ESD Electronic Systems Design
Synthesis Verification Testing Power Communication

NES Programming and protocols

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Outline

- IEEE 802.15.4
- ZigBee
  - ZigBee boards
  - ZigBee tools
- Example & Exercise

IEEE 802.15.4 & ZigBee

IEEE 802.15.4

- Standard IEEE 802.15.4 defines the protocol and interconnection of devices via radio communication in a **Personal Area Network** (PAN).
- It defines
  - **Physical** (PHY) layer.
  - **Media Access Control** (MAC) layer.
- It aims at
  - Low data rate
  - Low power
  - Low cost

ZigBee

- ZigBee is implemented over IEEE 802.15.4 PHY & MAC layers.
- Three different types of ZigBee devices:
  - ZigBee **Coordinator** (ZC)
  - ZigBee **Router** (ZR)
  - ZigBee **End Device** (ZED)

ZigBee Evaluation Board (1/2)

- Evaluation **Board** (EB)
  - SmartRF04EB

    http://www.ti.com/lit/ug/swru039b/swru039b.pdf

- Evaluation **Module** (EM)
  - CC2430EM

    http://www.ti.com/tool/cc2430em_refdes

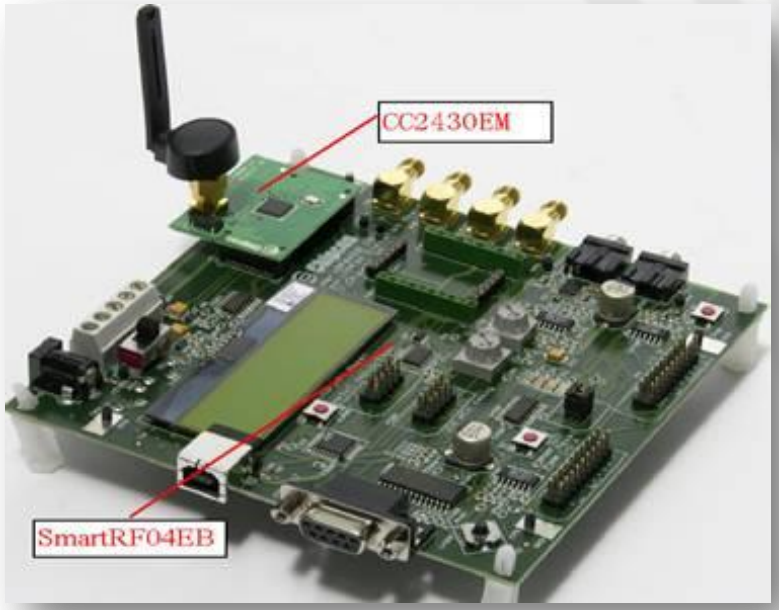


Fig.1 Evaluation Board

ZigBee Evaluation Board (2/2)

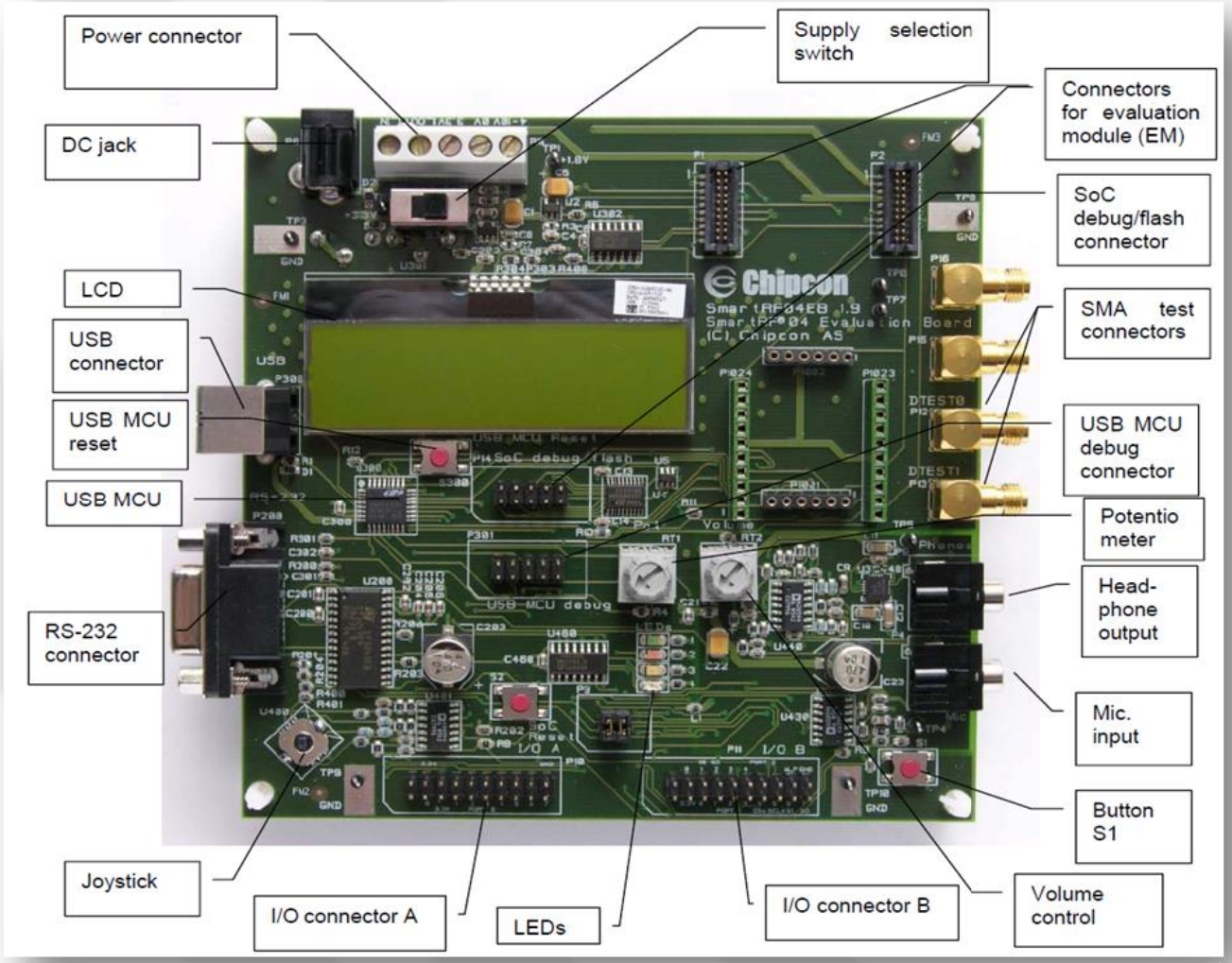


Fig.2 Evaluation board SmartRF04DK overview.

