mtp2otf 1.7

Build guide and technical reference

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1 Overview

mtp2otf converts the Type 1 fonts and TEX metrics of MathTime™ Professional 2 (MTPro2) to OpenType MATH. It keeps the source designs, including the optical script sizes, and supplies the layout data used by Unicode math engines. It contains no MTPro2 font: each licensee runs it on their own copy of the fonts.

Edition	Input	OpenType (CFF)	TrueType
Full	MTPro2 (complete)	`MTPro2Math.otf`	`MTPro2Math.ttf`
Lite	MTPro2 Lite	`MTPro2MathLite.otf`	`MTPro2MathLite.ttf`

The OpenType fonts are for LuaLATEX, the TrueType fonts for Microsoft Word on Windows. Full and Lite have different family names and can be installed together. No mtp2otf package is needed to use the fonts: Unicode characters and OpenType features give access to the designs. The custom commands of `mtpro2.sty` are not provided. See `mtp2otf-guide.pdf` for using the fonts.

MTPro2 has no upright Roman alphabet. Upright Latin letters and a few text symbols come from a Roman font, the *donor*, by default Nimbus Roman.

The converter was checked with `mtpro2.sty` 2009/4/27 v2.3 and its font definition files 2009/1/30 v2.2; other releases are untested.

Section 3 describes the font as rules. Values computed from the TFM and package files and the donor are not given; the build writes them to tables (section 2.6). The detailed rules are in appendix A, the converter in appendix B and the tables of the design in the remaining appendices.

2 Building the fonts

2.1 Requirements

- A POSIX shell.
- Python 3.10 or later with fontTools.
- `tx` of the Adobe Font Development Kit for OpenType (AFDKO).

The commands `python3` and `tx` must be found on `PATH`. Some installations of AFDKO do not put `tx` there; Debian and Ubuntu, for example, install it in `/usr/libexec/afdko`. Then add that directory to `PATH`:

```
PATH="/usr/libexec/afdko:$PATH" ./build.sh
```

No particular versions are required beyond these. The versions used are recorded in `build.log`.

2.2 Inputs

Create two directories beside `build.sh` and put in them:

`mtpro2/` the PFB and TFM files of MTPro2 and `mtpro2.sty`. The Full edition also needs the font definition files `umt2ms.fd`, `umt2mf.fd`, `umt2bb.fd` and `umt2hrb.fd`. Table 1 lists the fonts used; the Lite edition uses the 15 fonts of MTPro2 Lite.
`donor/` `NimbusRoman-Regular.otf` from the Artifex `urw-base35` fonts, or nothing if another donor is given with `-d`.

A donor must be a static (not variable), upright, proportional font of weight 300 to 599, with the 262 characters of appendix E, each with an outline. Upright means an italic angle of 0 and neither the italic nor the oblique flag set. OpenType (CFF) and TrueType fonts are accepted; CID-keyed CFF fonts are not. Besides Nimbus Roman, TeX Gyre Termes, the URW Times (`ztm`) and Monotype Times New Roman have been tried.

2.3 Running

```
./build.sh              build the Full edition
./build.sh -l           build the Lite edition
./build.sh -d FILE      use FILE as the donor
```

```
./build.sh -h           show the usage
./build.sh -V           show the version
```

The long forms `--lite`, `--donor FILE`, `--donor=FILE`, `--help` and `--version` are also accepted. A relative donor path is taken from the current directory.

2.4 Exit status and messages

Status	Meaning
0	the fonts were built
1	a problem with the inputs or the environment
2	a usage error

Errors are written to standard error, starting with `build.sh:`.

2.5 What is checked

The build needs every file, glyph and value it uses; it does not make a partial font. Before building, it checks, in this order, and reports everything missing at each stage together:

1. the command line (exit status 2);
2. `python3` (version 3.10 or later), fontTools, `tx` and the file `VERSION`;
3. the package files and the donor;
4. the declaration of every font role in the package files;
5. the PFB and TFM files of every role;
6. the contents: every slot the design uses (in the PFB, with its encoding and charstring, and in the TFM; for roles with optical sizes in all three sizes); the font dimensions used (`mt2syt` 5, 6, 8–15, 17, 22; `mt2sys` 5, 18, 19; `mt2syf` 5; `mt2exa` 8–12); the package values of section A.2.1; and the donor's characters and properties.

A donor that cannot be read as a font, lacks one of the tables `head`, `hmtx`, `cmap`, `OS/2` and `post`, has units per em outside 16–16384, is a variable font or is CID-keyed is rejected when it is read.

The finished fonts are not checked: if the inputs and the environment meet these requirements, the fonts are as this document describes.

2.6 Output

The fonts are written to `out/`, each under a temporary name that then replaces the old file, so a failed build leaves the earlier fonts intact. The creation dates in the fonts are the time of the build, or `SOURCE_DATE_EPOCH` if set; the same inputs, tools and date give the same fonts. Do not run two builds of the same edition at once.

The build also writes `build/full/` or `build/lite/`, after the fonts and as a whole, so that its files always belong to the fonts in `out/`:

File	Contents
`build.log`	version, date, tool versions, SHA-256 of inputs and outputs, and a summary of the font
`constants.tsv`	the MATH constants
`glyphs.tsv`	every glyph: code points, source, group, transformation, metrics, GDEF class, hinting dictionary
`variants.tsv`	the ready-made sizes of each growing symbol
`parts.tsv`	the parts of each assembly
`features.tsv`	every substitution
`kerns.tsv`	the kerning pairs
`dictionaries.tsv`	the hinting dictionaries

The tables give the values the rules of this document produce from the user's MTPro2 files. Their columns are described in appendix B.2. A build of Full takes about 15 seconds and 210 MB of memory, Lite about 4 seconds and 100 MB.

3 The font

Units are thousandths of an em. A glyph of a source is written `file:slot`, as `mt2exa:64`, or with the role of table 1, as `exa:64`.

3.1 Sources

Each role is one MTPro2 design; most roles have three optical sizes, text (T), script (S) and scriptscript (SS), each its own PFB and TFM. Full uses all 57 fonts of table 1, Lite the 15 of MTPro2 Lite, which are identical to those of the complete package.

Table 1: Roles

Role	Design	T, S, SS	Declaration	Lite
mi	math italic	mt2mit, mis, mif	`LMP1/mtt/m/it`	yes
sy	symbols	mt2syt, sys, syf	`LMP2/mtt/m/n`	yes
mb	bold upright	mt2mbt, mbs, mbf	`U/mtt/b/n`	yes
sya	AMS symbols	mt2syat, syas, syaf	`U/mt2sya/m/n`	
bmi	bold math italic	mt2bmit, bmis, bmif	`LMP1/mtt/b/it`	
bsy	bold symbols	mt2bsyt, bsys, bsyf	`LMP2/mtt/b/n`	
bb	blackboard	mt2bbt, bbs, bbf	`U/mt2bb/m/n`	
bbi	blackboard italic	mt2bbit, bbis, bbif	`U/mt2bb/m/it`	
bbd	bold blackboard	mt2bbdt, bbds, bbdf	`U/mt2bb/b/n`	
hrb	holey roman	mt2hrbt, hrbs, hrbf	`U/mt2hrb/m/n`	
hrbd	bold holey roman	mt2hrbdt, hrbds, hrbdf	`U/mt2hrb/b/n`	
hbi	holey italic	mt2hbit, hbis, hbif	`U/mt2hrb/m/it`	
ms	script	mt2mst, mss, msf	`U/mt2ms/m/it`	
mc	curly script	mt2mct, mcs, mcf	`U/mt2ms/m/n`	
bms	bold script	mt2bmst, bmss, bmsf	`U/mt2ms/b/it`	
mf	Fraktur	mt2mft, mfs, mff	`U/mt2mf/m/n`	
bmf	bold Fraktur	mt2bmft, bmfs, bmff	`U/mt2mf/b/n`	
exa	extension	mt2exa	`\MTEXA@`	yes
exe	larger extension	mt2exe	`\MTEXE@`	yes
exf	larger extension	mt2exf	`\MTEXF@`	yes
exg	larger extension	mt2exg	`\MTEXG@`	yes
xl	large operators	mt2xl	`\MTXL@`	yes
xxxl	larger operators	mt2xxxl	`\MTXXXL@`	yes

Of `mt2bsy*` only two slots are used; `mt2bexa`, `mt2hexa`, `mt2bsya*`, `mt2hsy*` and `mt2hsya*` are not used.

Besides the fonts, the build reads from `mtpro2.sty` and the `.fd` files the script ratios, the skew characters, the math accents, the font of each optical size, the scale of the extension fonts and the dimensions of `\vdots` and `\ddots`. The donor gives the 262 characters of appendix E and the dotless j. The bold upright letters and digits are MTPro2's own (`mt2mbt`); there is no bold donor.

3.2 Glyphs

A glyph that is not meant to change keeps the drawing of its source. Each glyph belongs to one group:

Group	Glyphs
`keep`	from a source slot, unchanged
`scale`	from a source slot, scaled about the origin (extension fonts, script delimiters)
`hshift`	from a source slot, shifted horizontally (combining accents, trimmed horizontal parts)
`vshift`	from a source slot, shifted vertically (sizes centred on the axis, parts, script accents)
`donor`	from the donor
`constructed`	new outlines (dots, primes, bars, braces, vector parts) and `.notdef`
`empty`	spaces

A glyph from a source slot belongs to the first of `vshift`, `hshift`, `scale` and `keep` that applies. Shifts are not rounded; the OpenType font keeps half units, to 0.01 unit.

The font covers what standard OpenType math uses. Some MTPro2 glyphs with a standard equivalent are left out, such as the fixed wide accents `\what`, the raised dots `\dotup` and `\smallint`; so are the bold symbols and the heavy fonts (appendix A.2.3).

3.3 Metrics

TFM values are read as exact fractions and rounded once, ties to even. With W the width and I the italic correction:

Glyph	Advance	Italic correction	Bottom-right kern
$I = 0$	W	none	none
$I > 0$, role with optical sizes	$W + I$	none	$-I$
$I > 0$, extension and operator fonts	$W + I$	I	none
constructed, donor	own	none	none

In a formula TEX adds the italic correction to the width, except with respect to the position of a subscript [2, §543]: it puts the correction after a character without a subscript [2, §755] and sets a superscript that much to the right of the subscript [2, §756]. In OpenType this offset can be given by math kerns at the corners instead of the italic correction [7, p. 20]. For the fonts with optical sizes, I therefore goes into the advance and the bottom-right kern $-I$ brings the subscript back, the conversion Hagen and Sundqvist describe for ConTeXt [9, §4.2]. No glyph has both an italic correction and a math kern; they note that both on one glyph would cause trouble [9, §4]. In the extension and operator fonts, which hold the big operators, I is also kept as italic correction: OpenType places the limits of a big operator by it [1], and since almost all engines apply no math kern to big operators, their scripts depend on the advance and the italic correction, the subscript moving inwards by I [8], as in TEX [2, §§749–750]. The top accent attachment of a source glyph is where TEX centres an accent [2, §738],

$$\operatorname{round}\bigl(1000\,(w + i + 2k)/2^{21}\bigr),$$

with w, i the TFM width and italic correction and k the kern with the skew character. Combining accents have advance 0 and are placed by the centre of their TEX box. TEX raises an accent by the amount its base exceeds the x-height of the accent's font [2, §738], which differs between the three sizes; OpenType has one AccentBaseHeight for all sizes [1]. Script and scriptscript accents are therefore lowered by the difference between their x-height and AccentBaseHeight. TFM kerns become GPOS kerns. Appendix A.4 has the details.

3.4 MATH constants

$s(i)$ is font dimension i of `mt2syt.tfm`, $e(i)$ of `mt2exa.tfm`, both in units; $\theta = e(8)$, $x = s(5)$. The basis says where each rule comes from:

TFM a value from the TFM files of MTPro2: a font dimension, in the role TEX gives it [2, §§700–701] and Vieth's correspondence assigns [7, Tables 1–7], or the size of characters;
OpenType the value the OpenType MATH specification suggests [1], with MTPro2's θ and x;
package a value of `mtpro2.sty`;
TEX the `\scriptspace` of plain TEX, 0.5 pt [3], at 10 pt, which Vieth matches with SpaceAfterScript [7, Table 5];
Latin Modern where OpenType has fewer values than TEX, the choice of Latin Modern Math [4];
conversion a choice of this conversion.

Constant	Rule	Basis
ScriptPercentScaleDown	script ratio $\times 100$	package
ScriptScriptPercentScaleDown	scriptscript ratio $\times 100$	package
DelimitedSubFormulaMinHeight	as DisplayOperatorMinHeight	conversion
DisplayOperatorMinHeight	midway between text and display operators	TFM, conversion
MathLeading	150	conversion
AxisHeight	$s(22)$	TFM
AccentBaseHeight	x	TFM
FlattenedAccentBaseHeight	height of math italic A	TFM
SubscriptShiftDown	$s(17)$ (sub2)	TFM, Latin Modern
SubscriptTopMax	round$(4x/5)$	OpenType
SubscriptBaselineDropMin	dimension 19 of `mt2sys` $\times$ script ratio	TFM, package
SuperscriptShiftUp	$s(14)$ (sup2)	TFM, Latin Modern
SuperscriptShiftUpCramped	$s(15)$ (sup3)	TFM
SuperscriptBottomMin	round$(x/4)$	OpenType
SuperscriptBaselineDropMax	dimension 18 of `mt2sys` $\times$ script ratio	TFM, package
SubSuperscriptGapMin	4θ	OpenType
SuperscriptBottomMaxWithSubscript	round$(4x/5)$	OpenType
SpaceAfterScript	1/20 em	TEX
UpperLimitGapMin	$e(9)$	TFM
UpperLimitBaselineRiseMin	$e(11)$	TFM
LowerLimitGapMin	$e(10)$	TFM
LowerLimitBaselineDropMin	$e(12)$	TFM
StackTopShiftUp	$s(10)$	TFM
StackTopDisplayStyleShiftUp	$s(8)$	TFM
StackBottomShiftDown	$s(12)$	TFM
StackBottomDisplayStyleShiftDown	$s(11)$	TFM
StackGapMin	3θ	OpenType
StackDisplayStyleGapMin	7θ	OpenType
StretchStackTopShiftUp	$e(11)$	TFM
StretchStackBottomShiftDown	$e(12)$	TFM
StretchStackGapAboveMin	$e(9)$	TFM
StretchStackGapBelowMin	$e(10)$	TFM
FractionNumeratorShiftUp	$s(9)$	TFM
FractionNumeratorDisplayStyleShiftUp	$s(8)$	TFM
FractionDenominatorShiftDown	$s(12)$	TFM
FractionDenominatorDisplayStyleShiftDown	$s(11)$	TFM
FractionNumeratorGapMin	θ	OpenType
FractionNumDisplayStyleGapMin	3θ	OpenType
FractionRuleThickness	θ	TFM
FractionDenominatorGapMin	θ	OpenType
FractionDenomDisplayStyleGapMin	3θ	OpenType
SkewedFractionHorizontalGap	350	conversion
SkewedFractionVerticalGap	102	conversion
Overbar/UnderbarVerticalGap	3θ	OpenType
Overbar/UnderbarRuleThickness	θ	TFM
OverbarExtraAscender, UnderbarExtraDescender	θ	OpenType
RadicalVerticalGap	$\theta + \lfloor \theta/4 \rfloor$	OpenType
RadicalDisplayStyleVerticalGap	$\theta + \lfloor x/4 \rfloor$	OpenType
RadicalRuleThickness	θ	TFM
RadicalExtraAscender	θ	OpenType
RadicalKernBeforeDegree	round$(5/18)$ em	OpenType
RadicalKernAfterDegree	$-$round$(10/18)$ em	OpenType
RadicalDegreeBottomRaisePercent	60	OpenType

Constant	Rule	Basis
MinConnectorOverlap	20	conversion

TEX has three superscript shifts (sup1 $s(13)$ for uncramped display style, sup2 $s(14)$ for the other uncramped styles, sup3 $s(15)$ for cramped styles) and two subscript shifts (sub1 $s(16)$ without, sub2 $s(17)$ with a superscript) [2, §700]; OpenType has two and one, SuperscriptShiftUp answering to sup1 and sup2 and SubscriptShiftDown to sub1 and sub2 [7, Table 5]. As in Latin Modern Math [4], sup2, sup3 and sub2 are used.

