



METAS-N001/EN

Requirements for the certification of movements and mechanical watches resistant to magnetic fields of 1.5 T (15 000 G)

This document is a translation of the original French text. In the event of discrepancies between the original French text and this document the French text shall prevail

Document number:	METAS-N001/EN
Version:	1.1
Approved on/by:	26.06.2017/GLS (FR-original)

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1 Introduction

This document (hereinafter: the Requirements) describes the certification process for fully mechanical watches. The certification mainly focuses on the watches' water resistance, chronometric performance, resistance to magnetic fields and power reserve.

The certification is based on a test carried out on every movement and every watch by the applicant (or agent thereof). The testing process is independently monitored by the Federal Institute of Metrology (METAS). METAS is the certifying body. The quality system and testing process implemented by the applicant is constantly monitored by METAS. The monitoring first includes the analysis of the results obtained by the applicant, followed by checks on samples taken by METAS.

This document includes two parts. Part A describes the technical requirements that must be met by each watch to get a certification. Part B describes the organisational requirements for the monitoring by METAS of the applicant's quality system and verification processes.

2 Conditions for certification and designation

The watch must satisfy the following conditions:

1. The watch must be "Swiss Made" and meet the requirements stated by ordinance of December 23 1971 on the use of the designation "Swiss" for watches (RS 232,119), in its latest current version.
2. The movement must be certified as a "chronometer" according to ISO 3159:2009 by an accredited laboratory ISO/IEC 17025:2005.
3. The movement and the watch must undergo test cycles (see Chapter 6) and meet the technical criteria (see Chapter 7).
4. METAS monitors the test results of the laboratory by carrying out a statistical analysis and checks on random samples (see Chapter 9).
5. The testing laboratory has a quality system approved by METAS (see chapter 10).

If all these conditions are met, the watch is certified as compliant with these Requirements. It may be given the designation "MASTER CHRONOMETER Certified 15 000 Gauss" (or shortened to "MASTER CHRONOMETER")

For watches certified as MASTER CHRONOMETER, the trademarks listed below may be used on the watches or in the sales literature:

a)



Registration number 684356

b)



MASTER CHRONOMETER

Registration number 684511

c)



MASTER CHRONOMETER

CERTIFIED 15'000 GAUSS

Part A: Technical requirements

3 Definitions

3.1 Terms

3.1.1 Applicant

The applicant is the legal entity that manufactures and markets the watches needing certification.

3.1.2 Testing laboratory

The testing laboratory is the entity that carries out the tests needed by the Requirements defined in this document, with the tests to be performed on the entire production certified by METAS. It may be the applicant's in-house laboratory or a third party contracted by the applicant and acting under the responsibility of the said applicant.

3.2 Measurements

3.2.1 Time given H

The time given refers to the time displayed by the watch.

Note: The time given by the reference clock is noted H_R , the time given by the watch tested is H_{DUT} .

3.2.2 State E

The state of the watch is obtained by subtracting the time given by the reference clock H_R from the time given by the watch tested H_{DUT} .

$$E = H_{DUT} - H_R$$

The state E is expressed in seconds (s).

3.2.3 Daily precision P_{Ji}

The daily precision (also called daily rate) indicates by how much time the tested clock is fast (>0) or slow (<0) when compared to the reference clock. The daily precision is calculated by subtracting the state of the watch tested at the time t_1 from the state of the watch tested at time t_2 and by calculating the results over 24 hours. To measure the daily precision, the $t_2 - t_1$ interval must be between 23 hours and 26 hours.

$$P_{Ji} = \frac{E_i(t_2) - E_i(t_1)}{t_2 - t_1}$$

The daily precision is expressed in seconds per day (s/d).

3.2.4 Average daily precision \bar{P}_J

The average daily precision (also called average daily rate) \bar{P}_J is the arithmetic average of the daily precisions for cycles 2, 4, 5 and 6 (see Chapter 6).

$$\bar{P}_J = \frac{P_{J1} + P_{J2} + P_{J3} + P_{J4}}{4}$$

The average daily precision is expressed in seconds per day (s/d).

