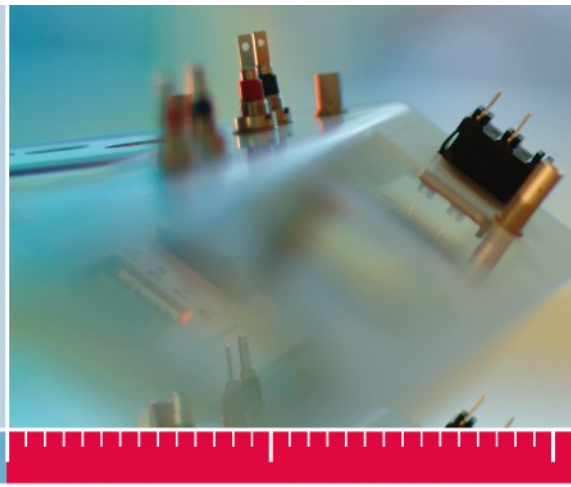
Welcome to witschi



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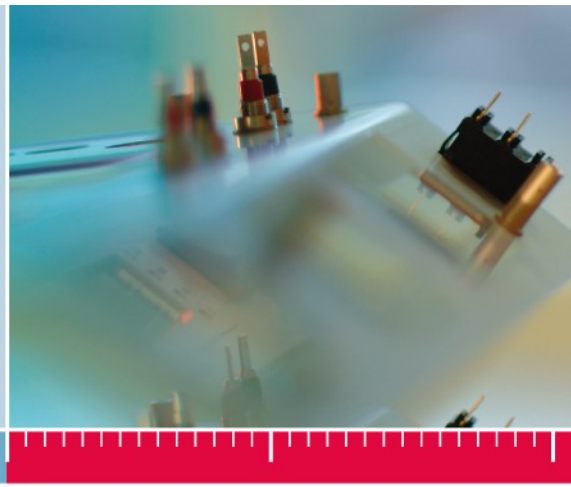
# Quartz knowledge for professionals



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UH

# Contents

**Components in detail**

- Batteries
- Quarz
- IC / regulation systems
- Control of the stepping motor (asservicement)

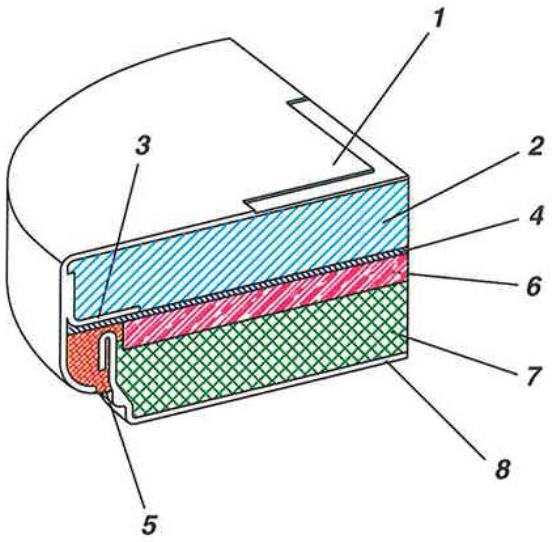
**Systematic trouble shooting**

**Calculation of the battery service life**

**Service philosophie – quartz watches**

# Batteries

## Construction (Cutaway view of a silver oxide cell Zn/Ag2O)




1: Can

2: Cathode (AG20)

3: Support ring

4:Separator

5: Gasket

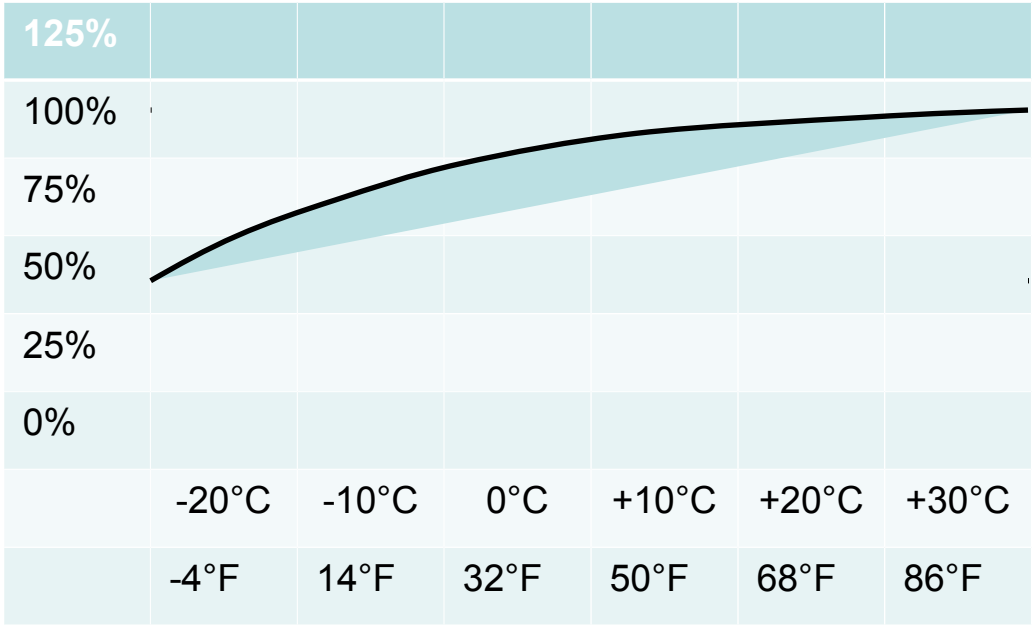
6: Electrolyte (NaOH or KOH)

7:Anode material (Zn)

8: Anode cap

# Batteries

## Capacity dependence vs. Temperature(mAh)




Typical temperature effect on miniature silver oxide batteries



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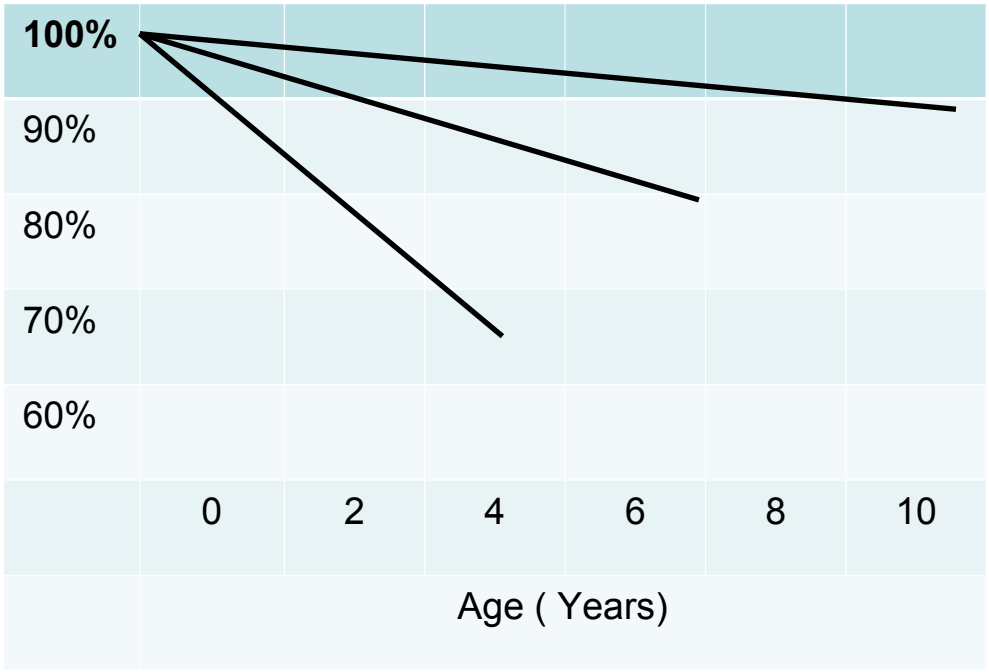
# Batteries

