

Tolerancing of bevel gears

Tolerances for tangential composite errors

DIN
3965
Part 3

Toleranzen für Kegelradverzahnungen;
Toleranzen für Wälzabweichungen

Supersedes September 1981 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

1 Scope and field of application

The parameters for which tolerances have been given in this standard are defined in DIN 3971. The tolerances specified apply for straight, skew and spiral bevel gears with and without axial offset. See also DIN 3965 Part 1.

2 Tolerances

This standard specifies tolerances for the following parameters:

- tangential composite error, F_i' ;
- tangential tooth-to-tooth composite error, f_i' ;
- long-wave component of tangential composite error, f_{li}' ;
- short-wave component of tangential composite error, f_{sk}' .

f_{sk}' is obtained by multiplying the relevant tabulated value by K_6 , which is a function of the total overlap, ε_γ , and is given by

$$K_6 = \frac{1}{\varepsilon_\gamma} \text{ for } \varepsilon_\gamma \text{ less than } 2 \text{ and}$$

$$K_6 = 0,5 \text{ for } \varepsilon_\gamma \text{ not less than } 2.$$

Continued on pages 2 to 16

Normal module, m_{mn} : 1 mm to 2 mmTolerances in μm

Mean reference diameter, d_m , in mm	Error F'_i for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10	4,5	6,5	9,0	12	17	24	34	47	76	121	193	309
Over 10 up to 50	5,5	8,0	11	16	22	31	43	60	97	155	247	396
Over 50 up to 125	7,0	9,5	13	19	26	37	51	72	115	184	294	471
Over 125 up to 280	7,5	11	15	21	30	42	58	81	130	209	334	534
Over 280 up to 560												
Over 560 up to 1000												
Over 1000 up to 1600												
Over 1600 up to 2500												

Mean reference diameter, d_m , in mm	Error f'_i for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10	2,5	3,5	5,0	7,5	10	14	20	28	45	72	115	184
Over 10 up to 50	2,5	4,0	5,5	7,5	10	15	21	29	46	74	118	188
Over 50 up to 125	3,0	4,0	5,5	7,5	11	15	21	30	47	76	121	194
Over 125 up to 280	3,0	4,0	5,5	8,0	11	16	22	31	49	78	126	201
Over 280 up to 560												
Over 560 up to 1000												
Over 1000 up to 1600												
Over 1600 up to 2500												

Normal module, m_{mn} : 1 mm to 2 mmTolerances in μm

Mean reference diameter, d_m , in mm	Error f'_k/K_6 for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10	3,0	4,0	5,5	7,5	11	15	21	29	47	74	119	190
Over 10 up to 50	3,0	4,0	6,0	8,0	11	16	22	31	50	80	129	206
Over 50 up to 125	3,5	4,5	6,5	9,0	13	18	25	35	56	89	142	228
Over 125 up to 280	3,5	5,0	7,0	10	14	20	28	39	62	99	158	253
Over 280 up to 560	X											
Over 560 up to 1000												
Over 1000 up to 1600												
Over 1600 up to 2500												

Mean reference diameter, d_m , in mm	Error f'_1 *) for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10	4,5	6,0	8,5	12	17	24	33	46	74	118	189	302
Over 10 up to 50	5,5	8,0	11	15	21	30	42	59	94	151	241	386
Over 50 up to 125	7,5	10	14	20	28	39	55	77	123	197	315	505
Over 125 up to 280	9,5	13	18	25	36	50	70	98	156	250	401	641
Over 280 up to 560	12	17	23	32	45	64	89	125	200	319	511	818
Over 560 up to 1000	15	21	29	41	57	80	112	157	251	402	644	1030
Over 1000 up to 1600	18	26	36	50	70	98	138	193	308	494	790	1264
Over 1600 up to 2500	22	31	43	61	85	119	166	233	372	595	953	1524
*) Applies to all modules.												

