

**User Manual**  
Rev 3.5  
**SmartRF® Studio 4.50**



**SmartRF®**

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# 1 Introduction

This user manual describes how to use SmartRF® Studio 4.50. This software is developed by Chipcon to the courtesy of our customers.

This software is made to configure the RFICs on the Evaluation Board for the CC400, CC900, CC1000 , CC1050, CC1010 and CC1020. By giving out this software the designers of radio systems can easily evaluate the RFICs at an early stage in the design-process. It is further a useful tool during the generation of the configuration data and for finding optimised external component values.

It is also a helpful tool to get to know the RFICs from Chipcon.

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## General information:

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*SmartRF*® is a registered trademark of Chipcon AS. SmartRF is Chipcon's RF technology platform with RF library cells, modules and design expertise. Based on SmartRF Chipcon develops standard component RF-circuits as well as full custom ASICs based on customers' requirements.

## 2 Installation

### 2.1 Before starting

The SmartRF® Studio software runs on Win95/Win98/WinNT/Win2000 and is used for generating the configuration data for the CC400, CC900, CC1000, CC1050, CC1010 and CC1020 RFICs, connected to the evaluation board through the PC parallel port.

The software is enclosed on a Chipcon CD-ROM. Make sure that this SmartRF® Studio version is the newest version available. If not, download the latest version from Chipcon's website.

### 2.2 System requirements

The following table describes the system requirements for SmartRF® Studio.

Category	Requirement
Hardware	IBM compatible PC, 486-based microprocessor or higher, CD-ROM driver, parallel port.
Memory	16-MB RAM minimum.
Operating system	Win 32 platform, i.e. Windows 95, 98, 2000 or NT.

### 2.3 Installing the program

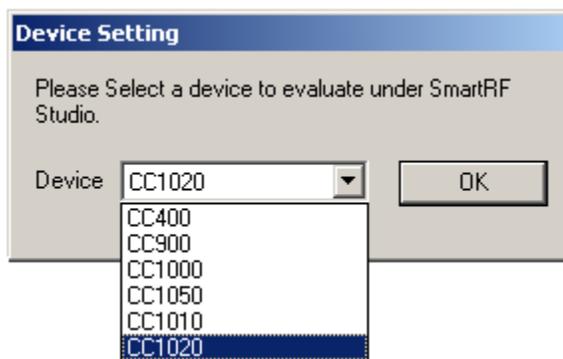
1. Insert the Chipcon CD-ROM into your computer.
2. At an MS-DOS command prompt or with Windows Explorer, copy all files to a destination folder on your computer

The CD-ROM contains a readme.txt file and a folder named SmartRF in the SmartRF Studio folder. Please read the readme.txt file before starting the program. Files included in the software package are named SmartRF\_Studio\_4\_50.exe, ccport.dll, SmartRF\_adapter.hex located in the SmartRF folder. The ccport.dll file gives access to the parallel port in Windows NT and Windows 2000, and must be in the same directory as the SmartRF\_Studio\_4\_50.exe file or in the windows system directory.

### 3 Overview of SmartRF® Studio

#### 3.1 Starting Smart RF Studio

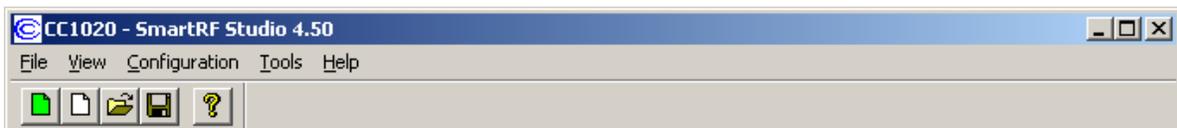
When starting the program a start-up splash-bitmap first appears. This gives the user information of the version of SmartRF® Studio. Be sure you have the latest version available. The splash disappears on any key stroke or after 10 seconds. Then a new dialog-box appears, forcing the user to select a device to work with. This dialog box is given below.



As can be seen, the user can choose between The CC400, CC900, CC1000, CC1050, CC1010 and CC1020. To activate the desired RFIC, click on OK or push Enter, when the device is selected in the combo-box.

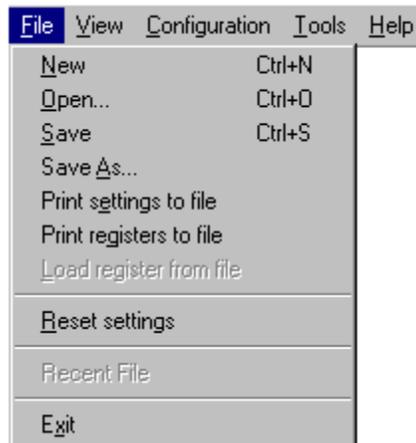
#### 3.2 SmartRF® Studio pull-down menus

SmartRF® Studio simplifies access to its features through the use of pull-down menus. The SmartRF® Studio menus are shown below.



### 3.2.1 File

The **File** menu contains items that create files and set up printing options.



**New** allows you to create a new SRF-file and set default settings.

**Open...** displays a file selection dialog box that asks you for the name of an SRF-file and opens it.

**Save** saves all the entered system parameters in the current SRF-file.

**Save As...** displays a file selection dialog box that asks you for the name of an SRF-file in which to save the entered system parameters.

**Print setting to file** displays a dialog box that enable you to save the entered system parameters together with the calculated component values in a TXT-file.

**Print registers to file** displays a dialog box that enable you to save the register values to a \*.txt file in Normal View and \*.eep file in Register View. In Normal View the values will be shown in hexadecimal code for all possible modes available for the selected transceiver, for easy inclusion in micro-controller code. In Register View this selection displays a dialog box that enable you to dump the present register values to a file. This is useful if the register settings are different from the default values given in the Normal View.

**Load registers from file** displays a dialog box that enables you to open the register values from a previous generated \*.eep file. This option is only activate in Register View

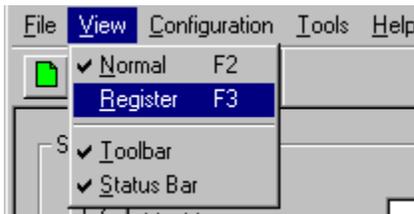
**Reset settings** will set the system parameters to default and update the configuration registers.

**Exit** quits SmartRF® Studio.

Note: When in 'Register' window only the **Exit**, **Print register to file** and **Load registers from file** entries will be available.

### 3.2.2 View

The **view** menu allows you to set Window options.



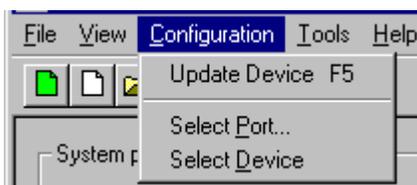
**Normal** shows you the system parameter entry screen.

**Register** shows you the configuration register screen.

**Toolbar** displays the SmartRF® Studio toolbar when selected.

**Status Bar** displays helpful tips at the bottom of the window when you hold the mouse pointer over a feature.

### 3.2.3 Configuration



The configuration menu allows you to change port address or device, and download the data to the device.

**Update Device** downloads the chosen settings to the transceiver device via the parallel port at the back of your computer.

**Select Port...** displays a window in which you can choose between different I/O addresses for the parallel port ('0x278', '0x378' or '0x3cb'). The default address is '0x378'. A 'Set as default' button makes the program store the new default value.

You can find the address in Windows NT by choosing 'Windows NT Diagnostics' under 'Administrative Tools' in the Windows 'Start Menu', and choose 'Resources' and 'I/O ports'. If you have more than one parallel port, contact your local IT manager.

**Select Device** displays the window that pops-up in the start of the program. Here you can change the device to evaluate. This selection is only active in Normal View.

### 3.2.4 Tools



The Tool menus have an option to select **programming**. This is a small program that let you program the CC400 and CC900 Demonstration Board. For more information on how this program works see chapter 6.1.

### 3.2.5 Help



The help menu provides access to useful information about the product.

**Help Topics** brings up a message box stating where you can find further help.

**About SmartRF® Studio** brings up a message box with the software revision and copyright information.

**Contact Chipcon** brings up a message box where you can find Chipcon contact information and links to our web-site and mail.

## 3.3 The SmartRF® Studio toolbar

In addition to the pull-down menus, the toolbar provides you with simplified access to useful SmartRF® Studio and Windows features:

Icon	Name	Description
	<i>Reset settings</i>	Sets the system parameters to default and updates the configuration registers.
	<i>New</i>	Allows you to create a new SRF-file.
	<i>Open</i>	Displays a file selection dialog box that asks you for the name of an SRF-file and opens it.
	<i>Save</i>	Saves all the entered system parameters in the current SRF-file.
	<i>Help topics</i>	Brings up a message box stating where you can find further help.

### 3.4 The status information

You will find status information at the bottom of the program window. This is shown in the figure below.



The user can observe the current consumption of the transceiver in the different settings in the Normal View. SmartRF® Studio also monitors the lock pin of the transceiver.

The Update device button downloads the chosen settings to the transceiver device via the parallel port (F5 can be used as a shortcut).

The bitmap of Chipcon is a link to the Chipcon homepage. By clicking on this picture, your default browser goes to our website, where you can find more information about our RF transceivers and us.

At the bottom of the window, there is a status bar, which provides hints about the various features in the program.

## 4 Descriptions of the different Views for CC400/CC900

When CC400/CC900 is used, the program has two configuration views. The parameter entry screen is the default window and can be chosen by pressing **F2** or selecting **Normal** from the **View** menu. In this window you can change the system parameters, get status information and component values.

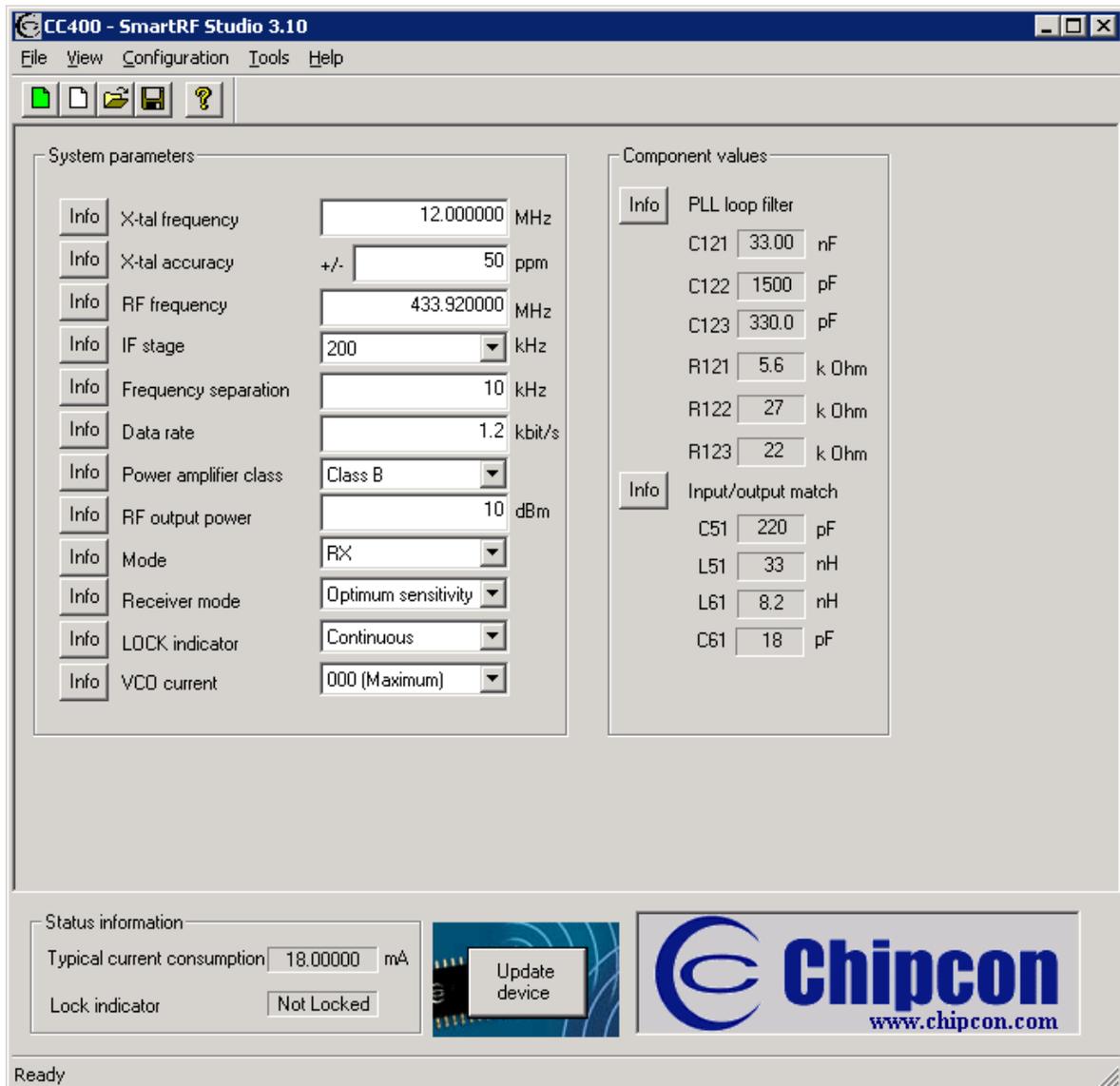
The other configuration window is the “register” configuration, which is selected by pressing **F3** or selecting **Register** from the **View** menu. It gives you the possibility to change the bits in the configuration registers directly. This window is mainly used to give additional information and we dissuade you to change the bits.

