Hunt for the Dashed Vertical Bar

BY STEVEN BALTAKATEI SANDOVAL

Updated on 2021-06-22T17:25Z.

1 Summary

There is no clearly suitable Unicode character to satisfy IUPAC recommendations to use the dashed vertical bar (¦) and double dashed vertical bar (⦙) glyphs for drawing line representations of electrochemical cells. New Unicode characters are recommended.

2 Background

While continuing the project to transcribe Professor HOWARD DEVOE's textbook *Thermodynamics and Chemistry* into TEXMACS, I noticed that the LATEX source code used a picture to draw a custom glyph in the chapter "Galvanic Cells"; the glyph represented a "liquid junction", an ion-permeable partition between two electrolyte phases of a galvanic cell. See Figure 1.

> The cell of Fig. 14.1 has a single electrolyte phase with essentially the same composition at both electrodes, and is an example of a *cell without liquid junction* or *cell without transference*. As an example of a *cell with transference*, consider the cell diagram
>
> $$\mathrm{Zn} \mid \mathrm{Zn^{2+}(aq)} \,\vdots\, \mathrm{Cu^{2+}(aq)} \mid \mathrm{Cu}$$
>
> This is the zinc–copper cell depicted in Fig. 14.2 on the next page, sometimes called a Daniell cell. The two electrolyte phases are separated by a liquid junction represented in the cell diagram by the dashed vertical bar. If the liquid junction potential can be assumed to be negligible, the liquid junction is instead represented by a pair of dashed vertical bars:
>
> $$\mathrm{Zn} \mid \mathrm{Zn^{2+}(aq)} \,\vdots\!\vdots\, \mathrm{Cu^{2+}(aq)} \mid \mathrm{Cu}$$

Figure 1. Excerpt of DeVoe's *Thermodynamics and Chemistry* utilizing custom vertical dashed line glyphs to depict liquid junctions in an electrochemical cell.

The unusual characters are "dashed vertical bar" (¦) and "double dashed vertical bars" (⦙) specified in the current IUPAC Compendium on Analytical Nomenclature (a.k.a. "Orange Book") (see Ref. 5.1). The characters are specified in Section 1.3.10, *Conventions converning the signs of electric potential differences, electromotive forces, and electrode potential.* A relevant excerpt from the online version of the Orange Book

is shown in Figure 2.

Conventions concerning the signs of electric potential differences, electromotive forces, and electrode potential[24]

(i) The electric potential difference for a galvanic cell

The cell should be represented by a diagram, for example:

$$\mathrm{Zn}\,|\,\mathrm{Zn^{2+}}\,\|\,\mathrm{Cu^{2+}}\,|\,\mathrm{Cu}$$

A single vertical bar (|) should be used to represent a phase boundary, a dashed vertical bar (¦) to represent a junction between miscible liquids, and double dashed vertical bars (‖) to represent a liquid junction in which the liquid junction potential is assumed to be eliminated. The electric potential difference, denoted ΔV or E, is equal in sign and magnitude to the electric potential of a metallic conducting lead on the right minus that of a similar lead on the left. The emf (electromotive force), also usually denoted E, is the limiting value of the electric potential difference for zero current through the cell, all local charage transfer equilibria and chemical equilibria being established. Note that the symbol E is often used for both the potential difference and the emf, and this can sometimes lead to confusion.

Figure 2. Excerpt from the IUPAC Orange Book (1999 online version, 1.3.10 *Electrochemistry* (PDF)) recommending use of "dashed vertical bar" and "double dashed vertical bars" glyphs in galvanic cell diagrams. See Ref. 5.1.

From this excerpt it is obvious that the glyph Devoe uses differs from that shown in the online version of the Orange Book. This is because IUPAC's PDF file utilizes a glyph that appears to be the one used for the Unicode `U+00A6 BROKEN BAR` character (¦) to represent the dashed vertical bar. However, a glyph more closely representing DeVoe's glyph appears in IUPAC's 1975 *Manual of Symbols and Terminology for Physicochemical Quantities and Units*, Appendix III (see Figure 3, Ref. 5.2). Unfortunately, the scan quality of the 1975 document available on the IUPAC website is not very high. Despite that difficulty the dashed vertical bar glyph is shown to consist of five vertical line segments, in contrast to the `U+00A6 BROKEN BAR`'s two (¦). In Figure 4, I drew my interpretation of the "dashed vertical bar" (⋮), "double dashed vertical bars" (⋮⋮) glyphs alongside the typical ASCII vertical line glyph; all three characters should have the same glyph height.

