

UltraSIL Polymer-Housed VariSTAR Type UI Intermediate-Class Surge Arresters

GENERAL

Cooper Power Systems has set a new standard of excellence for polymer-housed intermediate-class surge arresters. The UltraSIL™ Housed VariSTAR™ Type UI Intermediate-Class Arresters incorporate the industry recognized superior silicone rubber housing. This housing is applied over a gapless MOV internal design.

Cooper Power Systems Type UI Arresters have passed the IEEE Std C62.11 – 2005™ standard test requirements.

TABLE 1
UltraSIL (UI) Intermediate-Class Ratings and Characteristics

Arrester Characteristic	Rating	
Arrester Voltage Ratings (kV)	3-108	
Rated Discharge Energy (kJ/kV of MCOV)	Single Impulse Rating	Double Impulse Rating*
UI (3-108 kV)	3.4	5.5
System Frequency (Hz)	50/60	
Impulse Classifying Current (kA)	10	
High Current withstand** (kA)	100	
Pressure Relief Rating,*** kA rms sym.	40	
Cantilever Strength (in-lbs)	Ultimate	MDCL Static†
UI (3-108 kV)	10,000	4,000

* Double Impulse Rating assumes a two shot energy discharge within one minute.

** High current, short duration withstand within one minute (100 kA, 4/10 µs).

*** Cubicle Mount Pressure Relief Rating is 40 kA rms sym.

† Maximum design cantilever load-static or maximum working load is 40% of the ultimate.



Figure 1.
60 kV UltraSIL Housed VariSTAR Type UI Intermediate-Class Surge Arrester.

CONSTRUCTION

The unique construction of UltraSIL Housed Intermediate-Class Arresters begins with world class Metal Oxide Varistor (MOV) disks produced at our dedicated manufacturing facility in Olean, NY. By manufacturing our own disks we maintain a strict quality control over the entire production process, from initial raw material inspections to final physical and electrical testing of each disk. In addition, by controlling the manufacturing process of both disks and arresters, we achieve the optimal combination. Cooper Power Systems produces MOV disks of

unsurpassed quality through continuous improvements in disk formulation and manufacturing technology. The end result is a long history of in-service use with outstanding durability and protective capability.

Arrester production begins by stacking glass-collared MOV disks in series with aluminum end electrodes. Our proprietary process wraps the assembly with a high-strength woven fiberglass-reinforced epoxy composite. When cured, the arrester module is capable of withstanding extreme electrical and cantilever loading conditions.

The UltraSIL silicone rubber housing utilizes an interference fit and is bonded onto the internal module to form a solid, void free, high-dielectric strength insulation system. Once the housing is in place, each arrester must pass a strict series of electrical tests to insure the highest level of in-service performance.

The silicone rubber housing results in lighter weight than similarly rated porcelain housed arresters. The silicone rubber housing is also less sensitive to physical damage than porcelain.

