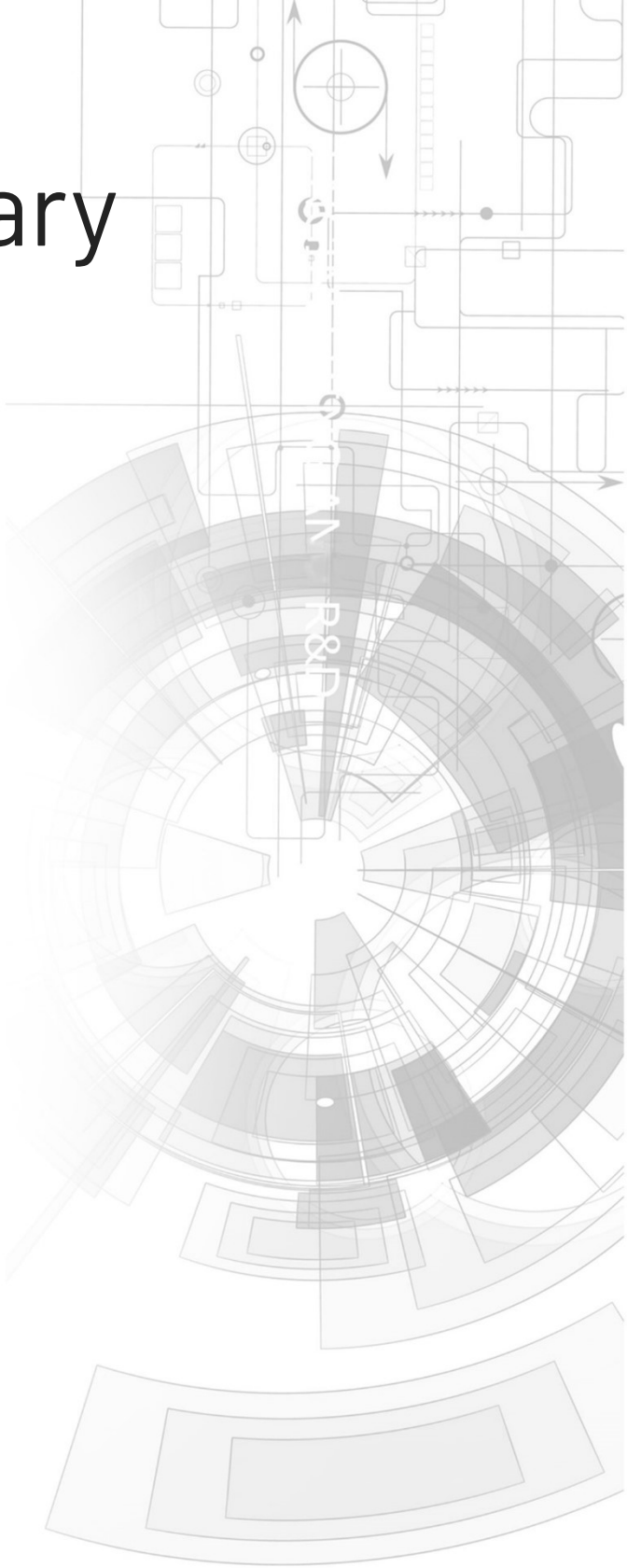
Graphics4D Library



Manual

Revision 1.1

Contents

1. Introduction

The Graphics4D Library is provided by 4D Systems for use with gen4-RP2350-XX product series. This library provides users access to the graphics and touch features of 4D Systems' RP2350 display modules.

Note however that some functionalities might not be supported by a certain product types, depending on its specifications. For instance, non-touch variants have no access to all touch-related functions. For more information on the specifications of a product, refer to its datasheet.

It is recommended to use Workshop5 IDE to get the most out of the library functions.

> **Note**
>
> Workshop5 is a **Windows-only** application.

2. Library Setup

When using Workshop5, the library is automatically included in the code.

```
#include "Graphics4D.h"
#include "GeneratedConsts.h"
```

The library can be included to projects using the header file `Graphics4D.h`

Additionally, Workshop5 generates a project specific header file `GeneratedConsts.h` which includes constants and useful functions.

By including the Graphics4D library, the main user code gains access to `gfx`, `img` and `touch` functions.

3. Initializing the Library

Before using library functions to draw to the screen or detect touch for touch variants. The `gfx`, `img` and `touch` needs to initialized.

For `gfx` and `touch`, this can be done by simply using the following functions as shown:

```
gfx.Initialize();
touch.Initialize();
```

These two are responsible for basic graphical library features and touch handling.

For `img`, you'll need to prepare a handle and prepare the graphical resources available in flash memory or microSD card.

```
int main() {
    gfx.Initialize();
    touch.Initialize();
    hndl = img.LoadImageControl(GRAPHICS_GCX);
}
```

Where `GRAPHICS_GCX` can be a string indicating the graphics file to load from microSD or a pointer to a flash memory region containing the graphical resources. Note that the library only supports the graphical resources generated by Workshop5 IDE based on the user interface.

