

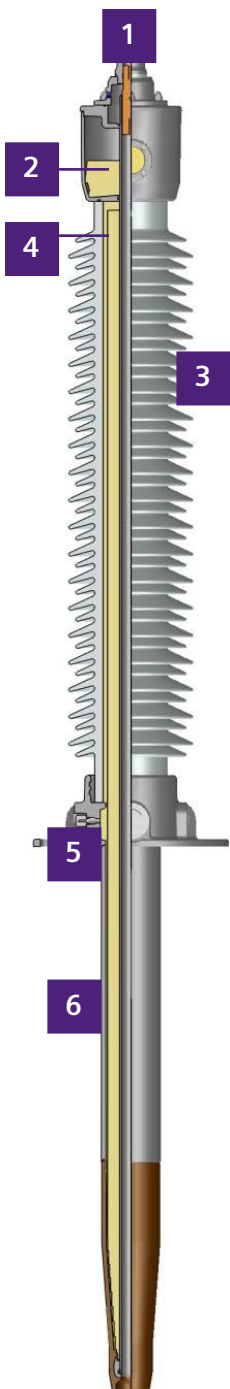
STARON

25-500 kV

OIP transformer condenser bushings
porcelain and composite insulator
IEEE standard



STARON – the preferred OIP insulated bushing designed for the new challenges in the transformer industry



Siemens Energy offers an extensive range of high voltage products, fully complying with the IEEE market requirements. Together with STAROIP, which provides the unique feature of stainless-steel bellow as oil expansion chamber, STARON completes the offer with a conventional IEEE design, providing oil sight glass to allow the regular check operations.

STARON – Taking up the challenge

Siemens Energy released our enhanced STARON portfolio to complete the offer for the IEEE market. This product portfolio is designed following the high-quality standards of Siemens Energy and providing increased grid safety thanks to the electrical and thermal margins included in the design and type test performed beyond IEEE Standard requirements.

STARON is the enhanced generation of Siemens Energy OIP (Oil Impregnated Paper) condenser bushing, with voltage ratings between 25 and 500 kV, specifically designed to meet IEEE market requirements, with an optimized design based on the conventional IEEE standards.

- | | |
|---------------|----------------|
| 1 Terminal | 4 Active part |
| 2 Oil filling | 5 Flange |
| 3 Insulator | 6 Oil-side end |

Standards

The STARON series complies with world-wide international standards and has been specifically designed and tested according to IEEE C57.19.01-2017 and IEEE C57.19.00-2004. STARON portfolio meets all applicable dimensional requirements of the IEEE Standard C57.19.01-2017, allowing interchangeability with your installed base.

Design

The fine capacitance graded core is wound onto the winding support inserting aluminum foils to control the electrical field both radially and axially. The head and flange consist of a weather resistant aluminum alloy. All O-ring seals are in a self-contained chamber and are made of temperature resistant elastomers.

Insulating Oil

The bushing is filled with mineral oil as a part of the insulation.

The oil used in STARON bushings has a very low affinity of solubilizing copper, therefore the copper migration phenomenon into the insulation is avoided.

Design characteristics

- Air side insulator: Porcelain cemented into the flange for **increased cantilever withstand capability**
- Design available with porcelain and **composite** insulators
- Oil side epoxy insulator providing high impact resistance and **reduced size**
- **Embedded end shield** in the epoxy insulator eliminates external shielding in draw lead applications up to 230 kV and provides greater internal clearances
- Horizontal transportation and storage possible
- **Draw lead adapters** to allow replacement of old draw lead bushings without modification of the existing stud & cable
- Standard creepage distance of 44 mm/kV (heavy pollution) USCD as per IEEE C57.19.100-2012 and 54 mm/kV (extra heavy pollution) available for ratings up to 230 kV
- Installation altitude: Standard 1.000m (3.300 ft), design available on request up to **3.000m** (10.000 ft)
- **Oil sight glass** or **magnetic oil level** options, available to allow the standard maintenance checks
- **Seismic:**
 - **High performance level** acc. to IEEE 693-2018, based on composite insulator design:
 - 161kV – 500kV: Reports based on comparable shake table test performed
 - <161kV: Qualified by static pull test or inherently acceptable



