PLM Smart Plug Solutions

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• The Smart Plug Concept

• The PLM smart plug demo board
  • Hardware:
    • PLM section
    • Metering Section
  • Firmware:
    • Architecture
    • Communication protocol

• Conclusions
The Smart Grid integrates new innovative tools and technologies from Energy *generation*, *transmission* and *distribution* all the way to consumer appliances and equipment.

**Before**  ➔ **After**

---

... *the intelligent power network of the future*
Home **Smart Grid** SCENARIO

*The key players in Home Smart Grid Scenario are the following:*

- In-Home Display
- E-Vehicle
- Smart Meter
- Smart Plug
- Concentrator
- Solar Panel

→ *This presentation focus on PLM SMART PLUG*

PLM = Power Line Modem
What is a Smart Plug?

- Is an ‘intelligent’ plug to which you connect home appliances, white goods, lights, TV and etc., to easily monitor and control the power consumption using remote control panel

Main Features:

- Monitor Home Appliance Loads Power consumption
- Remotely Turn ON/OFF loads
- Protect Loads from over-currents
- Schedule Automatic Turn ON/OFF of the Loads
- PLM Connectivity to In-Home Display and Control Panel
ST Solution Smart PLUG

**Power Line modem:**
- ST7540/70/80/90
- IEEE 802.15.4
- SPZBW or STM32W
- Sub GHz
  - Spirit 1

**Memory**
- Dual IF EEPROM
- RTC
- SENSORS & MEMS

**Energy Measurement ICs:**
- STPM01/10
- STPMC1
- STPMS1/2

**Microcontroller**
- STM32Fxx
- STM32W

**HAN Transceiver**

**Energy Meter ICs**

**Additional Functionality**

**Core Functionality**

**Smart Plug**

**POWER SUPPLY**
- VIPerxx, ALtair04-900
- DC/DC converter
The PLM Smart Plug: Design Challenges

**Metering Section:**
- High Accuracy measurements in a wide range:
  - (class 1 AC watt meters)
    - 1% in 1:5000 dynamic range
- This accuracy depends on:
  - load type (resistive, inductive, capacitive)
  - Current sensor type (shunt, CT, Rogowski coil)
  - Temperature (shunt resistors)
  - Noise capture of analog tracks
  - Ripple on Active energy
- Calibration: usually it is a very long process
- Meet Regulatory Compliances:
  - Single Phase: IEC61036 and ANSI C12.1
  - Low cost

**PLM Section:**
- Communication Robustness depends on:
  - Line Noise
  - Line Attenuation
  - Line Coupling
- A robust design has to:
  - Maximize the S/N ratio
  - Minimize the signal attenuation

**Attenuation sources**

**Noise sources**
The PLM Smart Plug demo board: overview

Intelligent Wall Plug to monitor/manage remotely energy consumption by Power Line Modem

Key Features:
- Energy consumption and electrical parameters monitoring
- Relay modes for On/Off features
- STPM01/10  energy meter IC
- Network/Standalone operative mode

Connectivity: Power Line Modem – ST7540 BFSK 4.8Kbs

Typical Applications:
- Smart Grid
- Home/building automation systems

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>STM32F103CBT6</td>
<td>32-bit MCU ARM Cortex-M3</td>
</tr>
<tr>
<td>STPM01</td>
<td>Energy meter</td>
</tr>
<tr>
<td>ST7540</td>
<td>B-FSK PLM</td>
</tr>
<tr>
<td>ALTAIR05T-800</td>
<td>AC/DC switching regulator</td>
</tr>
<tr>
<td>LD1117ADT33TR</td>
<td>3.3V linear regulator</td>
</tr>
</tbody>
</table>
PLM SmartPlug: Block Diagram

- **Relay**
- **Power Management**
- **PLM**
- **Energy Meter**

Connections:
- MAINS
- SPI
- GPIO
- I²S
- SPI

Components:
- ST7540
- STPM01
- STMicroelectronics Cortex

Brands:
- STMicroelectronics
- Systems Lab
- Technical Marketing
The PLM Smart Plug demo-kit: overview

» Hardware
  » STEVAL-IHP002V2
    - PLM Smart-Plug (to create PLM Home Area Network)
  » STEVAL-IHP003V1
    - PLM Data Concentrator connected to a PC via RS232

