CMOSTEK

AN103

CMT211xA/221xA One-Way RF Link Development Kits User's Guide

Introduction

CMT211xA/221xA One-Way RF Link Development Kits (Development Kits) are a set of the hardware and software tools designed to help the users to easily evaluate the performance and demonstrate the features of products CMT211xA and CMT221xA. These two series of devices are part of the CMOSTEK Microelectronics Co., Ltd. (CMOSTEK) NextGenRF^{TM} family, which include a complete line of transmitters, receivers and transceivers. The Development Kits covered in this document are listed in the table below

Table 1. Development Kits Covered in This Document

Development Kits	Part Number	Tx/Rx	Frequency (MHz)	Modulation
CMT211xA/221xA One-Way RF Link Development Kits	CMT2110A	Tx	240-480	OOK
	CMT2210A	Rx	300-480	OOK
	CMT2113A	Tx	240-480	(G)FSK/OOK
	CMT2213A	Rx	300-480	(G)FSK/OOK
	CMT2117A	Tx	240-960	OOK
	CMT2217A	Rx	300-960	OOK
	CMT2119A	Tx	240-960	(G)FSK/OOK
	CMT2219A	Rx	300-960	(G)FSK/OOK

The Development Kits contain the components of two evaluation boards named RF-EB, four Tx evaluation modules named CMT211xA-EM, four Rx evaluation module named CMT221xA-EM, a USB Programmer and a PC application named RFPDK (RF Products Development Kit). The package is shown in Figure 1.

Figure 1. CMT211xA/221xA One-Way RF Link Development Kits

Table of Contents

Abbreviations

Abbreviations used in this document are described below.

AN	Application Notes	**PC**	Personal Computer
API	Application Programming Interface	**PER**	Packet Error Rate
BOM	Bill of Materials	**RF**	Radio Frequency
CDROM	Compact Disk Read Only Memory	**RFPDK**	RF Products Development Kit
EB	Evaluation Board	**Rx**	Receiving, Receiver
EM	Evaluation Module(s)	**Tx**	Transmission, Transmitter
Err	Error	**SR**	Symbol Rate
OOK	On-Off Keying	**USB**	Universal Serial Bus
PA	Power Amplifier		

1. Development Kits Contents

The Development Kits contain the following components:

- 2 x **RF-EB** V1.0 evaluation boards
- 1 x **CMT2110A-EM** V1.0 Tx module (433.92 MHz)
- 1 x **CMT2210A-EM** V1.0 Rx module (433.92 MHz)
- 1 x **CMT2113A-EM** V1.0 Tx module (433.92 MHz)
- 1 x **CMT2213A-EM** V1.0 Rx module (433.92 MHz)
- 1 x **CMT2117A-EM** V1.0 Tx module (868.35 MHz)
- 1 x **CMT2217A-EM** V1.0 Rx module (868.35 MHz)
- 1 x **CMT2119A-EM** V1.0 Tx module (868.35 MHz)
- 1 x **CMT2219A-EM** V1.0 Rx module (868.35 MHz)
- 1 x **USB Programmer** V1
- 1 x **USB Cable**
- 6 x **AA Batteries**
- 4 x **Antennas**

Figure 2. Development Kits Contents

RF-EB

General purpose evaluation board for the CMOSTEK RF products. It can be used to evaluate and demonstrate the main features of CMT211xA, CMT221xA and other RF products.
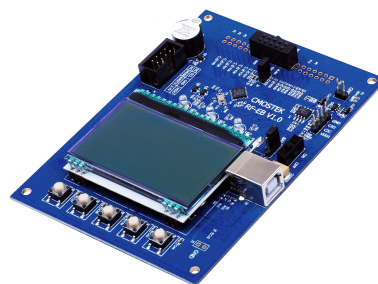
CMT211xA-EM

The CMT211xA-EM is the Tx evaluation module. The user can use it to evaluate the CMT211xA performance and features.

CMT221xA-EM

The CMT221xA-EM is the Rx evaluation module. The user can use it to evaluate the CMT221xA performance and features.

RFPDK

CMOSTEK provides the PC application that allows the users to configure all the product features to CMOSTEK NextGenRF^{TM} products in the most intuitional way. The installation pack can be found on the CDROM of the CMT211xA/221xA One-Way RF Link Development Kits.
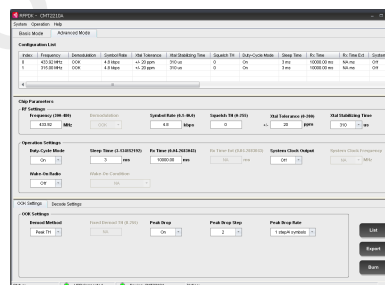
USB Programmer

It transmits data between the EM and the PC via two interfaces: USB to PC and serial port to EM. The protocols of the serial port differ for different parts (chips). The USB programmer automatically identifies the part on the EM once it is connected, and then uses the desired protocol to communicate to the part.

2. Application Schemes

The Development Kits can be used in 2 different application schemes.

- **Evaluation Scheme**:   Main product features can be configured and evaluated/demonstrated in this scheme.
- **Configuration Scheme**:   All product features of can be configured in this scheme.

2.1 Evaluation Scheme

The necessary components of the evaluation scheme are:

- Two RF-EBs
- CMT211xA-EM
- CMT221xA-EM

Main product features can be evaluated and demonstrated in this scheme. Follow the step-by-step instructions to start working in the Evaluation Scheme.

