SMPTE RECOMMENDED PRACTICE

Conversion from CEA-708 Caption Data to SMPTE-TT

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Foreword

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SMPTE Engineering Documents are drafted in accordance with the rules given in Part XIII of its Operations Manual.

SMPTE RP 2052-11 was prepared by Technology Committee 24TB.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Engineering Document. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

Introduction

This section is entirely informative and does not form an integral part of this Engineering Document.

In North America, CEA-708 is in broad use as a distribution format for closed captioning and related data. In the United States (US), for digital transmission via Cable and Terrestrial Transmission, where captions are present, it is required by regulation.

Although not directly used as an authoring format, the syntax of CEA-708 is in widespread use. Most or all 708 captions are converted from 608 by machine. Arguably, SMPTE RP 2052-10 is sufficient to cover today's practices, since converting both would theoretically result in substantively the same SMPTE-TT. However, it appears that US regulatory activity could alter this state of authoring and having a well-defined conversion between 708 and SMPTE-TT would facilitate US Broadcast Television and Internet content interoperability early in adoption.

There are different levels of CEA-708 implementation and regulation that are useful background for the SMPTE RP 2052-11 audience.

1. CEA-708 has a full toolkit useful for comprehensive authoring and transmission of caption (and subtitle) data. Multiple languages, on-screen windows, etc are supported. This is referred to as "full-708", profile. It is proposed that SMPTE RP 2052-11 provide the necessary conversion tools to populate the SMPTE ST 2052-1 syntax and losslessly tunnel the 708 stream (including support for its CEA-608 compatibility bytes).

2. CEA-708 decoders, when compliant with FCC rules, support a limited toolkit and have constraints expected on the incoming data stream. These restrictions should have no impact to SMPTE RP 2052-11 other than informative notes for clarity. Incoming streams that are constrained should be maintained as such through the SMPTE RP 2052-11 conversion.

The primary use case is a tunnel to a target device that has MPEG-2 TS output capability and the 708 information needs to be reconstructed.

Requirements consist of the following:

1. Support the conversion of 'full-708' into SMPTE ST 2052-1

2. Provide for a lossless tunnel (using the SMPTE ST 2052-1 tunnel mechanism) of 708 cc_data() data structure including 608 compatibility bytes and other signaling.

3. Support both file-based and real-time streaming scenarios.

1   Scope

This document defines the preferred method of converting from CEA-708 data as defined in CEA-708 into SMPTE-TT (as defined in SMPTE ST 2052-1). This document details how such a conversion can be made, and defines some constraints on the process so that the resulting SMPTE-TT file is interoperable between SMPTE-TT implementations.

2   Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword "reserved" indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword "forbidden" indicates "reserved" and in addition indicates that the provision will never be defined in the future.

A conformant implementation according to this document is one that includes all mandatory provisions ("shall") and, if implemented, all recommended provisions ("should") as described. A conformant implementation need not implement optional provisions ("may") and need not implement them as described.

Unless otherwise specified, the order of precedence of the types of normative information in this document shall be as follows: Normative prose shall be the authoritative definition; Tables shall be next; followed by formal languages; then figures; and then any other language forms.

3   Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this recommended practice. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this recommended practice are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

CEA-708-D, Digital Television (DTV) Closed Captioning

SMPTE ST 2052-1:2013, Timed Text Format (SMPTE-TT)

Unicode Consortium, Unicode 6.0.0, http://unicode.org/versions/Unicode6.0.0/

4   Definitions and Acronyms

4.1   Definitions

CEA-608: The term is used in this document to refer to the CEA-608 standard or to a data stream complying to that standard, depending on context. CEA 608 closed captions are composed of a byte sequence which is carried embedded in a video signal, and which when played on a suitably equipped video device creates text captions on the display.

CEA-708: The term is used in this document to refer to the CEA-708 standard or to a data stream complying to that standard, depending on context. CEA 607 closed captions are composed of a byte sequence which is carried embedded in a compressed video stream, and which when played on a suitably equipped video device creates text captions on the display.

Chunk: A segment of a media timeline that forms part of a larger contiguous sequence of timeline segments where each segment has a 1 to 1 mapping with a SMPTE-TT document.

Namespace: Mechanism for scoping the definitions of names in an XML document.

Presentation Processor: Hardware or software that creates a visible rendition of a document as defined in W3C TTML.

4.2   Acronyms

CEA: Consumer Electronics Association

FCC: (US) Federal Communication Commission

SMPTE-TT: SMPTE Timed Text

TTML: (W3C) Timed Text Markup Language

W3C: World Wide Web Consortium

XML: eXtensible Markup Language

5   CEA-708 Data Mapping to SMPTE-TT

5.1   Introduction

This document defines a conversion from CEA-708 data into a SMPTE-TT document (or series of document chunks) that will, when presented using a conforming SMPTE-TT Presentation Engine, give a functionally equivalent display. In most cases there will be no single correct conversion, but multiple possible interpretations that will generate a similar outcome when rendered. The constraints given in this document are intended to promote consistency amongst implementations of SMPTE-TT processors and to improve interoperability of SMPTE-TT files when displayed on those different implementations.

