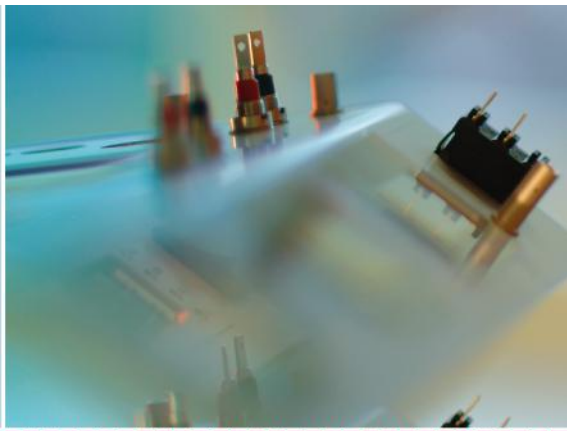
Welcome to witschi



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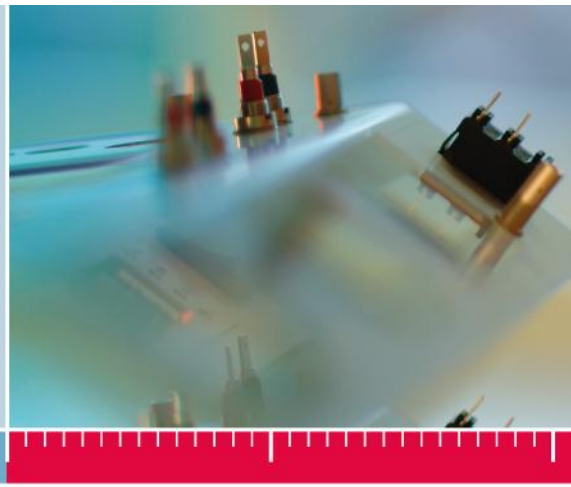
Welcome to the presentation
Quartz Watch Knowledge for Professionals



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Contents

Components in detail

- Batteries
- Quartz
- IC / rate adjustment systems
- Control of the stepping motor (asservissement)

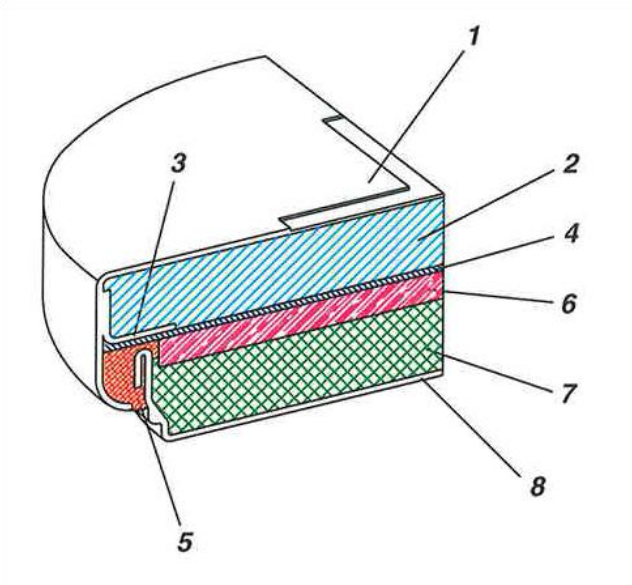
Systematic trouble shooting

Calculation of the battery service life

Service philosophy – Quartz & Mechanical Watches

Batteries

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



1: Can

2: Cathode (AG20)

3: Support ring

4: Separator

5: Gasket

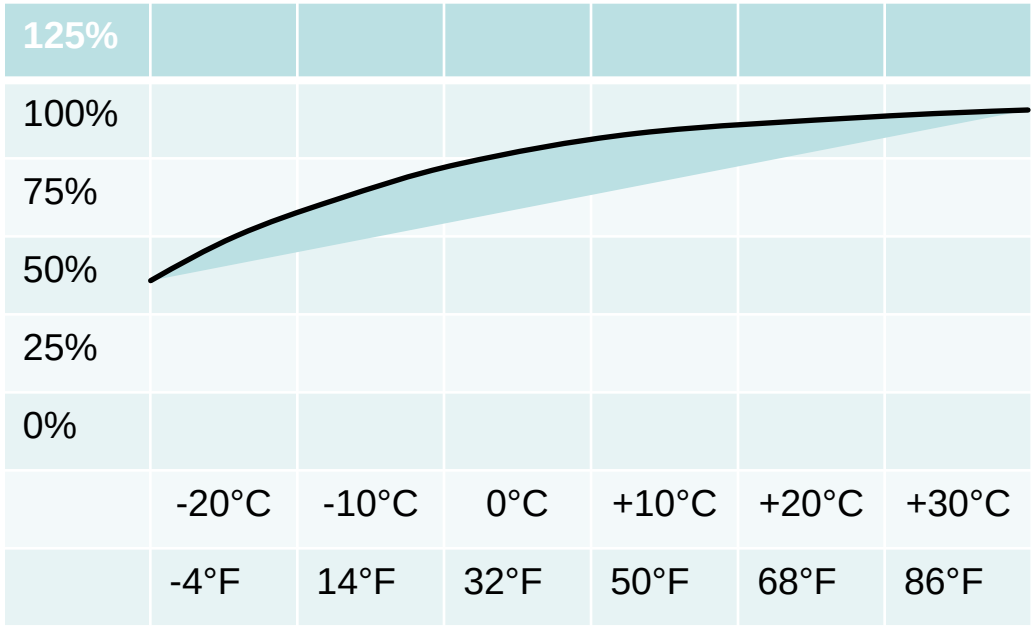
6: Electrolyte (NaOH /Sodium or KOH / Potassium)

7: Anode material (Zn)

8: Cap

Batteries

Capacity dependence on temperature



Example:

175 mAh Capacity

for type 357

Typical temperature effect on miniature silver oxide batteries

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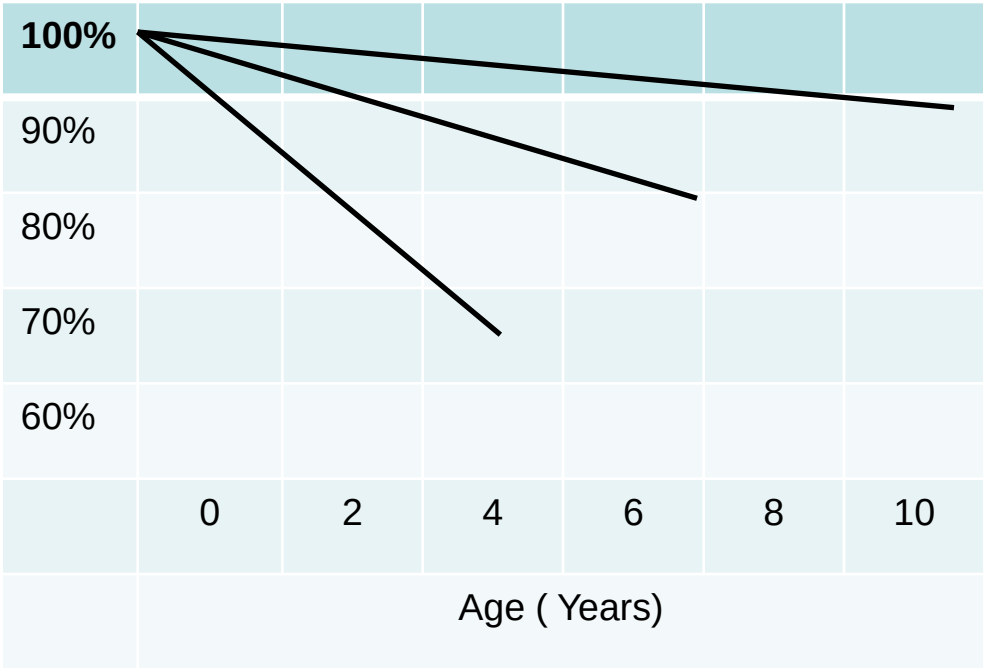
Batteries

Typical self discharge rate at different storage temperatures



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

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

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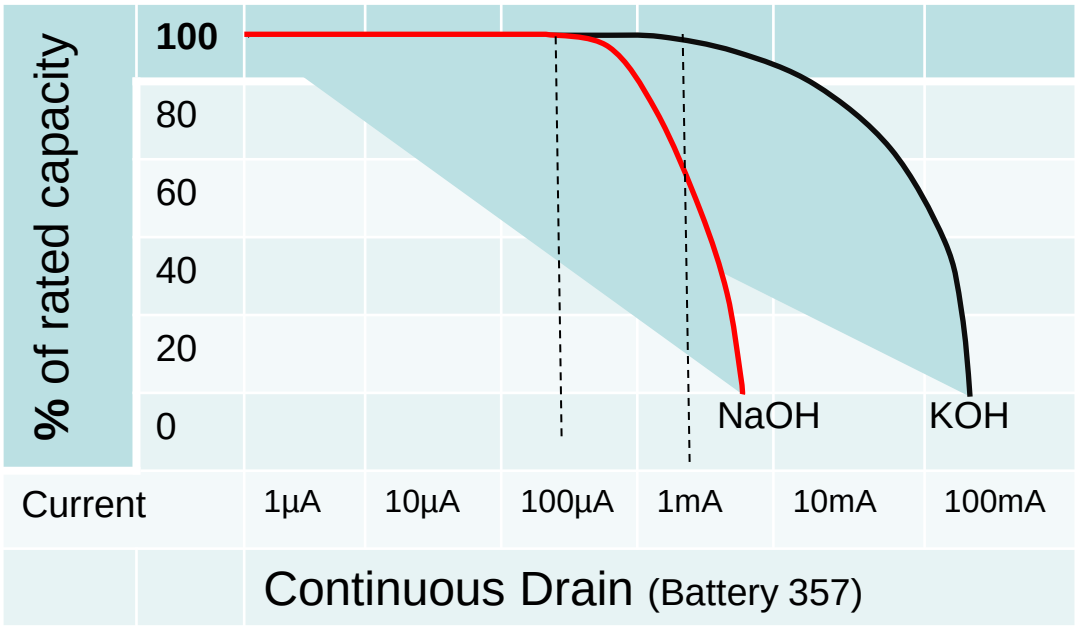
Batteries

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	1.5µA	24 h	36µAh	**36µAh**
Chrono	Not needed	→	→	
Alarm	Not needed	→	→	

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

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Batteries

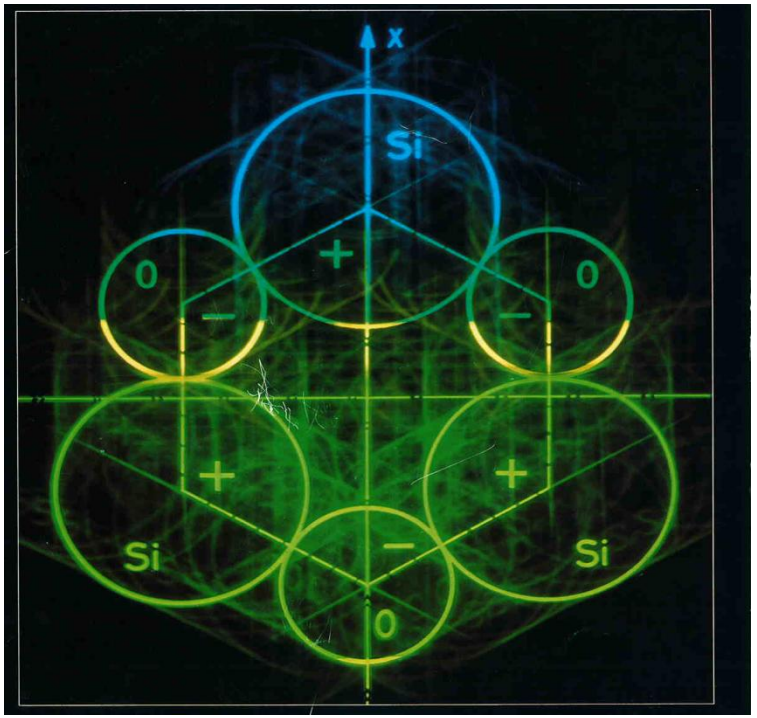
Calculation of battery life under different user conditions:

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	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



Quartz

Construction

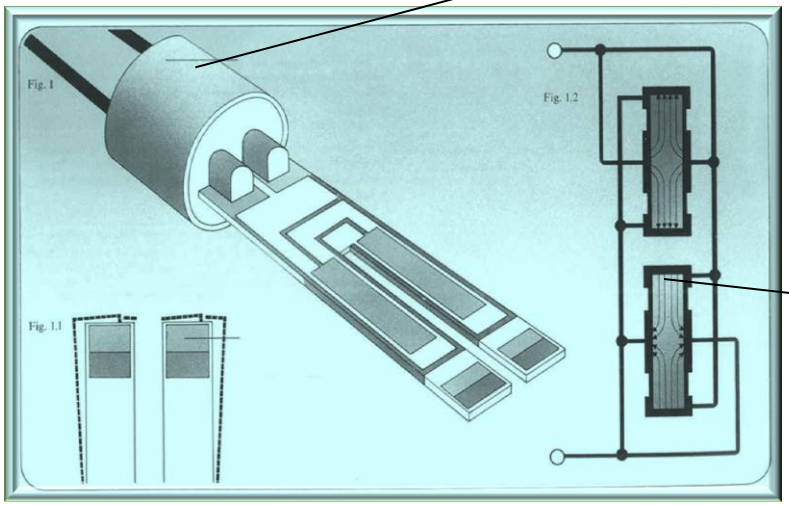


Fig. 1 and 1.1

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

Its two branches are animated by an anti-parallel oscillatory movement (flexion) 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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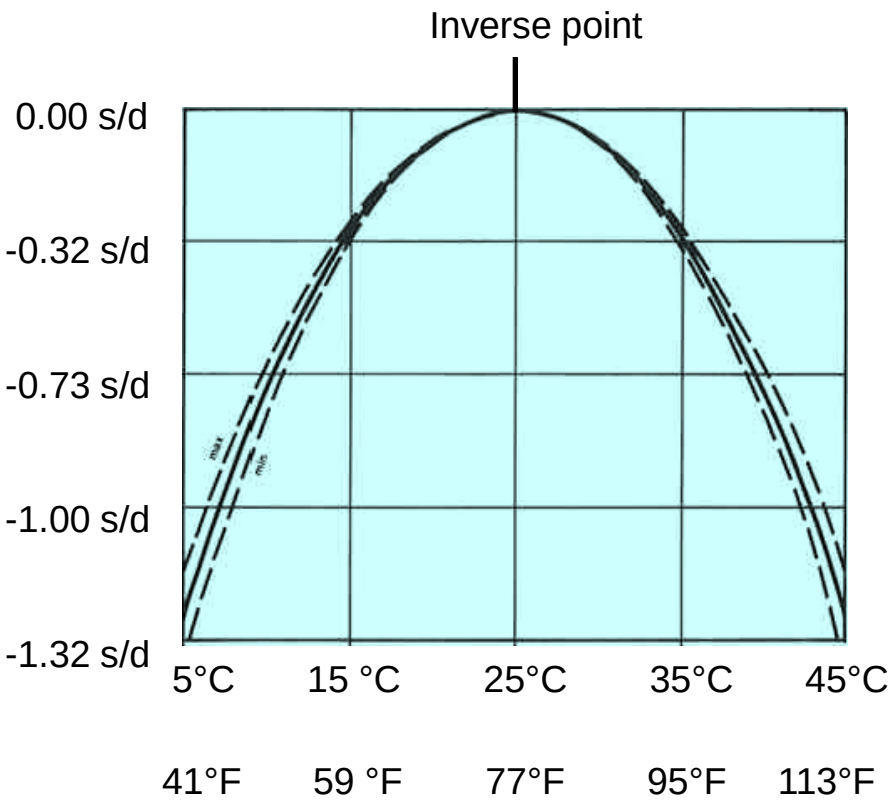
Quartz

Technical features



Dependency

Frequency / Temperature

Formula:

$$\frac{\triangle F}{Fo} = \mathbf{0.038}\ \frac{ppm}{°C_2}\ (T\text{-}To)_2 \pm 10\%$$

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

Calculation Example:

Temperature difference to the Inverse point
= 10°C/ 18°F

0.038 ppm x 0.0864 s/d x 10°C/2 (100°C)

