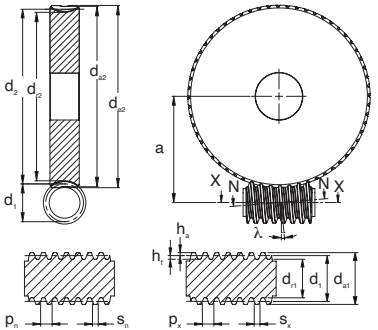
Worms and wheels

Description	Symbol	Unit	Formulae
Axial module	m_x		
Normal module	m_n		$= m_x \cdot \sin \lambda$
Normal pressure angle	α_n	degrees	$= \tan^{-1} (\tan \alpha n / \cos \lambda)$
Transverse pressure angle	αt	degrees	20°
Lead angle	λ	degrees	$= \tan^{-1} ((m_x \cdot Z_1) / d_2)$
Helix angle	β	degrees	$90 - \lambda$
Number of starts on worm	Z_1		
Number of starts on wheel	Z_2		
Profile shift coefficient	X		0 as standard
Addendum	h_a	mm	$1.m_x$
Dedendum	h_f	mm	$1.25m_x$
Tooth depth	h	mm	$2.25m_x$
Gear ratio	R		$= Z_2 / Z_1$
Centre distance	a	mm	$= (d_1+d_2) / 2$
Reference diameter of worm	d_1	mm	$(m_x.Z_1) / \tan \lambda$
Reference diameter of wheel	d_2	mm	$= Z_2.mx$
Tip diameter of worm	d_{a1}	mm	$= d_1 + (2m_x)$
Root diameter of worm	d_{r1}	mm	$= d_{a1} - (2.h)$
Tip diameter of wheel	d_{a2}	mm	$= d_2 + (2m_x)$
Root diameter of wheel	d_{r2}	mm	$= d_{a2} - (2.h)$
Outside diameter of wheel	d_{r2}	mm	$= d_{a2} + m_x$
Normal pitch	p_n	mm	$= \pi.m_n$
Axial pitch	p_x	mm	$= \pi.m_x$
Normal tooth thickness in pitch circle	s_n	mm	$= s_x.\cos \lambda$
Transversal tooth thickness in pitch circle	s_t	mm	$= (p_x/2) + 2m_x.x.\tan \alpha_t$

Tip diameter is the theoretical diameter of the gear without tooth thickness tolerance applied.
For s_n & s_x when x = zero, this is the theoretical tooth thickness. Actual tooth thickness will be less.



Efficiency

Efficiency

The following formulae allows an approximate value for the efficiency of a worm/wheel pair to calculated. The efficiency is dependent on the type of lubrication used (these figures are based on use of mineral oil) and do not take into account bearing, seal and other losses.

$\eta = \tan \lambda / \tan (\lambda + pz)$
$pz = \arctan (\mu)$
$v_s = (d_1 . n_1) / (19098 . \tan \lambda)$
$T_1' = (T_2 / u) * \eta$

T_1 = Input torque (Nm)
T_2 = Output torque (Nm)
R = Ratio
η = Efficiency
λ = Lead angle (degrees)
μ = Coefficient of friction
pz = Angle of friction
v_s = Sliding speed (m/s)
n_1 = Rotational speed of worm (rpm)
d_1 = Pitch diameter of worm (mm)

Speed (m/s)	μ for speeds 0-30m/s									
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.0-0.9	0.1500	0.0803	0.0694	0.0623	0.0583	0.0543	0.0521	0.0500	0.0480	0.0459
1.0-1.9	0.0438	0.0423	0.0410	0.0396	0.0382	0.0369	0.0359	0.0352	0.0344	0.0336
2.0-2.9	0.0329	0.0322	0.0316	0.0309	0.0304	0.0297	0.0293	0.0289	0.0286	0.0280
3.0-3.9	0.0276	0.0272	0.0268	0.0265	0.0261	0.0257	0.0254	0.0251	0.0248	0.0245
4.0-4.9	0.0242	0.0239	0.0236	0.0234	0.0232	0.0229	0.0226	0.0224	0.0223	0.0221
5.0-5.9	0.0219	0.0217	0.0215	0.0214	0.0212	0.0210	0.0209	0.0207	0.0205	0.0203
6.0-6.9	0.0202	0.0200	0.0199	0.0197	0.0196	0.0194	0.0193	0.0192	0.0190	0.0189
7.0-7.9	0.0187	0.0186	0.0185	0.0184	0.0183	0.0182	0.0181	0.0179	0.0178	0.0177
8.0-8.9	0.0176	0.0175	0.0174	0.0173	0.0173	0.0172	0.0172	0.0170	0.0169	0.0169
9.0-9.9	0.0169	0.0168	0.0166	0.0166	0.0164	0.0164	0.0164	0.0163	0.0162	0.0162
10.0-10.9	0.0161	0.0160	0.0159	0.0159	0.0159	0.0158	0.0157	0.0156	0.0156	0.0156
11.0-11.9	0.0155	0.0154	0.0154	0.0153	0.0153	0.0152	0.0151	0.0151	0.0150	0.0150
12.0-12.9	0.0149	0.0149	0.0149	0.0148	0.0148	0.0147	0.0147	0.0147	0.0146	0.0146
13.0-13.9	0.0146	0.0146	0.0146	0.0145	0.0145	0.0144	0.0144	0.0144	0.0144	0.0144
14.0-14.9	0.0143	0.0143	0.0143	0.0142	0.0142	0.0142	0.0142	0.0142	0.0141	0.0141
15.0-15.9	0.0141	0.0141	0.0141	0.0140	0.0140	0.0139	0.0139	0.0139	0.0139	0.0139
16.0-16.9	0.0139	0.0138	0.0138	0.0138	0.0138	0.0138	0.0137	0.0137	0.0137	0.0137
17.0-17.9	0.0137	0.0136	0.0136	0.0136	0.0136	0.0136	0.0135	0.0135	0.0135	0.0135
18.0-18.9	0.0135	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134	0.0134
19.0-19.9	0.0134	0.0133	0.0133	0.0133	0.0133	0.0133	0.0132	0.0132	0.0132	0.0132
20.0-20.9	0.0132	0.0131	0.0131	0.0131	0.0131	0.0131	0.0131	0.0131	0.0131	0.0131
21.0-21.9	0.0131	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130	0.0130
22.0-22.9	0.0130	0.0129	0.0129	0.0129	0.0129	0.0129	0.0129	0.0129	0.0129	0.0129
23.0-23.9	0.0129	0.0129	0.0128	0.0128	0.0128	0.0128	0.0128	0.0128	0.0128	0.0128
24.0-24.9	0.0128	0.0128	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127	0.0127
25.0-25.9	0.0127	0.0127	0.0126	0.0126	0.0126	0.0126	0.0126	0.0126	0.0126	0.0126
26.0-26.9	0.0126	0.0126	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125	0.0125
27.0-27.9	0.0125	0.0125	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124
28.0-28.9	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124	0.0124	0.0123	0.0123
29.0-29.9	0.0123	0.0123	0.0123	0.0123	0.0123	0.0123	0.0123	0.0123	0.0123	0.0123
30.0	0.0123	-	-	-	-	-	-	-	-	-