Embroidermodder

Reference Manual

The design, analysis and rationale of all Embroidermodder projects.

2.0.0-alpha4

August 2023

The Embroidermodder Team

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https://www.libembroidery.org

The Embroidermodder Team consists of all contributors to our projects at https://github.com/Embroidermodder. A copy of the contributor list is in **??** and maintained at https://www.libembroidery.org/docs/credits.

Dedicated to Jonathan Grieg

Open source software is made by people who care about good tools and other people.

You gave us so many ideas worth saving and we'll be working on, and sharing, your creations for some time.

Rock on!

Contents

Credits for Embroidermodder 2, libembroidery and all other related code

Please note that this file in not in alphabetical order. If you have contributed and wish to be added to this list, create a new credit bullet. Fill it in with your information and submit it to us. Supply your: your full name or pseudonym and GitHub handle, if available.

Kinds of contribution:

- Documentation - for changes to README files, manuals or help files.
- Artwork - for artwork other than designs.
- Bug Fixes - for small patches of a few lines.
- Translation - for large patches to the translation files.
- Designs - for an embroidery design sample or parametrized design as a toml file.
- Bindings - for programming language bindings for libembroidery.
- Commands - for Embroidermodder 2's in-built terminal.

finally there's "Core Developer" which is reserved for long term contributors.

Contributors

- Jonathan Greig (GitHub `redteam316`): Core Developer, Artwork, Documentation, Designs, Commands
- Josh Varga (GitHub `JoshVarga`): Core Developer
- Jens Diemer (GitHub `jedie`): Documentation
- Kim Howard (GitHub `turbokim`): BugFixes
- Martin Schneider (GitHub `craftoid`): Documentation
- Edward Greig (GitHub `Metallicow`): Artwork, Bug Fixes
- Sonia Entzinger: Translation
- SushiTee (GitHub `SushiTee`): Bug Fixes
- Vathonie Lufh (GitHub `x2nie`): Bug Fixes, Bindings
- Nina Paley: Designs
- Theodore Gray: Designs
- Jens-Wolfhard Schicke-Uffmann (GitHub `Drahflow`): Bug Fixes
- Robin Swift: (GitHub `robin-swift`) Core Developer, Documentation

Chapter 1

Introduction

1.1 The Embroidermodder Project and Team

The *Embroidermodder 2* project is a collection of small software utilities for manipulating, converting and creating embroidery files in all major embroidery machine formats. The program *Embroidermodder 2* itself is a larger graphical user interface (GUI) which is at the heart of the project.

The tools and associated documents are:

- The website `https://www.libembroidery.org`
- This reference manual covering the development of all these projects with the current version available here: `https://www.libembroidery.org/embroidermodder_2.0_manual.pdf`
- The GUI *Embroidermodder 2* covered in Chapter **??**.
- The core library of low-level functions: 'libembroidery', covered in Chapter **??**
- The CLI 'embroider', which is part of libembroidery
- Mobile embroidery format viewers and tools convered in Chapter **??**.
- Specs for an open source hardware embroidery machine extension called the Portable Embroidery Tool (PET) which is also part of libembroidery. See Chapter **??**.

The website, this manual and some scripts to construct the distribution are maintained in [Team, 2022–2023].

They all tools to make the standard user experience of working with an embroidery machine better without expensive software which is locked to specific manufacturers and formats. But ultimately we hope that the core *Embroidermodder 2* is a practical, ever-present tool in larger workshops, small cottage industry workshops and personal hobbyist's bedrooms.

Embroidermodder 2 is licensed under the zlib license and we aim to keep all of our tools open source and free of charge. If you would like to support the project check out our Open Collective (`https://opencollective.com/embroidermodder`) group. If you would like to help, please join us on GitHub. This document is written as developer training as well helping new users (see the last sections) so this is the place to learn how to start changing the code.

The Embroidermodder Team is the collection of people who've submitted patches, artwork and documentation to our three projects. The team was established by Jonathan Greig and Josh Varga. The full list is actively maintained below.

1.1.1 Core Development Team

Embroidermodder 2:

- Jonathan Greig (https://github.com/redteam316)
- Josh Varga (https://github.com/JoshVarga)
- Robin Swift (https://github.com/robin-swift)

Embroidermodder 1:

- Josh Varga (https://github.com/JoshVarga)
- Mark Pontius (http://sourceforge.net/u/mpontius/profile)

1.2 Credits for Embroidermodder 2, libembroidery and all other related code

If you have contributed and wish to be added to this list, alter the README on Embroidermodder github page (https://github.com/Embroidermodder/Embroidermodder) and we'll copy it to the libembroidery source code since that is credited to "The Embroidermodder Team".

1.3 Embroidermodder 1

The Embroidermodder Team is also inspired by the original Embroidermodder that was built by Mark Pontius and the same Josh Varga on SourceForge which unfortunately appears to have died from linkrot. We may create a distribution on here to be the official "legacy" Embroidermodder code but likely in a seperate repository because it's GNU GPL v3 and this code is written to be zlib (that is, permissive licensed) all the way down.

One reason why this is useful is that the rewrite by Jonathan Greig, John Varga and Robin Swift for Embroidermodder 2 should have no regressions: no features present in v1 should be missing in v2.

1.4 Features

Embroidermodder 2 has many advanced features that enable you to create awesome designs quicker, tweak existing designs to perfection, and can be fully customized to fit your workflow.

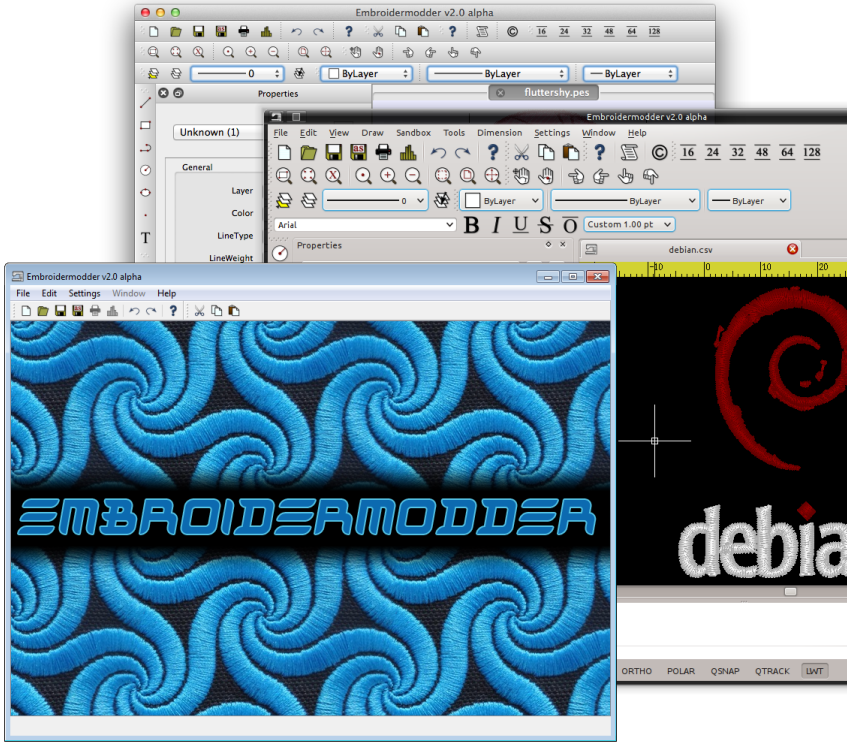
A summary of these features:

- Cross Platform
- Realistic rendering
- Various grid types and auto-adjusting rulers
- Many measurement tools
- Add text to any design
- Supports many formats
- Batch Conversion
- Scripting API

1.4.1 Cross Platform

If you use multiple operating systems, it's important to choose software that works on all of them.

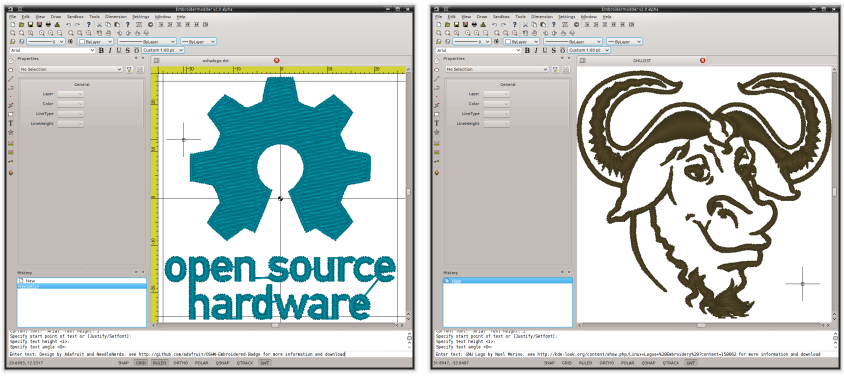
Embroidermodder 2 runs on Windows, Linux and Mac OS X. Let's not forget the Raspberry Pi (`https://www.raspberrypi.org`).



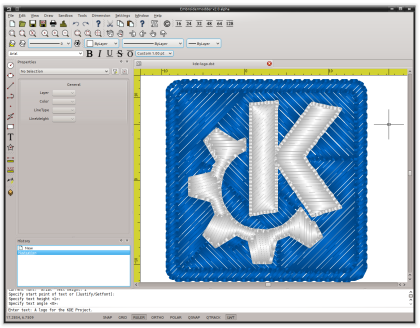
.Running on different platforms.
Running on different platforms

1.4.2 Realistic Rendering

It is important to be able to visualize what a design will look like when stitched and our pseudo "3D" realistic rendering helps achieve this (see Figure **??**).



// .Real render examples.



1.4.3 Various grid types and auto-adjusting rulers

Making use of the automatically adjusting ruler in conjunction with the grid will ensure your design is properly sized and fits within your embroidery hoop area.

Use rectangular, circular or isometric grids to construct your masterpiece!

Multiple grids and rulers in action Figure ref fig grid-ruler.

// .Grid and ruler examples. imagefeatures-grid-ruler-1.png

1.4.4 Many measurement tools

Taking measurements is a critical part of creating great designs. Whether you are designing mission critical embroidered space suits for NASA or some other far out design for your next meet-up, you will have precise measurement tools at your command to make it happen. You can locate individual points or find distances between any 2 points anywhere in the design!

Take quick and accurate measurements:

imageimages/features-measure-1.png

1.4.5 Add text to any design

Need to make company apparel for all of your employees with individual names on them? No sweat. Just simply add text to your existing design or create one from scratch, quickly and easily. Didn't get it the right size or made a typo? No problem. Just select the text and update it with the property editor.

Add text and adjust its properties quickly:

imageimages/features-text-1.png

1.4.6 Supports many formats

Embroidery machines all accept different formats. There are so many formats available that it can sometimes be confusing whether a design will work with your machine.

Embroidermodder 2 supports a wide variety of embroidery formats as well as several vector formats, such as SVG and DXF. This allows you to worry less about which designs you can use.

1.4.7 Batch Conversion

Need to send a client several different formats? Just use libembroidery-convert, our command line utility which supports batch file conversion.

There are a multitude of formats to choose from:

imageimages/features-formats-1.png[features formats

1.4.8 Scripting API

If you've got programming skills and there is a feature that isn't currently available that you absolutely cannot live without, you have the capability to create your own custom commands for Embroidermodder 2. We provide an QtScript API which exposes various application functionality so that it is possible to extend the application without requiring a new release. If you have created a command that you think is worth including in the next release, just contact us (contact.html) and we will review it for functionality, bugs, and finally inclusion.

An Embroidermodder 2 command excerpt:

```
var strList = str.split(",");
if(isNaN(strList[0]) || isNaN(strList[1]))
{
    setPromptPrefix("Point or option keyword required.");
    appendPromptHistory();
    setPromptPrefix("Specify second axis end point or [Rotation]: ");
}
else
{
    global.x3 = Number(strList[0]);
    global.y3 = Number(strList[1]);
    global.height = perpendicularDistance(global.x3, global.y3, global.x1, global.y1, global.x2, global.y2)*2.0;
    setRubberPoint("ELLIPSE_AXIS2_POINT2", global.x3, global.y3);
    vulcanize();
    endCommand();
}
```

1.5 Scraps

For Embroidermodder 2.0.0-alpha4, libembroidery 1.0.0-alpha, PET 1.0.0-alpha and EmbroideryMobile 1.0.0-alpha.

Since the document is shipped automatically try to update the revnumber each time you edit using 'revision.sh'.

Test these:

```
sudo apt install latexml texlive-latex-base imagemagick info2man

# For our command line tools:
makeinfo embroider.texi -o embroider.info
info2man embroider.info > embroider.1
texi2pdf embroider.texi
# Or groff macro package for example ms.
# These may be housed in libembroidery since they're to be shipped as part of
# the embroider tarball.

# For online documentation:
pandoc embroidermodder_refman.tex -f latex -t html -s -o emb_refman.html --bibliography embroidermodder
# Or latexml/latexmlpost
```

1.5.1 Command Language

Printer Command Language (PCL), see Packard [1992].

HP-GL/2 Vector Graphics described in Packard [1992]. Has commands like: "PU" Pen Up, "PR" Plot Relative, "EP" edge polygon.

So commands read like this:

```
PA40,10;
```

command argument seperator(,) argument terminator(;)

Constructing new commands from old ones in the command language is less natural in the HP-GL/2 language, but a similar layer for us is the tajima DST format [**?**] for existing printers and CNC commands for direct control... where'd we'd use G-Code [**?**] and Linux CNC [**?**].

Could we 'setpagedevice' to a printer in some cases and a similar CUPS service for embroidery machines in others?

All systems are supported by ghostscript, when you account for homebrew **?**:

```
brew update
brew upgrade
brew install ghostscript
brew cleanup
```

Vector graphic logos don't require the SVG Qt library.

1.5.2 Man Pages

We maintain a traditional manpage for `embroider` using the basic macros.

1.5.3 Arduino

```
apt-get install avr-libc gcc-avr uisp avrdude
```

1.6 Libembroidery

(Under construction, please wait for v1.0 release.)

Libembroidery is a low-level library for reading, writing, and altering digital embroidery files in C. It is part of the Embroidermodder Project for open source machine embroidery.

Libembroidery is the underlying library that is used by Embroidermodder 2 and is developed by The Embroidermodder Team **??**. A full list of contributors to the project is maintained in `https://github.com/Embroidermodder/embroidermodder` the Embroidermodder 2 github in the file 'CREDITS.md'. It handles over 45 different embroidery specific formats as well as several non-embroidery specific vector formats.

It also includes a CLI called 'embroider' that allows for better automation of changes to embroidery files and will be more up-to date than the Embroidermodder 2 GUI.

1.6.1 Documentation

Libembroidery is documented as part of this reference manual. If you need libembroidery for any non-trivial usage or want to contribute to the library we advise you read the appropriate design sections of the manual first. Copies of this manual will be shipped with the packaged version of libembroidery, but to build it we use the Doxyfile in `https://github.com/Embroidermodder/embroidermodder` the Embroidermodder git repository.

For more basic usage, 'embroider' should have some in-built help starting with:

```
1 $ embroider --help
```

1.6.2 License

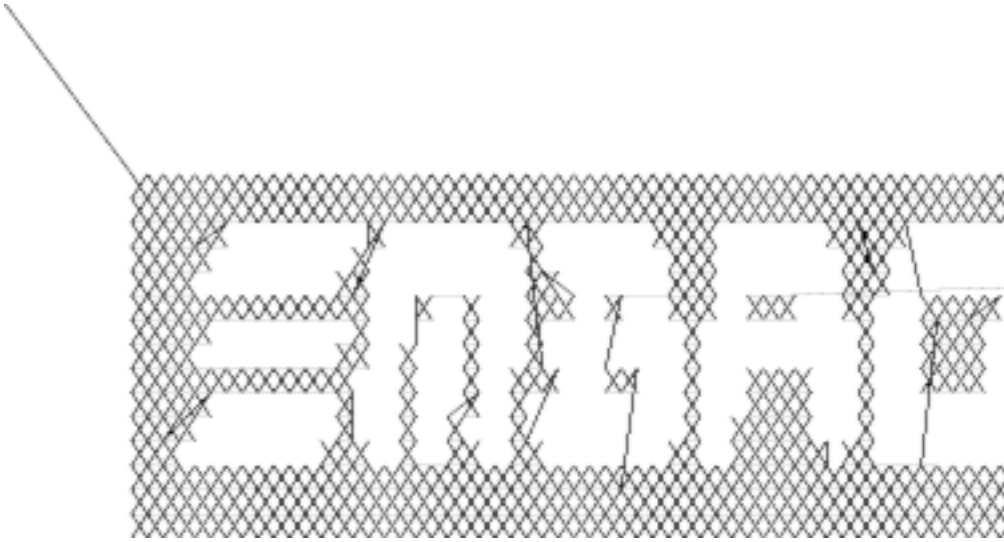
Libembroidery is distributed under the permissive zlib licence, see the LICENCE file.

1.7 Demos

We're currently trying out some fill techniques which will be demonstrated here and in the script 'qa_test.sh'.