= **- 0.32 s/d**

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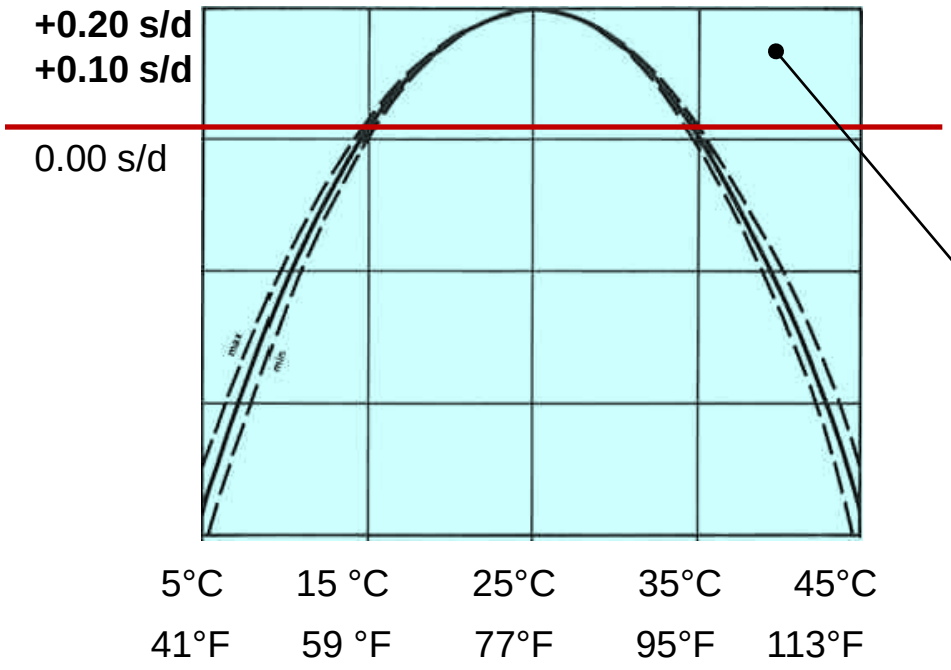
Quartz

Conclusion / Adjustment

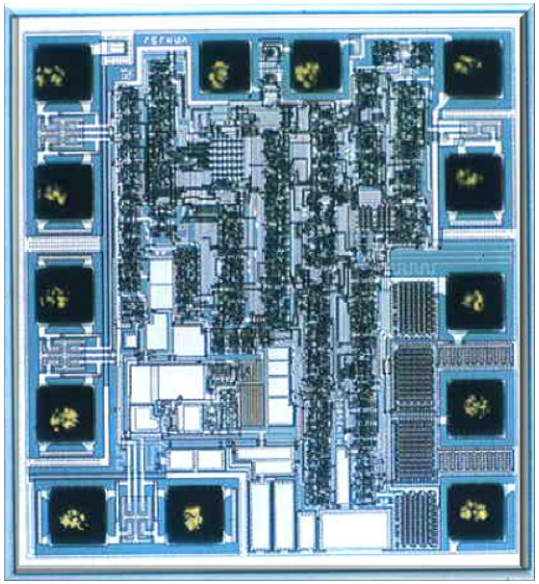


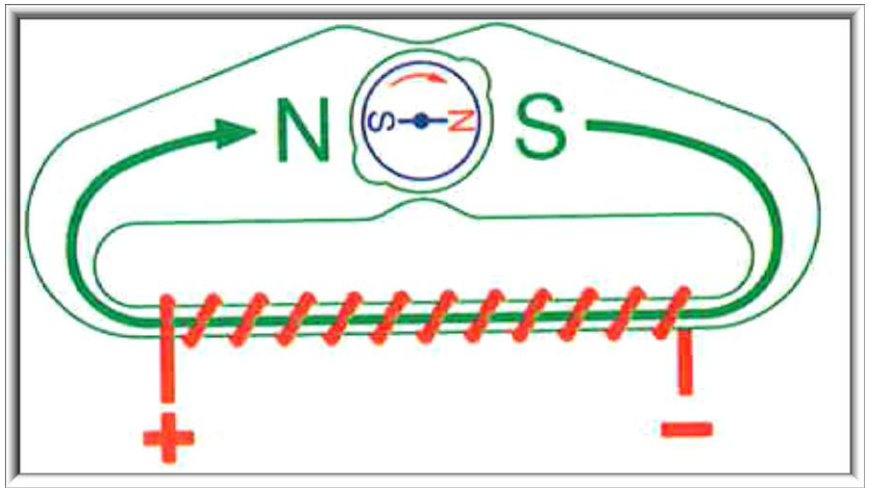
At room temperature, the rate accuracy on movements with trimmer systems should be adjusted on a level of

+ 0.10 to +0.20 seconds / day.

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

IC and Stepping motor





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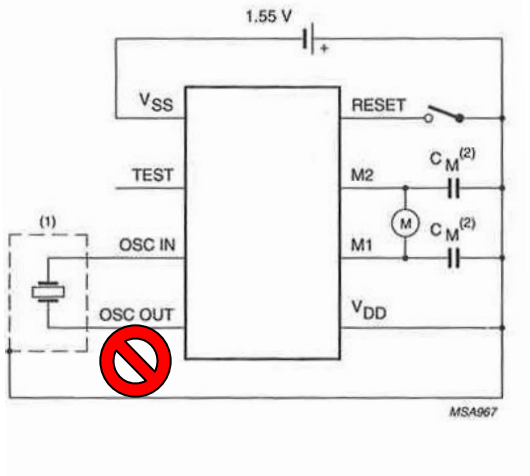
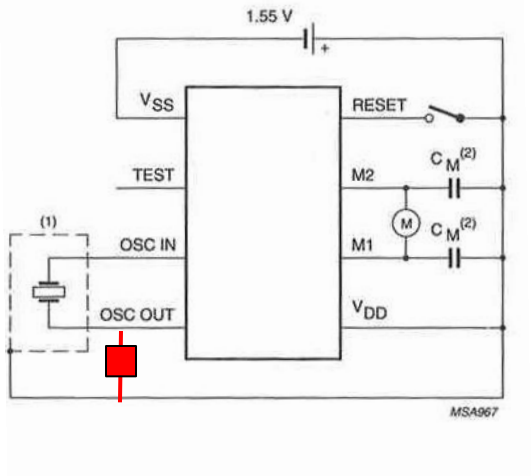
IC

