Your safety first!
This is the reason why our manual begins with the following guidelines:
– Use the transformer for its intended purpose.
– Follow the technical data given on the rating plate and in the specification.
– To facilitate and ensure high quality standards, the installation should be carried out by specially trained personnel or supervised by the ABB service department.
– Operations have to be carried out by specially trained electricians who are familiar with this manual.
– Observing the standards (DIN VDE/IEC), the local H&S regulations and the requirements of the local electric authority is recommended.

– The transformer operation mode should be changed in accordance with the instructions in this manual.
– All documentation should be available to all persons involved in installation, maintenance and operation.
– The involved personnel shall bear all responsibility for all aspects related to the operational safety as stated in EN 50110 (VDE 0105) and national regulations.
– Observe the safety rules, which are compliant with EN 50110 (VDE 0105). This standard regards ensuring a no-voltage status at the site for works to be carried out on the transformer.

If you have any questions regarding the information contained in this manual, our organisation will provide the necessary information.
Important information
This manual is intended to explain the product operation principle and product installation procedures.

NOTE:
All descriptions contained in this document are for general information only and do not make consideration for specific design requirements. Please refer to the exact design documentation while connecting the device.

Operating the device without first reading the manual may entail property damage, serious injury or death. The person responsible for the installation of the device should read this manual and follow the recommendations contained herein.

For your own safety:
– Make sure that all installation, service and maintenance works are carried by our professionals.
– Make sure that all applicable regulations will be preserved during all the work phases (installation, service, maintenance).

– Make sure that the guidelines contained in this manual are followed.

Basic guidelines for this manual.
Read the relevant chapters of this manual to provide adequate work.

Chapters in this manual are marked according to their meaning.

For the purposes of this manual, failure to follow the instructions concerning the dangers could result in death, serious injury and damage of equipment.
# Table of contents

1. Introduction .................................... 4  
2. Transformer delivery ................................ 4  
3. Transport, unpacking, lifting and erection ............. 4  
4. Storage ....................................... 4  
5. Installation ..................................... 4  
   5.1. Earthing terminals ............................. 4  
   5.2. Primary terminals ............................. 5  
   5.3. Secondary terminals ............................ 5  
   5.3.1. Current module terminals .................. 6  
   5.3.2. Voltage module terminals ................... 6  
   5.4. Ferroresonance .............................. 7  
6. Bolt tightening torques ................................ 7  
7. Operation and maintenance ............................ 7  
   7.1. Operator work .................................. 8  
   7.2. Corrosion protection ........................... 8  
8. Transformer design ................................ 9  
9. Disposal ........................................ 10  
   9.1. Recycling and disposal proceedings .......... 10  
10. Check list ..................................... 11  
   10.1. Before the first energising .................... 11  
   10.2. After the first energising .................... 11  
11. Final remarks ................................... 11
1. Introduction
This manual is valid for the combined instrument transformer type PVA 123a / PVA 145a. The instrument transformers are used for feeding the measurement and protection systems in power networks of 123 kV or 145 kV highest system voltage networks (or lower voltage) (regarding the highest phase-to-phase voltage effective value) and 50 Hz frequency. They are designed for operation in power systems with earthed or insulated neutral points as well as in compensated networks.

2. Transformer delivery
As standard method, the transformers are delivered in a unit packaging, in horizontal position on a transport bed. The delivered transformers are fully assembled, tested and ready for direct use. Product test protocols are delivered together with the transformers. Immediately after the delivery, check the transformer for any transport damage. Check the transport packaging. A damaged packaging may indicate a careless handling of the transformer. Then, check the transformer. Special attention should be paid to possible damage of sheds and binder at insulator flanges, the transformer tightness and the correct oil level indication in the device. Make sure that technical parameters given on the rating plate are in compliance with the parameters written in the purchase order. Any damage or other defects should be immediately notified to the manufacturer, and, if appropriate, the carrier. Photos will be helpful for any damage assessment.

