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Smart Energy Management with Home Area Networks

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Global Segment Marketing Leader – Smart Grid / Smart Energy
Session Introduction

- Presenter: Meera Balakrishnan, Global Segment Leader, Freescale Semiconductor
- Presentation: 50 minutes (including Q&A session)
- Abstract

Local networking of electronic devices in houses and buildings offer benefits in a number of areas, ranging from safety and security, to energy efficiency and home entertainment features.

Home area networks can be implemented via both wired and wireless solutions, using multiple different standards, and can be remotely controlled and monitored through a gateway to neighbor, wide area, or smart grid networks.

Freescale offers a wide portfolio of connectivity solutions and human-machine interfaces, combined with broad range of suitable microcontrollers and microprocessors.
Home Area Network Applications

Freescale Connectivity Solutions

Connectivity for Smart Energy Management

Start Designing with Freescale
Agenda

- Home Area Network Applications
- Freescale Connectivity Solutions
- Connectivity for Smart Energy Management
- Start Designing with Freescale
Terminology – Home Area Network

- Dedicated network connecting devices in the home such as displays, load control devices, and ultimately “smart appliances” into the overall smart metering system.

- May also be used to connect other meters (such as gas and water) to the NAN.

NOT A SINGLE-TECHNOLOGY NETWORK
The Challenge of HAN

► Connect the entire house/building network to the ‘external world’ for remote monitoring and control
  • For consumer: Remote control and monitoring of smart objects (HVAC, lighting, alarm systems)
  • For service providers: Remote metering for utility companies, security monitoring for surveillance companies

► Connect objects inside houses/buildings to offer smart interoperability features.
  • Example: PIR sensors connecting to HVAC system and lighting system to turn off heating when windows are open, or turn OFF lights when no presence is detected
New ‘Smart’ Networked Homes Forecast

CAGR 09-14
66.4%
HAN Connected Objects

**ENERGY**
- Gas Meters
- Water Meters
- Appliances
  - Refrigerators/freezers
  - Dishwashers
  - Washing machines / dryers
- HVAC
  - Thermostats
  - Air conditioning systems
  - Heat meters
- Smart Plugs
- Power Meters
- Lighting Systems

**MULTIMEDIA**
- Digital Set Top Boxes
- HDTV
- HiFi Systems

**SECURITY & MONITORING**
- Cameras
- Alarm Systems
- Monitoring Systems
  - Motion detectors
  - Door locks, key fobs
  - Window/door control
  - Smoke/flood/alarm detectors

**HAN + GATEWAYS**
- HAN Connected Objects
Market Drivers and Influencers

► Consumers
  • Desire for monitoring/controlling
  • Remote access to home

► Growing Energy Prices
  • Reduce home energy consumption
  • Smart consumption

► Service Providers
  • Innovative services around energy management and home security
  • Utilities to take control over energy usage

► Technology Enablers
  • Commoditization of LAN/WLAN networks
  • Maturity of low power technologies (ZigBee®, Z-Wave, etc.)

► Standardization Bodies
  • Individual protocol alliances (ZigBee, Z-Wave, HomePlug, etc.)
  • Application-oriented alliances:
    ▪ OpenHAN from UtilityAMI
    ▪ CECED for Appliances
Connectivity is Everything

- Home area network is a combination of various specialized networking technologies

- Challenge is to interconnect different technologies to offer smart services for
  - Comfort
  - Automation
  - Security
  - Energy management
Freescale Connectivity Solutions

Connectivity for Smart Energy Management

Start Designing with Freescale
Wireless Connectivity Strategy

► To provide all wireless solutions (from antenna to bits) required for remote control and monitoring applications in consumer and industrial markets:
  • All ISM frequency bands: 315 MHz, 433 MHz, 868 MHz, 915 MHz, 2.4 GHz
  • All integration levels: From standalone transmitters, receivers, and transceiver up to system-in-package with radio, microcontroller and memory in a single chip
  • Scalable wireless protocol: From simple point-to-point lightweight protocol, up to full ZigBee-compliant applications.

