Description	Symbol	Units	Equation	Gear 1	Gear 2
Normal module	m_n			2.900	
Transverse module	m_t		$= m_n / \cos \beta$	2.964	
Axial module	m_x		$= m_n / \sin \beta$	14.064	
Normal pressure angle	α_n	degrees		20	
Transverse pressure angle	α_t	degrees	$\tan \alpha_t = \tan \alpha_n / \cos \beta$	20.403	
Helix angle at reference circle	β	degrees		11.9	
Helix angle at base diameter	β_b	degrees	$\sin \beta_b = \cos \alpha_n * \sin \beta$	11.173	
Number of teeth	z			17	80
Profile Shift coefficient	x			0.500	0.000
Reference profile of gear			Typical 1.25 / 0.2 / 1.25 per DIN 867	1.5209/0.33/1.00	1.5211/0.33/1.00
Addendum of gear reference profile	h_{aP}	mm	Typical $= (1 * m_n)$ per DIN 867 or ISO 53	2.9	2.9
Dedendum of gear reference profile	h_{fP}	mm	Typical $= (1.25 * m_n)$ per DIN 867 or ISO 53	4.4106	4.4112
Tip alteration coefficient	k		Non-dimensional. A negative value yields a shorter addendum.	-0.0166	-0.0166
Tip alteration	km_n	mm	$= k * m_n$	-0.0480	-0.0480
Gear ratio	u		$= z_2 / z_1$ Subscript 1 or 2 denotes gear 1 or 2.	4.7059	
Reference diameter	d	mm	$= (z * m_n) / \cos \beta$	50.383	237.095
Base diameter	d_b	mm	$= d * \cos \alpha_t$	47.222	222.220
Tip diameter	d_a	mm	$= d + (2 * m_n * x) + (2 * h_{aP}) + (2 * km_n)$	58.987	242.799
Root diameter	d_f	mm	$= d - (2 * h_{fP}) - (2 * m_n * x)$	44.462	228.273
Addendum	h_a	mm	$= h_{aP} + (m_n * x) + km_n$	4.302	2.852
Dedendum	h_f	mm	$= h_{fP} - (m_n * x)$	2.961	4.411
Tooth depth	h	mm	$= h_a + h_f$	7.263	7.263
Tip form diameter	d_{Fa}	mm	End diameter of involute portion of the profile.	58.987	242.799
Root form diameter	d_{Ff}	mm	Start diameter of involute portion of the profile.	47.408	230.431
Active tip diameter	d_{Na}	mm	Highest point on involute profile mating gear makes contact. (EAP)	58.987	242.799
Active root diameter	d_{Nf}	mm	Lowest point on involute profile mating gear makes contact. (SAP)	48.306	233.796
Normal pitch on reference cylinder	p_n	mm	$= \pi * m_n$	9.111	
Transverse pitch on reference diameter	p_t	mm	$= \pi * m_t$	9.311	
Axial pitch on reference cylinder	p_x	mm	$= \pi * m_x$	44.183	
Axial Lead	p_z	mm	$= p_x * z$	751.103	3534.601
Normal tooth thickness on reference diameter	s_n	mm	$= (p_n / 2) + (2 * m_n * x * \tan \alpha_n)$	5.611	4.555
Transverse tooth thickness on reference diameter	s_t	mm	$= (p_t / 2) + (2 * m_t * x * \tan \alpha_n)$	5.734	4.655
Tooth thickness tolerance DIN 3967	T_{sn}	mm		0.0400 f25	0.0500 e25
Tooth thickness allowance	A_{sne}	mm	Subscript e is upper and i is lower.	-0.0190	-0.0560
	A_{sni}	mm	$= -T_{sn} - A_{sne}$ Subscript e is upper and i is lower.	-0.0590	-0.1060
Max normal tooth thickness	s_{ne}	mm	$= s_n - A_{sne}$	5.592	4.499
Min normal tooth thickness	s_{ni}	mm	$= s_n - A_{sni}$	5.552	4.449
Working transverse pressure angle	inv α_{wt}		$\text{inv } \alpha_{wt} = \text{inv } \alpha_t + (2 * ((x_1 + x_2) / (z_1 + z_2)) * \tan \alpha_n)$	0.01961	
	α_{wt}	degrees	inv $\alpha_{wt} = \tan \alpha_{wt} - \alpha_{wt}$ (α_{wt} in radians, solved by Laskin's method)	21.8430	
Operating pitch diameter	d_w	mm	$= d_b / \cos \alpha_{wt}$ (if $z_1 + z_2 = 0$, then $\alpha_{wt} = \alpha_t$ and $d_w = d$)	50.874	239.408
Centre distance	a	mm	$= (d_{w1} + d_{w2}) / 2$	145.1412	
Theoretical backlash				Lower	Upper
Change in circumferential backlash due to A_s	Δj_a	mm	$\approx 2 * A_s * \tan \alpha_{wt}$	-0.016	0.016
Circumferential backlash	j_t	mm	$\approx (((A_{sn1} + A_{sn2}) / \cos \beta) * (\cos \alpha_t / \cos \alpha_{wt})) + \Delta j_a$	-0.186	-0.061
Normal backlash	j_n	mm	$\approx j_t * \cos \alpha_{wt} * \cos \beta_b$	-0.170	-0.056
Angular backlash of gear 1	j_θ	degrees	$\approx (j_t * 360) / \pi * d_2$ j_t is entered as positive value	0.030	0.090

