UM10744

OM13500 & OM13500A, PCA9620 & PCx8537 demo board

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Document information

Info	Content
Keywords	LCD, Liquid Crystal Display, LCD driver, segment driver, PCA9620, PCF8537, PCA8537, LPCXpresso, Vertical Alignment (VA)
Abstract	The OM13500 is an LCD demo board which can be used to demonstrate and evaluate the PCA9620 segment driver. The OM13500A is the same board, but instead of PCA9620, PCA8537 is mounted. The latter has a reduced number of segment outputs and therefore is not able to drive all display elements of the display on the board. The only affected part is the dot matrix area on the display. 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 via two AA batteries, an AC adapter or USB.

Revision history

Rev	Date	Description
1	20130923	Initial version

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1. Introduction

This user manual describes the OM13500 and OM13500A demo boards. The boards consist of a base board, with a plugged in LPCXpresso board which contains the microcontroller to control the display driver. OM13500 and OM13500A are essentially the same. The difference lies only in the segment driver which is mounted on the board. Only one driver can be mounted. For OM13500 this is the PCA9620. The PCA9620 is a peripheral device which interfaces to almost any Liquid Crystal Display (LCD) with low multiplex rates. It generates the drive signals for any static or multiplexed LCD containing up to eight backplanes, 60 segments and up to 480 display elements. On the OM13500A, PCA8537BH is used instead. This driver generates the drive signals for any static or multiplexed LCD containing up to eight backplanes, 46 segments and 352 elements. Both display drivers are compatible with most microprocessors or microcontrollers. PCA9620 communicates via a two-line bidirectional I^2C-bus. The PCA8537 can be easily connected to a microcontroller by either the two line I^2C-bus (PCA8537AH) or a three-line bidirectional SPI-bus (PCA8537BH). Communication overheads are minimized using a display RAM with auto-incremented addressing and display memory switching. Both PCA9620 and PCA8537 feature an internal charge pump for on-chip generation of the LCD driving voltages. To ensure an optimal and stable contrast over the full temperature range, also a programmable temperature compensation has been included.

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

Features:

- Demonstrates PCA9620 (LQFP80) or PCA8537 (TQFP64) LCD driver
- Features a vertical alignment (VA) 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 either using 2 AA-batteries, via USB or via an AC adapter/external power supply. This can also be used for external V_{LCD}.
- Box contents:
    - OM13500 or OM13500A board (marked on the board)
    - OM13035 LPCXpresso board

The 12nc of the OM13500 board is: 9353 014 42598

2. Board description and layout

Fig 1 shows the top view of the board.