► Comprehensive partner ecosystem offering design services and turnkey wireless modules

► Add wireless connectivity feature to extensive range of core (8/16/32 bit) adapted to application performance needs

- MC13201/2
- MC33596
- MC33696
- MC13211/2/3
- MC13224
Wireless Connectivity Solutions Portfolio

APPLICATIONS
- Remote keyless entry
- Home automation
- Garage door opener
- Remote metering
- RF data transfer

802.15.4

Protocol
- 315MHz
- 434MHz
- 868MHz
- 915MHz
- 2400MHz

802.15.4

Multiple-chip
- PiP
- MC13224

Single-chip
- Tx/Rx/MCU/Memory
- MC13213
  - 60KB NVM
  - 4KB RAM

Single-chip
- Tx/Rx
- MC13202
  - Integrated Antenna Switch

Single-chip
- Tx/Rx
- MC13201
  - Integrated Antenna Switch

Single-chip
- Rx
- MC33596

Multiple-chip
- Tx/Rx
- MC33696

Proprietary

Single-chip
- Tx/Rx/MCU/Memory
- MC13212
  - 32KB NVM
  - 2KB RAM

Single-chip
- Tx/Rx
- MC13211
  - 16KB NVM
  - 1KB RAM

APPLICATIONS
- Remote keyless entry
- Home automation
- Garage door opener
- Remote metering
- RF data transfer

2400MHz
Quick RF Selector Guide

► Proprietary solutions (P2P cable replacement, star networks)
  • 315/433/868/915MHz → MC33696
  • 2.4GHz → MC13201, MC13211 with SMAC

► 802.15.4 MAC solutions (mesh networks, encryption, handshaking,...)
  • 2.4GHz → MC13202, MC13212 with 802.15.4 MAC

► ZigBee solutions (self-configured, self-healing networks, hundreds of nodes, industry standard)
  • 2.4GHz → MC13202, MC13213, MC13224 with BeeStack (ZigBee-compliant stack)
Multi-band Transceiver
315/434/868/915 MHz

- Transceiver with a programmable Frac’N PLL, RSSI circuit and a periodic wake up timer which activates the receiver while a data manager checks the content of incoming message
- BENEFITS:
  - Listen RKE or TPMS frame without MCU write (configuration switching)
  - Simple system design, SPI interface to MCU
  - Low system power consumption with data manager and strobe oscillator
  - Faster software development with data manager
  - Economical solution with few external components, small footprint (5x5 mm)

### MC33696 Overview

<table>
<thead>
<tr>
<th>Frequency</th>
<th>315/434/868/915MHz with Frac’N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulation</td>
<td>OOK / FSK</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>-108dBm</td>
</tr>
<tr>
<td>Data Rate</td>
<td>Up to 19.2 Kbps with data manager (Manchester encoding) or 40 kbps (NRZ encoding), no data manager.</td>
</tr>
<tr>
<td>Receiver Logic</td>
<td>Configuration switching</td>
</tr>
<tr>
<td></td>
<td>Data manager with clock recovery</td>
</tr>
<tr>
<td>Rx Sensitivity</td>
<td>-108dBm to –81dBm typ in 4 steps</td>
</tr>
<tr>
<td></td>
<td>RSSI: 75dB digital and 55dB analog</td>
</tr>
<tr>
<td>Rx current</td>
<td>9mA typ</td>
</tr>
<tr>
<td></td>
<td>Low power automatic wake up</td>
</tr>
<tr>
<td>Tx output power</td>
<td>-19 to +7 dBm in 4 steps</td>
</tr>
<tr>
<td>Tx current</td>
<td>11 mA max</td>
</tr>
<tr>
<td>Temp Range</td>
<td>-40°C to 85°C</td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>2.1V-3.6V or all 5V, Standby 250nA</td>
</tr>
<tr>
<td>Package</td>
<td>LQFP32 or QFN32 RoHS</td>
</tr>
</tbody>
</table>

