LT768x

High Performance TFT-LCD Graphics Controller

Application Notes for GCBASIC

V0.9a

Directory

1. Preface

This application note is based upon the application note provided by Levetop.   Levetop have supported the development of the GCBASIC library and Levetop have been so supportive.

This application note mainly describes the hardware interface, software libraries of LT768x, and the realization of the internal function. In the meantime, by utilizing the demo program, function library, and schematic diagram, customers can quickly set up the design environment of LT768x and develop their application with the TFT panel product. This manual can help users to get a quick start and shorten their development time on exploring LT768x.

1.1   System Architecture

To display an image on TFT panel, the image data must first be converted into electrical signals, and then the TFT driver transmits and continuously updates(scan) these signals to the LCD panel. As a result of the continuous transmission of scanned data, and the visual retention effect of human eyes, the image displayed on the TFT panel will be stable and complete as seen by human eyes. However, since the TFT driver does not have data store functions, it must continuously get the image data from the system side (such as MCU). The main function of the TFT controller is to assist the system to provide the image data to the TFT driver, and keep uploading the image data to the TFT panel continuously.

LT768x is a high-performance TFT-LCD graphics accelerated display controller. In addition to assist the MCU transfering display data to TFT driver as mentioned above, LT768x also provides 2D graphics acceleration, PIP (picture-in-picture), geometric graphics and other functions. In order to reduce the time taken by MCU to transmit image data, LT768x provides a SPI Master Interface to retrieve image data from SPI Flash through DMA transfer mode, and then save the data to the embedded display RAM of LT768x. SPI Flash is used to save image data such as pictures, fonts etc. LT768x will then transmit the specified display memory data of the selected display window through the RGB interface to the driver inside the external TFT panel. Therefore, LT768x not only enhance the display performance, but also greatly alleviate the processing burden on MCU.

Even if an 8bits MCU is used as the host, it can work well with a TFT display if LT768x is applied properly. The following diagram is the basic application architecture for LT768x:

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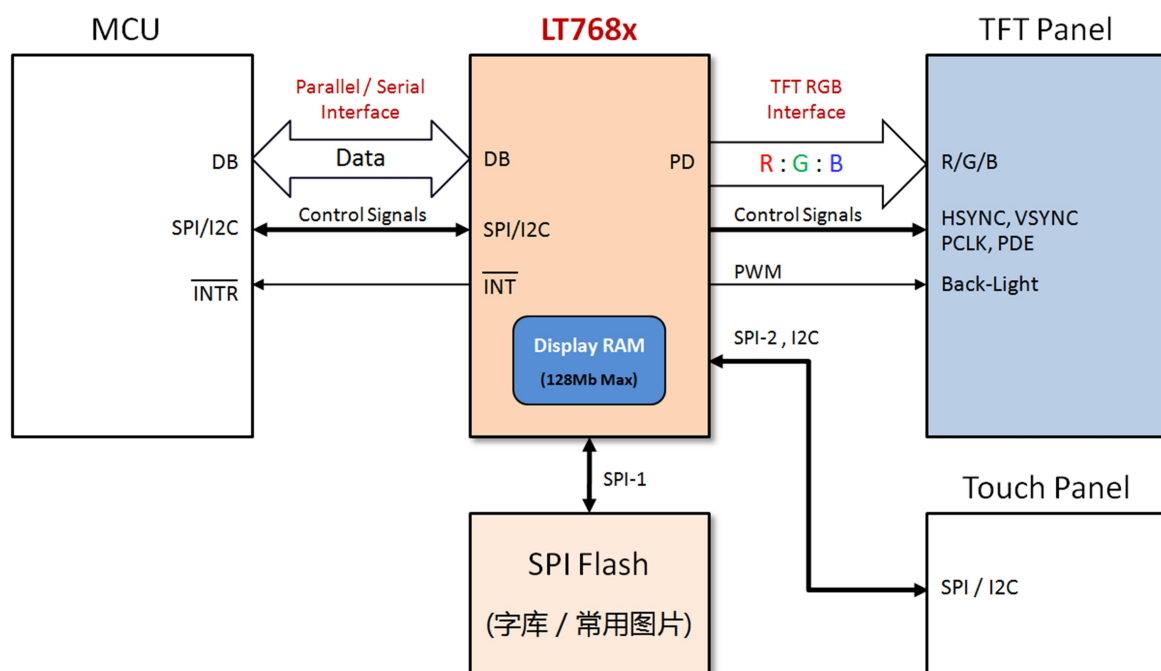**Figure 1-2: System Architecture of LT768x**

LT768x provides 2 sets of SPI master interfaces and 1 set of I2C interfaces. If the system wants to provide a touch screen function, the interface of touch controller can either connect to I2C or SPI interface of LT768x, and then the MCU can read or control the touch controller through LT768x. This will simplifies the interface of touch controller connection.

2.   Model Options

Table 2-1: LT768x Model Options

Support Features		LT7680A	LT7680B	LT7681	LT7683+	LT7686
Items	**Function**					
Package	LQFP / QFN	QFN-68	QFN-68	LQFP-128	LQFP-128	LQFP-128
LCD Spec.	Resolution/Max.	800*600	480*320	640*480	1024*768	1280*1024
	Colors	262K	262K	16.7M	16.7M	16.7M
	TFT Interface	RGB (18bits/Max)	RGB (18bits/Max)	RGB (24bits/Max)	RGB (24bits/Max)	RGB (24bits/Max)
Display RAM	Embed. RAM Size	64Mbit	64Mbit	128Mbit	128Mbit	128Mbit
	Layers	7 Layers/Min	12 Layers /Min	18 Layers/Min	11 Layers /Min	4 Layers /Min
MCU Interface	8080 8bit			V	V	V
	6800 8bit			V	V	V
	8080 16bit			V	V	V
	6800 16bit			V	V	V
	3 wire SPI	V	V	V	V	V
	4 wire SPI			V	V	V
	I2C	V	V	V	V	V
Others Interface	SPI Master (DMA Flash)	V (2)	V (2)	V (2)	V (2)	V (2)
	I2C Master			V	V	V
	PWM O/P	2	2	2	2	2
	GPIO O/P	7/max	7/max	28/max	28/max	28/max
	Smart Key-scan			5*5	5*5	5*5
Graphics Features	2D BTE Engine	V	V	V	V	V
	Geometric Drawing Engine	V	V	V	V	V
	Polygon Drawing	V	V	V	V	V
	Picture in Picture (PIP)	V	V	V	V	V
	Virtual Display	V	V	V	V	V
	Vertical Scrolling	V	V	V	V	V
	Horizontal Scrolling	V	V	V	V	V
	Mirror and Rotation	V	V	V	V	V
	Alpha-Blending	V	V	V	V	V
	Graphic Cursor	V	V	V	V	V
	Power-on Display	V	V	V	V	V
	Color-Bar Test	V	V	V	V	V
Text Features	Embed. ISO/IEC 8859	ISO8259	ISO8259	ISO8259	ISO8259	ISO8259
	Ext. Font (ext. SPI Flash)	V	V	V	V	V
	Text Enlargement	4*4	4*4	4*4	4*4	4*4
	Text Rotate	V	V	V	V	V
	Text Cursor	V	V	V	V	V
	User-defined Character	V	V	V	V	V
Power	Sleep Mode ($S_{tandby}/S_{uspend}/S_{leep}$)	V	V	V	V	V
	Power Source	3.3V	3.3V	3.3V	3.3V	3.3V

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Figure 2-1: LT768x Series

The LT768x of the same package are compatible. For example, LT7681, LT7683+ and LT7686 are all 128Pin LQFP packages, and their pin-assignments are compatible. The LT7680A and LT7680B are 68Pin QFN package, their pin-assignment are also compatible. The resolution is backward compatible. For example, the resolution of the LT7686 is 1280*1024, it can also be used on the lower resolution of the TFT screen.