ZigBee Demonstration Board (1/2)

- Demonstration **Board** (DB)
  - Chipcon CC2430DB

    http://www.ti.com/lit/ug/swru125/swru125.pdf

Fig.3 Demonstration board CC2430DB.

ZigBee Demonstration Board (2/2)

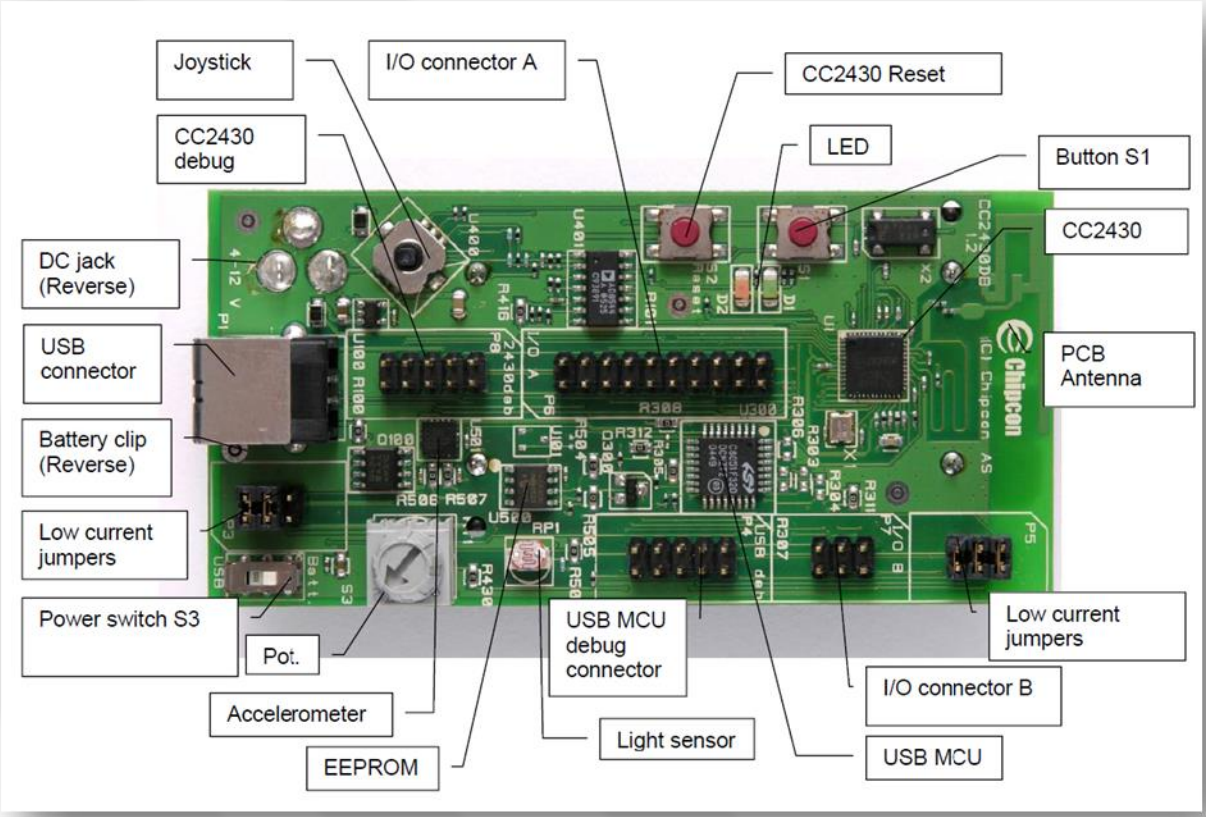


Fig. 4 Demonstration board CC2430DB overview.

ZigBee Tools

- **IAR** (**I**ngenjörsfirman **A**nders **R**undgren)
  - An embedded systems workbench IDE for building and running application on ZigBee boards.

