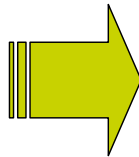# Smart Metering Solutions

Rolf Hertel – Global Applications Marketing
Neal Frager – Smart Metering Applications Engineer
October 2010

Smart Metering Selling Guide

What is Smart Metering?

Stakeholders in Smart Metering

▸ Governments rule regulations to reduce CO_2 emissions and energy consumption

▸ Utilities desire to have better peak load management

▸ Consumers benefit from energy awareness and can adapt accordingly

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Market Drivers

▸ **Smart Metering Value Proposition to Utilities (energy generation & grid)**
  – Cost savings by efficient remote reading & billing
  – Better peak load management / more efficient grid usage
  – New tariff model offerings
  – Better protection against tampering / remote turn-on and turn-off
  – Possibility to combine remote reading of gas, water and electricity usage

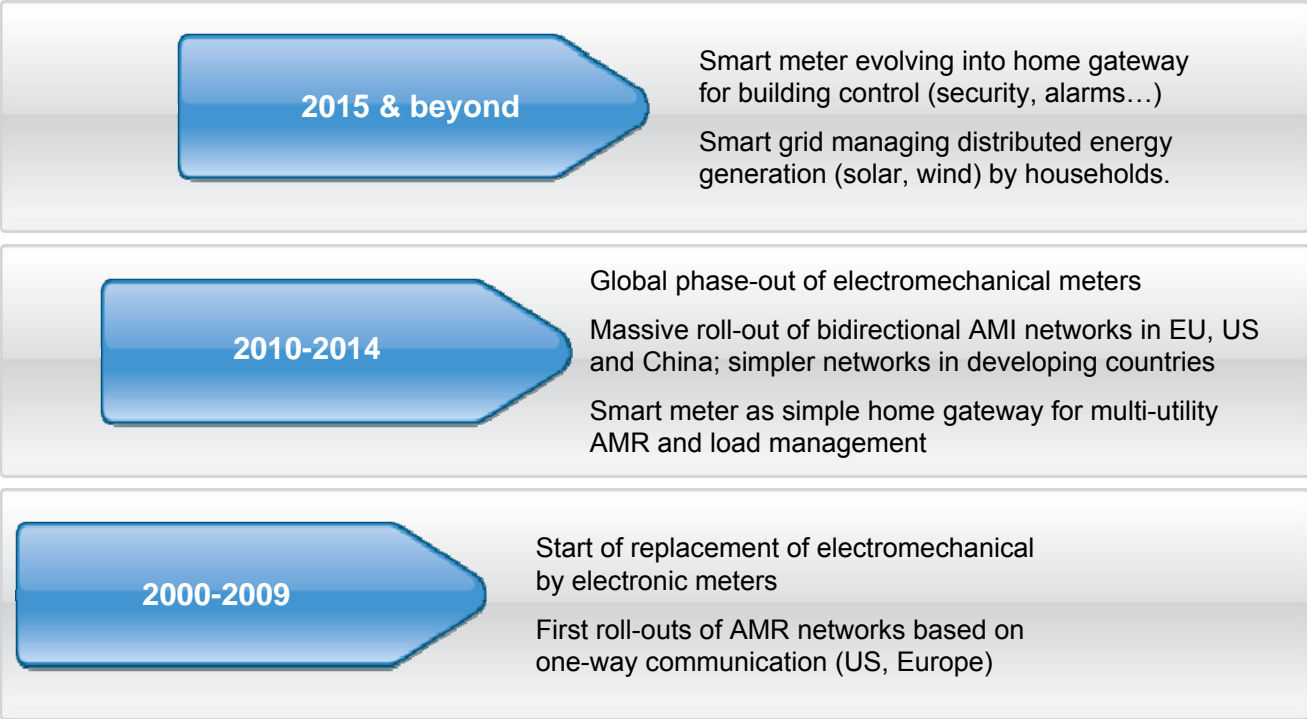▸ **Smart Metering Value Proposition to Consumers**
  – More accurate and frequent billing
  – Cost reduction by better insight into consumption
  – Ability to switch significant consumption to less expensive hours
  – Intelligent load management as a consumer / home automation

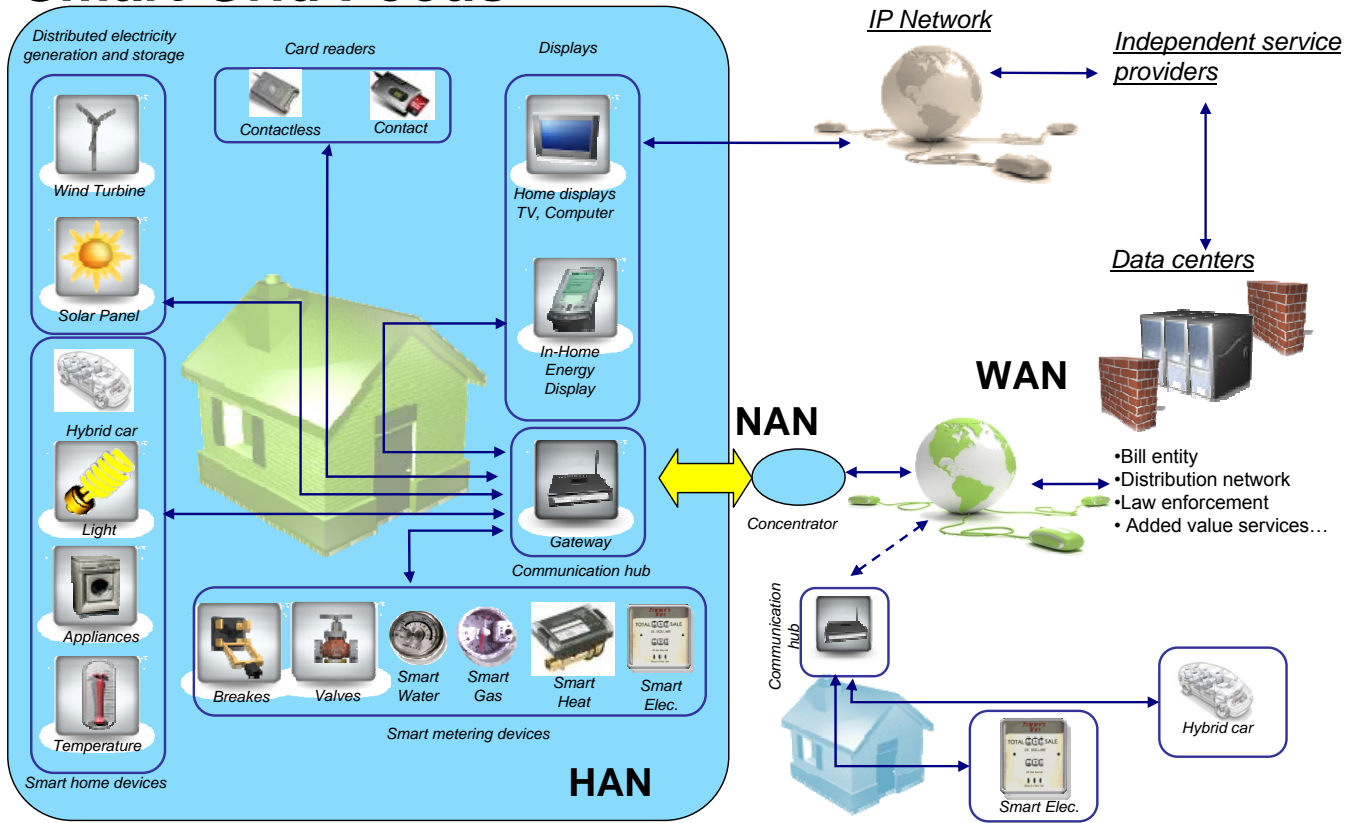▸ **Smart Metering Value Proposition for Governments**
  – Contribution to committed CO_2 emission reduction.
  – Increased awareness of energy consumption pattern leads to reduction of consumption
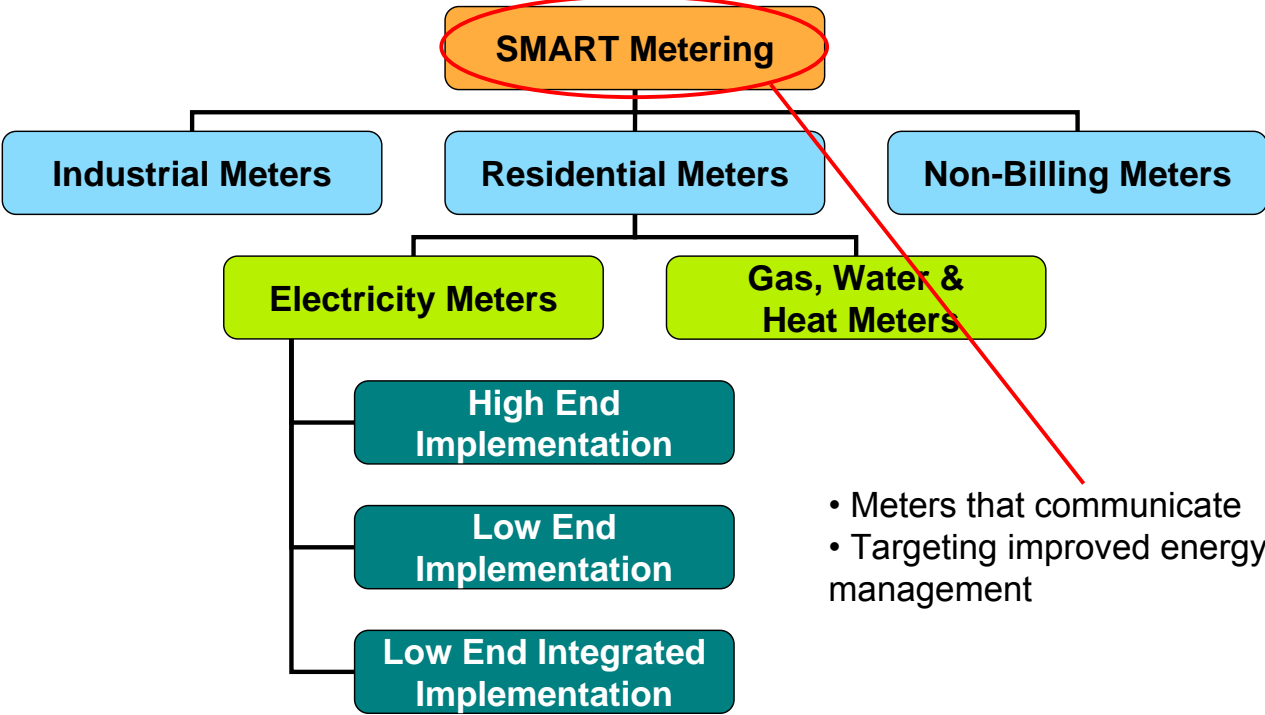 – Investment in smart metering networks will stimulate economy

5

Evolving Smart Metering Networks

2015 & beyond

Smart meter evolving into home gateway for building control (security, alarms…)

Smart grid managing distributed energy generation (solar, wind) by households.

2010-2014

Global phase-out of electromechanical meters

Massive roll-out of bidirectional AMI networks in EU, US and China; simpler networks in developing countries

Smart meter as simple home gateway for multi-utility AMR and load management

2000-2009

Start of replacement of electromechanical by electronic meters

First roll-outs of AMR networks based on one-way communication (US, Europe)

Smart Grid Focus

Distributed electricity generation and storage

Card readers
- Contactless
- Contact

Displays
- Home displays TV, Computer
- In-Home Energy Display

Wind Turbine

Solar Panel

Hybrid car

Light

Appliances

Temperature

Smart home devices

Breakes   Valves   Smart Water   Smart Gas   Smart Heat   Smart Elec.

Smart metering devices

Gateway

Communication hub

HAN

NAN

Concentrator

Communication hub

WAN

IP Network

Independent service providers

Data centers

- Bill entity
- Distribution network
- Law enforcement
- Added value services…

Smart Elec.

Hybrid car

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Market Segmentation & Characteristics

- Meters that communicate
- Targeting improved energy management

Market Segmentation & Characteristics

SMART Metering

Industrial Meters | Residential Meters | Non-Billing Meters

Electricity Meters

Gas, Water & Heat Meters

High End Implementation

Low End Implementation

Low End Integrated Implementation

- Highest performance
- Many communication options
- Targeting commercial real estate

Market Segmentation & Characteristics

- Optimized metrology inside
- Network connection optional
- Targeting consumers info

Market Segmentation & Characteristics

- Highest volume segment
- Balance of comm. & cost
- Targeting private households

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Market Segmentation & Characteristics

SMART Metering

- **Industrial Meters**
- **Residential Meters**
- **Non-Billing Meters**

Residential Meters:
- **Electricity Meters**
  - **High End Implementation**
  - **Low End Implementation**
  - **Low End Integrated Implementation**
- **Gas, Water & Heat Meters**
  - • Battery operated low-power
  - • Wireless comm. only

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Market Segmentation & Characteristics

```
                        ┌──────────────────┐
                        │  SMART Metering  │
                        └──────────────────┘
         ┌──────────────────────┼──────────────────────┐
┌──────────────────┐  ┌──────────────────┐  ┌──────────────────┐
│ Industrial Meters│  │Residential Meters│  │ Non-Billing Meters│
└──────────────────┘  └──────────────────┘  └──────────────────┘
                    ┌──────────┴──────────┐
            ┌──────────────────┐  ┌──────────────────┐
            │ Electricity Meters│  │  Gas, Water &    │
            │                  │  │  Heat Meters     │
            └──────────────────┘  └──────────────────┘
                    │
              ┌──────────────────┐
              │    High End      │
              │ Implementation   │
              └──────────────────┘
              ┌──────────────────┐
              │    Low End       │
              │ Implementation   │
              └──────────────────┘
              ┌──────────────────┐
              │ Low End Integrated│
              │ Implementation   │
              └──────────────────┘
```

- Highest volume within residential
- Comm. hub for HAN/NAN
- Comm. option for sub-meters

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Market Segmentation & Characteristics

- Home automation gateway
- Performance close to industrial

Market Segmentation & Characteristics

SMART Metering

- Industrial Meters
- Residential Meters
- Non-Billing Meters

Residential Meters:
- Electricity Meters
- Gas, Water & Heat Meters

Electricity Meters:
- High End Implementation
- Low End Implementation
- Low End Integrated Implementation

- Comm. to utility only
- Minimum required performance

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Market Segmentation & Characteristics

SMART Metering

- **Industrial Meters**
- **Residential Meters**
- **Non-Billing Meters**

Under Residential Meters:
- **Electricity Meters**
- **Gas, Water & Heat Meters**

Under Electricity Meters:
- **High End Implementation**
- **Low End Implementation**
- **Low End Integrated Implementation**

- Comm. to utility only
- Minimum required performance
- AFE integrated where allowed

Smart Metering Building Blocks

Smart Metering Building Blocks

RTC

Analog Front End

RFID UHF Connectivity
PCB Tracking ICs

Smart Card Interface
Contactless reader ICs

Logic

Discrete Components

Temperature Sensors

Power Supply
(STARplug)

AFE

MCU

UART

I²C

SPI

Flash

RS485

Ethernet

LCD Driver

LCD Segment Drivers

Wireless Connectivity

Zigbee Solutions

M-Bus Solutions

GSM / GPRS Solutions

Long Range RF Solutions

Wired Connectivity

Power Line Carrier

☐ Available
☐ Under Consideration

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Smart Metering Building Blocks

hyperlinks to www.NXP.com pages

Microcontrollers		Connectivity	Real Time Clock	LCD Display Driver	Power Supply
ARM Cortex M3 LPC17xx family Samples end 2008 M3 Core release 2, 120 MHz up to 64kB SRAM up to 512kB Flash Rich peripheral set True 12bit ADC True RTC (<1µA) Ethernet, USB, 5 UARTs **ARM Cortex M0** LPC11xx family 50 MHz up to 8kB SRAM up to 32kB Flash UART / SPI / I2C	**ARM7 LPC2000** LPC2000 family > 50 family members up to 72 MHz up to 1MB of Flash up to 100kB of SRAM Rich peripheral set Ethernet, USB, CAN on chip LCD Driver 10bit ADC 4 UARTs **ARM9 LPC3000** growing family, 270MHz 256KB RAM, LCD, Touch sc. Ethernet, (HS)USB, …	**Jennic JN5148** **Zigbee Pro** **Transceiver** 2.4 GHz transceiver with built-in low power MCU for Zigbee Pro and JenNet SW stacks **RF M-Bus** **OL23xx Family** 315 / 434 / 868 / 915 MHz operation 112 kcps to support all M-Bus protocols	**Lowest Power RTC** **PCF2123** typ. 120nA, Tunable to +/-1ppm at room temp. **Accurate RTC (aRTC)** **PCF2127,9** temperature sensor with compens. (3ppm) Quartz oscillator integrated **Low Power, Low cost** **RTC, PCF8563/85** w/w.o. RAM, low power 250nA	**LCD Segment Driver** PCF8562: 128 sgmt PCF8576D: 160 sgmt PCF8534A: 240 sgmt **LCD Character Driver** PCF2113: 120 icons & 2*12 / 1*24) (line*character) PCF2119: 160 icons & 2*16 (lines* characters) **LCD Graphic Driver** PCF8535: 65x133 PCF8531: 34x128	**Power Supply ICs** **Starplug TEA15xx** with integrated MOSFETs Valley switching for incr. efficiency and less EMI **Contact and** **contactless Reader** **ICs** RFID/NFC 13.56MHz contact smart card readers for prepaid meters