Rate adjustment systems



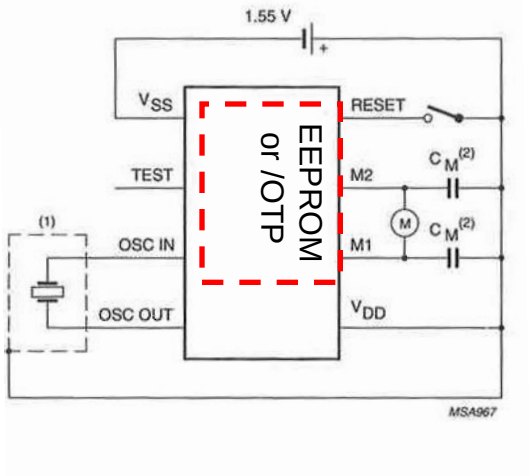
Adjustable quartz oscillator frequency by trimmer

(out dated)



Adjustable quartz oscillator frequency by fix cap

(e.g. Used for stop watches)



Rate adjustment by programmable inhibition system

- EEPROM (reprogrammable)
- OTP (one time programmable)

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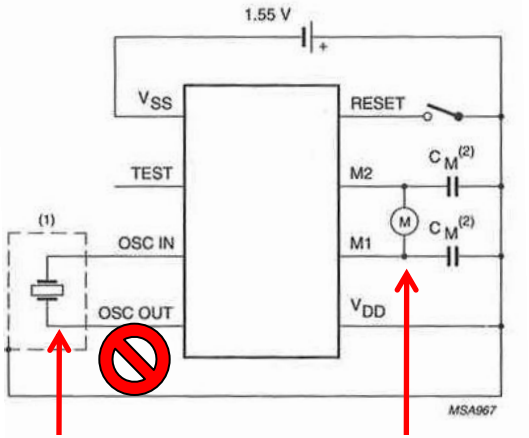
IC

Rate adjustment systems

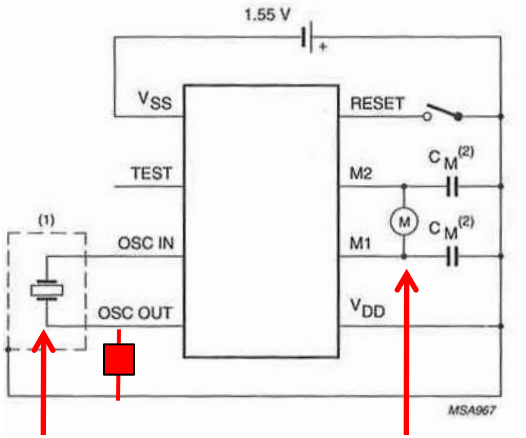
Trimmer system



Same test result with signal capture over quartz frequency or over motor pulses.

Rate is adjustable by service center

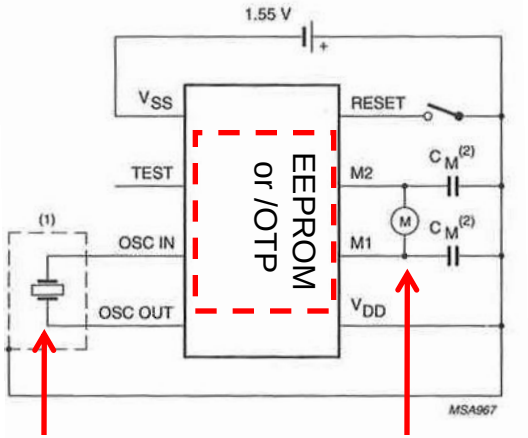
Fix cap system



Same test result with signal capture over quartz frequency or over motor pulses.

Adjustment in the production process

Inhibition system (digital)



After Inhibition time (10/ 60/120s) Different test result with signal capture over quartz frequency or over motor pulses.

Adjustment in the production process

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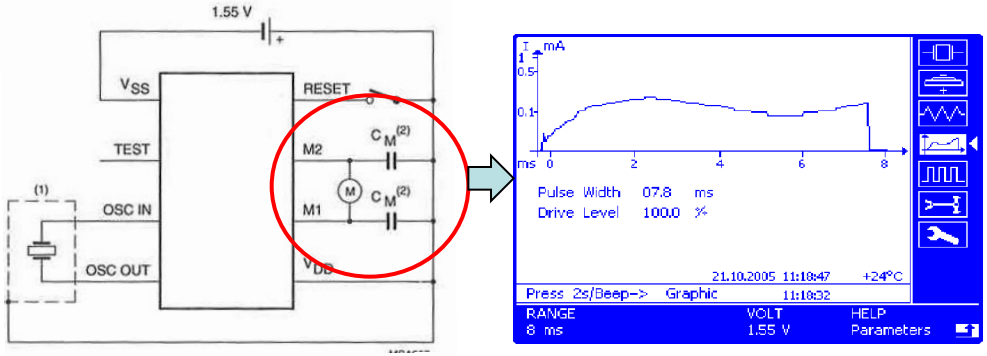
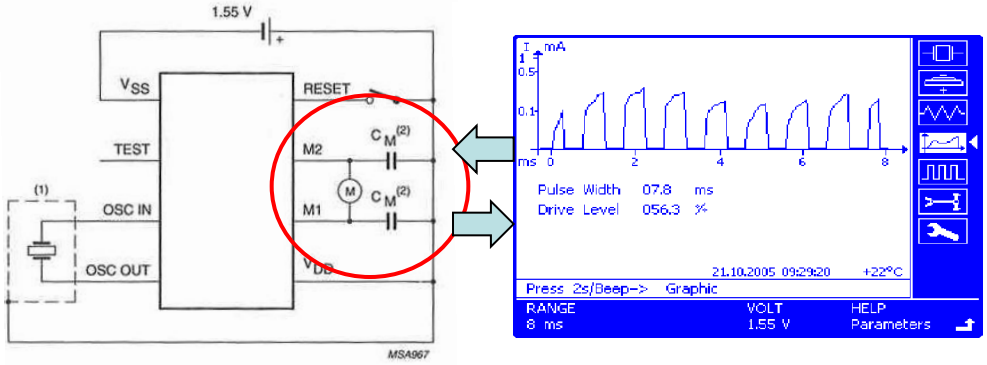
IC

Motor-Management systems (Asservissement)



IC without asservissement.
Motor pulse not chopped and with constant pulse width – it is not suitable for lower current consumption.
Mainly used in low cost calibers.



