Embedded connectivity

Stands for the integration of built-in wired and wireless communication interfaces including software and communication protocol support in non-phone devices, machines and vehicles and thus enables the rapid introduction of compute solutions to meet the sector's ever evolving needs.
Demo Session
Embedded Connectivity

802.15.4 @ 2.4GHz
STM32W + MEMS
Wireless Sensor
Gateway

Wireless SubGHz
Communication with
SPIRIT-I and STM32L

13.56MHz
ISO15693 / NFC
RFID Solutions

Embedded Ethernet

Embedded Connectivity - June 2012
Content

• Demo Session: Embedded Connectivity

• Sub GHz Solutions based on SPIRIT-1

• MBUS and KNX Communication Protocols for Smart Buildings and Smart Grid

• STM8L/STM32L1: Ultra Low Power Microcontroller for wireless communication

• Bluetooth Modules with embedded Firmware and BT Smart outlook

• Solutions for 13.56MHz (ISO15693 / RFID / NFC)

• Solutions for 2.4GHZ 802.15.4 (STM32W , STM32L1W, GreenNet)

• Embedded Ethernet

• Solution for CANopen on STM32

• Powerline Communication for Metering
Application Drivers towards 2015

2011 - 2015 CAGR

Market Size in 2015 (K$)

Source: IHS iSuppli
(SAM, ie excl DRAM, Flash, MPUs, Opto)
SPIRIT1
sub GHz RF transceiver
What is SPIRIT1?

- Low power RF Transceiver, intended for RF applications in the sub-1 GHz Band, with integrated packet handler targeting Smart Metering Applications.

- Designed to operate in 169 / 315 / 433 / 868 / 915 MHz, Frequency Bands ISM (Industrial, Scientific and Medical) and SRD (Short Range Device).

- For Systems with channel spacing down to 12.5 kHz, complying with the EN300 220 standard.

Applications
- Wireless Metering and Wireless Smart Grid (AMR and ISM)
- Home & Building Automation
- Wireless Sensor Network (WSN)
- Industrial Monitoring and Control
- Wireless Fire and Security Alarms

Suitable for Systems targeting compliance with:
- Europe: ETSI EN 300 220
- US: FCC CFR47 Part 15
- Japan: ARIB STD T-67


- Main operating parameters controlled via SPI

- Integrated SMPS allowing very low power consumption
• Wide supply voltage range from 1.8 V to 3.6V

• Configurable data rate from 1 to 500 kbps

• Supported modulation schemes:
  2-FSK (Binary Frequency shift keying),
  GFSK (Gaussian Frequency Shift Keying),
  MSK (Minimum Shift Keying)
  GMSK (Gaussian Minimum Shift Keying),
  ASK (Amplitude Shift keying) / OOK (On-off keying)

• RF Receiver
  • Excellent receiver sensitivity (169 MHz)
    • - 120 dBm at 1.2 kbps
    • - 103 dBm at 50 kbps
  
  • Adjacent channel selectivity (1% PER – 20 bytes packet length)
    • 55 dB at 12.5 kHz channel spacing

  • Blocking performance :
    • -28 dBm at 10 MHz offset, -36 dBm at 2MHz offset

  • IIP3 (Input third order intercept)
    • (Input Power -50 dBm 915 MHz) : -31 dBm

• RF Transmitter
  • Programmable Output Power
    -36 dBm to +11 dBm, in 0.5 dB steps
• **Integrated SMPS allows very low power consumption**

<table>
<thead>
<tr>
<th>Power mode</th>
<th>Power consumption</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shutdown</td>
<td>2.5 nA</td>
<td>Everything off</td>
</tr>
<tr>
<td>Standby</td>
<td>650 nA</td>
<td>SPI On, register retention</td>
</tr>
<tr>
<td>Sleep</td>
<td>950 nA</td>
<td>SPI on, register retention, Wakeup timer on</td>
</tr>
<tr>
<td>Ready</td>
<td>400 uA</td>
<td>SPI on, XTAL on</td>
</tr>
<tr>
<td>RX</td>
<td>9 mA*</td>
<td>SPI on, XTAL on, RF Synth on</td>
</tr>
<tr>
<td>TX</td>
<td>21 mA**</td>
<td>SPI on, XTAL on, RF Synth on</td>
</tr>
</tbody>
</table>

- SPI access is available in all the modes (except Shutdown) since the SPI block is powered by a dedicated LDO (no SMPS required)

- * (9mA RX, 433 MHz, FSK, 38.4kbps), similar also for other bands; SMPS ON, Vcc = 3.0V
- ** (21mA TX, +11dBm, 169 MHz)
**Key Features**

- **Peripherals & Support functions**

  - **Integrated packet handler**, Support for Automatic acknowledgment of received packets, retransmission and time-out protocol

  - **Automatic clear channel assessment** (CCA) Engine:
    - Channel access mechanism, based on the rule “Listen-before-talk” systems before transmitting; this avoids the simultaneous use of the channel by different transmitter.

