eZ430-Chronos™ Development Tool

User's Guide

TEXAS INSTRUMENTS

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If You Need Assistance

If you have any feedback or questions, support for the MSP430™ microcontrollers and the eZ430-Chronos™ software development tool is provided by the Texas Instruments Product Information Center (PIC) (see support.ti.com), the TI E2E Forum (http://e2e.ti.com/support/microcontrollers/msp43016-bit_ultra-low_power_mcus/f/166.aspx), and the eZ430-Chronos wiki at www.ti.com/chronoswiki. Additional device-specific information can be found on the MSP430 web site, www.ti.com/msp430.

Related Documentation from Texas Instruments

The primary sources of MSP430 information are the device-specific data sheets and user's guides. The most up-to-date versions of the user's guide documents available at the time of production have been provided on the CD-ROM included with this tool. However, the most current information is found at www.ti.com/msp430.

Information specific to the eZ430-Chronos development tool can be found at www.ti.com/chronos.

MSP430 device and IDE user's guides may be accessed on the included CD-ROM under the user's guides section. The IDE user's guides include detailed information on setting up a project for the MSP430 using Code Composer Studio™ integrated development environment (IDE) (SLAU157) and the IAR Embedded Workbench™ IDE (SLAU138).

FCC Warning

This equipment is intended for use in a laboratory test environment only. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case, the user is required to take whatever measures may be required to correct this interference his own expense.

Export Control Regulations

This development kit is subject to the export / import control regulations of the United States per the

harmonization code: ECCN 5A002A1A TSPA. Note that it may also be subject to export

control policies of local authorities.

Patents

German utility model and patent pending.

eZ430-Chronos™ Overview

1.1 Overview

The eZ430-Chronos software development tool is a highly integrated, wearable, wireless development system that is based on the CC430F6137. It may be used as a reference platform for watch systems, a personal display for personal area networks, or as a wireless sensor node for remote data collection.

Based on the CC430F6137 sub-1-GHz RF SoC, the eZ430-Chronos is a complete development system featuring a 96-segment LCD display, an integrated pressure sensor, and a three-axis accelerometer for motion sensitive control. The integrated wireless interface allows the eZ430-Chronos to act as a central hub for nearby wireless sensors such as pedometers and heart-rate monitors. The eZ430-Chronos offers temperature and battery voltage measurement and is complete with a USB-based CC1111 wireless interface to a PC.

The eZ430-Chronos watch may be disassembled to be reprogrammed with custom applications and includes an eZ430 USB programming interface.

eZ430-Chronos Features

- Fully functional sports watch based on the CC430F6137, an MSP430™ microcontroller with integrated sub-1-GHz wireless transceiver
- Watch can be reprogrammed for custom wireless applications
- Highly integrated watch includes on-board three-axis accelerometer, pressure sensor, temperature sensor, and battery voltage sensor
- 96-segment LCD display driven directly by the CC430 microcontroller
- Can be paired wirelessly with heart-rate monitors, pedometers, or other devices based on RF transceivers such as the CC430 or CC11xx devices
- Includes an eZ430-RF USB emulator that connects the eZ430-Chronos to a PC for real-time in-system programming and debugging.

Figure 1-1. eZ430-Chronos

1.2 Kit Contents

- One eZ430-Chronos watch (battery included)
- One eZ430-RF USB debugging interface
- One CC1111 USB RF access point
- One mini Phillips screwdriver
- Two spare screws
- One MSP430™ development tool CD containing documentation and development software
  - *eZ430-Chronos™ Windows® PC-Software and Source Code* SLAC341
  - *eZ430-Chronos™ Linux® PC-Software and Source Code* SLAC388
  - *eZ430-Chronos™ Development Tool User's Guide* SLAU292
  - *eZ430-RF2500 Development Tool User's Guide* SLAU227
  - *CC430 Family User's Guide* SLAU259
  - *Code Composer Studio™ v4.2 Core Edition* CCS Mediawiki
  - *Code Composer Studio™ v4.2 User's Guide for MSP430* SLAU157
  - *IAR Embedded Workbench™ KickStart™* SLAC050
  - *IAR Embedded Workbench™ User's Guide for MSP430* SLAU138

NOTE: For the latest software and documentation, visit www.ti.com/chronos or www.ti.com/chronoswiki.

Getting Started

2.1 Using the eZ430-Chronos Watch Stand Alone

For first time use, remove the eZ430-Chronos watch from box and press any button twice to wake the watch from sleep mode (after the first button press, the LCD displays the same content as shown on the box of the kit; after the second button press, the watch starts full operation).

> **NOTE:** For the next steps it is important to understand the eZ430-Chronos user concept. The top and bottom LCD lines can be controlled individually by pushing the buttons on the left side. The buttons on the right side are used to select or activate secondary functions. Detailed instructions are available in Section 3.2.
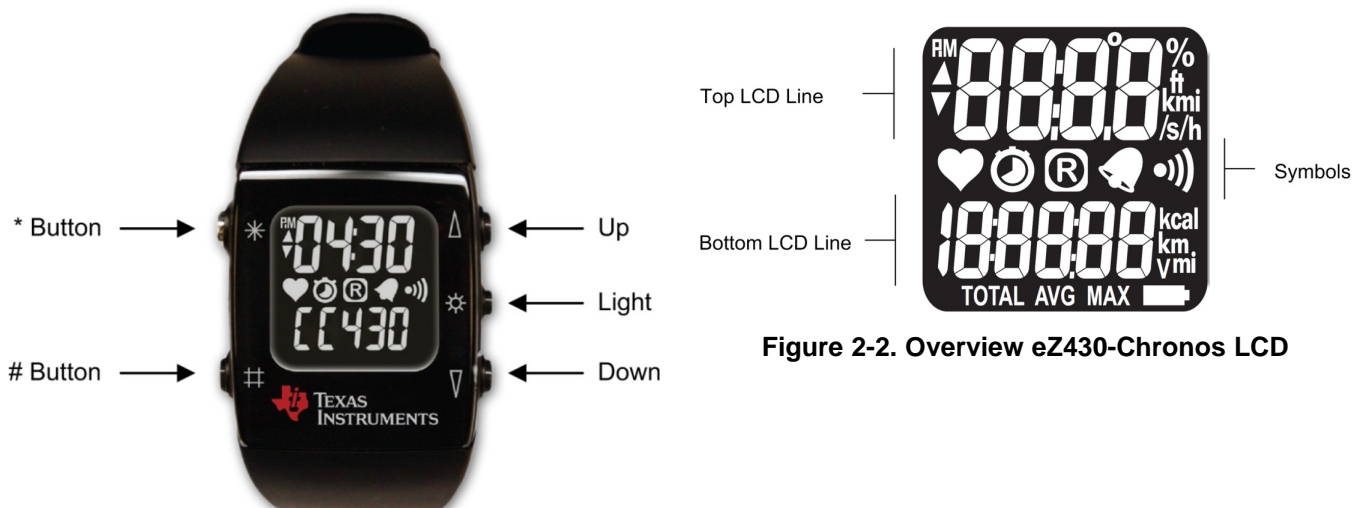
Figure 2-2. Overview eZ430-Chronos LCD

Figure 2-1. eZ430-Chronos Watch Push Buttons

2.1.1 Setting the Time

1. Push the "*" button until the time is displayed in the top LCD line.
2. Hold "*" for three seconds until the time disappears and "12H" or "24H" is shown on the LCD.
3. Select 12H/24H modes by pushing the "UP" or "DOWN" buttons.
4. Press "#" to continue with the time adjustment.
5. Set the hours by pushing the "UP" or "DOWN" button.
6. Press "#" to continue with the minute adjustment.
7. Set the minutes by pushing the "UP" or "DOWN" button.
8. Press "#" to continue with the second adjustment.
9. Set the seconds by pushing the "UP" or "DOWN" button.
10. Press "*" to confirm the settings and go back to normal operation, or press "#" to start over with step 2.

NOTE: If no button is pushed for more than 30 seconds, the previous settings are restored.

Alternatively, the time and date may be set wirelessly using the eZ430-Chronos Control Center (see Section 3.3.3).

2.1.2 Setting the Date

1. Push the "#" button until the date is displayed in the bottom LCD line.
2. Hold "#" for three seconds until the year flashes on the bottom LCD line.
3. Set the year by pushing the "UP" or "DOWN" button.
4. Press "#" to continue with the month adjustment.
5. Set the month by pushing the "UP" or "DOWN" button.
6. Press "#" to continue with the day adjustment.
7. Set the day by pushing the "UP" or "DOWN" button.
8. Press "*" to confirm the settings and go back to normal operation, or press "#" to start over with step 3.

NOTE: If no button is pushed for more than 30 seconds, the previous settings are restored.

2.1.3 Feature Overview and Menu Structure

Figure 2-3 shows all modes and secondary functions. A detailed description of the features can be found in Section 3.2.

Top modes:
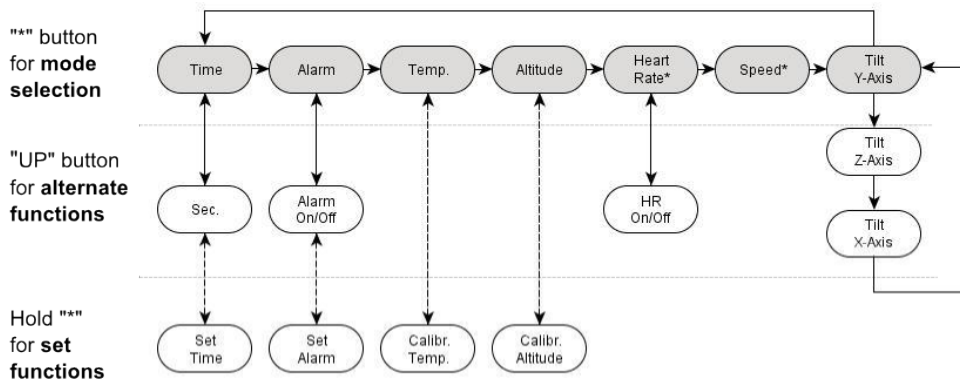
"*" button for **mode selection**

"UP" button for **alternate functions**

Hold "*" for **set functions**

To modify values in set functions use "UP/DOWN", press "#" for next item and "*" to store

Bottom modes:

"#" button for **mode selection**

"DOWN" button for **alternate functions**

Hold "#" for **set functions**
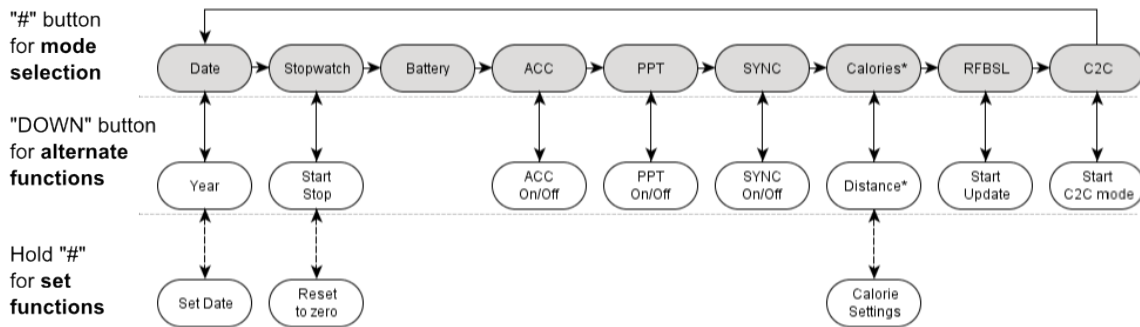
To modify values in set functions use "UP/DOWN", press "#" for next item and "*" to store

Figure 2-3. eZ430-Chronos Feature Overview and Menu Structure

2.2 Install Demo Application, Drivers and Firmware

The eZ430-Chronos PC software supports Windows® and Linux® (Ubuntu 9.10) operating systems. Download the latest eZ430-Chronos Software and Source Code Installer (SLAC341) for Windows and (SLAC388) for Linux from the eZ430-Chronos web page at www.ti.com/chronos or open it from the included CD.

2.2.1 Windows® Installation

1. Unzip the archive and run Chronos-Setup.exe.
2. Respond to the prompts to install the software. During the installation a separate window opens for the Windows driver installation. Accept the driver installation.

> **NOTE:** The eZ430-Chronos access point driver may not be certified by Microsoft. Therefore, Windows may generate a warning. Allow the driver installation to continue.

3. When installation finishes, connect the eZ430-Chronos RF USB access point to the PC and follow the Windows driver installation (see Section 2.3).
4. If prompted for the driver for the *TI CC1111 Low-Power RF to USB CDC Serial Port*, allow Windows to 'Install the software automatically'. This can be done only if the eZ430-Chronos PC Software package has already been installed.
5. Open the eZ430-Chronos Control Center program. A shortcut is available on the Desktop and the Start Menu under Programs > Texas Instruments > eZ430-Chronos > eZ430-Chronos Control Center.

For a detailed driver installation, see Appendix B.

2.2.2 Linux® Installation

The eZ430-Chronos PC software for Linux requires TCL/Tk. If the Linux distribution does not already include TCL/Tk yet, install both with the apt-get command:

sudo apt-get install tcl8.5

sudo apt-get install tk8.5

To generate keyboard events and mouse clicks through the watch buttons, xdotool is required. Install with the apt-get command:

sudo apt-get install xdotool

The PC now has the infrastructure for the eZ430-Chronos PC Software. Continue with the eZ430-Chronos installation:

1. Unzip the archive and run Chronos-Setup.
2. Respond to the prompts to install the software.
3. Insert the eZ430-Chronos RF USB access point to the PC.
4. Check the */dev* directory for new entry */dev/ttyACMx*, where *x* specifies the number of the port.
5. Set the COM variable in *eZ430-Chronos_CC_1_2.tcl* and *eZ430-Chronos_Datalogger_1_2.tcl* if the USB RF access point is not mounted as */dev/ttyACM0*
6. Set script files to executable: *chmod u+x ./eZ430-Chronos_CC_1_2.tcl* and *chmod u+x ./eZ430-Chronos_Datalogger_1_2.tcl*
7. Launch the script from terminal *./eZ430-Chronos_CC_1_2.tcl*

> **NOTE:** Linux is supported by the eZ430-Chronos Control Center and eZ430-Chronos Data Logger PC applications. The eZ430-Chronos software package also contains all source code for the watch module and access point, which are provided for Code Composer Studio and the IAR Embedded Workbench. Both IDEs are currently only available for Windows. CrossWorks from Rowley Associates supports Linux and MacOS but requires manual project setup. MSPGCC may be used for Linux as well.

2.3 Using the eZ430-Chronos Watch With a PC

1. The Control Center provides a variety of demos. A detailed description can be found in Section 3.3. The following sections describe only how to use the eZ430-Chronos watch to control the mouse pointer on the PC and to use it to control PowerPoint® presentation software.
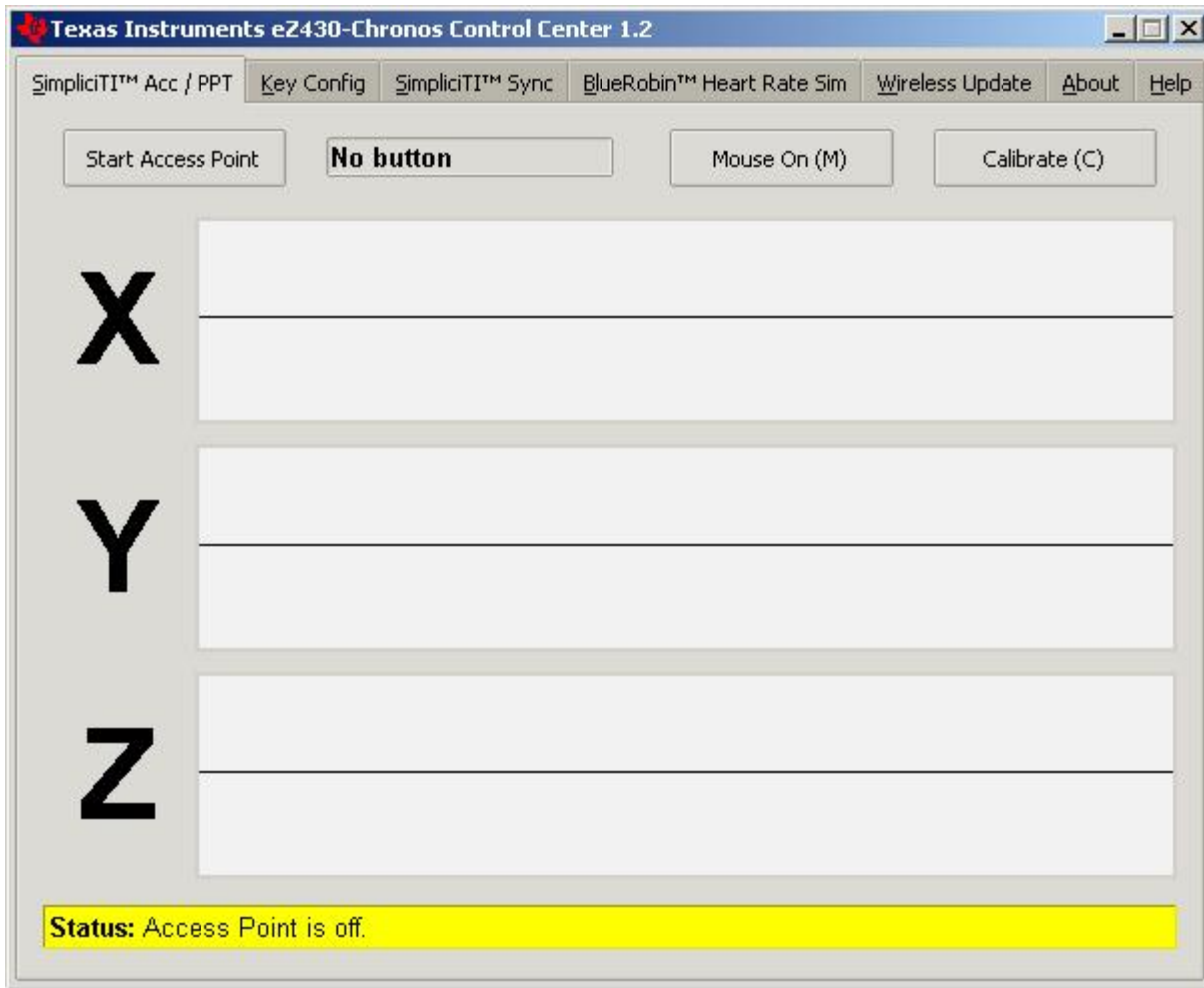
Figure 2-4. eZ430-Chronos Control Center

2.3.1 Transmission of Acceleration Data and Button Pushes

1. Select "SimpliciTI Acc/PPT" tab.
2. Click on "Start Access Point" to start PC. The control center status line displays "*Access point started. Now start watch in ACC, PPT or synch mode*" when the PC is ready
3. Select "ACC" mode in the bottom LCD line of the eZ430-Chronos watch and active the data transmission by pressing the "DOWN" button. The watch connects to the PC (this may take a few seconds) and starts transmitting 3-Axis acceleration values
4. Once connected, the Control Center status bar reports *Receiving data from acceleration sensor* and the values according to the axis. The graphs display the acceleration data of the watch for each axis.
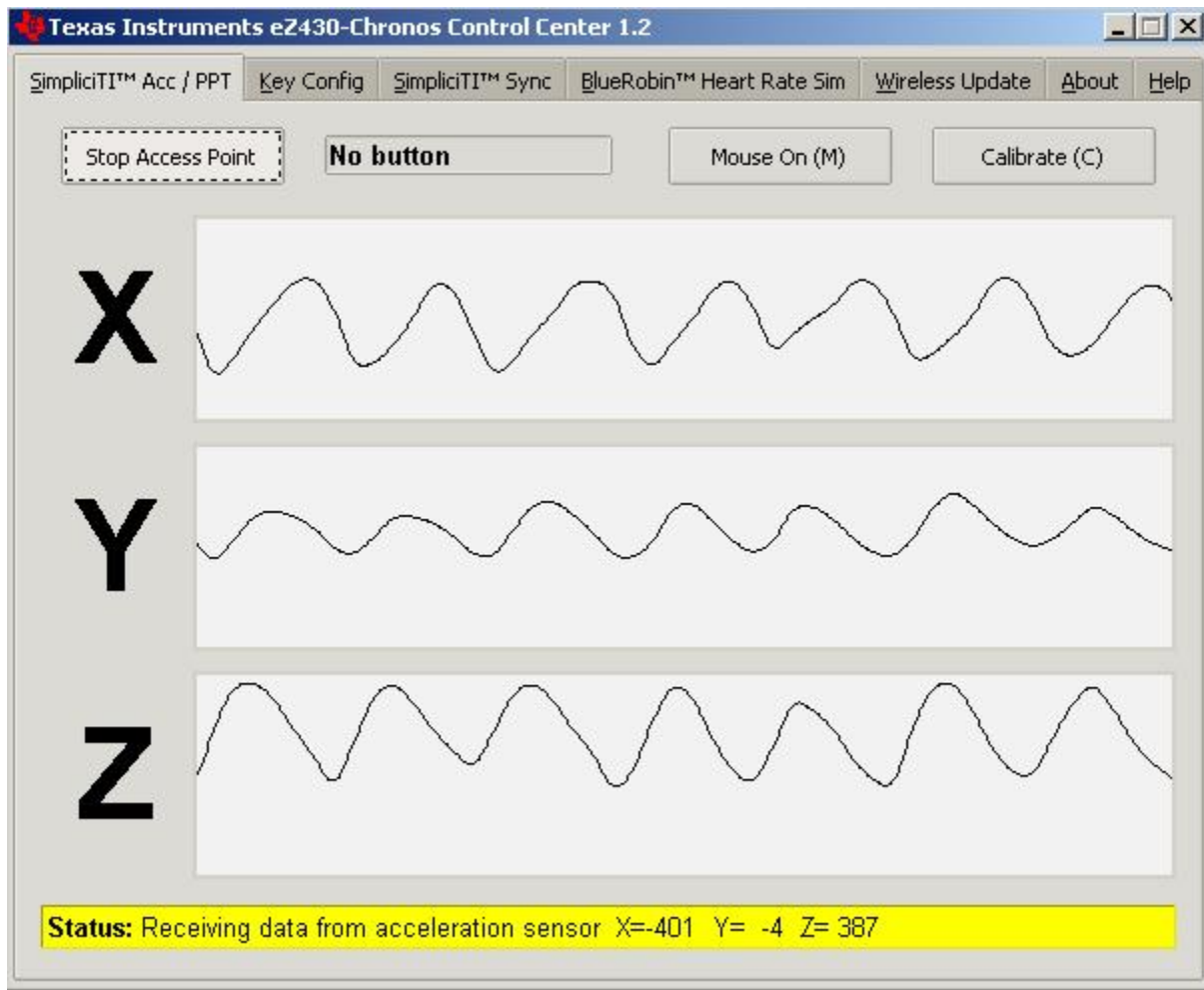
Figure 2-5. eZ430-Chronos Control Center With Acceleration Data

2.3.1.1 PC Mouse Control

1. Click on "*Mouse On (M)*" to control the PC mouse pointer with the eZ430-Chronos watch. Hold the watch with its display facing up. The mouse pointer moves vertically (x-axis in Control Center) when tilting the watch forward/backward and moves vertically (y-axis in Control Center) when tilting the watch left/right. Mouse clicks are possible as well:
   - Left single click: "*" button
   - Left double click: "#" button
   - Right click: "UP" button
2. Mouse control can be calibrated to set a point of zero acceleration (that is, no pointer movement) by selecting "Calibration (C)". It may be disabled by clicking on "Mouse Off (M)" or by pushing "M" on the PC keyboard.

   NOTE: Holding buttons (for example, for drag and drop) is not supported.

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3. Turn the demo off by pushing the "DOWN" button on the eZ430-Chronos watch and clicking "Stop Access Point" in the PC application

2.3.1.2   PowerPoint Control

The Control Center allows the user to map button pushes on the watch into keystrokes on the PC. The default setting is PowerPoint control, which allows switching slides forward/backward and to start the slide show.

1. Select "SimpliciTI Acc/PPT tab.
2. Click on "Start Access Point" to start linking. The control center status line displays "Access point started".
3. Select "PPt" mode in the bottom LCD line of the eZ430-Chronos watch and activate the RF link by pressing the "DOWN" button. The watch connects to the PC, this may take a moment.
4. Once connected, the Control Center status bar show when a button is pushed.
5. Open a PowerPoint presentation. Press "#" to go to presentation mode (slide show - F5), "UP" to switch to next slide (right arrow key) and "*" (left arrow key) to switch to previous slide.

> **NOTE:**   To avoid bouncing of the watch buttons, a delay of 0.6 s between transmissions is implemented; that is, if a button is pressed twice within less than 0.6, it is translated into one keystroke only.
>
> The eZ430-Chronos Control Center allows to the user to define other short cuts; for example, to control a music or video player. See Section 3.3.2 for details.

For troubleshooting tips, see Appendix A, Frequently Asked Questions.

eZ430-Chronos Software

3.1 Overview

This chapter describes the software that is included in the eZ430-Chronos kit. Different projects and PC user interfaces are available:

- eZ430-Chronos sports watch software
- Control Center PC software for Windows and Linux
- eZ430-Chronos watch data logger
- Data logger PC software for Windows and Linux

Many features of the eZ430-Chronos kit are based on TI's SimpliciTI protocol stack. However, the eZ430-Chronos watch can also be used as a heart-rate monitor. For this purpose, the BlueRobin™ ultra-low-power protocol stack can be used.[1] is implemented on the watch and USB access point. The protocol stacks are selected automatically, depending on which feature is used.

3.2 eZ430-Chronos Sports Watch Software

The sports watch firmware (default) provides a broad set of features. Besides basic watch functions such as time, date, alarm and stopwatch advanced sports watch features such as an altimeter, heart-rate monitor*, calorie*, vertical speed* and distance information* are available. The internal accelerometer provides acceleration data on the watch LCD and allows control of a PC by transferring the sensor's measurements. The watch can also be used to control PowerPoint or other PC software with its buttons.

User concept:

The different features are either available in the top or bottom LCD line.

There are three user modes available: **Modes** such as *Time* or *Date*, **Secondary Functions** that allow activation and deactivation of features (for example, to start or stop the stopwatch or to enable or disable the alarm), and **Set Functions** that allow changing settings (for example, setting the time or date or resetting the stopwatch) (see Figure 3-1).

- **Modes:** The different modes can be selected by using the button left of the corresponding LCD line.
  Examples:
  The "*" button allows selecting the top line mode
  The "#" button allows changing the bottom line modes
- **Secondary Functions:** Secondary functions provide an extension to the selected mode and are available through the button to the right of the corresponding LCD line.
  Examples:
  Toggling between time (HH:MM) and seconds (.SS) in time mode: push "UP" button to toggle between modes.
  Start/Stop in stopwatch mode: push "DOWN" to start or stop stopwatch
- **Set Functions:** Time, date and other options can be set by holding the button left of the corresponding LCD line.
  Examples:
  Setting the time (shown in top LCD line): hold the "*" button to enter the time set menu.
  Resetting the stopwatch (shown in bottom LCD line): hold the "#" button to reset.

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[1] BlueRobin is available from BM wireless at www.bmwireless.com.

An exception to the above modes is the **Keylock**. It allows locking the buttons to avoid accidental change or activation of modes (for example, when the watch is carried in a suitcase or bag). The keylock may be enabled or disabled by holding "#" and "DOWN" simultaneously for three seconds. The LCD shows "Loct" when the keylock is active and "oPEn" when it is inactive.

Top modes:
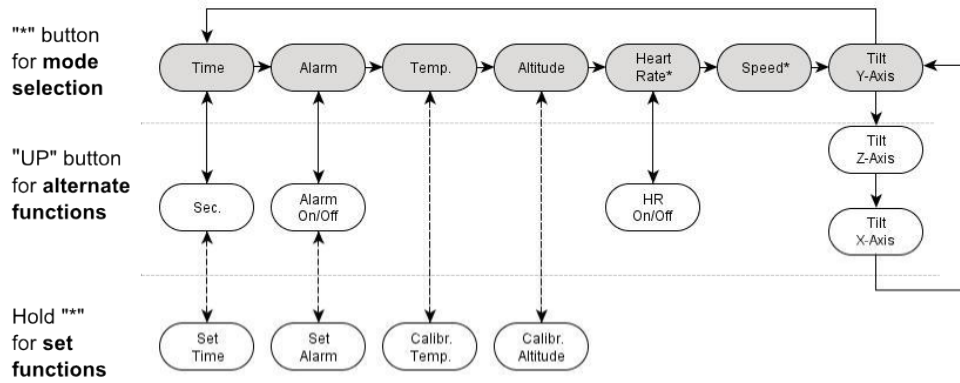
To modify values in set functions use "UP/DOWN", press "#" for next item and "*" to store

Bottom modes:
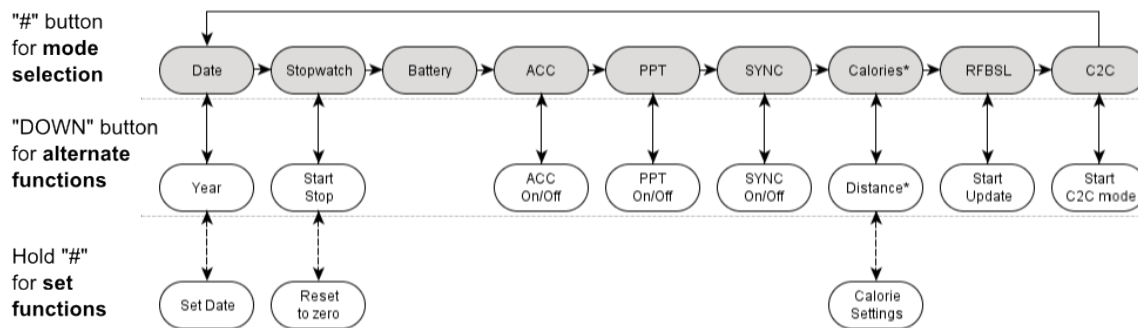
To modify values in set functions use "UP/DOWN", press "#" for next item and "*" to store

Note: Heart rate can be generated by eZ430-Chronos Control Center. Optional heart-rate monitor is available from BM innovations at www.bm-innovations.com/chronos.

Figure 3-1. eZ430-Chronos Feature Overview and Menu Structure

3.2.1 Detailed Feature Overview - Modes Using the Top LCD Line

3.2.1.1 Time Mode

Press "*" until the time mode is active (see Figure 3-1 for details).

Secondary function: Seconds. Press "UP" to activate the alternative display. To return to the HH:MM mode, push the "UP" button again.

Set function: Setting the time.

1. Hold "*" for three seconds until the time disappears and "12H" or "24H" is shown on the LCD
2. Select 12H/24H modes by pushing the "UP" or "DOWN" buttons
3. Press "#" to continue with the time adjustment
4. Set the hours by pushing the "UP" or "DOWN" button
5. Press "#" to continue with the minutes adjustment
6. Set the minutes by pushing the "UP" or "DOWN" button
7. Press "#" to continue with the second adjustment
8. Set the seconds by pushing the "UP" or "DOWN" button
9. Press "*" to confirm the settings and go back to normal operation, or press "#" to start over with step 2

> **NOTE:** If no button is pressed for more than 30 seconds, the previous settings are restored.

3.2.1.2 Alarm Mode

Press "*" until the alarm mode is active (see Figure 3-1 for details). The alarm mode can be distinguished from time mode by an alarm symbol (bell) that flashes when the alarm time is displayed.

Secondary function: Alarm on/off. Press "UP" to enable or disable the alarm. The settings are confirmed by "on" and "off" in the top LCD line. The bell icon stays on in all other modes when the alarm is enabled and does not appear when the alarm is disabled.

Set function: Setting the alarm time.

1. Hold "*" for three seconds until the alarm time hour starts to flash
2. Set the hours by pushing the "UP" or "DOWN" button
3. Press "#" to continue with the minutes adjustment
4. Set the minutes by pushing the "UP" or "DOWN" button
5. Press "*" to confirm the settings and go back to normal operation, or press "#" to start over with step 2

> **NOTE:** If no button is pressed for more than 30 seconds, the previous settings are restored.