> **Note:** For clarity, this document uses my vector drawings when representing the missing glyphs in parentheses (e.g. ⋮ and ⋮⋮). I had to go out of my way to create custom macros in TEXMACS to make them visible; they are rendered as PNG images when this document is exported to HTML format.

The galvanic cell is represented by a diagram. Thus, the chemical cell, consisting of an aqueous solution of hydrogen chloride (concentration c), a platinum-hydrogen electrode (partial pressure of hydrogen: p), and a silver–silver chloride electrode, both with copper terminals is represented by the diagram

$$\mathrm{Cu(s)\,|\,Pt(s)\,|\,H_2(g)\,|\,HCl(aq)\,|\,AgCl(s)\,|\,Ag(s)\,|\,Cu(s)}$$
$$\qquad\qquad\quad p \qquad\quad c$$

A single vertical bar (|) should be used to represent a phase boundary, a dashed vertical bar (⋮) to represent a junction between miscible liquids, and double, dashed vertical bars (⋮⋮) to represent a liquid junction, in which the liquid junction potential has been assumed to be eliminated.

Figure 3. Excerpt of *Manual of Symbols and Terminology for Physicochemical Quantities and Units* (1975), Appendix III by IUPAC showing the glyphs for "dashed vertical bar" and "double, dashed vertical bars". See Ref. 5.2.

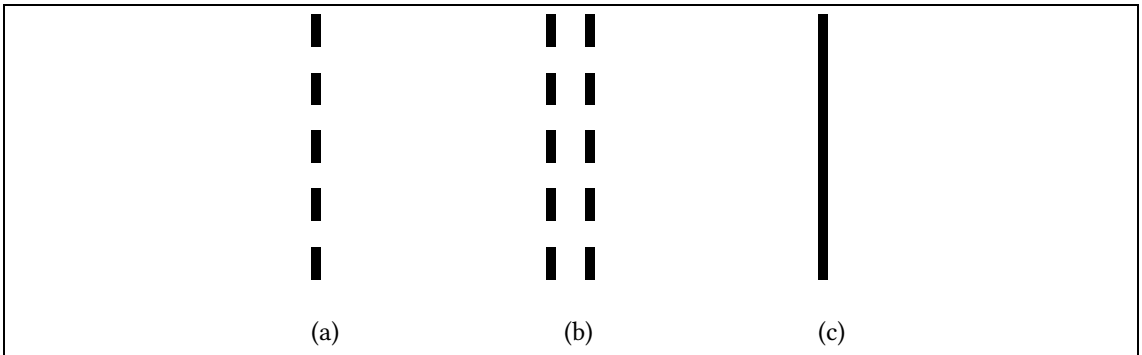

Figure 4. Shapes of (a) “dashed vertical bar” (SVG, EPS), (b) “double, dashed vertical bars”, and (c) `U+007C VERTICAL LINE`. All three glyphs should have the same height.

Additionally, while searching IUPAC literature mentioning electrochemistry notation I found that drafts of some chapters of the new edition of the Orange Book are available. A draft of the chapter covering galvanic cell diagrams was published in *Pure and Applied Chemistry* (see reference 5.3). This draft continues the current Orange Book's use of the typical `BROKEN BAR` glyph (¦) to represent the missing dashed vertical bar character (see Figure 5).

3.18 line representation of electrochemical cells

Notation giving *electrodes*, *electroactive substances*, and other relevant information for an *electrochemical cell*.

The notation starts and finishes with an electrode. Phase boundaries are denoted with a solid vertical bar |, boundaries between miscible liquids by a vertical dashed bar ¦, and a liquid junction by double vertical dashed bars ¦¦.

Note 1: The potential difference of an electrochemical cell is measured between a metallic conductor attached to the right-hand electrode of the notation and an identical metallic conductor attached to the left-hand electrode.

