June 22, 2010

**i.MX233 for Consumer Applications**

FTF-CON-F0601

**Bunnie Huang** - VP Hardware Engineering, Co-Founder of Chumby Industries, PhD

**Sujata Neidig** - i.MX Product Manager
The i.MX233 Applications Processor is ideal for consumer applications.

► ARM9 based processor
► Integrated power management and analog audio
► Reduces system costs
► Ideal for many consumer products, for example:
  • eReaders
  • Portable media players
  • Wi-Fi entertainment devices
  • Graphical remote controls
  • Digital picture frames
  • Audio peripherals and accessories

► Learn the technical details about the i.MX233 and get a tutorial about a specific use case with a Chumby
Session Introduction

Presenters:

- **Sujata Neidig**
  - i.MX Product Manager
  - Area of expertise: New product development and introduction to the market.

- **Bunnie Huang**
  - Vice President, Hardware Engineering & Co-Founder, Chumby Industries
  - Andrew “bunnie” Huang is a nocturnal hacker and the hardware lead; his responsibilities include the architecture, design and production of chumby devices, as well as the strategic planning and ecosystem development of the broader Chumby hardware platform. With a PhD in EE from MIT, he has completed several major projects, ranging from hacking the Xbox (and writing the eponymous book), to designing the world’s first fully-integrated photonic-silicon chips running at 10 Gbps with Luxtera, Inc., to building some of the first prototype hardware for silicon nanowire device research with Caltech.

This session’s duration is to be approximately 2 hours.
After completing this session you will be able to:

• Utilize the features of the i.MX233 apps processor for system level benefits

• Demonstrate the system level benefits to an actual case provided by Chumby.
i.MX Applications Processors Overview – Sujata Neidig
  • 5 min

i.MX233 Details – Sujata Neidig
  • Target applications
  • Product features
  • Development platform
  • Enablement
  • 40 min

i.MX233 Use Case – Bunnie Huang
  • Chumby
  • 45 min

i.MX23 Linux EVK Demo – Bunnie Huang
  • 20 min

Q&A
  • 10 min
Freescale Multimedia Markets

**Portable Consumer**
- Smartbook
- eReader
- Smartphone
- Portable Media Player
- Personal Navigation

**Automotive Infotainment**
- Audio
- Connectivity and Telematics
- Video and Navigation

**Home Consumer**
- Media Phone/Terminal
- iPod Accessories
- Remote Controls
- Digital Photo Frame
- Appliances

**Industrial**
- POS/Scanners
- Security and Surveillance
- Industrial Human Machine Interface (HMI)
- Medical
- Metering
Freescale Applications Processor Value Proposition

► Performance (MHz & Memory Efficiency)

► Low Power

► State of the art audio, video, and graphics software codecs

► Consistent and Scalable Architecture

► Complete OS/SW Platform

► Mixed Signal Integration
What Do Customers Want?

► Easy-to-Use
  • Simple and intuitive user interface
  • Customizable

► Constant Connectivity
  • “Always-on” –
    • WiFi
    • Bluetooth
    • 3G/4G

► Great Internet Experience
  • Excellent browser experience
  • Excellent graphics & video

► Instant-on
  • Fast boot within a few seconds
  • Cold boot as well as resume from sleep

► All Day Battery Life
  • Power management (PM) ‘without a fan’
Going Green – Energy Efficiency

- i.MX architecture is designed to provide optimal trade-off between performance and power
- Dynamic Voltage Frequency Scaling (DVFS) and Dynamic Processor Temperature Compensation (DPTC)
- Independent peripheral clock gating
- Multiple low power modes
- Hardware acceleration offloads CPU and lowers power consumption during run modes
  - Video encode/decode
  - Graphics
- Embedded software drivers are optimized to use low power techniques

i.MX devices consume less power which reduces the number of disposable batteries in landfills, prolongs the life of rechargeable batteries and limits the overall power consumption for devices plugged into outlets in the home, an operating room, or elsewhere. Saving energy and saving costs.
Freescale Product Longevity Program

► The embedded market needs **long-term product support**

► Freescale has a longstanding track record of **providing long-term production support** for our products

► Freescale offers a **formal product longevity program** for the market segments we serve

  • For the automotive and medical segments, Freescale will make a broad range of program devices available for a minimum of **15 years**

  • For all other market segments in which Freescale participates, Freescale will make a broad range of devices available for a minimum of **10 years**

  • **Life cycles** begin at the time of launch

► A list of participating **Freescale products** is available at: [www.freescale.com/productlongevity](http://www.freescale.com/productlongevity)
## i.MX ARM9 for the General Embedded Market