1. Turn off the RF-EB power switch (SW1, see Figure 6 in Page 10). It is always good practice to plug in or out the evaluation modules after the RF-EB is powered off.
2. Switch the Power Mode Jumper (J7, see Figure 6 in Page 10) to the USB or BAT side to select the available power supply source.
3. Plug the evaluation modules into both RF-EBs respectively. Please note that there are 2 sets of evaluation modules and antennas, the user should pair them properly according to their frequency labeled on them.
4. Turn on the power switch (SW1) of the RF-EB. The LED indicator for the power supply indication will be light up to show to "ON" status of the RF-EB.
5. Start to configure the evaluation modules according to the instructions displayed on the LCD and then evaluate the main features/performance.

2.2 Configuration Scheme

The necessary components of the configuration scheme are:

- RFPDK
- USB Programmer
- CMT211xA-EM or CMT221xA-EM

This scheme allows the user to freely customize all product features and program them into the chips. Once the programming is done successfully, the evaluation module is ready to be integrated into the user's own application systems. Moreover, the users can program chip configurations to their self-designed CMT211xA/221xA modules as long as the programming interface is reserved.
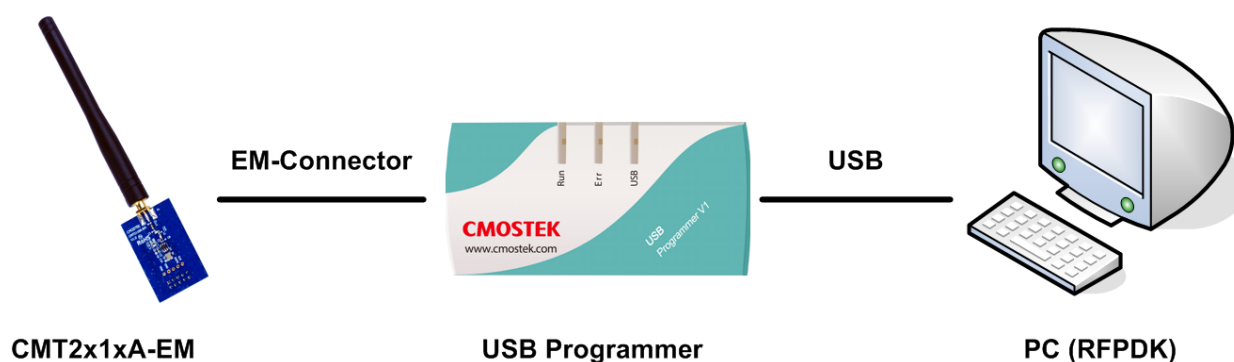
Figure 3. Configuration Setups

Follow the step-by-step instructions to start working in the Configuration Scheme.

1. Setup the configuration scheme as Figure 3.
2. Install the USB Programmer driver. The driver will be installed automatically on the computer. It should be noticed that if the RFPDK is already installed on the computer, make sure that the RFPDK is not running when the user is installing the USB Programmer driver.
3. Install the RFPDK to the computer. Refer to Section 7.1 for the detail procedure for the installation.
4. Start Configuring CMT211xA/221xA on the RFPDK and the USB Programmer. Once the configuration is done, the user can use the evaluation modules in the actual RF system.

Please refer to the "Chapter 7. RFPDK" for the RFPDK usage guidelines and refer to the following documents for more details.

Brief	Document Name
AN102	CMT2110/17A Configuration Guideline
AN108	CMT2210/17A Configuration Guideline
AN122	CMT2113/19A Configuration Guideline
AN128	CMT2213A Configuration Guideline
AN138	CMT2219A Configuration Guideline

Table 2. CMT211xA and CMT221xA Configuration Guidelines

3. CMT211xA-EM

The CMT211xA-EM is a Tx evaluation module with CMT211xA, the necessary external components and the matching network. The EM-Connector on the back side of the module allows the connection to the RF-EB or USB Programmer. The definitions of the EM-Connector pins are listed in Table 1.
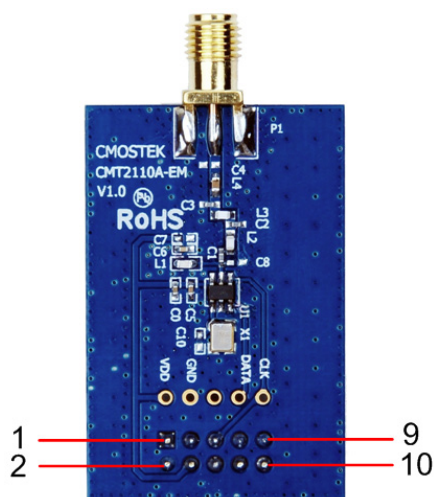
Pin	Signal Name
1	NC
2	GND
3	NC
4	VDD
5	CLK
6	NC
7	DATA
8	NC
9	NC
10	NC

Figure 4. Top View of CMT211xA-EM **Table 3. CMT211xA-EM EM-Connector Pin Definition**

The module can be used in the following schemes (see Chapter 2 for details)

1. Work with RF-EB in Evaluation Scheme
2. Work with USB Programmer and RFPDK in Configuration Scheme

The evaluation module contained in this Development Kits is designed with the matching network at 433.92 MHz. For application with different frequencies, the matching network might need to be changed.

See "Chapter 10 Appendix: CMT211xA-EM and CMT221xA-EM Schematics" for the CMT211xA-EM Schematic.

