

TN00033

LPC540xx Crystal-less USB Solution

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Technical Note

Document information

Info	Content
Keywords	LPC540xx, 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 LPC540xx family.



Revision history

Rev	Date	Description
1.1	20180507	Updated text for Section 2.1 “Calibration library” and Section 2.3 “Source code modifications” .
1.0	20180228	Initial version.

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1. Introduction

The LPC540xx family includes 360 KB of on-chip SRAM, a quad SPI Flash Interface (SPIFI) for expanding program memory, one high-speed and one full-speed USB host and device controller, Ethernet AVB, LCD controller, Smart Card Interfaces, SD/MMC, CAN FD, an External Memory Controller (EMC), a DMIC subsystem with PDM microphone interface and I2S, five 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 5.0 Msamples/sec ADC, and a temperature sensor.

The LPC540xx 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 ($\pm 0.25\%$ 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 LPC540xx application. In addition to this technical note, SDK software example (usb_d_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 LPC540xx.

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
- IAR IDE: iar_lib_fro_calib.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 `int_fro_calib_Get_Lib_Ver` (void) function. This function reads the version of the calibration library and returns 0x00000100. Otherwise, it returns 0x0.
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 LPC540xx 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 `ASYNCAPBCLKCTRL` registers, enable the clock to the timer (timer 3 or timer 4).
- b. 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,

```
ErrorCode_t Chip_Timer_Instance_Freq (CTIMER_Type *base, unsigned int timerFreq);
```

The library function returns `LPC_OK` if device ID of the LPC540xx 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 (*USBBD_HW_API::EnableEvent)(USBBD_HANDLE_T hUsb, uint32_t EPNum, uint32_t event_type, uint32_t enable)` to enable `FRAME_INT`.
5. When the `FRAME_INT` occurs, the user application code must call the `ErrorCode_t USB_SOF_Event(USBBD_HANDLE_T hUsb)`.

If the user application code uses USB ROM API, it can call `ErrorCode_t (*ErrorCode_t USBBD_HW_API::Init)(USBBD_HANDLE_T *phUsb, USB_CORE_DESCS_T *pDesc, USBBD_API_INIT_PARAM_T *param)`

For example:

```

USB_HANDLE_T g_hUsb;
USB_API_INIT_PARAM_T usb_param;
USB_CORE_DESCS_T desc;
ErrorCode_t ret = LPC_OK;
usb_param.USB_SOF_Event = USB_SOF_Event;
ret = USB_API->hw->Init(&g_hUsb, &desc, &usb_param);
    
```

2.4 LPC540xx 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 LPC540xx development board.

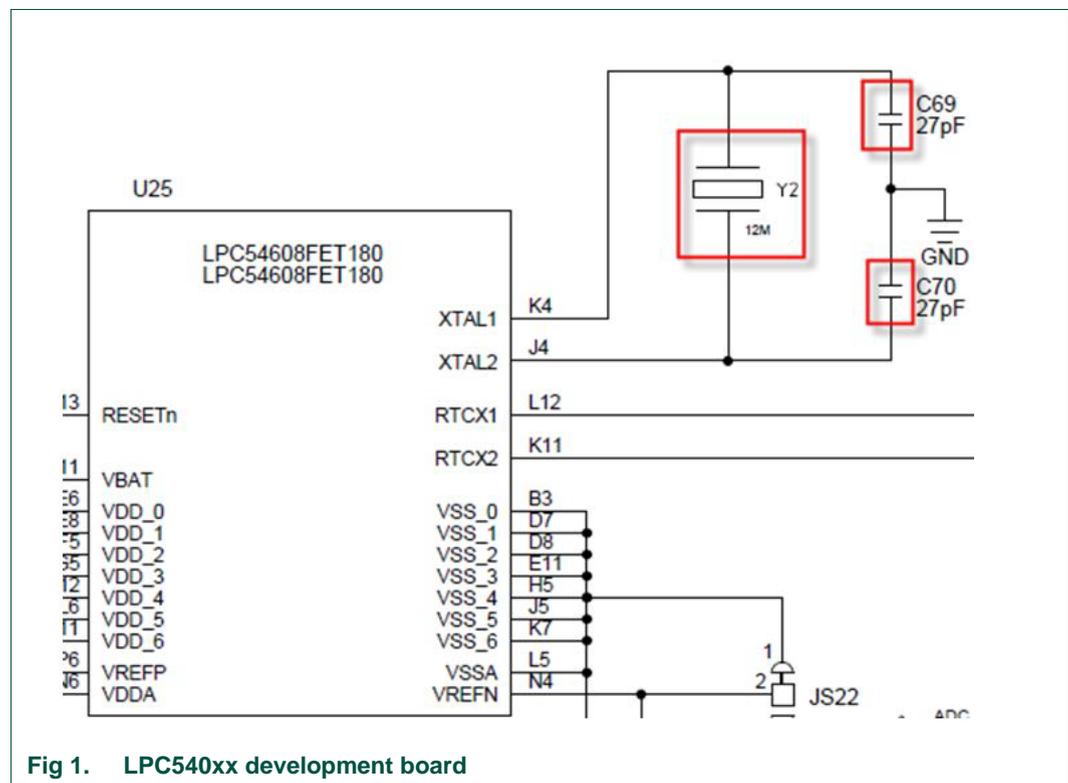


Fig 1. LPC540xx development board

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