

User Manual for new Functions

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1. Preface

This user manual describes only the new functions provided by this projects firmware for eZ430-Chronos Sports Watch.

General information about user concepts, software and watch hardware are provided by TI's document "User's Guide of eZ430-Chronos Development Tool, TI Literature Number: SLAU292A".

New functions of the top line menus:

Time adjustment menu (new submenu)

- Daily and weekly time adjustment improves watch accuracy significantly.
- Automatic adjustment for DST (Daylight saving time) available.

Altitude menu (new submenu)

- Ambient pressure display available, it is possible to toggle between altitude and ambient pressure view.
- Ambient pressure available in mBar and PSI

Tilt menu (new submenu)

- Water bubble available.

New functions of the bottom-line menus:

Date menu (new submenus)

- Days of Week display available.
- 6 languages for the Day of Week selectable.
- Second time available with an adjustable time difference to main time of 0...+23h.
- Toggles between views DAY/MONTH → Day of Week/DAY → YEAR → 2.Time → SECOND

Stopwatch menu (new submenu)

- Stopwatch configurable as Stop or LAP timer

Countdown timer menu (new menu)

- The countdown timer supports time intervals up to 19 hours, 59 minutes and 59 seconds.
- A stop and a continuous mode are available.

Agility measurement menu (new menu)

- The Agility measurement gives an indication of how often and how strong the watch has been accelerated in all directions.
- Programmable time interval and number of measurement cycles are available.

Number storage menu (new menu)

- A number storage for up to 10 4-digit numbers is available.
- A locking mechanism with a 4-digit key is available.

Random number generator menu (new menu)

- The random generator is able to generate random numbers from 0 to 9999.
- Both, the minimum and the maximum are adjustable.

SYNC menu (new submenus)

- Set some settings to preferred values
- Clear and unlock the number storage
- Restart (reset) the watch firmware
- Clock system monitoring control and reset
- Display SW Version and build date

Other new functions:

A short push of the backlight button activates the backlight for about 4 seconds.

Permanently monitoring of clock system.

Behavior of Time & Date in case of a Reset changed: Time & Date are set to their default values only if they are invalid.

➔ Important note for users of accessories like BM innovations heart rate monitor (a chest belt, but it is not included in eZ430-Chronos Sports Watch kit): These accessories use the BlueRobin wireless communication protocol from BM. This protocol is not available in this firmware. The Heart Rate Mode, Speed Mode and Calorie/Distance mode are not available.

However, almost all other wireless Chronos functions are based on TI's SimpliciTI protocol. ACC (Acceleration Mode – RF), PPT (PowerPoint Mode – RF), SYNC (Sync Mode – RF) and RFBSL (Wireless Update – RF) are available!