// center and caption imageimages/examples/logo.png[the logo

Converts to:



// center and caption crossstitch logo

1.7.1 Build

libembroidery and EmbroiderModder 2 use CMake builds so if you are building the project to use as a library we recommend you run:

```
git clone https://github.com/Embroidermodder/libembroidery
cd libembroidery
cmake .
cmake --build .
cmake --install .
```

This builds both the static and shared versions of the library as well as the command line program 'embroider'.

[Packard, 1992] [Team] [various authors, 2006-2023] [Inc., 1990] [Adobe Systems Inc, 1999] [Wiki, 2019] [Inc., 1997-2007] [Inc., 2017] [Oberg, 2020] [AutoDesk, 2012] [Team, 2013–2023] [Team, 2018–2023] [acatina, c2004] [Community, 2013] [UNKNOWN, c2012] [UNKNOWN, 2018] [Studio, 2009-2021] [Wiki, 2018–2019]

1.8 Graphical User Interface for PC

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1.8.1 Overview

UNDER MAJOR RESTRUCTURING, PLEASE WAIT FOR VERSION 2

`https://www.libembroidery.org`

Embroidermodder is a free machine embroidery application. The newest version, Embroidermodder 2 can:

- edit and create embroidery designs
- estimate the amount of thread and machine time needed to stitch a design
- convert embroidery files to a variety of formats
- upscale or downscale designs
- run on Windows, Mac and Linux

Embroidermodder 2 is very much a work in progress since we're doing a ground up rewrite to an interface in C using the GUI toolkit SDL2. The reasoning for this is detailed in the issues tab.

For a more in-depth look at what we are developing read our website (`https://www.libembroidery.org`) which includes these docs as well as the up-to date printer-friendly versions. These discuss recent changes, plans and has user and developer guides for all the Embroidermodder projects.

To see what we're focussing on right now, see the Open Collective News (`https://opencollective.com/embroidermodder`).

// fixme This current printer-friendly version is here (`https://www.libembroidery.org/EM2.0.0-alpha_refman_a4.pdf`).

1.8.2 License

The source code is under the terms of the zlib license: see 'LICENSE.md' in the source code directory.

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A copy of the license is included in Section **??**.

1.8.3 Build and Install

Assuming you already have the SDL2 libraries you can proceed to using the fast build, which assumes you want to build and test locally.

The fast build should be:

```
bash build.sh
```

or, on Windows:

```
.\build.bat
```

Then run using the 'run.bat' or 'run.sh' scripts in the build/ directory.

Otherwise, follow the instructions below.

If you plan to install the dev version to your system (we recommend you wait for the official installers and beta release first) then use the CMake build instead.

1.8.4 Install on Desktop

We recommend that if you want to install the development version you use the CMake build. Like this:

```
git submodule --init --update

mkdir build
cd build
cmake ..
cmake --build .
sudo cmake --install .
```

These lines are written into the file:

```
./build_install.sh
```

On Windows use the next section.

1.9 History

Embroidermodder 1 was started by Mark Pontius in 2004 while staying up all night with his son in his first couple months. When Mark returned to his day job, he lacked the time to continue the project. Mark made the decision to focus on his family and work, and in 2005, Mark gave full control of the project to Josh Varga so that Embroidermodder could continue its growth.

Embroidermodder 2 was conceived in mid 2011 when Jonathan Greig and Josh Varga discussed the possibility of making a cross-platform version. It is currently in active development and will run on GNU/Linux, Mac OS X, Microsoft Windows and Raspberry Pi.

All Embroidermodder downloads (downloads.html) are hosted on SourceForge.

The source code for Embroidermodder 1 (`http://sourceforge.net/p/embroidermodder/code/HEAD/tree/embroidermodder1`) has always been hosted on Sourceforge.

The source code for Embroidermodder 2 (`https://github.com/Embroidermodder/Embroidermodder`) was moved to GitHub on July 18, 2013.

The website for Embroidermodder (`https://github.com/Embroidermodder/www.libembroidery.org`) was moved to GitHub on September 9, 2013.

Chapter 2

Contact us

For general questions email: embroidermodder at gmail.com (`mailto:embroidermodder@gmail.com`)

To request a new feature open an issue on the main Embroidermodder GitHub repository (`https://github.com/Embroidermodder/Embroidermodder/issues`). We'll move it to the correct repository.

Chapter 3

Downloads

3.1 Alpha Build

This is a highly experimental build: we recommend users wait for the beta release when the basic features are functional.

Visit our GitHub Releases page (https://github.com/Embroidermodder/Embroidermodder/releases for the current build. Unfortunately, earlier builds went down with the Sourceforge page we hosted them on.

Chapter 4

GUI

Embroidermodder 2 is very much a work in progress since we're doing a ground up rewrite to an interface in Python using the GUI toolkit Tk. The reasoning for this is detailed in the issues tab.

For a more in-depth look at what we are developing read the developer notes (link to dev notes section). This discusses recent changes in a less formal way than a changelog (since this software is in development) and covers what we are about to try.

4.1 Documentation

The documentation is in the form of the website (included in the 'docs/' directory) and the printed docs in this file.

4.1.1 Development

If you wish to develop with us you can chat via the contact email on the website (`https://www.libembroidery.org`) or in the issues tab on the github page (`https://github.com/Embroidermodder/Embroidermodder/issues`). People have been polite and friendly in these conversations and I (Robin) have really enjoyed them. If we do have any arguments please note we have a Code of Conduct ('CODE_OF_CONDUCT.md') so there is a consistent policy to enforce when dealing with these arguments.

The first thing you should try is building from source using the build advice(link to build) above. Then read some of the development notes (link to dev notes.md) to get the general layout of the source code and what we are currently planning.

4.1.2 Testing

To find unfixed errors run the tests by launching from the command line with:

```
1 $ embroidermodder --test
```

then dig through the output. It's currently not worth reporting the errors, since there are so many but if you can fix anything reported here you can submit a PR.

4.2 Code Optimisations and Simplifications

4.2.1 Geometry

The geometry is stored, processed and altered via libembroidery. See the Python specific part of the documentation for libembroidery for this. What the code in Embroidermodder does is make the GUI widgets to change and view this information graphically.

For example if we create a circle with radius 10mm and center at '(20mm, 30mm)' then fill it with stitches the commands would be

```
1 from libembroidery import Pattern, Circle, Vector, satin
2 circle = Circle(Vector(20, 30), 10)
3 pattern = Pattern()
4 pattern.add_circle(circle, fill=satin)
5 pattern.to_stitches()
```

but the user would do this through a series of GUI actions:

1. Create new file
2. Click add circle
3. Use the Settings dialog to alter the radius and center
4. Use the fill tool on circle
5. Select satin from the drop down menu

So EM2 does the job of bridging that gap.

4.2.2 Postscript Support

In order to safely support user contributed/shared data that can define, for example, double to double functions we need a consistent processor for these descriptions.

Embroidermodder backends to the postscript interpreter included in libembroidery to accomplish this.

For example the string: '5 2 t mul add' is equivalent to the expression $2 * t + 5$.

The benefit of not allowing this to simply be a Python expression is that it is safe against malicious use, or accidental misuse. The program can identify whether the output is of the appropriate form and give finitely many calculations before declaring the function to have run too long (stopping equations that hang).

To see examples of this see the `assets/shapes/*.ps` files.

4.2.3 SVG Icons

To make the images easier to alter and restyle we could switch to svg icons. There's some code in the git history to help with this.

4.2.4 The Actions System

In order to simplify the development of a GUI that is flexible and easy to understand to new developers we have a custom action system that all user actions will go via an `actuator` that takes a string argument. By using a string argument the undo history is just an array of strings.

The C `action_hash_data` struct will contain: the icon used, the labels for the menus and tooltips and the function pointer for that action. There will be an accompanying argument for this function call, currently being drafted as 'action_call'. So when the user makes a function call it should contain information like the mouse position, whether special key is pressed etc.

4.2.5 Accessibility

Software can be more or less friendly to people with dyslexia, partial sightedness, reduced mobility and those who don't speak English. Embroidermodder 2 has, in its design, the following features to help:

- icons for everything to reduce the amount of reading required
- the system font is configurable: if you have a dyslexia-friendly font you can load it
- the interface rescales to help with partial-sightedness
- the system language is configurable, unfortunately the docs will only be in English but we can try to supply lots of images of the interface to make it easier to understand as a second language
- buttons are remappable: XBox controllers are known for being good for people with reduced mobility so remapping the buttons to whatever setup you have should help

Note that most of these features will be released with version 2.1, which is planned for around early 2023.

4.2.6 Sample Files

Various sample embroidery design files can be found in the 'embroidermodder2/samples' folder.

4.2.7 Shortcuts

A shortcut can be made up of zero or more modifier keys and at least one non-modifier key pressed at once.

To make this list quickly assessable, we can produce a list of hashes which are simply the flags ORed together.

The shortcuts are stored in the csv file 'shortcuts.csv' as a 5-column table with the first 4 columns describing the key combination. This is loaded into the shortcuts 'TABLE'. Each tick the program checks the input state for this combination by first translating the key names into indices for the key state, then checking for whether all of them are set to true.

4.2.8 Removed Elements

So I've had a few pieces of web infrastructure fail me recently and I think it's worth noting. An issue that affects us is an issue that can effect people who use our software.

4.2.9 Qt and dependencies

Downloading and installing Qt has been a pain for some users (46Gb on possibly slow connections).

I'm switching to FreeGLUT 3 (which is a whole other conversation) which means we can ship it with the source code package meaning only a basic build environment is necessary to build it.

4.2.10 Social Platform

Github is giving me a server offline (500) error and is still giving a bad ping.

So... all the issues and project boards etc. being on Github is all well and good assuming that we have our own copies. But we don't if Github goes down or some other major player takes over the space and we have to move (again, since this started on SourceForge).

This file is a backup for that which is why I'm repeating myself between them.

4.2.11 OpenGL

OpenGL rendering within the application. This will allow for Realistic Visualization - Bump Mapping/OpenGL/Gradients?

This should backend to a C renderer or something.

4.2.12 Configuration Data Ideas

Embroidermodder should boot from the command line regardless of whether it is or is not installed (this helps with testing and running on machines without root). Therefore, it can create an initiation file but it won't rely on its existence to boot: ‘ /.embroidermodder/config.json‘.

- Switch colors to be stored as 6 digit hexcodes with a ‘#‘.
- We've got close to a hand implemented ini read/write setup in ‘settings.py‘.

4.2.13 Distribution

When we release the new pip wheel we should also package:

- ‘.tar.gz‘ and ‘.zip‘ source archive.
- Debian package
- RPM package

Only do this once per minor version number.

- todo Screenshot a working draft to demonstrate.

4.2.14 Perennial Jobs

- Check for memory leaks
- Clear compiler warnings on ‘-Wall -ansi -pedantic‘ for C.
- Write new tests for new code.
- Get Embroidermodder onto the current version of libembroidery.
- PEP7 compliance.
- Better documentation with more photos/screencaps.

4.2.15 Full Test Suite

(This needs a hook from Embroidermodder to embroider's full test suite.)

The flag ‘–full-test-suite‘ runs all the tests that have been written. Since this results in a lot of output the details are both to stdout and to a text file called ‘test_matrix.txt‘.

Patches that strictly improve the results in the ‘test_matrix.txt‘ over the current version will likely be accepted and it'll be a good place to go digging for contributions. (Note: strictly improve means that the testing result for each test is as good a result, if not better. Sacrificing one critera for another would require some design work before we would consider it.)

4.2.16 Symbols

Symbols use the SVG path syntax.

In theory, we could combine the icons and symbols systems, since they could be rendered once and stored as icons in Qt. (Or as textures in FreeGLUT.)

Also we want to render the patterns themselves using SVG syntax, so it would save on repeated work overall.

4.3 Features

4.3.1 Bindings

Bindings for libembroidery are maintained for the languages we use internally in the project, for other languages we consider that the responsibility of other teams using the library.

So libembroidery is going to be supported on:

- ‘C‘ (by default)
- ‘C++‘ (also by default)
- ‘Java‘ (for the Android application MobileViewer)
- ‘Swift‘ (for the iOS application iMobileViewer)

For ‘C#‘ we recommend directly calling the function directly using the DllImport feature:

```
1 /* Calling readCsv() via C# as a native function. */
2 [DllImport("libembroidery.so", EntryPoint="readCsv")]
```

see this StackOverflow discussion for help: https://stackoverflow.com/questions/11425202/is-it-possible-to-call-a-c-function-from-c-net.

For Python you can do the same using ctypes: https://www.geeksforgeeks.org/how-to-call-a-c-function-in-python/.

4.3.2 Other Supported Thread Brands

The thread lists that aren't preprogrammed into formats but are indexed in the data file for the purpose of conversion or fitting to images/graphics.

- Arc Polyester
- Arc Rayon
- Coats and Clark Rayon
- Exquisite Polyester
- Fufu Polyester
- Fufu Rayon
- Hemingworth Polyester
- Isacord Polyester
- Isafil Rayon
- Marathon Polyester
- Marathon Rayon
- Madeira Polyester
- Madeira Rayon
- Metro Polyester
- Pantone
- Robison Anton Polyester
- Robison Anton Rayon
- Sigma Polyester
- Sulky Rayon
- ThreadArt Rayon
- ThreadArt Polyester
- ThreaDelight Polyester
- Z102 Isacord Polyester

4.4 House Style

These are rules for the general intended style of Embroidermodder's GUI source code. Not included are anything that a compiler will warn you about: fixing compiler warnings is more important than fixing style.

Most of this section is rationale, so skip to the end for the summary.

NEW DEVELOPERS: if your patch to Embroidermodder doesn't follow these rules, don't worry about it. We only ask that your source code follow the basic rules in the developer training section. These rules are for sculpting Embroidermodder into a body of code that is resiliant to future bugs and reliable for users.

4.4.1 Brevity

Readable source code is short. Developers have finite time and becoming acquainted with more than 1000 lines of dense C code is often too high a bar for a new developer to a project. However, this leads to a bunch of tradeoffs that have caused issues, so instead we consider the "minimal library" rather than "minimal code" approach. Not everyone will have used the more abstract, syntactic features of C++ like templates and operator overloading. Even if they are capable developers with these features it makes debugging far harder since the choice of called function is interpreted by the compiler and compiler errors are hundred line monsters per infraction of "these are all of the possible variations of this function that don't match".

Using C++'s 'unordered_map' can simplify source code in that anything can map to anything. However, it also means we don't have to associate related structures. For example the 'action_table' came together replacing a collection of unordered maps with one, then replaced the mapping with labelled indices. Since the 'actuator_core' is a giant switch/case statement this cuts the step of identifying the action by its label 'std::string'. The structure given by this table allowed the code to be much easier to interpret. So for this reason we don't recommend the use unordered maps or hashes any more.

4.4.2 Rigidity Vs. Ease of Modification

Difficult to restructure code is good if the structure that's there is good. It guides new developers into safe practices without having to explain them. Therefore we want ease of modification that comes from well chosen 'structs' and a carefully curated global header of .

4.4.3 Developer Prose

4.4.4 Macro Policy

Macros are great, you can do all sorts with them. But it's easy to make readable short code that is really difficult to safely modify.

4.4.5 Function Style

1. Don't write a new convenience function unless there are two existing applications of it in the source code.

2.

4.4.6 Summary

•

4.5 GUI Design

Embroidermodder 2 was written in C++/Qt5 and it was far too complex. We had issues with people not able to build from source because the Qt5 libraries were so ungainly. So I decided to do a rewrite in C/SDL2 (originally FreeGLUT, but that was a mistake) with data stored as YAML. This means linking 4-7 libraries depending on your system which are all well supported and widely available.

This is going well, although it's slow progress as I'm trying to keep track of the design while also doing a ground up rewrite. I don't want to throw away good ideas. Since I also write code for libembroidery my time is divided.

Overview of the UI rewrite

(Problems to be solved in brackets.)

It's not much to look at because I'm trying to avoid using an external widgets system, which in turn means writing things like toolbars and menubars over. If you want to get the design the actuator is the heart of it.

Without Qt5 we need a way of assigning signals with actions, so this is what I've got: the user interacts with a UI element, this sends an integer to the actuator that does the thing using the current state of the mainwindow struct of which we expect there to be exactly one instance. The action is taken out by a jump table that calls the right function (most of which are missing in action and not connected up properly). It also logs the number, along with key parts of the main struct in the undo history (an unsolved problem because we need to decide how much data to copy over per action). This means undo, redo and repeat actions can refer to this data.

4.6 To Do

These should be sorted into relevant code sections.