COMPARISON OF QUALITY GRADE STANDARDS

HOBBING & SHAPING

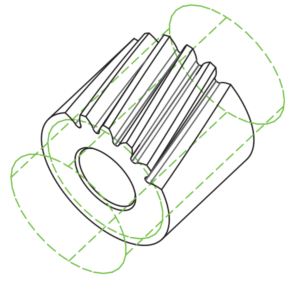
SHAVING

GRINDING

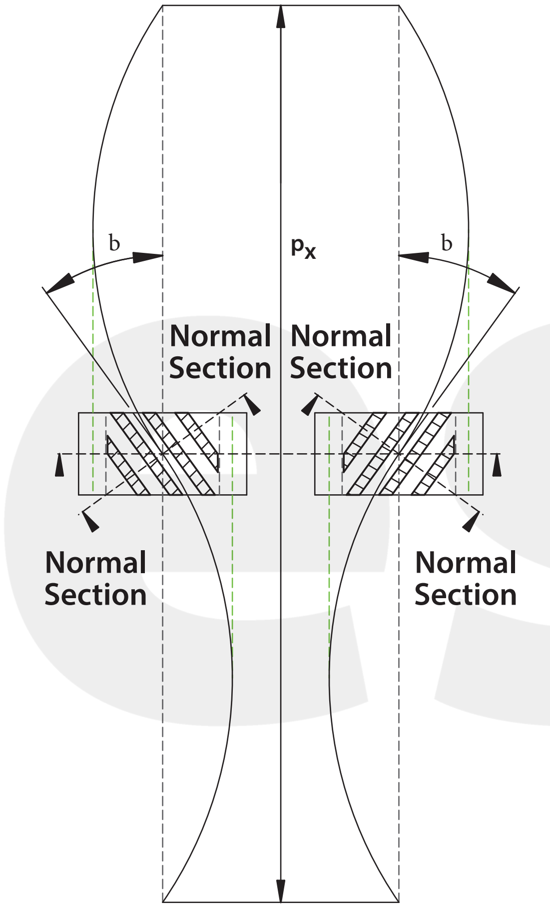
DIN 3961 - 3962	3	4	5	6	7	8	9	10
ISO 1328 : 1995/97	3	4	5	6	7	8	9	10
ISO 1328 : 2013	A3	A4	A5	A6	A7	A8	A9	A10
AGMA 2000	Q14	Q13	Q12	Q11	Q10	Q9	Q8	Q7
AGMA 2015	A3	A4	A5	A6	A7	A8	A9	A10

STANDARDS

Geometry	DIN 3960 ISO 21771 DIN 58405
Reference profile	DIN 867 ISO 53 DIN 3972 DIN 58412 DIN 58400
Backlash and tooth thickness	DIN 3967 DIN 58405 ISO TR 10064-2
Quality	DIN 3961 - 3962 ISO 1328 : 1995/97 ISO 1328 : 2013 AGMA 2000 AGMA 2015
Gear blanks & centre distance tolerance	ISO 10064-3 DIN 3964
Rating	ISO 6336 DIN 3990