» Software
  » Demo PC-GUI to manage PLM HANs and energy consumption;
  » Smart-Plug application;
  » PLM protocol stack (PHY, MAC and NTW)
The PLM Smart Plug demo-board

Hardware Description

» The power line modem section
» The metering section
The PLM Smart Plug demo-board

- ST7540: The Power Line Modem section
ST7540 Power Line Modem device

- **FSK modulation at 4.8kbps**
  - **MAIN FEATURES:**
    - Half duplex Frequency Shift Keying (FSK) transceiver;
    - Integrated single ended power line driver with accessible input and output terminals and programmable voltage and current control;
    - SPI/UART microcontroller interface;
    - Single 7.5 to 13.5V supply voltage;
    - Very low power consumption (Iq=5mA);
    - 8 programmable transmission frequencies in CENELEC bands A, B and C;
    - Programmable BAUD rate from 600 to 4800 bps;
    - Programmable carrier or preamble detection;
    - Band-in-use detection;
    - Secure access 48 bit control register;
    - Programmable header and frame length recognition;
    - Watchdog timer;
ST7540 coupling filters

The PLM Smart Plug demo-board
ST7540 Transmission filters

The PLM Smart Plug demo-board

Equation 1

\[ A(s) = \frac{A_0}{s^2 + \frac{s}{\omega_c} + 1} \]

where \( A_0 = \left(1 + \frac{R_{14}}{R_{12}}\right) \), \( \omega_c = \frac{1}{\sqrt{R_9 \cdot R_{10} \cdot C_{33} \cdot C_{21}}} \), and \( Q = \frac{\sqrt{\frac{R_9}{R_{12} \cdot R_{10} \cdot C_{33} \cdot C_{21}}}}{R_9 C_{33} + R_{10} C_{21} + R_9 C_{21}(1 - A_0)} \)

The corner frequency may be calculated as:

Equation 2

\[ f_c = \frac{1}{2\pi \sqrt{R_9 \cdot R_{10} \cdot C_{33} \cdot C_{21}}} = 135.7 \text{kHz} \]

Equation 3

\[ f_c = \frac{1}{2\pi \sqrt{L_5 \cdot C_{23}}} \]
The PLM Smart Plug demo-board

**ST7540 Receiver filters**

Equation 4

\[
R(s) = \frac{s \cdot L_6 + R_L}{R_{17}L_6C_{26}}
\]

\[
= \frac{\frac{R_{17} + R_L}{R_{17}L_6C_{26}} + \frac{L_6}{s}}{s^2 + \frac{R_{17} + R_L}{R_{17}L_6C_{26}}}
\]

where \( R_L \) is the DC series resistance of the inductor (in our case, about 2.7 \( \Omega \)). The center frequency and the quality factor of the filter can be expressed as:

Equation 5

\[
f_c = \frac{1}{2\pi} \cdot \omega_c = \frac{1}{2\pi} \cdot \sqrt{\frac{R_{17} + R_L}{R_{17}L_6C_{26}}} = \frac{1}{2\pi} \cdot \sqrt{\frac{R_{17}L_6C_{26}}{R_{17}R_LC_{26} + L_6}} \cdot \omega_c
\]

RX Passive Filter Response

**Frequency Response - Rx Filter**

- \( f = 72 \text{ kHz} \)
- \( G = -2.3 \text{ dB} \)
ST7540 Output Current/Voltage

- **Output Voltage level setting**

<table>
<thead>
<tr>
<th>V(PA.OUT) (V RMS)</th>
<th>V(PA.OUT) [dBuV RMS]</th>
<th>R7 [kΩ]</th>
<th>R8 [kΩ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.500</td>
<td>114</td>
<td>0.620</td>
<td>1.5</td>
</tr>
<tr>
<td>0.800</td>
<td>118</td>
<td>1.8</td>
<td>1.5</td>
</tr>
<tr>
<td>1.000</td>
<td>120</td>
<td>2.7</td>
<td>1.5</td>
</tr>
<tr>
<td>1.125</td>
<td>121</td>
<td>3.3</td>
<td>1.5</td>
</tr>
<tr>
<td>1.250</td>
<td>122</td>
<td>3.9</td>
<td>1.5</td>
</tr>
<tr>
<td>1.500</td>
<td>124</td>
<td>5.1</td>
<td>1.5</td>
</tr>
<tr>
<td>2.000</td>
<td>126</td>
<td>6.2</td>
<td>1.5</td>
</tr>
<tr>
<td>2.250</td>
<td>127</td>
<td>8.2</td>
<td>1.5</td>
</tr>
<tr>
<td>2.500</td>
<td>128</td>
<td>9.1</td>
<td>1.5</td>
</tr>
<tr>
<td>3.160</td>
<td>130</td>
<td>11</td>
<td>1.5</td>
</tr>
</tbody>
</table>

