PRODUCT INFORMATION

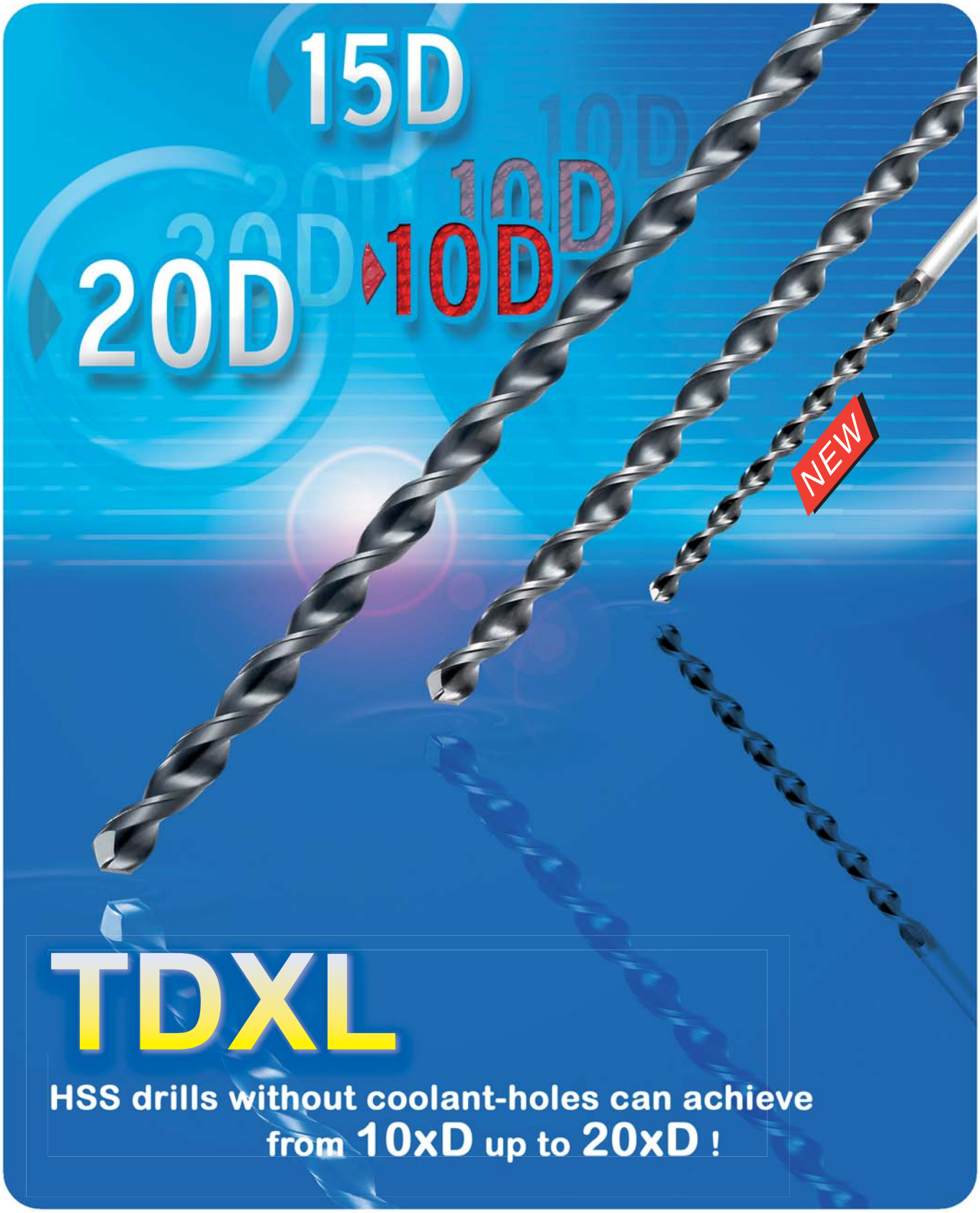
PAT.P.

TDXL Serie

TOKO-TON SPIRIT Total Commitment

Vol 2

HSS EXTRA LONG DRILLS
10 D, 15 D and 20 D !



TDXL

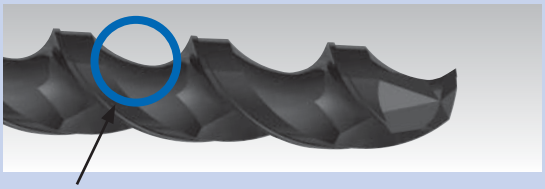
1. Newly developed flat flute (Pat. P.)
2. Newly developed low-resistance thinning (Pat. P.)
3. Newly developed compound flute lead construction (Pat. P.)
4. Newly developed WXL coating for drills

TDXL features four newly developed technologies including three patents pending!

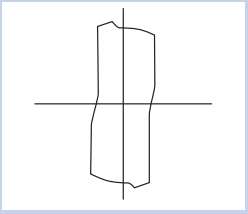
New technologies !

New flute shape (Pat. P.) dramatically improves chip evacuation ! It is capable of non-step drilling from 10 D up to 20xD!