3.2.1.3   Temperature Mode

Press "*" until the temperature mode is active (see Figure 3-1 for details). The temperature can be shown in degree Celsius or Fahrenheit. The selection depends on the time mode setting. In 12H mode, the temperature is shown in degrees Fahrenheit, in 24H mode in degrees Celsius. The temperature is measured in 1-second intervals. Positive temperatures are marked with a small arrow pointing up in the upper LCD line, left of the temperature. An arrow pointing down indicated temperatures below zero.

Secondary function: None

Set function: Temperature calibration (can also calibrated from PC software in Sync mode, see Section 3.3).

1. Hold "*" for three seconds until the temperature starts to flash
2. Set the temperatures by pushing the "UP" or "DOWN" button
3. Press "*" to confirm the settings

> **NOTE:**   The temperature is measured inside the watch right inside the CC430 device. When the watch is worn, the temperature of the watch may be different due to the body heat. For accurate temperature measurements, do not wear the watch and allow a sufficient amount of time for the watch to adapt to the surrounding temperature.

3.2.1.4   Altimeter Mode

Press "*" until the altimeter alarm mode is active (see Figure 3-1 for details). The altitude can be shown in metric or imperial units. In 12H time mode, the altitude is shown in imperial, in 24H time mode in metric units. The altitude is measured only when the altimeter mode is active, and measurement happen in intervals of 1 second.

The implementation of the altitude algorithm is done according to the VTI's application report AN33 without any additional low-power optimizations. Therefore, the altimeter is active only in altimeter mode. In addition, a timeout deactivates the measurements after 60 minutes. Altitudes above sea level are indicated with a small arrow pointing up in the upper LCD line, left of the altitude. Altitudes below sea level are indicated with a small arrow pointing down.

The altimeter algorithm is based on the air pressure and the ambient temperature. Therefore, changes in air pressure affect the altitude accuracy. For precise measurements, the altimeter needs to be calibrated manually upon weather changes.

> **NOTE:**   For most accurate altitude measurement, the watch needs to be fully exposed to the ambient temperature (that is, the watch should not be worn directly on the arm), because temperature is part of the altitude measurement (see Section 3.2.1.3).

Secondary function: Re-activate altimeter after timeout

Set function: Altitude calibration

1. Hold "*" for three seconds until the altitude starts to flash
2. Set the altitude by pushing the "UP" or "DOWN" button
3. Press "*" to confirm the settings.

3.2.1.5   Heart Rate Mode - RF [2]

Press "*" until the heart icon appears on the display that is heart rate mode is active (see Figure 3-1 for details). When this mode is active, heart rate is shown and burned calories are determined (additional settings must be made for first time use, see Section 3.2.2.7). For information on how to use the chest belt, see to the documentation included with the heart-rate monitor device.

> **NOTE:**   This mode requires a heart-rate monitor (chest belt) that is not included in this kit, but available from BM innovations, Germany (see www.bm-innovations.com/chronos). However, a heart rate can be simulated without a chest belt by the eZ430-Chronos Control Center, see Section 3.3 for details.
>
> While almost all other eZ430-Chronos functions are based on TI's SimpliciTI protocol, the heart-rate monitoring uses BlueRobin, an ultra-low-power low-data-rate wireless communication protocol from BM innovations.

Secondary function: Heart rate display on/off. Press "UP" to enable/disable the heart-rate monitoring. Once a connection is established, the heart rate is shown on the top LCD line

Set function: None

3.2.1.6   Speed Mode - RF [3]

Press "*" until the "mi/h" or "km/h" icon is shown on the display; that is, the speed mode is active (see Figure 3-1). Your running speed is shown on the LCD top line.

> **NOTE:**   This mode requires a heart-rate monitor (chest belt) which includes an accelerometer to determine running speed. Visit BM innovations at www.bm-innovations.com/chronos for available additions. However, speed can be simulated without a chest belt by the eZ430-Chronos Control Center, see Section 3.3.4 for details.
>
> While almost all other eZ430-Chronos functions are based on TI's SimpliciTI protocol, the speed mode uses BlueRobin, an ultra-low-power low-data-rate wireless communication protocol from BM innovations.

Secondary function: None

Set function: None

3.2.1.7   Tilt Mode

Press "*" until the tilt mode is active (see Figure 3-1). The acceleration is shown in G (9.81 m/s^2) for all three axes. After entering the tilt mode, the y-axis acceleration is shown by default, and the z-axis or x-axis can be selected. Positive acceleration values are marked with a small arrow pointing up in the top LCD line, left of the acceleration. Negative acceleration values are marked with a small arrow pointing down. After 60 minutes, a timeout deactivates the measurements.

Secondary function: Select axis. The default is y-axis, followed by z-axis and x-axis.

Set function: None

[2]   Additional accessory or eZ430-Chronos Control Center heart rate simulation required.
[3]   Additional accessory or eZ430-Chronos Control Center heart rate simulation required.

3.2.2 Detailed Feature Overview - Modes Using the Bottom LCD Line

3.2.2.1 Date Mode

Press "#" until the date mode is active (see Figure 3-1).

Secondary function: Year. Press "DOWN" to activate the alternative display. To return to day and month, push the "DOWN" button again.

Set function: Setting the date

1. Push the "#" button until the date is displayed in the bottom LCD line.

2. Hold "#" for three seconds until the year flashes on the bottom LCD line.

3. Set the year by pushing the "UP" or "DOWN" button.

4. Press "#" to continue with the month adjustment.

5. Set the month by pushing the "UP" or "DOWN" button.

6. Press "#" to continue with the day adjustment.

7. Set the day by pushing the "UP" or "DOWN" button. Press "*" to confirm the settings and go back to normal operation, or press "#" to start over with step 3.

> **NOTE:** If no key is pressed for more than 30 seconds, the previous settings are restored.

3.2.2.2 Stopwatch Mode

Press "#" until the stopwatch mode is active (see Figure 3-1). It supports up time intervals up to 19 hours, 59 minutes and 59 seconds. For the first 20 minutes, the resolution is 1/100 second, after 20 minutes the resolution changes to 1 second.

Secondary function: Start/stop. Press "DOWN" to start or stop the stopwatch

Set function: Reset stopwatch.

Hold the "#" button until the stopwatch is set to zero

3.2.2.3 Battery Voltage Mode

Press "#" until the battery voltage is shown (see Figure 3-1). It is updated once per minute.

Secondary function: None

Set function: None

3.2.2.4 Acceleration Mode - RF

This mode requires the eZ430-Chronos Control Center PC software.

Press "#" until "ACC" is shown on the LCD (see Figure 3-1). This mode provide a continuous transmission of 3D acceleration from the watch using TI's SimpliciTI protocol stack. In addition, the watch transmits a signal when the "#", "*" or "UP" buttons are pushed.

Secondary function: Start/stop transmission of acceleration data. Pushing "DOWN" starts/stops the pairing process or stop the transmission (the access point on the PC must be started first from the eZ430-Chronos Control Center (see Section 3.3.1). The RF icon on the LCD flashes when the radio is active. If the pairing fails, it disappears. The top LCD line shows the time during the pairing and until the data transmission is disabled.

Set function: None

3.2.2.5 PowerPoint Mode - RF

This mode requires the eZ430-Chronos Control Center PC software.

Press "#" until "PPt" is shown (see Figure 3-1). This mode allows control of a PowerPoint presentation by translating button pushes on the watch into keystrokes of the PC keyboard. No acceleration or other data is transmitted. The default settings are:

- "#" - Go to presentation mode (F5)
- "*" - Previous slide (Left)
- "UP" - Next slide (Right)

The Control Center allows user defined key settings (including combinations) - see Section 3.3.2.

Secondary function: Start/stop transmission of button pushes. Pushing "DOWN" starts/stops the pairing process or stops the transmission (the access point on the PC must be started from the eZ430-Chronos Control Center (see Section 3.3.1). The RF icon on the LCD flashes when the radio is active; if pairing fails, the icon disappears. The top LCD line shows the time during the pairing until the data transmission is disabled.

Set function: None

3.2.2.6 Sync Mode - RF

This mode requires the eZ430-Chronos Control Center PC software.

Press "#" until "SYnC" is shown (see Figure 3-1). This mode allows doing a variety of watch settings conveniently from the eZ430-Chronos Control Center PC software over the air (see Section 3.3.3).

- Time settings
- Date settings
- Altitude calibration
- Temperature calibration

Secondary function: Start/stop link for Sync Mode. Pushing "DOWN" starts/stops the pairing process or stop the link (the access point on the PC must be started first from the eZ430-Chronos Control Center (see Section 3.3.3). The RF icon on the LCD flashes when the radio is active. If the pairing fails, it disappears. After a successfully received message, the LCD shows "DONE". The top LCD line is off during the pairing and until the Sync Mode is disabled.

Set function: None

3.2.2.7 Calorie/Distance Mode - RF [4]

Press "#" until the "kcal" icon appears (see Figure 3-1). This mode shows the amount of calories that were burned while exercising, if the optional chest belt is used and heart rate mode is active. This mode also provides the distance (for example, when running) if a chest belt with build-in accelerometer is used. For accurate calorie determination, users need to set their sex and weight.

Secondary function: Distance. Press "DOWN" to activate the alternative display. To return to Calorie Mode, push the "DOWN" button again.

Set function: (Re-)setting calories and setting user weight and sex.

1. Push the "#" button until the calories is displayed in the bottom LCD line
2. Hold "#" for three seconds until the calorie value flashes on the bottom LCD line
3. (Re-)set the calories by pushing "UP" or "DOWN"
4. Press "#" to continue with the user sex adjustment
5. Set the user sex by pushing "UP" or "DOWN"
6. Press "#" to continue with user weight adjustment
7. Set the user weight (lb in 12H time mode, kg in 24H time mode) by pushing "UP" or "DOWN"
8. Press "*" to confirm the settings and go back to normal operation, or press "#" to start over with step 3

NOTE: If no key is pressed for more than 30 seconds, the previous settings are restored.

3.2.2.8 Wireless Update - RF

This mode requires the eZ430-Chronos Control Center PC software.

Press "#" until the "rFbSL" is shown (see Figure 3-1). This mode allows updating the firmware of the eZ430-Chronos watch wirelessly.

Secondary function: Start or restart the update process. Push "DOWN" once to switch to the confirmation menu "CONF". Pushing "DOWN" again starts or restarts the update process (the wireless update on the PC must be started from the eZ430-Chronos Control Center first (see Section 3.3.1)). At the beginning of the update the LCD shows "rAM" for a few seconds. During this time, the updater software is downloaded from the PC to the RAM of the CC430 on the watch. This program contains all memory write and LCD routines. After this transfer is finished, the code is executed from RAM, and the download of the actual firmware file is started. The LCD shows the progress in percent on the upper LCD line. After the transfer is complete, a reset starts the software on the watch. See Section 3.6.4 for details.

NOTE: When the wireless update is activated on the watch, it returns to the main application only with a reset, whether or not an update was performed. Time, data, alarm, and other RAM-based data are lost.

---

[4] Additional accessory or eZ430-Chronos Control Center heart rate simulation required.

3.2.2.9 Chronos-to-Chronos (C2C) Mode

This mode requires two eZ430-Chronos watches.

This mode allows the bidirectional control of two watches using SimpliciTI, the low-power RF network protocol. Press "#" until "C2C" is shown. Press "DOWN" in both watches to initiate the connection. Wait until both watches show the message "FOUND". After that the system is ready to go.

1. "STAR" - Change menu (upper line)
2. "NUM" - Change menu (lower line)
3. "UP" - Change displayed Acc Axis (just for the acceleration menu)

To stop, press "DOWN" to close the connection.

Set function: None

NOTE: The standard code for Chronos (out of the box) does not have the Chronos-to-Chronos communication feature. The reason for that is the limited size in the flash (32KB). The code for production has a special test function that ensures that everything is working properly before shipping. Because this function is used only during production, a #DEFINE is available to remove it and free the space necessary for the Chronos-to-Chronos communication. This define is in project.h.

3.3 eZ430-Chronos Control Center PC Software

The eZ430-Chronos Control Center software provides several features demonstrating the wireless capabilities of the kit on Windows and Linux operating systems. Different RF protocol stacks are automatically selected for use, depending on the function. Available features:

- 3D acceleration graph with PC mouse control
- Wireless remote control / PowerPoint control
- Time, date, and calibration data synchronization tool
- Heart rate and speed simulator
- Wireless firmware update

NOTE: Connect the USB RF access point to the PC before launching the Control Center software. For first time use, wait until Windows has finished the access point driver installation.

In case of problems on Windows PCs, check if the settings for the RF access point are correct in the Windows Device Manager *Start > Control Panel > System > Hardware > Device Manager*. The RF access point is listed under *Ports (COM & LPT)* as *TI CC1111 Low-Power RF to USB CDC Serial Port*. The port settings should be:

- Baud Rate: 115200
- Data bits: 8
- Parity: None
- Stop bits: 1
- Flow control: None

In case of problems on Linux PCs, ensure that the correct tty setting is specified. Check /dev for the new tty device after plugging in the RF access point. If the RF access point is assigned to a device other than *ttyACM0*, either remove the serial device that occupies this slot (for example, a modem), or change the script file variable "com" in *eZ430-Chronos_CC_1_2.tcl* located in */home/<user name>/Texas Instruments/eZ430-Chronos/Control Center/eZ430-Chronos Control Center*.

To launch the Control Center software on a Windows PC, shortcuts are available on the Desktop and in the Start Menu under *Programs > Texas Instruments > eZ430-Chronos > eZ430-Chronos Control Center*.

To launch the Control Center software on a Linux PC, browse to */home/<user name>/Texas Instruments/eZ430-Chronos/Control Center/eZ430-Chronos Control Center* and run *eZ430-Chronos_CC_1_2.tcl*.

The different features are grouped onto tabs of the Control Center window. The tabs also indicate which radio protocol is used.
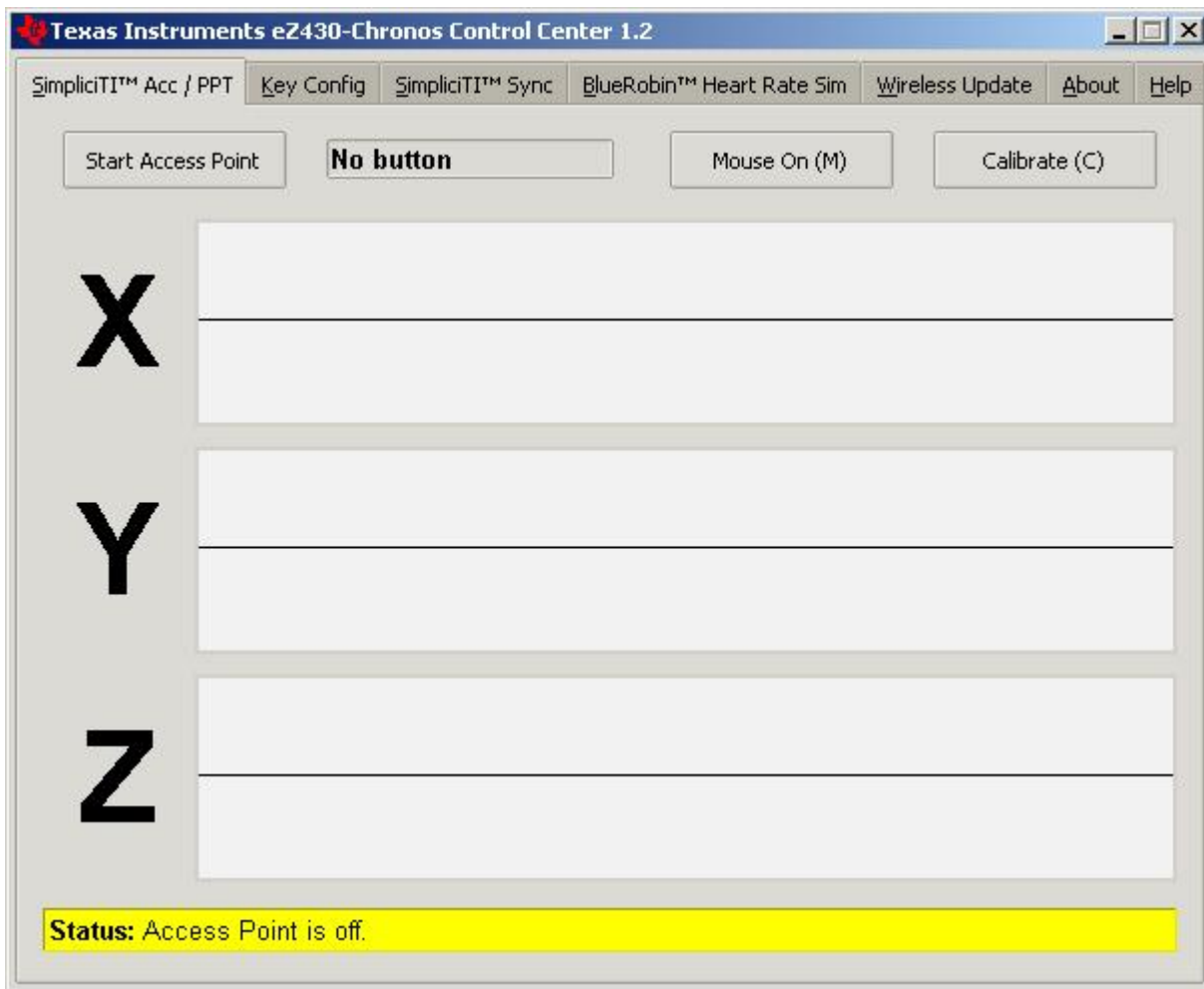
Figure 3-2. eZ430-Chronos Control Center

3.3.1 SimpliciTI™ Acc/PPT Tab (Mouse and PowerPoint Control)

The SimpliciTI Acc / PPT tab support two different features. It may be used to display the acceleration data transmitted by the watch, which can also be used to control the mouse pointer. It may also be used to remotely control the PC with user-definable shortcuts such as PowerPoint control.

Pairing watch and PC:

1. Activate the pairing on the PC by clicking on "Start Access Point". The control center status line displays "Access point started. Now start watch in acc, ppt or sync mode" when the PC is ready
2. Select "ACC" or "PPt" on the eZ430-Chronos watch by pushing the "#" button, depending on the desired function - see detailed description in Section 3.3.1.1 or in Section 3.2.2.4.
3. Initiate pairing on the watch by pushing the "DOWN" button to activate the selected mode

    After a short time, the link is established.

    In "ACC" mode, the Control Center status bar shows:
        "Receiving data from acceleration sensor X=... Y=... Z=...".

    In "PPt" mode, the Control Center status bar reports which button is pushed ("#", "*", or "UP").

3.3.1.1 Acc Mode

In this mode, the watch constantly transmits acceleration data to the PC. In addition, "#", "*" and "UP" button pushes are transferred. The Control Center software shows the 3D acceleration in graphs. Optionally, mouse control can be activated by clicking on *"Mouse On (M)"* or by pushing "M" on the keyboard.

Once active, the PC mouse pointer can be controlled by tilting the watch. Hold the watch with its display facing up. The mouse pointer moves vertically (x-axis in Control Center) when tilting the watch forward/backward and move vertically (y-axis in Control Center) when tilting it left/right. Mouse clicks are possible as well - see below. Mouse control can be calibrated (to set a point of zero acceleration that is no pointer movement) by selecting "Calibration (C)". It may be disabled by clicking on "Mouse Off (M)" or by pushing "M" on the PC keyboard.

- Left single click: "*" button
- Left double click: "#" button
- Right click: "UP" button

NOTE: Holding buttons (for example, to drag and drop) is not supported.

Turn the demo off by pushing the "DOWN" button on the eZ430-Chronos watch and clicking "Stop Access Point" in the PC application.
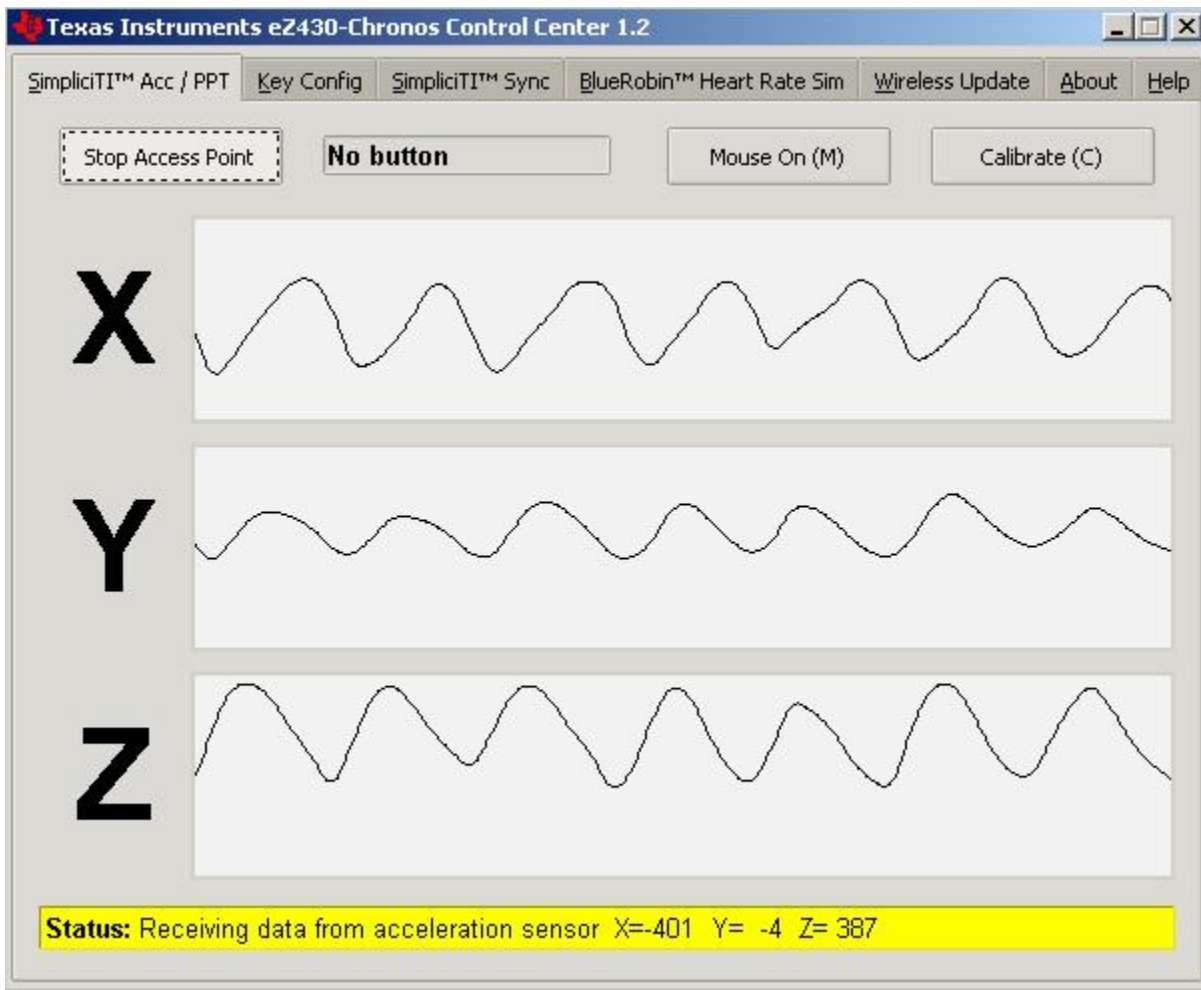
Figure 3-3. eZ430-Chronos Control Center With Acceleration Data

3.3.1.2 PPT Mode

This mode allows using the eZ430-Chronos watch as a simple PC remote control. Data is transmitted only when either the "#", "*", or "UP" button is pushed. This information is mapped into keystrokes on the PC. The default setting is PowerPoint control, and the buttons are mapped to:

- "#" to go to presentation mode (slide show - F5)
- "UP" to switch to next slide (right arrow key)
- "*" (left arrow key) to switch to previous slide

These settings can be changed to many other combinations; for example, such as controlling music players or standard Windows functions (see Section 3.3.2 for details).
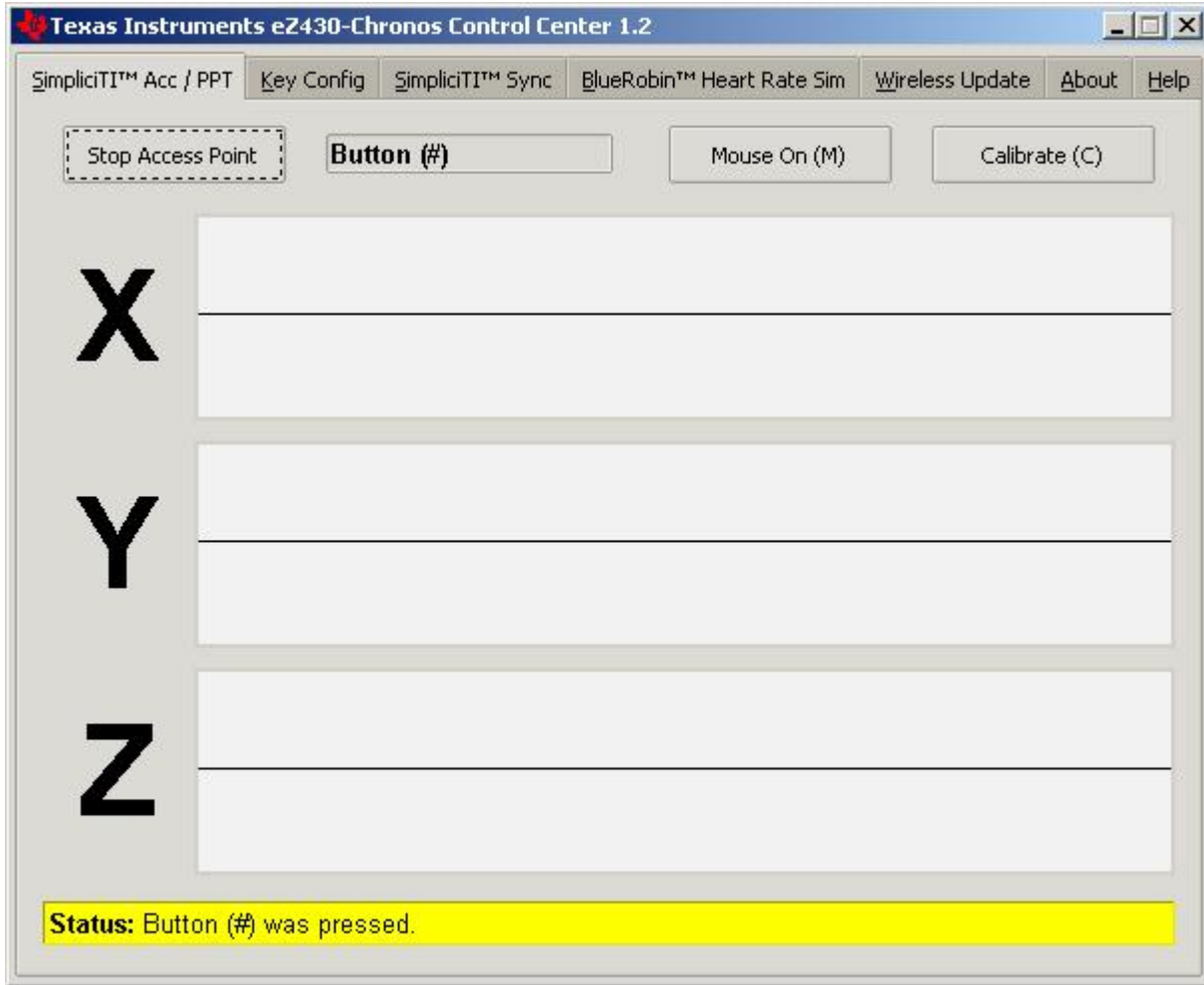
Figure 3-4. eZ430-Chronos Control Center With PPT Control

3.3.2 Key Configuration Tab

This tab contains the key mapping for the eZ430-Chronos watch buttons "#", "*" and "UP". Besides a single key selection (pull down menu for each button), also full combinations including "Shift", "Ctrl", "Alt" and "Windows" can be user defined by ticking the corresponding option. Changes can be made whilst the "PPT" mode is active. Configurations can be saved by clicking the "Save" button.

Predefined configurations are available in a pull down menu on top of the menu. Select configuration from menu and clock "Load" to activate them.

Predefined key configurations:

*   PowerPoint Control (*eZ430-Chronos-CC.ini*)
    "*" = previous slide
    "UP" = next slide
    "#" = start presentation (F5)
*   Windows Media Player (*Media Player Control.ini*)
    "*" = previous song
    "UP" = next song
    "#" = start/pause
*   iTunes (*iTunes Control.ini*)
    "*" = previous song
    "UP" = next song
    "#" = start/pause

The key mapping may be changes while PPT mode is active.
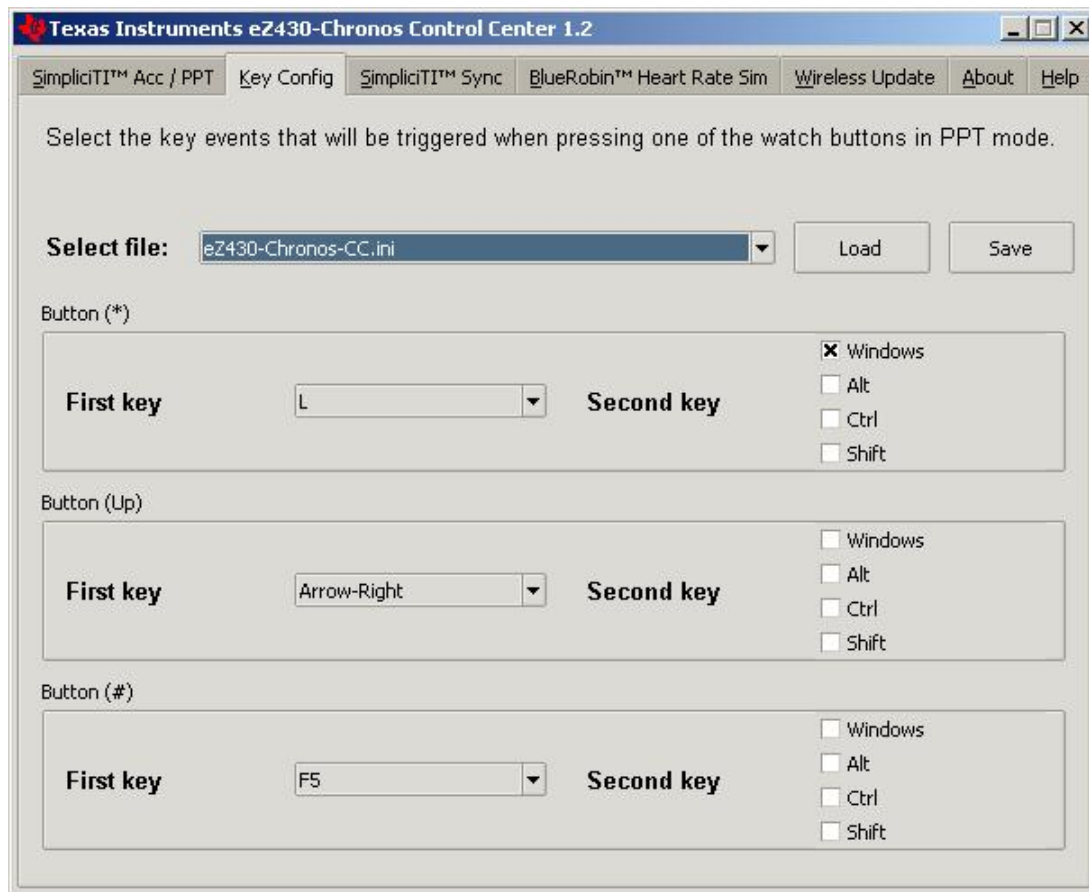
Figure 3-5. eZ430-Chronos Control Center Key Configuration

3.3.3 SimpliciTI™ Sync

The SimpliciTI Sync tab offers the possibility setting time/date of the watch including calibration data conveniently.

Pairing watch and PC:

1. Activate the pairing on the PC by clicking on "Start Access Point". The Control Center status line displays "Access point started. Now start watch in ACC, PPT or synch mode" when the PC is ready
2. Select "SYnC" on the eZ430-Chronos watch by pushing the "#" button.
3. Initiate pairing on the watch by pushing the "DOWN" button to activate the selected mode. After a short time, the link is established.

