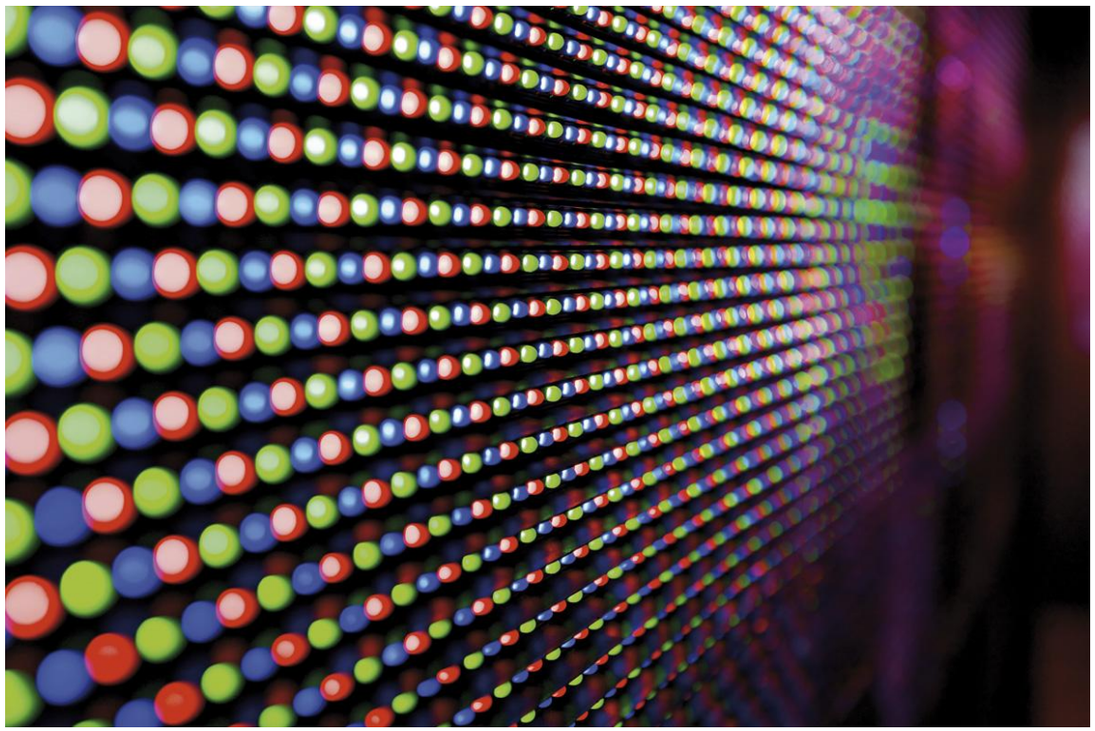
LED light control using DMX512 control method



June 2011

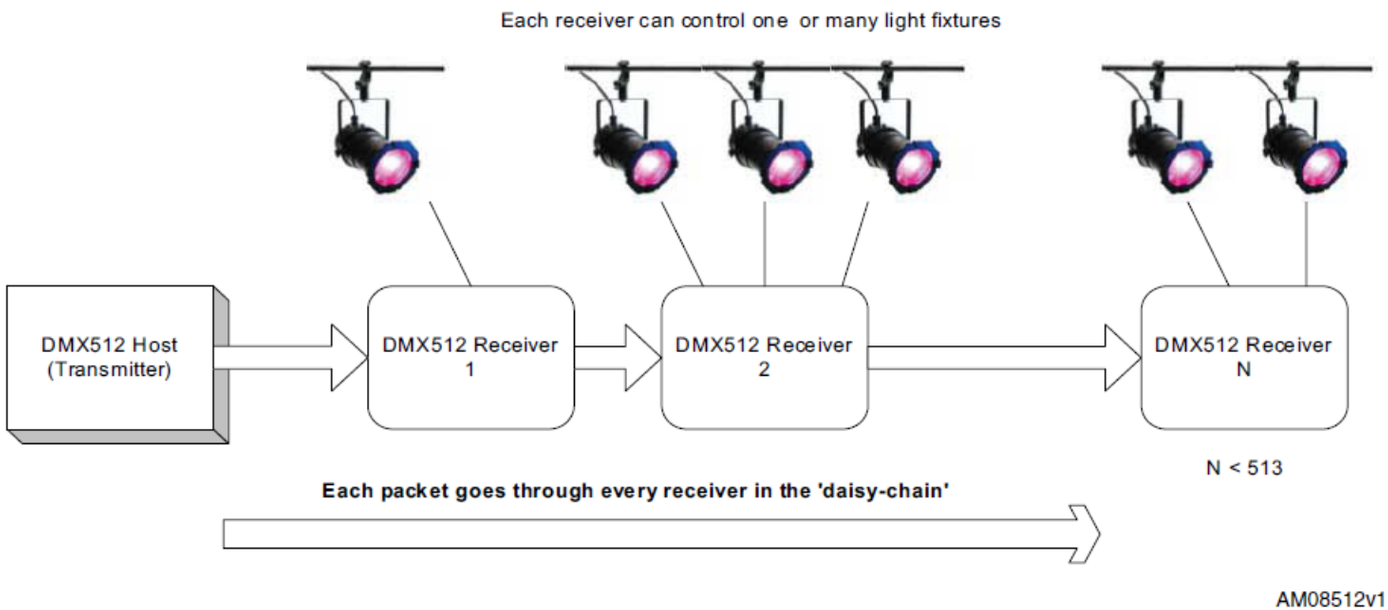
Why intelligent control?

