UM10817

OM13503, PCA8539 demo board

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Document information

Info	Content
Keywords	LCD driver, dot-matrix driver, COG, Chip-On-Glass, PCA8539, LPCXpresso, Vertical Alignment, VA
Abstract	The OM13503 is an LCD demo board which can be used to demonstrate and evaluate the PCA8539 dot-matrix driver. This is a Chip-On-Glass LCD driver which can drive a dot matrix up to 100 × 18 dots with a display size of up to 7”. The board is controlled by an LPCXpresso micro controller board, which contains the LPC1115, a Cortex M0 controller. A free IDE can be downloaded in order to modify the software. Supply of the board can be done via an AC adapter or USB connector.

Revision history

Rev	Date	Description
1	20140903	Initial version

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1. Introduction

This user manual describes the OM13503 demo board. The board consists of a base board, with a plugged in LPCXpresso board containing the microcontroller to control the display driver. The PCA8539 is a peripheral LCD driver which generates the drive signals for a dot matrix display of up to 18 rows and up to 100 columns. The PCA8539 was specifically designed for high-contrast Vertical Alignment (VA) LCDs. To generate the high V_{LCD} voltage it features an internal charge pump with integrated temperature compensation, and it communicates either via a two-line bidirectional I²C-bus or a four-line bidirectional SPI-bus.

This board was developed in order to provide a low cost tool to engineers, wishing to demonstrate and evaluate this LCD driver, and to get hands-on experience with writing code for it. Code written using this board can serve as an example for the final application. This enables rapid prototyping.

Features:

- Demonstrates PCA8539 LCD driver
- Features a vertical alignment (VA) COG display module with integrated backlight
- Plugged in OM13035 LPCXpresso board with LPC1115 microcontroller
- 3 push buttons
- User modifiable firmware, In-System/In-Application Programming (ISP/IAP) via USB
- Power supply can be done either via USB or an external power supply. This can also be used for an external V_{LCD}
- Box contents:
  - OM13503 base board (marked on the board)
  - OM13035 LPCXpresso board

The 12NC of the OM13503 board is 9353 031 21598.

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2. Board description and layout

In Fig 1 the top view of the board is given.



Fig 1. Top view of OM13503 demo board

For best optical performance, remove the protective foil from the display. A red colored pull tape can be found on the bottom left of the display. The optimal viewing angle for this display is 6 o'clock.

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2.1 Power Supply

Please refer to the schematic diagram of the board, which is given in Fig 3.

1. Via mini-USB connector P1. Now the 5 V come directly from the USB port. This supply is used for the PCA8539 directly, as well as to supply a 3.3 V regulator. The output of the regulator is used for the back light and to supply the micro controller.
2. Via an external DC power supply, for which connector P2 has been provided. Connect a voltage of 5 V (erroneously labeled as 6 V on the PCB) to pin 5. Again, that voltage is to supply the LCD driver and the 3.3 V regulator which in turn supplies the microcontroller and the backlight. The voltage connected to pin 1 must not exceed 16 V (erroneously labeled a 15 V MAX). It is to provide the LCD operating voltage. Diodes protect against damage in case of wrong polarity.

It is not possible to apply power via the plugged in LPCXpresso board. The USB connector on the LPCXpresso board is only meant for programming the flash memory. There are two ways to provide power to the base board:

The PCA8539 includes a temperature compensated internal V_{LCD} generator. If the internal voltage generator for V_{LCD} is not used, and one wants to quickly see the optical result of varying V_{LCD}, this can be achieved using the second supply option. Varying the voltage provided to pin 1 of connector P2 will directly influence the display contrast and the optimal voltage can be selected. Make sure that the voltage V_{LCD} does not exceed the maximum limit of 16 V of PCA8539. If external V_{LCD} is used, jumper JP7 must be removed and jumper JP8 must be placed. Ensure that the internal voltage generation (control register settings) is disabled.

Switch SW1 is used to select which of the two power supply options is activated. The 5 V output of the switch is used to directly supply the PCA8539 LCD driver. Furthermore the voltage labeled “3V3” is generated with an additional regulator, IC1. This 3.3 V supply is used to supply the microcontroller board LPCXpresso (via diode D3) and to supply the back light. At 3.3 V, the backlight draws a current of typically 180 mA, and this is why D3 was included. D3 prevents a current flowing from the LPCXpresso board to the back light when the USB cable is plugged into the LPCXpresso board, as this current would exceed the limits of the regulator on the LPCXpresso board.

The LPCXpresso board contains a JTAG/SWD debugger called the “LPC-Link” and a target MCU. LPC-Link is equipped with a 10-pin JTAG header and it seamlessly connects to the target via USB (the USB interface and other debug features are provided by NXP’s ARM9 based LPC3154 MCU). When the firmware needs to be updated, the LPCXpresso board will be connected using the USB to the computer on which the IDE is installed.

