

GNU Unifont  
15.0.04

Generated by Doxygen 1.8.20



---

1 Main Page	1
1.1 GNU Unifont C Utilities	1
1.2 LICENSE	1
1.3 Introduction	1
1.4 The C Programs	2
1.5 Perl Scripts	3
2 Data Structure Index	5
2.1 Data Structures	5
3 File Index	7
3.1 File List	7
4 Data Structure Documentation	9
4.1 Buffer Struct Reference	9
4.1.1 Detailed Description	9
4.2 Font Struct Reference	10
4.2.1 Detailed Description	10
4.3 Glyph Struct Reference	10
4.3.1 Detailed Description	11
4.3.2 Field Documentation	11
4.3.2.1 pos	11
4.4 NamePair Struct Reference	11
4.4.1 Detailed Description	12
4.5 Options Struct Reference	12
4.5.1 Detailed Description	12
4.6 Table Struct Reference	13
4.6.1 Detailed Description	13
4.7 TableRecord Struct Reference	13
4.7.1 Detailed Description	14
5 File Documentation	15
5.1 src/hex2otf.c File Reference	15
5.1.1 Detailed Description	20
5.1.2 Macro Definition Documentation	20
5.1.2.1 addByte	20
5.1.2.2 defineStore	20
5.1.3 Typedef Documentation	21
5.1.3.1 Buffer	21
5.1.3.2 Glyph	21
5.1.3.3 Options	21

---

5.1.3.4 Table	21
5.1.4 Enumeration Type Documentation	21
5.1.4.1 ContourOp	21
5.1.4.2 FillSide	22
5.1.4.3 LocaFormat	22
5.1.5 Function Documentation	23
5.1.5.1 addTable()	23
5.1.5.2 buildOutline()	24
5.1.5.3 byCodePoint()	26
5.1.5.4 byTableTag()	27
5.1.5.5 cacheBuffer()	28
5.1.5.6 cacheBytes()	28
5.1.5.7 cacheCFFOperand()	29
5.1.5.8 cacheStringAsUTF16BE()	30
5.1.5.9 cacheU16()	32
5.1.5.10 cacheU32()	33
5.1.5.11 cacheU8()	34
5.1.5.12 cacheZeros()	35
5.1.5.13 cleanBuffers()	36
5.1.5.14 ensureBuffer()	36
5.1.5.15 fail()	38
5.1.5.16 fillBitmap()	40
5.1.5.17 fillBlankOutline()	42
5.1.5.18 fillCFF()	43
5.1.5.19 fillCmapTable()	47
5.1.5.20 fillGposTable()	49
5.1.5.21 fillGsubTable()	50
5.1.5.22 fillHeadTable()	52
5.1.5.23 fillHheaTable()	53
5.1.5.24 fillHmtxTable()	55
5.1.5.25 fillMaxpTable()	56
5.1.5.26 fillNameTable()	57
5.1.5.27 fillOS2Table()	59
5.1.5.28 fillPostTable()	61
5.1.5.29 fillTrueType()	62
5.1.5.30 freeBuffer()	64
5.1.5.31 initBuffers()	65
5.1.5.32 main()	66
5.1.5.33 matchToken()	68
5.1.5.34 newBuffer()	68

---

---

5.1.5.35	<a href="#">organizeTables()</a>	70
5.1.5.36	<a href="#">parseOptions()</a>	71
5.1.5.37	<a href="#">positionGlyphs()</a>	74
5.1.5.38	<a href="#">prepareOffsets()</a>	75
5.1.5.39	<a href="#">prepareStringIndex()</a>	76
5.1.5.40	<a href="#">printHelp()</a>	77
5.1.5.41	<a href="#">printVersion()</a>	78
5.1.5.42	<a href="#">readCodePoint()</a>	79
5.1.5.43	<a href="#">readGlyphs()</a>	80
5.1.5.44	<a href="#">sortGlyphs()</a>	81
5.1.5.45	<a href="#">writeBytes()</a>	82
5.1.5.46	<a href="#">writeFont()</a>	83
5.1.5.47	<a href="#">writeU16()</a>	85
5.1.5.48	<a href="#">writeU32()</a>	86
5.2	<a href="#">src/hex2otf.h File Reference</a>	87
5.2.1	<a href="#">Detailed Description</a>	88
5.2.2	<a href="#">Macro Definition Documentation</a>	88
5.2.2.1	<a href="#">DEFAULT_ID0</a>	89
5.2.3	<a href="#">Variable Documentation</a>	89
5.2.3.1	<a href="#">defaultNames</a>	89
5.3	<a href="#">src/unibdf2hex.c File Reference</a>	90
5.3.1	<a href="#">Detailed Description</a>	90
5.3.2	<a href="#">Function Documentation</a>	91
5.3.2.1	<a href="#">main()</a>	91
5.4	<a href="#">src/unibmp2hex.c File Reference</a>	92
5.4.1	<a href="#">Detailed Description</a>	93
5.4.2	<a href="#">Function Documentation</a>	93
5.4.2.1	<a href="#">main()</a>	94
5.4.3	<a href="#">Variable Documentation</a>	101
5.4.3.1	<a href="#">bmp_header</a>	101
5.4.3.2	<a href="#">color_table</a>	101
5.4.3.3	<a href="#">unidigit</a>	101
5.5	<a href="#">src/unibmpbump.c File Reference</a>	102
5.5.1	<a href="#">Detailed Description</a>	102
5.5.2	<a href="#">Function Documentation</a>	103
5.5.2.1	<a href="#">get_bytes()</a>	103
5.5.2.2	<a href="#">main()</a>	104
5.5.2.3	<a href="#">regrid()</a>	109
5.6	<a href="#">src/unicoverage.c File Reference</a>	111
5.6.1	<a href="#">Detailed Description</a>	111

---

5.6.2 Function Documentation . . . . .	112
5.6.2.1 main() . . . . .	112
5.6.2.2 nextrange() . . . . .	114
5.6.2.3 print_subtotal() . . . . .	115
5.7 src/unidup.c File Reference . . . . .	116
5.7.1 Detailed Description . . . . .	117
5.7.2 Function Documentation . . . . .	117
5.7.2.1 main() . . . . .	117
5.8 src/unifont1per.c File Reference . . . . .	118
5.8.1 Detailed Description . . . . .	119
5.8.2 Macro Definition Documentation . . . . .	119
5.8.2.1 MAXFILENAME . . . . .	119
5.8.2.2 MAXSTRING . . . . .	119
5.8.3 Function Documentation . . . . .	120
5.8.3.1 main() . . . . .	120
5.9 src/unifontpic.c File Reference . . . . .	121
5.9.1 Detailed Description . . . . .	122
5.9.2 Macro Definition Documentation . . . . .	123
5.9.2.1 HDR_LEN . . . . .	123
5.9.3 Function Documentation . . . . .	123
5.9.3.1 genlongbmp() . . . . .	123
5.9.3.2 genwidebmp() . . . . .	127
5.9.3.3 gethex() . . . . .	132
5.9.3.4 main() . . . . .	134
5.9.3.5 output2() . . . . .	135
5.9.3.6 output4() . . . . .	136
5.10 src/unifontpic.h File Reference . . . . .	137
5.10.1 Detailed Description . . . . .	138
5.10.2 Variable Documentation . . . . .	138
5.10.2.1 ascii_bits . . . . .	138
5.10.2.2 ascii_hex . . . . .	138
5.10.2.3 hexdigit . . . . .	139
5.11 src/unigencircles.c File Reference . . . . .	139
5.11.1 Detailed Description . . . . .	140
5.11.2 Function Documentation . . . . .	140
5.11.2.1 add_double_circle() . . . . .	140
5.11.2.2 add_single_circle() . . . . .	142
5.11.2.3 main() . . . . .	143
5.12 src/unigenwidth.c File Reference . . . . .	145
5.12.1 Detailed Description . . . . .	146

---

5.12.2 Macro Definition Documentation . . . . .	146
5.12.2.1 PIKTO_SIZE . . . . .	146
5.12.3 Function Documentation . . . . .	146
5.12.3.1 main() . . . . .	146
5.13 src/unihex2bmp.c File Reference . . . . .	150
5.13.1 Detailed Description . . . . .	152
5.13.2 Function Documentation . . . . .	152
5.13.2.1 hex2bit() . . . . .	152
5.13.2.2 init() . . . . .	153
5.13.2.3 main() . . . . .	156
5.13.3 Variable Documentation . . . . .	160
5.13.3.1 hex . . . . .	160
5.14 src/unihexgen.c File Reference . . . . .	160
5.14.1 Detailed Description . . . . .	161
5.14.2 Function Documentation . . . . .	161
5.14.2.1 hexprint4() . . . . .	161
5.14.2.2 hexprint6() . . . . .	163
5.14.2.3 main() . . . . .	164
5.14.3 Variable Documentation . . . . .	165
5.14.3.1 hexdigit . . . . .	165
5.15 src/unipagecount.c File Reference . . . . .	166
5.15.1 Detailed Description . . . . .	167
5.15.2 Function Documentation . . . . .	167
5.15.2.1 main() . . . . .	167
5.15.2.2 mkftable() . . . . .	169
Index . . . . .	173





# Chapter 1

## Main Page

### 1.1 GNU Unifont C Utilities

This documentation covers C utility programs for creating GNU Unifont glyphs and fonts.

### 1.2 LICENSE

This program is free software: you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation, either version 2 of the License, or (at your option) any later version.

This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.

You should have received a copy of the GNU General Public License along with this program. If not, see <http://www.gnu.org/licenses/>.

### 1.3 Introduction

Unifont is the creation of Roman Czyborra, who created Perl utilities for generating a dual-width Bitmap Distribution Format (BDF) font 16 pixels tall, `unifont.bdf`, from an input file named `unifont.hex`. The `unifont.hex` file contained two fields separated by a colon: a Unicode code point as four hexadecimal digits, and a hexadecimal string of 32 or 64 characters representing the glyph bitmap pattern. Roman also wrote other Perl scripts for manipulating `unifont.hex` files.

Jungshik Shin wrote a Perl script, `johab2ucs2`, to convert Hangul syllable glyph elements into Hangul Johab-encoded fonts. These glyph elements are compatible with Jaekyung "Jake" Song's Hanterm terminal emulator. Paul Hardy modified `johab2ucs2` and drew Hangul Syllables Unicode elements for compatibility with this Johab encoding and with Hanterm. These new glyphs were created to avoid licensing issues with the Hangul Syllables glyphs that were in the original `unifont.hex` file.

Over time, Unifont was extended to allow correct positioning of combining marks in a TrueType font, coverage beyond Unicode Plane 0, and the addition of Under-ConScript Unicode Registry (UCSUR) glyphs. There is also partial support for experimental quadruple-width glyphs.

Paul Hardy wrote the first pair of C programs, [unihex2bmp.c](#) and [unibmp2hex.c](#), to facilitate editing the bitmaps at their real aspect ratio. These programs allow conversion between the Unifont .hex format and a Windows Bitmap or Wireless Bitmap file for editing with a graphics editor. This was followed by make files, other C programs, Perl scripts, and shell scripts.

Luis Alejandro González Miranda wrote scripts for converting unifont.hex into a TrueType font using Font $\leftarrow$ Forge.

Andrew Miller wrote additional Perl programs for directly rendering unifont.hex files, for converting unifont. $\leftarrow$ hex to and from Portable Network Graphics (PNG) files for editing based upon Paul Hardy's BMP conversion programs, and also wrote other Perl scripts.

David Corbett wrote a Perl script to rotate glyphs in a unifont.hex file and an awk script to substitute new glyphs for old glyphs of the same Unicode code point in a unifont.hex file.

何志翔 (He Zhixiang) wrote a program to convert Unifont files into OpenType fonts, [hex2otf.c](#).

## 1.4 The C Programs

This documentation only covers C programs and their header files. These programs are typically longer than the Unifont package's Perl scripts, which being much smaller are easier to understand. The C programs are, in alphabetical order:

Program	Description
<a href="#">hex2otf.c</a>	Convert a GNU Unifont .hex file to an OpenType font
<a href="#">unibdf2hex.c</a>	Convert a BDF file into a unifont.hex file
<a href="#">unibmp2hex.c</a>	Turn a .bmp or .wbmp glyph matrix into a GNU Unifont hex glyph set of 256 characters
<a href="#">unibmpbump.c</a>	Adjust a Microsoft bitmap (.bmp) file that was created by unihex2png but converted to .bmp
<a href="#">unicoverage.c</a>	Show the coverage of Unicode plane scripts for a GNU Unifont hex glyph file
<a href="#">unidup.c</a>	Check for duplicate code points in sorted unifont.hex file
<a href="#">unifont1per.c</a>	Read a Unifont .hex file from standard input and produce one glyph per .bmp bitmap file as output
<a href="#">unifontpic.c</a>	See the "Big Picture": the entire Unifont in one BMP bitmap
<a href="#">unigencircles.c</a>	Superimpose dashed combining circles on combining glyphs
<a href="#">unigenwidth.c</a>	IEEE 1003.1-2008 setup to calculate wchar_t string widths
<a href="#">unihex2bmp.c</a>	Turn a GNU Unifont hex glyph page of 256 code points into a bitmap for editing
<a href="#">unihexgen.c</a>	Generate a series of glyphs containing hexadecimal code points
<a href="#">unipagecount.c</a>	Count the number of glyphs defined in each page of 256 code points

## 1.5 Perl Scripts

The very first program written for Unifont conversion was Roman Czyborra's hexdraw Perl script. That one script would convert a unifont.hex file into a text file with 16 lines per glyph (one for each glyph row) followed by a blank line after each glyph. That allowed editing unifont.hex glyphs with a text-based editor.

Combined with Roman's hex2bdf Perl script to convert a unifont.hex file into a BDF font, these two scripts formed a complete package for editing Unifont and generating the resulting BDF fonts.

There was no combining mark support initially, and the original unifont.hex file included combining circles with combining mark glyphs.

The list below gives a brief description of these and the other Perl scripts that are in the Unifont package src subdirectory.

Perl Script	Description
bdfimplode	Convert a BDF font into GNU Unifont .hex format
hex2bdf	Convert a GNU Unifont .hex file into a BDF font
hex2sfd	Convert a GNU Unifont .hex file into a FontForge .sfd format
hexbraille	Algorithmically generate the Unicode Braille range (U+28xx)
hexdraw	Convert a GNU Unifont .hex file to and from an ASCII text file
hexkinya	Create the Private Use Area Kinya syllables
hexmerge	Merge two or more GNU Unifont .hex font files into one
johab2ucs2	Convert a Johab BDF font into GNU Unifont Hangul Syllables
unifont-viewer	View a .hex font file with a graphical user interface
unifontchojung	Extract Hangul syllables that have no final consonant
unifontksx	Extract Hangul syllables that comprise KS X 1001:1992
unihex2png	GNU Unifont .hex file to Portable Network Graphics converter
unihexfill	Generate range of Unifont 4- or 6-digit hexadecimal glyph
unihexrotate	Rotate Unifont hex glyphs in quarter turn increments
unipng2hex	Portable Network Graphics to GNU Unifont .hex file converter



## Chapter 2

# Data Structure Index

### 2.1 Data Structures

Here are the data structures with brief descriptions:

<a href="#">Buffer</a>	Generic data structure for a linked list of buffer elements . . . . .	<a href="#">9</a>
<a href="#">Font</a>	Data structure to hold information for one font . . . . .	<a href="#">10</a>
<a href="#">Glyph</a>	Data structure to hold data for one bitmap glyph . . . . .	<a href="#">10</a>
<a href="#">NamePair</a>	Data structure for a font ID number and name character string . . . . .	<a href="#">11</a>
<a href="#">Options</a>	Data structure to hold options for OpenType font output . . . . .	<a href="#">12</a>
<a href="#">Table</a>	Data structure for an OpenType table . . . . .	<a href="#">13</a>
<a href="#">TableRecord</a>	Data structure for data associated with one OpenType table . . . . .	<a href="#">13</a>



## Chapter 3

# File Index

### 3.1 File List

Here is a list of all documented files with brief descriptions:

src/ <a href="#">hex2otf.c</a>	
Hex2otf - Convert GNU Unifont .hex file to OpenType font . . . . .	15
src/ <a href="#">hex2otf.h</a>	
Hex2otf.h - Header file for <a href="#">hex2otf.c</a> . . . . .	87
src/ <a href="#">unibdf2hex.c</a>	
Unibdf2hex - Convert a BDF file into a unifont.hex file . . . . .	90
src/ <a href="#">unibmp2hex.c</a>	
Unibmp2hex - Turn a .bmp or .wbmp glyph matrix into a GNU Unifont hex glyph set of 256 characters . . . . .	92
src/ <a href="#">unibmpbump.c</a>	
Unibmpbump - Adjust a Microsoft bitmap (.bmp) file that was created by unihex2png but converted to .bmp . . . . .	102
src/ <a href="#">unicoverage.c</a>	
Unicoverage - Show the coverage of Unicode plane scripts for a GNU Unifont hex glyph file	111
src/ <a href="#">unidup.c</a>	
Unidup - Check for duplicate code points in sorted unifont.hex file . . . . .	116
src/ <a href="#">unifont1per.c</a>	
Unifont1per - Read a Unifont .hex file from standard input and produce one glyph per ".bmp" bitmap file as output . . . . .	118
src/ <a href="#">unifontpic.c</a>	
Unifontpic - See the "Big Picture": the entire Unifont in one BMP bitmap . . . . .	121
src/ <a href="#">unifontpic.h</a>	
Unifontpic.h - Header file for <a href="#">unifontpic.c</a> . . . . .	137
src/ <a href="#">unigencircles.c</a>	
Unigencircles - Superimpose dashed combining circles on combining glyphs . . . . .	139
src/ <a href="#">unigenwidth.c</a>	
Unigenwidth - IEEE 1003.1-2008 setup to calculate wchar_t string widths . . . . .	145
src/ <a href="#">unihex2bmp.c</a>	
Unihex2bmp - Turn a GNU Unifont hex glyph page of 256 code points into a bitmap for editing . . . . .	150
src/ <a href="#">unihexgen.c</a>	
Unihexgen - Generate a series of glyphs containing hexadecimal code points . . . . .	160
src/ <a href="#">unipagecount.c</a>	
Unipagecount - Count the number of glyphs defined in each page of 256 code points . . .	166





## Chapter 4

# Data Structure Documentation

### 4.1 Buffer Struct Reference

Generic data structure for a linked list of buffer elements.

#### Data Fields

- `size_t` capacity
- `byte * begin`
- `byte * next`
- `byte * end`

#### 4.1.1 Detailed Description

Generic data structure for a linked list of buffer elements.

A buffer can act as a vector (when filled with 'store\*' functions), or a temporary output area (when filled with 'cache\*' functions). The 'store\*' functions use native endian. The 'cache\*' functions use big endian or other formats in OpenType. Beware of memory alignment.

Definition at line 133 of file `hex2otf.c`.

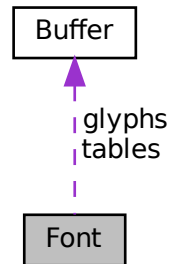
The documentation for this struct was generated from the following file:

- `src/hex2otf.c`

## 4.2 Font Struct Reference

Data structure to hold information for one font.

Collaboration diagram for Font:



### Data Fields

- [Buffer](#) \* tables
- [Buffer](#) \* glyphs
- `uint_fast32_t` glyphCount
- [pixels\\_t](#) maxWidth

### 4.2.1 Detailed Description

Data structure to hold information for one font.

Definition at line 628 of file `hex2otf.c`.

The documentation for this struct was generated from the following file:

- `src/hex2otf.c`

## 4.3 Glyph Struct Reference

Data structure to hold data for one bitmap glyph.

## Data Fields

- `uint_least32_t` [codePoint](#)  
undefined for glyph 0
- `byte` [bitmap](#) [[GLYPH\\_MAX\\_BYTE\\_COUNT](#)]  
hexadecimal bitmap character array
- `uint_least8_t` [byteCount](#)  
length of bitmap data
- `bool` [combining](#)  
whether this is a combining glyph
- `pixels_t` [pos](#)
- `pixels_t` [lsb](#)  
left side bearing (x position of leftmost contour point)

### 4.3.1 Detailed Description

Data structure to hold data for one bitmap glyph.

This data structure holds data to represent one Unifont bitmap glyph: Unicode code point, number of bytes in its bitmap array, whether or not it is a combining character, and an offset from the glyph origin to the start of the bitmap.

Definition at line 614 of file `hex2otf.c`.

### 4.3.2 Field Documentation

#### 4.3.2.1 `pos`

`pixels_t` [Glyph::pos](#)

number of pixels the glyph should be moved to the right (negative number means moving to the left)

Definition at line 620 of file `hex2otf.c`.

The documentation for this struct was generated from the following file:

- `src/hex2otf.c`

## 4.4 NamePair Struct Reference

Data structure for a font ID number and name character string.

```
#include <hex2otf.h>
```

## Data Fields

- int id
- const char \* str

### 4.4.1 Detailed Description

Data structure for a font ID number and name character string.

Definition at line 77 of file hex2otf.h.

The documentation for this struct was generated from the following file:

- [src/hex2otf.h](#)

## 4.5 Options Struct Reference

Data structure to hold options for OpenType font output.

## Data Fields

- bool truetype
- bool blankOutline
- bool bitmap
- bool gpos
- bool gsub
- int cff
- const char \* hex
- const char \* pos
- const char \* out
- [NameStrings](#) nameStrings

### 4.5.1 Detailed Description

Data structure to hold options for OpenType font output.

This data structure holds the status of options that can be specified as command line arguments for creating the output OpenType font file.

Definition at line 2453 of file hex2otf.c.

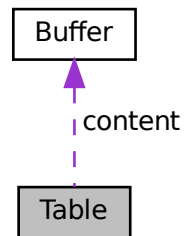
The documentation for this struct was generated from the following file:

- [src/hex2otf.c](#)

## 4.6 Table Struct Reference

Data structure for an OpenType table.

Collaboration diagram for Table:



### Data Fields

- `uint_fast32_t` tag
- `Buffer * content`

### 4.6.1 Detailed Description

Data structure for an OpenType table.

This data structure contains a table tag and a pointer to the start of the buffer that holds data for this OpenType table.

For information on the OpenType tables and their structure, see <https://docs.microsoft.com/en-us/typography/opentype/spec/otf#font-tables>.

Definition at line 645 of file `hex2otf.c`.

The documentation for this struct was generated from the following file:

- `src/hex2otf.c`

## 4.7 TableRecord Struct Reference

Data structure for data associated with one OpenType table.

## Data Fields

- `uint_least32_t` tag
- `uint_least32_t` offset
- `uint_least32_t` length
- `uint_least32_t` checksum

### 4.7.1 Detailed Description

Data structure for data associated with one OpenType table.

This data structure contains an OpenType table's tag, start within an OpenType font file, length in bytes, and checksum at the end of the table.

Definition at line 747 of file `hex2otf.c`.

The documentation for this struct was generated from the following file:

- [src/hex2otf.c](#)

## Chapter 5

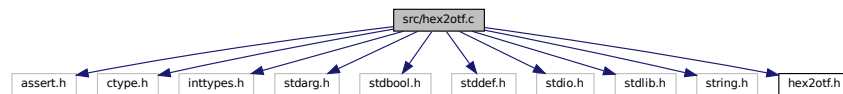
# File Documentation

### 5.1 src/hex2otf.c File Reference

hex2otf - Convert GNU Unifont .hex file to OpenType font

```
#include <assert.h>
#include <ctype.h>
#include <inttypes.h>
#include <stdarg.h>
#include <stdbool.h>
#include <stddef.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include "hex2otf.h"
```

Include dependency graph for hex2otf.c:



### Data Structures

- struct [Buffer](#)  
Generic data structure for a linked list of buffer elements.
- struct [Glyph](#)  
Data structure to hold data for one bitmap glyph.
- struct [Font](#)  
Data structure to hold information for one font.
- struct [Table](#)  
Data structure for an OpenType table.
- struct [TableRecord](#)  
Data structure for data associated with one OpenType table.
- struct [Options](#)  
Data structure to hold options for OpenType font output.

## Macros

- `#define VERSION "1.0.1"`  
Program version, for "--version" option.
- `#define U16MAX 0xffff`  
Maximum UTF-16 code point value.
- `#define U32MAX 0xffffffff`  
Maximum UTF-32 code point value.
- `#define PRI_CP "U+%.4"PRIFAST32`  
Format string to print Unicode code point.
- `#define static_assert(a, b) (assert(a))`  
If "a" is true, return string "b".
- `#define BX(shift, x) ((uintmax_t)(!(x)) << (shift))`  
Truncate & shift word.
- `#define B0(shift) BX((shift), 0)`  
Clear a given bit in a word.
- `#define B1(shift) BX((shift), 1)`  
Set a given bit in a word.
- `#define GLYPH_MAX_WIDTH 16`  
Maximum glyph width, in pixels.
- `#define GLYPH_HEIGHT 16`  
Maximum glyph height, in pixels.
- `#define GLYPH_MAX_BYTE_COUNT (GLYPH_HEIGHT * GLYPH_MAX_WIDTH / 8)`  
Number of bytes to represent one bitmap glyph as a binary array.
- `#define DESCENDER 2`  
Count of pixels below baseline.
- `#define ASCENDER (GLYPH_HEIGHT - DESCENDER)`  
Count of pixels above baseline.
- `#define FUPEM 64`  
Font units per em.
- `#define MAX_GLYPHS 65536`  
An OpenType font has at most 65536 glyphs.
- `#define MAX_NAME_IDS 256`  
Name IDs 0-255 are used for standard names.
- `#define FU(x) ((x) * FUPEM / GLYPH_HEIGHT)`  
Convert pixels to font units.
- `#define PW(x) ((x) / (GLYPH_HEIGHT / 8))`  
Convert glyph byte count to pixel width.
- `#define defineStore(name, type)`  
Temporary define to look up an element in an array of given type.
- `#define addByte(shift)`
- `#define getRowBit(rows, x, y) ((rows)[(y)] & x0 >> (x))`
- `#define flipRowBit(rows, x, y) ((rows)[(y)] ^= x0 >> (x))`
- `#define stringCount (sizeof strings / sizeof *strings)`
- `#define cacheCFF32(buf, x) (cacheU8 ((buf), 29), cacheU32 ((buf), (x)))`



## Typedefs

- typedef unsigned char [byte](#)  
Definition of "byte" type as an unsigned char.
- typedef int\_least8\_t [pixels\\_t](#)  
This type must be able to represent max(GLYPH\_MAX\_WIDTH, GLYPH\_HEIGHT).
- typedef struct [Buffer](#) [Buffer](#)  
Generic data structure for a linked list of buffer elements.
- typedef const char \* [NameStrings](#)[MAX\_NAME\_IDS]  
Array of OpenType names indexed directly by Name IDs.
- typedef struct [Glyph](#) [Glyph](#)  
Data structure to hold data for one bitmap glyph.
- typedef struct [Font](#) [Font](#)  
Data structure to hold information for one font.
- typedef struct [Table](#) [Table](#)  
Data structure for an OpenType table.
- typedef struct [Options](#) [Options](#)  
Data structure to hold options for OpenType font output.

## Enumerations

- enum [LocaFormat](#) { [LOCA\\_OFFSET16](#) = 0, [LOCA\\_OFFSET32](#) = 1 }  
Index to Location ("loca") offset information.
- enum [ContourOp](#) { [OP\\_CLOSE](#), [OP\\_POINT](#) }  
Specify the current contour drawing operation.
- enum [FillSide](#) { [FILL\\_LEFT](#), [FILL\\_RIGHT](#) }  
Fill to the left side (CFF) or right side (TrueType) of a contour.

## Functions

- void [fail](#) (const char \*reason,...)  
Print an error message on stderr, then exit.
- void [initBuffers](#) (size\_t count)  
Initialize an array of buffer pointers to all zeroes.
- void [cleanBuffers](#) ()  
Free all allocated buffer pointers.
- [Buffer](#) \* [newBuffer](#) (size\_t initialCapacity)  
Create a new buffer.
- void [ensureBuffer](#) ([Buffer](#) \*buf, size\_t needed)  
Ensure that the buffer has at least the specified minimum size.
- void [freeBuffer](#) ([Buffer](#) \*buf)  
Free the memory previously allocated for a buffer.
- defineStore (storeU8, uint\_least8\_t)
- void [cacheU8](#) ([Buffer](#) \*buf, uint\_fast8\_t value)  
Append one unsigned byte to the end of a byte array.
- void [cacheU16](#) ([Buffer](#) \*buf, uint\_fast16\_t value)

- Append two unsigned bytes to the end of a byte array.
- void [cacheU32](#) ([Buffer](#) \*buf, [uint\\_fast32\\_t](#) value)
- Append four unsigned bytes to the end of a byte array.
- void [cacheCFFOperand](#) ([Buffer](#) \*buf, [int\\_fast32\\_t](#) value)
- Cache charstring number encoding in a CFF buffer.
- void [cacheZeros](#) ([Buffer](#) \*buf, [size\\_t](#) count)
- Append 1 to 4 bytes of zeroes to a buffer, for padding.
- void [cacheBytes](#) ([Buffer](#) \*restrict buf, const void \*restrict src, [size\\_t](#) count)
- Append a string of bytes to a buffer.
- void [cacheBuffer](#) ([Buffer](#) \*restrict bufDest, const [Buffer](#) \*restrict bufSrc)
- Append bytes of a table to a byte buffer.
- void [writeBytes](#) (const [byte](#) bytes[], [size\\_t](#) count, [FILE](#) \*file)
- Write an array of bytes to an output file.
- void [writeU16](#) ([uint\\_fast16\\_t](#) value, [FILE](#) \*file)
- Write an unsigned 16-bit value to an output file.
- void [writeU32](#) ([uint\\_fast32\\_t](#) value, [FILE](#) \*file)
- Write an unsigned 32-bit value to an output file.
- void [addTable](#) ([Font](#) \*font, const char tag[static 4], [Buffer](#) \*content)
- Add a TrueType or OpenType table to the font.
- void [organizeTables](#) ([Font](#) \*font, bool isCFF)
- Sort tables according to OpenType recommendations.
- int [byTableTag](#) (const void \*a, const void \*b)
- Compare tables by 4-byte unsigned table tag value.
- void [writeFont](#) ([Font](#) \*font, bool isCFF, const char \*fileName)
- Write OpenType font to output file.
- bool [readCodePoint](#) ([uint\\_fast32\\_t](#) \*codePoint, const char \*fileName, [FILE](#) \*file)
- Read up to 6 hexadecimal digits and a colon from file.
- void [readGlyphs](#) ([Font](#) \*font, const char \*fileName)
- Read glyph definitions from a Unifont .hex format file.
- int [byCodePoint](#) (const void \*a, const void \*b)
- Compare two Unicode code points to determine which is greater.
- void [positionGlyphs](#) ([Font](#) \*font, const char \*fileName, [pixels\\_t](#) \*xMin)
- Position a glyph within a 16-by-16 pixel bounding box.
- void [sortGlyphs](#) ([Font](#) \*font)
- Sort the glyphs in a font by Unicode code point.
- void [buildOutline](#) ([Buffer](#) \*result, const [byte](#) bitmap[], const [size\\_t](#) byteCount, const enum [FillSide](#) fillSide)
- Build a glyph outline.
- void [prepareOffsets](#) ([size\\_t](#) \*sizes)
- Prepare 32-bit glyph offsets in a font table.
- [Buffer](#) \* [prepareStringIndex](#) (const [NameStrings](#) names)
- Prepare a font name string index.
- void [fillCFF](#) ([Font](#) \*font, int version, const [NameStrings](#) names)
- Add a CFF table to a font.
- void [fillTrueType](#) ([Font](#) \*font, enum [LocaFormat](#) \*format, [uint\\_fast16\\_t](#) \*maxPoints, [uint\\_fast16\\_t](#) \*maxContours)
- Add a TrueType table to a font.

- void [fillBlankOutline](#) ([Font](#) \*font)
 

Create a dummy blank outline in a font table.
- void [fillBitmap](#) ([Font](#) \*font)
 

Fill OpenType bitmap data and location tables.
- void [fillHeadTable](#) ([Font](#) \*font, enum [LocaFormat](#) locaFormat, [pixels\\_t](#) xMin)
 

Fill a "head" font table.
- void [fillHheaTable](#) ([Font](#) \*font, [pixels\\_t](#) xMin)
 

Fill a "hhea" font table.
- void [fillMaxpTable](#) ([Font](#) \*font, bool isCFF, [uint\\_fast16\\_t](#) maxPoints, [uint\\_fast16\\_t](#) maxContours)
 

Fill a "maxp" font table.
- void [fillOS2Table](#) ([Font](#) \*font)
 

Fill an "OS/2" font table.
- void [fillHmtxTable](#) ([Font](#) \*font)
 

Fill an "hmtx" font table.
- void [fillCmapTable](#) ([Font](#) \*font)
 

Fill a "cmap" font table.
- void [fillPostTable](#) ([Font](#) \*font)
 

Fill a "post" font table.
- void [fillGposTable](#) ([Font](#) \*font)
 

Fill a "GPOS" font table.
- void [fillGsubTable](#) ([Font](#) \*font)
 

Fill a "GSUB" font table.
- void [cacheStringAsUTF16BE](#) ([Buffer](#) \*buf, const char \*str)
 

Cache a string as a big-ending UTF-16 surrogate pair.
- void [fillNameTable](#) ([Font](#) \*font, [NameStrings](#) nameStrings)
 

Fill a "name" font table.
- void [printVersion](#) ()
 

Print program version string on stdout.
- void [printHelp](#) ()
 

Print help message to stdout and then exit.
- const char \* [matchToken](#) (const char \*operand, const char \*key, char delimiter)
 

Match a command line option with its key for enabling.
- [Options](#) [parseOptions](#) (char \*const argv[const])
 

Parse command line options.
- int [main](#) (int argc, char \*argv[])
 

The main function.

## Variables

- [Buffer](#) \* [allBuffers](#)

Initial allocation of empty array of buffer pointers.
- [size\\_t](#) [bufferCount](#)

Number of buffers in a [Buffer](#) \* array.
- [size\\_t](#) [nextBufferIndex](#)

Index number to tail element of [Buffer](#) \* array.

### 5.1.1 Detailed Description

hex2otf - Convert GNU Unifont .hex file to OpenType font

This program reads a Unifont .hex format file and a file containing combining mark offset information, and produces an OpenType font file.

Copyright

Copyright © 2022 何志翔 (He Zhixiang)

Author

何志翔 (He Zhixiang)

### 5.1.2 Macro Definition Documentation

#### 5.1.2.1 addByte

```
#define addByte(
    shift )
```

Value:

```
if (p == end) \
    break; \
record->checksum += (uint_fast32_t)*p++ « (shift);
```

#### 5.1.2.2 defineStore

```
#define defineStore(
    name,
    type )
```

Value:

```
void name (Buffer *buf, type value) \
{ \
    type *slot = getBufferSlot (buf, sizeof value); \
    *slot = value; \
}
```

Temporary define to look up an element in an array of given type.

This definition is used to create lookup functions to return a given element in unsigned arrays of size 8, 16, and 32 bytes, and in an array of pixels.

Definition at line 350 of file hex2otf.c.

### 5.1.3 Typedef Documentation

#### 5.1.3.1 Buffer

typedef struct [Buffer](#) [Buffer](#)

Generic data structure for a linked list of buffer elements.

A buffer can act as a vector (when filled with 'store\*' functions), or a temporary output area (when filled with 'cache\*' functions). The 'store\*' functions use native endian. The 'cache\*' functions use big endian or other formats in OpenType. Beware of memory alignment.

#### 5.1.3.2 Glyph

typedef struct [Glyph](#) [Glyph](#)

Data structure to hold data for one bitmap glyph.

This data structure holds data to represent one Unifont bitmap glyph: Unicode code point, number of bytes in its bitmap array, whether or not it is a combining character, and an offset from the glyph origin to the start of the bitmap.

#### 5.1.3.3 Options

typedef struct [Options](#) [Options](#)

Data structure to hold options for OpenType font output.

This data structure holds the status of options that can be specified as command line arguments for creating the output OpenType font file.

#### 5.1.3.4 Table

typedef struct [Table](#) [Table](#)

Data structure for an OpenType table.

This data structure contains a table tag and a pointer to the start of the buffer that holds data for this OpenType table.

For information on the OpenType tables and their structure, see <https://docs.microsoft.com/en-us/typography/opentype/spec/otff#font-tables>.

### 5.1.4 Enumeration Type Documentation

#### 5.1.4.1 ContourOp

enum [ContourOp](#)

Specify the current contour drawing operation.

Enumerator

OP_CLOSE	Close the current contour path that was being drawn.
OP_POINT	Add one more (x,y) point to the contour being drawn.

Definition at line 1136 of file hex2otf.c.

```

1136 {
1137     OP_CLOSE,    ///< Close the current contour path that was being drawn.
1138     OP_POINT     ///< Add one more (x,y) point to the contour being drawn.
1139 };

```

#### 5.1.4.2 FillSide

enum [FillSide](#)

Fill to the left side (CFF) or right side (TrueType) of a contour.

Enumerator

FILL_LEFT	Draw outline counter-clockwise (CFF, PostScript).
FILL_RIGHT	Draw outline clockwise (TrueType).

Definition at line 1144 of file hex2otf.c.

```

1144 {
1145     FILL_LEFT,    ///< Draw outline counter-clockwise (CFF, PostScript).
1146     FILL_RIGHT    ///< Draw outline clockwise (TrueType).
1147 };

```

#### 5.1.4.3 LocaFormat

enum [LocaFormat](#)

Index to Location ("loca") offset information.

This enumerated type encodes the type of offset to locations in a table. It denotes Offset16 (16-bit) and Offset32 (32-bit) offset types.

Enumerator

LOCA_OFFSET16	Offset to location is a 16-bit Offset16 value.
LOCA_OFFSET32	Offset to location is a 32-bit Offset32 value.

Definition at line 658 of file hex2otf.c.

```

658 {

```

```

659  LOCA_OFFSET16 = 0,    ///< Offset to location is a 16-bit Offset16 value
660  LOCA_OFFSET32 = 1    ///< Offset to location is a 32-bit Offset32 value
661 };

```

## 5.1.5 Function Documentation

### 5.1.5.1 addTable()

```

void addTable (
    Font * font,
    const char tag[static 4],
    Buffer * content )

```

Add a TrueType or OpenType table to the font.

This function adds a TrueType or OpenType table to a font. The 4-byte table tag is passed as an unsigned 32-bit integer in big-endian format.

Parameters

in,out	font	The font to which a font table will be added.
in	tag	The 4-byte table name.
in	content	The table bytes to add, of type <a href="#">Buffer</a> *.

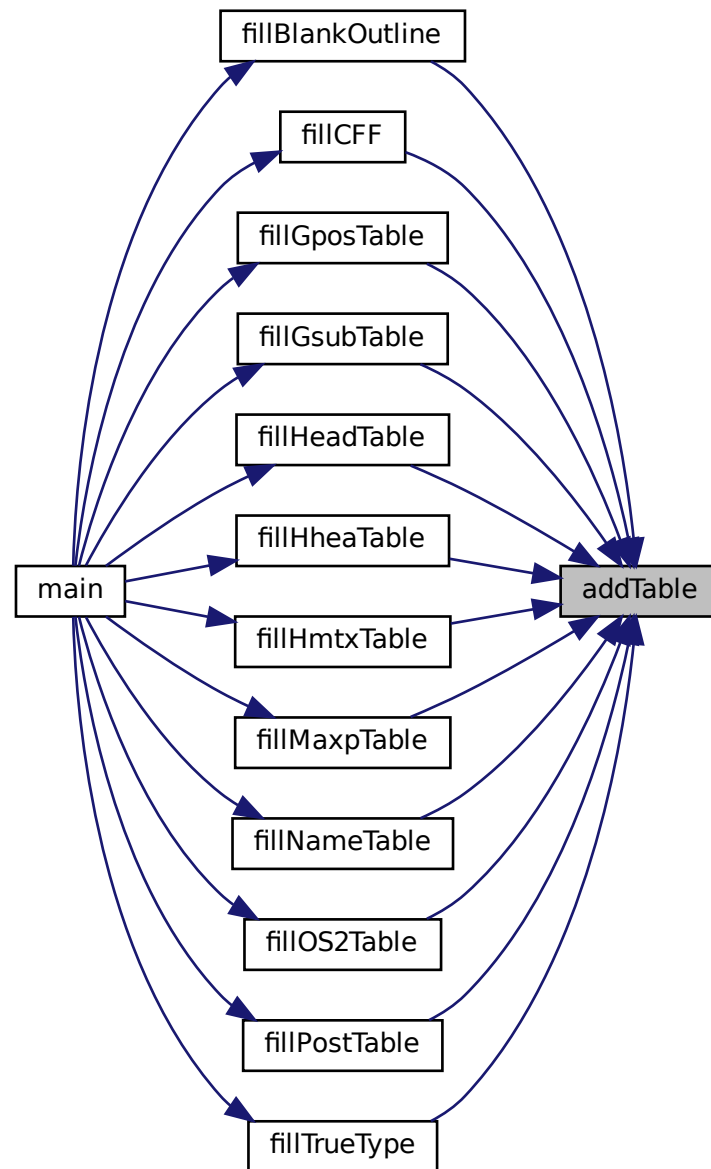
Definition at line 694 of file hex2otf.c.

```

695 {
696     Table *table = getBufferSlot (font->tables, sizeof (Table));
697     table->tag = tagAsU32 (tag);
698     table->content = content;
699 }

```

Here is the caller graph for this function:



#### 5.1.5.2 buildOutline()

```
void buildOutline (  
    Buffer * result,
```



```

const byte bitmap[],
const size_t byteCount,
const enum FillSide fillSide )

```

Build a glyph outline.

This function builds a glyph outline from a Unifont glyph bitmap.

Parameters

out	result	The resulting glyph outline.
in	bitmap	A bitmap array.
in	byteCount	the number of bytes in the input bitmap array.
in	fillSide	Enumerated indicator to fill left or right side.

Get the value of a given bit that is in a given row.

Invert the value of a given bit that is in a given row.

Definition at line 1160 of file hex2otf.c.

```

1162 {
1163     enum Direction {RIGHT, LEFT, DOWN, UP}; // order is significant
1164
1165     // respective coordinate deltas
1166     const pixels_t dx[] = {1, -1, 0, 0}, dy[] = {0, 0, -1, 1};
1167
1168     assert (byteCount % GLYPH_HEIGHT == 0);
1169     const uint_fast8_t bytesPerRow = byteCount / GLYPH_HEIGHT;
1170     const pixels_t glyphWidth = bytesPerRow * 8;
1171     assert (glyphWidth <= GLYPH_MAX_WIDTH);
1172
1173     #if GLYPH_MAX_WIDTH < 32
1174         typedef uint_fast32_t row_t;
1175     #elif GLYPH_MAX_WIDTH < 64
1176         typedef uint_fast64_t row_t;
1177     #else
1178         #error GLYPH_MAX_WIDTH is too large.
1179     #endif
1180
1181     row_t pixels[GLYPH_HEIGHT + 2] = {0};
1182     for (pixels_t row = GLYPH_HEIGHT; row > 0; row--)
1183         for (pixels_t b = 0; b < bytesPerRow; b++)
1184             pixels[row] = pixels[row] « 8 | *bitmap++;
1185     typedef row_t graph_t[GLYPH_HEIGHT + 1];
1186     graph_t vectors[4];
1187     const row_t *lower = pixels, *upper = pixels + 1;
1188     for (pixels_t row = 0; row <= GLYPH_HEIGHT; row++)
1189     {
1190         const row_t m = (fillSide == FILL_RIGHT) - 1;
1191         vectors[RIGHT][row] = (m ^ (*lower « 1)) & (~m ^ (*upper « 1));
1192         vectors[LEFT][row] = (m ^ (*upper )) & (~m ^ (*lower ));
1193         vectors[DOWN][row] = (m ^ (*lower )) & (~m ^ (*lower « 1));
1194         vectors[UP][row] = (m ^ (*upper « 1)) & (~m ^ (*upper ));
1195         lower++;
1196         upper++;
1197     }
1198     graph_t selection = {0};
1199     const row_t x0 = (row_t)1 « glyphWidth;
1200
1201     /// Get the value of a given bit that is in a given row.
1202     #define getRowBit(rows, x, y) ((rows)[(y)] & x0 » (x))
1203
1204     /// Invert the value of a given bit that is in a given row.
1205     #define flipRowBit(rows, x, y) ((rows)[(y)] ^ x0 » (x))
1206
1207     for (pixels_t y = GLYPH_HEIGHT; y >= 0; y--)
1208     {
1209         for (pixels_t x = 0; x <= glyphWidth; x++)

```

```

1210     {
1211         assert (!getRowBit (vectors[LEFT], x, y));
1212         assert (!getRowBit (vectors[UP], x, y));
1213         enum Direction initial;
1214
1215         if (getRowBit (vectors[RIGHT], x, y))
1216             initial = RIGHT;
1217         else if (getRowBit (vectors[DOWN], x, y))
1218             initial = DOWN;
1219         else
1220             continue;
1221
1222         static_assert ((GLYPH_MAX_WIDTH + 1) * (GLYPH_HEIGHT + 1) * 2 <=
1223             U16MAX, "potential overflow");
1224
1225         uint_fast16_t lastPointCount = 0;
1226         for (bool converged = false;;)
1227         {
1228             uint_fast16_t pointCount = 0;
1229             enum Direction heading = initial;
1230             for (pixels_t tx = x, ty = y;;)
1231             {
1232                 if (converged)
1233                 {
1234                     storePixels (result, OP_POINT);
1235                     storePixels (result, tx);
1236                     storePixels (result, ty);
1237                 }
1238                 do
1239                 {
1240                     if (converged)
1241                         flipRowBit (vectors[heading], tx, ty);
1242                     tx += dx[heading];
1243                     ty += dy[heading];
1244                 } while (getRowBit (vectors[heading], tx, ty));
1245                 if (tx == x && ty == y)
1246                     break;
1247                 static_assert ((UP ^ DOWN) == 1 && (LEFT ^ RIGHT) == 1,
1248                     "wrong enums");
1249                 heading = (heading & 2) ^ 2;
1250                 heading |= !getRowBit (selection, tx, ty);
1251                 heading ^= !getRowBit (vectors[heading], tx, ty);
1252                 assert (getRowBit (vectors[heading], tx, ty));
1253                 flipRowBit (selection, tx, ty);
1254                 pointCount++;
1255             }
1256             if (converged)
1257                 break;
1258             converged = pointCount == lastPointCount;
1259             lastPointCount = pointCount;
1260         }
1261
1262         storePixels (result, OP_CLOSE);
1263     }
1264 }
1265 #undef getRowBit
1266 #undef flipRowBit
1267 }

```

### 5.1.5.3 byCodePoint()

```

int byCodePoint (
    const void * a,
    const void * b )

```

Compare two Unicode code points to determine which is greater.

