SIST

SLOVENSKI STANDARD
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Human response to vibration - Measuring instrumentation (ISO 8041:1990)

Human response to vibration - Measuring instrumentation (ISO 8041:1990)

Schwingungseinwirkung auf den Menschen - Meßeinrichtung (ISO 8041:1990)

Réponse des individus aux vibrations - Appareillage de mesure (ISO 8041:1990)

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Human response to vibration — Measuring instrumentation (ISO 8041 : 1990)

Réponse des individus aux vibrations — Appareillage de mesure (ISO 8041 : 1990)

Schwingungseinwirkung auf den Menschen — Meßeinrichtung (ISO 8041 : 1990)

This European Standard was approved by CEN on 1991-10-01 as a prospective standard for provisional application. The period of validity of this ENV is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the ENV can be converted into a European Standard (EN).

CEN members are required to announce the existence of this ENV in the same way as for an EN and to make the ENV available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.

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CEN

European Committee for Standardization
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Foreword

Following consideration of the result of a Primary Questionnaire among members, the CEN Technical Board decided in October 1991 to submit the International Standard ISO 8041 : 1990 *Human response to vibration — Measuring instrumentation* to the Formal Vote for approval as European Prestandard.

The result of the Formal Vote was positive.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to announce this European Prestandard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

Introduction to the European Prestandard

This European Prestandard defines performance requirements for instrumentation suitable to assess the vibration to which persons are exposed at workplaces. In view of the complexity of situations in which people are exposed to vibration it may sometimes be necessary to use instrumentation with other characteristics.

Human response to vibration — Measuring instrumentation

1 Scope

This International Standard specifies instrumentation for a method of measurement of vibration in a given frequency range, given in ISO 2631-1 for assessing the vibration as perceived by human beings. It applies to instrumentation for the measurement of hand-arm vibration and/or whole-body vibration. For other methods of measurement, ISO 2631 and ISO 5349 should be consulted.

This International Standard specifies electrical, vibration and environmental tests to verify compliance with the characteristics specified (see clause 4). It also determines the method for sensitivity calibration.

The purpose of this International Standard is to ensure consistency and compatibility of results and reproducibility of measurements realized with different measuring instrumentation using this method of measurement.

An instrument or an instrument collection may be realized which fulfils only the necessary requirements for measurement of hand-arm or whole-body vibrations under certain conditions, for example in the z direction, provided that the purpose is clearly stated and pertinent requirements of this International Standard are fulfilled.

In conjunction with spectral analysis, proper filter characteristics shall be applied (see clause 4).

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 266 : 1975, *Acoustics — Preferred frequencies for measurements.*

ISO 1683 : 1983, *Acoustics — Preferred reference quantities for acoustic levels.*

ISO 2041 : —[1], *Vibration and shock — Vocabulary.*

ISO 2631-1 : 1985, *Evaluation of human exposure to whole-body vibration — Part 1: General requirements.*

ISO 2631-2 : 1989, *Evaluation of human exposure to whole-body vibration — Part 2: Continuous and shock-induced vibrations in buildings (1 to 80 Hz).*

ISO 2631-3 : 1985, *Evaluation of human exposure to whole-body vibration — Part 3: Evaluation of exposure to whole-body z-axis vertical vibration in the frequency range* 0,1 *to* 0,63 Hz.

ISO 5347-0 : 1987, *Methods for the calibration of vibration and shock pick-ups — Part 0: Basic concepts.*

ISO 5348 : 1987, *Mechanical vibration and shock — Mechanical mounting of accelerometers.*

ISO 5349 : 1986, *Mechanical vibration — Guidelines for the measurement and the assessment of human exposure to hand-transmitted vibration.*

ISO 5805 : 1981, *Mechanical vibration and shock affecting man — Vocabulary.*

ISO 8042 : 1988, *Shock and vibration measurements — Characteristics to be specified for seismic pick-ups.*

IEC 225 : 1966, *Octave, half-octave and third-octave band filters intended for the analysis of sounds and vibrations.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 2041 and ISO 5805, together with the following, apply.