Setting the watch:

1. Select metric or imperial units
2. Enter calibration data for the temperature and altitude OR read back the data from the watch by clicking on "Read Watch"
3. Click "Copy System Time" to set watch according to read the PC system time
4. Click "Set Watch" to transfer data to watch
5. The watch shows "DONE"
6. Push the "DOWN" button on watch to end connection
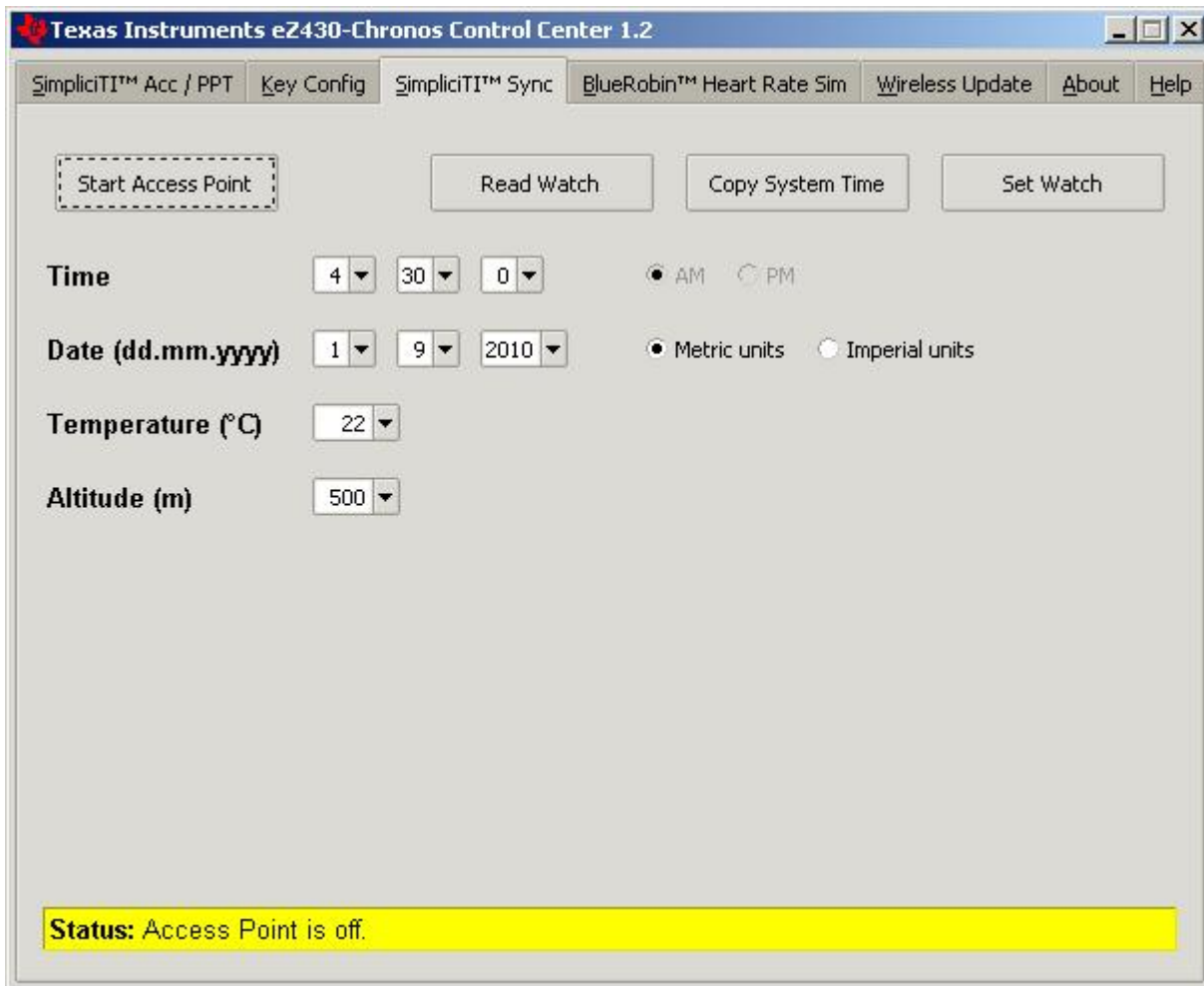
Figure 3-6. eZ430-Chronos Control Center Sync

3.3.4 BlueRobin™ Heart Rate Simulator

This mode simulates an active heart rate chest belt. Besides the heart rate it may also be used to transfer speed and distance data from the PC to the eZ430-Chronos watch.

Pairing watch and PC:

1. Activate link on the PC by clicking on "Start Transmitter". The Control Center status line displays "Transmitting heart rate (...bpm), speed (...km/h) and distance (...m)" when the PC is transmitting data. The heart rate may be changed by the heart rate and speed sliders or by selecting "sweep" for automatic heart rate and speed sweeping

2. Select heart rate mode (heart symbol is shown) by pushing the "*" button (see detailed description in Section 3.2.1.5).

3. Start receiver on watch by pushing the "UP" button

4. After a short moment, the current heart rate is displayed

    Speed can be selected by pushing the "*" button

    Calories can be selected by pushing the "#" button

    Distance can be selected by pushing the "DOWN" button in Calorie Mode (see Section 3.2.2.7).

5. The reception may be stopped by pushing "UP" while the heart rate is shown
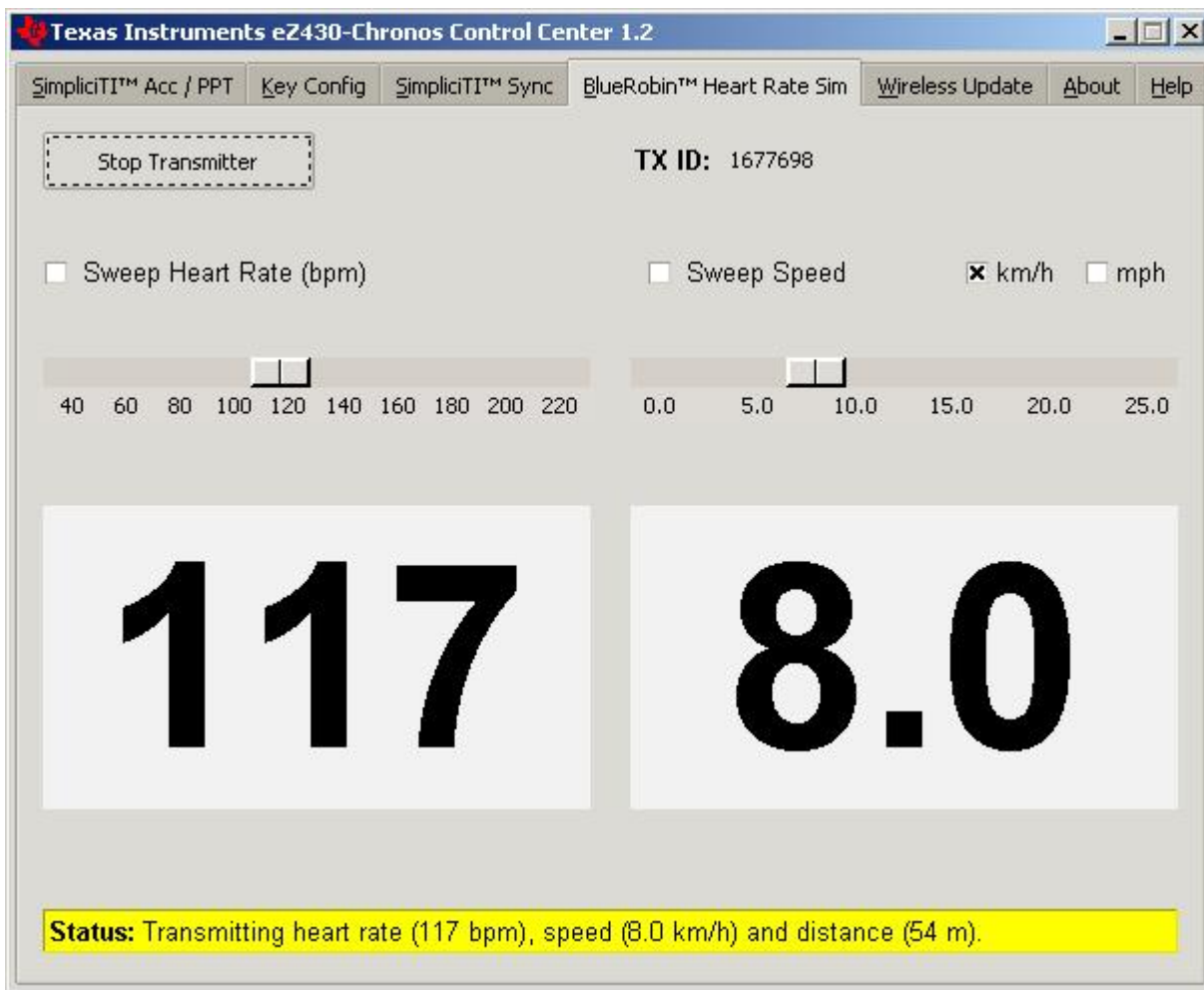
Figure 3-7. eZ430-Chronos Control Center Heart Rate Simulator

3.3.5 Wireless Update

This mode allows updating the firmware of the eZ430-Chronos watch wirelessly, without disassembling it.

Update procedure:

1. Select CC430 flash image (.txt file) by clicking on "Browse...". Example images for the sports watch software and the data logger application are located for Windows in *C:\Program Files\Texas Instruments\eZ430-Chronos\Recovery\eZ430-Chronos Watch\Applications* and for Linux in */home/<user name>/Texas Instruments/eZ430-Chronos/Recovery/eZ430-Chronos Watch/Applications*.

   NOTE: Ensure selecting the correct version of the flash images. If the wrong frequency is selected, no wireless communication is possible anymore. In that case, the watch must be updated using the eZ430 debug interface.

   Only transfer flash images to the watch, which allow invoking the updater software on the watch.

   The file to be downloaded to the watch must be in TI-TXT format to work with this update procedure. This new firmware must reside within the main memory flash (0x8000 to 0xFFFF), otherwise the update procedure fails due to boundary checks on the watch side.

2. Activate the update mechanism on the PC by clicking on "Update eZ430-Chronos Watch". The Control Center status line displays "Access point started. Now start watch in rFbSL mode" when the PC is ready.
3. Select "rFbSL" on the eZ430-Chronos watch by pushing the "#" button
4. Initiate update by pushing the "DOWN" button
5. After a short moment, the update is started

   At the beginning of the update the LCD shows "rAM" for a few seconds. During this time, the actual updater software is downloaded from the PC to the RAM of the CC430 on the watch. This program contains all memory write and LCD routines. After this transfer is finished, the code is executed from RAM, and the download of the firmware file is started. The LCD shows the progress in percent on the upper LCD line. After the transfer is complete, a reset starts the software on the watch (see Section 3.6.4).

   NOTE: If the update fails, it can be activated again by pushing the "DOWN" button again on the eZ430-Chronos watch, given that the wireless update is active in the eZ430-Chronos Control Center.
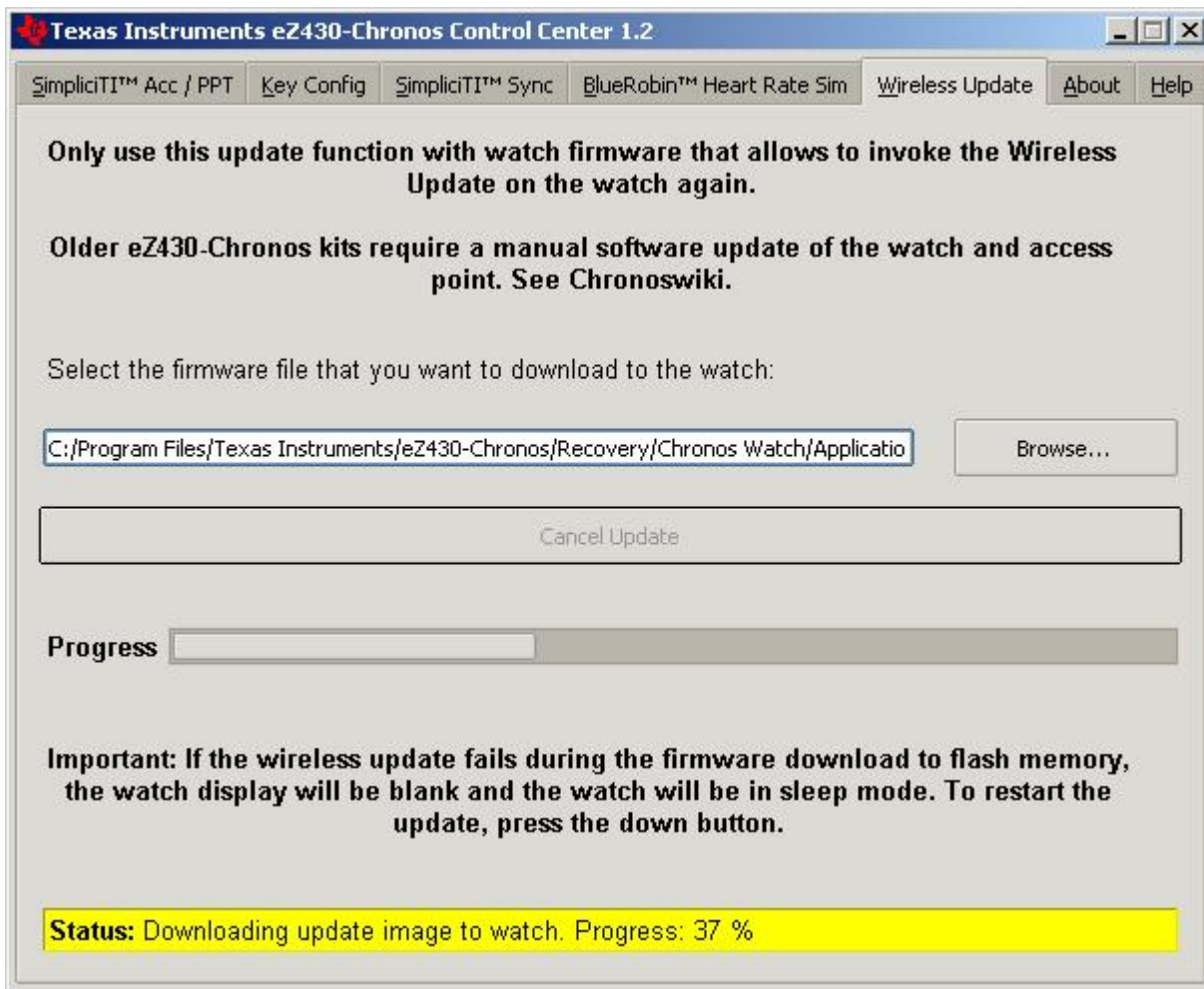
Figure 3-8. eZ430-Chronos Control Center Wireless Update

3.4 eZ430-Chronos Watch Data Logger

Besides the sports watch software, the eZ430-Chronos kit comes with an additional software project that turns the watch into a data logger. Heart rate,[5] temperature, and altitude can be logged in user definable intervals of 1 to 255 seconds. 8KB of flash memory is reserved for logging several hours up to days, depending on the settings. The stored data can be transferred to a PC (in CSV format) and used for further analysis. The data logger provides fewer features compared to the sports watch software as memory is freed for data storage. Most importantly, no **Set Functions** are available (that is, the watch cannot be set or calibrated standalone); however, this can be done conveniently by using the eZ430-Chronos Data Logger PC software. The software project for CCS can be found in *C:\Program Files\Texas Instruments\eZ430-Chronos\Software Projects\CCS\Data Logger* and for IAR in *C:\Program Files\Texas Instruments\eZ430-Chronos\Software Projects\IAR\Data Logger.*

Available features:

- Time, Date
- Temperature
- Altitude
- Heart rate
- Sync
- Wireless firmware update
- Data logger
- Battery monitoring

> **NOTE:** No **Set Functions** are available in this software. All settings can be done using the eZ430-Chronos Data Logger PC software.

User concept:

The user concept and the modes remain the same as in the sports watch software except for the **Set Functions** (see Section 2.1).

---

[5] Heart rate can be generated by eZ430-Chronos Control Center. Optional heart-rate monitor is available from BM innovations at www.bm-innovations.com/chronos.

Top modes:
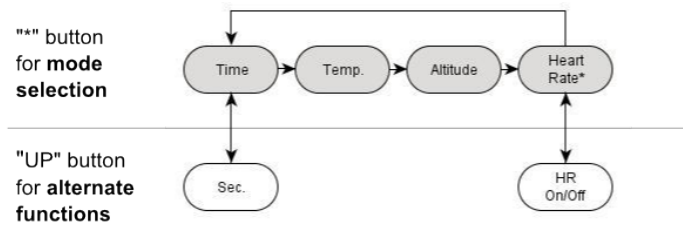
Bottom modes:
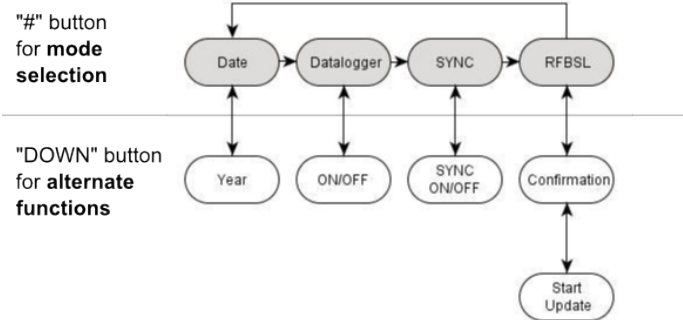
Figure 3-9. eZ430-Chronos Data Logger Feature Overview and Menu Structure

3.4.1 Detailed Feature Overview

As all available modes remain the same in the Data Logger software, only the additions are described in this section.

3.4.1.1 Data Logger Mode

The data logger mode can be selected by pushing the "*" button until the bottom LCD line shows "dLog". It may be enabled/disabled by pushing the "DOWN" button. If the heart rate data logging is selected (see Section 3.5) in data logger PC software, the heart-rate monitor is automatically enabled (the RF icon flashes until linked to a heart-rate monitor). When active, the record icon on the LCD is on (see Figure 1-1).

NOTE: Connect the USB RF access point to the PC before launching the Control Center software. For first time use, wait until Windows has finished the access point driver installation.

In case of problems on Windows PCs, check if the settings for the RF access point are correct in the Windows Device Manager *Start > Control Panel > System > Hardware > Device Manager*. The RF access point is listed under *Ports (COM & LPT)* as *TI CC1111 Low-Power RF to USB CDC Serial Port*. The port settings should be:

- Baud Rate: 115200
- Data bits: 8
- Parity: None
- Stop bits: 1
- Flow control: None

In case of problems on Linux PCs, ensure that the correct tty setting is specified. Check /dev for the new tty device after plugging in the RF access point. If the RF access point is assigned to a device other than *ttyACM0*, either remove the serial device that occupies this slot (for example, a modem), or change the script file variable "com" in *eZ430-Chronos_Datalogger_1_2.tcl* located in */home/<user name>/Texas Instruments/eZ430-Chronos/Control Center/eZ430-Chronos Data Logger*.

To launch the Control Center software, shortcuts are available in the Start Menu under *Programs > Texas Instruments > eZ430-Chronos > eZ430-Chronos Data Logger*.

3.5 Data Logger PC Software

The eZ430-Chronos data logger PC software allows reading out logged data from the watch. It can also be used to set and calibrate the watch, as its set modes were removed to free up as much memory as possible for data logging. Available features:

- Time, date and calibration data synchronization tool
- Read out of logged data
- Wireless firmware update

To launch the eZ430-Chronos Data Logger software on a Windows PC, shortcuts are available on the Desktop and in the Start Menu under *Programs > Texas Instruments > eZ430-Chronos > eZ430-Chronos Data Logger*.

To launch the eZ430-Chronos Data Logger software on a Linux PC, browse to */home/<user name>/Texas Instruments/eZ430-Chronos/Control Center/eZ430-Chronos Data Logger* and run *eZ430-Chronos_Datalogger_1_2.tcl*.

3.5.1 SimpliciTI Data Logger

The SimpliciTI Sync tab offers the possibility setting time/date of the watch including calibration data besides reading out logged data.

Pairing watch and PC:

1. Activate the pairing on the PC by clicking on "Start Access Point". The eZ430-Chronos Data Logger status line displays "Access point started. Now start watch in acc, ppt or sync mode" when the PC is ready

2. Select "SYnC" on the eZ430-Chronos watch by pushing the "#" button (see detailed description in Section 3.3.3).

3. Initiate pairing on the watch by pushing the "DOWN" button to activate the selected mode. After a short time, the link is established

Setting the watch:

1. Select metric or imperial units.

2. Enter calibration data for the temperature and altitude OR read back the data from the watch by clicking on "Read Watch"

3. Specify, which data should be logged

4. Define logging time interval (1 to 255 seconds), in which data is stored

5. Click "Copy System Time" to set watch according to read the PC's system time

6. Click "Set Watch" to transfer data to watch

7. The watch shows "DONE"

8. Push the "DOWN" button on watch to end connection

Reading out logged data:

1. Pair watch with PC in case not linked yet - see **Pairing watch and PC** above

2. Specify file name and location of log file

3. Click on "Download" to start data transfer

4. Push the "DOWN" button to stop connection when the transfer has finished.

The log file is stored in CSV format. Its content appears as one line per log. Each line starts with date, time, heart rate, temperature, and altitude. Parameters which were not logged are set to zero (according to settings in eZ430-Chronos Data Logger PC software).
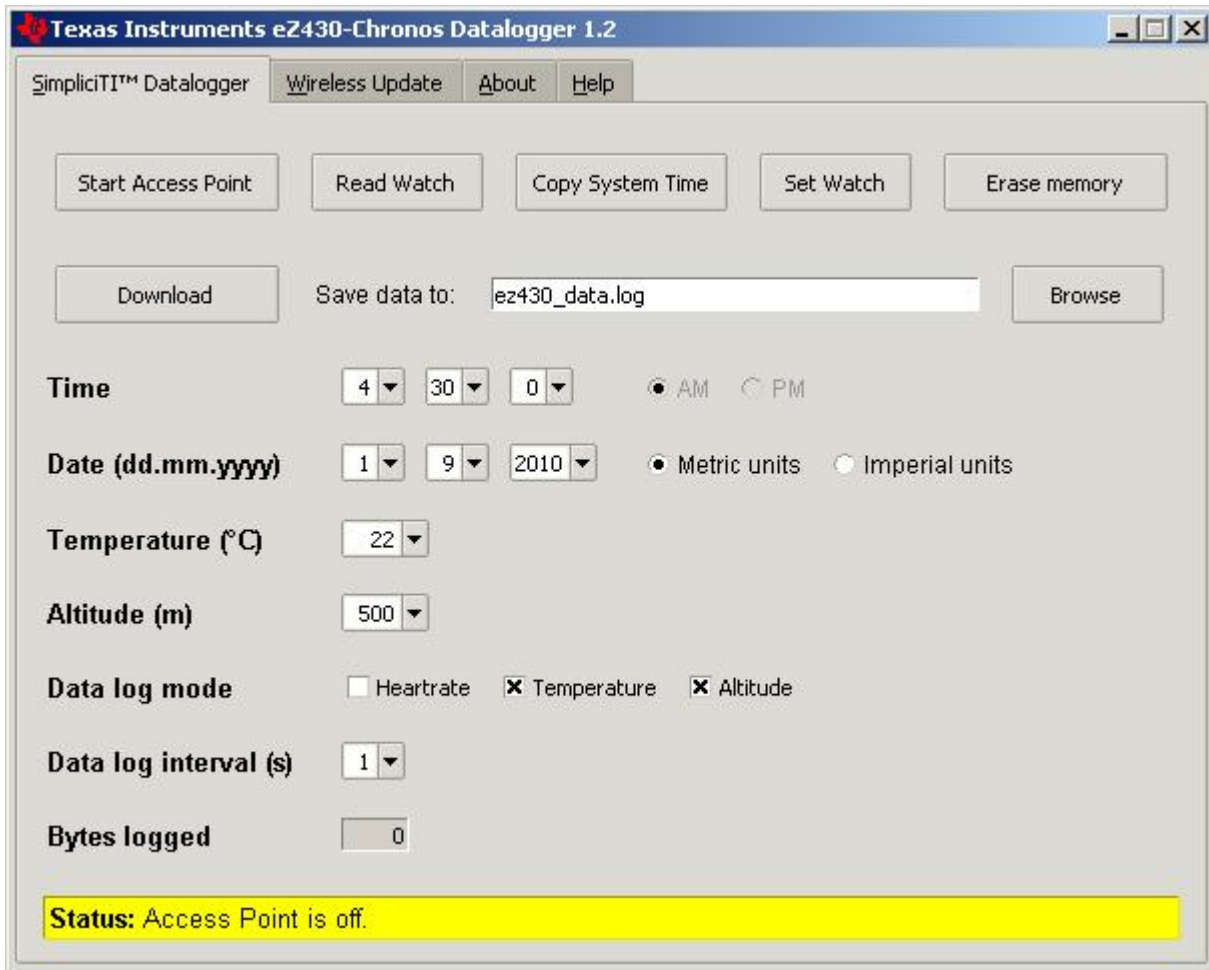
Figure 3-10. eZ430-Chronos Data Logger

3.5.2 *Wireless Update*

This mode allows updating the firmware of the eZ430-Chronos watch wirelessly, without having to disassemble the watch.

Update procedure:

1. Select CC430 flash image (.txt file) by clicking on "Browse...". Example images for the sports watch software and the data logger application are located for Windows in *C:\Program Files\Texas Instruments\eZ430-Chronos\Recovery\eZ430-Chronos Watch\Applications* and for Linux in */home/<user name>/Texas Instruments/eZ430-Chronos/Recovery/eZ430-Chronos Watch/Applications*.

> **NOTE:** Ensure selecting the correct version of the flash images. If the wrong frequency is selected, no wireless communication is possible anymore. In that case, the watch must be updated using the eZ430 debug interface.
>
> Only transfer flash images to the watch, which allow invoking the updater software on the watch.
>
> The file to be downloaded to the watch must be in TI-TXT format to work with this update procedure. This new firmware must reside within the main memory flash (0x8000 to 0xFFFF), otherwise the update procedure fails due to boundary checks on the watch side.

2. Activate the update mechanism on the PC by clicking on "Update eZ430-Chronos Watch". The Control Center status line displays "Access point started. Now start watch in rFbSL mode" when the PC is ready.
3. Select "rFbSL" on the eZ430-Chronos watch by pushing the "#" button
4. Push once "DOWN" button to switch to confirmation menu
5. Push "DOWN" again to initiate update
6. After a short moment, the update is started

At the beginning of the update the LCD shows "rAM" for a few seconds. During this time, the actual updater software is downloaded from the PC to the RAM of the CC430 on the watch. This program contains all memory write and LCD routines. After this transfer is finished, the code is executed from RAM, and the download of the firmware file is started. The LCD shows the progress in percent on the upper LCD line. After the transfer is complete, a reset starts the software on the watch. See Section 3.6.4 for details.

> **NOTE:** If the update fails, it can be activated again by pushing the "DOWN" button again on the eZ430-Chronos watch, given that the wireless update is active in the eZ430-Chronos Control Center.
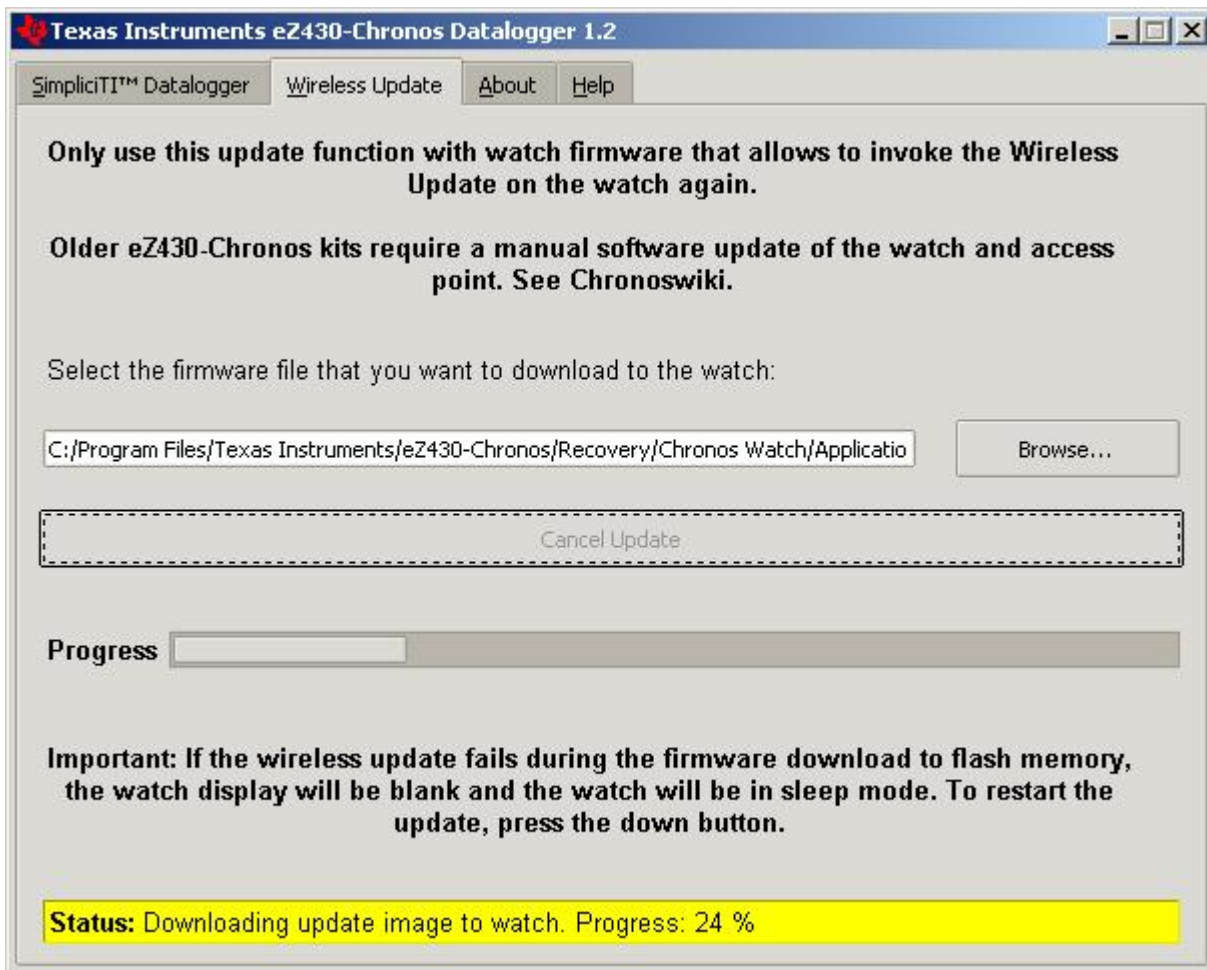
Figure 3-11. eZ430-Chronos Control Center Wireless Update

3.6 eZ430-Chronos Software Projects

3.6.1 IDE Installation

To edit and download code to the CC430 device used inside the eZ430-Chronos watch, Code Composer Studio v4.2 Core Edition or the IAR Embedded Workbench KickStart 5.10 (or higher) must be installed.

1. Download Code Composer Studio v4.2 Core Edition from www.ti.com/ccs, IAR Embedded Workbench KickStart from www.ti.com/iarkickstart or from the included CD
2. Extract the zip file and run the installation program
3. Respond to the prompts to install the IDE

NOTE: The eZ430-Chronos firmware projects are provided for both Code Composer Studio and IAR Embedded Workbench, the user has the option to select the IDE of their choice.

Currently Code Composer Studio and the IAR Embedded Workbench are only available for Windows. CrossWorks from Rowley Associates supports Linux and MacOS, but requires manual project setup. MSPGCC may be used for Linux as well.

3.6.2 Chronos-to-Chronos (C2C) Communication

This feature is a demonstration of what can be done using SimpliciTI (peer-to-peer) and two eZ430-Chronos watches. This code can be also be adapted to be used for custom applications, where the communication of two eZ430-Chronos watches is required. This mode allows one watch to wirelessly control the other. After a successful connection, it is possible to change the menus and show the accelerometer data from one watch in the other. The communication is bidirectional, so the control can be done from both watches.

