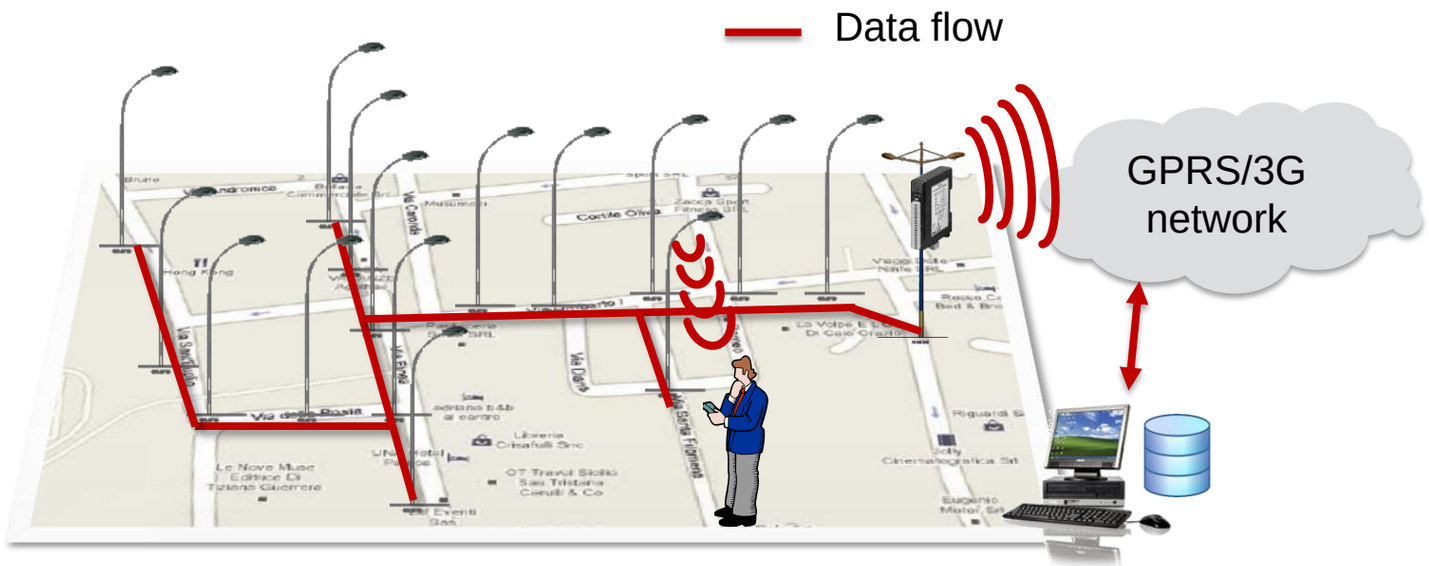
# Smart street lighting solutions



# Contents

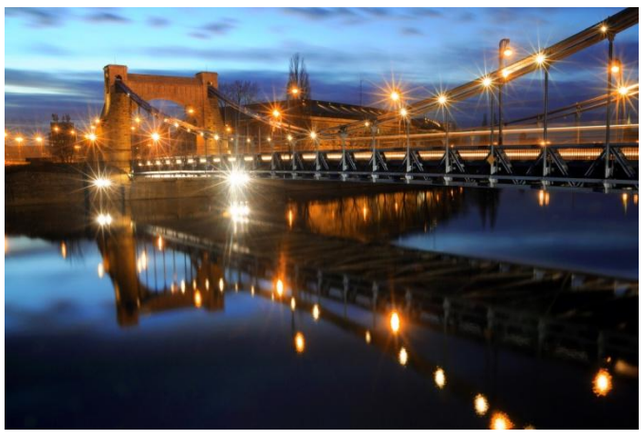
# Goals and design of street lighting

## Goals

- Ensure maximum visual safety for drivers and pedestrians
- Improve visibility of people and objects
- Provide the best light quality and the highest color rendering
- Make residential areas surer
- Enhance street furniture appearance