Examples: Pt(s) | H_2(g) | HCl(aq) | AgCl(s) | Ag(s)
Cu(s) | $CuSO_4$(aq) ¦ $ZnSO_4$(aq) | Zn(s)
Cu(s) | $CuSO_4$(aq) ¦¦ KCl(aq, sat) ¦¦ $ZnSO_4$(aq) | Zn(s)

Figure 5. Excerpt from the current draft of the 4th edition of the IUPAC Orange Book. See Ref. 5.3.

Lately as I've been transcribing DeVoe's *Thermodynamics and Chemistry*, my *modus operandi* after encountering an unusual glyph is to first check TEXMACS's extensive coverage of math symbols. Failing that, I search websites such as `unicode-table.com` for similar Unicode glyphs. I'll now summarize my hunt to search for appropriate characters to represent “dashed vertical bar” and “double dashed vertical bars”.

2.1 TEXMACS symbols

The closest symbol I could find in TEXMACS that approximates a “dashed vertical bar” is the vertical elipsis (⋮). Using this symbol as a substitute has the advantage of being available for quick entry via a keyboard shortcut (`. . Tab Tab Tab`) instead of inserting directly via Unicode point (`control+q # 2 2 e e`). However, typical glyphs used to represent the vertical elipsis symbol usually consist of three dots instead of line segments. I cannot find a symbol in TEXMACS consisting of vertical line segments. I could write a custom macro that constructs the symbol from other symbols or create a small drawing (which is what DeVoe did in the LATEX source code for *Thermodynamics and Chemistry*). However, custom macros reduce compatibility when a document must be exported to other formats; for example, I am editing this article in TEXMACS for possible export to PDF but the reader is likely reading this article in HTML format. Ideally, the “dashed vertical bar” glyph would be associated with its own Unicode character with a code point that both TEXMACS and web browsers parsing this article's HTML version could understand.

2.2 Unicode glyphs

Each Unicode character is visually represented by a glyph. To quote a reference page on `glyphsapp.com`:

> Characters are what you type, glyphs are what you see.

To be more verbose, each Unicode character has a unique **code point** (e.g. `U+007C`) which is associated with a **character name** (e.g. `VERTICAL LINE`) and a **glyph** (e.g. |). A glyph can be shared by several Unicode characters but the typesetting rules a program may apply to each character may differ.

I scanned `unicode-table.com` for characters with glyphs that match both DeVoe's custom glyph and anything that might match the description "dashed vertical bar".

I also performed a search of `unicode-search.net` for glyphs containing the string "`VERTICAL`" in their descriptions. This yielded more results.

I also checked the Unicode "Mathematical Symbols" code charts for possibly useful glyphs. Note, there are no code sets dedicated to modern chemistry although there is a set for alchemical symbols.

Table 1 lists various Unicode characters relevant to my search that I found.

Unicode Code point	**Glyph**	**Unicode Character name**	**Category**	**Potential use in electrochemistry notation**
`U+007C`	|	VERTICAL LINE	C0 Controls and Basic Latin	phase boundary
`U+00A6`	¦	BROKEN BAR	C1 Controls and Latin-1 Supplement	miscible liquid boundary
`U+2016`	‖	DOUBLE VERTICAL LINE	General Punctuation	liquid junction
`U+205E`	⁞	VERTICAL FOUR DOTS	General Punctuation	miscible liquid boundary
`U+22EE`	⋮	VERTICAL ELLIPSIS	Mathematical Operators	miscible liquid boundary
`U+2502`	│	BOX DRAWINGS LIGHT VERTICAL	Box Drawing	phase boundary
`U+2503`	┃	BOX DRAWINGS HEAVY VERTICAL	Box Drawing	phase boundary
`U+2506`	┆	BOX DRAWINGS LIGHT TRIPLE DASH VERTICAL	Box Drawing	miscible liquid boundary
`U+2507`	<#2507>	BOX DRAWINGS HEAVY TRIPLE DASH VERTICAL	Box Drawing	miscible liquid boundary
`U+250A`	┊	BOX DRAWINGS LIGHT QUADUPLE DASH VERTICAL	Box Drawing	miscible liquid boundary
`U+250B`	<#250b>	BOX DRAWINGS HEAVY QUADRUPLE DASH VERTICAL	Box Drawing	miscible liquid boundary
`U+1D100`	𝄀	MUSICAL SYMBOL SINGLE BARLINE	Musical Symbols	phase boundary
`U+1D101`	𝄁	MUSICAL SYMBOL DOUBLE BARLINE	Musical Symbols	liquid junction
`U+1D104`	𝄄	MUSICAL SYMBOL DASHED BARLINE	Musical Symbols	miscible liquid boundary

