TN00032

LPC546xx Crystal-less USB Solution

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Document information

Info	Content
Keywords	LPC546xx, 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 LPC546xx family.

Revision history

Rev	Date	Description
3.1	20160307	Updated text in Section 2.1 "Calibration library" and Section 2.2 "Source code modifications".
2.0	20160226	Initial version

Contact information

For more information, please visit: http://www.nxp.com

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1. Introduction

The LPC54xxx family includes up to 512 KB of flash, 200 KB of on-chip SRAM, up to 16 KB of EEPROM memory, a quad SPI Flash Interface (SPFI) for expanding program memory, one high-speed and one full-speed USB host and device controller, Ethernet AVB, LCD controller, Smart Card interfaces, SDIO/MMC, CAN FD, an External Memory Controller (EMC), a Serial Audio Interface (SAI), multiple general-purpose timers, a general-purpose timers, SCTimer/PWM, RTC/alarm timer, Multi-Rate Timer (MRT), a Windowed Watchdog Timer (WWDT), ten flexible serial communication peripherals (USART, SPI, I2S, I2C interface), Secure Hash Algorithm (SHA), 12-bit Δ-Σ/sampling/sec ADC, and a temperature sensor.

The LPC54xxx product family features one full-speed USB 2.0 device controller with crystal-less low-speed 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 to modify the software to integrate a crystal-less USB device operation in full-speed mode in the LPC54xxx application. In addition to this technical note, SDK software example (usbd_rom_hid_generic) is provided in the MCUXpresso/LPCXpresso, Keil, and IAR IDEs.

2. Description

This section describes the steps to implement a crystal-less USB full-speed operation for the LPC546xx.

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 ILPCXpresso, Keil, and IAR are:

- Keil IDE: lib_fro_calib
- IAR IDE: lib_fro_calib.a
- MCUXpresso ILPCXpresso IDE: libfro_calib_hardsta.a, libfro_calib_softsta.a

2.2 Header file

For SDK, include the following header file fro_calib.h.

2.3 Source code modifications

Add the following changes to the source code.

1. Call the int_fro_calib_Get_Lib_Ver (void) function. This function reads the version of the calibration library and returns 0x00000100. Otherwise, it returns 0.
2. The user application code must select the fro_hf as a clock source (value of 0x0 in the USBCLKSEL register) because the external crystal is no longer required. See the PLCKSEL0 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 timer (timer 0 or timer 1 or timer 2). Using the ASYNCAPBCTRL and ASYNCAPBCLKSEL registers, enable the clock to the timer (timer 0 or timer 4).
   b. Pass the timer peripheral (CTIMER0 or CTIMER1 or CTIMER2 or CTIMER3 or CTIMER4) and the system clock in Hz to the library call for SDK.

   ErrorStatus_t Chip_Timer_Initialize_Fro(CTIMER_Type *base, uint32_t int clkFreq);

   The library function returns LPC_OK if device ID of the LPC546xx is read, otherwise it returns ERR_FAILED.
4. The user application code must enable the FRAME_INT of the INTEN register.

   If using the USB ROM API, the user application code can use the ErrorCode_t* USBD_HW_API(EnableEvent(USBD_HANDLE_T hUsb, uint32_t EPNum, uint32_t event_type, uint32_t enable)) to enable FRAME_INT. Enable the workaround from USB_ROM.1 errata is implemented. See the LPC546xx errata sheet for more details.
5. When the FRAME_INT occurs, the user application code must call the ErrorCode_t USB_SOF_Event(USBD_HANDLE_T hUsb).

If the user application code uses USB ROM API, it can call ErrorCode_t(*ErrorCode_t USBD_API_API_Init)(USBD_HANDLE_T *phUsb, USB_CORE_DESCS_T *pDesc, USBD_API_INIT_PARAM_T *pParam)

For example:

```
USB_WMULT_T g_fUsb;
USB_API_INIT_PARAM_T usb_param;
USB_CORE_DESCS_T desc;
ErrorCode_t ret = LPC_OK;
usb_param.USB_IRQ_Event = USB_USB_Event;
ret = USBD_API->hw->Init(&g_fUsb, &desc, &usb_param);
```

2.4 LPC546xx development board

The crystal and capacitors can be removed because the external crystal is no longer required. For example, you can remove the following components on the LPC546xx development board. See Figure 6.

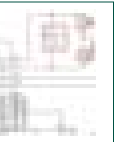

Fig 1. LPC546xx development board

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