White Paper

ispMACH 4000Z CPLDs in PDAs, Personal Media Players and Smart Phones

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Introduction

This paper provides an overview of portable, handheld computing, internet audio/video and communication devices, PDAs, Personal Media Players, and Smart Phones, and how Lattice low-cost programmable devices can be used to solve design challenges typical of these electronic products. The paper begins with an overview of the market for PDAs, Personal Media Players and Smart Phones, and how the market for these devices is set to converge in the near future. Next, the major building blocks of a PDA / Personal Media Player / Smart Phone are detailed, including an overview of the underlying technologies and standards that might be used in the system. Finally, the paper illustrates how the “zero-power” ispMACH™ 4000Z CPLDs can be used to implement ASSP bug fixes, power management, glue logic and security in a next generation, integrated Smart Phone / PDA / Personal Media Player design. Detailed information about the ispMACH 4000Z device family can be found on the Lattice website at www.latticesemi.com.

What is a PDA / Smart Phone / Personal Media Player?

A PDA (Personal Digital Assistant) is essentially the electronic replacement of the paper filofax combined with a mini-portable, handheld Personal Computer. PDAs typically perform functions such as calendar, alarm, address book, note-taking, data collection, to-do list, and games, along with limited word processing, spreadsheet and finance applications. Many PDAs provide e-mail and internet access, use touch-screen LCDs for data entry and are able to be synchronized (synched) to a PC. Popular PDA examples include Palm OS-devices, such as the PalmOne Tungsten T3, Microsoft PocketPC OS-devices, such as the HP iPAQ 4155 or Sony Clie PEG-TH55, and proprietary-OS devices, such as the RIM BlackBerry 7230. High-end PDAs typically have 64-128MB of installed memory along with an SDIO/MMC expansion slot for additional memory or peripherals, such as wireless modules, camera modules or MP3 player modules.

A Personal Media Player (PMP) is a set of portable devices including MP3 players, music jukeboxes, and video jukeboxes that store and play compressed media such as MP3, WMV, JPEG and MPEG-4 files. Popular examples include the Apple iPod, Diamond Rio, iRiver iHP-140, and the Archos AV300. Personal Media Players can be divided by storage media type -- hard-disk (HDD) versus solid state (typically flash) memory. The high price of solid-state flash memory relative to hard-disk storage is driving the PMP market towards miniature hard-disk based systems, such as the Apple iPod. According to Portal Player, a leading chip set manufacturer for PMPs, hard-disk based compressed media players are projected to grow to 45% share by 2005 [1]. Microsoft has announced a line of HDD-based media devices called Portable Media Centers that are expected to begin widespread release in the second half of 2004, partnering with Creative Technology, Samsung and iRiver. An early example of a Microsoft partner PMP device is the Creative Zen Portable Media Center, which has a storage capacity of 20GB or higher [2].

A Smart Phone is a mobile phone handset or terminal that includes some additional features of PDAs, such as address book, calendar, internet access and messaging. Popular examples are the Nokia 6600, Motorola MPx200, Sony Ericsson P900 and PalmOne Treo 600. The main distinction between Smart Phones and PDAs are that Smart Phones are more communications centric, whereas PDAs are more data-centric. Also, Smart Phones can typically be used with one hand, whereas PDAs usually require two hands. In addition to the PDA-operating systems named above from Palm and Microsoft, a consortium of wireless companies (Nokia, Samsung, Sony Ericsson and others) has created an additional OS for Smart Phones called Symbian.

Figure 1. Next Generation Devices Integrate Features of PDAs, Smart Phones and Personal Media Players

This paper focuses on the next generation of devices, such as the Sony Ericsson S700 (shown above-left), Nokia 7610 (shown above-middle) and PalmOne Treo 600 (shown above-right), that integrate many of the main features from PDAs, Smart Phones and Personal Media Players into a single device. It is clear that portable device convergence is underway, however, it is unclear whether consumers will be willing to carry around three devices (PDA, mobile phone and personal media player), two devices (smart phone and personal media player) or one device (ultimate smart phone) and what mix of functions and form will capture the most “wallet share”.

The Market

Convergence

In telecom, convergence means the transmission of voice, data and the internet over one technology, rather than separate, dedicated technologies for each media type. To have convergence, each media type must be able to be broken down into something that is able to be transported over one technology. Much convergence in telecom can be attributed to the digitization of voice, data and other information being transmitted via IP (Internet Protocol) packets.