Different needs for control

- **Energy saving**
  Dimming according to natural light, *on-off* according to room occupancy, for example
- **Comfort**
  Color changing (cool/warm) based on location and time of the day – improved productivity at work, more relaxing at home
- **Architectural/fashion**
  Creating different *effects* using same lights in scene setting for lounges, hotels, restaurants, shops, as well as building illumination
- **Light control**
  For specific applications such as theater stage lighting

What is DMX? (1/2)

- DMX – Digital MultipleX
  - For remote control of advanced lighting systems, including motorized lamps to set light intensity, light color, lamp rotation
  - For wired communication systems (twisted pairs + RS-485 such as PHY) in theatre stage lighting and exhibition lighting, for example



What is DMX? (2/2)

- DMX512 uses asynchronous data transmission up to 250 Kbaud/s (to dimmers, scanners, motorized decoders)
- Unidirectional, serial transmission and daisy-chain configuration up to 512 nodes (so called DMX universe) with max time 22 ms (roughly 44 Hz, **no visible delay**)
- The multiple receivers are connected to the DMX host in a daisy-chain topology and every packet goes through each receiver
- Very simple protocol – only 8-bit data one after another

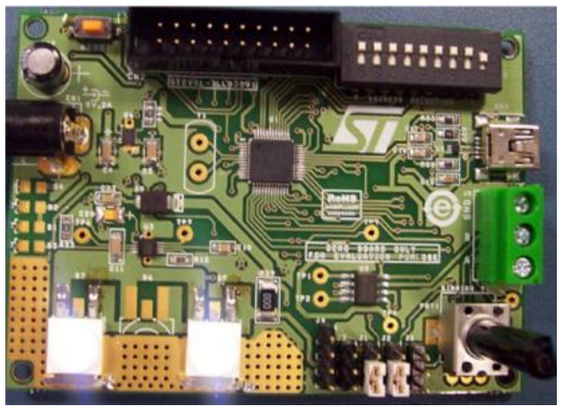
Lamp example

7 DMX channels
0: lamp intensity
1: rotation X axis (course)
2: rotation X axis (fine)
3: tilt Y axis (course)
4: tilt Y axis (fine)
5: color selection
6: gobo selection

STEVAL-ILL030V1 – description

Reference design and DMX512 communications protocol algorithm based on STM32

- Follows DMX512 2008 standard as well as timing constraints
- Configuration of a single board mode as transmitter, receiver or standalone
- LED intensity control using a 120 Hz PWM from 0% to 100%
- Connection to multiple receivers, up to 512, to a single host controller
- False-packet rejection, reset sequence timing check
- Two on-board 3 W LEDs and jumper option to drive external LEDs



Documentation

- **UM1004:** (user manual) DMX512 based LED lighting solution
- **UM0792:** Demonstration firmware for the DMX512 communication protocol **transmitter** based on the STM32F103Zx
- **UM0791:** Demonstration firmware for the DMX512 communication protocol **receiver** based on the STM32F103Zx
- **SW code (.hex):** available with the board – the application source (IDE IAR Embedded Workbench) is available only on request and is covered by license agreement