Logic ICs	Transistors, Diodes and ESD Protection
largest portfolio of functions and packages	large portfolio, ultra small packages, Low $R_{DS(ON)}$, MOSFETs, low $V_{CE(sat)}$ (BISS) trans., Low V_f Schottky diodes, ESD protection diodes and arrays, Complex discretes: RETs, loadswitches, etc

Smart Metering Building Blocks

RTC

Analog Front End

RFID UHF Connectivity PCB Tracking ICs

Smart Card Interface Contactless reader ICs

Logic

Discrete Components

Temperature Sensors

Power Supply (STARplug)

MCU

AFE | UART | I²C | SPI | Flash | RS485 | Ethernet | LCD Driver

LCD Segment Drivers

Wireless Connectivity

Zigbee Solutions

M-Bus Solutions

GSM / GPRS Solutions

Long Range RF Solutions

Wired Connectivity

Power Line Carrier

Available

Under Consideration

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Evolving Metering MCU Family Roadmap

Gas Water & Heat Metering MCU	• **Ultra Low Power Platform** • **All Regions** • **Under Consideration**
Integrated LE Metering MCU	• **3-Phase with AFE Included** • **India and Eastern Europe** • **Under Consideration**
Industrial Metering MCU	• **Ethernet IP Metering** • **All Regions** • **Q4-2010**
HE Residential Metering MCU	• **Anti-Tampering 3-Phase** • **Western Europe and USA** • **Q4-2010**
LE Residential Metering MCU	• **Single Phase Metering** • **China and Eastern Europe** • **Q3-2010**
Non-Billing Energy Metering IC	• **Single-Phase Non-Billing** • **All Regions** • **EM773 Available NOW!!!**

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Energy Metering IC for Non-Billing Meters EM773

- ▶ Perfect solution for non-billing metering apps
  - – Plug meters
  - – SMART appliances
  - – Industrial sub-meters

- ▶ Exceeds market requirements with better than 1% metering accuracy

- ▶ Most integrated and cost efficient solution

- ▶ No metering know-how required

- ▶ Fast time-to-market with demo designs

- ▶ Product differentiation via application SW

- ▶ Wireless M-Bus demonstrator design

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Energy Metering IC for Non-Billing Meters EM773

Optimized metrology inside with optional network connection

| Metrology Engine | Cortex-M0 48 MHz | Up to 32 KB Flash |
| Up to 8 KB SRAM |
| Advanced Peripheral Bus |
| 1x SPI 1x I²C | 1x UART RS485 / IrDA |
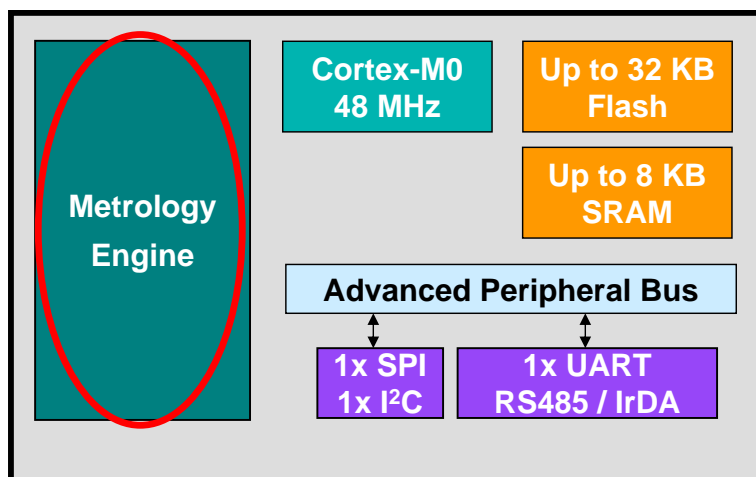
- Built-in metrology engine hardware and software
- Application programmable
- UART available for communications port
- Standard ARM support ecosystem available for easy development

33-pin HVQFN

Available NOW!!!

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Energy Metering IC Firmware
Integrated and Programmable E-Meter Solution

▶ Single phase measured hardware parameters:
 – W, VA, VAr, kWh, kVAh, kVArh, V, I, frequency, cosφ
 – Correct reactive power, also for non-sinusoidal currents
 – Registers for consumed, produced and total energy
 – Indication of energy costs (total and day counters)
  Optionally Real Time Clock for tariff differentiation

▶ Wireless M-Bus output (SPI to OL2381)

▶ Serial output (I2C / UART / SSP / SPI)

▶ Programmable device: enables customized applications
 – Low CPU load, other applications can run in-parallel with meter application
 – Example software with Low cost Real Time Operating System

▶ Low cost front end: Resistive voltage divider and shunt resistor (or current transformer for very high currents when required)
 – Multiple operational amplifier gain channels for large dynamic range
 – Depending on mains isolation requirements: Voltage transformer

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Energy Metering IC EM773 Principle block diagram

- ▶ Power supply
  - 3.3V as V_{DD} required

- ▶ Analog circuitry for current measurement
  - accuracy options

- ▶ Analog circuitry for voltage measurement

- ▶ Oscillator

25
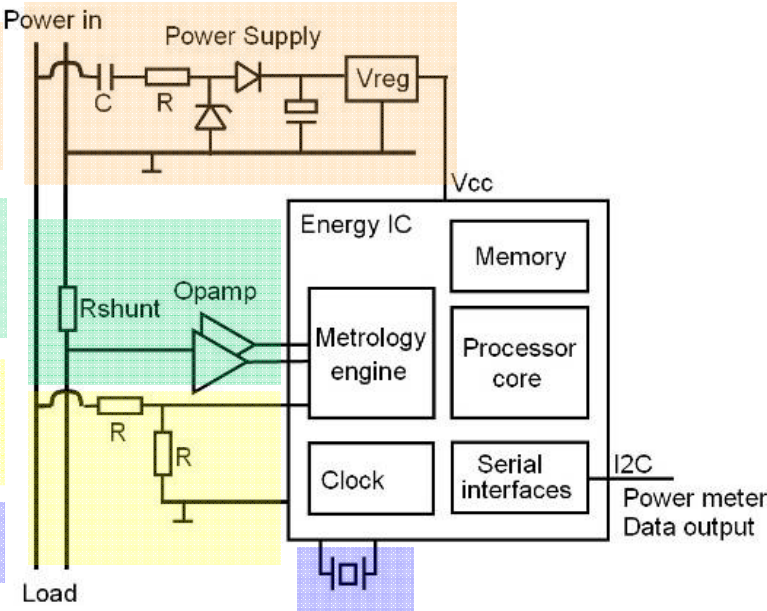
Energy Metering IC EM773
Analog input circuits options

Voltage measurement circuit

▸ Voltage Divider
  – Cost efficient solution

▸ Transformer
  – Full galvanic isolation

Current measurement circuit

▸ Shunt Resistor
  – Series resistor with defined low resistance
  – Cost efficient solution

▸ Current Transformer
  – Low dissipation at high current
  – Standalone or PCB mounted
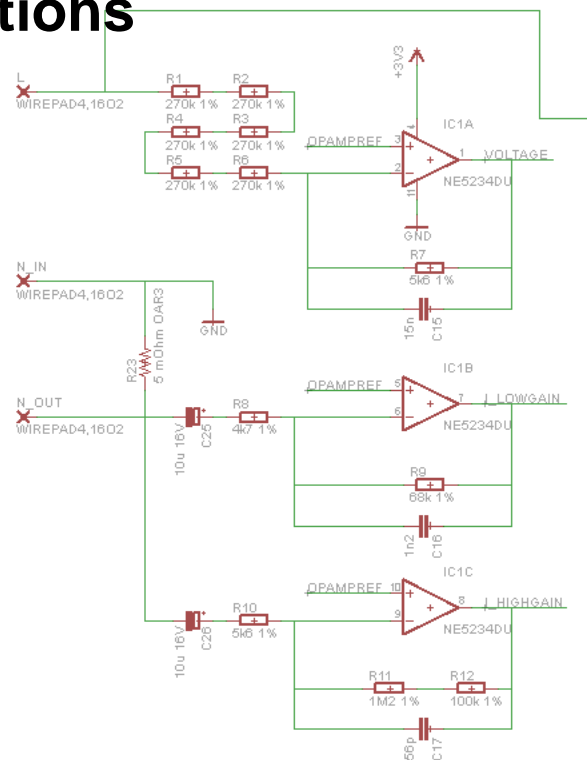
Energy Metering IC EM773
Metrology engine – Key functionality

- Embedded calculation of all relevant energy measurement parameters
  - P_{real}, $P_{reactive}$, $P_{apparent}$, V_{rms}, I_{rms}

- Accuracy better than 1% for 1:400 power range. Examples:
  - 0.1 W accuracy at 10 W load for a 4000 W_{max} meter
  - 0.092 W accuracy at 9.2 W for a 3680 W_{max} (230V 16A) plugmeter
  - 0.058 W accuracy at 5.8 W load for a 2300 W_{max} (115V 20A) appliance

- Improved accuracy for top end of the specified power range

- Automatic DC offset tracking

- Measurements include harmonics of the mains
  - Up to 40 harmonics for 50 Hz net frequency
  - Up to 33 harmonics for 60 Hz net frequency

- Correct reactive power calculation for non-sinusoidal currents (e.g. switched mode power supplies)

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Energy Metering IC EM773
Definition of API input values

- ▸ API Input: Voltage and Current
  - Start Metrology Engine with standard settings for Vpp, I1pp and I2pp derived from input circuits
  - Measure voltage and current from a calibrated source
  - Correct the voltage and current ranges Vpp, I1pp and I2pp with the relative difference

- ▸ API Input: Phase Correction
  - Measure the phase difference between voltage and current channels for two resistive loads (high current and low current) and enter this value Phi1 and Phi2 as the required phase correction

Energy Metering IC EM773 Calibration

▸ Real time calibration adjustments

- – The calibration parameters can be adjusted real-time by the application running on the Cortex M0 processor core.
- – This feature can for example be used to implement temperature compensation or to switch between different measurement inputs

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Energy Metering IC EM773
Definition of API output values

Q Reactive Power [VAR]

|S| Apparent Power [VA]

Φ
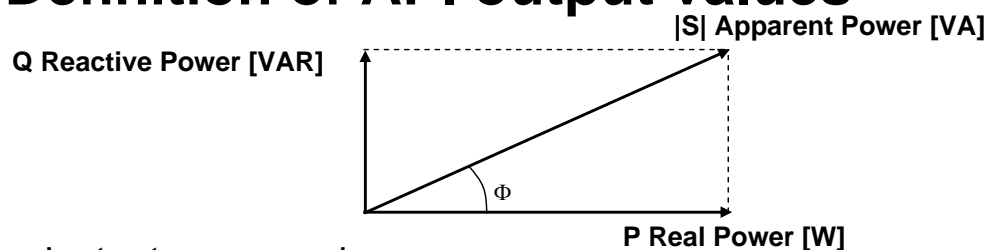
P Real Power [W]

▶ Instantaneous values:
- Real Power (P) [W]
- Reactive Power (Q) [VAR]
- Apparent Power (|S|) [VA]
- Voltage (V) [V]
- Current (I) [A]
- Power factor = Real / Apparent Power $\Rightarrow \cos(\Phi)$

▶ Accumulated over time in application SW
- Energy [kWh]

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Energy Metering IC EM773 Application software options

- Process P_{real}, $P_{reactive}$, $P_{apparent}$, V_{rms}, I_{rms} from Metrology Engine
  - Calulate kWh energy registers for one or more tariffs (T1, T2, ...)
  - 4-quadrant meter, measures both consumed energy (+T1, +T2, …)and produced energy (-T1,-T2, …)

- Energy-Creep filtering
  - Thresholds can be configured to prevent measuring noise energy

- Positive-accumulate-only option
  - Some applications require 2-quadrant operation

- Fully programmable to enable a multitude of output devices
  - Examples for Wireless M-bus, I2C LCD, UART output
  - Use the 50 MHz Cortex M0 processor core in the Energy Metering IC with up to 32 kB flash and 8 kB SRAM memory

EM773 Tool Highlights

- Evaluation boards
  - Plug meter with EM773 and OL2381
  - USB transceiver with LPC1343 and OL2381
  - Wireless M-Bus S1 Mode Software Included!

- IDEs Supporting EMxxx Metrology Engine
  - IAR Embedded Workbench for ARM (NOW!!!)
  - Keil and Code Red (Coming soon!)

- SWD debuggers
  - All debuggers supporting Cortex-M0

EM773 Plug Meter

PC Energy Display

M-Bus USB Adapter

MCU Residential & Industrial Electricity Meters
LPC17xx – Available NOW!!!

Highest performance with many options including ethernet

Up to 512 KB Flash	**Cortex-M3 120 MHz**	**Up to 64 KB SRAM**
		Ethernet

Advanced Peripheral Bus

12-bit / 8-ch ADC	**3x SPI 2x I²C**	**4x UART RS485 / IrDA**	**RTC**
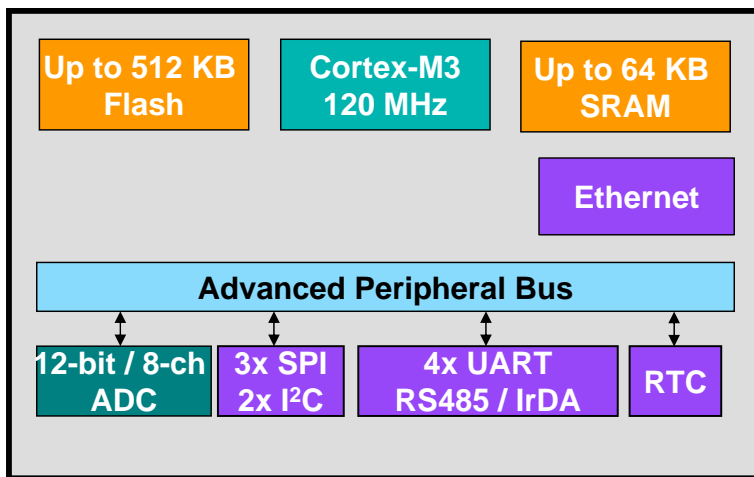
- Optimized solution for industrial metering
- Advanced apps with superior MCU performance
- Ultimate flexibility for modular development
- Integrated ethernet MAC for IP network connection

80/100-pin LQFP

http://ics.nxp.com/products/lpc1000/lpc17xx/

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LPC1700 Tools Highlights

- Evaluation boards
    - Embedded Artists
    - Hitex LPC17xx-Stick
    - IAR KSDK-LPC17xx
    - Keil MCB17xx
    - mBed LPC1768

- IDEs
    - IAR Embedded Workbench for ARM
    - ARM/Keil µVision4
    - CodeRed RedSuite
    - Hitex HiTOP
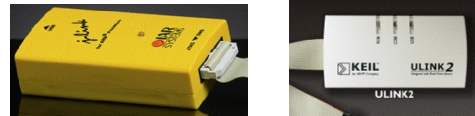
- JTAG debuggers
    - All debuggers supporting Cortex-M3
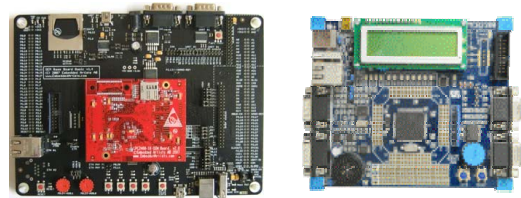
- Plus many more tools available!

