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## *CoolRunner-II CPLDs in Point of Sale Terminals*

*By: MSD Applications*

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A Point of Sale (POS) terminal is defined as a unit that allows the transfer of funds electronically, and can be thought of as a modern replacement for the traditional cash register. Due to the complexity of securing transactions, POS terminals are, however, much more complicated than push buttons and a cash drawer. A POS terminal will typically consist of a processor, a keypad, a card reader and a display but, on top of the usual payment processing functionality, a full feature machine may be able to record and track orders, connect to a network, manage inventory and more.

This White Paper discusses applications for CoolRunner™-II CPLDs in POS and HPOS terminals.

## Introduction

The POS terminal market is growing steadily with predicted worldwide shipments reaching 9.6 million units or \$1.86B by 2009, up from \$1.4B in 2006 according to Frost and Sullivan; [www.frost.com](http://www.frost.com). This growth is being driven by several factors:

- The continued need to make POS terminals more secure
- The inclusion of new and different wireless standards resulting in the need to replace “obsolete” technology
- Adoption in new markets such as China and India

There are two main categories of POS terminal; the immobile type that sits on a desk where one would have traditionally found the cash register, then the type that is continually mobile, for example receiving and processing payments around a restaurant. The latter is referred to as a portable or handheld POS (HPOS) terminal which is either in constant wireless communication with a computer, or processes data in batches when physically connected to a central unit.

With the rapid rise of wireless technology, wireless HPOS terminals are commonplace as handsets that can be carried around the retail, entertainment, and dining environments, adding flexibility to transactions. Whether in the local store, a restaurant or bar, a gas station or a nightclub, the popularity of HPOS terminals is on the rise, helping to make the HPOS terminal market worth over \$600M in 2007 according to Frost and Sullivan; [www.frost.com](http://www.frost.com).

## Basic HPOS Terminal

HPOS terminals are usually built around a vendor chipset designed for the low power portable consumer market, such as the XScale product range from Marvell. While these chipsets are good at what they do, they do not offer a great deal of flexibility. Adding new features can be a costly and time consuming procedure. Hence, using Xilinx CoolRunner-II CPLDs to incorporate features into a HPOS terminal can significantly save both time and cost. These applications are mobile and must run off batteries. Because CoolRunner-II CPLDs have very low power consumption even when active, new features can be incorporated without significantly denting the power budget.

A basic HPOS terminal usually consists of four features: a central processor, a card reader, a keypad and a display. The processor is very often an ARM, and the card reader may be a magnetic stripe reader or a smart card reader. The keypads and

displays vary greatly from terminal to terminal, so having a flexible solution that can be customized to different peripherals is highly advantageous.

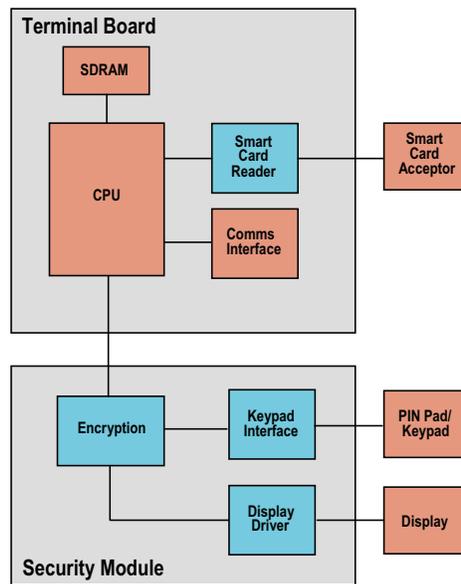


Figure 1: Basic HPOS Terminal

Figure 1 shows a block diagram of a basic POS terminal with the blue areas showing the functions that can be performed by a Xilinx CoolRunner-II CPLD. This example shows a typical chip and pin style card reader in which the interrogation of the card is done via the embedded smart card chip using the ISO7816 protocol. The CoolRunner-II CPLD can be used to provide a low cost method of interfacing to a smart card receiver as shown in Xilinx [Application Note 372](#).

Different HPOS terminals use different displays. Where only simple messages are needed to prompt the user for their PIN, a basic LCD capable of displaying only a few characters, such as 128 x 64 pixels, will suffice. However, as HPOS terminals are used more as complete ordering systems, a better resolution color screen becomes useful. As terminals use more sophisticated operating systems such as Windows CE, it is common to find a 3.5" color screen capable of displaying much more information. Using a CoolRunner-II CPLD to drive the display enables a manufacturer to use the same base platform with the same processor to drive models of different complexity. The CoolRunner-II CPLD can simply be reprogrammed to drive a larger or smaller display as needed. Xilinx [Application Note 904](#) shows how a small CoolRunner-II CPLD can be used to drive a simple character LCD module. A larger display can easily be controlled using a slightly larger Xilinx CPLD.

