

eZ430-Chronos Development Tool

User's Guide



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BlueRobin is a trademark of BM innovations GmbH.
All other trademarks are the property of their respective owners.

Read This First

If You Need Assistance

If you have any feedback or questions, support for the MSP430 device and the eZ430-Chronos is provided by the Texas Instruments Product Information Center (PIC), 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. Contact information for the PIC can be found on the TI web site at support.ti.com. 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 v4.1 ([SLAU157](#)) and the IAR Embedded Workbench ([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 is a highly integrated, wearable wireless development system based on the CC430. 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 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, MSP430 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 CC430
- Can be paired wirelessly with heart rate monitors, pedometers, or other devices based on RF transceivers such as the CC430 or CC11xx series.
- Includes an eZ430-RF USB emulator that connects the Chronos to a PC for real-time in-system programming and debugging.



Figure 1-1. eZ430-Chronos

1.2 Kit Contents, eZ430-Chronos

- 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- Development Tool User's Guide* [SLAU227](#)
 - *CC430 Family User's Guide* [SLAU259](#)
 - *Code Composer Studio v4.1.1 Core Edition* [CCS Mediawiki](#)
 - *Code Composer Studio v4.1 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 push any button twice to wake the watch from sleep mode (after pushing a button once, the LCD displays the same content as shown on the box of the kit, after the second button push 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. In-depth instructions are available in [Section 3.2](#).



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 3 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 your settings and go back to normal operation or "#" 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 Chronos Control Center (see [Section 3.3.3](#)).

2.1.2 Setting the date

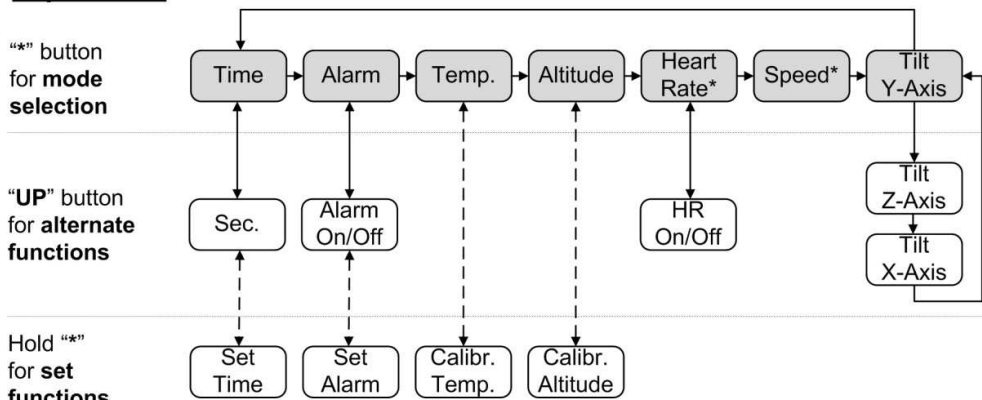
1. Push the "#" button until the date is displayed in the bottom LCD line.
2. Hold "#" for 3 seconds until the year flashes on the bottom LCD line.
3. Set the year by pushing the "UP" or "DOWN" button.
4. Press "#" to continue with the month adjustment.
5. Set the month by pushing the "UP" or "DOWN"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

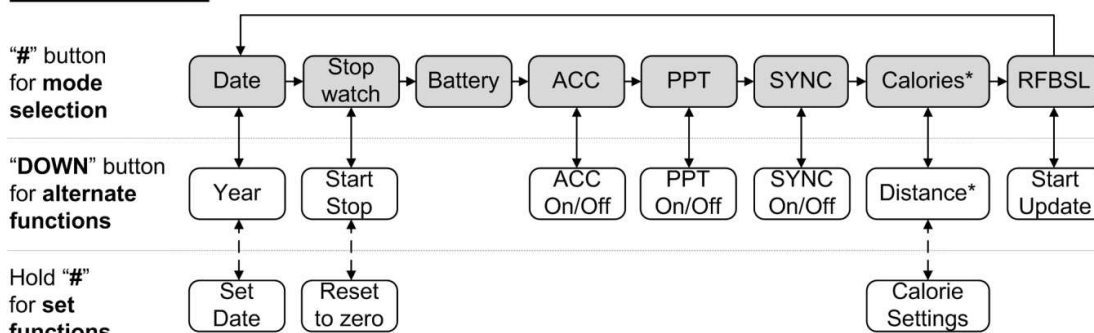
Figure 2-3 shows all modes and secondary functions. A detailed description of the features can be found in [Section 3.2](#).

Top modes:



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.

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 PCs (Ubuntu 9.10). 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 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 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 > Chronos Control Center.

For a detailed driver installation, see .

2.2.2 Linux Installation

The eZ430-Chronos PC software for Linux requires TCL/Tk. If your 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 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_1.tcl` and `eZ430-Chronos_Datalogger_1_1.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_1.tcl` and `chmod u+x ./eZ430-Chronos_Datalogger_1_1.tcl`
7. Launch the script from terminal `./eZ430-Chronos_CC_1_1.tcl`

NOTE: Linux is supported by the Chronos Control Center and Chronos Data Logger PC applications. The 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 Chronos watch to control the mouse pointer on your PC and to use it for PowerPoint control.

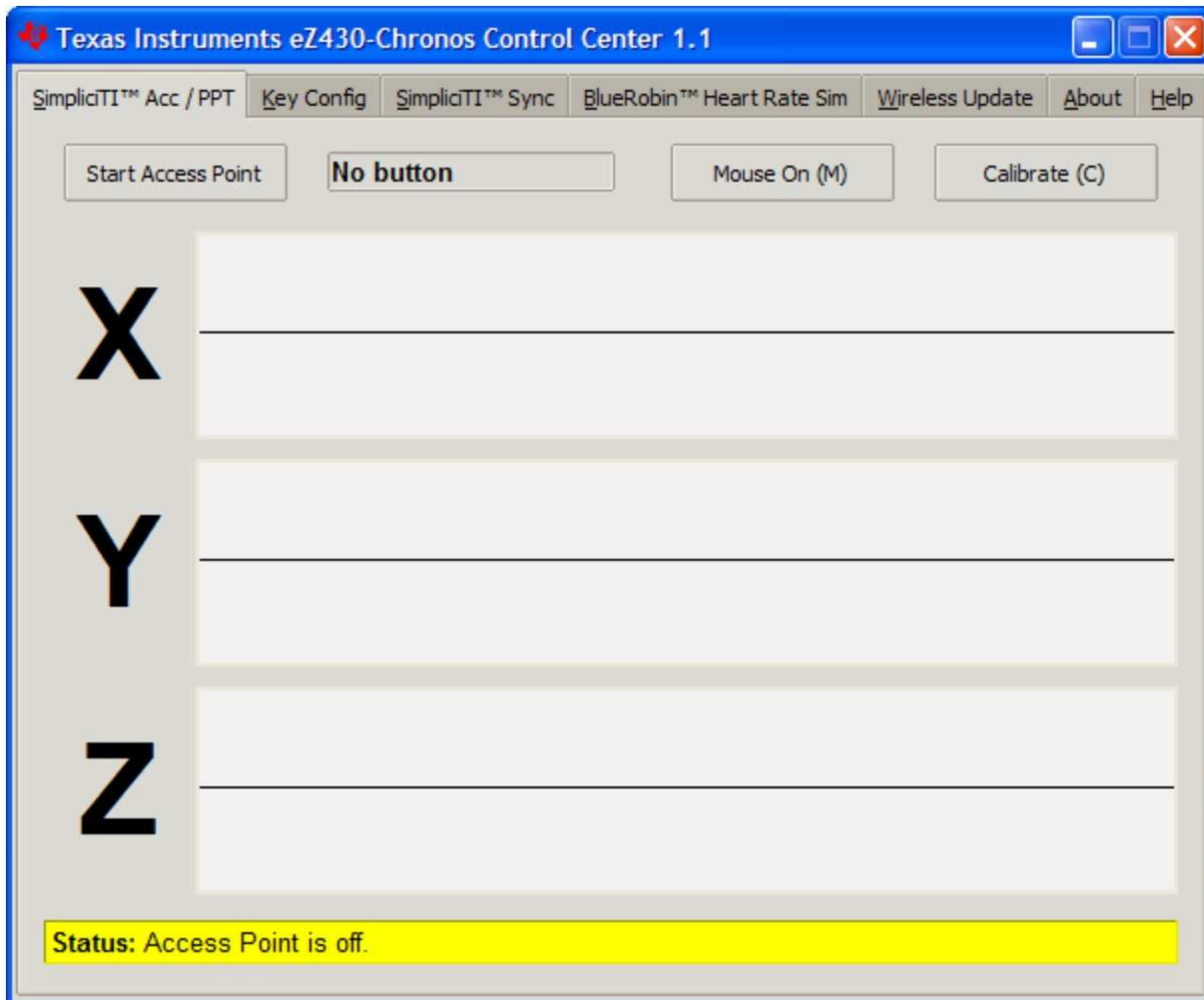


Figure 2-4. Chronos Control Center

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 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 3D 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.

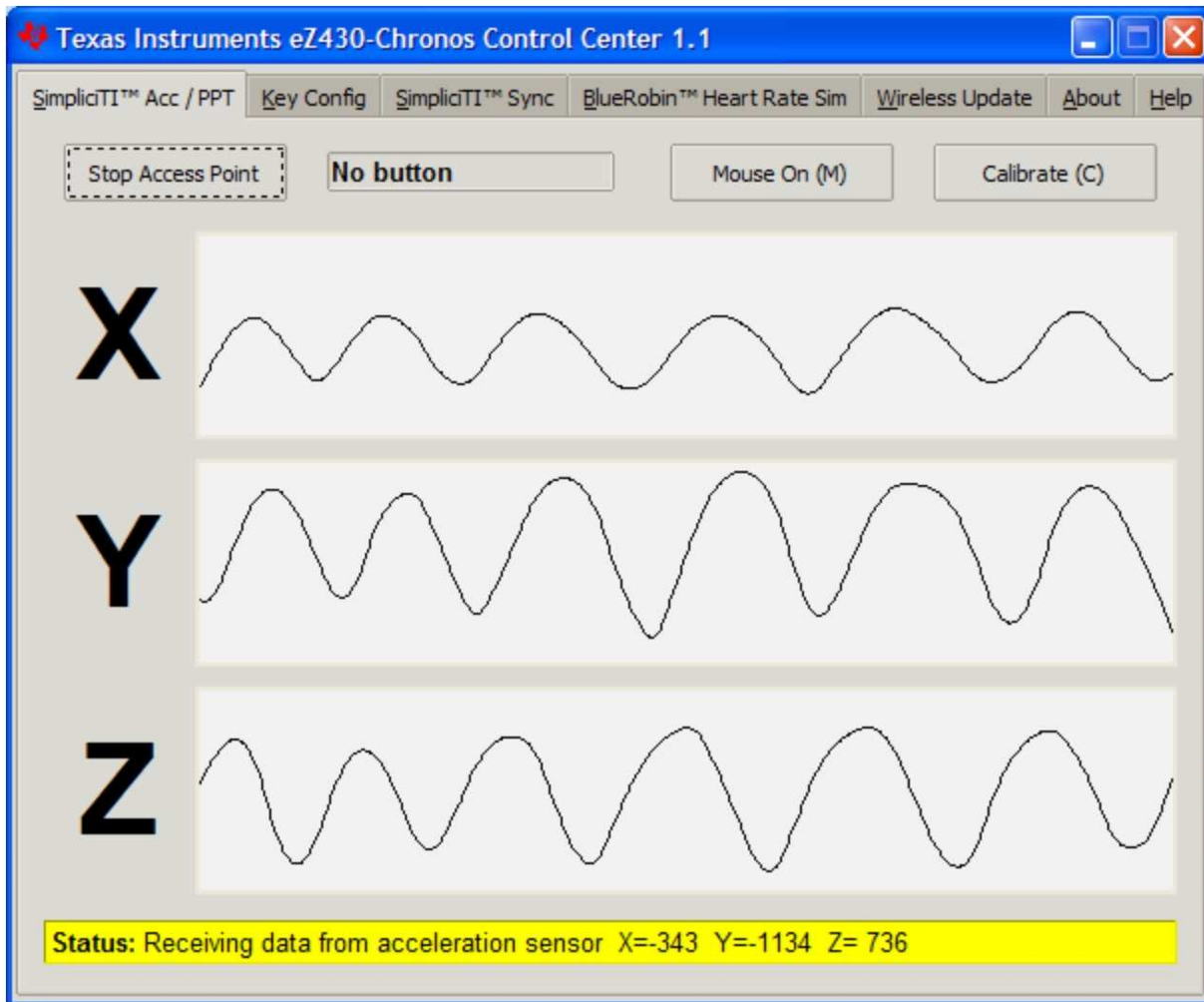


Figure 2-5. Chronos Control Center With Acceleration Data

2.3.1.1 PC Mouse Control

1. Click on "Mouse On (M)" to control the PC mouse pointer with the 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 (i.e., 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.

3. Turn the demo off by pushing the "DOWN" button on the 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 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; i.e., if a button is pressed twice within less than 0.6, it is translated into one keystroke only.

The 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:

1. Chronos sports watch software
2. Control Center PC software for Windows and Linux
3. Chronos watch data logger
4. 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 Chronos watch can also be used as a heart rate monitor. For this purpose, a second ultra-low power protocol stack called BlueRobin⁽¹⁾ is implemented on the watch and USB access point. The protocol stacks are selected automatically, depending on which feature is used.

3.2 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 controlling 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.

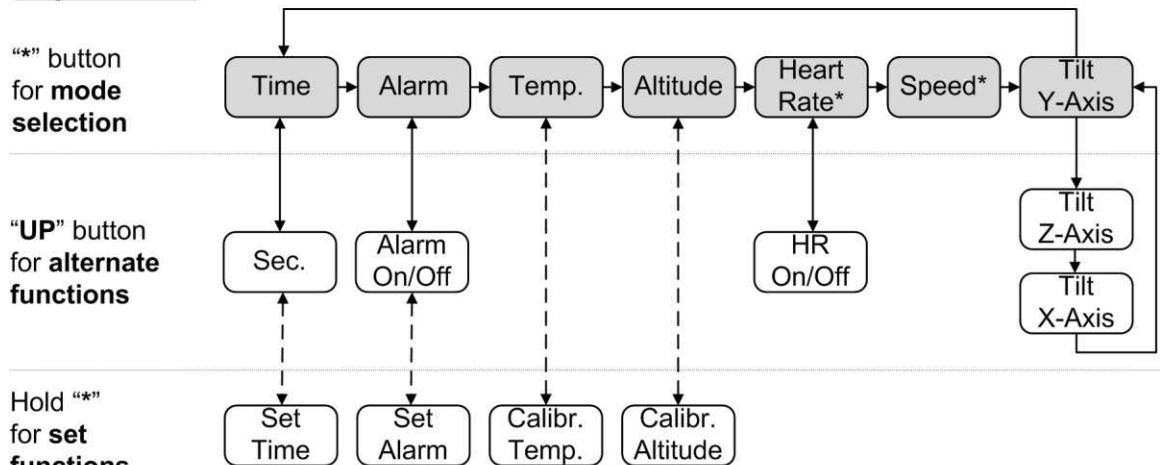
There are three user modes available: **Modes** such as *Time* or *Date*,... , **Secondary Functions** which allow (de-)activation of features (for example, to start or stop the stopwatch, enable/disable alarm, etc.), and the **Set Functions** which allow changing settings (setting time, date,...) or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

⁽¹⁾ BlueRobin is available from BM wireless at www.bmwireless.com.

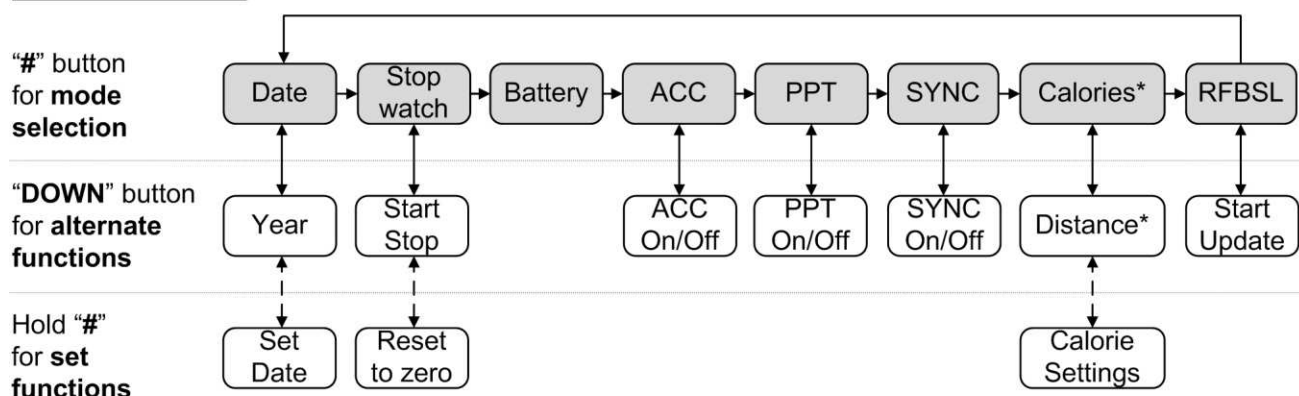
An exception to the above modes is the **Keylock**. It allows locking the buttons to avoid accidental change/activation of modes (for example, when the watch is carried in a suitcase or bag). The keylock may be enabled/disabled by holding "#" and "DOWN" simultaneously for 3 seconds. The LCD shows "Loct" 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 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 3 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 your settings and go back to normal operation or "#" to start over with step 2

NOTE: If you do not press any button 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, as an alarm symbol (bell) flashes when the alarm time is displayed.

Secondary function: Alarm on/off. Press "UP" to enable/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 it is disabled.

Set function: Setting the alarm time.

1. Hold "*" for 3 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 your settings and go back to normal operation or "#" to start over with step 2

NOTE: If you do not press any button 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 3 seconds until the temperature starts to flash
2. Set the temperatures by pushing the "UP" or "DOWN" button
3. Press "*" to confirm your 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 have ambient temperature (i.e., should not be worn directly on the arm), as 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 3 seconds until the altitude starts to flash
2. Set the altitude by pushing the "UP" or "DOWN" button
3. Press "*" to confirm your settings.

3.2.1.5 Heart Rate Mode - RF ⁽²⁾

Press "*" until the heart icon appears on the display i.e. 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 need to 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 Chronos Control Center, see [Section 3.3](#) for details.

While almost all other 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 wireless, Germany.

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; i.e., 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 Chronos Control Center, see [Section 3.3.4](#) for details.

While almost all other 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 wireless, Germany.

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 (9.81m/s²) 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.

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

Set function: None

⁽²⁾ Additional accessory or Chronos Control Center heart rate simulation required.

⁽³⁾ Additional accessory or 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 3 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 your settings and go back to normal operation or "#" 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 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 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 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 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 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 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 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. 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 3 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 your settings and go back to normal operation or "#" 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 Chronos Control Center PC software.

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

Secondary function: Start/re-start update process. Pushing "DOWN" starts/re-starts the update process (the wireless update on the PC must be started from the 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 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. Once this transfer was finished, the code is executed from RAM. At this point, the download of the actual firmware file is started. The LCD shows the progress in percent on the upper LCD line. Once the transfer was complete successfully, a reset starts the software on the watch. See [Section 3.6.3](#) for details.

NOTE: Whenever the wireless update was activated on the watch, it only 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.

3.3 Chronos Control Center PC Software

The Chronos Control Center software provides several features demonstrating the wireless capabilities of the kit on Windows and Linux PCs. 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

⁽⁴⁾ Additional accessory or Chronos Control Center heart rate simulation required.

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

In case of problems on Windows PCs, please 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 you see that the RF access point gets assigned to a different 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_1.tcl` located in `/home/<user name>/Texas Instruments/eZ430-Chronos/Control Center/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 > Chronos Control Center*.

To launch the Control Center software on a Linux PC, browse to `/home/<user name>/Texas Instruments/eZ430-Chronos/Control Center/Chronos Control Center` and run `eZ430-Chronos_CC_1_1.tcl`.

The different features are grouped onto tabs of the Control Center window. The tabs also indicate which radio protocol is used.