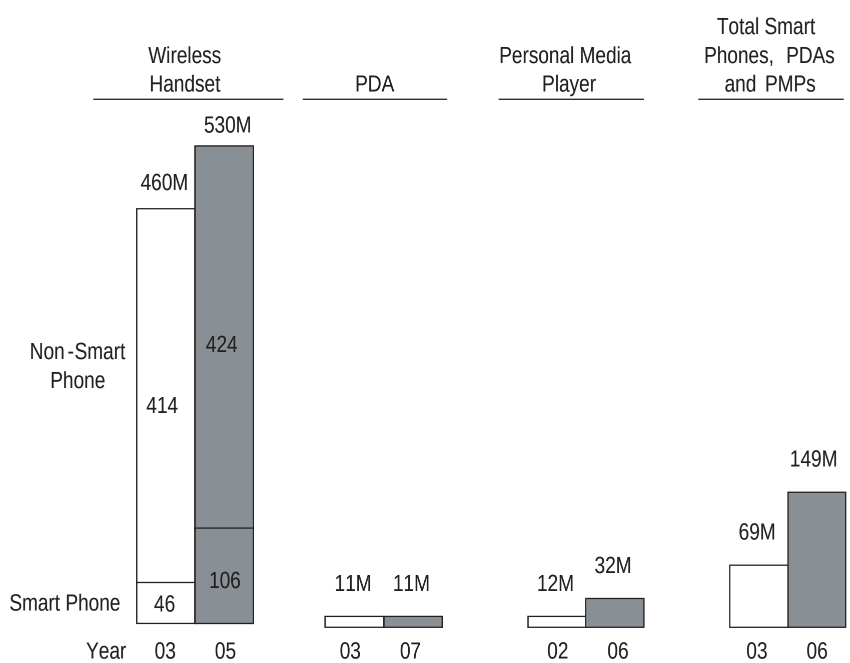
Convergence in telecom has broadened the access and availability of digital content for consumer electronic devices. For example, many people can access their emails today using their digital mobile phones using various standards based on IP packets. In the near future, convergence will lead to the availability of additional media types on digital mobile phones, such as video or digital television (DTV) broadcasts.

Larger availability of digital content and easy access to digital content via converged communication networks will lead to increased demand for digital consumer electronic devices [3]. According to Sony, we are currently undergoing a large shift in the electronics market from Personal Computer (PC) to Digital Consumer (DC) [4], with low power electronics, such as Lattice's zero-power ispMACH 4000Z CPLD device, playing an important role in the emerging Digital Consumer market.

High Growth

The market for Digital Consumer devices is growing quickly. A large portion of the Digital Consumer devices (>500 Million (M) units/year) market is made up of wireless handsets, PDAs and Personal Media Players, as shown in Figure 2 below.

Figure 2. Wireless Handset / Smart Phone, PDA and Personal Media Player Market Shipments (Mil. Units). Source: Lehman, Gartner, IDC.



The wireless handset market is expected to grow from 460M units in 2003 to 530M units in 2005 (Source: Lehman Brothers). Gartner estimates that Smart Phone share of wireless handsets will increase from 10% in 2003 to 20% in 2005.

The PDA market is expected to remain relatively flat over the next few years, from 11.4M units in 2003 to 11.2M units in 2007 (Source: Gartner Dataquest, March 2004), largely due to cannibalization of the consumer segment by Smart Phones. While the overall PDA market remains flat, enterprise segment purchases of PDAs are expected to grow from 30% in 2003 to 44% in 2005, making up for losses of sales to the consumer segment. Gartner predicts that Palm-OS devices will have a slightly larger share (44%) than Microsoft PocketPC devices (42%) in 2004.

In contrast to the PDA market, the Personal Media Player market is expected to grow rapidly over the next few years. According to IDC, portable compressed audio player shipments are expected to grow from 12M units in 2002 to 32M units in 2006.

Technologies / Features

There are many common technologies and features being built into Smart Phones, PDAs and Personal Media Players, including Bluetooth, Wi-Fi, WAP, GPS, MP3 and others. A brief description of a selection of enabling technologies/features follows.

