

Example

Creating a Clearance Fit using The Basic Hole System

Given the following fit **$\Phi 40 - H11/c11$**

From table for hole diameter = 40 and H11 we find

Upper deviation = +160 μm & Lower deviation = 0

From table for shaft diameter = 40 and c11 we find

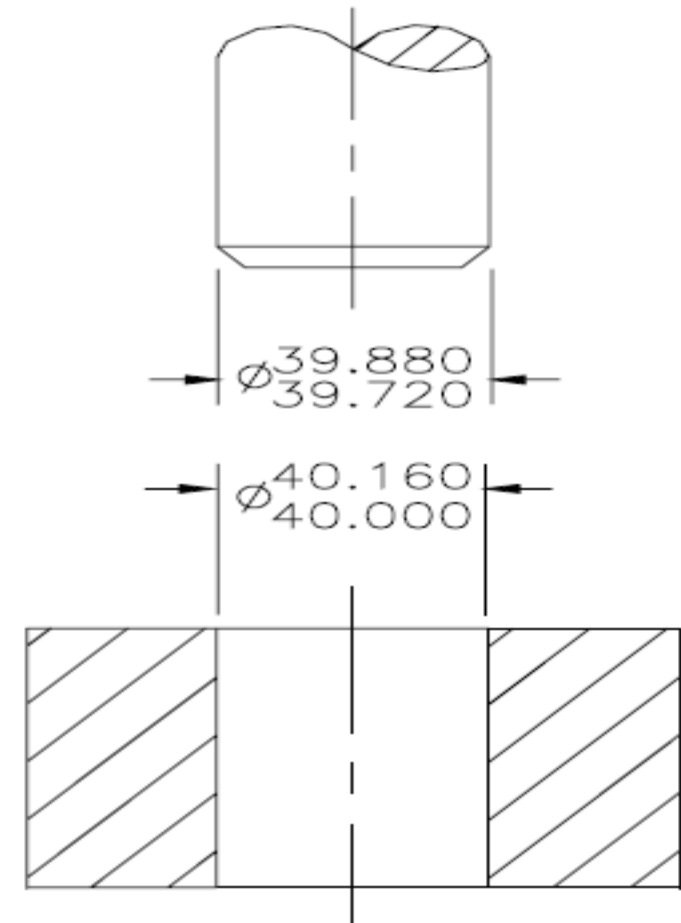
Upper deviation = -120 μm & Lower deviation = -280 μm

