LPC5500 (Niobe4 Nano) EVK Development Board Requirements

# Introduction and scope

This document describes requirements for a Development board set for the LPC5500 (Niobe4 Nano) series of MCUs. This document is intended to define features requirement, not details of how the board design is to be implemented.

This document is derived from LPC5500 (Niobe4 Mini) EVK board PRD documentation. There are no known issues in the latest LPC55S16 EVK board schematics. Thus, the key update from Niobe4 Mini (LPC55S16 EVK) to Niobe4 Nano EVK board is the removal of the USB controllers and audio Codec on Niobe 4 Mini. It should include removing USB HS and FS connectors, external power switch component for USB host, Codec WM8904, audio input and output connectors, etc.

Niobe 4 Nano EVK board should supports 64-pin package only with socket footprint for easy chip swap.

Since Niobe 4 Nano is a smaller package supporting 64-pin or 48-pin package only, many pins from LPC55S16 EVK board connectors unavailable to Niobe 4 Nano should be removed or rerouted. But, the connectors should support standard Arduino module and Mikroe module.

<https://www.circuito.io/blog/arduino-uno-pinout/>

<https://www.mikroe.com/mikrobus>

All GPIO pins, if not connected to the connectors, LEDs, and push buttons, should be brought to the unused expansion connector pins and/or additional pin connectors for easy access.

Due to the tolerance of the Torex 1.8V LDO regulator, +/- 2%, if the output is below 1.78V, BOD may be triggered inside the ROM causing debugger fail to connect to the target. Per feedback from the customer, marketing suggest that we should use 2.0V LDO regulator instead of 1.8V.

Add separate LED indication for both 3.3V and 2.0V power domains.

On the LPC55S16 EVK board, all LEDs pin are from Port1. To support both non-secured and secured GPIO (Port 0) indication, some or all GPIO pins from Port 0 will be useful. LEDs should be available for both packages.

High-light in red below indicates the update from LPC55S16 EVK board to Niobe 4 Nano.

# Use cases

This board is intended for general development use (mass market), with features to showcase the differentiating features of the product.

Mass Market target applications identified by marketing include:

* IoT and Connectivity
* Smart home/building
* Consumer Peripherals & Accessories
* General embedded

In these markets the key differentiators for LPC5500 Nano are CAN-FD and low power operation.

# Feature Set

The base board is required to have the following features.

* Largest flash/SRAM variant Niobe 4 Nano in LQFP package
* Capable of 2.0V or 3.3V operation using on-board regulation, or by injection of an external supply voltage.
* RTC crystal (XTAL32K)
* Crystal Oscillator (XTAL32M)
* Debug:
  + LPC-Link2 on-board debug, MCU-Link, and external debug probe options (as found on LPCXpresso55S16 boards)
  + I2C and SPI bridging via USB
  + UART VCOM
  + Debug probe Status LEDs
* Wake/User, ISP/User, Reset buttons
* CAN-FD:
  + CAN-FD transceiver and a D-sub connector compatible with PCAN-USB FD adaptor
* Expansion connectors:
  + LPCXpresso V3-style expansion connectors
* Other features:
  + RGB user LED

# Debug probe support

The Board shall include a Link2 debug probe on board. The Link2 probe shall include support for the following:

|  |  |
| --- | --- |
| Feature | Notes |
| Debug probe for external targets | As implemented on LPCXpresso55S16 |
| Connection for external SWD debug probe (standard 0.05” header) | SWO connections included. |
| SWO trace support via Link2 | As implemented on LPCXpresso55S16 |

|  |  |
| --- | --- |
| Feature |  |
| Link2 I2C host connection | As implemented on LPCXpresso546xx. Supports ISP boot mode over I2C. |
| Link2 SPI host connection | As implemented on LPCXpresso546xx. Supports ISP boot mode over SPI. |
| Link2 UART host connection | As implemented on LPCXpresso546xx. Supports ISP boot mode over UART. |

Parallel trace is currently not planned to be included due to size constraints. For this reason, the standard 10-pin, 0.05” debug connection will be used.