3. Transport, unpacking, erection
Transformers may be transported in either vertical or horizontal position. In the case of horizontal transport, transformers should be laid on a special bed in accordance with transport manual No 2GKK614136. Before laying the transformer, restrain its compensation bellows by inserting a flexible disc made of, for example, polyurethane foam, under the bellows cover. During horizontal transportation, the compensation bellows cannot have any freedom of movement due to its flexibility and possibility of damage. This manual contains all the information regarding the unpacking and erecting the transformer after delivery.

The flexible disc locking the compensation bellows should be removed once the transformer has been erected and stands upright.
In vertical transportation, due to the high centre of gravity position, the transformer should be transported on feet or platforms that enlarge the base size. Those elements shall be removed before locating the transformer on its support structure at the site. Transformers should be lifted with a crane of min. 1,000 kg lifting capacity using four slings of equal length (min. 3 m), min. 200 kg lifting capacity each. Hooks should be inserted in the lifting eyes on the transformer head.

4. Storage
Transformers should be stored on a level and hardened surface, preferably in the original packaging. Before a long-term storage, corrosion protection for the contact surfaces is recommended. Under unfavourable weather, during storage in horizontal position, water can condense inside the terminal box and induce corrosion. In such a case, take appropriate countermeasures.

Transformers can be stored outdoor for up to two years. If this period is exceeded, it is recommended to put transformers in a well-ventilated room or under a roof, and to insert silica gel or another moisture absorbent into the terminal boxes.

5. Installation
The support structure should be flat and horizontal. The level correction can be carried out using shims between the transformer and the support structure. Item 3 should be followed while erecting/lifting the transformer. Use bolts of correct size for fastening the transformer to the support structure. The support structure and fastening elements are not included in the delivery. The transformer should be placed in the vertical position at least 24 h before energising.

5.1. Earthing terminals
Two earthing terminals are located diagonally in the bottom tank. The contact surface should be thoroughly cleaned from oxides, so it becomes uniform and smooth. Additionally, a thin layer of conducting grease can be applied in order to improve contact. The earthing should be connected using stainless bolts.
5.2. Primary terminals
Primary terminals of the transformer, marked P1 and P2/A, are placed on the opposite sides of the head. The transformer can be switched on the primary side as well as on the secondary side. **A metal jumper is used for current range switching on the primary side.** The P2 terminal of the current module corresponding to the highest current range is connected with the A terminal of the voltage module.
The primary winding should be switched to the required current range by locating a moving jumper in the respective position. Fasten the jumper with two M16 bolts.

![Note: Jumper tightening torque 90 Nm](image)
Current range jumper positions are shown on the rating plate.

![Fig. 1. Example: Rating plate with current range jumper positions shown.](image)

All contact surfaces of the primary terminals should be flat and cleaned from the oxide layer before connecting. In the case of copper terminals, using extraction naphtha is usually sufficient. Conducting grease can be applied in order to improve contact. Use M12 bolts (stainless steel is recommended) to connect wire lugs with the terminals. Incorrect joints in the primary connections could induce the transformer to overheat, which can cause failures. Primary connections should be made in such a way so as to minimise mechanical static loads of the transformer terminals. The maximum short-term (60 seconds) allowable static load for each transformer terminal is 3,600 N in any direction. Only one terminal may be loaded with such force at a time. In the standard operation mode, the sum of all loads on the primary terminals should not exceed 50% of that value.

5.3. Secondary terminals
Secondary windings are connected to terminal blocks in the terminal box on the bottom tank of the transformer. Standard solution: Phoenix Contact ST spring connectors with terminals for up to 10 mm² or up to 6 mm² wire size. Each terminal is described in compliance with the winding markings given on the rating and schematic diagram plates. Yellow-green terminals (with the earthing mark) are intended for earthing the secondary windings with the use of push-in crosswise bridges. The crosswise bridge can be removed with a screwdriver, by inserting it in the slit and levering. Optionally, the connectors to which metering windings are led, may be adapted for sealing with use of a transparent cover. The current coil screen is led out with a pin through the resin bushing (tg δ terminal).
The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal. The terminal box also includes: the voltage coil screen (E) terminal, the voltage coil primary winding (N) terminal.
5.3.1. Current module terminals

Connect the external circuits to the current module secondary terminals as shown on the schematic diagram plate and in the design documentation.

