LPC5500

LPC5500 Crystal-less USB Solution

Rev. 1.0 — 4 November 2019 Technical Note

Document information

Info	Content
Keywords	LPC5500, Crystal, full-speed USB, FRO
Abstract	This technical note explains the usage of a software library to provide a full-speed USB crystal-less solution on the LPC5500 family.

Revision history

Rev	Date	Description
1.0	20191022	Initial version.

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1. Introduction

The LPC5500 product family features one full-speed USB 2.0 device controller with a crystal-less device mode.

To achieve crystal-less USB device operation in full-speed mode, NXP provides a software library solution that measures the Start of Frame (SOF) timing to meet full-speed operation (± 0.25 % data rate accuracy).

This technical note explains the steps required to modify the software to integrate a crystal-less USB device operation in full-speed mode in the LPC5500 application. In addition to this technical note, an SDK software example (usb_device_composite_hid_audio_unified) is provided in the MCUXpresso/LPCXpresso, Keil, and IAR IDEs.

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2. Description

This section describes the steps to implement a crystal-less USB full-speed operation for the LPC5500 family.

2.1 Calibration library

The software must include the FRO calibration library to enable appropriate calibration to meet the USB full-speed operations.

Pre-compiled libraries in SDK for MCUXpresso/LPCXpresso, Keil, and IAR are:

- Keil IDE: keil_lib_fro_calib_CM33_core0.lib, keil_lib_fro_calib_CM33_core1.lib
- IAR IDE: iar_lib_fro_calib_CM33_core0.a, iar_lib_fro_calib_CM33_core1.a
- MCUXpresso/LPCXpresso IDE: libfro_calib_hardabi.a, libfro_calib_softabi.a

2.2 Header file

For SDK, include the following header file: fsl_fro_calib.h.

2.3 Source code modifications

Add the following changes to the source code.

1. Call the fro_calib_Get_Lib_Ver (void) function. This function reads the version of the calibration library and returns 0x00000100.
2. The user application code must select the FRO 96 MHz clock as a clock source (value of 0x3 in the USB0CLKSEL register) because the external crystal is no longer required. See the LPC5500 user manual for more details.
3. The calibration library must use one of the 32-bit timers to measure SOF timing and enable appropriate calibration.
   a. Using the AHBCLKCTRL1 register, enable the clock to the CTimer (CTimer 0 or CTimer1 or CTimer2). Using the AHBCLKCTRL2 register, enable the clock to the CTimer (CTimer3 or CTimer4).
   b. Using CTIMERCLKSEL0/1/2/3/4 register, select FRO 96MHz clock as CTimer0/1/2/3/4 clock source.
   c. Pass the timer peripheral (CTIMER0 or CTIMER1 or CTIMER2 or CTIMER3 or CTIMER4) and the system clock in KHz to the library call for SDK,

   ```
   void Chip_Timer_Instance_Freq (CTIMER_Type *base, unsigned int ctimerFreq);
   ```
4. The user application code must enable the FRAME_INT_EN of the INTEN register in the usb_device_lpcip3511.c file:

   ```
    /* enable interrupts */
   lpc3511IpState->registerBase->INTEN = USB_LPC3511IP_INTSTAT_DEV_INT_MASK |
        USB_LPC3511IP_MAX_PHY_ENDPOINT_MASK
   #if (defined(USB_DEVICE_SOF_EVENT_ENABLE) && (USB_DEVICE_SOF_EVENT_ENABLE > 0U))
   | USB_LPC3511IP_INTSTAT_FRAME_INT_MASK
   #endif
   ```
5. FRAME_INT must be taken care in the usb_device_lpcip3511.c file.

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```
#if (defined(USB_DEVICE_SOF_EVENT_ENABLE) && (USB_DEVICE_SOF_EVENT_ENABLE > 0U))
    if (interruptStatus & USB_LPC3511IP_INTSTAT_FRAME_INT_MASK)
    {
     USB_DeviceLpc3511IpSofEvent(lpc3511IpState);
     }
#endif
```

6. When the FRAME_INT occurs, the user application code must call the void USB_SOF_Event (void).

2.4 LPC5500 development board

The crystal and capacitors can be removed because the external crystal is no longer required. For example, you can remove the components outlined in red in Figure 1 on the LPC55S6x development board.

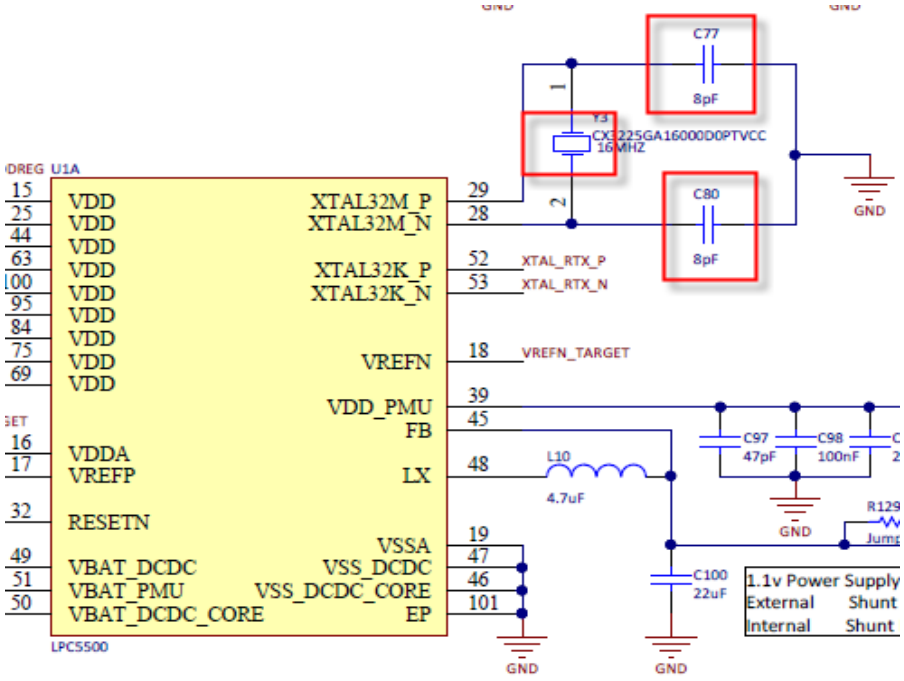

Fig 1. LPC55S6x development board

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