

MicroSet Watch Timer

Table of Contents

Learning to Use MicroSet	2
Features	2
Quick Start	4
Measure beat error	4
Measure the rate	4
Using MicroSet	7
Watch sensors	8
The Beat Error Mode	9
The Time Mode	12
Select the beat count	12
Read the results	12
Beep on completion	13
Blanking window	13
Time Mode Options	14
Show error per day	14
Running Average	15
Speaker On/Off	16
Data Capture	16
Dumping captured data	18
Paper tape output	19
The Accutron Mode	22
The Tick Mode.....	23
Balance Wheel Amplitude	24
The Computer interface	25
Configuration	26
Beep On/Off	26
Time Mode beat count	26
Blanking Window size	26
Time Mode display format	27
Oscillator calibration	27
Technical Functions.....	28
Technical Notes.....	29
Accessories	30
Hardware Options	30
Sample paper tape plots	31
Summary of operations	32

Learning to Use the MicroSet Timer

How this booklet is organized

The Quick Start section will provide very simplified step-by-step instructions for the basic operations of the MicroSet Watch Timer to help you get started.

After this, a description of each function with more detail about some of the background issues will be presented. We strongly recommend that you read this section, at least a little at a time, to understand the full features of the timer.

Following this a Technical Reference section will explain some of the fine points to consider if you're interested.

A short summary of each command will be found inside the back cover. A flow chart of operations will be found on the back cover.

If you have a question about some aspect of MicroSet, first look to the Table of Contents. You should also feel free to call or email us at Mumford Micro Systems to ask questions about issues that are not clear to you.

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Features

The MicroSet Watch Timer incorporates many unique features. These include:

- MicroSet is a small, portable, battery-operated unit that takes up little room on the workbench and can be easily taken in the field.
- It has a resolution of one part per million which means an accuracy of one second per week. A temperature compensated timebase (TCXO) is available as an option.
- It will display watch rate as "Beats Per Hour", "Seconds Per Beat", or seconds of error per day and is not limited to a programmed set of train times.
- The most common watch rates are automatically recognized.
- A special Running Average feature will display the total accumulated rate of a watch for as long as you let it run. This produces rate readings that are remarkably stable and much more accurate.
- A "Blanking Window" feature allows MicroSet to ignore sounds that occur at intervals other than the expected beat time. This greatly reduces false readings.
- The Beat Error Mode displays beat error to a tenth of a millisecond..
- The Accutron Mode will measure the rate of tuning fork watches as frequency of oscillation or error per day (optional sensor required).
- MicroSet will produce paper tape charts of watch performance when used with an inexpensive label printer (printer is optional).
- An optional interface to personal computers is available for more sophisticated analysis of watch performance, including balance wheel amplitude. This allows you to see how a watch rate varies over time, and to evaluate trends in these fluctuations that can help you diagnose problems and understand erratic behavior. The software will also simulate a traditional paper tape printer on the computer screen.
- An optional Balance Wheel Amplitude modification can be added that displays an oscillogram of each tick on the computer screen and calculates the balance wheel amplitude much more accurately.
- A variety of optional sensors are available for clocks and watches.

- An optional memory module can be added to capture watch data “in the field” for later analysis on a personal computer.
- Optional temperature and barometric sensors allow you to analyze compensation in watches.

Quick Start

For people who want to get started, and don't want to bother with explanations or background, we will start with a simple description of how to use MicroSet.

First, measure the beat error

The **Beat Error Mode** is used to get the watch adjusted so both halves of the beat are of equal duration.

Plug your watch sensor into the jack labeled "Sensor In" at the top end of the timer.

If you have the clip-on sensor, clip the alligator clip onto the winding stem or bow of the watch. Note: this sensor is not ideal for watches. Better results will be obtained with one of the other watch sensors.

If you have the Simple Watch Sensor, set your watch on top of the brass tube.

If you have the Clamping Watch Sensor, mount the watch between the sliding arm and the metal tube.

Turn MicroSet on with the LEVEL control. The LCD screen will say:

MicroSet Watch Timer

Set the Level Control to the 9 o'clock position.

Press the MODE button once. The screen says "**Beat Error...**"

If the LED on MicroSet is not blinking, turn the Level control up until the LED blinks once on each beat.

Press the BEGIN button.

The LED should now be blinking with each beat.

The LCD screen should now display the beat error of the watch. The readings should be consistent, but they may not be identical every time. For example, it might say "**Error: 8.5**". This means the beat error was 8.5 milliseconds.

If the beat error varies wildly, the Level control may not be set to the optimum level. Slowly turn the Level control up to find a setting where the beat error readings are the most stable.

It's beyond the scope of these instructions to tell you how to adjust the beat error in the watch. MicroSet's job is just to measure it.



Measure the rate

Once you have measured the beat error and set the Level control, use the **Time Mode** to get see what rate the watch is running at. MicroSet will measure a number of beats, then tell you the average rate for each beat.

Assuming MicroSet is still measuring beat error, press the MODE button once. The LCD screen should say:

Beat Error ...

Press the MODE button a second time. The LCD screen should say something similar to:

Time 10...

The LEVEL control should already be correctly adjusted from the Beat Error mode.

You can now choose how many beats of the watch to average before you get an

answer. The default setting is 10 beats. To change this, press the PLUS or MINUS buttons, or hold them down, until the number of beats you want to average is shown on the LCD screen. A value of “10” will get you a quick answer. The best number to use is twice the number of teeth on the escape wheel.

The LCD screen now says “**Time 10...**” (or the number you set)

Press the BEGIN button.

The LCD screen says “**Rate:**” and the LED blinks each time the watch ticks. MicroSet will measure the watch for the number of beats you specified. At the end of this time, MicroSet will give you the average rate of the watch. For example, it might say “**Rate: 18001.10**”. This means the average rate was 18010.10 Beats Per Hour. It might also say something like “**Rate: .200010**”. This means the average rate was .200010 Seconds Per Beat. You can configure MicroSet to display answers in either Beats Per Hour or Seconds Per Beat. Refer to the section titled “**Configuration - Display mode**” for more details on these two choices.

You can also set MicroSet to display how fast or slow the watch is in seconds per day. To do this, press the BEGIN button while MicroSet is measuring the rate.

The LCD screen will say:

Show error/day?

To say “Yes” (you want to see error per day) press the PLUS key.

MicroSet will now show you what it thinks the “Target Rate” is for this watch. In other words, MicroSet will guess what the correct rate is supposed to be. You must know what the correct rate for this watch is. If MicroSet has guessed correctly, press the BEGIN key again.

If MicroSet did not guess correctly, you can manually set the correct “Target” rate.

To do this, press the MINUS key. MicroSet will now display the last reading that it made on the watch. Use the PLUS and MINUS keys to adjust the proposed value until it is the correct rate for this watch. Then press BEGIN.

MicroSet now measures the rate of the watch and shows you how many seconds per day it is fast or slow.

Blanking Window

MicroSet uses an important technique to reduce interference and make more accurate readings. This is called the “Blanking Window”. It causes MicroSet to stop listening to the watch for a short while after each tick. By not listening until the next tick is due, MicroSet can ignore noise that’s not a real tick. But if MicroSet waits too long, it can miss a real tick. So the Blanking Window should be set to a correct value for the watch you’re using. If you’re measuring a fast beat watch (28,800 or 36,000 BPH) and MicroSet reads the rate as near 14,400 or 18,000 BPH, the Blanking Window is too long. Refer to the section titled “**Configuration - Blanking Window**” for more details on setting the Blanking Window.