MCU Smart Metering Communications Modules LPC13xx & LPC11xx – Available NOW!!!

Perfect MCU options for adding communications to existing meters

Up to 32 KB Flash	M0: 50 MHz M3: 72 MHz	Up to 8 KB SRAM

USB

Advanced Peripheral Bus

10-bit / 8-ch ADC	2x SPI 1x I²C	1x UART RS485 / IrDA
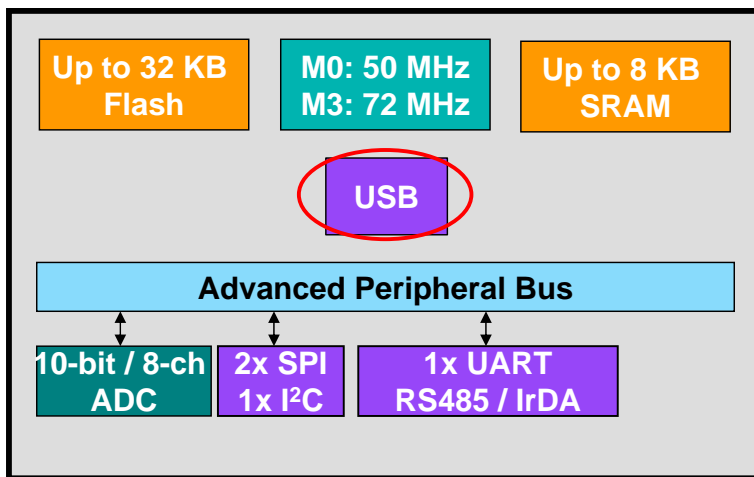
- ▸ Optimized solution for communications module
- ▸ Integrated USB option with LPC13xx family
- ▸ Demo USB keys available with LPC1343 and OL2381

33-pin QFN / 48-pin LQFP

http://ics.nxp.com/products/lpc1000/lpc11xx/
http://ics.nxp.com/products/lpc1000/lpc13xx/

LPC1300/1100 Tools Highlights

- Evaluation boards
  - LPC Xpresso
  - Hitex Sticks
  - IAR Kickstart Kits
  - Keil MCB1000

- IDEs
  - IAR Embedded Workbench for ARM
  - ARM/Keil μVision4
  - CodeRed RedSuite
  - Hitex HiTOP

- JTAG debuggers
  - All debuggers supporting Cortex-M0/M3

- Plus many more tools available!
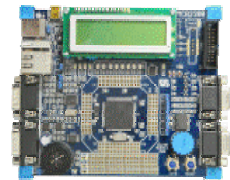
Where to get started?

- www.nxp.com/microcontrollers
  - MCU homepage

- www.nxp.com/lpczone
  - Product updates and training

- www.nxp.com/lpcxpresso

- www.mbed.org

Social media for NXP microcontrollers

twitter LPCZone

http://twitter.com/LPCZone

- Online community for NXP LPC microcontrollers.
- Follow LPCZone and you will have the most up-to-date information on the LPC product families.

You Tube™

http://www.youtube.com/user/LPCZone

- Design videos, trainings, interviews, fun

YAHOO! GROUPS

http://tech.groups.yahoo.com/group/lpc2000/
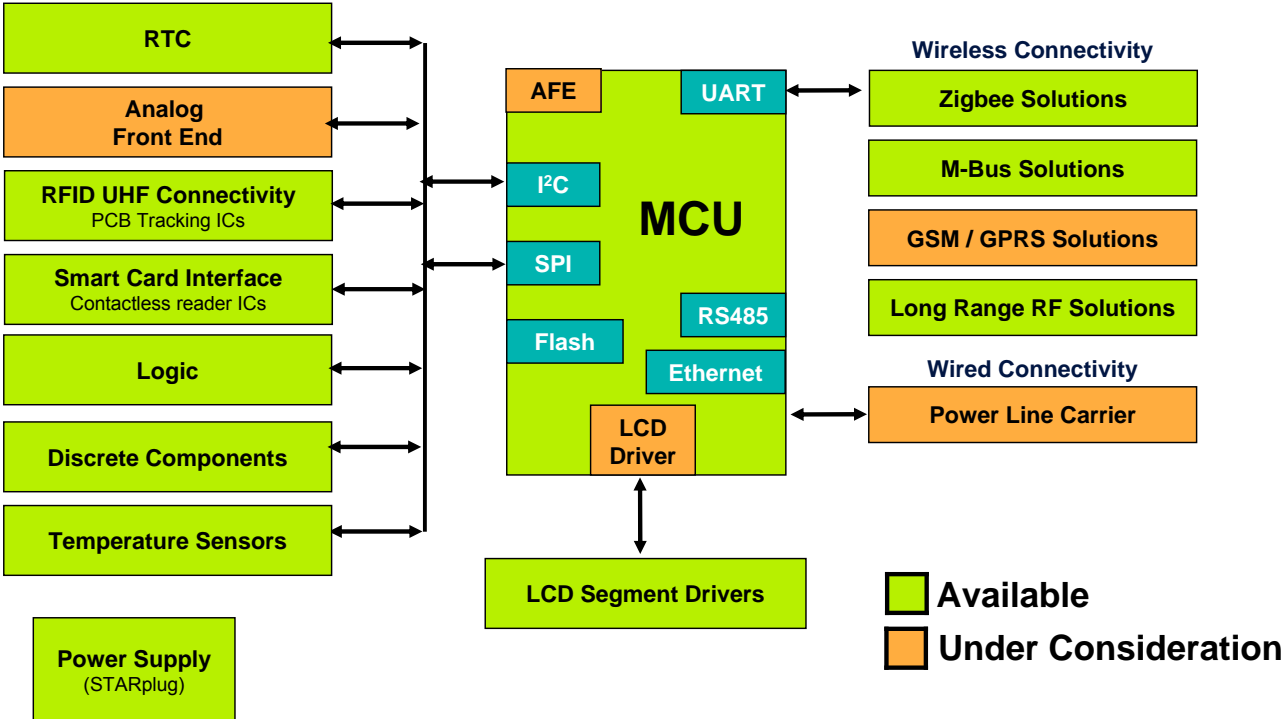
- More than 8,700 registered members (as of May 24, 2010)
- The #1 active Microcontroller user forum on Yahoo!

Smart Metering Building Blocks

RTC

Analog Front End

RFID UHF Connectivity
PCB Tracking ICs

Smart Card Interface
Contactless reader ICs

Logic

Discrete Components

Temperature Sensors

Power Supply
(STARplug)

AFE **UART**

I²C

MCU

SPI

RS485

Flash

Ethernet

LCD Driver

LCD Segment Drivers

Wireless Connectivity

Zigbee Solutions

M-Bus Solutions

GSM / GPRS Solutions

Long Range RF Solutions

Wired Connectivity

Power Line Carrier

Available

Under Consideration

NXP Wireless M-Bus Product offering

▸ Use Cases for In-house communication
  – Wireless Display   -- Sub-Meters (Gas / Water / Heat)
  – Smart Appliances   -- Remote Switches
  – USB dongle to access meter data by PC / mobile devices

▸ Advantages of Wireless M-Bus
  – Reliable and cost-efficient wireless solution
  – Technical advantages over Zigbee
  – Less installation cost

▸ NXP products for Wireless M-Bus solutions
  – OL2300: RF Transmitter
  – OL2311: RF Receiver
  – OL2381: RF Transceiver

▸ Full Wireless M-Bus Compliance

▸ Reference design available
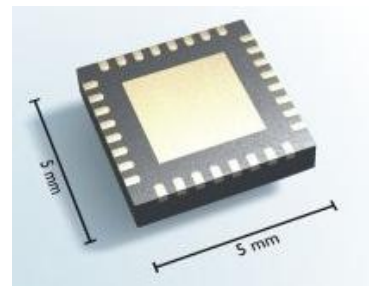
NXP RF Products for Wireless M-BUS
Value Propositions

- **Efficient Transmitter Power Amp** (required for S1 and S1m M-BUS modes)
  - Programmable power output for optimal performance in every M-BUS Tx Class

- **Highly Sensitive Receiver** (required for all receiving M-bus modes)
  - Programmable receiver gain for optimal reception performance / current consumption balance.

- **Flexible Data Rate** (required for T M-BUS modes)
  - Up to 112kcps data rate for compatibility with all M-bus modes

- **Polling Timer & Preamble Detection** (required for all M-BUS modes)
  - Flexible Signal Monitors prevent 'false wakeups' & allow long system battery life.

- **Multi-Channel Operation** (required for R2 M-BUS mode)
  - Entire RF Range can be programmed on-the-fly to operate on different radio channels (jammer avoidance)
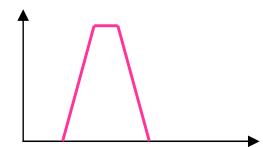
**Low Data Rate (S & R modes)**: Narrowband for communication distance
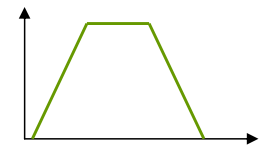
High Data Rate (T modes): Broadband channel filter

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OL2300 Overview

- Fractional N PLL based RF Transmitter Solution

- 315 / 434 / 868 / 915 MHz operation

- Auto Antenna Tuning capability

- Data Rate up to 112kchips/s

- Fully software configurable

- HVQFN 16
  Small package outline
  3mm x 3 mm

Transceiver - Bidirectional
OL2381 Overview

- Two Way RF Transceiver Solution (half duplex)

- Fractional N PLL: 315 / 434 / 868 / 915 MHz

- Value Proposition

  - Fully software configurable, including On-Chip programmable IF-Filter

  - Low Power Polling timer and preamble detection

  - High RX Sensitivity & High TX Efficiency
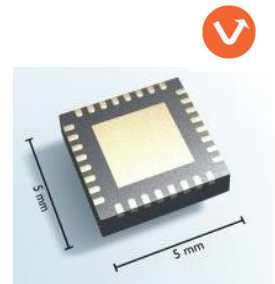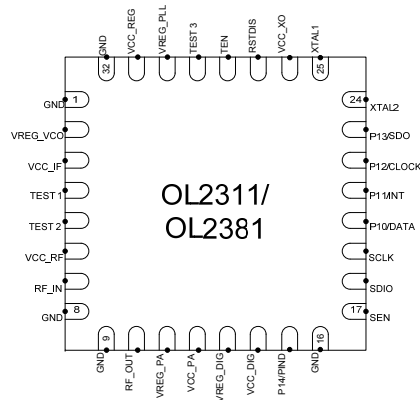
- HVQFN32 Package

  Quick Reference Data
  Supply Voltage: 2.1V … 3.6V
  Receive Current: 16.5 mA
  Transmit Current: 9mA @ 0dBm
  Sensitivity ASK -118 dBm @2.4kpbs (50kHz BW)
  Sensitivity FSK -112 dBm @2.4kpbs (50kHz BW)
  Lo Frequency Step Width: 150 Hz
  IF Channel BW: 50/75/100/150/200/300kHz
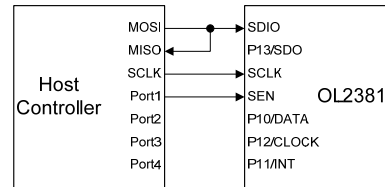 RSSI Dynamic Range: 80 dB
  Frequency Change Latency Time: 150µs

Wide band required   Narrow band desired

w/ optional multi-channel use
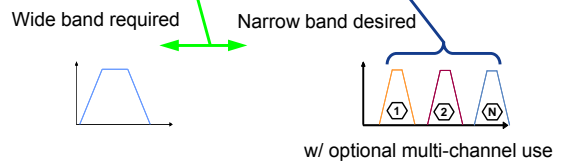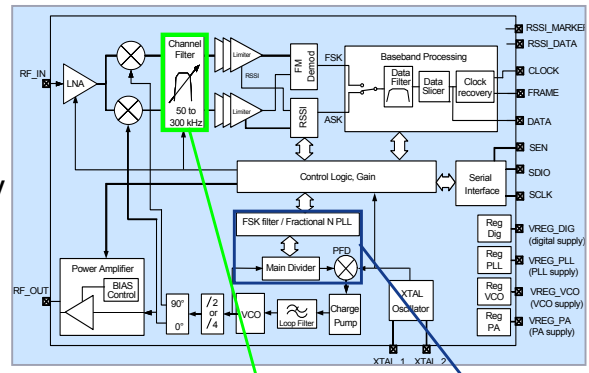
Key Application Strengths: Size and Integration

- LNA
- IF Polyphase Variable Channel Filter
- VCO +TANK
- PA
- SPI Interface

OL2311/ OL2381

Minimum

Host Controller

MOSI	SDIO
MISO	P13/SDO
SCLK	SCLK
Port1	SEN
Port2	P10/DATA
Port3	P12/CLOCK
Port4	P11/INT

OL2381

Maximum

Host Controller

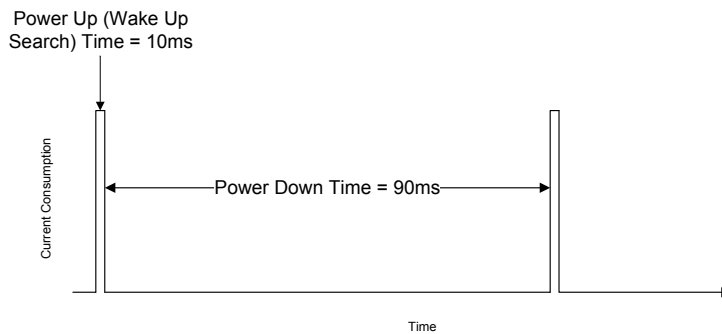| MOSI | SDIO |
MISO	P13/SDO
SCLK	SCLK
Port1	SEN
Port2	P10/DATA
Port3	P12/CLOCK
Port4	P11/INT

OL2381
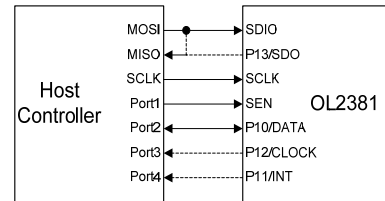
Application Strength – Low System Power Consumption with Intelligent Polling

Average System Current Consumption (mA)*

$$\frac{(16.5mA \times 10ms) + (5\mu A \times 90ms)}{100ms} = 1.65mA$$

Power Up (Wake Up Search) Time = 10ms

Current Consumption

Power Down Time = 90ms

Time

*Communication protocol and application dependent

Product Range Overview

Type Number		OL2300	OL2311	OL2381
Product Type		Transmitter	Receiver	Transceiver
Supply Voltage		2.1 V to 3.6 V	2.1 V to 3.6 V	2.1 V to 3.6 V
Operating Temperature	HVQFN	- 25 °C to + 85 °C	- 25°C to + 85 °C	- 25 °C to + 85 °C
Power Down Current		50 nA	500 nA	500 nA
UHF Carrier Frequency		300 - 920 MHz	300 - 928 MHz	300 - 928 MHz
Xtal Frequency		9 - 19 MHz	16 MHz	16 MHz
Transmitter			N/A	
Supply Current	XTAL	180 µA		900 µA
	PLL	1.3 mA		5 mA
	Tx@6dBm	7 mA		14 mA
Max Output Power		up to 12dBm		up to 10dBm
Data Rate		up to 112 kcps		up to 112 kcps
Modulation		ASK, FSK		ASK, FSK
Phase Noise	@100kHz	-76 dBc		-86 dBc
	@10MHz	-115 dBc		-130 dBc
Receiver		N/A		
Supply Current			16.5 mA	16.5 mA
Data Rate			up to 112 kcps	up to 112 kcps
Modulation			ASK, FSK	ASK, FSK
Sensitivity	ASK		-118 dBm	-118 dBm
	FSK@50kHz BW		-112 dBm	-112 dBm
Adjacent channel rejection			10 dB	10 dB
Image channel rejection	calibrated		40 dB	40 dB
Channel Filter BW			50 to 300 kHz	50 to 300 kHz
Polling Timer Period			1ms to 4096ms	1ms to 4096ms
RSSI	Dynamic Range		80 dB	80 dB
	Absolut Accuracy / Variation		±12 dB / ±3 dB	±12 dB / ±3 dB
Package		HVQFN16	HVQFN32	HVQFN32

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OL23xx Tool Highlights

▶ Evaluation boards
  – Plug meter with EM773 and OL2381
  – USB transceiver with LPC1343 and OL2381
  – Wireless M-Bus S1 Mode Software Included!