3.1 weighted vibration: Frequency-weighted overall r.m.s. acceleration. It is expressed in metres per second squared. Alternatively, instrumentation may express results in metres per second squared and as a level in decibels. The level in decibels is 20 times the logarithm to the base 10 of the ratio of a weighted acceleration, expressed in metres per second squared, to the reference acceleration.

1) To be published. (Revision of ISO 2041 : 1975.)

The acceleration is weighted in accordance with one of the five frequency weightings listed in table 1 and specified in tables 4 to 8.

Table 1 — Frequency ranges

Characteristics of vibration	Frequency range Hz	International Standard
Whole body, severe discomfort, *z*: designated W.B.S.D.*z*	0,1 to 1	ISO 2631-3
Whole body, *x-y*: designated W.B.*x-y*	1 to 80	ISO 2631-1
Whole body, *z*: designated W.B.*z*	1 to 80	ISO 2631-1
Whole body, combined: designated W.B.combined	1 to 80	ISO 2631-2
Hand-arm: designated H.-A.	8 to 1 000	ISO 5349

The acceleration is time-weighted using exponential averaging (see clause A.3 and annex D) with specified time constants, and peak or integrated mean-square values over a specified time period. When quoting the weighted acceleration, the frequency weighting and linear or exponential time-weighting shall be indicated.

NOTE — The term "weighted vibration" is often replaced by "weighted acceleration" or "vibration". Whenever a velocity transducer or displacement transducer is used, the weighting applied should be changed accordingly. The type of transducer used should always be reported.

3.2 reference acceleration: The acceleration for expressing vibration levels given in ISO 1683 as 10^{-6} m/s^2.

If a different reference acceleration is used, this shall be stated.

3.3 equivalent continuous vibration value and level

3.3.1 equivalent continuous vibration value: The equivalent continuous weighted acceleration, $a_{w\,eq}$, defined by the r.m.s. value:

$$a_{w\,eq} = \left\{ \frac{1}{T_m} \int_0^{T_m} [a_w(t)]^2 \, dt \right\}^{1/2} \qquad \ldots (1)$$

where

$a_w(t)$ is the instantaneous weighted acceleration, in metres per second squared;

T_m is the integration time interval, in seconds;

t is the time, in seconds.

3.3.2 equivalent continuous vibration level: The equivalent continuous weighted acceleration level, $L_{w\,eq}$, in decibels, defined by

$$L_{w\,eq} = 10 \lg \left\{ \frac{1}{T_m} \int_0^{T_m} \frac{[a_w(t)]^2}{a_0^2} \, dt \right\} \qquad \ldots (2)$$

where

a_0 is the reference acceleration ($a_0 = 10^{-6}$ m/s^2);

$a_w(t)$, T_m and t are as defined in 3.3.1.

The integration time interval shall always be specified.

3.4 crest factor: The ratio of the peak signal value evaluated over a specified time interval to the r.m.s. value over the same time interval.

NOTE — It is recommended that the r.m.s. value of the signal be measured using 60 s linear integration.

3.5 signal

3.5.1 pulse duty factor: For a rectangular sequence, the ratio between the pulse duration and the repetition period of the signal.

3.5.2 signal burst: One or more complete cycles of sinusoidal signal; for the purpose of this International Standard, the signal burst starts and ends at a zero crossing of the waveform.

3.5.3 burst duty factor: For a sequence of signal bursts, the ratio between the burst duration and the repetition period of the signal.

3.6 primary indicator range: A specified range of the indicator of a vibration-measuring instrumentation for which the vibration-measuring instrumentation readings are within particularly close tolerances on sensitivity linearity as specified in 6.7.

3.7 sensitivity linearity: The term indicating that the reading of the vibration-measuring instrumentation is proportional to the magnitude of the input signal, within stated tolerances.

3.8 reference calibration frequency: The frequency, specified by the manufacturer, used for calibration of the sensitivity of vibration-measuring instrumentation. Preferred reference calibration frequencies are given in table 2.