LT7680 is a 68Pin QFN (8mm*8mm) package with a smaller dimension. It can be used in the system PCB board or LCM PCB. It can also be welded on the FPC to form a standard TFT module with SPI interface, as shown in Figure 2-2 below. The designers can also integrate a standard TFT module and a LT768x control board to form a complete module so that most 8/16/32bits MCU can connect to this complete module directly, as shown in Figure 2-3.
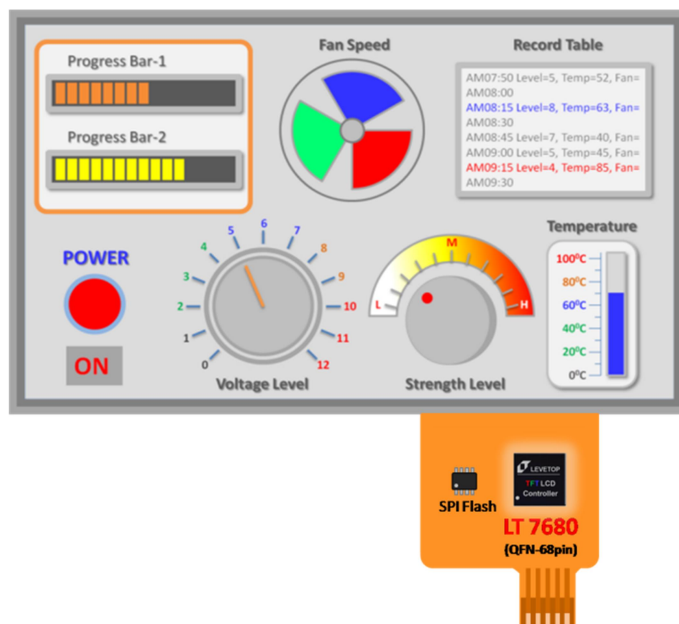

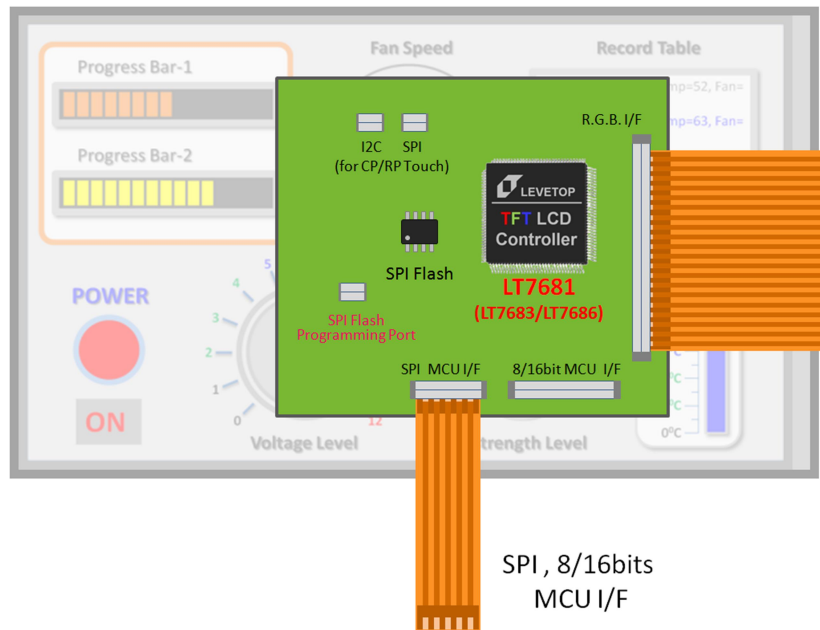**Figure 2-2: Standard SPI Interface TFT Module with LT7680**

Figure 2-3: Standard TFT Module with LT7681/7683+/7686

LT768x is controlled by the MCU so it can also be placed in the system board, and then connect with the standard RGB type TFT Panel. Show as below Figure 2-4.
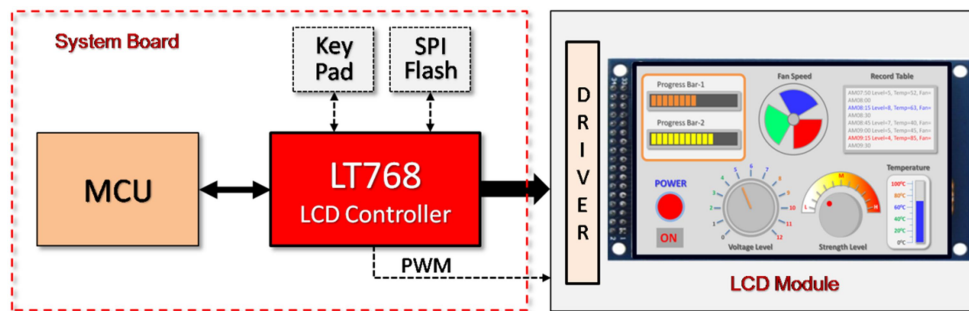

Figure 2-4: Design-in LT768x on System Board

3. Reset

3.1 Power-on Reset

LT768x has an embedded Power-On-Reset circuit. POR can issue an active low signal to synchronize the whole system through RST# pin. When system power (3.3V) on, internal reset will be active for at least 256 OSC clocks until the internal power is stable.

3.2 External Reset

External reset signal RST# allows LT768x to synchronize with external systems. The external reset signal must be stabilized for at least 256 crystal (OSC) clocks to be approved as shown in Figure 3-1. The MCU should check the BIT1(working mode status indication bit) of the state register STSR before setting up LT768x to ensure that LT768x is currently in "Normal Running State". External reset can be done through power-on reset or hardware reset issued by MCU, as shown in Figure 3-2, Figure 3-3.
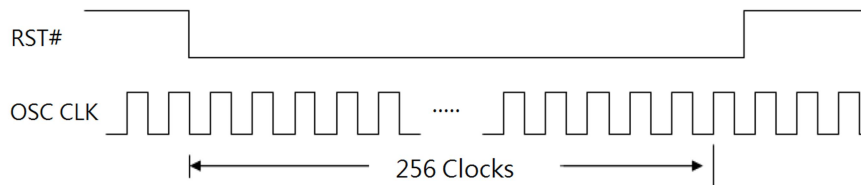

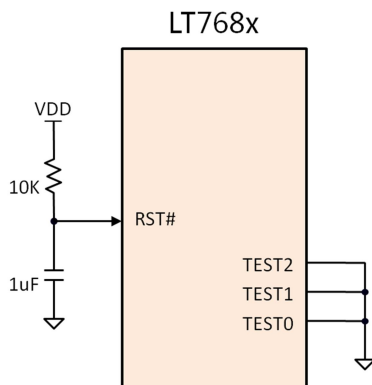
Figure 3-1: External Reset Signal - RST#