Level shifters except MCU-Link will be required to enable 2.0V operation of the target LPC5500 device, since the LPC432x device used to implement the Link2 probe has a minimum nominal supply voltage of 2.5V. To reduce/remove leakage current issues, the UART, I2C and SPI signals routed between the LPC5500 and the Link2 should pass through an isolating buffer, as implemented on the LPCXpresso55S16 boards.

ESD protection should be provided for the SWD debug connector (as implemented on LPCXpresso55Sxx boards.)

A jumper to force the Link2 into DFU mode shall be provided (as on all other LPCXpresso V3 boards.)

## Buttons

The Development Board should provide buttons to support functions found on LPCXpresso V3 boards, as summarized below. All buttons should be spaced and positioned so that they can still be pressed when a shield board is fitted (this is mandatory for the reset and ISP buttons.)

|  |  |
| --- | --- |
| Button | Notes |
| Wake / User button | Provides wake up from low-power mode function, or same pin can be used to trigger an interrupt. |
| ISP button | See Section 4. |
| Target reset button | Resets target when depressed. |

## Boot Mode control (ISP)

Boot modes are defined by the ROM operation. For the board, a single ISP control button (connected to P0\_5) will be provided. A jumper (not installed by default) shall be provided to enable the ISP pin to be held low (asserted) at all times.

Table 3 Boot Modes

|  |  |
| --- | --- |
| Boot source | ISP Button |
| Internal flash if valid code found, or fall through to ISP mode otherwise | Normal operation, ISP button not pressed or jumper not installed. |
| Enter ROM ISP mode | ISP button pressed or jumper installed. |

# LEDs

LEDs should be provided for the following purposes:

* Boot status and power LEDs as found on LPCXpresso V3 boards
* Target power
* Debug probe status LEDs as found on LPCXpresso V3 boards
* User LEDs in the form of an RGB LED

The User LEDs should be driven by port pins that can be used for PWM timer output, and the same ports use for these LEDs shall also be shared with the Arduino connect GPIO/PWM pins. At least one LED should support secure GPIO.

LEDs should be driven via transistors to ensure they light with similar brightness regardless of the MCU supply voltage. The LEDs should not light when the MCU port driving the LEDs is floating.

# User buttons

Two user buttons should be provided for general purpose use. Each should provide a pull up. One button should be labelled “Wake”, and should use a pin that supports wake from deep power down (labeled “wakeup” in the Excel pin assignments sheet). The second user button should be labelled “User”, and can be shared with the Expansion site or PMod connector.

# Power supply options

The board may be powered by a 2.0V or 3.3V regulator (user selectable, or user programmable.) These regulators can be powered by one of the following:

* Power only USB connector
* Debug probe USB connector

Notes:

1. Debug probe must only be powered when the Debug probe USB connector is used.

The VBAT pin shall be routed to a header with a GND signal (header not installed by default) to allow an external battery to be connected.

# USARTs

Flexcom0 USART (P0\_30, P0\_29) supports ISP boot, so shall be used for the VCOM port (routed to the Link2 probe) and also made available at a header. A jumper shall be provided to disable the Link2 connection when the header is being used.

An additional USART shall be available at the Arduino section of the Expansion connector.

# SPI

Flexcom3 SPI (P0\_2/P0\_3/P0\_4/P0\_6) supports ISP boot. It shall be connected to the Link2 probe to support ISP boot, and shall also available at the PMod expansion header. A jumper shall be provided to enable/disable Link2 when the PMod connection is being used.

A footprint of a 1-bit SPI NOR flash device with a jumper to enable the select pin is required so that we can test SPI recovery boot if needed.

# HS LSPI

The HS LSPI port shall be used to provide both HS LSPI and standard SPI support (ports P1\_1, P1\_2, P1\_3 and P0\_26) at the standard Arduino SPI interface location.

# I2C

Flexcom1 I2C (P0\_13, P0\_14) I2C supports ISP boot and shall be connected to the Link2 probe. It shall be connected to the Link2 probe to support ISP boot, and shall also available at the PMod expansion header.

