Data Adequacy Supplement

Attachment E

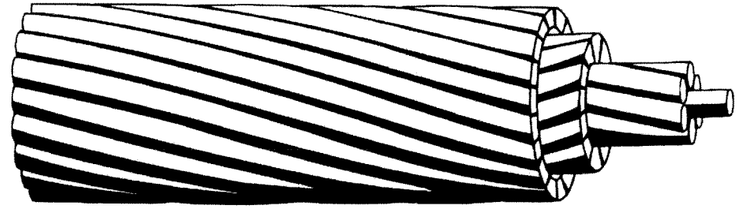
Transmission System Design

Part 2: Supporting Documentation

11-9 ACSR/TW

ACSR/TW

**Aluminum Conductor. Steel Reinforced.
Trapezoidal Shaped Aluminum Strands. Bare.**



APPLICATIONS

Shaped Wire Compact Concentric-Lay-Stranded Aluminum Conductor, Steel-Reinforced(ACSR/TW) is designed for use as a bare overhead conductor. There are two designs of ACSR/TW. One design gives an equal area of aluminum when compared to the standard ACSR conductor sizes. The other design gives an overall outside diameter equal to standard ACSR conductor sizes. Use of this conductor in the equal area design allows equal ampacity in a smaller diameter conductor when compared with standard ACSR conductor. Use of this conductor in the equal diameter design allows more ampacity in an equal diameter conductor when compared with standard ACSR conductor.

SPECIFICATIONS

Southwire ACSR/TW conductor meets or exceeds ASTM specification:

- B-779 Shaped Wire Compact Concentric-Lay-Stranded Aluminum Conductors, Steel-Reinforced (ACSR/TW).

CONSTRUCTION

Aluminum alloy 1350-H19 trapezoidal shaped wires, concentrically stranded about a steel core. Core wire for ACSR/TW is available with class A, B, or C galvanizing; "aluminized" aluminum coated (AZ); or aluminum-clad (AW[1]). Additional corrosion protection is available through the application of grease to the core or infusion of the complete cable with grease.

[1]For aluminum-clad ACSR/TW, contact you Southwire representative.

ACSR/TW CONDUCTOR
AREA EQUAL TO STANDARD ACSR SIZES

Code Name	Conductor Size			Type Code	Stranding			Outside Diameter		Weight per 1000 ft.			Rated Strength (lbs.)	Resistance		Allowable Ampacities+
	kcmil	Area (square ins.)			No. of Layers of Alum.	Alum.	Steel	Complete Conductor (ins.)	Steel Core (ins.)	Total	Alum.	Steel		Ohms/1000 ft.		
		Alum.	Total											DC @ 20°C	AC @ 75°C	
Merlin/TW	336.4	0.2642	0.2788	6	2	14	1x0.1367	0.630	0.1367	365.0	315.5	49.5	8560	0.0510	0.0625	508
Flicker/TW	477.0	0.3747	0.4233	13	2	18	7x0.0940	0.776	0.2820	612.8	448.4	164.4	17200	0.0357	0.0437	641
Hawk/TW	477.0	0.3746	0.4356	16	2	18	7x0.1053	0.789	0.3159	655.0	448.7	206.3	19400	0.0356	0.0435	645
Parakeet/TW	556.5	0.4371	0.4937	13	2	18	7x0.1015	0.835	0.3045	714.9	523.2	191.7	20000	0.0306	0.0375	706
Dove/TW	556.5	0.4371	0.5083	16	2	20	7x0.1138	0.852	0.3414	764.5	523.5	241.0	22600	0.0305	0.0374	711
Swift/TW	636.0	0.4995	0.5133	3	3	27	1x0.1329	0.850	0.1329	646.0	599.2	46.8	13500	0.0272	0.0335	750
Rook/TW	636.0	0.4995	0.5643	13	2	19	7x0.1085	0.890	0.3255	816.0	597.9	219.1	22900	0.0268	0.0329	766
Grosbeak/TW	636.0	0.4995	0.5808	16	2	20	7x0.1216	0.908	0.3648	873.5	598.4	275.1	25400	0.0267	0.0327	772
Tern/TW	795.0	0.6244	0.6675	7	2	17	7x0.0886	0.960	0.2658	892.0	745.9	146.1	21000	0.0215	0.0266	869
Puffin/TW	795.0	0.6244	0.6919	10	2	18	7x0.1108	0.980	0.3324	975.3	746.9	228.4	25900	0.0215	0.0264	876
Condor/TW	795.0	0.6244	0.7053	13	2	20	7x0.1203	0.993	0.3639	1021.0	747.2	273.8	28200	0.0214	0.0264	880
Drake/TW	795.0	0.6244	0.7261	16	2	20	7x0.1360	1.010	0.4080	1092.0	747.8	344.2	31800	0.0213	0.0263	887
Phoenix/TW	954.0	0.7493	0.7876	5	3	30	7x0.0837	1.044	0.2511	1032.0	901.6	130.4	23700	0.0181	0.0224	967
Rail/TW	954.0	0.7493	0.8011	7	3	32	7x0.0971	1.061	0.2913	1075.0	900.0	175.0	25900	0.0180	0.0224	973
Cardinal/TW	954.0	0.7493	0.8464	13	2	20	7x0.1329	1.084	0.3987	1226.0	897.3	328.7	33500	0.0178	0.0221	985
Snowbird/TW	1033.5	0.8117	0.8534	5	3	30	7x0.0871	1.089	0.2613	1115.0	973.8	141.2	25700	0.0167	0.0208	1017
Ortolan/TW	1033.5	0.8117	0.8678	7	3	32	7x0.1010	1.102	0.3030	1165.0	975.2	189.8	28100	0.0167	0.0207	1021
Curlew/TW	1033.5	0.8117	0.9169	13	2	20	7x0.1383	1.129	0.4149	1327.0	971.1	355.9	36300	0.0165	0.0204	1036

ACSR/TW CONDUCTOR
AREA EQUAL TO STANDARD ACSR SIZES

Code Name	Conductor Size			Type Code	Stranding			Outside Diameter		Weight per 1000 ft.			Rated Strength (lbs.)	Resistance		Allowable Ampacities+
	kcmil	Area (square ins.)			No. of Layers of Alum.	Alum.	Steel	Complete Conductor (ins.)	Steel Core (ins.)	Total	Alum.	Steel		Ohms/1000 ft.		
		Alum.	Total											DC @ 20°C	AC @ 75°C	
Avocet/TW	1113.0	0.8742	0.9191	5	3	30	7x0.0904	1.129	0.2712	1201.0	1048.9	152.1	27500	0.0155	0.0193	1063
Bluejay/TW	1113.0	0.8742	0.9347	7	3	33	7x0.1049	1.143	0.3147	1257.0	1052.2	204.8	30300	0.0155	0.0193	1069
Finch/TW	1113.0	0.8742	0.9851	13	3	38	19x0.0862	1.185	0.4310	1429.0	1052.6	376.4	39100	0.0154	0.0191	1084
Oxbird/TW	1192.5	0.9366	0.9848	5	2	30	7x0.0936	1.167	0.2808	1286.0	1123.0	163.0	29500	0.0144	0.0180	1111
Bunting/TW	1192.5	0.9366	1.0013	7	3	33	7x0.1085	1.181	0.3255	1343.0	1124.0	219.0	32400	0.0144	0.0181	1114
Grackel/TW	1192.5	0.9366	1.0554	13	3	38	19x0.0892	1.225	0.4460	1530.0	1127.0	403.0	41900	0.0144	0.0179	1130
Scissortail/TW	1272.0	0.9991	1.0505	5	3	30	7x0.0967	1.203	0.2901	1372.0	1198.0	174.0	31400	0.0135	0.0170	1152
Bittern/TW	1272.0	0.9990	1.0681	7	3	35	7x0.1121	1.220	0.3363	1433.0	1198.0	234.0	34600	0.0135	0.0170	1159
Pheasant/TW	1272.0	0.9990	1.1256	13	3	39	19x0.9210	1.264	0.4605	1632.0	1202.0	430.0	44100	0.0135	0.0168	1176
Dipper/TW	1351.0	1.0615	1.1348	7	3	35	7x0.1155	1.256	0.3465	1522.0	1274.0	248.0	36700	0.0127	0.0160	1202
Martin/TW	1351.0	1.0615	1.1959	13	3	39	19x0.0949	1.300	0.4745	1734.0	1278.0	456.0	46800	0.0127	0.0159	1219
Bobolink/TW	1431.0	1.1236	1.2017	7	3	36	7x0.1189	1.291	0.3567	1613.0	1350.0	263.0	38900	0.0120	0.0152	1243
Plover/TW	1431.0	1.1239	1.2664	13	3	37	19x0.0977	1.337	0.4885	1836.0	1353.0	483.0	49600	0.0120	0.0150	1262
Lapwing/TW	1590.0	1.2488	1.3351	7	3	36	7x0.1253	1.358	0.3759	1791.0	1499.0	292.0	42200	0.0183	0.0138	1323
Falcon/TW	1590.0	1.2488	1.4071	13	3	42	19x0.1030	1.408	0.5150	2040.0	1503.0	537.0	55100	0.0108	0.0136	1345
Chukar/TW	1780.0	1.3986	1.5120	8	3	37	19x0.0874	1.445	0.4370	2063.0	1676.0	387.0	50700	0.0096	0.0124	1420
Bluebird/TW	2156.0	1.0934	1.8312	8	4	64	19x0.0961	1.608	0.4805	2515.0	2047.0	468.0	61100	0.0080	0.0105	1586

+Ampacity calculated assuming: ambient 25°C, conductor 75°C, wind 2 ft./ sec., sun.

MAT
Rig Bar & Transmission Line Cable

ACSR/TW CONDUCTOR
DIAMETERS EQUAL TO STANDARD ACSR SIZES

Code Name	Conductor Size			Type Code	Stranding			Outside Diameter		Weight per 1000 ft.			Rated Strength (lbs.)	Resistance		Allowable Ampacities+
	kcmil	Area (square ins.)			No. of Layers of Alum.	Alum.	Steel	Complete Conductor (ins.)	Steel Core (ins.)	Total	Alum.	Steel		Ohms/1000 ft.		
		Alum.	Total											DC @ 20°C	AC @ 75°C	
Monongahela/TW	405.1	0.3181	0.3362	6	2	14	1x0.1520	0.68	0.152	441	379.8	61.2	10200	0.0423	0.0519	569
Mohawk/TW	571.7	0.449	0.5074	13	2	18	7x0.1030	0.846	0.309	734.7	537.3	197.4	20700	0.0298	0.0365	718
Calumet/TW	565.3	0.4439	0.5165	16	2	18	7x0.1147	0.858	0.3438	714.8	523.1	191.7	22900	0.03	0.0368	718
Mystic/TW	666.6	0.5236	0.5914	13	2	20	7x0.1111	0.913	0.333	856.3	626.6	229.7	24000	0.0255	0.0314	790
Oswego/TW	664.8	0.5221	0.6072	16	2	20	7x0.1244	0.927	0.3732	913.4	625.4	288	26600	0.0255	0.0313	794
Nechako/TW	768.9	0.6039	0.622	3	3	27	1x0.1520	0.93	0.152	781.9	720.7	61.2	16400	0.0255	0.0278	843
Maumee/TW	768.2	0.6034	0.6819	13	2	20	7x0.1195	0.977	0.3585	987.8	722.1	265.7	27700	0.0222	0.0273	862
Wabash/TW	762.8	0.5992	0.6966	16	2	20	7x0.1331	0.99	0.3993	1047	717	330	30500	0.0222	0.0274	863
Kettle/TW	957.2	0.7518	0.8038	7	3	32	7x0.0973	1.06	0.2919	1079	902.8	176.2	26000	0.018	0.0223	974
Fraser/TW	946.7	0.7436	0.8168	10	3	35	7x0.1154	1.077	0.3462	1142	894	248	29600	0.018	0.0223	978
Columbia/TW	966.2	0.7589	0.8573	13	2	21	7x0.1338	1.092	0.4014	1241	908	333	34000	0.0176	0.0218	993
Suwannee/TW	959.6	0.7537	0.8762	16	2	22	7x0.1493	1.108	0.4479	1318	903	415	37000	0.0177	0.0218	996
Cheyenne/TW	1168.1	0.9175	0.9646	5	3	30	7x0.0926	1.155	0.2778	1260	1100.4	159.6	28900	0.0148	0.0185	1095
Genesee/TW	1158	0.9095	0.9733	7	3	33	7x0.1078	1.165	0.3234	1308	1092	216	31600	0.0149	0.0186	1095
Hudson/TW	1158.4	0.9098	1.0281	13	2	26	7x0.1467	1.196	0.4401	1489	1089	400	39600	0.0147	0.0183	1111
Catawba/TW	1272	0.9991	1.0505	5	3	30	7x0.0967	1.203	0.2901	1372	1198	174	31400	0.0135	0.017	1152
Nelson/TW	1257.1	0.9874	1.0557	7	3	35	7x0.1115	1.213	0.3345	1417	1185.7	231.3	34200	0.0137	0.0172	1150
Yukon/TW	1233.6	0.9689	1.0925	13	3	38	19x0.0910	1.245	0.455	1586	1166.5	419.5	42900	0.0139	0.0173	1154

ACSR/TW CONDUCTOR
DIAMETERS EQUAL TO STANDARD ACSR SIZES

Code Name	Conductor Size			Type Code	Stranding			Outside Diameter		Weight per 1000 ft.			Rated Strength (lbs.)	Resistance		Allowable Ampacities+
	kcmil	Area (square ins.)			No. of Layers of Alum.	Alum.	Steel	Complete Conductor (ins.)	Steel Core (ins.)	Total	Alum.	Steel		Ohms/1000 ft.		
		Alum.	Total											DC @ 20°C	AC @ 75°C	
Truckee/TW	1372.5	1.078	1.1334	5	3	30	7x0.1004	1.248	0.3012	1481	1293.4	187.6	33400	0.0126	0.0159	1206
Mackenzie/TW	1359.7	1.0679	1.1418	7	3	36	7x0.1559	1.259	0.3477	1530	1280	250	36900	0.0127	0.0159	1206
Thames/TW	1334.6	1.348	1.1809	13	3	39	19x0.0944	1.29	0.472	1713	1261.6	451.4	46300	0.0128	0.016	1210
St. Croix/TW	1467.8	1.1529	1.2124	5	3	33	7x0.1041	1.292	0.3123	1585	1383	202	35800	0.0117	0.0149	1256
Miramichi/TW	1455.3	1.143	1.2222	7	3	36	7x0.1200	1.302	0.36	1640	1372	268	39200	0.0118	0.015	1256
Merrimack/TW	1433.6	1.125	1.2677	13	3	39	19x0.0978	1.34	0.489	1840	1356	434	49700	0.0119	0.015	1264
Platte/TW	1569	1.2323	1.2957	5	3	33	7x0.1074	1.334	0.3222	1693	1478	215	38200	0.011	0.014	1306
Potomac/TW	1557.4	1.2232	1.3079	7	3	36	7x0.1241	1.345	0.3723	1755	1468	287	41900	0.0111	0.014	1307
Rio Grande/TW	1533.3	1.2043	1.3571	13	3	39	19x0.1012	1.382	0.506	1968	1449	519	53200	0.0112	0.0141	1316
Schuylkill/TW	1657.4	1.302	1.392	7	3	36	7x0.128	1.386	0.384	1868	1563	305	44000	0.0104	0.0133	1356
Pecos/TW	1622	1.2739	1.4429	13	3	39	19x0.1064	1.424	0.532	2107	1533	574	57500	0.0106	0.0133	1363
Pee Dee/TW	1758.6	1.381	1.477	7	3	37	7x0.1319	1.427	0.3957	1982	1658	324	46700	0.0098	0.0126	1404
James/TW	1730.6	1.359	1.5314	13	3	34	19x0.1075	1.47	0.5375	2221	1636	585	59400	0.0099	0.0126	1415
Athabaska/TW	1949.6	1.5312	1.6377	7	3	42	7x0.1392	1.504	0.4176	2199	1838	361	51900	0.0088	0.0115	1491
Cumberland/TW	1926.9	1.5134	1.7049	13	3	42	19x0.1133	1.545	0.5665	2471	1821	650	65300	0.0089	0.0114	1507
Powder/TW	2153.8	1.6912	1.829	8	4	64	19x0.0961	1.602	0.4805	2498	2030	468	61100	0.008	0.0105	1584
Santee/TW	2627.3	2.063	2.2268	8	4	64	19x0.1062	1.762	0.531	3048	2477	571	74500	0.0066	0.0089	1768