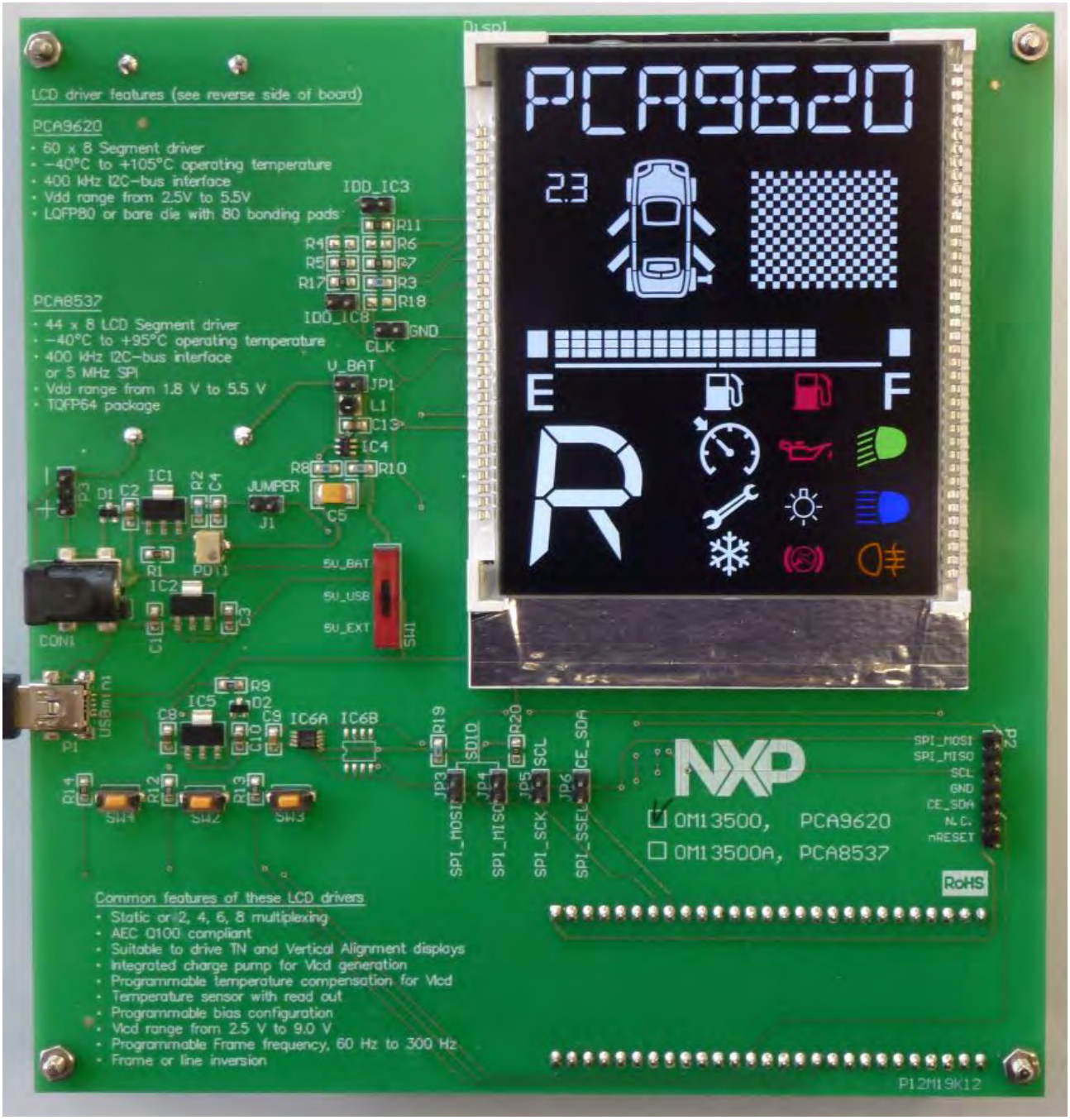

Fig 1. Top view of OM13500 demo board

For best optical performance, remove the protective foil from the display.

On the board, below the NXP logo, is indicated which version of the board (OM13500 with PCA9620 or OM13500A with PCA8537) it is. The LCD driver positions are located on the reverse side of the PCB, below the LCD. This location was chosen for layout reasons, as it results in shorter traces from the driver to the LCD.

2.1 Power Supply

The schematic diagram of the board is shown in Fig 2.

Besides applying power via the plugged in LPCXpresso board, there are three ways to provide power to the base board:

1. Via mini-USB connector P1. Now the 5V come directly from the USB port.
2. Using two AA batteries. An on-board switching regulator, built around IC4, generates 5V (5V_Bat). Whenever the batteries are inserted this regulator is running. The current consumption at no load is very low, in the order of 20 µA. Nevertheless, it is advisable to remove the jumper labeled “VBAT” when the board will not be used for a longer time while the batteries are inserted. This will interrupt the connection between batteries and switching regulator.
3. Via an external AC/DC adapter or DC power supply. The voltage may be in the range from 7 V to 18 V. For the adapter a plug CON1 has been provided, where the internal pin is +. It is also possible to connect the voltage to two pins (P3) using a DC power supply. A diode protects against damage in case of wrong polarity. Two linear regulators (IC1 and IC2) provide 5V (5V_ext) and the external V_{LCD} voltage VLCD_EXT, in case the internal charge pump is not used. This external voltage VLCD_EXT can be adjusted using potentiometer POT1.

PCA9620 and PCA8537 include a temperature compensated internal V_{LCD} generator. The third power supply option allows switching quickly between an external supplied or internal generated V_{LCD}. This is useful for evaluating the optical performance as a function of the voltage V_{LCD}, as the external supplied voltage can be varied quickly using potentiometer POT1. If the external V_{LCD} supply option is used also jumper J1 must be placed. Also the internal charge pump must be disabled.

Switch SW1 is used to select which of the three power supply options is being selected (5V_BAT, 5V_USB or 5V_EXT). The 5V output of the switch is used to supply the backlight of the display. Furthermore the voltage labeled “3V3_LPCXPR” is generated with an additional regulator, IC5. The 3.3V are used to supply the microcontroller board LPCXpresso, and to supply the logic V_{DD} of the LCD driver.

