Setup and Test Plan for CE & FCC Testing & Verification

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1 System Hardware Components

The over all system consists of two basic devices Data Logging Device (DLD) and Data Routing System (DRS), and one supporting device called Coverage Extending Device (CED).

1.1 DLD Model No. (Y5010-A)

1.1.1 Device Wiring and Operating Modes

The DLD is installed inside the vehicle and needs a three-wire connection (Power or PRW, Ground or GND, and Ignition or IGN) with two operational modes depending on the ignition status:

1- GPS data logging mode which operates only when the vehicle ignition is ON (high)
2- ZigBee function mode which operates only when the ignition is OFF (low)

When the car ignition is ON, the DLD is in the GPS data logging mode collecting data and storing them in the built-in SD memory. When the car ignition is OFF, the DLD switches to the ZigBee function mode listening to the DRS messages; if a DRS is detected, the DLD will start transmitting the new GPS logs to the DRS.

1.1.2 DLD Block Diagram

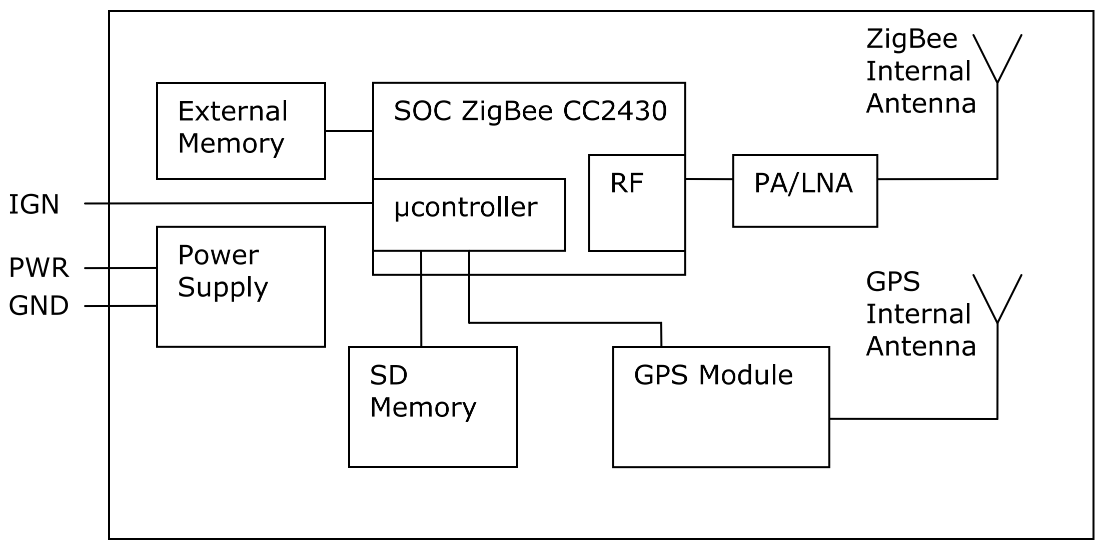


Figure 1: DLD Block Diagram

1.1.2.1 Power Supply

The power supply block consists of three functions inside:

- DC-DC converter - input voltage of 8-32 Volts and output of 3.3 Volts.

- Supervisory circuit to give an input voltage window from 8-32 Volts for protecting the device from voltage faults. In case of a fault occurrence, this will instruct the microcontroller to hold till the fault disappears.

- Ignition indicator connected to the microcontroller via an optocoupler for controlling the DLD mode of operation: “high” for GPS mode and “low” for ZigBee mode.

1.1.2.2 SOC ZigBee

It is System-on-Chip IC with the following built-in functions:

- Microcontroller with flash running the ZigBee protocol and the Device Application that controls the device state machine.
- RF Transceiver with transmitter output power controlled from -25 dBm to 0 dBm, the device operates on time duplex mode.

1.1.2.3 RF PA/LNA

Front End RF IC which contains fixed amplification PA of 20 dB gain with LNA and RF switches for duplexing function.

1.1.2.4 SD Memory

Removable 2G microSD memory for storing the GPS Data.

1.1.2.5 External Memory

Used during over-the-air firmware upgrade.