■ Flute Form



Highly rigid, wide flutes with smooth curves



Newly developed flat flute (Pat. P.)

■ Chip shape when drilling S50C

TDXL

Short, broken pieces

Competitor

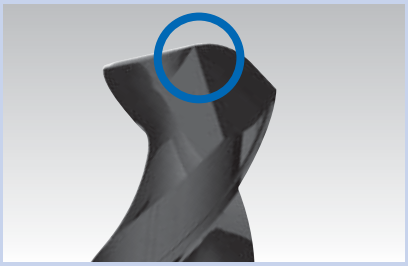
Long, curly chips

HSS EXTRA-LONG DRILL

New technologies !

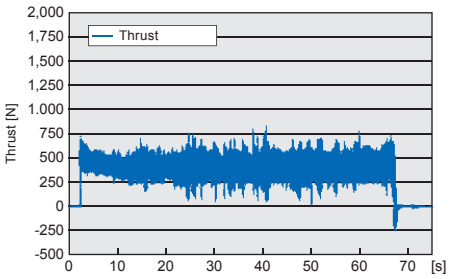
The newly developed thinning (Pat. P.) exhibited half the thrust resistance(in-house comparison)!

■ Thining Form



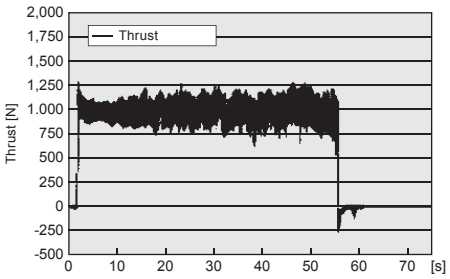
Sharp and low-thrust new thinning form

■ Thrust Resistance



TDXL

TDXL was tested at a depth of 20xD



Competitor

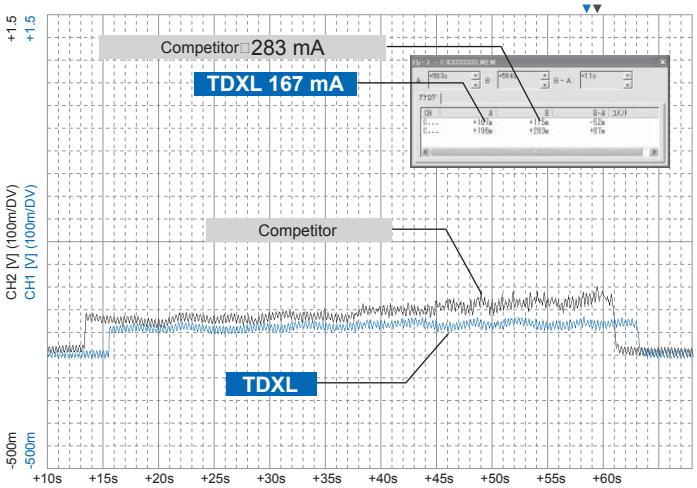
The competitor's product with a shorter flute was tested at a depth of 15xD

New technologies !

Newly developed compound flute lead construction (Pat. P.)

The newly conceived flute design widens in the middle, significantly improving chip evacuation. Thanks to this, it is capable of non-step drilling of up to 20xD.

■ Stable drilling power (spindle amperage)



New technologies !

New coating improves durability !

The newly developed WXL Coating makes drills sparkle!

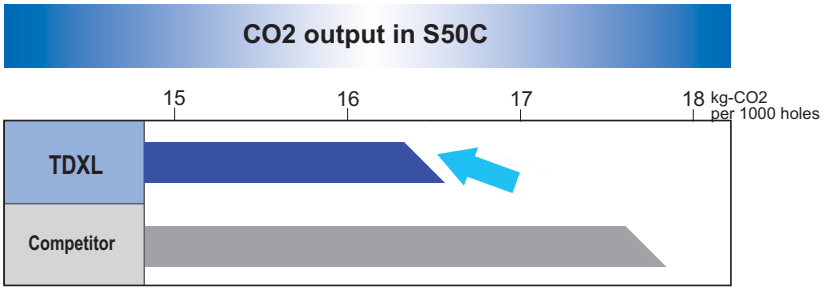
Processing Examples

■ Lower CO_2 output than competitors !!!!.

Eco-Friendly Commitment !

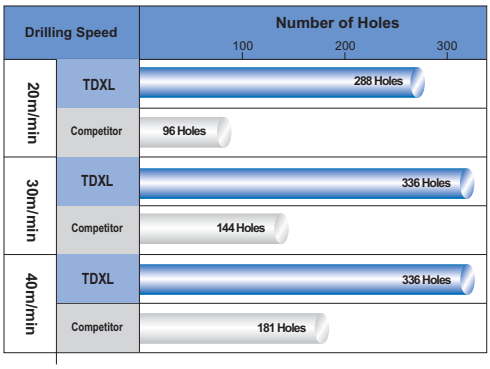
Compared to the competitor's product, cut CO_2 by 0,96 kg or 5,4% per 1000 holes !!