Table 2 — Preferred reference calibration frequencies

Characteristics of vibration	Reference calibration frequency		Weighting factor	
	ω s^{-1}	f Hz		
Whole body, severe discomfort, *z*	2,5	0,398	0,666	(−3,53 dB)
Whole body, *x-y*	50	7,96	0,254	(−11,91 dB)
Whole body, *z*	50	7,96	0,905	(−0,87 dB)
Whole body, combined	50	7,96	0,581	(−4,71 dB)
Hand-arm	500	79,6	0,202	(−13,89 dB)

3.9 reference calibration acceleration: An acceleration, specified by the manufacturer, used for calibrating the sensitivity of the vibration-measuring instrumentation.

NOTE — A reference calibration acceleration of 1 m/s^2 is preferred at 8 Hz, 80 Hz or 160 Hz. At 0,4 Hz a reference calibration acceleration of 0,1 m/s^2 is preferred.

4 Characteristics

Vibration-measuring instrumentation is generally a combination of a vibration transducer, an amplifier with a specified frequency weighting, and a detector-averager-indicator device with controlled characteristics. In clauses 5 and 6 specifications are given for these parts of the vibration-measuring instrumentation and tolerances are given for two types of vibration-measuring instrumentation. Any additional items (such as connectors, cables and preamplifiers) are regarded as integral parts of the vibration-measuring instrumentation. The manufacturer shall specify the connecting cable for which the calibration is valid. For instructions concerning mounting and calibration of transducers, see ISO 5348 and ISO 5347-0 respectively.

NOTE — This International Standard does not state a preference for either analogue or digital signal processing. Both techniques are compatible with this International Standard as long as the requirements are complied with.

The specified characteristics of measuring instrumentation considered in this International Standard are as follows:

a) frequency-weighting characteristics;

b) bandlimiting;

c) time-weighting, detector and indicator characteristics;

d) sensitivity to various environments.

The instrumentation specified in this International Standard may also be used for spectral analysis. In this case, filter characteristics shall comply with IEC 225.

4.1 Tolerances

The specifications given for type 1 and type 2 vibration-measuring instrumentation have the same nominal value and differ mainly in the tolerances allowed. Tolerances are generally tighter for type 1 than for type 2 instrumentation and differ for the two types to a degree which affects the manufacturing costs significantly.

4.2 Applications

Type 1 instrumentation is intended especially for use where the vibration environment can be closely specified and/or controlled, and where certain specifications are to be evaluated or met. The measurement accuracy possible with such an instrument will generally not be realized under ordinary conditions. Type 2 instrumentation is suitable for general applications.

4.3 Weighting characteristics

4.3.1 Frequency weighting

Human-response vibration-measuring instrumentation shall have one or more frequency-weighting characteristics designated as follows (for an explanation of the abbreviations, see table 1): 0,1 Hz to 1 Hz (W.B.S.D.*z*); 1 Hz to 80 Hz (W.B.*x-y* and W.B.*z*); 1 Hz to 80 Hz (W.B.combined); 8 Hz to 1 000 Hz (H.-A.). Other optional weighting characteristics may be included.

If such optional weighting characteristic is designated "flat", its frequency response with respect to the input signal, for example acceleration or velocity, shall be constant but imposed by the appropriate band limiting characteristic. A flat characteristic enables the instrumentation to function as a preamplifier for an auxiliary device or to measure the unweighted signal.

Weighting and amplifier circuits shall satisfy the requirements of 5.1. When the flat response is provided, the manufacturer shall specify its frequency range and tolerances. The tolerances shall not be greater than those for the frequency-weighting characteristics (tables 4 to 8).

4.3.2 Time weighting

Human-response vibration-measuring instrumentation shall have at least

a) a 1 s exponential averaging time constant;

b) a linear integrated mean-square value over 60 s or more.

If it includes additional time constants, these should preferably be 1/8 s or 8 s.

When provided, the peak characteristic allows the vibration-measuring instrumentation to indicate the maximum peak of the vibratory signal whether it is positive or negative.

The linear integrated mean square value can also be evaluated from the exponentially averaged signal in good approximation. In this case, the manufacturer shall specify the time constant used.

NOTE — The integration times specified should not be taken to be necessarily representative of an integration time of the human body.