- todo sort todo list.
- Alpha: High priority
  - Statistics from 1.0, needs histogram
  - Saving DST/PES/JEF (varga)
  - Saving CSV/SVG (rt) + CSV read/write UNKNOWN interpreted as COLOR bug
- Alpha: medium priority
  - Notify user of data loss if not saving to an object format.
  - Import Raster Image
  - SNAP/ORTHO/POLAR
  - Layer Manager + LayerSwitcher DockWidget
  - Reading DXF
- Alpha: low priority
  - Writing DXF

  - Up and Down keys cycle thru commands in the command prompt
  - Amount of Thread, Machine Time Estimation (also allow customizable times for setup, color changes, manually trimming jump threads, etc...that way a realistic total time can be estimated)
  - Otto Theme Icons - whatsthis icon doesn't scale well, needs redone
  - embroidermodder2.ico 16 x 16 looks horrible
- Alpha: lower priority
  - CAD Command: Arc (rt)
- beta
  - Custom Filter Bug - doesn't save changes in some cases
  - Cannot open file with '#' in name when opening multiple files (works fine when opening the single file)
  - Closing Settings Dialog with the X in the window saves settings rather than discards them
  - Advanced Printing
  - Filling Algorithms (varga)
  - Otto Theme Icons - beta (rt) - Units, Render, Selectors
- Finish before 2.0 release
  - QDoc Comments
  - Review KDE4 Thumbnailer
  - Documentation for libembroidery and formats
  - HTML Help files
  - Update language translations
  - CAD Command review: line
  - CAD Command review: circle
  - CAD Command review: rectangle
  - CAD Command review: polygon
  - CAD Command review: polyline
  - CAD Command review: point
  - CAD Command review: ellipse
  - CAD Command review: arc
  - CAD Command review: distance
  - CAD Command review: locatepoint
  - CAD Command review: move
  - CAD Command review: rgb
  - CAD Command review: rotate
  - CAD Command review: scale
  - CAD Command review: singlelinetext
  - CAD Command review: star
  - Clean up all compiler warning messages, right now theres plenty :P

- 2.0
  - tar.gz archive
  - zip archive
  - Debian Package (rt)
  - NSIS Installer (rt)
  - Mac Bundle?
  - press release
- 2.x/Ideas
  - libembroidery.mk for MXE project (refer to qt submodule packages for qmake based building. Also refer to plibc.mk for example of how write an update macro for github.)
  - libembroidery safeguard for all writers - check if the last stitch is an END stitch. If not, add an end stitch in the writer and modify the header data if necessary.
  - Cut/Copy - Allow Post-selection
  - CAD Command: Array
  - CAD Command: Offset
  - CAD Command: Extend
  - CAD Command: Trim
  - CAD Command: BreakAtPoint
  - CAD Command: Break2Points
  - CAD Command: Fillet
  - CAD Command: Chamfer
  - CAD Command: Split
  - CAD Command: Area
  - CAD Command: Time
  - CAD Command: PickAdd
  - CAD Command: Product
  - CAD Command: Program
  - CAD Command: ZoomFactor
  - CAD Command: GripHot
  - CAD Command: GripColor and GripCool
  - CAD Command: GripSize
  - CAD Command: Highlight
  - CAD Command: Units
  - CAD Command: Grid
  - CAD Command: Find
  - CAD Command: Divide
  - CAD Command: ZoomWindow (Move out of view.cpp)
  - Command: Web (Generates Spiderweb patterns)
  - Command: Guilloche (Generates Guilloche patterns)

  - Command: Celtic Knots
  - Command: Knotted Wreath
  - Lego Mindstorms NXT/EV3 ports and/or commands.
  - native function that flashes the command prompt to get users attention when using the prompt is required for a command.
  - libembroidery-composer like app that combines multiple files into one.
  - Settings Dialog, it would be nice to have it notify you when switching tabs that a setting has been changed. Adding an Apply button is what would make sense for this to happen.
  - Keyboard Zooming/Panning
  - G-Code format?
  - 3D Raised Embroidery
  - Gradient Filling Algorithms
  - Stitching Simulation
  - RPM packages?
  - Reports?
  - Record and Playback Commands
  - Settings option for reversing zoom scrolling direction
  - Qt GUI for libembroidery-convert
  - EPS format? Look at using Ghostscript as an optional add-on to libembroidery...
  - optional compile option for including LGPL/GPL libs etc... with warning to user about license requirements.
  - Realistic Visualization - Bump Mapping/OpenGL/Gradients?
  - Stippling Fill
  - User Designed Custom Fill
  - Honeycomb Fill
  - Hilbert Curve Fill
  - Sierpinski Triangle fill
  - Circle Grid Fill
  - Spiral Fill
  - Offset Fill
  - Brick Fill
  - Trim jumps over a certain length.
  - FAQ about setting high number of jumps for more controlled trimming.
  - Minimum stitch length option. (Many machines also have this option too)
  - Add 'Design Details' functionality to libembroidery-convert
  - Add 'Batch convert many to one format' functionality to libembroidery-convert
  - EmbroideryFLOSS - Color picker that displays catalog numbers and names.
- beta

- Realistic Visualization - Bump Mapping/OpenGL/Gradients?
- Get undo history widget back (BUG).
- Mac Bundle, .tar.gz and .zip source archive.
- NSIS installer for Windows, Debian package, RPM package
- GUI frontend for embroider features that aren't supported by embroidermodder: flag selector from a table
- Update all formats without color to check for edr or rgb files.
- Setting for reverse scrolling direction (for zoom, vertical pan)
- Keyboard zooming, panning
- New embroidermodder2.ico 16x16 logo that looks good at that scale.
- Saving dst, pes, jef.
- Settings dialog: notify when the user is switching tabs that the setting has been changed, adding apply button is what would make sense for this to happen.
- Update language translations.
- Replace KDE4 thumbnailer.
- Import raster image.
- Statistics from 1.0, needs histogram.
- SNAP/ORTHO/POLAR.
- Cut/copy allow post-selection.
- Layout into config.
- Notify user of data loss if not saving to an object format.
- Add which formats to work with to preferences.
- Cannot open file with '#' in the name when opening multiple files but works with opening a single file.
- Closing settings dialog with the X in the window saves settings rather than discarding them.
- Otto theme icons: units, render, selectors, what's this icon doesn't scale.
- Layer manager and Layer switcher dock widget.
- Test that all formats read data in correct scale (format details should match other programs).
- Custom filter bug – doesn't save changes in some cases.
- Tools to find common problems in the source code and suggest fixes to the developers. For example, a translation miss: that is, for any language other than English a missing entry in the translation table should supply a clear warning to developers.
- Converting Qt C++ version to native GUI C throughout.
- OpenGL Rendering: 'Real' rendering to see what the embroidery looks like, Icons and toolbars, Menu bar.
- Libembroidery interfacing: get all classes to use the proper libembroidery types within them. So 'Ellipse' has 'EmbEllipse' as public data within it.
- Move calculations of rotation and scaling into 'EmbVector' calls.

- GUI frontend for embroider features that aren't supported by embroidermodder: flag selector from a table
- Update all formats without color to check for edr or rgb files.
- Setting for reverse scrolling direction (for zoom, vertical pan)
- Keyboard zooming, panning
- Better integrated help: I don't think the help should backend to a html file somewhere on the user's system. A better system would be a custom widget within the program that's searchable.
- New embroidermodder2.ico 16x16 logo that looks good at that scale.
- Settings dialog: notify when the user is switching tabs that the setting has been changed, adding apply button is what would make sense for this to happen.

4.7 Contributing

4.7.1 Version Control

Being an open source project, developers can grab the latest code at any time and attempt to build it themselves. We try our best to ensure that it will build smoothly at any time, although occasionally we do break the build. In these instances, please provide a patch, pull request which fixes the issue or open an issue and notify us of the problem, as we may not be aware of it and we can build fine.

Try to group commits based on what they are related to: features/bugs/comments/graphics/commands/etc...

See the coding style here (coding-style).

4.7.2 Get the Development Build going

When we switch to releases we recommend using them, unless you're reporting a bug in which case you can check the development build for whether it has been patched. If this applies to you, the current development build is https://github.com/Embroidermodder

4.7.3 To Do

- Beta
  - Libembroidery 1.0.
  - Better integrated help: I don't think the help should backend to a html file somewhere on the user's system. A better system would be a custom widget within the program that's searchable.
  - EmbroideryFLOSS - Color picker that displays catalog numbers and names.
  - Custom filter bug – doesn't save changes in some cases.
  - Advanced printing.
  - Stitching simulation.
- 2.x/ideas
  - User designed custom fill.

These are key bits of reasoning behind why the GUI is built the way it is.

4.8 Translation of the user interface

In a given table the left column is the default symbol and the right string is the translation. If the translate function fails to find a translation it returns the default symbol.

So in US English it is an empty table, but in UK English only the dialectical differences are present.

Ideally, we should support at least the 6 languages spoken at the UN. Quoting `https://www.un.org`

> *There are six official languages of the UN. These are Arabic, Chinese, English, French, Russian and Spanish.*

We're adding Hindi, on the grounds that it is one of the most commonly spoken languages and at least one of the Indian languages should be present.

Written Chinese is generally supported as two different symbol sets and we follow that convension.

English is supported as two dialects to ensure that the development team is aware of what those differences are. The code base is written by a mixture of US and UK native English speakers meaning that only the variable names are consistently one dialect: US English. As for documentation: it is whatever dialect the writer prefers (but they should maintain consistency within a text block like this one).

Finally, we have "default", which is the dominant language of the internals of the software. Practically, this is just US English, but in terms of programming history this is the "C locale".

4.9 Old action system notes

Action: the basic system to encode all user input.

This typedef gives structure to the data associated with each action which, in the code, is referred to by the action id (an int from the define table above).

4.10 DESCRIPTION OF STRUCT CONTENTS

4.10.1 label

The action label is always in US English, lowercase, seperated with hyphens.

For example: `new-file`.

4.11 Flags

The bit based flags all collected into a 32-bit integer.

cols="1,6",title="Flags of EM actions"

bit(s)	description
0	User (0) or system (1) permissions.
1-3	The mode of input.
4-8	The object classes that this action can be applied to.
9-10	What menu (if any) should it be present in.
11-12	What

4.12 Description

The string placed in the tooltip describing the action.

4.13 Original Prompt System

NOTE: ‘main()‘ is run every time the command is started. Use it to reset variables so they are ready to go.

NOTE: ‘click()‘ is run only for left clicks. Middle clicks are used for panning. Right clicks bring up the context menu.

NOTE: ‘move()‘ is optional. It is run only after ‘enableMoveRapidFire()‘ is called. It will be called every time the mouse moves until ‘disableMoveRapidFire()‘ is called.

NOTE: ‘prompt()‘ is run when Enter is pressed. ‘appendPromptHistory‘ is automatically called before ‘prompt()‘ is called so calling it is only needed for erroneous input. Any text in the command prompt is sent as an uppercase string.

4.14 CAD command review

ID
0
1
|2 | |filename string |Save the current loaded EmbPattern to the supplied filname 'fn
|3
|4 | |mouse co-ords |Adds a circle to the design based on the supplied numbers, con
|5 | |mouse co-ords |Shifts the selected objects by the amount given by the mouse co
6
7
8
9
10
11
12
13
14
15
16
17
16
17
18	
19	
20	
21	
cols="1,1,1,6"	22	
23	
24	
25	
26	
27	
28	
29	
30	
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45		
46

4.15 Actions

4.15.1 ARC

4.15.2 CIRCLE

4.15.3 OPEN

4.16 Changelog

4.17 Ideas

Stuff that is now supposed to be generated by Doxygen:

- todo: Bibliography style to plainnat.
- todo: US letter paper version of printed docs.

Chapter 5

Formats

5.1 Overview

Read/Write Support Levels

The table of read/write format support levels uses the status levels described here:

	Status Label	*Description*
	‘rw-none‘	Either the format produces no output, rep
	‘rw-poor‘	A file somewhat similar to our examples is
.Read/Write Support Levels cols="1,8"	‘rw-basic‘	Simple files in this format run well on mac
	‘rw-standard‘	Files with non-standard features work on r
	‘rw-reliable‘	All known features don’t cause crashes. Al
	‘rw-complete‘	All known features of the format work on r

These can be split into ‘r-basic w-none‘, for example, if they don’t match.

So all formats can, in principle, have good read and good write support, because it’s defined in relation to files that we have described the formats for.

Test Support Levels

	Status Label
	‘test-none‘
cols="1,8"	‘test-basic‘
	‘test-thorough‘ | All features of that format has at least one test.
	‘test-fuzz‘ Can test the format for uses of features that we haven’t thought of by feeding in
	‘test-complete‘

So all formats can, in principle, have complete testing support, because it’s defined in relation to files that we have described the formats for.

Documentation Support Levels

Status Label	**Description**
‘doc-none‘	We haven’t researched this beyond finding example files.
‘doc-basic‘	We have a rough sketch of the size and contents of the header if there is one. We kn
‘doc-standard‘	We know some good sources and/or have tested all the features that appear to exist
‘doc-good‘	All features that were described somewhere have been covered here or we have thorc
‘doc-complete‘	There is a known official description and our description covers all the same feature

Not all formats can have complete documentation because it’s based on what information is publically available. So the total score is reported in the table below based on what level we think is available.

Overall Support

Since the overall support level is the combination of these 4 factors, but rather than summing up their values it's an issue of the minimum support of the 4.

Status Label	Description
'read-only'	If write support is none and read support is not none.
'write-only'	If read support is none and write support is not none.
'unstable'	If both read and write support are not none but testing or documentation is none
'basic'	If all ratings are better than none.
'reliable'	If all ratings are better than basic.
'complete'	If all ratings could not reasonably be better (for example any improvements rely o
'experimental'	For all other scenarios.

5.2 Table of Format Support Levels

Overview of documentation support by format.

cols="1,1,1"

Format		
Embroidery Format (.100')	rw-basic doc-none test-none	unstable
Embroidery Format (.10o')	rw-basic doc-none test-none	unstable
Embroidery Format ('.art')	rw-none doc-none test-none	experimental
Embroidery Format ('.bmc')	r-basic w-none doc-none test-none	unstable
Embroidery Format ('.bro')	rw-none doc-none test-none	experimental
Melco Embroidery Format ('.cnd')	rw-none doc-none test-none	experimental
Embroidery Thread Color Format ('.col')	rw-basic doc-none test-none	'experimer
Singer Embroidery Format ('.csd')	rw-none doc-none test-none	experimental
Comma Separated Values ('.csv')	rw-none doc-none test-none	experimental
Barudan Embroidery Format ('.dat')	rw-none doc-none test-none	experimental
Melco Embroidery Format (.dem)	rw-none doc-none test-none	experimental | B

- TODO Josh, Review this section and move any info still valid or needing work into TODO comments in the actual libembroidery code. Many items in this list are out of date and do not reflect the current status of libembroidery. When finished, delete this file.
  - Test that all formats read data in correct scale (format details should match other programs)
  - Add which formats to work with to preferences.
  - Check for memory leaks
  - Update all formats without color to check for edr or rgb files
  - Fix issues with DST (VERY important that DST work well)
- todo Support for Singer FHE, CHE (Compucon) formats?

Chapter 6

Geometry and Algorithms

6.1 To Do

Arduino

- Fix emb-outline files
- Fix thread-color files
- Logging of Last Stitch Location to External USB Storage(commonly available and easily replaced) ...wait until TRE is available to avoid rework
- inotool.org - seems like the logical solution for Nightly/CI builds
- Smoothieboard experiments

Testing

- looping test that reads 10 times while running valgrind. See 'embPattern_loadExternalColorFile()' Arduino leak note for more info.

Development

If you wish to develop with us you can chat via the contact email on the website `https://libembroidery.org` or in the issues tab on the github page `https://github.com/Embroidermodder/Embroidermodder/issues`. People have been polite and friendly in these conversations and I (Robin) have really enjoyed them. If we do have any arguments please note we have a Code of Conduct CODE_OF_CONDUCT.md so there is a consistent policy to enforce when dealing with these arguments.

The first thing you should try is building from source using the build advice (build) above. Then read some of the manual `https://libembroidery.org/emrm_alpha_a4.pdf` to get the general layout of the source code and what we are currently planning.

Testing

To find unfixed errors run the tests by launching from the command line with:

```
$ embroidermodder --test
```

then dig through the output. It's currently not worth reporting the errors, since there are so many but if you can fix anything reported here you can submit a PR.

6.2 Contributing

Funding

The easiest way to help is to fund development (see the Donate button above), since we can't afford to spend a lot of time developing and only have limited kit to test out libembroidery on.

Programming and Engineering

Should you want to get into the code itself:

- Low level C developers are be needed for the base library `libembroidery`.
- Low level assembly programmers are needed for translating some of `libembroidery` to `EmbroiderBot`.
- Hardware Engineers to help design our own kitbashed embroidery machine `EmbroiderBot`, one of the original project aims in 2013.
- Scheme developers and C/SDL developers to help build the GUI.
- Scheme developers to help add designs for generating of custom stitch-filled emblems like the heart or dolphi. Note that this happens in Embroidermodder not libembroidery (which assumes that you already have a function available).

Writing

We also need people familiar with the software and the general machine embroidery ecosystem to contribute to the documentation (https://github.com/Embroidermodder/www.libem

We need researchers to find references for the documentation: colour tables, machine specifications etc. The history is murky and often very poorly maintained so if you know anything from working in the industry that you can share: it'd be appreciated!

6.3 Embroidermodder Project Coding Standards

A basic set of guidelines to use when submitting code.

Code structure is mre important than style, so first we advise you read "Design" and experimenting before getting into the specifics of code style.