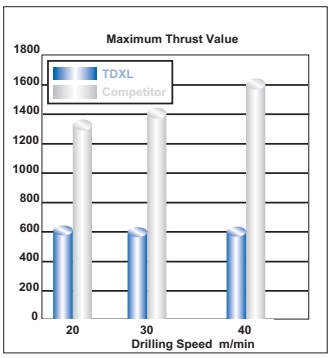
Tool	TDXL 10 × 10 D
Work Material	S50C (DIN CK50 AISI 1050)
Drilling Speed	25 m/min (796 min^{-1})
Feed	176 mm/min (0,22mm/rev) NON STEP
Depth of Holes	100 mm (10D) (Blind)
Coolant	Water Soluble
Machine	Vertical Machining Center



■ Compared to the competitor's product, the maximum thrust value is stable. Durability is 1,8 to 3 times greater !!

Tool	TDXL 7 × 15 D
Work Material	S50C (DIN CK50 AISI 1050)
Drilling Speed	20 ~ 40 m/min (910 ~ 1.820min^{-1})
Feed	127 ~ 255 mm/min (0,14mm/rev) NON STEP
Depth of Holes	99 mm (14 D) (Blind)
Coolant	Water Soluble
Machine	Horizontal Machining Center



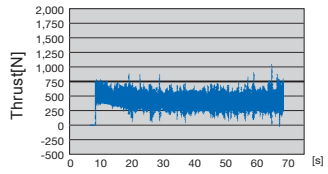
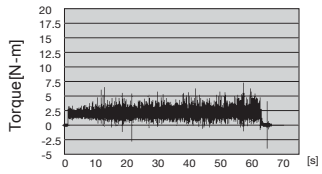
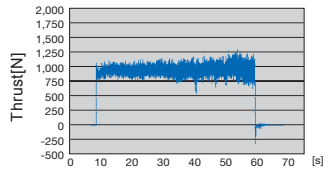
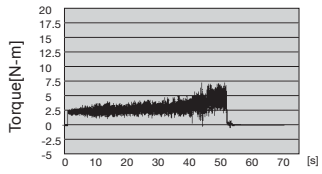
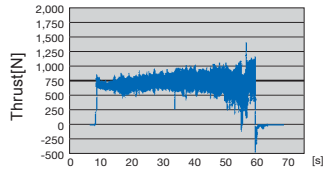
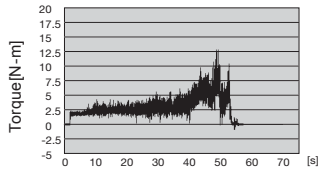
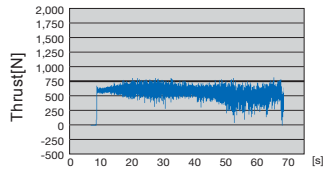
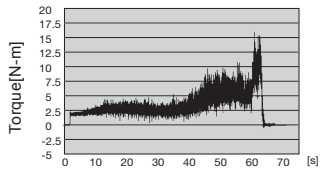
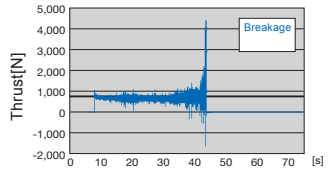
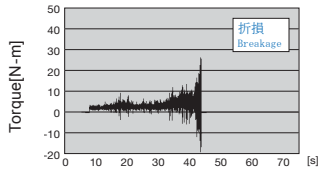


Tool runhout under 2µm

Drill for pilot hole

Tool	EX-GDS Ø 7,1 mm
Depth of Holes	14mm

Processing Examples

	Thrust	Torque
TDXL		
Competitor A	 High thrust	 Torque increased at about 20xD
Competitor B	 Thrust fluctuations	 Torque increased at about 12xD
Competitor C		 Despite its stable thrust, torque increased at the middle of the hole.
Competitor D		 Torque fluctuations began at about 8xD

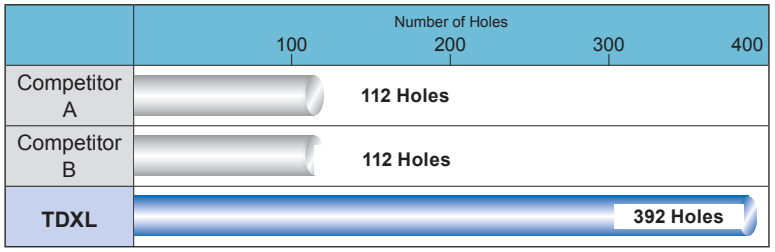
Competitor A & B : Because of its short flute length, it could drill only up to 25xD.

■ Our drill exhibited durability of more than 3 times the competitor's product! Horizontal machining, external coolant, 47 meters drilling length!