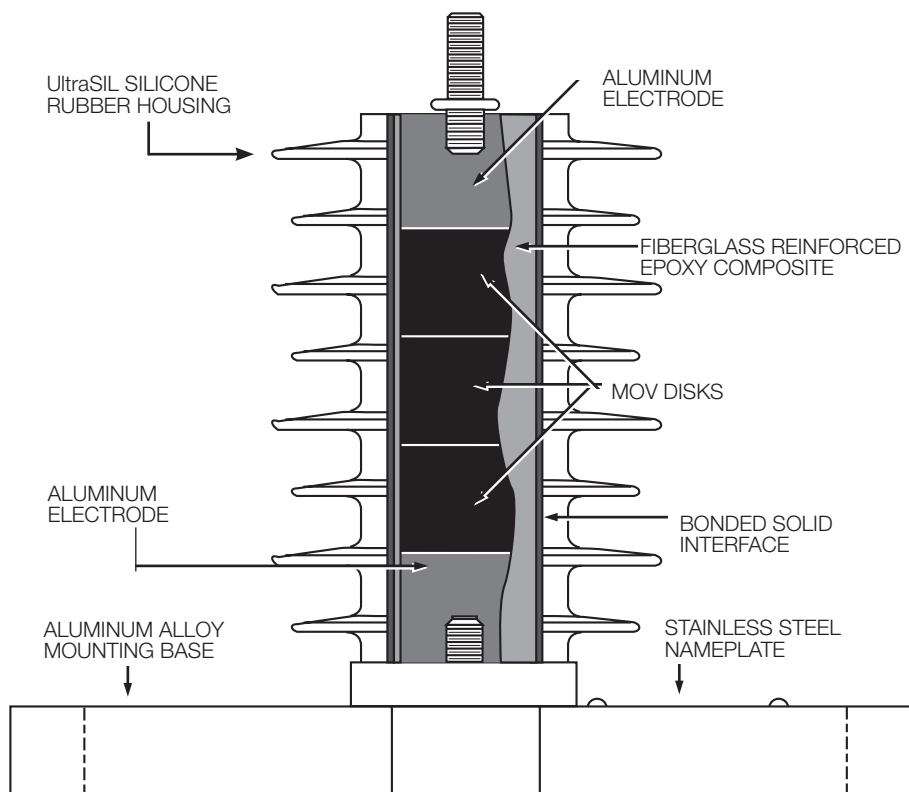


Figure 2.
Cutaway illustration of 10 kV UltraSIL Housed VariSTAR Intermediate-Class Arrester.

FEATURES

The UltraSIL silicone rubber housing was selected for its superior insulation performance when compared to other polymeric housing materials. Long term environmental testing has verified the lifetime performance advantage silicone rubber provides.

Independent laboratory tests have verified the superior water repellent behavior of silicone rubber, which is responsible for the lower external power losses, higher resistance to UV degradation and surface tracking, superior performance in contaminated environments, and other important insulating properties. Also, UltraSIL silicone rubber has been proven not to support biological growth and is non-flammable.

The basic silicone rubber housed arrester can be customized with a variety of terminal and mounting options which allow users to select the features that meet their application needs. Customers who require longer creepage housings can easily select a different housing option through the catalog numbering system. See pages 6-7 for a complete list of available options.

OPERATION

The operation of the VariSTAR Type UI Intermediate-Class Arrester is typical of gapless metal oxide arresters. During steady-state conditions, line-to-ground voltage is applied continuously between the line and ground terminals of the arrester. When surges occur, the arrester immediately limits, or clamps, the overvoltage condition by conducting the surge current to ground. After passage of the surge, the arrester returns to its initial state, conducting minimal leakage current. This minimal leakage current (which is primarily capacitive, with a small resistive component) can be tolerated on a continuing basis.

The UltraSIL Polymer-Housed Intermediate-Class Type UI Arrester easily surpasses the minimum fault current withstand requirements for intermediate-class arresters as defined in IEEE Std C62.11™ standard (16.1 kA). These arresters have been tested and shown to withstand fault currents exceeding 40 kA. During these tests, the silicone rubber housing ruptures without expelling internal parts.

Type UI arresters are ideal for protection against repeated high

energy switching surges and provide reliable protection for substation equipment, capacitor banks, multiple lines, and cable circuits. They are also ideal for applications where lighter weight and shorter heights (when compared to porcelain housed arresters) are critical.

DESIGN TESTING

The housing, internal components, and hardware of an arrester must work together as a system. This system must stand up to years of service while being subjected to a wide range of environmental and electrical stresses. To assure a superior level of performance, both arrester components and finished arresters have been subjected to a series of tests that accurately represents years of exposure to actual field conditions. This testing far exceeds the requirements of industry standards.

The Type UI arrester has also met or exceeded all requirements for Intermediate-Class arresters as defined by IEEE Std C62.11™ standard. A certified test report is available upon request. For a copy, please order Cooper Power Systems document CP9730.

PRODUCTION TESTS

Cooper Power Systems has implemented a complete production test program to ensure a quality product. Each MOV disk is subjected to a series of electrical tests to maintain quality. We also perform additional tests on every MOV disk batch. Listed below are the tests performed on the MOV disks:

- 100% Physical Inspection
- 100% Discharge Voltage Test
- 100% V_{ref} at 6 mA
- 100% Watt Loss Measured at 1.05 x MCOV
- 100% Transmission Line Discharge Energy Test
- Batch High-Current, Short-Duration Test
- Batch Thermal Stability Test
- Batch Aging Test

Each fully assembled UltraSIL Housed Intermediate-Class Arrester also must pass the following production tests:

- 100% Physical Inspection
- 100% V_{ref} Test
- 100% Watt Loss Test
- 100% Partial Discharge Inception Voltage Test

GENERAL APPLICATION RECOMMENDATIONS

The rating of an arrester is the maximum power-frequency line-to-ground voltage at which the arrester is designed to pass an operating duty-cycle test (as defined in IEEE Std C62.11™ standard). Table 2 provides a general application guide for the selection of the proper arrester rating for a given system voltage and grounding configurations as outlined in IEEE Std C62.22™ standard, which is the application guide for metal oxide surge arresters.