To send the configuration data to the transceiver chip, press **F5** or select **Update Device** from the **Configuration** menu or press the **Update device** button at the bottom of the screen.

Note: When pressing **Enter** the parameters will be checked and component values will be calculated, but the transceiver will not be programmed until **Update device** is activated.

## 4.1 The Normal configuration window for CC400/CC900

When you have chosen the Normal configuration window, the SmartRF® Studio appears as shown in the picture below.



You can get information about the different parameters by clicking on the **info** button to the left of the parameter. In addition to this, a tool-tip message appears when you move the mouse over a feature.

After you have changed some or all of the parameters, the external component values are calculated after pressing **Enter** or **Update device**. Component values for the Phase Lock Loop (PLL) filter and the input/output match to the antenna are shown to the right of the window. The values are given to you in terms of the standard E12-series. When you have changed the default parameter settings, use these values on the new external components. The component reference numbers refer to the application circuit shown in the datasheet.

Using the specified component values for the PLL loop filter will give an optimum loop bandwidth for the selected system parameters. If you need a faster PLL settling time, i.e. a larger loop bandwidth, the data rate can be set to a higher value and the corresponding component values can be used.

Using the specified component values for the input/output match will give an optimum match at the specified operating frequency. Minor tuning of the component values may be necessary to compensate for layout parasitics.

#### **4.1.1 System parameters**

This chapter describes the different parameters and the options you have when changing them. The default parameter list is given at the end of the chapter. For detailed information on parameter setting of CC400 and CC900 see Application note AN005.

##### **4.1.1.1 X-tal frequency**

The crystal frequency of your Development Kit evaluation board is 12.000000 MHz. Do not change the X-tal frequency parameter when using this module unless the crystal is being replaced. If you are using this program to generate configuration data for your special application, use a crystal frequency between 4.000 and 13.100 MHz and replace the crystal on the printed circuit board. The crystal should be designed for 12pF load capacitance. The frequency value is rounded to 6 digits after the MHz decimal point, i.e. 12.000000 MHz.

##### **4.1.1.2 X-tal accuracy**

Enter the total crystal accuracy between 0 and 500 ppm, including initial tolerance, temperature stability, loading and ageing. If you are using a trimming capacitor to adjust the crystal oscillator, the initial tolerance will be zero. The crystal accuracy is very important for narrow-band applications (i.e. 25 kHz-channel separation). For applications using wider bands crystal accuracy is not that important. The crystal stability has an influence on the minimum possible IF filter bandwidth and the maximum frequency separation that can be used. For highest possible sensitivity it is an advantage to use a crystal with high frequency accuracy (<20 ppm). For low cost applications, however, this can be a trade-off. The default value is 30 ppm.

### 4.1.1.3 RF frequency

The CC900 can operate at frequencies between 800 and 1000 MHz. The Development Kit evaluation board is optimised for operation in the ISM band at 868-870 MHz. However, it is possible to use the evaluation board for frequencies between approximately 850 and 910 MHz restricted by the VCO tank tuning range.

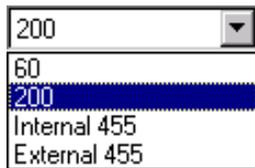
The CC400 can operate at frequencies between 300 and 500 MHz in 250 Hz steps. The Development Kit evaluation board is optimised for operation in the ISM band at 433.920 MHz. However, it is possible to use the evaluation board for frequencies between approximately 400 and 460 MHz restricted by the VCO tank tuning range.

Choosing frequencies outside this range will not work for this evaluation board and should only be done for generation of configuration data to be used in other applications.

Note: Depending on the crystal frequency, some RF frequencies are not allowed and an error message will pop up.

### 4.1.1.4 IF stage

For the CC900 and the CC400 there are four possible choices of IF-stage frequency: 60, 200, 455 kHz internal filter, or 455 kHz using an external ceramic filter. The default value is 200 kHz. The IF frequency is selected from a pull down menu.



The best sensitivity is obtained using the internal 60 kHz IF-filter and offers a cost optimised solution. If the operating temperature range shall be large, a relative stable reference crystal may be required when using the 60 kHz internal IF-filter. Optionally the initial crystal accuracy can be tuned using a trimming capacitor.

Using the 200 kHz internal IF-filter gives a very low cost solution that does not require a very stable crystal or a tuning capacitor. This is however obtained at the expense of lower sensitivity.

The best selectivity is obtained with an external 455 kHz ceramic filter, but at the cost of lower sensitivity. However, this can increase the cost of your system due to the external ceramic filter cost, and because of the narrow bandwidth of the external filter (typically 30 kHz) which requires a reference crystal with high accuracy ( $<\pm 10-20$  ppm). Note: When selecting the external 455 kHz filter, the user must ensure that the crystal accuracy together with the signal bandwidth (depend

on data rate and deviation) stays inside the filter bandwidth. The total occupied signal bandwidth can be approximated by Carson's rule:  $BW = \Delta f + 2 f_m$  where  $f_m$  is the modulation frequency. Using Manchester coding the modulation frequency (in kHz) will be equal to the bit rate (in kbit/s). A message-box opens when selecting 455 external filter. This messagebox can be useful to calculate the bandwidth of the filter according to Carson's rule and the crystal accuracy.

#### 4.1.1.5 Frequency separation

The frequency separation,  $\Delta f$ , is the difference between the frequency transmitted for a '0' ( $f_0$ ) and a '1' ( $f_1$ ). That is,  $f_0 = f_c - \Delta f/2$  and  $f_1 = f_c + \Delta f/2$  where  $f_c$  is the carrier frequency entered in the 'RF frequency' field.

The frequency separation can be adjusted between 1 and 200 kHz in 1 kHz steps. The default value is 20 kHz.

Depending on the chosen IF stage the recommended frequency separation is

5 - 40 kHz for IF = 60 kHz,

10 - 100 kHz for IF = 200 kHz.

5 - 20 kHz for IF = 455 kHz with external filter

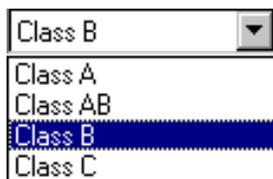
The sensitivity depends slightly on frequency separation.

#### 4.1.1.6 Data rate

The data rate can be set between 0.3 and 9.6 kbit/s. The default setting is 1.2 kbit/s. The data signal transmitted to the DIO pin must be Manchester encoded. The noise bandwidth of the receiver will be optimised to the selected data rate. Note that the baud rate is twice the bit rate when using Manchester coding.

#### 4.1.1.7 Power amplifier class

You can choose between four possible choices of PA-class: 'Class A', 'Class AB', 'Class B' and 'Class C'. The default choice is 'Class C'. The different classes are selected from a pull-down menu.



The selection of power amplifier operation class is a trade-off between output power, efficiency and harmonic generation. In class A or AB the amplifier is working more linear, and the harmonics will be low. However, the efficiency and the output power will also be low. For increased output power and efficiency, class B or C should be used, with the cost of somewhat higher harmonics.

#### 4.1.1.8 RF output power

For the CC900 case, the output RF power can be set in 1 dB steps between -20 and up to 4 dBm depending on the PA operating mode.

- Class A: -20 to -12 dBm (not recommended due to low efficiency)
- Class AB: -15 to -5 dBm (recommended -12 to -8 dBm)
- Class B: -8 to 1 dBm (recommended -8 to -3 dBm)
- Class C: -8 to 4 dBm (recommended -8 to 4 dBm)

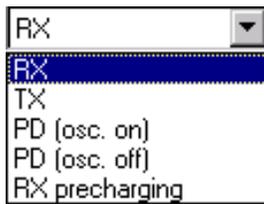
For the CC400 case, the output RF power can be set in 1 dB steps between -5 and up to 14 dBm depending on the PA operating mode.

- Class A: -5 to 0 dBm (not recommended due to low efficiency)
- Class AB: -4 to 6 dBm (recommended -4 to 3 dBm)
- Class B: 0 to 12 dBm (recommended 3 to 12 dBm)
- Class C: 0 to 14 dBm (recommended 12 to 14 dBm)

The default value is 0 dBm for CC900 and 10 dBm for CC400. Power in dBm is  $10 \log(P)$  where P is in mW.

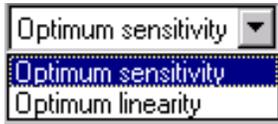
#### 4.1.1.9 Mode

The operation mode can be selected from a pull down menu. The chip can be set in RX (receive), TX (transmit) or PD (power down) mode. In PD you can select between complete power down (osc. off), or power down with the crystal oscillator running (osc. on).



Leaving the crystal oscillator running gives a shorter turn-on time at the expense of higher current consumption in the power down mode. RX precharging can be used to reduce the demodulator turn-on time. Please refer to the data sheet for further information on demodulator precharging. The default value is RX.

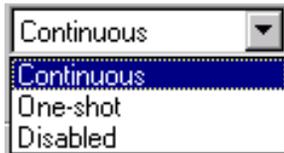
#### 4.1.1.10 Receiver mode



The receiver mode can be selected from a pull down menu. The receiver can be configured for optimum sensitivity (low noise figure) or optimum linearity (high input intercept point). When inter-modulation due to several transmitters in the same area is expected to be a problem, choose the optimum linearity option. Choose optimum sensitivity when maximum range is needed. The default value is optimum sensitivity.

#### 4.1.1.11 LOCK indicator

The synthesiser PLL lock indicator can be set in one of three modes: 'Continuous', 'One-shot' or 'Disabled' using the pull down window. Choosing 'Continuous' the lock indicator will monitor the PLL lock continuously also after an initial lock has occurred. Choosing the 'One-shot' mode the lock pin will stay high after an initial lock has occurred, even if the PLL occasionally should fall out of lock. If 'Disabled' is selected, the lock signal will be active regardless of the PLL status. The default value is 'Continuous'.



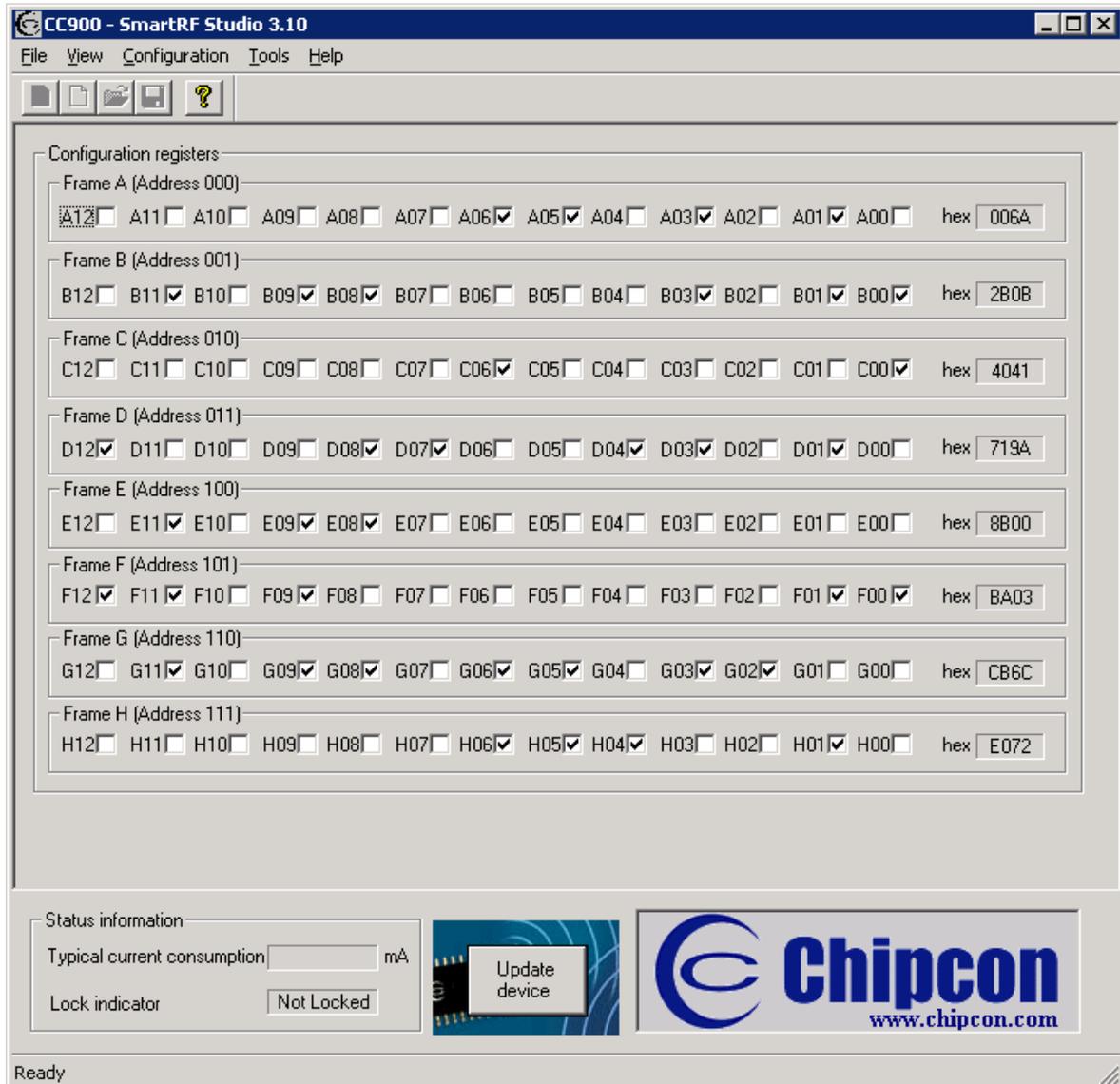
Important: The 'One-shot' lock signal is used internally in the CC900 to enable the transmitter. If the lock signal is not active (high) the transmitter will not be enabled. This is done in order to avoid the transmitter to emit out-of-band signals. If 'Disabled' is chosen this function is overridden and care should be taken, as the transmitter will transmit even when the PLL is not in lock.