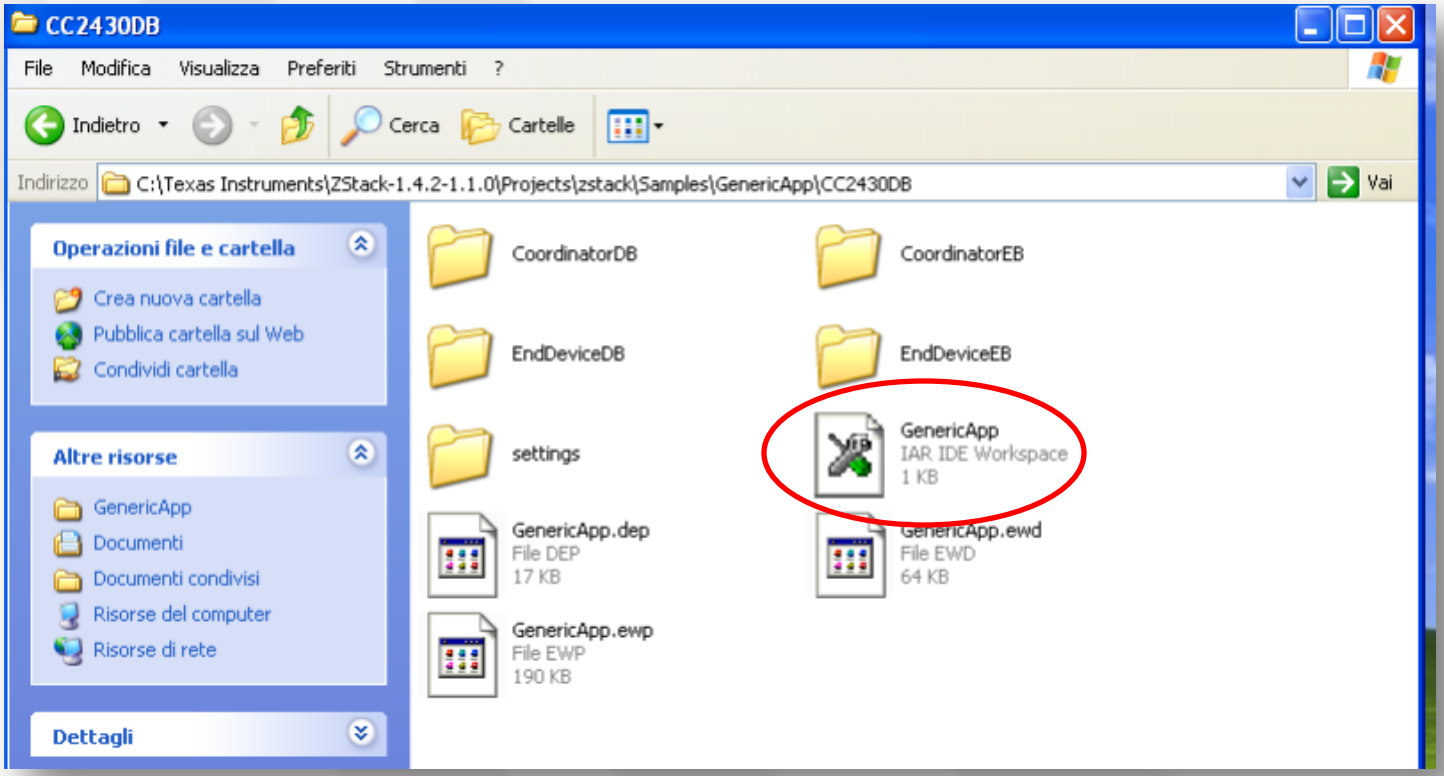
  http://www.iar.com
- **SmartRF**™ Studio
  - A Windows application that can be used to evaluate and configure Low Power RF-ICs from Texas Instruments.

  http://www.ti.com/tool/smartrftm-studio&DCMP=hpa_rf_general&HQS=Other+OT+smartrfstudio

Example & Exercise

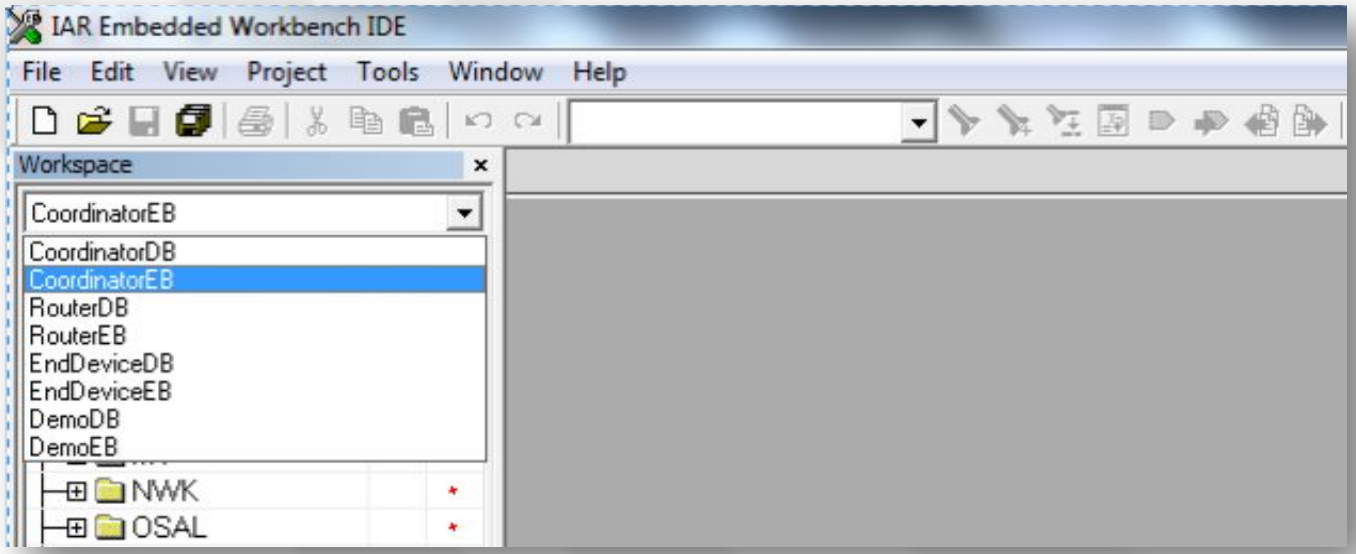
Example: Generic App (1/3)

- Open GenericApp example from Zstack Samples folder as shown below:
  - C:\Texas Instruments\Zstack-1.4.2-1.1.0\Projects\Samples\GenericApp\CC2430DB\GenericApp



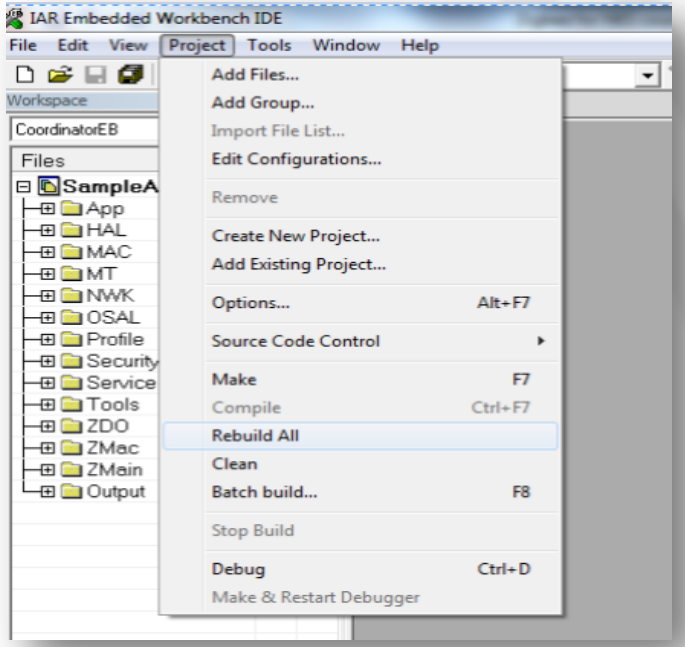
Example: Generic App (2/3)

- Choose Coordinator or End device based on your board type (ED, DB) and ZigBee role (ZC, ZR, ZED).
  - SmartRF04EB (Evaluation Board).
  - CC2430DB (Demonstration Board).