1.1.2.6 GPS Module

High sensitivity GPS Receiver that decodes the GPS signal and sends it to the microSD memory serially through the microcontroller.

1.1.3 Specifications

1.1.3.1 Modulation

The device uses FHSS over 15 frequency channels with 5 MHz spacing and a dwell time of 300 ms over each channel. On each channel the modem uses the DSSS, in other words, the DSSS signal is hopping over 15 frequency channels.

1.1.3.2 Operating Frequency

The frequency range is from 2400 to 2483.5 MHz.

1.1.3.3 Operation Conditions

Temperature: -10 to 80^{o}C.
Supply: 8-32 Volts.
Ignition: 8-32 Volts.

1.1.3.4 Antenna Used

- GPS Square 3 dBi. Datasheet is provided (see Appendix 1 - GPS Antenna).
- ZigBee PCB Antenna maximum Gain 3.3 dBi. Datasheet is provided (see Appendix 2 - 2.4 GHz Inverted F Antenna).

1.1.3.5 Maximum Output Power
16 dBm.

1.2 DRS Model No. (Y5030-C)

1.2.1 Device Wiring and Operating Modes
The DRS is permanently placed in the parking lots and needs power source and Ethernet connection to operate. It has two main functions working simultaneously:

1- ZigBee function, it is always ON serving the DLDs in its wireless range (see below).
2- Ethernet communication with the Application Server.

DRS always looks for the DLDs in vehicles by sending broadcasting messages on regular basis, every 20 seconds, and waits for a reply from any DLD in the range. Once the wireless connection is established, it starts to receive data from the DLD (one DLD at a time), and transfers the data through Ethernet to the Application Server for to be processed.

1.2.2 Block diagram

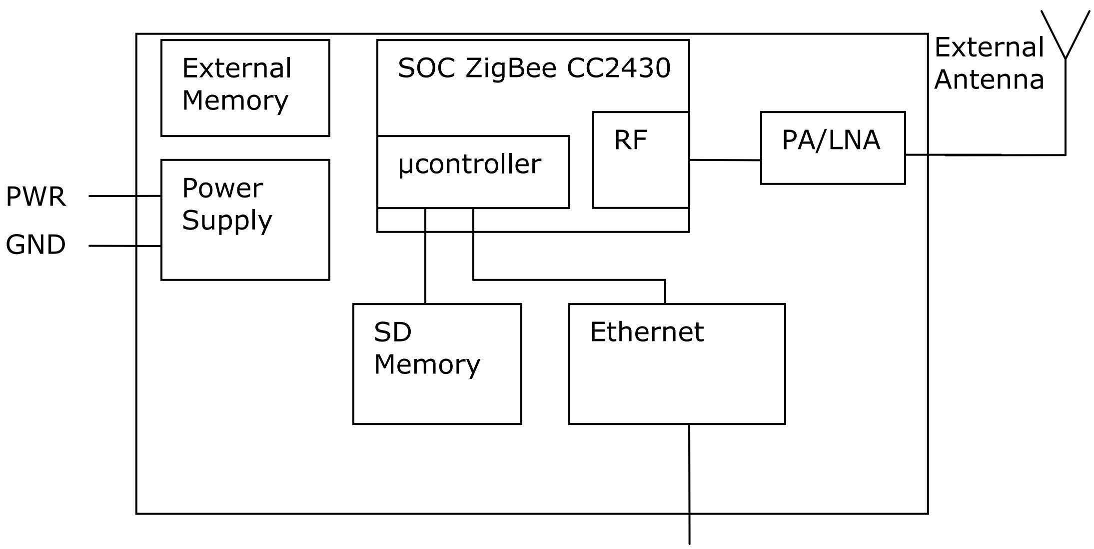


Figure 2: DRS Block Diagram

1.2.2.1 Power Supply
- DC-DC converter - input voltage of 8-32 Volts and output of 3.3 Volts.
- Supervisory circuit to give an input voltage window from 8-32 Volts for protecting the device from voltage faults. In case of a fault occurrence, this will instruct microcontroller to hold till the fault disappears.