In the standard operation mode, the current coil screen terminal (tg δ) should be earthed with a jumper.

Terminals in the terminal box are arranged so that, when using crosswise bridges, earthing is possible for any secondary terminal of a given winding.

Transformer with taps on the secondary side:
In the case of a transformer with the secondary side switching option, the unused taps must remain unearthed. Only connect the earthing to one of the terminals, which are connected with the external circuit for the selected secondary winding. Unused windings:
The first and the last terminals (for the secondary side switching option: those terminals correspond to the highest transformer ratio) of the unused secondary winding should be connected with each other (minimum wire size: 6 mm²) and earthed with a crosswise bridge. Each unused winding should be earthed in one point only.

Note:
Opening the current module secondary circuit in the standard operation mode causes high voltage on terminals of this circuit. This is hazardous to the staff and may damage the transformer insulation.

5.3.2. Voltage module terminals

Connect the external circuits to the current module secondary terminals as shown on the schematic diagram plate and in the design documentation.

In the standard operation mode, the screen terminal (E) and the primary winding terminal (N) for the voltage coil should be earthed using crosswise bridges to the adjacent earthing terminal. Terminals in the terminal box are arranged so that, when using crosswise bridges, earthing is possible for any secondary terminal of a given winding. The unused winding of the voltage part shall remain open; its end marked “..n” should be earthed using a crosswise bridge.

All the voltage module secondary windings include narrow sections made of copper wire (Cu-ETP), 1.2 mm diameter and 50
mm length (Fig. 3). Those narrow sections are located outside of the resin bushing downstream of the terminal block located in the transformer box.

Fig. 3. Narrow section of the voltage module secondary winding

The narrow sections protect the transformer against damage in the case of secondary terminals short-circuit. This solution is sufficient as the transformer protection within the short distance to the nearest protection device. Additional fuses in the transformer terminal box are not necessary.

If a short-circuit occurred and this protection was blown, the copper wire must be replaced.

**Note:**
Secondary terminals of the voltage module must never be short-circuited.
The ‘da-dn’ residual voltage windings used to connect three transformers in the open delta configuration should be earthed in one point only (in one of the three transformers). Earthing of those “da-dn” windings connected in more than one point will cause short-circuit and may damage the transformer.

### 5.4. Ferroresonance

The PVA 123a / PVA 145a combined transformers are ferroresonance-proof in a wide range of earthing and control capacitor capacitances as used in circuit breakers. However, in the case of networks where ferroresonance occurred before, or for particularly sensitive network configurations (e.g. with long cable lines), it is recommended to use an additional damping resistor of 50–60 Ohm/200 W in the open delta circuit of three da-dn transformer windings (the values are valid for the resistor voltage drop not exceeding 100 V during the earthing short-circuit.)

### 6. Bolt tightening torques

<table>
<thead>
<tr>
<th>Bolt Type</th>
<th>Torque (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M16 bolts for current jumper</td>
<td>90</td>
</tr>
<tr>
<td>M112 bolts for primary terminals</td>
<td>60</td>
</tr>
<tr>
<td>Bolts fastening the transformer to the support structure</td>
<td>280</td>
</tr>
</tbody>
</table>

### 7. Operation and maintenance

**Note:**
Combined transformers are HV devices, hence appropriate safety precautions shall be observed during their operation.
The transformer measurement range is only guaranteed within the operating range determined based on the ratings in compliance with the respective standards. The standard number is shown on the transformer rating plate. The measurement range of the transformer is also shown in the product test protocol as delivered with the transformer. The measurement parameters are not guaranteed off that range.
7.1. Maintenance

The combined transformers do not require any special maintenance procedures. Visual inspection is usually sufficient. The check-list is included at the end of this manual.

Visual inspection

The visual inspection should include the checking of:
- position of the oil level indicator,
- transformer tightness,
- absence of mechanical damage,
- insulator and binder condition at the insulator/flange joints. From time to time, the primary terminals torque should be checked.

