

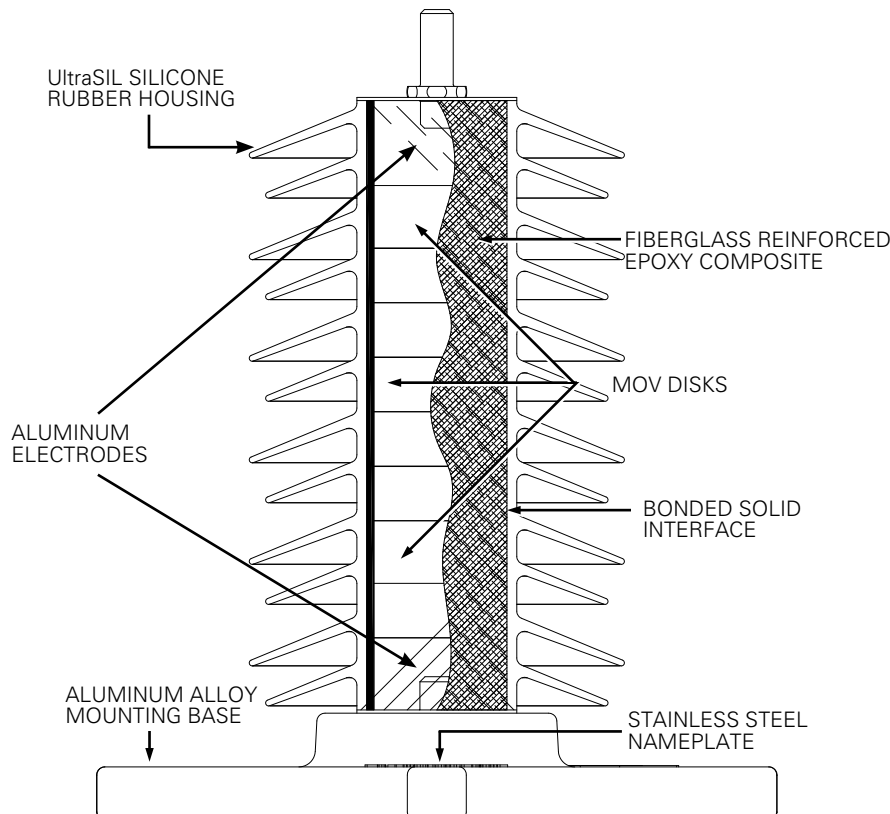
# UltraSIL™ polymer-housed VariSTAR™ Type UI intermediate-class surge arresters



## General

Eaton's Cooper Power Systems has set a new standard of excellence for polymer-housed intermediate-class surge arresters. The UltraSIL™ Polymer-Housed VariSTAR™ Type UI Intermediate-Class Arresters incorporate the industry recognized superior silicone rubber housing with a unique high creep alternating shed profile designed to withstand the most extreme environments. The "standard" silicone rubber housing is designed with a minimum specific creepage distance of 31 mm/kV L-L, which meets category IV (Very Heavy) pollution level according to the IEC standard. This housing is applied over a gapless MOV internal design.

Type UI arresters from Eaton's Cooper Power Systems meet or exceed the requirements of IEEE Std C62.11™-2005 standard including Short Circuit Tests performed in accordance with IEEE Std C62.11a™-2008 standard.



**Figure 1. Cutaway illustration of 10 kV UltraSIL Housed VariSTAR Intermediate-Class Arrester.**

## Construction

The unique construction of UltraSIL Polymer-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. Eaton's 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.

## Features

The UltraSIL silicone rubber housing was selected for its superior insulation performance when compared to other polymeric housing

**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)	3.9	
Single Impulse Rating		
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

\* High current, short duration withstand within one minute (100 kA, 4/10  $\mu$ s).

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

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

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 standard 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. Eaton's Cooper Power Systems provides high creep silicone rubber housings for standard arrester designs equivalent to 31 mm/kV or 1.22"/kV. 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 C62.11a™-2008 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™-2005 standard. A certified test report is available upon request. For a copy, please order Eaton's Cooper Power Systems document CP1121.