For limits, TEX keeps the gap between an upper limit and the operator at least $e(9)$ and the limit's baseline at least $e(11)$ above it; below, $e(10)$ and $e(12)$ [2, §751]. The limit and stretch stack constants follow these roles, as in Vieth's correspondence [7, Tables 1–2]. Latin Modern Math 1.959 assigns the two upper values, and the two corresponding stretch stack values, the other way round.

The specification suggests no value for MathLeading and DisplayOperatorMinHeight, and suggests 1.5 line heights for DelimitedSubFormulaMinHeight. MathLeading is the median of the values in Latin Modern Math (0.154 em) [4], STIX Two Math (0.150 em) [5] and Cambria Math (300/2048 em) [6]. DisplayOperatorMinHeight lies midway between the largest text operator and the smallest display operator, so that display style selects the display designs, and DelimitedSubFormulaMinHeight has the same value. MinConnectorOverlap is smaller than every connector length at which two parts join, so every join can meet it.

3.5 Growing symbols

Unicode	Input	Selection	Growth	Assembly
U+0028	\lparen	default	vertical	yes
U+0028	\lparen	cv07=1	vertical	yes
U+0029	\rparen	default	vertical	yes
U+0029	\rparen	cv07=1	vertical	yes
U+002F	\mathslash	default	vertical	no
U+005B	\lbrack	default	vertical	yes
U+005C	\backslash	default	vertical	no
U+005D	\rbrack	default	vertical	yes
U+007B	\lbrace	default	vertical	yes
U+007B	\lbrace	cv08=1	vertical	yes
U+007B	\lbrace	cv06=1	vertical	yes
U+007C	\vert	default	vertical	yes
U+007D	\rbrace	default	vertical	yes
U+007D	\rbrace	cv08=1	vertical	yes
U+007D	\rbrace	cv06=1	vertical	yes
U+0302	\widehat{...}	default	horizontal	no
U+0303	\widetilde{...}	default	horizontal	no
U+0305	\wideoverbar{...}	default	horizontal	yes
U+030C	\widecheck{...}	default	horizontal	no
U+2016	\Vert	default	vertical	yes
U+20D6	\overleftarrow{...}	default	horizontal	yes
U+20D7	\overrightarrow{...}	default	horizontal	yes
U+2190	\leftarrow	default	horizontal	yes
U+2191	\uparrow	default	vertical	yes
U+2192	\rightarrow	default	horizontal	yes
U+2193	\downarrow	default	vertical	yes
U+2194	\leftrightarrow	default	horizontal	yes
U+2195	\updownarrow	default	vertical	yes
U+21A6	\mapsto	default	horizontal	no
U+21D0	\Leftarrow	default	horizontal	yes
U+21D1	\Uparrow	default	vertical	yes
U+21D2	\Rightarrow	default	horizontal	yes
U+21D3	\Downarrow	default	vertical	yes
U+21D4	\Leftrightarrow	default	horizontal	yes

Unicode	Input	Selection	Growth	Assembly
U+21D5	\Updownarrow	default	vertical	yes
U+220F	\prod	default	vertical	no
U+220F	\prod	ss07=1	vertical	no
U+2210	\coprod	default	vertical	no
U+2210	\coprod	ss07=1	vertical	no
U+2211	\sum	default	vertical	no
U+2211	\sum	ss07=1	vertical	no
U+221A	\sqrt{...}	default	vertical	yes
U+2223	\mid	default	vertical	yes
U+2225	\parallel	default	vertical	yes
U+222B	\int	default	vertical	no
U+222C	\iint	default	vertical	no
U+222D	\iiint	default	vertical	no
U+222E	\oint	default	vertical	no
U+222F	\oiint	default	vertical	no
U+2230	\oiiint	default	vertical	no
U+2231	\intclockwise	default	vertical	no
U+2232	\varointclockwise	default	vertical	no
U+2233	\ointctrclockwise	default	vertical	no
U+22C0	\bigwedge	default	vertical	no
U+22C0	\bigwedge	cv05=1	vertical	no
U+22C1	\bigvee	default	vertical	no
U+22C2	\bigcap	default	vertical	no
U+22C3	\bigcup	default	vertical	no
U+2308	\lceil	default	vertical	yes
U+2309	\rceil	default	vertical	yes
U+230A	\lfloor	default	vertical	yes
U+230B	\rfloor	default	vertical	yes
U+23AA	\vbraceextender	default	vertical	yes
U+23B0	\lmoustache	default	vertical	yes
U+23B1	\rmoustache	default	vertical	yes
U+23DC	\overparen{...}	default	horizontal	yes
U+23DE	\overbrace{...}	default	horizontal	yes
U+23DE	\overbrace{...}	cv09=1	horizontal	yes
U+23DE	\overbrace{...}	cv09=2	horizontal	yes
U+23DF	\underbrace{...}	default	horizontal	yes
U+23DF	\underbrace{...}	cv09=1	horizontal	yes
U+23DF	\underbrace{...}	cv09=2	horizontal	yes
U+27E8	\langle	default	vertical	no
U+27E9	\rangle	default	vertical	no
U+27EE	\lgroup	default	vertical	yes
U+27EF	\rgroup	default	vertical	yes
U+2A00	\bigodot	default	vertical	no
U+2A01	\bigoplus	default	vertical	no
U+2A02	\bigotimes	default	vertical	no
U+2A03	\bigcupdot	default	vertical	no
U+2A04	\biguplus	default	vertical	no
U+2A06	\bigsqcup	default	vertical	no
U+2A0D	\intbar	default	vertical	no
U+2A0F	\fint	default	vertical	no

The sizes follow the TFM chains of next larger characters and the extensible recipes; sizes beyond them (the xl and xxxl operators, the large series of `mt2exe`, `mt2exf` and `mt2exg`) are added. The values of each size and part are in `variants.tsv` and `parts.tsv`.

Braces. The default braces are the *morphed* design, which grows most smoothly; `mtpro2.sty` defaults to the Curly design. Word cannot switch designs, so the default serves it best. `cv08` selects Curly with the large sizes, `cv06` straight

braces, which take precedence.

Delimiters in scripts. TEX tries the normal glyph of the next larger size before the large sizes. Each script and scriptscript delimiter and radical has its own series doing the same: its own glyph, then the larger sizes' glyphs scaled down, then the text series.

Angle brackets and bars. The sources give the angle brackets four large sizes and the bars only an assembly. Three angle sizes are interpolated between source sizes, and bars of all eight sizes are constructed with the top and bottom of the angle bracket of the same size. Matching both ends, not only the height, keeps the choice of size equal in script styles, where LuaTEX rounds height and depth separately.

Vectors. The extensible vectors U+20D7 and U+20D6 are assembled from a start, a shaft and the arrow head, keeping the source glyph's side bearings outside, so the shortest vector is the source arrow.

3.6 Characters and features

The character map follows the slot tables of appendix C. Forms that Unicode does not encode, such as curly script and the bold and holey blackboard letters, are in the Private Use Area (appendix D). The symbols slot 15 is both U+2219 and U+2022, slot 63 both U+22A5 and U+27C2, so that every `unicode-math` command for them finds a glyph.

The inputs below are the standard Unicode characters selected by the mathematical alphabet or symbol command. Features also follow the corresponding script-size designs. F = Full; L = Lite.

Feature	Design	Standard inputs	Edition
cv01	Swash z	U+1D467	F/L
	Bold forms	U+1D49B	F
cv02	Alternate Beta	U+03B2; U+1D6FD	F/L
	Bold forms	U+1D6C3; U+1D737	F
cv03	Alternate Delta	U+03B4; U+1D6FF	F/L
	Bold forms	U+1D6C5; U+1D739	F
cv04	Alternate Hbar	U+210F	F/L
cv05	Alternate Conjunction	U+2227; U+22C0	F/L
cv06	Straight Braces	U+007B; U+007D	F/L
cv07	Extended Parentheses	U+0028; U+0029	F/L
cv08	Extended Curly Braces	U+007B; U+007D	F/L
cv09	Horizontal Brace Forms: 1 = Plain 2 = Curly	U+23DE; U+23DF	F/L
cv10	Proper Inclusion Forms	U+228A; U+228B; U+2ACB; U+2ACC	F
cv11	Unequal Comparison Forms	U+2268; U+2269	F
cv12	Negated Comparison Forms: 1 = Slanted equality 2 = Double equality	U+2270; U+2271	F
cv13	Negated Inclusion Forms: 1 = Alternate inclusion 2 = Double equality	U+2288; U+2289	F
cv14	Not-Similar Form	U+2241	F
cv15	Proportional-To Form	U+221D	F
cv16	Smile and Frown Forms	U+2322; U+2323	F
cv17	Empty-Set Form	U+2205	F
cv18	Yen Form	U+00A5	F
cv19	Registered Form	U+00AE	F
ss01	Curly Script	Regular Script alphabet	F

Feature	Design	Standard inputs	Edition
ss02	Script Alternates	Regular and bold Script alternatives; existing Curly alternatives	F
ss03	Curly Script Alternates	Regular Script alphabet	F
ss04	Fraktur Alternates	Fraktur alternate inputs listed below	F
ss05	Heavy Blackboard	Upright Blackboard Latin and digits	F
ss06	Holey Blackboard	Upright Blackboard Latin and digits; U+213C--213F; U+2145--2149	F
ss07	Slanted Large Operators	U+220F--2211	F/L
ss08	Short Bar Relations	U+2223--2226	F
ss09	Thick Tilde Relations	U+223C; U+2248	F
ss10	Shaded Card Suits	U+2660; U+2663	F/L

ss05 and ss06 together select the heavier Holey upright Blackboard design. ss05 leaves the Greek and standard italic Blackboard characters unchanged. ss06 selects their corresponding Holey designs.

ss01 and ss02 can be combined. ss03 selects the Curly alternate series without requiring ss01; it overrides the regular Script choices of ss01 and ss02. ss04 remains independent.

For cv09, cv12 and cv13, choose one numbered value per tag. Value 0 disables that feature; it does not cancel another active feature. Negated comparisons (cv12) and inclusions (cv13) can use different choices. cv14 affects only U+2241.

Script alternate inputs: U+2110; U+2112; U+1D49E; U+1D4A2; U+1D4AC; U+1D4AE; U+1D4B4--U+1D4B5; U+1D4C7; U+1D4CF; U+1D4D2; U+1D4D6; U+1D4D8; U+1D4DB; U+1D4E0; U+1D4E2; U+1D4E8--U+1D4E9; U+1D4FB; U+1D503.

Fraktur alternate inputs: U+2111; U+211C; U+1D51C; U+1D535--U+1D536; U+1D584; U+1D59D--U+1D59E.

Substitutions are made in this order: ccmp, cv01 to cv19, ss01 to ss10, dtls, ssty. GPOS has only kerning. In GDEF, the combining accents and the wide bars are marks and all other glyphs base glyphs.

3.7 Hinting and TrueType

The OpenType fonts keep the hints of the Type 1 fonts: each source's Private dictionary and each glyph's stems, transformed with the outline. The CFF is therefore CID-keyed, with a font dictionary per source and transformation, and subroutinized. Constructed glyphs have no hints.

The TrueType fonts have the same glyphs and tables, with quadratic outlines within 0.6 unit and no hints: TrueType hints are programs with no counterpart in Type 1 hints. Their clipping values (usWinAscent 2953, usWinDescent 2954) are constants that work in Word; the OpenType values, covering every outline, are too large for Word.

3.8 Differences from MTPro2 with pdfLaTeX

The font follows the Type 1 fonts and mtpro2.sty; where OpenType math cannot express TeX's rules, these differences remain.

- *Scripts.* A subscript alone is shifted by sub2 rather than sub1, so it is lower; superscripts in display style use sup2 rather than sup1, so they are lower. Other styles agree.
- *Math axis.* The axis of the symbol fonts (font dimension 22) grows from text to scriptscript size; OpenType has the text value for all. The script outlines are kept, so in script and scriptscript style fraction bars and delimiter centres are below the minus and equals signs.
- *Accents.* In script sizes accents over bases lower than the x-height are lower than in TeX. Accents are raised by the outline of the base, not its TFM height, so they are higher over letters whose outline exceeds their box, such as the italic A.
- *Wide accents.* They grow from the ordinary accent, which is used over narrow bases; in scripts they shrink with the script size.
- *Limits.* Limits of display-size operators whose TFM box exceeds the ink (sum, product) are closer to the operator.
- *Delimiters.* \dbinom uses a smaller parenthesis; stacked fractions get a smaller assembly; bars, fixed-size delimiters and radicals differ by a few units.

- *Engines.* LuaTeX does not apply kerns in script sizes, and with the HarfBuzz renderer it does not read the math table. LuaTeX does not always use the bottom-right math kern of subscripts; using an ordinary letter as an operator changes its position; narrow subscripts may change the width of the box.
- *Word.* The Windows clipping values do not cover the largest glyphs; in Word, glyph bottoms were cut only with exact line spacing.

4 Release history

v1.0 Initial release.
v1.1 Added large glyphs, missing mathematical alphabets, and character-variant access.
v1.2 Corrected TFM kern interpretation and removed supplemental Word-oriented spacing adjustments, improving LuaLaTeX output.
v1.3 Revised MATH constants and prime conversion against the original sources, and reorganized the build tools.
v1.4 Revised Unicode mappings and standard input routes, reorganized character variants, and separated ordinary delimiter growth from optional large ready-made forms. Removed unused private-use entries.
v1.5 Added four original ready-made sizes to 27 large-operator series, including their existing character variants. Each series now contains six finite designs. Ordinary text/display selection is unchanged. Reorganized character variants and stylistic sets, separated independent symbol choices, and added feature labels and numbered-choice names.
v1.6 Included italic correction in ordinary mathematical advances and added compensating right-lower MATH kerns. Preserved source pair kerning, accent attachment and dedicated operator metrics.
v1.7 Rewrote the converter from a written design, with fontTools and AFDKO `tx` instead of FontForge and `tftopl`, and wrote the computed values to tables. Kept the Type 1 hints. Centred combining accents by their box and lowered script accents. Used sup2 for SuperscriptShiftUp. Added script-size delimiter series and outer bearings to vectors. Added Latin-1 letters to the donor characters. Replaced the Bold donor and the extended donor coverage by fixed donor characters, and simplified the build options.

