SMPTE RP 2052-10:2013
Revision of
SMPTE RP 2052-10:2012

SMPTE RECOMMENDED PRACTICE

Conversion from CEA-608 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 Administrative Practices.

SMPTE RP 2052-10 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.

1 Scope

This recommended practice document defines the preferred method of converting from CEA-608 data streams to 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 translation 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.

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

CEA-608-E (ANSI) (2008), Line 21 Data Services

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.

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 TML.

SMPTE-TT document: an encoding of some XML content conforming to the SMPTE-TT document type.

4.2 Acronyms

TTML: (W3C) Timed Text Markup Language

CEA: Consumer Electronics Association

SMPTE-TT: SMPTE Profile of W3C Timed Text

TTML: (W3C) Timed Text Markup Language

W3C: World Wide Web Consortium

XML: eXtensible Markup Language

XDS: eXtended Data System

5 CEA-608 Data Mapping to SMPTE-TT

This document defines conversion from CEA-608 data streams to 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 translation, 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-608 data can be obtained from various sources, including extraction from the NTSC line 21 waveform, data carried in line 21 of serial digital interface video or other methods such as directly from caption authoring file formats. Many formats may be acceptable so long as they enable the output waveform recreated by a presentation processor from tunneled data to conform to the CEA-608 standard.

The reference model for CEA-608 captioning contains two 32 x 15 character memories, one of which corresponds to the currently displayed captions, and another which is an off-screen composition area. The text which is mapped to SMPTE-TT corresponds to the text placed in the current display memory.

5.1 Conversion Constraints

SMPTE-TT documents converted from CEA-608 data streams shall have the constraints defined in Section 5 of this specification. The process of translation from a specific CEA-608 data stream may lead to a number of possible SMPTE-TT documents; no unique conversion is defined by this document.

5.2 SMPTE Namespaces for CEA-608

TTML allows for metadata to be added in private namespaces. SMPTE-TT documents need not use the prefixes below, although such prefixes are used in examples throughout this specification. It is assumed that if a full namespace declaration is not given in an example XML fragment then the definitions in Table 1 – Namespaces are set in an outer context in the surrounding XML.

Table 1 – Namespaces

Name	Prefix	Value
608 metadata	m608:	http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea608

5.3 Translating Metadata Information

The URI used for the origin attribute shall be: http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea608.

An informative XML schema is published as RP 2052-10b and posted online here:
http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt-608.xsd

The following metadata attributes may be added to the smpte:information item.

5.3.1 m608:channel

The channel(s) from which the translation was made. This applies to the content of the translated content of the document only, not the tunneled data.

Values:	(CC1 | CC2 | CC3 | CC4)
Initial:	CC1
Applies to:	smpte:information
Inherited:	no
Percentages:	N/A
Animatable:	none

5.3.2 m608:fieldStart

Determines the field association with the first two bytes of tunneled data (see Section 5.10). This does not apply to the translated content of the document. When tunneled data is present, this attribute shall be present.

Values:	1 | 2
Initial:	1
Applies to:	smpte:information
Inherited:	no
Percentages:	N/A
Animatable:	none

5.3.3 XDS Data attribute: Program Name (m608:programName)

Values:	<string> | none
Initial:	none
Applies to:	smpte:information
Inherited:	no
Percentages:	N/A
Animatable:	none

The values of this attribute, when used, shall be set to the string of ASCII characters in the XDS packet as defined in CEA-608, Section 9.5.1.3.

Program name may be carried in composite XDS Data, or in its own packet in the CEA-608 data. Either form may be used to set this attribute, however if program name is specified in both forms, then that specified in its own packet shall take precedence for setting this attribute.

5.3.4 XDS Data attribute: Program Type (m608:programType)

Values:	<string> | none
Initial:	none
Applies to:	smpte:information
Inherited:	no
Percentages:	N/A
Animatable:	none

The values of this attribute, when used, shall be set to the list of 2-character hex codes listed in CEA-608, Section 9.5.1.4.

5.3.5 XDS Data attribute: Content Advisory (m608:contentAdvisory)

Values:	<string> | none
Initial:	none
Applies to:	smpte:information
Inherited:	no
Percentages:	N/A
Animatable:	none

The values of this attribute, when used, shall be set to the 4-character hex representation of the 2-byte payload according to CEA-608, Section 9.5.1.5:

5.3.6 XDS Data attribute: Caption Services (m608:captionService)

Values:	<string>
Initial:	none
Applies to:	smpte:information
Inherited:	no
Percentages:	N/A
Animatable:	none

Note: The values of this attribute are drawn from CEA-608, Section 9.5.1.7

The original data for this attribute is in binary format. The value of this string is constructed by the concatenation of the field value strings in Table 2 separated by whitespace, from 1 up to 7 field values. xml:lang shall be set to the language codes in Table 3.

Table 2 – Field and Channel mapping

608 Binary value	Meaning	Field Value
0 0 0	field one, channel C1, captioning	F1C1CC
0 0 1	field one, channel C1, Text	F1C1TX
0 1 0	field one, channel C2, captioning	F1C2CC
0 1 1	field one, channel C2, Text	F1C2TX
1 0 0	field two, channel C1, captioning	F2C1CC
1 0 1	field two, channel C1, Text	F2C1TX
1 1 0	field two, channel C2, captioning	F2C2CC
1 1 1	field two, channel C2, Text	F2C2TX

5.3.7 XDS Data attribute: Copy and Redistribution Control Packet (m608:copyAndRedistributionControl)

Values:	<string>
Initial:	None
Applies to:	smpte:information
Inherited:	No
Percentages:	N/A
Animatable:	None

The values of this attribute, when used, shall be set to the 4-character hex representation of the 2-byte payload according to CEA-608, Section 9.5.1.8