## Production tests

Eaton's 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% Vref 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% Vref Test
- 100% Watt Loss Test
- 100% Partial Discharge Inception Voltage Test

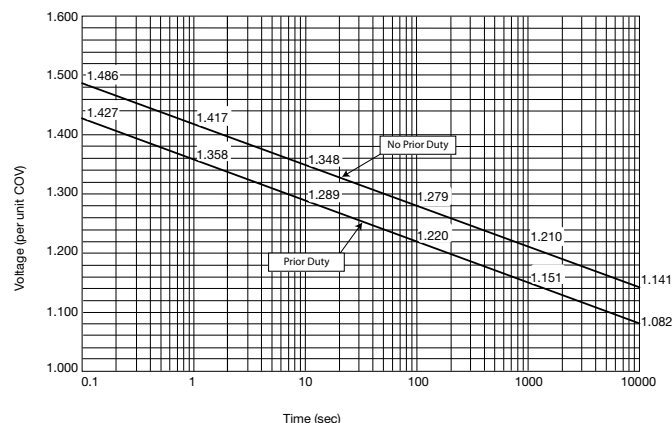
## General application recommendations

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™-2005 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™-2009 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, Eaton's Cooper Power Systems application engineers are available to make recommendations.

**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 2. Temporary overvoltage curve – 60° ambient temperature.**

**Note:** The TOV curve in Figure 2 applies to standard electrical build arresters. Consult manufacturer for further information regarding alternate electrical builds.

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 Eaton's Cooper Power Systems representative to have your individual system application needs reviewed.

## Temporary overvoltage (TOV) withstand ability

The UltraSIL Polymer-Housed Intermediate-Class arrester's ability to withstand 60 Hz overvoltage conditions (TOVs) is shown in Figure 2. 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).

The graphs in Figure 2 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 3.9 kJ/kV of MCOV.

## Dimensions, weight and spacing requirements

Figure 3 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 4 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.

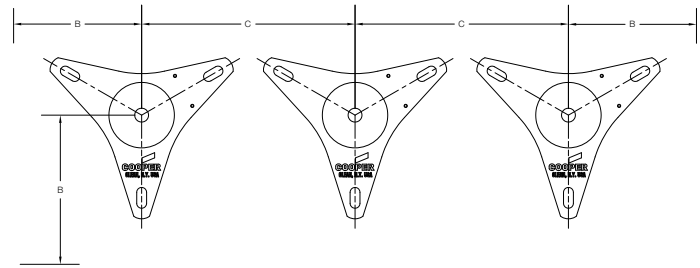


Figure 3. Three-phase in-line mounting arrangement.

## 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 4 ("31" in digits 11 and 12 of Table 5). Eaton's 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 table allows customers who may prefer options different from those in our standard Figure 4 configuration to develop a catalog number which provides the unique features they desire. For additional assistance please contact your Eaton's 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.