This function compares the Unicode code points contained within two [Glyph](#) data structures. The function returns 1 if the first code point is greater, and -1 if the second is greater.

## Parameters

in	a	A <a href="#">Glyph</a> data structure containing the first code point.
in	b	A <a href="#">Glyph</a> data structure containing the second code point.

## Returns

1 if the code point a is greater, -1 if less, 0 if equal.

Definition at line 1040 of file hex2otf.c.

```

1041 {
1042     const Glyph *const ga = a, *const gb = b;
1043     int gt = ga->codePoint > gb->codePoint;
1044     int lt = ga->codePoint < gb->codePoint;
1045     return gt - lt;
1046 }
```

## 5.1.5.4 byTableTag()

```

int byTableTag (
    const void * a,
    const void * b )
```

Compare tables by 4-byte unsigned table tag value.

This function takes two pointers to a [TableRecord](#) data structure and extracts the four-byte tag structure element for each. The two 32-bit numbers are then compared. If the first tag is greater than the first, then  $gt = 1$  and  $lt = 0$ , and so  $1 - 0 = 1$  is returned. If the first is less than the second, then  $gt = 0$  and  $lt = 1$ , and so  $0 - 1 = -1$  is returned.

## Parameters

in	a	Pointer to the first <a href="#">TableRecord</a> structure.
in	b	Pointer to the second <a href="#">TableRecord</a> structure.

## Returns

1 if the tag in "a" is greater, -1 if less, 0 if equal.

Definition at line 767 of file hex2otf.c.

```

768 {
769     const struct TableRecord *const ra = a, *const rb = b;
770     int gt = ra->tag > rb->tag;
771     int lt = ra->tag < rb->tag;
772     return gt - lt;
773 }
```

#### 5.1.5.5 cacheBuffer()

```
void cacheBuffer (
    Buffer *restrict bufDest,
    const Buffer *restrict bufSrc )
```

Append bytes of a table to a byte buffer.

Parameters

in,out	bufDest	The buffer to which the new bytes are appended.
in	bufSrc	The bytes to append to the buffer array.

Definition at line 523 of file hex2otf.c.

```
524 {
525     size_t length = countBufferedBytes (bufSrc);
526     ensureBuffer (bufDest, length);
527     memcpy (bufDest->next, bufSrc->begin, length);
528     bufDest->next += length;
529 }
```

#### 5.1.5.6 cacheBytes()

```
void cacheBytes (
    Buffer *restrict buf,
    const void *restrict src,
    size_t count )
```

Append a string of bytes to a buffer.

This function appends an array of 1 to 4 bytes to the end of a buffer.

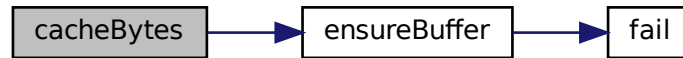
Parameters

in,out	buf	The buffer to which the bytes are appended.
in	src	The array of bytes to append to the buffer.
in	count	The number of bytes containing zeroes to append.

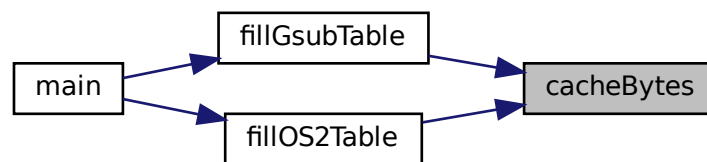
Definition at line 509 of file hex2otf.c.

```
510 {
511     ensureBuffer (buf, count);
512     memcpy (buf->next, src, count);
513     buf->next += count;
514 }
```

Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.7 cacheCFFOperand()

```
void cacheCFFOperand (
    Buffer * buf,
    int_fast32_t value )
```

Cache charstring number encoding in a CFF buffer.

This function caches two's complement 8-, 16-, and 32-bit words as per Adobe's Type 2 Charstring encoding for operands. These operands are used in Compact [Font](#) Format data structures.

Byte values can have offsets, for which this function compensates, optionally followed by additional bytes:

Byte Range	Offset	Bytes	Adjusted Range
0 to 11	0	1	0 to 11 (operators)
12	0	2	Next byte is 8-bit op code
13 to 18	0	1	13 to 18 (operators)
19 to 20	0	2+	hintmask and cntrmask operators
21 to 27	0	1	21 to 27 (operators)
28	0	3	16-bit 2's complement number
29 to 31	0	1	29 to 31 (operators)
32 to 246	-139	1	-107 to +107
247 to 250	+108	2	+108 to +1131
251 to 254	-108	2	-108 to -1131
255	0	5	16-bit integer and 16-bit fraction

## Parameters

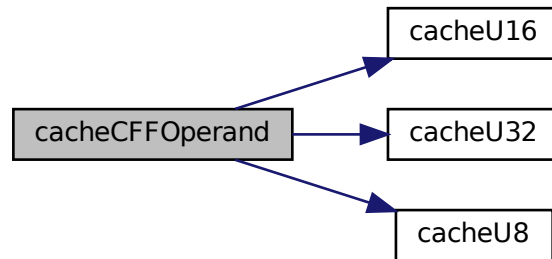
in,out	buf	The buffer to which the operand value is appended.
in	value	The operand value.

Definition at line 460 of file hex2otf.c.

```

461 {
462     if (-107 <= value && value <= 107)
463         cacheU8 (buf, value + 139);
464     else if (108 <= value && value <= 1131)
465     {
466         cacheU8 (buf, (value - 108) / 256 + 247);
467         cacheU8 (buf, (value - 108) % 256);
468     }
469     else if (-32768 <= value && value <= 32767)
470     {
471         cacheU8 (buf, 28);
472         cacheU16 (buf, value);
473     }
474     else if (-2147483647 <= value && value <= 2147483647)
475     {
476         cacheU8 (buf, 29);
477         cacheU32 (buf, value);
478     }
479     else
480         assert (false); // other encodings are not used and omitted
481     static_assert (GLYPH_MAX_WIDTH <= 107, "More encodings are needed.");
482 }
```

Here is the call graph for this function:



#### 5.1.5.8 cacheStringAsUTF16BE()

```

void cacheStringAsUTF16BE (
    Buffer * buf,
    const char * str )
```

Cache a string as a big-ending UTF-16 surrogate pair.

This function encodes a UTF-8 string as a big-endian UTF-16 surrogate pair.

## Parameters

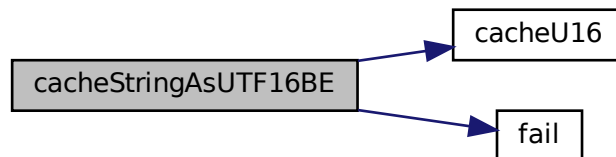
in,out	buf	Pointer to a <a href="#">Buffer</a> struct to update.
in	str	The character array to encode.

Definition at line 2316 of file hex2otf.c.

```

2317 {
2318     for (const char *p = str; *p; p++)
2319     {
2320         byte c = *p;
2321         if (c < 0x80)
2322         {
2323             cacheU16 (buf, c);
2324             continue;
2325         }
2326         int length = 1;
2327         byte mask = 0x40;
2328         for (; c & mask; mask »= 1)
2329             length++;
2330         if (length == 1 || length > 4)
2331             fail ("Ill-formed UTF-8 sequence.");
2332         uint_fast32_t codePoint = c & (mask - 1);
2333         for (int i = 1; i < length; i++)
2334         {
2335             c = *++p;
2336             if ((c & 0xc0) != 0x80) // NUL checked here
2337                 fail ("Ill-formed UTF-8 sequence.");
2338             codePoint = (codePoint « 6) | (c & 0x3f);
2339         }
2340         const int lowerBits = length==2 ? 7 : length==3 ? 11 : 16;
2341         if (codePoint » lowerBits == 0)
2342             fail ("Ill-formed UTF-8 sequence."); // sequence should be shorter
2343         if (codePoint >= 0xd800 && codePoint <= 0xdfff)
2344             fail ("Ill-formed UTF-8 sequence.");
2345         if (codePoint > 0x10ffff)
2346             fail ("Ill-formed UTF-8 sequence.");
2347         if (codePoint > 0xffff)
2348         {
2349             cacheU16 (buf, 0xd800 | (codePoint - 0x10000) » 10);
2350             cacheU16 (buf, 0xdc00 | (codePoint & 0x3fff));
2351         }
2352         else
2353             cacheU16 (buf, codePoint);
2354     }
2355 }
```

Here is the call graph for this function:



#### 5.1.5.9 cacheU16()

```
void cacheU16 (  
    Buffer * buf,  
    uint_fast16_t value )
```

Append two unsigned bytes to the end of a byte array.

This function adds two bytes to the end of a byte array. The buffer is updated to account for the newly-added bytes.

Parameters

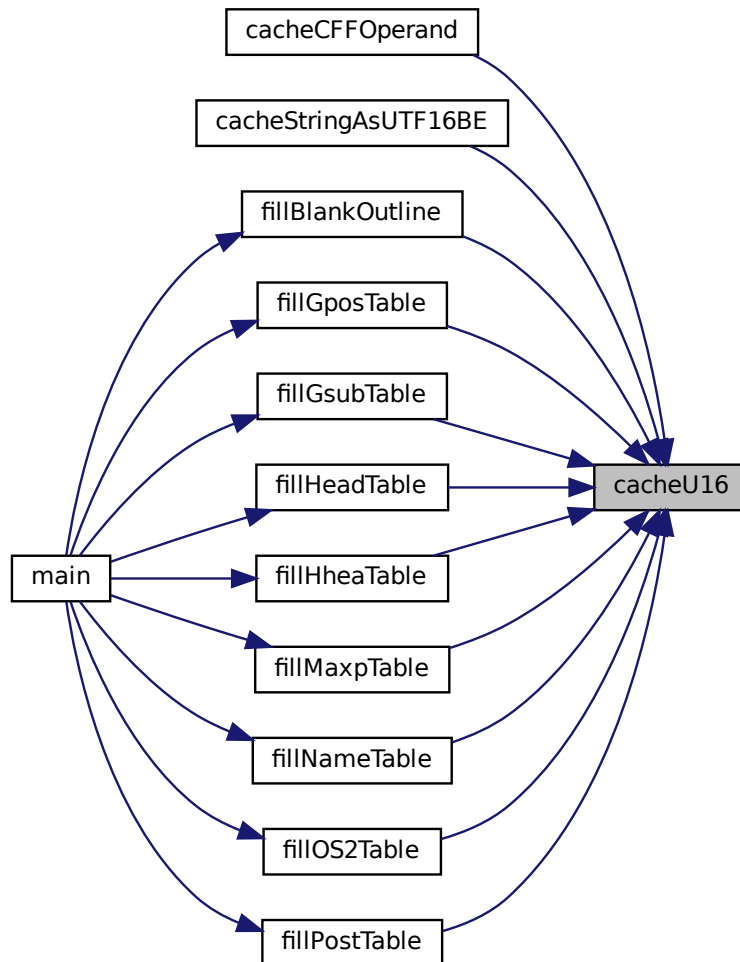
in,out	buf	The array of bytes to which to append two new bytes.
in	value	The 16-bit unsigned value to append to the buf array.

Definition at line 412 of file hex2otf.c.

```
413 {  
414     cacheU (buf, value, 2);  
415 }
```



Here is the caller graph for this function:



#### 5.1.5.10 cacheU32()

```
void cacheU32 (
    Buffer * buf,
    uint_fast32_t value )
```

Append four unsigned bytes to the end of a byte array.

This function adds four bytes to the end of a byte array. The buffer is updated to account for the newly-added bytes.

## Parameters

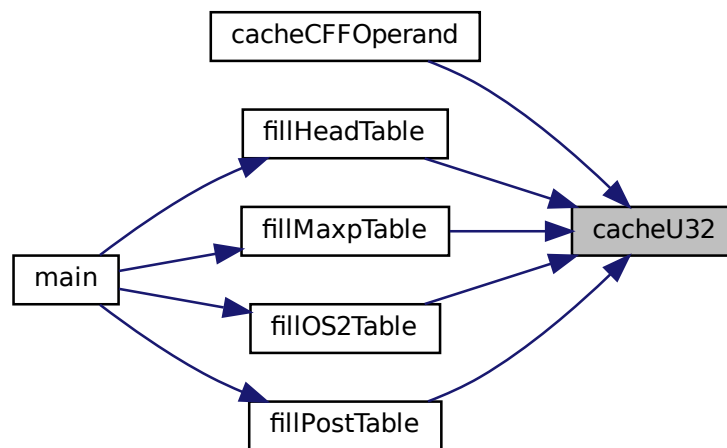
in,out	buf	The array of bytes to which to append four new bytes.
in	value	The 32-bit unsigned value to append to the buf array.

Definition at line 427 of file hex2otf.c.

```

428 {
429     cacheU (buf, value, 4);
430 }
```

Here is the caller graph for this function:

5.1.5.11 `cacheU8()`

```

void cacheU8 (
    Buffer * buf,
    uint_fast8_t value )
```

Append one unsigned byte to the end of a byte array.

This function adds one byte to the end of a byte array. The buffer is updated to account for the newly-added byte.

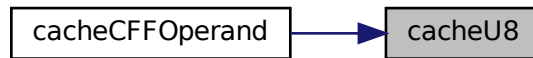
## Parameters

in,out	buf	The array of bytes to which to append a new byte.
in	value	The 8-bit unsigned value to append to the buf array.

Definition at line 397 of file hex2otf.c.

```
398 {
399     storeU8 (buf, value & 0xff);
400 }
```

Here is the caller graph for this function:



#### 5.1.5.12 cacheZeros()

```
void cacheZeros (
    Buffer * buf,
    size_t count )
```

Append 1 to 4 bytes of zeroes to a buffer, for padding.

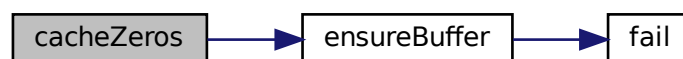
Parameters

in,out	buf	The buffer to which the operand value is appended.
in	count	The number of bytes containing zeroes to append.

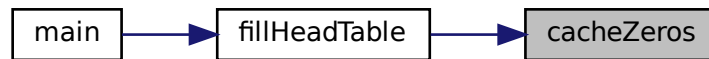
Definition at line 491 of file hex2otf.c.

```
492 {
493     ensureBuffer (buf, count);
494     memset (buf->next, 0, count);
495     buf->next += count;
496 }
```

Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.13 `cleanBuffers()`

```
void cleanBuffers ( )
```

Free all allocated buffer pointers.

This function frees all buffer pointers previously allocated in the `initBuffers` function.

Definition at line 170 of file `hex2otf.c`.

```
171 {  
172     for (size_t i = 0; i < bufferCount; i++)  
173         if (allBuffers[i].capacity)  
174             free (allBuffers[i].begin);  
175     free (allBuffers);  
176     bufferCount = 0;  
177 }
```

Here is the caller graph for this function:



#### 5.1.5.14 `ensureBuffer()`

```
void ensureBuffer (  
    Buffer * buf,  
    size_t needed )
```

Ensure that the buffer has at least the specified minimum size.

This function takes a buffer array of type `Buffer` and the necessary minimum number of elements as inputs, and attempts to increase the size of the buffer if it must be larger.

If the buffer is too small and cannot be resized, the program will terminate with an error message and an exit status of `EXIT_FAILURE`.

## Parameters

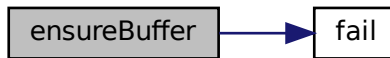
in,out	buf	The buffer to check.
in	needed	The required minimum number of elements in the buffer.

Definition at line 239 of file hex2otf.c.

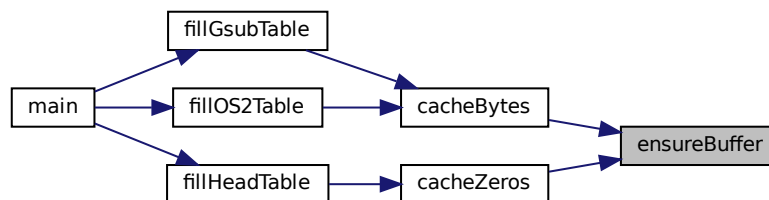
```

240 {
241     if (buf->end - buf->next >= needed)
242         return;
243     ptrdiff_t occupied = buf->next - buf->begin;
244     size_t required = occupied + needed;
245     if (required < needed) // overflow
246         fail ("Cannot allocate %zu + %zu bytes of memory.", occupied, needed);
247     if (required > SIZE_MAX / 2)
248         buf->capacity = required;
249     else while (buf->capacity < required)
250         buf->capacity *= 2;
251     void *extended = realloc (buf->begin, buf->capacity);
252     if (!extended)
253         fail ("Failed to allocate %zu bytes of memory.", buf->capacity);
254     buf->begin = extended;
255     buf->next = buf->begin + occupied;
256     buf->end = buf->begin + buf->capacity;
257 }
```

Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.15 fail()

```
void fail (  
    const char * reason,  
    ... )
```

Print an error message on stderr, then exit.

This function prints the provided error string and optional following arguments to stderr, and then exits with a status of EXIT\_FAILURE.

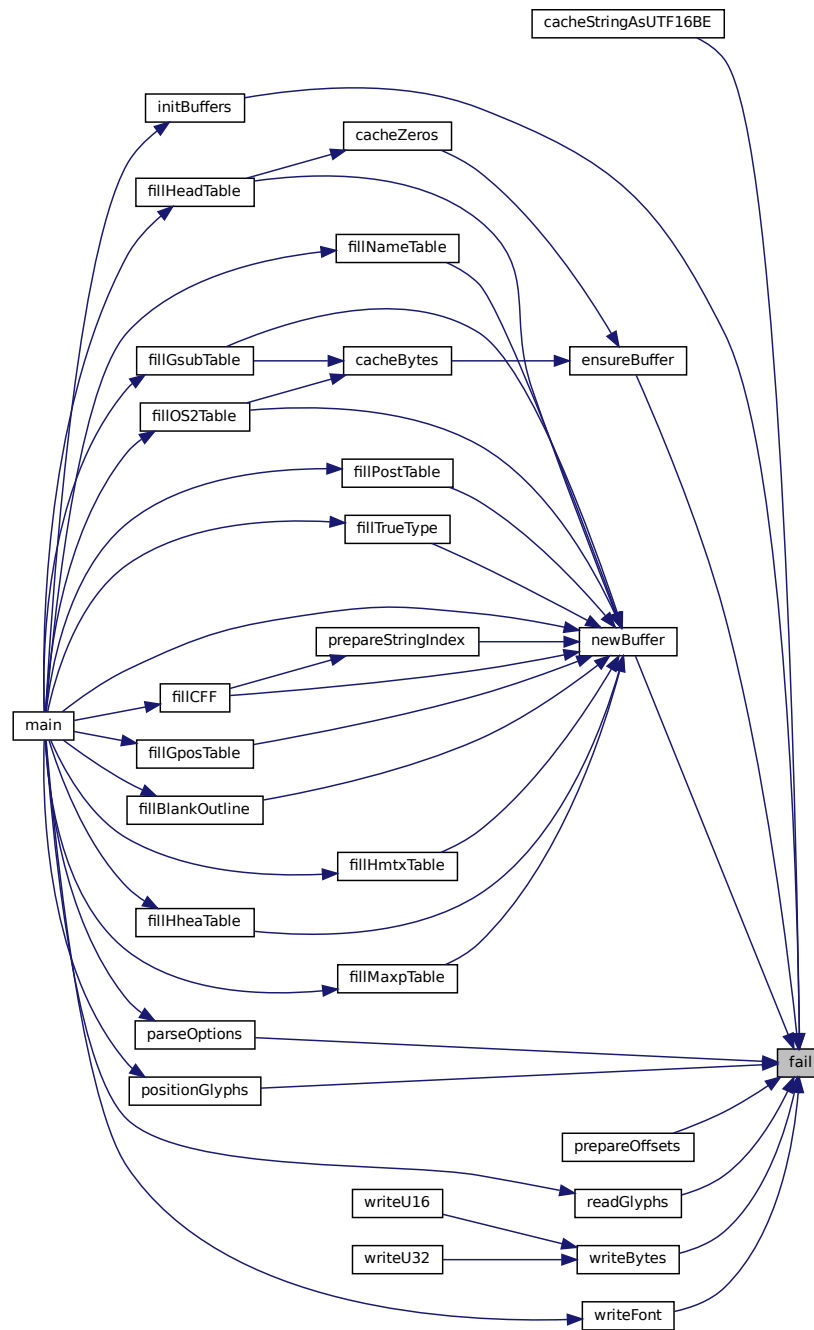
Parameters

in	reason	The output string to describe the error.
in	...	Optional following arguments to output.

Definition at line 113 of file hex2otf.c.

```
114 {  
115     fputs ("ERROR: ", stderr);  
116     va_list args;  
117     va_start (args, reason);  
118     vfprintf (stderr, reason, args);  
119     va_end (args);  
120     putc ('\n', stderr);  
121     exit (EXIT_FAILURE);  
122 }
```

Here is the caller graph for this function:



## 5.1.5.16 fillBitmap()

```
void fillBitmap (
    Font * font )
```

Fill OpenType bitmap data and location tables.

This function fills an Embedded Bitmap Data (EBDT) [Table](#) and an Embedded Bitmap Location (EBLC) [Table](#) with glyph bitmap information. These tables enable embedding bitmaps in OpenType fonts. No Embedded Bitmap Scaling (EBSC) table is used for the bitmap glyphs, only EBDT and EBLC.

Parameters

in,out	font	Pointer to a <a href="#">Font</a> struct in which to add bitmaps.
--------	------	---

Definition at line 1728 of file hex2otf.c.

```
1729 {
1730     const Glyph *const glyphs = getBufferHead (font->glyphs);
1731     const Glyph *const glyphsEnd = getBufferTail (font->glyphs);
1732     size_t bitmapsSize = 0;
1733     for (const Glyph *glyph = glyphs; glyph < glyphsEnd; glyph++)
1734         bitmapsSize += glyph->byteCount;
1735     Buffer *ebdt = newBuffer (4 + bitmapsSize);
1736     addTable (font, "EBDT", ebdt);
1737     cacheU16 (ebdt, 2); // majorVersion
1738     cacheU16 (ebdt, 0); // minorVersion
1739     uint_fast8_t byteCount = 0; // unequal to any glyph
1740     pixels_t pos = 0;
1741     bool combining = false;
1742     Buffer *rangeHeads = newBuffer (32);
1743     Buffer *offsets = newBuffer (64);
1744     for (const Glyph *glyph = glyphs; glyph < glyphsEnd; glyph++)
1745     {
1746         if (glyph->byteCount != byteCount || glyph->pos != pos ||
1747             glyph->combining != combining)
1748         {
1749             storeU16 (rangeHeads, glyph - glyphs);
1750             storeU32 (offsets, countBufferedBytes (ebdt));
1751             byteCount = glyph->byteCount;
1752             pos = glyph->pos;
1753             combining = glyph->combining;
1754         }
1755         cacheBytes (ebdt, glyph->bitmap, byteCount);
1756     }
1757     const uint_least16_t *ranges = getBufferHead (rangeHeads);
1758     const uint_least16_t *rangesEnd = getBufferTail (rangeHeads);
1759     uint_fast32_t rangeCount = rangesEnd - ranges;
1760     storeU16 (rangeHeads, font->glyphCount);
1761     Buffer *eblc = newBuffer (4096);
1762     addTable (font, "EBLC", eblc);
1763     cacheU16 (eblc, 2); // majorVersion
1764     cacheU16 (eblc, 0); // minorVersion
1765     cacheU32 (eblc, 1); // numSizes
1766     { // bitmapSizes[0]
1767         cacheU32 (eblc, 56); // indexSubTableArrayOffset
1768         cacheU32 (eblc, (8 + 20) * rangeCount); // indexTablesSize
1769         cacheU32 (eblc, rangeCount); // numberOfIndexSubTables
1770         cacheU32 (eblc, 0); // colorRef
1771         { // hori
1772             cacheU8 (eblc, ASCENDER); // ascender
1773             cacheU8 (eblc, -DESCENDER); // descender
1774             cacheU8 (eblc, font->maxWidth); // widthMax
1775             cacheU8 (eblc, 1); // caretSlopeNumerator
1776             cacheU8 (eblc, 0); // caretSlopeDenominator
1777             cacheU8 (eblc, 0); // caretOffset
1778             cacheU8 (eblc, 0); // minOriginSB
1779             cacheU8 (eblc, 0); // minAdvanceSB
1780             cacheU8 (eblc, ASCENDER); // maxBeforeBL
1781             cacheU8 (eblc, -DESCENDER); // minAfterBL
1782             cacheU8 (eblc, 0); // pad1
```



```

1783     cacheU8 (eblc, 0); // pad2
1784 }
1785 { // vert
1786     cacheU8 (eblc, ASCENDER); // ascender
1787     cacheU8 (eblc, -DESCENDER); // descender
1788     cacheU8 (eblc, font->maxWidth); // widthMax
1789     cacheU8 (eblc, 1); // caretSlopeNumerator
1790     cacheU8 (eblc, 0); // caretSlopeDenominator
1791     cacheU8 (eblc, 0); // caretOffset
1792     cacheU8 (eblc, 0); // minOriginSB
1793     cacheU8 (eblc, 0); // minAdvanceSB
1794     cacheU8 (eblc, ASCENDER); // maxBeforeBL
1795     cacheU8 (eblc, -DESCENDER); // minAfterBL
1796     cacheU8 (eblc, 0); // pad1
1797     cacheU8 (eblc, 0); // pad2
1798 }
1799 cacheU16 (eblc, 0); // startGlyphIndex
1800 cacheU16 (eblc, font->glyphCount - 1); // endGlyphIndex
1801 cacheU8 (eblc, 16); // ppemX
1802 cacheU8 (eblc, 16); // ppemY
1803 cacheU8 (eblc, 1); // bitDepth
1804 cacheU8 (eblc, 1); // flags = Horizontal
1805 }
1806 { // IndexSubTableArray
1807     uint_fast32_t offset = rangeCount * 8;
1808     for (const uint_least16_t *p = ranges; p < rangesEnd; p++)
1809     {
1810         cacheU16 (eblc, *p); // firstGlyphIndex
1811         cacheU16 (eblc, p[1] - 1); // lastGlyphIndex
1812         cacheU32 (eblc, offset); // additionalOffsetToIndexSubtable
1813         offset += 20;
1814     }
1815 }
1816 { // IndexSubTables
1817     const uint_least32_t *offset = getBufferHead (offsets);
1818     for (const uint_least16_t *p = ranges; p < rangesEnd; p++)
1819     {
1820         const Glyph *glyph = &glyphs[*p];
1821         cacheU16 (eblc, 2); // indexFormat
1822         cacheU16 (eblc, 5); // imageFormat
1823         cacheU32 (eblc, *offset++); // imageDataOffset
1824         cacheU32 (eblc, glyph->byteCount); // imageSize
1825         { // bigMetrics
1826             cacheU8 (eblc, GLYPH_HEIGHT); // height
1827             const uint_fast8_t width = PW (glyph->byteCount);
1828             cacheU8 (eblc, width); // width
1829             cacheU8 (eblc, glyph->pos); // horiBearingX
1830             cacheU8 (eblc, ASCENDER); // horiBearingY
1831             cacheU8 (eblc, glyph->combining ? 0 : width); // horiAdvance
1832             cacheU8 (eblc, 0); // vertBearingX
1833             cacheU8 (eblc, 0); // vertBearingY
1834             cacheU8 (eblc, GLYPH_HEIGHT); // vertAdvance
1835         }
1836     }
1837 }
1838 freeBuffer (rangeHeads);
1839 freeBuffer (offsets);
1840 }

```

Here is the caller graph for this function:



## 5.1.5.17 fillBlankOutline()

```
void fillBlankOutline (
    Font * font )
```

Create a dummy blank outline in a font table.

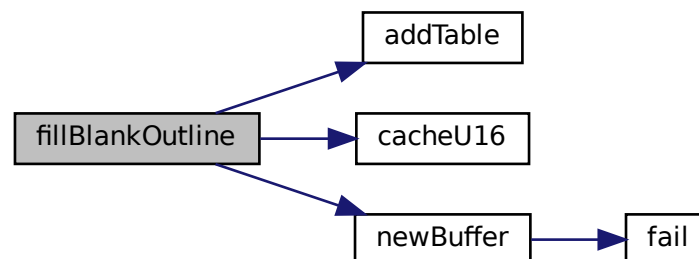
Parameters

in,out	font	Pointer to a <a href="#">Font</a> struct to insert a blank outline.
--------	------	---

Definition at line 1697 of file hex2otf.c.

```
1698 {
1699     Buffer *glyf = newBuffer (12);
1700     addTable (font, "glyf", glyf);
1701     // Empty table is not allowed, but an empty outline for glyph 0 suffices.
1702     cacheU16 (glyf, 0); // numberOfContours
1703     cacheU16 (glyf, FU (0)); // xMin
1704     cacheU16 (glyf, FU (0)); // yMin
1705     cacheU16 (glyf, FU (0)); // xMax
1706     cacheU16 (glyf, FU (0)); // yMax
1707     cacheU16 (glyf, 0); // instructionLength
1708     Buffer *loca = newBuffer (2 * (font->glyphCount + 1));
1709     addTable (font, "loca", loca);
1710     cacheU16 (loca, 0); // offsets[0]
1711     assert (countBufferedBytes (glyf) % 2 == 0);
1712     for (uint_fast32_t i = 1; i <= font->glyphCount; i++)
1713         cacheU16 (loca, countBufferedBytes (glyf) / 2); // offsets[i]
1714 }
```

Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.18 fillCFF()

```
void fillCFF (
    Font * font,
    int version,
    const NameStrings names )
```

Add a CFF table to a font.

Parameters

in,out	font	Pointer to a <a href="#">Font</a> struct to contain the CFF table.
in	version	Version of CFF table, with value 1 or 2.
in	names	List of NameStrings.

Use fixed width integer for variables to simplify offset calculation.

Definition at line 1329 of file hex2otf.c.

```

1330 {
1331     // HACK: For convenience, CFF data structures are hard coded.
1332     assert (0 < version && version <= 2);
1333     Buffer *cff = newBuffer (65536);
1334     addTable (font, version == 1 ? "CFF " : "CFF2", cff);
1335
1336     /// Use fixed width integer for variables to simplify offset calculation.
1337     #define cacheCFF32(buf, x) (cacheU8 ((buf), 29), cacheU32 ((buf), (x)))
1338
1339     // In Unifont, 16px glyphs are more common. This is used by CFF1 only.
1340     const pixels_t defaultWidth = 16, nominalWidth = 8;
1341     if (version == 1)
1342     {
1343         Buffer *strings = prepareStringIndex (names);
1344         size_t stringsSize = countBufferedBytes (strings);
1345         const char *cffName = names[6];
1346         assert (cffName);
1347         size_t nameLength = strlen (cffName);
1348         size_t namesSize = nameLength + 5;
1349         // These sizes must be updated together with the data below.
1350         size_t offsets[] = {4, namesSize, 45, stringsSize, 2, 5, 8, 32, 4, 0};
1351         prepareOffsets (offsets);
1352         { // Header
1353             cacheU8 (cff, 1); // major
1354             cacheU8 (cff, 0); // minor
1355             cacheU8 (cff, 4); // hdrSize

```

```

1356     cacheU8 (cff, 1); // offSize
1357 }
1358 assert (countBufferedBytes (cff) == offsets[0]);
1359 { // Name INDEX (should not be used by OpenType readers)
1360     cacheU16 (cff, 1); // count
1361     cacheU8 (cff, 1); // offSize
1362     cacheU8 (cff, 1); // offset[0]
1363     if (nameLength + 1 > 255) // must be too long; spec limit is 63
1364         fail ("PostScript name is too long.");
1365     cacheU8 (cff, nameLength + 1); // offset[1]
1366     cacheBytes (cff, cffName, nameLength);
1367 }
1368 assert (countBufferedBytes (cff) == offsets[1]);
1369 { // Top DICT INDEX
1370     cacheU16 (cff, 1); // count
1371     cacheU8 (cff, 1); // offSize
1372     cacheU8 (cff, 1); // offset[0]
1373     cacheU8 (cff, 41); // offset[1]
1374     cacheCFFOperand (cff, 391); // "Adobe"
1375     cacheCFFOperand (cff, 392); // "Identity"
1376     cacheCFFOperand (cff, 0);
1377     cacheBytes (cff, (byte[]) {12, 30}, 2); // ROS
1378     cacheCFF32 (cff, font->glyphCount);
1379     cacheBytes (cff, (byte[]) {12, 34}, 2); // CIDCount
1380     cacheCFF32 (cff, offsets[6]);
1381     cacheBytes (cff, (byte[]) {12, 36}, 2); // FDArray
1382     cacheCFF32 (cff, offsets[5]);
1383     cacheBytes (cff, (byte[]) {12, 37}, 2); // FDSelect
1384     cacheCFF32 (cff, offsets[4]);
1385     cacheU8 (cff, 15); // charset
1386     cacheCFF32 (cff, offsets[8]);
1387     cacheU8 (cff, 17); // CharStrings
1388 }
1389 assert (countBufferedBytes (cff) == offsets[2]);
1390 { // String INDEX
1391     cacheBuffer (cff, strings);
1392     freeBuffer (strings);
1393 }
1394 assert (countBufferedBytes (cff) == offsets[3]);
1395 cacheU16 (cff, 0); // Global Subr INDEX
1396 assert (countBufferedBytes (cff) == offsets[4]);
1397 { // Charsets
1398     cacheU8 (cff, 2); // format
1399     { // Range2[0]
1400         cacheU16 (cff, 1); // first
1401         cacheU16 (cff, font->glyphCount - 2); // nLeft
1402     }
1403 }
1404 assert (countBufferedBytes (cff) == offsets[5]);
1405 { // FDSelect
1406     cacheU8 (cff, 3); // format
1407     cacheU16 (cff, 1); // nRanges
1408     cacheU16 (cff, 0); // first
1409     cacheU8 (cff, 0); // fd
1410     cacheU16 (cff, font->glyphCount); // sentinel
1411 }
1412 assert (countBufferedBytes (cff) == offsets[6]);
1413 { // FDArray
1414     cacheU16 (cff, 1); // count
1415     cacheU8 (cff, 1); // offSize
1416     cacheU8 (cff, 1); // offset[0]
1417     cacheU8 (cff, 28); // offset[1]
1418     cacheCFFOperand (cff, 393);
1419     cacheBytes (cff, (byte[]) {12, 38}, 2); // FontName
1420     // Windows requires FontMatrix in Font DICT.
1421     const byte unit[] = {0x1e, 0x15, 0x62, 0x5c, 0x6f}; // 1/64 (0.015625)
1422     cacheBytes (cff, unit, sizeof unit);
1423     cacheCFFOperand (cff, 0);
1424     cacheCFFOperand (cff, 0);
1425     cacheBytes (cff, unit, sizeof unit);
1426     cacheCFFOperand (cff, 0);
1427     cacheCFFOperand (cff, 0);
1428     cacheBytes (cff, (byte[]) {12, 7}, 2); // FontMatrix
1429     cacheCFFOperand (cff, offsets[8] - offsets[7]); // size
1430     cacheCFF32 (cff, offsets[7]); // offset
1431     cacheU8 (cff, 18); // Private
1432 }
1433 assert (countBufferedBytes (cff) == offsets[7]);
1434 { // Private
1435     cacheCFFOperand (cff, FU (defaultWidth));
1436     cacheU8 (cff, 20); // defaultWidthX

```

```

1437     cacheCFFOperand (cff, FU (nominalWidth));
1438     cacheU8 (cff, 21); // nominalWidthX
1439 }
1440 assert (countBufferedBytes (cff) == offsets[8]);
1441 }
1442 else
1443 {
1444     assert (version == 2);
1445     // These sizes must be updated together with the data below.
1446     size_t offsets[] = {5, 21, 4, 10, 0};
1447     prepareOffsets (offsets);
1448     { // Header
1449         cacheU8 (cff, 2); // majorVersion
1450         cacheU8 (cff, 0); // minorVersion
1451         cacheU8 (cff, 5); // headerSize
1452         cacheU16 (cff, offsets[1] - offsets[0]); // topDictLength
1453     }
1454     assert (countBufferedBytes (cff) == offsets[0]);
1455     { // Top DICT
1456         const byte unit[] = {0x1e, 0x15, 0x62, 0x5c, 0x6f}; // 1/64 (0.015625)
1457         cacheBytes (cff, unit, sizeof unit);
1458         cacheCFFOperand (cff, 0);
1459         cacheCFFOperand (cff, 0);
1460         cacheBytes (cff, unit, sizeof unit);
1461         cacheCFFOperand (cff, 0);
1462         cacheCFFOperand (cff, 0);
1463         cacheBytes (cff, (byte[]) {12, 7}, 2); // FontMatrix
1464         cacheCFFOperand (cff, offsets[2]);
1465         cacheBytes (cff, (byte[]) {12, 36}, 2); // FDArray
1466         cacheCFFOperand (cff, offsets[3]);
1467         cacheU8 (cff, 17); // CharStrings
1468     }
1469     assert (countBufferedBytes (cff) == offsets[1]);
1470     cacheU32 (cff, 0); // Global Subr INDEX
1471     assert (countBufferedBytes (cff) == offsets[2]);
1472     { // Font DICT INDEX
1473         cacheU32 (cff, 1); // count
1474         cacheU8 (cff, 1); // offSize
1475         cacheU8 (cff, 1); // offset[0]
1476         cacheU8 (cff, 4); // offset[1]
1477         cacheCFFOperand (cff, 0);
1478         cacheCFFOperand (cff, 0);
1479         cacheU8 (cff, 18); // Private
1480     }
1481     assert (countBufferedBytes (cff) == offsets[3]);
1482 }
1483 { // CharStrings INDEX
1484     Buffer *offsets = newBuffer (4096);
1485     Buffer *charstrings = newBuffer (4096);
1486     Buffer *outline = newBuffer (1024);
1487     const Glyph *glyph = getBufferHead (font->glyphs);
1488     const Glyph *const endGlyph = glyph + font->glyphCount;
1489     for (; glyph < endGlyph; glyph++)
1490     {
1491         // CFF offsets start at 1
1492         storeU32 (offsets, countBufferedBytes (charstrings) + 1);
1493
1494         pixels_t rx = -glyph->pos;
1495         pixels_t ry = DESCENDER;
1496         resetBuffer (outline);
1497         buildOutline (outline, glyph->bitmap, glyph->byteCount, FILL_LEFT);
1498         enum CFFOp {rmoveto=21, hmoveto=22, vmoveto=4, hlineto=6,
1499             vlineto=7, endchar=14};
1500         enum CFFOp pendingOp = 0;
1501         const int STACK_LIMIT = version == 1 ? 48 : 513;
1502         int stackSize = 0;
1503         bool isDrawing = false;
1504         pixels_t width = glyph->combining ? 0 : PW (glyph->byteCount);
1505         if (version == 1 && width != defaultWidth)
1506         {
1507             cacheCFFOperand (charstrings, FU (width - nominalWidth));
1508             stackSize++;
1509         }
1510         for (const pixels_t *p = getBufferHead (outline),
1511             *const end = getBufferTail (outline); p < end;)
1512         {
1513             int s = 0;
1514             const enum ContourOp op = *p++;
1515             if (op == OP_POINT)
1516             {
1517                 const pixels_t x = *p++, y = *p++;

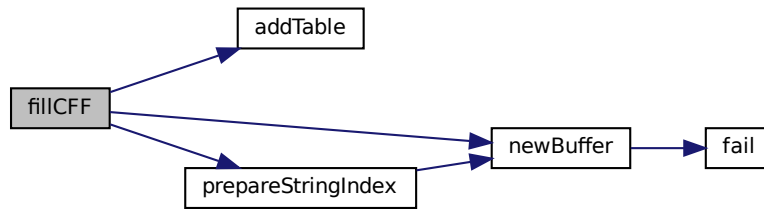
```

```

1518         if (x != rx)
1519         {
1520             cacheCFFOperand (charstrings, FU (x - rx));
1521             rx = x;
1522             stackSize++;
1523             s |= 1;
1524         }
1525         if (y != ry)
1526         {
1527             cacheCFFOperand (charstrings, FU (y - ry));
1528             ry = y;
1529             stackSize++;
1530             s |= 2;
1531         }
1532         assert (!(isDrawing && s == 3));
1533     }
1534     if (s)
1535     {
1536         if (!isDrawing)
1537         {
1538             const enum CFFOp moves[] = {0, hmoveto, vmoveto,
1539                                     rmoveto};
1540             cacheU8 (charstrings, moves[s]);
1541             stackSize = 0;
1542         }
1543         else if (!pendingOp)
1544             pendingOp = (enum CFFOp[]){0, hlineto, vlineto}[s];
1545     }
1546     else if (isDrawing)
1547     {
1548         // only when the first point happens to be (0, 0)
1549         cacheCFFOperand (charstrings, FU (0));
1550         cacheU8 (charstrings, hmoveto);
1551         stackSize = 0;
1552     }
1553     if (op == OP_CLOSE || stackSize >= STACK_LIMIT)
1554     {
1555         assert (stackSize <= STACK_LIMIT);
1556         cacheU8 (charstrings, pendingOp);
1557         pendingOp = 0;
1558         stackSize = 0;
1559     }
1560     isDrawing = op != OP_CLOSE;
1561 }
1562 if (version == 1)
1563     cacheU8 (charstrings, endchar);
1564 }
1565 size_t lastOffset = countBufferedBytes (charstrings) + 1;
1566 #if SIZE_MAX > U32MAX
1567     if (lastOffset > U32MAX)
1568         fail ("CFF data exceeded size limit.");
1569 #endif
1570 storeU32 (offsets, lastOffset);
1571 int offsetSize = 1 + (lastOffset > 0xff)
1572                 + (lastOffset > 0xffff)
1573                 + (lastOffset > 0xffffffff);
1574 // count (must match 'numGlyphs' in 'maxp' table)
1575 cacheU (cff, font->glyphCount, version * 2);
1576 cacheU8 (cff, offsetSize); // offSize
1577 const uint_least32_t *p = getBufferHead (offsets);
1578 const uint_least32_t *const end = getBufferTail (offsets);
1579 for (; p < end; p++)
1580     cacheU (cff, *p, offsetSize); // offsets
1581 cacheBuffer (cff, charstrings); // data
1582 freeBuffer (offsets);
1583 freeBuffer (charstrings);
1584 freeBuffer (outline);
1585 }
1586 #undef cacheCFF32
1587 }

```

Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.19 fillCmapTable()

```
void fillCmapTable (
    Font * font )
```

Fill a "cmap" font table.

The "cmap" table contains character to glyph index mapping information.