Key products

✓ STM32F103
✓ LDS3985M33R (voltage regulator)
✓ STCS1APUR
✓ ESDAULC6-3B6 (USB protection)
✓ STBP120AVDK6F (voltage protection)
✓ ST485ABDR

Typical applications

✓ Stage lighting
✓ Theaters
✓Choreographic lighting
✓ Automatic light systems

Board purpose

Make the DMX512 communication available also on STM32 MCUs and have a simple demonstrator Targeting medium/small size customers for lighting control

STM32F103C6T6

- STM32 Performance line (low density series)
  - 32-Kbyte Flash
  - 48-pin LQFP package
  - 2 to 3.6 V supply
  - Low-power modes with wake-up
  - Internal RC
  - -40/+105 C

- Peripherals required for DMX
  - Timer2 and Timer3 – 16-bit general-purpose timers
  - USART
  - IO pins
- STM32 bringing universality – USB connection, LED dimming, receiver/transmitter modes

STCS1A

- 1.5 A max constant-current LED driver
  - 4.5 to 40 V input voltage range
  - 1.5 A output current capability
  - PWM dimming and shutdown pin
  - Available in DFN8 (3 x 3 mm) and PowerSO-8 packages

- 0.5 A used on the demo
  - Up to 3 LEDs in parallel

Other devices

- ESDAULC6-3BP6
  - ESD protection for USB port
- LDS3985M33
  - Ultra-low drop voltage regulator for 3.3 V
- ST485AB
  - RS-485 transceiver
- STBP120
  - Overvoltage protection
- STPS340U
  - Power Schottky diode, 40 V

Software overview

Code size

- Total code size: ~10 Kbytes
- Total RAM usage: ~2.1 Kbytes
- Receiver code size: < 1 Kbyte
- Transmitter code size: ~1.2 Kbytes