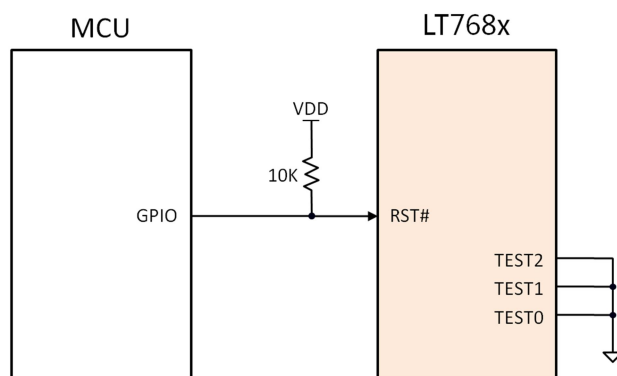**Figure 3-2: External Reset (1)**   **Figure 3-3: External Reset (2)**

3.3 Software Reset

If the Host writes 1 to registers REG[00h] bit0, LT768x will be reset by software. The software reset will only reset the internal state machine of LT768x, and the other registers values will not be affected or cleared. After the software reset is complete, the REG[00h] bit0 will automatically be cleared to 0.

To perform a software reset, simply call the following function:

SW_Reset(void)

3.4 Test Signals

TEST[2:0] are the test signals of LT768x, which is provided to LT768x for testing purposes. These pins should be connected to ground (GND) in normal use. As shown in above Figure 3-2 and 3-3.

If the system is off, and users want to update image datat to SPI Flash that connects to LT768x, then TEST[2] should be pulled low, and TEST[1] should be pulled high so that LT768x can enter TEST mode and disconnect external SPI Flash. This action will allow the data to be programmed to SPI Flash without being affected by LT768x. Please refer to Sections 18.4, 19.4, 21.3, and 22.3 for more details.

4. Geometric Drawing

4.1 Drawing Line

4.1.1 Drawing a Thin Line

```
Line
(
[Word] X1,              // X1-Axis
[Word] Y1,              // Y1-Axis
[Word] X2,              // X2-Axis
[Word] Y2,              // Y2-Axis
[Long] LineColor        // Line Color
)
```
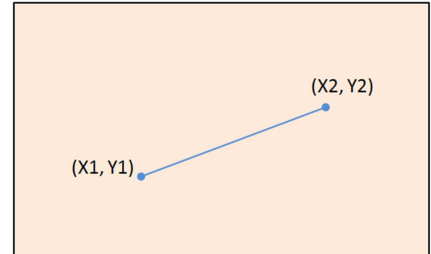

Figure 4-1: Drawing a Thin Line

Example: Drawing a red Thin Line from (100, 100) to (200, 200)

Line(100, 100, 200, 200, TFT_TFT_RED)

4.1.2 Drawing a Thick Line

```
Line
(
[Word] X1,              // X1-Axis
[Word] Y1,              // Y1-Axis
[Word] X2,              // X2-Axis
[Word] Y2,              // Y2-Axis
[Word] Width,            // Line Width
[Long] LineColor        // Line Color
)
```
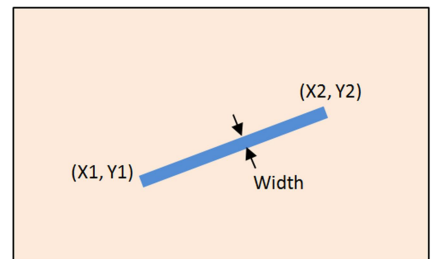

Figure 4-2: Drawing a Thick Line

Example: Drawing a red Thick Line from (120, 140) to (220, 260), and set the line width = 10.

Line(120, 140, 220, 260, 10, TFT_TFT_RED)

4.2 Drawing Circle

4.2.1 Drawing a Hollow Circle

Circle
(
[Word] XCenter,   // Center X-Axis
[Word] YCenter,   // Center Y-Axis
[Word] R,   // Radius
[Long] CircleColor   // Color
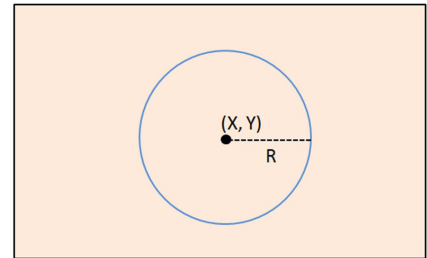)

Figure 4-3: Drawing a Hollow Circle

Example: Drawing a red Circle with a radius of 100, and the center is at (200, 200)

Circle(200, 200, 100, TFT_TFT_RED)

4.2.2 Drawing a Solid Circle

FilledCircle
(
[Word] XCenter,   // Center X-Axis
[Word] YCenter,   // Center Y-Axis
[Word] R,   // Radius
[Long] ForegroundColor   // Color
)
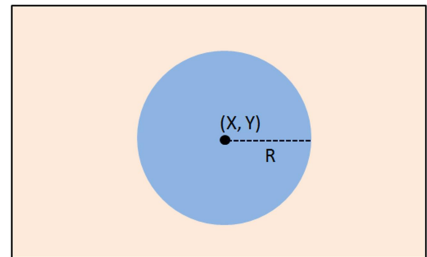
Figure 4-4: Drawing a Solid Circle

Example: Drawing a red Solid Circle with a radius of 100, and the center is at (200, 200)

FilledCircle (200, 200, 100, TFT_RED)

4.2.3 Drawing a Solid Circle with Frame

FramedFilledCircle (
[Word] XCenter,   // Center X-Axis
[Word] YCenter,   // Center Y-Axis
[Word] R,   // Radius
[Word] Width,   // Frame Width
[Long] CircleColor,   // Frame Color
[Long] ForegroundColor,   // Foreground Color
)

Figure 4-5: Drawing a Solid Circle with Frame
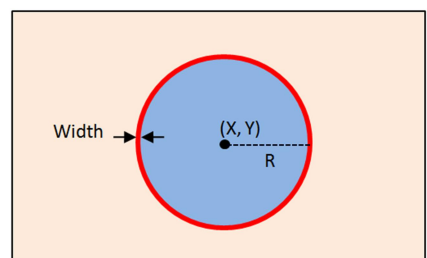
Example: Drawing a white solid circle with a red frame, the frame is 10, the radius is 100, and the center is at (200, 200)

FramedFilledCircle (200, 200, 100, 10, TFT_RED, TFT_WHITE)

Note: This function is completed by drawing two Solid Circle. The frame color is determined by the first Solid Circle, and foreground color is determined by the second Solid Circle.