▶ IDEs Supporting EMxxx Metrology Engine
  – IAR Embedded Workbench for ARM (NOW!!!)
  – Keil and Code Red (Coming soon!)

▶ IDEs Supporting Wireless M-Bus Stack
  – IAR Embedded Workbench for ARM (NOW!!!)
  – Keil and Code Red (Coming soon!)

▶ SWD debuggers
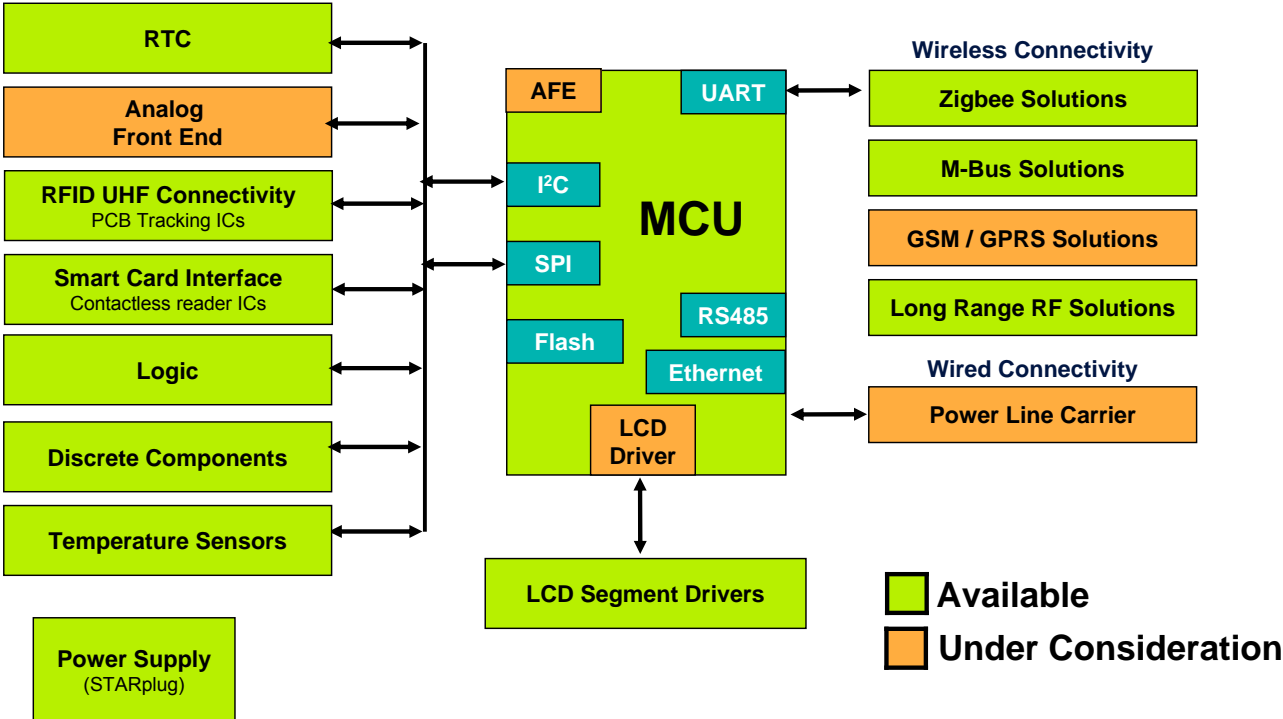 – All debuggers supporting Cortex-M0

EM773 Plug Meter

PC Energy Display

M-Bus USB Adapter

Smart Metering Building Blocks

NXP Value Proposition for Real Time Clocks (RTC) ⓥ

- ▶ Application context / why does timing matter?
  - – Tariff switching
  - – Time stamping (e.g. billing, anti tampering etc.)

- ▶ Timing accuracy levels
  - – The accuracy of normal RTC's is temperature dependant
  - – Options to achieve higher accuracy
    - • Temperature compensation
    - • Synchronization via network
  - – Rule of thumb: longer / no synchronization intervals – higher accuracy needed

- ▶ NXP most recommended parts
  - – PCF2127A / PCF2129A (highly accurate)
  - – PCF2123 / PCF8523 (ultra low power)

- ▶ Advantages:
  - – Integrated crystal
  - – Temperature compensated (incl. calibration)
  - – Ultra low power consumption (key for battery operated / backed systems)
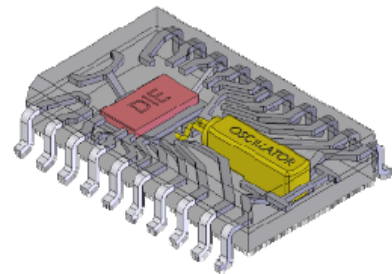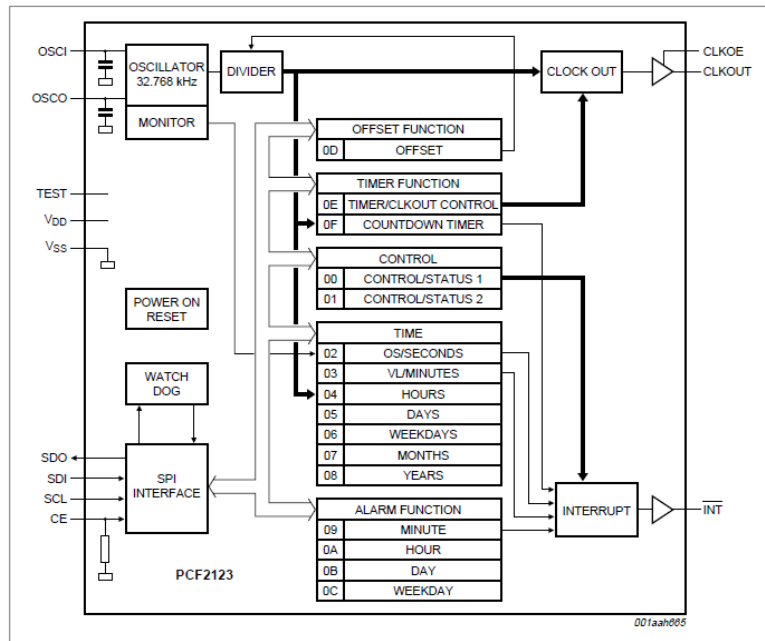
CWG **Realtime Clocks**

Low-power RTC Family

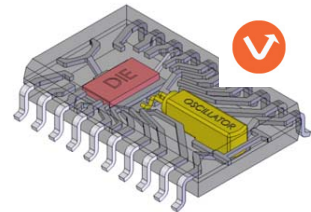▸ **PCF2123 Ultra-low Power RTC** (**100nA** (typ.) at Vdd = 2.0V and T_{amb} = 25ºC)

Key Features:

▸ Ultra low power **100nA/2V** (typ.)

▸ Large voltage range 1.5…5.5V

▸ SPI bus up to 6MHz

▸ Clock from seconds to 99 years

▸ Programmable Timer

▸ Frequency output with output enable pin

▸ Electronic tuning

▸ Small packages TSSOP14, HVQFN16 and U (die only)

CWG Realtime Clocks
Accurate RTC Family

▶ Selection Table **High Accuracy**

➢ Highly accurate time reference independent of temperature

➢ To enable accurate tariff switching in utility metering systems

Part	Description	Interface	Accuracy (typ.)	Package	Status
PCF2127A	real time clock/calendar; integrated RAM; temperature compensation; integrated quartz crystal; power management support; operating temperature range -40°C to +85°C	I²C & SPI	+/- 3ppm -15°C to +60°C +/- 5ppm -25°C to -15°C and +/- 5ppm +60°C to +65°C	SO20	*released*
PCF2129A	real time clock/calendar; temperature compensation; integrated quartz crystal; automotive option available; operating temperature range -40°C to +85°C	I²C & SPI	+/- 3ppm -15°C to +60°C +/- 5ppm -25°C to -15°C and +/- 5ppm +60°C to +65°C	SO20	*released*

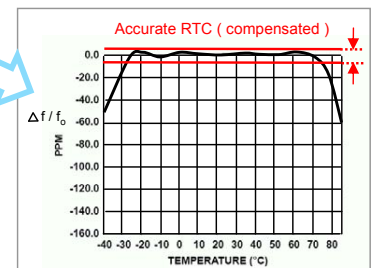**PCF2129A and PCF2127A NOW released and in volume production !!!**

CWG Realtime Clocks
Accurate RTC Family

▶ **PCF2129A/27A Highly accurate RTC** (**±3ppm** (typ.) over T_{amb}= -15ºC to +60ºC)

Key Features:

▸ **±3ppm** accuracy -15°C to +60°C (typ.)

▸ Integrated Quartz Crystal

▸ Temperature Compensation

▸ Factory calibrated

▸ 512 Byte of on-chip RAM (PCF2127A)

▸ SPI & I2C Interface

▸ SO20 Package
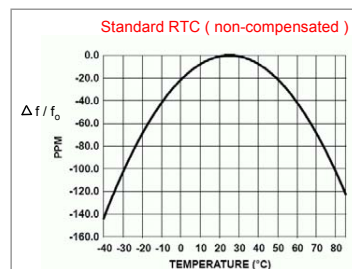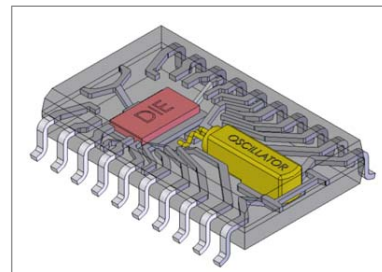
Standard RTC (non-compensated)

Accurate RTC (compensated)

CWG Realtime Clocks
Accurate RTC Family

▶ **PCF2129A/27A Highly accurate RTC** (**±3ppm** (typ.) over T_{amb}= -15ºC to +60ºC)

Type	PCF2127A	PCF2129A
Operating Temp. Range	-40ºC, …, +85ºC	-40ºC, …, +85ºC
Accuracy (typ.)	+/- 3ppm -15°C to +60°C +/- 5ppm -25°C to -15°C +/- 5ppm +60°C to +65°C	+/- 3ppm -15°C to +60°C +/- 5ppm -25°C to -15°C +/- 5ppm +60°C to +65°C
Interface	I²C and SPI	I²C and SPI
RAM	**512 Byte**	–
Package	SO20	SO20
Supply Voltage Range VDD	**1.8V – 4.2V**	**1.8V – 4.2V**
Battery Supply Voltage Range VBat	1.8V – 4.2V	1.8V – 4.2V
Supply Current (typ.)	650nA @ 3.0V and Tamb=25C	650nA @ 3.0V and Tamb=25C
Battery Switch over function	Yes	Yes
Battery Low-Detection Function	Yes	Yes
Extra Power Fail Detection Function	**Yes**	**No**
Battery backed Output Voltage Pin	Yes	Yes
Reset Output Pin	**Yes**	**No**
Countdown timer and watch dog function	**Yes**	**Watchdog only**
Time Stamp Function	Yes	Yes

The 5V version of PCF2127 formerly named PCF2128 is currently not in focus

CWG Realtime Clocks

▶ More Information:
  – http://ics.nxp.com/products/real.time.clock.calendars/

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Smart Metering Building Blocks

RTC

Analog Front End

RFID UHF Connectivity
PCB Tracking ICs

Smart Card Interface
Contactless reader ICs

Logic

Discrete Components

Temperature Sensors

Power Supply
(STARplug)

AFE | UART

I²C

MCU

SPI

Flash

RS485

Ethernet

LCD Driver

LCD Segment Drivers

Wireless Connectivity

Zigbee Solutions

M-Bus Solutions

GSM / GPRS Solutions

Long Range RF Solutions

Wired Connectivity

Power Line Carrier

Available
Under Consideration

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NXP Value Proposition for LCD Display Driver

▶ Application context
  – Display drivers are used to show the meter measurement data
  – Typical requirement is 128 to 160 segment display in the meter

▶ Implementation options
  – Integrated in MCU
  – Chip-on-Glass / Chip-on-Board
  – Stand-alone devices

▶ NXP most recommended stand-alone parts
  – PCF85162: 128 segment driver (4 x 32 segments)
  – PCF85176: 160 segment driver (4 x 40 segments)

▶ Advantages:
  – Low power consumption
  – Design flexibility (placement of DD vs. display)
  – Support of various displays technologies

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LCD Drivers: Key Products

Segment Drivers	Character Drivers	Graphic (Dot Matrix) Drivers

Segment Drivers
- PCF85162   4 x 32 Segments **NEW**
- PCF85176   4 x 40 Segments **NEW**
- PCF85134   4 x 60 Segments **NEW**
- PCF85133   4 x 80 Segments **NEW**
- PCF85132   4 x 160 Segments **NEW**
- PCA9620   8 x 60 Segments [1]

Character Drivers
- PCF2113   2-line x 12-Character Plus 120 icons
- PCF2116   2-line x 24-Character
- PCF2119   2-line x 16-Character Plus160 icons

Graphic (Dot Matrix) Drivers
- PCF8531   34 x 128 Small 4-x-20 Text Characters Full Graphics
- PCF8811   80 x 128 Large Universal display

[1] In Development

For Details, see the LCD Drivers Selection Guide
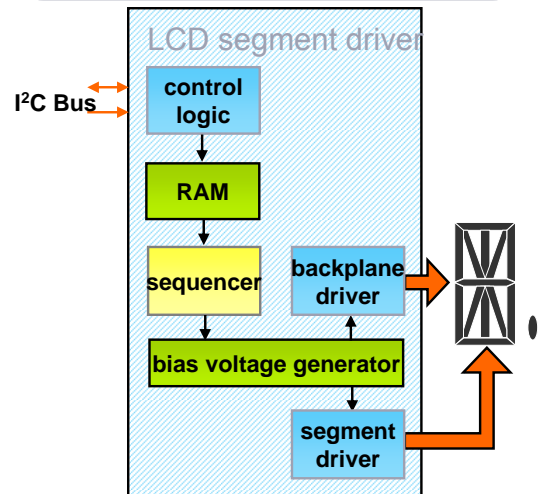
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CWG LCD Drivers

Segment Driver Family

▸ LCD Segment Drivers

Features

- ▸ Drives wide range of displays from 128, 160, 240, 320, 480 up to 640 segments
- ▸ Supports four different Multiplex Rates: 1:1 (static), 1:2, 1:3 and 1:4 (PCA9620 additionally Mux 1:8)
- ▸ On-chip RAM with auto incremental addressing
- ▸ Low power consumption
- ▸ Wide power supply range
- ▸ Two selectable frame frequency ranges: 82Hz typically or 110Hz typically (PCF85133)
- ▸ Programmable frame frequency from 60Hz to 90Hz (PCF85132)
- ▸ Internal charge pump and VLCD temperature compensation for better optical performance (PCA9620)

Key products

▸ PCF85162	4 x 32 segme	
▸ PCF85176	4 x 40 segments	
▸ PCF85134	4 x 60 segments	
▸ PCF85133	4 x 80 segments	
▸ PCF85132	4 x 160 segments	
▸ PCA9620	8x 60 segments *(in development)*	

LCD segment driver

I²C Bus → control logic → RAM → sequencer → bias voltage generator → segment driver; backplane driver

http://ics.nxp.com/products/lcd.drivers/segments/
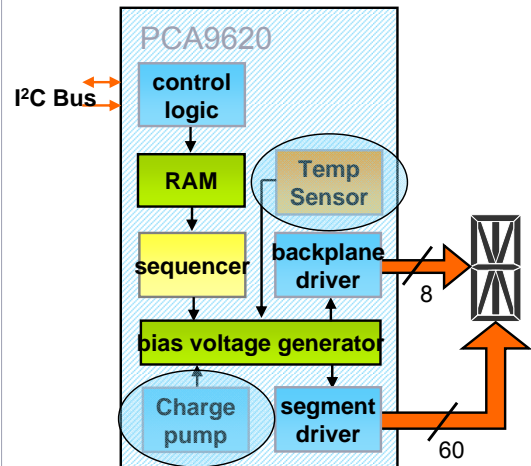
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CWG LCD Drivers
Segment Driver Family