Detailed description:
UM0792 transceiver

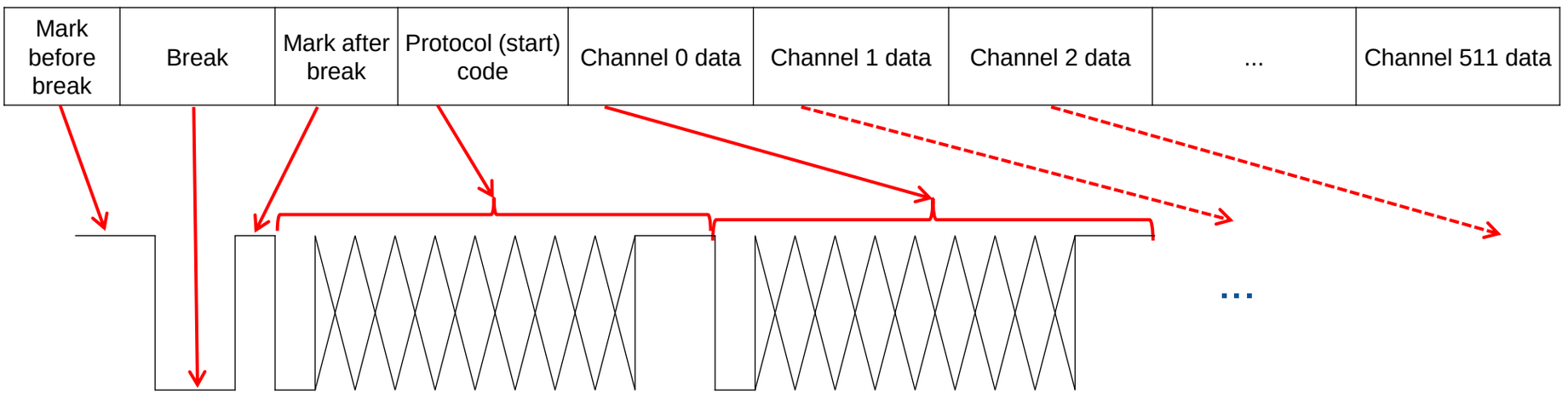
Detailed description:
UM0791 receiver

Reference design:
UM10004

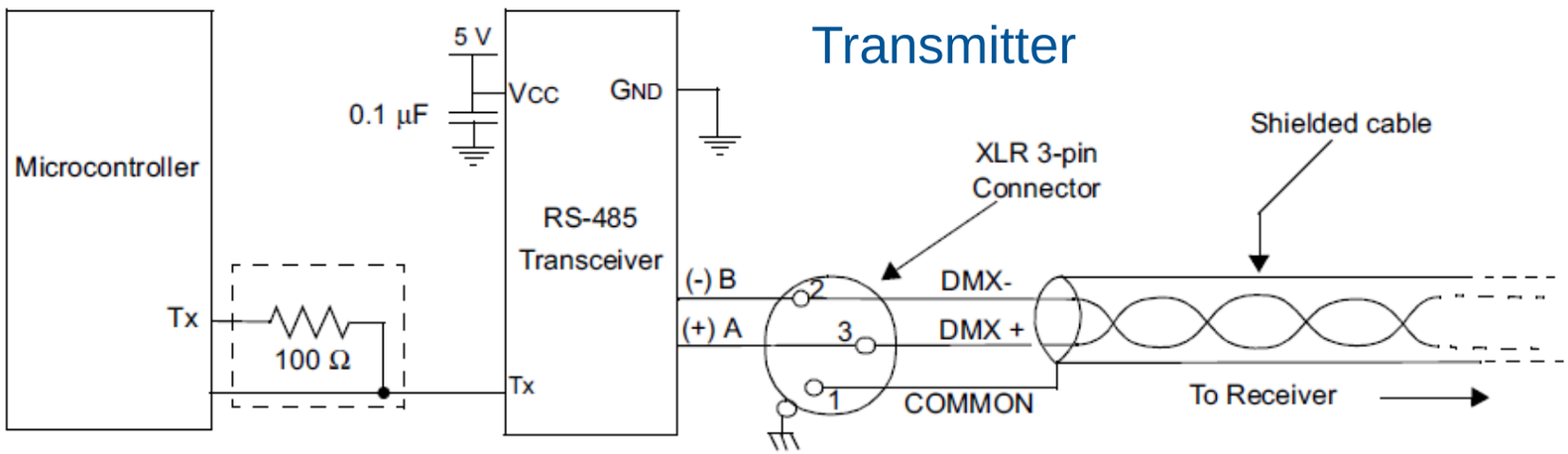
Note: the application source (IDE IAR Embedded Workbench) is available only on request and is covered by license agreement.

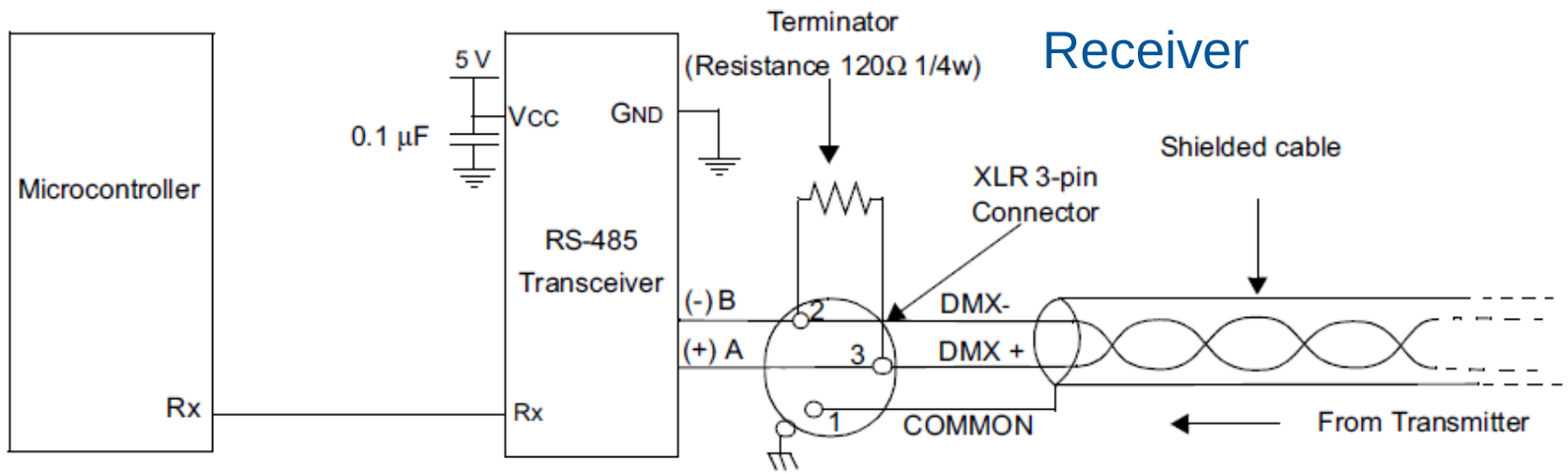
DMX details

- DMX protocol is a never ending stream of data at 250 Kbit/s. Fire-and-forget communication – no responses
  - Note: Bidirectional RDM protocol (packets are in between DMX data packets)
- One start bit, eight data bits, two stop bits and no parity
- Each device has a start address selected by DIP switches or in an electronic menu, for example
- Due to no error checking, cannot be used in safety or hazardous applications (such as pyrotechnics control)



