Network Transformers

Figure 1: Network Transformer

Introduction

Howard network transformers are designed and built according to the most exacting engineering standards to provide many years of outstanding performance and reliability in the most demanding utility network applications. Product scope includes capacities from 300 kVA through 2,500 kVA with high-voltage ratings from 2.4 kV through 34.5 kV and low-voltage ratings through 600 Volts. Network transformers are typically used to supply power to grid-type secondary distribution systems in areas of high load density, such as are found in large cities and are designed for either vault-type or subway-type applications. Vault-type network transformers are designed for installation in above-ground dry vaults, where occasional submersion may occur. Subway-type network transformers are designed for installation in subsurface vaults, where frequent or continuous submerged operation is likely. Subway designs may also be used in vault-type applications.

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Design and Manufacturing

Transformer Design

Howard network transformers are designed with conservative mechanical and electrical margins to withstand the harsh environments encountered in today's network distribution systems. Core-and-coil designs are optimized for the lowest procurement cost or lowest total owning cost according to each customer's specific requirements. All designs are guaranteed to meet the U.S. Department of Energy's minimum efficiency standards. General industry standards applicable to Howard network transformer designs include IEEE C57.12.00 Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers, ANSI C57.12.40 American National Standard for Secondary Network Transformers, Subway and Vault Types (Liquid Immersed)—Requirements, IEEE C57.12.90 Standard Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers and Guide for Short Circuit Testing of Distribution and Power Transformers, IEEE C57.93 Guide for Installation of Liquid-Immersed Power Transformers, IEEE C57.98 Guide for Transformer Impulse Tests, IEEE C57.100 Standard Test Procedure for Thermal Evaluation of Oil Immersed Distribution Transformers, 10 CFR Part 431, Department of Energy, Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule, and 10 CFR Part 431, Department of Energy, Energy Conservation Program: Test Procedures for Distribution Transformers; Final Rule.

Core-and-Coil Design

Howard's five-legged core-form design provides excellent mechanical strength that has been proven through rigorous design verification testing and years of field service. Mechanical strength is achieved through the use of a rugged steel mounting frame that provides solid support for core/coil assembly.

Core-and-coil designs are optimized to provide the lowest total owning cost or lowest purchase price according to each customer's specifications. In addition, all network transformer ratings, where applicable, are designed to satisfy the minimum efficiency standards set by the U.S. Department of Energy.

Core Construction

Cores are fabricated using high-efficiency grain-oriented silicon steel that has been precision slit and edge conditioned by the supplier. Step-lap joints are used to minimize losses and exciting current, and to insure quiet operation. Cores are designed to operate at flux densities well below saturation. Stress-relief annealing is employed to maximize efficiency and establish the required rectangular shape of each core loop. Prior to assembly each core is carefully tested to ensure it meets dimensional, exciting current and no-load loss specifications. Amorphous metal cores are available for those applications requiring ultra-low excitation losses.

Coil Construction

High-voltage coil windings are constructed of copper or aluminum magnet wire. Automatic wire tensioners, computer-controlled traverse mechanisms and laser alignment systems ensure that coils are wound tightly and accurately. Low-voltage coil windings are constructed of edge-conditioned full-width sheet conductor, available in either copper or aluminum. Low-voltage sheet windings provide the advantage of virtually eliminating axial forces during short circuit.

Turn-to-turn insulation in the high-voltage winding is Formvar® or extruded polymer coating. Main barrier and layer insulation in both low-voltage and high-voltage windings is thermally-upgraded craft, providing exceptional insulation life. Insulation paper is coated with a thermoset epoxy adhesive throughout the coil to produce excellent layer-to-layer bonding. Strategically placed oil ducts provide oil flow and adequate cooling throughout the windings. The insulation system is designed to provide exceptional impulse withstand capability.