4. CMT221xA-EM

The CMT221xA-EM is an Rx evaluation module with CMT221xA, the necessary external components and the matching network. The EM-Connector on the back side of the module allows the connection to the RF-EB or USB Programmer. The definitions of the EM-Connector pins are listed in Table 2.
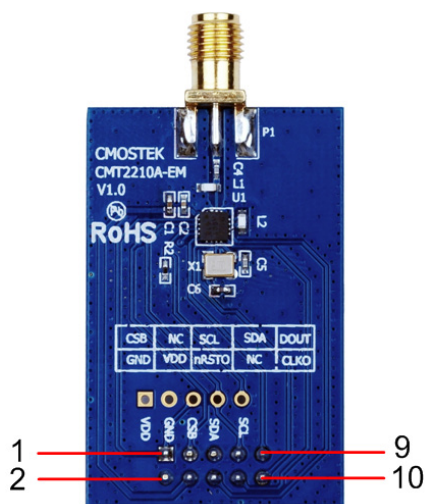

Pin	Signal Name
1	CSB
2	GND
3	NC
4	VDD
5	SCL
6	nRSTO
7	SDA
8	NC
9	DOUT
10	CLKO

Figure 5. Top View of CMT221xA-EM   **Table 4. CMT221xA-EM EM-Connector Pin Definition**

The module can be used in the following schemes (see Chapter 2 for details)

1.   Work with RF-EB in Evaluation Scheme
2.   Work with USB Programmer and RFPDK in Configuration Scheme

The evaluation module contained in this Development Kits is designed with the matching network at 433.92 MHz. For application with different frequencies, the matching network might need to be changed.

See "Chapter 10 Appendix: CMT211xA-EM and CMT221xA-EM Schematics" for the CMT221xA-EM Schematic.

5. RF-EB

The RF-EB is an evaluation board for demonstrating the main features of CMOSTEK NextGenRF^{TM} products and allowing the user to develop their own applications. The module can be used with the evaluation modules in Evaluation Scheme (see Chapter 2 for details).

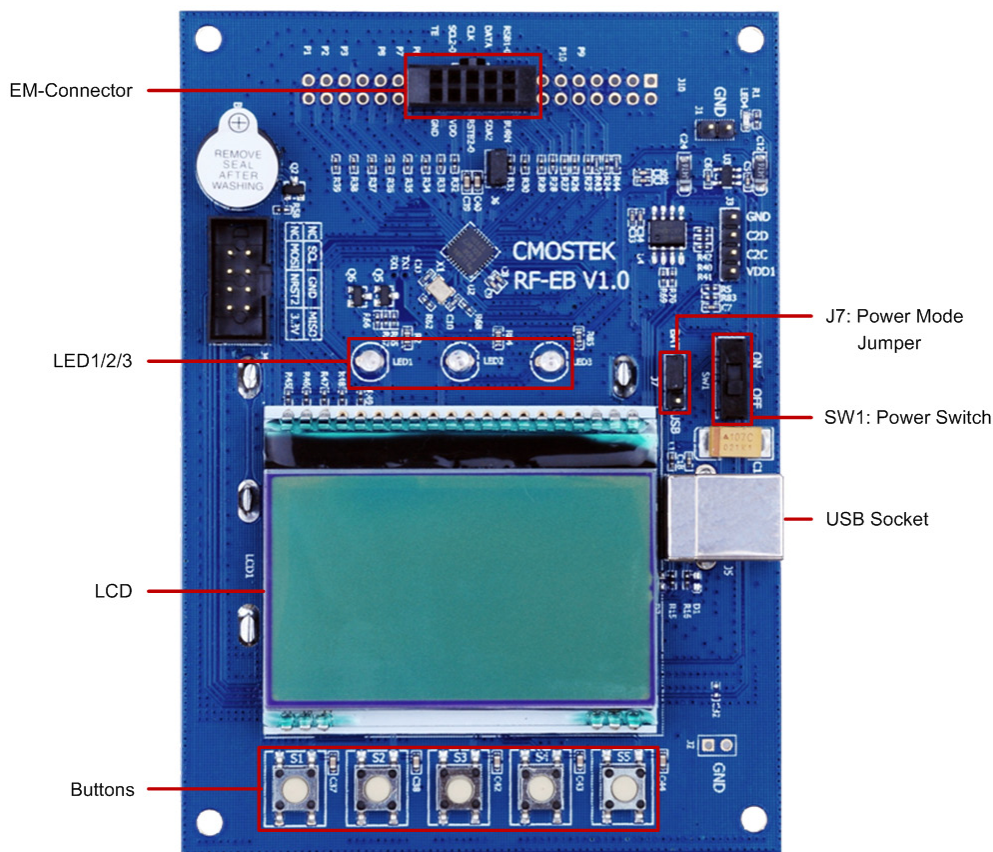The main components are shown in Figure 6 below:

Figure 6. Top View of RF-EB

5.1 Main Components

1. **EM-Connector** –The EM-Connector is 10-pin, 2.54 mm female connector which connects the RF-EB to the evaluation modules.
2. **LED** – There are 3 LEDs available to indicate the working status of the RF-EB.

   ■ **LED1** indicates that the RF-EB received 1 frame successfully when working with CMOSTEK Rx products.
   ■ **LED2** indicates that the RF-EB transmitted 1 frame out successfully when working with CMOSTEK Tx products.
   ■ **LED3** is reserved for future use.

