

FORMULA STUDENT GEARBOX

Shaft-hub connections

Version: V1-2025



Information for FSAE / FS-Team

The splined shaft connections should be as free of play as possible. For the ring gear, we even recommend a slightly loose press fit in the aluminum wheel hub. Any damage caused by loose fits is the responsibility of the teams.

The teams are allowed to modify the spline connections of their parts (in this case, the rotor shaft and wheel hub) in order to adjust the foot radii or diameters for other manufacturing processes, or simply for reasons of strength. However, the tooth widths must be taken into account and maintained in order to ensure that there is almost no backlash.

In accordance with DIN5480, concentricity must be maintained at 20 µm to the respective axis (wheel bearings for the spline of the wheel hub or rotor-shaft/ rotor-bearings for the sun gear)

We recommend assembling the spline connections using an assembly paste with high pressure load capacity. Please ensure that your oil is compatible with the paste.

Sun Gear

The sun gear shaft is equipped with a spline that fits the DTI Formula Student motor.

The corresponding dimensions can be found in the tables opposite.

The sun gear is secured with a M4 screw as intended by DTI.

In any case, HUMBEL is not responsible for loose rings or screws: The teams must use suitable methods (screw locking, Nord-Lock®, or positive locking) to ensure that the connections do not come loose.

Of course, teams with their own rotor shafts can also use the sun according to "DTI specifications."

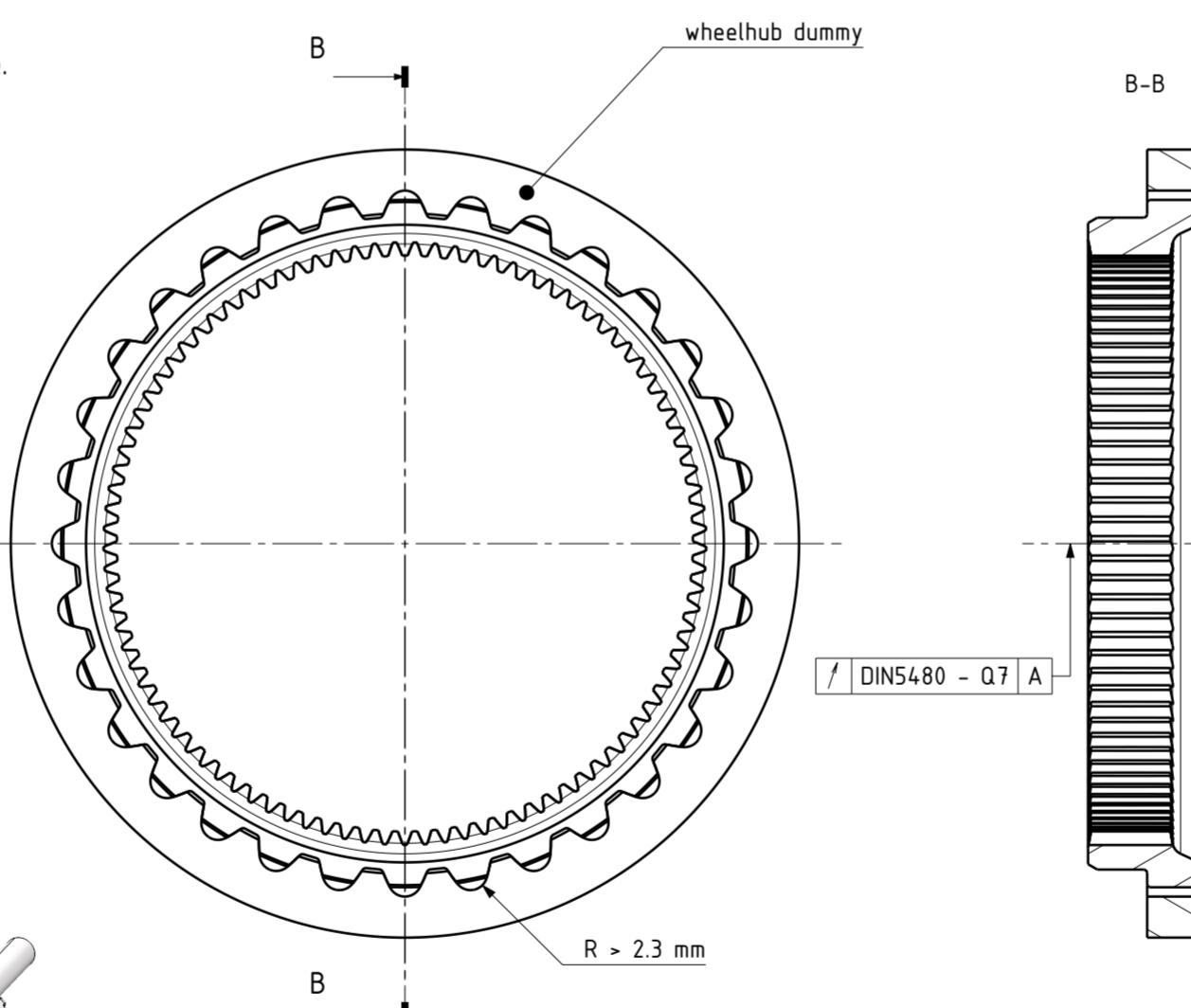
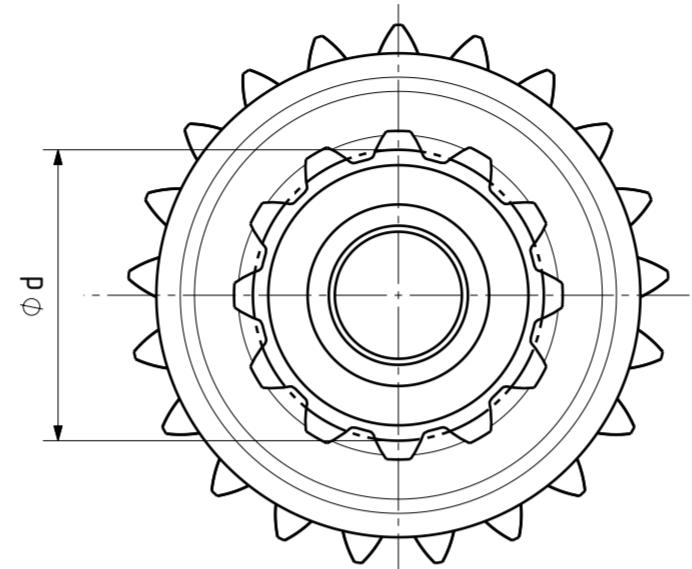
The splined shaft connection should be designed to match DTI.