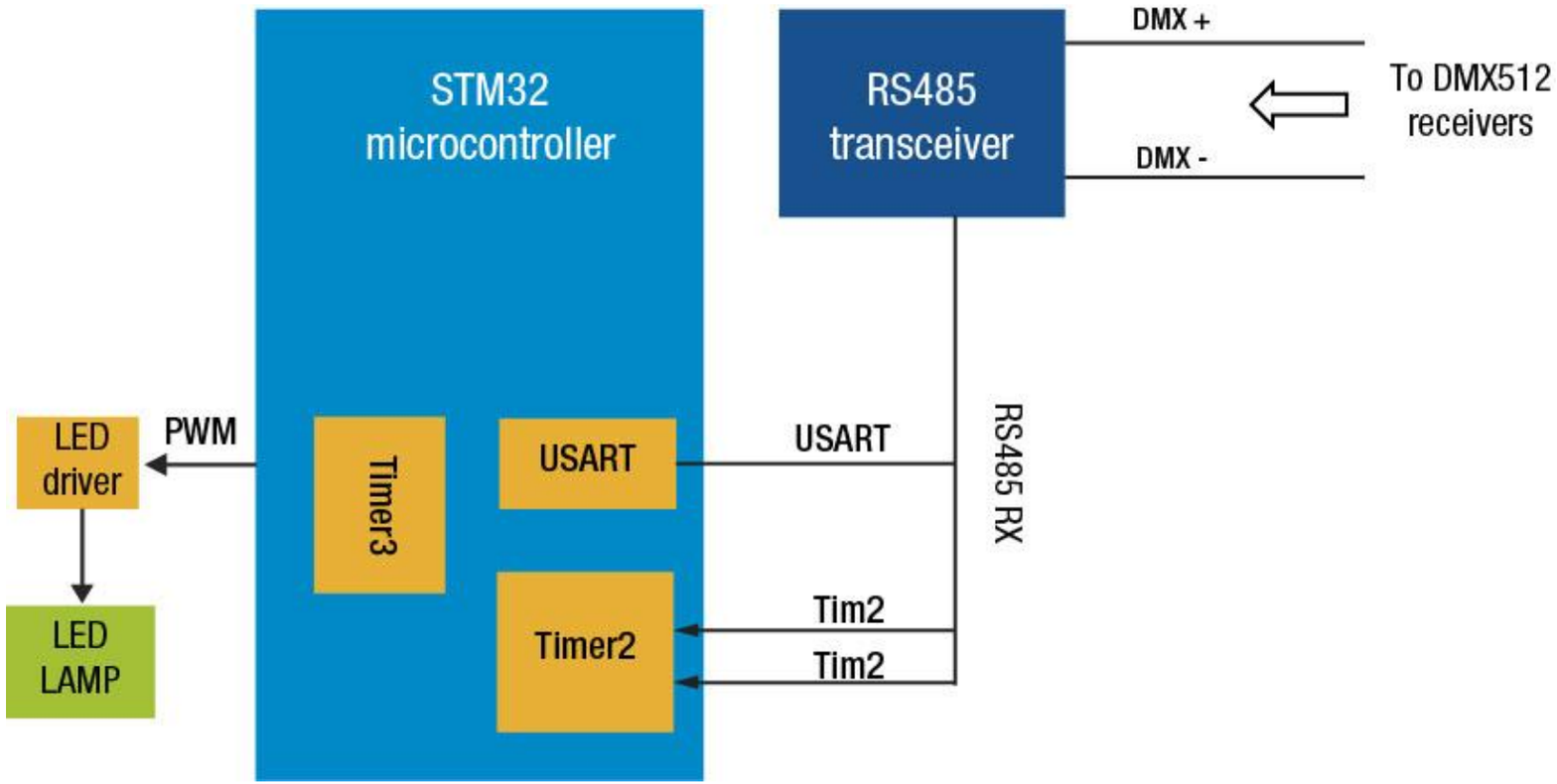
Interface


Transmitter
Microcontroller
5 V
0.1 µF
Vcc
GND
RS-485
Transceiver
Tx
100 Ω
Tx
(-) B
(+) A
2
3
1
DMX-
DMX +
COMMON
XLR 3-pin
Connector
Shielded cable
To Receiver