Calculations of dimension limits for hole and shaft

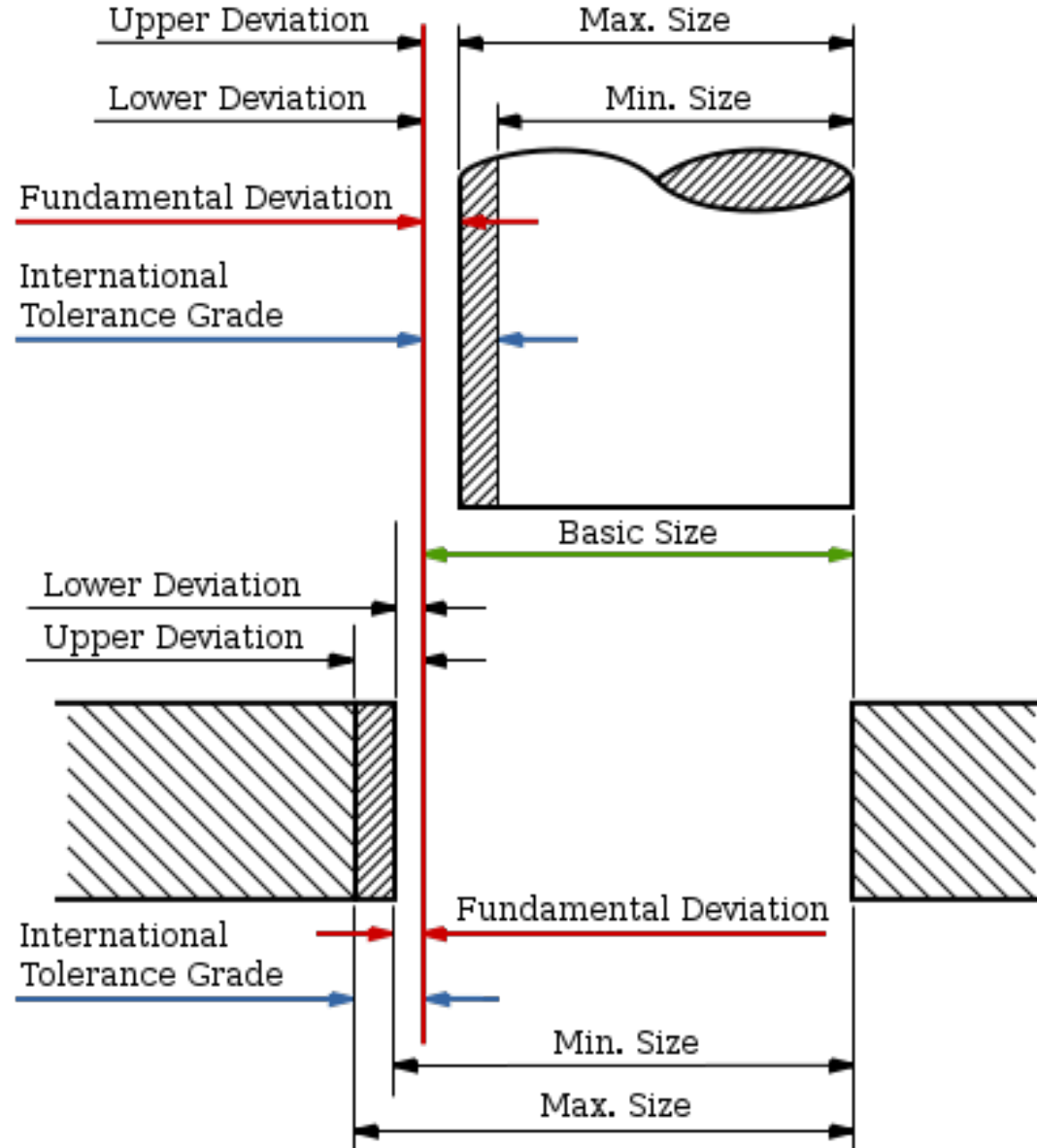
- Maximum hole diameter = $40 + 0.16 = 40.16 \text{ mm}$
- Minimum hole diameter = $40 + 0 = 40 \text{ mm}$
- Maximum shaft diameter = $40 + (-120) = 39.88 \text{ mm}$
- Minimum shaft diameter = $40 + (-280) = 39.72 \text{ mm}$

Maximum clearance = Maximum hole diameter - Minimum shaft diameter
= $40.16 - 39.72 = 0.44 \text{ mm}$

Minimum clearance = Minimum hole diameter - Maximum shaft diameter
= $40 - 39.88 = 0.12 \text{ mm}$



Allowances = minimum clearance = 0.12 mm = 120 μm



1.2 Symbols for Tolerances and Deviation and Symbols for Fits:

1. Tolerance values (The tolerance value is a function of the basic size and is indicated by a number called the grade.)

2. Tolerance zone position

The position of the tolerance zone with respect to the zero line, is indicated by a letter symbol, **a capital letter for holes and a small letter** for shafts. The tolerance size thus defined by its basic value followed by a symbol composed of a letter and a number. It is established by a combination of the fundamental deviation indicated by a letter and the IT grade number. In the dimension 50H8, the H8 specifies the tolerance zone.