1.2.2.2 SOC ZigBee
It is System-on-Chip IC with the following built-in functions:

- Microcontroller with flash running the ZigBee protocol and the Device Application that control the device state machine.
- RF Transceiver with transmitter output power controlled from -25 dBm to 0 dBm, the device operates on time duplex mode.

1.2.2.3 RF PA/LNA
Front End RF IC which contains fixed amplification PA of 20 dB gain with LNA and RF switches for duplexing function.

1.2.2.4 SD Memory
Contains the DLD Firmware to enable the system for over-the-air firmware upgrade for the DLDs.

1.2.2.5 External Memory
Stores the DRS firmware and is used during firmware upgrade.

1.2.2.6 Ethernet Module
Serial to Ethernet module connects the DRS to the LAN (targeting the Application Server).

1.2.3 Specifications

1.2.3.1 Modulation
The device uses FHSS over 15 frequencies channels with 5 MHz spacing and a dwell time of 300 ms over each channel. On each channel the modem uses the DSSS. (The DSSS signal is hopping over 15 frequency channels).

1.2.3.2 Operating Frequency
The frequency range is from 2400 to 2483.5 MHz.

1.2.3.3 Operating Condition
Temperature: -10 to 80^{o}C.
Supply: 8-32 Volts.

1.2.3.4 Antenna Used
External Antenna 3.2 dBi. Datasheet is provided (see Appendix 3 - Wireless External Antenna).

1.2.3.5 Maximum Output Power
16 dBm.

1.3 CED Model No. (Y5031-C)

1.3.1 Device Wiring and Operating Modes
The CED is a Repeater Device used to extend the coverage area of the DRS and works as a bridge between the DRS and the far-located DLDs that are outside of the DRS coverage. It requires power to operate and works in the ZigBee routing mode.

1.3.2 Block Diagram

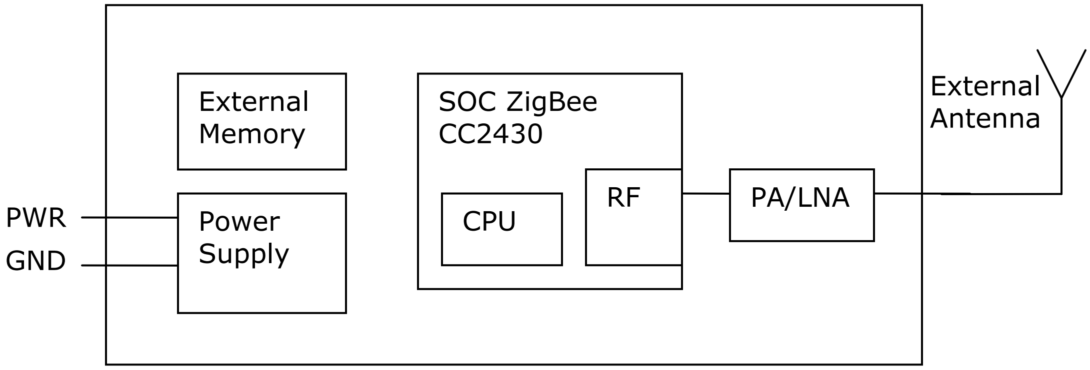


Figure 3: CED Block Diagram

1.3.2.1 Power Supply

- DC-DC converter - input voltage of 8-32 Volts and output of 3.3 Volts.
- Supervisory circuit to give an input voltage window from 8-32 Volts for protecting the device from voltage faults. In case of a fault occurrence, this will instruct microcontroller to hold till the fault disappears.

1.3.2.2 SOC ZigBee

It is System-on-Chip IC that has the following built-in functions:

- Microcontroller with flash running the ZigBee protocol and the Device Application that control the device state machine.
- RF Transceiver with transmitter output power controlled from -25 dBm to 0 dBm, the device operates on time duplex mode.

1.3.2.3 RF PA/LNA

Front End RF IC which contains fixed amplification PA of 20 dB gain with LNA and RF switches for duplexing function.

1.3.2.4 External Memory

Used during over-the-air firmware upgrade.