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. In this case, a 3.3V supply is generated on the LPCXpresso board via a linear regulator which is integrated in the LPC3154. However, this regulator has limited current delivery capability. If the LPCXpresso board is connected via USB to a computer without any other supply to the base board, the 3.3V from the LPCXpresso board is used to supply also the LCD base board. In this case the backlight will have limited intensity, but enough to see the result of software changes. Supply is via diode D2 and resistor R9.

For better contrast it is possible to supply the base board via USB connector P1 and the LPCXpresso via a second USB cable connected to the computer.

2.2 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 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.

2.3 Switches

Three switches are present on the board, SW1, SW2 and SW3. At the time of writing this user manual, functionality was not implemented in software yet.

2.4 Jumpers

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

- VBAT: This jumper connects the two AA batteries to the subsequent boost converter. Remove if the board will be stocked with the batteries inserted.
- J1: This jumper connects the V_{LCD} pin of the LCD drivers to the voltage VLCD_EXT which is generated on the base board if supply option 3 is used. However, if also the internal voltage generator is enabled, this can cause damage to the LCD driver. If the internal voltage generator is used, jumper J1 should be removed.
- JP3, JP4, JP5, JP6: These jumpers need only be placed when the SPI interface is used, which is only possible if PCA8537BH is mounted on the board. In all other

cases, communication with the LCD driver is through the I^2C-bus. This are pins 40 and 41 of the LPCXpresso connector.

- IDD_IC3: This jumper is not soldered onto the board during manufacturing. Instead, a 0 Ω resistor (R11) 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 Vdd pins of PCA9620. After measurements, a jumper header can be inserted.
- IDD_IC8: This jumper, along with 0 Ω resistor R17 fulfills the same function as IDD_IC3, but for the PCA8537. Note, that either PCA9620 or PCA8537 is mounted, never both.

In addition a few SMD 0 Ω resistors are mounted for I^2C address selection. The expectation is that these will seldom be removed, but it allows selecting a different I^2C slave address for PCA9620 (resistors R4 – R7) or PCA8537 (R18 and R20), without cutting tracks on the PCB.

2.5 Use of internal / external oscillator

Both LCD drivers offer the option of using the internal or an external oscillator. This can be set using the configuration registers. If the internal oscillator is used, the oscillator signal is available at connector “CLK”. If an external oscillator signal is used, this can be supplied to the LCD driver using this connector “CLK”.

2.6 Connectors

Besides the previously mentioned connectors, connector P2 contains the I^2C 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.