Workshop5 automatically generates the graphics file depending on project contents and define `GRAPHICS_GCX` in `GeneratedConsts.h`. The handle `hndl` is also declared in this file. Additionally, Workshop5 also generates a utility function `SetupMedia` that handles loading the graphical resources as well as providing useful parameters of the Workshop5 widgets added to the project.

A typical project will contain the code as shown:

```
#include "Graphics4D.h"
#include "GeneratedConsts.h"


int main() {

    // this is required for programming without manually entering bootloader
    stdio_init_all(); // must also enable usb stdio in CMakeLists
    // otherwise, manually put the board to bootloader mode

    gfx.Initialize();
    gfx.ScreenMode(PROJECT_ORIENTATION);
    gfx.Contrast(8);

    // touch.Initialize(); // uncomment when using touch

    // Uncomment when using widgets
    // SetupMedia(); // autogenerated helper function used to load graphical widgets

    // put your setup code here, to run once:

    while (true) {
        // put your main code here, to run repeatedly:

    }
}
```

4. Basic Graphics Functions

The following functions are included in `gfx`. These are basic draw functions including simple shapes.

4.1. Initialize

Initializes the graphics library and prepares the display for drawing.

Syntax: `gfx.Initialize();`

Argument	Type	Description
None	-	-

Return: `bool` - Returns `true` if initialization is successful; otherwise, `false`.

Example

```
if (gfx.Initialize()) {
    // Initialization successful
}
```

4.2. DrawWidget

Draws a widget at specified coordinates.

Syntax: `gfx.DrawWidget(num, f, x, y, gciArray);`

Argument	Type	Description
num	int	Widget ID number
f	int	Frame number or additional identifier
x	int	Horizontal position for widget
y	int	Vertical position for widget
gciArray	const uint8_t*	Pointer to widget graphics data

Return: None (*void*)

Example

```
gfx.DrawWidget(1, 0, 10, 10, myWidgetData);
// Draws widget ID 1 at (10, 10) using the specified graphics data
```

4.3. SetFramebuffer

Sets the framebuffer for direct access to the display buffer.

Syntax: `gfx.SetFramebuffer(buffer);`

Argument	Type	Description
buffer	uint16_t*	Pointer to the framebuffer memory

Return: None (*void*)

Example

```
gfx.SetFramebuffer(framebuffer);
// Sets the framebuffer for direct rendering
```

4.4. Reset

Resets the display to its initial state.

Syntax: `gfx.Reset();`

Argument	Type	Description
None	-	-

Return: None (*void*)

Example

```
gfx.Reset();
// Resets the display
```

4.5. SetBacklightLevel

Sets the backlight level of the display.

Syntax: `gfx.SetBacklightLevel(level);`

Argument	Type	Description
level	uint16_t	Backlight intensity level

Return: None (*void*)

Example

```
gfx.SetBacklightLevel(100);
// Sets the backlight level to 100
```

4.6. Contrast

Adjusts the display contrast.

Syntax: `gfx.Contrast(level);`

Argument	Type	Description
level	uint8_t	Contrast level (0-255)

Return: None (*void*)

Example

```
gfx.Contrast(128);
// Sets the contrast level to 128
```

4.7. GetWidth

Returns the width of the display in pixels.

Syntax: `gfx.GetWidth();`

Argument	Type	Description
None	-	-

Return: `uint` - Width of the display in pixels.

Example

```
uint width = gfx.GetWidth();
// Retrieves the display width
```

4.8. GetHeight

Returns the height of the display in pixels.

Syntax: `gfx.GetHeight();`

Argument	Type	Description
None	-	-

Return: `uint` - Height of the display in pixels.

Example

```
uint height = gfx.GetHeight();
// Retrieves the display height
```

4.9. ScreenMode

Sets the screen orientation mode.

Syntax: `gfx.ScreenMode(orientation);`

Argument	Type	Description
orientation	uint8_t	Screen orientation setting

Return: None (*void*)

Example

```
gfx.ScreenMode(1);
// Sets the screen orientation mode to 1
```

4.10. SetAddressWindow

Defines a rectangular area for subsequent drawing operations.

Syntax: `gfx.SetAddressWindow(x_start, y_start, x_end, y_end);`

Argument	Type	Description
x_start	uint16_t	Starting x-coordinate of the rectangle
y_start	uint16_t	Starting y-coordinate of the rectangle
x_end	uint16_t	Ending x-coordinate of the rectangle
y_end	uint16_t	Ending y-coordinate of the rectangle

Return: None (*void*)

Example

```
gfx.SetAddressWindow(10, 10, 100, 100);
// Defines a rectangular area from (10, 10) to (100, 100)
```

4.11. SendFrameBuffer

Sends a defined portion of the framebuffer to the display.

