eZ430-Chronos Wireless Watch Development Tool: Teardown & Getting Started

www.ti.com/chronoswiki
eZ430-Chronos for wireless networking applications

Complete hardware, software and support community
Simplify & inspire development with world’s first customizable tool within an intelligent sports watch

Unparalleled system integration and ultra-low power
Easily enable wireless connectivity, longer battery life, improved ergonomics

Low cost development kit at $49
Increase accessibility and reduce development cost
Chronos | Advanced Integration

CC430F6137 MCU

<1GHz RF
- 433, 868 & 915 MHz

2-Wire JTAG Access

96 segment LCD

Buzzer

3-Axis VTI Accelerometer

VTI Pressure & Altitude Sensor

Temperature Sensor

Voltage & Battery Sensor

CR2032 Battery

eZ430 Programmer

RF Access Point

Chronos Disassembly Tool
CC430 | RF + Ultra-Low Power MCU

MSP430™ Microcontroller
- Industry’s lowest power MCU
- 16-bit RISC architecture
- 20 MHz processor
- High-performance analog
- Sensor interface

CC1101 <1GHz RF Transceiver
- High sensitivity
- Low current consumption
- Excellent blocking performance
- Flexible data rate & modulation format

Intelligent Peripherals
- 100 nA comparator
- 8ch 12-bit ADC offering 200-ksp/s
- 96 segment LCD controller
- 128-bit AES security encryption/decryption coprocessor

64QFN Pin Package
- 9.1 mm x 9.1 mm area
CC430 Block Diagram
Chronos | The Software

• Free development software
  – Code Composer Studio
  – IAR Embedded Workbench
  – MSPGCC*
• Production-ready, open-source projects
• RF stacks available
  – SimpliciTI
  – BlueRobin
  – W-Mbus
  – 6LoWPAN
  – More coming…
• User generated apps and support on www.ti.com/chronoswiki
SimpliciTI

• TI proprietary low-power RF network protocol
• Low Cost:
  – < 8K FLASH
  – <1K RAM
• Flexible:
  – simple star w/ extendor
  – p2p communication
• Simple: Utilizes a very basic core API
• Low Power: Supports sleeping devices
**BM Wireless’ BlueRobin** Key Facts

- **BlueRobin**™ targets at
  - body area networks
  - long range monitoring systems

- **BlueRobin** provides
  - ultra-low power operation in TX and RX mode
  - multi-user support with patented collision avoidance
  - bi-directional and long range communication
  - remote data storage with automatic data download
  - built-in data encryption

- **BlueRobin** offers flexibility through
  - hardware independent implementation
  - small memory footprint and low resource requirements
  - support of all ISM bands (433MHz to 2.4GHz)

- **BlueRobin** key apps
  - Heart Rate, Speed, Distance, Steps, GPS, Temperature,
  - Altitude, Rotations, Weight, Blood Pressure, Blood Glucose
Chronos | Projects

- Watch functions: time, date, alarm, stopwatch
- Fitness function: running speed, distance, heart rate, calories burned
- Sensor data logging w/ wireless PC download
- PowerPoint Control
- Media Remote
- Motion-based mouse/PC game control
- Wireless App Updating
- Wireless door lock
- Virtual Theremin
- Robotics control
- **Blimp control**

More apps to come…
www.ti.com/chronoswiki
Endless possibilities | **Chronos serves as a central hub for nearby wireless sensors**
Chronos | Frequency Differences

- Available in 3 different frequencies
  - 433 MHz: Japan, India, WW
  - 868 MHz: Europe
  - 915 MHz: N. & S. America

- 868 & 915
  - Use identical watch hardware
  - Frequency is software selectable
  - 868 MHz RF Access Point has extra 0Ω R

- 433 MHz
  - Still in R&D
  - Available in June (estimated)
  - RF Range predicted to be worse than 868/915
Chronos | RF Access Point

- Based on CC1111 w/ integrated USB + <1GHz RF
- “Fixed function” to communicate with Chronos & PC
- Can be manually reprogrammed with CC Debugger
- Supports wireless updating of Chronos firmware via RF BSL
  - RF BSL not included on first production batch

