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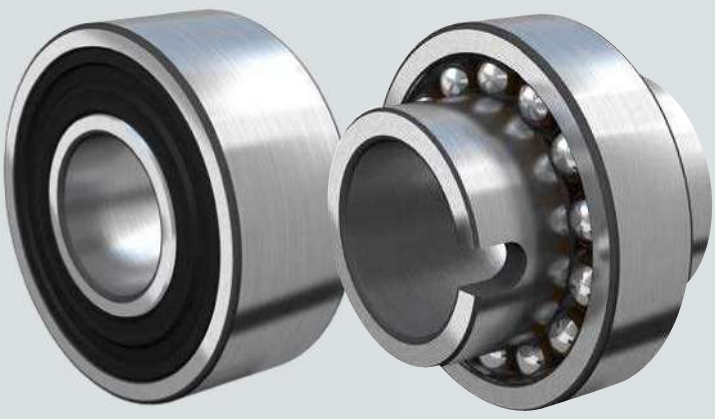

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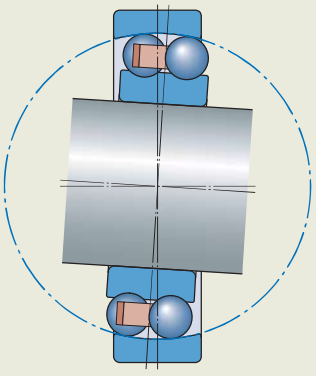

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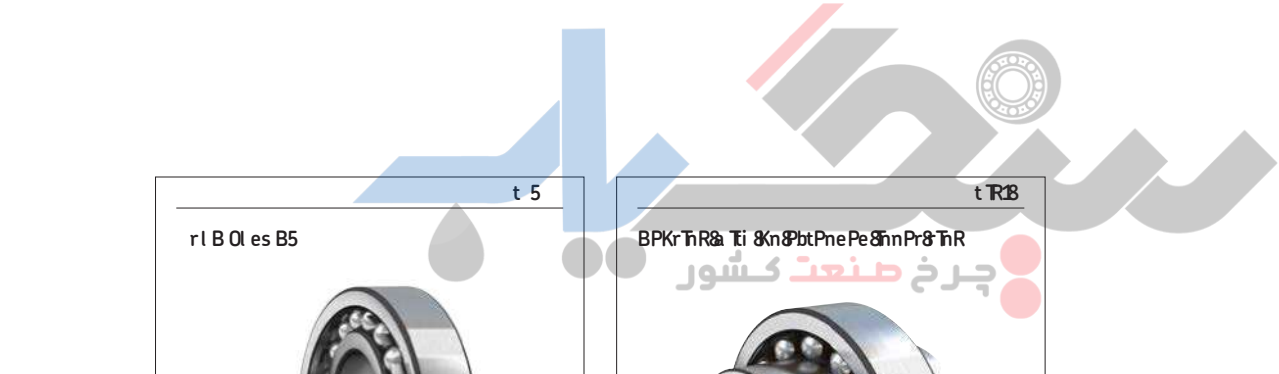

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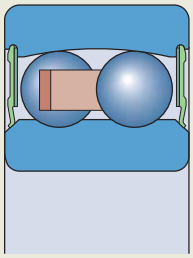