#### 4.1.1.12 VCO current

The VCO current can be set in 8 steps; '000' being the maximum and '111' being the minimum. The VCO current can be adjusted in order to check the gain margin of the VCO. Reducing the VCO current will decrease the amplitude of the VCO signal, and eventually the oscillator will cease to oscillate. In receive mode the LO leakage can be reduced by reducing the current, and hence the amplitude. However, the current should always be minimum two steps above where the oscillator stops, in order to have some start-up margin.

## 4.2 The register configuration window for CC400/CC900

When you have chosen the register configuration window, the SmartRF® Studio will look like the picture below.



In this mode you can change the 13 different bits in the 8 registers directly by clicking on the white squares. These bits are used to program the transceiver chip on the printed circuit board (PCB) that follows Development Kit. We dissuade you to change the bits without contacting our company first.

When changing the values and pressing **Enter** in the Normal configuration window described in chapter 4.1, the frames will change automatically. At the right side of the window, you can see the hex codes used to configure the transceiver. Here is the 3 bit address added to the 13 bit data-frames, giving the hex-value of the 16-bit frame normally stored in an micro-controller.

## 5 Descriptions of the different Views for CC1000

The CC1000 has two configuration views. The parameter entry screen is the default window and can be chosen by pressing **F2** or selecting **Normal** from the **View** menu. In this window you can change the system parameters, get status information and component values.

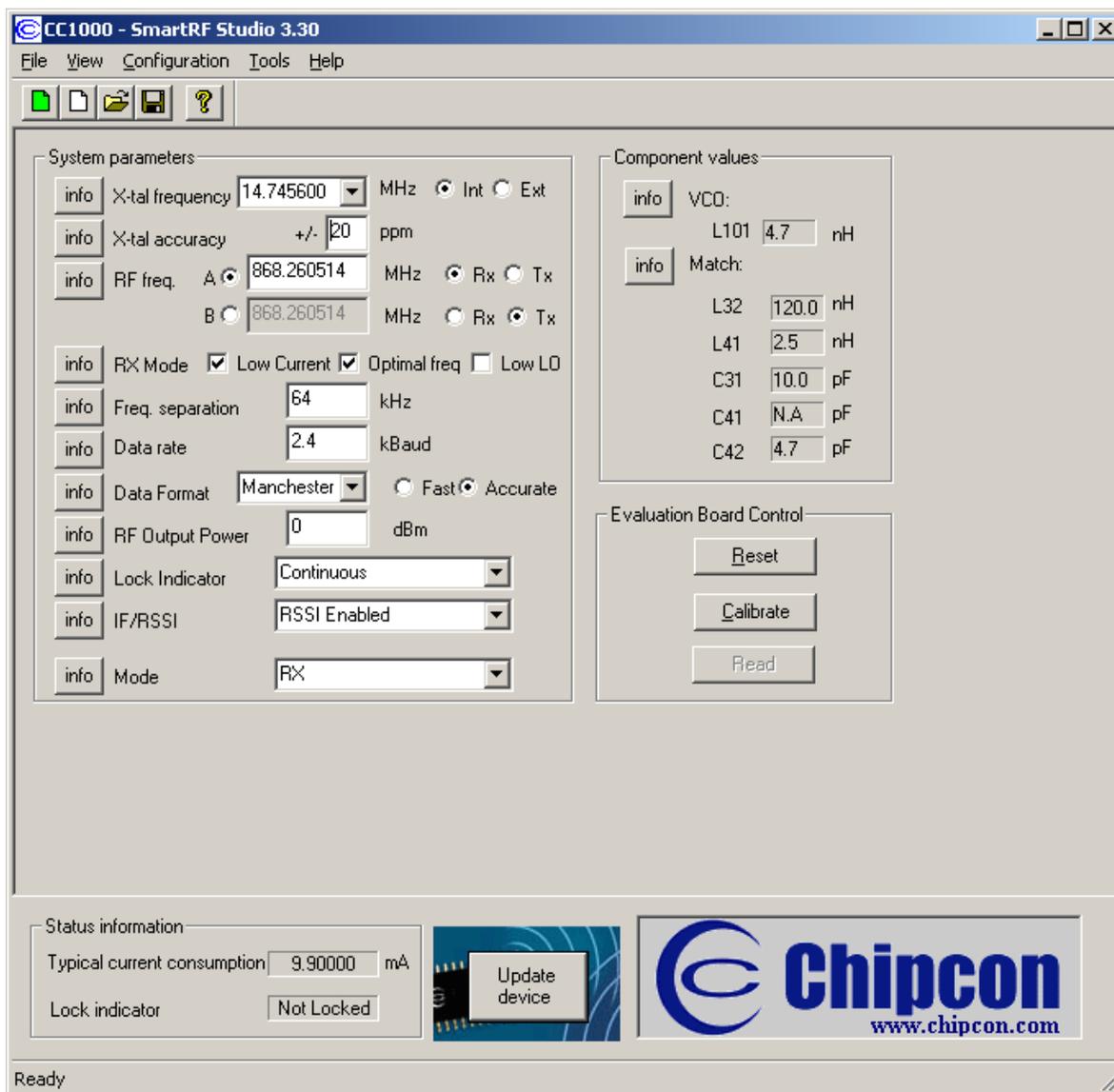
The other configuration window is the “register” configuration, which is selected by pressing **F3** or selecting **Register** from the **View** menu. It gives you the possibility to change the bits in the configuration registers directly. This window is mainly used to give additional information and we dissuade you to change the bits.

To send the configuration data to the transceiver chip, press **F5** or select **Update Device** from the **Configuration** menu or press the **Update device** button at the bottom of the screen.

Note: When pressing **Enter** the parameters will be checked and component values will be calculated, but the transceiver will not be programmed until **Update device** is activated.

## 5.1 The Normal configuration window for CC1000

When you have chosen the Normal configuration window, SmartRF® Studio appears like the picture below.



You can get information about the different parameters by clicking on the **info** button to the left of the parameter.

After you have changed some or all of the parameters, the external component values are calculated after pressing **Enter** or **Update device**. Component values for the input/output match to the antenna and the VCO Inductor are shown to the right of the window. The values are given to you in terms of the standard E12-

series. When you have changed the default parameter settings, use these values for the new external components. The component reference numbers refer to the application circuit shown in the datasheet.

Using the specified component values for the input/output match will give an optimum match at the specified operating frequency. Minor tuning of the component values may be necessary to compensate for layout parasitics.

### 5.1.1 System parameters

This chapter describes the different parameters and the options you have when changing them.

#### 5.1.1.1 Crystal frequency

The crystal frequency of your Development Kit evaluation board is 14.7456 MHz. Do not change the X-tal frequency parameter when using this module unless the crystal is being replaced. If you are using this program to generate configuration data for your special application, use a crystal frequency between:

- 3 – 4 MHz
- 6 – 8 MHz
- 9 – 16 MHz

Recommended frequencies are 3.6864, 7.3728, 11.0592 and 14.7456 MHz giving exact data rates. The recommended frequencies can be selected in the drop-down list. The frequency value is rounded to 6 digits after the MHz decimal point, i.e. 11.059200 MHz.



You can also choose to use an external crystal reference oscillator by selecting 'External' in the radio button.

The crystal frequency must be higher than 12 MHz in order to use higher data rates than 19.2 kbaud in SmartRF® Studio.

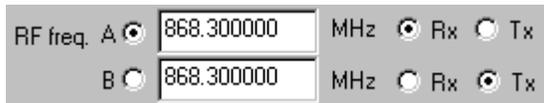
#### 5.1.1.2 Crystal accuracy

Enter the total crystal accuracy between 0 and 500 ppm, including initial tolerance, temperature stability, loading and ageing. If you are using a trimming capacitor to adjust the crystal oscillator, the initial tolerance will be zero. The crystal stability has an influence on the maximum data rate and frequency separation that can be used to stay in the passband of the internal IF filter bandwidth. For highest possible data rate or separation it is an advantage to use a crystal with high frequency accuracy

(<20 ppm). For low cost applications, however, this can be a trade-off. The default value is 20 ppm.

### 5.1.1.3 RF frequency

CC1000 has two separate frequency settings making it possible to select between Frequency A and B. A radio button is used for selecting the active frequency. There is further a radio button on each frequency, which informs the software, whether to calculate RX or TX frequency.



If the active frequency is different from the operation mode (see section 5.1.1.12), error messages will popup informing you to synchronise the active frequency with the operation mode.

The CC1000 can operate at frequencies between 300 and 1000 MHz. The Development Kit evaluation board is optimised for operation in either the ISM band at 868-870 MHz or the ISM band at 433.050 – 434.790 MHz . However, it is possible to use the evaluation board for frequencies outside this ISM band with restriction on the VCO Inductor. Choosing frequencies outside this range will not work for this evaluation board and should only be done for generation of configuration data to be used in other applications.

### 5.1.1.4 RX Mode

In RX mode you can optimise the sensitivity and current consumption.



The CC1000 have some RF frequencies that gives a more optimal sensitivity than others. By selecting the optimal frequency, SmartRF® studio will find the closest RX channel that gives this optimal sensitivity frequency. When optimal frequency is selected, SmartRF® Studio sets the selected RF frequency A to the closest optimal frequency, and forces frequency B to be equal to frequency A. The RF frequency B is disabled in optimal frequency mode.

SmartRF® Studio use low side LO when mixing down to the intermediate frequency in RX mode. When low LO is disabled, this down converting is based on high side LO. The data on DIO in RX mode is inverted using high side LO.

In order to use CC1000 in a battery operation system, it is important to reduce the current consumption in RX mode. By activating the Low Current consumption, the current consumption in RX mode is reduced. The sensitivity will drop 1-2 dB when the low current mode is used.

Default setting is low current and optimal frequency.

#### **5.1.1.5 Frequency separation**

The frequency separation,  $\Delta f$ , is the difference between the frequency transmitted for a '0' ( $f_0$ ) and a '1' ( $f_1$ ). That is,  $f_0 = f_C - \Delta f/2$  and  $f_1 = f_C + \Delta f/2$  where  $f_C$  is the carrier frequency entered in the 'RF frequency' field.

The frequency separation can be adjusted between 0 and 200 kHz in 1kHz steps. The default value is 64 kHz. A warning will pop-up if CC1000 is unable to modulate with the selected separation. The maximum value for the separation depends on the crystal frequency and RF frequency input, and will for all settings be larger than 64 kHz.

#### **5.1.1.6 Data rate**

The data rate can be set between 0.3 and 76.8 kbaud. The default setting is 2.4 kbaud. If synchronous mode and recommended crystal frequencies is selected, SmartRF® Studio will find the closest accurate data rate. If synchronous mode is selected without using recommended crystal frequencies, a warning will pop-up informing you that the data rate will differ from the one given in the Data rate input.

To get a higher data rate than 19.2 kbaud, the crystal frequency must be higher than 12 MHz in SmartRF® Studio. If the selected recommended frequency is 3.6864, 7.3728 or 11.0592 MHz in synchronous mode the maximum data rate is forced down to 19.2 kbaud (a pop-up message will inform the user). For a 14.745600 MHz crystal however the data rate is rounded to the closest accurate data rate up to 76.8 kbaud.

### 5.1.1.7 Data format

The CC1000 can be used with NRZ (Non-Return-to-Zero) data or Manchester (bi-phase-level) encoded data. The UART mode bypasses the on-chip synchronisation feature in CC1000.

The fast and accurate sets the preamble time needed in RX mode, before valid data can be received.



Please see data sheet of CC1000 for details.

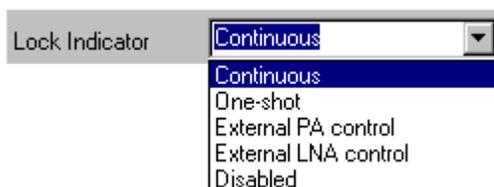
### 5.1.1.8 RF output power

For the CC1000 the output RF power can be set in 1 dB steps between -20 to 10 dBm. For frequencies higher than 500 MHz the upper limit is 5 dBm.

Power in dBm is  $10 \log(P)$  where P is in mW. The default value is 0 dBm.

### 5.1.1.9 Lock

The synthesiser PLL lock indicator can be set in one of three modes: 'Continuous', 'One-shot' or 'Disabled' using the pull down window. Choosing 'Continuous' the lock indicator will monitor the PLL lock continuously also after an initial lock has occurred. Choosing the



'One-shot' mode the CHP\_OUT (lock) pin will stay high after an initial lock has occurred, even if the PLL occasionally should fall out of lock. If 'Disabled' is selected, the lock signal will not be sent to the CHP\_OUT pin to give PLL status. 'External PA control' is selected if an external Power Amplifier is needed, and

'External LNA control' is selected if an external LNA is needed. The CHP\_OUT pin can then control the external LNA/PA, based on the setting of the TX\_PD and RX\_PD in the MAIN register of CC1000. Please see datasheet for details. The default value is 'Continuous'.

