162	3	238	6	314	155	390	246	466	45
11	52	87	254	163	40	239	146	315	155	391	7	467	46
12	1	88	2	164	3	240	6	316	155	392	8	468	47
13	54	89	0	165	42	241	170	317	155	393	9	469	225
14	1	90	2	166	3	242	6	318	155	394	178	470	48
15	56	91	4	167	52	243	184	319	155	395	197	471	49
16	1	92	2	168	3	244	6	320	155	396	198	472	50
17	58	93	22	169	74	245	220	321	155	397	177	473	51
18	1	94	2	170	3	246	6	322	155	398	10	474	52
19	60	95	32	171	90	247	236	323	155	399	238	475	53
20	1	96	2	172	3	248	6	324	155	400	203	476	54
21	62	97	34	173	94	249	238	325	155	401	11	477	55
22	1	98	2	174	3	250	6	326	155	402	212	478	155
23	64	99	44	175	100	251	240	327	155	403	12	479	155
24	1	100	2	176	3	252	6	328	155	404	196	480	3
25	66	101	50	177	110	253	242	329	155	405	200	481	4
26	1	102	2	178	3	254	6	330	155	406	210	482	128
27	68	103	56	179	112	255	244	331	155	407	13	483	174
28	1	104	2	180	3	256	20	332	155	408	14	484	200
29	70	105	60	181	114	257	21	333	155	409	15	485	212
30	1	106	2	182	3	258	155	334	155	410	199	486	1
31	72	107	64	183	116	259	214	335	155	411	202	487	2
32	1	108	2	184	3	260	201	336	155	412	206	488	155
33	74	109	68	185	118	261	207	337	155	413	208	489	160
34	1	110	2	186	3	262	215	338	155	414	215	490	155
35	76	111	70	187	120	263	199	339	155	415	16	491	155
36	1	112	2	188	3	264	1	340	155	416	194	492	155
37	78	113	74	189	122	265	162	341	155	417	17	493	155
38	1	114	2	190	3	266	206	342	155	418	204	494	155
39	80	115	76	191	124	267	203	343	155	419	236	495	155
40	1	116	2	192	3	268	2	344	155	420	229	496	155
41	82	117	84	193	126	269	3	345	155	421	231	497	155
42	1	118	2	194	3	270	197	346	155	422	18	498	2
43	84	119	86	195	128	271	204	347	155	423	205	499	243
44	1	120	2	196	3	272	198	348	155	424	19	500	160
45	86	121	88	197	180	273	200	349	155	425	20	501	244
46	1	122	2	198	3	274	4	350	155	426	195	502	155
47	88	123	90	199	206	275	196	351	155	427	21	503	1
48	1	124	2	200	3	276	5	352	155	428	22	504	155
49	90	125	92	201	240	277	194	353	155	429	23	505	155
50	1	126	2	202	4	278	6	354	155	430	237	506	172
51	92	127	94	203	26	279	195	355	155	431	24	507	155
52	1	128	2	204	4	280	210	356	155	432	25	508	155
53	94	129	96	205	88	281	7	357	155	433	242	509	155
54	1	130	2	206	4	282	211	358	155	434	26	510	155
55	96	131	98	207	110	283	8	359	155	435	211	511	155
56	1	132	2	208	4	284	202	360	155	436	27	512	1
57	98	133	118	209	142	285	212	361	155	437	28	513	160
58	1	134	2	210	4	286	9	362	56	438	228	514	155
59	100	135	132	211	172	287	205	363	57	439	29	515	162
60	1	136	2	212	4	288	208	364	173	440	193	516	7
61	102	137	148	213	216	289	10	365	175	441	227	517	8
62	1	138	2	214	4	290	193	366	183	442	30	518	226
63	104	139	162	215	224	291	11	367	218	443	233	519	228
64	1	140	2	216	4	292	12	368	168	444	240	520	229
65	106	141	178	217	244	293	13	369	179	445	226	521	230
66	1	142	2	218	5	294	14	370	181	446	247	522	160
67	222	143	186	219	36	295	15	371	1	447	31	523	242
68	1	144	2	220	5	296	16	372	2	448	243	524	225
69	224	145	200	221	64	297	17	373	155	449	230	525	1
70	1	146	2	222	5	298	18	374	180	450	32	526	2
71	234	147	210	223	118	299	19	375	241	451	33	527	243
72	1	148	2	224	5	300	155	376	162	452	34	528	227
73	236	149	222	225	174	301	155	377	213	453	232	529	3
74	1	150	2	226	5	302	155	378	214	454	239	530	4
75	238	151	234	227	206	303	155	379	217	455	35	531	5

532	155	611	9	690	2	769	1	848	155	927	227	1006	13
533	6	612	230	691	3	770	245	849	233	928	11	1007	14
534	4	613	245	692	229	771	229	850	242	929	237	1008	19
535	128	614	243	693	236	772	2	851	1	930	12	1009	20
536	202	615	244	694	155	773	3	852	2	931	243	1010	167
537	211	616	155	695	239	774	233	853	3	932	13	1011	187
538	162	617	228	696	1	775	4	854	4	933	14	1012	230
539	1	618	1	697	242	776	229	855	239	934	15	1013	237
540	155	619	237	698	5	777	3	856	5	935	236	1014	247
541	2	620	2	699	6	778	155	857	6	936	16	1015	231
542	3	621	3	700	245	779	233	858	174	937	244	1016	246
543	160	622	4	701	239	780	1	859	1	938	17	1017	1
544	155	623	242	702	155	781	225	860	155	939	18	1018	2
545	160	624	5	703	236	782	239	861	238	940	242	1019	155
546	3	625	6	704	233	783	2	862	233	941	160	1020	238
547	4	626	236	705	1	784	3	863	2	942	19	1021	3
548	155	627	238	706	225	785	4	864	229	943	20	1022	4
549	183	628	7	707	242	786	167	865	155	944	21	1023	236
550	244	629	160	708	2	787	238	866	160	945	238	1024	5
551	160	630	5	709	229	788	236	867	1	946	22	1025	245
552	176	631	6	710	3	789	242	868	3	947	23	1026	6
553	243	632	155	711	4	790	243	869	4	948	11	1027	172
554	1	633	236	712	3	791	1	870	155	949	12	1028	228
555	2	634	245	713	4	792	155	871	232	950	228	1029	249
556	185	635	1	714	155	793	2	872	229	951	243	1030	242
557	2	636	2	715	229	794	225	873	225	952	155	1031	7
558	184	637	225	716	233	795	6	874	239	953	174	1032	8
559	155	638	239	717	245	796	155	875	1	954	226	1033	9
560	160	639	229	718	225	797	232	876	233	955	1	1034	174
561	1	640	233	719	1	798	233	877	2	956	2	1035	10
562	174	641	242	720	239	799	1	878	155	957	3	1036	239
563	2	642	3	721	2	800	242	879	155	958	236	1037	11
564	182	643	4	722	4	801	236	880	155	959	160	1038	225
565	155	644	6	723	5	802	2	881	239	960	4	1039	243
566	1	645	7	724	160	803	239	882	155	961	233	1040	12
567	160	646	155	725	201	804	3	883	155	962	242	1041	233
568	160	647	233	726	243	805	229	884	155	963	245	1042	13
569	1	648	249	727	155	806	4	885	155	964	5	1043	14
570	155	649	242	728	174	807	5	886	155	965	249	1044	15
571	176	650	245	729	242	808	155	887	155	966	225	1045	16
572	174	651	1	730	1	809	155	888	155	967	6	1046	229
573	1	652	2	731	2	810	3	889	155	968	239	1047	17
574	155	653	3	732	3	811	4	890	155	969	7	1048	18
575	160	654	236	733	238	812	155	891	155	970	229	1049	160
576	174	655	239	734	239	813	174	892	155	971	8	1050	29
577	1	656	225	735	5	814	1	893	155	972	9	1051	30
578	160	657	4	736	155	815	233	894	155	973	10	1052	169
579	155	658	232	737	174	816	2	895	155	974	15	1053	232
580	155	659	5	738	233	817	225	896	24	975	16	1054	245
581	155	660	5	739	229	818	229	897	25	976	241	1055	155
582	155	661	6	740	1	819	239	898	232	977	174	1056	1
583	1	662	249	741	245	820	9	899	239	978	196	1057	173
584	172	663	242	742	2	821	10	900	248	979	249	1058	187
585	174	664	245	743	225	822	246	901	155	980	172	1059	235
586	155	665	155	744	3	823	249	902	167	981	1	1060	250
587	155	666	229	745	4	824	1	903	247	982	227	1061	2
588	2	667	239	746	229	825	174	904	250	983	2	1062	167
589	3	668	1	747	3	826	227	905	1	984	155	1063	230
590	155	669	2	748	225	827	233	906	2	985	242	1064	226
591	160	670	233	749	233	828	245	907	3	986	3	1065	231
592	181	671	225	750	242	829	155	908	4	987	4	1066	3
593	182	672	3	751	155	830	229	909	229	988	160	1067	4
594	184	673	4	752	1	831	239	910	174	989	236	1068	5
595	1	674	6	753	2	832	2	911	5	990	245	1069	6
596	155	675	7	754	3	833	3	912	230	991	5	1070	233
597	160	676	225	755	4	834	225	913	226	992	6	1071	248
598	155	677	233	756	155	835	4	914	6	993	233	1072	7
599	160	678	238	757	233	836	232	915	246	994	7	1073	172
600	155	679	246	758	245	837	5	916	235	995	235	1074	239
601	155	680	228	759	1	838	6	917	245	996	8	1075	240
602	155	681	236	760	229	839	244	918	233	997	244	1076	8
603	155	682	243	761	2	840	7	919	7	998	9	1077	237
604	155	683	1	762	239	841	8	920	240	999	229	1078	246
605	155	684	2	763	225	842	232	921	249	1000	10	1079	249
606	155	685	242	764	225	843	7	922	231	1001	239	1080	9
607	160	686	3	765	5	844	229	923	8	1002	225	1081	247
608	155	687	4	766	155	845	247	924	9	1003	232	1082	10
609	155	688	155	767	227	846	214	925	228	1004	11	1083	11
610	8	689	5	768	239	847	225	926	10	1005	12	1084	174

1085	12	1164	160	1243	225	1322	249	1401	155	1480	229	1559	5
1086	227	1165	13	1244	229	1323	174	1402	173	1481	9	1560	236
1087	13	1166	13	1245	245	1324	226	1403	172	1482	10	1561	6
1088	229	1167	14	1246	1	1325	2	1404	248	1483	11	1562	7
1089	244	1168	167	1247	2	1326	237	1405	1	1484	12	1563	8
1090	14	1169	172	1248	8	1327	243	1406	174	1485	13	1564	245
1091	15	1170	243	1249	9	1328	3	1407	2	1486	155	1565	225
1092	228	1171	173	1250	236	1329	245	1408	3	1487	245	1566	9
1093	16	1172	1	1251	249	1330	239	1409	229	1488	25	1567	172
1094	236	1173	2	1252	167	1331	240	1410	231	1489	26	1568	227
1095	17	1174	155	1253	238	1332	4	1411	232	1490	169	1569	10
1096	225	1175	249	1254	1	1333	5	1412	249	1491	187	1570	232
1097	18	1176	245	1255	172	1334	233	1413	233	1492	246	1571	11
1098	19	1177	174	1256	155	1335	6	1414	235	1493	230	1572	233
1099	20	1178	3	1257	174	1336	7	1415	4	1494	1	1573	12
1100	21	1179	238	1258	2	1337	8	1416	227	1495	155	1574	239
1101	22	1180	4	1259	3	1338	9	1417	225	1496	173	1575	243
1102	238	1181	242	1260	4	1339	160	1418	5	1497	226	1576	174
1103	243	1182	5	1261	243	1340	225	1419	246	1498	240	1577	13
1104	23	1183	6	1262	5	1341	229	1420	6	1499	2	1578	14
1105	24	1184	244	1263	233	1342	10	1421	228	1500	167	1579	229
1106	242	1185	7	1264	6	1343	11	1422	7	1501	3	1580	15
1107	160	1186	8	1265	160	1344	25	1423	226	1502	4	1581	16
1108	25	1187	9	1266	7	1345	26	1424	240	1503	5	1582	17
1109	26	1188	239	1267	229	1346	173	1425	8	1504	245	1583	244
1110	27	1189	225	1268	22	1347	187	1426	9	1505	227	1584	18
1111	28	1190	160	1269	23	1348	226	1427	243	1506	172	1585	19
1112	9	1191	10	1270	167	1349	234	1428	244	1507	231	1586	20
1113	10	1192	233	1271	173	1350	237	1429	247	1508	242	1587	21
1114	174	1193	11	1272	238	1351	242	1430	239	1509	6	1588	20
1115	155	1194	12	1273	227	1352	250	1431	10	1510	235	1589	21
1116	236	1195	229	1274	235	1353	230	1432	11	1511	7	1590	187
1117	1	1196	20	1275	242	1354	236	1433	12	1512	236	1591	226
1118	245	1197	21	1276	155	1355	1	1434	13	1513	237	1592	173
1119	2	1198	172	1277	226	1356	2	1435	236	1514	238	1593	237
1120	244	1199	226	1278	1	1357	3	1436	14	1515	249	1594	1
1121	230	1200	248	1279	2	1358	155	1437	15	1516	8	1595	155
1122	3	1201	155	1280	245	1359	245	1438	16	1517	174	1596	167
1123	225	1202	174	1281	3	1360	4	1439	245	1518	9	1597	227
1124	229	1203	250	1282	244	1361	167	1440	237	1519	10	1598	172
1125	233	1204	1	1283	172	1362	246	1441	17	1520	228	1599	236
1126	4	1205	235	1284	4	1363	249	1442	230	1521	11	1600	238
1127	242	1206	2	1285	5	1364	5	1443	160	1522	12	1601	2
1128	239	1207	160	1286	230	1365	6	1444	18	1523	244	1602	247
1129	5	1208	3	1287	237	1366	235	1445	242	1524	13	1603	3
1130	6	1209	4	1288	246	1367	239	1446	19	1525	243	1604	4
1131	7	1210	240	1289	6	1368	7	1447	20	1526	14	1605	249
1132	160	1211	5	1290	174	1369	8	1448	21	1527	15	1606	5
1133	8	1212	6	1291	240	1370	9	1449	238	1528	16	1607	6
1134	14	1213	230	1292	7	1371	10	1450	22	1529	225	1608	7
1135	15	1214	246	1293	8	1372	172	1451	23	1530	239	1609	8
1136	173	1215	7	1294	243	1373	11	1452	24	1531	17	1610	244
1137	231	1216	228	1295	9	1374	12	1453	25	1532	233	1611	174
1138	155	1217	237	1296	10	1375	227	1454	14	1533	18	1612	245
1139	167	1218	231	1297	228	1376	174	1455	15	1534	19	1613	9
1140	249	1219	8	1298	11	1377	13	1456	173	1535	229	1614	10
1141	1	1220	225	1299	12	1378	238	1457	237	1536	20	1615	242
1142	236	1221	239	1300	249	1379	233	1458	249	1537	160	1616	225
1143	2	1222	242	1301	13	1380	14	1459	155	1538	21	1617	243
1144	172	1223	9	1302	239	1381	225	1460	174	1539	22	1618	11
1145	242	1224	10	1303	14	1382	15	1461	1	1540	23	1619	12
1146	3	1225	11	1304	225	1383	243	1462	243	1541	24	1620	13
1147	174	1226	236	1305	15	1384	16	1463	2	1542	160	1621	233
1148	243	1227	12	1306	16	1385	17	1464	3	1543	22	1622	14
1149	245	1228	229	1307	233	1386	244	1465	245	1544	162	1623	15
1150	4	1229	227	1308	236	1387	18	1466	244	1545	167	1624	239
1151	5	1230	13	1309	17	1388	231	1467	240	1546	226	1625	229
1152	239	1231	244	1310	160	1389	229	1468	4	1547	235	1626	16
1153	6	1232	14	1311	229	1390	19	1469	239	1548	237	1627	160
1154	7	1233	243	1312	18	1391	20	1470	5	1549	238	1628	232
1155	233	1234	15	1313	19	1392	228	1471	233	1550	155	1629	17
1156	225	1235	16	1314	20	1393	21	1472	6	1551	247	1630	18
1157	8	1236	17	1315	21	1394	22	1473	232	1552	1	1631	19
1158	9	1237	238	1316	12	1395	23	1474	160	1553	2	1632	17
1159	232	1238	18	1317	13	1396	160	1475	225	1554	3	1633	18
1160	10	1239	19	1318	167	1397	24	1476	236	1555	187	1634	239
1161	11	1240	3	1319	187	1398	26	1477	7	1556	249	1635	246
1162	229	1241	239	1320	155	1399	27	1478	242	1557	240	1636	155
1163	12	1242	155	1321	1	1400	194	1479	8	1558	4	1637	235

1638	249	1659	10	1680	4	1701	6	1722	191	1743	172	1764	155
1639	1	1660	11	1681	233	1702	7	1723	225	1744	229	1765	239
1640	160	1661	243	1682	10	1703	8	1724	226	1745	243	1766	233
1641	226	1662	12	1683	11	1704	233	1725	230	1746	8	1767	1
1642	2	1663	244	1684	174	1705	9	1726	237	1747	9	1768	2
1643	225	1664	238	1685	155	1706	5	1727	228	1748	10	1769	3
1644	3	1665	13	1686	236	1707	6	1728	233	1749	174	1770	4
1645	237	1666	242	1687	237	1708	160	1729	247	1750	11	1771	5
1646	4	1667	14	1688	1	1709	172	1730	167	1751	12	1772	155
1647	227	1668	15	1689	2	1710	173	1731	1	1752	13	1773	155
1648	233	1669	16	1690	243	1711	244	1732	2	1753	14	1774	155
1649	5	1670	5	1691	238	1712	233	1733	187	1754	15	1775	155
1650	228	1671	229	1692	242	1713	1	1734	3	1755	16	1776	155
1651	229	1672	243	1693	3	1714	2	1735	4	1756	6	1777	155
1652	231	1673	249	1694	229	1715	225	1736	236	1757	7	1778	155
1653	6	1674	155	1695	4	1716	229	1737	5	1758	160	1779	155
1654	236	1675	1	1696	232	1717	3	1738	155	1759	174	1780	155
1655	240	1676	239	1697	160	1718	155	1739	238	1760	225	1781	155
1656	7	1677	2	1698	225	1719	4	1740	6	1761	229		
1657	8	1678	3	1699	5	1720	17	1741	239	1762	236		
1658	9	1679	225	1700	239	1721	160	1742	7	1763	250		

ANNEX D

(Informative)

AN OVERVIEW OF PSIP FOR TERRESTRIAL BROADCAST WITH APPLICATION EXAMPLES

The Program and System Information Protocol (PSIP) is a small collection of tables designed to operate within every Transport Stream for terrestrial broadcast of digital TV. Its purpose is to describe the information at the system and event levels for all virtual channels carried in a particular Transport Stream. Additionally, information for analog channels as well as digital channels from other Transport Streams may be incorporated. The relational hierarchy for the component tables is explained through typical application examples in this document.

PSIP is the result of combining and compacting two existing optional ATSC protocols: A/55 and A/56. Although these protocols were individually efficient and accomplished their purpose, their mutual implementation was difficult due to their structural differences and their overlapping definitions. PSIP solves this problem. The tables defined in PSIP use packet identifiers (PIDs) that are different from those specified by the optional A/55 and A/56 standards. This provision has been included to enable the operation of existing equipment designed or manufactured to support A/55 and/or A/56.

D1. INTRODUCTION

Under the adopted ATSC standard for digital TV, the typical 6 MHz channel used for analog TV broadcast supports about 19 Mbps of throughput for terrestrial broadcast. Since audiovisual signals with standard resolution can be compressed using MPEG-2 to sustainable rates of around 6 Mbps, then around 3 or 4 digital TV channels can be safely supported in a single physical channel without congestion. Moreover, enough bandwidth remains within the same Transport Stream to provide several additional low-bandwidth non-conventional services such as: weather reports, stock indices, headline news, software download (for games or enhanced applications), image-driven classified ads, home shopping, pay-per-view information, and others.