Parameters

in,out	font	The <a href="#">Font</a> struct to which to add the table.
--------	------	--

Definition at line 2109 of file hex2otf.c.

```

2110 {
2111     Glyph *const glyphs = getBufferHead (font->glyphs);
2112     Buffer *rangeHeads = newBuffer (16);
2113     uint_fast32_t rangeCount = 0;
2114     uint_fast32_t bmpRangeCount = 1; // 1 for the last 0xffff-0xffff range
2115     glyphs[0].codePoint = glyphs[1].codePoint; // to start a range at glyph 1
2116     for (uint_fast16_t i = 1; i < font->glyphCount; i++)
  
```

```

2117 {
2118     if (glyphs[i].codePoint != glyphs[i - 1].codePoint + 1)
2119     {
2120         storeU16 (rangeHeads, i);
2121         rangeCount++;
2122         bmpRangeCount += glyphs[i].codePoint < 0xffff;
2123     }
2124 }
2125 Buffer *cmap = newBuffer (256);
2126 addTable (font, "cmap", cmap);
2127 // Format 4 table is always generated for compatibility.
2128 bool hasFormat12 = glyphs[font->glyphCount - 1].codePoint > 0xffff;
2129 cacheU16 (cmap, 0); // version
2130 cacheU16 (cmap, 1 + hasFormat12); // numTables
2131 { // encodingRecords[0]
2132     cacheU16 (cmap, 3); // platformID
2133     cacheU16 (cmap, 1); // encodingID
2134     cacheU32 (cmap, 12 + 8 * hasFormat12); // subtableOffset
2135 }
2136 if (hasFormat12) // encodingRecords[1]
2137 {
2138     cacheU16 (cmap, 3); // platformID
2139     cacheU16 (cmap, 10); // encodingID
2140     cacheU32 (cmap, 36 + 8 * bmpRangeCount); // subtableOffset
2141 }
2142 const uint_least16_t *ranges = getBufferHead (rangeHeads);
2143 const uint_least16_t *const rangesEnd = getBufferTail (rangeHeads);
2144 storeU16 (rangeHeads, font->glyphCount);
2145 { // format 4 table
2146     cacheU16 (cmap, 4); // format
2147     cacheU16 (cmap, 16 + 8 * bmpRangeCount); // length
2148     cacheU16 (cmap, 0); // language
2149     if (bmpRangeCount * 2 > U16MAX)
2150         fail ("Too many ranges in 'cmap' table.");
2151     cacheU16 (cmap, bmpRangeCount * 2); // segCountX2
2152     uint_fast16_t searchRange = 1, entrySelector = -1;
2153     while (searchRange <= bmpRangeCount)
2154     {
2155         searchRange <<= 1;
2156         entrySelector++;
2157     }
2158     cacheU16 (cmap, searchRange); // searchRange
2159     cacheU16 (cmap, entrySelector); // entrySelector
2160     cacheU16 (cmap, bmpRangeCount * 2 - searchRange); // rangeShift
2161     { // endCode[]
2162         const uint_least16_t *p = ranges;
2163         for (p++; p < rangesEnd && glyphs[*p].codePoint < 0xffff; p++)
2164             cacheU16 (cmap, glyphs[*p - 1].codePoint);
2165         uint_fast32_t cp = glyphs[*p - 1].codePoint;
2166         if (cp > 0xffff)
2167             cp = 0xffff;
2168         cacheU16 (cmap, cp);
2169         cacheU16 (cmap, 0xffff);
2170     }
2171     cacheU16 (cmap, 0); // reservedPad
2172     { // startCode[]
2173         for (uint_fast32_t i = 0; i < bmpRangeCount - 1; i++)
2174             cacheU16 (cmap, glyphs[ranges[i]].codePoint);
2175         cacheU16 (cmap, 0xffff);
2176     }
2177     { // idDelta[]
2178         const uint_least16_t *p = ranges;
2179         for (; p < rangesEnd && glyphs[*p].codePoint < 0xffff; p++)
2180             cacheU16 (cmap, *p - glyphs[*p].codePoint);
2181         uint_fast16_t delta = 1;
2182         if (p < rangesEnd && *p == 0xffff)
2183             delta = *p - glyphs[*p].codePoint;
2184         cacheU16 (cmap, delta);
2185     }
2186     { // idRangeOffsets[]
2187         for (uint_least16_t i = 0; i < bmpRangeCount; i++)
2188             cacheU16 (cmap, 0);
2189     }
2190 }
2191 if (hasFormat12) // format 12 table
2192 {
2193     cacheU16 (cmap, 12); // format
2194     cacheU16 (cmap, 0); // reserved
2195     cacheU32 (cmap, 16 + 12 * rangeCount); // length
2196     cacheU32 (cmap, 0); // language
2197     cacheU32 (cmap, rangeCount); // numGroups

```



```

2198
2199     // groups[]
2200     for (const uint_least16_t *p = ranges; p < rangesEnd; p++)
2201     {
2202         cacheU32 (cmap, glyphs[*p].codePoint); // startCharCode
2203         cacheU32 (cmap, glyphs[p[1] - 1].codePoint); // endCharCode
2204         cacheU32 (cmap, *p); // startGlyphID
2205     }
2206 }
2207 freeBuffer (rangeHeads);
2208 }

```

Here is the caller graph for this function:



#### 5.1.5.20 fillGposTable()

```

void fillGposTable (
    Font * font )

```

Fill a "GPOS" font table.

The "GPOS" table contains information for glyph positioning.

Parameters

in,out	font	The <a href="#">Font</a> struct to which to add the table.
--------	------	--

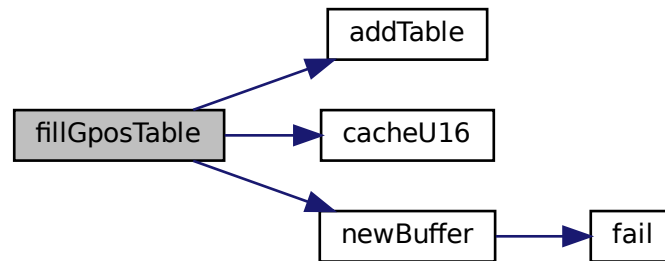
Definition at line 2241 of file hex2otf.c.

```

2242 {
2243     Buffer *gpos = newBuffer (16);
2244     addTable (font, "GPOS", gpos);
2245     cacheU16 (gpos, 1); // majorVersion
2246     cacheU16 (gpos, 0); // minorVersion
2247     cacheU16 (gpos, 10); // scriptListOffset
2248     cacheU16 (gpos, 12); // featureListOffset
2249     cacheU16 (gpos, 14); // lookupListOffset
2250     { // ScriptList table
2251         cacheU16 (gpos, 0); // scriptCount
2252     }
2253     { // Feature List table
2254         cacheU16 (gpos, 0); // featureCount
2255     }
2256     { // Lookup List Table
2257         cacheU16 (gpos, 0); // lookupCount
2258     }
2259 }

```

Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.21 fillGsubTable()

```
void fillGsubTable (
    Font * font )
```

Fill a "GSUB" font table.

The "GSUB" table contains information for glyph substitution.

Parameters

in,out	font	The <a href="#">Font</a> struct to which to add the table.
--------	------	--

Definition at line 2269 of file hex2otf.c.

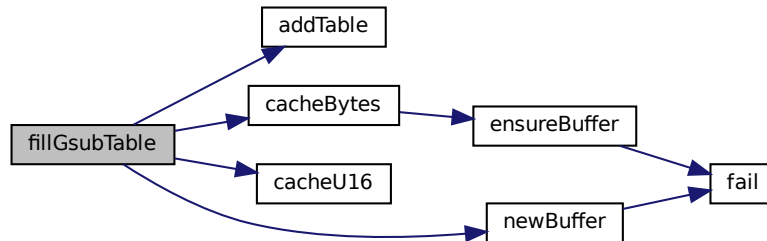
```
2270 {
2271     Buffer *gsub = newBuffer (38);
2272     addTable (font, "GSUB", gsub);
```

```

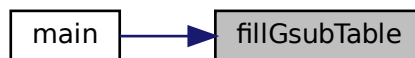
2273 cacheU16 (gsub, 1); // majorVersion
2274 cacheU16 (gsub, 0); // minorVersion
2275 cacheU16 (gsub, 10); // scriptListOffset
2276 cacheU16 (gsub, 34); // featureListOffset
2277 cacheU16 (gsub, 36); // lookupListOffset
2278 { // ScriptList table
2279     cacheU16 (gsub, 2); // scriptCount
2280     { // scriptRecords[0]
2281         cacheBytes (gsub, "DFLT", 4); // scriptTag
2282         cacheU16 (gsub, 14); // scriptOffset
2283     }
2284     { // scriptRecords[1]
2285         cacheBytes (gsub, "thai", 4); // scriptTag
2286         cacheU16 (gsub, 14); // scriptOffset
2287     }
2288     { // Script table
2289         cacheU16 (gsub, 4); // defaultLangSysOffset
2290         cacheU16 (gsub, 0); // langSysCount
2291         { // Default Language System table
2292             cacheU16 (gsub, 0); // lookupOrderOffset
2293             cacheU16 (gsub, 0); // requiredFeatureIndex
2294             cacheU16 (gsub, 0); // featureIndexCount
2295         }
2296     }
2297 }
2298 { // Feature List table
2299     cacheU16 (gsub, 0); // featureCount
2300 }
2301 { // Lookup List Table
2302     cacheU16 (gsub, 0); // lookupCount
2303 }
2304 }

```

Here is the call graph for this function:



Here is the caller graph for this function:



## 5.1.5.22 fillHeadTable()

```
void fillHeadTable (
    Font * font,
    enum LocaFormat locaFormat,
    pixels_t xMin )
```

Fill a "head" font table.

The "head" table contains font header information common to the whole font.

Parameters

in,out	font	The <code>Font</code> struct to which to add the table.
in	locaFormat	The "loca" offset index location table.
in	xMin	The minimum x-coordinate for a glyph.

Definition at line 1853 of file hex2otf.c.

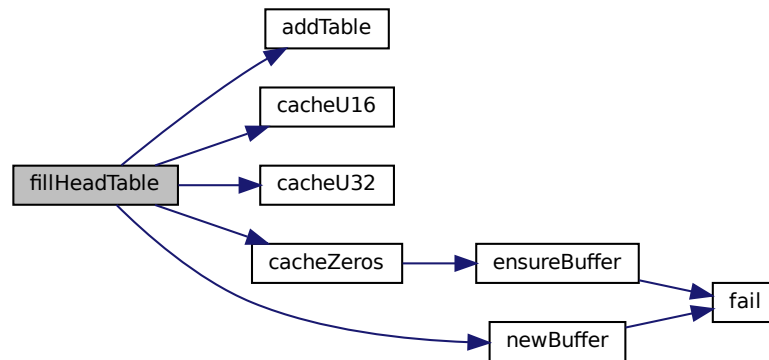
```
1854 {
1855     Buffer *head = newBuffer (56);
1856     addTable (font, "head", head);
1857     cacheU16 (head, 1); // majorVersion
1858     cacheU16 (head, 0); // minorVersion
1859     cacheZeros (head, 4); // fontRevision (unused)
1860     // The 'checksumAdjustment' field is a checksum of the entire file.
1861     // It is later calculated and written directly in the 'writeFont' function.
1862     cacheU32 (head, 0); // checksumAdjustment (placeholder)
1863     cacheU32 (head, 0x5f0f3cf5); // magicNumber
1864     const uint_fast16_t flags =
1865         + B1 (0) // baseline at y=0
1866         + B1 (1) // LSB at x=0 (doubtful; probably should be LSB=xMin)
1867         + B0 (2) // instructions may depend on point size
1868         + B0 (3) // force internal ppem to integers
1869         + B0 (4) // instructions may alter advance width
1870         + B0 (5) // not used in OpenType
1871         + B0 (6) // not used in OpenType
1872         + B0 (7) // not used in OpenType
1873         + B0 (8) // not used in OpenType
1874         + B0 (9) // not used in OpenType
1875         + B0 (10) // not used in OpenType
1876         + B0 (11) // font transformed
1877         + B0 (12) // font converted
1878         + B0 (13) // font optimized for ClearType
1879         + B0 (14) // last resort font
1880         + B0 (15) // reserved
1881     ;
1882     cacheU16 (head, flags); // flags
1883     cacheU16 (head, FUPEM); // unitsPerEm
1884     cacheZeros (head, 8); // created (unused)
1885     cacheZeros (head, 8); // modified (unused)
1886     cacheU16 (head, FU (xMin)); // xMin
1887     cacheU16 (head, FU (-DESCENDER)); // yMin
1888     cacheU16 (head, FU (font->maxWidth)); // xMax
1889     cacheU16 (head, FU (ASCENDER)); // yMax
1890     // macStyle (must agree with 'fsSelection' in 'OS/2' table)
1891     const uint_fast16_t macStyle =
1892         + B0 (0) // bold
1893         + B0 (1) // italic
1894         + B0 (2) // underline
1895         + B0 (3) // outline
1896         + B0 (4) // shadow
1897         + B0 (5) // condensed
1898         + B0 (6) // extended
1899         // 7-15 reserved
1900     ;
1901     cacheU16 (head, macStyle);
1902     cacheU16 (head, GLYPH_HEIGHT); // lowestRecPPEM
1903     cacheU16 (head, 2); // fontDirectionHint
1904     cacheU16 (head, locaFormat); // indexToLocFormat
```

```

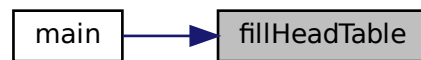
1905     cacheU16 (head, 0); // glyphDataFormat
1906 }

```

Here is the call graph for this function:



Here is the caller graph for this function:



### 5.1.5.23 fillHheaTable()

```

void fillHheaTable (
    Font * font,
    pixels_t xMin )

```

Fill a "hhea" font table.

The "hhea" table contains horizontal header information, for example left and right side bearings.

Parameters

in,out	font	The <code>Font</code> struct to which to add the table.
in	xMin	The minimum x-coordinate for a glyph.

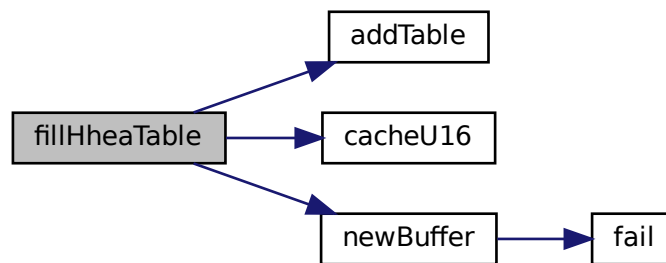
Definition at line 1918 of file hex2otf.c.

```

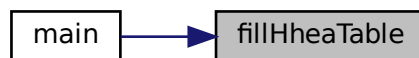
1919 {
1920     Buffer *hhea = newBuffer (36);
1921     addTable (font, "hhea", hhea);
1922     cacheU16 (hhea, 1); // majorVersion
1923     cacheU16 (hhea, 0); // minorVersion
1924     cacheU16 (hhea, FU (ASCENDER)); // ascender
1925     cacheU16 (hhea, FU (-DESCENDER)); // descender
1926     cacheU16 (hhea, FU (0)); // lineGap
1927     cacheU16 (hhea, FU (font->maxWidth)); // advanceWidthMax
1928     cacheU16 (hhea, FU (xMin)); // minLeftSideBearing
1929     cacheU16 (hhea, FU (0)); // minRightSideBearing (unused)
1930     cacheU16 (hhea, FU (font->maxWidth)); // xMaxExtent
1931     cacheU16 (hhea, 1); // caretSlopeRise
1932     cacheU16 (hhea, 0); // caretSlopeRun
1933     cacheU16 (hhea, 0); // caretOffset
1934     cacheU16 (hhea, 0); // reserved
1935     cacheU16 (hhea, 0); // reserved
1936     cacheU16 (hhea, 0); // reserved
1937     cacheU16 (hhea, 0); // reserved
1938     cacheU16 (hhea, 0); // metricDataFormat
1939     cacheU16 (hhea, font->glyphCount); // numberOfHMetrics
1940 }

```

Here is the call graph for this function:



Here is the caller graph for this function:



## 5.1.5.24 fillHmtxTable()

```
void fillHmtxTable (
    Font * font )
```

Fill an "hmtx" font table.

The "hmtx" table contains horizontal metrics information.

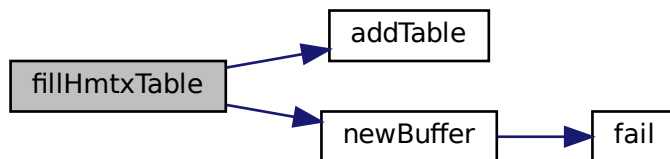
Parameters

in,out	font	The <a href="#">Font</a> struct to which to add the table.
--------	------	--

Definition at line 2087 of file hex2otf.c.

```
2088 {
2089     Buffer *hmtx = newBuffer (4 * font->glyphCount);
2090     addTable (font, "hmtx", hmtx);
2091     const Glyph *const glyphs = getBufferHead (font->glyphs);
2092     const Glyph *const glyphsEnd = getBufferTail (font->glyphs);
2093     for (const Glyph *glyph = glyphs; glyph < glyphsEnd; glyph++)
2094     {
2095         int_fast16_t aw = glyph->combining ? 0 : PW (glyph->byteCount);
2096         cacheU16 (hmtx, FU (aw)); // advanceWidth
2097         cacheU16 (hmtx, FU (glyph->lsb)); // lsb
2098     }
2099 }
```

Here is the call graph for this function:



Here is the caller graph for this function:



## 5.1.5.25 fillMaxpTable()

```
void fillMaxpTable (
    Font * font,
    bool isCFF,
    uint_fast16_t maxPoints,
    uint_fast16_t maxContours )
```

Fill a "maxp" font table.

The "maxp" table contains maximum profile information, such as the memory required to contain the font.

Parameters

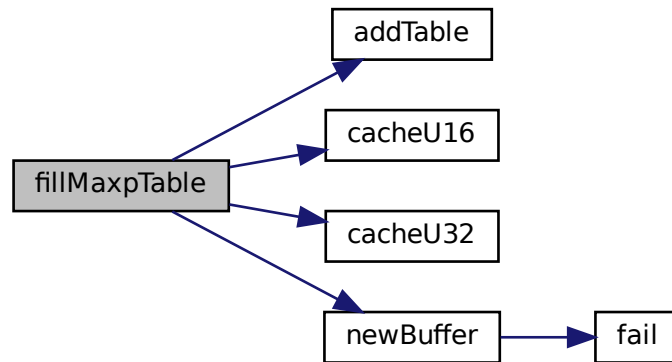
in,out	font	The <a href="#">Font</a> struct to which to add the table.
in	isCFF	true if a CFF font is included, false otherwise.
in	maxPoints	Maximum points in a non-composite glyph.
in	maxContours	Maximum contours in a non-composite glyph.

Definition at line 1954 of file hex2otf.c.

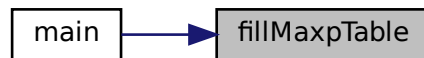
```
1956 {
1957     Buffer *maxp = newBuffer (32);
1958     addTable (font, "maxp", maxp);
1959     cacheU32 (maxp, isCFF ? 0x00005000 : 0x00010000); // version
1960     cacheU16 (maxp, font->glyphCount); // numGlyphs
1961     if (isCFF)
1962         return;
1963     cacheU16 (maxp, maxPoints); // maxPoints
1964     cacheU16 (maxp, maxContours); // maxContours
1965     cacheU16 (maxp, 0); // maxCompositePoints
1966     cacheU16 (maxp, 0); // maxCompositeContours
1967     cacheU16 (maxp, 0); // maxZones
1968     cacheU16 (maxp, 0); // maxTwilightPoints
1969     cacheU16 (maxp, 0); // maxStorage
1970     cacheU16 (maxp, 0); // maxFunctionDefs
1971     cacheU16 (maxp, 0); // maxInstructionDefs
1972     cacheU16 (maxp, 0); // maxStackElements
1973     cacheU16 (maxp, 0); // maxSizeOfInstructions
1974     cacheU16 (maxp, 0); // maxComponentElements
1975     cacheU16 (maxp, 0); // maxComponentDepth
1976 }
```



Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.26 fillNameTable()

```

void fillNameTable (
    Font * font,
    NameStrings nameStrings )
  
```

Fill a "name" font table.

The "name" table contains name information, for example for Name IDs.

Parameters

in,out	font	The <code>Font</code> struct to which to add the table.
in	names	List of <code>NameStrings</code> .

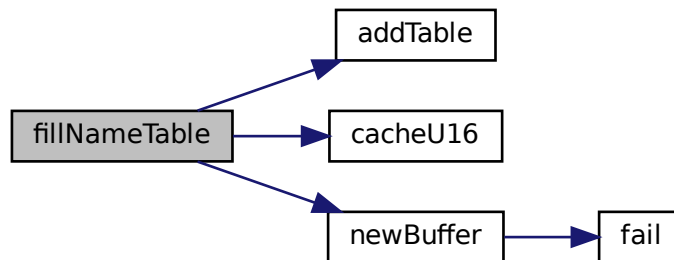
Definition at line 2366 of file hex2otf.c.

```

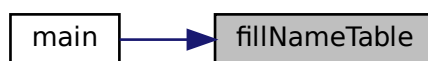
2367 {
2368     Buffer *name = newBuffer (2048);
2369     addTable (font, "name", name);
2370     size_t nameStringCount = 0;
2371     for (size_t i = 0; i < MAX_NAME_IDS; i++)
2372         nameStringCount += !nameStrings[i];
2373     cacheU16 (name, 0); // version
2374     cacheU16 (name, nameStringCount); // count
2375     cacheU16 (name, 2 * 3 + 12 * nameStringCount); // storageOffset
2376     Buffer *stringData = newBuffer (1024);
2377     // nameRecord[]
2378     for (size_t i = 0; i < MAX_NAME_IDS; i++)
2379     {
2380         if (!nameStrings[i])
2381             continue;
2382         size_t offset = countBufferedBytes (stringData);
2383         cacheStringAsUTF16BE (stringData, nameStrings[i]);
2384         size_t length = countBufferedBytes (stringData) - offset;
2385         if (offset > U16MAX || length > U16MAX)
2386             fail ("Name strings are too long.");
2387         // Platform ID 0 (Unicode) is not well supported.
2388         // ID 3 (Windows) seems to be the best for compatibility.
2389         cacheU16 (name, 3); // platformID = Windows
2390         cacheU16 (name, 1); // encodingID = Unicode BMP
2391         cacheU16 (name, 0x0409); // languageID = en-US
2392         cacheU16 (name, i); // nameID
2393         cacheU16 (name, length); // length
2394         cacheU16 (name, offset); // stringOffset
2395     }
2396     cacheBuffer (name, stringData);
2397     freeBuffer (stringData);
2398 }

```

Here is the call graph for this function:



Here is the caller graph for this function:



## 5.1.5.27 fillOS2Table()

```
void fillOS2Table (
    Font * font )
```

Fill an "OS/2" font table.

The "OS/2" table contains OS/2 and Windows font metrics information.

Parameters

in,out	font	The <a href="#">Font</a> struct to which to add the table.
--------	------	--

Definition at line 1986 of file hex2otf.c.

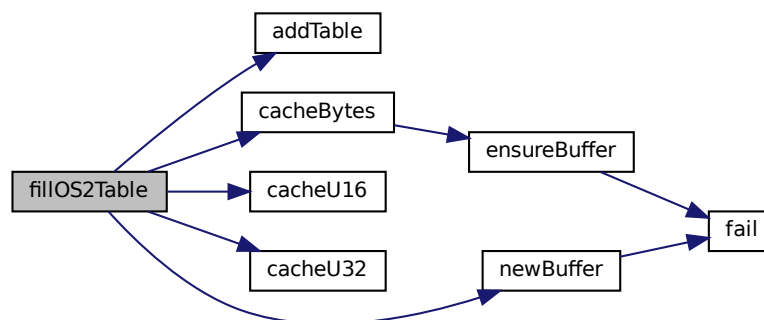
```
1987 {
1988     Buffer *os2 = newBuffer (100);
1989     addTable (font, "OS/2", os2);
1990     cacheU16 (os2, 5); // version
1991     // HACK: Average glyph width is not actually calculated.
1992     cacheU16 (os2, FU (font->maxWidth)); // xAvgCharWidth
1993     cacheU16 (os2, 400); // usWeightClass = Normal
1994     cacheU16 (os2, 5); // usWidthClass = Medium
1995     const uint_fast16_t typeFlags =
1996         + B0 (0) // reserved
1997         // usage permissions, one of:
1998         // Default: Installable embedding
1999         + B0 (1) // Restricted License embedding
2000         + B0 (2) // Preview & Print embedding
2001         + B0 (3) // Editable embedding
2002         // 4-7 reserved
2003         + B0 (8) // no subsetting
2004         + B0 (9) // bitmap embedding only
2005         // 10-15 reserved
2006 ;
2007     cacheU16 (os2, typeFlags); // fsType
2008     cacheU16 (os2, FU (5)); // ySubscriptXSize
2009     cacheU16 (os2, FU (7)); // ySubscriptYSize
2010     cacheU16 (os2, FU (0)); // ySubscriptXOffset
2011     cacheU16 (os2, FU (1)); // ySubscriptYOffset
2012     cacheU16 (os2, FU (5)); // ySuperscriptXSize
2013     cacheU16 (os2, FU (7)); // ySuperscriptYSize
2014     cacheU16 (os2, FU (0)); // ySuperscriptXOffset
2015     cacheU16 (os2, FU (4)); // ySuperscriptYOffset
2016     cacheU16 (os2, FU (1)); // yStrikeoutSize
2017     cacheU16 (os2, FU (5)); // yStrikeoutPosition
2018     cacheU16 (os2, 0x080a); // sFamilyClass = Sans Serif, Matrix
2019     const byte panose[] =
2020     {
2021         2, // Family Kind = Latin Text
2022         11, // Serif Style = Normal Sans
2023         4, // Weight = Thin
2024         // Windows would render all glyphs to the same width,
2025         // if 'Proportion' is set to 'Monospaced' (as Unifont should be).
2026         // 'Condensed' is the best alternative according to metrics.
2027         6, // Proportion = Condensed
2028         2, // Contrast = None
2029         2, // Stroke = No Variation
2030         2, // Arm Style = Straight Arms
2031         8, // Letterform = Normal/Square
2032         2, // Midline = Standard/Trimmed
2033         4, // X-height = Constant/Large
2034     };
2035     cacheBytes (os2, panose, sizeof panose); // panose
2036     // HACK: All defined Unicode ranges are marked functional for convenience.
2037     cacheU32 (os2, 0xffffffff); // ulUnicodeRange1
2038     cacheU32 (os2, 0xffffffff); // ulUnicodeRange2
2039     cacheU32 (os2, 0xffffffff); // ulUnicodeRange3
```

```

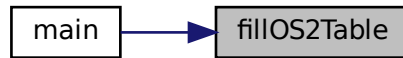
2040 cacheU32 (os2, 0x0efffff); // ulUnicodeRange4
2041 cacheBytes (os2, "GNU ", 4); // achVendID
2042 // fsSelection (must agree with 'macStyle' in 'head' table)
2043 const uint_fast16_t selection =
2044     + B0 (0) // italic
2045     + B0 (1) // underscored
2046     + B0 (2) // negative
2047     + B0 (3) // outlined
2048     + B0 (4) // strikeout
2049     + B0 (5) // bold
2050     + B1 (6) // regular
2051     + B1 (7) // use sTypo* metrics in this table
2052     + B1 (8) // font name conforms to WWS model
2053     + B0 (9) // oblique
2054     // 10-15 reserved
2055 ;
2056 cacheU16 (os2, selection);
2057 const Glyph *glyphs = getBufferHead (font->glyphs);
2058 uint_fast32_t first = glyphs[1].codePoint;
2059 uint_fast32_t last = glyphs[font->glyphCount - 1].codePoint;
2060 cacheU16 (os2, first < U16MAX ? first : U16MAX); // usFirstCharIndex
2061 cacheU16 (os2, last < U16MAX ? last : U16MAX); // usLastCharIndex
2062 cacheU16 (os2, FU (ASCENDER)); // sTypoAscender
2063 cacheU16 (os2, FU (-DESCENDER)); // sTypoDescender
2064 cacheU16 (os2, FU (0)); // sTypoLineGap
2065 cacheU16 (os2, FU (ASCENDER)); // usWinAscent
2066 cacheU16 (os2, FU (DESCENDER)); // usWinDescent
2067 // HACK: All reasonable code pages are marked functional for convenience.
2068 cacheU32 (os2, 0x603f01ff); // ulCodePageRange1
2069 cacheU32 (os2, 0xffff0000); // ulCodePageRange2
2070 cacheU16 (os2, FU (8)); // sxHeight
2071 cacheU16 (os2, FU (10)); // sCapHeight
2072 cacheU16 (os2, 0); // usDefaultChar
2073 cacheU16 (os2, 0x20); // usBreakChar
2074 cacheU16 (os2, 0); // usMaxContext
2075 cacheU16 (os2, 0); // usLowerOpticalPointSize
2076 cacheU16 (os2, 0xffff); // usUpperOpticalPointSize
2077 }

```

Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.28 fillPostTable()

```
void fillPostTable (
    Font * font )
```

Fill a "post" font table.

The "post" table contains information for PostScript printers.

Parameters

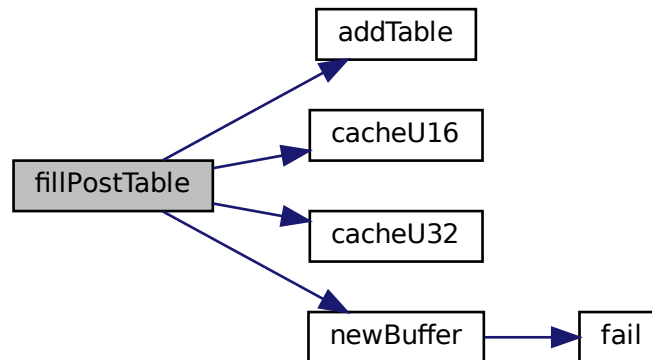
in,out	font	The <a href="#">Font</a> struct to which to add the table.
--------	------	--

Definition at line 2218 of file hex2otf.c.

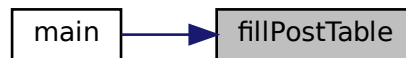
```

2219 {
2220     Buffer *post = newBuffer (32);
2221     addTable (font, "post", post);
2222     cacheU32 (post, 0x00030000); // version = 3.0
2223     cacheU32 (post, 0); // italicAngle
2224     cacheU16 (post, 0); // underlinePosition
2225     cacheU16 (post, 1); // underlineThickness
2226     cacheU32 (post, 1); // isFixedPitch
2227     cacheU32 (post, 0); // minMemType42
2228     cacheU32 (post, 0); // maxMemType42
2229     cacheU32 (post, 0); // minMemType1
2230     cacheU32 (post, 0); // maxMemType1
2231 }
```

Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.29 fillTrueType()

```

void fillTrueType (
    Font * font,
    enum LocaFormat * format,
    uint_fast16_t * maxPoints,
    uint_fast16_t * maxContours )
  
```

Add a TrueType table to a font.

Parameters

in,out	font	Pointer to a <a href="#">Font</a> struct to contain the TrueType table.
in	format	The TrueType "loca" table format, Offset16 or Offset32.
in	names	List of NameStrings.

Definition at line 1597 of file hex2otf.c.

```

1599 {
1600     Buffer *glyf = newBuffer (65536);
1601     addTable (font, "glyf", glyf);
1602     Buffer *loca = newBuffer (4 * (font->glyphCount + 1));
1603     addTable (font, "loca", loca);
1604     *format = LOCA_OFFSET32;
1605     Buffer *endPoints = newBuffer (256);
1606     Buffer *flags = newBuffer (256);
1607     Buffer *xs = newBuffer (256);
1608     Buffer *ys = newBuffer (256);
1609     Buffer *outline = newBuffer (1024);
1610     Glyph *const glyphs = getBufferHead (font->glyphs);
1611     const Glyph *const glyphsEnd = getBufferTail (font->glyphs);
1612     for (Glyph *glyph = glyphs; glyph < glyphsEnd; glyph++)
1613     {
1614         cacheU32 (loca, countBufferedBytes (glyph));
1615         pixels_t rx = -glyph->pos;
1616         pixels_t ry = DESCENDER;
1617         pixels_t xMin = GLYPH_MAX_WIDTH, xMax = 0;
1618         pixels_t yMin = ASCENDER, yMax = -DESCENDER;
1619         resetBuffer (endPoints);
1620         resetBuffer (flags);
1621         resetBuffer (xs);
1622         resetBuffer (ys);
1623         resetBuffer (outline);
1624         buildOutline (outline, glyph->bitmap, glyph->byteCount, FILL_RIGHT);
1625         uint_fast32_t pointCount = 0, contourCount = 0;
1626         for (const pixels_t *p = getBufferHead (outline),
1627              *const end = getBufferTail (outline); p < end;)
1628         {
1629             const enum ContourOp op = *p++;
1630             if (op == OP_CLOSE)
1631             {
1632                 contourCount++;
1633                 assert (contourCount <= U16MAX);
1634                 cacheU16 (endPoints, pointCount - 1);
1635                 continue;
1636             }
1637             assert (op == OP_POINT);
1638             pointCount++;
1639             assert (pointCount <= U16MAX);
1640             const pixels_t x = *p++, y = *p++;
1641             uint_fast8_t pointFlags =
1642                 + B1 (0) // point is on curve
1643                 + BX (1, x != rx) // x coordinate is 1 byte instead of 2
1644                 + BX (2, y != ry) // y coordinate is 1 byte instead of 2
1645                 + B0 (3) // repeat
1646                 + BX (4, x >= rx) // when x is 1 byte: x is positive;
1647                   // when x is 2 bytes: x unchanged and omitted
1648                 + BX (5, y >= ry) // when y is 1 byte: y is positive;
1649                   // when y is 2 bytes: y unchanged and omitted
1650                 + B1 (6) // contours may overlap
1651                 + B0 (7) // reserved
1652             ;
1653             cacheU8 (flags, pointFlags);
1654             if (x != rx)
1655                 cacheU8 (xs, FU (x > rx ? x - rx : rx - x));
1656             if (y != ry)
1657                 cacheU8 (ys, FU (y > ry ? y - ry : ry - y));
1658             if (x < xMin) xMin = x;
1659             if (y < yMin) yMin = y;
1660             if (x > xMax) xMax = x;
1661             if (y > yMax) yMax = y;
1662             rx = x;
1663             ry = y;
1664         }
1665         if (contourCount == 0)
1666             continue; // blank glyph is indicated by the 'loca' table
1667         glyph->lsb = glyph->pos + xMin;
1668         cacheU16 (glyf, contourCount); // numberOfContours
1669         cacheU16 (glyf, FU (glyph->pos + xMin)); // xMin
1670         cacheU16 (glyf, FU (yMin)); // yMin
1671         cacheU16 (glyf, FU (glyph->pos + xMax)); // xMax
1672         cacheU16 (glyf, FU (yMax)); // yMax
1673         cacheBuffer (glyf, endPoints); // endPtsOfContours[]
1674         cacheU16 (glyf, 0); // instructionLength
1675         cacheBuffer (glyf, flags); // flags[]
1676         cacheBuffer (glyf, xs); // xCoordinates[]
1677         cacheBuffer (glyf, ys); // yCoordinates[]
1678         if (pointCount > *maxPoints)

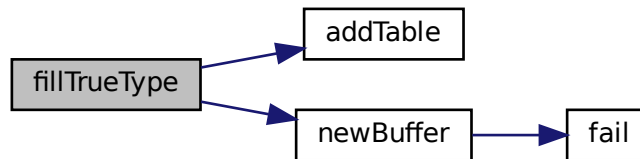
```

```

1679     *maxPoints = pointCount;
1680     if (contourCount > *maxContours)
1681         *maxContours = contourCount;
1682 }
1683 cacheU32 (loca, countBufferedBytes (glyf));
1684 freeBuffer (endPoints);
1685 freeBuffer (flags);
1686 freeBuffer (xs);
1687 freeBuffer (ys);
1688 freeBuffer (outline);
1689 }

```

Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.30 freeBuffer()

```

void freeBuffer (
    Buffer * buf )

```

Free the memory previously allocated for a buffer.

This function frees the memory allocated to an array of type `Buffer *`.

Parameters

in	buf	The pointer to an array of type <code>Buffer *</code> .
----	-----	---



Definition at line 337 of file hex2otf.c.

```
338 {  
339     free (buf->begin);  
340     buf->capacity = 0;  
341 }
```

#### 5.1.5.31 initBuffers()

```
void initBuffers (  
    size_t count )
```

Initialize an array of buffer pointers to all zeroes.

This function initializes the "allBuffers" array of buffer pointers to all zeroes.

Parameters

in	count	The number of buffer array pointers to allocate.
----	-------	--

Definition at line 152 of file hex2otf.c.

```
153 {  
154     assert (count > 0);  
155     assert (bufferCount == 0); // uninitialized  
156     allBuffers = calloc (count, sizeof *allBuffers);  
157     if (!allBuffers)  
158         fail ("Failed to initialize buffers.");  
159     bufferCount = count;  
160     nextBufferIndex = 0;  
161 }
```

Here is the call graph for this function:



Here is the caller graph for this function:



### 5.1.5.32 main()

```
int main (
    int argc,
    char * argv[] )
```

The main function.

Parameters

in	argc	The number of command-line arguments.
in	argv	The array of command-line arguments.

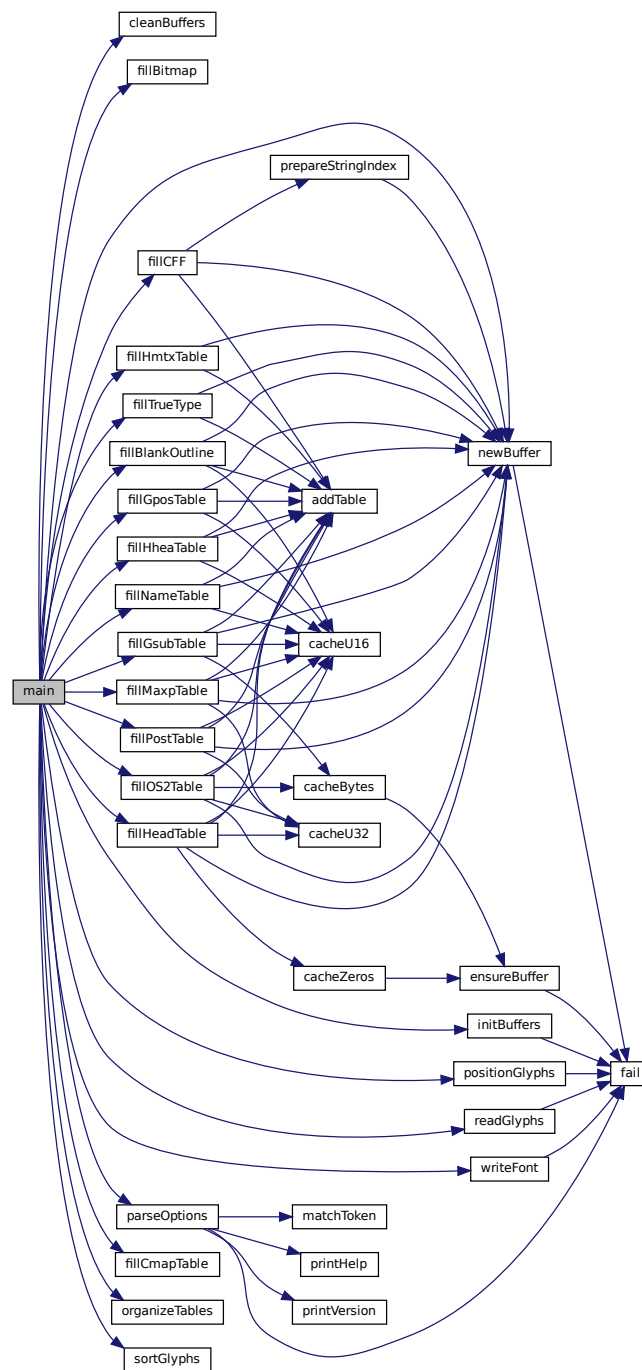
Returns

EXIT\_FAILURE upon fatal error, EXIT\_SUCCESS otherwise.

Definition at line 2603 of file hex2otf.c.

```
2604 {
2605     initBuffers (16);
2606     atexit (cleanBuffers);
2607     Options opt = parseOptions (argv);
2608     Font font;
2609     font.tables = newBuffer (sizeof (Table) * 16);
2610     font.glyphs = newBuffer (sizeof (Glyph) * MAX_GLYPHS);
2611     readGlyphs (&font, opt.hex);
2612     sortGlyphs (&font);
2613     enum LocaFormat loca = LOCA_OFFSET16;
2614     uint_fast16_t maxPoints = 0, maxContours = 0;
2615     pixels_t xMin = 0;
2616     if (opt.pos)
2617         positionGlyphs (&font, opt.pos, &xMin);
2618     if (opt.gpos)
2619         fillGposTable (&font);
2620     if (opt.gsub)
2621         fillGsubTable (&font);
2622     if (opt.cff)
2623         fillCFF (&font, opt.cff, opt.nameStrings);
2624     if (opt.trueType)
2625         fillTrueType (&font, &loca, &maxPoints, &maxContours);
2626     if (opt.blankOutline)
2627         fillBlankOutline (&font);
2628     if (opt.bitmap)
2629         fillBitmap (&font);
2630     fillHeadTable (&font, loca, xMin);
2631     fillHheaTable (&font, xMin);
2632     fillMaxpTable (&font, opt.cff, maxPoints, maxContours);
2633     fillOS2Table (&font);
2634     fillNameTable (&font, opt.nameStrings);
2635     fillHmtxTable (&font);
2636     fillCmapTable (&font);
2637     fillPostTable (&font);
2638     organizeTables (&font, opt.cff);
2639     writeFont (&font, opt.cff, opt.out);
2640     return EXIT_SUCCESS;
2641 }
```

Here is the call graph for this function:



### 5.1.5.33 matchToken()

```
const char* matchToken (
    const char * operand,
    const char * key,
    char delimiter )
```

Match a command line option with its key for enabling.

Parameters

in	operand	A pointer to the specified operand.
in	key	Pointer to the option structure.
in	delimiter	The delimiter to end searching.

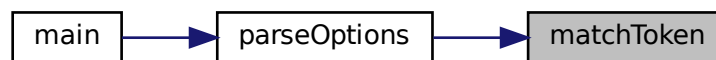
Returns

Pointer to the first character of the desired option.

Definition at line 2470 of file hex2otf.c.

```
2471 {
2472     while (*key)
2473         if (*operand++ != *key++)
2474             return NULL;
2475     if (!*operand || *operand++ == delimiter)
2476         return operand;
2477     return NULL;
2478 }
```

Here is the caller graph for this function:



### 5.1.5.34 newBuffer()

```
Buffer* newBuffer (
    size_t initialCapacity )
```

Create a new buffer.

This function creates a new buffer array of type [Buffer](#), with an initial size of initialCapacity elements.

## Parameters

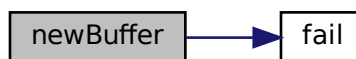
in	initialCapacity	The initial number of elements in the buffer.
----	-----------------	---

Definition at line 188 of file hex2otf.c.

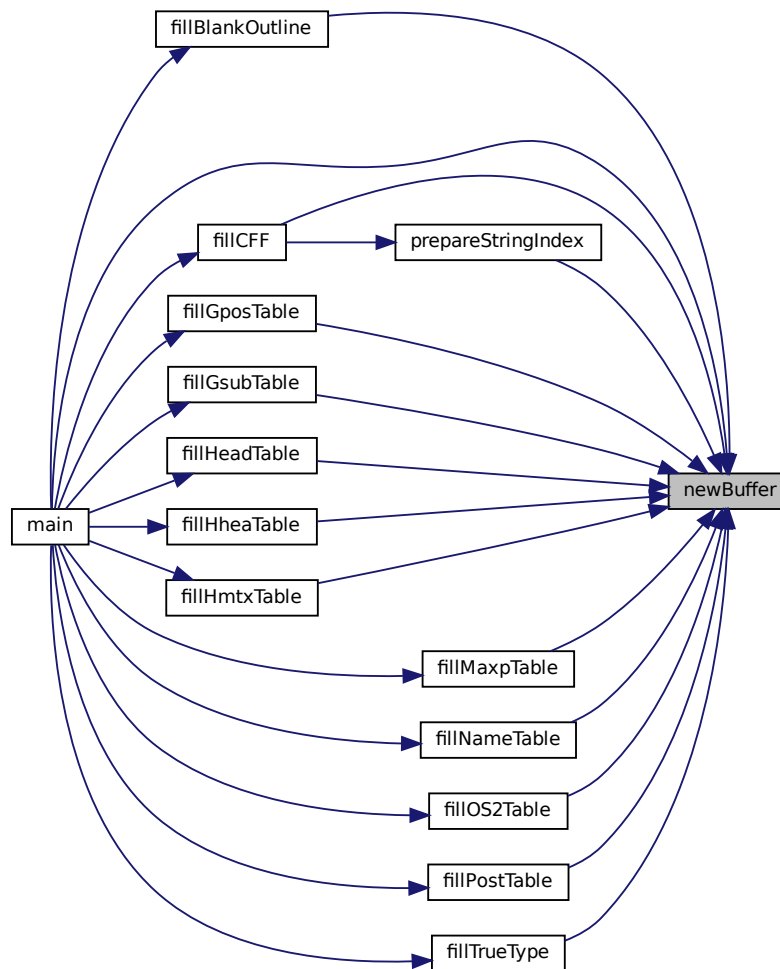
```

189 {
190     assert (initialCapacity > 0);
191     Buffer *buf = NULL;
192     size_t sentinel = nextBufferIndex;
193     do
194     {
195         if (nextBufferIndex == bufferCount)
196             nextBufferIndex = 0;
197         if (allBuffers[nextBufferIndex].capacity == 0)
198         {
199             buf = &allBuffers[nextBufferIndex++];
200             break;
201         }
202     } while (++nextBufferIndex != sentinel);
203     if (!buf) // no existing buffer available
204     {
205         size_t newSize = sizeof (Buffer) * bufferCount * 2;
206         void *extended = realloc (allBuffers, newSize);
207         if (!extended)
208             fail ("Failed to create new buffers.");
209         allBuffers = extended;
210         memset (allBuffers + bufferCount, 0, sizeof (Buffer) * bufferCount);
211         buf = &allBuffers[bufferCount];
212         nextBufferIndex = bufferCount + 1;
213         bufferCount *= 2;
214     }
215     buf->begin = malloc (initialCapacity);
216     if (!buf->begin)
217         fail ("Failed to allocate %zu bytes of memory.", initialCapacity);
218     buf->capacity = initialCapacity;
219     buf->next = buf->begin;
220     buf->end = buf->begin + initialCapacity;
221     return buf;
222 }
```

Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.35 organizeTables()

```

void organizeTables (
    Font * font,
    bool isCFF )
  
```

Sort tables according to OpenType recommendations.

The various tables in a font are sorted in an order recommended for TrueType font files.

## Parameters

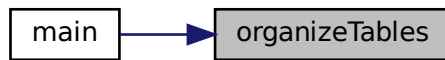
in,out	font	The font in which to sort tables.
in	isCFF	True iff Compact <a href="#">Font</a> Format (CFF) is being used.