<table>
<thead>
<tr>
<th>Feature</th>
<th>i.MX27(L)</th>
<th>i.MX233</th>
<th>i.MX253</th>
<th>i.MX257</th>
<th>i.MX258</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target Markets</strong></td>
<td>Consumer, &amp; Industrial</td>
<td>Consumer &amp; Industrial</td>
<td>Industrial &amp; Consumer</td>
<td>Industrial &amp; Consumer</td>
<td>Industrial</td>
</tr>
<tr>
<td><strong>Target Segments</strong></td>
<td>► IP Camera</td>
<td>► PMP, PND</td>
<td>► HMI</td>
<td>► “Smart Touch” HMI</td>
<td>► Secure Residential Gateway (Smart Meters)</td>
</tr>
<tr>
<td></td>
<td>► Media Phones</td>
<td>► Audio Accessories</td>
<td>► Portable/Tethered Printers</td>
<td>► Factory Automation (CAN)</td>
<td>► Point-of-sale</td>
</tr>
<tr>
<td></td>
<td>► Digital Signage</td>
<td>► VoIP</td>
<td>► Medical</td>
<td>► Barcode Scanners</td>
<td>► Biometrics</td>
</tr>
<tr>
<td></td>
<td>► Médical (Vidéo)</td>
<td>► Smart remotes</td>
<td>► Factory Automation (Ethernet)</td>
<td></td>
<td>► Secure Devices</td>
</tr>
<tr>
<td><strong>Core</strong></td>
<td>ARM926EJ-S™</td>
<td>ARM926EJ-S™</td>
<td>ARM926EJ-S™</td>
<td>ARM926EJ-S™</td>
<td>ARM926EJ-S™</td>
</tr>
<tr>
<td><strong>CPU Speed</strong></td>
<td>400 MHz</td>
<td>454 MHz</td>
<td>400 MHz</td>
<td>400 MHz</td>
<td>400 MHz</td>
</tr>
<tr>
<td><strong>Key Differences</strong></td>
<td>► MPEG-4/H.264 Video Encode / Decode</td>
<td>► Integrated power management</td>
<td>► DDR2</td>
<td>i.MX253 + CAN, Smartcard</td>
<td>i.MX257 + Secure key/data storage</td>
</tr>
<tr>
<td></td>
<td>► CMOS Sensor I/F</td>
<td>► Analog Audio</td>
<td>► Integrated Ethernet</td>
<td>► CMOS Sensor I/F</td>
<td>► Tamper detection</td>
</tr>
<tr>
<td></td>
<td>► 32-bit mDDR bus</td>
<td>► Small packages</td>
<td>► Integrated USB Phy’s</td>
<td>► Touchscreen controller</td>
<td>► Secure boot</td>
</tr>
<tr>
<td><strong>Package</strong></td>
<td>0.8mm 473BGA 0.65mm 404BGA</td>
<td>128LQFP 0.8mm 169BGA</td>
<td>0.8mm 400BGA</td>
<td>0.8mm 400BGA</td>
<td>0.8mm 400 BGA</td>
</tr>
<tr>
<td><strong>Positioning</strong></td>
<td>Video acceleration</td>
<td>Integrated power management and analog audio</td>
<td>Ethernet, DDR2</td>
<td>Ethernet, CAN, DDR2, Touchscreen controller</td>
<td>Security</td>
</tr>
<tr>
<td><strong>10KU Suggested Disty Resale</strong></td>
<td>$8.10 - $11.42</td>
<td>QFP $4.60-$5.29 BGA $5.42-$6.11</td>
<td>$6.26-$6.48</td>
<td>$7.00-$7.53</td>
<td>$8.11</td>
</tr>
<tr>
<td><strong>OS</strong></td>
<td>Linux, WinCE RTOS</td>
<td>Linux, WinCE</td>
<td>Linux, WinCE, RTOS</td>
<td>Linux, WinCE, RTOS</td>
<td>Linux, WinCE, RTOS</td>
</tr>
<tr>
<td><strong>General Availability</strong></td>
<td>Mass Production</td>
<td>Mass Production</td>
<td>Mass Production</td>
<td>Mass Production</td>
<td>Mass Production</td>
</tr>
</tbody>
</table>
i.MX233 Applications Processor

► Key Features and Advantages

• 454MHz ARM926EJ-S core
• PMU with high efficiency on-chip DC/DC with 4.2V output, supports Li-Ion batteries
• LCD Controller with touchscreen
• 1.5W Mono speaker amplifier
• Stereo headphone DAC w/ 99dB SNR & Stereo ADC w/ 85 dB SNR with integrated amplifiers
• NAND support – SLC/MLC and managed
• Hardware BCH (up to 20-bit correction) and RS ECC8 for current and future MLC NAND support
• DDR1 Support with integrated 2.5V NAND
• High speed USB with an embedded PHY

► Package and Temperature

• 169fpBGA 11x11mm .8mm
• 128LQFP 14x14mm
• -10 to +70C (Consumer)
• -40C to +85C (Industrial)
## i.MX233 Package Differences