4.3 Drawing Ellipse

4.3.1 Drawing a Hollow Ellipse

Ellipse
(
[Word] XCenter,   // Center X-Axis
[Word] YCenter,   // Center Y-Axis
[Word] X_R,   // X-Axis Radius
[Word] Y_R,   // Y-Axis Radius
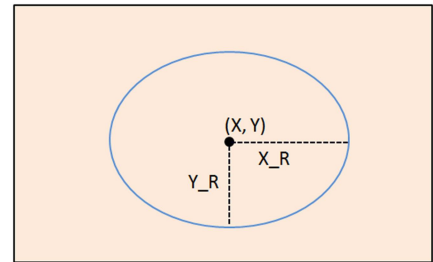[Long] EllipseColor   // Color
)

Figure 4-6: Drawing a Hollow Ellipse

Example: Drawing a red Ellipse with one radius = 80 and another = 50, and the center is at (100, 100)

Ellipse(100, 100, 80, 50, TFT_RED)

4.3.2 Drawing a Solid Ellipse

FilledEllipse
(
[Word] XCenter,   // Center X-Axis
[Word] YCenter,   // Center Y-Axis
[Word] X_R,   // X-Axis Radius
[Word] Y_R,   // Y-Axis Radius
[Long] ForegroundColor   // Foreground Color
)
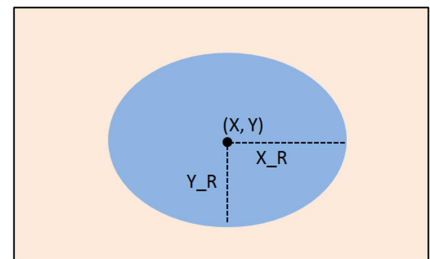
Figure 4-7: Drawing a Solid Ellipse

Example: Drawing a red Solid Ellipse with one radius = 80 and another = 50, and the center is at (100, 100)

FilledEllipse (100, 100, 80, 50, TFT_TFT_RED)

4.3.3 Drawing a Solid Ellipse with Frame

FramedFilledEllipse
(
[Word] XCenter,   // Center X-Axis
[Word] YCenter,   // Center Y-Axis
[Word] X_R,   // X-Axis Radius
[Word] Y_R,   // Y-Axis Radius
[Word] Width,   // Frame Width
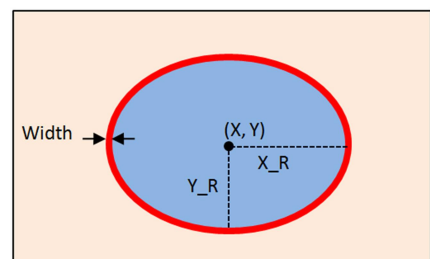
Figure 4-8: Drawing a Solid Ellipse with Frame

[Long] EllipseColor,   // Frame Color

[Long] ForegroundColor   // Foreground Color

)

Example: Drawing a white Solid Ellipse with a red frame, the frame is 10, the radiuses are 80 and 50, and the center is at (100, 100)

FramedFilledEllipse (100, 100, 80, 50, 10, TFT_RED, TFT_WHITE)

Note: This function is completed by drawing two Solid Ellipses. The frame color is determined by the first Solid Ellipse, and foreground color is determined by the second Solid Ellipse.

4.4   Drawing Rectangle

4.4.1   Drawing a Hollow Rectangle

Box
(
[Word] X1,   // Corner X1-Axis
[Word] Y1,   // Corner Y1-Axis
[Word] X2,   // Corner X1-Axis
[Word] Y2,   // Corner Y2-Axis
[Long] SquareColor   // Color
)
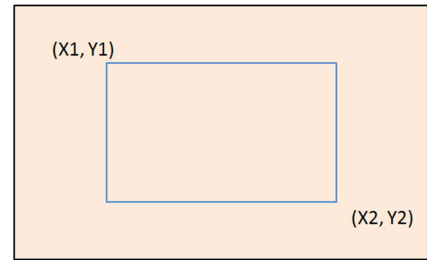
Figure 4-9: Drawing a Hollow Rectangle

Example: Drawing a red Rectangle with one corner = (50, 60) and another = (200,150).

Box(50, 60, 200, 150, TFT_RED)

4.4.2   Drawing a Solid Rectangle

FilledBox
(
[Word] X1,   // Corner X1-Axis
[Word] Y1,   // Corner Y1-Axis
[Word] X2,   // Corner X2-Axis
[Word] Y2,   // Corner Y2-Axis
[Long] ForegroundColor   // Foreground Color
)

Figure 4-10: Drawing a Solid Rectangle

Example: Drawing a red Solid Rectangle with one corner = (50, 60) and another = (200,150).
FilledBox (50, 60, 200, 150, TFT_RED)

4.4.3   Drawing a Solid Rectangle with Frame

FramedFilledBox
(
[Word] X1,   // Corner X1-Axis
[Word] Y1,   // Corner Y1-Axis
[Word] X2,   // Corner X2-Axis
[Word] Y2,   // Corner Y2-Axis
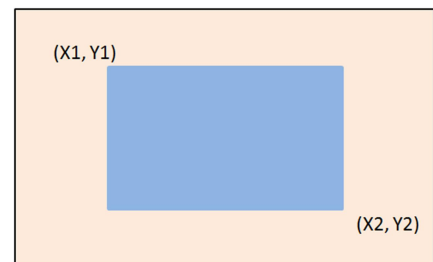[Word] Width,   // Frame Width
[Long] SquareColor,   // Frame Color
[Long] ForegroundColor   // Foreground Color
)
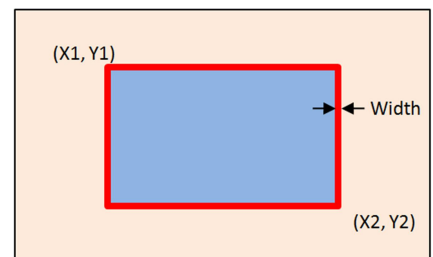
Figure 4-11: Drawing a Solid Rectangle with Frame

Example: Drawing a white solid Rectangle with a red frame. The frame width is 10, and the two corners are (50, 60) and (200, 150).

FramedFilledBox (50, 60, 200, 150, 10, TFT_RED, TFT_WHITE)

Note: This function is completed by drawing two Solid Rectangles. The frame color is determined by the first Solid Rectangle, and foreground color is determined by the second Solid Rectangle.

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4.5   Drawing Rounded-Rectangle

4.5.1   Drawing a Hollow Rounded-Rectangle

RoundRect
(
[Word] X1,	// Corner X1-Axis
[Word] Y1,	// Corner Y1-Axis
[Word] X2,	// Corner X2-Axis
[Word] Y2,	// Corner Y2-Axis
[Word] X_R,	// X-Axis Radius
[Word] Y_R,	// Y-Axis Radius
[Long] CircleSquareColor	// Color

)

Figure 4-12: Drawing a Hollow Rounded-Rectangle

Example: Drawing a red Rounded-Rectangle with one corner radius = 30, and another = 20, , and the corners are at (50, 60) and (200, 150).

RoundRect (50, 60, 200, 150, 30, 20, TFT_RED)

4.5.2   Drawing a Solid Rounded-Rectangle

FilledRoundRect
(
[Word] X1,	// Corner X1-Axis
[Word] Y1,	// Corner Y1-Axis
[Word] X2,	// Corner X2-Axis
[Word] Y2,	// Corner Y2-Axis
[Word] X_R,	// X-Axis Radius
[Word] Y_R,	// Y-Axis Radius
[Long] ForegroundColor,	// Foreground Color

)

Figure 4-13: Drawing a Solid Rounded-Rectangle

Example: Drawing a red Solid Rounded-Rectangle with one corner radius = 30, and another = 20, and the corners are at (50, 60) and (200, 150).