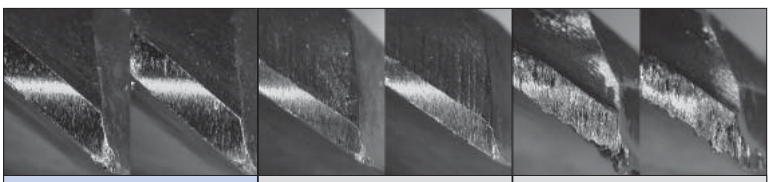
Tool	TDXL 6×20D
Work Material	SCM420H (Simillar DIN 15CrMo5)
Drilling Speed	24m/min (1,273min^{-1})
Feed	190mm/min (0.15mm/rev) (Up to 112 holes) Non-step
	229mm/min (0.18mm/rev) (Until tool life) Non-Step
Depth of Holes	120mm (20D) (Through)
Coolant	Water Soluble
Machine	Horizontal Machining Center

Drill for pilot hole

Tool	EX-GDS Ø 6,1
Depth of Holes	15mm



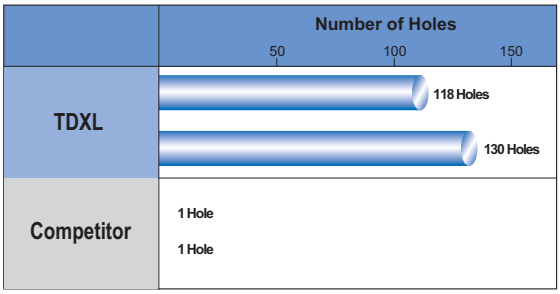
■ Wear Conditions



TDXL After Drilling 392 Holes | Competitor A After Drilling 112 Holes | Competitor B After Drilling 112 Holes

■ Compared to the competitor's product, our drill was capable of drilling an overwhelming number of holes !!

Tool	TDXL 1,6× 20 D	
Work Material	S50C (DIN CK50 AISI 1050)	
Drilling Speed	20 m/min (3.980 min^{-1})	
Feed	64 mm/min (0,016mm/rev) Non-step Up to 8 mm from beginning of hole	
	92 mm/min (0,023mm/rev) Non-step After 8 mm	
Depth of Holes	32 mm (20 D)	Blind
Coolant	Water Soluble	
Machine	Vertical Machining Center	

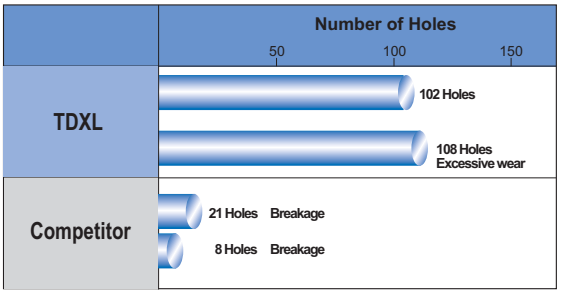


Drill for pilot hole

Tool	EX-GDS dia 1,65
Depth of Holes	4,8 mm

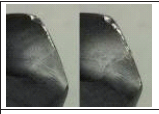
■ Stable non-step driling is possible even for material with 30 HRC !!

Tool	TDXL 10 × 10 D	
Work Material	SCM 440 (30 HRC)	
Drilling Speed	16 m/min (509 min^{-1})	
Feed	112 mm/min (0,22mm/rev) Non-step	
Depth of Holes	100 mm (10 D)	Blind
Coolant	Water Soluble	
Machine	Vertical Machining Center	



Drill for pilot hole

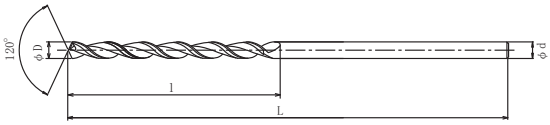
Tool	EX-GDS dia 10.1
Depth of Holes	20 mm

