3.2 inch QVGA TFT Color LCD User's Guide Version 1 & 2
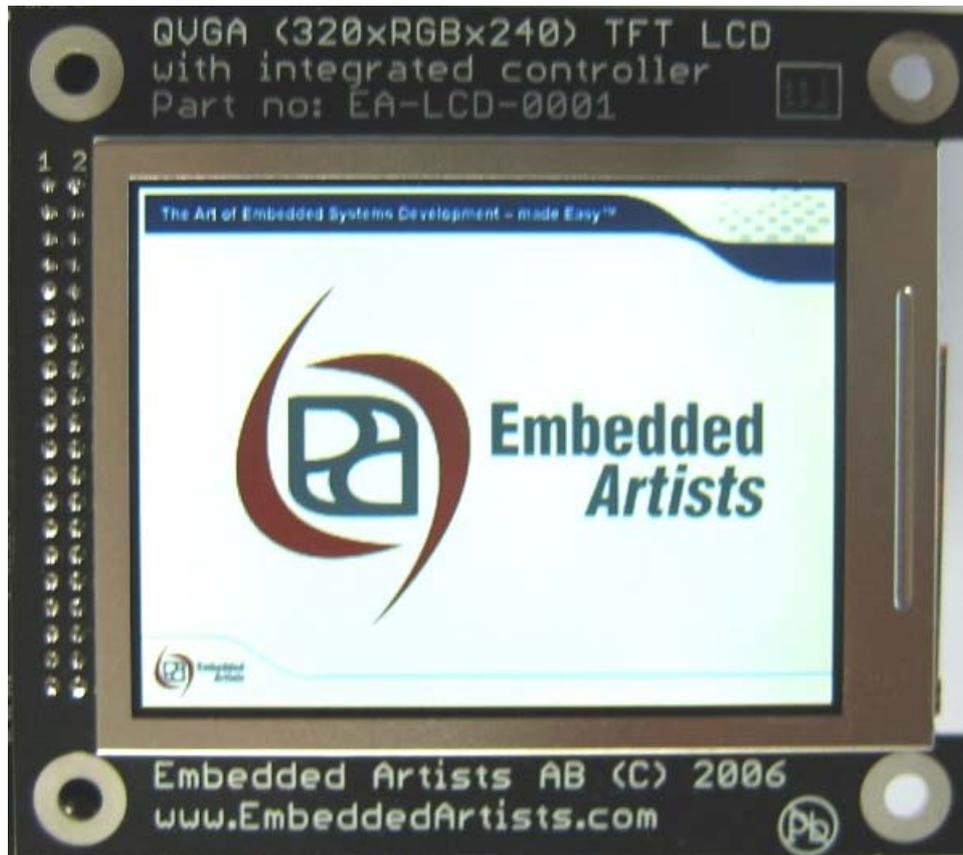
Give graphics and color to your application!

Embedded Artists

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1 Introduction

Thank you for buying Embedded Artists' *3.2 inch QVGA TFT Color LCD Board* based on a LCD from Truly. Sample applications for our NXP LPC2xxx based boards are also provided and can be downloaded from the support page. The *3.2 inch QVGA TFT Color LCD Board* will be called the *QVGA LCD Board* for short in the rest of this document.

1.1 Features

The *QVGA LCD Board* has the following features:

- Optional touch screen interface (available for version 2)

- 8-bit or 16-bit parallel interface. Only occupies 2 addresses (i.e., one address pin),

- or serial 8-bit (SPI-like) interface (max 10 MHz clock)

- Diagonal size: 3.2 inch

- Display technology: TFT

- Display mode: Transmissive

- No of pixels: 240xRGBx320 (QVGA size)

- Supply voltage: 3.0-3.3V

- White LED backlight, with PWM control

- View area: 48.6 x 64.8 mm

- Dot size: 0.2025 x 0.2025 mm

- Operating temperature: -20 to + 70 degrees Celsius

- No of colors: 262K (if 18-bit mode), 65k (if 16-bit mode)

- 2x20 pos connector (100 mil spacing) is required to interface the module, plus optional 1x6 pos connector

- Small form factor: 93 x 83 mm

1.2 Version 1 vs. Version 2

There exist two versions of the display. Version 1 uses a display from one display manufacturer and version 2 uses a display from another manufacturer.