## Typical self discharge rate at different storage temperatures




**Nominal Capacity in mAh (100%)**
(Silver oxid / Zn Ag2O system)

~ minus 7-8% after 10 years
at 0°C / 32°
~ minus 15% after 7 years
at 20°C / 68°F
~ minus 30% after 4 years
at 40°C / 104°F



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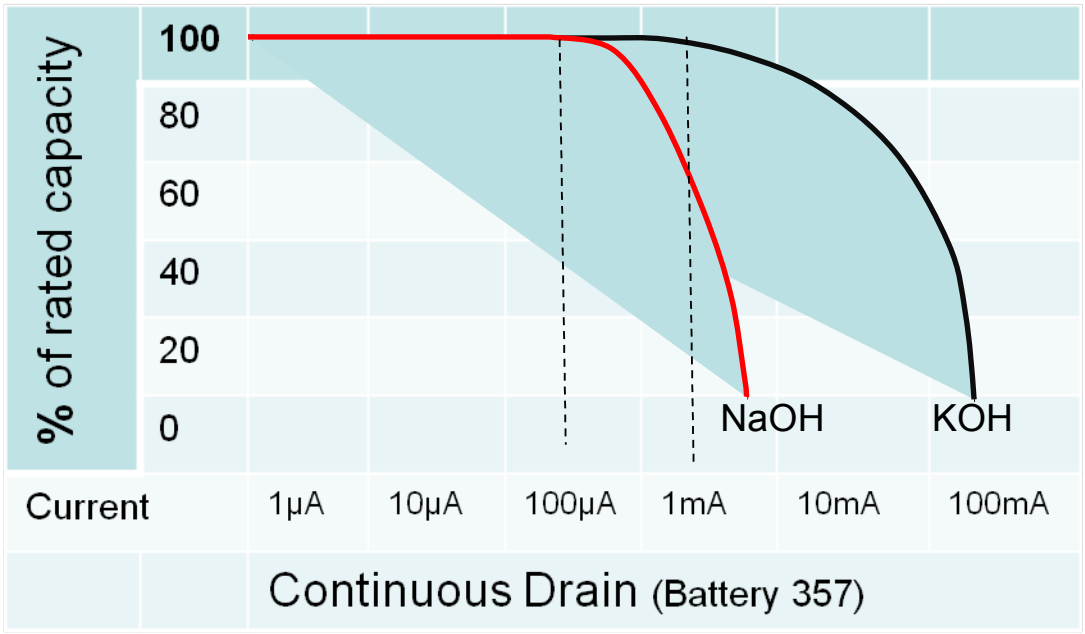
# Batteries

## Difference between High Drain and Low Drain Batteries




Efficiency (Voltage drop) of typical

Low Drain battery with
NaOH (Sodium )Electrolyte

VS (equivalent size / 357)

High Drain battery with
KOH (Potassium) Electrolyte



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# Batteries

## Calculation of battery life under different user conditions:

Example: Quartz Alarm Chrono / Battery type: 1.55 Volt 55mAh

| Function | Current consumption | Usage time per day | Current consumption per day | Total current consumption per day |
|---|---|---|---|---|
| Stepping motor Time | 1.5µA | 24 h | 36µAh | |
| Chrono | Not needed | → | | **36µAh** |
| Alarm | Not needed | → | | |

Battery Capacity: 55 mAh = 55000µAh : **36µAh** = Service life of: 1527 days **or <u>50 months</u>**



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# Batteries

## Calculation of battery life under different user conditions:

Example: Quartz Alarm Chrono / Battery type: 1.55 Volt 55mAh

| Function | Current consumption | Usage time per day | Current consumption per day | Total current consumption per day |
|---|---|---|---|---|
| Stepping motor Time | 1.5µA | 24 h | 36µAh | **60µAh** |
| Chrono | 8 µA | 3 h | 24µAh | |
| Alarm | Not needed | → | | |

Battery Capacity: 55 mAh = 55000µAh : **60µAh** = Service Life of: 916 days **or <u>30 months</u>**

# Batteries

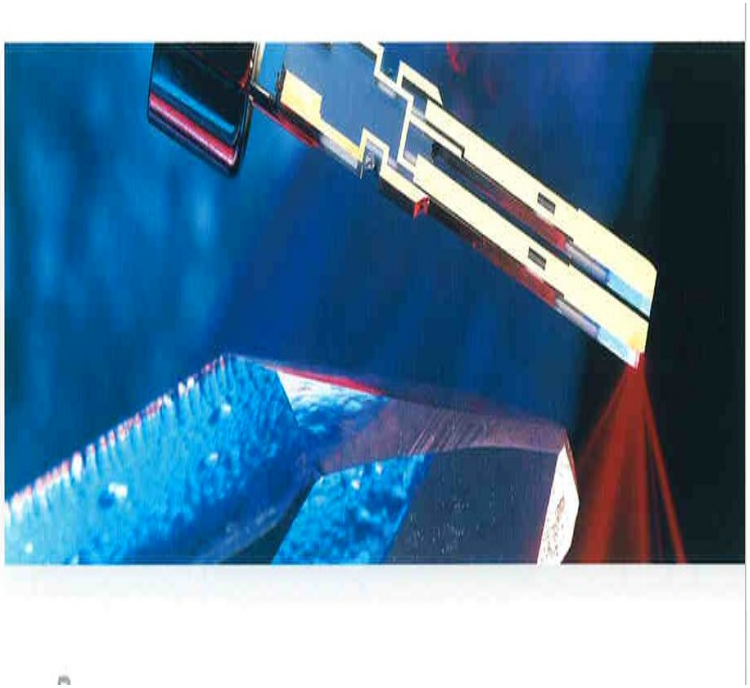
## Calculation of battery life under different user conditions:

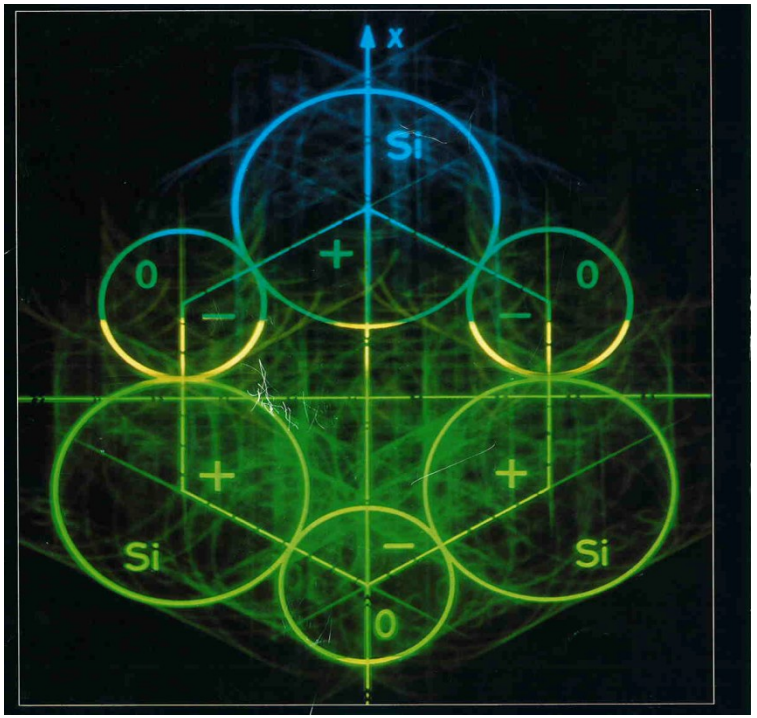
Example: Quartz Alarm Chrono / Battery type: 1.55 Volt 55mAh

| Function | Current consumption | Usage time per day | Current consumption per day | Total current consumption per day |
|---|---|---|---|---|
| Stepping motor Time | 1.5µA | 24 h | 36µAh | **66.6µAh** |
| Chrono | 8 µA | 3 h | 24µAh | |
| Alarm | 1200µA | 20 seconds =0.0055 h | 6.6µAh | |

Battery Capacity: 55 mAh = 55000µAh : **66.6µAh** = Service Life of: 826 days **or <u>27 months</u>**

# Quartz





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# Quartz

## Construction

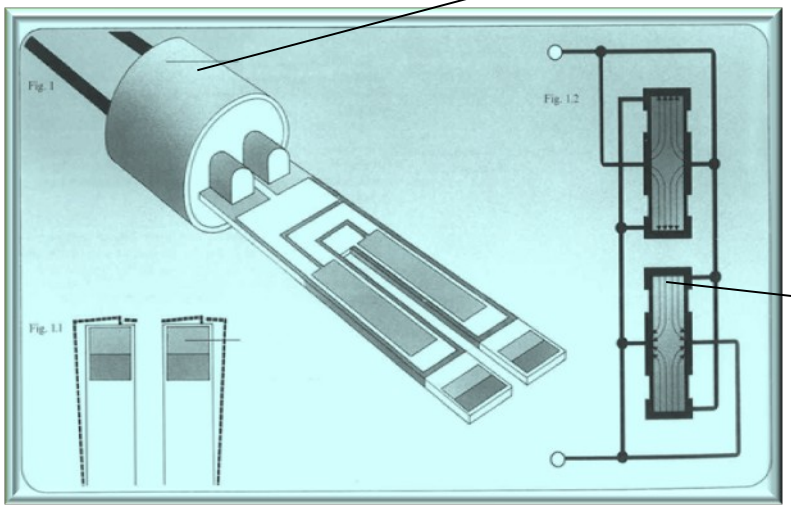


**Fig. 1 and 1.1**

Shows a tyipcal quartz tuning fork used for quartz watches on the base of its container.

Its two branches are animated by an antiparallel oscillatory movement (flection) in the plane of the tuning fork.

**Fig. 1.2**

Represents a section of the branches of the tuning fork, shows how the electrodes are connected, as well as the electric fields which are formed inside the crystal.



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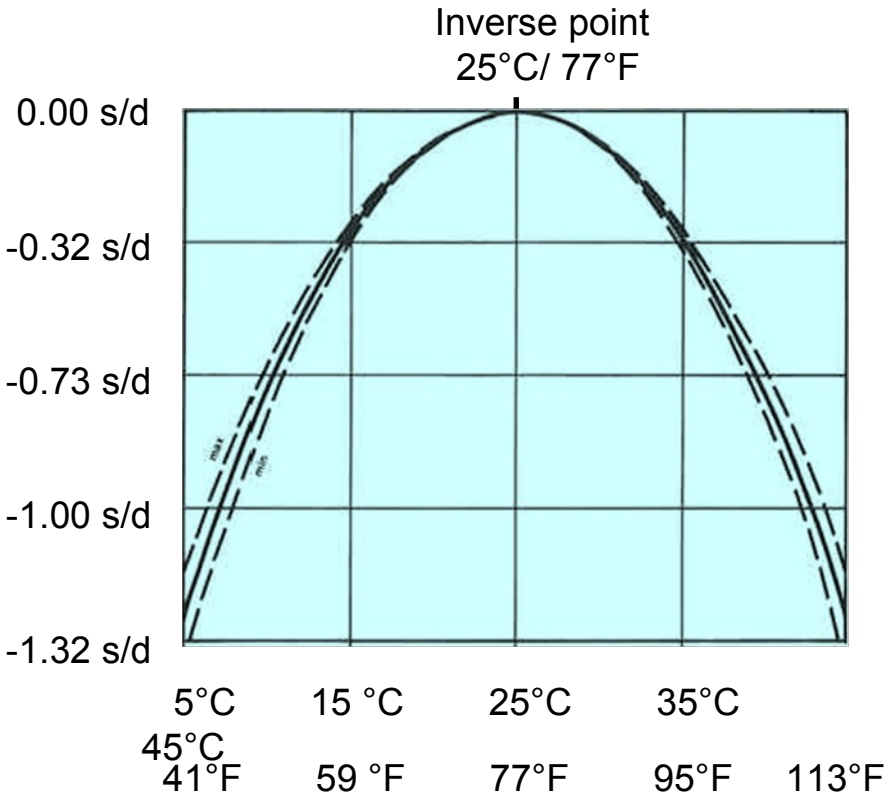
# Quartz

## Technical features




### Frequency vs. Temperature Dependency

Original formula:

$$\frac{\triangle F}{Fo} = \mathbf{0.038}\ \frac{ppm}{°C2}\ (T-To)\ 2\ +/-\ 10\%$$