5.3.8 XDS Data attribute: Audio Services (xml:lang)

If XDS caption services packet is not present, then xml:lang shall be set according to this paragraph. If the SMPTE-TT document is encoding the Primary Synchronous Caption Service (CC1) then the content is primary language captioning data in the same language; thus the language code used on the root xml:lang attribute shall be the ISO language code defined by the “Main” audio language bits of the XDS Audio Service (see CEA-608, Section 9.5.1.6) from Table 3 – Language codes:

Table 3 – Language codes

L2	L1	L0	Language	xml:lang code
0	0	0	Unknown	“”
0	0	1	English	“en”
0	1	0	Spanish	“es”
0	1	1	French	“fr”
1	0	0	German	“de”
1	0	1	Italian	“it”
1	1	0	Other	“”
1	1	1	None	“”

If the SMPTE-TT document is encoding the Secondary Synchronous Caption Service (CC2 or CC3), then the content is secondary language captioning data in the same language; thus the language code used on the root xml:lang attribute shall be the ISO language code defined by the “SAP” audio language bits of the XDS Audio Service (see CEA-608, Section 9.5.1.6).

If the XDS Audio Service packet and the XDS Captions Services packet are both not present; or the SMPTE-TT document is encoding from one of the Special Non-synchronous channels (CC2, CC4), then the xml:lang attribute should be set to the null string. Additionally, if the converted document contains only tunnel information and no presentation elements, xml:lang should be set to the empty string.

5.3.9 Additional XDS data

Translation of other XDS data, such as V-chip rating, time data, and text streams, are not defined by this specification but, if required, may be translated in a similar manner into a private namespace.

5.3.10 XDS Data example

The following example illustrates the use of CEA-608 XDS Data items to define a conversion from the captions of an English language news program:

```
<smpte:information
     xmlns:m608="http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea608"
     origin="http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea608" mode="Enhanced"
     m608:channel="CC1" m608:programName="Six O'clock News" m608:captionService ="F1C1CC"
/>
```

5.4 Channel Conversion

A separate logical sequence of SMPTE-TT chunks shall be created for each of CC1, CC2, CC3 and CC4 channels where present.

5.5 Preserved and Enhanced Modes

When translating from existing CEA-608 information, 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 will be needed.

The Preserved mode of translation for CEA-608 shall preserve the color, background spacing and timing of captions, including individual character timings in rollup and paint on mode.

The Enhanced mode of translation for CEA-608 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 pop-on style captions shall be retained; timing for rollup and paint on style may be approximated and may be converted to pop on style.

5.6 Header Information

Translated 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.

Translated SMPTE-TT shall contain as child elements of the <head> element (enclosed in <metadata>) one <smpte:information> element with the origin attribute set to “http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea608”, 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-608 .

5.7 Region Mapping

When SMPTE-TT documents are bound to a video track, the root container shall be the coded video height and width. If there is no specific binding to a video track and no tts:extent attribute on <tt>, then the root container extent shall be 640x480.

5.7.1 Pop-on regions

CEA-608 allows a maximum of four rows of caption text displayed simultaneously. For the pop-on mode, these rows may be placed anywhere on the screen and are not necessarily contiguous. Therefore each chunk of SMPTE-TT representing the caption may contain up to four regions for pop-on mode captions.

Translated SMPTE-TT that converts from pop-on captions shall contain as a child element of the <layout> element a <region> element with the id “pop1”. An example is given in Table 4 – Example of pop-on captions.

Table 4 – Example of pop-on captions

```
   <layout>
     <region xml:id='pop1' tts:backgroundColor='transparent'>
       <set begin='00:00:03:04' end='00:00:06:08' tts:origin='123px 193px' />
     </region>
  </layout>
```

Translated documents may also contain as child elements of the <layout> element additional <region> elements with the ids “pop2”, “pop3” or “pop4”. The additional <region> elements shall be included if the caption sequence to be translated requires more than 1, 2 or 3 non-contiguous lines to be displayed simultaneously.

The default <region> element background shall be transparent. Content elements placed in this region may specify a color background. The default <p> element background shall be black. If using addition color backgrounds from CEA-608, the default foreground color shall be other than the specified background color.

Translated SMPTE-TT shall use a single multiline <region> when the displayed lines are contiguous in the origin sequence. In such cases the lowest unused id shall be used to label the combined region.

Two lines are considered contiguous for the purpose of region combining if the initial cursor positions have the same column number, the row number differs by exactly 1. An example is given in Table 5 – Example use of <br>.

Table 5 – Example use of <br>

```
   <p region='pop1' style='basic' xml:space='preserve'
        begin='00:00:03:04' end='00:00:06:08'><span tts:backgroundColor='black'
tts:color='white' >Line 1,<br/><br/>Line 3</span>
   </p>
```

Otherwise each distinct output line may map to a separate region, as shown in Table 6 – Example using separate regions.

Table 6 – Example using separate regions

```
    <p region='pop1' style='basic' xml:space='preserve'
         begin='00:00:03:04' end='00:00:06:08'><span tts:backgroundColor='black'
tts:color='white' >Line 1,</span>
    </p>
    <p region='pop2' style='basic' xml:space='preserve'
            begin='00:00:03:04' end='00:00:06:08'><span
tts:backgroundColor='black' tts:color='white' >Line 3</span>
  </p>
```

Or each line may be placed in single region with leading whitespace as shown in Table 7 – Example using a single region.

Table 7 – Example using a single region

```
    <p region='pop1' style='basic' xml:space='preserve'
         begin='00:00:03:04' end='00:00:06:08'><span tts:backgroundColor='black'
tts:color='white' >Line 1,<br/><br/>    Line 3</span>
    </p>
```

5.7.2 Roll-up regions

In CEA-608 roll-up mode the displayed lines are contiguous.