A second I2C connection shall be available at the Arduino section of the Expansion connector.

# CAN-FD

To avoid conflict with the required Arduino board HS LSPI interface and ISP pin, P1\_2 and P1\_3 should be used as CAN\_RX and CAN\_TX respectively. A pair of jumpers should be used to switch between HS LSPI and CAN interface modes with the default position for CAN FD interface. CAN FD transceiver such as TJA1044 or TJA1051 can be considered to support CAN-FD. A 9-pin D-sub male connector should be installed on the board to be compatible with PCAN-USB FD adaptor.

# PLU support

PLU clock, inputs, and outputs shall be made available at the expansion connector. At this point, no additional functionality for the board is planned, although a bare/prototyping board for PLU work may be required (TBD). Note that the pinning of LPC804 is too different to enable re-use of the PLU shield made for that kit.

# RTC

A 32kHz crystal shall be provided on the add-on module for support of the device RTC function.

# Comparator

Minimal two comparator inputs and one comparator output shall be provided on the expansion connector.

# ADC

A differential pair ADC input shall be accessible via the expansion connector (Arduino analog connector). P0\_16 and P0\_23 should be used, to be close to the ADCREF inputs (as recommended by the Design Team.)

# Expansion Connectors

The Board shall provide expansion capabilities via PMod and Expansion connectors. LPCXpresso V3-style expansion connectors are to be included in this board design.

All GPIO pins, if not used by the peripherals or debugger interface, should be brought to the expansion connectors for debugging purposes.

The silkscreen should show the proper port pin number if they are used as general-purpose GPIO/PLU pin.

## PMod connections

A PMod connector shall be provided for host connection and to provide additional options for adding sensors, etc.

Table 2 Pmod connections

|  |  |  |
| --- | --- | --- |
| Function | LPC5500 flexcom port | Other functions/connections sharing port |
| SPI host (LPC55xx is host or slave) | 3 | Link2 |
| I2C host (LPC55xx is host or slave) | 1 | Link2 |
| GPIO | TBD | PLU / expansion connector |
| Interrupt | Make sure this isn’t shared with an Arduino interrupt signal (avoid Arduino signals D2-D8) | PLU / expansion connector |

## LPCXpresso V3-style expansion connectors

The Development Board shall include LPCXpresso V3 style expansion connectors, as shown in Figure 1.

Interface connections not be present / required on the Expansion Connectors are indicated in pale gray.

In Figure 1 the mandatory signals to be provided are shown in black.

Figure 1 Proposed expansion connector (Arduino outlined in red) with suggested port assignments

