Low Power CoolRunner CPLDs

An Ideal Fit for Smart Card Readers

Coolrunner CPLDs can be used to implement various functions within Smart Card Readers, and are especially beneficial in handheld, lightweight, battery-powered applications.

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Smart Cards are becoming a common part of our every day lives, and new ways to use this technology are being developed at a rapid pace. Because they hold more than 100 times the information contained on a standard magnetic strip card, Smart Cards can store small denominations of cash, accumulate medical records, be used as security cards, and can greatly ease on-line buying. Their applications and acceptance are increasing daily; the American Express® Blue Card now comes with a free Smart Card reader that connects to your PC so you can interrogate your account securely on-line, and you don't have to enter your account details every time you purchase from a website.

The Smart Card Reader

One of the fastest growing uses for Smart Cards is to replace the standard credit card; this has lead to a dramatic increase in portable battery powered Smart Card readers. These readers can be used in restaurants for payment at your table, in taxis and buses for payment on the move, and in on-line Web-based or main street stores.

Figure 1 shows the basic components of a Smart Card reader. These functions may also be integrated into cash registers, vending machines, public pay phones, set-top boxes, mobile phones, utility meters, and many other devices that require an authentication or secure payment system.

The functional blocks that make up the system are:

- Main data processing - typically a 16- or 32-bit microprocessor (MCU) for computational functions.
- Memory - to store data (operating system, variables, data storage) and microprocessor boot code.
- Security logic - to aid data encryption.
- Card reader interface - for both the Smart Card reader (contact and contactless) and the magnetic card reader.
- Keypad and keypad decoder - for entering Personal Identification Numbers (PINs) and other data, and the associated logic to decode the input.
- LCD Display driver - for user feedback.
- Modem and modem interface - for interfacing to wireless, cellular, and radio modems (usually PCMCIA type).

How it Works

In a typical consumer transaction:

- The merchant inserts the Smart Card into the card reader and power is applied to the card.
- The reader communicates with the Smart Card MCU to perform the card authentication cycle.

- During the initial read function the Smart Card interface logic passes the data to the card reader microprocessor via the security logic. (The CoolRunner device is a non-volatile EEPROM CPLD so it is secure and reliable and thus ideal for implementing security logic and MCU decoding.)

- The card reader instructs the user to enter a PIN via a message on the LCD. The user enters their PIN via the keypad; this is authenticated by the reader MCU. The PIN is verified by the MCU in the card which compares the PIN stored in it's RAM with the one presented. If the comparison is negative the CPU will refuse to work. The Smart Card keeps track of how many wrong PINs are entered and if it is over a predetermined number, typically three attempts, the card blocks itself against any future use.

- When the transaction is complete the card is ejected and removed. The Smart Card reader is then ready for the next transaction.

CoolRunner Technology is Key

The Coolrunner family of ultra low power, low cost CPLDs is ideal for this application. Not only do the CoolRunner devices consume less power than any other CPLD but they come in very small form factor packages, such as the 56 pin, 0.5mm pitch Chip Scale Package device shown in Figure 2. CoolRunner devices are available in both 3.3V and 5V versions, enabling Smart Card readers to easily accommodate both the new 3.3V Smart Cards and the older 5V types.

6mm

Figure 2 - CoolRunner XPLA3 64-macrocell 56-pin, 0.5mm pin pitch Chip Scale package.

Card reader to be updated in the field, thus increasing the effective system life. By integrating all of the logic into a small form factor, ultra-low-power CoolRunner CPLD, you can dramatically reduce the total PCB area and number of layers required.

Conclusion

The Smart Card market is on the brink of realising its full world-wide potential for cashless transactions, store loyalty schemes, access control systems, medical record cards, identity cards, drivers licenses, and many other applications. This year we will see personal computers shipped with Smart Card readers as standard equipment which will unlock widespread world-wide acceptance of multi-application Smart Cards, and hand-held battery powered Smart Card readers in taxis and buses will become common place.

Xilinx high-volume CoolRunner CPLD devices provide you with cost effective solutions that retain the traditional PLD time to market advantage but with the added benefit of ultra low power operation, very small form factor packages, and a secure, reliable, non-volatile process technology.
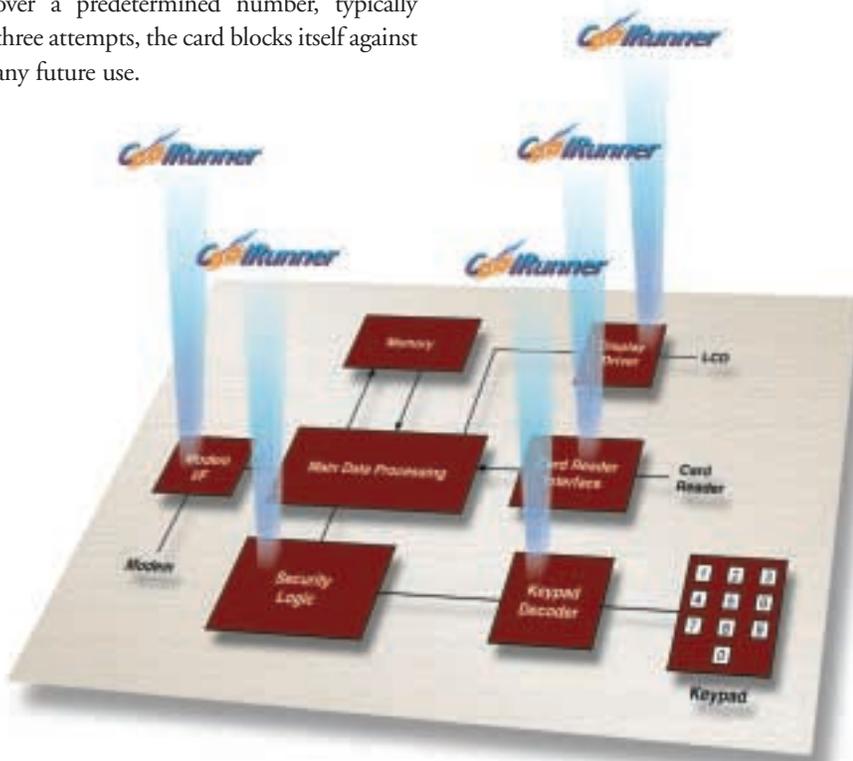

Figure 1 - Smart Card reader internal functions.

- When the PIN is verified, the purchase amount is entered by the merchant and the Smart Card is interrogated to see if it has enough stored value. If so, the amount entered is deducted from the stored value on the card.

- If it is not an SVC (Stored Value Card) transaction then the amount to be debited from the bank account will be verified using the modem (wireless, cellular, or radio).

CoolRunner CPLDs are perfect for performing the interfacing and decoding functions in the Smart Card reader. The main CoolRunner tasks are the memory interfacing, input/output expansion, keypad decoder logic, LCD interfacing, modem interfacing, and interfacing to the physical card reader itself. Because they are reprogrammable, CoolRunner devices allow the Smart

	XCR3032XL	XCR3064XL	XCR3128XL	XCR3256XL	XCR3384XL
Macrocells	32	64	128	256	384
Usable Gates	1000	2000	4000	8000	12000
t_{PD} (ns)	5	6	6	7.5	7.5
f_{SYS} (MHz)	200	166	166	133	133
Packages (Max. User I/Os)	44VQ (32) 48CS (32)	44VQ (32) *48CS (32) 56CP (44) 100VQ (64)	100VQ (80) 144TQ (104)	144TQ (104) 208PQ (160) 280CS (160)	280CS (216)

Table 1 - The CoolRunner family of CPLDs.