FilledRoundRect (50, 60, 200, 150, 30, 20, TFT_RED)

4.5.3   Drawing a Rounded-Rectangle with Frame

FramedFilledRoundRect

(

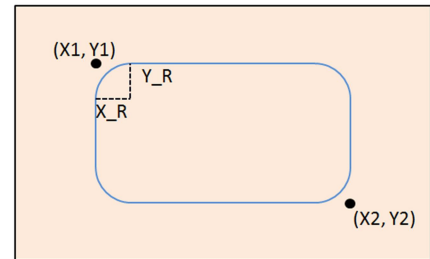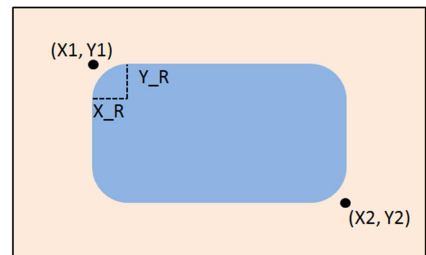| [Word] X1, | // Corner X1-Axis |
[Word] Y1,	// Corner Y1-Axis
[Word] X2,	// Corner X2-Axis
[Word] Y2,	// Corner Y2-Axis
[Word] X_R,	// X-Axis Radius
[Word] Y_R,	// Y-Axis Radius
[Word] Width,	// Frame Width
[Long] CircleSquareColor,	// Frame Color
[Long] ForegroundColor	// Foreground Color

)
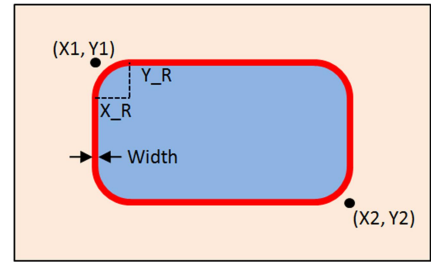
Figure 4-14: Drawing a Solid Rounded-Rectangle with Frame

Example: Drawing a white Rounded-Rectangle with a red frame, the radiuses are 30 and 20, the frame width is10, and the corners are at (50, 60) and (200, 150).

FramedFilledRoundRect (50, 60, 200, 150, 30, 20, 10, TFT_RED, TFT_WHITE)

Note: This function is completed by drawing two Rounded-Rectangles. The frame color is determined by the first solid Rounded-Rectangle, and foreground color is determined by the second Rounded-Rectangle.

4.6   Drawing Triangle

4.6.1   Drawing a Hollow Triangle

Triangle
(
[Word] X1,   // Corner X1-Axis
[Word] Y1,   // Corner Y1-Axis
[Word] X2,   // Corner X2-Axis
[Word] Y2,   // Corner Y2-Axis
[Word] X3,   // Corner X3-Axis
[Word] Y3,   // Corner Y3-Axis
[Long] TriangleColor   // Color
)

Figure 4-15: Drawing a Hollow Triangle

Example: Drawing a red Hollow Triangle with corners = (100,100), (50, 200), and (150, 150) respectively.

Triangle(100, 100, 50, 200, 150, 150, TFT_RED)

4.6.2   Drawing a Solid Triangle

FilledTriangle
(
[Word] X1,   // Corner X1-Axis
[Word] Y1,   // Corner Y1-Axis
[Word] X2,   // Corner X2-Axis
[Word] Y2,   // Corner Y2-Axis
[Word] X3,   // Corner X3-Axis
[Word] Y3,   // Corner Y3-Axis
[Long] ForegroundColor   // Foreground Color
)

Figure 4-16: Drawing a Solid Rectangle

Example: Drawing a red Solid Triangle with corners = (100,100), (50, 200), and (150, 150) respectively.

FilledTriangle (100, 100, 50, 200, 150, 150, TFT_RED)

4.6.3   Drawing a Solid Rectangle with Frame

FramedFilledTriangle
(
[Word] X1,   // Corner X1-Axis
[Word] Y1,   // Corner X1-Axis
[Word] X2,   // Corner X1-Axis
[Word] Y2,   // Corner X1-Axis
[Word] X3,   // Corner X1-Axis
[Word] Y3,   // Corner X1-Axis
[Long] TriangleColor,   // Frame Color
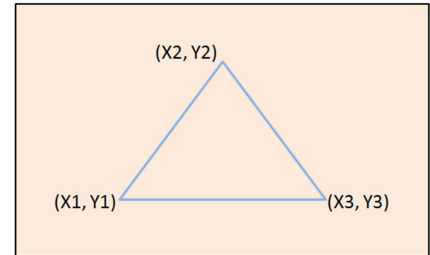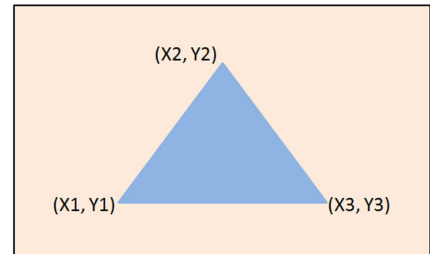[Long] ForegroundColor   // Foreground Color
)
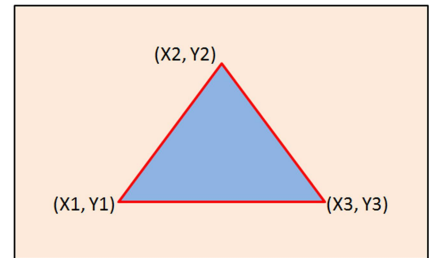
Figure 4-17: Drawing a Solid Rectangle with Frame

Example: Drawing a white Solid Triangle with a red Frame, and corners = (100,100), (50, 200), and (150, 150) respectively.

FramedFilledTriangle (100, 100, 50, 200, 150, 150, TFT_RED, TFT_WHITE)

Note: This function is completed by drawing a Solid and a Hollow Triangle. The foreground color is determined by the Solid Rectangle, and frame color is determined by the Hollow Rectangle.

4.7 Drawing Curve

4.7.1 Drawing an Upper-Left Curve

LeftUpCurve
(
[Word] XCenter,   // Center X-Axis
[Word] YCenter,   // Center Y-Axis
[Word] X_R,   // X-Axis Radius
[Word] Y_R,   // Y-Axis Radius
[Long] CurveColor   // Color
)

Figure 4-18: Drawing an Upper-Left Curve

Example: Drawing a red Upper-Left Curve with one radius = 100 and another = 70, and the center is at (100, 100)

LeftUpCurve(100, 100, 100, 70, TFT_RED)

4.7.2 Drawing a Lower-Left Curve

LeftDownCurve
(
[Word] XCenter,   // Center X-Axis
[Word] YCenter,   // Center Y-Axis
[Word] X_R,   // X-Axis Radius
[Word] Y_R,   // Y-Axis Radius
[Long] CurveColor   // Color
)

Figure 4-19: Drawing a Lower-Left Curve

Example: Drawing a red Lower-Left Curve with one radius = 100 and another = 70, and the center is at (100, 100)

LeftDownCurve(100, 100, 100, 70, TFT_RED)

4.7.3 Drawing an Upper-Right Curve

RightUpCurve
(
[Word] XCenter,   // Center X-Axis
[Word] YCenter,   // Center Y-Axis
[Word] X_R,   // X-Axis Radius
[Word] Y_R,   // Y-Axis Radius
[Long] CurveColor   // Color
)

Figure 4-20: Drawing an Upper-Right Curve

Example: Drawing a red Upper-Right Curve with one radius = 100 and another = 70, and the center is at (100, 100)

