

# Text styling control sequences – modernised ECMA-48 (ISO/IEC 6429) text styling

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## 1 Introduction

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There are several ‘higher-level mark-up’ techniques for styling text. Web pages use HTML combined with CSS (either embedded or by reference). RTF (Rich Text Format) and T<sub>E</sub>X are other examples of markup. The origin for HTML, SGML, is also used. Some “simpler” markup languages are called “mark-down”, but they still use (only) printable characters (thus easy to enter by keyboard), so cannot be invisible in plain text, only when interpreted at a higher level. These schemes can have surprising effects, like turning `-nnn-` into text with strike-through: ~~nnn~~.

Sometimes a somewhat more light-weight mark-up (but not necessarily one lacking power) is desired, such as mark-down, but *with the added requirement* that it be “invisible” at the “plain” text level (and better at avoiding surprising unintended formatting). One could try to design one from scratch. But... there is already one such scheme, indeed a well-established one, and in common use, namely ECMA-48 *control sequences* that control text style. While the use of ECMA-48 control sequences may seem old-fashioned, it has several advantages, and there is no need to consider it outdated:

1. ECMA-48 is a well-established standard, since several decades by now. The first edition dates from September 1976, nearly 50 years ago. The latest edition is from 1991, more than 30 years ago. It does need some updating, for Unicode, for modern display capabilities, modern document display and edit conventions, additional capabilities common in “higher level” schemes for styling text, etc.
2. The ECMA-48 control sequences have the advantage that they can be handled (interpreted or ignored) at the text level, no need for a parser at *higher* level. (It would still be considered a “higher level protocol” in the Unicode sense.) That is, due to the use of a (lead) control code, the mark-up does not consist solely of printable characters, like in so-called mark-downs (like that used in Wikipedia and elsewhere) or HTML, RTF and the like. The syntax is such that ECMA-48 control sequences, following the standard, can be parsed out easily and “blindly” (not needing to know if it is interpreted), and there is no need for any secondary encoding of some printable characters (like “&lt;” for ‘<’ in HTML).
3. ECMA-48 control sequences are still in very common use. They were particularly popular for terminals, that were later replaced by terminal emulators, which is what is used today. The latter have since been developed beyond the limits of any once-existing “physical” terminal model. The continued popularity of ECMA-48 control sequences is partly for historical reasons, and partly due to point 2. Those who use terminal emulators will encounter ECMA-48 styled text in just about every use instance. For example, it is used for the “man” command (print manual pages on the terminal); underline and bold occurs through-out those pages. It is also used by many other

commands for colouring (e.g., `grep` in modern Linux can mark matching substrings in bold red), as well as being popular for use in prompts, often embedding certain status data as styled text in the prompt. Many other programs that output to a terminal also use ECMA-48 styling of the output. Even though ECMA-48 is “old” it is very much still in active use and there is no end in sight.

4. The SGR (SELECT GRAPHIC RENDITION) control sequences (including the extensions given below) and HTSA2, SPD2, PTX (described below) are well interpretable in modern text editors. Just like formats such as RTF, HTML, etc., are supported by many modern text editors. Likewise, if desired, charset declaration, as well as images and graphics, see hints below (but is out of scope for the here proposed additions), based on ECMA-48 are well supportable in text editors. Thus, one could have a special file format (with a suitable extension such as “`txtf`”: `file.txtf`) for text styled with these ECMA-48 control sequences. Such a format would exclude interpretation of cursor movement or other control sequences that are not aimed at text formatting.

This is the closest one can get to “plain text formatting” (since control characters mark the “markup”) *while using an existing standard.* (In “higher level markup”, printable characters (only) act as control sequences per the syntax of the markup. That goes for HTML, RTF, markdown, etc.)

Some more items of interest w.r.t. ECMA-48:

1. ECMA-48 styling is popular to use for bold, underlining, italics as well as foreground and background colours. There is already support in the standard for much more, even though some need further extensions to be useful. In addition, some features should be moved to SGR (from other control sequences), to improve the design. Many implementations already support extensions w.r.t. colours and underlining (e.g., wavy underlines and colour of underlines separate from colour of the text). ECMA-48 also has support for CJK style of emphasis (similar to underlining).
2. A variety of PTX (PARALLEL TEXTS) is used for so-called “ruby” text, which is a particular kind of clarification text written above the actual (usually Japanese or Chinese) text. This is a feature only relatively lately added to HTML. But ruby text is supported, standards-wise, by ECMA-48 since more than 30 years, long before it was added to HTML.
3. ECMA-48 may appear not to have any mechanisms for specifying tables (though tab stops can be set, preferably via (resurrected) HTSA (HTSA2, CHARACTER TABULATION SET ABSOLUTE 2)). But ECMA-48 has another variety of PTX which, with some minor extensions (see below), can be used to make table rows, and hence true tables. Together with block frames (see below), cell frames and cell background colours can be supported. PTX and SDS/SRS (the latter two for bidi control, similar to the nesting Unicode bidi controls) are the only control sequence from ECMA-48 5<sup>th</sup> edition that allows for nesting (so one can have tables in tables, or “ruby” text in tables (though “ruby” in “ruby” or tables inside ruby may be less meaningful).
4. Headings and item lists are supported as *direct* formatting (and direct numbering) only (in particular size and bold or bold italic, as well as tab stops and HTJ). There are no “meta-formatting” controls by giving some kind of “element type”, and then elsewhere define the formatting for instances of that “element type” (cmp. CSS, which is a prime example of that approach, but exists also in, e.g., TeX) for this or anything else, like paragraphs or table cells. That may in a modern context be seen as a major flaw. But it is a basic design feature of ECMA-48 formatting, and therefore cannot be changed, or at least quite hard to change. We will therefore not introduce any “meta-formatting” controls here, though not prohibited for a future update.

5. Images and vector graphics have no apparent support in ECMA-48. But non-support for such features is not quite true. There are extension mechanisms that are “private use” or “for future standardisation” that can be used for this. In particular, APC (APPLICATION PROGRAM COMMAND), which takes a string parameter that can encode an image (in base-64 or use a link) or a kind of vector graphics (plotter commands or even SVG). (Some more hints below, but details are out of scope for this proposal.)
6. Hyperlinks were barely invented when ECMA-48 was last updated, so there is no standard support for them in ECMA-48. But some recent implementations based on ECMA-48 do have them via an extension. (And we will hint more on that below, even though details are out of scope for this proposal.)
7. There are no named styles. Just a “style state”, in general no stack of them (except for PTX and an extension based on an Xterm extension). So, by modern standards, it is quite rudimentary. It is really a low-grade “higher-level” protocol for text styling, except that there is no higher level. The codes are “ignorable” (as well as interpretable) for display of text, at the text level, by design. Even so, it is already quite advanced in some respects, for example it has (for decades) included support, standards-wise, a) for CJK style emphasis and b) CJK “ruby” texts (both supported in modern HTML/CSS) as well as framing of text on a line basis (similar in nature to Egyptian hieroglyph cartouches) also supported in modern HTML/CSS.
8. A type of text formatting which does not have any support in ECMA-48 5<sup>th</sup> edition is math expressions. While one could use **APC** and embed, e.g., TeX math expressions. However, for one thing, that does not cover full Unicode support for math expressions at least not for TeX math expressions. There is a separate proposal for math expressions.

In this proposal we also include some additions specifically for enabling easier conversion from ISCII styling and from Teletext styling (including that for Teletext subtitling, which is still a common use for Teletext today) to ECMA-48 styling (these are SGR extensions). The details of such conversions themselves are, however, out of scope for this proposal of additions.

ECMA-48 5<sup>th</sup> edition actually does not say how to use the control sequences, in particular it does not say how to use styling control sequences. For some other control sequences, there are some indications on how to use them. E.g., cursor movement control sequences are to be sent from the “display component” (to be understood as a display with associated keyboard; in practice what today is called a PC, it need not be a terminal or terminal emulator) to the “data component” (to be understood as the software that actually manages a document or a pseudo-document; in practice, text editor programs or text display programs, or programs that has some subcomponents that has text in them, like web browsers with an address line or fields in a form).

For text styling, which is the focus of this proposed update, the styling controls can be used as means of (approximately) display content (with mostly text) which is styled by other means. E.g., programs that display web pages mapping (approximately!) the HTML/CSS styling to ECMA-48 styling. An example of that is the Lynx web browser (<http://lynx.browser.org/>) displaying (text) web pages, in a very approximate manner, in a terminal emulator.

But the text styling control sequences can also be used as the storage format (in a text document), storing the styling as ECMA-48 control sequences directly. This is then a more light-weight alternative to using HTML/CSS or some other “highly capable” document formats (such as MS Word XML format, ECMA-376-1:2016: *Office Open XML File Formats — Fundamentals and Markup Language Reference*). Often, one does not need all the advanced capabilities of those storage formats for text documents, and a more light-weight format is sufficient. For that, ECMA-

48 text styling (as storage format) comes in handy, since completely unstyled “plain text” can be a bit too poor. So ECMA-48 text styling bridges a gap between the “highly capable” text formats, and the “very poor” pure plain text. And that with an existing mechanism. Though old it is still in widespread use, not needing to invent a completely new middle-ground format. Even RTF may be considered too heavy-handed. For terminal emulators, only ECMA-48 text styling is viable. All other currently existing text formatting mechanisms are out of the question, for technical reasons. In addition, there are also compatibility reasons, ruling out other technically possible (and currently imaginary) styling mechanisms. But here we will focus on storable documents and using ECMA-48 text styling for them in storage, no matter how they are displayed or handled internally in, say, text editing programs. Still, many of the suggested updates here are applicable also to terminal emulators, and certain proposals here are kept in line with what has been done for some terminal emulators.

## 2 Goals and non-goals for this update proposal

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### 2.1 Goals for the additions and clarifications in this proposal

- a) Encouraging existing implementations to support bold/regular/lean font weights in the modern way (no colour change), full colour specifications, use of proper syntax (in particular for full colour control sequences) and other commonly implemented features of ECMA-48 SGR so they are consistent from a user point of view. That is, trying to converge the interpretations of exactly how these should be interpreted (such as fixing commonly implemented colours to be the same RGB values across implementations, just like HTML/CSS named colours are reliable across implementations).
- b) Extending the ECMA-48 styling mechanism to other styles or style variants now supported in HTML/CSS, though it will not be as flexible as HTML/CSS, but still in “the same vein” as original ECMA-48. Plus, a minor extension to handle long division notation.
- c) Including some commonly supported ECMA-48 extensions, esp. those for colour levels, as well as some extensions for supporting Teletext styling functionality (which is/was commonly used), and some other older styling mechanisms (such as those for ISCII).
- d) Moving some styling controls (from other control sequences) to the “**m**” set of controls (i.e., SGR) and generalise them a bit (line and character spacing, font size, font size modification (condensed, extended), and more).
- e) Resurrecting HTSA (as HTSA2), “the better way” of setting tab stops. At the same time, other ways of setting tab stops will be deprecated.
- f) Specifying PTX better and generalise it, so that table rows with different cell widths (heights if vertical lines) can be used. (Note that PTX, oddly, is also used for “Ruby” text for Japanese/Chinese, though with other parameter numbers.)
- g) Extending SPD (as SPD2) (SELECT PRESENTATION DIRECTIONS) for specifying enablement of the Unicode Bidi algorithm (if that is at all implemented).
- h) Arithmetic “by hand” calculation (up to long division) layout is intended to be covered (details will be in a separate document). Doing addition, subtraction, multiplication, and division (between two decimal numerals) is an important part of any modern script. Still, that has not been well covered by Unicode or any other system (though MathML has an attempt at covering long division).

## 2.2 Non-goals for the additions and clarifications in this proposal

- a) To get all implementations of ECMA-48 to necessarily implement all the styling control sequences (indeed, some are not well suited for, e.g., terminal emulators). Likewise for the other control sequences discussed in this paper.
- b) Replace other styling mechanisms (RTF, ‘markdown’, ...), though support for ECMA-48 styling may be an *additional* mechanism, in particular in text editors.
- c) Add “structural” mark-up to ECMA-48 (auto-numbered lists, automatic heading numbering and styling, named styles, etc.) common in more advanced higher-level mark-up mechanisms. However, PTX has nesting structure, allowing to have tables in table cells.
- d) Handle math expression layout and styling. There is a separate proposal for handling math expressions, both in an ECMA-48 context, HTML/XML context, and other contexts where a “markdown” way of representing math expressions is more appropriate.
- e) Handle keyboard, mouse/similar input (and occasional output) and other functionality that is not text formatting related is not covered by this proposal. Those parts of ECMA-48, and extensions in those areas, may be covered in another separate proposal.

## 3 Regular expressions for parsing escape sequences, control sequences and control strings

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Originally, the syntax for escape sequences (not to be confused with character references, like `\n`, `\t`) and control sequences were formulated as byte sequences (or even bit sequences) in ECMA-48. But now we use Unicode, with several character representations that do not conserve the representation as byte sequences. So here we formulate the “overall” syntax (a regular expression), not as *byte* sequences, but as *character* sequences. While not a goal here, this also makes the control sequences applicable to EBCDIC based Latin script encodings.

The general (almost catch-all) syntax for ECMA-48 escape sequences, control sequences and control strings are as follows, generalized to specify Unicode (or ISO/IEC 10646) characters rather than bytes, but excluding code page shifting controls and escapes as well as device controls (except **DCS**):

```

c0-control-character ::=      [\u0001-\u0003\u0008-\u000D\u001A-\u001F] // has exclusions
ESC ::= \u001B
escape-sequence ::= ESC    [\u0040-\u004C\u0051\u0052\u0056-\u005F] // has exclusions
c1-control-character ::=      [\u0080-\u008C\u0091\u0092\u0096-\u009F] |
                                ESC  [\u0040-\u004C\u0051\u0052\u0056-\u005F] // has exclusions
cf-control-character ::=      // including line separators, replacement chars and non-characters:
                                <characters with general category Cf, Zl, Zp> | [\uFFFFD\uFFFC\uFDD0-\uFDEF\uFFFE\uFFFF]
SCI ::= (ESC \u005A|\u009A) // consider Unicode surrogates, non-characters, and Cf excluded:
sci-sequence ::=             SCI  [\u0001-\u0003\u0008-\u000D\u001C-\u007E\u00A0-\u00FF]
CSI ::= (ESC \u005B|\u009B) // using [\u003C-\u003F] first or [\u0070-\u007E] is private use:
control-sequence ::= CSI    [\u0030-\u003F]* [\u0020-\u002F]* [\u0040-\u007E]
```

Non-characters are *object replacement control characters*, each may (per paragraph only) refer to a table (consisting of table rows), an image, a vector graphic or a math expression. Note that a paragraph may contain nested paragraphs. *Object replacement control characters* are for runtime internal representation only, not for text storage or interchange.

Character encoding switching escape sequences, **ESC**[\u0020-\u002F]+[\u0030-\u004C\u0051-\u0052\u0056-\u007E], are excluded since character encoding switching is outdated and furthermore not allowed to be used with ISO/IEC 10646/Unicode.

Character encoding switching controls, **LS1** (U+000E), **LS0** (U+000F), **SS2** (U+008E), **SS3** (U+008F), device controls, U+0000, U+0004-U+0007, U+0010-U+0019, U+008D, U+0090, U+0093-U+0095, as well as code switching and device control escape sequences, **ESC**[\u0030-\u003F\u0060-\u007E], are excluded since they are not suitable for storing in text documents. Likewise are character references that refer to code switching or device controls, **ESC**[\u004D-\u0050\u0053-\u0055], excluded since they are unsuitable for storing in text document, as are all C0 and C1 device controls. Also start of device control string, **DCS**, is excluded since it is not suitable for storing in a text document. In addition, cursor movement control sequences should also be excluded for the same reason, but for brevity that is not expressed in the regular expressions above; but that would entail excluding certain control sequence terminating letters. Cursor movement control sequences are useful in other contexts involving text, but not for storing them in a text document.

A control character, escape sequence, SCI sequence, or control sequence shall not be a code page switching operation, and we have excluded existing ones in the regular expressions above. That is for all contexts, not just text storage. Hence the deletion of intermediary characters, [\u0020-\u002F]\*, from the syntax for escape sequences, which was reserved for ECMA-35 (*Character Code Structure and Extension Techniques*) and ECMA-43 (*8-Bit Coded Character Set Structure and Rules*) code page switching. Some C0 and C1 control characters were for code page switching (ECMA-43), but those shall not be interpreted, and have been excluded from the syntax above. Likewise, **LS0/SI** (\u000E), **LS1/SO** (\u000F), **SS2** (\u008E), **SS3** (\u008F), **LS1R** (**ESC** \u007E), **LS2** (**ESC** \u006E), **LS2R** (**ESC** \u007D), **LS3** (**ESC** \u006F), **LS3R** (**ESC** \u007C), or any other code-switching control, *shall* be uninterpreted and may cause an error indication. Escape sequences that do not stand for any codepage switching, like control character references, may still be meaningfully interpreted.

There are some C0 and C1 control codes purely for certain 1960-ies type terminals (like U+007F, U+0095, U+0096, U+0097, and most device control characters); those are unlikely to be interpreted anywhere at all today (in particular, xterm and its derivatives ignore them), and those controls are not recommended for any use, not even terminal emulators. Some control sequences are for keyboard input, and yet other control sequences are for updating a terminal screen/window. The latter two types of control sequences are of course unsuitable to be used in a text document, and should be ignored or filtered away if they occur in a text document, especially in an environment where they might otherwise be interpreted (such as a text editor showing text to the user via a terminal emulator); such a text editor may use such control sequences to update the terminal screen/window, but then they come from the editor program, not from the text document itself. The text styling control sequences that are the subject of this proposal can of course be used in a text document that is edited or displayed without any involvement of a terminal emulator; just an ordinary text editor in a modern “GUI”/window environment; just using ECMA-48 styling instead of RTF, a markdown system (there are several), HTML, or some newly invented “private use” markup for storing the text in file, or even as internal representation.

Note that the notation here refers to characters (including that \u0000-\u001F and \u0080-\u009F always refer to ECMA-48 C0 and C1, respectively), **not** to bit sequences. The character encoding need not be a Unicode (or ISO/IEC 10646) encoding. If it is in a Unicode encoding, it

may be either one (UTF-8, UTF-16BE, UTF-16LE, UTF-32BE, UTF-32LE). But it cannot be an encoding depending on code page switching, nor any encoding that does not cover the ASCII characters (excluding, among many others, national variants of ISO/IEC 646). The latter may be handled by ad-hoc mappings (not specified here).

A control string allows for freer content in the parameter part (compared to a control sequence): the parameters need not be numbers. However, no details of possible contents are given in ECMA-48, 5<sup>th</sup> edition. So all and any content for these is “private use” in the 5<sup>th</sup> edition.

```

DCS ::= (ESC \u0050|\u0090) // (xterm used this to “program” function keys) (deprecating)
SOS ::= (ESC \u0058|\u0098) // suitable for embedded image data and hyperlinks
ST  ::= (ESC \u005C|\u009C) // Xterm allowed (deprecating) BEL (\u0007) as alternative
OSC ::= (ESC \u005D|\u009D) // used in Xterm for setting window titles and such
PM  ::= (ESC \u005E|\u009E) // (a message targeted for a “status line”) (deprecating here)
APC ::= (ESC \u005F|\u009F) // suitable for vector graphics (like HP-GL or SVG)
control-string ::= // consider surrogates and non-characters excluded
(DCS|SOS|OSC|PM|APC) (\u0001-\u0003\u0008-\u000D\u001C-\u007E) | sci-sequence |
ESC[\u0040-\u004C\u0051\u0052\u0056\u0057\u0059] | control-sequence |
[\u0080-\u008C\u0091\u0092\u0096\u0097\u0099\u00A0-\u010FFFD])*ST

```

Also here, for control strings, consider Unicode surrogates, non-characters, and Cf characters excluded from `\u00A0-\u010FFFD`, which we for brevity express informally instead of in the regular expression. One should only use assigned character positions, but that changes over time, as more characters are encoded.

The contents of control strings are here generalised compared to ECMA-48 5<sup>th</sup> edition. But **BEL** (U+0007) and **NULL** (U+0000) are excluded. Noteworthy is that **ETX** is the *default* (can be changed) “label” terminator in HP-GL/2, and that URLs (if using a control string for those) may contain non-ASCII characters. Furthermore, control strings cannot nest, and that is expressed in the syntax above. “Labels” in HP-GL/2 correspond to `<text>` elements in SVG. Both allow text to be given in a “plotted”/“vector graphic” component. Styled “labels” should be allowed if HP-GL/2 is integrated via ECMA-48 control strings, and one should also allow math expressions constructed using C0/C1 control codes (see *A true plain text format for math expressions (and its XML compatible equivalent format)*, 2023) to be part of “labels”. Since **ETX** may be used in the latter, another characters (e.g., **SOH**, U+0001) should be used as label terminator.

A prefix of a *potential* match that in the end does not match, should be treated as a normal character sequence. A true match is normally not shown as is (except in a show-invisibles mode, if at all kept as is), but may affect the display of printable characters that follow. A match must never be case-mapped and should be invisible in display and ignored in collation operations, except for character references (see below).

The control strings cover DEVICE CONTROL STRING (**DCS**, `\u0090`, **ESC P**), APPLICATION PROGRAM COMMAND (**APC**, `\u009F`, **ESC \_**), PRIVACY MESSAGE (**PM**, `\u009E`, **ESC ^**), OPERATING SYSTEM COMMAND (**OSC**, `\u009D`, **ESC J**), and START OF STRING (**SOS**, `\u009B`, **ESC X**) sequences; terminated by a STRING TERMINATOR (**ST**, `\u009C`, **ESC \**) control character/escape sequence. All of these allow for (almost) any characters between the start and end control characters. ECMA-48 5<sup>th</sup> edition has for **SOS...ST** a bit different specification for the ... part than for the others (**DCS/PM/OSC/APC**). Making that distinction does not seem helpful, so we ignored it here, and all allow the same generalised “content” (in the catch-all-type of syntax given above).

### 3.1 General additions for control sequences

Here we reserve = (EQUAL SIGN), postfix, for denoting a negative value of a parameter. We cannot use HYPHEN-MINUS as that is reserved as an “intermediary character” that can occur only before the final character of the control sequence. And we reserve ? (QUESTION MARK) for denoting decimal separator, with at least one digit before the ?. Note that both FULL STOP and COMMA are “intermediary characters” associated with the final character. Note also that when <, =, >, or ? do *not* occur *first* after the **CSI**, they are *not* reserved for private use, but when one of those four characters occur *first* after the **CSI**, the control sequence is reserved for private use (a few such private use control sequences are defined for xterm).

### 3.2 Control strings: Some possible uses of APC and SOS

Some *possible* uses (*not* part of the proposal here) for APC and SOS control strings are:

- *Declare character encoding.* We here suggest (cmp. HTML) **SOS charset=<IANA charset-name>ST**, default: **UTF-8**. This declaration should be at the beginning of a document. **UTF-16** can then be used. In contrast to ISO 2022 escape sequences to *change* character encoding, this declaration does not change to any encoding, just *declaring* it (like for HTML).
- *Declare language.* We here suggest **SOS lang=<IANA language tag>ST**. No default value.
- *Embedding images* (via hypertext references), like **SOS [w=<width>;h=<height>;]img:<link to image>ST**; the (optional) width and height are values with unit (incl. *em*, and percent).
- *Embedding graphics as plotter commands or vector graphics.* Here we suggest two possibilities:
  - 1) Use HP-GL/2: **APC [w=<width>; h=<height>;] hpgl=<HP-GL/2 commands or .hgl filename>ST**. HP-GL can in principle, when used in an otherwise ECMA-48 context, be extended to use ECMA-48 styling for “label” (text) strings. Likewise can **SCI**-based math expressions (see *A true plain text format for math expressions (and its XML compatible equivalent format)*) be permitted in “labels”, but then use **SOH** as “label” terminator.
  - 2) Or, despite the apparent anachronism, use SVG with inline CSS: **APC [w=<width>; h=<height>;] svg=<SVG markup or .svg filename>ST**.

Many programs output “ASCII art”, assuming fixed width font, to display certain graphics on terminals or resort to produce the graphics in a file to be displayed by *another* program. By allowing the use of this kind of embedded graphics, the graphics can be output (also) directly to a terminal, as well as embed the graphics in a *.txtf* file.
- Define (possibly parametrised) macros via **APC**, that then can be used via control strings referencing them (and possibly giving parameters).

The examples here are applicable for *.txtf* documents (and use ECMA-48 based styling controls, also extended as proposed below).

### 3.3 Escape sequences and control sequences not suitable for in-text use

ISO/IEC 2022 escape sequence which were used for code switching, are disallowed. Such escape sequences shall be ignored. Other codepage switching controls shall also be ignored, and all are unsuitable to occur in any text. Also escape sequences or reset or lock/unlock are disallowed. Certain control sequences in ECMA-48 are edit position movements, screen redraw commands, interrogations/replies to/from a device (terminal) from/to an application, or other uses that is not text formatting. **Such** control sequences *shall not* be part of any “plain text formatted” document and shall be ignored if occurring in a text document.