- **Output Current Limit setting**

![Diagram of Power line modem section](image)
The PLM Smart Plug demo-board

- **STPM01**: The **Metering** section

![Diagram of PLM Smart Plug demo-board]
STPM01: Metering Section

- **MEASUREMENT**
  - Active, Reactive, Apparent Energies, Vrms, Irms, Frequency

- **SENSORS:** Rogowski*, Current Transformer, Shunt

- **OPERATION**
  - Stepper Motor *
  - MCU based

- **ACCURACY:** 0.1% in 1:1000 range

- **TAMPER PROOF:** 2 current channels available

- **SUPPORT IEC61036 AND ANSI C12.1**

- **CALIBRATION**
  - Very short calibration time
  - No ripple in the active energy
  - Separated for voltage and current

- **FLEXIBILITY**
  - from low to high end allows re-use of already tested boards layouts

- **OTP***
  - Prevention of tamper by changing calibration data
  - No need of loading the configuration data from MCU at startup
  - Perfect data retention in harsh environment

* NOT present on STPM10
STPM01 schematic

1. Current sensing
2. Anti Aliasing Filter

\[ f_p = \frac{1}{2\pi RC} = 7961.8 \text{Hz} \]

The PLM Smart Plug demo-board
The PLM Smart Plug demo-board

STPM01 schematic

3. Voltage sensing

Cross Talking Cancellation

R18, R19, R20, R21 Close to STPM01
ST7540 PLM – Data Concentrator Node

- **PLM Master, Data Concentrator:**
  - Serial Bridge Bode: RS232 to/from PLM bridge
- **PHY Layer:**
  - PLM chipset: ST7540
  - FSK modulation with low frequency deviation
  - Centre frequency 132.5 kHz ± 0.2%
  - Bitrate: 4800 or 2400 bits/s
  - PLM communication compliant with EN50065-1 (band C)
- **Data Link Layer, Network Layer, Application Layer:**
  - Protocol Processor: STM32
- **Power Management:**
  - SPAC265-3W AC-DC switched-mode power supply module.
  - 85Vac to 240Vac

Key products:
ST7540; STM32F103C8T6; ST1S03PU; ST3232C.
PLM Smart Plug Scenario

PLM Data Concentrator <-> PLM Smart Plug

HyperTerminal or GUI
PLM Smart Plug Scenario
Hyper Terminal Command

“get” → require info to a remote smartplug.
“identify” → Identify a specific smartplug inside the network.
“set” → Write information to a remote smartplug.
“list” → list the smartplug in the network already connected
“?” → give command list

Command list:
- get (read data from nodes)
- set (write data to nodes)
- identify (identify a specific node by led blinking )
- list (list all available nodes)
- route (print routing table)

Terminal Started
hello
Input Started...
CONSOLE v1.0 STARTED
PLM Started...
Local Address: 0
PLM SmartPlug: Firmware Overview
PLM SmartPlug: Communication Protocol Overview

Overview

- Power Line Modem Communication compliant to EN50065-1 (band C)
- FSK, FEC correction
- Data frame with max length of 100 bytes, CRC16, fixed ACK frame
- Network and Transport layers customized for the specific application.