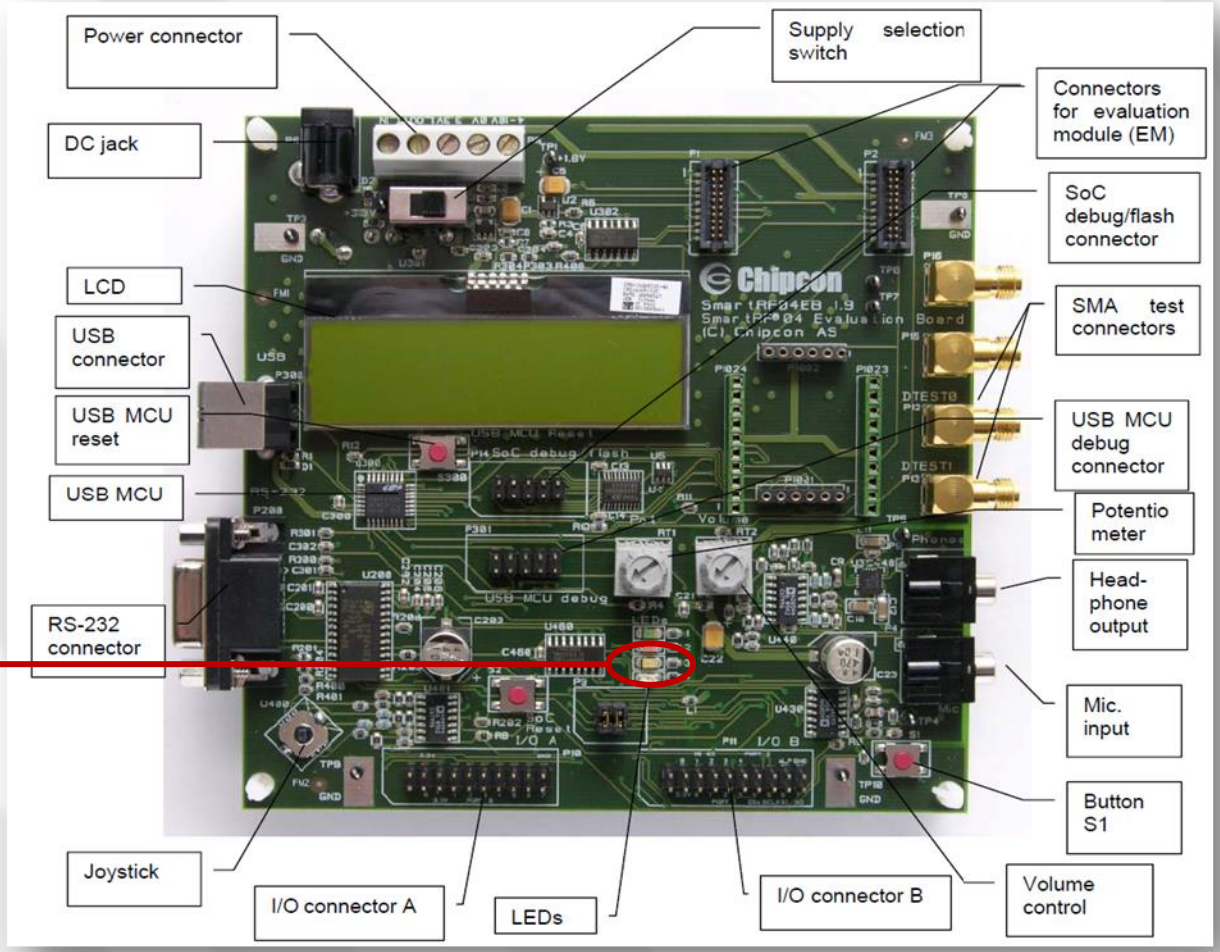
Example: Generic App (3/3)

- Build the Project
  - Project -> Rebuild All
- Run the Project
  - Project -> Debug
- Reset ZigBee Board
  - Button **S300** for E.Board
  - Button **S2** for D.Board
- Repeat these steps to configure all the devices, setting the correct board type (ED, DB) and ZigBee role (ZC, ZR, ZED).