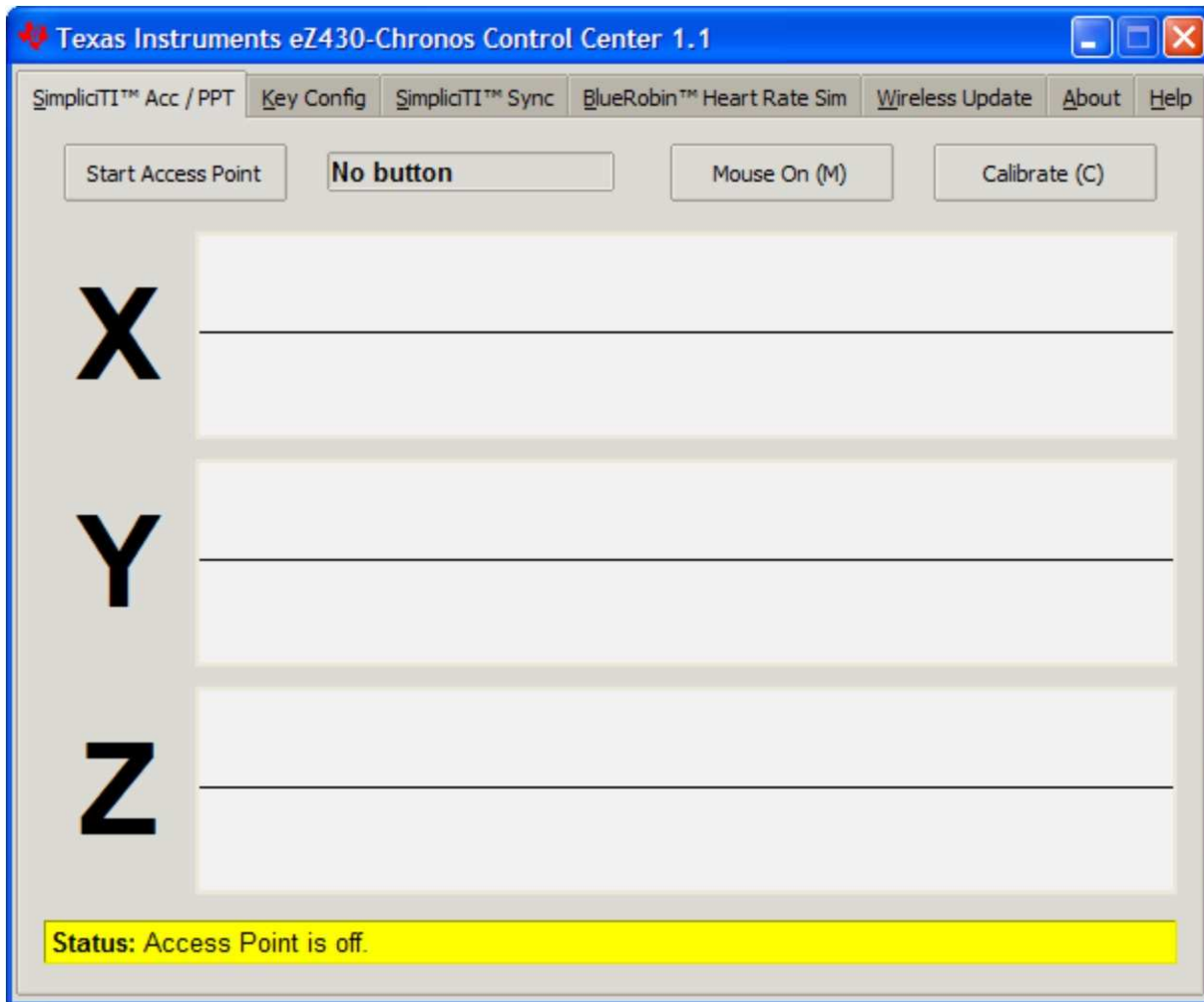


Figure 3-2. Chronos Control Center

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 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 i.e. 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 Chronos watch and clicking "Stop Access Point" in the PC application.

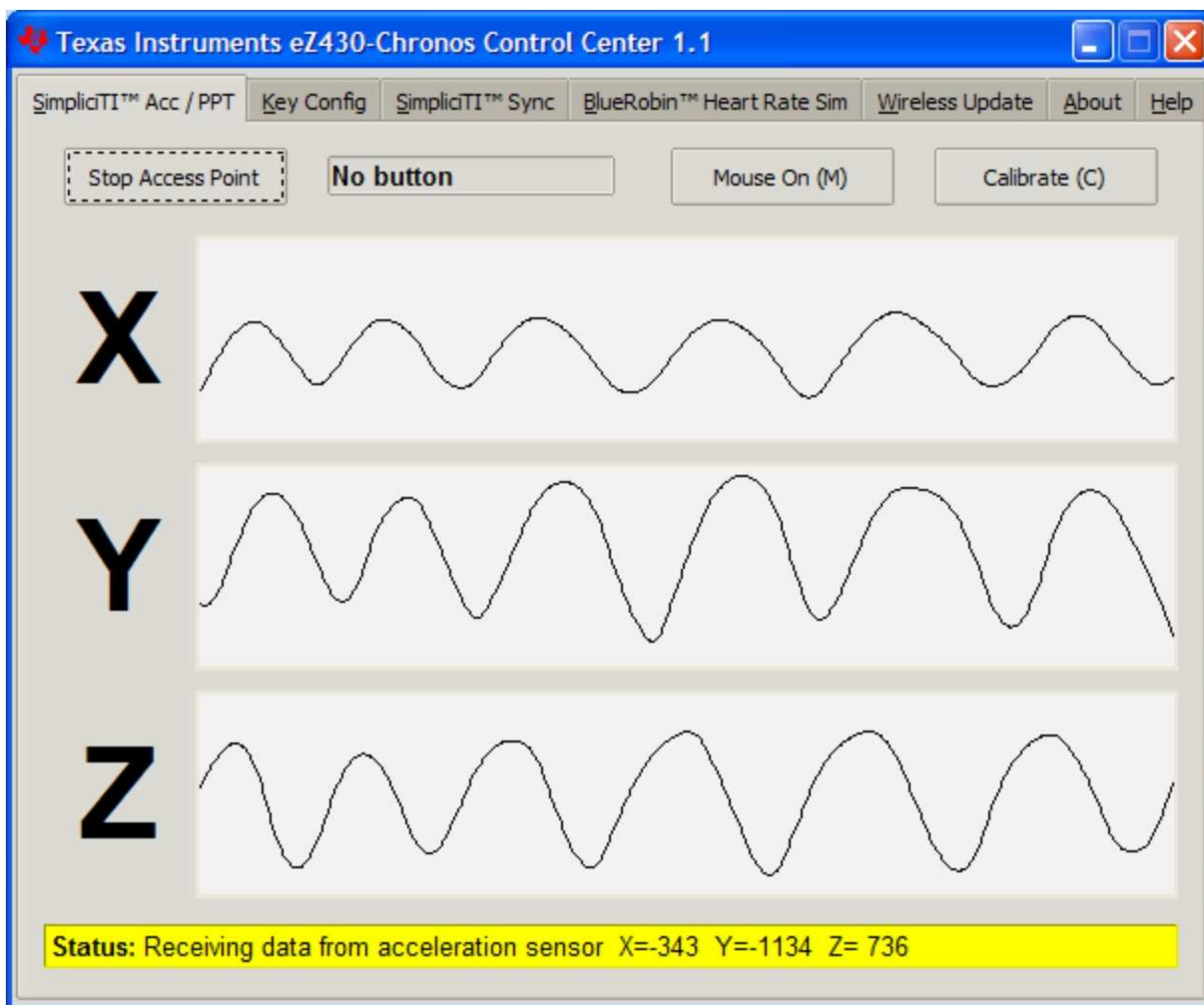


Figure 3-3. Chronos Control Center With Acceleration Data

3.3.1.2 PPT Mode

This mode allows using the 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).

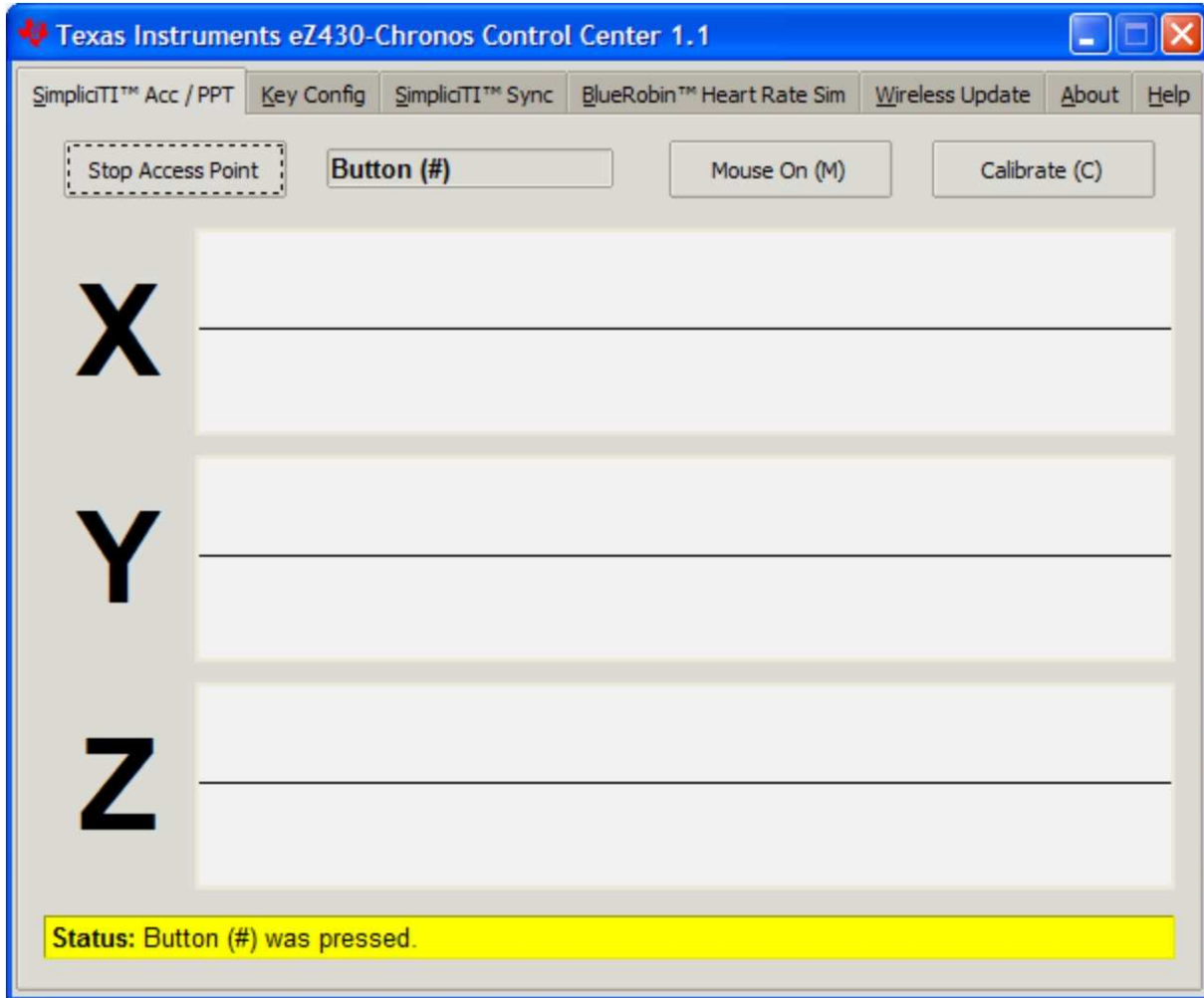


Figure 3-4. Chronos Control Center With PPT Control

3.3.2 Key Configuration Tab

This tab contains the key mapping for the 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.

Pre-defined configurations are available in a pull down menu on top of the menu. Select configuration from menu and click "Load" to activate them.

Pre-defined 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.

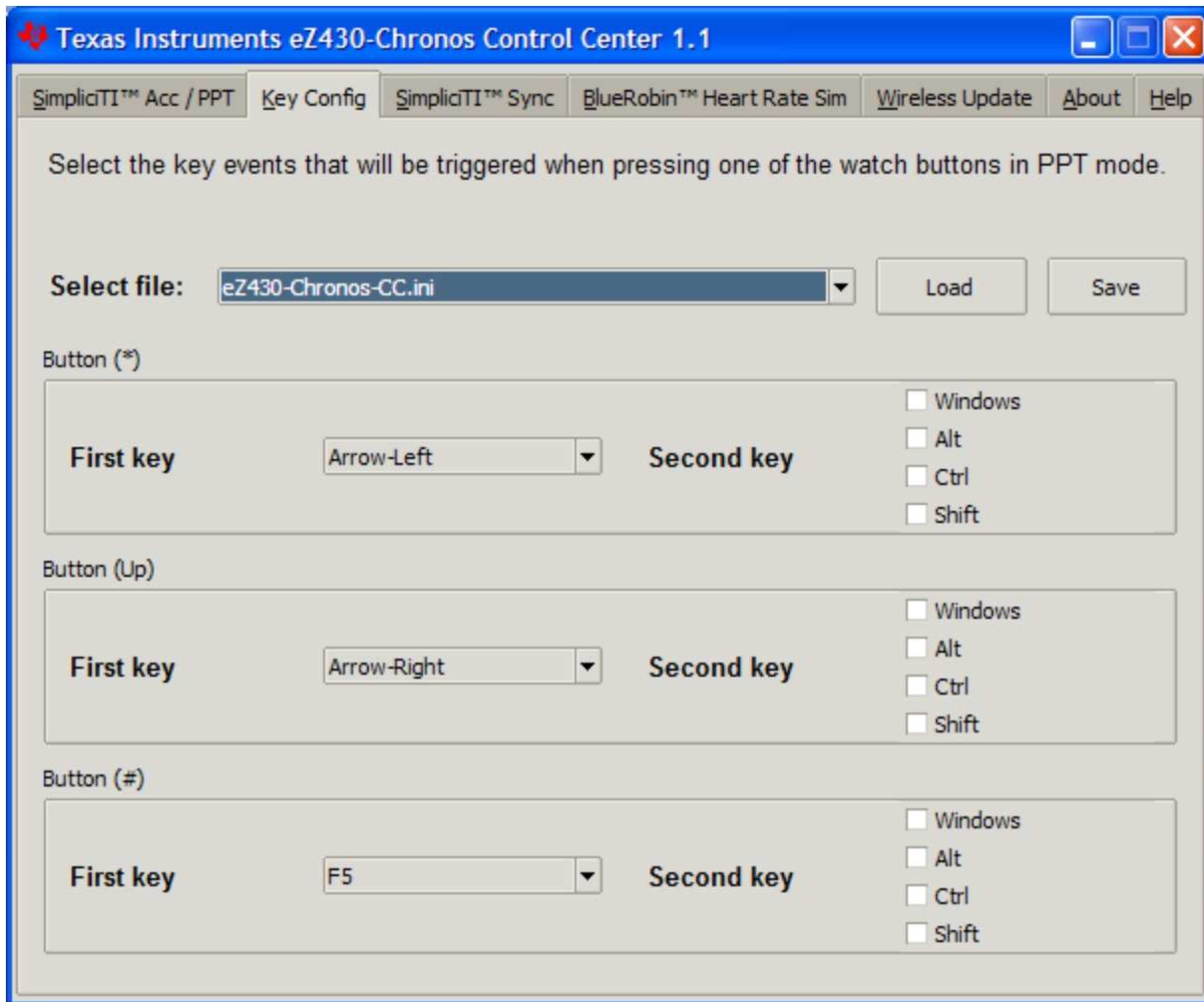


Figure 3-5. Chronos Control Center Key Configuration

3.3.3 SimpliTI Sync

The SimpliTI 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 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. Push the "DOWN" button on watch to end connection

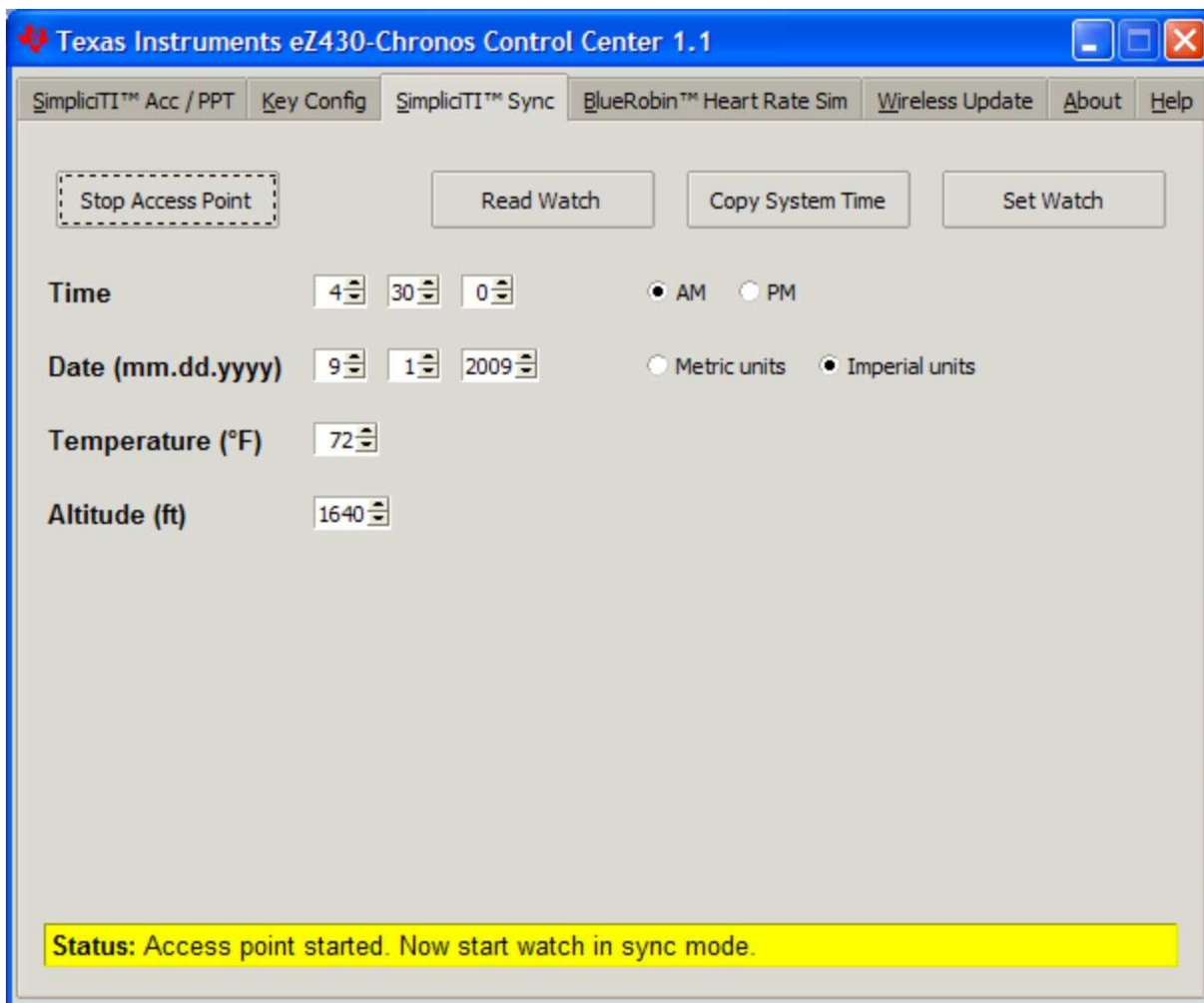


Figure 3-6. Chronos Control Center Sync

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 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