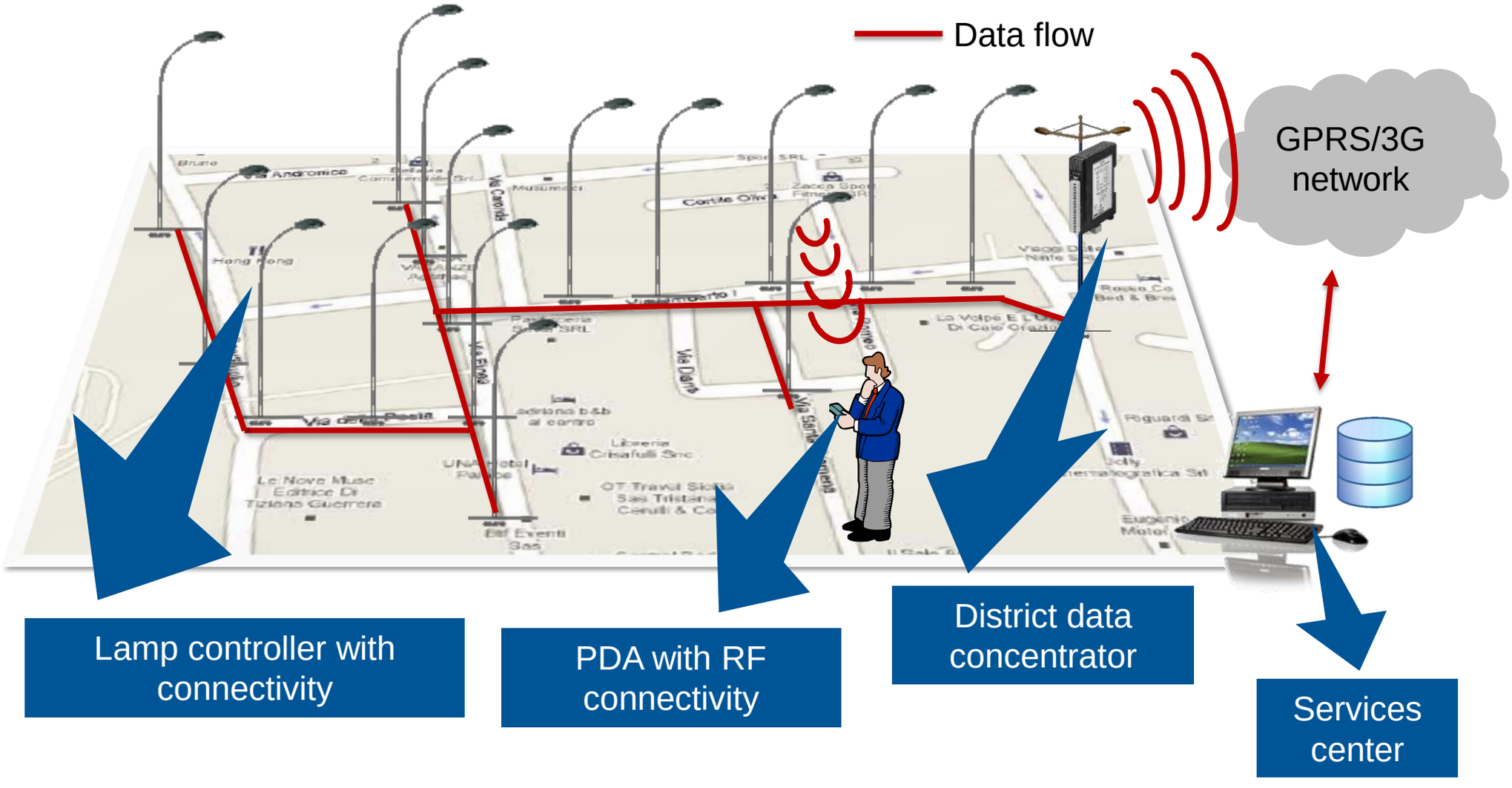
## Design principles

- Energy efficient
- Reliable and safe
- Technically advanced
- Cost effective
- Convenient for maintenance



# What is smart street lighting?

- Enables smart cities with highly-efficient street light driving, advanced monitoring and remote control

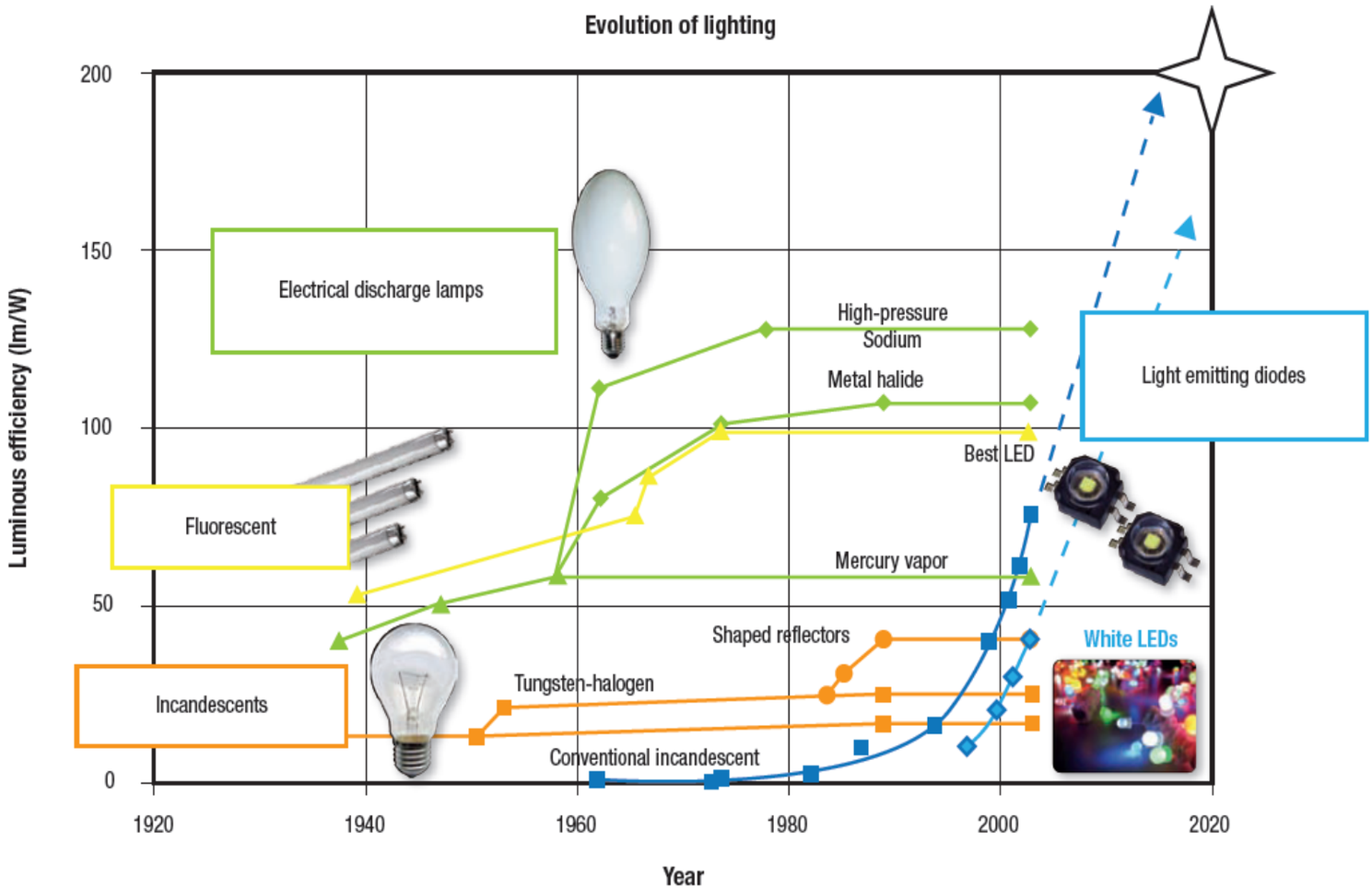


# Why smart street lighting?

- Reduced maintenance costs
- Reduced energy consumption
- Performance and energy-consumption data at your fingertips
- Reduced greenhouse gas emissions
- Greater citizen satisfaction

# From incandescent lamps to HID, LED

- Inefficient light sources such as incandescent lamps will be phased out
- LED technology will push the lighting market
- HID and HB LED offer outstanding luminous efficiency