  - **AES 128-bit encryption co-processor** is available for secure data transfer

  - Separate **96-byte RX/TX FIFOs**, accessible via the SPI interface for host processing

  - Supports **frequency hopping** under MCU control
    - Calibration can be made each time the MCU decide to change frequency or MCU can save and restore calibration data to make the frequency hopping faster

- **Package QFN 20 (4 x 4 mm)**
Main Block Description

• **Data link layer**
  - Support for channel configuration, packet handling and data buffering
  - Support Packet Formats (Basic, Stack, Wireless M-BUS)

  • The Host MCU can stay in power down until a valid RF packet has been received, and then burst read the data, greatly reducing the power consumption and computing power required from the host MCU

• **AES encryption co-processor**
  - Provides data security support as it embeds an advanced encryption standard (AES) core which implements a cryptographic algorithm

• **Analog temperature sensor**
  - The Host MCU can be used to read the chip temperature (e.g. it can be used to force radio recalibration)

• **Battery indicator and low battery detector**
MCU interface

SPI communication
- Write registers or FIFOs
- Read registers or FIFOs
- 17 Commands (State diagram, AES, FIFO flush)

GPIO communication
- Interrupt signals
- Monitoring signals ()
- Commands (TX/RX mode, Wake-up from external input)
- Input/output data (direct mode)
- Input/output reference clock (MCU clock out, 34.7 kHz for LDC mode input)
- Analog output: temperature sensor (GPIO 0)

SDN pin
- Shutdown signal

The SPIRIT1 has more than 200 registers for flexible usage of the transceiver
An abstraction layer is provided.

Each module of the library manages a specific feature of the SPIRIT1.

The SPIRIT1 library is developed in order to be platform independent. Every API function translates the high level command in a bit sequence to program the SPIRIT1.
SPIRIT1 SDK Suite GUI RF performance evaluation

- SPIRIT1 contains a GUI allowing to perform:
  - Radio configuration
  - RF tests (TX of un modulated carrier, TX PN9 sequence, RX activation)
  - Packet transmission/reception test with PER evaluation
  - AES engine encryption/decryption tests
  - Register read/write and dump
<table>
<thead>
<tr>
<th>Type</th>
<th>Purpose</th>
<th>Content</th>
<th>Order code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dev kit</td>
<td>RF performance evaluation, Point to Point RF communication, System Prototype development</td>
<td>2 x STM32L based motherboard 2 x SPIRIT1 RF modules</td>
<td>STEVAL-IKR001V1 (169 MHz)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>STEVAL-IKR001V2 (315 MHz)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>STEVAL-IKR001V3 (433 MHz)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>STEVAL-IKR001V4 (868 MHz)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>STEVAL-IKR001V5 (915 MHz)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>STEVAL-IKR001V6 (920 MHz, ARIB T-108)</td>
</tr>
</tbody>
</table>
ST with 3rd parties supports

- STM32L + SPIRIT-1
- STM32L + KNX Transceiver
- STM8L + KNX Transceiver
- STM32F4 + KNX Transceiver

Solutions for Smart Buildings
ST Wireless M-BUS Stack features

- EN13757-4:2005 (S1, S1m, T1, T2, R2).
  - Radio band: 868 MHz
- EN13757-4:2011 (N mode)
  - Radio band 169 Mhz
- GUI over USB Interface
- Features under development:
  - Device type: Meter/Concentrator/Sniffer

USB-HID

WM-BUS SOFTWARE APPLICATION

Database
(MS-SQL Server Compact)
STM8L/STM32L1

EnergyLite™ platform – Ultra-low-power devices
8-bit and 32-bit MCU families

Standard voltage & Ultra-low-power
- STM8S Mainstream
- STM8A Automotive
- STM8L Ultra-low-power
- STM8T Touch-sensing

High-performance & Ultra-low-power
- STM32F4 – Cortex-M4
- STM32F2 – Cortex-M3
- STM32F1 – Cortex-M3
- STM32F0 – Cortex-M0
- STM32L1 – Cortex-M3

Flash memory size (in bytes)

Features

STM32 L1
Intelligent Processors by ARM®

Embedded Connectivity - June 2012
STM8L/STM32L1 - Ultra-low-power MCUs

• With the EnergyLite™ platform, STMicroelectronics is strongly committed to ultra-low-power MCUs

• Energy saving
  • Ultra-low-power advanced architecture
  • High-performance core
  • Ultra-low-power in dynamic and static modes

• New STM8L/STM32L1 series increase STM8/STM32 offer
  • Enriches both the ultra-low-power EnergyLite™ platform and STM8/STM32 portfolio
  • More than 100 part numbers for ultra-low-power lines
Ultra-low-power portfolio

- ST’s 130 nm **ultra-low-leakage** process technology

Notes:
1. 80 pins for STM8L15x/16x only
2. BGA100 on STM32L15x up to 128 Kbytes only