In production, samples available
### MC13201/MC13202 Overview

<table>
<thead>
<tr>
<th><strong>Overview</strong></th>
<th>2.4 GHz transceiver with integrated Tx/Rx switch</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RF Component Count (No Controller)</strong></td>
<td>15 external components</td>
</tr>
<tr>
<td><strong>Network Support</strong></td>
<td>Point-to-point, star, cluster tree and mesh</td>
</tr>
<tr>
<td><strong>Connection to controller</strong></td>
<td>4-wire SPI</td>
</tr>
<tr>
<td><strong>Low Power Modes</strong></td>
<td>Off, hibernate (1μA), doze (3μA), and idle (40μA)</td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
<td>Up to -92 dBm</td>
</tr>
<tr>
<td><strong>Power Output</strong></td>
<td>-27 dBm to +4 dBm</td>
</tr>
<tr>
<td><strong>GPIO</strong></td>
<td>7</td>
</tr>
<tr>
<td><strong>Operating Voltage</strong></td>
<td>2.0 to 3.4 V</td>
</tr>
<tr>
<td><strong>Operating Temp</strong></td>
<td>-40° to +85°C</td>
</tr>
<tr>
<td><strong>Package</strong></td>
<td>5x5x1 mm 32-pin QFN (meets RoHS requirements)</td>
</tr>
</tbody>
</table>

► In mass production
MC13211/MC13212/MC13213 Overview

Software compatible to the MC1320x
- Proprietary Applications using SMAC
- IEEE® 802.15.4 Compliant Modem
- ZigBee Compliant Platform

In mass production
# ZigBee Technology Systems in a Package

<table>
<thead>
<tr>
<th></th>
<th>MC13211</th>
<th>MC13212</th>
<th>MC13213</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>2.4 GHz transceiver with integrated GT16 MCU</td>
<td>IEEE 802.15.4 compliant 2.4 GHz transceiver with integrated GT32 MCU</td>
<td>ZigBee-ready 2.4 GHz transceiver with integrated GT60 MCU</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Integrated 2.4 GHz transceiver with Tx/Rx switch and HCS08 GT family MCU</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low power modes for months to years of battery-powered applications</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ultra-low component count reduces complexity and cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network Topology</td>
<td>Point-to-point and star</td>
<td>Peer-to-peer, star and mesh</td>
<td></td>
</tr>
<tr>
<td>Software</td>
<td>Simple MAC (SMAC)</td>
<td>IEEE 802.15.4 MAC</td>
<td>BeeStack</td>
</tr>
<tr>
<td>Transfer Mode</td>
<td>Packet and streaming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Throughput</td>
<td>250 Kbps, O-QPSK modulation, DSSS energy spreading scheme</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Power Modes</td>
<td>4-RF (Off, Hibernate, Doze, Idle) and 4-MCU (Wait, STOP1, STOP2, STOP3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td></td>
<td>-92 dBm</td>
<td></td>
</tr>
<tr>
<td>Operating Voltage</td>
<td></td>
<td>2.0 to 3.4 V</td>
<td></td>
</tr>
<tr>
<td>FLASH Memory</td>
<td>16 KB Flash, 1 KB RAM</td>
<td>32 KB Flash, 2 KB RAM</td>
<td>60 KB Flash, 4 KB RAM</td>
</tr>
<tr>
<td>I/O</td>
<td>Up to 39 GPIO, 8-channel 10-bit ADC, 4 timers, 2 SCI, IIC, LVI, ICG, COP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Output</td>
<td></td>
<td>-27 dBm to +4 dBm (software selectable)</td>
<td></td>
</tr>
<tr>
<td>Operating Temp</td>
<td></td>
<td>-40º to +85ºC operating temperature</td>
<td></td>
</tr>
<tr>
<td>Package</td>
<td></td>
<td>9x9x1 mm 64-pin LGA (meets RoHS requirements)</td>
<td></td>
</tr>
</tbody>
</table>