It is therefore practical to anticipate that in the future, the list of services (virtual channels) carried in a physical transmission channel (6 MHz of bandwidth for the U.S.) may easily reach ten or more. What is even more important is that the number and type of services may also change continuously, thus becoming a more dynamic medium than what we have today.

An important feature of terrestrial broadcasting is that sources follow a distributed information model rather than a centralized one. Unlike cable or satellite, service providers are geographically distributed and have no interaction with respect to data unification or even synchronization. It is therefore necessary to develop a protocol for describing system information and event descriptions which is followed by every organization in charge of a physical transmission channel. System information allows navigation and access to each of the channels within the Transport Stream, whereas event descriptions give the user content information for browsing and selection.

In this document we describe the development of a transport-based implementation of the PSIP protocol using examples. Our hope is to introduce the reader to the most important concepts and components that constitute the protocol.

D2. ELEMENTS OF PSIP

PSIP is a collection of hierarchically-associated tables each of which describes particular elements of typical digital TV services. Figures D.1 and D.2 show the different components and the notation used to describe them. The packets of the base tables are all labeled with the base PID (base_PID) which has been chosen as 0x1FFB. The base tables are: the System Time Table (STT), the Rating Region Table (RRT), the Master Guide Table (MGT) and the Virtual Channel Table (VCT).

A second set of tables are the Event Information Tables (EIT) whose packet identifiers (PIDs) are defined in the MGT. A third set of tables are the Extended Text Tables (ETT), and similarly, their packet identifiers (PIDs) are defined in the MGT.

The System Time Table (STT) is a small data structure that fits in one packet and serves as a reference for time of day. Receivers can use this table as a reference for timing start times of advertised events.

It should be noted that, except for the MGT, PSIP tables may start in any byte position within an MPEG-2 transport stream packet. The Master Guide Table is special in that the first byte always is aligned with the first byte of the packet payload. The A/65 standard states this restriction as the pointer_field of the Transport Stream packet carrying the table_id field of the MGT section shall have the value 0x00 (section starts immediately after the pointer_field).

In general, table sections may span packet boundaries. Also, if the tables are small enough, more than one PSIP table may be present within a single transport stream packet. The MPEG-2 pointer_field mechanism is used to indicate the first byte of a table within a packet payload. The starting byte of subsequent tables that might be in the same payload is determined by processing successive section_length fields. The location of the section_length field is guaranteed to be consistent for any type of PSIP table, as the format conforms to MPEG-2 defined Program Specific Information (PSI) tables.

If a packet payload does not include the start of a table, the payload_unit_start_indicator bit in the packet header is set to ‘0’ and the pointer_field is not present.

Transmission syntax for the United States’ voluntary program rating system is included in this standard. The Rating Region Table (RRT) has been designed to transmit the rating standard in use for each country using the standard. Provisions were made for different rating systems for different countries and multi-country regions as well.

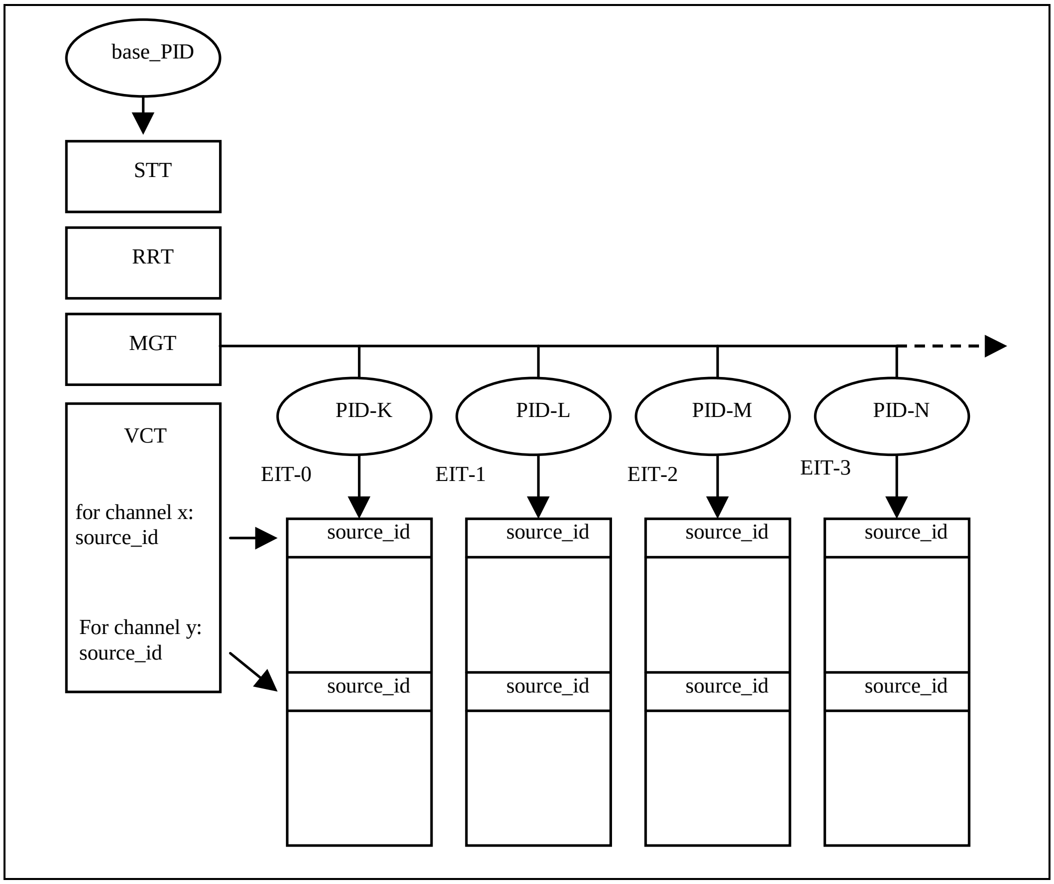


Figure D.1 Main Structure for the PSIP Tables

The Master Guide Table (MGT) provides general information about all of the other tables that comprise the PSIP standard. It defines table sizes necessary for memory allocation during decoding; it defines version numbers to identify those tables that need to be updated; it has a constrained header location to facilitate receiver acquisition; and it gives the packet identifiers (PIDs) that label the tables.

The Virtual Channel Table (VCT), also referred to as the Terrestrial VCT (TVCT), contains a list of all the channels that are or will be on-line plus their attributes. Among the attributes we have the channel name, navigation identifiers, stream components and types, etc.

As part of PSIP there are several Event Information Tables, each of which describes the events or TV programs associated with each of the virtual channels listed in the VCT. Each EIT is valid for a time interval of 3 hours. Since the total number of EITs is 128, up to 16 days of programming may be advertised in advance. EIT-0 always denotes the current 3 hours of programming, EIT-1 the next 3 hours, and so on. As a minimum, the first four EITs must always be present in every Transport Stream

Start times for EITs are constrained to be one of the following UTC times: 0:00 (midnight), 3:00, 6:00, 9:00, 12:00 (noon), 15:00, 18:00, and 21:00. Imposing constraints on the start times as well as the interval duration is necessary for the purpose of re-multiplexing. During re-multiplexing, EIT tables coming from several distinct Transport Streams may end up grouped together or *vice versa*. If no constraints were imposed, re-multiplexing equipment would have to parse EITs by content in real time, which is a difficult task.

For example, consider a broadcast corporation operating in the Eastern time zone of the U.S. This corporation decides to carry 6 EITs (18 hours of TV program information). If at present, the Eastern time is 15:30 EDT (19:30 UTC), then the coverage times for the EIT tables are:

Table D.1 An Example of EIT Coverage Times

EIT number	Version Num.	Assigned PID	Coverage (UTC)	Coverage (EDT)
0	6	123	18:00 - 21:00	14:00 - 17:00
1	4	190	21:00 - 24:00	17:00 - 20:00
2	2	237	0:00 - 3:00	20:00 - 23:00
3	7	177	3:00 - 6:00	23:00 - 2:00 (nd)
4	8	295	6:00 - 9:00	2:00 (nd) - 5:00 (nd)
5	15	221	9:00 - 12:00	5:00 (nd) - 8:00 (nd)

The abbreviation “nd” denotes next day. Before 17:00 EDT, the MGT will list the currently valid PIDs as: 123, 190, 237, 177, 295, and 221. At 17:00 EDT, table EIT-0 will become obsolete while the other ones will remain valid. At that time, the PID list can be changed to 190, 237, 177, 295, 221, maintaining the version number list as 4, 2, 7, 8, 15. Therefore, by simply shifting the listed PID values in the MGT, table EIT-1 can become EIT-0, table EIT-2 can become EIT-1, and so on.

However, it is also possible to regenerate one or several EITs at any time for correcting and/or updating the content (e.g. in cases where “to be assigned” events become known). Regeneration of EITs is flagged by updating version fields in the MGT. For example, if table EIT-2 needs to be updated at 16:17 EDT, then the new table must be transmitted with a version number equal to 3. Whenever the decoder monitoring the MGT detects a change in the version number of a table, it assumes that the table has changed and needs to be reloaded.

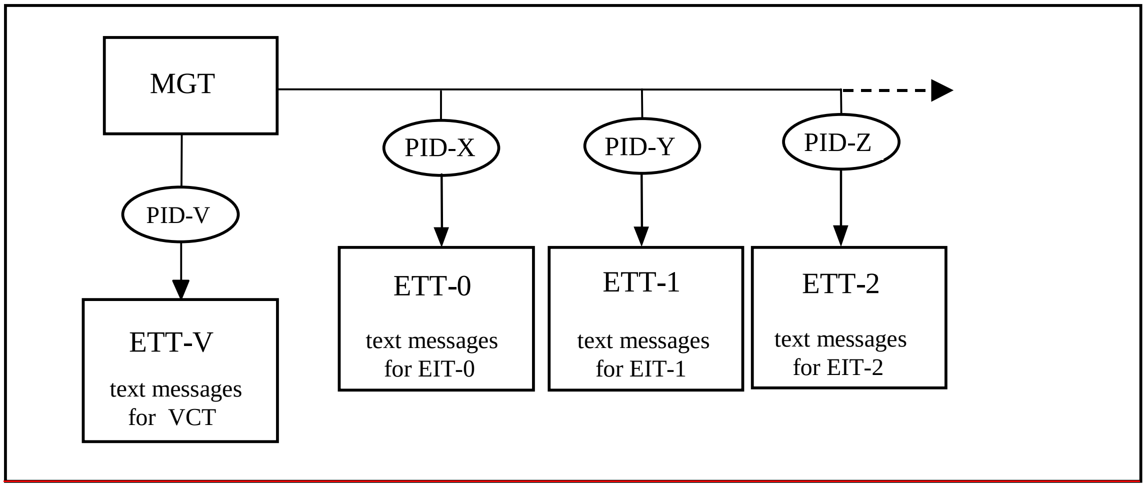


Figure D.2 Extended Text Tables in the PSIP Hierarchy.

As illustrated in Fig. D.2, there can be several Extended Text Tables (ETTs), each of them having its PID defined in the MGT. Each Event Information Table (EIT) can have one ETT. Similarly, the Virtual Channel Table can have one ETT. As its name indicates, the purpose of an Extended Text Table (ETT) is to carry text messages. For example, for channels in the VCT, the messages can describe channel information, cost, coming attractions, etc. Similarly, for an event such as a movie listed in the EIT, the typical message is a short paragraph that describes the movie itself. Extended Text Tables are optional.

In this final section paragraph we review once more the requirement list. The minimum amount of information required in an ATSC terrestrial digital Transport Stream is the VCT, the MGT, the RRT, the STT, and the first four EITs. All of the other elements are optional.

D3. APPLICATION EXAMPLE

For the purpose of this example, we assume that a broadcast group, here denominated NBZ, manages the frequency bands for RF channels 12 and 39. The first one is its analog channel whereas the second one will be used for digital broadcast. According to the premises established in this document, NBZ must carry the PSIP tables in the digital Transport Stream of RF channel 39. The tables must describe TV programs and other services provided on RF channel 39 but can also describe information for the analog RF channel 12.

Assume that NBZ operates in the Eastern time zone of the U.S., and that the current time is 15:30 EDT (19:30 UTC). NBZ decides to operate in minimal configuration, therefore only the first four EITs need to be transmitted. As explained previously, EIT-0 must carry event information for the time window between 14:00 and 17:00 EDT, whereas EIT-1 to EIT-3 will cover the subsequent 9 hours. For the first 6 hours, the following scenario applies:

Table D.2 The First 3-Hour Segment to be Described in VCT and EIT-0

		14:00-14:30	14:30 -15:00	15:00 - 15:30	15:30 - 16:00	16:00 - 16:30	16:30-17:00
PTC 12 (12-0)	NBZ	City Life	City Life	Travel Show	Travel Show	News	News
PTC 39 (12-1)	NBZ	City Life	City Life	Travel Show	Travel Show	News	News
PTC 39 (12-2)	NBZ	Soccer	Golf Report	Golf Report	Car Racing	Car Racing	Car Racing
PTC 39 (12-3)	NBZ	Secret Agent	Secret Agent	Lost Worlds	Lost Worlds	Lost Worlds	Lost Worlds
PTC 39 (12-4)	NBZ	Headlines	Headlines	Headlines	Headlines	Headlines	Headlines

Table D.3 The Second 3-Hour Segment to be Described in VCT and EIT-1

		17:00-17:30	17:30-18:00	18:00 - 18:30	18:30 - 19:00	19:00-19:30	19:30 - 20:00
PTC 12 (12-0)	NBZ	Music Today	NY Comedy	World View	World View	News	News
PTC 39 (12-1)	NBZ	Music Today	NY Comedy	World View	World View	News	News
PTC 39 (12-2)	NBZ	Car Racing	Car Racing	Sports News	Tennis Playoffs	Tennis Playoffs	Tennis Playoffs
PTC 39 (12-3)	NBZ	Preview	The Bandit	The Bandit	The Bandit	The Bandit	Preview
PTC 39 (12-4)	NBZ	Headlines	Headlines	Headlines	Headlines	Headlines	Headlines

Similar tables can be built for the next 6 hours (for EIT-2 and EIT-3). According to this scenario, NBZ broadcasts four regular digital channels (also called virtual channels and denoted by their major and minor channel numbers), one with the same program as the analog transmission, another for sports, and a third one for movies. The fourth one supports a service displaying headlines with text and images.

D3.1 The Master Guide Table (MGT)

The purpose of the MGT is to describe everything about the other tables, listing features such as version numbers, table sizes, and packet identifiers (PIDs). Fig. D.3 shows a typical Master Guide Table indicating, in this case, the existence in the Transport Stream of a Virtual Channel Table, the Rating Region Table, four EITs, one Extended Text Table for channels, and two Extended Text Tables for events.

The first entry of the MGT describes the version number and size of the Virtual Channel Table. The second entry corresponds to an instance of the Rating Region Table. If some region's policy makers decided to use more than one instance of an RRT, the MGT would list each PID, version number, and size. Notice that the base PID (0x1FFB) must be used for the VCT and the RRT instances as specified in PSIP.

The next entries in the MGT correspond to the first four EITs that must be supplied in the Transport Stream. The user is free to choose their PIDs as long as they are unique in the MGT list of PIDs. After the EITs, the MGT indicates the existence of an Extended Text Table for channels carried using PID 0x1AA0. Similarly, the last two entries in the MGT signal the existence of two Extended Text Tables, one for EIT-0 and the other for EIT-1.

MGT

table_type	**PID**	**version_num.**	**table size**
VCT	0x1FFB (base_PID)	4	485 bytes
RRT – USA	0x1FFB (base_PID)	1	560 bytes
EIT-0	0x1FD0	6	2730 bytes
EIT-1	0x1FD1	4	1342 bytes
EIT-2	0x1DD1	2	1224 bytes
EIT-3	0x1DB3	7	1382 bytes
ETT for VCT	0x1AA0	21	4232 bytes
ETT-0	0x1BA0	10	32420 bytes
ETT-1	0x1BA1	2	42734 bytes

Figure D.3 Content of the Master Guide Table

Descriptors can be added for each entry as well as for the entire MGT. By using descriptors, future improvements can be incorporated without modifying the basic structure of the MGT. The MGT is like a flag table that continuously informs the decoder about the status of all the other tables (except the STT which has an independent function). The MGT is continuously monitored at the receiver to prepare and anticipate changes in the channel/event structure. When tables are changed at the broadcast side, their version numbers are incremented and the new numbers are listed in the MGT. Based on the version updates and on the memory requirements, the decoder can reload the newly defined tables for proper operation.

D3.2 The Virtual Channel Table (VCT)

Figure D.4 shows the structure of the VCT which essentially contains the list of channels available in the Transport Stream. For convenience, it is possible to include analog channels and even other digital channels found in different Transport Streams.

The field number_of_channels_in_section indicates the number of channels described in one section of the VCT. In normal applications, as in the example being considered here, all channel information will fit into one section. However, there may be rare times when most of the physical channel is used to convey dozens of low-bandwidth services such as audio-only and data channels in addition to one video program. In those cases, the channel information may be larger than the VCT section limit of 1 Kbyte and therefore VCT segmentation will be required.

For example, assuming that a physical channel conveys 20 low-bandwidth services in addition to a TV program, and assuming that their VCT information exceeds 1 Kbyte, then two or more sections may be defined. The first section may describe 12 virtual channels and the second 9 if such a partition leads to VCT sections with less than 1 Kbyte.

A new VCT containing updated information can be transmitted at any time with the version_number increased by one. However, since a VCT describes only those channels from a particular Transport Stream, virtual channels added to the VCT at arbitrary times will not be detected by the receiver until it is tuned to that particular Transport Stream. For this reason, it is highly recommended that channel addition be made in advance to give the receivers the opportunity to scan the frequencies and detect the channel presence.

The fields major_channel_number and minor_channel_number are used for identification. The first one, the major channel number, is used to group all channels that are to be identified as belonging to a particular broadcast corporation (or particular identifying number such as 12 in this case). The minor channel number specifies a particular channel within the group.

The field short_name is a seven-character name for the channel and may allow text-based access and navigation. The fields transport_stream_id and program_number are included to link the VCT with the PAT and PMT. A sequence of flags follows these fields. The flags indicate: (1) if the channel is hidden (e.g. for NVOD applications), (2) if the channel has a long text message in the VCT-ETT, and (3) if the channel is visible in general or has some conditional access constraints.

After the flags, a description of the type of service offered is included, followed by the source_id. The source_id is simply an internal index for representing the particular logical channel. Event Information Tables and Extended Text Tables use this number to provide a list of associated events or text messages respectively.

VCT

current_next_indicator = 1
number_channels_in_section = 5

major num.	minor num.	short name	carrier freq. (MHz)	channel TSID	progr. num.	flags	service type	source id	descriptors
12	0	NBZ	205.25	0x0AA0	0x0AA0	--	analog	20	ch_name
12	1	NBZD	620.31	0x0AA1	0x00F1	--	digital	21	ch_name serv_locat.
12	5	NBZ-S	620.31	0x0AA1	0x00F2	--	digital	2	ch_name serv_locat.
12	12	NBZ-M	620.31	0x0AA1	0x00F3	--	digital	23	ch_name serv_locat.
12	31	NBZ-H	620.31	0x0AA1	0x00F8	--	digital	24	ch_name serv_locat.

Figure D.4 Content of the Virtual Channel Table

Two descriptors are associated with the logical channels in the example. The first one is extended_channel_name and, as its name indicates, it gives the full name of the channel. An example for channel NBZ-S could be: “NBZ Sports and Fitness”. The other one, the service_location descriptor, is used to list the available bit streams and their PIDs necessary to decode packets at the receiver. Assuming that NBZ-M offers bilingual transmission, then the following attributes are tabulated within its service_location descriptor:

PID_audio_1	AC-3 audio	English
PID_audio_2	AC-3 audio	Spanish
PID_video	MPEG-2 video	No lang.

Two VCTs may exist simultaneously in a Transport Stream: the current and the next VCT. The current VCT is recognized by having the flag current_next_indicator set to 1, while the next one has this flag set to 0. Although carrying the next VCT is optional, its use is recommended to give receivers advance notification of the new parameters that become operational during a VCT update.