It is allowed to provide power to the base board while LPCXpresso is connected to a computer, for example using two USB cables.

2.2 Switches

Three push buttons are present on the board, SW2, SW3 and SW4. They have currently no function assigned.

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2.3 Jumpers

The board contains a number of jumpers. Below they are listed, along with their functionality.

- **JP1 through JP6**: They are all used to select either the I²C-bus interface, or the SPI interface. They need to be all in the same position. The silk screen indicates which position to use for a given interface. Refer also to the datasheet.
- **JP7**: This jumper connects the V_{LCDOUT} and $V_{LCDSENSE}$ to the V_{LCDIN} pin of the PCA8539. It must be placed if the internal voltage generation is used.
- **JP8**: This jumper connects the V_{LCDIN} pin of the LCD driver to the external voltage VLCD_IN connected to connector P2. However, if also the internal voltage generator is enabled, this can cause damage to the LCD driver.
- **JP9**: This jumper may not have been soldered into the board during manufacturing. Instead, a 0 Ω resistor (R2) is mounted, in parallel with this jumper. Removing the 0 Ω resistor and mounting the jumper makes it easy to insert a current meter and measure the current consumption to the V_{DD} pins of the PCA8539. After measurements, a jumper header can be inserted.

2.4 Use of internal/external oscillator

The PCA8539 offers the option of using the internal oscillator or to use an external oscillator. Resistor jumper R1 (0 Ω) connects the OSC pin to V_{SS} for selecting the internal oscillator. If an external oscillator signal is desired, R1 must be removed and R12 must be mounted. If the internal oscillator is used, the oscillator signal is available at connector pin “CLK”. If an external oscillator signal is used, this can be supplied to the LCD driver using this connector “CLK”.

2.5 Connectors

Besides the previously mentioned connectors, connector P3 contains the I²C and SPI signals, along with V_{SS} and a reset signal. This connector can be used to connect the baseboard to another application/microcontroller. In that case, the LPCXpresso board must be removed.

2.6 LPCXpresso

LPCXpresso is a low-cost development platform available from NXP. The software consists of an enhanced, Eclipse-based IDE, a GNU C compiler, linker, libraries, and an enhanced GDB debugger. The hardware consists of the LPCXpresso development board which has an LPC-Link debug interface and an NXP LPC ARM-based microcontroller target. LPCXpresso is an end-to-end solution enabling embedded engineers to develop their applications from initial evaluation to final production.

The LPCXpresso IDE is based on the popular Eclipse development platform and includes several LPC-specific enhancements. It is an industry-standard GNU tool chain with an optimized C library that gives engineers all the tools necessary to develop high-quality software solutions quickly and cost-effectively. The C programming environment includes professional-level features. There is syntax coloring, source formatting, function folding, on- and offline help, and extensive project management automation.

The LPCXpresso target board, jointly developed by NXP, Code Red Technologies, and Embedded Artists, includes an integrated JTAG debugger (LPC-Link), so there is no need for a separate JTAG debug probe. The target portion of the board can connect to

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expansion boards to provide a greater variety of interfaces, and I/O devices. The on-board LPC-Link debugger provides a high-speed USB to JTAG/SWD interface to the IDE and it can be connected to other debug targets such as a customer prototype. Users can also use the LPCXpresso IDE with the Red Probe JTAG adapter from Code Red Technologies.

Refer to the “Getting started with NXP LPCXpresso”, listed in the references, for more information.

The board included with the base board is OM13035 which contains the LPC1115 MCU.

3. Board schematic and layout of OM13503

On the next pages the circuit diagram and PCB layout of the OM13503 board are given. Refer to Fig 2 and Fig 3.

