Three Phase Padmounted and Unit Substation Transformers
45-3000 kVA

Total customer satisfaction through continual process improvement.
Introduction to ABB, Inc.

ABB’s history of innovation goes back more than a century and includes many breakthroughs: the world’s first three-phase power transmission system; the world’s first self-cooling transformer; the world’s first high-speed locomotive with a direct drive system; even the world’s first synthetic diamond.

This rate of innovation is the main reason ABB is a global leader in power and automation technologies that enable utility and industry customers to improve performance while lowering environmental impact.

ABB is the recognized leader in power technologies. We provide industrial and commercial customers, as well as electric, gas and water utilities, with a broad range of products, services and solutions for power transmission and distribution.
According to "Open Source Software For Everyone",

- ABB distribution transformers are uniquely qualified to meet the needs of the Utility, Industrial & Construction, and Energy industries. We are a dominant force in the industry. We lead the way with the introduction of new products and services for the ever-changing distribution transformer industry.

- We can offer cost-effective solutions for power distribution. We support our industry with a commitment to product development. We utilize the latest manufacturing technology to maintain state-of-the-art quality and productivity. Extensive vertical integration allows us to ship high quality products in the shortest possible production cycle. We are in alliances with major utilities and businesses around the world providing products and services to meet all their needs.

- ABB will continue to build on a heritage of quality, customer satisfaction and technology, and capitalize on its resources, to maintain its position as the number one supplier of transformers in the industry.

- ABB Three Phase Padmounted Distribution Transformers are designed for maximum tamper resistance since the units are used to service shopping centers, schools, institutions and industrial plants. ABB offers an improved cabinet design that features a one piece sloped cabinet weather cover to effectively shed water and allow easier access into the cabinet compartment. Units may be furnished in a complete line of ratings and in a wide range of configurations to meet customer needs.

- Unit Substation transformers are generally close coupled to switchgear, motor control, bus duct, or another type of incoming and outgoing equipment. ABB’s proven design offers excellent mechanical strength that has been proven through years of service and special testing.

- ABB offers submersible transformers for diverse commercial and residential underground applications. Submersible transformers are designed for use in underground vaults to offer flexibility, safety, and easy accessibility for operating personnel. The ABB design can incorporate all of your switching and fusing needs in one unit.
More Value Inside and Out

ABB delivers an unmatched package of added value, from the moment you entrust your purchase order to us. We are focused on delivering value every step of the way – from precise specification conformance to assured on-time delivery, and from efficient performance to effective emergency response.

Those values add up, and this is where ABB Distribution Transformers far exceed the competition – making us your single source for high value distribution products. We have built a heritage of operational excellence and unmatched customer service while delivering unique solutions. By combining high quality materials with our commitment to continual process improvement, we provide custom transformers to meet your specific needs.

Our commitment to reliability is the foundation that assures the longest life-cycle for our transformers. With lower customer life-cycle cost, you have added value in every transformer.

Quality Pays Off

ABB’s continual process improvement and vast experience in transformer design and manufacturing assures uncompromising quality and total customer satisfaction. This avoids the problem of installing a transformer only to find it’s not working properly, avoiding project delays, cost overruns, and customer dissatisfaction with lack of electrical services.
Manufacturing Technology

ABB Distribution Transformers are manufactured with high quality materials and components which are tested under stringent conditions. This ensures that ABB transformers meet the highest standards anywhere in the world. When specified, we can design our products to handle the harshest environments.

ABB has a rich heritage of technology development and innovation and has pioneered many of the features you see in today’s transformers. This includes the introduction of foil windings and wound core technology and the use of vacuum cast coils which significantly increase reliability and safety. Designs are properly adapted to modern manufacturing technologies aimed at maintaining the highest quality standards and keeping costs competitive.

Timely Delivery

You can be assured that we will meet our delivery commitments, be it to current or contracted lead times or in response to emergencies. When we agree on a delivery schedule, we’ll make sure your transformers are on site and ready to install.