Assume for example that a Transport Stream contains a VCT with a version number of 6 which has been operational for 20 hours. At 10:00 p.m., a football game using much more bandwidth will be broadcast, and for this reason, the number of available channels and

PIDs will be redefined. Around 9:30 p.m., simultaneous transmission of the next VCT can start with a version number of 7. By continuously monitoring the MGT, a receiver can be informed that a next VCT is available. The receiver may want to cache the new VCT for future use. The receiver continues monitoring the MGT and when this table signals a version change for the current VCT (from 6 to 7), then the cached information can be used.

When the VCT refers to an analog service type, the channel_TSID cannot refer to the identifier of a "Transport Stream" in the MPEG-2 sense. Analog NTSC broadcast signals can, however, carry a 16-bit unique identifier called a "Transmission Signal Identifier."[9] For the example VCT in Figure D.4, the Transmission Signal Identifier for channel 12.0 is 0x0AA0. A receiver can use the Transmission Signal ID given in the analog channel's channel_TSID field to verify that the NTSC signal received at the frequency given in the VCT is actually the desired signal. In the case that the Transmission Signal ID is not known or not available, the channel_TSID field may contain 0xFFFF to indicate "unknown."

It is recommended that the broadcaster insert into the VCT any major-minor channel that would be used to carry any program announced in the EIT. This means if no current program was using 7-7, and if a program 16 days from now was going to use 7-7, that 7-7 would be in the VCT. This would enable receivers to include the channel number in a program guide presented to the consumer. If a program is announced in the EIT and the source ID for that program is not found in the VCT, the receiver cannot determine which "channel" to display for that program.

Any channels in the VCT which are not currently active shall have the hidden attribute set to 1 and the hide_guide attribute set to 0.

The following table shows DTV behavior for the various combinations of the hidden and hide_guide attributes. In the table the “x” entry indicates “don’t care.” A check in the “surf” column indicates the channel is available by channel surfing and via direct channel number entry. A check in the “guide” column indicates that the channel may appear in the program guide listing.

Table D.4 Receiver Behavior with Hidden and Hide Guide Attributes

hidden	**hide_guide**	**Receiver Behavior**		**Description**
		Surf	Guide	
0	x	✔	✔	Normal channel
1	1			Special access only
1	0		✔	Inactive channel

[9] A method to include such a unique 16-bit “Transmission Signal ID” in the NTSC VBI is specified in the EIA-752 specification.

D3.3 The Event Information Tables (EITs)

The purpose of an EIT is to list all events for those channels that appear in the VCT for a given time window. As mentioned before, EIT-0 describes the events for the first 3 hours, EIT-1 for the next 3 hours, and so on. EIT-i and EIT-j have different PIDs as defined in the MGT. In PSIP, tables can have a multitude of instances. The different instances of a table share the same table_id value and PID but use different table_id_extension values.

In PSIP, an instance of EIT-k contains the list of events for a single virtual channel with a unique source_id. For this reason, the table_id_extension has been renamed as source_id in the EIT syntax. Figure D.5 shows, for example, the NBZ-S instance for EIT-0. Following similar procedures, the NBZD, NBZ-M, and NBZ-H instances of EIT-0 can be constructed. The process can be extended and repeated to obtain all of the instances for the other tables in the time sequence: EIT-1, EIT-2, etc.

The three events programmed for the 3-hour period for NBZ-S are listed in Figure D.5. The field event_id is a number used to identify each event. If an event time period extends over more than one EIT, the same event_id has to be used. The event_id is used to link events with their messages defined in the ETT, and therefore it has to be unique only within a virtual channel and a 3-hour interval defined by EITs. The event_id is followed by the start_time and then the length_in_seconds. Notice that events can have start times before the activation time (14:00 EDT in this example) of the table.. The ETM_location specifies the existence and the location of an Extended Text Message (ETM) for this event. ETMs are simply long textual descriptions. The collection of ETMs constitutes an Extended Text Table (ETT).

EIT-0
source_id = 22 (NBZ-S instance)

num_events_in_section = 3

event ID	local start time	Length (seconds)	ETM location	title	descriptors
51	12:30	7200	01	Soccer Live	content_advisory
52	14:30	3600	00	Golf Report	closed_caption
53	15:30	9000	01	Car Racing	content_advisory

Figure D.5 Content of EIT-0 for NBZ-S

An example of an ETM for the Car Racing event may be:

> "Live coverage from Indianapolis. This car race has become the largest single-day sporting event in the world. Two hundred laps of full action and speed."

Several descriptors can be associated with each event. One is the content advisory descriptor which assigns a rating value according to one or more systems. Recall that the actual rating system definitions are tabulated within the RRT. Another is a closed caption descriptor which signals the existence of closed captioning and lists the necessary parameters for decoding.

D3.4 The Rating Region Table (RRT)

The Rating Region Table is a fixed data structure in the sense that its content remains mostly unchanged. It defines the rating standard that is applicable for each region and/or country. The concept of table instance introduced in the previous Section is also used for the RRT. Several instances of the RRT can be constructed and carried in the Transport Stream simultaneously. Each instance is identified by a different table_id_extension value (which becomes the rating_region in the RRT syntax) and corresponds to one and only one particular region. Each instance has a different version number which is also carried in the MGT. This feature allows updating each instance separately.

Figure D.6 shows an example of one instance of an RRT, defined as the first rating region and carrying the MPAA standard rating system [Note that this is not the correct data for rating region 1, see EIA-766 for that data definition.] Changes in the content of the RRT must be defined and approved by the ATSC. Each event listed in any of the EITs may carry a content advisory descriptor. This descriptor is an index or pointer to one or more instances of the RRT.

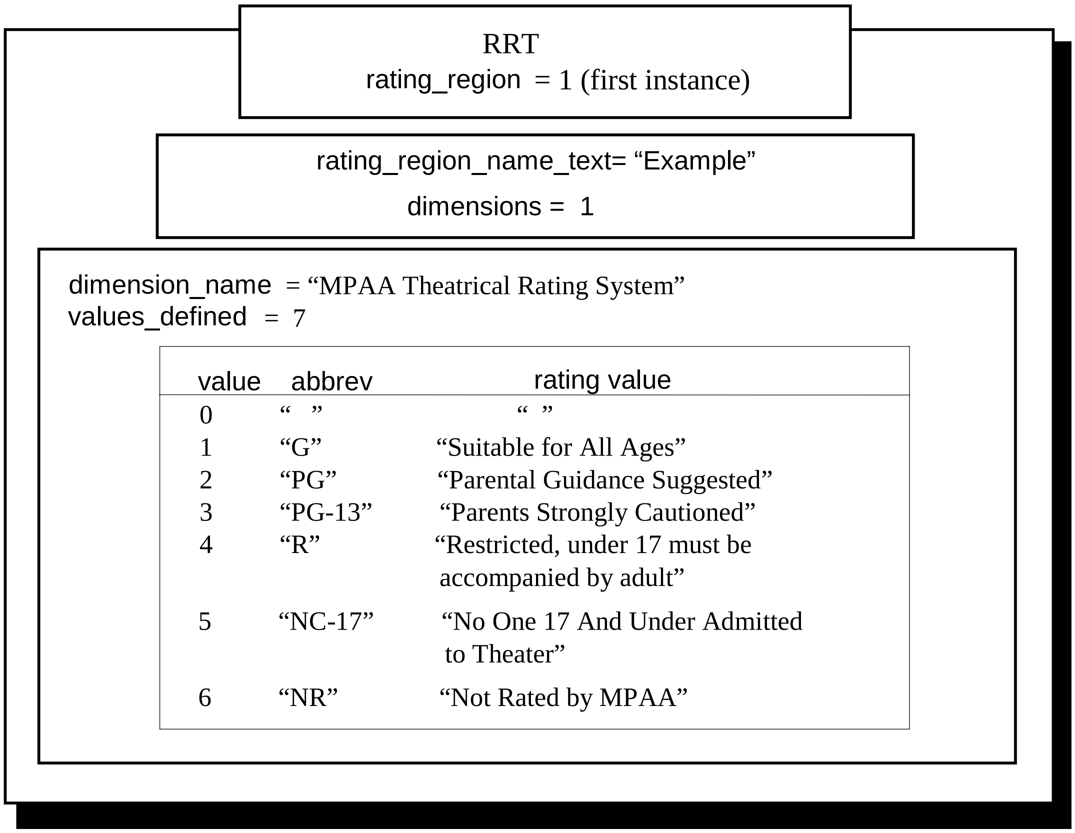


Figure D.6 An Instance of a Rating Region Table (RRT).

D4. PACKETIZATION AND TRANSPORT

In the previous sections, we have described how to construct the MGT, VCT, RRT, and EITs based on the typical scenario described in Tables D.1 and D.2. The number of virtual channels described in the VCT is 5 and therefore, each EIT will have 5 instances.

For the example, the size of the MGT is less than a hundred bytes and the VCT ranges between 300 to around 1500 bytes depending on the length of the text strings. Similarly, each EIT instance can have from 1 to about 3 Kbytes depending again on the text length.

Typically, the MGT, STT, VCT, and each instance of the RRT and EIT will have one or at most a few sections. For each table, the sections are appended one after the other, and then segmented into 184-byte packets. After adding the 4-byte MPEG-2 TS header, the packets are multiplexed with the others carrying audio, video, data, and any other components of the service. Figure D.7 illustrates this process.

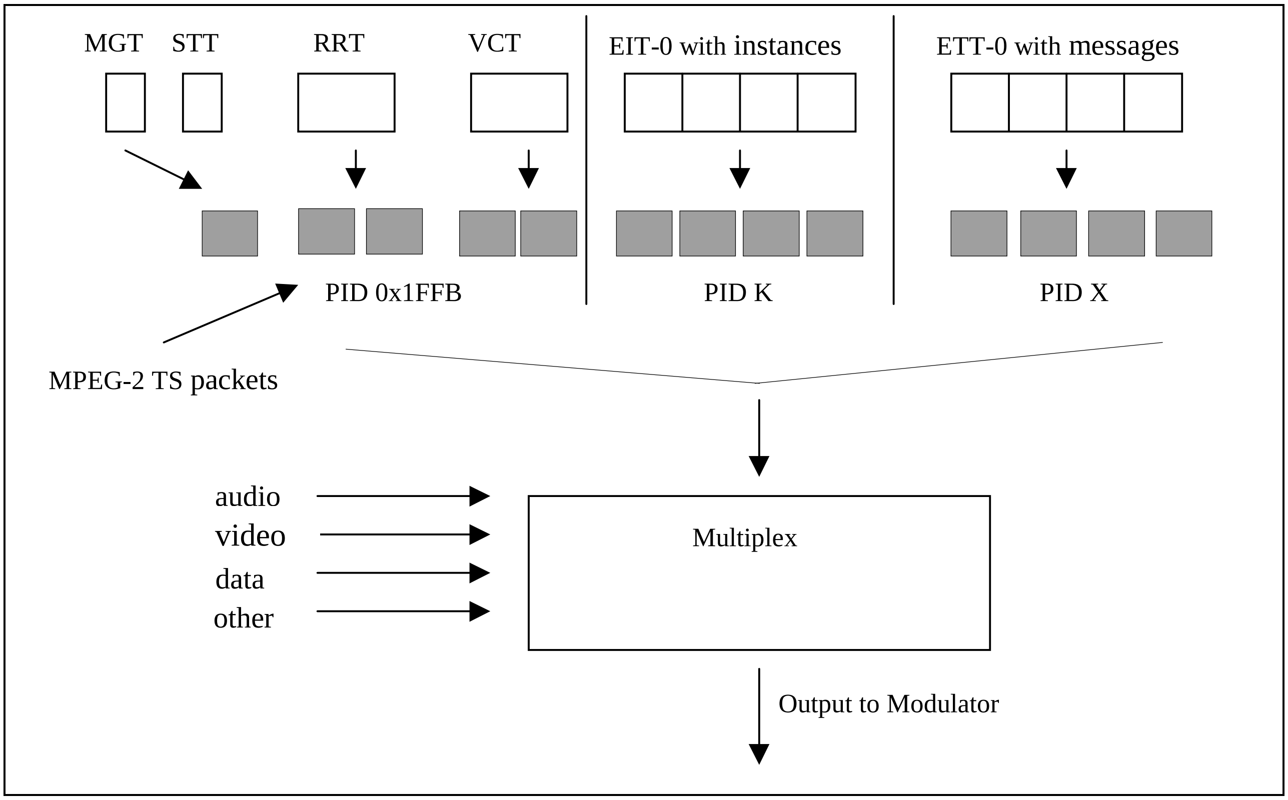


Figure D.7 Packetization and Transport of the PSIP tables

D5. TUNING OPERATIONS AND TABLE ACCESS

As described by the PSIP protocol, each Transport Stream will carry a set of tables describing system information and event description. For channel tuning, the first step is to collect the VCT from the Transport Stream which contains the current list of services available. Figure D.8 shows this process.

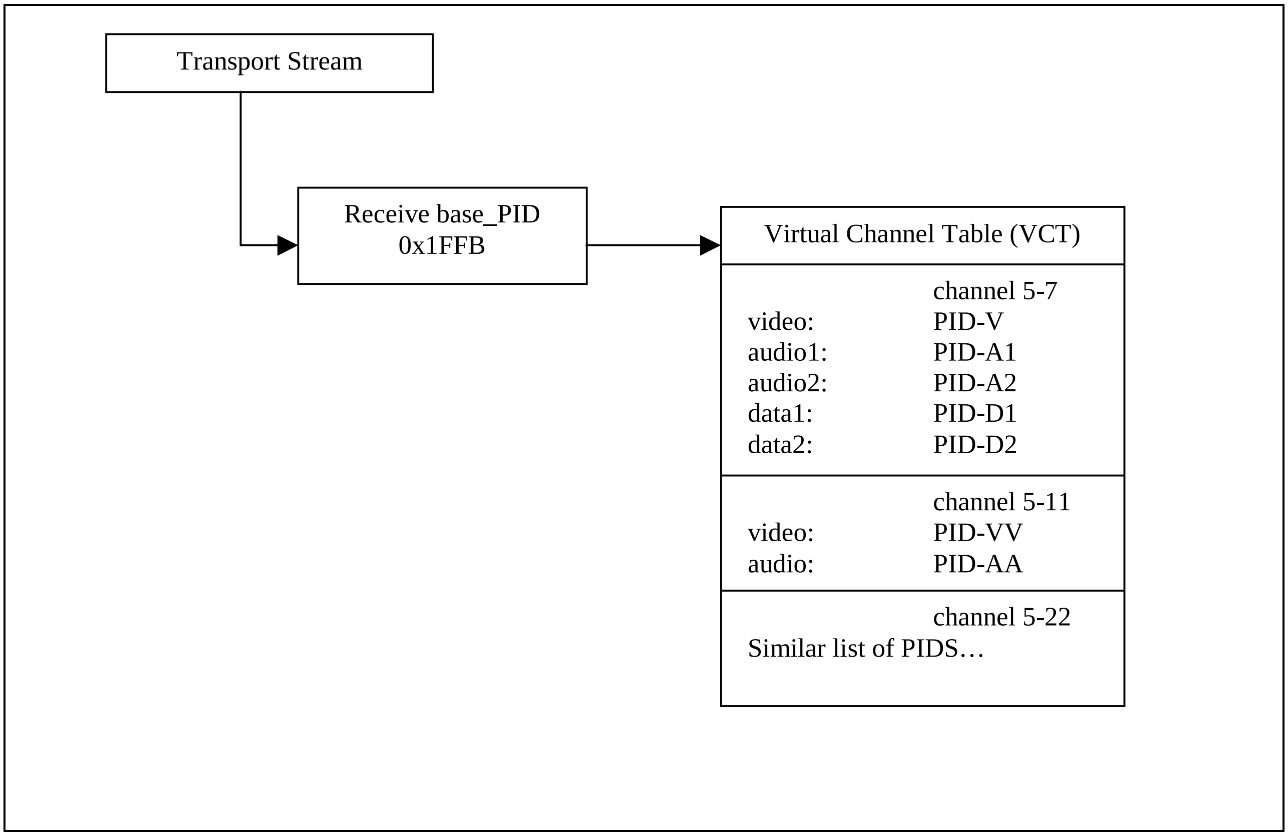


Figure D.8 Extraction of the VCT from the Transport Stream

Once the VCT has been collected, a user can tune to any virtual channel present in the Transport Stream by referring to the major and minor channel numbers. Assuming that in this case, the user selects channel 5 - 11, then the process for decoding the audio and video components is shown in Fig. D.9. For terrestrial broadcast, the existence of a service location descriptor in the VCT is mandatory and therefore there is no need to access the PAT or PMT for tuning to the principal television program services. This feature has been included in PSIP to minimize the time required for changing and tuning to channels. However, PAT and PMT information is required to be present in the Transport Stream to provide MPEG-2 compliance. Access to data or other supplemental services may require access to or monitoring of the PAT or PMT. Cable systems may choose not to carry the service location descriptor, and therefore the information contained therein (minus the language code) will be found in the PMT in some cable systems.

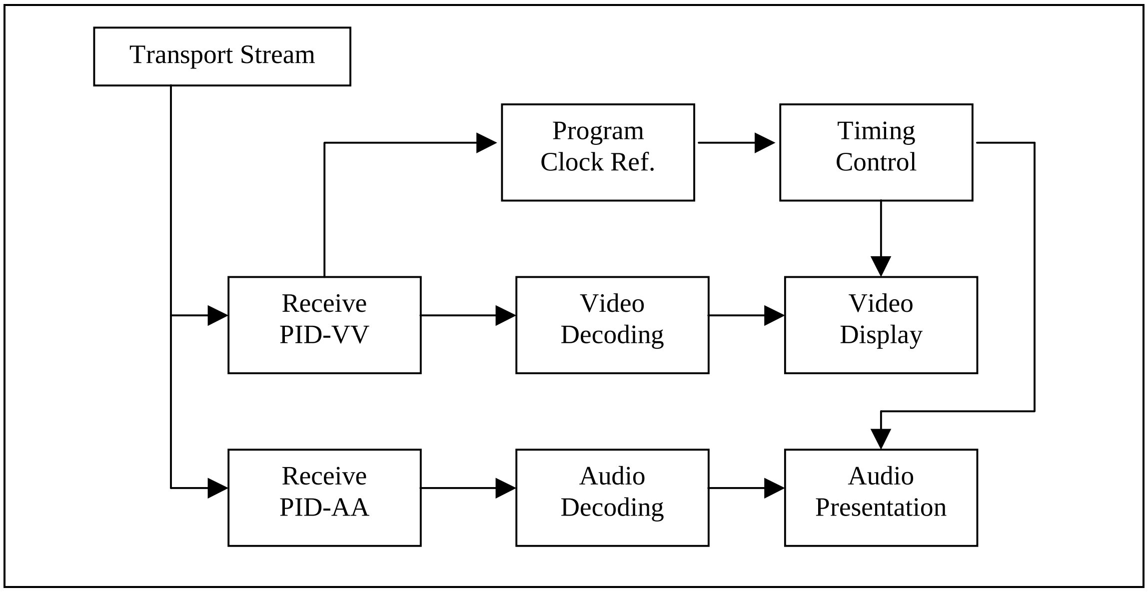


Figure D.9 Acquisition of Audiovisual Components

ANNEX E

(Informative)

TYPICAL SIZE OF PSIP TABLES

The typical sizes for the PSIP tables (STT, MGT, VCT, RRT, EIT and ETT) are calculated in this Section. The notation used here for the different equations is listed in the Table E.1.

Table E.1 Symbols

Symbol	Description
P	number of EITs (4 to 128)
C	number of virtual channels (analog and digital) per EIT
Cd	number of digital channels per EIT
E	number of events per virtual channel
R	number of rating regions
D	average number of rating dimensions per rating region
L	average number of rating values per rating dimension

E1. SYSTEM TIME TABLE (STT)

The typical size for the STT is 20 bytes, with the assumption of having no descriptors.