Running Average

There is a very useful feature built into MicroSet. It will keep a running average of all readings. This reduces the fluctuation between individual readings and gives you a more accurate average rate for the watch. To turn on the running average display, press the BEGIN button while MicroSet is measuring the rate. The LCD screen will say:

Show error/day?

We don’t care about this now, so press BEGIN again. The LCD screen will say:

Average: Off

To turn on the Average function, press the PLUS key. The LCD screen will say:

Average: On

Press MODE to begin measuring the watch again.

Now the watch rate will be displayed as the accumulated average. The number at the

left edge of the display indicates how many readings have been incorporated in the current average. The rate readings will be much more stable because small variations will be a small fraction of the total.

Using MicroSet

The following instructions document the operations of the MicroSet timer in greater detail. We strongly encourage you to read these descriptions to learn the details of each function.

The keypad

In general, you use the MODE button to select the various functions of MicroSet. If you press the MODE button over and over, MicroSet will cycle through the functions that are available in your timer. If you go past the function you want, keep pressing MODE and you'll come back to it.

When the mode you want is displayed on the LCD screen, press the BEGIN button to enter that mode. After you enter a mode you can usually press the MODE button again to get out of it.

The PLUS and MINUS keys are used to enter numbers and make other choices. One press will advance the count by one. If you hold down the PLUS or MINUS buttons they will "repeat" after a short while and make entries very quickly. In places where there are "Yes/No" questions, use PLUS for "Yes" and MINUS for "No".

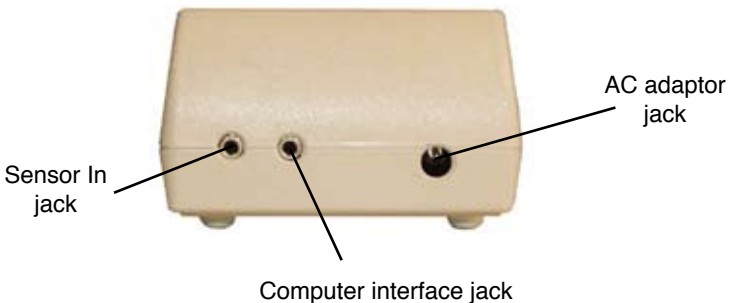
A flow chart of the MicroSet functions can be found on the back cover of this instruction book.

Power source

MicroSet will operate on a 9 volt battery or an AC wall adaptor. The battery is contained inside a door on the bottom of the unit. The AC adaptor plugs into a jack on the top end. AC operation is recommended when you have easy access to it. You can leave the battery in when the unit is plugged in to the AC adaptor and, if the AC goes off, MicroSet will keep running on the battery. If you lose your AC adaptor you can use any one that provides 7 to 15 volts DC at 1000 milliamps. The plug is a 2.1 mm coaxial barrel plug, with center positive polarity.

Turning it on

The round knob in the center of the keypad is the power switch and sensitivity control. Turn it clockwise to turn it on. MicroSet should beep twice to indicate it is waking up. It will then display "**MicroSet Watch Timer**" on the LCD screen. If this does not happen as expected (or any time you want to re-initialize MicroSet) press the red RESET button.



Watch sensors

There are several different sensors you could use with the MicroSet Watch Timer. The acoustic sensor that's included with MicroSet clock timers will attach to a watch with an alligator clip. This sensor may work on pocket watches (clip to the bow), but it's not the best choice for watches. It's not as sensitive as the other watch sensors, and it might scratch the watch.

The "Simple Watch Sensor" we offer is more sensitive than the clip-on. It's a small box with a brass tube sticking out of the top. Set the watch on top of this tube. This sensor is able to hear the component sounds of a tick for the Tick Mode or Balance Wheel Amplitude measurements. It's very modestly priced and is an economical watch sensor.



Simple Watch Sensor



Clamping Watch Sensor

The "Clamping Watch Sensor" is the best watch sensor we make. Its spring-loaded arm will hold the watch in place against the sensor insuring good contact for tick transmission. Also, it has six flat sides so you can take measurements of the watch in different positions. This sensor is the best choice for serious watchmakers.

The watch sensor made by Witschi in Switzerland is very good, and has the advantage that you can rotate the watch to various positions without picking it up. It has the

disadvantage of being very expensive. If you wish to use the Witschi watch holder we can probably get one for you and provide an interface to adapt it to MicroSet. Contact Mumford Micro for more information.

You may have a watch sensor from an earlier watch timer, like Vibrograph or Tick-O-Print. These sensors cannot be used with MicroSet. However, we may be able to update your old sensor with a new cable and sensing element to be compatible with MicroSet. Contact Mumford Micro for more information.

The Beat Error Mode

The first mode in MicroSet is the Beat Error Mode. It will measure, in milliseconds, the difference between the even and odd beats of a watch. If the watch were perfectly in beat, the beat error would be 0.0 milliseconds.

Plug your watch sensor into the jack labeled “Sensor In” at the top end of the timer. If you have the clip-on sensor, clip the alligator clip onto the winding stem or bow of the watch. If you have the Simple Watch Sensor, set your watch on top of the brass tube. If you have the Clamping Watch Sensor, mount the watch between the sliding arm and the metal tube.

Turn MicroSet on with the LEVEL control. The LCD screen will say:

MicroSet Watch Timer

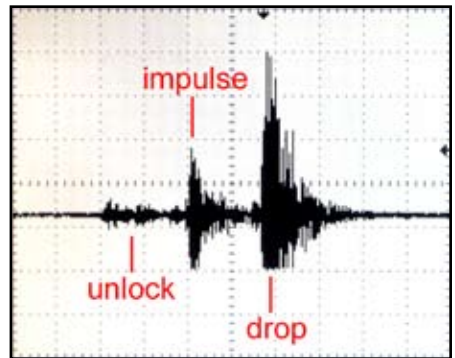
Set the Level Control to the 9 o'clock position. Press the MODE button once. The screen says

Beat Error...

If the LED on MicroSet is not blinking, turn the Level control up until the LED blinks once on each beat. Then press the BEGIN button. The LED should now blink twice and then pause, twice and pause, etc.

The LCD screen should now display the beat error of the watch. The readings should be consistent, but they may not be identical every time. If the beat error varies wildly, the Level control may not be set to the optimum level. Slowly turn the Level control up to find a setting where the beat error readings are the most stable.

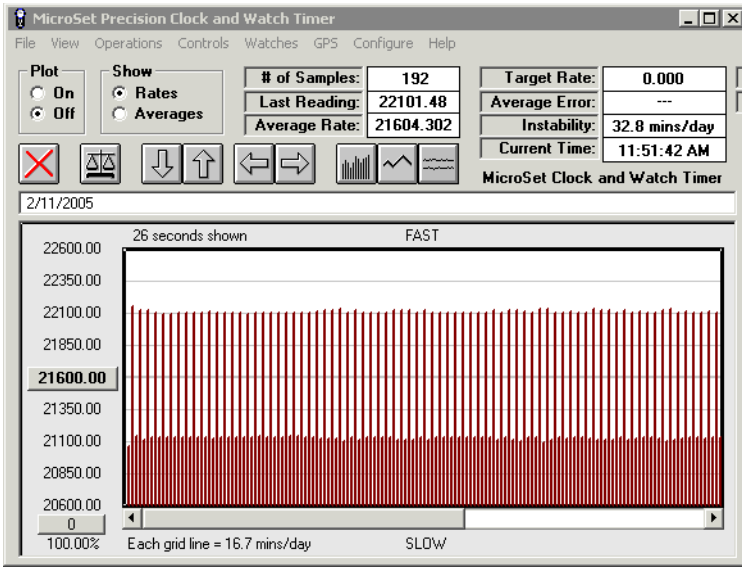
The Beat Error Mode is the best way to set the Level control to the optimum position. Getting the Level control set correctly is critical to getting accurate readings. The graph here shows what a watch tick looks like on an oscilloscope. The tick is made up of several component sounds. To get accurate readings with a watch timer, it must trigger on the same component of the watch tick on every beat. If it doesn't, the readings will jump around as the timer measures different intervals on different beats.