General Specification

- Static Network plus repeater
- Node address set by serial communication
- Node repeater function set by serial communication
- MAC function with FEC
PLM SmartPlug: Firmware Architecture

**Application Layer**
- Meter Task
- PLC Task
- Calendar Task
- Periodically Send Task
- Output Task
- Input UI Task

**RTOS**
- FREE RTOS V5.20

**RTOS independent Layer**
- Calendar Layer
- STPM01 Layer
- ST7540 Layer
- Relay Layer
- Console Layer

**Hardware dependent**
- RTC HAL
- STPM01 HAL
- ST7540 HAL
- Relay HAL
- RTOS HAL
- Main HAL

**Cortex STM32 Peripherals Library**

**STM32 Microcontroller Hardware**
PLM protocol: firmware

RTOS based: FreeRTOS

Main Features:

- CENELEC Band C PLM Communication
- PHY layer with FEC
- MAC with CSMA/CA and ACK
- 100 bytes network payload
- Static Network routing topology and addressing
- ON/OFF or Dimming management
- Load consumption measurement
PHY: Physical Level

**ST7540 role:**
- CENELEC 50065 band C
- FSK modulation with low frequency deviation
- Centre frequency 132.5 kHz ± 0.2% (± 0.25 kHz)
- Bit Rate 2400 bits/s.

**STM32 role:**
- Forward Error Correction (FEC) implemented to correct phase synchronous disturbances with a duration up to 1 ms
STM32 role:
- **Fixed length** (telegrams) messages with 100 bytes payload
- **ACK** and **Timeout** data transmission services
- **CSMA/CA**: Back off min ( > ACK time) + random part (2 to 150ms) as explained in the previous slide. The back off algorithm is not exponential and it is recalculated each time the band is in use before the transmission.
- **CRC16** protection with re-transmission mechanism
ST7540 DLL: Data Link Level

Node 1
- CSMA State: Transmission
- BU: Band in use
- $t_0$: TL_NetworkRequest
- $t_1$: Idle ($A+dT_1$)

Node 2
- CSMA State: Transmission
- BU: Band in use
- Idle ($A+dT_2$)

Node 3
- CSMA State: Not Able to Transmit
- BU: Band in use
- Idle ($A+dT_3$)

A = 200msec
2msec < $dT$ < 150msec
NET : Network Level

STM32 role:
- **Num.Nodes**: It supports up to 65535 nodes in each network
- **Address** (nodes and repeaters) statically **assigned** by serial communication
- **Repeaters** store a static routing table
Application Layer

**STM32 role:**
- Each node reads consumption data and sends it to the concentrator periodically.
- Each node can receive commands to switch on/off or to dim the load.

```
          Command received
          IDLE (Read from Metering IC)
            |                         |
            |   Message received   |
            v
  Process Command (ON/OFF ; Dim)  Response required
            |                         |
            |   TX (Reading from Metering IC) |
            v
  Reception
```

- **T1 elapsed**
- **Message received**

Diagram:
- **STM32 Standard Library**
- **FreeRTOS**
- **PLM PHY**
- **PLM MAC**
- **PLM NTWK**
- **Load Consumption Measurement**
- **Relay Management**
Application Layer: Example configuration

Data Concentrator
- Type: Receiver
- Local Id: 0.0
- Primary Remote Id: 0.0
- Secondary Remote Id: 0.0

SmartPlug 0
- Type: Repeater
- Local Id: 0.1
- Primary Remote Id: 0.0
- Secondary Remote Id: 0.0

SmartPlug 1
- Type: Node
- Local Id: 0.2
- Primary Remote Id: 0.0
- Secondary Remote Id: 0.0

SmartPlug 2
- Type: Node
- Local Id: 0.3
- Primary Remote Id: 0.1
- Secondary Remote Id: 0.1

SmartPlug 3
- Type: Node
- Local Id: 0.4
- Primary Remote Id: 0.1
- Secondary Remote Id: 0.1

Data Concentrator: STEVAL-IHP003V1/STEVAL-IHP002V1
SmartPlug: STEVAL-IHP002V1
Logical Link
AC cable
PLM SmartPlug: ST products Overview
STM32 today – platform effect

Select your fit product inside a wide, compatible portfolio
# STM32 – 7 product series

**STM32 F4 series** - High performance with DSP (STM32F405/415/407/417)

<table>
<thead>
<tr>
<th>Feature</th>
<th>STM32 F4 series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortex-M4 with DSP and FPU</td>
<td>Up to 192-Kbyte SRAM</td>
</tr>
<tr>
<td>Up to 1-Mbyte Flash</td>
<td>2x USB 2.0 OTG FS/HS</td>
</tr>
<tr>
<td>3-phase MC timer</td>
<td>2x CAN 2.0B</td>
</tr>
<tr>
<td>SDIO</td>
<td>Ethernet IEEE 1588</td>
</tr>
<tr>
<td>Processor</td>
<td>Crypto/hash processor and RNG</td>
</tr>
</tbody>
</table>