Definition at line 711 of file hex2otf.c.

```

712 {
713     const char *const cffOrder[] = {"head", "hhea", "maxp", "OS/2", "name",
714         "cmap", "post", "CFF ", NULL};
715     const char *const truetypeOrder[] = {"head", "hhea", "maxp", "OS/2",
716         "hmtx", "LTSH", "VDMX", "hdmx", "cmap", "fpgm", "prep", "cvt ", "loca",
717         "glyf", "kern", "name", "post", "gasp", "PCLT", "DSIG", NULL};
718     const char *const *const order = isCFF ? cffOrder : truetypeOrder;
719     Table *unordered = getBufferHead (font->tables);
720     const Table *const tablesEnd = getBufferTail (font->tables);
721     for (const char *const *p = order; *p; p++)
722     {
723         uint_fast32_t tag = tagAsU32 (*p);
724         for (Table *t = unordered; t < tablesEnd; t++)
725         {
726             if (t->tag != tag)
727                 continue;
728             if (t != unordered)
729             {
730                 Table temp = *unordered;
731                 *unordered = *t;
732                 *t = temp;
733             }
734             unordered++;
735             break;
736         }
737     }
738 }
```

Here is the caller graph for this function:



## 5.1.5.36 parseOptions()

```
Options parseOptions (
    char *const argv[const ] )
```

Parse command line options.

Option	Data Type	Description
truetype	bool	Generate TrueType outlines
blankOutline	bool	Generate blank outlines
bitmap	bool	Generate embedded bitmap
gpos	bool	Generate a dummy GPOS table
gsub	bool	Generate a dummy GSUB table
cff	int	Generate CFF 1 or CFF 2 outlines
hex	const char *	Name of Unifont .hex file
pos	const char *	Name of Unifont combining data file
out	const char *	Name of output font file
nameStrings	NameStrings	Array of TrueType font Name IDs

### Parameters

in	argv	Pointer to array of command line options.
----	------	---

### Returns

Data structure to hold requested command line options.

Definition at line 2500 of file hex2otf.c.

```

2501 {
2502     Options opt = {0}; // all options default to 0, false and NULL
2503     const char *format = NULL;
2504     struct StringArg
2505     {
2506         const char *const key;
2507         const char **const value;
2508     } strArgs[] =
2509     {
2510         {"hex", &opt.hex},
2511         {"pos", &opt.pos},
2512         {"out", &opt.out},
2513         {"format", &format},
2514         {NULL, NULL} // sentinel
2515     };
2516     for (char *const *argp = argv + 1; *argp; argp++)
2517     {
2518         const char *const arg = *argp;
2519         struct StringArg *p;
2520         const char *value = NULL;
2521         if (strcmp (arg, "--help") == 0)
2522             printHelp ();
2523         if (strcmp (arg, "--version") == 0)
2524             printVersion ();
2525         for (p = strArgs; p->key; p++)
2526             if ((value = matchToken (arg, p->key, '=')))
2527                 break;
2528         if (p->key)
2529         {
2530             if (!*value)
2531                 fail ("Empty argument: '%s'", p->key);
2532             if (*p->value)
2533                 fail ("Duplicate argument: '%s'", p->key);
2534             *p->value = value;
2535         }
2536         else // shall be a name string
2537         {
2538             char *endptr;
2539             unsigned long id = strtoul (arg, &endptr, 10);
2540             if (endptr == arg || id >= MAX_NAME_IDS || *endptr != '=')
2541                 fail ("Invalid argument: '%s'", arg);
2542             endptr++; // skip '='
2543             if (opt.nameStrings[id])
2544                 fail ("Duplicate name ID: %lu.", id);
2545             opt.nameStrings[id] = endptr;
2546         }
2547     }
2548     if (!opt.hex)

```

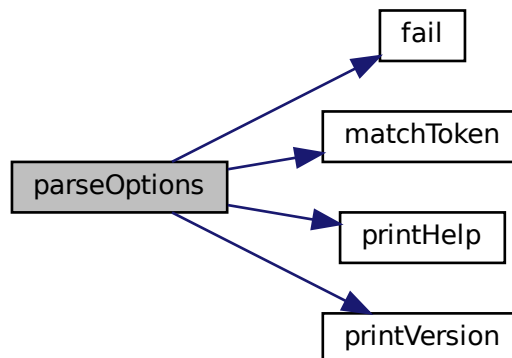


```

2549     fail ("Hex file is not specified.");
2550 if (opt.pos && opt.pos[0] == '\0')
2551     opt.pos = NULL; // Position file is optional. Empty path means none.
2552 if (!opt.out)
2553     fail ("Output file is not specified.");
2554 if (!format)
2555     fail ("Format is not specified.");
2556 for (const NamePair *p = defaultNames; p->str; p++)
2557     if (!opt.nameStrings[p->id])
2558         opt.nameStrings[p->id] = p->str;
2559 bool cff = false, cff2 = false;
2560 struct Symbol
2561 {
2562     const char *const key;
2563     bool *const found;
2564 } symbols[] =
2565 {
2566     {"cff", &cff},
2567     {"cff2", &cff2},
2568     {"truetype", &opt.truetype},
2569     {"blank", &opt.blankOutline},
2570     {"bitmap", &opt.bitmap},
2571     {"gpos", &opt.gpos},
2572     {"gsub", &opt.gsub},
2573     {NULL, NULL} // sentinel
2574 };
2575 while (*format)
2576 {
2577     const struct Symbol *p;
2578     const char *next = NULL;
2579     for (p = symbols; p->key; p++)
2580         if ((next = matchToken (format, p->key, ','))
2581             break;
2582     if (!p->key)
2583         fail ("Invalid format.");
2584     *p->found = true;
2585     format = next;
2586 }
2587 if (cff + cff2 + opt.truetype + opt.blankOutline > 1)
2588     fail ("At most one outline format can be accepted.");
2589 if (!(cff || cff2 || opt.truetype || opt.bitmap))
2590     fail ("Invalid format.");
2591 opt.cff = cff + cff2 * 2;
2592 return opt;
2593 }

```

Here is the call graph for this function:



Here is the caller graph for this function:



### 5.1.5.37 positionGlyphs()

```

void positionGlyphs (
    Font * font,
    const char * fileName,
    pixels_t * xMin )
  
```

Position a glyph within a 16-by-16 pixel bounding box.

Position a glyph within the 16-by-16 pixel drawing area and note whether or not the glyph is a combining character.

N.B.: Glyphs must be sorted by code point before calling this function.

Parameters

in,out	font	Font data structure pointer to store glyphs.
in	fileName	Name of glyph file to read.
in	xMin	Minimum x-axis value (for left side bearing).

Definition at line 1061 of file hex2otf.c.

```

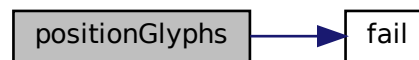
1062 {
1063     *xMin = 0;
1064     FILE *file = fopen (fileName, "r");
1065     if (!file)
1066         fail ("Failed to open file '%s'", fileName);
1067     Glyph *glyphs = getBufferHead (font->glyphs);
1068     const Glyph *const endGlyph = glyphs + font->glyphCount;
1069     Glyph *nextGlyph = &glyphs[1]; // predict and avoid search
1070     for (;;)
1071     {
1072         uint_fast32_t codePoint;
1073         if (readCodePoint (&codePoint, fileName, file))
1074             break;
1075         Glyph *glyph = nextGlyph;
1076         if (glyph == endGlyph || glyph->codePoint != codePoint)
1077         {
1078             // Prediction failed. Search.
1079             const Glyph key = { .codePoint = codePoint };
1080             glyph = bsearch (&key, glyphs + 1, font->glyphCount - 1,
1081                             sizeof key, byCodePoint);
1082             if (!glyph)
  
```

```

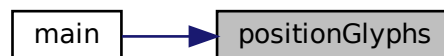
1083         fail ("Glyph "PRI_CP" is positioned but not defined.",
1084              codePoint);
1085     }
1086     nextGlyph = glyph + 1;
1087     char s[8];
1088     if (!fgets (s, sizeof s, file))
1089         fail ("%s: Read error.", fileName);
1090     char *end;
1091     const long value = strtol (s, &end, 10);
1092     if (*end != '\n' && *end != '\0')
1093         fail ("Position of glyph "PRI_CP" is invalid.", codePoint);
1094     // Currently no glyph is moved to the right,
1095     // so positive position is considered out of range.
1096     // If this limit is to be lifted,
1097     // 'xMax' of bounding box in 'head' table shall also be updated.
1098     if (value < -GLYPH_MAX_WIDTH || value > 0)
1099         fail ("Position of glyph "PRI_CP" is out of range.", codePoint);
1100     glyph->combining = true;
1101     glyph->pos = value;
1102     glyph->lsb = value; // updated during outline generation
1103     if (value < *xMin)
1104         *xMin = value;
1105 }
1106 fclose (file);
1107 }

```

Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.38 prepareOffsets()

```

void prepareOffsets (
    size_t * sizes )

```

Prepare 32-bit glyph offsets in a font table.

## Parameters

in	sizes	Array of glyph sizes, for offset calculations.
----	-------	--

Definition at line 1275 of file hex2otf.c.

```

1276 {
1277     size_t *p = sizes;
1278     for (size_t *i = sizes + 1; *i; i++)
1279         *i += *p++;
1280     if (*p > 2147483647U) // offset not representable
1281         fail ("CFE table is too large.");
1282 }
```

Here is the call graph for this function:



## 5.1.5.39 prepareStringIndex()

```

Buffer* prepareStringIndex (
    const NameStrings names )
```

Prepare a font name string index.

## Parameters

in	names	List of name strings.
----	-------	-----------------------

## Returns

Pointer to a [Buffer](#) struct containing the string names.

Get the number of elements in array `char *strings[]`.

Definition at line 1291 of file hex2otf.c.

```

1292 {
1293     Buffer *buf = newBuffer (256);
1294     assert (names[6]);
1295     const char *strings[] = {"Adobe", "Identity", names[6]};
1296     /// Get the number of elements in array char *strings[]
1297     #define stringCount (sizeof strings / sizeof *strings)
1298     static_assert (stringCount <= U16MAX, "too many strings");
```

```

1299     size_t offset = 1;
1300     size_t lengths[stringCount];
1301     for (size_t i = 0; i < stringCount; i++)
1302     {
1303         assert (strings[i]);
1304         lengths[i] = strlen (strings[i]);
1305         offset += lengths[i];
1306     }
1307     int offsetSize = 1 + (offset > 0xff)
1308                     + (offset > 0xffff)
1309                     + (offset > 0xfffff);
1310     cacheU16 (buf, stringCount); // count
1311     cacheU8 (buf, offsetSize); // offsetSize
1312     cacheU (buf, offset = 1, offsetSize); // offset[0]
1313     for (size_t i = 0; i < stringCount; i++)
1314         cacheU (buf, offset += lengths[i], offsetSize); // offset[i + 1]
1315     for (size_t i = 0; i < stringCount; i++)
1316         cacheBytes (buf, strings[i], lengths[i]);
1317 #undef stringCount
1318     return buf;
1319 }

```

Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.40 printHelp()

```
void printHelp ( )
```

Print help message to stdout and then exit.

Print help message if invoked with the "--help" option, and then exit successfully.

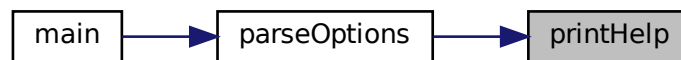
Definition at line 2426 of file hex2otf.c.

```

2426     {
2427     printf ("Synopsis: hex2otf <options>:\n\n");
2428     printf ("    hex=<filename>      Specify Unifont .hex input file.\n");
2429     printf ("    pos=<filename>      Specify combining file. (Optional)\n");
2430     printf ("    out=<filename>      Specify output font file.\n");
2431     printf ("    format=<f1>,<f2>,... Specify font format(s); values:\n");
2432     printf ("                        cff\n");
2433     printf ("                        cff2\n");
2434     printf ("                        truetype\n");
2435     printf ("                        blank\n");
2436     printf ("                        bitmap\n");
2437     printf ("                        gpos\n");
2438     printf ("                        gsub\n");
2439     printf ("\nExample:\n\n");
2440     printf ("    hex2otf hex=Myfont.hex out=Myfont.otf format=cff\n");
2441     printf ("For more information, consult the hex2otf(1) man page.\n\n");
2442
2443     exit (EXIT_SUCCESS);
2444 }

```

Here is the caller graph for this function:



#### 5.1.5.41 printVersion()

```
void printVersion ( )
```

Print program version string on stdout.

Print program version if invoked with the "--version" option, and then exit successfully.

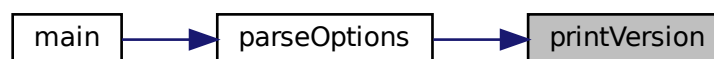
Definition at line 2407 of file hex2otf.c.

```

2407     {
2408     printf ("hex2otf (GNU Unifont) %s\n", VERSION);
2409     printf ("Copyright \u00A9 2022 \u4F55\u5FD7\u7FD4 (He Zhixiang)\n");
2410     printf ("License GPLv2+: GNU GPL version 2 or later\n");
2411     printf ("<https://gnu.org/licenses/gpl.html>\n");
2412     printf ("This is free software: you are free to change and\n");
2413     printf ("redistribute it. There is NO WARRANTY, to the extent\n");
2414     printf ("permitted by law.\n");
2415
2416     exit (EXIT_SUCCESS);
2417 }

```

Here is the caller graph for this function:



## 5.1.5.42 readCodePoint()

```
bool readCodePoint (
    uint_fast32_t * codePoint,
    const char * fileName,
    FILE * file )
```

Read up to 6 hexadecimal digits and a colon from file.

This function reads up to 6 hexadecimal digits followed by a colon from a file.

If the end of the file is reached, the function returns true. The file name is provided to include in an error message if the end of file was reached unexpectedly.

Parameters

out	codePoint	The Unicode code point.
in	fileName	The name of the input file.
in	file	Pointer to the input file stream.

Returns

true if at end of file, false otherwise.

Definition at line 919 of file hex2otf.c.

```
920 {
921     *codePoint = 0;
922     uint_fast8_t digitCount = 0;
923     for (;;)
924     {
925         int c = getc (file);
926         if (isxdigit (c) && ++digitCount <= 6)
927         {
928             *codePoint = (*codePoint « 4) | nibbleValue (c);
929             continue;
930         }
931         if (c == ':' && digitCount > 0)
932             return false;
933         if (c == EOF)
934         {
935             if (digitCount == 0)
936                 return true;
937             if (feof (file))
938                 fail ("%s: Unexpected end of file.", fileName);
939             else
940                 fail ("%s: Read error.", fileName);
941         }
942         fail ("%s: Unexpected character: %#.2x.", fileName, (unsigned)c);
943     }
944 }
```

## 5.1.5.43 readGlyphs()

```
void readGlyphs (
    Font * font,
    const char * fileName )
```

Read glyph definitions from a Unifont .hex format file.

This function reads in the glyph bitmaps contained in a Unifont .hex format file. These input files contain one glyph bitmap per line. Each line is of the form

<hexadecimal code point> ':' <hexadecimal bitmap sequence>

The code point field typically consists of 4 hexadecimal digits for a code point in Unicode Plane 0, and 6 hexadecimal digits for code points above Plane 0. The hexadecimal bitmap sequence is 32 hexadecimal digits long for a glyph that is 8 pixels wide by 16 pixels high, and 64 hexadecimal digits long for a glyph that is 16 pixels wide by 16 pixels high.

## Parameters

in,out	font	The font data structure to update with new glyphs.
in	fileName	The name of the Unifont .hex format input file.

Definition at line 966 of file hex2otf.c.

```
967 {
968     FILE *file = fopen (fileName, "r");
969     if (!file)
970         fail ("Failed to open file '%s'", fileName);
971     uint_fast32_t glyphCount = 1; // for glyph 0
972     uint_fast8_t maxByteCount = 0;
973     { // Hard code the notdef glyph.
974         const byte bitmap[] = "\0\0\0-fZZzvv~vv~\0\0"; // same as U+FFFD
975         const size_t byteCount = sizeof bitmap - 1;
976         assert (byteCount <= GLYPH_MAX_BYTE_COUNT);
977         assert (byteCount % GLYPH_HEIGHT == 0);
978         Glyph *notdef = getBufferSlot (font->glyphs, sizeof (Glyph));
979         memcpy (notdef->bitmap, bitmap, byteCount);
980         notdef->byteCount = maxByteCount = byteCount;
981         notdef->combining = false;
982         notdef->pos = 0;
983         notdef->lsb = 0;
984     }
985     for (;;)
986     {
987         uint_fast32_t codePoint;
988         if (readCodePoint (&codePoint, fileName, file))
989             break;
990         if (++glyphCount > MAX_GLYPHS)
991             fail ("OpenType does not support more than %lu glyphs.",
992                 MAX_GLYPHS);
993         Glyph *glyph = getBufferSlot (font->glyphs, sizeof (Glyph));
994         glyph->codePoint = codePoint;
995         glyph->byteCount = 0;
996         glyph->combining = false;
997         glyph->pos = 0;
998         glyph->lsb = 0;
999         for (byte *p = glyph->bitmap;; p++)
1000         {
1001             int h, l;
1002             if (isxdigit (h = getc (file)) && isxdigit (l = getc (file)))
1003             {
1004                 if (++glyph->byteCount > GLYPH_MAX_BYTE_COUNT)
1005                     fail ("Hex stream of 'PRI_CP' is too long.", codePoint);
1006                 *p = nibbleValue (h) « 4 | nibbleValue (l);
1007             }
1008         }
1009     }
1010 }
```

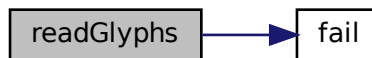


```

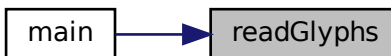
1008         else if (h == '\\n' || (h == EOF && feof (file)))
1009             break;
1010         else if (ferror (file))
1011             fail ("%s: Read error.", fileName);
1012         else
1013             fail ("Hex stream of \"PRI_CP\" is invalid.", codePoint);
1014     }
1015     if (glyph->byteCount % GLYPH_HEIGHT != 0)
1016         fail ("Hex length of \"PRI_CP\" is indivisible by glyph height %d.",
1017             codePoint, GLYPH_HEIGHT);
1018     if (glyph->byteCount > maxByteCount)
1019         maxByteCount = glyph->byteCount;
1020 }
1021 if (glyphCount == 1)
1022     fail ("No glyph is specified.");
1023 font->glyphCount = glyphCount;
1024 font->maxWidth = PW (maxByteCount);
1025 fclose (file);
1026 }

```

Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.44 sortGlyphs()

```

void sortGlyphs (
    Font * font )

```

Sort the glyphs in a font by Unicode code point.

This function reads in an array of glyphs and sorts them by Unicode code point. If a duplicate code point is encountered, that will result in a fatal error with an error message to stderr.

## Parameters

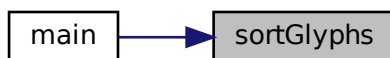
in,out	font	Pointer to a <a href="#">Font</a> structure with glyphs to sort.
--------	------	--

Definition at line 1119 of file hex2otf.c.

```

1120 {
1121     Glyph *glyphs = getBufferHead (font->glyphs);
1122     const Glyph *const glyphsEnd = getBufferTail (font->glyphs);
1123     glyphs++; // glyph 0 does not need sorting
1124     qsort (glyphs, glyphsEnd - glyphs, sizeof *glyphs, byCodePoint);
1125     for (const Glyph *glyph = glyphs; glyph < glyphsEnd - 1; glyph++)
1126     {
1127         if (glyph[0].codePoint == glyph[1].codePoint)
1128             fail ("Duplicate code point: \"PRI_CP\".", glyph[0].codePoint);
1129         assert (glyph[0].codePoint < glyph[1].codePoint);
1130     }
1131 }
```

Here is the caller graph for this function:



#### 5.1.5.45 writeBytes()

```

void writeBytes (
    const byte bytes[],
    size_t count,
    FILE * file )
```

Write an array of bytes to an output file.

## Parameters

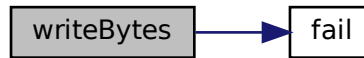
in	bytes	An array of unsigned bytes to write.
in	file	The file pointer for writing, of type FILE *.

Definition at line 538 of file hex2otf.c.

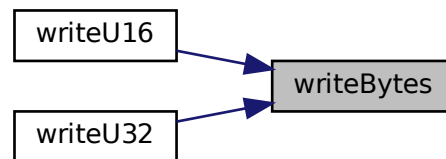
```

539 {
540     if (fwrite (bytes, count, 1, file) != 1 && count != 0)
541         fail ("Failed to write %zu bytes to output file.", count);
542 }
```

Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.46 writeFont()

```
void writeFont (
    Font * font,
    bool isCFF,
    const char * fileName )
```

Write OpenType font to output file.

This function writes the constructed OpenType font to the output file named "filename".

Parameters

in	font	Pointer to the font, of type <a href="#">Font</a> *.
in	isCFF	Boolean indicating whether the font has CFF data.
in	filename	The name of the font file to create.

Add a byte shifted by 24, 16, 8, or 0 bits.

Definition at line 786 of file hex2otf.c.

```

787 {
788     FILE *file = fopen (fileName, "wb");
789     if (!file)
790         fail ("Failed to open file '%s'", fileName);
791     const Table *const tables = getBufferHead (font->tables);
792     const Table *const tablesEnd = getBufferTail (font->tables);
793     size_t tableCount = tablesEnd - tables;
794     assert (0 < tableCount && tableCount <= U16MAX);
795     size_t offset = 12 + 16 * tableCount;
796     uint_fast32_t totalChecksum = 0;
797     Buffer *tableRecords =
798         newBuffer (sizeof (struct TableRecord) * tableCount);
799     for (size_t i = 0; i < tableCount; i++)
800     {
801         struct TableRecord *record =
802             getBufferSlot (tableRecords, sizeof *record);
803         record->tag = tables[i].tag;
804         size_t length = countBufferedBytes (tables[i].content);
805         #if SIZE_MAX > U32MAX
806             if (offset > U32MAX)
807                 fail ("Table offset exceeded 4 GiB.");
808             if (length > U32MAX)
809                 fail ("Table size exceeded 4 GiB.");
810         #endif
811         record->length = length;
812         record->checksum = 0;
813         const byte *p = getBufferHead (tables[i].content);
814         const byte *const end = getBufferTail (tables[i].content);
815
816         /// Add a byte shifted by 24, 16, 8, or 0 bits.
817         #define addByte(shift) \
818         if (p == end) \
819         break; \
820         record->checksum += (uint_fast32_t)*p++ « (shift);
821
822         for (;;)
823         {
824             addByte (24)
825             addByte (16)
826             addByte (8)
827             addByte (0)
828         }
829         #undef addByte
830         cacheZeros (tables[i].content, (~length + 1U) & 3U);
831         record->offset = offset;
832         offset += countBufferedBytes (tables[i].content);
833         totalChecksum += record->checksum;
834     }
835     struct TableRecord *records = getBufferHead (tableRecords);
836     qsort (records, tableCount, sizeof *records, byTableTag);
837     // Offset Table
838     uint_fast32_t sfntVersion = isCFF ? 0x4f54544f : 0x00010000;
839     writeU32 (sfntVersion, file); // sfntVersion
840     totalChecksum += sfntVersion;
841     uint_fast16_t entrySelector = 0;
842     for (size_t k = tableCount; k != 1; k >= 1)
843         entrySelector++;
844     uint_fast16_t searchRange = 1 « (entrySelector + 4);
845     uint_fast16_t rangeShift = (tableCount - (1 « entrySelector)) « 4;
846     writeU16 (tableCount, file); // numTables
847     writeU16 (searchRange, file); // searchRange
848     writeU16 (entrySelector, file); // entrySelector
849     writeU16 (rangeShift, file); // rangeShift
850     totalChecksum += (uint_fast32_t)tableCount « 16;
851     totalChecksum += searchRange;
852     totalChecksum += (uint_fast32_t)entrySelector « 16;
853     totalChecksum += rangeShift;
854     // Table Records (always sorted by table tags)
855     for (size_t i = 0; i < tableCount; i++)
856     {
857         // Table Record
858         writeU32 (records[i].tag, file); // tableTag
859         writeU32 (records[i].checksum, file); // checksum
860         writeU32 (records[i].offset, file); // offset
861         writeU32 (records[i].length, file); // length
862         totalChecksum += records[i].tag;
863         totalChecksum += records[i].checksum;
864         totalChecksum += records[i].offset;
865         totalChecksum += records[i].length;
866     }

```

```
867 freeBuffer (tableRecords);
868 for (const Table *table = tables; table < tablesEnd; table++)
869 {
870     if (table->tag == 0x68656164) // 'head' table
871     {
872         byte *begin = getBufferHead (table->content);
873         byte *end = getBufferTail (table->content);
874         writeBytes (begin, 8, file);
875         writeU32 (0xb1b0afbafbaU - totalChecksum, file); // checksumAdjustment
876         writeBytes (begin + 12, end - (begin + 12), file);
877         continue;
878     }
879     writeBuffer (table->content, file);
880 }
881 fclose (file);
882 }
```

Here is the call graph for this function:



Here is the caller graph for this function:



#### 5.1.5.47 writeU16()

```
void writeU16 (
    uint_fast16_t value,
    FILE * file )
```

Write an unsigned 16-bit value to an output file.

This function writes a 16-bit unsigned value in big-endian order to an output file specified with a file pointer.

## Parameters

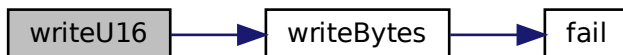
in	value	The 16-bit value to write.
in	file	The file pointer for writing, of type FILE *.

Definition at line 554 of file hex2otf.c.

```

555 {
556     byte bytes[] =
557     {
558         (value » 8) & 0xff,
559         (value    ) & 0xff,
560     };
561     writeBytes (bytes, sizeof bytes, file);
562 }
```

Here is the call graph for this function:



## 5.1.5.48 writeU32()

```

void writeU32 (
    uint_fast32_t value,
    FILE * file )
```

Write an unsigned 32-bit value to an output file.

This function writes a 32-bit unsigned value in big-endian order to an output file specified with a file pointer.

## Parameters

in	value	The 32-bit value to write.
in	file	The file pointer for writing, of type FILE *.

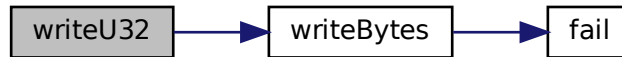
Definition at line 574 of file hex2otf.c.

```

575 {
576     byte bytes[] =
577     {
578         (value » 24) & 0xff,
579         (value » 16) & 0xff,
580         (value » 8) & 0xff,
581         (value    ) & 0xff,
582     };
```

```
583     writeBytes (bytes, sizeof bytes, file);  
584 }
```

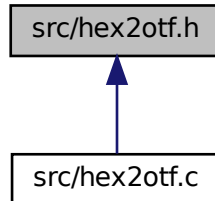
Here is the call graph for this function:



## 5.2 src/hex2otf.h File Reference

[hex2otf.h](#) - Header file for [hex2otf.c](#)

This graph shows which files directly or indirectly include this file:



### Data Structures

- struct [NamePair](#)  
Data structure for a font ID number and name character string.

### Macros

- `#define UNIFONT_VERSION "15.0.04"`  
Current Unifont version.
- `#define DEFAULT_ID0 "Copyright © 1998-2022 Roman Czyborra, Paul Hardy, \Qianqian Fang, Andrew Miller, Johnnie Weaver, David Corbett, \Nils Moskopp, Rebecca Bettencourt, et al."`
- `#define DEFAULT_ID1 "Unifont"`

- Default NameID 1 string ([Font](#) Family)
- `#define DEFAULT\_ID2 "Regular"`  
Default NameID 2 string ([Font](#) Subfamily)
- `#define DEFAULT\_ID5 "Version" UNIFONT_VERSION`  
Default NameID 5 string (Version of the Name [Table](#))
- `#define DEFAULT\_ID11 "https://unifoundry.com/unifont/"`  
Default NameID 11 string ([Font](#) Vendor URL)
- `#define DEFAULT\_ID13 "Dual license: SIL Open Font License version 1.1, \and GNU GPL version 2 or later with the GNU Font Embedding Exception."`  
Default NameID 13 string (License Description)
- `#define DEFAULT\_ID14 "http://unifoundry.com/LICENSE.txt, \https://scripts.sil.org/OFL"`  
Default NameID 14 string (License Information URLs)
- `#define NAMEPAIR(n) {(n), DEFAULT\_ID##n}`  
Macro to initialize name identifier codes to default values defined above.

## Typedefs

- typedef struct [NamePair](#) [NamePair](#)  
Data structure for a font ID number and name character string.

## Variables

- const [NamePair](#) [defaultNames](#) []  
Allocate array of NameID codes with default values.

### 5.2.1 Detailed Description

[hex2otf.h](#) - Header file for [hex2otf.c](#)

## Copyright

Copyright © 2022 [何志翔](#) (He Zhixiang)

## Author

[何志翔](#) (He Zhixiang)

### 5.2.2 Macro Definition Documentation



### 5.2.2.1 DEFAULT\_ID0

```
#define DEFAULT_ID0 "Copyright © 1998-2022 Roman Czyborra, Paul Hardy, \Qianqian Fang, Andrew Miller, Johnnie Weaver, David Corbett, \Nils Moskopp, Rebecca Bettencourt, et al."
```

Define default strings for some TrueType font NameID strings.

NameID	Description
-----	-----
0	Copyright Notice
1	Font Family
2	Font Subfamily
5	Version of the Name Table
11	URL of the Font Vendor
13	License Description
14	License Information URL

Default NameID 0 string (Copyright Notice)

Definition at line 53 of file hex2otf.h.

## 5.2.3 Variable Documentation

### 5.2.3.1 defaultNames

```
const NamePair defaultNames[]
```

Initial value:

```
=
{
    NAMEPAIR (0),
    NAMEPAIR (1),
    NAMEPAIR (2),
    NAMEPAIR (5),
    NAMEPAIR (11),
    NAMEPAIR (13),
    NAMEPAIR (14),
    {0, NULL}
}
```

Allocate array of NameID codes with default values.

This array contains the default values for several TrueType NameID strings, as defined above in this file. Strings are assigned using the NAMEPAIR macro defined above.

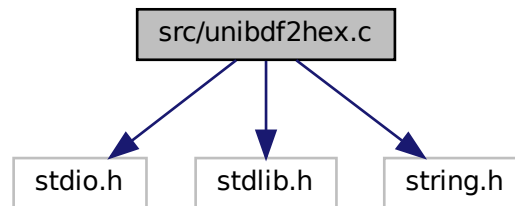
Definition at line 93 of file hex2otf.h.

## 5.3 src/unibdf2hex.c File Reference

unibdf2hex - Convert a BDF file into a unifont.hex file

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
```

Include dependency graph for unibdf2hex.c:



### Macros

- `#define UNISTART 0x3400`  
First Unicode code point to examine.
- `#define UNISTOP 0x4DBF`  
Last Unicode code point to examine.
- `#define MAXBUF 256`  
Maximum allowable input file line length - 1.

### Functions

- `int main ()`  
The main function.

#### 5.3.1 Detailed Description

unibdf2hex - Convert a BDF file into a unifont.hex file

Author

Paul Hardy, January 2008

Copyright

Copyright (C) 2008, 2013 Paul Hardy

Note: currently this has hard-coded code points for glyphs extracted from Wen Quan Yi to create the Unifont source file "wqy.hex".

## 5.3.2 Function Documentation

### 5.3.2.1 main()

int main ( )

The main function.

Returns

Exit status is always 0 (successful termination).

Definition at line 46 of file unibdf2hex.c.

```

47 {
48     int i;
49     int digitsout; /* how many hex digits we output in a bitmap */
50     int thispoint;
51     char inbuf[MAXBUF];
52     int bbxx, bbxy, bbxxoff, bbxyoff;
53
54     int descent=4; /* font descent wrt baseline */
55     int startrow; /* row to start glyph */
56     unsigned rowout;
57
58     while (fgets (inbuf, MAXBUF - 1, stdin) != NULL) {
59         if (strcmp (inbuf, "ENCODING ", 9) == 0) {
60             sscanf (&inbuf[9], "%d", &thispoint); /* get code point */
61             /*
62 If we want this code point, get the BBX (bounding box) and
63 BITMAP information.
64 */
65             if ((thispoint >= 0x2E80 && thispoint <= 0x2EFF) || /* CJK Radicals Supplement
66 (thispoint >= 0x2F00 && thispoint <= 0x2FDF) || /* Kangxi Radicals
67 (thispoint >= 0x2FF0 && thispoint <= 0x2FFF) || /* Ideographic Description Characters
68 (thispoint >= 0x3001 && thispoint <= 0x303F) || /* CJK Symbols and Punctuation (U+3000 is a space)
69 (thispoint >= 0x3100 && thispoint <= 0x312F) || /* Bopomofo
70 (thispoint >= 0x31A0 && thispoint <= 0x31BF) || /* Bopomofo extend
71 (thispoint >= 0x31C0 && thispoint <= 0x31EF) || /* CJK Strokes
72 (thispoint >= 0x3400 && thispoint <= 0x4DBF) || /* CJK Unified Ideographs Extension A
73 (thispoint >= 0x4E00 && thispoint <= 0x9FCF) || /* CJK Unified Ideographs
74 (thispoint >= 0xF900 && thispoint <= 0xFAFF)) /* CJK Compatibility Ideographs
75 {
76         while (fgets (inbuf, MAXBUF - 1, stdin) != NULL &&
77             strcmp (inbuf, "BBX ", 4) != 0); /* find bounding box */
78
79         sscanf (&inbuf[4], "%d %d %d %d", &bbxx, &bbxy, &bbxxoff, &bbxyoff);
80         while (fgets (inbuf, MAXBUF - 1, stdin) != NULL &&
81             strcmp (inbuf, "BITMAP", 6) != 0); /* find bitmap start */
82         fprintf (stdout, "%04X:", thispoint);
83         digitsout = 0;
84         /* Print initial blank rows */
85         startrow = descent + bbxyoff + bbxy;
86
87         /* Force everything to 16 pixels wide */
88         for (i = 16; i > startrow; i--) {
89             fprintf (stdout, "0000");
90             digitsout += 4;
91         }
92         while (fgets (inbuf, MAXBUF - 1, stdin) != NULL &&
93             strcmp (inbuf, "END", 3) != 0) { /* copy bitmap until END */
94             sscanf (inbuf, "%X", &rowout);
95             /* Now force glyph to a 16x16 grid even if they'd fit in 8x16 */
96             if (bbxx <= 8) rowout <= 8; /* shift left for 16x16 glyph */
97             rowout >= bbxxoff;
98             fprintf (stdout, "%04X", rowout);
99             digitsout += 4;
100         }
101     }

```

```

102      /* Pad for 16x16 glyph */
103      while (digitsout < 64) {
104          fprintf (stdout,"0000");
105          digitsout += 4;
106      }
107      fprintf (stdout,"\n");
108  }
109  }
110  }
111  exit (0);
112  }

```

## 5.4 src/unibmp2hex.c File Reference

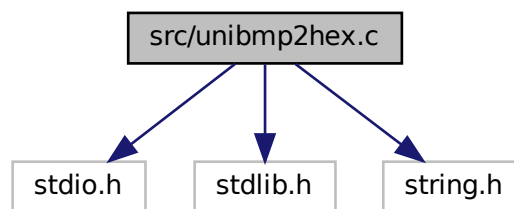
unibmp2hex - Turn a .bmp or .wbmp glyph matrix into a GNU Unifont hex glyph set of 256 characters

```

#include <stdio.h>
#include <stdlib.h>
#include <string.h>

```

Include dependency graph for unibmp2hex.c:



### Macros

- #define `MAXBUF` 256  
Maximum input file line length - 1.

### Functions

- int `main` (int argc, char \*argv[])  
The main function.

## Variables

- unsigned `hexdigit` [16][4]  
32 bit representation of 16x8 0..F bitmap
- unsigned `uniplane` =0  
Unicode plane number, 0..0xff ff.
- unsigned `planeset` =0  
=1: use plane specified with -p parameter
- unsigned `flip` =0  
=1 if we're transposing glyph matrix
- unsigned `forcewide` =0  
=1 to set each glyph to 16 pixels wide
- unsigned `unidigit` [6][4]
- struct {  
    char filetype [2]  
    int file\_size  
    int image\_offset  
    int info\_size  
    int width  
    int height  
    int nplanes  
    int bits\_per\_pixel  
    int compression  
    int image\_size  
    int x\_ppm  
    int y\_ppm  
    int ncolors  
    int important\_colors  
} `bmp_header`
- unsigned char `color_table` [256][4]

### 5.4.1 Detailed Description

unibmp2hex - Turn a .bmp or .wbmp glyph matrix into a GNU Unifont hex glyph set of 256 characters

#### Author

Paul Hardy, unifoundry <at> unifoundry.com, December 2007

#### Copyright

Copyright (C) 2007, 2008, 2013, 2017, 2019, 2022 Paul Hardy

Synopsis: unibmp2hex [-iin\_file.bmp] [-oout\_file.hex] [-phex\_page\_num] [-w]

### 5.4.2 Function Documentation

### 5.4.2.1 main()

```
int main (
    int argc,
    char * argv[] )
```

The main function.

Parameters

in	argc	The count of command line arguments.
in	argv	Pointer to array of command line arguments.

Returns

This program exits with status 0.

Definition at line 149 of file unibmp2hex.c.

```
150 {
151
152     int i, j, k;                /* loop variables */
153     unsigned char inchar;       /* temporary input character */
154     char header[MAXBUF];        /* input buffer for bitmap file header */
155     int wbmp=0; /* =0 for Windows Bitmap (.bmp); 1 for Wireless Bitmap (.wbmp) */
156     int fatal; /* =1 if a fatal error occurred */
157     int match; /* =1 if we're still matching a pattern, 0 if no match */
158     int empty1, empty2; /* =1 if bytes tested are all zeroes */
159     unsigned char thischar1[16], thischar2[16]; /* bytes of hex char */
160     unsigned char thischar0[16], thischar3[16]; /* bytes for quadruple-width */
161     int thisrow; /* index to point into thischar1[] and thischar2[] */
162     int tmpsum; /* temporary sum to see if a character is blank */
163     unsigned this_pixel; /* color of one pixel, if > 1 bit per pixel */
164     unsigned next_pixels; /* pending group of 8 pixels being read */
165     unsigned color_mask = 0x00; /* to invert monochrome bitmap, set to 0xFF */
166
167     unsigned char bitmap[17*32][18*32/8]; /* final bitmap */
168     /* For wide array:
169     0 = don't force glyph to double-width;
170     1 = force glyph to double-width;
171     4 = force glyph to quadruple-width.
172     */
173     char wide[0x200000]={0x200000 * 0};
174
175     char *infile="", *outfile=""; /* names of input and output files */
176     FILE *infp, *outfp; /* file pointers of input and output files */
177
178     if (argc > 1) {
179         for (i = 1; i < argc; i++) {
180             if (argv[i][0] == '-') { /* this is an option argument */
181                 switch (argv[i][1]) {
182                     case 'i': /* name of input file */
183                         infile = &argv[i][2];
184                         break;
185                     case 'o': /* name of output file */
186                         outfile = &argv[i][2];
187                         break;
188                     case 'p': /* specify a Unicode plane */
189                         sscanf (&argv[i][2], "%x", &uniplane); /* Get Unicode plane */
190                         planeset = 1; /* Use specified range, not what's in bitmap */
191                         break;
192                     case 'w': /* force wide (16 pixels) for each glyph */
193                         forcewidth = 1;
194                         break;
195                     default: /* if unrecognized option, print list and exit */
196                         fprintf (stderr, "\nSyntax:\n\n");
197                         fprintf (stderr, "  %s -p<Unicode_Page> ", argv[0]);
198                         fprintf (stderr, "-i<Input_File> -o<Output_File> -w\n\n");
199                         fprintf (stderr, "  -w specifies .wbmp output instead of ");
```

```

200         fprintf(stderr, "default Windows .bmp output.\n\n");
201         fprintf(stderr, "  -p is followed by 1 to 6 ");
202         fprintf(stderr, "Unicode plane hex digits ");
203         fprintf(stderr, "(default is Page 0).\n\n");
204         fprintf(stderr, "\nExample:\n\n");
205         fprintf(stderr, "  %s -p83 -iunifont.hex -ou83.bmp\n\n",
206                 argv[0]);
207         exit (1);
208     }
209 }
210 }
211 }
212 /*
213 Make sure we can open any I/O files that were specified before
214 doing anything else.
215 */
216 if (strlen (infile) > 0) {
217     if ((infp = fopen (infile, "r")) == NULL) {
218         fprintf(stderr, "Error: can't open %s for input.\n", infile);
219         exit (1);
220     }
221 }
222 else {
223     infp = stdin;
224 }
225 if (strlen (outfile) > 0) {
226     if ((outfp = fopen (outfile, "w")) == NULL) {
227         fprintf(stderr, "Error: can't open %s for output.\n", outfile);
228         exit (1);
229     }
230 }
231 else {
232     outfp = stdout;
233 }
234 /*
235 Initialize selected code points for double width (16x16).
236 Double-width is forced in cases where a glyph (usually a combining
237 glyph) only occupies the left-hand side of a 16x16 grid, but must
238 be rendered as double-width to appear properly with other glyphs
239 in a given script.  If additions were made to a script after
240 Unicode 5.0, the Unicode version is given in parentheses after
241 the script name.
242 */
243 for (i = 0x0700; i <= 0x074F; i++) wide[i] = 1; /* Syriac */
244 for (i = 0x0800; i <= 0x083F; i++) wide[i] = 1; /* Samaritan (5.2) */
245 for (i = 0x0900; i <= 0x0DFF; i++) wide[i] = 1; /* Indic */
246 for (i = 0x1000; i <= 0x109F; i++) wide[i] = 1; /* Myanmar */
247 for (i = 0x1100; i <= 0x11FF; i++) wide[i] = 1; /* Hangul Jamo */
248 for (i = 0x1400; i <= 0x167F; i++) wide[i] = 1; /* Canadian Aboriginal */
249 for (i = 0x1700; i <= 0x171F; i++) wide[i] = 1; /* Tagalog */
250 for (i = 0x1720; i <= 0x173F; i++) wide[i] = 1; /* Hanunoo */
251 for (i = 0x1740; i <= 0x175F; i++) wide[i] = 1; /* Buhid */
252 for (i = 0x1760; i <= 0x177F; i++) wide[i] = 1; /* Tagbanwa */
253 for (i = 0x1780; i <= 0x17FF; i++) wide[i] = 1; /* Khmer */
254 for (i = 0x18B0; i <= 0x18FF; i++) wide[i] = 1; /* Ext. Can. Aboriginal */
255 for (i = 0x1800; i <= 0x18AF; i++) wide[i] = 1; /* Mongolian */
256 for (i = 0x1900; i <= 0x194F; i++) wide[i] = 1; /* Limbu */
257 // for (i = 0x1980; i <= 0x19DF; i++) wide[i] = 1; /* New Tai Lue */
258 for (i = 0x1A00; i <= 0x1A1F; i++) wide[i] = 1; /* Buginese */
259 for (i = 0x1A20; i <= 0x1AAF; i++) wide[i] = 1; /* Tai Tham (5.2) */
260 for (i = 0x1B00; i <= 0x1B7F; i++) wide[i] = 1; /* Balinese */
261 for (i = 0x1B80; i <= 0x1BBF; i++) wide[i] = 1; /* Sundanese (5.1) */
262 for (i = 0x1BC0; i <= 0x1BFF; i++) wide[i] = 1; /* Batak (6.0) */
263 for (i = 0x1C00; i <= 0x1C4F; i++) wide[i] = 1; /* Lepcha (5.1) */
264 for (i = 0x1CC0; i <= 0x1CCF; i++) wide[i] = 1; /* Sundanese Supplement */
265 for (i = 0x1CD0; i <= 0x1CFF; i++) wide[i] = 1; /* Vedic Extensions (5.2) */
266 wide[0x2329] = wide[0x232A] = 1; /* Left- & Right-pointing Angle Brackets */
267 for (i = 0x2E80; i <= 0xA4CF; i++) wide[i] = 1; /* CJK */
268 // for (i = 0x9FD8; i <= 0x9FE9; i++) wide[i] = 4; /* CJK quadruple-width */
269 for (i = 0xA900; i <= 0xA92F; i++) wide[i] = 1; /* Kayah Li (5.1) */
270 for (i = 0xA930; i <= 0xA95F; i++) wide[i] = 1; /* Rejang (5.1) */
271 for (i = 0xA960; i <= 0xA97F; i++) wide[i] = 1; /* Hangul Jamo Extended-A */
272 for (i = 0xA980; i <= 0xA9DF; i++) wide[i] = 1; /* Javanese (5.2) */
273 for (i = 0xAA00; i <= 0xAA5F; i++) wide[i] = 1; /* Cham (5.1) */
274 for (i = 0xA9E0; i <= 0xA9FF; i++) wide[i] = 1; /* Myanmar Extended-B */
275 for (i = 0xAA00; i <= 0xAA5F; i++) wide[i] = 1; /* Cham */
276 for (i = 0xAA60; i <= 0xAA7F; i++) wide[i] = 1; /* Myanmar Extended-A */
277 for (i = 0xAAE0; i <= 0xA AFF; i++) wide[i] = 1; /* Meetei Mayek Ext (6.0) */
278 for (i = 0xABC0; i <= 0xABFF; i++) wide[i] = 1; /* Meetei Mayek (5.2) */
279 for (i = 0xAC00; i <= 0xD7AF; i++) wide[i] = 1; /* Hangul Syllables */
280 for (i = 0xD7B0; i <= 0xD7FF; i++) wide[i] = 1; /* Hangul Jamo Extended-B */

```