- **PCA9620 60x8 COG LCD Segment Driver** (supports up to **480 segments**)

Key Features:

- 480 Segment Drive in Mux 1:8 Mode
- I2C Interface
- Integrated charge pump
- Integrated temperature sensor
- On-chip VLCD generation
- Temperature compensated VLCD voltage
- Programmable and calibrated frame frequency
- Wide frame frequency range 60Hz to 300hZ
- Wide digital power supply range 1.8V to 5.5V
- Wide analog power supply range 2.5V to 5.5V
- Wide VLCD range 2.5V to 9.0V
- Wide operating temp range -40 to +95°C
- 12 x 12 x 1.4 mm LQFP80 package

PCA9620

I²C Bus → control logic → RAM → sequencer → bias voltage generator → Charge pump / segment driver

Temp Sensor → backplane driver

8 / 60

In Development

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CWG LCD Drivers

Character Driver Family

▶ LCD Character Drivers

Key products

- ▶ PCF2113 2 line by 12 characters + 120 icons
- ▶ PCF2119 2 line by 16 characters + 160 icons

Features

- ▶ On-chip character generator
- ▶ On-chip temperature compensation
- ▶ On-chip character ROM and RAM
- ▶ Low power consumption
- ▶ Minimum of external components
- ▶ On-chip LCD bias voltage generation
- ▶ Cursor support

LCD character driver

control logic

display RAM

character RAM | character ROM

I²C Bus

sequencer | row driver

bias voltage generator

column driver

http://ics.nxp.com/products/lcd.drivers/characters/
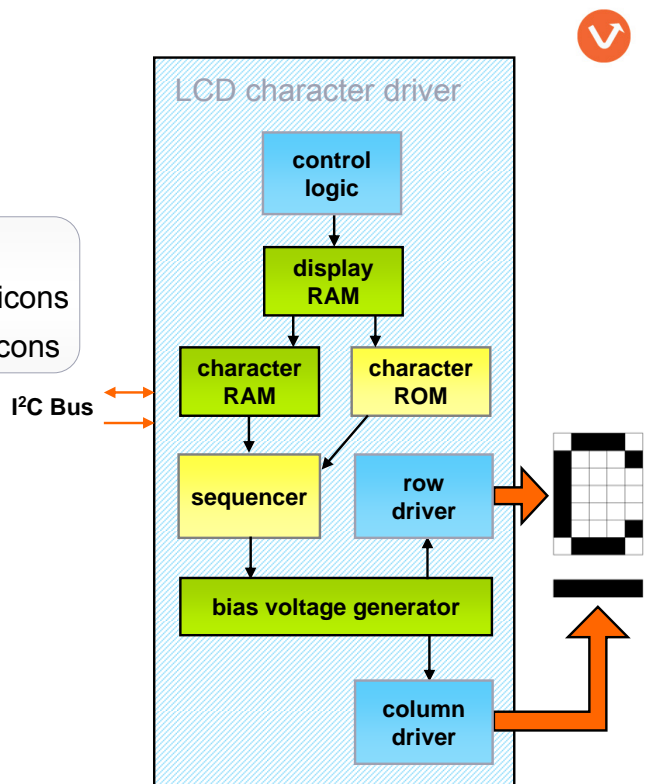
CWG LCD Drivers

Graphic Driver Family

- ▶ LCD Graphics Drivers

Key products

- ▶ PCF8531   34 x 128 small 4 x 20 chars of text, full graphic
- ▶ PCF8811   80 x 128 large universal display

Features

- ▶ Wide range of mux rates to optimize power and display size
- ▶ On-chip generation of LCD bias voltages
- ▶ Low number of external components
- ▶ Low power consumption
- ▶ Temperature compensation

Serial / parallel / I²C Interface

LCD graphic driver

- control logic
- display RAM
- sequencer
- bias voltage generator
- row driver
- column driver

http://ics.nxp.com/products/lcd.drivers/graphics/

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Smart Metering Building Blocks

RTC	
Analog Front End	
RFID UHF Connectivity PCB Tracking ICs	
Smart Card Interface Contactless reader ICs	
Logic	
Discrete Components	
Temperature Sensors	

Power Supply (STARplug)

AFE **UART**

I²C

MCU

SPI

Flash

RS485

Ethernet

LCD Driver

LCD Segment Drivers

Wireless Connectivity

Zigbee Solutions

M-Bus Solutions

GSM / GPRS Solutions

Long Range RF Solutions

Wired Connectivity

Power Line Carrier

☐ **Available**
☐ **Under Consideration**

NXP Value Proposition for Power Supply

Switch Mode Power Supply (SMPS)

▶ Application context
  – Power supplies in metering applications need to stay operational during over-voltage situations
  – Voltages up to 1200 V can occur in 3-phase meters!

▶ NXP recommended parts
  – TEA1520T AC/DC converter from StarPlug™ family

▶ Implementation
  – StarPlug™ + cascaded MOS-FET (to cope with the 1200 V)

▶ Metering Reference Design available (can be used for 3-phase systems)

▶ Advantages:
  – Designed for reliability
  – Universal design for ww mains supply
  – Low radiation (EMI)
  – Good efficiency, exceeds Energy Star standard

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Universal 3-phase Mains SMPS w/ STARplug

(Specifically intended for E-Metering applications)
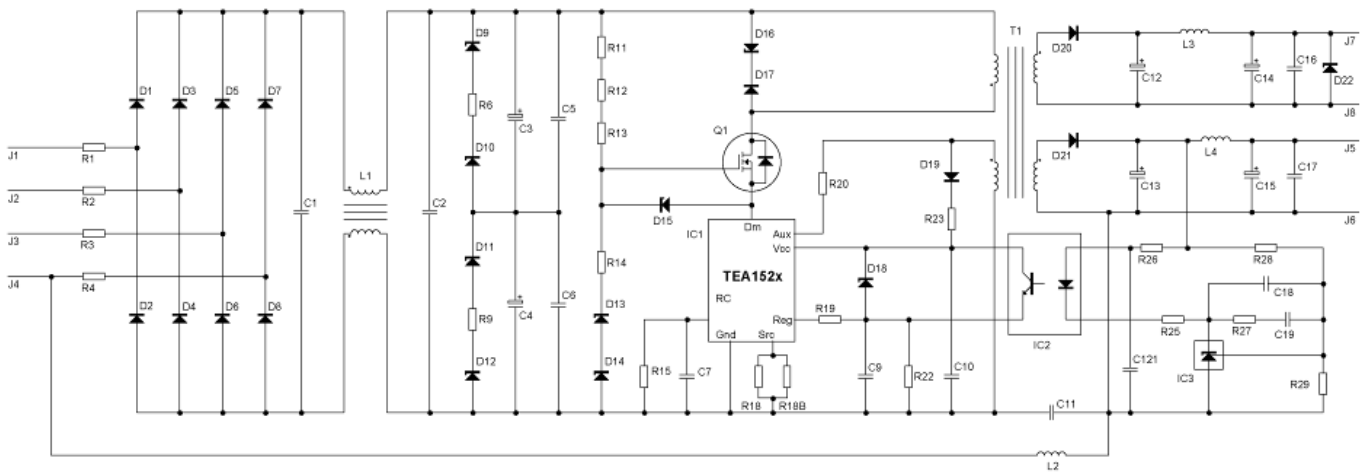
- **Supports all Global Mains Electricity Utility Networks (1-, 2- and 3-Phase).**
- **At least 20% additional voltage margin on the input stage and switching stage.**
- **Highly reliable**
- **Efficiency and no load power fully compliant with Energy Star 2.0**
- **EMI fully compliant with EN55022A**
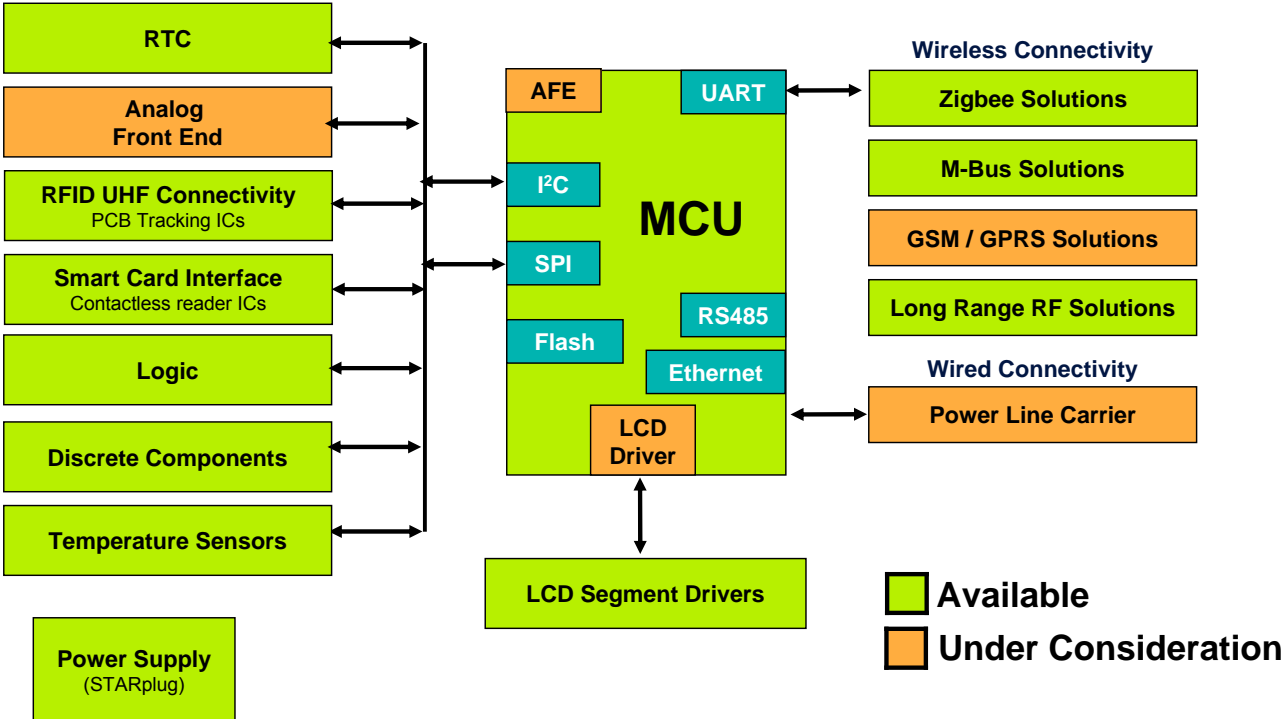
Power Supply STARplug™ portfolio

Type	Package	$R_{DS(on)}$	Max. output power
		Ω	Global mains
TEA1520T/N2	SO-14	48	2 - 5W
TEA1520P/N2	DIP-8	48	2 - 5W
TEA1521T/N2	SO-14	24	3 - 7W
TEA1521P/N2	DIP-8	24	3 - 7W
TEA1522T/N2	SO-14	12	7 - 9W
TEA1522P/N2	DIP-8	12	7 - 9W
TEA1523P/N2	DIP-8	6,5	9 - 12W
TEA1620P/N1	DIP-8	48	2 - 5W
TEA1622P/N1	DIP-8	12	7 - 9W
TEA1623P/N1	DIP-8	6,5	9 - 12W
TEA1623PH/N1	HDIP-16	6,5	12 - 30W

Smart Metering Building Blocks

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Leverage Selling Logic Products

The solutions to tune and complete a design quickly

Control and Interface logic
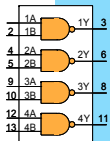
– AND, OR, NAND, NOR, INV, BUF . . .
– 1, 2, 4, 8, 16 & 32-bit solutions
– 5.0 V HC/T, AHC/T; 3.3 V LVC; 1.8 V AUP

Level translators
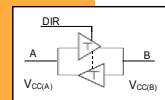
– Bi-directional translation
– 1, 2, 4, 8, 16 & 20-bit solutions
– 74LVCnT, 1.5 V ⟷ 5.5 V
  74AVCnT, 1.2 V ⟷ 3.6 V

Analogue Switches

– Low leakage for sensor multiplexing
– Low attenuation and distortion
– NX3, NX5, HEF, HC/T, LV, LVC
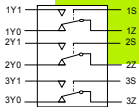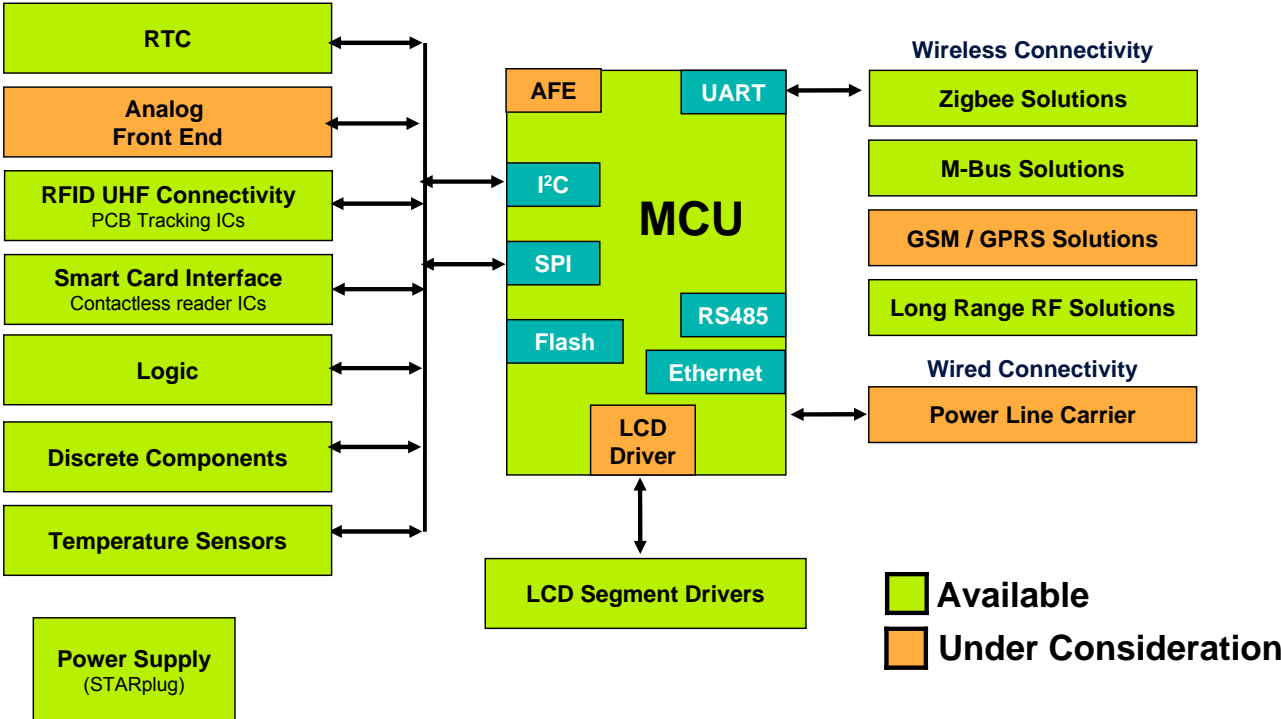
Innovation in Packages

– SO & TSSOP
– Small footprint DQFN
  • 0.5 mm & 0.4 mm pitch
– Picogates and MicroPak
  • 0.5 mm, 0.35 mm & 0.3 mm pitch

Smart Metering Building Blocks

RTC

Analog Front End

RFID UHF Connectivity
PCB Tracking ICs

Smart Card Interface
Contactless reader ICs

Logic

Discrete Components

Temperature Sensors

Power Supply
(STARplug)

MCU

AFE
UART
I²C
SPI
Flash
RS485
Ethernet
LCD Driver

LCD Segment Drivers

Wireless Connectivity

Zigbee Solutions

M-Bus Solutions

GSM / GPRS Solutions

Long Range RF Solutions

Wired Connectivity

Power Line Carrier

Available

Under Consideration

Leverage Selling Discrete Components

GA's broad portfolio offers one-stop shopping possibility

Flatpower packages:
SOD123W, SOD128

Leadless packages:
SOD882, SOT883
SOT886

ESD protection
PESD-series

TVS protection
PTVS-series

Innovation in Packaging

► **superior size/**
  performance ratio
► **increased design**
  options

ESD protection
EMI filtering

► **safeguard sensitive ICs**
► **match the triangle small size,**
  low line capacity
  robust protection