3.2.5 Instantaneous rate

The instantaneous rate indicates how the instrument tested is fast (>0) or slow (<0) with respect to the reference clock. The instantaneous rate is calculated by subtracting the state of the tested instrument observed at the time t_1 from the state of the tested instrument at time t_2 and by calculating the result over 24 hours. To measure an instantaneous rate, the $t_2 - t_1$ interval should at least exceed 30 seconds. The stabilisation time before taking the first state of the watch must be at least 20 seconds.

$$M_i = \frac{E_i(t_2) - E_i(t_1)}{t_2 - t_1}$$

The instantaneous rate is expressed in seconds per day (s/d).

3.2.6 Deviation from the daily precision E_M

The deviation from the daily precision E_M gives the absolute value of the deviation from the daily precision after exposing the watch to a magnetic field of 1.5 T.

$$E_M = |P_{J3} - P_{J2}|$$

The deviation from the daily precision E_M is expressed in seconds per day (s/d).

3.2.7 Power reserve R_M

The power reserve is the amount of time announced by the applicant during which the watch can operate without external power to the barrel spring.

The power reserve is expressed in hours (h).

3.2.8 Deviation from the instantaneous rate D_E

The deviation from the instantaneous rate D_E gives the absolute value of the deviation between the average instantaneous rate when the watch is fully wound (0 h, M_i) and after 2/3 of the power reserve ($M_{i-1/3}$).

$$D_E = \left| \frac{\sum_{i=1}^6 M_i}{6} - \frac{\sum_{i=1}^6 M_{i-1/3}}{6} \right|$$

The deviation from the instantaneous rate D_E is expressed in seconds per day (s/d).

3.2.9 Deviation from the instantaneous rate D_P

The deviation from the instantaneous rate D_P gives the difference between the largest and smallest instantaneous rate at different positions.

$$D_P = \max(M_1 : M_6) - \min(M_1 : M_6)$$

The deviation from the instantaneous rate D_P is expressed in seconds per day (s/d).

4 Watch categories

The watches tested are categorised according to the fitting characteristics of the movement:

Category	Fitting diameter D / mm	Fitting surface S / mm ²
I_a	$D > 26$	$S > 531$
I_b	$20 < D \leq 26$	$314 < S \leq 531$
II	$D \leq 20$	$S \leq 314$

5 Conditions set for the tests

5.1 Climatic conditions in the testing laboratory

The temperature in the testing laboratory must remain at $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$.

During cycle 10 (see Chapter 6), the environment in the testing laboratory must comply with the ISO 22810:2010 and ISO 6425:1996 standards.

During cycles 1 to 9, the relative humidity in the testing laboratory must remain between 30% and 70%, except in the storage area at 33°C where a relative humidity under 30% is allowed.

5.2 State of the movements and watches

The movements and watches tested must be in their final configuration (movement with all additional modules; watches as they will be marketed).

Throughout the tests, the hand position is not defined.

The auxiliary mechanisms for which the functions may be interrupted (chronograph, etc.) will be switched on during cycles 2 to 7 included. For other cycles, the interlocking may be chosen by the applicant regardless of whether the measurement is done with or without the chronograph function. On the other hand, if cycle 8 is measured without using the chronograph function, cycle 9 must also be measured without that function. The same rule applies in the opposite case. The applicant must inform METAS in writing of the measurements made with or without using the chronograph function.

5.3 Order of the test cycles

The sequencing of the positions during the test is not critical for the measurement of the instantaneous rates and the daily precision.

Cycle 1 must be carried out first. The sequencing of cycles 2 to 10 is not decisive. However, cycles 2 to 6 must be carried out in the order given, the same goes for cycles 8 and 9.