3. **Power Mode Jumper** – The power mode jumper (J7) determines the power supply source of the RF-EB. The board can be supplied by the USB (J7 switched to the USB side) or the batteries (J7 switched to the BAT side).
4. **Power Switch** – The power switch (SW1) allows the user to turn the RF-EB power on or off. It is recommended that the user shall power off the RF-EB before plugging in or out the CMT2110A-EM.
5. **USB Socket** – A USB (type B) socket is used on the RF-EB. A USB cable is provided in the Development Kits for the user to connect the RF-EB to the PC. The USB connection is for power supply only, not for data communication.
6. **LCD** – A 128*64 pixels LCD is available on the RF-EB to display the information for the configuration and demonstration

in the Evaluation Scheme.

7. **Buttons** –There are 5 buttons (S1-S5) on the RF-EB next to the LCD for the user to complete the evaluation modules configuration and demonstration following the step-by-step instructions shown on the LCD.

5.2 LCD Functional Icons

The Functional icons are displayed on the LCD to guide the user to go through the configuration process. The functions are shown in the table below.

Table 5. LCD Functional Icons Descriptions

Functional Icon	Descriptions
>	Cursor pointer, the cursor pointer only points to the items which are configurable.
↑↓	Move cursor pointer up and down.
Reset	Reset all configurations and return to the initial page.
<-	Go back to the previous page.
->	Go forward to the next page.
+	Increase value or select the next option.
–	Decrease value or select the previous option.
OK	Select to complete configuration and ready to start Tx/Rx.
TxOn	Start transmitting. The pre-defined frame is transmitted repeatedly until the TxOff is selected. This is only available when working with CMT2110A-EM.
TxOff	Stop transmitting. This is only available when working with CMT2110A-EM.
RxOn	Start receiving until the RxOff is selected. This is only available when working with CMT2210A-EM.
RxOff	Stop receiving. This is only available when working with CMT2210A-EM.

The user should notice the following points:

1. The RF-EB supports frequencies of 315 MHz, 433.92 MHz, 868.35 MHz and 915 MHz, when the frequency is changed from one to the other, the matching network of the evaluation modules should be changed accordingly.
2. To allow successfully transmission between the Tx and the Rx, the frame format of the Rx evaluation module must be set identical to that of the Tx evaluation module, see Table 6 for the frame format definition.

Table 6. Frame Structure

Field	Number of Bytes	Descriptions	Default Value
ID	1	This is the synchronization ID. The content is from 0 to 9.	5
Length	1	This indicates the length of the payload to be transmitted or received. The content is from 1 to 32.	10
Payload	Indicated by Length	The data to be transmitted or received. The content is 0x(00+55) 0x(01+55) 0x(02+55) … (Length – 2 + 0x55) (Length – 1 + 0x55).	-
Note:			
Example: if ID = **8**, n = **10**, the frame content is: **0x08 0x0A** 0x55 0x56 … 0x5D 0x5E.			

3. The Packet Error Rate (PER) can be impacted by:

- The matching network of the Tx and Rx evaluation module.
- The symbol rate. The Rx and the Tx symbol rate must be identical.
- The number of bytes contained in the frame. The shorter the frame is, the lower PER is achieved.

6. USB Programmer

The USB Programmer is the programming tool for the user to program the configuration into the CMOSTEK NextGenRF™ products with the RFPDK. The evaluation modules should be connected to the PC through the USB Programmer. There are 3 LEDs on the USB Programmer to indicate its working status.

6.1 EM-Connector

The EM-Connector on the USB Programmer is 10-pin, 2.54 mm female connector as shown below.
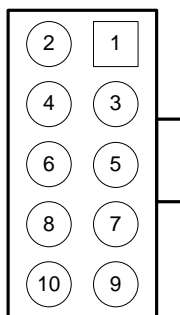

Figure 7. EM-Connector

Table 7. Pin Descriptions of EM-Connector

Pin Number	Pin Functions	
	CMT211xA	**CMT221xA**
1	Reserved	CSB
2	GND	GND
3	Reserved	Reserved
4	VDD	VDD
5	CLK	SCL
6	Reserved	Reserved
7	DATA	SDA
8	Reserved	Reserved
9	Reserved	Reserved
10	Reserved	Reserved

6.2 LED Indicators

The USB Programmer has 3 LED indicators to indicate 3 working status of the programmer, which are shown in Figure 8. See Table 8 for the descriptions of the LEDs.


Figure 8. LED Indicators on the USB Programmer

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Table 8. LED Indicators on the USB Programmer

Name	Descriptions	Color
Run	Flashes when there are valid connections between the PC and USB Programmer. Turned on when the evaluation modules is being programmed.	Green
Err	Turned on for 5 seconds when the programming has failed.	Red
USB	Turned on when the USB is correctly connected to the PC.	Green

6.3 USB Socket

The USB Programmer contains a type-B USB socket. A type-A to type-B USB cable is provided in the Development Kits for the user to connect the USB Programmer to the PC. The USB socket has two functions:

■ Obtain power from the PC to supply the USB Programmer.
■ Communicate to the RFPDK installed on the PC.
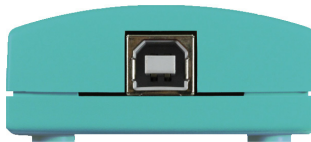
Figure 9. USB Socket

7. RFPDK

RFPDK (RF Products Development Kit) is a member of the CMT211xA/221xA One-Way RF Link Development Kits supporting the development and manufacturing with CMOSTEK NextGenRF™ products. It is a PC application runs on Windows 2000, XP, 7 and 8. It works with the USB Programmer to configure the CMOSTEK NextGenRF™ products.

