Trench CVTs and CCs

Introduction

Trench is a recognized world leader in the design and manufacture of high voltage equipment for application in electric utility and high energy industrial systems. As part of Trench’s product scope, the Company produces a diversified range of Instrument Transformers for transmission class voltages.

Instrument Transformers include: Voltage (Potential) Transformers (inductive and capacitive types), Current Transformers and Combined Instrument Transformers (voltage and current transformer in one unit).

Capacitor Voltage Transformers convert transmission class voltages, 72.5 - 1100 kV, to standardized low and easily measurable values with high level of fidelity, used for metering, protection and control of the high voltage system. As such, the need for accurate and reliable voltage transformation is essential. Additionally, Capacitor Voltage Transformers serve as coupling capacitors for coupling high frequency power line carrier (PLC) signals to the transmission line.

This brochure details the features and characteristics of Capacitor Voltage Transformers (CVT’s) and Coupling Capacitors (CC’s). Please refer to Trench brochure E210.10 for additional general information concerning high voltage Instrument Transformers.

Applications

Trench CVT’s and CC’s have several potential applications within a typical electric power substation.

- CVT’s provide voltage inputs for protection relays and revenue meters.
- CVT’s and CC’s can couple high frequency PLC signals to the power line.
- CVT’s and CC’s can be supplied with various capacitance ratings to reduce circuit breaker TRV (Transient Recovery Voltage), especially in the case of short line to ground faults.
- CVT’s and CC’s can be used for power quality monitoring. A special harmonic monitoring device allows for direct measurement of harmful harmonic voltages.

Features

- Meet all IEC and ANSI metering and protection classes (other standards on request).
- Applications from 72.5kV-1100kV.
- Trench Management System has been certified to ISO 9001, ISO 14001 and OHSAS 18001.
- Higher inherent capacitance values provide superior PLC coupling, better transient response performance and improved stability.
- Optimized insulation system design utilizing state-of-the-art processing techniques with mineral oil in Electromagnetic Unit (EMU) and synthetic insulating fluid in the capacitor sections.

- Stability of capacitance and accuracy over instrument’s expected service life and wide temperature range.
- Oil volume compensation by way of hermetically sealed stainless steel bellows without tubes, piping, or fittings assures the integrity of the dielectric system over time.
- CVT includes a pressure relief device.

Fig. 1 - 245kV Capacitor Voltage Transformer type TEVF 245
• Bellows puncture pin designed to provide for the release of internal pressure in the event of abnormal service conditions.
• Puncture pin operation results in an early indication to safely remove the unit from service.
• Line Trap mounting directly onto the CVT or CC is possible with some ratings (please consult factory).
• Guaranteed minimum creepage distances of our standard porcelain and composite insulators exceed ANSI and IEC requirements (refer to datasheet information below). Higher creepage distances are available for higher pollution applications.
• Maintenance-free oil filled cast aluminum basebox and stainless steel hardware are corrosion free and do not require painting.
• Factory testing and quality assurance requirements exceed international standards with impulse and ferroresonance tests being performed on a routine basis.
• Not prone to ferroresonance oscillations with the power system or circuit breaker capacitance.
• Passive ferroresonance suppression circuit provides superior damping while retaining fast transient response. This allows faster relay operation with less zone 1 overreach concern.
• Simple field installation - capacitor sections just bolt together. No wires to connect or gaskets needed between sections.

• Integrated porcelain flange and EMU cover ensure sealing integrity of the EMU for the life of the unit.
• Integrated single piece secondary bushing with low voltage terminal board (see Fig. 2). Other connection configurations are available on request.

Each capacitor section is equipped with a stainless steel expansion chamber for volume compensation of synthetic dielectric fluid as it expands and contracts with changes in ambient operating temperatures. Should there be excessive pressure build up within a capacitor section, the expansion chamber will engage a puncture pin, resulting in pressure release and visual indication of a problem.