The same message is true of the keypad. If it is possible that extra keys will be added to high end models, the manufacturer need not invest in a chipset that contains a larger keypad interface; they can simply use a small, low cost CoolRunner-II CPLD to provide the keypad interface. This way, the number of rows and columns can be fully customized, providing other keys for special functions. It is not uncommon for an HPOS terminal to require more keys than a cell phone for which the chipset was originally designed. Having over 50 keys on a terminal is not uncommon. An example of a CoolRunner-II CPLD at work as a keypad scanner is shown in Xilinx [Application Note 512](#). In this real world example, it was necessary to scan an 8 x 8 keypad – this was achievable in a very small 32 macrocell device.

The final function performed by a CoolRunner-II CPLD in the basic POS terminal is perhaps the most critical. Securing the terminal user’s information in order that it cannot be intercepted by a third party is vital. The CoolRunner-II CPLD acts as an encryption engine so that the customer’s PIN and other personal information can be secured before being transmitted from the secure module of the terminal into the main terminal board. The CoolRunner-II CPLD receives the information from the processor, displays it on the screen, monitors the keypad for the user’s personal information, encrypts that information, and then sends it back to the processor. Of course there are infinitely many methods of encrypting the data between the processor and the secure module, but they all follow similar patterns. For instance, the confidential data can be sent through an algorithm that performs a number of steps to hide the original data from prying eyes. On receipt of the data, the processor performs the necessary steps to retrieve the original data in order to perform the relevant instructions. More detail on the use of CoolRunner-II CPLDs as encryption engines can be found in [Xilinx Application Note 374](#).

## Feature Enhanced POS Terminal

While the basic POS terminal provides all the critical functionality necessary to take a payment from a customer, there are many circumstances that require additional features to be incorporated, as shown in [Figure 2](#).

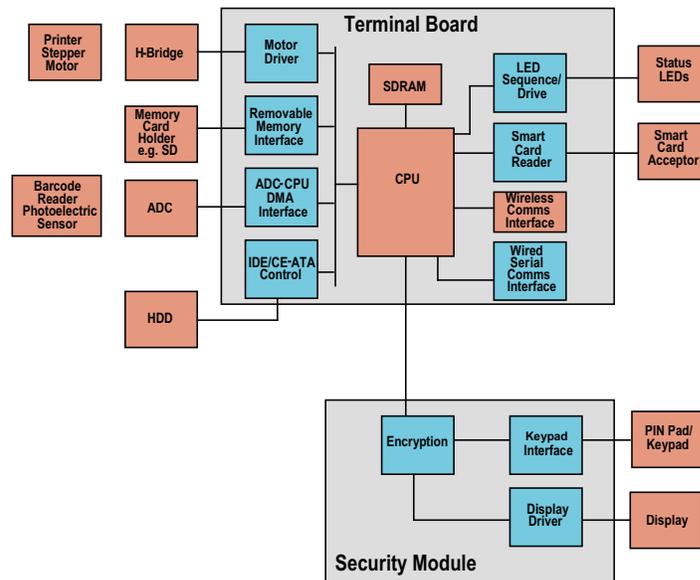


Figure 2: Full Featured POS Terminal

The additional features in this terminal are the printer, memory/storage interfaces, barcode reader, and wireless communication interface. It is common for the HPOS terminal to require extra memory interfaces, either removable storage media, such as SD or Compact Flash cards, or permanent internal storage, such as a hard disk drive for saving a record of all transactions made. One example of a CoolRunner-II CPLD acting in this fashion can be seen in [Xilinx Application Note 398](#) - CompactFlash Card Interface for CoolRunner-II CPLDs.

Due to the increasing number of peripherals that use the SDIO interface, SD ports are present in more and more end applications. Whereas traditionally SD ports were used to accept only memory cards, now they can be used to talk to peripherals such as

barcode readers, GPS receivers, Wi-Fi adapters, and Bluetooth adapters, all of which are available as SDIO peripherals, and many of which are applicable to HPOS terminals. Xilinx [Application Note 906](#) shows how a CoolRunner-II CPLD can be used to switch multiple SDIO peripherals on the same SD port, thereby saving the designer from having to invest in a more expensive chipset in order to gain another port.

