AN11121

USB CCID class smart card reader using LPCXpresso LPC11U14

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Document information

Info	Content
Keywords	USB CCID, LPCXpresso LPC11U14, smart card, ACOS3, ISO 7816, LPC11U14FHN33; LPC11U14FHI33; LPC11U14FBD48; LPC11U14FET48
Abstract	This application note describes a USB CCID class smart card reader using an LPCXpresso LPC11U14 board. This project implements a smart card reader that conforms to ISO/IEC 7816 protocol. When a CCID device is connected to a USB host, regardless of the presence of a smart card, the CCID prepares to communicate with the host by identifying its capabilities and requirements. When the CCID device detects a smart card insertion, it communicates this information to the host. Once the host receives the information about the smart card, the host communicates with the card through the CCID.

Revision history

Rev	Date	Description
2	20130212	Updated code: Bug fix, deleted some .svn directories
1.1	20111104	Table 1: Changed P1.19 to P0.19 for Gold Pad I/O.
1	20111006	Initial version.

Contact information

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1. Introduction

The LPC11U14 is an ARM Cortex-M0 based, low-cost 32-bit MCU, designed for 8/16-bit microcontroller applications, offering performance, low power, simple instruction set and memory addressing together with reduced code size compared to existing 8/16-bit architectures.

The peripheral complement of the LPC11U14 includes 32 kB of flash memory, 6 kB of SRAM data memory, one Fast-mode Plus I^2C-bus interface, one RS-485/EIA-485 USART with support for synchronous mode and smart card interface, two SSP interfaces, four general purpose counter/timers, a 10-bit ADC, and up to 40 general purpose I/O pins.

This application note describes a project that implements a USB CCID class smart card reader on an LPCXpresso LPC11U14 board. A smart card that conforms to the ISO7816 T0 protocol is used in this project.

This application note describes the following:

- Smart card basics
- Block diagram/overview of the setup
- Functional description of the system
- Requirements and system setup
- A guide to setup the demonstration
- Applications
- Conclusion

2. Smart card basics

A smart card is made of plastic and contains an embedded chip which either consists of a memory or microprocessor chip that enables the card to store or help in transaction of data. Smart cards are used for the purpose of identification, data storage, and to secure the account information of the user using such cards. Fig 1 depicts an ACOS3 smart card used in this application.

Fig 1. ACOS3 smart card

2.1 Types of smart cards

Smart cards can be broadly classified as:

- Contact cards – ISO 7816
- Contactless Cards – ISO 14443

2.1.1 Contact cards

Contact cards are the most common type of smart card. Contact cards conform to ISO7816 protocol. Electrical contacts are bonded to the card through a gold pad, which communicates with a card reader when inserted. This application uses contact cards.

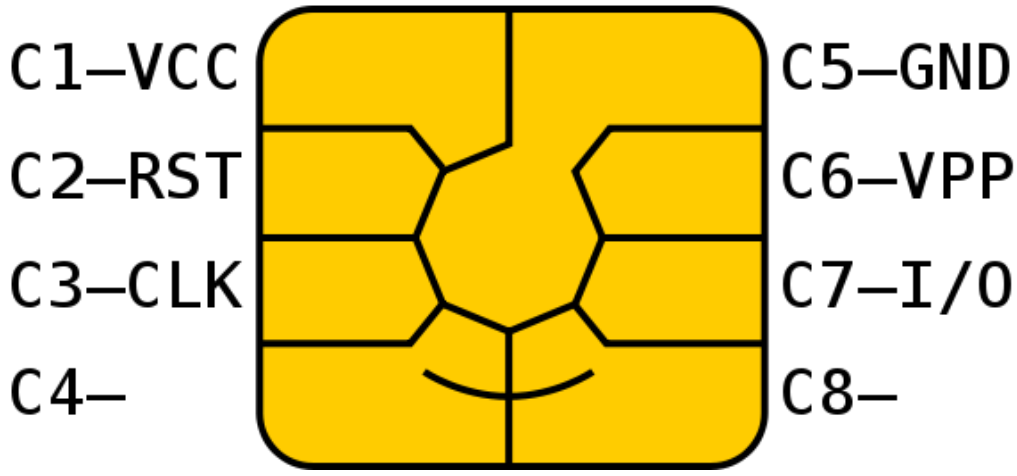

Fig 2. Smart card gold pad

Fig 2 shows a typical gold pad found on smart cards.

