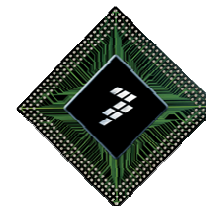


# i.MX28 Overview

## February 2010



**Confidential – NDA required**

# Freescal Multimedia Markets

## Portable Consumer

- Smartbook
- E-book
- Smartphone
- Portable Media Player
- Personal Navigation



## Automotive Infotainment

- Audio
- Connectivity and Telematics
- Video and Navigation



Low-Power  
High Integration  
Advanced Performance  
Platform Software

## Home Consumer

- Media Phone/Terminal
- iPod accessories
- Remote controls
- Digital Photo Frame
- Appliances



## Industrial

- POS/Scanners
- Security and Surveillance
- Industrial HMI
- Medical
- Metering



# i.MX Industrial and Embedded Roadmap

## Cortex A8

## ARM11

## ARM9

### i.MX31

- i.MX31L +
- OpenGL ES 1.1 3D

### i.MX31L

- ARM1136, 400 MHz
- USB (High Speed)
- Video Encode VGA

### i.MX27

- i.MX27L +
- D1 Video D/E

### i.MX27L

- ARM926, 400MHz
- Ethernet

In Development

### i.MX357

- i.MX353 +
- Open VG 1.1

### i.MX353

- ARM1136, 532 MHz
- Ethernet, DDR2
- USB Phy x 2, CAN x 2

### i.MX258

- i.MX257 +
- Security

### i.MX257

- i.MX253 +
- Touchscreen
- CAN x 2

### i.MX253

- ARM926, 400MHz
- Ethernet, DDR2
- USB Phy x 2

### i.MX233

- ARM926, 450MHz
- Touchscreen
- Integrated PM, Audio

### i.MX515

- i.MX513 +
- OpenGL ES 2.0

### i.MX513

- i.MX512 +
- 720p Video Decode
- D1 Video Encode

### i.MX512

- Cortex A8, 800MHz
- Ethernet, DDR2, USB Phy

### i.MX537

- Cortex A8, 800MHz
- 1080p Video Decode
- 720p Video Encode
- OpenGL ES 2.0
- Ethernet, USB Phy

### i.MX287

- i.MX286+
- 1588 Ethernet x 2, L2 Switch

### i.MX286

- i.MX283+ CAN x 2

### i.MX283

- ARM926, 450MHz
- Integrated PM
- 1588 Ethernet
- DDR2
- USB Phy x 2
- LCD

2009

2010

## i.MX28 Value Proposition

- ▶ Real-time, low cost, mid-performance processor family with LCD controller, Ethernet, CAN and other interfaces, for battery operated and fan less industrial control, networking, HMI, entry-level automotive audio and home consumer applications. Based on ARM9 core with WinCE and Linux operating systems support.
- ▶ High level of integration to reduce cost and complexity
  - On-chip power management eliminates external voltage regulator and ~20 discrete components (save \$2+); Power other devices; Charge batteries
  - Integrated Ethernet with L2 switch
  - Integrated CAN Controller, USB PHY, SD
  - WVGA LCD controller with touch screen (opt)
  - Memory encryption to protect against IP cloning
  - Various derivatives to support different feature sets
  - <\$12 10KU disty resale solution for the full featured i.MX28 device
- ▶ Device is included in Freescale product longevity program – 15 years
  - [www.freescale.com/productlongevity](http://www.freescale.com/productlongevity)
- ▶ Device consumes very low power (<0.5W worst case).
  - Can be used in battery operated and fanless applications.
  - Meets the criteria for FSL Energy Mark, [www.freescale.com/energyefficiency](http://www.freescale.com/energyefficiency)

# Industrial – i.MX28 Target Markets

## Industrial



- HMI (Factory Automation & Building Control)
- Industrial drive, PLC, I/O Control display controller
- Portable Medical and Diagnostics display
- Smart Energy Meters
- Industrial robotics display

## Point Of Sale



- Data Acquisition (Scanners)
- Fixed and Handheld Printers

Feature	Benefit
Integration and Connectivity – Ethernet, Ethernet Switch, CAN, Power Management, SDIO, DDR2, USB PHY	Reduced system cost and complexity, greater product feature scalability
LCD Controller and Touchscreen	Can drive high color displays for information display and user interaction
Industrial qualification and product longevity	Supports the full life of the product in the field
WinCE and Linux BSP's	Reuse software across i.MX platforms
Optimized performance and power consumption	Fanless automation, increased battery life for portable equipment

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# General Embedded – i.MX28 Target Markets

## Home & Office



- HMI (Appliances, Security Panels, Printers, Automation)
- Media Phones / VOIP
- PC/Audio Accessories
- Media Gateways
- High Tier Graphical Remote Controls
- Digital Picture Frames
- Portable Medical

Integration and Connectivity – Ethernet, CAN, Power Management, UARTs, PWMs, SPIs, SDIO	Reduced system cost and complexity for cost sensitive applications
LCD Controller and Touchscreen	Provides consumer with a rich interface to control the product
WinCE and Linux BSPs	Reuse software across platforms
Multimedia Codecs	Proven codecs enables quicker time to market. Complete software solution, with no NRE and software licensing included in processor price.
Optimized performance / power consumption	Increased battery life for portable equipment, better energy efficiency for wall-powered systems

# i.MX28 Family Product Comparison

Feature	i.MX283	i.MX286	i.MX287
On-chip RAM	128KB	128KB	128KB
Memory Interface	NAND Flash, DDR2, mDDR, LV-DDR2	NAND Flash, DDR2, mDDR, LV-DDR2	NAND Flash, DDR2, mDDR, LV-DDR2
LCD Interface	16-bit DDR2, mDDR, SDRAM	16-bit 150MHz DDR1, mDDR	16-bit 200MHz DDR2, mDDR
Touchscreen	Yes	Yes	Yes
Ethernet	X1	X1	x2
L2 Switch	-	-	Yes
CAN	-	x2	x2
12-bit ADC	x3	x5	x8
High Speed ADC	X1	X1	x1
USB2.0	OTG HS with HS PHY x1 HS Host with FS PHY x1	OTG HS with HS PHY x1 HS Host with FS PHY x1	OTG HS with HS PHY x1 HS Host with FS PHY x1
SDIO	x3	x3	x4
SPI	x3	X3	x4
UART	x3	x3	x6
PWM	x3	x3	x6
S/PDIF Tx	-	Y	Y
Package	204 16x16 FusionQuad	289 BGA	289 BGA

