INSTALLATION, OPERATIONS AND MAINTENANCE MANUAL

MEDIUM VOLTAGE OUTDOOR VOLTAGE TRANSFORMERS

5–34.5 kV

ENGINEERED
TO OUTRUN

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APPLICATION, INSTALLATION AND USE

VOG, VOY, VOZ, VOZZ and VRO voltage transformers

This installation, operation and maintenance manual is valid for dry-type medium voltage outdoor voltage transformers (VTs). These VTs include one-bushing transformers for line-to-ground (L-G) applications and two-bushing transformers for line-to-line (L-L) or L-G applications.

Safety information

⚠ WARNING

- Keep these instructions available to personnel responsible for the product's proper installation, maintenance and operation.
- Follow your company's safety procedures.
- Read these instructions carefully before attempting to install, operate or maintain this device. Failure to follow these instructions could cause severe personal injury, death or property damage.
- Apparatus covered by this instruction literature should be operated and serviced only by competent personnel familiar with the installation of this type of product and good safety practices. These instructions are written for such personnel and are not intended as a substitute for proper training and experience in safety procedures for this type of equipment.

Safety symbols

⚠

This is the safety alert symbol. It is used to alert you to potential physical injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

Danger indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Warning indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Caution indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Notice is used to address practices not related to physical injury.

General information

Voltage transformers (VTs) covered by this guide are designed to transform primary voltages from 5–34.5 kV to a level that is usable for measurement and protection devices. Most VTs are designed for 60 Hz but can also be designed for other frequencies.

Instrument voltage transformers can also be referred to as potential transformers (PTs).

This guide includes instructions for the following types of voltage transformers:

- VOG-11, VOG-15B and VOG-20B
- VOY-60, VOY-75B, VOY-95, VOY-11B, VOY-11G,VOY-12, VOY-15 and VOY-20
- VOZ-75B, VOZ-11B, VOZ-11G, VOZ-15 and VOZ-20
- VOZZ-15, VOZZ-15G, VOZZ-20G and VOZZ-20
- VRO-150G and VRO-200G

VTs with the letter “G” in the type designation are designed for line-to-ground (L-G) applications only, and the rest are designed for line-to-line (L-L) or L-G applications. VT type designations including the letters “Y”, “Z” or “ZZ” designate the burden per IEEE C57.13.

Any of these type designations may be followed by another letter that indicates additional features. The letter “E” indicates a high accuracy VT with 0.15 class accuracy. The letter “R” indicates the VT is designed with ABB’s ResiVolt™ technology for very fast transient (VFT) overvoltage resistance.

For additional naming conventions, reference ABB’s instrument transformer and sensor type designations guide.

Operating conditions

ABB’s medium voltage outdoor VTs are designed to be installed and operated on 5–34.5 kV overhead lines or inside enclosures that may experience condensation, such as pad-mounted metering cabinets in outdoor conditions.

Unless otherwise noted in the individual product literature, VTs are rated per IEEE C57.13 for ambient temperatures between -30 °C and +70 °C (storage and transportation temperatures in the same range). Select VTs are rated down to -50 °C, which is noted in the specific product literature when applicable. The average ambient temperature, measured over a period of 24 hours, should not exceed 30 °C and the temperature of the cooling air should not exceed 40 °C.

These transformers are designed and tested for applications up to 1000 meters above sea level. Contact the factory or your ABB sales representative for applications above 1000 meters.

For insulation and protection, transformer bodies are cast in either polyurethane or hydrophobic cycloaliphatic epoxy (HCEP). Units cast in polyurethane are black in appearance, and HCEP units are gray. Both materials can be used in outdoor environments; however, HCEP offers superior arc track, ozone and ultraviolet-resistive properties while providing excellent physical strength. The hydrophobic surface properties of HCEP are recommended for wet, humid, coastal or contaminated environments.

Before mounting, ensure that the characteristic data on the nameplate matches the requirements of the system.

For additional environmental service conditions, see IEEE C57.13.4.

