INTERNATIONAL STANDARD ISO 3274

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Instruments for the measurement of surface roughness by the profile method — Contact (stylus) instruments of consecutive profile transformation — Contact profile meters, system M

Instruments de mesurage de la rugosité des surfaces par la méthode du profil — Instruments à palpeur-aiguille, à transformation progressive du profil — Profilomètres à contact du système M

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up has the right to be represented on that Committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3274 was drawn up by Technical Committee ISO/TC 57, *Metrology and properties of surfaces*, and circulated to the Member Bodies in April 1974.

It has been approved by the Member Bodies of the following countries :

Austria	Italy	Sweden
Belgium	Japan	Switzerland
Bulgaria	Mexico	Turkey
Canada	Netherlands	United Kingdom
Chile	Poland	U.S.A.
Germany	Romania	U.S.S.R.
Hungary	South Africa, Rep. of	Yugoslavia
India	Spain	

The Member Body of the following country expressed disapproval of the document on technical grounds :

France

Instruments for the measurement of surface roughness by the profile method – Contact (stylus) instruments of consecutive profile transformation – Contact profile meters, system M

1 SCOPE AND FIELD OF APPLICATION

This International Standard defines the basic terms relating to system M profile meters, gives the basic parameters of these instruments and their numerical values and specifies their metrological characteristics.

NOTE – Similar International Standards relating to profile meters in other reference systems that may be accepted in future will be considered separately.

2 REFERENCES

ISO/R 468, *Surface roughness.*

ISO 1879, *Instruments for the measurement of surface roughness by the profile method – Vocabulary.*

3 DEFINITIONS

For a certain number of general terms used in this International Standard, the definitions are given in ISO/R 468 and ISO 1879. The definitions of terms specific to this International Standard are given below.

3.1 profile meter : An instrument used for the measurement of surface roughness parameters.

3.2 contact profile meter, system M : A contact (stylus) instrument of consecutive profile transformation used for the measurement of surface roughness according to system M.

3.3 modified profile : The effective profile defined by the combination of a stylus and profile meter filter, the latter being used for selecting a part of the spectrum of the real profile to be taken into consideration in the measurement of surface roughness parameters.

3.4 measuring traversing length : The length of the modified profile used for the measurement of surface roughness parameters.

NOTE – The measuring traversing length comprises one or several sampling lengths.

3.5 profile meter with predetermined traversing length : A profile meter in which the length used for measurement has a defined beginning and end determined by switches or other instrumental means.

NOTE – These profile meters generally indicate and hold the reading of the measured parameter obtained at the end of the stated measuring length.

3.6 profile meter with "running" traversing length (giving a "running" average) : A profile meter in which the length used for measurement results from the time constant of the profile meter and moves with a pick-up along the traversing length.

NOTE – In these profile meters the reading may fluctuate according to local variations of the profile.

3.7 *static measuring force* : The force which the stylus exerts along its axis on the examined surface without taking into account the dynamic components that arise from the traversing of the surface by a stylus.

3.8 rate of change of the static measuring force : The change of the static measuring force per unit displacement of the stylus along its axis.

3.9 cut-off, λ_B : The value of the wavelength λ numerically equal to the sampling length and conventionally taken as the upper limit of transmission of the profile meter.

NOTE – The given upper limit conventionally separates the nominally transmitted components of the effective profile spectrum from those that are nominally suppressed.

3.10 basic error of a profile meter reading : The difference between the profile meter reading and the value of the surface roughness parameter that is determined by the defined nominal response of a profile meter, expressed in percent.

3.11 method divergence of a profile meter reading : The difference between the value of a surface roughness parameter that is determined by the defined nominal response of a profile meter and the value of the parameter determined according to ISO/R 468, expressed in percent.[1]

1) This definition is provisional. It may be dealt with later in a separate document.

4 BASIC PARAMETERS

4.1 Stylus angle

The nominal value of the stylus angle, in radians (degrees), shall be one of the following :

1,05 (60); 1,57 (90)

4.2 Tip radius of the stylus

The nominal value of the tip radius of the stylus, in micrometres, shall be one of the following :

2; 5; 10

4.3 Static measuring force

The static measuring force shall ensure continuous contact of the stylus with the surface being measured.

The recommended values of the static measuring force and rate of change of measuring force are given in table 1.