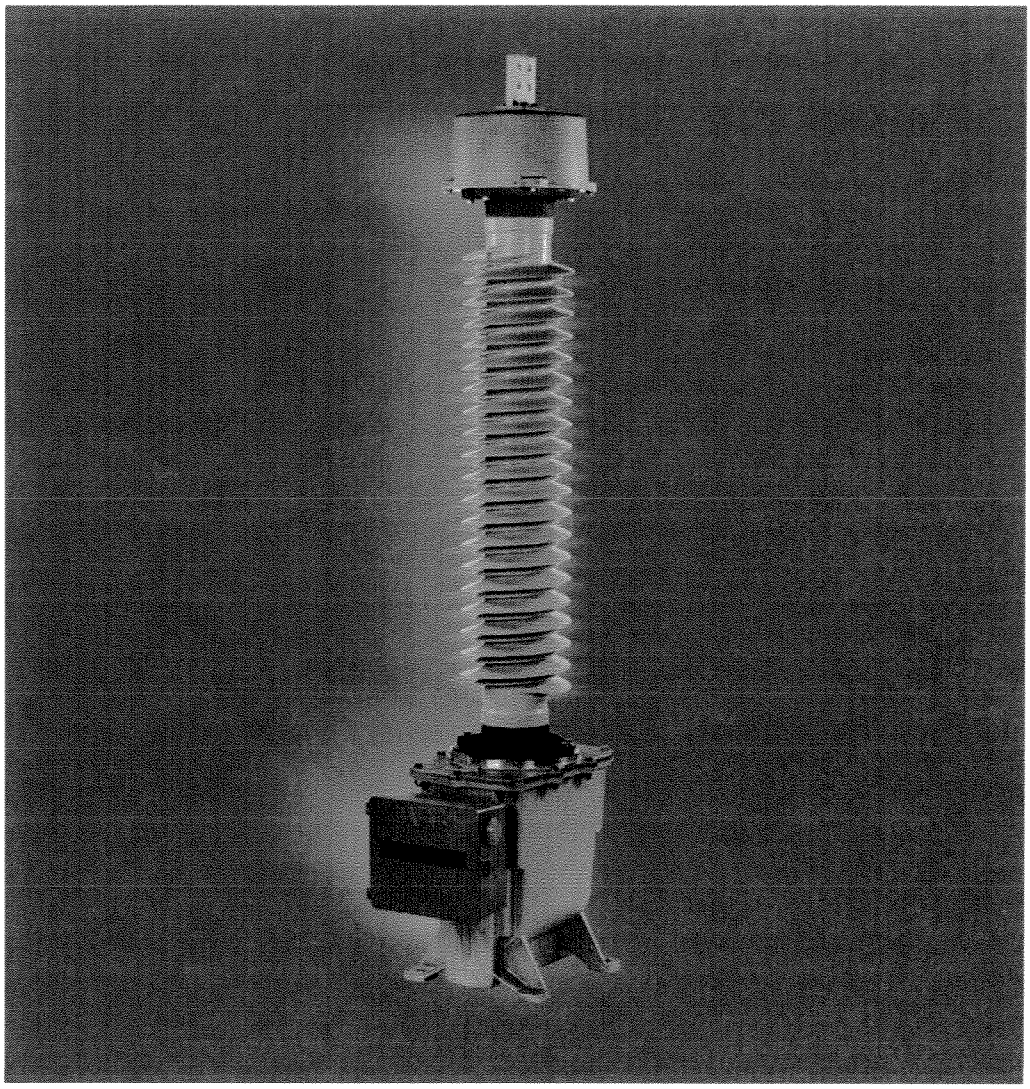
+Ampacity calculated assuming: ambient 250C, conductor 75°C, wind 2 ft./ sec., sun.

Southwire
One Southwire Drive
Carrollton, Ga. 30119 USA

MADE IN ★ THE USA

Capacitor Voltage Transformer CPB 72.5 - 245 kV

For outdoor installation



Design features and advantages

ABB's capacitor voltage transformers (CVTs) are intended for connection between phase and ground in net-works with isolated or grounded neutral.

ABB offers a world-class CVT with efficient ferro-resonance suppression and good transient response.

The design corresponds to the requirements of IEC and all national standards based on them.

Due to the design of the capacitor elements, described below, CPB is, with regard to accuracy, equivalent to inductive voltage transformers.

Capacitor Voltage Divider

The capacitor voltage divider (CVD) consists of a large number of series-connected, oil-insulated capacitor elements. The units are completely filled with synthetic oil, which is kept under a slight overpressure by the design of the expansion system. O-ring seals are used throughout the design.

The capacitor elements are designed with respect to the demands made by revenue metering, and their active component consists of aluminum foil, insulated with paper/polypropylene film, impregnated by a PCB-free synthetic oil, which has better insulating properties than normal mineral oil and is required for the mixed dielectric.

Electromagnetic Unit

The voltage divider and the electromagnetic unit are connected by internal bushings, which is necessary for applications with high accuracy.

The EMU has double-enameled copper windings and an iron core made of high quality steel sheet and is insulated in a hermetically sealed aluminum tank with mineral oil.

The primary coil is divided into a main winding, and a set of externally connected trimming windings. The nominal intermediate voltage is approximately $22/\sqrt{3}$ kV.

The electromagnetic unit have a reactor, which is connected in series between the voltage divider and the high voltage end of the primary winding. This reactor compensates for the shift in phase angle caused by the capacitive voltage divider. The inductive reactances are tuned individually on each transformer before accuracy testing.

Climate

These transformers are designed for, and are installed in widely varying conditions, from arctic to desert climates, on every continent.

Ferro-resonance

The low induction, combined with an efficient damping circuit, gives a safe and stable damping of ferro-resonance at all frequencies and voltages up to the rated voltage factor.

Life time

The low voltage stress within the capacitor elements ensures a safe product with an expected service life of more than 30 years.

Transient properties

The high intermediate voltage and high capacitance result in good transient properties.

Stray capacitance

The design with the compensating reactor on the high voltage side of the main winding ensures less than 200 pF stray capacitance, which is the most stringent requirement in the IEC standard for carrier properties.

Stability

The CPB have a high Quality Factor, as a result of their comparatively high capacitance, combined with a high intermediate voltage.

The Quality Factor = $C_{equivalent} \times U^2_{intermediate}$ is a measure of the accuracy stability and the transient response. The higher this factor, the better the accuracy, and the better the transient response.

Material

All external metal surfaces are made of an aluminum alloy, resistant to most known environment factors. Bolts, nuts, etc. are made of acid-proof steel. The aluminum surfaces do not normally need painting.

Creepage distance

As standard, CPB is offered with creepage distance 25 mm/kV phase-phase (IEC polution class Heavy). Longer creepage distances can be offered on request.

Silicone Rubber Insulators

The complete CVT range is available with silicone rubber (SIR) insulators. Our SIR insulators are produced with a patented helical extrusion molding technique, which gives completely joint-free insulators with outstanding performance. All CVTs with this type of insulators have the same high creepage distance 25 mm/kV phase-phase, as porcelain.

Mechanical stability

The mechanical stability gives sufficient safety margin for normal wind loads and conductor forces.

Design features and advantages

Ferro-resonance damping circuit

All CVTs need to incorporate some kind of ferro-resonance damping, since the capacitance in the voltage divider, in series with the inductance of the transformer and the series reactor, constitutes a tuned resonance circuit.

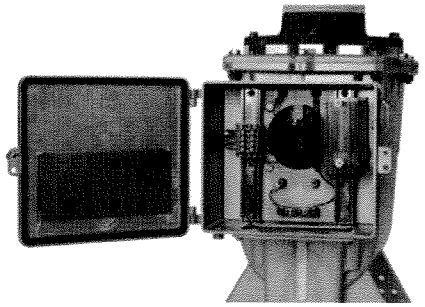
This circuit can be brought into resonance, that may saturate the iron core of the transformer by various disturbances in the network. This phenomenon can also overheat the electro-magnetic unit, or lead to insulation breakdown.

The CPB uses a damping circuit, connected in parallel with one of the secondary windings. The damping circuit consists of a reactor with an iron core, and an oil-cooled resistor in series. Under normal use, the iron core of the damping reactor is not saturated, yielding high impedance, so that practically no current is flowing through this circuit.

Rating plates

Corrosion resistant rating plates with text and wiring diagrams are used. General data can be found on the door of the terminal box, connection diagrams and secondary winding data on the inside.

Each capacitor unit is marked with measured capacitance at the top.



Secondary voltage and burdens

Standards IEC 60044-5

Rated data at 50 or 60 Hz, Voltage factor 1.5 or 1.9

The transformer normally has one or two windings for continuous load, and one earth-fault winding.

Other configurations can be offered according to requirements.

Approximate maximum total burdens in VA

Measuring winding		
Highest class	**Voltage factor 1.5*)**	**Voltage factor 1.9*)**
0.2	50	Available on request
0.5	100	
1.0/3P	200	
Earth-fault winding, irrespective of the voltage factor		
3P/6P	100	Available on request

*) The IEC standards state as standard values for effectively earthed systems 1.5/30 sec.
For systems without effective earthing with automatic earth fault tripping rated voltage factor 1.9/30 sec., and 1.9/8 hrs for systems with insulated neutral point without automatic earth fault tripping.

The above values are total maximum values for the secondary winding(s), voltage 100/√3 or 110/√3 V and one or no residual voltage winding, class 3P, intended for connection in open delta, voltage 100 or 110 (100/3 or 110/3) V. For other configurations please consult us.

If the transformer has more than one continuously loaded winding, possibly with different classes, the table above must be applied to the sum of these burdens and the most accurate class.

Since the residual voltage winding is not loaded except during a fault, the effect of its load on the accuracy of the other windings is disregarded in accordance with IEC.

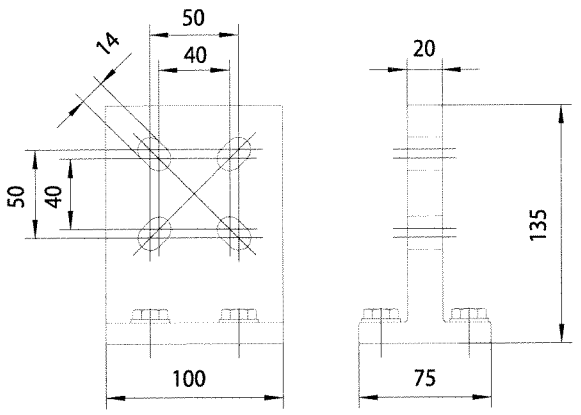
Stated values should only be considered as maximum values. Please note that modern meters and protection require much lower burdens than those above, and to achieve best accuracy you should avoid specifying burdens higher than necessary.

Primary terminal

CPB is normally delivered with a flat 4-hole aluminum pad, suitable for bolts with C-C from 40 to 50 mm and for connecting normal aluminum cable clamps. Other primary terminals can be offered on request, such as a round aluminum studs, Ø=30 mm.

Test forces at the primary terminal as per IEC 60044-5 clause 7.6:

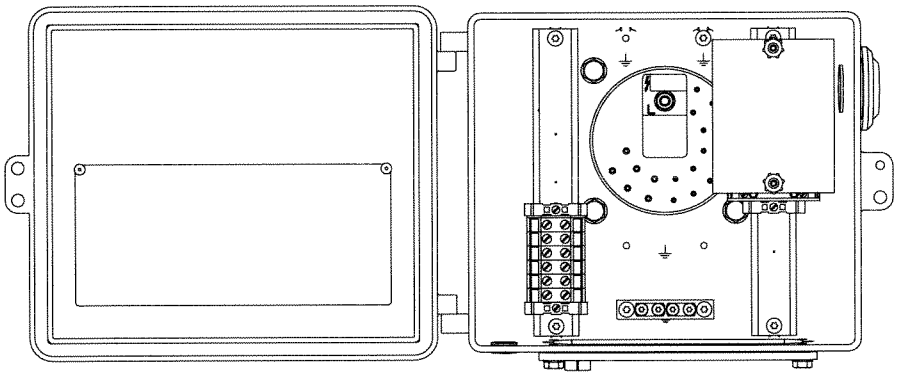
72 kV: 500 N
123-170 kV: 1000 N
245 kV: 1250 N



Secondary terminal box and secondary terminals

The transformer is equipped with a secondary terminal box, protection class IP55. This box is equipped with a detachable, undrilled gland plate, which on installation can be drilled for cable bushings. It is also provided with a drain. The terminal box have space for fuses or micro circuit breakers.

The secondary terminals normally consist of Phoenix standard terminal blocks for wire cross-section 10 mm^2.



Standard terminal box
without accessories

In the terminal box are also terminals (d1-d2) for damping circuit, terminals for the adjustment windings (B1 to B10) and the capacitor low voltage terminal "L" (for power line carrier equipment).

Terminals d1 - d2 and B1 - B10 are intended for factory settings and thus located behind a sealed covering hood to prevent inadvertent reconnection.

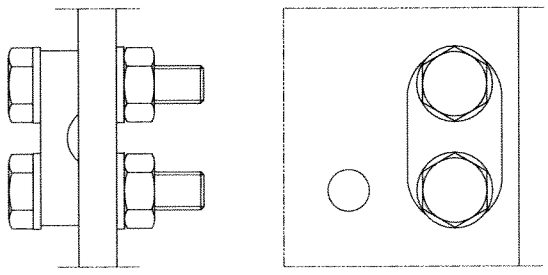
The "L" terminal must always be grounded if no carrier equipment is connected.

Ground terminals

The transformer is normally equipped with a ground clamp with a cap of nickel-plated brass, for conductors 8-16 mm (area 50-200 mm^2), which can be moved to either mounting foot.

A stainless steel bar, 80 x 145 x 8 mm, can be quoted on request. The bar can be supplied undrilled or drilled according to IEC or NEMA standards.

Grounding terminals for the secondary circuits are placed inside the terminal box.



Design data according to IEC

Number of capacitor units, capacitance, flashover and creepage distance

			Normal insulator (minimum values)			
Type	Number of capacitor units	Standard capacitance	Flashover distance Polymer/Porcelain	Creepage distance	Protected creepage distance	Insulator with extra long creepage distance (minimum values)
		pF (+10; -5%)	mm	mm	mm	
CPB 72	1	18200	680/660	1813	800	Offered on request. Normally insulator as for the nearest higher voltage
CPB 123	1	11200	1025/1005	3075	1300	
CPB 145	1	9100	1235/1215	3625	1600	
CPB 170	1	7800	1445/1425	4250	1900	
CPB 245	1	5600	2005/1985	6125	2700	Not available

Test voltages: IEC 60044-5

Type	Highest voltage for equipment (Um)	1min wet/dry	LIWL 1.2/50 µs	Switching impulse 250/2500 µs	PD test voltage	Max. PD level	RIV test voltage	RIV level
	kV	kV	kV	kV	kV	pC*)	kV Max.	µV
CPB 72	72.5	140/140	325	-	1.2 x U_m	10	-	-
CPB 123	123	230/230	550	-	1.2 x U_m	10	78	≤ 2500
CPB 145	145	275/275	650	-	1.2 x U_m	10	92	≤ 2500
CPB 170	170	325/325	750	-	1.2 x U_m	10	108	≤ 2500
CPB 245	245	460/460	1050	-	1.2 x U_m	10	156	≤ 2500

Test voltages above are valid for altitudes ≤ 1000 meters above sea level.

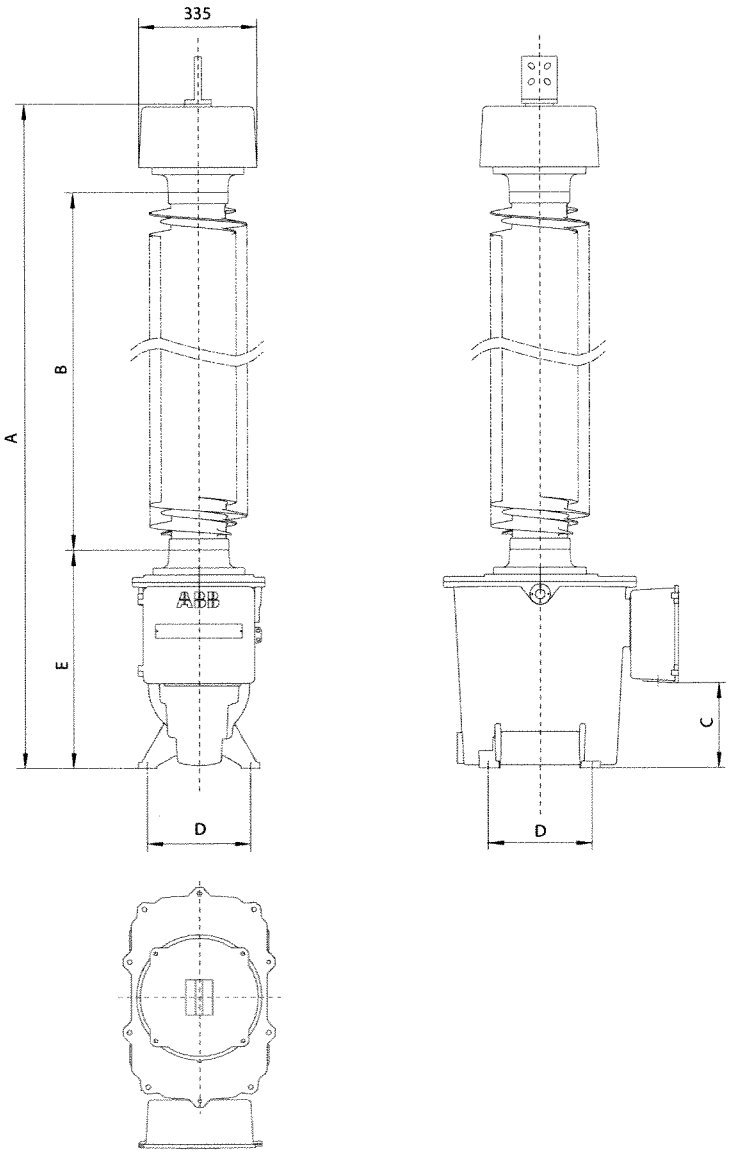
*) 5 pC at test voltage 1.2 x $U_m/\sqrt{3}$

Dimensions

Capacitor Voltage Transformer CPB

		A	B	C	D	E
Type	Number of capacitor units	Total height*)	Flashover distance Polymer/Porcelain	Height to flange	Mounting hole distance	Ground level height Polymer/Porcelain
		mm	mm	mm	mm	mm
CPB 72	1	1580	680/660	225	335	640/650
CPB 123	1	1925	1025/1005	225	335	640/650
CPB 145	1	2135	1235/1215	225	335	640/650
CPB 170	1	2345	1445/1425	225	335	640/650
CPB 245	1	2905	2005/1985	225	335	640/650

*) Primary terminal excluded.