Table 1. Unicode characters with possible uses in electrochemistry diagrams. The "Potential use in electrochemistry notation" column definitions are taken from the current draft of the 4th edition of the IUPAC Orange Book (see Figure 5). These glyph definitions are:

- "phase boundary" – a solid vertical bar
- "miscible liquid boundary" – a vertical dashed bar
- "liquid junction" – double vertical dashed bars

2.2.1 Basic Latin and General Punctuation characters

Some characters and glyphs from the "C0 Controls and Basic Latin", "C1 Controls and Latin-1 Supplement", and "General Punctuation" categories may be useful as-is. For example, as mentioned earlier, `U+00A6 BROKEN BAR` (¦) and `U+007C VERTICAL LINE` (|) have glyphs which are already used by IUPAC (see Figure 2); `VERTICAL LINE` (|) represents a phase boundary and `BROKEN BAR` (¦) represents a miscible liquid boundary. However, the `BROKEN BAR` glyph does not closely match the "dashed vertical bar" glyph (⁞) recommended by IUPAC in the 1975 document predating the Unicode standard (see Figure 3).

2.2.2 Box Drawing characters

The "Box Drawing" category covers characters used in command-line interfaces that use glyphs to draw lines for window-like graphical environments. Several of the glyphs, such as U+250A, BOX DRAWINGS LIGHT QUADRUPLE DASH VERTICAL (┊), are visually similar to the 1975 IUPAC recommended glyphs (see Figure 3). However, the characters themselves (the code point and idea the glyph represents) are meant to be used in a monospace environment (see Figure 6) with no kerning. Kerning is how glyphs are spaced between one another and is important for readability of math equations. For example, using several U+2502 BOX DRAWINGS LIGHT VERTICAL (│) characters in a row in this paragraph without space characters in-between results in: ||||||||. In contrast, using several U+007C VERTICAL LINE (|) characters in a row results in: ||||||||. The two characters may use visually similar glyphs but their kerning rules may differ.

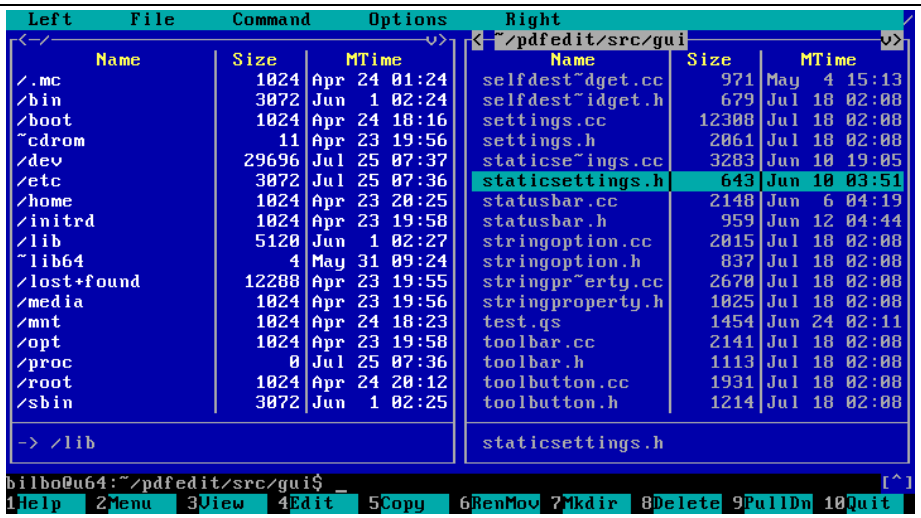

Image © bilboq / GPLv2+ (2,3)

Figure 6. Example use of box drawing characters in command-line interface of the Midnight Commander program.