Source: U.S Department of energy 2004, Philips Lighting 2005

# HID, LED: highest performances

## High intensity discharge (HID)

- Ignition at very high voltage
- Warm-up phase is required
- Steady-state phase with lamp power control is needed
- Different performances according to the metals and filler materials
  - **High pressure sodium (up to 150 lm/W)**
  - **Metal halide (up to 110 lm/W)**
  - **Mercury vapor (up to 60 lm/W)**

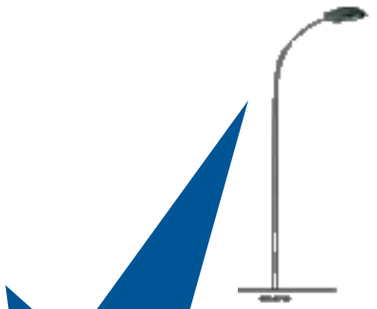
## Light emitting diode (LED)

- A LED is activated when a DC voltage is applied
- The luminous flux and dominant wavelength are controlled by average current
- The ripple current has to be kept at acceptable levels
- Dimming can be implemented through digital or analog control
  - **Best LED efficiency: 150 lm/W**

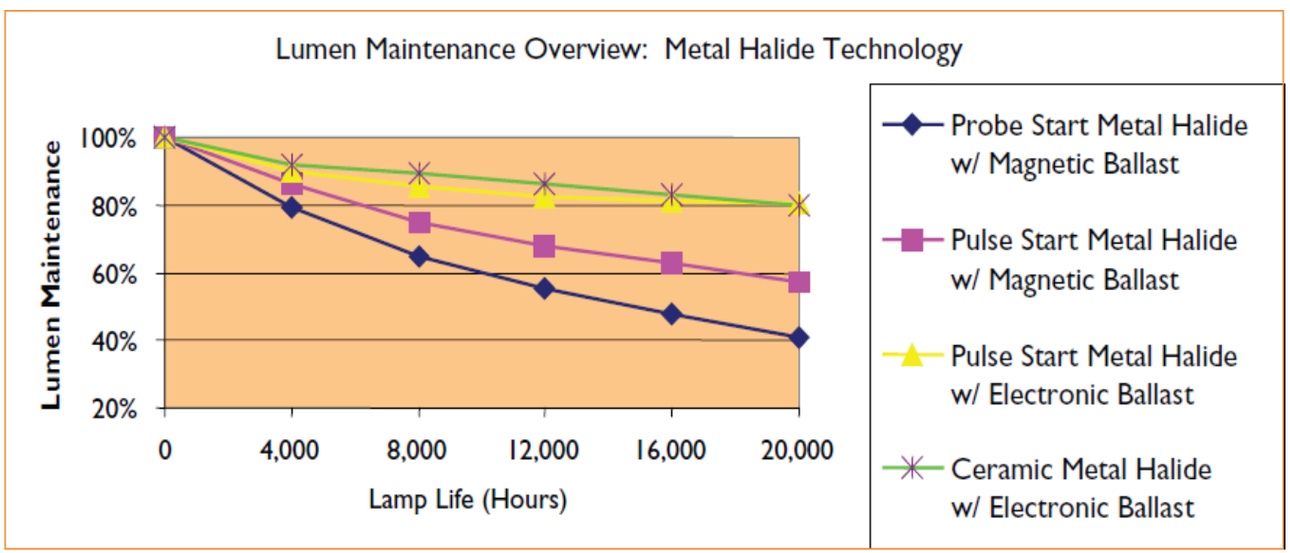
Source: OSRAM

# Electronic ballasts for HID lamps

- Increased lamp life
- Enhanced lumen constancy with life
- 10-15% lower energy consumption than magnetic ballasts
- More reliable lamp operation (end of life protection)
- Electronic ballasts are smaller than electromagnetic ballasts
- Electronics allow smart communication



**Lamp controller with connectivity**

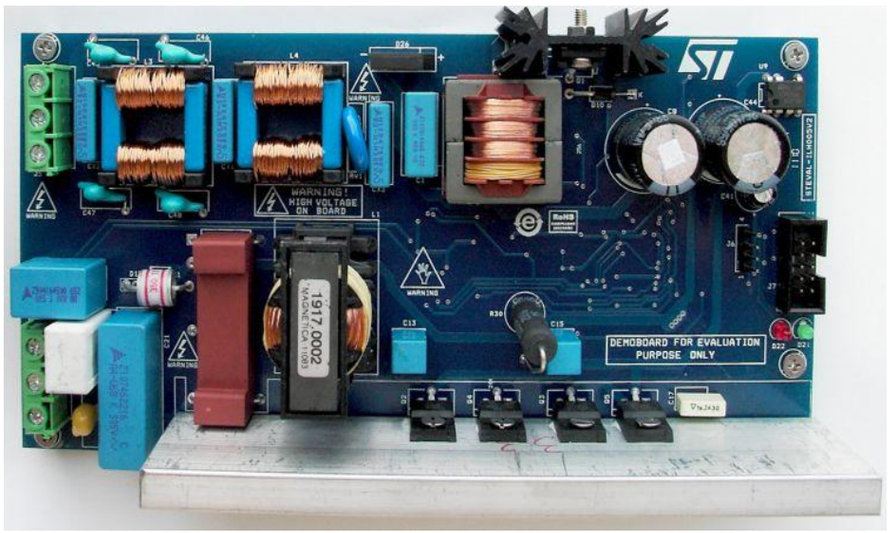



Source: Philips Lighting

# 150 W electronic ballast for HID lamps

## Description and purpose

- 2-stage electronic ballast for 150 W HID (high-intensity discharge) lamp, including a boost converter (PFC) working in transition mode (TM), and a full bridge inverter to drive a lamp with a low-frequency square wave




ESICOM order code: STEVAL-ILH005V2*

## Key features

- Input: 185 to 265 $V_{AC}$, 50 Hz
- Load: 150 W MH or HPS lamp
- PF = 0.99, THD = 2.8%
- Dimmable
- Average efficiency: 90%
- EN55015 compliant
- Remote control interfacing by PLM