### 3.4 Unicode character references

Certain escape sequences (**ESC** [\u0040-\u005F]) refer to ECMA-48 C1 control characters (**ESC** [\u0040-\u004C\u0050-\u0052\u0056-\u005F], excluding unsuitable C1 controls). They are useful in case the normal C1 controls are not available, or their availability is uncertain. This is a limited form of character references, only for C1 “control” characters. Note that *not* all ESC character references are zero-width in rendering.

Also characters with (Unicode) scalar values greater than 009F will get character references defined here. The ESC character references for C1 characters always refer to C1 as defined in ECMA-48 5<sup>th</sup> ed. regardless of character encoding, considering what follows the ESC as a character, not a byte (so, e.g., **ESC I** refers to **HTJ** also if the encoding is, for instance, EBCDIC based). C0 may be rearranged in some character encodings, like those that are EBCDIC based. We refer to the *characters*, **not** the bytes (or larger code representations). Note that most CSI character references result in characters that are not zero-width, while most other CSI control sequences are zero-width in rendering.

Unicode has very many characters encoded. We here introduce Unicode character references, in ECMA-48 style, for (Unicode) scalar values greater than 009F. This mechanism is similar to HTML’s decimal numeric character references. Here we propose as a decimal character reference as a control sequence:

- **CSI** *n*\_, where *n* is a Unicode codepoint (scalar value) in *decimal* form (hexadecimal cannot be used due to ECMA-48 syntactic reasons), without leading zeroes and only referring to valid Unicode scalar values larger than 159 (decimal). Note that **CSI** *n*\_ cannot be used directly after **SCI**.

However, direct character use and using a Unicode character encoding is preferred.

\u009B (**CSI**) is in the C1 space, and is therefore avoided by many terminal emulator implementations, due to the risk of misinterpreting something that is *not* a control code for this control code. Since terminal emulators easily may run in the “wrong” character encoding (compared to what is actually output to the terminal), this is a particularly sensitive issue for terminal emulators. Therefore, a \x9B (ISO/IEC 8859 series) or \xC2\x9B (UTF-8) is often not interpreted as a \u009B, since the encoding setting is not trustworthy in a terminal emulator where an outputting program may blindly output in a different encoding than the one set for the terminal emulator, maybe one that does not even have a C1 area. Though far from a complete solution, one is then only interpreting the **ESC** [ alternative for **CSI**, in many terminal emulators.

The situation is different for text files with formatting/styling in the ECMA-48 way, where using C1 characters directly should not be a problem if the file is coded in UTF-8 or UTF-16. However, if one is using a Windows codepage or an old MacOS codepage for the file, one will need to use the **ESC** variants for ECMA-48 C1 characters, as those encodings do not have the ECMA-48 C1 characters.

## 4 Ink-less (mostly) characters

The handling of line breaks and spaces, and a few other characters is important enough for the rendering of text, that some guidelines are called for. Many of the C0 and C1 “control” characters are not given correct properties in Unicode, especially for bidi, line breaking, and spacing. We will skip over device controls, however, since they are not suitable to be present in text files (plain or other), and should then effectively (if not actually) be replaced by SUBSTITUTE.

Note that the characters below contrast to edit position movement commands, e.g., CURSOR NEXT LINE which is a cursor movement command (for text displaying, and perhaps text editing, applications). Control sequences for edit position movement (or extension/shrinking of text selection) are not intended to be part of text. There is unfortunately no quick and easy distinction in ECMA-48 whether a control sequence is fit for “in-text” or not, other than enumeration. The characters below, however, if entered from a keyboard (or entered by pasting) insert these characters in the text, if working with a text editing application or some kind of field that allows text entry. However, some line break characters may be interpreted as an “execute” control in applications such as command line interpreters.

#### 4.1 Space-ish characters: HT, HTJ, SP, NBSP, NNBSP, ENSP, EMSP, IDSP, ...

The following characters “move” the display position (and for HTJ also moves the display position of some preceding characters) in the character progression direction and there should be no glyph lookup (except possibly for OGHAM SPACE) via the font (unless in a “show invisibles” mode, where there is also a glyph for these, but that may be taken from another font and not related to the character via the font, just via the application).

- U+0009; CHARACTER TABULATION (**HT**). HT moves *at least* 1 en, to the next tab stop after that in the character progression direction. HT does *not* stretch when justifying. This was originally intended for “rapid form fill-out”, where the paper had the actual form pre-printed, and just filling in the field data on the printer, just like for mechanical typewriters. But it rapidly gained a slightly different use: rapid spacing for non-forms. Note that **CSI [n]I** (CURSOR FORWARD TABULATION, CHT) and **CSI [n]Z** (CURSOR BACKWARD TABULATION, CBT) are *cursor movement* commands when editing a document. These are thus not at all suitable to be stored in a (formatted) text document.
- U+0009; CHARACTER TABULATION WITH JUSTIFICATION (**HTJ**, as a character reference: **ESC I**). HTJ not only moves to the ‘next’ tab stop in the character progression direction (but moves *at least* 1 en) like HT, it also moves the *preceding* characters (back to the nearest of: beginning of text, nearest preceding (NLF or automatic) line break or nearest preceding HT/HTJ *character* (not preceding tab stop as originally defined) in the same displayed line) to align the end of that text with the next tab stop at least 1 en after the current position (movement in the character progression direction). Useful for alignment of numeric literals (with the same number of decimals) on several lines or aligning item labels in a text items list. HTJ must act as HT for line breaking and bidi. Correct line break property is BK, correct bidi property is S.
- U+0020; SPACE (**SP**). The width of SP, using a proportional font, is often less than en width, and can stretch for automatically justified lines.
- U+3000; IDEOGRAPHIC SPACE (**IDSP**). Nominally 1 em wide but may stretch in automatically justified lines.
- U+1680; OGHAM SPACE MARK. May have a glyph; if glyph is missing it acts as an SP. (No glyph for an OGHAM SPACE MARK that is in a sequence of spaces that is followed by a line break (hard or automatic).)
- U+00A0; NO-BREAK SPACE (**NBSP**). Same width as SP but does not allow for automatic line break. **NBSP** can stretch for automatically justified lines.
- U+202F; NARROW NO-BREAK SPACE (**NNBSP**). Should be **PSP** (U+2008) width. Suitable as space between digit groups (usually of 3 digits).
- U+2007; FIGURE SPACE (no-break). Should be the width of a “0”, esp. if fixed-width (“tabular”) digits.

- U+2008; PUNCTUATION SPACE (**PSP**). Should be the width of a FULL STOP or COMMA glyph (current font and font size), unfortunately it is not no-break; see NNBS.
- U+0082; BREAK PERMITTED HERE (**BPH**, as character reference: **ESC B**). Handle equivalently to U+200B ZERO WIDTH SPACE. Makes explicit a position for allowed automatic line break. Correct line break property: ZW. Compare the control **SHY**.
- U+200B; ZERO WIDTH SPACE (**ZWSP**). Handle equivalently to **BPH**.
- U+0083; NO BREAK HERE (**NBH**, also as character reference: **ESC C**). Handle equivalently to U+2060 WORD JOINER. Correct line break property: WJ.
- U+FEFF; ZERO WIDTH NO-BREAK SPACE (**ZWNBS**). The original replacement for NBH, but was co-opted as “byte order mark” (iff very first in a text *file*; not if first in a string in other kinds of string storage, and when concatenating files, all but the resulting first ZWNBS will lose their “byte order mark” significance). This character is not recommended to use at all.
- U+2060; WORD JOINER (**WJ**). Zero-width no-break word *separator*, despite the name. Handle the same as NBH.
- U+00AD; SOFT HYPHEN (**SHY**). A zero-width space (cmp. **BPH**), but explicitly indicates a hyphenation position. If a hyphenation is done at that point (by a text hyphenator), SOFT HYPHEN displays as <HYPHEN, LS> in most scripts, maybe more characters depending on the hyphenation rules (adding a letter in some cases is common). Char. ref.: **CSI 170\_**.
- U+2000; EN QUAD (canonically equivalent to U+2002 EN SPACE).
- U+2001; EM QUAD (canonically equivalent to U+2003 EM SPACE).
- U+2002; EN SPACE (1/2 em).
- U+2003; EM SPACE. Nominally approximately the width of an “m”. But better, approximately the height of “Åg” (and some fonts may need size adjustment).
- U+2004; THREE-PER-EM SPACE (1/3 em).
- U+2005; FOUR-PER-EM SPACE (1/4 em).
- U+2006; SIX-PER-EM SPACE (1/6 em).
- U+2009; THIN SPACE (1/8 em).
- U+200A; HAIR SPACE (1/24 em).
- U+205F; MEDIUM MATHEMATICAL SPACE (4/18 em, 1/4.5 em).
- U+180E; MONGOLIAN VOWEL SEPARATOR (zero-width but may change the shaping of adjacent Mongolian vowels).
- U+001A, U+FFFD; SUBSTITUTE, REPLACEMENT CHARACTER, these two should *display* the same, with some glyph. Used for conversion errors and other errors like using a device control in a text file or a malformed control sequence. Correct line break property (for both): AL, correct bidi property (for both): ON, correct general category (for both): SO.
- U+FFFC; OBJECT REPLACEMENT CHARACTER and “non-characters”. These are not spaces but are placeholders (per paragraph!) for (parsed out): math expressions, tables, vector graphics, images and perhaps other kinds of “objects” (e.g., “ligated” emoji sequences). These placeholders should never occur in “interchange” or storage and should be replaced by SUBSTITUTE (or REPLACEMENT CHARACTER) if they do. Each paragraph internally has a table saying which non-character stands for which “object” in the paragraph, and of course the “object” (math expression, table, ...) itself. The number of “non-characters” in Unicode is a bit stingy, even though the “scope” is only one paragraph. An application that really needs more of them can use a small part of the PUA (private use area), e.g., the one on plane 16. Correct line break property: CB, correct bidi property: ON, correct general category: SO.

## 4.2 Line break characters: LF, CR, CR+LF, PS, LS, VT, FF, ...

The following characters “just” advance the display position in the line progression direction plus to a beginning of line position in the character progression direction. Just as for most “default ignorable” Unicode characters these should have no glyph lookup via the font (unless in a “show invisibles” mode, where these characters also have glyphs, but may be taken from another font and not related to the character via the font, just via the application).

- U+000A; LINE FEED (**LF**), originally pure line feed, now handled as equivalent to **CRLF/NEL/PS**. (With default *stty* settings in Unix/Linux, an output LF is converted to CRLF.)
- U+000D; CARRIAGE RETURN (**CR**) (entered by *return* key) often mapped to LF/CRLF or even NEL; but sometimes still interpreted as a pure carriage return, e.g., in SMS messages, and in “raw mode” *tty* output (Unix/Linux). The line break property *CR* should be interpreted: “Cause a line break (after), except between **CR** and **LF**, **CR** and **VT**, **CR** and **FF**”.
- <U+000D, U+000A>; CARRIAGE RETURN, LINE FEED (**CRLF**), must be handled as a single line break; it is *not* two (explicit/hard) line breaks, it is just one. Note that <LF, CR> is not handled as a single unit, but is two “hard” line breaks.
- U+000B; LINE TABULATION (**VT**) (often possible to enter from a keyboard as *shift-return*), **VT/CRVT** (the latter as a single unit) must act as LS for bidi.  
VT was originally intended for rapid form fill-out (where the paper had the actual form pre-printed, and just filling in the field data). But it has gained a new use: to act as LS, in C0.
- U+000C; FORM FEED (**FF**) (sometimes possible to enter as *ctrl-return*), **FF/CRFF** (the latter as a single unit) must act as LS for bidi. Correct bidi property: S (just as for **VT**). Inside a table cell, math expression or vector graphics or there is no pagination, FF has the same effect as VT. Furthermore, **FF/CRFF** does *not* cause an additional page break if right after an automatic page break.
- U+0085; NEXT LINE (also as character reference: **ESC E**) (NEL), was intended as replacement for **CRLF** but is actively used only in EBCDIC based environments. Must act as **PS** for bidi. Should normally not occur in text (though there should be no special marking or error indication) except when the text is converted from EBCDIC.
- U+2029; PARAGRAPH SEPARATOR (**PS**) Intended to disambiguate **CR/LF/CRLF**.
- U+2028; LINE SEPARATOR (**LS**) Intended to disambiguate **CR/LF/CRLF**. But now, instead, **VT** is often used in this sense (LS) rather than VT’s original sense.
- U+001C, U+001D, U+001E, U+001F; **IS4, IS3, IS2, IS1** (these should *normally not* occur in text) Default display as line breaks, perhaps with an extra mark (e.g., encircled “IS4”, ..., “IS1”). Correct line break property: BK, correct bidi property (for all 4): B.  
**IS1** to **IS4** were *originally* based on UNIT SEPARATOR (US) to FILE SEPARATOR (FS) from ASCII/EBCDIC. But **IS1** to **IS4** are not necessarily hierarchical, and *even if* hierarchical, **IS1** need not be the “lowest” in the hierarchy. This is the case since ECMA-48 4<sup>th</sup> ed., December 1986, first edition to cover these. Their use as separators is *application defined*, i.e., they are private-use data separator characters.
- U+0001, U+0002, U+0003, U+0004; **SOH, STX, ETX, EOT** (these should *normally not* occur in text, though **STX** and **ETX** will be reused for delimiting (short) text parts *within* math expressions) Default display as line breaks, perhaps with an extra mark (e.g., encircled “SOH”, ..., “EOT”). Correct line break property: BK, correct bidi property: B; these do not apply when inside a math expression, since a math expression is parsed into a structure before display, and further bidi is very limited in a math expression.  
**EOT** has been reused essentially as FILE SEPARATOR (FS) (*from* the keyboard) in Unix/Linux systems (i.e., when received via a */dev/tty* character device, in default *stty* setting).

Few applications (or “devices” in ECMA-48 5<sup>th</sup> edition terms) handle these in the way originally intended. (Some systems also fiddle with some of these characters; “cooked” mode vs. “raw” mode; effectively “modified interpretation” vs. “original interpretation”. The details are out of scope for this paper.) But that does not mean that they should be left completely uninterpreted.

If not interpreted in the original way, interpret (by default) each of them as a line breaking character.

Many applications today implement automatic line breaking (and automatically re-evaluating the line breaking upon change of “line width” on the “front end”). Certain control sequences (here proposed not to be used, see below) assume that all line breaking is done by hard line-breaks (i.e. explicit line break characters). But much of ECMA-48, esp. SGR, work well also when many line-breaks (or, rather, line wrapping) are made automatically.

Note that when doing automatic line breaking, one should try to avoid local “jaggedness” in line length, if possible, like done by T<sub>E</sub>X via a points system, as well as by automatic hyphenation.

There is some ambiguity as to how to represent a “paragraph break” vs. an explicit “line break”. The recommendation here is: LF, CR, CRLF, NEL, PS should be regarded as equivalent, and (CR)VT, (CR)FF, LS should be regarded as equivalent (though (CR)FF also still often retains its original interpretation). VT is commonly used in place of LS in many applications today.

The interpretation of the style set by **CSI 69:...m** and **CSI 70:...m** (both new) are affected by the difference between PS (etc.) and LS (etc.): namely whether a line is considered as a:

- paragraph start line: text just after beginning of text, LF, CR, CRLF, NEL or PS,
- not paragraph start line: text just after automatic line break, (CR)VT, (CR)FF or LS.

The distinction also affects the Unicode bidi algorithm, when that is enabled (see SPD2 below).

## 5 SELECT GRAPHIC RENDITION – SGR (extended and clarified)

Note that certain styling should *not* be applied to prestyled characters, e.g., MATHEMATICAL BOLD CAPITAL A is bold and upright regardless of weight and italics settings. Emoji are in addition insensitive to text colour setting. Prestyled as superscript characters are displayed as first level superscripts, regardless of superscript/subscript/neither setting (see below). We will not make a full list here. Note also, that when bidi is used, a single logically contiguous style substring may be split into multiple substrings of that style. The details of this are out of scope for this proposal.

ECMA-48 “mode” changes **shall not** be supported. GRGM – GRAPHIC RENDITION COMBINATION MODE must be fixed to CUMULATIVE. TSM – TABULATION STOP MODE must be fixed to MULTIPLE. Further, GCC – GRAPHIC CHARACTER COMBINATION (a kind of character combination; **CSI ... SP \_**) shall not be implemented, nor should BS or CR be used for overtyping, except for typewriter-like devices (which are very rare today); Unicode has other ways of composing characters, and here we give other ways of underlining, overstriking and make bold. RM – RESET MODE (**CSI ...I**; small ell) and SM – SET MODE (**CSI ...h**) also **shall not** be implemented.

The SGR control sequence can specify several rendition changes in a single control sequence. But **CSI a;b;c;...;x;y;zm** can be turned to **CSI am CSI bm CSI cm...CSI xm CSI ym CSI zm** (with no semicolon within the variables, but here they may contain colon, the space between **m** and **CSI** is part of the notation here, not to occur literally).

Note that when (and if) bidi processing is applied, a single original “span” with a particular “graphic rendition” (called “style” today) may be split up into *several* display spans with *other* display spans having other styles *in-between*. How to manage and represent that in an

implementation is out of scope for this proposal but needs to be handled by an implementation of ECMA-48 styling that also implements bidi processing.

Here we go through the SGR codes, existing in ECMA-48 5<sup>th</sup> ed. as well as here proposed extensions, additions and clarifications, grouped by function, not just listed numerically.

## 5.1 RESET RENDITION (extended, primarily for command line apps)

This control sequence resets the SGR settings to the default (which may be preset or set in preferences). What is the default is out of scope for this proposal (as it is for ECMA-48 5<sup>th</sup> ed.). If pushing SGR attributes is supported (see below), the top-of-stack of stored-away values are counted as default. Reset rendition should be avoided in documents and output. This is a shortcut that can be handy, not needing to reset the style changes one by one.

This is useful in cases where the “current SGR state” is not or cannot be known by the application, and a reset is desired. For instance, at the *beginning* of a terminal program’s prompt (after a very first **ST**, just in the, slightly unlikely, case the previous output was terminated in the middle of a control string).

- **CSI Om** Reset rendition. The 0 can be omitted (**CSI m**). Resets rendition attributes (set via SGR) to the default setting and may (should) also close nesting layout features like PTX (tables/Ruby), bidi controls (ECMA-48 or Unicode) and other nesting features (like for math expressions). It should not close explicit stacking of SGR settings (à la *xterm*, see below). The exact extent of what is reset is implementation defined. The main use for **CSI Om** is for terminal emulators, though it can be handy (but not necessary) for dealing with conversion from ISCI (to the extent its formatting was ever implemented) or Teletext (which commonly uses colouring); except for these two, **CSI Om** should not be used in (ECMA-48 formatted) text files.

Hard line breaks do not, according to the ECMA-48 standard, reset the rendition set by SGR control sequences. However, some spacing setting control sequences, here proposed *not* to be used (replacements in SGR are proposed below), are auto-reset on (hard) line-breaks.

A prompt (for a command line interpreter) should *begin* with **ST** (to close any control string that may happen to be open) and then **CSI Om**, followed by the actual prompt. **CSI Om** should not be used in any other context (with the exception of ISCI or Teletext formatting being converted, where using **CSI Om** is handy, but *not* necessary). **CSI Om** is the only control sequence in this proposal that is specifically for terminals (or, rather, command line interpreters). All the rest in this proposal is suitable for a text document format, and the UI styling controls suitable for a text document editor. However, ISCI formatting and Teletext formatting do formatting reset when moving to next line (or page; so when emulating those, e.g., due to character coding conversion, a **CSI Om** is suitable just after an (explicit) line break (or explicit page break), to make the emulation correct.

Styles that are set *within* a table cell, a math expression text part, or a vector graphics text part are reset at end of said component.

A note for terminal emulators (command line interpreters): Some programs (esp. those outputting partial content of large text files or text streams) currently do assume, or even do, effectively reset the SGR set rendition, inserting extra **CSI Om**, and more, on (some) hard line breaks. That may result in somewhat “style thwarted” display of some portion of text, compared to if the entire preceding part of the document had been read and been ECMA-48 interpreted

before display, if the document has styling that spans more than (say) a few lines or “paragraphs”.

## 5.2 FONT WEIGHT (clarified, extended with variants)

Font weight is the scale where the boldness or leanness of a font is given, there is even degrees of boldness or leanness. Most modern fonts have a normal weight and a bold variant, many have also a lean variant. In multiple-master fonts one can continuously vary this aspect of a font from hyper-lean to hyper-bold within the font (no need for parallel fonts). This setting does not alter the colour of the text and does not affect in-line images (like emoji) in the text, nor prestyled bold, italic or Fraktur characters, nor ‘line drawing’ characters.

- **CSI 1[:v]m Bold font variant**. Cancels lean and normal (and current bold variant). Variants (note that the separator is colon, *not* semicolon): Variants: **CSI 1:700m** bold (default for **CSI 1[:v]m**), **CSI 1:400m** normal weight (alias for **CSI 22m**), **CSI 1:600m** semibold (if available, otherwise bold), **CSI 1:800m** extra-bold (if available, otherwise bold). **CSI 1:300m** select lean/light. *v* can be a value between 1 and 1000 (inclusive) selecting a weight as in OpenType and CSS, *v*=0 does a relative change to “lighter” as in CSS ‘*font-weight: lighter*’, and 1001 does a relative change to “bolder” as in CSS ‘*font-weight: bolder*’.
- **CSI 2[:v]m Lean/faint (light) font variant**. Same as **CSI 1[:v]m**, but the default for *v* is 300.
- **CSI 22[:v]m Normal weight** (neither bold nor lean). Same as **CSI 1[:v]m**, but the default for *v* is 400. 400 is also the initial (default) font weight.

Note: there is NO CHANGE IN COLOUR (or intensity) for these font weight changes, only change in weight. Fonts that are multiple-master do this within the font, otherwise there may be a font change to a related font. Contexts that are strictly fixed width might not implement the more “extreme” bolds, even if available in the fonts, since they usually need wider advance widths. This styling does not apply to inline images (e.g., emoji) or characters that are prestyled w.r.t. boldness/leanness or italic/Fraktur/double-struck. The value of the font weight may adjust the width of “en” and “em”.

This styling is autoterminated at text component end (end of table cell, end of text items in math expression and vector graphics, *if* started in the subcomponent), but is inherited to text components.

## 5.3 ROMAN/ITALIC (or OBLIQUE) STYLE (extended with variants)

This styling does not affect inline images (like emoji) in the text, nor prestyled bold, italic or Fraktur characters, nor ‘line drawing’ characters.

- **CSI 3[:v]m Italicized or oblique** (−8° to −12°). Oblique (normally synthesised) if there is no associated italic version. Variants: **CSI 3:0m** alias for **CSI 23m**, default :1: **CSI 3:1m** italicized (if available, otherwise −8° to −12° oblique), **CSI 3:1=m**: +8° to +12° oblique (normally synthesised) which is sometimes used in RTL scripts. This styling does not apply to inline images (e.g., emoji) or characters that are prestyled w.r.t. boldness/leanness or italic/Fraktur/double-struck (e.g., MATHEMATICAL characters). Does not apply to Fraktur (or ‘calligraphic’) fonts, if such a font is set, this setting also changes to the default font. The value of *v* can be interpreted as “−*v* times 10 degrees glyph inclination/skew”, though the exact factor, 10 here, is implementation defined. A value of *v* between 0.5 and 1.5

uses an italic variant if available for the current font but modifies the inclination between more upright to more oblique, with 1 meaning “as is”.

- **CSI 23[:v]m** Roman/upright, i.e. not italicized/oblique (default). If the current font is a “calligraphic” font, this setting also changes to the default (and non-calligraphic) font. Same variants as **CSI 3[:v]m**, but the default variant is **0**. In addition, variant **1** is always interpreted as oblique (–8° to –12°), never as italic. Does not apply to characters that are prestyled w.r.t. italics/bold/Fraktur. Upright is also the initial (default) setting for this.

This styling is autoterminated at text component end (end of table cell, end of text items in math expression and vector graphics, *if* started in the subcomponent), but is inherited to text components.

## 5.4 FONT CHANGE (extended with variants; Fraktur is moved here)

One of the following two non-calligraphic fonts should be the default or initial font. Changing font does *not* change any currently set tabulation positions, even if the ‘em’ changes.