2.1.2 Contactless cards

Contactless cards employ Radio-Frequency Identification (RFID) to communicate between the card and reader without physical insertion of the card. These cards conform to the ISO 14443 protocol. In this application, contactless cards are not supported.

A detailed description of smart cards can be found at: http://www.smartcardbasics.com/.

3. System setup

An optimal system setup requires the socket holder to be mounted behind the LPCXpresso board. Fig 3 and Fig 4 depict the system setup.

The schematics followed to connect the smart card socket to the necessary pins are described in Section 3.1.

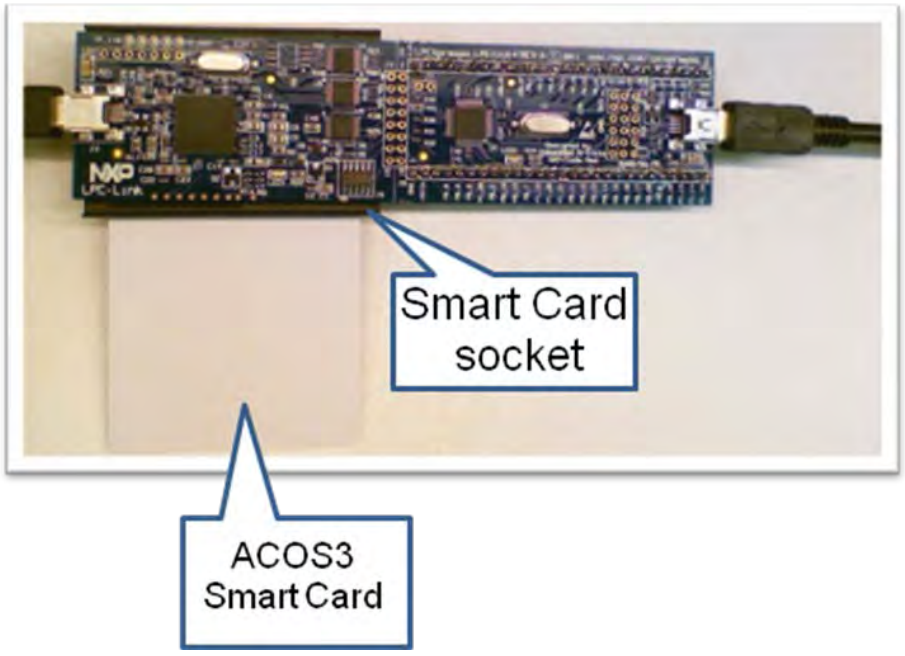

Fig 3. System setup - front view