CEA-708 data can be obtained primarily from digital video streams (MPEG-2 or H.264). It can also come from other methods such as directly from caption authoring file formats, although most CEA-708 data at this writing is converted from CEA-608. Many input formats may be acceptable so long as they enable the same cc_data() structure recreated by a presentation processor from tunneled data to conform to the CEA-708 standard.

There is no detailed buffering model for CEA-708 except to note that off-screen compositioning and rendering is required for all windows, in addition to the display memory. The text which is mapped to SMPTE-TT corresponds to the final text placed in the current display memory.

5.2   Conversion Constraints

SMPTE-TT documents converted from CEA-708 data shall have the constraints defined in Section 5 of this specification. The process of conversion from a specific CEA-708 data stream may lead to a number of possible SMPTE-TT documents; no unique conversion is defined by this document.

Although the US FCC regulations define minimum decoder functionality (in affect a strict profile of CEA-708), the conversion defined in this specification is a full conversion of CEA-708 except as noted. If the input is known to conform to the FCC minimum decoder functionality, the converter can set the metadata fccMinimum attribute.

5.3   SMPTE Namespaces for CEA-708

TTML allows for metadata to be added in private namespaces. The namespace for the extensions, including metadata, defined in this document shall be as defined in Table 1. An informative XML schema is defined in SMPTE RP 2052-11b.

When a prefix is used, SMPTE-TT documents should use the namespace prefix in Table 1. Although this prefix is used in examples throughout this specification the m708 namespace can also be the default. Also, it is assumed that if a full namespace declaration is not given in an example XML fragment in this document then the namespace in Table 1 is set in an outer context in the surrounding XML.

Table 1 – Namespace and Prefix

Prefix	Namespace
m708:	http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea708

5.4   Converting Metadata Information

The URI used for the origin attribute shall be:

http://www.smpte-ra.org/schemas/2052-1/2013/smpte- tt#cea708.

The attributes defined in this section should be added to the <smpte:information> element to encode the CEA-708 metadata for the caption service that was converted.

Additionally, when tunnel data is present, the metadata for all caption services should be encoded in the <m708:service> elements within the <smpte:information> element.

5.4.1   <m708:service> Element

This element should be used to convey the 708 metadata as defined in CEA-708, Section 4. One element shall be used for each caption service. It is a simple type with various attributes defined in this section. It is a child only of <smpte:information> (contained in <metadata>).

5.4.2 m708:number Attribute

This is the service number.

Type	unsigned integer
Values:	1-31 inclusive
Initial:	none
Applies to:	m708:service, smpte:information
Inherited:	no
Percentages:	N/A
Animatable:	none

5.4.3 xml:lang Attribute

This is the service language as defined by XML.

5.4.4 m708:aspectRatio Attribute

This is the aspect ratio.

Type	enumeration
Values:	4:3 or 16:9
Initial:	none
Applies to:	m708:service, smpte:information
Inherited:	no
Percentages:	N/A
Animatable:	none

5.4.5 m708:easyReader Attribute

This is "easy reader".

Type	Boolean
Values:	true or false
Initial:	none
Applies to:	m708:service, smpte:information
Inherited:	no
Percentages:	N/A
Animatable:	none

5.4.6 m708:fccMinimum Attribute

If the converter has knowledge that the service that has been converted conforms to the FCC minimum decoder functionality as defined in US 47CFR79.102, then this flag should be set.

Type	boolean
Values:	true or false
Initial:	false
Applies to:	m708:service, smpte:information
Inherited:	no
Percentages:	N/A
Animatable:	none

5.5   Caption Service Conversion

A separate logical sequence of SMPTE-TT chunks shall be created for each caption service. There is no multiplexing of more than one service per instance document. Note that up to 31 services are possible.

5.6   Preserved and Enhanced Modes

When converting, unless it is known that the exact replication of the visual appearance is required, Enhanced mode will give greater latitude to create a more conformant SMPTE-TT document. If exact replication is required, then Preserved mode should be set.

The Preserved mode of conversion for CEA-708 shall preserve the color, background spacing and timing of captions, including individual character timings in the various window compositing and visibility modes.

The Enhanced mode of conversion for CEA-708 shall retain equivalence classes of caption style, but may map to alternative specific styles (e.g., all text that is red in the original sequence shall be mapped to the same style class in the result, but the style applied need not be red). Timing for window visibility "on" commands shall be retained.

5.7   Header Information

Converted SMPTE-TT shall contain as a child element of the <head> element one <layout> element, containing at least one specific <region>. SMPTE-TT shall not rely on the default region of TTML.