1.3.3 Specifications

1.3.3.1 Modulation

The device uses FHSS over 15 frequency channels with 5 MHz spacing with a dwell time of 300 ms over each channel On each channel the modem use the DSSS. (The DSSS signal is hopping over 15 frequency channels).

1.3.3.2 Operating Frequency

The frequency range is from 2400 to 2483.5 MHz.

1.3.3.3 Operating Condition

Temperature: -10 to 80°C.
Supply: 8-32 Volts.

1.3.3.4 Antenna Used

External Antenna 3.2 dBi. Datasheet is provided (see Appendix 3 - Wireless External Antenna).

1.3.3.5 Maximum output power

16 dBm.

2 Testing Tools and Operation

2.1 Tools List

Younivate will provide the following tools and software for CE and FCC testing and verification:

1- TI Development Kit
2- Smart RF software
3- USB type B cable
4- RF cable for ZigBee
5- RF SMA-RP to SMA Adapter
6- RF SMA to SMA Adapter
7- Server Application demo
8- Ethernet cross cable
9- A DLD plastic (if needed)
10- Two JTAG cables (if needed)

2.2 Function Testing

The following functions can be tested by one or more of the tools listed above in section 2.1:

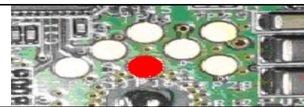
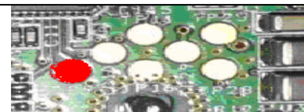
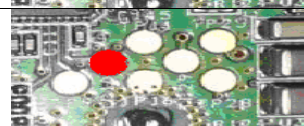
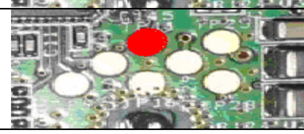
2.2.1 ZigBee Function Mode Testing

In order to control the operation mode of the ZigBee functionality, Rx, Tx, continuous and packet, modulated and un-modulated transmission, and the frequency of operation, you need to operate the device through the smart RF application with TI Development Kit to communicate with the devices through JTAG cable. We have prepared the DLD and the DRS sample with JTAG cable drawn out to ease the process.

2.2.1.1 JTAG Cable Connection

Find the following connection to install:

Table 1: List of Connections

Wire Number	On Board Location
1-GND	
2- 3.3 V	
3- CLK	
4- Data	
7- Reset	

2.2.1.2 How to Use "Smart RF"

Once you install the Smart RF application, connect the TI Development Kit to the PC with USB cable, then open the application, and select tab "Smart 04DK"; then press the ON button on the TI Development Kit, the application will show the following:

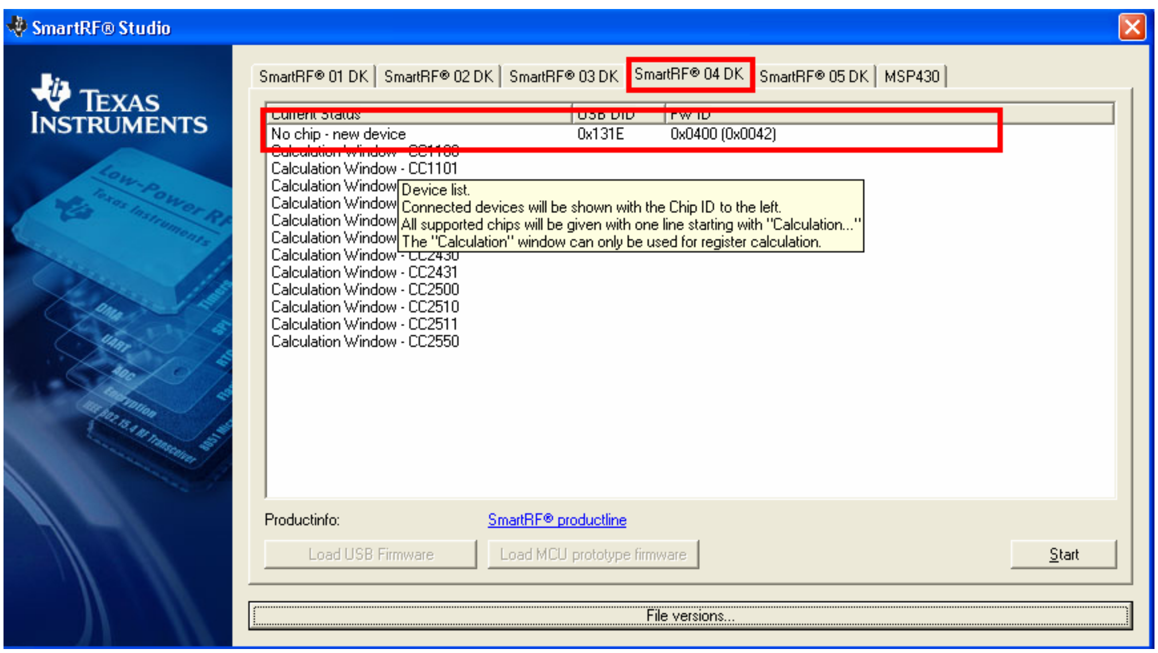


Figure 4: SmartRF Window

Now, connect the 12/24 Volt supply to the Device Under Test (DUT) and connect the JTAG cable of the device to the cable coming out of the TI Development Kit, then press the Red Reset Button. The application should show that new chip is detected.

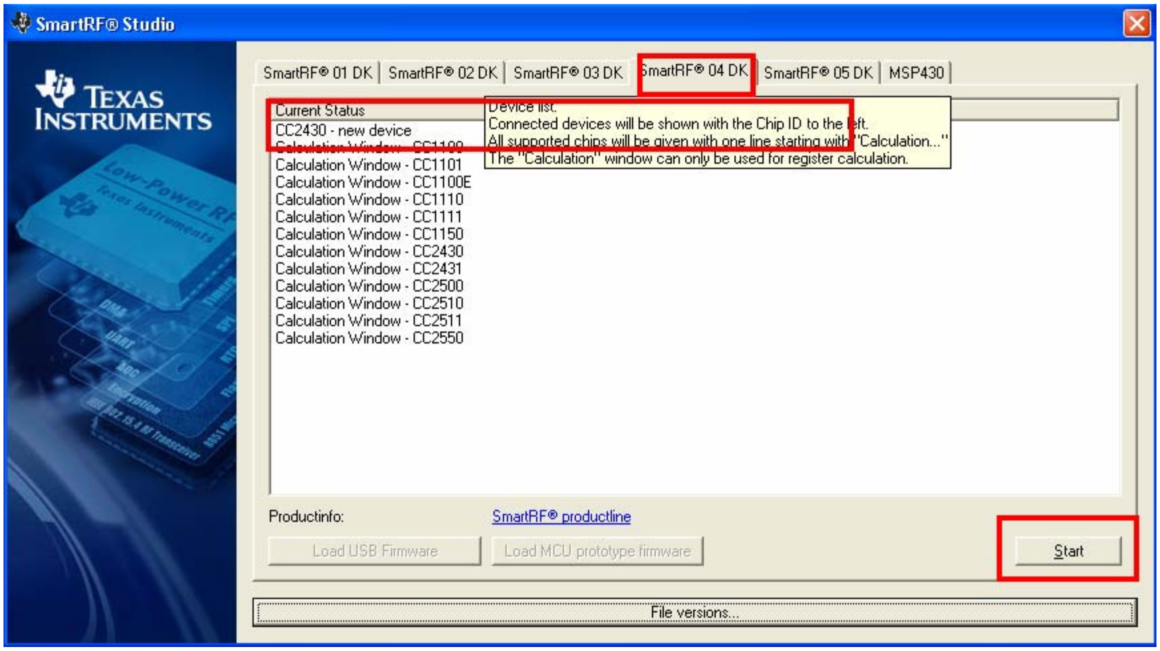


Figure 5: SmartRF showing "Device Detected"

Select the new device and press START to go to the window to configure the operation as follows:

Each time you want to make a test you have to set the frequency, the power, and then select the test function Tx mode or Rx /Tx packet mode.