3.6.2.1 Detailed Description of C2C Communication

When the C2C mode starts, the system sets a new SimpliciTI address for the eZ430-Chronos watches based on the time and accelerometer data. In SimpliciTI peer-to-peer mode, the connection occurs when one device listens and other tries to link. In C2C mode, the devices must change between listen and link modes to enable bidirectional control. It is important to do perform the switch randomly to ensure at least one possible state for connection. To enable this process, , one timer interrupt is set to 100 ms. The interrupt routine calls a function that changes the connection mode in a pseudo-random way, using the accelerometer data.

After the connection is established, the first message synchronizes the timers from both watches. This way it is possible to ensure low power to this system, making the watches sleep most of the time and wake for a short period of time to send and receive data.
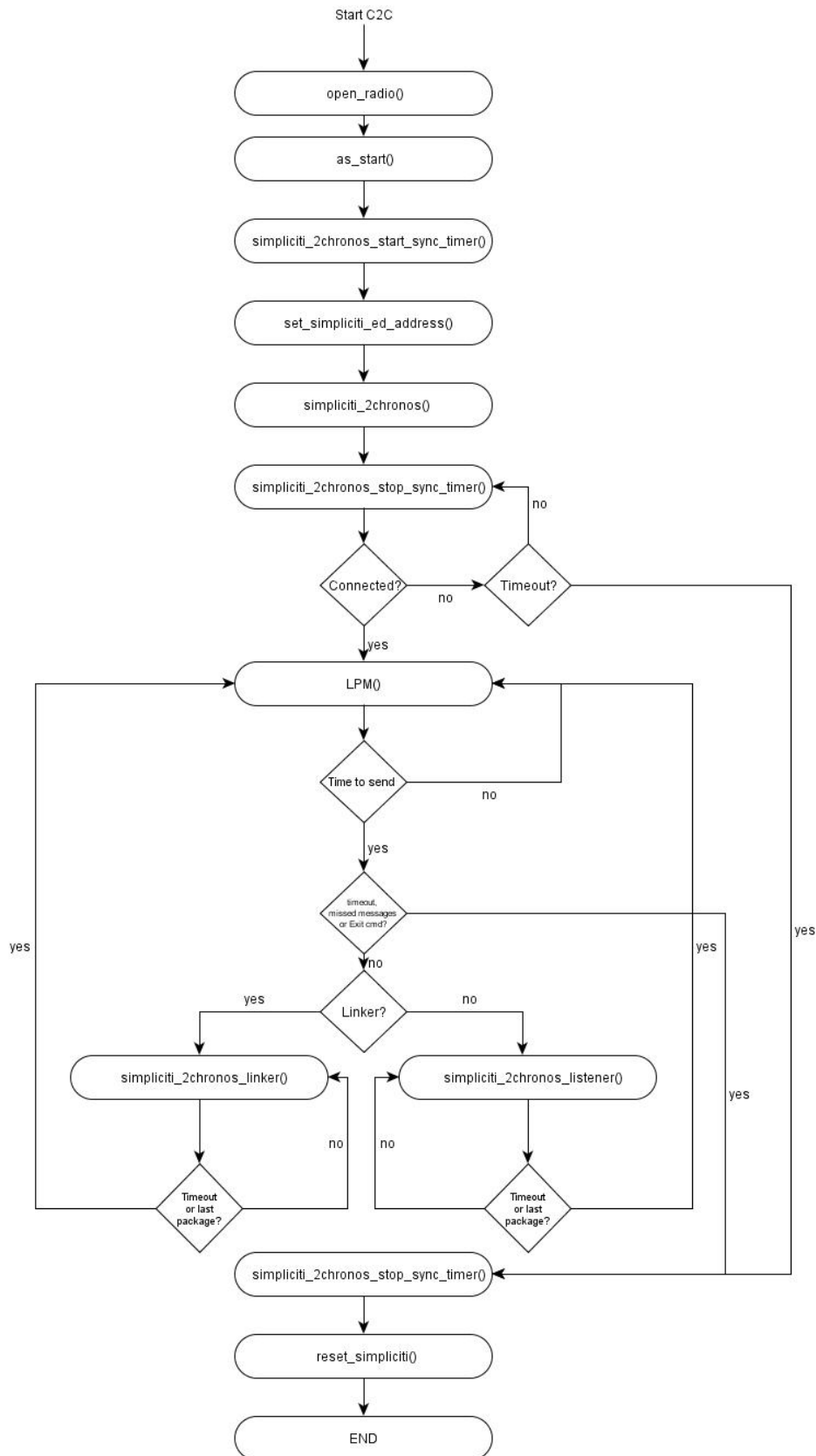
Figure 3-12. Chronos-to-Chronos Communication Flowchart

To disconnect, press the "DOWN" button. If one watch is moved out of range or if the link is lost for any other reason, the watch tries to send messages for some time and, if the other device cannot be found, it automatically exits C2C mode.

3.6.3 eZ430-Chronos Watch Software Flow

The watch software is structured according to the menu items. The source for each menu item is stored in a separate source file (for example, "temperate.c" for the temperature menu and its functions). Details can be found in the flow chart in Figure 3-13. The data logger application works in a very similar way and, therefore, is not described separately.

Each menu item has at least the following functions:

- "UP" or "DOWN" button pushed
- "*" or "#" button is pressed for more than three seconds

The source code file "menu.c" contains two linked lists with menu items, one for the upper LCD line (Line1), one for the lower LCD line (Line2). Each list entry contains the following pointers:

- Pointer to next menu item
- "UP" or "DOWN" button is pressed
- "*" or "#" button is pressed for more than three seconds

To support the various RF frequencies and compiler licenses, the following configurations are available:

RF Frequencies

- 915 MHz (USA)
- 868 MHz (Europe)
- 433 MHz (Other regions)

IDE Versions (CCS, IAR)

- Unrestricted IDE versions
- Free IDE versions (CCS Core Edition, IAR KickStart). To allow recompilation of the source code, parts of the source code files have been embedded in libraries; for example, the SimpliciTI stack and most of the hardware drivers.

Figure 3-13 shows the basic software flow of the sports watch application.
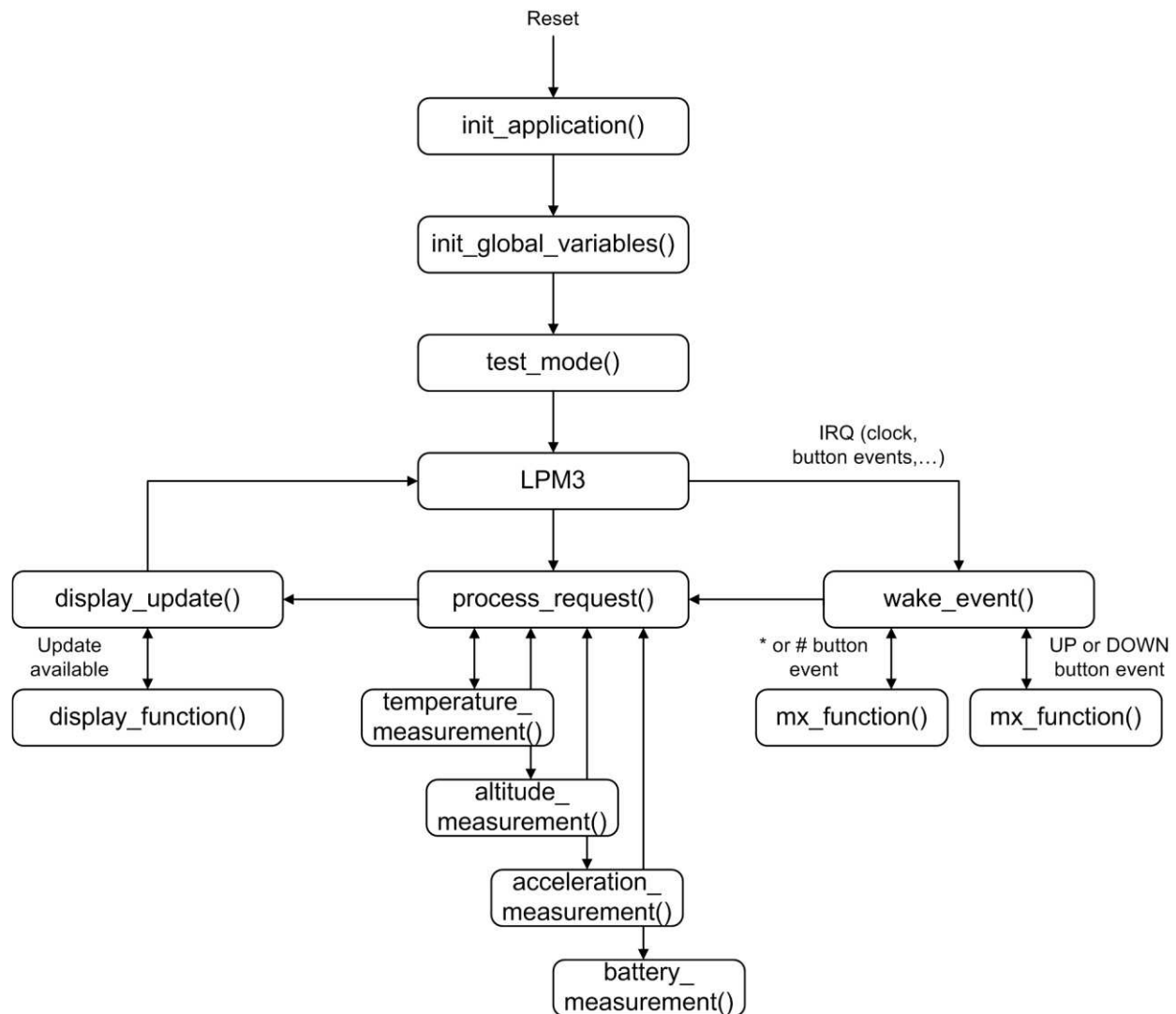
Figure 3-13. eZ430-Chronos Software Flowchart

After a power-up reset, the hardware is initialized, the display memory is cleared and the radio is set to sleep mode. The main loop waits for wake-up events, which can be either a scheduled event such as a clock interrupt, or a button event.

Button events lead to the execution of either mx_functions or sx_functions.

If the LCD is updated with new data, the modules set a display flag, and LCD Line1, Line2, or both are updated by calling the menu-specific display functions. Display updates have been reduced as much as possible; for example, when the time changes from 10:22 to 10:23, only the last digit is updated.

3.6.4 eZ430-Chronos Wireless Update Feature

The wireless update feature allows to perform a firmware update of the eZ430-Chronos watch wirelessly, that is the watch does not need to be opened. The wireless updater should be seen as an application and not as an universal BSL. It can only be invoked by the main application, which needs to be created in a certain way (see Section 3.6.4.2). In addition it may must be modified to comply local RF regulatory. The current consumption during the update process may be significant. Considering the small battery capacity, the updater is intended to be used only occasionally.

> **NOTE:** References in the software projects and the menu items of the watch refer to it as "RF BSL" and "WBSL" for simplicity reasons.
>
> Whenever the wireless update is activated on the watch, it returns to the main application with a reset, wether or not an update was performed. Time, data, alarm, and other RAM-based data are lost.

3.6.4.1 Overview and Components of the Wireless Update Feature

As described in Section 3.6.4, the wireless update feature allows wireless updates of the eZ430-Chronos firmware. One of the requirements for the wireless update implementation is to use as little flash memory as possible. Therefore, a lightweight radio protocol was developed, which resides in the BSL flash area of the CC430. The software that handles the LCD progress information and the flash memory programming is downloaded over the air and executed in RAM. Components of the wireless updater include:

- Radio protocol in BSL memory area of the CC430 (eZ430-Chronos watch module)
- The "RAM-based updater" contains LCD and flash write routines (transferred from PC to RAM of watch module)
- Radio protocol stack of the wireless update on RF access point (CC1111)
- PC application supporting the update functionality

The update procedure works as follows:

1. Wireless update functionality is activated in the PC application, after a valid flash image is selected
2. RF access point is ready and awaits a request from a watch
3. Wireless update is activated on the watch
4. Watch downloads LCD and flash write routines (RAM-based updater) from the PC into the RAM of the CC430. The watch displays "rAN" (=RAM).
5. Watch executes the RAM-based updater. This starts the actual code (flash image) download process. The LCD shows the progress.
6. A reset starts the new application on the watch when the update is finished.

The FAQ in Appendix A also list common questions on the wireless update feature.

3.6.4.2 Detailed Description of the Wireless Update Feature

To invoke the wireless update procedure, the main application must call the start of the wireless updater, which is located at address 0x1000. Therefore, the sports watch and data logger projects contain an extra menu item called "rFbSL". When activated, it determines if the battery level of the watch is sufficient to start a wireless update and then calls address 0x1000. At this time, the user application is no longer running.

> **NOTE:** Whenever the wireless update is activated on the watch, it returns to the main application with a reset, whether or not an update was performed. Time, data, alarm, and other RAM-based data is lost.

After invoking the wireless update (rFbSL), the watch tries to link to a listening RF access point and start the update procedure. If the link is successful, the watch downloads the RAM-based updater into the RAM of the CC430. Once finished, this software then tries to link again with the RF access point to download the actual update image. If this link is successful, a mass flash erase is performed, which erases all the

main memory flash (0x8000 to 0xFFFF). The watch then starts to receive all of the data packets and writes them to flash, checking if each word was written successfully. If the link is not successful, the watch generates a reset to restart the user application. During the download of the update image, a percentage indicator appears on the watch. When download is complete, "dOnE" is shown on the LCD, and a reset is generated to start the new user application that has just been written to flash.

A detailed flow of the update software on the watch and the USB access point can be found in Figure 3-14 and Figure 3-15.
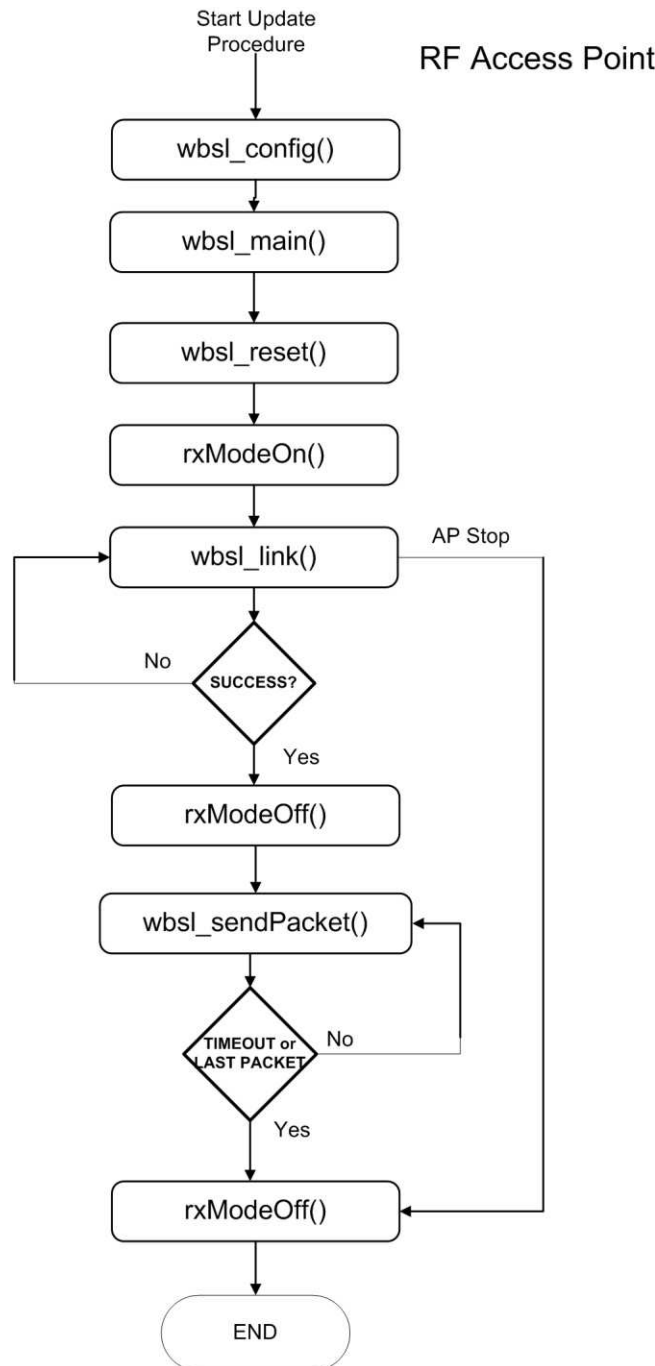
Figure 3-14. Flow Chart of Wireless Updater on Access Point
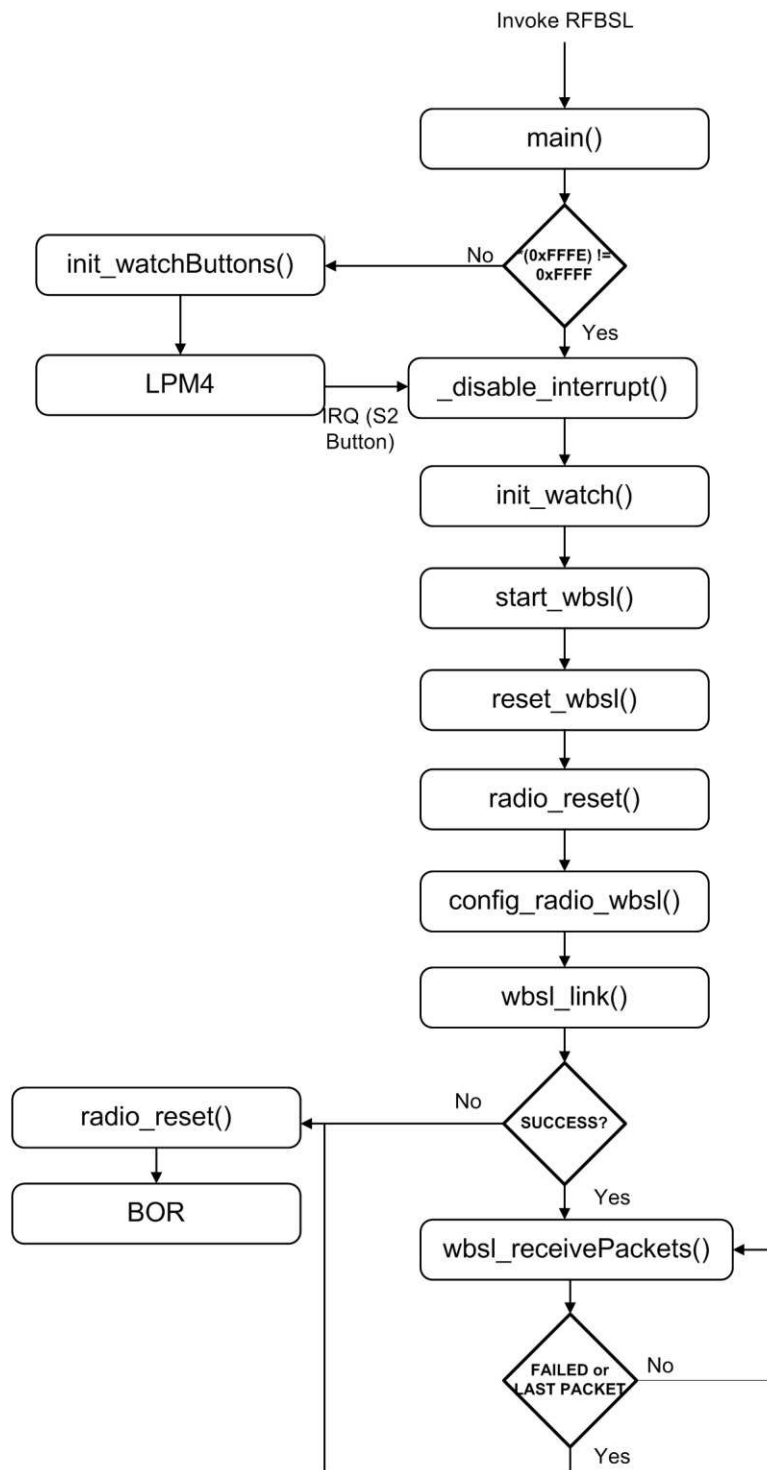
Figure 3-15. Flow Chart of Flash Based Wireless Updater on eZ430-Chronos Watch Module

3.6.4.3 Error Handling

The wireless updater is designed to be fail safe. The radio protocol contains limited error handling due to its small footprint, but the updater provides recovery if the update process fails. Upon communication failures, the watch is put in low-power mode (LPM4) and the LCD is turned off. The update process can be restarted by pushing the "DOWN" button after the update process is restarted on the PC.

3.6.4.4 Upgrading Existing eZ430-Chronos Kits

Earlier eZ430-Chronos kits (production date prior to 04/2010; the production date may be found on bottom of eZ430-Chronos box) do not support the wireless update feature. Therefore, the kits must be updated manually. In addition to a new version of the PC software, firmware updates of the RF access point and the eZ430-Chronos watch are required.

3.6.4.4.1 RF Access Point Update

The CC Debugger is required to reprogram the CC1111 based RF access point. To perform the update, the SmartRF Flash Programmer software is used to on the PC.

1. Solder a debug interface connector cable onto the CC1111 access point as shown in Figure 3-16.

Figure 3-16. eZ430-Chronos RF Access Point Connection to CC Debugger

CC-Debugger	RF Access Point
Pin 1	GND
Pin 2	Vcc
Pin 3	P2.2 (DC)
Pin 4	P2.1 (DD)
Pin 7	RST
Pin 9	Vcc

2. Connect RF access point to CC Debugger and press the "Reset". The LED on the CC Debugger should become green.
3. Launch the SmartRF Programmer software
4. Open .hex file according to frequency in *C:\Program Files\Texas Instruments\eZ430-Chronos\Recovery\RF Access Point*
5. Select "Erase, program and verify"
6. Clock "Perform actions"
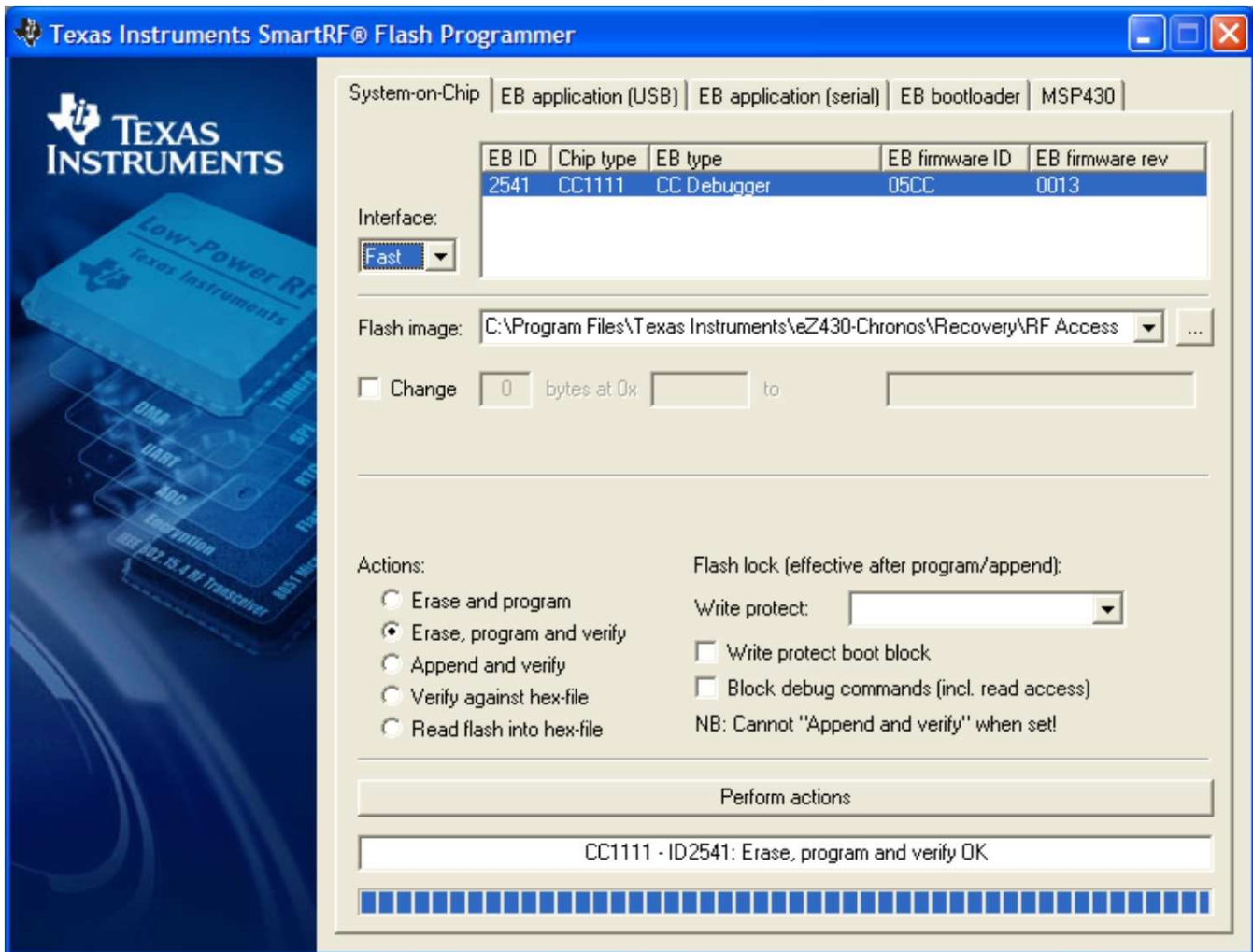
Figure 3-17. SmartRF Flash Programmer

3.6.4.4.2 eZ430-Chronos Watch Update

The update of the eZ430-Chronos watch needs to be done in two stages. First, the wireless updater needs to be written to the BSL area of the flash memory of the CC430. Afterwards, the main application must be loaded onto the watch. The easiest and fasted way is using BM innovations' Firmware Update Tool. It writes the wireless updater into the BSL memory of the watch and programs the corresponding sports watch firmware according to the latest eZ430-Chronos software release (recommended).

Alternatively, wireless updater may be loaded onto the watch using the included IAR Embedded Workbench (free KickStart version is sufficient). Moreover, the .txt image may be written to the device by using 3rd party tools such as the free FET-Pro430 Lite software from Elprotronic.

3.6.4.4.2.1 *eZ430-Chronos Watch Update Using IAR*

The project is available in *C:\Program Files\Texas Instruments\eZ430-Chronos\Software Projects\eZ430-Chronos Watch\IAR\Wireless Update*. The eZ430-Chronos watch module needs to be connected to the emulator which must be connected to the PC.

1. Open project by double clicking "Wireless Updater.eww"
2. Select build configuration according to frequency in *Project > Edit Configurations...*
3. Click *Project > Download and Debug*
4. Close the Embedded Workbench after code was written
5. Program watch main application as described in Section 3.6.5.

3.6.5 *eZ430-Chronos Firmware*

To restore or modify the original watch projects, the source code must be installed. This happens during the installation of the demo software package (SLAC341), which contains two different sets of examples. Code Composer Studio v4.2 or the IAR Workbench can be used, regardless if code limited or not.

3.6.5.1 Using Code Composer Studio™ v4.2

1. Launch Code Composer Studio v4.2: *Start > All Programs > Texas Instruments > Code Composer Studio v4 > Code Composer Studio v4*
2. Create new Workspace or open existing Workspace that does not yet contain eZ430-Chronos projects

---

NOTE: Workspaces should not be located in a long path of directories as Windows only supports path names up to 255 characters. Keep in mind that the projects contain subdirectories as well.

---

3. Import eZ430-Chronos Projects by clicking: *Project > Import Existing CCE/CCS Eclipse Project*
4. Click Browse and browse to eZ430-Chronos Projects (default directory: *C:\Program Files\Texas Instruments\eZ430-Chronos\Software Projects\eZ430-Chronos Watch\CCS*). Confirm directory by clicking OK
5. The eZ430-Chronos sports watch project appears as *ez430_chronos*, the eZ430-Chronos data logger appears as *ez430_chronos_datalogger*. Select *Copy projects into workspace* to create a new copy of the projects
6. Click Finish to finalize the project import. The projects appear in the *C/C++ Projects view of CCS*
7. Select the right version of the project. Each project comes with six different project settings (build configurations), which can be selected in *Project > Properties > C/C++ Build > Active Configuration > Configuration*:
   915 MHz – Limited CCS Core Edition (USA)
   868 MHz – Limited CCS Core Edition (Europe)
   433 MHz – Limited CCS Core Edition (Other regions)
   915 MHz – Unrestricted CCS Platinum (USA)
   868 MHz – Unrestricted CCS Platinum (Europe)
   433 MHz – Unrestricted CCS Platinum (Other regions)
8. Go to *Target > Debug Active > Debug Active Project* to launch the debugger

3.6.5.2   Using IAR Embedded Workbench™

1. Launch the Embedded Workbench: *Start > All Programs > IAR Systems > IAR Embedded Workbench KickStart for MSP430 5.10 > IAR Embedded Workbench*

2. Open eZ430-Chronos Workspace by: *File > Open > Workspace...*

3. Browse to eZ430-Chronos Projects (default directory: *C:\Program Files\Texas Instruments\eZ430-Chronos\Software Projects\IAR\eZ430-Chronos Watch\Sports Watch* or *C:\Program Files\Texas Instruments\eZ430-Chronos\Software Projects\IAR\eZ430-Chronos Watch\Data Logger*)

4. Select **.eww* file and click *Open*

5. Select the right version of the project. Each project comes with four different project settings (build configurations), which can be selected on top of the Workspace window:

   915 MHz – Limited IAR KickStart (USA)

   868 MHz – Limited IAR KickStart (Europe)

   433 MHz – Limited IAR KickStart (Other regions)

   915 MHz – Unrestricted IAR Workbench (USA)

   868 MHz – Unrestricted IAR Workbench (Europe)

   433 MHz – Unrestricted IAR Workbench (Other regions)

6. Go to *Project > Download and Debug* to launch the debugger

3.6.6   eZ430-Chronos GUI Sources

Full sources of the eZ430-Chronos Control Center and eZ430-Chronos Data Logger are available in the eZ430-Chronos software packages for Windows SLAC341 and Linux SLAC388. The sources are copied to the PC during the software installation. The graphical user interfaces are based on TCL/Tk.

3.6.6.1   eZ430-Chronos GUI for Windows

The eZ430-Chronos PC software consists of a TCL/Tk executable and a DLL, which handles the communication with the RF access Point. Download TCL/Tk for Windows for free from http://www.activestate.com/activetcl. Once TCL/Tk was installed on the computer, a double-click on a TCL script (*.tcl) starts the interpreter and executes the script. Alternatively, start the TCL interpreter *wish.exe* and execute the script with the "source" command. If the script filename contains blanks, put it into quotes. The sources files are located in *C:\Program Files\Texas Instruments\eZ430-Chronos\Control Center\GUI Sources*

3.6.6.1.1   TCL/TK Handling

A wrapping tool is needed to compile all TCL/Tk components into standalone applications. The freeware tool Freewrap http://freewrap.sourceforge.net may be used for that purpose.

1. Open Command Prompt

2. Navigate to the Freewrap directory; for example, *C:\Tcl\freewrap*

3. Start Freewrap with the complete path to the TCL script to be wrapped; for example, *freewrap.exe C:\Program Files\Texas Instruments\eZ430-Chronos\Control Center\eZ430-Chronos Control Center\eZ430-Chronos CC 1_2.tcl*

A standalone application, which only requires the corresponding Windows DLL is generated. It can be used on every PC, TCL/Tk must not be installed.

3.6.6.1.2 Control Center DLL

The sources for the DLL are available in the eZ430-Chronos Windows package and can be found in *C:\Program Files\Texas Instruments\eZ430-Chronos\Control Center\GUI Sources\DLL*.

The eZ430-Chronos Windows DLL has been developed using Microsoft Visual C++ 2008 Express Edition. In order to rebuild the DLL file the Microsoft Visual Studio must be installed, since the registry enumeration code uses MFC functions. If Microsoft Visual Studio is not present, it is still possible to rebuild the DLL, but the "enumser" source code part needs to be removed from the project. Therefore, the BM_GetCOM() function won't work anymore.