**Overview**: Ultra-low component count reduces complexity and cost.

**Network Topology**: Point-to-point and star, Peer-to-peer, star and mesh.

**Software**: Simple MAC (SMAC), IEEE 802.15.4 MAC, BeeStack.

**Transfer Mode**: Packet and streaming.

**Throughput**: 250 Kbps, O-QPSK modulation, DSSS energy spreading scheme.

**Low Power Modes**: 4-RF (Off, Hibernate, Doze, Idle) and 4-MCU (Wait, STOP1, STOP2, STOP3).

**Sensitivity**: -92 dBm.

**Operating Voltage**: 2.0 to 3.4 V.

**FLASH Memory**: 16 KB Flash, 1 KB RAM, 32 KB Flash, 2 KB RAM, 60 KB Flash, 4 KB RAM.

**I/O**: Up to 39 GPIO, 8-channel 10-bit ADC, 4 timers, 2 SCI, IIC, LVI, ICG, COP.

**Power Output**: -27 dBm to +4 dBm (software selectable).

**Operating Temp**: -40º to +85ºC operating temperature.

**Package**: 9x9x1 mm 64-pin LGA (meets RoHS requirements).

Changing wireless networking market dynamics

- Integrated 2.4 GHz transceiver with 32-bit CPU
  - 802.15.4-compliant transceiver
  - ARM7TDMI™ up to 26 Mhz
- Lowest power
  - Significant power reduction – up to 45%
  - 21 mA Rx & 29 mA Tx with radio and MCU
- Plenty of memory for ZigBee Applications
  - 80 KB ROM (802.15.4 MAC, device drivers)
  - 128 KB serial Flash
  - 96 KB SRAM
- Improved RF performance
  - -96 dBm sensitivity (DCD mode)
  - -100 dBm (NCD mode, +3-4 mA current)
  - +5 dBm power output
- Hardware accelerator reduces MCU overhead
  - MAC accelerator (sequencer and DMA interface)
  - AES 128-bit hardware encryption/decryption
- Best in class peripherals
  - UART, SPI, KBI, 8 channel 12-bit ADC, 4x16-bit timer, I²C, SSI (I²S), 64 GPIO

- Unique platform in a package
  - High integrated package
  - RF matching in package
  - Requires power, crystal and 50 Ohm antenna
  - 9.5 mm x 9.5 mm 99-pin LGA

- Availability
  - In mass production
Freescale Multi-Offering Approach with 802.15.4

Networking Layers

SMAC

Customer Defined & Developed

802.15.4

Customer Defined & Developed

Synkro

Customer Defined & Developed

RF4CE

Customer Defined

ZigBee®

Customer Defined

Memory-upgradeable and pin-compatible MCUs and RF ICs

802.15.4 PHY

802.15.4 MAC

802.15.4 PHY

802.15.4 MAC

802.15.4 PHY

802.15.4 MAC

802.15.4 PHY

802.15.4 MAC

802.15.4 PHY

802.15.4 MAC

802.15.4 PHY

802.15.4 MAC
## Protocol Comparison

<table>
<thead>
<tr>
<th>Feature</th>
<th>SMAC</th>
<th>802.15.4 MAC</th>
<th>SynkroRF</th>
<th>RF4CE</th>
<th>ZigBee</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Typical Applications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable Replacement</td>
<td>Wireless Control</td>
<td>Cable Replacement</td>
<td>RF Remote Control</td>
<td>Home Automation</td>
<td></td>
</tr>
<tr>
<td>Wireless Toys and Games</td>
<td>Wireless Automation</td>
<td>Wireless Control</td>
<td>Home Entertainment and Control</td>
<td></td>
<td>Smart Energy</td>
</tr>
<tr>
<td>Wireless Meter Reading</td>
<td>Home Automation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Network Stack</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Network Profiles</strong></td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Memory Requirements</strong></td>
<td>4-8K</td>
<td>40-50K</td>
<td>32K</td>
<td>&lt;40K</td>
<td>50-100K</td>
</tr>
<tr>
<td><strong>Network Topology</strong></td>
<td>Point-to-Point</td>
<td>Peer-to-Peer</td>
<td>Co-existing Star</td>
<td>Co-existing Star</td>
<td>Tree</td>
</tr>
<tr>
<td></td>
<td>Star</td>
<td>Tree</td>
<td></td>
<td></td>
<td>Mesh</td>
</tr>
<tr>
<td></td>
<td>Mesh</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Typical # of Nodes</strong></td>
<td>2-100</td>
<td>2-1000*</td>
<td>32 per Controlled Device</td>
<td>32 per Target Device</td>
<td>2-250 ZigBee</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2-1000 ZigBee Pro</td>
</tr>
<tr>
<td><strong>Typical IC Cost</strong></td>
<td>$1-2</td>
<td>$2-3</td>
<td>$2-3</td>
<td>$2-3</td>
<td>$3-5</td>
</tr>
<tr>
<td><strong>Typical Data Throughput</strong></td>
<td>50-115K</td>
<td>90-115K</td>
<td>70-100K</td>
<td>70-100K</td>
<td>30-70K</td>
</tr>
</tbody>
</table>
Agenda

► Home Area Network Applications

► Freescale Connectivity Solutions

► Connectivity for Smart Energy Management

► Start Designing with Freescale
Energy Management is not just a utilities matter.