References

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[2] Donald E. Knuth, *TEX: The Program*, Computers & Typesetting, Volume B, Addison-Wesley, 1986. Section numbers as in `tex.web` of TeX Live: `https://github.com/TeX-Live/texlive-source/blob/trunk/texk/web2c/tex.web` (checked 2026-11-21).

[3] Donald E. Knuth, `plain.tex`, the plain TeX format, version 3.1415926535, described in *The TEXbook*, Appendix B.

[4] Bogusław Jackowski, Piotr Strzelczyk and Piotr Pianowski, *Latin Modern Math*, version 1.959, GUST e-foundry. `https://www.gust.org.pl/projects/e-foundry/lm-math` (checked 2026-11-21).

[5] The STIX Fonts project, *STIX Two Math*, versions 2.00–2.02 and 2.12. `https://github.com/stipub/stixfonts` (checked 2026-11-21).

[6] Microsoft, *Cambria Math*, version 6.99, supplied with Microsoft Windows (checked 2026-11-21).

[7] Ulrik Vieth, *OpenType Math Illuminated*, MAPS 38 (2009), pp. 12–21 (pages cited here); also *TUGboat* 30:1 (2009), pp. 22–31. `https://www.ntg.nl/maps/38/03.pdf` (checked 2026-11-21).

[8] Noto Fonts, *Building OpenType math fonts*, sections "Italic correction" and "Math kerning". `https://github.com/notofonts/math/blob/main/documentation/building-math-fonts/index.md` (checked 2026-11-21).

[9] Hans Hagen and Mikael P. Sundqvist, *New directions in math fonts*, *TUGboat* 43:3 (2022), pp. 300–310.

A Design rules

This appendix gives the rules of section 3 in full.

A.1 Product

	Full	Lite
Family name (name IDs 1, 4, 16)	MTPro2 Math	MTPro2 Math Lite
PostScript name (6)	MTPro2Math	MTPro2MathLite
Style (2, 17)	Regular	Regular
Unique ID (3)	MTP2;MTPro2Math	MTP2;MTPro2MathLite

- Version string (name 5) `Version 1.7`; `head.fontRevision` 1.7.
- Copyright (name 0): *Copyright (C) Publish or Perish, Inc. 2005. Outlines from the MathTime(TM) Professional II Type1 fonts. Unofficial OpenType MATH conversion for the licensee's own use; redistribution of this font file is not permitted.*
- Trademark (name 7): *MathTime is a trademark of Publish or Perish, Inc.*
- The name table has IDs 0–7, 16 and 17 for Macintosh (1, 0, 0) and Windows (3, 1, 0x409), and the names of the selectors (ID 256 and later) for Windows only.
- Units per em 1000.
- `OS/2`: version 4, weight class 400, width class 5, vendor `MTP2`, `fsType` 8 (editable embedding), `fsSelection` 0x00C0 (regular, use typographic metrics), PANOSE 2 0 5 3 0 0 0 0 0 0, default and break character 32, subscript size and offset 650, 700, 0, 140, superscript 650, 700, 0, 480, strikeout 49 and 258.
- `post`: underline position −75, thickness 50.
- `head`: flags 0x0B, smallest readable size 8 pixels; the dates are the time of the build or `SOURCE_DATE_EPOCH`.
- Computed from the glyphs: the Unicode and code page ranges, the average width, the first and last character, the maximum context and the bounding boxes.

A.2 Sources

A.2.1 Package values

From `mtpro2.sty` (and for Full the `.fd` files):

- the script ratios `\defaultscriptratio` and `\defaultscriptscriptratio`;
- the skew character of each family, a declaration in an `.fd` file for a shape taking precedence;
- the math accents declared with `\DeclareMathAccent` in the symbols family;
- for each role, the font of each optical size: of the size ranges of `\DeclareFontShape`, the range without upper bound is text, the one without lower bound scriptscript, the other script;
- the scale of the extension fonts: the number of `\multiply\dimen@\tw@` before `\font\MTEXE@=mt2exe at \the\dimen@` and its like;
- the dimensions of the dots: the `\baselineskip` of `\vdots` and the `\raise` and `\mkern` of `\ddots`.

A.2.2 Donor

The donor gives the 262 characters of appendix E and the dotless j (U+0237): its own U+0237 if it has one, otherwise its j without the dot. The j must then have exactly two contours, exactly one of which (the body) crosses the baseline, and the other (the dot) must lie wholly above the body; otherwise the build stops. Donor glyphs are scaled from the donor's units per em to 1000, advance widths rounded. Quadratic outlines are converted to the same cubic curves, and composite glyphs are decomposed.

The Lite edition has no ð (U+00F0): Full takes it from the AMS symbols (`\eth`), which Lite lacks, and taking it from the donor in Lite alone would give the same character two designs.

The bold upright letters and digits (U+1D400–U+1D433, U+1D7CE–U+1D7D7) are MTPro2's own `\mbf`, slots 65–90, 97–122 and 48–57 of `mt2mbt`, `mbs` and `mbf`; there is no bold donor. The digits U+0030–U+0039 are those of `mt2mit`.

A.2.3 What is included

The font covers what standard OpenType math uses; every form, size and input path of MTPro2 is not the aim. Not included:

Glyphs	Slots	Standard entry instead
the fixed wide accents `\what`, `\wtilde`, `\wcheck`	sy:121–123	the horizontal series of U+0302, U+0303, U+030C
raised dots `\dotup` to `\ddddotup`	sy:84, 85, 173, 174	U+0307, U+0308, U+20DB, U+20DC
`\smallint`	sy:115	U+222B
the hooks of hooked arrows	mi:44, 45	the composed arrows
italic dbar	mi:181	U+0111 (mi:182)
the AMS forms of `\npreceq`, `\nsucceq`	sya:142, 143	U+22E0, U+22E1 (sy:153, 160)
the AMS forms of `\nsqsubset`, `\nsqsupset`	sya:215, 216	U+22E2, U+22E3 (sy:156, 163)
`\openbullet`	sy:14	U+2218 (sy:66)
bold symbols, heavy fonts, bold extension		none

The wide bars `\wbar` and `\wwbar` (sy:120, 83) are steps of the overline series and have private code points (U+E24E, U+E24A).

A.3 Glyphs and outlines

A.3.1 Principle

A glyph that is not meant to change keeps the drawing of its source. Outlines are compared by geometry: a straight line drawn as a cubic curve, an open contour closed and a segment of length zero are the same. Converting Type 1 to CFF changes no coordinate, advance or hint.

A.3.2 Which slots

1. The slot tables (appendix C): for every listed slot of a role, the text glyph gets the listed code points, and the same slot of the script and scriptscript fonts gives its `ssty` forms 1 and 2.
2. Slots used only as outputs of features (appendix F) are included without code points, in all three sizes.
3. From the fonts without optical sizes (`exa`, `exe`, `exf`, `exg`, `xl`, `xxxl`), the slots used as sizes or parts of extensible shapes (section 3.5).
4. A slot needed with a different position or as a different step of a series gives another glyph from the same slot. In particular, a step that two series follow differently (to a different next size or assembly) is copied for the later series, because TEX engines give each glyph one next larger size.

Every glyph is reachable from the character map, from a substitution or from an extensible shape.

A.3.3 Vertical shifts

Glyphs with code points stay where their sources have them. A glyph without code points is shifted vertically by one of these rules (heights after scaling):

1. *Centred on the math axis*: steps of vertical series taken from a font without optical sizes, without code points, other than the root, in large operator series (root in an extension font) and in delimiter series mixing several extension fonts (the large series of `cv07` and `cv08`). The shift is AxisHeight − vertical centre, rounded, and none if less than 1 in size. Delimiter series made only of `mt2exa` (brackets, floors and ceilings, angles, slashes, radicals, straight and morphed braces) keep the position of the source. This moves the work of placing on the axis from the TEX box to the outline and keeps the clipping area of the TrueType font small; TEX engines centre these glyphs on the axis anyway.
2. *Bottom at 539*: the steps of the Curly overbrace series, each step on its own, the parts by one shift for the series.
3. *Bottom at 0*: the parts of vertical assemblies.

4. *Bottom at 569*: the end parts of the normal and Plain overbraces, and the middle part using the same shift: the lowest ink of the parts made from source slots is put at 569.
5. *Raised by AccentBaseHeight*: the heads of the extensible vectors.

The script and scriptscript accents are lowered as described in section A.4.5.

A.4 Metrics

A.4.1 Numbers

TFM fix-words are read as rational numbers and rounded once, to the nearest integer, ties to even.

A.4.2 Advance width and italic correction

W is the TFM width, I the italic correction, both multiplied by the scale. For a glyph that keeps the box of its source slot:

Glyph	Advance	Italic correction	Bottom-right kern
$I = 0$	W	none	none
$I > 0$, role with optical sizes	$W + I$	none	$-I$ (one value)
$I > 0$, extension and large operator fonts	$W + I$	I	none
constructed	section A.12	0	none
donor	the donor's	0	none

The advance is rounded after the sum. An italic correction of 0 is not recorded. The TFM records of `exa:182`, 183 and 184 (the first morphed braces) are broken; those of slots 8, 9 and 176 are used. Glyphs that change their box (accents, parts, primes) follow their own rules.

A.4.3 Top accent attachment

For a glyph from a source slot, with w and i the width and italic correction in TFM units (2^{20} per em) and k its kern with the skew character (0 if none):

$$\text{TopAccent} = \text{round}\Big(1000 \cdot \frac{w + i + 2k}{2 \cdot 2^{20}}\Big).$$

The skew character is that declared for the source file (an `.fd` shape declaration before the family declaration). The value is not recomputed after the advance becomes $W + I$. Every glyph that keeps the box of its slot has it; donor glyphs and spaces have none. Other rules come first:

1. combining accents (below);
2. the primes (section A.12);
3. parts and glyphs with changed outline or advance: none, or half the advance;
4. glyphs of zero TFM width that are not combining accents (the negation slash U+0338): the horizontal centre of the ink.

A.4.4 Combining accents

As in TEX, the centre of the accent's box (its TFM width W) is placed at the attachment point. The rule applies to the slots that `mtpro2.sty` declares with `\DeclareMathAccent` in the symbols family and whose text glyph has a code point of general category Mn (13 accents, and slot 78 also for U+0305), in all three sizes. They have advance 0, and

$$\text{TopAccent} = C = -\big(\text{AxisHeight} + \text{round}(\theta/4)\big)$$

in every size, θ being the default rule thickness ($e(8)$; the rounding takes ties to even). The outline is shifted by $C - W/2$, with W the rounded TFM width of the size and $W/2$ not rounded. C is a convention of the font's coordinates; it cancels in the final position. Accents with a positive advance (`\wbar`, `\wwbar`) have TopAccent at half the advance.

A.4.5 Vertical position of script accents

OpenType math raises an accent by the amount the outline of the base exceeds AccentBaseHeight, one value for all sizes. TEX uses the x-height of the accent's font (font dimension 5), which grows from the text to the scriptscript symbol font. The script and scriptscript accents are therefore moved down by the difference: $dy = -$(x-height of the size $-$ AccentBaseHeight), x-height being font dimension 5 of `mt2sys` and `mt2syf`.

This applies to the S and SS glyphs of the slots declared with `\DeclareMathAccent` in the symbols family (including `\wbar` and `\wwbar`), 18 in each size: 15 from the source fonts, the copy for U+0305, the extensible part of the overline and the mirrored U+20D6. The shift is applied once. It does not apply to the parts of the extensible vectors (rule 5 of section A.3.3), the negation slash or the tie, nor to the text size.

A.4.6 Kerning

The TFM kerns are copied to GPOS `kern`, without adding or removing italic corrections. Pairs with the skew character on the right are left out. Every glyph made from a slot gets the kerns of that slot. Ligature and boundary programs are not supported; a TFM with them is an input error.

A.5 Growing symbols

A.5.1 Series

- 27 large operators, each with six sizes (text, display, xl, XL, XXL, XXXL) and no assembly.
- Parentheses and braces: a normal series of five sizes and an assembly; with `cv07` and `cv08` a large series of 23 sizes and an assembly, whose roots are separate glyphs in each optical size.
- Brackets, floors, ceilings and slashes: five sizes. Angle brackets, bars and double bars: eight sizes. The bars have constructed steps, and the angle brackets constructed steps of heights 1100, 1450 and 2100 (section A.12).
- Horizontal: hat (37 sizes), tilde (37), check (35), over parenthesis (24 and an assembly), braces (35 and an assembly), six relation arrows, the vectors and the overline.

The steps follow the TFM chains of next larger characters and the extensible recipes. Steps beyond them (the xl and xxxl operators, the large series of `exe`, `exf` and `exg`, constructed steps) and the morphed braces are given explicitly.

A.5.2 Braces

The default vertical braces are the *morphed* design: left `exa:182`, 184, 186, 188, right 183, 185, 187, 189, then the assembly. This differs on purpose from the default of `mtpro2.sty` (the Curly design, 8, 110, 26, 40): Word cannot switch series, so the default is the design that grows most smoothly. The Curly series (with the large sizes) is selected by `cv08`, the straight one by `cv06`, which takes precedence. The TFM chain of the morphed braces is broken (182 leads nowhere and 183 to the left assembly), so it is not followed.

A.5.3 Delimiters in script sizes

TEX tries the normal glyph of the next larger size before the large sizes of `mt2exa`. Each S and SS glyph of a vertical delimiter or radical (not of the large operators) is the root of its own series:

- S: the S glyph; the T glyph scaled by $1/r_1$; the steps of the T series larger than that; the T assembly.
- SS: the SS glyph; the S glyph scaled by r_1/r_2; the T glyph scaled by $1/r_2$; the larger T steps; the T assembly.

r_1 and r_2 are ScriptPercentScaleDown and ScriptScriptPercentScaleDown as fractions. A step is larger if its Advance-Measurement exceeds that of the step before. The scaled glyphs are new glyphs, three per root, shared by roots with the same outline; their advances are rounded, their coordinates not.

A.5.4 Extensible vectors

The vectors U+20D7 and U+20D6 keep, outside the assembled arrow, the side bearings of the source glyphs. For each size, b is the left side bearing of the minus sign (slot 0), W the TFM width of the right arrow (slot 33), r its right side bearing, R the ink width of its head and C the length of the shaft: the smaller of the ink width of the minus sign and the distance from the left of the ink of the arrow to its leftmost point outside the shaft's vertical range.

Part	Outline	Advance	Connectors	Extender
start	the shaft rectangle moved right by b	$b + C$	0, C	no
shaft	a rectangle of width C	C	C, C	yes
head	the ink of the arrow, left at 0	$R + r$	measured, 0	no

All parts are raised by AccentBaseHeight from the position of the source. The shortest assembly is $b + R + r = W$. The only ready-made size is the root. U+20D6 is the mirror image, with parts head, shaft, start; the shaft is shared.