Under fault conditions and other system anomalies, higher than normal voltages can be imposed upon an arrester. With an improper arrester selection, these abnormal system voltages can cause an arrester to fail. To help ensure that the proper arrester is selected, Cooper Power Systems application engineers are available to make recommendations. The following information is normally required:

1. Maximum system operating voltage.
2. System grounding conditions;
 - A. For four-wire circuits, grounding conditions depend upon whether the system is multi-grounded, whether it has a neutral impedance and whether common primary and secondary neutrals are used.
 - B. For three-wire circuits, grounding conditions depend upon whether the system is solidly grounded at the source, grounded through neutral impedance at the source transformers or ungrounded.
3. Available Fault Current.
4. Maximum line-to-ground voltage and overvoltage duration during fault conditions.

Contact your Cooper representative to have your individual system application needs reviewed.

TEMPORARY OVERVOLTAGE (TOV) WITHSTAND ABILITY

The UltraSIL Polymer-Housed Intermediate-Class Arresters' ability to withstand 60 Hz overvoltage conditions (TOV's) is shown in Figure 3. The graph illustrates the time an arrester can survive such a voltage, and recover, without going into thermal runaway for a given voltage magnitude (expressed in Per Units of arrester MCOV).

TABLE 2
Recommended Arrester Applications for VariSTAR Intermediate-Class Arresters

System Voltage (kV rms)		Recommended Arrester Rating (MCOV) kV rms	
Nominal	Maximum	Three-Wire or Four-Wire Wye Solidly Grounded Neutral	Delta and Ungrounded Wye
2.4	2.52	3 (2.55)	3 (2.55)
4.16	4.37	3 (2.55)	6 (5.10)
4.8	5.04	–	6 (5.10)
6.9	7.25	6 (5.10)	9 (7.65)
8.32	8.74	6 (5.10)	9 (7.65) 10 (8.40)
12.0	12.7	9 (7.65) 10 (8.40)	12 (10.2) 15 (12.7)
12.47	13.2	9 (7.65) 10 (8.40)	15 (12.7) 18 (15.3)
13.2	13.97	10 (8.40) 12 (10.2)	15 (12.7) –
13.8	14.5	10 (8.40) 12 (10.2)	15 (12.7) 18 (15.3)
20.78	21.8	15 (12.7) 21 (17.0)	24 (19.5) 27 (22.0)
22.9	24.2	18 (15.3) 21 (17.0)	24 (19.5) –
24.9	26.4	18 (15.3) 21 (17.0)	24 (19.5) 27 (22.0)
34.5	36.5	27 (22.0) 30 (24.4)	36 (29.0) 39 (31.5)
46	48.3	36 (29.0) 39 (31.5)	48 (39.0) –
69	72	54 (42.0) 60 (48.0)	72 (57.0) –
115	121	90 (70.0) 96 (76.0)	108 (84.0) –
138	145	108 (84.0)	–

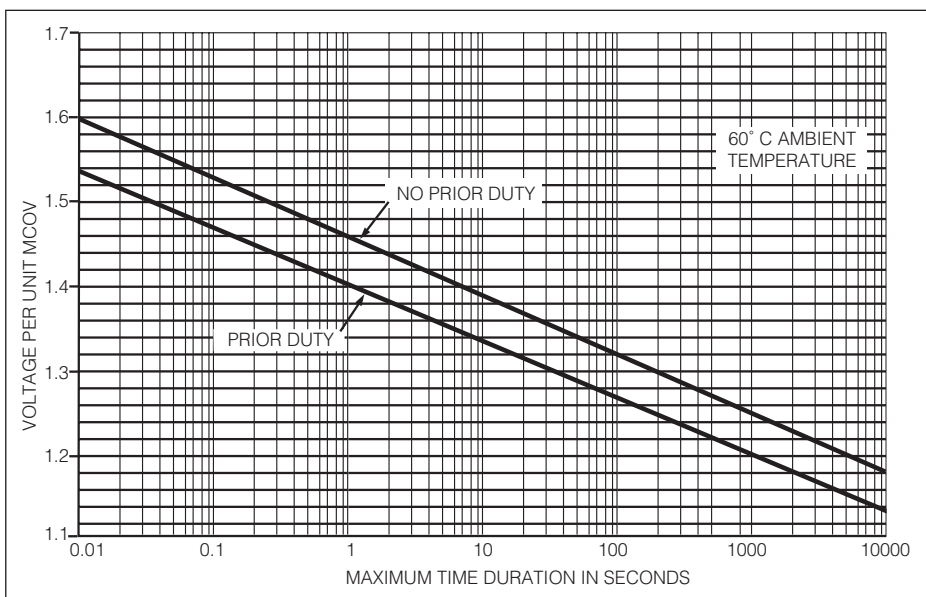


Figure 3.
Temporary overvoltage curve – 60° ambient temperature.