Legend:
- STM8L: 151 without LCD, 152 with LCD and 162 with LCD and 128-bit AES
- STM32L1: 151 without LCD, 152 with LCD and 162 with LCD and 128-bit AES

- More than 100 part numbers
- From 2- to 384-Kbyte Flash
- 20 to 144 pins
# Ultra-low-power series – 3 lines

## Feature-rich 32-bit solution: STM32L151/152/162 line

<table>
<thead>
<tr>
<th>Feature</th>
<th>STM32L151/152/162</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 MHz Cortex-M3 CPU</td>
<td></td>
</tr>
<tr>
<td>BOR/ PVD</td>
<td></td>
</tr>
<tr>
<td>Main osc. input 1-24 MHz</td>
<td></td>
</tr>
<tr>
<td>Up to 12-Kbyte data</td>
<td></td>
</tr>
<tr>
<td>Up to 384-Kbyte Flash</td>
<td></td>
</tr>
<tr>
<td>Up to 48-Kbyte SRAM</td>
<td></td>
</tr>
<tr>
<td>RTC with 32 kHz osc.</td>
<td></td>
</tr>
<tr>
<td>Up to 12-channel DMA</td>
<td></td>
</tr>
<tr>
<td>12-bit ADC (1 μs)</td>
<td></td>
</tr>
<tr>
<td>2x 12-bit DAC</td>
<td></td>
</tr>
<tr>
<td>LCD 8x4 0 4x4 4</td>
<td></td>
</tr>
<tr>
<td>AES 128-bit</td>
<td></td>
</tr>
<tr>
<td>ULP MSI</td>
<td></td>
</tr>
<tr>
<td>MP UET M</td>
<td></td>
</tr>
<tr>
<td>US B FS</td>
<td></td>
</tr>
<tr>
<td>SDI O</td>
<td></td>
</tr>
<tr>
<td>FSM C</td>
<td></td>
</tr>
<tr>
<td>3x op-amps</td>
<td></td>
</tr>
</tbody>
</table>

## Feature-rich 8-bit solution: STM8L151/152/162 line

<table>
<thead>
<tr>
<th>Feature</th>
<th>STM8L151/152/162</th>
</tr>
</thead>
<tbody>
<tr>
<td>STM8 core @ 16 MHz</td>
<td></td>
</tr>
<tr>
<td>BOR/ PVD</td>
<td></td>
</tr>
<tr>
<td>Main osc. input 1-16 MHz</td>
<td></td>
</tr>
<tr>
<td>Up to 4-Kbyte SRAM</td>
<td></td>
</tr>
<tr>
<td>RTC with 32 kHz osc.</td>
<td></td>
</tr>
<tr>
<td>Up to 64-Kbyte Flash</td>
<td></td>
</tr>
<tr>
<td>Up to 2-Kbyte data</td>
<td></td>
</tr>
<tr>
<td>Up to 4-channel DMA</td>
<td></td>
</tr>
<tr>
<td>12-bit ADC (1 μs)</td>
<td></td>
</tr>
<tr>
<td>12-bit DAC</td>
<td></td>
</tr>
<tr>
<td>LCD 8x4 0 4x4 4</td>
<td></td>
</tr>
<tr>
<td>AES 128-bit</td>
<td></td>
</tr>
</tbody>
</table>

## Entry level 8-bit solution: STM8L101 line

<table>
<thead>
<tr>
<th>Feature</th>
<th>STM8L101</th>
</tr>
</thead>
<tbody>
<tr>
<td>STM8 core @ 16 MHz</td>
<td></td>
</tr>
<tr>
<td>BOR/ PVD</td>
<td></td>
</tr>
<tr>
<td>Main osc. input 1-16 MHz</td>
<td></td>
</tr>
<tr>
<td>Up to 8-Kbyte Flash*</td>
<td></td>
</tr>
<tr>
<td>Up to 1.5-Kbyte SRAM</td>
<td></td>
</tr>
</tbody>
</table>

Note: * Embedded EEPROM in the Flash
STM8L – Ultra-low-power modes

Typical @ 25 °C

192 µA/MHz
Dynamic Run
From Flash

90 µA/MHz
Dynamic Run
From RAM

5.1 µA
Low-power Run
@ 32 kHz

3.0 µA
Low-power Wait
@ 32 kHz

1.2 µA
Active Halt with RTC

0.4 µA
Halt

Notes:
- POR/PDR on
- RAM content preserved
- BOR option at 2.4 µA
- Startup time from active Halt 5 µs
- Run and Wait consumption values are independent of $V_{DD}$
- Active Halt and Halt values measured at $V_{DD} = 1.8$ V
STM32L1 – Ultra-low-power modes

Typical @ 25 °C

- 230 μA/MHz
- 186 μA/MHz
- 9 μA
- 4.9 μA
- 1.3 μA/0.45 μA
- 1.0 μA/0.3 μA

Notes:
- POR/PDR on
- RAM content preserved
- BOR option at 2.4 μA
- Startup time from Stop 8 µs
- Run and Sleep consumption value are independent of V_{DD}
- Stop and standby values measured at V_{DD} = 1.8 V
- Low-power Run and Low-power Sleep are measured with Flash off
Ultra-low-power Discovery kits