Converted SMPTE-TT shall contain as child elements of the <head> element one <smpte:information> element with the origin attribute set to "http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea708", and the mode set to Preserved or Enhanced depending on which set of constraints from this document have been applied.

<smpte:image> and smpte:backgroundImage shall not be used in files converted from CEA-708.

5.8   Coordinate System

5.8.1   Region Mapping

In general, TTML regions are the representation of 708 windows. Windows shall be placed within the root container, with tts:origin and tts:extent ranges according to the constraints of CEA 708.

TTML regions do not "scroll" per se. Text flows into the region according to all the active text at any point in time. Text is effectively re-rendered at each point in time when text becomes, or is no longer, active. BY proper setting of tts:begin and tts:end, simulation of scrolling will occur.

5.8.2   Cursor Positioning

The converter shall emulate the cursor positioning of CEA-708, including control codes, and line wrap behavior. However, Unicode control codes are not be used, so the translator shall emulate the affect with appropriate text positioning and use of <br/>.

5.9   Chunk Mapping

Each significant alteration in the CEA-708 caption display shall be mapped into one SMPTE-TT chunk in the logical sequence. A significant alteration is any user visible change in the display (e.g. the addition or deletion of text).

Temporary changes of duration of less than the threshold time (as defined in SMPTE ST 2052-1, Section 5.7.4.1) and non-visible events are not considered significant alterations and shall not be mapped. For example, if the text "hilp me" is converted into "help me" using cursor positioning; and the letter "i" remains visible for less than the threshold time, then the letter "i" shall not be mapped.

Each significant alteration may be mapped into a unique chunk, or chunks may be aggregated together. This document does not place an upper bound on such aggregation.

The begin time of the mapped chunk, plus the offset time at which the SMPTE-TT display causes the corresponding effect to occur shall not differ from the origin event time by more than one frame.

One CEA-708 control event that will normally result in a significant alteration in the caption display is the DisplayWindow command.

For additions to a visible window in Preserve mode, every character placement may be a significant alteration.

5.10   Style Mapping

5.10.1 Color and Opacity

CEA-708 supports 64 colors specified by 4 levels each of red, green and blue. These are converted into the various color-based attributes in TTML. The most robust representation shall be used. In the general case the "#rrggbb" syntax will be needed. The minimum color list table (CEA-708, Table 29) is a subset of the nameColor values and thus likely to be usable in practice. The alternative minimum color list table (CEA-708, Table 30) does not match the defined namedColor values, but may be used when matched to the RGB values.

CEA-708 opacity has four levels, including "flashing". The other three levels, when applied to Windows (<region>) shall be mapped to tts:opacity according to Table 2. For foreground and background text, the opacity shall be mapped to alpha values in the tts:color and tts:backgroundColor attributes according to Table 3.

Table 2 – Window Opacity Conversion

CEA-708 Window Opacity	Description	tts:opacity
0	Solid	1.0
1	Flash	n/a – see below
2	Translucent	0.5
3	Transparent	0.0

Table 3 – Text Opacity Conversion

CEA-708 Text Opacity	Description	tts:color, tts:backgroundColor
0	Solid	rgba(r,g,b,255)
1	Flash	n/a – see below
2	Translucent	rgba(r,g,b,128)
3	Transparent	rgba(r,g,b,0)

Window flashing "opacity" should be accomplished with the <set> animation as described in TTML Section 11.1.1. Flashing for foreground and background text "opacity" should be done in a similar manner.

5.10.2 Font Styles

5.10.2.1 Font Size

CEA-708 supports three font sizes loosely defined as STANDARD, SMALL and LARGE. Details are decoder dependent, but for interoperable conversion purposes these shall be set according to Table 4.

Table 4 – Font Size Conversion

CEA-708 Font Size	Description	tts:fontSize
0	SMALL	0.5c
1	STANDARD	1c
2	LARGE	2c

5.10.2.2 Font Styles

CEA-708 supports eight font styles. There is no requirement to support any specific font, but the CEA-708 font style settings shall be set to tts:fontFamily values as defined in Table 5. Styles 5, 6 and 7 have no equivalent and are mapped to "default".

Table 5 – Font Style Conversion

CEA-708 Font Style	Description	tts:fontFamily
0	Default (undefined)	default
1	Monospaced with serifs (similar to Courier)	monospaceSerif
2	Proportionally spaced with serifs (similar to Times New Roman)	proportionalSerif
3	Monospaced without serifs (similar to Helvetica Monospaced)	monospaceSansSerif
4	Proportionally spaced without serifs (similar to Arial and Swiss)	proportionalSansSerif
5	Casual font type (similar to Dom and Impress)	casual
6	Cursive font type (similar to 6Coronet and Marigold)	cursive
7	Small capitals (similar to Engravers Gothic)	smallCaps

5.10.2.3 Edge Type and Edge Color

CEA-708 edge type does not have a direct mapping to TTML style, but is simulated with varying tts:textOutline settings. The color and type shall be mapped as defined in Table 6. The "[color]" symbol indicates a color encoding according to Section 5.10.1. It should be set to the same hue as the foreground color with a different luminance to simulate the shadow affect as displayed in CEA-708.