3. Board schematic and layout

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

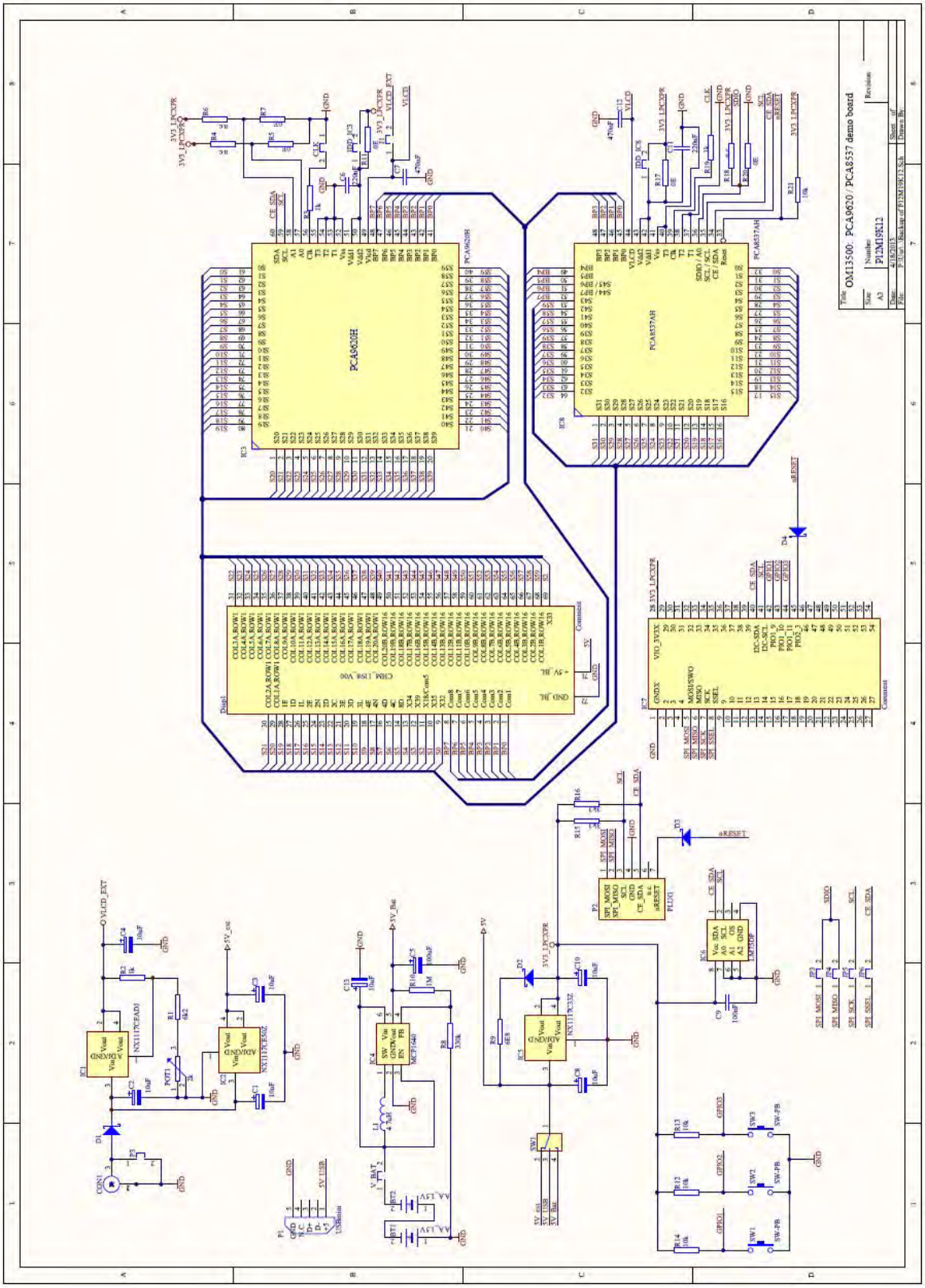

Fig 2. OM13500 schematic

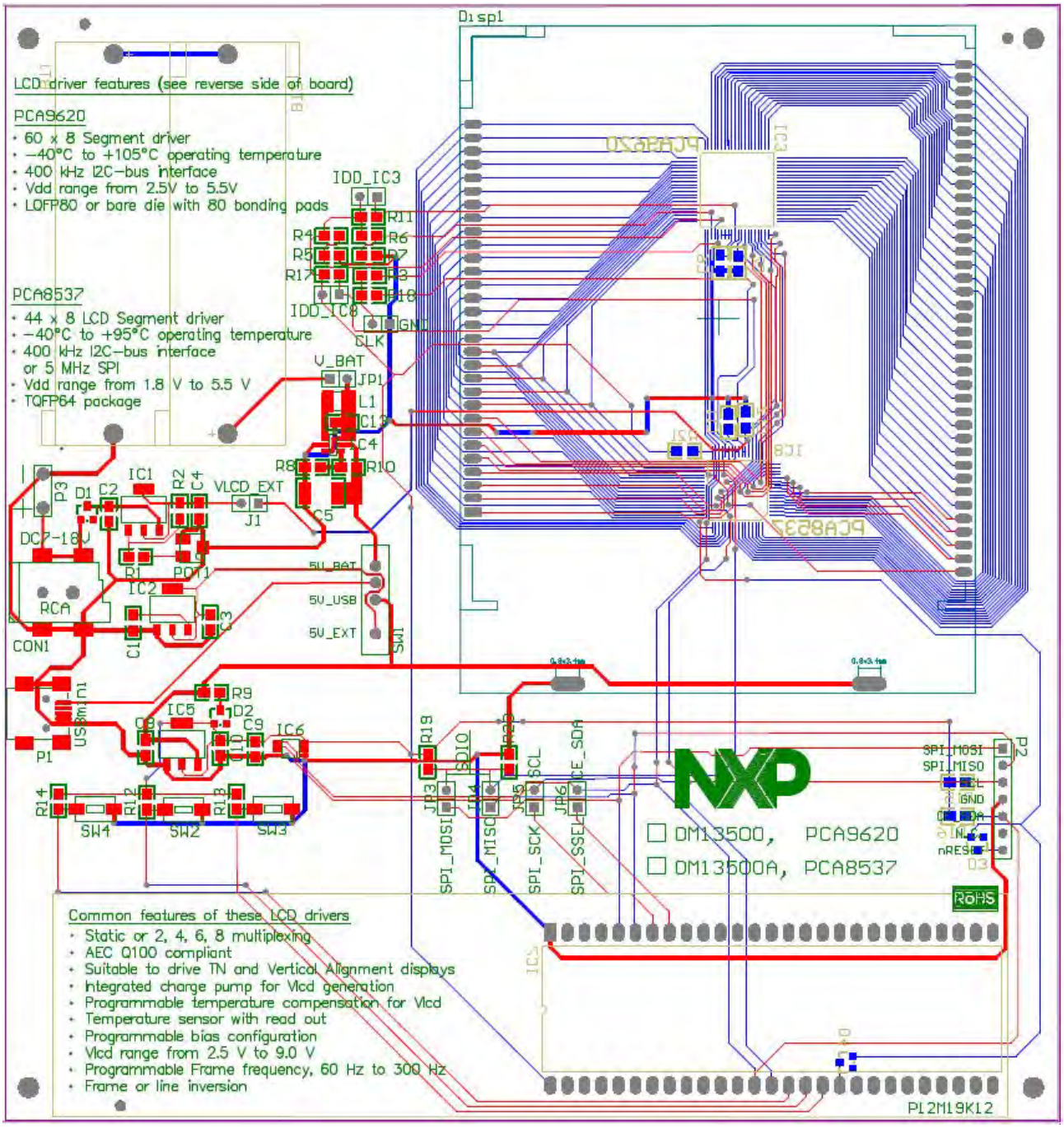

Fig 3. PCB layout

The LPCXpresso board and battery holder are on the reverse side of the base board.

4. Software code example

Section 8 of the PCA9620 data sheet contains all the commands and their description. In order to be able to write software for this driver, it will be necessary to read the datasheet.

Below, an example for the configuration of the PCA9620 for use with the LCD on this board 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 PCA9620 to configure it for the module on this board.

These settings will also work for PCA8537.

```
I2CWrite[0] = PCA9620_ADDR;
I2CWrite[1] = 0b10000000;    // control byte
I2CWrite[2] = 0xCC;          // Internal oscillator, no CLKOUT
I2CWrite[3] = 0b10000000;    // control byte
I2CWrite[4] = 0xC3;          // Charge pump enabled, Vlcd = 3*Vdd
I2CWrite[5] = 0b10000000;    // control byte
I2CWrite[6] = 0xCB;          // Temp. compensation and meas, enabled
I2CWrite[7] = 0b10000000;    // control byte
I2CWrite[8] = 0x47;          // set VLCD, MSB=0111
I2CWrite[9] = 0b10000000;    // control byte