E2. MASTER GUIDE TABLE (MGT)

The typical size for the MGT (in bytes), based on the assumptions listed in the column "Assumption", is shown in Table E.2

Table E.2 Typical Size (bytes) of MGT

Part	Size (bytes)	Assumption
PSI header and trailer	12	
message body	38+22*P	1. With one Terrestrial VCT, one channel ETT, one RRT instance, P EITs and P event ETTs 2. No descriptors
Total	50+22*P	

E3. TERRESTRIAL VIRTUAL CHANNEL TABLE (TVCT)

The typical size of the TVCT (bytes), based on the assumptions listed in the column labeled "Assumption" is shown in Table E.3.

Table E.3 Typical TVCT Size (bytes)

Part	Size (bytes)	Assumption
PSI header and trailer	12	1. All TVCT messages are carried in one section.
message body	4+32*C	
extended channel name descriptor	20*C	2. One string and one segment per string for long channel name text. 3. Long channel name text is compressed by Huffman coding with a standard table, and the text length after compression is 10 bytes
service location descriptor	23*Cd	4. Three elementary streams per virtual channel for digital channels.
Total	16+52*C+23*Cd	

E4. RATING REGION TABLE (RRT)

The typical size (in bytes per rating region) of the RRT, based on the assumptions listed in the column "Assumption", is shown in Table E.4.

Table E.4 Typical Size (in bytes per rating region) of RRT

Part	Size (bytes per rating region)	Assumption
PSI header and trailer	12	1. One section only.
message body	25+D*(14+ 26*L)	2. One string and one segment per string for all text. 3. Rating region name text is compressed by Huffman coding with a standard table, and the size after compression is 12 bytes. 4. Dimension name text is compressed by Huffman coding with a standard table, and the size after compression is 4 bytes. 5. Abbreviated rating value text is compressed by Huffman coding with a standard table, and the size after compression is 2 bytes. 6. Rating value text is compressed by Huffman coding with a standard table, and the size after compression is 6 bytes. 7. No descriptors.
Total	37+D*(14+26*L)	

E5. EVENT INFORMATION TABLE (EIT)

The typical size of the EIT (in bytes per virtual channel per EIT), based on the assumptions listed in the column "Assumption", is shown in Table E.5.

Table E.5 Typical Size (bytes per virtual channel per EIT) of EIT

Part	Size (bytes per virtual channel per EIT)	Assumption
PSI header and trailer	12	1. One section only
message body	2+30*E	2. One string and one segment per string for title text. 3. Title text is compressed by Huffman coding with a standard table, and the size after compression is 10 bytes. 4. No AC-3 and service location descriptors.
closed captioning service descriptor	9*E	5. number_of_services = 1.
content advisory descriptor	(3+R*(3+2*D))*E	6. No rating_description_text.
Total	14+(42+R*(3+2*D))*E	

E6. EXTENDED TEXT TABLE (ETT)

The typical size for the ETT (in bytes per virtual channel per EIT, or bytes per event per EIT), based on the assumptions listed in the column labeled "Assumptions", is shown in Table E.6.

Table E.6 Typical Size (bytes per virtual channel or bytes per event) of ETT

Part	Size (bytes per virtual channel per EIT, or bytes per event per EIT)	Assumptions
PSI header and trailer	12	
message body	508	1. A virtual channel or an event can have one text string and one segment per string for the extended text message. 2. Extended text message is compressed by Huffman coding with a standard table, and the size after compression is 500 bytes.
Total	520	

E7. AN EXAMPLE FOR TERRESTRIAL BROADCAST

Suppose that a TV provider is in charge of two physical transmission channels, one for analog and the other for digital services. Assume that the digital Transport Stream carries five virtual channels, each with 6 events in EIT-0, EIT-1, EIT-2 and EIT-3. For each virtual channel and each event an extended text message is available.

Regarding the Rating Region Table, suppose that a single rating region is defined with six dimensions and five values per dimension. Based on these assumptions, typical sizes for every PSIP table can be calculated. The results are listed in Table E.7 and Table E.8.

Table E.7 Typical Sizes of PSIP tables (except ETT) for the Example

Part	Size in bytes (excluding Transport Stream packet header)	Size in Transport Stream packets
STT	20	1
MGT	138	1
TVCT	443	3
RRT	901	5
Subtotal for tables identified by the base_PID	**1502**	**10**
EIT-0	2136	12
EIT-1	2136	12
EIT-2	2136	12
EIT-3	2136	12
Total	**10046**	**58**

Table E.8 Typical Sizes of ETTs for the Example

Part	Size in bytes (excluding Transport Stream packet header)	Size in Transport Stream packets
Channel ETT	3120	17
Event ETT-0	18720	102
Event ETT-1	18720	102
Event ETT-2	18720	102
Event ETT-3	18720	102
Total	**78000**	**425**

ANNEX F

(Informative)

AN OVERVIEW OF HUFFMAN-BASED TEXT COMPRESSION

This section describes the Huffman-based text compression and coding methods supported in the Program and System Information Protocol. In particular, this section:

- Describes the partial first-order Huffman coding used to compress PSIP text data.
- Provides background description of finite-context Huffman coding. The mechanisms for generating and parsing Huffman codes are described.
- Describes the decode tree data structure.
- Defines the character set supported by this Standard.

F1. DATA COMPRESSION OVERVIEW

Program and System Information data may use partial first-order Huffman encoding to compress English-language text. The Huffman-table based approach has the following features:

- A typical firmware-resident Huffman decode table requires less than 2K of storage.
- The encode and decode algorithms are relatively simple and fast.
- Since first-order Huffman codes are significantly influenced by language phonetics, codes produced from a sample of current program titles produce reasonable compression ratios for future program titles, even though the future program titles may be significantly different from current titles. Therefore, hard-coded tables stored in receiver non-volatile memory are helpful.

The data compression approach has the following implementation characteristics:

- Program descriptions and program titles may use different Huffman codes. Titles and descriptions have significantly different text characteristics; for example, program titles usually have an upper-case character following a space character, whereas program descriptions usually have a lower-case character following a space-character.
- Hard-coded decode tables, one optimized for titles and one for descriptions, must reside in the receiver’s non-volatile memory.

F2. OVERVIEW OF CONTEXT-SENSITIVE HUFFMAN CODING

F2.1 Overview

Each and every character does not occur with the same frequency in program titles and program descriptions. For example, the character "e" occurs more often than the character "x." With Huffman coding, the number of bits used to represent a character is inversely proportional to the character's usage frequency.

The Huffman coding compression ratio depends upon the statistical distribution of the characters being compressed. When character usage is uniformly distributed, no compression is achieved with Huffman coding. To achieve satisfactory compression, the Huffman codes are generated using statistics that match the data being compressed. For example, Huffman codes generated from Pascal computer programs would be less than ideal for compressing C programs. For text strings in the PSIP, program descriptions and program titles may be compressed with different sets of Huffman codes

Context-sensitive Huffman coding recognizes that a character's usage statistics are context dependent. For example, the character "u" has a high probability of occurrence after the character "q". The "order" of the Huffman code defines the "look-back" context by which a character is coded. With order-0, each character is coded independently of the previous character. With order-1, the Huffman code used to represent a given character depends upon the previous character. In zero-order Huffman compression, the occurrence probability of the alphabet elements is used to develop an optimal encoding tree. In first-order Huffman, the conditional probability of a character, given that the previous character is known, is used as the basis of a decoding tree. For this reason, while zero-order Huffman has typically a single tree, first-order Huffman has many, one for each character.

Huffman compression involves the following steps:

- Determine the statistical distribution of the characters or symbols in the source data.
- Create Huffman codes from this statistical information.
- Encode the source data: Translate each character into its corresponding Huffman code.

To decompress the coded data, the data string is parsed bit-by-bit and translated to the original characters. To do this, the decompressor must have the correct decode table, which maps the Huffman codes to their corresponding characters. The following example illustrates the generation and decoding of Huffman codes.

F2.2 Example

Huffman codes are mapped to their corresponding characters using a binary tree structure. The leaves of this tree are the alphabet elements to be coded. The tree is produced by recursively summing the two nodes in the tree with the lowest usage frequency. For the following example, assume that an alphabet contains the following twelve characters which occur a certain number of times in the sample database:

Table F.1 Example Character Set and Frequency of Character Occurrence

Character	Occurrence Number
'a'	144
'b'	66
'c'	30
'd'	30
'e'	18
'f'	12
'g'	6
'h'	1
'i'	1
'j'	1
ESC	arbitrary

The "escape" character is inserted into the table to handle input characters which rarely occur, and have no corresponding Huffman codes. In this example, no Huffman codes will be generated for the characters 'h', 'i', and 'j'. Instead, their frequencies will be summed into the ESC character. Whenever one of these characters occur in the input stream, the encoder inserts the ESC Huffman code, then inserts the original ASCII value for that character.

Figure F.1 shows the construction of the Huffman tree from the character frequencies. The two nodes with the lowest frequencies, ('ESC' and 'g'), are joined together, with a resulting node weight of (9). The next two lowest nodes, ('f' and the intermediate node), are then joined together, with the combined weight of (21). This process continues until the tree's root node is formed. Once the tree is completed, the bit (1) is assigned to all right-hand branches, and the bit (0) is assigned to all left-hand branches.

Decoding a Huffman string is straight-forward. Starting at the Huffman tree root, the decoder parses the string, bit by bit, until it reaches a leaf node. The leaf node is the decoded character. The decoder then moves back to the root of the Huffman tree to continue decoding the bit string. For example, the input string 10111011100010 would be decoded into 'beeaab'.

This example uses order-0 Huffman codes. With order-1, each character in the alphabet has an associated tree of Huffman codes for possible succeeding characters. The ESC character would be inserted into each of these order-1 tables to handle statistically unlikely character pairs.

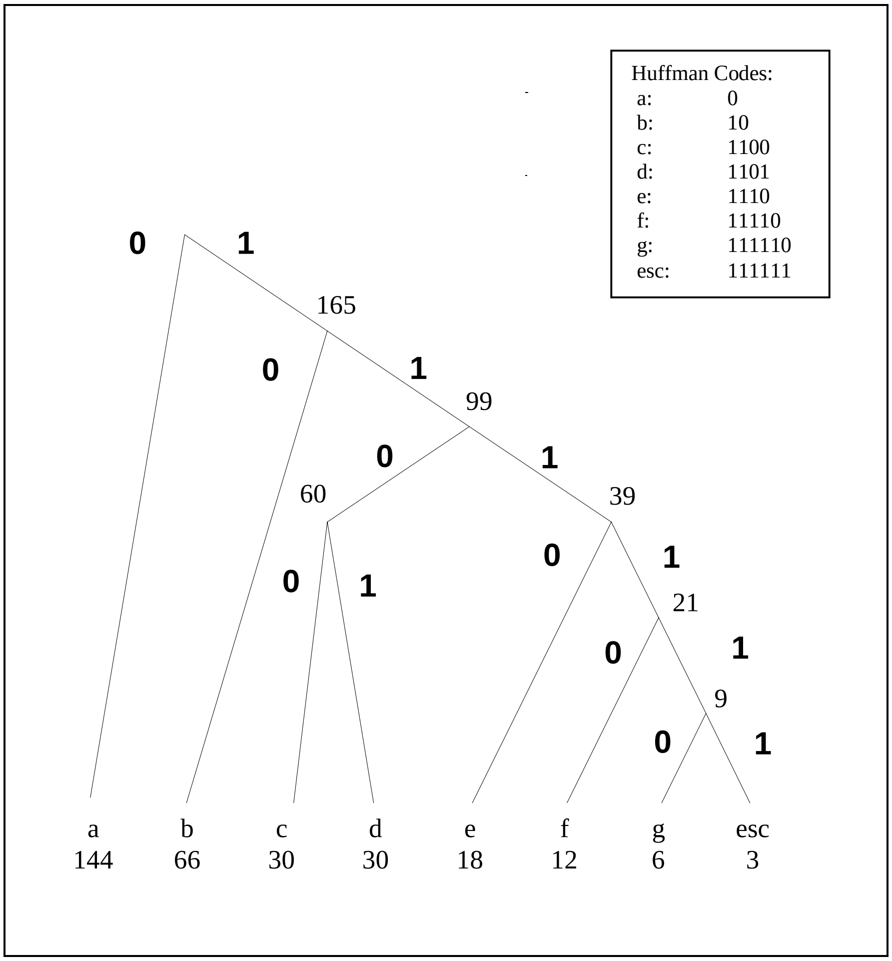


Figure F.1 Example Huffman Tree

F2.3 Decode Tree Example

Actual implementations of Huffman decoders need to map the trees into a suitable data structure that can be used by a computer or processor to traverse the tree top-down. In Annex C, a possible method for representing the trees was described and explicitly defined. Such a method is used here to build the decoding tree data for the example given in Figure F.1. Although an order-0 tree, this table is representative of order-1 decode trees, except that the bytes of each order-1 tree start at a byte location specified by the corresponding tree root offset (rather than starting at location 0).

Table F.2 Decode Tree Example

Byte #	Left/Right Child Word Offset or Character Leaf	
0 (tree root)	225	(ASCII "a" + 128)
1	1	(word offset of right child)
2 (tree node)	226	(ASCII "b" + 128)
3	2	(word offset of right child)
4 (tree node)	3	(word offset of left child)
5	4	(word offset of right child)
6 (tree node)	227	(ASCII "c" + 128)
7	228	(ASCII "d" + 128)
8 (tree node)	229	(ASCII "e" + 128)
9	5	(word offset of right child)
10 (tree node)	230	(ASCII "f" + 128)
11	6	(word offset of right child)
12 (tree node)	231	(ASCII "g" + 128)
13	155	(ASCII "ESC" + 128)

F2.4 Encoding/Character Decoding Examples with 1st-order Huffman tables

As an example of using the Huffman table defined in Table C.4 in Annex C, here we show the procedure to encode and decode the string “The next” using the tables optimized for titles. The coding sequence that generates the bit stream for “The next” is described in Figure F.2.

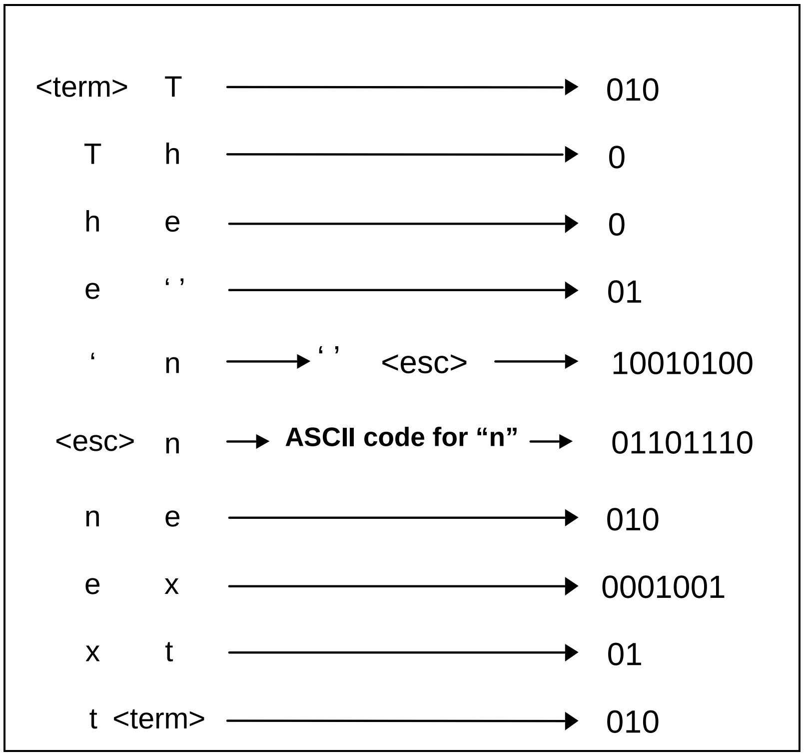


Figure F.2 Coding Example for the String “The next”

The first character ‘T’ is encoded assuming that the previous one was a *terminate* character. The second letter ‘h’ is encoded based on the Huffman tree corresponding to the prior symbol ‘T.’ The sequence proceeds as shown in the Figure. The combination blank-space followed by an ‘n’ is not listed in the tree, thus the escape character is used to switch the coding process to uncompressed mode. Once in this mode, the ‘n’ is encoded using its standard 8-bit ISO Latin-1 value. After the ‘n’, an ‘e’ is encoded using the appropriate n-tree and the algorithm continues until reaching the final letter followed by a string-terminate character. Uncompressed transmission of this string requires 9 bytes, while after compression, only 39 bits, equivalent to 5 bytes, are needed.

Decoding requires traversing the different trees top-down. As an example, Figure F.3 shows the tree when the prior character is ‘x’. From our example, after decoding the letter ‘x’, the remaining bit sequence is ‘01010’. Traversing the x-tree top-down using this sequence shows that ‘01’ corresponds to ‘t’, a newly decoded character. The process now jumps to the t-tree and so on, to decode the remaining bits until the terminate code results. Notice that the trees can be obtained by examining the encoding tables or by following the semantics of the provided decoding tables.

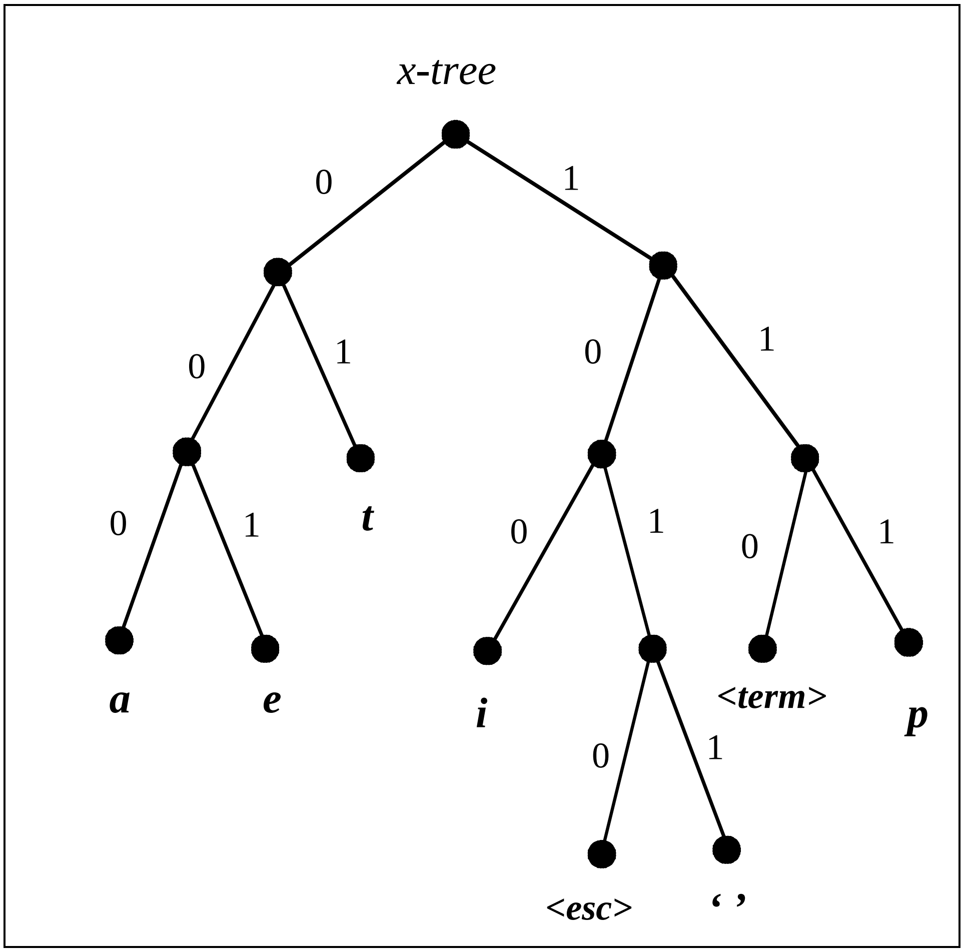


Figure F.3 Huffman Tree for Prior Symbol “x”

ANNEX G

(Informative)

AN OVERVIEW OF PSIP FOR CABLE

As described in this standard, certain data specified in the Program and System Information Protocol (PSIP) forms a mandatory part of every ATSC-compliant digital multiplex signal delivered via terrestrial broadcast. Annex D provides an overview of the use of PSIP for the terrestrial broadcast application. This Annex supplements that discussion, focusing on the use of PSIP for digital cable.