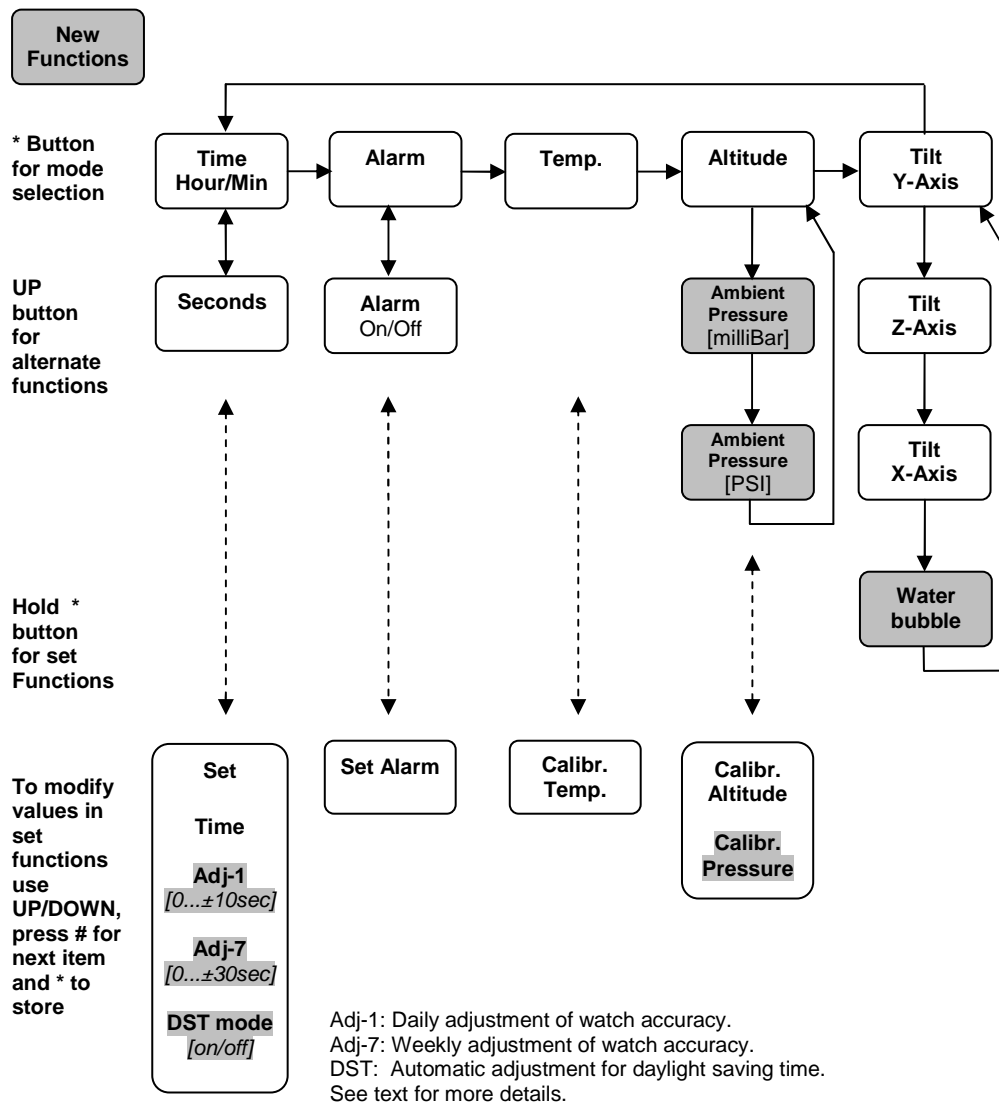


Figure 1 eZ430-Chronos Feature Overview and Menu Structure – Top modes

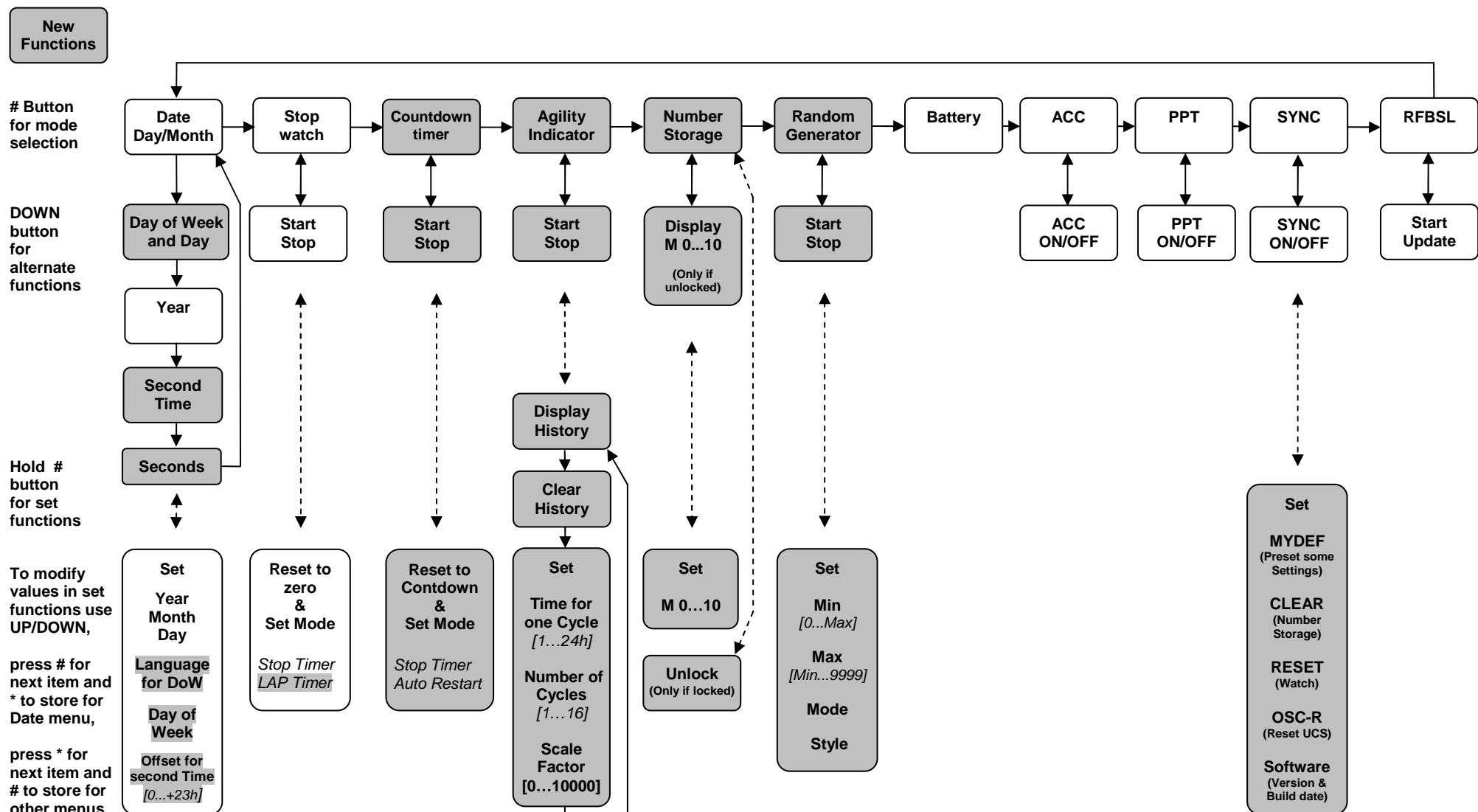


Figure 2 eZ430-Chronos Feature Overview and Menu Structure – Bottom modes

2. Time Mode

Press "*" until the time mode is active (see Figure 1).

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

Set functions: Setting the time, daily and weekly accuracy adjustment and DST (Daylight Saving Time) mode.

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 minute's adjustment
6. Set the minutes by pushing the "UP" or "DOWN" button
7. Press "#" to continue with the second's adjustment
8. Set the seconds by pushing the "UP" or "DOWN" button
9. Press "#" to continue with the daily accuracy adjustment
10. Set the seconds by pushing the "UP" or "DOWN" button, positive values are marked with a small arrow pointing up and negative values are marked with a small arrow pointing down
11. Press "#" to continue with the weekly accuracy adjustment
12. Set the seconds by pushing the "UP" or "DOWN" button, positive values are marked with a small arrow pointing up and negative values are marked with a small arrow pointing down
13. Press "#" to continue with DST (Daylight Saving Time) mode
14. Set it to "AUTO" or "NO" by pushing the "UP" or "DOWN" button
15. Press "*" to confirm your settings and go back to normal operation or "#" to start over with step 2

How does daily/weekly adjustment work?

The daily adjustment adds the ADJ-1 seconds every day at midnight to the time.

The weekly adjustment adds the ADJ-7 seconds every week at midnight from Sunday to Monday to the time. The weekly adjustment adds both, ADJ-1 and ADJ-7 seconds at the same time.