```

281 for (i = 0xF900; i <= 0xFAFF; i++) wide[i] = 1; /* CJK Compatibility */
282 for (i = 0xFE10; i <= 0xFE1F; i++) wide[i] = 1; /* Vertical Forms */
283 for (i = 0xFE30; i <= 0xFE60; i++) wide[i] = 1; /* CJK Compatibility Forms */
284 for (i = 0xFFE0; i <= 0xFFE6; i++) wide[i] = 1; /* CJK Compatibility Forms */
285
286 wide[0x303F] = 0; /* CJK half-space fill */
287
288 /* Supplemental Multilingual Plane (Plane 01) */
289 for (i = 0x010A00; i <= 0x010A5F; i++) wide[i] = 1; /* Kharoshthi */
290 for (i = 0x011000; i <= 0x01107F; i++) wide[i] = 1; /* Brahmi */
291 for (i = 0x011080; i <= 0x0110CF; i++) wide[i] = 1; /* Kaithi */
292 for (i = 0x011100; i <= 0x01114F; i++) wide[i] = 1; /* Chakma */
293 for (i = 0x011180; i <= 0x0111DF; i++) wide[i] = 1; /* Sharada */
294 for (i = 0x011200; i <= 0x01124F; i++) wide[i] = 1; /* Khojki */
295 for (i = 0x0112B0; i <= 0x0112FF; i++) wide[i] = 1; /* Khudawadi */
296 for (i = 0x011300; i <= 0x01137F; i++) wide[i] = 1; /* Grantha */
297 for (i = 0x011400; i <= 0x01147F; i++) wide[i] = 1; /* Newa */
298 for (i = 0x011480; i <= 0x0114DF; i++) wide[i] = 1; /* Tirhuta */
299 for (i = 0x011580; i <= 0x0115FF; i++) wide[i] = 1; /* Siddham */
300 for (i = 0x011600; i <= 0x01165F; i++) wide[i] = 1; /* Modi */
301 for (i = 0x011660; i <= 0x01167F; i++) wide[i] = 1; /* Mongolian Suppl. */
302 for (i = 0x011680; i <= 0x0116CF; i++) wide[i] = 1; /* Takri */
303 for (i = 0x011700; i <= 0x01173F; i++) wide[i] = 1; /* Ahom */
304 for (i = 0x011800; i <= 0x01184F; i++) wide[i] = 1; /* Dogra */
305 for (i = 0x011900; i <= 0x01195F; i++) wide[i] = 1; /* Dives Akuru */
306 for (i = 0x0119A0; i <= 0x0119FF; i++) wide[i] = 1; /* Nandinagari */
307 for (i = 0x011A00; i <= 0x011A4F; i++) wide[i] = 1; /* Zanabazar Square */
308 for (i = 0x011A50; i <= 0x011AAF; i++) wide[i] = 1; /* Soyombo */
309 for (i = 0x011B00; i <= 0x011B5F; i++) wide[i] = 1; /* Devanagari Extended-A */
310 for (i = 0x011F00; i <= 0x011F5F; i++) wide[i] = 1; /* Kawi */
311 for (i = 0x011C00; i <= 0x011C6F; i++) wide[i] = 1; /* Bhaiksuki */
312 for (i = 0x011C70; i <= 0x011CBF; i++) wide[i] = 1; /* Marchen */
313 for (i = 0x011D00; i <= 0x011D5F; i++) wide[i] = 1; /* Masaram Gondi */
314 for (i = 0x011EE0; i <= 0x011EFF; i++) wide[i] = 1; /* Makasar */
315 for (i = 0x012F90; i <= 0x012FFF; i++) wide[i] = 1; /* Cypro-Minoan */
316 /* Make Bassa Vah all single width or all double width */
317 for (i = 0x016AD0; i <= 0x016AFF; i++) wide[i] = 1; /* Bassa Vah */
318 for (i = 0x016B00; i <= 0x016B8F; i++) wide[i] = 1; /* Pahawh Hmong */
319 for (i = 0x016F00; i <= 0x016F9F; i++) wide[i] = 1; /* Miao */
320 for (i = 0x016FE0; i <= 0x016FFF; i++) wide[i] = 1; /* Ideograph Sym/Punct */
321 for (i = 0x017000; i <= 0x0187FF; i++) wide[i] = 1; /* Tangut */
322 for (i = 0x018800; i <= 0x018AFF; i++) wide[i] = 1; /* Tangut Components */
323 for (i = 0x01AFF0; i <= 0x01AFFF; i++) wide[i] = 1; /* Kana Extended-B */
324 for (i = 0x01B000; i <= 0x01B0FF; i++) wide[i] = 1; /* Kana Supplement */
325 for (i = 0x01B100; i <= 0x01B12F; i++) wide[i] = 1; /* Kana Extended-A */
326 for (i = 0x01B170; i <= 0x01B2FF; i++) wide[i] = 1; /* Nushu */
327 for (i = 0x01CF00; i <= 0x01CFCF; i++) wide[i] = 1; /* Znamenny Musical */
328 for (i = 0x01D100; i <= 0x01D1FF; i++) wide[i] = 1; /* Musical Symbols */
329 for (i = 0x01D800; i <= 0x01DAAF; i++) wide[i] = 1; /* Sutton SignWriting */
330 for (i = 0x01E2C0; i <= 0x01E2FF; i++) wide[i] = 1; /* Wancho */
331 for (i = 0x01E800; i <= 0x01E8DF; i++) wide[i] = 1; /* Mende Kikakui */
332 for (i = 0x01F200; i <= 0x01F2FF; i++) wide[i] = 1; /* Encl Ideograp Suppl */
333 wide[0x01F5E7] = 1; /* Three Rays Right */
334
335 /*
336 Determine whether or not the file is a Microsoft Windows Bitmap file.
337 If it starts with 'B', 'M', assume it's a Windows Bitmap file.
338 Otherwise, assume it's a Wireless Bitmap file.
339
340 WARNING: There isn't much in the way of error checking here --
341 if you give it a file that wasn't first created by hex2bmp.c,
342 all bets are off.
343 */
344 fatal = 0; /* assume everything is okay with reading input file */
345 if ((header[0] = fgetc (infp)) != EOF) {
346     if ((header[1] = fgetc (infp)) != EOF) {
347         if (header[0] == 'B' && header[1] == 'M') {
348             wbmp = 0; /* Not a Wireless Bitmap -- it's a Windows Bitmap */
349         }
350         else {
351             wbmp = 1; /* Assume it's a Wireless Bitmap */
352         }
353     }
354     else
355         fatal = 1;
356 }
357 else
358     fatal = 1;
359
360 if (fatal) {
361     fprintf (stderr, "Fatal error; end of input file.\n\n");

```



```

362     exit (1);
363 }
364 /*
365 If this is a Wireless Bitmap (.wbmp) format file,
366 skip the header and point to the start of the bitmap itself.
367 */
368 if (wbmp) {
369     for (i=2; i<6; i++)
370         header[i] = fgetc (infp);
371     /*
372 Now read the bitmap.
373 */
374     for (i=0; i < 32*17; i++) {
375         for (j=0; j < 32*18/8; j++) {
376             inchar = fgetc (infp);
377             bitmap[i][j] = ~inchar; /* invert bits for proper color */
378         }
379     }
380 }
381 /*
382 Otherwise, treat this as a Windows Bitmap file, because we checked
383 that it began with "BM". Save the header contents for future use.
384 Expect a 14 byte standard BITMAPFILEHEADER format header followed
385 by a 40 byte standard BITMAPINFOHEADER Device Independent Bitmap
386 header, with data stored in little-endian format.
387 */
388 else {
389     for (i = 2; i < 54; i++)
390         header[i] = fgetc (infp);
391
392     bmp_header.filetype[0] = 'B';
393     bmp_header.filetype[1] = 'M';
394
395     bmp_header.file_size =
396         (header[2] & 0xFF) | ((header[3] & 0xFF) << 8) |
397         ((header[4] & 0xFF) << 16) | ((header[5] & 0xFF) << 24);
398
399     /* header bytes 6..9 are reserved */
400
401     bmp_header.image_offset =
402         (header[10] & 0xFF) | ((header[11] & 0xFF) << 8) |
403         ((header[12] & 0xFF) << 16) | ((header[13] & 0xFF) << 24);
404
405     bmp_header.info_size =
406         (header[14] & 0xFF) | ((header[15] & 0xFF) << 8) |
407         ((header[16] & 0xFF) << 16) | ((header[17] & 0xFF) << 24);
408
409     bmp_header.width =
410         (header[18] & 0xFF) | ((header[19] & 0xFF) << 8) |
411         ((header[20] & 0xFF) << 16) | ((header[21] & 0xFF) << 24);
412
413     bmp_header.height =
414         (header[22] & 0xFF) | ((header[23] & 0xFF) << 8) |
415         ((header[24] & 0xFF) << 16) | ((header[25] & 0xFF) << 24);
416
417     bmp_header.nplanes =
418         (header[26] & 0xFF) | ((header[27] & 0xFF) << 8);
419
420     bmp_header.bits_per_pixel =
421         (header[28] & 0xFF) | ((header[29] & 0xFF) << 8);
422
423     bmp_header.compression =
424         (header[30] & 0xFF) | ((header[31] & 0xFF) << 8) |
425         ((header[32] & 0xFF) << 16) | ((header[33] & 0xFF) << 24);
426
427     bmp_header.image_size =
428         (header[34] & 0xFF) | ((header[35] & 0xFF) << 8) |
429         ((header[36] & 0xFF) << 16) | ((header[37] & 0xFF) << 24);
430
431     bmp_header.x_ppm =
432         (header[38] & 0xFF) | ((header[39] & 0xFF) << 8) |
433         ((header[40] & 0xFF) << 16) | ((header[41] & 0xFF) << 24);
434
435     bmp_header.y_ppm =
436         (header[42] & 0xFF) | ((header[43] & 0xFF) << 8) |
437         ((header[44] & 0xFF) << 16) | ((header[45] & 0xFF) << 24);
438
439     bmp_header.ncolors =
440         (header[46] & 0xFF) | ((header[47] & 0xFF) << 8) |
441         ((header[48] & 0xFF) << 16) | ((header[49] & 0xFF) << 24);
442

```

```

443     bmp_header.important_colors =
444         (header[50] & 0xFF) | ((header[51] & 0xFF) « 8) |
445         ((header[52] & 0xFF) « 16) | ((header[53] & 0xFF) « 24);
446
447     if (bmp_header.ncolors == 0)
448         bmp_header.ncolors = 1 « bmp_header.bits_per_pixel;
449
450     /* If a Color Table exists, read it */
451     if (bmp_header.ncolors > 0 && bmp_header.bits_per_pixel <= 8) {
452         for (i = 0; i < bmp_header.ncolors; i++) {
453             color_table[i][0] = fgetc (infp); /* Red */
454             color_table[i][1] = fgetc (infp); /* Green */
455             color_table[i][2] = fgetc (infp); /* Blue */
456             color_table[i][3] = fgetc (infp); /* Alpha */
457         }
458     }
459     /* Determine from the first color table entry whether we
460     are inverting the resulting bitmap image.
461     */
462     if ( (color_table[0][0] + color_table[0][1] + color_table[0][2])
463          < (3 * 128) ) {
464         color_mask = 0xFF;
465     }
466 }
467
468 #ifdef DEBUG
469
470     /*
471     Print header info for possibly adding support for
472     additional file formats in the future, to determine
473     how the bitmap is encoded.
474     */
475     fprintf (stderr, "Filetype: '%c%c'\n",
476             bmp_header.filetype[0], bmp_header.filetype[1]);
477     fprintf (stderr, "File Size: %d\n", bmp_header.file_size);
478     fprintf (stderr, "Image Offset: %d\n", bmp_header.image_offset);
479     fprintf (stderr, "Info Header Size: %d\n", bmp_header.info_size);
480     fprintf (stderr, "Image Width: %d\n", bmp_header.width);
481     fprintf (stderr, "Image Height: %d\n", bmp_header.height);
482     fprintf (stderr, "Number of Planes: %d\n", bmp_header.nplanes);
483     fprintf (stderr, "Bits per Pixel: %d\n", bmp_header.bits_per_pixel);
484     fprintf (stderr, "Compression Method: %d\n", bmp_header.compression);
485     fprintf (stderr, "Image Size: %d\n", bmp_header.image_size);
486     fprintf (stderr, "X Pixels per Meter: %d\n", bmp_header.x_ppm);
487     fprintf (stderr, "Y Pixels per Meter: %d\n", bmp_header.y_ppm);
488     fprintf (stderr, "Number of Colors: %d\n", bmp_header.ncolors);
489     fprintf (stderr, "Important Colors: %d\n", bmp_header.important_colors);
490
491 #endif
492
493     /*
494     Now read the bitmap.
495     */
496     for (i = 32*17-1; i >= 0; i--) {
497         for (j=0; j < 32*18/8; j++) {
498             next_pixels = 0x00; /* initialize next group of 8 pixels */
499             /* Read a monochrome image -- the original case */
500             if (bmp_header.bits_per_pixel == 1) {
501                 next_pixels = fgetc (infp);
502             }
503             /* Read a 32 bit per pixel RGB image; convert to monochrome */
504             else if ( bmp_header.bits_per_pixel == 24 ||
505                      bmp_header.bits_per_pixel == 32) {
506                 next_pixels = 0;
507                 for (k = 0; k < 8; k++) { /* get next 8 pixels */
508                     this_pixel = (fgetc (infp) & 0xFF) +
509                                 (fgetc (infp) & 0xFF) +
510                                 (fgetc (infp) & 0xFF);
511
512                     if (bmp_header.bits_per_pixel == 32) {
513                         (void) fgetc (infp); /* ignore alpha value */
514                     }
515
516                     /* convert RGB color space to monochrome */
517                     if (this_pixel >= (128 * 3))
518                         this_pixel = 0;
519                     else
520                         this_pixel = 1;
521
522                     /* shift next pixel color into place for 8 pixels total */
523                     next_pixels = (next_pixels « 1) | this_pixel;

```

```

524     }
525   }
526   if (bmp_header.height < 0) { /* Bitmap drawn top to bottom */
527     bitmap [(32*17-1) - i][j] = next_pixels;
528   }
529   else { /* Bitmap drawn bottom to top */
530     bitmap [i][j] = next_pixels;
531   }
532 }
533 }
534
535 /*
536 If any bits are set in color_mask, apply it to
537 entire bitmap to invert black <--> white.
538 */
539 if (color_mask != 0x00) {
540   for (i = 32*17-1; i >= 0; i--) {
541     for (j=0; j < 32*18/8; j++) {
542       bitmap [i][j] ^= color_mask;
543     }
544   }
545 }
546
547 }
548
549 /*
550 We've read the entire file. Now close the input file pointer.
551 */
552 fclose (infp);
553 /*
554 We now have the header portion in the header[] array,
555 and have the bitmap portion from top-to-bottom in the bitmap[] array.
556 */
557 /*
558 If no Unicode range (U+nnnnnn00 through U+nnnnnnFF) was specified
559 with a -p parameter, determine the range from the digits in the
560 bitmap itself.
561
562 Store bitmaps for the hex digit patterns that this file uses.
563 */
564 if (!planeset) { /* If Unicode range not specified with -p parameter */
565   for (i = 0x0; i <= 0xF; i++) { /* hex digit pattern we're storing */
566     for (j = 0; j < 4; j++) {
567       hexdigit[i][j] =
568         (((unsigned)bitmap[32 * (i+1) + 4 * j + 8 ])[6] << 24 ) |
569         (((unsigned)bitmap[32 * (i+1) + 4 * j + 8 + 1][6] << 16 ) |
570         (((unsigned)bitmap[32 * (i+1) + 4 * j + 8 + 2][6] << 8 ) |
571         (((unsigned)bitmap[32 * (i+1) + 4 * j + 8 + 3][6]
572
573     }
574   }
575 /*
576 Read the Unicode plane digits into arrays for comparison, to
577 determine the upper four hex digits of the glyph addresses.
578 */
579 for (i = 0; i < 4; i++) {
580   for (j = 0; j < 4; j++) {
581     unidigit[i][j] =
582       (((unsigned)bitmap[32 * 0 + 4 * j + 8 + 1][i + 3] << 24 ) |
583       (((unsigned)bitmap[32 * 0 + 4 * j + 8 + 2][i + 3] << 16 ) |
584       (((unsigned)bitmap[32 * 0 + 4 * j + 8 + 3][i + 3] << 8 ) |
585       (((unsigned)bitmap[32 * 0 + 4 * j + 8 + 4][i + 3]
586
587   }
588 }
589 tmpsum = 0;
590 for (i = 4; i < 6; i++) {
591   for (j = 0; j < 4; j++) {
592     unidigit[i][j] =
593       (((unsigned)bitmap[32 * 1 + 4 * j + 8 ])[i] << 24 ) |
594       (((unsigned)bitmap[32 * 1 + 4 * j + 8 + 1][i] << 16 ) |
595       (((unsigned)bitmap[32 * 1 + 4 * j + 8 + 2][i] << 8 ) |
596       (((unsigned)bitmap[32 * 1 + 4 * j + 8 + 3][i]
597
598   tmpsum |= unidigit[i][j];
599 }
600 }
601 if (tmpsum == 0) { /* the glyph matrix is transposed */
602   flip = 1; /* note transposed order for processing glyphs in matrix */
603 /*
604 Get 5th and 6th hex digits by shifting first column header left by
605 1.5 columns, thereby shifting the hex digit right after the leading
606 "U+nnnn" page number.

```

```

605 */
606     for (i = 0x08; i < 0x18; i++) {
607         bitmap[i][7] = (bitmap[i][8] « 4) | ((bitmap[i][9] » 4) & 0xf);
608         bitmap[i][8] = (bitmap[i][9] « 4) | ((bitmap[i][10] » 4) & 0xf);
609     }
610     for (i = 4; i < 6; i++) {
611         for (j = 0; j < 4; j++) {
612             unidigit[i][j] =
613                 ((unsigned)bitmap[4 * j + 8 + 1][i + 3] « 24) |
614                 ((unsigned)bitmap[4 * j + 8 + 2][i + 3] « 16) |
615                 ((unsigned)bitmap[4 * j + 8 + 3][i + 3] « 8) |
616                 ((unsigned)bitmap[4 * j + 8 + 4][i + 3] );
617         }
618     }
619 }
620
621 /*
622 Now determine the Unicode plane by comparing unidigit[0..5] to
623 the hexdigit[0x0..0xF] array.
624 */
625 uniplane = 0;
626 for (i=0; i<6; i++) { /* go through one bitmap digit at a time */
627     match = 0; /* haven't found pattern yet */
628     for (j = 0x0; !match && j <= 0xF; j++) {
629         if (unidigit[i][0] == hexdigit[j][0] &&
630             unidigit[i][1] == hexdigit[j][1] &&
631             unidigit[i][2] == hexdigit[j][2] &&
632             unidigit[i][3] == hexdigit[j][3]) { /* we found the digit */
633             uniplane |= j;
634             match = 1;
635         }
636     }
637     uniplane «= 4;
638 }
639 uniplane »= 4;
640 }
641 /*
642 Now read each glyph and print it as hex.
643 */
644 for (i = 0x0; i <= 0xf; i++) {
645     for (j = 0x0; j <= 0xf; j++) {
646         for (k = 0; k < 16; k++) {
647             if (flip) { /* transpose glyph matrix */
648                 thischar0[k] = bitmap[32*(j+1) + k + 7][4 * (i+2) ];
649                 thischar1[k] = bitmap[32*(j+1) + k + 7][4 * (i+2) + 1];
650                 thischar2[k] = bitmap[32*(j+1) + k + 7][4 * (i+2) + 2];
651                 thischar3[k] = bitmap[32*(j+1) + k + 7][4 * (i+2) + 3];
652             }
653             else {
654                 thischar0[k] = bitmap[32*(i+1) + k + 7][4 * (j+2) ];
655                 thischar1[k] = bitmap[32*(i+1) + k + 7][4 * (j+2) + 1];
656                 thischar2[k] = bitmap[32*(i+1) + k + 7][4 * (j+2) + 2];
657                 thischar3[k] = bitmap[32*(i+1) + k + 7][4 * (j+2) + 3];
658             }
659         }
660     }
661     /*
662     If the second half of the 16*16 character is all zeroes, this
663     character is only 8 bits wide, so print a half-width character.
664     */
665     empty1 = empty2 = 1;
666     for (k=0; (empty1 || empty2) && k < 16; k++) {
667         if (thischar1[k] != 0) empty1 = 0;
668         if (thischar2[k] != 0) empty2 = 0;
669     }
670     /*
671     Only print this glyph if it isn't blank.
672     */
673     if (!empty1 || !empty2) {
674         /*
675         If the second half is empty, this is a half-width character.
676         Only print the first half.
677         */
678         Original GNU Unifont format is four hexadecimal digit character
679         code followed by a colon followed by a hex string.  Add support
680         for codes beyond the Basic Multilingual Plane.
681
682         Unicode ranges from U+0000 to U+10FFFF, so print either a
683         4-digit or a 6-digit code point.  Note that this software
684         should support up to an 8-digit code point, extending beyond
685         the normal Unicode range, but this has not been fully tested.

```

```

686 */
687     if (uniplane > 0xff)
688         fprintf (outfp, "%04X%X%X%X:", uniplane, i, j); // 6 digit code pt.
689     else
690         fprintf (outfp, "%02X%X%X:X:", uniplane, i, j); // 4 digit code pt.
691     for (thisrow=0; thisrow<16; thisrow++) {
692         /*
693         If second half is empty and we're not forcing this
694         code point to double width, print as single width.
695         */
696         if (!forcewide &&
697             empty2 && !wide[(uniplane « 8) | (i « 4) | j]) {
698             fprintf (outfp,
699                 "%02X",
700                 thischar1[thisrow]);
701         }
702         else if (wide[(uniplane « 8) | (i « 4) | j] == 4) {
703             /* quadruple-width; force 32nd pixel to zero */
704             fprintf (outfp,
705                 "%02X%02X%02X%02X",
706                 thischar0[thisrow], thischar1[thisrow],
707                 thischar2[thisrow], thischar3[thisrow] & 0xFE);
708         }
709         else { /* treat as double-width */
710             fprintf (outfp,
711                 "%02X%02X",
712                 thischar1[thisrow], thischar2[thisrow]);
713         }
714     }
715     fprintf (outfp, "\n");
716 }
717 }
718 }
719 exit (0);
720 }

```

### 5.4.3 Variable Documentation

#### 5.4.3.1 bmp\_header

struct { ... } bmp\_header

Bitmap Header parameters

#### 5.4.3.2 color\_table

unsigned char color\_table[256][4]

Bitmap Color [Table](#) – maximum of 256 colors in a BMP file

Definition at line 137 of file unibmp2hex.c.

#### 5.4.3.3 unidigit

unsigned unidigit[6][4]

The six Unicode plane digits, from left-most (0) to right-most (5)

Definition at line 115 of file unibmp2hex.c.

## 5.5 src/unibmpbump.c File Reference

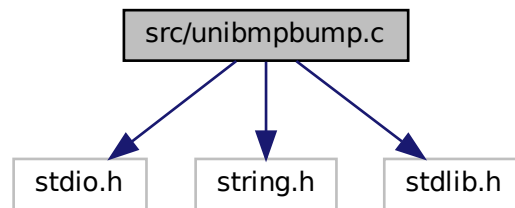
unibmpbump - Adjust a Microsoft bitmap (.bmp) file that was created by unihex2png but converted to .bmp

```
#include <stdio.h>
```

```
#include <string.h>
```

```
#include <stdlib.h>
```

Include dependency graph for unibmpbump.c:



### Macros

- `#define VERSION "1.0"`  
Version of this program.
- `#define MAX_COMPRESSION_METHOD 13`  
Maximum supported compression method.

### Functions

- `int main (int argc, char *argv[])`  
The main function.
- `unsigned get_bytes (FILE *infp, int nbytes)`  
Get from 1 to 4 bytes, inclusive, from input file.
- `void regrid (unsigned *image_bytes)`  
After reading in the image, shift it.

#### 5.5.1 Detailed Description

unibmpbump - Adjust a Microsoft bitmap (.bmp) file that was created by unihex2png but converted to .bmp

#### Author

Paul Hardy, unifoundry <at> unifoundry.com

## Copyright

Copyright (C) 2019 Paul Hardy

This program shifts the glyphs in a bitmap file to adjust an original PNG file that was saved in BMP format. This is so the result matches the format of a unihex2bmp image. This conversion then lets unibmp2hex decode the result.

Synopsis: unibmpbump [-iin\_file.bmp] [-oout\_file.bmp]

## 5.5.2 Function Documentation

## 5.5.2.1 get\_bytes()

```
unsigned get_bytes (
    FILE * infp,
    int nbytes )
```

Get from 1 to 4 bytes, inclusive, from input file.

Parameters

in	infp	Pointer to input file.
in	nbytes	Number of bytes to read, from 1 to 4, inclusive.

Returns

The unsigned 1 to 4 bytes in machine native endian format.

Definition at line 487 of file unibmpbump.c.

```
487     {
488     int i;
489     unsigned char inchar[4];
490     unsigned inword;
491
492     for (i = 0; i < nbytes; i++) {
493         if (fread (&inchar[i], 1, 1, infp) != 1) {
494             inchar[i] = 0;
495         }
496     }
497     for (i = nbytes; i < 4; i++) inchar[i] = 0;
498
499     inword = ((inchar[3] & 0xFF) « 24) | ((inchar[2] & 0xFF) « 16) |
500             ((inchar[1] & 0xFF) « 8) | (inchar[0] & 0xFF);
501
502     return inword;
503 }
```

### 5.5.2.2 main()

```
int main (
    int argc,
    char * argv[] )
```

The main function.

Parameters

in	argc	The count of command line arguments.
in	argv	Pointer to array of command line arguments.

Returns

This program exits with status EXIT\_SUCCESS.

Definition at line 50 of file unibmpbump.c.

```
50     {
51
52     /*
53     Values preserved from file header (first 14 bytes).
54     */
55     char file_format[3]; /* "BM" for original Windows format */
56     unsigned filesize; /* size of file in bytes */
57     unsigned char rsvd_hdr[4]; /* 4 reserved bytes */
58     unsigned image_start; /* byte offset of image in file */
59
60     /*
61     Values preserved from Device Independent Bitmap (DIB) Header.
62
63     The DIB fields below are in the standard 40-byte header. Version
64     4 and version 5 headers have more information, mainly for color
65     information. That is skipped over, because a valid glyph image
66     is just monochrome.
67     */
68     int dib_length; /* in bytes, for parsing by header version */
69     int image_width = 0; /* Signed image width */
70     int image_height = 0; /* Signed image height */
71     int num_planes = 0; /* number of planes; must be 1 */
72     int bits_per_pixel = 0; /* for palletized color maps (< 2^16 colors) */
73
74     The following fields are not in the original spec, so initialize
75     them to 0 so we can correctly parse an original file format.
76     */
77     int compression_method=0; /* 0 --> uncompressed RGB/monochrome */
78     int image_size = 0; /* 0 is a valid size if no compression */
79     int hres = 0; /* image horizontal resolution */
80     int vres = 0; /* image vertical resolution */
81     int num_colors = 0; /* Number of colors for pallettized images */
82     int important_colors = 0; /* Number of significant colors (0 or 2) */
83
84     int true_colors = 0; /* interpret num_colors, which can equal 0 */
85
86     /*
87     Color map. This should be a monochrome file, so only two
88     colors are stored.
89     */
90     unsigned char color_map[2][4]; /* two of R, G, B, and possibly alpha */
91
92     /*
93     The monochrome image bitmap, stored as a vector 544 rows by
94     72*8 columns.
95     */
96     unsigned image_bytes[544*72];
97
98     /*
99     Flags for conversion & I/O.
```



```

100 */
101 int verbose = 0; /* Whether to print file info on stderr */
102 unsigned image_xor = 0x00; /* Invert (= 0xFF) if color 0 is not black */
103
104 /*
105 Temporary variables.
106 */
107 int i, j, k; /* loop variables */
108
109 /* Compression type, for parsing file */
110 char *compression_type[MAX_COMPRESSION_METHOD + 1] = {
111     "BI_RGB", /* 0 */
112     "BI_RLE8", /* 1 */
113     "BI_RLE4", /* 2 */
114     "BI_BITFIELDS", /* 3 */
115     "BI_JPEG", /* 4 */
116     "BI_PNG", /* 5 */
117     "BI_ALPHABITFIELDS", /* 6 */
118     "", /* 7 - 10 */
119     "BI_CMYK", /* 11 */
120     "BI_CMYKRLE8", /* 12 */
121     "BI_CMYKRLE4", /* 13 */
122 };
123
124 /* Standard unihex2bmp.c header for BMP image */
125 unsigned standard_header[62] = {
126     /* 0 */ 0x42, 0x4d, 0x3e, 0x99, 0x00, 0x00, 0x00, 0x00,
127     /* 8 */ 0x00, 0x00, 0x3e, 0x00, 0x00, 0x00, 0x28, 0x00,
128     /* 16 */ 0x00, 0x00, 0x40, 0x02, 0x00, 0x00, 0x20, 0x02,
129     /* 24 */ 0x00, 0x00, 0x01, 0x00, 0x01, 0x00, 0x00, 0x00,
130     /* 32 */ 0x00, 0x00, 0x00, 0x99, 0x00, 0x00, 0xc4, 0x0e,
131     /* 40 */ 0x00, 0x00, 0xc4, 0x0e, 0x00, 0x00, 0x00, 0x00,
132     /* 48 */ 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00,
133     /* 56 */ 0x00, 0x00, 0xff, 0xff, 0xff, 0x00
134 };
135
136 unsigned get_bytes(FILE *, int);
137 void regrid(unsigned *);
138
139 char *infile="", *outfile=""; /* names of input and output files */
140 FILE *infp, *outfp; /* file pointers of input and output files */
141
142 /*
143 Process command line arguments.
144 */
145 if (argc > 1) {
146     for (i = 1; i < argc; i++) {
147         if (argv[i][0] == '-') { /* this is an option argument */
148             switch (argv[i][1]) {
149                 case 'i': /* name of input file */
150                     infile = &argv[i][2];
151                     break;
152                 case 'o': /* name of output file */
153                     outfile = &argv[i][2];
154                     break;
155                 case 'v': /* verbose output */
156                     verbose = 1;
157                     break;
158                 case 'V': /* print version & quit */
159                     fprintf(stderr, "unibmpbump version %s\n", VERSION);
160                     exit(EXIT_SUCCESS);
161                     break;
162                 case '-': /* see if "--verbose" */
163                     if (strcmp(argv[i], "--verbose") == 0) {
164                         verbose = 1;
165                     }
166                     else if (strcmp(argv[i], "--version") == 0) {
167                         fprintf(stderr, "unibmpbump version %s\n", VERSION);
168                         exit(EXIT_SUCCESS);
169                     }
170                     break;
171                 default: /* if unrecognized option, print list and exit */
172                     fprintf(stderr, "\nSyntax: \n\n");
173                     fprintf(stderr, "    unibmpbump ");
174                     fprintf(stderr, "-i<Input_File> -o<Output_File>\n\n");
175                     fprintf(stderr, "-v or --verbose gives verbose output");
176                     fprintf(stderr, "\n on stderr\n\n");
177                     fprintf(stderr, "-V or --version prints version");
178                     fprintf(stderr, "\n on stderr and exits\n\n");
179                     fprintf(stderr, "\nExample: \n\n");
180                     fprintf(stderr, "    unibmpbump -iuni0101.bmp");

```

```

181         fprintf(stderr, "-onew-uni0101.bmp\n\n");
182         exit(EXIT_SUCCESS);
183     }
184 }
185 }
186 }
187
188 /*
189 Make sure we can open any I/O files that were specified before
190 doing anything else.
191 */
192 if (strlen(infile) > 0) {
193     if ((infp = fopen(infile, "r")) == NULL) {
194         fprintf(stderr, "Error: can't open %s for input.\n", infile);
195         exit(EXIT_FAILURE);
196     }
197 }
198 else {
199     infp = stdin;
200 }
201 if (strlen(outfile) > 0) {
202     if ((outfp = fopen(outfile, "w")) == NULL) {
203         fprintf(stderr, "Error: can't open %s for output.\n", outfile);
204         exit(EXIT_FAILURE);
205     }
206 }
207 else {
208     outfp = stdout;
209 }
210
211 /* Read bitmap file header */
212 file_format[0] = get_bytes(infp, 1);
213 file_format[1] = get_bytes(infp, 1);
214 file_format[2] = '\0'; /* Terminate string with null */
215
216 /* Read file size */
217 filesize = get_bytes(infp, 4);
218
219 /* Read Reserved bytes */
220 rsvd_hdr[0] = get_bytes(infp, 1);
221 rsvd_hdr[1] = get_bytes(infp, 1);
222 rsvd_hdr[2] = get_bytes(infp, 1);
223 rsvd_hdr[3] = get_bytes(infp, 1);
224
225 /* Read Image Offset Address within file */
226 image_start = get_bytes(infp, 4);
227
228 /*
229 See if this looks like a valid image file based on
230 the file header first two bytes.
231 */
232 if (strncmp(file_format, "BM", 2) != 0) {
233     fprintf(stderr, "\nInvalid file format: not file type \"BM\".\n\n");
234     exit(EXIT_FAILURE);
235 }
236
237 if (verbose) {
238     fprintf(stderr, "\nFile Header:\n");
239     fprintf(stderr, "  File Type:  \"%s\"\n", file_format);
240     fprintf(stderr, "  File Size:  %d bytes\n", filesize);
241     fprintf(stderr, "  Reserved:   ");
242     for (i = 0; i < 4; i++) fprintf(stderr, " 0x%02X", rsvd_hdr[i]);
243     fputc('\n', stderr);
244     fprintf(stderr, "  Image Start: %d. = 0x%02X = 0%05o\n\n",
245             image_start, image_start, image_start);
246 } /* if (verbose) */
247
248 /*
249 Device Independent Bitmap (DIB) Header: bitmap information header
250 ("BM" format file DIB Header is 12 bytes long).
251 */
252 dib_length = get_bytes(infp, 4);
253
254 /*
255 Parse one of three versions of Device Independent Bitmap (DIB) format:
256 Length Format
257 -----
258 12 BITMAPCOREHEADER
259 40 BITMAPINFOHEADER

```

```

262 108 BITMAPV4HEADER
263 124 BITMAPV5HEADER
264 */
265 if (dib_length == 12) { /* BITMAPCOREHEADER format -- UNTESTED */
266     image_width = get_bytes (infp, 2);
267     image_height = get_bytes (infp, 2);
268     num_planes = get_bytes (infp, 2);
269     bits_per_pixel = get_bytes (infp, 2);
270 }
271 else if (dib_length >= 40) { /* BITMAPINFOHEADER format or later */
272     image_width = get_bytes (infp, 4);
273     image_height = get_bytes (infp, 4);
274     num_planes = get_bytes (infp, 2);
275     bits_per_pixel = get_bytes (infp, 2);
276     compression_method = get_bytes (infp, 4); /* BI_BITFIELDS */
277     image_size = get_bytes (infp, 4);
278     hres = get_bytes (infp, 4);
279     vres = get_bytes (infp, 4);
280     num_colors = get_bytes (infp, 4);
281     important_colors = get_bytes (infp, 4);
282
283     /* true_colors is true number of colors in image */
284     if (num_colors == 0)
285         true_colors = 1 « bits_per_pixel;
286     else
287         true_colors = num_colors;
288
289     /*
290     If dib_length > 40, the format is BITMAPV4HEADER or
291     BITMAPV5HEADER. As this program is only designed
292     to handle a monochrome image, we can ignore the rest
293     of the header but must read past the remaining bytes.
294     */
295     for (i = 40; i < dib_length; i++) (void)get_bytes (infp, 1);
296 }
297
298 if (verbose) {
299     fprintf (stderr, "Device Independent Bitmap (DIB) Header:\n");
300     fprintf (stderr, "  DIB Length:  %9d bytes (version = ", dib_length);
301
302     if (dib_length == 12) fprintf (stderr, "\"BITMAPCOREHEADER\"\n");
303     else if (dib_length == 40) fprintf (stderr, "\"BITMAPINFOHEADER\"\n");
304     else if (dib_length == 108) fprintf (stderr, "\"BITMAPV4HEADER\"\n");
305     else if (dib_length == 124) fprintf (stderr, "\"BITMAPV5HEADER\"\n");
306     else fprintf (stderr, "unknown");
307     fprintf (stderr, "  Bitmap Width:  %6d pixels\n", image_width);
308     fprintf (stderr, "  Bitmap Height:  %6d pixels\n", image_height);
309     fprintf (stderr, "  Color Planes:  %6d\n", num_planes);
310     fprintf (stderr, "  Bits per Pixel: %6d\n", bits_per_pixel);
311     fprintf (stderr, "  Compression Method: %2d --> ", compression_method);
312     if (compression_method <= MAX_COMPRESSION_METHOD) {
313         fprintf (stderr, "%s", compression_type [compression_method]);
314     }
315     /*
316     Supported compression method values:
317     0 --> uncompressed RGB
318     11 --> uncompressed CMYK
319     */
320     if (compression_method == 0 || compression_method == 11) {
321         fprintf (stderr, " (no compression)");
322     }
323     else {
324         fprintf (stderr, "Image uses compression; this is unsupported.\n\n");
325         exit (EXIT_FAILURE);
326     }
327     fprintf (stderr, "\n");
328     fprintf (stderr, "  Image Size:          %5d bytes\n", image_size);
329     fprintf (stderr, "  Horizontal Resolution: %5d pixels/meter\n", hres);
330     fprintf (stderr, "  Vertical Resolution:  %5d pixels/meter\n", vres);
331     fprintf (stderr, "  Number of Colors:     %5d", num_colors);
332     if (num_colors != true_colors) {
333         fprintf (stderr, " --> %d", true_colors);
334     }
335     fputc ('\n', stderr);
336     fprintf (stderr, "  Important Colors:      %5d", important_colors);
337     if (important_colors == 0)
338         fprintf (stderr, " (all colors are important)");
339     fprintf (stderr, "\n\n");
340 } /* if (verbose) */
341
342 /*

```

```

343 Print Color Table information for images with pallettized colors.
344 */
345 if (bits_per_pixel <= 8) {
346     for (i = 0; i < 2; i++) {
347         color_map [i][0] = get_bytes (infp, 1);
348         color_map [i][1] = get_bytes (infp, 1);
349         color_map [i][2] = get_bytes (infp, 1);
350         color_map [i][3] = get_bytes (infp, 1);
351     }
352     /* Skip remaining color table entries if more than 2 */
353     while (i < true_colors) {
354         (void) get_bytes (infp, 4);
355         i++;
356     }
357
358     if (color_map [0][0] >= 128) image_xor = 0xFF; /* Invert colors */
359 }
360
361 if (verbose) {
362     fprintf (stderr, "Color Palette [R, G, B, %s] Values:\n",
363             (dib_length <= 40) ? "reserved" : "Alpha");
364     for (i = 0; i < 2; i++) {
365         fprintf (stderr, "%7d: [", i);
366         fprintf (stderr, "%3d,", color_map [i][0] & 0xFF);
367         fprintf (stderr, "%3d,", color_map [i][1] & 0xFF);
368         fprintf (stderr, "%3d,", color_map [i][2] & 0xFF);
369         fprintf (stderr, "%3d]\n", color_map [i][3] & 0xFF);
370     }
371     if (image_xor == 0xFF) fprintf (stderr, "Will Invert Colors.\n");
372     fputc ('\n', stderr);
373 } /* if (verbose) */
374
375
376
377 /*
378 Check format before writing output file.
379 */
380 if (image_width != 560 && image_width != 576) {
381     fprintf (stderr, "\nUnsupported image width: %d\n", image_width);
382     fprintf (stderr, "Width should be 560 or 576 pixels.\n\n");
383     exit (EXIT_FAILURE);
384 }
385
386 if (image_height != 544) {
387     fprintf (stderr, "\nUnsupported image height: %d\n", image_height);
388     fprintf (stderr, "Height should be 544 pixels.\n\n");
389     exit (EXIT_FAILURE);
390 }
391
392 if (num_planes != 1) {
393     fprintf (stderr, "\nUnsupported number of planes: %d\n", num_planes);
394     fprintf (stderr, "Number of planes should be 1.\n\n");
395     exit (EXIT_FAILURE);
396 }
397
398 if (bits_per_pixel != 1) {
399     fprintf (stderr, "\nUnsupported number of bits per pixel: %d\n",
400             bits_per_pixel);
401     fprintf (stderr, "Bits per pixel should be 1.\n\n");
402     exit (EXIT_FAILURE);
403 }
404
405 if (compression_method != 0 && compression_method != 11) {
406     fprintf (stderr, "\nUnsupported compression method: %d\n",
407             compression_method);
408     fprintf (stderr, "Compression method should be 1 or 11.\n\n");
409     exit (EXIT_FAILURE);
410 }
411
412 if (true_colors != 2) {
413     fprintf (stderr, "\nUnsupported number of colors: %d\n", true_colors);
414     fprintf (stderr, "Number of colors should be 2.\n\n");
415     exit (EXIT_FAILURE);
416 }
417
418
419 /*
420 If we made it this far, things look okay, so write out
421 the standard header for image conversion.
422 */
423 for (i = 0; i < 62; i++) fputc (standard_header[i], outfp);

```

```

424
425
426  /*
427  Image Data.  Each row must be a multiple of 4 bytes, with
428  padding at the end of each row if necessary.
429  */
430  k = 0; /* byte number within the binary image */
431  for (i = 0; i < 544; i++) {
432      /*
433      If original image is 560 pixels wide (not 576), add
434      2 white bytes at beginning of row.
435      */
436      if (image_width == 560) { /* Insert 2 white bytes */
437          image_bytes[k++] = 0xFF;
438          image_bytes[k++] = 0xFF;
439      }
440      for (j = 0; j < 70; j++) { /* Copy next 70 bytes */
441          image_bytes[k++] = (get_bytes (infp, 1) & 0xFF) ^ image_xor;
442      }
443      /*
444      If original image is 560 pixels wide (not 576), skip
445      2 padding bytes at end of row in file because we inserted
446      2 white bytes at the beginning of the row.
447      */
448      if (image_width == 560) {
449          (void) get_bytes (infp, 2);
450      }
451      else { /* otherwise, next 2 bytes are part of the image so copy them */
452          image_bytes[k++] = (get_bytes (infp, 1) & 0xFF) ^ image_xor;
453          image_bytes[k++] = (get_bytes (infp, 1) & 0xFF) ^ image_xor;
454      }
455  }
456
457
458  /*
459  Change the image to match the unihex2bmp.c format if original wasn't
460  */
461  if (image_width == 560) {
462      regrid (image_bytes);
463  }
464
465  for (i = 0; i < 544 * 576 / 8; i++) {
466      fputc (image_bytes[i], outfp);
467  }
468
469
470  /*
471  Wrap up.
472  */
473  fclose (infp);
474  fclose (outfp);
475
476  exit (EXIT_SUCCESS);
477 }

```

### 5.5.2.3 regrid()

```
void regrid (
    unsigned * image_bytes )
```

After reading in the image, shift it.

This function adjusts the input image from an original PNG file to match [unihex2bmp.c](#) format.

Parameters

in,out	image_bytes	The pixels in an image.
--------	-------------	-------------------------

Definition at line 514 of file unibmpbump.c.

```

514     {
515     int i, j, k; /* loop variables */
516     int offset;
517     unsigned glyph_row; /* one grid row of 32 pixels */
518     unsigned last_pixel; /* last pixel in a byte, to preserve */
519
520     /* To insert "00" after "U+" at top of image */
521     char zero_pattern[16] = {
522         0x00, 0x00, 0x00, 0x00, 0x18, 0x24, 0x42, 0x42,
523         0x42, 0x42, 0x42, 0x42, 0x24, 0x18, 0x00, 0x00
524     };
525
526     /* This is the horizontal grid pattern on glyph boundaries */
527     unsigned hgrid[72] = {
528         /* 0 */ 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xfe,
529         /* 8 */ 0x00, 0x81, 0x81, 0x00, 0x00, 0x81, 0x81, 0x00,
530         /* 16 */ 0x00, 0x81, 0x81, 0x00, 0x00, 0x81, 0x81, 0x00,
531         /* 24 */ 0x00, 0x81, 0x81, 0x00, 0x00, 0x81, 0x81, 0x00,
532         /* 32 */ 0x00, 0x81, 0x81, 0x00, 0x00, 0x81, 0x81, 0x00,
533         /* 40 */ 0x00, 0x81, 0x81, 0x00, 0x00, 0x81, 0x81, 0x00,
534         /* 48 */ 0x00, 0x81, 0x81, 0x00, 0x00, 0x81, 0x81, 0x00,
535         /* 56 */ 0x00, 0x81, 0x81, 0x00, 0x00, 0x81, 0x81, 0x00,
536         /* 64 */ 0x00, 0x81, 0x81, 0x00, 0x00, 0x81, 0x81, 0x00
537     };
538
539
540     /*
541     First move "U+" left and insert "00" after it.
542     */
543     j = 15; /* rows are written bottom to top, so we'll decrement j */
544     for (i = 543 - 8; i > 544 - 24; i--) {
545         offset = 72 * i;
546         image_bytes[offset + 0] = image_bytes[offset + 2];
547         image_bytes[offset + 1] = image_bytes[offset + 3];
548         image_bytes[offset + 2] = image_bytes[offset + 4];
549         image_bytes[offset + 3] = image_bytes[offset + 4] =
550             ~zero_pattern[15 - j--] & 0xFF;
551     }
552
553     /*
554     Now move glyph bitmaps to the right by 8 pixels.
555     */
556     for (i = 0; i < 16; i++) { /* for each glyph row */
557         for (j = 0; j < 16; j++) { /* for each glyph column */
558             /* set offset to lower left-hand byte of next glyph */
559             offset = (32 * 72 * i) + (9 * 72) + (4 * j) + 8;
560             for (k = 0; k < 16; k++) { /* for each glyph row */
561                 glyph_row = (image_bytes[offset + 0] « 24) |
562                     (image_bytes[offset + 1] « 16) |
563                     (image_bytes[offset + 2] « 8) |
564                     (image_bytes[offset + 3]);
565                 last_pixel = glyph_row & 1; /* preserve border */
566                 glyph_row »= 4;
567                 glyph_row &= 0xFFFFFFE;
568                 /* Set left 4 pixels to white and preserve last pixel */
569                 glyph_row |= 0xF0000000 | last_pixel;
570                 image_bytes[offset + 3] = glyph_row & 0xFF;
571                 glyph_row »= 8;
572                 image_bytes[offset + 2] = glyph_row & 0xFF;
573                 glyph_row »= 8;
574                 image_bytes[offset + 1] = glyph_row & 0xFF;
575                 glyph_row »= 8;
576                 image_bytes[offset + 0] = glyph_row & 0xFF;
577                 offset += 72; /* move up to next row in current glyph */
578             }
579         }
580     }
581
582     /* Replace horizontal grid with unihex2bmp.c grid */
583     for (i = 0; i <= 16; i++) {
584         offset = 32 * 72 * i;
585         for (j = 0; j < 72; j++) {
586             image_bytes[offset + j] = hgrid[j];
587         }
588     }
589
590     return;
591 }

```

## 5.6 src/unicoverage.c File Reference

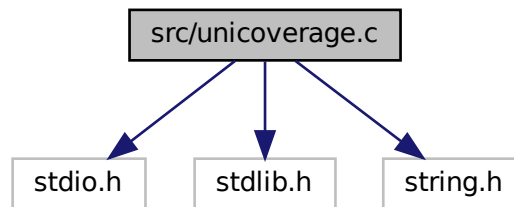
unicoverage - Show the coverage of Unicode plane scripts for a GNU Unifont hex glyph file

```
#include <stdio.h>
```

```
#include <stdlib.h>
```

```
#include <string.h>
```

Include dependency graph for unicoverage.c:



### Macros

- `#define` [MAXBUF](#) 256  
Maximum input line length - 1.

### Functions

- `int` [main](#) (`int argc`, `char *argv[]`)  
The main function.
- `int` [nextrange](#) (`FILE *coveragefp`, `int *cstart`, `int *cend`, `char *coverstring`)  
Get next Unicode range.
- `void` [print\\_subtotal](#) (`FILE *outfp`, `int print_n`, `int nglyphs`, `int cstart`, `int cend`, `char *coverstring`)  
Print the subtotal for one Unicode script range.

### 5.6.1 Detailed Description

unicoverage - Show the coverage of Unicode plane scripts for a GNU Unifont hex glyph file

#### Author

Paul Hardy, unifoundry <at> unifoundry.com, 6 January 2008

#### Copyright

Copyright (C) 2008, 2013 Paul Hardy

Synopsis: `unicoverage [-ifont_file.hex] [-ocoverage_file.txt]`

This program requires the file "coverage.dat" to be present in the directory from which it is run.

## 5.6.2 Function Documentation

### 5.6.2.1 main()

```
int main (
    int argc,
    char * argv[] )
```

The main function.

Parameters

in	argc	The count of command line arguments.
in	argv	Pointer to array of command line arguments.

Returns

This program exits with status 0.

Definition at line 68 of file unicoverage.c.