**Preliminary: Subject to Change**

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# i.MX287 Applications Processor

## ► Key Features and Advantages

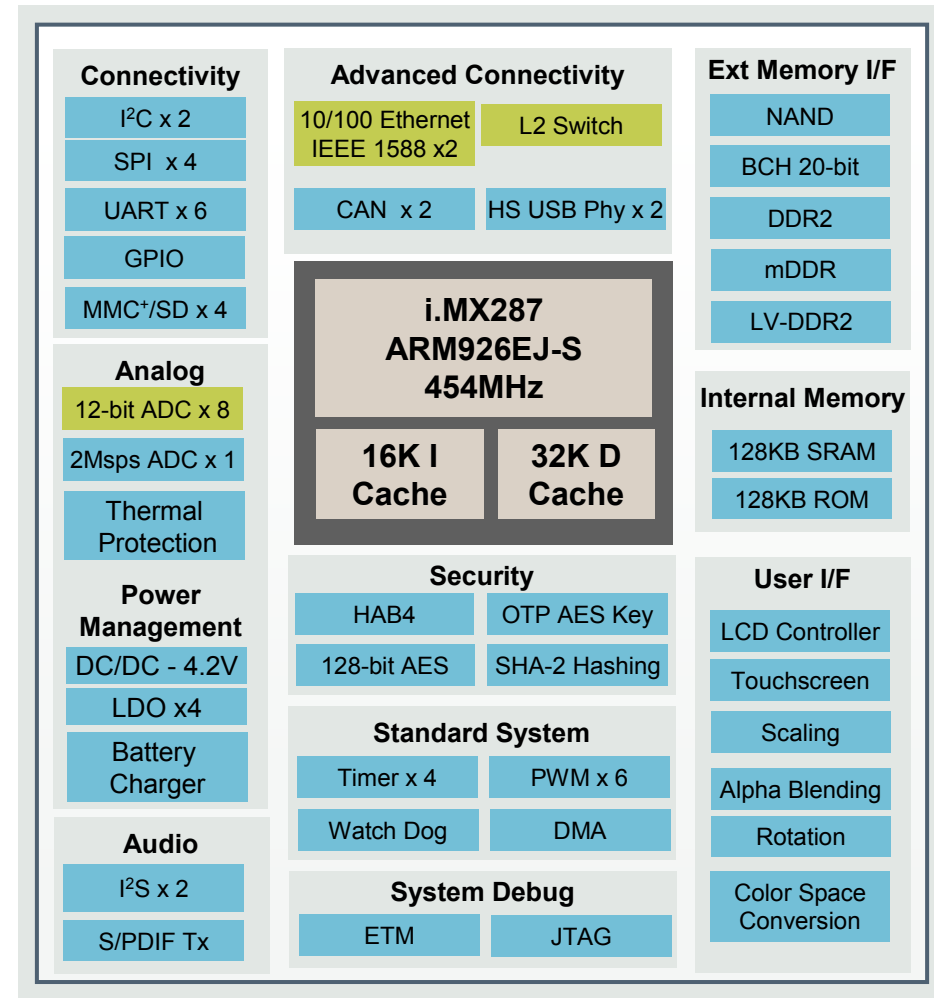
- 454MHz ARM926EJ-S core w/ 32KB Cache
- PMU with high efficiency on-chip DC/DC, supports Li-Ion batteries
- Dual Ethernet with RMIII support and L2 Switch
- Dual CAN interfaces
- LCD Controller with Touchscreen
- NAND support – SLC/MLC and eMMC 4.4 managed
- Hardware BCH (up to 20-bit correction)
- 200 MHz 16-bit DDR2, LV-DDR2, mDDR external memory support
- Dual High speed USB with embedded PHY
- 8 General purpose 12-bit ADC channels and single 2 Msps ADC channel
- LCD Controller with Touchscreen
- Temperature sensor for thermal protection
- Multiple connectivity ports (UARTs, SSP, SDIO, SPI, I2C, I2S)
- 3.3V I/O, 10 year lifetime (Industrial)

## ► Package and Temperature

- 289 BGA 14x14mm .8mm
- -40C to +85C (Industrial)

## ► Availability:

- Samples: Q1 2010
- Production: Q3 2010



Enhanced features from i.MX286

**Preliminary: Subject to change**



# i.MX286 Applications Processor

## ► Key Features and Advantages

- 454MHz ARM926EJ-S core w/ 32KB Cache
- PMU with high efficiency on-chip DC/DC, supports Li-Ion batteries
- Ethernet with RMII support
- Dual CAN interfaces
- LCD Controller with Touchscreen
- NAND support – SLC/MLC and eMMC 4.4 managed
- Hardware BCH (up to 20-bit correction)
- 200 MHz 16-bit DDR2, LV-DDR2, mDDR external memory support
- Dual High speed USB with embedded PHY
- 8 General purpose 12-bit ADC channels and single 2 Msps ADC channel
- Temperature sensor for thermal protection
- Multiple connectivity ports (UARTs, SSP, SDIO, SPI, I2C, I2S)
- 3.3V I/O, 10 year lifetime (Industrial)