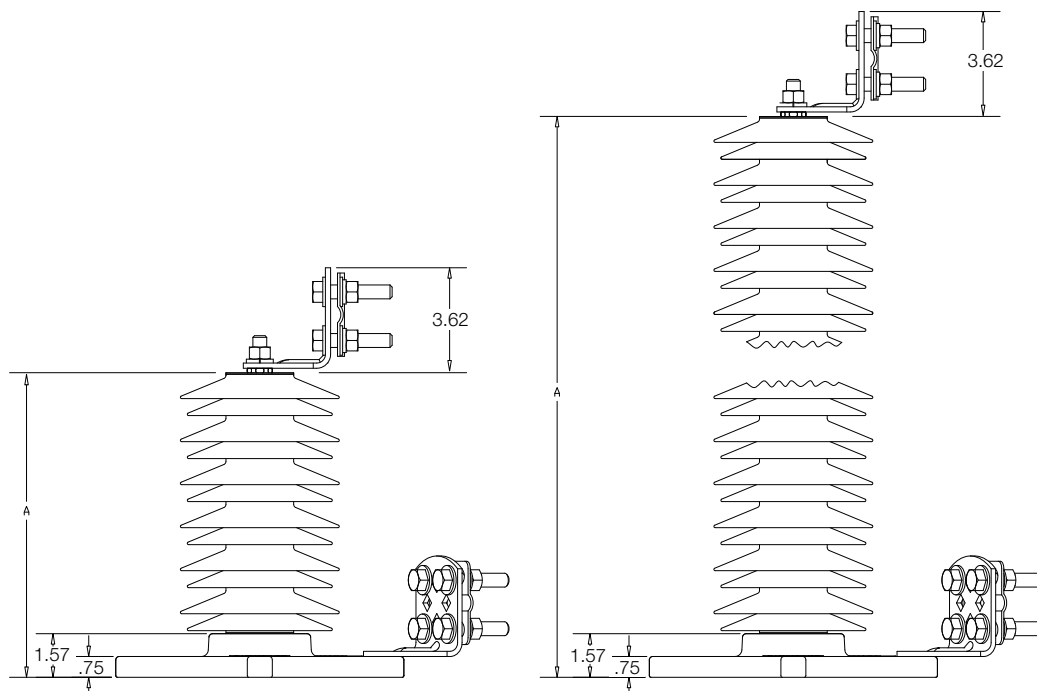


Figure 4. Outline drawing of standard UltraSIL Polymer-Housed Intermediate-Class Arresters (for standard catalog numbers see Table 3).

**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)	Arrester MCOV (kV, rms)	Figure 4 Dim. "A" (Inches)	Weight (lbs.)	Figure 3 Dim. "B" Minimum Phase-to-Ground Clearances (Inches)	Figure 3 Dim. "C" Minimum Phase-to-Phase Clearances (Inches)	Insulation Withstand Voltages			
						Creepage Distance (Inches)	1.2/50 Impulse (kV, Crest)	60 Hz, dry 60 Seconds (kV, rms)	61 Hz, wet 10 Seconds (kV, rms)
3	2.55	6.3	11	5.5	10	23	86	60	48
6	5.1	6.3	11	5.5	10	23	86	60	48
9	7.65	7.9	11	5.9	10.4	30.7	115	80	64
10	8.4	7.9	11	6.1	10.6	30.7	115	80	64
12	10.2	7.9	11	6.6	11.1	30.7	115	80	64
15	12.7	7.9	11	7.5	12	30.7	115	80	64
18	15.3	9.4	13.2	8.6	13.1	38.4	134	94	75
21	17.0	9.4	13.2	8.5	13.1	38.4	134	94	75
24	19.5	11.0	13.2	9.5	14	46.1	155	109	88
27	22.0	12.5	15.4	10.5	15	53.7	176	123	101
30	24.4	12.5	15.4	11.5	16	53.7	176	123	101
33	27.5	14.1	15.4	12.7	17.2	61.4	201	140	113
36	29.0	14.1	15.4	13.3	17.8	61.4	201	140	113
39	31.5	15.6	15.4	14.3	18.8	69.1	217	151	126
42	34.0	15.6	15.4	15.2	19.7	69.1	217	151	126
45	36.5	17.1	17.6	16.2	20.7	76.8	237	164	139
48	39.0	18.7	17.6	17.2	21.7	84.4	252	172	152
54	42.0	18.7	17.6	18.4	22.9	84.4	252	172	152
60	48.0	21.8	19.8	20.8	25.3	99.8	294	201	173
66	53.0	21.8	19.8	22.7	27.2	99.8	294	201	173
72	57.0	23.4	19.8	24.3	28.8	107.5	316	212	187
78	62.0	28.2	24.3	26.3	30.8	130.5	418	291	239
84	68.0	29.7	24.3	28.7	33.2	138.2	434	302	252
90	72.0	31.2	24.3	30.2	34.7	145.9	454	315	265
96	76.0	32.8	24.3	31.8	36.3	153.5	474	328	278
108	84.0	35.9	28.7	35	39.5	168.9	504	344	304