Table 6 – Edge Type and Color Conversion

CEA-708 Edge Type and Edge Color	Description	tts:textOutline
0	NONE	none
1	RAISED	[color] 5%
2	DEPRESSED	[color] 5% 5%
3	UNIFORM	[color] 10%
4	LEFT_DROP_SHADOW	[color] 5% 10%
5	RIGHT_DROP_SHADOW	[color] 10% 5%

5.10.2.4 Miscellaneous

Several CEA-708 font properties have a simple conversion:

- Italic, when set, shall result in tts:fontStyle="italic", else "normal".

- Underline, when set, shall result in tts:textDecoration="underline", else "none"

- Foreground Color shall set tts:color according to Section 5.10.1.

- Background Color shall set tts:backgroundColor according to Section 5.10.1.

- Edge Color chall set tts:textOutline according to Section 5.10.1.

There is no direct mapping of CEA-708 character offset to a TTML style (except for "NORMAL" of course). "SUBSCRIPT and "SUPERSCRIPT" have to be simulated with a change in size and position of the text.

5.10.2.5   Text Metadata

CEA-708 "pens" can have a "text tag" that is descriptive metadata about the text. The values are defined in CEA-708, Section 8.10.5.9 and repeated in Table 7 below for convenience. These shall be mapped to the ttm:Role attribute as defined in Table 7.

Table 7 – Text Tag Conversion

CEA-708 Text Tag	Description	ttm:role value
0	Dialog	dialog
1	Source or speaker ID	source
2	Electronically reproduced voice	reproduction
3	Dialog in language other than primary	x-smpte-subtitle
4	Voiceover	x-smpte-voiceover
5	Audible Translation	caption
6	Subtitle Translation	transcription
7	Voice quality description	quality
8	Song Lyrics	lyrics
9	Sound effect description	sound
10	Musical score description	x-smpte-musical-score
11	Expletive	expletive
12	(undefined)	dialog
13	(undefined)	dialog
14	(undefined)	dialog
15	Text not to be displayed	suppressed

5.10.3 Window Styles

5.10.3.1 Justify

CEA-708 supports four text justification settings. Values 0-2 shall be mapped to the textAlign settings defined in Table 8. Justify value 3 (FULL) has no direct mapping and shall either be set to "center" or simulated with explicit word spacing.

Table 8 – Justify Conversion

CEA-708 Justify	Description	tts:textAlign
0	LEFT	left
1	RIGHT	right
2	CENTER	center
3	FULL	center

5.10.3.2 Print Direction

CEA-708 supports four text print direction settings. The values shall be mapped to the tts:writingMode as defined in Table 9.The tts:writingMode values are also a function of the 708 window scroll direction setting. Only ½ of the print direction and scroll direction combinations are supported. Emulation would have to be done character by character in the defined direction.

Note that if scrolling actually occurs (in contrast to just flow within the region), then this must be simulated by the converter.

Table 9 – Print Direction Conversion

CEA-708 Print Direction	Description	Scroll Direction	tts:writingMode
0	LEFT_TO_RIGHT	TTB	lrtb
0	LEFT_TO_RIGHT	BTT	
1	RIGHT_TO_LEFT	TTB	rltb
1	RIGHT_TO_LEFT	BTT	
2	TOP_TO_BOTTOM	TTB	tblr
2	TOP_TO_BOTTOM	BTT	tbrl
3	BOTTOM_TO_TOP	TTB	
3	BOTTOM_TO_TOP	BTT	

5.10.3.3   Miscellaneous

One window style is easily mapped:

- When Word Wrap is set, converters shall set tts:wrapOption="wrap", else "noWrap".

Some affects are not supported directly and are more difficult to emulate, such as display affect and ts attributes:

- Display Effect (SNAP, FADE, WIPE)

- (WIPE) Effect Direction (ltr, rtl, ttb, btt)

- (WIPE and FADE) Effect Speed (seconds)

5.11   Character Mapping

5.11.1 Introduction

The 708 code sets shall be mapped to Unicode values as defined in the following tables in this section.

The C0 Code Set is control codes with no printable symbols, but is included here for completeness and potential semantic clarity from Unicode. TTML is not prescriptive about control code behavior, so translators SHALL NOT output Unicode control code and thus shall emulate their net effect according to Unicode.

C1 is the set of 708 commands also with no printable symbols and are thus the core of the translation according to the earlier provisions of this document.

Note that Code Sets C2 and C3 are undefined in CEA-708-D.

5.11.2 C0 Code Set

The following control codes are listed in Table 10 for convenience and potential semantic clarity from Unicode.