4.4 Indication under reference conditions

The indication of the vibration-measuring instrumentation under the reference conditions as defined in 3.8, 3.9, 7.3 and 7.4 shall be accurate within 8 % (± 0,7 dB) and $^{+12\%}_{-11\%}$ (± 1 dB) for type 1 and type 2 instrumentation respectively after any warm-up period specified by the manufacturer. A means shall be available to check and maintain calibration at the reference frequency. This may be fulfilled by proper recommendations given in the manufacturer's instructions for use.

4.5 Battery-operated instrumentation

If the vibration-measuring instrumentation is battery operated, suitable means shall be provided to check that the battery voltage and stability is adequate to operate the instrumentation within its specifications.

4.6 Maximum change in reading

After a warm-up period, to be specified by the manufacturer but to be less than 10 min in duration, the reading shall not change within 1 h of continuous operation under constant test conditions by more than the value shown in table 3.

Table 3 — Maximum change in reading within 1 h of operation

Type 1		Type 2	
%	dB	%	dB
3,5	0,3	6	0,5

4.7 Sensitivity axis of the vibration transducer

The manufacturer shall specify the main axis of sensitivity and the transverse sensitivity. Additionally, information shall be given regarding the amount of simultaneous transverse vibration allowed in order to maintain the stated main axis sensitivity at the specified value ±6 % (±0,5 dB).

5 Frequency-weighting and amplifier characteristics

5.1 General

The complete instrumentation comprising the transducer, amplifier, weighting network and detector-indicator shall have one or more of the characteristics and tolerances given in tables 4 to 8 (corresponding graphs and analytical expressions are given for information in annex B and annex C respectively). Provisions for external filter connection may be included.

5.2 Sensitivity or level-range control

When a sensitivity or level-range control is included it shall not introduce errors greater than ±3,5 % (±0,3 dB) for type 1 and ±6 % (±0,5 dB) for type 2 instrumentation for all settings and frequencies in the working range with reference to a range setting specified by the manufacturer. The reference range shall include the calibration vibration defined in 3.9 and the above tolerances shall be verified on the basis of this level.

5.3 Manual sensitivity or level-range control

When a manual sensitivity or level-range control is included in a vibration-measuring instrumentation, the primary indicator ranges shall overlap by at least a factor of 0,6 (5 dB) if the step of the range control is 10 dB and by at least a factor of 0,3 (10 dB) if the step of the range control is greater.

5.4 Peak-handling capacity

The amplifier shall have a peak-handling capacity sufficient to meet the requirements of 6.2.

If an automatic range control system is used, its settling time shall be specified.

5.5 Overload indicator

Overload detectors shall, where necessary, be placed in the amplifier chain and shall indicate when the peak-handling capacity has been exceeded. If overload can cause erroneous readings, this shall be indicated.

For the linear-integration facility of the instrumentation a latching overload indicator shall be provided.

5.6 Signal-to-noise ratio

The maximum level of internal noise on any measurement range shall be at least a factor of 1,8 (5 dB) below the specified minimum vibration measurable on that range. A test for verifying the signal-to-noise ratio is given in 8.6.

5.7 Properties of electrical output

In cases where output terminals are provided to monitor signal waveforms, the instrumentation shall not introduce more than 2 % distortion when the test signal is not more than a factor of 0,3 (10 dB) below the equivalent upper limit of the weighted vibration magnitude which the instrumentation is designed to measure.

At the upper limit of vibration, to be stated by the manufacturer, the total harmonic distortion generated between the vibratory input and the signal output, where the latter is provided, shall be less than 10 % at any frequency for that range.

For all frequency weightings, at the upper limit of each primary indicator range, the manufacturer shall state the frequency range for which the error resulting from non-linear distortion generated between the vibratory input and the signal output is less than $^{+12\%}_{-11\%}$ (±1 dB).

6 Detector and indicator characteristics

6.1 Instrumentation indication

The indication of the vibration-measuring instrumentation with any detector-indicator characteristics in operation shall be the r.m.s. and, if included, the peak value of the signal, the time constant or integration time being specified.