Terminator
(Resistance 120Ω 1/4w)
Receiver
Microcontroller
5 V
0.1 µF
Vcc
GND
RS-485
Transceiver
Rx
Rx
(-) B
(+) A
2
3
1
DMX-
DMX +
COMMON
XLR 3-pin
Connector
Shielded cable
From Transmitter

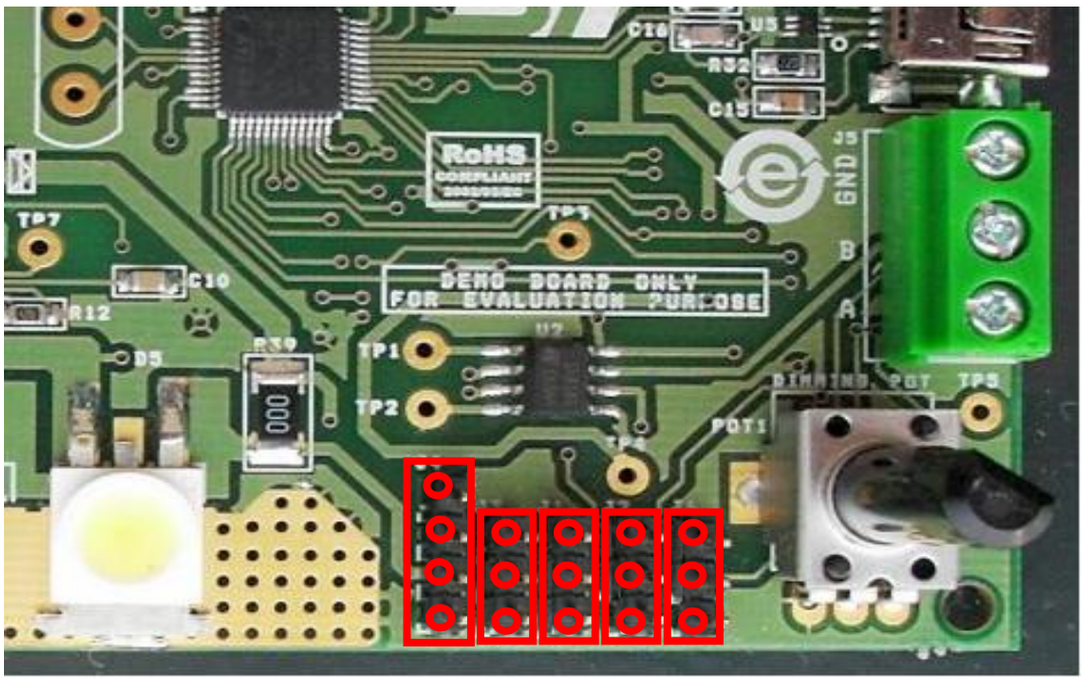
Receiver (1/2)

- The receiver extracts a particular slot from the packet and modifies the duty cycle of the PWM output as per the data received
- Timer3 is used to generate a 120 Hz LED dimming signal according received data