Table 10 – C0 Code Set

708 Code(s)	708 Symbol(s)	Unicode Value(s)	Unicode Description
00	NUL	0000	<control> NULL
03	ETX	0003	<control> End of Text
08	BS	0008	<control> Back Space
0C	FF	n/a	n/a This code is equivalent to 708 CLW command (88)
0D	CR	000D+00FF	<control> Carriage Return, then Form Feed
0E	HCR	000D	<control> Carriage Return
10	EXT1	n/a	n/a This code accesses the G2 and G3 code sets. See below.
18	P16	n/a	n/a This code accesses regional 16-bit character codes.

EXT1 (beyond the defined G2 and G3 symbols) and P16 are not defined and have no conversion to SMPTE-TT.

Note: There might be regional use of P16 that could be mapped by users of this specification into appropriate Unicode values, consistent with this specification.

5.11.3 G0 Code Set

The G0 codes 0x20-0x7E are identical to the Unicode values and are not enumerated in Table 11.

Table 11 – G0 Code Set

708 Code(s)	708 Symbol(s)	Unicode Value(s)	Unicode Description
20-7E	<misc>	0020-007E	<misc>
7F	Note	266A	Eighth Note

5.11.4 G1 Code Set

There are minor variations in the G1 symbols from the Unicode symbols (e.g. AA and BA) as drawn in the respective standards, but since both 708 and Unicode U0080 claim the symbols are intended to be "ISO 8859-1 Latin-1", then the variations are assumed to be equivalent. Since the codes are the same, they are not enumerated in Table 12.

Table 12 – G1 Code Set

708 Code(s)	708 Symbol(s)	Unicode Value(s)	Unicode Description
A0-FF	<misc>	00A0-00FF	<misc>

5.11.5 G2 Code Set

The G2 and G3 code sets are accessed by a double byte sequence starting with EXT1 (10). When encountering an undefined G2 or G3 code, decoders should present either a space (0020) or underline (005F).

Note: G2: 7A-7F do not match any Unicode symbols exactly, but a similar and useful collection of codes that enable box drawings are defined below.

Table 13 – G2 Code Set

708 Code(s)	708 Symbol(s)	Unicode Value(s)	Unicode Description
1020	TSP	n/a	[Note: command code, not a symbol]
1021	NBTSP	n/a	[Note: command code, not a symbol]
1025	…	2026	Horizontal ellipsis
102A		0160	Latin capital letter S with caron
102C		0152	Latin capital ligature OE
1030	Block	2588	Full block
1031	'	2018	Left single quotation mark
1032	'	2019	Right single quotation mark
1033	"	201C	Left double quotation mark
1034	"	201D	Right double quotation mark
1035	•	2022	Bullet
1039	TM	2122	Trade mark sign
103A		0161	Latin small letter S with caron
103C		0153	Latin small ligature OE
103D	SM	2120	Service mark sign
103F		0178	Latin capital letter Y with diaeresis
1076	1/8	215B	Vulgar fraction one eighth
1077	3/8	215C	Vulgar fraction three eighths
1078	5/8	215D	Vulgar fraction five eighths
1079	7/8	215E	Vulgar fraction seven eighths
107A		2502	Box drawings light vertical
107B		2510	Box drawings light down and left
107C		2514	Box drawings light up and right
107D		2500	Box drawings light horizontal
107E		2518	Box drawings light up and left
107F		250C	Box drawings light down and right

5.11.6 G3 Code Set

Table 14 – G3 Code Set

708 Code(s)	708 Symbol(s)	Unicode Value(s)	Unicode Description
10A0	[CC]		The 4-symbol sequence: "[CC]".

5.12   Time Mapping

CEA-708 captions do not define an intrinsic timecode or "presentation time", but instead rely on the frame delivery time of the caption packets. In order to map CEA-708 data to SMPTE-TT, the concept of "significant moments" is used, which are the times at which the CEA 708 display changes. An example of an event which causes a significant moment in CEA-708 would be the DisplayWindows command. The delivery time of this command would need to be converted to a begin attribute value on the respective SMPTE-TT elements. The text on display as a result of the command being executed would be converted into the contained SMPTE-TT text.

In order for event times to be defined, a zero frame shall be defined by command in the original CEA- 708 data. All times in the derived SMPTE-TT file shall then be defined from that event in terms of multiples of the field or frame rate of the video, converted into time values as defined by SMPTE-TT. Derived SMPTE-TT files shall use the 'media' clock mode of SMPTE-TT.

The full set of CEA-708 events, and their mappings to significant moments are defined in Table 15.

Not all significant moments are mapped to captions in the final document. Moments that are masked by a subsequent significant moment within the threshold time shall be ignored; and in Enhanced mode, groups of significant moments may be aggregated together.