```
69 {
70
71     int    print_n=0;        /* print # of glyphs, not percentage */
72     unsigned i;              /* loop variable */
73     unsigned slen;           /* string length of coverage file line */
74     char    inbuf[256];      /* input buffer */
75     unsigned thischar;       /* the current character */
76
77     char *infile="", *outfile=""; /* names of input and output files */
78     FILE *infp, *outfp;      /* file pointers of input and output files */
79     FILE *coveragefp;        /* file pointer to coverage.dat file */
80     int cstart, cend;         /* current coverage start and end code points */
81     char coverstring[MAXBUF]; /* description of current coverage range */
82     int nglyphs;             /* number of glyphs in this section */
83     int nextrange();          /* to get next range & name of Unicode glyphs */
84
85     void print_subtotal (FILE *outfp, int print_n, int nglyphs,
86                         int cstart, int cend, char *coverstring);
87
88     if ((coveragefp = fopen ("coverage.dat", "r")) == NULL) {
89         fprintf (stderr, "\nError: data file \"coverage.dat\" not found.\n\n");
90         exit (0);
91     }
92
93     if (argc > 1) {
94         for (i = 1; i < argc; i++) {
95             if (argv[i][0] == '-') { /* this is an option argument */
96                 switch (argv[i][1]) {
97                     case 'i': /* name of input file */
98                         infile = &argv[i][2];
99                         break;
100                     case 'n': /* print number of glyphs instead of percentage */
101                         print_n = 1;
102                     case 'o': /* name of output file */
103                         outfile = &argv[i][2];
104                         break;
105                     default: /* if unrecognized option, print list and exit */
106                         fprintf (stderr, "\nSyntax:\n\n");
107                         fprintf (stderr, "  %s -p<Unicode_Page> ", argv[0]);
108                         fprintf (stderr, "-i<Input_File> -o<Output_File> -w\n\n");
109                         exit (1);

```

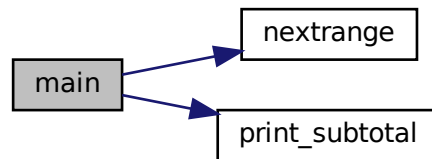


```

110     }
111   }
112 }
113 }
114 /*
115  Make sure we can open any I/O files that were specified before
116  doing anything else.
117 */
118 if (strlen (infile) > 0) {
119   if ((infp = fopen (infile, "r")) == NULL) {
120     fprintf (stderr, "Error: can't open %s for input.\n", infile);
121     exit (1);
122   }
123 }
124 else {
125   infp = stdin;
126 }
127 if (strlen (outfile) > 0) {
128   if ((outfp = fopen (outfile, "w")) == NULL) {
129     fprintf (stderr, "Error: can't open %s for output.\n", outfile);
130     exit (1);
131   }
132 }
133 else {
134   outfp = stdout;
135 }
136
137 /*
138  Print header row.
139 */
140 if (print_n) {
141   fprintf (outfp, "# Glyphs      Range      Script\n");
142   fprintf (outfp, "-----      ----      ----\n");
143 }
144 else {
145   fprintf (outfp, "Covered      Range      Script\n");
146   fprintf (outfp, "-----      ----      ----\n");
147 }
148
149 slen = nextrange (coveragefp, &cstart, &cend, coverstring);
150 nglyphs = 0;
151
152 /*
153  Read in the glyphs in the file
154 */
155 while (slen != 0 && fgetc (inbuf, MAXBUF-1, infp) != NULL) {
156   sscanf (inbuf, "%x", &thischar);
157
158   /* Read a character beyond end of current script. */
159   while (cend < thischar && slen != 0) {
160     print_subtotal (outfp, print_n, nglyphs, cstart, cend, coverstring);
161
162     /* start new range total */
163     slen = nextrange (coveragefp, &cstart, &cend, coverstring);
164     nglyphs = 0;
165   }
166   nglyphs++;
167 }
168
169 print_subtotal (outfp, print_n, nglyphs, cstart, cend, coverstring);
170
171 exit (0);
172 }

```

Here is the call graph for this function:



#### 5.6.2.2 nextrange()

```

int nextrange (
    FILE * coveragefp,
    int * cstart,
    int * cend,
    char * coverstring )
  
```

Get next Unicode range.

This function reads the next Unicode script range to count its glyph coverage.

Parameters

in	coveragefp	File pointer to Unicode script range data file.
in	cstart	Starting code point in current Unicode script range.
in	cend	Ending code point in current Unicode script range.
out	coverstring	String containing <cstart>-<cend> substring.

Returns

Length of the last string read, or 0 for end of file.

Definition at line 187 of file unicoverage.c.

```

190 {
191     int i;
192     static char inbuf[MAXBUF];
193     int retval; /* the return value */
194
195     retval = 0;
196
197     do {
198         if (fgets (inbuf, MAXBUF-1, coveragefp) != NULL) {
199             retval = strlen (inbuf);
  
```

```

200     if ((inbuf[0] >= '0' && inbuf[0] <= '9') ||
201         (inbuf[0] >= 'A' && inbuf[0] <= 'F') ||
202         (inbuf[0] >= 'a' && inbuf[0] <= 'f')) {
203         sscanf (inbuf, "%x-%x", cstart, cend);
204         i = 0;
205         while (inbuf[i] != ' ') i++; /* find first blank */
206         while (inbuf[i] == ' ') i++; /* find next non-blank */
207         strncpy (coverstring, &inbuf[i], MAXBUF);
208     }
209     else retval = 0;
210 }
211 else retval = 0;
212 } while (retval == 0 && !feof (coveragefp));
213
214 return (retval);
215 }

```

Here is the caller graph for this function:



### 5.6.2.3 print\_subtotal()

```

void print_subtotal (
    FILE * outfp,
    int print_n,
    int nglyphs,
    int cstart,
    int cend,
    char * coverstring )

```

Print the subtotal for one Unicode script range.

Parameters

in	outfp	Pointer to output file.
in	print_n	1 = print number of glyphs, 0 = print percentage.
in	nglyphs	Number of glyphs in current range.
in	cstart	Starting code point for current range.
in	cend	Ending code point for current range.
in	coverstring	Character string of "<cstart>-<cend>".

Definition at line 228 of file unicoverage.c.

```

229                                     {
230
231     /* print old range total */
232     if (print_n) { /* Print number of glyphs, not percentage */
233         fprintf (outfp, " %6d ", nglyphs);
234     }
235     else {
236         fprintf (outfp, " %5.1f%%", 100.0*nglyphs/(1+cend-cstart));
237     }
238
239     if (cend < 0x10000)
240         fprintf (outfp, " U+%04X..U+%04X  %s",
241                 cstart, cend, coverstring);
242     else
243         fprintf (outfp, " U+%05X..U+%05X  %s",
244                 cstart, cend, coverstring);
245
246     return;
247 }

```

Here is the caller graph for this function:



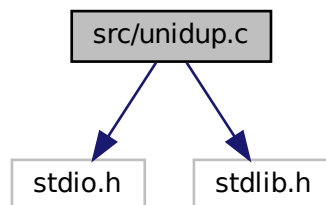
## 5.7 src/unidup.c File Reference

unidup - Check for duplicate code points in sorted unifont.hex file

```
#include <stdio.h>
```

```
#include <stdlib.h>
```

Include dependency graph for unidup.c:



### Macros

- `#define MAXBUF 256`  
Maximum input line length - 1.

## Functions

- `int main (int argc, char **argv)`  
The main function.

### 5.7.1 Detailed Description

unidup - Check for duplicate code points in sorted unifont.hex file

#### Author

Paul Hardy, unifoundry <at> unifoundry.com, December 2007

#### Copyright

Copyright (C) 2007, 2008, 2013 Paul Hardy

This program reads a sorted list of glyphs in Unifont .hex format and prints duplicate code points on stderr if any were detected.

Synopsis: `unidup < unifont_file.hex`

[Hopefully there won't be any output!]

### 5.7.2 Function Documentation

#### 5.7.2.1 main()

```
int main (  
    int argc,  
    char ** argv )
```

The main function.

#### Parameters

in	argc	The count of command line arguments.
in	argv	Pointer to array of command line arguments.

#### Returns

This program exits with status 0.

Definition at line 48 of file unidup.c.

```

49 {
50
51     int ix, iy;
52     char inbuf[MAXBUF];
53     char *infile; /* the input file name */
54     FILE *infilep; /* file pointer to input file */
55
56     if (argc > 1) {
57         infile = argv[1];
58         if ((infilep = fopen (infile, "r")) == NULL) {
59             fprintf (stderr, "\nERROR: Can't open file %s\n\n", infile);
60             exit (EXIT_FAILURE);
61         }
62     }
63     else {
64         infilep = stdin;
65     }
66
67     ix = -1;
68
69     while (fgets (inbuf, MAXBUF-1, infilep) != NULL) {
70         sscanf (inbuf, "%X", &iy);
71         if (ix == iy) fprintf (stderr, "Duplicate code point: %04X\n", ix);
72         else ix = iy;
73     }
74     exit (0);
75 }

```

## 5.8 src/unifont1per.c File Reference

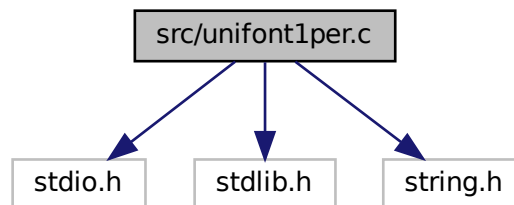
unifont1per - Read a Unifont .hex file from standard input and produce one glyph per ".bmp" bitmap file as output

```

#include <stdio.h>
#include <stdlib.h>
#include <string.h>

```

Include dependency graph for unifont1per.c:



## Macros

- #define `MAXSTRING` 266
- #define `MAXFILENAME` 20

## Functions

- `int main ()`  
The main function.

### 5.8.1 Detailed Description

unifont1per - Read a Unifont .hex file from standard input and produce one glyph per ".bmp" bitmap file as output

#### Author

Paul Hardy, unifoundry <at> unifoundry.com, December 2016

#### Copyright

Copyright (C) 2016, 2017 Paul Hardy

Each glyph is 16 pixels tall, and can be 8, 16, 24, or 32 pixels wide. The width of each output graphic file is determined automatically by the width of each Unifont hex representation.

This program creates files of the form "U+<codepoint>.bmp", 1 per glyph.

Synopsis: unifont1per < unifont.hex

### 5.8.2 Macro Definition Documentation

#### 5.8.2.1 MAXFILENAME

```
#define MAXFILENAME 20
```

Maximum size of a filename of the form "U+%06X.bmp".

Definition at line 60 of file unifont1per.c.

#### 5.8.2.2 MAXSTRING

```
#define MAXSTRING 266
```

Maximum size of an input line in a Unifont .hex file - 1.

Definition at line 57 of file unifont1per.c.

### 5.8.3 Function Documentation

#### 5.8.3.1 main()

```
int main ( )
```

The main function.

Returns

This program exits with status EXIT\_SUCCESS.

Definition at line 69 of file unifont1per.c.

```

69     {
70
71     int i; /* loop variable */
72
73     /*
74     Define bitmap header bytes
75     */
76     unsigned char header [62] = {
77     /*
78     Bitmap File Header -- 14 bytes
79     */
80     'B', 'M', /* Signature */
81     0x7E, 0, 0, 0, /* File Size */
82     0, 0, 0, 0, /* Reserved */
83     0x3E, 0, 0, 0, /* Pixel Array Offset */
84
85     /*
86     Device Independent Bitmap Header -- 40 bytes
87
88     Image Width and Image Height are assigned final values
89     based on the dimensions of each glyph.
90     */
91     0x28, 0, 0, 0, /* DIB Header Size */
92     0x10, 0, 0, 0, /* Image Width = 16 pixels */
93     0xF0, 0xFF, 0xFF, 0xFF, /* Image Height = -16 pixels */
94     0x01, 0, /* Planes */
95     0x01, 0, /* Bits Per Pixel */
96     0, 0, 0, 0, /* Compression */
97     0x40, 0, 0, 0, /* Image Size */
98     0x14, 0x0B, 0, 0, /* X Pixels Per Meter = 72 dpi */
99     0x14, 0x0B, 0, 0, /* Y Pixels Per Meter = 72 dpi */
100    0x02, 0, 0, 0, /* Colors In Color Table */
101    0, 0, 0, 0, /* Important Colors */
102
103    /*
104    Color Palette -- 8 bytes
105    */
106    0xFF, 0xFF, 0xFF, 0, /* White */
107    0, 0, 0, 0 /* Black */
108    };
109
110    char instring[MAXSTRING]; /* input string */
111    int code_point; /* current Unicode code point */
112    char glyph[MAXSTRING]; /* bitmap string for this glyph */
113    int glyph_height=16; /* for now, fixed at 16 pixels high */
114    int glyph_width; /* 8, 16, 24, or 32 pixels wide */
115    char filename[MAXFILENAME]; /* name of current output file */
116    FILE *outfp; /* file pointer to current output file */
117
118    int string_index; /* pointer into hexadecimal glyph string */
119    int nextbyte; /* next set of 8 bits to print out */
120
121    /* Repeat for each line in the input stream */
122    while (fgets (instring, MAXSTRING - 1, stdin) != NULL) {
123        /* Read next Unifont ASCII hexadecimal format glyph description */

```



```

124     sscanf (instring, "%X:%s", &code_point, glyph);
125     /* Calculate width of a glyph in pixels; 4 bits per ASCII hex digit */
126     glyph_width = strlen (glyph) / (glyph_height / 4);
127     snprintf (filename, MAXFILENAME, "U+%06X.bmp", code_point);
128     header [18] = glyph_width; /* bitmap width */
129     header [22] = -glyph_height; /* negative height --> draw top to bottom */
130     if ((outfp = fopen (filename, "w")) != NULL) {
131         for (i = 0; i < 62; i++) fputc (header[i], outfp);
132         /*
133         Bitmap, with each row padded with zeroes if necessary
134         so each row is four bytes wide. (Each row must end
135         on a four-byte boundary, and four bytes is the maximum
136         possible row length for up to 32 pixels in a row.)
137         */
138         string_index = 0;
139         for (i = 0; i < glyph_height; i++) {
140             /* Read 2 ASCII hexadecimal digits (1 byte of output pixels) */
141             sscanf (&glyph[string_index], "%2X", &nextbyte);
142             string_index += 2;
143             fputc (nextbyte, outfp); /* write out the 8 pixels */
144             if (glyph_width <= 8) { /* pad row with 3 zero bytes */
145                 fputc (0x00, outfp); fputc (0x00, outfp); fputc (0x00, outfp);
146             }
147             else { /* get 8 more pixels */
148                 sscanf (&glyph[string_index], "%2X", &nextbyte);
149                 string_index += 2;
150                 fputc (nextbyte, outfp); /* write out the 8 pixels */
151                 if (glyph_width <= 16) { /* pad row with 2 zero bytes */
152                     fputc (0x00, outfp); fputc (0x00, outfp);
153                 }
154                 else { /* get 8 more pixels */
155                     sscanf (&glyph[string_index], "%2X", &nextbyte);
156                     string_index += 2;
157                     fputc (nextbyte, outfp); /* write out the 8 pixels */
158                     if (glyph_width <= 24) { /* pad row with 1 zero byte */
159                         fputc (0x00, outfp);
160                     }
161                     else { /* get 8 more pixels */
162                         sscanf (&glyph[string_index], "%2X", &nextbyte);
163                         string_index += 2;
164                         fputc (nextbyte, outfp); /* write out the 8 pixels */
165                     } /* glyph is 32 pixels wide */
166                 } /* glyph is 24 pixels wide */
167             } /* glyph is 16 pixels wide */
168         } /* glyph is 8 pixels wide */
169         fclose (outfp);
170     }
171 }
172 }
173
174 exit (EXIT_SUCCESS);
175 }

```

## 5.9 src/unifontpic.c File Reference

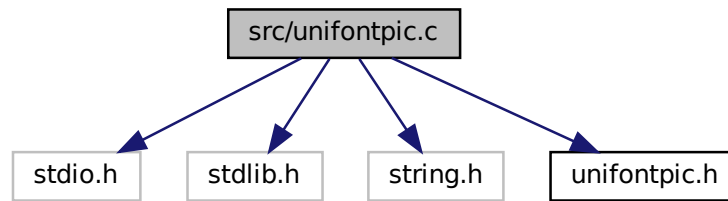
unifontpic - See the "Big Picture": the entire Unifont in one BMP bitmap

```

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include "unifontpic.h"

```

Include dependency graph for unifontpic.c:



## Macros

- `#define HDR_LEN 33`

## Functions

- `int main (int argc, char **argv)`  
The main function.
- `void output4 (int thisword)`  
Output a 4-byte integer in little-endian order.
- `void output2 (int thisword)`  
Output a 2-byte integer in little-endian order.
- `void gethex (char *instring, int plane_array[0x10000][16], int plane)`  
Read a Unifont .hex-format input file from stdin.
- `void genlongbmp (int plane_array[0x10000][16], int dpi, int tinynum, int plane)`  
Generate the BMP output file in long format.
- `void genwidebmp (int plane_array[0x10000][16], int dpi, int tinynum, int plane)`  
Generate the BMP output file in wide format.

### 5.9.1 Detailed Description

unifontpic - See the "Big Picture": the entire Unifont in one BMP bitmap

#### Author

Paul Hardy, 2013

#### Copyright

Copyright (C) 2013, 2017 Paul Hardy

## 5.9.2 Macro Definition Documentation

### 5.9.2.1 HDR\_LEN

```
#define HDR_LEN 33
```

Define length of header string for top of chart.

Definition at line 67 of file unifontpic.c.

## 5.9.3 Function Documentation

### 5.9.3.1 genlongbmp()

```
void genlongbmp (
    int plane_array[0x10000][16],
    int dpi,
    int tinynum,
    int plane )
```

Generate the BMP output file in long format.

This function generates the BMP output file from a bitmap parameter. This is a long bitmap, 16 glyphs wide by 4,096 glyphs tall.

Parameters

in	plane_array	The array of glyph bitmaps for a plane.
in	dpi	Dots per inch, for encoding in the BMP output file header.
in	tinynum	Whether to generate tiny numbers in wide grid (unused).
in	plane	The Unicode plane, 0..17.

Definition at line 294 of file unifontpic.c.

```
295 {
296
297   char header_string[HDR_LEN]; /* centered header */
298   char raw_header[HDR_LEN]; /* left-aligned header */
299   int header[16][16]; /* header row, for chart title */
300   int hdrlen; /* length of HEADER_STRING */
301   int startcol; /* column to start printing header, for centering */
302
303   unsigned leftcol[0x1000][16]; /* code point legend on left side of chart */
304   int d1, d2, d3, d4; /* digits for filling leftcol legend */
305   int codept; /* current starting code point for legend */
306   int thisrow; /* glyph row currently being rendered */
307   unsigned toprow[16][16]; /* code point legend on top of chart */
```

```

308 int digitrow;      /* row we're in (0..4) for the above hexdigit digits */
309
310 /*
311 DataOffset = BMP Header bytes + InfoHeader bytes + ColorTable bytes.
312 */
313 int DataOffset = 14 + 40 + 8; /* fixed size for monochrome BMP */
314 int ImageSize;
315 int FileSize;
316 int Width, Height; /* bitmap image width and height in pixels */
317 int ppm; /* integer pixels per meter */
318
319 int i, j, k;
320
321 unsigned bytesout;
322
323 void output4(int), output2(int);
324
325 /*
326 Image width and height, in pixels.
327
328 N.B.: Width must be an even multiple of 32 pixels, or 4 bytes.
329 */
330 Width = 18 * 16; /* (2 legend + 16 glyphs) * 16 pixels/glyph */
331 Height = 4099 * 16; /* (1 header + 4096 glyphs) * 16 rows/glyph */
332
333 ImageSize = Height * (Width / 8); /* in bytes, calculated from pixels */
334
335 FileSize = DataOffset + ImageSize;
336
337 /* convert dots/inch to pixels/meter */
338 if (dpi == 0) dpi = 96;
339 ppm = (int)((double)dpi * 100.0 / 2.54 + 0.5);
340
341 /*
342 Generate the BMP Header
343 */
344 putchar('B');
345 putchar('M');
346
347 /*
348 Calculate file size:
349
350 BMP Header + InfoHeader + Color Table + Raster Data
351 */
352 output4 (FileSize); /* FileSize */
353 output4 (0x0000); /* reserved */
354
355 /* Calculate DataOffset */
356 output4 (DataOffset);
357
358 /*
359 InfoHeader
360 */
361 output4 (40); /* Size of InfoHeader */
362 output4 (Width); /* Width of bitmap in pixels */
363 output4 (Height); /* Height of bitmap in pixels */
364 output2 (1); /* Planes (1 plane) */
365 output2 (1); /* BitCount (1 = monochrome) */
366 output4 (0); /* Compression (0 = none) */
367 output4 (ImageSize); /* ImageSize, in bytes */
368 output4 (ppm); /* XpixelsPerM (96 dpi = 3780 pixels/meter) */
369 output4 (ppm); /* YpixelsPerM (96 dpi = 3780 pixels/meter) */
370 output4 (2); /* ColorsUsed (= 2) */
371 output4 (2); /* ColorsImportant (= 2) */
372 output4 (0x00000000); /* black (reserved, B, G, R) */
373 output4 (0x00FFFFFF); /* white (reserved, B, G, R) */
374
375 /*
376 Create header row bits.
377 */
378 snprintf (raw_header, HDR_LEN, "%s Plane %d", HEADER_STRING, plane);
379 memset ((void *)header, 0, 16 * 16 * sizeof (int)); /* fill with white */
380 memset ((void *)header_string, ' ', 32 * sizeof (char)); /* 32 spaces */
381 header_string[32] = '\0'; /* null-terminated */
382
383 hdrlen = strlen (raw_header);
384 if (hdrlen > 32) hdrlen = 32; /* only 32 columns to print header */
385 startcol = 16 - ((hdrlen + 1) >> 1); /* to center header */
386 /* center up to 32 chars */
387 memcpy (&header_string[startcol], raw_header, hdrlen);
388

```

```

389  /* Copy each letter's bitmap from the plane_array[] we constructed. */
390  /* Each glyph must be single-width, to fit two glyphs in 16 pixels */
391  for (j = 0; j < 16; j++) {
392      for (i = 0; i < 16; i++) {
393          header[i][j] =
394              (ascii_bits[header_string[j+j ] & 0x7F][i] & 0xFF00) |
395              (ascii_bits[header_string[j+j+1] & 0x7F][i] » 8);
396      }
397  }
398
399  /*
400  Create the left column legend.
401  */
402  memset ((void *)leftcol, 0, 4096 * 16 * sizeof (unsigned));
403
404  for (codept = 0x0000; codept < 0x10000; codept += 0x10) {
405      d1 = (codept » 12) & 0xF; /* most significant hex digit */
406      d2 = (codept » 8) & 0xF;
407      d3 = (codept » 4) & 0xF;
408
409      thisrow = codept » 4; /* rows of 16 glyphs */
410
411      /* fill in first and second digits */
412      for (digitrow = 0; digitrow < 5; digitrow++) {
413          leftcol[thisrow][2 + digitrow] =
414              (hexdigit[d1][digitrow] « 10) |
415              (hexdigit[d2][digitrow] « 4);
416      }
417
418      /* fill in third digit */
419      for (digitrow = 0; digitrow < 5; digitrow++) {
420          leftcol[thisrow][9 + digitrow] = hexdigit[d3][digitrow] « 10;
421      }
422      leftcol[thisrow][9 + 4] |= 0xF « 4; /* underscore as 4th digit */
423
424      for (i = 0; i < 15; i++) {
425          leftcol[thisrow][i] |= 0x00000002; /* right border */
426      }
427
428      leftcol[thisrow][15] = 0x0000FFFE; /* bottom border */
429
430      if (d3 == 0xF) { /* 256-point boundary */
431          leftcol[thisrow][15] |= 0x00FF0000; /* longer tic mark */
432      }
433
434      if ((thisrow % 0x40) == 0x3F) { /* 1024-point boundary */
435          leftcol[thisrow][15] |= 0xFFFF0000; /* longest tic mark */
436      }
437  }
438
439  /*
440  Create the top row legend.
441  */
442  memset ((void *)toprow, 0, 16 * 16 * sizeof (unsigned));
443
444  for (codept = 0x0; codept <= 0xF; codept++) {
445      d1 = (codept » 12) & 0xF; /* most significant hex digit */
446      d2 = (codept » 8) & 0xF;
447      d3 = (codept » 4) & 0xF;
448      d4 = codept & 0xF; /* least significant hex digit */
449
450      /* fill in last digit */
451      for (digitrow = 0; digitrow < 5; digitrow++) {
452          toprow[6 + digitrow][codept] = hexdigit[d4][digitrow] « 6;
453      }
454  }
455
456  for (j = 0; j < 16; j++) {
457      /* force bottom pixel row to be white, for separation from glyphs */
458      toprow[15][j] = 0x0000;
459  }
460
461  /* 1 pixel row with left-hand legend line */
462  for (j = 0; j < 16; j++) {
463      toprow[14][j] |= 0xFFFF;
464  }
465
466  /* 14 rows with line on left to fill out this character row */
467  for (i = 13; i >= 0; i--) {
468      for (j = 0; j < 16; j++) {
469          toprow[i][j] |= 0x0001;

```

```

470     }
471 }
472
473 /*
474 Now write the raster image.
475
476 XOR each byte with 0xFF because black = 0, white = 1 in BMP.
477 */
478
479 /* Write the glyphs, bottom-up, left-to-right, in rows of 16 (i.e., 0x10) */
480 for (i = 0xFFFF0; i >= 0; i -= 0x10) {
481     thisrow = i » 4; /* 16 glyphs per row */
482     for (j = 15; j >= 0; j--) {
483         /* left-hand legend */
484         putchar ((~leftcol[thisrow][j] » 24) & 0xFF);
485         putchar ((~leftcol[thisrow][j] » 16) & 0xFF);
486         putchar ((~leftcol[thisrow][j] » 8) & 0xFF);
487         putchar (~leftcol[thisrow][j] & 0xFF);
488         /* Unifont glyph */
489         for (k = 0; k < 16; k++) {
490             bytesout = ~plane_array[i+k][j] & 0xFFFF;
491             putchar ((bytesout » 8) & 0xFF);
492             putchar ( bytesout & 0xFF);
493         }
494     }
495 }
496
497 /*
498 Write the top legend.
499 */
500 /* i == 15: bottom pixel row of header is output here */
501 /* left-hand legend: solid black line except for right-most pixel */
502 putchar (0x00);
503 putchar (0x00);
504 putchar (0x00);
505 putchar (0x01);
506 for (j = 0; j < 16; j++) {
507     putchar ((~toprow[15][j] » 8) & 0xFF);
508     putchar (~toprow[15][j] & 0xFF);
509 }
510
511 putchar (0xFF);
512 putchar (0xFF);
513 putchar (0xFF);
514 putchar (0xFC);
515 for (j = 0; j < 16; j++) {
516     putchar ((~toprow[14][j] » 8) & 0xFF);
517     putchar (~toprow[14][j] & 0xFF);
518 }
519
520 for (i = 13; i >= 0; i--) {
521     putchar (0xFF);
522     putchar (0xFF);
523     putchar (0xFF);
524     putchar (0xFD);
525     for (j = 0; j < 16; j++) {
526         putchar ((~toprow[i][j] » 8) & 0xFF);
527         putchar (~toprow[i][j] & 0xFF);
528     }
529 }
530
531 /*
532 Write the header.
533 */
534
535 /* 7 completely white rows */
536 for (i = 7; i >= 0; i--) {
537     for (j = 0; j < 18; j++) {
538         putchar (0xFF);
539         putchar (0xFF);
540     }
541 }
542
543 for (i = 15; i >= 0; i--) {
544     /* left-hand legend */
545     putchar (0xFF);
546     putchar (0xFF);
547     putchar (0xFF);
548     putchar (0xFF);
549     /* header glyph */
550     for (j = 0; j < 16; j++) {

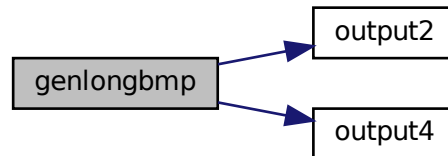
```

```

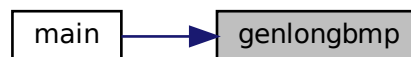
551     bytesout = ~header[i][j] & 0xFFFF;
552     putchar ((bytesout » 8) & 0xFF);
553     putchar ( bytesout      & 0xFF);
554 }
555 }
556
557 /* 8 completely white rows at very top */
558 for (i = 7; i >= 0; i--) {
559     for (j = 0; j < 18; j++) {
560         putchar (0xFF);
561         putchar (0xFF);
562     }
563 }
564
565 return;
566 }

```

Here is the call graph for this function:



Here is the caller graph for this function:



### 5.9.3.2 genwidebmp()

```

void genwidebmp (
    int plane_array[0x10000][16],
    int dpi,
    int tinynum,
    int plane )

```

Generate the BMP output file in wide format.

This function generates the BMP output file from a bitmap parameter. This is a wide bitmap, 256 glyphs wide by 256 glyphs tall.

## Parameters

in	plane_array	The array of glyph bitmaps for a plane.
in	dpi	Dots per inch, for encoding in the BMP output file header.
in	tinynum	Whether to generate tiny numbers in 256x256 grid.
in	plane	The Unicode plane, 0..17.

Definition at line 581 of file unifontpic.c.

```

582 {
583
584   char header_string[257];
585   char raw_header[HDR_LEN];
586   int header[16][256]; /* header row, for chart title */
587   int hdrlen;          /* length of HEADER_STRING */
588   int startcol;        /* column to start printing header, for centering */
589
590   unsigned leftcol[0x100][16]; /* code point legend on left side of chart */
591   int d1, d2, d3, d4;          /* digits for filling leftcol[][] legend */
592   int codept;                 /* current starting code point for legend */
593   int thisrow;                /* glyph row currently being rendered */
594   unsigned toprow[32][256];   /* code point legend on top of chart */
595   int digitrow;               /* row we're in (0..4) for the above hexdigit digits */
596   int hexalpha1, hexalpha2;   /* to convert hex digits to ASCII */
597
598   /*
599   DataOffset = BMP Header bytes + InfoHeader bytes + ColorTable bytes.
600   */
601   int DataOffset = 14 + 40 + 8; /* fixed size for monochrome BMP */
602   int ImageSize;
603   int FileSize;
604   int Width, Height; /* bitmap image width and height in pixels */
605   int ppm;           /* integer pixels per meter */
606
607   int i, j, k;
608
609   unsigned bytesout;
610
611   void output4(int), output2(int);
612
613   /*
614   Image width and height, in pixels.
615
616   N.B.: Width must be an even multiple of 32 pixels, or 4 bytes.
617   */
618   Width = 258 * 16; /* ( 2 legend + 256 glyphs) * 16 pixels/glyph */
619   Height = 260 * 16; /* (2 header + 2 legend + 256 glyphs) * 16 rows/glyph */
620
621   ImageSize = Height * (Width / 8); /* in bytes, calculated from pixels */
622
623   FileSize = DataOffset + ImageSize;
624
625   /* convert dots/inch to pixels/meter */
626   if (dpi == 0) dpi = 96;
627   ppm = (int)((double)dpi * 100.0 / 2.54 + 0.5);
628
629   /*
630   Generate the BMP Header
631   */
632   putchar('B');
633   putchar('M');
634   /*
635   Calculate file size:
636
637   BMP Header + InfoHeader + Color Table + Raster Data
638   */
639   output4 (FileSize); /* FileSize */
640   output4 (0x0000); /* reserved */
641   /* Calculate DataOffset */
642   output4 (DataOffset);
643
644   /*
645   InfoHeader
646   */
647   output4 (40); /* Size of InfoHeader */

```



```

648 output4 (Width);      /* Width of bitmap in pixels */
649 output4 (Height);     /* Height of bitmap in pixels */
650 output2 (1);          /* Planes (1 plane) */
651 output2 (1);          /* BitCount (1 = monochrome) */
652 output4 (0);          /* Compression (0 = none) */
653 output4 (ImageSize);  /* ImageSize, in bytes */
654 output4 (ppm);         /* XpixelsPerM (96 dpi = 3780 pixels/meter) */
655 output4 (ppm);         /* YpixelsPerM (96 dpi = 3780 pixels/meter) */
656 output4 (2);          /* ColorsUsed (= 2) */
657 output4 (2);          /* ColorsImportant (= 2) */
658 output4 (0x00000000); /* black (reserved, B, G, R) */
659 output4 (0x00FFFFFF); /* white (reserved, B, G, R) */
660
661 /*
662 Create header row bits.
663 */
664 snprintf (raw_header, HDR_LEN, "%s Plane %d", HEADER_STRING, plane);
665 memset ((void *)header, 0, 256 * 16 * sizeof (int)); /* fill with white */
666 memset ((void *)header_string, ' ', 256 * sizeof (char)); /* 256 spaces */
667 header_string[256] = '\0'; /* null-terminated */
668
669 hdrlen = strlen (raw_header);
670 /* Wide bitmap can print 256 columns, but limit to 32 columns for long bitmap. */
671 if (hdrlen > 32) hdrlen = 32;
672 startcol = 127 - ((hdrlen - 1) » 1); /* to center header */
673 /* center up to 32 chars */
674 memcpy (&header_string[startcol], raw_header, hdrlen);
675
676 /* Copy each letter's bitmap from the plane_array[] we constructed. */
677 for (j = 0; j < 256; j++) {
678     for (i = 0; i < 16; i++) {
679         header[i][j] = ascii_bits[header_string[j] & 0x7F][i];
680     }
681 }
682
683 /*
684 Create the left column legend.
685 */
686 memset ((void *)leftcol, 0, 256 * 16 * sizeof (unsigned));
687
688 for (codept = 0x0000; codept < 0x10000; codept += 0x100) {
689     d1 = (codept » 12) & 0xF; /* most significant hex digit */
690     d2 = (codept » 8) & 0xF;
691
692     thisrow = codept » 8; /* rows of 256 glyphs */
693
694     /* fill in first and second digits */
695
696     if (tinynum) { /* use 4x5 pixel glyphs */
697         for (digitrow = 0; digitrow < 5; digitrow++) {
698             leftcol[thisrow][6 + digitrow] =
699                 (hexdigit[d1][digitrow] « 10) |
700                 (hexdigit[d2][digitrow] « 4);
701         }
702     }
703     else { /* bigger numbers -- use glyphs from Unifont itself */
704         /* convert hexadecimal digits to ASCII equivalent */
705         hexalpha1 = d1 < 0xA ? '0' + d1 : 'A' + d1 - 0xA;
706         hexalpha2 = d2 < 0xA ? '0' + d2 : 'A' + d2 - 0xA;
707
708         for (i = 0; i < 16; i++) {
709             leftcol[thisrow][i] =
710                 (ascii_bits[hexalpha1][i] « 2) |
711                 (ascii_bits[hexalpha2][i] « 6);
712         }
713     }
714
715     for (i = 0; i < 15; i++) {
716         leftcol[thisrow][i] |= 0x00000002; /* right border */
717     }
718
719     leftcol[thisrow][15] = 0x0000FFFE; /* bottom border */
720
721     if (d2 == 0xF) { /* 4096-point boundary */
722         leftcol[thisrow][15] |= 0x00FF0000; /* longer tic mark */
723     }
724
725     if ((thisrow % 0x40) == 0x3F) { /* 16,384-point boundary */
726         leftcol[thisrow][15] |= 0xFFFF0000; /* longest tic mark */
727     }
728 }

```

```

729
730 /*
731 Create the top row legend.
732 */
733 memset ((void *)toprow, 0, 32 * 256 * sizeof (unsigned));
734
735 for (codept = 0x00; codept <= 0xFF; codept++) {
736     d3 = (codept » 4) & 0xF;
737     d4 = codept      & 0xF; /* least significant hex digit */
738
739     if (tinynum) {
740         for (digitrow = 0; digitrow < 5; digitrow++) {
741             toprow[16 + 6 + digitrow][codept] =
742                 (hexdigit[d3][digitrow] « 10) |
743                 (hexdigit[d4][digitrow] « 4);
744         }
745     }
746     else {
747         /* convert hexadecimal digits to ASCII equivalent */
748         hexalpha1 = d3 < 0xA ? '0' + d3 : 'A' + d3 - 0xA;
749         hexalpha2 = d4 < 0xA ? '0' + d4 : 'A' + d4 - 0xA;
750         for (i = 0 ; i < 16; i++) {
751             toprow[14 + i][codept] =
752                 (ascii_bits[hexalpha1][i]    ) |
753                 (ascii_bits[hexalpha2][i] » 7);
754         }
755     }
756 }
757
758 for (j = 0; j < 256; j++) {
759     /* force bottom pixel row to be white, for separation from glyphs */
760     toprow[16 + 15][j] = 0x0000;
761 }
762
763 /* 1 pixel row with left-hand legend line */
764 for (j = 0; j < 256; j++) {
765     toprow[16 + 14][j] |= 0xFFFF;
766 }
767
768 /* 14 rows with line on left to fill out this character row */
769 for (i = 13; i >= 0; i--) {
770     for (j = 0; j < 256; j++) {
771         toprow[16 + i][j] |= 0x0001;
772     }
773 }
774
775 /* Form the longer tic marks in top legend */
776 for (i = 8; i < 16; i++) {
777     for (j = 0x0F; j < 0x100; j += 0x10) {
778         toprow[i][j] |= 0x0001;
779     }
780 }
781
782 /*
783 Now write the raster image.
784
785 XOR each byte with 0xFF because black = 0, white = 1 in BMP.
786 */
787
788 /* Write the glyphs, bottom-up, left-to-right, in rows of 16 (i.e., 0x10) */
789 for (i = 0xFF00; i >= 0; i -= 0x100) {
790     thisrow = i » 8; /* 256 glyphs per row */
791     for (j = 15; j >= 0; j--) {
792         /* left-hand legend */
793         putchar ((~leftcol[thisrow][j] » 24) & 0xFF);
794         putchar ((~leftcol[thisrow][j] » 16) & 0xFF);
795         putchar ((~leftcol[thisrow][j] » 8) & 0xFF);
796         putchar (~leftcol[thisrow][j]      & 0xFF);
797         /* Unifont glyph */
798         for (k = 0x00; k < 0x100; k++) {
799             bytesout = ~plane_array[i+k][j] & 0xFFFF;
800             putchar ((bytesout » 8) & 0xFF);
801             putchar ( bytesout      & 0xFF);
802         }
803     }
804 }
805
806 /*
807 Write the top legend.
808 */
809 /* i == 15: bottom pixel row of header is output here */

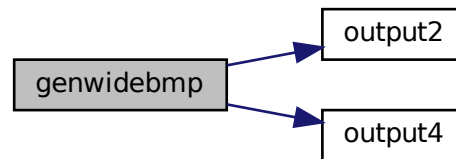
```

```

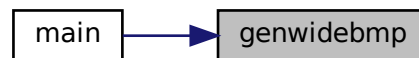
810  /* left-hand legend: solid black line except for right-most pixel */
811  putchar (0x00);
812  putchar (0x00);
813  putchar (0x00);
814  putchar (0x01);
815  for (j = 0; j < 256; j++) {
816      putchar ((~toprow[16 + 15][j] » 8) & 0xFF);
817      putchar ( ~toprow[16 + 15][j]      & 0xFF);
818  }
819
820  putchar (0xFF);
821  putchar (0xFF);
822  putchar (0xFF);
823  putchar (0xFC);
824  for (j = 0; j < 256; j++) {
825      putchar ((~toprow[16 + 14][j] » 8) & 0xFF);
826      putchar ( ~toprow[16 + 14][j]      & 0xFF);
827  }
828
829  for (i = 16 + 13; i >= 0; i--) {
830      if (i >= 8) { /* make vertical stroke on right */
831          putchar (0xFF);
832          putchar (0xFF);
833          putchar (0xFF);
834          putchar (0xFD);
835      }
836      else { /* all white */
837          putchar (0xFF);
838          putchar (0xFF);
839          putchar (0xFF);
840          putchar (0xFF);
841      }
842      for (j = 0; j < 256; j++) {
843          putchar ((~toprow[i][j] » 8) & 0xFF);
844          putchar ( ~toprow[i][j]      & 0xFF);
845      }
846  }
847
848  /*
849  Write the header.
850  */
851
852  /* 8 completely white rows */
853  for (i = 7; i >= 0; i--) {
854      for (j = 0; j < 258; j++) {
855          putchar (0xFF);
856          putchar (0xFF);
857      }
858  }
859
860  for (i = 15; i >= 0; i--) {
861      /* left-hand legend */
862      putchar (0xFF);
863      putchar (0xFF);
864      putchar (0xFF);
865      putchar (0xFF);
866      /* header glyph */
867      for (j = 0; j < 256; j++) {
868          bytesout = ~header[i][j] & 0xFFFF;
869          putchar ((bytesout » 8) & 0xFF);
870          putchar ( bytesout      & 0xFF);
871      }
872  }
873
874  /* 8 completely white rows at very top */
875  for (i = 7; i >= 0; i--) {
876      for (j = 0; j < 258; j++) {
877          putchar (0xFF);
878          putchar (0xFF);
879      }
880  }
881
882  return;
883 }

```

Here is the call graph for this function:



Here is the caller graph for this function:



### 5.9.3.3 gethex()

```

void gethex (
    char * instring,
    int plane_array[0x10000][16],
    int plane )
  
```

Read a Unifont .hex-format input file from stdin.

Each glyph can be 2, 4, 6, or 8 ASCII hexadecimal digits wide. [Glyph](#) height is fixed at 16 pixels.

Parameters

in	instring	One line from a Unifont .hex-format file.
in,out	plane_array	Bitmap for this plane, one bitmap row per element.
in	plane	The Unicode plane, 0..17.

Definition at line 215 of file unifontpic.c.  
 216 {

```

217 char *bitstring; /* pointer into instring for glyph bitmap */
218 int i; /* loop variable */
219 int codept; /* the Unicode code point of the current glyph */
220 int glyph_plane; /* Unicode plane of current glyph */
221 int ndigits; /* number of ASCII hexadecimal digits in glyph */
222 int bytespl; /* bytes per line of pixels in a glyph */
223 int temprow; /* 1 row of a quadruple-width glyph */
224 int newrow; /* 1 row of double-width output pixels */
225 unsigned bitmask; /* to mask off 2 bits of long width glyph */
226
227 /*
228 Read each input line and place its glyph into the bit array.
229 */
230 sscanf (instring, "%X", &codept);
231 glyph_plane = codept » 16;
232 if (glyph_plane == plane) {
233     codept &= 0xFFFF; /* array index will only have 16 bit address */
234     /* find the colon separator */
235     for (i = 0; (i < 9) && (instring[i] != ':'); i++);
236     i++; /* position past it */
237     bitstring = &instring[i];
238     ndigits = strlen (bitstring);
239     /* don't count '\n' at end of line if present */
240     if (bitstring[ndigits - 1] == '\n') ndigits--;
241     bytespl = ndigits » 5; /* 16 rows per line, 2 digits per byte */
242
243     if (bytespl >= 1 && bytespl <= 4) {
244         for (i = 0; i < 16; i++) { /* 16 rows per glyph */
245             /* Read correct number of hexadecimal digits given glyph width */
246             switch (bytespl) {
247                 case 1: sscanf (bitstring, "%2X", &temprow);
248                     bitstring += 2;
249                     temprow «= 8; /* left-justify single-width glyph */
250                     break;
251                 case 2: sscanf (bitstring, "%4X", &temprow);
252                     bitstring += 4;
253                     break;
254                 /* cases 3 and 4 widths will be compressed by 50% (see below) */
255                 case 3: sscanf (bitstring, "%6X", &temprow);
256                     bitstring += 6;
257                     temprow «= 8; /* left-justify */
258                     break;
259                 case 4: sscanf (bitstring, "%8X", &temprow);
260                     bitstring += 8;
261                     break;
262             } /* switch on number of bytes per row */
263             /* compress glyph width by 50% if greater than double-width */
264             if (bytespl > 2) {
265                 newrow = 0x0000;
266                 /* mask off 2 bits at a time to convert each pair to 1 bit out */
267                 for (bitmask = 0xC0000000; bitmask != 0; bitmask »= 2) {
268                     newrow «= 1;
269                     if ((temprow & bitmask) != 0) newrow |= 1;
270                 }
271                 temprow = newrow;
272             } /* done conditioning glyphs beyond double-width */
273             plane_array[codept][i] = temprow; /* store glyph bitmap for output */
274         } /* for each row */
275     } /* if 1 to 4 bytes per row/line */
276 } /* if this is the plane we are seeking */
277
278 return;
279 }

```

Here is the caller graph for this function:



### 5.9.3.4 main()

```
int main (
    int argc,
    char ** argv )
```

The main function.

Parameters

in	argc	The count of command line arguments.
in	argv	Pointer to array of command line arguments.

Returns

This program exits with status `EXIT_SUCCESS`.

Definition at line 87 of file `unifontpic.c`.

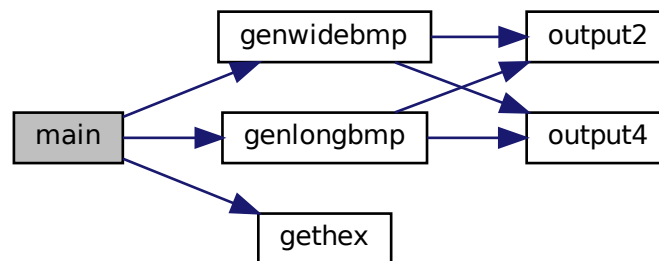
```
88 {
89     /* Input line buffer */
90     char instring[MAXSTRING];
91
92     /* long and dpi are set from command-line options */
93     int wide=1; /* =1 for a 256x256 grid, =0 for a 16x4096 grid */
94     int dpi=96; /* change for 256x256 grid to fit paper if desired */
95     int tinynum=0; /* whether to use tiny labels for 256x256 grid */
96
97     int i, j; /* loop variables */
98
99     int plane=0; /* Unicode plane, 0..17; Plane 0 is default */
100    /* 16 pixel rows for each of 65,536 glyphs in a Unicode plane */
101    int plane_array[0x10000][16];
102
103    void gethex();
104    void genlongbmp();
105    void genwidebmp();
106
107    if (argc > 1) {
108        for (i = 1; i < argc; i++) {
109            if (strcmp (argv[i], "-l", 2) == 0) { /* long display */
110                wide = 0;
111            }
112            else if (strcmp (argv[i], "-d", 2) == 0) {
113                dpi = atoi (&argv[i][2]); /* dots/inch specified on command line */
114            }
115            else if (strcmp (argv[i], "-t", 2) == 0) {
116                tinynum = 1;
117            }
118            else if (strcmp (argv[i], "-P", 2) == 0) {
119                /* Get Unicode plane */
120                for (j = 2; argv[i][j] != '\0'; j++) {
121                    if (argv[i][j] < '0' || argv[i][j] > '9') {
122                        fprintf (stderr,
123                            "ERROR: Specify Unicode plane as decimal number.\n\n");
124                        exit (EXIT_FAILURE);
125                    }
126                }
127                plane = atoi (&argv[i][2]); /* Unicode plane, 0..17 */
128                if (plane < 0 || plane > 17) {
129                    fprintf (stderr,
130                        "ERROR: Plane out of Unicode range [0,17].\n\n");
131                    exit (EXIT_FAILURE);
132                }
133            }
134        }
135    }
```

```

133     }
134   }
135 }
136
137
138 /*
139 Initialize the ASCII bitmap array for chart titles
140 */
141 for (i = 0; i < 128; i++) {
142     gethex (ascii_hex[i], plane_array, 0); /* convert Unifont hexadecimal string to bitmap */
143     for (j = 0; j < 16; j++) ascii_bits[i][j] = plane_array[i][j];
144 }
145
146
147 /*
148 Read in the Unifont hex file to render from standard input
149 */
150 memset ((void *)plane_array, 0, 0x10000 * 16 * sizeof (int));
151 while (fgets (instring, MAXSTRING, stdin) != NULL) {
152     gethex (instring, plane_array, plane); /* read .hex input file and fill plane_array with glyph data */
153 } /* while not EOF */
154
155
156 /*
157 Write plane_array glyph data to BMP file as wide or long bitmap.
158 */
159 if (wide) {
160     genwidebmp (plane_array, dpi, tinynum, plane);
161 }
162 else {
163     genlongbmp (plane_array, dpi, tinynum, plane);
164 }
165
166 exit (EXIT_SUCCESS);
167 }

```

Here is the call graph for this function:



### 5.9.3.5 output2()

```

void output2 (
    int thisword )

```

Output a 2-byte integer in little-endian order.

## Parameters

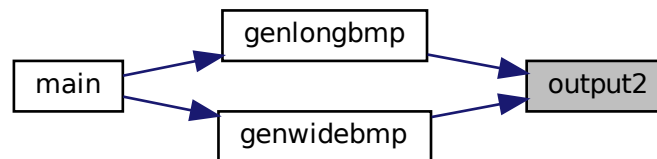
in	thisword	The 2-byte integer to output as binary data.
----	----------	--

Definition at line 194 of file unifontpic.c.