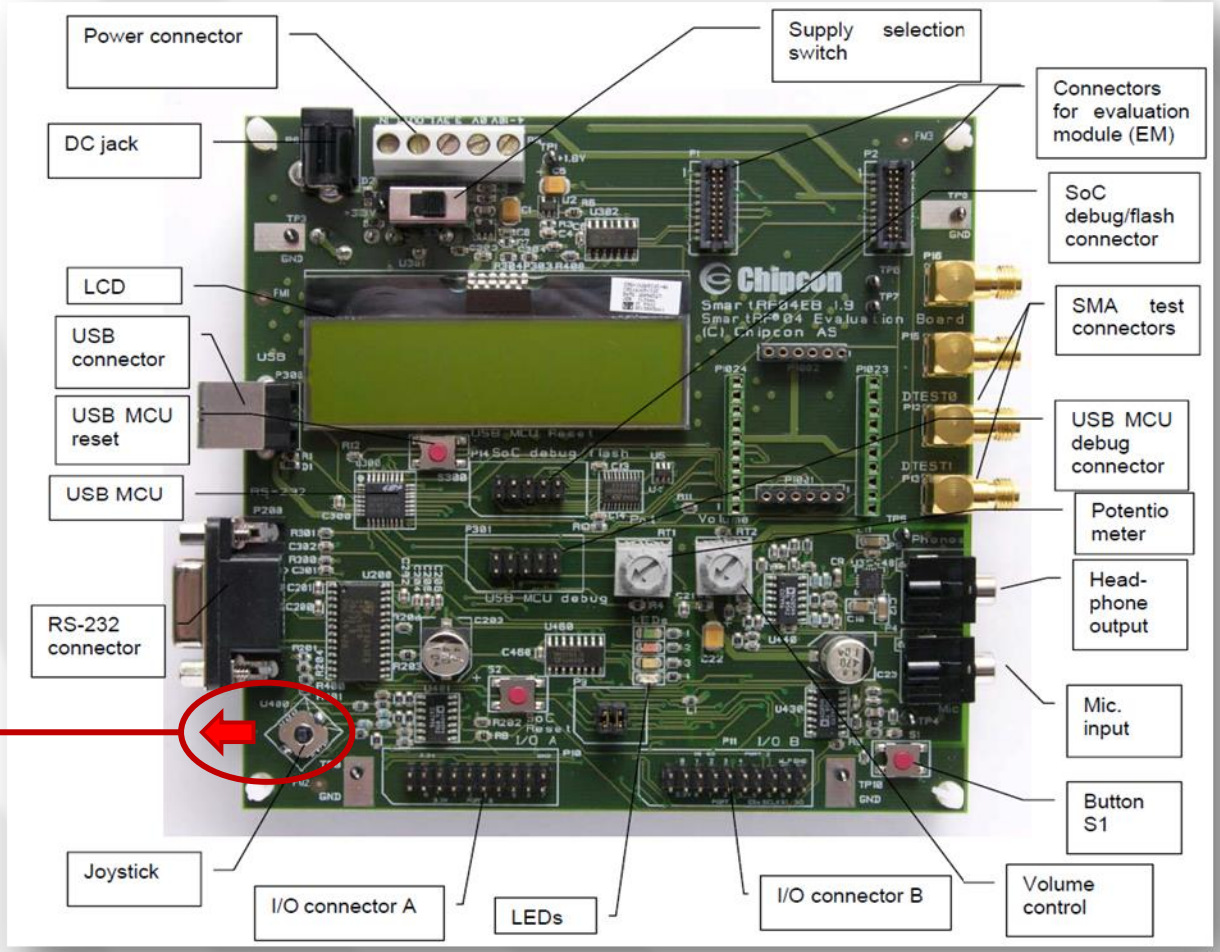
ZC - Network formation

Orange light is *ON* when the node form the Network.

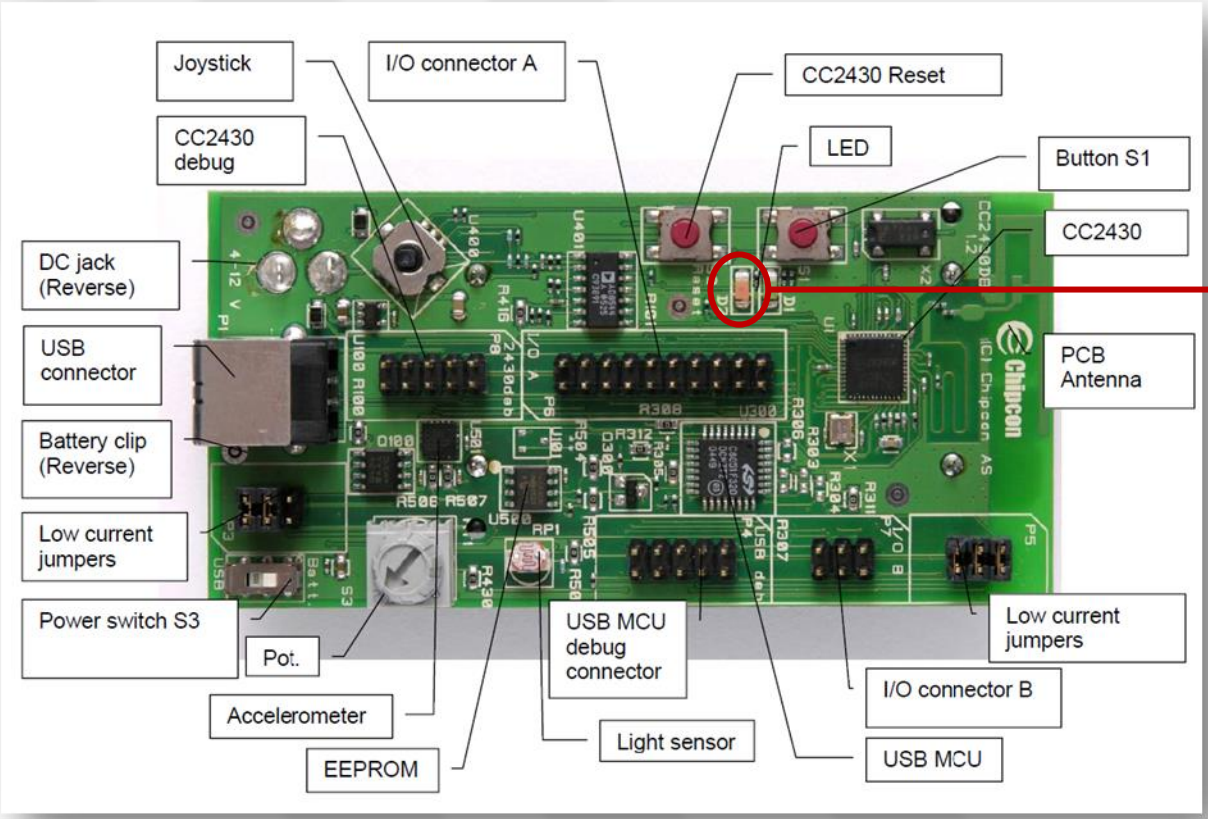


ZC - Auto scan mode

Push the joystick to the *left* to activate the auto scan mode.