Important: The 'One-shot' lock signal is used internally in the CC1000 to enable the transmitter. If the lock signal is not active (high) the transmitter will not be enabled. This is in order to avoid the transmitter to emit out-of-band signals. If 'Disabled' is chosen this function is overridden and care should be taken, as the transmitter will transmit even when the PLL is not in lock.

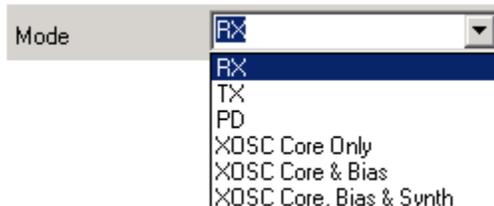
### 5.1.1.10 IF/RSSI

The IF/RSSI pin on CC1000 can be configured to give out the IF frequency or RSSI. Choosing external IF, an 10.7 MHz IF signal will be available at the IF/RSSI pin. Using RSSI, an analogue voltage inversely proportional to the received signal strength is available at the pin. See datasheet for details. The default value is RSSI enable.

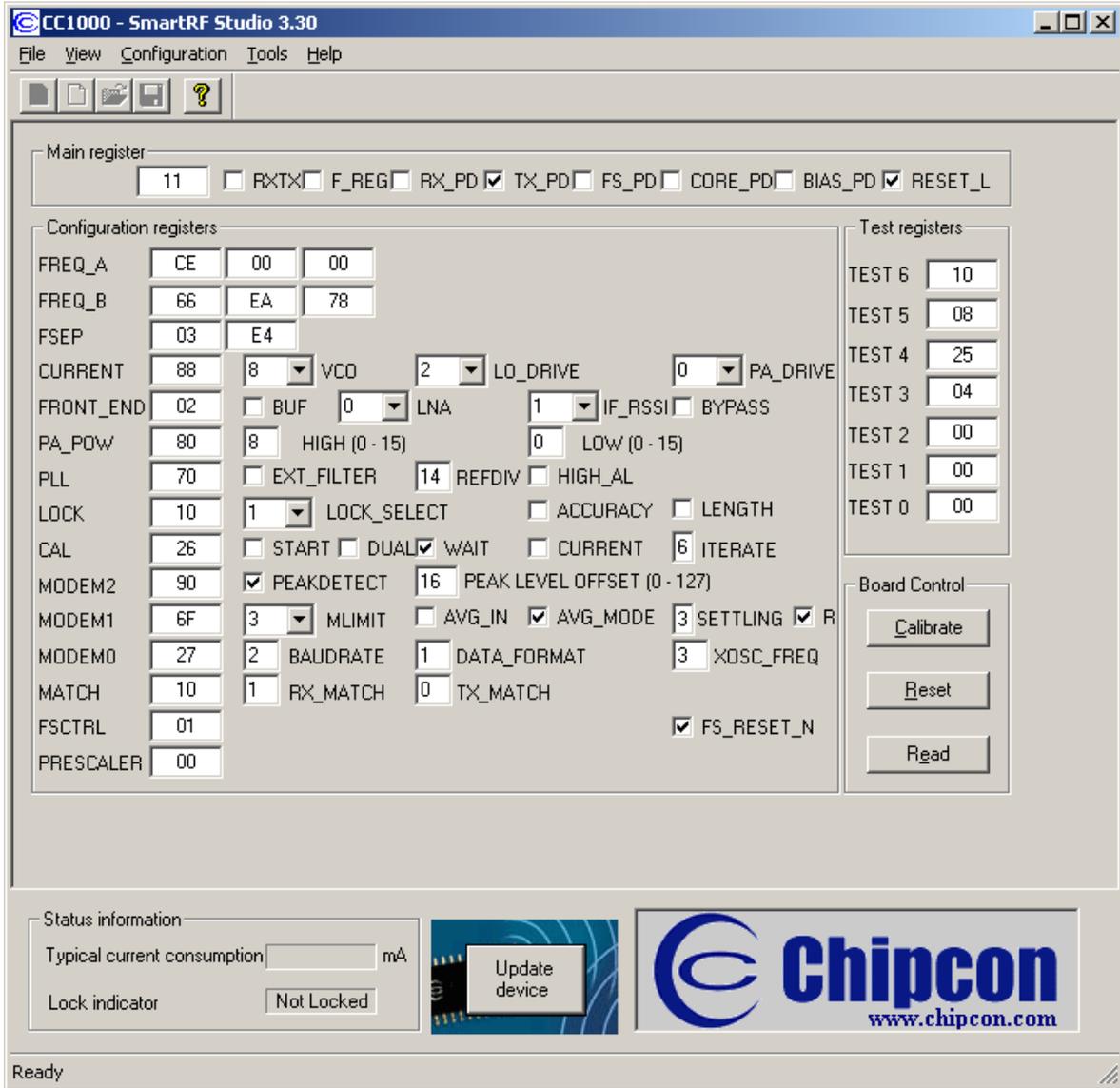


### 5.1.1.11 Operation Mode

The type of operation mode can be selected from a pull down menu. The chip can be set in RX (receive), TX (transmit) or PD (power down) mode. In PD you can select between complete power down (osc. off), or power down with the crystal oscillator core, bias and/or frequency synthesiser running. Leaving the crystal oscillator running gives a shorter turn-on time at the expense of higher current consumption in the power down mode. The default value is RX.



## 5.2 The register configuration window for CC1000



When you have chosen the register configuration window, SmartRF® Studio will look like the picture below.

In this mode you can change the Register values. You can enter the hex values directly or use the implemented control boxes for each register. These control boxes give detailed information on the bits to be controlled in the specified register. Please see the data sheet for detailed information on the register settings. When a hex value is written to a register and **enter** is pushed, the control boxes for the specific register will be updated and visa versa for changes made in the control

boxes. The bits are used to program the transceiver chip on the CC1000EB, and the CC1000 will be programmed with the register information when Update device (F5) is pushed. We dissuade you to change the bits without first study the datasheet or contacting our company.

When changing the values and pressing **Enter** in the Normal configuration window described in chapter 5.1, the frames will change automatically. Changing view to Register View the optimised register values for the Normal View is given.

### 5.3 Evaluation Board Control

In the CC1000 mode of SmartRF® Studio, you will find Evaluation board Control buttons (Calibrate, Reset and Read). The function of these buttons is given in this chapter.



**Calibrate** activates the on-chip calibration feature of the VCO and PLL on the CC1000.

**Reset** performs a hardware reset of CC1000 setting all the register to default values.

**Read** starts to read back the register information on the CC1000 chip. The information is given in a dialog box together with the register name. This button is only active in register view.

## 6 Descriptions of the different Views for CC1050

The CC1050 has two configuration views. The parameter entry screen is the default window and can be chosen by pressing **F2** or selecting **Normal** from the **View** menu. In this window you can change the system parameters, get status information and component values.

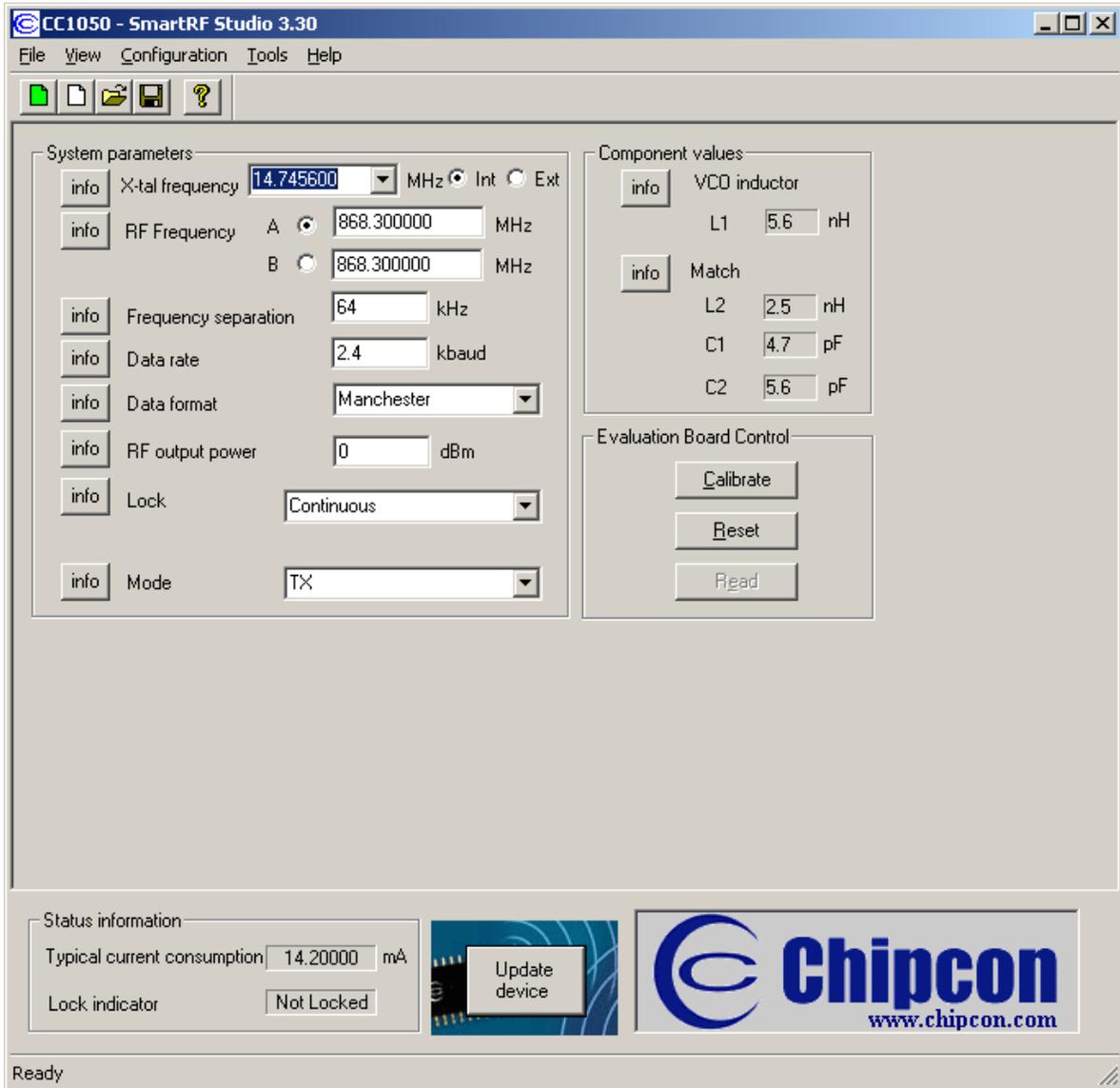
The other configuration window is the “register” configuration, which is selected by pressing **F3** or selecting **Register** from the **View** menu. It gives you the possibility to change the bits in the configuration registers directly. This window is mainly used to give additional information and we dissuade you to change the bits.

To send the configuration data to the transmitter chip, press **F5** or select **Update Device** from the **Configuration** menu or press the **Update device** button at the bottom of the screen.

Note: When pressing **Enter** the parameters will be checked and component values will be calculated, but the transmitter will not be programmed until **Update device** is activated.

## 6.1 The Normal configuration window for CC1050

When you have chosen the Normal configuration window, SmartRF® Studio appears like the picture below.



You can get information about the different parameters by clicking on the **info** button to the left of the parameter.

After you have changed some or all of the parameters, the external component values are calculated after pressing **Enter** or **Update device**. Component values for the input/output match to the antenna and the VCO Inductor are shown to the right of the window. The values are given to you in terms of the standard E12-

series. When you have changed the default parameter settings, use these values for the new external components. The component reference numbers refer to the application circuit shown in the datasheet.

Using the specified component values for the output match will give an optimum match at the specified operating frequency. Minor tuning of the component values may be necessary to compensate for layout parasitics.

### 6.1.1 System parameters

This chapter describes the different parameters and the options you have when changing them.

#### 6.1.1.1 Crystal frequency

The crystal frequency of your Development Kit evaluation board is 14.7456 MHz. Do not change the X-tal frequency parameter when using this module unless the crystal is being replaced. If you are using this program to generate configuration data for your special application, use a crystal frequency between:

- 3 – 4 MHz
- 6 – 8 MHz
- 9 – 16 MHz

Recommended frequencies are 3.6864, 7.3728, 11.0592 and 14.7456 MHz giving exact data rates. The recommended frequencies can be selected in the drop-down list. The frequency value is rounded to 6 digits after the MHz decimal point, i.e. 11.059200 MHz.



You can also choose to use an external crystal reference oscillator by selecting 'External' in the radio button.

#### 6.1.1.2 RF frequency

CC1050 has two separate frequency settings making it possible to select between Frequency A and B. A radio button is used for selecting the active frequency.



The CC1050 can operate at frequencies between 300 and 1000 MHz. The Development Kit evaluation board is optimised for operation in either the ISM band at 868-870 MHz or the ISM band at 433.050 – 434.790 MHz . However, it is possible to use the evaluation board for frequencies outside this ISM band with restriction on the VCO Inductor. Choosing frequencies outside this range will not work for this evaluation board and should only be done for generation of configuration data to be used in other applications.