Estimated shipping data

Capacitor Voltage Transformers CPB

Type	Net weight incl. oil Polymer/Porcelain	Oil	Shipping weight Polymer/Porcelain	Shipping dimensions L x W x H	Shipping volume Total
	kg	kg	kg	m	m^3
CPB 72	185/215	41	720/750 [1]	1.67 x 0.94 x 1.85 [1]	2.5 [1]
CPB 123	195/241	42	770/816 [1]	1.67 x 0.94 x 2.19 [1]	2.8 [1]
CPB 145	200/256	42	785/841 [1]	1.67 x 0.94 x 2.46 [1]	3.1 [1]
CPB 170	205/270	44	359/424 [2]	3.18 x 0.65 x 1.05 [2]	2.17 [2]
CPB 245	225/315	45	425/515 [2]	3.32 x 0.65 x 1.05 [2]	2.27 [2]

1) Vertical 3-pack
2) Horizontal 1-pack

Installation and maintenance

Unpacking

Please check the crates and their contents for damage during transportation upon receipt. Should there be any damage, please contact ABB for advice before the goods are handled further. Any damage should be documented (photographed).

Assembly

The electromagnetic unit and the capacitor voltage divider are delivered as one unit.

Maintenance

The CPB is designed for a service life of more than 30 years, and is practically maintenance-free. We recommend however the following checks and measures.

- **Visual check**
  We recommend a periodic inspection, to check for oil leakages and also to inspect the insulator for collection of dirt.

- **Control measurements of the CVD**
  Since the voltage divider is permanently sealed under slight over pressure it is not possible to take oil samples from it.
  Under normal service conditions, no noticeable ageing will occur within the capacitors (verified by ageing tests). However discrepancies between the secondary voltages in parallel phases can be an indication of a fault in a capacitor part of one of the voltage transformers, which is why such a comparison is recommended. In such a case a further measurement of the capacitance value is recommended. Readings can be taken between the top and the "L" terminal in the secondary terminal box.

- **Control measurements of the EMU**
  An easy test is to measure the insulation resistance in mega-ohms (max. test voltage 1,000 VDC) of the secondary windings.
  Since the high voltage winding of the transformer is not capacitively graded, a measurement of the loss angle (tan delta) will give no significant result.

Environmental aspects

Impregnant

Both Faradol 810 (the synthetic oil in the voltage dividers), and Nynäs NYTRO 10 XN (the standard transformer oil in the electromagnetic unit) are free from PCB and other strongly harmful substances, and pose a low impact to the environment.

Destruction

After draining the oils, they can be burnt in an appropriate plant. In this respect, Faradol has similar combustion properties as normal mineral oil.

The disposal should be carried out in accordance with local legal provisions, laws and regulations.

The porcelain can be deposited after it has been crushed.

The metals in the electromagnetic unit and the housings of the voltage divider can be recycled. Aluminum parts are labeled with material specifications. In order to recycle the copper in the windings, the oil-saturated paper insulation should be burnt.

The aluminum in the capacitor elements, with their combination of foil, paper and polypropylene film, can be recycled after the insulation has been burnt; the plastic film will not emit any harmful substances during this process.

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High Voltage Products

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Internet: http://www.abb.com

NOTE! ABB AB is working continuously to improve the products. We therefore reserve the right to change designs, dimensions and data without prior notice.

 Publication 1HSM 9543 42-01en, Capacitor Voltage Transformer CPB 72.5 - 245 kV, Edition 1, 2008-10. Print: henningsons.se

High Voltage Surge Arresters
Buyer's Guide — Section HS PEXLIM T-T

Power and productivity
for a better world™

ABB

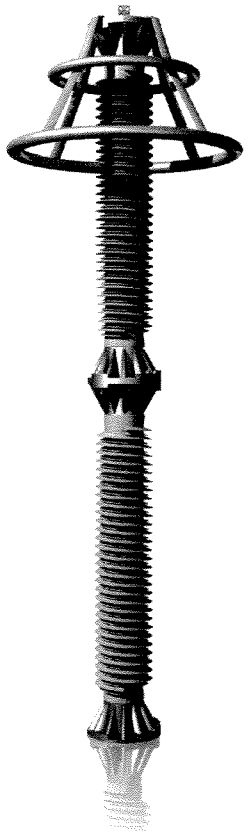
Zinc-Oxide Surge Arrester HS PEXLIM T-T

Protection of switchgear, transformers and other equipment in high voltage systems against atmospheric and switching overvoltages.

- in areas with very high lightning intensity
- where grounding or shielding conditions are poor or incomplete
- for important installations
- where energy requirements are very high (e.g. very long lines, capacitor protection).
- Specially suited to extreme seismic zones.

Superior where low weight, non-fragility and additional personnel safety is required.

Other data can be ordered on request. Please contact your local sales representative.



Brief performance data

System voltages (U_m)	245 - 800 kV
Rated voltages (U_r)	180 - 624 kV
Nominal discharge current (IEC)	10/15/20 kA_{peak}
Classifying current (ANSI/IEEE)	10/15 kA_{peak}
Discharge current withstand strength:	
High current 4/10 µs	100 kA_{peak}
Low current 2000 µs	2200 A_{peak}
Energy capability:	
Line discharge class (IEC)	Class 5
[2 impulses, (IEC Cl. 8.5.5)	15.4 kJ/kV (U_r)]
Fulfils/exceeds requirements of ANSI transmission-line discharge test for 362 kV systems.	
Short-circuit/Pressure relief capability	65 kA_{sym}
External insulation	Fulfils/exceeds standards
Mechanical strength:	
Specified long-term load (SLL)	19000 Nm
Specified short-term load (SSL)	28000 Nm
Service conditions:	
Ambient temperature	-50 °C to +45 °C
Design altitude	max. 1000 m
Frequency	15 - 62 Hz

HS PEXLIM T-T

Guaranteed protective data

Max. system voltage	Rated voltage	Max. continuous operating voltage [1]		TOV capability [2]		Max. residual voltage with current wave						
		as per IEC	as per ANSI/IEEE			30/60 µs			8/20 µs			
U_m	U_r	U_c	MCOV	1 s	10 s	0.5 kA	1 kA	2 kA	5 kA	10 kA	20 kA	40 kA
kV_{rms}	kV_{rms}	kV_{rms}	kV_{rms}	kV_{rms}	kV_{rms}	kV_{peak}	kV_{peak}	kV_{peak}	kV_{peak}	kV_{peak}	kV_{peak}	kV_{peak}
245	180	144	144	209	198	354	364	371	389	405	438	476
	192	154	154	218	207	369	380	387	406	423	457	497
	216	156	174	246	233	415	427	435	457	476	514	559
	228	156	180	259	246	438	451	459	482	502	542	590
300	228	182	182	259	246	438	451	459	482	502	542	590
	240	191	191	273	258	461	475	484	507	528	571	621
362	258	206	209	310	293	523	538	548	575	599	647	704
	264	211	212	310	293	523	538	548	575	599	647	704
	276	221	221	314	297	531	546	556	583	608	656	714
380	288	230	230	328	310	554	569	580	609	634	685	745
400	300	240	240	342	323	577	593	604	634	660	713	776
420	330	264	267	378	358	638	656	669	702	731	789	859
	360	267	291	410	388	692	712	725	761	792	856	931
	390	267	315	444	420	750	771	786	824	858	927	1013
550	396	317	318	474	448	793	816	831	872	908	981	1072
	420	336	336	478	453	807	830	846	888	924	998	1091
	444	349	353	506	479	853	878	894	938	977	1060	1153
800	On request											

More detailed information on the TOV capability and the protective characteristics are given in Publ. 1HSM 9543 13-01en.

1) The continuous operating voltages U_c (as per IEC) and MCOV (as per ANSI) differ only due to deviations in type test procedures.
U_c has to be considered only when the actual system voltage is higher than the tabulated.
Any arrester with U_c higher than or equal to the actual system voltage divided by √3 can be selected.

2) With prior duty equal to the maximum single-impulse energy stress (10.0 kJ/kV (U_r)).

3) Arresters for system voltages 36 kV or below can be supplied, on request, when the order also includes arresters for higher system voltages.

Arresters with lower or higher rated voltages may be available on request for special applications.

HS PEXLIM T-T

Technical data for housings

Max. system voltage	Rated voltage	Housing	Creepage distance	External insulation				Dimensions					
U_m	U_r			1.2/50 µs dry	50 Hz wet (60s)	60 Hz wet (10s)	250/2500 µs wet	Mass	A_{max}	B	C	D	Fig.
kV_{rms}	kV_{rms}		mm	kV_{peak}	kV_{rms}	kV_{rms}	kV_{peak}	kg	mm	mm	mm	mm	
245	180-216	TH245	7150	1081	524	510	750	170	2310	600	-	300	1
	228	TV245	9900	1500	700	700	1050	245	3495	600	-	300	2
300	228-240	TV300	9900	1500	700	700	1050	260	3495	1600	800	1000	3
362	258-276	TH362	9900	1500	700	700	1050	265	3495	1600	800	1000	3
380	288	TH380	9900	1500	700	700	1050	270	3495	1600	800	1000	3
400	300	TM400	9900	1500	700	700	1050	270	3495	1600	800	1000	3
420	330	TH420	12100	1831	874	860	1275	300	4035	1600	800	1000	3
	360	TH420	12100	1831	874	860	1275	300	4035	1200	800	600	3
	390	TV420	14300	2162	1048	1020	1500	330	4575	1200	800	600	3
550	396	TH550	14300	2162	1048	1020	1500	350	4890	2000	1000	1200	4
	420	TH550	14300	2162	1048	1020	1500	350	4890	2000	1000	1200	4
	444	TH550	14850	2250	1050	1050	1575	405	5540	2000	1000	1200	5

*) Sum of withstand voltages for empty units of arrester.

HS PEXLIM T-T

Technical data for housings

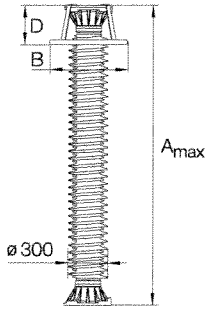


Figure 1

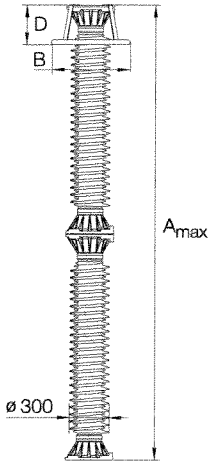


Figure 2

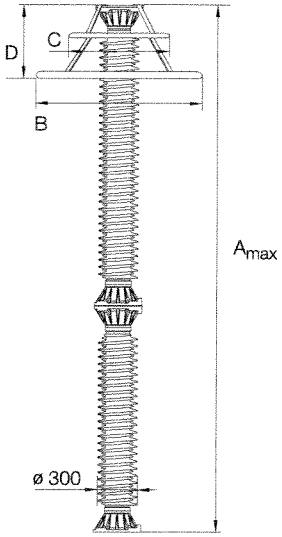


Figure 3

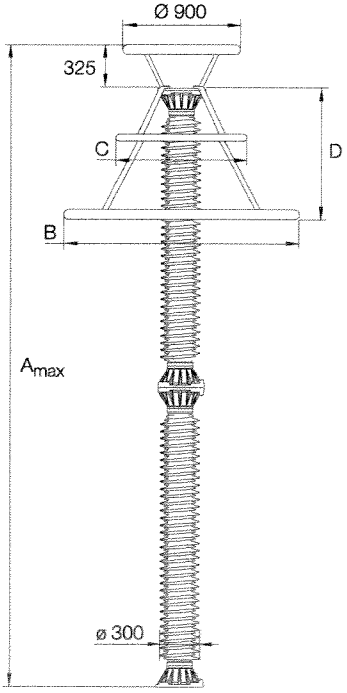


Figure 4

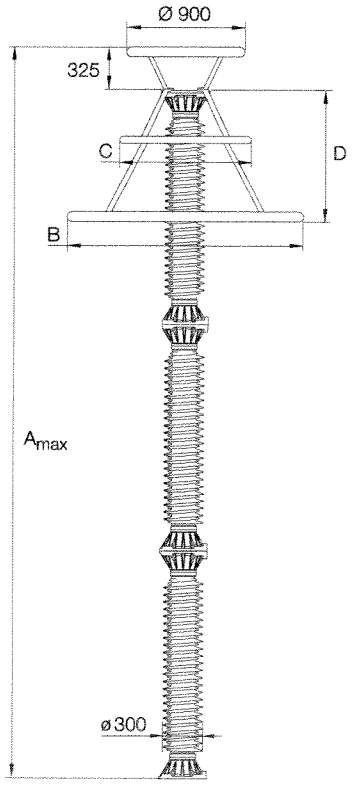
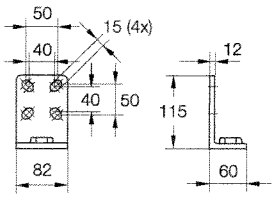


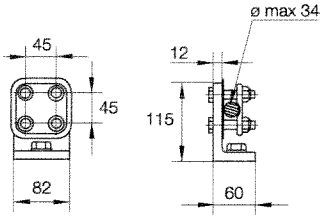
Figure 5

HS PEXLIM T-T
Accessories

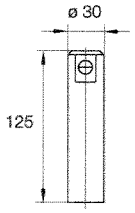
Line terminals



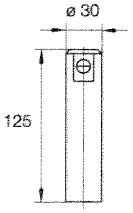
1HSA410 000-A
Aluminium



1HSA410 000-B
Aluminium flag with other items in stainless steel

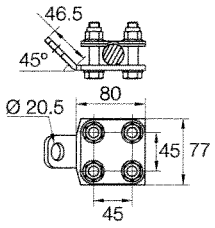


1HSA410 000-C
Aluminium

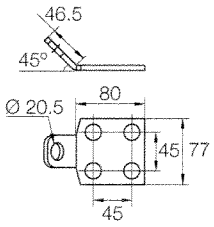


1HSA410 000-D
Aluminium

Earth terminals

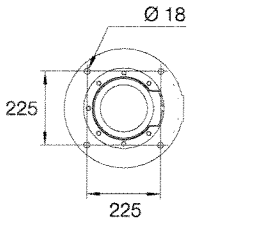


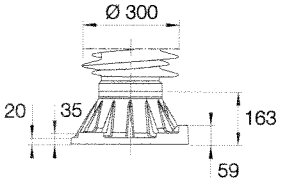
1HSA420 000-U
Stainless steel



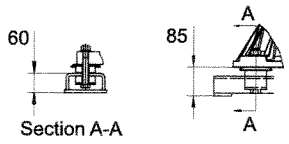
1HSA420 000-002
Stainless steel

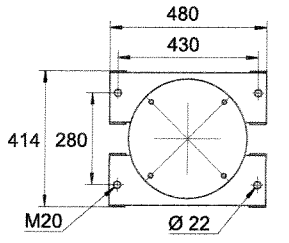
Drilling plans





Without insulating base
Aluminium





Insulating base
1HSA430 000-P
Galvanized steel

M20 bolts for connection to structure are not supplied by ABB.