The transformer tightness is of a particular importance as moisture could penetrate the device in the case of oil leaks.

Oil level indicator:

Changes of the oil level indicator position depend on oil temperature in the transformer. The indicator should remain within the green field range. Indication of the upper or bottom red field means an incorrect transformer operation. In such a case, the transformer should be put out of service, and the manufacturer should be contacted.

An expansion bellows (1) (stainless steel) is mounted on the head lid. The bellows compensates for the oil thermal expansion inside the transformer. The oil level indicator (2) is placed on the upper surface of the bellows. The bellows is seated in a metal housing (3) equipped with a window (4). The cover removal does not result in unsealing of the transformer. The entire compensation system is shown in Fig. 5.

Note:

Oil level indication for all three transformers installed on adjacent phases should be almost equal.

Measurement of the dielectric loss factor $\tan \delta$:

It is recommended to perform such measurement separately for each module: voltage module, and current module. In each of these modules, respective terminals are marked with the symbols $\tan \delta$ and $E$. Those terminals are used for connecting the measuring bridge only. Remember to earth them after the measurement. Typically, the test voltage should be 10 kV RMS and should be applied across the primary terminals and earth.

Oil sampling:

Due to the fact that transformers are tight, they do not require oil level inspection on regular basis. Oil used in the transformer meets PN-EN 60296 requirements (IEC 60296).

Oil check is recommended after 15–20 years of operation or after a fault if any suspicion as to the transformer efficiency exists. Contact the manufacturer in order to obtain necessary instructions for the oil sampling procedure. Oil sampling without the manufacturer’s permission during the guarantee period is the reason for guarantee cancellation.

7.2. Corrosion protection

External components of the transformer casing are made of corrosion-proof cast aluminium alloy. Casts can be unpainted or painted. Standard colours for the paint coat: light-grey (RAL 7035), grey-green (RAL 7033). The remaining metal parts, e.g. bolts, are made of stainless steel.

Fig. 5. Compensation system.
8. Transformer design
The PVA 123a / PVA 145a combined instrument transformer consists of: current module, and voltage module located in a common air-tight housing filled with transformer oil.

O-ring seals are made of NBR oil-resistant rubber. Calibration results and markings (if any) for the measuring windings are shown on the transformer body and on the rating plate (if required).

Fig. 6. PVA 123a and PVA 145a combined instrument transformer

1. bottom tank
2. hollow insulator
3. head
4. expansion bellows in housing
5. current module
6. voltage module
7. terminal box for secondary circuits
8. P2/A primary terminal
9. P1 primary terminal
10. fastening holes
11. transport and erection eyes
12. oil level indicator
13. earthing terminal
9. Disposal
In the case of correct operation and no mechanical damage, the transformer should operate for more than 30 years. Once this period has expired or if operation is no longer required, it is recommended to dispose of the transformer.

Basic materials:

<table>
<thead>
<tr>
<th>Item</th>
<th>Material</th>
<th>Quantity [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Copper (Cu – ETP)</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Aluminium alloy AC-Al Si10Mg (Cu)</td>
<td>130</td>
</tr>
<tr>
<td>3</td>
<td>Steel</td>
<td>55</td>
</tr>
<tr>
<td>4</td>
<td>Transformer sheet steel</td>
<td>50 – 150</td>
</tr>
<tr>
<td>5</td>
<td>Permalloy (iron-nickel alloy)</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>Mineral transformer oil</td>
<td>150</td>
</tr>
<tr>
<td>7</td>
<td>Electrical grade paper</td>
<td>45</td>
</tr>
<tr>
<td>8</td>
<td>Solid insulation materials (epoxy resin, bakelite paper)</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>Porcelain</td>
<td>110</td>
</tr>
<tr>
<td>10</td>
<td>Composite insulator</td>
<td>40</td>
</tr>
</tbody>
</table>

Item 9 and 10 are alternatives.

Above values are approximate.