<table>
<thead>
<tr>
<th>Function</th>
<th>128 LQFP</th>
<th>169 BGA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>External Memory Interface (2.5V DDR, 1.8VrDDR)</strong></td>
<td>► DRAM pins</td>
<td>► 1 chip enable</td>
</tr>
<tr>
<td></td>
<td>► Maximum DRAM capacity supported</td>
<td>► 64MB</td>
</tr>
<tr>
<td><strong>General Purpose Media Interface (GPMI)</strong></td>
<td>► NAND data width</td>
<td>► 8-bit data</td>
</tr>
<tr>
<td></td>
<td>► Number of external NANDs supported</td>
<td>► 2 dedicated CS#/RDY# pin pairs + 2 CS#/RDY# pin pairs muxed with I2C,PWM2 and LCD_RESET pins</td>
</tr>
<tr>
<td><strong>LCD Interface (LCDIF)</strong></td>
<td>► RGB (DOTCK) mode – “dumb display”</td>
<td>► 8-bit serial</td>
</tr>
<tr>
<td></td>
<td>► VSYNC/WSYNC system mode – “smart display”</td>
<td>► 8-bit, up to 18 bit w/ pin share (muxed with NAND interface)</td>
</tr>
<tr>
<td><strong>Mono Speaker Amplifier</strong></td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Serial Audio Interface</strong></td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>ADC</strong></td>
<td>► Number supported</td>
<td>► 2 (or 3 w/o 2.5V DDR)</td>
</tr>
<tr>
<td></td>
<td>► Touchscreen supported</td>
<td>► No</td>
</tr>
<tr>
<td><strong>UARTs</strong></td>
<td>1 Debug UART, 1 App UART</td>
<td>1 Debug UART, 2 App UARTs</td>
</tr>
<tr>
<td><strong>Synchronous Serial Ports (SSP)</strong></td>
<td>► SD/MMC/SSP</td>
<td>► SSP1 – 4-bit data</td>
</tr>
<tr>
<td></td>
<td>► SSP2 – 8-bit data (muxed with NAND interface)</td>
<td>► SSP2 – 8-bit data (muxed with NAND interface)</td>
</tr>
<tr>
<td><strong>Rotary Encoder</strong></td>
<td>Muxed with PWM and Debug UART</td>
<td>Dedicated</td>
</tr>
<tr>
<td><strong>Real Time Clock (RTC)</strong></td>
<td>24MHz</td>
<td>32kHz and 24MHz</td>
</tr>
<tr>
<td><strong>Pulse Width Modulation (PWM) Channels</strong></td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>
## Key HW Differences: i.MX25 vs. i.MX233

<table>
<thead>
<tr>
<th>Feature</th>
<th>i.MX25</th>
<th>i.MX233</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-chip RAM</td>
<td>128KB</td>
<td>32KB</td>
</tr>
<tr>
<td>Flash Interface</td>
<td>MLC/SLC NAND Flash w/ 8-bit RS, NOR Flash</td>
<td>SLC/MLC/Managed NAND Flash w/ 20-bit BCH, 8-bit RS</td>
</tr>
<tr>
<td>DRAM Interface</td>
<td>16-bit DDR2, mDDR, SDRAM</td>
<td>16-bit DDR1, mDDR</td>
</tr>
<tr>
<td>Display Processing</td>
<td>1 overlay, alpha blending, panning</td>
<td>8 overlays, alpha blending, scaling, rotation, color space conversion</td>
</tr>
<tr>
<td>Integrated TV-Out</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>CMOS Sensor Interface</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td>CAN</td>
<td>x2</td>
<td>-</td>
</tr>
<tr>
<td>10/100 Ethernet</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td>Analog Audio</td>
<td>External</td>
<td>Integrated stereo ADC/DAC with amplifiers, Mono speaker amp output</td>
</tr>
<tr>
<td>S/PDIF Interface</td>
<td>No</td>
<td>1 output</td>
</tr>
<tr>
<td>Power Management</td>
<td>External</td>
<td>DC-DC switched converters, 4 linear regulators</td>
</tr>
<tr>
<td>USB 2.0</td>
<td>OTG HS with HS PHY x1, HS Host with FS PHY x1</td>
<td>1 HS port (Host/Device) with PHY</td>
</tr>
<tr>
<td>SIM</td>
<td>x2</td>
<td>-</td>
</tr>
<tr>
<td>P-ATA</td>
<td>Yes</td>
<td>-</td>
</tr>
<tr>
<td>Secure Key Storage</td>
<td>Equivalent capabilities</td>
<td>Equivalent capabilities</td>
</tr>
<tr>
<td>Tamper Detection</td>
<td>Voltage, frequency, temperature, mesh</td>
<td>-</td>
</tr>
<tr>
<td>Secure Boot</td>
<td>Yes – mechanism differs</td>
<td>Yes – mechanism differs</td>
</tr>
</tbody>
</table>
i.MX233 CPU Sub-system