- **CSI 20m** Change to a predetermined calligraphic font (set). So-called “calligraphic” fonts are extra adorned fonts. This includes Fraktur (<https://en.wikipedia.org/wiki/Fraktur>). Italic/oblique does not apply to this kind of fonts, so “italics” is implicitly cancelled when changing to a calligraphic font. Which font (or font set with different weights) may be given by the implementation or may be settable in preferences (or even an **APC** control string).
- **CSI 26[:v]m** Change to a predetermined proportional (non-calligraphic) font (set) (serif or sans-serif). Variants: **CSI 26:1m** serif, **CSI 26:2m** sans-serif. Which font (or font set with different weights, condensed/expanded, and italic or not) may be given by the implementation or may be settable in preferences (or even FNT or an **APC** command). **CSI 26:0m** resets to initial (default) font, serif, sans-serif, or “fixed” width. A calligraphic font cannot be initial font.
- **CSI 50m** Change to a predetermined “fixed” width (non-calligraphic) font (set). Kerning is not applied. Which font (or font set with different weights, condensed/expanded, and italic or not) may be given by the implementation or may be settable in preferences. Though called “fixed width”, it will have three different widths: 0-width (non-spacing diacritics, most escape and control sequences, as well as most control strings; though the latter will not be handled by the font per se, but long before), narrow (most scripts), wide (double-width) for CJK, Hangul and emoji (and “...”). Note that some characters come as both emoji and non-emoji (may use variant selectors to indicate which); they have different widths.
- For y in **10** to **19**, **CSI ym**: Pick from a font palette of up to ten fonts (set permanently, as preferences, via FNT – FONT SELECTION, or via **APC** control string). Each index refers to a set of fonts, varying in italics and weight, if not multiple-master. E.g., **CSI 19;1m** (i.e., **CSI 19mCSI 1m**) will select the bold version of the font at index 19 (whether multiple-master or separate font file for the bold). For each such font set, there needs to be information whether it is “calligraphic” or not (for the interpretation of **CSI 3m** and **CSI 23m**). (Note: xterm has an extension with which one can specify a font by name to change to or change the font palette. It uses **OSC** but should use **APC**.)



Changing font does not in itself change the width of spaces, the advance widths of which are not to be directly read from the font (except for OGHAM SPACE MARK, which may have a glyph, and spaces whose width correlate with the width of certain digits or punctuation characters). However, for fixed-width fonts the nominal advance width for SP and NBSP are 1 en. For variable-width (“proportional”) fonts, the nominal advance width for SP and NBSP is usually set to a somewhat smaller value (like 0,7 to 0,9 en, but is implementation defined, and may be settable as a user preference).

This styling is autoterminated at text component end (end of table cell, end of text items in math expression and vector graphics, *if* started in the subcomponent), but is inherited to text components.

## 5.5 FONT SIZE CHANGE (new, replacing GSS, GSM)

In “original” ECMA-48, units for sizes and advances were set by a separate control sequence, SSU (SELECT SIZE UNIT). This design is flawed for several reasons (major reason: the unit is separated from the value and that can easily lead to very wrong interpreted values, especially if one is doing cut-and-paste of raw ECMA-48 styled strings, or similar kinds of substitutions), and replacements for “SSU dependent” control sequences are proposed below. But we do keep the unit codes from SSU, for backwards compatibility on that point. Zoom is applied after size determination. Changing font size or font magnification does *not* change any currently set tabulation positions.

Unit codes (**0** to **8** from SSU, **9** is new; an implementation need not support all units):

- **0** CHARACTER – ‘en’ (0,5 em) in the character progression direction (usually horizontally), even for double-width scripts (CJK); ‘em’ in the line progression direction (usually vertically) (‘em’ is also supported as a unit in CSS)
- **1** MILLIMETRE (this is called ‘mm’ in CSS, it is not necessarily exactly 1 mm)
- **2** COMPUTER DECIPOINT – 0,03528 mm (254/7200 mm) (this is called ‘pt’ in CSS)
- **3** DECIDIDOT – 0,03759 mm (10/266 mm)
- **4** MIL – 0,025 4 mm (254/10 000 mm)
- **5** BASIC MEASURING UNIT (BMU) – 0,02117 mm (254/12000 mm)
- **6** MICROMETRE – 0,001 mm
- **7** PIXEL – The smallest increment that can be specified in an (old) display device (this is called ‘px’ in CSS, it is not necessarily one actual pixel in size, especially with modern high-resolution devices 1px may be two or more actual pixels)
- **8** DECIPOINT – 0,035 14 mm (35/996 mm)
- **9** default size (value parameter ignored) (the top “pushed” size w.r.t. **CSI !**, see below)

They should be interpreted in the same way as in HTML/CSS (extended for the units that are not in HTML/CSS), see <https://www.w3.org/Style/Examples/007/units.en.html>.

- **CSI 76:u:sm** Font size. Unit *u* as per above. *s* can be negative with EQUAL SIGN (=) postfix, indicating negation (for an upside down mirrored glyph), *s* can be fractional with ? as decimal marker, e.g. **CSI 76:2:14?5m**, for 14,5 points. **CSI 76:9m** resets to default size. This replaces GSS (GRAPHIC SIZE SELECTION), which is here proposed not to be used nor implemented. SSU is also proposed not to be used/implemented, and the units are given in the SGR control code sequences instead. This replacement is due to several factors, because GSS was ill designed. a) The unit was set separately, which can cause major

unintended rendition flaws. b) Even though there were several units associated with this, GSS did not allow for decimal values, so no (near accurate) conversion was possible, nor did it allow for negative values (which is of course optional to implement). c) Sizing is to be reset by **CSI 0m**, but GSS was not. Note that increasing the font size may temporarily increase the line spacing in order to accommodate the larger glyphs, if the line spacing is given in the “em” unit. The size should be glyph size based (e.g., based on Åg-height or similar glyph measure, and the adjustment may vary over a single font), not just verbatim size from the font, so that glyphs appear size-wise similar for a given requested size. Changing the font size also changes the size of the en and em (approx. Åg height, *after* adjusting the declared font em) units. The Åg height (or similar) refers to the nominal size, *not* the superscript/subscript (subs/sups) size nor the small caps (c2sc/c2pc) size.

- **CSI 77:a:bm** Font magnification. *a* (vertical factor) and *b* (horizontal factor) can be fractional (‘?’ as decimal marker), and *b* can be negative (‘=’ as negation sign, postfix), e.g., **CSI 77:1:0?8m** for narrow (may use condensed/expanded axis in a multiple master font), **CSI 77:1:1m** resets. This setting is *not* accumulative. Arguments are direct factors, not percent. This replaces GSM (GRAPHIC SIZE MODIFICATION) which is here proposed not to be used. This replacement is due to several factors, because GSM was ill-designed. a) It was percentages but did not allow for decimal values. b) Font magnification is to be reset by **CSI 0m**, but GSM was not. This setting should take into account condensed/expanded variants in a multiple master font. Increasing the *vertical* height via magnification will “glue” the glyphs at cap height, making them expand below the (normal) baseline on horizontal lines *without* increasing the line spacing, whereas increasing the font size “glue” them to the baseline, growing the line spacing for the lines with increased font size. Changing font magnification does *not* change the size of the en and em units, but changes the glyph and space advance.

This styling is autoterminated at text component end (end of table cell, end of text items in math expression and vector graphics, *if* started in the subcomponent), but is inherited to text components.

## 5.6 UPPER/LOWER HALF GLYPHS (new, for ISCII support only)

This control sequence is strongly not recommended. It is proposed *only* to make certain conversions from ISCII more direct (or in some aberrant (non-use-case) cases: possible). Xterm also has similar functionality, but whole line only and using **ESC #3** and **ESC #4** (are reset at eol).

- **CSI 113:vm** Show horizontally halved glyphs. Variants: **:0** show glyphs normally, **:1** show only the upper half of the glyphs (for combining sequences), cutting about half cap height and counting only half an em for these glyphs for line height calculations, **:2** show only the lower half of the glyphs (for combining sequences), moved up to just under the half glyphs of previous line (so that two lines with the same text, constant size, the upper half joins with the lower half). Note that this only does the “glyph halving”, size change (often to double height) must be done separately (in contrast to ISCII and xterm).

This styling is autoterminated at text component end (end of table cell, end of text items in math expression and vector graphics, *if* started in the subcomponent) and at hard line breaks (NLF), and is *not* inherited to text components.

For other use than ISCII and xterm compatibility, this styling is strongly deprecated.

## 5.7 RAISED/LOWERED TO FIRST INDEX POSITION (new, replacing PLU, PLD)

ECMA-48 has PLU (PARTIAL LINE UP/BACKWARD) and PLD (PARTIAL LINE DOWN/FORWARD) for making indices (if the character progression direction is horizontal), mimicking manual typewriters, moving the paper. They do have a bit of generality, and *nroff* in its days used such partial line movements to output mathematical expressions using typewriter-like terminals (but for mechanical reasons, the printed lines had to be rearranged so that the paper only moved in one direction and the paper passed through several times, with different type wheels).

That way of printing math expressions is not recommended. For math expressions, allowing for good typography and layout, we recommend the math expression representations presented in *A true plain text format for math expressions (and its XML compatible equivalent format)*.

In addition, superscripting and subscripting (when not in a mathematical expression) are now often regarded as character styling. Indeed, OpenType fonts have dedicated styling “features” for superscripts and subscripts (not intended for math expressions), but can otherwise be achieved by relative sizing and relative placement of the “ordinary” glyphs.

The control sequences below will make characters display at the first index position, raised or lowered. This replaces PARTIAL LINE FORWARD and PARTIAL LINE BACKWARD codes for making indices. PLD/PLU do not do the size change normally associated with superscripts or subscripts.

Note that for some uses, like powers of units (like m<sup>2</sup>), chemical numerical subscripts (like H<sub>2</sub>O) as well as phonetic notation (like <sup>h</sup>), preformatted Unicode characters are *strongly* preferred over using styling to achieve the raised/lowered display. Preformatted Unicode characters are also sometimes preferred for certain abbreviations, like ordinals with letter superscripts, and also for other common abbreviations in (e.g.) French. Preformatted superscript/subscripts are not affected by the control sequences for superscript/subscript styling.

On the first instance after a “normal” character of a switch directly from superscript to subscript or vice versa, whether by these control sequences or preformatted superscript/subscript characters, the display position is moved back to after the last “normal” character. When ending, the display position is moved to after the longest of the two sequences. This way, one can apply superscript and subscript nicely together. However, attempting to apply multiple raised or multiple lowered strings to the same “normal” character will have an implementation defined effect.

If the character progression direction is vertical, the superscripts and subscripts apply *horizontally* (opposite the line progression direction) to the preceding “normal” character.

- **CSI 56:1[:v]m** Raised to first superscript level and slightly smaller, about 80% current set size. (May use the OpenType feature ‘sup’s’ if available.) Overline will temporarily skip; strike-through and underline are not affected (not moved). Does not accumulate, i.e., one cannot achieve second level superscript or superscript of a subscript. v=0 (default): no underline at superscript level, v=1: singly underlined at superscript level, v=2: doubly underlined at superscript level. These superscript underlines are not sensitive to the underline/overline/... colour setting, but follow the “foreground” colour setting.
- **CSI 56:1=m** Lowered to first subscript level and slightly smaller, about 80% current set size. (May use the OpenType feature ‘sub’s’ if available.) Underline will temporarily skip; strike-through and overline are not affected (not moved). Does not accumulate, i.e., one cannot achieve second level subscript or subscript of a superscript.

- **CSI 56[:0]m** Not raised/lowered and back to the set size. (Default.)

Superscripting and subscripting is a very common notation in mathematics. But those superscripts subscripts (that are part of math expressions) will need to use a different mechanism in order to fit with math expression layout. See details in *A true plain text format for math expressions (and its XML compatible equivalent format)*, 2023, <https://github.com/kent-karlsson/control/blob/main/math-layout-controls-2023-A.pdf>.

Text superscript/subscript is *autoterminated* at the *start* of a math expression, table, vector graphic, image, emoji or a hard line break (NLF), and also at the end of a component. There should be no automatic line break within a text superscript/subscript even if it contains spaces or punctuation that would otherwise allow automatic line break.

## 5.8 LIGATURES (new)

Modern fonts often support ligatures. However, fixed width fonts usually do not have ligatures, though some scripts do have required ligatures ('rllig' feature in OpenType). Proportional fonts should have required ligatures (if any in the scripts supported), and modern ligatures ('liga' feature in OpenType). Exactly which (modern) ligatures are supported depends on the font, but commonly (for the Latin script) fi, fj, fl, fb, fh, fk, ff, ffi, ffj, ffl, ffb, ffh, ffk would be covered by 'liga', but may cover more, like ft, fft, and even 'if', 'iff', 'jf' and tf, as well as fö, ffö, fä, ffä and others.

However, emoji "ligatures" of emoji sequences will not use this but need to use another mechanism. Indeed, ligated emoji sequences are insensitive to bidi, and must be parsed out.

- **CSI 57[:0]m** Reset to default w.r.t. ligatures. Fixed width font: same as **CSI 57:1m**. Proportional width font: same as **CSI 57:2m**. Note that for proportional fonts, kerning is always enabled.
- **CSI 57:1m** Only required ligatures (none in the Latin script). A required ligature (of two letters) may have the same width as one letter. OpenType feature 'rllig'.
- **CSI 57:2m** In addition to required ligatures, use also modern ligatures (according to the font). For a fixed width font, this is usually the same as **CSI 57:1m**. OpenType features 'rllig' and 'liga'; 'liga' ligatures should not incur any width changes, or very small ones.
- **CSI 57:vm**,  $v = 3$  or greater. Reserved for future use; historical/'hlig' ligatures (include in **CSI 57:2m**?); discretionary/'dlig': mostly for [acegmnopqrs][bfhklt] where one can connect the letter pair by an arc (ct; which used to be popular); 'clig'/'calt' contextual alternatives.

## 5.9 SMALL CAPS (new)

Small caps style is often the preferred style for abbreviations/acronyms in uppercase. Note that for phonetic notation, preformatted Unicode characters are strongly preferred. This styling does not apply to letters that are already small caps. Small caps can be simulated by using a smaller font size. Exceptionally, lowercase as small caps are sometimes used in headings or lead text. Note though that the mapping to uppercase is sometimes language dependent, for instance for German and Turkish. These styling variants only apply to cased alphabets, and has no effect on letters from uncased alphabets/ideographs/etc.

- **CSI 66[:0]m** Normal uppercase and lowercase rendering (default). Implies **CSI 67[:0]m**.
- **CSI 66:1m** Uppercase letters rendered in smaller than normal size (but > x-height), small caps. Lowercase letters are not affected, but ASCII digits and "&" should be affected.

OpenType feature 'c2sc' (simulate if not available). This is *regularly* used for uppercase abbreviations/acronyms and other stretches of uppercase letters.

- **CSI 66:2m** Uppercase letters rendered in even smaller than normal size (approximately x-height), also called petit caps. OpenType feature 'c2pc'. Sometimes a distinction is made between small and petit caps. Lowercase letters are not affected, but ASCII digits and '&' should be affected. If petit caps are not available, this selects small caps (if available).
- **CSI 66:666m** Lowercase letters rendered as the petit caps of their uppercase. Original uppercase letters are not affected. Digits are not affected. OpenType feature 'pcap'. Note that mapping to uppercase is sometimes language dependent, and this display mode might not respect that (implementation defined). Petit caps from lowercase can be seen as violating Unicode character identity. In some scripts (not the Latin script) lowercase looks much like petit caps.
- **CSI 66:999m** Lowercase letters rendered as the small caps of their uppercase. Original uppercase letters are not affected. Digits are not affected. OpenType feature 'smcp'. This is *sometimes* used for headings/titles/captions and even first paragraph lead texts. Note that mapping to uppercase is sometimes language dependent, and this display mode might not respect that (implementation defined). Small caps from lowercase can be seen as violating Unicode character identity.

While uppercase to small/petit caps and lowercase to small/petit caps in principle could be combined (turning all into small/petit caps), that is not supported here. Likewise, map to (normal size) uppercase *as a display style* (turning all into uppercase) is not supported here. Nor is mapping uppercase to lowercase *as a display style* supported here.

Text smallcaps/petitcaps is *autoterminated* at the start of a math expression, table, vector graphic, image, emoji or a hard line break (NLF), and also at the end of a component.

## 5.10 UPPERCASE/LOWERCASE/FIXED-WIDTH /PROPORTIONAL DIGITS (new)

Lowercase digits are often preferred in running text (which is mostly lowercase). For tabular-like contexts or arithmetic expressions, fixed width digits are preferred. These styles apply only to the (narrow) digits 0 to 9, not digits in other scripts, nor fullwidth 0 to 9.

- **CSI 67[:0]m** Uppercase fixed width digits (default). OpenType feature 'lnum' and, if needed, 'tnum'; 'tnum' is not needed for fonts that are (generally) fixed width.
- **CSI 67:1m** Lowercase fixed width digits. Sometimes called "old-style" digits/figures, despite modern use. If available in the font. OpenType feature 'onum' and, if needed, 'tnum'.
- **CSI 67:2m** Uppercase proportional width digits. Has effect if available in the font. OpenType features 'pnum' and 'lnum'. For fixed width fonts: same as **CSI 67:0m**.
- **CSI 67:3m** Lowercase proportional width digits. Sometimes called "old-style" digits/figures, despite modern use. Has effect if available in the font. OpenType features 'onum' and 'pnum'. For fixed width fonts: same as **CSI 67:1m**.
- **CSI 67:99m** Uppercase fixed width digits, where the (ASCII) 0 has a middle dot or an internal diagonal stroke. OpenType feature 'zero' with 'lnum' and, if needed, 'tnum'. This style was originally (long before OpenType) for computer terminals (and printers), but now used more for effect and rarely used in terminal emulators. Same as **CSI 67:0m**, if this variant is not available, but some fonts may have this as the only variant for 0.

Note that ‘lnum’ (uppercase) and ‘onum’ (lowercase) are contradictory, as are ‘tnum’ (fixed width) and ‘pnum’ (proportional width). Other combinations are ok. **CSI 66:1m** and **CSI 66:2m** also should affect ASCII digits (to rendered as small caps or petit caps) regardless of **CSI 67:vm**.

This styling is *autoterminated* at text component end (end of table cell, end of text items in math expression and vector graphics, *if* started in the subcomponent), but is inherited to text components.

## 5.11 LINE INDENTS AND JUSTIFICATION (new, replacing JFY, QUAD, ...)

Line indents can be used for first line intent for “ordinary” paragraphs, and for non-first line indents mostly for bulleted/numbered lists. For bulleted/numbered lists, the bullet or the number can be in a “tab field” and have an HTJ (CHARACTER TABULATION WITH JUSTIFICATION, U+0089 or, as a character reference, **ESC I**) just after the bullet/number part, and then a HT to the tab position set at the same position as the non-start line indent (<HTJ,HT>).

The line indent control sequences should occur only at the beginning of a paragraph. At other positions, the result is implementation defined. Line indents are *not* reset by **CSI 0m** (but are reset by RESET TO INITIAL STATE, **ESC c**, which is commonly implemented in terminal emulators, but like **CSI 0m** is not a good fit for a document format). SLH, SLL, SPH and SPL should not be used since they are ill-defined: their “positions” are undefined.

- **CSI 69:u:v[:s]m** First line (of paragraph if  $s$  is 1 (default), after LS/VT/... if  $s$  is 2) BOL (beginning of line) indent (beginning of text, and after: LF, CR, PS, ...; after LS, VT, ... if  $s = 2$ ). Distance from *default* BOL position (as set by preference setting or by context (such as window size, or cell size)). On left side for LTR, on right side for RTL, on top for vertical lines. Does not accumulate. Unit  $u$  as per SSU units (0 to 8), 9 for reset to default (value ignored and can be omitted).  $v$  is positive (or zero), can be fractional. If the  $s = 2$  variant is not set after an  $s = 1$  variant setting, the  $s = 2$  setting inherits the  $s = 1$  setting from **CSI 70:u:v[:s]m**.
- **CSI 70:u:v[:s]m** Non-first line (of paragraph if  $s$  is 1 (default), after LS/VT/... if  $s$  is 2) BOL line indent (after auto-line-break). Distance from *default* BOL position (as set by preference setting or by context (such as window size, or cell size)). On left side for LTR, on right side for RTL, on top for vertical lines. Does not accumulate. Unit  $u$  as per SSU units (0 to 8), 9 for reset to default (value ignored and can be omitted). If  $s = 1$  (default), this also sets two tab stops that “belong” to the **CSI 70:u:v:1m** ( $s = 1$ ) setting: one at the position given, and one 1 en (current font and size; additional spacing can be achieved by using various space characters) prior (in the character progression direction) to that position. These two tab stops are not altered via HTSA2 (see below). Default tab stops before (in the character progression direction) these two tab stops are ignored when “tabbing”.  $v$  is positive (or zero), can be fractional. (Nit: hanging indents can be useful for terminal emulators as well.) If an  $s = 2$  variant is not set after an  $s = 1$  variant setting, the  $s = 2$  setting inherits the  $s = 1$  setting from **CSI 70:u:v:1m**.
- **CSI 71:u:v[:j]m** EOL (end of line) line indent. Distance from *default* EOL position (as set by preference setting or by context (such as window size, or table cell size)). On right side for LTR, on left side for RTL, on bottom for vertical lines. Does not accumulate. Unit  $u$  as per SSU units (0 to 8), 9 for reset to default (remaining two parameters are then ignored and can be omitted).  $v$  is positive (or zero), can be fractional.

- $j = 0$ : (default) Flush lines to set BOL, as set by **CSI 69:u:v[:s]m** and **CSI 70:u:v[:s]m**.
  - $j = 1$ : Flush lines (after BOL, or if tab stops are used then after last used tab stop) to set EOL position (space/tab characters, at end of line not counted).
  - $j = 2$ : Centre line content on the available line between BOL, or latest used tab stop used, and EOL positions as set by the (**CSI 69:u:v[:s]m** or **CSI 70:u:v[:s]m** or HTSA2) and **CSI 71:u:v[:j]m** control sequences (spaces/tabs at end of line are not counted).
  - $j = 3$ : (replacing JFY) Stretch lines between (the nearest of) BOL or latest *used* tab stop, and EOL positions (if possible) *that are not at end of paragraph nor ends with VT/LS/FF/...* (otherwise, flush to BOL) to fill up the line space by widening SPs, NBSPs, IDSPs, though that should be avoided for spaces before/after words in certain scripts (e.g. Arabic) where the words are instead lengthened by adding ARABIC TATWEEL to some of the words.
  - $j=4$  or  $j=5$ : No automatic line breaking, first align VT/LS/... separated lines in each paragraph on first occurrence of COMMA, FULLWIDTH COMMA or ARABIC DECIMAL SEPARATOR ( $j=4$ ) or to FULL STOP or FULLWIDTH FULL STOP ( $j=5$ ) (align with end of line if no occurrence of those characters in the line), then align the entire paragraph to end of line as set by **CSI 71:u:v[:j]m** (assuming that the line contents all fit).
- The behaviour for line content that cannot fit in the line is implementation defined, but should normally use automatic line breaking.
- Except for  $j=0$ , if there are HT/HTJ characters in the line, only the part after the last HT/HTJ character in the displayed line is affected by the adjustment from that HT/HTJ character's "target" position, which is used as *temporary* BOL position, to EOL position.

This styling is *autoterminated* at text component end (end of table cell, end of text items in math expression and vector graphics) *if* started in the subcomponent, and is inherited to text subcomponents (like table cells).

## 5.12 LINE SPACING (new, replacing SLS, SVS, SPI)

The line progression direction "movement" when there is a line break. Default, about 1,3 em.

- **CSI 72[:u:s[:sb[:sa]]]m** Line spacing.  $u$  unit as per SSU (0 is em, 1 to 8 per SSU, 9 resets to default 1,2 em (counting the largest font size in the line) line spacing regardless of  $s$ , which then can be omitted), 9 is default for  $u$ . However, objects (such as tables, vector graphics, math expressions) are counted by their real size in the line progression direction, they are also centred in the line space (in the line progression direction), unless the object specified differently.  $s$  can be fractional (e.g., **CSI 72:0:1?5m** for 1,5 em line spacing). This replaces SLS (SET LINE SPACING), SVS (SELECT LINE SPACING), SPI (SPACING INCREMENT) which are proposed not to be used. If the unit is 'em', it is the em (after adjustment, so Åg height really) of the largest glyph (considering font sizes) in the displayed line, not counting math expressions, tables, vector graphics or images in the line (which may give extra line spacing).  $sb$  (reusing the unit  $u$ ), default **0**, is the extra spacing before a paragraph (in the line progression direction),  $sa$  (reusing the unit  $u$ ), default  $sb$ , is the extra spacing after a paragraph. Extra spacing before a paragraph is not issued at the beginning of page (but is issued at the beginning of a table cell), extra spacing after a paragraph is not issued at end of page (but is issued at the end of a table cell). When extra space after a paragraph is adjacent to extra space before a paragraph, the max of the two is used, not the sum.

Line spacing is inherited into table cells. A line spacing control sequence set in a table cell is automatically reset at end of cell. Note that line spacing is *not* reset to default by **CSI 0m**, only by

another line spacing control (**CSI 72m** resets line spacing to default), or by RESET TO INITIAL STATE (**ESC c**) (for terminal emulators, not recommended for document formats).

### 5.13 ADVANCEMENT MODIFICATION (new, replacing SACS, SDCS, SSW)

Not recommended, but extra letter separation has been used for emphasis, esp. in German Fraktur, but also in other instances.