G1. INTRODUCTION

PSIP was designed, as much as possible, to be independent of the physical system used to deliver the MPEG-2 multiplex. Therefore, the System Time Table, Master Guide Table, Virtual Channel Table (VCT), and Event Information Tables and Extended Text Tables are generally applicable equally as well to cable as to terrestrial broadcast delivery methods. The differences can be summarized as follows:

- For cable, the Cable Virtual Channel Table (CVCT) provides the VCT function, while the Terrestrial Virtual Channel Table (TVCT) applies for terrestrial broadcast. The cable VCT includes two parameters not applicable to the terrestrial broadcast case, and the syntax of several parameters in the table is slightly different for cable as compared to the terrestrial broadcast case. The specifics are discussed in Section G2.
- Use of the program guide portion of PSIP (EIT and ETT) for cable is considered optional, while it is mandatory when PSIP is used for terrestrial broadcasting. Cable operators are free to *not* provide any program guide data at all if they so choose, or provide the data in a format other than PSIP if they do support an EPG.

G2. COMPARING CVCT AND TVCT

While the syntax of the Cable and Terrestrial VCTs are nearly identical, the Cable VCT has two parameters not present in the Terrestrial VCT: a “path select” bit, and a bit that can indicate that a given virtual channel is transported out-of-band (OOB). Also, the semantics of the major and minor channel number fields and the source_id differ for the Cable VCT as compared with its terrestrial broadcast counterpart.

G2.1. Path Select

Use of the path select is required when PSIP is used in a cable network in which two separate physical cables are present. In such a case, the value of the path_select bit indicates whether the receiver should select the cable connected to its primary port (“path 1”) or the secondary cable (“path 2”).

G2.2 Out of Band

When a cable virtual channel is flagged as being "out of band," it is carried on an out-of-band channel at the given carrier_frequency. In general, out of band channels are delivered using different transmission formats (symbol rates, etc.) than the regular multiplexes. More than one standard format exists. A typical cable-ready digital TV or VCR will not process OOB data, unless perhaps it is in the context of an access control function such as monitoring an EMM stream.

If a receiver is implemented with a dedicated OOB tuner, it can select and process the OOB multiplex if a user chooses a virtual channel flagged as out_of_band. Receivers not capable of receiving or processing data on out-of-band carriers may use the out_of_band flag as a way to skip or ignore them.

G2.3 Major and Minor Channel Numbers

When PSIP is used for terrestrial broadcast, care must be taken in the assignment of major and minor channel numbers to avoid conflicts. For example, the PSIP standard indicates that for the US and its possessions, a terrestrial broadcaster with an existing NTSC license shall use a major channel number for digital services that corresponds to the NTSC RF channel number in present use for the analog signal. For cable, such restrictions are technically unnecessary. The use or potential re-assignment of a broadcaster's major channel number is beyond the scope of this standard. For terrestrial broadcast, the major channel number is limited to the range 1 to 99 for ATSC digital television or audio services. For cable, major channel numbers may range from 1 to 999.

For minor channel numbers, broadcasters specify that zero shall be used for NTSC analog television services, 1 to 99 for ATSC digital television or audio only services, or 1 to 999 for data services. Minor channel numbers for cable, on the other hand, have no restrictions on use: they can range from 0 to 999 for any type of service.

G2.4 Source Ids

The source_id parameter is defined identically between cable and terrestrial broadcast VCTs, except that for the cable case, value 0x0000 indicates that the programming source is not identified. Value zero is therefore valid for cable but is reserved (not presently defined) for terrestrial broadcast.

A source ID with value zero is useful for cases where a cable operator wishes to define a channel for which no EPG data is currently available. It would also be useful to an operator who wishes not to supply EPG data at all.

G3. IN-BAND VERSUS OUT-OF-BAND SYSTEM INFORMATION

Cable operators often make use of one or more out-of-band (OOB) control channels. OOB control gives the operator nearly guaranteed access to each set-top box deployed in a cable network, because a dedicated tuner in each set-top remains tuned to the OOB channel independent of where the user might choose to tune the frequency-agile tuner while accessing various services.

Without an OOB channel, the cable operator either wouldn't be able to supply a uninterrupted stream of control messages to each set-top, or would be forced to carry (redundantly) the same control stream on each analog and digital signal. Duplicating the control stream this way is costly and wasteful of bandwidth. Analog channels in the network pose a problem because there isn't a convenient way to add a channel for control data to each NTSC signal.

PSIP data on cable is provided in-band so that cable-ready consumer electronic equipment can receive navigation data without having to process an OOB channel. Some custom, cable system-specific receiving devices may supplement the PSIP data by making use of other data, provided that the delivery of such data does not conflict with any requirements of the PSIP specification.

G4. USING PSIP ON CABLE

PSIP data carried on cable in-band is analogous to PSIP included in the terrestrial digital broadcast multiplex: a receiver can discover the structure of digital services carried on that multiplex by collecting the current VCT from it. A cable-ready digital TV can visit each digital signal on the cable, in sequence, and record from each a portion of the full cable VCT. This is exactly the same process a terrestrial digital broadcast receiver performs to build the terrestrial channel map.

G4.1 Terrestrial Virtual Channel Maps on Cable

If a cable operator chooses to deploy digital cable boxes in a cable network, to properly support the cable terminals, that network will need to conform to the transmission and transport standards defined through the Society of Cable Telecommunications Engineers (SCTE). In some instances, however, a small cable operator may offer a cable service in which no cable boxes are required. That operator may wish to implement a low-cost headend where off-air terrestrial broadcasts are simply received and placed onto the cable, as is done with a community antenna scheme such as SMATV. In some cases, signals may be shifted in frequency before being placed on the cable (such as to move a UHF frequency down to the VHF range).

In cases such as these, a receiver may encounter a Terrestrial Virtual Channel Table when acquiring a Transport Stream from the 75Ω cable port on the receiver. Although that TS does not comply with SCTE standards for digital cable, cable-ready receivers should nonetheless be designed to handle the case where a Terrestrial VCT is found where a Cable VCT is expected.

G4.2 Frequency Specification in the Cable VCT

The Cable VCT specifies the frequency that the digital Transport Stream or analog NTSC picture carrier associated with a particular virtual channel is to be found. The frequency specified in the CVCT may be incorrect, however, and receivers should be designed to accommodate this inconsistency.

As mentioned, one way in which this can occur when a small cable system or SMATV operator shifts the frequency of an analog or digital signal without correcting the PSIP data. Another way in which it can occur is if a cable operator takes an off-air broadcast signal and does not edit the PSIP data when it is modulated for cable.

Receiving equipment should be designed to minimize reliance on the accuracy of the frequencies quoted in the VCT. The recommended approach involves use of a digital signal's Transport Stream ID (TSID) and an analog NTSC signal's Transmission Signal ID (we call this the analog TSID). The FCC is expected to assign each broadcast station operator in the US two unique TSID values, one for analog and one for digital transmission. The digital TSID is defined by the MPEG-2 *Systems* specification, ISO/IEC 13818-1. The analog TSID is defined in EIA-752, and is simply a 16-bit signal identifier that is carried in an Extended Data Service packet according to the EIA-608 *Recommended Practice for Line-21 Data Service* standard.

Upon initial setup by an installer or consumer, a receiver should perform an automatic scan of all frequencies where analog or digital signals may be found.[10] The frequencies used for the scan correspond to standard frequency plans for off-air broadcast or cable, as appropriate. When a signal is found at a given frequency, the receiver should take note of the analog or digital TSID. Although not all analog signals are required to include TSIDs, all digital transport streams are required to carry the unique TSID.

Now, when asked to acquire a specific service, instead of using the frequency quoted by the VCT for that service, the receiver can instead use the frequency upon which it was last found. The only case in which this approach fails is if an analog TSID is not available—in such a case, the receiver must rely on the frequency quoted in the VCT.

The data in the modulation field may also be in error unless the cable system modifies it. The SCTE has standardized two modulation modes for cable television transmission of digital television. The terrestrial broadcast PSIP shall indicate ATSC 8-VSB modulation for over-the-air transmission of digital television. Any receiver that does not have access to an out-of-band data stream indicating the modulation modes of the various carriers on the network will need to be designed to acquire any of the modes that may be present. In the US, 64-QAM, 256-QAM, 8-VSB or 16-VSB modulation may be encountered.

G4.3 Service Location on Cable

The service_location_descriptor() indicates the stream types, PID and language code for each elementary stream that comprises a virtual channel. As mentioned, one of the differences between the terrestrial and cable is that the service_location_descriptor() is not required in the Cable VCT, even though its use is mandatory for the Terrestrial VCT. The difference arises from the fact that cable operators may re-multiplex digital Transport Steams that are available to them, adding or deleting services as necessary to create cable Transport Streams. A motivation for re-multiplexing is that the data rate for information on cable is typically higher than that available from terrestrial broadcast transmissions, and a cable operator may wish to construct multiplexes that make full use of the channel capacity.

For cable, the receiver or set-top box needs to learn the structure of each service via the PMT which contains the same information as the service_location_descriptor() [except for the

[10] It is strongly recommended that such a scan is done also when the receiver is in the "off" state to refresh VCT and program guide data.

language code]. ATSC multiplexes are MPEG-2 compliant, and the presence of the PMT is mandatory.

A typical cable receiver or set-top box may implement a scheme where the last-used PID values for audio and video streams are stored with each VCT record. Initial acquisition of a virtual channel may be slower by as much as 400 milliseconds (the maximum interval between repetitions of the PMT) since the PMT will need to be processed to learn the PID values, but subsequent acquisitions can avoid this delay. However, one step in the acquisition process should always be to check the current PMT to verify that the PID values have not changed since the last acquisition of the service. If they have changed, the new values replace the old.

G4.4 Analog Channel Sharing

Some cable operators time-share certain 6-MHz slots between two analog television services, switching from one to the other on a daily schedule. If PSIP were to be used (out of band) to describe such a shared analog channel, two approaches are possible:

1. Define the channel as a single entity, using one source ID. The channel name may be a combination of the two service names, such as “WXYZ/USTV” for example. Or it could be a neutral name such as “Combo.” Since the channel is defined as a single entity in PSIP, it appears as one horizontal grid line on the EPG display.
2. Define the channel using two source IDs, one for the first source and another for the second. Using PSIP it would be possible to assign each source a separate channel name. Both would be assigned the same channel number and frequency, corresponding to the channel’s EIA RF 6-MHz band on the cable. Use of the RF channel number is necessary for consistency between DTV receivers using PSIP and analog receivers that tune and number using the conventional analog method. On the EPG grid, each of the services are expected to show “Off the air” (or equivalent) during the part of the broadcast day when the transmission channel is being used for the other source.

The second case represents an unusual situation for the DTV, in that two services share the exact same channel number. If the user selects such a doubly-defined channel by direct entry of the number, the frequency is unambiguous so the DTV can tune straightforwardly. If the DTV would wish to display the proper channel name or program name, it must rely on the analog TSID to properly identify the received signal.

In both of these cases, it is the responsibility of the cable headend to perform source switching as necessary to create the composite channel.

G5. RE-MULTIPLEXING ISSUES

As mentioned, a cable operator may wish to take incoming digital Transport Streams from various sources (terrestrial broadcast, satellite, or locally generated), add or delete services or elementary streams, and then re-combine them into output Transport Streams. If the incoming Transport Streams carry PSIP data, care must be taken to properly process this data in the re-multiplexer.

Specifically, the re-multiplexer needs to account for any MPEG or PSIP fields or variables that are scoped to be unique within the Transport Stream. Such fields include PID values, MPEG program_numbers, source_id tags that are in the range 0x0001 through 0x0FFF and event_id fields.

Other PSI and PSIP-related tasks that need to be performed include:

- Construct an output Virtual Channel Table represents the virtual channels that will be included in the resulting Transport Stream.
- Combine EIT and ETT data from the various sources and remove data for any deleted services. (Rules for deleting services are beyond the scope of this standard.)
- The output Rating Region Table includes all regions that the cable operator is either required to support or chooses to support.
- Rebuild the Master Guide Table to represent the resulting PSIP tables.
- The service_location_descriptors present in incoming Terrestrial Virtual Channel Tables may be deleted, and if so should be reconstructed to identify all the services in the Cable Virtual Channel Table for a new transport stream.
- Edit the MPEG-2 Program Map Table to accurately reflect the Transport Stream PID values for all elementary streams in each service.

The special case of remultiplexing without adding or dropping content in the transport stream does not require PSIP modification, although some modification could reduce frequency information inconsistencies.

G6. THE TRANSITION TO PSIP ON CABLE

The first digital cable boxes to employ MPEG-2 transport and video coding were deployed in North America beginning in 1996. This PSIP standard was developed and approved by the ATSC in 1997. In 1998, the use of PSIP on cable was balloted and approved by the Digital Video Subcommittee of SCTE.

Cable systems supporting the first digital cable terminals provide an out-of-band control channel for system control and addressing of these boxes. System Information in accordance with ATSC A/56 *System Information for Digital Television*, as extended by the SCTE DVS-011 *Cable and Satellite Extensions to ATSC System Information Standard* provides navigational information such as the cable frequency plan in use, the channel line-up, and channel names and numbers. The A/56 standard used the same virtual channel map approach that PSIP uses.

Cable operators wishing to support cable-ready CE equipment in their network would need to begin sending PSIP data in-band for each digital transport multiplex. PSIP support involves supplying transport stream packets with PID value 0x1FFB. Legacy digital terminals are unaffected by the presence of these new packets, because they have no reason to process data from PID 0x1FFB. Both the PSIP and the A/56 SI data can co-exist in the same system with neither affecting the other.

G7. DATA RATES FOR PSIP ON CABLE

The typical sizes of PSIP data in the cable application are computed here. Since the structure of the PSIP tables is unchanged from the terrestrial application, the analysis of table sizes found in Annex E of the PSIP standard applies equally well to cable. On cable, the service_location_descriptor() is optional, however, so the CVCT data size may be reduced by (23 * Cd) where Cd represents the number of digital services in the multiplex.

If the CVCT is repeated at a rate of 2.5 repetitions per second, and we say that there are 10 digital channels and one reference to an analog channel, the total data rate for each instance of the CVCT is:

$$R_{CVCT} = \text{(size of CVCT in bytes)} * \text{(8 bits/byte)} * \text{(table repetition rate)} =$$

$$= (16+52*11) * 8 * 2.5 = 11{,}760 \text{ bps}$$

If the MGT is repeated at a rate of one repetition each 150 milliseconds, and it includes references to EIT-0 through –3, the data rate for the MGT is:

$$R_{MGT} = \text{(size of MGT in bytes)} * \text{(8 bits/byte)} * \text{(table repetition rate)} =$$

$$= 138 *8 * 1 / .15 = 7360 \text{ bps}$$

An adjustment needs to be made to account for the fact that the MGT must be placed into the transport multiplex such that the first byte of the table (the table_id) aligns with the first byte of the packet payload. If we assume that, on average, half of the prior packet's payload (for the base_PID) will be padded to create this alignment, the data rate for the padding is:

$$RPAD = \text{(number of pad bytes)} * \text{(8 bits/byte)} * \text{(MGT repetition rate)} =$$

$$= 92 *8 * 1 / .15 = 4907 \text{ bps}$$

If the RRT is repeated at a rate of one repetition per minute, assuming one region with nine dimensions and an average of four levels per dimension, the data rate is:

$$R_{RRT} = \text{(size of RRT in bytes)} * \text{(8 bits/byte)} * \text{(table repetition rate)} =$$

$$= (37+9*(14+26*4)) * 8 * 1/60 = 1099 * 8 / 60 = 147 \text{ bps}$$

If the STT is repeated at a rate of once per second the data rate is:

$$R_{STT} = 20 * 8 = 160 \text{ bps}$$

So, the total data rate for tables required for the cable application is:

$$R_{TOTAL} = R_{CVCT} + R_{MGT} + RPAD + R_{RRT} + R_{STT}$$

$$= 11{,}760 + 7360 + 4907 + 147 + 160 = 19.427 \text{ kbps} \cong 25 \text{ kbps}$$

The analysis can be extended to include the case that EIT/ETT is present in the multiplex as well.

Doc. A/65-A
31 May 00

AMENDMENT NO. 1 TO REVISION A OF

ATSC STANDARD:

PROGRAM AND SYSTEM INFORMATION PROTOCOL

FOR TERRESTRIAL BROADCAST AND CABLE

DOC. A/65A – (31 MAY 00)

(AMENDMENT)

ADVANCED TELEVISION SYSTEMS COMMITTEE

1) Section 2

Add the following text to the list of references:

17. EIA 608A *Recommended Practice for Line 21 Data Service*, Electronic Industry Association (*informative*).
18. U.S. Code of Federal Regulations (CFR) Title 47, 47CFR11, Emergency Alert System (EAS), U.S. Government Printing Office, Washington, DC 20040, http://www.fcc.gov/wtb/rules.html (*normative*).
19. Federal Information Processing Standard, FIPS Pub 6-4, Counties and Equivalent Entities of the U.S., Its Possessions, and Associated Areas -- 90 Aug 31, U.S. Government Printing Office, Washington, DC 20040, http://www.itl.nist.gov/fipspubs (*normative*).