- Electrolux, Enel, Indesit and Telecom Italia have signed an agreement to test an innovative system in which "smart" appliances optimize home energy consumption.

- Edelia (EDF), Sagemcom, Delta Dore currently running a pilot in Bretagne (France).

- Utility providers, industrial OEMs, service providers, telecom operators all are jumping on the boat to develop new products and services that manage power consumption at home.
Energy Management with ZigBee Smart Energy Profile

ZigBee Smart Energy Application Profile addresses communication from the meter to the HAN (Home Area Network) for purposes of load control and demand response:

- Load control provides the ability for the utility to turn off loads for short periods of time in the customer premise during peak loads.
- Demand response is the ability for utilities to communicate with a home to communicate changing utility rates during peak times, etc. The user will then have the option of taking voluntary actions to reduce personal consumption.
Home Area Network (HAN) BlackBox Solution

- **BlackBox** allows greatest flexibility for ZigBee SE 2.0
  - Allows for upgrade path as the SE 2.0 stack grows
  - Currently SE 1.0 + ECC will fit entirely on the MC13224

- **ZigBee IC** runs 802.15.4 MAC and ZigBee SE Stack Profile
  - Keeps 802.15.4 timing critical requirements on MC13224
  - BeeStack BlackBox application allows flexible memory split from network to application

- **Host MCU** runs any overflow from ZigBee IC
  - Application profile and device customer’s application

- **UART connection** from host MCU to MC13224 for communication
The Home Energy Gateway
- Collects power consumption data from various sources
- Controls activation/deactivation of HAN appliances
- Generates dashboards to provide feedback about power usage
- Provides control menus to control appliances
- Provides a ubiquitous link to the WAN for remote control/readout
Home Energy Gateway: Where? What For?

Utility Companies

Energy Saving Services
Monitor and Alert

Internet

Remote Control and
Monitor

In-Home Display

Home Displays, Computers
TV, Computer

Home Gateway

Residential Gateway

Wind Turbin
Solar Panel
Light
Appliance
Temperature

Breaker
Valves
Smart Water
Smart Gas
Smart Elec

Home Energy Gateway

Consumer

Utility Companies

Energy Saving Services
Monitor and Alert

Internet

Remote Control and
Monitor

In-Home Display

Home Displays, Computers
TV, Computer

Home Gateway

Residential Gateway

Wind Turbin
Solar Panel
Light
Appliance
Temperature

Breaker
Valves
Smart Water
Smart Gas
Smart Elec

Home Energy Gateway

Residential Gateway

Consumer

Utility Companies

Energy Saving Services
Monitor and Alert

Internet

Remote Control and
Monitor

In-Home Display

Home Displays, Computers
TV, Computer

Home Gateway

Residential Gateway

Wind Turbin
Solar Panel
Light
Appliance
Temperature

Breaker
Valves
Smart Water
Smart Gas
Smart Elec

Home Energy Gateway

Residential Gateway

Consumer

Utility Companies

Energy Saving Services
Monitor and Alert

Internet

Remote Control and
Monitor

In-Home Display

Home Displays, Computers
TV, Computer

Home Gateway

Residential Gateway

Wind Turbin
Solar Panel
Light
Appliance
Temperature

Breaker
Valves
Smart Water
Smart Gas
Smart Elec

Home Energy Gateway

Residential Gateway

Consumer

Utility Companies

Energy Saving Services
Monitor and Alert

Internet

Remote Control and
Monitor
Home Energy Gateway: Examples of Existing User Interfaces
Agenda

- Home Area Network Applications
- Freescale Connectivity Solutions
- Connectivity for Smart Energy Management
- Start Designing with Freescale1
Freescale ZigBee Offering

- Based on oldest and most stable 802.15.4 implementation
  - Designed for embedded processors
  - Buffer based memory system allows for a fast stack with no HEAP that can be fragmented

- Freescale supports both ZigBee and ZigBee Pro
  - ZigBee 2007 SP1 golden unit
  - ZigBee 2007 SP2 compliant platform