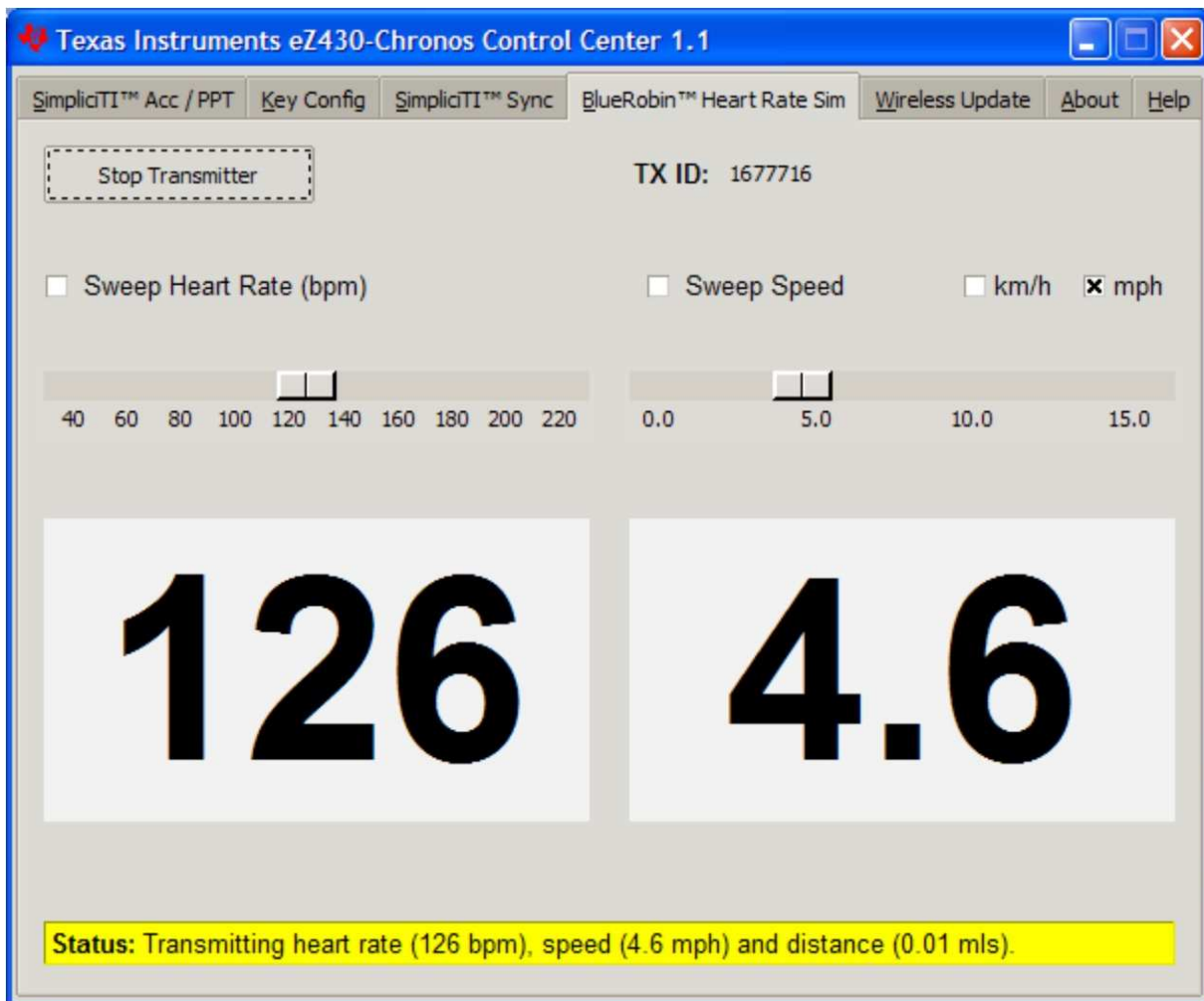


Figure 3-7. Chronos Control Center Heart Rate Simulator

3.3.5 Wireless Update

This mode allows updating the firmware of the 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\Chronos Watch\Applications* and Linux in */home/<user name>/Texas Instruments/eZ430-Chronos/Recovery/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 (0x8000-0xFFFF), 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 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 Chronos watch by pushing the "#" button
4. 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. Once this transfer was finished, the code is executed from RAM. At this point, the download of the actual firmware file is started. The LCD shows the progress in percent on the upper LCD line. Once the transfer was complete successfully, a reset starts the software on the watch. See [Section 3.6.3](#) for details.

NOTE: In case the update fails, it can be activated again by pushing the "DOWN" button again on the Chronos watch, given that the wireless update is active in the Chronos Control Center.

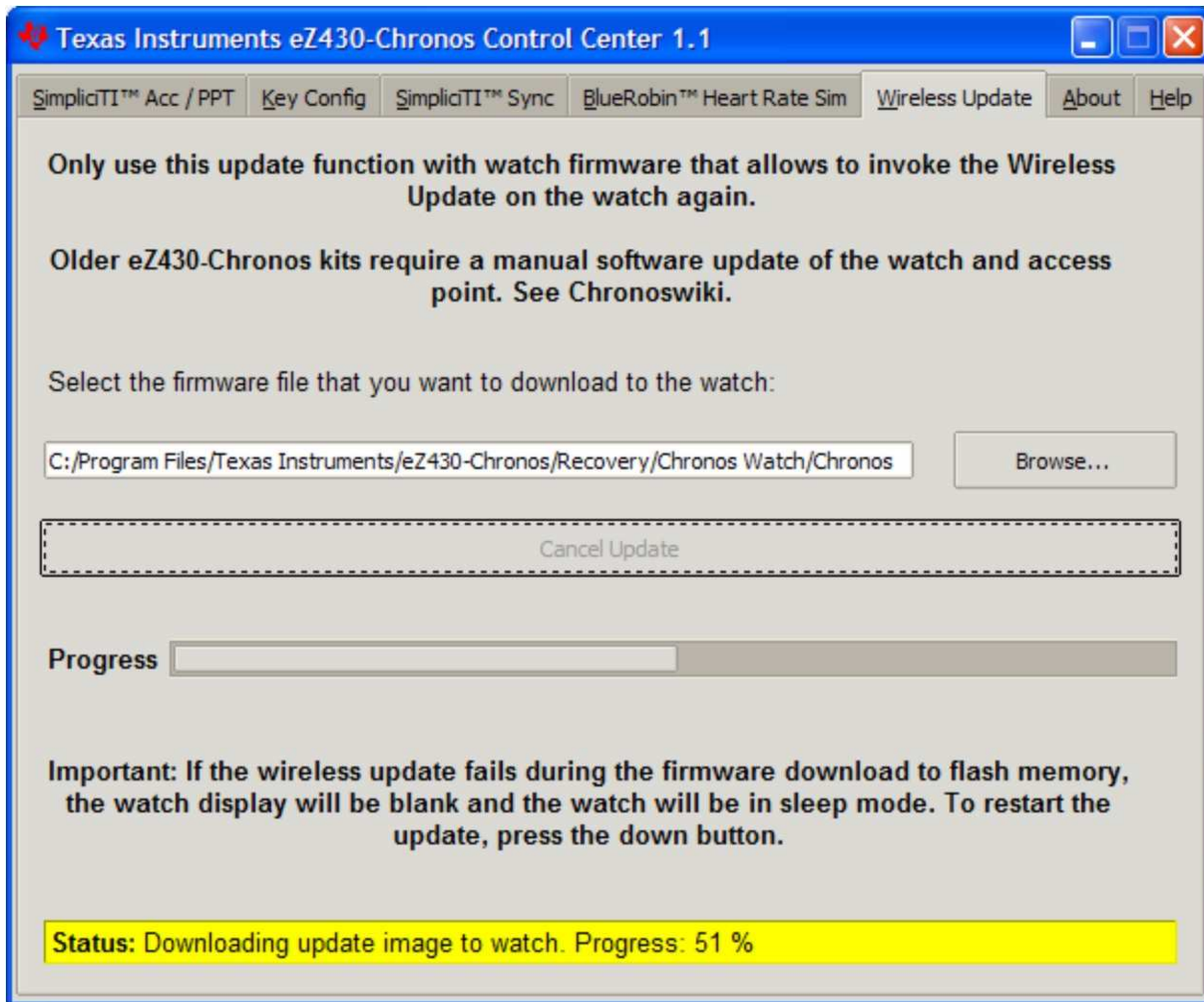


Figure 3-8. Chronos Control Center Wireless Update

3.4 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 (i.e., the watch cannot be set or calibrated standalone); however, this can be done conveniently by using the 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:

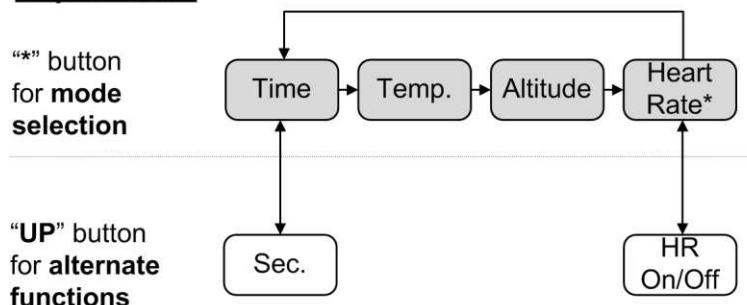
- Time, Date
- Temperature
- Altitude
- Heart rate
- Sync
- Wireless firmware update
- Data logger
- Battery monitoring

NOTE: No **Set Functions** are available in this software. All settings can be done using the 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](#)).

Top modes:



Bottom modes:

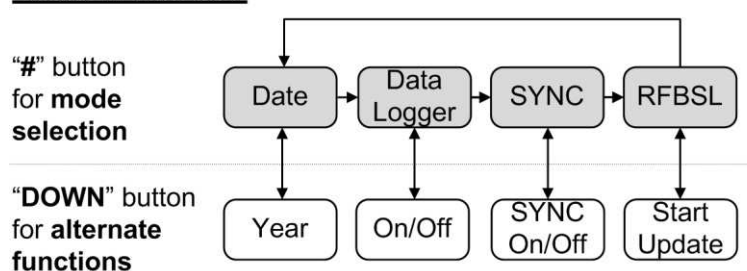


Figure 3-9. eZ430-Chronos Data Logger Feature Overview and Menu Structure

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

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 next section) 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, you may also have to wait until Windows has finished the access point driver installation.

In case of problems on Windows PCs, please 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 you see that the RF access point gets assigned to a different 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_1.tcl` located in `/home/<user name>/Texas Instruments/eZ430-Chronos/Control Center/Chronos Data Logger`.

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

To launch the Chronos Data Logger software on a Linux PC, browse to `/home/<user name>/Texas Instruments/eZ430-Chronos/Control Center/Chronos Data Logger` and run `eZ430-Chronos_Datalogger_1_1.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 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 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. 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 Chronos Data Logger PC software).

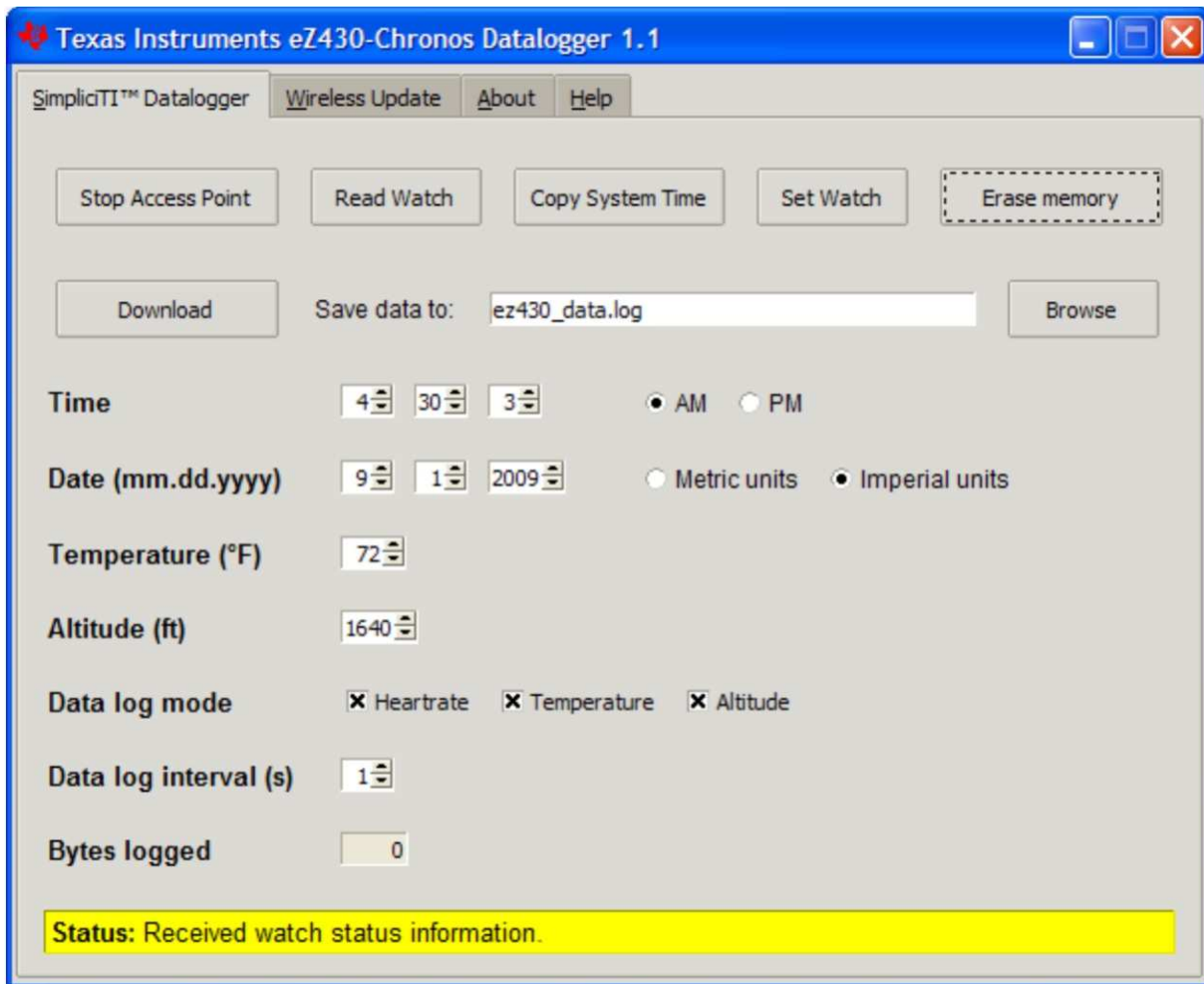


Figure 3-10. Chronos Data Logger

3.5.2 Wireless Update

This mode allows updating the firmware of the 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\Chronos Watch\Applications* and Linux in */home/<user name>/Texas Instruments/ez430-Chronos/Recovery/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 (0x8000-0xFFFF), 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 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 Chronos watch by pushing the "#" button
4. 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. Once this transfer was finished, the code is executed from RAM. At this point, the download of the actual firmware file is started. The LCD shows the progress in percent on the upper LCD line. Once the transfer was complete successfully, a reset starts the software on the watch. See [Section 3.6.3](#) for details.

NOTE: In case the update fails, it can be activated again by pushing the "DOWN" button again on the Chronos watch, given that the wireless update is active in the Chronos Control Center.

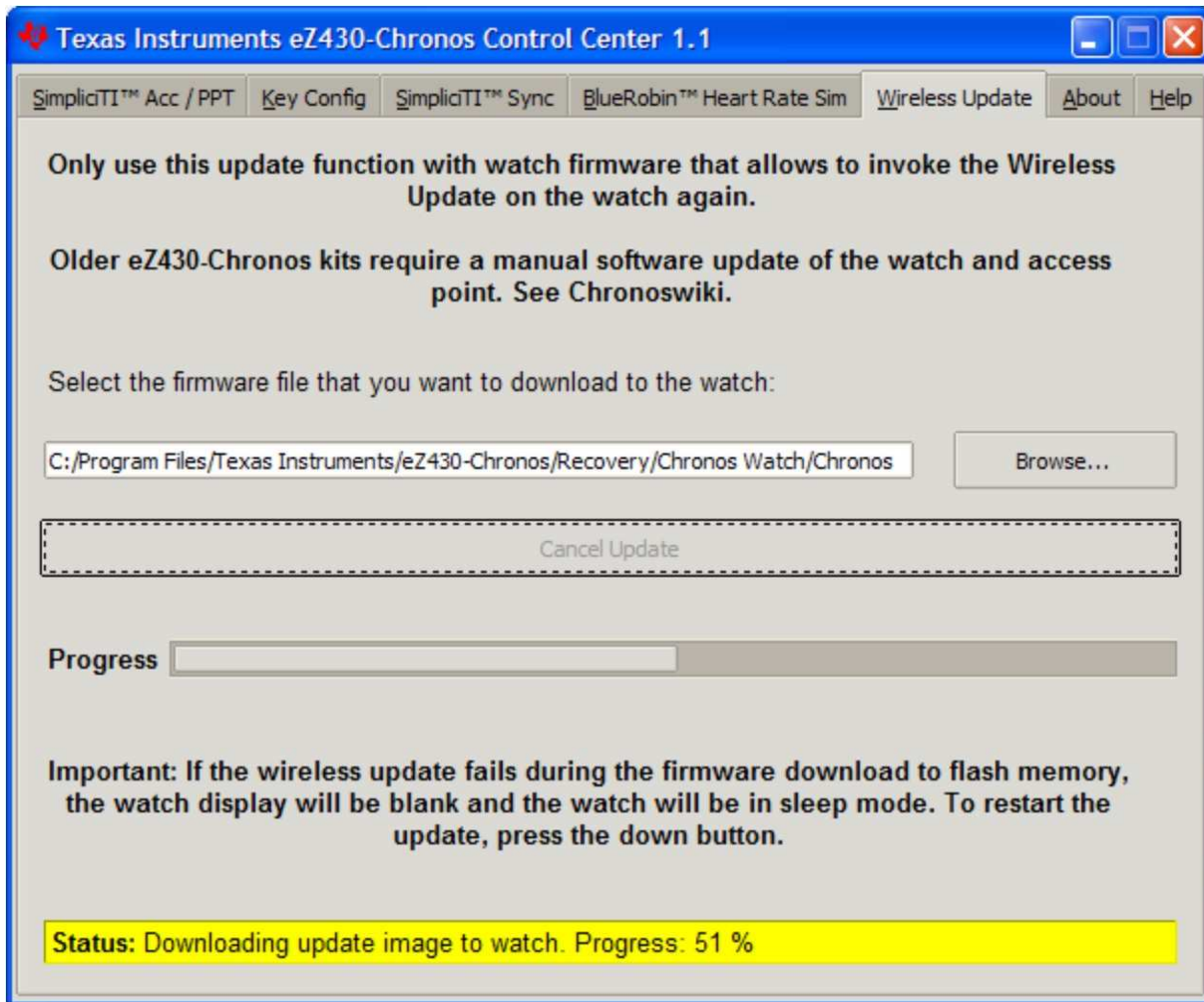


Figure 3-11. Chronos Control Center Wireless Update

3.6 eZ430-Chronos Software Projects

3.6.1 IDE Installation

To edit and download code to the CC430 device used inside the Chronos watch, Code Composer Studio v4.1 Core Edition or the IAR Embedded Workbench 4.21 KickStart (or higher) must be installed.

1. Download Code Composer Studio v4.1 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 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 below. 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 3 seconds

The source code file "menu.c" contains two linked lists with menu items, one for the upper (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 3 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 3-12 shows the basic software flow of the sports watch application.