## ► Package and Temperature

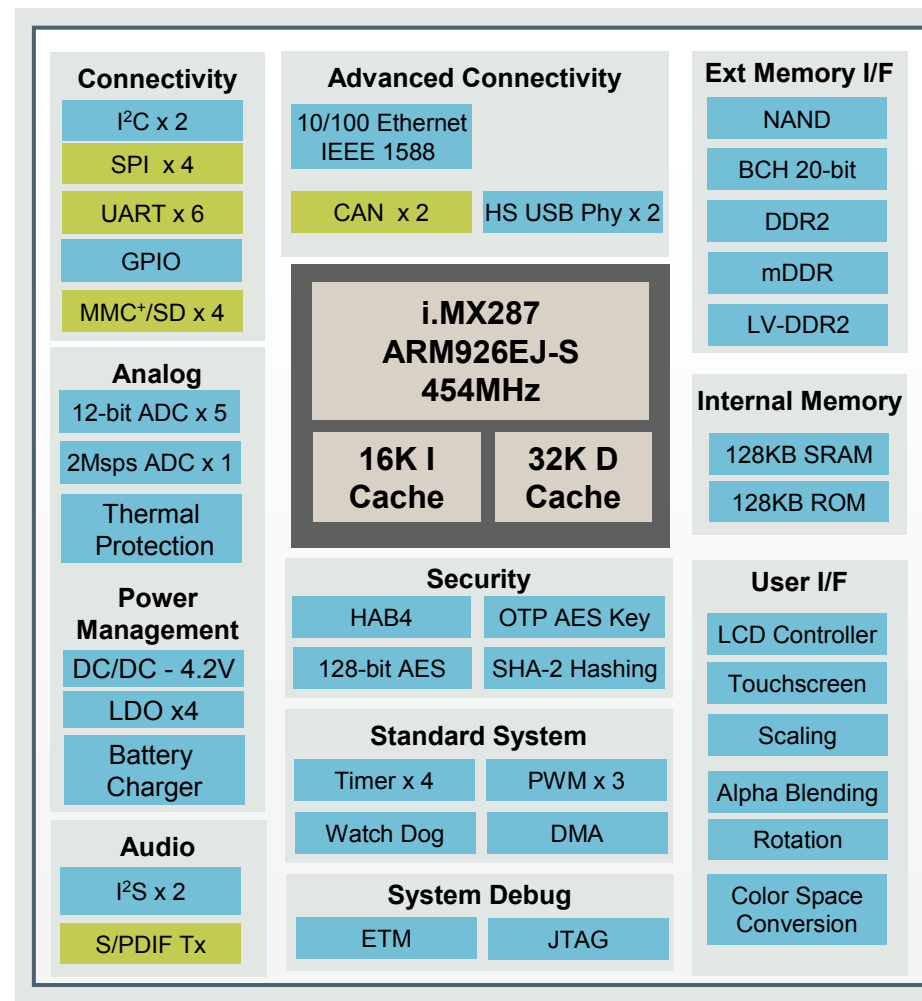
- 289 BGA 14x14mm .8mm
- -40C to +85C (Industrial)

## ► Availability:

- Samples: Q2 2010
- Production: Q3 2010

**Preliminary: Subject to change**

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Enhanced features from i.MX283

# i.MX283 Applications Processor

## ► Key Features and Advantages

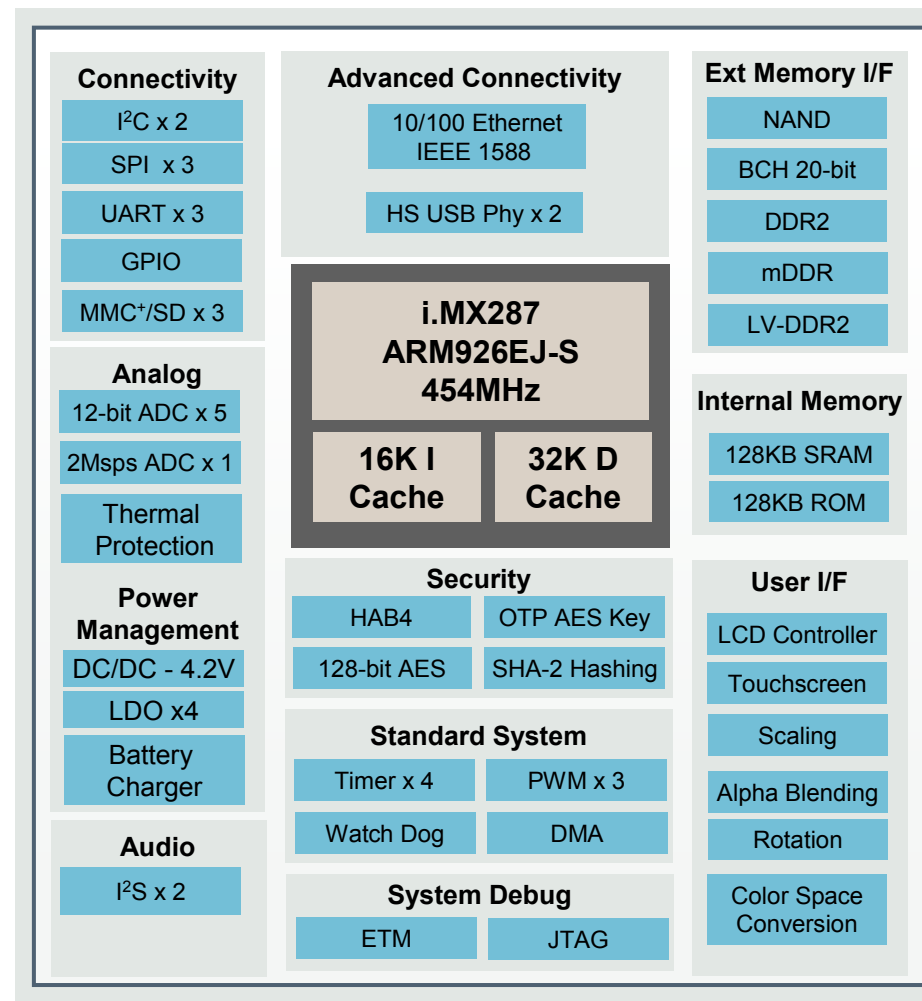
- 454MHz ARM926EJ-S core w/ 32KB Cache
- PMU with high efficiency on-chip DC/DC, supports Li-Ion batteries
- Ethernet with RMII support
- Dual CAN interfaces
- LCD Controller with Touchscreen
- NAND support – SLC/MLC and eMMC 4.4 managed
- Hardware BCH (up to 20-bit correction)
- 200 MHz 16-bit DDR2, LV-DDR2, mDDR external memory support
- Dual High speed USB with embedded PHY
- 8 General purpose 12-bit ADC channels and single 2 Msps ADC channel
- Temperature sensor for thermal protection
- Multiple connectivity ports (UARTs, SSP, SDIO, SPI, I2C, I2S)
- 3.3V I/O, 10 year lifetime (Industrial)