The similarities between the versions are:

- Same physical size of display module.

- Same optical features and capabilities.

- Same main 2x20 pos interface connector (100 mil spacing).

The differences are:

- Different internal display controllers are used. The programming interface is not identical but very similar. A reference software driver exists that supports both versions simultaneous.

- Version 2 of the display module has a touch screen option.

- A 6 pos extra interface connector has been added beside the main 2x20 pos interface connector. This extra connector carries signals for touch screen interface and some

extra signals for direct RGB-control of display (useful when interfacing the LPC2478 MCU from NXP).

1.3 ESD Precaution

Always take ESD precaution when handling the *QVGA LCD Module*. Components are exposed for direct finger touches and can be damaged unless ESD precaution is taken.

1.4 Other Products from Embedded Artists

Embedded Artists has a broad range of LPC2xxx based boards that are very low cost and developed for prototyping / development as well as for OEM applications. Modifications for OEM applications can be done easily, even for modest production volumes. Contact Embedded Artists for further information about design and production services.

1.4.1 Design and Production Services

Embedded Artists provide design services for custom designs, either completely new or modification to existing boards. Specific peripherals and I/O can be added easily to different designs, for example, communication interfaces, specific analog or digital I/O, and power supplies. Embedded Artists has a broad, and long, experience in designing industrial electronics, in general, and with Philips LPC2xxx microcontroller family, in specific. Our competence also includes wireless and wired communication for embedded systems. For example IEEE802.11b/g (WLAN), Bluetooth™, ZigBee™, ISM RF, Ethernet, CAN, RS485, and Fieldbuses.

1.4.2 Boards and Kits

Visit Embedded Artists' home page, www.EmbeddedArtists.com, for information about other boards / kits or contact your local distributor.

2 Design Description

This chapter describes the hardware design of the *QVGA LCD Board*.

2.1 Backlight Control

White LEDs are used as backlight on the display. The LED current is set to 15 mA. A step-up DC/DC converted is used to generate a constant LED current. The switching frequency is fixed to 1.2 MHz.

The intensity of the backlight (i.e., the white LEDs) is varied by varying the LED current. There are two ways to very the LED current between 0-15 mA. A digital PWM signal is needed with the same logic levels as the power supply (typically 3.3V).

- Modulate the shutdown pin of the DC/DC converter (signal **LED_SHDN**). A low input signal turn off the DC/DC converted and a high level activate it. A high duty cycle on the PWM signal equals high intensity.

- Modulate the current set pin of the DC/DC converter (signal **LED_PWM**). A low input signal increase the LED current and a high level reduce it. A high duty cycle on the PWM signal equals low intensity.

The frequency of the modulation (PWM) signal should ideally be in the 5-10 kHz region.

2.2 On-board LCD Controller, display version 2

The display has an embedded controller, SSD1289 from Solomon Systech. This controller chip has 1.3 Mbit embedded display RAM, which is enough for storing a complete 320xRGBx240 picture with 18 bit color depth.

There are a couple of interface alternatives to this controller. Either 18-bit, 16-bit, 9-bit or 8-bit parallel interface or a serial interface. There are 4 pins that are used to configure the interface. The table below lists the different options. L is statically tied to low logic level and H is statically tied to high logic level.