A watch tick

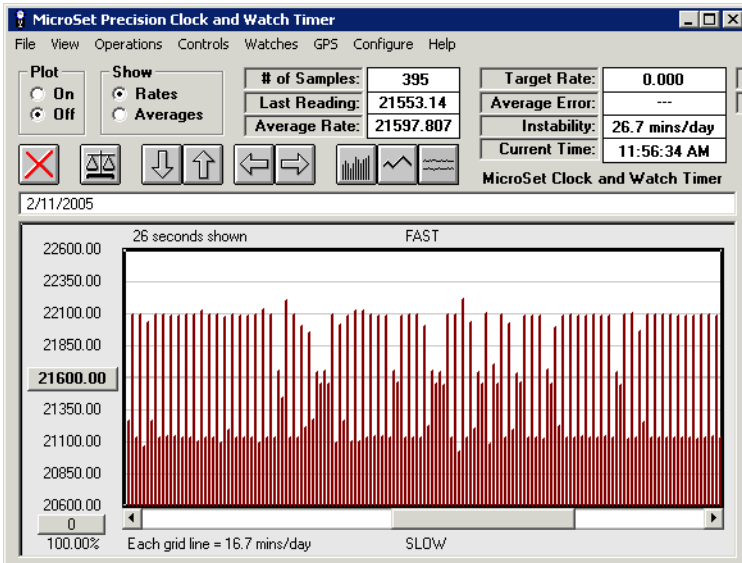
Another way to get the Level control set properly is to use the MicroSet Windows Interface Software. This computer program is a big asset in watch timing. Among other things, it allows you to see changes in rate over time, and evaluate what those changes mean. If you configure MicroSet to measure every single beat of a watch, the numbers change too quickly on the built-in LCD screen to make sense of them. But if these readings are plotted on a computer screen, you can quickly see when the readings are measuring each beat accurately. Accurate readings will alternate between a tall one and a short one. The differences will be very consistent.

The graph below shows a watch that's measuring accurately. Notice how each reading alternates consistently. This setup will produce accurate readings on the MicroSet LCD screen.



The Level control is set correctly

The next graph shows a watch with the Level control set too low. The readings are irregular because some beats are measured at different parts of the tick sound. This setup will produce jumpy, inaccurate readings in MicroSet.



The Level control is set too low

Even when the Level control is set correctly the Beat Error value may not be the same every time. There will often be some variation. But the variation should be small if the Level control is set properly. Of course flaws in the watch will also produce erratic beat

error readings. And the beat error will change if the watch is measured in different positions.

To terminate the Beat Error Mode you can hold down the MODE button or press the RESET button.

The Time Mode

The second mode in the MicroSet Watch Timer is the Time Mode. It's used to measure the rate of the watch. Press the MODE button until the LCD screen says:

Time 10...

This means MicroSet is in the mode to measure beat times, and is set to measure 10 beats.

We will assume your watch is still mounted in the sensor after the Beat Error Mode. If you have not yet measured the beat error of the watch, do that first because the Beat Error Mode is used to properly set the Level control.

Select the beat count

You can set the number of beats MicroSet will measure before giving you the rate. Press the PLUS button to increase the beat count. Press the MINUS button to decrease the beat count. The beat count is displayed on the LCD screen. For example, when set to measure 20 beats, the display will show:

Time 20...

If you hold the PLUS or MINUS buttons down continuously, the beat count will increase or decrease rapidly.

If you measure a small number of beats you'll get a reading more quickly. But you'll get more accurate readings by measuring more beats. The ideal number of beats to measure is twice the number of teeth on the escape wheel. You may prefer to read fewer beats at first to get quick answers, and more beats later to get more accurate answers.

But you should always read an even number of beats. If you were to "Time" 11 beats, or 21, you would incorporate the beat error into the reading and get erratic results. The one possible exception to this rule is when you might want to read just one beat (Time: 1), to display beat error on the computer screen.

Reading the results

When you have the Time Mode configured with the beat count you want to use, press the BEGIN button to start measuring the watch. MicroSet will say:

Rate:

as it measures the first period. The beat LED should blink and, after the selected number of beats have occurred, MicroSet will divide the total amount of time that has elapsed by the number of beats you selected and display the average length of each beat in one of two possible formats: Beats Per Hour or Seconds Per Beat. The format shown depends on how your timer is presently configured. For example, you might see **one** (not both) of the following displays:

Rate: .200015

Rate: 18010.34

The first line is the average beat time displayed in Seconds Per Beat. The second line is the rate of the watch displayed in Beats Per Hour. You can select which format MicroSet will use. See the "**Configuration - Display mode**" section in these instructions to change the current setting and for an explanation of the differences.

You can also display rates as seconds of error per day. This feature is explained under "**Time Mode Options**".

To restart the Time Mode you can press the MODE button, or press the RESET button to reset the timer.

Beep on completion

If the total period being measured is longer than about 10 seconds, you can instruct MicroSet to produce an audible beep whenever a reading is complete. This way the display doesn't need to be watched constantly to see when a new reading is ready. See the "**Configuration - Beep tone**" section in these instructions to turn the beep on or off.

Blanking Window

MicroSet will ignore any sounds that occur at a time that is outside a "window" of when the correct beat is likely to occur. This reduces false triggering on noisy watches. It can also prevent a false reading if you drop a screwdriver on the table or the sensor cable gets bumped. The Blanking Window can greatly reduce these sources of inaccurate readings and is an important feature that you should become familiar with.

The Blanking Window has a default value that's specified in the Configuration Mode. The setting of the Blanking Window should be matched to the watch you're working on. If the window is too long, MicroSet will not be able to measure fast beat watches because it will ignore every other beat. If it's shorter than it needs to be, MicroSet will be more susceptible to noise.

For measuring watches with a beat time of 18,000 BPH to 21,600 BPH, a Blanking Window of "8" is appropriate. If you're working on watches with beat times of 28,800 to 36,000 BPH, set the Blanking Window to "4".

You can tell if the Blanking Window is set correctly for the watch you're working on. The red LED on the front of MicroSet blinks on every beat. The LED is on while the Blanking Window is active, and goes off when MicroSet begins to listen for the next tick. The feature will be most effective if the LED is off for a very short time before it comes on again. This indicates that MicroSet is ignoring sound most of the time, then begins to listen just before the next tick arrives. If the LED seems to blink half as fast as the watch beats, it's an indication that the Blanking Window is too big and you're missing every other beat.

To program a default value for the Blanking Window, see "**Configuration - Minimum blanking**" for details.

You can also change the size of the Blanking Window "on the fly" as you measure a watch. Every time MicroSet finishes a reading, if the PLUS key is down, the Blanking Window gets longer by one count. If the MINUS key is held down, the Blanking Window gets shorter by one count.