Bushing head: detail of oil sight glass



STARON – Your benefits

- Maximum reliability due to special design, rigorous testing and use of proven materials
- More robust electrical design validated by highest requirements of IEEE and IEC standards
- **Syphon design** (feature inside the bushing head) allows storage and installation in different positions
- **High interchangeability** with existing IEEE designs makes them suitable for many retrofitting cases
- Qualified for optional ambient temperature down to **-60°C**

Large variety of bottom terminals

Bottom terminals according to IEEE Std. C57.19.01-2017

Fig. 2.4: $1\frac{3}{4}$ " diameter, $\text{Ø}9/16$ " holes (x2)

Fig. 2.5: $1\frac{3}{4}$ " diameter, $\text{Ø}9/16$ " holes (x4)

Fig. 3.4: $R4$ " radius, 6.75 " length, 0.375 "-16 (x4) 0.75 " DEEP (3.75 BCD)

Fig. 3.5: $R4$ " radius, $\text{Ø}8\frac{1}{4}$ " diameter, $\frac{1}{2}$ "-13 (x8) $\frac{3}{4}$ " DEEP (6.75" BCD) holes

Fig. 3.6: $\text{Ø}8\frac{1}{4}$ " diameter, $\frac{1}{2}$ "-13 (x8) $\frac{3}{4}$ " DEEP (6.75" BCD) holes

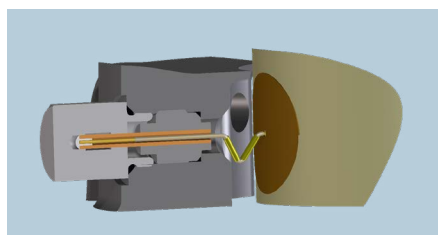
Additional terminals available

Embedded shield

Removable Split Conductor, 4 fixing screws, Threaded part (dimensions according to drawing)

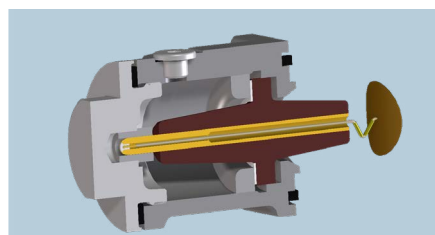
1200 A

Taps designed for different requirements



Test tap

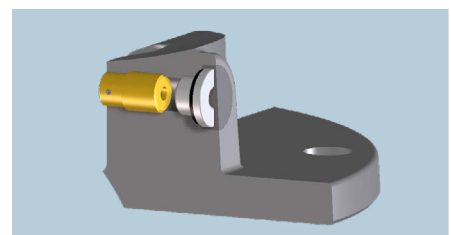
STARON – IEEE bushings rated 69 kV and below are provided with a test tap. This tap is usually grounded and is intended for measurement of power factor, capacitance from conductor to tap, as well as offering the possibility to connect to an on-line monitoring system. Since the capacitance from tap to ground is not controlled, the tap is not intended for use as a voltage divider during normal operation.



Voltage tap

Bushings with rated voltage starting from 115 kV and above are provided with a voltage tap as required by IEEE Std. C57.19.01-2017.

Under normal operation the tap cover is installed and the tap is grounded. When opening the cap, it's possible to connect the bushing to a monitoring device.



Oil sampling plug

The oil sampling valve is available on all voltage levels at the flange position. The plug allows all maintenance operations to be performed as described in the instruction manual.