**Table 4. Protective Characteristics of the UltraSIL Polymer-Housed Intermediate-Class Arrester Type UI**

Arrester Rating (kV, rms)	Arrester MCOV (kV, rms)	TOV*		Front-of-Wave Protective Level** (kV Crest)	Maximum Discharge Voltage (kV Crest) 8/20us Current Wave***						Switching Surge Protective Level**** (kV Crest)
		1 Sec	10 Sec		1.5kA	3kA	5kA	10kA	20kA	40kA	
3	2.55	3.5	3.3	8.8	6.8	7.2	7.6	8.3	9.1	10.4	6.3
6	5.1	6.9	6.6	17.5	13.6	14.4	15.2	16.6	18.2	20.7	12.5
9	7.65	10.4	9.9	26.2	20.4	21.6	22.7	24.9	27.3	31.1	18.8
10	8.4	11.4	10.8	28.8	22.4	23.7	24.9	27.3	29.9	34.1	20.6
12	10.2	13.9	13.1	34.9	27.2	28.8	30.3	33.1	36.3	41.4	25
15	12.7	17.2	16.4	43.5	33.8	35.8	37.7	41.3	45.2	51.5	31.1
18	15.3	20.8	19.7	52.4	40.8	43.1	45.4	49.7	54.5	62.1	37.5
21	17.0	23.1	21.9	58.2	45.3	47.9	50.4	55.2	60.5	69	41.6
24	19.5	26.5	25.1	66.7	51.9	55	57.8	63.3	69.4	79.1	47.8
27	22.0	29.9	28.4	75.3	58.6	62	65.2	71.4	78.3	89.2	53.9
30	24.4	33.1	31.5	83.5	65	68.8	72.3	79.2	86.8	98.9	59.8
33	27.5	37.3	35.4	94.1	73.2	77.5	81.5	89.3	97.9	112	67.3
36	29.0	39.4	37.4	99.2	77.2	81.7	86	94.2	104	118	71
39	31.5	42.8	40.6	108	83.9	88.8	93.4	103	113	128	77.1
42	34.0	46.2	43.8	117	90.5	95.8	101	111	121	138	83.2
45	36.5	49.6	47.0	125	97.2	103	109	119	130	148	89.4
48	39.0	53.0	50.3	134	104	110	116	127	139	159	95.5
54	42.0	57.0	54.1	144	112	119	125	137	150	171	103
60	48.0	65.2	61.9	165	128	136	143	156	171	195	118
66	53.0	72.0	68.3	182	142	150	158	172	189	215	130
72	57.0	77.4	73.5	195	152	161	169	185	203	232	140
78	62.0	84.2	79.9	213	165	175	184	202	221	252	152
84	68.0	92.3	87.7	233	181	192	202	221	242	276	167
90	72.0	97.8	92.8	247	192	203	214	234	257	292	177
96	76.0	103.2	98.0	260	203	215	226	247	271	309	186
108	84.0	114.1	108.3	288	224	237	249	273	299	341	206

\* Temporary Overvoltage (TOV) with Prior Duty.

\*\* Based on a 10 kA current impulse that results in a discharge voltage cresting in 0.5 μs

\*\*\* Contact manufacturer for alternate electrical builds.

\*\*\*\* 45-60 μs rise time for a 500 A peak current surge.

**Table 5. UltraQUIK Catalog Numbering System for UltraSIL Polymer-Housed Intermediate-Class Arresters**

1 <b>U</b>	2 <b>I</b>	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
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**Catalog Number Digits:****1 = "U"** (UltraSIL Polymer-Housed Arrester)**2 = "I"** (Intermediate-Class Arrester)**3 = "A"** Standard Electrical Build\*

\* Consult manufacturer for further information regarding alternate electrical builds.

**4 = "A"** Standard Cantilever Strength Design**5 through 10** = 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)**090072** = 90 kV (72.0 kV)**096076** = 96 kV (76.0 kV)**108084** = 108 kV (84.0 kV)**11 = "A"** Standard

**Table 5. UltraQUIK Catalog Numbering System for UltraSIL Polymer-Housed Intermediate-Class Arresters (continued)**

1	U	2	I	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
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**12 and 13 = Housing Code (Select from Table below):** Please contact your Eaton's Cooper Power Systems Sales Representative for further information regarding available housing codes.

Arrester Rating (kV rms)	Standard Housing Code	Maximum Housing Code (Extra Creepage)
3	06	08
6	06	08
9	08	10
10	08	10
12	08	12
15	08	14
18	10	14
21	10	16
24	12	18
27	14	18
30	14	20
33	16	22
36	16	22
39	18	24
42	18	26
45	20	28
48	22	28
54	22	28
60	26	28
66	26	28
72	28	28
78	34	46
84	36	50
90	38	50
96	40	52
108	44	56

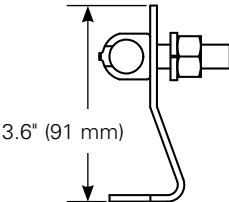
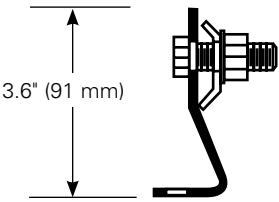
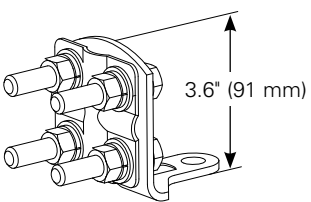
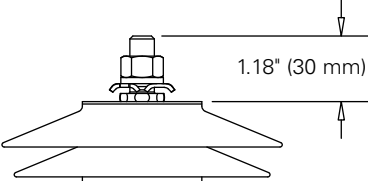
**Housing Code Creep Distances in Inches**