Input an appropriate amount of seconds during time adjustment procedure as described above.

The top line shows the seconds, the arrows acts as sign.

The bottom line shows the string "ADJ-1" for daily value and "ADJ-7" for weekly value.

An example:

Your watch runs to fast, i.e. 13 seconds per week.

Set ADJ-1 = -2 [sec/day] and ADJ-7 = 1 [sec/week]. It gives $7 \cdot (-2) + 1 = -13$ [sec/week].

Another possibility would be ADJ-1 = 0 [sec/day] and ADJ-7 = -13 [sec/week].

How does the automatic daylight saving time adjustment work?

The European algorithm works if 24-hour mode (metric units) is active:

+1 hour at 2 a.m. in the night from Saturday to Sunday at last weekend in March

-1 hour at 3 a.m. in the night from Saturday to Sunday at last weekend in October

The American algorithm works if 12-hour mode (AM/PM and English units) is active:

+1 hour at 2 a.m. in the night from Saturday to Sunday at second weekend in March

-1 hour at 2 a.m. in the night from Saturday to Sunday at first weekend in November

➔ **Switch this automatic off if you cannot use it!**

Defaults after reset:

12H/24H-mode: 24H / 12:00:00 / ADJ-1 = 0 / ADJ-7 = 0 / DST mode: off

3. Altimeter / Ambient pressure Mode

Press "*" until the altimeter/ambient pressure mode is active (see Figure 1).

Secondary function: Display ambient pressure in hPa (hecto Pascal; 1 hPa = 1 mBar), Display ambient pressure in PSI (pound-force per square inch; 1 hPa = 0.0145 PSI) and re-activate altimeter / ambient pressure after timeout.

Press "UP" to activate the alternative displays. To return to the altimeter mode, push the "UP" button again.

Set function: Altitude and ambient pressure 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 continue with the ambient pressure adjustment
4. Set the ambient pressure (always in mBar) by pushing the "UP" or "DOWN" button
5. Press "*" to confirm your setting.

The ambient pressure calibration does not affect the altimeter.

4. Tilt Mode

Press "*" until the tilt mode is active (see Figure 1).

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

The acceleration is shown in G (9.81m/s^2) for all three axes. After entering the tilt mode, the y-axis acceleration is shown by default, and the z-axis, x-axis or water bubble mode 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.

The water bubble mode is marked by an „o“. This mode uses the x-axis and y-axis acceleration data from the sensor. The direction of deviation from horizontal position is shown by sliding display segments, similar to a water bubble.

Press "UP" to activate the alternative displays.

5. Date Mode

Press "#" until the date mode is active (see Figure 2).

Secondary functions: Day of Week + Day / Year / Second time. Press "DOWN" to activate the alternative displays. To return to day and month, push the "DOWN" button again.

Set function: Setting the date, day of week and offset (in hours) for secondary time

1. Push the "#" button until one of the date mode displays 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 continue with the Language for Day of Week adjustment.
9. Set the Language for Day of Week by pushing the "UP" or "DOWN" button.
10. Press "#" to continue with the Day of Week adjustment.
11. Set the Day of Week by pushing the "UP" or "DOWN" button.
12. Press "#" to continue with the offset for second time adjustment.
13. Set the offset for second time (in hours) by pushing the "UP" or "DOWN" button.
14. Press "*" to confirm your settings and go back to normal operation or "#" to start over with step 3.

How does day of week + day mode work?

This display mode shows the English shortcuts for the days of week. It uses a special font. This font uses two seven-segments for some characters for a better readability.

How does second time work?

The second time gives the opportunity to display the watch's time with an adjustable offset for the hours. In other words: It is possible to display another time zone on the bottom line.

The second time could be useful for tourists. The main time display on top line shows the local time and the second time display on bottom line shows the home time zone or vice versa. The difference between both time zones must be adjusted as described above.