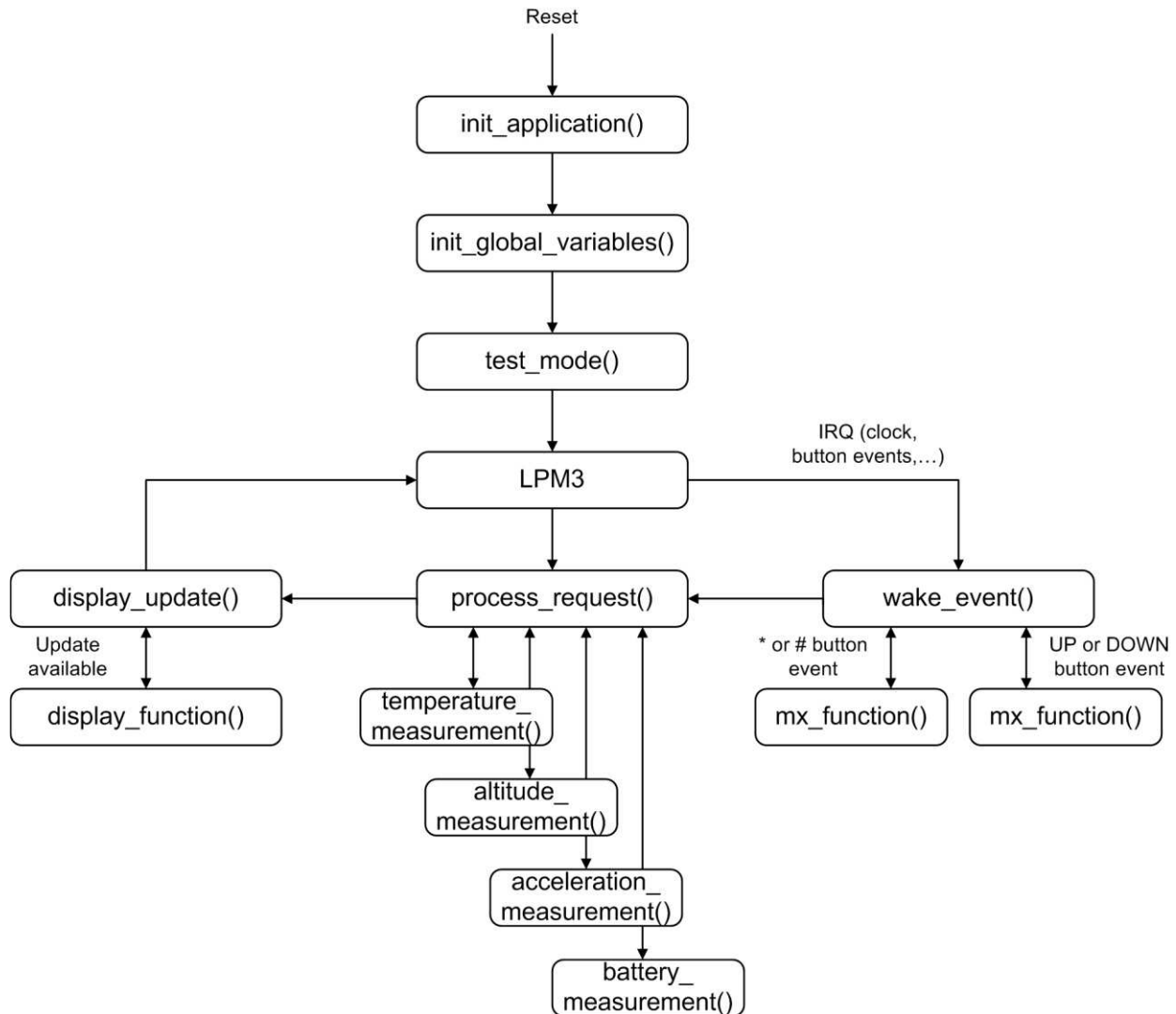


Figure 3-12. Chronos Software Flowchart

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. Care was taken to perform the least amount of display updates; for example, when the time changes from "10:22" to "10:23", only the last digit is updated.

3.6.3 eZ430-Chronos Wireless Update Feature

The wireless update feature allows to perform a firmware update of the eZ430-Chronos watch wirelessly, i.e. the watch does not need to be opened. The wireless updater should be seen as an application and not as a universal BSL. It can only be invoked by the main application, which needs to be created in a certain way (see [Section 3.6.3.2](#)). 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 occasionally only.

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, regardless if an update was performed or not. Time, data, alarm and other RAM based data is lost.

3.6.3.1 Overview and Components of the Wireless Update Feature

As described in the previous section, the wireless update feature allows updating the Chronos firmware wirelessly. One of the requirements for the wireless update was to spend as little flash memory as possible. Therefore, the lightweight radio protocol was developed, which resides in the BSL Flash area of the CC430. The software part handing the LCD progress information and the Flash memory programming is download over the air and executed in RAM. Components of the wireless updater:

- Radio protocol in BSL memory area of the CC430 (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 was activated in PC application, after a valid flash image was selected
2. RF access point ready - awaits request from watch
3. Wireless update is activated on watch
4. Watch downloads LCD and flash write routines (RAM based updater) from the PC into RAM of CC430. Watch shows "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 also list common questions on the wireless update Feature.

3.6.3.2 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 contains an extra menu item called "rFbSL". Once activated, it checks if the battery level of the watch is sufficient to start a wireless update, and then calls address 0x1000. At this point 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, regardless if an update was performed or not. 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). It then start receiving all 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. "dOnE" appears 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 3-13](#) and [Figure 3-14](#).

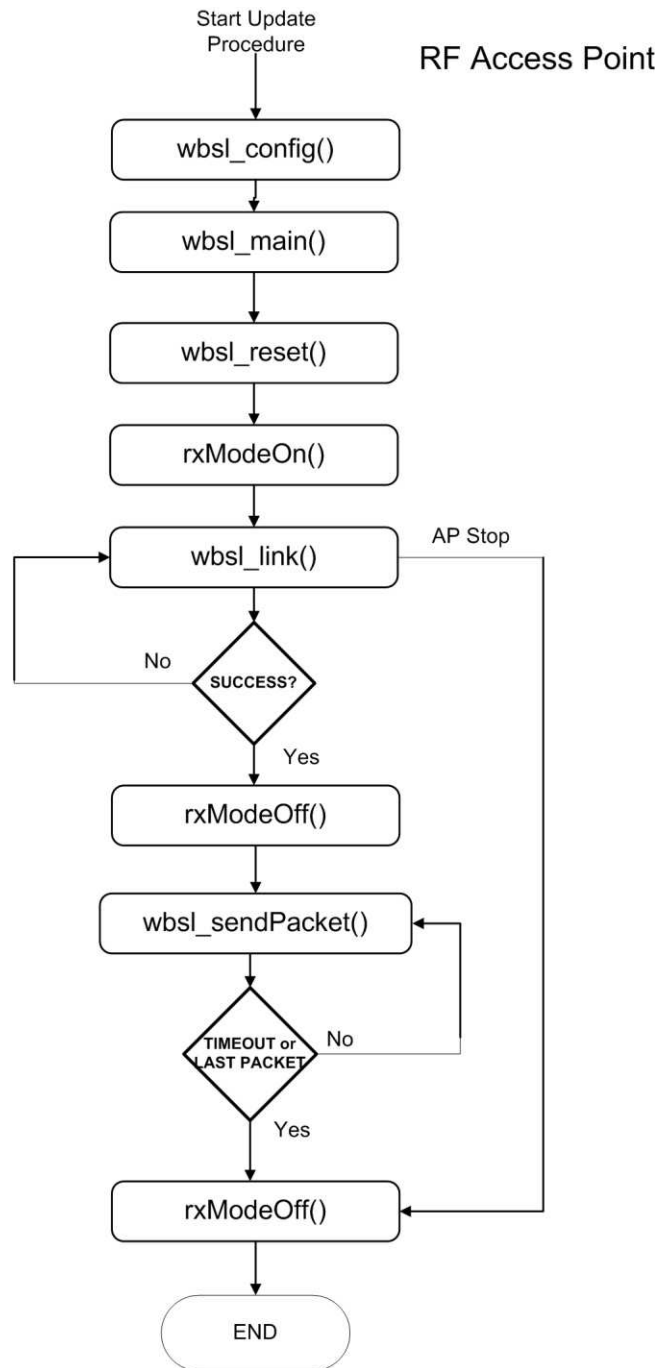


Figure 3-13. Flow Chart of Wireless Updater on Access Point

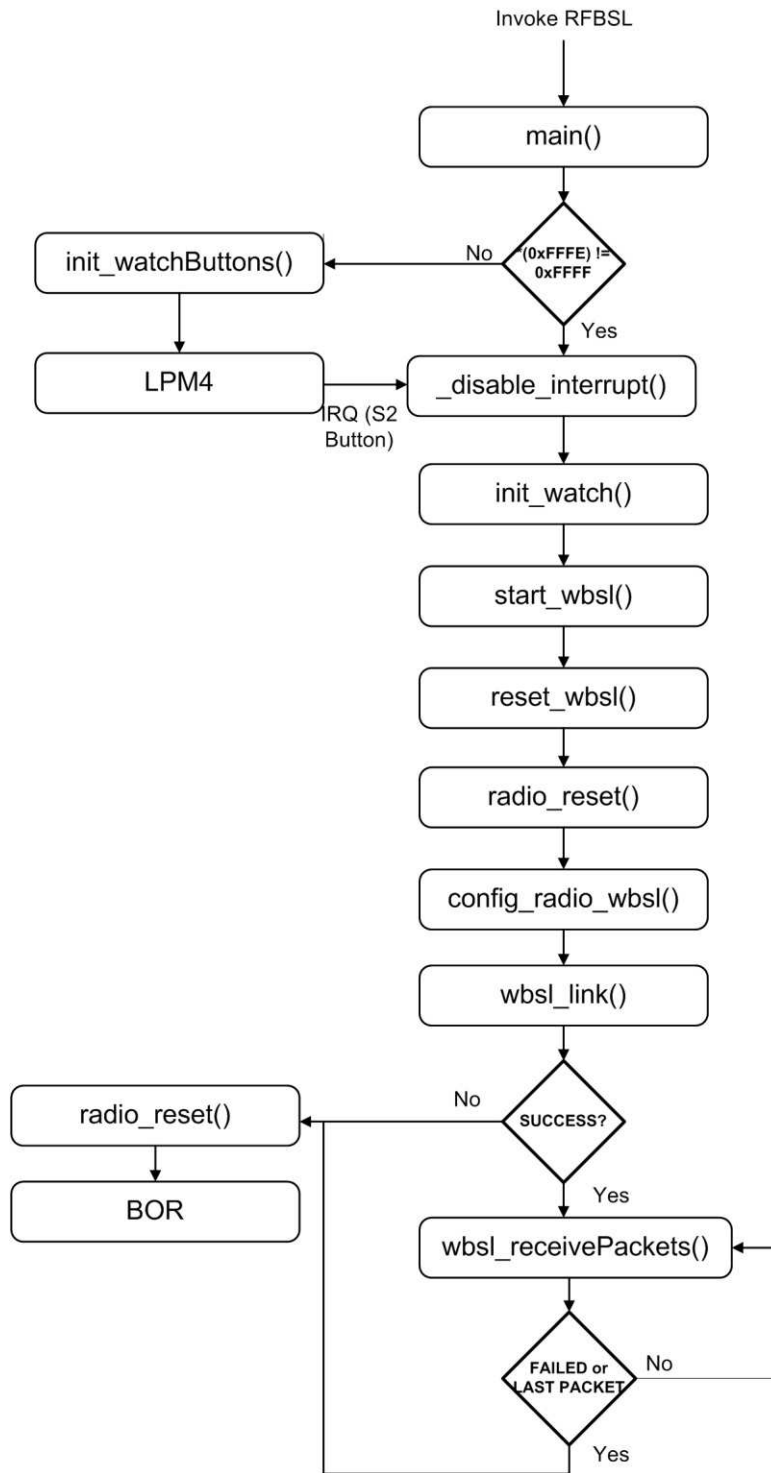


Figure 3-14. Flow Chart of Flash Based Wireless Updater on Chronos Watch Module

3.6.3.3 Error Handling

The wireless updater was created in a fail safe way. The radio protocol only contains limited error handling due to its small footprint, but the updater provides recovery in case the update process failed. Upon communication failures, the watch is put in low-power mode (LPM4) and the LCD is turned-off. The update process can be re-started by pushing the "DOWN" button after the update process was re-started on the PC side.

3.6.3.4 Upgrading existing eZ430-Chronos Kits

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

3.6.3.4.1 RF Access Point Update

The [CC Debugger](#) is required to re-program the CC1111 based RF access point. To perform the update, the [SmartRF Flash Programmer](#) software is used to on the PC side.

1. Solder a debug interface connector cable onto the CC1111 access point as shown in [Figure 3-15](#).



Figure 3-15. 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. Click "Perform actions"

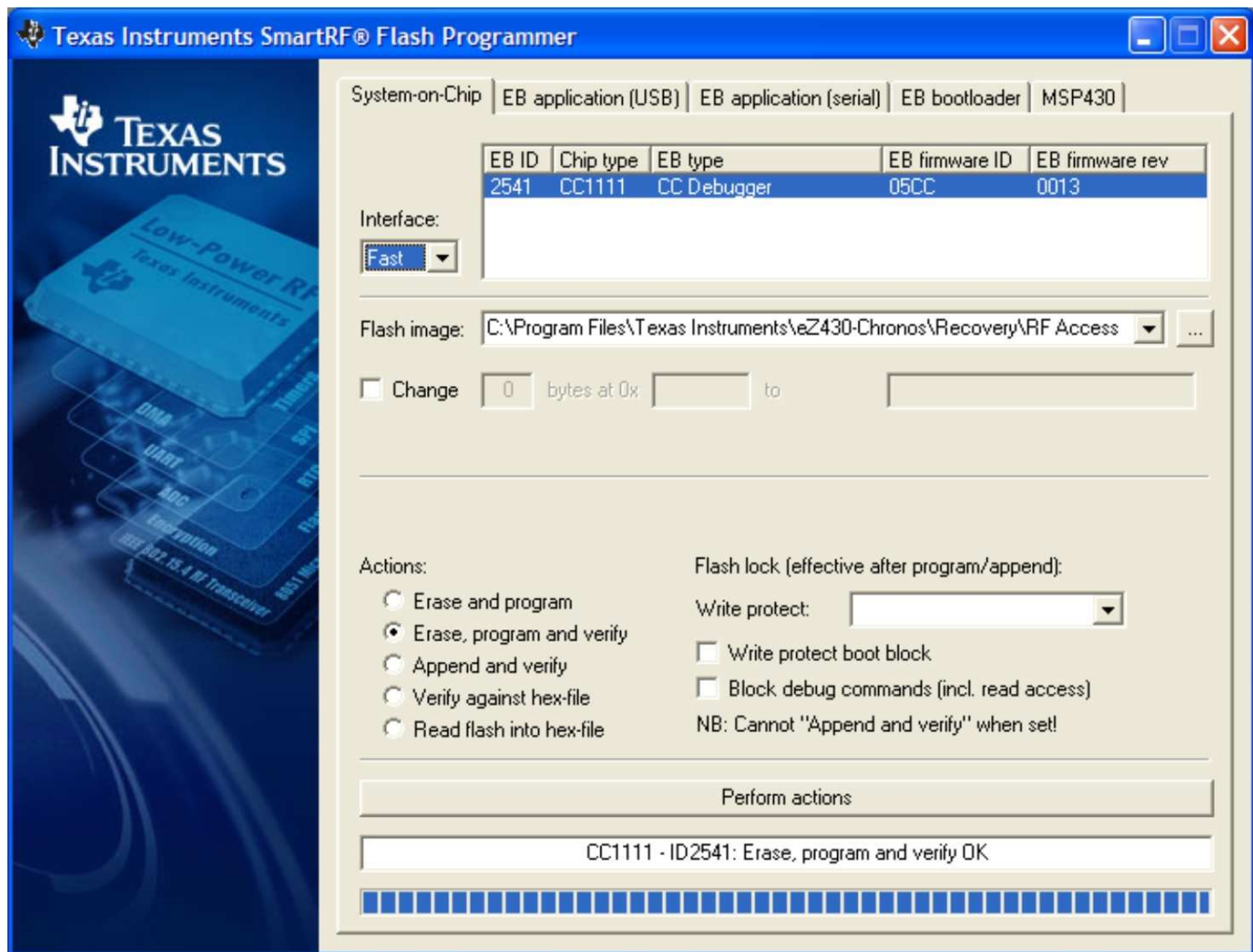


Figure 3-16. SmartRF Flash Programmer

3.6.3.4.2 Chronos Watch Update

The update of the 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 fastest 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 Chronos software release (recommended).

Alternatively, wireless updater may be loaded onto the watch using the included IAR Embedded Workbench (free KickStart version is sufficient). The project is available in `C:\Program Files\Texas Instruments\ez430-Chronos\Software Projects\Chronos Watch\IAR\Wireless Update`. The 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 3.6.4](#).

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 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 v4.1 or the IAR Workbench can be used, regardless if code limited or not.

3.6.4.1 Using Code Composer Studio v4.1

1. Launch Code Composer Studio v4.1: *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 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 Chronos Projects by clicking: *Project > Import Existing CCE/CCS Eclipse Project*
4. Click Browse and browse to Chronos Projects (default directory: *C:\Program Files\Texas Instruments\ez430-Chronos\Software Projects\Chronos Watch\CCS*). Confirm directory by clicking OK
5. The Chronos sports watch project appears as *ez430_chronos*, the 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*:
 - 915MHz – Limited CCS Core Edition (USA)
 - 868MHz – Limited CCS Core Edition (Europe)
 - 433MHz – Limited CCS Core Edition (Other regions)
 - 915MHz – Unrestricted CCS Platinum (USA)
 - 868MHz – Unrestricted CCS Platinum (Europe)
 - 433MHz – Unrestricted CCS Platinum (Other regions)
8. Go to *Target > Debug Active > Debug Active Project* to launch the debugger

3.6.4.2 Using IAR Embedded Workbench

1. Launch the Embedded Workbench: *Start > All Programs > IAR Systems > IAR Embedded Workbench KickStart for MSP430 4.2.1 > IAR Embedded Workbench*
2. Open Chronos Workspace by: *File > Open > Workspace...*
3. Browse to to Chronos Projects (default directory: *C:\Program Files\Texas Instruments\ez430-Chronos\Software Projects\IAR\Chronos Watch\Sports Watch* or *C:\Program Files\Texas Instruments\ez430-Chronos\Software Projects\IAR\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:
 - 915MHz – Limited IAR Kickstart (USA)
 - 868MHz – Limited IAR Kickstart (Europe)
 - 433MHz – Limited IAR Kickstart (Other regions)
 - 915MHz – Unrestricted IAR Workbench (USA)
 - 868MHz – Unrestricted IAR Workbench (Europe)
 - 433MHz – Unrestricted IAR Workbench (Other regions)
6. Go to *Project > Download and Debug* to launch the debugger

3.6.5 Chronos GUI Sources

Full sources of the Chronos Control Center and Chronos Data Logger are available in the Chronos software packages for Windows [SLAC341](#) and Linux [SLAC388](#) and is copied to your system during the software installation. The graphical user interfaces are based on TCL/Tk.

3.6.5.1 Chronos GUI for Windows

The 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.

3.6.5.1.1 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\Chronos Control Center\eZ430-Chronos CC 1_1.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.

3.6.5.1.2 The Control Center DLL

The sources for the DLL are available in the 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. Since the registry enumeration code uses MFC functions, Microsoft Visual Studio must be installed on the computer as well. In case 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. In case the DLL shall be compiled without the TCL interface, the respective source code file and the references to the TCL libraries need to 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 30ms, 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 Fuctions

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

intlen

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

3.6.5.2 Chronos GUI for Linux

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

See [Section 3.3](#) for instructions on how to run these scrips 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 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 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](#).