Header to JTAG signals has to be manually added
RF BSL | Wireless Updating

- Wireless update of watch firmware
- Small RF Stack resides in BSL memory
- Application must include function to invoke BSL

- Pros:
  - ~10x faster than downloading code via SBW
  - No need to open enclosure

- Cons:
  - No debug capability
  - Power hog
  - Not supported out-of-the-box on early units (before 4/2010)
Chronos | Data Logger

- Chronos can be used as a data logger for:
  - Heart rate
  - Temperature
  - Altitude

- User definable intervals
  - 1 to 255 seconds

- 8kB of Flash memory reserved

- The stored data can be transferred to a PC
**PC/Chronos Communication**

- **RF Access Point open**
  - Virtual COM Port over USB
  - bps 115200
  - Data bits 8
  - Parity None
  - Stop Bits 1
  - Flow Control None

- **Control Center automatically**
  - Opens COM port
  - Transfers data
  - Decodes packets
  - Displays info

- **API available for manual data transfer**

- **Scripts available for:**
  - Python
  - Processing
  - Ruby
  - .net

- **All community developed, supported**
Chronos | Extra Hardware

- **Heart Rate Monitors**
  - BM-CS5 (800m)
  - BM-CS5SR (10m): 49€

- **Bike Sensors**
  - Speed and distance (according to BMi Q4 2010)

- **Compatible RF Development Boards**
  - AMB8423
  - EM430F6137RF900
  - CC1101EMK433
  - CC1111EMK868-915
Getting Started: What you need

• **Hardware:**
  1. eZ430-Chronos
  2. Computer: Windows / Linux

• **Software:**
  1. eZ430-Chronos Software Package: [Windows](https://www.ti.com/tool/SLAC341), [Linux](https://www.ti.com/tool/SLAC388)
  2. IDE: [IAR](https://www.iar.com) or [CCS](https://www.ti.com/tool/CCS)
  3. Firmware Update tool (adds rfBSL)

• **Documentation**
  3. [CC430F613x Datasheet](https://www.ti.com/tool/CC430F613x): Electrical specs for CC430F613x
Chronos Software Package

- All files copied to C:\Program Files\Texas Instruments\eZ430-Chronos

- What’s included:
  - Control Center
    - Control Center GUI binary
    - Data logger GUI binary
    - GUI source code
  - Documentation
    - Chronos User Guide
    - Schematics, Layout (Gerbers) & BOM
  - RF Access Point Driver
  - Binary images (Recovery)
    - Sports watch/Chronos
    - Datalogger app
    - rfBSL
    - RF Access Point
  - Software projects
    - Sports watch (CCS/IAR)
    - Datalogger (CCS/IAR)
    - RF Access Point (IAR)
Working with the Chronos Project (CCS)

• Open CCS
  – Pick any workspace
  – Close welcome screen

• Import Project
  – Project > Import existing…
  – Browse to C:\Program Files\Texas Instruments\eZ430-Chronos\Software Projects
  – Select „Copy Projects into workspace“

• Select „Active Project“
  – Right Click on project name

• Select „Active Build“
  – Select correct frequency & IDE version (core vs. full)

• Debug
Adding RFBSL to RF Access Point

- Hardware You’ll need
  - RF Access Point
  - CC Debugger

- Add connector to RF AP

- Run “Smart RF Flash Programmer”

- Load RF Access Point

- Recovery image

- Erase, Program, & Verify
Adding RF BSL to Chronos Watch

- RF BSL includes a small RF protocol stack with error recovery
- Resides within reserved BSL memory
  - Accessing via IAR/CCS is tricky
- Easiest update method
  - Use Firmware Update Tool
  - Select correct script for watch frequency
  - Automatically updates BSL + User Application
- User App needs to be modified to invoke BSL from menus
Next lab:

1. get Chronos running with the default software. Demonstrate the accelerometer data on your PC.

2. Get Chronos talking to Amber wireless module

3. Use Chronos accelerometer to control remote LEDs

4. Stretch: Implement simple template-correlation-based gesture recognition to command remote LEDs to toggle