Table 4 — Frequency weighting: whole body, severe discomfort, *z* axis, 0,1 Hz to 1 Hz (motion sickness), based on ISO 2631-3

Frequency, Hz		Weighting factor (values stated × 10⁻³)		Tolerance %	Weighting gain, dB		Tolerance dB
Nominal	True¹⁾	Excluding band-limiting	Including band-limiting		Excluding band-limiting	Including band-limiting	
0,01	0,010 0	1 000	15,85	+26 —	0,00	−36,00	+2 —
0,012 5	0,012 5	1 000	25,12	+26 —	0,00	−32,00	+2 —
0,016	0,015 8	1 001	39,80	+26 —	+0,01	−28,00	+2 —
0,02	0,019 9	1 001	63,03	+26 —	+0,01	−24,01	+2 —
0,025	0,025 1	1 001	99,65	+26 —	+0,01	−20,03	+2 —
0,031 5	0,031 6	1 002	156,9	+26 —	+0,02	−16,09	+2 —
0,04	0,039 8	1 004	244,5	+26 —	+0,03	−12,23	+2 —
0,05	0,050 1	1 006	372,0	+26 −21	+0,05	−8,59	±2
0,063	0,063 1	1 009	538,3	+26 −21	+0,08	−5,38	±2
0,08	0,079 4	1 014	716,6	+26 −21	+0,12	−2,89	±2
0,1	0,100 0	1 020	862,6	+26 −21	+0,17	−1,28	±2
0,125	0,125 9	1 029	955,3	+12 −11	+0,24	−0,40	±1
0,16	0,158 5	1 036	1 004	+12 −11	+0,31	+0,04	±1
0,2	0,199 5	1 033	1 019	+12 −11	+0,28	+0,16	±1
0,25	0,251 2	994,5	984,6	+12 −11	−0,05	−0,13	±1
0,315	0,316 2	880,1	867,5	+12 −11	−1,11	−1,23	±1
0,4	0,398 1	686,6	665,4	0	−3,27	−3,54	0
0,5	0,501 2	480,3	446,1	+12 −11	−6,37	−7,01	±1
0,63	0,631 0	318,5	269,4	+26 −21	−9,94	−11,39	±2
0,8	0,794 3	209,3	148,0	+26 −21	−13,59	−16,60	±2
1	1,000	139,2	74,27	+26 −21	−17,13	−22,58	±2
1,25	1,259	94,67	35,02	+26 −21	−20,48	−29,11	±2
1,6	1,585	66,15	16,12	+26 —	−23,59	−35,86	+2 —
2	1,995	47,52	7,439	+26 —	−26,46	−42,57	+2 —
2,5	2,512	35,03	3,485	+26 —	−29,11	−49,16	+2 —
3,15	3,162	26,38	1,661	+26 —	−31,58	−55,59	+2 —
4	3,981	20,20	0,803 4	+26 —	−33,89	−61,90	+2 —
5	5,012	15,65	0,393 1	+26 —	−36,11	−68,11	+2 —
6,3	6,310	12,24	0,193 9	+26 —	−38,25	−74,25	+2 —

1) Preferred frequencies according to ISO 266.

Table 5 — Frequency weighting: whole body, x axis and y axis, 1 Hz to 80 Hz, based on ISO 2631