Bluetooth / PAN

Bluetooth is a low-power, short-range (<10 meters), wireless communications standard, typically used for peripheral data bus functions. Bluetooth operates over a 2.45GHz radio band, and promises speeds up to 12Mbps in future generations. The current generation of Bluetooth-enabled devices typically has a data throughput of 500kbps, sufficient bandwidth for portable headphones, headsets, cell phone hands-free kits, PC synching functions, and wireless printing. Bluetooth has effectively replaced cables and Infrared (IrDA) for low-power, short-range wireless data transfer to peripherals. Bluetooth is a standard that is enabling PAN (Personal Area Network), organizing a set of devices (mobile phone, PDA, laptop, desktop, audio player) to work together.

802.11 / Wi-Fi / Zigbee

802.11 is a set of IEEE standards for wireless LAN communication, over larger distances (<61 meters) than Bluetooth, at higher data rates. Wi-Fi is synonymous with 802.11b, which enables up to 11Mbps speeds using the 2.4GHz radio band. Typical throughput for current generations of Wi-Fi equipment is around 5Mbps, much faster than Bluetooth.

Wi-Fi buildout is expanding rapidly. Jiwire, a leading multi-national hotspot directory, lists the number of global Wi-Fi hotspots, with the United States leading with over 20,000 as shown in table 1. According to April 2003 estimates by the Yankee Group, the number of Wi-Fi hotspots in the US will increase from 21,140 in 2004 to 72,480 in 2007.

Table 1. Number of Global Wi-Fi Hotspots in March, 2004. Source: Jiwire, March 2004

Country	Wi-Fi Hotspots
United States	20,487
United Kingdom	4,620
France	1,616
Germany	1,167
Japan	1,022
Taiwan	643
Canada	571
Australia	539
Sweden	435

Wi-Fi is considered an enabling technology for VoIP (Voice over IP), or packet based voice service. In Japan, DoCoMo has announced dual-mode 3G and Wi-Fi VoIP service, the idea being to use the Wi-Fi band when within the area of a Wi-Fi network and 3G when outside the Wi-Fi network.

Unfortunately, 802.11b/Wi-Fi typically consumes more power than 2G/3G wireless networks and Bluetooth, thus a new standard called Zigbee, also known as 802.15.4, has emerged for lower data rate applications that require longer distances over 2.4 GHz radio bands. Zigbee supports maximum data rates up to 250kbps up to 100 meters using RF bands, including 2.4 GHz.

2.5G: GPRS / EDGE / WAP

GPRS (General Packet Radio Service) is an overlay onto the GSM infrastructure to allow packet switching of data on 2G (2nd generation) GSM networks, and is thus considered 2.5G. GPRS can essentially be implemented primarily through a base station software upgrade to GSM [5], and offers mobile speeds up to 60kbps and fixed speeds up to 171.2kbps. EDGE (Enhanced Data for GSM Evolution) is the next generation of GPRS, offering mobile speeds up to 180kbps and fixed speeds up to 384kbps. Unlike GPRS, EDGE does require a hardware upgrade of the network's base stations.

WAP (Wireless Application Protocol) is a standard that allows internet information to be sent directly to mobile phone screens. WAP is similar to HTML for mobile devices, an open wireless mark-up language standard. Combined with GPRS or EDGE, WAP enables internet browsing on mobile phones.

3G

3G means the third generation of mobile services, promising streaming video over mobile wireless networks. 3G represents the complete transition from a circuit switched mobile to a packet-based environment, offering global roaming. 3G is defined as having a data rate of up to 384kbps in a mobile environment and 2Mbps in a fixed environment. Various 3G technologies include cdma2000, UMTS and WCDMA. According to Nokia, there are at least 16 live 3G WCDMA networks launched commercially to date, mainly in Asia and Europe.

GPS

GPS (Global Positioning System) uses radio signals received from 24 satellites to determine the position of the device. GPS is a feature in many mobile phones required for emergency (911) assistance. According to PDA industry analyst Canalys, GPS is helping spur lackluster consumer sales in PDAs due to competitively priced GPS navigation bundles.