9.1. Recycling and disposal proceedings
Recycling and disposal should meet national (or local) regulations. On the territory of the Republic of Poland, the transformer disposal procedure is defined in the ‘Ustawa o odpadach’ (‘The Waste Act’) dated the 14th of December 2012 as published in Dziennik Ustaw (official gazette) issue 21/2013, as amended.
10. Check list

10.1. Before the first energising

<table>
<thead>
<tr>
<th>What to check:</th>
<th>When</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. External packing appearance</td>
<td>A</td>
<td>No signs of careless handling</td>
</tr>
<tr>
<td>2. Transformer tightness</td>
<td>A, B, C</td>
<td>No visible oil leaks or greasy stains (even if the packaging is intact)</td>
</tr>
<tr>
<td>3. Transformer housing</td>
<td>B, C</td>
<td>Insulator, terminals and housing of the transformer show no signs of mechanical damage.</td>
</tr>
<tr>
<td>4. Oil level</td>
<td>B, C</td>
<td>Oil level indicator is in the proper position</td>
</tr>
<tr>
<td>5. Quality and correctness of connections</td>
<td>C</td>
<td>The connections are reliable and in accordance with the design</td>
</tr>
</tbody>
</table>

10.2. After the first energising

<table>
<thead>
<tr>
<th>What to check:</th>
<th>When</th>
<th>Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Transformer tightness</td>
<td>D, E</td>
<td>No visible oil leaks or greasy stains</td>
</tr>
<tr>
<td>7. Transformer housing</td>
<td>D, E</td>
<td>Insulator, terminals and housing of the transformer show no signs of mechanical damage.</td>
</tr>
<tr>
<td>8. Oil level</td>
<td>D, E</td>
<td>Oil level indicator is in the proper position</td>
</tr>
<tr>
<td>9. Secondary winding insulation test (measurement method)</td>
<td>E</td>
<td>Values dependent on age, voltage level, measurement method and temperature</td>
</tr>
<tr>
<td>10. Dielectric loss factor $\tan \delta$ (measurement method depends on local practices)</td>
<td>E</td>
<td>Values dependent on age, voltage level, measurement method and temperature. It is recommended to measure the current module and voltage module separately. Respective terminals are marked: $\tan \delta$ and ‘E’.</td>
</tr>
<tr>
<td>11. Oil sampling: gas analysis (DGA), $\tan \delta$, water content</td>
<td>E</td>
<td>Measurements did not indicate exceeding of permissible limits</td>
</tr>
</tbody>
</table>

When

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>After arrival of the transformer to the site</td>
</tr>
<tr>
<td>B</td>
<td>After unpacking</td>
</tr>
<tr>
<td>C</td>
<td>Directly before applying voltage</td>
</tr>
<tr>
<td>D</td>
<td>During routine inspections in accordance with the schedule determined for the station</td>
</tr>
<tr>
<td>E</td>
<td>After 15–20 operation years, or an inspection of efficiency after a fault if any suspicion as to the transformer efficiency</td>
</tr>
</tbody>
</table>

11. End

For additional information concerning the operation and maintenance of PVA 123a / PVA 145a transformers, please contact the transformer manufacturer.
For more information, please contact:

**ABB Contact Center**  
tel.: +48 22 22 37 777  
e-mail: kontakt@pl.abb.com

**ABB Sp. z o.o.**  
Branch Office in Przasnysz  
ul. Leszno 59  
06-300 Przasnysz  
Tel.: +48 22 22 38 931, +48 22 22 39 255  
Fax: +48 22 223 89 58

[www.abb.pl](http://www.abb.pl)

We reserve the right to make technical changes or modify the contents of this document without prior notice. Purchase orders will include terms and conditions to be agreed. ABB AG does not accept any responsibility whatsoever for potential errors or possible lack of information in this document.

We reserve all rights to this document and to the subject matter and illustrations contained herein. Any reproduction, disclosure to third parties or utilisation of its contents – in whole or in parts – is forbidden without prior written consent of ABB AG.

© Copyright 2014 ABB  
All rights reserved