A.5.5 Values

- *AdvanceMeasurement* of a size: the ink length in the direction of growth, rounded down, plus 1; for the vectors and the overline, the ink width rounded up.
- *FullAdvance* of a part: vertically the ink height, rounded; horizontally the advance.
- Vertical parts have their ink bottom at 0 and keep their horizontal position and advance. The part slots are those of the TFM extensible recipes.
- Horizontal parts are trimmed on the joining side: a part joining on the left has its ink moved to start at 0; a part joining on the right has its advance set to the right of its ink. The outer side keeps the source's bearing.
- *Connector lengths*: equal to FullAdvance for extenders; 0 at the outer ends of an assembly; otherwise measured from the outline. The outline's extent along the direction of growth is divided into 64 strips; in each, at its middle, the minimum and maximum across the direction are taken (curves approximated by 8 line segments). Counting from the joining end, the strips whose minimum and maximum stay within 8 units of those of the end strip are counted; the length is that number times the strip length, rounded down.
- The horizontal braces (over, under, Plain, Curly) also limit the inner connectors to the extender's thickness less 8: the extender is as high as the TFM height of `exa:130`.
- Assemblies have italic correction 0.
- *ExtendedShapeCoverage*: the steps without code points of vertical series other than roots, the parts of vertical assemblies, and the nine text integrals U+222B–U+2233.
- MinConnectorOverlap 20.

A.6 Character set

- The character map has formats 4 and 12, for platforms 0 and 3. Private code points are U+E000–U+E284 (appendix D).
- The slot tables are in appendix C; 77 groups of code points share a glyph, such as Latin and Greek capitals of the same form. The symbols slot 15 is both U+2219 and U+2022, slot 63 both U+22A5 and U+27C2, so that the commands of `unicode-math` for these symbols all find a glyph.
- Spaces have the widths of Unicode (appendix H); the figure space U+2007 is as wide as the digits and the punctuation space U+2008 as the period.

A.7 Layout

A.7.1 Selectors and features

Full has `cv01`–`cv19` and `ss01`–`ss10`, Lite `cv01`–`cv09`, `ss07` and `ss10`, with the same meanings; all are off by default. Their numbers, entry characters and alternatives are fixed. Besides them: `ssty` (two alternates), `dtls` and `ccmp` (ligatures of primes). Every feature is registered for the scripts `DFLT`, `latn` and `math`. The names of the selectors are in appendix F.

Substitutions are given for text glyphs; when both input and output have script and scriptscript forms, the same substitution is made between those forms.

A.7.2 Order

One lookup per feature, in this order: `ccmp`, `cv01` to `cv19`, `ss01` to `ss10`, `dtls`, `ssty`. Exchanging any two of the following changes results, so they keep this order: `ss01` before `ss02`, `ss03` before `dtls`, `cv18` and `cv19` before `ssty`.

A.7.3 GPOS and GDEF

GPOS has only `kern`. GDEF classes: marks (class 3) are the glyphs with a code point of general category Mn, `\wbar` and `\wwbar`, and their S and SS forms; all other glyphs are base glyphs (class 1). All lookups have flag 0.

A.8 Vertical metrics

	OpenType	TrueType
typographic ascender, descender, line gap	806, −194, 200	same
`hhea` ascent, descent, line gap	806, −194, 200	same
x-height, cap height	AccentBaseHeight, FlattenedAccentBaseHeight	same
`usWinAscent`, `usWinDescent`	the extent of all outlines	2953, 2954

The line spacing is that of Latin Modern Math [4]; it is not derived from the TFM. The Windows values of the TrueType fonts are constants known to work with Word; Word fails with values as large as those of the OpenType fonts. They do not cover the tallest glyphs (the largest operators and delimiters); that does not cut them off in Word.

A.9 Hinting

The OpenType fonts keep the hints of the Type 1 fonts: each source font's Private dictionary and each glyph's stems. The CFF is therefore CID-keyed, with one font dictionary per Private dictionary used (listed by the build in `dictionaries.tsv`), selected by an `FDSelect` of format 3. The charstrings are subroutinized; the charstrings expanded, the Private dictionaries (other than `defaultWidthX`, `nominalWidthX` and `Subrs`) and the dictionary of each glyph are the same before and after. Advances in the charstrings agree with `hmtx`.

Group	Stems	Private dictionary
`keep`	as in the source	the source's
`hshift`	vertical stems moved by the shift	the source's
`scale` (by s)	positions and widths times s	lengths times s, BlueScale divided by s
`vshift` (by dy, scaled by s)	times s, then moved by dy	as for `scale`, and the alignment zones moved by dy; one dictionary per source, s and dy
`constructed`, `empty`	none	none
`donor`	the donor's if CFF, else none	the donor's if CFF, else none

The lengths are BlueValues, OtherBlues, FamilyBlues, FamilyOtherBlues, StdHW, StdVW, StemSnapH, StemSnapV, BlueShift and BlueFuzz; changed values are rounded to 0.01. Ghost stems (width −20 at the top, −21 at the bottom) are marks, not widths: only the edge they mark is scaled and moved. Copies use the dictionary of their original. Values of the sources are copied as they are, including BlueScale values that Type 1 checkers call too large.

Constructed glyphs have no hints: there is nothing in the sources to copy for new shapes, and glyphs put together from several source glyphs were drawn by TEX as separate glyphs with their own dictionaries. The TrueType fonts have no hints: TrueType hints are programs that move points, with no correspondence to Type 1 stems and zones.

A.10 Glyph names and order

Glyph names exist only in the design and the converter; neither font contains them. A name is a base name and suffixes.

- Base: `uniXXXX` or `uXXXXX` from the primary code point (the smallest non-private code point, or the private one if there is no other). A glyph without code points takes the base of the glyph it is reached from (the one with the smallest primary code point if several); a step copy the name of its series' root with the step; a part the name of the first root using it.
- Suffixes, in order: the features reaching the glyph (fewest features, then the first tag in alphabetical order; an alternate adds its number, as `.cv09.2`); the step (`.v1`, …, `.h1`, …); the part (`.bot`, `.ext`, `.mid`, `.top`, `.left`, `.right`); the size (`.s`, `.ss`).

Order: `.notdef`; glyphs with code points by primary code point; glyphs without, by the primary code point of their base and then by suffix.

A.11 TrueType

The TrueType fonts have the same glyphs, metrics and layout tables. Outlines are converted to quadratic curves within 0.6 unit and their direction reversed; coordinates are integers. Left side bearings are the left of the ink; `maxp` has one zone; `post` is format 3.

A.12 Constructed glyphs

Dimensions come from the sources: a point is the design size of `mt2syt`, a mu 1/18 of its quad (font dimension 6), both rounded to units. The constructions are listed in appendix H.

Primes U+2032–U+2034, U+2057, U+2035: the S glyph scaled by the script ratio and raised by sup1 (`mt2syt` dimension 13), repeated at $0.7W$. The S and SS forms repeat the S and SS glyphs at W (one prime is the source glyph). TopAccent of one prime: round$(0.7(W + I)/2)$.
Dotless j U+0237: see the donor.
Rows the horizontal braces U+23DE, U+23DF, the Plain braces and their middles, the XXXL conjunction: source glyphs side by side.
Spaced dots U+2026 (`mi:58`), U+22EF (`\cdotp`, `sy:1`), U+2237 (`sy:87`): dots with a thin space (3 mu) between; the advance is the sum.
Vertical dots U+22EE: as `\vdots` of `mtpro2.sty`, three dots its `\baselineskip` apart, centred on the axis; the advance of one dot.
Diagonal dots U+22F1, U+22F0: as `\ddots` of `mtpro2.sty`, three dots raised by its three `\raise` amounts (in reverse order for U+22F0) with its inner `\mkern` between, centred on the axis; the advance of three dots and two gaps.
Moustaches U+23B0, U+23B1: the bottom and top parts of the TFM recipe, the bottom with its ink at 0 and the top overlapping it by as much as the bottom rises above the baseline (at most the top's height); the advance of the bottom part.
Brace extender a rectangle 200 wide and as high as the TFM height of `exa:130`, shared by the over, under and Curly series.
Mirrors U+20D6 and the left vector parts: about TopAccent if the advance is 0 and TopAccent is set, otherwise about the middle of the box.
Bars the steps of U+007C and U+2016: rectangles in the horizontal ranges of the contours of the source bar, from the top to the bottom of the ink of the angle bracket step of the same size.
Interpolated angles the steps 1100, 1450 and 2100 of the angle brackets: the neighbouring steps interpolated by height, centred on the axis and rounded.
Vector parts see section 3.5.
Over parenthesis parts the parts of the assembly of U+23DC, cut from `exa:194`.

B The converter

B.1 Processing

0. `build.sh` reads the command line and checks the environment, then runs `python3 tools/mtp2otf.py full|lite DONOR` with the absolute path of the donor.
1. The design data (section B.3) is read and checked.
2. Check: the package files and the donor.
3. The package files are read; the role declarations give the font files and scales.
4. Check: the PFB and TFM files.
5. The sources are read: Type 1 through `tx -cff +b`, which changes no coordinate, advance or hint.
6. The `chain` entries of the series are expanded along the TFM chains.
7. Check: the contents.
8. The font plan is made; the OpenType and TrueType fonts are written; the CFF is subroutinized.
9. The log and the tables are written to `build/full/` or `build/lite/` (section 2.6).

B.1.1 Subroutinization

The OpenType font is written without subroutines to a temporary directory, and `tx -cff +S +b` makes the CFF table that replaces it. `tx` rewrites the Private dictionaries: it chooses `defaultWidthX` and `nominalWidthX`, rounds reals to 0.01 and may reorder stem widths. The converter checks that the glyph order and each glyph's dictionary are

unchanged and restores every dictionary value except `defaultWidthX`, `nominalWidthX` and `Subrs`. It writes `FDSelect` in format 3: `tx` writes format 4, defined only for CFF2, when there are more than 256 ranges, as this font has.

B.2 Build tables

Section 3 gives the rules of the font; the values the rules give depend on the TFM files, the package files and the donor. The build writes them to tab-separated tables, as the plan of the font has them:

File	Columns	Rows
`constants.tsv`	`constant, value`	the MATH constants, in the order of the MATH table, and MinConnectorOverlap
`glyphs.tsv`	`glyph, codepoints, source, group, scale, dx, dy, advance, italic, math_kern, top_accent, class, extended, dictionary`	every glyph, in glyph order
`variants.tsv`	`root, axis, step, glyph, measurement`	the ready-made sizes of each extensible glyph, in the order of the MATH table
`parts.tsv`	`root, axis, index, glyph, extender, start, end, full`	the parts of each assembly, from bottom or left
`features.tsv`	`feature, input, output`	every substitution, including those between script and scriptscript forms, in the order of application and then of input glyphs
`kerns.tsv`	`left, right, value`	the kerning pairs, in glyph order
`dictionaries.tsv`	`dictionary, source, scale, dy, key, value`	the Private dictionaries of the CFF, by number and key

The files are UTF-8 with LF line ends. The first line names the columns; an empty field means no value. Glyphs are named as in section A.10. A slot is written `file:slot`, such as `mt2syt:69`, with the file name, so the script and scriptscript fonts are told apart. Integers are written as such; other values in the shortest decimal that reads back as the same value (such as `-480.5`); scale factors as ratios (`10/7`).

`glyphs.tsv` `codepoints`: hexadecimal, ascending, separated by spaces. `source`: where the outline comes from: a slot, `donor:U+0041` or `constructed:` and the name of the construction (appendix H); empty for spaces and `.notdef`. `group`: `keep`, `scale`, `hshift`, `vshift`, `donor`, `constructed` or `empty` (section 3.2). `scale`, `dx`, `dy`: the scaling about the origin and the following shift applied to the source outline; for the donor, the scale converts its units per em. `italic`: the MATH italic correction; `math_kern`: the bottom-right math kern; `top_accent`: the top accent attachment. `class`: the GDEF class, 1 or 3. `extended`: `yes` if in ExtendedShapeCoverage. `dictionary`: the number of the font dictionary.
`variants.tsv` `step` counts the sizes from 0 in the order of the MATH table; the first size need not be the root itself. `measurement` is the AdvanceMeasurement. Roots with an assembly only appear in `parts.tsv` alone.
`parts.tsv` `index` counts from 0; `extender` is `yes` for an extender; `start` and `end` are the connector lengths and `full` the FullAdvance. Assemblies have italic correction 0.
`features.tsv` the inputs of a ligature and the outputs of an alternate substitution are separated by spaces.
`dictionaries.tsv` `source` is the source file (`donor` for the donor's dictionary), `scale` and `dy` the transformation the dictionary was made for (section A.9). Arrays are separated by spaces. Dictionary 0 is the empty dictionary of glyphs without hints and has one line. `defaultWidthX`, `nominalWidthX` and `Subrs` are left out: subroutinization chooses them.

The tables are not read back from the fonts. In the OpenType font the coordinates are rounded to 0.01 unit (section 3.2) and BlueScale to the precision of a CFF real number; every other value is the same.

B.3 Design data

What the font contains by choice rather than by rule is kept in tab-separated tables in `tools/data/`. Values in the MTPro2 files (TFM dimensions and chains, package declarations) are not in them and are read from the sources. The tables list text glyphs only; script and scriptscript follow from the rules. The first line names the columns; code points are hexadecimal.

File	Columns	Contents
`roles.tsv`	`role, declaration, lite`	the roles: the font shape declaration (encoding/family/series/shape) or the command loading an extension font, and whether Lite uses it
`slots.tsv`	`role, slot, codepoints`	glyphs with code points, one per line; several code points share the glyph
`metrics.tsv`	`role, slot, metrics`	slots whose TFM record is broken, and the slot whose record replaces it
`donor.tsv`	`codepoints`	donor characters; further code points share the glyph
`spaces.tsv`	`codepoint, advance`	spaces; an advance `U+0030` means the advance of that glyph
`constructed.tsv`	`name, codepoints, method, arguments`	constructed glyphs
`features.tsv`	`feature, input, output`	substitutions; several inputs make a ligature; repeated inputs make alternates in order; the order of the file is the order of the lookups
`stretch.tsv`	`root, axis, kind, glyph`	extensible series: `v` or `h`; `variant` (a size), `part`, `extender` or `chain` (the TFM chain from that slot); in order of size, parts from bottom or left
`feature_names.tsv`	`feature, name, description, options`	names of the selectors; alternatives separated by `;`
`series.tsv`	`root, bottom, connector_cap, measure`	per series: the height of the ink bottom of parts and sizes; whether inner connectors are limited by the extender; `ceil` for measuring sizes rounded up

A `chain` line is replaced by the sizes reached through the TFM chain from that slot; at a character with an extensible recipe, its parts (bottom, extender, middle, extender, top) follow the other lines as the assembly. A root with both `chain` and `part` lines is an error.

Glyphs are referred to as `U+0028` (the glyph with that code point; the smallest non-private one for a shared glyph), `mi:46` (the glyph without code points made from that slot, one per slot, existing when referred to) or by the name of a constructed glyph. A slot used as a part is a different glyph from the same slot used elsewhere.