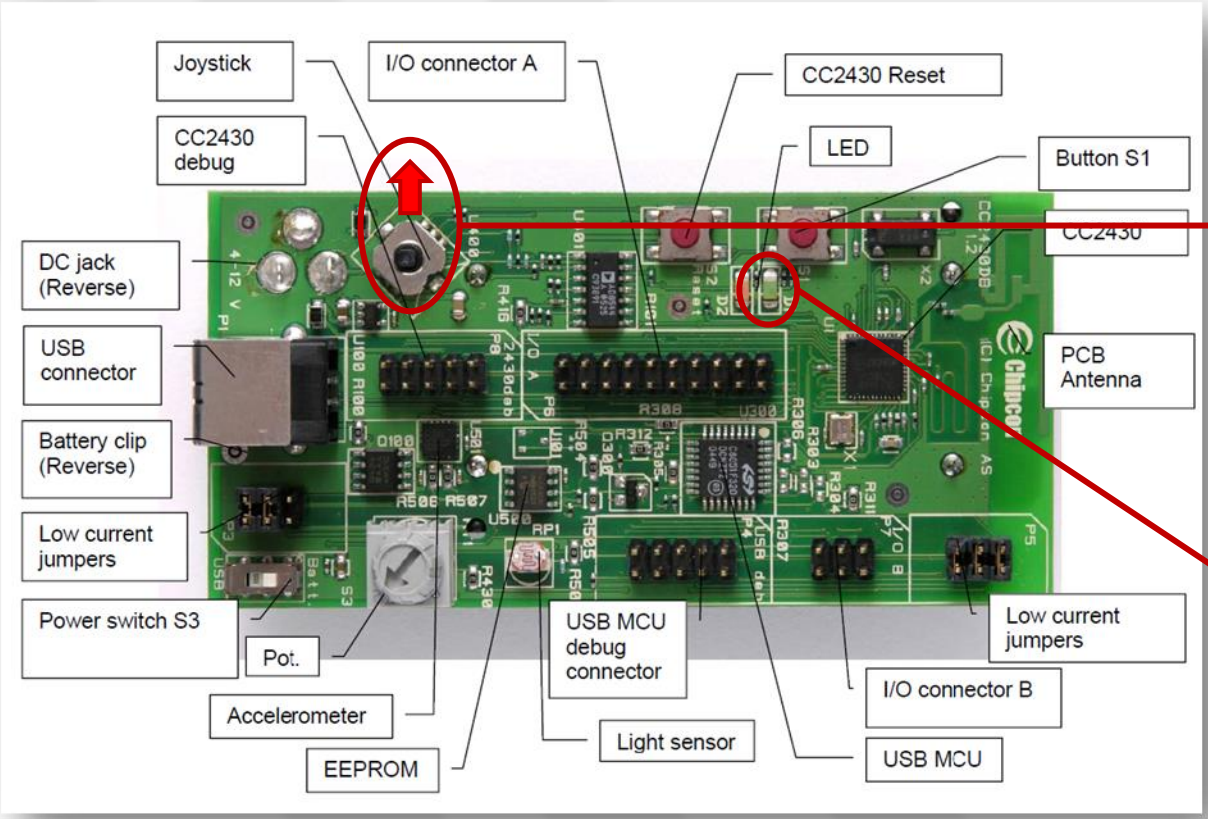


ZED - Network binding



Red light is *ON* when the node joins the Network or *blinks* when it disconnects from the Network.

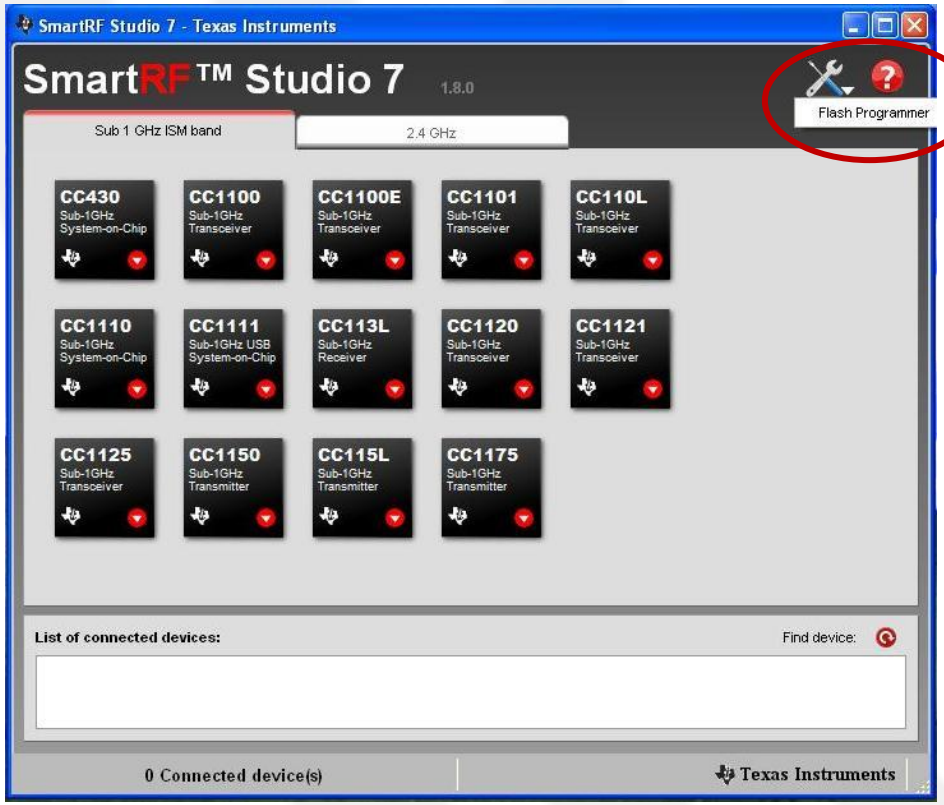
ZED - Send message



Push the joystick to the *top* to send the message.
(the application will continue to send the message every 5s)

If the **green** light is *ON*, it means that the message has been sent.

