

# DALI-to-DALI Wireless Bridge Interface

## 1 Introduction

DALI is a digital control bus, designed for lighting applications. It consists of a differential signal, bi-phase encoded at the data rate of 1200 baud. The bus is designed to act in a master-slave manner. Masters have the right to initiate data transfers by the use of 19-bit-length frames. Slaves can only reply to masters requests by the use of 9-bit-length frames. Up to 64 masters in multi-master configurations and 64 slaves can coexist in the same bus. In the DALI nomenclature, masters are called Master Controllers (MCs) and slaves are called Control Gears (CGs). Usually master controllers have multifunction panels that permit the user to interact in the lighting system. Control gears are generally ballasts, dimmers, relé. In multi-master configurations master controllers are also presence sensors, light sensors, switches. MCs can also power CGs till 2 mA each one when mains electricity is not available. The bus is in idle state when signal differential voltage is high; admitted values for low signal are between  $-6.5\text{ V}$  and  $6.5\text{ V}$  while the high level can range in the  $9\text{ V}$  to  $22\text{ V}$  interval with a recommended value of  $16\text{ V}$ . This makes also the bus really immune to interferers. Moreover protocol temporal constraints help for this aim, in fact violations must be discarded. The high number of lighting points permit to design complex lighting environments and the low bus latencies to achieve a very natural interactions with the lighting points. Scenes are also permitted and it is possible to control groups of lamps together.

## 2 Wireless Bridging Between DALI Systems

This DALI-to-DALI wireless bridge interface is a wireless gateway that transfers data from a DALI network to another DALI network by the use of an

IEEE 802.15.4 wireless link.

This interface permits to implement a flexible design of DALI networks without the constraints of DALI bus wireline.

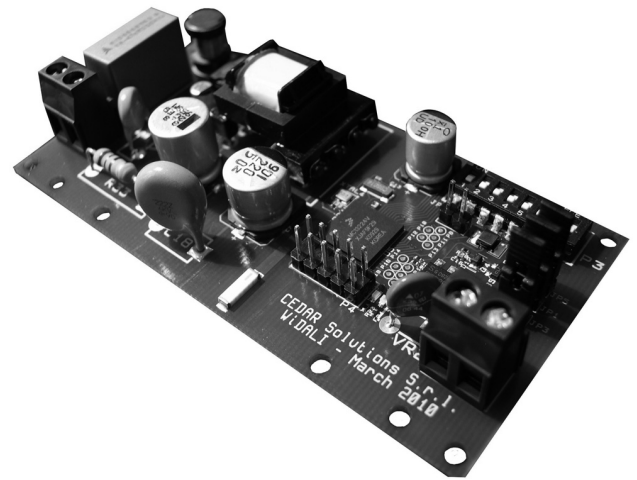


Figure 1. DALI-to-DALI wireless bridge interface

## 3 Main Features

The main features of this DALI-to-DALI wireless bridge interface are listed below:

- Full DALI compliant (IEC 62386-102);
- 6 mA current consumption (in CG mode);
- Isolated switching power supply (in MC mode);
- IEEE 802.15.4 compliant 2.4 GHz radio;
- Multi-hop radio communication;
- Network security;
- Box dimensions:  $120\text{ mm} \times 65\text{ mm} \times 36\text{ mm}$ ;
- Low-cost.



## 4 Bridge Block Diagram

In the blocks scheme is represented the DALI-to-DALI wireless bridge interface. It consists of a very low-power microcontroller with IEEE 802.15.4 embedded radio. The DALI driver permits to interface the low voltage logic to DALI levels, converting the signal to a differential one. An integrated low-cost high-performance switching power supply with current and voltage limitations is suitable for electrical DALI characteristics. An ad-hoc developed firmware permits to create the wireless network, to manage DALI frames and route them to corresponding remote CGs: all respecting DALI rules about protocol and timing constraints.

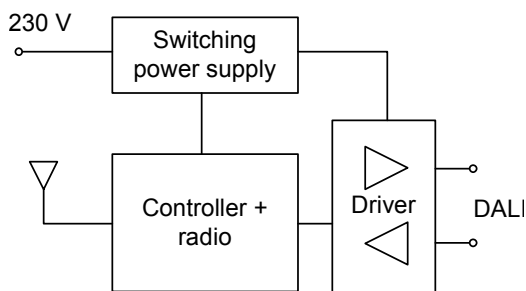


Figure 2. Bridge block diagram

## 5 Application Scenario

The DALI-to-DALI wireless bridge interface extends DALI network wireline by the air in a completely transparent way for DALI MCs and CGs. The device can be used mainly in two configurations, acting like a single lighting point wireless extender or a lighting points group wireless extender.

### 5.1 Wireless Lighting Points

In the first scenario it is possible to locate DALI CGs in the space independently from DALI bus wireline.

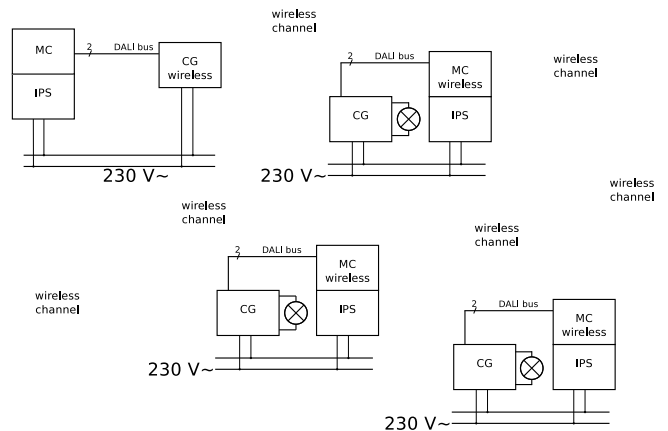
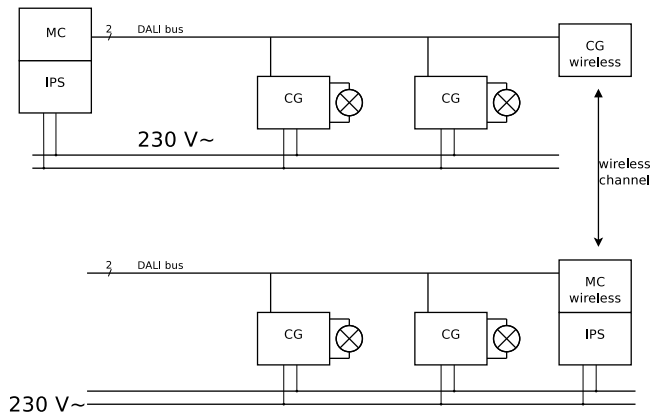


Figure 3. Wireless lighting points

### 5.2 Wireless DALI Network Extension

In the second scenario, it is possible to re-route other DALI wired buses detached from the main DALI wired bus where the control panel is attached to. This means that the DALI-to-DALI wireless bridge interface must be able also to supply power to the new DALI bus trunk, by the use of an Internal Power Supply (IPS). The IPS can be turned on or off respectively if the wireless device is acting like a MC or emulating a CG in the bus. Be aware that when emulating a CG it does not consume any DALI CG addresses, but only a limited amount of current from the self-powered DALI bus. This means that all 64 CG DALI addresses are available and that the maximum number of lighting point in the same DALI network is conserved. DALI network trunks are bonded together to the same wireless network by the use of an identification PAN ID.

Cryptography is also used to avoid attacks, by setting a cryptographic key on the wireless device. This improves network security and avoids cross interferences with other DALI-to-DALI wireless bridge interfaces that can be used by near radio systems.



**Figure 4.** Wireless DALI network extension