Method	Arguments
`prime`	slot, count
`dotless`	none
`row`	slots
`spaced`	slot, count
`vdots`	slot
`ddots`	slot[, `up`]
`moustache`	bottom part, top part
`rule`	slot, width (height: the slot's TFM height)
`mirror`	glyph
`column`	slot, angle bracket step
`interpolate`	height
`vector`	`start`, `shaft` or `head`
`overparen`	slot, `left`, `ext` or `right`

B.4 Modules

Directory	Modules
`tools/`	`mtp2otf.py` (the build, the log and the tables), `preflight.py` (checks), `errors.py`; shared: `outline.py`, `charstring.py`
`tools/design/`	`load.py` (reading and checking the design data, expanding chains), `types.py`
`tools/sources/`	`load.py`, `types.py`, `package.py` (`.sty` and `.fd`), `tfm.py`, `type1.py`, `donor.py`
`tools/plan/`	`build.py`, `types.py`, `glyphs.py`, `placement.py`, `metrics.py`, `kerns.py`, `constants.py`, `constructed.py`, `stretch.py`, `connectors.py`, `features.py`, `names.py`, `hints.py`, `product.py`
`tools/emit/`	`font.py`, `cff.py`, `layout.py`, `math.py`, `tables.py` (the tables of the build)

Modules are imported by names relative to `tools/`, as `from sources.tfm import read_tfm`. The version is kept in `VERSION` only. The code follows PEP 8 with lines of at most 79 characters and passes pyflakes.

C Slot tables

Each entry is *slot*=*code points*; code points after a slash share the glyph. The same slot of the script and scriptscript fonts gives the `ssty` forms.

mi (Lite), 182 glyphs

0=1D6E4; 1=1D6E5; 2=1D6E9/1D6F3; 3=1D6EC; 4=1D6EF; 5=1D6F1; 6=1D6F4; 7=1D6F6; 8=1D6F7; 9=1D6F9; 10=1D6FA; 11=1D6FC; 12=1D6FD; 13=1D6FE; 14=1D6FF; 15=1D716; 16=1D701; 17=1D702; 18=1D703; 19=1D704; 20=1D705; 21=1D706; 22=1D707; 23=1D708; 24=1D709; 25=1D70B; 26=1D70C; 27=1D70E; 28=1D70F; 29=1D710; 30=1D719; 31=1D712; 32=1D713; 33=1D714; 34=1D700; 35=1D717; 36=1D71B; 37=1D71A; 38=1D70D; 39=1D711; 40=21BC; 41=21BD; 42=21C0; 43=21C1; 46=0028; 46=27EE; 47=0029; 47=27EF; 48=0030; 49=0031; 50=0032; 51=0033; 52=0034; 53=0035; 54=0036; 55=0037; 56=0038; 57=0039; 58=002E; 59=002C; 60=003C; 61=002F; 62=003E; 63=22C6; 64=2202/1D715; 65=1D434/1D6E2; 66=1D435/1D6E3; 67=1D436; 68=1D437; 69=1D438/1D6E6; 70=1D439; 71=1D43A; 72=1D43B/1D6E8; 73=1D43C/1D6EA; 74=1D43D; 75=1D43E/1D6EB; 76=1D43F; 77=1D440/1D6ED; 78=1D441/1D6EE; 79=1D442/1D6F0; 80=1D443/1D6F2; 81=1D444; 82=1D445; 83=1D446; 84=1D447/1D6F5; 85=1D448; 86=1D449; 87=1D44A; 88=1D44B/1D6F8; 89=1D44C; 90=1D44D/1D6E7; 91=266D; 92=266E; 93=266F; 94=2323; 95=2322; 96=2113; 97=1D44E; 98=1D44F; 99=1D450; 100=1D451; 101=1D452; 102=1D453; 103=1D454; 104=210E; 105=1D456; 106=1D457; 107=1D458; 108=1D459; 109=1D45A; 110=1D45B; 111=1D45C/1D70A; 112=1D45D; 113=1D45E; 114=1D45F; 115=1D460; 116=1D461; 117=1D462; 118=1D463; 119=1D464; 120=1D465; 121=1D466; 122=1D467; 123=1D6A4; 124=1D6A5; 125=2118; 126=1D718; 127=03A9; 128=0393; 129=0394; 130=0398/03F4; 131=039B; 132=039E; 133=03A0; 134=03A3; 135=03A5; 136=03A6; 137=03A8; 138=0021; 139=003F; 140=005B; 141=005D; 142=2020; 143=2021; 144=00A7; 145=00B6; 146=03B1; 147=03B2; 148=03B3; 149=03B4; 150=03F5; 151=03B6; 152=03B7; 153=03B8; 154=03B9; 155=03BA; 156=03BB; 157=03BC; 158=03BD; 159=03BE; 160=03C0; 161=03C1; 162=03C3; 163=03C4; 164=03C5; 165=03D5; 166=03C7; 167=03C8; 168=03C9; 169=03B5; 170=03D1; 171=03D6; 172=03F1; 173=03C2; 174=03C6; 175=03F0; 176=E240; 177=03D0; 178=E241; 179=E242; 180=E000; 182=0111

sy (Lite), 178 glyphs

0=2212; 1=22C5; 2=00D7; 3=2217; 4=00F7; 5=22C4; 6=00B1; 7=2213; 8=2295; 9=2296; 10=2297; 11=2298; 12=2299; 13=25CB; 15=2219/2022; 16=224D; 17=2261; 18=2286; 19=2287; 20=2264; 21=2265; 22=2AAF; 23=2AB0; 24=223C; 25=2248; 26=2282; 27=2283; 28=226A; 29=226B; 30=227A; 31=227B; 32=2190; 33=2192; 34=2191; 35=2193; 36=2194; 37=2197; 38=2198; 39=2243; 40=21D0; 41=21D2; 42=21D1; 43=21D3; 44=21D4; 45=2196; 46=2199; 47=221D; 49=221E; 50=2208; 51=220B; 52=25B3; 53=25BD; 54=0338; 56=2200; 57=2203; 58=00AC; 59=2205; 60=211C; 61=2111; 62=22A4; 63=22A5/27C2; 64=2135; 65=0361; 66=2218; 67=002B; 68=003D; 69=20D7; 70=25B7; 71=25C1; 73=003B; 74=0300; 75=0301; 76=030C; 77=0306; 78=0304; 78=0305; 79=0302; 80=0307; 81=0303; 82=0308; 83=E24A; 86=030A; 87=003A/2236; 88=2216; 89=228D; 90=2A40; 91=222A; 92=2229; 93=228E; 94=2227; 95=2228; 96=22A2; 97=22A3; 98=230A; 99=230B; 100=2308; 101=2309; 102=007B; 103=007D; 104=27E8; 105=27E9; 106=007C; 106=2223; 107=2016; 107=2225; 108=2195; 109=21D5; 110=005C; 111=2240; 112=221A; 113=2A3F; 114=2207/1D6FB; 116=2294; 117=2293; 118=2291; 119=2292; 120=E24E; 124=2663; 125=2662; 126=2661; 127=2660; 128=2667; 129=E252; 130=2664; 131=E253; 132=210F; 133=2209; 134=2220; 135=2250; 136=22A7; 137=22C8; 138=2245; 139=21A9; 140=21AA; 141=27F5; 142=27F6; 143=27F8; 144=27F9; 145=21A6; 146=27FC; 147=27F7; 148=27FA; 149=21CC; 150=226E; 151=2270; 152=2280; 153=22E0; 154=2284; 155=2288; 156=22E2; 157=226F; 158=2271; 159=2281; 160=22E1; 161=2285; 162=2289; 163=22E3; 164=2260; 165=2262; 166=2241;

167=2244; 168=2249; 169=2247; 170=226D; 171=20DB; 172=20DC; 175=E256; 176=2972; 177=03DD; 178=E258; 179=2A3C; 180=2254; 181=2255; 182=2259; 183=22B6/E25A; 184=22B7/E25B; 185=E25C; 186=E25D

mb (Lite), 62 glyphs

48=1D7CE; 49=1D7CF; 50=1D7D0; 51=1D7D1; 52=1D7D2; 53=1D7D3; 54=1D7D4; 55=1D7D5; 56=1D7D6; 57=1D7D7; 65=1D400/1D6A8; 66=1D401/1D6A9; 67=1D402; 68=1D403; 69=1D404/1D6AC; 70=1D405; 71=1D406; 72=1D407/1D6AE; 73=1D408/1D6B0; 74=1D409; 75=1D40A/1D6B1; 76=1D40B; 77=1D40C/1D6B3; 78=1D40D/1D6B4; 79=1D40E/1D6B6; 80=1D40F/1D6B8; 81=1D410; 82=1D411; 83=1D412; 84=1D413/1D6BB; 85=1D414; 86=1D415; 87=1D416; 88=1D417/1D6BE; 89=1D418; 90=1D419/1D6AD; 97=1D41A; 98=1D41B; 99=1D41C; 100=1D41D; 101=1D41E; 102=1D41F; 103=1D420; 104=1D421; 105=1D422; 106=1D423; 107=1D424; 108=1D425; 109=1D426; 110=1D427; 111=1D428/1D6D0; 112=1D429; 113=1D42A; 114=1D42B; 115=1D42C; 116=1D42D; 117=1D42E; 118=1D42F; 119=1D430; 120=1D431; 121=1D432; 122=1D433

exa (Lite), 30 glyphs

70=2A06; 72=222E; 74=2A00; 76=2A01; 78=2A02; 80=2211; 81=220F; 82=222B; 83=22C3; 84=22C2; 85=2A04; 86=22C0; 87=22C1; 96=2210; 141=23AA; 142=2A03; 146=222C; 148=222D; 150=222F; 152=2230; 154=2232; 156=2233; 158=2231; 160=E281; 162=E282; 164=E283; 166=E284; 170=2A0D; 172=2A0F; 190=23DC

sya, 210 glyphs

0=22A1; 1=229E; 2=22A0; 3=25A1; 4=25A0; 5=2B1D; 6=25CA; 7=29EB; 8=21BB; 9=21BA; 11=21CB; 12=229F; 13=22A9; 14=22AA; 15=22A8; 16=21A0; 17=219E; 18=21C7; 19=21C9; 20=21C8; 21=21CA; 22=21BE; 23=21C2; 24=21BF; 25=21C3; 26=21A3; 27=21A2; 28=21C6; 29=21C4; 30=21B0; 31=21B1; 32=21DD; 33=21AD; 34=21AB; 35=21AC; 36=2257; 37=227F; 38=2273; 39=2A86; 40=22B8; 41=2234; 42=2235; 43=2251; 44=225C; 45=227E; 46=2272; 47=2A85; 48=2A95; 49=2A96; 50=22DE; 51=22DF; 52=227C; 53=2266; 54=2A7D; 55=2276; 58=2253; 59=2252; 60=227D; 61=2267; 62=2A7E; 63=2277; 64=228F; 65=2290; 66=22B3; 67=22B2; 68=22B5; 69=22B4; 70=2605; 71=226C; 72=25BE; 73=25B6; 74=25C0; 77=25B5; 78=25B4; 79=25BF; 80=2256; 81=22DA; 82=22DB; 83=2A8B; 84=2A8C; 86=21DB; 87=21DA; 88=2713; 89=22BB; 90=22BC; 91=2A5E; 93=2221; 94=2222; 95=E261; 96=E262; 97=E263; 98=22D0; 99=22D1; 100=22D3; 101=22D2; 102=22CF; 103=22CE; 104=22CB; 105=22CC; 106=2AC5; 107=2AC6; 108=224F; 109=224E; 110=22D8; 111=22D9; 112=231C; 113=231D; 115=24C8; 116=22D4; 117=2214; 118=223D; 119=22CD; 120=231E; 121=231F; 122=2720; 123=2201; 124=22BA; 125=229A; 126=229B; 127=229D; 128=E264; 129=E265; 136=2268; 137=2269; 138=E266; 139=E267; 140=2A87; 141=2A88; 144=22E8; 145=22E9; 146=22E6; 147=22E7; 148=E26A; 149=E26B; 150=2AB5; 151=2AB6; 152=2AB9; 153=2ABA; 154=2A89; 155=2A8A; 156=E26C; 158=27CB; 159=27CD; 160=E26D; 161=E26E; 162=E26F; 163=E270; 164=2ACB; 165=2ACC; 166=E271; 167=E272; 168=228A; 169=228B; 170=E273; 171=E274; 172=2226; 173=2224; 174=E275; 175=E276; 176=22AC; 177=22AE; 178=22AD; 179=22AF; 180=22ED; 181=22EC; 182=22EA; 183=22EB; 184=219A; 185=219B; 186=21CD; 187=21CF; 188=21CE; 189=21AE; 190=22C7; 191=E001; 192=2204; 193=2132; 194=2141; 195=2127; 196=00F0; 197=2242; 198=2136; 199=2137; 200=2138; 201=22D6; 202=22D7; 203=22C9; 204=22CA; 205=E277; 206=E278; 207=E279; 208=E27A; 209=224A; 210=2AB8; 211=2AB7; 212=21B6; 213=21B7; 214=03F6; 219=21E0; 220=21E2; 221=2933/E27D; 222=25C7; 223=21C5; 224=21F5; 225=296E; 226=296F; 227=2963; 228=2965; 229=293E/E27E; 230=293F/E27F

bmi, 135 glyphs

0=1D71E; 1=1D71F; 2=1D723/1D72D; 3=1D726; 4=1D729; 5=1D72B; 6=1D72E; 7=1D730; 8=1D731; 9=1D733; 10=1D734; 11=1D736; 12=1D737; 13=1D738; 14=1D739; 15=1D750; 16=1D73B; 17=1D73C; 18=1D73D; 19=1D73E; 20=1D73F; 21=1D740; 22=1D741; 23=1D742; 24=1D743; 25=1D745; 26=1D746; 27=1D748; 28=1D749; 29=1D74A; 30=1D753; 31=1D74C; 32=1D74D; 33=1D74E; 34=1D73A; 35=1D751; 36=1D755; 37=1D754; 38=1D747; 39=1D74B; 64=1D6DB/1D74F; 65=1D468/1D71C; 66=1D469/1D71D; 67=1D46A; 68=1D46B; 69=1D46C/1D720; 70=1D46D; 71=1D46E; 72=1D46F/1D722; 73=1D470/1D724; 74=1D471; 75=1D472/1D725; 76=1D473; 77=1D474/1D727; 78=1D475/1D728; 79=1D476/1D72A; 80=1D477/1D72C; 81=1D478; 82=1D479; 83=1D47A; 84=1D47B/1D72F; 85=1D47C; 86=1D47D; 87=1D47E; 88=1D47F/1D732; 89=1D480; 90=1D481/1D721; 97=1D482; 98=1D483; 99=1D484; 100=1D485; 101=1D486; 102=1D487; 103=1D488; 104=1D489; 105=1D48A; 106=1D48B; 107=1D48C; 108=1D48D; 109=1D48E; 110=1D48F; 111=1D490/1D744; 112=1D491; 113=1D492; 114=1D493; 115=1D494; 116=1D495; 117=1D496; 118=1D497; 119=1D498; 120=1D499; 121=1D49A; 122=1D49B; 126=1D752; 127=1D6C0; 128=1D6AA; 129=1D6AB; 130=1D6AF/1D6B9; 131=1D6B2; 132=1D6B5; 133=1D6B7; 134=1D6BA; 135=1D6BC; 136=1D6BD; 137=1D6BF; 146=1D6C2; 147=1D6C3; 148=1D6C4; 149=1D6C5; 150=1D6DC; 151=1D6C7; 152=1D6C8; 153=1D6C9; 154=1D6CA; 155=1D6CB; 156=1D6CC; 157=1D6CD; 158=1D6CE; 159=1D6CF; 160=1D6D1; 161=1D6D2; 162=1D6D4; 163=1D6D5; 164=1D6D6; 165=1D6DF; 166=1D6D8; 167=1D6D9; 168=1D6DA; 169=1D6C6; 170=1D6DD; 171=1D6E1; 172=1D6E0; 173=1D6D3; 174=1D6D7; 175=1D6DE