The graphs in Figure 3 show TOV withstand ability, with and without prior duty. The prior duty curve is based upon absorption of rated energy immediately

preceding application of the overvoltage which is 3.4 kJ/kV of MCOV.

**DIMENSIONS, WEIGHTS
AND SPACING
REQUIREMENTS**

Figure 4 illustrates a three-phase in-line mounting arrangement. Dimensions B and C reference minimum phase-to-ground and phase-to-phase distances respectively. These dimensions are listed in Table 3. Figure 5 shows an outline drawing of the standard UltraSIL housed Type UI Intermediate-Class arrester. The referenced dimension for all kV ratings are listed in Table 3. This table also includes the insulation withstand characteristics and weights for the Type UI arrester family.

ORDERING INFORMATION

Table 3 includes the standard catalog numbers for Type UI arresters. The arrester represented by the standard catalog number is configured with the connectors and mounting arrangement shown in Figure 5 (“31” in digits 11 and 12 of Table 5). Cooper Power Systems offers many other options that allow customers to select specific features they desire. Options on housing sizes, hardware and mounting options are available and defined in Table 5. This

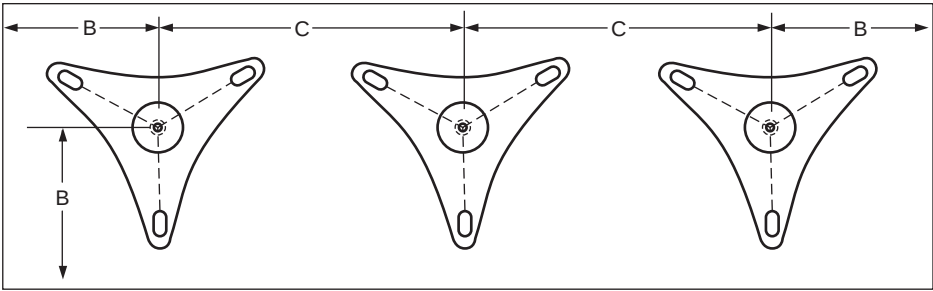


Figure 4.
Three-phase In-line mounting arrangement.

table allows customers who may prefer options different from those in our standard Figure 5 configuration to develop a catalog number which provides the unique features they desire. For additional assistance please contact your Cooper Power Systems sales representative.

**PROTECTIVE
CHARACTERISTICS**

All UltraSIL Polymer-Housed Intermediate-Class Arresters provide excellent overvoltage protection for electrical equipment. The specific protective characteristics for each arrester rating are shown on the next page in Table 4.