```

195 {
196
197     putchar ( thisword      & 0xFF);
198     putchar ((thisword » 8) & 0xFF);
199
200     return;
201 }
```

Here is the caller graph for this function:



### 5.9.3.6 output4()

```

void output4 (
    int thisword )
```

Output a 4-byte integer in little-endian order.

## Parameters

in	thisword	The 4-byte integer to output as binary data.
----	----------	--

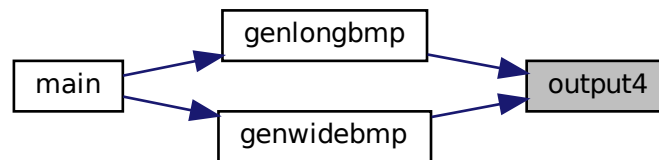
Definition at line 176 of file unifontpic.c.

```

177 {
178
179     putchar ( thisword      & 0xFF);
180     putchar ((thisword » 8) & 0xFF);
181     putchar ((thisword » 16) & 0xFF);
182     putchar ((thisword » 24) & 0xFF);
183
184     return;
185 }
```



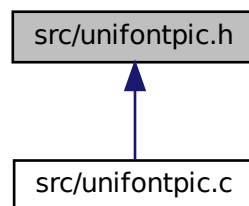
Here is the caller graph for this function:



## 5.10 src/unifontpic.h File Reference

[unifontpic.h](#) - Header file for [unifontpic.c](#)

This graph shows which files directly or indirectly include this file:



### Macros

- `#define` [MAXSTRING](#) 256  
Maximum input string allowed.
- `#define` [HEADER\\_STRING](#) "GNU Unifont 15.0.04"  
To be printed as chart title.

### Variables

- `const char *` [ascii\\_hex](#) [128]  
Array of Unifont ASCII glyphs for chart row & column headings.
- `int` [ascii\\_bits](#) [128][16]  
Array to hold ASCII bitmaps for chart title.
- `char` [hexdigit](#) [16][5]  
Array of 4x5 hexadecimal digits for legend.

### 5.10.1 Detailed Description

[unifontpic.h](#) - Header file for [unifontpic.c](#)

Author

Paul Hardy, July 2017

Copyright

Copyright (C) 2017 Paul Hardy

### 5.10.2 Variable Documentation

#### 5.10.2.1 `ascii_bits`

```
int ascii_bits[128][16]
```

Array to hold ASCII bitmaps for chart title.

This array will be created from the strings in `ascii_hex[]` above.

Definition at line 177 of file `unifontpic.h`.

#### 5.10.2.2 `ascii_hex`

```
const char* ascii_hex[128]
```

Array of Unifont ASCII glyphs for chart row & column headings.

Define the array of Unifont ASCII glyphs, code points 0 through 127. This allows using `unifontpic` to print charts of glyphs above Unicode Plane 0. These were copied from `font/plane00/unifont-base.hex`, plus U+0020 (ASCII space character).

Definition at line 40 of file `unifontpic.h`.

## 5.10.2.3 hexdigit

```
char hexdigit[16][5]
```

Initial value:

```
= {
    {0x6,0x9,0x9,0x9,0x6},
    {0x2,0x6,0x2,0x2,0x7},
    {0xF,0x1,0xF,0x8,0xF},
    {0xE,0x1,0x7,0x1,0xE},
    {0x9,0x9,0xF,0x1,0x1},
    {0xF,0x8,0xF,0x1,0xF},
    {0x6,0x8,0xE,0x9,0x6},
    {0xF,0x1,0x2,0x4,0x4},
    {0x6,0x9,0x6,0x9,0x6},
    {0x6,0x9,0x7,0x1,0x6},
    {0xF,0x9,0xF,0x9,0x9},
    {0xE,0x9,0xE,0x9,0xE},
    {0x7,0x8,0x8,0x8,0x7},
    {0xE,0x9,0x9,0x9,0xE},
    {0xF,0x8,0xE,0x8,0xF},
    {0xF,0x8,0xE,0x8,0x8}
}
```

Array of 4x5 hexadecimal digits for legend.

hexdigit contains 4x5 pixel arrays of tiny digits for the legend. See [unihexgen.c](#) for a more detailed description in the comments.

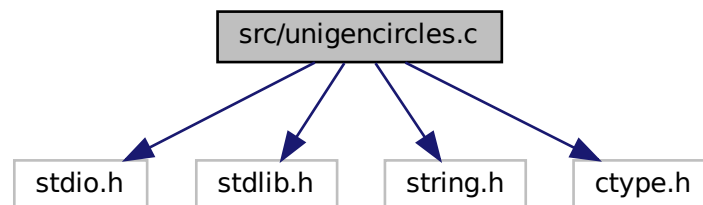
Definition at line 186 of file unifontpic.h.

## 5.11 src/unigencircles.c File Reference

unigencircles - Superimpose dashed combining circles on combining glyphs

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <ctype.h>
```

Include dependency graph for unigencircles.c:



## Macros

- `#define MAXSTRING 256`  
Maximum input line length - 1.

## Functions

- `int main (int argc, char **argv)`  
The main function.
- `void add_single_circle (char *glyphstring)`  
Superimpose a single-width dashed combining circle on a glyph bitmap.
- `void add_double_circle (char *glyphstring, int offset)`  
Superimpose a double-width dashed combining circle on a glyph bitmap.

### 5.11.1 Detailed Description

unigencircles - Superimpose dashed combining circles on combining glyphs

#### Author

Paul Hardy

#### Copyright

Copyright (C) 2013, Paul Hardy.

### 5.11.2 Function Documentation

#### 5.11.2.1 add\_double\_circle()

```
void add_double_circle (  
    char * glyphstring,  
    int offset )
```

Superimpose a double-width dashed combining circle on a glyph bitmap.

#### Parameters

in,out	glyphstring	A double-width glyph, 16x16 pixels.
--------	-------------	-------------------------------------

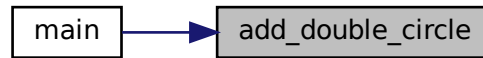
Definition at line 221 of file unigencircles.c.

```

222 {
223
224     char newstring[256];
225     /* Circle hex string pattern is "00000008000024004200240000000000" */
226
227     /* For double diacritical glyphs (offset = -8) */
228     /* Combining circle is left-justified. */
229     char circle08[64]={0x0,0x0,0x0,0x0, /* row 1 */
230         0x0,0x0,0x0,0x0, /* row 2 */
231         0x0,0x0,0x0,0x0, /* row 3 */
232         0x0,0x0,0x0,0x0, /* row 4 */
233         0x0,0x0,0x0,0x0, /* row 5 */
234         0x0,0x0,0x0,0x0, /* row 6 */
235         0x2,0x4,0x0,0x0, /* row 7 */
236         0x0,0x0,0x0,0x0, /* row 8 */
237         0x4,0x2,0x0,0x0, /* row 9 */
238         0x0,0x0,0x0,0x0, /* row 10 */
239         0x2,0x4,0x0,0x0, /* row 11 */
240         0x0,0x0,0x0,0x0, /* row 12 */
241         0x0,0x0,0x0,0x0, /* row 13 */
242         0x0,0x0,0x0,0x0, /* row 14 */
243         0x0,0x0,0x0,0x0, /* row 15 */
244         0x0,0x0,0x0,0x0}; /* row 16 */
245
246     /* For all other combining glyphs (offset = -16) */
247     /* Combining circle is centered in 16 columns. */
248     char circle16[64]={0x0,0x0,0x0,0x0, /* row 1 */
249         0x0,0x0,0x0,0x0, /* row 2 */
250         0x0,0x0,0x0,0x0, /* row 3 */
251         0x0,0x0,0x0,0x0, /* row 4 */
252         0x0,0x0,0x0,0x0, /* row 5 */
253         0x0,0x0,0x0,0x0, /* row 6 */
254         0x0,0x2,0x4,0x0, /* row 7 */
255         0x0,0x0,0x0,0x0, /* row 8 */
256         0x0,0x4,0x2,0x0, /* row 9 */
257         0x0,0x0,0x0,0x0, /* row 10 */
258         0x0,0x2,0x4,0x0, /* row 11 */
259         0x0,0x0,0x0,0x0, /* row 12 */
260         0x0,0x0,0x0,0x0, /* row 13 */
261         0x0,0x0,0x0,0x0, /* row 14 */
262         0x0,0x0,0x0,0x0, /* row 15 */
263         0x0,0x0,0x0,0x0}; /* row 16 */
264
265     char *circle; /* points into circle16 or circle08 */
266
267     int digit1, digit2; /* corresponding digits in each string */
268
269     int i; /* index variables */
270
271
272     /*
273     Determine if combining circle is left-justified (offset = -8)
274     or centered (offset = -16).
275     */
276     circle = (offset >= -8) ? circle08 : circle16;
277
278     /* for each character position, OR the corresponding circle glyph value */
279     for (i = 0; i < 64; i++) {
280         glyphstring[i] = toupper (glyphstring[i]);
281
282         /* Convert ASCII character to a hexadecimal integer */
283         digit1 = (glyphstring[i] <= '9') ?
284             (glyphstring[i] - '0') : (glyphstring[i] - 'A' + 0xA);
285
286         /* Superimpose dashed circle */
287         digit2 = digit1 | circle[i];
288
289         /* Convert hexadecimal integer to an ASCII character */
290         newstring[i] = (digit2 <= 9) ?
291             ('0' + digit2) : ('A' + digit2 - 0xA);
292     }
293
294     /* Terminate string for output */
295     newstring[i++] = '\n';
296     newstring[i++] = '\0';
297
298     memcpy (glyphstring, newstring, i);
299
300     return;
301 }

```

Here is the caller graph for this function:



### 5.11.2.2 add\_single\_circle()

```
void add_single_circle (
    char * glyphstring )
```

Superimpose a single-width dashed combining circle on a glyph bitmap.

Parameters

in,out	glyphstring	A single-width glyph, 8x16 pixels.
--------	-------------	------------------------------------

Definition at line 163 of file unigencircles.c.

```

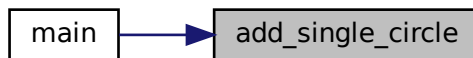
164 {
165     char newstring[256];
166     /* Circle hex string pattern is "000000080000024004200240000000000" */
167     char circle[32]={0x0,0x0, /* row 1 */
168         0x0,0x0, /* row 2 */
169         0x0,0x0, /* row 3 */
170         0x0,0x0, /* row 4 */
171         0x0,0x0, /* row 5 */
172         0x0,0x0, /* row 6 */
173         0x2,0x4, /* row 7 */
174         0x0,0x0, /* row 8 */
175         0x4,0x2, /* row 9 */
176         0x0,0x0, /* row 10 */
177         0x2,0x4, /* row 11 */
178         0x0,0x0, /* row 12 */
179         0x0,0x0, /* row 13 */
180         0x0,0x0, /* row 14 */
181         0x0,0x0, /* row 15 */
182         0x0,0x0}; /* row 16 */
183
184     int digit1, digit2; /* corresponding digits in each string */
185
186     int i; /* index variables */
187
188     /* for each character position, OR the corresponding circle glyph value */
189     for (i = 0; i < 32; i++) {
190         glyphstring[i] = toupper (glyphstring[i]);
191
192         /* Convert ASCII character to a hexadecimal integer */
193         digit1 = (glyphstring[i] <= '9') ?
194             (glyphstring[i] - '0') : (glyphstring[i] - 'A' + 0xA);
195
196         /* Superimpose dashed circle */
197         digit2 = digit1 | circle[i];
198     }
  
```

```

199
200     /* Convert hexadecimal integer to an ASCII character */
201     newstring[i] = (digit2 <= 9) ?
202         ('0' + digit2) : ('A' + digit2 - 0xA);
203 }
204
205 /* Terminate string for output */
206 newstring[i++] = '\n';
207 newstring[i++] = '\0';
208
209 memcpy (glyphstring, newstring, i);
210
211 return;
212 }

```

Here is the caller graph for this function:



### 5.11.2.3 main()

```

int main (
    int argc,
    char ** argv )

```

The main function.

Parameters

in	argc	The count of command line arguments.
in	argv	Pointer to array of command line arguments.

Returns

This program exits with status EXIT\_SUCCESS.

Definition at line 73 of file unigencircles.c.

```

74 {
75
76     char teststring[MAXSTRING]; /* current input line */
77     int loc; /* Unicode code point of current input line */
78     int offset; /* offset value of a combining character */
79     char *gstart; /* glyph start, pointing into teststring */
80
81     char combining[0x110000]; /* 1 --> combining glyph; 0 --> non-combining */
82     char x_offset [0x110000]; /* second value in *combining.txt files */

```

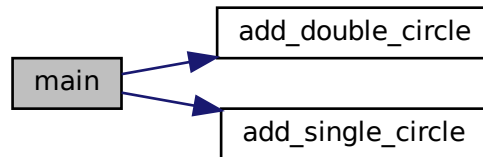
```

83
84 void add_single_circle(char *); /* add a single-width dashed circle */
85 void add_double_circle(char *, int); /* add a double-width dashed circle */
86
87 FILE *infilefp;
88
89 /*
90 if (argc != 3) {
91     fprintf (stderr,
92         "\n\nUsage: %s combining.txt nonprinting.hex < unifont.hex > unifontfull.hex\n\n");
93     exit (EXIT_FAILURE);
94 }
95 */
96
97 /*
98 Read the combining characters list.
99 */
100 /* Start with no combining code points flagged */
101 memset (combining, 0, 0x110000 * sizeof (char));
102 memset (x_offset, 0, 0x110000 * sizeof (char));
103
104 if ((infilefp = fopen (argv[1], "r")) == NULL) {
105     fprintf (stderr, "ERROR - combining characters file %s not found.\n\n",
106         argv[1]);
107     exit (EXIT_FAILURE);
108 }
109
110 /* Flag list of combining characters to add a dashed circle. */
111 while (fscanf (infilefp, "%X:%d", &loc, &offset) != EOF) {
112     /*
113     U+01107F and U+01D1A0 are not defined as combining characters
114     in Unicode; they were added in a combining.txt file as the
115     only way to make them look acceptable in proximity to other
116     glyphs in their script.
117     */
118     if (loc != 0x01107F && loc != 0x01D1A0) {
119         combining[loc] = 1;
120         x_offset [loc] = offset;
121     }
122 }
123 fclose (infilefp); /* all done reading combining.txt */
124
125 /* Now read the non-printing glyphs; they never have dashed circles */
126 if ((infilefp = fopen (argv[2], "r")) == NULL) {
127     fprintf (stderr, "ERROR - nonprinting characters file %s not found.\n\n",
128         argv[1]);
129     exit (EXIT_FAILURE);
130 }
131
132 /* Reset list of nonprinting characters to avoid adding a dashed circle. */
133 while (fscanf (infilefp, "%X:%s", &loc) != EOF) combining[loc] = 0;
134
135 fclose (infilefp); /* all done reading nonprinting.hex */
136
137 /*
138 Read the hex glyphs.
139 */
140 teststring[MAXSTRING - 1] = '\0'; /* so there's no chance we leave array */
141 while (fgets (teststring, MAXSTRING-1, stdin) != NULL) {
142     sscanf (teststring, "%X", &loc); /* loc == the Unioce code point */
143     gstart = strchr (teststring, ':') + 1; /* start of glyph bitmap */
144     if (combining[loc]) { /* if a combining character */
145         if (strlen (gstart) < 35)
146             add_single_circle (gstart); /* single-width */
147         else
148             add_double_circle (gstart, x_offset[loc]); /* double-width */
149     }
150     printf ("%s", teststring); /* output the new character .hex string */
151 }
152
153 exit (EXIT_SUCCESS);
154 }

```



Here is the call graph for this function:

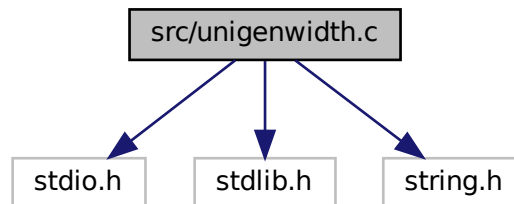


## 5.12 src/unigenwidth.c File Reference

unigenwidth - IEEE 1003.1-2008 setup to calculate wchar\_t string widths

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
```

Include dependency graph for unigenwidth.c:



### Macros

- `#define MAXSTRING 256`  
Maximum input line length - 1.
- `#define PIKTO_START 0x0F0E70`  
Start of Pikto code point range.
- `#define PIKTO_END 0x0F11EF`  
End of Pikto code point range.
- `#define PIKTO_SIZE (PIKTO_END - PIKTO_START + 1)`

## Functions

- `int main (int argc, char **argv)`  
The main function.

### 5.12.1 Detailed Description

unigenwidth - IEEE 1003.1-2008 setup to calculate wchar\_t string widths

Author

Paul Hardy.

Copyright

Copyright (C) 2013, 2017 Paul Hardy.

All glyphs are treated as 16 pixels high, and can be 8, 16, 24, or 32 pixels wide (resulting in widths of 1, 2, 3, or 4, respectively).

### 5.12.2 Macro Definition Documentation

#### 5.12.2.1 PIKTO\_SIZE

```
#define PIKTO_SIZE (PIKTO_END - PIKTO_START + 1)
```

Number of code points in Pikto range.

Definition at line 52 of file unigenwidth.c.

### 5.12.3 Function Documentation

#### 5.12.3.1 main()

```
int main (  
    int argc,  
    char ** argv )
```

The main function.

## Parameters

in	argc	The count of command line arguments.
in	argv	Pointer to array of command line arguments.

## Returns

This program exits with status EXIT\_SUCCESS.

Definition at line 63 of file unigenwidth.c.

```

64 {
65
66     int i; /* loop variable */
67
68     char teststring[MAXSTRING];
69     int loc;
70     char *gstart;
71
72     char glyph_width[0x20000];
73     char pikto_width[PIKTO_SIZE];
74
75     FILE *infilefp;
76
77     if (argc != 3) {
78         fprintf(stderr, "\n\nUsage: %s <unifont.hex> <combining.txt>\n\n", argv[0]);
79         exit (EXIT_FAILURE);
80     }
81
82     /*
83     Read the collection of hex glyphs.
84     */
85     if ((infilefp = fopen (argv[1], "r")) == NULL) {
86         fprintf(stderr, "ERROR - hex input file %s not found.\n\n", argv[1]);
87         exit (EXIT_FAILURE);
88     }
89
90     /* Flag glyph as non-existent until found. */
91     memset (glyph_width, -1, 0x20000 * sizeof (char));
92     memset (pikto_width, -1, (PIKTO_SIZE) * sizeof (char));
93
94     teststring[MAXSTRING-1] = '\0';
95     while (fgets (teststring, MAXSTRING-1, infilefp) != NULL) {
96         sscanf (teststring, "%X:%s", &loc);
97         if (loc < 0x20000) {
98             gstart = strchr (teststring, ':') + 1;
99             /*
100             16 rows per glyph, 2 ASCII hexadecimal digits per byte,
101             so divide number of digits by 32 (shift right 5 bits).
102             */
103             glyph_width[loc] = (strlen (gstart) - 1) » 5;
104         }
105         else if ((loc >= PIKTO_START) && (loc <= PIKTO_END)) {
106             gstart = strchr (teststring, ':') + 1;
107             pikto_width[loc - PIKTO_START] = strlen (gstart) <= 34 ? 1 : 2;
108         }
109     }
110
111     fclose (infilefp);
112
113     /*
114     Now read the combining character code points. These have width of 0.
115     */
116     if ((infilefp = fopen (argv[2], "r")) == NULL) {
117         fprintf(stderr, "ERROR - combining characters file %s not found.\n\n", argv[2]);
118         exit (EXIT_FAILURE);
119     }
120
121     while (fgets (teststring, MAXSTRING-1, infilefp) != NULL) {
122         sscanf (teststring, "%X:%s", &loc);
123         if (loc < 0x20000) glyph_width[loc] = 0;
124     }
125
126     fclose (infilefp);

```

```

127
128 /*
129 Code Points with Unusual Properties (Unicode Standard, Chapter 4).
130
131 As of Unifont 10.0.04, use the widths in the "nonprinting.hex"
132 files. If an application is smart enough to know how to handle
133 these special cases, it will not render the "nonprinting" glyph
134 and will treat the code point as being zero-width.
135 */
136 // glyph_width[0]=0; /* NULL character */
137 // for (i = 0x0001; i <= 0x001F; i++) glyph_width[i]=-1; /* Control Characters */
138 // for (i = 0x007F; i <= 0x009F; i++) glyph_width[i]=-1; /* Control Characters */
139
140 // glyph_width[0x034F]=0; /* combining grapheme joiner */
141 // glyph_width[0x180B]=0; /* Mongolian free variation selector one */
142 // glyph_width[0x180C]=0; /* Mongolian free variation selector two */
143 // glyph_width[0x180D]=0; /* Mongolian free variation selector three */
144 // glyph_width[0x180E]=0; /* Mongolian vowel separator */
145 // glyph_width[0x200B]=0; /* zero width space */
146 // glyph_width[0x200C]=0; /* zero width non-joiner */
147 // glyph_width[0x200D]=0; /* zero width joiner */
148 // glyph_width[0x200E]=0; /* left-to-right mark */
149 // glyph_width[0x200F]=0; /* right-to-left mark */
150 // glyph_width[0x202A]=0; /* left-to-right embedding */
151 // glyph_width[0x202B]=0; /* right-to-left embedding */
152 // glyph_width[0x202C]=0; /* pop directional formatting */
153 // glyph_width[0x202D]=0; /* left-to-right override */
154 // glyph_width[0x202E]=0; /* right-to-left override */
155 // glyph_width[0x2060]=0; /* word joiner */
156 // glyph_width[0x2061]=0; /* function application */
157 // glyph_width[0x2062]=0; /* invisible times */
158 // glyph_width[0x2063]=0; /* invisible separator */
159 // glyph_width[0x2064]=0; /* invisible plus */
160 // glyph_width[0x206A]=0; /* inhibit symmetric swapping */
161 // glyph_width[0x206B]=0; /* activate symmetric swapping */
162 // glyph_width[0x206C]=0; /* inhibit arabic form shaping */
163 // glyph_width[0x206D]=0; /* activate arabic form shaping */
164 // glyph_width[0x206E]=0; /* national digit shapes */
165 // glyph_width[0x206F]=0; /* nominal digit shapes */
166
167 // /* Variation Selector-1 to Variation Selector-16 */
168 // for (i = 0xFE00; i <= 0xFE0F; i++) glyph_width[i] = 0;
169
170 // glyph_width[0xFEFF]=0; /* zero width no-break space */
171 // glyph_width[0xFFFF9]=0; /* interlinear annotation anchor */
172 // glyph_width[0xFFFA]=0; /* interlinear annotation separator */
173 // glyph_width[0xFFFFB]=0; /* interlinear annotation terminator */
174 /*
175 Let glyph widths represent 0xFFFC (object replacement character)
176 and 0xFFFD (replacement character).
177 */
178
179 /*
180 Hangul Jamo:
181
182 Leading Consonant (Choseong): leave spacing as is.
183
184 Hangul Choseong Filler (U+115F): set width to 2.
185
186 Hangul Jungseong Filler, Hangul Vowel (Jungseong), and
187 Final Consonant (Jongseong): set width to 0, because these
188 combine with the leading consonant as one composite syllabic
189 glyph. As of Unicode 5.2, the Hangul Jamo block (U+1100..U+11FF)
190 is completely filled.
191 */
192 // for (i = 0x1160; i <= 0x11FF; i++) glyph_width[i]=0; /* Vowels & Final Consonants */
193
194 /*
195 Private Use Area -- the width is undefined, but likely
196 to be 2 charcells wide either from a graphic glyph or
197 from a four-digit hexadecimal glyph representing the
198 code point. Therefore if any PUA glyph does not have
199 a non-zero width yet, assign it a default width of 2.
200 The Unicode Standard allows giving PUA characters
201 default property values; see for example The Unicode
202 Standard Version 5.0, p. 91. This same default is
203 used for higher plane PUA code points below.
204 */
205 // for (i = 0xE000; i <= 0xF8FF; i++) {
206 // if (glyph_width[i] == 0) glyph_width[i]=2;
207 // }

```

```

208
209  /*
210  <not a character>
211  */
212  for (i = 0xFDD0; i <= 0xFDEF; i++) glyph_width[i] = -1;
213  glyph_width[0xFFFE] = -1; /* Byte Order Mark */
214  glyph_width[0xFFFF] = -1; /* Byte Order Mark */
215
216  /* Surrogate Code Points */
217  for (i = 0xD800; i <= 0xDFFF; i++) glyph_width[i] = -1;
218
219  /* CJK Code Points */
220  for (i = 0x4E00; i <= 0x9FFF; i++) if (glyph_width[i] < 0) glyph_width[i] = 2;
221  for (i = 0x3400; i <= 0x4DBF; i++) if (glyph_width[i] < 0) glyph_width[i] = 2;
222  for (i = 0xF900; i <= 0xFAFF; i++) if (glyph_width[i] < 0) glyph_width[i] = 2;
223
224  /*
225  Now generate the output file.
226  */
227  printf ("/\n");
228  printf ("  wcwidth and wcswidth functions, as per IEEE 1003.1-2008\n");
229  printf ("  System Interfaces, pp. 2241 and 2251.\n");
230  printf ("  Author: Paul Hardy, 2013\n");
231  printf ("  Copyright (c) 2013 Paul Hardy\n");
232  printf ("  LICENSE:\n");
233  printf ("/\n");
234  printf ("  This program is free software: you can redistribute it and/or modify\n");
235  printf ("  it under the terms of the GNU General Public License as published by\n");
236  printf ("  the Free Software Foundation, either version 2 of the License, or\n");
237  printf ("  (at your option) any later version.\n");
238  printf ("/\n");
239  printf ("  This program is distributed in the hope that it will be useful,\n");
240  printf ("  but WITHOUT ANY WARRANTY; without even the implied warranty of\n");
241  printf ("  MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the\n");
242  printf ("  GNU General Public License for more details.\n");
243  printf ("/\n");
244  printf ("  You should have received a copy of the GNU General Public License\n");
245  printf ("  along with this program. If not, see <http://www.gnu.org/licenses/>.\n");
246  printf ("/\n");
247
248  printf ("#include <wchar.h>\n");
249  printf ("/* Definitions for Pkto CSUR Private Use Area glyphs */\n");
250  printf ("#define PIKTO_START\t0x%06X\n", PIKTO_START);
251  printf ("#define PIKTO_END\t0x%06X\n", PIKTO_END);
252  printf ("#define PIKTO_SIZE\t(PIKTO_END - PIKTO_START + 1)\n");
253  printf ("/\n");
254  printf ("/* wcwidth -- return charcell positions of one code point */\n");
255  printf ("inline int nwcwidth (wchar_t wc)\n");
256  printf ("  return (wcswidth (&wc, 1));\n");
257  printf ("/\n");
258  printf ("/\n");
259  printf ("int nwcwidth (const wchar_t *pwcs, size_t n)\n");
260  printf ("  int i; /* loop variable */\n");
261  printf ("  unsigned codept; /* Unicode code point of current character */\n");
262  printf ("  unsigned plane; /* Unicode plane, 0x00..0x10 */\n");
263  printf ("  unsigned lower17; /* lower 17 bits of Unicode code point */\n");
264  printf ("  unsigned lower16; /* lower 16 bits of Unicode code point */\n");
265  printf ("  int lowpt, midpt, highpt; /* for binary searching in plane1zeroes[] */\n");
266  printf ("  int found; /* for binary searching in plane1zeroes[] */\n");
267  printf ("  int totalwidth; /* total width of string, in charcells (1 or 2/glyph) */\n");
268  printf ("  int illegalchar; /* Whether or not this code point is illegal */\n");
269  putchar ('\n');
270
271  /*
272  Print the glyph_width[] array for glyphs widths in the
273  Basic Multilingual Plane (Plane 0).
274  */
275  printf ("  char glyph_width[0x20000] = {\n");
276  for (i = 0; i < 0x10000; i++) {
277    if ((i & 0x1F) == 0)
278      printf ("    /* U+%04X */\n", i);
279    printf ("%d,", glyph_width[i]);
280  }
281  for (i = 0x10000; i < 0x20000; i++) {
282    if ((i & 0x1F) == 0)
283      printf ("    /* U+%06X */\n", i);
284    printf ("%d", glyph_width[i]);
285    if (i < 0x1FFFF) putchar (',' );
286  }
287  printf ("  };\n");
288

```

```

289  /*
290  Print the pikto_width[] array for Pikto glyph widths.
291  */
292  printf (" char pikto_width[PIKTO_SIZE] = {");
293  for (i = 0; i < PIKTO_SIZE; i++) {
294      if ((i & 0x1F) == 0)
295          printf ("\n /* U+%06X */ ", PIKTO_START + i);
296      printf ("%d", pikto_width[i]);
297      if ((PIKTO_START + i) < PIKTO_END) putchar (',' );
298  }
299  printf ("\n }; \n\n");
300
301  /*
302  Execution part of wcswidth.
303  */
304  printf ("\n");
305  printf (" illegalchar = totalwidth = 0;\n");
306  printf (" for (i = 0; illegalchar && i < n; i++) {\n");
307  printf ("     codept = pwcs[i];\n");
308  printf ("     plane = codept » 16;\n");
309  printf ("     lower17 = codept & 0x1FFFF;\n");
310  printf ("     lower16 = codept & 0xFFFF;\n");
311  printf ("     if (plane < 2) { /* the most common case */\n");
312  printf ("         if (glyph_width[lower17] < 0) illegalchar = 1;\n");
313  printf ("         else totalwidth += glyph_width[lower17];\n");
314  printf ("     }\n");
315  printf ("     else { /* a higher plane or beyond Unicode range */\n");
316  printf ("         if ((lower16 == 0xFFFE) || (lower16 == 0xFFFF)) {\n");
317  printf ("             illegalchar = 1;\n");
318  printf ("         }\n");
319  printf ("         else if (plane < 4) { /* Ideographic Plane */\n");
320  printf ("             totalwidth += 2; /* Default ideographic width */\n");
321  printf ("         }\n");
322  printf ("         else if (plane == 0x0F) { /* CSUR Private Use Area */\n");
323  printf ("             if (lower16 <= 0x0E6F) { /* Kinya */\n");
324  printf ("                 totalwidth++; /* all Kinya syllables have width 1 */\n");
325  printf ("             }\n");
326  printf ("             else if (lower16 <= (PIKTO_END & 0xFFFF)) { /* Pikto */\n");
327  printf ("                 if (pikto_width[lower16 - (PIKTO_START & 0xFFFF)] < 0) illegalchar = 1;\n");
328  printf ("                 else totalwidth += pikto_width[lower16 - (PIKTO_START & 0xFFFF)];\n");
329  printf ("             }\n");
330  printf ("         }\n");
331  printf ("         else if (plane > 0x10) {\n");
332  printf ("             illegalchar = 1;\n");
333  printf ("         }\n");
334  printf ("         /* Other non-printing in higher planes; return -1 as per IEEE 1003.1-2008. */\n");
335  printf ("     } else if (/* language tags */\n");
336  printf ("         codept == 0x0E0001 || (codept >= 0x0E0020 && codept <= 0x0E007F) ||\n");
337  printf ("         /* variation selectors, 0x0E0100..0x0E01EF */\n");
338  printf ("         (codept >= 0x0E0100 && codept <= 0x0E01EF)) {\n");
339  printf ("             illegalchar = 1;\n");
340  printf ("         }\n");
341  printf ("     } /*\n");
342  printf ("     Unicode plane 0x02..0x10 printing character\n");
343  printf ("     */\n");
344  printf ("     else {\n");
345  printf ("         illegalchar = 1; /* code is not in font */\n");
346  printf ("     }\n");
347  printf (" }\n");
348  printf (" }\n");
349  printf (" }\n");
350  printf (" if (illegalchar) totalwidth = -1;\n");
351  printf (" }\n");
352  printf (" return (totalwidth);\n");
353  printf (" }\n");
354  printf (" }\n");
355
356  exit (EXIT_SUCCESS);
357 }

```

## 5.13 src/unihex2bmp.c File Reference

unihex2bmp - Turn a GNU Unifont hex glyph page of 256 code points into a bitmap for editing

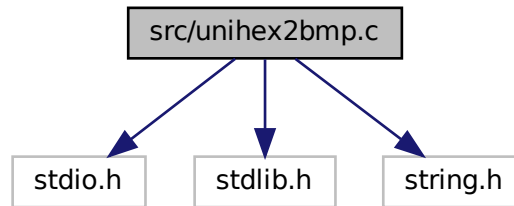
```

#include <stdio.h>
#include <stdlib.h>

```

```
#include <string.h>
```

Include dependency graph for unihex2bmp.c:



## Macros

- `#define MAXBUF 256`

## Functions

- `int main (int argc, char *argv[])`  
The main function.
- `int hex2bit (char *instring, unsigned char character[32][4])`  
Generate a bitmap for one glyph.
- `int init (unsigned char bitmap[17 * 32][18 * 4])`  
Initialize the bitmap grid.

## Variables

- `char * hex [18]`  
GNU Unifont bitmaps for hexadecimal digits.
- `unsigned char hexbits [18][32]`  
The digits converted into bitmaps.
- `unsigned unipage = 0`  
Unicode page number, 0x00..0xff.
- `int flip = 1`  
Transpose entire matrix as in Unicode book.

### 5.13.1 Detailed Description

unihex2bmp - Turn a GNU Unifont hex glyph page of 256 code points into a bitmap for editing

Author

Paul Hardy, unifoundry <at> unifoundry.com, December 2007

Copyright

Copyright (C) 2007, 2008, 2013, 2017 Paul Hardy

This program reads in a GNU Unifont .hex file, extracts a range of 256 code points, and converts it a Microsoft Bitmap (.bmp) or Wireless Bitmap file.

Synopsis: unihex2bmp [-iin\_file.hex] [-oout\_file.bmp] [-f] [-phex\_page\_num] [-w]

### 5.13.2 Function Documentation

#### 5.13.2.1 hex2bit()

```
int hex2bit (
    char * instring,
    unsigned char character[32][4] )
```

Generate a bitmap for one glyph.

Convert the portion of a hex string after the ':' into a character bitmap.

If string is  $\geq 128$  characters, it will fill all 4 bytes per row. If string is  $\geq 64$  characters and  $< 128$ , it will fill 2 bytes per row. Otherwise, it will fill 1 byte per row.

Parameters

in	instring	The character array containing the glyph bitmap.
out	character	<a href="#">Glyph</a> bitmap, 8, 16, or 32 columns by 16 rows tall.

Returns

Always returns 0.

Definition at line 361 of file unihex2bmp.c.

```
362 {
```

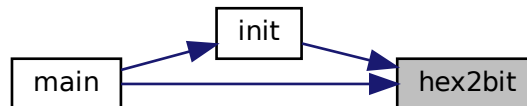


```

363
364 int i; /* current row in bitmap character */
365 int j; /* current character in input string */
366 int k; /* current byte in bitmap character */
367 int width; /* number of output bytes to fill - 1: 0, 1, 2, or 3 */
368
369 for (i=0; i<32; i++) /* erase previous character */
370     character[i][0] = character[i][1] = character[i][2] = character[i][3] = 0;
371 j=0; /* current location is at beginning of instring */
372
373 if (strlen (instring) <= 34) /* 32 + possible '\r', '\n' */
374     width = 0;
375 else if (strlen (instring) <= 66) /* 64 + possible '\r', '\n' */
376     width = 1;
377 else if (strlen (instring) <= 98) /* 96 + possible '\r', '\n' */
378     width = 3;
379 else /* the maximum allowed is quadruple-width */
380     width = 4;
381
382 k = (width > 1) ? 0 : 1; /* if width > double, start at index 1 else at 0 */
383
384 for (i=8; i<24; i++) { /* 16 rows per input character, rows 8..23 */
385     sscanf (&instring[j], "%2hhx", &character[i][k]);
386     j += 2;
387     if (width > 0) { /* add next pair of hex digits to this row */
388         sscanf (&instring[j], "%2hhx", &character[i][k+1]);
389         j += 2;
390         if (width > 1) { /* add next pair of hex digits to this row */
391             sscanf (&instring[j], "%2hhx", &character[i][k+2]);
392             j += 2;
393             if (width > 2) { /* quadruple-width is maximum width */
394                 sscanf (&instring[j], "%2hhx", &character[i][k+3]);
395                 j += 2;
396             }
397         }
398     }
399 }
400
401 return (0);
402 }

```

Here is the caller graph for this function:



### 5.13.2.2 init()

```

int init (
    unsigned char bitmap[17 * 32][18 * 4] )

```

Initialize the bitmap grid.

## Parameters

out	bitmap	The bitmap to generate, with 32x32 pixel glyph areas.
-----	--------	---

## Returns

Always returns 0.

Definition at line 412 of file unihex2bmp.c.

```

413 {
414     int i, j;
415     unsigned char charbits[32][4]; /* bitmap for one character, 4 bytes/row */
416     unsigned toppixelrow;
417     unsigned thiscol;
418     unsigned char pnybble0, pnybble1, pnybble2, pnybble3;
419
420     for (i=0; i<18; i++) { /* bitmaps for '0'..'9', 'A'..'F', 'u', '+' */
421
422         hex2bit (&hex[i][5], charbits); /* convert hex string to 32*4 bitmap */
423
424         for (j=0; j<32; j++) hexbits[i][j] = ~charbits[j][1];
425     }
426
427     /*
428     Initialize bitmap to all white.
429     */
430     for (toppixelrow=0; toppixelrow < 17*32; toppixelrow++) {
431         for (thiscol=0; thiscol<18; thiscol++) {
432             bitmap[toppixelrow][((thiscol « 2) | 0)] = 0xff;
433             bitmap[toppixelrow][((thiscol « 2) | 1)] = 0xff;
434             bitmap[toppixelrow][((thiscol « 2) | 2)] = 0xff;
435             bitmap[toppixelrow][((thiscol « 2) | 3)] = 0xff;
436         }
437     }
438     /*
439     Write the "u+nnnn" table header in the upper left-hand corner,
440     where nnnn is the upper 16 bits of a 32-bit Unicode assignment.
441     */
442     pnybble3 = (unipage » 20);
443     pnybble2 = (unipage » 16) & 0xf;
444     pnybble1 = (unipage » 12) & 0xf;
445     pnybble0 = (unipage » 8) & 0xf;
446     for (i=0; i<32; i++) {
447         bitmap[i][1] = hexbits[16][i]; /* copy 'u' */
448         bitmap[i][2] = hexbits[17][i]; /* copy '+' */
449         bitmap[i][3] = hexbits[pnybble3][i];
450         bitmap[i][4] = hexbits[pnybble2][i];
451         bitmap[i][5] = hexbits[pnybble1][i];
452         bitmap[i][6] = hexbits[pnybble0][i];
453     }
454     /*
455     Write low-order 2 bytes of Unicode number assignments, as hex labels
456     */
457     pnybble3 = (unipage » 4) & 0xf; /* Highest-order hex digit */
458     pnybble2 = (unipage » 0) & 0xf; /* Next highest-order hex digit */
459     /*
460     Write the column headers in bitmap[] (row headers if flipped)
461     */
462     toppixelrow = 32 * 17 - 1; /* maximum pixel row number */
463     /*
464     Label the column headers. The hexbits[][] bytes are split across two
465     bitmap[][] entries to center the hex digits in a column of 4 bytes.
466     OR highest byte with 0xf0 and lowest byte with 0xf to make outer
467     nybbles white (0=black, 1=white).
468     */
469     for (i=0; i<16; i++) {
470         for (j=0; j<32; j++) {
471             if (flip) { /* transpose matrix */
472                 bitmap[j][((i+2) « 2) | 0] = (hexbits[pnybble3][j] » 4) | 0xf0;
473                 bitmap[j][((i+2) « 2) | 1] = (hexbits[pnybble3][j] « 4) |
474                     (hexbits[pnybble2][j] » 4);
475                 bitmap[j][((i+2) « 2) | 2] = (hexbits[pnybble2][j] « 4) |
476                     (hexbits[i][j] » 4);
477                 bitmap[j][((i+2) « 2) | 3] = (hexbits[i][j] « 4) | 0xf0;

```

```

478     }
479     else {
480         bitmap[j][((i+2) << 2) | 1] = (hexbits[i][j] >> 4) | 0xf0;
481         bitmap[j][((i+2) << 2) | 2] = (hexbits[i][j] << 4) | 0x0f;
482     }
483 }
484 }
485 /*
486 Now use the single hex digit column graphics to label the row headers.
487 */
488 for (i=0; i<16; i++) {
489     toppixelrow = 32 * (i + 1) - 1; /* from bottom to top */
490
491     for (j=0; j<32; j++) {
492         if (!flip) { /* if not transposing matrix */
493             bitmap[toppixelrow + j][4] = hexbits[pnybble3][j];
494             bitmap[toppixelrow + j][5] = hexbits[pnybble2][j];
495         }
496         bitmap[toppixelrow + j][6] = hexbits[i][j];
497     }
498 }
499 /*
500 Now draw grid lines in bitmap, around characters we just copied.
501 */
502 /* draw vertical lines 2 pixels wide */
503 for (i=1*32; i<17*32; i++) {
504     if ((i & 0x1f) == 7)
505         i++;
506     else if ((i & 0x1f) == 14)
507         i += 2;
508     else if ((i & 0x1f) == 22)
509         i++;
510     for (j=1; j<18; j++) {
511         bitmap[i][(j << 2) | 3] &= 0xfe;
512     }
513 }
514 /* draw horizontal lines 1 pixel tall */
515 for (i=1*32-1; i<18*32-1; i+=32) {
516     for (j=2; j<18; j++) {
517         bitmap[i][(j << 2) | 0] = 0x00;
518         bitmap[i][(j << 2) | 1] = 0x81;
519         bitmap[i][(j << 2) | 2] = 0x81;
520         bitmap[i][(j << 2) | 3] = 0x00;
521     }
522 }
523 /* fill in top left corner pixel of grid */
524 bitmap[31][7] = 0xfe;
525
526 return (0);
527 }

```

Here is the call graph for this function:



Here is the caller graph for this function:



### 5.13.2.3 main()

```
int main (
    int argc,
    char * argv[] )
```

The main function.

Parameters

in	argc	The count of command line arguments.
in	argv	Pointer to array of command line arguments.

Returns

This program exits with status 0.

Definition at line 96 of file unihex2bmp.c.