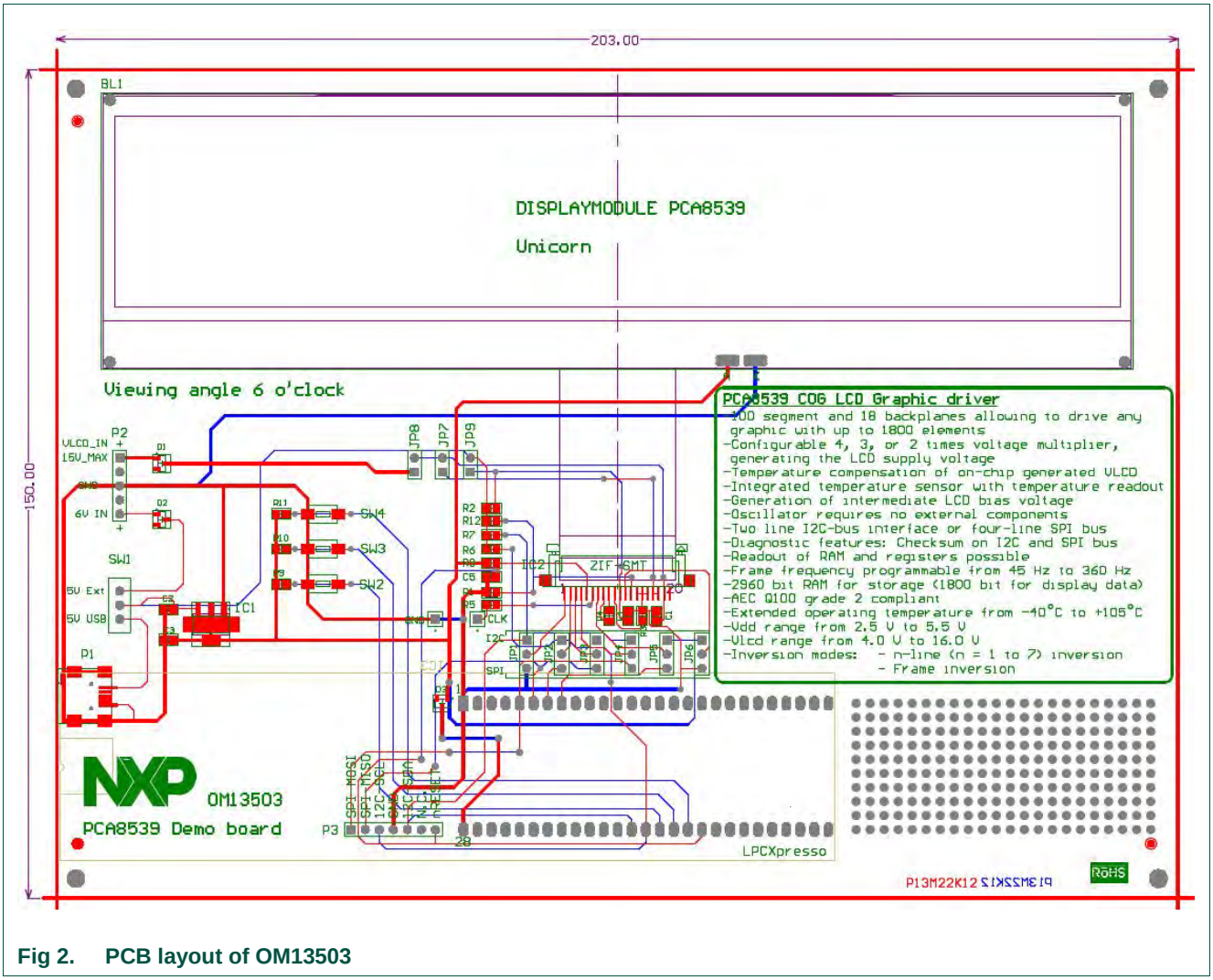


Fig 2. PCB layout of OM13503

The LPCXpresso board is on the reverse side of the base board.