7.1   Installation Steps

Important Note: Before installing this software, local administration rights must be obtained from your network administrator.

Double click the RFPDK setup icon in the CDROM to install the RFPDK onto the computer.

Figure 10. RFPDK Setup Icon

7.2   Starting the RFPDK

The RFPDK can be started by double-clicking the RFPDK icon on the PC Desktop, as shown in Figure 11 below. For Windows 2000, XP and 7, the user can also start the RFPDK from the Microsoft Windows® Start button by clicking Start → All Programs → CMOSTEK → RFPDK → CMOSTEK RFPDK V1.32.

Figure 11. Starting RFPDK from PC Desktop

Once the program has started, the device selection panel of the RFPDK appears as shown in Figure 12. The user can use the two tabs at the top of the panel to choose the product family: either devices operating in the 2.4 GHz frequency band or the sub-1 GHz frequency band. Under each tab, all the products belong to the family are listed in the middle of the panel. The products can be filtered by the buttons of All, Transmitters, Receivers and Transceivers. The main features of the products, including Device, Function, Band, Package, Modem and Symbol Rate, are shown to assist the device selection.

If an evaluation module is connected to the PC through the USB Programmer, the device part number, USB Programmer hardware version and firmware revision will appear in the "List of connected device".

The rest part of this chapter takes configuring the CMT2110A-EM with the RFPDK as an example unless otherwise noted.
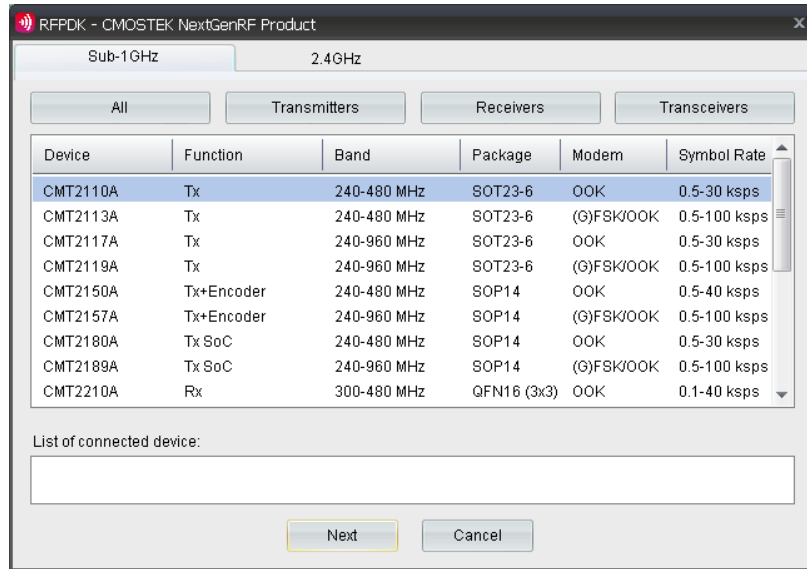
Figure 12. Device Selection Panel

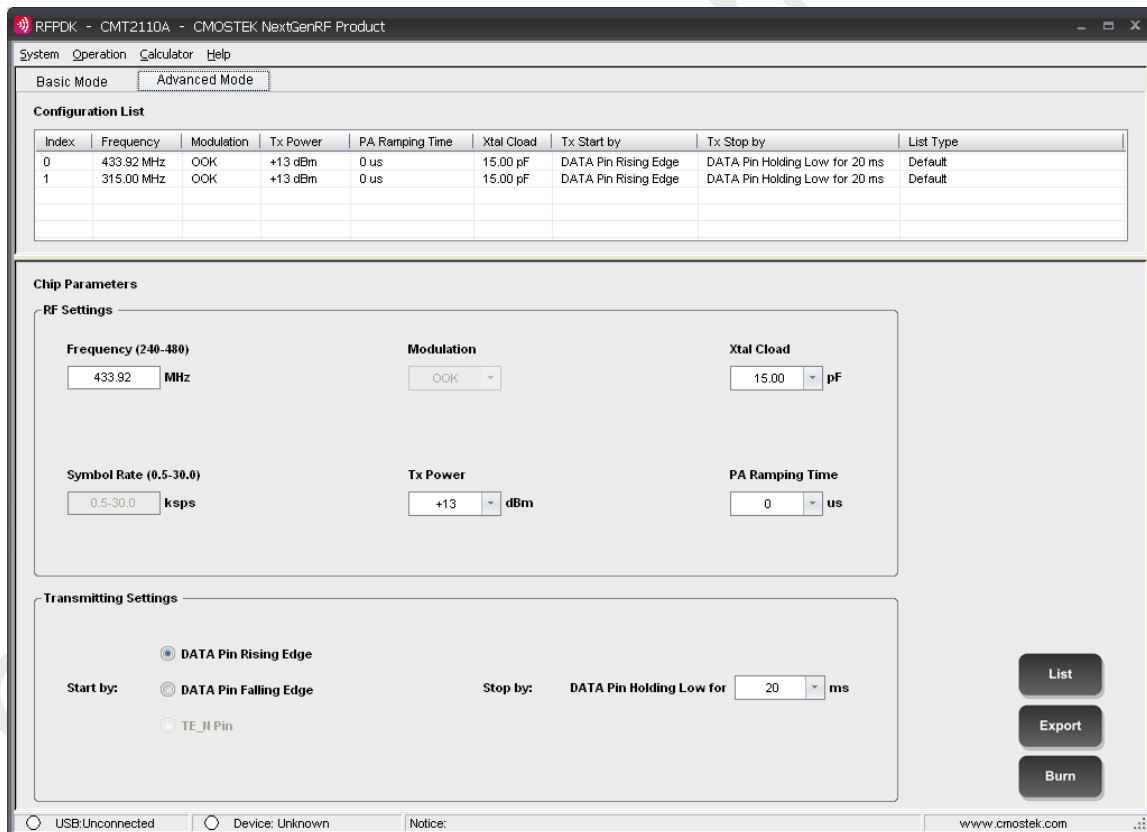Select the proper device, and then click "Next", the Device Control Panel appears as below.