The DLL has two interface sections, one that exports standard C functions, and a second one exporting TCL-compliant functions. These TCL-compliant functions are used by the graphical user interface. Hence, when compiling the DLL, TCL needs to be present in the default directory (*C:\Tcl*); otherwise, the reference to the TCL libraries (tcl85.lib, tclstub85.lib) is invalid. If the DLL is compiled without the TCL interface, the respective source code file and the references to the TCL libraries must be deleted.

COM Port Management

1. Opening the COM port

   Prior to any communication, the COM port where the RF access point is connected must be opened. The hardware is powered up immediately after the unit is connected. Some parts of the hardware require a startup time of several hundred milliseconds. As a result, any access to the hardware should not be done within one second after connecting the device.

   NOTE: To address COM ports higher than COM9 in Windows, precede the "COMxx" string with the sequence "\\.\".

   The COM port is opened with the following function:
   ```
   bool BM_OpenCOM(    char * strPortName,
       DWORD dwBaudrate = 115200,
       WORD wTimeout = 30,
       bool bRTS = false,
       bool bDTR = false);
   ```
   Parameters

   strPortName

   Name of the COM port (for example, "\\.\COM11").

   wTimeout

   Time in milliseconds a reply to a command is expected; default value is 30 ms, should not be changed

   dwBaudrate

   Baudrate for the serial interface; default is 115200 Baud, should not be changed

   bRTS

   State of RTS line during normal operation; default is false (=GND), should not be changed

   bDTR

   State of DTR line during normal operation; default is false (=GND), should not be changed

   Return Value

   Returns true if COM port could be opened, otherwise returns false.

2. Closing the COM port

   A successfully opened COM port must be closed when quitting the application to release all allocated memory and the port itself.

   The COM port is closed with the following function:
   ```
   void BM_CloseCOM(void);
   ```

3. Locating the RF access point

This function checks the Windows registry for the friendly name "TI CC1111 Low-Power RF to USB CDC Serial Port" and returns the COM port number if the device was found.

```
bool BM_GetCOM(unsigned char& bPortNb);
```

Parameters

bPortNb

Number of the COM port (for example, „11")

Return Value

Returns true if device was found, otherwise returns false.

4. Resetting the RF access point

After power-up, the hardware is not automatically reset. Use the following function to initialize the RF access point hardware. This function can also be used during normal operation if an error condition was detected.

```
bool BM_Reset(void);
```

Return Value

Returns true if RF access point could be initialized successfully and false if the reset failed.

5. Read status from RF access point

This command returns the current RF access point status.

```
bool BM_GetStatus(WORD& wStatus);
```

Parameters

wStatus

Current status of RF access point HW_IDLE, HW_SIMPLICITI_STOPPED, HW_SIMPLICITI_TRYING_TO_LINK, HW_SIMPLICITI_LINKED, HW_BLUEROBIN_STOPPED, HW_BLUEROBIN_TRANSMITTING, HW_ERROR, HW_NO_ERROR, HW_NOT_CONNECTED

Return Value

Returns true if command could be executed and false if the command execution failed.

BlueRobin Functions

1. Set BlueRobin Heart Rate

This command sets the heart rate value that is transmitted in each BlueRobin packet.

```
bool BM_BR_SetHeartrate(WORD wHeartrate);
```

Parameters

wHeartrate

Heart rate in bpm

Return Value

Returns true if command could be executed and false if the command execution failed.

2. Set BlueRobin ID

This command sets the transmitter ID for BlueRobin transmission.

```
bool BM_BR_SetID(DWORD dwID);
```

Parameters

dwID

24-bit transmitter ID

Return Value

Returns true if command could be executed and false if the command execution failed.

3. Read BlueRobin ID
    This command reads the transmitter ID for BlueRobin transmission.

    ```
    bool BM_BR_GetID(DWORD& dwID);
    ```

    Parameters
    dwID
        24-bit transmitter ID
    Return Value
        Returns true if command could be executed and false if the command execution failed.
4. Start BlueRobin transmission
    This command starts the BlueRobin transmission.

    ```
    bool BM_BR_Start(void);
    ```

    Return Value
        Returns true if command could be executed and false if the command execution failed.
5. Stop BlueRobin transmission
    This command stops the BlueRobin transmission.

    ```
    bool BM_BR_Stop(void);
    ```

    Return Value
        Returns true if command could be executed and false if the command execution failed.

SimpliciTI Functions

1. Start SimpliciTI in acc/ppt mode
    This command starts SimpliciTI in acc/ppt mode.

    ```
    bool BM_SPL_Start(void);
    ```

    Return Value
        Returns true if command could be executed and false if the command execution failed.
2. Start SimpliciTI in sync mode
    This command starts SimpliciTI in sync mode.

    ```
    bool BM_SYNC_Start(void);
    ```

    Return Value
        Returns true if command could be executed and false if the command execution failed.
3. Stop SimpliciTI
    This command exits the SimpliciTI stack.

    ```
    bool BM_SPL_Stop(void);
    ```

    Return Value
        Returns true if command could be executed and false if the command execution failed.

4.   Read SimpliciTI acc/ppt data

This command reads the received data from the RF access point buffer.

```
bool BM_SPL_GetData(DWORD& wData);
```

Parameters

wData

4 byte data (byte3, byte2, byte1, byte0)

byte3 = Acceleration value Z-axis

byte2 = Acceleration value Y-axis

byte1 = Acceleration value X-axis

byte0 = 0x11 → Left mouse click (acc mode)

byte0 = 0x21 → Left mouse double-click (acc mode)

byte0 = 0x31 → Right mouse click (acc mode)

byte0 = 0x12 → Button * (ppt mode)

byte0 = 0x22 → Button # (ppt mode)

byte0 = 0x32 → Button ↑ (ppt mode)

byte0 = 0xFF → Data has been read before

Return Value

Returns true if command could be executed and false if the command execution failed.

5.   Read SimpliciTI sync buffer status

This command reads the buffer status during sync mode from the RF access point buffer.

```
bool BM_SYNC_GetBufferStatus(WORD& wStatus);
```

Parameters

wStatus

Buffer status

0 = Buffer empty

1 = Data available for download

Return Value

Returns true if command could be executed and false if the command execution failed.

6.   Read SimpliciTI sync buffer

This command reads the buffer content during sync mode.

```
bool BM_SYNC_ReadBuffer(BYTE * bData);
```

Parameters

bData

19-byte SimpliciTI data Packet content defined watch sending routine

Return Value

Returns true if command could be executed and false if the command execution failed.

Wireless Update Functions

1.   Start wireless update

This command starts SimpliciTI in acc/ppt mode.

```
BR_COMM_API bool BM_WBSL_Start(void)
```

Return Value

Returns true if command could be executed and false if the command execution failed.

2.   Stop wireless update

This command exits the SimpliciTI stack.

```
BR_COMM_API bool BM_WBSL_Stop(void)
```

Return Value

Returns true if command could be executed and false if the command execution failed.

3. Get status of update

   This command reads the buffer status during sync mode from the RF access point buffer.

   ```
   BR_COMM_API bool BM_WBSL_GetStatus(DWORD& wData)
   ```

   Parameters

   dwData

   Status

   1 = linking

   2 = linked

   4 = error

   Return Value

   Returns true if command could be executed and false if the command execution failed.

4. Send Data (Text File parts) to the End Device

   This command reads the buffer status during sync mode from the RF access point buffer.

   ```
   BR_COMM_API bool BM_WBSL_Send_Data(BYTE * data, int len, DWORD& dwData)
   ```

   Parameters

   data

   Pointer to byte array

   len

   Array length

   dwData

   Return value

   Return Value

   dwData = Length of last transmitted package.

5. Get status of packet (checks if a new packet needs to be sent from the GUI)

   This command reads the buffer status during sync mode from the RF access point buffer.

   ```
   BR_COMM_API bool BM_WBSL_GetPacketStatus(DWORD& wData)
   ```

   Return Value

   dwData

   0x80 = error

   0x01 = disabled

   0x02 = processing packet

   0x04 = send info packet

   0x08 = send new data packet

3.6.6.2 eZ430-Chronos GUI for Linux

The eZ430-Chronos PC software for Linux consists of a TCL/Tk scrips, similar to its Windows equivalent. The scripts are available in*/home/<user name>/Texas Instruments/eZ430-Chronos/Control Center/eZ430-Chronos Control Center*.

See Section 3.3 for instructions on how to run these scripts on Linux machines.

eZ430-Chronos Hardware

4.1 Programming/Reprogramming the eZ430-Chronos Watch: Disassembly and Assembly of the Housing

To program and debug code on the CC430, it needs to be connected to a PC with a JTAG interface. The eZ430-Chronos kit includes the eZ430-RF JTAG interface for that purpose. It can only be connected to the eZ430-Chronos watch after the watch electronic module is removed from its housing. This chapter describes how to remove the watch electronics from the housing and how to assemble it again.

> **NOTE:** Videos with detailed instructions can be found on www.ti.com/chronos and the CD that is included in the kits.

4.1.1 Disassembly of eZ430-Chronos Watch

1. Open screws on back of watch. Use the included Phillips screwdriver
2. Remove metal back of watch. Be careful not to damage the gasket between the watch and the metal back
3. Lift out the watch module. Use the screwdriver as shown in Figure 4-1.

Figure 4-1. Removing Watch Module from Housing

4. Remove the battery before connecting the module to the emulator. Place the screwdriver tip between the battery and the battery holder (small metal tab) and push the tab away from battery (see Figure 4-2). Detailed instructions are shown in the eZ430-Chronos Disassembly/Assembly video on www.ti.com/chronoswiki.
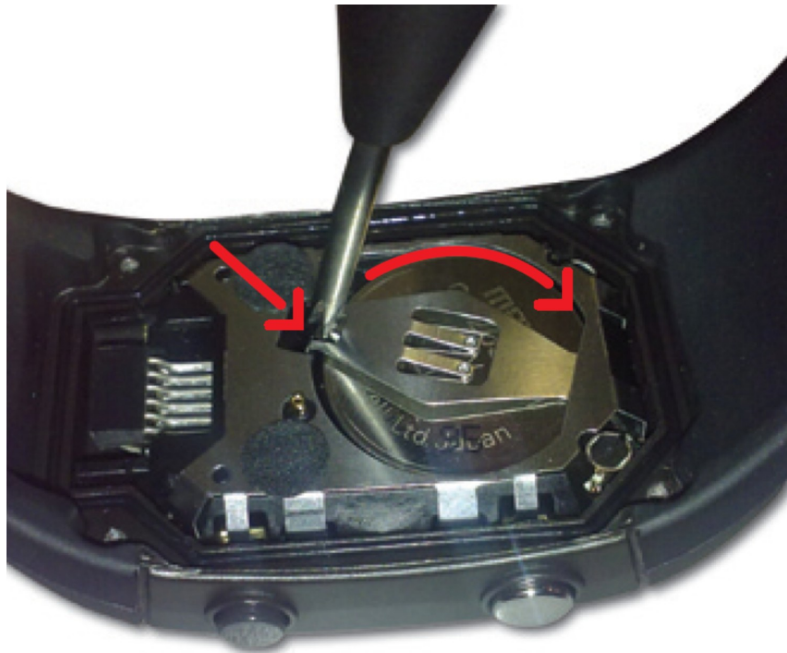
Figure 4-2. Removing Watch Battery

CAUTION

Always remove the battery from the watch before connecting the watch to an emulator, to prevent the battery from being charged.

WARNING

Properly dispose of the battery. Keep the battery out of the reach of children. If the battery is swallowed, contact a physician immediately.

5. Connect the watch to the emulator. The watch module and the USB connector must be on the same side of the PCB as shown in Figure 4-3. Be careful when connecting the watch module, because its small plastic strips can get stuck at components on the emulator.

Plastic Strip Watch Module   Components on Debug Interface
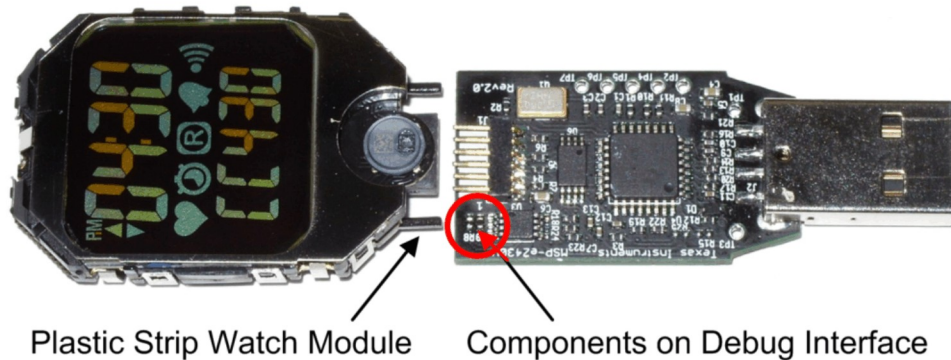
Figure 4-3. eZ430-Chronos Watch Module Attached to eZ430-RF Debug Interface

NOTE:
- Never disassemble the watch module itself.
- Do not bend the metal strips that are used as contacts for the buttons.
- Be careful when connecting the watch module to the debug interface; its small plastic strips can get stuck at components on the emulator.

4.1.2 Assembly of eZ430-Chronos Watch

1. Insert the battery ("+" facing up) into watch module and close battery holder clip by pushing the open end towards the module. If the small clip at the end of the holder does not snap into the plastic frame, it may need to be bent inwards slightly
2. Gently insert watch module into the housing. Insert it in parallel to the housing. Do not try to insert one side first (see Figure 4-4). Ensure that the small metal strips of the buttons on watch module slide over buttons of the housing (see Figure 4-5).
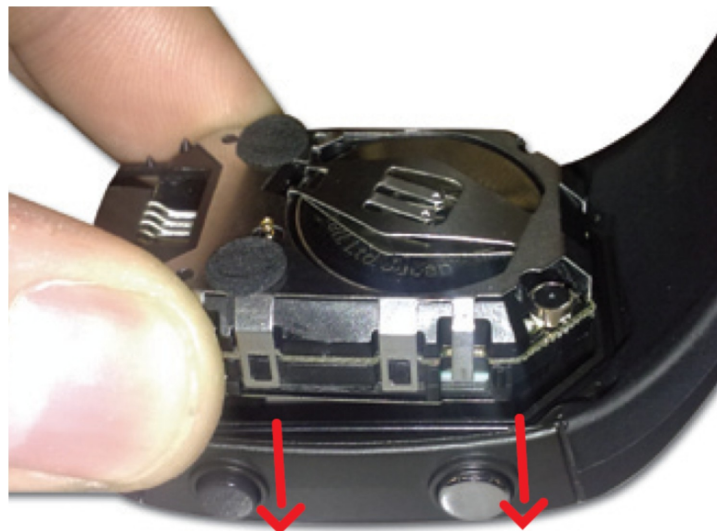
Figure 4-4. eZ430-Chronos Watch Module Insertion Into Housing
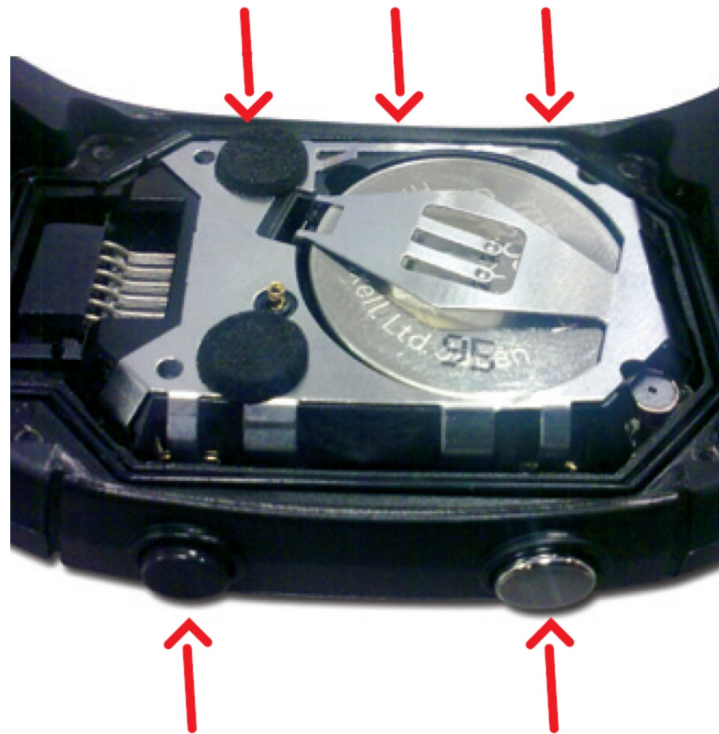
Figure 4-5. Metal Strips of Watch Housing and Buttons of Housing

---

CAUTION

Be careful when inserting the watch module. Do not push in the watch module or tighten the screws without checking if the module is in position. The metal strips of the buttons may get stuck at the buttons of the watch housing. If this happens, gently push the strips towards the module with the screwdriver until they slide over the buttons (see Figure 4-6).
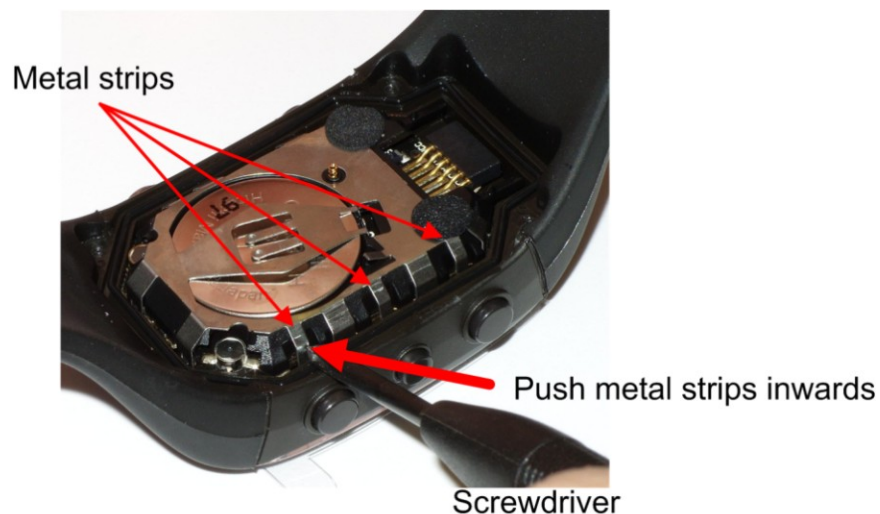
Figure 4-6. Push Metal Strips Inward

3. Ensure that the gasket is in its position and replace the back with the screws again. Try using the existing thread in the plastic housing and do not over tighten the screws.

4.2   Functional Description of the eZ430-Chronos Watch

The core technology behind the eZ430-Chronos watch is the CC430F6137 microcontroller with its integrated <1-GHz radio. The CC430 also controls the LCD and its temperature sensor is used for temperature measurement. The only other ICs on the watch PCB are pressure and acceleration sensors and the LCD backlight driver.
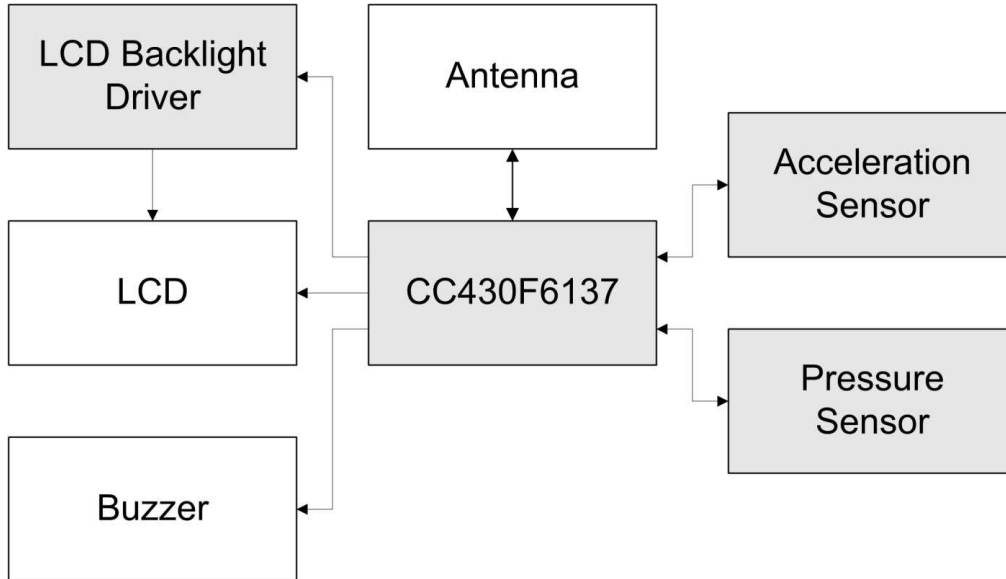
Figure 4-7. eZ430-Chronos Watch Block Diagram

The PCB does not include an antenna; the metal frame of the watch module that surrounds the LCD is used as antenna. The antenna is tuned for best performance when the watch is worn or held in hands.
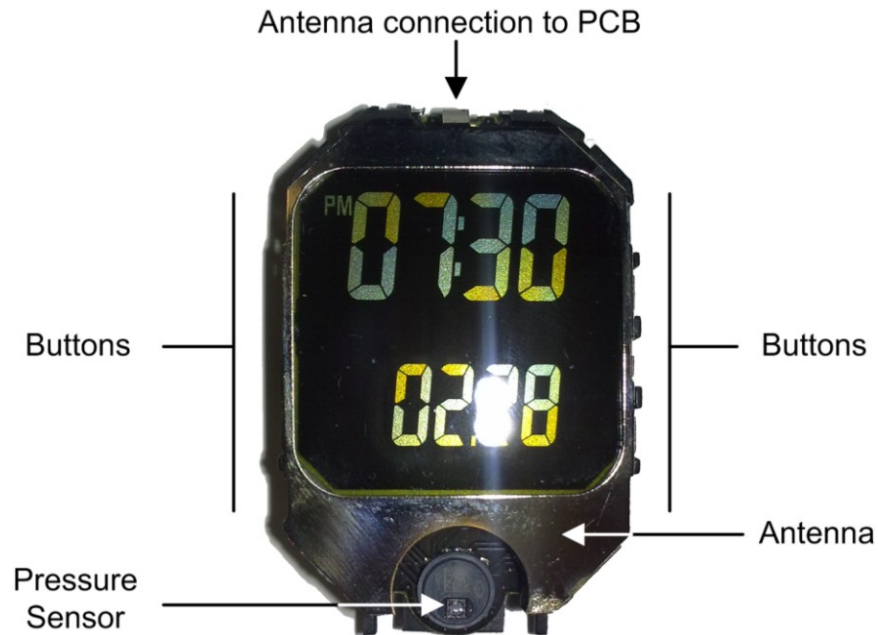
Figure 4-8. eZ430-Chronos Watch Module Front
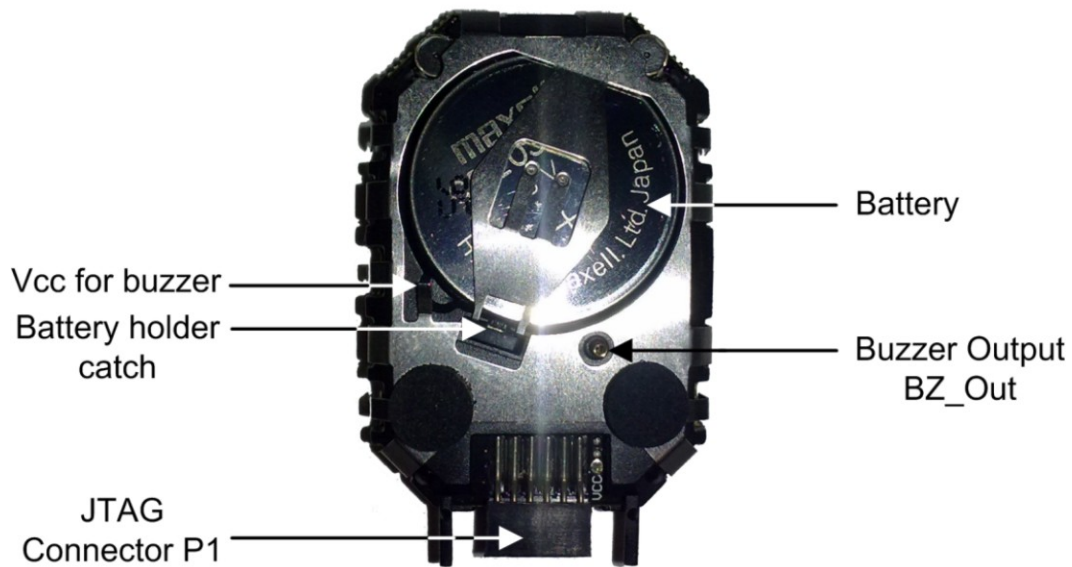
Figure 4-9. eZ430-Chronos Watch Module Back

Table 4-1. Estimated Battery Life (Sports Watch Software)

Mode	Average Current	Battery Life
Shelf mode (LPM4)	2.7 µA	92.6 months
Welcome screen (LPM3)	8.9 µA	28.0 months
Time/Date	9.0 µA	27.7 months
Continuous temperature measurement	10.0 µA	25.0 months
Continuous altitude measurement	18.0 µA	13.8 months
Continuous acceleration measurement	166.0 µA	1.5 months
Continuous BlueRobin RX	40.0 µA	6.2 months
Continuous SimpliciTI PPT (no button pressed)	10.0 µA	25.0 months
Continuous SimpliciTI SYNC	0.9 mA	8 days
Continuous SimpliciTI ACC	3.7 mA	2 days
1h/day BlueRobin RX	10.3 µA	24.2 months
1h/day SimpliciTI PPT (no button pressed)	9.1 µA	25.4 months
1h/day SimpliciTI SYNC	46.1 µA	5.4 months
1h/day SimpliciTI ACC	169.9 µA	1.4 months

4.3   Functional Description of the eZ430-Chronos RF Access Point

The RF access point allows wireless communication with the eZ430-Chronos directly from the PC to download data, sync information, or control programs running on the PC (see Figure 4-10). It is based on the CC1111F32 controller, which features an integrated USB controller in addition to a <1-GHz radio.
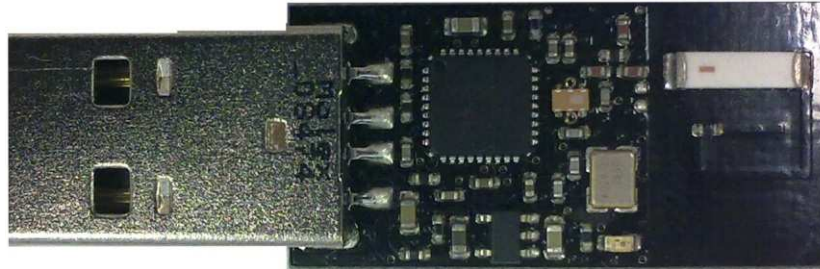
Figure 4-10. eZ430-Chronos RF Access Point

NOTE: The access point is this kit comes in a small production-ready design. Therefore, it does not include a JTAG connector. However, the bottom side provides pads that allow soldering cables to connect the CC1111 to the CC Debugger. TI also offers the professional CC1111EMK868-915 development kit including connectors and a push button.

To reprogram RF access point, a debug interface connector cable needs to be soldered onto the CC1111 access point as shown in Figure 4-11.

Figure 4-11. eZ430-Chronos RF Access Point Connection to CC Debugger

CC-Debugger	RF Access Point
Pin 1	GND
Pin 2	Vcc
Pin 3	P2.2 (DC)
Pin 4	P2.1 (DD)
Pin 7	RST
Pin 9	Vcc

4.4 Functional Description of the eZ430-Chronos Debug Interface

The eZ430-Chronos kit includes an USB emulator that provides full programming and debugging features using its Spy-Bi-Wire (2-wire) interface. It features a back channel MSP430 application UART that may be used independently of a debug session.

NOTE: Despite the fact that the watch module is equipped with a 6-pin connector, there is no UART connection from the watch to the emulator as all pins of the CC430 are already used for other purposes.

Supported devices:
- CC430F51xx
- CC430F61xx
- MSP430F20xx
- MSP430F21x2
- MSP430F22xx
- MSP430F41x2
- MSP430F54xx
- MSP430F54xxA
- MSP430F55xx

Connector J1 on the emulator (starting on top with pin 1) (see Figure 4-12).
- UART TX (from emulator to target)
- 3.6-V supply for target
- TEST/SBWTCK
- RST/SBWTDIO
- GND
- UART RX (from target to emulator)
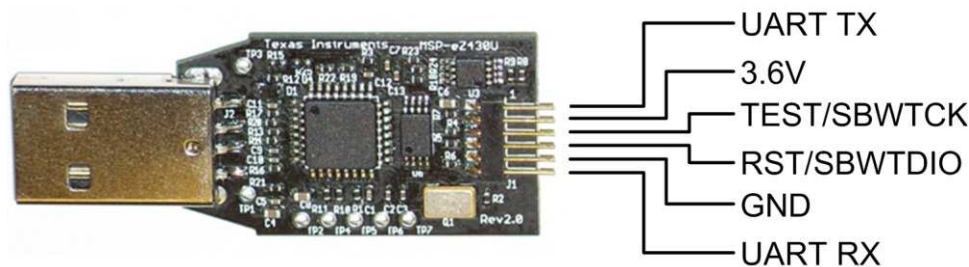
Figure 4-12. eZ430-Chronos Debug Interface

4.4.1 MSP430 Application UART

The eZ430-Chronos emulator includes a back channel MSP430 Application UART that may be used independently of a debug session. This allows the user to transfer serial data to a terminal window at a fixed rate of 9600 bps with no flow control. Check the Device Manager for COM port assignment of the MSP430 Application UART (for more details, see Section B.2).

4.5 Schematics, Layout, BOM, and LCD

Gerber files for the eZ430-Chronos watch module are part of the eZ430-Chronos software packages for Windows SLAC341 and Linux SLAC388.

