

# HOW TO DETERMINE THE NECESSARY TEST WEIGHTS

## MAXIMUM TOLERANCE FOR WEIGHTS ACCORDING TO OIML R111:2004

Nominal value	E1	E2	F1	F2	M1	M1-2	M2	M2-3	M3
	+/- mg	+/- mg	+/- mg	+/- mg	+/- mg	+/- mg	+/- mg	+/- mg	+/- mg
1 mg	0,003	0,006	0,020	0,06	0,20				
2 mg	0,003	0,006	0,020	0,06	0,20				
5 mg	0,003	0,006	0,020	0,06	0,20				
10 mg	0,003	0,008	0,025	0,08	0,25				
20 mg	0,003	0,010	0,03	0,10	0,3				
50 mg	0,004	0,012	0,04	0,12	0,4				
100 mg	0,005	0,016	0,05	0,16	0,5		1,6		
200 mg	0,006	0,020	0,06	0,20	0,6		2,0		
500 mg	0,008	0,025	0,08	0,25	0,8		2,5		
1 g	0,010	0,030	0,10	0,3	1,0		3,0		10
2 g	0,012	0,040	0,12	0,4	1,2		4,0		12
5 g	0,016	0,050	0,16	0,5	1,6		5,0		16
10 g	0,020	0,060	0,20	0,6	2,0		6,0		20
20 g	0,025	0,080	0,25	0,8	2,5		8,0		25
50 g	0,030	0,10	0,3	1,0	3,0		10		30
100 g	0,05	0,16	0,5	1,6	5		16		50
200 g	0,10	0,30	1,0	3,0	10		30		100
500 g	0,25	0,80	2,5	8,0	25		80		250
1 kg	0,5	1,6	5	16	50		160		500
2 kg	1,0	3,0	10	30	100		300		1.000
5 kg	2,5	8,0	25	80	250		800		2.500
10 kg	5	16	50	160	500		1.600		5.000
20 kg	10	30	100	300	1.000		3.000		10.000
50 kg	25	80	250	800	2.500	5.000	8.000	16.000	25.000
		<b>+/- g</b>	<b>+/- g</b>	<b>+/- g</b>	<b>+/- g</b>	<b>+/- g</b>	<b>+/- g</b>	<b>+/- g</b>	<b>+/- g</b>
100 kg		0,16	0,5	1,6	5	10	16	30	50
200 kg		0,30	1,0	3,0	10	20	30	60	100
500 kg		0,80	2,5	8,0	25	50	80	160	250
1.000 kg		1,6	5	16	50	100	160	300	500
2.000 kg			10	30	100	200	300	600	1.000
5.000 kg			25	80	250	500	800	1.600	2.500

## DEFAULT DENSITIES FOR WEIGHT MATERIALS

Ident.	Material	Density at 68°F	Density uncertainty U(k=2)
		kg/m <sup>3</sup>	kg/m <sup>3</sup>
GG	Cast iron	7200	400
ST	Steel	7800	200
AL	Aluminium	2700	120
NS	German silver ickel silver	8600	170
MS	Brass finely turned	8400	100
MSN	Brass nickel plated	8400	100
MSM	Brass miralloy	8400	100
VA	Stainless steel	7900	140
HF12	austenit stainless steel	7950	80
HE210	Special stainless steel	8000	30

## LIMITS OF MAGNETIC CHARACTERISTICS

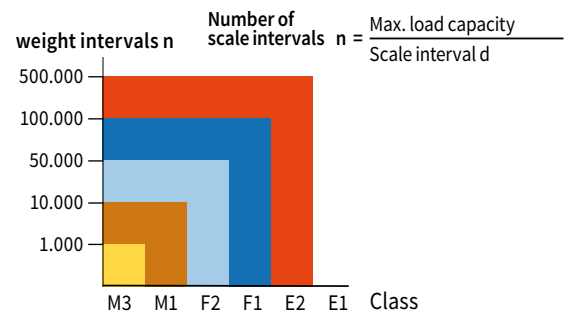
Class	Magnetization	Magnetic susceptibility X		
	μM (μT)	m ≤ 1 g	2 g ≤ m ≤ 10 g	m ≤ 20 g
E1	< 2,5	< 0,25	< 0,06	< 0,02
E2	< 8	< 0,9	< 0,18	< 0,07
F1	< 25	< 10	< 0,7	< 0,2
F2	< 80	-	< 4	< 0,8
M1	< 250	-	-	-
M1-2	< 500	-	-	-
M2	< 800	-	-	-
M2-3	< 1600	-	-	-
M3	< 2500	-	-	-

## EXAMPLE

A balance has a maximum rated capacity of 1,000 g and a scale division  $d$  of 10 mg. The user manual specifies an external calibration weight with a nominal value of 1 kg. According to step A.1, the number of scale intervals that the balance can measure is 100,000.

According to step A.2, the required tolerance with a nominal weight of 1 kg is between 5 and 10 mg. Tolerance class F1 meets this requirement ( $\pm 5$  mg).

The following test loads are determined in step B.2: 250 g, 500 g, 750 g and 1 kg. According to OIML R111 the following four test weights in the class F1 are determined: 50 g, 200 g, 500 g and 1 kg.



Accuracy of the balance (scale)	Resolution of the balance: quotient of max. range/readability	Required tolerance class of the weights
IV Ordinary accuracy scale	$\leq 1.000 d$	Klasse M3
III Medium accuracy scale	$\leq 10.000 d$	Klasse M1
II Precision balance	$\leq 50.000 d$	Klasse F2
I Analytical balance	$\leq 100.000 d$	Klasse F1
	$\geq 100.000 d$	Klasse E2

### A.

#### DETERMINE THE RIGHT TOLERANCE CLASS FOR THE TEST WEIGHTS

- Determine the number of intervals  $n$  by dividing the maximum weight by the scale division  $d$  (smallest reading digit) of the weighing range (measuring range).

$$\text{Number of steps } n = \frac{\text{Max. load capacity}}{\text{Scale interval } d}$$

- Determine the tolerance class of the test weights from the required tolerance.

Weighing range (measuring range)	Tolerance of the test weight, depending on the safety requirement
$n = 100.000$	0,5 $d$ and 1 $d$
$100.000 < n < 500.000$	Between 1 $d$ and 2 $d$
$n > 500.000$	less than 3 $d$

For this, choose a nominal value equal or close to the maximum value of the weighing range (measuring range). This nominal value should always be greater than 80% of the maximum rated capacity.

You can round up or down by a small amount. In case of doubt you should always choose the next smaller tolerance.

### B.

#### DETERMINE THE REQUIRED NOMINAL VALUES (WEIGHTS)

- Cursory testing

You can make most of the test measurements for the weighing range with just one test weight (nominal value). The nominal value of the external calibration weight is often used for this purpose (consult the user guide or operating software of your balance). This nominal value should always be greater than 80% of the maximum rated capacity.

- Complete testing

Use this method to check the weighing range (measuring range) against the maximum potential requirements. The following four test loads are required: 25%, 50%, 75% and 100% (or at least 80%) of the maximum rated capacity.

The test weight for 100% (or at least 80%) of the maximum rated capacity should consist of just one weight, rather than a combination of several test weights.

If you have any questions, we would be pleased to advise you on choosing suitable test weights for your measuring or test task. We support you in the specification of test plans and give you recommendations about appropriate documentation and interpretation of your test results.