MPEG-2/4/AVC/H.264

MPEG (Moving Picture Experts Group) are a set of standards for video and audio compression. Currently most popular for video is MPEG-2, which is being used for digital TV broadcast, HDTV and DVD. MPEG-2 supports up to six surround sound channels. MPEG-4 is a next generation video codec (coder/decoder), being currently used in Japan for stationary reception of digital video broadcast. H.264 is a video codec for digital video broadcast to mobile devices. According to EETimes [6], Japan's top six broadcasters have adopted H.264 for digital TV broadcast reception to mobile (not stationary) devices, launching services as soon as March 2006. Japan began broadcasting digital video to stationary devices using MPEG-4 as the video codec in December 2003.

MP3/WMA

MP3 is the most popular standard today for compressed internet audio. MP3 stands for MPEG-1 Audio Layer 3, and is a variable sampling rate codec that allows users to determine the sampling rate/quality. For near-CD quality, MP3 requires a bit rate of 96-128kbps. Within each sequence of MP3 audio frames is all necessary information for decoding, thus MP3 files have more overhead than many newer, alternative compression formats. For example, Microsoft's compression format, called WMA for Windows Media Audio, compresses audio twice as much as MP3 for similar quality audio.

3D Graphics

With more graphics in the user interface on mobile phones and PDAs, and the desire to run faster and more compelling games, some handheld vendors are adding graphics co-processors or accelerators to their devices. For example, Intel has recently announced the Marathon 3D graphics chip for handheld devices. According to EE Times [7], the next generations of Marathon chip will support H.264, an interface to 1-inch HDDs, GPS, 802.11 and potentially be integrated in with their baseband XScale chip in 2005.

Storage: Flash and HDD

Current generations of Portable Media Player devices run on compact flash in various formats. Although small in form factor and solid state (i.e. no skipping), large (>1MB) flash memories are relatively expensive and make up a majority of the costs in Portable Media Players. However, small HDDs (Hard Disk Drives) are starting to take hold in the Portable Media market. According to Portal Player, nearly 30% of the Portable Media market uses HDD based storage. A 4GB hard drive can hold approximately 17 hours of video, 10,000 photos or 1,000 songs (60 hours of music) [2], with all disk space dedicated to either video, pictures, or music. The market leading Apple iPOD and newer iPOD minis are equipped with HDDs.

PDAs are typically equipped with flash expansion slots, and some mobile phone handsets are beginning to feature an expansion slot for removable flash cards. For example, the Toshiba CDMA 2000-1x phone model A5501T supports a plug-in SD flash memory card. According to EE Times [8], the standard format for mobile handset memory expansion in still to be determined, choosing between SIM (Subscriber Identity Module) expansion and removable flash cards or both.

Other Technologies

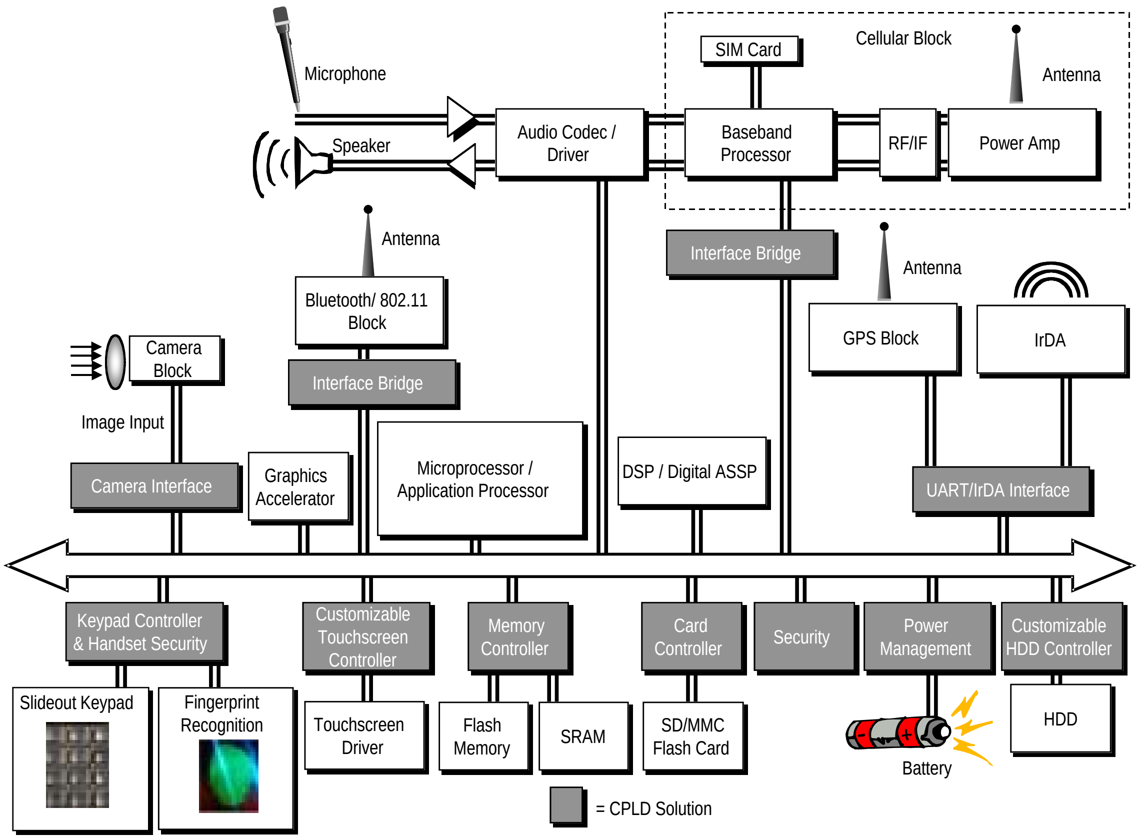
Other technologies such as USB & USBII, Firewire, voice recognition, handwriting recognition, fingerprint recognition, IP datacasting, UWB (Ultra Wide Band), SDR (Software Defined Radio), Linux-OS and others not mentioned here may take hold in PDAs, Personal Media Players and Smart Phones.