4.5.1 *eZ430-Chronos-433 Watches*
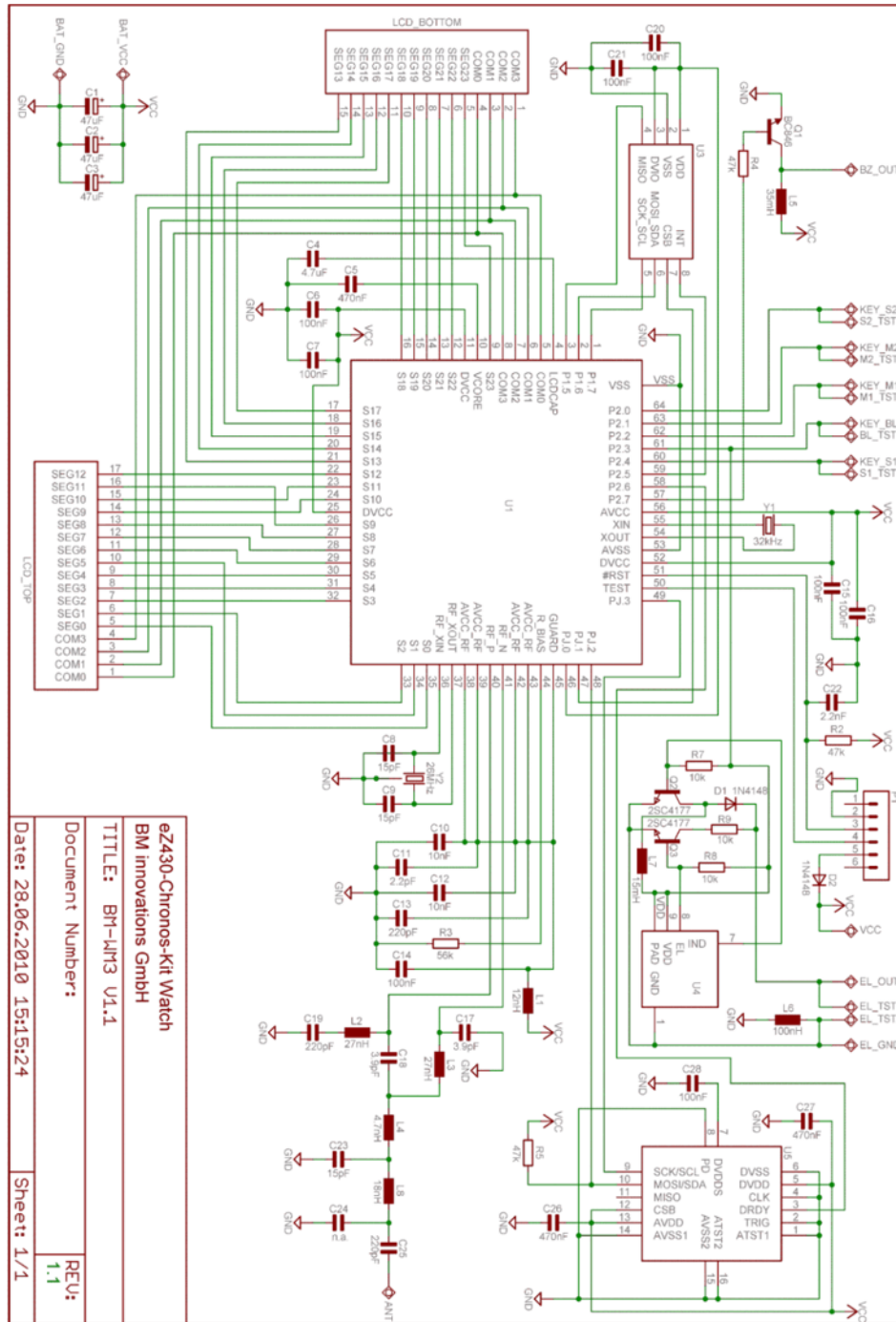
Figure 4-13. eZ430-Chronos-433 Watch, Schematics

Figure 4-14. eZ430-Chronos-433 Watch, PCB Components on Top Layer

Figure 4-15. eZ430-Chronos-433 Watch, Layout Top Layer (LCD Side)

Figure 4-16. eZ430-Chronos-433 Watch, Layout Second Layer

Figure 4-17. eZ430-Chronos-433 Watch, Layout Third Layer

Figure 4-18. eZ430-Chronos-433, Layout Bottom Layer (Battery Side)

Table 4-2. eZ430-Chronos-433 Watch, BOM List

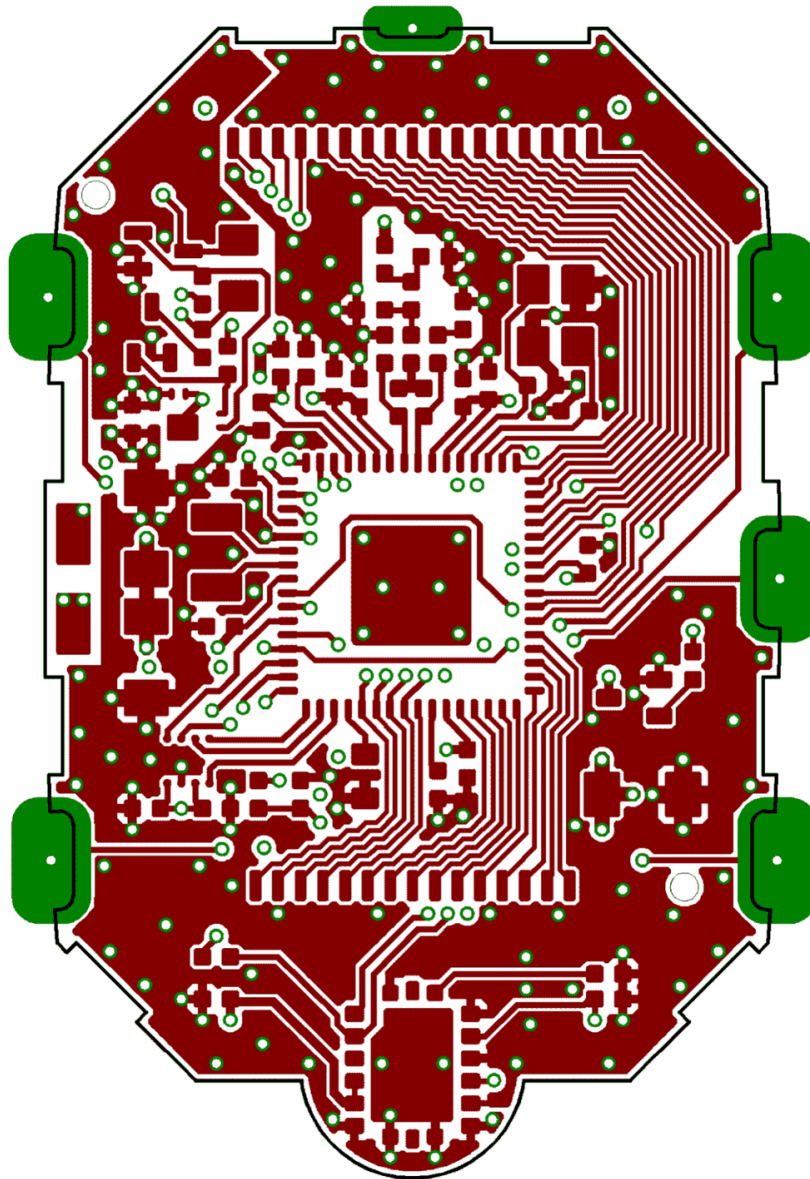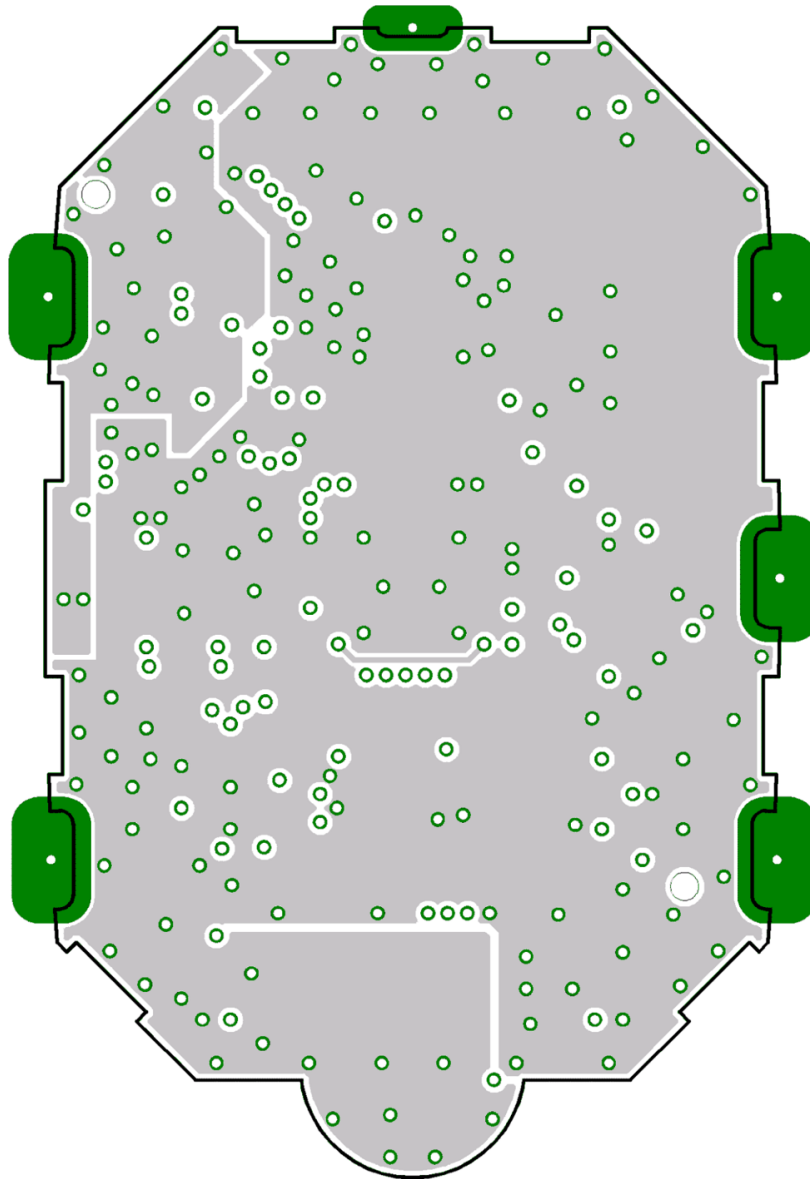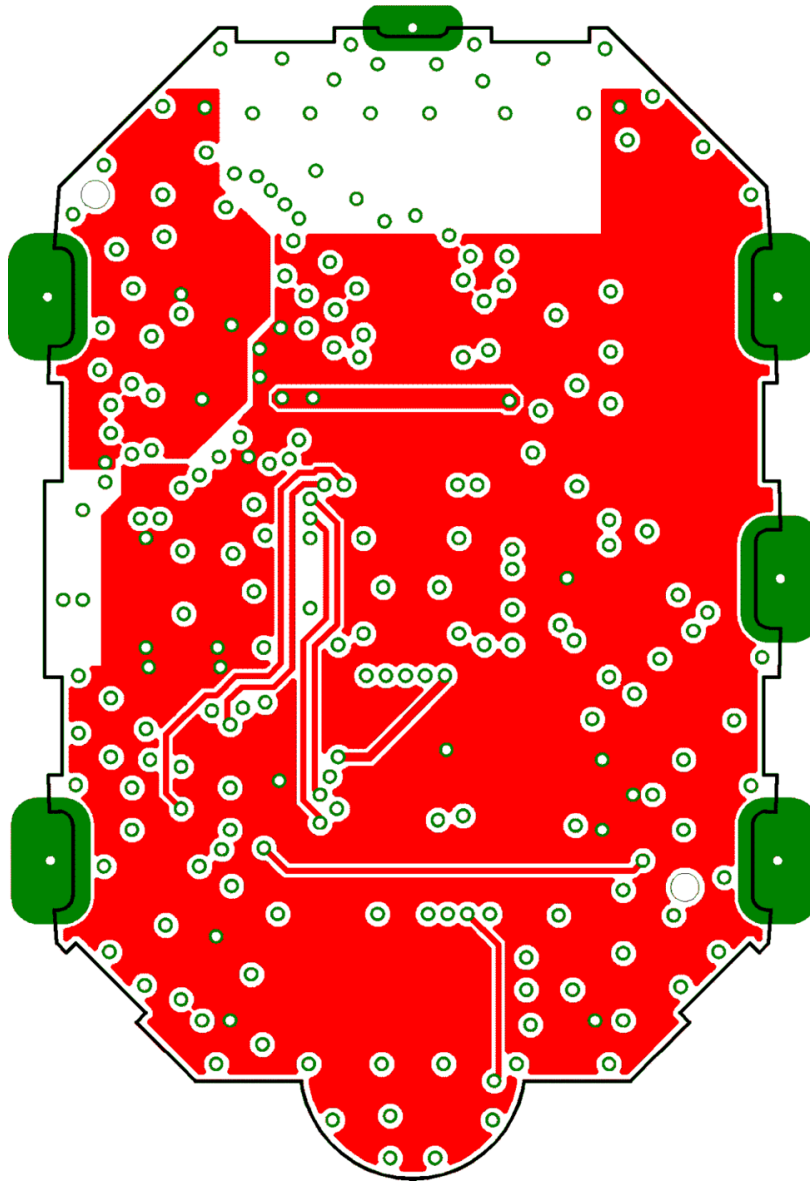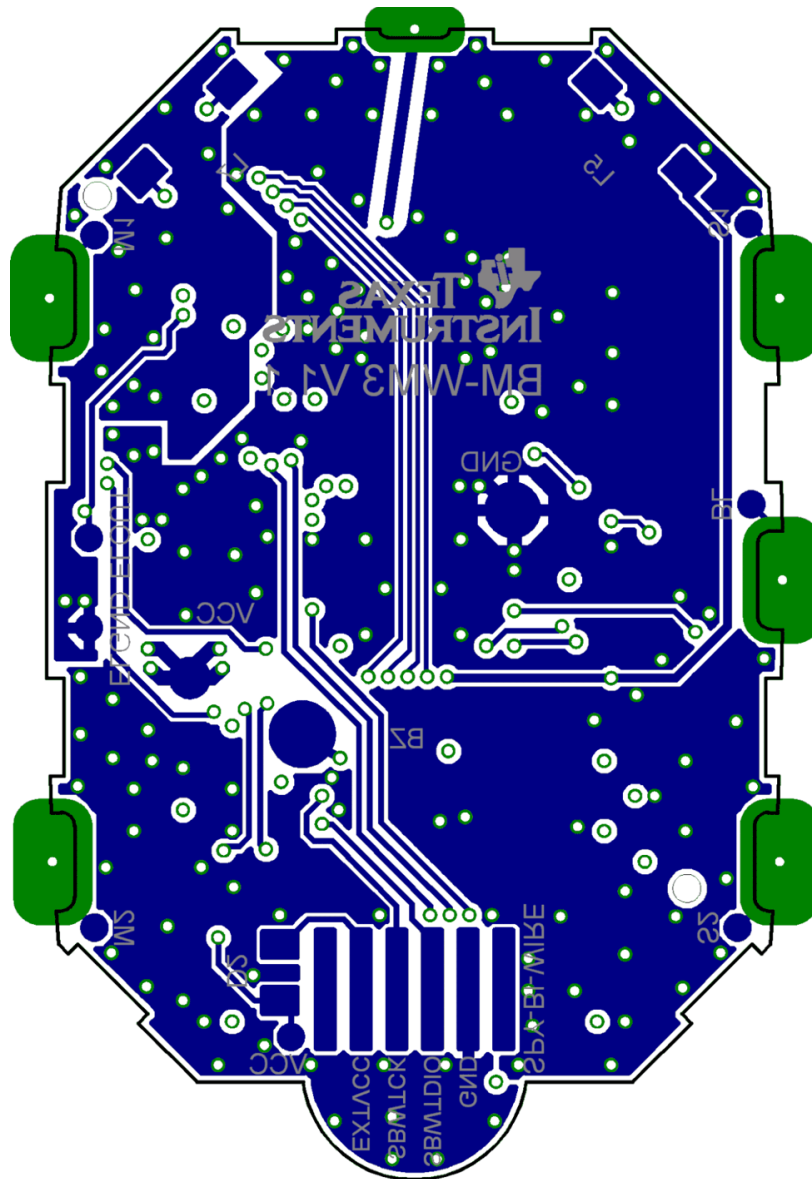| Designator	Value	Tolerance	Footprint	Description	Manufacturer
C1	47 µF	±20%	TAJ-A	Capacitor SMD	Tantalum, height max. 1.6 mm
C2	47 µF	±20%	TAJ-A	Capacitor SMD	Tantalum, height max. 1.6 mm
C3	47 µF	±20%	TAJ-A	Capacitor SMD	Tantalum, height max. 1.6 mm
C4	4.7 µF	±20%, X5R	603	Capacitor SMD	
C5	470 nF	±10%, X5R	402	Capacitor SMD	
C6	100 nF	±10%, X7R	402	Capacitor SMD	
C7	100 nF	±10%, X7R	402	Capacitor SMD	
C8	15 pF	±5%, COG/NP0	402	Capacitor SMD	
C9	15 pF	±5%, COG/NP0	402	Capacitor SMD	
C10	10 nF	±10%, X7R	402	Capacitor SMD	
C11	2.2 pF	±0.25 pF, COG/NP0	402	Capacitor SMD	
C12	10 nF	±10%, X7R	402	Capacitor SMD	
C13	220 pF	±10%, COG/NP0	402	Capacitor SMD	
C14	100 nF	±10%, X7R	402	Capacitor SMD	
C15	100 nF	±10%, X7R	402	Capacitor SMD	
C16	100 nF	±10%, X7R	402	Capacitor SMD	
C17	3.9 pF	±0.1 pF, COG/NP0	402	Capacitor SMD	Johanson 500R07S3R9BV4
C18	3.9 pF	±0.1 pF, COG/NP0	402	Capacitor SMD	Johanson 500R07S3R9BV4
C19	220 pF	+-10%, COG/NP0	402	Capacitor SMD	
C20	100 nF	±10%, X7R	402	Capacitor SMD	
C21	100 nF	±10%, X7R	402	Capacitor SMD	
C22	2.2 nF	±10%, X7R	402	Capacitor SMD	
C26	470 nF	±10%, X5R	402	Capacitor SMD	
C27	470 nF	±10%, X5R	402	Capacitor SMD	
C28	100 nF	±10%, X7R	402	Capacitor SMD	
D1	1N4148		805	Diode SMD	
D2	1N4148		805	Diode SMD	
L1	12 nH	±5%	402	Inductor Monolithic SMD	Johanson L-07C12NJV4
L2	27 nH	±5%	402	Inductor Monolithic SMD	Johanson L-07C27NJV4
L3	27 nH	±5%	402	Inductor Monolithic SMD	Johanson L-07C27NJV4
L4	4.7 nH	±0.3nH	402	Inductor Monolithic SMD	Johanson L-07C4N7SV4
L5	35 mH, RDC≤250Ω, IDC≥1mA	±10%		Inductor Coil	
L6	100 nH	±10%	402	Inductor Monolithic SMD	
L7	4mH, RDC≤100Ω, IDC≥10mA	±10%		Inductor Coil	
L8	18 nH	±5%	402	Inductor Monolithic SMD	Johanson L-07C18NJV4
P1	Female Header 1.27mm			Connector SMD	for example, MPE-Garry BL SMD 91-06
PCB1	CUSTOM, solder stop black			PCB, 4 layers, 0.6 mm thick	
Q1	BC846BW or BC847BW		SOT323	Bipolar Transistor NPN SMD	
Q2	BC846BW or BC847BW		SOT323	Bipolar Transistor NPN SMD	
Q3	BC846BW or BC847BW		SOT323	Bipolar Transistor NPN SMD	
R2	47k	±5%	402	Resistor SMD	
R3	56k	±1%	402	Resistor SMD	
R4	47k	±5%	402	Resistor SMD	
R5	47k	±5%	402	Resistor SMD	
R7	10k	±5%	402	Resistor SMD	
R8	10k	±5%	402	Resistor SMD	
R9	10k	±5%	402	Resistor SMD	

Table 4-2. eZ430-Chronos-433 Watch, BOM List (continued)

Designator	Value	Tolerance	Footprint	Description	Manufacturer
U1	CC430F6137IRGC		QFN64	MCU with ISM Transceiver	TI
U3	CMA3000-D01		WLP	Acceleration Sensor SPI	VTI
U4	HKA5403Q-30		DIE	EL Driver	
U5	SCP1000-D11			Pressure Sensor I2C	VTI
Y1	32.768kHz, CL=12.5pF, ESR≤80kΩ	±20ppm	3.2 x 1.5 mm2	Crystal SMD	Microcrystal CC7V-T1A
Y2	26MHz, CL=10pF, ESR≤40Ω	±10ppm	3.2 x 2.5 mm2	Crystal SMD	Epson TSX3225-X1E000021014300

4.5.2 eZ430-Chronos-868 and -915 Watches
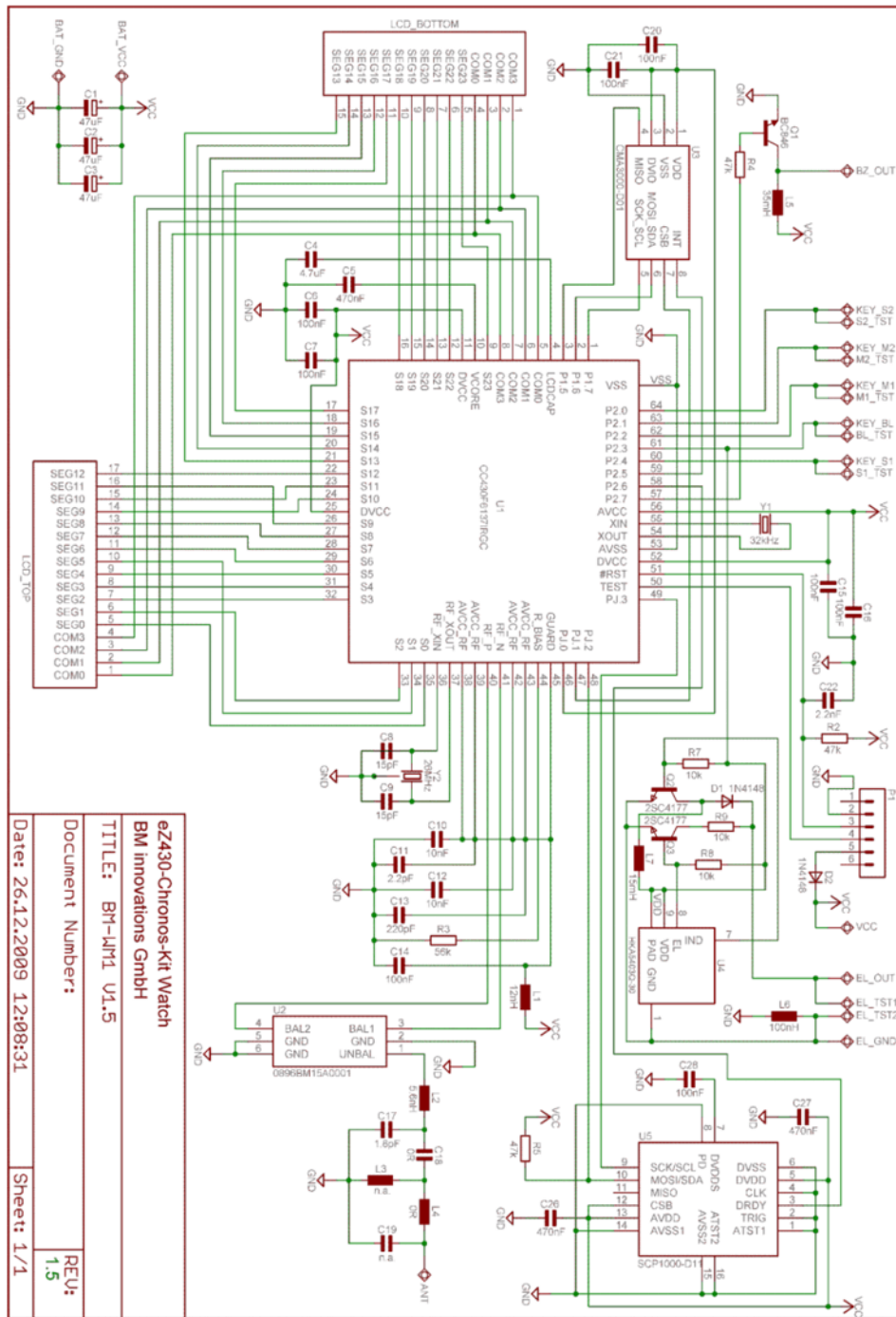
Figure 4-19. eZ430-Chronos-868 and -915 Watch, Schematics
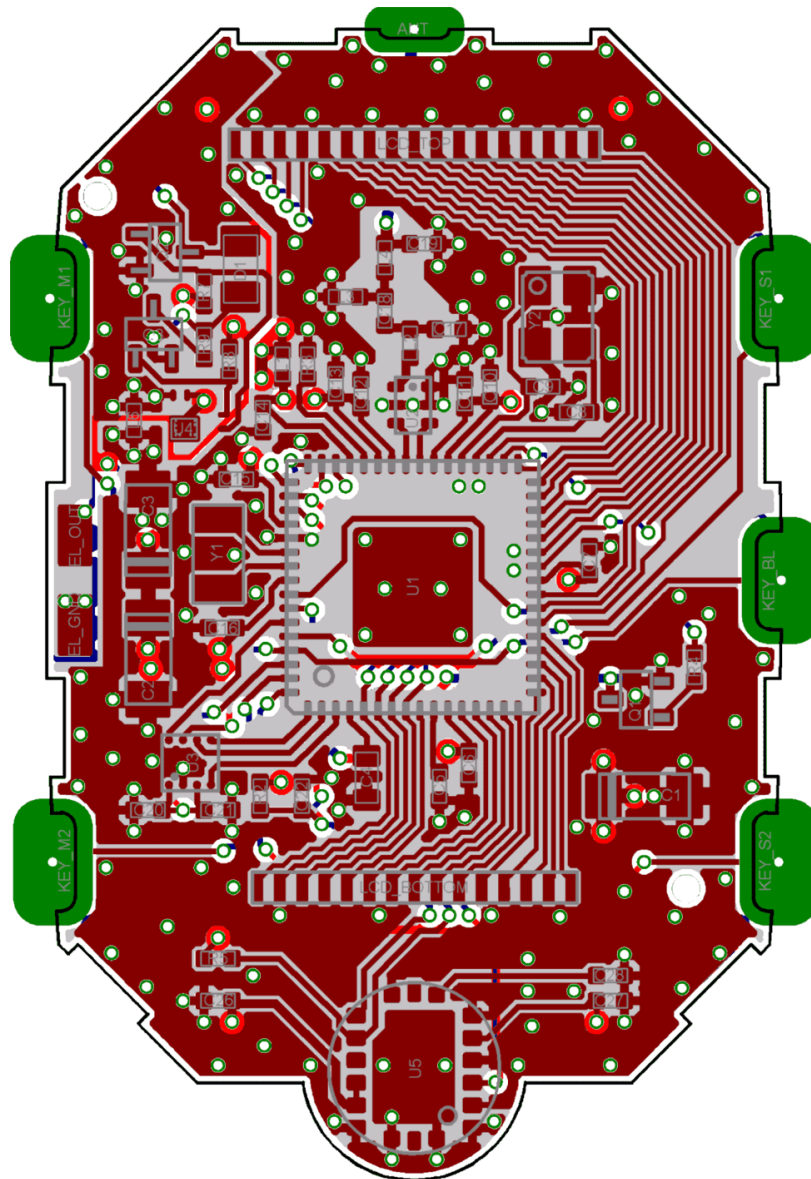
Figure 4-20. eZ430-Chronos-868 and -915 Watch, PCB Components on Top Layer
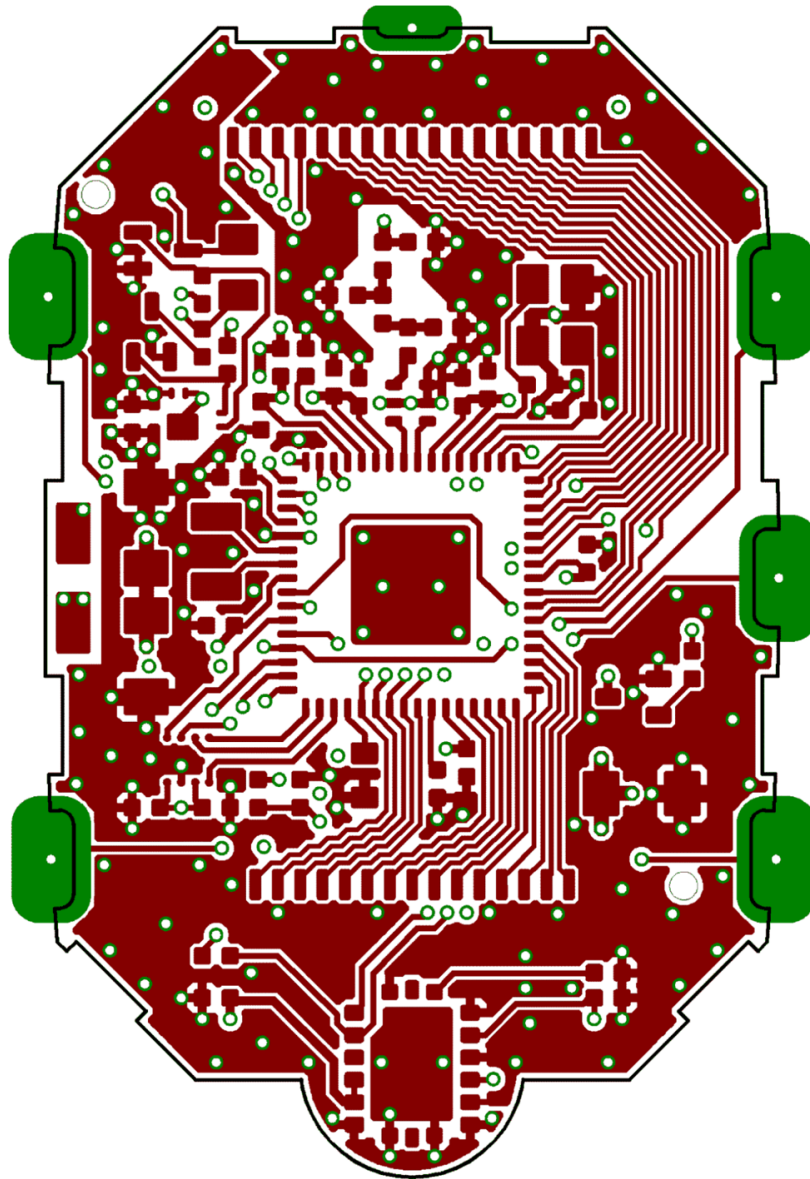
Figure 4-21. eZ430-Chronos-868 and -915 Watch, Layout Top Layer (LCD Side)
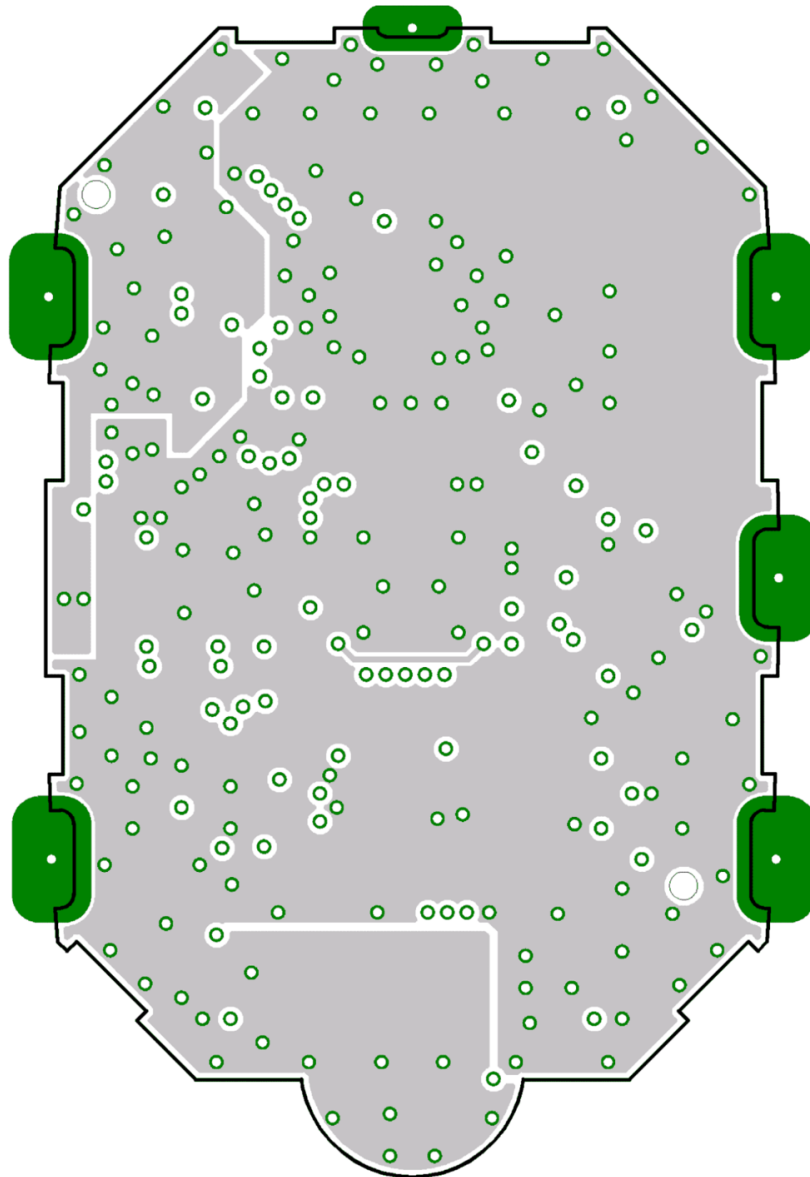
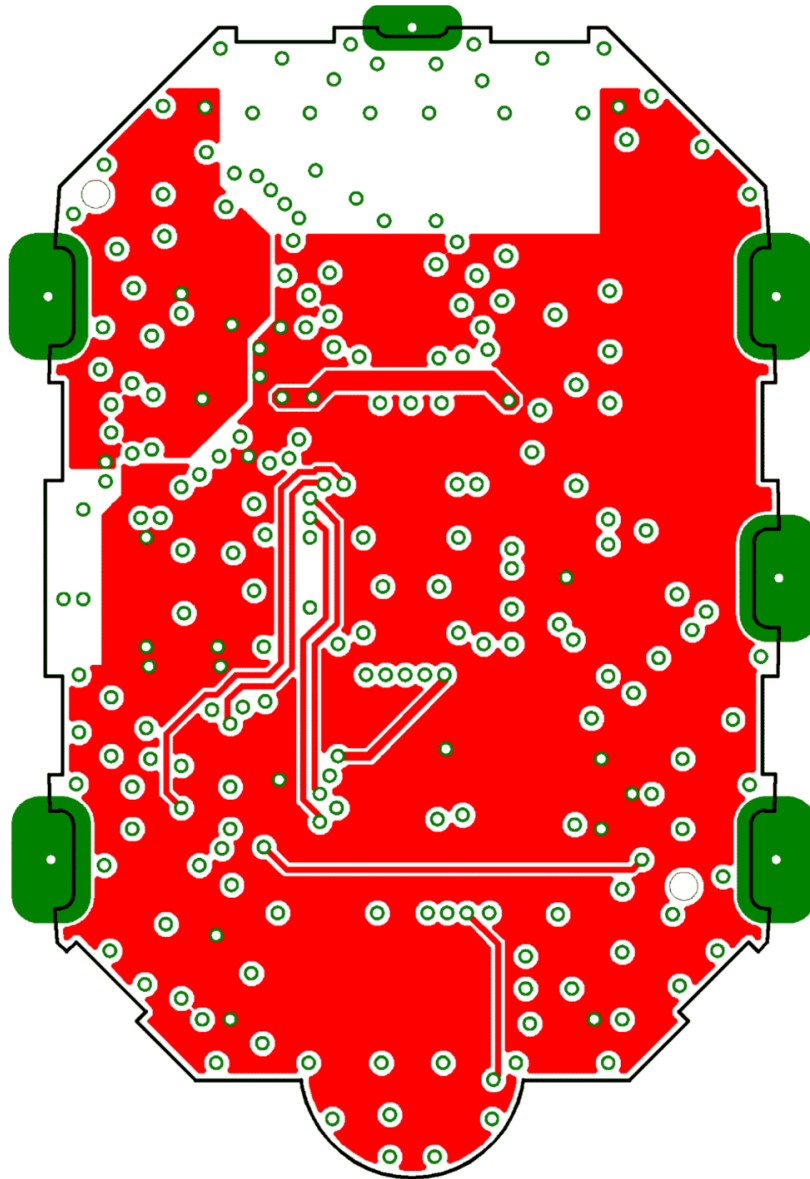**Figure 4-22. eZ430-Chronos-868 and -915 Watch, Layout 2nd Layer**