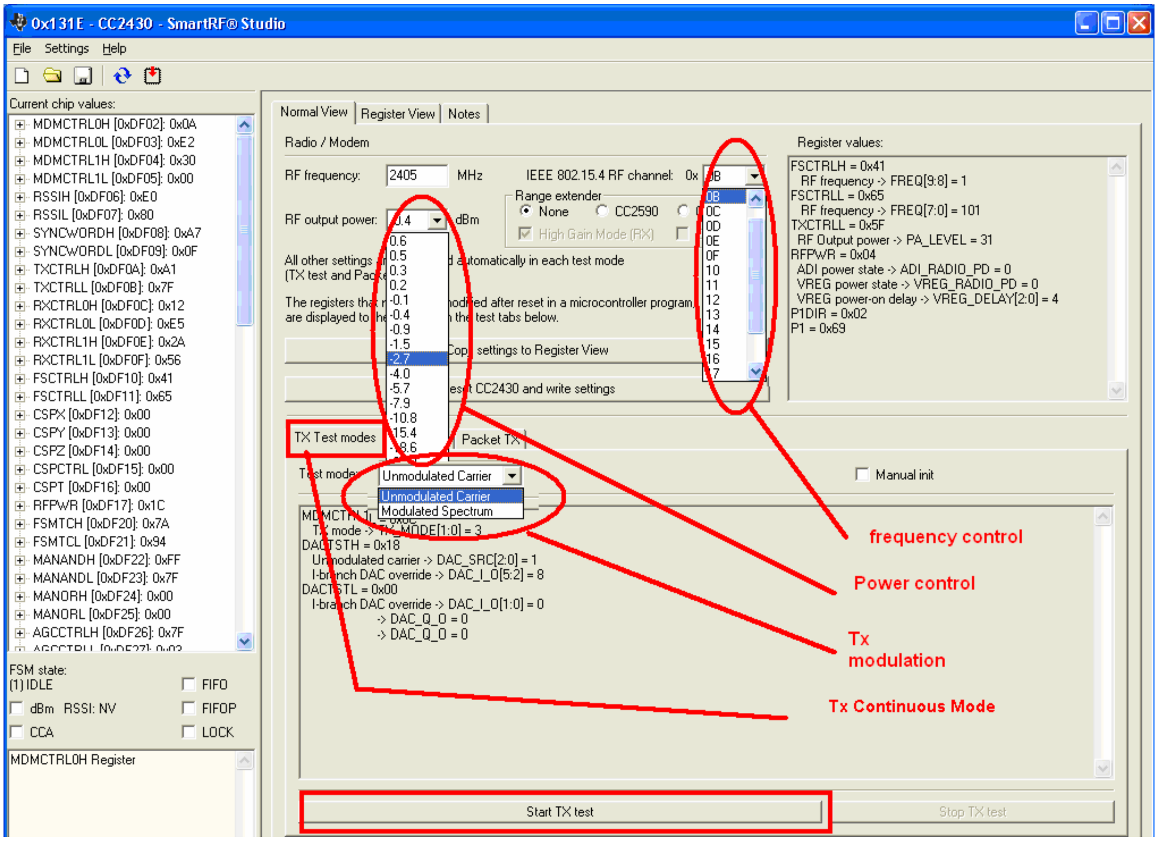


Figure 6: Configuration Settings

1- Frequency Channel
The device operates on a frequency from channel 0x0B to 0x19.

2- Power Level
The device always operates at a power -2.7 dB.

3- Continuous Transmission Modulated
From the three tabs, select Tx Test modes, and from the list select Modulated Spectrum.

4- Continuous Transmission Un-modulated "CW"
From the three tabs, select test mode Tx Continuous, and from the list select Un-modulated Carrier.