- ARM926EJ-S Processor (ARM v5TE)
- Up to 454MHz performance @ 1.55V
- 16KB I$ + 16KB D$ (4-way set-associative)
- Low-power 90LP implementation
- 32KB of on-chip SRAM (intended for application with DRAM)
- Vectored interrupt controller with 128 fully programmable sources and up to 4 levels of IRQ nesting.
- Coresight ETM9 for higher-speed trace (DDR data, better compression)
- 1-wire Serial JTAG interface for debug
- Supports wait-for-interrupt low-power mode
i.MX233 – Low Power Features/Characteristics

► Supports dynamic voltage frequency scaling (DVFS) which provides the most efficient power per MIPS for the application

► Architectural and automated clock gating

► External memory controller implements four levels of low-power modes

► Auto-slow feature on bus-clock (HCLK) with hardware controlled slow-down/speed-up based on bus activity

► Wait-for-Interrupt, standby mode system power = 2mA (~7.5mW)
  • CPU clock stopped, wakes up from interrupt
  • Interrupt from press
  • Supports wake-up from touchscreen:
    ▪ supported by using a timer loop to check LR ADC status, ~100μA current
  • Quick power-up

► Power-down – Real-Time Clock (RTC) only power = 12μA typical
  • Only RTC active
  • Power-up time is longer than standby power mode
Integration of a DC-DC switching converter and linear regulators

- Powers digital blocks and components (e.g., system clocks)
- Provides audio power (e.g., headphones and analog components)
- Powers I/O peripherals (e.g., NAND flash and SD/MMC cards)
- Powers 2.5V DDR1 (1.7V-3.25V)

Power sources

- Li-Ion batteries (2.9V – 4.2V)
- Direct power from 5V source (USB, wall power, or other source)

Battery charging capability

- Allows battery to be fully charged while device is in use
- Current and voltage sensors allows firmware to monitor the voltage and current into the battery to determine “charged” status

On-chip silicon temperature sensors
Logical Diagram of i.MX233 Power Block
i.MX233 – Low Resolution A/D (LRADC)

- 12-bit Low-resolution ADC

- 16 total measurement nodes available:
  - 6 physical channels available as external inputs
  - 8 “virtual” assignable channels do actual measurements and can be mapped to any of the 16 measurement nodes

- Integrated 4-wire touch-screen controller
  - wide range of impedance support, e.g., 200-400 Ohm and 50K Ohm

- Temperature sensor functionality (on-die, and external with diode or thermistor)

- Example configuration:
  - 2 channels for a 12X12 button array or touch screen
  - 2 channels for an internal temp sensor (requires 2 channels)
  - 1 channel for a battery
  - 1 channel for VDDIO
  - 1 channel for external temp sensing
  - 1 channel left open
i.MX233 – Analog Audio

- Stereo DAC with 99 dB SNR

- Stereo ADC with 85 dB SNR

- Stereo headphone amplifier
  - Short-circuit protection
  - Direct drive to eliminate bulky and expensive DC-blocking capacitors
  - Click/pop free operation via software (BSP audio driver)

- Mono speaker amplifier provides up to $1.75 \text{ W}_{\text{rms}}$ output (4 $\Omega$ load), powered directly by Li-Ion battery or external 4.2V supply

- Two stereo line inputs

- Microphone input with pre-amp and bias generator
Support for mDDR (1.8V) and DDR1 (2.5V), with all voltages supplied with an integrated power management unit

Up to 150MHz with 16-bit interface

Four ports with a hybrid AHB/AXI mix, allowing high-bandwidth masters to make more efficient requests (internally developed)

Internally developed improvements in arbitration options:
- Timestamp mode with write-priority loop (HW coherency)
- Port priority mode (highest always wins)
- Hybrid priority mode (mix of timestamp and port priority modes)

Full support of mDDR power modes including self-refresh and clock gating

Hardware assisted on-the-fly frequency changing
General-Purpose Media Interface Controller

- Enables access to media devices that have NAND
- Supports up to four NAND Flash devices
- Provides an interface to ECC module
- Supports 3.3V only

Hardware BCH/ECC Interface

- Provides a forward error-correction function to improve the reliability of various storage media that may be attached to the i.MX233
- Reed-Solomon 4/8-bit correction (9-bit parity symbols)
- BCH engine with up to 20-bit correction (2-bit increments) with 13-bit parity
  - Programmable NAND page layout for future NAND support

NAND Types supported:

- SLC NAND
- MLC NAND
- Managed NAND – eMMC 4.2/4.3, LBA
Two independent Synchronous Serial Ports (SSP) are used for:

- SD/MMC removable cards
- eSD/eMMC/iNAND chips
- SPI control and communication
- Peripheral chips such as Wi-Fi or Bluetooth using SDIO
- Two dedicated DMA channels
- Maximum clock rate of 50 MHz
i.MX233 Peripherals – Display

8 x Overlays RGB (S1) → Video YUV (S0) → PXP Block

- CSC + Scale
- Colorkey / Alpha-Blend
- Rotation

PXP

TV-Out block

- TVE NTSC/PAL Encoder (digital)
  ← BT.656
- Video DAC (analog)

To TV Out Pins

LCDIF

- Display Out (RGB, System, BT.656)

Video DAC (analog) → LCDIF Block

To LCD Pins

8 x Overlays RGB (S1)
PiXel Pipeline

- Bi-linear YUV/YCbCr scaling and color space conversion, rotation
- Multiple graphic overlays (BITBLT) with concurrent alpha blending and color keying
- Processes 8x8 blocks and linked commands
Display Controller (LCDIF)

- Up to 24-bit DOTCLK, system-mode, VSYNC with programmable timings
- On-the-fly RGB → YCbCr 4:2:2 for ITU-R/BT.656 DV interface (with interlacing)
- Rich support for RGB formats including pixel packing and swizzling
- 128-pixel FIFO provides robustness for up to VGA resolution at 60Hz
- AXI Master for efficiency
- Direct internal connection to TVE
i.MX233 Peripherals – Other I/O

► I²C
  • EEPROM, Sensors
  • DMA controlled with Master mode up to 400KHz

► 4-Channel 16-Bit Timers with Rotary Decoder

► Five-Channel Pulse Width Modulator (PWM)

► Real-Time Clock
  • Options for 24MHz, 32KHz or 32.768KHz
  • Storage of “persistent bits”
  • Wake from alarm

► UARTs
  • 2 x 3.25Mbps Application UARTs
  • 1 x 115Kbps Debug UART

► S/PDIF Transmit

► Dual Serial Audio Interface (SAIF), Three Stereo Pairs
  • Full-duplex stereo transmit and stereo receive operations (requires both SAIF interfaces)
  • Bluetooth hands-free connection
  • I²S, left-justified, right-justified, and non-standard formats
i.MX233 Evaluation Kit (EVK)

**Single Board Development Platform – Price, Performance, Personality**

<table>
<thead>
<tr>
<th>CPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.MX233 Application Processor (169 BGA)</td>
</tr>
<tr>
<td>2 x 64MB DDR1</td>
</tr>
<tr>
<td>2GB NAND FLASH</td>
</tr>
<tr>
<td>SPI Flash/EEPROM footprints</td>
</tr>
<tr>
<td>DC/DC converter components</td>
</tr>
<tr>
<td>Li-Ion battery connector</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Debug</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debug serial port</td>
</tr>
<tr>
<td>JTAG</td>
</tr>
<tr>
<td>ETM footprint</td>
</tr>
<tr>
<td>Reset, interrupt, boot switches</td>
</tr>
<tr>
<td>Debug display/LED’s</td>
</tr>
<tr>
<td>Power source</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Peripherals</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD/MMC card slot</td>
</tr>
<tr>
<td>USB Host/Device</td>
</tr>
<tr>
<td>2 App UARTs ports</td>
</tr>
<tr>
<td>Ethernet supported via SPI header</td>
</tr>
<tr>
<td>Navigation keys</td>
</tr>
<tr>
<td>Mic input, headphone output (jack)</td>
</tr>
<tr>
<td>Line-in jack</td>
</tr>
<tr>
<td>Speaker connector</td>
</tr>
<tr>
<td>Composite TV Out connector</td>
</tr>
<tr>
<td>3-Axis Freescale accelerometer – MMA7455LT</td>
</tr>
<tr>
<td>Expansion port for optional peripheral card</td>
</tr>
</tbody>
</table>

| Option | Description |
|------------------|
| MCIMX23LEVKJ | Linux® EVK | MSRP $399 |
| MCIMX23WEVKJ | Windows® Embedded CE 6.0 EVK | MSRP $399 |
| MCIMX23LCD | 4.3” WQVGA Touchscreen LCD Display (add-on module) | MSRP $199 |