HS PEXLIM T-T
Shipping data

Rated voltage	Housing	Number of arresters per crate					
		One		Three		Six	
U_r		Volume	Gross	Volume	Gross	Volume	Gross
kV_{rms}		m^3	kg	m^3	kg	m^3	kg
180	TH245	5.4	315	5.4	676	6.0	1262
192	TH245	5.4	316	5.4	680	6.0	1270
216	TH245	5.4	321	5.4	692	6.0	1295
228	TV245	2.6	340	4.3	893	-	-
228	TV300	2.8	405	5.3	1006	-	-
240	TV300	2.8	407	5.3	1011	-	-
258	TH362	2.8	411	5.3	1026	-	-
264	TH362	2.8	411	5.3	1026	-	-
276	TH362	2.8	412	5.3	1028	-	-
288	TH380	2.8	414	5.3	1033	-	-
300	TM400	2.8	416	5.3	1038	-	-
330	TH420	5.8	507	6.6	1163	-	-
360	TH420	5.2	452	5.5	1086	-	-
390	TV420	5.2	483	5.5	1179	-	-
396	TH550	6.7	611	6.7	1355	-	-
420	TH550	6.7	612	6.7	1357	-	-

Rated voltage	Housing	Number of arresters per crate			
		One		Two	
U_r		Volume	Gross	Volume	Gross
kV_{rms}		m^3	kg	m^3	kg
444	TH550	3.7	602	5.5	1054

Each crate contains a certain number of arrester units and accessories for assembly and erection. A packing list is attached externally on each crate.

Each separate crate is numbered and the numbers of all crates and their contents are listed in the shipping specification. ABB reserves the right to pack arresters in the most effective/economic combination. Alternate or non-standard crates may involve additional charges.

The table above is to be seen as an approximation and specific data for deliveries may differ from the values given.

For more information please contact:

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NOTE! ABB AB is working continuously to improve the products. We therefore reserve the right to change designs, dimensions and data without prior notice.

Section of 1HSM 9543 12-00en Surge Arresters Buyer's Guide, Edition 7, 2009-06

Power and productivity
for a better world™

LAPP LINE® COMPACTION

LAPP

HORIZONTAL VEE

COMPACT TRANSMISSION LINE DESIGN 115kV - 500kV

CATALOG 606

LAPP INSULATOR
LEROY, N.Y. 14482

HORIZONTAL VEE APPLICATIONS

DESIGN CONSIDERATIONS

The Horizontal Vee assembly is completely articulated. It is free to rotate about the axis between the attachment point of the suspension string to the structure and the attachment point of the rigid insulator, or strut, to the structure. Should unbalanced longitudinal loads occur, for any reason, the insulator will tend to rotate about this axis. Since the strut is a tension or compression insulator only, the points of attachment to the structure are designed to provide freedom of movement, preventing both bending and torsional loading of the strut. Refer to Figure 1 below.

The axis of rotation is inclined at an angle from vertical at the hinge angle so that, when the assembly rotates, the line end rises. This provides a self-restoring force which is particularly helpful during construction and conductor stringing operations. In service, the conductor weight and tension stabilize the assembly in its normal position.

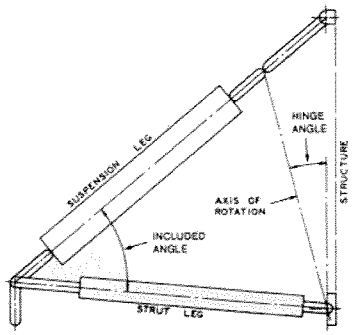


FIGURE 1

The line load is applied to the Horizontal Vee assembly at the point where the axes of the suspension string and the strut intersect. This prevents bending forces on the strut, particularly under unbalanced loading, either static or dynamic. Only tension loads can be transmitted to the suspension insulators, but alternately, both tension and compression loads can be applied to the strut insulators.

Rotational freedom is provided between the conductor and the insulator assembly by standard suspension fittings. If the conductor breaks, the Horizontal Vee assembly adjacent to the break will swing in line with the conductor, and act as a dead-end assembly.

All of the standard Horizontal Vee assemblies listed in this catalog have a 45° included angle. Experience has shown 45° to be an efficient angle for loading the insulator legs while, at the same time, minimizing the distance between the conductor and the structure. Assemblies with other angles can be provided.

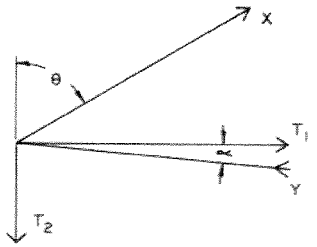


FIGURE 2

Figure 2 is a load diagram showing the division of externally applied loads into the two insulator legs. The relationship between these loads is expressed in the following formulae:

$$T_1 = Y \cos \alpha - X \sin \theta$$
$$T_2 = X \cos \theta + Y \sin \alpha$$

where

T_2 = Vertical load, downward, lbs.
T_1 = Horizontal load toward structure, lbs.
X = Suspension insulator load, lbs.
Y = Strut insulator load, lbs.
θ = Angle of suspension string to vertical
α = Angle of strut insulator to horizontal

Angles α and θ are constant for all the assemblies shown in this bulletin ($\alpha = 5°$, $\theta = 50°$). The equations for insulator loads can, therefore, be simplified to the following:

$$X = 1.409\, T_2 - 0.123\, T_1$$
$$Y = 1.083\, T_2 + 0.909\, T_1$$

As an example, the following calculation applies to NESC heavy loading on a No. 307318 345 kV Horizontal Vee tangent assembly to be used on 800 ft. spans (equal weight and wind spans) two 954 MCM 45/7 ACSR "Rail" conductors per phase.

The transverse load from wind pressure on the iced subconductor is .7217 lb./ft., and the load T_1 is:

T_1 = .7217 lb./ft. X 2 (Conductor/Phase) X 800 ft.
= 1155 lbs.

The vertical load from the iced subconductor is 2.114 lb./ft. and the load T_2 is:

T_2 = 2.114 lb./ft. X 2 (Conductor/Phase) X 800 ft.
= 3382 lbs.

With transverse wind blowing toward structure, insulator loads are:

X = 1.409 (3382) − 0.123 (1155)
= 4623 lbs. (Tension load in suspension insulator string)
Y = 1.083 (3382) + 0.909 (1155)
= 4713 lbs. (Compression load in strut)

With transverse loads blowing away from structure,

X = 1.409 (3382) + 0.123 (1155)
= 4907 lbs. (Tension load in suspension insulator string)
Y = 1.083 (3382) − 0.909 (1155)
= 2613 lbs. (Compression load in strut)

These values are well within the maximum recommended working load ratings of the insulators.

The same procedure can be used to calculate loads for the extreme wind and/or ice loads which are assumed for the transmission line design.

The maximum conductor swing angle for each assembly is indicated on the catalog drawings. Adapters listed on page 9 are recommended for higher swing angles, such as may be required on heavy outside line angles (with resultant forces toward the structure), or high wind loading locations which may occur in hurricane areas.

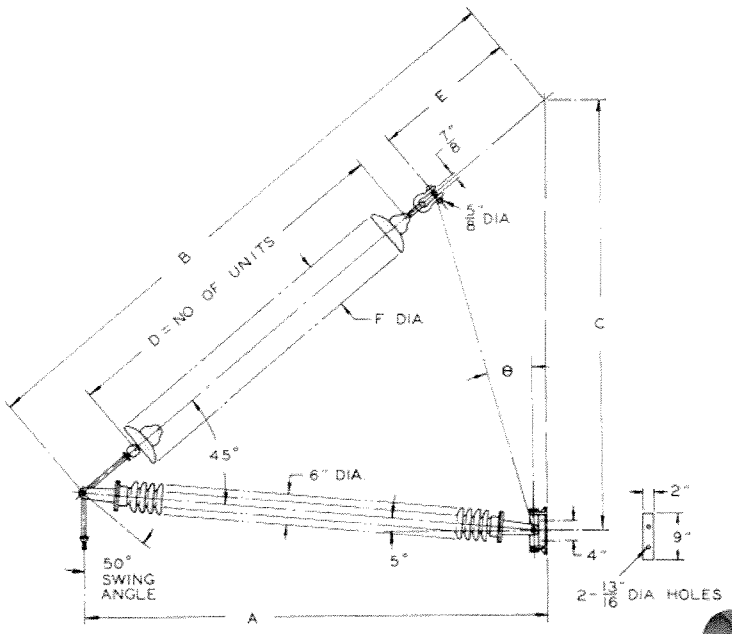
HORIZONTAL VEE ASSEMBLIES
230 kV

The standard Horizontal Vee design listed in the table will meet the requirements for most applications at this voltage level. All of these assemblies have a 45° included angle and are available for steel, concrete or wood pole mounting in four insulation levels determined by the number of suspension insulators required. The strut insulator matches the electrical characteristics of the number of suspensions in the assembly.

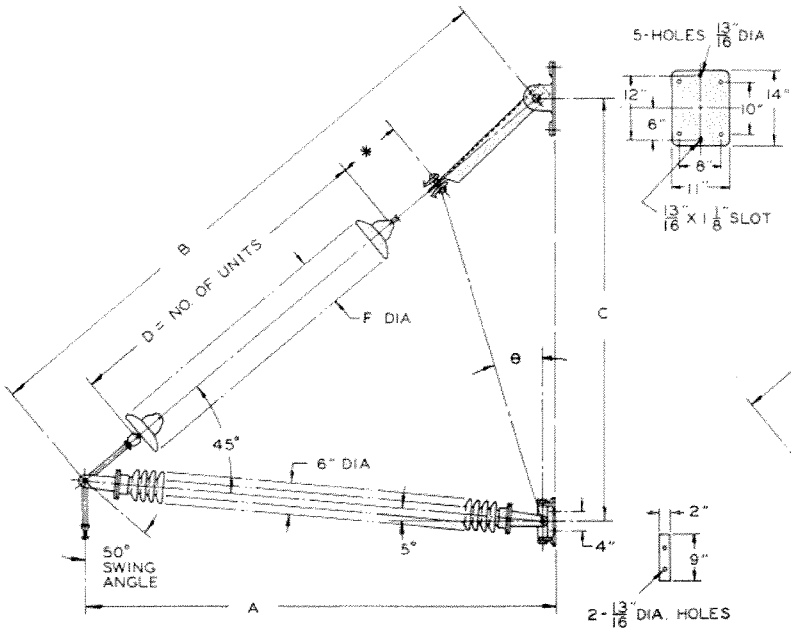
The basic assembly is cataloged without the top mounting bracket for use on structures where a stub arm is supplied as part of the structure. This design is recommended for new construction on steel poles or lattice towers.

The addition of suffix "A" or "C" to the catalog number indicates that a top mounting bracket is required, and denotes the type of structure being used. A suitable top mounting bracket is supplied with the assembly. These assemblies are furnished complete, with the exception of the conductor clamps, which must be ordered separately. The Horizontal Vee assemblies accommodate all standard aluminum suspension clamps with a NEMA 52-5 socket and are suitable for single or bundled conductors. Clamps can be ordered by using a separate catalog number as shown on page 9.

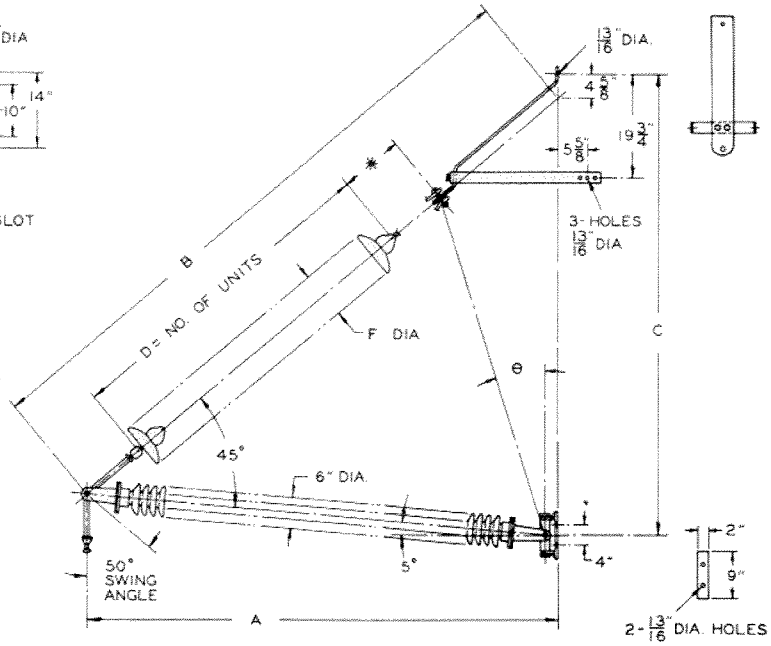
Insulators are light gray, Lapp No. 70 glaze. Hardware is ferrous, hot-dip galvanized.



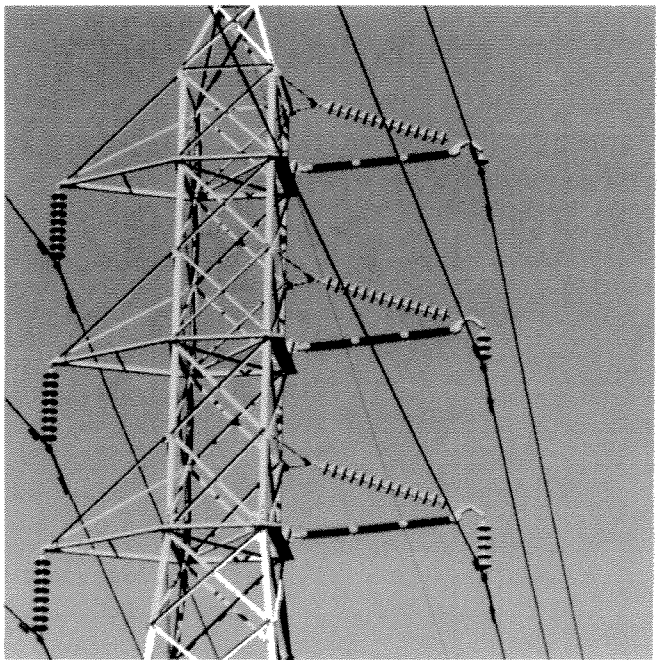
Catalog Number	Hinge Angle	Dimensions in Inches						Strength Ratings Lbs.		Aprx. Net Weight/Assy. Lbs.
		A	B	C	D	E	F	Suspensions	Struts	
BASIC ASSEMBLIES										
307312	22°	96 3/8	125 13/16	89 1/16	12	37 9/16	9	15K	15K	260
307313	21°	101 3/8	132 3/8	93 3/4	13	38 3/8	9	15K	15K	275
307314	22°	108 9/16	141 3/4	100 3/8	14	42	10	20K	25K	375
307315	20°	111 9/16	145 11/16	103 3/16	15	40 3/16	10	20K	25K	395
STEEL POLE OR CONCRETE POLE MOUNTING										
307312A	16°	96 3/8	121 9/16	86 3/8	12	—	9	15K	15K	315
307313A	15°	101 3/8	128 1/8	91	13	—	9	15K	15K	330
307314A	14°	108 9/16	137	97 3/8	14	—	10	20K	25K	430
307315A	13°	111 9/16	141 1/4	100 5/16	15	—	10	20K	25K	450
WOOD POLE MOUNTING										
307312C	16°	96 3/8	126	93 13/16	12	—	9	15K	15K	295
307313C	15°	101 3/8	132 9/16	98 1/2	13	—	9	15K	15K	310
307314C	14°	108 9/16	141 7/16	104 13/16	14	—	10	20K	25K	415
307315C	13°	111 9/16	145 11/16	107 13/16	15	—	10	20K	25K	435