**1 ppm** = $\frac{86400\ sec/\ day}{1'000'000}$ = **0.0864 sec/day**

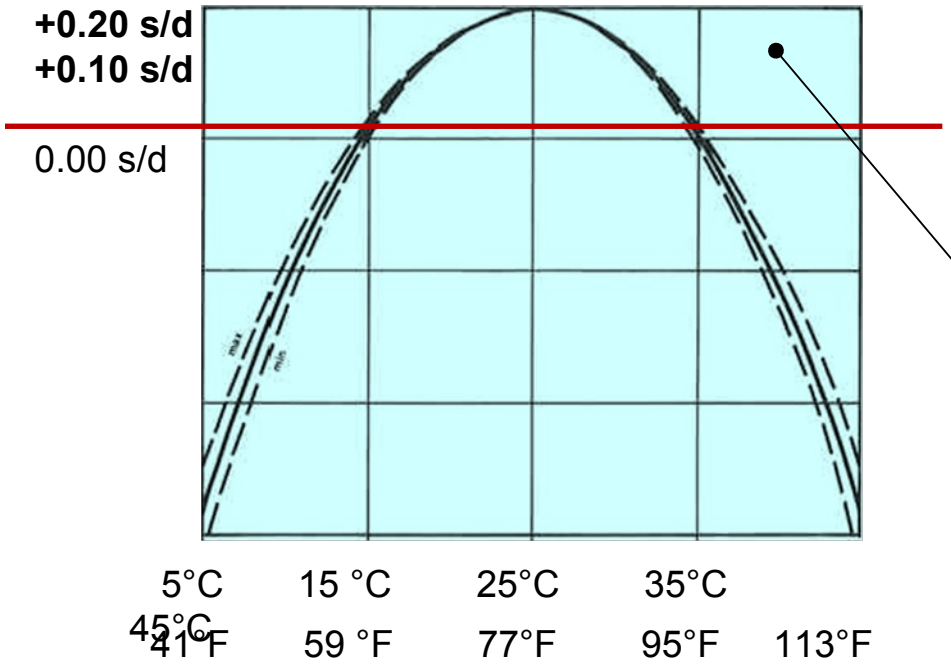
**Calculation Example:**

Delta Temperature to Inverse point = 10°

0.038 ppm x 0.0864 s/d x 10°/2 (100°) = **- 0.32 s/d**

# Quartz

## Conclusion / Adjustment




At room temperature, the quartz rate on movments with variable trimmer systems should be adjusted always on a level of

+ 0.10 to + 0.20 seconds / day

**Never** on 0.00 seconds per day or less (minus values)



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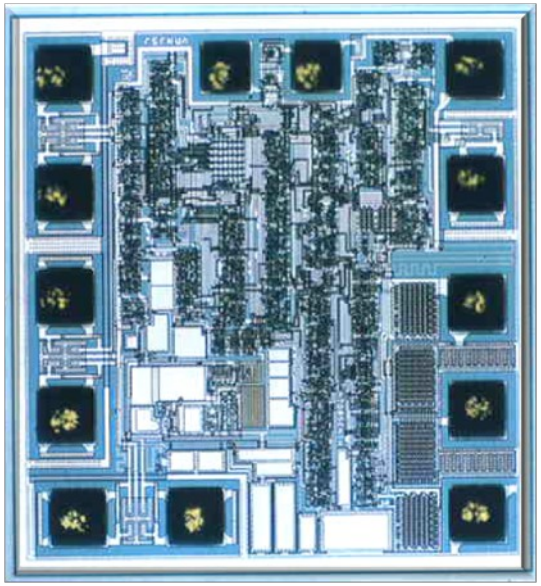
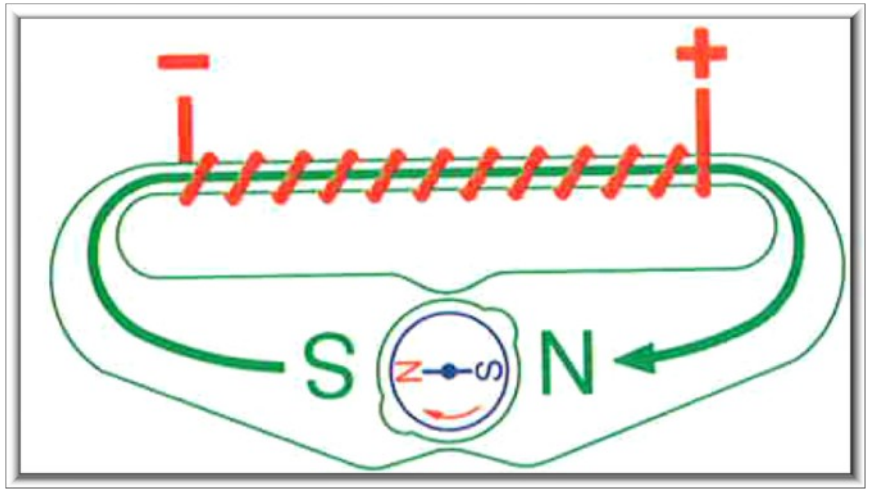
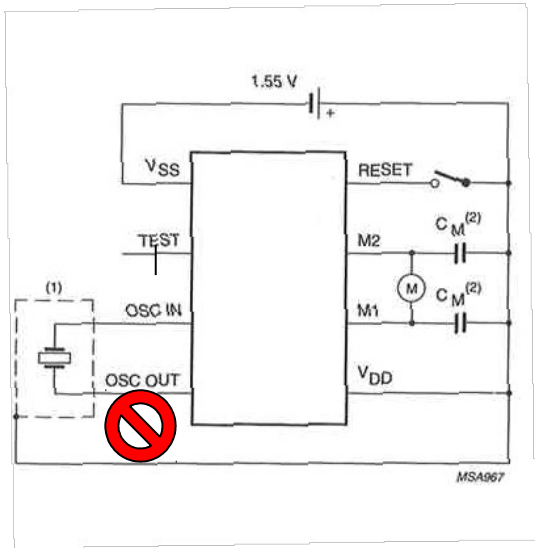
# IC and Stepping motor