For the near term, supporting additional technologies, features and applications will require special circuitry or ASSPs, and an interface for these ASSPs to the processor bus. Bus interfacing and bridging is a key application for Complex Programmable Logic Devices (CPLDs).

PDA / Smart Phone / Media Player Block Diagram

For simplicity, we will use the term Smart Handheld to lump together PDAs, Smart Phones, and Portable Media Players. The key functional blocks that make up a Smart Handheld device are illustrated in Figure 3.

Figure 3. Smart Handheld Device Block Diagram



This simplified block diagram for Smart Handhelds can be broken into processing, cellular and other key functions:

Processing Functions

- **DSP/Digital ASSP:** performs voice, audio, data, and video processing, encoding/decoding, and other signal processing tasks
- **Microprocessor/Application Processor:** supports standard operating systems and applications software
- **Graphics Accelerator:** supports megapixel cameras, interactive gaming, digital television, 3D graphics

Cellular Block and Other Radio/IrDA Functions

- **Wireless baseband and radio ICs:** supports radio baseband, antenna, SIM
- **Other Radio/IrDA and Interface:** supports GPS, IrDA, Bluetooth and 802.11

Other Key Functions

- **Memory Controller:** flash and SRAM control and addressing
- **Keypad / Touchscreen Controller:** control and decoding for keypad and touchscreen/LCD
- **Camera Block and Interface:** supports CCD or CMOS image input sensor and processing
- **Security:** security function, including DES, code morphing protection etc.
- **Power Management:** control and optimize power to ASSPs and peripherals (backlight, HDD, etc.)
- **Card/HDD Controller:** interfaces with SD/MMC/CompactFlash cards, controls HDD (media storage)

Each of the functional blocks in this block diagram is typically implemented by a small number of ASSPs, or several of these blocks are integrated into chip sets of ASSPs. Manufacturers such as Intel, Motorola, Qualcomm, Texas Instruments, Portal Player and others offer chip sets that perform many of these block functions with various levels of integration.

CPLD Applications in Smart Handheld Devices

Although most functionality is typically implemented in ASSP chip sets, there are several common applications for CPLDs in Smart Phones, PDAs and Personal Media Players. Sometimes there are mismatches between the ASSPs used to implement each of the functional blocks in the system and additional peripherals that are not on these blocks. The system level “glue logic” needed to interface ASSPs and peripherals is a typical application for CPLDs. For example, keypad controllers and memory address decoders are often implemented in CPLDs.

In addition, due to time pressures, early versions of ASSPs can have errata/bugs that require logic fixes. These bug fixes are often taken care of by CPLDs as well. Designers must balance the tradeoffs of waiting for the next revision of these ASSPs that fix the bugs or designing in an inexpensive (<$1.00 in volume) CPLD that fixes bugs from the beginning and launching the product to market ahead of competition. CPLD device capacity that is unused by the bug fixes can be used to further integrate additional control logic in the system.