IC Type with asservissement.
Chopped motor pulses with two-way control between rotor and IC.
Power management to reduce the energy for moving the hands and to extend the battery life.
Mainly used in sophisticated movements.

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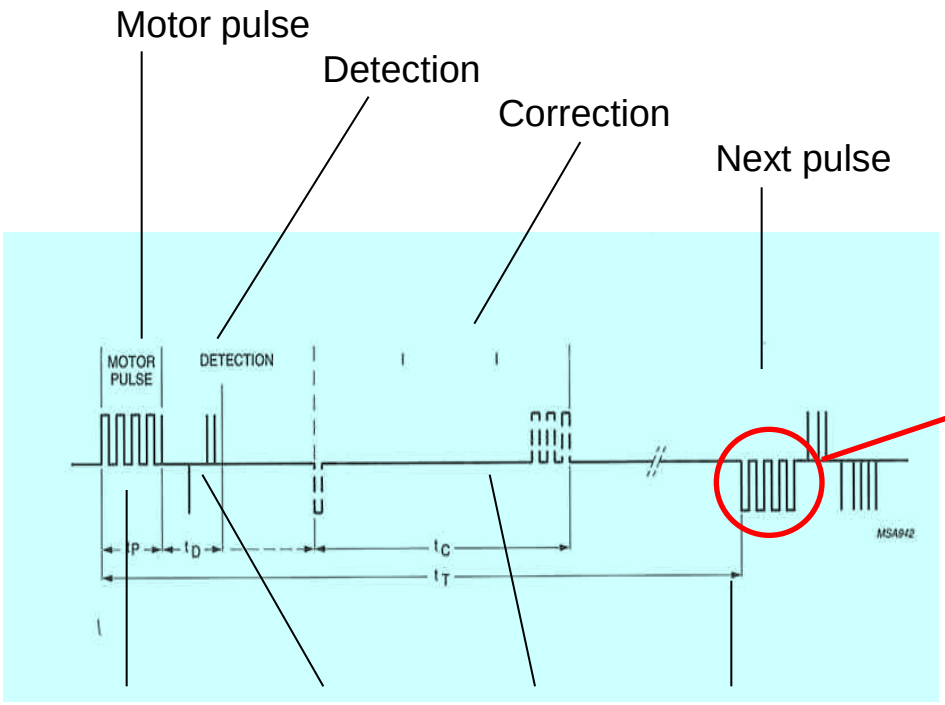
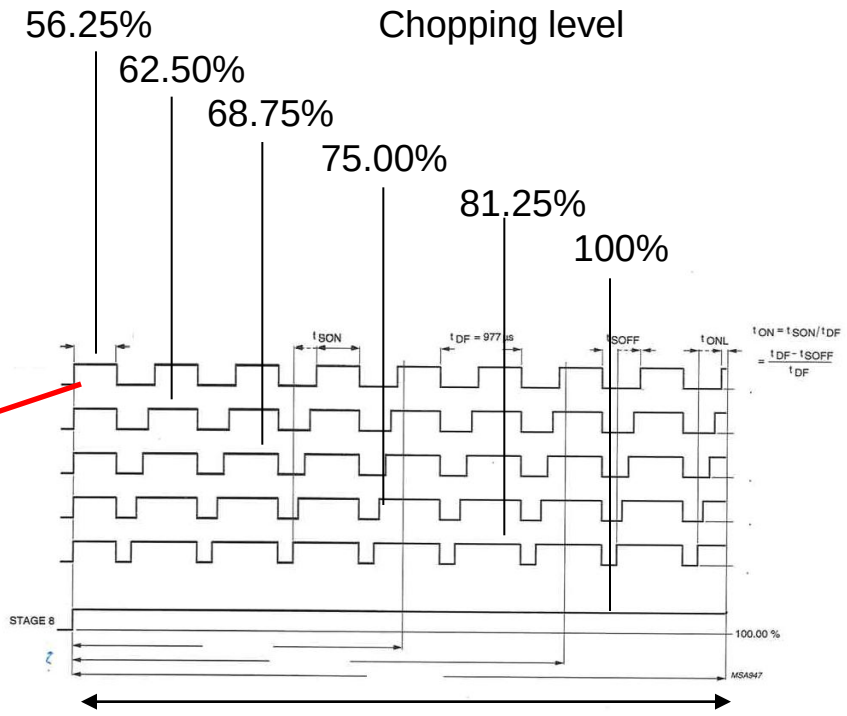
IC

Motor- Management function (Asservissement)



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

Timing



Time: 4 – 12 milliseconds (ms)

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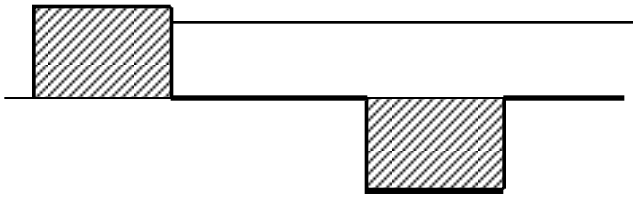
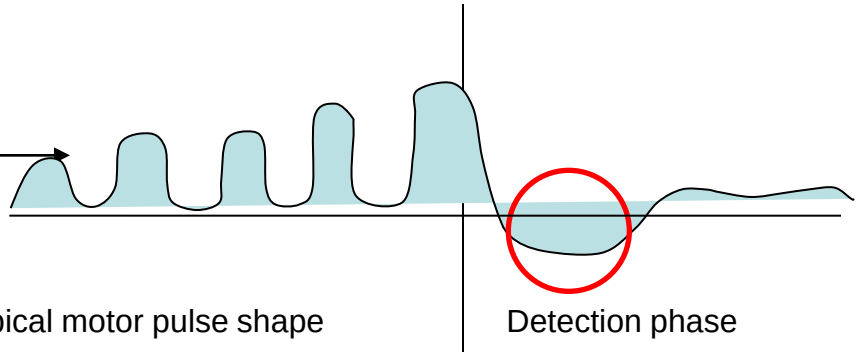
IC - Motor-Management

IC with adaptive motor pulses
(Asservissement)
Function mode of the motor drive stages.