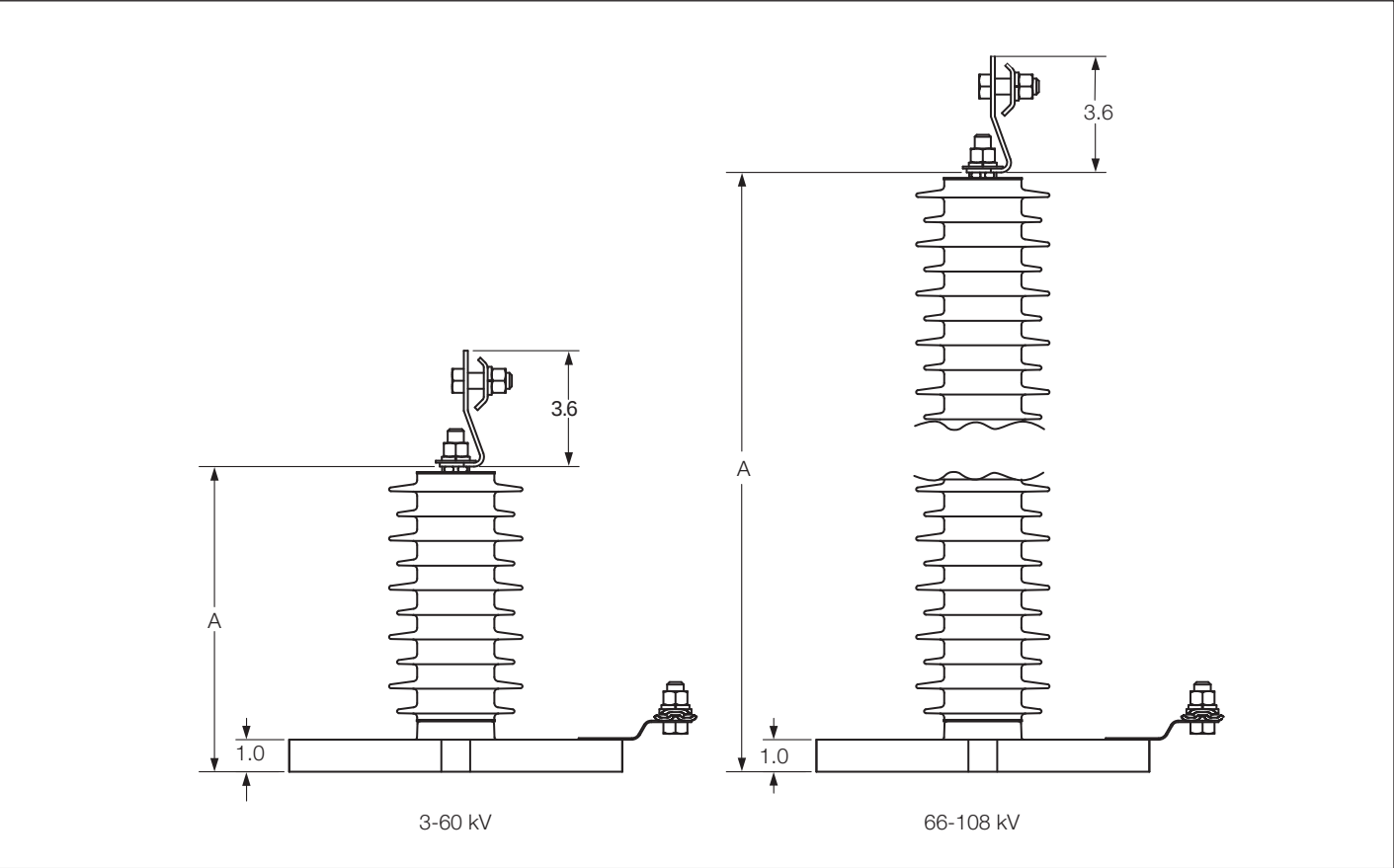


Figure 5.
Outline drawing of standard UltraSIL Polymer-Housed Intermediate-Class Arresters (for standard catalog numbers see Table 3).

TABLE 3

Catalog Numbers, Dimensions, Weights, Spacing Requirements and Insulation Withstand Levels of UltraSIL Polymer-Housed Intermediate-Class Arrester (Standard Configuration)

Arrester Rating (kV, rms)	Catalog Number	Figure 5 Dim. "A" (inches)	Figure 4 Dim. "B" Minimum Phase-to-Ground Clearance (inches)	Figure 4 Dim. "C" Minimum Phase-to-Phase Clearance (inches)	Creepage Distance (inches)	Insulation Withstand Voltages			Weight (lbs.)
						1.2/50 Impulse (kV, crest)	60 Hz, dry 60 seconds (kV, rms)	60 Hz, wet 10 seconds (kV, rms)	
3	UI003A	6.1	5.2	9.7	12.2	105	67	44	11.4
6	UI006A	6.1	5.4	9.9	12.2	105	67	44	11.7
9	UI009A	7.7	5.8	10.3	16.2	130	86	59	12.9
10	UI010A	7.7	6.0	10.5	16.2	130	86	59	12.9
12	UI012A	9.2	6.5	11.0	20.3	149	102	68	14.1
15	UI015A	10.7	7.3	11.8	24.3	171	115	81	15.2
18	UI018A	10.7	8.3	12.8	24.3	171	115	81	15.6
21	UI021A	10.7	9.0	13.5	24.3	171	115	81	15.6
24	UI024A	12.3	9.2	13.7	28.4	193	126	93	16.7
27	UI027A	13.8	10.1	14.6	32.4	214	136	105	17.9
30	UI030A	15.4	11.0	15.5	36.5	236	144	117	19.1
33	UI033A	15.4	12.2	16.7	36.5	236	144	117	19.4
36	UI036A	15.4	12.8	17.3	36.5	236	144	117	19.4
39	UI039A	16.9	13.8	18.3	40.5	255	151	124	20.6
42	UI042A	18.4	14.7	19.2	44.6	279	158	142	21.8
45	UI045A	18.4	15.6	20.1	44.6	279	158	142	22.0
48	UI048A	21.5	16.6	21.1	52.7	322	173	166	24.1
54	UI054A	21.5	17.7	22.2	52.7	322	173	166	24.4
60	UI060A	24.6	19.9	24.4	60.8	366	192	190	26.8
66	UI066A	30.8	21.9	26.4	77.0	491	295	241	33.9
72	UI072A	32.3	23.4	27.9	81.0	510	302	248	35.0
78	UI078A	33.8	25.3	29.8	85.1	534	309	266	36.6
84	UI084A	36.9	27.5	32.0	93.2	580	323	296	38.9
90	UI090A	36.9	28.3	32.8	93.2	580	323	296	39.5
96	UI096A	38.5	30.5	35.0	97.2	602	330	308	40.7
108	UI108A	43.1	33.5	38.0	109.4	666	355	344	44.2

