

Apple Color Emoji, and the sequences it draws

Apple Color Emoji is 192 MB, a TrueType COLLECTION of two faces that share their tables, and 99.5 per cent of it is one table: "sbix", a PNG file per glyph at nine sizes from 20 to 160 pixels to the em. So every mark on these pages is a PICTURE - an image XObject placed by a Type 3 glyph description, with the alpha channel of the PNG as its soft mask. The page overleaf is the same page in Noto Color Emoji, where every mark is a path.

An emoji face does not draw one picture per character. It draws one picture per SEQUENCE, and which characters make one up is a property of the FACE rather than of Unicode. This face has no GSUB table at all: what joins a thumb to a skin tone is "morx", a chain of finite state machines, and every glyph it picks was compared with hb-shape - one call per unit, 0 differ.



The row example 02.09 sets in Noto Emoji, the MONOCHROME face, set here in Apple Color Emoji - the same twenty-one marks, character for character. Twenty-three code points make twenty-one pictures: the desert island carries U+FE0F and the chilli U+FE0E, the TEXT presentation selector, and this face has a glyph for neither - each rides along with the mark in front of it and comes back out of the /ToUnicode.



One character each - and the last one is two, because a heart carries the emoji presentation selector U+FE0F behind it.



The same seven at twice the size. Every mark on these pages is a PICTURE - a PNG out of the face's 160 pixel strike, placed by a Type 3 glyph description - so it is sharp up to its own resolution and no further, which is the one thing a drawn colour font does better. Measured off this document: 6.350 mm at 18 pt against 12.700 mm at 36 pt, which is exactly twice - the advance comes out of the face's hmtx either way. [pdfimages -list] finds nothing in the file all the same, and that is worth knowing rather than surprising: it walks PAGE content streams, and every picture here sits inside a Type 3 glyph description.



Two to seven characters each: two families, two flags of regional indicator pairs, the transgender flag with its joiner and its two selectors, and the Scottish flag - a black flag and six invisible tag characters spelling "gbst". The skin tones have a page of their own overleaf.

One sequence, one glyph, one width

The measurement below is the whole claim of this page, and it is read off the document rather than asserted: [textWidth] answers the same number for a sequence of seven characters as for a single emoji, because in the font they are the same thing - one glyph, one entry in the /Widths array, one byte in the string that sets it. A font that had taken the sequence apart would measure seven times as wide and draw seven pictures.

mark	characters	width	sequence
😊	1	3.528 mm	U+1F600
❤️	2	3.528 mm	U+2764 U+FE0F
🇩🇪	2	3.528 mm	U+1F1E9 U+1F1EA
👍	2	3.528 mm	U+1F44D U+1F3FD
👨🏠	4	3.528 mm	U+1F9D1 U+1F3FD U+200D U+1F33E
👨🏠	5	3.528 mm	U+1F477 U+1F3FD U+200D U+2640 U+FE0F
👨🏠	5	3.528 mm	U+1F468 U+200D U+1F469 U+200D U+1F467
🏳️	5	3.528 mm	U+1F3F3 U+FE0F U+200D U+26A7 U+FE0F
👨🏠	7	3.528 mm	U+1F468 U+200D U+1F469 U+200D U+1F467 U+200D U+1F466
🏳️	7	3.528 mm	U+1F3F4 U+E0067 U+E0062 U+E0073 U+E0063 U+E0074 U+E007F

Ten units, one to seven characters each, and one width for all of them: 3.528 mm at 10 pt. The last row is seven characters wide and one glyph big, and the two in the middle carry a skin tone and a joiner at once.

The skin tones, one icon at a time

A skin tone is not a picture. U+1F3FB to U+1F3FF are the five Fitzpatrick MODIFIERS, and a modifier changes the mark in front of it: the base emoji and the modifier are one sequence, one glyph in the face and one glyph here, with one advance and one /ToUnicode entry carrying both code points back. The three rows below are the same icon through the whole ramp, so that what the modifier does is visible rather than described.



The base on its own, then the same base through all five modifiers: U+1F44D, and U+1F44D followed by U+1F3FB, U+1F3FC, U+1F3FD, U+1F3FE, U+1F3FF. Six units, eleven code points, six glyphs - every one of them the same width, because a modifier adds nothing to the advance.



The same ramp on a ZWJ SEQUENCE, which is the case that matters: the builder is U+1F477, a zero width joiner, the female sign U+2640 and a presentation selector, and the modifier goes in as the SECOND code point rather than at the end. Six units - four code points for the first and five for the other five - six glyphs, one width. A match that took the base and the tone and then stopped would draw a toned builder and then refuse the joiner; one that matched neither would draw five pictures where the face draws one.