A tap voltage (approximately 5-12kV depending on type) is taken from the lowest capacitor section, (C2), and fed to an electromagnetic circuit in the cast aluminum basebox. The basebox contains an intermediate transformer which provides the secondary output voltages via multiple tapped windings, a series compensating reactor, and the ferroresonance suppression circuitry. The basebox is filled with high quality, newly blended mineral oil; specially treated, filtered, degassed and dehydrated to ensure the oil remains stable at the operating ambient temperatures for the life of the unit.

Ferroresonance is simply and effectively controlled by utilization of low flux magnetic circuitry and saturable reactor controlled damping circuit connected across the secondary winding. The ferroresonance suppression circuit does not adversely affect transient response.

Construction
Trench CVT’s consist of two basic assemblies: a high voltage capacitor divider and a basebox which houses the electro-magnetic components. The high voltage capacitor divider may consist of single or multiple capacitor sections.

CC and TRV capacitors are similar in construction with the CVT, but have no electromagnetic unit. Two configurations are available, flat base mounting or mounted on an air-filled basebox.

Series connected capacitor elements, housed in porcelain or composite insulator shells, each hermetically sealed, are referred to as capacitor sections. The capacitor elements consist of aluminum foil, low loss electrical grade polypropylene film/Kraft paper insulation and impregnated with high quality, newly blended synthetic dielectric fluid; specially treated, filtered, degassed and dehydrated to ensure that the fluid remains stable at the operating ambient temperatures for the life of the unit.

Fig. 2 - Low Voltage Terminal Board (integrated into oil to air feed through bushing)
Electrical Performance Characteristics

<table>
<thead>
<tr>
<th>Model</th>
<th>TEVF</th>
<th>TEVP</th>
<th>TETP</th>
<th>TEMF</th>
<th>TEMP</th>
<th>TEIRF</th>
<th>TEIMF</th>
<th>TEHMF, TEHMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacitance</td>
<td>Standard</td>
<td>Medium</td>
<td>Medium</td>
<td>Standard</td>
<td>Medium</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Extra High</td>
</tr>
<tr>
<td>Accuracy Class ANSI C93.1</td>
<td>Two Main Windings, Each</td>
<td>-</td>
<td>-</td>
<td>0.15 Y (0 to 75 VA)</td>
<td>0.15 MWXYZ (200 VA)</td>
<td>0.15 Y (0 to 75 VA)</td>
<td>-</td>
<td>0.15 MWXYZ, ZZ (400 VA)</td>
</tr>
<tr>
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<td>-</td>
<td>-</td>
<td>0.3 MWXYZ (200 VA)</td>
<td>0.3 MWXYZ, ZZ (400 VA)</td>
<td>0.3 MWXYZ (200 VA)</td>
<td>0.15 MWXYZ (200 VA)</td>
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<tr>
<td></td>
<td></td>
<td>0.6 MWXYZ (200 VA)</td>
<td>0.6 MWXYZ (200 VA)</td>
<td>0.6 ZZ, ZZ (400 VA)</td>
<td>0.6 ZZ, ZZ (400 VA)</td>
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<td>0.3 WXYZ, ZZ (400 VA)</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>1.2 ZZ (400 VA)</td>
<td>1.2 ZZ (400 VA)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Auxiliary Winding**

- 1.2 Y - Other ratings available upon request

**IEC 60044-5 and Other Standards**

Revenue metering and protective relaying accuracy classes available

**Transient Response**

<table>
<thead>
<tr>
<th>Burden</th>
<th>ZT (200 VA)</th>
<th>ZZT (400 VA)</th>
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</thead>
<tbody>
<tr>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>6%</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>5%</td>
<td>5%</td>
<td></td>
</tr>
</tbody>
</table>

**Ferroresonance Suppression**

Less than 10% (of peak) after 10 cycles at 150% of rated voltage. (Other over voltage factors available)

**Thermal rating**

1000 VA | 1500 VA

**Notes:**

1. Two main windings are supplied as standard, with a third auxiliary winding available as an option.
2. The accuracy class for total simultaneous loading is equal to the values given for the main winding(s).
3. Higher burdens on special request.