Ring Gear

Our proposal for a splined shaft connection for the wheel hub (.dxf-file included / table opposite) has an adapted foot radius (increased to > 2 mm). This makes it possible to produce the contour in the wheel hub on a universal milling machine (or of course EDM). The teams thus save themselves gear-specific manufacturing processes such as shaping or gear hobbing.

The ring gear can be secured axially in various ways: with a shoulder in the hub on one side (particularly advantageous as splines can be milled), outer race of the wheel-bearing, a retaining ring, screws, or other concepts developed by the teams.

Deformation of the ring gear due to excessive pressure in the splined shaft must be prevented.



Spline Tothing DIN 5480 SUN Zahnwellenverbindung DIN 5480		
Normal module [mm] <i>Normalmodul</i>	m_n	0.8
Number of teeth <i>Zähnezahl</i>	z	12
Normal pressure angle [°] <i>Normaleingriffswinkel</i>	α_n	30
Nominal helix angle [°] <i>Nennschrägungswinkel</i>	β	0
Profile shift coefficient <i>Profilverschiebungsfaktor</i>	x	0.3250
Reference diameter [mm] <i>Teilkreisdurchmesser</i>	d_1	9.600
Tip diameter [mm] <i>Kopfkreisdurchmesser</i>	d_{a1}	10.900 (0/-0.070)
Root diameter [mm] <i>Fusskreisdurchmesser</i>	d_r	9.170 - 9.220
Root form diameter [mm] <i>Fussformkreisdurchmesser</i>	d_{rf}	9.392 - 9.418
Profile control diameter [mm] <i>Start der Profilauswertung</i>	d_{cr}	9.450
Base diameter [mm] <i>Grundkreisdurchmesser</i>	d_b	8.314
Tooth thickness tolerance <i>Zahndickentoleranz</i>	-	DIN 5480 k
Base tangent length actual [mm] <i>Zahnweite actual</i>	W_k	6.140 - 6.154
Number of teeth spanned <i>Messzähnezahl</i>	k	3

Images from "DTI F-SIC_Motor_Shaft_Involute Spline.pdf"

Spline Designation: DIN 5480-30deg Flat root, Side fit-11x0,8x30°x12 9H 7h	
5	4
Internal Involute Spline Data	
Hub Addendum Modification	$x_{2m} = 0,260 \text{ mm}$
Hub Tooth Addendum	$h_{2P} = 0,440 \text{ mm}$
Hub Tooth Height	$h_{2P} = 0,800 \text{ mm}$
Hub Tip Circle Diameter	$d_{a2} = 9,400 \text{ mm}$
Hub Min Form Root Diameter	$d_{f2} = 10,872 \text{ mm}$
Hub Root Circle Diameter	$d_{f2} = 11,000 \text{ mm}$
Hub Tooth Thickness	$s_2 = 0,956 \text{ mm}$
Hub Space Width	$e_2 = 1,557 \text{ mm}$