Other less common, but useful CPLD applications in Smart Handheld devices include power management, security and others. Blocks shaded in gray in the block diagram in Figure 3 can be integrated into CPLDs.

Example CPLD Applications in Smart Handhelds

- ASSP/ASIC bug fixes
- Replace discrete logic solutions, logic integration
- Glue logic / interface bridge between CPU, DSP, graphics accelerator, flash, LEDs, UART, ethernet controller, SIM card controller, proprietary bus, camera block, bluetooth block, cellular block, IrDA
- Memory controller, flash control, ROM address decoder, PCMCIA decoder, CompactFlash interface, SDIO/MMC interface, customizable HDD controller
- LCD/touchscreen interface, logic level shifting between LCD and ASSPs, user interface control, keypad controller, keypad decoder, handset security, fingerprint recognition interface
- LCD image rotation, image processing offload functions
- Code morphing software protection, watchdog function
- Power management, DSP configuration

A brief description of CPLD applications in smart handhelds follows, falling into three main categories: power management and boot-up, bridging and interface, and security.

Power Management and Boot-up

Extending the battery life of a handheld system is a key design requirement. This can be accomplished in several ways. Since power is proportional to current and voltage, designers must lower the current or lower the voltage (or both) whenever possible.

One method to minimize voltage is to minimize the voltage potential of devices that must be active. Some of the key system components may only be available in higher voltages, such as 3.3V. A common function of CPLD logic is I/O voltage translation. Thus, a designer can use a CPLD to translate from a 3.3V component to a 1.8V ASSP.

Another method to reduce power, called dynamic power management, is to power down devices when they are not needed. Selectively shutting down unutilized components or slowing down underutilized ones reduces power consumption considerably. CPLDs can be used for chip-select generation, power down of ASSPs and other components in the system, such as power-hungry LCD backlighting and HDDs. Some algorithms consume less overall system power when implemented by CPLDs rather than by a software and processor. For example, consuming less power, a CPLD can perform a keypad scan function rather than taking the processor out of sleep mode and having the processor perform the scan function.

Another obvious choice to lower power is choosing lowest power components. For applications best served by CPLDs, Lattice's ispMACH 4000Z CPLD has the industry's lowest static power consumption at 10µA standby current and 1.8V operation. More features of the Lattice ispMACH 4000Z CPLD are covered in a later section.

Since they are non-volatile and instant-on, CPLDs are also extensively used for boot-up functions, such as power-up sequencing and DSP / ASSP / ASIC configuration. Multi-voltage system power-up sequencing requires devices to be instant-on, ready to manage power-up timing and sequencing for devices in the system. Several common types of system components, such as DSPs, ASSPs, and ASICs require initialization and configuration. CPLDs are often used to control non-volatile memory such as flash during boot-up to configure these system components.

Bridging and Interface Logic

As briefly mentioned above, CPLDs are often used to interface various ASSPs and other components into the processor bus network, effectively bridging the signals from one component to allow it to interface with another component. CPLDs create bus interfaces, interrupts and control logic for processors, allowing them to communicate with peripherals, such as cameras. Many of the CPLD applications blocks shaded in Figure 3 fall into this category.

With CPLDs, designers are able to design-in and interface future applications into the processor bus network. CPLDs can be used to plan for feature upgrades and changes to make a device future-proof [9]. Some functions can only be done in hardware, not software. For example, a CCD array cannot be coded into software only, rather an electrical CCD chip must be present, as well as an interface to a bus to allow software and the microprocessor to talk to the CCD array chip. In another example, a CPLD can perform logic level shifting between the ASSP chipset and LCD display to keep up with new generation LCD logic levels. Often new generation LCD displays have different I/O logic levels than older generation displays. Therefore existing ASSP or ASIC chipsets may not interface to the new LCD display without logic level shifting.

For algorithms that require speeds faster than software is able to handle or consume less power than processors burn, CPLDs enable future-proof products, enabling consumers to upgrade their models to support additional standards for compressed audio or video. Building flexibility into a product helps differentiate products from competition and calm consumers uncomfortable with lack of standardization and the potential for obsolescence.

Performing computations or making decisions, CPLDs are also used for complex control logic, such as a keypad or touchpad controller, and for expanding the number of I/Os, since many buses are designed to limit the number of I/Os required by the processor.