**Typical CVT Single Line Diagram**

![Typical CVT Single Line Diagram](image)
Table I - Standard Capacitance, LP
Electrical, Mechanical and Physical Data (A)
Type TECF, TEVF and TEMF

<table>
<thead>
<tr>
<th>Maximum continuous operating voltage, phase to phase</th>
<th>Impulse withstand, 1.2/50 μs kV (BIL)</th>
<th>Power frequency withstand, kV, 1 min. Dry</th>
<th>Power frequency withstand, kV, 10 sec. Wet</th>
<th>Standard Capacitance pF (A)</th>
<th>Guaranteed minimum creepage distance in / mm (B)</th>
<th>Dimension h1 in / mm (C)</th>
<th>Approx. weight lb / kg (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>72.5</td>
<td>350</td>
<td>165</td>
<td>140</td>
<td>10 000</td>
<td>71.5 / 1 813</td>
<td>54.68 / 1 388</td>
<td>410 / 185</td>
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<tr>
<td>123</td>
<td>550</td>
<td>265</td>
<td>230</td>
<td>6 000</td>
<td>121 / 3 075</td>
<td>66.4 / 1 688</td>
<td>450 / 203</td>
</tr>
<tr>
<td>145</td>
<td>650</td>
<td>320</td>
<td>275</td>
<td>5 000</td>
<td>143 / 3 625</td>
<td>74.3 / 1 888</td>
<td>475 / 215</td>
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<tr>
<td>170</td>
<td>750</td>
<td>370</td>
<td>325</td>
<td>4 300</td>
<td>167.5 / 4 250</td>
<td>82.6 / 2 098</td>
<td>505 / 229</td>
</tr>
<tr>
<td>245(^4)</td>
<td>1 050</td>
<td>525</td>
<td>460</td>
<td>3 000</td>
<td>241 / 6 125</td>
<td>105.7 / 2 684</td>
<td>590 / 268</td>
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<tr>
<td>300</td>
<td>1 300</td>
<td>650</td>
<td>565</td>
<td>2 500</td>
<td>295.3 / 7 500</td>
<td>130.8 / 3 321</td>
<td>670 / 303</td>
</tr>
<tr>
<td>362</td>
<td>1 550</td>
<td>785</td>
<td>680</td>
<td>2 150</td>
<td>356.3 / 9 050</td>
<td>147.3 / 3 741</td>
<td>730 / 331</td>
</tr>
<tr>
<td>420</td>
<td>1 550</td>
<td>785</td>
<td>680</td>
<td>1 650</td>
<td>413.4 / 10 500</td>
<td>188.3 / 4 784</td>
<td>855 / 387</td>
</tr>
<tr>
<td>550</td>
<td>1 800</td>
<td>900</td>
<td>780</td>
<td>1 430</td>
<td>496 / 12 600</td>
<td>193.8 / 4 921</td>
<td>895 / 406</td>
</tr>
</tbody>
</table>

Notes:
1. Values in the table are for ANSI Standard. Ratings for IEC and other standards are also available.
2. Dimension h1 is for TEVF, TEMF, and for TECF on an air-filled base box.
3. For flat base mounting, dimension h11, subtract approximately 14.38 inches (365 mm) from h1 [h11] and 275 lbs (120 kg) from weight in table.
4. The standard design for 245kV units utilizes a single porcelain section - 2 section units are available upon request.
5. Higher creepage distances are available on request.

Table II - Medium Capacitance, LP
Electrical, Mechanical and Physical Data (B)
Type TECP, TEVP and TETP