Table 15 – Significant Moments for 708 Commands

708 Command	Significant Moments	Description
Set Current Window	<none>	(Only sets the target of following text)
DefineWindow w visible=1	When the window is created.	An empty region becomes visible
Clear Windows	On receipt	All identified regions are cleared of text but remain visible with background color restored.
Delete Windows	On receipt	All identified regions are cleared of text and made invisible.
Display Windows	On receipt	All identified regions are made visible.
Hide Windows	On receipt	All identified regions are made invisible.
Toggle Windows	On receipt	All identified region visibility is "toggled".
Set Window Attributes on a visible Window	On receipt	Update backgroundColor, region opacity, and edge styles
Set Pen Attributes	<none>	Only sets various internal attributes
Set Pen Color	<none>	Only sets internal tts:color
Set Pen Location	<none>	Only sets internal position
Delay	<none>	Alters the time of processing the next command.
Delay Cancel	<none>	Alters the time of processing the next command.
Reset	On receipt	Clear all regions and their visibility.
<control codes that would cause a scroll>	On receipt	Translator "cursor" position is updated, and region text is updated if a scroll would have occurred.

5.13 Tunneling CEA-708 Data

In mapping from CEA-708 data, it might be required as part of the process to preserve in the mapped SMPTE- TT document a stored version of the original data stream (as enabled by SMPTE ST 2052-1, Section 5.4). When the original CEA-708 data is stored, the cc_data() structure defined in CEA-708, Section 4.4 shall be converted to digital form for storage in the following manner.

Each cc_data() shall be encoded within a <data> element **in presentation time order** (not decode time order). The datatype attribute shall be set to "http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea708"

More than one cc_data() may be encoded in a single <data> element, with the boundaries determined by examining the cc_count field(s) until the data is exhausted.

Converters may choose to not encode empty cc_data() structures (608 bytes are either missing or null; and there is no 708 data present); and converters may also prune null 708 data (cc_valid=0), by adjusting cc_count. Sparse encoding (not a cc_data() for every video frame) means for the gaps that there is no 708 data present and the 608 compatibility bytes are null (with odd parity) {0x80, 0x80, 0x80, 0x80}. Removing the entire cc_data() is only practical in <body> since there is no signaling for how many cc_data() were omitted.

The <data> element may be placed within the <head> but should be interspersed throughout the document aligning with equivalently timed <div>, <p> or <span> elements. Note that this could require SMPTE-TT timing elements with no SMPTE-TT content.

Synchronization with video frames is done based on the external timing context of the document and (if <data> is used in <body>) also the timing information within the <body>. When <data> elements are located in the <head> the first cc_data() in the first <data> element shall be aligned with the first presented video frame; and all subsequent cc_data() structures shall be aligned with following sequentially presented video frames. When <data> elements are located in the <body> the first cc_data() within a timed element shall be aligned with the presented video frame corresponding to the time the containing element becomes active; and and all subsequent cc_data() structures in the same containing element shall be aligned with the following sequential video frames.

Downstream decoders reconstructing the cc_data() in the video are cautioned to reconstruct cc_data() sizes (including the "9600 bps") according to CEA-708 and the video encoding parameters of the reconstructed video. In the general case it might not be possible to reconstruct the cc_data() exactly as it was on the original source material.

Annex A Bibliography (Informative)

SMPTE RP 2052-10:2013, Conversion from CEA-608 Data to SMPTE-TT

SMPTE RP 2052-11a:2013, SMPTE-TT 708 Example XML Document

SMPTE RP 2052-11b:2013, SMPTE-TT 708 XML Schema

CEA-608-E, Line 21 Data Services

FCC Regulations – 47 CFR, Section 79.102, Closed Caption Decoder Requirements for Digital Television Receivers and Converter Boxes

Annex B Example Encoding (Informative)

An example converted document is shown in Table B.1. This is also in SMPTE RP2052-11a.