TABLE 1

Nominal values of the tip radius of the stylus, in micrometres	2	5	10
Maximum values of the static measuring force at mean level of the stylus, in newtons (grams-force)	0,000 7 (0,07)	0,004 (0,4)	0,016 (1,6)
Maximum values of the rate of change of measuring force, in newtons per metre (grams-force per micrometre)	35 (0,003 5)	200 (0,020 0)	800 (0,080 0)

NOTE — Maximum values of the rate of change of measuring force are considered to be provisional and may be amended.

4.4 Load exerted by the pick-up skid on the surface to be measured

The load exerted by the pick-up on the surface to be measured shall not exceed 0,5 N (50 gf) for hard materials.

For soft materials the load exerted shall be lower.

NOTE — The value of the load exerted by the skid may be amended.

4.5 Tip radius of the skid, ρ

When employing one skid (figure 1), or two skids disposed on a straight line normal to the direction of the pick-up movement (figure 2), the radius ρ of the skid in plane A-A and planes parallel to it (figures 1 and 2) shall not be less than 50 times the cut-off.

NOTE — For measurement with cut-off values of 2,5 mm and more it will generally be preferable to use an auxiliary guiding surface.

4.6 Surface roughness of the pick-up skids

The value of the surface roughness of the pick-up skids shall not exceed $R_z = 0{,}1\ \mu m$

4.7 Transmission characteristics in the long-wave region

Transmission characteristics in the long-wave region are determined by the nominal transmission coefficients (by absolute value) given in table 2 and figure 3.

The rate of attenuation in figure 3 is equivalent to that produced by two RC-networks having equal time constants and separated by a buffer. For this system the maximum slope of the transmission curve is 12 dB per octave and the phase shift at the cut-off λ_B is 60°.

TABLE 2

λ	Cut-off, mm 0,25		0,8		2,5		8,0	
mm	*K* %	dB	*K* %	dB	*K* %	dB	*K* %	dB
0,025	99,7	− 0,03						
0,05	98,7	− 0,12						
0,08	96,7	− 0,29	99,7	− 0,03				
0,10	94,9	− 0,45	99,5	− 0,05				
0,25	75,0	− 2,50	96,8	− 0,28	99,7	− 0,03		
0,5	42,9	− 7,35	88,5	− 1,06	98,7	− 0,12		
0,8	22,7	− 12,9	75,0	− 2,50	96,7	− 0,29	99,7	− 0,03
1,0	15,8	− 16,0	65,8	− 3,64	94,9	− 0,45	99,5	− 0,05
2,5	2,9	− 30,7	23,5	− 12,6	75,0	− 2,50	96,8	− 0,28
5,0	0,75	− 42,5	7,1	− 22,9	42,9	− 7,35	88,5	− 1,06
8,0			2,9	− 30,7	22,7	− 12,9	75,0	− 2,50
10,0			1,8	− 34,5	15,8	− 16,0	65,8	− 3,64
25,0					2,9	− 30,7	23,5	− 12,6
50,0					0,75	− 42,5	7,1	− 22,9
80,0							2,9	− 30,7

The transmission coefficient K of such a system is defined by the following equation :

$$K = \frac{1}{(1 - j\,0{,}577\ \lambda/\lambda_B)^2}$$

where $j = \sqrt{-1}$

The transmission coefficient for wavelength λ_B is equal to 75 %. The error introduced by the skid should be negligible.

NOTES

1 In a practical determination the values of transmission coefficients shall be determined relative to the flat part of the curves in figure 3.

2 Transmission characteristics are given for the most widely used cut-offs.

3 If other transmission characteristics are proposed they shall meet the following requirements :

a) they should be technically feasible, particularly from the economic point of view;

b) when measuring the values of surface roughness parameters they shall reduce the method divergences.

Such transmission characteristics shall be considered in a separate document specifying the necessary symbols.

4.8 Measuring traversing length

The recommended values of the measuring traversing length, according to the cut-off, are given in table 3.

TABLE 3

Type of profile meter	Cut-off λ_B	Measuring traversing length
	mm	mm
With predetermined traversing length	0,08 0,25 0,8 2,5 8	0,4 to 2 1,25 to 5 2,4 to 8 5 to 15 16 to 40
With "running" traversing length	0,08, 0,25 0,8	2,5 to 16 5 to 16

NOTE — Numerical values for the measuring traversing length may be amended at a later date.