Rigorous testing for maximum lifetime reliability



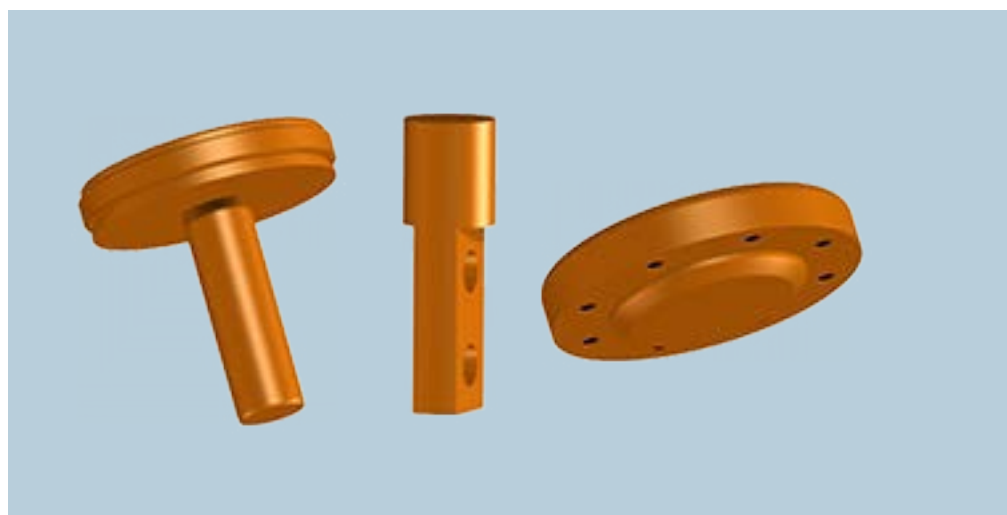
STARON condenser bushing with OIP active part, is tested with stringent requirements:

- Type test performed as per IEEE C57.19.00-2004,
- Electrical test levels: Highest electrical values between IEEE and IEC Standards (IEC 60137-2017)

Conductor types

Depending on the current rating, STARON is provided with different conductor and connection designs (for detailed dimension, please refer to the following table)

- **Draw-lead** conductor, when the rated current is relatively low, a dedicated connection to the internal draw-lead bolt is provided. Draw-lead can be customized with adapters to facilitate the interchangeability with an existing bushing to be replaced
- **Removable conductor** is delivered for medium current ratings. It provides the possibility to install the lower part directly in the transformer turret, facilitating the installation
- **Fixed conductor**, when higher current capability is required. The bottom terminal is made out of copper and according to IEEE dimensions