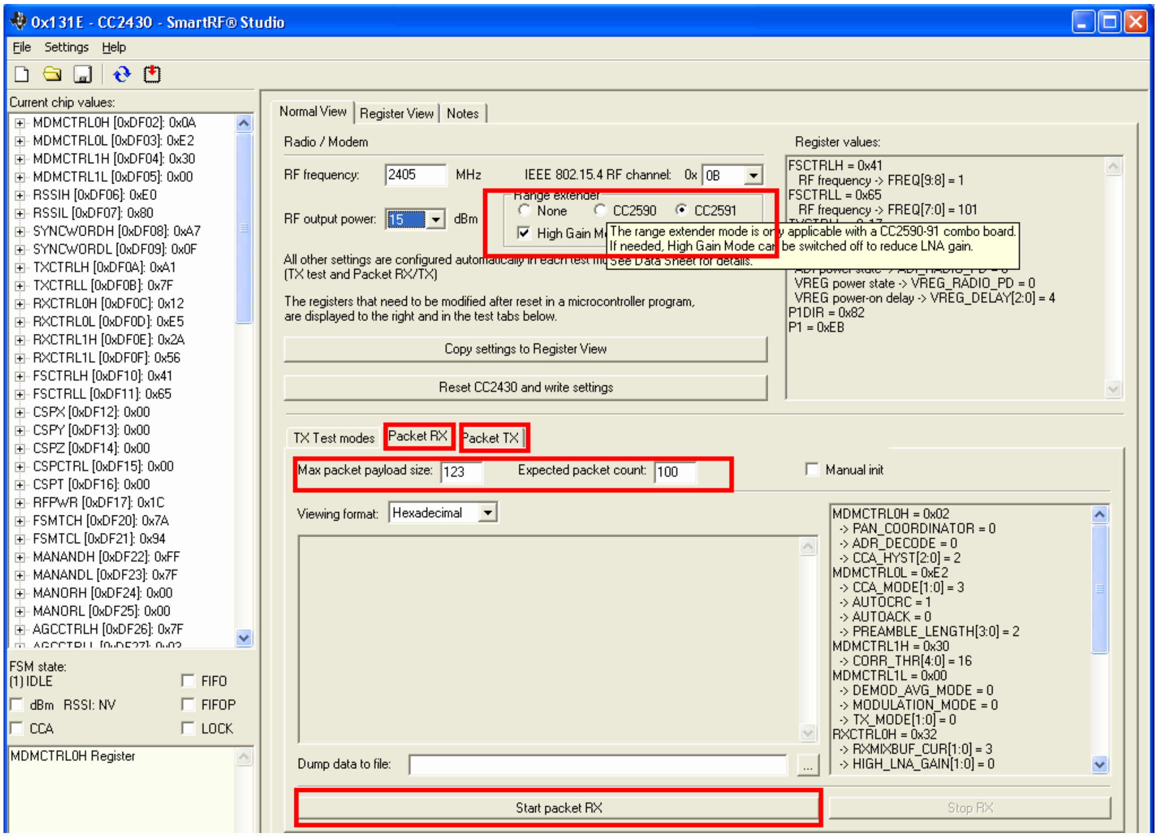


Figure 7: Configuration Settings

5- *Packet Rx "Receiving Mode"*

From the range extender block select CC2591 and select High Gain Mode. This is the normal operation mode for the Receiver operation.

From the three tabs select Packet Rx, you can define the payload and number of packet to be received.

6- *Packet Tx Transmission*

From the three tabs select Packet Tx, you can define the payload and the number of packet to transmit.

2.2.2 GPS Function Mode Testing (DLD Only)

To test the GPS you have to go to the normal operational mode as follows:

1- Connect the device to the Power 12/24 V; wait for the green LED to blink three times.
2- Place the Jumper between pins 3 and 2 to simulate ignition ON.
3- The device now is in the GPS logging mode, it will start searching for GPS signal if available, then it will log the location and write it to the internal SD memory.

2.2.3 Ethernet Function

In the DRS, the Ethernet will be activated at power up. All the DRSs are programmed to a fixed IP address that has to be configured on the Windows TCP/IP protocol. See "System Normal Operation" below in section 2.2.4.1 for more details.

2.2.4 Overall System Operation

2.2.4.1 System Normal Operation "Minimum Criteria to Test the Devices"

To test the DLD and the DRS in the normal mode of operation:

1- Install Younivate YouniVu Demo.

2- In the Network Connections, right-click the connection associated with the network interface card to which the YouniVu Data Routing System (DRS) device will be connected using the crossover cable. Select Properties, in the General tab, select "Internet Protocol (TCP/IP)" and then click Properties. After making the following settings, click OK on both dialog boxes:

- Select "Use the following IP address".
- Set the IP address to: 169.254.0.1.
- Set the subnet mask to: 255.255.0.0.