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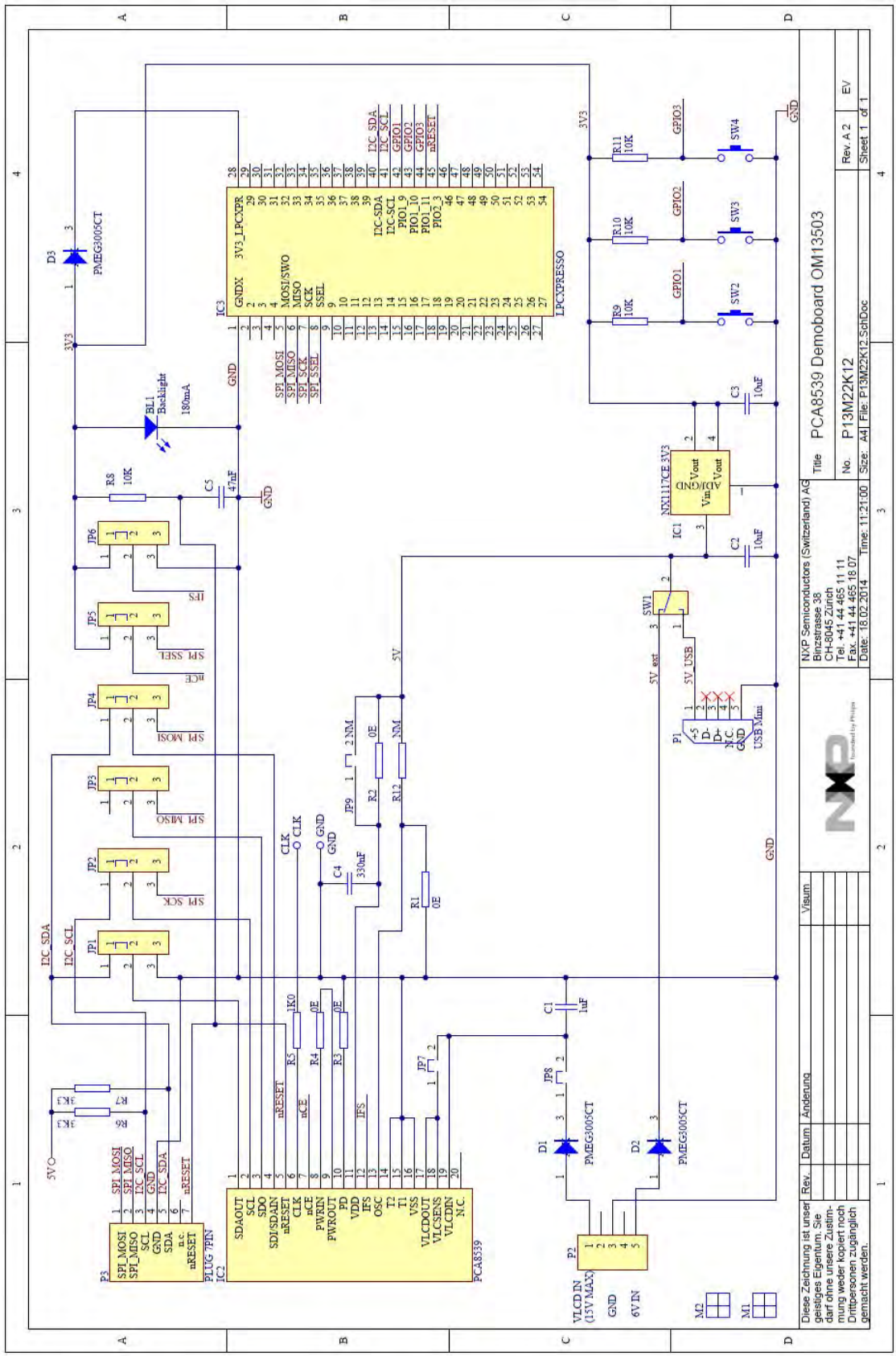


Fig 3. Schematic of OM13503

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4. Display module

The display is a Passive Matrix Vertically Aligned (PMVA) negative display providing a very dark background with a very wide and symmetric viewing angle.

5. Software code example

The PCA8539 data sheet contains all the commands and their description. In order to write software for this driver, it is necessary to read the datasheet.

Below, an example for the configuration of the module is listed. Exact details of how to write the functions are left to the programmer. This example shows the data to be sent to the PCA8539 to configure it for use with the module on this board.

```
//Configure PCA8539
I2CWrite = PCA8539_ADDR;
I2CWrite = 0b10000000;      // control byte
I2CWrite = 0x01;            // Initialize
I2CWrite = 0b10000000;      // control byte
I2CWrite = 0x02;            // OTP refresh

delay_ms(20);

I2CWrite = PCA8539_ADDR;
I2CWrite = 0b10000000;      // control byte
I2CWrite = 0x21;            // Enable CLKOUT signal
I2CWrite = 0b10000000;      // control byte
I2CWrite = 0x50;            // Set multiplex mode to 1:18
I2CWrite = 0b11000000;      // control byte
I2CWrite = 0x40;            // Set to frame inversion mode
I2CWrite = 0b11000000;      // control byte
I2CWrite = 0x2A;            // Display address increments by 1
2CWrite = 0b11000000;       // control byte
I2CWrite = 0x90;            // set frame frequency to 160 Hz
I2CWrite = 0b11000000;      // control byte
I2CWrite = 0x04;            // Display config. segment data L to R
I2CWrite = 0b11100000;      // control byte
I2CWrite = 0xAC;            // Set MSB Vlcd to 01100
I2CWrite = 0b11100000;      // control byte
I2CWrite = 0x9D;            // Set LSB Vlcd to 1101
// MSB=0xAC, LSB=0x9D, resulting in 10.15V
I2CWrite = 0b11100000;      // control byte
I2CWrite = 0x85;            // Enable charge pump and set to 3x
I2CWrite = 0b11100000;      // control byte
I2CWrite = 0x05;            // Enable temperature comp. of Vlcd
I2CWrite = 0b11000000;      // control byte
I2CWrite = 0x24;            // Enable display
I2CWrite = 0b10000000;      // control byte
```


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6. References

The documents listed below provide further useful information. They are available at NXP's website www.nxp.com.

[1] **LPCXPresso**: Getting started with NXP LPCXpresso

[2] **PCA8539**: Product data sheet

[3] **UM10204**: I²C-bus specification and user manual

[4] **AN11267**: EMC & system level ESD design guidelines for LCD drivers

[5] **NXP LPCXpresso** http://www.nxp.com/lpcxpresso

[6] **NXP LPCZone** http://www.nxp.com/techzones/microcontrollers-techzone/news.html

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