TABLE 4

Protective Characteristics of the UltraSIL Polymer-Housed Intermediate-Class Arrester

Arrester Rating (kV rms)	Arrester MCOV (kV rms)	TOV* (kV rms)		Front-of-wave Protective Level** (kV Crest)	Maximum Discharge Voltage (kV crest) 8/20 μ s Current Wave						Switching Surge Protective Level*** (kV crest)
		1 sec	10 sec		1.5 kA	3 kA	5 kA	10 kA	20 kA	40 kA	
3	2.55	3.73	3.56	9.3	7.0	7.4	7.7	8.4	9.4	11.0	6.5
6	5.1	7.47	7.11	18.1	13.9	14.7	15.4	16.7	18.6	21.4	13.0
9	7.65	11.2	10.7	27.0	20.9	22.0	23.1	25.0	27.7	31.7	19.5
10	8.4	12.3	11.7	29.6	23.0	24.2	25.4	27.4	30.4	34.8	21.4
12	10.2	14.9	14.2	35.9	27.9	29.4	30.8	33.3	36.9	42.1	26.0
15	12.7	18.6	17.7	44.6	34.7	36.6	38.3	41.4	45.9	52.2	32.4
18	15.3	22.4	21.3	53.6	41.8	44.0	46.2	49.8	55.2	62.8	39.0
21	17.0	24.9	23.7	59.5	46.4	48.9	51.3	55.4	61.3	69.7	43.4
24	19.5	28.6	27.2	68.2	53.3	56.1	58.8	63.5	70.3	79.9	49.8
27	22.0	32.2	30.7	77.0	60.1	63.3	66.3	71.6	79.3	90.0	56.1
30	24.4	35.7	34.0	85.3	66.6	70.2	73.6	79.4	87.9	99.8	62.3
33	27.5	40.3	38.4	96.1	75.1	79.1	82.9	89.5	99.1	112	70.2
36	29.0	42.5	40.5	101	79.2	83.4	87.4	94.4	105	119	74.0
39	31.5	46.1	43.9	111	86.0	90.6	95.0	103	113	129	80.4
42	34.0	49.8	47.4	119	92.8	97.8	103	111	122	139	86.8
45	36.5	53.4	50.9	128	99.7	105	110	119	131	149	93.1
48	39.0	57.1	54.4	136	107	112	118	127	140	159	99.5
54	42.0	61.5	58.6	147	115	121	127	137	151	171	107
60	48.0	70.3	67.0	167	131	138	145	156	173	196	123
66	53.0	77.6	73.9	186	145	153	160	173	191	217	135
72	57.0	83.5	79.5	200	156	164	172	186	205	233	145
78	62.0	90.8	86.5	217	169	178	187	202	223	253	158
84	68.0	99.6	94.9	237	186	196	205	221	245	278	174
90	70.0	102.5	97.7	245	191	201	211	228	252	286	179
96	76.0	111.3	106.0	265	208	219	229	247	274	310	194
108	84.0	123.0	117.2	293	229	242	253	273	302	343	214

* Temporary overvoltage with prior duty energy surge.