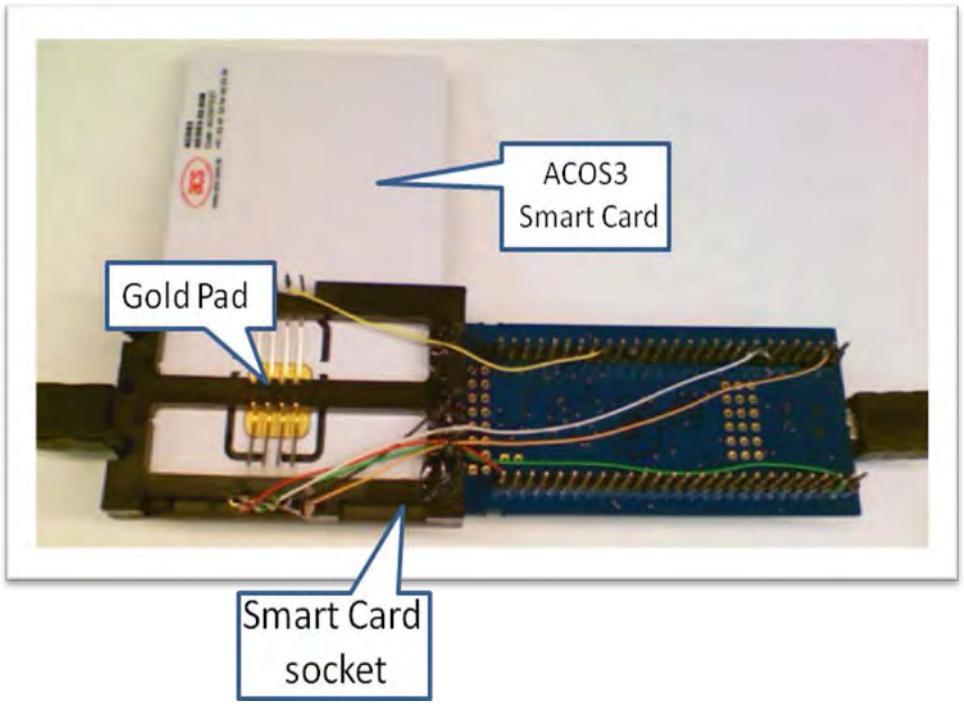

Fig 4. System setup - rear view

3.1 Schematics

The wiring from the card socket to the LPCXpresso board is listed in Table 1.

Table 1. Schematics

Smartcard socket	LPCXpresso
Card detect	P1.14
Gold Pad reset	P1.16
Gold Pad I/O	P0.19
Gold Pad clk	P0.17
Gold Pad power	3.3v
Gold Pad ground	GND

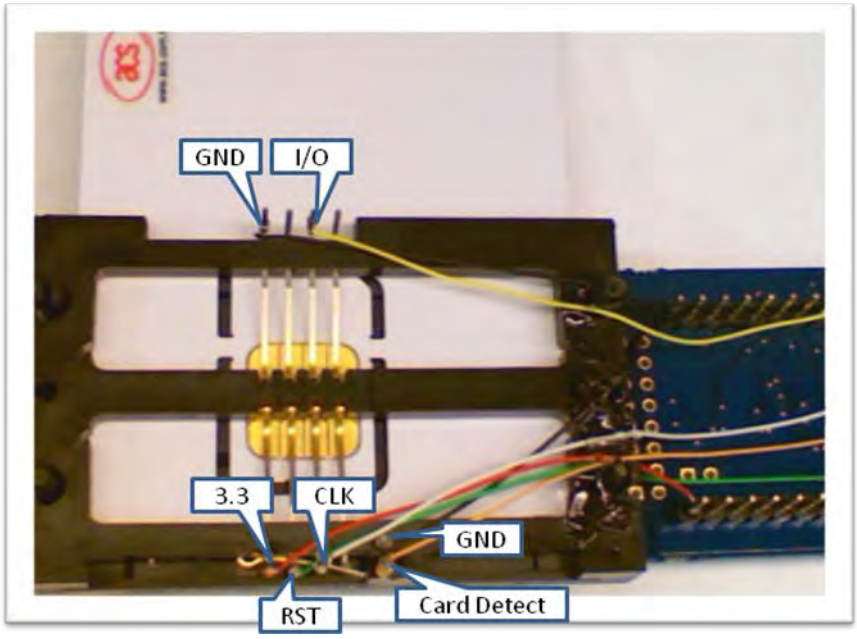

Fig 5. Smart card socket pin details

4. System overview

This project contains a USB CCID class (smart card) example device that runs on top of a USART interface. There are four major components in this example:

1. The USART layer.
2. The generic smartcard (ISO7816) layer.
3. A card specific layer that drives an ACOS3 smart card.
4. USB CCID class layer.