**Key products**

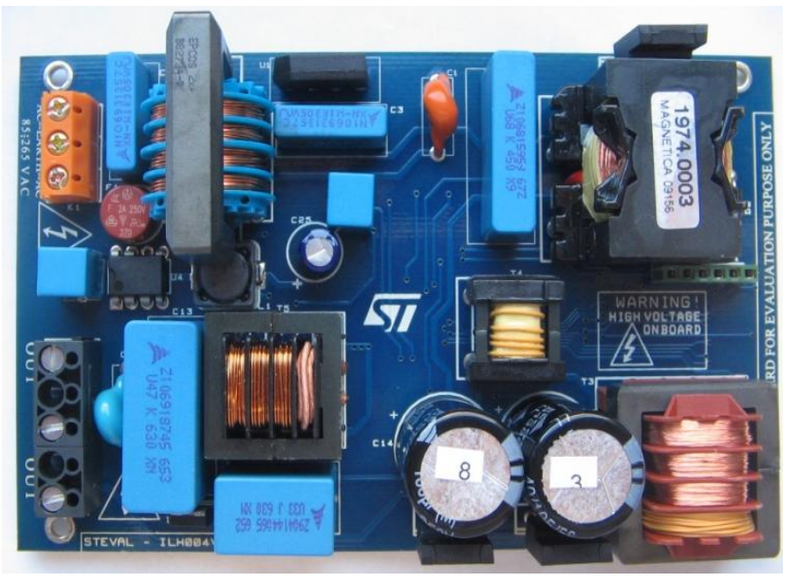
STF10NM60ND; STGF10NC60SD; STTH1L06; STTH1R06; VIPer16L; L6562A; L6388E; TS272; ST7FLITE39F2

* Available in Q1/2012

# 70 W electronic ballast for HID lamps

## Description and purpose

- Fully digital ballast to drive 70 W HID lamps, based on two ICs, the digital combo driver L6382D5 and a low-cost 8-bit microcontroller, able to manage the PFC and the half bridge stage




ESICOM order code: STEVAL-ILH004V1*

## Key features

- Wide input voltage range
- High power factor (up to 0.998) and very low THD (5%)
- PFC boost working in TM
- Half bridge based on power MOSFETs
  - Controls the igniter circuit
  - Implements buck converter in TM
  - Provides alternate low frequency square wave current
- Overvoltage and short-circuit protection
- Suitable for HPS and MH lamps

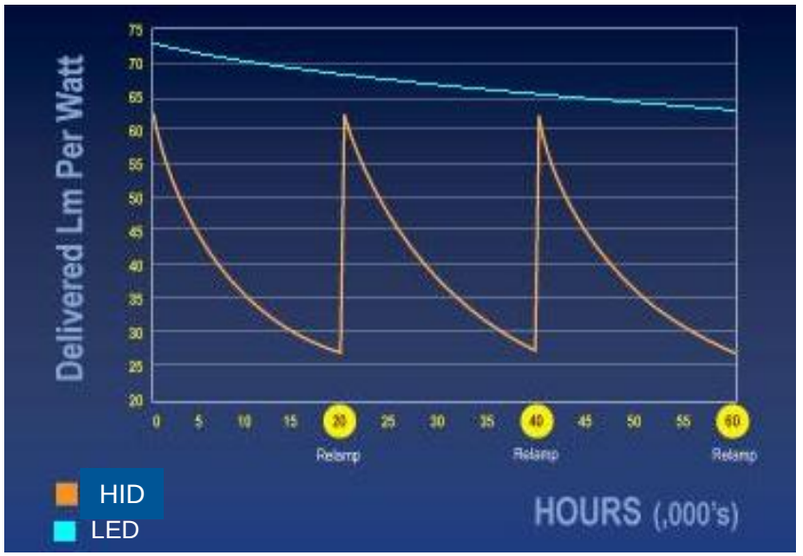
**Key products**

L6382D5; STF8NM60ND; STTH1L06; VIPer16L; ST7LITE49K2; LIC01.

* Available in Q1/2012

# Using LEDs in street lighting

- The green way to lowering energy costs
  - Low power consumption
  - Long lumen constancy
  - Long and predictable lifetime
  - Light emission can be easily redirected
  - Reliability (robust against shock and vibration)
  - Environment friendly ($CO_2$ saving and mercury free)
  - Quick turn on/off and dimming




Source of graphic: RUUD lighting

# 100 W and above

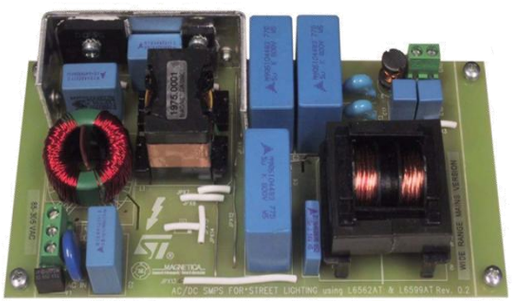
- 130 W LED driver based on L6562AT and L6599AT

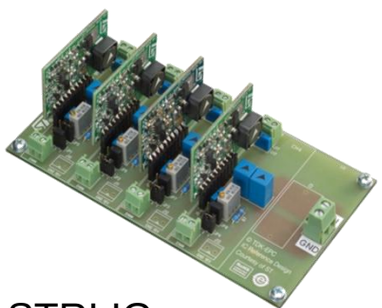
## Description and purpose

The system is composed of three stages:

- a front-end **PFC**
- an LLC **resonant converter**
- an **inverse buck** converter

The key benefits are very high efficiency, long term reliability and small form factor





ESICOM order code: EVL130W-STRLIG, EVL130W-SL-EU, EVL6562A-LED

## Key features

- Input mains range: 85 to 305 $V_{AC}$
- SMPS output voltage: 48 V at 2.7 A
- Long life time, electrolytic capacitors are not used
- Mains harmonics: meet EN61000-3-2 Class-C
- Efficiency at full load: > 93%
- EMI: meets EN55022-Class-B, EN55015
- Digital dimming