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | |  | |  |  |  |  | **Ard** | Signal (L) | | | Ports | | | Signal (R) |
|  | |  | |  |  |  |  | D15 | FC3\_SCL | | | P0\_21\* |  | P0\_0 | GPIO |
| Signal (L) | | Ports | | | | Signal (R) |  | D14 | FC3\_SDA | | | P0\_20\* |  | P0\_1 | GPIO |
| GPIO | | P0\_31 | |  | P0\_28 | GPIO |  |  | AREF | | |  |  | P0\_18 | GPIO |
| GPIO | | P0\_7 | |  | P0\_24 | GPIO |  |  | GND | | | GND |  | P0\_5 | GPIO / ISP button |
|  | |  | |  | P0\_8 | - |  | D13 | PLU / HS\_SCK | | | P1\_2 |  | P0\_20\* | GPIO/I2S7\_DAT |
|  | |  | |  |  | IO |  | D12 | PLU / HS\_MISO | | | P1\_3 |  | P0\_19 | I2S7\_WS |
| VBatt / RESET | |  | |  |  | RST |  | D11 | PLU / HS\_MOSI | | | P0\_26 |  | P0\_21\* | GPIO/I2S7\_CLK |
|  | |  | |  |  | 3V3 |  | D10 | PLU / HS\_CS | | | P1\_1 |  | P0\_10\* | GPIO/I2S6\_CLK |
| GPIO | | P0\_4 | |  |  | 5V |  | D9 | PWM( Usr LED) | | | P0\_25 |  | P0\_12 | GPIO/I2S6\_WS |
| GPIO | | P0\_6 | |  |  | GND |  | D8 | INT | | | P0\_10\* |  | P0\_11 | GPIO/I2S6\_DAT |
| GPIO | | P0\_30 | |  |  | GND |  |  |  | | |  |  |  |  |
| GPIO | | P1\_29 | |  |  | VIN |  | D7 | PWM | | | P0\_27 |  | P0\_29 | ACOMPO |
|  | |  | |  |  |  |  | D6 | PWM | | | P0\_2 |  | P1\_25 | GPIO |
| GPIO | | P1\_9 | |  | P0\_16 | A0 ADC+ | A0 | D5 | PWM (Usr LED) | | | P0\_21\* |  | P0\_21\* | GPIO/PLU\_CLK |
| GPIO | | P1\_10 | |  | P0\_23\* | A1 ADC- | A1 | D4 | PWM | | | P0\_3 |  | P1\_0 | GPIO/PLU\_O |
| GPIO | | P1\_11 | |  | P0\_9 | A2 Comp | A2 | D3 | PWM (Usr LED) | | | P0\_22\* |  | P0\_20\* | GPIO/PLU\_I |
| GPIO/MCLK | | P0\_23\* | |  | P0\_0 | A3 ADC | A3 | D2 | INT | | | P0\_15 |  | P1\_29 | GPIO |
| FC1 SDA/CTS | | P0\_13 | |  | P0\_13 | A4 ADC | A4 | D1 | FC4\_TXD | | | P0\_20\* |  | P0\_13\* | GPIO/PLU\_I |
| FC1 SCL/RTS | | P0\_14 | |  | P0\_14 | A5 ADC | A5 | D0 | FC4\_RXD | | | P1\_21 |  | P1\_1\* | WAKEUP |
|  | |  | |  |  | - |  |  | GPIO | | | P1\_4 |  | P0\_22\* | GPIO/PLU\_O |
|  | |  | |  |  | - |  |  | GPIO | | | P1\_5 |  | P0\_14\* | GPIO/PLU\_I |
|  | |  | |  |  |  |  | | |  |  |  |  | \*P0\_10, \*P0\_13, \*P0\_14, \*P0\_20, \*P0\_21, \*P0\_22, \*P0\_23  shared |  |
|  | |  | |  |  | - |  | | |  |  |  |  |  |  |
|  | |  | |  |  |  |  | | |  |  |  |  |  |  |
|  |  | |  | | | |  | | |  |  |  |  |  |  |

## Mikroe Click Board

Since Mikroe connectors offer a wide range of low-cost sensor boards, inclusion of a Mikroe click board site is required as the same on LPCXpresso55S16 EVK board. Signals would be shared with the Arduino connector. At least one of the PWM outputs should be routed to a LED pins.

<https://download.mikroe.com/documents/standards/mikrobus/mikrobus-standard-specification-v200.pdf>