Board size = 5” x 7”
<table>
<thead>
<tr>
<th>Company</th>
<th>Type</th>
<th>Contact</th>
<th>URL</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amax Technology, Ltd.</td>
<td>H/W and S/W</td>
<td>Billy Yeung, VP of Sales and Marketing Division - <a href="mailto:billy@amaxhk.com">billy@amaxhk.com</a></td>
<td><a href="http://www.amaxhk.com">www.amaxhk.com</a></td>
<td>ODM</td>
</tr>
<tr>
<td>CodeSourcery</td>
<td>Tools</td>
<td>N/A</td>
<td><a href="http://www.codesourcery.com">www.codesourcery.com</a></td>
<td>Linux tools: compiler/ debugger/profiler</td>
</tr>
<tr>
<td>Foxda Technology, Ltd.</td>
<td>H/W, S/W</td>
<td>Sunny Chan, Managing Director - <a href="mailto:sunny.chan@foxda.com.hk">sunny.chan@foxda.com.hk</a></td>
<td><a href="http://www.foxda.com">www.foxda.com</a></td>
<td>ODM</td>
</tr>
<tr>
<td>Novtech</td>
<td>H/W, S/W</td>
<td>Yossi Har-nov – <a href="mailto:yossi@novtech.com">yossi@novtech.com</a></td>
<td><a href="http://www.icytecture.com">www.icytecture.com</a></td>
<td>IDH</td>
</tr>
<tr>
<td>Perception Digital</td>
<td>H/W, S/W</td>
<td>Venus Wong, Senior Marketing Manager - <a href="mailto:venuswong@perceptiondigital.com">venuswong@perceptiondigital.com</a></td>
<td><a href="http://www.perceptiondigital.com">www.perceptiondigital.com</a></td>
<td>IDH</td>
</tr>
<tr>
<td>Thotaka</td>
<td>H/W</td>
<td><a href="mailto:mohan@thotaka.com">mohan@thotaka.com</a></td>
<td><a href="http://www.thotaka.com">www.thotaka.com</a></td>
<td>i.MX233 QFP reference board board and System on Module (SOM)</td>
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## i.MX233 Partners – System Integrators/Software

<table>
<thead>
<tr>
<th>Company</th>
<th>Type</th>
<th>Contact</th>
<th>URL</th>
<th>Product</th>
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<tr>
<td>Adeneo</td>
<td>S/W</td>
<td><a href="mailto:sales@adeneo-embedded.com">sales@adeneo-embedded.com</a></td>
<td><a href="http://www.adeneo-embedded.com">www.adeneo-embedded.com</a></td>
<td>WinCE customization</td>
</tr>
<tr>
<td>Allgo Systems</td>
<td>H/W, S/W</td>
<td>Aji Anirudhan - <a href="mailto:aji@allgosystems.com">aji@allgosystems.com</a></td>
<td><a href="http://www.allgosystems.com">www.allgosystems.com</a></td>
<td>Linux, Android</td>
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<tr>
<td>Repap Systems</td>
<td>S/W</td>
<td>Guna Shekaran - <a href="mailto:guna@repapsystems.com">guna@repapsystems.com</a></td>
<td></td>
<td>Android</td>
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<tr>
<td>Nokia</td>
<td>S/W</td>
<td></td>
<td><a href="http://qt.nokia.com/">http://qt.nokia.com/</a></td>
<td>Qt – Cross Platform Application and UI Framework</td>
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# i.MX233 Availability

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>MSRP</th>
<th>Availability</th>
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</thead>
<tbody>
<tr>
<td>MCIMX233DJM4B</td>
<td>i.MX233, Consumer version, 169 BGA</td>
<td>$6.03</td>
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<tr>
<td>MCIMX233CJM4B</td>
<td>i.MX233, Industrial version, 169 BGA</td>
<td>$6.79</td>
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<td>MCIMX233DAG4B</td>
<td>i.MX233, Consumer version, 128 LQFP</td>
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<td>MCIMX233CAG4B</td>
<td>i.MX233 Industrial version, 128 LQFP</td>
<td>$5.88</td>
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<tr>
<td>MCIMX23LEVKJ</td>
<td>i.MX233 Evaluation Kit with Linux BSP</td>
<td>$399</td>
<td>Available</td>
</tr>
<tr>
<td>MCIMX23WEVKJ</td>
<td>i.MX233 Evaluation Kit with WinCE BSP</td>
<td>$399</td>
<td>Available</td>
</tr>
<tr>
<td>MCIMX23LEVKJC</td>
<td>i.MX233 Evaluation Kit with Linux BSP</td>
<td>$399</td>
<td>Available</td>
</tr>
<tr>
<td>MCIMX23WEVKJC</td>
<td>i.MX233 Evaluation Kit with WinCE BSP</td>
<td>$399</td>
<td>Available</td>
</tr>
<tr>
<td>MCIMX23LCD</td>
<td>LCD module (4.3” WQVGA Touchscreen)</td>
<td>$199</td>
<td>Available</td>
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</table>
Chumby

The **Chumby One** Use Case
What is a Chumby?