Example for shaft: 45 g7

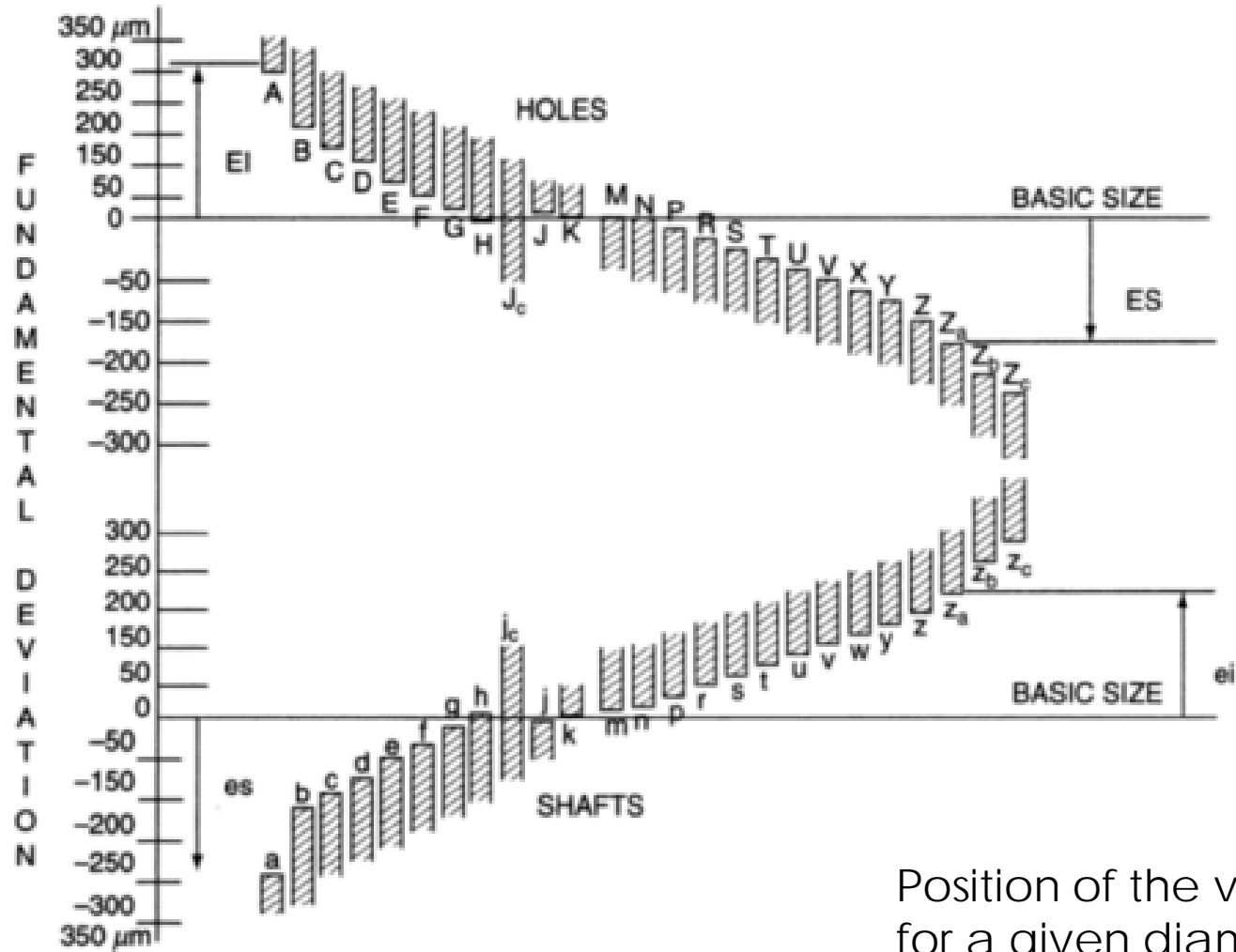
International Tolerance Grade (IT)



(a) HOLE



(b) SHAFT



Position of the various tolerance zones for a given diameter in the ISO system

FUNDAMENTAL TOLERANCES OF GRADES 01, 0 AND 1 TO 16

Diameter steps in mm	Values of tolerance in microns (1 micron = 0.001 mm)																	
	Tolerance grades																	
	01	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14*	15*	16*
To and inc 3	0.3	0.5	0.8	1.2	2	3	4	6	10	14	25	40	60	100	140	250	400	600
Over 3																		
To and inc 6	0.4	0.6	1	1.5	2.5	4	5	8	12	18	30	48	75	120	180	300	480	750
Over 6																		
To and inc 10	0.4	0.6	1	1.5	2.5	4	6	9	15	22	36	58	90	150	220	360	580	900
Over 10																		
To and inc 18	0.5	0.8	1.2	2	3	5	8	11	18	27	43	70	110	180	270	430	700	1100
Over 18																		
To and inc 30	0.6	1	1.5	2.5	4	6	9	13	21	33	52	84	130	210	330	520	840	1300
Over 30																		
To and inc 50	0.6	1	1.5	2.5	4	7	11	16	25	39	60	110	160	250	390	620	1000	1600
Over 50																		
To and inc 80	0.8	1.2	2	3	5	8	13	19	30	46	74	120	190	300	460	740	1200	1900
Over 80																		
To and inc 120	1	1.5	2.5	4	6	10	15	22	35	54	87	140	220	350	540	870	1400	2200
Over 120																		
To and inc 180	1.2	2	3.5	5	8	12	18	25	40	63	100	160	250	400	630	1000	1600	2500
Over 180																		
To and inc 250	2	3	4.5	7	10	14	20	29	46	72	115	185	290	460	720	1150	1850	2900
Over 250																		
To and inc 315	2.5	4	6	8	12	16	23	32	52	81	130	210	320	520	810	1300	2100	3200
Over 315																		
To and inc 400	3	5	7	9	13	18	25	36	57	89	140	230	360	570	890	1400	2300	3600
Over 400																		
To and inc 500	4	6	8	10	15	20	27	40	63	97	155	250	400	630	970	1550	2500	4000