RightUpCurve(100, 100, 100, 70, TFT_RED)

4.7.4 Drawing a Lower-Right Curve

RightDownCurve
(
[Word] XCenter,   // Center X-Axis
[Word] YCenter,   // Center Y-Axis
[Word] X_R,   // X-Axis Radius
[Word] Y_R,   // Y-Axis Radius
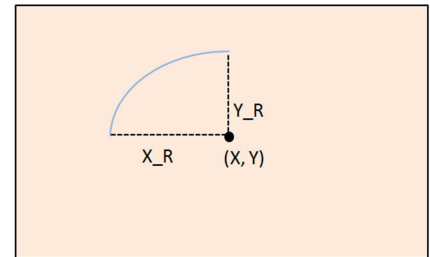[Long] CurveColor   // Color
)

Figure 4-21: Drawing a Lower-Right Curve

Example: Drawing a red Lower-Right Curve with one radius = 100 and another = 70, and the center is at (100, 100)

RightDownCurve(100, 100, 100, 70, TFT_RED)

4.8   Drawing 1/4 Ellipse

4.8.1   Drawing an Upper-Left 1/4 Ellipse

FilledLeftUpCurve

(

[Word] XCenter,   // Center X-Axis

[Word] YCenter,   // Center Y-Axis

[Word] X_R,   // X-Axis Radius

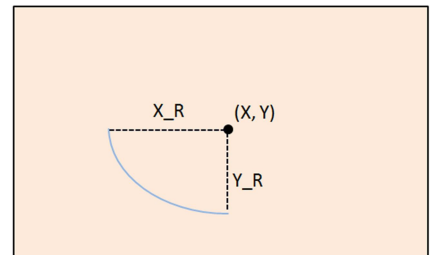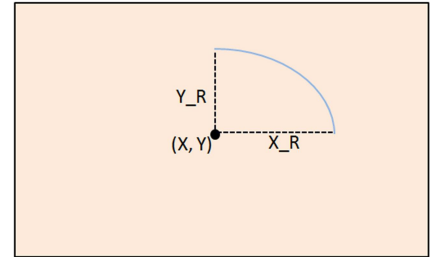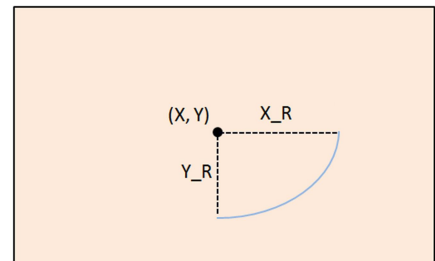[Word] Y_R,   // Y-Axis Radius

[Long] ForegroundColor   // Color

)

Figure 4-22: Drawing an

Upper-Left 1/4 Ellipse

Example: Drawing a red Upper-Left 1/4 Ellipse with one radius = 100 and another = 70, and the center is at (100, 100)

FilledLeftUpCurve(100, 100, 100, 70, TFT_RED)

4.8.2   Drawing an Lower-Left 1/4 Ellipse

FilledLeftDownCurve

(

[Word] XCenter,   // Center X-Axis

[Word] YCenter,   // Center Y-Axis

[Word] X_R,   // X-Axis Radius

[Word] Y_R,   // Y-Axis Radius

[Long] ForegroundColor   // Color

)

Figure 4-23: Drawing a

Lower-Left 1/4 Ellipse

Example: Drawing a red Lower-Left 1/4 Ellipse with one radius = 100 and another = 70, and the center is at (100, 100)

FilledLeftDownCurve(100, 100, 100, 70, TFT_RED)

4.8.3 Drawing an Upper-Right 1/4 Ellipse

FilledRightUpCurve

(

[Word] XCenter,   // Center X-Axis

[Word] YCenter,   // Center Y-Axis

[Word] X_R,   // X-Axis Radius

[Word] Y_R,   // Y-Axis Radius

[Long] ForegroundColor   // Color

)

Figure 4-24: Drawing an Upper-Right 1/4 Ellipse

Example: Drawing a red Upper-Right 1/4 Ellipse with one radius = 100 and another = 70, and the center is at (100, 100)

FilledRightUpCurve(100, 100, 100, 70, TFT_RED)

4.8.4 Drawing an Lower-Right 1/4 Ellipse

FilledRightDownCurve

(

[Word] XCenter,   // Center X-Axis

[Word] YCenter,   // Center Y-Axis

[Word] X_R,   // X-Axis Radius

[Word] Y_R,   // Y-Axis Radius
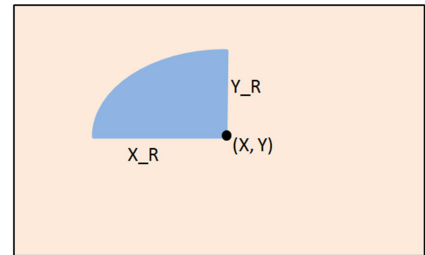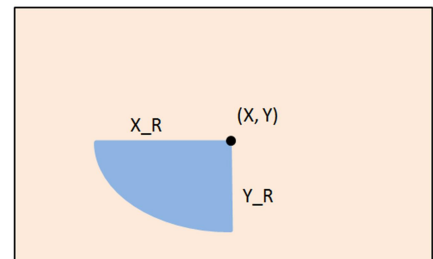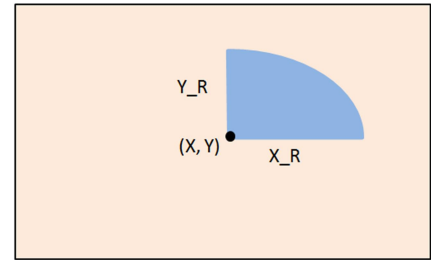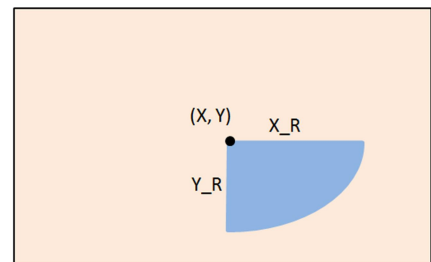
[Long] ForegroundColor   // Color

)

Figure 4-25: Drawing a Lower-Right 1/4 Ellipse

Example: Drawing a red Lower-Right 1/4 Ellipse with one radius = 100 and another = 70, and the center is at (100, 100)

FilledRightDownCurve(100, 100, 100, 70, TFT_RED)

4.9   Drawing Quadrilateral

4.9.1   Drawing a Hollow Quadrilateral

Quadrilateral

(

[Word] X1,   // Corner X1-Axis

[Word] Y1,   // Corner Y1-Axis

[Word] X2,   // Corner X2-Axis

[Word] Y2,   // Corner Y2-Axis

[Word] X3,   // Corner X3-Axis

[Word] Y3,   // Corner Y3-Axis

[Word] X4,   // Corner X4-Axis

[Word] Y4,   // Corner Y4-Axis

[Long] ForegroundColor   // Frame Color

)

Figure 4-26: Drawing a Hollow Quadrilateral

Example: Drawing a red Hollow Quadrilateral with the corners = (50, 50), (200, 80), (150, 130) and (60, 100) respectively.

Quadrilateral(50, 50, 200, 80, 150, 130, 60, 100, TFT_RED)

Note: The quadrilateral can be arbitrarily set coordinates of four corners. But the rectangle only need sets the coordinates of two corners.