**STM32 F3 series** - Mixed-signal with DSP (STM32F302/303/313/372/373/383)

<table>
<thead>
<tr>
<th>Feature</th>
<th>STM32 F3 series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortex-M4 with DSP and FPU</td>
<td>Up to 48-Kbyte SRAM &amp; CCM-SRAM</td>
</tr>
<tr>
<td>Up to 256-Kbyte Flash</td>
<td>USB 2.0 FS</td>
</tr>
<tr>
<td>2x 3-phase MC timer (144 MHz)</td>
<td>CAN 2.0B</td>
</tr>
<tr>
<td>Up to 7x comparator</td>
<td>3x 16-bit ΣΔ ADC</td>
</tr>
<tr>
<td>4x PGA</td>
<td></td>
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</table>

**STM32 F2 series** - High performance (STM32F205/215/207/217)

<table>
<thead>
<tr>
<th>Feature</th>
<th>STM32 F2 series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortex-M3 CPU</td>
<td>Up to 128-Kbyte SRAM</td>
</tr>
<tr>
<td>Up to 1-Mbyte Flash</td>
<td>2x USB 2.0 OTG FS/HS</td>
</tr>
<tr>
<td>3-phase MC timer</td>
<td>2x CAN 2.0B</td>
</tr>
<tr>
<td>SDIO</td>
<td>Ethernet IEEE 1588</td>
</tr>
<tr>
<td>Processor</td>
<td>Crypto/hash processor and RNG</td>
</tr>
</tbody>
</table>

**STM32 F1 series** - Mainstream - 5 product lines (STM32F100/101/102/103 and 105/107)

<table>
<thead>
<tr>
<th>Feature</th>
<th>STM32 F1 series</th>
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</thead>
<tbody>
<tr>
<td>Cortex-M3 CPU</td>
<td>Up to 96-Kbyte SRAM</td>
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<tr>
<td>Up to 1-Mbyte Flash</td>
<td>USB 2.0 OTG FS</td>
</tr>
<tr>
<td>3-phase MC timer</td>
<td>Up to 2x CAN 2.0B</td>
</tr>
<tr>
<td>SDIO</td>
<td>Ethernet IEEE 1588</td>
</tr>
</tbody>
</table>

**STM32 F0 series** – Entry level (STM32F050/051)

<table>
<thead>
<tr>
<th>Feature</th>
<th>STM32 F0 series</th>
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<tbody>
<tr>
<td>Cortex-M0 CPU</td>
<td>Up to 8-Kbyte SRAM</td>
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<tr>
<td>Up to 64-Kbyte Flash</td>
<td>3-phase MC timer</td>
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<tr>
<td>Comparator</td>
<td>CEC</td>
</tr>
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</table>

**STM32 L1 series** - Ultra-low-power (STM32L151/152/162)

<table>
<thead>
<tr>
<th>Feature</th>
<th>STM32 L1 series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortex-M3 CPU</td>
<td>Up to 48-Kbyte SRAM</td>
</tr>
<tr>
<td>Up to 384-Kbyte Flash</td>
<td>USB FS device</td>
</tr>
<tr>
<td>Up to 12-Kbyte EEPROM</td>
<td>LCD 8x40 4x44</td>
</tr>
<tr>
<td>Comparator</td>
<td>BOR MSIVSCal</td>
</tr>
<tr>
<td>AES 128-bit</td>
<td></td>
</tr>
</tbody>
</table>

**STM32 W series** - Wireless (STM32W108)

<table>
<thead>
<tr>
<th>Feature</th>
<th>STM32 W series</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cortex-M3 CPU</td>
<td>Up to 16-Kbyte SRAM</td>
</tr>
<tr>
<td>Up to 256-Kbyte Flash</td>
<td>2.4 GHz IEEE 802.15.4 Transceiver</td>
</tr>
<tr>
<td>Lower MAC Digital baseband</td>
<td>AES 128-bit</td>
</tr>
</tbody>
</table>