Normal module, m_{mn} : over 2 mm to up and including 3,55 mmTolerances in μm

Mean reference diameter, d_m , in mm	Error F'_i for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50	6,5	9,0	13	18	25	35	49	69	110	176	282	451
Over 50 up to 125	7,5	11	15	21	30	42	58	81	130	208	333	533
Over 125 up to 280	8,5	12	17	24	33	47	66	92	147	235	376	602
Over 280 up to 560	9,5	14	19	27	37	52	73	103	164	262	420	672
Over 560 up to 1000												
Over 1000 up to 1600												
Over 1600 up to 2500												

Mean reference diameter, d_m , in mm	Error f'_i for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50	3,0	4,5	6,5	9,0	12	17	24	34	54	86	138	221
Over 50 up to 125	3,5	4,5	6,5	9,0	13	18	25	35	55	88	141	226
Over 125 up to 280	3,5	4,5	6,5	9,5	13	18	25	36	57	91	146	233
Over 280 up to 560	3,5	5,0	7,0	9,5	13	19	26	37	59	94	151	242
Over 560 up to 1000												
Over 1000 up to 1600												
Over 1600 up to 2500												

Normal module, m_{mn} : over 2 mm up to and including 3,55 mm

Tolerances in μm

Mean reference diameter, d_m , in mm	Error f'_k/K_6 for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50	3,5	5,0	7,0	9,5	14	19	27	37	59	95	152	244
Over 50 up to 125	4,0	5,5	7,5	11	15	21	29	40	65	104	166	265
Over 125 up to 280	4,0	6,0	8,0	12	16	23	32	44	71	113	182	290
Over 280 up to 560	4,5	6,5	9,0	13	18	25	35	49	79	126	202	323
Over 560 up to 1000												
Over 1000 up to 1600												
Over 1600 up to 2500												

Normal module, m_{mn} : over 3,55 mm up to and including 6 mmTolerances in μm

Mean reference diameter, d_m , in mm	Error F'_i for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50	7,5	10	15	20	29	40	56	78	125	200	320	513
Over 50 up to 125	8,5	12	17	24	33	47	66	92	147	235	376	602
Over 125 up to 280	10	14	19	27	38	53	74	103	165	264	423	676
Over 280 up to 560	11	15	21	30	42	59	82	115	184	294	470	752
Over 560 up to 1000	12	17	23	33	46	64	90	126	201	322	516	825
Over 1000 up to 1600	13	18	25	35	50	69	97	136	218	349	558	893
Over 1600 up to 2500												

Mean reference diameter, d_m , in mm	Error f'_i for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50	4,0	5,5	7,5	10	15	21	29	40	64	103	165	264
Over 50 up to 125	4,0	5,5	7,5	11	15	21	29	41	66	105	169	270
Over 125 up to 280	4,0	5,5	8,0	11	15	22	30	42	67	108	173	276
Over 280 up to 560	4,0	6,0	8,0	11	16	22	31	43	70	111	178	285
Over 560 up to 1000	4,5	6,0	8,5	12	16	23	32	45	72	115	185	295
Over 1000 up to 1600	4,5	6,0	8,5	12	17	24	33	47	75	120	192	307
Over 1600 up to 2500												

Normal module, m_{mn} : over 3,55 mm up to and including 6 mm

Tolerances in μm

Mean reference diameter, d_m , in mm	Error f'_k/K_6 for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50	4,0	6,0	8,0	11	16	22	31	44	70	113	180	288
Over 50 up to 125	4,5	6,5	9,0	12	17	24	34	47	76	121	194	310
Over 125 up to 280	5,0	7,0	9,5	13	19	26	37	51	82	131	209	335
Over 280 up to 560	5,5	7,5	10	15	20	29	40	56	90	144	230	368
Over 560 up to 1000	6,0	8,0	12	16	23	32	44	62	99	159	254	407
Over 1000 up to 1600	6,5	9,0	13	18	25	35	49	69	110	176	281	450
Over 1600 up to 2500												

Normal module, m_{mn} : over 6 mm up to and including 10 mmTolerances in μm

Mean reference diameter, d_m , in mm	Error F'_i for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50	8,5	12	17	23	33	46	64	90	144	230	368	589
Over 50 up to 125	10	14	19	27	38	53	75	105	167	268	428	685
Over 125 up to 280	11	16	22	30	43	60	83	117	187	299	478	765
Over 280 up to 560	12	17	24	34	47	66	92	129	207	331	529	847
Over 560 up to 1000	13	19	26	37	51	72	101	141	226	362	578	925
Over 1000 up to 1600	14	20	28	40	55	78	109	152	244	390	624	998
Over 1600 up to 2500	15	22	30	42	59	83	116	163	261	417	667	1068