Security

CPLDs can also be used to protect a design's IP (Intellectual Property) from being stolen. For example, consumer applications may have IP protection requirements, such as proprietary video or audio algorithms, which require security. By implementing these functions in CPLDs they are effectively protected. Lattice CPLDs have a security bit protection scheme, providing excellent protection from both invasive and non-invasive attacks [10].

In addition, CPLDs can help protect from overbuilding (when a contract manufacturer builds more than the requested quantity of systems). The CPLD can contain a portion of a security encryption algorithm for software code and a key that can be wirelessly programmed into the CPLD, after the handset is manufactured, only at an authorized location.

ispMACH™ 4000Z Low-Cost, Zero-Power CPLDs

Lattice brings together zero power, high speed, and tiny TQFP and chip-scale BGA packaging to provide a superior CPLD solution for Smart Handheld applications. The ispMACH 4000Z is the world's lowest power CPLD with a static current of 10µA. The ispMACH 4000Z also supports an extended power supply operating range of 1.6V to 1.9V, accommodating the end-of-battery-life voltage of many battery-powered systems. The ispMACH 4000Z device’s 1.8V logic core also consumes the industry’s lowest dynamic power – without sacrificing speed. With speeds to 3.5ns, the ispMACH 4000Z delivers ultra low-power and high-performance, at industry leading prices. Table 2 shows device densities, package options and other key specifications for the ispMACH 4000Z CPLDs.

Table 2. ispMACH 4000Z CPLD Family Parameters

	ispMACH 4032ZC	**ispMACH 4064ZC**	**ispMACH 4128ZC**	**ispMACH 4256ZC**
Macrocells	32	64	128	256
I/O + Dedicated Inputs	32+4/32+4	32+4/32+12/64+10 /64+10	64+10/96+4	64+10/96+4/128+4
t_{PD}	3.5	3.7	4.2	4.5
t_S	2.2	2.5	2.7	2.9
t_{CO}	3.0	3.2	3.5	3.8
f_{MAX}	267	250	220	200
Supply Voltage (V)	1.8	1.8	1.8	1.8
Standby Current (Max./Typ. µA)	20/10	25/11	35/12	55/13
Pins/Balls/Package	48 TQFP 56 csBGA	48 TQFP 56 csBGA 100 TQFP 132 csBGA	100 TQFP 132 csBGA	100 TQFP 132 csBGA 176 TQFP

Key Features

- Lowest static I_{CC} – only 10µA
- 1.8V core logic for low dynamic power
- Extended power supply operation range 1.6V to 1.9V
- Lowest price per macrocell
- 3.5ns t_{PD}, 267MHz Fmax
- 32, 64, 128 and 256 macrocell densities
- Space saving chip scale BGA and TQFP package options
- Lead-free package options available
- Easily interfaces with standard 1.8V, 2.5V, 3.3V and 5V I/O
- Hot socketing capability
- Non-volatile, IEEE 1532 compliant
- In-system programmable (ISP™) for faster time-to-market, low-cost manufacturing and field upgrades

The ispMACH 4000Z CPLD offers a low-risk, low-cost companion chip to ASICs and ASSPs for Smart Handheld applications. Designers are taking advantage of the flexibility and reprogrammability of the ispMACH 4000Z to add new product features late in the design cycle, reconfigure products in the field, keep pace with changing standards, in addition to traditional glue logic tasks and ASIC bug fixes. Lattice programmable logic solutions offer faster time-to-market, greater flexibility and lower cost during both design and manufacturing. Plus, Lattice products offer all the benefits of in-system programmability (ISP).

ISP

ISP (In-system programming) let's you design, prototype, debug and redesign your board while your logic devices remain soldered directly on the PCB. All this without changing your pin-out, even with incremental logic changes. Design one board for multiple applications or feature sets — no need to keep multiple patterned devices for each configuration. Configure your product during board test using ATE or reconfigure your product after it's been shipped at 3.3V. ISP enables future-proof handheld products. Unlike devices based on volatile SRAM technology, Lattice's ispMACH 4000Z devices are based on non-volatile E2CMOS® technology, so Lattice products do not require an external configuration memory or microcontroller, thereby reducing board space and component cost.