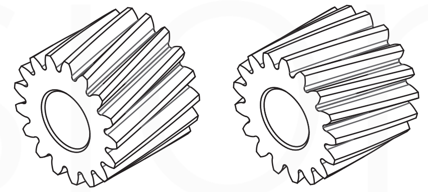


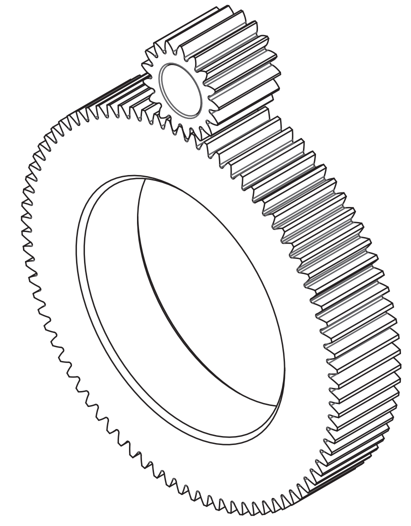
Reference Cylinder



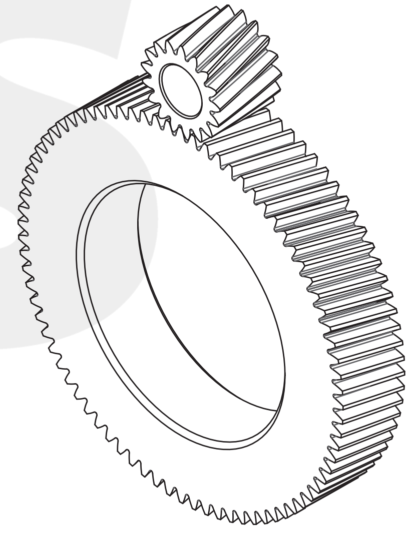
Left Hand Helix

Right Hand Helix

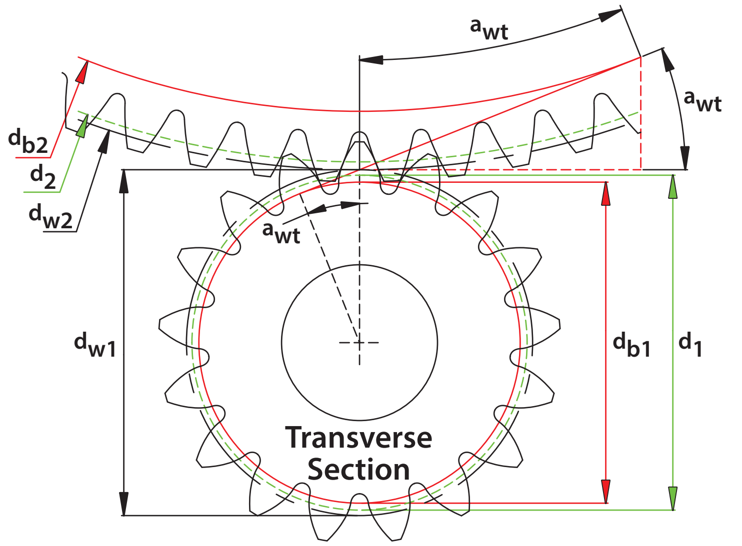




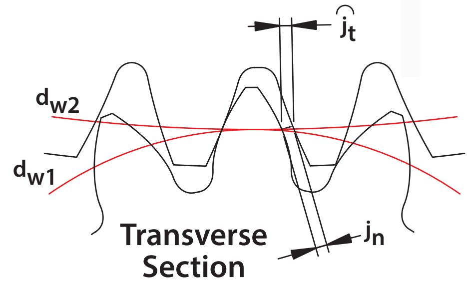
Spur Gear



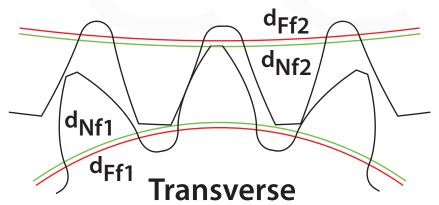
Helical Gear



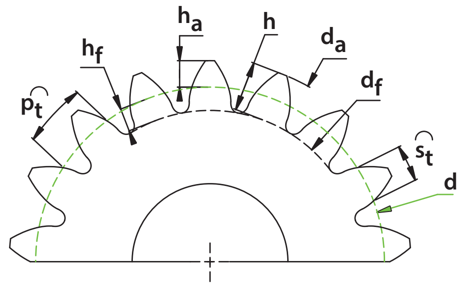
Transverse Section



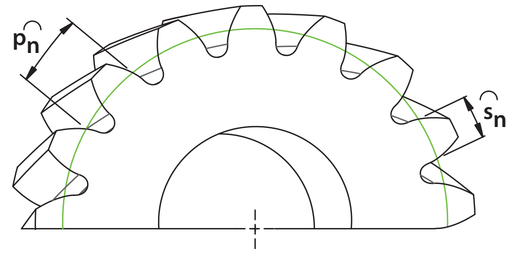
Transverse Section



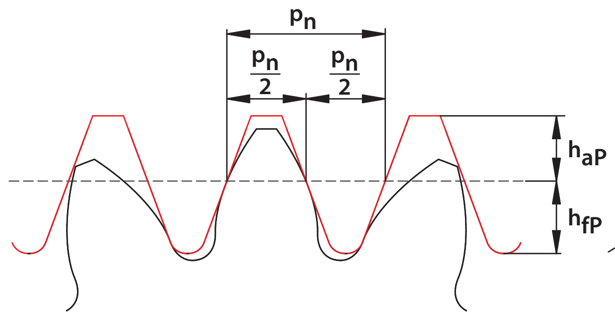
Transverse Section



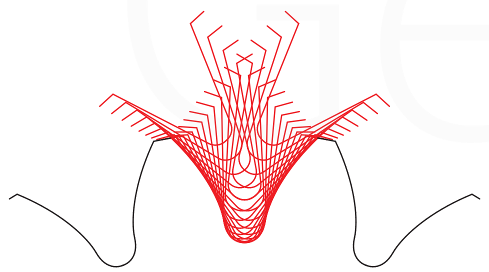
Transverse Section



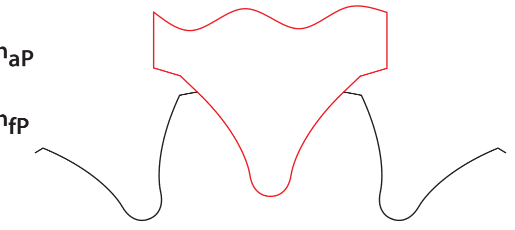
Normal Section