**Key products**

L6562AT, L6599AT, STF21NM60N, STD10NM60N, SEA05, STTH3L06U, STPS1L60A, STPS2H100A, STN3NF06

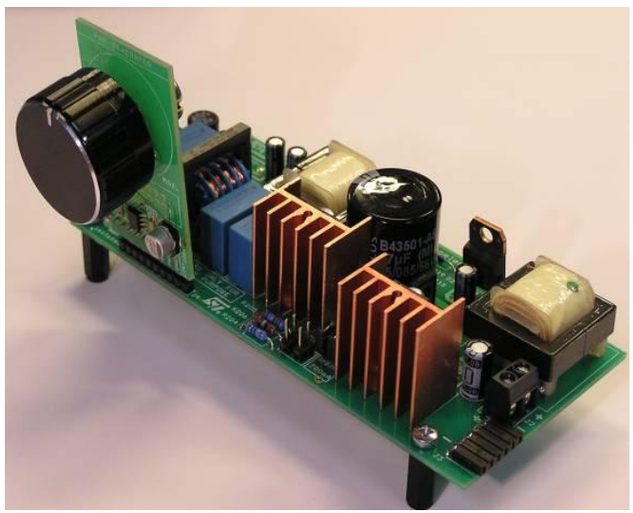
# 80 W and above

- 80 W offline LED driver with dimming based on L6562A

## Description and purpose

- An innovative non-isolated solution for driving LEDs where high power factor, high efficiency and individual LED brightness regulation is required

- **PFC boost, inverse buck converter**



ESICOM order code: STEVAL-ILL013V1

## Key features

- Wide input voltage range: 88 to 265 $V_{AC}$
- LED current set to 350 mA, 700 mA and 1 A
- High efficiency (~90%) and high power factor
- Universal PWM input for dimming (ext. board required)
- Non-isolated SMPS
- Brightness regulation between 0% and 100%
- EMI filter implemented
- EN55015 and EN61000-3-2 compliant

**Key products**

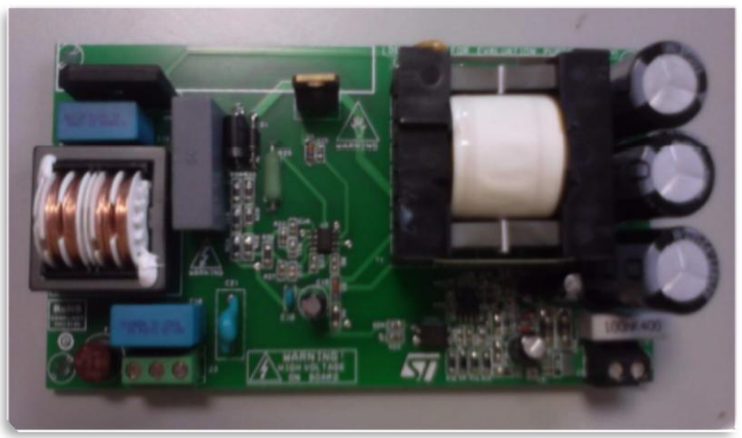
L6562A, STTH1L06A, STF10NM50N, STP8NM50N , STPSC806D, BUX87

# Up to 75 W

- 60 W offline LED driver for single LED string based on L6562AT

## Description and purpose

- Single-stage isolated solution based on L6562AT and TSM101, offering high performance with a simple and reliable design for LED street lighting
- **High power factor flyback**



ESICOM order code: STEVAL-ILL042V1*

## Key features

- Input voltage range: 185 to 265 $V_{AC}$
- Able to drive single LED String
- Provides 350 mA to 0.5 A constant current for LED
- Max output voltage: 130 $V_{DC}$
- No input electrolytic capacitor
- Efficiency: from 91% to 92.5%
- PF > 0.95
- Maximum $2f_{LINE}$ output ripple: 1.0%

**Key products**

L6562AT; STP7N95K3; TSM101; 1.5KE350A; STTH1L06; STTH2L06

* Available in Q1/2012

# Innovative multi-string LED driving

- Digital constant-current controller for multi-string LED driving based on STM8S

## Description and purpose

- Complete platform (HW/SW) for LED multi-string constant-current control based on an innovative methodology
- Each LED string can be dimmed and brightened independently
- System can be interfaced with ZigBee or PLM modules for remote control