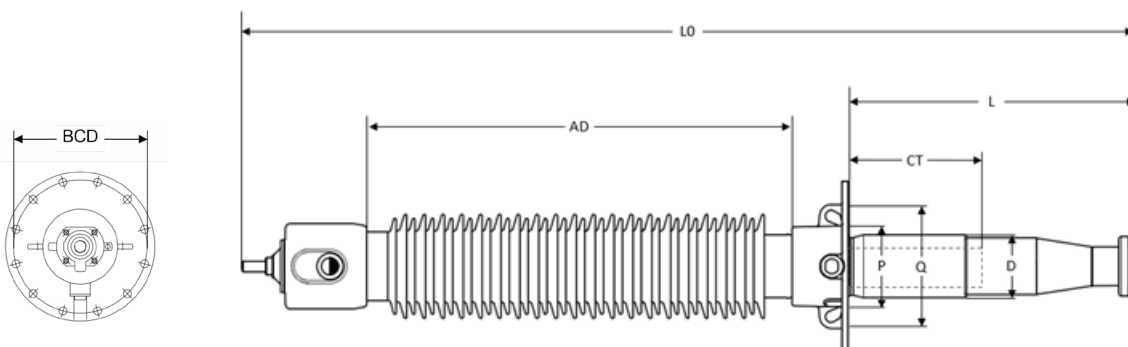


Typical terminations for fixed conductor design

Electrical characteristics

Bushing Style	Nominal system voltage	Basic lightning impulse level	Maximum line-to-ground voltage	Rated current	Connection to transformer	Dry withstand	Wet withstand	Wet switching impulse	Minimum creepage	Minimum arcing distance	Maximum altitude
	kV	kV	kV	A		kV	kV	kV	in (mm)	in (mm)	ft (m)
STARON 150-25-800 E21	25	150	16	800	Draw Lead	60	50	NA	30.7 (780)	9.25 (235)	10000 (3048)
STARON 150-25-1200 E21	25	150	16	1200	Split conductor	60	50	NA	30.7 (780)	9.25 (235)	10000 (3048)
STARON 150-25-2000 E21	25	150	16	2000	Bottom	60	50	NA	30.7 (780)	9.25 (235)	10000 (3048)
STARON 150-25-3000 E21	25	150	16	3000	Bottom	60	50	NA	30.7 (780)	9.25 (235)	10000 (3048)
STARON 200-34.5-800 E21	34.5	200	22	800	Draw Lead	80	75	NA	44.1 (1120)	13.38 (340)	10000 (3048)
STARON 200-34.5-1200 E21	34.5	200	22	1200	Split conductor	80	75	NA	44.1 (1120)	13.38(340)	10000 (3048)
STARON 200-34.5-2000 E21	34.5	200	22	2000	Bottom	80	75	NA	44.1 (1120)	13.38 (340)	10000 (3048)
STARON 200-34.5-3000 E21	34.5	200	22	3000	Bottom	80	75	NA	44.1 (1120)	13.38 (340)	10000 (3048)
STARON 350-69-800 E21	69	350	44	800	Draw Lead	160	140	NA	88.5 (2248)	23.6 (600)	6562 (2000)
STARON 350-69-1200 E21	69	350	44	1200	Split conductor	160	140	NA	88.5 (2248)	23.6 (600)	6562 (2000)
STARON 350-69-2000 E21	69	350	44	2000	Bottom	160	140	NA	88.5 (2248)	24 (610)	6562 (2000)
STARON 350-69-3000 E21	69	350	44	3000	Bottom	160	140	NA	88.5 (2248)	24 (610)	6562 (2000)
STARON 550-115-800 E23	115	550	88	800	Draw Lead	260	230	NA	150.1 (3813)	41.34 (1050)	6562 (2000)
STARON 550-115-1200 E23	115	550	88	1200	Split conductor	260	230	NA	150.1 (3813)	41.34 (1050)	6562 (2000)
STARON 550-115-2000 E23	115	550	88	2000	Bottom	260	230	NA	150.1 (3813)	41.34 (1050)	6562 (2000)
STARON 550-115-3000 E23	115	550	88	3000	Bottom	260	230	NA	150.1 (3813)	41.34 (1050)	6562 (2000)
STARON 650-138-800 E23	138	650	102	800	Draw Lead	310	275	NA	177.0 (4495)	49.21 (1250)	6562 (2000)
STARON 650-138-1200 E23	138	650	102	1200	Split conductor	310	275	NA	177.0 (4495)	49.21 (1250)	6562 (2000)
STARON 650-138-2000 E23	138	650	102	2000	Bottom	310	275	NA	177.0 (4495)	49.21 (1250)	6562 (2000)
STARON 650-138-3000 E23	138	650	102	3000	Bottom	310	275	NA	177.0 (4495)	49.21 (1250)	6562 (2000)
STARON 750-161-800 E23	161	750	146	800	Draw Lead	365	315	NA	207.5 (5270)	57.48 (1460)	6562 (2000)
STARON 750-161-1200 E23	161	750	146	1200	Split conductor	365	315	NA	207.5 (5270)	57.48 (1460)	6562 (2000)
STARON 750-161-2000 E23	161	750	146	2000	Bottom	365	315	NA	207.5 (5270)	57.48 (1460)	6562 (2000)
STARON 750-161-3000 E23	161	750	146	3000	Bottom	365	315	NA	207.5 (5270)	57.48 (1460)	6562 (2000)
STARON 900-230-800 E23	230	900	146	800	Draw Lead	425	350	NA	299.3 (7603)	84.645 (2150)	7927 (2430)
STARON 900-230-1200 E23	230	900	146	1200	Split conductor	425	350	NA	299.3 (7603)	84.645(2150)	7927 (2430)
STARON 900-230-2000 E23	230	900	146	2000	Bottom	425	350	NA	299.3 (7603)	84.645 (2150)	7927 (2430)
STARON 900-230-3000 E23	230	900	146	3000	Bottom	425	350	NA	299.3 (7603)	84.645 (2150)	7927 (2430)
STARON 1175-345-800 E23	345	1175	220	800	Draw Lead	520	NA	825	384.3 (9760)	94.5 (2400)	4921 (1500)
STARON 1175-345-2000 E23	345	1175	220	2000	Bottom	520	NA	825	384.3 (9760)	94.5 (2400)	6234 (1900)
STARON 1175-345-3000 E23	345	1175	220	3000	Bottom	520	NA	825	384.3 (9760)	94.5 (2400)	6234 (1900)
STARON 1675-500-800 E23	500	1675	318	800	Draw Lead	750	NA	1175	703.3 (17864)	149.6 (3800)	5577 (1700)
STARON 1675-500-2000 E23	500	1675	318	2000	Bottom	750	NA	1175	703.3 (17864)	149.6 (3800)	5577 (1700)
STARON 1675-500-3000 E23	500	1675	318	3000	Bottom	750	NA	1175	703.3 (17864)	149.6 (3800)	5577 (1700)