18 bit parallel 6800-style i/f	16 bit parallel 6800-style i/f	9 bit parallel 6800-style i/f	8 bit parallel 6800-style i/f	18 bit parallel 8080-style i/f	16 bit parallel 8080-style i/f	9 bit parallel 8080-style i/f	8 bit parallel 8080-style i/f	Configuration pins
H	H	L	L	H	H	L	L	PS0 / CFG1
H	H	H	H	L	L	L	L	PS1 / CFG2
H	L	H	L	H	L	H	L	PS2 / CFG3
L	H	L	H	L	H	L	H	PS4 / CFG4
Does not matter. This pin is currently not used.								CFG5
Does not matter. This pin is currently not used.								CFG6

3-wire serial SPI i/f	4-wire serial SP Ii/f	6 bit RGB i/f	16 bit RGB + 4-wire SPI i/f	18 bit RGB + 4-wire SPI i/f	Configuration pins
H	L	H	L	H	PS0 / CFG1
H	H	H	H	L	PS1 / CFG2
H	H	L	L	L	PS2 / CFG3
H	H	L	L	L	PS4 / CFG4
Does not matter. This pin is currently not used.					CFG5
Does not matter. This pin is currently not used.					CFG6

If the parallel interface is selected, there are two different interface types; either 6800 or 8080 style. See datasheet for details about timing and how the different control signals are used.

Interface	Description
8080 style	i86 interface RD/E signal is Read strobe WR/RW signal is Write strobe
6800 style	M68 interface RD/E signal is Enable signal WR/RW signal is RW signal (high = read, low = write)

If a serial interface is used, see the datasheet for details about timing and how the different control signals are used. Note that maximum clock frequency is 13 MHz.

2.3   On-board touch screen Controller, display version 2

The touch screen controller used is TSC2046 from Texas Instruments. This chip has a SPI interface and shares the SI, SO, SCK pins in the main interface connector, with the LCD controller. Pin 45 must however be low (TSC2046 chip CS#) in order to communicate with the touch screen controller. See TSC2046 datasheet for details about the serial interface.

2.4   On-board LCD Controller, display version 1

The display has an embedded controller, IS2102B from ISRON. This controller chip has 1.3 Mbit embedded display RAM, which is enough for storing a complete 320xRGBx240 picture with 18 bit color depth.

There are a couple of interface alternatives to this controller. Either 16-bit or 8-bit parallel interface or a serial interface. There are 6 pins that are used to configure the interface. The table below lists the different options. L is statically tied to low logic level and H is statically tied to high logic level.

16 bit parallel 18-bit color depth (9+9)	16 bit parallel 18-bit color depth (16+2)	16 bit parallel 16-bit color depth	8 bit parallel 18-bit color depth (6+6+6)	8 bit parallel 18-bit color depth (8+8+2)	8 bit parallel 16-bit color depth (8+8)	9 bit serial 18-bit color depth (9+9)	8 bit serial 16-bit color depth (8+8)	Configuration pins
L	L	L	L	L	L	H	H	PSX / CFG1
H	H	L	H	H	L	-	-	DTX1 / CFG2
L	H	L	L	H	H	-	-	DTX2 / CFG3
L	L	L	H	H	H	H	H	BWS0 / CFG4
H	H	H	H	H	H	L	H	BWS1 / CFG5
Does not matter. This pin is currently not used. Set to L.								BWS2 / CFG6

If the parallel interface is selected, there are two different interface types. The configuration pin C86 is used to select between the *i86 interface* and the *M68 interface*. See datasheet for details about timing and how the different control signals are used.

C86 pin	Description
Low	i86 interface
	RD/E signal is Read strobe
	WR/RW signal is Write strobe
High	M68 interface
	RD/E signal is Enable signal
	WR/RW signal is RW signal (high = read, low = write)

If a serial interface is used, see the datasheet for details about timing and how the different control signals are used. Note that maximum clock frequency is 10 MHz.

2.5   Interface (pin description)

The table below describes the 40 pin interface to the *QVGA LCD Module*. A 2x20 pos (100 mil spacing) header connector facing down is used. See datasheet for details about interface timing.

Pin	Description
1, 39	Power supply for QVGA LCD Module. Both pins must be connected to the power supply. Pin 1 supply the QVGA LCD and pin 39 supply the backlight.
2, 10, 40	Ground
3	CFG1 / PSX interface configuration pin (see description above)
4	C86 interface configuration pin (see description above). Not used on version 2.