I2CWrite[10] = 0x5A;         // set VLCD, LSB=1010. VLCD = 6.66 V
I2CWrite[11] = 0b10000000;   // control byte
I2CWrite[12] = 0x00;         // Set MUX mode to 1:8
I2CWrite[13] = 0b10000000;   // control byte
I2CWrite[14] = 0xC5;         // Set 1/4 bias
I2CWrite[15] = 0b10000000;   // control byte
I2CWrite[16] = 0xD4;         // Driving scheme A, charge pump 1 MHz
I2CWrite[17] = 0b10000000;   // control byte
I2CWrite[18] = 0x72;         // Set frame-frequency = 240 Hz
I2CWrite[19] = 0b10000000;   // control byte
I2CWrite[20] = 0x39;         // Display enable
I2CWrite[21] = 0b10000000;   // control byte
I2CWrite[22] = 0x80;         // Set Data pointer = 0
I2CWrite[23] = 0b00100000;   // Write to DDRAM
```

5. 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] **PCA9620**: Product data sheet

[3] **PCA8537**: Product data sheet

[4] **PCF8537**: Product data sheet

[5] **UM10204**: I^2C-bus specification and user manual

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

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

[8] NXP LPCZone http://www.nxp.com/lpczone

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7. List of figures

8. Contents

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