```

97 {
98
99   int i, j;           /* loop variables */
100   unsigned k0;        /* temp Unicode char variable */
101   unsigned swap;      /* temp variable for swapping values */
102   char inbuf[256];    /* input buffer */
103   unsigned filesize;  /* size of file in bytes */
104   unsigned bitmapsiz; /* size of bitmap image in bytes */
105   unsigned thischar;  /* the current character */
106   unsigned char thischarbyte; /* unsigned char lowest byte of Unicode char */
107   int thischarrow;    /* row 0..15 where this character belongs */
108   int thiscol;        /* column 0..15 where this character belongs */
109   int toppixelrow;    /* pixel row, 0..16*32-1 */
110   unsigned lastpage=0; /* the last Unicode page read in font file */
111   int wbmp=0;         /* set to 1 if writing .wbmp format file */
112
113   unsigned char bitmap[17*32][18*4]; /* final bitmap */
114   unsigned char charbits[32][4]; /* bitmap for one character, 4 bytes/row */
115
116   char *infile="", *outfile=""; /* names of input and output files */
117   FILE *infp, *outfp; /* file pointers of input and output files */
118
119   int init();          /* initializes bitmap row/col labeling, &c. */
120   int hex2bit();       /* convert hex string --> bitmap */
121

```

```

122     bitmapsize = 17*32*18*4; /* 17 rows by 18 cols, each 4 bytes */
123
124     if (argc > 1) {
125         for (i = 1; i < argc; i++) {
126             if (argv[i][0] == '-') { /* this is an option argument */
127                 switch (argv[i][1]) {
128                     case 'f': /* flip (transpose) glyphs in bitmap as in standard */
129                         flip = !flip;
130                         break;
131                     case 'i': /* name of input file */
132                         infile = &argv[i][2];
133                         break;
134                     case 'o': /* name of output file */
135                         outfile = &argv[i][2];
136                         break;
137                     case 'p': /* specify a Unicode page other than default of 0 */
138                         sscanf (&argv[i][2], "%x", &unipage); /* Get Unicode page */
139                         break;
140                     case 'w': /* write a .wbmp file instead of a .bmp file */
141                         wbmp = 1;
142                         break;
143                     default: /* if unrecognized option, print list and exit */
144                         fprintf (stderr, "\nSyntax:\n\n");
145                         fprintf (stderr, "  %s -p<Unicode_Page> ", argv[0]);
146                         fprintf (stderr, "-i<Input_File> -o<Output_File> -w\n\n");
147                         fprintf (stderr, "  -w specifies .wbmp output instead of ");
148                         fprintf (stderr, "default Windows .bmp output.\n\n");
149                         fprintf (stderr, "  -p is followed by 1 to 6 ");
150                         fprintf (stderr, "Unicode page hex digits ");
151                         fprintf (stderr, "(default is Page 0).\n\n");
152                         fprintf (stderr, "\nExample:\n\n");
153                         fprintf (stderr, "  %s -p83 -iunifont.hex -ou83.bmp\n\n",
154                                 argv[0]);
155                         exit (1);
156                 }
157             }
158         }
159     }
160     /*
161     Make sure we can open any I/O files that were specified before
162     doing anything else.
163     */
164     if (strlen (infile) > 0) {
165         if ((infp = fopen (infile, "r")) == NULL) {
166             fprintf (stderr, "Error: can't open %s for input.\n", infile);
167             exit (1);
168         }
169     }
170     else {
171         infp = stdin;
172     }
173     if (strlen (outfile) > 0) {
174         if ((outfp = fopen (outfile, "w")) == NULL) {
175             fprintf (stderr, "Error: can't open %s for output.\n", outfile);
176             exit (1);
177         }
178     }
179     else {
180         outfp = stdout;
181     }
182
183     (void)init(bitmap); /* initialize bitmap with row/column headers, etc. */
184
185     /*
186     Read in the characters in the page
187     */
188     while (lastpage <= unipage && fgets (inbuf, MAXBUF-1, infp) != NULL) {
189         sscanf (inbuf, "%x", &thischar);
190         lastpage = thischar > 8; /* keep Unicode page to see if we can stop */
191         if (lastpage == unipage) {
192             thischarbyte = (unsigned char)(thischar & 0xff);
193             for (k0=0; inbuf[k0] != '\n'; k0++);
194             k0++;
195             hex2bit (&inbuf[k0], charbits); /* convert hex string to 32*4 bitmap */
196
197             /*
198             Now write character bitmap upside-down in page array, to match
199             .bmp file order.  In the .wbmp and .bmp files, white is a '1'
200             bit and black is a '0' bit, so complement charbits[].
201             */
202

```

```

203     thiscol = (thischarbyte & 0xf) + 2; /* column number will be 1..16 */
204     thischarrow = thischarbyte » 4; /* character row number, 0..15 */
205     if (flip) { /* swap row and column placement */
206         swap = thiscol;
207         thiscol = thischarrow;
208         thischarrow = swap;
209         thiscol += 2; /* column index starts at 1 */
210         thischarrow -= 2; /* row index starts at 0 */
211     }
212     toppixelrow = 32 * (thischarrow + 1) - 1; /* from bottom to top */
213
214     /*
215     Copy the center of charbits[] because hex characters only
216     occupy rows 8 to 23 and column byte 2 (and for 16 bit wide
217     characters, byte 3). The charbits[] array was given 32 rows
218     and 4 column bytes for completeness in the beginning.
219     */
220     for (i=8; i<24; i++) {
221         bitmap[toppixelrow + i][(thiscol « 2) | 0] =
222             ~charbits[i][0] & 0xff;
223         bitmap[toppixelrow + i][(thiscol « 2) | 1] =
224             ~charbits[i][1] & 0xff;
225         bitmap[toppixelrow + i][(thiscol « 2) | 2] =
226             ~charbits[i][2] & 0xff;
227         /* Only use first 31 bits; leave vertical rule in 32nd column */
228         bitmap[toppixelrow + i][(thiscol « 2) | 3] =
229             ~charbits[i][3] & 0xfe;
230     }
231     /*
232     Leave white space in 32nd column of rows 8, 14, 15, and 23
233     to leave 16 pixel height upper, middle, and lower guides.
234     */
235     bitmap[toppixelrow + 8][(thiscol « 2) | 3] |= 1;
236     bitmap[toppixelrow + 14][(thiscol « 2) | 3] |= 1;
237     bitmap[toppixelrow + 15][(thiscol « 2) | 3] |= 1;
238     bitmap[toppixelrow + 23][(thiscol « 2) | 3] |= 1;
239 }
240
241 /*
242 Now write the appropriate bitmap file format, either
243 Wireless Bitmap or Microsoft Windows bitmap.
244 */
245 if (wbmp) { /* Write a Wireless Bitmap .wbmp format file */
246     /*
247     Write WBMP header
248     */
249     fprintf (outfp, "%c", 0x00); /* Type of image; always 0 (monochrome) */
250     fprintf (outfp, "%c", 0x00); /* Reserved; always 0 */
251     fprintf (outfp, "%c%c", 0x84, 0x40); /* Width = 576 pixels */
252     fprintf (outfp, "%c%c", 0x84, 0x20); /* Height = 544 pixels */
253     /*
254     Write bitmap image
255     */
256     for (toppixelrow=0; toppixelrow <= 17*32-1; toppixelrow++) {
257         for (j=0; j<18; j++) {
258             fprintf (outfp, "%c", bitmap[toppixelrow][(j«2)  ]);
259             fprintf (outfp, "%c", bitmap[toppixelrow][(j«2) | 1]);
260             fprintf (outfp, "%c", bitmap[toppixelrow][(j«2) | 2]);
261             fprintf (outfp, "%c", bitmap[toppixelrow][(j«2) | 3]);
262         }
263     }
264 }
265 else { /* otherwise, write a Microsoft Windows .bmp format file */
266     /*
267     Write the .bmp file -- start with the header, then write the bitmap
268     */
269     /* 'B', 'M' appears at start of every .bmp file */
270     fprintf (outfp, "%c%c", 0x42, 0x4d);
271
272     /* Write file size in bytes */
273     filesize = 0x3E + bitmapsize;
274     fprintf (outfp, "%c", (unsigned char)((filesize      ) & 0xff));
275     fprintf (outfp, "%c", (unsigned char)((filesize » 0x08) & 0xff));
276     fprintf (outfp, "%c", (unsigned char)((filesize » 0x10) & 0xff));
277     fprintf (outfp, "%c", (unsigned char)((filesize » 0x18) & 0xff));
278
279     /* Reserved - 0's */
280     fprintf (outfp, "%c%c%c%c", 0x00, 0x00, 0x00, 0x00);
281
282     /* Offset from start of file to bitmap data */

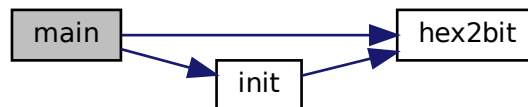
```

```

284     fprintf (outfp, "%c%c%c%c", 0x3E, 0x00, 0x00, 0x00);
285
286     /* Length of bitmap info header */
287     fprintf (outfp, "%c%c%c%c", 0x28, 0x00, 0x00, 0x00);
288
289     /* Width of bitmap in pixels */
290     fprintf (outfp, "%c%c%c%c", 0x40, 0x02, 0x00, 0x00);
291
292     /* Height of bitmap in pixels */
293     fprintf (outfp, "%c%c%c%c", 0x20, 0x02, 0x00, 0x00);
294
295     /* Planes in bitmap (fixed at 1) */
296     fprintf (outfp, "%c%c", 0x01, 0x00);
297
298     /* bits per pixel (1 = monochrome) */
299     fprintf (outfp, "%c%c", 0x01, 0x00);
300
301     /* Compression (0 = none) */
302     fprintf (outfp, "%c%c%c%c", 0x00, 0x00, 0x00, 0x00);
303
304     /* Size of bitmap data in bytes */
305     fprintf (outfp, "%c", (unsigned char)((bitmapsize) & 0xff));
306     fprintf (outfp, "%c", (unsigned char)((bitmapsize » 0x08) & 0xff));
307     fprintf (outfp, "%c", (unsigned char)((bitmapsize » 0x10) & 0xff));
308     fprintf (outfp, "%c", (unsigned char)((bitmapsize » 0x18) & 0xff));
309
310     /* Horizontal resolution in pixels per meter */
311     fprintf (outfp, "%c%c%c%c", 0xC4, 0x0E, 0x00, 0x00);
312
313     /* Vertical resolution in pixels per meter */
314     fprintf (outfp, "%c%c%c%c", 0xC4, 0x0E, 0x00, 0x00);
315
316     /* Number of colors used */
317     fprintf (outfp, "%c%c%c%c", 0x02, 0x00, 0x00, 0x00);
318
319     /* Number of important colors */
320     fprintf (outfp, "%c%c%c%c", 0x02, 0x00, 0x00, 0x00);
321
322     /* The color black: B=0x00, G=0x00, R=0x00, Filler=0xFF */
323     fprintf (outfp, "%c%c%c%c", 0x00, 0x00, 0x00, 0x00);
324
325     /* The color white: B=0xFF, G=0xFF, R=0xFF, Filler=0xFF */
326     fprintf (outfp, "%c%c%c%c", 0xFF, 0xFF, 0xFF, 0x00);
327
328     /*
329     Now write the raw data bits.  Data is written from the lower
330     left-hand corner of the image to the upper right-hand corner
331     of the image.
332     */
333     for (toppixelrow=17*32-1; toppixelrow >= 0; toppixelrow--) {
334         for (j=0; j<18; j++) {
335             fprintf (outfp, "%c", bitmap[toppixelrow][(j«2)  ]);
336             fprintf (outfp, "%c", bitmap[toppixelrow][(j«2) | 1]);
337             fprintf (outfp, "%c", bitmap[toppixelrow][(j«2) | 2]);
338
339             fprintf (outfp, "%c", bitmap[toppixelrow][(j«2) | 3]);
340         }
341     }
342 }
343 exit (0);
344 }

```

Here is the call graph for this function:



### 5.13.3 Variable Documentation

#### 5.13.3.1 hex

char\* hex[18]

Initial value:

```
= {
    "0030:0000000018244242424242424180000",
    "0031:000000000818280808080808083E0000",
    "0032:0000000003C4242020C102040407E0000",
    "0033:0000000003C4242021C020242423C0000",
    "0034:00000000040C142444447E0404040000",
    "0035:000000007E4040407C020202423C0000",
    "0036:000000001C2040407C424242423C0000",
    "0037:000000007E02020404080808080000",
    "0038:000000003C4242423C424242423C0000",
    "0039:000000003C4242423E02020204380000",
    "0041:0000000018242442427E424242420000",
    "0042:000000007C4242427C424242427C0000",
    "0043:000000003C42424040404042423C0000",
    "0044:00000000784442424242424244780000",
    "0045:000000007E4040407C404040407E0000",
    "0046:000000007E4040407C40404040400000",
    "0055:0000000042424242424242423C0000",
    "002B:0000000000000808087F080808000000"
}
```

GNU Unifont bitmaps for hexadecimal digits.

These are the GNU Unifont hex strings for '0'-'9' and 'A'-'F', for encoding as bit strings in row and column headers.

Looking at the final bitmap as a grid of 32\*32 bit tiles, the first row contains a hexadecimal character string of the first 3 hex digits in a 4 digit Unicode character name; the top column contains a hex character string of the 4th (low-order) hex digit of the Unicode character.

Definition at line 62 of file unihex2bmp.c.

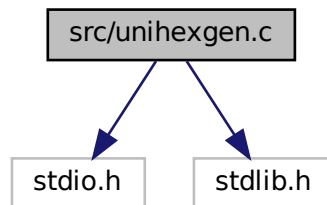
## 5.14 src/unihexgen.c File Reference

unihexgen - Generate a series of glyphs containing hexadecimal code points

```
#include <stdio.h>
```

```
#include <stdlib.h>
```

Include dependency graph for unihexgen.c:





## Functions

- int `main` (int argc, char \*argv[])  
The main function.
- void `hexprint4` (int thiscp)  
Generate a bitmap containing a 4-digit Unicode code point.
- void `hexprint6` (int thiscp)  
Generate a bitmap containing a 6-digit Unicode code point.

## Variables

- char `hexdigit` [16][5]  
Bitmap pattern for each hexadecimal digit.

### 5.14.1 Detailed Description

unihexgen - Generate a series of glyphs containing hexadecimal code points

Author

Paul Hardy

Copyright

Copyright (C) 2013 Paul Hardy

This program generates glyphs in Unifont .hex format that contain four- or six-digit hexadecimal numbers in a 16x16 pixel area. These are rendered as white digits on a black background.

argv[1] is the starting code point (as a hexadecimal string, with no leading "0x").

argv[2] is the ending code point (as a hexadecimal string, with no leading "0x").

For example:

```
unihexgen e000 f8ff > pua.hex
```

This generates the Private Use Area glyph file.

This utility program works in Roman Czyborra's unifont.hex file format, the basis of the GNU Unifont package.

### 5.14.2 Function Documentation

#### 5.14.2.1 hexprint4()

```
void hexprint4 (  
    int thiscp )
```

Generate a bitmap containing a 4-digit Unicode code point.

Takes a 4-digit Unicode code point as an argument and prints a unifont.hex string for it to stdout.

## Parameters

in	thiscp	The current code point for which to generate a glyph.
----	--------	---

Definition at line 160 of file unihexgen.c.

```

161 {
162
163     int grid[16]; /* the glyph grid we'll build */
164
165     int row;      /* row number in current glyph */
166     int digitrow; /* row number in current hex digit being rendered */
167     int rowbits;  /* 1 & 0 bits to draw current glyph row */
168
169     int d1, d2, d3, d4; /* four hexadecimal digits of each code point */
170
171     d1 = (thiscp » 12) & 0xF;
172     d2 = (thiscp » 8) & 0xF;
173     d3 = (thiscp » 4) & 0xF;
174     d4 = (thiscp ) & 0xF;
175
176     /* top and bottom rows are white */
177     grid[0] = grid[15] = 0x0000;
178
179     /* 14 inner rows are 14-pixel wide black lines, centered */
180     for (row = 1; row < 15; row++) grid[row] = 0x7FFE;
181
182     printf ("%04X:", thiscp);
183
184     /*
185     Render the first row of 2 hexadecimal digits
186     */
187     digitrow = 0; /* start at top of first row of digits to render */
188     for (row = 2; row < 7; row++) {
189         rowbits = (hexdigit[d1][digitrow] « 9) |
190                 (hexdigit[d2][digitrow] « 3);
191         grid[row] ^= rowbits; /* digits appear as white on black background */
192         digitrow++;
193     }
194
195     /*
196     Render the second row of 2 hexadecimal digits
197     */
198     digitrow = 0; /* start at top of first row of digits to render */
199     for (row = 9; row < 14; row++) {
200         rowbits = (hexdigit[d3][digitrow] « 9) |
201                 (hexdigit[d4][digitrow] « 3);
202         grid[row] ^= rowbits; /* digits appear as white on black background */
203         digitrow++;
204     }
205
206     for (row = 0; row < 16; row++) printf ("%04X", grid[row] & 0xFFFF);
207
208     putchar ('\n');
209
210     return;
211 }

```

Here is the caller graph for this function:



## 5.14.2.2 hexprint6()

```
void hexprint6 (
    int thiscp )
```

Generate a bitmap containing a 6-digit Unicode code point.

Takes a 6-digit Unicode code point as an argument and prints a unifont.hex string for it to stdout.

Parameters

in	thiscp	The current code point for which to generate a glyph.
----	--------	---

Definition at line 223 of file unihexgen.c.

```
224 {
225
226     int grid[16]; /* the glyph grid we'll build */
227
228     int row;      /* row number in current glyph */
229     int digitrow; /* row number in current hex digit being rendered */
230     int rowbits;  /* 1 & 0 bits to draw current glyph row */
231
232     int d1, d2, d3, d4, d5, d6; /* six hexadecimal digits of each code point */
233
234     d1 = (thiscp » 20) & 0xF;
235     d2 = (thiscp » 16) & 0xF;
236     d3 = (thiscp » 12) & 0xF;
237     d4 = (thiscp » 8) & 0xF;
238     d5 = (thiscp » 4) & 0xF;
239     d6 = (thiscp ) & 0xF;
240
241     /* top and bottom rows are white */
242     grid[0] = grid[15] = 0x0000;
243
244     /* 14 inner rows are 16-pixel wide black lines, centered */
245     for (row = 1; row < 15; row++) grid[row] = 0xFFFF;
246
247
248     printf ("%06X:", thiscp);
249
250     /*
251     Render the first row of 3 hexadecimal digits
252     */
253     digitrow = 0; /* start at top of first row of digits to render */
254     for (row = 2; row < 7; row++) {
255         rowbits = (hexdigit[d1][digitrow] « 11) |
256                 (hexdigit[d2][digitrow] « 6) |
257                 (hexdigit[d3][digitrow] « 1);
258         grid[row] ^= rowbits; /* digits appear as white on black background */
259         digitrow++;
260     }
261
262     /*
263     Render the second row of 3 hexadecimal digits
264     */
265     digitrow = 0; /* start at top of first row of digits to render */
266     for (row = 9; row < 14; row++) {
267         rowbits = (hexdigit[d4][digitrow] « 11) |
268                 (hexdigit[d5][digitrow] « 6) |
269                 (hexdigit[d6][digitrow] « 1);
270         grid[row] ^= rowbits; /* digits appear as white on black background */
271         digitrow++;
272     }
273
274     for (row = 0; row < 16; row++) printf ("%04X", grid[row] & 0xFFFF);
275
276     putchar ('\n');
277
278     return;
279 }
```

Here is the caller graph for this function:



### 5.14.2.3 main()

```
int main (
    int argc,
    char * argv[] )
```

The main function.

Parameters

in	argc	The count of command line arguments.
in	argv	Pointer to array of command line arguments (code point range).

Returns

This program exits with status EXIT\_SUCCESS.

Definition at line 112 of file unihexgen.c.

```

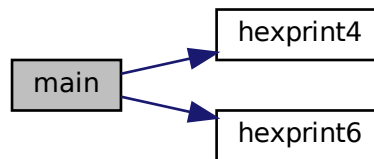
113 {
114
115     int startcp, endcp, thiscp;
116     void hexprint4(int); /* function to print one 4-digit unifont.hex code point */
117     void hexprint6(int); /* function to print one 6-digit unifont.hex code point */
118
119     if (argc != 3) {
120         fprintf (stderr, "\n%s - generate unifont.hex code points as\n", argv[0]);
121         fprintf (stderr, "four-digit hexadecimal numbers in a 2 by 2 grid.\n");
122         fprintf (stderr, "or six-digit hexadecimal numbers in a 3 by 2 grid.\n");
123         fprintf (stderr, "Syntax:\n\n");
124         fprintf (stderr, "    %s first_code_point last_code_point > glyphs.hex\n\n", argv[0]);
125         fprintf (stderr, "Example (to generate glyphs for the Private Use Area):\n\n");
126         fprintf (stderr, "    %s e000 f8ff > pua.hex\n\n", argv[0]);
127         exit (EXIT_FAILURE);
128     }
129
130     sscanf (argv[1], "%x", &startcp);
131     sscanf (argv[2], "%x", &endcp);
132
133     startcp &= 0xFFFFF; /* limit to 6 hex digits */
134     endcp   &= 0xFFFFF; /* limit to 6 hex digits */
135
136     /*
137     For each code point in the desired range, generate a glyph.
```

```

138 */
139 for (thiscp = startcp; thiscp <= endcp; thiscp++) {
140     if (thiscp <= 0xFFFF) {
141         hexprint4 (thiscp); /* print digits 2/line, 2 lines */
142     }
143     else {
144         hexprint6 (thiscp); /* print digits 3/line, 2 lines */
145     }
146 }
147 exit (EXIT_SUCCESS);
148 }

```

Here is the call graph for this function:



### 5.14.3 Variable Documentation

#### 5.14.3.1 hexdigit

```
char hexdigit[16][5]
```

Initial value:

```

= {
    {0x6,0x9,0x9,0x9,0x6},
    {0x2,0x6,0x2,0x2,0x7},
    {0xF,0x1,0xF,0x8,0xF},
    {0xE,0x1,0x7,0x1,0xE},
    {0x9,0x9,0xF,0x1,0x1},
    {0xF,0x8,0xF,0x1,0xF},
    {0x6,0x8,0xE,0x9,0x6},
    {0xF,0x1,0x2,0x4,0x4},
    {0x6,0x9,0x6,0x9,0x6},
    {0x6,0x9,0x7,0x1,0x6},
    {0xF,0x9,0xF,0x9,0x9},
    {0xE,0x9,0xE,0x9,0xE},
    {0x7,0x8,0x8,0x8,0x7},
    {0xE,0x9,0x9,0x9,0xE},
    {0xF,0x8,0xE,0x8,0xF},
    {0xF,0x8,0xE,0x8,0x8}
}

```

Bitmap pattern for each hexadecimal digit.

hexdigit[][] definition: the bitmap pattern for each hexadecimal digit.

Each digit is drawn as a 4 wide by 5 high bitmap, so each digit row is one hexadecimal digit, and each entry has 5 rows.

For example, the entry for digit 1 is:

```
{0x2,0x6,0x2,0x2,0x7},
```

which corresponds graphically to:

```
-#- ==> 0010 ==> 0x2 -##- ==> 0110 ==> 0x6 -#- ==> 0010 ==> 0x2 -#- ==> 0010 ==> 0x2
-### ==> 0111 ==> 0x7
```

These row values will then be exclusive-ORed with four one bits (binary 1111, or 0xF) to form white digits on a black background.

Functions `hexprint4` and `hexprint6` share the hexdigit array; they print four-digit and six-digit hexadecimal code points in a single glyph, respectively.

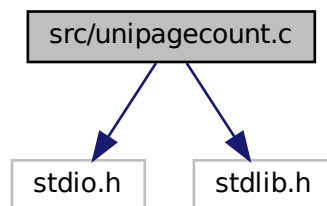
Definition at line 84 of file `unihexgen.c`.

## 5.15 `src/unipagecount.c` File Reference

`unipagecount` - Count the number of glyphs defined in each page of 256 code points

```
#include <stdio.h>
#include <stdlib.h>
```

Include dependency graph for `unipagecount.c`:



### Macros

- `#define` `MAXBUF` 256  
Maximum input line size - 1.

## Functions

- int `main` (int argc, char \*argv[])  
The main function.
- void `mkftable` (unsigned plane, int pagecount[256], int links)  
Create an HTML table linked to PNG images.

### 5.15.1 Detailed Description

`unipagecount` - Count the number of glyphs defined in each page of 256 code points

#### Author

Paul Hardy, unifoundry <at> unifoundry.com, December 2007

#### Copyright

Copyright (C) 2007, 2008, 2013, 2014 Paul Hardy

This program counts the number of glyphs that are defined in each "page" of 256 code points, and prints the counts in an 8 x 8 grid. Input is from stdin. Output is to stdout.

The background color of each cell in a 16-by-16 grid of 256 code points is shaded to indicate percentage coverage. Red indicates 0% coverage, green represents 100% coverage, and colors in between pure red and pure green indicate partial coverage on a scale.

Each code point range number can be a hyperlink to a PNG file for that 256-code point range's corresponding bitmap glyph image.

#### Synopsis:

```
unipagecount < font_file.hex > count.txt
unipagecount -phex_page_num < font_file.hex -- just 256 points
unipagecount -h < font_file.hex           -- HTML table
unipagecount -P1 -h < font.hex > count.html -- Plane 1, HTML out
unipagecount -l < font_file.hex           -- linked HTML table
```

### 5.15.2 Function Documentation

#### 5.15.2.1 `main()`

```
int main (
    int argc,
    char * argv[] )
```

The main function.

## Parameters

in	argc	The count of command line arguments.
in	argv	Pointer to array of command line arguments.

## Returns

This program exits with status 0.

Definition at line 67 of file unipagecount.c.

```

68 {
69
70 char inbuf[MAXBUF]; /* Max 256 characters in an input line */
71 int i, j; /* loop variables */
72 unsigned plane=0; /* Unicode plane number, 0 to 0x16 */
73 unsigned page; /* unicode page (256 bytes wide) */
74 unsigned unichar; /* unicode character */
75 int pagecount[256] = {256 * 0};
76 int onepage=0; /* set to one if printing character grid for one page */
77 int pageno=0; /* page number selected if only examining one page */
78 int html=0; /* =0: print plain text; =1: print HTML */
79 int links=0; /* =1: print HTML links; =0: don't print links */
80 void mkftable(); /* make (print) flipped HTML table */
81
82 size_t strlen();
83
84 if (argc > 1 && argv[1][0] == '-') { /* Parse option */
85     plane = 0;
86     for (i = 1; i < argc; i++) {
87         switch (argv[i][1]) {
88             case 'p': /* specified -p<hexpage> -- use given page number */
89                 sscanf (&argv[1][2], "%x", &pageno);
90                 if (pageno >= 0 && pageno <= 255) onepage = 1;
91                 break;
92             case 'h': /* print HTML table instead of text table */
93                 html = 1;
94                 break;
95             case 'l': /* print hyperlinks in HTML table */
96                 links = 1;
97                 html = 1;
98                 break;
99             case 'P': /* Plane number specified */
100                 plane = atoi(&argv[1][2]);
101                 break;
102         }
103     }
104 }
105 /*
106 Initialize pagecount to account for noncharacters.
107 */
108 if (!onpage && plane==0) {
109     pagecount[0xfd] = 32; /* for U+FDD0..U+FDEF */
110 }
111 pagecount[0xff] = 2; /* for U+nnFFFE, U+nnFFFF */
112 /*
113 Read one line at a time from input. The format is:
114
115 <hexpos>:<hexbitmap>
116
117 where <hexpos> is the hexadecimal Unicode character position
118 in the range 00..FF and <hexbitmap> is the sequence of hexadecimal
119 digits of the character, laid out in a grid from left to right,
120 top to bottom. The character is assumed to be 16 rows of variable
121 width.
122 */
123 while (fgets (inbuf, MAXBUF-1, stdin) != NULL) {
124     sscanf (inbuf, "%X", &unichar);
125     page = unichar » 8;
126     if (onpage) { /* only increment counter if this is page we want */
127         if (page == pageno) { /* character is in the page we want */
128             pagecount[unichar & 0xff]++; /* mark character as covered */
129         }
130     }
131 }

```



```

131     else { /* counting all characters in all pages */
132         if (plane == 0) {
133             /* Don't add in noncharacters (U+FDD0..U+FDEF, U+FFFE, U+FFFF) */
134             if (unichar < 0xfdd0 || (unichar > 0xfdef && unichar < 0xfffe))
135                 pagecount[page]++;
136         }
137     }
138     else {
139         if ((page >> 8) == plane) { /* code point is in desired plane */
140             pagecount[page & 0xFF]++;
141         }
142     }
143 }
144 if (html) {
145     mkftable (plane, pagecount, links);
146 }
147 else { /* Otherwise, print plain text table */
148     if (plane > 0) fprintf (stdout, " ");
149     fprintf (stdout,
150             " 0 1 2 3 4 5 6 7 8 9 A B C D E F\n");
151     for (i=0; i<0x10; i++) {
152         fprintf (stdout, "%02X%X ", plane, i); /* row header */
153         for (j=0; j<0x10; j++) {
154             if (onepage) {
155                 if (pagecount[i*16+j])
156                     fprintf (stdout, " * ");
157                 else
158                     fprintf (stdout, " . ");
159             }
160             else {
161                 fprintf (stdout, "%3X ", pagecount[i*16+j]);
162             }
163         }
164         fprintf (stdout, "\n");
165     }
166 }
167 }
168 exit (0);
169 }

```

Here is the call graph for this function:



### 5.15.2.2 mkftable()

```

void mkftable (
    unsigned plane,
    int pagecount[256],
    int links )

```

Create an HTML table linked to PNG images.

This function creates an HTML table to show PNG files in a 16 by 16 grid. The background color of each "page" of 256 code points is shaded from red (for 0% coverage) to green (for 100% coverage).

## Parameters

in	plane	The Unicode plane, 0..17.
in	pagecount	Array with count of glyphs in each 256 code point range.
in	links	1 = generate hyperlinks, 0 = do not generate hyperlinks.

Definition at line 185 of file unipagecount.c.

```

186 {
187     int i, j;
188     int count;
189     unsigned bgcolor;
190
191     printf("<html>\n");
192     printf("<body>\n");
193     printf("<table border=\"3\" align=\"center\">\n");
194     printf("  <tr><th colspan=\"16\" bgcolor=\"#ffcc80\">");
195     printf("GNU Unifont Glyphs<br>with Page Coverage for Plane %d<br>(Green=100%%, Red=0%%)</th></tr>\n", plane);
196     for (i = 0x0; i <= 0xF; i++) {
197         printf("  <tr>\n");
198         for (j = 0x0; j <= 0xF; j++) {
199             count = pagecount[(i « 4) | j];
200
201             /* print link in cell if links == 1 */
202             if (plane != 0 || (i < 0xd || (i == 0xd && j < 0x8) || (i == 0xf && j > 0x8))) {
203                 /* background color is light green if completely done */
204                 if (count == 0x100) bgcolor = 0xceffcc;
205                 /* otherwise background is a shade of yellow to orange to red */
206                 else bgcolor = 0xff0000 | (count « 8) | (count » 1);
207                 printf("    <td bgcolor=\"#%06X\">", bgcolor);
208                 if (plane == 0)
209                     printf(" <a href=\"png/plane%02X/uni%02X%X%X.png\">%X%X</a>", plane, plane, i, j, i, j);
210                 else
211                     printf(" <a href=\"png/plane%02X/uni%02X%X%X.png\">%02X%X%X</a>", plane, plane, i, j, plane, i, j);
212                 printf("</td>\n");
213             }
214             else if (i == 0xd) {
215                 if (j == 0x8) {
216                     printf("    <td align=\"center\" colspan=\"8\" bgcolor=\"#cccccc\">");
217                     printf("<b>Surrogate Pairs</b>");
218                     printf("</td>\n");
219                 } /* otherwise don't print anything more columns in this row */
220             }
221             else if (i == 0xe) {
222                 if (j == 0x0) {
223                     printf("    <td align=\"center\" colspan=\"16\" bgcolor=\"#cccccc\">");
224                     printf("<b>Private Use Area</b>");
225                     printf("</td>\n");
226                 } /* otherwise don't print any more columns in this row */
227             }
228             else if (i == 0xf) {
229                 if (j == 0x0) {
230                     printf("    <td align=\"center\" colspan=\"9\" bgcolor=\"#cccccc\">");
231                     printf("<b>Private Use Area</b>");
232                     printf("</td>\n");
233                 }
234             }
235         }
236         printf("  </tr>\n");
237     }
238     printf("</table>\n");
239     printf("</body>\n");
240     printf("</html>\n");
241
242     return;
243 }

```

Here is the caller graph for this function:





# Index

- add\_double\_circle
  - unigencircles.c, [140](#)
- add\_single\_circle
  - unigencircles.c, [142](#)
- addByte
  - hex2otf.c, [20](#)
- addTable
  - hex2otf.c, [23](#)
- ascii\_bits
  - unifontpic.h, [138](#)
- ascii\_hex
  - unifontpic.h, [138](#)
- bmp\_header
  - unibmp2hex.c, [101](#)
- Buffer, [9](#)
  - hex2otf.c, [21](#)
- buildOutline
  - hex2otf.c, [24](#)
- byCodePoint
  - hex2otf.c, [26](#)
- byTableTag
  - hex2otf.c, [27](#)
- cacheBuffer
  - hex2otf.c, [27](#)
- cacheBytes
  - hex2otf.c, [28](#)
- cacheCFFOperand
  - hex2otf.c, [29](#)
- cacheStringAsUTF16BE
  - hex2otf.c, [30](#)
- cacheU16
  - hex2otf.c, [31](#)
- cacheU32
  - hex2otf.c, [33](#)
- cacheU8
  - hex2otf.c, [34](#)
- cacheZeros
  - hex2otf.c, [35](#)
- cleanBuffers
  - hex2otf.c, [36](#)
- color\_table
  - unibmp2hex.c, [101](#)
- ContourOp
  - hex2otf.c, [21](#)
- DEFAULT\_ID0
  - hex2otf.h, [88](#)
- defaultNames
  - hex2otf.h, [89](#)
- defineStore
  - hex2otf.c, [20](#)
- ensureBuffer
  - hex2otf.c, [36](#)
- fail
  - hex2otf.c, [37](#)
- FILL\_LEFT
  - hex2otf.c, [22](#)
- FILL\_RIGHT
  - hex2otf.c, [22](#)
- fillBitmap
  - hex2otf.c, [39](#)
- fillBlankOutline
  - hex2otf.c, [41](#)
- fillCFF
  - hex2otf.c, [43](#)
- fillCmapTable
  - hex2otf.c, [47](#)
- fillGposTable
  - hex2otf.c, [49](#)
- fillGsubTable
  - hex2otf.c, [50](#)
- fillHeadTable
  - hex2otf.c, [51](#)
- fillHheaTable
  - hex2otf.c, [53](#)
- fillHmtxTable
  - hex2otf.c, [54](#)
- fillMaxpTable
  - hex2otf.c, [55](#)
- fillNameTable
  - hex2otf.c, [57](#)
- fillOS2Table
  - hex2otf.c, [59](#)
- fillPostTable
  - hex2otf.c, [61](#)
- FillSide
  - hex2otf.c, [22](#)
- fillTrueType
  - hex2otf.c, [62](#)

- Font, [10](#)
- freeBuffer
  - hex2otf.c, [64](#)
- genlongbmp
  - unifontpic.c, [123](#)
- genwidebmp
  - unifontpic.c, [127](#)
- get\_bytes
  - unibmpbump.c, [103](#)
- gethex
  - unifontpic.c, [132](#)
- Glyph, [10](#)
  - hex2otf.c, [21](#)
  - pos, [11](#)
- HDR\_LEN
  - unifontpic.c, [123](#)
- hex
  - unihex2bmp.c, [160](#)
- hex2bit
  - unihex2bmp.c, [152](#)
- hex2otf.c
  - addByte, [20](#)
  - addTable, [23](#)
  - Buffer, [21](#)
  - buildOutline, [24](#)
  - byCodePoint, [26](#)
  - byTableTag, [27](#)
  - cacheBuffer, [27](#)
  - cacheBytes, [28](#)
  - cacheCFFOperand, [29](#)
  - cacheStringAsUTF16BE, [30](#)
  - cacheU16, [31](#)
  - cacheU32, [33](#)
  - cacheU8, [34](#)
  - cacheZeros, [35](#)
  - cleanBuffers, [36](#)
  - ContourOp, [21](#)
  - defineStore, [20](#)
  - ensureBuffer, [36](#)
  - fail, [37](#)
  - FILL\_LEFT, [22](#)
  - FILL\_RIGHT, [22](#)
  - fillBitmap, [39](#)
  - fillBlankOutline, [41](#)
  - fillCFF, [43](#)
  - fillCmapTable, [47](#)
  - fillGposTable, [49](#)
  - fillGsubTable, [50](#)
  - fillHeadTable, [51](#)
  - fillHheaTable, [53](#)
  - fillHmtxTable, [54](#)
  - fillMaxpTable, [55](#)
  - fillNameTable, [57](#)
  - fillOS2Table, [59](#)
  - fillPostTable, [61](#)
  - FillSide, [22](#)
  - fillTrueType, [62](#)
  - freeBuffer, [64](#)
  - Glyph, [21](#)
  - initBuffers, [65](#)
  - LOCA\_OFFSET16, [22](#)
  - LOCA\_OFFSET32, [22](#)
  - LocaFormat, [22](#)
  - main, [66](#)
  - matchToken, [67](#)
  - newBuffer, [68](#)
  - OP\_CLOSE, [22](#)
  - OP\_POINT, [22](#)
  - Options, [21](#)
  - organizeTables, [70](#)
  - parseOptions, [71](#)
  - positionGlyphs, [74](#)
  - prepareOffsets, [75](#)
  - prepareStringIndex, [76](#)
  - printHelp, [77](#)
  - printVersion, [78](#)
  - readCodePoint, [79](#)
  - readGlyphs, [79](#)
  - sortGlyphs, [81](#)
  - Table, [21](#)
  - writeBytes, [82](#)
  - writeFont, [83](#)
  - writeU16, [85](#)
  - writeU32, [86](#)
- hex2otf.h
  - DEFAULT\_ID0, [88](#)
  - defaultNames, [89](#)
- hexdigit
  - unifontpic.h, [138](#)
  - unihexgen.c, [165](#)
- hexprint4
  - unihexgen.c, [161](#)
- hexprint6
  - unihexgen.c, [162](#)
- init
  - unihex2bmp.c, [153](#)
- initBuffers
  - hex2otf.c, [65](#)
- LOCA\_OFFSET16
  - hex2otf.c, [22](#)
- LOCA\_OFFSET32
  - hex2otf.c, [22](#)
- LocaFormat
  - hex2otf.c, [22](#)
- main

- hex2otf.c, [66](#)
- unibdf2hex.c, [91](#)
- unibmp2hex.c, [93](#)
- unibmpbump.c, [103](#)
- unicoverage.c, [112](#)
- unidup.c, [117](#)
- unifont1per.c, [120](#)
- unifontpic.c, [134](#)
- unigencircles.c, [143](#)
- unigenwidth.c, [146](#)
- unihex2bmp.c, [156](#)
- unihexgen.c, [164](#)
- unipagecount.c, [167](#)
- matchToken
  - hex2otf.c, [67](#)
- MAXFILENAME
  - unifont1per.c, [119](#)
- MAXSTRING
  - unifont1per.c, [119](#)
- mkftable
  - unipagecount.c, [169](#)
- NamePair, [11](#)
- newBuffer
  - hex2otf.c, [68](#)
- nextrange
  - unicoverage.c, [114](#)
- OP\_CLOSE
  - hex2otf.c, [22](#)
- OP\_POINT
  - hex2otf.c, [22](#)
- Options, [12](#)
  - hex2otf.c, [21](#)
- organizeTables
  - hex2otf.c, [70](#)
- output2
  - unifontpic.c, [135](#)
- output4
  - unifontpic.c, [136](#)
- parseOptions
  - hex2otf.c, [71](#)
- PIKTO\_SIZE
  - unigenwidth.c, [146](#)
- pos
  - Glyph, [11](#)
- positionGlyphs
  - hex2otf.c, [74](#)
- prepareOffsets
  - hex2otf.c, [75](#)
- prepareStringIndex
  - hex2otf.c, [76](#)
- print\_subtotal
  - unicoverage.c, [115](#)
- printHelp
  - hex2otf.c, [77](#)
- printVersion
  - hex2otf.c, [78](#)
- readCodePoint
  - hex2otf.c, [79](#)
- readGlyphs
  - hex2otf.c, [79](#)
- regrid
  - unibmpbump.c, [109](#)
- sortGlyphs
  - hex2otf.c, [81](#)
- src/hex2otf.c, [15](#)
- src/hex2otf.h, [87](#)
- src/unibdf2hex.c, [90](#)
- src/unibmp2hex.c, [92](#)
- src/unibmpbump.c, [102](#)
- src/unicoverage.c, [111](#)
- src/unidup.c, [116](#)
- src/unifont1per.c, [118](#)
- src/unifontpic.c, [121](#)
- src/unifontpic.h, [137](#)
- src/unigencircles.c, [139](#)
- src/unigenwidth.c, [145](#)
- src/unihex2bmp.c, [150](#)
- src/unihexgen.c, [160](#)
- src/unipagecount.c, [166](#)
- Table, [13](#)
  - hex2otf.c, [21](#)
- TableRecord, [13](#)
- unibdf2hex.c
  - main, [91](#)
- unibmp2hex.c
  - bmp\_header, [101](#)
  - color\_table, [101](#)
  - main, [93](#)
  - unidigit, [101](#)
- unibmpbump.c
  - get\_bytes, [103](#)
  - main, [103](#)
  - regrid, [109](#)
- unicoverage.c
  - main, [112](#)
  - nextrange, [114](#)
  - print\_subtotal, [115](#)
- unidigit
  - unibmp2hex.c, [101](#)
- unidup.c
  - main, [117](#)
- unifont1per.c
  - main, [120](#)

- MAXFILENAME, [119](#)
- MAXSTRING, [119](#)
- unifontpic.c
  - genlongbmp, [123](#)
  - genwidebmp, [127](#)
  - gethex, [132](#)
  - HDR\_LEN, [123](#)
  - main, [134](#)
  - output2, [135](#)
  - output4, [136](#)
- unifontpic.h
  - ascii\_bits, [138](#)
  - ascii\_hex, [138](#)
  - hexdigit, [138](#)
- unigencircles.c
  - add\_double\_circle, [140](#)
  - add\_single\_circle, [142](#)
  - main, [143](#)
- unigenwidth.c
  - main, [146](#)
  - PIKTO\_SIZE, [146](#)
- unihex2bmp.c
  - hex, [160](#)
  - hex2bit, [152](#)
  - init, [153](#)
  - main, [156](#)
- unihexgen.c
  - hexdigit, [165](#)
  - hexprint4, [161](#)
  - hexprint6, [162](#)
  - main, [164](#)
- unipagecount.c
  - main, [167](#)
  - mkftable, [169](#)
- writeBytes
  - hex2otf.c, [82](#)
- writeFont
  - hex2otf.c, [83](#)
- writeU16
  - hex2otf.c, [85](#)
- writeU32
  - hex2otf.c, [86](#)