5	CFG2 / DTX1 interface configuration pin (see description above)
6	CFG3 / DTX2 interface configuration pin (see description above)
7	CFG4 / BWS0 interface configuration pin (see description above)
8	BWS1 interface configuration pin (see description above). Not used on version 2.
9	BWS2 interface configuration pin (see description above). Not used on version 2.
11-12	D17-D16 data inputs if 18-bit color depth is used. Not used when 8 or 16-bit parallel interface is used.
13-28	D15-D0 databus. D0-D7 is used for 8-bit parallel interface. D0-D15 is used when 16-bit parallel interface is used.
29	CS – Chip Select, active low
30	RST – reset input, active low.
31	RS – Register Set input. Controls if control registers or display ram is accessed. Normally connected to A1 if 16-bit parallel interface or A0 if 8-bit interface.
32	WR/RW – Write strobe, active low, or Read/Write strobe (depending on C86 pin (v1) or CFG settings(v2))
33	RD/E – Read strobe, active low, or Enable strobe (depending on C86 pin (v1) or CFG settings(v2))
34	SI – Serial Input, if the serial interface is used. Set low if not used.
35	SCL – Serial Clock, if the serial interface is used. Set low if not used.
36	SO – Serial Output, if the serial interface is used.
37	LED_PWM, digital PWM signal input (5-10 kHz) for controlling the backlight. Low duty cycle = high intensity. Leave open if not used.
38	LED_SHDN, digital PWM signal input (5-10 kHz) for controlling the backlight. High duty cycle = high intensity. Leave open if not used.

On display version 2 a new extra 1x6 pos (100 mil spacing) header connector facing down exists. See datasheet for details about interface timing.

Pin	*Description*
41	DOTCLK, needed when using RGB interface
42	HSYNC, needed when using RGB interface
43	VSYNC, needed when using RGB interface
44	DEN, needed when using RGB interface
45	Touch screen controller CS#
46	Touch screen controller PENIRQ#

The picture below illustrates the pin numbering of the *QVGA LCD Module*.
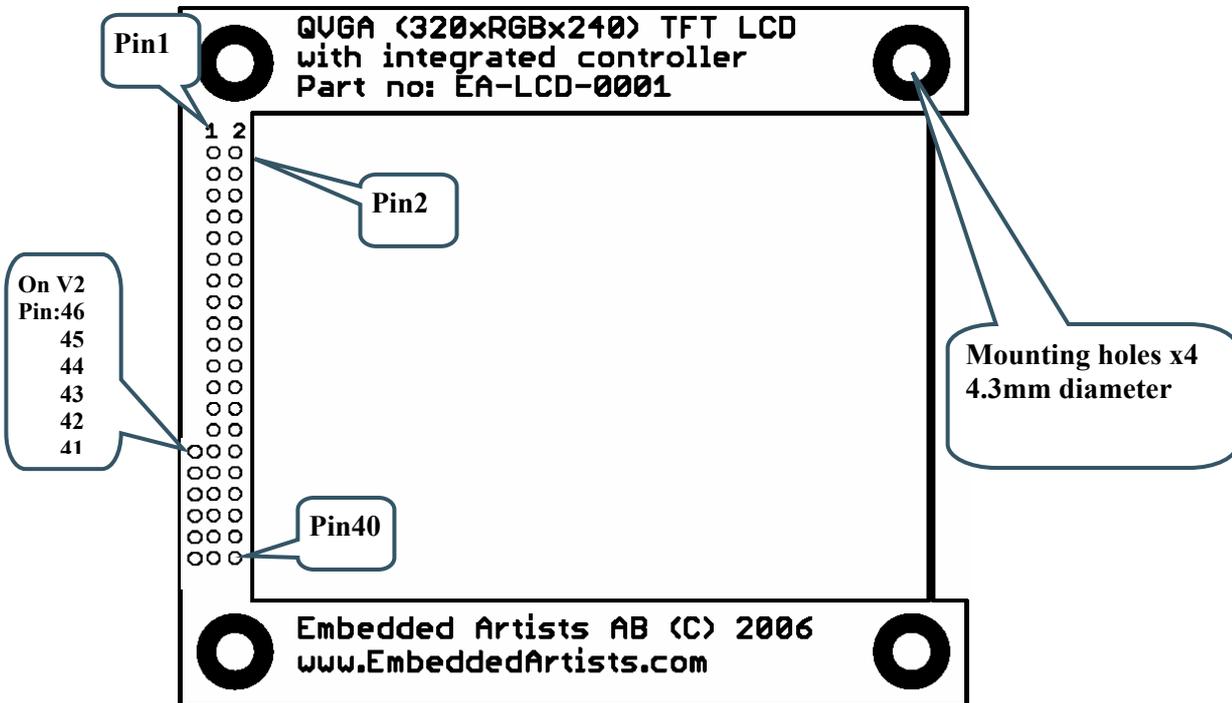
Figure 1 - 3.2 inch QVGA TFT Color LCD Board Pin Numbering