Where Code Goes

Anything that deals with the specifics of embroidery file formats, threads, rendering to images, embroidery machinery or command line interfaces should go in 'libembroidery' not here.

Where Non-compiled Files Go

TODO: Like most user interfaces Embroidermodder is mostly data, so here we will have a list describing where each CSV goes.

Ways in which we break style on purpose

Most style guides advise you to keep functions short. We make a few pointed exceptions to this where the overall health and functionality of the source code should benefit.

The 'actuator' function will always be a mess and it should be: we're keeping the total source lines of code down by encoding all user action into a descrete sequence of strings that are all below `_STRING_LENGTH` in length. See the section on the actuator (TODO) describing why any other solution we could think here would mean more more code without a payoff in speed of execution or clarity.

6.4 Version Control

Being an open source project, developers can grab the latest code at any time and attempt to build it themselves. We try our best to ensure that it will build smoothly at any time, although occasionally we do break the build. In these instances, please provide a patch, pull request which fixes the issue or open an issue and notify us of the problem, as we may not be aware of it and we can build fine.

Try to group commits based on what they are related to: features/bugs/comments/graphics/commands/etc...

6.5 Donations

Creating software that interfaces with hardware is costly. A summary of some of the costs involved:

- Developer time for 2 core developers
- Computer equipment and parts
- Embroidery machinery
- Various electronics for kitbashing Embroiderbot
- Consumable materials (thread, fabric, stabilizer, etc...)

If you have found our software useful, please consider funding further development by donating to the project on Open Collective (`https://opencollective.com/embroidermodder`).

6.6 Embroidermodder Project Coding Standards

Rather than maintain our own standard for style, please defer to the Python's PEP 7 [van Rossum and Warsaw, 2001] for C style and emulating that in C++.

A basic set of guidelines to use when submitting code. Defer to the PEP7 standard with the following additions:

- All files and directories shall be lowercase and contain no spaces.
- Structs and class names should use 'LeadingCapitals'.
- Enums and constants should be 'BLOCK_CAPITALS'.

- Class members and functions without a parent class should be ‘snake_case‘. With the exception of when one of the words is a "class" name from libembroidery in which case it has the middle capitals like this: ‘embArray_add‘.
- Don’t use exceptions.
- Don’t use ternary operator (?:) in place of if/else.
- Don’t repeat a variable name that already occurs in an outer scope.

6.6.1 Version Control

Being an open source project, developers can grab the latest code at any time and attempt to build it themselves. We try our best to ensure that it will build smoothly at any time, although occasionally we do break the build. In these instances, please provide a patch, pull request which fixes the issue or open an issue and notify us of the problem, as we may not be aware of it and we can build fine.

Try to group commits based on what they are related to: features/bugs/comments/graphics/commands/etc...

6.6.2 Comments

When writing code, sometimes there are items that we know can be improved, incomplete or need special clarification. In these cases, use the types of comments shown below. They are pretty standard and are highlighted by many editors to make reviewing code easier. We also use shell scripts to parse the code to find all of these occurrences so someone wanting to go on a bug hunt will be able to easily see which areas of the code need more love.

libembroidery and Embroidermodder are written in C and adheres to C89 standards. This means that any C99 or C++ comments will show up as errors when compiling with gcc. In any C code, you must use:

```
/* Use C Style Comments within code blocks.
 *
 * Use Doxygen style code blocks to place todo, bug, hack, warning,
 * and note items like this:
 *
 * \todo EXAMPLE: This code clearly needs more work or further review.
 *
 * \bug This code is definitely wrong. It needs fixed.
 *
 * \hack This code shouldn't be written this way or I don't
 * feel right about it. There may a better solution
 *
 * \warning Think twice (or more times) before changing this code.
 * I put this here for a good reason.
 *
 * \note This comment is much more important than lesser comments.
 */
```

6.7 Ideas

6.7.1 Why this document

I’ve been trying to make this document indirectly through the Github issues page and the website we’re building but I think a straightforward, plain-text file needs

to be the ultimate backup for this. Then I can have a printout while I'm working on the project.

6.7.2 Qt and dependencies

I'm switching to SDL2 (which is a whole other conversation) which means we can ship it with the source code package meaning only a basic build environment is necessary to build it.

6.7.3 Documentation

Can we treat the website being a duplicate of the docs a non-starter? I'd be happier with tex/pdf only and (I know this is counter-intuitive) one per project.

6.7.4 Social Platform

So... all the issues and project boards etc. being on Github is all well and good assuming that we have our own copies. But we don't if Github goes down or some other major player takes over the space and we have to move (again, since this started on SourceForge).

This file is a backup for that which is why I'm repeating myself between them.

6.7.5 Identify the meaning of these TODO items

- Saving CSV/SVG (rt) + CSV read/write UNKNOWN interpreted as COLOR bug '#179'
- Lego Mindstorms NXT/EV3 ports and/or commands

6.7.6 Progress Chart

The chart of successful from-to conversions (previously a separate issue) is something that should appear in the README.

6.7.7 Standard

The criteria for a good Pull Request from an outside developer has these properties, from most to least important:

- No regressions on testing.
- Add a feature, bug fix or documentation that is already agreed on through GitHub issues or some other way with a core developer.
- No GUI specific code should be in libembroidery, that's for Embroidermodder.
- Pedantic/ansi C unless there's a good reason to use another language.
- Meet the style above (i.e. PEP 7, Code Lay-out (`https://peps.python.org/pep-0007/#code-lay-out`). We'll just fix the style if the code's good and it's not a lot of work.
- 'embroider' should be in POSIX style as a command line program.
- No dependancies that aren't "standard", i.e. use only the C Standard Library.

6.7.8 Image Fitting

A currently unsolved problem in development that warrants further research is the scenario where a user wants to feed embroider an image that can then be .

6.7.9 To Place

A *right-handed coordinate system* is one where up is positive and right is positive. Left-handed is up is positive, left is positive. Screens often use down is positive, right is positive, including the OpenGL standard so when switching between graphics formats and stitch formats we need to use a vertical flip (‘embPattern_flip‘).

‘0x20‘ is the space symbol, so when padding either 0 or space is preferred and in the case of space use the literal ’ ’.

6.7.10 To Do

We currently need help with:

- Thorough descriptions of each embroidery format.
- Finding resources for each of the branded thread libraries (along with a full citation for documentation).
- Finding resources for each geometric algorithm used (along with a full citation for documentation).
- Completing the full ‘–full-test-suite‘ with no segfaults and at least a clear error message (for example “not implemented yet”).
- Identifying “best guesses” for filling in missing information when going from, say ‘.csv‘ to a late ‘.pes‘ version. What should the default be when the data doesn’t clarify?
- Improving the written documentation.
- Funding, see the Sponsor button above. We can treat this as “work” and put far more hours in with broad support in small donations from people who want specific features.

Beyond this the development targets are categories sorted into:

- Basic Features
- Code quality and user friendliness
- embroider CLI
- Documentation
- GUI
- electronics development

6.7.11 Basic features

- Incorporate '#if 0' ed parts of 'libembroidery.c'.
- Interpret how to write formats that have a read mode from the source code and vice versa.
- Document the specifics of the file formats here for embroidery machine specific formats. Find websites and other sources that break down the binary formats we currently don't understand.
- Find more and better documentation of the structure of the headers for the formats we do understand.

6.7.12 Code quality and user friendliness

- Document all structs, macros and functions (will contribute directly on the web version).
- Incorporate experimental code, improve support for language bindings.
- Make stitch x, y into an EmbVector.

6.7.13 Documentation

Run 'sloccount' on 'extern/' and '.' (and) so we know the current scale of the project, aim to get this number low. Report the total as part of the documentation.

Try to get as much of the source code that we maintain into C as possible so new developers don't need to learn multiple languages to have an effect. This bars the embedded parts of the code.

6.7.14 GUI

- Make EmbroideryMobile (Android) also backend to 'libembroidery' with a Java wrapper.
- Make EmbroideryMobile (iOS) also backend to 'libembroidery' with a Swift wrapper.
- Share some of the MobileViewer and iMobileViewer layout with the main EM2. Perhaps combine those 3 into the Embroidermodder repository so there are 4 repositories total.
- Convert layout data to JSON format and use cJSON for parsing.

6.8 Development

6.8.1 Contributing

If you're interested in getting involved, here's some guidance for new developers. Currently The Embroidermodder Team is all hobbyists with an interest in making embroidery machines more open and user friendly. If you'd like to support us in some other way you can donate to our Open Collective page (click the Donate button) so we can spend more time working on the project.

All code written for libembroidery should be ANSI C89 compliant if it is C. Using other languages should only be used where necessary to support bindings.

6.8.2 Debug

If you wish to help with development, run this debug script and send us the error log.

```
#!/bin/bash

rm -fr libembroidery-debug

git clone http://github.com/embroidermodder/libembroidery libembroidery-debug
cd libembroidery-debug

cmake -DCMAKE_BUILD_TYPE=DEBUG .
cmake --build . --config=DEBUG

valgrind ./embroider --full-test-suite
```

While we will attempt to maintain good results from this script as part of normal development it should be the first point of failure on any system we haven't tested or format we understand less.

6.8.3 Binary download

We need a current 'embroider' command line program download, so people can update without building.

Chapter 7

Programming principles for the C core

End arrays of char arrays with the symbol "END", the code will never require this symbol as an entry.

Define an array as one of 3 kinds: constant, editable or data.

- Constant arrays are defined const and have fixed length matching the data.
- Editable arrays are fixed length, but to a length based on the practical use of that array. A dropdown menu can't contain more than 30 items, because we don't want to flood the user with options. However it can nest indefinately, so it is not restricted to a total number of entries.
- Data arrays is editable and changes total size at runtime to account for user data.

7.1 Style rules for arrays

1.

Chapter 8

Libembroidery on Embedded Systems

The libembroidery library is designed to support embedded environments as well as desktop, so it can be used in CNC applications.

Originally, the embedded system aspect of the Embroidermodder project was targeted at the higher end prototyping board as part of a general effort to make our own open source hardware ().

However, the task of building the interface for a full OSHW embroidery machine neatly splits into the tasks of building a user interface to issue the commands and the rig itself starting with the stepper motors that wire into this control circuit. A well built control circuit could issue commands to a variety of different machine layouts (for example many features are not present on some machines)

8.1 Compatible Boards

We recommend using an Arduino Mega 2560 or another board with equal or greater specs. That being said, we have had success using an Arduino Uno R3 but this will likely require further optimization and other improvements to ensure continued compatibility with the Uno. See below for more information.

8.2 Arduino Considerations

There are two main concerns here: Flash Storage and SRAM.

libembroidery continually outgrows the 32KB of Flash storage on the Arduino Uno and every time this occurs, a decision has to be made as to what capabilities should be included or omitted. While reading files is the main focus on arduino, writing files may also play a bigger role in the future. Long term, it would be most practical to handle the inclusion or omission of any feature via a single configuration header file that the user can modify to suit their needs.

SRAM is in extremely limited supply and it will deplete quickly so any dynamic allocation should occur early during the setup phase of the sketch and sparingly or not at all later in the sketch. To help minimize SRAM consumption on Arduino and ensure libembroidery can be used in any way the sketch creator desires, it is required that any sketch using libembroidery must implement event handlers. See the ino-event source and header files for more information.

There is also an excellent article by Bill Earl on the Adafruit Learning System [1].

8.3 Space

Since a stitch takes 3 bytes of storage and many patterns use more than 10k stitches, we can't assume that the pattern will fit in memory. Therefore we will need to buffer the current pattern on and off storage in small chunks. By the same reasoning, we can't load all of one struct beore looping so we will need functions similar to binaryReadInt16 for each struct.

This means the EmbArray approach won't work since we need to load each element and dynamic memory management is unnecessary because the arrays lie in storage.

TODO: Replace EmbArray functions with 'embPattern_' load functions.

8.4 Tables

All thread tables and large text blocks are too big to compile directly into the source code. Instead we can package the library with a data packet that is compiled from an assembly program in raw format so the specific padding can be controlled.

In the user section above we will make it clear that this file needs to be loaded on the pattern USB/SD card or the program won't function.

TODO: Start file with a list of offsets to data with a corresponding table to load into with macro constants for each label needed.

8.5 Current Pattern Memory Management

It will be simpler to make one file per EmbArray so we keep an EmbFile* and a length, so no malloc call is necessary. So there needs to be a consistent tmpfile naming scheme.

TODO: For each pattern generate a random string of hexadecimal and append it to the filenames like 'stitchList_A16F.dat'. Need to check for a file which indicates that this string has been used already.

8.6 Special Notes

Due to historical reasons and to remain compatible with the Arduino 1.0 IDE, this folder must be called "utility". Refer to the arduino build process for more infofootnote:[https://arduino.github.io/arduino-cli/0.19/sketch-build-process/].

libembroidery relies on the Arduino SD library for reading files. See the ino-file source and header files for more information.

8.7 The Assembly Split

One problem to the problem of supporting both systems with abundant memory (such as a 2010s or later desktop) and with scarce memory (such as embedded systems) is that they don't share the same assembly language. To deal with this:

[1] http://learn.adafruit.com/memories-of-an-arduino?view=all

there will be two equivalent software which are hand engineered to be similar but one will be in C and the other in the assembly dialects we support.

All assembly will be intended for embedded systems only, since a slightly smaller set of features will be supported. However, we will write a ‘x86‘ version since that can be tested.

That way the work that has been done to simplify the C code can be applied to the assembly versions.

Chapter 9

Electronics development

9.1 Ideas

Currently experimenting with Fritzing 8 (8), upload netlists to embroiderbot when they can run simulations using the asm in 'libembroidery'.

Create a common assembly for data that is the same across chipsets 'libembrodiery_data_internal.s'.

Make the defines part of 'embroidery.h' all systems and the function list 'c code only'. That way we can share some development between assembly and C versions.

Chapter 10

Mobile

Again, it would help to use the C library we have already developed, however for Android the supported platform is for Java applications.

`https://github.com/java-native-access/jna`

`https://github.com/marketplace/actions/setup-android-ndk`

`https://developer.android.com/ndk/guides`

See the bindings section for how this is achieved.

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Appendix A

Tread Tables

A.1 Arc Threads

Table A.1: = Arc Polyester Threads

Name	RGB hex code	Catalog Code

Table A.2: = Arc Rayon Threads

Name	**RGB hex code**	**Catalog Code**

A.2 Coats and Clark Rayon Codes

Table A.3: = Coats and Clark Rayon Threads

Name	**RGB hex code**	**Catalog Code**

A.3 DXF Colors

Based on the DraftSight color table.