5 METROLOGICAL CHARACTERISTICS

5.1 Permissible deviations of the stylus angle shall not exceed the values given in table 4.

TABLE 4

Nominal values of the stylus angle, in radians (degrees)	1,05 (60)	1,57 (90)
Permissible deviations of the stylus angle, in radians (degrees)	+ 0,18 (+ 10) – 0,09 (– 5)	+ 0,09 (+ 5) – 0,18 (– 10)

5.2 Permissible deviations of the tip radius of the stylus shall not exceed the values given in table 5.

TABLE 5

Nominal values of the tip radius of the stylus, in micrometres	2	5	10
Permissible deviations of the tip radius of the stylus, in micrometres	± 0,5	± 1	± 2,5

5.3 Permissible transmission coefficients by absolute value are given by :

$$\text{Upper limit} = \frac{1{,}03}{1 + 0{,}29\ (\lambda/\lambda_B)^2}$$

$$\text{Lower limit} = \frac{0{,}97}{1 + 0{,}39\ (\lambda/\lambda_B)^2}$$

The numerical values for permissible transmission coefficients are given in table 6 and are plotted in figure 4.

TABLE 6

λ/λ_B	Lower limit		Upper limit	
	K %	dB	K %	dB
0,01	97,0	– 0,27	103,0	+ 0,26
0,1	96,6	– 0,30	102,7	– 0,23
0,2	95,5	– 0,40	101,8	+ 0,15
0,3	93,7	– 0,56	100,4	+ 0,03
0,5	88,4	– 1,07	96,0	– 0,26
0,7	81,4	– 1,78	90,2	– 0,90
1,0	69,8	– 3,13	79,8	– 1,96
1,5	51,7	– 5,74	62,3	– 4,12
2,0	37,9	– 8,43	47,7	– 6,44
3,0	21,5	– 13,5	28,5	– 10,9
5,0	9,0	– 20,9	12,5	– 18,1
10,0	2,4	– 32,3	3,4	– 29,3
20,0	0,6	– 44,2	0,9	– 41,1

5.4 The permissible basic error of calibration δ (figure 5) is considered to have systematic and random components. Permissible values are given below for the systematic and random components (δ_{syst} and σ respectively) of the basic error, expressed as a percentage of the real value of the surface roughness parameter and defined in terms of a profile meter whose characteristics have the nominal values defined in this International Standard :

Systematic error (δ_{syst} %) : ± 5; ± 10; ± 15.

Random error (σ %) : 1; 2; 4.

The basic error is defined by the formula

$$|\delta| = |\delta_{syst}| + n\sigma$$

where n is a numerical value chosen according to the required confidence probability.

NOTES

1 The foregoing numerical values for the systematic component of the basic error relate to full scale.

2 For readings less than full scale, the absolute systematic component of the basic error may be determined from a binominal formula

$$\delta_{syst} = a + bx$$

where

a and b are constant coefficients;

x is the scale reading.

3 The foregoing numerical values for the random component of the basic error refer to any point of a scale.

4 Numerical values determined as above relate to the wavelength range with upper limit 0,2 λ_B.

5 Numerical values for the basic error should be supplemented by a statement of the waveform (or the surface spectrum) to which these values relate, and this should permit correlation with the permissible transmission coefficients (see 5.3).