- **CSI 110[:z]m** Advancement modification (times **CSI 111:xm** (spaces only) and **CSI 77:a:bm** modification) in the character progression direction after kerning. *z* can be fractional (? as decimal marker), affects spaces as well, **CSI 110:1m** resets (factor = 1; short **CSI 110m**), no accumulation. E.g., **CSI 110:1?3mabcCSI 110:1md** sets “abcd” with 1,3 times the nominal advance width of each letter, “stretching” the word. Factors other than 1 may break up ligatures and cursive joins, but for Arabic ‘kashida’ strokes may be inserted. Factors less than 1 should *not* be used, as that may result in (partial) overtyping with implementation defined display results. (As an extreme example, **CSI 110:0mabcCSI 110:1md** sets “abcd” all at the ‘same’ position.) Changing the advance does *not* change the “en” and “em” unit sizes, nor tab stops. This replaces SACS and SDCS which are here proposed not to be used. The latter depended on separately set unit and were not reset by **CSI 0m**, were additive, not multiplicative, and were reset by line breaks.
- **CSI 111[:x]m** Space (Unicode general category Zs characters) advancement modification (times **CSI 110:zm** and **CSI 77:a:bm** modification), in the character progression direction; this is before stretching SP, NBSP, IDSP for line justification reasons. *x* can be fractional (? as decimal marker); **CSI 111:1m** resets (factor = 1; short: **CSI 111m**), no accumulation. Note that if the line is justified (**CSI 71:u:v:3m**), some spaces may be “stretched” a bit more than given here (but never less), due to line justification. Values less than 1 should not be used. Changing the space advance factor does *not* change the “en” and “em” unit sizes, nor tab stops. This replaces SSW which is here proposed not to be used. The latter depended on separately set unit and was not reset by **CSI 0m**, was additive, not multiplicative, and was reset by line breaks.

This styling is *autoterminated* at text component end (end of table cell, end of text items in math expression and vector graphics) *if* started in the subcomponent, and is *not* inherited to text subcomponents (like table cells).

### 5.14 UNDERLINE (extended with variants)

ECMA-48 does not allow for several different types of underlines on the same piece of text, and even if one were to allow it, it would not be possible to have differently coloured underlines on the same piece of text (but see the section on UI underlines below, which are *not* part of the text styling, but part of the UI). Similarly for overline and strike-through. The underline is drawn just below the baseline. The underline should skip descenders, like those in “jgppy” as well as letters with diacritics below. But do not skip LOW LINE, which nowadays is usually displayed on the baseline, not below the baseline, even though its origin in typewriters was for underlining.

- **CSI 4[:v]m** Singly underlined. Variants: **CSI 4:0m** not underlined (same as **CSI 24m**), **CSI 4:1m** solid (medium, default), **CSI 4:2m** double thin solid lines (same as **CSI 21m**), **CSI 4:3m** wavy/curly, **CSI 4:4m** dotted, **CSI 4:5m** dashed (medium), **CSI 4:6m** double wavy, **CSI 4:7m** thin solid, **CSI 4:8m** bold solid, **CSI 4:9m** bold wavy, **CSI 4:10m** thin dashed, **CSI 4:11m** bold



dashed, **CSI 4:12m** double thin dashed. Each variant of **CSI 4m** cancels current **CSI 4m**, if any, and cancels **CSI 21m**. Thin and thick is relative to current font size.

- **CSI 21[:v]m** Doubly underlined. **CSI 21m** cancels **CSI 4m**, if any. Same as **CSI 4[:v]m**, but with different default (:2).
- **CSI 24[:v]m** Not underlined. Same as **CSI 4[:v]m**, but with different default (:0). If the underlining is *initiated* via this control sequence (i.e., non-zero *v*), the underline is a bit lower so that it goes under common descenders (for g, j, etc.) and there is no gap in the underlining for such letters, nor for lowercase digits, nor for subscripts via **CSI 56:1=m**.

The underline is drawn in the character progression direction and is on the line progression direction side of the text line. Compare HTML underline (`<span style="text-decoration: underline">`). The underlining “follows” the baseline (not text superscript/subscript) of the text (note in particular for Indic scripts, where the glyphs align on a high line) in case of size changes. However, there is no underlining of math expressions (**CSI 24[:v]m**, *v* > 0: that go below first subscript level), vector graphics, tables nor images. Adding underline does not change the spacing in any direction. Underline is *not* inherited into math expressions, table cells or vector graphics texts.

## 5.15 OVERLINE (extended with variants)

The overline is drawn slightly above cap height. Used for some math notations, like decimal sequence repetition for rational numbers, but should still skip diacritics above capital letters (with an exception, see below).

- **CSI 53[:v]m** Overlined. Same variants as **CSI 4m**, default is :1, medium solid line. Each **CSI 53[:v]m** cancels current **CSI 53[:v]m**, if any.
- **CSI 55[:v[:w]]m** Not overlined. Same as **CSI 53[:v]m**, but with different default (:0). If overlining is initiated via this control sequence (i.e. non-zero *v*), the overline is a bit higher so that it goes over single above-capital letter accent marks (for Å, Ö, etc.), and no gap in the overlining for such letters, nor for superscripts via **CSI 56:1m**.  
*w*, default value 0 (no “extra” line), having the value 1 indicates that a straight line should be drawn in the line progression direction (i.e. usually vertical) between the (would be) position of an underline (**CSI 24[:v]m**) and the (would be) position of the overline (**CSI 55[:v[:w]]m**); compare **CSI 51[:v[:r]]m**. With *w*=2, the line is curved like a ‘), with *w*=3, the line is curved like a ‘(. This “extra” line functionality can be used for the various notational conventions for long division but may of course be used for other purposes.

The overline is drawn in the character progression direction and is on the opposite side of the line progression direction side of the text line. Compare HTML overline (`<span style="text-decoration: overline">`). The overlining “follows” the (not text superscript/subscript) capline of the text in case of size changes. However, there is no overlining of math expressions (**CSI 55[:v[:w]]m**, *v* > 0: that go above first superscript level), vector graphics, tables nor images. Adding an overline does not change the spacing in any direction. Overline is *not* inherited into math expressions, table cells or vector graphics texts.

## 5.16 STRIKE-THROUGH (extended with variants)

Strike-through, or crossed-out, is commonly used to mark text that is planned to be deleted or otherwise outdated, wrong, but still shown for comparison with new text (that may be marked in some way to indicate that it is new), or just marking as closed (e.g., issue is closed, proposal rejected, or similar).

- **CSI 9[:v]m** Crossed out (strike-through). Same variants as **CSI 4m**, default is :1, medium solid line. Each **CSI 9[:v]m** cancels current **CSI 9[:v]m**, if any.
- **CSI 29[:v]m** Not crossed out. Same as **CSI 9[:v]m** but with different default (:0).

The strike-through (cross-out) line is drawn in the character progression direction, at a suitable mid-text-line position, text superscripts/subscripts get the cross-out at the “normal” character position’s midline. Compare HTML line-through (`<span style="text-decoration: line-through">`). Crossed-out is inherited into math expressions (text parts), table cells, vector graphics texts.

## 5.17 OVERSTRUCK TEXT GRAPHEMES (new)

In some contexts, one may want to do a special kind of overstrike. One that applies to each text grapheme (e.g., combining sequence, but more general, esp. for Indic scripts).

- **CSI 116[:v]m** Start overstriking text graphemes. *v* indicates the kind of overstrike: :1 for / overstrike, :2 for \ overstrike, :3 for ʌ overstrike, :4 for ∟ overstrike, :5 for ∟ overstrike, :6 for ∟ overstrike, :7 for a crossed over (X) overstrike, :8 for a | overstrike, :9 for a | with / (double) overstrike, :10 for a | with \ (double) overstrike. **CSI 116:0m** (default) for stopping overstrike of text graphemes.

Graphemewise overstriking is inherited into math expressions, table cells and vector graphics texts.

## 5.18 EMPHASIS MARKING FOR CJK (extended with variants)

Traditionally, CJK does not use bold or italic/oblique but other ways of emphasising; and the “underline” is different (CJK glyphs have a lower baseline than non-CJK characters). Compare CSS (<https://developer.mozilla.org/en-US/docs/Web/CSS/text-emphasis-style>). Proposed here are some extensions to ECMA-48, to handle some variants that CSS covers. All of these should cancel “western” underline/overline, but not cancel strike-through/crossed-out.

- **CSI 60[:v]m** CJK underline (on the right side if vertical character progression direction). Same variants as **CSI 4m**, default is :1, medium solid line. (Negative variant value can be used for overline/left side line.)
- **CSI 61[:v]m** CJK double underline (on the right side if vertical character progression direction). Same as **CSI 60[:v]m**, but different default (:2). (Negative variant value can be used for overline/left side line.)
- **CSI 62[:v]m** CJK overline (on the left side if vertical character progression direction). Same variants as **CSI 4m**, default is :1, medium solid line. (Negative variant value can be used for underline/right side line.)
- **CSI 63[:v]m** CJK double overline (on the left side if vertical character progression direction). Same as **CSI 62[:v]m**, but different default (:2). (Negative variant value can be used for underline/right side line.)
- **CSI 64[:v]m** CJK stress marks (dot placed under/over (right/left side if vertical writing)). Variants: **CSI 64:0m** no CJK stress mark or line (same as **CSI 65m**), **CSI 64:1m** filled dot (●) under/right each CJK combining sequence (default), **CSI 64:1=m** filled dot over/left, **CSI 64:2m** filled sesame (ゝ) under/right, **CSI 64:2=m** filled sesame over/left, **CSI 64:3m**

hollow dot (◦) under/right, **CSI 64:3=m** hollow dot over/left, **CSI 64:4m** hollow sesame (◌̣) under/right, **CSI 64:4=m** hollow sesame over/left. Ruby text (see below, PTX) should be placed “outside” of these marks.

- **CSI 65m** Cancel the effect of the renditions established by parameter values 60 to 64. Each of 60 to 64 primary parameter values should cancel any of the five; including “itself” since the variant may change (solid, double, wavy, dotted, dashed; position; dot/sesame, filled/hollow).

Each of the six above cancel the “western” underline and overline, but not strike-through. “Western” underline/overline cancel the CJK emphasis marks. These are *not* inherited into math expressions, table cells or vector graphics texts.

## 5.19 FRAMING TEXT EMPHASIS (clarified and extended with variants)

Put an inline frame around a span of text. This styling is a bit like old Egyptian cartouches.

- **CSI 51[:v[:r]]m** Framed string. At line break, the framing is terminated (no line at EOL side) and restarted (no line at BOL side) on the new line. Cancelled by **CSI 51[:v[:r]]m**, **CSI 52[:v[:r]]m**, **CSI 54[:v[:r]]m** (which all may also start another framing). Line above is just above singly accented capital letters, like Å, É. Line below is just below descenders, for letters like “jgppy”. Same variants for *v* as **CSI 4m**, default variant is :1, medium solid line. *r*, default 0, gives corner rounding; :0 is non-rounded corners, :1 is for 0,25 en radius rounded corners, :2 is for 0,5 en radius rounded corners, :3 is for 0,75 en radius rounded corners :4 is for 1 en radius rounded corners. If background colour is set at the same positions as encirclement, the colour change ideally follows the encirclement. If there is a font size change within a framed string, the effect is implementation defined.
- **CSI 52[:v[:r]]m** Encircled string. Same as **CSI 51[:v[:r]]m**, but the default for *r* is 4.
- **CSI 54[:v[:r]]m** Not framed, not encircled. Same as **CSI 51[:v[:r]]m** and **CSI 52[:v[:r]]m**, but the default for *v* is 0.

These are useful not only for Egyptian cartouche-like effect (which is an unusual use for these, but handy for explaining this), but also for such things like prompts in terminal emulators or grouping “special” letter sequences, or name labels. Compare framed “span”s in HTML (`<span style="border: solid">`). The framing border follows the *maximum* ascender/descender in the line of text (after automatic line breaking) including math expressions, tables, vector graphics and images, which are *not* skipped by the framing. Adding framing does not change the spacing in any direction. Framing is *not* inherited into table cells, math expressions (text parts), or vector graphics texts, but is autoterminated at the end of a subcomponent *if* started in the subcomponent.

## 5.20 COLOURING (extended and clarified, ‘named’ colours have fix colour)

The original ECMA-48 assumed only two “colour planes”, background and foreground. Modern text applications (used with common higher-level protocols for document formatting) have several more planes. Also, some uses of ECMA-48 have already, in existing implementations, been extended with more colour planes, for instance a separate colour plane for underlines.

User interface windows with ECMA-48 text is here proposed to have the following logical graphic “planes”, from “bottom” to “top”. However, an implementation need not work explicitly with colour planes, and there may be more logical colour planes than described here.

Colour values should be in the interval 0—255, negative values interpreted as 0 and larger values interpreted as 255. A value is then rounded down to an available value on the device.

0) Anything that is behind the window (like other windows and desktop background). Usually this is not seen at all (within the window in question) due to opaque colours on the higher planes, but some applications do allow transparency so that what is behind the window can be seen.

0.5) TV/video image; for Teletext-like applications.

1) Background fill colour or image. This may be (partially) transparent, even though it usually isn't. May be settable in preferences.

1.5) Block background colours. Settable via FRAMED BLOCK, **CSI 114:....m** (see below, section 5.22). It is actually several planes if PTX table rows are used (see below, section 7).

2) Text background colour or better called text highlight colour if the default text background colour (plane 2) is fully transparent, which is common nowadays. Filling up the line height for the *full* line, even if the line height is varying within the line (usually horizontal but may be vertical for CJK and Mongolian script); from below descenders and up; or, for vertical text: the full width of the vertical line. Usually, but not necessarily, defaults to a solid colour (often white, or same as plane 1 colour), or fully transparent. The default may be settable in preferences. Colour can be set by **CSI 48:....m**. A *negative* transparency for the colours on planes 4 to 6 may “punch trough” this colour plane; e.g. **CSI 43;38:2::0:0:255=m** will make a “gold” background “punched through” by the text.

2.5) Text selection colours. Used for marking text as “selected”. Fully transparent for parts that are not selected. Some systems may have a separate “search match highlight” level. The colours for these are set by the system but may be settable in preferences. For a more ECMA-48 like solution, they can be set by control sequences proposed in the “UI text marking” section below; however, such UI text marking control sequences should never be part of a document.

3 and 3.5) Shadow planes. For character “shadows”. Colours set by **CSI 8z:....m** (there can be multiple shadows, with different colours, all-around shadow is on plane 3.5). This kind of shadow is supported in HTML/CSS. Text decoration, like underlines, associated with shadowed text, should then also get a shadow.

4) Emphasis marks (CJK emphasis marks, the *lines* for underline/overline). Defaults to follow text foreground colour. Colour can be set by **CSI 58:....m**.

5) Text foreground colour (colour for the character glyphs). Usually defaults to black colour. Default may be settable in preferences. Apart from transparency (including blinking and concealed (transparent) characters) and negative image, the colour setting does not affect emoji (or other inline images/graphics, if such are permitted). Colour can be set by **CSI 38:....m**.

6) Text “decoration” (the *lines* for overstrike/strikeout, and for encircled/framed). Defaults to follow text foreground colour. Colour can be set by **CSI 68:....m**.

6.5) Maybe multiple colouring planes for spell and style checking underlines. Can be set by control sequences proposed in the “UI text marking” section below; such sequences should never be part of a document.

7...) Some systems allow for (temporary) popups (with styled text) overlaying the “real” text. From the point of view of this document, that is part of the UI, not the document display itself.

Implementations are not required to support all planes. E.g., an implementation may choose to omit the shadow plane and the text “decoration” plane. But the text background plane and the text foreground plane are required. Colour settings are inherited into table cells, math expressions (all parts), and vector graphics texts, but is autoterminated at the end of a subcomponent *if* started in the subcomponent.

Colours (red, green, blue, transparency for the actual colours (0 is fully opaque, 255 is fully transparent), cyan, magenta, yellow, black) are given as integer values 0 to 255. To specify more than 8 bits per colour per pixel: use ***nnn>mmm***, where ***nnn*** is between 0 and 255 inclusive, ***mmm*** is between 0 and 255 inclusive, and ***nnn*** alone is short for ***nnn>nnn***, i.e., the least significant 8 bits part is a copy of the most significant 8 bits. If the hardware supports, e.g., 10 bits per colour per pixel, then the least significant 6 bits are ignored. Similarly for 11 bits per colour, etc.

### 5.20.1 Text background colour (full colour as basis, clarified and extended)

Text background colour, or better referred to as text highlight colour, when using more than two colour planes, and the default colour for this is fully transparent. For the allowed values for *r*, *g*, *b*, *c*, *m*, *y*, *k*, see above regarding values. 0 is the default value for transparency, i.e., fully opaque. Unless it is negative, the parameter *i* is ignored (and can be omitted, but not the : separators), so is the parameter *a*.

With just two planes this is the colour behind the text. With more colour planes this is the text highlight colour (preferably with a default that is fully transparent). Usage hint: colours should be selected so that there is sufficient contrast between (total) background colour, and foreground colours (text, underlines/ overlines, string framing).

Any display or print colour calibration adjustments are external to any ECMA-48 based text.

- **CSI 48:0m** Reset background colour to default text background/highlight colour. The 0 can be omitted (**CSI 48m**). Same as **CSI 49m**. (Default is taken from top of style stack, if style stacking is implemented; and is the inherited setting in case of inheritance.)
- **CSI 48:1m** Fully transparent text background/highlight (i.e. no highlight, the fill background is seen behind the text). Short for **CSI 48:2::0:0:0:255m**. Recommended default.
- **CSI 48:2:[i]:r:g:b[:t[:a:0]]m** Text background colour as RGB(T) (the separator here is colon).
- **CSI 48:3:[i]:c:m:y[:t[:a:0]]m** Text background colour as CMY(T) (the separator here is colon).
- **CSI 48:4:[i]:c:m:y:k[:a:0]m** Text background colour as CMYK (the separator here is colon).
- **CSI 48:5:p[:t]m** Text background/highlight colour from colour palette. *p* from 0 and up. Size of palette is implementation defined. Palette colours may be fixed by the implementation or be (partially) settable in preferences. If settable, various colour themes may be settable for the palette. There is also a possibility to set colour palette values via control sequences. If a transparency value is given, that overrides the transparency value from the palette.
- **CSI 48:6m** Copy current foreground colour to background colour. Not recommended. Useful (only) for making conversion from Teletext more convenient. Deprecated.

- **CSI 49m** Reset to default text background/highlight colour (may be settable in preferences); for subcomponents, resets to the inherited background/highlight colour.

The text background/highlight colour is inherited to text subcomponents: to table cells, to math expressions (all parts), to vector graphics (text/label parts; perhaps with the condition that the text/label parts are well integrated with ECMA-48 formatting).

### 5.20.2 Text foreground colour (full colour as basis, clarified and extended)

Each of  $r, g, b, c, m, y, k$  in 0—255;  $t$  in 0—255 (0 is opaque, 255 is fully transparent; negative value may be used to “punch through” text background/highlight colour, with given degree of transparency for foreground colour). 0 is the default value for transparency, i.e. fully opaque. Unless it is negative, the parameter  $i$  is ignored (and can be omitted, but not the separators), so is the parameter  $a$ . The transparency part of the foreground colour applies also to inline images/graphics (like emoji), which otherwise keep their colours, in a multiplicative manner.

Of course, for readability, the text foreground colour should be in sufficient contrast to the effective background colour (whether that is via text background/highlight colour or the plane 1 background). There is no automatic contrast guarantee.

- **CSI 38[:0]m** Reset foreground colour to default foreground colour. The 0 can be omitted (**CSI 38m**). Same as **CSI 39m**. (Default is taken from top of style stack, if style stacking is implemented; and is the inherited setting in case of inheritance.)
- **CSI 38:1m** Fully transparent foreground. Short for **CSI 38:2::0:0:0:255m**. Not recommended, but useful for conversion from Teletext. Deprecated.
- **CSI 38:2:[i]:r:g:b[:t[:a:0]]m** Foreground colour as RGB(T) (the separator here is colon).
- **CSI 38:3:[i]:c:m:y[:t[:a:0]]m** Foreground colour as CMY(T) (the separator here is colon).
- **CSI 38:4:[i]:c:m:y:k[:a:0]m** Foreground colour as CMYK (the separator here is colon).
- **CSI 38:5:p[:t]m** Foreground colour from colour palette. Uses the same palette as for background colour.  $p$  is in an implementation defined range, but not negative. If a transparency value is given, that overrides the transparency value from the palette.
- **CSI 38:6m** Copy current background colour to foreground colour. Not recommended. Useful (only) for making conversion from ISCI more convenient. Deprecated.
- **CSI 38:7m** Copy current all around shadow colour to foreground colour. Not recommended. Useful (only) for making conversion from ISCI more convenient. Deprecated.
- **CSI 38:8m** Optionally transparent foreground. Like **CSI 38:1m**, but can be “revealed”.
- **CSI 38:9:b:p1[:t1]:p2[:t2]m** Gradient glyph colouring.  $p1$  (start colour) and  $p2$  (end colour) are indices in the colour palette.  $b$  is an angle between **180**= (–180) and **180** degrees, 0 degrees is up. The angle gives the direction of the gradient, which starts and stops just within the “em box”. For gradient purposes, glyphs should be considered to be horizontally “centred” in the em box.  $t1$  and  $t2$ , if present, are transparency overrides.
- **CSI 39m** Reset to default text foreground colour (may be settable in preferences); for subcomponents, resets to the inherited background/highlight colour.

The text foreground colour is inherited to text subcomponents: to table cells, to math expressions (all parts), to vector graphics (text/label parts; perhaps with the condition that the text/label parts are well integrated with ECMA-48 formatting).

### 5.20.3 Short forms for colours (extended, and colours are given fixed values)

The colours here are a compromise and should be used for new or updated implementations. For a palette, possibly user settable (see section 4.21.7 below), use **CSI 38:5:n[:t]m** or **CSI 48:5:n[:t]m**. The colours for the short forms are *not* fetched from the palette, they are fixed colours.

Most terminal emulators nowadays use some variety of dull colours rather than clear colours for shortcut numbers in the 30 and 40 range, but are keeping the clear colours at higher numbers after the **CSI** (and, for compatibility, we follow that here). These colours are here fixed (just like the named colours for CSS), to get an (as close as possible) reliable colour output.

- x** in **3, 4**:     **CSI 3y:...** foreground; these colours are fully opaque colours  
                      **CSI 4y:...** background; these may be partially transparent (transparency is implementation defined, may be settable via preferences or **APC** control)

<b>CSI x0[:t]m</b> is short for <b>CSI x8:2::0:0:0:tm</b>	Pure black ■ (CSS Black)
<b>CSI x1[:t]m</b> is short for <b>CSI x8:2::205:0:0:tm</b>	Dull red ■ (Xterm's Red)
<b>CSI x2[:t]m</b> is short for <b>CSI x8:2::0:205:0:tm</b>	Dull green ■ (Xterm's Green)
<b>CSI x3[:t]m</b> is short for <b>CSI x8:2::255:215:0:tm</b>	Dull yellow ■ (CSS Gold)
<b>CSI x4[:t]m</b> is short for <b>CSI x8:2::0:0:205:tm</b>	Dull blue ■ (CSS Mediumblue)
<b>CSI x5[:t]m</b> is short for <b>CSI x8:2::205:0:205:tm</b>	Dull magenta ■ (Xterm's Magenta)
<b>CSI x6[:t]m</b> is short for <b>CSI x8:2::0:205:205:tm</b>	Dull cyan ■ (Xterm's Cyan, ≈ CSS DarkTurquoise)
<b>CSI x7[:t]m</b> is short for <b>CSI x8:2::255:255:255:tm</b>	Pure white (CSS White)

Largely following existing implementations, we define some additional short forms for fixed background and foreground colours. This is a proposed addition, but most terminal emulators already implement some variety of clear/pure colours here.

- x** in **9, 10**:     **CSI 9y:...** foreground, reset by **CSI 39m**, **z** is **3**; fully opaque colours  
                      **CSI 10y:...** background, reset by **CSI 49m**, **z** is **4**; these may be partially transparent (implementation defined)

<b>CSI x0[:t]m</b> is short for <b>CSI z8:2::105:105:105:tm</b>	Dark grey ■ (CSS DimGrey)
<b>CSI x1[:t]m</b> is short for <b>CSI z8:2::255:0:0:tm</b>	Clear red ■ (CSS Red)
<b>CSI x2[:t]m</b> is short for <b>CSI z8:2::0:255:0:tm</b>	Clear green ■ (CSS Lime)
<b>CSI x3[:t]m</b> is short for <b>CSI z8:2::255:255:0:tm</b>	Clear yellow ■ (CSS Yellow)
<b>CSI x4[:t]m</b> is short for <b>CSI z8:2::0:0:255:tm</b>	Clear blue ■ (CSS Blue)
<b>CSI x5[:t]m</b> is short for <b>CSI z8:2::255:0:255:tm</b>	Clear magenta ■ (CSS Magenta)
<b>CSI x6[:t]m</b> is short for <b>CSI z8:2::0:255:255:m:t</b>	Clear cyan ■ (CSS Cyan)
<b>CSI x7[:t]m</b> is short for <b>CSI z8:2::220:220:220:tm</b>	Light grey ■ (CSS Gainsboro)
<b>CSI x8[:t]m</b> is short for <b>CSI z8:2::169:169:169:tm</b>	Medium grey ■ (CSS DarkGrey)
<b>CSI x9[:t]m</b> is short for <b>CSI z8:2::255:140:0:tm</b>	Orange ■ (CSS DarkOrange)

### 5.20.4 Text emphasis mark colour (new, but has implementations)

Underline, overline, CJK emphasis lines/marks. *p, r, g, b, c, m, y, k, t, i, a* as above.