Figure 4-23. eZ430-Chronos-868 and -915 Watch, Layout 3rd Layer
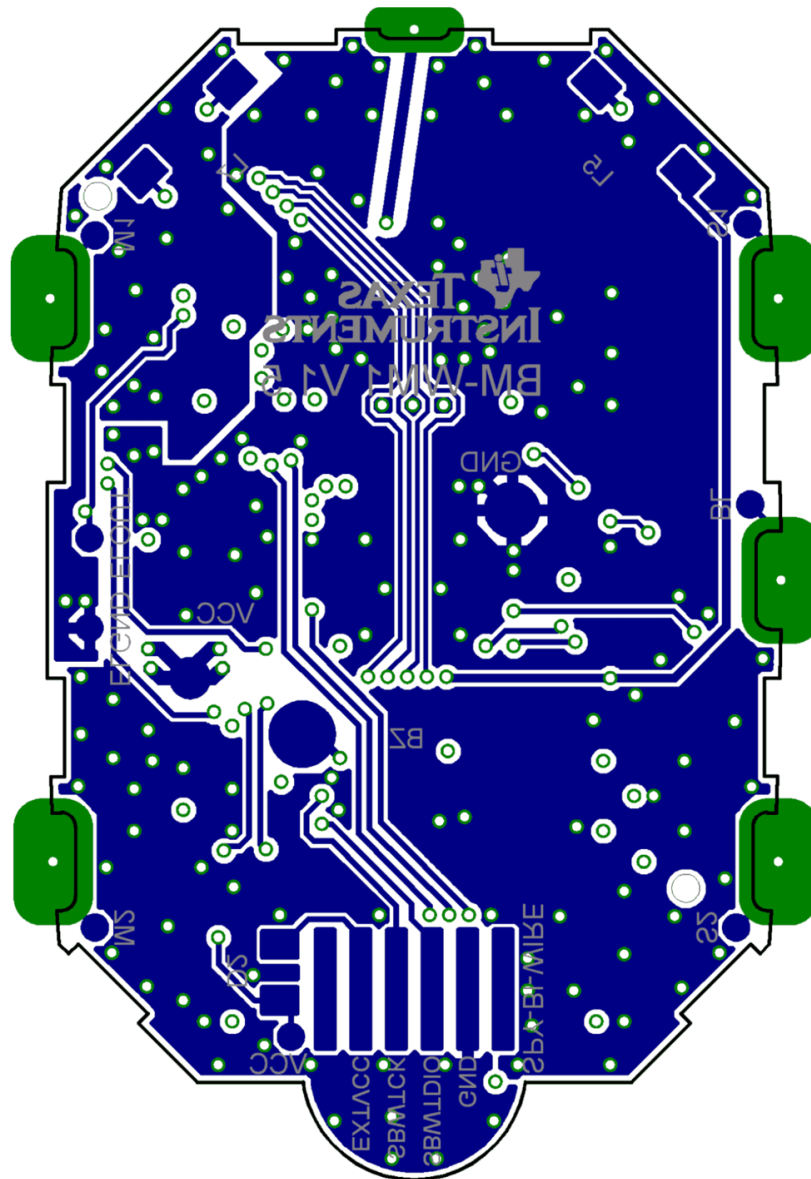
Figure 4-24. eZ430-Chronos-868 and -915 Watch, Layout Bottom Layer (Battery Side)

Table 4-3. eZ430-Chronos-868 and -915 Watch, BOM List

Designator	Value	Tolerance	Footprint	Description	Manufacturer
C1	47 µF	±20%	TAJ-A	Capacitor SMD	Tantalum, height max. 1.6mm
C2	47 µF	±20%	TAJ-A	Capacitor SMD	Tantalum, height max. 1.6mm
C3	47 µF	±20%	TAJ-A	Capacitor SMD	Tantalum, height max. 1.6mm
C4	4.7 µF	±20%, X5R	603	Capacitor SMD	
C5	470 nF	±10%, X5R	402	Capacitor SMD	
C6	100 nF	±10%, X7R	402	Capacitor SMD	
C7	100 nF	±10%, X7R	402	Capacitor SMD	
C8	15 pF	±5%, COG/NP0	402	Capacitor SMD	
C9	15 pF	±5%, COG/NP0	402	Capacitor SMD	
C10	10 nF	±10%, X7R	402	Capacitor SMD	
C11	2.2 pF	±0.25pF, COG/NP0	402	Capacitor SMD	
C12	10 nF	±10%, X7R	402	Capacitor SMD	
C13	220 pF	±10%, COG/NP0	402	Capacitor SMD	
C14	100 nF	±10%, X7R	402	Capacitor SMD	
C15	100 nF	±10%, X7R	402	Capacitor SMD	
C16	100 nF	±10%, X7R	402	Capacitor SMD	
C17	1.8 pF	±0.1pF, COG/NP0	402	Capacitor SMD	Johanson 500R07S1R8BV4
C18	0R	±5%	402	Resistor SMD	
C19	N.A.				
C20	100 nF	±10%, X7R	402	Capacitor SMD	
C21	100 nF	±10%, X7R	402	Capacitor SMD	
C22	2.2 nF	±10%, X7R	402	Capacitor SMD	
C26	470 nF	±10%, X5R	402	Capacitor SMD	
C27	470 nF	±10%, X5R	402	Capacitor SMD	
C28	100 nF	±10%, X7R	402	Capacitor SMD	
D1	1N4148		805	Diode SMD	
D2	1N4148		805	Diode SMD	
L1	12 nH	±5%	402	Inductor Monolithic SMD	Johanson L-07C12NJV4
L2	5.6 nH	±0.3nH	402	Inductor Monolithic SMD	Johanson L-07C5N6SV4
L3	N.A.				
L4	0R	±5%	402	Resistor SMD	
L5	35 mH, RDC≤250Ω, IDC≥1mA	±10%		Inductor Coil	
L6	100nH	±10%	402	Inductor Monolithic SMD	
L7	4mH, RDC≤100Ω, IDC≥10mA	±10%		Inductor Coil	
P1	Female Header 1.27mm			Connector SMD	for example, MPE-Garry BL SMD 91-06
PCB1	CUSTOM, solder stop black			PCB, 4 layers, 0.6 mm thick	
Q1	BC846BW or BC847BW		SOT323	Bipolar Transistor NPN SMD	
Q2	BC846BW or BC847BW		SOT323	Bipolar Transistor NPN SMD	
Q3	BC846BW or BC847BW		SOT323	Bipolar Transistor NPN SMD	
R2	47k	±5%	402	Resistor SMD	
R3	56k	±1%	402	Resistor SMD	
R4	47k	±5%	402	Resistor SMD	
R5	47k	±5%	402	Resistor SMD	
R7	10k	±5%	402	Resistor SMD	
R8	10k	±5%	402	Resistor SMD	
R9	10k	±5%	402	Resistor SMD	

Table 4-3. eZ430-Chronos-868 and -915 Watch, BOM List (continued)

Designator	Value	Tolerance	Footprint	Description	Manufacturer
U1	CC430F6137IRGC		QFN64	MCU with ISM Transceiver	TI
U2	0896BM15A0001			896MHz Balun	Johanson
U3	CMA3000-D01		WLP	Acceleration Sensor SPI	VTI
U4	HKA5403Q-30		DIE	EL Driver	
U5	SCP1000-D11			Pressure Sensor I2C	VTI
Y1	32.768kHz, CL=12.5pF, ESR≤80kΩ	±20ppm	3.2 x 1.5 mm2	Crystal SMD	Microcrystal CC7V-T1A
Y2	26MHz, CL=10pF, ESR≤40Ω	±10ppm	3.2 x 2.5 mm2	Crystal SMD	Epson TSX3225-X1E000021014300

PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	COM3	COM2	COM1	COM0	SEG23	SEG22	SEG21	SEG20	SEG19	SEG18	SEG17	SEG16	SEG15	SEG14	SEG13	SEG12
COM0				COM0	P	1D	TOTAL	2D	AVG	3D	DP1	4D	MAX	5D	S0	S3
COM1			COM1		1E	1C	2E	2C	3E	3C	4E	4C	5E	5C	5B	
COM2		COM2			1G	1B	2G	2B	3G	3B	4G	4B	5G	5B		
COM3	COM3				1F	1A	2F	2A	3F	3A	4F	4A	5F	5A		

PIN	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
	SEG11	SEG10	SEG9	SEG8	SEG7	SEG6	SEG5	SEG4	SEG3	SEG2	SEG1	SEG0	COM3	COM2	COM1	COM0
COM0		6D	S2	S1	7D			8D		9D		▷	COM3	COM2	COM1	COM0
COM1		6C	6E	DP2	7C	7E	DP3	8C	8E	9C	9E	◁			COM1	COM0
COM2		6B	6G		7B	7G	COL3	8B	8G	9B	9G	RM	COM2		COM2	
COM3		6A	6F	COL2	7A	7F	COL1	8A	8F	9A	9F	PM	COM3			

UDT 东莞励成电子有限公司

DONGGUAN LEGEND DISPLAY CO., LTD

APPROVED BY			CUSTOM NO.	RA121		UNITS	mm
CHECKED BY			DESIGN NO.& (VERSION)	LDT60390101(A0)		SCALE	
DRAWING BY	Y1e	2009-01-06	MODEL NO.	S60390101ZMN-F		SHEET	2 OF 4
REMARK							

FAX NO.:0769-22665932

Figure 4-25. LCD Segment Map

Figure 4-26. LCD Pinout

4.6   Access Point Schematics, Layout and BOM

Gerber files for the eZ430-Chronos access point are part of the eZ430-Chronos software packages for Windows SLAC341 and Linux SLAC388.

4.6.1   eZ430-Chronos-433 RF Access Point

Figure 4-27. eZ430-Chronos-433 RF Access Point, Schematics

Figure 4-28. eZ430-Chronos-433 RF Access Point, PCB Components on Top Layer

Figure 4-29. eZ430-Chronos-433 RF Access Point, Layout Top Layer

Figure 4-30. eZ430-Chronos-433 RF Access Point, Layout Bottom Layer

Table 4-4. eZ430-Chronos-433 Access Point, BOM List

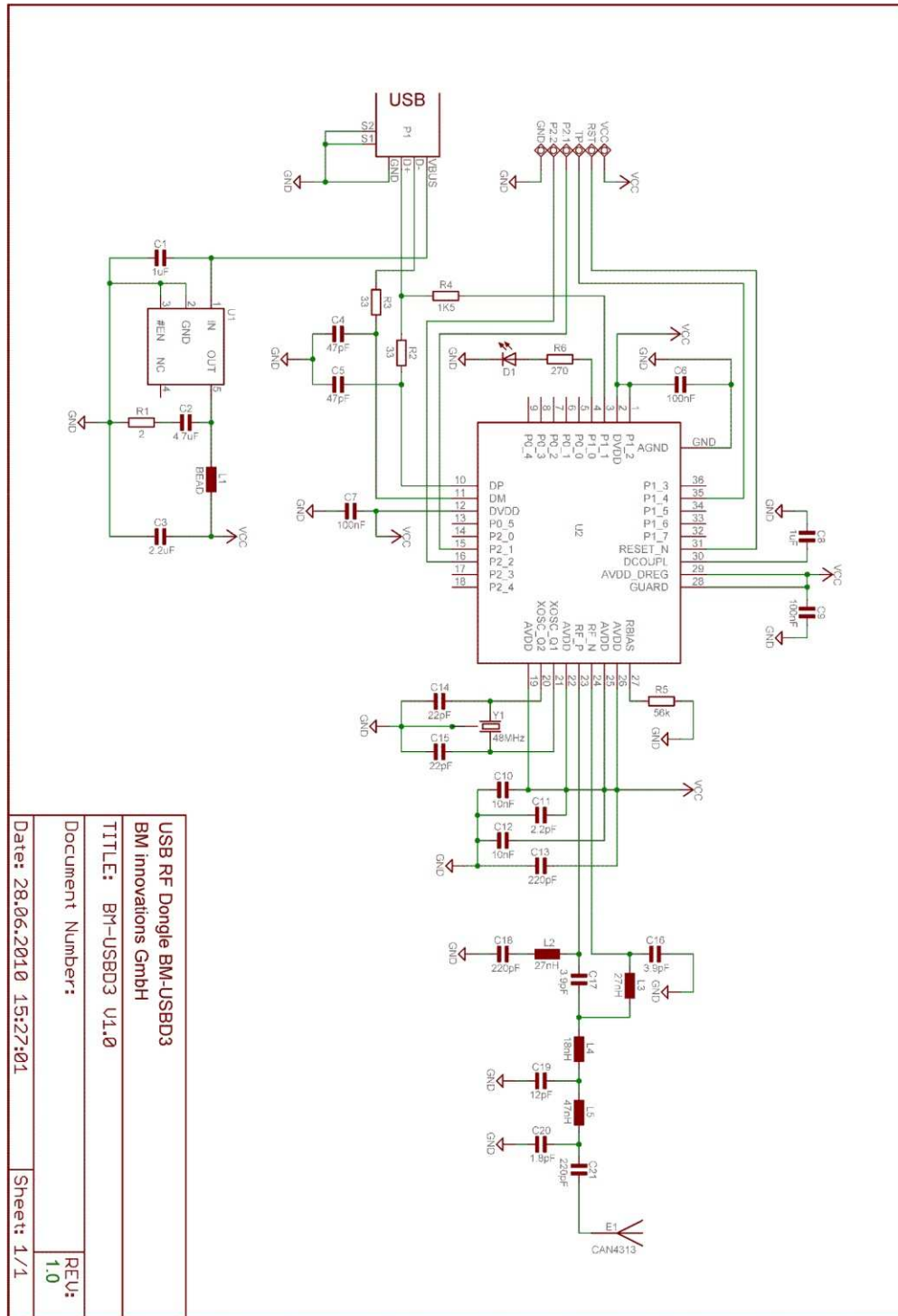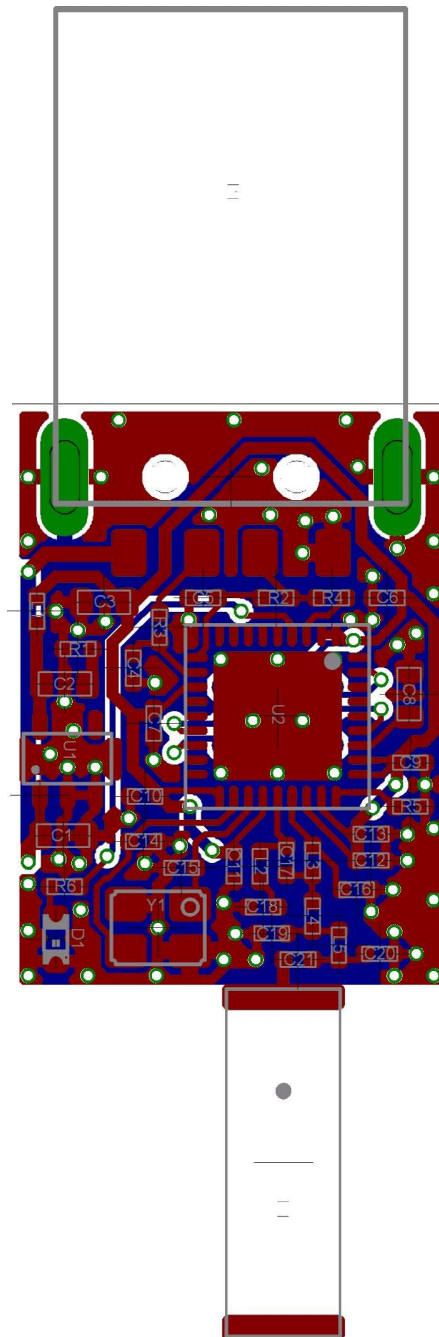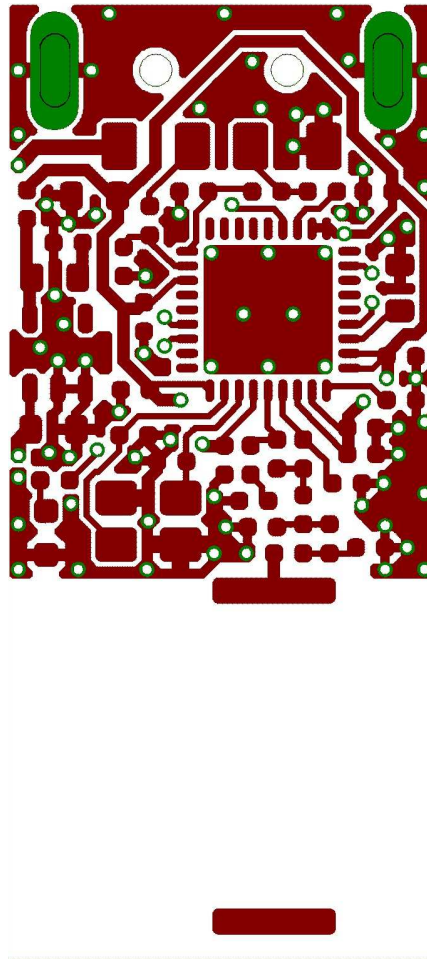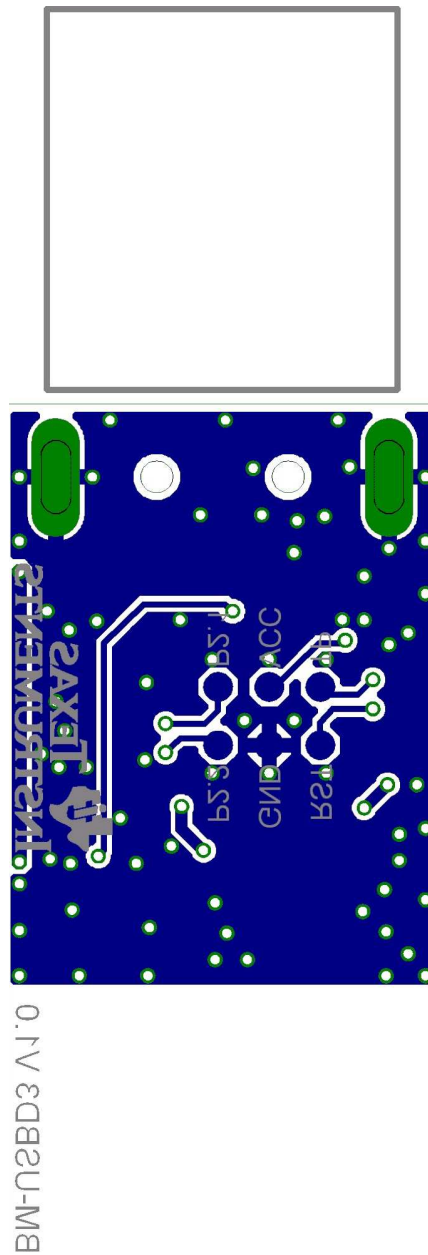| Designator	Value	Tolerance	Footprint	Description	Manufacturer
C1	1 μF	+-10%, X5R	603	Capacitor SMD	
C2	4.7 μF	+-10%, X5R	603	Capacitor SMD	
C3	2.2 μF	+-10%, X5R	603	Capacitor SMD	
C4	47 pF	+-10%, COG/NP0	402	Capacitor SMD	
C5	47 pF	+-10%, COG/NP0	402	Capacitor SMD	
C6	100 nF	+-10%, X7R	402	Capacitor SMD	
C7	100 nF	+-10%, X7R	402	Capacitor SMD	
C8	1 μF	+-10%, X5R	603	Capacitor SMD	
C9	100 nF	+-10%, X7R	402	Capacitor SMD	
C10	10 nF	+-10%, X7R	402	Capacitor SMD	
C11	2.2 pF	+-0.25pF, COG/NP0	402	Capacitor SMD	
C12	10 nF	+-10%, X7R	402	Capacitor SMD	
C13	220 pF	+-10%, COG/NP0	402	Capacitor SMD	
C14	22 pF	+-5%, COG/NP0	402	Capacitor SMD	
C15	22 pF	+-5%, COG/NP0	402	Capacitor SMD	
C16	3.9 pF	+-0.1pF, COG/NP0	402	Capacitor SMD	Johanson 500R07S3R9BV4
C17	3.9 pF	+-0.1pF, COG/NP0	402	Capacitor SMD	Johanson 500R07S3R9BV4
C18	220 pF	+-10%, COG/NP0	402	Capacitor SMD	
C18	220 pF	+-10%, COG/NP0	402	Capacitor SMD	
C19	220 pF	+-10%, COG/NP0	402	Capacitor SMD	
C20	220 pF	+-10%, COG/NP0	402	Capacitor SMD	
C21	220 pF	+-10%, COG/NP0	402	Capacitor SMD	
D1	green		603	LED SMD	
E1	0868AT43A0020			Chip Antenna	Johanson
L1	Ferrite Bead 1k, 1R, min. 100mA		402	EMI Filter SMD	for example, TDK MMZ1005S102C
L2	27 nH	+-5%	402	Inductor Monolithic SMD	Johanson L-07C27NJV4
L3	27 nH	+-5%	402	Inductor Monolithic SMD	Johanson L-07C27NJV4
L4	18 nH	+-5%	402	Inductor Monolithic SMD	Johanson L-07C18NJV4
L5	47nH	+-5%	402	Inductor Monolithic SMD	Johanson L-07C47NJV4
P1	USB Type A			USB Plug	for example, Lumberg 241007
PCB1	CUSTOM, solder stop black			PCB, 2 layers, 0.8 mm thick	
R1	2R	+-5%	402	Resistor SMD	
R2	33R	+-5%	402	Resistor SMD	
R3	33R	+-5%	402	Resistor SMD	
R4	1.5k	+-5%	402	Resistor SMD	
R5	56k	+-1%	402	Resistor SMD	
R6	270R	+-5%	402	Resistor SMD	
U1	TPS76933DBV		SOT-23	Linear Regulator	TI
U2	CC1111F32RSP		QFN36	ISM Transceiver	TI
Y1	48MHz, CL=16pF, ESR≤40Ω	+-10ppm	23.2 x 2.5 mm2	Crystal SMD	Epson TSX3225-X1E000021040300

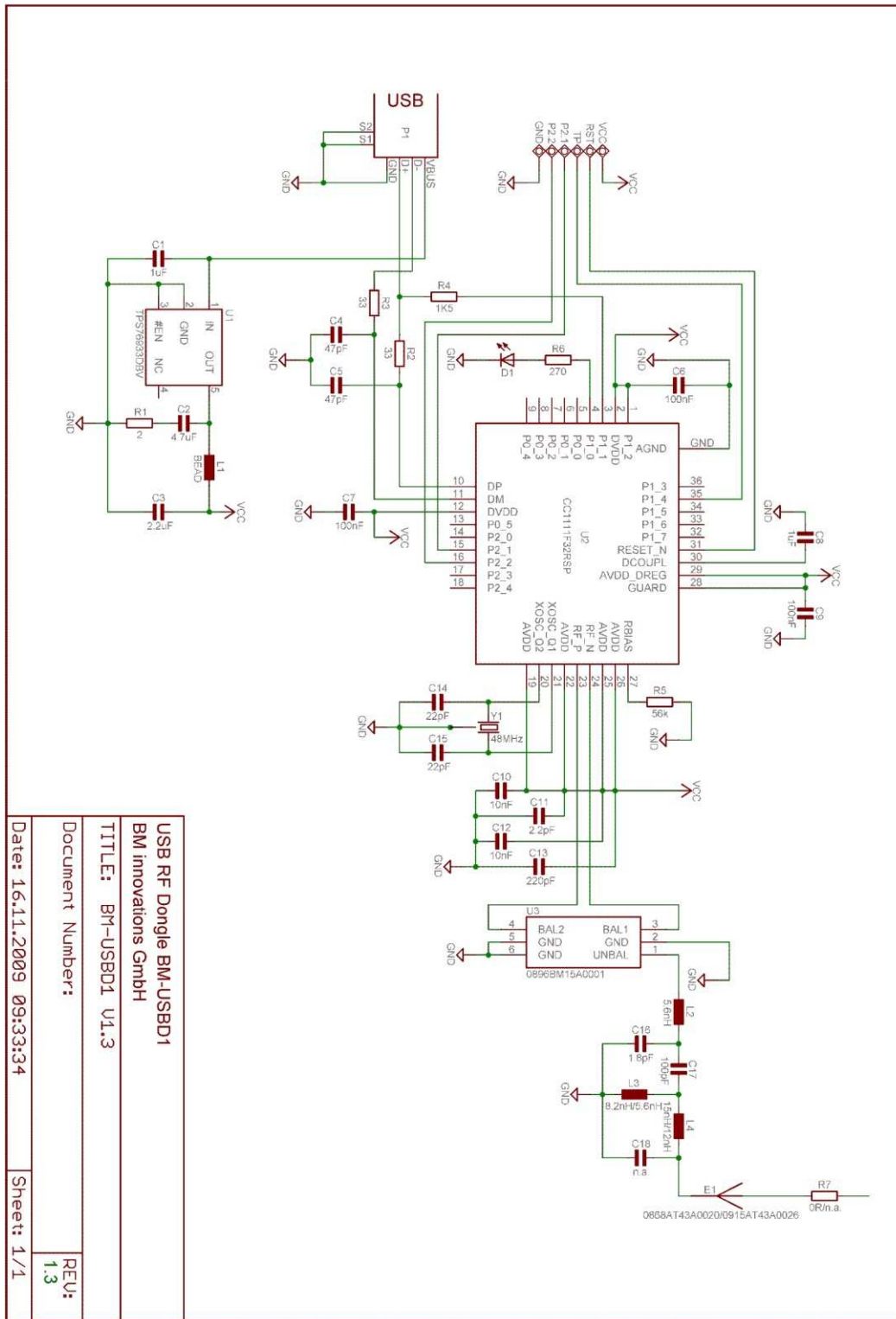### 4.6.2 eZ430-Chronos-868 and -915 RF Access Point