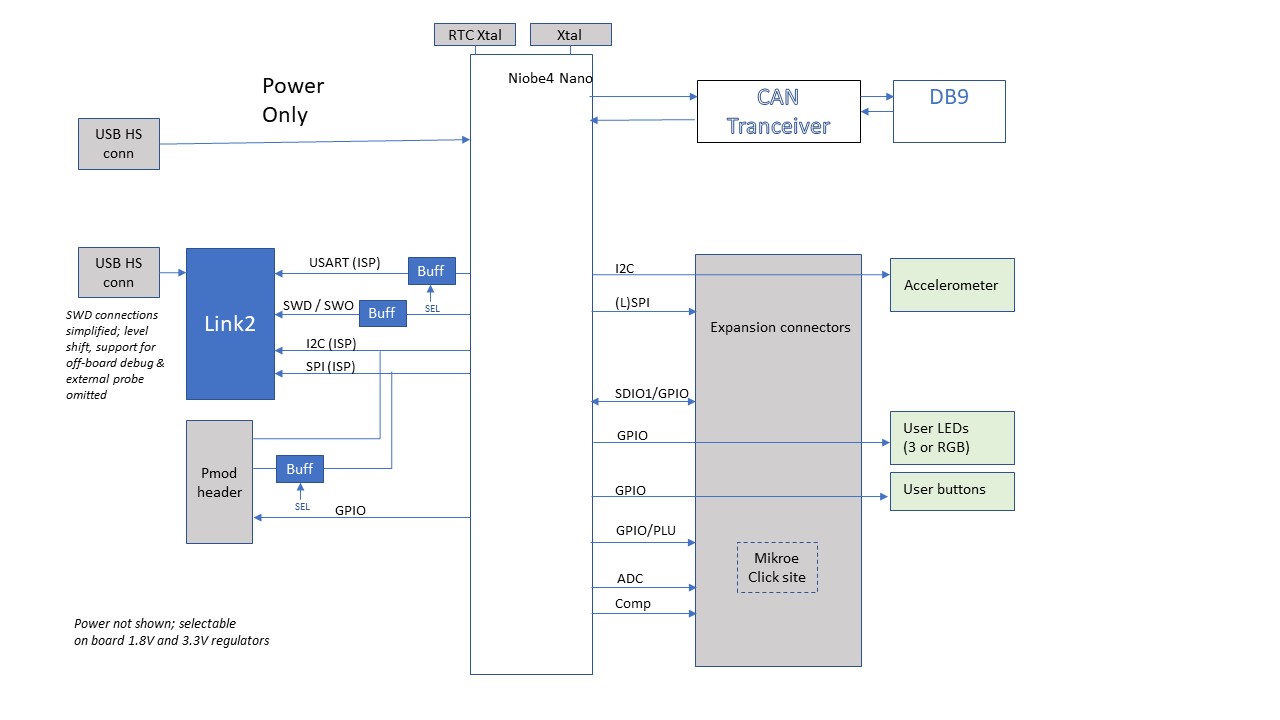
# Power (current) measurement

VDD, VDDA, and VBAT should be measured separately.

# Accelerometer

The board shall include an NXP accelerometer with current SDK support. Thus, no H/W change is needed from LPC55S16 EVK board. Zero-ohm resistors (installed by default) shall be provided in line with the I2C clock and data lines to this device such that this device can be disabled. The same I2C port as connected to the Expansion header shall be used for this device.

**Niobe 4 Nano Block Diagram**



# Version history

|  |  |  |  |
| --- | --- | --- | --- |
| Version | Author | Date | Notes/updates |
| 0.0 | Tom Tang | April 03, 2020 | First draft (limited distribution). This draft is based the last Niobe4 Mini EVK board PRD. The key difference from LPC55S16 EVK board is the removal of the USB HS, USB FS, and Audio Codec related circuitry. |
| 0.1 | Tom Tang | April 09,2020 | Niobe 4 Nano supports 64-pin and 48 pin package only. Many GPIO pins on the 100-pin LPC55S16 have been removed. It’s important that expansion connectors should support standard Arduino and Mikroe modules on both 64-pin and 48-pin packages. |
| 0.2 | Tom Tang | 04/15/2020 | Incorporated valuable feedback from Brendon S. including MCU-Link, Arduino UART RTS/CTS, and 1-bit NOR SPI flash Recovery support. |
| 0.3 | Tom Tang | 04/21/2020 | Removed requirement to support both 48-pin and 64-pin package, according to marketing, only 64-pin package support is needed with socket footprint. |
| 0.4 | Tom Tang | 05/07/2020 | Replace 1.8V LDO regulator with 2.0V one. |

Approvals:

|  |  |  |  |
| --- | --- | --- | --- |
| Approver | Dept/function | Version approved | Date approved |
| Andy Lin | Marketing |  |  |
| Amish Desai | Applications |  |  |
| Al Morrow | Validation |  |  |
| CK Phua | Applications |  |  |
| Brendon Slade | Eco-system |  |  |