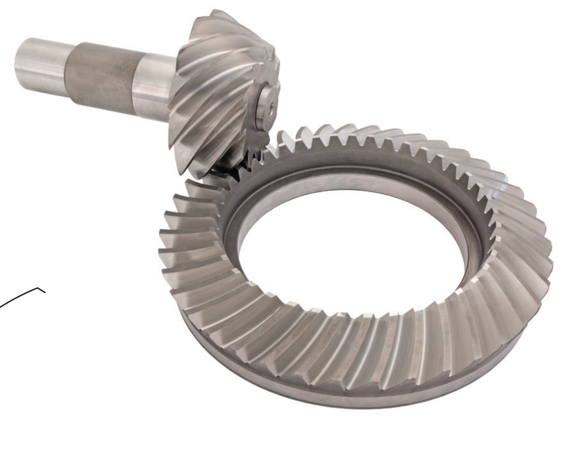
Reference Profile



Generating Hobbing or Shaping



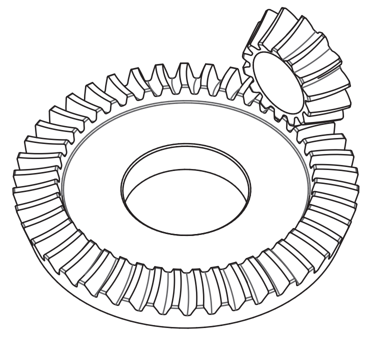
Precision Profile Form Grinding



PRECISION GROUND BEVEL TYPES

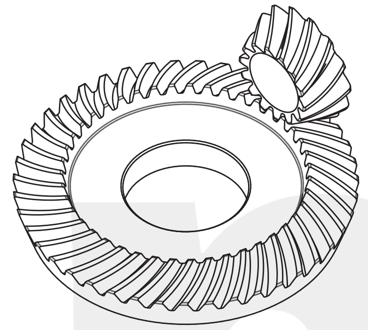
Gleason Zerol Bevel

- Face width up to 25% of cone distance.
- Spiral angle from zero up to 10°.
- Completing with duplex tooth taper systems.
- Gear generated or formate (plunge) grinding.



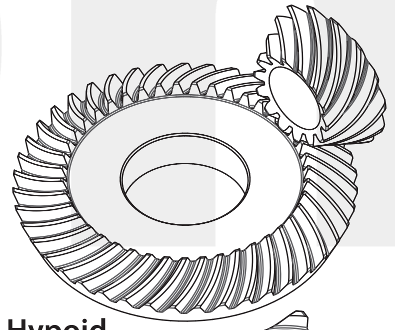
Spiral Bevel

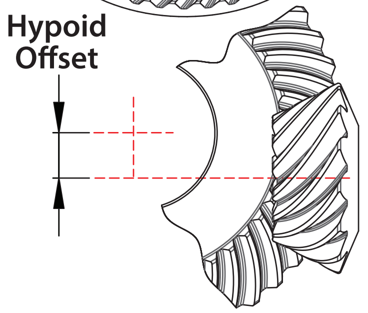
- Face width up to 33% of cone distance.
- Spiral angles 28 -38° typical. 10-45° achievable.
- Completing with duplex tooth taper systems.