Dimensions listed in this document are for general reference and may be subject to change. For specific dimensions, refer to the outline drawing.



Mechanical characteristics

Bushings Style	Approx. Weight	Mounting angle from vertical	Total length [L0]	Oil end length [L]	CT	D	P	Q	Inside tube diameter	Bottom terminal	Top terminal	Flange bolt holes	BCD
	lb (kg)	deg. °	in (mm)	in (mm)	in (mm)	in (mm)	in (mm)	in (mm)	in (mm)				in (mm)
STARON 150-25-800 E21	80 (36)	0 to 60	53.7 (1364)	29.5 (749)	21 (534)	3.15 (80)	4 (102)	6.25 (159)	1.4 (35.7)	NA	1.5-12UNF-2A x 3.15	4 x ø0.94 (24)	7.25 (184)
STARON 150-25-1200 E21	90 (41)	0 to 60	57.7 (1466)	29.5 (749) *	21 (534)	3.15 (80)	4 (102)	6.25 (159)	1.4 (35.7)	1.5-12UNF-2A x 2.13	1.5-12UNF-2A x 3.15	4 x ø0.94 (24)	7.25 (184)
STARON 150-25-2000 E21	160 (73)	0 to 60	56.7 (1440)	31.5 (800)	21 (534)	3.94 (100)	4 (102)	6.25 (159)	NA	Fig. 2.4	1.5-12UNF-2A x 2.5	4 x ø0.88 (23)	7.25 (184)
STARON 150-25-3000 E21	165 (75)	0 to 60	56.7 (1440)	31.5 (800)	21 (534)	3.94 (100)	5.5 (140)	7.25 (184)	NA	Fig. 2.5	2-12UNF-2A x 3	4 x ø0.88 (23)	8.25 (209.6)
STARON 200-34.5-800 E21	90 (41)	0 to 60	59.84 (1520)	31.5 (800)	21 (534)	3.15 (80)	4 (102)	6.25 (159)	1.4 (35.7)	NA	1.5-12UNF-2A x 3.15	4 x ø0.94 (24)	7.25 (184)
STARON 200-34.5-1200 E21	99 (45)	0 to 60	63.82 (1621)	31.5 (800) *	21 (534)	3.15 (80)	4 (102)	6.25 (159)	1.4 (35.7)	1.5-12UNF-2A x 2.13	1.5-12UNF-2A x 3.15	4 x ø0.94 (24)	7.25 (184)
STARON 200-34.5-2000 E21	170 (77)	0 to 60	62.83 (1596)	33.5 (851)	21 (534)	3.94 (100)	4 (102)	6.25 (159)	NA	Fig. 2.4	1.5-12UNF-2A x 2.5	4 x ø0.88 (23)	7.25 (184)
STARON 200-34.5-3000 E21	175 (79)	0 to 60	62.83 (1596)	33.5 (851)	21 (534)	3.94 (100)	5.5 (140)	7.25 (184)	NA	Fig. 2.5	2-12UNF-2A x 3	6 x ø0.88 (23)	9.25 (235)
STARON 350-69-800 E21	105 (48)	0 to 60	77.64 (1972)	37.5 (952)	21 (534)	3.94 (100)	6 (152)	8.25 (210)	1.4 (35.7)	NA	1.5-12UNF-2A x 3.15	6 x ø0.88 (23)	9.25 (235)
STARON 350-69-1200 E21	110 (50)	0 to 60	81.67 (2074)	37.5 (952) *	21 (534)	3.94 (100)	6 (152)	8.25 (210)	1.4 (35.7)	1.5-12UNF-2A x 2.13	1.5-12UNF-2A x 3.15	6 x ø0.88 (23)	9.25 (235)