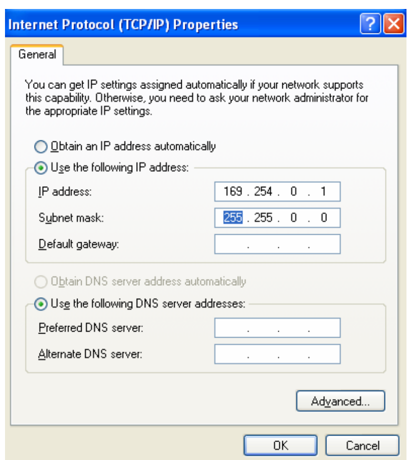


Figure 8: Network Configurations

3- Connect the DRS using the crossover cable, run the demo and click Initiate.

4- Wait until the Application detects the DRS, showing the message "Searching for Devices".

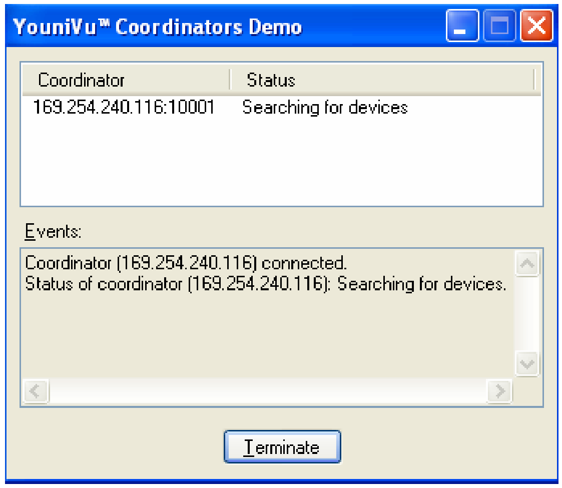


Figure 9: Coordinator Status

5- The files received from the Data Logging Devices (DLDs) will be stored in a folder named “Uploaded” inside the installation folder of the demo.

6- If the devices has successfully sent the GPS Data files to the Uploaded folder, then the overall system (DRS, DLD, and CED if used) are within specs.

7- Note that each DLD should be used with the Corresponding DRS that operates on the same frequency channel.

3 SAMPLE DETAILS

3.1 DLD (Y5010-A)

Three samples have been prepared, each of them with some variation to give flexibility for testing and a control over the device operation mode.

1- DLD ID (00000001)

Frequency is fixed on the lower-edge frequency 2405 MHz; the following is done over this sample:

a- A hole on the DLD back to give a conductive access to the ZigBee RF Port.
b- The GPS Antenna is disconnected and a 50 Ω probe is connected to give an access to the GPS RF port.
c- Jumper is placed on the terminal block to switch to GPS mode.
d- A GPS Data file is installed in the microSD for System Normal Operation.

2- DLD ID (00000002)

Frequency is fixed on the middle frequency 2440 MHz; and a GPS Data file is installed in the microSD for System Normal Operation.

3- DLD ID (00000003)

Frequency is fixed on the higher-edge frequency 2475 MHz, the following is done over this sample:

a- A hole is made on the DLD rear-side to give a conductive access to the ZigBee RF Port.
b- A Data cable is drawn out to control the device through ZigBee functions using the Windows Application provided “Smart RF”.
c- A GPS Data file is installed in the microSD for System Normal Operation.

3.2 DRS (Y5030-C)

Three samples have been prepared each with some variation to give flexibility for testing and a control over the device operation mode.

1- DRS ID (00080001)

Frequency is fixed on the lower-edge frequency 2405 MHz, no changes are made on this device.

2- DRS ID (00080002)

Frequency is fixed on the middle frequency 2440 MHz, no changes are made on this device.

3- DRS ID (00080003)

Frequency is fixed on the higher-edge frequency 2475 MHz, and a data cable is drawn out to control the Device through ZigBee functions using the Windows Application provided “SmartRF”.

3.3 CED (Y5031-C)

A single sample is prepared (CED ID 00000004); the device has the same function as the DRS but without the Ethernet capability and is fixed on the middle frequency 2440 MHz.