Figure 13. Device Control Panel

7.3   Device Control Panel

7.3.1 Basic Mode and Advanced Mode

The RFPDK has two configuration modes: Basic Mode and Advanced Mode.

■   **Basic Mode**

A few fundamental settings of the selected device are available for the users to easily get started with their design.

■   **Advanced Mode**

All settings of the selected device are available for the users to configure the device more flexibly.

The details of each feature/setting are described in configuration guidelines of each product, as shown in Table 2.

In both Basic and Advanced modes, default configurations can be loaded for direct use, or as a starting point to further customize the chip in the differentiating RF systems.

7.3.2 Configuration List and Chip Parameters

The control panel contains a Configuration List area and a Chip Parameters area.

■   **Configuration List**

It lets the users to select predefined chip configuration from the list, including the default configurations provided by CMOSTEK or the customized configurations save by the user. For the non-default configurations, the user can add notes to the "List Type" column by double-clicking the cell, as shown in the below figure.

Configuration List

Index	Frequency	Modulation	Tx Power	Xtal Cload	List Type	
0	433.92 MHz	OOK	+10 dBm	15.00 pF	Default	
1	315 MHz	OOK	+10 dBm	15.00 pF	Default	
2	315 MHz	OOK	+12 dBm	15.00 pF	2014-05-16 16:08:40, the user can add note here	
3	316 MHz	OOK	+12 dBm	15.00 pF	2014-05-16 16:08:46	

Figure 14. Add Note to User-saved Configurations

■   **Chip Parameters**

This area contains the parameters to configure the device.

7.3.3 List, Export and Burn

Saving the configurations, generating the EEPROM image file for manufacturing and programming the configuration to the device can be done by pressing the List, Export and Burn buttons on the panel, respectively.

■   **List**

The users can click the List button to save a new configuration to the "Configuration List".

■   **Export**

The user can click the Export button to export the current configurations to an EEPROM image file suffixed by ".exp". The file can be loaded by the manufacturing programmer in mass production phase to program the CMOSTEK NextGenRF™ products.

■   **Burn**

Once all the parameters are properly set and all the hardware are correctly connected, the user can click the Burn button to program the configuration to the chip. A message will pop out to confirm whether the programming is done

successfully or not. If the programming is failed, the users should double check the setup and try again.

7.3.4 Status and Notice

Status information and Notice information is shown at the bottom of the Control Panel.

■ **Status**

It indicates whether the USB Programmer and the device are properly connected to the PC or not. Table 7 shows the details.

Table 9. Status Information in Control Panel

Status	Descriptions
🟢 USB: Connected	The USB Programmer is properly connected to the PC.
🔴 USB: Unconnected	The USB Programmer is unconnected or improperly connected to the PC.
🟢 Device: CMT2110A	The device is properly connected to the USB Programmer.
🔴 Device: Unknown	The device is unconnected or improperly connected to the USB Programmer, or the device is connected but the USB Programmer is in "Unconnected" status.
🔴 Device: CMT2110A	The device plugged in is different from that selected in the Device Selection Panel. The part number of the plugged device will be displayed. The Burn button is disabled in this case.

■ **Notice**

It indicates the process and the results of the Burn action, as shown in Table 8 below:

Table 10. Notice Information in Control Panel

Notice	Descriptions
Notice: Burning parameters to the device, please wait…	The RFPDK is executing the Burn action.
Notice: Burning is done successfully.	The Burn action is completed successfully.
Notice: Burning failed. Please check the setup and try again.	The Burn action is failed and stopped. The users should check the setup and try again.