STARON 350-69-2000 E21	142 (64)	0 to 60	81.42 (2068)	39.5 (1003)	21 (534)	5.12 (130)	6 (152)	8.25 (210)	NA	Fig. 2.4	1.5-12UNF-2A x 2.5	6 x ø0.88 (23)	9.25 (235)
STARON 350-69-3000 E21	215 (97)	0 to 60	81.42 (2068)	39.5 (1003)	21 (534)	5.12 (130)	7 (178)	9.25 (235)	NA	Fig. 2.5	2-12UNF-2A x 3	6 x ø0.88 (23)	10.25 (260.4)
STARON 550-115-800 E23	255 (116)	0 to 60	105.83 (2688)	43 (1092)	23 (584)	5.12 (130)	9.88 (251)	11.88 (302)	1.6 (41)	NA	1.5-12UNF-2A x 3.15	6 x ø1.25 (32)	13.25 (337)
STARON 550-115-1200 E23	365 (166)	0 to 60	108.82 (2764)	43 (1092) *	23 (584)	5.12 (130)	9.88 (251)	11.88 (302)	1.6 (41)	1.5-12UNF-2A x 2	1.5-12UNF-2A x 3.15	6 x ø1.25 (32)	13.25 (337)
STARON 550-115-2000 E23	270 (122)	0 to 60	103.67 (2633)	43 (1092)	23 (584)	5.9 (150)	9.88 (251)	11.88 (302)	NA	Fig. 3.5	1.5-12UNF-2A x 2.5	6 x ø1.25 (32)	13.25 (337)
STARON 550-115-3000 E23	545 (247)	0 to 60	109.25 (2775)	43 (1092)	23 (584)	7.48 (190)	9.88 (251)	11.88 (302)	NA	Fig. 3.5	2-12UNF-2A x 3	6 x ø1.25 (32)	13.25 (337)
STARON 650-138-800 E23	330 (150)	0 to 60	117.48 (2984)	46.75 (1188)	23 (584)	5.12 (130)	10.88 (276)	12.88 (327)	1.6 (41)	NA	1.5-12UNF-2A x 3.15	6 x ø1.25 (32)	14.25 (362)
STARON 650-138-1200 E23	365 (166)	0 to 60	120.47 (3060)	46.75 (1188) *	23 (584)	5.12 (130)	10.88 (276)	12.88 (327)	1.6 (41)	1.5-12UNF-2A x 2	1.5-12UNF-2A x 3.15	6 x ø1.25 (32)	14.25 (362)
STARON 650-138-2000 E23	310 (141)	0 to 60	115.3 (2929)	46.75 (1188)	23 (584)	5.9 (150)	10.88 (276)	12.88 (327)	NA	Fig. 3.5	1.5-12UNF-2A x 2.5	6 x ø1.25 (32)	14.25 (362)
STARON 650-138-3000 E23	595 (270)	0 to 60	120.9 (3071)	46.75 (1188)	23 (584)	7.48 (190)	10.88 (276)	12.88 (327)	NA	Fig. 3.5	2-12UNF-2A x 3	6 x ø1.25 (32)	14.25 (362)
STARON 750-161-800 E23	435 (197)	0 to 30	134.7 (3421)	50.25 (1276)	23 (584)	6.9 (175)	12.38 (314)	14.38 (365)	1.6 (41)	NA	1.5-12UNF-2A x 2	8 x ø1.25 (32)	15.75 (400)
STARON 750-161-1200 E23	520 (236)	0 to 30	137.7 (3498)	50.25 (1276) *	23 (584)	6.9 (175)	12.38 (314)	14.38 (365)	1.6 (41)	1.5-12UNF-2A x 2	1.5-12UNF-2A x 2	8 x ø1.25 (32)	15.75 (400)