### 6.1.1.3 Frequency separation

The frequency separation,  $\Delta f$ , is the difference between the frequency transmitted for a '0' ( $f_0$ ) and a '1' ( $f_1$ ). That is,  $f_0 = f_C - \Delta f/2$  and  $f_1 = f_C + \Delta f/2$  where  $f_C$  is the carrier frequency entered in the 'RF frequency' field.

The frequency separation can be adjusted between 0 and 200 kHz in 1 kHz steps. The default value is 64 kHz. A warning will pop-up if CC1050 are unable to modulate with the selected separation. The maximum value for the separation depends on the crystal frequency and RF frequency input, and will for all settings be larger than 64 kHz.

### 6.1.1.4 Data rate

The data rate can be set between 0.6 and 76.8 kbaud. The default setting is 2.4 kbaud. If synchronous mode and recommended crystal frequencies is selected, SmartRF® Studio will find the closest accurate data rate. If synchronous mode is selected without using recommended crystal frequencies, a warning will pop-up informing you that the data rate will differ from the one given in the Data rate input.

### 6.1.1.5 Data format

The CC1050 can be used with NRZ (Non-Return-to-Zero) data or Manchester (bi-phase-level) encoded data. The UART mode bypasses the on-chip synchronisation feature in CC1050.



Please see data sheet of CC1050 for details.

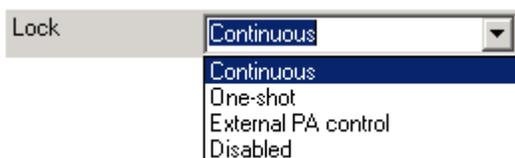
### 6.1.1.6 RF output power

For the CC1050 the output RF power can be set in 1 dB steps between -20 to 12 dBm. For frequencies higher than 500 MHz the upper limit is 8 dBm.

Power in dBm is  $10 \log (P)$  where P is in mW. The default value is 0dBm.

### 6.1.1.7 Lock

The synthesiser PLL lock indicator can be set in one of three modes: 'Continuous', 'One-shot' or 'Disabled' using the pull down window. Choosing 'Continuous' the lock indicator will monitor the PLL lock continuously also after an initial lock has occurred. Choosing the

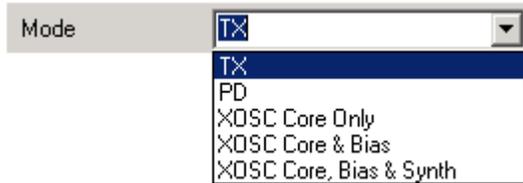


'One-shot' mode the CHP\_OUT (lock) pin will stay high after an initial lock has occurred, even if the PLL occasionally should fall out of lock. If 'Disabled' is selected, the lock signal will not be sent to the CHP\_OUT pin to give PLL status. 'External PA control' is selected if an external Power Amplifier is needed. The CHP\_OUT pin can then control the external PA, based on the setting of the TX\_PD in the MAIN register of CC1050. Please see datasheet for details. The default value is 'Continuous'.

Important: The 'One-shot' lock signal is used internally in the CC1050 to enable the transmitter. If the lock signal is not active (high) the transmitter will not be enabled. This is in order to avoid the transmitter to emit out-of-band signals. If 'Disabled' is chosen this function is overridden and care should be taken, as the transmitter will transmit even when the PLL is not in lock.

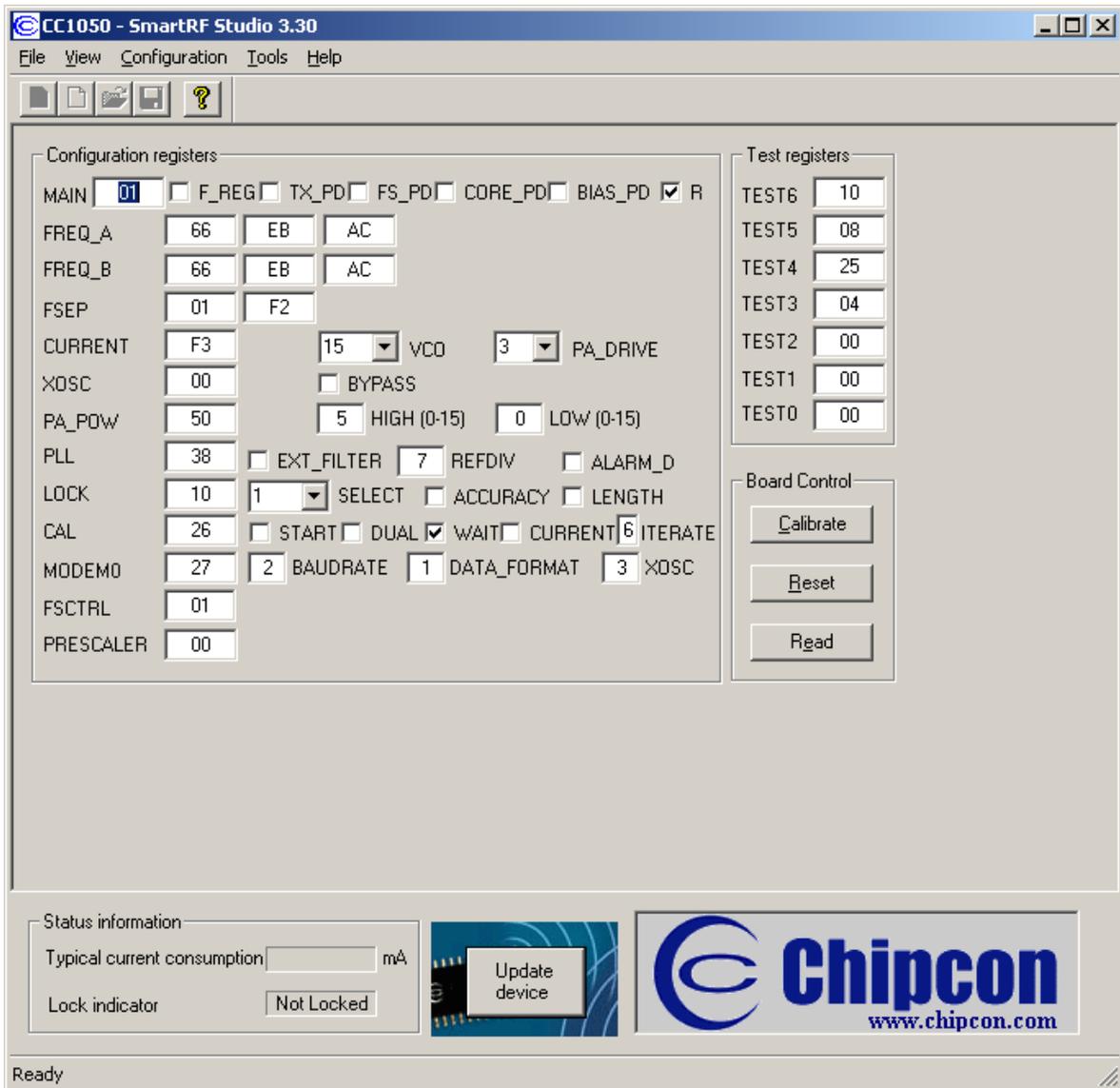
### 6.1.1.8 Mode

The type of operation mode can be selected from a pull down menu. The chip can be set in TX (transmit) or PD (power down) mode. In PD you can select between complete power down (osc. off), or power down with the crystal oscillator core, bias and/or frequency synthesiser running. Leaving the crystal oscillator running gives a shorter turn-on time at the expense of higher current consumption in the power down mode. The default value is TX.



## 6.2 The register configuration window for CC1050

When you have chosen the register configuration window, SmartRF® Studio will look like the picture below.



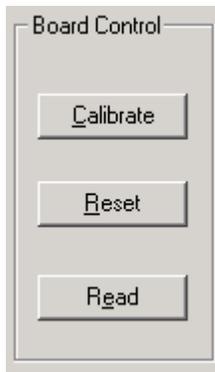
In this mode you can change the Register values. You can enter the hex values directly or use the implemented control boxes for each register. These control boxes give detailed information on the bits to be controlled in the specified register. Please see the data sheet for detailed information on the register settings. When a hex value is written to a register and **enter** is pushed, the control boxes for the specific register will be updated and visa versa for changes made in the control boxes. The bits are used to program the transmitter chip on the CC1050EB, and the CC1050 will be programmed with the register information when Update device

(F5) is pushed. We dissuade you to change the bits without first study the datasheet or contacting our company.

When changing the values and pressing **Enter** in the Normal configuration window described in chapter 6.1, the frames will change automatically. Changing view to Register View the optimised register values for the Normal View is given.

### 6.3 Evaluation Board Control

In the CC1050 mode of SmartRF® Studio, you will find Evaluation board Control buttons (Calibrate, Reset and Read). The function of these buttons is given in this chapter.



**Calibrate** activates the on-chip calibration feature of the VCO and PLL on the CC1050.

**Reset** performs a hardware reset of CC1050 setting all the register to default values.

**Read** starts to read back the register information on the CC1050 chip. The information is given in a dialog box together with the register name. This button is only active in register view.

## 7 Descriptions of the different Views for CC1010

The CC1010 has two configuration views. The parameter entry screen is the default window and can be chosen by pressing **F2** or selecting **Normal** from the **View** menu. In this window you can change the system parameters, get status information and component values.

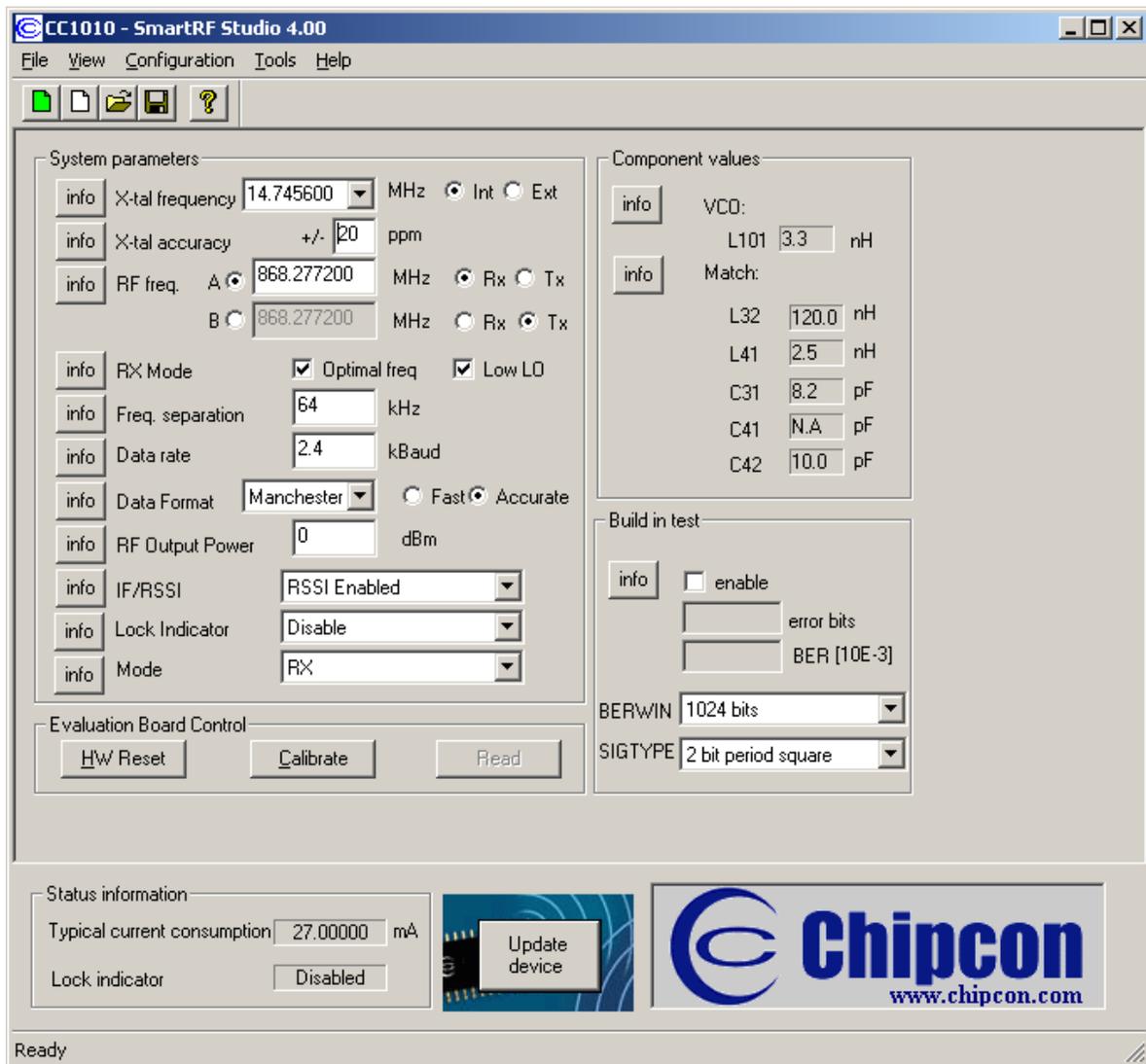
The other configuration window is the “register” configuration, which is selected by pressing **F3** or selecting **Register** from the **View** menu. It gives you the possibility to change the bits in the configuration registers directly. This window is mainly used to give additional information and we dissuade you to change the bits.