Table A.4: = SHV Threads

Name	RGB hex code	Catalog Code
0x000000	Black	TODO
0x0000ff	Blue	TODO
0x33cc66	Green	TODO
0xff0000	Red	TODO
0xff00ff	Purple	TODO
0xffff00	Yellow	TODO
0x7f7f7f	Grey	TODO
0x339aff	Light Blue	TODO
0x00ff00	Light Green	TODO
0xff7f00	Orange	TODO
0xffa0b4	Pink	TODO
0x994b00	Brown	TODO
0xffffff	White	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0xff7f7f	Light Red	TODO
0xff7fff	Light Purple	TODO
0xffff99	Light Yellow	TODO
0xc0c0c0	Light Grey	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0xffa541	Light Orange	TODO
0xffcccc	Light Pink	TODO
0xaf5a0a	Light Brown	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x00007f	Dark Blue	TODO
0x007f00	Dark Green	TODO
0x7f0000	Dark Red	TODO
0x7f007f	Dark Purple	TODO
0xc8c800	Dark Yellow	TODO
0x3c3c3c	Dark Gray	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0xe83f00	Dark Orange	TODO
0xff667a	Dark Pink	TODO

A.4 Exquisite Polyester Codes

Table A.5: = Exquisite Polyester Threads

Name	**RGB hex code**	**Catalog Code**

A.5 Fufu Threads

Table A.6: = Fufu Polyester Threads

Name	RGB hex code	Catalog Code

A.6 Hemingworth Polyester Codes

Table A.7: = SHV Threads

Name	RGB hex code	Catalog Code
0x000000	Black	TODO
0x0000ff	Blue	TODO
0x33cc66	Green	TODO
0xff0000	Red	TODO
0xff00ff	Purple	TODO
0xffff00	Yellow	TODO
0x7f7f7f	Grey	TODO
0x339aff	Light Blue	TODO
0x00ff00	Light Green	TODO
0xff7f00	Orange	TODO
0xffa0b4	Pink	TODO
0x994b00	Brown	TODO
0xffffff	White	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0xff7f7f	Light Red	TODO
0xff7fff	Light Purple	TODO
0xffff99	Light Yellow	TODO
0xc0c0c0	Light Grey	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0xffa541	Light Orange	TODO
0xffcccc	Light Pink	TODO
0xaf5a0a	Light Brown	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x00007f	Dark Blue	TODO
0x007f00	Dark Green	TODO
0x7f0000	Dark Red	TODO
0x7f007f	Dark Purple	TODO
0xc8c800	Dark Yellow	TODO
0x3c3c3c	Dark Gray	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0xe83f00	Dark Orange	TODO
0xff667a	Dark Pink	TODO

A.7 HUS Colors

(find a citation)

CSV format: red, green, blue, name, catalog number

.HUS Colors

Table A.8: = HUS Colors

Name	**RGB hex code**	**Catalog Code**
0x000000	Black	TODO
0x0000ff	Blue	TODO
0x00ff00	Light Green	TODO
0xff0000	Red	TODO
0xff00ff	Purple	TODO
0xffff00	Yellow	TODO
0x7f7f7f	Gray	TODO
0x339aff	Light Blue	TODO
0x33cc66	Green	TODO
0xff7f00	Orange	TODO
0xffa0b4	Pink	TODO
0x994b00	Brown	TODO
0xffffff	White	TODO
0x00007f	Dark Blue	TODO
0x007f00	Dark Green	TODO
0x7f0000	Dark Red	TODO
0xff7f7f	Light Red	TODO
0x7f007f	Dark Purple	TODO
0xff7fff	Light Purple	TODO
0xc8c800	Dark Yellow	TODO
0xffff99	Light Yellow	TODO
0x3c3c3c	Dark Gray	TODO
0xc0c0c0	Light Gray	TODO
0xe83f00	Dark Orange	TODO
0xffa541	Light Orange	TODO
0xff667a	Dark Pink	TODO
0xffcccc	Light Pink	TODO
0x732800	Dark Brown	TODO
0xaf5a0a	Light Brown	TODO

A.8 Isacord Polyester Codes

Table A.9: = Isacord Polyester Threads

Name	RGB hex code	Catalog Code
?	0xFFFFFF	10
?	0xFFFFFF	15 /* TODO: duplicate case value */
?	0xFFFFFF	17 /* TODO: duplicate case value */
?	0x000000	20
?	0xFFFDED	101
?	0x6D757B	108
?	0x515B61	111
?	0x5D5D5D	112
?	0xCFCFCF	124
?	0xA1A9B4	131
?	0x192024	132
?	0x9EA5AA	142
?	0xCFD1D5	145
?	0xC6BDB4	150
?	0xD5C4B3	151
?	0x7C8283	152
?	0xFEF5F0	180
?	0xE9D7D9	182
?	0xEBE3DD	184
?	0xE0DA5F	221
?	0xBFBA28	232
?	0xFAF6CC	250
?	0xF9F8E8	270
?	0xFDF76C	310
?	0xF5D300	311
?	0x797E24	345
?	0xB0AA76	352
?	0x898F2B	442
?	0x98996D	453
?	0x6B7E6F	463
?	0x3E4F34	465
?	0xEDEF05	501
?	0xF5D300	506 /* TODO: duplicate case value */
?	0xFDE896	520
?	0xD7CE8A	532
?	0xB18B00	542
?	0xB28F11	546
?	0xB69F56	552
?	0xF8D73E	600
?	0xF8D73E	605 /* TODO: duplicate case value */
?	0xF7DC00	608
?	0xFEF09A	630
?	0xFDE896	640 /* TODO: duplicate case value */
?	0xF5D2A6	651
?	0xFEF9EA	660
?	0xFAF6E7	670

?	0xBEBEA8	672
?	0xF7C35F	700
?	0xF5CA00	702
?	0xDFA200	704
?	0xFCF538	706
?	0xFADC59	713
?	0x8C7E6A	722
?	0x594900	747
?	0xD6BF94	761
?	0x656452	776
?	0xF1AF00	800
?	0xF5BA5D	811
?	0xE1A23E	821
?	0xCCAB3F	822
?	0xDFA200	824 /* TODO: duplicate case value */
?	0xD0A44F	832
?	0xCD944A	842
?	0xE3BC61	851
?	0x947C4A	853
?	0xCBBFA2	861
?	0xA5866A	862
?	0xEBE7DD	870
?	0x9FA086	873
?	0x9A897B	874
?	0xF3B259	904
?	0xCA832C	922
?	0xC07314	931
?	0xAC6613	932
?	0x744808	933
?	0xBD9565	934
?	0xC98300	940
?	0xAF7D3E	941
?	0x483928	945
?	0xFEFEED	970
?	0x6A4129	1055
?	0xFDE2C1	1060
?	0xA68A68	1061
?	0xED9206	1102
?	0xEE9C00	1106
?	0xEE8751	1114
?	0xA35214	1115
?	0xF8C000	1120
?	0xB7976B	1123
?	0x9D5A21	1134
?	0xF3D8A8	1140
?	0xFACFAE	1141
?	0x7A4427	1154
?	0xDFC8AB	1172
?	0xE89763	1211
?	0xF1A236	1220
?	0xE5571D	1300
?	0xD9674C	1301

?	0xE4501E	1304
?	0xEA7134	1305
?	0xE12A23	1306
?	0xC14817	1311
?	0xC45331	1312
?	0xD5815E	1332
?	0xBB3D2E	1334
?	0xBE2D1A	1335
?	0x5F1B23	1342
?	0x7A3441	1346
?	0xFBBF95	1351
?	0xF4A773	1352
?	0x693920	1355
?	0xF9C598	1362
?	0x432731	1366
?	0x464537	1375
?	0xF4A782	1430
?	0xE22D2A	1501
?	0xA93121	1514
?	0xEC7168	1521
?	0xF6B08E	1532
?	0xF9C5B9	1551
?	0x806A61	1565
?	0xE36C63	1600
?	0xE44733	1701
?	0xDF0032	1703
?	0xE0003D	1704
?	0xCF0040	1725
?	0xF1CDCE	1755
?	0xE9C9BD	1760
?	0xE8C0B8	1761
?	0xE00046	1800
?	0xD6445D	1805
?	0xF49E95	1840
?	0xFCDAD5	1860
?	0x636254	1874
?	0x394535	1876
?	0xE10057	1900
?	0xBD0041	1902
?	0xC00343	1903
?	0xA9023A	1904
?	0xBE004F	1906
?	0x910230	1911
?	0x86023E	1912
?	0x9A0C3B	1913
?	0xA33050	1921
?	0xF28DA6	1940
?	0xCE427A	1950
?	0x959595	1972
?	0xA33145	2011
?	0x9F454C	2022
?	0xC7979B	2051
?	0x9F003F	2101

?	0x78093F	2113
?	0x6D0627	2115
?	0x432732	2123
?	0xE6778B	2152
?	0xDF8390	2153
?	0xF9BFC0	2155
?	0xFBD1D6	2160
?	0xD8D5D0	2166
?	0xF7DED6	2170
?	0xF7DEDE	2171
?	0xE8418C	2220
?	0x8C0C4A	2222
?	0x883A40	2224
?	0xEE71A1	2230
?	0xA95A68	2241
?	0xFAC8D3	2250
?	0xD3007E	2300
?	0xD20067	2320
?	0x651533	2333
?	0x3A212B	2336
?	0xFDE5EC	2363
?	0x970059	2500
?	0xAA4381	2504
?	0x820052	2506
?	0xE20078	2520
?	0xBF006A	2521
?	0xF189AF	2550
?	0xF7B4CA	2560
?	0x494949	2576
?	0x893480	2600
?	0x6C0051	2611
?	0xD994B9	2640
?	0xE6B7CF	2650
?	0xECD2DE	2655
?	0x606D8C	2674
?	0x610051	2711
?	0x490251	2715
?	0x89347F	2720
?	0xC690A1	2764
?	0x6F067B	2810
?	0xA974AB	2830
?	0x4C0F7B	2900
?	0x664090	2905
?	0x83589D	2910
?	0x8C6DAA	2920
?	0xC9B5D4	3040
?	0xC790BA	3045
?	0x707070	3062
?	0x2A377E	3102
?	0x35247A	3110
?	0x260751	3114
?	0x353A90	3210
?	0x524A90	3211

?	0x7D77AF	3241
?	0x9083A3	3251
?	0x14214E	3323
?	0x7F8BC2	3331
?	0x1B3C78	3333
?	0x2E4B9B	3335
?	0x11263C	3344
?	0x202A65	3353
?	0x171B4A	3355
?	0x002232	3444
?	0x2D4491	3522
?	0x261257	3536
?	0x3A2885	3541
?	0x233B7D	3543
?	0x273C82	3544
?	0x272651	3554
?	0x28438C	3600
?	0x243A7D	3611
?	0x4055A1	3612
?	0x1A4C8D	3622
?	0x92B1DC	3640
?	0x648DC7	3641
?	0xD0DEEE	3650
?	0xC8D6ED	3652
?	0x00507F	3732
?	0x12253C	3743
?	0xB7D1E3	3750
?	0xAFC9E5	3761
?	0xCED2D1	3770
?	0x3D6AA1	3810
?	0x7BA2D3	3815
?	0x91B9E2	3820
?	0xB4CEEB	3840
?	0x507193	3842
?	0x007EBA	3900
?	0x0082C4	3901
?	0x006CA5	3902
?	0x4ABDF0	3910
?	0x86AACA	3951
?	0x697698	3953
?	0xA6D8F6	3962
?	0xE1E1E1	3971
?	0x0093B9	4010
?	0x507793	4032
?	0x265674	4033
?	0xEAF0F9	4071
?	0x838689	4073
?	0x2DB0CF	4101
?	0x0095C6	4103
?	0x00A4D9	4111
?	0x00A9C9	4113
?	0x0082AD	4116
?	0x00405D	4133

?	0x192024	4174 /* TODO: duplicate case value */
?	0x4FB4CB	4220
?	0x8DCEE4	4230
?	0x8DCDDB	4240
?	0xD5EBF2	4250
?	0x007B8D	4410
?	0x0091A5	4421
?	0x007D8C	4423
?	0x007986	4425
?	0x5FBFD1	4430
?	0x006981	4442
?	0x007F92	4452
?	0x002F38	4515
?	0x007389	4531
?	0x007B8D	4610 /* TODO: duplicate case value */
?	0x00A3A0	4620
?	0x0B7F85	4625
?	0x005B63	4643
?	0x234544	4644
?	0x005B63	5005 /* TODO: duplicate case value */
?	0x00A6AD	5010
?	0xB4DCD8	5050
?	0x00876E	5100
?	0x009084	5101
?	0x48BAB7	5115
?	0x00AF8C	5210
?	0x8CCCC2	5220
?	0x47B9AE	5230
?	0x197E6D	5233
?	0x006E42	5324
?	0x004D3D	5326
?	0x002F38	5335 /* TODO: duplicate case value */
?	0x002D1F	5374
?	0x008663	5411
?	0x006B4E	5415
?	0x008663	5422 /* TODO: duplicate case value */
?	0x52BA84	5500
?	0x14A363	5510
?	0x007848	5513
?	0x008663	5515 /* TODO: duplicate case value */
?	0x52A04F	5531
?	0x94ADA1	5552
?	0x103828	5555
?	0x85C875	5610
?	0x14B26D	5613
?	0x1A781E	5633
?	0x157436	5643

?	0xC9E3C5	5650
?	0x6B9181	5664
?	0xA5C278	5822
?	0x70953F	5833
?	0x273014	5866
?	0x81C750	5912
?	0x457021	5933
?	0x506702	5934
?	0xBBDB41	5940
?	0x003518	5944
?	0xE3EB00	6010
?	0xBED782	6051
?	0x919600	6133
?	0x484601	6156

A.9 Isafil Rayon Codes

Table A.10: = Isafil Rayon Threads

Name	RGB hex code	Catalog Code
?	0xFFFFFF	10
?	0xFFFFFF	15 /* TODO: duplicate case value */
?	0xFFFFFF	17 /* TODO: duplicate case value */
?	0x000000	20
?	0xFFFDED	101
?	0x7D7D7D	104
?	0x515B61	107
?	0x6D757B	108
?	0xACACAC	109
?	0x515B61	111 /* TODO: duplicate case value */
?	0x5D5D5D	112
?	0xCFCFCF	124
?	0xA1A9B4	131
?	0x6D757B	141 /* TODO: duplicate case value */
?	0x9EA5AA	142
?	0xCFD1D5	145
?	0xC6BDB4	150
?	0xD5C4B3	151
?	0x7C8283	152
?	0x898F94	156
?	0xFEF5F0	180
?	0xE9D7D9	182
?	0xEBE3DD	184
?	0xE0DA5F	221
?	0xBFBA28	232
?	0xECE9C1	241
?	0xFAF6CC	250
?	0xECE7A5	251
?	0xECEADB	260
?	0xF9F8E8	270
?	0xFDF76C	310
?	0xF5D300	311
?	0x797E24	345
?	0xB0AA76	352
?	0x898F2B	442
?	0x98996D	453
?	0x6E772E	454
?	0x6B7E6F	463
?	0x3E4F34	465
?	0xEDEF05	501
?	0xFAF6CC	505 /* TODO: duplicate case value */
?	0xF5D300	506 /* TODO: duplicate case value */
?	0xFFFBD1	510
?	0xFDE896	520
?	0xD7CE8A	532

?	0xB18B00	542
?	0xAA8D00	545
?	0xB28F11	546
?	0xAC9436	551
?	0xB69F56	552
?	0xF4EE8C	580
?	0xF1EB35	590
?	0xF8D73E	600
?	0xF8D73E	605 /* TODO: duplicate case value */
?	0xF7CB47	610
?	0xF7E400	615
?	0xFDE896	620 /* TODO: duplicate case value */
?	0xEEDB00	625
?	0xFEF09A	630
?	0xFDE1AF	635
?	0xFDE896	640 /* TODO: duplicate case value */
?	0xF5D2A6	651
?	0xFEF9EA	660
?	0xFAF6E7	670
?	0xBEBEA8	672
?	0xF7C35F	700
?	0xF5CA00	702
?	0xDFA200	704
?	0xFCF538	706
?	0xFADC59	713
?	0x8C7E6A	722
?	0x827000	726
?	0x636254	732
?	0x594900	747
?	0xD6BF94	761
?	0x656452	776
?	0xF1AF00	800
?	0xF3C200	805
?	0xF5BA5D	811
?	0xE1A23E	821
?	0xCCAB3F	822
?	0xDFA200	824 /* TODO: duplicate case value */
?	0xF3B044	830
?	0xD0A44F	832
?	0xCD944A	842
?	0xE3BC61	851
?	0x947C4A	853
?	0x001F48	866
?	0xEBE7DD	870
?	0x9FA086	873
?	0x9A897B	874
?	0xEE9C00	900
?	0xF3B259	904
?	0xCA832C	922

?	0xC07314	931
?	0xAC6613	932
?	0x744808	933
?	0xBD9565	934
?	0x806800	936
?	0xC98300	940
?	0xAF7D3E	941
?	0x483928	945
?	0xFEECD9	961
?	0xFEFEED	970
?	0xDD973A	1041
?	0x6A4129	1055
?	0xFDE2C1	1060
?	0xA68A68	1061
?	0xD76814	1099
?	0xED873F	1100
?	0xEC870E	1101
?	0xED9206	1102
?	0xEE9C00	1106 /* TODO: duplicate case value */
?	0xC45331	1113
?	0xEE8751	1114
?	0xA35214	1115
?	0xF8C000	1120
?	0xB7976B	1123
?	0x9D5A21	1134
?	0xF3D8A8	1140
?	0xFACFAE	1141
?	0xDFC8AB	1172
?	0xE89763	1211
?	0xF1A236	1220
?	0x3D2723	1276
?	0xE5571D	1300
?	0xE8643C	1302
?	0xE4501E	1304
?	0xEA7134	1305
?	0xE12A23	1306
?	0xC14817	1311
?	0xC45331	1312 /* TODO: duplicate case value */
?	0xD7623E	1313
?	0xED7C56	1320
?	0x92291B	1324
?	0xD5815E	1332
?	0xBB3D2E	1334
?	0xBE2D1A	1335
?	0x5F1B23	1342
?	0x7A3441	1346
?	0x84291D	1348
?	0xFBBF95	1351
?	0xF4A773	1352
?	0x693920	1355
?	0xF9C6A1	1361

?	0xF9C598	1362
?	0x432731	1366
?	0x464537	1375
?	0x4D2E18	1376
?	0xD64F42	1421
?	0xF4A782	1430
?	0xE22D2A	1501
?	0xA93121	1514
?	0xEC7168	1521
?	0xF6B08E	1532
?	0xF9C5B9	1551
?	0x806A61	1565
?	0x464537	1573 /* TODO: duplicate case value */
?	0xE36C63	1600
?	0xF9C7B9	1630
?	0xE44733	1701
?	0xDF0032	1703
?	0xE44733	1705 /* TODO: duplicate case value */
?	0xCF0040	1725
?	0xDB686B	1750
?	0xF1CDCE	1755
?	0xE9C9BD	1760
?	0xE8C0B8	1761
?	0xE00046	1800
?	0xE43449	1802
?	0xD6445D	1805
?	0xF49E95	1840
?	0xB76663	1842
?	0xE36C63	1849 /* TODO: duplicate case value */
?	0xF0887D	1850
?	0xFAC7C1	1855
?	0xFCDAD5	1860
?	0xFDE3D3	1870
?	0x636254	1874 /* TODO: duplicate case value */
?	0x394535	1876
?	0xE10057	1900
?	0xBD0041	1902
?	0xC00343	1903
?	0xA9023A	1904
?	0x960018	1905
?	0xBE004F	1906
?	0x910230	1911
?	0x86023E	1912
?	0x9A0C3B	1913
?	0xA41F39	1914
?	0xA33050	1921
?	0xF28DA6	1940
?	0xCE427A	1950
?	0xF2B9BE	1960