Competitor		Competitor after 8 holes
TDXL		TDXL after 93 holes 

10D Operation Type Dimensions

X thinning
D < 3

R thinning
D ≥ 3



- Tool Material — HSS-Co
- SurfaceTreatment — WXL Coating

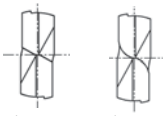
- For 10D operation

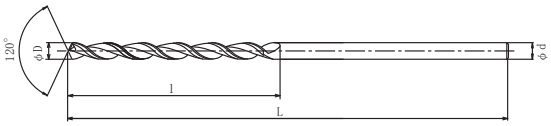
Unit:mm

EDP No,	D	ℓ	L	d	Euro
NEW 8622816	1,6 × 10D	26	75	1,6	
NEW 8622818	1,8 × 10D	26	75	1,8	
NEW 8622820	2 × 10D	26	75	2	
NEW 8622821	2,1 × 10D	33	75	2,1	
NEW 8622822	2,2 × 10D	33	75	2,2	
NEW 8622823	2,3 × 10D	33	75	2,3	
NEW 8622824	2,4 × 10D	33	75	2,4	
NEW 8622825	2,5 × 10D	33	75	2,5	
NEW 8622826	2,6 × 10D	40	90	2,6	
NEW 8622827	2,7 × 10D	40	90	2,7	
NEW 8622828	2,8 × 10D	40	90	2,8	
NEW 8622829	2,9 × 10D	40	90	2,9	
NEW 8622830	3 × 10D	40	90	3	
NEW 8622831	3,1 × 10D	45	100	3,1	
NEW 8622832	3,2 × 10D	45	100	3,2	
NEW 8622833	3,3 × 10D	45	100	3,3	
NEW 8622834	3,4 × 10D	50	100	3,4	
NEW 8622835	3,5 × 10D	50	100	3,5	
NEW 8622836	3,6 × 10D	50	100	3,6	
NEW 8622837	3,7 × 10D	50	100	3,7	
NEW 8622838	3,8 × 10D	50	100	3,8	
NEW 8622839	3,9 × 10D	50	100	3,9	
NEW 8622840	4 × 10D	50	100	4	
NEW 8622841	4,1 × 10D	55	115	4,1	
NEW 8622842	4,2 × 10D	55	115	4,2	
NEW 8622843	4,3 × 10D	60	115	4,3	
NEW 8622844	4,4 × 10D	60	115	4,4	
NEW 8622845	4,5 × 10D	60	115	4,5	
NEW 8622846	4,6 × 10D	60	115	4,6	
NEW 8622847	4,7 × 10D	60	115	4,7	
NEW 8622848	4,8 × 10D	65	115	4,8	
NEW 8622849	4,9 × 10D	65	115	4,9	
NEW 8622850	5 × 10D	65	115	5	
NEW 8622851	5,1 × 10D	70	128	5,1	
NEW 8622852	5,2 × 10D	70	128	5,2	
NEW 8622853	5,3 × 10D	70	128	5,3	
NEW 8622854	5,4 × 10D	78	128	5,4	
NEW 8622855	5,5 × 10D	78	128	5,5	
NEW 8622856	5,6 × 10D	78	128	5,6	
NEW 8622857	5,7 × 10D	78	128	5,7	
NEW 8622858	5,8 × 10D	78	128	5,8	
NEW 8622859	5,9 x 10D	78	128	5,9	
NEW 8622860	6 x 10D	78	128	6	
NEW 8622861	6,1 × 10D	78	140	6,1	
NEW 8622862	6,2 × 10D	87	140	6,2	
NEW 8622863	6,3 × 10D	87	140	6,3	
NEW 8622864	6,4 × 10D	87	140	6,4	
NEW 8622865	6,5 × 10D	87	140	6,5	
NEW 8622866	6,6 × 10D	87	140	6,6	
NEW 8622867	6,7 × 10D	87	140	6,7	
NEW 8622868	6,8 × 10D	90	140	6,8	
NEW 8622869	6,9 × 10D	90	140	6,9	
NEW 8622870	7 × 10D	90	140	7	
NEW 8622871	7,1 × 10D	100	155	7,1	
NEW 8622872	7,2 × 10D	100	155	7,2	
NEW 8622873	7,3 × 10D	100	155	7,3	
NEW 8622874	7,4 × 10D	100	155	7,4	
NEW 8622875	7,5 × 10D	100	155	7,5	
NEW 8622876	7,6 × 10D	105	155	7,6	

EDP No,	D	ℓ	L	d	Euro
NEW 8622877	7,7 × 10D	105	155	7,7	
NEW 8622878	7,8 × 10D	105	155	7,8	
NEW 8622879	7,9 × 10D	105	155	7,9	
NEW 8622880	8 × 10D	105	155	8	
NEW 8622881	8,1 × 10D	110	165	8,1	
NEW 8622882	8,2 × 10D	110	165	8,2	
NEW 8622883	8,3 × 10D	110	165	8,3	
NEW 8622884	8,4 × 10D	110	165	8,4	
NEW 8622885	8,5 × 10D	110	165	8,5	
NEW 8622886	8,6 × 10D	115	165	8,6	
NEW 8622887	8,7 × 10D	115	165	8,7	
NEW 8622888	8,8 × 10D	115	165	8,8	
NEW 8622889	8,9 × 10D	115	165	8,9	
NEW 8622890	9 × 10D	115	165	9	
NEW 8622891	9,1 × 10D	125	190	9,1	
NEW 8622892	9,2 × 10D	125	190	9,2	
NEW 8622893	9,3 × 10D	125	190	9,3	
NEW 8622894	9,4 × 10D	125	190	9,4	
NEW 8622895	9,5 × 10D	125	190	9,5	
NEW 8622896	9,6 × 10D	130	190	9,6	
NEW 8622897	9,7 × 10D	130	190	9,7	
NEW 8622898	9,8 × 10D	130	190	9,8	
NEW 8622899	9,9 × 10D	130	190	9,9	
NEW 8622900	10 × 10D	130	190	10	
NEW 8622901	10,1 × 10D	140	205	10,1	
NEW 8622902	10,2 × 10D	140	205	10,2	
NEW 8622903	10,3 × 10D	140	205	10,3	
NEW 8622904	10,4 × 10D	140	205	10,4	
NEW 8622905	10,5 × 10D	140	205	10,5	
NEW 8622906	10,6 × 10D	145	205	10,6	
NEW 8622907	10,7 × 10D	145	205	10,7	
NEW 8622908	10,8 × 10D	145	205	10,8	
NEW 8622909	10,9 × 10D	145	205	10,9	
NEW 8622910	11 × 10D	145	205	11	
NEW 8622911	11,1 × 10D	155	215	11,1	
NEW 8622912	11,2 × 10D	155	215	11,2	
NEW 8622913	11,3 × 10D	155	215	11,3	
NEW 8622914	11,4 × 10D	155	215	11,4	
NEW 8622915	11,5 × 10D	155	215	11,5	
NEW 8622916	11,6 × 10D	155	215	11,6	
NEW 8622917	11,7 × 10D	155	215	11,7	
NEW 8622918	11,8 × 10D	155	215	11,8	
NEW 8622919	11,9 × 10D	155	215	11,9	
NEW 8622920	12 × 10D	155	215	12	