If you hold down the PLUS key while MicroSet is measuring a watch, you'll see that the LED stays on for an increasingly longer time and blinks off for a shorter time. If you set MicroSet to "time" a short beat count, like "Time: 4", the change will happen more quickly. In this way you can increase the Blanking Window to the optimum value for the watch you're working on. You can probably reach a point where the LED doesn't seem to go off at all. This is the maximum setting. If you pass this point, the LED will begin to blink half as fast as the watch ticks because you're skipping every other beat. If this happens, hold down the MINUS key to reduce the Blanking Window by one or more counts.

MicroSet will keep this value of the Blanking Window until you turn it off or press the RESET key. Then it will revert to the default value that was specified with the Configuration Mode.

Time Mode Options

Once MicroSet is running in the Time Mode you can access several Time Mode Options. These are additional functions that are related to the measurement of rate. Some of them are extra cost options. If you wish to add an option you don't have, give us a call.

To access the Time Mode Options in your MicroSet, press the BEGIN button while the Time Mode is running. You can step through the different Time Mode Options that may be in your timer by pressing BEGIN several times.

Show Error Per Day

The first Time Mode Option allows MicroSet to display rate readings as seconds of error per day rather than as Beats Per Hour or Seconds Per Beat.

To activate the Error Per Day option you should be running in the Time Mode. You should have already displayed one or more rate readings, and the reading should be close to the correct rate for the watch you're working on. If the reading is not close to the correct rate, the error will be too great to display as seconds per day.

Enter the Time Mode Options by pressing BEGIN. The LCD screen will say:

Show error/day?

To answer "Yes", press the PLUS key. If you wish to answer "No", press the Minus key. Assuming you answered "yes", MicroSet will then guess the correct rate for the watch based on the last reading that was taken. MicroSet is programmed to recognize the most common watch rates. For example, MicroSet might say:

Target: 18000.00

This means that MicroSet has guessed that the correct rate (the "target" rate) for this watch is 18000 BPH. If this is correct, just hit the BEGIN key and MicroSet will return to measuring the rate of the watch, but now the rate will be displayed as seconds of error per day. In other words, MicroSet will now tell you how fast or slow the watch is. If the value shown is positive, the watch is fast. If the value is negative, the watch is slow.

If the rate MicroSet guesses is not correct for the watch, you can manually adjust the target rate. To do this, press the MINUS key (for "No") when MicroSet guesses the wrong rate. MicroSet will then show you the last reading it made on your watch.

Let's say you were working on a watch, and the last reading taken in the Time Mode was 20946.55 Beats Per Hour. MicroSet would show this value on the LCD screen:

Target: 20946.55

MicroSet needs to know the correct rate for the watch before it can calculate the error between the correct rate and the current rate. You need to know the correct rate for the watch. In this case, the correct rate might be 20944.44 BPH. You can adjust the proposed number with the PLUS and MINUS keys. To make the value larger, press (or hold) the PLUS key. To make it smaller, press (or hold) the MINUS key. When you press PLUS or MINUS the proposed rate will change by a small amount. If you hold the key down, the value will change rapidly. If you hold the key down even longer, the value will change even more quickly.

Use the PLUS and MINUS keys to change the proposed Target rate from 20946.55 to 20944.44. The LCD screen will say:

Target: 20944.44

To enter this value and begin timing the watch again, press the BEGIN key. MicroSet will now show you the rate of the watch in terms of seconds per day of error.

As you enter the target rate in this way, if MicroSet has been displaying the rate as Beats Per Hour, the PLUS and MINUS keys will change the proposed rate by an odd value (.09 BPH). This is normal. If you cannot get MicroSet to display the exact rate you want, choose the closest value. The rate that MicroSet gives you will still be more accurate than a tenth of a second per day.

If you want to turn off the Error Per Day display mode, press the BEGIN key to access the Time Mode Options. Press BEGIN until the LCD screen says:

Show error/day?

To answer “No”, press the MINUS key. MicroSet will return to the previous display mode, whether it was Seconds Per Beat or Beats Per Hour.

Running Average

The Running Average option is one of the most useful functions of MicroSet. When the Running Average function is turned on, MicroSet will accumulate a running average of every rate reading it has taken and display the average rate of the watch over any length of time you wish to let it run. It will cause rate readings to settle down to very stable and accurate values that change only in small fractions after just a few minutes.

To activate the Running Average option you should be running in the Time Mode. Press the BEGIN key to access the Time Mode Options. Press BEGIN again until the LCD screen says:

Average: Off

To turn on the Running Average function, press the PLUS key. The LCD screen will say:

Average: On

Now hit the MODE button to return to the Time Mode. As new readings are shown on the LCD screen, they will appear in the following format:

1: 18000.00

The first digit is the number of samples that have been taken. The number after the colon is the Running Average rate. In the example shown, the rate is displayed as Beats Per Hour, but the Running Average function works if you have MicroSet configured to show Seconds Per Beat or Error Per Day.

Each time a new reading comes in, the number to the left of the colon will increase by one to show you how many readings have been taken and the average rate will be calculated and displayed. The difference between subsequent readings will get smaller and smaller. As time goes on you get an increasingly accurate reading of the average rate of the watch.

To turn off the Running Average mode, enter the Time Mode Options and press BEGIN until the LCD screen says:

Average: On

Press the MINUS button to change it to “Average: Off” and then press MODE to return to the Time Mode.

If you wish to reset the running average value, enter the Time Mode Options and press BEGIN until the LCD screen says:

Average: On

Press PLUS and then MODE to return to the Time Mode. The running average value will be reset and a new average will be calculated.

If you're using the Running Average feature and a bad beat comes in, it will throw off the whole average because the bad value becomes incorporated with every reading. For this reason, take special care to get clean readings in the Running Average mode. In typical operation, the Running Average rate shown will become more and more stable over time. The readings might grow and shrink a little, but the amount of change should get smaller and smaller with each reading. If you notice that the rate just keeps getting bigger and bigger, or smaller and smaller, it may mean you have a bad sample that has thrown off the running average. In this case you may wish to re-enter the Running Average mode to reset the average and start over.

Normally we recommend using a relatively large number of beats for the Time Mode. For example, if you set MicroSet to "Time: 2", you'll get less accurate and more erratic answers than if you set it to "Time: 30". This seems to be much less important with the Running Average mode. You can get accurate readings with smaller beat counts with the Running Average and get answers more quickly.

Speaker On/Off

If you bought the optional beat amplifier for your timer, you turn it on and off with a Time Mode Option. If you didn't buy the internal beat amplifier, this option will not appear in your timer.

If you have the amplifier, you turn it on by pressing BEGIN while the Time Mode is running. Press BEGIN until the LCD screen says:

Speaker: Off

Press the PLUS key to turn the speaker on. If it's already on, press the MINUS key to turn it off. You can now return to the Time Mode by pressing MODE and the speaker will stay as you set it.

The volume of the speaker is controlled by the existing LEVEL control. To make it louder, turn the LEVEL control clockwise.

MicroSet will continue to take readings while the speaker is on. You may notice that there is a slight hissing sound when MicroSet displays a new value on the LCD screen. This sound is not a flaw in the watch, it's an amplification of the LCD screen working. Also, if you have MicroSet plugged into a personal computer, you may hear an extra sound when data is sent to the computer. Don't be fooled by these sounds and think they're coming from your watch. If they bother you, reenter the Time Mode Options by pressing the BEGIN key. This will stop MicroSet from taking readings and you'll only hear the watch.