Energy- efficient
Eco- friendly

► **lower power consumption**
► **generate less heat**
► **halogen-free**

Small- scale integration

► **reduce part count**
► **save costs**
► **increase reliability**

MEGA Schottky
diodes
PMEG-series

Low V_{CEsat} (BISS)
Transistors
PBSS-series

Double RET's /
double Transistors

Double / Triple /
Quad Diodes

Loadswitches,
MosFet drivers

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Broadliner in standard products

Diodes
→ Low V_F (MEGA) Schottky diodes
→ Zener diodes
→ Small-signal switching diodes

Protection and signal conditioning
→ ESD protection diodes, TVS diodes
→ EMI and ESD filters, Integrated Discretes
→ HDMI Transceiver / Receiver

Transistors
→ Low V_{CEsat} (BISS) transistors
→ Resistor-equipped transistors (RETs)
→ Small-signal and medium power bipolar transistors

Small-signal MOSFETs

Standard Linear products
→ Adjustable shunt voltage regulator ICs
→ Voltage regulators

…. in 43 packages
→ Ultra-small leadless
→ Medium power leadless
→ FlatPower and Flat-lead
→ Standard industry packages

… over 384,000 km

All discretes produced in three years easily cover the distance from earth to moon

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ESD protection, TVS diodes
New IC technology is vulnerable for ESD, NXP has the right solution

- ESD protection Diodes,
  - There are many interface connectors, NXP will protect them with there best in class PESD devices, for single and multiple lines
  - Protection diodes with low (C_d) capacitance for high speed data lines like USB. Special devices for HDMI

- 400W TVS diodes to protect against surge charges.
  - Best in class value for surge/PCB area - double compared to competition
  - Smallest package offering 400 W surge capability
  - Low maximum leakage current –10x lower than competition

ESD protection
PESD-series

TVS protection
PTVS-series

ESD protection
EMI filtering

► **safeguard sensitive ICs**
► **match the triangle small size,**
   low line capacity
   **robust protection**

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Integration
The way forward to make it Cost effective & Reliable

▸ Pick & Place cost
  – This is be coming a large part of the total cost, when product prices are close to 0.01€

▸ Less components improve the quality
  – Thermal stress on the solder joins leads to 50% of the malfunctions of electronic equipment

▸ Solution:
  – Voltage regulators
  – Loadswitches
  – RET's & double RET's
  – Mosfet Drivers
  – Matched Pairs Transistors

Combination:
  – Triple & Quad Diodes
  – Double Transistors
  – Double Low V_{CEsat}
  – Low V_{CEsat} / Low V_F Modules

Small-scale integration
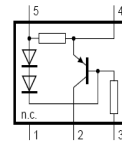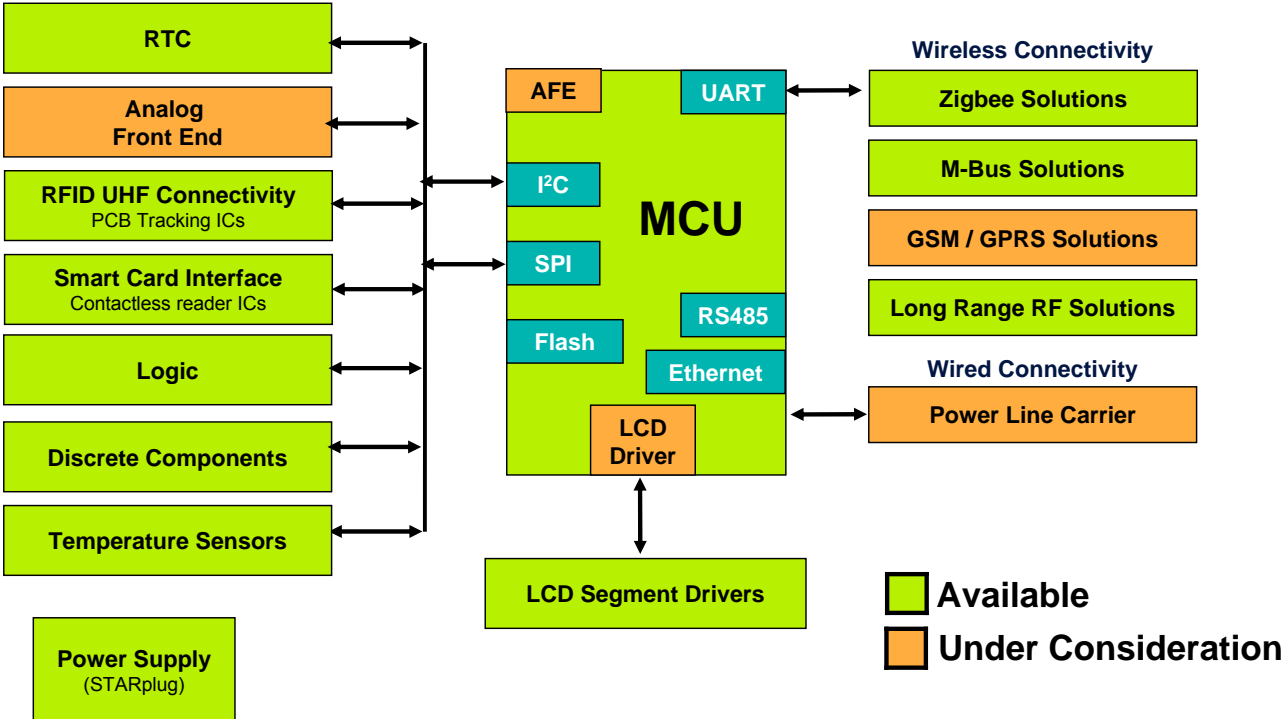
Small- scale integration

► **reduce part count**

► **save costs**

► **increase reliability**

RETs
PDTC/A-series
PBRN/P-series

Complex discretes
e.g. PBLS-, PMD-,
PMP-series

Smart Metering Building Blocks

Available
Under Consideration

Principle of Prepaid Contactless Metering
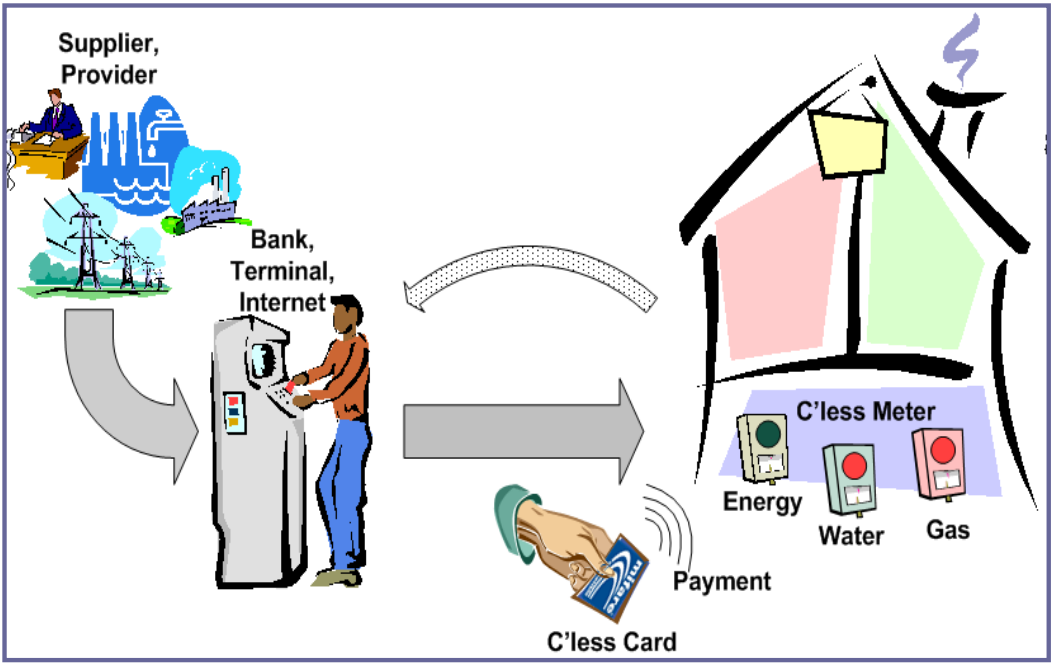
NXP Value Proposition in Prepaid Metering

- Current solutions for prepaid meters
    - Magnetic cards   - Tokens
    - Contact smart cards   - Keypad / Numeric tokens

- Advantages of contactless technology
    - Better protection against environmental effects (dust, humidity, etc.)
    - Longer lifetime, no maintenance
    - User convenience

- NXP offers a broad card IC and reader IC portfolio for prepaid metering

- Most recommended solutions

Reader ICs

| MFRC530 MICORE I ISO 14443A | MFRC522 MICORE II ISO 14443A | MIFARE Plus MF1 S61 MF1 S71 | MIFARE DESFire (EV1) MF3 D21 MF3 D41 MF3 D81 |
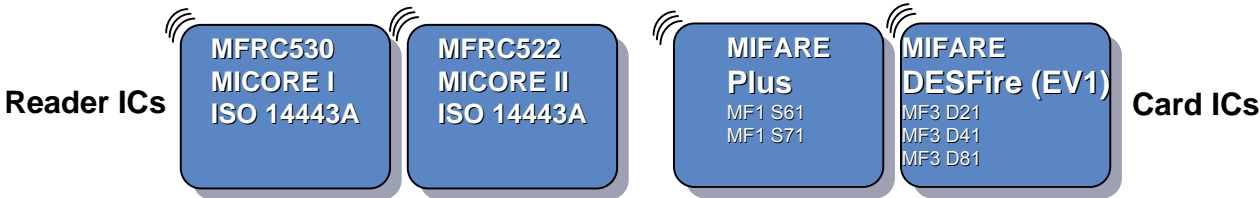
Card ICs

NXP supports prepaid metering with a broad card IC and reader IC portfolio

Most recommended reader ICs

Most recommended card ICs

	MFRC530 MICORE I ISO 14443A	MFRC522 MICORE II ISO 14443A	MIFARE Plus MF1 S61 MF1 S71	MIFARE DESFire (EV1) MF3 D21 MF3 D41 MF3 D81	
Operating Distance	Up to 10 cm		crypto1, AES	3DES, (AES)	**HW Crypto**
Power Supply	3,3 / 5 V	3,3 V	2, 4 Kbyte	2, 4, 8 Kbyte	**EEPROM**
RF Interface Power	Up to 500 mW	Up to 500 mW w. amplifier	MIFARE Classic compatible	-	**Special Features**
Serial Interface	8 bit parallel, 3,3 V digital supply, SPI	I2C, SPI, RS232, 3,3 V digital supply	CC EAL 4+	CC EAL 4+	**Certification**

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MFRC522 – MIFARE Reader

Market

> Infrastructure Contactless Reader
> Portable equipment, consumer device
> Metering

Customer Benefits

> Low cost RF front-end IC
> ISO14443 A, MIFARE
> Provided with SW BFL (Basic Function library)
> Easy integration

Supported RF protocols

Reader/Writer mode

> ISO/IEC A R/W support up to 848 kbit/s
> R/W support for MIFARE 1K, 4K
> ISO/IEC 14443-3 (ULC)
> ISO/IEC 14443-4 (DESFire, Plus)

Features

> 64 Byte FIFO

> Interrupts using IRQ pin

> Dedicated ID for every Operating Mode

> 2.5 V- 3.6 V power supply, typ. 3.3V

> PVDD interface supply voltage down to 1,6V

> Low cost packages HVQFN32

> Basic Function Library (source code)

Interfaces

> SPI, I²C, Serial UART

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MFRC530
MIFARE Reader

Market

> Infrastructure Contactless Reader
> consumer device
> Metering

Customer Benefits

> High Power RF front-end IC
> ISO14443 A support
> Provided with SW BFL (Basic Function library)
> Easy integration

Features

> 64 Byte FIFO
> Interrupts using IRQ pin
> Dedicated ID for every Operating Mode
> 2.5 V- 3.6 V or 4.5V - 5.5V power supply,
> SO 32 High power package
> Basic Function Library (source code)
> Unique serial number

Supported RF protocols

Reader/Writer mode

> ISO/IEC14443A R/W support up to 424 kbit/s

> R/W support for MIFARE 1K, 4K

> ISO/IEC 14443-3 (ULC)

> ISO/IEC 14443-4 (DESFire, Plus)

Interfaces

> SPI, 8 bit parallel interface

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Smart Metering Building Blocks

RTC	
Analog Front End	
RFID UHF Connectivity PCB Tracking ICs	
Smart Card Interface Contactless reader ICs	
Logic	
Discrete Components	
Temperature Sensors	

Power Supply (STARplug)

AFE | **UART**

I²C

MCU

SPI

Flash

RS485

Ethernet

LCD Driver

LCD Segment Drivers

Wireless Connectivity

Zigbee Solutions

M-Bus Solutions

GSM / GPRS Solutions

Long Range RF Solutions

Wired Connectivity

Power Line Carrier

☐ **Available**
☐ **Under Consideration**

Temperature Sensor Value Proposition

Why used?
- Determine the temperature
- Set window for Interrupt, alarm, fan control, shutdown, etc.

Where used?
- Instrumentation for front-end data calibration
- On-board temperature measurement for system management

Why NXP Thermal Sensor?
- Large selection of commonly used local sensor and local/remote sensor thermal sensors in a wide range of packages
- Invented the I^{2}C-bus, very proficient designers with bullet proof designs
- Continuous innovation with new low price LM75B local sensor in small 2 x 3 mm package

Part #	Accuracy	SMBus Timeout
LM75A / 75B	±2 ˚C	A = No; B = Yes
SE95	±1 ˚C	No
SE98A / 98B	±1 ˚C	Yes
SE97 / 97B*	±1 ˚C	Yes

local

local   wire   Remote Diode Sensor
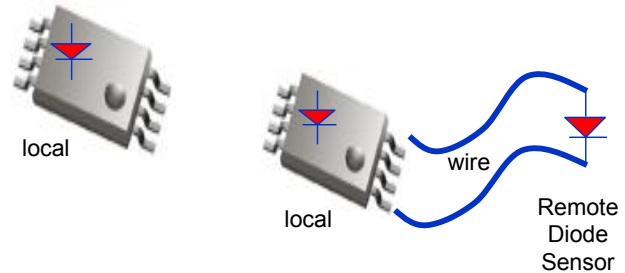
Part #	Local Sensor Accuracy	Remote Sensor Accuracy
NE1617A	±2 ˚C	±3 ˚C
NE1619**	±3 ˚C	±5 ˚C
SA56004	±2 ˚C	±1 ˚C

Note: * With 2Kbit EEPROM; ** With voltage monitors

80

LM75B
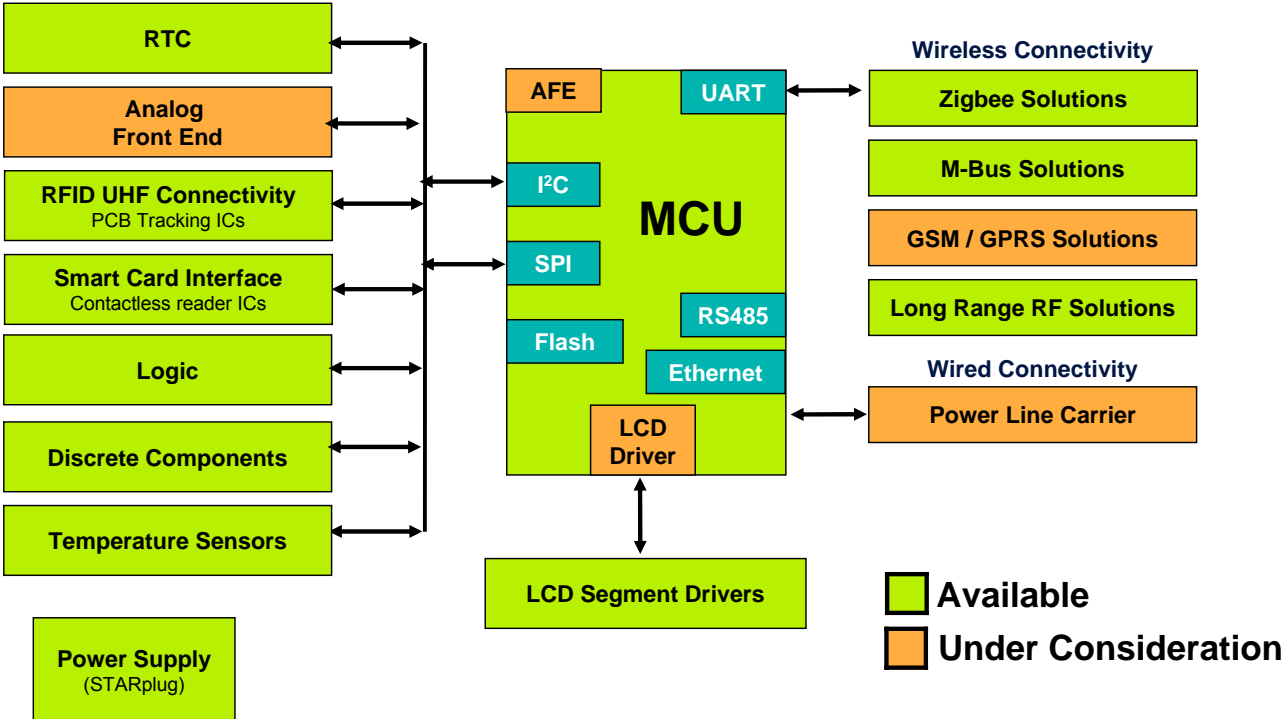# Local Digital Temp. Sensor & Thermal Watchdog