2) Section 3.2

Add the following acronyms to the list of Acronyms and Abbreviations:

DCC Directed Channel Change
DCCRR DCC Capable DTV Reference Receiver
DCCSCT DCC Selection Code Table

3) Section 4.2

Replace Table 4.2 with the following table:

Table 4.2 ID Ranges and Values

Table ID Value (hex)	Tables	PID	Ref.
	ISO/IEC 13818-1 Sections:		
0x00	PROGRAM ASSOCIATION TABLE (PAT)	0	Ref. [10]
0x01	CONDITIONAL ACCESS TABLE (CAT)	1	Ref. [10]
0x02	TS PROGRAM MAP TABLE (PMT)	per PAT	Ref. [10]
0x03-0x3F	[ISO Reserved]		
	User Private Sections:		
0x40-0x7F	[User Private for other systems]		
0x80-0xBF	[User Private]		
	Other documents:		
0xC0-0xC6	[Used in other systems]		
	PSIP Tables:		
0xC7	MASTER GUIDE TABLE (MGT)	0x1FFB	Sec.6.2
0xC8	TERRESTRIAL VIRTUAL CHANNEL TABLE (TVCT)	0x1FFB	Sec.6.3.1
0xC9	CABLE VIRTUAL CHANNEL TABLE (CVCT)	0x1FFB	Sec.6.3.2
0xCA	RATING REGION TABLE (RRT)	0x1FFB	Sec.6.4
0xCB	EVENT INFORMATION TABLE (EIT)	per MGT	Sec.6.5
0xCC	EXTENDED TEXT TABLE (ETT)	per MGT	Sec.6.6
0xCD	SYSTEM TIME TABLE (STT)	0x1FFB	Sec.6.1
0xD3	DIRECTED CHANNEL CHANGE TABLE (DCCT)	0x1FFB	Sec.6.7
0xD4	DIRECTED CHANNEL CHANGE SELECTION CODE TABLE (DCCSCT)	0x1FFB	Sec.6.8
0xCE-0xD2	[Reserved for future ATSC use]		
0xD5	[Reserved for future ATSC use]		
0xD6-0xD8	[Used in other systems]		
0xD9-0xDF	[Reserved for future ATSC use]		
0xE0-0xE5	[Used in other systems]		
0xE6-0xFE	[Reserved for future ATSC use]		
0xFF	**Inter-message Filler**		

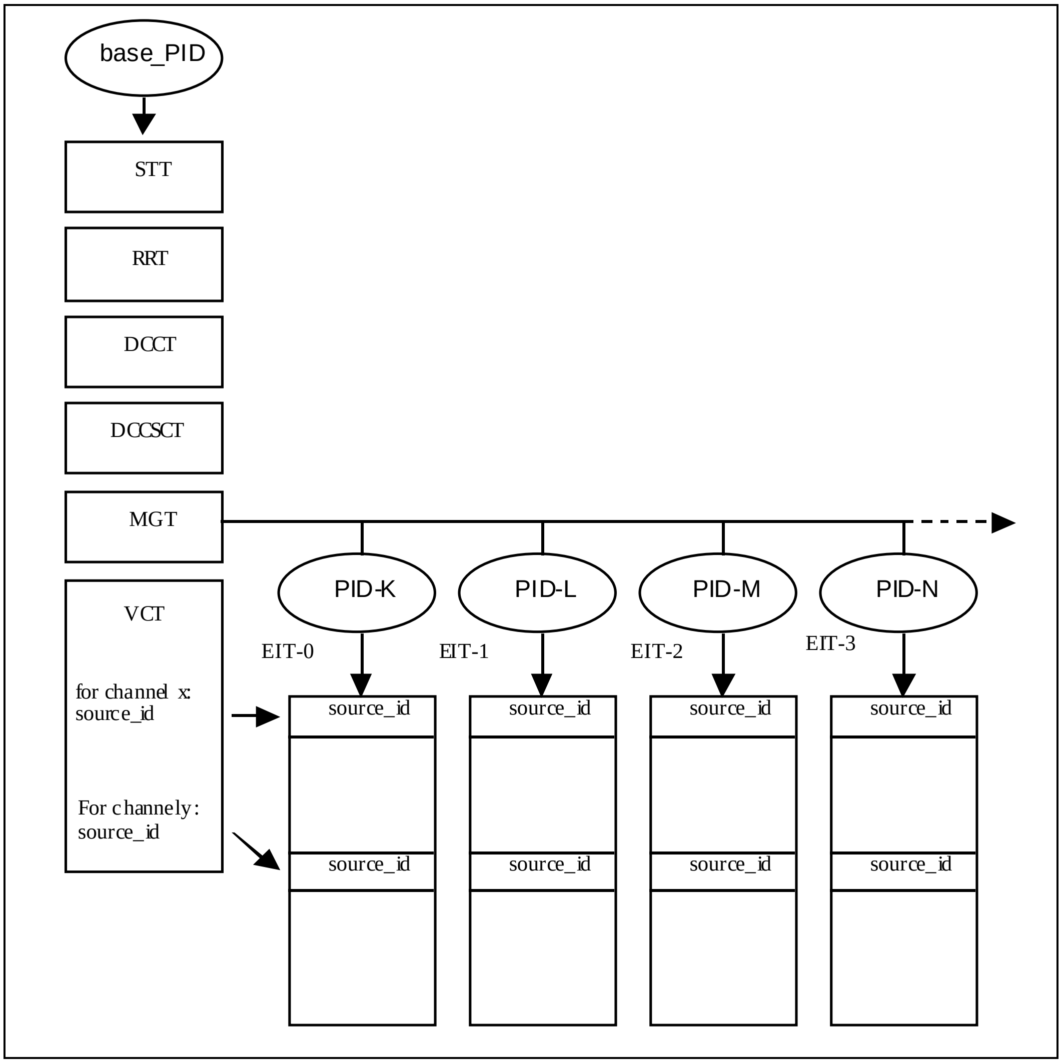
4) Section 5

Replace the second paragraph with the following paragraph:

The base PID (base_PID) is an explicitly defined value (0x1FFB) used to identify the packets for the following tables for terrestrial and cable systems: The System Time Table (STT), the Master Guide Table (MGT), the Rating Region Table (RRT), the Virtual Channel Table (VCT), the optional Directed Channel Change Table (DCCT), and the optional Directed Channel Change Selection Code Table (DCCSCT). Several Event Information Tables (EIT) are also part of the PSIP data structures, with their PIDs explicitly defined in the MGT. Figure 5.1 illustrates the relations between these elements.

5) Section 5

Replace Figure 5.1 with the following figure:



6) Section 5

Replace the third paragraph with the following paragraph:

As the name indicates, the System Time Table (STT) carries time information needed for any application requiring synchronization. The Rating Region Table (RRT) defines rating tables valid for different regions or countries. The Master Guide Table (MGT) defines sizes, PIDs, and version numbers for all of the relevant tables. The Virtual Channel Table (VCT) actually exists in two versions: one for terrestrial and a second one for cable applications. Its purpose is to tabulate virtual channel attributes required for navigation and tuning. The terrestrial and cable versions are similar in structure, with the latter redefining the semantics of some fields pertinent to cable operations. The optional Directed Channel Change Table carries information necessary to perform a channel change to be performed at a time specified by the broadcaster. The optional Directed Channel Change Selection Code Table permits a broadcast program categorical classification table to be downloaded for use by some Directed Channel Change requests.

7) Section 6

Replace the text in Section 6 with the following text:

6. SPECIFICATIONS

This chapter describes the bit stream syntax and semantics for the System Time Table (STT), Master Guide table (MGT), Virtual Channel Table (VCT), Rating Region Table (RRT), Event Information Table (EIT), Extended Text Table (ETT), the optional Directed Channel Change Table (DCCT), the optional Directed Channel Change Selection Code Table (DCCSCT), core descriptors, and the multiple string structure.

8) Section 6.2

Replace table 6.3 Table Types with the following table:

Table 6.3 Table Types

table_type	Meaning
0x0000	**Terrestrial VCT with** current_next_indicator=**1**
0x0001	**Terrestrial VCT with** current_next_indicator=**0**
0x0002	**Cable VCT with** current_next_indicator=**1**
0x0003	**Cable VCT with** current_next_indicator=**0**
0x0004	**channel ETT**
0x0005	**DCCT**
0x0006	**DCCSCT**
0x0007-0x00FF	**[Reserved for future ATSC use]**
0x0100-0x017F	**EIT-0 to EIT-127**
0x0180-0x01FF	**[Reserved for future ATSC use]**
0x0200-0x027F	**event ETT-0 to event ETT-127**
0x0280-0x0300	**[Reserved for future ATSC use]**
0x0301-0x03FF	**RRT with rating_region 1-255**
0x0400-0x0FFF	**[User private]**
0x1000-0xFFFF	**[Reserved for future ATSC use]**

9) New Section 6.7

Renumber the existing Section 6.7 (including the changes introduced by Amendment No. 1 and Technical Corrigendum No. 1) to 6.9 and change all numbers from 6.7.x to 6.9.x.. Renumber the existing Section 6.8 (including the changes introduced by Amendment No. 1 and Technical Corrigendum No. 1) to 6.10 and change all numbers from 6.8.x to 6.10.x. Renumber Tables 6.16 through 6.26 inclusive to Tables 6.25 through 6.35 inclusive and add the following new subsection:

6.7 Directed Channel Change Table (DCCT)

The optional Directed Channel Change Table provides definitions of virtual channel change requests. The table permits the broadcaster to indicate when the viewing experience can be enhanced by a virtual channel change within or between physical channels. The requested channel change may be unconditional or may be based upon geographic, demographic, or categorical broadcast programming content selection criteria which may be specified and provided by the viewer to his/her "DCC capable DTV reference receiver[11]" (hereinafter DCCRR) through a menu setup type of procedure or through direct input. In the event that the viewer does not provide some of the Directed Channel Change Table (DCCT) setup selection criteria to the DCCRR, the DCCRR shall not respond to that portion of a DCC request. Additionally, if Directed Channel Change is not supported by a DTV reference receiver there shall be no visible impact on the main broadcast program perceived by the viewer.

The following constraints apply to the Transport Stream packet carrying the DCCT:

- PID for DCCT shall have the value 0x1FFB (base_PID)
- transport_scrambling_control bits shall have the value '00'
- adaptation_field_control bits shall have the value '01'

The bit stream syntax for the Directed Channel Change Table is shown in Table 6.16 below.

[11] Note: receiver implementation is optional.

Table 6.16 Bit Stream Syntax for the Directed Channel Change Table

Syntax	Bits	Format
directed_channel_change_table_section () {		
table_id	8	0xD3
section_syntax_indicator	1	‘1’
private_indicator	1	‘1’
reserved	2	‘11’
section_length	12	uimsbf
table_id_extension	16	0x0000
reserved	2	‘11’
version_number	5	uimsbf
current_next_indicator	1	‘1’
section_number	8	0x00
last_section_number	8	0x00
protocol_version	8	uimsbf
dcc_vc_count	8	uimsbf
for (i = 0; i < dcc_vc_count; i++) {		
reserved	4	‘1111’
dcc_from_major_channel_number	10	uimsbf
dcc_from_minor_channel_number	10	uimsbf
reserved	4	‘1111’
dcc_to_major_channel_number	10	uimsbf
dcc_to_minor_channel_number	10	uimsbf
dcc_start_time	32	uimsbf
dcc_end_time	32	uimsbf
dcc_selection_count	8	uimsbf
for (j = 0; j < dcc_selection_count; j++) {		
dcc_selection_type	8	uimsbf
dcc_selection_id	64	uimsbf
reserved	6	‘111111’
dcc_descriptors_length	10	uimsbf
for (k = 0; k < N; k++) {		
descriptor()		
}		
}		
reserved	6	‘111111’
descriptors_length	10	uimsbf
for (j = 0; j < N; j++) {		
descriptor()		
}		
}		
reserved	6	‘111111’
additional_descriptors_length	10	uimsbf
for (i = 0; i < N; i++) {		
additional_descriptor()		
}		
CRC_32	32	rpchof
}		

table_id — This is an 8-bit field, which shall be set to 0xD3, identifying this table as the Directed Channel Change Table.

section_syntax_indicator — This 1-bit field shall be set to '1'. It denotes that the section follows the generic section syntax beyond the section length field.

private_indicator — This 1-bit field shall be set to '1'.

section_length — 12-bit field specifying the number of remaining bytes in this section immediately following the section_length field up to the end of the section.

table_id_extension — This 16-bit field shall be set to 0x0000.

version_number — This 5-bit field is the version number of the DCC Table identified by the combination of fields table_id and table_id_extension. The version number shall be incremented by 1 modulo 32 when any field in this instance of the DCC Table changes. In any case, the value of the version_number shall be identical to that of the corresponding entries in the MGT.

current_next_indicator — This 1-bit indicator is always set to '1' for a DCCT section; the DCCT sent is always currently applicable.

section_number — The value of this 8-bit field shall always be 0x00 (this table is only one section long).

last_section_number — The value of this 8-bit field shall always be 0x00.

protocol_version — An 8-bit unsigned integer field whose function is to allow, in the future, this table type to carry parameters that may be structured differently than those defined in the current protocol. At present, the only valid value for protocol_version is 0x00. Non-zero values of protocol_version may only be processed by decoders designed to accommodate the later versions as they become standardized.

dcc_vc_count — An 8-bit unsigned integer that specifies the number of virtual channels that will be affected by this DCC Table. This outer loop will permit the association of a DCC request with each virtual channel within a physical channel.

dcc_from_major_channel_number — A 10-bit number in the range of 1 to 99 that represents the "major" channel number, as defined in section 6.3.1 Terrestrial Virtual Channel Table or 6.3.2 Cable Virtual Channel Table. The specified dcc_from_major_channel_number must be a major channel currently defined in the VCT and may have the attribute of hidden. The dcc_from_major_channel_number together with the dcc_from_minor_channel_number fully identifies the virtual channel that must be currently tuned in order that the DCC request may be in effect.

dcc_from_minor_channel_number — A 10-bit number in the range of 1 to 999 that represents the "minor" or "sub-" virtual channel number, as defined in section 6.3.1 Terrestrial Virtual Channel Table or 6.3.2 Cable Virtual Channel Table. The specified dcc_from_minor_channel_number must be a minor channel currently defined in the VCT and may have the attribute of hidden. The dcc_from_minor_channel_number together with the dcc_from_major_channel_number fully identifies the virtual channel that must be currently tuned in order that the DCC request may be in effect.

dcc_to_major_channel_number — A 10-bit number in the range of 1 to 99 that represents the "major" channel number, as defined in section 6.3.1 Terrestrial Virtual Channel Table or 6.3.2 Cable Virtual Channel Table. The specified dcc_to_major_channel_number must be a major channel currently defined in the VCT and may have the attribute of hidden. The dcc_to_major_channel_number together with the dcc_to_minor_channel_number fully identifies the virtual channel to which the DCCRR is requested to tune when the DCC request is in effect.

dcc_to_minor_channel_number — A 10-bit number in the range of 1 to 999 that represents the "minor" or "sub-" virtual channel number, as defined in section 6.3.1 Terrestrial Virtual Channel Table or 6.3.2 Cable Virtual Channel Table. The specified dcc_to_minor_channel_number must be a minor channel currently defined in the VCT and may have the attribute of hidden. The dcc_to_minor_channel_number together with the dcc_to_major_channel_number fully identifies the virtual channel to which the DCCRR is requested to tune when the DCC request is in effect.

dcc_start_time — A 32-bit unsigned integer quantity representing the start time of this request as the number of GPS seconds since 00:00:00 UTC, January 6th, 1980. This shall specify the start time of the time interval during which the DCC request may be in effect.

dcc_end_time — A 32-bit unsigned integer quantity representing the end time of this request as the number of GPS seconds since 00:00:00 UTC, January 6th, 1980. This shall specify the end time of the time interval during which the DCC request may be in effect.

dcc_selection_count — This 8-bit unsigned integer specifies the number of dcc_selection_types and dcc_selection_ids to be associated with the directed channel change request. The directed channel change request shall be in effect whenever the DCCRR is tuned to the dcc_from_channel_number, the current time is between the dcc_start_time and the dcc_end_time, and one or more of the selection conditions in the loop may be valid.

dcc_selection_type — This 8-bit unsigned integer specifies the type of the value contained within the dcc_selection_id and shall have the values listed in Table 6.17.

Table 6.17 DCC Selection Type Assignments

Value	Meaning
* 0x00	An unconditional channel change is requested. Value is not used.
* 0x01	Value is a specific or range of numeric character postal codes in the range 00000001 to 00099999.
0x02	Value is an alphanumeric character postal code comprising 8 characters.
* 0x03	Value is a Program Identifier conforming to ATSC A/57 (Ref. [5]) provider_index, program_event_id, and segment_index fields of the program_identifier_descriptor.
0x04	Reserved.
0x05	Value is an unsigned demographic selection bit field with a logical AND of a non-zero result selection.
0x06	Value is an unsigned demographic selection bit field with a logical XOR of a zero result selection.
0x07	Value is a category selection code field with a logical AND of a non-zero result selection.
0x08	Value is a category selection code field with a logical XOR of a zero result selection.
0x09	A secondary redirect switch triggered upon detection of a failure to be authorized to remain on the requested “from” major/minor channel. Value is not used. Subsequent destination channel conditions and possibilities are contained within the descriptor loop.
0x0A	A departing request action is requested in case the viewer switches away from the specified “from” major and minor channel number.
0x0B	An arriving request action is requested in case the viewer switches into the specified “to” major and minor channel number.
0x0C	Value is a location_code conforming to the state_code, county_subdivision, and county_code.
0x0D	Switch if value is greater than or equal to stored value. Value is a rating_value as described in the Content Advisory Descriptor.
0x0E	Switch if value is less than or equal to stored value. Value is a rating_value as described in the Content Advisory Descriptor.
* 0x0F	A return to previous Virtual Channel is requested if engaged in a DCC request. Value is not used.
0x10	Reserved.
* 0x11	Value is a specific or range of numeric character postal codes in the range 00000001 to 00099999 used in a logical NOT exclusion selection.
0x12	Value is an alphanumeric character postal code comprising 8 characters used in a logical NOT exclusion selection.
0x13-0x14	Reserved.
0x15	Value is an unsigned demographic selection bit field with a logical NOT AND of a non-zero result selection.
0x16	Value is an unsigned demographic selection bit field with a logical NOT XOR of a zero result selection.
0x17	Value is a category selection code field with a logical NOT AND of a non-zero result selection.
0x18	Value is a category selection code field with a logical NOT XOR of a zero result selection.
0x19-0x1B	Reserved
0x1C	Value is the logical NOT of a location_code conforming to the state_code, county_subdivision, and county_code.
0x1D-0x1F	Reserved
*0x20-0x27	A switch based on Viewer-Direct-Select 0-7 is requested. Value is not used.
0x28-0x7F	Reserved.
0x80-0xFF	Private.

NOTE: Items marked with an asterisk (*) above are required within a DTV device providing minimal support for Directed Channel Change within the United States.

dcc_selection_id — This 64-bit unsigned integer contains the data identified by the dcc_selection_type field, and is described below. Note: 8 bit characters specified for use within this section shall mean characters defined in ANSI/ISO 8859-1, "8-Bit Single-Byte Coded Graphic Character Sets – Part 1: Latin Alphabet No. 1".

If the dcc_selection_type is specified to be of type "unconditional" (0x00), the dcc_selection_id shall be 0x00 and the DCCRR shall unconditionally switch to the dcc_to_major_channel_number and dcc_to_minor_channel_number at the specified dcc_start_time.

If the dcc_selection_type is specified to be of type 0x01 or 0x11, the dcc_selection_id shall consist of a right justified five numeric 8-bit ASCII character postal code field in the range of 00001 to 99999 padded on the left with "0" or 0x30 characters. The DCCRR shall compare that value to a stored representation of a numeric postal code entered by the user from setup menus within the DCCRR to determine if there is a match. If a match occurs, the DCCRR shall switch to the virtual channel specified in the dcc_to_major_channel_number and dcc_to_minor_channel_number fields at the specific dcc_start_time. If a question mark ("?" or 0x3F) character appears in any of the five least significant numeric character positions, that position shall be considered to be a wildcard which will permit a selection on any numeric digit within that position. For example 00055?98 would permit matches on 00055098 through 00055998. Similarly, 00055??8 would permit matches on 00055008 through 00055998. Note that the special case 00000000 is not a valid postal code. Note that multiple numeric postal code specifications may be made within a single DCCT by means of the dcc_selection_count loop. If the dcc_selection_type is defined to be of type 0x11, the selection of possible postal codes would consist of the logical remainder set of all possible postal codes NOT previously excluded by prior dcc_selection_type 0x11 types specified within this DCC request, if any.

If the dcc_selection_type is specified to be of type 0x02 or 0x12, the dcc_selection_id shall consist of a right justified eight alphanumeric and special 8-bit ASCII character postal code field of unspecified format padded on the left with space characters (0x20). The field may also contain separator characters, as necessary, to format the postal code according to country conventions. The separator characters may consist of any of the following special characters: comma (0x2C), dash (0x2D), period (0x2E), slash (0x2F) or space (0x30). The separator characters shall be considered to be "do not care" placeholders for purposes of logical comparison to a postal code stored within the DTV device. The DCCRR shall compare that value to a stored representation of a postal code entered by the user from setup menus within the DCCRR to determine if there is a match. If a match occurs, the DCCRR shall switch to the virtual channel specified in the dcc_to_major_channel_number and dcc_to_minor_channel_number fields at the specific dcc_start_time. The alphanumeric and special characters permitted shall be any printing character within the ASCII character set from 0x20 through 0x7E inclusive. If a question mark ("?" or 0x3F) character appears in any of the eight character positions, that position shall be considered to be a wildcard which will permit a selection on any character within that position. For example " 5B3-5Q?" would permit matches on 5B3-5Q0 through 5B3-5Q9 assuming the postal format convention was a numeric character in the rightmost character position. Similarly, " 5B3-5?3" would permit matches on 5B3-5A3 through 5B3-5Z3 assuming the postal format convention for the second from the rightmost character is alphabetic. Note that multiple postal codes may be specified within a single DCCT by means of the dcc_selection_count loop. If the dcc_selection_type is defined to be of type 0x12, the selection of possible postal codes would consist of the logical remainder set of all possible postal codes NOT previously excluded by prior dcc_selection_type 0x12 types specified within this DCC request, if any.