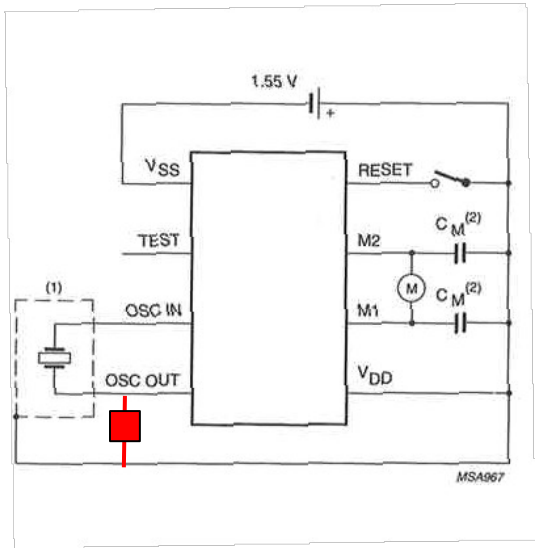


# IC

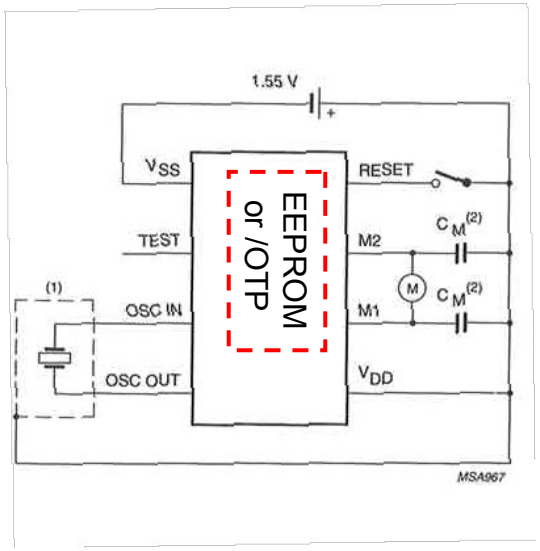
## Rate adjustment systems




Adjustable oscillator frequency by trimmer (old system)




Oscillator frequency adjusted by fix cap. (e.g. Used for stop watches)




Rate adjusted by Inhibition systems
- EEPROM (re- programmable)
- OTP (one time programmable)



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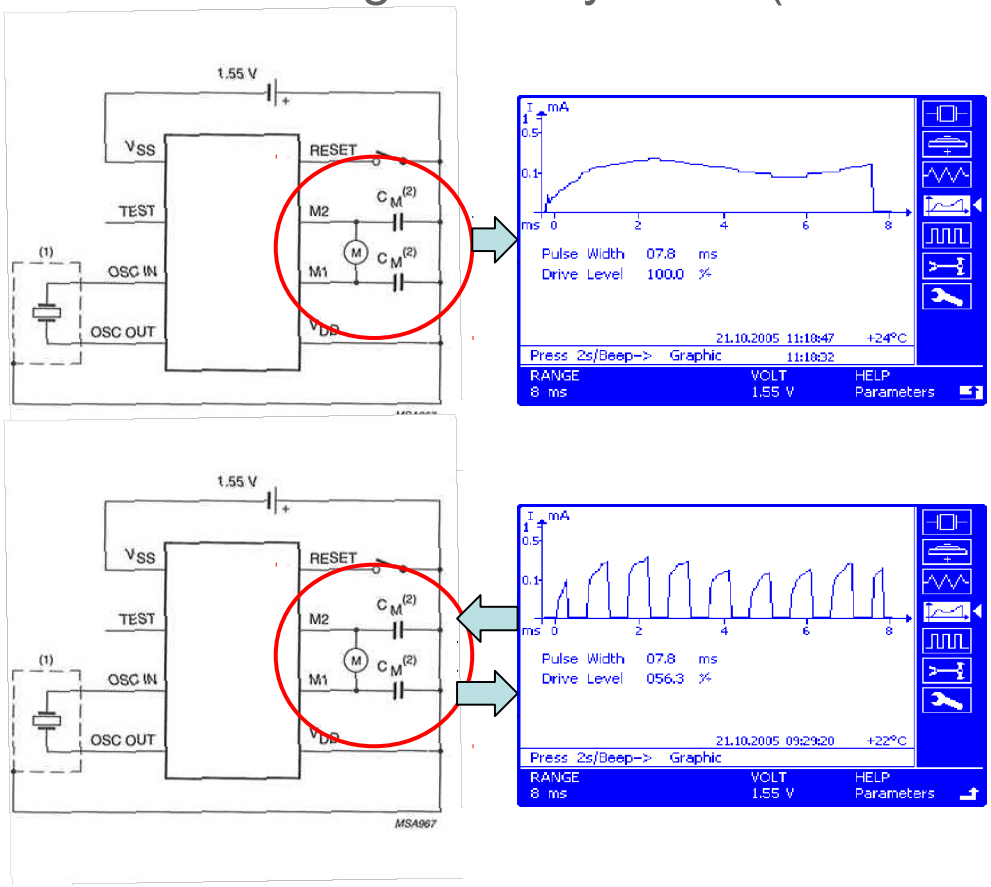
# IC

## Motor-Management systems (asservicement)




IC Type without asservicement.
Motor output: Fixpulse
Without any contol of the requested minimum energy to move the hands.
Mainly used in cheap calibers

IC Type with asservicement.
Motor output: Chopped puls
Two-way contol between rotor and IC.
Management of the requested minimum energy to move the hands and to extend the service life of the battery.
Mainly used in sophisticated movements. (ETA /Ronda/ Miyota)