Examples:

1. The second time should be 6 hours ahead: Set offset to 6.
2. The second time should be 3 hours back: Set offset to 21 ($24 - 3 = 21$).

Language for Day of Week

English → German → Portuguese → Russian → Spanish → French

Defaults after reset:

01.01.2012 / Sunday / offset for second time = 0 hours / Language for Day of Week = English

6. Stopwatch Mode

Press “#” until the stopwatch mode is active (see Figure 2).

It supports 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.

The indicator for the stopwatch is the “STOPWATCH” symbol. It flashes if the stopwatch menu is currently displayed. The symbol is static on if the stopwatch menu is currently not displayed, but the stopwatch is in use.

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

Set function: Reset stopwatch and setting the stopwatch mode.

1. Hold the “#” for 3 seconds until “Mode” is shown on the top line and “Stop” or “LAP” on the bottom line. The stopwatch is set to zero.
2. Set the stopwatch mode by pushing the “UP” or “DOWN” button.
3. Press “#” to confirm your setting.

How does the “LAP” mode work?

There is only one difference to the stop-mode: After the start of the stopwatch in the LAP mode by pressing the “DOWN” button, a subsequent “DOWN” button push does not stop the stopwatch. It is still running in the background. The display shows only the frozen stop time. The next “DOWN” button push switches back to the still running stopwatch.

Default stopwatch mode after reset: “Stop”

7. Countdown Timer Mode

Press “#” until the countdown timer mode is active (see Figure 2). The predefined countdown time is shown in the display.

It supports time intervals up to 19 hours, 59 minutes and 59 seconds.

The indicator for the countdown timer is the “RECORD” symbol. It flashes if the countdown timer menu is currently displayed. The symbol is static on if the countdown timer menu is currently not displayed, but the countdown timer is in use.

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

Set function: Reset countdown timer and setting the countdown timer mode.

1. Hold the "#" for 3 seconds until the hour's flashes on the bottom LCD line. First, the countdown timer is set to predefined countdown time.
2. Set the hours by pushing the "UP" or "DOWN" button.
3. Press "*" to continue with the minute's adjustment.
4. Set the minutes by pushing the "UP" or "DOWN" button.
5. Press "*" to continue with the second's adjustment.
6. Set the seconds by pushing the "UP" or "DOWN" button.
7. Press "*" to continue with the countdown timer mode setting. "Mode" is shown on the top line and "Stop" or "Cont" on the bottom line.
8. Set the countdown timer mode by pushing the "UP" or "DOWN" button.
9. Press "#" to confirm your setting and go back to normal operation or "*" to start over with step 2.

The countdown timer does not affect the stopwatch. Both could run simultaneously.

How does the "Stop timer" mode work?

There is an acoustic alarm if the adjusted countdown time elapsed. The countdown timer stops and resets to the adjusted countdown.

How does the "Auto restart" (if "Cont" is shown) mode work?

There is an acoustic alarm if the adjusted countdown time elapsed. The countdown timer stops and resets to the adjusted countdown and starts again.

In other words, the countdown timer continues automatically after it expired. It has to stop explicitly by pressing the "DOWN" button or holding the "#" for 3 seconds. The countdown timer mode must be active (in display) to stop it!

Default countdown time after reset: 0:05:00 (5 minutes).

8. Agility Indicator Mode

This mode gives an indication of how often and how strong the watch has been accelerated in all directions. The measurement could be done over a programmable time interval of 1 to 24 hours in steps of 1 hour and over 1 to 16 cycles. The measurements of all cycles are stored in the history. A programmable scaling factor helps to handle the high range of measurement values and the restricted display capabilities of the watch display.

Press "#" until the agility indicator mode is active (see Figure 2).

The indicator for the agility measurement is the "HEART" symbol. It flashes if agility measurement menu is currently displayed. The symbol is static on if the agility measurement menu is currently not displayed, but the agility measurement is in use.