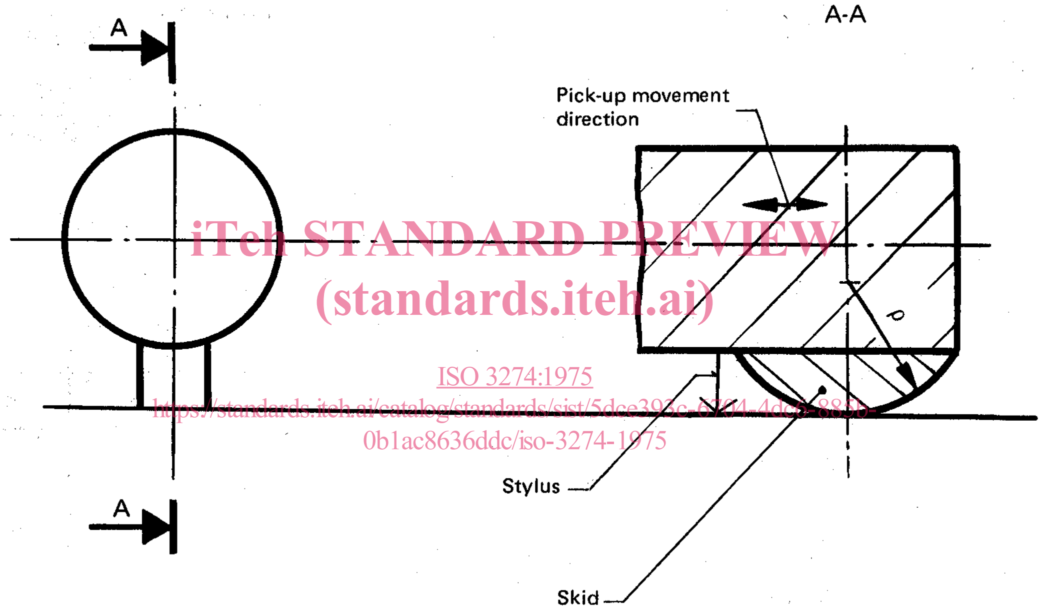

FIGURE 1 — **Pick-up with one skid**