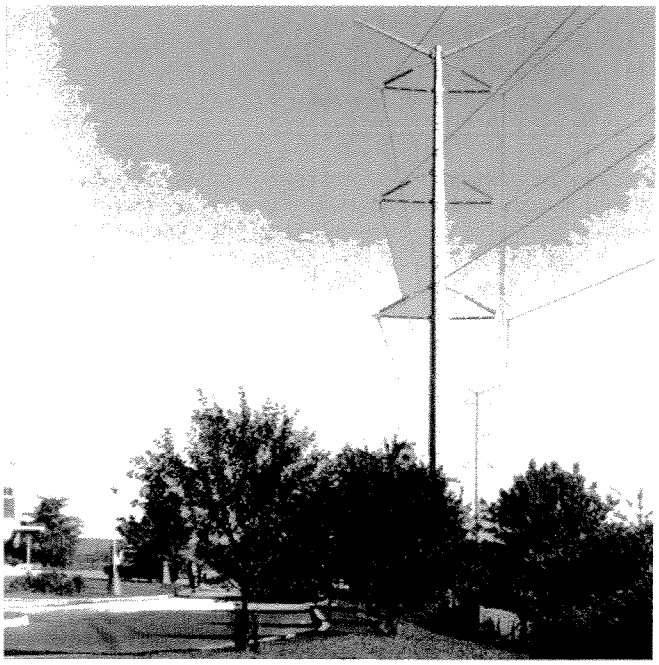
Steel Pole or Concrete Mounting



Wood Pole Mounting

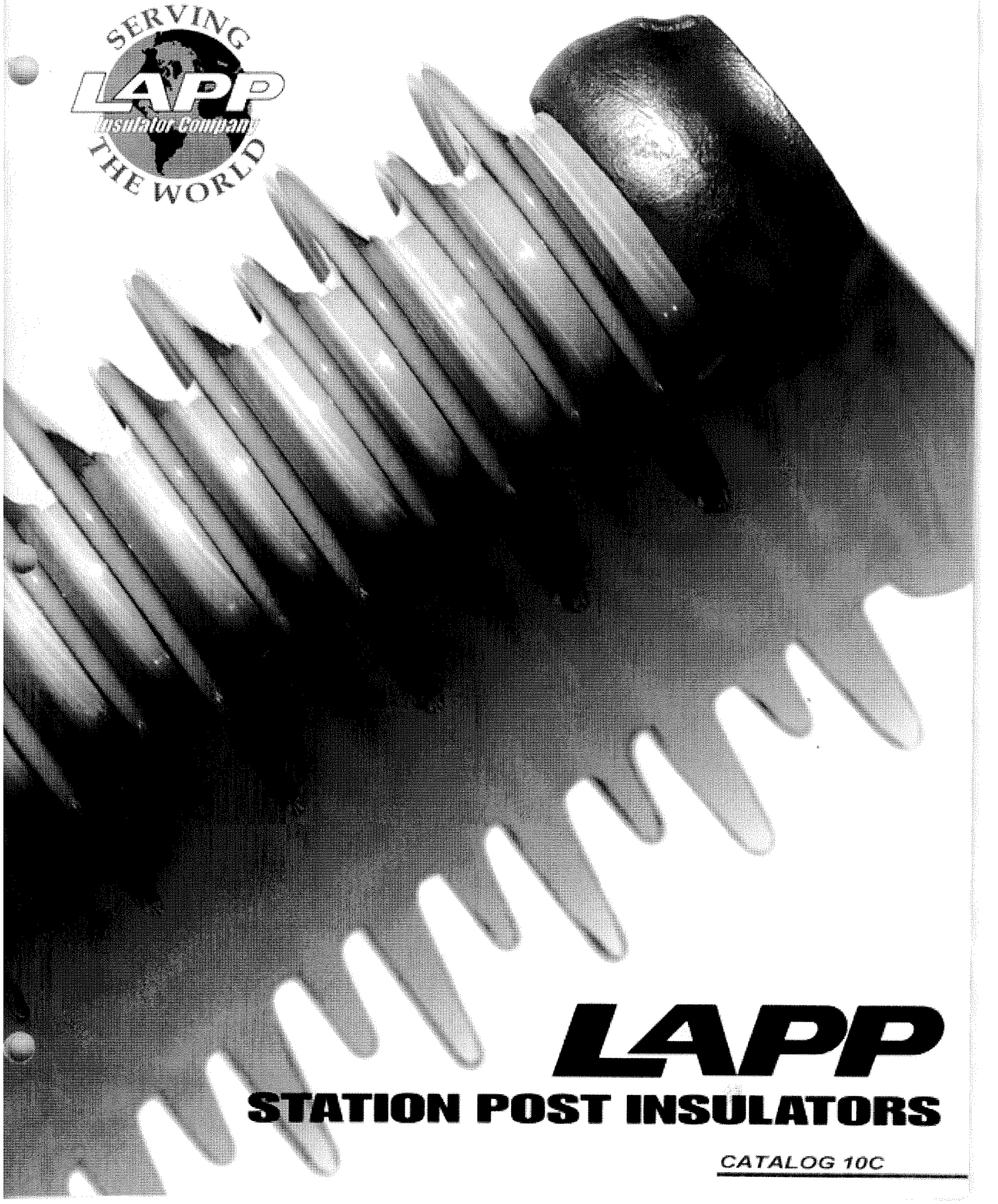


Horizontal Vee construction made it possible to upgrade one side of a double circuit 115 kV line to 230 kV. Capacity was increased from 200 MVA to 400 MVA on same structures at minimal cost.



Neat appearance of double circuit Horizontal Vee design on tapered steel poles helped gain public acceptance for this 230 kV transmission line through an attractive residential area.

*Linkage made up of standard fittings to hold overall length.



LAPP

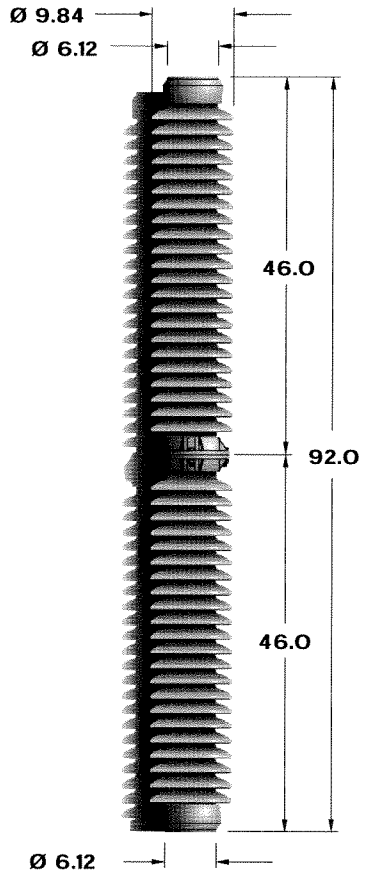
STATION POST INSULATORS

CATALOG 10C

LAPP

1050 kV BIL STACKS

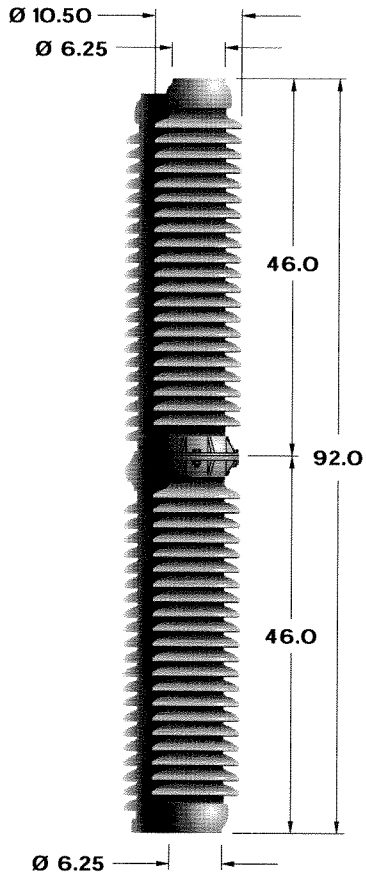
STANDARD STRENGTH UNIT



4 TAPPED HOLES
5/8-11 +.015 OVERSIZE
11/16" FULL THREAD
ON 5.0" BOLT CIRCLE

315312-70

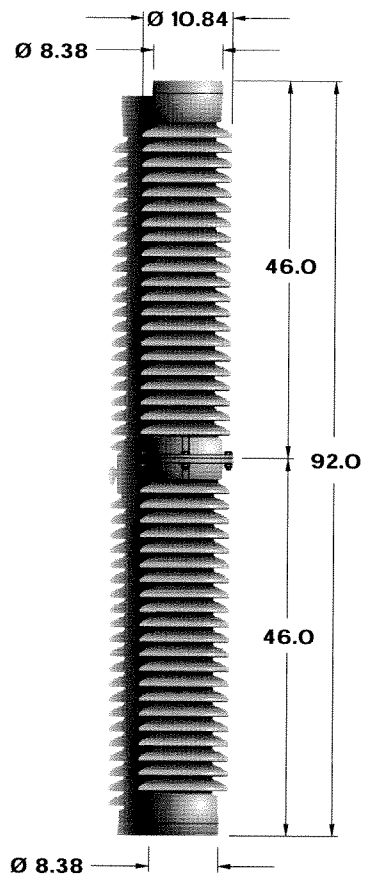
HIGH STRENGTH UNIT



4 TAPPED HOLES
5/8-11 +.015 OVERSIZE
3/4" FULL THREAD
ON 5.0" BOLT CIRCLE

315316-70

EXTRA-HIGH STRENGTH UNIT



4 TAPPED HOLES
3/4-10 +.015 OVERSIZE
7/8" FULL THREAD
ON 7.0" BOLT CIRCLE

315362-70

CHARACTERISTICS

Lapp Catalog Number	315312-70	315316-70	315362-70
Ansi Technical Reference Number	T.R.312	T.R.316	T.R.362
Dimensions			
Leakage Distance, Inches	198	198	198
Mechanical Values *			
Cantilever Strength, Pounds	800	1250	2300
Tensile Strength, Pounds	20000	25000	40000
Torsion Strength, Inch-Pounds	40000	90000	120000
Compression Strength, Pounds	60000	75000	100000
Electrical Values			
Impulse Flashover, Positive, kV	1210	1210	1210
Low Frequency Withstand, 10 Sec. Wet, kV	455	455	455
Impulse Withstand, kV	1050	1050	1050
Radio Influence Voltage Data			
Test Voltage, Rms to Ground, kV	146	146	146
Maximum RIV, Microvolts at 1000 kHz	500	500	500
Weight			
Net Weight, Each, Pounds	384	450	580

* For Maximum recommended working loads see "Specifications," page 6.

Note: For RG glazed insulators equivalent to these standard insulators, see table on page 9.

Illustrations shown are true representations of Lapp products at the time of printing, but are subject to change at any time.

ALL DIMENSIONS ARE IN INCHES

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ISO 9002

PRODUCT CATALOG – ACSR (Aluminum Conductor, Steel Reinforced)

ASTM CONDUCTOR SIZES

Code Word	Size (AWG or KCM)	Stranding (Al/St)	Diameter (inches) Indiv. Wires Al	Stl	Steel Core	Complete Cable	Weight Per 1000 ft (Lbs) Al	Stl	Total	Content % Al	Stl	Rated Strength (Lbs)	Resistance[1] Ohms/1000 ft DC @ 20 °C	AC @ 75 °C	Current Rating[2] (Amps)	
Turkey	6	6/1	.0661	.0661	.0661	.198	24.5	11.6	36.1	67.90	32.10	1,190	.641	.806	105	
Swan	4	6/1	.0834	.0834	.0834	.250	39.0	18.4	57.4	67.90	32.10	1,860	.403	.515	140	
Swanate	4	7/1	.0772	.1029	.1029	.257	39.0	28.0	67.0	58.13	41.87	2,360	.399	.519	140	
Sparrow	2	6/1	.1052	.1052	.1052	.316	62.0	29.3	91.3	67.90	32.10	2,850	.254	.332	184	
Sparate	2	7/1	.0974	.1299	.1299	.325	62.0	44.7	106.7	58.13	41.87	3,640	.251	.338	184	
Robin	1	6/1	.1181	.1181	.1181	.354	78.2	36.9	115.1	67.90	32.10	3,550	.201	.268	212	
Raven	1/0	6/1	.1327	.1327	.1327	.398	98.7	46.6	145.3	67.90	32.10	4,380	.159	.217	242	APT
Quail	2/0	6/1	.1489	.1489	.1489	.447	124.3	58.7	183.0	67.90	32.10	5,300	.126	.176	276	
Pigeon	3/0	6/1	.1672	.1672	.1672	.502	156.7	74.0	230.7	67.90	32.10	6,620	.100	.144	315	
Penguin	4/0	6/1	.1878	.1878	.1878	.563	197.7	93.4	291.1	67.90	32.10	8,350	.0795	.119	357	
Waxwing	266.8	18/1	.1217	.1217	.1217	.609	250.3	39.2	289.5	86.45	13.55	6,880	.0643	.0787	449	
Partridge	266.8	26/7	.1013	.0788	.2364	.642	251.7	115.6	367.2	68.53	31.47	11,300	.0637	.0779	475	
Ostrich	300.0	26f7	.1074	.0835	.2505	.680	282.9	129.8	412.7	68.53	31.47	12,700	.0567	.0693	492	
Merlin	336.4	18/1	.1367	.1367	.1367	.683	315.8	49.5	365.2	86.45	13.55	8,680	.0510	.0625	519	
Linnet	336.4	26[7	.1137	.0884	.2652	.720	317.1	145.4	462.5	68.53	31.47	14,100	.0505	.0618	529	
Oriole	336.4	30f7	.1059	.1059	.3117	.741	318.2	208.9	527.1	60.35	39.65	17,300	.0502	.0613	535	
Chickadee	297.5	18/1	.1486	.1486	.1486	.743	373.1	58.5	431.6	86.45	13.55	9.940	.0432	.0529	576	
Brant	397.5	24/7	.1287	.0858	.2574	.772	375.0	137.0	512.0	73.23	26.77	14,600	0430	.0526	584	
Ibis	397.5	26/7	.1236	.0961	.2883	.783	374.7	171.9	546.6	68.53	31.47	16,300	.0428	.0523	587	
Lark	397.5	30/7	.1151	.1151	.3453	.806	375.8	246.8	622.6	60.35	39.65	20,300	.0425	.0519	594	
Pelican	477.0	18/1	.1628	.1628	.1628	.814	447.8	70.2	518.0	86.45	13.55	11,800	.0360	.0442	646	MPT
Flicker	477.0	2417	.1410	.0940	.2820	.846	450.1	164.4	614.5	73.23	26.77	17,200	.0358	.0439	655	
Hawk	477.0	26f7	.1354	.1053	.3159	.858	449.6	206.4	656.0	68.53	31.47	19,500	.0356	.0436	659	
Hen	477.0	30/7	.1261	.1261	.3783	.883	451.1	296.2	747.3	60.35	39.65	23,800	.0354	.0433	666	
Osprey	556.5	18/1	.1758	.1758	.1758	.879	522.2	81.8	604.1	86.45	13.55	13,700	.0308	.0379	711	Ring Bus / Transmission Line
Parakeet	556.5	240	.1523	.1015	.3045	.914	525.1	191.7	716.9	73.23	26.77	19,800	.0307	.0376	721	
Dove	556.5	26f7	.1463	.1138	.3414	.927	525.0	241.0	766.0	68.53	31.47	22,600	.0306	.0375	726	
Eagle	556.5	30/7	.1362	.1362	.4086	.953	526.3	345.6	871.8	60.35	39.65	27,800	.0303	.0372	734	
Peacock	605.0	24/7	.1588	.1059	.3177	.953	570.9	208.7	779.6	73.23	26.77	21,600	.0282	.0346	760	
Squab	605.0	26/7	.1525	.1186	.3558	.966	570.4	261.8	832.2	68.53	31.47	24,300	.0281	.0345	765	
Wood Duck	605.0	30f7	.1420	.1420	.4260	.994	572.0	375.6	947.7	60.35	39.55	28,900	.0279	.0342	774	
Teal	605.0	30/19	.1420	.0852	.4260	.994	572.0	367.4	939.4	60.89	39.11	30,000	.0279	.0342	773	
Kingbird	636.0	18/1	.1880	.1880	.1880	.940	597.2	93.6	690.8	86.45	13.55	15,700	.0270	.0332	773	
Swift	636.0	36/1	.1329	.1329	.1329	.930	596.9	46.8	643.7	92.80	7.20	13,800	.0271	.0334	769	
Rook	636.0	2417	.1628	.1085	.3255	.977	600.0	219.1	819.1	73.23	26.77	22,600	.0268	.0330	784	