To send the configuration data to the transceiver chip, press **F5** or select **Update Device** from the **Configuration** menu or press the **Update device** button at the bottom of the screen. In order to configure the CC1010EB, you first need an embedded software (SmartRF®\_adapter.hex) inside CC1010 that communicate with the SmartRF® Studio. SmartRF® Studio will check the embedded software the first time **Update device** is activated. If the CC1010 embedded software differs from the required software (SmartRF\_adapter.hex), a programming application (ccprog.exe) will be activated, allowing the user to configure CC1010 with the software SmartRF®\_adapter.hex. The user only need to click on the **Do it** button in order to update the CC1010 core with the required embedded software. After verifying the programming the user can exit this programming window and work with the SmartRF® Studio window. For additional information regarding the programming application (ccprog.exe), please study the IDE User Manual.

Note: When pressing **Enter** the parameters will be checked and component values will be calculated, but the transceiver will not be programmed until **Update device** is activated.

## 7.1 The Normal configuration window for CC1010

When you have chosen the Normal configuration window, SmartRF® Studio appears like the picture below.



You can get information about the different parameters by clicking on the **info** button to the left of the parameter.

After you have changed some or all of the parameters, the external component values are calculated after pressing **Enter** or **Update device**. Component values for the input/output match to the antenna and the VCO Inductor are shown to the right of the window. The values are given to you in terms of the standard E12-series. When you have changed the default parameter settings, use these values

for the new external components. The component reference numbers refer to the application circuit shown in the datasheet.

Using the specified component values for the input/output match will give an optimum match at the specified operating frequency. Minor tuning of the component values may be necessary to compensate for layout parasitics.

### 7.1.1 System parameters

This chapter describes the different parameters and the options you have when changing them.

#### 7.1.1.1 Crystal frequency

The crystal frequency of your Development Kit evaluation board is 14.7456 MHz. Do not change the X-tal frequency parameter when using this module unless the crystal is being replaced. If you are using this program to generate configuration data for your special application, use a crystal frequency between:

- 3 – 4 MHz
- 6 – 8 MHz
- 9 – 24 MHz

Recommended frequencies are 3.6864, 7.3728, 11.0592, 14.7456, 18.4320 and 22.1184 MHz giving exact data rates. The recommended frequencies can be selected in the drop-down list. The frequency value is rounded to 6 digits after the MHz decimal point, i.e. 11.059200 MHz.



You can also choose to use an external crystal reference oscillator by selecting 'External' in the radio button.

The crystal frequency must be 14.7456 MHz in order to use the maximum data rate of 76.8 kbaud in SmartRF® Studio. For 22.1184 and 7.3728 MHz the maximum data rate is 38.4 kbaud. The other recommended crystal frequencies will give a maximum data rate of 19.2 kbaud.

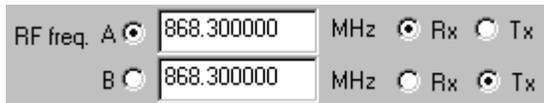
#### 7.1.1.2 Crystal accuracy

Enter the total crystal accuracy between 0 and 500 ppm, including initial tolerance, temperature stability, loading and ageing. If you are using a trimming capacitor to adjust the crystal oscillator, the initial tolerance will be zero. The crystal stability has an influence on the maximum data rate and frequency separation that can be used to stay in the passband of the internal IF filter bandwidth. For highest possible data rate or separation it is an advantage to use a crystal with high frequency accuracy

(<20 ppm). For low cost applications, however, this can be a trade-off. The default value is 20 ppm.

### 7.1.1.3 RF frequency

CC1010 has two separate frequency settings making it possible to select between Frequency A and B. A radio button is used for selecting the active frequency. There is further a radio button on each frequency, which informs the software, whether to calculate RX or TX frequency.



If the active frequency is different from the operation mode (see section 5.1.1.12), error messages will popup informing you to synchronise the active frequency with the operation mode. This check is performed on **Update device**.

The CC1010 can operate at frequencies between 300 and 1000 MHz. The Development Kit evaluation board is optimised for operation in either the ISM band at 868-870 MHz or the ISM band at 433.050 – 434.790 MHz . However, it is possible to use the evaluation board for frequencies outside this ISM band with restriction on the VCO Inductor. Choosing frequencies outside this range will not work for this evaluation board and should only be done for generation of configuration data to be used in other applications.

### 7.1.1.4 RX Mode

In RX mode you can optimise the sensitivity.



The CC1010 have some RF frequencies that gives a more optimal sensitivity than others. By selecting the optimal frequency, SmartRF® studio will find the closest RX channel that gives this optimal sensitivity frequency. When optimal frequency is selected, SmartRF® Studio sets the selected RF frequency A to the closest optimal frequency, and forces frequency B to be equal to frequency A. The RF frequency B is disabled in optimal frequency mode.

SmartRF® Studio use low side LO when mixing down to the intermediate frequency in RX mode. When low LO is disabled, this down converting is based on high side LO. The data on DIO in RX mode is inverted using high side LO.

Default setting is optimal frequency and low LO.

### 7.1.1.5 Frequency separation

The frequency separation,  $\Delta f$ , is the difference between the frequency transmitted for a '0' ( $f_0$ ) and a '1' ( $f_1$ ). That is,  $f_0 = f_C - \Delta f/2$  and  $f_1 = f_C + \Delta f/2$  where  $f_C$  is the carrier frequency entered in the 'RF frequency' field.

The frequency separation can be adjusted between 0 and 200 kHz in 1kHz steps. The default value is 64 kHz. A warning will pop-up if CC1010 is unable to modulate with the selected separation. The maximum value for the separation depends on the crystal frequency and RF frequency input, and will for all settings be larger than 64 kHz.

### 7.1.1.6 Data rate

The data rate can be set between 0.3 and 76.8 kbaud. The default setting is 2.4 kbaud. If synchronous mode and recommended crystal frequencies is selected, SmartRF® Studio will find the closest accurate data rate. If synchronous mode is selected without using recommended crystal frequencies, a warning will pop-up informing you that the data rate will differ from the one given in the Data rate input.

To get a higher data rate than 19.2 kbaud, the crystal frequency must be higher than 12 MHz in SmartRF® Studio. If the selected recommended frequency is 3.6864, 11.0592, 18.4320 MHz in synchronous mode the maximum data rate is forced down to 19.2 kbaud (a pop-up message will inform the user). For a 14.745600 MHz crystal however the data rate is rounded to the closest accurate data rate up to 76.8 kbaud and for 7.3728 and 22.1184 MHz the maximum data rate is 38.4 kbaud.

### 7.1.1.7 Data format

The CC1010 can be used with NRZ (Non-Return-to-Zero) data or Manchester (bi-phase-level) encoded data. The UART mode bypasses the on-chip synchronisation feature and the Transparent mode bypass both the synchronisation and oversampling algorithm in CC1010.

The fast and accurate sets the preamble time needed in RX mode, before valid data can be received.



Please see data sheet of CC1010 for details.

### 7.1.1.8 RF output power

For the CC1010 the output RF power can be set in 1 dB steps between -20 to 10 dBm. For frequencies higher than 500 MHz the upper limit is 4 dBm.

Power in dBm is  $10 \log (P)$  where P is in mW. The default value is 0 dBm.

### 7.1.1.9 Lock

The synthesiser PLL lock indicator can be read from an internal register. This read operation is done each second and can be disabled if the constantly reading of the register influences testing parameters.



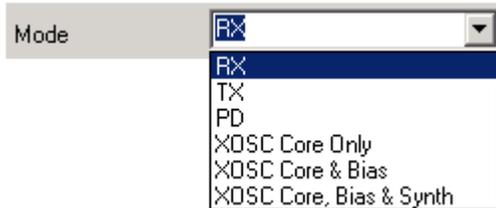
### 7.1.1.10 IF/RSSI

The AD2 pin on CC1010 can be configured to give out the IF frequency or RSSI. Choosing external IF, a 10.7 MHz IF signal will be available on the AD2 pin. Using RSSI, an analogue voltage inversely proportional to the received signal will then be available on this pin. See datasheet for details. The default value is RSSI enable.



### 7.1.1.11 Operation Mode

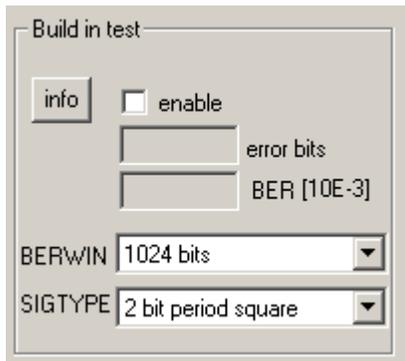
The type of operation mode can be selected from a pull down menu. The chip can be set in RX (receive), TX (transmit) or PD (power down) mode. In PD you can select between complete power down (osc. off), or power down with the crystal oscillator core, bias and/or frequency synthesiser running. Leaving the crystal oscillator running gives a shorter turn-on time at the expense of higher current consumption in the power down mode.



The default value is RX.

### 7.1.1.12 Built in test

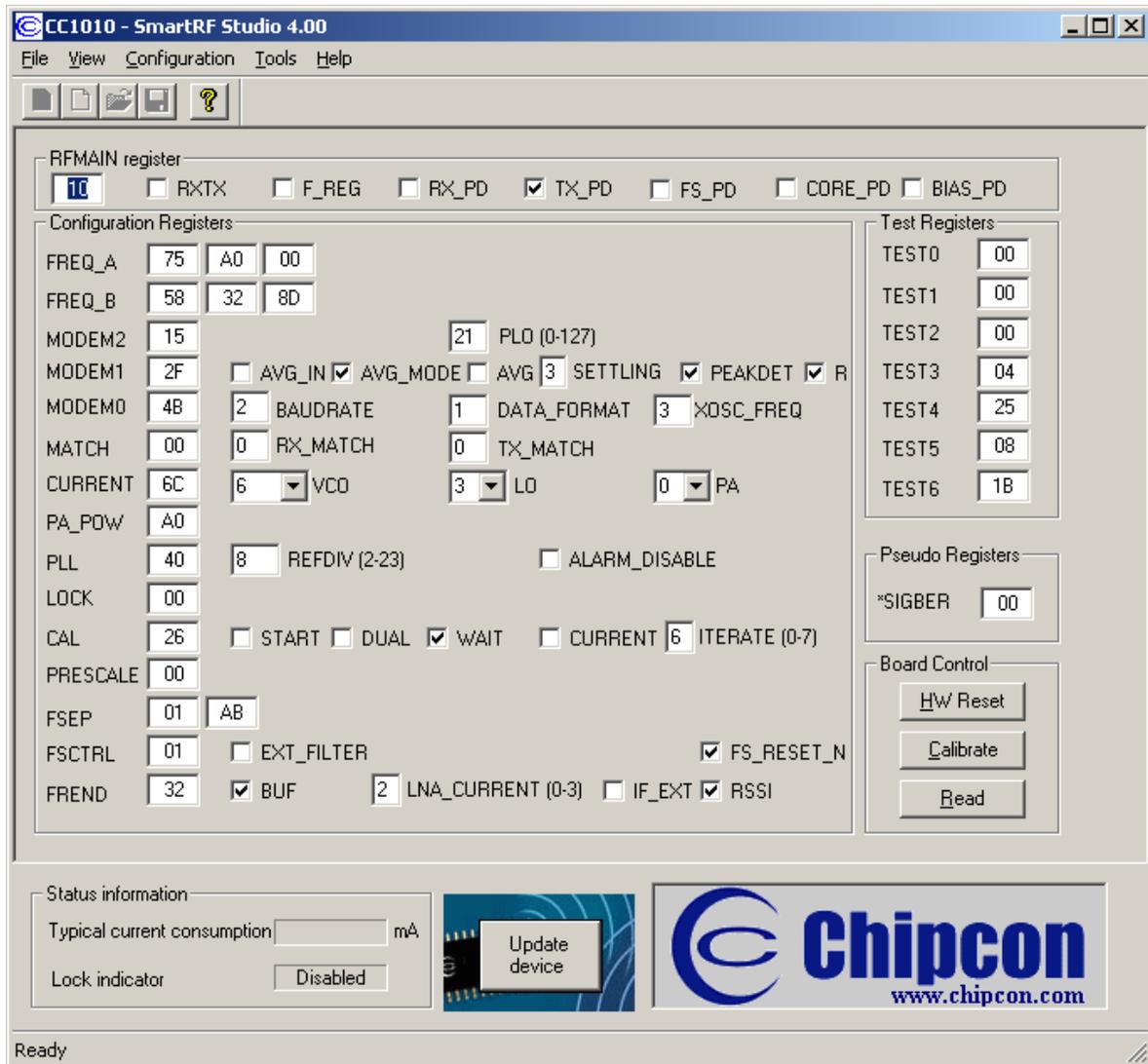
A built-in BER-estimator and signal generator is implemented in the SmartRF® Studio adapter program.



In RX mode the BER-estimator can be used in conjunction with an RF signal generator connected to the DIO connector. The selected signal type (SIGTYPE) is then provided on the DIO pin and is used as a reference sequence. The BER-estimator locks onto the received signal and then compares it to the signal transmitted on DIO, measuring the BER over a configurable number of transmitted bits given by BER window (BERWIN). When this measurement window is complete, the numbers of bits in error are transferred to SmartRF® Studio together with the estimated BER. The maximum data rate for the BER estimator is 4.8 kbaud. In TX mode the selected signal type is transmitted over the RF link.

## 7.2 The register configuration window for CC1010

When you have chosen the register configuration window, SmartRF® Studio will look like the picture below.