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

Set function: Display the agility measurement history, clear the history, set the time interval for a measurement cycle, set the number of measurement cycles and set the scale factor.

1. Hold the "#" for 3 seconds until the display shows "H -1" on the top line. The bottom line shows the measurement value of the last finished measurement cycle.
2. Press "*" repeatedly to continue with the history of measured values. The display shows "H -2" , "H -3" ... until "H -16" displayed on the top line
3. Press "*" again to continue with the clear menu. The display shows "CLEAR" on the bottom line and "OFF" on the top line.
4. Switch between "ON" and "OFF" by pushing the "UP" or "DOWN" button. If "ON" is displayed, the clear command will be executed immediately after subsequent "*" or "#" push.
5. Press "*" to continue with the time interval adjustment. The display shows "SET" on the top line and "T 1" on the bottom line.
6. Set the time interval by pushing the "UP" or "DOWN" button.

7. Press "*" to continue with the number of cycles adjustment. The display shows "SET" on the top line and "C 1" on the bottom line.
8. Set the number of cycles by pushing the "UP" or "DOWN" button.
9. Press "*" to continue with the scale factor setting. The display shows "SCAL" on the top line and the factor on the bottom line.
10. Set the scale factor by pushing the "UP" or "DOWN" button. The new scale factor will be in use immediately.
11. Press "#" to confirm your settings and go back to normal operation or "*" to start over with step 2.

How does the agility indicator work?

The measurement uses the acceleration sensor. The acceleration is measured every second for all three axes.

The indicator is the sum of the differences of consecutive measurements. Therefore, the indicator accumulates the difference of the acceleration values of all three axes over the programmed time and stores the value for every cycle.

In general, longer measurement intervals produce higher values.

→ Keep in mind that an active acceleration sensor draws about 15 times more current than the watch with a deactivated sensor! A measurement over 24 hours and 16 cycles' uses up about one half of a new and full charged battery!

How does the history work?

The history shows the measured agility indicator values of finished measurement cycles. Start/stop measurement and a change of time interval, number of cycles and scaling factor do not affect the stored values in the history. In fact, the history is a first-in-first-out buffer.

If the history displayed, the value marked with "H -1" is the lastly stored value.

The history could be displayed also during a running measurement. This stops the measurement for the short time the history is displayed, but continues automatically and immediately after leaving it.

How does the scaling factor work?

The scaling factor does not affect the stored values in the history. It affects only the displayed values (history and currently running measurement). This means, it is possible to decrease / increase the amount of needed digits. The watch display allows numbers less than 20000. If a number greater than 19999 shall be displayed, a flashing "19999" will be displayed. A higher scaling factor will solve this problem.

→ It is possible but not recommended to change the time interval and/or the number of cycles during a running measurement!

A time interval change during a running measurement affects the current cycle: It resets the current indicator value and starts the measurement with the new time interval.

A change of number of cycles during a running measurement resets the cycle counter to this new setting.

This does not affect the history, but keep in mind that the history could contain measurements with different time intervals!

Some examples:

12 hours should be monitored on some days. You are interested in trend, one value per hour.

Clear the history, set the time interval to 1 [hour] and the number of cycles to 12. The default scale factor 10 is a good starting point, you can adapt it later (during or after the measurement). Start the measurement. It stops automatically after the 12th cycle. Read out the history. Change the scale factor if the range of the values is not suitable and read out the history again. Clear the history and start the measurement at the next day.

You are interested in supervising of the movement of something over a long time.

First, check the battery. Use a new battery if you are not sure if it has enough energy for this long measurement! Clear the history, set the time interval to 24 [hours] and the number of cycles to the maximum of 16. Fix the watch in an appropriate way and start the measurement. It stops automatically after 16 days. Read out the history. Change the scale factor if the range of the values is not suitable and read out the history again.

Defaults after reset:

History memories = 0 / Time interval = 1 hour / Number of cycles = 1 / Scale factor = 10

9. Number Storage Mode

11 memories for four digit numbers are available. The first one (M 0) is used for the key of the locking mechanism.