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ISO 9002

ASTM CONDUCTOR SIZES

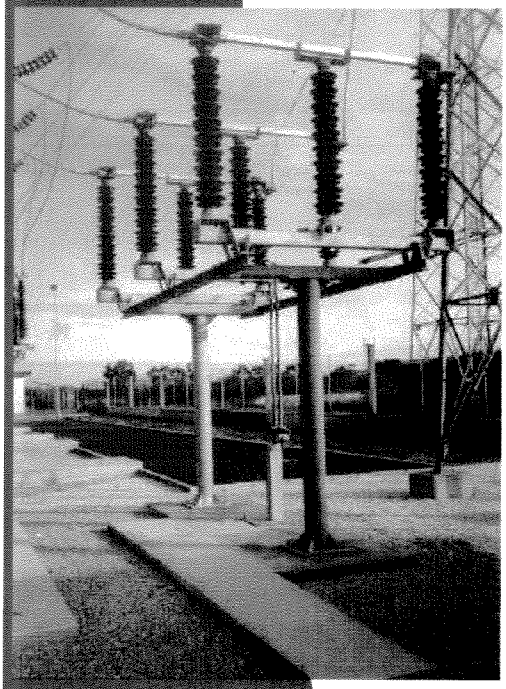
Code Word	Size (AWG or KCM)	Stranding (Al/St)	Diameter (inches) Indiv. Al	Wires Stl	Steel Core	Complete Cable	Weight Per 1000 ft (Lbs) Al	Stl	Total	Content % Al	Stl	Rated Strength (Lbs)	Resistance[1] Ohms/1000 ft DC @ 20 °C	AC @ 75 °C	Current Rating[2] (Amps)
Grosbeak	636.0	26/7	.1564	.1216	.3648	.990	599.9	275.2	875.1	68.53	31.47	25,200	.0267	.0328	789
Scoter	636.0	30/7	.1456	.1456	.4368	1.019	601.4	394.9	996.3	60.35	39.55	30,400	.0256	.0325	798
Egret	636.0	30/19	.1456	.0874	.4370	1.019	601.4	386.6	988.0	60.89	39.11	31,500	.0266	.0326	798
Flamingo	666.6	24/7	.1667	.1111	.3333	1.000	629.1	229.7	858.8	73.23	26.77	23,700	.0256	.0315	807
Gannet	666.6	26/7	.1601	.1245	.3735	1.014	628.7	288.5	917.1	68.53	31.47	26,400	.0255	.0313	812
stilt	715.5	24/7	.1727	.1151	.3453	1.036	675.2	246.5	921.8	73.23	26.77	25,500	.0239	.0294	844
Starling	715.5	26/7	.1659	.1190	.3870	1.051	675.0	309.7	984.7	68.53	31.47	28,400	.0238	.0292	849
Redwing	715.5	30/19	.1544	.0926	.4630	1.081	676.3	434.0	1110	60.89	39.11	34,600	.0236	.0290	859
Coot	795.0	36/1	.1486	.1486	1486	1.040	746.2	58.5	804.7	92.80	7.20	16,800	.0217	.0268	884
Cuckoo	795.0	24/7	.1820	.1213	.3639	1.092	749.9	273.8	1024	73.23	26.77	27,900	.0215	.0265	901
Drake	795.0	26/7	.1749	.1360	.4080	1.108	750.3	344.2	1094	68.53	31.47	31,500	.0214	.0263	907
Tern	795.0	45/7	.1329	.0886	.2658	1.063	749.8	146.1	895.9	83.69	16.31	22,100	.0216	.0269	887
Condor	795.0	54/7	.1213	.1213	.3639	1.092	749.5	273.6	1023	73.25	26.75	28,200	.0215	.0272	889
Mallard	795.0	30/19	.1628	.0977	.4885	1.140	751.9	483.1	1235	60.89	39.11	38,400	.0213	.0261	918
Ruddy	900.0	45/7	.1414	.0943	.2829	1.131	848.7	165.5	1014	83.69	16.31	24,400	.0191	.0239	958
Canary	900.0	5417	.1291	.1291	.3873	1.162	849.0	309.9	1159	73.25	26.75	31,900	.0190	.0241	961
Rail	954.0	45/7	.1456	.0971	.2913	1.165	899.9	175.5	1075	83.69	16.31	25,900	.0180	.0225	993
Cardinal	954.0	54/7	.1329	.1329	.3987	1.196	899.7	328.4	1228	73.25	26.75	33,800	.0179	.0228	996
Ortolan	1033.5	45/7	.1515	.1010	.3030	1.212	974.3	189.8	1164	83.69	16.31	27,700	.0167	.0209	1043
Curlew	1033.5	54/7	.1383	.1383	.4149	1.245	974.3	355.6	1330	73.25	26.75	36,600	.0165	.0211	1047
Bluejay	1113.0	45/7	.1573	.1049	.3147	1.259	1050	204.8	1255	83.69	16.31	29,800	.0155	.0194	1092
Finch	1113.0	54/19	.1436	.0862	.4310	1.293	1056	376.1	1432	73.75	26.75	39,100	.0154	.0197	1093
Bunting	1192.5	45/7	1628	.1085	.3255	1.302	1125	219.1	1344	83.69	16.31	32,000	.0144	.0182	1139
Grackle	1192.5	54/19	.1486	.0892	.4460	1.338	1130	402.7	1533	73.75	26.25	41,900	.0144	.0184	1140
Bittern	1272.0	45/7	.1681	.1121	.3363	1.345	1200	233.9	1433	83.69	16.31	34,100	.0135	.0171	1184
Pheasant	1272.0	54/19	.1535	.0921	.4605	1.382	1206	429.3	1635	73.75	26.25	43,600	.0135	.0173	1187
Dipper	1351.5	45/7	1733	.1155	.3465	1.386	1275	248.3	1525	83.69	16.31	36,200	.0127	.0162	1229
Martin	1351.5	54/19	.1582	.0949	.4745	1.424	1281	455.8	1737	73.75	26.25	46,300	.0127	.0163	1232
Boblink	1431.0	4517	.1783	.1189	.3567	1.427	1350	263.1	1613	83.69	16.31	38,300	.0120	.0153	1272
Plover	1431.0	54/19	.1628	.0977	.4885	1.465	1357	483.1	1840	73.75	26.25	49,100	.0120	.0155	1275

Ring Bus/ Transmission Line.

S3C

Double Side Break Disconnect Switch 72.5 to 245 kV

Disconnect Switches are an essential element of electrical power transmission systems. They provide visible air gap isolation of line sections and equipment for safe maintenance and repair. The S3C is a low profile, reduced phase-to-phase distance, double side break switch, on which the center insulator rotates to open and close the switch. Both terminal pads are rigid and well supported.



S3C 145 kV
2000A

RELIABILITY

The S3C is a superior disconnect switch, a result of over 70 years of AREVA T&D experience in developing high voltage switches. Optimum mechanical and electrical characteristics of the current carrying parts are ensured through the use of high-strength aluminum alloys combined with silver plated copper contacts. The rectangular aluminum blade is attached to the top of the center-rotating insulator. It moves smoothly from a fully open position to fully closed in the stop in the jaw. A galvanized structural steel channel base supports the insulators and the live parts, assuring a high-strength, rigid design. The center insulator stack rotates on weather-sealed, greaseless rotor bearings that require no maintenance.

PERFORMANCE

Contact pressure is applied to the reverse loop copper jaw fingers by stainless steel springs which are insulated at one end, eliminating any possibility of annealing the springs due to their carrying current. As current rises, jaw contact pressure is increased due to the reverse-loop finger design. Thanks to the specific design, magnetic forces due to fault currents tend to push the blade deeper into the jaw rather than out.

FLEXIBILITY

AREVA T&D experts are pleased to propose customized solutions: vertical, underhung and phase-over-phase solutions are available.

QUALITY

AREVA T&D designs, manufactures, tests and delivers its disconnect switches in accordance with the latest ANSI and IEC Standards, maintaining a quality assurance system according to ISO 9001 (2000) and ISO 14001.

OPTIONAL DEVICES

The S3C can be fitted with one or two ground switches. The following types of arc restrictors are also available: simple arcing horn, high performance bus transfer contacts (IEC62271-102 annex B), whip type interrupters (to handle line charging or ransformer magnetizing currents).

Customer Benefits

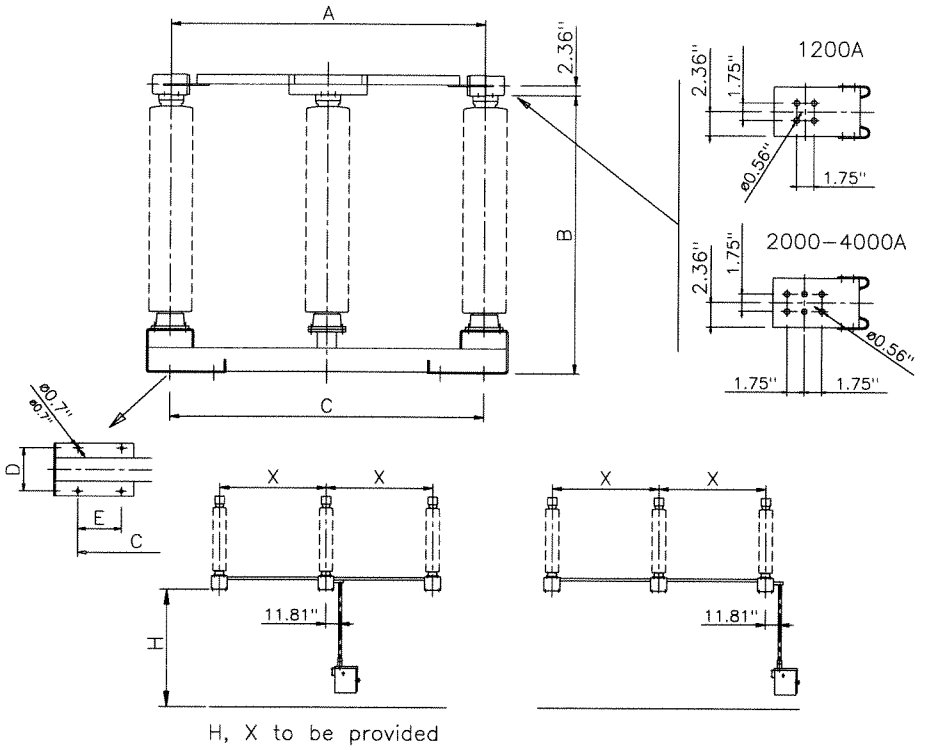
- Proven reliability
- High performance with reduced phase-to-phase distance
- ISO 9001 quality
- Built-in ground switches and arc restrictors available
- Virtually no maintenance
- Easy start-up and commissioning

AREVA T&D

AREVA

INSTALLATION AND MAINTENANCE

The S3C is recognized worldwide as being easy to install and adjust with no special tools required. Both the disconnect switches and ground switches are pre-assembled, adjusted and tested as completely as possible. The S3C is virtually maintenance free, thanks to lifetime greased or self-lubricated parts, self-wiping contacts and the use of corrosion-free materials.



Customized layouts available upon request. Phase-to-phase distance defined by substation layout

Technical Data (ANSI)							
Rated Voltage	Rated Current	Short time current	BIL	A	B	C	D
kV	up to Amps	up to kA	kV	inches	inches	inches	inches
72.5	3150	50	350	39.37	42.99	39.37	8.66
123	3150	50	550	59.06	57.99	59.06	8.66
145	3150	50	650	70.87	67.80	70.87	10.63
170	3150	50	750	78.74	75.79	78.74	10.63
245	3150	50	1050	110.24	105.79	110.24	13.39

*IEC ratings also available

AREVA T&D Worldwide Contact Center
http://www.areva-td.com/contactcentre/
Tel: +44 (0) 1785 250 070

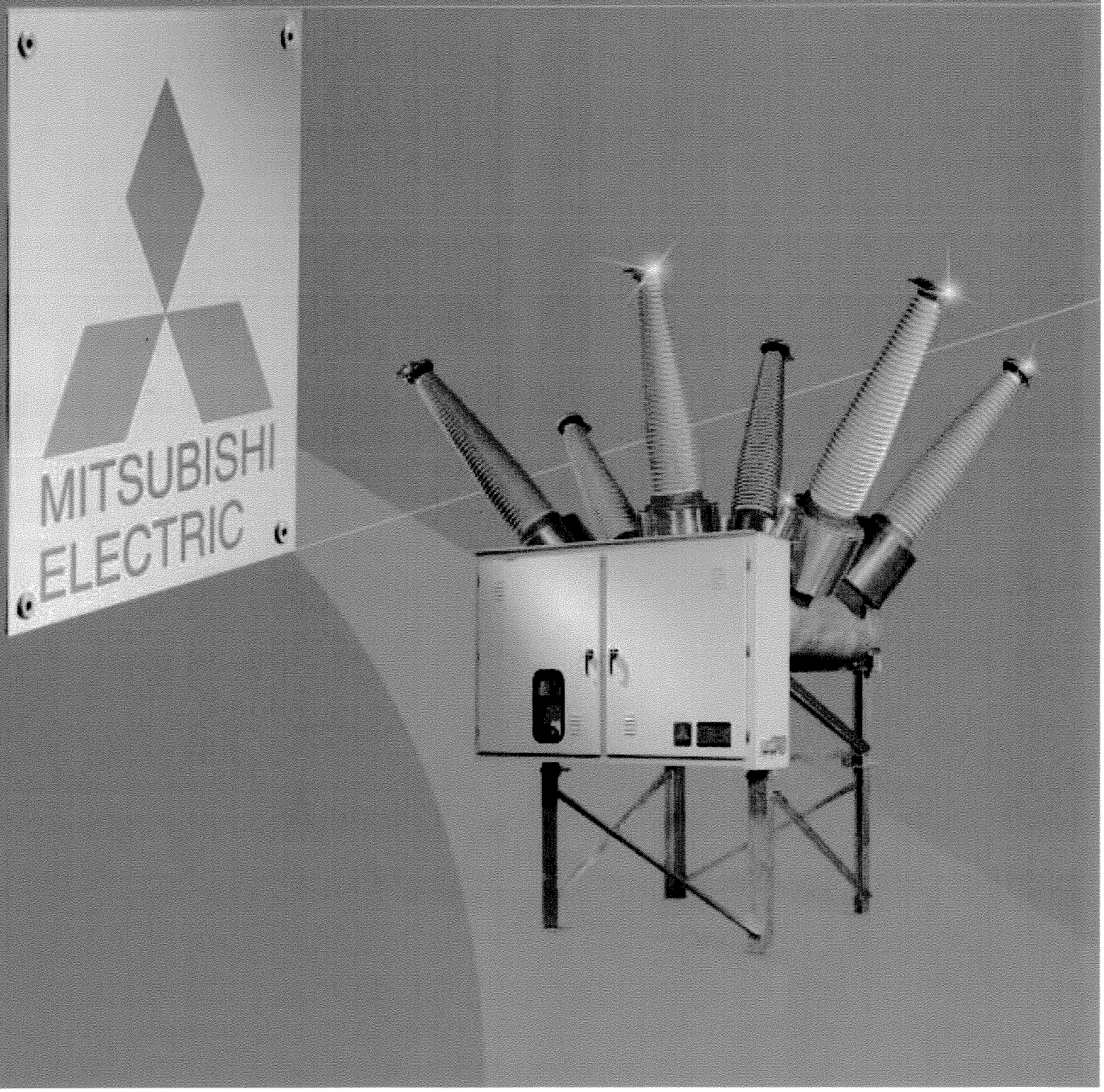
AREVA T&D North America Contact Center
1-888-AREVA TD (273 8283)
customer.care.usa@areva-td.com
www.areva-td.com

MITSUBISHI ELECTRIC
POWER PRODUCTS, INC.

SF_6 CIRCUIT BREAKER

DEAD TANK TYPE

MODEL: 200-SFMT-40E
200-SFMT-50F
200-SFMT-63F



Introduction

Mitsubishi Electric Power Products, Inc. is an affiliate of Mitsubishi Electric Corporation.

Factory

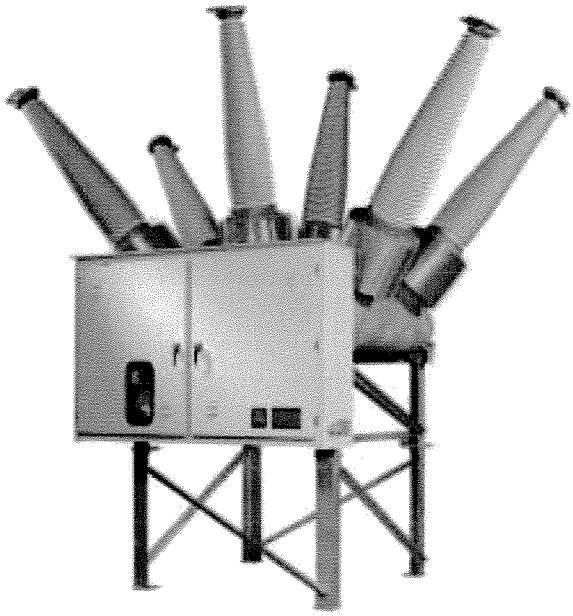
Mitsubishi Electric Power Products Manufacturing facility is located in Warrendale, Pennsylvania, a suburb of Pittsburgh. This location also serves as the center for product service and training.

Evolutionary Design

Thousands of SFMT breakers rated at transmission voltages through 1100kV have been installed and are operating reliably on T&D systems worldwide. Introduced in 1974, the design is based on proven engineering principals and extensive development and testing.

The SFMT features gang-operated, isolated phase dead tanks supported by a galvanized steel frame. Each tank houses a single-break puffer interrupter and supports two porcelain or composite bushings. The tanks and bushings are pressurized with SF_6 gas.

The frame also supports the control cabinet. It houses a spring-type operating mechanism, interphase linkages and the control circuits.



TYPE	200-SFMT-40E	200-SFMT-50F	200-SFMT-63F
Voltage (max kV)	245	245	245
BIL (kV Crest)	900	900	900
60 Hz withstand (kV)	425	425	425
Continuous Current (A)	1200 / 2000 / 3000	1200 / 2000 / 3000	1200 / 2000 / 3000
Interrupting Current (kA)	40	50	63
Interrupting Time (cycles)	2 / 3	2 / 3	2 / 3
Total Weight (lbs / kgs)	11,434 / 5,197	11,434 / 5,197	11,434 / 5,197
Weight of SF_6 (lbs / kgs)	126 / 57	186 / 84.4	201 / 91.4

Revolutionary Performance

The SFMT reflects Mitsubishi Electric's commitment to supply power circuit breakers with extended service lives, and that meet or exceed the most demanding specifications for interrupting, insulating, and current-carrying capabilities. The design and performance of all breakers are fully verified in accordance with the procedures of ANSI C37 and IEC 62271-100, and by procedures at Mitsubishi's laboratories that subject the breakers to conditions that are considerably more comprehensive and severe.

These procedures have confirmed the safety and ruggedness of Mitsubishi breakers. For example, tests confirm Mitsubishi breakers withstand 10,000 mechanical operations and severe seismic forces, and that the breakers operate reliably in extremely low or high temperatures.

Users also report extraordinarily low cost of ownership based on exceptional reliability, application flexibility, safety, and ease of maintenance.