2.6   Optimum Viewing Angle

Optimum viewing angles are as illustrated below.
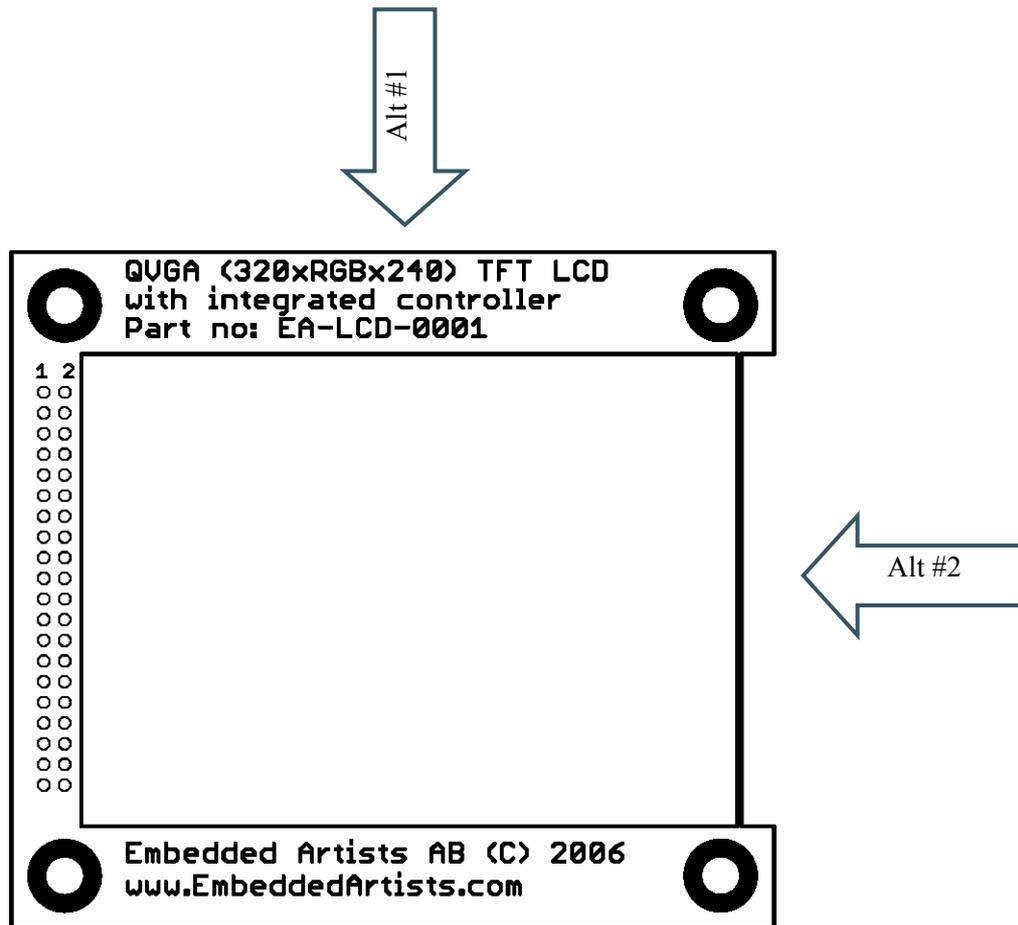
Figure 2 - 3.2 inch QVGA TFT Color LCD Board Optimum Viewing Angle