Housing Code	Creepage (in.)
06	23.0
08	30.7
10	38.4
12	46.1
14	53.7
16	61.4
18	69.1
20	76.8
22	84.4
24	92.1
26	99.8
28	115.2
34	130.5
36	138.2
38	145.9
40	153.5
44	168.9
46	176.6
48	184.3
50	192.0
52	199.7
54	207.4
56	215.1

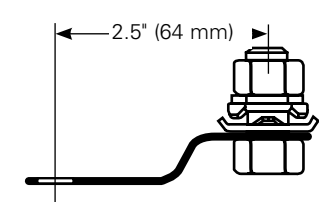
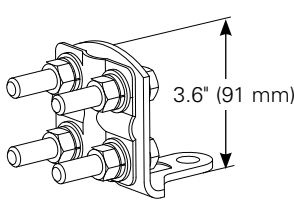
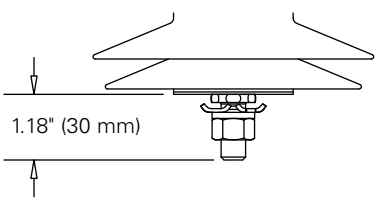
**Table 5. UltraQUIK Catalog Numbering System for UltraSIL Polymer-Housed Intermediate-Class Arresters (continued)**

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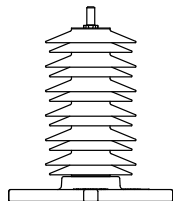
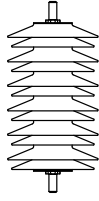
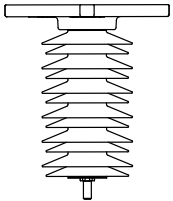
**14 = Line Terminal Options**

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

**15 = Ground Terminal Options**

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

 <p><b>A = Mounting Base Located on Bottom</b> <b>(Standard Option)</b></p>	 <p><b>B = No Mounting Base</b> (Cubicle Mount) (UI Type 3-36 kV)</p>	 <p><b>C = Mounting Base Located on Top</b> (Suspension Mount)</p>
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**17 = "1" – Nameplate for Standard or Suspension Mount**  
**"2" – Nameplate for Cubicle Mount (3-36 kV) Option Code "B" for digit 16.**

**18 = "1" Packaging**



## 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 5 for an example of a 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 6 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. Contact your local Eaton's Cooper Power Systems representative for further mounting configuration details.

## Additional Information

- S235-102-1, UltraSIL Polymer-Housed VariSTAR Type UI Intermediate-Class Surge Arresters Installation Instructions
- CP1121, UltraSIL Polymer-Housed VariSTAR Type UI Intermediate-Class Surge Arresters Certified Test Report

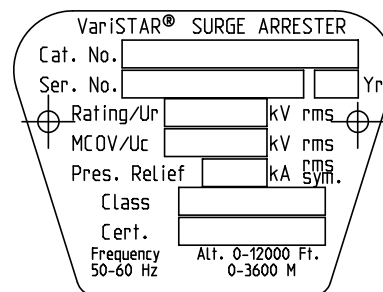


Figure 5. Detail of blank nameplate.

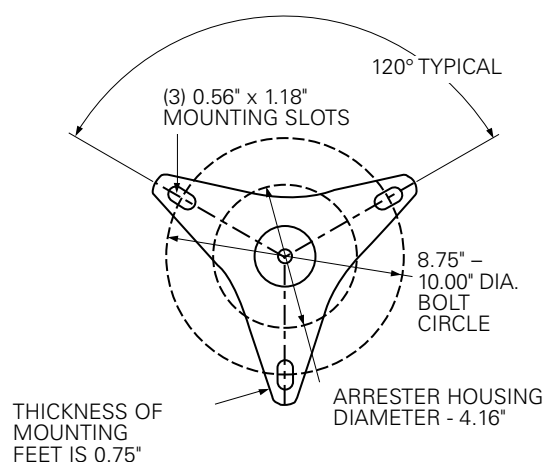


Figure 6. Mounting base details.





**Eaton**

1000 Eaton Boulevard  
Cleveland, OH 44122  
United States  
Eaton.com

**Eaton's Cooper Power Systems Business**

2300 Badger Drive  
Waukesha, WI 53188  
United States  
Cooperpower.com

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