**Common core peripherals and architecture:**

- Communication peripherals: USART, SPI, I2C
- Multiple general-purpose timers
- Integrated reset and brown-out warning
- Multiple DMA
- 2x watchdogs
- Real-time clock
- Integrated regulator PLL and clock circuit
- External memory interface (FSMC)
- Up to 3x 12-bit DAC
- Up to 4x 12-bit ADC (Up to 5 MSPS)
- Main oscillator and 32 kHz oscillator
- Low-speed and high-speed internal RC oscillators
- -40 to +85 °C and up to 105 °C operating temperature range
- Low voltage 2.0 to 3.6 V or 1.65/1.7 to 3.6 V (depending on series)
- Temperature sensor

![STM32 F4](image1.png)
![STM32 F3](image2.png)
![STM32 F2](image3.png)
![STM32 F1](image4.png)
![STM32 F0](image5.png)
![STM32 L1](image6.png)
![STM32 W108](image7.png)
## STM32F/L/W Complete offer

<table>
<thead>
<tr>
<th>Model</th>
<th>Core</th>
<th>Frequency</th>
<th>Voltage</th>
<th>Features/NIC</th>
<th>Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>STM32 F0 Entry</td>
<td>Cortex-M0</td>
<td>48 MHz</td>
<td>1.8 to 3.6V</td>
<td>8/16 bit appli</td>
<td>16KB – 128KB</td>
</tr>
<tr>
<td>STM32 F1 Mainstream</td>
<td>Cortex-M3</td>
<td>24 to 72 MHz</td>
<td>2.0 to 3.6V</td>
<td>Widest portfolio</td>
<td>16KB -1MB</td>
</tr>
<tr>
<td>STM32 F2 Hi Perf</td>
<td>Cortex-M3</td>
<td>120 MHz</td>
<td>1.7 to 3.6V</td>
<td>High performance</td>
<td>128KB -1MB</td>
</tr>
<tr>
<td>STM32 F3 Analog / DSP</td>
<td>Cortex-M4</td>
<td>72 MHz</td>
<td>1.8 to 2.0</td>
<td>3.6V High perf &amp; DSP</td>
<td>512KB -2MB</td>
</tr>
<tr>
<td>STM32 F4 Hi Perf / DSP</td>
<td>Cortex-M4</td>
<td>168 MHz</td>
<td>1.7 to 3.6V</td>
<td>High perf &amp; DSP</td>
<td>512KB -2MB</td>
</tr>
<tr>
<td>STM32 L1 Mainstream</td>
<td>Cortex-M3</td>
<td>32 MHz</td>
<td>1.65 to 3.6V</td>
<td>2.4 GHz Radio</td>
<td>32KB – 384KB</td>
</tr>
<tr>
<td>STM32 W Wireless</td>
<td>Cortex-M3</td>
<td>24 MHz</td>
<td>1.65 to 3.6V</td>
<td>2.4 GHz Radio</td>
<td>128KB – 256KB 16KB SRAM</td>
</tr>
</tbody>
</table>

- **Platform optimized for cost effectiveness**: 16KB – 128KB
- **5 lines Foundation of STM32**: Best mix Features/Perf 16KB -1MB
- **2 lines Advanced connectivity**: Encryption 128KB -1MB 128k SRAM
- **5 lines ADC 5Mps, 16-bit ΣΔ ADC, PGA, Comp**: Hi-Res timer, 64KB – 256KB
- **2 lines Advanced connectivity**: Encryption 512KB -2MB 256kB SRAM
- **3 lines USB, LCD, AES, Analog**: 32KB – 384KB 48KB SRAM
- **ZigBee IP, RF4CE**: 128KB – 256KB 16KB SRAM

- **Cost Smart**
- **Wide range**
- **High Performance**
- **Advanced & SoC solution**
- **High Performance w/ DSP**
- **Broad range**
- **Wireless**
ST PLC product roadmap

**Performances, speed**

- 200 Mbit/s
- 128 Kbit/s
- 28.8 Kbit/s
- 4.8 Kbit/s

**Today**

- ST757x
- ST758x
- ST7538
- ST7540

**Protocol independent narrowband PLC transceivers**

**STarGRID™ platform**

- Multiple standard narrowband PLC SoC

**Baseband PLC SoC**

- AMI
- HAN
- HEMS
- V2G...