ESICOM order code: STEVAL-ILL031V1

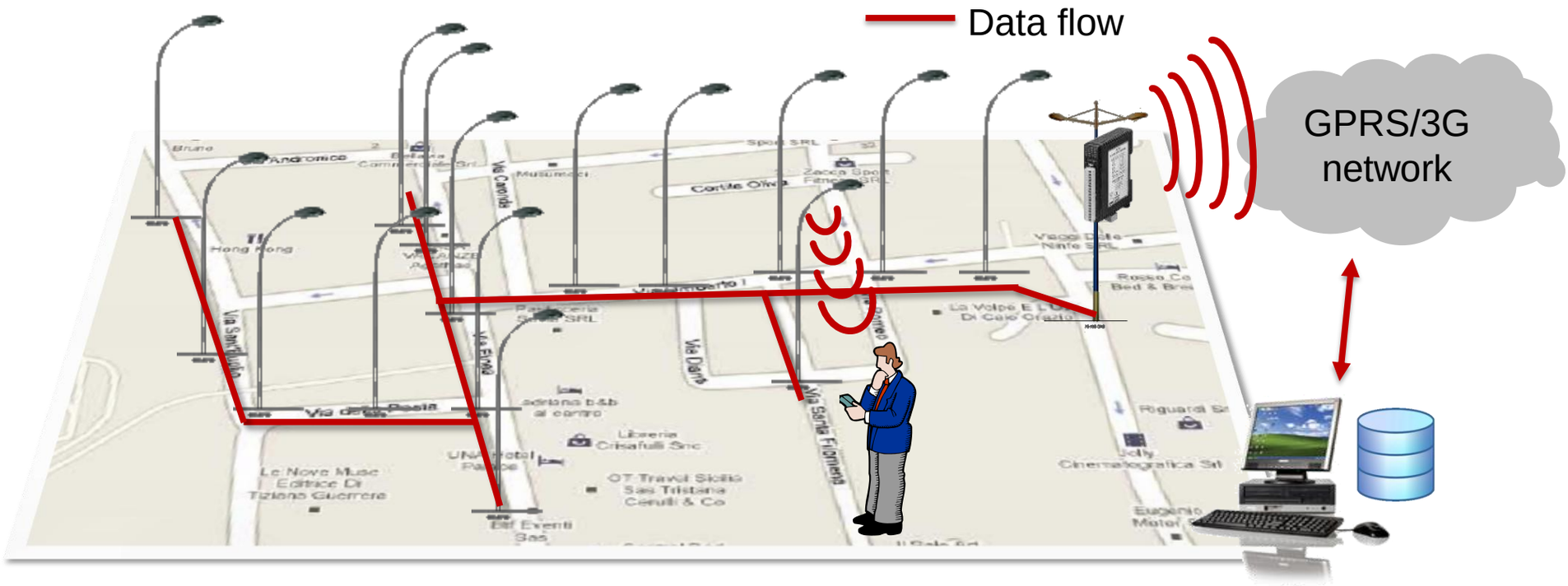
## Key features

- Input DC bus voltage: 48 V
- Independent LED string average current control
- Inverse buck topology
- System power: 120 W
- Switching frequency: 100 kHz
- Ripple current <10%
- Global dimming from 0% to 100% at 225 Hz (PWM dimming)
- Independent analog dimming on 4 channels
- Short-circuit protection

**Key products**

STM8S208RB; STPS1L60; STN3NF06

# Smart communication

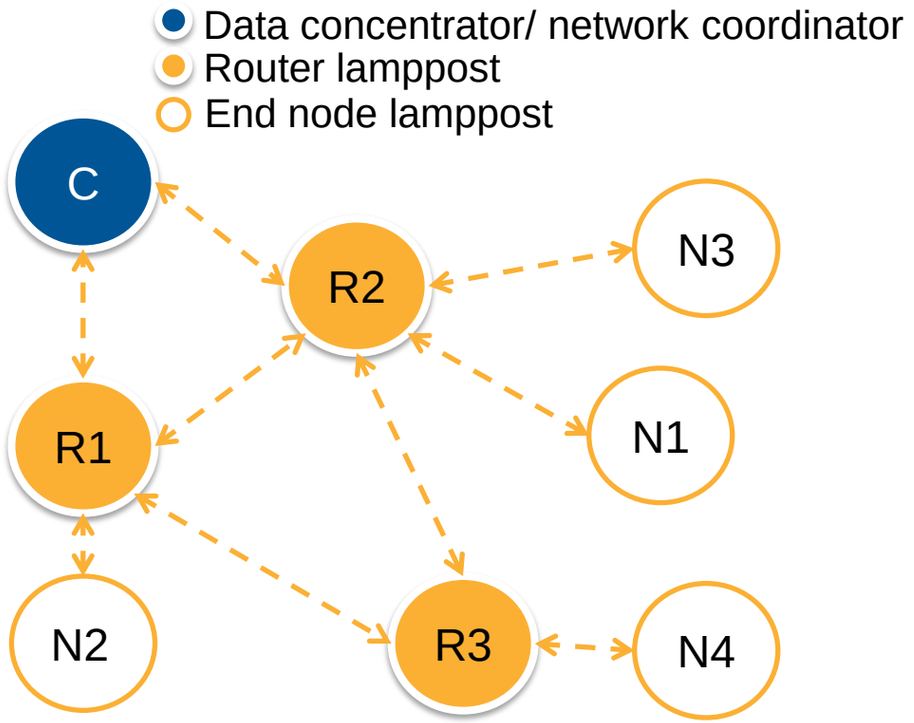



Dimming level, adjust on/off timing, lamp failure, consumed energy, lamp-burning hours, lamppost tilt, etc.

**Highway: simple linear topology** **City centre: complex topology**

# Wireless network solution

- IEEE 802.15.4 - ZigBee® network
  - A mesh topology is used to reach the data concentrator
- A network for each district is identified by its PANID
- Lamppost's node configuration using RFID EEPROM which can be written/read during both manufacturing process and installation procedure by the PDA




**Lamppost communication mode**

**STM32W or SPZB32W1x2.1**

**M24LR64-R**

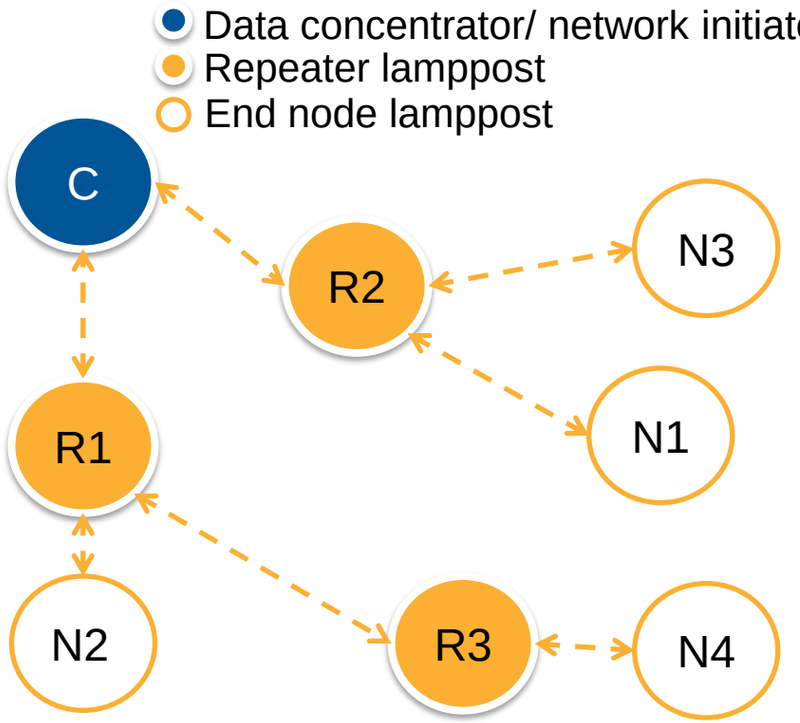
**STM32W108xx**: 32-bit MCU ARM Cortex-M3 ZigBee system on chip