bsy, 2 glyphs

114=1D6C1/1D735; 177=1D7CB

bb, 62 glyphs

48=1D7D8; 49=1D7D9; 50=1D7DA; 51=1D7DB; 52=1D7DC; 53=1D7DD; 54=1D7DE; 55=1D7DF; 56=1D7E0; 57=1D7E1; 65=1D538; 66=1D539; 67=2102; 68=1D53B; 69=1D53C; 70=1D53D; 71=1D53E; 72=210D; 73=1D540; 74=1D541; 75=1D542; 76=1D543; 77=1D544; 78=2115; 79=1D546; 80=2119; 81=211A; 82=211D; 83=1D54A; 84=1D54B; 85=1D54C; 86=1D54D; 87=1D54E; 88=1D54F; 89=1D550; 90=2124; 97=1D552; 98=1D553; 99=1D554; 100=1D555; 101=1D556; 102=1D557; 103=1D558; 104=1D559; 105=1D55A; 106=1D55B; 107=1D55C; 108=1D55D; 109=1D55E; 110=1D55F; 111=1D560; 112=1D561; 113=1D562; 114=1D563; 115=1D564; 116=1D565; 117=1D566; 118=1D567; 119=1D568; 120=1D569; 121=1D56A; 122=1D56B

bbi, 9 glyphs

68=2145/E14D; 100=2146/E167; 101=2147/E168; 105=2148/E16C; 106=2149/E16D; 128=213E; 133=213F; 148=213D; 160=213C

bbd, 62 glyphs

48=E100; 49=E101; 50=E102; 51=E103; 52=E104; 53=E105; 54=E106; 55=E107; 56=E108; 57=E109; 65=E10A; 66=E10B; 67=E10C; 68=E10D; 69=E10E; 70=E10F; 71=E110; 72=E111; 73=E112; 74=E113; 75=E114; 76=E115; 77=E116; 78=E117; 79=E118; 80=E119; 81=E11A; 82=E11B; 83=E11C; 84=E11D; 85=E11E; 86=E11F; 87=E120; 88=E121; 89=E122; 90=E123; 97=E124; 98=E125; 99=E126; 100=E127; 101=E128; 102=E129; 103=E12A; 104=E12B; 105=E12C; 106=E12D; 107=E12E; 108=E12F; 109=E130; 110=E131; 111=E132; 112=E133; 113=E134; 114=E135; 115=E136; 116=E137; 117=E138; 118=E139; 119=E13A; 120=E13B; 121=E13C; 122=E13D

hrb, 62 glyphs

48=E180; 49=E181; 50=E182; 51=E183; 52=E184; 53=E185; 54=E186; 55=E187; 56=E188; 57=E189; 65=E18A; 66=E18B; 67=E18C; 68=E18D; 69=E18E; 70=E18F; 71=E190; 72=E191; 73=E192; 74=E193; 75=E194; 76=E195; 77=E196; 78=E197; 79=E198; 80=E199; 81=E19A; 82=E19B; 83=E19C; 84=E19D; 85=E19E; 86=E19F; 87=E1A0; 88=E1A1; 89=E1A2; 90=E1A3; 97=E1A4; 98=E1A5; 99=E1A6; 100=E1A7; 101=E1A8; 102=E1A9; 103=E1AA; 104=E1AB; 105=E1AC; 106=E1AD; 107=E1AE; 108=E1AF; 109=E1B0; 110=E1B1; 111=E1B2; 112=E1B3; 113=E1B4; 114=E1B5; 115=E1B6; 116=E1B7; 117=E1B8; 118=E1B9; 119=E1BA; 120=E1BB; 121=E1BC; 122=E1BD

hrbd, 62 glyphs

48=E1C0; 49=E1C1; 50=E1C2; 51=E1C3; 52=E1C4; 53=E1C5; 54=E1C6; 55=E1C7; 56=E1C8; 57=E1C9; 65=E1CA; 66=E1CB; 67=E1CC; 68=E1CD; 69=E1CE; 70=E1CF; 71=E1D0; 72=E1D1; 73=E1D2; 74=E1D3; 75=E1D4; 76=E1D5; 77=E1D6; 78=E1D7; 79=E1D8; 80=E1D9; 81=E1DA; 82=E1DB; 83=E1DC; 84=E1DD; 85=E1DE; 86=E1DF; 87=E1E0; 88=E1E1; 89=E1E2; 90=E1E3; 97=E1E4; 98=E1E5; 99=E1E6; 100=E1E7; 101=E1E8; 102=E1E9; 103=E1EA; 104=E1EB; 105=E1EC; 106=E1ED; 107=E1EE; 108=E1EF; 109=E1F0; 110=E1F1; 111=E1F2; 112=E1F3; 113=E1F4; 114=E1F5; 115=E1F6; 116=E1F7; 117=E1F8; 118=E1F9; 119=E1FA; 120=E1FB; 121=E1FC; 122=E1FD

hbi, 5 glyphs

68=E20D; 100=E227; 101=E228; 105=E22C; 106=E22D

ms, 52 glyphs

65=1D49C; 66=212C; 67=1D49E; 68=1D49F; 69=2130; 70=2131; 71=1D4A2; 72=210B; 73=2110; 74=1D4A5; 75=1D4A6; 76=2112; 77=2133; 78=1D4A9; 79=1D4AA; 80=1D4AB; 81=1D4AC; 82=211B; 83=1D4AE; 84=1D4AF; 85=1D4B0; 86=1D4B1; 87=1D4B2; 88=1D4B3; 89=1D4B4; 90=1D4B5; 97=1D4B6; 98=1D4B7; 99=1D4B8; 100=1D4B9; 101=212F; 102=1D4BB; 103=210A; 104=1D4BD; 105=1D4BE; 106=1D4BF; 107=1D4C0; 108=1D4C1; 109=1D4C2; 110=1D4C3; 111=2134; 112=1D4C5; 113=1D4C6; 114=1D4C7; 115=1D4C8; 116=1D4C9; 117=1D4CA; 118=1D4CB; 119=1D4CC; 120=1D4CD; 121=1D4CE; 122=1D4CF

mc, 52 glyphs

65=E010; 66=E011; 67=E012; 68=E013; 69=E014; 70=E015; 71=E016; 72=E017; 73=E018; 74=E019; 75=E01A; 76=E01B; 77=E01C; 78=E01D; 79=E01E; 80=E01F; 81=E020; 82=E021; 83=E022; 84=E023; 85=E024; 86=E025; 87=E026; 88=E027; 89=E028; 90=E029; 97=E02A; 98=E02B; 99=E02C; 100=E02D; 101=E02E; 102=E02F; 103=E030; 104=E031; 105=E032; 106=E033; 107=E034; 108=E035; 109=E036; 110=E037; 111=E038; 112=E039; 113=E03A; 114=E03B; 115=E03C; 116=E03D; 117=E03E; 118=E03F; 119=E040; 120=E041; 121=E042; 122=E043

bms, 52 glyphs

65=1D4D0; 66=1D4D1; 67=1D4D2; 68=1D4D3; 69=1D4D4; 70=1D4D5; 71=1D4D6; 72=1D4D7; 73=1D4D8; 74=1D4D9; 75=1D4DA; 76=1D4DB; 77=1D4DC; 78=1D4DD; 79=1D4DE; 80=1D4DF; 81=1D4E0; 82=1D4E1; 83=1D4E2; 84=1D4E3; 85=1D4E4; 86=1D4E5; 87=1D4E6; 88=1D4E7; 89=1D4E8; 90=1D4E9; 97=1D4EA; 98=1D4EB; 99=1D4EC; 100=1D4ED; 101=1D4EE; 102=1D4EF; 103=1D4F0; 104=1D4F1; 105=1D4F2; 106=1D4F3; 107=1D4F4; 108=1D4F5; 109=1D4F6; 110=1D4F7; 111=1D4F8; 112=1D4F9; 113=1D4FA; 114=1D4FB; 115=1D4FC; 116=1D4FD; 117=1D4FE; 118=1D4FF; 119=1D500; 120=1D501; 121=1D502; 122=1D503

mf, 50 glyphs

65=1D504; 66=1D505; 67=212D; 68=1D507; 69=1D508; 70=1D509; 71=1D50A; 72=210C; 74=1D50D; 75=1D50E; 76=1D50F; 77=1D510; 78=1D511; 79=1D512; 80=1D513; 81=1D514; 83=1D516; 84=1D517; 85=1D518; 86=1D519; 87=1D51A; 88=1D51B; 89=1D51C; 90=2128; 97=1D51E; 98=1D51F; 99=1D520; 100=1D521; 101=1D522; 102=1D523; 103=1D524; 104=1D525; 105=1D526; 106=1D527; 107=1D528; 108=1D529; 109=1D52A; 110=1D52B; 111=1D52C; 112=1D52D; 113=1D52E; 114=1D52F; 115=1D530; 116=1D531; 117=1D532; 118=1D533; 119=1D534; 120=1D535; 121=1D536; 122=1D537

bmf, 52 glyphs

65=1D56C; 66=1D56D; 67=1D56E; 68=1D56F; 69=1D570; 70=1D571; 71=1D572; 72=1D573; 73=1D574; 74=1D575; 75=1D576; 76=1D577; 77=1D578; 78=1D579; 79=1D57A; 80=1D57B; 81=1D57C; 82=1D57D; 83=1D57E; 84=1D57F; 85=1D580; 86=1D581; 87=1D582; 88=1D583; 89=1D584; 90=1D585; 97=1D586; 98=1D587; 99=1D588; 100=1D589; 101=1D58A; 102=1D58B; 103=1D58C; 104=1D58D; 105=1D58E; 106=1D58F; 107=1D590; 108=1D591; 109=1D592; 110=1D593; 111=1D594; 112=1D595; 113=1D596; 114=1D597; 115=1D598; 116=1D599; 117=1D59A; 118=1D59B; 119=1D59C; 120=1D59D; 121=1D59E; 122=1D59F

D Private use

Code point, then the slot.

E000=mi:180; E001=sya:191; E010=mc:65; E011=mc:66; E012=mc:67; E013=mc:68; E014=mc:69; E015=mc:70; E016=mc:71; E017=mc:72; E018=mc:73; E019=mc:74; E01A=mc:75; E01B=mc:76; E01C=mc:77; E01D=mc:78; E01E=mc:79; E01F=mc:80; E020=mc:81; E021=mc:82; E022=mc:83; E023=mc:84; E024=mc:85; E025=mc:86; E026=mc:87; E027=mc:88; E028=mc:89; E029=mc:90; E02A=mc:97; E02B=mc:98; E02C=mc:99; E02D=mc:100; E02E=mc:101; E02F=mc:102; E030=mc:103; E031=mc:104; E032=mc:105; E033=mc:106; E034=mc:107; E035=mc:108; E036=mc:109; E037=mc:110; E038=mc:111; E039=mc:112; E03A=mc:113; E03B=mc:114; E03C=mc:115; E03D=mc:116; E03E=mc:117; E03F=mc:118; E040=mc:119; E041=mc:120; E042=mc:121; E043=mc:122; E100=bbd:48; E101=bbd:49; E102=bbd:50; E103=bbd:51; E104=bbd:52; E105=bbd:53; E106=bbd:54; E107=bbd:55; E108=bbd:56; E109=bbd:57; E10A=bbd:65; E10B=bbd:66; E10C=bbd:67; E10D=bbd:68; E10E=bbd:69; E10F=bbd:70; E110=bbd:71; E111=bbd:72; E112=bbd:73; E113=bbd:74; E114=bbd:75; E115=bbd:76; E116=bbd:77; E117=bbd:78; E118=bbd:79; E119=bbd:80; E11A=bbd:81; E11B=bbd:82; E11C=bbd:83; E11D=bbd:84; E11E=bbd:85; E11F=bbd:86; E120=bbd:87; E121=bbd:88; E122=bbd:89; E123=bbd:90; E124=bbd:97; E125=bbd:98; E126=bbd:99; E127=bbd:100; E128=bbd:101; E129=bbd:102; E12A=bbd:103; E12B=bbd:104; E12C=bbd:105; E12D=bbd:106; E12E=bbd:107; E12F=bbd:108; E130=bbd:109; E131=bbd:110; E132=bbd:111; E133=bbd:112; E134=bbd:113; E135=bbd:114; E136=bbd:115; E137=bbd:116; E138=bbd:117; E139=bbd:118; E13A=bbd:119; E13B=bbd:120; E13C=bbd:121; E13D=bbd:122; E14D=bbi:68; E167=bbi:100; E168=bbi:101; E16C=bbi:105; E16D=bbi:106; E180=hrb:48; E181=hrb:49; E182=hrb:50; E183=hrb:51; E184=hrb:52; E185=hrb:53; E186=hrb:54; E187=hrb:55; E188=hrb:56; E189=hrb:57; E18A=hrb:65; E18B=hrb:66; E18C=hrb:67; E18D=hrb:68; E18E=hrb:69; E18F=hrb:70; E190=hrb:71; E191=hrb:72; E192=hrb:73; E193=hrb:74; E194=hrb:75; E195=hrb:76; E196=hrb:77; E197=hrb:78; E198=hrb:79; E199=hrb:80; E19A=hrb:81; E19B=hrb:82; E19C=hrb:83; E19D=hrb:84; E19E=hrb:85; E19F=hrb:86; E1A0=hrb:87; E1A1=hrb:88; E1A2=hrb:89; E1A3=hrb:90; E1A4=hrb:97; E1A5=hrb:98; E1A6=hrb:99; E1A7=hrb:100; E1A8=hrb:101; E1A9=hrb:102; E1AA=hrb:103; E1AB=hrb:104; E1AC=hrb:105; E1AD=hrb:106; E1AE=hrb:107; E1AF=hrb:108; E1B0=hrb:109; E1B1=hrb:110; E1B2=hrb:111; E1B3=hrb:112; E1B4=hrb:113; E1B5=hrb:114; E1B6=hrb:115; E1B7=hrb:116; E1B8=hrb:117; E1B9=hrb:118; E1BA=hrb:119; E1BB=hrb:120; E1BC=hrb:121; E1BD=hrb:122; E1C0=hrbd:48; E1C1=hrbd:49; E1C2=hrbd:50; E1C3=hrbd:51; E1C4=hrbd:52; E1C5=hrbd:53;