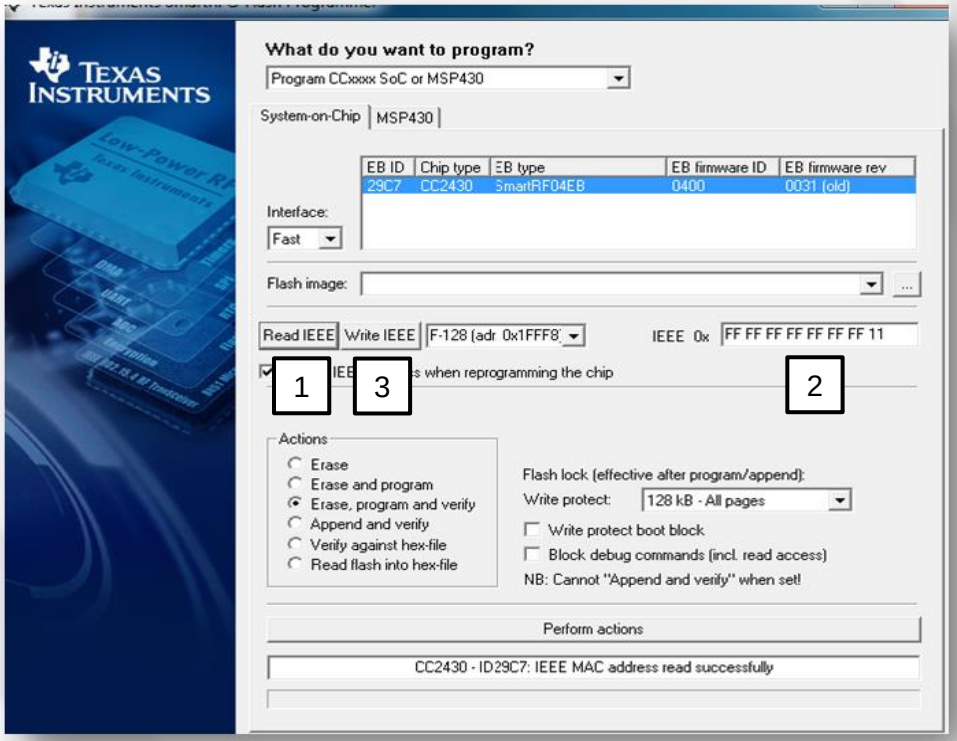
Change IEEE address (1)



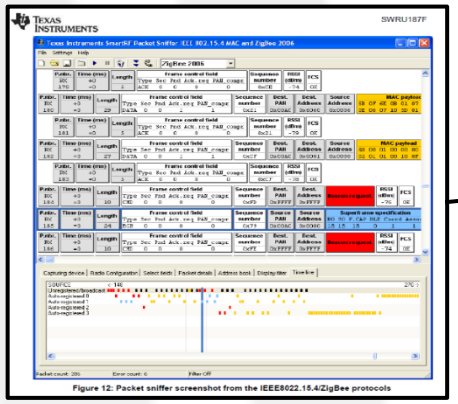
Open the SmartRF Flash Programmer tool.

Change IEEE address (2)

- Then in order:
  1. Read IEEE
  2. Change IEEE address
     - (8 bytes)
  3. Write IEEE



RF sniffing (1)