Syntax: `gfx.SendFrameBuffer(x1, y1, x2, y2);`

Argument	Type	Description
x1	uint	Horizontal starting position of the framebuffer area
y1	uint	Vertical starting position of the framebuffer area
x2	uint	Horizontal ending position of the framebuffer area
y2	uint	Vertical ending position of the framebuffer area

Return: None (*void*)

Example

```
gfx.SendFrameBuffer(0, 0, 50, 50);
// Sends the portion of the framebuffer from (0, 0) to (50, 50) to the display
```

4.12. GetFrameBuffer

Retrieves the pointer to the current framebuffer.

Syntax: `gfx.GetFrameBuffer();`

Argument	Type	Description
None	-	-

Return: `uint16_t*` - Pointer to the framebuffer.

Example

```
uint16_t* buffer = gfx.GetFrameBuffer();
// Gets a pointer to the framebuffer
```

4.13. BlendColor

Blends two colors based on a specified alpha value.

Syntax: `gfx.BlendColor(base_color, new_color, alpha);`

Argument	Type	Description
base_color	uint16_t	The base color to blend
new_color	uint16_t	The color to blend with the base
alpha	uint8_t	Alpha value for blending (0-255)

Return: `uint16_t` - The resulting color after blending.

Example

```
uint16_t blended = gfx.BlendColor(BLUE, RED, 128);
// Blends BLUE and RED with 50% opacity for RED
```

4.14. Cls

Clears the screen, optionally updating the framebuffer.

Syntax: `gfx.Cls(draw_fb);`

Argument	Type	Description
draw_fb	bool	Specifies whether to update the framebuffer

Return: None (*void*)

Example

```
gfx.Cls(true);
// Clears the screen and updates the framebuffer
```

4.15. RectangleFilled

Draws a solid rectangle with a specified color.

Syntax: `gfx.RectangleFilled(x1, y1, x2, y2, color, draw_fb);`

Argument	Type	Description
x1	int	Horizontal position of the first endpoint
y1	int	Vertical position of the first endpoint
x2	int	Horizontal position of the second endpoint
y2	int	Vertical position of the second endpoint
color	uint16_t	Color of the rectangle
draw_fb	bool	Specifies whether to update the framebuffer

Return: None (*void*)

Example

```
gfx.RectangleFilled(10, 10, 50, 50, GREEN, true);
// Draws a green filled rectangle from (10, 10) to (50, 50)
```

4.16. RectangleFilled (with color array)

Draws a solid rectangle using an array of colors.

Syntax: `gfx.RectangleFilled(x1, y1, x2, y2, colors, draw_fb);`

Argument	Type	Description
x1	int	Horizontal position of the first endpoint
y1	int	Vertical position of the first endpoint
x2	int	Horizontal position of the second endpoint
y2	int	Vertical position of the second endpoint
colors	const uint16_t*	Array of colors for filling the rectangle
draw_fb	bool	Specifies whether to update the framebuffer

Return: None (*void*)

Example

```
gfx.RectangleFilled(10, 10, 50, 50, myColorArray, true);
// Draws a filled rectangle with colors from myColorArray
```

4.17. RectangleFilled (with buffer)

Draws a solid rectangle using a buffer.

Syntax: `gfx.RectangleFilled(x1, y1, x2, y2, buffer, draw_fb);`

Argument	Type	Description
x1	int	Horizontal position of the first endpoint
y1	int	Vertical position of the first endpoint
x2	int	Horizontal position of the second endpoint
y2	int	Vertical position of the second endpoint
buffer	const uint8_t*	Buffer of color data for the rectangle
draw_fb	bool	Specifies whether to update the framebuffer

Return: None (*void*)

Example

```
gfx.RectangleFilled(10, 10, 50, 50, myBuffer, true);
// Draws a filled rectangle using data from myBuffer
```

4.18. RectangleFilledWithAlpha

Draws a solid rectangle with alpha transparency.

Syntax: `gfx.RectangleFilledWithAlpha(x1, y1, x2, y2, buffer, draw_fb);`

Argument	Type	Description
x1	int	Horizontal position of the first endpoint
y1	int	Vertical position of the first endpoint
x2	int	Horizontal position of the second endpoint
y2	int	Vertical position of the second endpoint
buffer	const uint8_t*	Buffer with color and alpha data
draw_fb	bool	Specifies whether to update the framebuffer

Return: None (*void*)

Example

```
gfx.RectangleFilledWithAlpha(10, 10, 50, 50, myAlphaBuffer, true);
// Draws a filled rectangle with alpha transparency using myAlphaBuffer
```

4.19. Hline

Draws a horizontal line at a specified vertical position.