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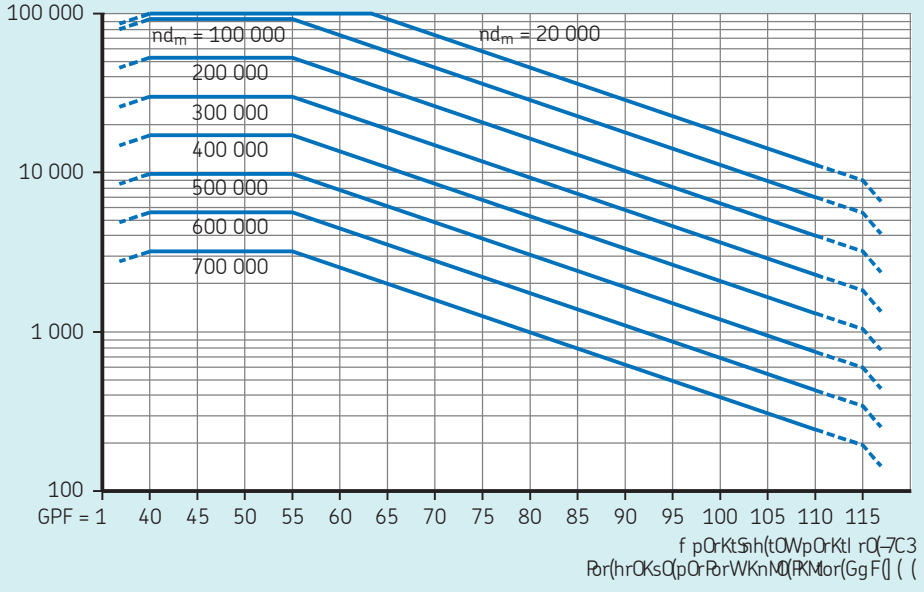

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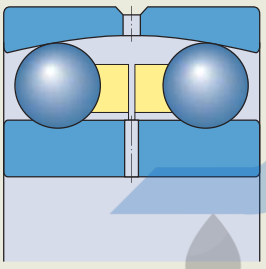

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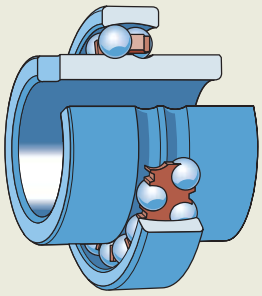

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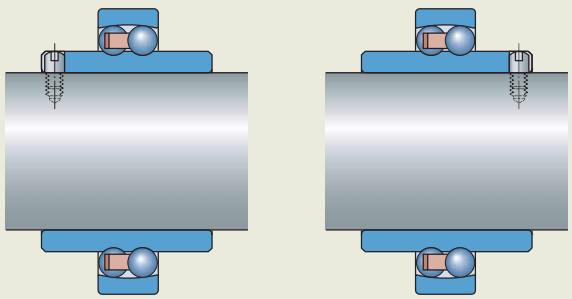

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	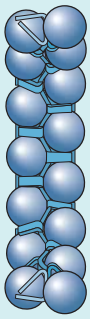	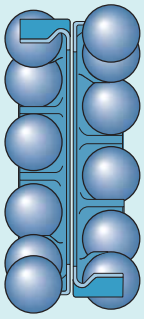	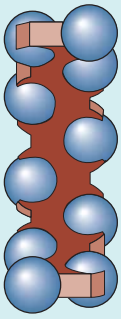	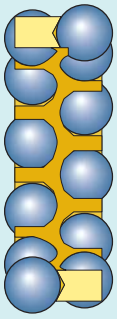	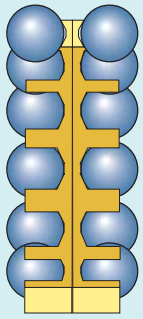
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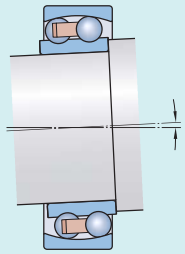

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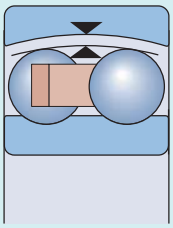

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BPKrTnRs&aTi8K8KpPrPe8LorP8

BorP8eTK3 PtPr h	SKeTK28EntPrnK2MPKrKnMP D1		i Ct- c,		D•	
	o	9)	o	9)	o	9)
8(	46					
46	57					
57	67					
67	7					
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877	847					