?	0x959595	1972
?	0xA33145	2011
?	0x9F454C	2022
?	0xC7979B	2051
?	0xD18D89	2053
?	0x970038	2100
?	0x9F003F	2101
?	0x78093F	2113
?	0x432732	2123
?	0xE6778B	2152
?	0xDF8390	2153
?	0xF9BFC0	2155
?	0xFBD1D6	2160
?	0xFDE3DB	2165
?	0xD8D5D0	2166
?	0xFEEDE2	2168
?	0xF7DED6	2170
?	0xF7DEDE	2171
?	0xFCD9C4	2180
?	0xE8418C	2220
?	0x8C0C4A	2222
?	0x883A40	2224
?	0xEE71A1	2230
?	0xA95A68	2241
?	0xFAC8D3	2250
?	0xD3007E	2300
?	0xBF006A	2310
?	0xD20067	2320
?	0x780C38	2332
?	0x651533	2333
?	0x3A212B	2336
?	0xF2E0DC	2360
?	0xFDE5EC	2363
?	0x970059	2500
?	0x8B1771	2502
?	0xAA4381	2504
?	0xB40073	2505
?	0x820052	2506
?	0xD63C81	2513
?	0xE20078	2520
?	0xBF006A	2521 /* TODO: duplicate case value */
?	0xEE71A1	2524 /* TODO: duplicate case value */
?	0xF189AF	2550
?	0xF7B4CA	2555
?	0xF7B4CA	2560 /* TODO: duplicate case value */
?	0x494949	2576
?	0x394248	2578
?	0x893480	2600
?	0x6C0051	2611
?	0xCD73A6	2620

?	0xD994B9	2640
?	0xDDBDD5	2645
?	0xE6B7CF	2650
?	0xECD2DE	2655
?	0x606D8C	2674
?	0x646A6E	2675
?	0x610051	2711
?	0x704191	2712
?	0x490251	2715
?	0x2F206F	2743
?	0xC690A1	2764
?	0x6F067B	2810
?	0xAD85B1	2820
?	0xA974AB	2830
?	0x4C0F7B	2900
?	0x664090	2905
?	0x83589D	2910
?	0x8C6DAA	2920
?	0xC9B5D4	3040
?	0xC790BA	3045
?	0x707070	3062
?	0x2A377E	3102
?	0x3C1F81	3103
?	0x35247A	3110
?	0x260751	3114
?	0x28135B	3133
?	0x6E5DA3	3200
?	0x353A90	3210
?	0x524A90	3211
?	0x785FA3	3213
?	0x241757	3222
?	0x7D77AF	3241
?	0x9083A3	3251
?	0xB2AABD	3262
?	0x392D88	3301
?	0x5661A8	3321
?	0x323887	3322
?	0x14214E	3323
?	0x3A2885	3330
?	0x7F8BC2	3331
?	0x1B3C78	3333
?	0xB9BDD9	3340
?	0x11263C	3344
?	0x202A65	3353
?	0x171B4A	3355
?	0x959ACA	3420
?	0x6A76B5	3430
?	0x11263C	3443 /* TODO: duplicate case value */
?	0x002232	3444
?	0x2D4491	3522
?	0x261257	3536
?	0x53428A	3540

?	0x3A2885	3541 /* TODO: duplicate case value */
?	0x233B7D	3543
?	0x273C82	3544
?	0x272651	3554
?	0x28438C	3600
?	0x243A7D	3611
?	0x4055A1	3612
?	0x1A4C8D	3622
?	0x1E569F	3631
?	0x92B1DC	3640
?	0x648DC7	3641
?	0xD0DEEE	3650
?	0xEAF0F9	3661
?	0x00507F	3732
?	0x12253C	3743
?	0xB7D1E3	3750
?	0xD0DEEE	3752 /* TODO: duplicate case value */
?	0xAFC9E5	3761
?	0xCED2D1	3770
?	0x3D6AA1	3810
?	0x91B9E2	3820
?	0x00779E	3822
?	0xB4CEEB	3840
?	0x507193	3842
?	0xD5E3F4	3845
?	0x9AB8D3	3851
?	0x007EBA	3900
?	0x0082C4	3901
?	0x006CA5	3902
?	0x4ABDF0	3910
?	0x86AACA	3951
?	0x485E8A	3952
?	0x697698	3953
?	0xC5E1F3	3961
?	0xA6D8F6	3962
?	0xE1E1E1	3971
?	0x0093B9	4010
?	0x006587	4022
?	0x87C7EA	4030
?	0x507793	4032
?	0x265674	4033
?	0x9ED4E6	4040
?	0xEAF0F9	4071 /* TODO: duplicate case value */
?	0x0096C1	4100
?	0x2DB0CF	4101
?	0x0095C6	4103
?	0x0081AA	4105
?	0x00A4D9	4111
?	0x00A9C9	4113
?	0x5DBFD2	4121

?	0x00405D	4133
?	0x192024	4174 /* TODO: duplicate case value */
?	0x192024	4175 /* TODO: duplicate case value */
?	0x4FB4CB	4220
?	0x8DCEE4	4230
?	0x2DB0CF	4231 /* TODO: duplicate case value */
?	0x006587	4232 /* TODO: duplicate case value */
?	0x8DCDDB	4240
?	0xD5EBF2	4250
?	0x007389	4400
?	0x007B8D	4410
?	0x00B2CA	4420
?	0x0091A5	4421
?	0x007D8C	4423
?	0x007986	4425
?	0x5FBFD1	4430
?	0x004250	4432
?	0x8DCEE4	4440 /* TODO: duplicate case value */
?	0x006981	4442
?	0x007F92	4452
?	0x008192	4500
?	0x007079	4513
?	0x002F38	4515
?	0x00646A	4516
?	0x007389	4531 /* TODO: duplicate case value */
?	0x007B8D	4610 /* TODO: duplicate case value */
?	0x00A3A0	4620
?	0x0B7F85	4625
?	0x005B63	4643
?	0x234544	4644
?	0x8CCDD3	4840
?	0x006F73	5000
?	0x005B63	5005 /* TODO: duplicate case value */
?	0x00A6AD	5010
?	0x49BAC0	5020
?	0xCFDDE0	5040
?	0xB4DCD8	5050
?	0x00876E	5100
?	0x009084	5101
?	0x00B1AE	5111
?	0x48BAB7	5115
?	0x00AF8C	5210
?	0x8CCCC2	5220
?	0x47B9AE	5230
?	0x197E6D	5233

?	0x8CCCC2	5240 /* TODO: duplicate case value */
?	0x005B63	5255 /* TODO: duplicate case value */
?	0x006E42	5324
?	0x004D3D	5326
?	0x002F38	5335 /* TODO: duplicate case value */
?	0x002D1F	5374
?	0x002F38	5375 /* TODO: duplicate case value */
?	0x008663	5411
?	0x006B4E	5415
?	0x008663	5422 /* TODO: duplicate case value */
?	0x006B56	5425
?	0x008879	5431
?	0xDBE9E5	5460
?	0x6AC093	5470
?	0x52BA84	5500
?	0x14A363	5510
?	0x007848	5513
?	0x008663	5515 /* TODO: duplicate case value */
?	0x52A04F	5531
?	0x6EA293	5542
?	0x94ADA1	5552
?	0x103828	5555
?	0x63BE5F	5600
?	0x85C875	5610
?	0x2CB431	5611
?	0x14B26D	5613
?	0x40B780	5620
?	0x1A781E	5633
?	0x157436	5643
?	0xC9E3C5	5650
?	0x6B9181	5664
?	0x3A6D57	5765
?	0x103828	5766 /* TODO: duplicate case value */
?	0x02140C	5776
?	0xA5C278	5822
?	0xB4D383	5832
?	0x70953F	5833
?	0xA2D289	5840
?	0x273014	5866
?	0x81C750	5912
?	0x457021	5933
?	0x506702	5934
?	0xBBDB41	5940
?	0x003518	5944
?	0xE3EB00	6010
?	0xBED782	6051

?	0x2D3B01	6065
?	0xDCDDD1	6071
?	0x919600	6133
?	0x484601	6156

A.10 JEF Colors

To do: find a citation

A.11 Madeira Threads

Table A.11: = Madeira Polyester Threads

Name	RGB hex code	Catalog Code

Table A.12: = Madeira Rayon Threads

Name	RGB hex code	Catalog Code

A.12 Marathon Polyester Codes

Table A.13: = SHV Threads

Name	RGB hex code	Catalog Code
0x000000	Black	TODO
0x0000ff	Blue	TODO
0x33cc66	Green	TODO
0xff0000	Red	TODO
0xff00ff	Purple	TODO
0xffff00	Yellow	TODO
0x7f7f7f	Grey	TODO
0x339aff	Light Blue	TODO
0x00ff00	Light Green	TODO
0xff7f00	Orange	TODO
0xffa0b4	Pink	TODO
0x994b00	Brown	TODO
0xffffff	White	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0xff7f7f	Light Red	TODO
0xff7fff	Light Purple	TODO
0xffff99	Light Yellow	TODO
0xc0c0c0	Light Grey	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0xffa541	Light Orange	TODO
0xffcccc	Light Pink	TODO
0xaf5a0a	Light Brown	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x00007f	Dark Blue	TODO
0x007f00	Dark Green	TODO
0x7f0000	Dark Red	TODO
0x7f007f	Dark Purple	TODO
0xc8c800	Dark Yellow	TODO
0x3c3c3c	Dark Gray	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0xe83f00	Dark Orange	TODO
0xff667a	Dark Pink	TODO

A.13 Marathon Rayon Codes

Table A.14: = SHV Threads

Name	RGB hex code	Catalog Code
0x000000	Black	TODO
0x0000ff	Blue	TODO
0x33cc66	Green	TODO
0xff0000	Red	TODO
0xff00ff	Purple	TODO
0xffff00	Yellow	TODO
0x7f7f7f	Grey	TODO
0x339aff	Light Blue	TODO
0x00ff00	Light Green	TODO
0xff7f00	Orange	TODO
0xffa0b4	Pink	TODO
0x994b00	Brown	TODO
0xffffff	White	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0xff7f7f	Light Red	TODO
0xff7fff	Light Purple	TODO
0xffff99	Light Yellow	TODO
0xc0c0c0	Light Grey	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0xffa541	Light Orange	TODO
0xffcccc	Light Pink	TODO
0xaf5a0a	Light Brown	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x00007f	Dark Blue	TODO
0x007f00	Dark Green	TODO
0x7f0000	Dark Red	TODO
0x7f007f	Dark Purple	TODO
0xc8c800	Dark Yellow	TODO
0x3c3c3c	Dark Gray	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0xe83f00	Dark Orange	TODO
0xff667a	Dark Pink	TODO

A.14 Metro Polyester Code

Table A.15: = SHV Threads

Name	RGB hex code	Catalog Code
0x000000	Black	TODO
0x0000ff	Blue	TODO
0x33cc66	Green	TODO
0xff0000	Red	TODO
0xff00ff	Purple	TODO
0xffff00	Yellow	TODO
0x7f7f7f	Grey	TODO
0x339aff	Light Blue	TODO
0x00ff00	Light Green	TODO
0xff7f00	Orange	TODO
0xffa0b4	Pink	TODO
0x994b00	Brown	TODO
0xffffff	White	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0xff7f7f	Light Red	TODO
0xff7fff	Light Purple	TODO
0xffff99	Light Yellow	TODO
0xc0c0c0	Light Grey	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0xffa541	Light Orange	TODO
0xffcccc	Light Pink	TODO
0xaf5a0a	Light Brown	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0x00007f	Dark Blue	TODO
0x007f00	Dark Green	TODO
0x7f0000	Dark Red	TODO
0x7f007f	Dark Purple	TODO
0xc8c800	Dark Yellow	TODO
0x3c3c3c	Dark Gray	TODO
0x000000	Black	TODO
0x000000	Black	TODO
0xe83f00	Dark Orange	TODO
0xff667a	Dark Pink	TODO

A.15 Pantone Codes

See https://www.pantone-colours.com/

Table A.16: = Pantone Colors

Name	**RGB hex code**	**Catalog Code**
100	"?"	0xFFFFFF7D
101	"?"	0xFFFFFF36
102	"?"	0xFFFFFC0D
103	"?"	0xFFD1CB00
104	"?"	0xFFB3AD00
105	"?"	0xFF807C00
106	"?"	0xFFFFFA4F
?	0xFFFFF536	107
?	0xFFFFF00D	108
?	0xFFFFE600	109
?	0xFFEDD100	110
?	0xFFBAA600	111
?	0xFF9E8E00	112
?	0xFFFFED57	113
?	0xFFFFEB45	114
?	0xFFFFE833	115
?	0xFFFFD600	116
?	0xFFD9B200	117
?	0xFFBA9900	118
?	0xFF827200	119
?	0xFFFFE86B	120
?	0xFFFFF2B0	1205
?	0xFFFFE34F	121
?	0xFFFFE88C	1215
?	0xFFFFD433	122
?	0xFFFFD461	1225
?	0xFFFFC20F	123
?	0xFFFFB517	1235
?	0xFFF0AD00	124
?	0xFFD19700	1245
?	0xFFBD8C00	125
?	0xFFA87B00	1255
?	0xFFA17800	126
?	0xFF7D5B00	1265
?	0xFFFFED80	127
?	0xFFFFE359	128
?	0xFFFFD63B	129
?	0xFFFFB300	130
?	0xFFE89E00	131
?	0xFFB38100	132
?	0xFF705A00	133
?	0xFFFFE38C	134
?	0xFFFFDB87	1345
?	0xFFFFCF66	135
?	0xFFFFCC70	1355
?	0xFFFFBA3D	136
?	0xFFFFB547	1365
?	0xFFFFA61A	137
?	0xFFFF991A	1375
?	0xFFFC9200	138
?	0xFFED8500	1385

?	0xFFC47C00	139
?	0xFFA15F00	1395
?	0xFF755600	140
?	0xFF5E3C00	1405
?	0xFFFFCF7D	141
?	0xFFFFB83D	142
?	0xFFFFA626	143
?	0xFFFF8500	144
?	0xFFEB7C00	145
?	0xFFAB6100	146
?	0xFF705100	147
?	0xFFFFD6A1	148
?	0xFFFFBA75	1485
?	0xFFFFC487	149
?	0xFFFFAB54	1495
?	0xFFFFA64D	150
?	0xFFFF943B	1505
?	0xFFFF850D	151
?	0xFFFC7C00	152
?	0xFFE66000	1525
?	0xFFD17100	153
?	0xFF9E4A00	1535
?	0xFFA85B00	154
?	0xFF472200	1545
?	0xFFFFE0B8	155
?	0xFFFFC7A8	1555
?	0xFFFFC794	156
?	0xFFFFA882	1565
?	0xFFFF914D	157
?	0xFFFF8C47	1575
?	0xFFFF6308	158
?	0xFFFF701A	1585
?	0xFFED5100	159
?	0xFFF26300	1595
?	0xFFAD4200	160
?	0xFFB34F00	1605
?	0xFF5C2C00	161
?	0xFF914000	1615
?	0xFFFFD9C7	162
?	0xFFFFB0A1	1625
?	0xFFFFB08F	163
?	0xFFFF9C85	1635
?	0xFFFF8A45	164
?	0xFFFF8257	1645
?	0xFFFF690A	165
?	0xFFFF5E17	1655
?	0xFFFF5C00	166
?	0xFFFF5200	1665
?	0xFFD45500	167
?	0xFFB83D00	1675
?	0xFF692D00	168
?	0xFF8F2E00	1685
?	0xFFFFCCCC	169

?	0xFFFF998F	170
?	0xFFFF7852	171
?	0xFFFF571F	172
?	0xFFF54C00	173
?	0xFFA33100	174
?	0xFF662400	175
?	0xFFFFBFD1	176
?	0xFFFF9EC9	1765
?	0xFFFFBAE0	1767
?	0xFFFF8C99	177
?	0xFFFF87B5	1775
?	0xFFFF6BA3	1777
?	0xFFFF6970	178
?	0xFFFF5480	1785
?	0xFFFF3D66	1787
?	0xFFFF291F	1788
?	0xFFFF3600	179
?	0xFFFF0F00	1795
?	0xFFF50002	1797
?	0xFFE33000	180
?	0xFFC41200	1805
?	0xFFB80007	1807
?	0xFF872300	181
?	0xFF7D0C00	1815
?	0xFF570900	1817
?	0xFFFFBDE6	182
?	0xFFFF8AC9	183
?	0xFFFF5296	184
?	0xFFFF173D	185
?	0xFFF5002F	186
?	0xFFCC002B	187
?	0xFF800400	188
?	0xFFFFA1E6	189
?	0xFFFFB8ED	1895
?	0xFFFF73C7	190
?	0xFFFF96E8	1905
?	0xFFFF3D9E	191
?	0xFFFF4ACC	1915
?	0xFFFF0052	192
?	0xFFFF0073	1925
?	0xFFDE004B	193
?	0xFFF20068	1935
?	0xFFAB003E	194
?	0xFFCF005B	1945
?	0xFF73002E	195
?	0xFFA10040	1955
?	0xFFFFBFF5	196
?	0xFFFF8CE6	197
?	0xFFFF38AB	198
?	0xFFFF0061	199
?	0xFFE00053	200
?	0xFFB50043	201
?	0xFF910039	202