Features

- Pin-for-pin replacement for industry standard LM75 and LM75A
- I^{2}C-bus interface - 8 devices on the same bus
- Power supply range from 2.8 V to 5.5 V
- Temperatures range from -55 °C to +125 °C
- Frequency range 20 Hz to 400 kHz with bus fault time-out to prevent hanging up the bus
- 11-bit ADC - temperature resolution of 0.125 °C
- Temperature accuracy of:
  - ±2 °C from -25 °C to +100 °C
  - ±3 °C from -55 °C to +125 °C
- Programmable temperature threshold and hysteresis set points
- Max supply current of 1.0 μA in shutdown mode
- Stand-alone operation as thermostat at power-up
- ESD protection exceeds 4500 V HBM per JESD22-A114, 450 V MM per JESD22-A115 and 2000 V CDM per JESD22-C101
- Small 8-pin package types: SO8 and TSSOP8
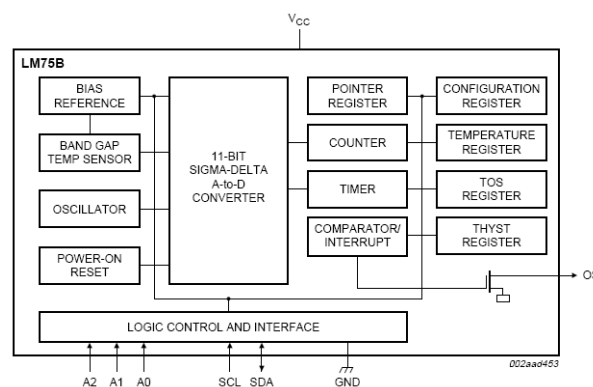
Type number	Topside mark	Package		Version
		Name	Description	
LM75BD	LM75BD	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1
LM75BDP	LM75B	TSSOP8	plastic thin shrink small outline package; 8 leads; body width 3 mm	SOT505-1
LM75BGD	75B	XSON8U	plastic extremely thin small outline package; no leads; 8 terminals; UTLP based; body 3 × 2 × 0.5 mm	SOT996-2

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Smart Metering Building Blocks

RTC

Analog Front End

RFID UHF Connectivity
PCB Tracking ICs

Smart Card Interface
Contactless reader ICs

Logic

Discrete Components

Temperature Sensors

Power Supply
(STARplug)

AFE | **UART**

I²C

MCU

SPI

Flash

RS485

Ethernet

LCD Driver

LCD Segment Drivers

Wireless Connectivity

Zigbee Solutions

M-Bus Solutions

GSM / GPRS Solutions

Long Range RF Solutions

Wired Connectivity

Power Line Carrier

☐ **Available**
☐ **Under Consideration**

Why RFID in Consumer Electronics Who benefits?

RFID chip → PCB manufacturing → Electronic Manuf. Service → Brand Owner (Prime Decision Maker)

Higher degree of automation for tracking and quality management, increased throughput time

Configuration: RFID based generation of derivatives: Less Inventory, shorter lead times

Brand Protection:
Grey Markets reached 13% of global phone market in 2009

Theft Deterrence (Disable/Enable)

Recycling ← Consumer ← Retailer ←

Reduce Cost - increase speed for sorting operation

Read out Warranty info directly from the product

Theft deterrence (EAS+ Disable/Enable)
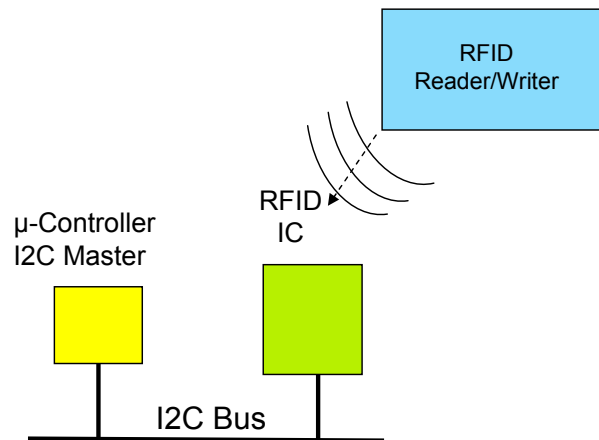
Inventory Management

Use Case: Product Configuration

Reduction of order lead times as well as cost of stock keeping

- ▶ Use RFID to configure/modify the product at late stage in supply chain
- ▶ Create commercial derivatives in the warehouse, while device is already packaged and inside the box

RFID
Reader/Writer

μ-Controller
I2C Master

RFID
IC

I2C Bus

Use Case: Service Efficiency

▶ Fast check via RFID if warranty does apply for the product
  – Has the product been sold through an authorized sales channel ?
  – Has warranty time period exceeded ?

▶ Write service operation history into the RFID memory

▶ Safe time during service with product specific info stored on RFID chip
  – Which firmware version was used, production lot number, etc.

▶ Read-out of basic product information stored on the RFID chip in case electronics device doesn't boot anymore.

RFID easy to use on PCBs

- Mounting of the RFID IC onto of the PCB
- RFID chip embedded inside the PCB
- The RFID antenna is part of the PCB

Chip embedded
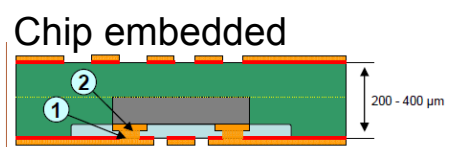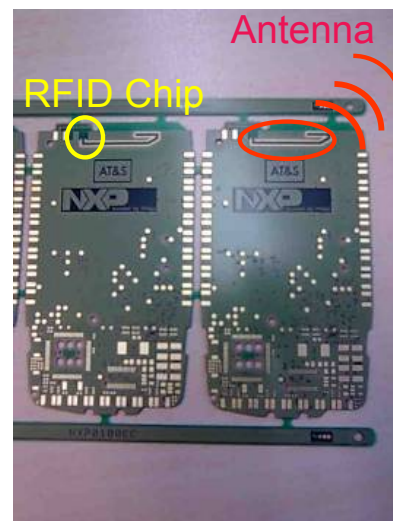
Why NXP ? – Our offering

▶ Superior product portfolio with special features tailored to the requirements for RFID in the electronics device market

▶ NXP provides technical support
  – RFID system optimization and reference antenna designs

Product Offering	Application
UCODE G2XL, G2XM 512 bit user memory	PCB tracking and tracing, theft deterrence, production control
UCODE G2iL, G2iL+ data transfer, digital switch	Product **Configuration**, PCB tracking and tracing, theft deterrence, production control

Note: for further information on UCODE products
please refer to the UCODE product presentation
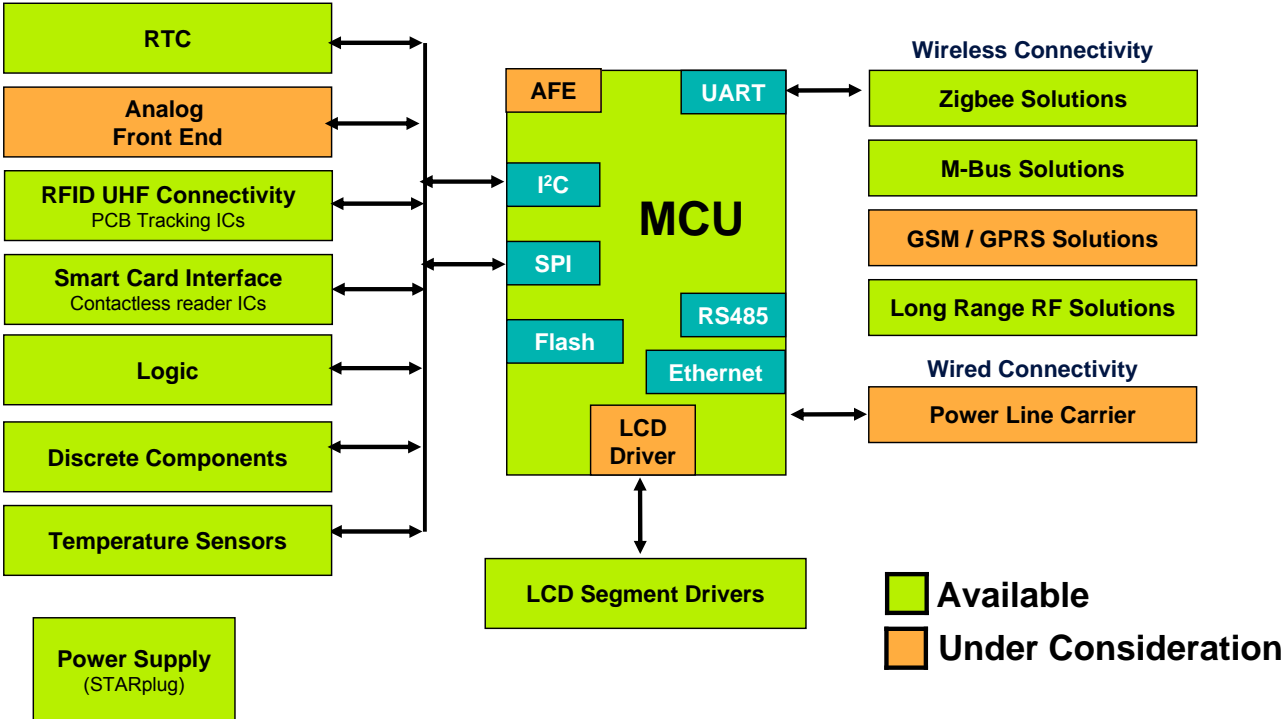
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Comparison RFID v. Barcode

- RFID advantages:
  - no line of sight
  - Fast read outs, bulk reading
  - Data storage

	Scan technology	PCB area required	Scan - Speed	Degree of Automation	Flexibility	Long Term Data Retention	Robust
Barcode	**Optically** – requires line of sight	1 cm2 for 2-D barcode	**Slow**, only one at a time – often done manually	Need to Re-adjust scanner for product changeover	Stores fixed Identification number only. New barcode needed for derivative generation	Can be removed, or get lost – Labels are only sticked to the product	**No** small parts of dirt lead to read failures
RFID	**Electro-Magnetically** Can read through everything except Metal	1 cm 2 for antenna	**Fast** 100+/second	No re-adjustment Reader "finds" the RFID tag in the antenna field independent from its location	Fixed unique ID number + read/write Memory Write derivative UID into memory and lock it.	RFID chip is an invisible fixed part of the product and stays with the product until recycling	**Yes** No line of sight required Chip embedded inside the PCB

Smart Metering Building Blocks

RTC		
Analog Front End		
RFID UHF Connectivity PCB Tracking ICs		
Smart Card Interface Contactless reader ICs		
Logic		
Discrete Components		
Temperature Sensors		

MCU
- AFE
- UART
- I²C
- SPI
- Flash
- RS485
- Ethernet
- LCD Driver

LCD Segment Drivers

Power Supply (STARplug)

Wireless Connectivity
- Zigbee Solutions
- M-Bus Solutions
- GSM / GPRS Solutions
- Long Range RF Solutions

Wired Connectivity
- Power Line Carrier

☐ Available
☐ Under Consideration
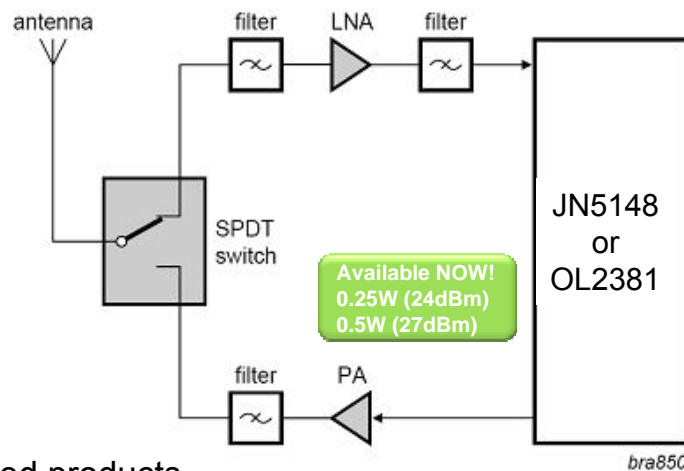
Long Range RF in Smart Metering

NXP Solutions for Sensitivity and Antenna Range Extension

Recommended products

- LNA: **BGU7003**, BGA2001, MMIC; **BFU6/7xxF**, SiGe:C RF Tr, SOT343F
- PA: **BGA7024** (24dBm), **BGA7027** (27dBm), MMIC, SOT89 `NEW!`

Need more choice? www.nxp.com/rfmanual (p. 36)

400-2700MHz Medium Power Amplifiers (MPA)

Released

BGA2031
5th generation Medium Power Variable Gain Amplifier MMIC
• *Gain   up to 23 dB
• *Gain Control Range 56 dB
• *P1dB   up to **13 dBm**

BGA6589
5th gen Medium Power MMIC Amplifier
• *Gain   up to 17 dB
• *P1dB   up to **20 dBm**

5th gen RF Transistor MPA
BFG21W
• *Gain   up to 12 dB
• *P1dB   up to **24 dBm**

*for detail pls. refer to datasheet

NEW Products

24 and 27dBm 6th generation **MMIC Medium Power Amplifier**

BGA7124 – 0.25W
BGA7127 – 0.5W
SOT908
• plastic thermal enhanced very thin small outline package
• body 3 x 3 x 0.85 mm

BGA7124 – 0.25W
BGA7127 – 0.5W
SOT89
• Plastic surface-mounted package
• Collector pad for good heat transfer
• 3 leads

In Development

30, 33dBm 6th generation **Medium Power Amplifiers**

BGA	7x27	7x30	7x33	
P1dB	27	30	33	dBm
Gain	16	13	13	dB

• Wideband, 400MHz to 2700MHz
• Single stage, gain @ 2GHz

BGA7204 6th generation **Variable Gain amplifier**
• P1dB 27dBm
• Wide frequency range, 400-2750MHz
• Small-signal gain, 20dB @ 2GHz
• Broad gain-control range, 30dB
• OIP3 40dBm
• NF 5dB at maximum gain setting

BGU7003 7th generation LNA MMIC

- Applicable between 40 MHz and 6 GHz
- Integrated, temperature-stabilized bias for easy design
- Bias current configurable with external resistor
- Low noise figure (NF): 0.80 dB at 1.575 GHz
- High insertion power gain: 18.3 dB at 1.575 GHz
- Optimized performance at low 5 mA supply current
- ESD protection > 1 kV Human Body Model (HBM) on all pins
- Low current consumption in power-down mode (<1 μA)
- Supply voltage: 2.2 to 2.85 V
- Small, 6-pin SOT891 leadless package (1.0 x 1.0 x 0.5 mm)
- Proven, robust QUBiC4X SiGeC process technology (fT = 110 GHz)

6th & 7th Generation Wideband Transistors

LNAs (BFU710, 610, 730, 630)   DRIVERS & DISCRETE PA

| Higher gain/ Lower NF and OIP3 | Higher linearity (OIP3) / Output power (P1dB) |

7th Generation

BFU710
- High Gain 17.3 dB @ 12 GHz
- f_T = 43 GHz @ 12 mA
- max Vceo = **2.8 V**
- Applications:
  - Ku-band LNA
  - 1st stage LNA SDARS
- Competitors:
  - IFX: BFP720