* Upto 1 mm, Grades 14 to 16 are not provided.

DIAMETER STEPS IN mm		VALUES OF TOLERANCES IN MICRONS																	
		(1 MICRON = 0.001 mm)																	
		TOLERANCE GRADES																	
		01	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14*	15*	16*
TO and mm	3	0.3	0.5	0.8	1.2	2	3	4	6	8	10	14	25	40	60	100	140	400	600
Over To and mm	3 6	0.4	0.6	1	1.5	2.5	4	5	8	12	18	30	48	75	120	180	300	400	750
Over To and mm	6 10	0.4	0.6	1	1.5	2.5	4	6	9	15	22	36	58	90	150	220	360	580	900
Over To and mm	10 18	0.5	0.8	1.2	2	3	5	8	11	18	27	43	70	110	180	270	430	700	1100
Over To and mm	18 30	0.6	1	1.5	2.5	4	6	9	13	21	33	52	84	130	210	330	520	840	1300
Over To and mm	30 50	0.6	1	1.5	2.5	4	7	11	16	25	39	62	100	160	250	390	620	1000	1600
Over To and mm	50 80	0.8	1.2	2	3	5	8	13	19	30	46	74	120	190	300	460	740	1200	1900
Over To and mm	80 120	1	1.5	2.5	4	6	10	15	22	35	54	87	140	220	350	540	870	1400	2200
Over To and mm	120 180	1.2	2	3.5	5	8	12	18	25	40	63	100	160	250	400	630	1000	1600	2500
Over To and mm	180 250	2	3	4.5	7	10	14	20	29	46	72	115	185	290	460	720	1150	1850	2900
Over To and mm	250 315	2.5	4	6	8	12	16	23	32	52	81	130	210	320	520	810	1300	2100	3200
Over To and mm	315 400	3	5	7	9	13	18	25	36	57	89	140	230	360	570	890	1400	2300	3600
Over To and mm	400 500	4	6	8	10	15	20	27	40	63	97	155	250	400	630	970	1550	2500	4000