Each SMPTE-TT file that translates from roll-up captions in preserve mode shall contain as a child element of the <layout> element, a <region> element with the id “rollup”. Roll-up regions may use explicit TTML timing and repetition to replicate the rollup style.

5.7.3 Paint-on regions

Each SMPTE-TT file that translates from paint-on captions in preserve mode shall contain as a child element of the <layout> element, a <region> element with the id “paint”. Translated documents may also contain as child elements of the <layout> element additional <region> elements with the ids “paint2”, “paint3” or “paint4”.

Paint on translation in preserve mode may use explicit timing using span elements for replaced text, or may use repetition of complete captions as shown in Table 8 – Example of repetition using span.

Table 8 – Example of repetition using span

```
    <p region='paint' style='basic' begin='00:00:01:00' end='00:00:04:00'>This sentence
contains a <span dur='2s'>replaced</span><span begin='2s' dur='2s'
tts:color='red'>replaced</span> word</p>
```

The above example changes the color of the word ‘replaced’ to red half way through the caption presentation. The same visual result can be achieved by repeating the caption twice as shown in Table 9 – Example repeating the caption.

Table 9 – Example repeating the caption

```
    <p region='paint' style='basic' begin='00:00:01:00' end='00:00:02:00'>This sentence
contains a replaced word</p>
    <p region='paint' style='basic' begin='00:00:02:00' end='00:00:04:00'>This sentence
contains a <span tts:color='red'>replaced</span> word</p>
```

The latter is easier to compute from a CEA-608 stream, but results in a larger output file.

5.8 Cursor Positioning

5.8.1 Chunk mapping

Each significant alteration in the CEA-608 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-608 control event that will normally result in a significant alteration in the caption display is the swapping of the offscreen and onscreen buffers caused by an End of Caption command in pop on mode.

For roll-up captions in preserve mode, every character placement may be a significant alteration.

For paint-on captions in preserve mode conversion each visible change may be a significant alteration. Enhance mode translation may regard the final line as the only significant alteration.

5.8.2 Preamble codes

In pop-on style captions, the preamble codes used to set the row and column shall be applied to the <region> element to which the text will be placed. The origin of the region should be set to the row and column using an appropriate metric. If the exact video size is known, then px units may be used; otherwise the % or c units should be used. If multiple lines are to be set in the same region, then the leftmost such line should be used to set the horizontal position of the region. Other lines placed in the region shall use whitespace indentation.

If a <region> is only used once (that is, the chunk is for a single caption), then the style can be applied directly to the region. If not then the style should be applied using the <set> animation mechanism to occur at the appropriate time. See example in Table 17 – Example caption conversion – whole document.

Tab Offset commands at the start of line shall be mapped to region positioning. Tab Offset commands within a line can affect the final text of the caption (see Section 5.9.2), but shall not be mapped to positioning in SMPTE-TT.

CEA 608 Data is typically authored such that the 32x15 character grid of displayed captions lies within the so called safe title area of the video picture area. SMPTE-TT regions are typically more closely fitting to the contained text and are set in reference to the full video area, so will not necessarily fall within the safe area. Thus converters shall set the ttp:cellResolution attribute so that a 32x15 character grid will lie within the safe area and will place regions based on percentage metrics, so that the default font size of 1c in height, and cell positioning will work as expected. For example, for content authored with an 80%H and 80%V safe title area, an origin=”10% 10%” would be correspond to the top left hand corner of the safe title area, and the required ttp:cellResolution=”40 19”.

For example the CEA-608 preamble sequence: 0x1774 0x1722 moves to the cursor to row 8 column 10. causing subsequent text output to be displayed at that position. To create the same behavior in SMPTE-TT the text must be placed in a region, and the region origin moved so that the text is in the correct position. For example, assuming an 80% safe title area, by applying <set tts:origin=”25% 42% “ …> to the <region> element that, when using a monospace font, maps to the expected lines and columns for CEA-608.

Note: Very early CEA-608 caption files were constrained not to use rows 5-11; subsequently when use of these rows was permitted, the cursor would be positioned twice, once in an outer row, and then again in the middle rows. Older devices (such as the TeleCaption II) would not respect the second move; thus the captions would be visible but not in the optimal place. Newer devices (CEA-608 compliant) would respect the newer move, cancelling the first move.

When translating to SMPTE-TT only the final position of the region shall be translated.

Subsequent text after all the preamble code and before the cursor moves to a different row shall be wrapped in a <p> element, with region attribute set to map the text into the appropriate region. The start time of the <p> should be calculated to match the time defined in Section 5.9.4; the end time of any text currently mapped into the region should be calculated similarly.

Note: For subsequent text lines in merged regions, no preamble positioning is required, and text may be wrapped in a <p> </p> sequence.

5.9 Style Mapping

5.9.1 Default style

The default style applied to SMPTE-TT caption regions when converting from CEA-608 shall be white foreground, black background, monospace font, no text decoration, single height and non-outlined text. This state corresponds to the presumed conditions at the beginning of each displayed row.

Table 10 – Basic style settings indicates the CEA-608 style settings, and their mapping into SMPTE-TT.