## ► Package and Temperature

- 204 16x16 Fusion Quad
- -20 to +70C (Consumer)
- -40C to +85C (Industrial)

## ► Availability:

- Samples: Q2 2010
- Production: Q4 2010



**Preliminary: Subject to change**

## New Package Technology - FusionQuad®

- ▶ New package technology from Amkor.
- ▶ Based upon the addition of exposed bottom lands within a standard VQFP package format.
- ▶ 50% footprint reduction versus standard TQFP for a given pin count.
- ▶ Provides excellent RF electrical performance characteristics with short signal paths to the bottom lands and high power dissipation capability with the solderable exposed die attach paddle.
- ▶ Unique footprint allows for use of low cost PCBs in end application due to the space available for coarse routing vias between the bottom lands and the outer peripheral leads.



## i.MX28 – CPU Subsystem

- ▶ ARM926EJ-S Processor with up to 454MHz performance @ 1.45V
- ▶ Custom Caches for maximum performance and low power (16K + 32K)
- ▶ Low-power 90LP implementation
- ▶ 128KB of On-Chip SRAM
- ▶ 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) debug
- ▶ Standard 6-wire JTAG for debug
- ▶ Support wait-for-interrupt low-power mode



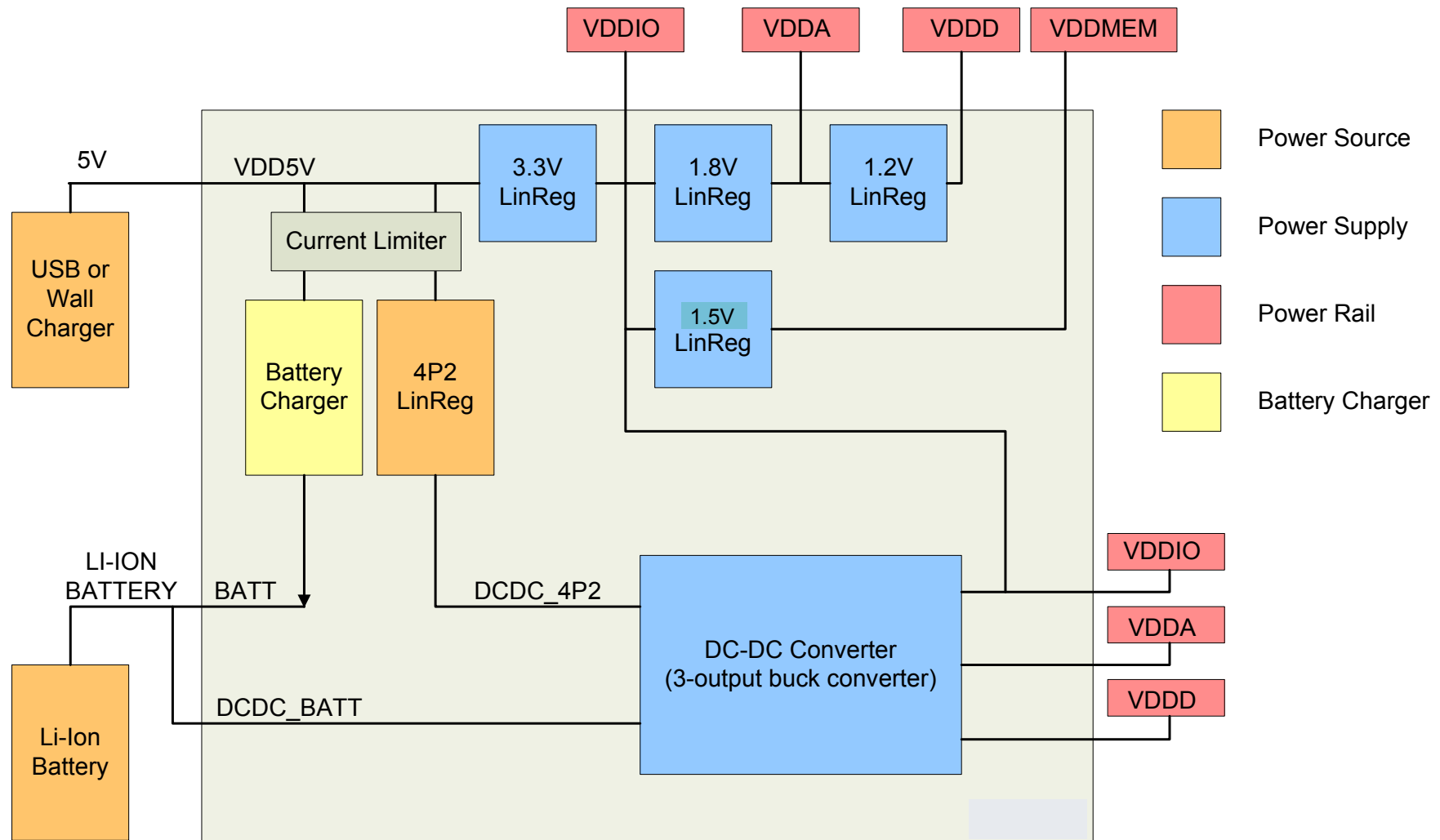
## i.MX28 – Low Power Features/Characteristics

- ▶ 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 implement five levels of low-power modes (mDDR)
- ▶ Synchronous clocking mode from CPU, bus to memory controller, reduces latency and thus MHz/MIPS requirements
- ▶ Auto-slow on bus-clock (HCLK) with HW 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
  - SRAM retained
  - Supports Interrupt from press
  - Supports wake-up from touchscreen
  - Quick power up
- ▶ Power-down (RTC-only) power = 12uA
  - Only RTC active
  - Power up longer