The project allows the user to choose between two different configurations based on the value of USB_CCID defined in *usbcfg.h:*

1. USB_CCID = 1 -> USB CCID device.
2. USB_CCID = 0 -> Stand alone ACOS3 smart card test.

A block diagram of the software components is shown in Fig 6:

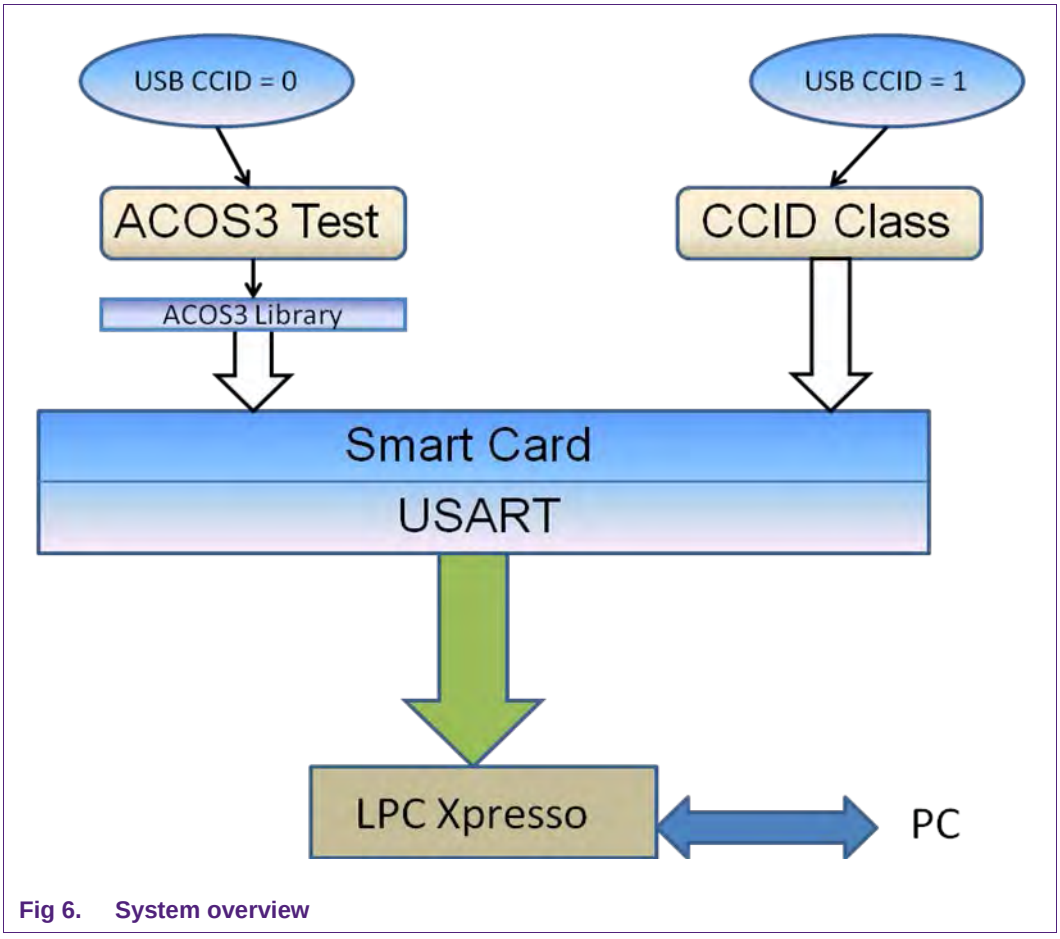

Fig 6. System overview

5. Requirements

5.1 Hardware

- LPCXpresso LPC11U14
- Smart card socket. The socket used in this application can be found at: http://www.bgmicro.com/soc1021.aspx
- ACOS3 smart card. The smart card used in this application can be found at: http://www.acs.com.hk/index.php?pid=product&id=ACOS3