Frequency, Hz		Weighting factor (values stated × 10^{-3})		Tolerance %	Weighting gain, dB		Tolerance dB
Nominal	True[1)]	Excluding band-limiting	Including band-limiting		Excluding band-limiting	Including band-limiting	
0,1	0,100 0	1 001	15,86	+26 —	+0,01	−36,00	+2 —
0,125	0,125 9	1 001	25,14	+26 —	+0,01	−31,99	+2 —
0,16	0,158 5	1 002	39,85	+26 —	+0,02	−27,99	+2 —
0,2	0,199 5	1 003	63,14	+26 —	+0,02	−23,99	+2 —
0,25	0,251 2	1 004	99,93	+26 —	+0,04	−20,01	+2 —
0,315	0,316 2	1 007	157,6	+26 —	+0,06	−16,05	+2 —
0,4	0,398 1	1 010	246,1	+26 —	+0,09	−12,18	+2 —
0,5	0,501 2	1 015	375,5	+26 −21	+0,13	−8,51	±2
0,63	0,631 0	1 022	545,1	+26 −21	+0,19	−5,27	±2
0,8	0,794 3	1 029	727,3	+26 −21	+0,25	−2,77	±2
1	1,000	1 032	873,1	+26 −21	+0,28	−1,18	±2
1,25	1,259	1 023	950,8	+12 −11	+0,20	−0,44	±1
1,6	1,585	985,6	955,9	+12 −11	−0,13	−0,39	±1
2	1,995	903,8	892,6	+12 −11	−0,88	−0,99	±1
2,5	2,512	781,7	777,8	+12 −11	−2,14	−2,18	±1
3,15	3,162	644,2	642,9	+12 −11	−3,82	−3,84	±1
4	3,981	515,9	515,5	+12 −11	−5,75	−5,76	±1
5	5,012	408,2	408,1	+12 −11	−7,78	−7,78	±1
6,3	6,310	322,1	322,0	+12 −11	−9,84	−9,84	±1
8	7,943	254,2	254,2	0	−11,90	−11,90	0
10	10,00	200,9	200,9	+12 −11	−13,94	−13,94	±1
12,5	12,59	159,1	159,0	+12 −11	−15,97	−15,97	±1
16	15,85	126,1	126,0	+12 −11	−17,99	−17,99	±1
20	19,95	99,98	99,90	+12 −11	−20,00	−20,01	±1
25	25,12	79,34	79,18	+12 −11	−22,01	−22,03	±1
31,5	31,62	62,98	62,67	+12 −11	−24,02	−24,06	±1
40	39,81	50,01	49,39	+12 −11	−26,02	−26,13	±1

Table 5 (*concluded*)

Frequency, Hz		Weighting factor (values stated × 10⁻³)		Tolerance %	Weighting gain, dB		Tolerance dB
Nominal	True[1)]	Excluding band-limiting	Including band-limiting		Excluding band-limiting	Including band-limiting	
50	50,12	39,71	38,52	+12 −11	−28,02	−28,29	±1
63	63,10	31,54	29,30	+12 −11	−30,02	−30,66	±1
80	79,43	25,05	21,19	+26 −21	−32,02	−33,48	±2
100	100,0	19,90	14,07	+26 −21	−34,02	−37,03	±2
125	125,9	15,80	8,433	+26 −21	−36,02	−41,48	±2
160	158,5	12,55	4,643	+26 −21	−38,03	−46,66	±2
200	199,5	9,971	2,429	+26 —	−40,03	−52,29	+2 —
250	251,2	7,920	1,240	+26 —	−42,03	−58,13	+2 —
315	316,2	6,291	0,626 0	+26 —	−44,03	−64,07	+2 —
400	398,1	4,997	0,314 7	+26 —	−46,03	−70,04	+2 —
500	501,2	3,969	0,157 9	+26 —	−48,03	−76,03	+2 —
630	631,0	3,153	0,079 1	+26 —	−50,03	−82,03	+2 —
800	794,3	2,505	0,039 6	+26 —	−52,03	−88,03	+2 —

1) Preferred frequencies according to ISO 266.

Table 6 — Frequency weighting: whole body, *z* axis, 1 Hz to 80 Hz, based on ISO 2631

Frequency, Hz		Weighting factor (values stated × 10⁻³)		Tolerance %	Weighting gain, dB		Tolerance dB
Nominal	True[1)]	Excluding band-limiting	Including band-limiting		Excluding band-limiting	Including band-limiting	
0,1	0,100 0	420,9	6,671	+26 —	−7,52	−43,52	+2 —
0,125	0,125 9	421,5	10,58	+26 —	−7,50	−39,51	+2 —
0,16	0,158 5	422,4	16,80	+26 —	−7,49	−35,49	+2 —
0,2	0,199 5	423,7	26,68	+26 —	−7,46	−31,48	+2 —
0,25	0,251 2	425,9	42,38	+26 —	−7,41	−27,46	+2 —
0,315	0,316 2	429,3	67,20	+26 —	−7,34	−23,45	+2 —
0,4	0,398 1	434,6	105,9	+26 —	−7,24	−19,50	+2 —
0,5	0,501 2	442,9	163,8	+26 −21	−7,07	−15,71	±2
0,63	0,631 0	455,8	243,2	+26 −21	−6,82	−12,28	±2