<table>
<thead>
<tr>
<th>Maximum continuous operating voltage, phase to phase</th>
<th>Impulse withstand, 1.2/50 μs kV (BIL)</th>
<th>Power frequency withstand, kV, 1 min. Dry</th>
<th>Power frequency withstand, kV, 10 sec. Wet</th>
<th>Medium Capacitance pF (B)</th>
<th>Guaranteed minimum creepage distance in / mm (B)</th>
<th>Dimension h2 in / mm (C)</th>
<th>Approx. weight lb / kg (D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>72.5</td>
<td>350</td>
<td>165</td>
<td>140</td>
<td>20 800</td>
<td>71.5 / 1 813</td>
<td>55.4 / 1 406</td>
<td>490 / 223</td>
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<td>123</td>
<td>550</td>
<td>265</td>
<td>230</td>
<td>12 500</td>
<td>121 / 3 075</td>
<td>67.2 / 1 706</td>
<td>550 / 249</td>
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<tr>
<td>145</td>
<td>650</td>
<td>320</td>
<td>275</td>
<td>10 400</td>
<td>143 / 3 625</td>
<td>75 / 1 906</td>
<td>585 / 266</td>
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<tr>
<td>170</td>
<td>750</td>
<td>370</td>
<td>325</td>
<td>8 300</td>
<td>167.5 / 4 250</td>
<td>83.3 / 2 116</td>
<td>620 / 281</td>
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<tr>
<td>245(^4)</td>
<td>1 050</td>
<td>525</td>
<td>460</td>
<td>6 200</td>
<td>241 / 6 125</td>
<td>106.6 / 2 706</td>
<td>720 / 326</td>
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<tr>
<td>300</td>
<td>1 300</td>
<td>650</td>
<td>565</td>
<td>4 100</td>
<td>295.3 / 7 500</td>
<td>132.4 / 3 363</td>
<td>815 / 369</td>
</tr>
<tr>
<td>362</td>
<td>1 550</td>
<td>785</td>
<td>680</td>
<td>3 500</td>
<td>356.3 / 9 050</td>
<td>148.9 / 3 783</td>
<td>880 / 399</td>
</tr>
<tr>
<td>420</td>
<td>1 550</td>
<td>785</td>
<td>680</td>
<td>3 000</td>
<td>413.4 / 10 500</td>
<td>189.8 / 4 820</td>
<td>1040 / 472</td>
</tr>
<tr>
<td>550</td>
<td>1 800</td>
<td>900</td>
<td>780</td>
<td>2 800</td>
<td>496 / 12 600</td>
<td>195.4 / 4 963</td>
<td>1080 / 490</td>
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</table>

Notes:
1. Values in the table are for ANSI Standard. Ratings for IEC and other standards are also available.
2. Dimension h2 is for TECP, TEVP, and for TETP on an air-filled base box.
3. For flat base mounting, dimension h21, subtract approximately 14.38 inches (365 mm) from h2 [h21] and 275 lbs (120 kg) from weight in table.
4. The standard design for 245kV units utilizes a single porcelain section - 2 section units are available upon request.
5. Higher creepage distances are available on request.
Table III - Medium Capacitance, UNI
Electrical, Mechanical and Physical Data (C)
Type TECP, TEVP and TEMP

<table>
<thead>
<tr>
<th>Maximum continuous operating voltage, phase to phase</th>
<th>Power frequency withstand, kV, 1 min. Dry</th>
<th>Power frequency withstand, kV, 10 sec. Wet</th>
<th>Medium Capacitance pF (C)</th>
<th>Guaranteed minimum creepage distance in / mm³</th>
<th>Dimension h³</th>
<th>Approx. weight lb / kg³</th>
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</thead>
<tbody>
<tr>
<td>72.5</td>
<td>350</td>
<td>165</td>
<td>140</td>
<td>20 800</td>
<td>71.5 / 1 813</td>
<td>60.5 / 1 536</td>
</tr>
<tr>
<td>123</td>
<td>550</td>
<td>265</td>
<td>230</td>
<td>12 500</td>
<td>121 / 3 075</td>
<td>72.3 / 1 836</td>
</tr>
<tr>
<td>145</td>
<td>650</td>
<td>320</td>
<td>275</td>
<td>10 400</td>
<td>143 / 3 625</td>
<td>80.2 / 2 036</td>
</tr>
<tr>
<td>170</td>
<td>750</td>
<td>370</td>
<td>325</td>
<td>8 300</td>
<td>167.5 / 4 250</td>
<td>88.4 / 2 246</td>
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<tr>
<td>245k¹</td>
<td>1 050</td>
<td>525</td>
<td>460</td>
<td>6 200</td>
<td>241 / 6 125</td>
<td>111.6 / 2 836</td>
</tr>
<tr>
<td>300</td>
<td>1 300</td>
<td>650</td>
<td>565</td>
<td>5 200</td>
<td>295.3 / 7 500</td>
<td>137.5 / 3 493</td>
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<tr>
<td>362</td>
<td>1 550</td>
<td>785</td>
<td>680</td>
<td>4 100</td>
<td>356.3 / 9 050</td>
<td>154 / 3 913</td>
</tr>
<tr>
<td>420</td>
<td>1 550</td>
<td>785</td>
<td>680</td>
<td>3 500</td>
<td>413.4 / 10 500</td>
<td>194.9 / 4 950</td>
</tr>
<tr>
<td>550</td>
<td>1 800</td>
<td>900</td>
<td>780</td>
<td>2 800</td>
<td>496 / 12 600</td>
<td>200.5 / 5 093</td>
</tr>
</tbody>
</table>