Cycles 6, 8 and 9 can be carried out in parallel, as described in section 6.6.

5.4 Measurement uncertainty

The measurement tools and procedures must ensure extended measurement uncertainties for each criterion while satisfying the following equation:

$$U_c \leq \frac{T_c}{C_m}$$

U_c : Extended measurement uncertainty for the criterion ($k = 2$)

T_c : Tolerance on the criterion

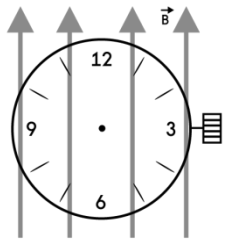
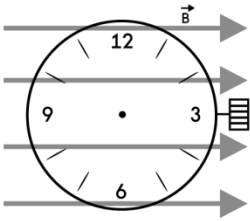
C_m : Measurement capability index. C_m must be ≥ 5 .

6 Test cycles

The measurements required for assessing the different criteria are obtained by carrying out the following cycles:

6.1 Cycle 1

1. Wind the movement up.
2. Subject the movement to a magnetic field according to the following procedure:

Axis of the magnetic field	Illustration	Magnetic field / T	Minimum time / s
6h to 12h		1.5	30
3h to 9h		1.5	30

The tolerance on the magnetic field is $0/+0.20$ T. The magnetic field must be constant within the volume taken by the movement.

3. Check criterion S_j :
The movement must not stop during each of the two passes in the magnetic field.
4. Demagnetise the movement.

6.2 Cycle 2

1. Wind the watch up.
2. Note the state of the watch: E_l .
3. Subject the watch to the following sequence:

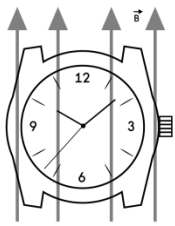
Position of the watch ¹	Simulation time / min	Temperature / °C
CH	300 ± 30	33 ± 2
9H	180 ± 30	33 ± 2
FH	180 ± 30	33 ± 2
3H	180 ± 30	33 ± 2
3H	300 ± 30	23 ± 2
CH	300 ± 30	23 ± 2

¹ Positions of the watch according to standard ISO 3158:2009.

4. Measure the state of the watch: E_2 .
5. Calculate the daily rate P_{J1} .

6.3 Cycle 3

1. Wind the watch up.
2. Subject the watch to a magnetic field according to the following procedure:

Axis of the magnetic field	Illustration	Magnetic field / T	Minimum time / s
6h to 12h		1.5	30

The tolerance on the magnetic field is $0/+0.20$ T. The magnetic field must be constant within the volume taken by the watch.

3. Check criterion S_2 :
The watch doesn't stop during the test when it is placed in the magnetic field.

6.4 Cycle 4

1. Measure the state of the watch: E_1 .
2. Subject the watch to the following sequence:

Position of the watch	Simulation time / min	Temperature / °C
CH	300 ± 30	33 ± 2
9H	180 ± 30	33 ± 2
FH	180 ± 30	33 ± 2
3H	180 ± 30	33 ± 2
3H	300 ± 30	23 ± 2
CH	300 ± 30	23 ± 2

3. Measure the state of the watch: E_2 .
4. Calculate the daily rate P_{J2} .

6.5 Cycle 5

1. Wind the watch up.
2. Demagnetise the watch.
3. Note the state of the watch: E_1 .

4. Subject the watch to the following sequence:

Position of the watch	Simulation time / min	Temperature / °C
CH	300 ± 30	33 ± 2
9H	180 ± 30	33 ± 2
FH	180 ± 30	33 ± 2
3H	180 ± 30	33 ± 2
3H	300 ± 30	23 ± 2
CH	300 ± 30	23 ± 2

5. Note the state of the watch: E_2 .
 6. Calculate the daily rate P_{J3} .

6.6 Cycle 6

1. Wind the watch up.
 2. Perform cycle 8 if required (see 5.3). In this case, wind up the watch as described in point 1 above (cycle 6).
 3. Measure the state of the watch: E_1 .
 4. Subject the watch to the following sequence:

Position of the watch	Simulation time / min	Temperature / °C
CH	300 ± 30	33 ± 2
12H	180 ± 30	33 ± 2
FH	180 ± 30	33 ± 2
6H	180 ± 30	33 ± 2
6H	300 ± 30	23 ± 2
CH	300 ± 30	23 ± 2

5. Note the state of the watch: E_2 .
 6. Calculate the daily rate P_{J4} .
 7. Perform cycle 9 if cycle 8 was carried out in point 2 below (cycle 8). In this case, wind up the watch as described in point 1 above (cycle 6).

6.7 Cycle 7

1. Wind the watch up (or as a continuation of a previous cycle).
2. Let the watch run according to the following parameters:

Simulation time / h
According to the power reserve

3. Check criterion R_M :
The watch runs for a duration matching the power reserve announced by the manufacturer.

6.8 Cycle 8

1. Wind the watch up
2. Subject the watch to the following sequence:

Measurement No	Position of the watch	Minimum stabilisation time / s	Minimum measurement time / s
M_1	3H	20	30
M_2	6H	20	30
M_3	9H	20	30
M_4	12H	20	30
M_5	CH	20	30
M_6	FH	20	30

The measurement must be carried out within 2 hours after winding up.

3. Calculate the deviation from the instantaneous rate D_P

6.9 Cycle 9

1. Wind the watch up. If cycle 9 is carried out after the cycle 8, winding up the watch is performed at the same time as that of the cycle 8.
2. Operate the watch at 65% to 75% of its power reserve as announced by the manufacturer (1/3 of the remaining power reserve).
3. Subject the watch to the following sequence:

Measurement No	Position of the watch	Minimum stabilisation time / s	Minimum measurement time / s
$M_{1-1/3}$	3H	20	30
$M_{2-1/3}$	6H	20	30
$M_{3-1/3}$	9H	20	30
$M_{4-1/3}$	12H	20	30
$M_{5-1/3}$	CH	20	30
$M_{6-1/3}$	FH	20	30

4. Calculate the deviation from the instantaneous rate D_E .

6.10 Cycle 10

1. Subject the watch to the sequence of water overpressure tests according to the table below (depending on the announced pressure for the watch):

Announced pressure	Step 1		Transi tion	Step 2		Transiti on	Step 3		Reference
	Over pressure / bar	Durati on / min	Durati on / min	Overpres sure	Durati on / min	Duratio n / min	Over pressure / bar	Duratio n / min	
$3 \text{ bar} < p \leq 5 \text{ bar}$	0	3	1	p	10	1	0	3	ISO 22810:2010
$5 \text{ bar} < p < 30 \text{ bar}$	0	3	1	p	20	1	0	10	
$p \geq 30 \text{ bar}$ without a unidirectional rotating bezel									
$p \geq 10 \text{ bar}$ with a unidirectional rotating bezel	0	30	1	$p + 25\%$	120	1	0.3	60	ISO 6425:1996

2. Check criterion *W*:
The watch head must pass the condensation test as stated in paragraph 4.2 of standard ISO 22810:2010.

7 Acceptance criteria

Each watch tested must meet the following requirements, depending on the category to which it belongs:

Criterion	Unit	Requirements by category		
		I_a	I_b	II
S_1	–	The movement doesn't stop when submitted to a magnetic field during the test		
\bar{P}_j	s/d	$0 \leq \bar{P}_j \leq 5$	$0 \leq \bar{P}_j \leq 6$	$0 \leq \bar{P}_j \leq 7$
S_2	–	The watch doesn't stop when submitted to a magnetic field during the test		
E_M	s/d	$E_M \leq 5$	$E_M \leq 5$	$E_M \leq 5$
R_M	–	The watch still operates at the value of the announced power reserve		
D_E	s/d	$D_E \leq 8$	$D_E \leq 10$	$D_E \leq 12$
D_P	s/d	$D_P \leq 12$	$D_P \leq 14$	$D_P \leq 16$
W	–	The watch can withhold a defined overpressure (depending on the certifying process)		