Figure 4-31. eZ430-Chronos-868 and -915 RF Access Point, Schematics
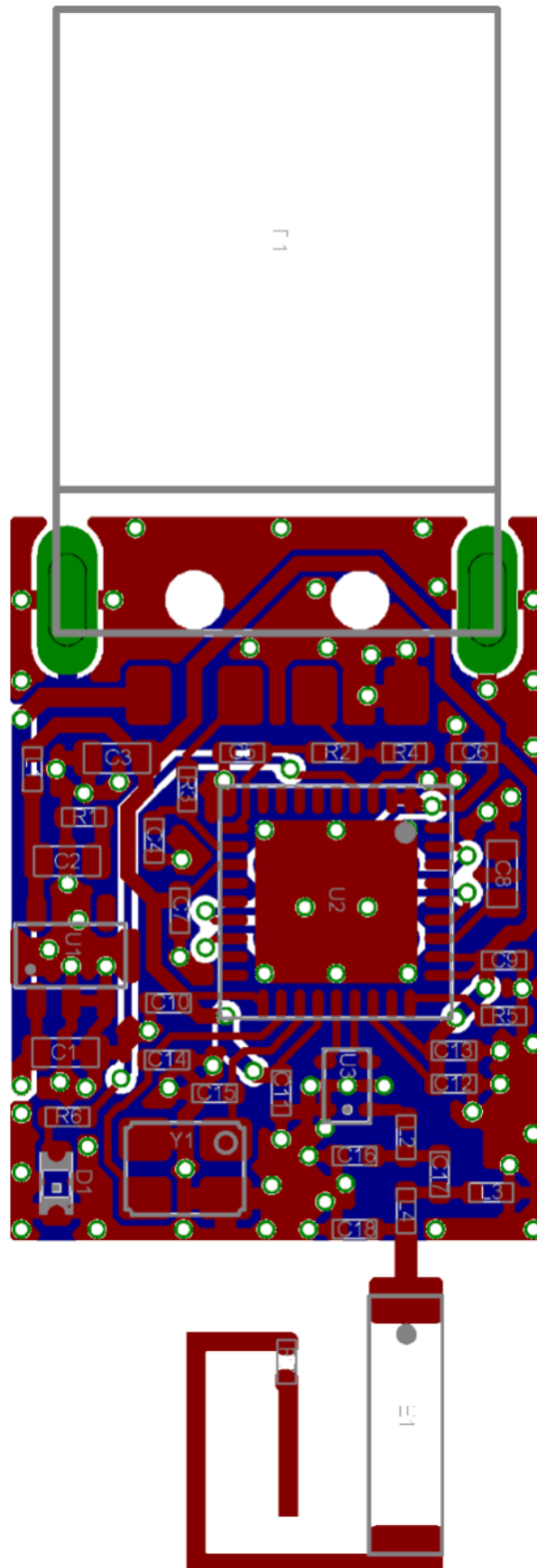
Figure 4-32. eZ430-Chronos-868 and -915 RF Access Point, PCB Components on Top Layer
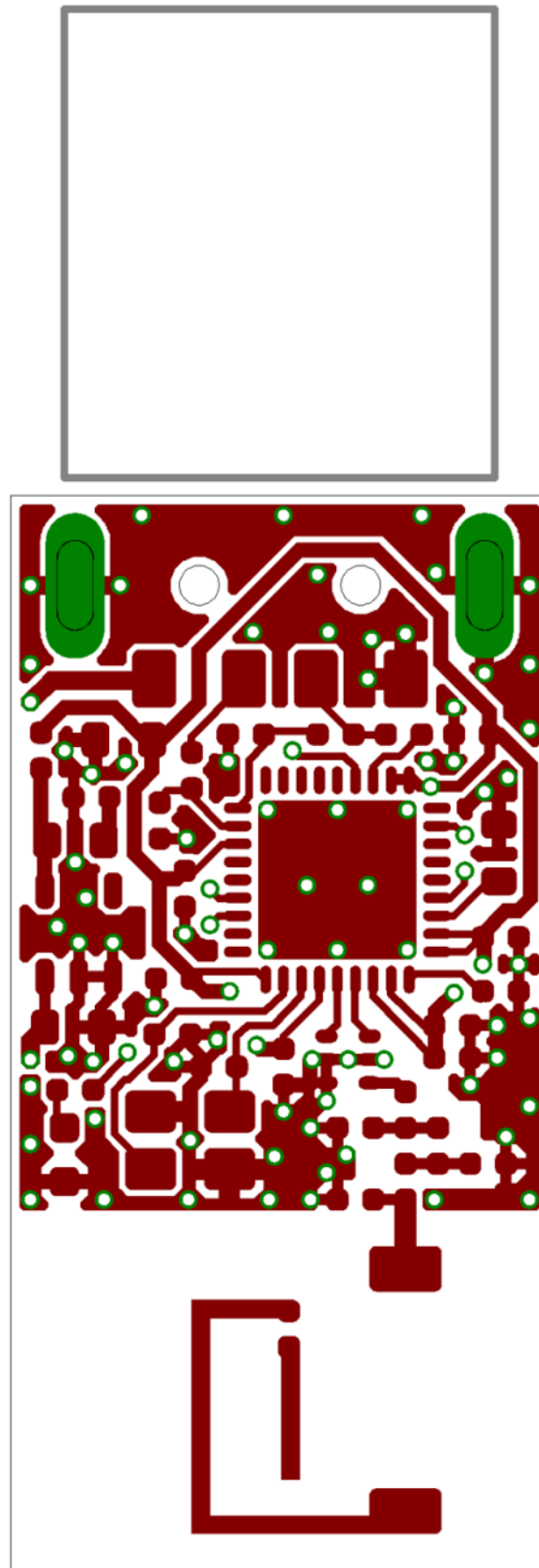
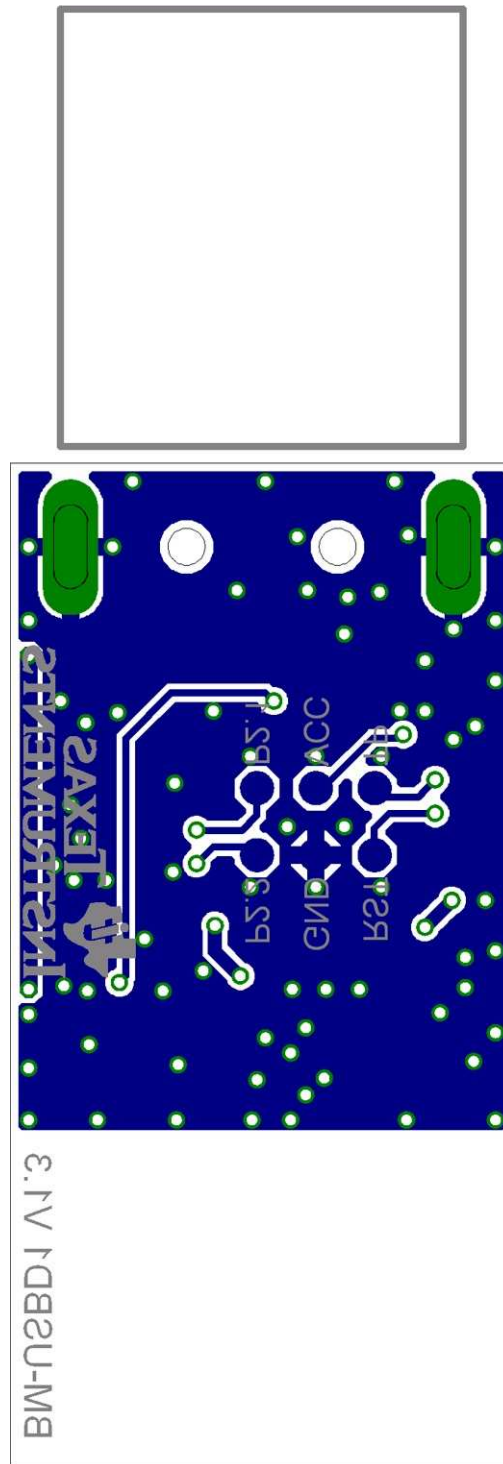**Figure 4-33. eZ430-Chronos-868 and -915 RF Access Point, Layout Top Layer**

Figure 4-34. eZ430-Chronos-868 and -915 RF Access Point, Layout Bottom Layer

Table 4-5. eZ430-Chronos-868 Access Point, BOM List

Designator	Value	Tolerance	Footprint	Description	Manufacturer
C1	1 µF	+-10%, X5R	603	Capacitor SMD	
C2	4.7 µF	+-10%, X5R	603	Capacitor SMD	
C3	2.2 µF	+-10%, X5R	603	Capacitor SMD	
C4	47 pF	+-10%, COG/NP0	402	Capacitor SMD	
C5	47 pF	+-10%, COG/NP0	402	Capacitor SMD	
C6	100 nF	+-10%, X7R	402	Capacitor SMD	
C7	100 nF	+-10%, X7R	402	Capacitor SMD	
C8	1 µF	+-10%, X5R	603	Capacitor SMD	
C9	100 nF	+-10%, X7R	402	Capacitor SMD	
C10	10 nF	+-10%, X7R	402	Capacitor SMD	
C11	2.2 pF	+-0.25pF, COG/NP0	402	Capacitor SMD	
C12	10 nF	+-10%, X7R	402	Capacitor SMD	
C13	220 pF	+-10%, COG/NP0	402	Capacitor SMD	
C14	22 pF	+-5%, COG/NP0	402	Capacitor SMD	
C15	22 pF	+-5%, COG/NP0	402	Capacitor SMD	
C16	1.8 pF	+-0.1pF, COG/NP0	402	Capacitor SMD	Johanson 500R07S1R8BV4
C17	100 pF	+-10%, COG/NP0	402	Capacitor SMD	
C18	N.A.				
D1	green		603	LED SMD	
E1	0915AT43A0026			Chip Antenna	Johanson
L1	Ferrite Bead 1k, 1R, min. 100mA		402	EMI Filter SMD	for example, TDK MMZ1005S102C
L2	5.6 nH	+-0.3nH	402	Inductor Monolithic SMD	Johanson L-07C5N6SV4
L3	5.6 nH	+-0.3nH	402	Inductor Monolithic SMD	Johanson L-07C5N6SV4
L4	12 nH	+-5%	402	Inductor Monolithic SMD	Johanson L-07C12NJV4
P1	USB Type A			USB Plug	for example, Lumberg 241007
PCB1	CUSTOM, solder stop black			PCB, 2 layers, 0.8 mm thick	
R1	2R	+-5%	402	Resistor SMD	
R2	33R	+-5%	402	Resistor SMD	
R3	33R	+-5%	402	Resistor SMD	
R4	1.5k	+-5%	402	Resistor SMD	
R5	56k	+-1%	402	Resistor SMD	
R6	270R	+-5%	402	Resistor SMD	
R7	0R	+-5%	402	Resistor SMD	
U1	TPS76933DBV		SOT-23	Linear Regulator	TI
U2	CC1111F32RSP		QFN36	ISM Transceiver	TI
U3	0896BM15A0001			896MHz Balun	Johanson
Y1	48MHz, CL=16pF, ESR≤40Ω	+-10ppm	23.2 x 2.5 mm2	Crystal SMD	Epson TSX3225-X1E000021040300

Table 4-6. eZ430-Chronos-915 Access Point, BOM List

Designator	Value	Tolerance	Footprint	Description	Manufacturer
C1	1 µF	+-10%, X5R	603	Capacitor SMD	
C2	4.7 µF	+-10%, X5R	603	Capacitor SMD	
C3	2.2 µF	+-10%, X5R	603	Capacitor SMD	
C4	47 pF	+-10%, COG/NP0	402	Capacitor SMD	
C5	47 pF	+-10%, COG/NP0	402	Capacitor SMD	
C6	100 nF	+-10%, X7R	402	Capacitor SMD	
C7	100 nF	+-10%, X7R	402	Capacitor SMD	
C8	1 µF	+-10%, X5R	603	Capacitor SMD	
C9	100 nF	+-10%, X7R	402	Capacitor SMD	
C10	10 nF	+-10%, X7R	402	Capacitor SMD	
C11	2.2 pF	+-0.25pF, COG/NP0	402	Capacitor SMD	
C12	10 nF	+-10%, X7R	402	Capacitor SMD	
C13	220 pF	+-10%, COG/NP0	402	Capacitor SMD	
C14	22 pF	+-5%, COG/NP0	402	Capacitor SMD	
C15	22 pF	+-5%, COG/NP0	402	Capacitor SMD	
C16	1.8 pF	+-0.1pF, COG/NP0	402	Capacitor SMD	Johanson 500R07S1R8BV4
C17	100 pF	+-10%, COG/NP0	402	Capacitor SMD	
C18	N.A.				
D1	green		603	LED SMD	
E1	0915AT43A0026			Chip Antenna	Johanson
L1	Ferrite Bead 1k, 1R, min. 100mA		402	EMI Filter SMD	for example, TDK MMZ1005S102C
L2	5.6 nH	+-0.3nH	402	Inductor Monolithic SMD	Johanson L-07C5N6SV4
L3	5.6 nH	+-0.3nH	402	Inductor Monolithic SMD	Johanson L-07C5N6SV4
L4	12 nH	+-5%	402	Inductor Monolithic SMD	Johanson L-07C12NJV4
P1	USB Type A			USB Plug	for example, Lumberg 241007
PCB1	CUSTOM, solder stop black			PCB, 2 layers, 0.8 mm thick	
R1	2R	+-5%	402	Resistor SMD	
R2	33R	+-5%	402	Resistor SMD	
R3	33R	+-5%	402	Resistor SMD	
R4	1.5k	+-5%	402	Resistor SMD	
R5	56k	+-1%	402	Resistor SMD	
R6	270R	+-5%	402	Resistor SMD	
R7	N.A.				
U1	TPS76933DBV		SOT-23	Linear Regulator	TI
U2	CC1111F32RSP		QFN36	ISM Transceiver	TI
U3	0896BM15A0001			896MHz Balun	Johanson
Y1	48MHz, CL=16pF, ESR≤40Ω	+-10ppm	23.2 x 2.5 mm2	Crystal SMD	Epson TSX3225-X1E000021040300

4.6.3 Debugging Interface Schematics and Layout

Figure 4-35. USB Debug Interface, Schematic

Figure 4-36. USB Debug Interface, Schematic

Figure 4-37. USB Debug Interface, PCB Components on Top Layer

Figure 4-38. USB Debug Interface, PCB Components on Bottom Layer

Figure 4-39. USB Debug Interface, Layout Top Layer

Figure 4-40. USB Debug Interface, Layout Bottom Layer

Frequently Asked Questions

A.1 FAQs

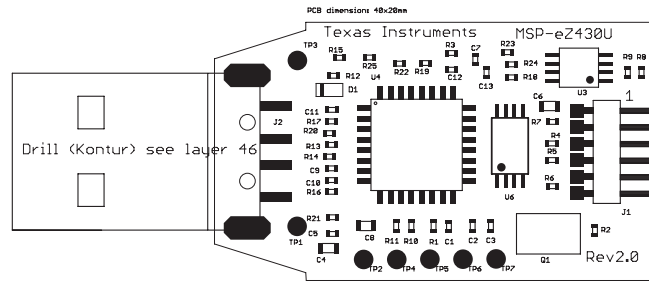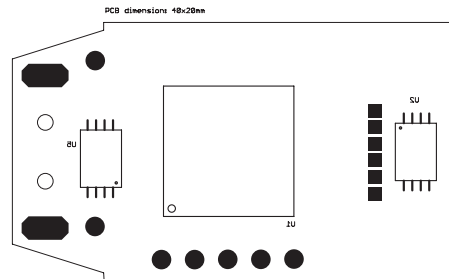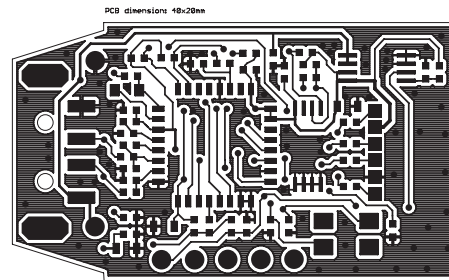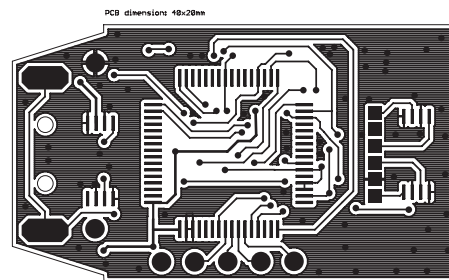1. **My eZ430-Chronos watch doesn't respond when I push buttons, instead it shows "Loct" in the LCD?**

   "Loct" on the 7-segment LCD stands for "Lock" and indicates that the keylock is active. By holding "#" and "DOWN" for three seconds simultaneously unlocks or locks the buttons. The LCDs shows "oPEn" when the keylock is disabled.

2. **Why doesn't my eZ430-Chronos watch always respond when buttons are pushed?**

   If buttons are pushed slowly (that is, held down too long), button pushes are ignored.

3. **Why doesn't my eZ430-Chronos respond when I try to push buttons in short intervals in PPT or ACC mode?**

   Especially in PPT mode it is important to avoid bouncing of the buttons. Therefore, an artificial delay on the receiver side is implemented. Button pushes are translated into keystrokes or mouse clicks only if there is at least 0.5 seconds between two of them.

4. **Is my eZ430-Chronos waterproof?**

   Yes, it is 30-m waterproof. This indicates that it resists splashes and rain. However, it cannot be used while taking a shower, swimming, diving, surfing, snorkeling or any other water sports. Set the watch before exposing it to excessive water. Pressing the buttons in water or heavy rainstorms may cause water to enter the watch.

5. **The reported temperature is incorrect, how can I calibrate the sensor?**

   A temperature offset is stored in Flash, which is calibrated at production. If the offset is erased or is incorrect, it can be changed to an appropriate level; see Section 3.2.1.3 for details.

6. **The reported altitude is incorrect, why is that and how can I calibrate the sensor?**

   The altitude is determined from barometric pressure. Therefore, the altimeter needs to be recalibrated as the pressure changes with the weather. See Section 3.2.1.4 for details on how to calibrate the altimeter. In addition, the altitude is a function of the temperature in addition to the barometric pressure. Therefore, the watch needs to have ambient temperature, wearing it on the arm or close to the body may cause inaccurate measurements.

7. **Why is there a timeout for the altimeter?**

   The altimeter algorithm is implemented according to an application report from VTI. It is not optimized for ultra-low current consumption. For enhanced battery life, the altimeter stops operation after one hour. It can be reactivated by pushing the "UP" button.

8. **How can TI sell the eZ430-Chronos for only US$49?**

   The eZ430-Chronos kit is intended to be an attractive development kit and is not intended to be a consumer product. Texas Instruments and the partner companies are sponsoring components or services to increase the accessibility of flexible and innovative development systems to a broader audience. Consumer products usually retail for higher prices.

9. **Why are the backchannel pins not connected on the eZ430-Chronos PCB despite the fact that the eZ430-Chronos debug interface supports the backchannel?**

   All pins of the CC430 were used for the LCD, buttons, or sensors.

10. **Why is there no JTAG connector on the RF access point?**

    The access point is designed to be production ready and as small as possible. Therefore, no debug connector is added. However, it may be reprogrammed by attaching a TI low power wireless debug interface to the corresponding pads on the bottom side of the PCB, or using TI's CC1111EMK868-915.

11. **When I try to compile the source code with IAR KickStart, I get the following error:**
    Fatal Error[e89]: Too much object code produced (more than 0x4000 bytes) for this package

    IAR KickStart currently has a 16KB code size limitation, and the project being compiled is larger than 16KB (0x4000 = 16384). Select the limited project version in the Workspace pull-down menu of the IDE or use a full license of IAR. A 30-day evaluation version of IAR is available from http://supp.iar.com/Download/SW/?item=EW430-EVAL.

12. **When I try to compile the source code with Code Composer Studio v4.2, I get the following error:**
    error: output file "eZ430_chronos_ISM_xxx.out exceeds code size limit

    Code Composer Studio v4.2 Core Edition is limited to 16kB of code size and the project being compiles is larger than 16KB. Select the limited project version in the Build Property Configuration pull-down menu of the IDE or use the Platinum Edition of CCS. A 30-day evaluation version is available from http://tiexpressdsp.com/index.php/Category:Code_Composer_Studio_v4

13. **What is the range of the eZ430-Chronos kit?**

    In free field distances of up to 100 m (328 ft) have been measured. The range in other conditions, especially within buildings, is hard to predict. It also depends on the protocol stack that is used.

14. **A button fell of the eZ430-Chronos housing after I reassembled it.**

    The buttons of the eZ430-Chronos watch housing are held by small C-clips. If the metal strips for the buttons of the watch module bent and stuck at the watch housing buttons, they could have removed the C-clip. Open the watch, locate the C-clip, and reassemble the button.

15. **How do I know whether I have a 915-MHz, 868-MHz, or 433-MHz kit?**

    Each eZ430-Chronos kit has a sticker on the box that includes the part number/frequency. The 915-MHz/868-MHz watches are the same for both frequencies from a hardware perspective. The USB access points are slightly different. The 868-MHz version has a 0-Ω resistor next to the antenna, and the 915-MHz version does not. The 433-MHz watches and access points (with blue antenna, larger than 915-MHz/868-MHz versions) are different from a hardware and software perspective and cannot be used for other frequencies.

16. **How do I restore the original software on my eZ430-Chronos watch?**

    The eZ430-Chronos software on the PC contains source code projects as well as Flash images, which may be used to restore the original software state of the watch module. The .txt files are located in *C:\Program Files\Texas Instruments\eZ430-Chronos\Software Projects\Recovery*. To program the .txt flash images tool such as the Flash Pro Lite software from Elprotronic (www.elprotronic.com) can be used. Ensure that the information memory block D is not erased, as it contains calibration data and the ID of the watch module.

17. **I have erased the watch module ID and calibration data. What happens now?**

    If information memory block D was erased, default values for the calibration data and ID are used. See function read_calibration_values() in main.c for details.

18. **I have more than one eZ430-Chronos watch connecting to one access point at the same time. How can I prevent this?**

    Each eZ430-Chronos kit has a unique ID stored in information memory block D. If this block was erased, the ID is equal on all watches. See FAQ item 17 about restoring the ID value.

19. **Can I purchase the eZ430-Chronos kit or components of it in quantities? Can I get a customized version?**

    Yes, our partner BM innovations (http://www.bm-innovations.com) provides all components of the eZ430-Chronos kit in volume as well as a range of other products.

20. **Which version of SimpliciTI is used with eZ430-Chronos?**

    The current software release used SimpliciTI 1.1.1.

21. **The LCD of my eZ430-Chronos remains blank after a wireless update. What can I do?**

    In case of an error during the wireless update, the watch does not go back to the previous software version as its Flash memory was deleted. To reduce current consumption, the watch is put in low-power mode (LPM4) and the LCD is turned off. As the wireless update software is still active, the update procedure can be started again despite the fact that the LCD remains blank. This can be done, by selecting a flash image (.txt file) on the wireless update tabs of the eZ430-Chronos Control Center PC software and clicking on "Update eZ430-Chronos Watch". To start the update on the watch, press the "DOWN" button. The update is started. For details, see Section 3.6.4.

22. **The wireless update procedure always returns an error while downloading to flash.**

Make sure that the file you are trying to download does not include data outside the main flash boundaries, which are 0x8000 to 0xFFFF. This protection mechanism avoids writing of data to non-existent or restricted addresses. Try to download one of the original example project's .txt files, which are available for Windows in *C:\Program Files\Texas Instruments\eZ430-Chronos\Recovery\eZ430-Chronos Watch\Applications* and for Linux in */home/<user name>/Texas Instruments/eZ430-Chronos/Recovery/eZ430-Chronos Watch/Applications*. If the update still does not work, the RAM-based updater may be corrupted; see the next question.

23. **The wireless update always returns an error while downloading to RAM.**

Make sure that the file named "ram_based_updater.txt", which is located on the working directory of your Control Center or Data Logger GUI has not been changed. If so, reinstall the eZ430-Chronos Software to restore the original file.

24. **I get an error message right after I start the wireless update on the PC.**
    Failed to start Wireless Update.

Check if the RF access point contains right software version. Kits older than 04/2010 (date code can be found on bottom of the eZ430-Chronos box) require a manual update as described in Section 3.6.4.

25. **Activating the rFbSL mode on the watch always results in a rest.**

This is normal. Whenever the wireless update was activated on the watch, it returns to the main application with a reset, regardless if an update was performed or not. Time, data, alarm, and other RAM-based data is lost. For details, see Section 3.6.4.

26. **The buzzer doesn't work when the watch is not inside the housing. What's wrong?**

This is normal as the buzzer is located on the metal back of the watch. It is only connected to the watch module when the back is mounted on the watch.

Detailed Hardware Driver Installation Guide

Detailed instructions for the Windows driver installation of the access point and the Debug Interface. The instructions are shown for Windows XP, but are similar in Windows Vista and Windows 7.

B.1 eZ430-Chronos RF Access Point

1. The eZ430-Chronos access point USB drivers are included in the eZ430-Chronos installer package. A separate driver wizard window opens during installation as shown in Figure B-1. Continue by clicking next. A Windows warning may appear as the driver is not certified. Accept the driver installation.

Figure B-1. Device Driver installation Wizard for the Access Point

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2. The driver installation wizard shows if the driver is successfully installed (see Figure B-2)

Figure B-2. Successful Driver Installation for Access Point

3. Insert the access point.
4. Windows detects the new hardware as *TI CC1111 Low-Power RF to USB CDC Serial Port* (see Figure B-3).

Figure B-3. Access Point Detection

5. Windows may open the *Found New Hardware Wizard*. If so, select *No, not this time* (see Figure B-4).

Figure B-4. Windows Found New Hardware Wizard

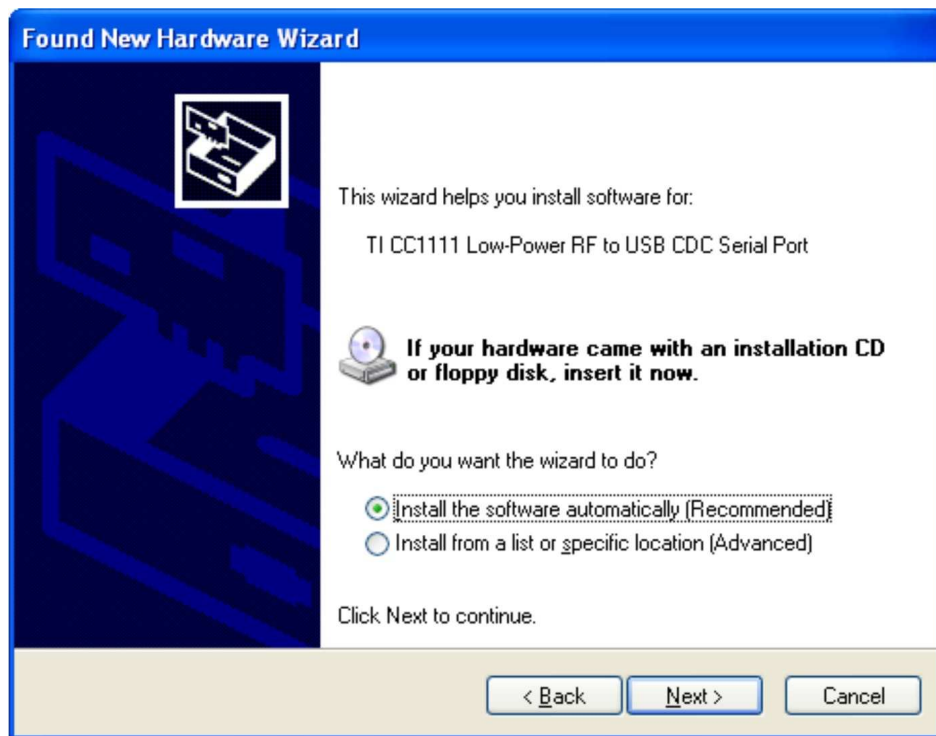6. Select *Install the software automatically* in next dialog (see Figure B-5).

Figure B-5. Automatic Driver installation

7. A Windows warning appears as the driver is not certified. Click *Continue Anyway* (see Figure B-6). The drivers are installed.

Figure B-6. Windows Uncertified Driver Installation Warning

8. The Windows Device Manager lists the device *TI CC1111 Low-Power RF to USB CDC Serial Port (COMx)* in *Ports (COM & LPT)* (see Figure B-7).
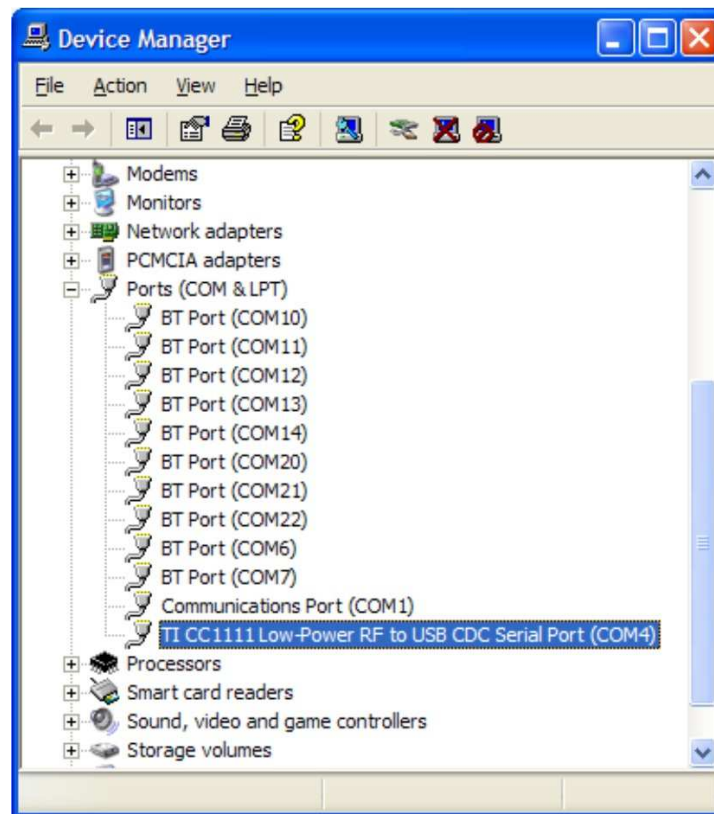

Figure B-7. Access Point in Windows Device Manager

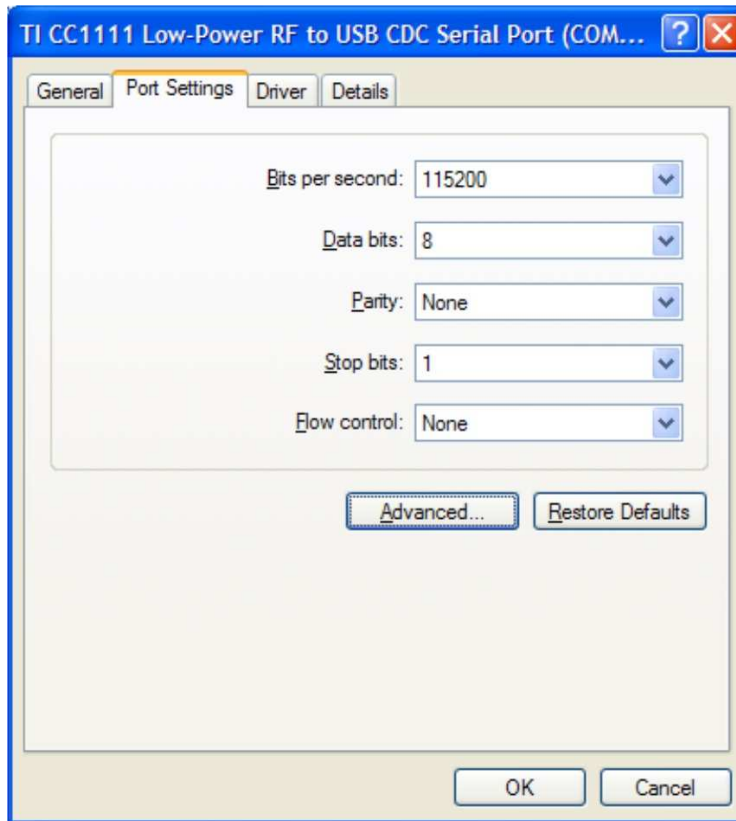9. Verify correct properties of the port settings (see Figure B-8).

Figure B-8. CC1111 Port Settings

B.2 eZ430-RF Debug Interface

1. Install an IDE of your choice (see Section 3.6), it contains the drivers for the debug interfaces
2. Connect the eZ430-RF USB Debug Interface to an USB port of the PC
3. Windows should now recognize the new hardware as an "MSP430 XXX x.xx.xx" (see Figure B-9). The device name may be different from the one shown here.

Figure B-9. eZ430-RF Windows Driver Installation

4. The drivers are installed automatically without any user interaction.
5. The USB debug interface is installed and ready to use. The Windows Device Manager lists a new entries for a Human Interface Device and the MSP430 Application UART (COMx) (see Figure B-10).
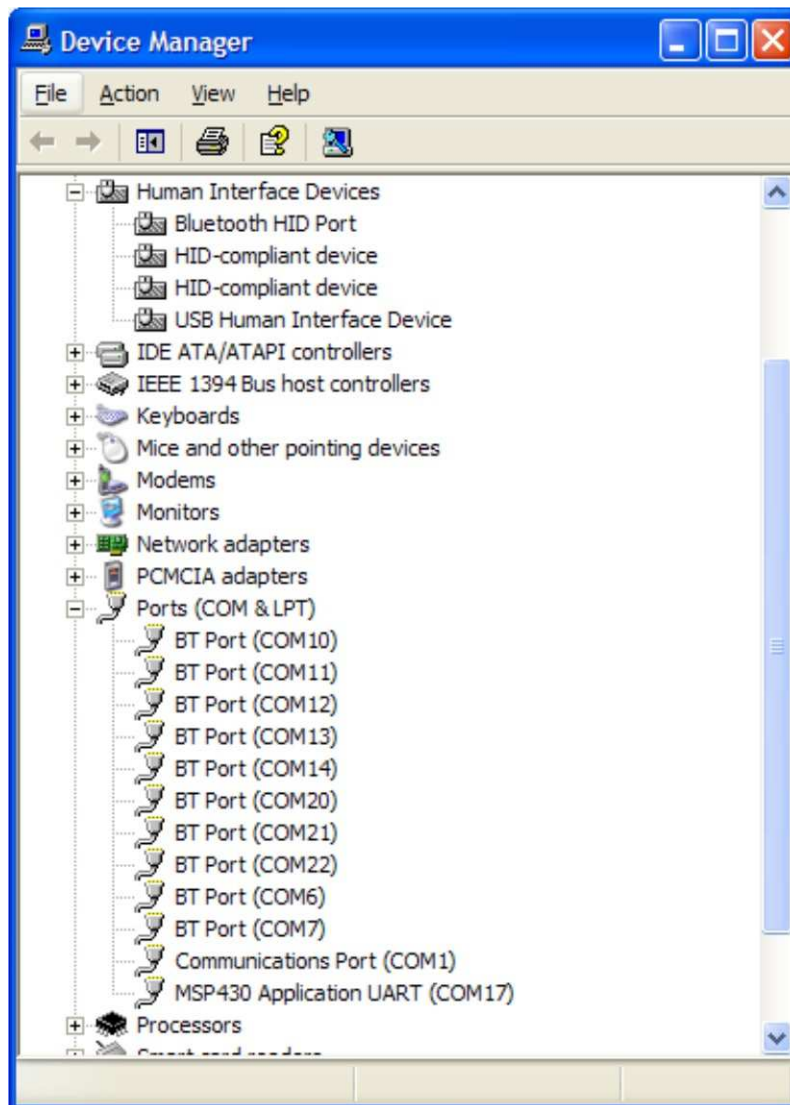
Figure B-10. eZ430-RF in Windows Device Manager as HID and COM Port Devices

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