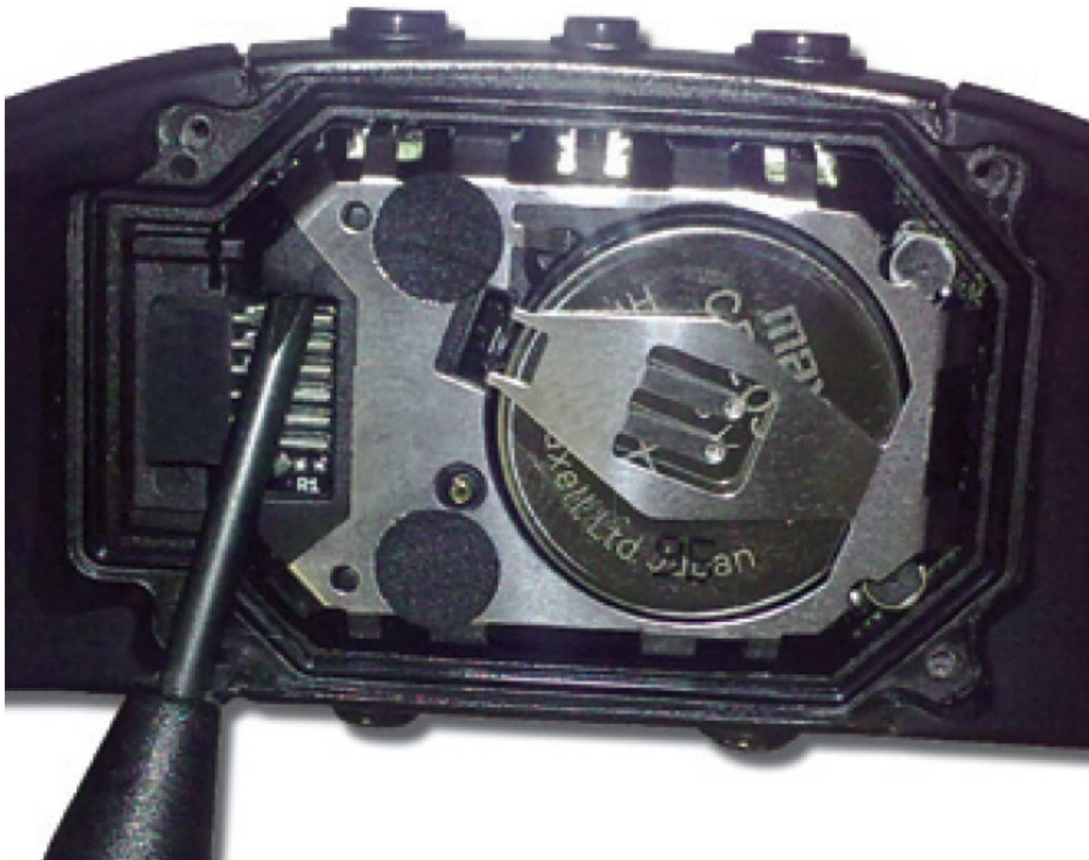


Figure 4-1. Removing Watch Module from Housing

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



Figure 4-2. Removing Watch Battery

CAUTION

- (1) Always remove battery before connecting to emulator preventing the battery from being charged.
- (2) Ensure to dispose the battery properly. Keep out of the reach of children. In case swallowed, contact physician immediately.

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

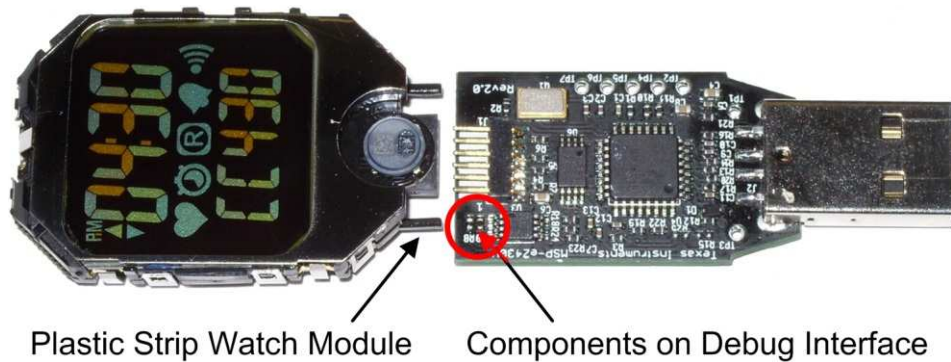


Figure 4-3. Chronos Watch Module Attached to eZ430-RF Debug Interface

NOTE:

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

4.1.2 Assembly of 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](#)).

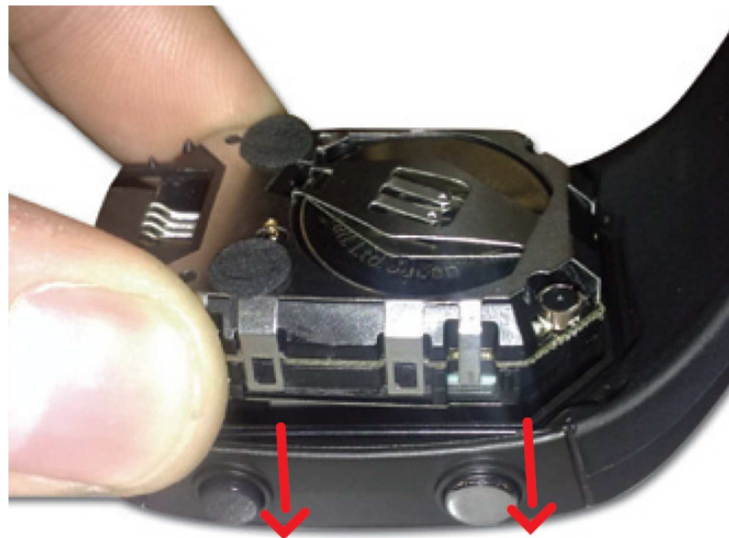


Figure 4-4. Chronos Watch Module Insertion Into Housing

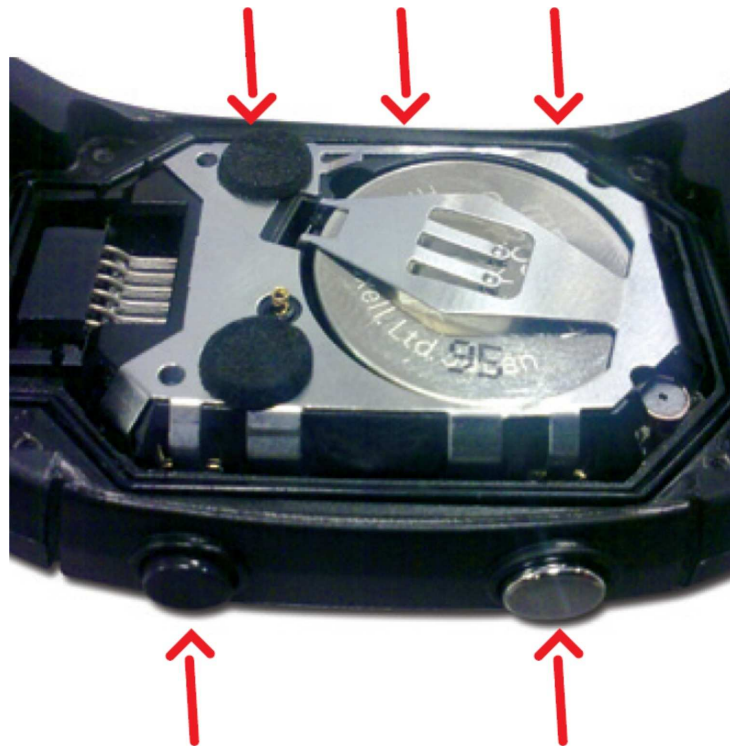


Figure 4-5. Metal Strips of Watch Housing and Buttons of Housing

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](#)).

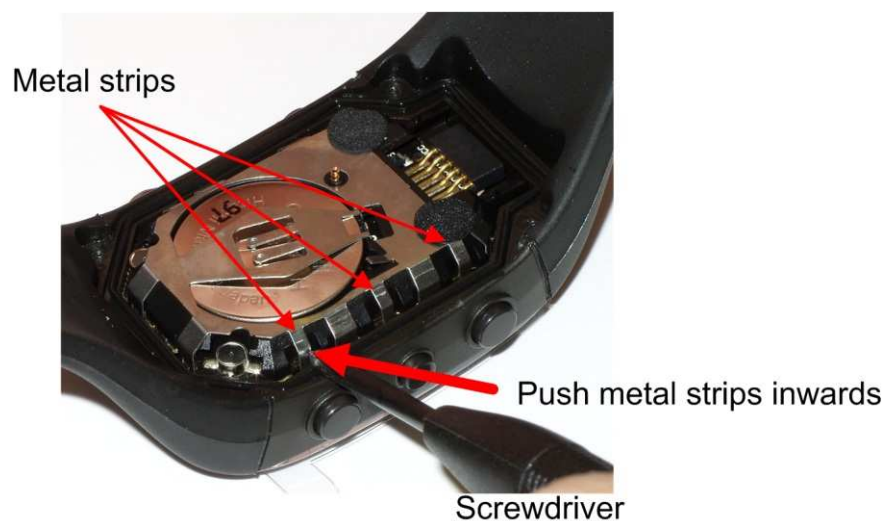


Figure 4-6. Push Metal Strips Inward

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 Chronos Watch

The core technology behind the eZ430-Chronos watch is the CC430F6137 microcontroller with its integrated <1GHz 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.

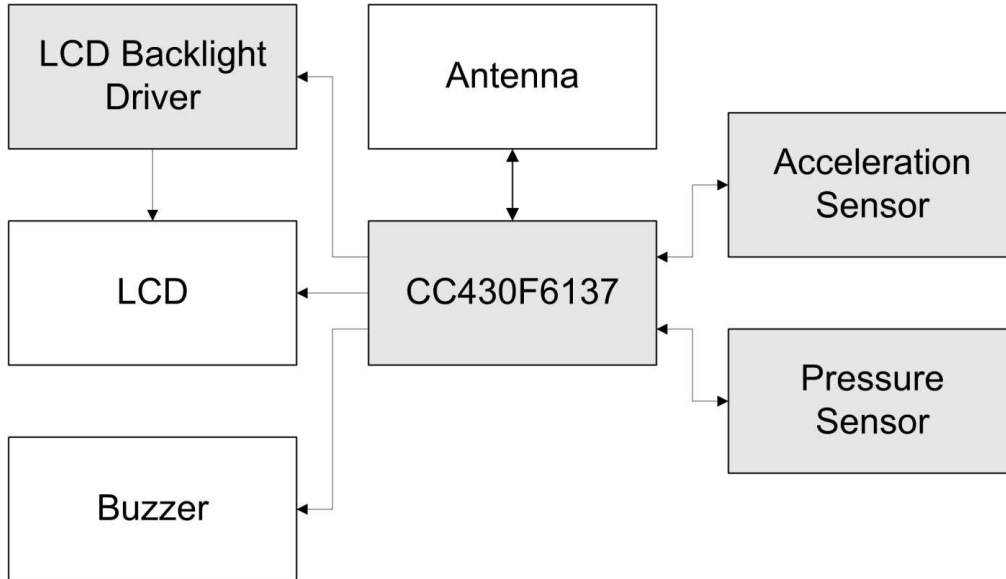
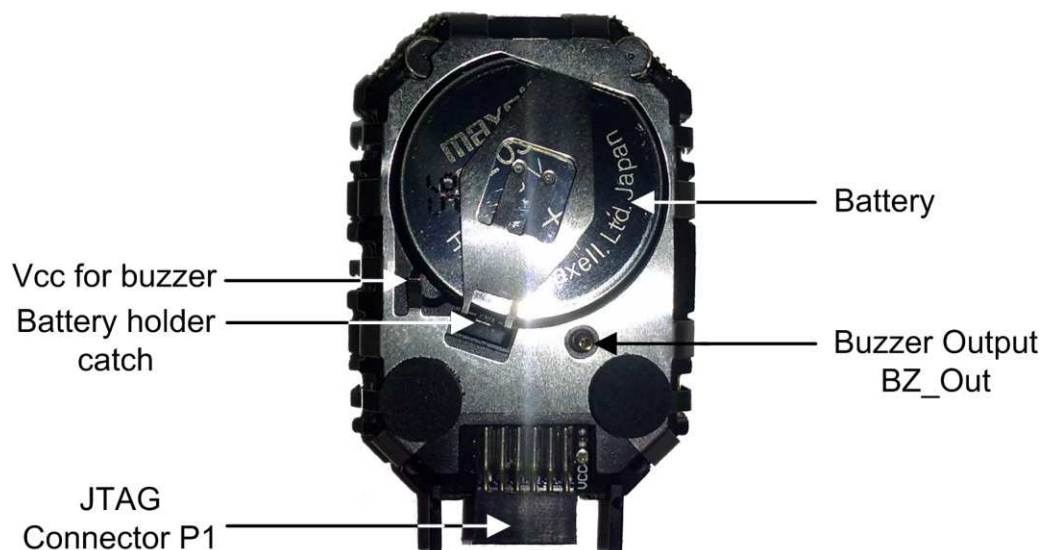


Figure 4-7. eZ430-Chronos Watch Block Diagram

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 μ A	92.6 months
Welcome screen (LPM3)	8.9 μ A	28.0 months
Time/Date	9.0 μ A	27.7 months
Continuous temperature measurement	10.0 μ A	25.0 months
Continuous altitude measurement	18.0 μ A	13.8 months
Continuous acceleration measurement	166.0 μ A	1.5 months
Continuous BlueRobin RX	40.0 μ A	6.2 months
Continuous SimpliciTI PPT (no button pressed)	10.0 μ A	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 μ A	24.2 months
1h/day SimpliciTI PPT (no button pressed)	9.1 μ A	25.4 months
1h/day SimpliciTI SYNC	46.1 μ A	5.4 months
1h/day SimpliciTI ACC	169.9 μ A	1.4 months

4.3 Functional Description of the eZ430-Chronos RF Access Point

The RF access point allows you to wirelessly communicate with the Chronos directly from your PC to download data, sync information, or control programs running on your computer (see [Figure 4-10](#)). It is based on the CC1111F32 controller, which features an integrated USB controller in addition to a <1-GHz radio.

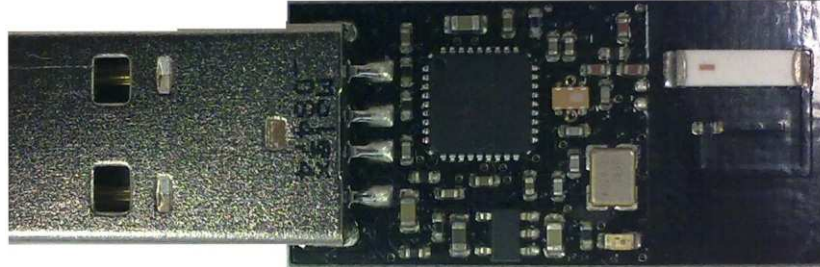


Figure 4-10. eZ430-Chronos RF Access Point

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 re-program 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)
- 3.6V supply for target
- TEST/SBWTCK
- RST/SBWTDIO
- GND
- UART RX (from target to emulator)

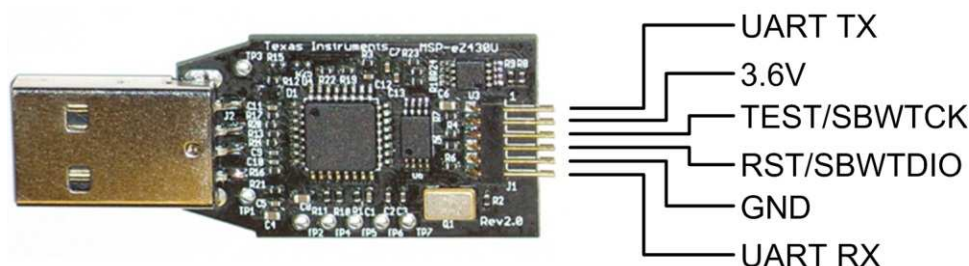


Figure 4-12. eZ430-Chronos Debug Interface

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 eZ430-Chronos Watch Schematics, Layout, BOM, and LCD