8 Rules in the event of an intervention during the certification procedure

1. A correction of the movement cancels the results of the certification. Every cycle in the test must be repeated.
2. In the event of a one-off intervention on the movement, every test cycles, except that relating to criterion S_1 , must be repeated. The adjustment of the rate of a movement and the replacement of a component of a movement by an identical component (same size and same material) is considered as a one-off intervention.

For example: replacing the date module or an automatic module, etc.

Note: installing and removing of the winding stem and/or screws and clamps for the casing are considered as an intervention on the watch head and should abide by the statement in point 3.

3. In the event of an intervention on the watch head with an opening of the back of the watch (uncasing/casing, replacing the dial/hands), test cycle 10 for criterion W (water resistance) must be repeated.
4. In the event of an intervention on the watch without opening the bottom (polishing, installation of a wristlet, etc.), the certification results are not void. None of the tests need to be repeated.

Part B: Organisational requirements

In order to validate the results from measurements carried out by the testing laboratory, METAS must be able to constantly monitor the testing laboratory. As such:

1. METAS sets up a monitoring plan for the results (see chapter 9);
2. the testing laboratory sets up a quality management system which has to be audited and accepted by METAS (see Chapter 10).

9 Monitoring Plan

METAS monitors the certification process at two different levels. Firstly, METAS carries out a statistical analysis on the results from measurements carried out by the testing laboratory. Secondly, METAS checks the process via a sampling program.

9.1 Statistical analysis of the results

The testing laboratory provides METAS with all results of the measurements taken on which METAS carries out a statistical analysis to detect potential flaws.

Furthermore, METAS records:

1. the serial number of the movement used for the “chronometer” certification according to standard ISO 3159:2009;
2. the serial number of the watch head having undergone the tests described in Chapter 6.

9.2 Sampling checks

Sampling checks for criteria P_J , S_2 , E_M , R_M , D_E and D_P are carried out by METAS according to ISO 2859-1: 1999 with an S4-AQL1 inspection level by default. METAS can adapt the sampling method in agreement with the laboratory and the applicant. The S_I and W criterion are assessed at random. This ensures that the measurements for certification are carried out correctly by the testing laboratory. METAS will notify the applicant of the test results.

In case of non-compliance, three actions may be required, depending on the situation:

1. the applicant analyses the cause of non-compliance and suggests improvements;
2. METAS carries out additional measurements on watches they have chosen and made available by the applicant;
3. METAS carries out an audit to analyse the reason behind the non-compliance.

10 Quality management system

The testing laboratory has implemented a quality management system (quality system) approved and supervised by METAS.

10.1 Description of the quality system

The quality system contains an adequate description of:

1. the verification processes;
2. the calibration processes for the instruments used;
3. the qualifications and training of the staff in charge of the checks; and
4. the system for archiving the results.

10.1.1 Verification processes

The testing laboratory has documentation on the verification processes which allows them to assess the technical criteria set out in Part A of this document.

10.1.2 Calibration processes for the instruments used

The testing laboratory has documentation on the calibration processes of instruments used to measure and determine criteria D_E , D_P , P_J and E_M . The instruments must be periodically calibrated. The interval specified in the documentation of the testing laboratory will ensure that measurement uncertainties are traceable and adequate (as defined in §2.41 of VIM [7]). METAS is given the calculation of the

measurement uncertainties by the testing laboratory. The GUM [8] is at the basis of the calculation of measurement uncertainties. These calculations are used to control the measurement methods and monitor the statistics of the measurements.

The performance of the measuring instruments is checked according to a frequency defined by the testing laboratory and documented in its quality system (at least every six months). The results should be documented.