And once more with a shorter sequence around the tone: a person, a sheaf of rice and the joiner between them. Six units of three and four code points, six glyphs, one width. Every unit on this page was checked against hb-shape - the glyph this package picks for a sequence is the glyph HarfBuzz picks.

What this face carries

Measured over the whole file on 2026-08-26: 192 123 488 bytes, of which the "sbix" table is 191 134 508 - 99.5 per cent. It holds NINE STRIKES, one per size: 20, 26, 32, 40, 48, 52, 64, 96 and 160 pixels to the em, and 3 706 433, 5 583 528, 7 261 741, 9 766 787, 12 755 001, 15 308 789, 20 159 534, 36 665 254 and 79 788 940 bytes of PNG in them. At the largest strike 3600 of the 3844 glyphs carry a picture, 136 carry none - the space, the joiner, the tag characters - and 108 carry a "flip" record, which is not a picture at all but another glyph's number: the runner and the walker facing the other way are the same PNG with a negative horizontal scale, and two Type 3 glyphs then share one image XObject.

This document draws from the 160 pixel strike, which is what [colorFont] takes where -strike names none: a Type 3 font is built once and set at every size the document uses, so nothing at build time knows which size to choose, and of the two ways to be wrong only one is visible. -strike 64 makes the same document a quarter of the size.

-  a picture out of the face and nothing else - which is every mark on these pages
-  160 by 160 pixels, RGBA, and the alpha channel becomes the /SMask of the image XObject
-  the same picture at nine resolutions in the file, of which exactly one reaches the document
-  an image XObject per glyph, placed by a Type 3 glyph description with one "cm" and one "Do"
-  no gradient, no shading, no blend mode - a bitmap face needs none of the machinery a COLR version 1 face needs
-  the same, reached through six invisible tag characters

In the running text

One string, one call, two faces: -fallback names the faces that may set what -family cannot, and the chain offers a SEQUENCE as one unit - longest match first - rather than a character at a time. That is what lets a family emoji stand in the middle of a sentence instead of breaking apart at its joiners, and it is why the marks below need no space around them: a sequence glued to the word in front of it is still one glyph.

The crate 📦 left the depot 🚞 on Tuesday and reached the family 👨👩👦 in 🇩🇪 on Thursday, who signed for it 👍 at 14:20 ✅. Two pallets went back ⚠️ - the 🇫🇷 consignment is still on the water, and the 🇬🇧 one has not left the yard.

The characters that draw nothing

Of the 1469 characters this face's cmap maps, a good many draw nothing at all: the space, the zero width joiner, and the tag characters a flag like the Scottish one is spelled with. They are real entries in the cmap and they have real glyph numbers, and at every one of the nine strikes their picture is EMPTY - 136 glyphs of 3844 at the largest. So a font built from one would be valid, extractable and blank, with nothing reporting it. That is refused by name, and only where such a character is asked for ALONE: inside a sequence the joiner and the tags are swallowed by the state machine and come back out through the /ToUnicode, which is what the last row of the width table on the first page shows.

The message, caught from this very page: tclpdf: the glyph forming of this face deletes every character of -chars (U+200D) - a joiner, a variation selector or a tag character draws nothing by design and is swallowed by the sequence it belongs to, so on its own it leaves no glyph at all and the font would come out empty

Check it yourself

The first command hands the sequences back unchanged - joiners, skin tones, selectors and tag characters included - which is the /ToUnicode of a Type 3 font doing its work. The second counts the image XObjects: 120, which is one picture and one soft mask for each of the sixty glyphs that have one. [pdfimages -list] finds none of them, because it walks page content streams and these sit inside glyph descriptions. The third is the font's own table of glyph procedures, and its keys spell the sequences out one code point at a time - one procedure for all seven characters of the Scottish flag. The fourth counts the placements, one per glyph drawn.

```
pdftotext 02.18-apple-color-emoji.pdf - | head -20
qpdf --qdf --object-streams=disable 02.18-apple-color-emoji.pdf - | grep -ac "^ */Subtype /Image"
qpdf --qdf --object-streams=disable 02.18-apple-color-emoji.pdf - | grep -a -A22 /CharProcs
qpdf --qdf --object-streams=disable 02.18-apple-color-emoji.pdf - | grep -ac " Do"
```