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PoMTv

d ThT3 l 3 8boKe For(KNNSSonKV(SnPorWKtSon(4 (pKRP892•	$F_{rm} = k_r \left(\frac{\nu n}{1\,000} \right)^{2/3} \left(\frac{d_m}{100} \right)^2$	**kc3 Lo2s** B LOKrSnh(a SNtR(-WW3 N(LOKrSnh(LorO(NSKWOtOr(-WW3(N_W LOKrSnh(WOKn(NSKWOtOr(-WW3( ] (/ (-N(. (D≤ O MKWl VKtSon(PKMtor(-proel M&KL2Ps/(pKRP8 02≤ F_K KbSKV(oKN(-+e 3 F_{Kp} WKbSWl W(pOrWSss$LVO(KbSKV(oKN(-+e 3(F_r rKNSKV(oKN(-+e 3 F_{rW} WSnSWl W(rKNSKV(oKN(-+e 3(l_r WSnSWl W(oKN(PKMtor(-proel M8 tKL2Ps≤(n(rotKtSonKV(spOON(-+r2WSn3 g(OqlSlKVOnt(NcnKWSM(LOKrSnh(oKN(-+e 3 g (OqlSlKVOnt(stKtSM(LOKrSnh(oKN(-+e 3(Y /(Y /(Y (MKWl VKtSon(PKMtors(-proel M&KL2Ps≤ ≥ oSVJSsNosSc(Kt(opOrKtSnh(tOWpOrK8 tl rO(-WW 2≤3
AbTK2boKe8MKrrcThR8 MKpKMtc	BOKrSnhs(WoI ntON(on(Kn(KNKptOr(sVOOJO(on(pVKSn(sRKPts(a SRol t(K(-boON(KLI tWOnt,(F_{Kp}(] (/ (B(N(proJSNON(tRO(LOKrSnhs(KrO(NorrOMVc(WoI ntON1	
EqI TWK2Pnt8 ecnK3 TM&LPKrThR8 2boKe For(KNNSSonKV(SnPorWKtSon(4 (pKRP8 9	F_KZF_r(O(O(4 (g(] (F$_r$(. (Y (F$_K$(F_KZF_r(° (O(4 (g(] (/ (F$_r$(. (Y (F$_K$	
EqI TWK2Pnt8tKtTM8 LPKrThR8boKe For(KNNSSonKV(SnPorWKtSon(4 (pKRP8920	g (] (F$_r$(. (Y (F$_K$	

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m pmtMabtm av

>WS qSt- 3vv3tl,S CqStca3hmaS- qStcaxtS kCt vS,k c,3hm3hmdc,, dSct3hmv Ocn dS ,3- 3&Sh de

aWS h3- Snv3Cnc, vacd3;3ae CkaWS dSct3hm t3hmv cnh dc,,v
aWS OcmS
aWS vSc,v
aWS ,x dt3Dcna

. WStS aS- qStcaxtSv Cxav3hS aWS qSt- 3vv3tl,S tcnmS ctS SzqSOaSh OCnacOa Mu

C mc B c B dmB m d

Mu vS,k c,3hm3hmdc,, dSct3hmv ctS WSca vacd3;3gShxq aC (7C(° 42+Os-1

Fm d

j tOOV(or(LrKss(MKhOs(MKn(LO(I sON(Kt(tRO(sKWO(opOrKtSnh(tOWpOrKtl rOs(Ks(tRO(LOKrSnh(rSnhs(KnN(LKW&1(For(tOWpOrKtl rO(WSVSs(oP(poVcWOr(MKhOs/(rOPOr(to(*So(c) gF-eKl gt*/(pKRP8944-1

kPK2s

kRO(pOrWSss$LVO(opOrKtSnh(tOWpOrKtl rO(POr(e Bi (sOKV&(S(6 (to(. (7C(°1 2(ω(5 2+Os-1(kOWpOrKtl rOs(I p(to((7C(° 42+Os-1(MKn(LO(toVOrKtON(POr(LrSOPpOrSoNs1
kcpSMKWc/(tOWpOrKtl rO(pOKI s(KrO(Kt(tRO(sOKV(Sp1

yl LrTMKnts

kOWpOrKtl rO(WSVSs(POr(tRO(hrOKsOs(I sON(Sn(sOKVON(j xF(sOVP8KWSnnSnh(LKW(LOKrSnhs(KrO(proJSNON(Sn(tKL2P89/(pKRP8 91(For(tOWpOrK8tl rO(WSVSs(oP(otROr(j xF(hrOKsOs/(rOPOr(to(*g(geuml +K+tandKy(g+ bs+ FgKtg*/(pKRP899•1
v ROn(I sSnh(V LrSMKnts(not(sI pp(WSON(Lc(j xF/(tOWpOrKtl rO(WSVSs(sRol VN(LO(OJKV KtON(KNMorNSnh(to(tRO(j xF(trKP→M(MSnRt(MonMOpt(-pKRP8991≤1