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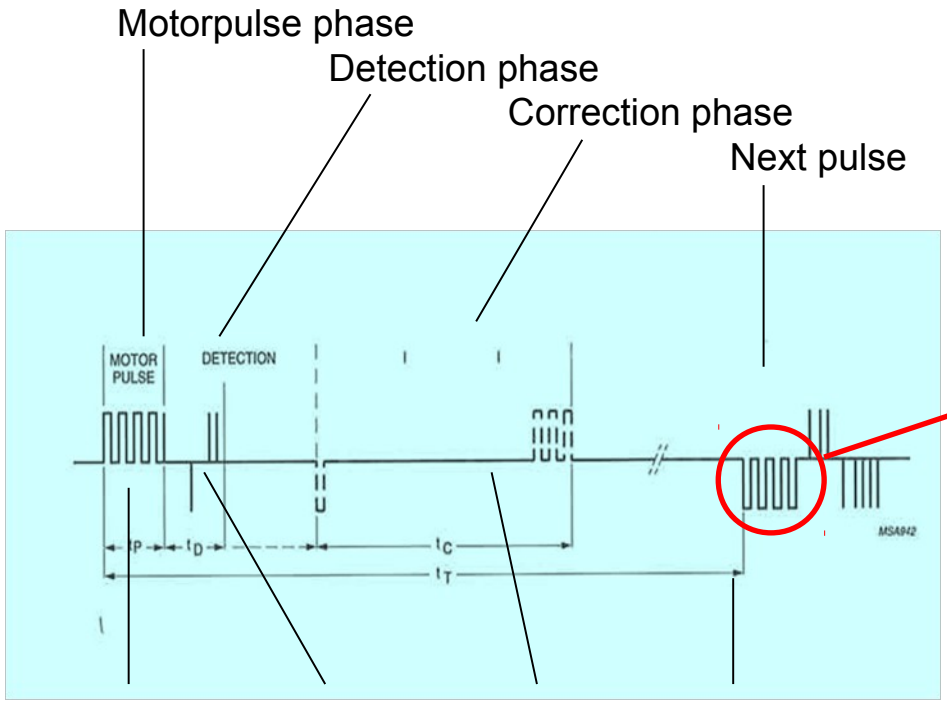
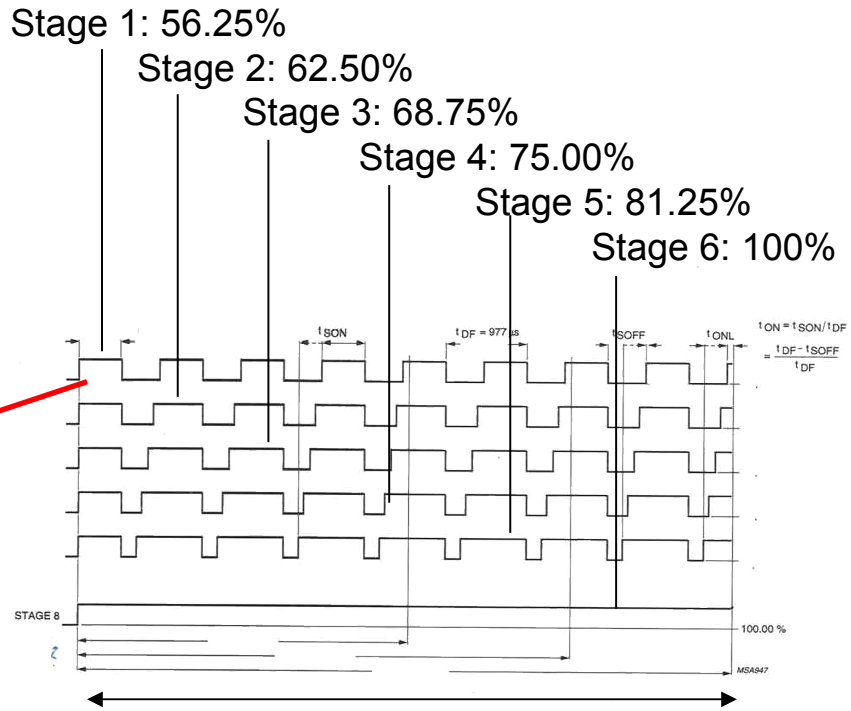
# IC

## Motor- Management function (asservicement)




4- 12 ms / 20-30ms / 30-35 ms / 1 second

Timing




Time: 4 – 12 milliseconds ( ms )



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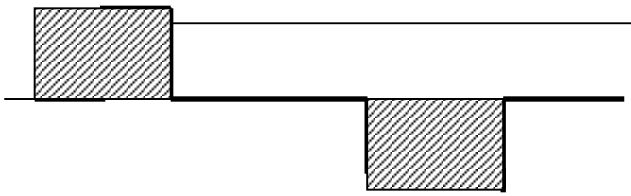
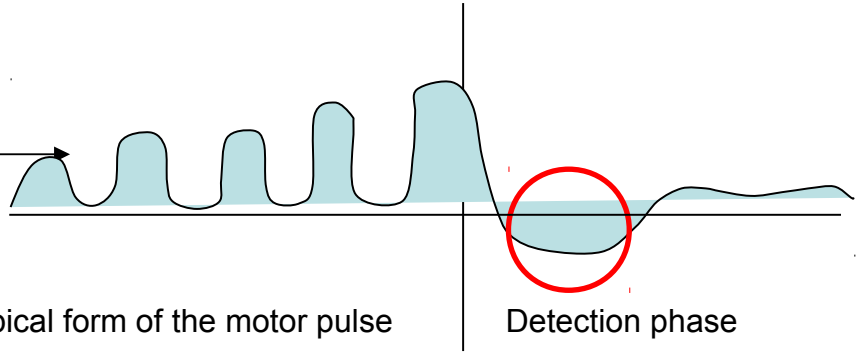
# IC - Motor-Management

Function mode of the motor drive stages of watch IC with adaptive pulses (asservissement)

Symbolically drawn motor pulses ( + / - )

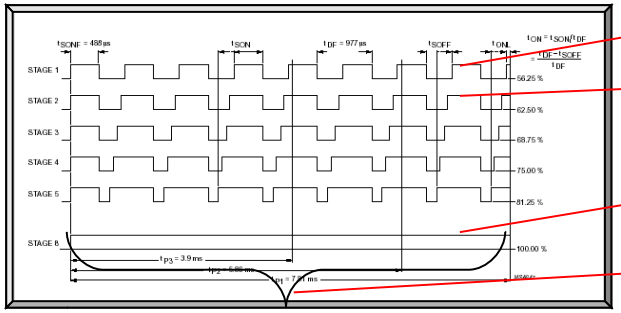




Typical form of the motor pulse

Detection phase (- Voltage)

Data sheet (Philips). Typical watch IC with adaptive motor pulses (asservissement)




Stage 1 = Lowest stage: 56.25% of 7.8ms = 4.38 ms

Stage 2 = 62.50 % of 7.8 ms = 4.87 ms net pulse width

Stage 6 = 100 % of 7.8 ms

Constant pulse width (example 7.8ms)

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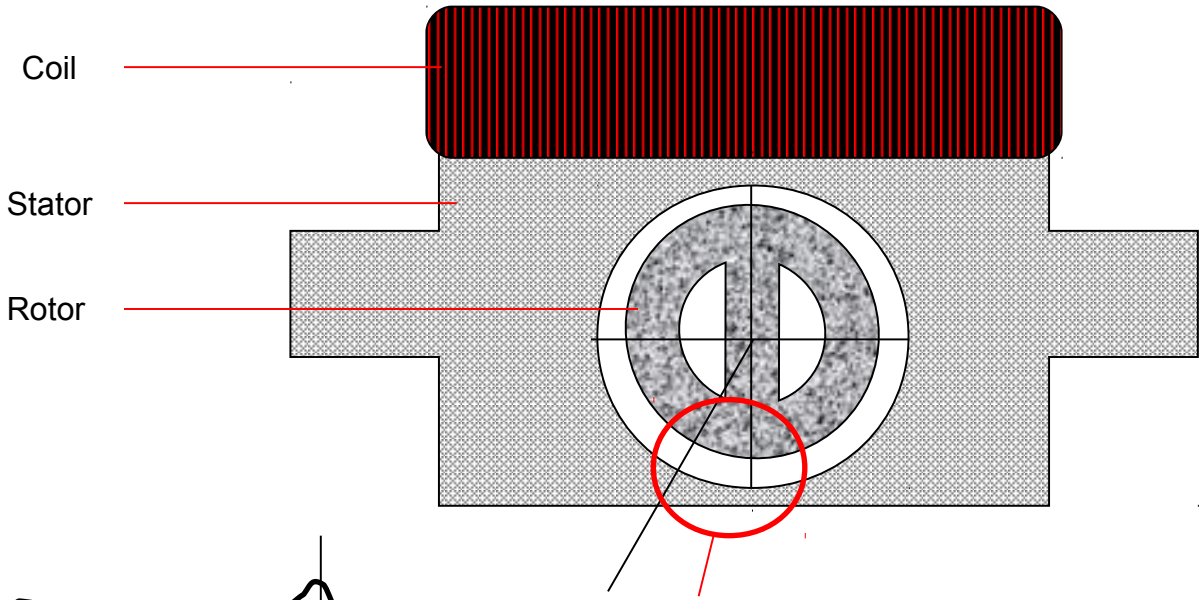
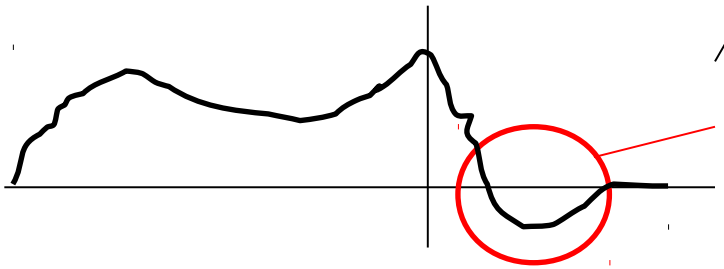
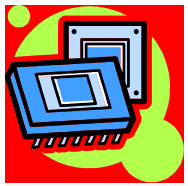
# IC - Motor-Management