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

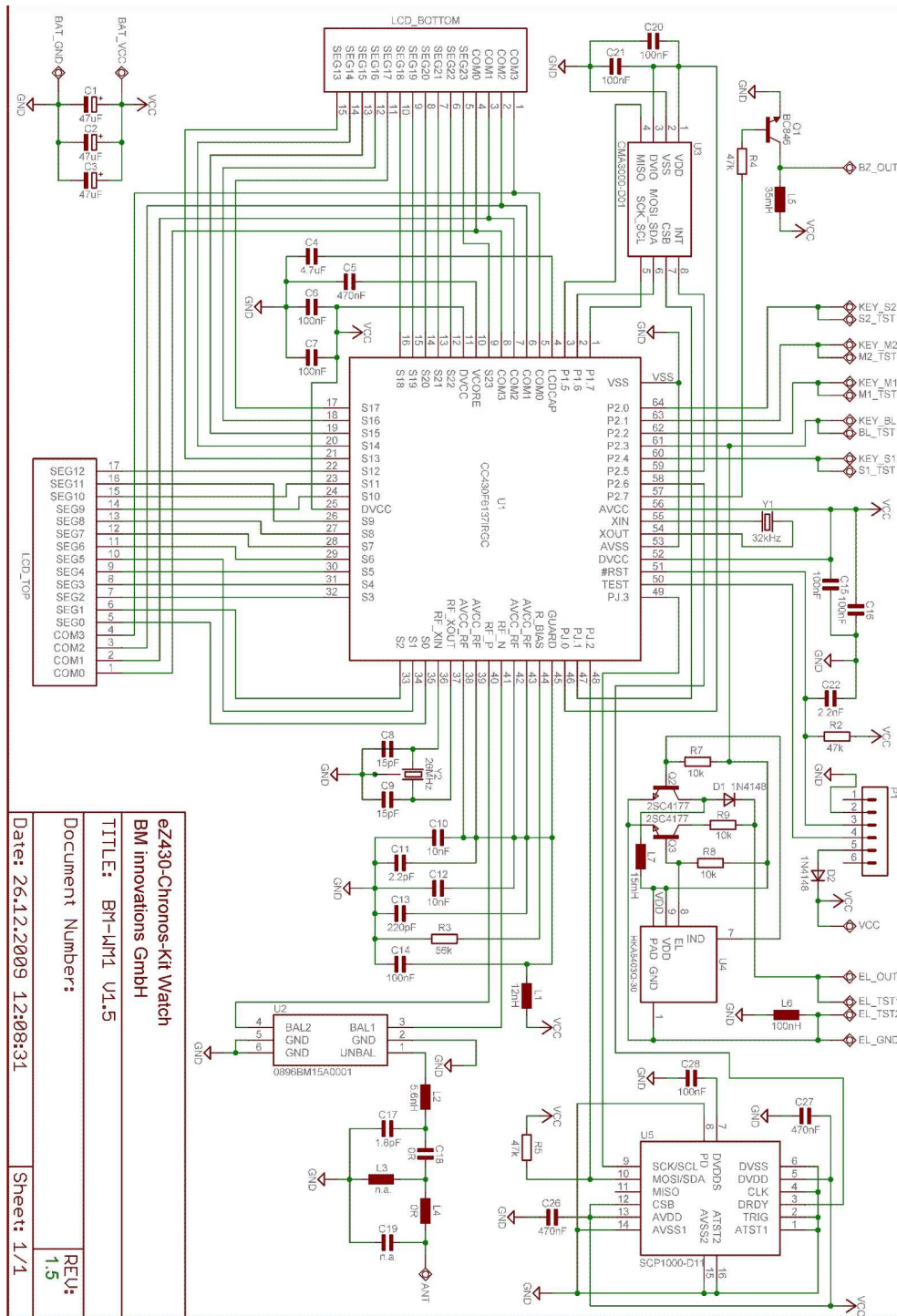


Figure 4-13. eZ430-Chronos-868 and -915 Watch, Schematics

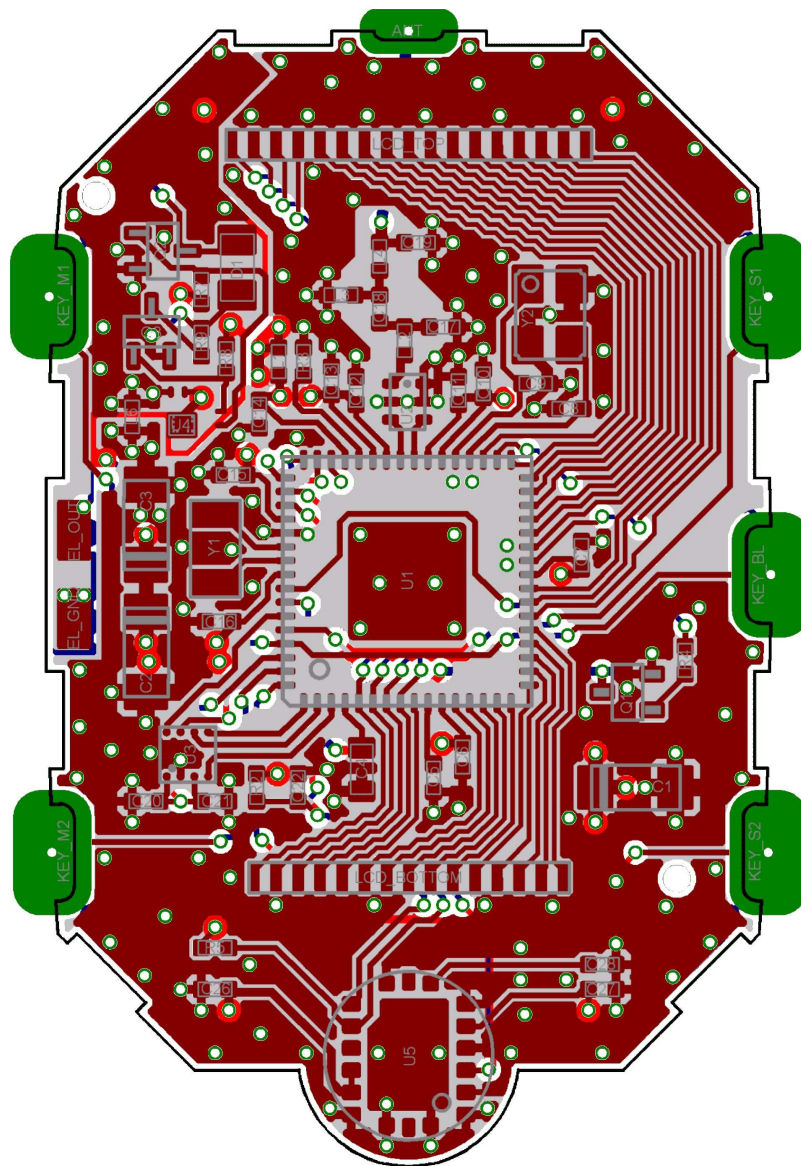


Figure 4-14. eZ430-Chronos-868 and -915 Watch, PCB Components on Top Layer

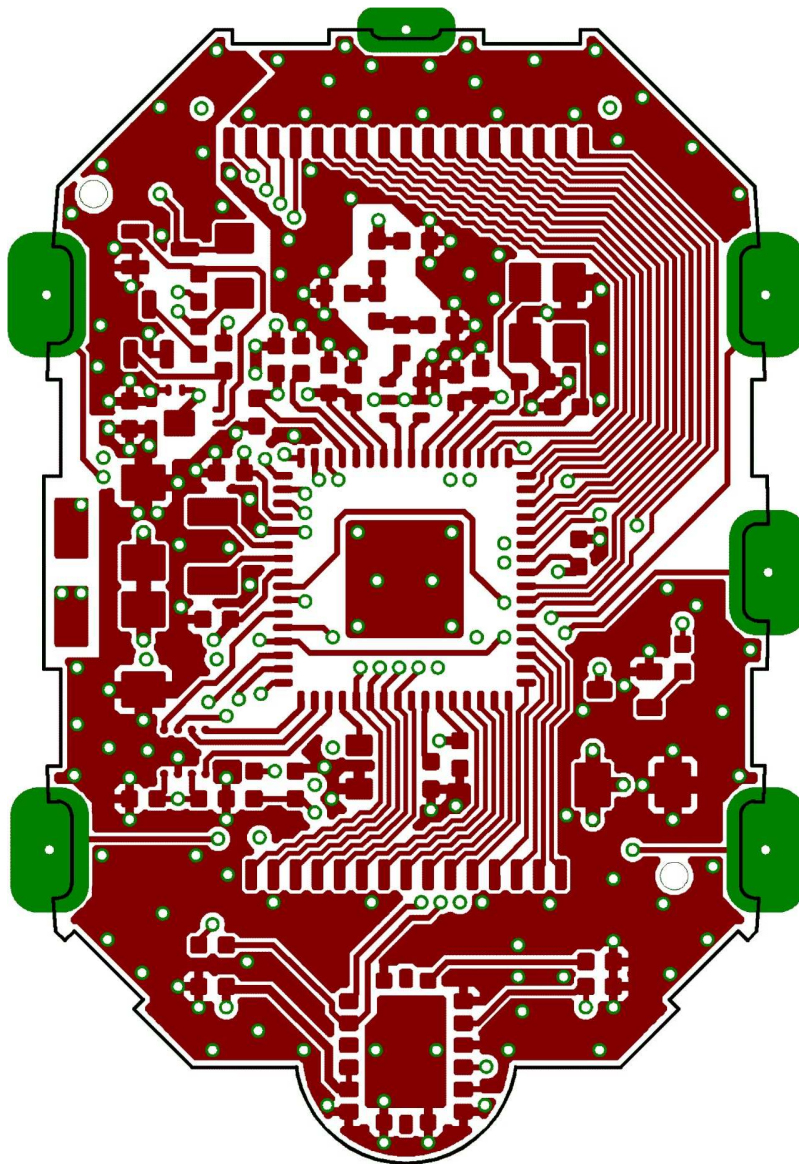


Figure 4-15. eZ430-Chronos-868 and -915 Watch, Layout Top Layer (LCD Side)

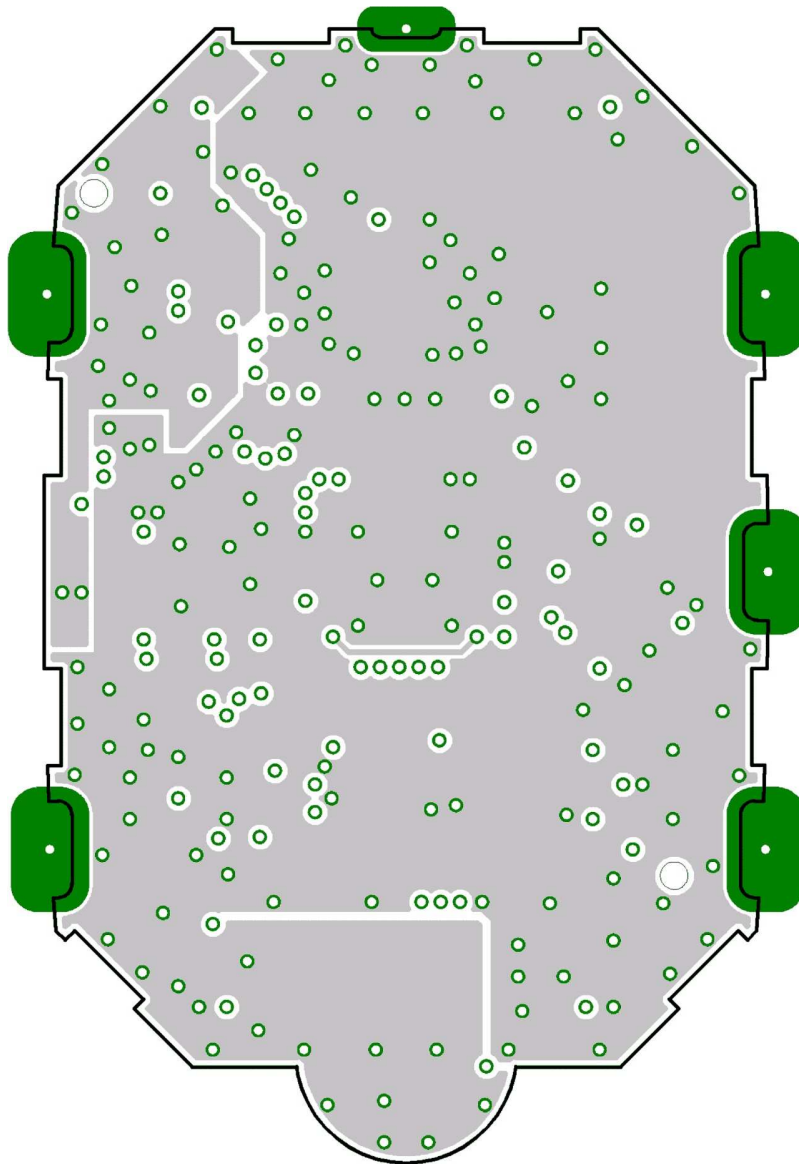


Figure 4-16. eZ430-Chronos-868 and -915 Watch, Layout 2nd Layer

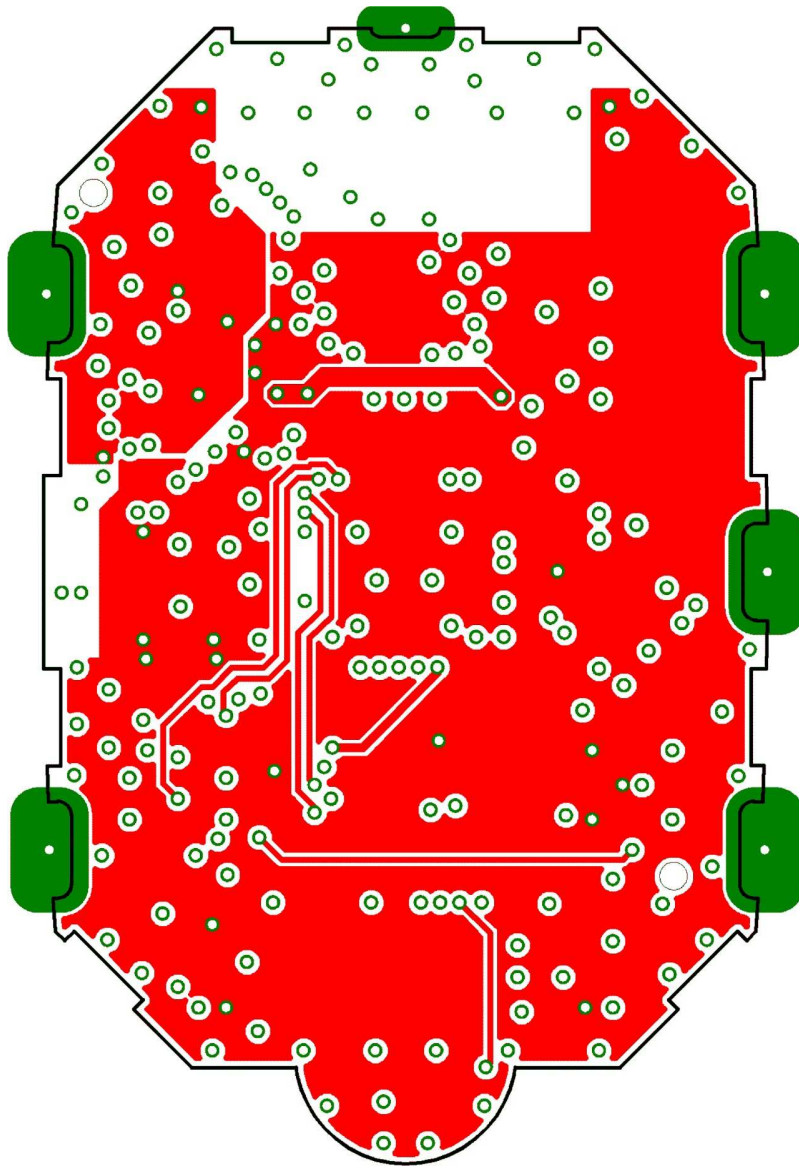


Figure 4-17. eZ430-Chronos-868 and -915 Watch, Layout 3rd Layer

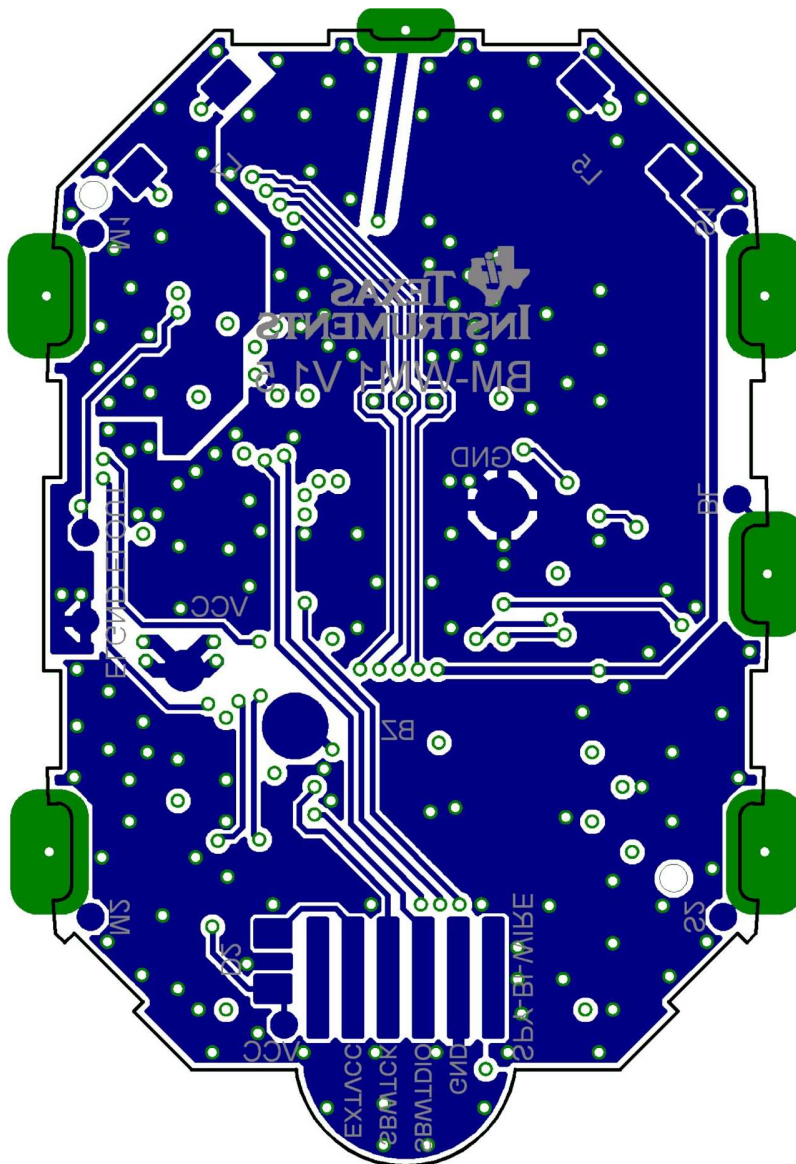


Figure 4-18. eZ430-Chronos-868 and -915 Watch, Layout Bottom Layer (Battery Side)

Table 4-2. eZ430-Chronos-868 and -915 Watch, BOM List

Designator	Value	Tolerance	Footprint	Description	Manufacturer
C1	47uF	±20%	TAJ-A	Capacitor SMD	Tantalum, height max. 1.6mm
C2	47uF	±20%	TAJ-A	Capacitor SMD	Tantalum, height max. 1.6mm
C3	47uF	±20%	TAJ-A	Capacitor SMD	Tantalum, height max. 1.6mm
C4	4.7uF	±20%, X5R	603	Capacitor SMD	
C5	470nF	±10%, X5R	402	Capacitor SMD	
C6	100nF	±10%, X7R	402	Capacitor SMD	
C7	100nF	±10%, X7R	402	Capacitor SMD	
C8	15pF	±5%, COG/NP0	402	Capacitor SMD	
C9	15pF	±5%, COG/NP0	402	Capacitor SMD	
C10	10nF	±10%, X7R	402	Capacitor SMD	
C11	2.2pF	±0.25pF, COG/NP0	402	Capacitor SMD	
C12	10nF	±10%, X7R	402	Capacitor SMD	
C13	220pF	±10%, COG/NP0	402	Capacitor SMD	
C14	100nF	±10%, X7R	402	Capacitor SMD	
C15	100nF	±10%, X7R	402	Capacitor SMD	
C16	100nF	±10%, X7R	402	Capacitor SMD	
C17	1.8pF	±0.1pF, COG/NP0	402	Capacitor SMD	Johanson 500R07S1R8BV4
C18	0R	±5%	402	Resistor SMD	
C19	N.A.				
C20	100nF	±10%, X7R	402	Capacitor SMD	
C21	100nF	±10%, X7R	402	Capacitor SMD	
C22	2.2nF	±10%, X7R	402	Capacitor SMD	
C26	470nF	±10%, X5R	402	Capacitor SMD	
C27	470nF	±10%, X5R	402	Capacitor SMD	
C28	100nF	±10%, X7R	402	Capacitor SMD	
D1	1N4148		805	Diode SMD	
D2	1N4148		805	Diode SMD	
L1	12nH	±5%	402	Inductor Monolithic SMD	Johanson L-07C12NJV4
L2	5.6nH	±0.3nH	402	Inductor Monolithic SMD	Johanson L-07C5N6SV4
L3	N.A.				
L4	0R	±5%	402	Resistor SMD	
L5	35mH, RDC<=250Ohm, IDC>=1mA	±10%		Inductor Coil	
L6	100nH	±10%	402	Inductor Monolithic SMD	
L7	4mH, RDC<=1000Ohm, 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 4-2. 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<=80kOhm	±20ppm	3.2 x 1.5 mm ²	Crystal SMD	Microcrystal CC7V-T1A
Y2	26MHz, CL=10pF, ESR<=40Ohm	±10ppm	3.2 x 2.5 mm ²	Crystal SMD	Epson TSX3225-X1E000021014300