Table 10 – Basic style settings

Blue Italics	tts:color='blue' tts:fontStyle='italic'
Blue	tts:color='blue'
Blue Underline	tts:color='blue' tts:text Decoration='underline'
Blue Underline Italics	tts:color='blue' tts:textDecoration='underline' tts:fontStyle='italic'
Cyan	tts:color='cyan'
Cyan Italics	tts:color='cyan' tts:fontStyle='italic'
Cyan Underline	tts:color='cyan' tts:textDecoration='underline'
Cyan Underline Italics	tts:color='cyan' tts:textDecoration='underline' tts:fontStyle='italic'
Green	tts:color='green'
Green Italics	tts:color='green' tts:fontStyle='italic'
Green Underline	tts:color='green' tts:textDecoration='underline'
Green Underline Italics	tts:color='green' tts:textDecoration='underline' tts:fontStyle='italic'
Magenta	tts:color='magenta'
Magenta Italics	tts:color='magenta' tts:fontStyle='italic'
Magenta Underline	tts:color='magenta' tts:textDecoration='underline'
Magenta Underline Italics	tts:color='magenta' tts:textDecoration='underline' tts:fontStyle='italic'
Red	tts:color='red'
Red Italics	tts:color='red' tts:fontStyle='italic'
Red Underline	tts:color='red' tts:textDecoration='underline'
Red Underline Italics	tts:color='red' tts:textDecoration='underline' tts:fontStyle='italic'
White	tts:color='white'
White Italics	tts:color='white' tts:fontStyle='italic'
White Underline	tts:color='white' tts:textDecoration='underline'
White Underline Italics	tts:color='white' tts:textDecoration='underline' tts:fontStyle='italic'
Yellow	tts:color='yellow'
Yellow Italics	tts:color='yellow' tts:fontStyle='italic'
Yellow Underline	tts:color='yellow' tts:textDecoration='underline'
Yellow Underline Italics	tts:color='yellow' tts:textDecoration='underline' tts:fontStyle='italic'

The default style shall be present in each of the defined captions. It may be indicated by reference or as inline style. An example of referenced style is shown in Table 11 – Example of referenced style..

Table 11 – Example of referenced style

```
    <styling>
       <style xml:id='basic' tts:color='white'
                             tts:fontFamily='monospace'
                             tts:lineHeight='100%'
                             tts:fontSize='1c'
                             tts:fontWeight='bold' />
     </styling>
…
     <p region='pop1' style='basic' ... </p>
```

5.9.2 Mid row codes

The effects of mid row codes shall be mapped to SMPTE-TT <span> elements with the appropriate style sets. Attribute precedence shall be supported by not converting the masked styles, for example, the command sequence [82h 01h], (underline and red) would map to:

<span tts:foreground=”red”>

ignoring the masked control codes; whereas [01h 82h] would map to:

<span tts:foreground=”red” tts:fontDecoration=”underline” >

Note: It is possible using CEA-608 mid row codes to set up a sequence such as the following:

Red, red underlined, blue underlined, blue

Since SMPTE-TT is XML based and uses nesting, it is not possible to map both reds to one span, and both underlines to one span; this sequence would have to be mapped to four individual spans.

For this reason mid row translation for CEA-608 shall be restricted to a single level of nested spans, and that each affected property shall be repeated.

5.9.3 Foreground and background style

The additional foreground and background styles from CEA-608 Table 3 (Background and Foreground Attribute Codes) may be either mapped to SMPTE-TT styles defined in Table 12 – Foreground and background style mapping, or may be mapped to black. Background styles shall be applied to the <span> element containing the text, and not the <p> or <region>, elements. The latter would cause additional whitespace to be affected by the background change.

Table 12 – Foreground and background style mapping

Mnemonic	Style	SMPTE-TT style
BWO	Background White, Opaque	tts:backgroundColor='FFFFFFFF'
BWS	Background White, Semi-transparent	tts:backgroundColor='88FFFFFF'
BGO	Background Green, Opaque	tts:backgroundColor='FF00FF00'
BGS	Background Green, Semi-transparent	tts:backgroundColor='8800FF00'
BBO	Background Blue, Opaque	tts:backgroundColor='FFFFFFFF'
BBS	Background Blue, Semi-transparent	tts:backgroundColor='88FFFFFF'
BCO	Background Cyan, Opaque	tts:backgroundColor='FFFFFFFF'
BCS	Background Cyan, Semi-transparent	tts:backgroundColor='88FFFFFF'
BRO	Background Red, Opaque	tts:backgroundColor='FFFFFFFF'
BRS	Background Red, Semi-transparent	tts:backgroundColor='88FFFFFF'
BYO	Background Yellow, Opaque	tts:backgroundColor='FFFFFFFF'
BYS	Background Yellow, Semi-transparent	tts:backgroundColor='88FFFFFF'
BMO	Background Magenta, Opaque	tts:backgroundColor='FFFFFFFF'
BMS	Background Magenta, Semi-transparent	tts:backgroundColor='88FFFFFF'
BAO	Background Black, Opaque	tts:backgroundColor='FFFFFFFF'
BAS	Background Black, Semi-transparent	tts:backgroundColor='88FFFFFF'
BT	Background Transparent	tts:backgroundColor='FFFFFFFF'
FA	Foreground Black	tts:backgroundColor='88FFFFFF'
FAU	Foreground Black Underline	tts:backgroundColor='FFFFFFFF'

5.9.3.1 112 standard characters

The 112 standard characters shall be mapped onto Unicode code points as defined by Table 13 – Unicode Mappings – standard characters.