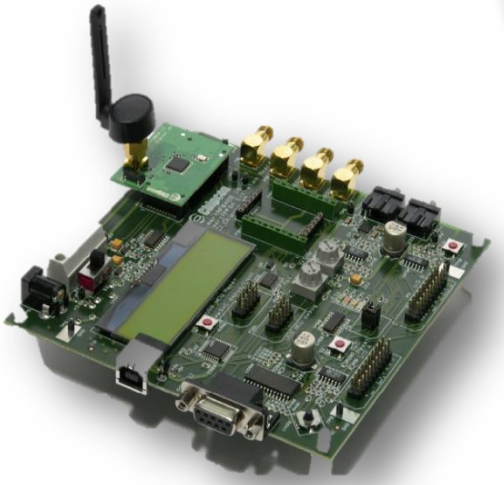
Packet Sniffer

RF Sniffer

Transmitter
ZigBee End Device

MESSAGE

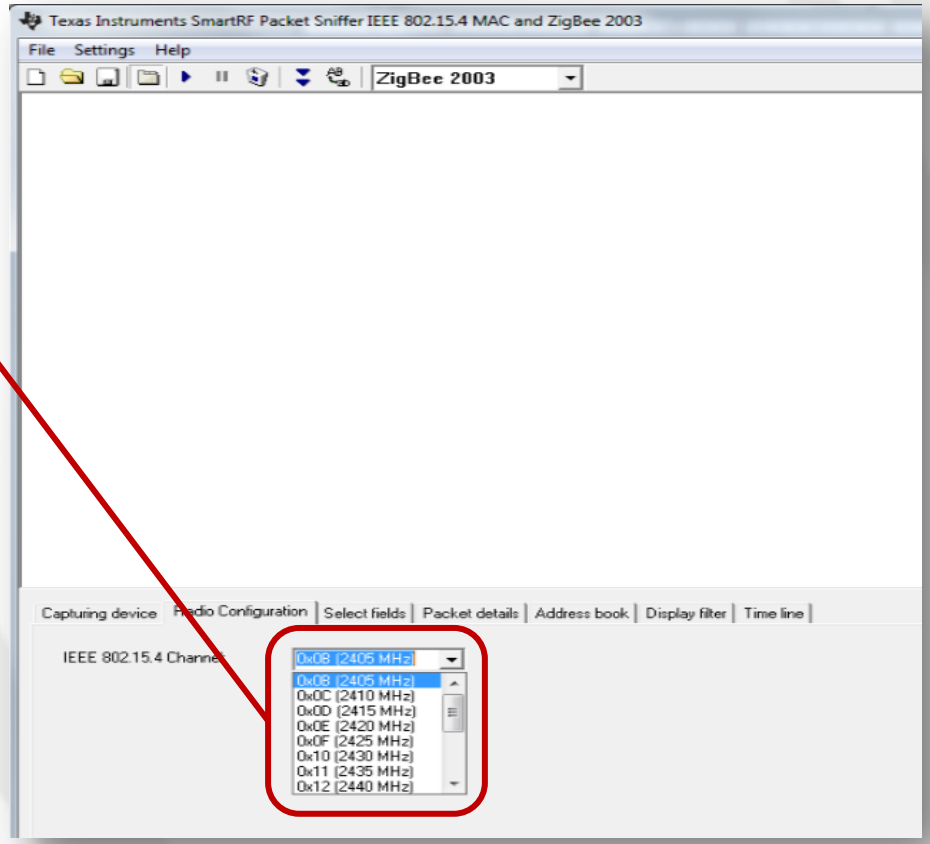
IEEE 802.15.4
ZigBee



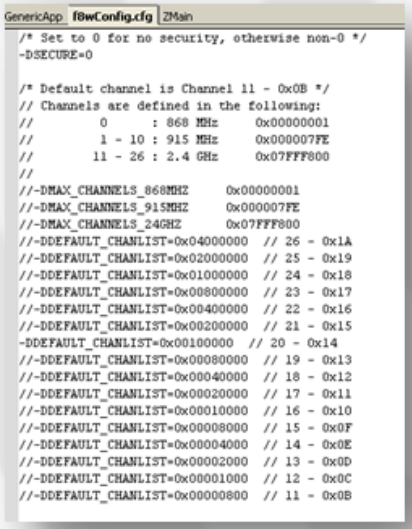
Receiver
ZigBee Coordinator

RF sniffing (2)

Open the SmartRF Packet Sniffer tool and choose the desidered sniffing operating frequency.



P.S. The frequency should be the same as the one in the application configuration file (*.cfg*)



RF sniffing (3)

Start the packet capturing.

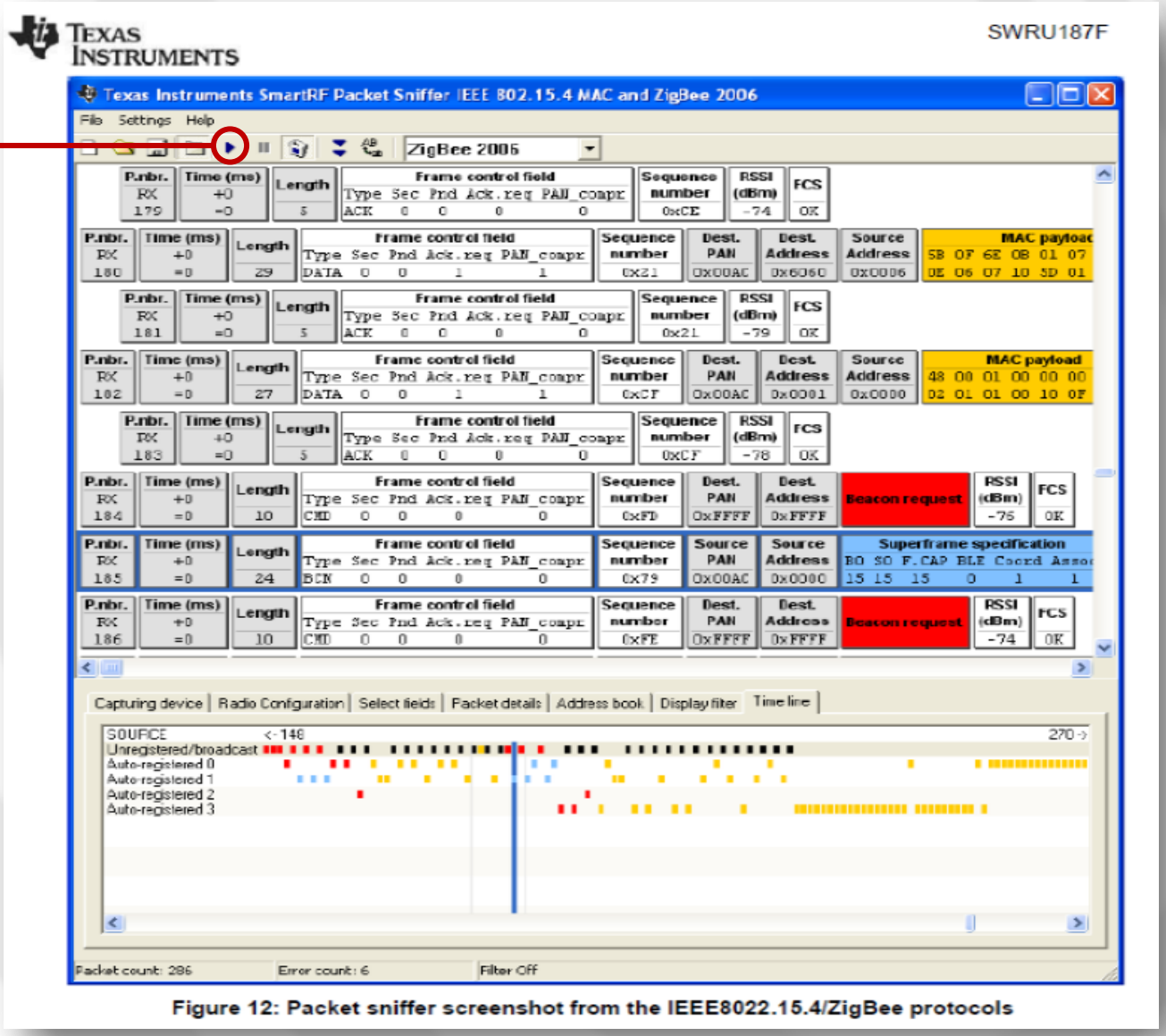


Figure 12: Packet sniffer screenshot from the IEEE8022.15.4/ZigBee protocols

Exercise

- Configure the GenericApp based on the following requirements:
  - Change the sent message to «Ciao NES».
  - Change the operating frequency to 2415 MHz.
  - Change the IEEE address of the coordinator node to «00 11 22 33 44 55 66 77».
  - Run the application and sniff the data.