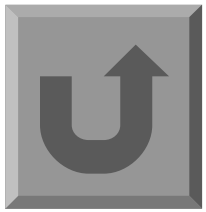
## How does it works?



The return of the rotor **(-Voltage)** will be confirmed to the IC as „successful executed step“





# Systematic troubleshooting | Quartz Watches

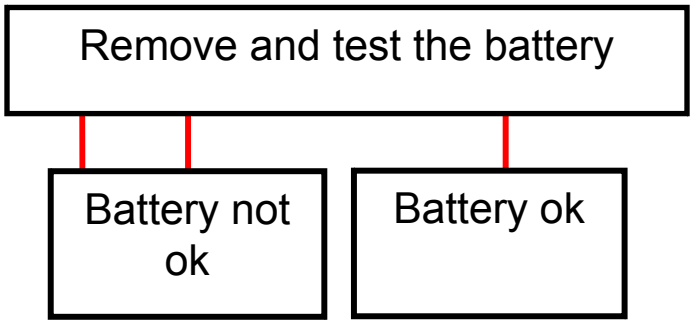
**Tests and settings**

**Battery test**
*TESTMODE MODULE: battery test*

**Caution:**
**Always** check the movement for corrosion and the **insulation** of the battery case!

**Test sequence**

Situation: watch stopped



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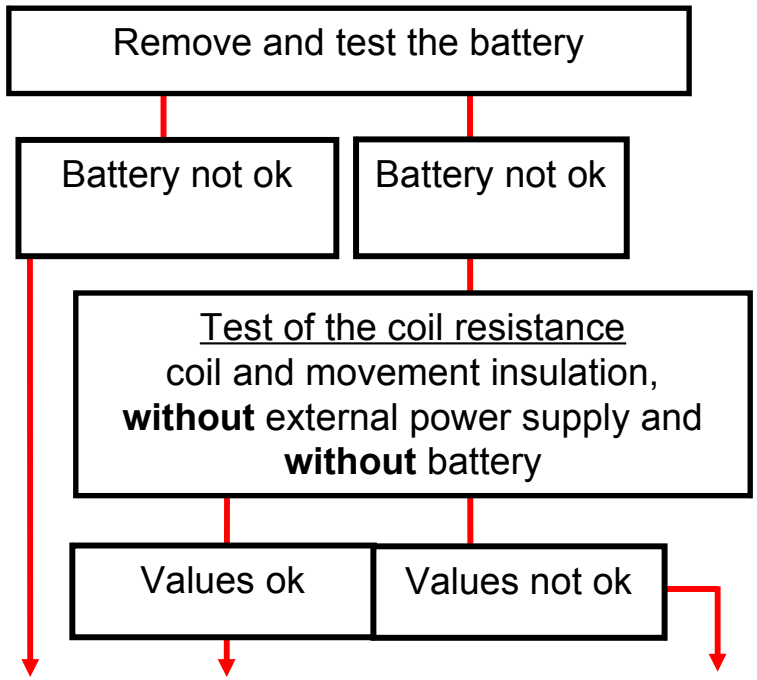
# Systematic troubleshooting | Quartz Watches

**Battery test**
*TESTMODE MODULE: battery test*
**Caution: Always** check the movement for corrosion and the **insulation** of the battery case!

**Test of the coil resistance and of the insulation values:**
*TESTMODE MODULE: resistance*

Situation: watch stopped



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# Systematic troubleshooting | Quartz Watches

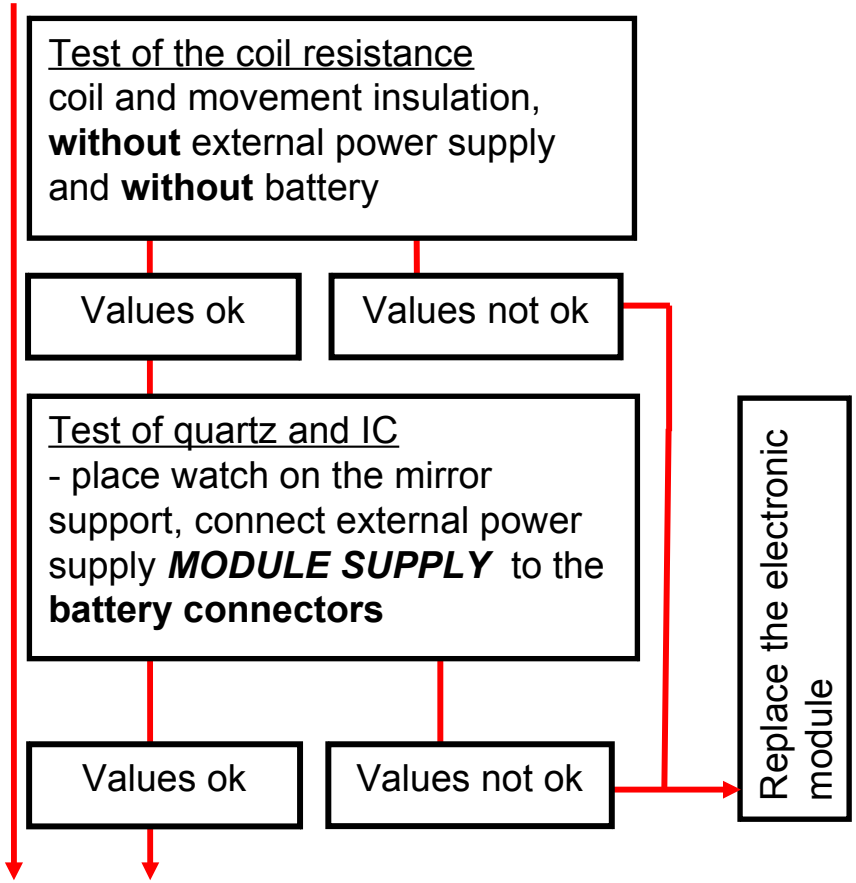
**Test of the coil resistance and of the insulation values:**

