

LPC55S1x/LPC551x

LPC55S1x/LPC551x Crystal-less USB Solution

Rev. 1.0 — 17 March 2020

Technical Note

Document information

| Info | Content |
|-----------------|--|
| Keywords | LPC55S1x/LPC551x, 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 LPC55S1x/LPC551x family. |



Revision history

| Rev | Date | Description |
|-----|----------|------------------|
| 1.0 | 20200317 | Initial version. |

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1. Introduction

The LPC55S1x/LPC551x product family features a 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 ($\pm 0.25\%$ 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 LPC55S1x/LPC551x 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.

2. Description

This section describes the steps to implement a crystal-less USB full-speed operation for the LPC55S1x/LPC551x 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.lib
- IAR IDE: iar_lib_fro_calib_CM33.a
- MCUXpresso 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

Regardless of the IDE used to build the project, a preprocessor symbol in the compiler needs to be defined and added as “USB_DEVICE_FRO_CAL_LIBRARY_ENABLE=1”. A global search for this keyword can find all the necessary modification for the USB crystal-less operation.

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 0x00010000.
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. In this example, I2S MCLK, 24.576MHz uses PLL0 clock output, then, the input clock of the PLL0 is switched from the original external crystal to FRO 12MHz. See the LPC55S16 user manual related to the clock configuration for more details.
3. The calibration library must use one of the 32-bit timers to measure SOF timing and enable appropriate calibration. Note: Using the AHBCLKCTRL1 register to enable the clock to the CTimer 0, CTimer1, or CTimer2. Using the AHBCLKCTRL2 register to enable the clock to the CTimer3 or CTimer4.
 - a. Using CTIMERCLKSEL0/1/2/3/4 register, select FRO 96MHz clock as CTimer0/1/2/3/4 clock source.
 - b. Pass the timer peripheral (CTIMER0, CTIMER1, CTIMER2, 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);
 - 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
#endif

```

5. FRAME_INT must be taken care in the usb_device_lpcip3511.c file.

```

#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 USB_SOF_Event() API where FRO clock will be constantly calibrated based on the SOF frame from the USB host.

2.4 LPC55S16 EVK development board

The 16MHz crystal, circuit reference Y2, and capacitors can be removed because the external crystal is no longer required, See the LPC55S16 EVK development board User Manual and schematics for more details.

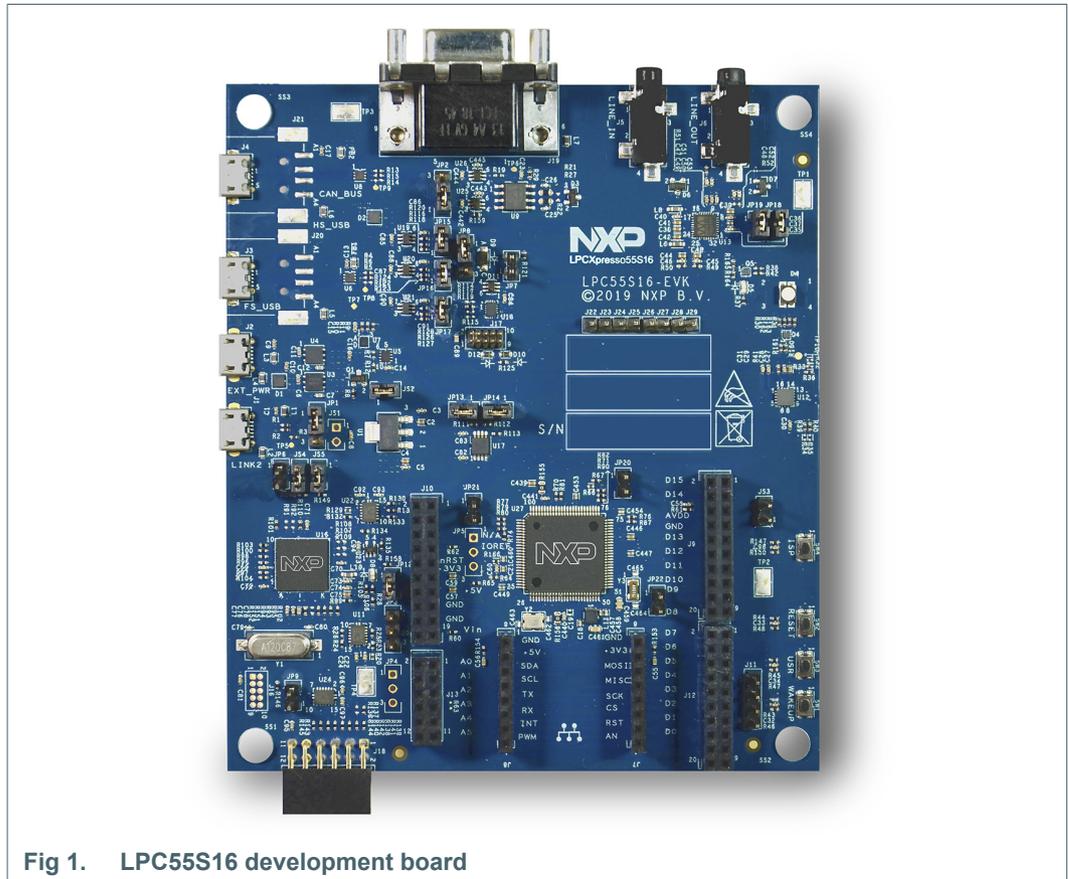


Fig 1. LPC55S16 development board

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