Symbolically drawn motor pulses (+ / -)



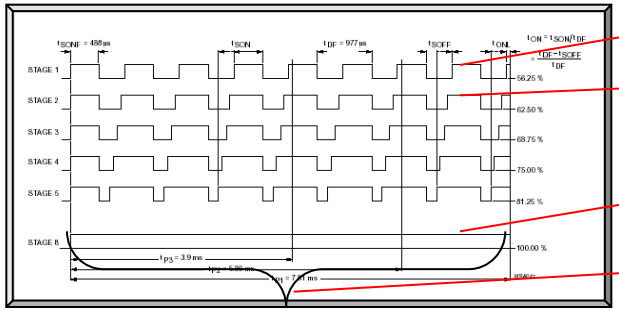


Typical motor pulse shape

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

Stage 6 = 100 % of 7.8 ms

Constant pulse width (example 7.8ms)

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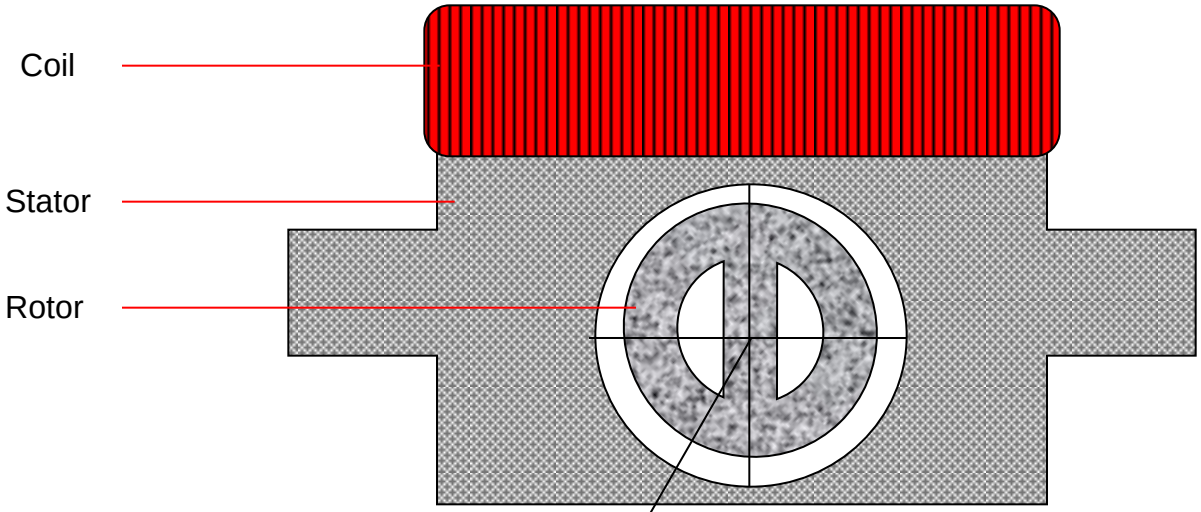
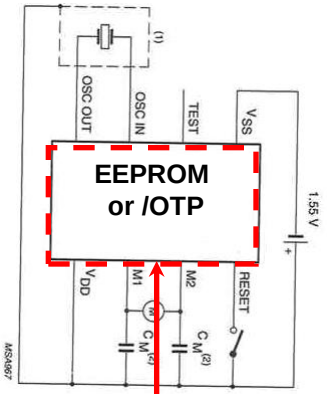
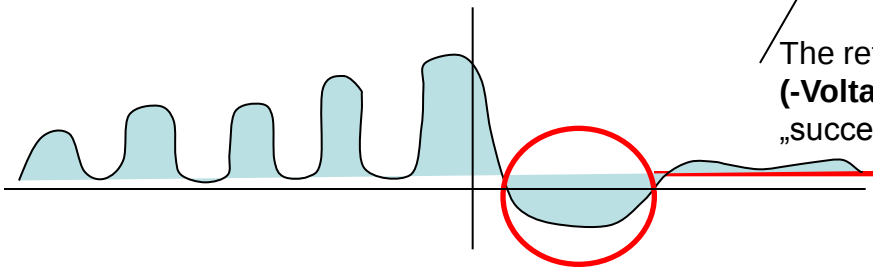
IC - Motor-Management

How does it work?







The return of the rotor **to the initial position (-Voltage)** will be detected by the IC as „successful executed step“.

O.K. Next Step

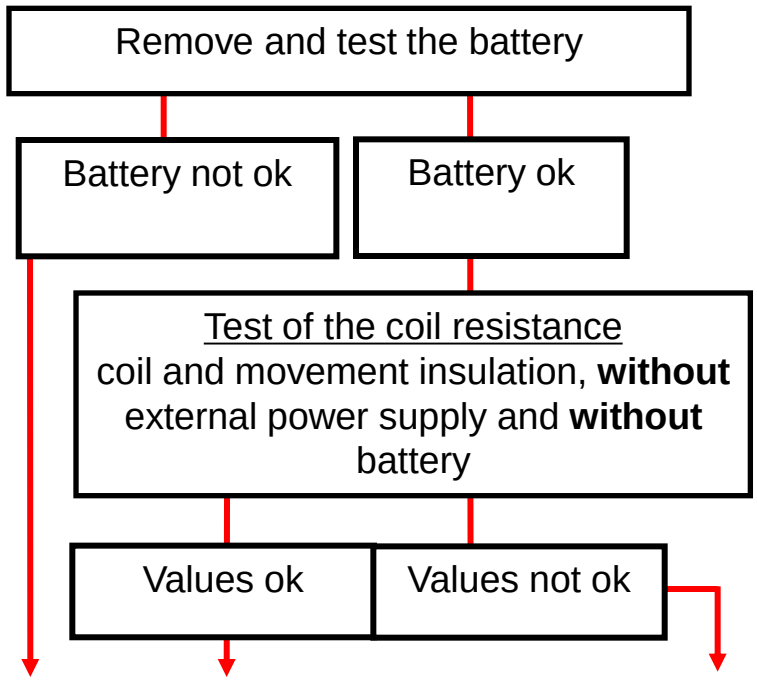
Systematic troubleshooting | Quartz Watches

Select ***Battery test*** in main menu.