Barcodes are a machine-readable representation of information often used in a retail environment. They can be read by optical scanners known as barcode readers, which can be sufficiently small form factor to fit into an HPOS terminal. A barcode reader will typically consist of a photodiode or photoelectric sensor that is aimed at the barcode, and an analog to digital converter that converts the analog output of the photoelectric sensor into usable digital data. There are many different ADCs on the market, each with a specific number of bits, resolution, and number of channels. Xilinx [Application Note 355](#) shows how a CoolRunner CPLD can be used to interface to an ADS7870 ADC from Texas Instruments.

As HPOS terminals are designed to be on the move at all times, it is often a requirement that they incorporate a printer in order to print proof of purchase receipts or tickets at reasonable speed. Receipt printers can take several forms – Impact Printers, Thermal Printers, and even Inkjet Printers, depending on the requirements of the user and the situation in which the terminal is to be used. Typically 12 lines per second is considered sufficiently quick for an HPOS terminal. Regardless of which type of printer mechanism is implemented in the terminal, it will often use a stepper motor to spool the paper and move the print head. CoolRunner-II CPLDs can combine with external transistor drivers, such as an h-bridge, for easy control of a stepper motor as shown in Xilinx [Application Note 940](#).

## Power Saving

Advanced RISC Machines started early developing low power methods to operate microprocessors. Subsequently, the licensing vendors all added their own methods to further reduce processor power. Typical power reduction operations involve clock gating, voltage throttling, and on board memory management to reduce transfers within the device. These are sometimes referred to as run, wait, doze, sleep, hibernate, and so on. Also, operating systems like Symbian have added “power awareness” to the mix, so that unused resources can be parked in the lowest power mode possible for the current tasks being executed. This all works well and lowers processor power. However, lowering power in the rest of the system exceeds the scope of these methods. Enter CoolRunner-II CPLDs. CoolRunner-II CPLDs are designed to be inherently low power parts. That is important, but alone is not enough. CoolRunner-II special features can also be used to lower the power in other devices. Using clock dividers and our patented DataGATE technology can reduce power in many (if not all) of the chips on your design. Xilinx [Application Note 378](#) shows how to do this, and Xilinx [White Paper 227](#) shows just how much power you can save with DataGATE. Blocking power to other chips can also reduce electromagnetic fields

being propagated on your board and emanating from your system. This powerful signal blocking technique can pay off in many ways!

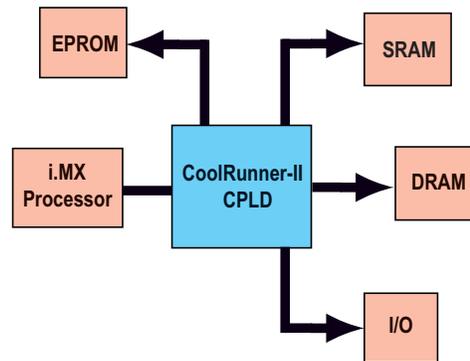


Figure 3: DataGATE Blocking

## Conclusion

CoolRunner-II CPLDs are quickly becoming the standard for low power, low cost, high volume, handheld products. This application note has focused on how these powerful products can make life easier when building Handheld Point of Sale Terminals, but CoolRunner-II CPLDs work just as well in all handheld electronic systems, to add functionality, save power and get products to market fast. In addition, the ultra small form factor packages and embedded configuration memory ensure that the board space used by a CoolRunner-II CPLD is kept to an absolute minimum.

## References:

Frost and Sullivan report ([www.frost.com](http://www.frost.com))

[Application Note 905](#): Using CoolRunner-II with OMAP, XScale, i.MX & Other Chipsets

[Application Note 372](#): CoolRunner-II Smart Card Reader

[Application Note 904](#): CoolRunner-II Character LCD Module Interface

[Application Note 512](#): Implementing Keypad Scanners with CoolRunner-II

[Application Note 374](#): CryptoBlaze: 8-Bit Security Microcontroller

[Application Note 398](#): CompactFlash Card Interface for CoolRunner-II CPLD

[Application Note 906](#): Supporting Multiple SD Devices with CoolRunner-II CPLDs

[Application Note 355](#): Serial ADC Interface Using a CoolRunner CPLD

[Application Note 940](#): Using Xilinx CPLDs as Motor Controllers

[Application Note 378](#): Using CoolRunner-II CPLD Advanced Features

[White Paper 227](#): The Real Value of CoolRunner-II DataGATE

## Revision History

The following table shows the revision history for this document:

Date	Version	Description of Revisions
11/27/07	1.0	Initial Xilinx release. (for v1.0 only)

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