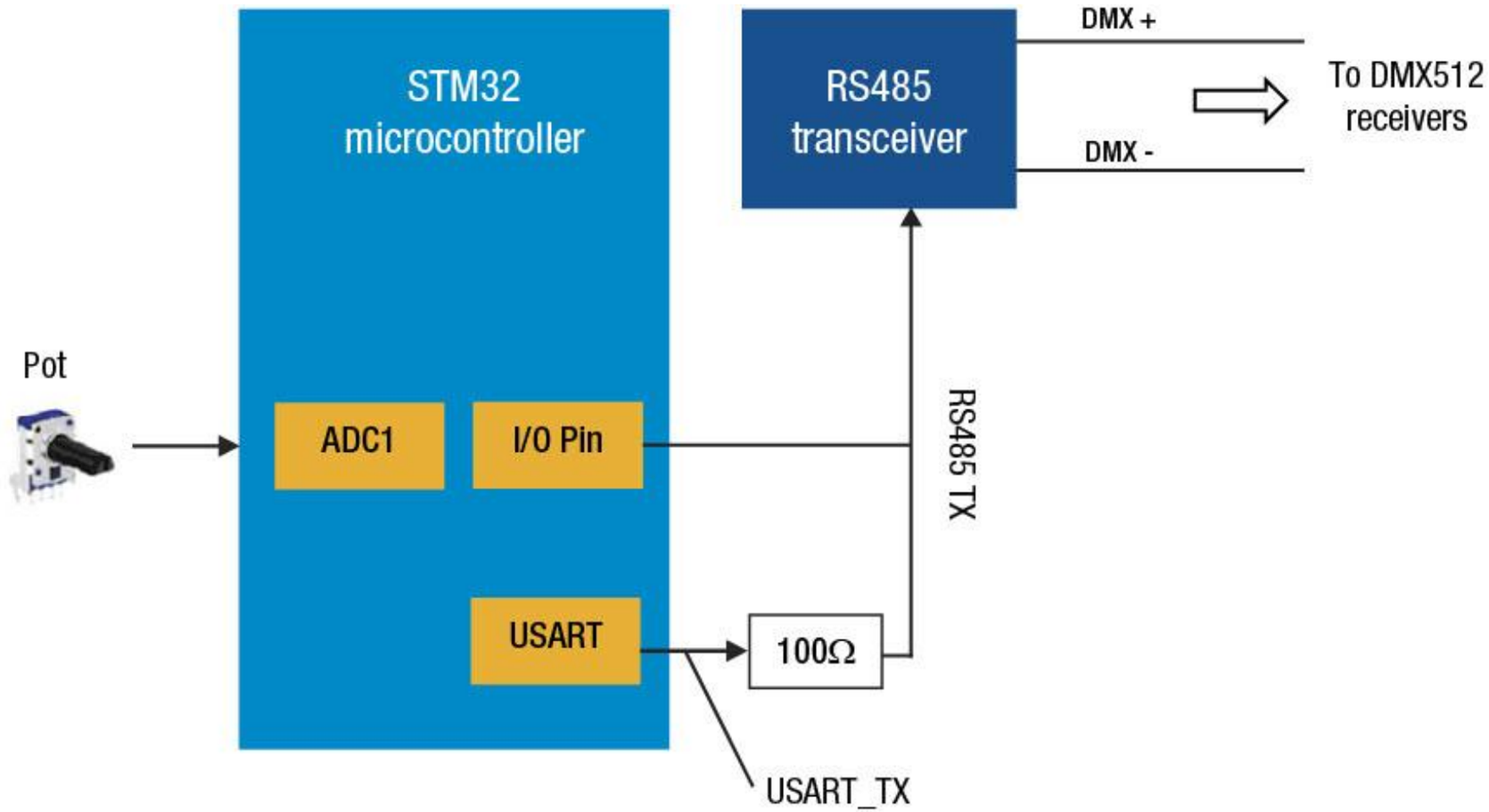
Receiver (2/2)

- J1 – driver enable, 2-3 connected
- J2 – receiver enable, 2-3 connected
- J3 – mode select, 2-3 connected
- J6 – terminator selector
  - End of the line: 1-2 connected
  - Middle of the line: 2-3 connected



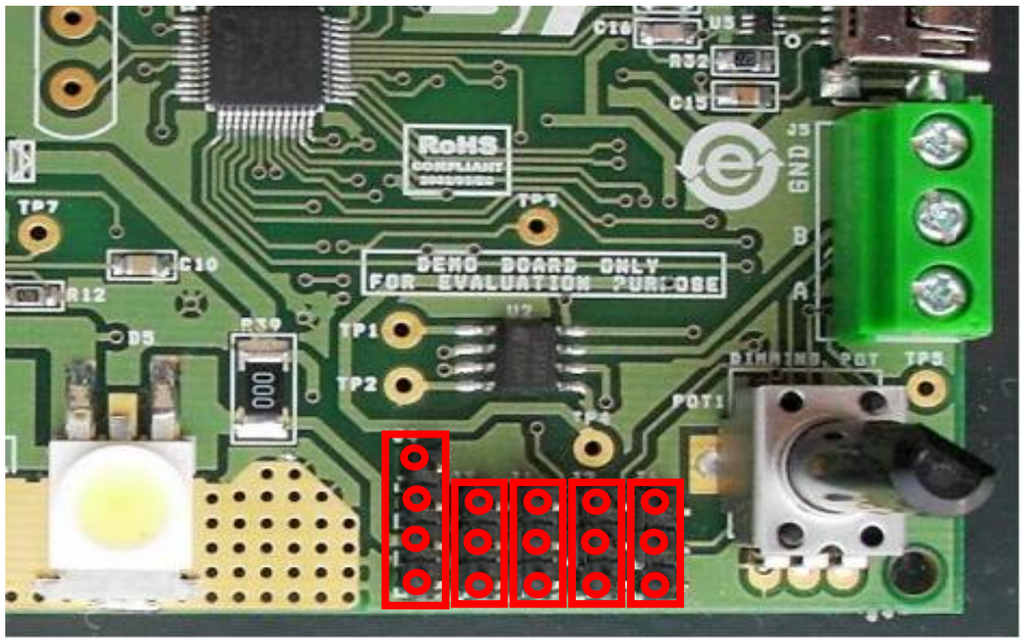
Transmitter (1/2)