- **CSI 58[:0]m** Reset text emphasis mark colour to follow foreground text colour. Default. The 0 can be omitted (**CSI 58m**). (Note: does not reset to inherited text emph. colour.)
- **CSI 58:1m** Fully transparent text emphasis. (Not recommended.) Shadow, if any, will still be visible.
- **CSI 58:2[:i]:r:g:b[:t[:a:0]]m** Text emphasis colour as RGB(T) (the separator here is colon).

- **CSI 58:3:[i]:c:m:y[:t[:a:0]]m** Text emphasis colour as CMY(T) (the separator here is colon).
- **CSI 58:4:[i]:c:m:y:k[:a:0]m** Text emphasis colour as CMYK (the separator here is colon).
- **CSI 58:5:p[:t]m** Text emphasis colour from colour palette. Uses the same palette as for background colour.
- **CSI 59m** Reset emphasis colour to follow text foreground colour. Reset any colour set by **CSI 58:...m** as well as **CSI 68:...m**. (Note: does not reset to inherited text emph. colour.)

### 5.20.5 Text overstrike and text framing colour (new)

Overstrike (strike-through), encircling lines, framing lines (not for block frames), margin lines. *p*, *r*, *g*, *b*, *c*, *m*, *y*, *k*, *t*, *i*, *a* as above.

- **CSI 68[:0]m** Reset text crossed-out/strike-through and text framing colour to follow foreground text colour. The 0 can be omitted, **CSI 68m**.
- **CSI 68:1m** Fully transparent overstrike and framing lines. (Not recommended.)
- **CSI 68:2:[i]:r:g:b[:t[:a:0]]m** Text overstrike and text framing colour as RGB(T) (the separator here is colon).
- **CSI 68:3:[i]:c:m:y[:t[:a:0]]m** Text overstrike and text framing colour as CMY(T) (the separator here is colon).
- **CSI 68:4:[i]:c:m:y:k[:a:0]m** Text overstrike and text framing colour as CMYK (the separator here is colon). (Fully opaque.)
- **CSI 68:5:p[:t]m** Text overstrike and text framing colour from colour palette. Uses the same palette as for background colour.

### 5.20.6 Text shadow colours (new)

Outline and shadow are included as styles in ISCII, and shadow is supported (with lots of variation) via CSS. The shadow styling can be used to produce (attached-to-glyph) shadow, outline and bevel effects. Text shadows are also useful (and is used when not using text background) for such things as subtitles, that should be readable for a large variety of background colours (in a video image).

Note that the full glyph casts a shadow, that can be seen through transparent glyphs. Glyphs can have several shadows, usually of different colours. How overlapping shadows display is implementation defined. Also transparent, including fully transparent, glyphs cast shadows. The shadows here *need not* behave exactly like “real” shadows, despite the name.

*e* is an angle between **180=** and **180** degrees, 0 degrees is “light” from top of “paper”.

*d* in **1** (0.01em shadow), **2** (0.02em), ..., **99** (0.99em shadow)

*f* in **0** (no blur, default), **1** (0.01em blur), ..., **99** (0.99em blur); *r*, *g*, *b*, *c*, *m*, *y*, *k*, *t* as above.

Note that the second parameter (*d*) and the seventh parameter (*f*) differ in interpretation here compared to how these parameters are interpreted in other colour control sequences.

- **CSI 80[:0]m** Cancel all-around shadow, directional shadow and its “counter-shadow”. All-around shadow is on colour plane 3.5. The all-around shadow does *not* itself cast a shadow. (Note: does not reset to inherited all-around shadow.)
- **CSI 80:2:d:r:g:b[:t[:f]]m** All-around shadow colour as RGB(T).
- **CSI 80:3:d:c:m:y[:t[:f]]m** All-around shadow colour as CMY(T).



- **CSI 80:4:d:c:m:y:k[:f]]m** All-around shadow colour as CMYK. Fully opaque.
- **CSI 80:5:d:p[:t][:f]]m** All-around shadow colour from palette. *p* is palette index.
- **CSI 80:6:d[:f]]m** Copy current foreground colour to all-around shadow colour. Not recommended. Useful for making conversion from ISCII more convenient.
- **CSI 80:9:d:b:p1[:t1]:p2[:t2][:f]]m** Gradient all-around glyph shadow colouring. *p1* (start colour) and *p2* (end colour) are indices in the colour palette. *b* is an angle between **180=** and **180** degrees, 0 degrees is towards top of “paper”. The angle gives the direction of the gradient, which starts and stops just within the “em box” of each (base) character. For gradient purposes, glyphs should be considered to be horizontally “centred” in the em box.
- **CSI 81[:0]m** Cancel directed shadow, and its “counter-shadow” (if any).
- **CSI 81:e:2:d:r:g:b[:t[:f]]m** Directional shadow colour as RGB(T).
- **CSI 81:e:3:d:c:m:y[:t[:f]]m** Directional shadow colour as CMY(T).
- **CSI 81:e:4:d:c:m:y:k[:f]]m** Directional shadow colour as CMYK.
- **CSI 81:e:5:d:p[:t[:f]]m** Directional shadow colour from palette.
- **CSI 81:e:6:d[:f]]m** Copy current foreground colour to directed shadow colour. Not recommended. Useful for making conversion from ISCII more convenient.
- **CSI 81:e:9:d:b:p1[:t1]:p2[:t2][:f]]m** Gradient directional glyph shadow colouring. *p1* (start colour) and *p2* (end colour) are indices in the colour palette. *b* is an angle between **180=** and **180** degrees, 0 degrees is up. The angle gives the direction of the gradient, which is just within the em box of each (base) character. For gradient purposes, glyphs should be considered to be horizontally “centred” in the em box.
- **CSI 82:...m** “Counter-shadow”. Same parameters as for **CSI 81:e:...m**, except that there is no *d* parameter, the inherited direction is 180 degrees opposite to the (just set) direction for **CSI 81:e:d:...m**. Using a “counter-shadow” can be used to get a bevel-like or embossed effect.

Note: If using **CSI 80:...m** and the foreground colour is same as the (fill or text) background opaque colour, that can give an outline effect. Multiple shadows, and with the foreground colour same as the (text or fill) background opaque colour, that can give an embossed effect, depending on colour selection for the shadows. Compare the use of shadows in HTML/CSS, as illustrated in: <https://codepen.io/daryl/pen/yAuGj>, (note `background-clip:text`); [https://www.midwinter-dg.com/permalink-7-great-css-based-text-effects-using-the-text-shadow-property\\_2011-03-03.html](https://www.midwinter-dg.com/permalink-7-great-css-based-text-effects-using-the-text-shadow-property_2011-03-03.html).

The text shadow colour(s) are inherited to text subcomponents: to table cells, to math expressions (all parts), to vector graphics (text/label parts; perhaps with the condition that the text/label parts are well integrated with ECMA-48 formatting).

### 5.20.7 Colour palette (extended with capability to be set via control sequences)

The colour palette, accessible via **CSI s8:5:n[:t]m** (*s* in 3, 4, 5, 6) as well as gradient colouring as well as UI text colours, holds a set of colours, and a colour is accessible by an index number (*n*). These colours may be settable via preferences or installation of a colour palette. Another possibility is to have **CSI s8:u:n=:d:e:f:g[:a:0]m** (*s* in 3, 4, 5, 6 but is ignored, *u* in 2 (RGBT), 3 (CMYT), 4 (CMYK)) set the colour palette at index *n* to the colour given by the rest of the

arguments, *without changing the current colour setting*, only the palette. An implementation may limit the portion of the palette that is settable. Note: changes to the palette are *not* reset by **CSI 0m**. If the colour palette at index  $n$  is changed during the use of that palette index, the effect is implementation defined. It may take effect immediately or be take effect when that palette index is next explicitly used (or anywhere there-between). The palette colour settings do not affect the fixed colours available via the short forms for predefined colours. (The Linux console uses an **OSC** command for this kind of setting of the palette colours.)

E.g. <https://www.fossmint.com/nord-modern-design-color-theme-palette-for-your-terminal/> has 16 pastel colours that could be set as the colours of index 0 to 15 of the palette (if the implementation allows such setting); this does *not* change the colours of the “named” colours in ECMA-48 which we have fixed here. <https://linuxconfig.org/the-best-linux-terminal-color-schemes-for-2019> has a list of various colour palettes, suitable for (a part of) the palette.

At indices 16 to 255 the conventional colours should be stored, and be protected from change.

### 5.20.8 Negative image text (clarified)

The negative image applies to colour planes 1 to 6, just where the affected text is displayed, and should apply to inline images/graphics (like emoji) which should also be turned into negatives (as in photo negative). Often **CSI 7m** has erroneously been interpreted as switching background and foreground colours. That would not work for transparency, nor for planes other than 2 and 5; and, importantly, that is unlikely to produce a negative image.

- **CSI 7[:f]m Negative image (if  $f$  is 0?0)**.  $f$ , default value **0?0**, value between 0 and 1 inclusive.  $f$  is a factor to use on each RGB colour value  $c$ ;  $f$  being 0.0 specifies fully negative colour,  $f$  being 1.0 specifies fully positive colour; final colour  $c'$ , for each of R, G, B ( $c$ ) is computed as  $c' = f \cdot c + (1-f) \cdot (255-c) = 255 - c - 255 \cdot f + 2 \cdot f \cdot c$ , if 8 bits per colour per pixel. Transparency is not affected.  
CMYK values are first converted to CMY by including the  $K$  value to each of the CMY values:  $C' = C \cdot (255-K)/255$ ,  $M' = M \cdot (255-K)/255$ ,  $Y' = Y \cdot (255-K)/255$ , if 8 bits per colour per pixel.
- **CSI 27[:f]m Positive image (if  $f$  is 1?0)**. Same as **CSI 7[:f]m**, but the default for  $f$  is **1?0**.

### 5.20.9 Concealed (censored) text (extended with variants)

“Hide” characters. Not recommended. The concealed text may still be visible if the text is “selected” (for editing, e.g., copying by a copy-paste operation; depending on how “selected” is visibly marked), and a subsequent paste will also reveal the characters. Thus, one should not use “concealed” (nor any other form of transparent) for passwords or other text that is meant not to be extractable. This was not a concern for original ECMA-48, but it is in a modern setting. Indeed, it is common not to show characters in a password at all (Unix approach), or hide the password by displaying substitute characters, like bullets (web page approach).

- **CSI 8[:v]m Concealed/censored text**. Text spans are at planes 3 to 6 temporarily fully transparent. This overrides any set or changed colours for the text. Variants: **:0** cancel concealed characters, **:1** (default) fully transparent as described, **:2** instead blur or **:3** pixelate the text to a degree that the text is unreadable, **:4** replace with an Åg-height line (in the text foreground colour at starting point; still cut and paste can reveal the text).
- **CSI 28[:v]m Cancel “concealed text” effect**. Same as **CSI 8:0m**. Variants as above.

The text concealment/censoring is inherited to text subcomponents: to table cells, to math expressions (all parts), to vector graphics (text/label parts; perhaps with the condition that the text/label parts are well integrated with ECMA-48 formatting).

### 5.20.10 Blinking text (extended with variants)

Cyclically varying transparency (between the set transparency and 255 (fully transparent)) for text spans and at colour planes 3 to 6. If this is used in a context where inline images are allowed (e.g. emoji), the images in the span blink as well. The same for shadows, underlines, text block frames.

- **CSI 5[:f[:v[:p[:w[:t]]]]]]m Slowly blinking** (less than approximately 2,5 Hz, implementation defined). The default for *v* is approximately **1** to **2** (Hz), exact value is implementation defined. Cancels rapid blinking. Parameters:  
*f* is approximate frequency in Hz. If **0**, then effectively *v* (inverse special velocity) is **0** and *p* (phase shift) is **0**, regardless of given values (thus no extra transparency if *f* is **0**).  
*v* is inverse (approximate) velocity in the character progression direction, 10/*v* em/s, where the em is that of the default font size. The default is **0**, indicating “infinite” spatial speed. *v* can be negative (apparent movement opposite the character progression direction). So *v*=**5** gives the speed 2 em/s in the character progression direction. The granularity of this “movement” may be coarse, like per en rather than per pixel.  
*p* is the approximate phase shift in the unit 45° for the frequency *f*. *p* can be negative, default is **0**, indicating a “leftmost” *minimal* point of extra transparency for the waveform.  
*w* is the waveform indicator: **:1** sinusoidal, **:2** triangular, **:3** trapezoidal (implementation defined), **:4** rectangular (default). The transparency change need not be very smooth.  
*t* is timeout (since start of display of that text portion) in seconds. **0** (default) or negative: no timeout. When timeout occurs, the control effectively turns into a **CSI 8m** (for the blinking text span).
- **CSI 6[:f[:v[:p[:w[:t]]]]]]m Rapidly blinking** (more than approximately 2,5 Hz, implementation defined). Cancels slow blinking. Same variants as for **CSI 5[:f[:v[:p[:w[:t]]]]]]m**, but the default for *f* is approximately **3** to **4** (Hz), exact value is implementation defined.
- **CSI 25[:f[:v[:p[:w[:t]]]]]]m Steady** (not blinking). Cancels rapid/slow blinking. Same variants as for **CSI 5[:f[:v[:p[:w[:t]]]]]]m**, but the default for *f* is **0** (Hz).

The text blinking is inherited to text subcomponents: to table cells, to math expressions (all parts), to vector graphics, to images.

Note that while blinking text, *directly* via HTML, is deprecated in HTML, for HTML there are also other ways to create a blinking or similar “movement” effect. For instance: CSS animation, EcmaScript code altering the transparency, and animated GIFs.

### 5.20.11 Fadability control (new)

Teletext allows a page to be made transparent, except parts specially marked. This is intended to allow important parts of a page be shown even if the overall page is not shown, instead showing the background image (colour plane 0 or 0.5), in the case of Teletext, the TV image. The intended use is for “flash news” and subtitles to be shown when otherwise watching the TV program. In the Teletext version this allows the rest of the page to fade (completely), except the subtitles (or news flash) which do not fade. (Note that a Teletext page otherwise covers the entire TV image.)

This fade is orthogonal to (but composable with) the fade done by blinking.

- **CSI 112:fm** Fade control factor.  $f$  can be fractional (with  $.$  as decimal marker), value between 0 and 1 inclusive. Factor to use on transparency value (after mapping ECMA-48 value to the range  $[0, 1]$ ,  $(255-t)/255$ ; 0,0 is fully transparent, 1,0 is fully opaque) when set by preference to use this factor. Default is not to use this factor. Final transparency factor is computed as  $1-p \cdot (1-f)$ , where  $p = 1$  (from the preference setting) means to use the fade control factor,  $p = 0$  means don't use the fade control factor (default); values between 0 and 1 can be used also for the preference setting (this allows for intermediate fades). In a TV-like setting, and  $p = 1$ , using factor  $f = 0$  will show the TV background (colour plane 0), factor  $f = 1$  will show the text. Affects both text background (all backgrounds, planes 1 to 3.5), text decorations, text itself including inline images/graphics, i.e. planes 1 to 6. The nominal computed total transparency, in  $[0, 1]$  with 1 as opaque, is multiplied with  $(1-p \cdot (1-f))$  giving a final transparency for planes 1 to 6.

The text fade factor is inherited to text subcomponents: to table cells, to math expressions (all parts), to vector graphics (text/label parts; perhaps with the condition that the text/label parts are well integrated with ECMA-48 formatting).

## 5.21 MARGIN LINE (new)

A line in the margin for a displayed line of text may be used as a kind of emphasis marking. It is also popular as change marks ("change bars"). Another use for this kind of line is for block quotes (marking one or more 'paragraphs' (as defined here) in entirety, usually also indenting the lines).

- **CSI 78[:v][:p]]m** Line in the margin before the beginning-of-line position. Positioned just outside ("before") the minimum of **CSI 69:...m** and **CSI 70:...m** setting. **CSI 78:0m** terminates. Displayed for lines where (non-zero) **CSI 78:vm** is in effect, at about 1 en to 1 em before the beginning of lines. Same variants ( $v$ ) as **CSI 4m**, default is **:8**, bold solid line. If there are several different non-zero **CSI 78:...m** in effect for one display text line, the displayed effect is implementation defined.  $p$  is an index in the colour palette (see below) for the colour of the margin line. Default is current text foreground colour. If started in a table cell, the margin line is inside the cell (at the current nesting level, see PTX below), rather than in the "page" margin.
- **CSI 79[:v][:p]]m** Line in the margin after end-of-line position. Positioned just outside ("after") the **CSI 71:...m** setting. **CSI 79:0m** terminates. Displayed for lines where (non-zero) **CSI 79:vm** is in effect, at about 1 en to 1 em after the end of lines. Same variants ( $v$ ) as **CSI 4m**, default is **:8**, bold solid line. If there are several different non-zero **CSI 79:...m** in effect for one physical text line, the displayed effect is implementation defined.  $p$  is an index in the colour palette (see below) for the colour of the margin line. Default is current text foreground colour. If started in a table cell, the margin line is inside the cell (at the current nesting level, see PTX below), rather than in the "page" margin.

Note that the margin lines are displayed only in the margin of lines (after line wrapping) where the margin line styling is in effect; it is *not* just considering explicit line breaks, but also automatic ones. Text margin line is *not* inherited to subcomponents.

## 5.22 FRAMED PARAGRAPHS BLOCK (new)

Framing a block allows for paragraphs (and row cells) to be framed and get a different background colour (colour plane(s) 1.5, see below). These control sequences should occur “between” paragraphs (or row cells), if they occur at other locations the effect is implementation defined. The margin positions of the lines are just outside the default start position and default end position of lines (line indent control sequences do not affect the framed block line positions); if it is a row cell (see PTX below) that is framed, the lines are drawn at the cell boundaries. Compare framed “div”s in HTML. If multiple framed block lines are co-located (from adjacent framed blocks), the displayed result is implementation defined.

- CSI 114**`[:[v]][:[p1]][:[b]][:[p2]][:c]]]`**m** Start frame of paragraphs. Same variants (*v*) as for **CSI 4m**, default is **3**, medium solid line, *p1* is the palette (see below) index for the frame colour (default: current text foreground colour), *p2* is the palette index for the frame fill colour, default is transparent (colour plane(s) 1.5). *b* a value in the range 0—15, default 15, read as a bit pattern indicating which sides get the line;
  - bit 1: line progression direction lead side,
  - bit 2: character progression lead side,
  - bit 3: character progression terminating side,
  - bit 4: line progression terminating side.
 Sides not listed inherit line setting from immediately preceding **CSI 114...m** if any (there may be up to four in a row, with different values for *v* and *b*; only the last value for *p2* and *c* take effect), otherwise no line. Terminated by **CSI 114...m** which also starts another block frame unless it is *directly* after another **CSI 114...m**, by **CSI 115m**, and by end of cell. If pagination is supported, and a framed block crosses a page break (automatic or explicit), there is no block line drawn at the page break. *c*=0 allow automatic page breaks within the block (should still avoid typographic widows/orphans), *c*=1 (default) avoid automatic page breaks within the block.
- CSI 115m** End frame of paragraphs. If the block framing was started in a row cell (see PTX below), the block frame closes automatically at end of that cell. There may thus be multiple levels of block frames, one “outer”, and one per row level (there may be rows within cells; see PTX below). Through this mechanism, cells (from PTX rows) may be framed and coloured (the entire cell, not just the text portion, if started at the beginning of the cell (just after a **CSI 1\** or a **CSI 2\**) and auto-terminated at cell end, at a **CSI 2\** or a **CSI 0\**, ideally joining lines of layoutwise adjacent cells, also if in different rows).

While framed paragraph block is *not* inherited to subcomponents, the frame fill colour (colour plane(s) 1.5) is visible also for subcomponents, especially if their background/highlight colour (colour plane 2) is transparent (which is the normal case).

## 6 CHARACTER TABULATION SET ABSOLUTE (2) – HTSA/HTSA2 (resurrected, improved, replacing HTS, CTC5, TBC3)

CHARACTER TABULATION SET ABSOLUTE (HTSA) has the control sequence **CSI** *t1;t2;...;tn* **SP N** (note the space (SP) before the capital **N**, it is part of the control sequence), where each *ti* is a position in the line (from the beginning position of the line, not counting current line indents, assuming a fixed width font, and each position indication thus in the unit *en*). HTSA was deprecated in the

fourth edition of ECMA-48 (for unknown reasons), and it does have a flaw (which we will fix here).

But the other way of setting tab stops in ECMA-48 (HTS) has a *much* more serious flaw: one must move (by printing something, likely spaces) to the positions where one wants to set the tab stops. Besides outputting something (which is often an absolute no-no for setting tab stops), the positioning is also unreliable, and depend on the advance widths of glyphs (or spaces), which vary in a “proportional” font and between fonts.

## 6.1 HTSA2 ((re)new)

HTSA sets the tab stops without anything getting printed, and the positions are not dependent on individual glyph’s advance widths. Thus, here we instead suggest that HTS (CHARACTER TABULATION SET) and CTC (CURSOR TABULATION CONTROL, which in addition has a misleading name, it is not a cursor control at all) are not to be used in favour of resurrecting HTSA as HTSA2; using **CSI...!N** instead of **CSI...SP N**. VTS, for setting line tab stops, is in practice already unused.

Before the first HTSA2, the default is to have tab stops every 4 en to 8 en of the *default* font size (implementation defined, may be part of preferences, changing the (“global” to the document) default font size preference may also change the position of the default tab stops).

Each HTSA2 replaces all previously set HTSA2 tab stops. **CSI !N**, i.e. an empty list of positions, in effect resets to using the default tab stops (but keeping the **CSI 70:u:vm** tab stops). Until the last, in the character progression direction, explicitly set tab stop (that is HTSA2 or **CSI 70:u:vm** tab stop), the HTSA2 or **CSI 70:u:vm** tab stops overshadow the default tab stops.

But HTSA does have a flaw (or two). The unit was set by SSU, and we have already proposed not to use other control sequences that depended on SSU as well as not using SSU itself. So, in the resurrected version (HTSA2), we ignore any SSU setting, and have units associated with each of the tab position values. The unit codes (0 to 8) are the same as for SSU (0 is ‘en’ of the *current* font, *current* size, not counting **CSI 77:....m** setting). Fractional values are allowed with ? as decimal marker.

- **CSI [u1:]p1;...;[un:]pn!N** Set character tabulation tab stops according to the stoplist. *n* may be 0 (empty list). All tab stops set by a previous HTSA2 are removed (not those set by **CSI 70:....m**). The stop list is a semicolon-separated unordered list of positions from the default start of line in the character progression direction. Positions are given as [unitcode:]value, where the unit code is from the SSU unit codes, and the value is a (possibly fractional) value indicating the distance (when combined with the unit) from *default* start of line in the character progression direction (so tab stops do not move when changing paragraph line indents). The unit can be omitted, and the default unit code is then 0 (en).

The values (with unit) are *each* an offset from the default *beginning* of line (in the character progression direction), not from the previous tab stop (hence “absolute”). E.g., **CSI 5;11?5;15!N** sets tab stops at 5 en, 11,5 en and 15 en from the default beginning position of lines (in the character progression direction; *not* considering **CSI 70:....m** setting). When en is used as unit for a tab stop, it needs to be associated with the current absolute value of en or internally convert the position value that uses en as unit to use a non-en unit. Note that while already set tab stops must not be changed even if the size of en changes (by a font size change), follow-on HTSA2 control sequences are affected by a change of en, if the en unit is used.

The tab positions need not be ordered in the HTSA2 control sequence. However, it is recommendable that the tab stop positions should not be closer to each other than 1 em (2 en). The tab positions may of course be sorted internally, to make their use (internally) easier.

Default tab stops that are 1 em or more *after*, in the character progression direction, the *furthest* explicitly set by HTSA2 (or **CSI 70:....m**) tab stop are still in effect. Default tab stops before that are overridden by the HTSA2 tab stops. The HTSA2 control sequence should occur only at beginning of a line. At other positions, the result is implementation defined.

HTSA2 tab stops are *not* inherited to any subcomponents, like table cells, and tab stops cannot be set in subcomponents, except for tab stops set by line indent setting (**CSI 70:....m**) which are settable in table cells.

## 7 PARALLEL TEXTS – PTX (clarified and extended)

PTX, as specified in ECMA-48 5<sup>th</sup> ed., have two completely different uses. While both are “parallel texts” in some sense, one is most easily conceived of as a table row, and the other is for so-called Ruby annotations as used in Japanese and Chinese (though for Chinese there is a fallback to use a parenthetical instead). Unfortunately, they start with the same control sequence in ECMA-48 5<sup>th</sup> ed. Note: As a singular exception, PTX/table row does have a nesting structure.