E1C6=hrbd:54; E1C7=hrbd:55; E1C8=hrbd:56; E1C9=hrbd:57; E1CA=hrbd:65; E1CB=hrbd:66; E1CC=hrbd:67; E1CD=hrbd:68; E1CE=hrbd:69; E1CF=hrbd:70; E1D0=hrbd:71; E1D1=hrbd:72; E1D2=hrbd:73; E1D3=hrbd:74; E1D4=hrbd:75; E1D5=hrbd:76; E1D6=hrbd:77; E1D7=hrbd:78; E1D8=hrbd:79; E1D9=hrbd:80; E1DA=hrbd:81; E1DB=hrbd:82; E1DC=hrbd:83; E1DD=hrbd:84; E1DE=hrbd:85; E1DF=hrbd:86; E1E0=hrbd:87; E1E1=hrbd:88; E1E2=hrbd:89; E1E3=hrbd:90; E1E4=hrbd:97; E1E5=hrbd:98; E1E6=hrbd:99; E1E7=hrbd:100; E1E8=hrbd:101; E1E9=hrbd:102; E1EA=hrbd:103; E1EB=hrbd:104; E1EC=hrbd:105; E1ED=hrbd:106; E1EE=hrbd:107; E1EF=hrbd:108; E1F0=hrbd:109; E1F1=hrbd:110; E1F2=hrbd:111; E1F3=hrbd:112; E1F4=hrbd:113; E1F5=hrbd:114; E1F6=hrbd:115; E1F7=hrbd:116; E1F8=hrbd:117; E1F9=hrbd:118; E1FA=hrbd:119; E1FB=hrbd:120; E1FC=hrbd:121; E1FD=hrbd:122; E20D=hbi:68; E227=hbi:100; E228=hbi:101; E22C=hbi:105; E22D=hbi:106; E240=mi:176; E241=mi:178; E242=mi:179; E24A=sy:83; E24E=sy:120; E252=sy:129; E253=sy:131; E256=sy:175; E258=sy:178; E25A=sy:183; E25B=sy:184; E25C=sy:185; E25D=sy:186; E261=sya:95; E262=sya:96; E263=sya:97; E264=sya:128; E265=sya:129; E266=sya:138; E267=sya:139; E26A=sya:148; E26B=sya:149; E26C=sya:156; E26D=sya:160; E26E=sya:161; E26F=sya:162; E270=sya:163; E271=sya:166; E272=sya:167; E273=sya:170; E274=sya:171; E275=sya:174; E276=sya:175; E277=sya:205; E278=sya:206; E279=sya:207; E27A=sya:208; E27D=sya:221; E27E=sya:229; E27F=sya:230; E281=exa:160; E282=exa:162; E283=exa:164; E284=exa:166

E Donor characters

262 characters, and U+0237 (constructed):

0022–0027; 002A; 002D; 0040–005A; 005E–007A; 007E; 00A3; 00A5; 00AE; 00B0; 00B7; 00C0–00D6; 00D8–00EF; 00F1–00F6; 00F8–010F; 0112–0125; 0128–0131; 0134–0137; 0139–013E; 0143–0148; 014C–0151; 0154–0165; 0168–017E; 01FA–01FF; 0218–021B; 02C6; 02DC; 1E80–1E85; 1EF2–1EF3; 2044; 20AC

Shared with Greek: 0041=0391; 0042=0392; 0045=0395; 0048=0397; 0049=0399; 004B=039A; 004D=039C; 004E=039D; 004F=039F; 0050=03A1; 0054=03A4; 0058=03A7; 005A=0396; 006F=03BF

F Features

Names

Tag	Name	Description
cv01	Swash z	Use swash mathematical italic z.
cv02	Alternate Beta	Use alternate beta in the available styles and weights.
cv03	Alternate Delta	Use alternate delta in the available styles and weights.
cv04	Alternate Hbar	Use the original hslash form for hbar.
cv05	Alternate Conjunction	Use alternate small and large conjunction signs.
cv06	Straight Braces	Select straight braces; overrides extended Curly braces.
cv07	Extended Parentheses	Enable the additional large ready-made parentheses.
cv08	Extended Curly Braces	Enable the additional large ready-made Curly braces.
cv09	Horizontal Brace Forms	Select the design of overbraces and underbraces. Alternatives: Plain, Curly
cv10	Proper Inclusion Forms	Use alternate proper subset and superset signs.
cv11	Unequal Comparison Forms	Use alternate less-than and greater-than but not equal signs.
cv12	Negated Comparison Forms	Select negated comparisons independently of negated inclusions. Alternatives: Slanted equality, Double equality
cv13	Negated Inclusion Forms	Select the AMS alternate or double-equality negated inclusions. Alternatives: Alternate inclusion, Double equality
cv14	Not-Similar Form	Use the alternate not-similar sign.
cv15	Proportional-To Form	Use the alternate proportional-to sign.
cv16	Smile and Frown Forms	Use the smaller smile and frown signs.
cv17	Empty-Set Form	Use the alternate empty-set sign.
cv18	Yen Form	Use the original AMS yen sign.
cv19	Registered Form	Use the original AMS registered sign.
ss01	Curly Script	
ss02	Script Alternates	
ss03	Curly Script Alternates	
ss04	Fraktur Alternates	
ss05	Heavy Blackboard	
ss06	Holey Blackboard	

Tag	Name	Description
ss07	Slanted Large Operators	
ss08	Short Bar Relations	
ss09	Thick Tilde Relations	
ss10	Shaded Card Suits	

Substitutions

Text glyphs only, in lookup order; *input* → *output*, alternatives separated by |. `mi:46` is the glyph without code points made from that slot.

ccmp (3) 2032 2032 2032 2032 → 2057; 2032 2032 2032 → 2034; 2032 2032 → 2033

cv01 (2) 1D467 → E000; 1D49B → bmi:180

cv02 (4) 1D6FD → E240; 03B2 → 03D0; 1D6C3 → bmi:177; 1D737 → bmi:176

cv03 (4) 1D6FF → E241; 03B4 → E242; 1D6C5 → bmi:179; 1D739 → bmi:178

cv04 (1) 210F → E256

cv05 (7) 2227 → E258; 22C0 → E284; exa:94 → exa:167; xl:103 → xl:122; xl:7 → xl:26; xl:55 → xl:76; xxxl:7 → conjunction.alt.xxxl

cv06 (4) 007B → E25C; 007D → E25D; sy:102 → E25C; sy:103 → E25D

cv07 (2) 0028 → mi:46; 0029 → mi:47

cv08 (2) 007B → sy:102; 007D → sy:103

cv09 (2) 23DE → overbrace.plain | exe:176; 23DF → underbrace.plain | exe:144

cv10 (4) 2ACB → E271; 2ACC → E272; 228A → E26D; 228B → E26E

cv11 (2) 2268 → E264; 2269 → E265

cv12 (2) 2270 → E266 | E26A; 2271 → E267 | E26B

cv13 (2) 2288 → E273 | E26F; 2289 → E274 | E270

cv14 (1) 2241 → E26C

cv15 (1) 221D → E261

cv16 (2) 2323 → E262; 2322 → E263

cv17 (1) 2205 → E001

cv18 (1) 00A5 → sya:85

cv19 (1) 00AE → sya:114

ss01 (64) 1D49C → E010; 212C → E011; 1D49E → E012; 1D49F → E013; 2130 → E014; 2131 → E015; 1D4A2 → E016; 210B → E017; 2110 → E018; 1D4A5 → E019; 1D4A6 → E01A; 2112 → E01B; 2133 → E01C; 1D4A9 → E01D; 1D4AA → E01E; 1D4AB → E01F; 1D4AC → E020; 211B → E021; 1D4AE → E022; 1D4AF → E023; 1D4B0 → E024; 1D4B1 → E025; 1D4B2 → E026; 1D4B3 → E027; 1D4B4 → E028; 1D4B5 → E029; 1D4B6 → E02A; 1D4B7 → E02B; 1D4B8 → E02C; 1D4B9 → E02D; 212F → E02E; 1D4BB → E02F; 210A → E030; 1D4BD → E031; 1D4BE → E032; 1D4BF → E033; 1D4C0 → E034; 1D4C1 → E035; 1D4C2 → E036; 1D4C3 → E037; 2134 → E038; 1D4C5 → E039; 1D4C6 → E03A; 1D4C7 → E03B; 1D4C8 → E03C; 1D4C9 → E03D; 1D4CA → E03E; 1D4CB → E03F; 1D4CC → E040; 1D4CD → E041; 1D4CE → E042; 1D4CF → E043; ms:3 → E012; ms:7 → mc:7; ms:9 → E018; ms:12 → E01B; ms:17 → mc:17; ms:19 → E022; ms:25 → mc:25; ms:26 → E029; ms:50 → E03B; ms:58 → E043; ms:123 → mc:123; ms:124 → mc:124

ss02 (25) 1D49E → ms:3; 1D4A2 → ms:7; 2110 → ms:9; 2112 → ms:12; 1D4AC → ms:17; 1D4AE → ms:19; 1D4B4 → ms:25; 1D4B5 → ms:26; 1D4C7 → ms:50; 1D4CF → ms:58; E016 → mc:7; E01C → mc:13; E01D → mc:14; E020 → mc:17; E028 → mc:25; 1D4D2 → bms:3; 1D4D6 → bms:7; 1D4D8 → bms:9; 1D4DB → bms:12; 1D4E0 → bms:17; 1D4E2 → bms:19; 1D4E8 → bms:25; 1D4E9 → bms:26; 1D4FB → bms:50; 1D503 → bms:58

ss03 (114) 1D49C → E010; 212C → E011; 1D49E → E012; 1D49F → E013; 2130 → E014; 2131 → E015; 1D4A2 → mc:7; 210B → E017; 2110 → E018; 1D4A5 → E019; 1D4A6 → E01A; 2112 → E01B; 2133 → mc:13; 1D4A9 → mc:14; 1D4AA → E01E; 1D4AB → E01F; 1D4AC → mc:17; 211B → E021; 1D4AE → E022; 1D4AF → E023; 1D4B0 → E024; 1D4B1 → E025; 1D4B2 → E026; 1D4B3 → E027; 1D4B4 → mc:25; 1D4B5 → E029; 1D4B6 → E02A; 1D4B7 → E02B; 1D4B8 → E02C; 1D4B9 → E02D; 212F → E02E; 1D4BB → E02F; 210A → E030; 1D4BD → E031; 1D4BE → E032; 1D4BF → E033; 1D4C0 → E034; 1D4C1 → E035; 1D4C2 → E036; 1D4C3 → E037; 2134 → E038; 1D4C5 → E039; 1D4C6 → E03A; 1D4C7 → E03B; 1D4C8 → E03C; 1D4C9 → E03D; 1D4CA → E03E; 1D4CB → E03F; 1D4CC → E040; 1D4CD → E041; 1D4CE → E042; 1D4CF → E043; E010 → E010; E011 → E011; E012 → E012; E013 → E013; E014 → E014; E015 → E015; E016 → mc:7; E017 → E017; E018 → E018; E019 → E019; E01A → E01A; E01B → E01B; E01C → mc:13; E01D → mc:14; E01E → E01E; E01F → E01F; E020 → mc:17; E021 → E021; E022 → E022; E023 → E023; E024 → E024; E025 → E025; E026 → E026; E027 → E027; E028 → mc:25; E029 → E029; E02A → E02A; E02B → E02B; E02C → E02C; E02D → E02D; E02E → E02E; E02F → E02F; E030 → E030; E031 → E031; E032 → E032; E033 → E033; E034 → E034; E035 → E035; E036 → E036; E037 → E037; E038 → E038; E039 → E039; E03A → E03A; E03B → E03B; E03C → E03C; E03D → E03D; E03E → E03E; E03F → E03F; E040 → E040; E041 → E041; E042 → E042; E043 → E043; ms:3 → E012; ms:7 → mc:7; ms:9 → E018; ms:12 → E01B; ms:17 → mc:17; ms:19 → E022; ms:25 → mc:25; ms:26 → E029; ms:50 → E03B; ms:58 → E043

ss04 (8) 211C → mf:82; 2111 → mf:73; 1D51C → mf:25; 1D535 → mf:56; 1D536 → mf:57; 1D584 → bmf:25; 1D59D → bmf:56; 1D59E → bmf:57

ss05 (128) 1D7D8 → E100; 1D7D9 → E101; 1D7DA → E102; 1D7DB → E103; 1D7DC → E104; 1D7DD → E105; 1D7DE → E106; 1D7DF → E107; 1D7E0 → E108; 1D7E1 → E109; 1D538 → E10A; 1D539 → E10B; 2102 → E10C; 1D53B → E10D; 1D53C → E10E; 1D53D → E10F; 1D53E → E110; 210D → E111; 1D540 → E112; 1D541 → E113; 1D542 → E114; 1D543 → E115; 1D544 → E116; 2115 → E117; 1D546 → E118; 2119 → E119; 211A → E11A; 211D → E11B; 1D54A → E11C; 1D54B → E11D; 1D54C → E11E; 1D54D → E11F; 1D54E → E120; 1D54F → E121; 1D550 → E122; 2124 → E123; 1D552 → E124; 1D553 → E125; 1D554 → E126; 1D555 → E127; 1D556 → E128; 1D557 → E129; 1D558 → E12A; 1D559 → E12B; 1D55A → E12C; 1D55B → E12D; 1D55C → E12E; 1D55D → E12F; 1D55E → E130; 1D55F → E131; 1D560 → E132; 1D561 → E133; 1D562 → E134; 1D563 → E135; 1D564 → E136; 1D565 → E137; 1D566 → E138; 1D567 → E139; 1D568 → E13A; 1D569 → E13B; 1D56A → E13C; 1D56B → E13D; E18A → E1CA; E18B → E1CB; E18C → E1CC; E18D → E1CD; E18E → E1CE; E18F → E1CF; E190 → E1D0; E191 → E1D1; E192 → E1D2; E193 → E1D3; E194 → E1D4; E195 → E1D5; E196 → E1D6; E197 → E1D7; E198 → E1D8; E199 → E1D9; E19A → E1DA; E19B → E1DB; E19C → E1DC; E19D → E1DD; E19E → E1DE; E19F → E1DF; E1A0 → E1E0; E1A1 → E1E1; E1A2 → E1E2; E1A3 → E1E3; E1A4 → E1E4; E1A5 → E1E5; E1A6 → E1E6; E1A7 → E1E7; E1A8 → E1E8; E1A9 → E1E9; E1AA → E1EA; E1AB → E1EB; E1AC → E1EC; E1AD → E1ED; E1AE → E1EE; E1AF → E1EF; E1B0 → E1F0; E1B1 → E1F1; E1B2 → E1F2; E1B3 → E1F3; E1B4 → E1F4; E1B5 → E1F5; E1B6 → E1F6; E1B7 → E1F7; E1B8 → E1F8; E1B9 → E1F9; E1BA → E1FA; E1BB → E1FB; E1BC → E1FC; E1BD → E1FD; E180 → E1C0; E181 → E1C1; E182 → E1C2; E183 → E1C3; E184 → E1C4; E185 → E1C5; E186 → E1C6; E187 → E1C7; E188 → E1C8; E189 → E1C9; bb:123 → bbd:123; bb:124 → bbd:124; hrb:123 → hrbd:123; hrb:124 → hrbd:124

ss06 (139) 1D7D8 → E180; 1D7D9 → E181; 1D7DA → E182; 1D7DB → E183; 1D7DC → E184; 1D7DD → E185; 1D7DE → E186; 1D7DF → E187; 1D7E0 → E188; 1D7E1 → E189; 1D538 → E18A; 1D539 → E18B; 2102 → E18C; 1D53B → E18D; 1D53C → E18E; 1D53D → E18F; 1D53E → E190; 210D → E191; 1D540 → E192; 1D541 → E193; 1D542 → E194; 1D543 → E195; 1D544 → E196; 2115 → E197; 1D546 → E198; 2119 → E199; 211A → E19A; 211D → E19B; 1D54A → E19C; 1D54B → E19D; 1D54C → E19E; 1D54D → E19F; 1D54E → E1A0; 1D54F → E1A1; 1D550 → E1A2; 2124 → E1A3; 1D552 → E1A4; 1D553 → E1A5; 1D554 → E1A6; 1D555 → E1A7; 1D556 → E1A8; 1D557 → E1A9; 1D558 → E1AA; 1D559 → E1AB; 1D55A → E1AC; 1D55B → E1AD; 1D55C → E1AE; 1D55D → E1AF; 1D55E → E1B0; 1D55F → E1B1; 1D560 → E1B2; 1D561 → E1B3; 1D562 → E1B4; 1D563 → E1B5; 1D564 → E1B6; 1D565 → E1B7; 1D566 → E1B8; 1D567 → E1B9; 1D568 → E1BA; 1D569 → E1BB; 1D56A → E1BC; 1D56B → E1BD; E10A → E1CA; E10B → E1CB; E10C → E1CC; E10D → E1CD; E10E → E1CE; E10F → E1CF; E110 → E1D0; E111 → E1D1; E112 → E1D2; E113 → E1D3; E114 → E1D4; E115