Mean reference diameter, d_m , in mm	Error f'_i for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50	4,5	6,5	9,5	13	18	25	36	50	80	127	204	326
Over 50 up to 125	5,0	6,5	9,5	13	18	26	36	51	81	130	207	332
Over 125 up to 280	5,0	7,0	9,5	13	19	26	37	52	83	132	212	338
Over 280 up to 560	5,0	7,0	10	14	19	27	38	53	85	136	217	347
Over 560 up to 1000	5,0	7,0	10	14	20	28	39	55	87	140	223	357
Over 1000 up to 1600	5,5	7,5	10	15	21	29	40	56	90	144	231	369
Over 1600 up to 2500	5,5	7,5	11	15	21	30	42	58	93	149	238	382

Normal module, m_{mn} : over 6 mm up to and including 10 mm

Tolerances in μm

Mean reference diameter, d_m , in mm	Error f'_k/K_6 for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50	5,0	7,0	10	14	19	27	38	53	84	135	215	344
Over 50 up to 125	5,5	7,5	10	15	20	29	40	56	89	143	229	366
Over 125 up to 280	5,5	8,0	11	16	22	30	43	60	96	153	245	391
Over 280 up to 560	6,0	8,5	12	17	24	33	46	65	103	166	265	424
Over 560 up to 1000	6,5	9,5	13	18	26	36	50	71	113	181	289	463
Over 1000 up to 1600	7,5	10	14	20	28	39	55	77	123	198	316	506
Over 1600 up to 2500	8,5	11	16	22	31	43	60	84	135	216	346	554

Normal module, m_{mn} : over 10 mm up to and including 16 mmTolerances in μm

Mean reference diameter, d_m , in mm	Error F'_i for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50												
Over 50 up to 125	11	16	22	31	44	61	86	120	192	308	492	788
Over 125 up to 280	13	18	25	35	49	68	95	133	213	341	546	874
Over 280 up to 560	14	19	27	38	53	75	105	147	235	375	601	961
Over 560 up to 1000	15	21	30	42	58	81	114	160	255	408	653	1045
Over 1000 up to 1600	16	23	32	45	62	87	122	171	274	439	702	1123
Over 1600 up to 2500	17	24	34	48	67	93	131	183	292	468	749	1198

Mean reference diameter, d_m , in mm	Error f'_i for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50												
Over 50 up to 125	6,0	8,5	12	17	23	33	46	64	103	164	263	420
Over 125 up to 280	6,0	8,5	12	17	24	33	47	65	104	167	267	427
Over 280 up to 560	6,5	9,0	12	17	24	34	47	66	106	170	272	435
Over 560 up to 1000	6,5	9,0	13	18	25	35	49	68	109	174	279	446
Over 1000 up to 1600	6,5	9,5	13	18	25	36	50	70	112	179	286	457
Over 1600 up to 2500	7,0	9,5	13	19	26	37	51	72	115	184	294	470

Normal module, m_{mn} : over 10 mm up to and including 16 mm

Tolerances in μm

Mean reference diameter, d_m , in mm	Error f'_k/K_6 for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50												
Over 50 up to 125	6,5	9,0	12	17	24	34	48	67	107	170	273	436
Over 125 up to 280	6,5	9,5	13	18	26	36	50	70	113	180	288	461
Over 280 up to 560	7,0	10	14	20	27	38	54	75	121	193	309	494
Over 560 up to 1000	7,5	11	15	21	30	41	58	81	130	208	333	533
Over 1000 up to 1600	8,5	12	16	23	32	45	63	88	141	225	360	576
Over 1600 up to 2500	9,0	13	18	25	35	49	68	95	152	244	390	624

Normal module, m_{mn} : over 16 mm up to and including 25 mmTolerances in μm

Mean reference diameter, d_m , in mm	Error f'_i for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50												
Over 50 up to 125	13	19	26	36	51	71	100	139	223	357	571	914
Over 125 up to 280	15	20	29	40	56	78	110	153	246	393	629	1006
Over 280 up to 560	16	22	31	44	61	86	120	168	268	429	687	1099
Over 560 up to 1000	17	24	34	47	66	93	130	181	290	464	743	1189
Over 1000 up to 1600	18	26	36	51	71	99	139	194	311	497	795	1272
Over 1600 up to 2500	20	27	38	54	75	105	147	206	330	528	845	1352