Syntax: `gfx.Hline(y, x1, x2, color, draw_fb);`

Argument	Type	Description
y	int	Vertical position for the line
x1	int	Starting horizontal position for the line
x2	int	Ending horizontal position for the line
color	uint16_t	Color of the line
draw_fb	bool	Specifies whether to update the framebuffer

Return: None (*void*)

Example

```
gfx.Hline(20, 0, 100, RED, true);
// Draws a red horizontal line from (0, 20) to (100, 20)
```

4.20. Vline

Draws a vertical line at a specified horizontal position.

Syntax: `gfx.Vline(x, y1, y2, color, draw_fb);`

Argument	Type	Description
x	int	Horizontal position for the line
y1	int	Starting vertical position for the line
y2	int	Ending vertical position for the line
color	uint16_t	Color of the line
draw_fb	bool	Specifies whether to update the framebuffer

Return: None (*void*)

Example

```
gfx.Vline(10, 0, 100, BLUE, true);
// Draws a blue vertical line from (10, 0) to (10, 100)
```

4.21. PutPixel

Sets a pixel at the specified coordinates with the given color.

Syntax: `gfx.PutPixel(int x, int y, uint16_t color, bool draw_fb = true);`

Argument	Type	Description
x	int	X-coordinate of the pixel
y	int	Y-coordinate of the pixel
color	uint16_t	Color of the pixel
draw_fb	bool	Whether to draw to framebuffer

Return: `void`

Example

```
gfx.PutPixel(10, 20, 0xFFFF);
// Sets a white pixel at (10, 20)
```

4.22. Line

Draws a line between two points with the specified color.

Syntax: `gfx.Line(int x1, int y1, int x2, int y2, uint16_t color, bool draw_fb = true);`

Argument	Type	Description
x1	int	X-coordinate of the starting point
y1	int	Y-coordinate of the starting point
x2	int	X-coordinate of the endpoint
y2	int	Y-coordinate of the endpoint
color	uint16_t	Color of the line
draw_fb	bool	Whether to draw to framebuffer

Return: `void`

Example

```
gfx.Line(10, 10, 50, 50, 0x07E0);
// Draws a green line from (10, 10) to (50, 50)
```

4.23. Ellipse

Draws an ellipse centered at the specified coordinates with the given radii and color.

Syntax: `gfx.Ellipse(int x, int y, uint x_rad, uint y_rad, uint16_t color, bool draw_fb = true);`

Argument	Type	Description
x	int	X-coordinate of the ellipse center
y	int	Y-coordinate of the ellipse center
x_rad	uint	Horizontal radius of the ellipse
y_rad	uint	Vertical radius of the ellipse
color	uint16_t	Color of the ellipse
draw_fb	bool	Whether to draw to framebuffer

Return: `void`

Example

```
gfx.Ellipse(40, 30, 20, 10, 0xF800);
// Draws a red ellipse centered at (40, 30)
```

4.24. EllipseFilled

Draws a filled ellipse centered at the specified coordinates with the given radii and color.

Syntax: `gfx.EllipseFilled(int x, int y, uint x_rad, uint y_rad, uint16_t color, bool draw_fb = true);`

Argument	Type	Description
x	int	X-coordinate of the ellipse center
y	int	Y-coordinate of the ellipse center
x_rad	uint	Horizontal radius of the ellipse
y_rad	uint	Vertical radius of the ellipse
color	uint16_t	Color of the filled ellipse
draw_fb	bool	Whether to draw to framebuffer

Return: `void`

Example

```
gfx.EllipseFilled(40, 30, 20, 10, 0x001F);
// Draws a filled blue ellipse centered at (40, 30)
```

4.25. Circle

Draws a circle centered at the specified coordinates with the given radius and color.

Syntax: `gfx.Circle(int x, int y, uint radius, uint16_t color, bool draw_fb = true);`

Argument	Type	Description
x	int	X-coordinate of the circle center
y	int	Y-coordinate of the circle center
radius	uint	Radius of the circle
color	uint16_t	Color of the circle
draw_fb	bool	Whether to draw to framebuffer

Return: `void`

Example

```
gfx.Circle(50, 50, 15, 0xFFE0);
// Draws a yellow circle centered at (50, 50)
```

4.26. Arc

Draws an arc centered at the specified coordinates with the given radius and start angle.

Syntax: `gfx.Arc(int x, int y, uint radius, int sa, uint16_t color, bool draw_fb = true);`

Argument	Type	Description
x	int	X-coordinate of the arc center
y	int	Y-coordinate of the arc center
radius	uint	Radius of the arc
sa	int	Start angle of the arc
color	uint16_t	Color of the arc
draw_fb	bool	Whether to draw to framebuffer

Return: `void`

Example

```
gfx.Arc(30, 30, 10, 45, 0x07E0);
// Draws an arc with 45-degree start angle centered at (30, 30)
```

4.27. ArcFilled

Draws a filled arc centered at the specified coordinates with the given radius, start angle, and end angle.