**Tomorrow**

- STxxx

**Command and control**

- AMR

**OpenPLC standard and new technologies**

- Landis+Gyr
- IBERDROLA
- OpenPLC

**SAE International**

- Prime Alliance
- OpenMeter

**Protocol independent narrowband PLC transceivers**
ST7540 power line modem

MAIN FEATURES:

- Half duplex Frequency Shift Keying (FSK) transceiver;
- Integrated single ended power line driver with accessible input and output terminals and programmable voltage and current control;
- SPI/UART microcontroller interface;
- Single 7.5 to 13.5V supply voltage;
- Very low power consumption (Iq=5mA);
- 8 programmable transmission frequencies in CENELEC bands A, B and C;
- Programmable BAUD rate from 600 to 4800 bps;
- Programmable carrier or preamble detection;
- Band-in-use detection;
- Secure access 48 bit control register;
- Programmable header and frame length recognition;
- Watchdog timer;
STarGIRD™ SoC: The narrowband PLC platform ready now for massive industrial smart grid roll outs

- Scalable pin-to-pin compatible solutions
- Programmable DSP for multiple modulations
- 8-bit core for multiple protocols management
- Suitable for CENELEC and FCC bands
- Integrated AFE & Power Amplifier
- AES Encryption
- Lowest BOM

ST7570
- S-FSK modulation
- 2.4 kbps baud
- IEC 61334-5-1 + LINKY compliant
- Ready for ERDF G1

ST758x
- n-PSK modulation
- 28.8 kbps baud
- The only Meters&More compliant (ST7581)
- Deployed in ENEL/ENDESA project (13M meters)

ST7590
- OFDM modulation
- 128 kbps baud
- PRIME “certified” by KEMA
- Selected by IBERDROLA for STAR PROJECT

OPEN meter
Open Public Extended Network metering

STarGIRD™ SoC: The narrowband PLC platform ready now for massive industrial smart grid roll outs
Metering Products Portfolio

**STPM01**
1° order ΣΔ A/D
Accuracy 0.1% in 1:1000 range
OTP, SPI, pulsed output

**STPM1x (4p/n)**
1° order ΣΔ A/D
Accuracy 0.1% in 1:1000 range
OTP, pulsed output

**STPM10**
1° order ΣΔ A/D
Accuracy 0.1% in 1:1000 range
SPI

**STPMC1**
Digital calculator
Up to 5 channels input ΣΔ streaming
4 DSPs for ΣΔ i/u streaming
112 configuration bits
OTP, SPI, pulsed output

**STPMS2 (H/L)**
2° order ΣΔ A/D
Accuracy 0.5% in 1:10000 range (H)
Accuracy 0.5% in 1:5000 range (L)
Energy monitoring: STPM01

Complete set of electrical parameters available through SPI interface (Vrms, Irms, frequency, active, reactive and apparent energy, status flags,…);

MAIN FEATURES:

- LED driving for visible information about power, tamper detection and no-load conditions;
- Zero-cross sine wave current signal available, allow turn on/off of heavy inductive loads avoiding arcing phenomenon;
- OTP for calibration and configuration with very fast and accurate software calibration;
- Support 50-60HZ - IEC62052-11, IEC62053 2x specification;
- Less than 0.1% error;
The PLM E-Meter

**STPMS2 Smart sensor:**
- Vcc supply range 3 – 5.5V
- 2nd order Sigma Delta Modulators
- Programmable chopper stabilized low noise and low offset amplifier
- Exceed 50-60 Hz IEC 687/1036 spec for class1, class0.5 and class0.2 AC watt meters
- Less than 0.1% error over 1:5000 range
- Internal low drop regulator @ 3V typ
- Precision voltage reference: 1.23V and 30 ppm/°C Max (only STPMS2L)

**STPMC1 calculator:**
- Processing of Sigma Delta current/voltage signals delivered by Smart Sensors.
- Basic computational functions plus integrators, decimators, filters.
- Measurement of active, reactive, apparent energy, current/voltage RMS and frequency values
- Software calibration and mutual compensation
The PLM E-Meter

- **Metering Section:** Poly-phase Proposed Solution: STPMC+STPMS2

2 phases – 3wires STN

3 phases – 4wires RSTN

- Multi chip solution for noise immunity
- Fast Calibration
- Tamper Detection
- Class 0.2
- Shunt/CT/Rogowsky
- Temp coeff adj.
Thank You