7.4 Burn Log

After each burning, the log information of the burning is recorded automatically by the RFPDK into the Burn Log. The maximum number of recorded lines is limited to 1000. The old information is over-written by the new ones. The user can open the Burn Log by selecting Operation → Open Log. A Burn Log example is shown below:
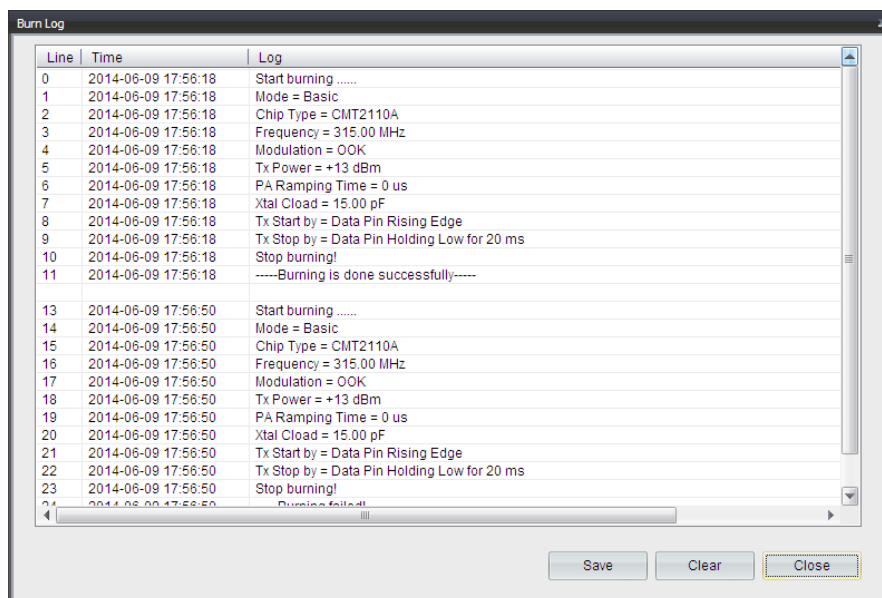
Figure 15. Burn Log

The user can save the Burn Log to a text file by pressing the Save button. This text file is one of the necessary materials to send back to CMOSTEK when the user asks for any technical support.

7.5 Import & Burn

If the .exp file is already available, the user can use the Import & Burn feature (Operation □ Import & Burn) to burn the configuration file to its corresponding device. As shown in the figure below.

Figure 16. Import & Burn

Click the "Open File" button, select the .exp file, and click "Burn" button to continuously burn the configuration file to the devices. For higher efficient manufacturing burning, the user can use the Off-line Writer, please refer to "AN140 CMOSTEK Writer Manual" for more details

7.6 Calculator

For CMT225xA, A calculator tool is available for the user to calculator the time related parameters, such as Rx Time, Sleep Time and etc, as shown in the figure below.

Figure 17. Calculator for CMT225xA

7.7 RSSI Scan

For Rx products, the RSSI Scan feature is available on the upper-right corner of the RFPDK Device Control Panel. With it being selected, a screen pops out as below, it can help the user to quickly evaluate the current signal strength received by the device.
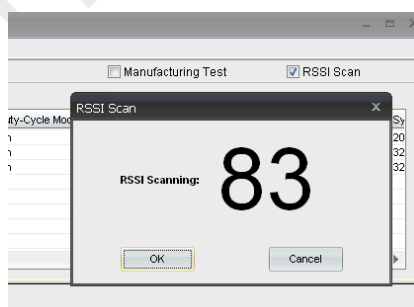

Figure 18. RSSI Scan

8. Frequently Asked Questions

Q1. Why do I not see any response from the PC when I plug the USB cable of the USB Programmer to the PC?
A1. Please try the following steps to resolve the problem:

1. Make sure the USB port is functioning well.
2. Make sure the USB connection is solid by checking if the "USB" LED on the USB Programmer is on.
3. Try another USB port on the PC.

If the problem still exists, please contact CMOSTEK for further support.

Q2. I plugged out the USB cable while the USB Programmer is running. After that, why can I not use any USB device on the PC anymore?
A2. It is commonly seen that such unexpected error might happen to the USB system if the user plugs out the USB device during any data communication. CMOSTEK recommends the user to close the RFPDK before plugging out the USB Programmer, and then reboot the PC to resolve this problem.

Q3. Can I install the RFPDK on a PC on which I don't have administration right?
A3. CMOSTEK recommends the user to obtain the administration right before installing the RFPDK.

Q4. Can the RFDPK and the USB Programmer support all CMOSTEK RF products?
A4. The current version of RFPDK and USB Programmer supports the existing RF products. In the future, CMOSTEK will update the RFPDK and USB Programmer firmware to support the new products. The user can visit www.cmostek.com for the latest version of the RFPDK and contact CMOSTEK to upgrade your USB Programmer.

Q5. Why can I not install the USB Programmer driver on the PC?
A5. Please try the following steps to resolve this problem:

1) Make sure the USB port is functioning well.
2) Plug out the USB cable, close the RFPDK application, and try to plug in the USB cable again.

If the problem still exists, please contact CMOSTEK for further support.

9. Document Change List

Table 11. Document Change List

Rev. No	Chapter	Description of Changes	Date
0.9		Initial version	2014-06-14
1.0	7	Add Section 7.5	2014-06-30
1.1	All 7	Change to cover CMT211xA and CMT221xA products Add Section 7.6 and 7.7	2015-6-17