Tank Construction

Network transformer tanks are of sealed construction, including a sub-base and a welded main cover with bolted (standard) or welded hand-hole cover. The sub-base consists of steel bars parallel to the long axis of the transformer with jacking areas located along the length and width of the tank bottom. The copper-bearing steel plate used to construct the tank is reinforced with side wall braces, and all tank seams are continuously welded. The completely sealed tank is capable of withstanding a pressure of 7 psig without permanent deformation and 15 psig without rupture. Four lifting lugs are supplied and arranged for lifting of the complete transformer including the network protector, if attached. Tank grounding provisions consist of copper-faced or stainless-steel pads welded to the tank. Fastening hardware is composed of corrosion-resistant steel. The tank exterior finish is in accordance to the requirements of ANSI C57.12.40.

High-Voltage Switch and Terminal Chamber

The high-voltage switch is a fluid-immersed rotary type switch located in the high-voltage switch chamber, with an adjacent terminal chamber located above. An optional single-chamber design is available. The switch has three operating positions, OPEN, CLOSED, and GROUND, clearly indicated on the switch indicator plate. A mechanical stop is provided to prevent unintentional operation of the switch and to allow an electrical interlock to prevent operation if the transformer is energized. Several different types high-voltage cable entrances are available.

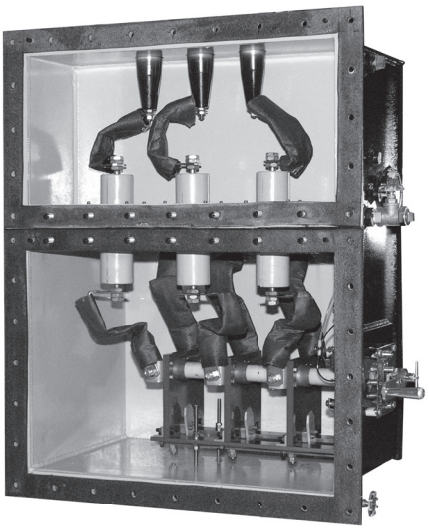

Figure 2: High-Voltage Switch and Terminal Chamber

Network Protector Provisions

A secondary throat and support brackets are provided on the low-voltage termination side of the tank that are suitable for mounting a low-voltage network protector.

Figure 3: Network Protector Provisions

Table 1: Factory Testing

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Factory Testing

In addition to numerous quality inspections throughout the manufacturing process, final tests are conducted on the completed network transformer to ensure proper function of all systems. All tests are conducted in accordance with applicable industry standards. Test equipment is state-of-the-art and capable of extremely accurate and reliable test measurements, meeting all the industry loss measurement standards. All test systems are calibrated regularly according to industry standards. Calibration of loss-measuring equipment is NIST traceable.

The following standard and optional production-line tests are performed. Standard tests are performed on each completed transformer. Optional tests are performed upon customer request and at customer expense. Customers may arrange to witness factory testing. All tests will be made in accordance with the latest revisions of IEEE C57.12.00 Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers and IEEE C57.12.90 Standard Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers and Guide for Short Circuit Testing of Distribution and Power Transformers.

Production-Line Tests	Standard Test	Optional Test
Winding resistance	•	
Winding insulation resistance (Megger)		•
Ratio	•	
Polarity and phase relation	•	
Insulation power factor		•
No-load losses and excitation current	•	
Impedance voltage and load losses	•	
Zero-phase sequence impedence voltage		•
Temperature rise		•
Low frequency dielectric tests	•	
Applied potential	•	
Induced potential	•	
Lightning impulse	•	
Front-of-wave impulse		•
Audible sound level		•
Leak test	•	
Partial discharge (RIV)		•
ANSI impulse test		•

Quality Assurance

Howard employees understand the importance of quality, particularly as it relates to network transformer applications. Emphasis on quality begins at design and follows throughout the manufacturing and delivery processes. Only the highest quality components and materials are used in Howard network transformers. Attention to detail during manufacture, and careful inspection and testing ensure that a high level of quality is maintained.