Technical details

For transformer dimensions, refer to the dimensional drawings in the product literature. Rated values for each individual transformer are stated in the product literature and on the product’s nameplate.

Some VTs are specially designed to withstand very fast transient (VFT) overvoltages. These VTs make up the family of transformers that are designed with ResiVolt™ transient resistant technology, which offers unparalleled performance in applications where frequent line switching is present, including but not limited to areas with significant recloser or capacitor bank switching or where renewable generation is present.

VRO models meet IEC 61869-3, Clause 7.2.3 and CAN/CSA 411.1, Clause 6.6 requirements for basic impulse and fast impulse transient withstand.

Installation instructions

Safety instructions

⚠ WARNING

Always consider the transformer as part of the circuit to which it is connected. Do not touch the leads, terminals or other parts of the transformer unless they are known to be de-energized and grounded.

⚠ WARNING

Always ground instrument transformers using appropriate grounding methods based on the application. This can be done through the metallic baseplate, grounding L-bracket connected to the baseplate and to the ground terminal inside the secondary junction box. See section 1.5.5 for additional grounding instructions.

01 Possible grounding connections include the baseplate, external L-bracket or inside junction box

NOTICE

Never short-circuit the secondary terminals of a voltage transformer, even when it is not in use. A secondary short circuit will cause the unit to overheat and fail in a very short period.

Lifting

VT lifting methods depend on the weight of the transformer. Regardless if lifting the transformer by hand or using a strap, HCEP or polyurethane VTs should always be lifted by the lowest bushing shed (see figure 03). Two-bushing VTs can be lifted by the base of either bushing. VOZZ transformers should be lifted by the four ring-type lifting lugs located at each corner of the baseplate. Review figure 02 and the individual product literature for transformer weight to ensure the lifting hoist, strap and other equipment are properly rated for the transformer's weight. Lifting the transformer should be performed slowly and fluently without any abrupt movements.

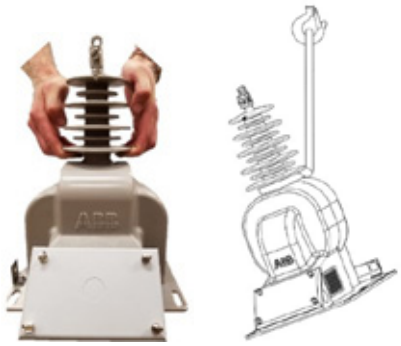
NOTICE

Never lift voltage transformers by the primary terminal clamp.

TABLE 1: APPROXIMATE OUTDOOR VT WEIGHTS

Transformer type	Approximate weight (lbs.)
VOY-60, VOY-95	40
VOG-11	45
VOY-11G, VOZ-11G	80
VOZ-75B, VOY-11B, VOZ-11B	83
VOY-12	75
VOG-15R	85
VOG-15B, VOG-20B, VOG-20BR	125
VOY-15, VOZ-15, VOY-20, VOZ-20	125
VOZZ-15G	202
VOZZ-15	205
VOZZ-20G	370
VOZZ-20	380
VRO-150G	140
VRO-200G	145

Note: All weights are for HCEP transformers, except for VOZZ transformers, which are only cast in polyurethane.



02 Proper lifting method by sling or by hand

Primary connections

The electro-tin plated primary bushing terminal has a ⅜–16 screw used for fastening of the primary conductor to the H1/H2 terminal. For torque values, see figure 05. This clamp-type terminal accepts10 AWG to 250 MCM wire (see figure 04).

03 Clamp-type primary terminal connection for VTs

Stud-type terminals (0.750–16 x 1.125), ideal for use in primary metering cabinets and other applications, are also available on some transformer types and are to be fastened with 60–100 ft-lbs. of torque per figure 05.

The H2 neutral terminal is insulated to withstand a 19 kV test level and can be disconnected from the external ground cable for power factor measurement.