→ E1D5; E116 → E1D6; E117 → E1D7; E118 → E1D8; E119 → E1D9; E11A → E1DA; E11B → E1DB; E11C → E1DC; E11D → E1DD; E11E → E1DE; E11F → E1DF; E120 → E1E0; E121 → E1E1; E122 → E1E2; E123 → E1E3; E124 → E1E4; E125 → E1E5; E126 → E1E6; E127 → E1E7; E128 → E1E8; E129 → E1E9; E12A → E1EA; E12B → E1EB; E12C → E1EC; E12D → E1ED; E12E → E1EE; E12F → E1EF; E130 → E1F0; E131 → E1F1; E132 → E1F2; E133 → E1F3; E134 → E1F4; E135 → E1F5; E136 → E1F6; E137 → E1F7; E138 → E1F8; E139 → E1F9; E13A → E1FA; E13B → E1FB; E13C → E1FC; E13D → E1FD; E100 → E1C0; E101 → E1C1; E102 → E1C2; E103 → E1C3; E104 → E1C4; E105 → E1C5; E106 → E1C6; E107 → E1C7; E108 → E1C8; E109 → E1C9; 2145 → E20D; 2146 → E227; 2147 → E228; 2148 → E22C; 2149 → E22D; 213C → hbi:160; 213D → hbi:148; 213E → hbi:128; 213F → hbi:133; bb:123 → hrb:123; bb:124 → hrb:124; bbd:123 → hrbd:123; bbd:124 → hrbd:124; bbi:123 → hbi:123; bbi:124 → hbi:124

ss07 (18) 2211 → E281; exa:88 → exa:161; xl:105 → xl:119; xl:9 → xl:23; xl:57 → xl:73; xxxl:9 → xxxl:25; 220F → E282; exa:89 → exa:163; xl:106 → xl:120; xl:10 → xl:24; xl:58 → xl:74; xxxl:10 → xxxl:26; 2210 → E283; exa:97 → exa:165; xl:107 → xl:121; xl:11 → xl:25; xl:59 → xl:75; xxxl:11 → xxxl:27

ss08 (4) 2226 → E276; 2224 → E275; 2223 → E277; 2225 → E278

ss09 (2) 223C → E279; 2248 → E27A

ss10 (2) 2663 → E252; 2660 → E253

dtls (28) 1D456 → 1D6A4; 1D457 → 1D6A5; 1D55A → bb:123; 1D55B → bb:124; 1D4BE → ms:123; 1D4BF → ms:124; 1D526 → mf:123; 1D527 → mf:124; E032 → mc:123; E033 → mc:124; 1D4F2 → bms:123; 1D4F3 → bms:124; 1D58E → bmf:123; 1D58F → bmf:124; 1D48A → bmi:123; 1D48B → bmi:124; E12C → bbd:123; E12D → bbd:124; 2148 → bbi:123; 2149 → bbi:124; E1AC → hrb:123; E1AD → hrb:124; E1EC → hrbd:123; E1ED → hrbd:124; E22C → hbi:123; E22D → hbi:124; 1D422 → mb:16; 1D423 → mb:17

G Extensible series

Text roots only; sizes in order, then the parts of the assembly (from bottom or left; * an extender). `chain` stands for the sizes and recipe reached through the TFM chain from that slot.

Vertical, 64 roots

0028: 0028 chain exa:0; **0029**: 0029 chain exa:1; **002F**: 002F chain exa:14; **005B**: 005B chain exa:2; **005D**: 005D chain exa:3; **2191**: 2191 | exa:63* exa:120; **2193**: 2193 | exa:121 exa:63*; **21D1**: 21D1 | exa:119* exa:126; **21D3**: 21D3 | exa:127 exa:119*; **230A**: 230A chain exa:4; **230B**: 230B chain exa:5; **2308**: 2308 chain exa:6; **2309**: 2309 chain exa:7; **007B**: 007B exa:182 chain exa:184; **007D**: 007D exa:183 chain exa:185; **27E8**: 27E8 langle.1100 exa:10 langle.1450 exa:68 langle.2100 chain exa:28; **27E9**: 27E9 rangle.1100 exa:11 rangle.1450 exa:69 rangle.2100 chain exa:29; **007C**: 007C bar.1100 bar.1200 bar.1450 bar.1800 bar.2100 bar.2400 bar.3000 | exa:12 exa:12* exa:12; **2016**: 2016 doublebar.1100 doublebar.1200 doublebar.1450 doublebar.1800 doublebar.2100 doublebar.2400 doublebar.3000 | exa:13 exa:13* exa:13; **2195**: 2195 | exa:121 exa:63* exa:120; **21D5**: 21D5 | exa:127 exa:119* exa:126; **005C**: 005C chain exa:15; **221A**: 221A chain exa:112; **E25C**: E25C chain exa:174; **E25D**: E25D chain exa:175; **2211**: 2211 exa:88 xl:105 xl:9 xl:57 xxxl:9; **220F**: 220F exa:89 xl:106 xl:10 xl:58 xxxl:10; **2210**: 2210 exa:97 xl:107 xl:11 xl:59 xxxl:11; **222B**: 222B exa:90 xl:108 xl:12 xl:60 xxxl:12; **222E**: 222E exa:73 xl:109 xl:13 xl:61 xxxl:13; **2A00**: 2A00 exa:75 xl:96 xl:0 xl:48 xxxl:0; **2A01**: 2A01 exa:77 xl:97 xl:1 xl:49 xxxl:1; **2A02**: 2A02 exa:79 xl:98 xl:2 xl:50 xxxl:2; **22C3**: 22C3 exa:91 xl:100 xl:4 xl:52 xxxl:4; **22C2**: 22C2 exa:92 xl:101 xl:5 xl:53 xxxl:5; **2A04**: 2A04 exa:93 xl:102 xl:6 xl:54 xxxl:6; **22C0**: 22C0 exa:94 xl:103 xl:7 xl:55 xxxl:7; **22C1**: 22C1 exa:95 xl:104 xl:8 xl:56 xxxl:8; **2A06**: 2A06 exa:71 xl:99 xl:3 xl:51 xxxl:3; **222C**: 222C exa:147 xl:115 xl:19 xl:69 xxxl:21; **222D**: 222D exa:149 xl:116 xl:20 xl:70 xxxl:22; **222F**: 222F exa:151 xl:117 xl:21 xl:71 xxxl:23; **2230**: 2230 exa:153 xl:118 xl:22 xl:72 xxxl:24; **2232**: 2232 exa:155 xl:112 xl:16 xl:66 xxxl:18; **2233**: 2233 exa:157 xl:113 xl:17 xl:67 xxxl:19; **2231**: 2231 exa:159 xl:114 xl:18 xl:68 xxxl:20; **2A03**: 2A03 exa:143; **E281**: E281 exa:161 xl:119 xl:23 xl:73 xxxl:25; **E282**: E282 exa:163 xl:120 xl:24 xl:74 xxxl:26; **E283**: E283 exa:165 xl:121 xl:25 xl:75 xxxl:27; **E284**: E284 exa:167 xl:122 xl:26 xl:76 conjunction.alt.xxxl; **2A0D**: 2A0D exa:171 xl:124 xl:28 xl:78 xxxl:31; **2A0F**: 2A0F exa:173 xl:125 xl:29 xl:79 xxxl:32; **23B0**: 23B0 | exa:140 exa:141* exa:137; **23B1**: 23B1 | exa:139 exa:141* exa:138; **23AA**: 23AA | exa:141 exa:141* exa:141; **mi:46**: mi:46 chain exa:0 exe:0 exe:2 exe:4 exe:6 exe:12 exe:28 exf:0 exf:2 exf:4 exf:6 exf:12 exf:28 chain exg:0; **mi:47**: mi:47 chain exa:1 exe:1 exe:3 exe:5 exe:7 exe:13 exe:29 exf:1 exf:3 exf:5 exf:7 exf:13 exf:29 chain exg:1; **sy:102**: sy:102 chain exa:8 exe:8 exe:128 exe:130 exe:132 exe:134 exe:136 exf:8 exf:128 exf:130 exf:132 exf:134 exf:136 chain exg:8; **sy:103**: sy:103 chain exa:9 exe:9 exe:129 exe:131 exe:133 exe:135 exe:137 exf:9 exf:129 exf:131 exf:133 exf:135 exf:137 chain exg:9; **27EE**: 27EE | exa:58 exa:136* exa:56; **27EF**: 27EF | exa:59 exa:62* exa:57; **2223**: 007C bar.1100 bar.1200 bar.1450 bar.1800 bar.2100 bar.2400 bar.3000 | exa:12 exa:12* exa:12; **2225**: 2016 doublebar.1100 doublebar.1200 doublebar.1450 doublebar.1800 doublebar.2100 doublebar.2400 doublebar.3000 | exa:13 exa:13* exa:13

Horizontal, 20 roots

2190: 2190 27F5 | sy:32 sy:0* sy:0; **2192**: 2192 27F6 | sy:0 sy:0* sy:33; **2194**: 2194 27F7 | sy:32 sy:0* sy:33; **21D0**: 21D0 27F8 | sy:40 sy:72* sy:72; **21D2**: 21D2 27F9 | sy:72 sy:72* sy:41; **21D4**: 21D4 27FA | sy:40 sy:72* sy:41; **20D7**: 20D7 | vector.start vector.shaft* vector.head (measure=ceil); **030C**: exa:122 chain exe:122 chain exf:122 chain exg:122; **0302**: chain exa:98 chain exe:98 chain exf:98 chain exg:98; **0303**: chain exa:101 chain exe:101 chain exf:101 chain exg:101; **21A6**: 21A6 27FC; **23DC**: chain exa:191 exe:208 exe:209 exe:210 exe:211 exe:212 exe:213 chain exf:177 chain exg:177 | overparen.left overparen.ext* overparen.right; **20D6**: 20D6 | leftvector.head vector.shaft* leftvector.start (measure=ceil); **23DE**: | exa:130 brace.ext* overbrace.mid brace.ext* exa:131 (bottom=569, connector_cap=yes); **23DF**: | exa:132 brace.ext* underbrace.mid brace.ext* exa:133 (connector_cap=yes); **overbrace.plain**: | exa:130 brace.ext* exa:135 brace.ext* exa:131 (bottom=569, connector_cap=yes); **underbrace.plain**: | exa:132 brace.ext* exa:134 brace.ext* exa:133 (connector_cap=yes); **exe:144**: exe:144 exe:145 exe:146 exe:147 exe:148 exe:149 exe:150 exe:151 exe:152 exe:153 exe:154 exe:155 exe:156 exe:157 exe:158 exe:159 exe:160 exf:144 exf:145 exf:146 exf:147 exf:148 exf:149 exf:150 exf:151 exf:152 exf:153 exf:154 exf:155 exg:144 exg:145 exg:146 exg:147 exg:148 exg:149 | exa:132 brace.ext* underbrace.mid brace.ext* exa:133 (connector_cap=yes); **exe:176**: exe:176 exe:177 exe:178 exe:179 exe:180 exe:181 exe:182 exe:183 exe:184 exe:185 exe:186 exe:187 exe:188 exe:189 exe:190 exe:191 exe:192 exf:160 exf:161 exf:162 exf:163 exf:164 exf:165 exf:166 exf:167 exf:168 exf:169 exf:170 exf:171 exg:160 exg:161 exg:162 exg:163 exg:164 exg:165 | exa:130 brace.ext* overbrace.mid brace.ext* exa:131 (bottom=539, connector_cap=yes); **0305**: 0305 E24E E24A | sy:83 sy:83* sy:83 (measure=ceil)

H Constructed glyphs and spaces

Name	Code point	Method	Arguments
prime	2032	prime	sy:48 1
backprime	2035	prime	sya:56 1
dprime	2033	prime	sy:48 2
tprime	2034	prime	sy:48 3
qprime	2057	prime	sy:48 4
dotlessj	0237	dotless	
lmoustache	23B0	moustache	exa:140 exa:137
rmoustache	23B1	moustache	exa:139 exa:138
ldots	2026	spaced	mi:58 3
cdots	22EF	spaced	sy:1 3
vdots	22EE	vdots	mi:58
ddots	22F1	ddots	mi:58
adots	22F0	ddots	mi:58 up
squaredots	2237	spaced	sy:87 2
leftvector	20D6	mirror	U+20D7
overbrace	23DE	row	exa:130 exa:133 exa:132 exa:131
underbrace	23DF	row	exa:132 exa:131 exa:130 exa:133
overbrace.plain		row	exa:130 exa:135 exa:131
underbrace.plain		row	exa:132 exa:134 exa:133
overbrace.mid		row	exa:133 exa:132
underbrace.mid		row	exa:131 exa:130
brace.ext		rule	exa:130 200
conjunction.alt.xxxl		row	xxxl:28 xxxl:29
bar.1100		column	exa:12 langle.1100
bar.1200		column	exa:12 exa:10
bar.1450		column	exa:12 langle.1450
bar.1800		column	exa:12 exa:68
bar.2100		column	exa:12 langle.2100
bar.2400		column	exa:12 exa:28
bar.3000		column	exa:12 exa:42
doublebar.1100		column	exa:13 langle.1100
doublebar.1200		column	exa:13 exa:10
doublebar.1450		column	exa:13 langle.1450
doublebar.1800		column	exa:13 exa:68
doublebar.2100		column	exa:13 langle.2100
doublebar.2400		column	exa:13 exa:28

Name	Code point	Method	Arguments
doublebar.3000		column	exa:13 exa:42
langle.1100		interpolate	1100
langle.1450		interpolate	1450
langle.2100		interpolate	2100
rangle.1100		interpolate	1100
rangle.1450		interpolate	1450
rangle.2100		interpolate	2100
vector.start		vector	start
vector.shaft		vector	shaft
vector.head		vector	head
leftvector.head		mirror	vector.head
leftvector.start		mirror	vector.start
overparen.left		overparen	exa:194 left
overparen.ext		overparen	exa:194 ext
overparen.right		overparen	exa:194 right

Spaces (code point=advance):

0020=333; 00A0=333; 2000=500; 2001=1000; 2002=500; 2003=1000; 2004=333; 2005=250; 2006=167; 2007=U+0030; 2008=U+002E; 2009=200; 200A=100; 200B=0; 202F=200; 205F=222; 2061=0; 2062=0; 2063=0; 2064=0