Small, Lead-Free Packages Available

Another handheld design challenge is tight board space. The ispMACH 4000Z family is available in a tiny, low profile 56-ball chip-scale BGA package featuring a 6 by 6 millimeter body size, as shown in Figure 4. Packages are also available at 1.2mm body height and less, conforming to PCMCIA requirements. In addition, Lattice has qualified a wide variety of space-saving package types in lead-free (Pb-Free) configurations, including the Thin Quad Flat Pack (TQFP), Fine Pitch BGA (fpBGA), Fine Pitch Super BGA (fpSBGA), Chip Scale BGA (csBGA) and Quad Flat-pack (QFN). Lattice Pb-Free package options are also fully complaint with the European Union (EU) directive on the Restrictions on the Use of Hazardous Substances (RoHS). RoHS compliance ensures the elimination of lead (Pb), mercury (Hg), cadmium (Cd), hexavalent chromium (Cr(VI)) and two classes of flame retardants used in package mold compounds. Lattice supports the RoHS directive two years in advance of the July, 2006 deadline for compliance.

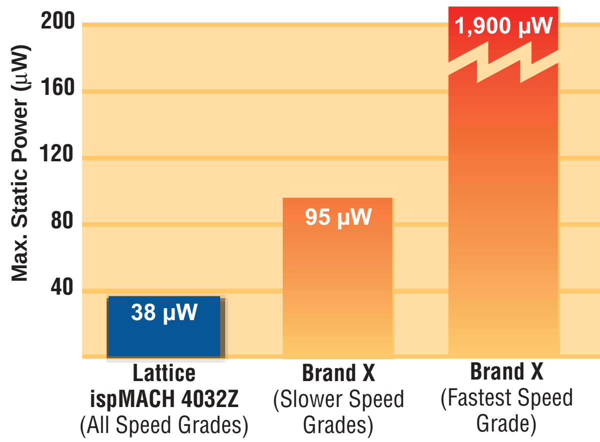
Figure 4. Lattice Offers the World's Smallest CPLD Packaging

The ispMACH 4000Z family is available in broad range of densities, from 32 macrocells to 256 macrocells. With many packages available in multiple densities, the ispMACH 4000Z family delivers density migration in the same package.

Lowest Power Consumption

Lattice's 1.8-volt ispMACH 4000Z CPLD family sets a new industry standard for the lowest power consumption, while still maintaining the flexibility to interface with 1.8, 2.5 or 3.3 volt logic. At 20 microamps maximum static current, the ispMACH 4000Z consumes 50 times less power than any competitive CPLD for fastest speed grades, as shown in Figure 5.

Figure 5. Lattice's ispMACH 4000Z delivers power consumption that is 50 times lower than the competition



Extended Operating Voltage

Extended battery life is a key feature for any handheld product. While competitive CPLDs shut down at 1.65-volts or higher, the ispMACH 4000Z device operates down to 1.6-volts, extending the battery life of handheld products. Many handheld systems take advantage of the ability to run 1.8-volt processors at lower voltages to lower power consumption. Likewise, the ispMACH 4000Z is able to be powered at 1.6-volts, thus reducing power further.

Low Cost

Lattice is a leading supplier of CPLDs. Designed on a proven and popular architecture, and leveraging our highest volume process technology, the ispMACH 4000Z is Lattice's lowest cost CPLD family. Lattice's ispMACH 4000Z CPLDs provide the most cost-effective logic implementation for today's Smart Handheld applications.

Conclusion

While it is clear that the market for PDAs, Smart Phones and Portable Media Players is growing rapidly, it is unclear which features and standards will capture the most wallet share, and also whether or not consumers will be willing to purchase three, two or one of these devices. With several wireless standards, PAN standards, media standards, and storage options, it is likely that supporting multiple standards will be a requirement for the near future. Designers will be faced with the task of interfacing sets of ASSPs built for each standard. CPLDs allow designers to accomplish this task easily while future-proofing their Smart Handheld designs as well.

Lattice Brings the Best Together for Smart Handhelds with the ispMACH 4000Z CPLD with zero power, high performance, space-saving packages and low cost. Lattice's Zero Power ispMACH 4000Z is the first in-system programmable logic device that fits perfectly in today's Smart Handheld products. Lattice's ispMACH 4000Z gets your products to market faster than ever before at the lowest possible price.

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Technical Support Assistance

Hotline: 1-800-LATTICE (North America)

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