Table for fundamental deviations for shafts

Fundamental deviation		Upper deviation <i>ei</i>													
Letter		<i>m</i>	<i>n</i>	<i>p</i>	<i>r</i>	<i>s</i>	<i>t</i>	<i>u</i>	<i>v</i>	<i>x</i>	<i>y</i>	<i>z</i>	<i>za</i>	<i>zb</i>	<i>zc</i>
Grade		01 to 16													
Nominal size															
Over	To														
mm	mm														
-	3	+2	+4	+6	+10	+14	-	+18	-	+20	-	+26	+32	+40	+60
3	6	+4	+8	+12	+15	+19	-	+23	-	+28	-	+35	+42	+50	+80
6	10	+6	+10	+15	+19	+23	-	+28	-	+34	-	+42	+52	+67	+97
10	14	+7	+12	+18	+23	+28	-	+33	-	+40	-	+50	+64	+90	+130
14	18								+39	+45	-	+60	+77	+108	+150
18	24	+8	+15	+22	+28	+35	-	+41	+47	+54	+63	+73	+98	+136	+188
24	30						+41	+48	+55	+64	+75	+88	+118	+160	+218
30	40	+9	+17	+26	+34	+43	+48	+60	+68	+80	+94	+112	+148	+200	+274
40	50						+54	+70	+81	+97	+114	+136	+180	+242	+325
50	65	+11	+20	+32	+41	+53	+66	+87	+102	+122	+144	+172	+226	+300	+405
65	80				+43	+59	+75	+102	+120	+146	+174	+210	+274	+360	+480
80	100	+13	-23	+37	+51	+71	+91	+124	+146	+178	+214	+258	+335	+445	+585
100	120				+54	+79	+104	+144	+172	+210	+254	+310	+400	+525	+690
120	140	+15	+27	+43	+63	+92	+122	+170	+202	+248	+300	+365	+470	+620	+800
140	160				+65	+100	+134	+190	+228	+280	+340	+415	+535	+700	+900
160	180	+17	+31	+50	+68	+108	+146	+210	+252	+310	+380	+465	+600	+780	+1000
180	200				+77	+122	+166	+236	+284	+350	+425	+520	+670	+880	+1150
200	225	+20	+34	+56	+80	+130	+180	+258	+310	+385	+470	+575	+740	+960	+1250
225	250				+84	+140	+196	+284	+340	+425	+520	+640	+820	+1050	+1350
250	280	+21	+37	+62	+94	+158	+218	+315	+385	+475	+580	+710	+920	+1200	+1550
280	315				+98	+170	+240	+350	+425	+525	+650	+790	+1000	+1300	+1700
315	355	+23	+40	+68	+108	+190	+268	+390	+475	+590	+730	+900	+1150	+1500	+1900
355	400				+144	+208	+294	+435	+530	+660	+820	+1000	+1300	+1650	+2100
400	450	+26	+44	+78	+126	+232	+330	+490	+595	+740	+920	+1100	+1450	+1850	+2400
450	500				+132	+252	+360	+540	+660	+820	+1000	+1250	+1600	+2100	+2600
Grade		6 to 16													
500	560	+30	+50	+88	+150	+280	+400	+600							
560	630				+155	+310	+450	+660							
630	710	+34	+56	+100	+175	+340	+500	+740							
710	800				+185	+380	+560	+840							
800	900	+40	+66	+120	+210	+430	+620	+940							
900	1000				+220	+470	+680	+1050							
1000	1120	+44	+78	+144	+250	+520	+780	+1150							
1120	1250				+260	+580	+840	+1300							

Adapted from: Metrology & Measurement By Bewoor

https://books.google.com.sa/books?id=2ck0AwAQBAJ&pg=SA6-PA13&pg=SA6-PA13&dq=fundamental+deviation+selection+fits+IT&source=bl&ots=ZOM0zNqpP&sig=ofRGWwezbxKzJe9uW9zwxVZRZPdk&hl=en&sa=X&redir_esc=y#v=onepage&q=fundamental%20deviation%20selection%20fits%20IT&f=false

Table for fundamental deviations for holes

Fundamental		Lower deviation EI											Upper deviation ES								
Letter	A*	B*	c	CD	D	E	EF	F	FG	G	H	J ^b	J			K		M		N	
Grade	01 to 16											6	7	8	≤8	>8	≤8 ^c	>8	≤8	>8 ^d	
Nominal sizes																					
Over	To	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
mm	mm																				
-	3	270	140	60	34	20	14	10	6	4	2	0									
	3	6	270	140	70	46	30	20	14	10	6	4	0								
	6	10	280	150	80	56	40	25	18	13	8	5	0								
	10	14	290	150	95	-	50	32	-	16	-	6	0								
	14	18																			
	18	24	300	160	110	-	65	40	-	20	-	7	0								
	24	30																			
	30	40	310	170	120	-	80	50	-	25	-	9	0								
	40	50	320	180	130																
	50	60	340	190	140	-	100	60	-	30	-	10	0								
	65	80	360	200	150																
	80	100	380	220	170	-	120	72	-	36	-	12	0								
	100	120	410	240	180																
	120	140	460	260	200																
	140	160	520	280	210	-	145	85	-	43	-	14	0								
	160	180	580	310	230																
	180	200	660	340	240																
	200	225	740	380	260	-	170	100	-	50	-	15	0								
	225	250	820	420	280																
	250	280	920	480	300	-	190	110	-	56	-	17	0								
	280	315	1050	540	330																
	315	355	1200	600	360	-	210	125	-	62	-	18	0								
	335	400	1350	680	400																
	400	450	1500	760	440	-	230	135	-	68	-	20	0								
	450	500	1650	840	480																
Grade	6 to 16																				
500	630	-	-	-	-	260	145	-	76	-	22	0									
630	800	-	-	-	-	290	160	-	80	-	24	0									
800	1000	-	-	-	-	320	170	-	86	-	26	0									
1000	1250	-	-	-	-	350	195	-	98	-	28	0									
1250	1600	-	-	-	-	390	220	-	110	-	30	0									
1600	2000	-	-	-	-	430	240	-	120	-	32	0									

*Not applicable to sizes up to 1 mm.
^bIn grades 7 to 11, the two symmetrical deviations ± IT/2 should be rounded if the IT value in micrometres in an odd value by replacing it by the even value immediately below.
^cSpecial case: for M6, ES = -9 from 250 to 315 (instead of -11).
^dNot applicable to sizes up to 1 mm.