15D Operation Type Dimensions





- Tool Material — HSS-Co
- SurfaceTreatment — WXL Coating

- For 15D operation

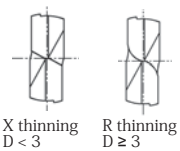
Unit:mm

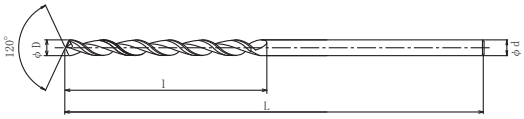
EDP No.	D	ℓ	L	d	Euro
8623016	1.6 × 15D	30	70	1.6	
8623018	1.8 × 15D	34	75	1.8	
8623020	2 × 15D	36	80	2.0	
8623021	2.1 × 15D	38	80	2.1	
8623022	2.2 × 15D	40	80	2.2	
8623023	2.3 × 15D	42	85	2.3	
8623024	2.4 × 15D	44	85	2.4	
8623025	2.5 × 15D	46	85	2.5	
8623026	2.6 × 15D	48	100	2.6	
8623027	2.7 × 15D	50	100	2.7	
8623028	2.8 × 15D	50	100	2.8	
8623029	2.9 × 15D	54	105	2.9	
8623030	3 × 15D	54	105	3.0	
8623031	3.1 × 15D	56	110	3.1	
8623032	3.2 × 15D	58	110	3.2	
8623033	3.3 × 15D	60	110	3.3	
8623034	3.4 × 15D	62	115	3.4	
8623035	3.5 × 15D	64	115	3.5	
8623036	3.6 × 15D	66	115	3.6	
8623037	3.7 × 15D	68	120	3.7	
8623038	3.8 × 15D	70	120	3.8	
8623039	3.9 × 15D	70	120	3.9	
8623040	4 × 15D	72	120	4.0	
8623041	4.1 × 15D	74	135	4.1	
8623042	4.2 × 15D	76	135	4.2	
8623043	4.3 × 15D	78	140	4.3	
8623044	4.4 × 15D	80	140	4.4	
8623045	4.5 × 15D	82	140	4.5	
8623046	4.6 × 15D	84	145	4.6	
8623047	4.7 × 15D	86	145	4.7	
8623048	4.8 × 15D	86	145	4.8	
8623049	4.9 × 15D	88	150	4.9	
8623050	5 × 15D	90	150	5.0	
8623051	5.1 × 15D	92	150	5.1	

EDP No.	D	ℓ	L	d	Euro
8623052	5.2 × 15D	94	155	5.2	
8623053	5.3 × 15D	96	155	5.3	
8623054	5.4 × 15D	98	155	5.4	
8623055	5.5 × 15D	100	155	5.5	
8623056	5.6 × 15D	102	160	5.6	
8623057	5.7 × 15D	104	165	5.7	
8623058	5.8 × 15D	106	165	5.8	
8623060	6 × 15D	108	170	6.0	
8623062	6.2 × 15D	112	170	6.2	
8623063	6.3 × 15D	114	175	6.3	
8623065	6.5 × 15D	118	200	6.5	
8623066	6.6 × 15D	120	200	6.6	
8623068	6.8 × 15D	124	200	6.8	
8623069	6.9 × 15D	126	200	6.9	
8623070	7 × 15D	126	200	7.0	
8623071	7.1 × 15D	128	200	7.1	
8623075	7.5 × 15D	136	205	7.5	
8623080	8 × 15D	144	215	8.0	
8623081	8.1 × 15D	146	215	8.1	
8623082	8.2 × 15D	148	220	8.2	
8623085	8.5 × 15D	154	225	8.5	
8623086	8.6 × 15D	156	225	8.6	
8623088	8.8 × 15D	160	230	8.8	
8623090	9 × 15D	162	230	9.0	
8623093	9.3 × 15D	168	240	9.3	
8623095	9.5 × 15D	172	240	9.5	
8623097	9.7 × 15D	176	245	9.7	
8623098	9.8 × 15D	178	245	9.8	
8623100	10 × 15D	180	250	10.0	
8623105	10.5 × 15D	190	270	10.5	
8623110	11 × 15D	200	280	11.0	
8623115	11.5 × 15D	208	290	11.5	
8623118	11.8 × 15D	214	295	11.8	
8623120	12 × 15D	216	300	12.0	