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

Test of the coil resistance and of the insulation values:
Select ***Resistance (coil) test*** in main menu.

Situation: Watch is not running



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Systematic troubleshooting | Quartz Watches

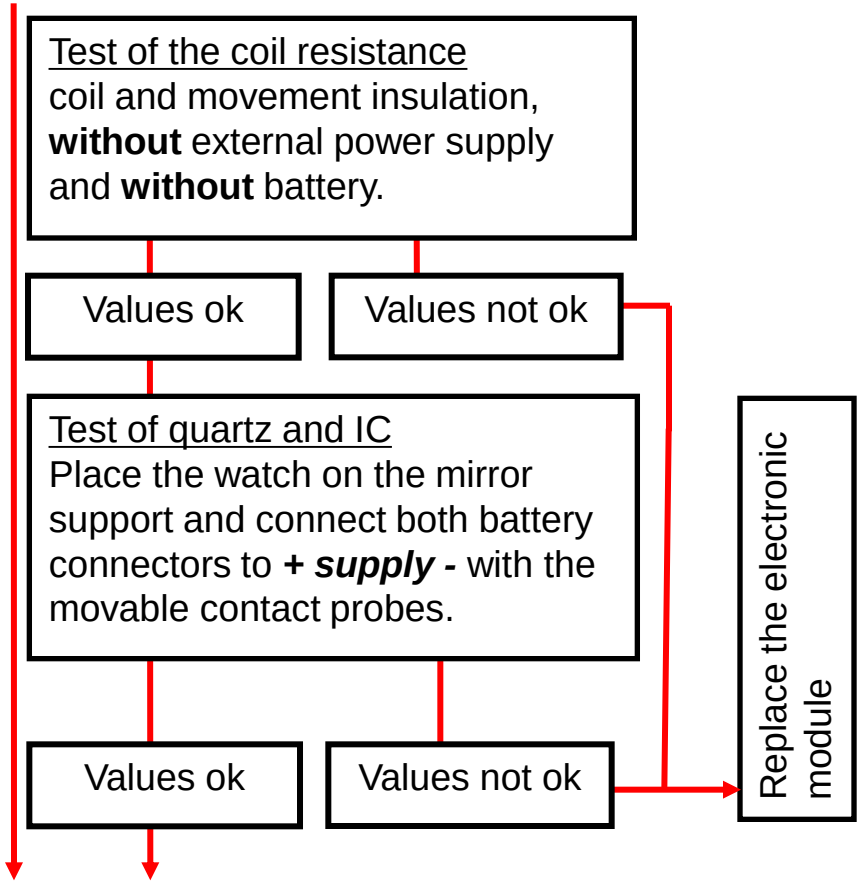
Test of the coil resistance and of the insulation values:
Select ***Resistance (coil) test*** in main menu.

Functional test of quartz and IC

Select ***Rate and consumption test*** in main menu.

SIGNAL: Auto (Cons)
TIME: Auto
VOLT: 1.55V-3.00V

- Winding stem - POS: Reset



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Systematic troubleshooting | Quartz Watches

Test of the stepping motor:
- Winding stem - POS: <u>Neutral</u>
SIGNAL: Auto (Cons)
TIME: 4 s
VOLT 1.55V - 3.00V

<u>Test of the stepping motor</u>
Place the watch on the mirror support and connect both battery connectors to ***+ supply -*** with the movable contact probes.

<u>Test of the lower starting voltage</u>
Place the watch on the mirror support and connect both battery connectors to ***+ supply -*** with the movable contact probes **and the negative test probe with RT/T**

Set voltage to 1.55V / 3.00V. Decrease slowly the voltage until hand stops moving.

Value ok
- Replace battery
- Close watch

Value not ok

Systematic troubleshooting | Quartz Watches

Important visual check

Check if:
- steel particles block the rotor or the gear train
- particles between crown and case block the reset mechanism
- hands touch the inside face of the glass
- hands have no axial freedom
- whether the calendar mechanism functions correctly

Service philosophy for quartz watches

What is the difference between the service quality for Mechanical Watches and for Quartz Watches?

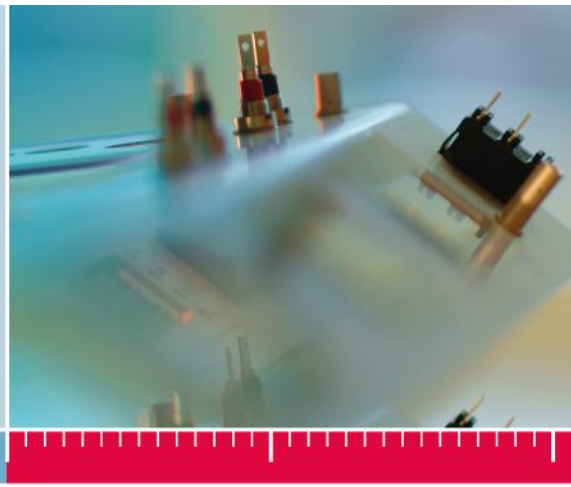
Mechanical Watch in upper price scale

Jewelry quartz Watch in upper price scale

The difference is **nothing!**

Equivalent to the requested service quality from the customer.

Thank you for your attention



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