AN11015

Adding ISP to LPC1102 systems

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Document information

Info	Content
Keywords	LPC1102, ISP, FLASH, DEBUGGING
Abstract	This application note details a simple implementation which adds ISP functionality to a design. The principle can be extended in various ways, but is a recommended starting point for projects targeting LPC1102.

Revision history

Rev	Date	Description
1	20110105	Initial version.

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1. Introduction

Because of the reduced pin count on LPC1102 devices it is difficult to anticipate what functionality a customer will use. Thus, the designer was given flexibility in how to add In-System Programming (ISP) support to their devices.

Many other similar devices in the NXP ARM Cortex-M0 and Cortex-M3 device families have a dedicated ISP pin which is evaluated by the bootloader. On the LPC1102, the designer must add this functionality to their application by taking into account the hardware and features used by their application.

The GUI tool Flash Magic (http://www.flashmagictool.com/) can be used to program LPC1102 (as well as many other NXP devices) using serial communication once ISP has been [re]invoked.

Blank LPC1102 parts will not have valid user code, and thus the bootloader will automatically invoke ISP. However, once a part is programmed with a valid application there is no way of automatically invoking ISP in hardware.

It should also be mentioned that certain applications may require pins normally used for Serial Wire Debugging (SWD) to be used for other peripherals (such as SPP/SPI). When SWD is no longer available (especially during product development) reprogramming the device can become difficult, or in some cases impossible. By adding a user controlled ISP invocation, these applications can allow themselves to be programmed via SWD flash loaders because SWD pins are enabled when ISP is invoked. If this step is neglected, the device may need to be reset to cause ISP to be invoked.

Should an application use P0_10 or P1_3 as GPIO or peripheral function pins, the designers should plan to add user invoked ISP functionality to the design as early as possible. Doing so will avoid conditions in which the LPC1102's flash cannot be reprogrammed.

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2. Hardware design

This application note was designed around example LPC1102 PCBs. On these boards the UART pins TX and RX were unused. The decision was made to allocate RX (P1_6) as the custom user ISP pin.

A header was installed on the PCB with P1_6 and a wire connected to GND. If a jumper was installed, ISP would be activated by the application code. This is illustrated in Fig 1.

Additionally, in this design, the SWCLK pin must be used for SSP communication. The application code will force the pin into SWD mode at runtime should this jumper be installed, as a means of making reprogramming via LPC-Link (or other) debuggers easier during application development.

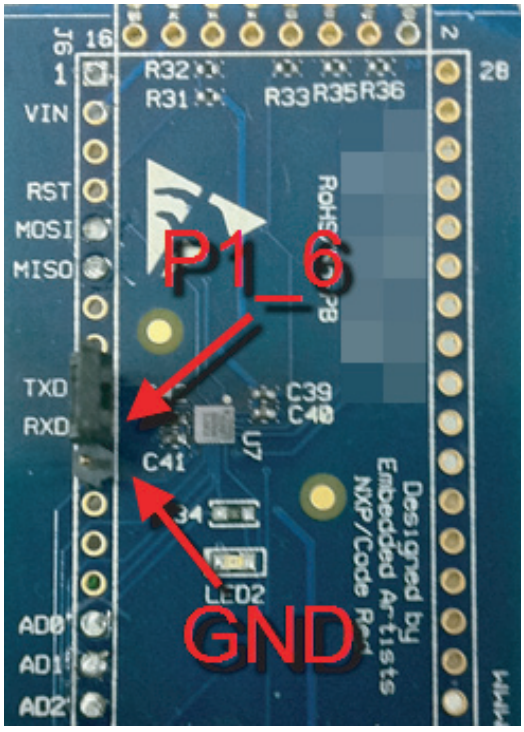

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Fig 1. Jumper detail: When connected P1_6 is connected to GND

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3. Software implementation

Implementing the user ISP mode in firmware is fairly straight forward. Because most development environments may abstract away low level initialization, care should be taken to ensure that the main function executes relatively early after the LPC1102 resets. Some tools may initialize C language runtimes, or do additional hardware-related initialization tasks, which may in unlikely situations prevent the code illustrated here from operating as intended.

The flow of execution can be summarized as follows:

1. Enable the relevant LPC_GPIO block
2. Configure the selected ISP pin as an input
3. Read the level on the ISP pin and conditionally invoke ISP via the “Reinvoke ISP” IAP command.

```
int main(void)
{
  /* Check for ISP... */
  InitGPIO();
  /* Assign P1_6 as INPUT */
  SetGPIOIn(ISP_PORT,ISP_PIN);
  LPC_GPIO1->DATA = 0;

  /*Check for the assertion (low) of user ISP Pin*/
  if ( 0 == GetGPIOBit(ISP_PORT,ISP_PIN) )
  {
    ReinvokeISP();
  }
  /* Setup system PLL */
  SystemInit();
  …
}
```

(1) Note – As stated previously, this project ensured that main() is called very early in the reset exception handler. Always confirm how your development environment behaves prior to executing main().

Fig 2. Example C code executed at startup

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```
void ReinvokeISP(void)
{
  IAP iap_entry = (IAP)0x1fff1ff1;
  uint32_t command[5], result[4];
  /* make sure 32-bit Timer 1 is turned on before
  calling ISP */
  LPC_SYSCON->SYSAHBCLKCTRL |= 0x00400;
  /* make sure GPIO clock is turned on before calling ISP */
  LPC_SYSCON->SYSAHBCLKCTRL |= 0x00040;
  /* make sure IO configuration clock is turned
  on before calling ISP */
  LPC_SYSCON->SYSAHBCLKCTRL |= 0x10000;
  /* make sure AHB clock divider is 1:1 */
  LPC_SYSCON->SYSAHBCLKDIV = 1;

  /* Send Reinvoke ISP command to ISP entry point*/
  command[0] = 57;

  /* Set stack pointer to ROM value (reset default).
  This must be the last piece of code executed before
  calling ISP, because most C expressions and function
  returns will fail after the stack pointer is changed. */
  __set_MSP(*((uint32_t *)0x1FFF0000)); /* inline asm */

  /* Invoke ISP. We call "iap_entry" to invoke
  ISP because the ISP entry is done through the same
  command interface as IAP. */
  iap_entry(command, result);

  // Code will never return!
}
```

Fig 3. Example C code to invoke ISP mode manually

It is also possible to conditionally set the function of the SWD pins as needed. Fig 4 shows an example that will only allow the device to use SSP functionality when the ISP pin is de-asserted.

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```
while(1)
{
  /* Only enable SSP when jumper is absent */
  if (GetGPIOBit(ISP_PORT,ISP_PIN))
  {
    LPC_IOCON->JTAG_TCK_PIO0_10 &= ~0x07;
    /* SSP CLK */
    LPC_IOCON->JTAG_TCK_PIO0_10 |= 0x02;
  }

  /* SSP data transfer takes place */
  …

  /* Switch Back to  SWCLK */
  LPC_IOCON->JTAG_TCK_PIO0_10 &= ~0x07;
  LPC_IOCON->JTAG_TCK_PIO0_10 |= 0x00;
}
```

Fig 4. Example C code which will only allow pins to be used for SSP when jumper is not connected

4. Conclusion

By implementing a user controlled ISP invocation, designers can ensure that their parts can be reprogrammed under all conditions. It should be noted that this example application is fairly straight forward, but more complicated methods of triggering the IAP call to invoke ISP can be used. For example, if an application has a serial command interface, rather than using a GPIO pin, a command could invoke ISP.

By ensuring that SWD pins can be forced into debugging mode, development becomes much easier, as the device does not need to be power cycled in order to be reprogrammed.

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