Secondary connections

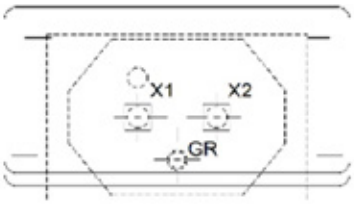
Secondary connections are made inside the secondary junction box and include brass hex-head slotted screws. Connections can be made with ring terminals or by using the ¼"–20 x 0.375" screws as clamp-type connections for 18–5 AWG wire (minimum of 11 AWG wire is recommended).

TABLE 2: RECOMMENDED TORQUE VALUES FOR SCREW CONNECTIONS

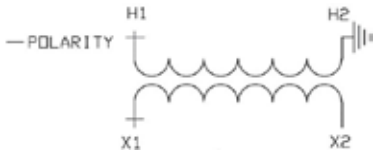
Screw	Min. torque (ft-lbs.)	Max. torque (ft-lbs.)
¼–20	2.5	4
⅜–16	15	26
7/16–14	25	37
¾–16	60	100

Refer to product nameplates for wiring diagrams for each style. Examples of different types of secondary connections are shown below. Unlabeled dashed circles represent polarity markers.

Single secondaries



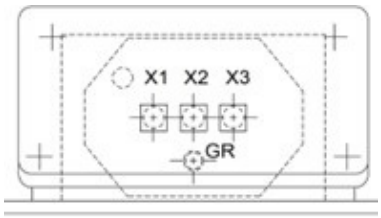
SINGLE SECONDARY



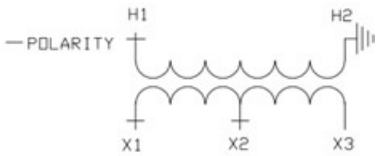
04 Single secondary connections inside junction box

Single secondary styles only have one secondary winding and only require secondary connections on the X1–X2 terminals.

Tapped secondaries



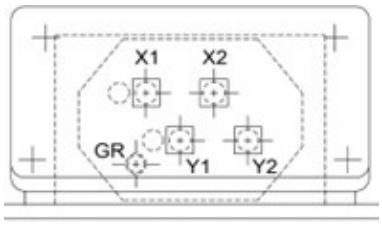
TAPPED SECONDARY



For tapped secondary styles, two of the three connections must always be used. X1–X3 is the full winding and X2–X3 is the tapped ratio.

Example: 175/300:1
X1–X3, 175:1
X2–X3, 300:1

Double secondaries

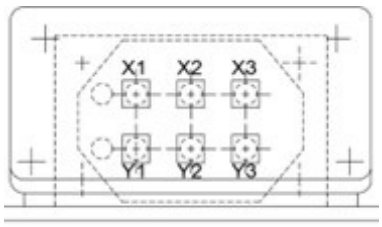


DOUBLE SECONDARY

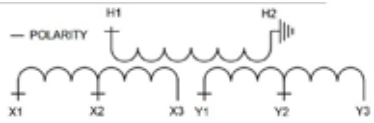
For double secondary styles, X1–X2 represents the X winding ratio and Y1–Y2 represents the Y winding ratio.

Example: 175 and 300:1
X1–X2, 175:1
Y1–Y2, 300:1

Double tapped secondaries



DOUBLE TAPPED SECONDARY

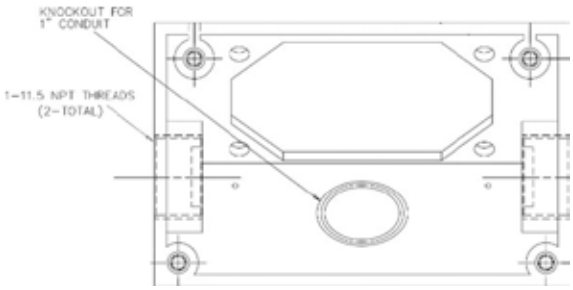


For double tapped secondary styles, X1–X3 andY1–Y3 represent the full winding ratio for the X and Y windings, respectively. In both cases, two connections on the same winding must be used. Because the junction box has no space inside for a ground connection, the transformer must be externally grounded by the L-bracket grounding terminal or baseplate.