STM8L Discovery

STM8L evaluation board
- Embedded ST-LINK for STM8L
- USB interface for debugging and programming
- Numerous examples available on www.st.com/stm8l-discovery

STM32L-Discovery

Everything to discover
- STM32L evaluation board
- Embedded ST-LINK/V2
- USB interface for debugging and programming
- Numerous examples
Dual Interface EEPROM

May 2012
Dual Interface EEPROM – Introduction

- Low-power I2C interface
- Digital Output for MCU control
- Unique Energy Harvesting Function
- High-reliability EEPROM
- RFID and NFC compatible RF interface
Dual Interface EEPROM - M24LR product line

• Comprehensive portfolio
  • Memory density: 4-Kbit, 16-Kbit and 64-Kbit
  • Large package choice

• RF interface:
  • Long range RFID
  • NFC (ISO15693)

Serial Interface: low-power I2C

Energy Harvesting from RF

- M24LR04E (4-Kbit)
- M24LR16E (16-Kbit)
- M24LR64E (64-Kbit)
Dual Interface EEPROM - How it works

- Based on Passive RFID technology
  - Just add a 13.56 MHz inductive antenna onto your PCB

No battery needed to operate the dual interface EEPROM in RF mode
M24LR64 block diagram

I²C interface
- industry standard
- 1.8-5.5V, 400kHz

ISO 15693 RF interface
- industry standard
- passive RFID technology
- high-speed mode (up to 53 Kbit/s)

I²C/RF protocol
Power management and I²C/RF arbitration unit

64-bit UID
64-bit Unique Identifier (Factory-Programmed and Locked)

Power extraction

RF protocol

64-Kbit EEPROM

Password protection scheme
What is M24LR16E Energy Harvesting?

- When the Energy Harvesting function is ON, the M24LR16E can deliver the extra energy to other components
### M24LR16E Energy Harvesting Performance

<table>
<thead>
<tr>
<th>Range</th>
<th>$H_{\text{min}}$</th>
<th>$P_{\text{min}}$</th>
<th>$V_{\text{out}} \ @ \ I=0$</th>
<th>$V_{\text{out}} \ @ \ I_{\text{sink_max}}$</th>
<th>$I_{\text{sink_max}} \ @ \ P_{\text{min}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>3,5 A/m</td>
<td>100 mW</td>
<td>2,7 to 4,5 V</td>
<td>1,7 V</td>
<td>6 mA</td>
</tr>
<tr>
<td>01</td>
<td>2,4 A/m</td>
<td>66 mW</td>
<td>2,7 to 4,5 V</td>
<td>1,9 V</td>
<td>3 mA</td>
</tr>
<tr>
<td>10</td>
<td>1,6 A/m</td>
<td>33 mW</td>
<td>2,7 to 4,5 V</td>
<td>2,1 V</td>
<td>1 mA</td>
</tr>
<tr>
<td>11</td>
<td>1,0 A/m</td>
<td>18 mW</td>
<td>2,7 to 4,5 V</td>
<td>2,3 V</td>
<td>300 uA</td>
</tr>
</tbody>
</table>

- Enables to remotely
  - Recharge your battery!
  - Power your board!
Embedded reader-writer: CR95HF chip

- Full support of ST ISO15693 products with CR95HF
  - Software libraries
  - Reference design
  - Application notes

Design your own embedded RF reader-writer

ISO15693 Memory Library

Optional AES Encryption Library (e.g. STM32 UM0586)

Host controller

UART

SPI

M24LR64, M24LR16E, M24LR04E
4-Kbit, 16-Kbit and 64-Kbit Dual I/F EEPROM

LRI1K, LRI2K, LRI62K, LRI64K
1, 2 and 64-Kbit ISO15693 RFID tag ICs
DEMO-CR95HF-A support

- Ideal for demonstrations and performance assessment
- Directly plugs on your computer (USB), comes with PC software

**CR95HF drivers (ANSI C)**
- Source code CR95HF drivers.rar
- Application note AN3355

**Schematics and gerber files**
- Schematics (0017031-B-SCM.pdf)
- Gerber files (0017031-B-Gerber.zip)

**Antenna design guidelines**
- Application note AN3394
- Antenna design simplified basic tool

**PC demonstration software**
- M24LRxx Application Software 2.0.zip

Host system
2.4GHz WIRELESS @ ST

May 2012
OEM Modules

**BlueTooth (Blue Modules)**

**IEEE 802.15.4**

- Off-the-shelf RF **plug&play solutions**
  - Enable short **time-to-market** product development
  - **No RF specific knowledge** is required for the integration of the modules in the target application

- **Cost-effective** for design of multiple platforms or multiple versions of the same platform
  - Save 8-12 months in design cycle
  - Significantly reduce engineering and production costs

- **Pre-certified** RF modules
  - reduce the effort and certification cost on the customer side