The speaker is mounted to the back of MicroSet, where it faces the work table. The rubber feet on MicroSet hold the timer off the table and let the sound out. In fact, the speaker is louder when MicroSet is sitting on a work table than it is if you turn it over and face the speaker towards you. However, the speaker will be loudest when sitting on a hard, reflective surface. The sound will be muffled if you set it on a padded or carpeted surface.

Data Capture

The next Time Mode Option is Data Capture. This is an extra cost option. If you didn't purchase Data Capture, the option will not be available. When Data Capture is turned on, rate readings taken by the timer are stored in memory within the timer as they are displayed on the LCD screen. At some later time you can connect MicroSet to a personal computer and "dump" the data that has been captured into the Windows Interface Program. This allows you to capture data for the computer even though the watch you're

working on is not near a computer.

This feature will be useful if you have a computer in your office but not in the shop. Or perhaps there is a watch you're interested in buying at a local shop, and you'd like to examine its performance before you commit to purchase. Assuming the shop keeper will allow it, you can capture the behavior of the watch in the shop and examine it later on your computer. Even if you have a computer handy to use with MicroSet, you don't need to tie it up with monitoring a watch. The computer can be free for other things and MicroSet can monitor the watch all by itself.

To use Data Capture, MicroSet must be in the Time Mode and taking readings. Press the BEGIN key to access the Time Mode Options. Press BEGIN until the LCD screen says:

Capture: Off

The default condition is for Data Capture to be off. To begin capturing your readings, you must turn it on. Do this by pressing the PLUS key. The LCD screen will then say:

Capture: 1

The number "1" means that MicroSet will capture every reading in memory. You can press the PLUS key again and the number "1" can be increased up to 250. The number that you select is the number of readings that will occur before one is stored in the Capture memory. For example, if you set the LCD screen to show:

Capture: 10

MicroSet will store one reading for every ten that occur.

When we say "readings" we don't mean "beats". If MicroSet is configured to measure 30 beats with "Time: 30", each reading of 30 beats is the "reading" that's captured with Data Capture.

The reason for saving fewer than every reading is that the Capture memory can hold no more than 8,125 readings. This is quite a lot, but there may be times when you would prefer to capture over a longer period of time. By skipping some readings your Capture time is increased.

After setting the Data Capture count value, you can go back to the Time Mode and begin capturing readings. Do this by pressing the MODE key.

MicroSet will now resume taking readings from the watch under study. Every new reading that's displayed on the LCD screen will be followed by the letter "C", to indicate that they are being captured. The readings will be stored in memory inside the timer until the memory storage is filled. If you fill the Capture memory, the Capture function will be turned off and the letter "C" will no longer appear after each rate reading.

Here are some typical kinds of measurements and the length of time you can capture with a Capture count of "1". If you enter a number larger than "1", multiply the duration shown by the number you entered for the Capture count:

- Pocket watch, "Time: 60" (one reading every 12 seconds)
Will capture for 27 hours
- Pocket watch, "Time: 1" (capture every beat)
Will capture for 27 minutes

When you have captured all the data you want, you should turn off the Capture function. Press the BEGIN key to access the Time Mode Options. Press BEGIN again until the LCD screen shows:

Capture: 1 (or some other number)

Press the MINUS button until the LCD screen says:

Capture: Off

This indicates that the Capture function has been turned off and new readings will no longer be stored.

When you turn Capture off, MicroSet stores a marker in the data to indicate where the end is. This allows you to turn the timer off and still be able to Dump the data at a later date. The data is stored in nonvolatile memory, and you can leave MicroSet off for an hour, or a month, and still get the data out. However, if you turn Data Capture "On" again, it will start a new data session and any previous data will be erased.

You can capture more than one "session" of data with the Capture function. You can stop the Time Mode (or use any other function of MicroSet), or set up on a different watch, and then Capture more data. If you wish to do this, do NOT turn the Data Capture off. As long as Data Capture is left on, the data will go into memory and it can be dumped to a PC later. If you turn off the Capture function you cannot add any more data.

Dumping captured data

When you're ready to transfer your captured data to the PC, plug MicroSet into the serial port of your Windows computer with the cable provided. To Dump the data, put MicroSet in the Time Mode and press the BEGIN button to access the Time Mode Options. Press BEGIN until the LCD screen says:

Dump?

Be sure the Windows Interface Program is ready to accept data (the "Plot: On" button is selected) and press PLUS on the timer. This will start the data dump. Every reading stored in the timer will come flying out of MicroSet. The numbers will appear on the LCD screen so fast that they will be illegible. New data points will appear on the computer screen as fast as your computer is able to display them. When the dump is complete, the timer will return to the start of the Time Mode. You can dump the data as many times as you like; it will stay in memory until you turn Data Capture "On" again, which resets the storage area and begins a new capture.

Here are some things to keep in mind about the Capture process.

- 1) You can use Data Capture whether MicroSet is configured to display Seconds Per Beat or Beats Per Hour. But the data captured will always be saved as Seconds Per Beat. When you dump the data to the PC, even though MicroSet may have been displaying Beats Per Hour, you will dump Seconds Per Beat. You can see Beats Per Hour on the computer screen if you configure it to show Beats Per Hour.
- 2) Normally, when you capture readings from the timer on the computer, the computer stores the time of day that each reading was taken. When you examine the data on the PC screen, you can tell when each sample was taken because it has a "time stamp". When you dump data from the timer's Capture function, it all comes in very quickly, even though it may have taken days to collect it. The time stamp associated with each sample will be the instant it transferred to the computer, not the actual time it was captured. The Windows Interface Program has a command to correct the time stamps. It's called "Change timestamps" and can be found under the Operations menu. To correct the timestamps you must know the time that the first reading was captured and the number of beats between each captured reading. For example, if MicroSet was set to Time 30 beats, there were 30 beats between each reading. But if you set the Capture count to "Capture: 10", there would be 300 beats between each captured reading.

- If you wish to correct the timestamps, you must make a note of the start time and counter values of your capture data when you start Data Capture.
- 3) That data will be saved in the timer for as long as you like, but if you turn Capture "On", any stored data will be lost. If you wish to capture more than one watch, you must do so without turning off the timer and without turning off the Capture function between watches.
 - 4) Remember to "close" the Data Capture by turning "Off" the Capture function when you are through. If you turn off the timer without turning off the Capture function, the timer will not know where the end of the data is when you Dump it. However, as long as you do not turn off the timer, you can Dump the data without "closing" the Data Capture. The Dump command keeps track of the current end of data as long as the timer is left on. This allows you to Dump the data in the middle of a capture and then continue to capture more.

Paper tape output

The last Time Mode Option is Paper Tape. It allows MicroSet to print traditional paper tape charts (like a Vibrograph or Tickprint produces) on an inexpensive label printer. The paper tape printer is an optional accessory. Call or write for price and availability.

We prefer to use the Windows Interface Software to display a simulation of a paper tape printer instead of using an actual paper tape printer. The simulation allows additional features a real printer can't reproduce, and requires no paper.

To use the paper tape printer, plug the special data cable (available from us) into the MicroSet Data Out jack at the end of the timer. This is the jack normally used by the computer interface. MicroSet must be in the Time Mode and generating readings. Press the BEGIN key to access the Time Mode Options, and press BEGIN as many times as necessary to reach the Paper Tape option. The LCD screen will say:

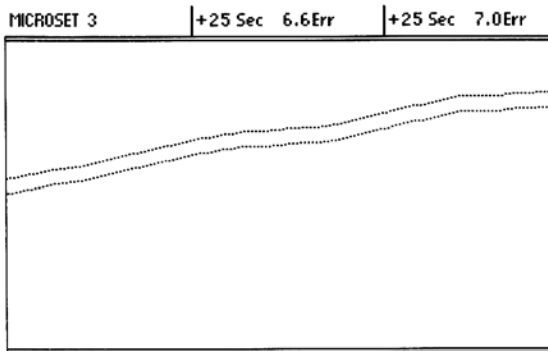
Paper tape?