Syntax:

```
gfx.ArcFilled(int x, int y, uint radius, int sa, int ea, uint16_t color, bool draw_fb = true);
```

Argument	Type	Description
x	int	X-coordinate of the arc center
y	int	Y-coordinate of the arc center
radius	uint	Radius of the arc
sa	int	Start angle of the arc
ea	int	End angle of the arc
color	uint16_t	Color of the filled arc
draw_fb	bool	Whether to draw to framebuffer

Return: `void`

Example

```
gfx.ArcFilled(30, 30, 10, 45, 90, 0x07E0);
// Draws a filled arc from 45 to 90 degrees centered at (30, 30)
```

4.28. CircleFilled

Draws a filled circle centered at the specified coordinates with the given radius and color.

Syntax: `gfx.CircleFilled(int x, int y, uint radius, uint16_t color, bool draw_fb = true);`

Argument	Type	Description
x	int	X-coordinate of the circle center
y	int	Y-coordinate of the circle center
radius	uint	Radius of the filled circle
color	uint16_t	Color of the filled circle
draw_fb	bool	Whether to draw to framebuffer

Return: `void`

Example

```
gfx.CircleFilled(50, 50, 15, 0xFFE0);
// Draws a filled yellow circle centered at (50, 50)
```

4.29. Triangle

Draws a triangle using the specified vertices and color.

Syntax: `gfx.Triangle(int x1, int y1, int x2, int y2, int x3, int y3, uint16_t color, bool draw_fb = true);`

Argument	Type	Description
x1	int	X-coordinate of vertex 1
y1	int	Y-coordinate of vertex 1
x2	int	X-coordinate of vertex 2
y2	int	Y-coordinate of vertex 2
x3	int	X-coordinate of vertex 3
y3	int	Y-coordinate of vertex 3
color	uint16_t	Color of the triangle
draw_fb	bool	Whether to draw to framebuffer

Return: `void`

Example

```
gfx.Triangle(10, 10, 20, 30, 40, 10, 0xF800);
// Draws a red triangle with vertices (10, 10), (20, 30), and (40, 10)
```

4.30. TriangleFilled

Draws a filled triangle using the specified vertices and color.

Syntax:

```
gfx.TriangleFilled(int x1, int y1, int x2, int y2, int x3, int y3, uint16_t color, bool draw_fb = true);
```

Argument	Type	Description
x1	int	X-coordinate of vertex 1
y1	int	Y-coordinate of vertex 1
x2	int	X-coordinate of vertex 2
y2	int	Y-coordinate of vertex 2
x3	int	X-coordinate of vertex 3
y3	int	Y-coordinate of vertex 3
color	uint16_t	Color of the filled triangle
draw_fb	bool	Whether to draw to framebuffer

Return: `void`

Example

```
gfx.TriangleFilled(10, 10, 20, 30, 40, 10, 0xF800);
// Draws a filled red triangle with vertices (10, 10), (20, 30), and (40, 10)
```

4.31. Polyline

Draws a polyline defined by a series of vertices with the specified color.

Syntax: `gfx.Polyline(uint len, const int *vx, const int *vy, uint16_t color, bool draw_fb = true);`

Argument	Type	Description
len	uint	Number of vertices in the polyline
vx	const int*	Array of X-coordinates of the vertices
vy	const int*	Array of Y-coordinates of the vertices
color	uint16_t	Color of the polyline
draw_fb	bool	Whether to draw to framebuffer

Return: `void`

Example

```
int x[] = {10, 20, 30, 40};
int y[] = {10, 20, 10, 20};
gfx.Polyline(4, x, y, 0xFFFF);
// Draws a polyline connecting the specified vertices in white
```

4.32. Polygon

Draws a polygon defined by a series of vertices with the specified color.

Syntax: `gfx.Polygon(uint len, const int *vx, const int *vy, uint16_t color, bool draw_fb = true);`

Argument	Type	Description
len	uint	Number of vertices in the polygon
vx	const int*	Array of X-coordinates of the vertices
vy	const int*	Array of Y-coordinates of the vertices
color	uint16_t	Color of the polygon
draw_fb	bool	Whether to draw to framebuffer

Return: `void`

Example

```
int x[] = {10, 20, 30};
int y[] = {10, 30, 10};
gfx.Polygon(3, x, y, 0xF800);
// Draws a red polygon connecting the specified vertices
```

4.33. PolygonFilled

Draws a filled polygon defined by a series of vertices with the specified color.

Syntax:

```
gfx.PolygonFilled(uint len, const int *vx, const int *vy, uint16_t color, bool draw_fb = true);
```

Argument	Type	Description
len	uint	Number of vertices in the polygon
vx	const int*	Array of X-coordinates of the vertices
vy	const int*	Array of Y-coordinates of the vertices
color	uint16_t	Color of the filled polygon
draw_fb	bool	Whether to draw to framebuffer

Return: `void`

Example

```
int x[] = {10, 20, 30};
int y[] = {10, 30, 10};
gfx.PolygonFilled(3, x, y, 0x07E0);
// Draws a filled green polygon connecting the specified vertices
```

4.34. SetBackgroundColor

Sets the background color of the display.