Notes:
[1] Values in the table are for ANSI Standard. Ratings for IEC and other standards are also available.
[2] Dimension h³ is for TECP, TEVP and for TEMP on an air-filled base box.
[3] For flat base mounting, dimension h³1, subtract approximately 19.2 inches (487 mm) from h³ [h³1] and 476 lbs (216 kg) from weight in table.
[4] The standard design for 245kV units utilizes a single porcelain section - 2 section units are available upon request.
[5] Higher creepage distances are available on request.

Table IV - Intermediate Capacitance, UNI
Electrical, Mechanical and Physical Data (D)
Type TEICF, TEICP, TEIMF and TEIRF

<table>
<thead>
<tr>
<th>Maximum continuous operating voltage, phase to phase</th>
<th>Power frequency withstand, kV, 1 min. Dry</th>
<th>Power frequency withstand, kV, 10 sec. Wet</th>
<th>Intermediate Capacitance pF (D)</th>
<th>Guaranteed minimum creepage distance in / mm³</th>
<th>Dimension h⁴</th>
<th>Approx. weight lb / kg³</th>
</tr>
</thead>
<tbody>
<tr>
<td>72.5</td>
<td>350</td>
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<td>140</td>
<td>40 000</td>
<td>71.5 / 1 813</td>
<td>64.4 / 1 636</td>
</tr>
<tr>
<td>123</td>
<td>550</td>
<td>265</td>
<td>230</td>
<td>20 000</td>
<td>121 / 3 075</td>
<td>76.2 / 1 938</td>
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<tr>
<td>145</td>
<td>650</td>
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<td>143 / 3 625</td>
<td>84.1 / 2 136</td>
</tr>
<tr>
<td>170</td>
<td>750</td>
<td>370</td>
<td>325</td>
<td>15 000</td>
<td>167.5 / 4 250</td>
<td>92.4 / 2 346</td>
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<td>460</td>
<td>10 000</td>
<td>241 / 6 125</td>
<td>115.6 / 2 836</td>
</tr>
<tr>
<td>300</td>
<td>1 300</td>
<td>650</td>
<td>565</td>
<td>8 200</td>
<td>295.3 / 7 500</td>
<td>145.4 / 3 693</td>
</tr>
<tr>
<td>362</td>
<td>1 550</td>
<td>785</td>
<td>680</td>
<td>7 500</td>
<td>356.3 / 9 050</td>
<td>162 / 4 116</td>
</tr>
<tr>
<td>420</td>
<td>1 550</td>
<td>785</td>
<td>680</td>
<td>5 500</td>
<td>413.4 / 10 500</td>
<td>206.7 / 5 251</td>
</tr>
<tr>
<td>550</td>
<td>1 800</td>
<td>900</td>
<td>780</td>
<td>5 000</td>
<td>496 / 12 600</td>
<td>208.4 / 5 293</td>
</tr>
<tr>
<td>800</td>
<td>2 425</td>
<td>1 200</td>
<td>1 050</td>
<td>4 000</td>
<td>750.6 / 19 065</td>
<td>301.2 / 7 650</td>
</tr>
</tbody>
</table>