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mt vv f mvpnmmT

>W5vqSSh tca3mnv3n aW5 **proel M8KL2Ps** 3nh3DcaS

aW5 **rPgPrPnMP8pPPe** y W8DW5ncd,Svc Fx3D(cvvSvv- SnaCkaW5vqSSh Ocqcd3,a35v ktC- caW5t- c,ktc- SCktSkStSnO5 aW5 **2B3 TTnR8pPPe** y W8DW3vc - SOWtn3Dc, ,3- 3aaWtavWCx,h nCadS SzO5ShSh xn,Svv aW5 dSct3mnhSv3mn cnh aW5 cqq,3Dca3Cn ctS chcqaShkCt W8mW5t vqSShv

uCt chh3a3Cnc, 3nkCt- ca3Cn tSkStaC *4r3ueKn K31 r3ueKyu3 enWwr33W* **pKRP8962**

Dmv n honv TmtMaonv

BM ptoatbv on

>W5 dc,,v CkvC- SdScht 1 t t w u: wr upKubW)up K•: wW)fk: wp) K•: i: fum- **–R1892** •: cf b: wp) K•: rupKub wpn fu: •wK Wm K•: **proel M8KL2P pKRP8 01** fnWw•pb Wi: kpnw•Wu: We •: n W w•-n•n- kp rpn: nKw•n k pw: ruph• •KTkp K•: i: fum-

BmMt n v on v mmymv

:) f •-n•n- if i: fum-we •K• f kfr: u: W ipu: kfn i: pbnK We •K•

f n fWfr K: uw: : c: pn r f •n puwK: rr: W w•f)Kw **–R1899**
f e •K• Wufe f w: : c: pn wK: rr: Ww•f)Kw **–R189**

AWfr K: uw: : c: wfu: wbrr •.Wkp r : K: e •K• f pk •n- W c•k:
vpufrrupruf K: gv fWfr K: uw: : c: w u:): u kp K•: **proel M8KL2P pKRP8 04**
•: n bw•n- w f : Wi: fum-w f : wbu: frrupruf K: gv fWfr K: uw: : c: fww i •.w : - t W w•-n w: : c: u): ukp K•: **proel M8 tKL2P** fu: bw: WKp ru: c: nKK•: pk •n- W c•k:)up •nK u): um- e •K• K•: w f **–R1896** A K: u nf K•c: T bw: f wr f k: uum- i: K•e: : n K•: i: fum- fnWK•: pk e f w•: u vpuf WW K•pnf •n)pu fK•pn
AWérK3uwC33M3w **pKRP892•0**
(K8Wzed eOwC33M3w **pKRP89241**

BmMt n vc a Mh meamnTmT nnmtt n

•: n K•e p p) K•: w i: fum-wfu: bw: WKp wbrr puKf w•f)K kp pkfK K•: w•f)Kf h•f T K•: •nn: uum- wpKw bwKi: fuufn-: W fk•n- K•pe fuWwpufe fT)up : fk• pK•: u **–R18 pKRP8 9**

FTR1892

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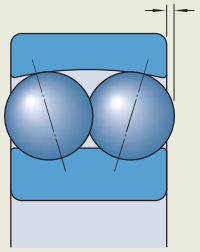

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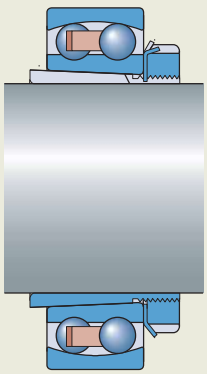