Test Dimensions	
Base Tangent Length over Teeth	$W_e = 6,148 \text{ mm}$
Base Tangent Length over Spaces	$W_i = 5,255 \text{ mm}$
Test Dimension over Pins	$Me = 13,521 \text{ mm}$
Test Dimension between Pins	$Mi = 9,240 \text{ mm}$
Pin Diameter, Hub	$dp = 1,000 \text{ mm}$
Teeth Number, Hub	$n_2 = 3,000 \text{ ul}$

Spline toothing DIN 5480 SHAFT Zahnwellenverbindung DIN 5480		
Normal module [mm] <i>Normalmodul</i>	m_n	3
Number of teeth <i>Zähnezahl</i>	z	32
Normal pressure angle [°] <i>Normaleingriffswinkel</i>	α_n	30
Nominal helix angle [°] <i>Nennschrägungswinkel</i>	β	0
Profile shift coefficient <i>Profilverschiebungsfaktor</i>	x	-0.15
Reference diameter [mm] <i>Teilkreisdurchmesser</i>	d_1	96.000
Tip diameter [mm] <i>Kopfkreisdurchmesser</i>	d_{a1}	96.000 (0/-0.100)
Root diameter [mm] <i>Fusskreisdurchmesser</i>	d_r	91.195 - 91.238
Root form diameter [mm] <i>Fussformkreisdurchmesser</i>	d_{rf}	91.980 - 92.017
Profile control diameter [mm] <i>Start der Profilauswertung</i>	d_{cr}	92.100
Base diameter [mm] <i>Grundkreisdurchmesser</i>	d_b	83.138
Tooth thickness tolerance <i>Zahndickentoleranz</i>	-	DIN 5480 m
Base tangent length [mm] <i>Zahnweite</i>	W_k	40.746 - 40.767
Number of teeth spanned <i>Messzähnezahl</i>	k	5
Dia. two-ball dimension actual [mm] <i>Diametrales Zweikugelmaß actual</i>	M_{dk}	103.380 - 103.421
Effective diameter of ball [mm] <i>Effektiver Messkörperdurchmesser</i>	D_{Meff}	5.5

Recommendation HUB DIN 5480 - N 98.40x3.00x32x7H		
Internal spline toothing DIN 5480 Innen-Zahnwellenverbindung DIN 5480		
Normal module [mm] <i>Normalmodul</i>	m_n	3
Number of teeth <i>Zähnezahl</i>	z	-32
Normal pressure angle [°] <i>Normaleingriffswinkel</i>	α_n	30
Nominal helix angle [°] <i>Nennschrägungswinkel</i>	β	0
Profile shift coefficient <i>Profilverschiebungsfaktor</i>	x	0.15
Reference diameter [mm] <i>Teilkreisdurchmesser</i>	d_1	96.000
Tip diameter [mm] <i>Kopfkreisdurchmesser</i>	d_{a1}	92.100 (0/0.080)
Root diameter [mm] <i>Fusskreisdurchmesser</i>	d_r	98.526 - 98.569
Root form diameter [mm] <i>Fussformkreisdurchmesser</i>	d_{rf}	96.104 - 96.149
Profile control diameter [mm] <i>Start der Profilauswertung</i>	d_{cr}	96.000
Base diameter [mm] <i>Grundkreisdurchmesser</i>	d_b	83.138
Tooth thickness tolerance <i>Zahndickentoleranz</i>	-	DIN 5480 H
Base tangent length [mm] <i>Zahnweite</i>	W_k	40.746 - 40.767
Number of teeth spanned <i>Messzähnezahl</i>	k	5
Dia. two-ball dimension act. [mm] <i>Diametrales Zweikugelmaß act.</i>	M_{dk}	87.342 - 87.391
Effective diameter of ball [mm] <i>Effektiver Messkörperdurchmesser</i>	D_{Meff}	5.25

Maßstab / Scale	A2	Blatt / Sheet	Projektname / Project name	Werkstoff / Material	Gewicht / Weight
1:1		02 / 02	HUMB.2411		0 kg
Tolerierungsgrundsatz Fundamental tolerancing principle			ISO 8015	Gezeichnet Drawn by	tim.schulte
Allgemeintoleranzen General tolerances			ISO 2768-mK	Geprüft Reviewed by	tim.schulte
Revisionskommentar Revision comment				Freigegeben Released by	dominik.brunner
Benennung / Designation				Datum / Date	18.09.2025
Zeichnungsnr. / Drawing number				Zeichnungsnr. / Drawing number	
HU-00142405				Revision	A

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