STARON 750-161-2000 E23	470 (213)	0 to 30	132.64 (3369)	50.25 (1276)	23 (584)	7.48 (190)	12.38 (314)	14.38 (365)	NA	Fig. 3.5	1.5-12UNF-2A x 2.5	8 x ø1.25 (32)	15.75 (400)
STARON 750-161-3000 E23	520 (236)	0 to 30	132.64 (3369)	50.25 (1276)	23 (584)	7.48 (190)	12.38 (314)	14.38 (365)	NA	Fig. 3.5	2-12UNF-2A x 3	8 x ø1.25 (32)	15.75 (400)
STARON 900-230-800 E23	650 (295)	0 to 30	161.85 (4111)	50.25 (1276)	23 (584)	7.87 (200)	17.13 (435)	19.5 (495)	2.16 (55)	NA	1.5-12UNF-2A x 2	12 x ø1.25 (32)	21 (533)
STARON 900-230-1200 E23	810 (367)	0 to 30	164.85 (4188)	50.25 (1276) *	23 (584)	7.87 (200)	17.13 (435)	19.5 (495)	2.16 (55)	1.5-12UNF-2A x 2	1.5-12UNF-2A x 2	12 x ø1.25 (32)	21 (533)
STARON 900-230-2000 E23	728 (330)	0 to 30	159.80 (4059)	50.25 (1276)	23 (584)	8.66 (220)	17.13 (435)	19.5 (495)	NA	Fig. 3.5	1.5-12UNF-2A x 2.5	12 x ø1.25 (32)	21 (533)
STARON 900-230-3000 E23	956 (433)	0 to 30	159.80 (4059)	50.25 (1276)	23 (584)	8.66 (220)	17.13 (435)	19.5 (495)	NA	Fig. 3.5	2-12UNF-2A x 3	12 x ø1.25 (32)	21 (533)
STARON 1175-345-800 E23	1100 (499)	0 to 20	175.00 (4445)	51 (1295)	23 (584)	9.25 (235)	17.13 (435)	19.5 (495)	2.16 (55)	NA	1.5-12UNF-2A x 2	12 x ø1.25 (32)	21 (533)
STARON 1175-345-2000 E23	1200 (544)	0 to 20	171.00 (4345)	51 (1295)	23 (584)	9.84 (250)	17.13 (435)	19.5 (495)	NA	Fig. 3.6	1.5-12UNF-2A x 2.5	12 x ø1.25 (32)	21 (533)
STARON 1175-345-3000 E23	1200 (544)	0 to 20	171.50 (4355)	51 (1295)	23 (584)	9.84 (250)	17.13 (435)	19.5 (495)	NA	Fig. 3.6	2-12UNF-2A x 3	12 x ø1.25 (32)	21 (533)
STARON 1675-500-800 E23	2200 (998)	0 to 20	249.06 (6326)	65 (1651)	23 (584)	11.45 (291)	20.75 (527)	23 (584.2)	2.28 (58)	NA	1.5-12UNF-2A x 2.5	12 x ø1.25 (32)	25 (635)
STARON 1675-500-2000 E23	2330 (1057)	0 to 20	246.53 (6262)	65 (1651)	23 (584)	12.2 (310)	20.75 (527)	24 (584.2)	NA	Fig. 3.6	1.5-12UNF-2A x 2.5	12 x ø1.25 (32)	25 (635)
STARON 1675-500-3000 E23	2830 (1282)	0 to 20	246.53 (6262)	65 (1651)	23 (584)	12.2 (310)	20.75 (527)	23 (584.2)	NA	Fig. 3.6	2-12UNF-2A x 3	12 x ø1.25 (32)	25 (635)

*Oil length without bottom connection.

STARON 150-25-800 E21



Type designation – an example of STARON product designation

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