Syntax: `gfx.SetBackgroundColor(uint16_t color);`

Argument	Type	Description
color	uint16_t	Color to set as the background

Return: `uint16_t` - Previous background color.

Example

```
uint16_t oldColor = gfx.SetBackgroundColor(0x0000);
// Sets the background color to black and saves the previous color
```

4.35. ClipWindow

Defines a clipping window for rendering.

Syntax: `gfx.ClipWindow(int x1, int y1, int x2, int y2);`

Argument	Type	Description
x1	int	X-coordinate of the top-left corner
y1	int	Y-coordinate of the top-left corner
x2	int	X-coordinate of the bottom-right corner
y2	int	Y-coordinate of the bottom-right corner

Return: `bool` - `true` if the clipping window was set successfully, `false` otherwise.

Example

```
if (gfx.ClipWindow(10, 10, 100, 100)) {
    // Clipping window set successfully
}
```

4.36. SetFont

Sets the font for text rendering.

Syntax: `gfx.SetFont(const uint8_t *f);`

Argument	Type	Description
f	const uint8_t*	Pointer to the font data

Return: `const uint8_t*` - Pointer to the previous font.

Example

```
const uint8_t* previousFont = gfx.SetFont(myFont);
// Sets a new font and saves the previous one
```

4.37. SetFontForeground (TextArea4D)

Sets the foreground color for text in a specified area.

Syntax: `gfx.SetFontForeground(TextArea4D area, uint16_t color);`

Argument	Type	Description
area	TextArea4D	Area for which to set the color
color	uint16_t	Foreground color

Return: `uint16_t` - Previous foreground color.

Example

```
uint16_t oldColor = gfx.SetFontForeground(myTextArea, 0xFFFF);
// Sets the foreground color to white for the specified area
```

4.38. SetFontBackground (TextArea4D)

Sets the background color for text in a specified area.

Syntax: `gfx.SetFontBackground(TextArea4D area, uint16_t color, bool transparent = false);`

Argument	Type	Description
area	TextArea4D	Area for which to set the color
color	uint16_t	Background color
transparent	bool	Whether the background is transparent

Return: `uint16_t` - Previous background color.

Example

```
uint16_t oldColor = gfx.SetFontBackground(myTextArea, 0x0000, true);
// Sets the background color to black for the specified area with transparency
```

4.39. SetFontForeground

Sets the foreground color for text rendering.

Syntax: `gfx.SetFontForeground(uint16_t color);`

Argument	Type	Description
color	uint16_t	Foreground color

Return: `uint16_t` - Previous foreground color.

Example

```
uint16_t oldColor = gfx.SetFontForeground(0xFFFF);
// Sets the foreground color to white
```

4.40. SetFontBackground

Sets the background color for text rendering.

Syntax: `gfx.SetFontBackground(uint16_t color, bool transparent = false);`

Argument	Type	Description
color	uint16_t	Background color
transparent	bool	Whether the background is transparent

Return: `uint16_t` - Previous background color.

Example

```
uint16_t oldColor = gfx.SetFontBackground(0x0000, false);
// Sets the background color to black without transparency
```

4.41. MoveTo

Moves the current drawing position to the specified coordinates.

Syntax: `gfx.MoveTo(int x, int y);`

Argument	Type	Description
x	int	X-coordinate of the new position
y	int	Y-coordinate of the new position

Return: `bool` - `true` if the move was successful, `false` otherwise.

Example

```
if (gfx.MoveTo(50, 100)) {
    // Move to coordinates (50, 100) successfully
}
```

4.42. MoveRel

Moves the current drawing position relative to its current position.

Syntax: `gfx.MoveRel(int x_offset, int y_offset);`

Argument	Type	Description
x_offset	int	X-offset to move from current position
y_offset	int	Y-offset to move from current position

Return: `bool` - `true` if the move was successful, `false` otherwise.

Example

```
if (gfx.MoveRel(10, -5)) {
    // Move 10 units right and 5 units up from the current position
}
```

4.43. print

Prints a string at the current position.

Syntax: `gfx.print(const char *str, bool draw_fb = true);`

Argument	Type	Description
str	const char*	String to print
draw_fb	bool	Whether to draw to framebuffer

Return: `size_t` - Number of characters printed.

Example

```
size_t charsPrinted = gfx.print("Hello, World!");
// Prints "Hello, World!" at the current position
```

4.44. printf

Prints a formatted string at the current position.

Syntax: `gfx.printf(const char *format, ...);`

Argument	Type	Description
format	const char*	Format string
...	...	Additional arguments as needed

Return: `size_t` - Number of characters printed.