Features of the SFMT Design Insulation

- Dead Tank Construction
- Only SF_6 for Open Gap Insulation
- No Solid Insulation Bridging the Open Contacts
- Low Operating Pressure (72 psig @ 20°C) for 245kV, 40kA rating (85 psig @ 20°C) for 245kV, 50kA or 63kA ratings

Primary Electrical Parts/Interrupters

- True Puffer Interrupters
- Contacts Easily Accessible for Inspection and Changeout
- Verified Full Dielectric and Interrupting Rating at Lockout Pressure
- High Strength Porcelain or Composite Bushings
- Integral NEMA 4-hole bushing terminal

Application Flexibility

- Mechanically Tested and Verified to –50°C with tank heaters
- Definite Purpose Capacitive Current Switching Capability
- Reactor Switching Capability
- Tested and Verified for Seismic Applications
- Quiet Operation; Suitable for Urban Installations

Mechanical Operations

- Spring Type Operating Mechanism
- Energy Stored in Powerful Torsion Bars
- Universal Type Spring Charging Motor (AC/DC)
- Quick Spring Charging for O-CO-10 sec-CO Duty Cycle

Rapid Installation

- Bushings Shipped Installed
- Integral NEMA 4-Hole Bushing Terminals
- Complete Breaker Factory Assembled and Production Tested
- Lightweight to Minimize Foundation Size

Controls

- Space for Two or more BCTs per Bushing

Proof

- Tested and Verified for 90% Short Line

Fault

- Tested and Verified to Exceed ANSI and IEC Standards
- Verified in Environmental Test Lab
- Production Tested as a Fully Assembled Breaker

Options

- Tank Heaters for Low Temperature Applications
- High Altitude
- Composite Insulators

Features to Reduce Installation and Maintenance

All SFMT breakers are fully assembled, pressurized and tested to ANSI or IEC and Mitsubishi standards prior to shipment. Each breaker is shipped with 5 psig of SF_6 gas. Installation is completed rapidly and easily. Site work is limited to removing all packing, bolting the sub-frame to the foundation and bolting the breaker to the sub-frame. Then, using bottled SF_6 gas, the interrupter tanks and bushings are filled to operating pressure, and the control and power leads are connected. The breaker is then ready for final inspection and any field testing required by the user.

The torsion bar spring mechanism requires no maintenance over the life of the breaker.

Critical interrupter components (stationary and moving arcing contacts and nozzles) need only be inspected after 2000 operations at rated load current. The components are removed easily by simply unbolting the tank inspection cover. Unlike other designs, there are no interrupter valves, seal rings, solid insulation or screens to inspect.

Specification For Auxiliary Power Transformer Liquid Filled Transformers Data Sheet	Job No.: 120006	Spec. No.: ES-E412
	Item No.:	No. Req'd: 2
	Project: Solana	

Transformer Name Tag: APT1 and APT2 (ITEM 1)

Service [X] Outdoor [ ] Indoor

Cooling Type

[ ] Oil [X] Envirotemp FR3
[ ] ONAN (Self-cooled)
[ ] ONAN / ONAF (Self-cooled / Forced Air-cooled)
[ ] ONAN / ONAFF (ONAN with FA Provisions)
[ ] ONAN / ONAF / ODAF (Self-cooled / Forced Air-cooled / Forced Oil-cooled
[ ] KNAN / KNAFF (Self-cooled / FA Provisions)
[X] KNAN / KNAF (Self-cooled / FA Cooled)
Vendor shall optional price standard oil

Windings [ ] Mfg. Std. [X] Copper

	Primary	Secondary
Voltage (NOM)	245 kV	13,800 V
Bushing BIL (KV)	1050	110
Winding BIL (KV)	S+2	S+2
Standard	[ ]	[ ]
Delta	[X]	[ ]
Wye, Solidly Grd.	[ ]	[ ]
Wye, Resist. Grd.	[ ]	[X]

Impedance
[X] Standard 8 %
[ ] Special _____%;

Ratings (Three Phase/60 Hz) ✓
Max Rating is ~~60~~ 30 MVA of running/starting load
_____ KVA, 55°C Rise, KNAN
_____ KVA, 65°C Rise, KNAN
_____ KVA, 55/65°C Rise, KNAN / KNAFF
/ MVA, 55/65°C Rise, KNAN / KNAF
* - Vendor to provide standard frame design
Vendor to optionally price standard oil filled design

Primary Connections
Connecting Equipment 245 kV Substation
Connection Type
[X] Cable, TOP Entry, from above grade
[ ] Bus Duct
[ ] Throat
Bushing Type
[X] Cover
[ ] Sidewall

Stud Size Standard Nema 4 hole design
Connector ~~1000 AWG~~ 1600

Secondary Connections
Connecting Equipment ~~3,000~~ Amp NSB
Connection Type
[ ] Cable, _____ Entry, from above grade
[X] Bus Duct
[ ] Throat
Bushing Type
[X] Cover
[ ] Sidewall

Stud Size _____
Connector _____

Tap Changers

[X] No Load Tap Changer
No. of Taps 2.5 % Each, qty 4
[ ] Load Tap Changer (120V/1PH/60Hz)

[ ] Remote Auto/Off/Man PB/SW
[ ] Remote Status Lights
[ ] Remote Raise/Lower PB/SW
[ ] Remote Tap Ratio Indicator

No.	Date	Description	By	Chk'd	App'd	App'd
0	23 SEP 08	For Review	SDE			

Specification For Auxiliary Power Transformer Liquid Filled Transformers Data Sheet	Job No.: 120006	Spec. No.: ES-E412
	Item No.:	No. Req'd: 2
	Project: Solana	

Transformer Name Tag: APT1 and APT2

Losses (KW) – Vendor to provide

Load	Core	Winding	Total
50%	6	62.6	
75%	16.5	140.7	
100%	34	250	284

* Without Auxiliary losses

Bushing Current Transformers – See One Lines

Primary
[ ] 600 /5 Ratio
C800 Accuracy Class
Vendor to optional propose cost savings
Secondary
[ ] 3000 /5 Ratio
C800 Accuracy Class
Vendor to optional propose cost savings

Lightning Arrestors
Primary
[X] Station Type Metal Oxide Porcelain
[ ] Intermediate Type
Location

Secondary
[ ] Station Type
[ ] Intermediate Type
Location

Terminal Boxes
Primary [X] Air Filled [ ] Oil Filled
Entry [X] Top [ ] Bottom [ ] Side
Secondary [X] Air Filled [ ] Oil Filled
Entry [X] Top [ ] Bottom [ ] Side

Metering and Instrumentation

Main Tank

[X]Liquid Level Indicator With Low Level Contact
[X] Liquid Level Relay (Device 71Q-1)
[X] Liquid Temp. Indicator With Two High Temp Contacts For Fan Control And Alarm
[X] Vac. Press. Indicator
[X] Vac. Press. Alarm
[X] Winding Temp. Indicator
[X] Winding Temp. Relay (Device 49)
[ ] Fault Pressure Relay (Device 63FP)
[X] Digital Dissolved Gas Detection Meter

Accessories
[X] Sampling Device
[X] Handhole
[X] Pressure Relief Valve

Testing
(Per IEEE C57.12.90™ - 2006)
Short Circuit:
[ ] Perform Complete Test
[X] Certify Capability of Passing Test
[ ] Do Not Perform Test

Heat Run:
[X] Perform Complete Test
ANSI Test: [ ] Type 1 [X] Type 2
[ ] Certify Capability of Passing Test
[ ] Do Not Perform Test

No.	Date	Description	By	Chk'd	App'd	App'd
0	23 SEP 08	For Review	SDE			

ABENGOA

RFQ No.:

Specification For Auxiliary Power Transformer Liquid Filled Transformers Data Sheet	Job No.: 120006	Spec. No.: ES-E412
	Item No.:	No. Req'd: 2
	Project: Solana	

Transformer Name Tag: APT1 and APT2

Neutral Grounding Resistor

[X] Provided per Specification ES-E530
- [ ] Located in LV Compartment
- [ ] Mounted on Transformer

[ ] Provisions for Mounting only
- [ ] Located in LV Compartment
- [ ] Mounting on Transformer

Load Tap Changer Tank – Not applicable

[ ] Liquid Level Indicator
[ ] Liquid Level Alarm (Device 71Q-2)
[ ] Fault Pressure Relay (63PF)
[ ] _____

Interrupter Switch – Not Applicable

[ ] Provide per Specification ES-E325

[ ] Air [ ] Liquid Filled
[ ] Fuse _____amps
Service
_____Volts/3ϕ/60 Hz _____KV BIL
Frame Size _____amps
Interrupting Capacity _____MVA

Operation
[ ] Manual [ ] Electrical

Mounting
[ ] HV Compartment
[ ] Separate Enclosure
[ ] Transition Section

[ ] Space Heater _____Watts

Incoming Connections - ____

Outgoing Connections - ____

Note: Auxiliary Power Transformers must be able to hand voltage variations of +/- 10%.

No.	Date	Description	By	Chk'd	App'd	App'd
0	23 SEP	For Review	SDE			

2

ABENCS

RFQ No.: Page 2 of 4

Specification For Main Power Transformer Liquid Filled Transformers Data Sheet	Job No.: 120006	Spec. No.: ES-E411
	Item No.:	No. Req'd: 2
	Project: Solana	

Transformer Name Tag: MPT1 and MPT2 ITEM 2

Service [X] Outdoor [ ] Indoor

Cooling Type

[ ] Oil [X] Envirotemp FR3
[ ] ONAN (Self-cooled)
[ ] ONAN / ONAF (Self-cooled / Forced Air-cooled)
[ ] ONAN / ONAFF (ONAN with FA Provisions)
[ ] ONAN / ONAF / ODAF (Self-cooled / Forced Air-cooled / Forced Oil-cooled
[ ] KNAN / KNAFF (Self-cooled / FA Provisions)
[X] KNAN / KNAF (Self-cooled / FA Cooled)
Vendor shall optional price standard oil

Windings [ ] Mfg. Std. [X] Copper

	Primary	Secondary
Voltage (NOM)	245 kV	13,800 V
Bushing BIL (KV)	1050	110
Winding BIL (KV)	S+2	S+2
Standard	[ ]	[ ]
Delta	[ ]	[X]
Wye, Solidly Grd.	[X]	[ ]
Wye, Resist. Grd.	[ ]	[ ]

Impedance
[X] Standard 8 %
[X] Special 14 %; Optionally price

Ratings (Three Phase/60 Hz)
Maximum Rating of Generator is 168.4 MVA MW
_____ KVA, 55°C Rise, KNAN
_____ KVA, 65°C Rise, KNAN
_____ KVA, 55/65°C Rise, KNAN / KNAFF
/ MVA, 55/65°C Rise, KNAN / KNAF
* - Vendor to provide standard frame design
Vendor to optionally price standard oil filled design

Primary Connections
Connecting Equipment 245 kV Substation
Connection Type
[X] Cable, TOP Entry, from above grade
[ ] Bus Duct
[ ] Throat
Bushing Type
[X] Cover
[ ] Sidewall

Stud Size Standard Nema 4 hole design
Connector 1000 AWG

Secondary Connections

Connecting Equipment 8,000 Amp IPB
Connection Type
[ ] Cable, _____ Entry, from above grade
[X] Bus Duct
[ ] Throat
Bushing Type
[X] Cover
[ ] Sidewall

Stud Size _____
Connector _____

Tap Changers

[X] No Load Tap Changer
No. of Taps 2.5 % Each, qty 4
[ ] Load Tap Changer (120V/1PH/60Hz)

[ ] Remote Auto/Off/Man PB/SW
[ ] Remote Status Lights
[ ] Remote Raise/Lower PB/SW
[ ] Remote Tap Ratio Indicator

No.	Date	Description	By	Chk'd	App'd	App'd
0	23 SEP 08	For Review	SDE			

Specification For Main Power Transformer Liquid Filled Transformers Data Sheet	Job No.: 120006	Spec. No.: ES-E411
	Item No.:	No. Req'd: 2
	Project: Solana	

Transformer Name Tag: MPT1 and MPT2

Losses (KW) – Vendor to provide

Load	Core	Winding	Total
50%	29	136.3	
75%	42.8	306.6	
100%	89	545	634

* Without Auxiliary losses

Bushing Current Transformers – See One Lines

Primary
[ ] 600 /5 Ratio
C800 Accuracy Class
Vendor to optional propose cost savings

Secondary
[ ] 8000 /5 Ratio
C800 Accuracy Class
Vendor to optional propose cost savings

Lightning Arrestors

Primary
[X] Station Type Metal Oxide Porcelain
[ ] Intermediate Type
Location

Secondary
[ ] Station Type
[ ] Intermediate Type
Location

Terminal Boxes

Primary [X] Air Filled [ ] Oil Filled
Entry [X] Top [ ] Bottom [ ] Side
Secondary [X] Air Filled [ ] Oil Filled
Entry [X] Top [ ] Bottom [ ] Side

Metering and Instrumentation

Main Tank

[X] Liquid Level Indicator With Low Level Contact
[X] Liquid Level Relay (Device 71Q-1)
[X] Liquid Temp. Indicator With Two High Temp Contacts For Fan Control And Alarm
[X] Vac. Press. Indicator
[X] Vac. Press. Alarm
[X] Winding Temp. Indicator
[X] Winding Temp. Relay (Device 49)
[ ] Fault Pressure Relay (Device 63FP)
[X] Digital Dissolved Gas Detection Meter

Accessories
[X] Sampling Device
[X] Handhole
[X] Pressure Relief Valve

Testing
(Per IEEE C57.12.90™ - 2006)
Short Circuit:
[X] Perform Complete Test
[ ] Certify Capability of Passing Test
[ ] Do Not Perform Test

Heat Run:
[X] Perform Complete Test
ANSI Test: [ ] Type 1 [X] Type 2
[ ] Certify Capability of Passing Test
[ ] Do Not Perform Test

No.	Date	Description	By	Chk'd	App'd	App'd
0	23 SEP 08	For Review	SDE			

Specification For Main Power Transformer Liquid Filled Transformers Data Sheet	Job No.: 120006	Spec. No.: ES-E411
	Item No.:	No. Req'd: 2
	Project: Solana	

Transformer Name Tag: MPT1 and MPT2

Neutral Grounding Resistor – Not Applicable

[ ] Provided per Specification ES-E530
[ ] Located in LV Compartment
[ ] Mounted on Transformer

[ ] Provisions for Mounting only
[ ] Located in LV Compartment
[ ] Mounting on Transformer

Load Tap Changer Tank – Not applicable

[ ] Liquid Level Indicator
[ ] Liquid Level Relay (Device 71Q-2)
[ ] Fault Pressure Relay (63P)
[ ] _____

Interrupter Switch – Not Applicable

[ ] Provide per Specification ES-E325

[ ] Air [ ] Liquid Filled
[ ] Fuse _____amps
Service
_____Volts/3ϕ/60 Hz _____KV BIL
Frame Size _____amps
Interrupting Capacity _____MVA

Operation
[ ] Manual [ ] Electrical

Mounting
[ ] HV Compartment.
[ ] Separate Enclosure
[ ] Transition Section

[ ] Space Heater _____Watts

Incoming Connections - ____
_____

Outgoing Connections - ____
_____

Note: Main Power Transformers must be able to hand voltage variations of +/- 5% on a 13.8 kV basis from a commercial power transformer.