Press "#" until the number storage mode is active (see Figure 2).

The indicator for the number storage mode is the "TOTAL" symbol. The symbol is static on if the number storage menu is currently displayed.

Secondary function: Press "DOWN" to show all memories in storage successive. First, the memory number will be displayed for short time on the bottom line. The display changed to the memory content (the 4-digit number). If the number storage is locked, it must be temporary unlocked before an access to the storage is possible!

Unlock/display function (Storage locked):

1. Press "#" until the number storage mode is active (see Figure 2). The display shows "M 0" for a short time and than "----"
2. Hold the "#" for 3 seconds until "----" changes to "0000"
3. Set the right key by pushing the "UP" or "DOWN" button.
4. Press "#" to confirm your setting. The number storage is temporary unlocked now. Do not change the menu. A menu change locks the number storage immediately!
5. Push "DOWN" button until the right memory is in focus.

Set function (Storage unlocked): Set the 4-digit number in memory.

1. Push "DOWN" button until the wanted memory is in focus.
2. Hold the "#" for 3 seconds until the stored number flashes. The memory number will be shown in the top line (i.e. "M 1").
3. Set the new 4-digit number in current memory by pushing the "UP" or "DOWN" button.
4. Press "#" to confirm your setting.

Unlock/set function (Storage locked): The display shows "M 0" for a short time and than "----"

1. Hold the "#" for 3 seconds until "----" changes to "0000"
2. Set the right key by pushing the "UP" or "DOWN" button.
3. Press "#" to confirm your setting. The number storage is temporary unlocked now. Do not change the menu. A menu change locks the number storage immediately!
4. Push "DOWN" button until the right memory is in focus.
5. Hold the "#" for 3 seconds until the stored number flashes.
6. Set the new number in current memory by pushing the "UP" or "DOWN" button.
7. Press "#" to confirm your setting. Go to 2. if more memories shall be changed.
8. Press "#" to change the menu. The number storage is locked now.

How does the number storage work?

Up to 11 4-digit-numbers could be stored in the watch's µP-RAM. It is accessible if it is always or temporary unlocked.

➔ **Keep in mind that there is no encryption! Everybody who has access to your watch and has a little bit know how in disassembling the watch and MSP430 debugging can read out the whole storage including the key also if it is locked!**

How does the locking mechanism work?

Memory 0 works as key. If Memory 0 is set to "0000", the whole storage is always unlocked.

Set memory 0 to another number, "----" will be displayed until the right key was set. The storage is than temporary unlocked. A menu change locks it immediately!

Defaults after reset:

Unlocked / M 0 = "0000" / M 1 = "0001" / ... / M 10 = "0010"

10. Random Generator Mode

Press "#" until the random generator mode is active (see Figure 2).

The indicator for the random generator mode is the "AVG" symbol. The symbol is static on if the number storage menu is currently displayed.

The random generator is able to generate random numbers from 0 to 9999. Both, the minimum and the maximum are adjustable. A continuous mode generates a new number every second. Otherwise, every push to the "DOWN" button generates one new number.

The normal display style shows the generated numbers. The alternative style shows five digit numbers, where only the last digit changes. First, the digits shift left.

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

Set function: Reset countdown timer and setting the countdown timer mode.

1. Hold the "#" for 3 seconds until "HI" is shown on the top LCD line.
2. Set the maximum number by pushing the "UP" or "DOWN" button.
3. Press "*" to continue with the minimum number adjustment. "LO" is shown on the top LCD line.
4. Set the minimum number by pushing the "UP" or "DOWN" button.
5. Press "*" to continue with the mode adjustment. "MODE" is shown on the top LCD line.
6. Set the mode by pushing the "UP" or "DOWN" button.
7. Press "*" to continue with the style adjustment. "STYL" is shown on the top LCD line.
8. Set the style 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.