10. Appendix: CMT211xA-EM and CMT221xA-EM Schematics

Take CMT2110A-EM and CMT2210A-EM as examples, the CMT2x13/17/19A are pin-2-pin replaceable to the CMT2x10A.
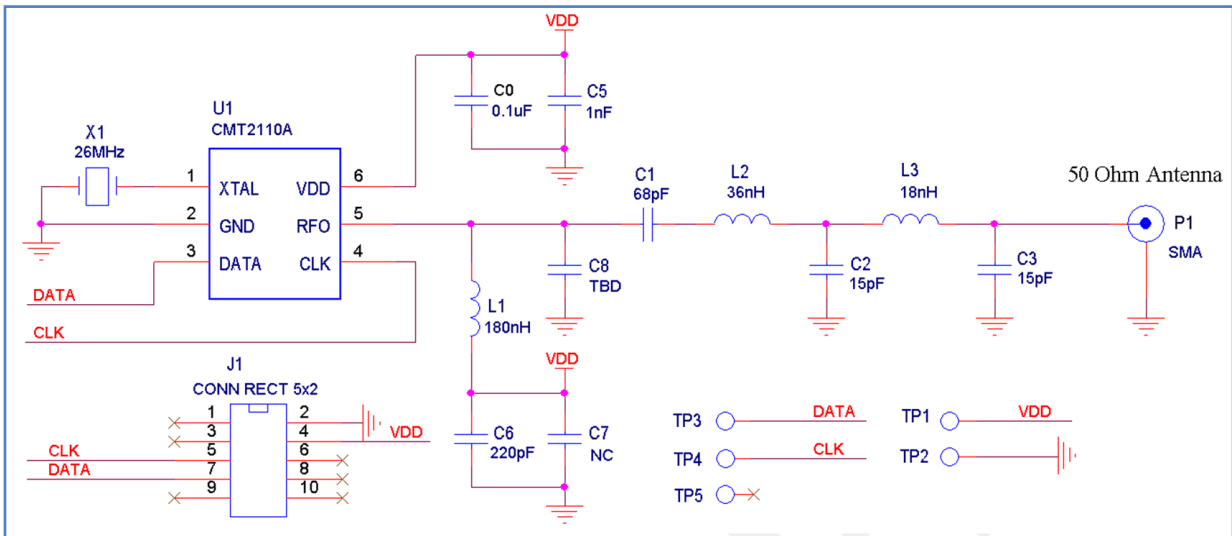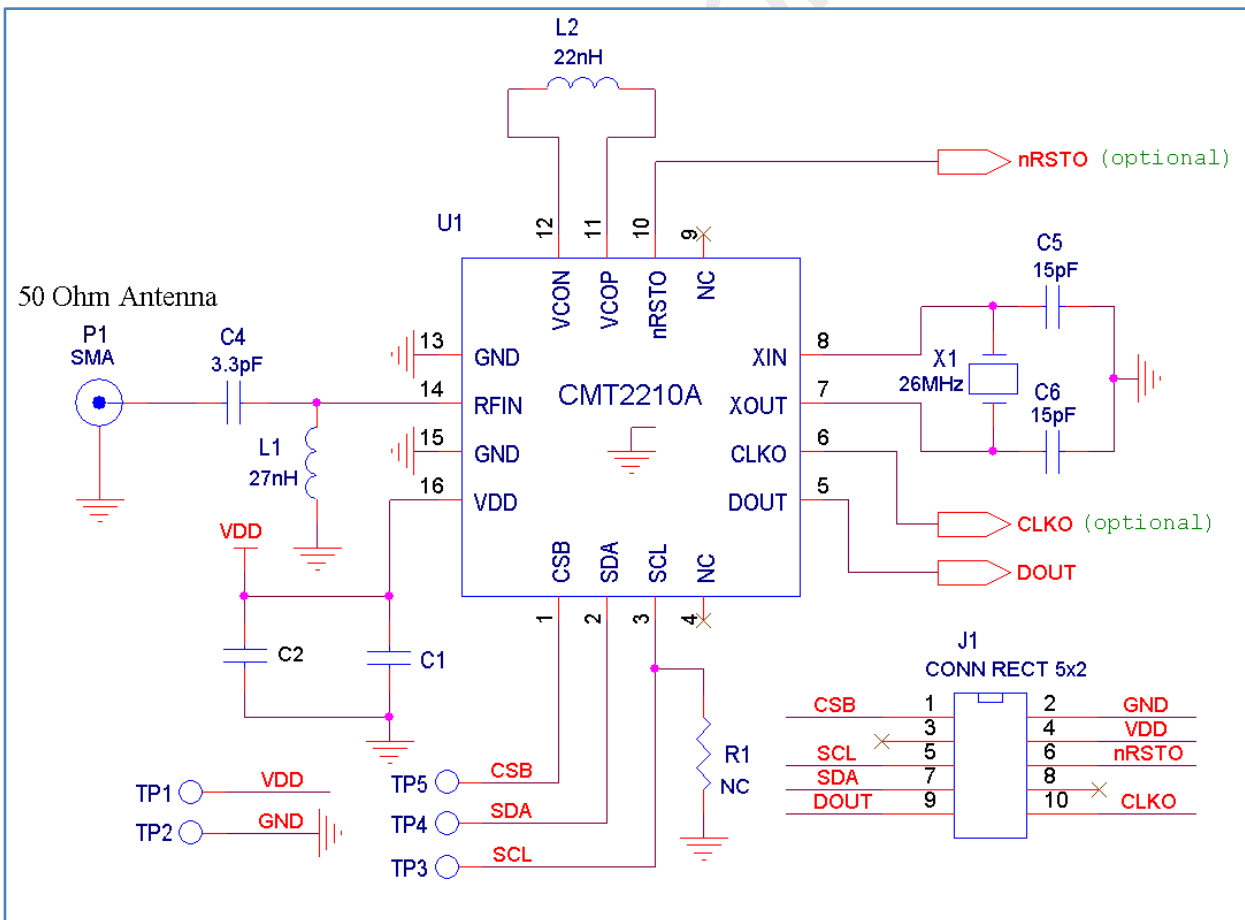
Figure 19. 433.92 MHz CMT2110A-EM Schematic

Figure 20. 433.92 MHz CMT2210A-EM Schematic