** Based on a 10 kA current impulse that results in a discharge voltage cresting in 0.5 μ s.

*** 45-60 μ s rise time 500 A current surge.

TABLE 5
UltraQUIK Catalog Numbering System for UltraSIL Polymer-Housed Intermediate-Class Arresters

1 U	2 I	3	4	5	6	7	8	9	10	11	12	13	14 1	15 1
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Catalog Number Digits:

1 = “U” (UltraSIL Polymer-Housed Arrester)

2 = “I” (Intermediate-Class Arrester)

3 through 8 = Arrester Rating: Duty-cycle (MCOV)

003002 = 3 kV (2.55 kV)

006005 = 6 kV (5.1 kV)

009007 = 9 kV (7.65 kV)

010008 = 10 kV (8.4 kV)

012010 = 12 kV (10.2 kV)

015012 = 15 kV (12.7 kV)

018015 = 18 kV (15.3 kV)

021017 = 21 kV (17.0 kV)

024019 = 24 kV (19.5 kV)

027022 = 27 kV (22.0 kV)

030024 = 30 kV (24.4 kV)

033027 = 33 kV (27.0 kV)

036029 = 36 kV (29.0 kV)

039031 = 39 kV (31.5 kV)

042034 = 42 kV (34.0 kV)

045036 = 45 kV (36.5 kV)

048039 = 48 kV (39.0 kV)

054042 = 54 kV (42.0 kV)

060048 = 60 kV (48.0 kV)

066053 = 66 kV (53.0 kV)

072057 = 72 kV (57.0 kV)

078062 = 78 kV (62.0 kV)

084068 = 84 kV (68.0 kV)

090070 = 90 kV (70.0 kV)

096076 = 96 kV (76.0 kV)

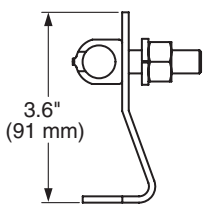
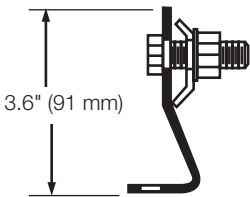
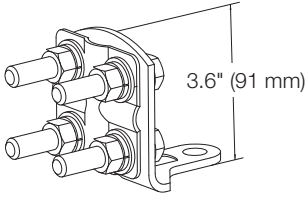
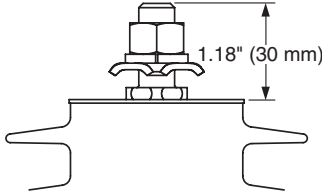
108084 = 108 kV (84.0 kV)

9 and 10 = Housing Code (Select from Table below):

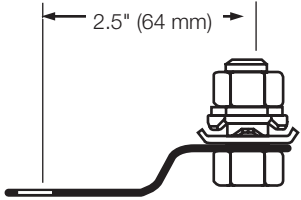
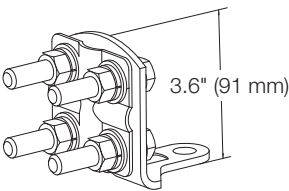
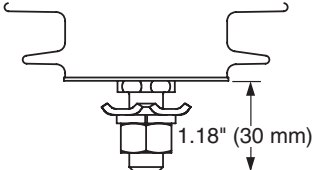
Arrester Rating	Standard Housing Code	Optional Housing Codes (Extra-Creepage)
3	06	08
6	06	08
9	08	10
10	08	10
12	10	12
15	12	14
18	12	14
21	12	14 or 16
24	14	16 or 18
27	16	18
30	18	20
33	18	20 or 22
36	18	20 or 22
39	20	22 or 24
42	22	24 or 26
45	22	26 or 28 (63.5)
48	26	28 or 30
54	26	28 or 30
60	30	Not Available
66	38	40 or 42
72	40	42 or 44 (99.8)
78	42	44 or 46
84	46	48 or 50 (113)
90	46	48 or 50
96	48	50 or 52 (118)
108	54	56 (127) or 58 (132)

Housing Code	Creepage Distance (in.)
	UI
06	12.2
08	16.2
10	20.3
12	24.3
14	28.4
16	32.4
18	36.5
20	40.5
22	44.6
24	48.6
26	52.7
28	56.7
30	60.8
32	64.8
34	68.9
36	72.9
38	77.0
40	81.0
42	85.1
44	89.1
46	93.2
48	97.2
50	101.3
52	105.3
54	109.4
56	113.4
58	117.5

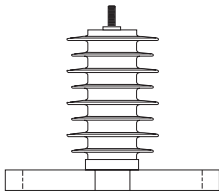
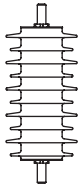
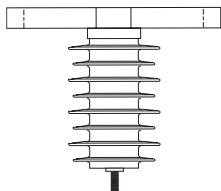
11 = Line Terminal Options