The performance of the devices with regards to criteria S_1 , S_2 , and W are to be controlled by calibrated instruments, according to a frequency defined by the testing laboratory and documented in its quality system (at least once a year). The verification results should be documented. The instruments used for the verification should also be calibrated once a year which should be traceable. The results should be documented.

10.1.3 Staff in charge of the checks

The testing laboratory has a list of people in charge of the checks. For each of them, elements proving their technical skills for the testing (such as basic training, continuing education, etc.) are given.

10.1.4 Archiving the results

The testing laboratory has a description of the system for archiving the results. It includes the location and the duration of the archiving. The raw results of the cycles are stored for at least a year. The assessment of the criteria for each watch is stored for at least ten years.

10.2 Monitoring the quality system by METAS

10.2.1 Assessment

METAS audits the quality system and the testing procedures implemented by the testing laboratory to assess whether the testing process are controlled. If needed, METAS may issue a certificate stating that the laboratory meets the requirements set out in Chapter 10.1 of this document.

The testing laboratory certification is valid for three years.

10.2.2 Interim audits

Between two assessments, METAS will carry out regular audits (at least once a year) to ensure the testing laboratory maintains and applies its quality system. The audit report will be transmitted to the testing laboratory. The audits are planned so as to have checked the entire testing processes every three years.

10.2.3 Access to testing laboratories

At any time, METAS may request a visit to the testing laboratory's premises. During these visits, METAS can, if necessary, carry out or order tests on watches to verify the correct operation of the quality system. METAS will prepare a report on the visit and a test report, if needed, and send a copy to the testing laboratory.

10.2.4 Access to information

The applicant must ensure that METAS can access all necessary information including:

1. the quality system described in Chapter 10.1,
2. proof that conditions 1 and 2 of Chapter 2 are met,
3. Proof that the technical criteria discussed in Chapter 7 are satisfied for each movement and each watch.

10.2.5 Changes to the quality system

The testing laboratory will inform METAS of any intended changes to the quality system. METAS will assess the proposed changes and decide whether the modified quality system will meet the conditions set out in Chapter 10.1.

11 Rights to this document and revision

11.1 Rights to this document

METAS owns the copyright on these Requirements. The *Creative Commons* organisation licence is granted by METAS: Attribution – No commercial use - No modification 4.0 International (CC BY-NC-ND 4.0).

11.2 Revision

11.2.1 Requests for revisions

All requests for a revision of the Requirements should be sent to METAS in writing and include the following information:

- The proposed modification;
- A justification; and
- A presentation of the impacts the change will have.

Requests for revision which do not meet these formal requirements will be returned by METAS to their authors for further corrections.

Requests for revision may be submitted in any official language from Switzerland or in English.

11.2.2 Consultation

METAS inform all companies producing watches which are certified according to these Requirements of any requests for revision. These manufacturing companies are then invited to take a position in writing on these revisions.

Any modification or revision of the Requirements first require the agreement of METAS and of each company producing watches which have been certified according to the said Requirements for over 12 months.

Note: during the first 12 months after these requirements are brought into force, changes or revisions are made by mutual agreement between METAS and companies producing watches certified according to these Requirements.

References

- [1] ISO 3159:2009: Timekeeping instruments – Wrist-Chronometer with balance oscillator
- [2] ISO 3158:1976: Timekeeping instruments - Symbolisation of control positions
- [3] ISO 22810:2010: Horology – Water-resistant watches
- [4] ISO 6425:1996: Divers' watches
- [5] ISO/IEC 17025:2005: General requirements for the competence of testing and calibration laboratories
- [6] ISO 2859-1:1999: Sampling procedures for inspection by attributes - Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection
- [7] VIM: International vocabulary of metrology – Basic and general concepts and associated terms (3rd edition), JCGM 200:2012
- [8] GUM: Guide to the Expression of Uncertainty in Measurement, JCGM 100:2008