Table 13 – Unicode Mappings – standard characters

upper-case alphabet	A – Z	0041 – 005A
lower-case alphabet	a – z	0061 – 007A
numerals	0 – 9	0030 – 0039
accented letters	á à â ç é è ê í î Ñ ñ ó ô ú û	00E1 LATIN SMALL LETTER A WITH ACUTE (equivalently 0061+0301 a with combining acute accent) 00E0 LATIN SMALL LETTER A WITH GRAVE (equivalently 0061+0300 a with combining grave accent) 00E2 LATIN SMALL LETTER A WITH CIRCUMFLEX (equivalently 0061+0302 a with combining circumflex accent) 00E7 Minuscule ç (equivalently 0063+0327 a with combining cedilla) 00E9 LATIN SMALL LETTER E WITH ACUTE (equivalently 0065+0301 e with combining acute accent) 00E8 LATIN SMALL LETTER E WITH GRAVE (equivalently 0065+0300 e with combining grave accent) 00EA LATIN SMALL LETTER E WITH CIRCUMFLEX (equivalently 0065+0302 e with combining circumflex accent) 00ED LATIN SMALL LETTER I WITH ACUTE (equivalently 0061+0301 i with combining acute accent) 00EE LATIN SMALL LETTER I WITH CIRCUMFLEX (equivalently 0069+0302 i with combining circumflex accent) 00D1 LATIN CAPITAL LETTER N WITH TILDE (equivalently 004E+0303 N with combining tilde) 00F1 LATIN SMALL LETTER N WITH TILDE (equivalently 006E+0303 n with combining tilde) 00F3 LATIN SMALL LETTER O WITH ACUTE (equivalently 006F+0301 o with combining acute accent) 00F4 LATIN SMALL LETTER O WITH CIRCUMFLEX (equivalently 006F+0302 o with combining circumflex accent) 00FA LATIN SMALL LETTER U WITH ACUTE (equivalently 0075+0301 u with combining acute accent 00FB LATIN SMALL LETTER U WITH CIRCUMFLEX (equivalently 0075+0302 u with combining circumflex accent
punctuation and signs	! , . : ; ' " # % & @ / ( ) [ ] + - ÷ < = > ? ° ¢ $ £ ® ™ ½ ¿	0021 ! EXCLAMATION MARK 002C , COMMA 002E . FULL STOP 003A : COLON 003B ; SEMICOLON 0027 ' APOSTROPHE 0022 " QUOTATION MARK 0023 # NUMBER SIGN 0025 % PERCENT SIGN 0026 & AMPERSAND 0040 @ COMMERCIAL AT 002F / SOLIDUS 0028 (LEFT PARENTHESIS 0029) RIGHT PARENTHESIS

		005B [LEFT SQUARE BRACKET 005D] RIGHT SQUARE BRACKET 002B + PLUS SIGN 002D - HYPHEN-MINUS 00F7 ÷ DIVISION SIGN 003C < LESS-THAN SIGN 003D = EQUALS SIGN 003E > GREATER-THAN SIGN 003F ? QUESTION MARK 00B0 ° DEGREE SIGN 00A2 ¢ CENT SIGN 0024 $ DOLLAR SIGN 00A3 £ POUND SIGN 00AE ® REGISTERED SIGN 2122 ™ TRADE MARK 00BD ½ VULGAR FRACTION ONE HALF 00BF ¿ INVERTED QUESTION MARK
other characters	music note, standard space, transparent space, solid block	26AA ♪ EIGHTH NOTE 0020 SPACE 0020 SPACE 2588 █ FULL BLOCK

5.9.3.2 Extended characters

The additional characters referenced in CEA-608 shall be mapped onto Unicode code points as defined in Table 14 – Unicode Mappings – additional characters.

Table 14 – Unicode Mappings – additional characters

Extended Character Set—Spanish	Á É Ó Ú Ü ü ‘ ¡	00C1 LATIN CAPITAL LETTER A WITH ACUTE 00C9 LATIN CAPITAL LETTER E WITH ACUTE 00D3 LATIN CAPITAL LETTER O WITH ACUTE 00DA LATIN CAPITAL LETTER U WITH ACUTE 00DC LATIN CAPITAL LETTER U WITH DIAERESIS 00FC LATIN SMALL LETTER U WITH DIAERESIS 2018 LEFT SINGLE QUOTATION MARK 00A1 INVERTED EXCLAMATION MARK
Miscellaneous	* ' _ © sm • “ ”	002A ASTERISK 0027 NEUTRAL SINGLE QUOTATION MARK 2501 BOX DRAWINGS HEAVY HORIZONTAL 00A9 COPYRIGHT SIGN 2120 SERVICE MARK 2022 BULLET 201C LEFT DOUBLE QUOTATION MARK 201D RIGHT DOUBLE QUOTATION MARK
Extended Character Set—French	À Â Ç È Ê Ë ë Î Ï ï Ô Ù ù Û « »	00C0 LATIN CAPITAL LETTER A WITH GRAVE 00C2 LATIN CAPITAL LETTER A WITH CIRCUMFLEX 00C7 LATIN CAPITAL LETTER C WITH CEDILLA 00C8 LATIN CAPITAL LETTER E WITH GRAVE 00CA LATIN CAPITAL LETTER E WITH CIRCUMFLEX 00CB LATIN CAPITAL LETTER E WITH DIAERESIS 00EB LATIN SMALL LETTER E WITH DIAERESIS 00CE LATIN CAPITAL LETTER I WITH CIRCUMFLEX 00CF LATIN CAPITAL LETTER I WITH DIAERESIS