---

**SPBT Series**
- SPBT2532 (BT 2.1)
- SPBT2632 (BT 3.0)

**SPZB32W Series**
- SPZB32W1 (STM32W108CB)
Blue Modules Key Features

- Multiple antenna and trasmission range options available
- BT 2.1 EDR / BT 3.0 Compliant
- Integrated Serial Port Profile and AT layer command interface
- FW upgradable via UART
- Micro sized Form Factor
- Support of Low Power Use Modes
- Industrial Operating Temperature Range
- Bluetooth Qualified and RF Certified (FCC, CE, IC)

- SPBT2532C2.AT
- SPBT2632CxA.AT2

ST core leading industry technology inside

- STM32F103
- STLC2500D
- STLC2690

SW Libraries Available

- AT-command layer
- IAP Profile
- SPP profile

AmpedRF
Blue Modules are **CE** and **Bluetooth® certified. Radio type compliant** for US and Canada.

<table>
<thead>
<tr>
<th>BQB qualified design</th>
<th>CE Statement of opinion*</th>
<th>FCC and IC</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPBT2532C2.AT</td>
<td><strong>B016360</strong></td>
<td><strong>0307-ARAJ00079</strong></td>
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<tr>
<td>SPBT2532C2.AT2</td>
<td>Product type: End Product</td>
<td>Measurements in accordance with:</td>
</tr>
<tr>
<td></td>
<td>TGP Version: Core 2.1/2.1 + EDR TCRL-2009-1</td>
<td>EN 300 328 V 1.7.1 (2004-11)</td>
</tr>
<tr>
<td></td>
<td>Core Spec Version: 2.1/2.1 +EDR</td>
<td>EN 301 489-17 V 1.2.1:2002</td>
</tr>
<tr>
<td></td>
<td>Product Description: Bluetooth Module</td>
<td>EN 60950-1</td>
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<tr>
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<td>QD ID: <strong>B016360</strong></td>
<td>CE 0051</td>
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<tr>
<td>SPBT2632C1A.AT2</td>
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<td><strong>0447-ARAM00002</strong></td>
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<td>Product type: End Product</td>
<td>Measurements in accordance with:</td>
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<td>TGP Version: Core 3.0</td>
<td>EN 300 328 V 1.7.1 (2006-10)</td>
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<td>EN 301 489-17 V 2.1.1 (2009)</td>
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<td><strong>0307-ARMJ00003</strong></td>
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<td>TGP Version: Core 3.0</td>
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<td></td>
<td>Core Spec Version: 3.0</td>
<td>EN 301 489-17 V 2.1.1 (2009)</td>
</tr>
</tbody>
</table>

* Reports available on request
Hardware Architecture and RF Performances

**Class 1**
- **Tx Power**: +10 dBm.
- **Rx Sensitivity**: -90 dBm
- **Size**: 15 mm x 27 mm

**Class 2**
- **Tx Power**: +0 dBm.
- **Rx Sensitivity**: -86 dBm
- **Size**: 11.6 mm x 13.5 mm

**Class 2**
- **Tx Power**: +4 dBm.
- **Rx Sensitivity**: -85 dBm
- **Size**: 10.5 mm x 13.5 mm

---

**BT 3.0**

STE STLC2690 *Bluetooth IC*

- **SPBT2632C1A.AT2**

**BT 3.0**

STE STLC2690 *Bluetooth IC*

- **SPBT2632C2A.AT2**

**BT 2.1 + EDR**

STE STLC2500D *Bluetooth IC*

- **SPBT2532C2.AT**
- **SPBT2532C2.AT2**

---

**Antenna**

**LPO clock**

**Voltage regulator**

**BT radio**

**Bandpass filter**

**STM 32F**

**GPIOs**

**UART**

**V supply**
Software Architecture

AT(2) Interpreter (abserial)

BT Protocol Stack

Higher Layers

- SPP
- SDAP
- iAP*
- GAP
- RFCOMM
- SDP
- L2CAP

BT Protocol Stack

Lower Layers

- HCI
- LMP/LM
- Baseband/LC
- Bluetooth Protocol Stack
- Higher Layers
- Lower Layers
- AT(2) Interpreter (abserial)

GPIOs

UART

STM

32F

Flash

RAM

Bandpass filter

BT radio

Voltage regulator

Crystal

LPO clock

V supply
Profiles and AT Command Layer

PART NUMBER SCHEMA: SPBT2x32Cxx.AT(2)

Integrated Profiles

- **Generic Access Profile (GAP)**
  - Discovers and connects to other devices
  - Security (authentication)
  - idle mode procedure: inquiry
  - linking, paging, connection

- **Service Discovery Profile (SDP)**
  - Locates/describes services from/to other devices

- **Serial Port Profile (SPP)**
  - Emulates legacy serial communication

- **iPOD Accessory Protocol (iAP)**
  - Supports communication with Apple iOS Bluetooth enabled device*

(*) The external Apple authentication coprocessor and MFI certification are required