### 7.1 Multiple texts (cells) in a single (table) row (extended)

This defines a single table row with (formatted) text content in each cell or the row. There is no automatic framing. If a cell has no data, has a negative width indication and lines up with a cell in a directly preceding row, if any, those cells are merged (vertically if line progression direction is top-to-bottom, horizontally if line progression is left-to-right or right to left).

- **CSI 1[;u:s]\** Beginning of first text (of the list of parallel texts) (i.e., start of first cell in a table row). *u:s* gives the initial (minimum) row advance (as unit and measure); default is current line advance as set by **CSI 72:u:s[:sb[:sa]]m**.
- **CSI 2[;u:s[:v]]\** End of previous text and beginning of next text (i.e., cell boundary). *u:s* gives the width of the cell (in the character progression direction) just terminated, default is width of content without automatic line breaking.
  - v=0*: flush the set of text lines in the (possibly spanned) cell to the “start of text lines” side of the cell (default);
  - v=1*: flush the set of text lines in the (possibly spanned) cell to the “end of lines” side of the cell;
  - v=2*: centre the set of lines in the lines progression direction on the available space;
  - v=3*: span cell, content is concatenated with the corresponding cell in the column (using multiple table rows), if any, in the directly preceding table row (if any) and (if so) extends the in that way preceding (in the line progression direction) table cell, if the text content actually is concatenated with a preceding cell, text block border and text block background colour are ignored, and those of the so preceding cell are used. Note that spanning in the character progression direction is handled just by the width specifications.

All SGR styling is reset to that at the start of each cell of the row to inherit from before the table row, and any styling changes apply only within each cell.
- **CSI 0[;u:s[:v]]\** End of list of parallel texts (i.e. end of cell and end of table row). *u:s* as above. *v* as above. The syntax for this use of PTX is **CSI 1\principal text(CSI 2[;ux:sx[:vx]]\**

*supplementary text*) + **CSI 0**[;uy:sy[;vy]]\ . This corresponds in principle to the HTML: `<tr><td>principal text</td><td>supplementary text</td></tr>`, but with cell widths (heights for vertical lines). All SGR styling is reset to that at the start of the row.

Note that lines drawn around the cells, as well as cell background colour is set via **FRAMED BLOCK** (see section 5.22).

The layout is unspecified in ECMA-48, but multi-column display is what is mentioned (*“the strings may [here interpreted as “shall”, to get a stringent, and generally useful, interpretation of PTX] be presented in successive lines in **parallel columns**, with their beginnings aligned with one another and the shorter of the paragraphs followed by an appropriate amount of “white space”.*). This was intended for translations or similar but is actually more general and can be used for any kind of table row. Note that cell texts may have several instances of the Ruby variant of PTX (see next section), and also nested use of this kind of PTX parallel texts (i.e., table rows within a table cell). Tab stops and line indents are inherited and are interpreted from “beginning of cell” for each cell.

Automatic line breaking is done on text within each cell (if given a width), and the cell height (width for vertical lines) is the maximum cell height in the row. The beginning and end of lines should have about 1 en margin to the cell border. Multiple contiguous rows (with explicit line break between) form a table, but there is no automatic alignment of cell borders, and columns form only if there is alignment. There are no automatic lines drawn between table cells, but framed blocks (see section 5.22 above) can be used to both frame a cell and give it a background colour.

Note that **CSI 1**\...**CSI 2**\...**CSI 2**\.....**CSI 0**\ (PTX) is one of the few mechanisms in ECMA-48 that specifies nesting; the others are the bidi controls. Note also that bidi algorithm needs to be applied in isolation for each PTX cell (if bidi is enabled), and that each a PTX row is a single “object” for the bidi algorithm outside of the sequence of PTX rows. I.e., each table row, as a whole, must be atomic for bidi processing. A table row’s cells are laid out according to the current character progression direction. And the line and character progression directions are inherited to each cell, but can be set per cell via SPD. Further, bidi, if enabled, applies to each cell of the row, in isolation.

There must be a line break between each **CSI 0**\ and **CSI 1**\ in order to create a table of rows, where the rows are laid out in the line progression direction. A (single) PTX row with no line break before nor after, will be an inline table row; note that a cell in such a row can have a table. Cells in each row should have consistent widths, with the exception of cells that span columns.

## 7.2 Japanese/Chinese pronunciation annotations of words/phrases (clarified)

This is the other (completely different) use for PTX. It has nothing to do with tables. The principal text and the phonetic annotation here are not expected to contain RTL characters, nor bidi controls.

- **CSI 1**\ Beginning of principal text to be phonetically annotated. The principal text should be a “word” or short phrase. This must not contain any PTX control sequences.
- **CSI 3**\ or **CSI 4**\ End of principal text and beginning of Japanese (3) or Chinese (4) phonetic annotation text (Ruby text). The phonetic annotation text is usually Hiragana or Katakana text for Japanese, Pinyin (i.e., Latin) or Bopomofo text for Chinese. There can be only one



such phonetic annotation per principal text. The principal and supplementary texts must *not* contain any PTX control sequences. **CSI 3\** does not allow for parenthesis fallback, but **CSI 4\** does (compare **<rp>** in HTML). All SGR styling is reset to that at the start of the Ruby text, but the phonetic annotation is usually rendered slightly smaller than the principal text.

- **CSI 5\** End of Chinese/Japanese phonetic annotation. The syntax for this use of PTX is **CSI 1\***principal text***CSI (3 or 4)\***phonetic annotation***CSI 5\**. This corresponds in principle to the HTML **<rb>***principal text***</rb><rt>***phonetic annotation***</rt>**. An implementation may allow **CSI 0\** to terminate also Ruby annotations. All SGR styling is reset to that at the start of the Ruby.

This corresponds to the Ruby markup in HTML (<https://www.w3.org/International/articles/ruby/markup.en>) for producing so-called Ruby text, i.e. phonetic annotations written above (horizontal lines) or to the right (vertical lines) of the principal text in Japanese or Chinese (though for Chinese, ECMA-48 suggests the alternative of using a parenthetical inline annotation). For Ruby layout details, see text on HTMLs Ruby markup. There should be no bidi or RTL in Ruby notation.

Since Ruby is (in principle) targeted at Japanese and Chinese, bidi is not expected to even be enabled. But in case it is: The Ruby component as a whole must be atomic (i.e., handled as a single, bidi neutral, character) for bidi processing. And the character progression direction is inherited to each part. Further, bidi, if enabled, applies to each part of the Ruby notation, in isolation. The parentheses fallback is laid out in the character progression direction.

## 8 SELECT CHARACTER ORIENTATION (2) – SCO/SCO2

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The SCO – SELECT CHARACTER ORIENTATION control sequence, **CSI v SP e**, where the unit for *v* is 45°, is not very clearly defined in ECMA-48 5<sup>th</sup> edition. It may mean to rotate each character (or grapheme cluster) individually. That has some applications and can be seen in some signage (like for shops, Latin letters upright while the reading direction is from top to bottom), but that is rare for text documents, even though it could have applications for table cells and vector graphics.

### 8.1 SCO2 (new)

We will here make a different interpretation, which is commonly applied in text documents. To be on the safe side, we will use a different control sequence (call it SCO2): **CSI v!e**; but we will keep the unit as 45°, but allow negative values, preferring values between (inclusive) 90° and –90° (**2=**), fractional values may be allowed for table cells.

- **CSI v!e** Rotate pages. For page rotation, only allow integer multiples of 90° (**0, 2, 4, 2=, 4=**). When used as a page rotation control sequence, it acts (also) as a hard page break, FF (but not as a paragraph separator). The page rotation does *not* accumulate (the rotation indication is always relative to the nominal upright).
- **CSI v!e** Rotate table cell. For rotating the displayed content of a table cell. Automatic line breaking is turned off *unless* the rotation is an integer multiple of 180° (**0, 4, 4=**). When used as a table cell rotation control sequence, it should occur (at most once) only at the very beginning of a table cell and affects only the content of that table cell.

The rotation combines with the *inherited* rotation (if any, and can be multiple inheritance levels), and this is the rotation that is inherited into subcomponents: table rows (tables are allowed inside tables), math expressions, vector graphics, ..., *in their entirety*.

## 9 SELECT PRESENTATION DIRECTIONS – SPD/SPD2

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ECMA-48 has a mechanism for setting text presentation direction, SELECT PRESENTATION DIRECTIONS (SPD). SPD selects the line and character progression directions. The default should be interpreted as left to right character progression, and top to bottom text line progression. An application may also have a (global) user preference SPD setting, used unless SPD is implemented and overrides that preference. SPD has the format **CSI c[;0] SP S** (*c* is a code for which directions are set; the second argument here (**0**) shall(!) be omitted). We will here introduce an *augmentation* to SPD, SPD2, **CSI...!S**. All of the alternatives for SPD control sequences are *without* any bidi processing, while the additional alternatives for SPD2 control sequences *can* turn on bidi processing, and then setting the paragraph bidi level. While this notionally is a “mode”, it is not formally an ECMA-48 “mode”. Note that all ECMA-48 “modes” are very strongly deprecated, including BI-DIRECTIONAL SUPPORT MODE.

- When used as a page presentation directions control sequence, it acts (also) as a paragraph separator (PS). If the line progression direction is changed, it acts (also) as a hard page break, FF. (Line progression from bottom to top should not be used, especially not in a multipage document.)
- When used as a table cell presentation directions control sequence, it should occur (at most once) only at the very beginning of a table cell and affects only that table cell.

This is the interpretation of “takes effect immediately”, both for a) the “presentation component” (display or printed output), and b) other than the control sequence being stored there, it has no effect on the “data component” (internal representation or stored file). There is no change in the display/print of text prior to the SPD(2) control sequence. The second argument is always 0 (omit), and there is no movement of the cursor (or change of text selection) in a text editor due to an SPD/SPD2 control sequence, apart from implied PS/FF. (Other interpretations do not even make sense...)

Note that this is *not* a rotation, and there is no accumulation. The setting is inherited into some subcomponents: table rows, vector graphics, partially into math expressions (bidi on/off only).

### 9.1 Text layout directions and the Unicode bidi algorithm

While SPD specifies text progression directions, we will not enable bidi processing for any of the SPD (**CSI ... SP S**) directions. Text is laid out strictly in the directions specified, and any rotation of glyphs is given by SCI (**CSI ... SP e**). For SPD2 (**CSI ... !S**) we will build in application (or not) of the Unicode bidi algorithm. This gives some needed parameters for the Unicode bidi algorithm, if at all enabled.

The steps for rendering a piece of text work on a “paragraph” of text, separated by PS and other NLFs including. Note that a paragraph can *contain* nested structure that in turn may contain paragraphs (such as a table row, which has cells each of which contain paragraphs). Thus, the parsing out of table rows and math expressions (both of which may have *internal* PS/NLFs) needs to be done *before* the determination of “paragraphs” separated by PS or other NLFs. Several

steps require that the *internal* string representation covers the UCS without character references; though not the *external* representation.

1. Replace each character reference, see section 3.4, with the character it refers to. Note that **ESC [** is a character reference for **CSI** and that **CSI ...\_** are character references.
2. While parsing out paragraphs (considering also SPD2 as a paragraph separator), parse out structures such as table cells (note that tables may nest), Ruby text, math expressions (see <https://github.com/kent-karlsson/control/blob/main/math-layout-controls-2023-A.pdf>), hyperlinks, as well as vector graphics and images (which may be represented inline as control strings, or as *img* hyperlinks) in the paragraph, as well as sequences of emojis (and ZWJ), see <https://unicode.org/emoji/charts/emoji-list.html>.

**CSI 0m** should (implementation defined) imply inserting closing of table rows (**CSI 0\**), and math expressions (multiple U+0081 (**MEC**), **ETX**, as appropriate), both of which may nest, including with each other, as well as closing of hyperlinks and Ruby texts (**CSI 5\**).

Replace each of the parsed-out parts by a unique (per paragraph) non-character, indicating which “text object” it replaces. The text objects are stored in an internal table per paragraph. Some text objects may contain text in turn, like table rows which has cells which have text in them; likewise for Ruby text, hyperlinks, math expressions and vector graphics (with text boxes). Note that a sequence of cells in a table row will be laid out in the character progression direction, regardless of bidi level for the corresponding non-character, just like that the HT/HTJ direction is bidi level independent for the HT/HTJ, but sensitive to the paragraph bidi level/direction (set via SPD2).

3. Convert LRE to LRI (the LRE replacement), RLE to RLI (the RLE replacement), FSI to LRI if the character progression is LR and to RLI if the character progression is RL (i.e., *no* dependence on “first strong bidi” character for FSI, since reading direction needs to be predictable; just as for the paragraph itself), and convert PDF’s that close LRE/LRI/RLE/RLI each to PDI.

Whether the legacy (ECMA-48) bidi control sequences are interpreted is implementation defined. However, this will limit the “range” of the original ECMA-48 bidi controls to each paragraph, a limitation originally not present. If implemented, **CSI 0** and **CSI 0[** ECMA-48 bidi control sequences, should be converted to PDF (U+202C), **CSI 1** should be converted to LRO (U+202D), and **CSI 2** to RLO (U+202E), **CSI 1[** to LRO (U+202D) if the current direction is RL and to RLO (U+202E) if the current direction is LR.

**CSI 0m** should (implementation defined) imply inserting closing of bidi controls (RLI/LRI/LRO/RLO), inserting a sequence of PDF/PDI.

4. Transform styling control sequences (including styling push/pop, if implemented) into (within paragraph) non-overlapping style runs, removing the styling control sequences. The styling of a paragraph will initially inherit the style before the paragraph; do similarly for parsed out parts, such as table cells and math expressions. How a style run is represented is implementation defined but needs to be manageable when substrings are rearranged in the bidi rearrangement step; this rearrangement step may split style runs.
5. Convert any remaining escape sequences, control sequences, control strings, and SCI sequences as in step 2, but the stored data is just the control substring as is. The style range data needs to be adjusted to these substitutions; this step may be done jointly with step 4.

6. Apply steps 3 to 10 recursively as appropriate to the parsed-out parts in the internal per paragraph lookup table. For cells in table rows it is applied to the cell content, for math expressions only apply them to identifiers and text components, for vector graphics, apply them to text components, for hyperlinks apply it to the display string part of the hyperlink (not the link part).
7. If Unicode bidi processing is enabled, per SPD2 setting, apply the Unicode bidi algorithm *level calculation* to the resulting string, with non-characters for the parsed-out parts (step 2 and step 5), paragraph direction as per SPD2 setting.
8. Compute the width (and height) of the text parts, taking into account the bidi level, glyph width (after stretch, if any) and height (both after SCO rotation (not SCO2), if any), kerning and ligatures, cursive joining, and whitespace widths, (HT/HTJ “width” need be recalculated during automatic line breaking) and compute automatic line break positions, also taking into account the generated hyphen in case of automatic or semi-automatic (SHY) hyphenation. Space widening or kashida insertion applies only to the last HT/HTJ separated portion (if there is any HT/HTJ at all in the text line, otherwise the whole line) of the text line.
9. If bidi processing is enabled, per SPD2 setting, apply the Unicode bidi algorithm *reordering part*, keeping track of styling spans and split them if needed based on the reordering. Treat HTJ as HT; and (CR)VT and (CR)FF are treated as LS.
10. The portions of the text line (separated by line breaks and HT/HTJ), as well as HT and HTJ are laid out in the character progression direction, styling as per styling run data, which has been adjusted according to bidi reordering. Table cells in a table row are also laid out in the paragraph progression direction. Math expressions are insensitive to paragraph direction setting (and to all other SPD/SPD2 settings), except for bidi enabled/not enabled, but sensitive to rotation (if implemented). When laying out the text line, the non-characters are replaced by the display of the text objects that were parsed out in the initial steps. It is implementation defined what is done with control sequences, control strings, etc. that are not otherwise interpreted (as bidi controls, styling controls, table rows, Ruby, math expressions, vector graphics, hyperlinks, ...).

The Unicode bidi algorithm is intended for “prose” text, text that is supposed to be in natural or constructed “natural-like” languages, where there may be portions that are in an RTL script. That is for anything between tweets and novels or Wikipedia pages. Applying the bidi algorithm (steps 7 and 9) “wholesale” on text that is computer source code of some kind, however, is *not* recommended, even if it may contain RTL text portions, as the source code then might not only be hard to read, but even misleading about what the code actually is, like appear to have swapped arguments to operators which the actual execution of the code will not do, or have a misleading display order for data elements in a source data file. Therefore, **CSI 0!S** (no bidi processing) is strongly recommended for all kinds of computer source code, whether program or data. If one wants to have source code where elements such as identifiers, string literals, and comments are bidi processed, then an IDE should be used. An IDE editor can do programming language (or data language) parsing and apply bidi in isolation on each such element.

Further, bidi processing is not appropriate for text that is displayed in vertical lines of text, like for Mongolian or for CJK (though the latter is often presented in horizontal lines in modern texts).

## 9.2 SPD2 (new; with bidi settings and implicit rotation)

With the (new) SPD2 the following text display directions, and bidi paragraph direction can be set. Note that HT/HTJ, the text portions separated by HT/HTJ, as well as cells (each as a whole) in table rows are always laid out in the character progression direction.

- **CSI 0!S** Character progression left-to-right, text line progression top-down, no bidi processing and no automatic cursive joining or ligatures for right-to-left scripts. For most scripts including CJK/Hangul horizontal. Same as **CSI 0 SP S**. Glyphs for Mongolian characters are rotated 90° clockwise (in some fonts they may already be so rotated) and are *not* cursively joined. This covers also so-called “visual order” (and pre-joined glyphs for Arabic) for right-to-left scripts. Left-to-right scripts that feature ligatures and cursive joining (and are supported by the current font and implementation) have that done.
- **CSI 1!S** CJK/Hangul vertical, text line progression right to left, no bidi processing. See <https://www.unicode.org/Public/UNIDATA/VerticalOrientation.txt> for rotation information. Characters that are non-CJK, non-Hangul, non-Mongolian, non-wide, but are strong left-to-right or are symbols get their glyphs rotated 90° clockwise, strong right-to-left characters get their glyphs rotated 90° counter-clockwise.
- **CSI 2!S** Mongolian vertical, text line progression left to right, no bidi processing. Characters that are non-CJK, non-Hangul, non-Mongolian, non-wide, but are strong left-to-right or are symbols get their glyphs rotated 90° clockwise, strong right-to-left characters get their glyphs rotated 90° counter-clockwise. Cursive joining is done for Mongolian characters.
- **CSI 3!S** Character progression right-to-left, text line progression top-down, with Unicode bidi processing. This setting sets the bidi “*paragraph direction*” to RL. Mongolian characters are considered bidi strong RTL and their glyphs are rotated 90° clockwise. Cursive joining, and ligatures, are done for right-to-left scripts that have that feature (and the script are supported by the implementation), and direction not overridden by LRO.
- **CSI 8!S** Character progression left-to-right, text line progression top-down, with Unicode bidi processing. This setting sets the bidi “*paragraph direction*” to LR. Mongolian characters are considered bidi strong RTL and their glyphs are rotated 90° clockwise. Cursive joining, and ligatures, are done for “bidi” scripts that have that feature (and the script are supported by the implementation), and direction not overridden by LRO.
- **CSI 10!S** Within a paragraph, every odd line is left-to-right, every even line is right-to-left, text line progression top-down. Boustrophedon. No bidi processing, no cursive joining. For some ancient texts, where glyphs are mirrored when going right-to-left. Extremely rare use, except possibly for mirroring words like “AMBULANCE”...
- **CSI 99!S** Reset to default directions, per preference/default setting.

Through bidi processing, a portion of a paragraph’s text can be displayed in the character progression direction “opposite” to that set by SPD. Note that a paragraph’s “bidi direction” is *never* derived from first “strong bidi” character in the paragraph, it is set from SPD (or its default). The START DIRECTED STRING/START REVERSED STRING control sequences are not to be used in favour to the Unicode bidi control characters. For automatic line breaking, LS (or VT or FF) shall automatically temporarily be inserted *before* bidi processing. Thus, glyph (including ligaturing and cursive shaping) widths must be computed before bidi processing. Note that escape sequences, control sequences and control strings must be interpreted before bidi processing. Exactly how style ranges are represented is implementation defined; but which characters have which style shall not be altered by bidi processing. An embedded graphics or table shall work as if it is a single bidi neutral character for bidi processing. Likewise for each

math expression. Note that math expressions are out of reach for the bidi algorithm (except for identifiers, each in isolation) and out of reach for any case mapping.

If line progression direction is changed, it is per page: The control should be at the beginning of text or hard page break ((CR)FF. If line progression is not changed, but character progression within lines are changed, the change is per “paragraph”. The change code should be at the beginning of the part of text affected. If not, the change will take effect only after next explicit break (FF or automatic page break for line progression changes, hard line break except VT/LS/FF for character only progression changes). An SPD2 in a table cell only affects that table cell.

## 10 PAGE FORMAT SELECTION

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A replacement for PAGE FORMAT SELECTION may be proposed in a future version of this suggested update, for setting page size, page margins, and page columns (and gutter), and maybe other page related settings (except SCO2 and SPD2 which are covered here), or even whole document settings, like page scroll (or book binding) direction.

## 11 STYLE BRACKETING – Pushing and popping SGR, HTSA2 and colour palette states (new, experimental)

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*This is an experimental suggestion. It is modelled after an XTerm feature, and may be applicable only to terminal emulator implementations, not so much for text document formatting implementations. This feature should not be used within any subcomponent, like table cells.*

In contrast to, e.g., HTML, there is no general nesting, or bracketing, structure in ECMA-48. But PTX, PARALLEL TEXTS, does have a structure and nesting ability (**CSI 1\.....CSI 0**; row start...row end). So does SDS/SRS (START DIRECTED STRING (**CSI 1**].....**CSI 0**] and **CSI 2**].....**CSI 0**]; cmp. LRO...PDF and RLO...PDF), START REVERSED STRING (**CSI 1**[.....**CSI 0**[; cmp. LRO/RLO...PDF, LRO or RLO is selected to be opposite the direction at the point of **CSI 1**[). Math expression also needs to have a nesting structure.

But XTerm has a nonstandard extension for pushing and popping SGR state. That extension uses private-use “final bytes” (final characters), namely “{” and “}”. If one wants to standardise this functionality, non-private-use final characters need to be used (with intermediary character(s)). Here we suggest the control sequences:

- **CSI n!**[ push a copy of all currently set rendition attributes and more: SGR, HTSA, colour palette plus language, charset (can conceivably change for terminal emulators), as well as font palette. Mark the stack entry with the “GUID”, or non-GUID, *n* (decimal digits only).
- **CSI n!**] pop the rendition attributes stack to and including the topmost level marked with the GUID *n*, using the last popped (GUID *n*) stacked attributes as the currently set ones (both SGR, HTSA colour palette, language, charset, and font palette). **No-op** w.r.t. those settings if *n* is not encountered the stack. For output to a terminal emulator, the GUID should be hard to “guess” if not known. For use inside a document, one may use a very simple non-GUID, like “1” or the current save stack depth.

All PTX, math expressions, and bidi control nesting are closed, even if the GUID is not encountered in the stack.

Note that **ESC c** (RESET TO INITIAL STATE, for terminal emulators only) resets even more, if implemented.

## 12 UI TEXT MARKING (new, not to be stored in docs)

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Some applications mark, for instance, search matches, or substrings selected for edit operations (the latter usually only one substring at the time) by using a differently coloured background (exactly which colour varies by application, or even preference setting). Some applications also mark suspected spell errors by a special underline (wavy red seems popular), or suspected style issues (of various kinds) by another coloured underline. Such markings are not part of the styling of the text, but are part of the user interface. An application which does these markings (only) on the “display side” need not invoke any control sequences (or HTML/CSS, or other markup) to display these; and indeed should use different colour layers for those than for the regular background/underline. But for an application where a “remote side” (using ECMA-48 control sequences) decides what to mark that way, it is possible to sometimes repurpose the backgrounds and underlines available via SGR. For such applications (like for applications intended to be displaying the text on a terminal) an ability to “access” the colour planes normally used for those UI markings would be better.

So here we propose UI marking control sequences, which are separate from SGR. UI markings should not be stored in documents. These control sequences are intended for applications where the “remote” side “orders” temporary UI markings, such as “selected”/“matching”, spelling or style “remark”, substring “now being processed”, and similar cases. As opposed to SGR background or underline which cannot have multiple underlines or multiple backgrounds (a limitation compared to some other markup systems), a substring can have multiple UI backgrounds (e.g. both “matching” and “selected”), and multiple UI underlines (e.g. both spell error and style warning), and they do not override the backgrounds or underlines that are part of the document that is displayed (though they may interfere visually). When bidi is used, one span may be split into several separately displayed sections (just as for SGR styles).