5.2 Software

- LPCXpresso IDE, Version 4.0 or later. The download link for the software can be found at: http://lpcxpresso.code-red-tech.com/LPCXpresso/

Getting started with NXP LPCXpresso is a detailed description on how to get started, importing, and compiling projects in the LPCXpresso IDE, and can be found at:

http://www.nxp.com/documents/other/LPCXpresso_Getting_Started_Guide.pdf

6. Software algorithm

Two different build configurations are shown in Fig 7:

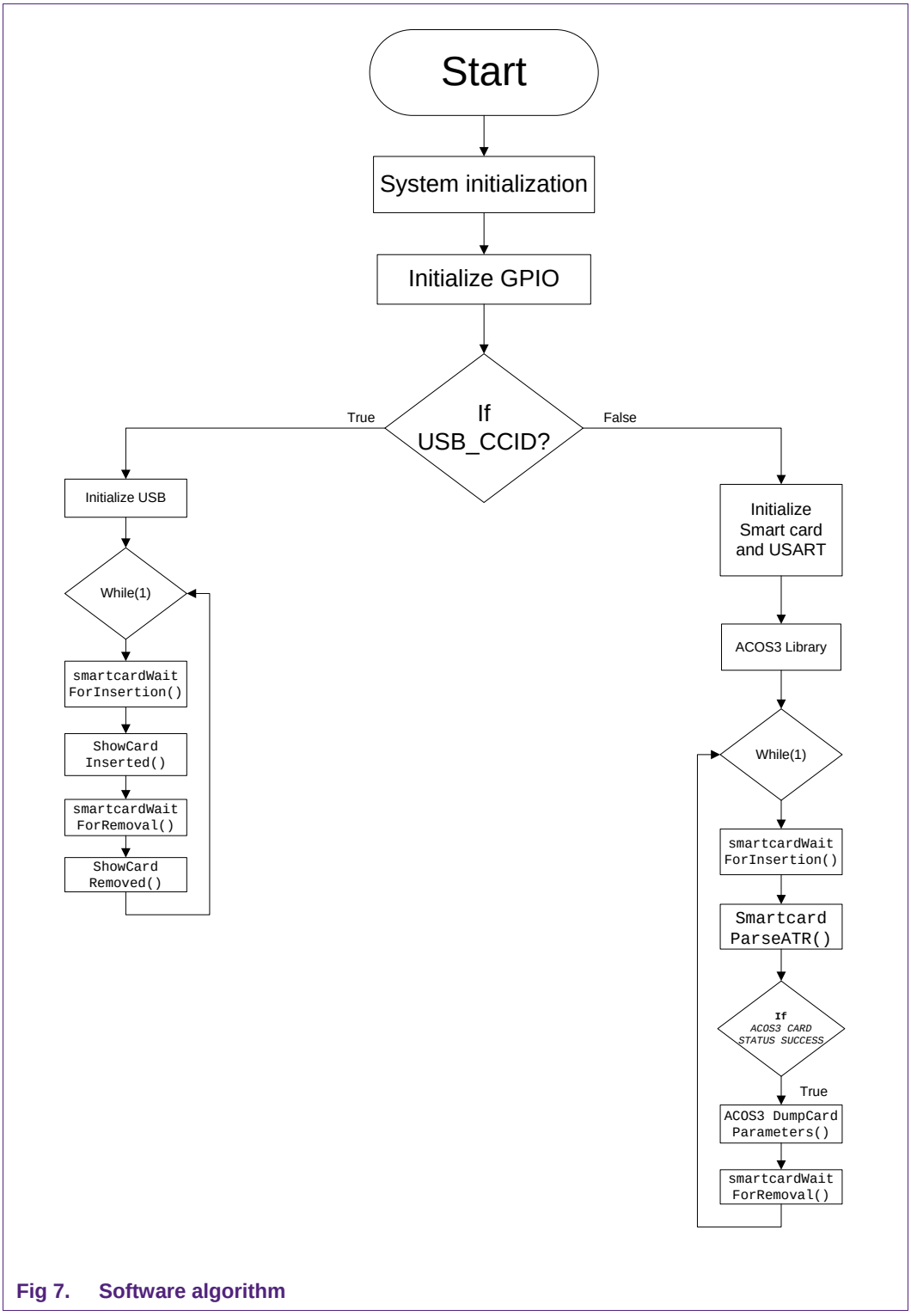

Fig 7. Software algorithm

Once the device is powered up, system initialization is done by setting up the Main clock and enabling the I/O configuration block by enabling the required bits in SYSAHBCLKCTRL register. Then the GPIO block is initialized and the USB_CCID definition is checked. The USB_CCID definition allows the user to switch between using the project as a USB CCID smart card test or as a standalone ACOS smartcard reader.

If USB_CCID = 1 -> USB CCID test

- The USB driver is initialized.
- An endless loop is entered where:
  - A card insertion/removal is detected by an interrupt raised by the smart card holder socket which is connected to P1_14 GPIO.
  - USB CCID class commands are acted upon.

If USB_CCID = 0 -> Smartcard test

- The USART layer is initialized.
- ACOS3 Library is invoked.
- An endless loop is entered where:
  - A card insertion/removal is detected by an interrupt raised by the smart card holder socket which is connected to P1_14 GPIO.
  - A series of commands are sent to the card and the response is displayed.

7. Demonstration

7.1 LED status

The status of the LED on the LPCXpresso board indicates any one of the following:

- Continuously blinking: Indicates that a card has not been inserted yet.
- Continuously On: Indicates that a card has been inserted.
- Activity: When a card insertion is detected, the USART activity is indicated by toggling the LED.