If the dcc_selection_type is specified to be of type0x03, the dcc_selection_id shall begin with a 16 bit field (uimsbf) (represented as iiii in the Value in Table 6.18) left justified in the 64 bit dcc_selection_id field. This initial field shall correspond to the provider_index field of the program_identifier_descriptor defined in Ref. [5]. The next 24 bits of the 64 bit dcc_selection_id field (represented as pppppp in the Value in Table 6.18) shall correspond to the program_event_id field of the program_identifier_descriptor defined in Ref. [5]. The next 4 bits of the 64 bit dcc_selection_id (represented as s in the Value in Table 6.18) shall correspond to the segment_index field of the program_identifier_descriptor to be defined in a forthcoming revision to Ref. [5]. If the segment_index portion of the dcc_selection_id field is non-zero, any of dcc_selection_type values from 0x20 through 0x27 is present, and the viewer makes or has made a selection using a DCC "Viewer-Direct-Select" function (see dcc_selection_type 0x20-0x27 below), a DCCRR offering persistence of selections shall, upon viewer command, store the value of the most significant 44 bits of dcc_selection_id together with the number of the DCC Viewer-Direct-Select function the viewer has selected. Upon future appearance of the same set of values of the most significant 44 bits of dcc_selection_id, the DCCRR shall execute a function equivalent to the DCC Viewer-Direct-Select function selected by the viewer on the prior occasion the particular broadcast program was processed by the DCCRR. In this case, the DCCRR shall switch to the virtual channel specified in the dcc_to_major_channel_number and dcc_to_minor_channel_number fields at the specific dcc_start_time associated with the DCC Viewer-Direct-Select function having the same number as that selected by the viewer on the prior occasion when the selection was stored. If the dcc_selection_type is defined to be of type 0x03, the EIT associated with this request must also contain a matching program_identifier_descriptor.

Table 6.18 Program Identifier Format

Value	Meaning
0xiiiippppppsxxxxx	provider/program/segment id

If dcc_selection_type is equal to 0x05, 0x06, 0x15, or 0x16, the dcc_selection_id shall be specified to be a demographic selection bit field as described in Table 6.19 below. The DCCRR shall compare the value to a stored value which had been entered by the user within setup menus to determine if there is a match.

Table 6.19 Demographic Selection Type Assignments

Value	Meaning
0x0000000000000001	Males
0x0000000000000002	Females
0x0000000000000004	Ages 2-5
0x0000000000000008	Ages 6-11
0x0000000000000010	Ages 12-17
0x0000000000000020	Ages 18-34
0x0000000000000040	Ages 35-49
0x0000000000000080	Ages 50-54
0x0000000000000100	Ages 55-64
0x0000000000000200	Ages 65+
0x0000000000000400	Working
0x0000000000000800 - 0x8000000000000000	Reserved

If the selection is specified to be of type AND (dcc_selection_type 0x05) with a non-zero result, the received dcc_selection_id will be logically bitwise ANDed with the DCCRR's stored value. If the result is non zero, the DCCRR shall switch to the virtual channel specified in the dcc_to_major_channel_number and dcc_to_minor_channel_number fields at the specified dcc_start_time. Logical ANDing with a non zero result will permit selection based upon at least one and possibly more selection criteria. In other words, switch if any of the criteria are selected by the viewer. If the dcc_selection_type is defined to be of type 0x15, the selection would consist of the logical remainder set of all possible selections NOT previously excluded by prior selections of type 0x15 within this DCC request, if any.

If the selection is specified to be of type XOR (dcc_selection_type 0x06) with a zero result, the received dcc_selection_id will be logically bitwise exclusive or'd with the DCCRR's stored value. If the result is zero, the DCCRR shall switch to the virtual channel specified in the dcc_to_major_channel_number and dcc_to_minor_channel_number fields at the specified dcc_start_time. Logical XORing with a zero result will permit selection based upon the exact selection criteria. In other words, switch if and only if the precisely matching criteria have been selected by the viewer. If the dcc_selection_type is defined to be of type 0x16, the selection would consist of the logical remainder set of all possible selections NOT previously excluded by prior selections of type 0x16 within this DCC request, if any.

If dcc_selection_type is equal to 0x07, 0x08, 0x17, or 0x18, the dcc_selection_id shall be specified to be a categorical selection code field. The DCCRR shall compare the code values obtained from the dcc_selection_id field to stored values which had been entered by the user through selection setup menus to determine if there is a match. Each occurrence of the dcc_selection_id may contain up to eight categorical selection codes, each code having a length of eight bits.

If the categorical selection is specified to be of type AND (dcc_selection_type 0x07) with a non-zero result, the received dcc_selection_id will be parsed to obtain non-zero category codes and then logically bitwise ANDed with the DCCRR's stored value(s). If the result is non zero, the DCCRR shall switch to the virtual channel specified in the dcc_to_major_channel_number and dcc_to_minor_channel_number fields at the specified dcc_start_time. Logical ANDing with a non zero result will permit selection based upon at least one and possibly more selection criteria. In other words, switch if any of the criteria are selected by the viewer. If the dcc_selection_type is defined to be of type 0x17, the selection would consist of the logical remainder set of all possible selections NOT previously excluded by prior selections of type 0x17 within this DCC request, if any.

If the categorical selection is specified to be of type XOR (dcc_selection_type 0x08) with a zero result, the received dcc_selection_id will be parsed to obtain non-zero category codes and then logically bitwise exclusive or'd with the DCCRR's stored value(s). If the result is zero, the DCCRR shall switch to the virtual channel specified in the dcc_to_major_channel_number and dcc_to_minor_channel_number fields at the specified dcc_start_time. Logical XORing with a zero result will permit selection based upon the exact selection criteria. In other words, switch if and only if the precisely matching criteria have been selected by the viewer. If the dcc_selection_type is specified to be of type 0x18, the selection would consist of the logical remainder set of all possible selections NOT previously excluded by prior selections of type 0x18 within this DCC request, if any.

Up to a maximum of eight of the 8-bit wide categorical selection codes shall be right justified and packed into the dcc_selection_id 64-bit field. Each of the categorical selection codes shall consist of the values 0x01 through 0xFF. If a code is not specified, the value of 0x00 shall be used as a place holder. There is a significance to the left/right order of the packing of the codes. The rightmost, or least significant, code shall be one of codes from the "Basic" group (codes 0x20 through 0x26 defined in Table 6.24). The next most significant code may be one or more of the "Detail" group codes (0x27 through 0xAD) in a sorted order that may indicate amount of subject material contained within the broadcast program. Table 6.20 below illustrates the categorical selection criteria code packing within the dcc_selection_id field.

Table 6.20 Examples of Selection Code Packing

Value	Meaning
0x0000000000000000	no codes specified
0x0000000000222120	3 codes in least significant 24 bits
0x0000000052304120	4 codes in least significant 32 bits
0x3031323334353620	8 codes in 64 bits

If the dcc_selection_type is specified to be of type 0x09, and if the DCCRR is tuned by the viewer to a major and minor channel number specified by the dcc_from_major_channel_number and the dcc_from_minor_channel_number for which the viewer is not authorized, the DCCRR shall immediately, upon determination of the unauthorized status, tune to the dcc_to_major_channel_number and dcc_to_minor_channel_number. The action of this mechanism provides an ability to "redirect" viewers to an alternate channel in the event they are not authorized to view the requested channel for any reason.

If the dcc_selection_type is specified to be of type 0x0A and if the DCCRR switches out of the major and minor channel number specified in dcc_from_major_channel_number and dcc_from_minor_channel_number, the DCCRR shall execute the requested function specified within the descriptor loop defined in 6.9.11. The values within dcc_to_major_channel_number and dcc_to_minor_channel_number are set to "do not care" values which shall be ignored by the DCCRR.

If the dcc_selection_type is specified to be of type 0x0B, the DCCRR shall execute the requested function specified within the descriptor loop defined in 6.9.12 when the DCCRR switches into the major and minor channel number specified in dcc_to_major_channel_number and dcc_to_minor_channel_number. The values within dcc_from_major_channel_number and dcc_from_minor_channel_number are set to "do not care" values which shall be ignored by the DCCRR.

location_code — This 24-bit unsigned integer field contains state_code, county_subdivision, and county_code sub fields (defined below) used in identification of a geographic location.

If the dcc_selection_type is specified to be of type 0x0C or 0x1C, the DCCRR shall interpret the dcc_selection_id as a right justified 0 padded packing of the 24-bit location_code field within the 64-bit dcc_selection_id field as shown in Table 6.21 below. If the dcc_selection_type is specified to be of type 0x1C, the selection would consist of the logical remainder set of all possible locations NOT previously excluded by prior selections of type 0x1C within this DCC request, if any. The location_code fields are described in Table 6.21 below.

Table 6.21 Conditional Type Value Format

Syntax	Bits	Format
dcc_selection_type {		
pad	40	0x00
location_code {		
state_code	8	uimsbf range 0..99
county_subdivision	4	uimsbf range 0..9
reserved	2	'11'
county_code	10	uimsbf rang 0..999
}		
}		

state_code — This 8-bit unsigned integer in the range 0 to 99 specifies the State or Territory. state_code is coded according to State and Territory FIPS number codes (see 47 CFR 11.15(f).). A value of 0 specifies all states and territories.

county_subdivision — This 4-bit unsigned integer in the range 0 to 9 specifies county subdivisions as shown in Table 6.22

Table 6.22 County Subdivision Coding

county_subdivision	Meaning
0x0	All or an unspecified portion of a county
0x1	Northwest
0x2	North Central
0x3	Northeast
0x4	West Central
0x5	Central
0x6	East Central
0x7	Southwest
0x8	South Central
0x9	Southeast
0xA-F	[Reserved]

county_code — This 10-bit unsigned integer in the range 0 to 999 specifies a county within a state. county_code is coded according to State and Territory Federal Information Processing Standard (FIPS) number codes maintained by the National Institute of Standards and Technology (NIST) in FIPS PUB 6-4. A value of 0 specifies the entire state or territory.

If the dcc_selection_type is specified to be of type 0x0D or 0x0E, the DCCRR shall interpret the dcc_selection_id as a right justified 0 padded packing of a single 4-bit rating_value field (specified in Section 6.9.4 of this document describing the Content Advisory Descriptor) within the 64-bit dcc_selection_id field. If the dcc_selection_type is specified to be of type 0x0D the DCCRR shall perform a channel change if the rating_value specified by the viewer and stored within the DCCRR is greater than or equal to the value sent within the least significant 4 bits of the dcc_selection_id in this DCC request. If the dcc_selection_type is specified to be of type 0x0E the DCCRR shall perform a channel change if the rating_value specified by the viewer and stored within the DCCRR is less than or equal to the value sent within least significant 4 bits of the dcc_selection_id in this DCC request.

If the dcc_selection_type is specified to be of type 0x0F, and if the DCCRR is engaged in a DCC request, the DTV shall tune back to the channel from which it was previously directed (the previous dcc_from_major_channel_number and dcc_from_minor_channel_number).

If the dcc_selection_type is specified to be of type 0x20 through 0x27, the DCCRR shall tune to the virtual channel specified in the dcc_to_major_channel_number and dcc_to_minor_channel_number based upon the viewer's selection of one of eight "Viewer-Direct-Select" function buttons (or equivalent). For example, if the viewer chooses Viewer-Direct-Select Button 2 and a DCC request has been defined for that button, the DCCRR shall immediately switch to that major and minor channel number when the viewer presses the button (or in some fashion chooses the function) regardless of other conditions, satisfied or not, associated with the DCC request.

dcc_selection_id — This 64-bit unsigned integer contains the data identified by the dcc_selection_type field which has been described above.

CRC_32 — This is a 32-bit field that contains the CRC value that ensures a zero output from the registers in the decoder defined in Annex A of ISO/IEC 13818-1 "MPEG-2 Systems" after processing the entire Directed Channel Change Table section.

hide_guide — The hide_guide bit found within the VCT should be set to 1 to prevent hidden channels used within a DCC request from being displayed in EPG displays.

10) New Section 6.8

Add the following new subsection:

6.8 DCC Selection Code Table (DCCSCT)

The optional Directed Channel Change Selection Code Table (DCCSCT) carries code values and selection criteria name information for use with categorical selection code processing in the Directed Channel Change Table. Additionally, the DCCSCT is used to transmit descriptors containing location code and name data for subsequent download into storage within a DCCRR.

The following constraints apply to the Transport Stream packets carrying the DCCSCT sections.

- PID shall have the value 0x1FFB (base_PID)
- transport_scrambling_control bits shall have the value '00'
- adaptation_field_control bits shall have the value '01'

The bit stream syntax for the Directed Channel Change Selection Code Table is shown in Table 6.23.

table_id — This is an 8-bit field, which shall be set to 0xD4, identifying this table as the DCC Selection Code Table (DCCSCT).

section_syntax_indicator — This 1-bit field shall be set to '1'. It denotes that the section follows the generic section syntax beyond the section length field.

private_indicator — This 1-bit field shall be set to '1'.

section_length — 12-bit field specifying the number of remaining bytes in this section immediately following the section_length field up to the end of the section.

Table 6.23 Bit Stream Syntax for the DCC Selection Code Table

Syntax	Bits	Format
dcc_selection_code_table_section () {		
table_id	8	0xD4
section_syntax_indicator	1	‘1’
private_indicator	1	‘1’
reserved	2	‘11’
section_length	12	uimsbf
table_id_extension	16	uimsbf
reserved	2	‘11’
version_number	5	uimsbf
current_next_indicator	1	‘1’
section_number	8	0x00
last_section_number	8	0x00
protocol_version	8	uimsbf
selection_categories_defined	8	uimsbf
for(i = 0; i < selection_categories_defined; i++) {		
selection_category_code	8	uimsbf
selection_category_name_length	8	uimsbf
selection_category_name_text()	var	
reserved	6	‘111111’
descriptors_length	10	uimsbf
for (j = 0; j < N; j++) {		
descriptors()		
}		
}		
reserved	6	‘111111’
additional_descriptors_length	10	uimsbf
for (i = 0; i < N; i++) {		
additional_descriptors()		
}		
CRC_32	32	rpchof
}		

table_id_extension — A 16-bit unsigned integer field whose value specifies the type of information contained within the selection category loop. A table_id_extension value of 0x0000 specifies that the information contained within the selection category loop is associated with selection categories. A table_id_extension value of 0x0001 specifies that the information contained within the inner descriptor loop is a dcc_location_code_descriptor.

If the table_id_extension is specified as 0x0001 to indicate that location code information is being sent, the selection_category_code should be set to 0xFF, the selection_category_name_length set to 0x00, and the selection_category_name_text field may be empty because no categorical information is being transmitted within this instance of the table. At least one dcc_location_code_descriptor, as defined in section 6.9.13 below should appear within the inner descriptor loop.

version_number — This 5-bit field is the version number of the DCCSC Table identified by combination of the fields table_id and table_id_extension. The version number shall be incremented by 1 modulo 32 when any field in this instance of the DCC Selection Code Table changes. In any case, the value of the version_number shall be identical to that of the corresponding entries in the MGT.

current_next_indicator — This 1-bit indicator is always set to '1'.

section_number — The value of this 8-bit field shall always be 0x00.

last_section_number — The value of this 8-bit field shall always be 0x00.

protocol_version — An 8-bit unsigned integer field whose function is to allow, in the future, this table type to carry parameters that may be structured differently than those defined in the current protocol. At present, the only valid value for protocol_version is 0x00. Non-zero values of protocol_version may only be processed by decoders designed to accommodate the later versions as they become standardized.

selection_categories_defined — An 8-bit unsigned integer number that specifies the total number of entries in the category table to follow.

selection_category_code — An 8-bit unsigned integer number that specifies the value of the category code. The categorical selection codes conform to the initial Program Type codes specified in the Program Type packet (0x04) of the Extended Data Service Packets specified in EIA-608A, however that initial list has been extended by the list provided within the DCCSCT of this standard. Additionally, the list may be further extended in the future by revision to this standard and the contents of the DCCSCT. Currently specified category codes are listed in Table 6.24 below.

It should be noted that this table is to be downloaded to the DCCRR and should not be hard coded. Additionally, provision has been made for the inclusion of additional generic codes in the future (similar to those assigned to values 0x20 through 0x26 in the Basic group) in the range of 0xF0 through 0xFE.

A selection_category_code of 0xFF is reserved to specify a null entry for the category code. A null category, together with a zero length for the selection_category_name_length and empty selection_category_name_text field permits information to be carried in the descriptors field which may be unrelated to category codes (for example, the dcc_location_code_descriptor).

selection_category_name_length — An 8-bit unsigned integer number that specifies the total length in bytes of the selection_category_name_text() field to follow.

selection_category_name_text() — A data structure containing a multiple string structure which specifies the selection criteria name, e.g. "Sports". Text strings are formatted according to the rules outlined in Section 6.10. The string for the selection_category_name_text() shall be limited to 24 characters or less. Currently defined category names are listed in Table 6.24 below. The category names shall appear exactly as defined in Table 6.24.

The list of category names and their respective codes are broken down into two groups. The first group consists of codes 0x20 through 0x26 and may be called the "Basic" group. The second group contains the codes 0x27 through 0xAD and is called the "Detail" group. The Basic group is used to define the broadcast program at the highest level. Use of the DCCT for categorical selection shall specify one or more of these Basic group codes to define the general category of the broadcast program. Broadcast programs which may fit more than one basic category may specify several of these category names. The name "Other" is used when the broadcast program doesn't really fit into the other Basic categories. These Basic categories shall be specified before any of the categories from the Detail group.

The Detail group may be used to add more specific information if appropriate. These categories are optional and shall follow the Basic categories. Broadcast programs that may fit more than one Detail category may specify several of these categories. Only categories which actually apply to the broadcast program content should be specified. If the broadcast program cannot be accurately described with any of these categories, then none of them should be sent. In that case one of the categories from the Basic group would be all that would be required.

CRC_32 — This is a 32-bit field that contains the CRC value that ensures a zero output from the registers in the decoder defined in Annex A of ISO/IEC 13818-1 "MPEG-2 Systems" after processing the entire DCC Selection Code Table section.

hide_guide — The hide_guide bit found within the VCT should be set to 1 to prevent hidden channels used within a DCC request from being displayed in EPG displays.

Table 6.24 Categorical Selection Code Assignments

Value	Meaning	Value	Meaning	Value	Meaning
0x00	Not Available	0x4F	Hobby	0x80	Art
0x01-1F	Reserved	0x50	Hockey	0x81	Auto Racing
0x20	Education	0x51	Home	0x82	Aviation
0x21	Entertainment	0x52	Horror	0x83	Biography
0x22	Movie	0x53	Information	0x84	Boating
0x23	News	0x54	Instruction	0x85	Bowling
0x24	Religious	0x55	International	0x86	Boxing
0x25	Sports	0x56	Interview	0x87	Cartoon
0x26	Other	0x57	Language	0x88	Children
0x27	Action	0x58	Legal	0x89	Classic Film
0x28	Advertisement	0x59	Live	0x8A	Community
0x29	Animated	0x5A	Local	0x8B	Computers
0x2A	Anthology	0x5B	Math	0x8C	Country Music
0x2B	Automobile	0x5C	Medical	0x8D	Court
0x2C	Awards	0x5D	Meeting	0x8E	Extreme Sports
0x2D	Baseball	0x5E	Military	0x8F	Family
0x2E	Basketball	0x5F	Miniseries	0x90	Financial
0x2F	Bulletin	0x60	Music	0x91	Gymnastics
0x30	Business	0x61	Mystery	0x92	Headlines
0x31	Classical	0x62	National	0x93	Horse Racing
0x32	College	0x63	Nature	0x94	Hunting/Fishing/Outdoors
0x33	Combat	0x64	Police	0x95	Independent
0x34	Comedy	0x65	Politics	0x96	Jazz
0x35	Commentary	0x66	Premier	0x97	Magazine
0x36	Concert	0x67	Prerecorded	0x98	Motorcycle Racing
0x37	Consumer	0x68	Product	0x99	Music/Film/Books
0x38	Contemporary	0x69	Professional	0x9A	News-International
0x39	Crime	0x6A	Public	0x9B	News-Local
0x3A	Dance	0x6B	Racing	0x9C	News-National
0x3B	Documentary	0x6C	Reading	0x9D	News-Regional
0x3C	Drama	0x6D	Repair	0x9E	Olympics
0x3D	Elementary	0x6E	Repeat	0x9F	Original
0x3E	Erotica	0x6F	Review	0xA0	Performing Arts
0x3F	Exercise	0x70	Romance	0xA1	Pets/Animals
0x40	Fantasy	0x71	Science	0xA2	Pop
0x41	Farm	0x72	Series	0xA3	Rock & Roll
0x42	Fashion	0x73	Service	0xA4	Sci-Fi
0x43	Fiction	0x74	Shopping	0xA5	Self Improvement
0x44	Food	0x75	Soap Opera	0xA6	Sitcom
0x45	Football	0x76	Special	0xA7	Skating
0x46	Foreign	0x77	Suspense	0xA8	Skiing
0x47	Fund Raiser	0x78	Talk	0xA9	Soccer
0x48	Game/Quiz	0x79	Technical	0xAA	Track/Field
0x49	Garden	0x7A	Tennis	0xAB	True
0x4A	Golf	0x7B	Travel	0xAC	Volleyball
0x4B	Government	0x7C	Variety	0xAD	Wrestling
0x4C	Health	0x7D	Video	0xAE-EF	Reserved
0x4D	High School	0x7E	Weather	0xF0-FE	Reserved for expansion of Basic categories (e.g. 0x20-0x26)
0x4E	History	0x7F	Western	0xFF	Null (not a category)

11) Section 6.9 (old 6.7 Core Descriptors)

Change the first sentence from:

Table 6.16 lists all of the core descriptors and their descriptor tags.