		00EF LATIN SMALL LETTER I WITH DIAERESIS 00D4 LATIN CAPITAL LETTER O WITH CIRCUMFLEX 00D9 LATIN CAPITAL LETTER U WITH GRAVE 00F9 LATIN SMALL LETTER U WITH GRAVE 00DB LATIN CAPITAL LETTER U WITH CIRCUMFLEX 00AB LEFT POINTING GUILLEMET 00BB RIGHT POINTING GUILLEMET
Extended Character Set—Portuguese	Ã ã Í Ì ì Ò ò { } \ ^ _ | ~	00C3 LATIN CAPITAL LETTER A WITH TILDE 00C3 LATIN SMALL LETTER A WITH TILDE 00CD LATIN CAPITAL LETTER I WITH ACUTE 00CC LATIN CAPITAL LETTER I WITH GRAVE 00EC LATIN SMALL LETTER I WITH GRAVE 00D5 LATIN CAPITAL LETTER O WITH TILDE 00F5 LATIN SMALL LETTER O WITH TILDE 007D BRACE, OPENING 007B BRACE, CLOSING 005C REVERSE SOLIDUS 028C LATIN SMALL LETTER TURNED V 005F LOW LINE 007C VERTICAL LINE 007E TILDE
Extended Character Set—German	Ä ä ö ß ¥ ¤ ¦	00C4 LATIN CAPITAL LETTER A WITH DIAERESIS 00E4 LATIN SMALL LETTER A WITH DIAERESIS 00F6 LATIN SMALL LETTER O WITH DIAERESIS 00DF ESZETT 00A5 YEN SIGN 00A4 CURRENCY SIGN 2503 BOX DRAWINGS HEAVY VERTICAL
Extended Character Set—Danish	Å å Ø ø ┏ ┓ ┗ ┛	00C5 LATIN CAPITAL LETTER A WITH RING ABOVE 00E5 LATIN SMALL LETTER A WITH RING ABOVE 00D8 LATIN CAPITAL LETTER O WITH STROKE 00F8 LATIN SMALL LETTER O WITH STROKE 250F BOX DRAWINGS HEAVY DOWN AND RIGHT 2513 BOX DRAWINGS HEAVY DOWN AND LEFT 2517 BOX DRAWINGS HEAVY UP AND RIGHT 251B BOX DRAWINGS HEAVY UP AND LEFT

5.9.4 Time mapping

Note: CEA-608 captions do not define an intrinsic time, but instead rely on the frame delivery time of the byte control codes. In order to map CEA-608 captions to SMPTE-TT, the concept of “significant moments” is used, which are the times at which the CEA 608 display changes. An example of an event which causes a significant moment in CEA-608 would be the End of Caption control code. The delivery time of this control code would need to be translated to end and begin attributes on consecutive SMPTE-TT elements. The text on display as a result of the control code being executed would be converted into the contained text.

In order for event times to be defined, a zero frame shall be defined by one control code in the original CEA-608 data. All times in the derived SMPTE-TT file shall then be defined from that event in terms of multiples of the field rate of the video (or frame rate for progressive content), converted into time code as defined by SMPTE-TT. Derived SMPTE-TT files shall use the ‘media’ clock mode of SMPTE-TT.

The full set of CEA-608 events, and their mappings to significant moments are defined in Table 15 – Significant moments.

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

Code	Significant moments	Description
{RCL}	In Enhance mode, a significant moment occurs before processing this code.	Resume Caption Loading
{BS}		Backspace
{AOF}	Ignored	reserved (formerly Alarm Off)
{AON}	Ignored	reserved (formerly Alarm On)
{DER}	In preserve mode, a significant moment occurs after the line is cleared for paint on and rollup style.	Delete to End of Row
{RU(n) }	If caption mode is not already rollup, a significant moment occurs after screen is cleared. If in rollup mode, and height is decreased, a significant moment occurs after the extra lines are erased.	Roll-Up Captions-n Rows
{FON}	Ignored	Flash On
{RDC}	In Enhance mode, a significant moment occurs before processing this code.	Resume Direct Captioning
{TR}	Ignored	Text Restart
{RTD}	Ignored	Resume Text Display
{EDM}	In Enhance mode, a significant moment occurs before processing this code. In all modes a significant moment occurs after processing this code.	Erase Displayed Memory
{CR}	In rollup captions a significant moment occurs after processing this code.	Carriage Return
{ENM}		Erase Non-Displayed Memory
{EOC}	In all modes a significant moment occurs after processing this code.	End of Caption (Flip Memories)
{TO(n) }		Tab Offset n Column
{PAC(x,y)}	In preserve mode if caption mode is paint on a significant moment occurs after processing this code. In all modes if caption mode is rollup a significant moment occurs after processing this code.	Preamble code (row, column)
{MRC(c)}		Mid row code (color)

5.10 Tunneling CEA-608 Data

In mapping from CEA-608 data, it may be required as part of the process to preserve in the mapped SMPTE-TT document a stored version of the original data stream (as defined in SMPTE ST 2052-1, Section 5.4).

The original CEA-608 data stream shall be converted to digital form for storage in the following manner: CEA-608 data shall be converted into a sequence of byte pairs. Each pair will have been associated with either field 1 or field 2 in the original data stream. The bytes shall be stored in the mapped document in alternate order: two bytes for the first field and then two bytes for the next and so on, for example:

11221122…

The field association of the first pair of the sequence shall be indicated by using the m608:fieldStart attribute in the mapped document, which shall have the value 1 if the first pair of bytes came from field one, and 2 if from field 2.

The sequence of data bytes, shall then be encoded using one of the encoding forms defined in SMPTE ST 2052-1, and embedded into a conforming mapped SMPTE-TT document using the datatype = "http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea608".

Note: The frame rate for the tunneled data remains that of the CEA-608 data stream source material, that is, 30/1.001 fps (the frame rate for NTSC video), regardless of any frame rate specified in the SMPTE-TT ttp:frameRate parameter attribute (which has a different function). The conversion to SMPTE-TT may specify an alternate frame rate; e.g., if the output is intended to be used with a converted video format. If it is intended that the tunneled data be reused with the converted video, then any such converted video will need to conform to the 30/1.001 fps frame rate.