Adapted from: Metrology & Measurement By Bewoor

https://books.google.com.sa/books?id=2ck0AwAQBAJ&pg=SA6-PA13&pg=SA6-PA13&dq=fundamental+deviation+selection+fits+IT&source=bl&ots=ZOM0zNqpP&sig=ofRGWezbxKzJe9uW9zwxVZRZPdk&hl=en&sa=X&redir_esc=y#v=onepage&q=fundamental%20deviation%20selection%20fits%20IT&f=false

Table for fundamental deviations for holes

Please note that all values in this table are actually negative

Fundamental deviation		Upper deviation ES											Values for Δ^*										
Letter	P to ZC	P	R	S	T	U	V	X	Y	Z	ZA	ZB	ZC										
Grade	≤ 7	> 7																					
Nominal sizes													Grades:										
Over	To	-	-	-	-	-	-	-	-	-	-	-	-	3	4	5	6	7	8				
mm	mm																						
-	3	6	10	14	-	18	-	20	-	26	32	40	60	0	0	0	0	0	0				
3	6	12	15	19	-	23	-	28	-	35	42	50	80	1	1.5	1	3	4	6				
6	10	15	19	23	-	28	-	34	-	42	52	67	97	1	1.5	2	3	6	7				
10	14	18	23	28	-	33	-	40	-	50	64	90	130	1	2	3	3	7	9				
14	18						39	45	-	60	77	108	150										
18	24	22	28	35	-	41	47	54	63	73	98	136	188	1.5	2	3	4	8	12				
24	30						48	55	64	75	88	118	160							218			
30	40	26	34	43	-	48	60	68	80	94	112	148	200	1.5	3	4	5	9	14				
40	50						54	70	81	97	114	136	180							242	325		
50	65	32	41	53	66	87	102	122	144	172	226	300	405	2	3	5	6	11	16				
65	80						102	120	146	174	210	274	360							480			
80	100	37	51	71	91	124	146	178	214	258	335	445	585	2	4	5	7	13	19				
100	120						172	210	254	310	400	525	690										
120	140	43	63	92	122	170	202	248	300	365	470	620	800	3	4	6	7	15	23				
140	160						228	280	340	415	535	700	900										
160	180						252	310	380	465	600	780	1000										
180	200	50	77	122	166	266	284	350	425	520	670	880	1150	3	4	6	9	17	26				
200	225						310	385	470	575	740	960	1250										
225	250						340	425	520	640	820	1050	1350										
250	280	56	94	158	218	315	385	475	580	710	920	1200	1550	4	4	7	9	20	29				
280	315						425	525	650	790	1000	1300	1700										
315	355	62	108	190	268	390	475	590	730	900	1150	1500	1800	4	5	7	11	21	32				
355	400						660	820	1000	1300	1650	2100											
400	450	68	126	232	330	490	595	740	920	1100	1450	1850	2400	5	5	7	13	23	34				
450	500						660	820	1000	1250	1600	2100	2600										
Grade		6 to 16																					
500	560	78	150	280	400	600																	
560	630		155	310	450	660																	
630	710	88	175	340	500	740																	
710	800		185	380	560	840																	
800	900	100	210	430	620	940																	
900	1000		220	470	680	1050																	
1000	1120	120	250	520	780	1150																	
1120	1250		260	580	840	1300																	

* In determining K, M, N up to Grade 8 and P to ZC up to Grade 7, add the Δ value appropriate to the grade as indicated, e.g. for P7 from 18 to 30, $\Delta = 8$ therefore ES = -14.

Adapted from: Metrology & Measurement By Bewoor

https://books.google.com.sa/books?id=2ck0AwAQBAJ&pg=SA6-PA13&pg=SA6-PA13&dq=fundamental+deviation+selection+fits+IT&source=bl&ots=ZOM0zNqpP&sig=ofRGWwezbxKzJe9uW9zwxVZRZPdK&hl=en&sa=X&redir_esc=y#v=onepage&q=fundamental%20deviation%20selection%20fits%20IT&f=false