- **CSI 0!m** End all UI text marks. Stop all UI text markings.
- **CSI 1:n!m** Start UI background colour mark to the colour of index  $n$  in the palette.  $n$  is here used both as an index to the palette (same palette as used for SGR) and as an identifier for which UI background is referenced. This way multiple markings (of different palette indices) can overlap, though there is no nesting. Colour plane 2.5. Terminated by **CSI 1:n!m** with same value for  $n$  (restarting with the same colour) or **CSI 2:n!m** with same value for  $n$  or by **CSI 0!m**.
- **CSI 2:n!m** End UI background colour mark that started by using index  $n$  in the palette. Other UI background colour marks are not affected.
- **CSI 3:n[:v]!m** Start UI underline having the colour of index  $n$  in the palette.  $n$  here is used both as an index to the palette and as an identifier for which UI underline is referenced. This way multiple markings can overlap (e.g. both spell check marking and style check marking; of different palette indices), though there is no nesting. Same variants as **CSI 4m**, but these lines are a bit lower under the characters (close to the descenders). Default is double wavy underline. Multiple UI underlines on the same substring may stack. If the line progression direction is left to right, the “underline” is to the right of the text. If the line progression direction is right to left, the “underline” is to the left of the text. Colour planes

6.5. Terminated by **CSI 3:n[:v]!m** with same value for  $n$  (possibly changing type of underline, but not colour) or **CSI 4:n!m** with same value for  $n$ , and by **CSI 0!m**.

- **CSI 4:n!m** End UI underline that started by using by index  $n$  in the palette. Other UI underlines are not affected.

## 13 Cut and paste

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Modern systems offer a “cut and paste” functionality, enabling to save a “clip” in a “clipboard” and then insert that “clip” somewhere else, often via another application. The data saved in the clipboard is in a system dependent format, or even multiple formats. But it usually allows for saving text styling attributes when saving a text clip.

However, it is (and will probably continue to be) unlikely that the styling is saved by using ECMA-48 control sequences in the “clipboard” (though the ECMA-48 control sequences can in principle be stored in the “plain text” version of the clip; recipient programs might not be able to interpret ECMA-48 control sequences). If one does not want to lose the styling attributes (when cutting-and-pasting from an application that does interpret ECMA-48 styling attributes to one that does not, but supports other styling methods), then conversion(s) are needed at some point(s), so that what is saved in the clipboard closely follows the style of the original, to the extent reasonably possible. In addition, saving a clip as “plain text” may or may not keep ECMA-48 style control sequences, whether interpreted or not. That depends on the application and other circumstances.

The clipboard, as mentioned, as well as the receiving application need not support the ECMA-48 way of specifying styling, but one can still get a good, or in ideal cases even perfect, styling copied via the clipboard. E.g., HTML with inline CSS, a possible clipboard format, can represent nearly all the styles mentioned above (some styles, like “margin lines”, use of “colour palette”, excepted). Further, that format might not be able to fully handle all the line break characters listed above, nor HTJ nor tab stop settings, though LF and functionally equivalent characters can be represented by “<p>” or “</p><p>” (unless within a “<pre>”) and VT and functionally equivalent characters by “<br/>” in HTML. In any case one needs to pick up formatting in effect from before the beginning of the text to be copied and reset at the end of the text copied.

When pasting to a terminal emulator, only proper plain text (no ECMA-48 control sequences, nor any other ESC sequences) is often preferable (removing them from “plain text” if need be). An exception could be an ECMA-48 enabled terminal window text editor, but then the pasting needs to convert the styles stored in the clipboard to ECMA-48 control sequences.

When copying from a terminal emulator to an external text editor, it may be a good idea to convert LF to VT (in addition to keeping styling). That way auto-numbered lists (common in rich text editors) will not get messed up if pasting into a list item from a terminal emulator.

## 14 Control/escape/sci sequences and combining characters

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A C0/C1/Cf control character, escape sequence or a control sequence must not occur just before a combining character. Since the final character in an escape sequence or a control sequence, as well as an SCI sequence, is a printable (ASCII) character, often a letter, applying normalisation to NFC may combine that final character and the combining character to a precomposed character,



thus “ruining” the escape/control/sci sequence, and misapply the combining character to the wrong base character.

## 15 Conversion examples

While we will not here take up conversion from all kinds of older, but in some parts similar, text styling representations, we will take up (partially, as sketches only) two of them:

- Teletext. Teletext is still in use (2023) and implemented in all (globally) modern TV sets/TV boxes also those for DVB (Digital Video Broadcasting), including its styling (mostly colouring) mechanisms. We will only cover the “basics”, and not the newer extensions (more colours, italics, bold, ...) mainly due to the complication that those have “out of line” (i.e., only in the Teletext *protocol*) representations.
- ISCII. ISCII includes, in the standard, mechanisms for styling text. These mechanisms have not been covered (hitherto) in the conversions of ISCII to Unicode.

### 15.1 Converting Teletext styling to ECMA-48 styling

Teletext is still in common use around the world, especially for optional subtitling, though the use of Teletext for news pages has declined or even been abandoned. Teletext allows for certain style settings, mostly to do with colour. There are also control bits in the Teletext protocol for handling bold, italic and underline. The colour codes also select which set of characters to use (either alphanumeric or “mosaic” characters, the latter are Teletext specific symbols used to build up larger (and crude...) graphics). Note that the coding for “alphanumeric” characters have multiple variants for G0/G2, various Latin subsets, Greek, Cyrillic, Arabic and Hebrew. The used character set is selected among several 7-bit charsets, including national variants of ISO/IEC 646, *except* C0 which ISO/IEC 646 (ECMA-6) requires to be the C0 of ECMA-48/ISO/IEC 6429. These are selected by control bits in the Teletext *protocol*. In addition **0x1B** can be used to switch between a primary and a secondary G0+G2 set. Further, the “mosaic” characters (G1) have two variants, a “contiguous” form (default, and selected by **0x19**) and a “separated” form (selected by **0x1A**). From a modern encoding point of view the latter are separate characters. Teletext also allows for dynamically defined (“bitmapped”) fonts of unspecified charsets.

The table is a rough sketch only, far from all details have been worked out. For instance, Teletext overrides (italics, bold, underline, more colours, proportional font, G3 characters) are not covered here, though the functionality is covered by this proposed update to ECMA-48. The styling and codepage selection via the Teletext *protocol* is *not* covered here.

Teletext	ECMA-48 (as extended here)
<b>0x00</b> Alpha black (and sets “alpha mode”, G0)	<b>SP? CSI 30m</b>
<b>0x01</b> Alpha red (and sets “alpha mode”, G0)	<b>SP? CSI 91m</b>
<b>0x02</b> Alpha green (and sets “alpha mode”, G0)	<b>SP? CSI 92m</b>
<b>0x03</b> Alpha yellow (and sets “alpha mode”, G0)	<b>SP? CSI 93m</b>
<b>0x04</b> Alpha blue (and sets “alpha mode”, G0)	<b>SP? CSI 94m</b>
<b>0x05</b> Alpha magenta (and sets “alpha mode”, G0)	<b>SP? CSI 95m</b>
<b>0x06</b> Alpha cyan (and sets “alpha mode”, G0)	<b>SP? CSI 96m</b>
<b>0x07</b> Alpha white (and sets “alpha mode”, G0) (default)	<b>SP? CSI 37m</b>
<b>0x08</b> Flash (phases (0°, 180°, ...), rates (1Hz, 2Hz) and other effects, like apparent flash movement, specified)	<b>SP? CSI 5m</b>

Teletext	ECMA-48 (as extended here)
<b>0x09</b> Steady (default) (exceptionally a “set-at” control)	<b>CSI 25m SP?</b> (note order)
<b>0x0A</b> End box (default) (not in subtitle or news-flash text)	<b>SP? CSI 112:0m</b> (allow 100% fade)
<b>0x0B</b> Start box (subtitles mainly; was also for news-flashes)	<b>SP? CSI 112:1m</b> (allow 0% fade)
<b>0x0C</b> Normal size (default) (exceptionally: “set-at” control)	<b>CSI 77:1:1m SP?</b> (note order)
<b>0x0D</b> Double height (note: background & foreground overrides onto next line, which should be empty)	<b>SP? CSI 77:2:1m</b> (interaction to next line is implementation defined)
<b>0x0E</b> Double width	<b>SP? CSI 77:1:2m</b>
<b>0x0F</b> Double size (note: background & foreground overrides onto next line, which should be empty)	<b>SP? CSI 77:2:2m</b> (interaction to next line is implementation defined)
<b>0x10</b> Mosaics black (and sets “mosaics mode”, G1)	<b>SP? CSI 30m</b>
<b>0x11</b> Mosaics red (and sets “mosaics mode”, G1)	<b>SP? CSI 91m</b>
<b>0x12</b> Mosaics green (and sets “mosaics mode”, G1)	<b>SP? CSI 92m</b>
<b>0x13</b> Mosaics yellow (and sets “mosaics mode”, G1)	<b>SP? CSI 93m</b>
<b>0x14</b> Mosaics blue (and sets “mosaics mode”, G1)	<b>SP? CSI 94m</b>
<b>0x15</b> Mosaics magenta (and sets “mosaics mode”, G1)	<b>SP? CSI 95m</b>
<b>0x16</b> Mosaics cyan (and sets “mosaics mode”, G1)	<b>SP? CSI 96m</b>
<b>0x17</b> Mosaics white (and sets “mosaics mode”, G1)	<b>SP? CSI 37m</b>
<b>0x18</b> Conceal (ignored on the currently displayed page until user presses a ‘reveal’ button on the remote control)	<b>CSI 38:8m SP?</b> ( <i>not CSI 8m</i> )
<b>0x19</b> (“mosaics mode”) Contiguous mosaic graphics (default); note: does <i>not</i> unset underlined in “alpha mode”	(converter change) <b>SP?</b>
<b>0x1A</b> (“mosaics mode”) Separated mosaic graphics; note: does <i>not</i> set underlined in “alpha mode”	(converter change) <b>SP?</b>
<b>0x1B</b> called “escape”, but is <u>unrelated</u> to ESCAPE, its works like LOCKING SHIFT x: switching between code pages	<b>SP?</b> (converter change)
<b>0x1C</b> Black background (default) (“set-at”)	<b>CSI 40m SP?</b>
<b>0x1D</b> Set background colour by copying foreground colour	<b>CSI 48:6m SP?</b>
<b>0x1E</b> Hold mosaics (details of hold/release mosaics is beyond the scope of this paper) (“set-at”)	<b>(SP? := &lt;current mos. char&gt;) SP?</b>
<b>0x1F</b> Release mosaics (details of hold/release mosaics is beyond the scope of this paper)	<b>SP? (SP? := SP)</b>
<i>line break</i> (implicit) (in Teletext all style settings (and locking shift) are auto-reset for each “row”, i.e., text line; there are no line break characters in Teletext, instead the Teletext <i>protocol</i> has numbered “rows” of text)	<b>CSI 0m LF (SP? := SP)</b> <i>CSI 0m is used only for convenience here, to reset “all in one go”; should use individual resetting controls</i>

## 15.2 Converting ISCII styling to ECMA-48 styling

ISCII formally allows for 31 style settings (many of them outline/shadow) by combining several ATR (attribute; the code for ATR in ISCII is **0xEF**) codes (similar to that ECMA-48 stylings can be combined; but not quite same, vide: ATR HLT ATR BLD does not set independent style attributes, but specifies extra-bold, **CSI 1:3m**). Here we give some of the ISCII styles, and their corresponding ECMA-48 styling codes. The table is a rough sketch only. We will not give the combinations here, just the basic ones.

ISCII (all these ATR toggle)	ECMA-48 (as extended here)
ATR BLD (= ATR <b>0</b> ) (bold)	<b>CSI 1m or CSI 1:3m, CSI 22m</b>
ATR ITA (= ATR <b>1</b> ) (italic)	<b>CSI 3m, CSI 23m</b>
ATR UL (= ATR <b>2</b> ) (underline)	<b>CSI 4m, CSI 24m</b>

ISCII (all these ATR toggle)	ECMA-48 (as extended here)
ATR EXP (= ATR 3) (expand)	<b>CSI 77:1:2m, CSI 77:1:1m</b>
ATR HLT (= ATR 4) (highlight/bold)	<b>CSI 1m or CSI 1:3m, CSI 22m</b>
ATR OTL (= ATR 5) (outline)	<b>CSI 80:6:5;38:6m</b> (setting the all-around 0,05 em shadow colour to be the current text colour, and then setting the text colour to be the same as the (opaque) background colour), <b>CSI 38:7;89m</b> (if not combined with ATR SHD)
ATR SHD (= ATR 6) (shadow)	<b>CSI 81:45:6:10;80:6:5;38:6m</b> (extra shadow to the ‘south-east’), <b>CSI 38:7;89m</b> (if not combined with ATR OTL)
ATR TOP (= ATR 7) (top half of double height glyphs)	<b>CSI 77:2:1;113:1m, CSI 77:1:1;113:0m</b>
ATR LOW (= ATR 8) (low half of double height glyphs)	<b>CSI 77:2:1;113:2m, CSI 77:1:1;113:0m</b>
ATR DBL (= ATR 9) (double size)	<b>CSI 77:2:2m</b> (combined with ATR TOP and ATR LOW one can get <b>CSI 77:4:2m</b> and combined with ATR EXP also <b>CSI 77:4:4m</b> ) or maybe <b>CSI 76:0:2m</b> (not clear from ISCII), <b>CSI 77:1:1m</b> or maybe <b>CSI 76:0:0?5m</b>
<line break char> (in ISCII all style settings are auto-reset on explicit line break)	<b>CSI 0m</b> , <line break char>; <b>CSI 0m</b> is used only for convenience in this table

## 16 Security aspects

Filtering out ECMA-48 escape sequences, control sequences or control strings, or “undesirable” control characters, or expanding character references, at the “wrong point” of the process, may expose security sensitive data (such as blocked commands) that may have been “hidden” by ECMA-48 control/escape sequences, etc., earlier on. These issues have been ever-present in ECMA-48, it is nothing new to this update proposal.

The same warning is valid for any other substring(s) removal, substitution or insertion, such as replacing line breaks with spaces, HT to SPs, removing HTML tags or converting HTML character references, adding explicit line breaks, or removing/replacing portions that have encoding errors, do case mapping or spell correction. All of these are common automatic edits.

## 17 Conclusions

Whether to regard ECMA-48 text styling as a higher-level protocol (for text styling) or not is mostly a matter of taste. Technically it is a (text styling) protocol at the text level. The current principal application, in terminal emulators, relies on it being text level, rather than higher level.

ECMA-48 may seem a bit old-fashioned, since the first edition was issued in September 1976. It has seen little use outside of terminals and terminal emulators, where it is still “alive and well”; though there were some efforts to incorporate parts of it in a document format standard. Much of ECMA-48 is concerned with “terminal only” functionality (some technically possible to apply to modern text editors, also those that do not run “under” a terminal emulator, like cursor movement control sequences, but modern editors use other mechanisms). Despite this, the styling mechanisms can still be used in a modern context, also when storing (styled) text in files.

Especially if one modernises the capabilities of ECMA-48 styling, which we are proposing in this paper. Those modernisations can be applied both to terminal emulators as well as text files storing text in a “plain text formatting” format. While one could invent from scratch a different “plain text formatting” format, there seems little need for that considering that we already have ECMA-48. For backward compatibility reasons, terminal emulators will need to stay with ECMA-48. The additions proposed in this paper are in “the spirit of” ECMA-48, and much can apply to terminal emulators as well. With the modernisations, ECMA-48 styling is viable as a text formatting protocol for text files, as well as terminal emulators.

In addition to extending ECMA-48 styling in order to modernise it (in a compatible way), we have also added some functionality to support styling that was present in ISCII, and support for styling that is used in current Teletext use around the world (these days, mostly used for user optional subtitling, though sometimes still in use for news and other pages). With these extensions, ISCII text that use ISCII formatting can be converted to Unicode while preserving the formatting via these ECMA-48 extensions. Likewise, Teletext texts can be converted to Unicode preserving the formatting via these ECMA-48 extensions, supporting the effort to support “old computers” (though Teletext is still in use!). For Teletext, one also need to interpret the Teletext protocol itself for bold/italics/underline, proportional font, line breaks (Teletext has *no* line break characters, instead lines have explicit numbers given in the Teletext protocol), page/subpage numbers (which aren’t text, but gives a structure to the set of Teletext pages being transmitted), as well as charset information (Teletext uses its own charset switching mechanism, out of band and not using any escape sequences).

Possible uses for ECMA-48 (including the extensions proposed here):

- Terminal emulators, which are the current major “client” for ECMA-48. Unfortunately, terminal emulators have a very strict fixed size character cell approach, which in no way is demanded by ECMA-48. But many applications using terminal emulators assume this very strict fixed size character cell approach. Therefore, it may be hard for terminal emulators to adopt features such as proportional fonts, font size as a style, proper tables (PTX), math expressions, vector graphics (“plotter drawings”) and several other features. (Side note: Some terminals, 4 decades ago, could display math expressions, slightly crudely, but apparently no terminal emulator can do anything similar today. And we also had “plotter” terminals 4 decades ago, but no terminal emulator can “plot” today. One can instead generate web pages (or images), but no terminal emulator support...)
- Emulation of “old text applications”. This includes various now defunct computer systems that had control codes similar to those of ECMA-48, such as those using PETSCII, ATASCII, EBCDIC (which for a limited set of systems is still in use), ISCII, as well as Teletext (which is *still* in use; for TV broadcasts and TV sets/boxes, for short news pages and for optional subtitles). This is mostly for archival/library and database conversion use, converting from old character representation to a Unicode based representation of the texts, without losing “control” (like styling) part of the data.
- Text editors that support not just “plain text” but also styled text, tables and math expressions and perhaps vector graphics (diagrams, ...). Such text editors are still not “full-featured” document editors, but more capable than “plain text” editors. This is the main motivation for this proposed update/extension to ECMA-48.

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# Appendix A – Control sequences summary

## SGR

**CSI [0]m** Reset rendition. Handy for things like beginning of prompts, where the current state is unknown.

This is intended for terminal emulators. Should not be used in ECMA-48 formatted text files.

**CSI 1[:v]m** Bold font variant. Default weight 700.

**CSI 2[:v]m** Lean font variant. Default weight 300.

**CSI 3[:v]m** Italicized or oblique.

**CSI 4[:v]m** Singly underlined.

**CSI 5[:f[:v[:p[:w[:t]]]]]m** Slowly blinking. Blinking is mostly for such applications as terminal emulators.

**CSI 6[:f[:v[:p[:w[:t]]]]]m** Rapidly blinking. Blinking affects transparency, not colour in any other way.

**CSI 7[:f]m** Negative image.

**CSI 8[:v]m** Concealed/censored characters. Note that this is only a display effect, the text is still there.

**CSI 9[:v]m** Crossed out (strike-through) characters.

**CSI 10m, ..., CSI 19m** Palette of font sets (... —lean—normal—bold—extra bold— ...; italic/upright; “optical” adaptations for compressed/expanded and different sizes, or a multiple-masters font). (Each should have information if it is calligraphic or not. If not calligraphic, there should be information whether they are sans-serif, serif, or fixed-width.) Note: **CSI 26:0m**: default font set, **CSI 50m**: default fixed width font set, **CSI 26:1m**: default serifed proportional font set, **CSI 26:2m**: default sans-serif proportional font set.

**CSI 20m** Change to a predetermined Fraktur font set. Italic/oblique does not apply.

**CSI 21[:v]m** Doubly underlined.

**CSI 22[:v]m** Normal weight (neither bold nor lean). Default weight 400.

**CSI 23[:v]m** Roman/upright, i.e. not italicized/oblique. Default. Does not alter bold, underlined, etc.

**CSI 24[:v]m** Not underlined. Default.

**CSI 25[:f[:v[:p[:w[:t]]]]]m** Steady (not blinking). Default.

**CSI 26[:v]m** Change to a predetermined serif or non-serif proportional (but non-calligraphic) font set.

**CSI 27[:f]m** Positive image. Default.

**CSI 28[:v]m** Cancel “concealed/censored characters” effect. Default.

**CSI 29[:v]m** Not crossed out. Default.

Foreground colour shorts (default transparency is 0, i.e., fully opaque):

**CSI 30[:t]m** is short for **CSI 38:2::0:0:0:tm**, Pure black foreground.

**CSI 31[:t]m** is short for **CSI 38:2::205:0:0:tm**, Dull red foreground.

**CSI 32[:t]m** is short for **CSI 38:2::0:205:0:tm**, Dull green foreground.

**CSI 33[:t]m** is short for **CSI 38:2::255:215:0:tm**, Dull yellow foreground.

**CSI 34[:t]m** is short for **CSI 38:2::0:0:205:tm**, Dull blue foreground.

**CSI 35[:t]m** is short for **CSI 38:2::205:0:205:tm**, Dull magenta foreground.

**CSI 36[:t]m** is short for **CSI 38:2::0:205:205:tm**, Dull cyan foreground.

**CSI 37[:t]m** is short for **CSI 38:2::255:255:255:tm**, Pure white foreground.

**CSI 38[:0]m** Reset text foreground colour to default foreground colour.

**CSI 38:1m** Fully transparent foreground. Short for **CSI 38:2::0:0:0:255m**.

**CSI 38:2[:i]:r:g:b[:t[:a:0]]m** Foreground colour as RGB(T).

**CSI 38:3[:i]:c:m:y[:t[:a:0]]m** Foreground colour as CMY(T).

**CSI 38:4[:i]:c:m:y:k[:a:0]m** Foreground colour as CMYK.

However, if *i* is negative (including negative zero, **0=**), there is no change in foreground colour, but there is an assignment to the colour palette (unless the position is write protected).

**CSI 38:5:p[:t]m** Foreground colour from colour palette.

**CSI 38:6m** Copy current background colour to foreground colour. Not recommended.

**CSI 38:7m** Copy current all-around shadow colour to foreground colour. Not recommended.

**CSI 38:8m** Optionally transparent foreground. (for Teletext.) Deprecated.

**CSI 38:9:b:p1[:t1]:p2[:t2]m** Gradient glyph colouring.

**CSI 39m** Reset text foreground colour to default foreground colour.

Background (or highlight) colour shorts (default transparency is implementation defined, and may be settable in preferences):

**CSI 40[:t]m** is short for **CSI 48:2::0:0:0:tm**, Pure black background.

- CSI 41[:t]m** is short for **CSI 48:2::205:0:0:tm**, Dull red background.
- CSI 42[:t]m** is short for **CSI 48:2::0:205:0:tm**, Dull green background.
- CSI 43[:t]m** is short for **CSI 48:2::255:215:0:tm**, Dull yellow background.
- CSI 44[:t]m** is short for **CSI 48:2::0:0:205:tm**, Dull blue background.
- CSI 45[:t]m** is short for **CSI 48:2::205:0:205:tm**, Dull magenta background.
- CSI 46[:t]m** is short for **CSI 48:2::0:205:205:tm**, Dull cyan background.
- CSI 47[:t]m** is short for **CSI 48:2::255:255:255:tm**, Pure white background.
- CSI 48[:0]m** Reset background/highlight colour to default text background/highlight colour.
- CSI 48:1m** Fully transparent text background/highlight (default if more than two colour planes).
- CSI 48:2[:i]:r:g:b[:t[:a:0]]m** Text background colour as RGB(T).
- CSI 48:3[:i]:c:m:y[:t[:a:0]]m** Text background colour as CMY(T).
- CSI 48:4[:i]:c:m:y:k[:a:0]m** Text background colour as CMYK.
- However, if *i* is negative (including negative zero, **0=**), there is no change in background/highlight colour, but there is an assignment to the colour palette (unless the position is write protected).
- CSI 48:5:p[:t]m** Text background/highlight colour from colour palette.
- CSI 48:6m** Copy current foreground colour to background colour. Not recommended. For Teletext.
- CSI 49m** Reset background/highlight colour to default text background/highlight colour.
- CSI 50m** Change to a predetermined “fixed” width font set. (Three widths, width 0 en for non-spacing characters, width 1 en for “narrow” characters, 2 en (i.e., 1 em) for “wide” characters.)
- CSI 51[:v[:r]]m** Framed string.
- CSI 52[:v[:r]]m** Encircled string.
- CSI 53[:v]m** Overlined.
- CSI 54[:v[:r]]m** Not framed, not encircled.
- CSI 55[:v[:w]]m** Not overlined. (Note the additional parameters that modify this.)
- CSI 56:1[:v]m** Raised to first superscript level and slightly smaller. Cmp. DEC **CSI?4m** (private use).
- CSI 56[:0]m** Not raised/lowered and back to the set size (default). Cmp. DEC **CSI?24m** (private use).
- CSI 56:1=m** Lowered to first subscript level and slightly smaller. Cmp. DEC **CSI?5m** (private use).
- For math (inside **SME...EME**), use **SCI^** and **SME\_**. See math proposal for details.
- CSI 57[:0]m** Reset to default w.r.t. ligatures.
- CSI 57:1m** Only required ligatures.
- CSI 57:2m** In addition to required ligatures, use also modern ligatures (according to the font).
- CSI 57:vm**, *v* = 3 or greater. Reserved for future use.
- CSI 58[:0]m** Reset text emphasis mark colour to follow foreground colour (default).
- CSI 58:1m** Fully transparent text emphasis (not recommended).
- CSI 58:2[:i]:r:g:b[:t[:a:0]]m** Text emphasis colour as RGB(T).
- CSI 58:3[:i]:c:m:y[:t[:a:0]]m** Text emphasis colour as CMY(T).
- CSI 58:4[:i]:c:m:y:k[:a:0]m** Text emphasis colour as CMYK.
- However, if *i* is negative (including negative zero, **0=**), there is no change in text emphasis colour, but there is an assignment to the colour palette (unless the position is write protected).
- CSI 58:5:p[:t]m** Text emphasis colour from colour palette.
- CSI 59m** Reset emphasis colour to follow text foreground colour.
- CSI 60[:v]m** CJK underline (on the right side if vertical character progression direction).
- CSI 61[:v]m** CJK double underline (on the right side if vertical character progression direction).
- CSI 62[:v]m** CJK overline (on the left side if vertical character progression direction).
- CSI 63[:v]m** CJK double overline (on the left side if vertical character progression direction).
- CSI 64[:v]m** CJK stress marks (dot placed under/over (right/left side if vertical writing)).
- CSI 65m** Cancel the effect of the renditions established by parameter values 60 to 64.
- CSI 66[:0]m** Normal uppercase and lowercase rendering (default). Implies **CSI 67[:0]m**.
- CSI 66:1m** Uppercase letters, 0 to 9, and & rendered as small caps.
- CSI 66:2m** Uppercase letters, 0 to 9, and & rendered as petit caps.
- CSI 66:666m** Lowercase letters rendered as the petit caps of their uppercase. Language dependent.
- CSI 66:999m** Lowercase letters rendered as the small caps of their uppercase. Language dependent.