If transformers arrive too early, they can get in the way on the job site, and if they arrive late it’s much worse. ABB makes sure that your padmounted transformers arrive when you need them, so your work can proceed seamlessly.
Distribution Transformer Testing

The ABB commitment to manufacture quality distribution transformers is backed by a series of transformer tests used to verify conformance to performance characteristics outlined in the latest revisions of IEEE C57.12.00 and IEEE C57.12.90. These identified tests are also part of the Quality System which is audited semi-annually by DET NOSKE VERITAS (DNV) to the ISO Standards.

Testing Program

Factory tests are performed on a transformer to confirm that it is properly designed and constructed to carry rated load and that it will withstand the conditions it will be exposed to in service. Each transformer manufactured by ABB must undergo a series of tests.

1. Polarity, Phase-Relation, and Ratio
2. Demag Test
3. Applied Voltage Test of the HV
4. Applied Voltage Test of the LV
5. Induced Voltage Test
6. No-Load (Excitation) Loss and Excitation Current
7. Impedance Voltage and Load Loss
8. Full Wave Impulse
9. Continuity Check

Test Facilities

The multi-station, automated test facilities are operated by process control computers. Required interaction with test floor personnel is minimal with the computers initiating and monitoring each test, and then analyzing the test results feedback. The computers are programmed to conduct tests according to IEEE standards, and according to the ratings of each transformer style, the test floor computers will initiate appropriate test setups, compare results with established IEEE standard limits, and determine acceptance for each tested unit.

The test results for each unit are recorded and stored on computer files for access and analysis.

Polarity, Phase-Relation, and Ratio Tests

These tests verify proper phase-relation (three phase), ratio, and polarity (single phase) of the transformer under test. To pass, a unit must demonstrate the proper polarity or phase-relation and have a turns ratio within one-half of one percent of the nominal voltage ratio.

Demag Test

Some transformers require the Demag Test to remove any residual magnetism in preparation for an impulse test. It also serves as a no-load exciting current test. A transformer passes this test if the exciting current does not exceed the limit specified for the design of the transformer.

Applied Voltage Test of HV

This test checks the dielectric integrity of insulation structures between the high voltage and low voltage, and between the high voltage and ground. A pass/fail decision is made by monitoring the test current intensity. If the resulting current is larger than specified normal leakage and capacitive current, the unit is rejected. This test is omitted for transformers with a permanently grounded high voltage winding.

Applied Voltage Test of LV

This dielectric test is similar to the Applied Voltage test of the high voltage circuitry except that the integrity of insulation structures between the low voltage and the high voltage, and between the low voltage and ground is checked. A pass/fail decision is made by monitoring the test current intensity. If the resulting current is larger than specified normal leakage and capacitive current, the unit is rejected.

Induced Voltage Test

The principal purpose of this test is to verify the dielectric strength of turn to turn, layer to layer, phase to phase, and other insulation structures within the transformer windings by inducing an overvoltage condition (at higher than normal frequency to avoid saturation of the core). The test current is monitored, and if it exceeds limits specified for each transformer, the unit is rejected.

No-Load Loss and Excitation Current

This test measures the no-load (excitation) loss and the transformer exciting current with rated voltage applied. If the exciting current and/or the no-load loss exceed the limits specified, the transformer is rejected.

Impedance Voltage and Load Loss

This test measures the load loss and the impedance voltage at rated current. The load loss and the impedance voltage must be within specified limits.

Full Wave Impulse

The impulse test is one of several tests designed to verify the dielectric strength of the many insulation structures within the distribution transformer against line voltage surges. It is performed to comply with IEEE standards and for quality assurance. The change in the IEEE standard in 1993 required all manufacturers to install fault detection sensitive enough to detect a single turn short.

Continuity Check

This test is performed on all transformers to verify transformer circuit and component integrity. This test is performed with an ohmmeter to verify that the internal wiring is correct.

The transformer’s nameplate is compared to manufacturing information for style, serial number, kVA, HV rating, LV rating, tap voltages, impedance, conductor materials and coil BIL rating. The bushings, electrical accessories, and fuses are verified.
Special Tests

Some tests are performed at the option of the customer.