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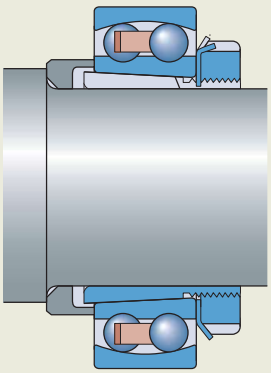

Tn c va5qqSh vWtka

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Apptopt Maamf mMt n obv n v

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i N s q,x- - St q3;Cy d,CO(WCxv3hmv Sn(tRO(/(/((KnN((sOrSDs (Fe y(5KnhON(RoI sSnhs (j AF(pV WWOr(-pSWoa s{LVoM(RoI sSnhs(Por(SnMR(sRKPts

ANNSSonKVSnPorWKtSon(KLoI t(j xF(LOKrSnh(RoI sSnhs(Ss KJKSVKLVO(onVSnO(Kt(slP1MoW2RoI sSnhs1

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i obnan f mMt n v c a MhgnTthM fotm

i OPOr(to(*l CynK(n h3eu(n wd(K8 e kSO(nWL(ke0 hCu3/(pKRP8 291

i obnan f mMt n v c a MaMpmtmT fotm

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98FPP2TnR8i P8MPKrKnMP8Pel MtTon&c8 tI rnTnR8Kne8a TwP2TnR8i P8oI tPr8TnR8 ,-R189 -

0(kRSs(WOtRoN(Ss(JKVSN(Por(LOKrSnhs(a SR(e orWKV(rKNSKV(MOKrKnMO(-not(Por(sOKVON(LOKrSnhs<1

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8dI PKsI rTnR8i P8ZoMn8hI t8TRi tPnTnR8KnR2P8 ,tKL2P81.8pKRP8 4-

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For(LOKrSnhs(a SR(N(fi((WW/(j xF(rOMoW8 WOnNs(I sSnh(tRO(j xF(DrSIO8I p(z OtRoN(kRSs(Ss(K(PKst/(rOV8KLVO(KnN(sKPO(WOtRoN(to(NOtOrWSnO(tRO(Kppropr8KtO(SntOrPOrOnMO(-x1(ANNSSonKVSnPorWKtSon(Ss KJKSVKLVO(onVSnO(Kt(slP1MoW2N-SIO8I p1

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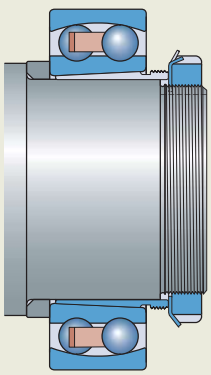

FTR1896

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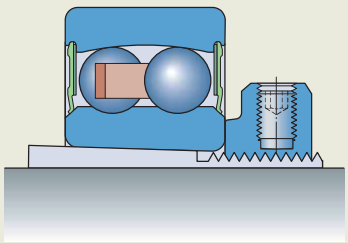

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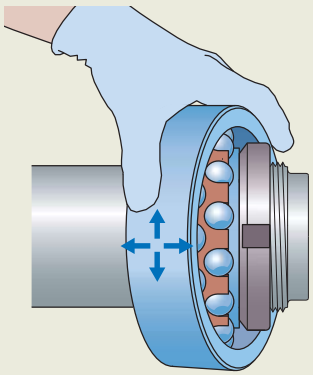

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lgT6

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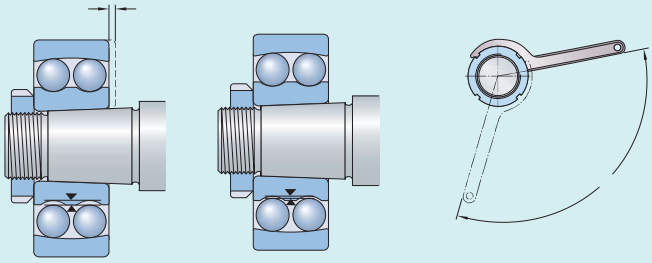

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