Example

```
size_t charsPrinted = gfx.printf("Value: %d", 42);
// Prints "Value: 42" at the current position
```

4.45. CreateTextArea

Creates a text area for rendering text.

Syntax: `gfx.CreateTextArea(int x1, int y1, int x2, int y2, uint16_t fg_color, uint16_t bg_color);`

Argument	Type	Description
x1	int	X-coordinate of the top-left corner
y1	int	Y-coordinate of the top-left corner
x2	int	X-coordinate of the bottom-right corner
y2	int	Y-coordinate of the bottom-right corner
fg_color	uint16_t	Foreground color
bg_color	uint16_t	Background color

Return: `TextArea4D` - The created text area.

Example

```
TextArea4D area = gfx.CreateTextArea(10, 10, 100, 50, 0xFFFF, 0x0000);
// Creates a text area with specified dimensions and colors
```

4.46. print (TextArea4D)

Prints a string in the specified text area.

Syntax: `gfx.print(TextArea4D area, const char *str, bool draw_fb = true);`

Argument	Type	Description
area	TextArea4D	The text area to print into
str	const char*	String to print
draw_fb	bool	Whether to draw to framebuffer

Return: `size_t` - Number of characters printed.

Example

```
size_t charsPrinted = gfx.print(area, "Hello, Text Area!");
// Prints "Hello, Text Area!" in the specified text area
```

4.47. printf (TextArea4D)

Prints a formatted string in the specified text area.

Syntax: `gfx.printf(TextArea4D area, const char *format, ...);`

Argument	Type	Description
area	TextArea4D	The text area to print into
format	const char*	Format string
...	...	Additional arguments as needed

Return: `size_t` - Number of characters printed.

Example

```
size_t charsPrinted = gfx.printf(area, "Value: %d", 42);
// Prints "Value: 42" in the specified text area
```

5. Image Control Functions

The following functions are included in `img`. These allows displaying of widgets generated by Workshop5 into to flash memory or as a file in the microSD.

5.1. LoadImageControl (Pointer)

Loads an image control from a pointer to image data.

Syntax: `img.LoadImageControl(const uint8_t *ptr);`

Argument	Type	Description
ptr	const uint8_t*	Pointer to the image data

Return: `ImageControl4D` - Handle to the loaded image control.

Example

```
ImageControl4D imgControl = img.LoadImageControl(imageDataPtr);
// Loads an image control from a pointer to image data
```

5.2. LoadImageControl (Filename)

Loads an image control from a specified file.

Syntax: `img.LoadImageControl(const char *filename);`

Argument	Type	Description
filename	const char*	Path to the image file

Return: `ImageControl4D` - Handle to the loaded image control.

Example

```
ImageControl4D imgControl = img.LoadImageControl("path/to/image.bmp");
// Loads an image control from a specified file
```

5.3. GetCount

Retrieves the number of images in the image control.

Syntax: `img.GetCount(ImageControl4D hndl);`

Argument	Type	Description
hndl	ImageControl4D	Handle to the image control

Return: `uint` - Number of images in the control.

Example

```
uint count = img.GetCount(imgControl);
// Retrieves the number of images in the image control
```

5.4. GetFile

Retrieves a pointer to the file associated with the image control.

Syntax: `img.GetFile(ImageControl4D hndl);`

Argument	Type	Description
hndl	ImageControl4D	Handle to the image control

Return: `FIL*` - Pointer to the file associated with the image control.

Example

```
FIL* filePtr = img.GetFile(imgControl);
// Retrieves a pointer to the file associated with the image control
```

5.5. GetInfo

Retrieves media information for a specified image.

Syntax: `img.GetInfo(ImageControl4D hndl, uint index);`

Argument	Type	Description
hndl	ImageControl4D	Handle to the image control
index	uint	Index of the image

Return: `MediaInfo4D` - Information about the specified image.

Example

```
MediaInfo4D info = img.GetInfo(imgControl, 0);
// Retrieves media information for the first image
```

5.6. SetProperties

Sets properties for a specified image in the image control.

Syntax: `img.SetProperties(ImageControl4D hndl, uint index, const uint16_t *properties);`

Argument	Type	Description
hndl	ImageControl4D	Handle to the image control
index	uint	Index of the image
properties	const uint16_t*	Pointer to an array of properties

Return: `void`

Example

```
uint16_t props[] = {10, 20, 30};
img.SetProperties(imgControl, 0, props);
// Sets properties for the first image in the control
```

5.7. SetValue

Sets a value for a specified property of an image.

Syntax: `img.SetValue(ImageControl4D hndl, uint index, uint16_t value);`

Argument	Type	Description
hndl	ImageControl4D	Handle to the image control
index	uint	Index of the image
value	uint16_t	Value to set for the property

Return: `uint16_t` - The new value of the property.

Example

```
uint16_t newValue = img.SetValue(imgControl, 0, 5);
// Sets the value of the first image's property
```

5.8. GetValue

Gets a value for a specified property of an image.