Howard's quality management system is designed to ensure that all of the company's products and services meet or exceed our customers' requirements and is certified by DQS-UL as being compliant with ISO-9001:2008. The ISO-9001:2008 standard covers design, manufacturing, and servicing systems, and is the most stringent and comprehensive standard in the internationally recognized ISO-9000 series of quality standards.

CERTIFICATE

UL DQS Inc.
Management Systems Solutions

hereby certifies that the company

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Reference No. 10002179

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Reference No. 10003978

has implemented and maintains a **Quality Management System**.

Scope:
The design and manufacture of distribution and power transformers.

Through an audit, documented in a report, it was verified that the management system fulfills the requirements of the following standard:

ISO 9001 : 2008

Certificate Registration No. 10002179 QM08
Date of Certification 2009-09-27
Valid until 2012-04-13

Ganesh Rao
President

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Features and Accessories

Howard network transformers are available with a wide range of features and accessories in order to satisfy the requirements of even the most demanding applications. Contact the factory or your area sales representative for the availability of other design options not listed.

Standard Features and Accessories

Howard network transformers are supplied with the following standard features and accessories:

- Self-cooled power ratings (ONAN)—300 kVA through 2,500 kVA, three-phase
- High-voltage rating—from 2.4 kV through 34.5 kV
- High-voltage taps—Per ANSI C57.12.40.
- Low-voltage ratings—through 600 Volts
- BIL levels—Per ANSI C57.12.40
- Excitation limit—Per ANSI C57.12.00
- Average temperature rise—55ºC/65ºC
- Frequency—60 Hertz
- Impedance and impedance tolerance—Per ANSI C57.12.40
- Audible sound levels—Per ANSI C57.12.40
- Service location—vault-type network transformers are suitable for installation in above-ground dry vaults where occasional submersion is possible. Subway-type network transformers are suitable for installation in subsurface vaults where frequent or continuous submersion is likely. Subway type designs are suitable for subway or vault applications.
- Cooling/insulating fluid—Type II mineral oil with oxidation inhibitor
- Fluid preservation system—sealed tank
- Main tank—copper-bearing steel construction, with sub-base, main cover, and the following standard accessories:
  - Dial-type magnetic liquid-level indicator (without alarm contacts) welded to tank
  - Dial-type thermometer (without alarm contacts)
  - Combination drain and bottom filter valve
  - Filling plug and upper filter press connection
  - Top liquid sampling plug
  - Air test provision
  - Grounding pad welded to tank
  - Lifting provisions for complete unit
  - Lifting provisions for main tank cover
  - Cover-mounted, pad-lockable tap changer switch under protective pipe cap for de-energized operation (on units supplied with high-voltage taps)
  - Bolted hand hole cover
  - Corrosion-resistant steel fastening hardware
  - Secondary throat suitable for mounting network protector, with mounting holes, guide pins, gasket, and steel plate shipping guard
  - Subway-type radiator panels (when required by design)
  - Pressure-relief valve (subway type)
- Primary terminal chamber—sealed enclosure welded to main tank above the primary switch chamber, with the following standard accessories:
  - Bolted cover with, gasket, guide pins, and lifting provisions
  - Drain plug
  - Liquid filling plug
  - Liquid level and vent plug
  - Three replaceable primary bushings between terminal chamber and switch chamber, with terminals
  - Primary entrance consisting of one of the following two methods: 1) wiping sleeves or 2) dead-front bushing bushings
- Primary switch chamber—sealed enclosure welded to main tank beneath the primary switch chamber, with the following accessories:
  - Bolted cover with, gasket, guide pins, and lifting provisions
  - Three-pole, three-position, 200 Ampere, non-interrupting high-voltage switch and external operating handle with latch
  - Electrical interlock on switch
  - Dial-type magnetic liquid level indicator welded to chamber (without alarm contacts)
  - Liquid filling plug
  - Air test provision
  - Drain valve
  - Mineral oil insulating fluid
- Low-voltage termination consisting of the following:
  - Three externally replaceable bushings bolted to the tank within the secondary throat
  - Three flexible connectors for electrical connection to a network protector
  - Low-voltage neutral connection welded to the tank
- Paint finish—catalyzed epoxy primer plus catalyzed urethane enamel topcoat; 3.0 mils nominal dry thickness
- Nameplate—non-corrosive diagrammatic nameplate, permanently attached with non-corrosive hardware

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Optional Features and Accessories

The following optional features and accessories are available. Check with the factory for the availability of other features and accessories not listed.