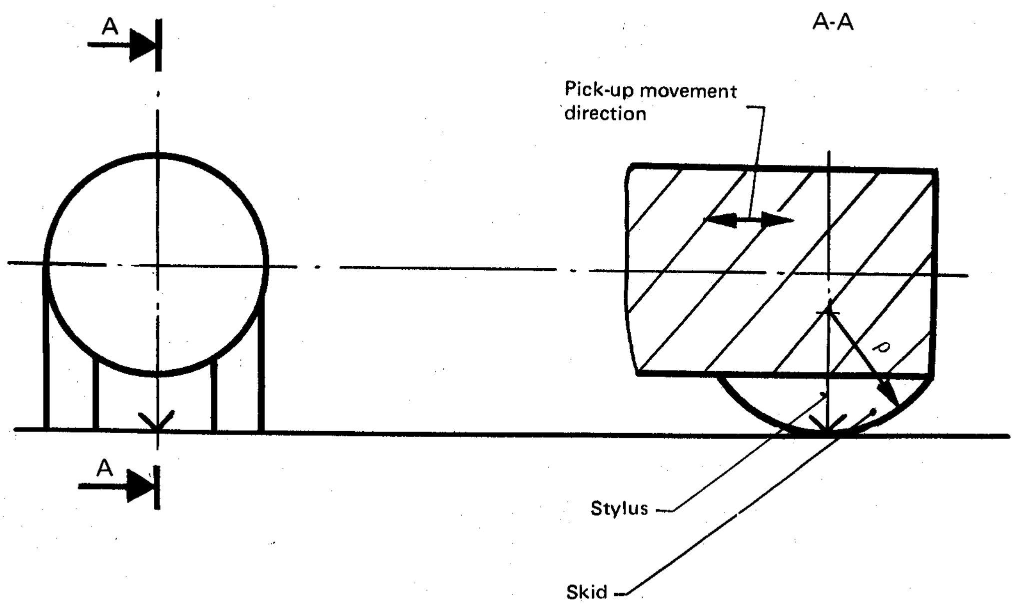

FIGURE 2 — **Pick-up with two skids**

FIGURE 3