### AT(2) Interpreter

- **GAP**
- **SPP**
- **SDAP**
- **iAP**
- **RFCOMM**
- **L2CAP**
- **SDP**
- **LMP/LM**
- **Baseband/LC**

### AT Command

<table>
<thead>
<tr>
<th>BlueTooth version</th>
<th>AT command</th>
<th>AT2 command</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>2.1 + EDR</code></td>
<td><code>SPBT2532C2</code></td>
<td><code>SPBT2532C2</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td><code>SPBT2632C2A</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td><code>SPBT2632C1A</code></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Point-to-point communication</th>
<th>Multipoint communication</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><code>X</code></td>
<td><code>-</code></td>
</tr>
<tr>
<td></td>
<td><code>X</code></td>
<td><code>X</code></td>
</tr>
</tbody>
</table>

### Profiles

<table>
<thead>
<tr>
<th></th>
<th>SPP</th>
<th>iAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Android</td>
<td><code>-</code></td>
<td><code>X</code></td>
</tr>
<tr>
<td>iPhone</td>
<td><code>-</code></td>
<td><code>X</code></td>
</tr>
</tbody>
</table>
### HW Features

<table>
<thead>
<tr>
<th>SPBT2532C2</th>
<th>SPBT2632C2A</th>
<th>SPBT2632C1A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RESET (Nrst) pin</strong></td>
<td><strong>BOOT pin</strong></td>
<td></td>
</tr>
<tr>
<td><strong>4x UART(I2C) pins (Tx, Rx, Cts, Rts)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>6x pins JTAG interface (Jtdi, Jtdo, Jtms, Jtck, Jtrst, Nrst)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2.1V to 3.6V supply</strong></td>
<td><strong>2.7V to 3.6V supply</strong></td>
<td></td>
</tr>
<tr>
<td><strong>GPIO High Level = 3V</strong></td>
<td><strong>GPIO High Level = 2.1V</strong></td>
<td></td>
</tr>
<tr>
<td><strong>4x GPIOs</strong></td>
<td><strong>7x GPIOs</strong></td>
<td><strong>16x GPIOs</strong></td>
</tr>
<tr>
<td><strong>Antenna pin</strong></td>
<td><strong>LPA pin</strong></td>
<td></td>
</tr>
</tbody>
</table>
## Power Consumption Performances

<table>
<thead>
<tr>
<th></th>
<th>SPBT2532C2.AT</th>
<th>SPBT2632C2A.AT2</th>
<th>SPBT2632C1A.AT2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Speed CPU Mode 32 MHz</strong></td>
<td>Av. Values</td>
<td>Av. Values</td>
<td>Av. Values</td>
</tr>
<tr>
<td>ACL data 115K Baud UART at max throughput (Master)</td>
<td>39.0 mA</td>
<td>23 mA</td>
<td>23 mA</td>
</tr>
<tr>
<td>ACL data 115K Baud UART at max throughput (Slave)</td>
<td>39.0 mA</td>
<td>27.5 mA</td>
<td>27.5 mA</td>
</tr>
<tr>
<td>Connection, no data traffic, Master</td>
<td>28.9 mA</td>
<td>9.1 mA</td>
<td>9.1 mA</td>
</tr>
<tr>
<td>Connection, no data traffic, Slave</td>
<td>34.5 mA</td>
<td>11.2 mA</td>
<td>11.2 mA</td>
</tr>
<tr>
<td>Connection 375 ms sniff</td>
<td>----</td>
<td>490 (ext. LPO) uA</td>
<td>490 uA</td>
</tr>
<tr>
<td>Standby, (page/inquiry scan), without deep sleep</td>
<td>28.3 (33.2) mA</td>
<td>8.6 (9.5) mA</td>
<td>8.6 (9.5) mA</td>
</tr>
<tr>
<td>Standby, (page/inquiry scan), with deep sleep, no external LPO</td>
<td>2.1 (7.2) mA</td>
<td>1.7 (2.7) mA</td>
<td>----</td>
</tr>
<tr>
<td>Standby, (page/inquiry scan), with deep sleep, with external LPO</td>
<td>----</td>
<td>70 (520) uA</td>
<td>70 (520) uA</td>
</tr>
</tbody>
</table>
STEVAL-SPBTxATVx

- Blue Modules reference designs and evaluation boards for a fast evaluation of AT commands
- Power Supplied via the USB interface
- Compact and Small form factor
- LEDs connected to GPIO for testing purposes
- UART/USB bridge from Silicon Lab

Typical Usage

HyperTerminal

ABserial Commands/Events

HOST A:

HOST B

HyperTerminal

ABserial Commands/Events
Support tools

Order codes

<table>
<thead>
<tr>
<th>Order code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPBT2532C2.AT</td>
<td>Bluetooth V2.1+EDR, Class2, antenaless, AT command FW</td>
</tr>
<tr>
<td>SPBT2532C2.AT2</td>
<td>Bluetooth V2.1+EDR, Class2, antenaless, AT2 command FW</td>
</tr>
<tr>
<td>SPBT2632C2A.AT2</td>
<td>Bluetooth V3.0, Class2, antenna, AT2 command FW</td>
</tr>
<tr>
<td>SPBT2632C1A.AT2</td>
<td>Bluetooth V3.0, Class1, antenna, AT2 command FW</td>
</tr>
</tbody>
</table>

Evaluation boards

<table>
<thead>
<tr>
<th>Order code</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEVAL-SPBT2ATV2</td>
<td>USB dongle, evaluation board for SPBT2532C2.AT</td>
<td>available</td>
</tr>
<tr>
<td>STEVAL-SPBT2ATV3</td>
<td>USB dongle, evaluation board for SPBT2532C2.AT2</td>
<td>available</td>
</tr>
<tr>
<td>STEVAL-SPBT3ATV3</td>
<td>USB dongle, evaluation board for SPBT2632C2A.AT2</td>
<td>available</td>
</tr>
<tr>
<td>STEVAL-SPBT4ATV3</td>
<td>USB dongle, evaluation board for SPBT2632C1A.AT2</td>
<td>available</td>
</tr>
</tbody>
</table>

Other tools

Documentation

| Datasheets
| Application note
| AT command user manual |

Technical support

Contact us @ onlinesupport@st.com
802.15.4 Target Applications

- Home/Building Automation
- Healthcare Assisted Living
- Environmental Monitoring
- Sport & Wellness
- Industrial
- Smart Energy
- Games & Remote Controller

STM32W an open 802.15.4 Platform

Chipsets
RF Modules
STM32W architecture overview

- 32-bit ARM Cortex-M3 core running at 24 MHz
- Up to 256-Kbyte Flash and 16-Kbyte RAM
- Fully IEEE 802.15.4 compliant radio at 2.4 GHz
- Power management
  - Deep sleep mode: <1 µA with RAM retention
- On-chip debug support
  - ARM JTAG/SWD
  - Packet trace interface enables remote monitoring of radio messages
- ARM memory protection unit
  - To detect erroneous software accesses
- Sleep timer, watchdog timer and GP timers
- AES-128 encryption acceleration
- Serial communication (UART/SPI/I²C)
- GPIO
- ADC (6 channels, first-order 12-bit sigma delta)
STM32W F/W combinations/portfolio
(for all versions)

SimpleMAC
Full design freedom
RF control

Customer application
Network layer (optional)

15.4 MAC interface

ZigBee IP
SmartGrid
Customer application
SE2.0 profile
IPV6 network layer
ZigBee IP
e:o 2Q/12 (Beta)

15.4 MAC interface

RF4CE
Consumer, remote controls
Customer application
ZID profile
ZRC profile
RF4CE stack
Network layer

15.4 MAC Interface

Part Number last digit mapping

Customer code
Libraries available
Alpha released, Beta planned in June 2012 (depends on Zigbee Alliance specification ratification)
Alpha released, Beta planned Q4 2012 (depends on CSEP specification ratification)
The ST IEEE 802.15.4 Simple MAC Library provides a set of APIs allowing access to the PHY and lower-MAC functionality of the STM32W SoC:

- RX/TX functionalities
- Radio channel selection
- **Transmit power level** control
- Boost mode control
- Radio **sleep** and **wakeup** control
- LQI and RSSI for received packets
- Implements Unslotted CSMA transmit support including CCA
- Ability to enable/disable receiver
- Automatic acknowledgement management
SPZB32W Series Options

Part Number Schema

Product Family
802.15.4/ZigBee
RF Modules

Memory Options (integrated micro)
32Wx → 32W1: 8/128 kB STM32W108CBU6
32Wx → 32W2: 16/256 kB STM32W108CCU7

Antenna Options
y→A: Integrated Antenna
y→C: Integrated UFL Connector

Power Transmission Options
z→1: Long Range (Integrated PA) (up to +20 dBm/100 mW)
z→2: Normal Range (+3 dBm /2 mW typical)

Stack Options
Blank: Open (only for evaluation boards)
t→4: SimpleMAC
STM32W – PRODUCT PORTFOLIO

Flash size (bytes)

- 256 K
- 192 K
- 128 K
- 64 K

Packages
- QFN 40 pins
- QFN 48 pins

ZigBee IP
- STM32W108HB
- STM32W108CB
- STM32W108C8
- STM32W108CC
- STM32W108CZ

Also Integrated in the SPZB32W Series of RF Modules
SPZB32W Key Features – Block Diagrams

- Onboard 24MHz and 32kHz stable Xtals
- Supply Range 2.1 V – 3.3 V
- Exported the STM32W peripherals (UART, I2C, SPI, ADC)
- JTAG interface for programming and debugging
- SMD Modules with side pads for easy soldering and optical inspection
- Operating in the industrial temperature range: -40 °C to +85 °C
- Small Form Factor: 26.5 mm x 16.4 mm
- All the versions are pintopin compatible
  - Unless one GPIO between the normal and long range versions