 1 = Eyebolt Connector Accepts copper or aluminum conductors from .16" dia. (#6) to .575" dia. (250 MCM)	 3 = Clamp Style Connector Accepts copper or aluminum conductors from .16" dia. (#6) to .82" dia. (500 MCM) (Standard Option)	 4 = NEMA Four-hole Pad Accepts copper or aluminum conductors from .16" dia. (#6) to .82" dia. (500 MCM)
 5 = Wire Clamp Accepts copper or aluminum conductors from .16" dia. (#6) to .575" dia. (250 MCM) (Cubicle Mount)		

12 = Ground Terminal Options

 1 = Clamp Style Connector Accepts copper or aluminum conductors from .16" dia. (#6) to .575" dia. (250 MCM) (Standard Option)	 5 = NEMA Four-hole Pad Accepts copper or aluminum conductors from .16" dia. (#6) to .82" dia. (500 MCM)	 B = Wire Clamp Accepts copper or aluminum conductors from .16" dia. (#6) to .575" dia. (250 MCM) (Cubicle Mount)
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13 = Mounting Arrangement

 A = Mounting Base Located on Bottom (Standard Option)	 B = No Mounting Base (Cubicle Mount)	 C = Mounting Base Located on Top (Suspension Mount)
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14 = "1" – Nameplate for Standard and Suspension Mount

"2" – Nameplate for Cubicle Mount

15 = "1"

NAMEPLATE INFORMATION

A stainless steel nameplate is attached to the base of every UltraSIL Polymer-Housed Type UI Arrester. The arrester catalog number, serial number, year of manufacture, duty-cycle ratings, MCOV ratings, and pressure relief rating are among the details provided on the nameplate. For cubicle mount arresters, the information is etched in the top plate of the arrester. See Figure 6 for an example of a blank nameplate.

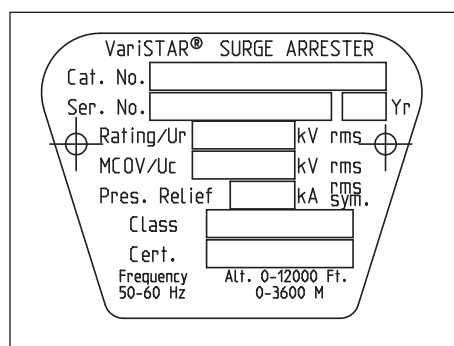


Figure 6.
Detail of blank nameplate.

MOUNTING INFORMATION

The standard base of the UltraSIL Polymer-Housed Type UI Arrester is designed for mounting on 8.75" or 10" diameter bolt circle patterns. The three mounting holes are each spaced 120° from the others and are designed to handle 0.5" diameter bolts. Mounting hardware (bolts, nuts, and washers) is not included with the arrester. See Figure 7 for mounting base details.

The UltraSIL Polymer-Housed Type UI Arrester has an ultimate cantilever strength rating of 10,000 in-lbs. An inherently strong design allows the UltraSIL arrester to be mounted in a variety of ways. These arresters can be mounted vertically, with attachment at the base, suspension (underhung) mounted or cubicle mounted. In order to underhang the arrester the proper orientation of the mounting base is required. UltraSIL Polymer-Housed Intermediate-Class Type UI Arresters can also be horizontally mounted through 108 kV. Please select the proper mounting arrangement option in the catalog number as shown in Table 5.

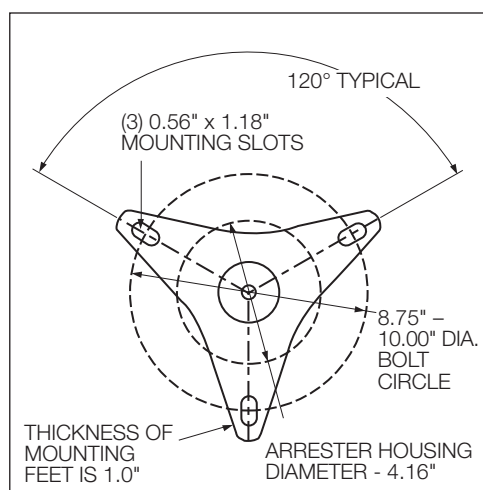


Figure 7.
Mounting base details.

ADDITIONAL INFORMATION

■ S235-75-1 UltraSIL Polymer-Housed VariSTAR Type UI Intermediate-Class Surge Arresters Installation Instructions

■ CP9730 UltraSIL Polymer-Housed VariSTAR Type UI Intermediate-Class Surge Arresters Certified Test Report