?	0xFFFFA8F7	203
?	0xFFFF6BF7	204
?	0xFFFF29E8	205
?	0xFFF70099	206
?	0xFFCF0076	207
?	0xFFA10067	208
?	0xFF78004F	209
?	0xFFFF9CF0	210
?	0xFFFF73EB	211
?	0xFFFF47E3	212
?	0xFFFF0DBA	213
?	0xFFEB009B	214
?	0xFFBA0079	215
?	0xFF82074E	216
?	0xFFFFB8FF	217
?	0xFFFA63FF	218
?	0xFFFC1FFF	219
?	0xFFD400B8	220
?	0xFFB30098	221
?	0xFF69005E	222
?	0xFFFF8AFF	223
?	0xFFFC5EFF	224
?	0xFFFC2BFF	225
?	0xFFFF00FF	226
?	0xFFCF00C0	227
?	0xFF960090	228
?	0xFF660057	229
?	0xFFFFA8FF	230
?	0xFFFC7AFF	231
?	0xFFF754FF	232
?	0xFFE300FF	233
?	0xFFB100BD	234
?	0xFF910099	235
?	0xFFFCB3FF	236
?	0xFFFABAFF	2365
?	0xFFF782FF	237
?	0xFFE66EFF	2375
?	0xFFF05EFF	238
?	0xFFCF36FF	2385
?	0xFFE336FF	239
?	0xFFBA0DFF	2395
?	0xFFD10FFF	240
?	0xFFA800FF	2405
?	0xFFB600FA	241
?	0xFF9D00EB	2415
?	0xFF750082	242
?	0xFF7700BD	2425
?	0xFFF2B5FF	243
?	0xFFE89EFF	244
?	0xFFDB78FF	245
?	0xFFB51AFF	246
?	0xFFA300FF	247
?	0xFF9600FA	248

?	0xFF6E00B8	249
?	0xFFF2D1FF	250
?	0xFFDE9CFF	251
?	0xFFC270FF	252
?	0xFF910DFF	253
?	0xFF8000FF	254
?	0xFF5E00BF	255
?	0xFFEDCCFF	256
?	0xFFCFA6FF	2562
?	0xFFC7ABFF	2563
?	0xFFB5A3FF	2567
?	0xFFDBA8FF	257
?	0xFFB387FF	2572
?	0xFFB391FF	2573
?	0xFF998CFF	2577
?	0xFF913DFF	258
?	0xFF8A47FF	2582
?	0xFF8A5EFF	2583
?	0xFF6957FF	2587
?	0xFF5F00D9	259
?	0xFF661AFF	2592
?	0xFF631CFF	2593
?	0xFF2600FF	2597
?	0xFF5B00BD	260
?	0xFF5C00F7	2602
?	0xFF4D00FA	2603
?	0xFF2D00ED	2607
?	0xFF500099	261
?	0xFF4F00DB	2612
?	0xFF5000D9	2613
?	0xFF2E00D9	2617
?	0xFF3F0073	262
?	0xFF3C008F	2622
?	0xFF4700AD	2623
?	0xFF2800B0	2627
?	0xFFE6DBFF	263
?	0xFFB8BAFF	2635
?	0xFFBDB8FF	264
?	0xFF99A3FF	2645
?	0xFF7570FF	265
?	0xFF7582FF	2655
?	0xFF361AFF	266
?	0xFF6166FF	2665
?	0xFF1C00FF	267
?	0xFF2800E0	268
?	0xFF0900E6	2685
?	0xFF2600AB	269
?	0xFF0C0082	2695
?	0xFFB0BAFF	270
?	0xFF99B3FF	2705
?	0xFFCFE8FF	2706
?	0xFFD4F0FF	2707
?	0xFFBDE6FF	2708

?	0xFF91A1FF	271
?	0xFF6E8CFF	2715
?	0xFF8CB5FF	2716
?	0xFFB5E0FF	2717
?	0xFF5496FF	2718
?	0xFF6B85FF	272
?	0xFF3B52FF	2725
?	0xFF3657FF	2726
?	0xFF4A94FF	2727
?	0xFF0A4FFF	2728
?	0xFF0009EB	273
?	0xFF000DFF	2735
?	0xFF0017FF	2736
?	0xFF0020FA	2738
?	0xFF0000B8	274
?	0xFF000BD9	2745
?	0xFF0012E6	2746
?	0xFF001ED9	2747
?	0xFF001AD9	2748
?	0xFF030091	275
?	0xFF0005B3	2755
?	0xFF000BB5	2756
?	0xFF0020B3	2757
?	0xFF0026BD	2758
?	0xFF020073	276
?	0xFF00048C	2765
?	0xFF000887	2766
?	0xFF001A75	2767
?	0xFF001F8F	2768
?	0xFFBAEDFF	277
?	0xFF9CDBFF	278
?	0xFF52A8FF	279
?	0xFF003BD1	280
?	0xFF0031AD	281
?	0xFF002675	282
?	0xFFA6E8FF	283
?	0xFF73CFFF	284
?	0xFF1C91FF	285
?	0xFF0055FA	286
?	0xFF0048E0	287
?	0xFF0041C4	288
?	0xFF00246B	289
?	0xFFBFFAFF	290
?	0xFF96FAFF	2905
?	0xFFABF7FF	291
?	0xFF69EDFF	2915
?	0xFF82E3FF	292
?	0xFF26C2FF	2925
?	0xFF006BFA	293
?	0xFF008AFF	2935
?	0xFF0055C9	294
?	0xFF0079DB	2945
?	0xFF0045A1	295

?	0xFF0058A1	2955
?	0xFF00294D	296
?	0xFF00395C	2965
?	0xFF82FCFF	297
?	0xFFB3FFF2	2975
?	0xFF4FEDFF	298
?	0xFF69FFF0	2985
?	0xFF26CFFF	299
?	0xFF1AE3FF	2995
?	0xFF008FFF	300
?	0xFF00A0FA	3005
?	0xFF0073D1	301
?	0xFF0089CC	3015
?	0xFF006080	302
?	0xFF00687D	3025
?	0xFF003B42	303
?	0xFF004744	3035
?	0xFFB3FFEB	304
?	0xFF7DFFE8	305
?	0xFF40FFED	306
?	0xFF009CBA	307
?	0xFF008087	308
?	0xFF004741	309
?	0xFF91FFE6	310
?	0xFF91FFE0	3105
?	0xFF5EFFE0	311
?	0xFF5EFFD1	3115
?	0xFF0AFFE3	312
?	0xFF2BFFC9	3125
?	0xFF00DECC	313
?	0xFF00E8C3	3135
?	0xFF00B3A2	314
?	0xFF00C49F	3145
?	0xFF009180	315
?	0xFF009E78	3155
?	0xFF00523C	316
?	0xFF005940	3165
?	0xFFD1FFEB	317
?	0xFF9EFFD9	318
?	0xFF7AFFCF	319
?	0xFF00EDA4	320
?	0xFF00C487	321
?	0xFF00A66F	322
?	0xFF008754	323
?	0xFFB8FFE0	324
?	0xFFA1FFD1	3242
?	0xFFA8FFCF	3245
?	0xFF91FFC2	3248
?	0xFF70FFBD	325
?	0xFF87FFC2	3252
?	0xFF82FFB8	3255
?	0xFF69FFAB	3258
?	0xFF21FF9E	326

?	0xFF4AFFAB	3262
?	0xFF4FFFA1	3265
?	0xFF1AFF82	3268
?	0xFF00D477	327
?	0xFF00FF8F	3272
?	0xFF0DFF87	3275
?	0xFF00F26D	3278
?	0xFF00AD5F	328
?	0xFF00D975	3282
?	0xFF00ED77	3285
?	0xFF00CC5E	3288
?	0xFF008A4A	329
?	0xFF008A46	3292
?	0xFF00C95F	3295
?	0xFF009440	3298
?	0xFF006635	330
?	0xFF004F24	3302
?	0xFF006327	3305
?	0xFF00471D	3308
?	0xFFC2FFD6	331
?	0xFFB3FFCC	332
?	0xFF91FFBA	333
?	0xFF00F763	334
?	0xFF00B33E	335
?	0xFF00872D	336
?	0xFFB0FFCC	337
?	0xFFA6FFBF	3375
?	0xFF87FFAD	338
?	0xFF8CFFAB	3385
?	0xFF29FF70	339
?	0xFF63FF8C	3395
?	0xFF00E84F	340
?	0xFF26FF59	3405
?	0xFF00B53C	341
?	0xFF00C72E	3415
?	0xFF00912A	342
?	0xFF009421	3425
?	0xFF02631C	343
?	0xFF005710	3435
?	0xFFBAFFC4	344
?	0xFF9EFFAD	345
?	0xFF73FF87	346
?	0xFF00F723	347
?	0xFF00C21D	348
?	0xFF00940D	349
?	0xFF0D4000	350
?	0xFFD4FFD6	351
?	0xFFBAFFBF	352
?	0xFF9EFFA3	353
?	0xFF33FF1A	354
?	0xFF0FFF00	355
?	0xFF09BA00	356
?	0xFF167000	357

?	0xFFBAFF9E	358
?	0xFFA3FF82	359
?	0xFF6BFF33	360
?	0xFF4FFF00	361
?	0xFF46E800	362
?	0xFF3EC200	363
?	0xFF349400	364
?	0xFFE0FFB5	365
?	0xFFCCFF8F	366
?	0xFFADFF69	367
?	0xFF6EFF00	368
?	0xFF61ED00	369
?	0xFF52BA00	370
?	0xFF407000	371
?	0xFFE6FFAB	372
?	0xFFD6FF8A	373
?	0xFFC2FF6E	374
?	0xFF96FF38	375
?	0xFF74F200	376
?	0xFF6BC200	377
?	0xFF436600	378
?	0xFFE8FF6B	379
?	0xFFDEFF47	380
?	0xFFCCFF17	381
?	0xFFB5FF00	382
?	0xFFA5CF00	383
?	0xFF90B000	384
?	0xFF686B00	385
?	0xFFF0FF70	386
?	0xFFE6FF42	387
?	0xFFDBFF36	388
?	0xFFCCFF26	389
?	0xFFB7EB00	390
?	0xFF95AB00	391
?	0xFF798200	392
?	0xFFF7FF73	393
?	0xFFFCFF52	3935
?	0xFFF0FF3D	394
?	0xFFF7FF26	3945
?	0xFFEBFF26	395
?	0xFFF0FF00	3955
?	0xFFE3FF0F	396
?	0xFFEBFF00	3965
?	0xFFCCE300	397
?	0xFFB5B500	3975
?	0xFFABB800	398
?	0xFF969200	3985
?	0xFF919100	399
?	0xFF5C5900	3995
?	0xFFD6D0C9	400
?	0xFFC4BBAF	401
?	0xFFB0A597	402
?	0xFF918779	403

?	0xFF706758	404
?	0xFF474030	405
?	0xFFD6CBC9	406
?	0xFFBDAEAC	407
?	0xFFA89796	408
?	0xFF8C7A77	409
?	0xFF705C59	410
?	0xFF47342E	411
?	0xFF050402	412
?	0xFFCCCCBA	413
?	0xFFB3B3A1	414
?	0xFF969684	415
?	0xFF80806B	416
?	0xFF585943	417
?	0xFF3E402C	418
?	0xFF000000	419
?	0xFFD9D9D9	420
?	0xFFBDBDBD	421
?	0xFFABABAB	422
?	0xFF8F8F8F	423
?	0xFF636363	424
?	0xFF3B3B3B	425
?	0xFF000000	426 /* TODO: duplicate case value */
?	0xFFE3E3E3	427
?	0xFFCDD1D1	428
?	0xFFA8ADAD	429
?	0xFF858C8C	430
?	0xFF525B5C	431
?	0xFF2D393B	432
?	0xFF090C0D	433
?	0xFFEDE6E8	434
?	0xFFDED6DB	435
?	0xFFC2BFBF	436
?	0xFF8A8C8A	437
?	0xFF394500	438
?	0xFF293300	439
?	0xFF202700	440
?	0xFFDAE8D8	441
?	0xFFBECFBC	442
?	0xFF9DB39D	443
?	0xFF7E947E	444
?	0xFF475947	445
?	0xFF324031	446
?	0xFF272E20	447
?	0xFF2D3E00	448
?	0xFF4F3A00	4485
?	0xFF3D5200	449
?	0xFF8A6E07	4495
?	0xFF506700	450
?	0xFFA38B24	4505
?	0xFFABB573	451
?	0xFFC2B061	4515

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?	0xFFD4C581	4525
?	0xFFDBE3BF	453
?	0xFFE3DA9F	4535
?	0xFFE8EDD6	454
?	0xFFF0E9C2	4545
?	0xFF594A00	455
?	0xFF917C00	456
?	0xFFB89C00	457
?	0xFFE6E645	458
?	0xFFF0ED73	459
?	0xFFF5F28F	460
?	0xFFF7F7A6	461
?	0xFF402600	462
?	0xFF361500	4625
?	0xFF6B3D00	463
?	0xFF8F4A06	4635
?	0xFF955300	464
?	0xFFB8743B	4645
?	0xFFCCAD6B	465
?	0xFFD19B73	4655
?	0xFFE0C791	466
?	0xFFE6BC9C	4665
?	0xFFE8D9A8	467
?	0xFFF0D5BD	4675
?	0xFFF0E8C4	468
?	0xFFF5E4D3	4685
?	0xFF4A1A00	469
?	0xFF420D00	4695
?	0xFFAB4800	470
?	0xFF823126	4705
?	0xFFD15600	471
?	0xFFA8625D	4715
?	0xFFFFA87A	472
?	0xFFBF827C	4725
?	0xFFFFC4A3	473
?	0xFFD9A9A7	4735
?	0xFFFFD9BD	474
?	0xFFE6BEBC	4745
?	0xFFFFE3CC	475
?	0xFFF0D8D3	4755
?	0xFF381C00	476
?	0xFF4F1800	477
?	0xFF6B1200	478
?	0xFFB08573	479
?	0xFFD9B5B0	480
?	0xFFE8CFC9	481
?	0xFFF2E0DE	482
?	0xFF660700	483
?	0xFFB50900	484
?	0xFFFF0D00	485
?	0xFFFF8796	486
?	0xFFFFA6B8	487

?	0xFFFFBDCF	488
?	0xFFFFD9E3	489
?	0xFF471300	490
?	0xFF7A1A00	491
?	0xFF942200	492
?	0xFFF283BB	493
?	0xFFFFABDE	494
?	0xFFFFC2E3	495
?	0xFFFFD6E8	496
?	0xFF381100	497
?	0xFF330E00	4975
?	0xFF662500	498
?	0xFF853241	4985
?	0xFF853100	499
?	0xFFA85868	4995
?	0xFFE38DB3	500
?	0xFFC47A8F	5005
?	0xFFF7B5D7	501
?	0xFFE3AAC1	5015
?	0xFFFCCFE3	502
?	0xFFEDC2D1	5025
?	0xFFFFE3EB	503
?	0xFFF7DFE1	5035
?	0xFF320000	504
?	0xFF600000	505
?	0xFF770000	506
?	0xFFDE82C4	507
?	0xFFF2A3E3	508
?	0xFFFFC2ED	509
?	0xFFFFD4F0	510
?	0xFF3D0066	511
?	0xFF2B0041	5115
?	0xFF6100CE	512
?	0xFF592482	5125
?	0xFF8A1FFF	513
?	0xFF8257B8	5135
?	0xFFD980FF	514
?	0xFFB38CE0	5145
?	0xFFED9EFF	515
?	0xFFD4B3EB	5155
?	0xFFF7BAFF	516
?	0xFFE8CFF2	5165
?	0xFFFFD1FF	517
?	0xFFF2E0F7	5175
?	0xFF2E005C	518
?	0xFF1C0022	5185
?	0xFF44009D	519
?	0xFF3D0C4E	5195
?	0xFF5C00E0	520
?	0xFF7A5E85	5205
?	0xFFBA87FF	521
?	0xFFB59EC2	5215
?	0xFFD4A1FF	522