- Gear generated or formate (plunge) grinding.



Hypoid

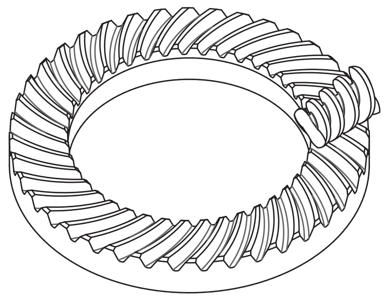
- Face width up to 33% of cone distance.
- Spiral angles 36 - 45° typical. Other angles achievable.
- Offset up to 25% gear pitch diameter.
- 5 and above teeth on pinion.
- Enlarged pinion compared to equivalent spiral bevel.
- Completing with duplex tooth taper systems.
- Gear generated or formate (plunge) grinding.





Gleason High Ratio Hypoid (HRH)

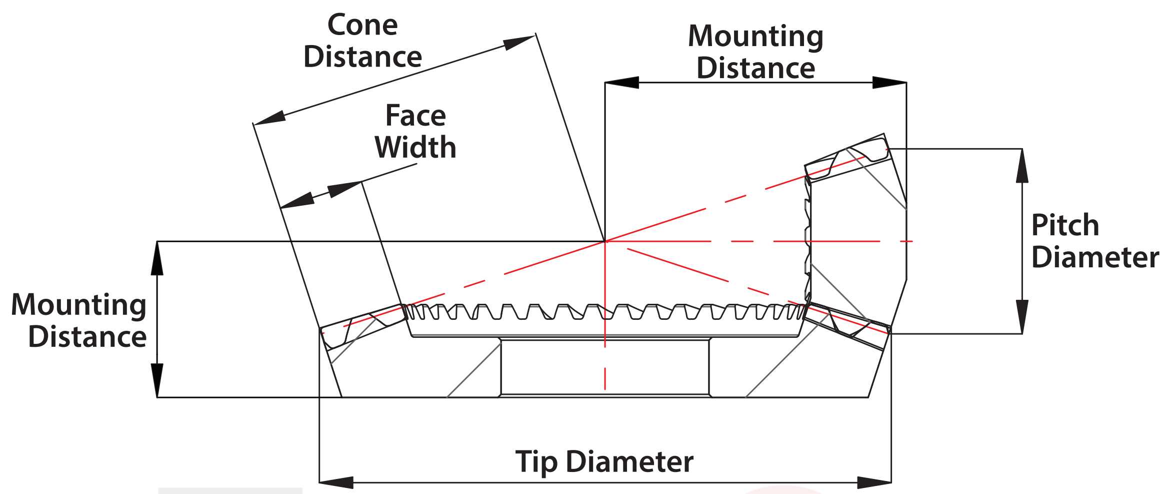
- Ratio 15:1 and above.
- 1-4 teeth on pinion.
- Parallel tooth depth.
- Tooth depth limited to 5mm.
- Offset 0.2 - 0.33 of outside diameter of gear.