7.2 Smart card reader as a USB CCID device

1. Connect J3 and J8 of the LPCXpresso to the PC.
2. Import the project USBCCID.zip in LPCXpresso IDE.

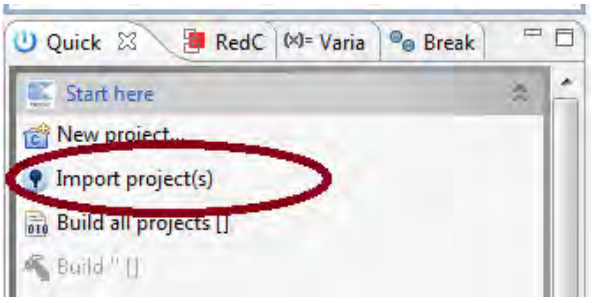

Fig 8. Import project

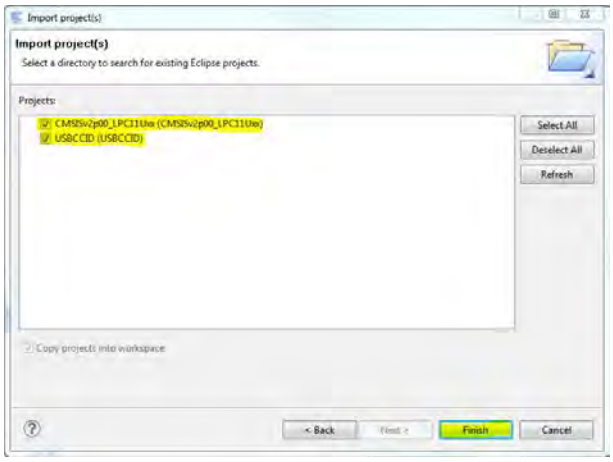

Fig 9. Finish importing project

3. Build and Debug project.

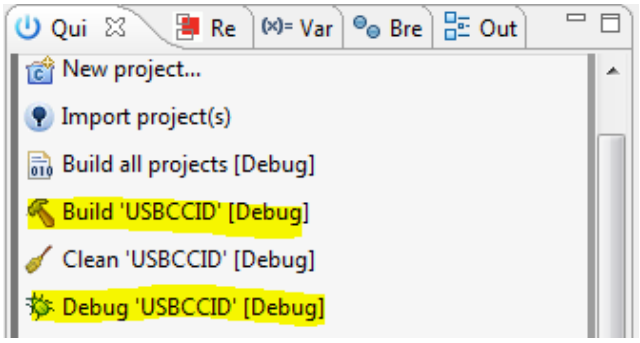

Fig 10. Build and debug project

4. Insert the ACOS3 smart card.
5. The status LED remains switched on until the card is removed.
6. Observe the output as shown below.

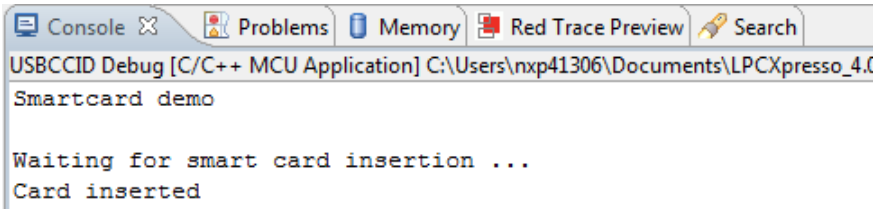

Fig 11. USB CCID output

7.3 Smart card reader as a ACOS3 smart card test device

1. Maintain the system setup as mentioned above.
2. Make the following changes in “USBCCID/src/usbcfg.h”.

#define USB_CCID	1