Answer "Yes" by pressing the PLUS button. MicroSet will then display the last reading that was taken in the Time Mode. MicroSet must know the correct rate for the watch in order to calculate the paper tape data. MicroSet will guess the correct rate, just as it does when you set MicroSet to display Error Per Day. If the proposed rate is correct you can accept it by pressing the BEGIN button, or manually adjust it by pressing the MINUS button. For more detail on selecting the Target rate, refer to the instructions for configuring Error Per Day earlier in these instructions.

When the proposed Target rate is correct, press the BEGIN key. The LCD screen will then say:

Paper tape: 1x

and the printer should begin to print. To stop printing, press the MODE button. A short sample of the paper tape is shown below.



Paper tape strip

As the tape runs, a black dot will be printed on the tape for each beat of the watch. The position of the dot depends on the rate and beat error of the watch. If the watch is fast, the lines will wander off the top of the tape. If the watch is slow, the lines will wander off the bottom. If the watch is running at exactly the correct rate, the lines will be straight. After 100 beats, MicroSet will print the current rate of the watch at the top of the tape. In this example, it printed “+25 Sec”, which means the watch is 25 seconds per day fast.

In the strip above, there are two lines. This is because the watch is not in perfect beat. The difference between these two times is the “beat error”. Larger beat errors appear as more separation between the two lines. Every 100 beats MicroSet prints the last beat error at the top of the tape, after the current rate. In this example, the beat error was 6.6 milliseconds.

If you do not see two clean rows of dots like the sample shown, your watch may be very dirty or the level may not be set correctly. Start with the level control of MicroSet set to maximum. Adjust it downward if you don’t get clean results. It will also help to use a good watch sensor.

While the tape is running you can rotate the watch to different positions to evaluate the effect. It is beyond the scope of these instructions to teach you how to read the many possible variations in the printed pattern, and what they all mean. Much has been written on this subject, and many people have learned how to read the output of Vibrograph, Tickoprint, and WatchMaster timers. A listing of several common faults and the tapes they produce can be seen at the end of these instructions.

There are several controls on the paper tape display that exceed the abilities of the original paper tape timers. MicroSet will allow you to magnify the beat error to see finer detail. To do this, press the PLUS button while MicroSet is printing a tape. The LCD screen will say:

Paper tape: 2x

and the printed tape will be magnified two times. The beat error will appear twice as large in the pattern of dots, but the value printed at the tape edge will be correct. You can press the PLUS button again for a scale of “4x”, and a third time for a scale of “8x”. To return to lesser magnifications, press the MINUS key. The LCD screen will always tell you what magnification is in use.

If the rows of dots are running at the edge of the tape and you would like to center them, press the BEGIN button. This will start a new reading and re-center the dots to the middle of the tape. You can also use this button if you've moved the watch or otherwise disturbed the current reading and wish to start a clean measurement of the next 100 beats.

It's difficult to see the details of the individual beats when the overall rate is fast or slow, because the dots run off the edge of the tape. This was unavoidable with traditional paper tape timers. But because MicroSet allows you to specify any arbitrary rate as the correct rate, you can get the lines to run straight simply by telling MicroSet that the current rate is the correct rate. In other words, when you first enter the Paper Tape Mode, simply accept the last rate reading without adjusting it to be the known correct rate. In this case, the lines will be straight, the beat errors will be easy to see, and any fluctuation in rate will be easily seen as a divergence from straight lines.

The Accutron Mode

The MicroSet Watch Timer includes a special mode for measuring tuning fork watches (like Accutron) that use a tuning fork motor to drive the movement. These tuning forks run at a variety of frequencies, with 360 cycles per second (or “Hertz”) being the most common. MicroSet will automatically detect the correct rate of any of the following frequencies:

300
341 1/3
360
440
480

The Accutron mode requires a special, optional, inductive sensor. This sensor will also trigger on the motor impulse of quartz watches and clocks, and you can measure them with MicroSet too.

To use the Accutron mode, press the MODE button until the LCD screen says:

Accutron...

Set a watch on the inductive sensor. The tuning fork in the watch is near the 12 o'clock position. Place the watch so the tuning fork is at the center of the sensor. Turn the MicroSet level control all the way up and the LED should come on and stay on. This means the watch is running and MicroSet can sense the tuning fork. Press the BEGIN button and MicroSet will say:

Blocks: 5...

This allows you to choose how many cycles to measure before a rate reading is returned. If you select “5 blocks” you'll get a reading about once every two seconds, depending on the frequency of the watch you are measuring. This is usually an adequate interval to get an accurate reading. If you prefer to get fewer readings over longer periods, press the PLUS button to increase the “Block” count. When ready to start measuring, press the BEGIN button. MicroSet will say:

Rate:

When the first reading is ready, it will appear after the word “Rate”. MicroSet will automatically adjust to the rate of the tuning fork and read out the rate as seconds per day of error.

You can also display the actual frequency of the tuning fork. To see this, press and release the MINUS button. The display will change to frequency of the fork. To return to error per day, press and release the PLUS button.

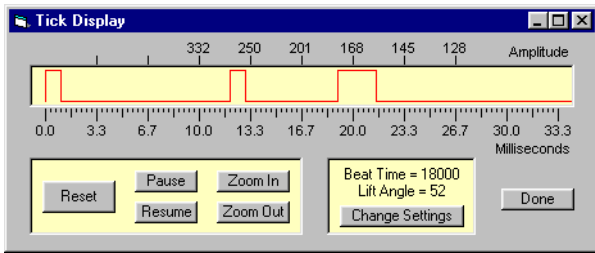
If you have the Windows Interface Program for MicroSet, you can capture Accutron watch rate over time on the computer. MicroSet must be configured to output Accutron rates as frequency. These rates will be displayed as a graph on the computer, and you can see the effect of temperature or position on the frequency of the tuning fork.

Tick Mode

MicroSet includes a function to transmit digital information about the watch tick to the Windows Interface Program. To use this Tick Mode, you must have version 3 of the Interface Program.

If you purchased the optional Balance Wheel Amplitude feature you will not have a Tick Mode in your timer. This is because the Tick Mode is unnecessary.

A watch tick is a complex sound, composed of several shorter sounds that arise from the actions within the watch escapement. These sounds are sometimes called “the five shocks”, but there are three sounds that are the most significant. They are the unlocking, the impulse, and the drop. It is useful to know the details of these sounds. The Tick Mode will send the raw data needed by the Windows Interface Program to produce a graphical representation of the watch tick. From this graphical representation you can measure the duration and placement of the component sounds. The MicroSet Interface Program also calculates the balance wheel amplitude based on the beat time and lift angle of the watch. The image below shows the Tick Mode display on a personal computer. Instructions for using the Tick Mode come with the computer interface software.