## i.MX28 - Power Management Unit

- ▶ Integration of a DC-DC switching converter and linear regulators that provide four output rails
  - Powers digital blocks and components such as system clocks
  - Powers I/O peripherals like NAND flash and SD/MMC cards
  - Powers 1.5V DDR2
- ▶ Power sources
  - Li-Ion batteries (2.9V – 4.2V)
  - Direct power from 5V source (USB, wall power or other source)
  - Internal 4.2V power source generated from 5V 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 speed and temp sensors
  - Hardware thermal protection and shutdown circuitry

# Logical Diagram of Power Block



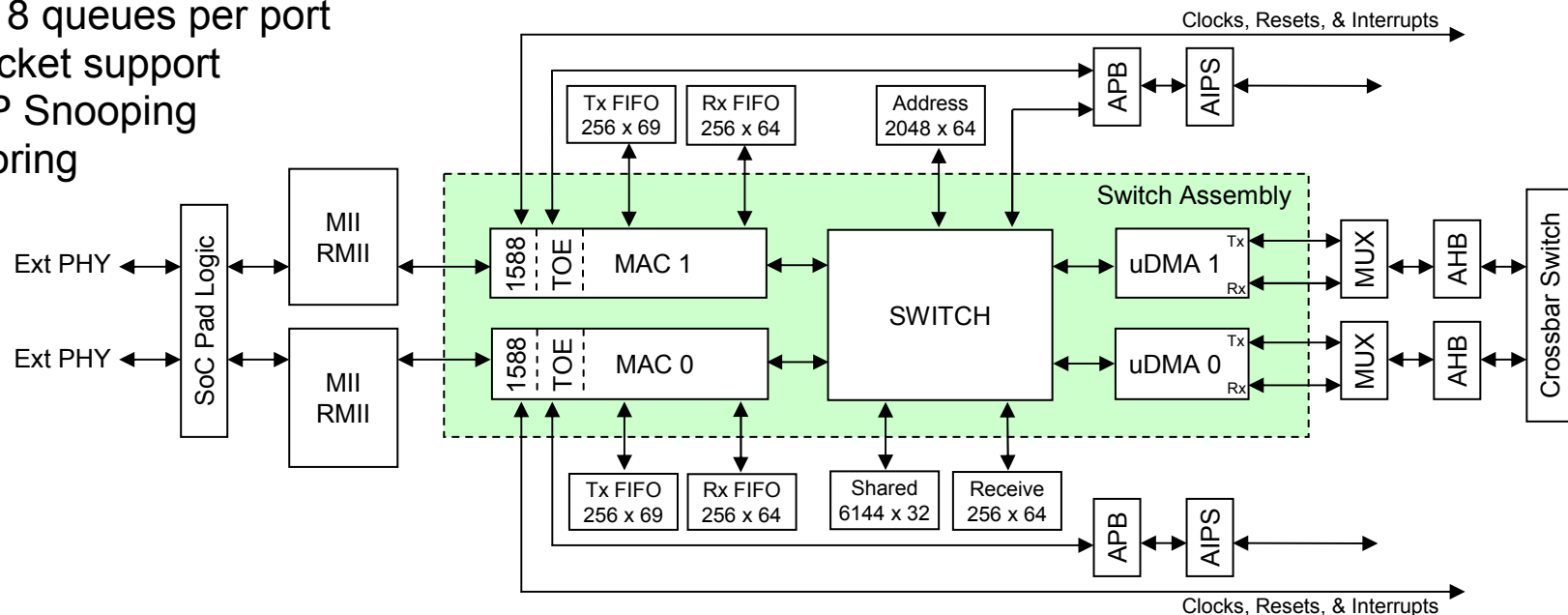
# Embedded Ethernet Assembly w/ L2 Switch

## Product Features:

- ▶ 3-Port Switch (one internal)
- ▶ Separate dual-port FIFOs for max throughput
- ▶ TCP/IP Offload Engine (TOE)
- ▶ Hardware Time-stamping (IEEE 1588)
- ▶ Simple handshake programmable FIFO i/f
- ▶ Fast cut-through mode (MAC)
- ▶ Link aggregation, redundant backplane
- ▶ QoS with 8 queues per port
- ▶ Magic packet support
- ▶ Level 3 IP Snooping
- ▶ Port Mirroring

## System Benefits:

- **Cost-effective daisy-chain networks**
- **Efficient ring networks with redundancy**
- **Improved determinism using hardware time stamping of packets (1588)**





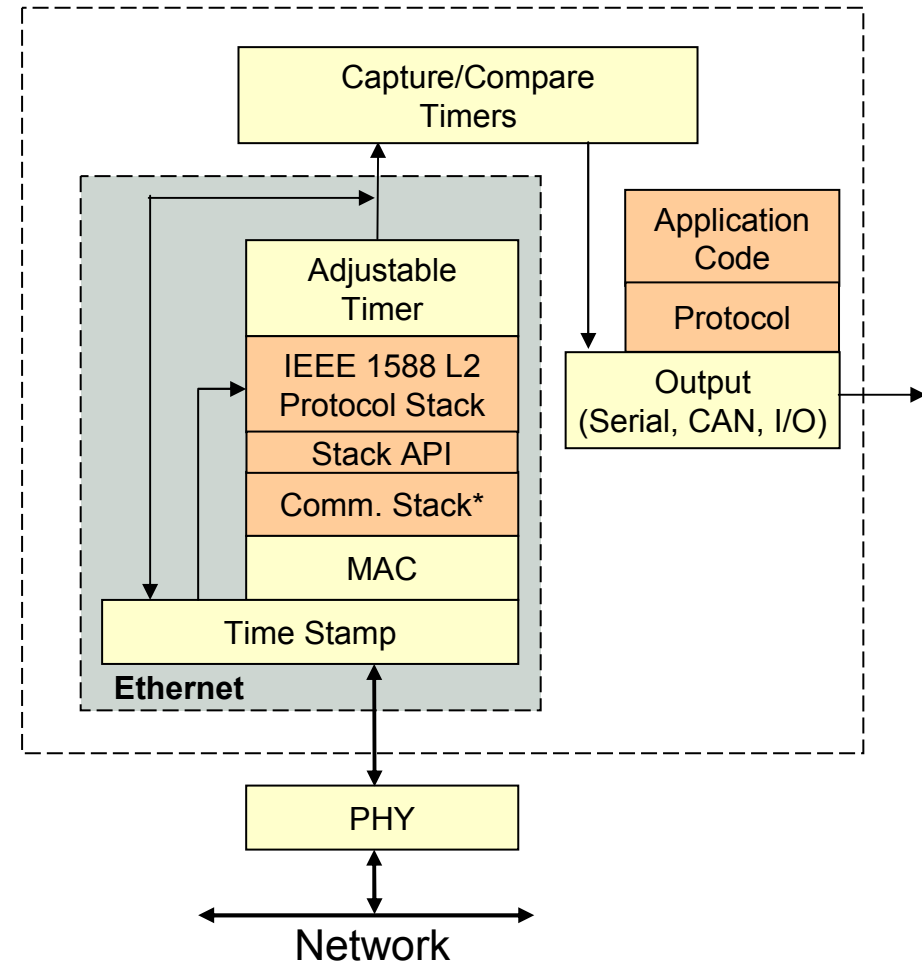
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## HARDWARE