20D Operation Type Dimensions

- Tool Material — **HSS-Co**
- Surface Treatment — **WXL Coating**





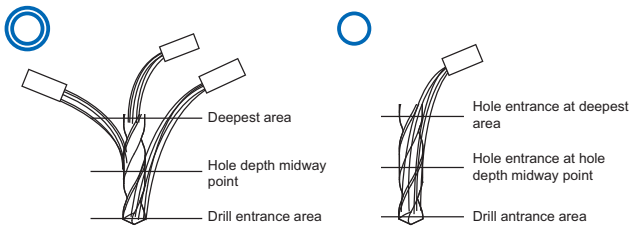
- For 20D operation

EDP No.	D	ℓ	L	d	Euro
8623216	1.6 × 20D	38	85	1.6	
8623218	1.8 × 20D	42	85	1.8	
8623220	2 × 20D	46	85	2.0	
8623221	2.1 × 20D	50	90	2.1	
8623222	2.2 × 20D	52	90	2.2	
8623223	2.3 × 20D	54	95	2.3	
8623224	2.4 × 20D	56	95	2.4	
8623225	2.5 × 20D	58	100	2.5	
8623226	2.6 × 20D	60	110	2.6	
8623227	2.7 × 20D	64	115	2.7	
8623228	2.8 × 20D	66	115	2.8	
8623229	2.9 × 20D	68	120	2.9	
8623230	3 × 20D	70	120	3.0	
8623231	3.1 × 20D	72	125	3.1	
8623232	3.2 × 20D	74	125	3.2	
8623233	3.3 × 20D	76	125	3.3	
8623234	3.4 × 20D	80	130	3.4	
8623235	3.5 × 20D	82	130	3.5	
8623237	3.7 × 20D	86	135	3.7	
8623238	3.8 × 20D	88	140	3.8	
8623240	4 × 20D	92	140	4.0	
8623241	4.1 × 20D	96	155	4.1	
8623242	4.2 × 20D	98	155	4.2	
8623243	4.3 × 20D	100	160	4.3	

EDP No.	D	ℓ	L	d	Euro
8623245	4.5 × 20D	104	165	4.5	
8623246	4.6 × 20D	106	165	4.6	
8623248	4.8 × 20D	112	170	4.8	
8623250	5 × 20D	116	175	5.0	
8623251	5.1 × 20D	118	180	5.1	
8623252	5.2 × 20D	120	180	5.2	
8623255	5.5 × 20D	128	185	5.5	
8623257	5.7 × 20D	132	190	5.7	
8623258	5.8 × 20D	134	200	5.8	
8623260	6 × 20D	138	200	6.0	
8623263	6.3 × 20D	146	200	6.3	
8623265	6.5 × 20D	150	225	6.5	
8623268	6.8 × 20D	158	225	6.8	
8623269	6.9 × 20D	160	230	6.9	
8623270	7 × 20D	162	230	7.0	
8623275	7.5 × 20D	174	245	7.5	
8623280	8 × 20D	184	255	8.0	
8623281	8.1 × 20D	188	255	8.1	
8623282	8.2 × 20D	190	260	8.2	
8623285	8.5 × 20D	196	265	8.5	
8623290	9 × 20D	208	275	9.0	
8623300	10 × 20D	230	300	10.0	
8623310	11 × 20D	254	350	11.0	
8623320	12 × 20D	276	350	12.0	

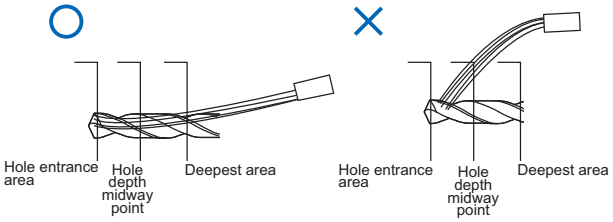
Coolant Application Key Points

Vertical machining center



Allow the coolant to move along the drill if the discharge flow rate is low or the number of nozzles is too few.

Horizontal machining center



If there are too few coolant nozzles is small, increase the amount of coolant and its discharge pressure and allow the coolant to move along the drill so that it is applied constantly to the entrance.

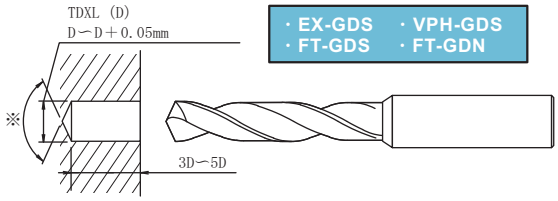
If there are too few coolant nozzles is small, the coolant that is applied to the hole entrance will stray from the hole along the way.

Recommended Operation For Using TDXL

① Make a pilot hole.

- For a pilot hole, select same size or below 0.05mm larger size drill than TDXL. For deep holes, we recommend using the same diameter. Use the same diameter for holes with higher straightness requirements.

- The recommended drills for a pilot hole are listed below.

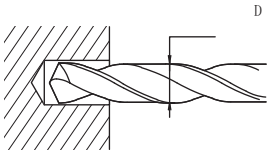


※ Although there is no particular point angle requirement, the use of high-precision drills such as OSG's EX-GDS, VPH-GDS or other carbide drills is recommended.