Syntax: `img.GetValue(ImageControl4D hndl, uint index);`

Argument	Type	Description
hndl	ImageControl4D	Handle to the image control
index	uint	Index of the image

Return: `uint16_t` - The value of the specified property.

Example

```
uint16_t value = img.GetValue(imgControl, 0);
// Gets the value of the first image's property
```

5.9. SetPosition

Sets the position of a specified image in the image control.

Syntax: `img.SetPosition(ImageControl4D hndl, uint index, int16_t x, int16_t y);`

Argument	Type	Description
hndl	ImageControl4D	Handle to the image control
index	uint	Index of the image
x	int16_t	X-coordinate of the position
y	int16_t	Y-coordinate of the position

Return: `void`

Example

```
img.SetPosition(imgControl, 0, 50, 100);
// Sets the position of the first image to (50, 100)
```

5.10. GetFrames

Gets the number of frames for a specified image.

Syntax: `img.GetFrames(ImageControl4D hndl, uint index);`

Argument	Type	Description
hndl	ImageControl4D	Handle to the image control
index	uint	Index of the image

Return: `uint16_t` - The number of frames for the specified image.

Example

```
uint16_t frames = img.GetFrames(imgControl, 0);
// Gets the number of frames for the first image
```

5.11. Show

Displays a specified image from the image control.

Syntax: `img.Show(ImageControl4D hndl, uint index, bool draw_fb = true);`

Argument	Type	Description
hndl	ImageControl4D	Handle to the image control
index	uint	Index of the image
draw_fb	bool	Whether to draw to framebuffer

Return: `void`

Example

```
img.Show(imgControl, 0);
// Displays the first image from the image control
```

5.12. Clear

Clears a specified image in the image control with a given color.

Syntax: `img.Clear(ImageControl4D hndl, uint index, uint16_t color, bool draw_fb = true);`

Argument	Type	Description
hndl	ImageControl4D	Handle to the image control
index	uint	Index of the image
color	uint16_t	Color to clear the image with
draw_fb	bool	Whether to draw to framebuffer

Return: `void`

Example

```
img.Clear(imgControl, 0, 0xFFFF);
// Clears the first image with white color
```

6. Touch Handling Functions

The following functions are included for touch support.

6.1. Initialize

Initializes the touch object.

Syntax: `touch.Initialize();`

Argument	Type	Description
None	-	-

Return: `bool` - `true` if initialization was successful, `false` otherwise.

Example

```
if (touch.Initialize()) {
    // Touch object initialized successfully
}
```

6.2. SetHandler

Sets a callback function to handle touch events.

Syntax: `touch.SetHandler(TouchHandler user_cb = NULL);`

Argument	Type	Description
user_cb	TouchHandler	Callback function for touch events

Return: `void`

Example

```
void onTouch() {
    // Handle touch event
}

touch.SetHandler(onTouch);
// Sets the callback function for touch events
```

6.3. Calibrate

Calibrates the touch screen.

Syntax: `touch.Calibrate();`

Argument	Type	Description
None	-	-

Return: `bool` - `true` if calibration was successful, `false` otherwise.

Example

```
if (touch.Calibrate()) {
    // Touch screen calibrated successfully
}
```

6.4. GetPoints

Performs touch reading operations and returns the number of points.

Syntax: `touch.GetPoints();`

Return: `uint8_t` - number of active touch points

Example

```
uint8_t points = touch.GetPoints();
// Retrieves the number of touch points
```

6.5. GetStatus

Retrieves the status of the touch point.

Syntax: `touch.GetStatus();`

Argument	Type	Description
point	uint8_t	index specifying touch (usually ignored for single touch)

Return: `int8_t` - Status of the touch object.

Example

```
int8_t status = touch.GetStatus();
// Retrieves the status of the touch object
```

6.6. GetID

Retrieves the ID of the currently active touch point.

Syntax: `touch.GetID();`

Argument	Type	Description
point	uint8_t	index specifying touch (usually ignored for single touch)

Return: `int16_t` - ID of the active touch point.

Example

```
int16_t id = touch.GetID();
// Retrieves the ID of the currently active touch point
```

6.7. GetX

Retrieves the X-coordinate of the currently active touch point.

Syntax: `touch.GetX();`

Argument	Type	Description
point	uint8_t	index specifying touch (usually ignored for single touch)

Return: `int16_t` - X-coordinate of the active touch point.

Example

```
int16_t x = touch.GetX();
// Retrieves the X-coordinate of the active touch point
```

6.8. GetY

Retrieves the Y-coordinate of the currently active touch point.

Syntax: `touch.GetY();`

Argument	Type	Description
point	uint8_t	index specifying touch (usually ignored for single touch)

Return: `int16_t` - Y-coordinate of the active touch point.

Example

```
int16_t y = touch.GetY();
// Retrieves the Y-coordinate of the active touch point
```

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