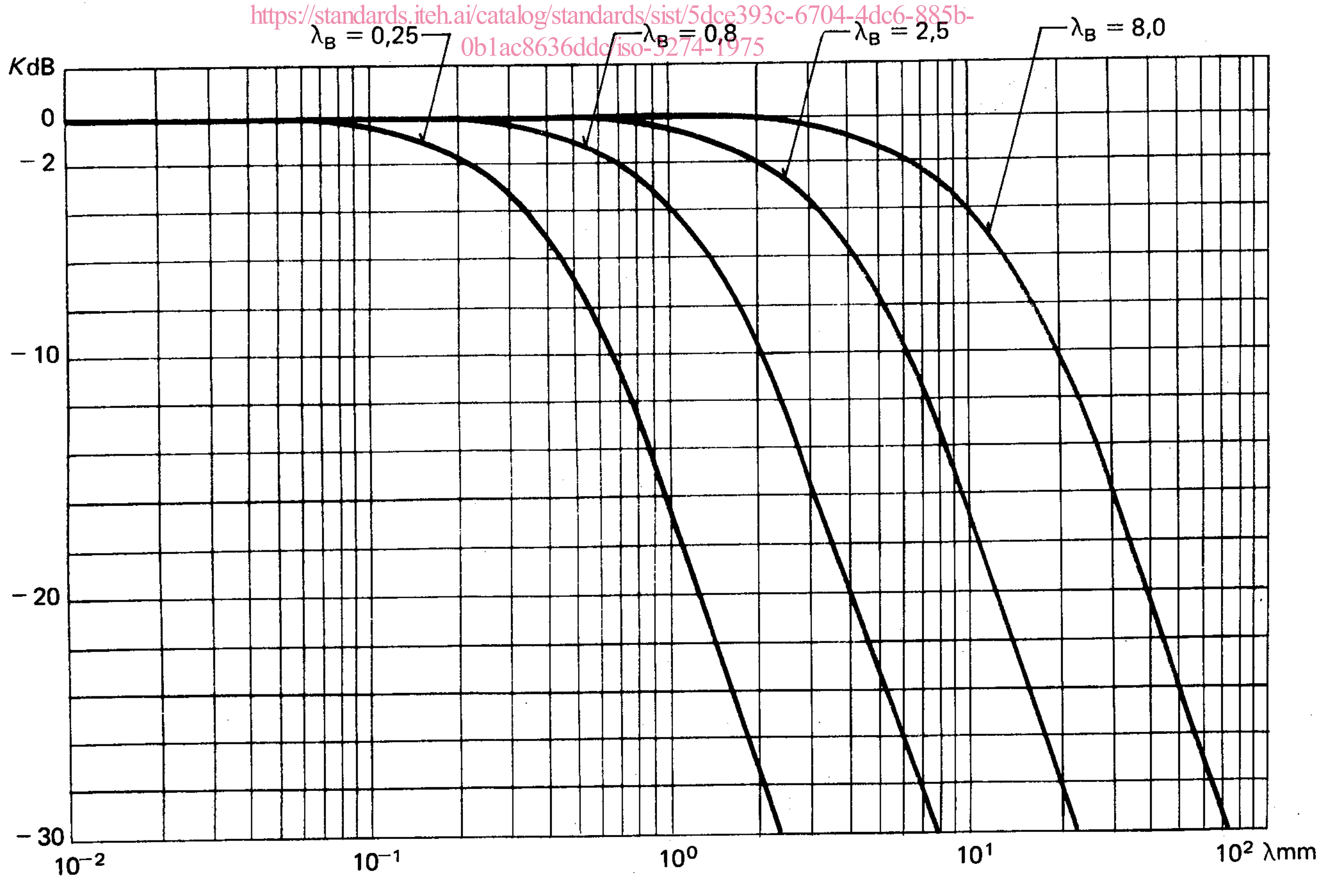

FIGURE 3

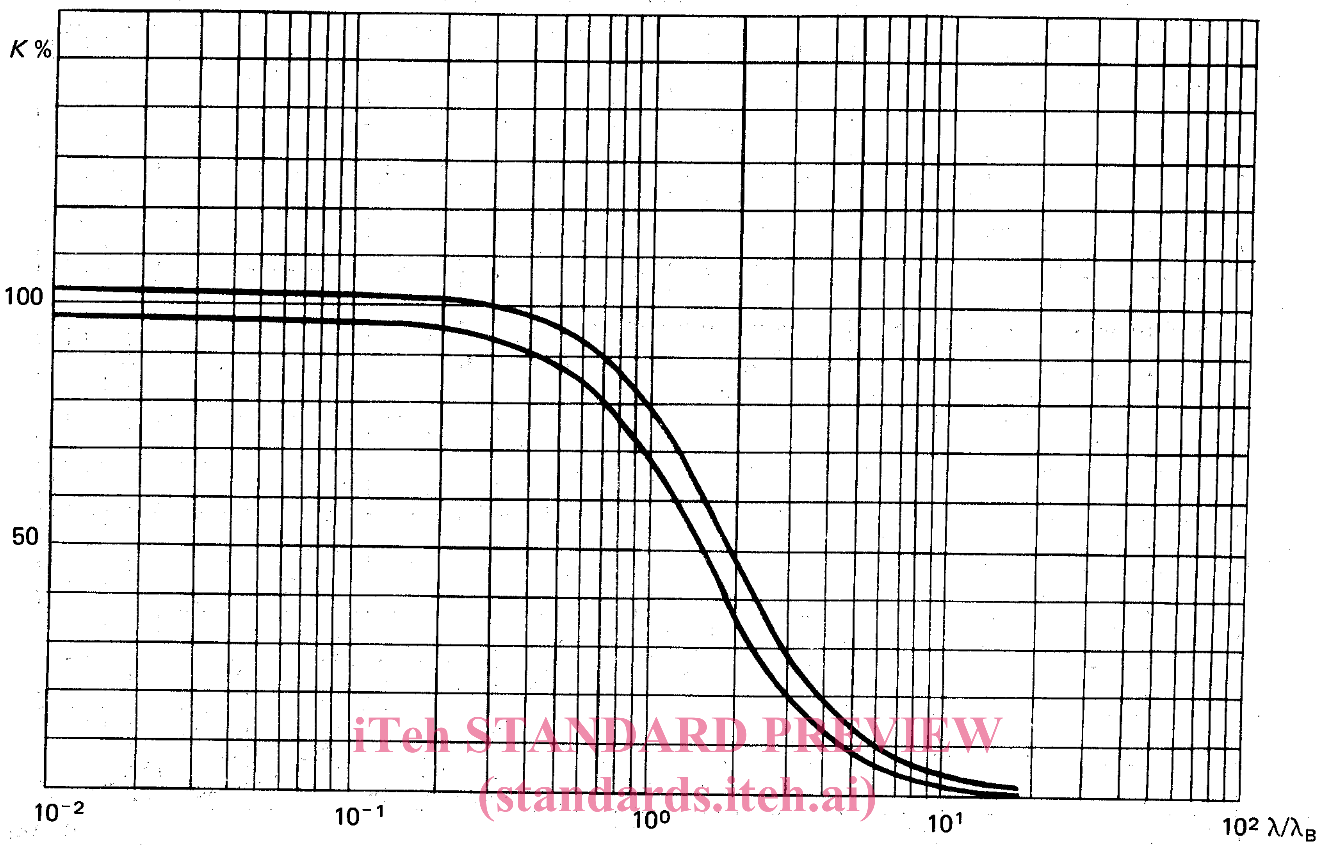

FIGURE 4