2.7   Connecting version 2 to OEM Base Board < v1.5

Version 1.5 and above of the OEM Base Board has direct connectors for all 46 positions in the interface connector. Version 1.4 and below do not have the 6 extra positions (pos 41-46). These have been added for version2 of the display.

The touch screen controller can still be accessed with just one extra wire, from pin 45 on the display module to P0.16 on the OEM Base Board. P0.16 is used for chip select of the touch screen controller. Other pins work just as well, but P0.16 is used on v1.5 and above of the OEM Base Board.
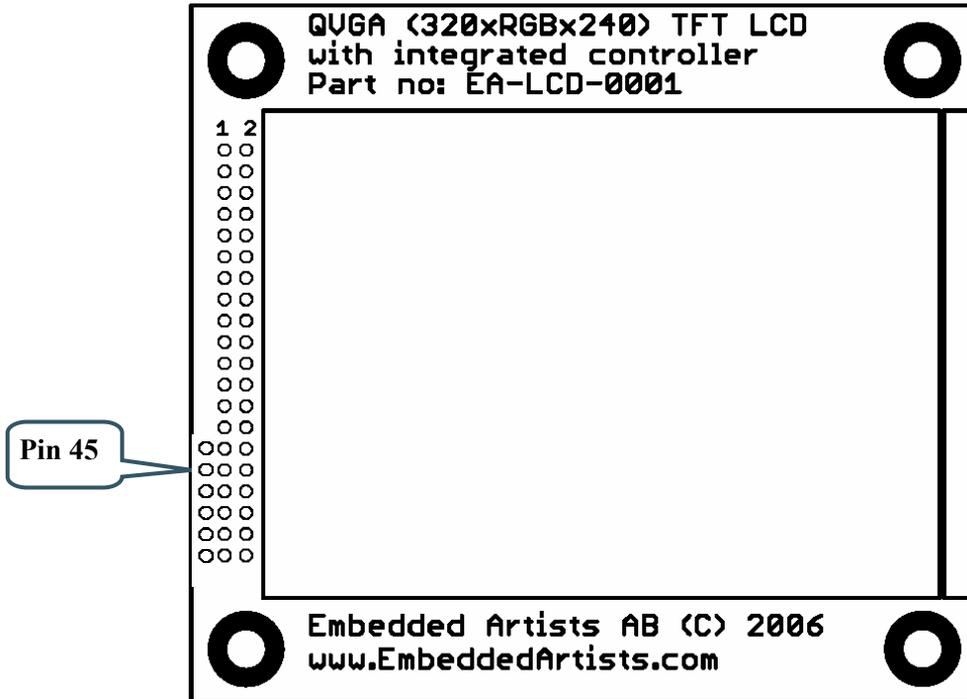
Figure 3 - 3.2 inch QVGA TFT Color LCD Board Pin 45

Simply connect a wire from pin 45 on the display module to P0.16 on the OEM Base Board. Figure 4 and 5 below illustrate the wire connection. Also note that the three SPI jumpers must be inserted, see Figure 4 for details.