Sound Testing

IEEE standards define the required sound levels for transformer but some customers specify reduced sound levels. The sound generated by a transformer is affected by the core geometry, flux density, tank design, and the quality of assembly of all the transformer components into a completed unit. Sound tests are made with the unit powered at 100% and 110% of rated voltage under no-load conditions.

Temperature Tests

Core losses and coil losses are the primary sources of heating within the transformer. Our transformers are guaranteed to have an average coil winding temperature of no more than 65° C rise over ambient air temperature when operated at rated voltage and load conditions.

The temperature test is performed to determine the thermal characteristics of the transformer and to verify that they are within design limits.

Calibration

Test equipment is calibrated on a scheduled basis by trained technicians. Calibration records are maintained in accordance with the Quality System procedures. These are audited semi-annually by DNV in accordance with ISO Standards.

Short Circuit Withstand Capabilities

Distribution transformers are subjected to external short circuits on the secondary side. Such external faults can develop on the service line, in the house wiring or in connected loads due to numerous environmental reasons. These faults can be line-to-ground, double line-to-ground or line-to-line.

To meet these operating conditions, the American National Standard Institute (IEEE) has set standards concerning short circuit withstand capability. These standards require that distribution transformers shall be designed and constructed to withstand the mechanical and thermal stresses produced by these external short circuits.

The current standards relating to short circuit strength are IEEE C57.12.00 which sets the short circuit withstand requirements for distribution transformers and IEEE C57.12.90 which provides procedures for short circuit testing.

For distribution transformers, the magnitude of the short circuit current, the numbers of short-circuit tests and the duration of each short circuit test are defined by IEEE standards as follows.

A. Magnitude

<table>
<thead>
<tr>
<th>Category</th>
<th>Single Phase kVA</th>
<th>Three Phase kVA</th>
<th>Withstand Capability*</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>5-25</td>
<td>15-75</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>37.5-100</td>
<td>112.5-300</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>167-500</td>
<td>500</td>
<td>25</td>
</tr>
<tr>
<td>II</td>
<td>750-2500</td>
<td></td>
<td>1/ZT**</td>
</tr>
</tbody>
</table>

*Base current (Symmetrical) per unit for all distribution transformers with secondary rated 600 V and below.

**The short circuit current will be limited by the transformer impedance only.

B. Number of Tests

Each phase of the transformer shall be subjected to a total of six tests, four with symmetrical fault currents and two with asymmetrical fault currents.

C. Duration of Short Circuit Tests

When short circuit tests are performed the duration of each test shall be 0.25 s except that one test satisfying the symmetrical current requirement shall be made for a longer duration on distribution transformers. The duration of the long test in each case shall be as follows:

Category I:

\[ T = 1250/I^2 \]

Where \( T \) is the duration in seconds,

And \( I = I_{sc}/I_R \) = symmetrical short circuit current, in multiples of normal base current except I shall not exceed the maximum symmetrical current magnitudes listed in A.

Where \( I_{sc} = I_R/Z_{T}\) = symmetrical short circuit current, in rms amperes

\( I_R = \) rated current on the given tap connection, in rms amperes

\( Z_T = \) transformer impedance on the given tap connection in per unit on the same apparent power base as \( I_R \)

Category II:

\[ T = 1.0 \text{ second} \]

Criteria of Satisfactory Performance

According to IEEE Standards a unit is considered to have passed the test if it passes a visual inspection and dielectric tests. Recommended additional checks include examination of wave shape of terminal voltage and current, leakage impedance measurement and excitation current test. (Refer to IEEE C57.12.90.)

The standard allows the following variations in the leakage impedance:

<table>
<thead>
<tr>
<th>( Z_T ) (Per Units)</th>
<th>Percentage Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0299 or less</td>
<td>22.5-500 ( Z_T )</td>
</tr>
<tr>
<td>0.0300 or more</td>
<td>7.5</td>
</tr>
</tbody>
</table>

\( Z_T = \) per unit impedance of the transformer
Paint Finish Process

ABB utilizes a multi-step process to apply a corrosion resistant finish to transformers. The materials and processes used are designed to protect against the effects of abrasion, sunlight, rural and industrial atmospheres, and humidity. Each carefully controlled process step has a specific purpose, and each step builds on the previous steps to form the complete protection system that ensures that our transformers meet IEEE functional paint specification guidelines.