Vdd

32.768kHz Xtal

24MHz Xtal

STM32W108

Balun

BPF

GPIO

Jtag

SPZB32Wxy2.t –
(TX: +3dbm : ITX: 32mA)

Vdd

32.768kHz Xtal

24MHz Xtal

STM32W108

PA/LNA

BPF

GPIO

Jtag

SPZB32Wxy1.t –
(TX: up to 20dBm: ITX: 130 mA)
SPZB32W Use modes

**SOC Use Mode:**
STM32W runs both the protocol and the application both stored in the integrated Flash

**Network Coprocessor Use Mode:**
STM32W runs the protocol while an host processor runs and store the application

API

- Application
- Protocol Stack
- MAC+PHY

**CLI/API**

- Application
- Protocol Stack
- MAC+PHY

**Host (i.e. STM32F)**

- SPI/UART
Tools and Reference Boards

STM32W Development Kits

STM32W Control Kit

SPZB32W Reference and Evaluation Boards

STEVAL-IDZ401V1

STEVAL-IDZ30xV1

STEVAL-IDX001V1 + STEVAL-IDX001V1x
(motherboard) (daughterboard)
SPZB32W Reference Designs

SOC Use Mode:
STM32W stores and runs both the protocol and the application

- Application
- Protocol Stack
- MAC+PHY

STEVAL-IDZ401V1
- Optimized USB Dongle Design
- Powered and programmable via USB
- STM32F USB Bridge
- Integrated JTAG

STEVAL-IDZ30xV1
- Flexible and expandable development board
- Multiple Power Supply Options
- SiLab USB Bridge
- Integrated temperature sensor, configurable buttons, configurable LEDs and voltage battery measurement circuitry
SPZB32W Reference Design

Network Coprocessor Use Mode:
STM32W stores and runs the protocol while an host processor stores and runs the application

- General Purpose Motherboard (MB - STEVAL-IDX001V1) based on an STM32F103RE micro (512 kBytes)
- Companion Daughterboard (DB - STEVAL-IDX001V12) based on an SPZB32W module
- Included multiple configurable buttons and leds in both the motherboard and the daughterboard
- Enabled evaluation of the EZSP library of ZigBee PRO available from ST
STM32F207 in STEVAL-PCC010V2

Embedded Ethernet
Evaluation board STEVAL-PCC010V2

- 25MHz
- Reset
- LEDs
- Bootstrap jumpers
- MII / RMII connectors
- Bootstrap jumpers
- RJ45 with emb. transformer

Embedded Connectivity - June 2012
STM32F207 MII/RMII controller board STEVAL-PCC010V2

- STM32F207 MCU with Ethernet MAC, MII and RMII I/F
- USB connector: used to deliver +5V power
- On board LDO to deliver 3.3V
- Reset and general purpose button
- 25MHz on board crystal
- MII Connector compatible with the Ethernet PHY evaluation boards
- Full JTAG connector (20 pin)
- Firmware: lwIP TCP/IP based web server

Board dimensions only 35 x 45 mm
SW support - firmware

• Simple webserver demo

• Based on MCD STM32F2x7_ETH_LwIP (light weight IP TCP/IP stack demo) – free of charge
  • Only low level Ethernet driver files adapted to support ST802RT1A (stm32_eth.c, stm32_eth.h)
  • Webserver webpages modified

• Official STM32F2x7_ETH_LwIP is not yet available (we will distribute updated version for STEVAL-PCC010V2 when available)
1) Connect CAT5 Ethernet cable to the ST802RT1A Ethernet PHY board on one side and to the PC on the other side. Power up the board with USB cable.

2) Setup network settings: In Control Panel – Network Connections right click on your network card and open Properties

3) Select IP protocol properties: Select Internet Protocol (TCP/IP), click Properties and set Static IP address

   IP Address: 192.168.0.4
   Subnet mask: 255.255.255.0

4) Run your web browser and open page http://192.168.0.8. You should be able to see the first page of the web server running on the demonstration kit.

You can also ping to the board using ping command on your PC.
Higher-layer protocol for embedded control systems

Internationally standardized (EN 50325-4)

Profiles for
- Communication
- Devices
- Application

CANopen provides very flexible configuration capabilities.

These specifications are developed, maintained and certified by CAN in Automation members.

Quality assured by conformance test
CANopen STM3210C-EVAL evaluation kit

• Application example demonstrates
  • SDO, PDO protocol processing, heartbeat, simple digital and analog input and output via the STM32 peripherals of the microcontroller and the color TFT LCD
    • PDO - Process Data Object
    • SDO – Service Data Object

• System requirements
  • 1 x STM3210C-EVAL board
  • CAN interface with CAN/CANopen bus monitor, for example USB-to-CAN compact HW and MiniMon v3 or canAnalyser v2.7 PC SW by IXXAT
  • FlashLoader tool supporting download of Intel HEX files into the STM32F107 microcontroller
Thank you