Annex A Bibliography (Informative)

SMPTE RP 2052-10a, SMPTE TT Example 608 XML Document

SMPTE RP 2052-10b, SMPTE TT 608 XML Schema

Annex B Example Encoding (Informative)

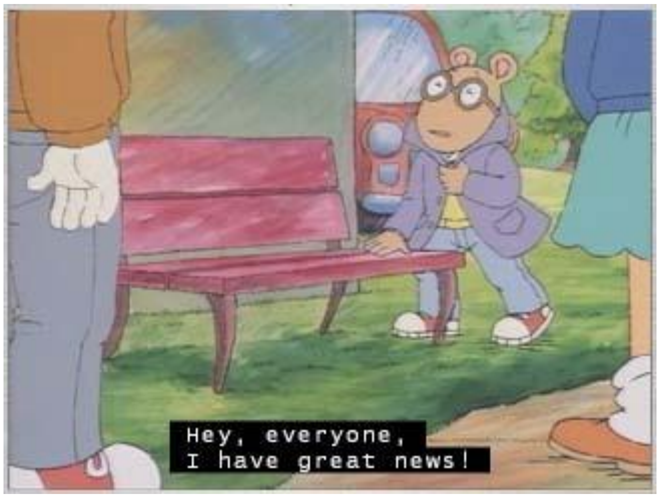

Figure 1 – Caption example
'Arthur' Image courtesy WGBH Boston,
Image and text ©1996, 2010 WGBH Educational Foundation" Used with permission

A CEA-608 byte sequence to create the captions in Figure 1 is as follows. Note that 608 bytes use odd parity:

```
9420 94AE 9452 9723 C8E5 792C 20E5 76E5 F279 EF6E E52C

94F2 9723 4920 6861 76E5 2067 F2E5 61F4 206E E5F7 73A1 942C 942F
```

Some bytes in this sequence are the characters of the text, and others are control codes that determine how the text is to be displayed. In this case it breaks down into the following:

{RCL}{ENM}{PAC(13, 3)}{TO3}Hey, everyone,
{PAC(14, 3)}{TO3}I have great news!{EDM}{EOC}

See CEA-608 for full mapping of byte sequences to control codes and their meaning. The control codes considered by this recommendation are given in in Table 15 – Significant moments and presented in braces in the text.

This caption, when converted to SMPTE-TT maps to the SMPT-TT snippet shown in Table B.1.

Table B.1 – Example caption conversion

```
<p region='pop1' style='basic' xml:space='preserve'
        begin='00:00:03:04' end='00:00:06:08'><span tts:backgroundColor='black'
tts:color='white' >Hey, everyone,<br/>I have great news!</span></p>
```

In the context of a whole document the example looks like the SMPTE-TT in Table B.2 – Example caption conversion – whole document.