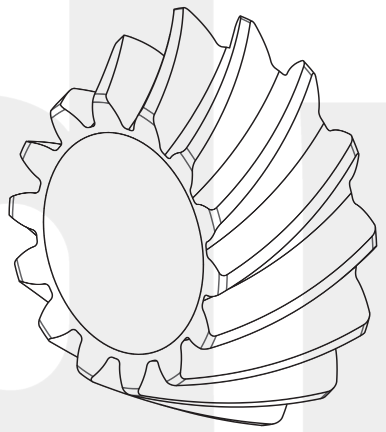


Gleason Super High Ratio Hypoid (SRH)

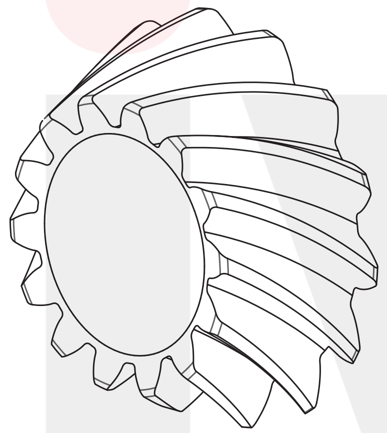
- 25-100 teeth on gear.
- Advance design and machine universal motion control (UMC) systems can be applied to highly optimise gear sets for greater efficiencies and ratios compared to worm gears and HRH gear sets.

GEOMETRY

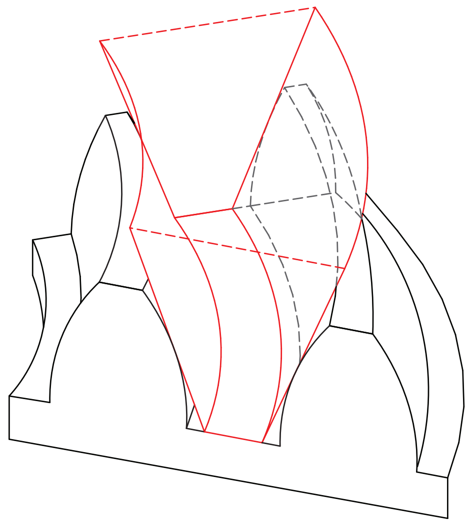




Left Hand Spiral

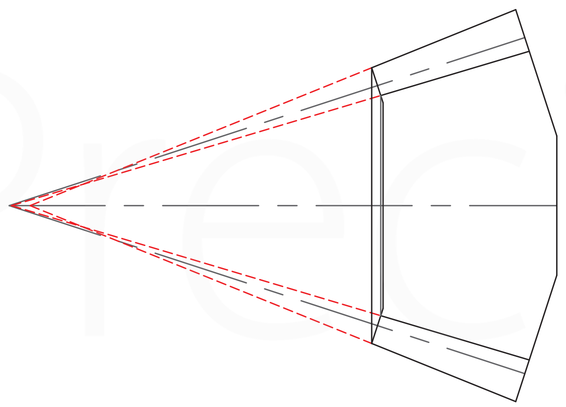


Right Hand Spiral



Duplex Tooth Taper

Root line of both pinion and gear is tilted to produce a constant slot width over tooth length. This allows both flanks to be machined at the same time.
The tooth thickness and tooth height reduces over tooth length.



Face angle

Typically made parallel to root angle of mating gear to maintain a contact clearance over face width.

INDUSTRY 4.0 CLOSED LOOP DESIGN AND MANUFACTURING SYSTEM