C	23 S...	...for Review	SDE		
B					
N		Description	By	Chk'd	App'd	App'd

SIEMENS

ANSIFORM

SIEMENS **PROPOSAL Nº** **08-890A**

Manufacture plant: Siemens Andina Transformers - Bogota Colombia **DATE** **01/20/2009**

POWER TRANSFORMER PERFORMANCE SPECIFICATION

FOR **SOLANA GENERATING STATION - APT1 y 2** **ITEM NO.** 1

SPECIFICATION NO. ES - E412 Z = 8% a OA

Type Step Down	**Cooling**	**H Winding**		**X Winding**		**Y Winding**	
3 Limbs- Core	Core Type	kV	245	kV	13.8	kV	0
3 Phase	OA	MVA	32.1	MVA	32.1	MVA	
60 Hertz	FA	MVA	42.8	MVA	42.8	MVA	
55/65 °C. Temp Rise	FA	MVA	53.7	MVA	53.7	MVA	
Temp(°C), mn/Av/mx -10/30/40							

ADDITIONAL APPROXIMATE VOLTAGES

H Winding	+/- 2 @2.5% DETC FC
X Winding	(none)
Y Winding	(none)

CONNECTIONS FOR OPERATION

Transf. in Bank	**To Transform From**	**Connected**	**To Transform to**	**Connected**
1	245 KV, 3 Phase	delta	13.8 KV, 3 Phase	grd. wye

DIELECTRIC TESTS

Applied Voltage (to other windings & ground)	
H Winding (kV)	Per ANSI
X Winding (kV)	
Y Winding (kV)	

Induced Voltage (phase-ground)	
One-hour level (kV)	Per ANSI
Enhancement level (kV)	

BASIC IMPULSE LEVEL		**IMPEDANCE VOLTS (Percent)**	**PERFORMANCE DATA LOADING**			
	(Bush / Wind.)					
H Line kV	1050/1050	H to X % 8 (245 / 13.8 KV) at 32.1 MVA	H Winding kV	245	MVA	32.1
H Neutral kV			X Winding kV	14	MVA	32.1
X Line kV	110/110		Y Winding kV		MVA	
X Neutral kV	110/110					
Y Line kV						

SOUND LEVEL dB(A)	Per NEMA

AUXILIARY LOSS (kW)	FA: 3.63; FA: 3.63; Total: 7.26

PERFORMANCE DATA

Excitation	**Exciting Current**		**No-Load Loss**		**Total Loss**		**Percent Regulation**	
100% V	(%)	0.159	(kW)	34	(kW)	284	100% PF	80% PF
110% V	(%)	0.538	(kW)	48	@60 MVA. 245 / 13.8		1.5338	9.987
Exciting current at 32.1 MVA					KV. 85 °C			

APPROXIMATE DIMENSIONS (inches). WEIGHTS (pounds); Not for construction purposes

Outline Drawing No. SAT		E2009 - 016	
Height Overall	A	310	Shipping
Length / Depth	B	390	230
Width	C	182	123
Height over Case	D	150	150
Untanking Height		299	+ slings

Core and Coils	85360
Case and Fittings	49500
Oil (9194 Gals.)	67100
Total Weight	201960
Shipping (heaviest piece)	123123
Shipped in dry air or nitrogen	

Remarks: Liquid preservation System with Conservator Diaphragm Tank - -

SIEMENS

ANSIFORM

SIEMENS **PROPOSAL Nº** **08-890A**

Manufacture plant: Siemens Andina Transformers - Bogota Colombia **DATE** **01/20/2009**

POWER TRANSFORMER PERFORMANCE SPECIFICATION

FOR **SOLANA GENERATING STATION - MPT1** **ITEM NO.** 2

SPECIFICATION NO. ES - E411 Z = 8% a OA

Type	Step Up	Cooling	H Winding		X Winding		Y Winding	
3 Limbs- Core		Core Type	kV	245	kV	13.8	kV	0
3 Phase		OA	MVA	96.4	MVA	96.4	MVA	
60 Hertz		FA	MVA	128.5	MVA	128.5	MVA	
55/65 °C. Temp Rise		FA	MVA	160.7	MVA	160.7	MVA	
Temp(°C). mn/Av/mx	-10/30/40							

ADDITIONAL APPROXIMATE VOLTAGES

H Winding	+/- 2 @2.5% DETC FC
X Winding	(none)
Y Winding	(none)

CONNECTIONS FOR OPERATION

Transf. in Bank	To Transform From	Connected	To Transform to	Connected
1	13.8 KV. 3 Phase	delta	245 KV, 3 Phase	grd. wye

DIELECTRIC TESTS

Applied Voltage (to other windings & ground)	
H Winding (kV)	Per ANSI
X Winding (kV)	
Y Winding (kV)	

Induced Voltage (phase-ground)	
One-hour level (kV)	Per ANSI
Enhancement level (kV)	

BASIC IMPULSE LEVEL		IMPEDANCE VOLTS (Percent)	PERFORMANCE DATA LOADING			
	(Bush / Wind.)					
H Line kV	1050/1050	H to X % 8 (245 / 13.8 KV) at 96.4 MVA	H Winding kV	245	MVA	96.4
H Neutral kV	110/110		X Winding kV	14	MVA	96.4
X Line kV	110/110		Y Winding kV		MVA	
X Neutral kV						
Y Line kV						

SOUND LEVEL dB(A)	Per NEMA

AUXILIARY LOSS (kW)	FA: 8.58; FA: 8.58; Total: 17.16

PERFORMANCE DATA

Excitation	Exciting Current		No-Load Loss		Total Loss		Percent Regulation	
100% V	(%)	0.1596	(kW)	89	(kW)	634	100% PF	80% PF
110% V	(%)	0.618	(kW)	132	@180 MVA. 245 / 13.8		1.418	9.895
Exciting current at 96.4 MVA					KV, 85 °C			

APPROXIMATE DIMENSIONS (inches). WEIGHTS (pounds); Not for construction purposes

Outline Drawing No. SAT		E2009 - 014	
Height Overall	A	324	Shipping
Length / Depth	B	434	267
Width	C	244	138
Height over Case	D	150	150
Untanking Height		299	+ slings

Core and Coils	201740
Case and Fittings	82720
Oil (14029 Gals.)	102300
Total Weight	386760
Shipping (heaviest piece)	258284
Shipped in dry air or nitrogen	

Remarks: Liquid preservation System with Conservator Diaphragm Tank - -

SIEMENS
ANSIFORM

SIEMENS **PROPOSAL Nº** **08-890A**
Manufacture plant: Siemens Andina Transformers - Bogota Colombia **DATE** **01/20/2009**

POWER TRANSFORMER PERFORMANCE SPECIFICATION

FOR SOLANA GENERATING STATION - MPT2 **ITEM NO.** 3
SPECIFICATION NO. ES - E411 Z = 14% a OA

Type Step Up	**Cooling**	**H Winding**		**X Winding**		**Y Winding**	
3 Limbs- Core	Core Type	kV	245	kV	13.8	kV	0
3 Phase	OA	MVA	96.4	MVA	96.4	MVA	
60 Hertz	FA	MVA	128.5	MVA	128.5	MVA	
55/65 °C. Temp Rise	FA	MVA	160.7	MVA	160.7	MVA	
Temp(°C). mn/Av/mx -10/30/40							

ADDITIONAL APPROXIMATE VOLTAGES

H Winding	+/- 2 @2.5% DETC FC
X Winding	(none)
Y Winding	(none)

CONNECTIONS FOR OPERATION

Transf. in Bank	**To Transform From**	**Connected**	**To Transform to**	**Connected**
1	13.8 KV. 3 Phase	delta	245 KV, 3 Phase	grd. wye

DIELECTRIC TESTS

Applied Voltage (to other windings & ground)	
H Winding (kV)	Per ANSI
X Winding (kV)	
Y Winding (kV)	

Induced Voltage (phase-ground)	
One-hour level (kV)	Per ANSI
Enhancement level (kV)	

BASIC IMPULSE LEVEL		**IMPEDANCE VOLTS (Percent)**	**PERFORMANCE DATA LOADING**			
	(Bush / Wind.)					
H Line kV	1050/1050	H to X % 14 (245 / 13.8 KV) at 96.4 MVA	H Winding kV	245	MVA	96.4
H Neutral kV	110/110		X Winding kV	14	MVA	96.4
X Line kV	110/110		Y Winding kV		MVA	
X Neutral kV						
Y Line kV						

SOUND LEVEL dB(A)	Per NEMA

AUXILIARY LOSS (kW)	FA: 11.44; FA: 11.44; Total: 22.88

PERFORMANCE DATA

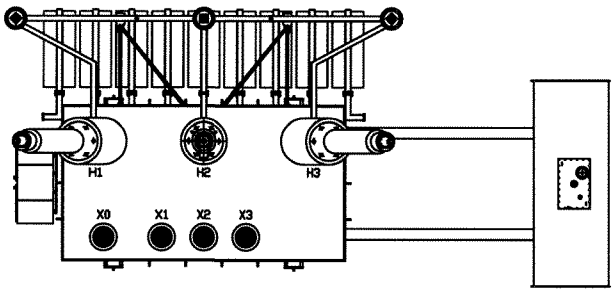
Excitation	**Exciting Current**		**No-Load Loss**		**Total Loss**		**Percent Regulation**	
100% V	(%)	0.1204	(kW)	66	(kW)	766	100% PF	80% PF
110% V	(%)	0.478	(kW)	99	@180 MVA. 245 / 13.8		3.8049	18.1317
Exciting current at 96.4 MVA					KV, 85 °C			

APPROXIMATE DIMENSIONS (inches). WEIGHTS (pounds); Not for construction purposes

Outline Drawing No. SAT		E2009 - 015	
Height Overall	A	324	Shipping
Length / Depth	B	434	268
Width	C	244	138
Height over Case	D	150	150
Untanking Height		299	+ slings

Core and Coils	174020
Case and Fittings	88220
Oil (14003 Gals.)	102080
Total Weight	364320
Shipping (heaviest piece)	230234
Shipped in dry air or nitrogen	

Remarks: Liquid preservation System with Conservator Diaphragm Tank - -



PRELIMINARY SKETCH

CLIENT: ABENER ENGINEERING-SOLANA

THREE PHASE POWER TRANSFORMER
POWER ..... 32.1/40.0/53.7 MVA
NOMINAL VOLTAGE ..... 245(NLTC±2x2.5%)/13.8 KV
PHASE DISPLACEMENT Dyn1
FREQUENCY ..... 60 Hz
COOLING ONAN/ONAF1/ONAF2

APROXIMATE WEIGHT (Lb.)
OIL ..... 67100 (9194 Gals.)
CORE AND COILS 85360
TOTAL WEIGHT 201960
SHIPPING WEIGHT 123123

ALTITUDE 1000 masl

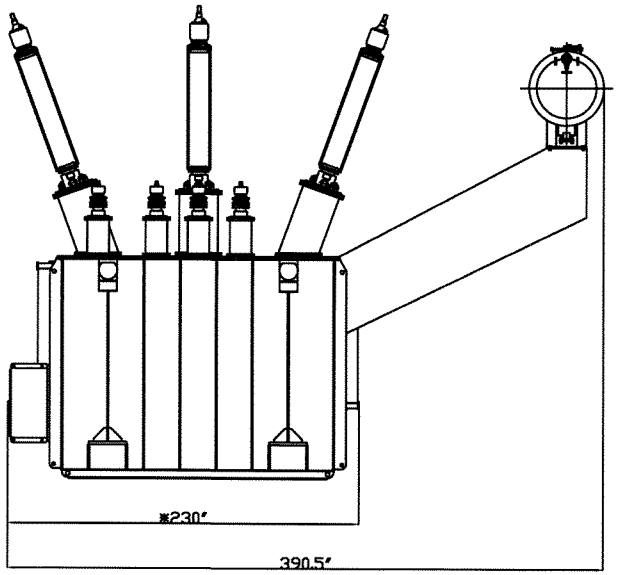
NOTE:

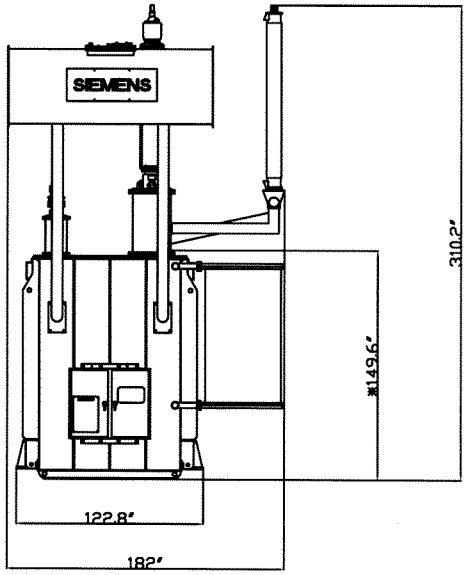
THIS DRAWING IS A PRELIMINARY PROPOSAL AND DOES NOT INDICATE THE EXACT DETAILS OF CONSTRUCTION, ARRANGEMENT OF ACCESSORIES OR THE FINAL DIMENSIONS OF THE TRANSFORMER. THIS INFORMATION SHOULD NOT BE USED FOR FINAL CONSTRUCTION ARRANGEMENTS OR FOR THE FOUNDATION UNLESS SPECIFICALLY APPROVED BY THE FACTORY. ALL DIMENSIONS, WEIGHTS AND VOLUMES ARE APPROXIMATE.

TOLERANCE ±10%

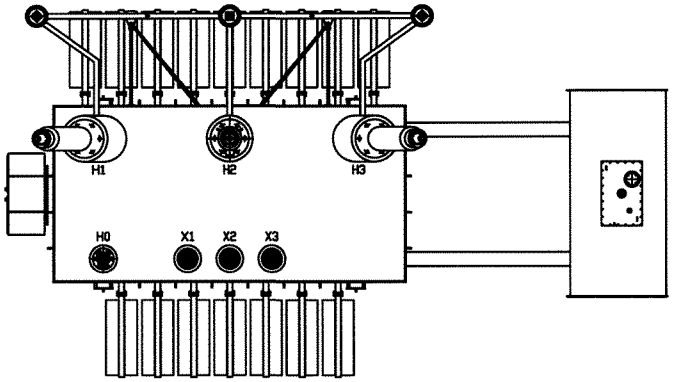
* : SHIPPING DIMENSION
DIMENSION IN INCHES

APT182





Date 16/01/2009	Approved by ARCINIEGAS	Change	
Group PTD-TPD		Name PRELIMINARY SKETCH	Tolerances Unnamed ± 10%
Made By CALDERON / Checked by CASTELLANOS		Client ABENER ENGINEERING-SOLANA	Sc.
SIEMENS	SAT	PA Dwg. N°. ED9-016	Sh N° 1/1



PRELIMINARY SKETCH

CLIENT: ABENER ENGINEERING-SOLANA

THREE PHASE POWER TRANSFORMER

POWER	96.4/128.5/160.7 MVA
NOMINAL VOLTAGE	245(MTC±2x2.5%)/13.8 KV
PHASE DISPLACEMENT	YNd1
FREQUENCY	60 Hz
COOLING	ONAN/ONAF1/ONAF2

APROXIMATE WEIGHT (Lb.)

OIL	102300 (14029 Gals.)
CORE AND COILS	201740
TOTAL WEIGHT	386760
SHIPPING WEIGHT	258284

ALTITUDE 1000 masl

NOTE:

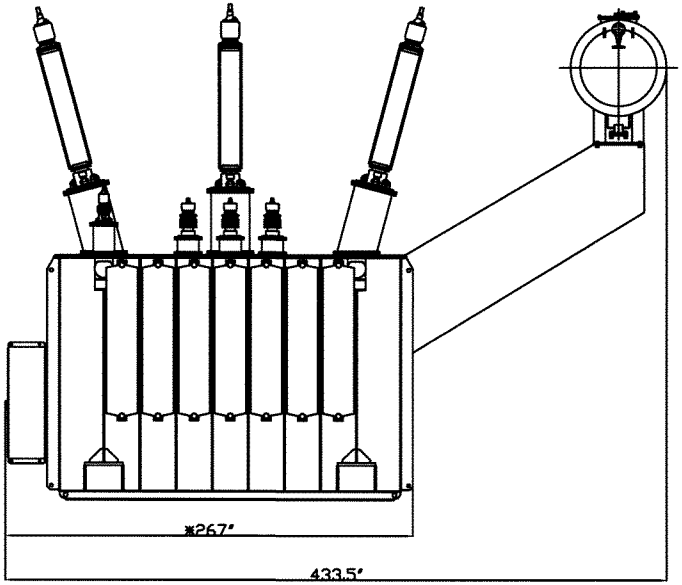
THIS DRAWING IS A PRELIMINARY PROPOSAL AND DOES NOT INCLUDE THE EXACT DETAILS OF CONSTRUCTION, ARRANGEMENT OF ACCESSORIES OR THE FINAL DIMENSIONS OF THE TRANSFORMER. THIS INFORMATION SHOULD NOT BE USED FOR FINAL CONSTRUCTION ARRANGEMENTS OR FOR THE FOUNDATION UNLESS SPECIFICALLY APPROVED BY THE FACTORY. ALL DIMENSIONS, WEIGHTS AND VOLUMES ARE APPROXIMATE.

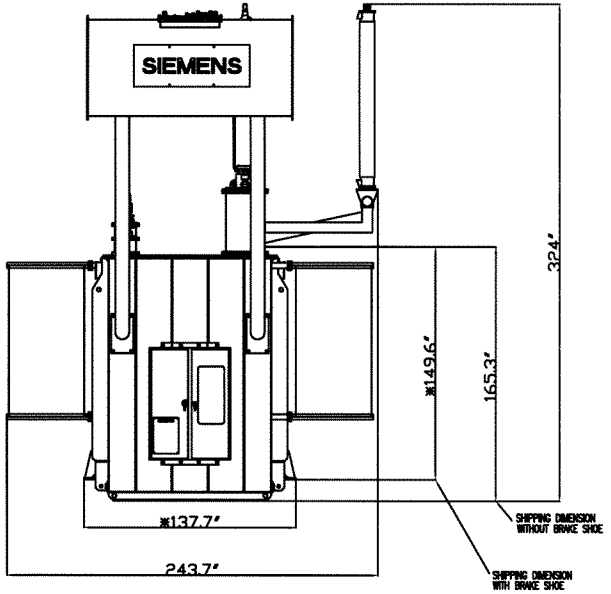
TOLERANCE ±10%.

* : SHIPPING DIMENSION

DIMENSION IN INCHES

MPT 1/2





Date 15/01/2009	Approved by ARCINIEGAS	Change	
Group PTD-TPD			
Made By CALDERON / Checked by CASTELLANOS		Name PRELIMINARY SKETCH	Tolerances General ± 10%
SIEMENS	SAT	Client ABENER ENGINEERING-SOLANA	Sh. 1
		PA Dwg. N°. E09-014	Rev. N° 1/1