Paint Process Procedure

Transformer parts receive the following steps of surface preparation prior to painting.

1. Abrasive cleaning: All parts are cleaned or prepped to remove welding by-products and provide more consistent adhesion and corrosion protection.

2. Alkaline wash cleaner: Removes mill oils, drawing oils, and shop soils that could interfere with good adhesion.

3. Water rinse.

4. Iron phosphate coating: Provides a firm anchor for good paint adhesion and provides resistance to underfilm corrosion should the paint film be damaged, exposing bare metal.

5. Water rinse.

6. Deionized water rinse: Removes any ionic contamination to prepare for first application of paint.

The entire cleaning and pretreating process is automatic and conveyorized with all chemicals applied by spray. The pretreatment system combines the latest in cleaning technology such as DI rinses and iron phosphate over abrasive cleaning in a tried and true format to provide the best possible pretreatment before paint is applied.

One of the keys to effectiveness of the ABB paint finish system is the primer. The green epoxy primer is applied by cationic electrodeposition – a dip process in which positively charged primer particles are attracted to grounded parts (cathodes). This method applies a very uniform, pinhole-free coating which penetrates and thoroughly coats all parts. This is a highly effective process for coating parts with difficult geometry. The process utilizes practically 100% of the primer paint, and since the primer is water borne OSHA and EPA emission standards are met. The primer is free of lead and chrome. After rinsing, parts are cured in an oven in preparation for the next step.

After the transformer is assembled, a final coating of two-component urethane paint is spray applied for color and additional film build. The final coat provides the weatherability necessary to protect the unit from sunlight and maintain its appearance.

Summary

The ABB paint system utilizes advanced techniques and materials to provide a superior finish system on padmounted distribution transformers. Each step in the process is specifically designed to maximize finish performance while minimizing waste to provide the best possible combination of performance.
# Paint Finish Specifications and Test Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Test Method</th>
<th>Specification</th>
<th>Typical ABB Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total exterior film build</td>
<td>Elcometer 456 Basic F</td>
<td>Not specified by IEEE</td>
<td>2-4 mils</td>
</tr>
<tr>
<td>Adhesion</td>
<td>ASTM D3359</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Humidity 1000 hrs.</td>
<td>ASTM D4585 @45c</td>
<td>No blisters, up to 1 pencil hardness change per ASTM D3363</td>
<td>No blisters, no softening</td>
</tr>
<tr>
<td>Impact, 80 InLb</td>
<td>ASTM D2794/ ASTM B117</td>
<td>No red rust after 24 hrs.</td>
<td>No red rust after 24 hrs.</td>
</tr>
<tr>
<td>Oil resistance</td>
<td>Immerse in 100c Oil for 72 hrs.</td>
<td>No loss of adhesion per ASTM 3359, no blisters, no streaking, up to 1 pencil hardness change per ASTM D3363</td>
<td>No loss of adhesion, no blisters, no streaking, no change in hardness, color or gloss</td>
</tr>
<tr>
<td>QUV, 500 hrs.</td>
<td>ASTM G53/D523</td>
<td>50% loss of gloss, no cracks, no crazing</td>
<td>40% loss of gloss, no cracks, no crazing</td>
</tr>
<tr>
<td>Abrasion, 3000 cycles</td>
<td>ASTM D4060</td>
<td>No red rust after 24 hrs.</td>
<td>No red rust after 24 hrs.</td>
</tr>
<tr>
<td>Gravelometer, 60 PSI</td>
<td>ASTM 3170/ SAE J400</td>
<td>After 24 hrs. red rust in chips to not exceed 4B rating</td>
<td>4A (better than 4B)</td>
</tr>
<tr>
<td>QUV/SCAB, 15 cycles</td>
<td>ASTM G53</td>
<td>6 rating per ASTM D1654, no blisters</td>
<td>6 rating per ASTM D1654, no blisters</td>
</tr>
</tbody>
</table>

Paint meets or exceeds IEEE C57.12.28 and EEMAC Y1-2, Canadian Standard.

Individual product specification sheets located in folder.