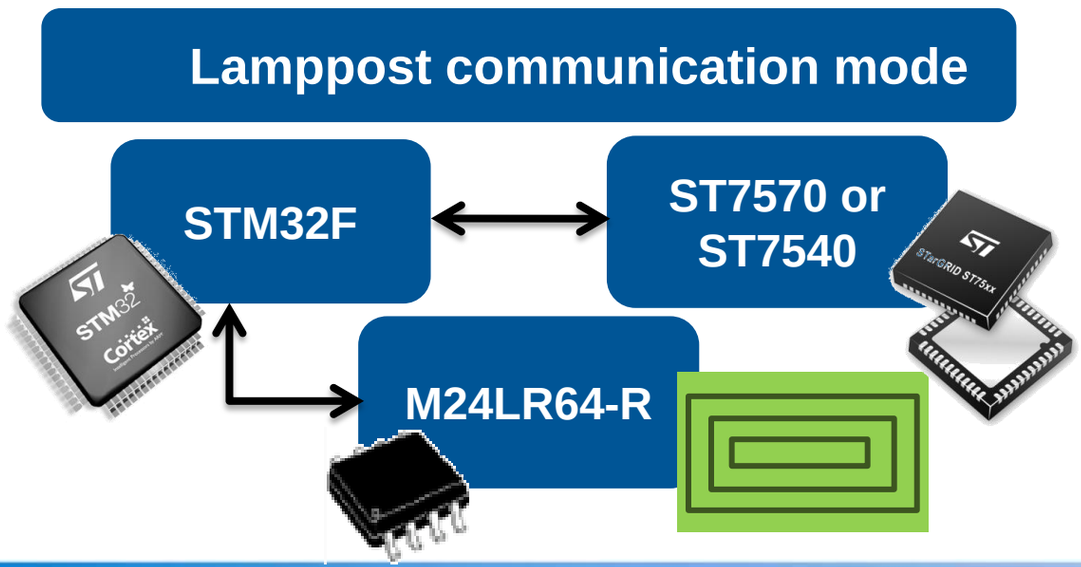
**SPZB32W1x2.1:** ZigBee PRO modules based on the STM32W chipset

**M24LR64-R**: 64-Kbit Dual Interface EEPROM (I²C and ISO 15693 RF protocol at 13.56 MHz)

# PLC wired network solution

- IEC 61334-5-1 power line communication network (ST7570) or proprietary protocol (ST7540)
  - Configured to work in CENELEC band B or C to avoid interference with AMR network
  - Data repeaters are used to reach the data concentrator
- A network for each district identified by unique identification
- Node configuration using RFID EEPROM which can be written/read during both manufacturing process and installation procedure by the PDA

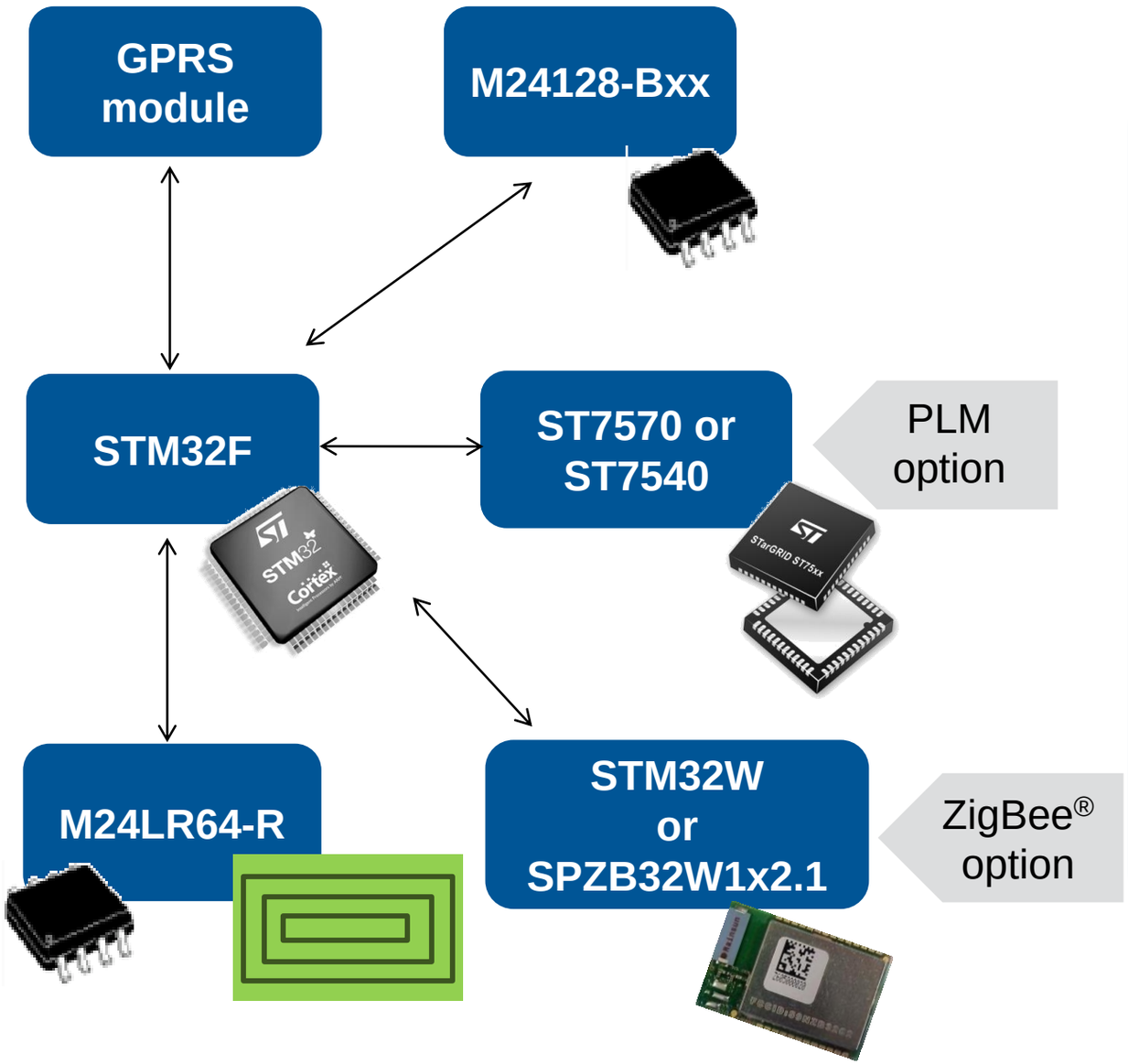



**STM32F103xx**: 32-bit MCU ARM Cortex-M3 microcontroller
**M24LR64-R:** 64-Kbit Dual Interface EEPROM ($I^2C$ and ISO 15693 RF protocol at 13.56 MHz)
**ST7570:** IEC 61334-5-1 compliant PLM
**ST7540:** FSK stripped down power line transceiver

