

# TN00033

## LPC540xx Crystal-less USB Solution

Rev. 1.1 — 7 May 2018

Technical Note

### Document information

Info	Content
<b>Keywords</b>	LPC540xx, Crystal, full-speed USB, FRO
<b>Abstract</b>	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 <a href="#">Section 2.1 “Calibration library”</a> and <a href="#">Section 2.3 “Source code modifications”</a> .
1.0	20180228	Initial version.

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## 1. Introduction

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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 (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 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:

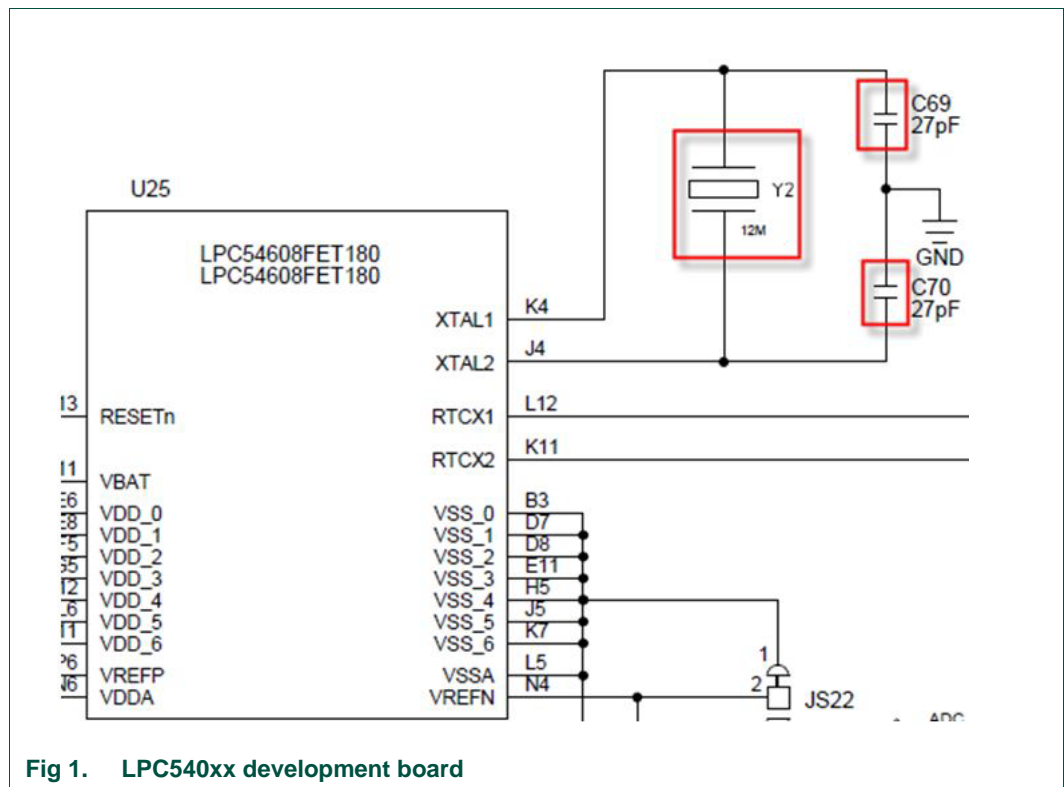
```

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.



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