How does the minimum/maximum setting work?

The maximum random number is adjustable between minimum+1...9999.

The minimum random number is adjustable between 0...maximum-1.

The random generator creates numbers between minimum and maximum.

How do the modes work?

The mode "CONT" means the random generator generates new numbers every second,

The mode "ONCE" means the random generator generates one new number after "DOWN" button pressed.

How do the modes work?

The style "ALL-" means the random generator generates 1...4 digit numbers in the range of minimum and maximum.

The style "ONE-" means the random generator generates five digit numbers. Only the last digit is new, all other digits shifted left before.

An example:

Configuration: MAX=6, MIN=1, Mode="ONCE" and Style="ALL-".

The watch generates numbers 1...6 for a game of dice.

Defaults after reset:

MAX = 9999, MIN = 0, Mode = "CONT" and Style = "ALL-".

The random generator uses pressure and temperature sensor values for initialization.

11. Sync Mode

Press "#" until "SYNC" is shown (see Figure 2).

Secondary function: Start/stop link for Sync Mode. Pushing "DOWN" starts/stops the pairing process or stop the link.

Set function: Some helpful things.

1. Hold the "#" for 3 seconds until the display shows "MYDEF" on the bottom LCD line.
2. Set "NO" or "YES" on the top line by pushing the "UP" or "DOWN" button.
3. Press "*" to confirm "MYDEF" setting and continue with the "CLEAR" function.
4. Set "NO" or "YES" on the top line by pushing the "UP" or "DOWN" button.
5. Press "*" to confirm "CLEAR" setting and continue with the "RESET" function.
6. Set "NO" or "YES" on the top line by pushing the "UP" or "DOWN" button.
7. Press "*" to confirm "RESET" setting and – only in case of "NO" - continue with "OSC-R" function.
8. Set "NO", "YES", "AUTO" or "MAN" on the top line by pushing the "UP" or "DOWN" button.
9. Press "*" to confirm "OSC-R" setting and continue with the "SW" (Software version) function.
10. Change the display of version and build date on the top line by pushing the "UP" or "DOWN" button.
11. Press "#" to leave the set function or "#" to start over with step 2. (Not possible after "RESET" and "YES"!))

How does MYDEF work?

Sets some settings to the authors preferred values:

Daily accuracy adjustment (Adj-1)	-2 [sec]
Weekly accuracy adjustment (Adj-7)	-3 [sec]
Automatic adjustment for daylight saving time	on
Ambient pressure offset calibration	-2 [hPa]
Altitude offset calibration	30 [m]
Temperature offset calibration	4 [°C]
Countdown timer	6:30 [min]
OSC-R	AUTO

How does CLEAR work?

Clears the number storage by resetting all memories to its default values and unlock it by setting key memory to "0000".

This is useful in case of locked number storage and forgotten key.

Choices are: NO → YES

How does RESET work?

Restarts and resets the watch. It is like a reset and new initialization of everything after software download.

Choices are: NO → YES

How does OSC-R work?

The firmware checks the clock system of the watch once per minute. If a clock system failure occurred, the "MAX" symbol appears in the display. An ESD event could be the root cause for such a failure and the effect could be a suddenly running fast or slow watch.

This submenu provides some reset capability for the Unified Clock System (UCS).

Choices are: NO → YES → AUTO → MAN

NO	Do nothing
YES	Reset UCS and clear "MAX" symbol now (once)
AUTO	Reset UCS immediately after an oscillator fail interrupt occurred. The "MAX" symbol will be displayed for approximately 12 hours and cleared automatically
MAN	Turn AUTO back to manual reset

How does the display of software version and build date work?

First, it displays the currently installed software version on the top line, followed by the year of the build, followed by the month and day of the build. The bottom line shows "SW".

There are no choices.

Defaults after reset: "NO" for all.

12. Backlight

A short push of the light button activates the backlight for about 4 seconds.