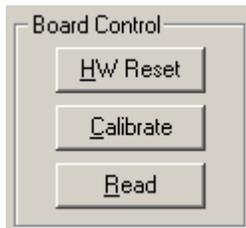


In this mode you can change the Register values. You can enter the hex values directly or use the implemented control boxes for each register. These control boxes give detailed information on the bits to be controlled in the specified register. Please see the data sheet for detailed information on the register settings. When a hex value is written to a register and **enter** is pushed, the control boxes for the specific register will be updated and vice versa for changes made in the control boxes. The bits are used to program the transceiver chip on the CC1010EB, and the CC1010 will be programmed with the register information when Update device (F5) is pushed. We dissuade you to change the bits without first study the datasheet or contacting our company.

When changing the values and pressing **Enter** in the Normal configuration window described in chapter 7.1, the frames will change automatically. Changing view to Register View the optimised register values for the Normal View is given.

### 7.3 Evaluation Board Control

In the CC1010 mode of SmartRF® Studio, you will find Evaluation board Control buttons (Calibrate, Reset and Read). The function of these buttons is given in this chapter.



**Calibrate** activates the on-chip calibration feature of the VCO and PLL on the CC1010.

**HW Reset** performs a hardware reset of CC1010 setting all the register to default values.

**Read** starts to read back the register information on the CC1010 chip. The information is given in a dialog box together with the register name. This button is only active in register view.

## 8 Descriptions of the different Views for CC1020

The CC1020 has two configuration views. The parameter entry screen is the default window and can be chosen by pressing **F2** or selecting **Normal** from the **View** menu. In this window you can change the system parameters, get status information and component values.

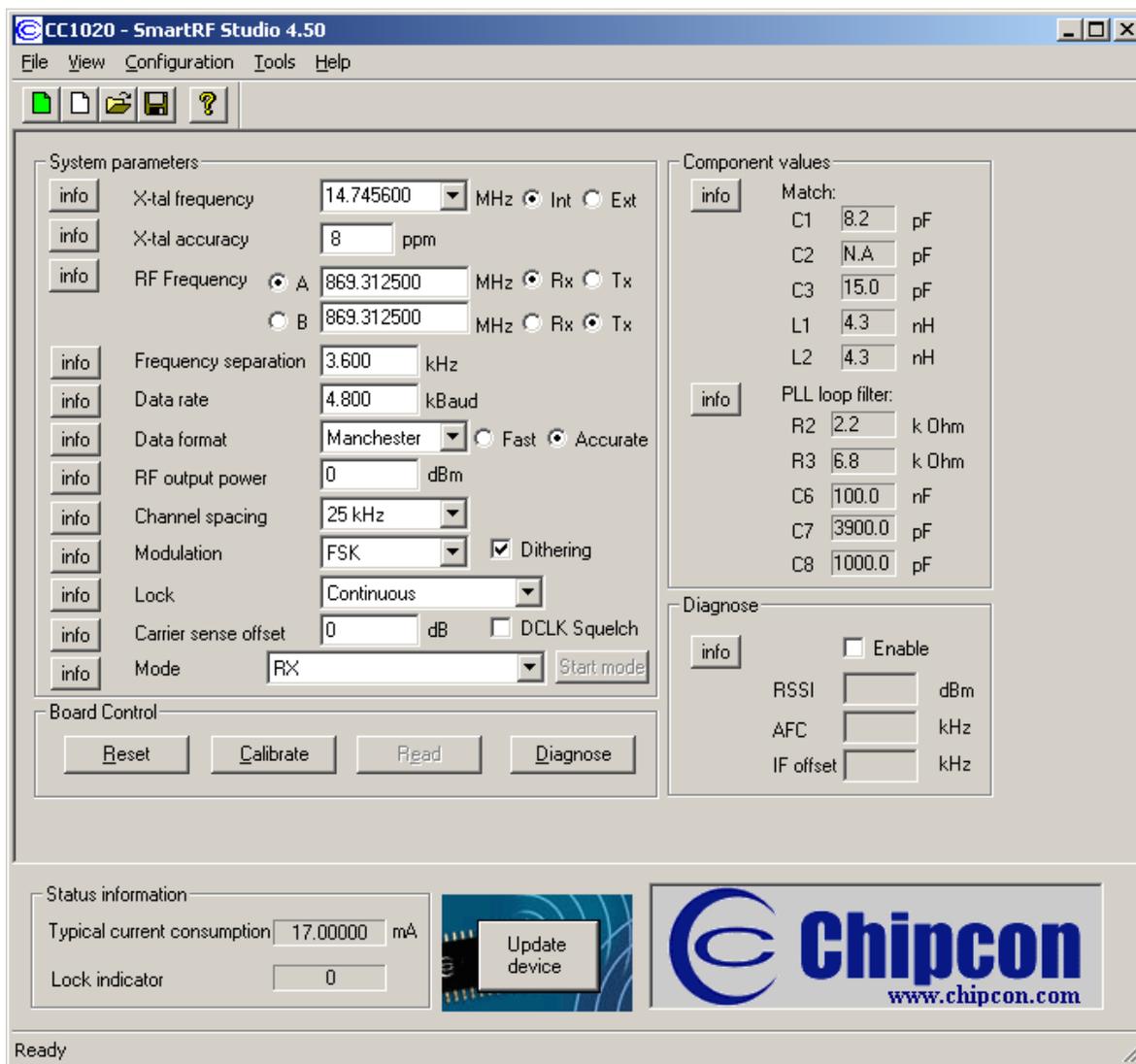
The other configuration window is the “register” configuration, which is selected by pressing **F3** or selecting **Register** from the **View** menu. It gives you the possibility to change the bits in the configuration registers directly. This window is mainly used to give additional information and we dissuade you to change the bits.

To send the configuration data to the transceiver chip, press **F5** or select **Update Device** from the **Configuration** menu or press the **Update device** button at the bottom of the screen.

Note: When pressing **Enter** the parameters will be checked and component values will be calculated, but the transceiver will not be programmed until **Update device** is activated.

## 8.1 The Normal configuration window for CC1020

When you have chosen the Normal configuration window, SmartRF® Studio appears like the picture below.



You can get information about the different parameters by clicking on the **info** button to the left of the parameter.

After you have changed some or all of the parameters, the external component values are calculated after pressing **Enter** or **Update device**. The values are given in terms of the standard E12-series. When you have changed the default parameter settings, use these values for the new external components. The component reference numbers refer to the application circuit shown in the datasheet and the CC1020DK User Manuals.

Using the specified component values for the input/output match will give an optimum match at the specified operating frequency. Minor tuning of the component values may be necessary to compensate for layout parasitics.

### 8.1.1 System parameters

This chapter describes the different parameters and the options you have when changing them.

#### 8.1.1.1 Crystal frequency

The crystal frequency of your Development Kit evaluation module is 14.7456 MHz. Do not change the X-tal frequency parameter when using this module unless the crystal is being replaced. If you are using this program to generate configuration data for your special application, use a crystal frequency between:

4 - 20 MHz

Recommended frequencies are 4.9152, 7.3728, 9.8304, 12.288, 14.7456, 17.2032 and 19.6608 MHz giving exact data rates. The recommended frequencies can be selected in the drop-down list. The frequency value is rounded to 6 digits after the MHz decimal point, i.e. 14.745600 MHz.



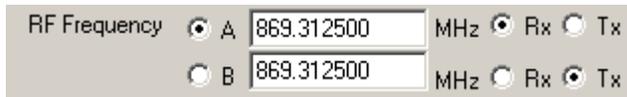
You can also choose to use an external crystal reference oscillator by selecting 'External' in the radio button.

#### 8.1.1.2 Crystal accuracy

Enter the total crystal accuracy between 0 and 100 ppm, including initial tolerance, temperature stability, loading and ageing. If you are using a trimming capacitor to adjust the crystal oscillator, the initial tolerance will be zero. The crystal stability has an influence on the maximum data rate and frequency separation that can be used to stay in the passband of the internal programmable IF filter bandwidth. The default value is 5 ppm.

#### 8.1.1.3 RF frequency

CC1020 has two separate frequency settings making it possible to select between Frequency A and B. A radio button is used for selecting the active frequency. There is further a radio button for each frequency, which informs the software, whether to calculate RX or TX frequency.



If the active frequency is different from the operation mode (see section 8.1.1.12), error messages will popup informing you to synchronise the active frequency with the operation mode.

CC1020 can operate at frequencies between 424 – 470 MHz and 848 - 940 MHz. Your Development Kit test module is optimised for operation in the ISM band at 868 or 433 MHz. However, it is possible to use the test module for frequencies outside this ISM band with the restriction of the external components.

#### 8.1.1.4 Frequency separation

The frequency separation  $dF$  can be between 0 and 108 kHz at 424 – 470 MHz, and between 0 and 216 kHz at 848 – 940 MHz.. This is the difference between the frequency transmitted for a '0' ( $F_0$ ) and a '1' ( $F_1$ ). That is,  $F_0 = F_c - dF/2$  and  $F_1 = F_c + dF/2$ , where  $F_c$  is the carrier frequency entered in the 'RF frequency' field. The total occupied signal bandwidth can be approximated by Carson's rule:  $BW = dF + 2 F_m$ , where  $F_m$  is the modulation frequency. Using NRZ coding the baud rate is equal to the bit rate. Using Manchester coding the modulation frequency (in kHz) will be equal to the bit rate (in kbit/s) and the baud rate is twice the bit rate.

#### 8.1.1.5 Data rate

The data rate can be set between 0.45 and 153.6 bBaud. Using NRZ mode, the data rate in kbits/s is equal to the Baud rate. Using Manchester code, the Baud rate is twice the bit rate. The demodulator, data slicer and bit synchroniser is optimised according to the selected data rate.

In synchronous mode using recommended crystal frequencies, the data rate will be rounded to the closest accurate data rate given in the data sheet.

#### 8.1.1.6 Data format

CC1020 can be configured for three different data formats: Synchronous 'NRZ', Synchronous 'Manchester' or 'Asynchronous UART'. The data formats refer to the encoding used when modulating the signal, either NRZ (Non-Return-to-Zero) data or Manchester encoded data (also known as bi-phase-level) can be used. In the synchronous modes CC1020 provide the data clock at DCLK.

When Manchester mode is selected, the output signal will be modulated even if no signal is connected to the DIO line. This is because the Manchester coding of the

data is done by the CC1020. Therefore the DIO signal should be NRZ coded even when Manchester mode is selected.



The selection between Fast and Accurate controls the settling time of the averaging filter in the demodulator. Please see the data sheet for details.

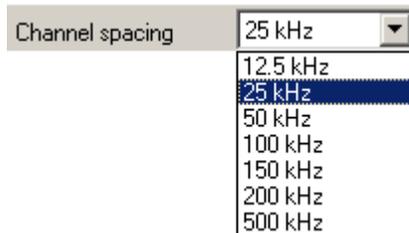
### 8.1.1.7 RF output power

For the CC1020 the output RF power can be set in 1 dB steps between -20 to 2 dBm. For frequencies lower than 500 MHz the upper limit is TBD dBm.

Power in dBm is  $10 \log(P)$  where P is in mW. The default value is 0 dBm.

### 8.1.1.8 Channel spacing

The 6 dB IF bandwidth is programmable according to the channel spacing needed. In narrow band operation the IF bandwidth is critical in order to get good adjacent channel rejection. Further the AGC in CC1020 will be optimised based on the channel spacing selection.



### 8.1.1.9 Modulation

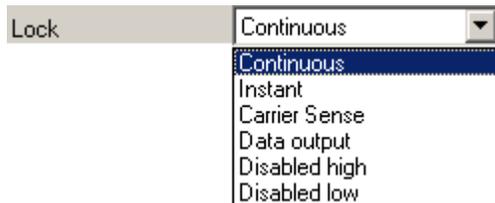
CC1020 can modulate FSK, GFSK or OOK/ASK. Using GFSK the data is shaped, using a Gaussian filter before FSK modulation, in order to improve the occupied bandwidth. OOK is a type of amplitude modulation used in digital systems where the RF carrier is turned on and off in order to modulate the data.



In a fractional-N synthesizer, spurious signals can occur at certain frequencies depending on the division ratios in the PLL. To reduce the strength of these spurs the Dithering can be enabled.

### 8.1.1.10 Lock

The synthesiser PLL lock indicator can be set in one of three modes: 'Continuous', 'One-shot' or 'Disabled'. Choosing 'Continuous' the lock indicator will monitor the PLL lock continuously also after an initial lock have occurred. Choosing the 'Instant' mode the LOCK pin will stay high after an initial lock has occurred, even if the PLL occasionally should fall out of lock. If 'Disabled' is selected, the lock signal will be fixed to high or low regardless of the PLL status. The LOCK pin can also be used as a Carrier Sense indicator or be set to a fixed level. In synchronous mode the data in RX mode can be given on the LOCK pin when Data output is selected. In asynchronous mode the data output is always provided on DCLK.



Note that the Lock indicator pin on CC1020 is active low.

### 8.1.1.11 Carrier sense

The carrier sense signal is based on the RSSI value and the programmable carrier sense level. The Carrier sense signal is high as long as the RSSI is stronger than the given threshold. The threshold is given by the sensitivity in RX mode and adding the carrier sense offset.