To:

Table 6.25a and 6.25b list all of the core descriptors and their descriptor tags.

12) Section 6.9 (old 6.7 Core Descriptors)

Change Table 6.16 to:

Table 6.25a List of Descriptors for PSIP Tables.

Descriptor Name	Descriptor tag	Terrestrial					
		PMT	MGT	VCT	EIT	DCCT	DCCSCT
stuffing descriptor	0x80	*	*	*	*	*	*
AC-3 audio descriptor	0x81	S			M		
caption service descriptor	0x86	O			M		
content advisory descriptor	0x87	O			M		
program identifier descriptor	0xnn	O			M		
extended channel name descriptor	0xA0			M			
service location descriptor	0xA1			S			
time-shifted service descriptor	0xA2			M			
component name descriptor	0xA3	M					
dcc departing request descriptor	0xA8					M	
dcc arriving request descriptor	0xA9					M	
dcc location code descriptor	0xAB						M
user private	0xC0-0xFE	*	*	*	*	*	*

Table 6.25b List of Descriptors for PSIP Tables.

Descriptor Name	Descriptor tag	Cable					
		PMT	MGT	VCT	EIT	DCCT	DCCSCT
stuffing descriptor	0x80	*	*	*	*	*	*
AC-3 audio descriptor	0x81	S			O		
caption service descriptor	0x86	M			O		
content advisory descriptor	0x87	M			O		
program identifier descriptor	0xnn	M			O		
extended channel name descriptor	0xA0			M			
service location descriptor	0xA1			M			
time-shifted service descriptor	0xA2			M			
component name descriptor	0xA3	M					
dcc departing request descriptor	0xA8					M	
dcc arriving request descriptor	0xA9					M	
dcc location code descriptor	0xAB						M
user private	0xC0-0xFE	*	*	*	*	*	*

13) Section 6.9.2 (old 6.7.2 Program Identifier Descriptor)

Replace with:

6.9.2 Program Identifier Descriptor

The program_identifier_descriptor, as defined in Ref. [5], may be used in the PMT and must be used in EITs in order to enable use of the dcc_selection_types of 0x03 or 0x04 in the Directed Channel Change Table.

14) New Section 6.9.11

Add the following new subsection:

6.9.11 DCC Departing Request Descriptor

This descriptor provides instructions for the actions to be performed by a DCCRR upon detection of a manual channel change requested by the viewer using either the channel change controls on the DCCRR or a remote control device just prior to executing the channel change itself. This function shall be defeatable by the viewer within setup menu selections and shall default to "not enabled" if the viewer does not explicitly enable it.

The bit stream syntax for the dcc_departing_request_descriptor() is shown in Table 6.36.

Table 6.36 Bit Stream Syntax for the DCC Departing Request Descriptor

Syntax	Bits	Format
dcc_departing_request_descriptor() {		
descriptor_tag	8	0xA8
descriptor_length	8	uimsbf
dcc_departing_request_type	8	uimsbf
dcc_departing_request_text_length	8	uimsbf
dcc_departing_request_text()	var	
}		

descriptor_tag — This 8-bit unsigned integer shall have the value 0xA8, identifying this descriptor as dcc_departing_request_descriptor().

descriptor_length — This 8-bit unsigned integer specifies the length (in bytes) immediately following this field up to the end of this descriptor.

dcc_departing_request_type — This 8-bit unsigned integer specifies the type of the DCC departing request and shall have the values listed in Table 6.37.

dcc_departing_request_text _length — An 8-bit unsigned integer number that specifies the total length in bytes of the dcc_departing_request_text() field to follow.

dcc_departing_request_text() — The departing request window text in the format of a multiple string structure (see Section 6.10).

Table 6.37 DCC Departing Request Type Assignments

Value	Meaning
0x00	Generic departing request occurrance. No useful text in dcc_departing_request_text.
0x01	Cancel any outstanding departing request type and immediately perform a channel change upon request by the viewer.
* 0x02	Display departing request text in a centered window for a minimum of 10 seconds prior to performing the channel change requested by the viewer or for a lesser amount of time if the viewer issues another channel change request or a "continue", "OK", "proceed", or equivalent command.
* 0x03	Display departing request text in a centered window indefinitely until viewer issues another channel change request or a "continue", "OK", "proceed", or equivalent command.
0x04-0xFF	Reserved

* Note: implementation of Departing Request types 0x02 and 0x03 are within the discretion of DCCRR manufacturers or may be disabled by viewers through an interactive setup session.

15) New Section 6.9.12

Add the following new subsection:

6.9.12 DCC Arriving Request Descriptor

This descriptor provides instructions for the actions to be performed by a DCCRR upon arrival at a newly changed channel. The arrival channel change request shall be executed within 30 seconds of arrival at, and detection within, the channel PSIP stream (this implies that, and is dependent upon, the descriptor being repeated or issued by the broadcaster and detected by the DCCRR in at least 30 second cycles). The channel change shall be requested by the viewer using either the channel change controls on the DCCRR, or a remote control device. This function shall be defeatable by the viewer within setup menu selections and shall default to “not enabled” if the viewer does not explicitly enable it.

The bit stream syntax for the dcc_arriving_request_descriptor() is shown in Table 6.38.

Table 6.38 Bit Stream Syntax for the DCC Arriving Request Descriptor

Syntax	Bits	Format
dcc_arriving_request_descriptor() {		
descriptor_tag	8	0xA9
descriptor_length	8	uimsbf
dcc_arriving_request_type	8	uimsbf
dcc_arriving_request_text_length	8	uimsbf
dcc_arriving_request_text()	var	
}		

descriptor_tag — This 8-bit unsigned integer shall have the value 0xA9, identifying this descriptor as dcc_arriving_request_descriptor().

descriptor_length — This 8-bit unsigned integer specifies the length (in bytes) immediately following this field up to the end of this descriptor.

dcc_arriving_request_type — This 8-bit unsigned integer specifies the type of the DCC arriving request and shall have the values listed in Table 6.39.

dcc_arriving_request_text _length — An 8-bit unsigned integer number that specifies the total length in bytes of the dcc_arriving_request_text() field to follow.

dcc_arriving_request_text() — The arriving request window text in the format of a multiple string structure (see Section 6.10).

Table 6.39 DCC Arriving Request Type Assignments

Value	Meaning
0x00	Generic arrival request occurrance. No useful text in dcc_arriving_request_text.
0x01*	Display arriving request text in a centered window for a minimum of 10 seconds after performing the channel change requested by the viewer, or for a less amount of time if the viewer issues a "continue", "OK", "proceed", or equivalent command.
0x02*	Display arriving request text in a centered window indefinitely after performing a channel change request requested by the viewer until viewer issues a "continue", "OK", "proceed", or equivalent command.
0x03-0xFF	Reserved

* Note: implementation of Arriving Request types 0x01 and 0x02 are within the discretion of DCCRR manufacturers or may be disabled by viewers through an interactive setup session.

16) New Section 6.9.13

Add the following new subsection:

6.9.13 DCC Location Code Descriptor

This descriptor provides information to be loaded into storage within the DCCRR to allow the viewer, through an interactive setup session, to select the state, county, and county subdivision of the viewer’s location so that location codes, sent within a DCC request, may be identified and matched. The DCC Location Code Descriptor may appear within the descriptor loop of the DCC Selection Code Table (DCCSCT). The descriptor permits a DCCRR to acquire location names and code information from the DTV stream so that information may be utilized in an interactive manner by a viewer to identify the state and county location to the DCCRR.

Each DTV station may emit a DCC Location Code Descriptor within the DCCSCT which contains only the information that particular DTV station considers to be within it’s viewing coverage area. The DCCRR need only acquire a single copy of the location codes for a particular viewer - and it may be acquired from any DTV station within reception range of the DCCRR. Once the viewer has defined the codes to the DCCRR, the DCCRR need not acquire the DCC Location Code Descriptor again unless the viewer resets or moves the DCCRR. This mechanism of acquisition minimizes the number of repetitions that must occur within the broadcast stream and the frequency with which the DCCRR must parse the descriptor.

The bit stream syntax for the dcc_location_code_descriptor() is shown in Table 6.40.

Table 6.40 Bit Stream Syntax for the DCC Location Code Descriptor

Syntax	Bits	Format
dcc_location_code_descriptor() {		
descriptor_tag	8	0xAB
descriptor_length	8	uimsbf
dcc_state_location_code	8	uimsbf range 1..99
dcc_state_location_code_text_length	8	uimsbf
dcc_state_location_code_text()	var	
reserved	6	'111111'
dcc_county_location_code	10	uimsbf range 1..999
dcc_county_location_code_text_length	8	uimsbf
dcc_county_location_code_text()	var	
}		

descriptor_tag — This 8-bit unsigned integer shall have the value 0xAB, identifying this descriptor as dcc_location_code_descriptor().

descriptor_length — This 8-bit unsigned integer specifies the length (in bytes) immediately following this field up to the end of this descriptor.

dcc_state_location_code — This 8-bit unsigned integer in the range 1 to 99 specifies the State or Territory. The dcc_state_location_code is coded according to State and Territory FIPS number codes (see 47 CFR 11.15(f).).

dcc_state_location_code_text_length — An 8-bit unsigned integer number that specifies the total length in bytes of the dcc_state_location_code_text() field to follow.

dcc_state_location_code_text() — The name of a state in the format of a multiple string structure (see Section 6.10).

dcc_county_location_code — This 10-bit unsigned integer in the range 1 to 999 specifies a county within a state. The dcc_county_location_code is coded according to State and Territory Federal Information Processing Standard (FIPS) number codes maintained by the National Institute of Standards and Technology (NIST) in FIPS PUB 6-4.

dcc_county_location_code_text_length — An 8-bit unsigned integer number that specifies the total length in bytes of the dcc_county_location_code_text() field to follow.

dcc_county_location_code_text() — The name of a county in the format of a multiple string structure (see Section 6.10).

17) New Section 7.3

Add the following new subsection:

7.3 Buffer Model Considerations to Support Directed Channel Change for Terrestrial Broadcast

The maximum cycle time for the Directed Channel Change Table (DCCT) shall not exceed 150 ms. while a DCC request is in progress. The maximum cycle time for the DCCT shall not exceed 400 ms. within 10 seconds of an impending DCC request and 5 seconds following a DCC request. There shall be no maximum cycle time for the DCCT if there are no impending DCC requests.

The maximum cycle time for the Directed Channel Change Selection Code Table (DCCSCT) shall not exceed 3,600,000 ms. (1 hour).

18) New Section E7. DIRECTED CHANNEL CHANGE TABLE (DCCT)

Renumber the existing section E7 (and tables) to E9 and add the following new subsection:

E7. DIRECTED CHANNEL CHANGE TABLE

The typical size for the DCCT is 44 bytes, with the assumption of having a single from/to channel, a single selection criterion, and no additional descriptors. The typical size for the DCCT (in bytes) based on the assumptions listed in the column “Assumption” is shown in Table E.7.

Table E.7 Typical Size (bytes) of DCCT

Part	Size (bytes)	Assumption
PSI header and trailer	13	
message body	3+(17*V)+(11*S)	1. No descriptors. 2. V = number of virtual channels affected. 3. S = number of selection criteria.
Total	16+(17*V)+(11*S)	

19) New Section E8. DIRECTED CHANNEL CHANGE SELECTION CODE TABLE (DCCSCT)

Renumber the existing section E8 (and tables) to E10 and add the following new subsection:

E8. DIRECTED CHANNEL CHANGE SELECTION CODE TABLE

The typical size for the DCCSCT is 26 bytes, with the assumption of having a single selection category and no additional descriptors. The typical size for the DCCSCT (in bytes) based on the assumptions listed in the column “Assumption” is shown in Table E.8.

Table E.8 Typical Size (bytes) of DCCSCT

Part	Size (bytes)	Assumption
PSI header and trailer	13	
message body	3+(Sc*(4+6))	1. No descriptors. 2. Sc = number of selection categories 3. Selection Category Name is compressed by Huffman coding with a standard table, and the text length after coding is 6 bytes.
Total	16+(Sc*10)	

20) New Annex H. An Overview of Directed Channel Change

Add the following new Annex:

ANNEX H

(Informative)

AN OVERVIEW OF DIRECTED CHANNEL CHANGE

Directed Channel Change (DCC) is an optional capability that offers broadcasters, and other system operators the ability to steer viewers between linked, alternative streams of broadcast program content when viewers provide display systems with information that enables or controls the functionality. DCC permits broadcast program providers the ability to enhance their broadcast program content with offerings of alternative choices that can be selected directly by viewers or that can be automatically selected in display systems based upon information provided by viewers to indicate specific interests. It permits broadcasters and system operators to direct the attention of viewers to content which the broadcast program distributor has categorized and the viewer has elected to receive when available. Directed Channel Change provides broadcasters and system operators a great deal of flexibility in broadcast programming the DTV multiplex to provide content delivery services to targeted audiences. DCC is designed to be useful on display systems that implement PSIP, without requiring additional, complex data processing capability.

H1. INTRODUCTION

A Directed Channel Change request is a trigger event sent within the PSIP stream of the DTV multiplex that will cause a “DCC-capable DTV reference receiver” (DCCRR) to select a different virtual channel from that to which it is already tuned. Depending upon the kind of DCC request, the change to a different virtual channel can occur without intervention by the viewer, if the viewer has enabled the capability by providing required information during a setup process or during operation of the display. Alternatively, the change can take place under direct control of the viewer, for instance using a remote control device.

To enable the automatic carrying out of a DCC request within a DCCRR, the DTV viewer will be required to provide information to the display system. This may be accomplished through an interactive setup session or may be done during operation of the receiver, as different viewing options become available. The information provided by the viewer to the DCCRR will permit the unit to determine which, if any, alternate virtual channel the DCCRR should display upon receipt of a DCC request. This selection will take place through the DCCRR matching the viewer information with categorization information or other selection criteria sent by the broadcaster or system operator. There are also forms of DCC request that enable real time viewer selections among alternate broadcast program streams, such as, for example, alternate camera views of a sporting event.

H2. DCC SWITCH CRITERIA

A switch from a currently viewed virtual channel to another virtual channel may be accomplished upon occurrence of any of the following selection criteria, some of which may be used in combination:

- Unconditional switch *
- Postal code, zip code *, or location code
- Program Identifier*
- Demographic category
- Content subject category
- Authorization level
- Content advisory value
- One of eight user categories*

* Items required within a DTV device providing minimal support for Directed Channel Change within the United States.

In addition to the criteria listed above that serve to include groups of viewers into a DCC request, several of the criteria may also be used to exclude viewers from inclusion in a request. For example, instead of listing many zip codes for inclusion of viewers in a DCC request, the inverse logic may be used to specify the group of all viewers not included within a group of zip codes.

Two other DCC request actions have also been defined: an action to be taken upon a viewer switching away from a channel, and an action to be taken upon a viewer switching into a channel.

The broadcaster may specify more than one type of selection criteria within a single DCC request. For example, it is possible to specify several individual zip codes by employing the loop structure within the DCC Table.

H2.1 Unconditional Switch

An unconditional switch would cause all viewers' channel, regardless of any other DCC selection criteria selected within the DCCRR, to switch to a specified virtual channel. A potential use of this criteria would be to aggregate viewers on different virtual channels to a single channel.

H2.2 Postal Code, Zip Code, or Location Code

A channel change based upon the viewer's location may be accomplished by using one or more of these criteria. Broadcasters may use these capabilities to provide targeted broadcast programming based upon a viewer's location within the viewing area.

H2.3 Program Identifier

A channel change based upon a broadcast program's episode and version number may be accomplished with this criteria. Use of this function would permit a broadcaster to direct a viewer's attention to a broadcast of a particular broadcast program having a certain episode and version number. If the viewer had previously enabled a function within the DCCRR that would “remember” a particular broadcast program’s episode/version number, the viewer could be directed to that broadcast program again upon detection of this criteria within the multiplex.

H2.4 Demographic Category

A Directed Channel Change may be accomplished using demographic categories as a switching criteria. Demographics such as age group and gender can be selected.

H2.5 Content Subject Category

A channel change based upon the subject matter of the content of the broadcast program can be accomplished. Nearly 140 categories of subject matter have been tabulated that can be assigned to describe the content of a broadcast program. A broadcaster may use this category of DCC request switching to direct a viewer to a broadcast program based upon the viewer’s desire to receive content of that subject matter. Although nearly 140 subject categories have been identified for inclusion in this revision of the specification, additional categories may be determined in the future and may be transmitted to the DCCRR through a table revision mechanism (the Directed Channel Change Selection Code Table).

H2.6 Authorization Level

A channel change may be accomplished using this mechanism in the event that the viewer attempts to switch to a virtual channel that he is not authorized to view. This category of DCC would permit the DCCRR to be directed to an alternative channel (such as a “barker” channel informing the viewer of his ineligibility to view the channel) instead of the channel the viewer attempted to tune.

H2.7 Content Advisory Level

This category of DCC is similar to that described in the preceding section (Authorization Level) but would redirect the viewer to another channel if the content advisory level in the DCCRR has been previously set above or below the value specified within this DCC request.

H2.8 User Specified Category

This category of DCC would allow a broadcaster to specify one of eight classifications of a broadcast program so that if a viewer pressed one of eight “viewer-direct-select” buttons on a remote control, he would be directed to a virtual channel airing a broadcast program having that classification. This function would permit a broadcaster to define classifications not anticipated by this standard and then permit the viewer to be directed to broadcast programs or segments having those classifications.

H2.9 Arriving/Departing Request

Two additional Directed Channel Change request actions are specified. A Departing Request descriptor may be used within a DCC signal the occurrance of a departing request or to cause a text box to appear for a definable amount of time prior to performing a channel change requested by the viewer. The text box may be used by the broadcaster to present information to the viewer, such as plot elements remaining in the broadcast program or upcoming segment schedule information.

An Arriving Request descriptor may be used to signal the occurrences of an arriving request or cause a text box to appear for a definable amount of time upon arrival at a newly tuned virtual channel. For example, the text box may be used by the broadcaster to convey story line information up to this point in time, or even broadcast program schedule change or preemption information such as a broadcast program delayed announcement due to the previous or current broadcast program running long.

H3. DOWNLOADABLE SELECTION CODE TABLE

Through an optional downloadable table mechanism called the Directed Channel Change Selection Code Table, up to 255 content descriptions and selection codes may be delivered to DCC capable DTV reference receivers over the broadcast link. The table may be updated in the future to provide additional, or alternate, selection categories. An initial set has been provided within this standard to permit a baseline capability which may be extended, if required, by industry agreement and revision to the standard.

Through a downloadable table mechanism within the Directed Channel Change Selection Code Table, data necessary for a viewer to identify the location of the DCCRR may also be acquired without placing stringent memory requirements upon DCCRR designs to accommodate potentially voluminous data useful only during setup.

The table is transmitted within the multiplex on a fairly infrequent basis - for example, no more frequently than once per hour. New category table editions may be identified by a table identification having a higher number than that currently loaded within the DCCRR.

21) Table Of Contents

Renumber Table Of Contents headings as necessary.