# Data concentrator

- One concentrator for each district




**STM32F107xx:** 32-bit MCU ARM Cortex-M3 microcontroller with Ethernet

**M24LR64-R:** 64-Kbit Dual Interface EEPROM ($I^2C$ and ISO 15693 RF protocol at 13.56 MHz)

**ST7570:** IEC 61334-5-1 compliant PLM

**ST7540:** FSK stripped down power line transceiver

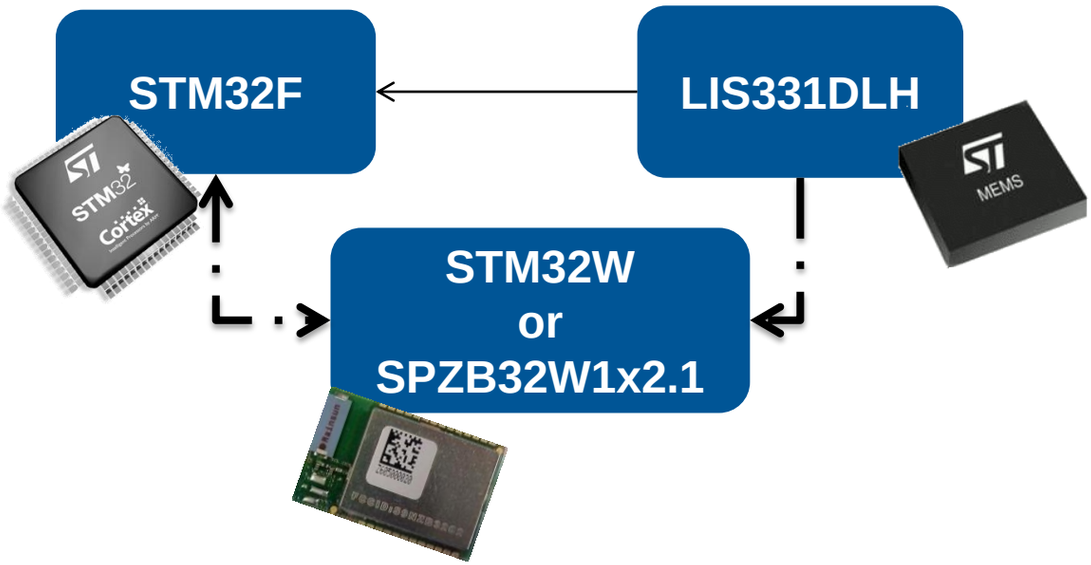
**STM32W108xx:** 32-bit MCU ARM Cortex-M3 ZigBee system on chip

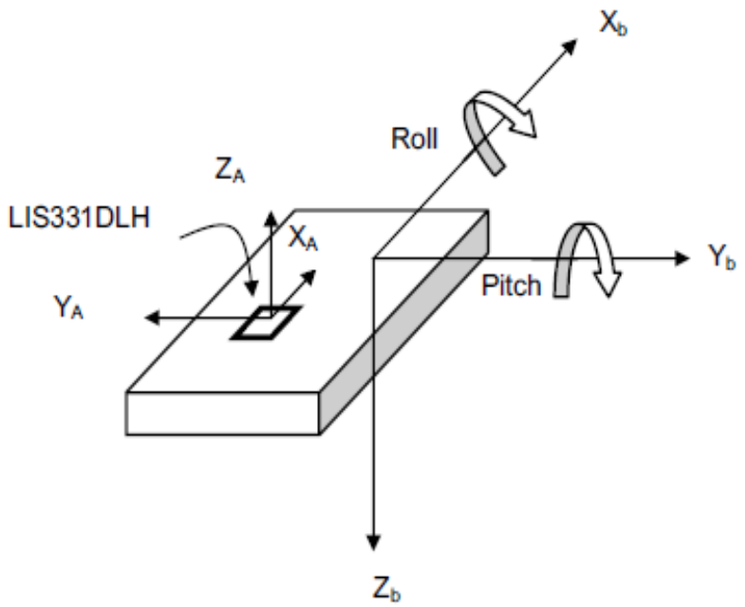
**SPZB32W1x2.1:** ZigBee PRO modules based on the STM32W chipset

**M24128-Bxx:** 128-Kbit EEPROM

# Real-time lamppost fall detection

- One low-g 3-axis accelerometer for each lamppost
- Tilt angle measurement
- Lamppost fall detection
- Key application benefits
  - Road safety
  - Reduced maintenance cost



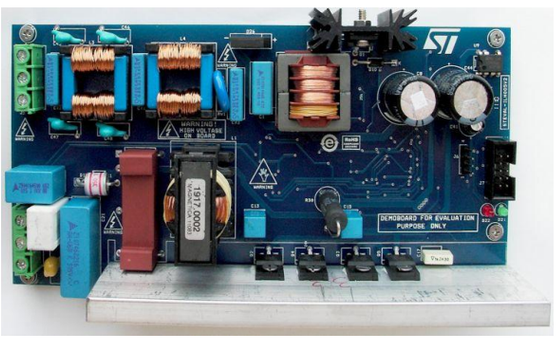



# Solutions for smart street lighting

- 150 W HID lamp ballast + ST7540-based communication for networked street lighting

## Description and purpose

- Innovative networked street lighting system with remote control and monitoring based on PLM, including a dedicated PC GUI



ESICOM order code: STEVAL-ILH005V2*
STEVAL-IHP003V1

## Key features

- Lamp driver and controller
  - 150 W high-efficiency HID lamp ballast
  - High reliability (up to 85°C ambient temperature)
  - Dimmable and EN55015 compliant
  - Suitable for HPS and MH lamps
- Communication section
  - Remote control on power line
  - Routing policies to cover long distances without dedicated hardware resources
  - Allows remote turn-on/off, dimming, lamp and ballast status monitoring

* Available in Q1/2012

# Thank you

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