Three SPI jumpers must be inserted since communication with touch screen controller is via SPI.
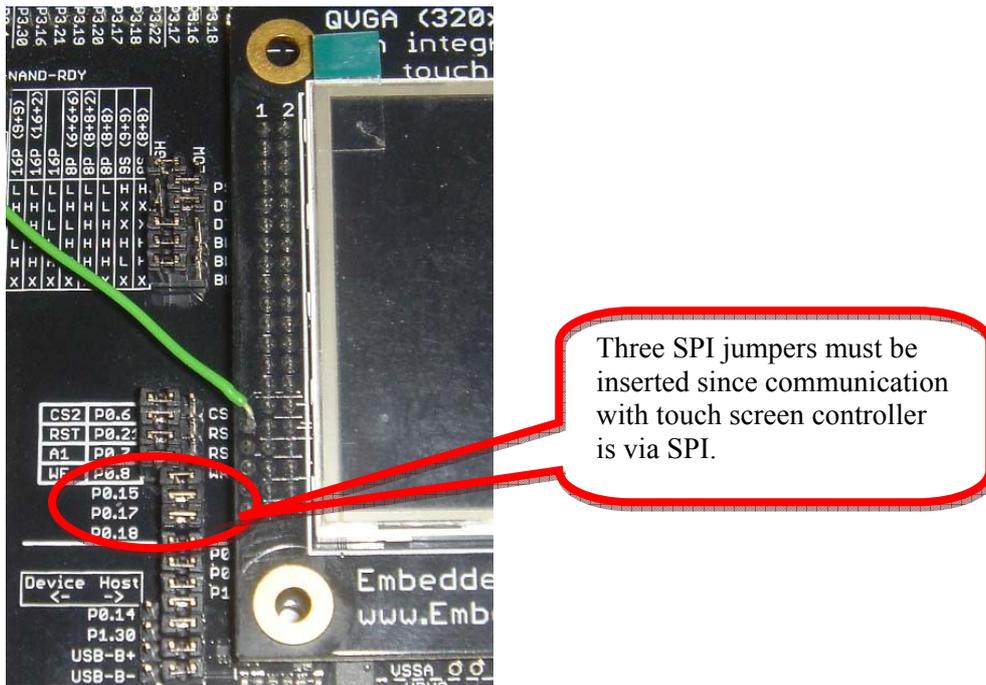
Figure 4 – Picture of Wire to Pin 45 on Display Module
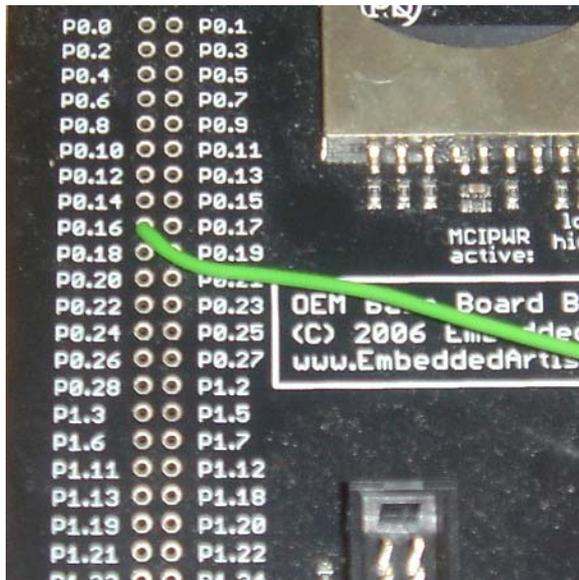
Figure 5 – Wire to p0.16 on OEM Base Board