TO	
#define USB_CCID	0

3. Save project, build and debug as mentioned earlier.
4. Now Insert the ACOS3 smart card.
5. The status LED indicates the USART activity.
6. Observe the output as shown below.

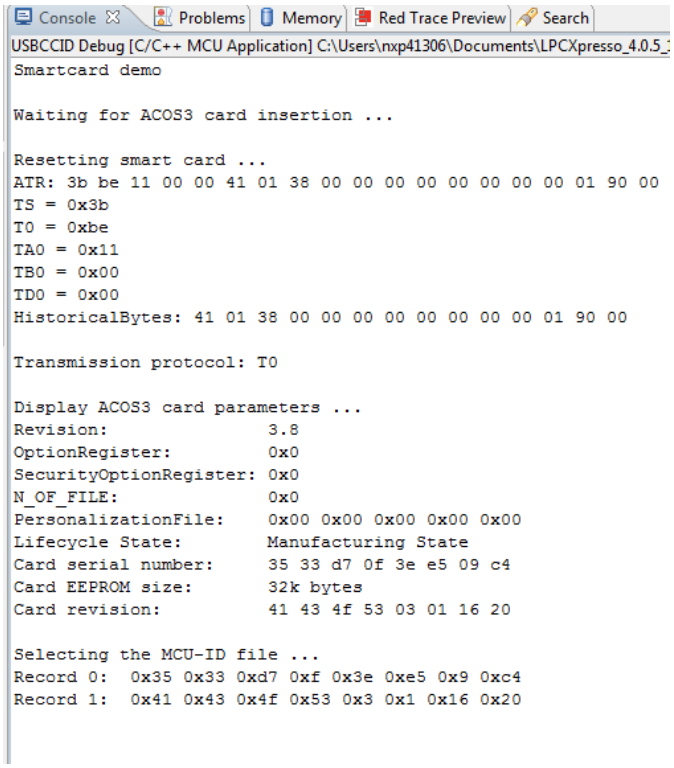

Fig 12. ACOS parameter dump

8. Conclusion

The USB CCID Smart card reader project demonstrates the capability of LPCXpresso LPC11U14 to efficiently utilize the USART, ISO 7816 protocol and successfully implement a USB CCID class example device.

Further, this example device could be used as a standalone smart card reader in commercial products. Enhancements such as a smart card socket that can read various form factors of the smart card (SIM card, micro SIM card) are possible.

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