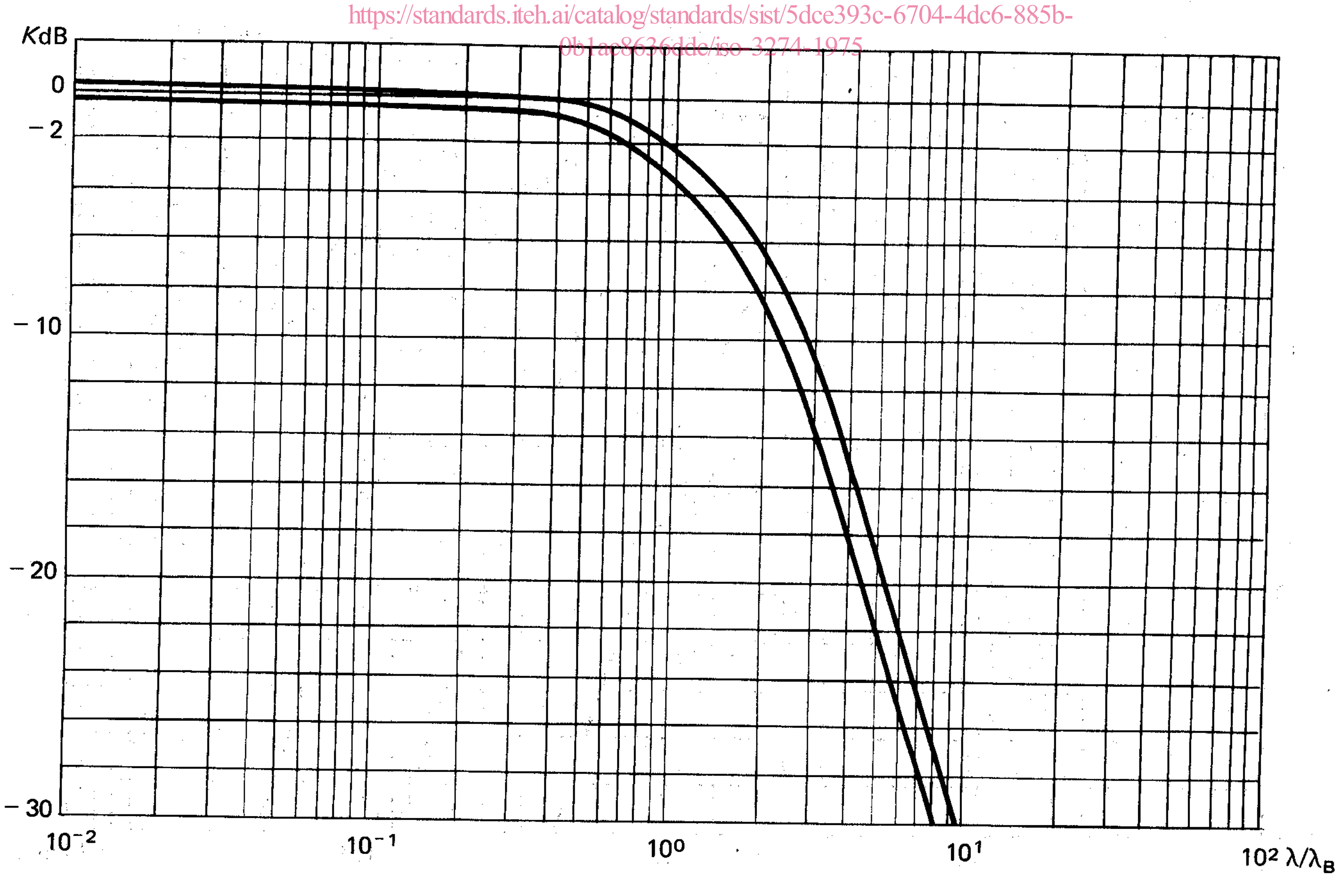

FIGURE 4

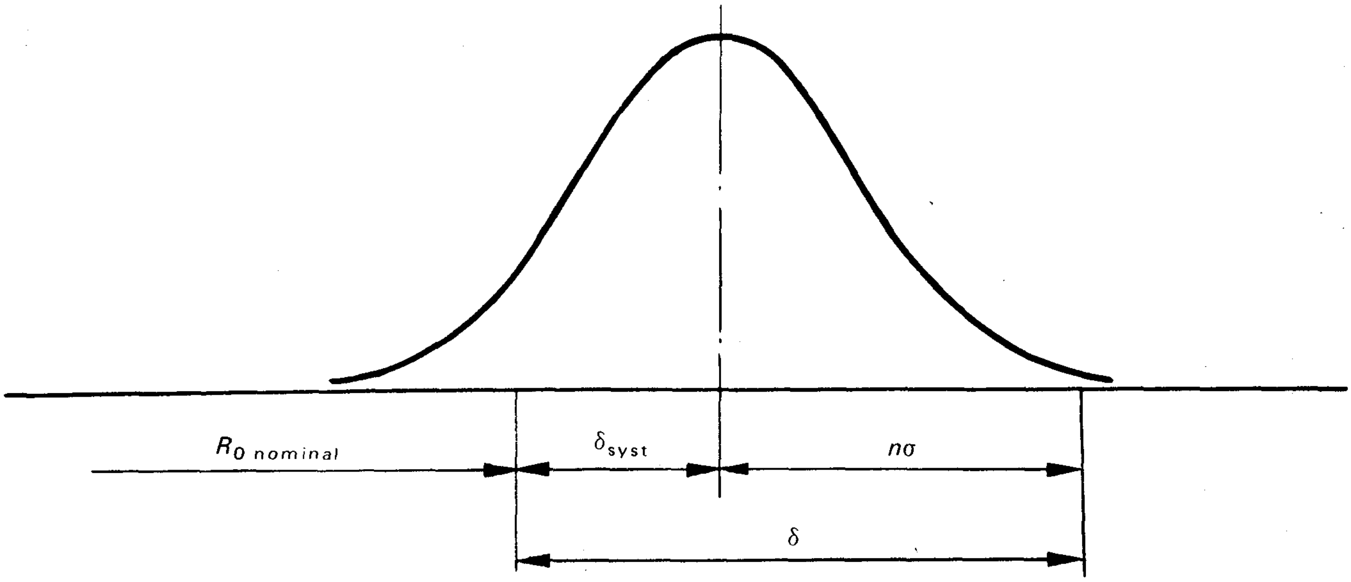

FIGURE 5