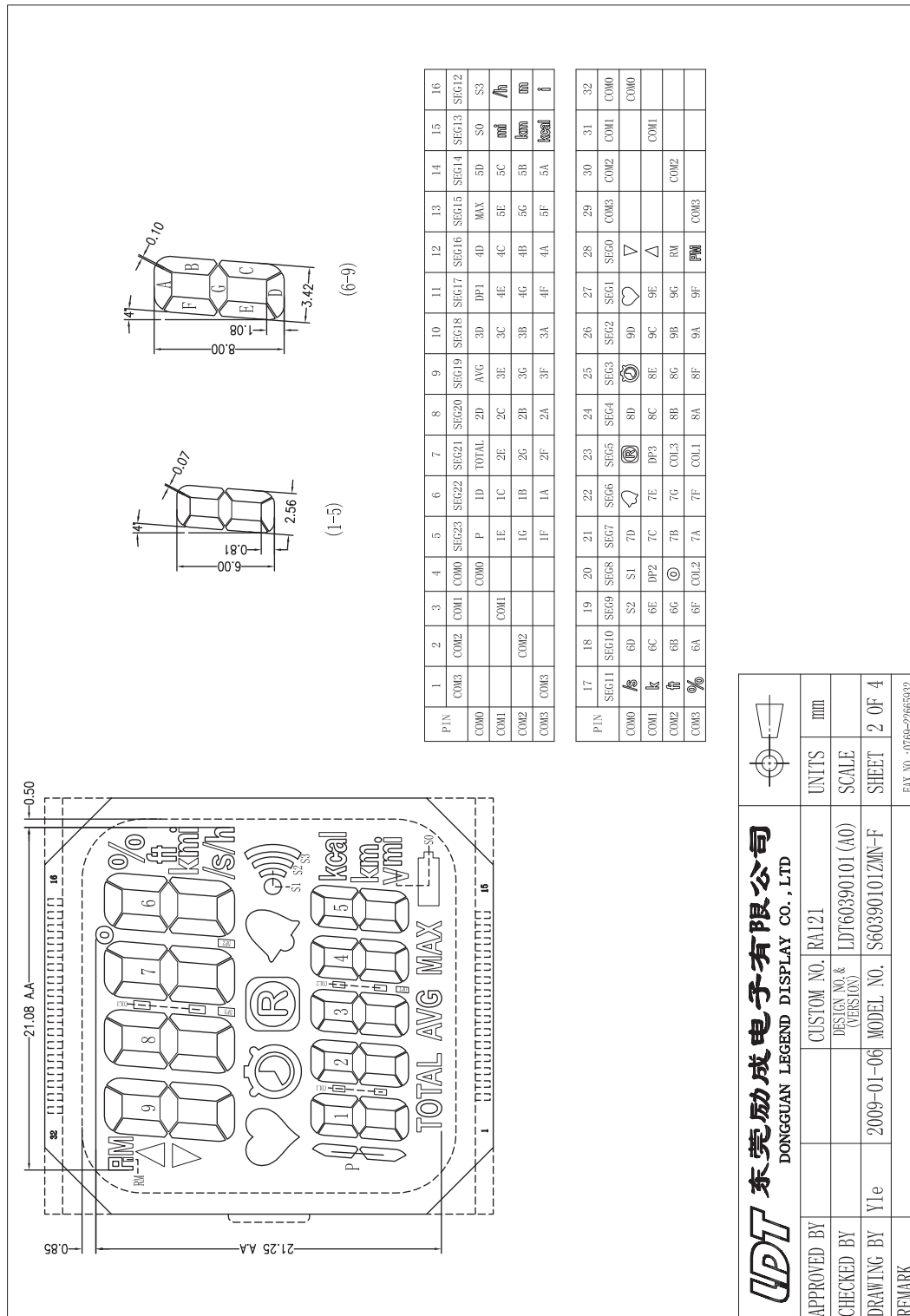


Figure 4-19. eZ430-Chronos Watch, LCD Segment Map

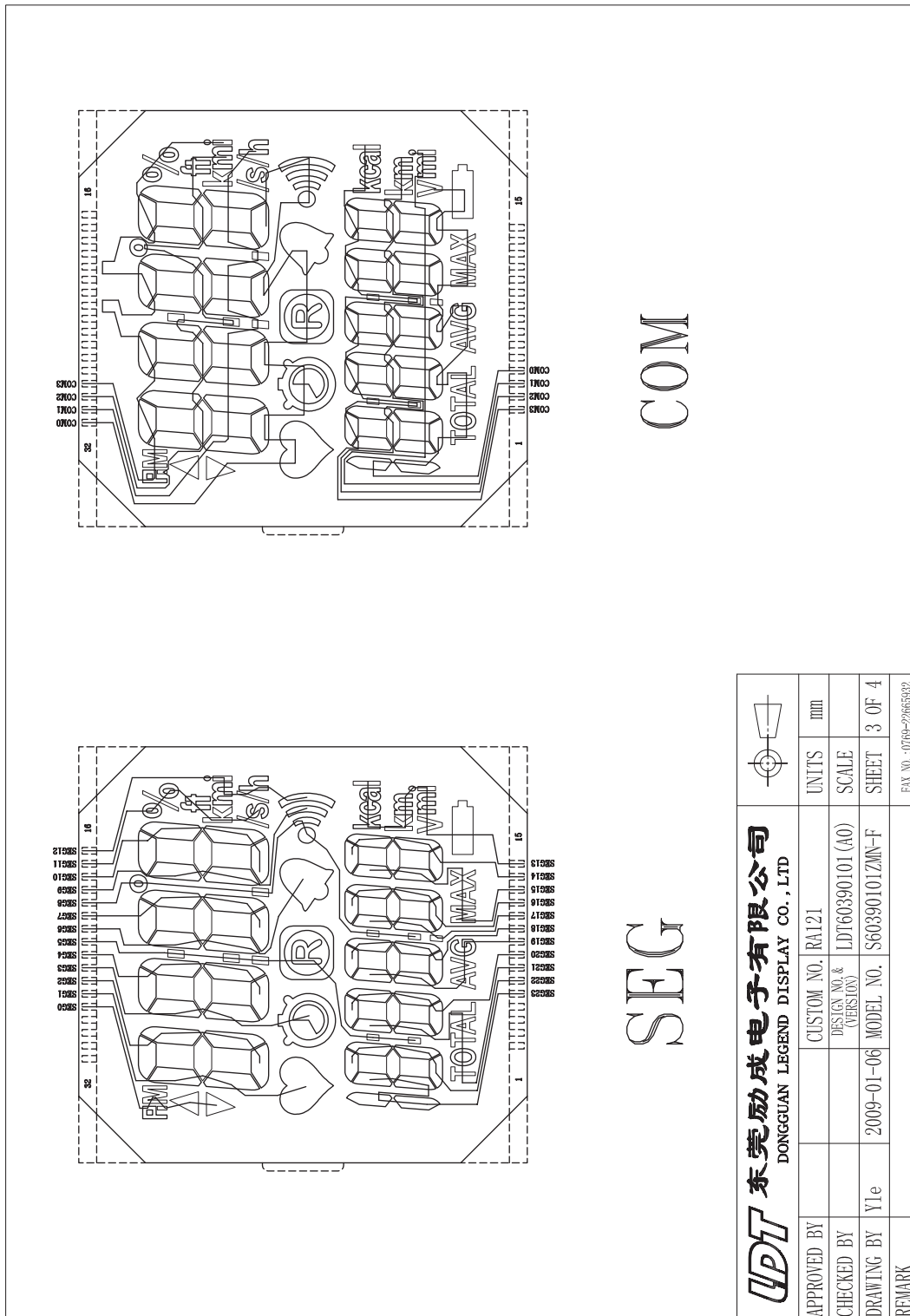


Figure 4-20. eZ430-Chronos Watch, LCD Pinout

4.6 eZ430-Chronos Access Point Schematics, Layout and BOM

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

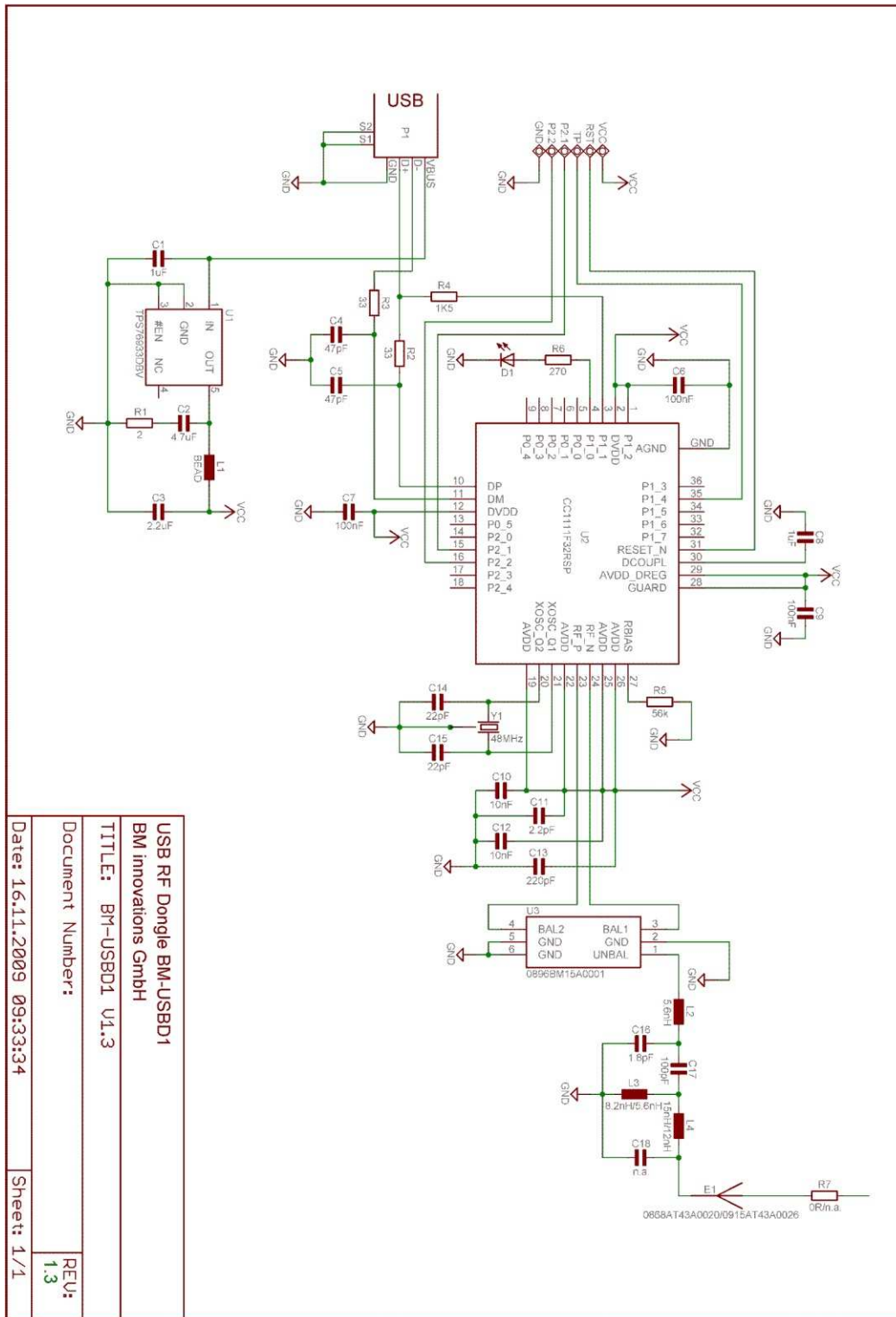


Figure 4-21. eZ430-Chronos-868 and -915 RF Access Point, Schematics

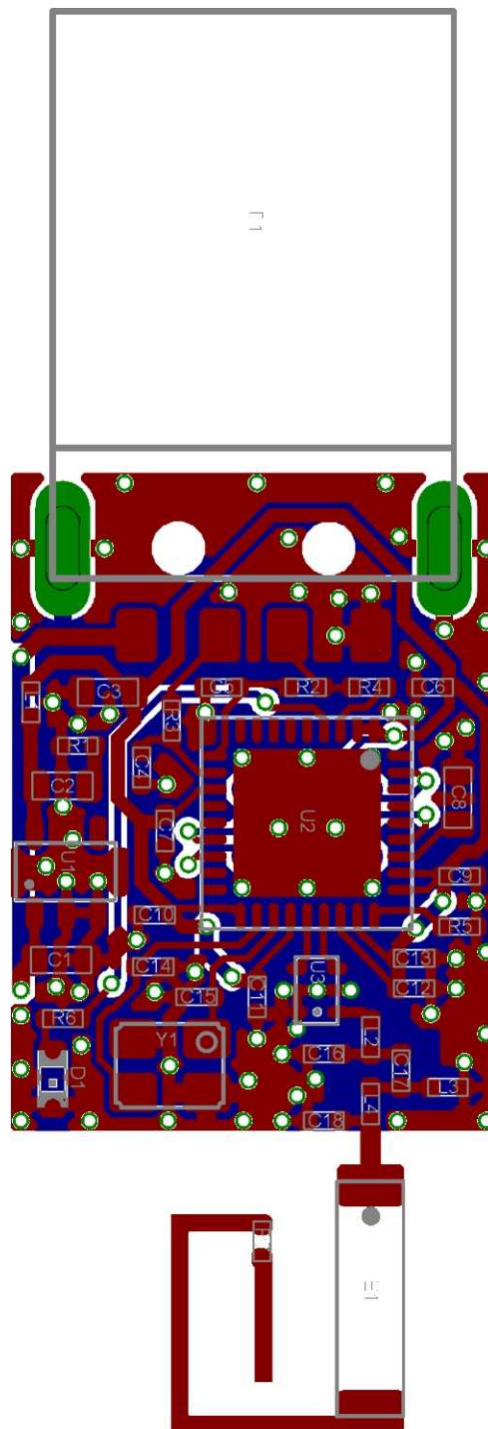


Figure 4-22. eZ430-Chronos-868 and -915 RF Access Point, PCB Components on Top Layer

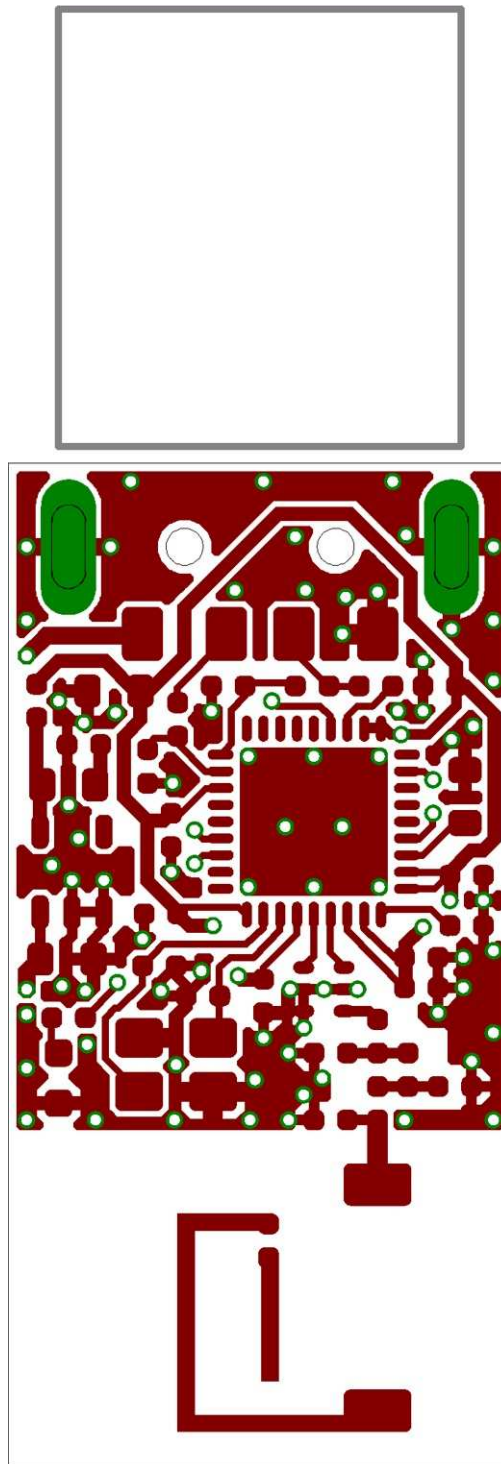


Figure 4-23. eZ430-Chronos-868 and -915 RF Access Point, Layout Top Layer (LCD side)

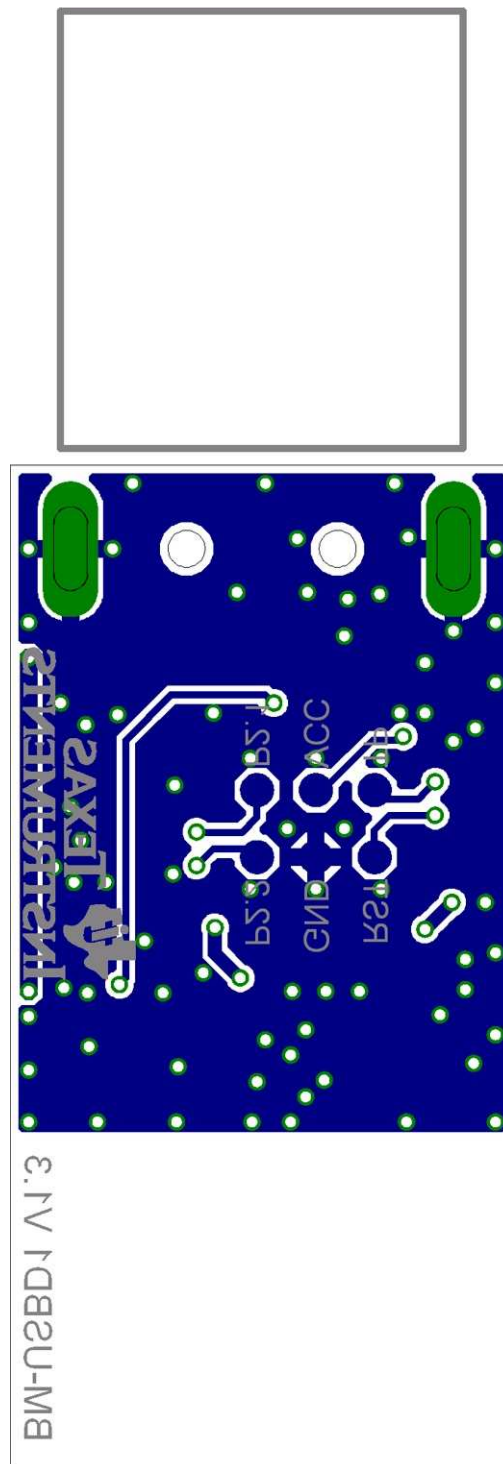


Figure 4-24. eZ430-Chronos-868 and -915 RF Access Point, Layout Bottom Layer

Table 4-3. eZ430-Chronos-868 Access Point, BOM List

Designator	Value	Tolerance	Footprint	Description	Manufacturer
C1	1.0uF	+10%, X5R	603	Capacitor SMD	
C2	4.7uF	+10%, X5R	603	Capacitor SMD	
C3	2.2uF	+10%, X5R	603	Capacitor SMD	
C4	47pF	+10%, COG/NP0	402	Capacitor SMD	
C5	47pF	+10%, COG/NP0	402	Capacitor SMD	
C6	100nF	+10%, X7R	402	Capacitor SMD	
C7	100nF	+10%, X7R	402	Capacitor SMD	
C8	1.0uF	+10%, X5R	603	Capacitor SMD	
C9	100nF	+10%, X7R	402	Capacitor SMD	
C10	10nF	+10%, X7R	402	Capacitor SMD	
C11	2.2pF	+0.25pF, COG/NP0	402	Capacitor SMD	
C12	10nF	+10%, X7R	402	Capacitor SMD	
C13	220pF	+10%, COG/NP0	402	Capacitor SMD	
C14	22pF	+5%, COG/NP0	402	Capacitor SMD	
C15	22pF	+5%, COG/NP0	402	Capacitor SMD	
C16	1.8pF	+0.1pF, COG/NP0	402	Capacitor SMD	Johanson 500R07S1R8BV4
C17	100pF	+10%, COG/NP0	402	Capacitor SMD	
C18	N.A.				
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	5.6nH	+0.3nH	402	Inductor Monolithic SMD	Johanson L-07C5N6SV4
L3	8.2nH	+5%	402	Inductor Monolithic SMD	Johanson L-07C8N2JV4
L4	15nH	+5%	402	Inductor Monolithic SMD	Johanson L-07C15NJV4
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<=40Ohm	+10ppm	23.2 x 2.5 mm ²	Crystal SMD	Epson TSX3225-X1E000021040300

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

Designator	Value	Tolerance	Footprint	Description	Manufacturer
C1	1.0uF	+10%, X5R	603	Capacitor SMD	
C2	4.7uF	+10%, X5R	603	Capacitor SMD	
C3	2.2uF	+10%, X5R	603	Capacitor SMD	
C4	47pF	+10%, COG/NP0	402	Capacitor SMD	
C5	47pF	+10%, COG/NP0	402	Capacitor SMD	
C6	100nF	+10%, X7R	402	Capacitor SMD	
C7	100nF	+10%, X7R	402	Capacitor SMD	
C8	1.0uF	+10%, X5R	603	Capacitor SMD	
C9	100nF	+10%, X7R	402	Capacitor SMD	
C10	10nF	+10%, X7R	402	Capacitor SMD	
C11	2.2pF	+0.25pF, COG/NP0	402	Capacitor SMD	
C12	10nF	+10%, X7R	402	Capacitor SMD	
C13	220pF	+10%, COG/NP0	402	Capacitor SMD	
C14	22pF	+5%, COG/NP0	402	Capacitor SMD	
C15	22pF	+5%, COG/NP0	402	Capacitor SMD	
C16	1.8pF	+0.1pF, COG/NP0	402	Capacitor SMD	Johanson 500R07S1R8BV4
C17	100pF	+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	5.6nH	+0.3nH	402	Inductor Monolithic SMD	Johanson L-07C5N6SV4
L3	5.6nH	+0.3nH	402	Inductor Monolithic SMD	Johanson L-07C5N6SV4
L4	12nH	+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<=40Ohm	+10ppm	23.2 x 2.5 mm ²	Crystal SMD	Epson TSX3225-X1E000021040300