- The 1588 stack can adjust and update the internal timer used as a local clock reference.
- The 1588 time stamp is implemented as close to the external MAC as possible, to provide maximum precision.
- Each network connection can run independently, together, or with embedded L2 switch.
- Internal capture/compare timers allow for other outputs to be synchronized to the network time base.

## SOFTWARE

- Supports standard TCP/IP protocol, UDP protocol, and various proprietary protocols. \*
- Time Stamping (1588 based) stack easily integrated into new IP stacks using the API provided.



# i.MX28 – Flash Memory Support

## ► Flash Memory Types Supported

- Raw SLC NAND
- Raw MLC NAND
- Managed NAND – eMMC 4.4, LBA
- SPI NOR Flash

## ► General-Purpose Media Interface Controller

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

## ► Hardware BCH Interface

- Provides a forward error-correction function to improve the reliability of raw NAND memory that may be attached to the i.MX28
- BCH Engine with up to 20-bit correction (2-bit increments) with 13-bit parity.

## i.MX28 – Security

- ▶ Data Co-Processor (DCP) Peripheral
  - High Assurance Book (HAB4)
  - DCP OTP key can be used to wrap (encrypt) other keys or data
  - H/W accelerated decryption / encryption
  - H/W accelerated hash functions, SHA-256
- ▶ On-Chip One Time Programmable (OTP) ROM
  - Enables / disables device functionality (i.e. JTAG)
  - Holds one customer specified encryption key
- ▶ SRAM storage for four additional temporary keys. SW can select from the OTP or the additional keys via the descriptor interface.
  - Once the keys have been provisioned to the SRAM they cannot be read directly by SW. (Write-Once-Only)
- ▶ On-Chip Boot ROM
  - Integrated boot loader is only method for booting device
  - Can be configured to authenticate and decrypt boot images

- ▶ Up to four independent Synchronous Serial Ports (SSP)
  - SD/MMC removable cards
  - eSD/eMMC/iNAND chips
  - SPI control and communication
    - Supports Winbond SPI dual/quad read modes up to 52MHz SCK frequency
  - Peripheral chips such as Wi-Fi or Bluetooth using SDIO
  - Dedicated DMA channels
  - Maximum clock rate of 50 MHz

## i.MX28 – Low Resolution A/D (LRADC)

- ▶ 12-bit Low-Resolution ADC, up to 0.5% battery level accuracy
- ▶ 16 total measurement nodes available
  - 8 physical channels available as external inputs
  - 8 “virtual” assignable channels for doing actual measurements can be mapped to any of the 16 measurement nodes
- ▶ Integrated 4-wire and 5-wire touch-screen controller (with wide range of impedance support, e.g 200-400 Ohm and 50K Ohm)
- ▶ Integrated temperature sensor function (on-die, and external with diode or thermistor) to monitor the internal die temperature
  - Three sigma temperature error of +/-1.5% in degrees Kelvin
  - Temperature sampling has a 3 sigma sample-to-sample variation of 2 degrees Kelvin which can be averaged out .
  - Thermal protection on i.MX28 - Safety switch will reset the part when the shutdown temperature is reached
- ▶ Single channel high speed ADC – 2Msps at 12-bits

## i.MX28 Peripherals – Other I/O

### ▶ I<sup>2</sup>C

- EEPROM, Sensors
- DMA controlled with M/S mode up to 400KHz

### ▶ 4-Channel 16-Bit Timers with Rotary Decoder

### ▶ Six-Channel Pulse Width Modulator (PWM)

### ▶ Real-Time Clock

- Options for 24MHz, 32KHz or 32.768KHz
- Storage of “persistent bits”
- Wake from alarm

### ▶ UARTs

- 5 x 3.25Mbps App UARTs
- 1 x 115Kbps Debug UART

### ▶ S/PDIF Transmit

### ▶ Dual Serial Audio Interface (SAIF), Two Stereo Pairs

- Full-duplex stereo transmit and stereo receive operations (requires both SAIF interfaces)
- Bluetooth hands-free connection
- I<sup>2</sup>S, left-justified, right-justified, and non-standard formats