- Series-multiple high-voltage winding
- Delta-wye connection
- Special high-voltage taps
- Special low-loss high efficiency designs
- Design optimization to lowest total owning cost
- 50 Hertz operating frequency
- Special impedance
- Special sound level
- Special phase relationship
- Special BIL level
- Over excitation capability
- 65° C average temperature rise
- Special ambient temperature
- Operation at altitudes above 3300 feet
- Copper windings
- Core ground test point located inside tank accessible from bolted handhole
- Electrostatic shields
- Optional tank features and accessories
  - Special hardware
  - Welded handhole cover
  - Additional bolted or welded hand-hole
  - Special tank design pressure (up to 15 psig)
  - Ground connectors
  - Special tank dimensions
  - Tank undercoating
  - Omit pressure-relief valve
- Optional gauges and fittings
  - Dial-type magnetic liquid-level gauge (with alarm contacts)
  - Dial-type thermometer (with alarm contacts)
  - Pressure-vacuum gauge (with or without alarm contacts)
  - Automatic pressure-relief device (with or without alarm contacts)
  - Drain valve with liquid sampling valve
  - Additional drain valve on tank or switch chamber
  - Spare gaskets for secondary throat, bolted handholes, high-voltage terminal chamber, and switch chamber
  - Sight gauge for high-voltage terminal chamber
  - Other options (check with factory)
- Optional high-voltage switch features and accessories
  - Interrupting switch or other special switches
  - Provisions for phase sequence identification (phasing tubes)
  - Phase sequence indication (sequential grounding), including 3 internal grounding contacts, 5-position switch to indicate phase when switch is moved from transformer positions to ground position
  - Additional electrical interlocks
  - Viewing windows for observation of switch blades (with hinged protective cover)
- Optional high-voltage entrance features and accessories
  - Single-conductor or multi-conductor wiping sleeves, or pothead entrance
  - Six universal bushing wells for loop feed with or without loadbreak inserts (HV switch must be omitted)
  - Three integral loadbreak bushings
  - Three non-loadbreak bushings
  - Six non-loadbreak bushings for loop feed (HV switch must be omitted)
  - Six integral loadbreak bushings for loop feed (HV switch must be omitted)
  - Three molded bushings mounted on front of terminal chamber in lieu of the standard wiping sleeve
  - Potheads, one 3-conductor or three 1-conductor, instead of the standard terminal chamber
  - Bottom entrance of HV cable, including wiping sleeves
  - Packing gland or stuffing box
  - Phase separation barriers in compartment (when switch is omitted)
  - Dielectric fluid or compound for terminal chamber
- Optional low-voltage air terminations
  - Welded low-voltage bushings
  - Fully insulated low-voltage neutral bushing
  - Other low-voltage termination options (check with factory)
- Optional network protector provisions (check with factory)
- Optional dielectric fluids
  - Silicone fluid
  - FR3 natural ester-based fluid

Warranty Service and Maintenance

Warranty Service

Should product defects be discovered during the warranty period, immediately contact the factory or your area sales representative. A warranty claim will be processed, so that any problem can be resolved quickly.

Replacement Parts

Replacement parts can be obtained by contacting the factory or your area sales representative. Be prepared to provide the transformer serial number, which is located on the transformer's diagrammatic nameplate.

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Catalog Section 94-10
Document 2.4.85, Revision 0, April 9, 2010

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