Table B.2 – Example caption conversion – whole document

```
<?xml version="1.0" encoding="UTF-8"?>
<tt xml:lang="en"
          xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
          xmlns="http://www.w3.org/ns/ttml"
          xmlns: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"
          xmlns:smpte="http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt"
    xmlns:m608="http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea608"
          xsi:schemaLocation="
                    http://www.w3.org/ns/ttml
                    ttaf1-dfxp.xsd
                    http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt
                    smpte-tt.xsd
                    http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea608
                    smpte-tt-608.xsd">
    <head>
    <ttm:title>CEAv1.2zeroTT-CC1</ttm:title>
    <ttm:desc>Translation example of 608 CC1 from CEAv1.2zero.trp</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#cea608"
m608:channel="CC1"/>
                    <smpte:data encoding="Base64" datatype="http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea608">
                    <!-- Hex 608 data for easier debug
                              112*{80808080} -->
                              gICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICA
                              gICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICA
                              gICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICA
                              gICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICA
                              gICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICA
                              gICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICA
                              gICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICA
                              gICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgA==
                    </smpte:data>
   </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 region="pop1" style="basic" xml:space="preserve">
        <metadata>
                              <smpte:data encoding="Base64" datatype="http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea608">
                              <!-- Hex 608 data for easier debug
                                        8080152C
                                        942C9D20
                                        1C209D2C
                                        1C2C8080
                                        14*{80808080}
                                        80801520
                                        942013F4
                                        13F497A1
                                        97A154E5
                                        54E573F4
                                        73F42043
                                        20436170
                                        6170F4E9
                                        F4E9EF6E
                                        EF6E7380
                                        738094D0
                                        94D097A1
                                        97A1C454
                                        C454D620
                                        D620C1E3
                                        C1E3E3E5
                                        E3E57373
                                        737320D0
                                        20D0F2EF
                                        F2EFEAE5
                                        EAE5E3F4
                                        E3F42C20
                                        2C2057C7
                                        57C7C2C8
                                        C2C8ADCE
                                        ADCE43C1
                                        43C1CD80
                                        CD809470
                                        94709723
                                        9723A8F2
                                        A8F2756E
                                        756E6EE9
                                        6EE96E67
                                        6E6720F4
                                        20F4E96D
                                        E96DE5BA
                                        E5BA2034
                                        2034206D
                                        206DE96E
                                        E96EAE20
                                        AE2031B5
                                        31B52073
                                        2073E5E3
                                        E5E3AE29
                                        AE29152C
                                        942C152F
                                        942F8080 -->
                                        gIAVLJQsnSAcIJ0sHCyAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICA
                                        gICAgICAgICAgICAgICAgIAVIJQgE/QT9Jehl6FU5VTlc/Rz9CBDIENhcGFw9On06e9u725zgHOA
                                        lNCU0Jehl6HEVMRU1iDWIMHjwePj5ePlc3NzcyDQINDy7/Lv6uXq5eP04/QsICwgV8dXx8LIwsit
                                        zq3OQ8FDwc2AzYCUcJRwlyOXI6jyqPJ1bnVubulu6W5nbmcg9CD06W3pbeW65bogNCA0IG0gbelu
                                        6W6uIK4gMbUxtSBzIHPl4+XjrimuKRUslCwVL5QvgIA=
                              </smpte:data>
        </metadata>
        <!-- EOC on picture 176 -->
                    <p  begin="00:00:05.87" end="00:00:12.98">Test Captions<br/> DTV Access Project, WGBH-NCAM<br/>   (running time:
4min. 15 sec.)</p>
          </div>
          <div region="pop1" style="basic" xml:space="preserve">
       <metadata>
                              <smpte:data encoding="Base64" datatype="http://www.smpte-ra.org/schemas/2052-1/2013/smpte-tt#cea608">
                              <!-- Hex 608 data for easier debug
                                        23*{80808080}
                                        80809D20
                                        1C201CD0
                                        1CD0A843
                                        A8434334
                                        43322920
                                        29205468
                                        5468E973
                                        E9732064
                                        206461F4
                                        61F46120
                                        6120E973
                                        E9731C70
                                        1C70E96E
                                        E96E2043
                                        20436170
                                        6170F4E9
                                        F4E9EF6E
                                        EF6E2043
                                        20436861
                                        68616E6E
                                        6E6EE5EC
                                        E5EC2034
                                        20329D2C
                                        1C2C8080
                                        7*{80808080}
                                        80809D2C
                                        1C2C9D2F
                                        1C2F8080
                                        26*{80808080}
                                        80801520
                                        94201370
                                        1370A843
                                        A84343B3
                                        43312946
                                        29464343
                                        434320B9
                                        20B931AD
                                        31AD3131
                                        3131B980
                                        B98094D0
                                        94D05461
                                        546162EC
                                        62ECE520
                                        E520EFE6
                                        EFE620D3
                                        20D3F461
                                        F4616E64
                                        6E6461F2
                                        61F26420
                                        64204368
                                        436861F2
                                        61F261E3
                                        61E3F4E5
                                        F4E5F273
                                        F273BA80
                                        BA809470
                                        947020A1
                                        20A1A223
                                        A223A425
                                        A42526A7
                                        26A7A829
                                        A8292AAB
                                        2AAB2CAD
                                        2CADAE2F
                                        AE2FB031
                                        B03132B3
                                        32B324B5
                                        34B5B637
                                        B63738B9
                                        38B9BA3B
                                        BA3BBC3D
                                        BC3D3EBF
                                        3EBF152C
                                        942C8080
                                        8*{80808080}
                                        8080152C
                                        942C152F
                                        942F8080 -->
                                        gICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICA
                                        gICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgJ0gHCAc0BzQqEOoQ0M0QzIpICkg
                                        VGhUaOlz6XMgZCBkYfRh9GEgYSDpc+lzHHAccOlu6W4gQyBDYXBhcPTp9Onvbu9uIEMgQ2hhaGFu
                                        bm5u5ezl7CA0IDKdLBwsgICAgICAgICAgICAgICAgICAgICAgICAgICAgICdLBwsnS8cL4CA
                                        gICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICA
                                        gICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgICAgBUglCATcBNw
                                        qEOoQ0OzQzEpRilGQ0NDQyC5ILkxrTGtMTExMbmAuYCU0JTQVGFUYWLsYuzlIOUg7+bv5iDTINP0
                                        YfRhbmRuZGHyYfJkIGQgQ2hDaGHyYfJh42Hj9OX05fJz8nO6gLqAlHCUcCChIKGiI6IjpCWkJSan
                                        JqeoKagpKqsqqyytLK2uL64vsDGwMTKzMrMktTS1tje2Nzi5OLm6O7o7vD28PT6/Pr8VLJQsgICA
                                        gICAgICAgICAgICAgICAgICAgICAgICAgICAFSyULBUvlC+AgA==
                              </smpte:data>
        </metadata>
        <!-- EOC on picture 442 -->
                    <p  begin="00:00:14.75" end="00:00:24.76">(CC1)FCC 91-119<br/>Table of Standard
Characters:<br/>!&quot;#$%&amp;'()'á+,-./0123456789:;&lt;=&gt;?</p>
          </div>
  </body>
</tt>
```

Annex C Example Translation (Informative)

An example translation document is found in RP 2052-10a. The pseudo-code algorithm in Table C.1 – Pseudo-code for example translation exemplifies the translation of a CEA-608 data stream into a SMPTE-TT document.

Note: It is a common practice when creating a CEA-608 data stream to double all two-byte commands that are starting with 10 to 1F. This practice is to overcome transmission errors. In translating from a CEA-608 data streams, CC encoders should disregard duplicate codes, this detail is ignored in the pseudo-code.

Table C.1 – Pseudo-code for example translation

```
 Convert CEA 608 byte stream ->
 {
     Set last caption to null;

     For each word in data
     {
         hi = High byte of word;
         lo = Low byte of word;

          Process Bytes(hi, lo);

         if (display text has changed) {
             if (last caption is not null) {
                 set last caption end time to current time
                 if (last caption text is not empty) {
                           Add last caption to output;
                 }
                 Set last caption to new caption where{
                     Text = current display text
                     Start = current time,
                     End = current time,
                     Origin = origin of display text bounding box,
                     Extent = extent of display text bounding box
                  };
                }
           }
     }
     if (last caption text is not empty) {
         Add last caption to output;
     }
 }


Process Bytes(hi, lo) =>

if (hi is a control byte and matches selected channel)
     {
         function = Create Miscellaneous Control(hi, lo);
         if (function == null) function = Create Preamble Control(hi, lo);
         if (function == null) function = Create MidRow Control(hi, lo);
         if (function == null) function = Create Extended Char Control(hi, lo);
         if (function!= null)
         {
             Process Control Code(function);
         }
     }
     else if (hi is not a control byte)
```

```
            {
                if (hi is not ignorable)
                {
                    Process Print Character(hi);
                  }
                  Process Print Character(lo);
            }

            Increment Frame();
```