4.9.2   Drawing a Solid Quadrilateral

FilledQuadrilateral

(

[Word] X1,   // Corner X1-Axis

[Word] Y1,   // Corner Y1-Axis

[Word] X2,   // Corner X2-Axis

[Word] Y2,   // Corner Y2-Axis

[Word] X3,   // Corner X3-Axis

[Word] Y3,   // Corner Y3-Axis

[Word] X4,   // Corner X4-Axis

[Word] Y4,   // Corner Y4-Axis

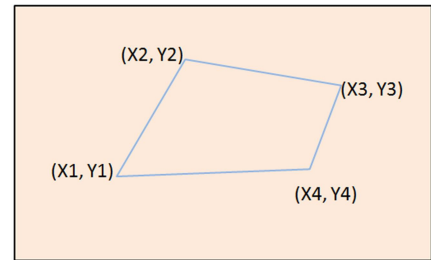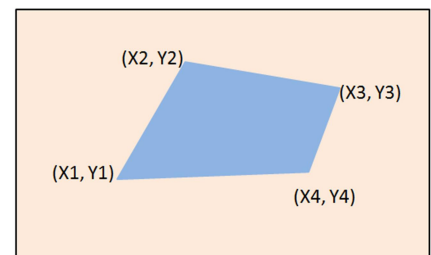[Long] ForegroundColor   // Foreground Color

)

Figure 4-27: Drawing a Solid Quadrilateral

Example: Drawing a red Solid Quadrilateral with the corners = (50, 50), (200, 80), (150, 130) and

(60, 100) respectively.

FilledQuadrilateral (50, 50, 200, 80, 150, 130, 60, 100, TFT_RED)

4.10　Drawing Pentagonal

4.10.1　Drawing a Hollow Pentagonal

Pentagon

(

[Word] X1,	// Corner X1-Axis
[Word] Y1,	// Corner Y1-Axis
[Word] X2,	// Corner X2-Axis
[Word] Y2,	// Corner Y2-Axis
[Word] X3,	// Corner X3-Axis
[Word] Y3,	// Corner Y3-Axis
[Word] X4,	// Corner X4-Axis
[Word] Y4,	// Corner Y4-Axis
[Word] X5,	// Corner X5-Axis
[Word] Y5,	// Corner Y5-Axis
[Long] ForegroundColor	// Frame Color

)

Figure 4-28: Drawing a Hollow Pentagonal

Example: Drawing a red Hollow Pentagonal with the coners = (50, 100), (120, 130), (150, 160), (100, 180) and (80, 140) respectively.

Pentagon(50, 100, 120, 130, 150, 160, 100, 180, 80, 140, TFT_RED)

4.10.2　Drawing a Solid Pentagonal

FilledPentagon

(

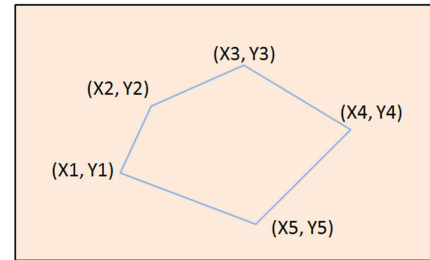|	
[Word] X1,	// Corner X1-Axis
[Word] Y1,	// Corner Y1-Axis
[Word] X2,	// Corner X2-Axis
[Word] Y2,	// Corner Y2-Axis
[Word] X3,	// Corner X3-Axis
[Word] Y3,	// Corner Y3-Axis
[Word] X4,	// Corner X4-Axis
[Word] Y4,	// Corner Y4-Axis
[Word] X5,	// Corner X5-Axis
[Word] Y5,	// Corner Y5-Axis
[Long] ForegroundColor	// Foreground Color

)
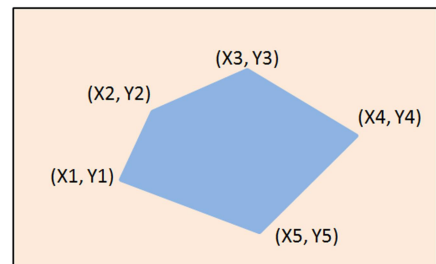
Figure 9-29: Drawing a Solid Pentagonal

Example: Drawing a red Solid Pentagonal with corners = (50, 100), (120, 130), (150, 160), (100, 180) and (80, 140) respectively.

FilledPentagon (50, 100, 120, 130, 150, 160, 100, 180, 80, 140, TFT_RED)

4.11   Drawing Cylinder

Cylinder
(
[Word] XCenter,   // Center X-Axis
[Word] YCenter,   // Center X-Axis
[Word] X_R,   // X Radius
[Word] Y_R,   // Y Radius
[Word] H,   // Cylinder Height
[Long] CylinderColor,   // Frame Color
[Long] ForegroundColor   // Foreground Color
)

Figure 4-30: Drawing a Cylinder

Example: Drawing a blue Cylinder with a red frame, the radiuses are 100 and 50, the height is 150, and the center is at (200, 300).

Cylinder (200, 300, 50, 100, 150, TFT_RED, TFT_BLUE)

Note: The implementation of drawing a Cylinder is integrated by some of the drawing functions mentioned in this Chapter, and the parameters of the Ellipse in this function are based on the bottom Ellipse.

4.12   Drawing Cube

FilledCube

(

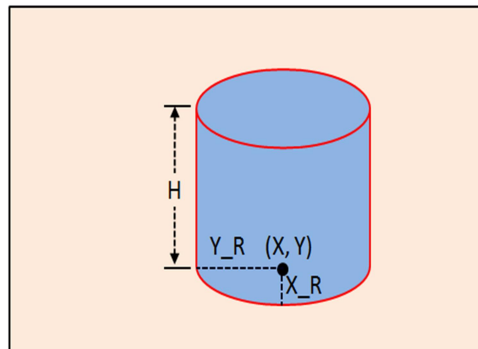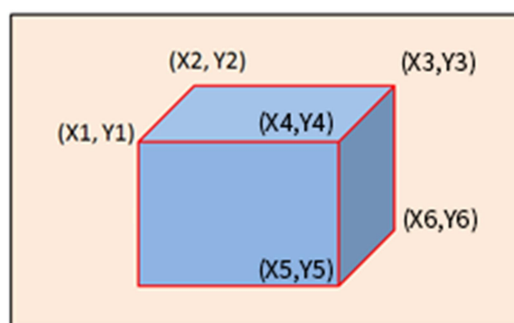| [Word]	X1,	// X1-Axis
[Word]	Y1,	// Y1-Axis
[Word]	X2,	// X2-Axis
[Word]	Y2,	// Y2-Axis
[Word]	X3,	// X3-Axis
[Word]	Y3,	// Y3-Axis
[Word]	X4,	// X4-Axis
[Word]	Y4,	// Y4-Axis
[Word]	X5,	// X5-Axis
[Word]	Y5,	// Y5-Axis
[Word]	X6,	// X6-Axis
[Word]	Y6,	// Y6-Axis
[Long]	QuadrangularColor,	// Frame Color
[Long]	ForegroundColor	// Foreground Color

)

Figure 4-31: Drawing a Cube

Example: Drawing a blue Cube with a red frame, the 6 points are (300, 300), (350, 250), (400, 250), (350, 300), (350, 350), and (400, 300)

FilledCube (300, 300, 350, 250, 400, 250, 350, 300, 350, 350, 400, 300, TFT_RED, TFT_BLUE)

Note: The implementation of drawing a Cube is integrated by some of the drawing functions mentioned in this Chapter.