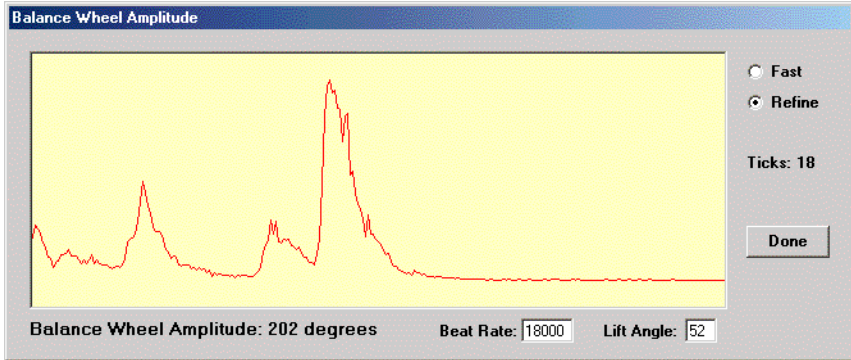
The Tick Mode

The digital representation of the tick sound in the Tick Mode is not ideal. A more accurate representation of the tick sound and the balance wheel amplitude can be obtained with an extra-cost addition to MicroSet called “Balance Wheel Amplitude”. This is described next.

Balance Wheel Amplitude Mode

The Balance Wheel Amplitude Mode works like the Tick Mode except that it uses an optional analog to digital converter inside MicroSet to display a more accurate view of the tick sound. This more accurate view allows the Windows interface program to calculate and display the balance wheel amplitude much more accurately. The Balance Wheel Amplitude Mode is optional, and if you didn't buy it with your timer, it will not be available. It can be added later if you wish. Contact Mumford Micro Systems for more information.

Instructions for using the Balance Wheel Amplitude Mode come with the Windows interface software.



The Balance Wheel Amplitude Mode

The Computer Interface

If you purchased MicroSet with the optional Computer Interface Software, you can record readings on a computer. This is a very powerful feature with great benefit to the watchmaker. Three versions of the software are available. To take full advantage of the watch functions you need Version 3 of the Windows software.

You will find that, in most watches, the rate will change from one reading to the next. This happens for many reasons. With a personal computer connected to MicroSet you can see how the rate changes over time and get a feeling for the range and stability of the watch you're working with. You can capture rate data for as long as you like and plot the changes to reveal the effects of positional error, spring tension, wheel errors, temperature change, and many other factors. The software presents live charts and running averages of rate changes, all of which can be saved on disk or printed on paper for later reference or to give to customers.

The Windows interface software is also needed to display balance wheel amplitude.

Paper tape watch timer simulation

The Windows interface program version 3 will also display a simulation of the paper tape displays of early watch timing machines like Vibrograph and Tickoprint. If you've used one of these machines, you have learned that they can reveal subtle details about how a watch is performing. The trouble with these machines is that they're old, less accurate, expensive, and noisy! MicroSet and the Windows interface program can produce the same kinds of displays, but with added features made possible by the computer. Rate information is displayed directly rather than interpreted from the slope of the readings. Beat error can be read directly from the screen. The sloping lines can be "normalized" to run flat so irregularities can be more easily observed, and you can "zoom in" or out to see finer detail or longer periods. The graphs can be saved on disk or printed on paper. And the software can be set to work for any beat time, so you need not interpret the displays differently for unusual beat watches.

The computer interface can be added to any MicroSet. Please call for details and availability.

Configuration

There are a several settings that are available to configure the behavior of your MicroSet timer. These settings are remembered from one day to the next, even when MicroSet is turned off. To enter the Configuration mode, do the following:

- Be sure MicroSet is turned off
- Hold down the MODE button
- Turn on the timer and wait until the words “BEEP ON” or “BEEP OFF” appear on the LCD screen.

You can cycle through the different Configuration settings by pressing the MODE key.

Beep On/Off

You can configure MicroSet to beep every time a Time Mode measurement that takes longer than about 10 seconds is complete. When you first enter the Configuration mode, the display will show either “**Beep On**” or “**Beep Off**”. To turn the beep on, press the PLUS button. To turn the beep off press the MINUS button.

If you're through with configuration after turning the BEEP on or off, hit the RESET button. To continue with the next configuration setting, press the MODE button.

Time mode beats

This setting lets you store the default value of beats to be measured in the Time Mode. When you use the Time Mode, you specify the number of beats to measure before the average rate of each beat is given. This configuration setting lets you select a starting value that suits your work style. You might prefer to start with a low number, like two or four, so you can get a result quickly. Or you may prefer to start with a higher beat count to get more accurate results. Whatever value you choose, it should be an even number or “1”.

When MicroSet is at this Configuration setting the LCD screen will say something like:

Time beats: 10

To increase the number, press the PLUS key. To decrease the number, press the MINUS key. When the number you'd like to use is showing you can hit the RESET button to exit the Configuration Mode. Or, to continue with the next configuration setting, press the MODE button.

Blanking Window size

This setting lets you store the default duration for the Blanking Window. The Blanking Window is the feature in the MicroSet Time Mode that allows it to ignore sounds that occur between proper ticks. Because MicroSet can measure watches as fast as 36,000 BPH and clocks as slow as 30 seconds per beat, there is no one setting for the Blanking Window that will serve all timepieces perfectly.

When MicroSet is at this Configuration setting the LCD screen will say something like:

Blanking: 8

To increase the number, press the PLUS key. To decrease the number, press the MINUS key. The following values of the Blanking Window can be used for the beat times shown:

- 18,000 BPH -- use 11
- 21,600 BPH -- use 9
- 28,800 BPH -- use 6
- 36,000 BPH -- use 4

When the number you'd like to use is showing you can hit the RESET button to exit the Configuration Mode. Or, to continue with the next configuration setting, press the MODE button.

Time Mode display format

You can configure MicroSet to display the results of its Time Mode measurements in Seconds Per Beat or in Beats Per Hour. When you enter this configuration setting the display will show either

Units: Secs

or

Units: BPH

To have MicroSet display Time Mode measurements in Seconds Per Beat, press the PLUS key and the display will show "**Units: Secs**". To have MicroSet display time measurements in Beats Per Hour press the MINUS key and the display will show "**Units: BPH**".

MicroSet can also display rate as seconds of error per day. This setting is made with the Time Mode Options.

If you're through with configuration after this setting, hit the RESET button. To continue with the next configuration setting, press the MODE button.

Oscillator calibration

The final setting in the Configuration Mode allows you to enter a "trim" value that is used to correct for inherent errors in the quartz crystal time base. This unique feature allows us to recalibrate your MicroSet timer with software if the accuracy of the quartz crystal changes over time. Don't change this setting unless you know what you're doing and have a good reason to change it. You may want to record the factory setting for this value inside the back cover of this instruction manual. If anything goes wrong and the trim value gets changed, you can re-enter the original value. You (or we) can make adjustments to this setting as the unit ages, and it allows us to recalibrate MicroSet without making any changes to the hardware.

When you enter the Trim Mode, the display will show something like the following:

Trim: 0

The range of values is +99 to -99. To increase the trim value, press the PLUS button. To decrease the trim value, press the MINUS button. When the value you want is displayed, you must press the BEGIN button if you want MicroSet to memorize it. When you do, the LCD screen will show "OK!" and the trim value will be stored in permanent memory for future use. This extra key press helps to insure that the trim value will not be changed accidentally.

The units of Trim are "parts per million". If the Trim value is "+1", it means the crystal oscillator is accurate to one part per million, and the remaining one part per million error is corrected with the software Trim value. The final error of the timer is always zero parts per million when it's at the same temperature it was when it was calibrated.

Experience has shown that MicroSet does not lose much accuracy over time. We have gotten several units back for upgrades after more than a year, and the trim value has always been within two or three parts per million of correct. Often the timebase has not drifted at all after a year. A change of 1.65 parts per million is a change of one second per week. Your timer is not likely to be off by more than this in a year's time.