Mean reference diameter, d_m , in mm	Error f'_i for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50												
Over 50 up to 125	8,0	11	15	22	30	42	59	83	133	212	339	543
Over 125 up to 280	8,0	11	16	22	31	43	60	84	134	215	343	549
Over 280 up to 560	8,0	11	16	22	31	43	61	85	136	218	349	558
Over 560 up to 1000	8,0	12	16	23	32	44	62	87	139	222	355	568
Over 1000 up to 1600	8,5	12	16	23	32	45	63	88	142	227	362	580
Over 1600 up to 2500	8,5	12	17	24	33	46	65	90	145	231	370	593

Normal module, m_{mn} : over 16 mm up to and including 25 mm

Tolerances in μm

Mean reference diameter, d_m , in mm	Error f'_k/K_6 for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50												
Over 50 up to 125	7,5	11	15	21	29	41	57	80	127	204	326	522
Over 125 up to 280	8,0	11	16	22	30	43	60	83	134	214	342	547
Over 280 up to 560	8,5	12	16	23	32	45	63	88	141	226	362	579
Over 560 up to 1000	9,0	13	18	25	34	48	67	94	151	242	386	618
Over 1000 up to 1600	9,5	13	19	26	37	51	72	101	161	258	413	661
Over 1600 up to 2500	10	14	20	28	39	55	77	108	173	277	443	709

Normal module, m_{mn} : over 25 mm up to and including 50 mmTolerances in μm

Mean reference diameter, d_m , in mm	Error F'_1 for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50												
Over 50 up to 125												
Over 125 up to 280	18	25	35	49	69	96	134	188	301	481	770	1232
Over 280 up to 560	19	27	38	53	74	104	145	203	326	521	833	1333
Over 560 up to 1000	21	29	41	57	80	111	156	218	349	559	894	1431
Over 1000 up to 1600	22	31	43	60	85	118	166	232	371	594	951	1521
Over 1600 up to 2500	23	33	46	64	89	125	175	245	392	628	1005	1608

Mean reference diameter, d_m , in mm	Error f'_1 for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50												
Over 50 up to 125												
Over 125 up to 280	11	16	22	31	44	61	86	120	192	308	492	788
Over 280 up to 560	12	16	23	32	44	62	87	122	194	311	498	797
Over 560 up to 1000	12	16	23	32	45	63	88	123	197	315	504	807
Over 1000 up to 1600	12	17	23	33	46	64	89	125	200	320	511	818
Over 1600 up to 2500	12	17	24	33	46	65	91	127	203	325	519	831

Normal module, m_{mn} : over 25 mm up to and including 50 mm

Tolerances in μm

Mean reference diameter, d_m , in mm	Error f'_k/K_6 for tolerance class											
	1	2	3	4	5	6	7	8	9	10	11	12
Over 1 up to 10												
Over 10 up to 50												
Over 50 up to 125												
Over 125 up to 280	10	14	20	27	38	54	75	105	168	270	431	690
Over 280 up to 560	10	15	20	29	40	56	79	110	176	282	452	723
Over 560 up to 1000	11	15	22	30	42	59	83	116	186	297	476	762
Over 1000 up to 1600	12	16	23	32	45	63	88	123	196	314	503	805
Over 1600 up to 2500	12	17	24	34	47	66	93	130	208	333	533	852

Standards referred to

DIN 3965 Part 1 Tolerancing of bevel gears; basic concepts

DIN 3971 Terminology and parameters for bevel gears and bevel gear pairs

Previous editions

DIN 3965 Part 3: 09.81.

Amendments

The following amendments have been made in comparison with the September 1981 edition.

- a) The status of the standard is no longer that of a preliminary standard.
- b) The standard has been editorially revised.

Explanatory notes

DIN 3965 Parts 1 to 4 provide only information on the gear blank and on errors that can be measured by conventional means.

The finer tolerances cannot yet be measured under production conditions. Nevertheless, the tables shown in DIN 3965 Parts 2 and 3 cover all diameter ranges, the fields crossed out indicating that for these diameter ranges no tolerances can currently be specified.

In future, more advanced gauging and calculation methods may allow errors to be dealt with, which have not as yet been specified, such as profile errors, and more information to be provided regarding the accuracy of bevel gears.

The parameters (see clause 3) have been defined in DIN 3971, the aim of which was to include as many quantities as possible without regard for the current feasibility or difficulty of their measurement.

The structure of the tolerance system for bevel gears has been brought into line with that for cylindrical gears. The relationship between the parameters are the same, except for an overall shift in the tolerance system by one tolerance class. The tolerance system proposed may thus serve as an adequate basis for international discussion.

International Patent Classification

F 16 H 55/08

F 16 H 55/17