4.13 Drawing Table

GLCDMakeTable (

[Word] X1,	// Start Corner X-Axis
[Word] Y1,	// Start Corner Y-Axis
[Word] W,	// Cell Width (W)
[Word] H,	// Cell Height (H)
[Word] Cols,	// Column Number (total) (CN)
[Word] Rows,	// Row Number (total) (RN)
[Word] width1,	// Inner Frame Width
[Word] width2,	// Outer Frame Width
[Byte] mode,	// Bit0: Item Table is Vertical, Bit1: Item Table is Horizontal
[Long] TableColor,	// Frame Color (C1)
[Long] ItemColor,	// Item Table Color (C2)
[Long] ForegroundColor	// Content Table Color (C3)

)
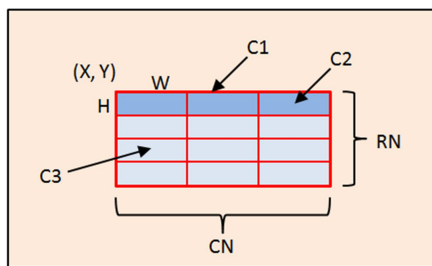
Figure 4-32: Drawing a Horizontal Accent
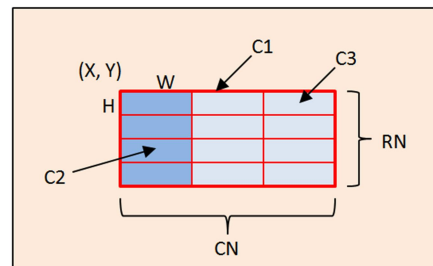
Figure 4-33: Drawing a Vertical Accent

Example: Example: Drawing a horizontal table window at (5, 20) position. The cell size is 31*20, table number of rows is 22, table number of columns is 25, the frame color is red, foreground color of Item table is green, foreground color of content table is white, inner frame width is 1, outer frame width is 3.

#define TOPL	5
#define TOPR	20
#define CELLW	31
#define CELLH	20
#define NUMOFCOLS	25
#define NUMOFROWS	22
#define INNERFRAME	1

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```
#define OUTERFRAME            3
// These constants control the accent of the table.   These are additive.
#define TOPROWACCENT          2
#define LEFTCOLUMNACCENT      1
#define NOACCENT              0


GLCDMakeTable ( TOPL, TOPR, CELLW, CELLH, NUMOFCOLS, NUMOFROWS,
INNERFRAME, OUTERFRAME,   TOPROWACCENT + LEFTCOLUMNACCENT, TFT_RED,
TFT_GREEN, TFT_WHITE ).
```

Note: The implementation of drawing a Table is integrated by some of the drawing functions mentioned in this Chapter.

5. Function Library List

Table 24-1: Function Library List

No.	Function Name	Function Description
1	LT7686_Software_Reset ()	Software Reset
2	InitGLCD_LT7686()	Setup Clock & PLL
63	LT7686_Display_ColorBar(TRUE)	Color Bar Display Enable
64	LT7686_Display_ColorBar(FALSE)	Color Bar Display Disable
65	Line()	Drawing a Thin Line
66	Line()	Drawing a Thick Line
67	Circle()	Drawing a Hollow Circle
68	FilledCircle()	Drawing a Solid Circle
69	FramedFilledCircle()	Drawing a Solid Circle with Frame
70	Ellipse()	Drawing a Hollow Ellipse
71	FilledEllipse()	Drawing a Solid Ellipse
72	FramedFilledEllipse()	Drawing a Solid Ellipse with Frame
73	Square()	Drawing a Hollow Rectangle
74	FilledSquare()	Drawing a Solid Rectangle
75	FramedFilledSquare()	Drawing a Solid Rectangle with Frame
76	CircleSquare()	Drawing a Hollow Rounded-Rectangle
77	FilledCircleSquare()	Drawing a Solid Rounded-Rectangle
78	FramedFilledCircleSquare()	Drawing a Rounded-Rectangle with Frame
79	Triangle()	Drawing a Hollow Triangle
80	FilledTriangle()	Drawing a Solid Triangle
81	FramedFilledTriangle_Frame()	Drawing a Solid Rectangle with Frame
82	LeftUpCurve()	Drawing an Upper-Left Curve
83	LeftDownCurve()	Drawing a Lower-Left Curve
84	RightUpCurve()	Drawing an Upper-Right Curve
85	RightDownCurve()	Drawing a Lower-Right Curve
86	FilledLeftUpCurve()	Drawing an Upper-Left 1/4 Ellipse
87	FilledLeftDownCurve()	Drawing an Lower-Left 1/4 Ellipse
88	FilledRightUpCurve()	Drawing an Upper-Right 1/4 Ellipse
89	FilledRightDownCurve()	Drawing an Lower-Right 1/4 Ellipse
90	Quadrilateral()	Drawing a Hollow Quadrilateral
91	FilledQuadrilateral()	Drawing a Solid Quadrilateral
92	Pentagon()	Drawing a Hollow Pentagonal
93	FilledPentagon()	Drawing a Solid Pentagonal

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No.	Function Name	Function Description
94	Cylinder()	Drawing Cylinder
95	Quadrangular()	Drawing Cube
96	GCLDMakeTable()	Drawing Table
106	Select_Internal_Font_Init()	Internal Font Initialize
107	Print_Internal_Font_String()	Setup Internal Font
108	Select_Outside_Font_Init()	External Font Initialize
109	Print_Outside_Font_String()	Setup External Font
110	Print_Outside_Font_String_BIG5()	显示外建字库(BIG5)
111	Print_Outside_Font_GB2312_48_72()	显示大的外建字库
112	Print_Outside_Font_BIG5_48_72()	显示大的外建字库(BIG5)
113	Font_Line_Distance()	使用外建字库 – 文字行距
114	Text_cursor_Init()	Text Cursor Initialize
115	Enable_Text_Cursor()	Enable Text Cursor
116	Disable_Text_Cursor()	Disable Text Cursor
117	Graphic_cursor_Init()	Graphic Cursor Initialize
118	Set_Graphic_cursor_Pos()	Change Graphic Cursor Position
119	Enable_Graphic_Cursor()	Enable Graphic Cursor
120	Disable_Graphic_Cursor()	Disable Graphic Cursor
121	PWM0_Init()	PWM0 Initialize
122	PWM1_Init()	PWM1 Initialize
123	PWM0_Duty([Word] Compare_Buffer)	Setup PWM0 Duty Rate
124	PWM1_Duty([Word] Compare_Buffer)	Setup PWM1 Duty Rate
129	Standby()	Enter Standby Mode
130	Suspend()	Enter Suspend Mode
131	SleepMode()	Enter Sleep Mode
132	Wkup_Standby()	Wakeup from Standby Mode
133	Wkup_Suspend()	Wakeup from Suspend Mode
134	Wkup_Sleep()	Wakeup from Sleep Mode

⟩ Version History

Table A-1: Version History

Version	Date	Revision Description

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