- Timer3 controls time between slots (sent bytes) up to 512
- Timer2 controls break timing



Transmitter (2/2)

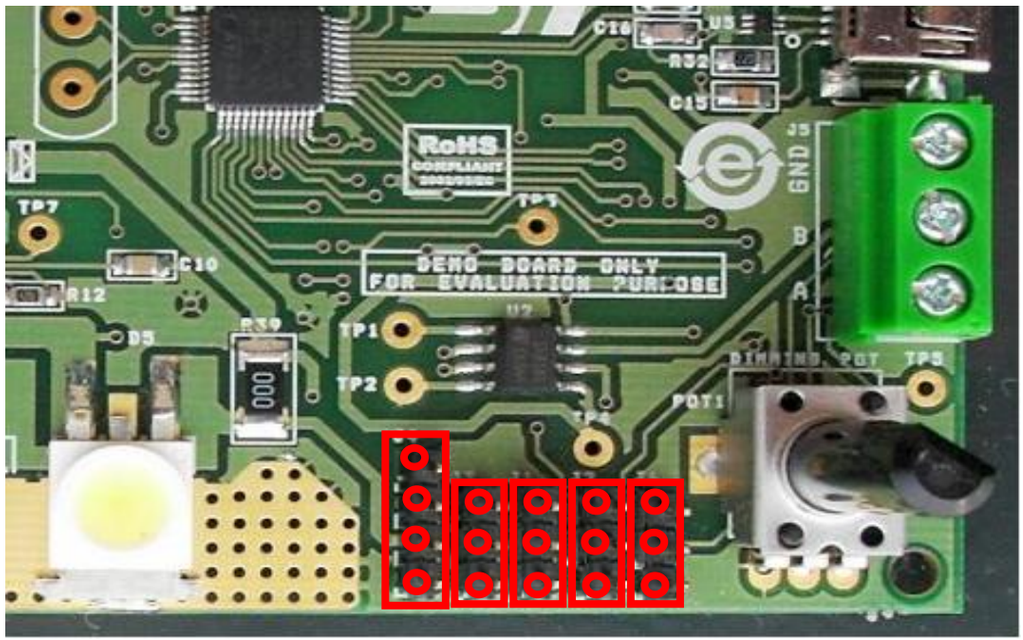
- J1 – driver enable, 1-2 connected
- J2 – receiver enable, 1-2 connected
- J3 – mode select, 2-3 connected



Standalone mode

LED on board is controlled directly by potentiometer

- J1 – driver enable, 2-3 connected
- J2 – receiver enable, 1-2 connected
- J3 – mode select, 1-2 connected



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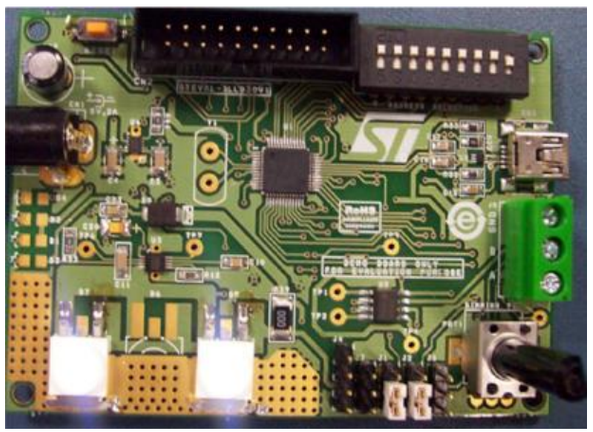

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Thank you for your attention

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