- CSI 67[:0]m** Uppercase fixed width digits (default).
- CSI 67:1m** Lowercase fixed width digits. (Sometimes misleadingly called “old-style” digits.)
- CSI 67:2m** Uppercase proportional width digits.
- CSI 67:3m** Lowercase proportional width digits. (Sometimes misleadingly called “old-style” digits.)
- CSI 67:99m** Uppercase fixed width digits, where the ‘0’ has a middle dot or an internal diagonal stroke.
- CSI 68[:0]m** Reset text crossed-out/strike-through and string framing colour to follow foreground colour.
- CSI 68:1m** Fully transparent overstrike and framing lines. (Not recommended.)
- CSI 68:2[:i]:r:g:b[:t[:a:0]]m** Text overstrike and string framing colour as RGB(T).
- CSI 68:3[:i]:c:m:y[:t[:a:0]]m** Text overstrike and string framing colour as CMY(T).
- CSI 68:4[:i]:c:m:y:k[:a:0]m** Text overstrike and string framing colour as CMYK.
- However, if *i* is negative (including negative zero, 0=), there is no change in overstrike/framing colour, but there is an assignment to the colour palette (unless the position is write protected).
- CSI 68:5:p[:t]m** Text overstrike and string framing colour from colour palette.
- CSI 69:u:v[:s]m** First line BOL (beginning of line) indent. Side is given by SPD2 (explicit or default). Effect starts at current paragraph, with FF, VT and LS counted as inside of paragraph. This, and the two following, should be at the beginning of a paragraph.
- CSI 70:u:v[:s]m** Non-first line BOL line indent (after auto-line-break). Side is given by SPD2.
- CSI 71:u:v[:j]m** EOL (end of line) line indent. Also sets paragraph justification. Side is given by SPD2.
- CSI 72:u:s[:sb[:sa]]m** Line spacing, Intra-paragraph, and before/after paragraph *extra* spacing.
- CSI 73m** Reserved for HTML-like superscript start. In contrast to all other SGR controls, **CSI 73m...CSI 75m** nest. Use instead **CSI 56:1m**, which does not nest. For math (inside **SME...EME**), use **SCI^**.
- CSI 74m** Reserved for HTML-like subscript start. In contrast to all other SGR controls, **CSI 74m...CSI 75m** nest. Use instead **CSI 56:1=m**, which does not nest. For math (inside **SME...EME**), use **SCI\_**.
- CSI 75m** Reserved for HTML-like superscript/subscript end. Use instead **CSI 56:0m**, which does not nest.
- CSI 76:u:sm** Font size.
- CSI 77:a:bm** Font magnification.
- CSI 78[:v][:p]m** Line in the margin before the beginning-of-line position. Side determined by SPD2 setting.
- CSI 79[:v][:p]m** Line in the margin after end-of-line position. Side determined by SPD2 setting.
- CSI 80[:0]m** Cancel all-around shadow, directional shadow and its “counter-shadow” (if any).
- CSI 80:2:d:r:g:b[:t[:f]]m** All-around shadow colour as RGB(T).
- CSI 80:3:d:c:m:y[:t[:f]]m** All-around shadow colour as CMY(T).
- CSI 80:4:d:c:m:y:k[:f]m** All-around shadow colour as CMYK. Fully opaque.
- CSI 80:5:d:p[:t[:f]]m** All-around shadow colour from palette. *p* is palette index.
- CSI 80:6:d[:f]m** Copy current foreground colour to all-around shadow colour. Not recommended.
- CSI 80:9:d:b:p1[:t1]:p2[:t2][:f]m** Gradient all-around glyph shadow colouring.
- CSI 81[:0]m** Cancel directional shadow and its “counter-shadow” (if any).
- CSI 81:e:2:d:r:g:b[:t[:f]]m** Directional shadow colour as RGB(T).
- CSI 81:e:3:d:c:m:y[:t[:f]]m** Directional shadow colour as CMY(T).
- CSI 81:e:4:d:c:m:y:k[:f]m** Directional shadow colour as CMYK.
- CSI 81:e:5:d:p[:f]m** Directional shadow colour from palette.
- CSI 81:e:6:d[:f]m** Copy current foreground colour to directed shadow colour. Not recommended.
- CSI 81:e:9:d:b:p1[:t1]:p2[:t2][:f]m** Gradient directional glyph shadow colouring.
- CSI 82:...m** “Counter-shadow” to the current directional shadow.
- CSI 83m, ..., CSI 89m** Reserved.
- Foreground colour shorts (default transparency is 0, i.e. fully opaque):
- CSI 90[:t]m** is short for **CSI 38:2::105:105:105:tm**, dark grey foreground.
- CSI 91[:t]m** is short for **CSI 38:2::255:0:0:tm**, clear red foreground.
- CSI 92[:t]m** is short for **CSI 38:2::0:255:0:tm**, clear green foreground.
- CSI 93[:t]m** is short for **CSI 38:2::255:255:0:tm**, clear yellow foreground.
- CSI 94[:t]m** is short for **CSI 38:2::0:0:255:tm**, clear blue foreground.



**CSI 95[:t]m** is short for **CSI 38:2::255:0:255:tm**, clear magenta foreground.

**CSI 96[:t]m** is short for **CSI 38:2::0:255:255:tm**, clear cyan foreground.

**CSI 97[:t]m** is short for **CSI 38:2::220:220:220:tm**, light grey foreground.

**CSI 98[:t]m** is short for **CSI 38:2::169:169:169:tm**, medium grey foreground.

**CSI 99[:t]m** is short for **CSI 38:2::255:140:0:tm**, orange foreground.

Background (or highlight) colour shorts (default transparency is implementation defined):

**CSI 100[:t]m** is short for **CSI 48:2::105:105:105:tm**, dark grey background.

**CSI 101[:t]m** is short for **CSI 48:2::255:0:0:tm**, clear red background.

**CSI 102[:t]m** is short for **CSI 48:2::0:255:0:tm**, clear green background.

**CSI 103[:t]m** is short for **CSI 48:2::255:255:0:tm**, clear yellow background.

**CSI 104[:t]m** is short for **CSI 48:2::0:0:255:tm**, clear blue background.

**CSI 105[:t]m** is short for **CSI 48:2::255:0:255:tm**, clear magenta background.

**CSI 106[:t]m** is short for **CSI 48:2::0:255:255:tm**, clear cyan background.

**CSI 107[:t]m** is short for **CSI 48:2::220:220:220:tm**, light grey background.

**CSI 108[:t]m** is short for **CSI 48:2::169:169:169:tm**, medium grey background.

**CSI 109[:t]m** is short for **CSI 48:2::255:140:0:tm**, orange background.

**CSI 110[:z]m** Advancement modification.

**CSI 111[:x]m** Space advancement modification.

**CSI 112:fm** Fade control factor.

**CSI 113:vm** Show horizontally halved glyphs. (For conversion from ISCII and xterm, otherwise deprecated.)

**CSI 114[:v][:[p1][:[b][:[p2][:[c]]]]m** Start frame of paragraphs. Should be at beginning of a paragraph.

**CSI 115m** End frame of paragraphs. Should be at end of a paragraph. There is no nesting of frames.

**CSI 116:vm** Overstriking grapheme by grapheme, by slashes, arrows or crosses.

## HTSA2 (original HTSA remains deprecated)

**CSI [u1:]p1;...;[un:]pn!N** Set tab stops according to the stoplist. **CSI !N** clears all HTSA2 set tab stops.

## SPD2 (augmenting SPD, which is *not* deprecated)

**CSI 0!S** Character progression left-to-right, no bidi processing. HT and HTJ as well as cells in a table row are in left-to-right order. Common default. Also used for *visual order* (when the bidi algorithm or a precursor thereof and shaping (using ARABIC...FORM characters) has been done separately prior to rendering). Same as **CSI 0 SP S**. BOL is at the left side. Suitable for most scripts (LTR, user not able to read RTL scripts). Very suitable for source code (.java, .css, .cpp, .xml, .json, .cvs, and many other kinds of computer source code) texts, *especially* if there is any RTL script content (no bidi processing or cursive shaping *at all*, in contrast to “visual order”), since it avoids bidi pitfalls that may occur for source code (but less likely for running text, “prose”).

**CSI 1!S** CJK/Hangul vertical, line progression right-to-left, no bidi processing but (in contrast to **CSI 1 SP S**) rotates non-CJK/Hangul characters, including parentheses/brackets and other punctuation. Character progression, HT and HTJ as well as cells in a table row are in top-to-bottom order. Table rows are in right-to-left order. BOL is at the top side.

**CSI 2!S** Mongolian vertical, line progression left-to-right, no bidi processing but (in contrast to **CSI 2 SP S**) rotates non-Mongolian (and non-CJK/Hangul) characters, including parentheses/brackets/punctuation. Character progression, HT and HTJ as well as cells in a table row are in top-to-bottom order. Table rows are in left-to-right order. BOL is at the top side.

**CSI 3!S** Character reading direction right-to-left, with Unicode bidi processing; actually sets paragraph direction to “1” for the bidi algorithm, but “printing order” still left-to-right after bidi rearrangement and mirroring; but HT and HTJ as well as cells in a table row are in right-to-left order. BOL is at the right side. Suitable for texts in “bidi scripts” (with occasional occurrences of LTR texts, such as numerals, or Latin script phrases). *Do not use* for source code (.java, .json, ...), as it is certain to misprint the code.

**CSI 4!S, ..., CSI 7!S** Reserved.

**CSI 8!S** Character reading direction left-to-right, with Unicode bidi processing; actually sets paragraph direction to “0” for the bidi algorithm, but “printing order” still left-to-right after bidi

rearrangement and mirroring; HT and HTJ as well as cells in a table row are in left-to-right order. BOL is at the left side. Suitable for (non-code) text in an “LTR script” with occasional “bidi script” phrases. *Unsuitable* for source code (.java, .json, .cpp, .xml, ...), since it *may* cause misreading if RLT text occurs (in identifiers, comments, or string literals) in the source code.

**CSI 10!S** Boustrophedon. No bidi processing, but right-to-left text lines get *all* glyphs mirrored. BOL (for beginning of paragraph) is at the left side (but switches for every line of text). Historical interest.

**CSI 11!S**, ..., **CSI 98!S** Reserved.

**CSI 99!S** Reset to default directions, per preference or default setting. Note that if an SPD2 setting is within a table cell, a pop to outer SPD2 setting is implicit at end of cell.

## SCO2 (rotation of pages, rotation of table cell)

**CSI v!e** Rotate pages (until change of rotation) when at explicit beginning of page, or rotate content of table cell when at the beginning of a table cell. The unit for  $v$  is  $45^\circ$ .

## UI text emphasis marking

For temporary text styling for UI reasons, like marking text selection, spell errors, pattern matches, etc. for terminal emulator-oriented programs (other programs are likely to use other mechanisms for UI text marking). These control sequences should not occur in “**.txtf**” text documents, but are for UI.

**CSI 0!m** End all UI text marks. Stop all UI text markings. Handy for things like beginning of prompts, where the current state of UI text marking is unknown.

**CSI 1:n!m** Start UI background colour mark to the colour of index  $n$  in the palette.

**CSI 2:n!m** End UI background colour mark that started by using index  $n$  in the palette.

**CSI 3:n[:v]!m** Start UI underline, variant  $v$ , having the colour of index  $n$  in the palette.

**CSI 4:n!m** End UI underline that started by using by index  $n$  in the palette.

## PTX as table row

**CSI 1[:u:s]\** Beginning of first text of the list of parallel texts. Beginning of table row or beginning of base text for Ruby annotation (below).

**CSI 2[:n[:v]]\** End of previous text (cell) and beginning of next text (cell) (i.e., cell boundary).

**CSI 0[:n[:v]]\** End of list of parallel texts (i.e. end of row).

## PTX as Ruby text

**CSI 1\** Beginning of principal text to be phonetically annotated. Beginning of table row (above) or beginning of base text for Ruby annotation. Any  $:u:s$  is ignored if this is for Ruby text.

**CSI 3\** or **CSI 4\** End of principal text and beginning of Japanese (3) or Chinese (4) phonetic annotation text (Ruby text). There should be only one of these between **CSI 1\** and **CSI 5\**.

**CSI 5\** End of Chinese/Japanese phonetic annotation.

## Push/Pop styling

**CSI !** push a copy of all currently explicitly set rendition attributes.

**CSI n!** pop the rendition attributes stack till it has  $n$  levels. If  $n$  is omitted,  $n$  is current stack size minus one. If  $n$  is **1=** (and push/pop is implemented), this is a “super-reset” to system defaults.

## Some ECMA-48 related possibilities **not** detailed in this proposal

**SOS charset=<IANA charset-name>ST** Declare character encoding (akin to XML/HTML/CSS), using IANA charset names, non-ISO/IEC 2022. Should occur only at the beginning of an (ECMA-48 formatted) text file.

Note: a declaration, not a codepage “switch”. (All kinds of codepage *switching* have been deprecated/excluded in this proposal.) **SOS lang=<IANA language tag>ST** Language tagging.

**APC hpgl:<HP-GL/2 commands or .hgl filename>ST** Embed HP-GL/2 graphics (extended with ECMA-48 formatting and math expressions in ‘labels’ (text subcomponents)). Additions: Allow SGR styling for “labels” (text components of the vector graphics) and allow SCI based math expressions in “labels”. **APC svg:<SVG markup or .svg filename>ST** Embed SVG graphics.

# Appendix B – Character properties for C0/C1 and non-characters

We have proposed several changes to the (“default”) Unicode properties for many C0/C1 “control” characters (that they are called “control” characters is in many cases an historical accident, the majority of them are no more “control” than Unicode “non-control” characters, or at least it depends on ones point of view. Sure, there are true “control” characters, most of them “device controls”, like BEL (U+0007) which momentarily sounds the “bell” (often turned into a quick window blink to be more acceptable in an office environment...). Since the Unicode character properties unfortunately often are unhelpful or outright wrong, we here give a summary of more appropriate property assignments as suggested in the main text.

c.p.	Name and comments	g.c.	Bidi	LB
0000	<del>NULL</del> (special use as string terminator, see also SYN)	Cc	BN	CM
0001	START OF HEADING (can be reused as “label” terminator)	Zp	B	BK
0002	START OF TEXT (reused for embedded text in math. expr.)	Zp	B	BK
0003	END OF TEXT (reused for embedded text in math. expr.)	Zp	B	BK
0004	<del>END OF TRANSMISSION</del> (default EOF indicator for TTys)	Cc	B	BK
0005	<del>ENQUIRY</del>	Cc	BN	CM
0006	<del>ACKNOWLEDGE</del>	Cc	BN	CM
0007	<b>AUDIBLE BELL</b> (\a, need not be audible, may be visible)	Cc	BN	CM
0008	<del>BACKSPACE</del> (\b, often misused for should-be <b>CSI 1;OX</b> )	Cc	BN	CM
0009	CHARACTER TABULATION (HT, \t)	Cf	S	BA
000A	LINE FEED (LF, \n)	Zp	B	LF
000B	LINE TABULATION (VT, \v)	Zl	S	<b>LF</b>
000C	FORM FEED (FF, \f)	Zl	S	<b>LF</b>
000D	CARRIAGE RETURN (CR, \r)	Zp	B	CR
000E	<del>LOCKING SHIFT ONE</del> (not interpreted in Unicode based text)	Cc	BN	CM
000F	<del>LOCKING SHIFT ZERO</del> (not interpreted in Unicode based text)	Cc	BN	CM
0010	<del>DATA LINK ESCAPE</del> (regard as <b>eliminated</b> ; the standards for <b>these</b> escape sequences, ECMA-24/ECMA-37, are withdrawn)	Cc	BN	CM
0011	DEVICE CONTROL ONE (default XON for TTys)	Cc	BN	CM
0012	<del>DEVICE CONTROL TWO</del>	Cc	BN	CM
0013	DEVICE CONTROL THREE (default XOFF for TTys)	Cc	BN	CM
0014	<del>DEVICE CONTROL FOUR</del>	Cc	BN	CM
0015	<del>NEGATIVE ACKNOWLEDGE</del>	Cc	BN	CM
0016	<del>SYNCHRONOUS IDLE</del> (SYN is a replacement for NULL)	Cc	BN	CM
0017	<del>END OF TRANSMISSION BLOCK</del>	Cc	BN	CM
0018	<del>CANCEL</del> (inline application-defined-extent string eraser, cancel word/line/...; do not confuse with INTERRUPT, <b>ESC a</b> )	Cc	BN	CM
0019	<del>END OF MEDIUM</del>	Cc	BN	CM
001A	SUBSTITUTE (origin for REPLACEMENT CHARACTER)	So	ON	AI
001B	ESCAPE (\e) (when received from TTY often misused for a should-be <b>ESC a</b> , INTERRUPT; note that this relies on timing, since e.g. arrow keys send, via TTY, control sequences that start with <b>ESC()</b> )	Cf	BN	CM
001C	INFORMATION SEPARATOR FOUR (IS4) ( <b>private use</b> )	Zp	B	BK
001D	INFORMATION SEPARATOR THREE (IS3) <b>separators,</b>	Zp	B	BK
001E	INFORMATION SEPARATOR TWO (IS2) <b>no standard</b>	Zp	B	BK
001F	INFORMATION SEPARATOR ONE (IS1) <b>hierarchy!!)</b>	Zp	B	BK
007F	<del>DELETE</del> (7-bit “anti-NULL”, <b>eliminated</b> from ECMA-48!) (often misused for should-be <b>CSI 1=;OX</b> )	Cc	BN	CM
0080	<b>START OF MATH EXPRESSION</b> (SME) (see math proposal)	Cf	BN	OP
0081	<b>END OF MATH EXPRESSION</b> (EME) (see math proposal)	Cf	BN	CL
0082	BREAK PERMITTED HERE (origin for ZERO WIDTH SPACE)	Cf	BN	ZW
0083	NO BREAK HERE (origin for ZERO WIDTH NO-BREAK SPACE, and original WORD JOINER)	Cf	BN	WJ
0084	<b>MATH HORIZONTAL DIVISION</b> (MHD) (see math proposal)	Cf	BN	BK
0085	NEXT LINE (NEL) (~CRLF, but essentially only EBCDIC use)	Zp	B	NL

## Text styling control sequences – modernised ECMA-48 (ISO/IEC 6429) text styling

c.p.	Name and comments	g.c.	Bidi	LB
0086	START OF SELECTED AREA ( <i>send-selected; mirror pair, but</i>	<b>Cf</b>	ON	<b>OP</b>
0087	END OF SELECTED AREA ( <i>interaction with bidi unclear</i> )	<b>Cf</b>	ON	<b>CL</b>
0088	<del>CHARACTER TABULATION SET</del> ( <i>use HTSA2 instead</i> )	Cc	BN	CM
0089	CHARACTER TABULATION WITH JUSTIFICATION (HTJ)	<b>Cf</b>	<b>S</b>	<b>BA</b>
008A	<del>LINE TABULATION SET</del>	Cc	BN	CM
008B	<del>PARTIAL LINE FORWARD (PLD)</del> ( <i>do not use for sup/sub</i> )	Cc	BN	CM
008C	<del>PARTIAL LINE BACKWARD (PLU)</del> ( <i>do not use for sup/sub</i> )	Cc	BN	CM
008D	<del>REVERSE LINE FEED</del>	Cc	BN	CM
008E	<del>SINGLE SHIFT TWO</del> ( <i>not interpreted in Unicode texts</i> )	Cc	BN	CM
008F	<del>SINGLE SHIFT THREE</del> ( <i>not interpreted in Unicode texts</i> )	Cc	BN	CM
0090	DEVICE CONTROL STRING (DCS) ( <i>some use in xterm</i> )	<b>Cf</b>	BN	<b>OP</b>
0091	<del>PRIVATE USE ONE</del> ( <i>use Unicode's PUAs instead</i> )	Cc	BN	CM
0092	<del>PRIVATE USE TWO</del> ( <i>use Unicode's PUAs instead</i> )	Cc	BN	CM
0093	<del>SET TRANSMIT STATE</del>	Cc	BN	CM
0094	CANCEL CHARACTER ( <i>inline character eraser, ~DELETE</i> )	Cc	BN	CM
0095	<del>MESSAGE WAITING</del>	Cc	BN	CM
0096	START OF GUARDED AREA ( <i>read-only area; mirror pair, but</i>	<b>Cf</b>	BN	<b>OP</b>
0097	END OF GUARDED AREA ( <i>interaction with bidi unclear</i> )	<b>Cf</b>	BN	<b>CL</b>
0098	START OF STRING (SOS)	<b>Cf</b>	BN	CM
0099	<b>MATH MIRROR SYMBOL</b> (MMS) ( <i>see math. expr. proposal</i> )	<b>Cf</b>	BN	CM
009A	SINGLE CHARACTER INTRODUCER (SCI) ( <i>new math controls</i> )	<b>Cf</b>	BN	CM
009B	CONTROL SEQUENCE INTRODUCER (CSI)	<b>Cf</b>	BN	CM
009C	STRING TERMINATOR (ST)	<b>Cf</b>	BN	<b>CL</b>
009D	OPERATING SYSTEM COMMAND (OSC)	<b>Cf</b>	BN	<b>OP</b>
009E	PRIVACY MESSAGE (PM)	<b>Cf</b>	BN	<b>OP</b>
009F	APPLICATION PROGRAM COMMAND (APC)	<b>Cf</b>	BN	<b>OP</b>
FFFC	OBJECT REPLACEMENT CHARACTER	So	ON	CB
nFFFE, nFFFF (with <i>n</i> in 0..F), FDD0 ..FDEF	Non-characters. Primary use: object replacement characters (per paragraph, see bidi handling described in main text). For the primary use, as well as other possible uses, it is not helpful to handle them as unassigned (Cn), much more helpful to handle them as <i>object replacement characters</i> .	<b>SO</b>	<b>ON</b>	<b>CB</b>

\a, ..., \e are the C/C++/Java/PHP/bash/... character references (often misleadingly called “escape sequences”) usable in source code character literals and string literals. There are also octal (\o, \O), hexadecimal (\x), and Unicode (\u, \U) character references (for source code string literals) in many programming languages. HTML has a similar, but different, system for character references.

SOH/STX/ETX/EOT were intended for a kind of telegram styled messaging, no longer used as far as the author knows. However, the STX/ETX we suggest to be *reused inside* of math expressions (in a proposed new representation for math expressions), for start/end of embedded short texts, like short explanatory notes, or hexadecimal numerals.

Some hitherto unused control codes are proposed to be used for math expression representation. See details in *A true plain text format for math expressions (and its XML compatible equivalent format)*, 2023, <https://github.com/kent-karlsson/control/blob/main/math-layout-controls-2023-A.pdf>.

U+0084 (MHD) can be interpreted as LF when outside of a math expression. (Xterm.) This, and a few other math symbols will be handled as layout control characters in math expressions.

The IS1/IS2/IS3/IS4 are as far as the author knows no longer used (at all). But note that they not only got name changes when incorporated into ECMA-48 (from ASCII, in turn from EBCDIC), they also lost any standard hierarchy. Hierarchy, if any (the separators need not be hierarchical at all), is defined by the user/context/application, i.e., if used at all. Therefore, it makes no sense to regard one of them as being “tab-like” (for bidi and for line breaking).

START/END OF GUARDED/SELECTED AREA are part of ECMA-48’s support for a kind of terminals-based forms (terminals that could edit locally and had a “send”-button). Those controls (as they stand) are probably not a good idea to pick up for modern use.

Uninterpreted control codes and control sequences/strings, should *display* as SUBSTITUTE, i.e., as REPLACEMENT CHARACTER, and not be invisible. That does *not* imply actual replacement/substitution.