Table B.1 – Example Encoding XML Document.

```
<?xml version="1.0" encoding="UTF-8"?>
<tt xml:lang="en"
:xsi="http://www.w3.org/2001/XMLSchema-instance"
="http://www.w3.org/ns/ttml"
:tts="http://www.w3.org/ns/ttml#styling"
  xmlns:ttm="http://www.w3.org/ns/ttml#metadata"
  xmlns:ttp="http://www.w3.org/ns/ttml#parameter"
:smpte="http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt"
  xmlns:m708="http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea708"
 :schemaLocation="
              ://www.w3.org/ns/ttml
              -dfxp.xsd
              ://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt
              tt.xsd
              ://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea708
              tt-708.xsd">
  <head>
   <ttm:title>CEAv1.2zeroTT-708-S1</ttm:title>
   <ttm:desc>
              example of 708 Service 1 from CEAv1.2zero.trp.
              TTML content matches the 608 from which the 708 was transcoded rather than the precise 708 (with artifacts).
              focus of this example is for the 708 metadata and tunneling.
   </ttm:desc>
   <ttm:copyright>Copyright 2004-2012 CEA, SMPTE</ttm:copyright>
   <metadata>
                            <ttm:agent type="person"/>
                            <smpte:information mode="Preserved" origin="http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea708" m708:service="1"/>
   </metadata>
   <styling>
     <style xml:id='basic' tts:color='white' tts:backgroundColor="black" tts:fontFamily='monospace' tts:fontSize='100%' tts:fontWeight='bold' />
   </styling>
   <layout>
     <region xml:id="pop1" tts:origin="9c 13c" tts:extent="" tts:showBackground="whenActive"/>
   </layout>
  </head>
  <body>
   <div begin="00:00:03.77">
      <metadata>
                            <smpte:data encoding="Base64" datatype="http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea708">
                            <!-- Hex cc_data for easier debug
FF FC 80 80 FD 15 2C FF 43 42 FE 8C FF FE 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 94 2C FD 9D 20 FF 83 22 FE 8C FF FE 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 1C 20 FD 9D 2C FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 1C 2C FD 80 80 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
                            --
>/8gID9FSz/Q0L+jP/+AAD6AAD6AAD6AAD6AAD6AAD6AAD6AAD6AAD6AAD6AAD6AAD6AAD6AABU//yULP2dIP+DIv6M//4AAPoAAPoAAPoAAPoAAPoAAPoAAPoAAPoAAPoAAPoAAPoA//Bwg/Z0s+gAA+gAA+gAA+gAA+gAA+gAA+gAA+gAA+gAA+gAA
+gAA+gAA+gAA+gAA+gAAVP/8HCz9gID6AAD6AAD6AAD6AAD6AAD6AAD6AAD6AAD6AAD6AAD6AAD6AAD6AAD6AAA=
                            </smpte:data>
      </metadata>
   </div>
   <div begin="00:00:04.37">
      <metadata>
                            <smpte:data encoding="Base64" datatype="http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea708">
                            <!-- Hex cc_data for easier debug
FF FC 80 80 FD 15 20 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 94 20 FD 13 F4 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 13 F4 FD 97 A1 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 97 A1 FD 54 E5 FF CC 54 FE 98 00 FE 3C 00 FE 00 1F FE 11 92 FE 00 09 FE 91 2A FE 00 00 FE 90 05 FE 00 54 FE 65 03 FE 00 00 FA 00 00
FF FC 54 E5 FD 73 F4 FF 45 23 FE 34 FE 98 00 FE 3C 00 FE 00 1F FE 11 92 FE 00 09 FE 91 2A FE 00 00 FE 90 05 FE 00 54 FE 65 03 FE 43 73 FE 74 03 FE 00 00 FA 00 00
FF FC 73 F4 FD 20 43 FF 45 23 FE 73 74 FE 03 43 FE 20 43 FE 03 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 20 43 FD 61 70 FF 85 23 FE 20 43 FE 03 43 FE 61 70 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 61 70 FD F4 E9 FF C5 23 FE 61 70 FE 03 43 FE 74 69 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC F4 E9 FD EF 6E FF 05 23 FE 74 69 FE 03 43 FE 6F 6E FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC EF 6E FD 73 80 FF 45 23 FE 6F 6E FE 03 42 FE 73 03 FE 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 73 80 FD 94 D0 FF 83 22 FE 73 03 FE 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC D0 FD 97 A1 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 97 A1 FD C4 54 FF C8 4D FE 98 00 FE 3C 00 FE 01 1F FE 11 92 FE 01 01 FE 44 54 FE 03 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC C4 54 FD D6 20 FF 0A 2D FE 98 00 FE 3C 00 FE 01 1F FE 11 92 FE 01 01 FE 44 54 FE 03 43 FE 56 20 FE 03 00 FA 00 00 FA 00 00 FA 00 00
FF FC D6 20 FD C1 E3 FF 45 23 FE 56 20 FE 03 43 FE 41 63 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC C1 E3 FD E3 E5 FF 85 23 FE 41 63 FE 03 43 FE 63 65 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC E3 E5 FD 73 73 FF C5 23 FE 63 65 FE 03 43 FE 73 73 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 73 73 FD 20 D0 FF 05 23 FE 73 73 FE 03 43 FE 20 50 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 20 D0 FD F2 EF FF 45 23 FE 20 50 FE 03 43 FE 72 6F FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC F2 EF FD EA E5 FF 85 23 FE 72 6F FE 03 43 FE 6A 65 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC EA E5 FD E3 F4 FF C5 23 FE 6A 65 FE 03 43 FE 63 74 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC E3 F4 FD 2C 20 FF 05 23 FE 63 74 FE 03 43 FE 2C 20 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 2C 20 FD 57 C7 FF 45 23 FE 2C 20 FE 03 43 FE 57 47 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 57 C7 FD C2 C8 FF 85 23 