BFU730
- High Gain 20.1 dB @ 5.8 GHz
- f_T = 55 GHz @ 25 mA
- max Vceo = **2.8 V**
- Applications:
  - Ku-band LNA
  - 5-GHz WLAN, LTE
- Competitors:
  - IFX: BFP740
  - NESG3031M05

BFU760
- Gain 24.0 dB @ 1.8 GHz
- f_T = 45 GHz @ 55 mA
- max Vceo = **2.8 V**
- Applications:
  - High linearity amplifiers
- Competitors:
  - IFX: BFP750

BFU790
- Gain 21 dB @ 1.5 GHz
- f_T = 25 GHz @ 100 mA
- max Vceo = **2.8 V**
- Applications:
  - High linearity amplifiers
- Competitors:

6th Generation

BFU610
- High Gain 20.2 dB @ 5.8 GHz
- f_T = 15 GHz @ **4 mA**
- max Vceo = **5.0 V**
- Applications:
  - DRO satellite LNB
- Competitors:
  - NEC: NESG2021M05

BFU630
- High Gain 26 dB @ 1.8 GHz
- f_T = 21 GHz @ 10 mA
- max Vceo = **5.0 V**
- Applications:
  - WLAN, WiMax
  - SDARS, LTE
- Competitors:
  - IFX: BFP640
  - NESG2031M05

BFU660
- Gain 23.7 dB @ 1.8 GHz
- f_T = 21 GHz @ 20 mA
- max Vceo = **5.0 V**
- Applications:
  - High linearity amplifiers
- Competitors:
  - NESG2101M05

BFU690
- Gain 13.7 dB @ 1.8 GHz
- f_T = 18 GHz @ 50 mA
- max Vceo = **5.0 V**
- Applications:
  - High linearity amplifiers
- Competitors:
  - IFX: BFP650

5th Generation Medium Power MMICs

Type	OIP3 850 MHz	P1dB 850 MHz	OIP3 2400 MHz	P1dB 2400 MHz	NF @ 850	NF @1950
BGA6289	31.4	16.6	24.5	15.1	3.8	4.05
BGA6489	33.2	20.4	27	17.4	3.29	3.5
BGA6589	33.5	20.1	30.5	19.9	3.25	3.45

- **Features**
  - high linearity
  - **In *cost effective* bipolar silicon process**
  - 50 ohm in/ out
  - 20 dBm output pwr
  - single supply

5th Generation MMICs

Low Noise Wideband Amplifiers
Package: SC88/ SOT363

Type	Limits			@ 900MHz			@1800 MHz			Gain^3 (db) @				@	
	Vs (V)	Is (mA)	Ptot (mW)	NF (dB)	Gain (dB)	IIP$_3$ (dBm)	NF (dB)	Gain (dB)	IIP$_3$ (dBm)	100 mhz	1 GHz	2.6 ghz	3.0 ghz	Vs (V)	Is (mA)
BGA2001	4.5	30	135	1.3	22[1]	-7.4	1.3	19.5[1]	-4.5	20	17.1	11.6	10.7	2.5	4
BGA2003	4.5	30	135	1.8	24[1]	-6.5	1.8	16[1]	-4.8	26	18.6	11.1	10.1	2.5	10[2]
BGA2011	4.5	30	135	1.5	19[3]	10	-	-	-	24	14.8	8	6.5	3	15
BGA2012	4.5	15	70	-	-	-	1.7	16[3]	10	22	18.2	11.6	10.5	3	7

Notes : 1. MSG 2. Adjustable bias 3. $|S_{21}|^2$ 4. Under development

2 Stage Variable Gain Linear Amplifier
Package: SC88/ SOT363

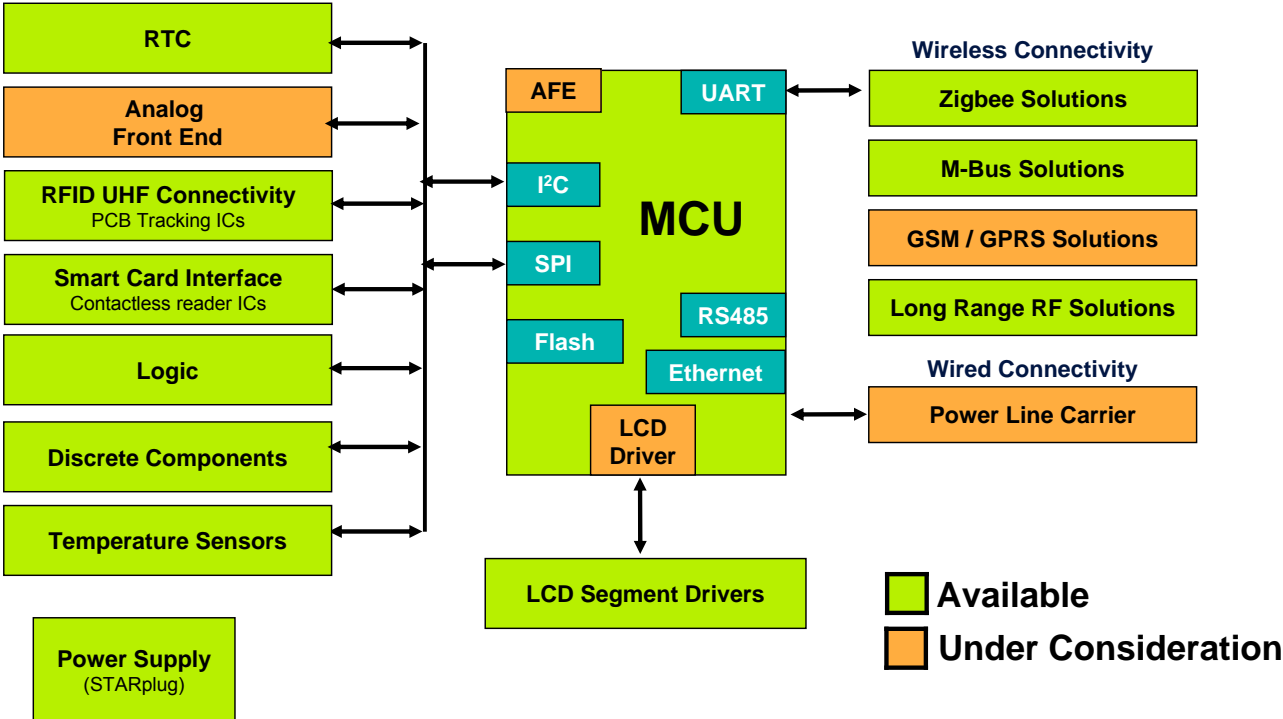| Type	Limits			Frequency Range (MHz)	@ 900MHz				@1900 MHz				@	
	Vs (V)	Is (mA)	Ptot (mW)		Gain^1 (dB)	ΔG^2 (dB)	P1dB (dBm)	ACPR (dBc)	Gain^1 (dB)	ΔG^2 (dB)	P1dB (dBm)	ACPR (dBc)	Vs (V)	Is (mA)
BGA2031/1	3.3	50	200	800-2500	24	62	11	49	23	56	13	49	3	51

Notes: 1. Gain = G_P, power gain. 2. ΔG = Gain control range

Wideband Linear Mixer
Package: SC88/ SOT363

Type	Limits			RF Input Range (MHz)	IF Output Range (MHz)	@ 880MHz			@2450 MHz			@	
	Vs (V)	Is (mA)	Ptot (mW)			NF (dB)	Gain^1 (dB)	OIP3 (dBm)	NF (dB)	Gain^1 (dB)	OIP3 (dBm)	Vs (V)	Is (mA)
BGA2022	4	10	40	0-2500	0-500	9	5	4	9	6	10	3	6

Notes: 1. Gain = G_C, Conversion gain

Smart Metering Building Blocks

| RTC |
| Analog Front End |
| RFID UHF Connectivity — PCB Tracking ICs |
| Smart Card Interface — Contactless reader ICs |
| Logic |
| Discrete Components |
| Temperature Sensors |
| Power Supply (STARplug) |

MCU
- AFE
- UART
- I²C
- SPI
- Flash
- RS485
- Ethernet
- LCD Driver

LCD Segment Drivers

Wireless Connectivity
- Zigbee Solutions
- M-Bus Solutions
- GSM / GPRS Solutions
- Long Range RF Solutions

Wired Connectivity
- Power Line Carrier

- ☐ Available
- ☐ Under Consideration

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Jennic JN5148 Low Power Zigbee Wireless

- Single Chip Device:

- Microcontroller:
  - High Performance 32-bit RISC CPU core – programmable clock, 4-32MHz
  - *Rich User Peripherals* – mixed digital and analogue
    - UARTs, SPI, 2-Wire Serial (I²C), GPIO, Timers, PWM, 12-bit ADC, DAC, Comparators
    - JTAG debug port,
    - Large memory footprint - 128kBytes RAM
    - 128kBytes ROM for 15.4 MAC, stacks

- IEEE802.15.4 2.4GHz transceiver
  - 98dB link budget, achieving 30-50m indoors
  - 128-bit AES encryption, highly secure networking

- System implementation
  - Low sleep power consumption - 1.3uA with timer
  - Low power - 15mA TX, 18mA RX (35% less than competition)
  - External BOM (<50c) – Crystal, Discretes, Serial Flash
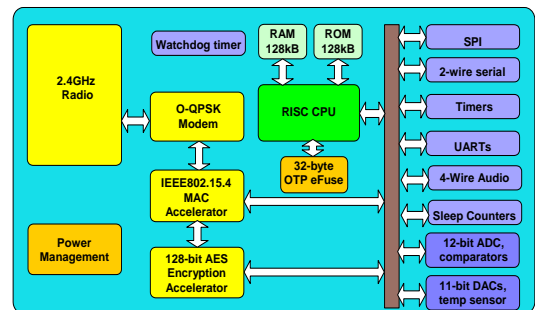
Jennic JN5148 Module Product Range

▶ All modules include JN5148 chip, plus support components

▶ Standard power modules:
  – With integrated printed antenna   **JN5148-001-M00**

  – With uFl connector   **JN5148-001-M03**

▶ High power module:
  – High Power with uFl connector   **JN5148-001-N**
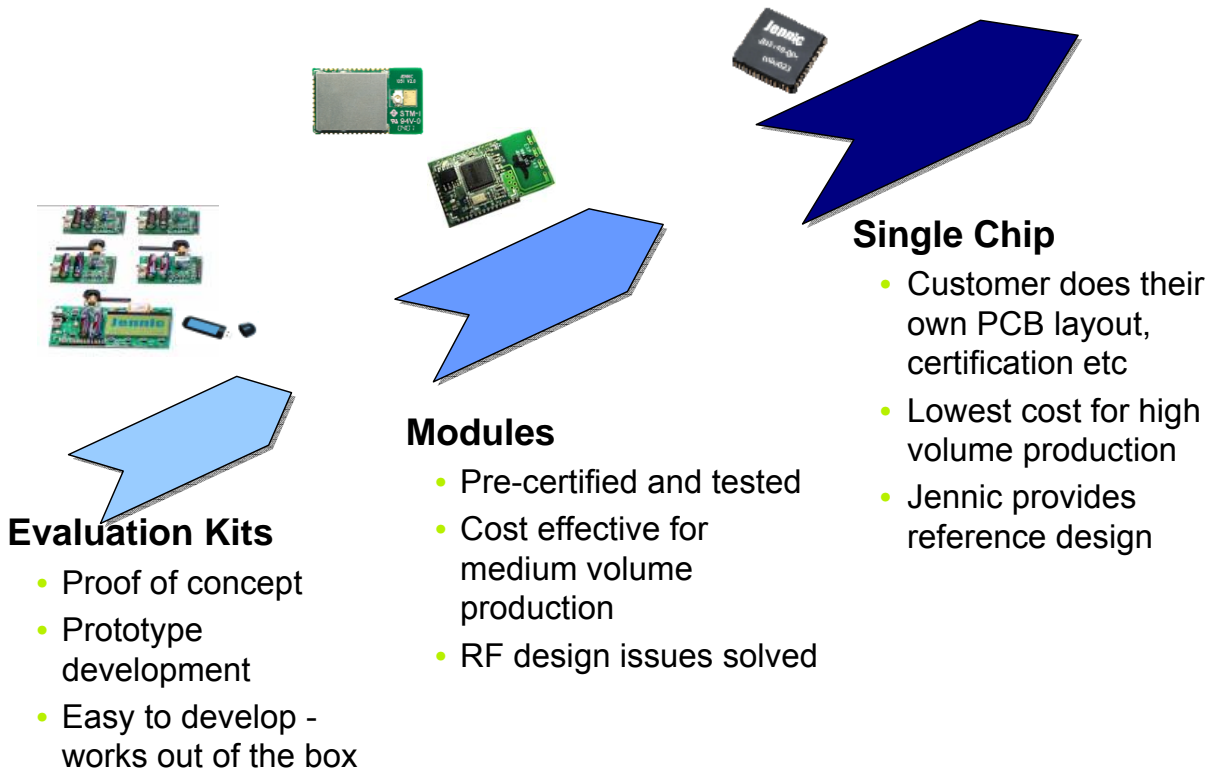   • +20dBm

» Module value proposition
    • Fast time to market
    • Ready approved to FCC and EU regulations
    • No need for RF design resource for board and test design
   • Overall cheaper cost of implementation up to 20-50ku

Jennic JN5148 Product Cycle

Single Chip

- Customer does their own PCB layout, certification etc
- Lowest cost for high volume production
- Jennic provides reference design

Modules

- Pre-certified and tested
- Cost effective for medium volume production
- RF design issues solved

Evaluation Kits

- Proof of concept
- Prototype development
- Easy to develop - works out of the box

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Software: JenNet Network Stack

- Proprietary network stack
  - No Alliance membership fee
  - No additional cost for product certification

- For JN5148 family of chips and modules
  - Proprietary network - supports star, tree and linear topologies
    - 85kB code space for application on coordinator/router
    - 95kB code space for application on end device
  - Recommended maximum network size is 500 nodes
  - Reliable and robust communication
  - Advanced network management and self repair mechanism
  - Easy to use compared to ZigBee PRO

JenNet

IEEE802.15.4 MAC

IEEE802.15.4 PHY

100
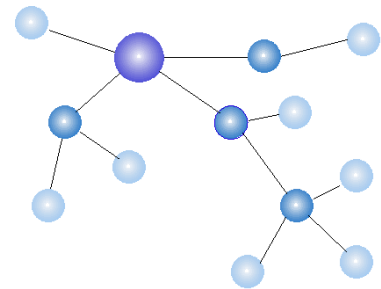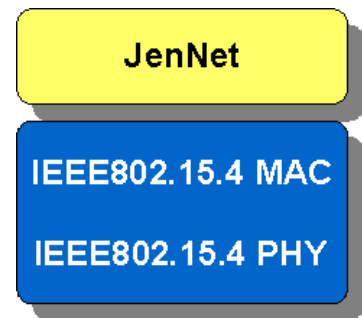
Software: ZigBee PRO

- ZigBee software stacks are developed and managed by the ZigBee Alliance
  - Feature rich, but very complicated to use
  - Recommended only if interoperability is the key requirement

- ZigBee PRO
  - Standardised mesh networking stack with profiles to address specific applications
    - Ensures interoperability
  - Focus market is the emerging Smart Energy market
    - Other profiles include Home Automation, Commercial Building Automation
  - Provides features to support real world scenarios
    - Frequency agility, enhanced security

- The ZigBee Alliance operate a rigorous certification process
  - To ensure interoperability at a platform and system level
  - Provide a recognisable logo / branding

- NXP ZigBee PRO solution provides:
  - ZigBee Compliant Platform using JN5148
  - Smart Energy profiles for In-Premises Display (IPD)
  - Smart Energy Load Control and Demand Response
  - Home Automation profiles

JN5148 Evaluation Kit

- ▶ Hardware
  - Controller and 4 sensor boards

- ▶ Eclipse IDE
  - Graphical software development tool
  - C compiler, assembler, debugger
  - Home sensor demo out of the box
  - IEEE802.15.4 Protocol stack
  - Stacks supplied as object library with APIs

- ▶ JenNet kit
  - JenNet Library

- ▶ ZigBee PRO kit
  - ZigBee PRO networking library
    - Smart Energy profile on request
    - Home Automation profile on request

Evaluation kit roll-out into distribution on October 1st