Example: 175/300:1 and 175/300:1
X1–X3, 175:1
X2–X3, 300:1
Y1–Y3, 175:1
Y2–Y3, 300:1

Secondary junction box

The junction box for the secondary terminals is made of plastic (DuPont Rynite 935) with a one-inch 11.5 NPT threaded conduit hub on each side and a one-inch non-threaded knockout on the bottom (see figure 07). Secondary junction boxes are shipped with all conduit connections sealed to prevent water ingress during shipping, but the seals are designed to be removed easily for installation and use. A cover and thumb screws are provided to close the junction box after connections are made.



05 Secondary junction box with bottom knockout

Grounding

Voltage transformers must be connected to ground potential by the aluminum baseplate, internal junction box ground and/or baseplate ground lug (L-shaped bracket). The maximum resistance measured between the H2/N/⏚ terminal and transformer grounding point should not exceed5 Ω.

Always ground one secondary terminal of the transformer (X2/n recommended), except the residual voltage windings of a voltage transformer connected to open delta. Residual voltage windings connected to open delta must have Y2/dn terminal earthed only on one of three transformers. When the secondary of the transformer is interconnected, there should be only one grounded point to prevent accidental paralleling with system grounding. In case of disconnection from the ground, the grounding screw must be removed from the secondary terminal.

Mounting

Transformers can be mounted in either upright (vertical) or cantilever (horizontal) positions asper figure 08. They can also be mounted upside down in an “underhang” position, but this is not recommended due to the location of the weep holes on the bottom of the junction box. Weep holes allow moisture to exit the junction box; however, mounting in an underhang position creates potential for rainwater to enter the box. Contact the factory or your ABB sales representative for applications where underhang mounting is required.

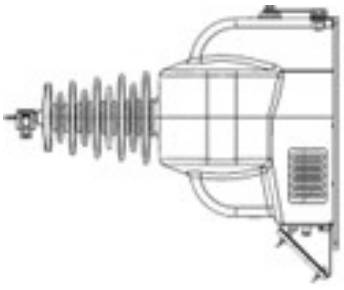
The maximum cantilever load that can be applied to the primary terminal is 5 ft.-lb.

Specific mounting orientation options can be found below and in the individual product literature.

TABLE 3: ACCEPTABLE MOUNTING ORIENTATIONS FOR OUTDOOR VTS

Transformer type	Upright	Cantilever
VOY-60, VOY-95	•	•
VOG-11	•	•
VOY-11G, VOZ-11G	•	•
VOZ-75B, VOY-11B, VOZ-11B	•	•
VOY-12	•	•
VOG-15R	•	•
VOG-15B, VOG-20B, VOG-20BR	•	•
VOY-15, VOZ-15, VOY-20, VOZ-20	•	•
VOZZ-15G	•	
VOZZ-15	•	
VOZZ-20G	•	
VOZZ-20	•	
VRO 150G	•	•
VRO 200G	•	•

06 Representation of a VT mounted in the upright orientation



07 Representation of a VT mounted in the cantilever orientation

Transformers are provided with aluminum base plates for mounting to cross arms, racks, etc. See the individual product literature for specific baseplate mounting dimensions. Mounting bolts are not included.

Clearance
Always ensure adequate clearances between the live components of transformers, medium voltage lines and ground. These clearances can be found and referenced in IEEE and NEMA standards.

Instructions for use
Uses for VTs
Voltage transformers are used to isolate the primary and secondary circuits from each other to protect the secondary equipment from the harmful effects of higher voltages appearing during normal operation. These higher voltages are reduced to much lower and safer levels, typically 115–120 V.

Voltage transformers provide measurement for the purpose of revenue metering, control and protection applications, and can be used as an auxiliary power source, such as powering medium voltage apparatus controllers.

NOTICE

The use of VTs for purposes other than described in this manual, or at higher than advertised voltages, is not recommended and will void the manufacturer's warranty if not agreed upon with ABB. Before installation, discuss with ABB any application conditions that may exceed product ratings.

VT voltage designations
Voltage class designations may vary slightly by application. For example, units listed as 36 kV may have a nominal system voltage rating of 34.5 kV and maximum system voltage rating of 36.5 kV, as per IEEE C57.13, and may be rated for 38 kV if used in switchgear applications.