FE 57 47 FE 03 43 FE 42 48 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC C2 C8 FD AD CE FF C5 23 FE 42 48 FE 03 43 FE 2D 4E FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC AD CE FD 43 C1 FF 05 23 FE 2D 4E FE 03 43 FE 43 41 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 43 C1 FD C0 80 FF 45 23 FE 43 41 FE 03 42 FE 4D 03 FE 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC CD 80 FD 94 70 FF 83 22 FE 4D 03 FE 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 94 70 FD 97 23 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 97 23 FD A8 F2 FF C8 4D FE 98 00 FE 3C 00 FE 02 1F FE 11 92 FE 02 03 FE 28 72 FE 03 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC A8 F2 FD 75 6E FF 0A 2D FE 98 00 FE 3C 00 FE 02 1F FE 11 92 FE 02 03 FE 28 72 FE 03 43 FE 75 6E FE 03 00 FA 00 00 FA 00 00 FA 00 00
FF FC 75 6E FD 6E E9 FF 45 23 FE 75 6E FE 03 43 FE 6E 69 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 6E E9 FD 6E 67 FF 85 23 FE 6E 69 FE 03 43 FE 6E 67 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 6E 67 FD 20 F4 FF C5 23 FE 6E 67 FE 03 43 FE 20 74 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 20 F4 FD E9 6D FF 05 23 FE 20 74 FE 03 43 FE 69 6D FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC E9 6D FD E5 BA FF 45 23 FE 69 6D FE 03 43 FE 65 3A FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC E5 BA FD 20 34 FF 85 23 FE 65 3A FE 03 43 FE 20 34 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 20 34 FD 20 6D FF C5 23 FE 20 34 FE 03 43 FE 20 6D FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 20 6D FD E9 6E FF 05 23 FE 20 6D FE 03 43 FE 69 6E FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC E9 6E FD AE 20 FF 45 23 FE 69 6E FE 03 43 FE 2E 20 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC AE 20 FD 31 B5 FF 85 23 FE 2E 20 FE 03 43 FE 31 35 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
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FF FC 20 73 FD E5 E3 FF 05 23 FE 20 73 FE 03 43 FE 65 63 FE 03 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
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```

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        </smpte:data>
     </metadata>
    </div>
   <div region="pop1" style="basic" xml:space="preserve">
          <p begin="00:00:05.87" end="00:00:12.98">Test Captions
 DTV Access Project, WGBH-NCAM
  (running time: 4min. 15 sec.)</p>
          </div>
   <div begin="00:00:07.64">
       <metadata>
          <smpte:data encoding="Base64" datatype="http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea708">
          <!-- Hex cc data for easier debug -->

FF FC 80 80 FD 9D 20 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 1C 20 FD 1C D0 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 1C D0 FD A8 43 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC A8 43 FD 43 34 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 43 32 FD 29 20 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 29 20 FD 54 68 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 54 68 FD E9 73 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC E9 73 FD 20 64 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 20 64 FD 61 F4 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 61 F4 FD 61 20 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
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FF FC E9 73 FD 1C 70 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 1C 70 FD E9 6E FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC E9 6E FD 20 43 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 20 43 FD 61 70 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
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FF FC 20 43 FD 68 61 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
FF FC 68 61 FD 6E 6E FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00 FA 00 00
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Annex C US FCC Profile Information (Informative)

US FCC regulations (47 CFR, Section 79.102) do not require full support for code set G2, and define some acceptable alternative symbols from G0 and G1. Support for G3 (just the CC symbol) is not required. When encountering an undefined G2 code, decoders should present either a space (0020) or underline (005F). When encountering an undefined G3 code, decoders shall present an underline (005F).

Table C.1 – G2 Code Set – US FCC Alternative Codes

708 Code(s)	708 Symbol(s)	Alternative Unicode Value(s)	Unicode Description
1020	TSP	n/a	[Note: command code, not a symbol]
1021	NBTSP	n/a	[Note: command code, not a symbol]
1025	…	005F	Low line
102A		0160	Latin capital letter S with caron
102C		0152	Latin capital ligature OE
1030	Block	2588	Full block
1031	'	0027	Apostrophe
1032	'	0027	Apostrophe
1033	"	0022	Quotation mark
1034	"	0022	Quotation mark
1035	•	00B7	Middle dot
1039	TM	2122	Trade mark sign
103A		0161	Latin small letter S with caron
103C		0153	Latin small ligature OE
103D	SM		[Note: FCC neither requires nor prescribes an alternative.]
103F		0178	Latin capital letter Y with diaeresis
1076	1/8	0025	Percent sign
1077	3/8	0025	Percent sign
1078	5/8	0025	Percent sign
1079	7/8	0025	Percent sign
107A		002D	Hyphen-minus
107B		002D	Hyphen-minus
107C		002D	Hyphen-minus
107D		002D	Hyphen-minus
107E		002D	Hyphen-minus
107F		002D	Hyphen-minus