?	0xFFD4BAD9	5225
?	0xFFE6BDFF	523
?	0xFFE6D4E6	5235
?	0xFFF0D9FF	524
?	0xFFF0E6ED	5245
?	0xFF270085	525
?	0xFF0D0B4D	5255
?	0xFF3B00ED	526
?	0xFF20258A	5265
?	0xFF4500FF	527
?	0xFF3848A8	5275
?	0xFF9673FF	528
?	0xFF7280C4	5285
?	0xFFBD99FF	529
?	0xFFA8B3E6	5295
?	0xFFD1B0FF	530
?	0xFFC7CEED	5305
?	0xFFE6CCFF	531
?	0xFFE4E4F2	5315
?	0xFF00193F	532
?	0xFF00227B	533
?	0xFF002CAA	534
?	0xFF94B3ED	535
?	0xFFB0C7F2	536
?	0xFFC7DBF7	537
?	0xFFDEE8FA	538
?	0xFF00274D	539
?	0xFF00223D	5395
?	0xFF003473	540
?	0xFF3A728A	5405
?	0xFF00449E	541
?	0xFF5A8A96	5415
?	0xFF5EC1F7	542
?	0xFF79A6AD	5425
?	0xFF96E3FF	543
?	0xFFB8CDD4	5435
?	0xFFB3F0FF	544
?	0xFFCCDCDE	5445
?	0xFFC7F7FF	545
?	0xFFDAE8E8	5455
?	0xFF02272B	546
?	0xFF002B24	5463
?	0xFF000D09	5467
?	0xFF003440	547
?	0xFF167A58	5473
?	0xFF1D4230	5477
?	0xFF00465C	548
?	0xFF43B08B	5483
?	0xFF48705D	5487
?	0xFF56ADBA	549
?	0xFF73C9AD	5493
?	0xFF829E90	5497
?	0xFF7BC1C9	550

?	0xFF9CDBC5	5503
?	0xFFA1B5A8	5507
?	0xFFA2D7DE	551
?	0xFFC7F2E1	5513
?	0xFFBED1C5	5517
?	0xFFC5E8E8	552
?	0xFFDCF7EB	5523
?	0xFFD5E3DA	5527
?	0xFF143319	553
?	0xFF102E14	5535
?	0xFF115422	554
?	0xFF327A3D	5545
?	0xFF187031	555
?	0xFF5A9E68	5555
?	0xFF66BA80	556
?	0xFF84BD8F	5565
?	0xFF98D9AD	557
?	0xFFA9D4B2	5575
?	0xFFBAE8CA	558
?	0xFFCAE6CC	5585
?	0xFFCEF0D8	559
?	0xFFDDEDDA	5595
?	0xFF0D4018	560
?	0xFF050F07	5605
?	0xFF127A38	561
?	0xFF2E522B	5615
?	0xFF1AB058	562
?	0xFF5A7D57	5625
?	0xFF79FCAC	563
?	0xFF89A386	5635
?	0xFFA1FFCC	564
?	0xFFAEBFA6	5645
?	0xFFC4FFDE	565
?	0xFFC5D1BE	5655
?	0xFFDBFFE8	566
?	0xFFDAE6D5	5665
?	0xFF0E4D1C	567
?	0xFF14A346	568
?	0xFF04D45B	569
?	0xFF85FFB5	570
?	0xFFADFFCF	571
?	0xFFC4FFDB	572
?	0xFFDBFFE8	573 /* TODO: duplicate case value */
?	0xFF314A0E	574
?	0xFF1F2E07	5743
?	0xFF243600	5747
?	0xFF3E7800	575
?	0xFF3F5410	5753
?	0xFF547306	5757
?	0xFF4F9C00	576
?	0xFF5C6E1D	5763
?	0xFF849C32	5767

?	0xFFAEE67C	577
?	0xFF909E5A	5773
?	0xFFA5B85E	5777
?	0xFFC0F090	578
?	0xFFAFBA86	5783
?	0xFFCEDE99	5787
?	0xFFCDF7A3	579
?	0xFFC9D1A5	5793
?	0xFFDCE8B0	5797
?	0xFFDCFAB9	580
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?	0xFFE9F0CE	5807
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?	0xFF999632	5835
?	0xFFD3F032	584
?	0xFFB3B15F	5845
?	0xFFDEFA55	585
?	0xFFD1D190	5855
?	0xFFE8FF78	586
?	0xFFDEDEA6	5865
?	0xFFF2FF99	587
?	0xFFEBEBC0	5875
?	0xFFFFFFB5	600
?	0xFFFFFF99	601
?	0xFFFFFF7D	602 /* TODO: duplicate case value */
?	0xFFFCFC4E	603
?	0xFFF7F71E	604
?	0xFFEDE800	605
?	0xFFE0D700	606
?	0xFFFCFCCF	607
?	0xFFFAFAAA	608
?	0xFFF5F584	609
?	0xFFF0F065	610
?	0xFFE3E112	611
?	0xFFCCC800	612
?	0xFFB3AB00	613
?	0xFFF5F5C4	614
?	0xFFF0EDAF	615
?	0xFFE8E397	616
?	0xFFD4CF6E	617
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?	0xFF918C00	619
?	0xFF787200	620
?	0xFFD9FAE1	621
?	0xFFBAF5C6	622
?	0xFF9CE6AE	623
?	0xFF72CC85	624
?	0xFF4BAB60	625

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?	0xFF04290A	627
?	0xFFCFFFF0	628
?	0xFFA8FFE8	629
?	0xFF87FFE3	630
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?	0xFFADFFEB	635
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?	0xFF73FFE8	637
?	0xFF2BFFE6	638
?	0xFF00F2E6	639
?	0xFF00C7C7	640
?	0xFF00ABB3	641
?	0xFFD2F0FA	642
?	0xFFB8E4F5	643
?	0xFF8BCCF0	644
?	0xFF64A7E8	645
?	0xFF4696E3	646
?	0xFF0056C4	647
?	0xFF002D75	648
?	0xFFD9EDFC	649
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?	0xFF00399E	654
?	0xFF002B7A	655
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?	0xFFC2EBFF	657
?	0xFF96CCFF	658
?	0xFF5CA6FF	659
?	0xFF1A6EFF	660
?	0xFF0048E8	661
?	0xFF003BD1	662 /* TODO: duplicate case value */
?	0xFFEDF0FF	663
?	0xFFE3E8FF	664
?	0xFFC8CFFA	665
?	0xFFA4A6ED	666
?	0xFF6970DB	667
?	0xFF3E40B3	668
?	0xFF201E87	669
?	0xFFFFDEFF	670
?	0xFFFCCCFF	671
?	0xFFF7A8FF	672
?	0xFFF082FF	673
?	0xFFE854FF	674
?	0xFFCD00F7	675
?	0xFFBB00C7	676
?	0xFFFADEFF	677

?	0xFFF7C9FF	678
?	0xFFF2BAFF	679
?	0xFFE18EFA	680
?	0xFFC15FF5	681
?	0xFFA82FE0	682
?	0xFF810091	683
?	0xFFFACFFA	684
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?	0xFFDC7EE0	687
?	0xFFC459CF	688
?	0xFF9D27A8	689
?	0xFF690369	690
?	0xFFFCD7E8	691
?	0xFFFAC0E1	692
?	0xFFF0A8D3	693
?	0xFFE683BA	694
?	0xFFBF508A	695
?	0xFF991846	696
?	0xFF7D0925	697
?	0xFFFFD6EB	698
?	0xFFFFC2E6	699
?	0xFFFFA3DB	700
?	0xFFFF78CC	701
?	0xFFF24BA0	702
?	0xFFD62463	703
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?	0xFFFFB3DB	707
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?	0xFFFFB875	714
?	0xFFFFA14A	715
?	0xFFFF8717	716
?	0xFFFA7000	717
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?	0xFFFFE6BF	719
?	0xFFFCD7A7	720
?	0xFFF7BC77	721
?	0xFFE89538	722
?	0xFFD4740B	723
?	0xFFA14C00	724
?	0xFF823B00	725
?	0xFFFAE6C0	726
?	0xFFF2CEA0	727
?	0xFFE6B577	728
?	0xFFD19052	729
?	0xFFB56E2B	730

?	0xFF753700	731
?	0xFF5C2800	732
?	0xFFFFF5D1	7401
?	0xFFFFF0B3	7402
?	0xFFFFE680	7403
?	0xFFFFE833	7404 /* TODO: duplicate case value */
?	0xFFFFE600	7405 /* TODO: duplicate case value */
?	0xFFFFD100	7406
?	0xFFE3B122	7407
?	0xFFFFBF0D	7408
?	0xFFFFB30D	7409
?	0xFFFFB373	7410
?	0xFFFFA64F	7411
?	0xFFED8A00	7412
?	0xFFF57300	7413
?	0xFFE37B00	7414
?	0xFFFFD1D9	7415
?	0xFFFF6666	7416
?	0xFFFF4040	7417
?	0xFFF24961	7418
?	0xFFD15473	7419
?	0xFFCC2976	7420
?	0xFF630046	7421
?	0xFFFFE8F2	7422 /* TODO: duplicate case value */
?	0xFFFF73C7	7423 /* TODO: duplicate case value */
?	0xFFFF40B3	7424
?	0xFFED18A6	7425
?	0xFFD10073	7426
?	0xFFB80040	7427
?	0xFF73173F	7428
?	0xFFFFD1F7	7429
?	0xFFFAB0FF	7430
?	0xFFF296ED	7431
?	0xFFE667DF	7432
?	0xFFD936B8	7433
?	0xFFCC29AD	7434
?	0xFFA60095	7435
?	0xFFF7EBFF	7436
?	0xFFF0CCFF	7437
?	0xFFD9A6FF	7438
?	0xFFCCA6FF	7439
?	0xFFB399FF	7440
?	0xFFA380FF	7441
?	0xFF804DFF	7442
?	0xFFF0F2FF	7443
?	0xFFCCD4FF	7444
?	0xFFADC6F7	7445
?	0xFF919EFF	7446
?	0xFF5357CF	7447

?	0xFF4E4373	7448
?	0xFF270020	7449
?	0xFFCCE6FF	7450
?	0xFF99C9FF	7451
?	0xFF80ADFF	7452
?	0xFF80BDFF	7453
?	0xFF73AEE6	7454
?	0xFF3378FF	7455
?	0xFF6B9AED	7456
?	0xFFE0FFFA	7457
?	0xFF90F0E4	7458
?	0xFF5FDED1	7459
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?	0xFF38B8FF	7461
?	0xFF0073E6	7462
?	0xFF003359	7463
?	0xFFBFFFE6	7464
?	0xFF80FFBF	7465
?	0xFF4DFFC4	7466
?	0xFF0DFFBF	7467
?	0xFF00A5B8	7468
?	0xFF007A99	7469
?	0xFF1C778C	7470
?	0xFFB8FFDB	7471
?	0xFF7AFFBF	7472
?	0xFF46EB91	7473
?	0xFF14C78F	7474
?	0xFF59B386	7475
?	0xFF00663A	7476
?	0xFF105249	7477
?	0xFFD1FFDB	7478
?	0xFF73FF80	7479
?	0xFF66FF80	7480
?	0xFF66FF73	7481
?	0xFF33FF40	7482
?	0xFF117300	7483
?	0xFF008013	7484
?	0xFFF0FFE6	7485
?	0xFFCCFFB3	7486
?	0xFFB3FF8C	7487
?	0xFF91FF66	7488
?	0xFF5FED2F	7489
?	0xFF5BA621	7490
?	0xFF689900	7491
?	0xFFD1ED77	7492
?	0xFFC5E693	7493
?	0xFFA3D982	7494
?	0xFF86B324	7495
?	0xFF5F9E00	7496
?	0xFF738639	7497
?	0xFF263300	7498
?	0xFFFFFAD9	7499
?	0xFFF7F2D2	7500

?	0xFFF0E6C0	7501
?	0xFFE6D395	7502
?	0xFFBFA87C	7503
?	0xFF997354	7504
?	0xFF735022	7505
?	0xFFFFF2D9	7506
?	0xFFFFE6B3	7507
?	0xFFF5D093	7508
?	0xFFF2C279	7509
?	0xFFE39F40	7510
?	0xFFBF6900	7511
?	0xFFAB5C00	7512
?	0xFFF7CBB2	7513
?	0xFFF2B896	7514
?	0xFFE09270	7515
?	0xFFA65000	7516
?	0xFF8F3900	7517
?	0xFF663D2E	7518
?	0xFF423500	7519
?	0xFFFFD6CF	7520
?	0xFFE6ACB8	7521
?	0xFFD68196	7522
?	0xFFCC7A85	7523
?	0xFFBA544A	7524
?	0xFFB36259	7525
?	0xFFA63A00	7526
?	0xFFEDE8DF	7527
?	0xFFE6DFCF	7528
?	0xFFD4CBBA	7529
?	0xFFADA089	7530
?	0xFF80735D	7531
?	0xFF594A2D	7532
?	0xFF261E06	7533
?	0xFFE6E1D3	7534
?	0xFFCCC6AD	7535
?	0xFFADA687	7536
?	0xFFC6CCB8	7537
?	0xFFA2B39B	7538
?	0xFFA0A395	7539
?	0xFF474747	7540
?	0xFFEDF2F2	7541
?	0xFFC1D6D0	7542
?	0xFFA6B3B3	7543
?	0xFF8A9799	7544
?	0xFF495C5E	7545
?	0xFF304547	7546
?	0xFF0A0F0F	7547

A.16 PCM Color Codes

A.17 PEC Color Codes

A.18 Robinson Anton Polyester Codes

A.19 Sigma Polyester Codes

A.20 Sulky Rayon Colors

A.21 SVG Colors

Converted from the table at: https://www.w3.org/TR/SVGb/types.html#ColorKeywords

NOTE: This supports both UK and US English names, so the repeated values aren't an error.

A.22 ThreadArt Threads

A.23 ThreaDelight Polyester Codes

A.24 Z102 Threads

Table A.17: = Z102 Isacord Polyester

Name	RGB hex code	Catalog Code
?	0xF8FFFF	17
?	0x000000	20
?	0xB7BABA	105
?	0x73787A	108
?	0x454B58	138
?	0x9EA9A6	142
?	0xC8C6BD	150
?	0xFAEE5C	220
?	0xE5CB4F	221
?	0xFFF46A	230
?	0xFEF9D9	270
?	0xFFDC00	311
?	0x624F00	345
?	0xB8B25A	352
?	0x8D8F5B	453
?	0xFFF4A5	520
?	0xB98E03	542
?	0xE4C180	651
?	0xC5BFA6	672
?	0x96836D	722
?	0x4E3500	747
?	0xDDCBA5	761
?	0x605840	776
?	0xFFAF02	800
?	0xF6AE32	811
?	0xC89334	822
?	0xE59300	824
?	0xC89340	832
?	0x9E947F	873
?	0xC8700B	922
?	0xBB5704	931
?	0xB19072	1061
?	0xFF8101	1102
?	0xB1500A	1115
?	0xC09C72	1123
?	0x843D07	1134
?	0xD8A67D	1141
?	0x82421B	1154
?	0xFF7319	1300
?	0xFF3D1E	1305
?	0xBA4005	1311
?	0xC73C13	1312
?	0xE66B21	1332
?	0x3D1C11	1346
?	0xFFBC95	1351
?	0xFFCC93	1362
?	0x373732	1375
?	0xFFAF94	1532
?	0x5B4032	1565
?	0xFF6046	1600
?	0xFF6D71	1753

?	0xEBBAAE	1755
?	0xEB2D2B	1805
?	0xFF988F	1840
?	0x434331	1874
?	0xC11914	1902
?	0xC8100D	1903
?	0xBF0A21	1906
?	0xD23C3E	1921
?	0x8F8C93	1972
?	0xA31A1C	2011
?	0x4D0308	2115
?	0xFFCDCC	2155
?	0x871C45	2500
?	0xDB4083	2508
?	0xFF668A	2520
?	0xC91243	2521
?	0xFFA0B6	2530
?	0xFEA5B9	2550
?	0x626C7E	2674
?	0x5E1942	2711
?	0x33001D	2715
?	0xA57B8D	2764
?	0x702A69	2810
?	0xB385BC	2830
?	0x240047	2900
?	0x724593	2910
?	0x634D86	2920
?	0x000136	3110
?	0x000021	3355
?	0x054ABD	3522
?	0x1C005D	3541
?	0x001F71	3544
?	0x002E5E	3622
?	0x71AAD8	3630
?	0x001748	3644
?	0xC8DBE4	3650
?	0x9FC7DF	3730
?	0x082E4D	3743
?	0x98B0BC	3750
?	0x23679C	3810
?	0x3D657E	3842
?	0x00669F	3901
?	0x47AEDD	3910
?	0xBBDFEB	3962
?	0xBABEB7	3971
?	0x015D7E	4032
?	0xD5DDDB	4071
?	0x888D8E	4073
?	0x007CA6	4103
?	0x3EBBC8	4111
?	0x005C79	4116
?	0x80CCD8	4240
?	0xACCEC7	4250

?	0x006E74	4410
?	0x002A29	4515
?	0x38A4AE	4620
?	0xAFD8CD	5050
?	0x149B7B	5210
?	0x7AC8AF	5220
?	0x187166	5233
?	0x004B23	5374
?	0x006835	5415
?	0x5C9C51	5531
?	0x0E9543	5613
?	0x5E7A17	5833
?	0x225926	5944
?	0xBCD633	6011
?	0xBBCD91	6051
?	0x978B3C	6133

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