To exit the calibration mode press the MODE key.

Technical Functions

There are several “technical functions” built into MicroSet that are not necessarily related to timing watches. These functions are put in as utilities to help the experimenter, or to extend the usefulness of the timer. Not all timers will have all functions. To access the technical functions, hold down the BEGIN button when you turn on the timer. To move from one technical function to the next, press the MODE key.

Temperature

If you purchased the simple temperature sensor for MicroSet, the first technical function will display the temperature once per second. This reading is also sent to the computer interface if you have it, so you can record the temperature when you aren't measuring a watch.

Barometer

If you purchased the optional Atmospheric Sensor for MicroSet, this technical function will display the barometric pressure followed by the temperature every other second. These readings are also sent to the computer interface if you have it, so you can record the barometer and temperature when you aren't measuring a watch.

Width

This function probably has no use for the watchmaker. It will display the amount of time a sensor is triggered. For example, if you're using an optical sensor on a clock pendulum, it will measure how long the sensor is blocked each time the pendulum passes. With watches, it measures the time the acoustic sensor is active at each watch tick. This reading is sent to the computer interface if you have it.

Dark / Light

This function probably has no use for the watchmaker. It will display the amount of time a sensor is triggered, followed by the amount of time the sensor is NOT triggered. This reading is sent to the computer interface if you have it.

Tachometer

This function will display the RPM of a spinning tool like a lathe or mill. To use it, you need to arrange an optical or magnetic sensor to trigger once on each rotation of the tool. The best way is probably to get a spare magnetic sensor from Mumford Micro and use epoxy to hold the magnet to some part of the tool where you can mount the sensor. This is an easy way to add a tachometer to your watchmaker's lathe or other tooling used in watchmaking.

Technical Notes

This section contains technical details about the operation of MicroSet, and explains the limits and benefits of different settings.

Seconds Per Beat or Beats Per Hour

Why would you select one mode or the other? It depends on personal preference. Most people are used to Beats Per Hour. Others may prefer Seconds Per Beat.

Limits in the oscillator calibration

MicroSet is tuned to a GPS reference signal when we assemble it to get the greatest accuracy from the crystal timebase. When MicroSets are assembled, the oscillator components are hand selected to arrive at a frequency that's within one or two parts per million of the correct rate. The trim value entered in the MicroSet Configuration Mode can adjust the timing calculations to correct any remaining error of the crystal. When we ship a MicroSet, it's accurate to one part per million at room temperature. This is better than one second per week.

Thermal stability

Quartz oscillators like the one in MicroSet are susceptible to temperature changes. If you measure a watch when MicroSet is at 100 degrees the rate will appear different than if you measure it at 50 degrees. A temperature change like this is likely to have a bigger effect on the watch itself, but we would still like to have some idea about how MicroSet changes with temperature. We have found that, on average (and quite linearly) MicroSet will read an increase of 0.65 parts per million per degree Fahrenheit. In other words, if the temperature of the timer were to change 5 degrees, you could expect the value of your readings to change by about 3 parts per million. This is the equivalent of 2 seconds per week in a watch.

However, it takes a couple of hours for temperature changes to penetrate to the crystal. We have found that, in typical operation, the rate changes by just 2 or 3 parts per million for a room temperature change of over 20 degrees. These changes are probably too small to matter in most watch work. If you wish better stability than this from MicroSet, keep the temperature constant or buy the optional TCXO timebase.

Accessories

There are many accessories available to extend the capabilities of the MicroSet timer. Some of these are listed below. Contact us for further details.

- A padded carrying case
- Optional watch sensors
- Accutron watch sensor
- Temperature and barometric sensors
- Software interface for personal computers

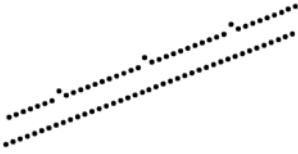
Hardware Options

There are several optional features that can be added to the MicroSet hardware. These are listed below. Contact us for further details.

- Built-in beat amplifier
- Temperature and Atmospheric sensor
- Data Capture Memory
- Balance Wheel Amplitude
- TCXO timebase

**The most current information about MicroSet features and accessories is available on the Internet.
Go to www.WatchTimer.com**

Typical errors as revealed by paper tape printer



A damaged tooth on the escape wheel



Irregular transmission or dirty escapement



Balance is isochronous but not in poise when watch is turned



Balance is not isochronous when watch is turned



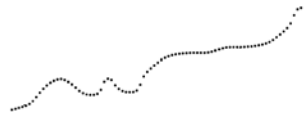
Faulty escapement or damaged pallet stone



Balance is knocking



Escape wheel is out of round



Excessive sideshake on pallet-staff or balance pivots, or defective train



Variation in balance amplitude



Variation in running of balance, poor transmission, or loss of amplitude

Summary of Operations

Beat Error Mode - measure beat error

Press BEGIN to start measuring. The number of milliseconds of beat error will be shown.

Time Mode - measure the rate a watch

Press PLUS or MINUS to set the number of beats to measure.

Press BEGIN to start measuring.

Blanking Window - to make the timer immune to other sounds

To maximize it, hold PLUS until the LED stays on.

To minimize it, hold MINUS until the LED stays off.

You can adjust the default setting of OFF with the Configuration Mode.

Time Mode Options

Press BEGIN to access the options available in your timer.

Show error/day: Press PLUS to enter the correct rate of the timepiece or press MINUS to disengage Error Per Day calculation. MicroSet will guess the correct Target Rate. If it's right, press BEGIN. If it's not right, press MINUS to display the last value measured, then press PLUS or MINUS to adjust it.

Average On/Off: Press PLUS to turn it on, MINUS to turn it off

Speaker On/Off: Press PLUS to turn it on, MINUS to turn it off

Data Capture: Press PLUS to begin data capture. The number shown will be the number of readings taken before one is saved. Set the number to zero to stop capture.

Dump: Press PLUS to dump the captured data to a personal computer.

Paper tape: Press PLUS to begin paper tape output. After the current rate is shown, press PLUS or MINUS to adjust it. Select the correct rate for a rate reading, or just accept the current rate for a flat tape. Press BEGIN to start printing. Press PLUS to zoom in, MINUS to zoom out. Press BEGIN to restart a reading at the center of the tape. Press MODE to terminate paper tape printing.

Accutron Mode - show the rate of tuning fork watches

Press BEGIN and select the number of "blocks" to measure (the time before a reading appears).

Press BEGIN to start measuring.

Press PLUS to see the rate as Error Per Day.

Press MINUS to see the rate as frequency of the fork.

Tick Mode - send information about watch ticks to a PC

Press BEGIN to start sending tick data to the PC.

Balance Wheel Amplitude Mode - measure balance wheel amplitude with a PC (optional)

Press BEGIN to start sending data to the PC.

Configuration Mode - to set various parameters of operation

Hold down NODE when you turn on the timer to enter the Configuration Mode.

Beep: Press PLUS to turn the beeper ON, press MINUS to turn it OFF.

Time beats: Press PLUS or MINUS to set the default number of beats for the Time Mode.

Blanking: Press PLUS or MINUS to set the value of the Blanking Window when it is turned off. Use 8 for most cases. Use 5 if you measure fast beat watches.

Units: Press PLUS to see rates as Seconds Per Day, press MINUS to see rates as Beats Per Hour.

Trim: Oscillator calibration. Do not change this. Press MODE to exit.