Generically, a *chumby* device is an internet application (app) viewer with rich media capabilities

- Passive viewing of web content in “app” format – more on this later
- Implies the following product requirements:
  - Ability to play:
    - MP3 and AAC file formats
    - FLV (Flash Video) @ ~200 kbps
    - QVGA with no stutter/frame loss
    - Adobe Flash interactive user interface (UI) and animation
  - Compatibility with various WiFi solutions
What is a Chumby?

Additional requirements of the Chumby One:

- Li-Ion rechargeable battery support
- Microphone input
- Touchscreen LCD input/output
- Embedded speaker
- Expandability
- Volume control knob
- FM Radio
- Fairly strong cryptographic authentication
- 3-axis accelerometer
- **Low cost:**
  - Target $99 retail
  - *Significant* challenge for the product
Gen I Chumby: the Chumby Classic (c. 2006)

Chumby classic sold for $199 on-line

$15.32 core silicon BOM
(excluding FLASH and CPU)
Gen II Chumby: the Chumby One (c. 2009)

► Chumby One sells for $119 on-line (can hit $99 retail)

$2.80 core silicon BOM (excluding FLASH and CPU)
Key to Savings

► Where we saved money:
  • Over $6 in analog bits and pieces were saved going to the i.MX233
    • High level of analog integration is the most distinguishing feature of the i.MX233 versus other contemporary solutions
    • Single-inductor design with no catch diode saves space and cost
  • Integrated AES engine with a user-unreadable key allowed us to remove an external crypto engine IC (~$1.25 cost-adjusted savings)
  • DDR1 saves a memory chip while maintaining bandwidth targets
    • Video and Flash animation playback are bandwidth-dominated apps
  • Battery and video integration “for free”

► What we lost versus previous generation:
  • Speaker is lower fidelity, lower power, and mono
  • One fewer USB port (driven partially by battery power consideration)
Other Key Features

► 454 MHz ARM9 core
  • No other CPU in this integration class has sufficient horsepower to run our software (driving requirement: FLV video support)

► SD card boot
  • Elimination of MLC NAND has total cost of ownership benefits
    • Cheaper device programming
      • We use Chumby Ones to burn our ROMs, so production capability can scale exponentially over time at almost zero incremental cost
    • Late-binding device programming (can deploy a flying firmware update on the line)
    • Less risk in product returns due to managed bad block structure
    • Faster development cycle due to use of ext3 fs over cramfs or JFFS2

► Very tight power supply integration
  • Small passives footprint (particularly L’s and C’s)
  • On the downside:
    • Little flexibility on configuration
      • Chumby One has an external +5V boost for USB host
    • Software configuration a bit tricky
      • had to do some tricks around +5V handoff
Chumby One as a Platform

► Chumby One is a reference design
  • Chumby is more a software and content company than a hardware company
  • Features of the reference design:
    • Optimized for portability and ease of design-in
    • Cost-reduced to fit in a large range of OEM applications
    • Easier OS, application development versus Gen I
Chumby: the Internet Ecosystem for Consumer Electronics

► “Cloud-based” and uniquely designed from the ground up for many connected consumer electronics devices
► Passive web app-viewing experience: your internet status in an embedded device

- always on — no wait to boot up
- always on — no wait to launch browser
- touchscreen — no keyboard/mouse
- ambient — no user interaction required, but...
- fully-interactive — not just a viewer
- information at a glance
- personalized info — only what you want
- chumby runs on MANY inexpensive devices
- one account - for all of your devices

net-connected TVs
digital photo frames
internet radios
blu-ray players
in-car devices
screen phones
videogame consoles
new net-connected devices
Chumby “Cloud” Approach Enables Rapid Deployment of New Services

Transactions, subscriptions, detailed user-profiling & targeted advertising

- Photo processing services
- Subscription services
- Messaging services
- Targeted advertising
- Sell custom alarm tones/videos
- Integrate with smartphone apps
- Sell content “applications”
- Affiliate transactions e.g., eBay bids, Amazon purchases, Flickr subscriptions
- Video on demand
- Real-time stream of small Flash widgets
- Video on demand

Chumby widgets live here

Affiliate transactions e.g., eBay bids, Amazon purchases, Flickr subscriptions
Chumby Content Partners

- Over 1,500 apps
- Open publishing platform based on Flash – over 2 million potential developers
Using the Chumby Service

Users create a single account to manage a set of devices

Apps are drag-and-drop and added to channels that play in continuous loops

Channels & apps can be shared between devices and friends

<table>
<thead>
<tr>
<th>Categories</th>
<th>Widgets</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entertainment (102)</td>
<td>Wheel of Shame</td>
<td>Zillowers Watch (or play) zilla-monsters fighting in the middle of the city.</td>
</tr>
<tr>
<td>Finance (8)</td>
<td>Will &amp; Phila II</td>
<td>Author: Yummy Version: 1.0 Created: 10/23/08</td>
</tr>
<tr>
<td>Games (4)</td>
<td>Word Up</td>
<td></td>
</tr>
<tr>
<td>Health (14)</td>
<td>Yellow</td>
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<tr>
<td>Humor (48)</td>
<td>Yeetzone</td>
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<tr>
<td>IT &amp; Network (19)</td>
<td>ZOOG</td>
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<tr>
<td>Jeannine (71)</td>
<td>ZAP!</td>
<td></td>
</tr>
<tr>
<td>Lifestyle (21)</td>
<td>Zitter and the Magic Carpet</td>
<td></td>
</tr>
</tbody>
</table>

manage widgets in 'geeky & cheeky by bunnie' channel:

Drag and drop widgets to change play order. Customize, remove, or send a widget to other channels or to friends' chummys using the links beside each thumbnail. [If the customize options aren't working, turn off your pop-up blocker].

<table>
<thead>
<tr>
<th>Google Hot Trends</th>
<th>All In One Clock</th>
<th>Chuck Norris Facts</th>
<th>NEXIS Circuit Clock</th>
<th>Trailer Addict</th>
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</thead>
<tbody>
<tr>
<td><img src="image" alt="Google Hot Trends" /></td>
<td><img src="image" alt="All In One Clock" /></td>
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<tr>
<th>Zitter</th>
<th>Dot Clock</th>
<th>Engadget</th>
<th>Spike Bobblehead (mutant)</th>
<th>Community Canvas</th>
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<td><img src="image" alt="Spike Bobblehead" /></td>
<td><img src="image" alt="Community Canvas" /></td>
</tr>
</tbody>
</table>
Chumby in Action

- Powerpoint example of the chumby experience
Chumby Low-end OEM Module

► New announcement: chumby low-end OEM module
► Same basic core of Chumby One but contains connectors aimed at rapid integration and design-in of chumby technology
  • 3x on-board USB host ports (one powered off of battery)
  • Integrated directional switch
  • Header for LCD breakout board or other interface circuitry
  • Support for “Arduino” shield (hobbyist market)
  • Integrated bank of LEDs
  • Standardized power connector
  • Integrated NTSC video out via 3.5mm jack
Chumby Low-end OEM Module Feature Summary

Feature summary

- Uses the Sony PSP +5V power jack
- Has A/V jack embedded as a 3.5mm connector; "compatible" with iPod Video connector
- Can support one Li-ion battery and power one USB port while on battery
- Flexible LCD/IO expansion connector
- On-board backlight boost converter for LCD
- Microphone connector
- Mono speaker connector
- 4-direction + push mechanical switch on board
- 3-axis accelerometer
- 4 GPIO programmable LEDs
- 2 power status LEDs
- Rotary quadrature encoder connector
- Serial port connector (TTL 3.3V)
- microSD firmware card
- Additional 0.1" x 0.1" 18-pin hack-header that includes USB ports, I²C, and some GPIO
- Overall up to 6 analog in, 2 analog out, and some 20+ digital I/Os available
- 3x USB 2.0 high speed ports available (one fully battery powered, 2 powered off of Vin)
- Mounting holes identical to those used on the Chumby One
- Small form factor – 2.5” x 3.4”
- Design can be "thin" (< 1cm tall) if the arduino shield connectors on the backside are omitted
Demonstrate the Chumby One

Explain how to set-up the EVK to the PC
  • Pull out of box, hook-up cables, set switches
  • Insert SD Card

Run demo on the EVK (will have stations set-up with this)
  • Highlight the Chumby software advantages.
  • Participants can use the EVK’s LCD to navigate through some widgets – this is interactive!
Freescale’s i.MX233 ARM9 applications processor provides unique integration which provides high level of system BOM savings and performance capabilities.

The i.MX233 is targeted for consumer and general embedded applications. The Chumby One is one example application that benefits from the i.MX233.
For Further Information

► For i.MX233 overview, featured partners, featured tools, documentation and part numbers, [www.freescale.com/imx233](http://www.freescale.com/imx233)

► For information on the i.MX233 development platform, [www.freescale.com/imx23evk](http://www.freescale.com/imx23evk)
  - Hardware evaluation kit information, documentation and part numbers
  - Linux and Windows BSPs and associated documentation
  - Multimedia codecs and associated documentation

► i.MX Community Forum – [www.imxcommunity.org](http://www.imxcommunity.org)

► Chumby – [www.chumby.com](http://www.chumby.com)
www.iMXcommunity.org

A Freescale supported open web community of developers sharing common interest in transforming i.MX applications processors into practically anything imaginable.

i.MX Community

- Serves all component enablement peripherals including basic to complex software
- i.MX Forums, Groups and Blogs Posts
- News, Photos and Videos
- Training, Events and Promotions

Check it out!
Become a member today and you will be entered to win a i.MX development system of your choice. Drawing will be held on June 30th.