14400/24940Y — This unit is rated for 14400 operating volts. It can be connected at 14400 volts L-G on a 24940 volt system (L-L volts are 24940 V) OR it can be connected L-L on a system with 14400 V L-L. This unit is not suitable for operation at 24940 volts. The "Y" indicates it has two fully insulated bushings, suitable for L-L connection.

14400/24940GY — This unit is rated for 14400 operating volts. It can be connected at 14400 volts L-G on a 24940 V system (L-L volts are 24940 V). It CANNOT be connected L-L. The "GY" indicates it only has one fully insulated bushing, making it suitable for L-G connection only.
14400/14400Y — This unit is rated for 14400 operating volts. It can be connected at 14400 V L-L.

14400/14400GY — This unit is rated for 14400 operating volts; however, it can only be connected L-G. Therefore, the actual operating voltage of the unit is 14400/1.73. The accuracy and thermal ratings of this unit are based on 14400 V. This is typical where there is a relay connected to the unit that should operate when there is a single L-G fault. In this condition, the L-G voltage becomes equal to the L-L voltage. The "GY" indicates it only has one fully insulated bushing, making it suitable for L-G connection only.

Fusing
Fuse selection should consider VT thermal ratings, in-rush expectations and time coordination with up- and down-stream protection devices. In many cases, fusing may be applied to both the primary and secondary sides. Primary fuses protect the system and other connected equipment in the case of VT failure, whereas secondary fuses protect the VT from damage in the event of secondary faults or short circuits.

Ferroresonance protection
The primary method for stopping ferroresonance is to "damp" the circuit. There are three main approaches for this: damping resistors, saturable reactors and active electronic damping. ABB has developed two products that can be used as ferroresonance protection, the FSR saturable reactor and VT Guard PRO active electronic dampening device. Contact your ABB sales representative for more information.

1. **Damping resistors —** This approach uses a high-power resistor in parallel with the secondary load. This can be deployed on existing installations of PTs. Contact ABB for recommendations on using damping resistors.
2. **FERROGUARD™ outdoor saturable reactor (FSR-983) —** The FSR-983 is a type of passive protection that can offer more protection than simpler damping resistors while potentially having a smaller impact on VT performance accuracy. The FSR-983 is typically used in retrofit or upgrade applications and is specifically designed to be paired and matched with each individual transformer. When voltages increase above the normally expected values, FERROGUARD saturates and dramatically increases the damping burden on the main transformer to help avoid damage to the VT from the ferroresonance event.
3. **VT Guard PRO —** The VT Guard PRO is considered an active suppression device and has the advantage of not affecting VT performance accuracy; however, it requires a residual VT winding for connection. Mainly used in new installations, the VT Guard PRO applies prompt damping action without creating excessive power consumption.

Instructions for maintenance
Excessive dust or other kinds of pollution must be cleaned off the transformer. HCEP transformers can be cleaned with spirits, petrol or toluene. Polyurethane transformers should be cleaned with water or water and a mild soap. Review material safety data sheets (SDS) and use appropriate safety procedures and personal protective equipment when using any chemicals.

Traces of arcs and minor surface damages can be removed easily with sandpaper, after which the surface needs to be treated by applying a thin layer of silicone paste. Instructions for repairing greater surface damages must be requested from ABB.

Transportation and storage
The permissible transportation and storage temperature is from -30 °C to +70 °C.

Some VTs are rated to -50 °C — see the appropriate individual product literature for temperature range.

In ideal conditions, the transformers should be kept in their original packaging or in dry and clean accommodations, protected from direct sunlight, precipitation and frost. This additional protection will increase the longevity of the transformer.

Transformers are packed in wooden crates orin boxes on a skid. It is important to adhere to package labeling such as “do not stack,” proper storage direction, etc.

Disposal of the transformer
Materials used in instrument transformers are non-toxic and will not harm the environment. All appropriate regulations should be followed in product disposal.

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