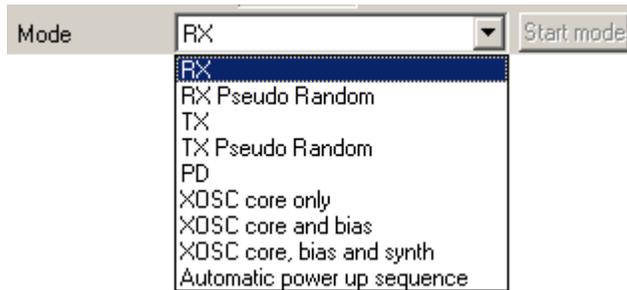


The DCLK pin on CC1020 can be used to give an interrupt signal to the MCU when the RSSI level exceeds the given threshold level. This function can be used to wake or interrupt the MCU when a strong signal is received. The DCLK Squelch enables this feature.

### 8.1.1.12 Operation Mode

The chip can be set in RX (receive), TX (transmit) or PD (power down) mode. You can also power up selected parts of the chip; the crystal oscillator core, the bias module and the synthesiser. These modes can be used to evaluate performance during a power up sequence.

The disabled 'Start mode' button will be activated in 'TX Pseudo Random' and 'Automatic power up sequence' selection and the caption will change to respectively 'Start PN9' and 'wake-up'.



When Automatic power up sequence is selected, the CC1020 wakes up in RX mode and check the carrier sense signal. The power up sequencing is initiated by a negative transition on PSEL. Pushing the 'wake up' button does this. Please refer to the data sheet for further information on power-on sequencing.

If pseudo random sequence is selected, the DIO is XOR'ed with this predefined sequence both in TX and RX. BER can easily be found by having DIO low in TX and count the number of '1' received on the DIO in RX and divide by 3. The pseudo random sequence in TX mode is initiated by a negative transition on PSEL. Pushing the 'Start PN9' button does this.

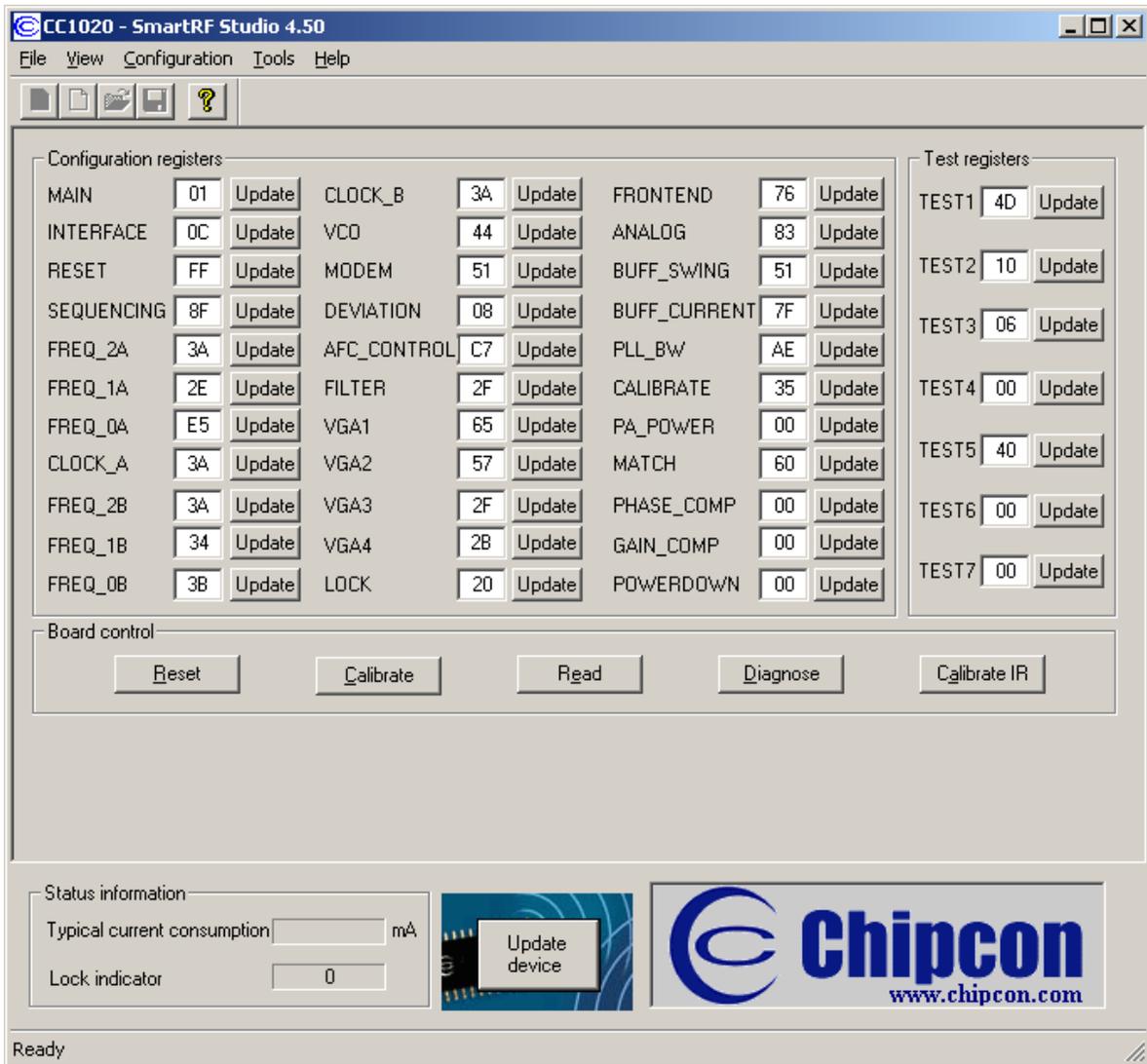
### 8.1.1.13 Diagnose

By enabling the diagnose feature, the averaging value of the RSSI, AFC and IF offset is calculated and updated each second. The RSSI signal is given in dBm and the AFC and IF Offset is given in kHz. For optimum sensitivity the crystal loading, or the RX frequency should be tuned until AFC indicates 0 kHz.



## 8.2 The register configuration window for CC1020

When you have chosen the register configuration window, SmartRF® Studio will look like the picture below.



In this mode you can change the Register values by enter the hex values. Please see the data sheet for detailed information on the register settings. The registers are used to program the transceiver chip on the CC1020EM, and the CC1020 will be programmed with the register information when Update device (F5) is pushed. You can also configure each register by pushing the update button for the respective register entry. We dissuade you to change the bits without first study the datasheet or contacting our company.

When changing the values and pressing **Enter** in the Normal configuration window described in chapter 5.1, the frames will change automatically. Changing view to Register View the optimised register values for the Normal View is given.

### 8.3 Evaluation Board Control

In the CC1020 mode of SmartRF® Studio, you will find Evaluation board Control buttons (Calibrate, Reset and Read). The function of these buttons is given in this chapter.



**Calibrate** activates the on-chip calibration feature of the VCO and PLL on the CC1020.

**Reset** performs a hardware reset of CC1020 setting all the register to default values.

**Read** starts to read back the register information on the CC1020 chip. The information is given in a dialog box together with the register name. This button is only active in register view.

**Diagnose** performs a read-back of the status registers. In normal view the read-back values are provided in signed format (when needed) and the value of each bit in the STATUS register is listed up. Further the CC1020 version is given in this window. In register view the read back value of the status register is provided as register value in hex format.

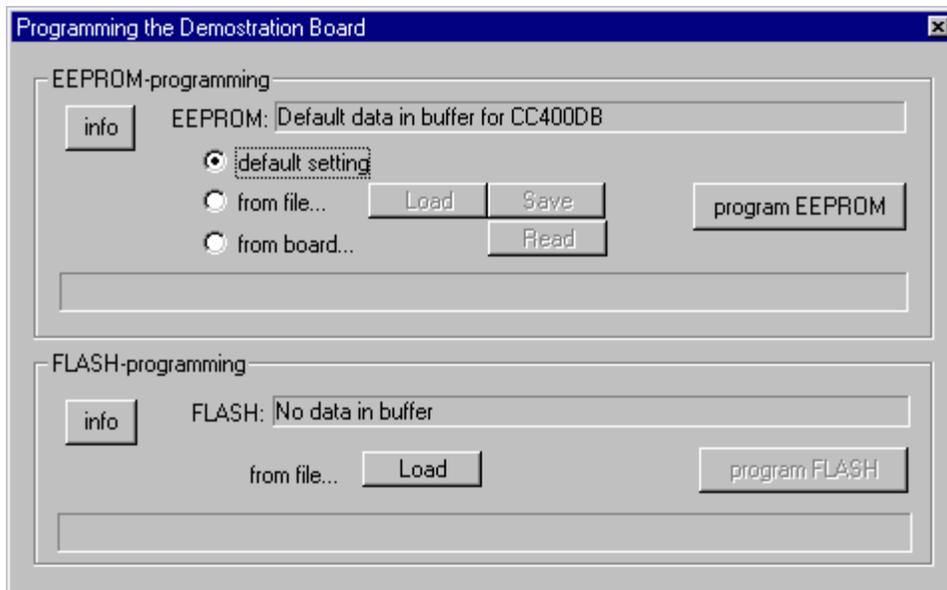
**Calibrate IR** is only active in Register view, and performs a calibration algorithm that improves the image rejection feature on CC1020. In order to use this feature you need to connect a signal generator operation on the image frequency. Please see data sheet for details.

## 9 Description of the Tools in SmartRF® Studio

Tools in the SmartRF® Studio are small independent software programs that are accessible from the Tools menu.

### 9.1 Programming

It is possible to program the microcontroller on the Demonstration Board for the CC400 and the CC900 from SmartRF® Studio. Selecting **Programming** in the **Tools** menu (Alt+T+P) open a new window tool for this demonstration board programming. This window is as shown below.



The interface communicates with the Evaluation Board. Before programming can start, you must plug the Demonstration Board into the edge connector on the CC400/900 Evaluation Board. The software will inform you if you have not installed the Demonstration Board correctly on the demonstrator before programming. Please see the User Manuals for the Development Kit for details regarding the Evaluation Board and Demonstration Board.

Before programming the demonstration board the battery should be removed, because the Evaluation board gives power to the MCU during programming.

#### 9.1.1 EEPROM-programming

The register setting for the transceivers is stored in the EEPROM of the microcontroller. The idea is that the user can change the settings of the transceivers on the demonstrator by changing the data in the EEPROM.

Before you can program the EEPROM, you must load valid data into the EEPROM-buffer. This can be done by either using the *default setting*, *load from file* or *read from board*.

If *default setting* is selected, then the EEPROM-buffer is filled with default values that correspond to the data in the demonstration board when you got it. This is a proper selection when you want to go back to the recommended settings after testing the demonstrator using other settings. To use the correct default setting for the demonstrator board, the user must ensure that the selected device in SmartRF® Studio is the same as the transceiver on the demonstration board. If CC400 is selected the default setting is according to the EEPROM setting given in CC400DBK User Manual, and if CC900 is selected the default setting is according to the EEPROM setting given in CC900DBK User Manual. If CC1000 is selected before the programming tool is opened, the default setting radio button will not give a default setting, because we have for the moment not implemented a demonstrator for CC1000.

If *from file* is selected, then the load and the save buttons are enabled. Here you can either load data from a file to the EEPROM-buffer, or save the EEPROM-buffer to a file. There are two types of files that are allowed to load. That is the \*.eep and \*.txt. The eep-format is the normal file type for the EEPROM data. The txt-file is the text-file that is generated under SmartRF® Studio when *print register to file* is selected in Normal View. If another text-file is loaded an error message will open. When saving the buffer to a file, the format will be of \*.eep.

If *from board* is selected, then the read and save buttons are enabled. By clicking on this button, the software starts to read the EEPROM of the connected demonstration board, into the EEPROM-buffer. The Progress bar at the bottom of the EEPROM-programming frame starts to go, and indicate the progress of the reading. An error message will open if no demonstrator is connected to the evaluation board. The buffer data can now be used to either program to another board or store to a \*.eep file.

When the EEPROM-buffer contains useful data, the *program EEPROM* button is enabled. This button writes the data from the EEPROM-buffer to the EEPROM of the microcontroller. The Progress bar at the bottom of the EEPROM-programming frame indicates the progress of the programming. An error message will be shown if no demonstrator is connected to the evaluation board.

### **9.1.2 FLASH-programming**

The main program of the microcontroller is stored in the FLASH memory. This program can be loaded into the FLASH-buffer. The file-format is generic Hex Format (ASCII-file). Please have in mind that not all types of hex format can be used in SmartRF® Studio. The format SmartRF® Studio can handle is given below:

```
000000:c005
000001:c115
000002:c125
000003:c0a9
000004:c001
000005:c000
.....
```

the generic hex format is of the type:

```
AAAAAA:DDDD
```

Where:

A = Address

D = Data

When the FLASH-buffer contains useful data, the *program FLASH* button is enabled. This button writes the data from the FLASH-buffer to the FLASH memory of the microcontroller. The Progress bar at the bottom of the FLASH-programming frame indicates the progress of the programming. An error message will be shown if no demonstrator is connected to the evaluation board.

Please have in mind that the EEPROM is erased during the FLASH-programming, and must manually be updated by the user with the *program EEPROM* button (see 8.1.1).

Please also have in mind that the FLASH programmer in SmartRF® Studio can only be used on a CC400/CC900DB v.2.00 or newer, due to the new Atmel MCU (tiny12) on this board.

*Note: To generate a generic hex file in AVR Studio (use version 3.5 or newer), click on 'Project Settings' in the 'Project' menu, and select 'Generic' in the 'Output File Format' combo box. For further information, see Atmel's documentation.*