4.7 eZ430-Chronos Debugging Interface Schematics and Layout

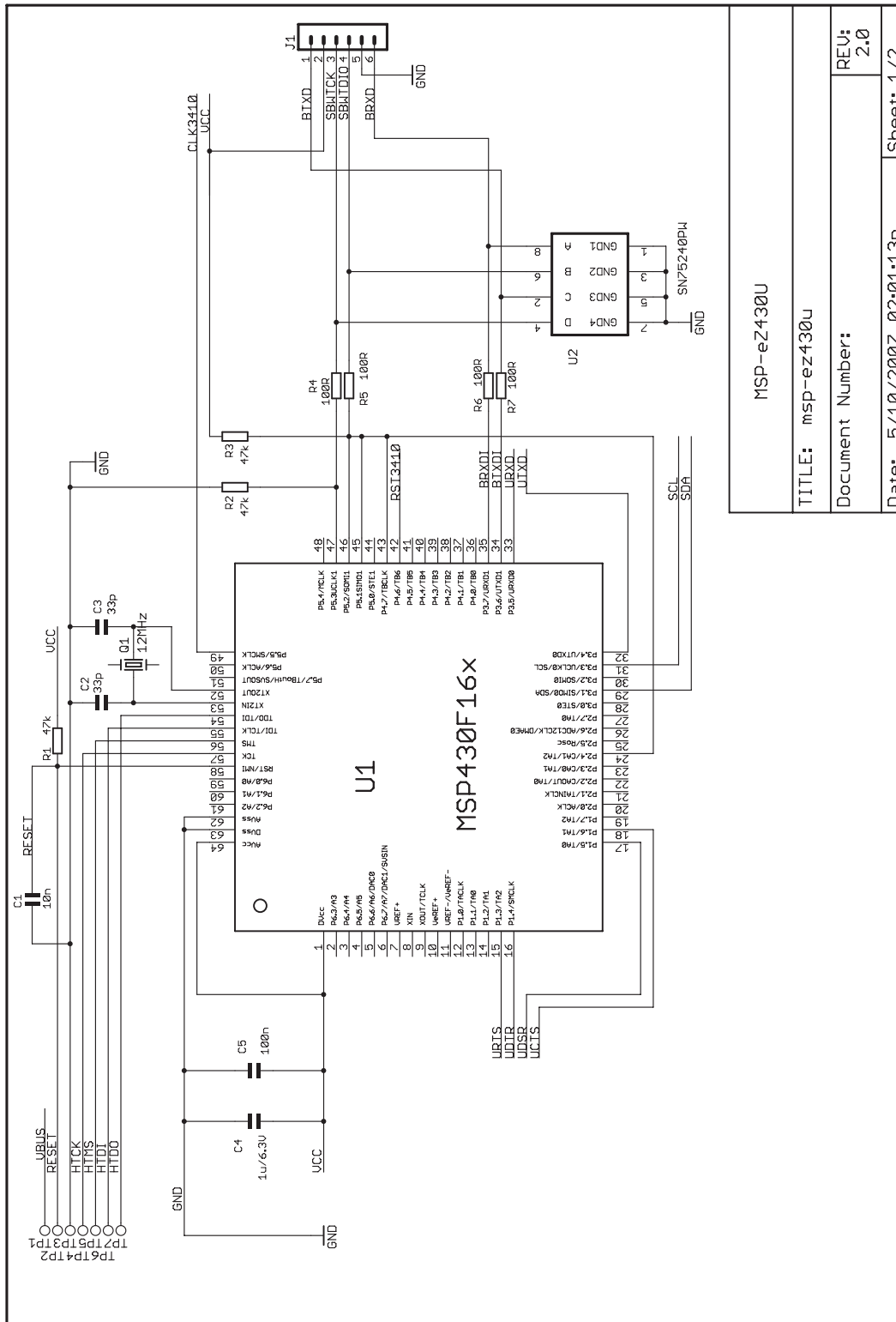
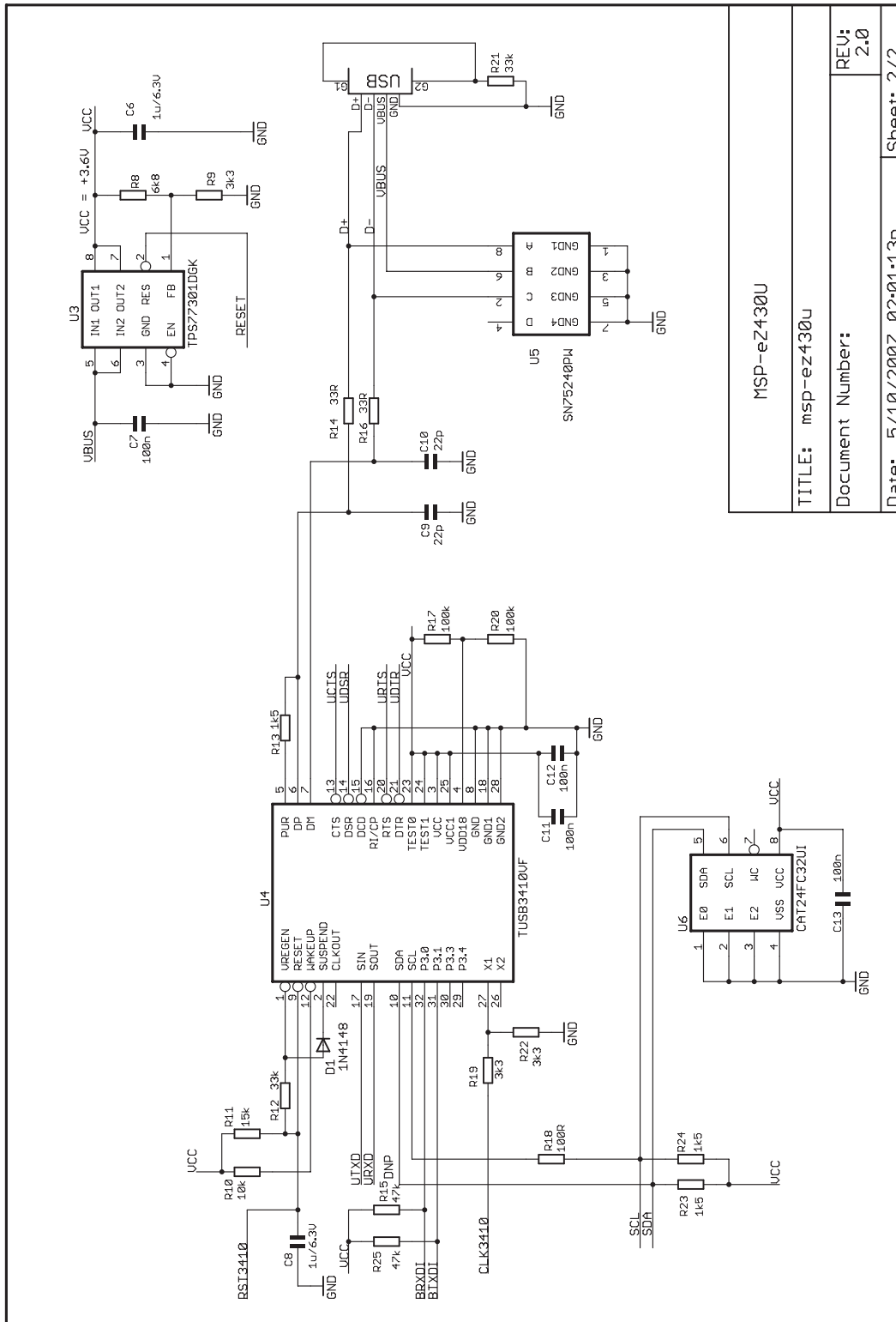


Figure 4-25. eZ430-Chronos USB Debug Interface, Schematic



MSP-eZ430U	
TITLE: msp-ez430U	REV: 2.0
Document Number:	Sheet: 2/2
Date: 5/10/2007 02:01:13p	

Figure 4-26. eZ430-Chronos USB Debug Interface, Schematic

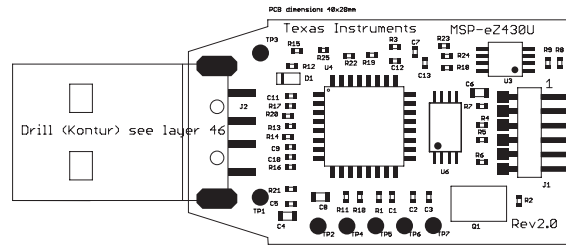


Figure 4-27. eZ430-Chronos USB Debug Interface, PCB Components on Top Layer

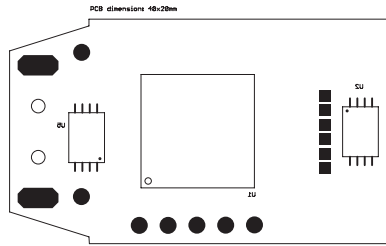


Figure 4-28. eZ430-Chronos USB Debug Interface, PCB Components on Bottom Layer

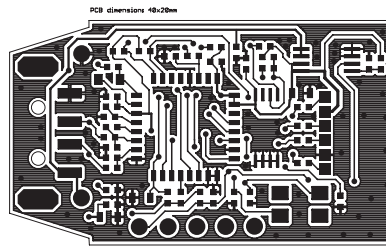


Figure 4-29. eZ430-Chronos USB Debug Interface, Layout Top Layer

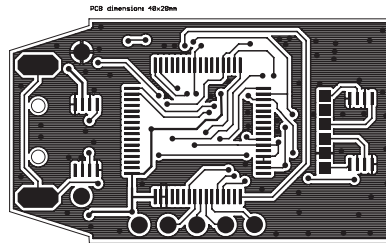


Figure 4-30. eZ430-Chronos USB Debug Interface, Layout Bottom Layer

Frequently Asked Questions

A.1 FAQs

- 1. My 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 3 seconds simultaneously unlocks or locks the buttons. The LCDs shows "oPEn" when the keylock is disabled.
- 2. Why doesn't my Chronos watch always respond when buttons are pushed?**

If buttons are pushed slowly (i.e., held down too long), button pushes are ignored.
- 3. Why doesn't my 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 Chronos waterproof?**

Yes, it is 30m 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 re-calibrated 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 re-activated 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 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 v4.1, I get the following error: error: output file "eZ430_chronos_ISM_xxx.out exceeds code size limit**
 Code Composer Studio v4.1 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 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 off of the Chronos housing after I re-assembled it.**
 The buttons of the 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 re-assemble 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 Chronos watch?**
 The 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\leZ430-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 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 Chronos kit in volume as well as a range of other products.
20. **Which version of SimpliciTI is used with Chronos?**
 The current software release used SimpliciTI 1.1.1.
21. **The LCD of my 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 Chronos Control Center PC software and clicking on "Update Chronos Watch". To start the update on the watch, press the "DOWN" button. The update is started. For details, see [Section 3.6.3](#).

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

Please make sure that the file you are trying to download does not include data outside the main flash boundaries, which are 0x8000 – 0xFFFF. This protection mechanism avoids writing of data to non-existent or restricted addresses. Please try to download one of the original example project's .txt, which are available for Windows in *C:\Program Files\Texas Instruments\ez430-Chronos\Recovery\Chronos Watch\Applications* and for Linux in */home/<user name>/Texas Instruments/ez430-Chronos/Recovery/Chronos Watch/Applications*. If the update still doesn't work, the RAM based updater may be corrupted. Please see next FAQ item.

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

Please 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, please re-install the 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 Chronos box) require a manual update as described in [Section 3.6.3](#).

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 3.6.3](#).

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

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



Figure B-2. Successful Driver Installation for Access Point

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



Figure B-3. eZ430-Chronos Access Point Detection

- 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

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

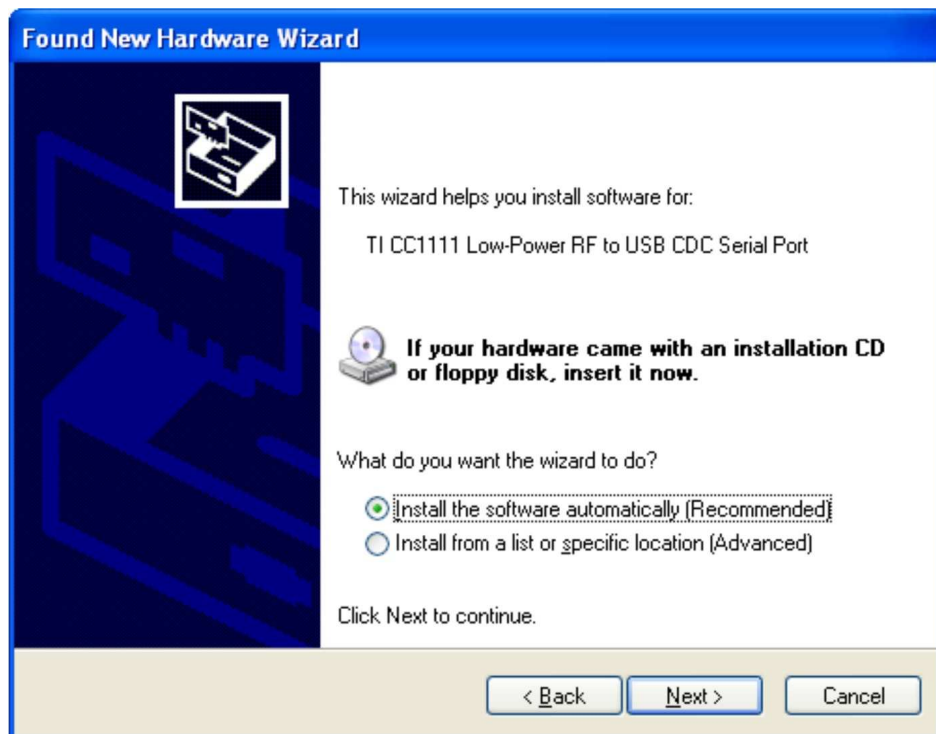


Figure B-5. Automatic Driver installation

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](#)).

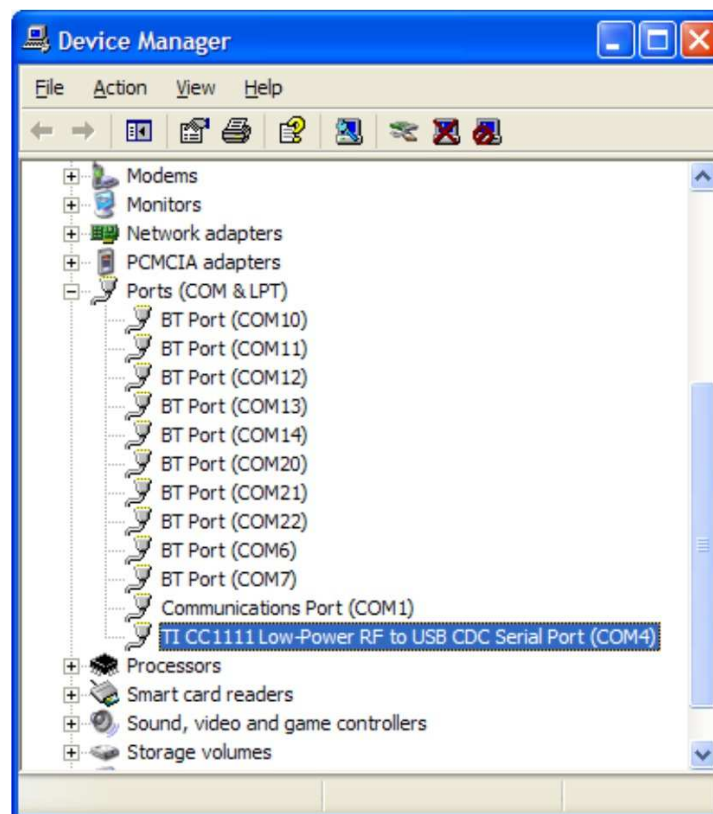


Figure B-7. eZ430-Chronos Access Point in Windows Device Manager

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

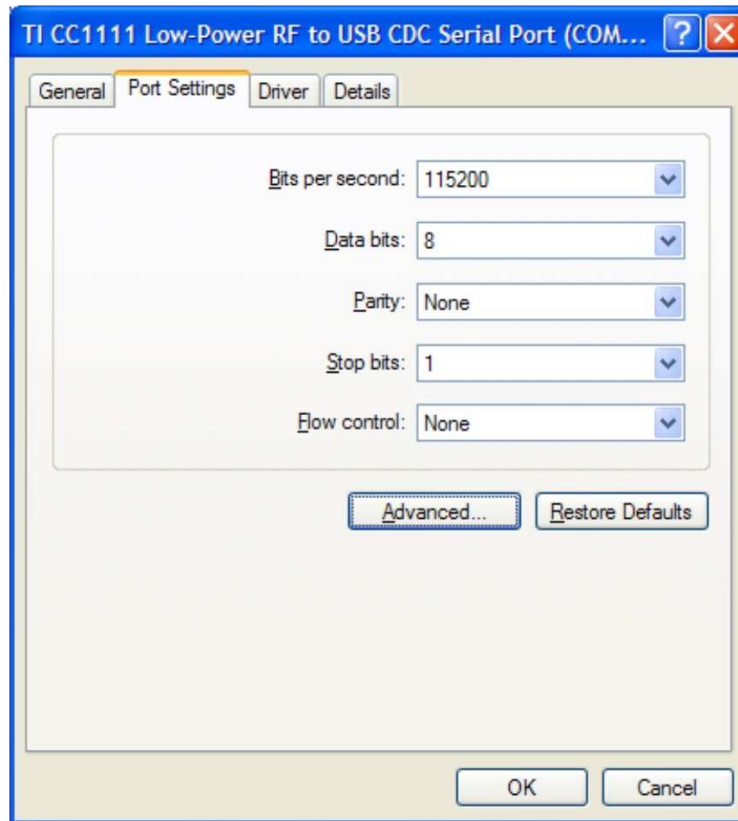


Figure B-8. CC1111 Port Settings

B.2 eZ430-RF Debug Interface

1. Install an IDE of your choice (see section xxx) IDE, 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.

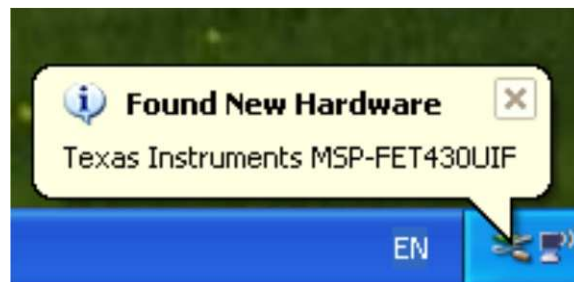


Figure B-9. eZ430-RF Windows Driver Installation

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](#)).

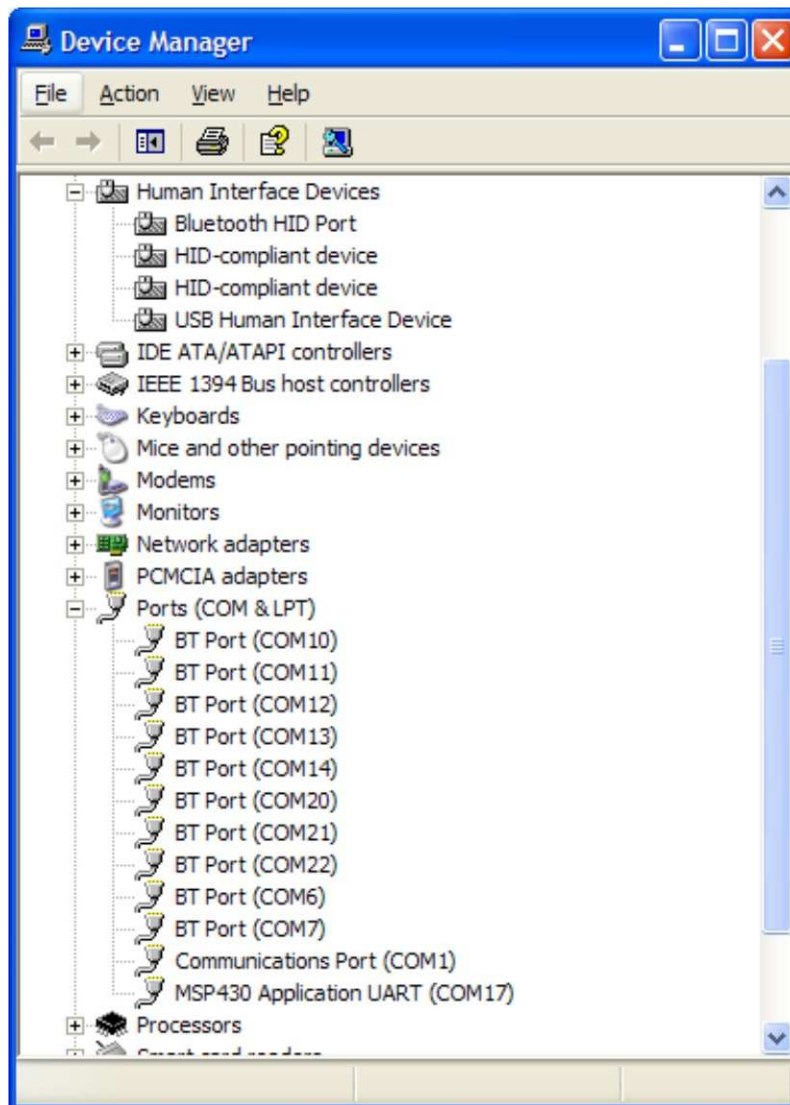


Figure B-10. eZ430-RF in Windows Device Manager as HID and COM Port Devices

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