Notes:
[1] Values in the table are for ANSI Standard. Ratings for IEC and other standards are also available.
[2] Dimension h⁴ is for TEICF, TEICP, TEIMF and for TEIRF on an air-filled base box.
[3] For flat base mounting, dimension h⁴1, subtract approximately 19.2 inches (487 mm) from h⁴ [h⁴1] and 476 lbs (216 kg) from weight in table.
[4] The standard design for 245kV units utilizes a single porcelain section - 2 section units are available upon request.
[5] Higher creepage distances are available on request.
Table V - Extra High Capacitance, UNI
Electrical, Mechanical and Physical Data (E)
Type TEHCF, TEHCP, TEHMF, and TEHMP

<table>
<thead>
<tr>
<th>Maximum continuous operating voltage, phase to phase</th>
<th>Impulse withstand 1.2/50 µs kV (BIL)</th>
<th>Power frequency withstand, kV, 1 min. Dry</th>
<th>Power frequency withstand, kV, 10 sec. Wet</th>
<th>Extra High Capacitance pF (E)</th>
<th>Guaranteed minimum creepage distance in / mm</th>
<th>Dimension h5 / mm</th>
<th>Approx. weight lb / kg</th>
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<td>350</td>
<td>165</td>
<td>140</td>
<td>50 000</td>
<td>112.2 / 2 850</td>
<td>1100 / 499</td>
<td>71.3 / 1 810</td>
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<td>550</td>
<td>265</td>
<td>230</td>
<td>47 500</td>
<td>112.2 / 2 850</td>
<td>1100 / 499</td>
<td>71.3 / 1 810</td>
</tr>
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<td>650</td>
<td>320</td>
<td>275</td>
<td>38 100</td>
<td>139 / 3 530</td>
<td>1175 / 533</td>
<td>79.8 / 2 026</td>
</tr>
<tr>
<td>170</td>
<td>750</td>
<td>370</td>
<td>325</td>
<td>30 500</td>
<td>166.1 / 4 220</td>
<td>1300 / 590</td>
<td>88.3 / 2 242</td>
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<td>245</td>
<td>1 050</td>
<td>525</td>
<td>460</td>
<td>22 800</td>
<td>224.4 / 5 700</td>
<td>1649 / 748</td>
<td>121.7 / 3 092</td>
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<td>650</td>
<td>565</td>
<td>15 800</td>
<td>332.3 / 8 440</td>
<td>1975 / 896</td>
<td>155.5 / 3 950</td>
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<td>785</td>
<td>680</td>
<td>15 200</td>
<td>332.3 / 8 440</td>
<td>1975 / 896</td>
<td>155.5 / 3 950</td>
</tr>
<tr>
<td>420</td>
<td>1 550</td>
<td>785</td>
<td>680</td>
<td>12 700</td>
<td>417 / 10 590</td>
<td>2350 / 1066</td>
<td>197.8 / 5 023</td>
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<tr>
<td>550</td>
<td>1 800</td>
<td>900</td>
<td>780</td>
<td>10 100</td>
<td>498.4 / 12 660</td>
<td>2700 / 1225</td>
<td>223 / 5 664</td>
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<tr>
<td>800</td>
<td>2 425</td>
<td>1 200</td>
<td>1 050</td>
<td>6 200</td>
<td>664.6 / 16 880</td>
<td>3426 / 1554</td>
<td>290.5 / 7 379</td>
</tr>
</tbody>
</table>

Notes:
1. Values in the table are for ANSI Standard. IEC and other standards ratings are also available.
2. Dimension h5 is for TEHCF, TEHCP, TEHMF, and for TEHMP on an air-filled base box.
3. For flat base mounting, dimension h5, subtract approximately 18.25 inches (464 mm) from h5 and 550 lbs (250 kg) from weight in table.
4. Higher creepage distances are available on request.
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