# i.MX28 Enablement Strategy

## Evaluation Kit (EVK) - Price. Performance. Personality

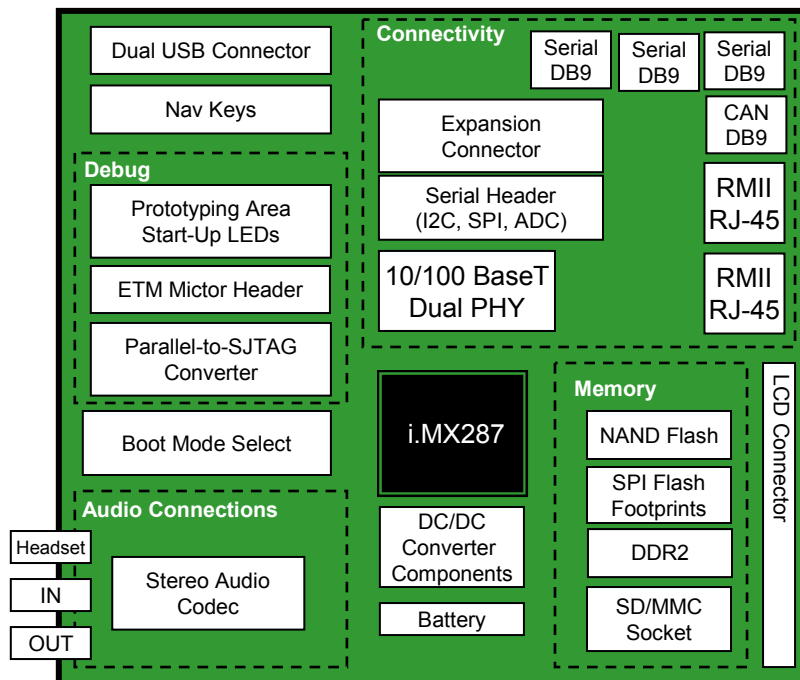
- Price-effective with out compromising performance
- Allows the customer to ultimately develop, debug and demonstrate the personality of their next great product
- Optional 4.3" WVGA LCD add-on module available
- Target hardware development cost <\$700

## Software Support

- OS/RTOS
  - Linux and WinCE BSPs provided by Freescale at no cost
  - Other RTOS - TBD
- Common audio and video codecs available
  - MP4, AVI, WMA, AAC, MP3
- Industrial ethernet protocol software stacks support plan with partners
  - IEEE 1588 Ethernet stack – IXAAT
  - PROFINET Stack – Softing
  - CANopen stack – IXAAT
  - EtherNet/IP, DeviceNet, Modbus TCP/IP stacks – Real-time Automation

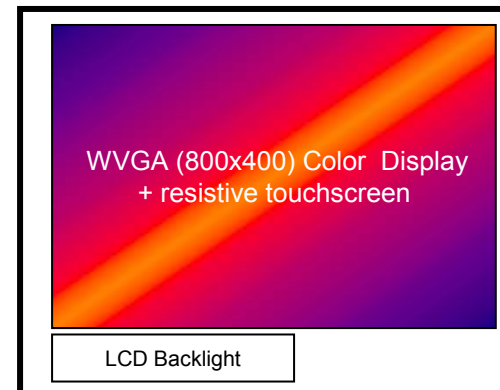
# i.MX28 Evaluation Kit (EVK)

Price. Performance. Personality.		
CPU	Debug	Peripherals
<ul style="list-style-type: none"> <li>▶ i.MX28 Applications Processor (289 BGA)</li> <li>▶ DDR2</li> <li>▶ NAND FLASH</li> <li>▶ SPI Flash footprint</li> <li>▶ ETM Support</li> <li>▶ DC/DC Converter components</li> <li>▶ Li-Ion battery connector</li> </ul>	<ul style="list-style-type: none"> <li>▶ Debug Serial Port</li> <li>▶ JTAG</li> <li>▶ Reset, Interrupt, boot switches</li> <li>▶ Debug display/LED's</li> <li>▶ Power Source</li> </ul>	<ul style="list-style-type: none"> <li>▶ WVGA Touchscreen LCD Display (add-on module)</li> <li>▶ SD/MMC Card Slot</li> <li>▶ Dual USB Host/Device connector</li> <li>▶ CAN connector</li> <li>▶ Dual Ethernet with Switch for testing of features and throughput</li> <li>▶ Navigation keys</li> <li>▶ Mic input, headphone output (jack)</li> </ul>



## SW Tools support:

- Freescale Linux and WinCE BSPs
- RTOS (TBD)
- IEEE 1588 Support (IXXAT)



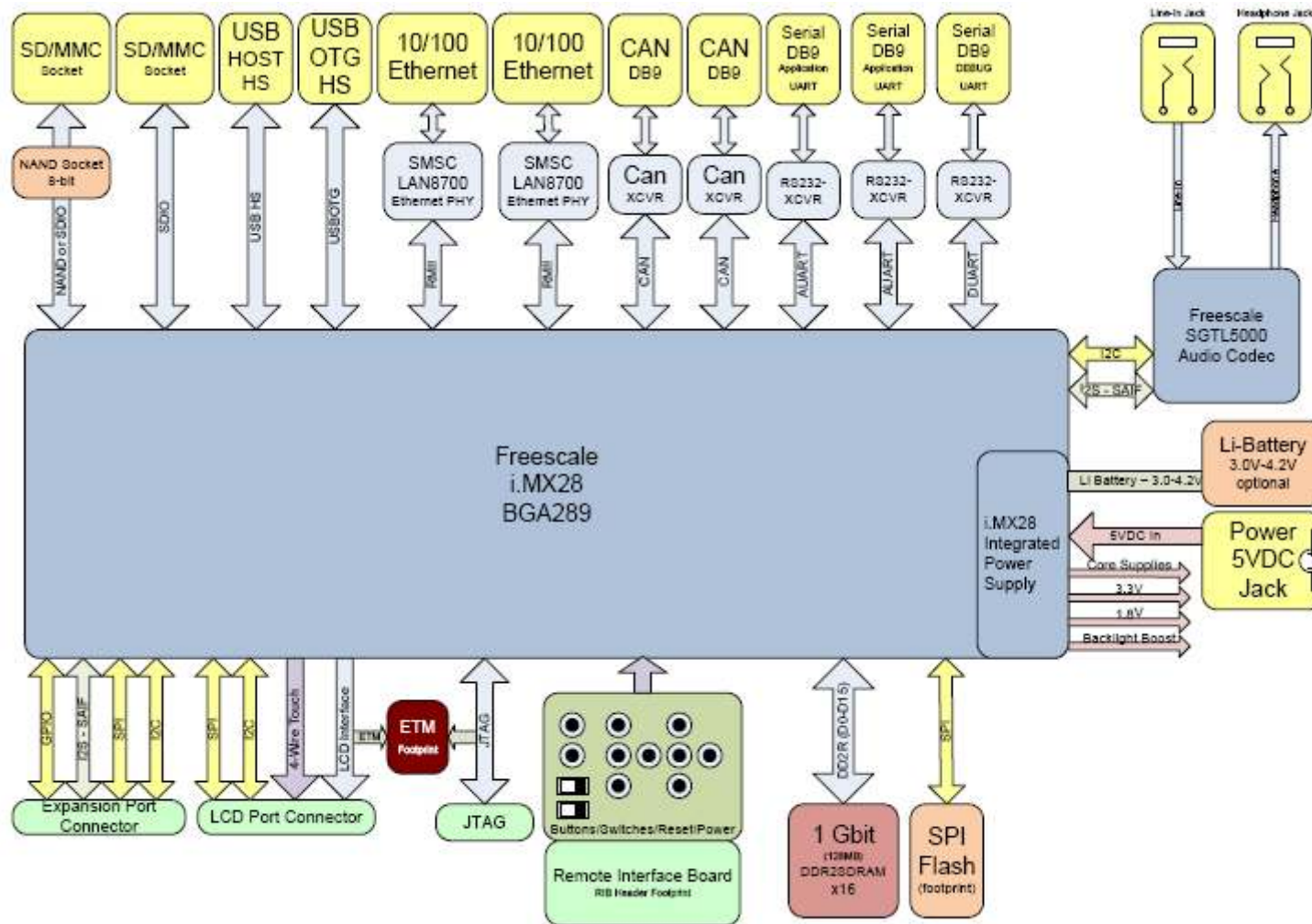
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# i.MX28 EVK Block Diagram