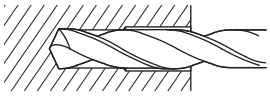
★ When using an OSG leading drill (NC-LDS, VP-LDS, etc) for centering, set the feed rate for the TDXL to 1% of the drill diameter from the entrance of the hole to 3xD. After that, increase the feed to the range indicated in the "Recommended Conditions".

② TDXL

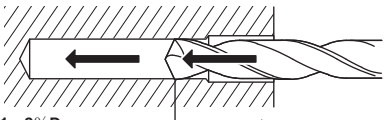
Insert the TDXL while it is rotating (it is unnecessary to decrease the speed)



③ Start supplying the coolant (when drilling 30xD with small-diameter drills, the pressure of the coolant can cause the drill to vibrate)



④ At the start of drilling, set the feed rate to 1% of the drill diameter and increase the feed rate when the depth reaches between 3xD and 5xD.



1－2%D
Increase feed rate tobetween 1 and 2%

3－5D 1%D
Set it to 1%D between 3xD and 5xDTheCompleteSolutionOSG

Notes

TDXL 10D, 15D and 20D Type Recommended Drilling Conditions

WORK MATERIAL	CARBON STEELS S50C S35C 500 ~ 710N/mm²		ALLOY STEELS SCM SCr SNCM 710 ~ 900N/mm²		TOOL STEELS DIE STEELS (unquenched) SKD SK DH31 DAC 710 ~ 900N/mm²		DUCTILE CAST IRON FCD400 FCD500 ~ 500N/mm²		CAST IRON FC250 ~ 350N/mm²	
DRILLING SPEED	20 ~ 24 m/min		18 ~ 22 m/min		12 ~ 16 m/min		16 ~ 20 m/min		18 ~ 24 m/min	
DRILL DIA. (mm)	SPEED (min^{-1})	FEED RATE (mm/rev)	SPEED (min^{-1})	FEED RATE (mm/rev)	SPEED (min^{-1})	FEED RATE (mm/rev)	SPEED (min^{-1})	FEED RATE (mm/rev)	SPEED (min^{-1})	FEED RATE (mm/rev)
1,6	4.000	0,016 ~ 0,03	4.000	0,016 ~ 0,03	2,700	0,016 ~ 0,03	3.600	0,01 ~ 0,03	4,150	0,03 ~ 0,05
2	3.200	0,02 ~ 0,05	3.200	0,02 ~ 0,04	2,200	0,02 ~ 0,04	2.850	0,01 ~ 0,04	3.350	0,04 ~ 0,06
3	2.200	0,03 ~ 0,08	2.200	0,03 ~ 0,08	1,500	0,03 ~ 0,07	1.900	0,02 ~ 0,08	2.250	0,06 ~ 0,1
4	1.600	0,04~ 0,1	1.600	0,04 ~ 0,1	1,150	0,04 ~ 0,09	1.460	0,02 ~ 0,1	1.650	0,08 ~ 0,13
5	1.300	0,05 ~ 0,13	1.300	0,05 ~ 0,13	900	0,05 ~ 0,12	1.150	0,03 ~ 0,13	1.350	0,1 ~ 0,16
6	1.100	0,06 ~ 0,15	1.100	0,06 ~ 0,15	750	0,06 ~ 0,14	955	0,04 ~ 0,15	1.100	0,12 ~ 0,19
8	800	0,08 ~ 0,2	800	0,08 ~ 0,2	550	0,08 ~ 0,18	715	0,05 ~ 0,2	835	0,16 ~ 0,26
10	650	0,1 ~ 0,25	650	0,1 ~ 0,25	450	0,1 ~ 0,23	575	0,06 ~ 0,25	670	0,2 ~ 0,32
12	550	0,12 ~ 0,3	550	0,12 ~ 0,3	380	0,12 ~ 0,28	475	0,07 ~ 0,3	555	0,24 ~ 0,38

1. The indicated speeds and feeds are for drilling with water-soluble oil. When using non-water soluble oil, set the drilling speed, reduce the drilling speed by 20-30%.
2. The most suitable cutting fluid is water-soluble oil (10-30 times dilution).
3. Refer to the "Coolant Application Key Points" for instructions on how to apply the coolant.
4. If chip evacuation becomes difficult during non-step drilling due to the type of work material or its annealed condition, perform step-feed drilling. In this case, we recommend the peck feed method in which the drill is retracted at a rate of approximately 100 times the feed rate (mm/rev).
5. If the number of nozzles on a horizontal machine center is too few or the discharge flow rate is insufficient, perform step-feed drilling. In this case, we recommend a step-feed method in which the drill is retracted to the entrance of the hole.
6. Be sure to center the hole before using this drill. To center the hole, use an OSG leading drill (NC-LDS, VP-LDS, etc.) or a stub drill of the same diameter to make a pilot hole. The point angle of a leading drill may be 90°, 120°, or 130°.
7. Use the step-feed method for drilling in quenched and tempered steels.

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