*TESTMODE MODULE: resistance*

**Test of the quartz and IC operation:**

*TESTMODE RATE: stepp.motor*
*TESMODE MODULE: cons. µA*
*PARAMETER: supply voltage* 1.55V-3.00V

**- Winding stem - POS: Reset**



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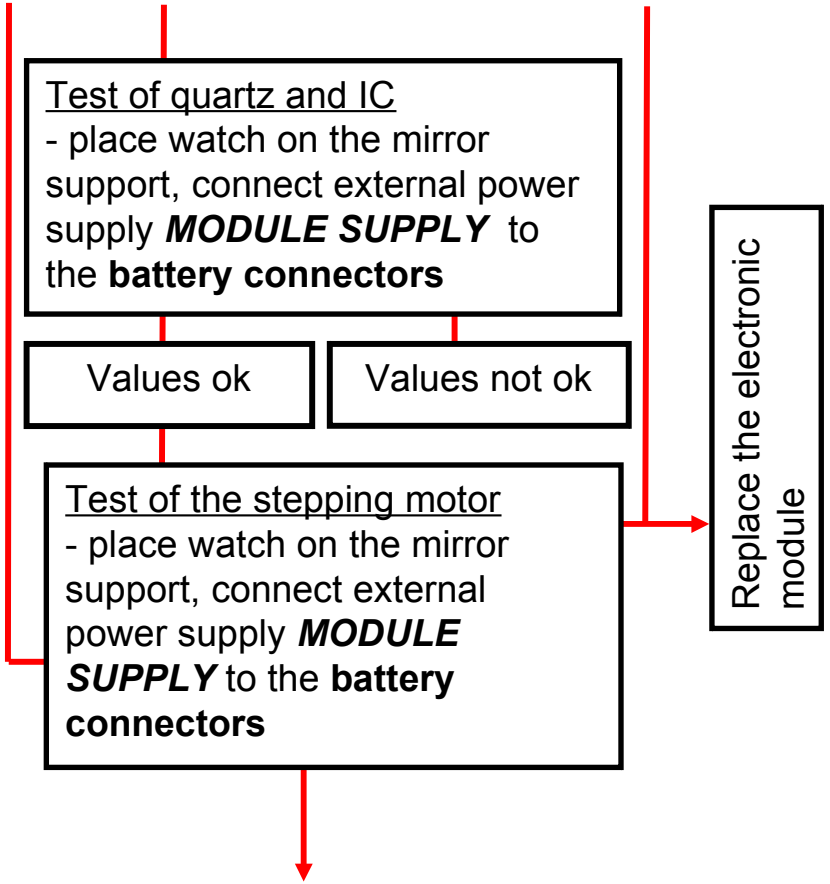
# Systematic troubleshooting | Quartz Watches

**Test of the quartz and IC operation:**
*TESTMODE RATE: stepp.motor*
*TESMODE MODULE: cons. µA*
*PARAMETER: supply voltage* 1.55V - 3.00V

**- Winding stem - POS: Reset**

**Test of the stepping motor:**
**- Winding stem - POS: <u>Neutral</u>**
*TESTMODE RATE: stepp motor*
*TESTMODE MODULE: cons. µA*
*PARAMETER: supply voltage* 1.55V - 3.00V
*meas.time rate =>* 60 s
*meas.time cons.* 60 s
*TEST CONTROL: start test*



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# Systematic troubleshooting | Quartz Watches

**Test of the stepping motor:**
**- Winding stem - POS: <u>Neutral</u>**
*TESTMODE RATE: stepp motor*
*TESTMODE MODULE: cons.* µA
*PARAMETER: supply voltage* 1.55V - 3.00V
*meas.time rate =>* 60 s
*meas.time cons.=>* 4 s
*TEST CONTROL: start test*

**Test of the starting voltage**
- Same test as stepping motor;
- battery test tip with RT/T measuring point of the movement

**Start with:**
*PARAMETER: supply voltage 1.55-3.00V*
Voltage reduced until the movement stops

<u>Test of the stepping motor</u>
- place watch on the mirror support, connect external power supply ***MODULE SUPPLY*** to the **battery connectors**

<u>Test of the lower starting voltage</u>
- place watch on the mirror support, connect external power supply ***MODULE SUPPLY*** to the battery connectors, **and the negative test probe with RT/T**

Values ok
**- new battery**
**- close watch**

Values not ok

# Systematic troubleshooting | Quartz Watches

**Test of the starting voltage**
- Same test as stepping motor;
- battery test tip with RT/T measuring point of the movement

**Start with:**
*PARAMETER: supply voltage 1.55-3.00V.* Voltage reduced until the movement stops

Mechanical test

Test of the lower starting voltage
- place watch on the mirror support, connect external power supply ***MODULE SUPPLY*** to the battery connectors
- **minus** battery test tips **to the test point RT/T** of the movement

Values ok
**- new battery**
**- close watch**

Values not ok

**Important mechanical tests:**
- steel particles block the rotor/gear train
- particles between crown and case block the reset mechanism
- hands touch the inside face of the glass
- hands have no axial freedom
- Calendar mechanism

# Service philosophy for quartz watches

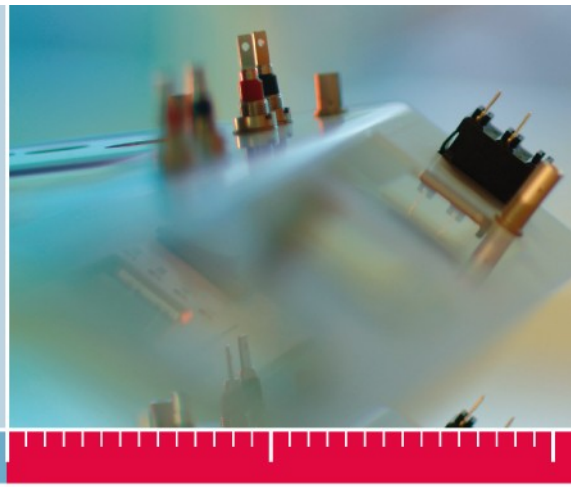
What is the difference between the quality of service for mechanical-  and quartz watches ?

Expensive mechanical watch for 10‘0000 $

Expensive jewelery quartz watch for 10‘0000 $

The difference is **<u>zero (0) $.</u>**
Equivalent to the requested service quality from the customer

# Thank you for your attention



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