2.2.3 Music characters

Music characters in Table 1 have glyphs that may be useful. In $\TeX_{\text{MACS}}$, the vertical bars render with almost no horizontal spacing. However, like the box drawing characters, the character code points themselves should not be used in math or chemistry equations.

3 Discussion

IUPAC's recommendation to use "dashed vertical bar" (┊) and "double dashed vertical bars" (┋) glyphs (as early as 1975, see Ref. 5.2) predates the Unicode standard (first published in October 1991, see Ref. 5.4). So the Unicode Consortium could have added characters with such glyphs had IUPAC requested it. I can find little correspondance on the unicode.org website mentioning IUPAC beyond clarification about how to spell sulfur/sulphur, a superscript comma issue that could be solved with MathML, and how to name some elements in chinese. The absence of an appropriate character and glyph in a mathematics-related code set may be the result of inaction on the part of IUPAC members. This is not surprising since most characters used in chemistry publications are present in Unicode. For example, the unusual glyph ⇌ is regularly used in chemistry textbooks to indicate a reversible reaction like so:

$$\mathrm{H_2\,(g) + O_2\,(g) \rightleftharpoons H_2O_2\,(l)} \qquad \Delta G^\circ = -120.31\,\mathrm{kJ/mol}$$

The ⇌ glyph is used by the Unicode character U+21CC RIGHTWARDS HARPOON OVER LEFTWARDS HARPOON.

Other non-ASCII glyphs in this example chemical equation may include:

- U+0394 GREEK CAPITAL LETTER DELTA (Δ): Indicates a change in variable G°.

- U+2218 RING OPERATOR (∘): Indicates that Gibbs free energy, G, is measured at some standard condition.

Since the upcoming version of IUPAC's Orange Book continues to reference the missing glyphs (see Ref. 5.3), I believe Unicode should add the characters in Table 2.

Unicode Code point	Glyph	Unicode Character name	Category	Potential use in electrochemistry notation
U+?????	⋮	VERTICAL DASHED BAR	???	miscible liquid boundary
U+?????	⋮	DOUBLE VERTICAL DASHED BAR	???	liquid junction

Table 2. Characters to be added to Unicode to satisfy IUPAC Orange Book recommendations for drawing galvanic cell diagrams. For lack of appropriate glyphs, the musical glyph U+1D104 MUSICAL SYMBOL DASHED BARLINE (𝄆) was modified (see EPS file) to construct both. When created, the new glyphs should match the height of U+007C VERTICAL LINE glyph (|); see Fig 4.

4 Conclusion

⋮ and ⋮ are two glyphs recommended by IUPAC for line representations of electrochemical cells since at least 1975 yet have no corresponding Unicode character. The missing glyphs are depicted in Table 2. I recommend two new Unicode characters be added incorporating these missing glyphs.

If you, the reader, are aware of some upcoming change to Unicode or some solution that already exists that supplies the missing glyphs I would ask you to notify me (Twitter, Email, *etc.*).

5 References

5.1 IUPAC Compendium on Analytical Nomenclature (Orange Book)

IUPAC Compendium on Analytical Nomenclature, Definitive Rules 1997, 3rd Edition, IUPAC Orange Book, prepared for publication by J. Inczedy, T. Lengyel, and A.M. Ure, Blackwell Science, 1998 [ISBN 0-632-05127-2]

5.2 Manual of Symbols and Terminology for Physiochemical Quantities an Units

Paul, Martin A. *Manual of Symbols and Terminology for Physicochemical Quantities and Units*. London: Butterworths, 1975. Appendix III. Print. OCLC: 2299040. Archive link.

5.3 Terminology of electrochemical methods of analysis (IUPAC Recommendations 2019)

Pingarrón, José M., Labuda, Ján, Barek, Jiří, Brett, Christopher M. A., Camões, Maria Filomena, Fojta, Miroslav and Hibbert, D. Brynn. "Terminology of electrochemical methods of analysis (IUPAC Recommendations 2019)" *Pure and Applied Chemistry*, vol. 92, no. 4, 2020, pp. 641-694. https://doi.org/10.1515/pac-2018-0109

5.4 History of Unicode Release and Publication Dates

History of Unicode Release and Publication Dates. Accessed 2020-06-17. unicode.org.