3 Board Mechanical Dimensions

Figure 6 below contains a drawing of the board that includes mechanical measures. Four 4.3 mm grounded mounting holes are used.
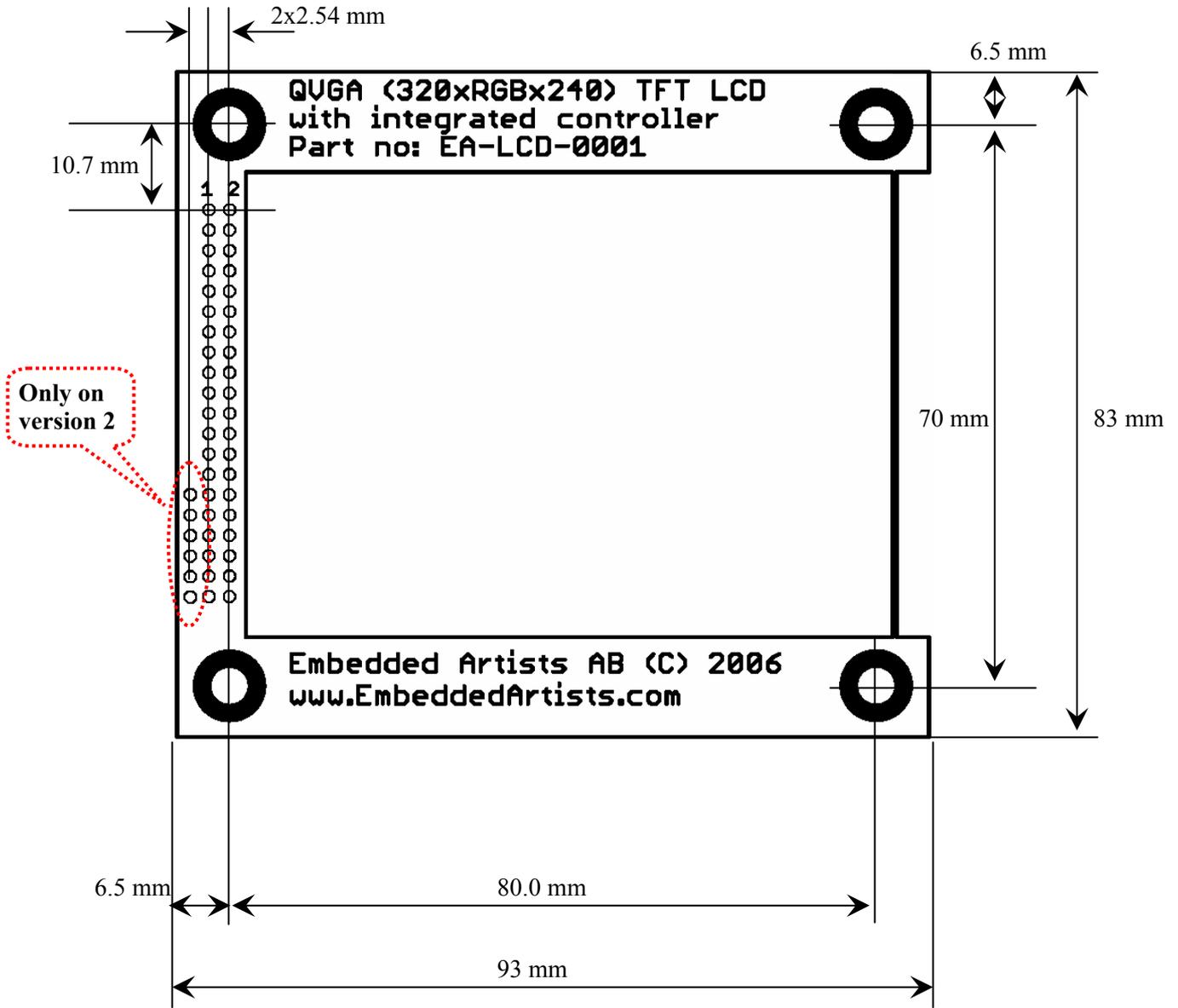

Figure 6 - 3.2 inch QVGA TFT Color LCD Board Mechanical Dimensions

4 Product Registration

You can download a lot of valuable information and programs that will easy your program development from the support pages. See details below about the product registration process, which allows you to always have access to the latest versions.

4.1 Product Registration

By registering as a customer of Embedded Artists you will get access to valuable material and information that will get you up-and-running instantly:

- The latest version of the software, both as binary image (hex file) and as source code.

- Datasheets of LCD controller.

- Image conversion program for generating bitmaps from pictures.

Registering is easy and done quickly.

1) Visit http://www.EmbeddedArtists.com, select *Support* and then *Register*.

2) Type in the products serial number (can be found on the ESD bag of the *QVGA LCD Board*) along with your personal information.