- Provides memory optimization
  - Optimizes memory usage by only compiling features needed
Freescale ZigBee Offering

► Supports combo device
  • Allows single device to support all devices types
  • Reduces SKU requirements
  • Provides greatest flexibility for device configuration

► Simplified network configuration reduces development time
  • BeeKit provides simplified and flexible network configuration
  • Provides sample applications for Smart Energy profile
    ▪ Energy service portal
    ▪ Metering device
    ▪ Load control
    ▪ In-premise display
    ▪ PCT
    ▪ Smart appliances
Based on Freescale’s 3rd Generation 802.15.4 2.4GHz PiP

- **1322x-SRB**
  - MMA7260Q 3-axis acceleration sensor
  - MPXV5010G pressure sensor
  - Temperature sensor
  - 2.5 mm headset/audio in jack
  - Speaker
  - Joystick, buttons and LEDs
  - J-TAG interface for debug and programming

- **1322x-NCB**
  - Graphic LCD display
  - 2.5 mm headset/audio in jack
  - Speaker
  - Joystick, buttons and LEDs
  - SMA connector
  - JTAG and Nexus debug interface

- **1322x-LPB**
  - Supports on-chip buck converter
  - Lowest power board for current measurements
  - JTAG interface for debug and programming

- **1322x-USB**
  - USB dongle and 802.15.4/ZigBee packet sniffer
  - Programming via USB
  - Optional JTAG connector for debug and programming
A new approach to wireless applications development

- Graphical user interface (GUI) to create, and validate network configuration
  - Complementary tool to traditional IDEs
- Codebases deliver libraries, templates and applications
  - Supports Simple MAC (SMAC), IEEE 802.15.4 MAC, SynkroRF and BeeStack
- Exports directly to IDE for development and debug
  - Applications are decoupled from the stack implementation
  - Allows for easy code updates and promotes code reuse
MC13224 Extended Range Reference Design

► Provides an FCC-qualified reference design
  • MC13224
  • RF circuitry
    ▪ PA UPG2250T5N
    ▪ Switch UPG2158T5K
    ▪ Balun
    ▪ Band pass filter
    ▪ 3 inductors
  • Uses F antenna

► Specs
  • +20 dBm power output
  • 1”x1.5” under shield
    ▪ Excludes antenna

Data is preliminary and subject to change
Home Energy Gateway Reference Design

2.4 GHz

802.11b/g
Atheros AR6002

SMSC LAN8720

SD PWM
DDR2 controller

NANDFC
SD

FEC/RMII (shared with PLM)

USB
RTC GPIO
UART
JTAG
OTG
LCDC TS
I2C

1x RGB Event Led
1x ON/OFF Led

USB FS

Buzzer

External Storage + SD/SDIO Extension(s)

Off-board AC->DC conversion

Off-board AC->DC conversion

W'less M-Bus
9S08 QE32
TRX

Zigee SE
MC13224V

1x RGB Event Led
1x ON/OFF Led

Debug

Either one or the other display, through specific connectors
Current Layout

Break-off area
(contains WVGA LCD related logic)

Main PCB
Phase 1: HEG reference board including

- Application processor: i.MX
- Memory: 1 Gbitx8  SLC Nand Flash + 512 Mbitx16 DDR2 DRAM
- ZigBee: FSL MC13224V (ZigBee SE 1.0 – will be followed by ZigBee SE 2.0)
- Wireless M-Bus or RS-485
- Wi-Fi 802.11b/g
- One Ethernet
- One UMI connector
- RS-232 for debug and maintenance
- Two USB with on-chip PHY
- SD/MMC card reader
- RTC backed-up by a coin battery
- Matrix LCD or 4"3 WVGA LC (both options will be available)
- Offboard AC-DC power supply
- Linux OS
Freescale Solutions for Smart Energy Management

► Extended range of connectivity solutions
  • From proprietary solutions to world standard protocols such as 802.15.4, ZigBee or RF4CE
  • Various levels of integration, from standalone radio transceivers up to complete platform-in-package solutions

► Best-in-class development tools
  • BeeKit Environment Tool for the world best time-to-market introduction
  • Large portfolio of development kits

► Home Energy Gateway Reference Design
  • Connects home objects to the network
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