## i.MX28 Milestones

Milestone	Target Date
Alpha Customer Samples (BGA)	March 2010
Alpha EVK for Customers	March 2010
Preliminary BSP (ER1) – Alpha Customers	March 2010
Preliminary Customer Documentation – Alpha customers	Datasheet – Dec 2009, Reference Manual – end March 2010
Preliminary BSP (ER2)	Mid-April 2010
Beta customer engagement (Beta BSP, beta EVK, docs)	June 2010
Preliminary FusionQuad customer samples	TBD
Auto/Industrial Qualification	Sept 2010
Launch BGA (Production, final BSPs, final docs)	Sept 2010
Launch FusionQuad (Production, final BSPs, final docs)	Q4 2010



# i.MX28 Family Product Comparison

Feature	i.MX281	i.MX285	i.MX283	i.MX286	i.MX287
Market Segments	Automotive	Automotive	Consumer & Industrial	Industrial	Industrial
LCDIF	-	Y	Y	Y	Y
Touchscreen	-	Y	Y	Y	Y
Ethernet	x1	x1	x1	X1	x2
L2 Switch	-	-	-	-	Y
CAN	x2	x2	-	x2	x2
12-bit ADC	x8	x8	X3	X5	x8
High Speed ADC	x1	x1	x1	x1	x1
USB2.0	x1 HS Host/Device with PHY, x1 HS Host with PHY	x1 HS Host/Device with PHY, x1 HS Host with PHY	x1 HS Host/Device with PHY, x1 HS Host with PHY	x1 HS Host/Device with PHY, x1 HS Host with PHY	x1 HS Host/Device with PHY, x1 HS Host with PHY
SDIO	x4	x4	x3	x4	x4
SPI	x4	x4	x3	x4	x4
UART	x6	x6	x3	x6	x6
PWM	x3	x3	x3	x3	x5
S/PDIF Tx	Y	Y	Y	Y	Y
Package	289 BGA, 204 16x16 FusionQuad	289 BGA	204 16x16 FusionQuad	289 BGA	289 BGA
Temperature	-40 to 85	-40 to 85	-10 to 70, -40 to 85	-40 to 85	-40 to 85

Preliminary: Subject to Change

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# Target Applications

## i.MX28

- ▶ **Real-time, low cost, mid-performance ARM9 microprocessor family with WinCE and Linux operating system support, LCD controller, Ethernet, CAN and other interfaces. Ideal for battery operated and fanless automotive, industrial and consumer applications.**
- ▶ **Automotive**
  - ▶ Entry-level Automotive Audio
- ▶ **Industrial Control, Networking and HMI**
  - ▶ HMI for Factory Automation & Building Control
  - ▶ Industrial Drives, PLC, I/O Control display controller
  - ▶ Industrial robotics display
  - ▶ Smart Energy Meters
  - ▶ Data Acquisition (Handheld Scanners)
  - ▶ Fixed and Handheld Printers
- ▶ **Medical**
  - ▶ Portable Medical and Diagnostics display
- ▶ **Home Consumer**
  - ▶ HMI (Appliances, Security Panels, Printers)
  - ▶ Media Phones / VOIP
  - ▶ PC/Audio Accessories
  - ▶ Media Gateways
  - ▶ High Tier Graphical Remote Controls
  - ▶ Digital Picture Frames
- ▶ Alpha samples                      Feb 2010
- ▶ Launch                                Sep 14, 2010
- ▶ Production                          Sep 2010

## MCF5441x Modelo

- ▶ **Real-time, low cost, low-power. mid-performance ColdFire V4 controller family with MQX and Linux operating system support, Ethernet, CAN and other interfaces. Ideal for fanless industrial applications.**
- ▶ **Building Control**
  - ▶ Access panels, Elevators, Security, HVAC
    - Backend, real-time processing
- ▶ **Industrial Control and Networking**
  - ▶ Ethernet to serial connectivity devices
  - ▶ Networked control power grid controller
- ▶ **Medical Diagnostics**
  - ▶ Non-portable, data analysis and processing
- ▶ **Motor Control**
  - ▶ Up to 2 motors, low voltage
- ▶ Alpha samples                      Now
- ▶ Launch                                Sept 14, 2010
- ▶ Production                          Nov 2010